A Rare Case of Spinal Endometriosis

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Purpose
To illustrate a rare case of spinal endometriosis seen on lumbar magnetic resonance imaging (MRI).

Materials and Methods
A 31-year-old female with a significant history of endometriosis status post total abdominal hysterectomy, salpingoophrectomy with multiple other subsequent surgeries including left nephrouretectomy, ileal cystectomy, ileostomy (also as sequelae from endometriosis) who had back pain and leg weakness. Pelvic MRI revealed a large multilobulated mass within the pelvis with encasement of sacral nerve roots. Lumbar MRI confirmed these findings as well as an intradural intramedullary endometriosis extending from L5 to S4.

Results
Sagittal proton density fat saturated image of the pelvis shows a large multilobulated mass with extension into the spinal canal and into the patient's ileal conduit. Axial post-contrast T1-weighted lumbar MRI is remarkable for multiple extradural and intradural masses with patchy leptomeningeal enhancement. A second axial postcontrast T1-weighted image shows perineural enhancement of the sacral nerve roots, which correspond clinically to the patient's symptoms of sciatica. Thoracic postcontrast-enhanced T1-weighted image shows mild enhancement of the dorsal cord at T12.

Conclusions
Spinal endometriosis is a rare cause of sciatica. Usually, patients will have leg pain in tandem with their menstrual cycle, termed catamenial sciatica. There are many different theories for intramedullary extension of endometrial tissue, including perineural spread, venous spread through Batson's veins, and the ectopic expression of Wnt-7a signaling. On MRI, endometriosis appears as heterogeneous on T1-weighted sequences, with areas of low signal due to hemosiderin deposition and areas of high signal due to hemorrhage. With contrast, there is enhancement. Some have proposed that increased signal on T2-weighted images within the sacral nerve roots and cord is
suggestive of perineural spread. Diffusion tensor imaging with tractography has been reported to be beneficial with endometriosis, with patients with endometriosis showing lower fractional anisotropy values and a disorganized appearance of the sacral nerve roots.
Arterial Spin Labeling MRI Perfusion Acetazolamide Challenge for Assessing Cerebrovascular Reserve in Moya-Moya

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Purpose
To demonstrate cerebrovascular reserve evaluation using arterial spin labeling (ASL) perfusion in moyamoya and to review the advantages and disadvantages of ASL.

Materials and Methods
A 29-year-old female with a history of moyamoya presents with migraines, right-sided hemiparesis, and gait instability and previous left encephaloduroarteriosynangiosis (EDAS). Evaluation of cerebrovascular reserve was requested.

Results
Arterial spin labeling maps show appropriate response to acetazolamide administration with globally increased cerebral blood flow (CBF). Subtraction images better demonstrate the relative difference in increased CBF following administration of acetazolamide. Although there was relatively less increase in CBF in the EDAS territory, no steal phenomenon was demonstrated.

Conclusions
Moyamoya patients, for whom serial surveillance scans are needed, arterial spin labeling (ASL) perfusion acetazolamide challenge can assess whole-brain cerebrovascular reserve (CVR) without radiation or intravenous contrast, and even grade collateral flow. Pre and postacetazolamide scans are performed in one scan session, allowing easy subtraction and interpretation. This is in contrast to the labor intensive process of manual regions of interest (ROIs) placement. Longer arterial transit times are a potential pitfall of calculated CBF. Arterial spin labeling works on the assumption that the postlabeling delay set as an acquisition parameter is longer than the longest physiologic transit time. Long transit delays, as seen in collateral flow states, may underestimate ASL estimated CBF if the postlabeling delay is not adequate. With acetazolamide administration, there is global increase in blood flow with concomitant decreased transit delays. This bias may artifactually increase the magnitude of delta-CBF, though the direction of delta-CBF will be correct.
Atypical Teratoid Rhabdoid Tumor of the Third Cranial Nerve (AT/RT)

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Purpose
Atypical tumor/rhabdoid tumor (AT/RT) is a rare, aggressive tumor of the central nervous system (CNS), more commonly seen in the pediatric age group, typically before the age of 3 years. Once thought to represent a more aggressive type of primitive neuroectodermal tumor (PNET), AT/RT first was recognized as a completely separate entity by the World Health Organization in 2000. Characteristic imaging features of AT/RT are well described; however, when found in uncommon locations these tumors can present difficulty in pre-operative diagnosis. We present this case to highlight that the differential diagnosis of an AT/RT involving the third cranial nerve is rather limited when its location, characteristic imaging features and patient's age are taken into consideration.

Materials and Methods
A previously healthy 13-month-old girl was seen by an ophthalmologist for 2 months of outward deviation of the left eye and drooping eyelid. On exam she was found to have a left third cranial nerve palsy. Magnetic resonance imaging (MRI) showed an enhancing mass in the interpeduncular fossa, related to the midbrain and hypothalamus. The cisternal segment of the left third cranial nerve could not be identified as a separate structure, unlike the normal right third cranial nerve. The patient underwent stereotactic biopsy of the lesion, which was found to be an AT/RT. The patient currently is undergoing aggressive chemotherapy and conformal radiation therapy. Follow-up imaging at 7 months following initial diagnosis has demonstrated stability of the tumor.

Results
A, B: Axial T2 (A) and postcontrast sagittal T1 (B) images show a homogeneously enhancing, relatively T2 hypointense lesion centered in the interpeduncular fossa, inseparable from the left cerebral peduncle. C: Coronal reformatted balanced FFE image shows a normal right third cranial nerve (black arrow) and the relatively T2 hypointense mass (white arrows) in the expected location of the left third cranial nerve. D: Axial diffusion-weighted image demonstrates peripheral regions of restricted diffusion (white arrows) within the tumor.

Conclusions
We report a case of an AT/RT of the third cranial nerve. Although rarely reported
previously, when imaging characteristics and patient age are taken into consideration AT/RT is the leading diagnostic consideration of a tumor arising from a cranial nerve.

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EE-50 6:00AM - 2:45PM

Balloon-Assisted Glue Embolization: An Adjunct Technique for Management of Intraprocedural Aneurysm Rupture

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Purpose
Balloon-assisted coil embolization is a standard procedure performed for the treatment of ruptured cerebral aneurysms. Intraprocedural re-rupture is a potentially lethal complication during coil embolization of ruptured cerebral aneurysms. In such cases, rapid management is necessary to avoid catastrophic outcomes. n-Butyl cyanoacrylate (nBCA) glue is used widely in neurointerventions for several intracranial vascular embolization types. The authors present two cases of a novel implementation of nBCA for intraprocedural re-rupture during balloon-assisted coil embolization.

Materials and Methods
Patient 1 is a 60-year-old female who presented with Hunt-Hess 5, Fisher 4 SAH. Computed tomography (CT) demonstrated bilateral 1 cm carotid T aneurysms, site of rupture unclear (Fig. A). Balloon-assisted coil embolization of the right was first performed. After the 4th coil was properly placed, intraprocedural re-rupture occurred and persisted despite complete 5th coil placement. Following balloon inflation, it was decided to prepare 50% n-BCA glue to prevent further blood loss. 0.2 mL nBCA was injected into the aneurysm through the microcatheter in place from endovascular coiling. Balloon-assisted coil embolization of the left aneurysm then was performed. During 1st coil placement, intraprocedural re-rupture occurred and persisted despite complete deployment. Following balloon-inflation, 0.2 mL nBCA was injected through the existing microcatheter. Maneuvers resulted in successful hemostasis (Fig. B).

Patient 2 is a 65-year-old female who presented with Hunt-Hess 1, Fisher 3 SAH. Angiography confirmed an 8 mm left callosomarginal aneurysm (Fig. C). Balloon-assisted coil embolization was initiated. Intraprocedural re-rupture at the aneurysm occurred and persisted despite deployment of the 2nd coil. 0.1 mL nBCA injection failed to stop bleeding. The entire left A2-A3 then was glue-occluded to achieve successful hemostasis. No infarction occurred, as 4-day follow-up angiography confirmed excellent collateral flow from the splenial artery. Decompressive hemicraniectomy was performed to evacuate residual hematoma (Fig. D). Fifty percent nBCA concentration was selected to prevent distal glue migration. Balloon and microcatheter systems in both cases were intact postprocedure. One-month follow up for both patients confirmed no glue emboli or other postprocedural complications.

Results
Figure A: 1 cm carotid T aneurysms. Figure B: Post coiling plus gluing of carotid T aneurysms, no extravasation. Figure C: 8 x 6 mm left callosomarginal aneurysm. Figure D: Post CT shows contained hemorrhage, contrast, and glue casts.

Conclusions
Intraprocedural rupture during aneurysm treatment typically is managed by deploying coils to seal the re-rupture site. In cases like above, further coil deployment could not prevent further SAH extravasation. By taking advantage of an existing inflated balloon and well positioned microcatheter, nBCA glue administration for re-rupture closure can be considered when hemostasis is not achieved easily. Retrospective
analysis of a larger patient cohort managed with this technique is ultimately necessary to validate this conclusion.
Big Masses- One or Two

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Purpose
Radiologists often encounter more than one mass in a similar region on imaging. This case evokes the idea of probability and the usage of imaging knowledge to narrow down the differentials. Is it two masses or one big mass?

Materials and Methods
A 56-year-old male presents with headaches and worsening gait abnormality. He is seen in the emergency department (ED) and receives a head magnetic resonance imaging (MRI) that shows two large masses in close proximity without definite connection to each other. One mass is located intra-axial in the left temporal lobe and the other mass is located in the left foramen ovale with extra-axial extension to the left middle cranial fossa. During surgery, the two masses were both resected. Pathology revealed both masses to be glioblastoma.

Results
The 3 cm left temporal lobe intra-axial mass contains isointense T1 signal, heterogeneous T2 signal, thick, irregular peripheral contrast enhancement with central nonenhancement suggesting necrosis. No restricted diffusion was seen within the left temporal lobe mass. Surrounding the mass is abnormal hyperintense T2 Flair signal within the white matter, suggesting vasogenic edema. A separate well circumscribed, extra-axial, iso to hyperintense T2, smooth contrast-enhancing lesion in the left foramen ovale extends into the left middle cranial fossa. The foramen ovale is expanded. The two tumors were in proximity to each other without a clear connection.

Conclusions
This is a unique case report showing extra-axial extension of an intracranial glioblastoma and how imaging can be misleading. The constellation of intra-axial MRI findings including central necrosis, thick, irregular peripheral contrast enhancement, and surrounding vasogenic edema suggests a high grade glioma. On the opposite end of the spectrum, the extra-axial lesion contains homogeneous enhancement and foramen ovale widening without osseous destruction that is most consistent with a benign lesion such as a menigioma or schwannoma.
Cerebral Amyloid Angiopathy-Related Inflammation (CAA-RI); Characteristic Presentation and Imaging Findings.

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Purpose
Cerebral amyloid angiopathy-related inflammation (CAA-RI) is a relatively newly recognized uncommon diagnosis. It is a subtype of CAA presenting with acute/subacute cognitive decline and is reversible with medical treatment. Correct identification of CAA-RI and differentiation from other pathologies allow timely institution of treatment and avoid unnecessary brain surgery. We describe the distinctive imaging pattern of CAA-RI on computed tomography (CT) and magnetic resonance imaging (MRI).

Materials and Methods
A 66-year-old active man presented with gradually progressive confusion, forgetfulness and headaches over 1 month. Neurological exam showed language deficits. Given abnormalities seen on CT scan of the head at presentation, the patient was admitted to neurosurgery. However, after further investigation with MRI, the patient was managed medically with corticosteroids (Prednisone 60 mg/day). Improvement was noted on neurological examination during his hospital stay and the patient was discharged home with plan for gradual steroid tapering.

Results
At presentation, noncontrast CT of the head revealed multifocal areas of vasogenic edema in the left parietal lobe (Fig. A) and to a lesser extent the left frontal lobe raising concern for metastatic disease. Magnetic resonance imaging revealed multifocal confluent T2/FLAIR hyperintensities predominantly subcortical, asymmetrically involving both cerebral hemispheres and most prominent in the left parietal lobe (Fig. B). Mild associated mass effect was noted. No diffusion restriction or enhancement. echoplanar gradient T2* imaging revealed characteristic multifocal cortical and subcortical blooming foci of microhemorrhages sparing the central gray matter nuclei, and posterior fossa (Figs. C and D).

Conclusions
Cerebral amyloid angiopathy-related inflammation is an uncommon newly recognized cause of acute/subacute cognitive decline reversible with medical treatment. It has a characteristic MRI appearance with confluent white matter abnormalities and associated cortical/subcortical microhemorrhages. Awareness of the typical imaging
findings is crucial to avoid misinterpretation as neoplastic infiltration or infectious pathology. Correct identification of CAA-RI allows timely institution of treatment and avoids unnecessary brain surgery or biopsy.
Cerebral Lipiodol Embolism following Lymphatic Embolization for Plastic Bronchitis due to Anomalous Lymphovenous Connections: Utility of Dual Energy CT

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Purpose
To demonstrate the imaging of cerebral Lipiodol embolism following lymphatic embolization due to anomalous drainage of a lymphatic duct into the venous system. The utility of dual energy computed tomography (CT) spectral separation in establishing the diagnosis also will be illustrated.

Materials and Methods
Plastic bronchitis (PB) is a lymphatic flow disorder that causes formation of casts in the airways causing obstruction and respiratory compromise. Injury to the thoracic duct, congenital abnormalities, or high venous pressures can result in lymphatic flow issues and leakage into the airways. This is seen most commonly after surgery for complex congenital heart disease. Diagnosis and treatment at our institution is by dynamic contrast magnetic resonance (MR) lymphangiography to provide a roadmap for selective lymphatic duct embolization using Lipiodol, coils, and/or glue. Lipiodol (Ethiodol) is an ethiodized poppyseed oil contrast agent that can be used as a chemoembolization agent, particularly in the liver. This agent can result in neurological complications due to embolism via the hepatic veins. A 15-year-old boy with pulmonary atresia and PB received underwent lymphatic embolization with Lipiodol, n-Butyl cyanoacrylate glue, and coils. There were no intraprocedural complications. A few hours after the procedure, he became acutely unresponsive and had a seizure.

Results
A CT scan done after sudden neurologic deterioration showed innumerable scattered unusual hyperdensities bilaterally throughout the supra- and infra-tentorial brain. Dual energy CT postprocessing revealed that the hyperdensities demonstrated spectral characteristics consistent with iodine which almost disappeared on virtual noncontrast CT. This indicated that the hyperdensities were indeed iodine containing material (Lipiodol) rather than multifocal hemorrhage or glue. Review of the imaging showed a very subtle anomalous connection between a lymphatic duct and the pulmonary vein. A follow-up brain MRI a few days later showed multiple areas of T2/FLAIR
hyperintense signal abnormality in these areas. There were punctate foci of susceptibility and a few small foci of mild restricted diffusion in these areas suggestive of embolism. The cerebral hyperdensities gradually decreased over the course of hospitalization. His neurological deficits gradually improved over the next weeks with rehabilitation therapies, and had completely resolved by hospital discharge.

Conclusions
Treatment of plastic bronchitis by lymphatic embolization generally is a safe procedure. Anomalous lymphovenous connections may contribute to the development of neurologic complications. Cerebral Lipiodol embolism (CLE) should be considered in the differential diagnosis for patients who develop new neurological symptoms with this unique neuroimaging pattern after undergoing an interventional lymphatic procedure. The mechanism of Lipiodol's neurotoxicity is unknown, and could be related to its vaso-occlusive, osmolar, or other chemical or physical properties. Dual energy CT is very helpful in confirming the diagnosis by demonstrating the spectral nature of the cerebral abnormalities.
**Cerebrotendinous Xanthomatosis**

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**Purpose**

The purpose is to show the classic imaging features of cerebrotendinous xanthomatosis, a rare treatable neurodegenerative disease.

**Materials and Methods**

This 40-year-old male presents with decades of slowly progressive gait instability and leg weakness which have become much more severe in the last 10 years; he now requires the use of a walker for ambulation. His history also is significant for medically controlled epilepsy and intellectual disability. Family history is significant for similar reported "shakiness" in his brother and sister, without associated work up or diagnosis. His physical examination is significant for lower limb spasticity, mild distal lower limb weakness, pes cavus, hyperreflexic deep tendon reflexes, marked ataxia in all extremities, and spastic gait. EMG/NCS showed mild, nonuniform motor nerve conduction slowing that was nonspecific and not consistent with hereditary polyneuropathy.

**Results**

Magnetic resonance imaging (MRI) of the brain shows marked cerebellar atrophy. There is prominent mineralization of the dentate nuclei with surrounding gliosis, The dentate nuclei are hyperintense on T1-weighted images with T2/susceptibility hypointensity. Axial susceptibility-weighted imaging (SWI): This image demonstrates susceptibility hypointensity related to the dentate nuclei. Anteriorly, the mineralization is curvilinear while posteriorly it is more globular.

**Conclusions**

A case of cerebrotendinous xanthomatosis is presented, demonstrating classic imaging features including prominent mineralization of the dentate nuclei. This rare lipid-storage disease is characterized by lesions in the dentate nuclei, with foci of deposition also found to involve the temporal lobes and deep gray nuclei. Pyramidal and cerebellar signs commonly are found in patients, as well as signs of early aging including early cataract formation, atherosclerosis, and osteoporosis. Achilles tendon xanthoma formation also is classically seen. Early diagnosis is crucial as early treatment with chenodeoxycholic acid is the most effective intervention preventing further neurological damage and deterioration. Because of this, recognition of early imaging signs is imperative.
Chronic Inflammatory Demyelinating Polyradiculoneuropathy: Clinical, Pathologic, and Radiologic Correlation of an Interesting Disease Process.

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Purpose
To demonstrate, in a pictorial review, the salient diagnostic, radiologic, clinical and associated pathology/pathophysiology of chronic inflammatory demyelinating polyneuropathy. Electrodiagnosis with electromyography also is discussed.

Materials and Methods
A 57-year-old male presented with unilateral upper and lower extremity numbness, decreased dexterity, and balance and gait symptoms. Magnetic resonance imaging (MRI) brachial plexus and electrodiagnostic evaluation was performed. The patient subsequently was treated with corticosteroids, with some resolution of symptoms, but developed adverse effects, including weight gain and Cushingoid features. Intravenous immunoglobulin therapy was initiated with a modest improvement in symptoms.

Results
Diffuse enlargement with associated T2/STIR hyperintense signal, involving all visualized cervical spinal nerves including the entirety of the bilateral brachial plexus nerve roots through the branches.

Conclusions
Our case demonstrated enlargement with associated T2/STIR hyperintense signal,
involving all visualized cervical spinal nerves including the entirety of the bilateral brachial plexus nerve roots through the branches. We will discuss the clinical course of patients, including treatment options. Additionally a discussion of pathology of this disease process will be performed. Classic findings in CIDP include: -Enlargement and T2/STIR hyperintense nerve roots/plexi/peripheral nerves. -Most commonly involves lumbar nerves but also cervical/brachial plexus/intercostal nerves. -Cranial nerves also may be involved. -T2 hyperintense lesions in the periventricular white matter (similar appearance to MS) can be seen as well. -Mild to moderate enhancement of the involved nerves. Differential diagnostic considerations include: -Acute inflammatory demyelinating polyneuropathy. -Inherited demyelinating neuropathies (Charcot Marie Tooth, Dejerine Sottas), -Neurofibromatosis type I.
Concurrent Thromboangiitis Obliterans and Moyamoya disease: A Rare Presentation with Potential Pathophysiological Implications

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Purpose
Thromboangiitis obliterans (Buerger's disease) is a progressive vasculopathy of the distal extremities associated with tobacco use and thought to be immune mediated. Cerebral involvement in systemic disease is extremely rare and isolated cerebral disease (Spatz-Lindenberg disease) is an uncommon cause of vascular dementia. Currently, there is only one published report of moyamoya disease associated with thromboangiitis obliterans. Thromboangiitis obliterans (Buerger's disease) is an inflammatory disorder which affects the small and medium-sized vasculature in predominantly young, male smokers. The vessels most often affected are those in the extremities and give the appearance of a "corkscrew" or "tree roots" on angiogram. Smoking appears to be the most contributing risk factor with a synergistic effect with other factors that cause vessel inflammation. The diagnosis is made clinically since there are no serologic markers to screen for. No treatment other than smoking cessation has been found to stop disease progression. In severe cases, bypass grafts have been performed to salvage limbs (1). Moyamoya disease, also known as spontaneous occlusion of the circle of Willis, is a cerebrovascular disease which causes progressive stenosis or occlusion of the terminal internal carotid arteries. Due to the stenoses/blockages, collateral circulation forms which resemble a "puff of smoke," moyamoya in Japanese, during angiography. Patients with moyamoya tend to demonstrate cerebral ischemia, intracranial hemorrhage, or no symptoms at all. The pathogenesis of the disease is still uncertain (2). Treatment for moyamoya includes the EDAS (encephaloduroarteriosynangiosis) procedure in which a scalp artery is dissected and a small opening is made in the skull beneath the artery so that it can be sutured to a branch of the middle cerebral artery to improve perfusion. The following case report demonstrates a rare occurrence of a patient with both Buerger's disease and moyamoya.

Materials and Methods
A 54-year-old white male with a known history of Buerger's disease presented with several days of headaches and dizziness and was found to have a subacute left PICA infarct. Work up demonstrated a distal PICA occlusion thought to be embolic from a left subclavian atheroma proximal to the vertebral artery origin. Angiography revealed occlusion of the right ICA terminus with moyamoya pattern. Cerebral SPECT perfusion study revealed relative hypoperfusion of the right hemisphere that was more marked after administration of acetazolamide and the patient underwent an encephaloduroarteriosynangiosis. To prevent ischemia and/or intracranial
hemorrhage, varying surgical procedures can be performed for direct and indirect
revascularization. The direct revascularization technique involves using a branch of
the superficial temporal artery (STA) for a direct anastomosis to a branch of the
ipsilateral middle cerebral artery (MCA) on the superficial surface of the brain. This
procedure is known as the STA-MCA bypass and results in over 95% graft patency
with "excellent long term outcomes" and is the first line recommendation. The
indirect revascularization procedures include EDAS and EMS (encephalo-myo-
synangiosis). With EDAS, a branch of the superficial temporal artery is laid onto the
surface of the brain without a direct connection to another vessel. An EMS is another
indirect bypass procedure where the temporalis muscle is dissected and placed on the
surface of the brain through an opening made on the surface of the skull. The two
indirect revascularization procedures take approximately 6-8 weeks for
neovascularization to occur (6).

Results
Pandey and Steinberg have found that the surgical morbidity and mortality of STA-
MCA revascularization was 3.5% and 0.7% respectively per treated hemisphere. The
cumulative 5-year risk of peri-operative or subsequent stroke or death was 5.5% and
98.1% of patients originally presenting with a TIA were without a recurrent TIA.
They also found that morbidity and mortality of the indirect revascularization
techniques were 0% and 5.7% respectively. The annual risk of cerebrovascular events
was 0% in pediatric patients and 0.4% in adults in these patients. Angiography and
stenting also have been proposed as treatment options for moyamoya however
revascularization remains the preferred treatment due to reported failures (7). There
has been only one published report of thromboangiitis obliterans with an associated
moyamoya disease. Neurologic signs are very rare with thromboangiitis obliterans
and occur in fewer than 2% of cases with the cortical surface and nearby territories are
most often affected (3). Moyamoya is thought to be hereditary and afflicted
individuals also have been found to have increased levels of thyroid antibodies (4, 5).
This uncommon presentation may have deeper pathophysiological meaning as
possibly one autoimmune-mediated disease may increase the likelihood of the other.
Other possibilities include moyamoya disease being a sequela of long standing
thromboangiitis obliterans.

Conclusions
It is believed that surgical revascularization is the preferred treatment for moyamoya
to prevent further cerebrovascular events. Moyamoya associated with Buerger's
disease is a rare occurrence but treatment should be unchanged with STA-MCA
revascularization as the first line recommendation.

EE-36

6:00AM - 2:45PM

Cryptococcosis gatti meningitis in an immunocompetent patient
Purpose
To present intracranial imaging finding in a rare case of Cryptococcus gattii in an immunocompetent individual and briefly review relevant literature on this emerging condition.
Materials and Methods
A 49-year-old female presented with severe headache over a week. Her other significant history include cough and fever during her recent overseas vacation. She was evaluated with computed tomography (CT) and magnetic resonance imaging (MRI) brain followed by cerebrospinal fluid (CSF) analysis which lead to the diagnosis of intracranial cryptococcosis from Cryptococcal gatti. Cryptococcus gattii is primarily found in tropical and subtropical regions of the world unlike the more ubiquitous Cryptococcus neoformans. Cryptococcus gattii has been recognized as causing infections in humans and animals on Vancouver Island, British Columbia, and Cryptococcus gatti infections were first recognized in the United States Pacific Northwest (Oregon and Washington) in 2004 (1). To our knowledge, intracranial cryptococcosis due to Cryptococcus gattii is rare and Cryptococcus gattii is now considered as an emerging disease (2).
Results
Initial CT demonstrated left frontal subcortical edema which was felt suspicious for an underlying mass. However further evaluation with MRI showed multifocal subcortical edema, edema in the corpus callosum, with leptomeningeal and perivascular enhancement.
Conclusions
Cryptococcosis is typically seen in immunocomprised individuals but with emerging Cryptococcus gattii, cryptococcosis can be seen in immunocompetent patients particular with history of travel.

EE-51

Delayed Coil Migration within the Sinonasal Cavity after Endovascular Occlusion of Internal Carotid Artery Pseudoaneurysm

Prola, J.
OHSU
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Diagnosis and management of a rare sphenoid wing mass with clinical findings mimicking a carotid cavernous sinus fistula

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Purpose
The purpose is to describe an unusual presentation of vision loss from a rare sphenoid wing hemangioendothelioma and present imaging findings that would be crucial for neurosurgical planning.

Materials and Methods
A 37-year-old female presented with blurred vision for 1 week, tinnitus, chemosis and proptosis. Initial clinical diagnosis was conjunctivitis. Initial imaging diagnosis was lymphoma or meningioma with compression of the optic nerve. Severe blood loss resulted in aborted surgery and cerebral angiogram. Tumor embolization resulted in complete resolution of proptosis and vision loss. Tumor then was biopsied but not resected.

Results
Axial CT image shows arterial enhancing aggressive left sphenoid wing mass, early opacification and enlargement of the left ophthalmic vein and facial vein. Magnetic resonance imaging (MRI) image show flow voids in the left sphenoid wing mass and early venous enhancement in the left orbit. Left external carotid angiogram shows profound enlargement of left middle meningeal artery and deep temporal artery filling tumor blush and venous shunting of blood flow to the superior ophthalmic vein. Postembolization lateral image shows tantalum opacified cast of Onyx liquid embolic within the tumor.

Conclusions
Imaging plays a critical role in patient management of tumor resection. Findings such as vascular shunting from a tumor can alert the surgeon to high risk of bleeding during resection. By recognizing these potential complications, neuroradiology can offer a more complete patient care pathway encompassing both diagnosis and therapy.
EE-20

Diagnostic Challenge in a Case of Bing Neel Syndrome with Orbital Involvement, Imaging Findings Before and After Treatment
Purpose
To highlight the diagnostic challenge of Bing-Neel syndrome (BNS), a rare complication of Waldenström Macroglobulinemia, which can present with stroke-like symptoms (1), as in our case. We review computed tomography (CT) and magnetic resonance imaging (MRI) findings in BNS and discuss imaging techniques being used to narrow the differential diagnosis.

Materials and Methods
A 65-year-old Caucasian female with a past medical history of treated Non Hodgkins lymphoma and Waldenström Macroglobulinemia presented with sudden onset expressive aphasia. In the weeks prior to presentation she had increased lethargy, malaise and worsening exercise tolerance. Work up included a lumbar puncture and cerebrospinal fluid (CSF) analysis which illustrated an elevated IgM level. Cytology and flow cytometry showed an IgM kappa-type monoclonal gammopathy. The patient was started on systemic chemotherapy with rituximab and bendamustine as well as intrathecal methotrexate. After treatment, the monoclonal gammopathy resolved and CSF IgM levels decreased. Clinically, the expressive aphasia and focal neurological deficits had resolved.

Results
On presentation, noncontrast head CT demonstrated no acute abnormalities. Contrast-enhanced MRI demonstrated scattered punctate foci of hyperintensity on T2-WI in the periventricular and subcortical white matter. Diffusion-weighted imaging (DWI) was negative for acute ischemia. Abnormal enhancement was present within both internal auditory canals (IACs). An MRI performed approximately 7 weeks later (before treatment) demonstrated foci of signal abnormalities on T2-WI in the periventricular and subcortical white matter with more extensive and confluent involvement. Additional intracranial structures were involved including the optic chiasm, optic tracts, and brainstem. Postcontrast images demonstrated more extensive enhancement, most prevalent in the brain and brainstem. Again, no acute ischemia was demonstrated on DWI. Evaluation of the orbits demonstrated bilateral proptosis, scleral thickening and enhancement, and T2 hyperintensity in the retrobulbar fat. There also was abnormal enhancement of the optic nerves. After receiving both systemic and intrathecal chemotherapy, MRIs of the brain and the orbits demonstrated improvement in the areas of abnormal enhancement and signal abnormalities. The infiltration and enhancement of the retrobulbar fat resolved, as did the proptosis.

Conclusions
Bing-Neel syndrome is a rare entity. The most common and specific radiological findings have yet to be established (2). Commonly reported findings include hyperintensities on T2-WI with variable enhancement (3) in the white matter,
brainstem and leptomeninges. Diffusion-weighted imaging appearance is under investigation, with one reported case of scattered small foci of diffusion restriction (4). Few cases of orbital involvement have been reported, but findings include diffuse infiltration of the orbital fat and proptosis (5). Our case demonstrates white matter and brainstem T2/FLAIR signal abnormalities with enhancement, and diffuse infiltration of the retrobulbar fat with proptosis. We demonstrate the appearance from presentation to post-treatment.
Diagnostic Dilemma of Aggressive Variant of Multiple Sclerosis Using Advanced MR Techniques – A Case Report of Rumefactive Multiple Sclerosis

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Purpose
Multiple sclerosis (MS) affects 2.5 million people worldwide with 10-20% presenting with primary progressive form. Aggressive, tumor like appearance of tumefactive MS is exceedingly rare, estimated at 1-2/1000 cases of MS (Poser et al, 1992). This presentation aims to demonstrate pitfalls of conventional imaging and utility of advanced magnetic resonance (MR) techniques in diagnosis of MS variants.

Materials and Methods
A 33-year-old right-handed female presented with 4 months of headache, right hemianopia and aphasia. Initial imaging showed left posterior cerebral vasogenic edema and mass effect. She was diagnosed with multiple sclerosis by biopsy. Tapering dose of steroids and levetiracetam were initiated. Patient rapidly worsened 1 month after biopsy and discontinuation of steroid. She represented to the ED with 3 days of headache, visual changes, nausea and vomiting. Patient initially received 1000mg of methylprednisolone for seven doses, then tapered to 250mg over six doses. Patient was discharged on hospital day (HD) 16 on 60 mg prednisone daily with no neurologic improvement since presentation. Patient is expected to start chemotherapy agents upon clinical deterioration.

Results
Magnetic resonance on HD2 showed a right occipito-temporo-parietal lobe enhancing lesion with edema causing mass effect (A). The findings were concerning for tumefactive MS or primary malignancy. A repeat MRI on HD4 after low dose steroids showed enhancing lesion with edema, with decreased mass effect (B). Arterial spin labeling showed decreased perfusion. Spectroscopy showed increased choline in high FLAIR signal and increased lactate in low FLAIR signal areas (C). These findings supported demyelinating disease. Repeat MRI after 5 days of high dose steroids showed more prominent slowed diffusion at the margins of abnormal FLAIR hyperintensities, likely indicating ongoing demyelination (D). Differential includes lymphoma and primary intracranial malignancy.

Conclusions
In addition to CT and conventional MR sequences, MR perfusion and spectroscopy can be used to further characterize atypical lesions.
Diffuse Osseous Metastasis of an Extra-adrenal Paraganglioma: A rare entity.

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Purpose
To describe a rare case of diffuse osseous metastasis from an extra-adrenal paraganglioma.

Materials and Methods
A 47-year-old female with a history of familial paraganglioma found to have multifocal areas of abnormal uptake in the vertebral bodies on a sestamibi examination during work up for hypercalcemia. She has a history of bilateral carotid body paragangliomas, resected on the left with the right-sided tumor followed radiographically and stable for 8 years.

Results
Fig. 1: Contrast-enhanced neck computed tomography (CT) demonstrates an avidly enhancing nodule (arrow) at the right carotid bifurcation. This is presumed to represent a carotid body tumor in this patient with a known history of familial paraganglioma and has remained stable over several studies. Note the extensive post-treatment changes in the left neck status postresection and radiation of the left carotid body malignant paraganglioma. Fig. 2: Sagittal SPECT-CT Sestamibi scan demonstrates increased activity within sclerotic lesions involving the T3 and T6 vertebral bodies (white arrows). A focal area of increased uptake in the region of the parathyroid gland is compatible with a hyperfunctioning parathyroid (red arrow). Fig. 3: Sagittal T1-weighted images of the thoracic spine. There are several hypointense lesions scattered throughout the thoracic spine (white arrows), which demonstrate enhancement postcontrast (not shown). These lesions correspond to the areas of increased activity seen on the prior Sestamibi scan. Fig. 4: Axial CT image in prone position shows 14.5G 12.5cm Bard® Ostycut® needle inserted into the sclerotic lesion involving the T3 body using a right transpedicular approach.

Conclusions
Metastatic cervical paragangliomas are exceedingly rare with local recurrence being the most common pattern of disease recurrence. Only four case reports of osseous metastasis from a head and neck paraganglioma can be found in the literature. Nonetheless, osseous metastases from paragangliomas can occur.
Fetal MRI in a Case of Subcortical Band Heterotopia Due to Doublecortin Mutation: Enlarged Ganglionic Eminences As Potential Biomarker.
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Purpose
Detecting lissencephaly spectrum abnormalities on fetal imaging at midgestation is extremely challenging because the normally developing brain at 18-24 weeks has minimal gyration, a relatively thin cortex, and developmental structures such as the subventricular zone which simulate arrested gray matter. A potentially useful fetal magnetic resonance imaging (MRI) finding for lissencephaly is described.

Materials and Methods
A 35-year-old female G3P1 was referred for incomplete visualization of the cavum septum pellucidum on a second trimester ultrasound. On fetal MRI at 20 weeks 2 days gestation, the cavum septum pellucidum was present. No gross cortical malformation was noted at this time though unusually prominent medial and caudal ganglionic eminences (GE) were present (Fig. 1 arrows). Follow-up fetal MRI at 36 weeks and a postnatal MRI at 4 months of age demonstrated diffuse subcortical band heterotopia and gyral simplification (Fig. 2), worse anteriorly. The patient developed infantile spasms and underwent genetic testing, detecting a mutation in the DCX gene on Xq23, causative for pachygyria and an attenuated subcortical band heterotopia phenotype in females.

Results
Figure 1. HASTE fetal MRI. Figure 2. Postnatal axial T2.

Conclusions
While the range of normal appearances has not been fully defined yet, GE are typically quite difficult to discretely identify on fetal MRI, and this case suggests that GE enlargement could serve as a biomarker for lissencephaly, at least for lissencephaly due to DCX mutations. This case also provides support for the importance of GE cavitation and enlargement described recently in fetal MRI case series with microcephaly and callosal abnormalities, connecting the enlargement of the GE to a specific malformation of cortical development. Although lissencephalies generally are conceptualized as having impaired radial migration, animal experiments and human neuropathology series have demonstrated abnormal tangential migration from GE in some genetically defined lissencephalies. Analogous to the large GE in this paper, abnormal accumulation of heterotopic GABAergic neurons within the deep cortical layers, subventricular zone, and lateral ganglionic eminences also have been reported in a DCX autopsy specimen. Therefore, impaired tangential migration may be a general feature of lissencephalies, and if the observations in this case can be replicated, fetal MRI may be an important tool for detailing the contribution of tangential migration in a larger number of living human subjects.
Flat Panel Catheter Angiotomography (FPCA) for the Detection of Aberrant Intramedullary Veins Associated with Spinal Cavernous Malformations

G. Griffith¹, P. Gailloud²
Purpose
Intramedullary cavernous malformations (CM) account for 5% to 12% of all spinal vascular pathologies (1). Because of their progressive nature, intramedullary CMs generally are treated surgically. Spinal digital subtraction angiography (SpDSA) is occasionally obtained in that setting in order to exclude other diagnoses, notably in the presence of atypical lesions or presentations. While CMs typically are not demonstrated with standard angiographic techniques, the identification of associated aberrant veins (also called "cryptic venous anomalies") can be used as an angiographic diagnostic criterion. These venous anomalies, observed during surgery in up to 94% of spinal CMs2, have been identified only recently radiologically using flat-panel catheter angiotomography (FPCA), a novel imaging method (3). We report two cases of aberrant veins associated with intramedullary CMs diagnosed with FPCA.

Materials and Methods
Case 1: A 26-year-old man presented 2 weeks after a new bleed from a cervical intramedullary CM treated surgically 3 years prior. Magnetic resonance imaging (MRI) showed a heterogeneously enhancing, expansile mass at C3-C5 suggesting hemorrhagic CM. SpDSA requested prior to possible surgical re-exploration was negative, but FPCA documented aberrant intramedullary veins topographically matching the lesions noted on MRI. Case 2: A 29-year-old man with a history of surgically released tethered cord (2 years prior) was investigated for a 4-year history of bilateral progressive back, upper and lower extremity pain, and stiffness with difficulty ambulating. Magnetic resonance imaging revealed a new focal intramedullary lesion at T5 suggesting a CM. SpDSA was negative, but FPCA showed aberrant intramedullary topographically matching the lesions noted on MRI.

Results
Axial and sagittal images of two cases show radial channels collecting into an enlarged intramedullary vein.

Conclusions
We report two instances of suspected CM in patients with complex clinical presentations, in whom further investigation by angiography was requested prior to possible surgical exploration. In both cases, SpDSA was unremarkable (including the angiographic venous phase), but FPCA documented the presence of aberrant intramedullary veins consistent with the "cryptic venous anomalies" typically noted in association with CMs. These veins can be seen as a spinal equivalent to the developmental venous anomalies classically associated with cerebral CMs, and can be used as a strong angiographic sign in favor of the diagnosis of intramedullary CM. The pre-operative detection of these aberrant veins also has a direct impact upon
surgical planning, as intra-operative complications have been shown to vary with their morphology and location.
Hashimoto’s Encephalopathy: An atypical imaging presentation

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Purpose
Hashimoto's encephalopathy (HE) is a rare syndrome with variable clinical and imaging manifestations in the presence of elevated titers of anti-thyroid antibodies that responds to immunosuppressive therapy (1-3). Patient presentations more commonly include seizure activity and subacute, progressive cognitive impairment (3); psychiatric disturbances, progressive dementia, alteration in mental status and multiple stroke-like episodes additionally have been reported (3, 4). Imaging findings associated with HE include nonspecific T2/FLAIR hyperintensities involving supratentorial subcortical/periventricular white matter, hippocampus, brainstem and cerebellum (4, 5). We present a case of HE with undocumented imaging findings consisting of scattered, predominantly cortically based T2/FLAIR hyperintensities and restricted diffusion affecting bilateral cerebral hemispheres in a transient, and fully reversible pattern.

Materials and Methods
Patient is a 29-year-old male with a history of seizure activity, beginning in 2011, who presented early 2015 with refractory seizure activity despite an ongoing regimen of multiple anti-epileptic home medications. Initial seizure manifestation occurred in December 2011, requiring patient hospitalization with status epilepticus. Clinically, the patient continued to present over the years with recurrent seizure activity, episodes of progressive confusion and transient sensory abnormalities, including hemi-body numbness. Discontinuation of all home medications resulted in epilepsy partialis continua. Clinical work up revealed an abnormally elevated anti-thyroid peroxidase antibody with normal TSH levels. Patient was started on high-dose Solumedrol with significant reported improvement. He subsequently was treated with oral prednisone taper and finally switched to Cellcept. There have been no symptoms following initiation of immunosuppressive therapy.

Results
Retrospective review of serial MRI brain imaging demonstrated multifocal areas of, predominantly cortically based, T2/FLAIR hyperintensities some of which demonstrated restricted diffusion were noted on the 1/15/2015 exam. On short term (1/23/15) follow-up exam the initial findings were fully reversible, with new foci...
evident. Figure 1 depicts examples of migratory, reversible foci of restricted diffusion on serial exams.

Conclusions

Hashimoto's encephalopathy is a treatable autoimmune encephalopathy that should remain as a differential consideration in the setting of seizures. Imaging findings are nonspecific, but may include a migratory pattern of scattered, predominantly cortically based T2/FLAIR hyperintense signal foci with associated restricted diffusion, and demonstrating complete resolution on follow up.
Hemifacial Myohyperplasia: Imaging Features of an Unusual Disorder

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Purpose
To demonstrate the computed tomography (CT) and magnetic resonance imaging (MRI) findings of the rare and challenging entity of hemifacial myohyperplasia. To our knowledge, this disorder has not been reported in the radiological literature.

Materials and Methods
A 5-year-old male presents clinically with a left cheek and paranasal mass along the nasofacial crease, initially evaluated at an outside institution at 3 months of age. As a neonate, the patient had facial asymmetry. The patient had subsequently undergone a biopsy of the superficial paranasal and cheek mass with the pathology result of normal fat and striated muscle. The biopsy of the left cheek also demonstrated minimal focal myositis, but otherwise demonstrated unremarkable striated muscle cells. The patient later presented to our institution at the age of 24 months with the underlying clinical diagnosis of hemifacial microsomia. In addition, the patient clinically had left subcutaneous paranasal and cheek mass-like lesions which had been slowly growing. The lesion was manifested by fullness of the left side of the nose on exam and was soft and mobile with an irregular shape.

Results
On CT and MRI, there was an area of soft tissue thickening and mass-like lesion along the nasolabial region, extending along the nasolabial crease on the left laterally anterior to the maxillary sinus. It extended inferiorly to over the left mandible and in the cranial dimension along the left side of the nasal bone to the level of the medial aspect of the eyelid. The lesion did not extend into the maxillary sinus, nasal cavity, or postseptal orbit. The lesion followed the signal intensity of muscle on T1- and T2-weighted images and there was mild enhancement of the lesion, similar to the degree of enhancement of other muscles. This was compatible with the prior pathology of striated muscle and fat. On closer inspection, the lesion followed the anatomy of and involved multiple perioral and facial muscles, including the orbicularis oris, zygomaticus, risorius, levator anguli oris, levator labii superioris, nasalis, procerus, and parts of the orbicularis oculi muscles. There was no extension beyond the contour of these enlarged muscles. Following the imaging, initial plans for resective surgery...
were postponed. The exact treatment for this condition is unknown. Surgery for cosmetic correction of the abnormalities has been considered.

Conclusions
Hemifacial myohyperplasia is a rare and intriguing disorder of the facial muscles in children that can present diagnostic challenges. The clinical and imaging features of hemifacial myohyperplasia may mimic head and neck neoplastic or infectious etiologies in pediatric patients and potentially may lead to unnecessary treatments. The patient presented depicts the distinctive radiologic findings with reported normal muscle pathology report, which can characterize this rare disorder.

EE-02
6:00AM - 2:45PM

IgG4-related Infundibulo-hypophysitis and Hypertrophic Pachymeningitis in a Patient with Panhypopituitarism

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Purpose
To outline a case of IgG4-related infundibulo-hypophysitis and hypertrophic pachymeningitis and elucidate subsequent radiographic findings.

Materials and Methods
A 54-year-old female with rheumatoid arthritis, Chiari I malformation, diabetes type II and hypothyroidism was admitted for worsening headaches, diplopia, nausea and vomiting. The headaches were exacerbated during Valsalva-type maneuvers. The patient was found to have a sellar and dural mass causing pan-hypopituitarism and diabetes insipidus (DI). Subsequently, the patient underwent craniotomy with surgical biopsy as well as shunt decompression.

Results
Magnetic resonance imaging (MRI) of the brain with intravenous gadolinium contrast revealed an enlarged, thickened, and markedly enhanced pituitary gland and stalk. The stalk measured 6 mm in thickness and a soft tissue sellar mass measured up to 2 cm. There was additional marked thickening and enhancement of the tentorium and posterior falx with resultant mild compression of the midbrain and underlying Chiari I malformation. These findings were most suggestive of inflammatory or infectious granulomatous process such as tuberculosis or sarcoid, while lymphoma was considered less likely. However this constellation of findings may also represent IgG4-related infundibulo-hypophysitis and hypertrophic pachymeningitis.

Conclusions
This case highlights a patient with worsening headaches, diplopia, and panhypopituitarism, with a markedly enlarged and thickened pituitary gland and stalk.
with concomitant dural thickening. Surgical biopsy of the dural lesion was most consistent with IgG4-related hypertrophic pachymeningitis. Pathology revealed dense fibroconnective tissue with mixed inflammatory infiltrate and multinucleated giant cells, focally positive for IgG4. She was treated with high dose steroids and managed medically for DI. IgG4-related systemic syndrome is a recently described entity which can involve multiple organs and is characterized by elevated serum IgG4 with tissue infiltration of IgG4-positive plasma cells. As depicted here, it can involve the pituitary gland and manifest as panhypopituitarism and DI while simultaneously producing hypertrophic pachymeningitis.
Infantile Vanishing White Matter Disease

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Purpose
Vanishing white matter disease (VWMD) is an autosomal recessive inherited leukodystrophy with variable ages of diagnosis. Disease severity has an inverse correlation with age of onset and thus infantile presentations often are rapidly progressive and fatal (1). Classically, patients present with spasticity and cerebellar ataxia (1, 2). It is an autosomal recessive disorder caused by mutation in eukaryotic translation initiation factor 2B (eIF2B), which leads to disruption of cell proliferation and apoptosis (1-3). Imaging findings classically include diffuse signal abnormality of the white matter with sparing of the U-fibers (1). This case demonstrates a severe case of the disease's infantile form (4).

Materials and Methods
The patient is a 6-month-old female who presented to our institution in July 2015 with failure to thrive and new complex partial seizure activity including upper extremity extensor posturing and perioral cyanosis. Physical examination revealed bilateral cataracts and microcephaly. Genetic testing revealed two mutations in the EIF2B2 gene from the mother and father. The variant inherited from the mother has been reported in association with vanishing white matter disease. The patient has since had some seizure control with Keppra, but has expectedly continued to decline clinically with significant delay of developmental milestones.

Results
Initial brain magnetic resonance imaging (MRI) in July 2015 revealed mild ventriculomegaly without evidence of cortical thinning. There was T2 hyperintense signal throughout the deep and subcortical white matter with thinning of the corpus callosum. The patient's repeat MRI brain in October 2015 demonstrated diffuse progression in findings with interval cortical thinning and continued diffuse white matter signal abnormality, without sparing of the cortical U fibers as reported with the classic infantile form.

Conclusions
Vanishing white matter disease is a progressive leukodystrophy with poor prognosis in its infantile form. Imaging findings classically include diffuse signal abnormality. Correlating with rapid clinical decline, rapid progression of white matter signal abnormality was demonstrated in 3 months without U-fiber sparing.
Invasive Mucormycosis: a lesson in the need for early radiographic diagnosis.

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Purpose
Mucormycosis is a highly aggressive invasive fungal infection that can be clinically devastating. Complicating matters, clinical diagnosis is made difficult by low sensitivity of blood and tissue cultures for identifying infection, with as many as 90% of cases not confirmed until post mortem examination in some studies. Early diagnosis and recognition of initial subtle imaging signs suggestive of the diagnosis may allow for earlier treatment and improved patient outcomes. In this teaching case...
we highlight the early and late radiologic manifestations of this aggressive infection that were present despite persistently negative cultures.

Materials and Methods

Our patient is a 68-year-old male with relapsed AML who was admitted in his usual state of health for FLAG chemotherapy. The patient developed neutropenic fever on day 7 of admission with altered mental status. Left periorbital swelling and mild visual changes were noted on hospital day 11, but were attributed to dependent edema and altered mental status. The patient's condition deteriorated over the next few days with worsened peri-orbital swelling, vision changes and declining mental status. A fungal etiology was considered unlikely based on repeat negative cultures, sequential sinonasal endoscopies with no findings of fungal disease, and sinus mucosal biopsy negative for fungal elements. Steroid nasal spray decongestion was started on day 17 for suspected bacterial cellulitis/sinusitis. After a diagnostic magnetic resonance imaging (MRI) on day 18, the diagnosis of invasive mucormycosis was confirmed by orbital biopsy. Treatment with amphotericin B was initiated but the patient unfortunately succumbed to the infection the following day.

Results

An MRI on hospital day 10 (Fig. 1) showed left-sided sinusitis and a small area of left frontal dural enhancement, but there was thought to be no evidence of invasive sinusitis at this time. Retrospective examination of the initial MR revealed an early black turbinate sign, which in combination with the dural enhancement could have raised suspicion for mucormycosis. Computed tomography (CT) on hospital day 17 showed bi-frontal edema with parenchymal hemorrhage and worsened orbital inflammatory changes. Magnetic resonance brain on day 18 showed findings pathognomonic for invasive mucormycosis including intracranial invasion with extensive frontal lobe and orbital involvement with diffusion restriction and nonenhancement of affected areas.

Conclusions

This case highlights the importance of a high level of vigilance in detecting the early imaging findings of mucormycosis, which can be difficult to diagnose clinically. Hypoenhancement of a turbinate in the appropriate clinical setting warrants a high degree of suspicion to avoid delays in treatment and diagnosis. Serial imaging may be necessary to monitor progression of disease and the response to therapy.
Isolated Parenchymal Neurosarcoidosis as a Mimic with Initial Presentation of Hemiparesis: A Case Report

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Purpose
Isolated neurosarcoidosis presents as an initial presentation in less than 3% of cases. Disease may involve any portion of the central nervous system (CNS), cranial nerves, meninges, and blood vessels. Symptoms may occur from mass effect of granulomas as well as infiltration. This case report highlights imaging findings associated with brain parenchymal sarcoidosis as an initial manifestation of the disease.

Materials and Methods
A 43-year-old previously healthy male presented with left arm and hand weakness progressing to left facial droop and left leg weakness. Differential diagnosis from magnetic resonance imaging (MRI) included primary central nervous system lymphoma, tumefactive MS, and neoplasm. Initial concern was for multiple sclerosis. He was treated with IV solumedrol and experienced temporary, mild regression of
symptoms. Concern for neoplasm led to biopsy which showed granulomatous inflammation suggesting sarcoidosis. Evaluation for infectious causes was negative. Lab values were normal and chest computed tomography (CT) was negative.

Results

Initial CT report indicated no evidence of acute intracranial abnormality. Magnetic resonance imaging showed an area of confluent high T2-FLAIR signal involving the right centrum semiovale and corona radiata without associated mass effect. The more ill-defined posterior component of this region of the signal abnormality extended into the thalamus and mesencephalon via the cerebral peduncle, showing restricted diffusion. Ill-defined enhancement was noted throughout the area of T2 signal abnormality. There was no signal abnormality of the corpus callosum or cerebellum. No signal abnormality crossed the midline. The major arterial flow voids were normal. The process did not appear to cross midline. The lateral ventricles and other cerebrospinal fluid (CSF)-containing spaces were symmetric and appropriate in size.

Conclusions

Sarcoidosis is a highly variable granulomatous disease that can affect multiple structures within the nervous system. While brain parenchymal lesions can be seen in isolated neurosarcoidosis, brain parenchymal disease leading to progressive hemiparesis is a rare initial manifestation.
Longus colli tendinitis mimicking a retropharyngeal abscess in a 12 year old girl.

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Purpose
Acute calcific tendinitis of the longus colli muscle is a rare condition that causes severe neck pain (1). Calcium hydroxyapatite crystals are deposited causing acute inflammatory changes in the muscle. This is a benign condition that usually mimics more serious causes of acute neck pain such as retropharyngeal abscess, meningitis and infectious spondylitis (2). Classic imaging findings of calcification in the prevertebral soft tissues on computed tomography (CT) and plain film may not be present (3). Longus colli tendinitis is an important condition to recognize as it can be treated conservatively and usually will resolve with symptomatic treatment after 1 to 2 weeks. Here we present a case of acute longus colli tendinitis presenting unilaterally with imaging findings strongly suggestive of a retropharyngeal abscess. This case demonstrates the unusual appearances that can occur with this condition and we suggest that longus colli tendinitis should be considered in the differential diagnosis of imaging pathology involving this muscle.

Materials and Methods
A 12-year-old girl with no significant past medical history presented to the emergency department complaining of severe neck pain. Blood biochemistry showed raised inflammatory markers and a neck ultrasound demonstrated reactive lymphadenopathy. An emergency magnetic resonance imaging (MRI) of the neck showed a large rim enhancing inflammatory mass within the left longus colli tendon, suggestive of an abscess. The patient underwent a surgical neck exploration and biopsy of the postnasal space. However no collection was identified intra-operatively and histology only showed reactive lymphoid hyperplasia. The patient received intravenous antibiotics and after a week in hospital her symptoms and systemic condition improved. A follow-up MRI at 1 month demonstrated marked improvement of the imaging findings.

Results
Plain films of the cervical spine did not show any obvious calcification of the prevertebral soft tissues. In the acute phase fat saturated T1 postcontrast MRI showed a large irregular rim enhancing inflammatory mass in the prevertebral soft tissues within the left long colli muscle. Follow-up MRI showed marked improvement with
some minor inflammatory high T2 signal in the longus colli muscle with a small residual collection.

Conclusions
Here we present a rare case of longus colli tendinitis mimicking as a retropharyngeal abscess. The imaging findings and patient's clinical condition improved with conservative management. Longus colli tendinitis is a rare benign condition but should be considered in the differential diagnosis of a patient with acute severe neck pain and especially those with imaging pathology involving the longus colli muscle.
Purpose
Magnetic resonance imaging (MRI) may depict hypertrophic olivary degeneration from lesions involving the dentate-rubro-olivary pathway (Triangle of Guillain and Mollaret or myoclonic triangle) (1). The triangle represents a feedback pathway for modulating spinal cord motor activity. Specifically, the inferior olivary nucleus sends afferents to the contralateral dentate nucleus via the inferior cerebellar peduncle. The dentate afferents travel through the superior cerebellar peduncle to the contralateral red nucleus. The triangle is completed by afferent fibers coursing from the red nucleus to the ipsilateral inferior olivary nucleus via the central tegmental tract. We report a unique case of injuries to the dentatorubro-olivary pathway bilaterally in a single patient with both hypertrophic olivary and deafferentation changes in the dentate.

Materials and Methods
A 63-year-old male with past medical history significant for prior right pontine hemorrhage was referred to our institute for follow-up imaging. Evaluation of MR imaging at time of the hemorrhage demonstrated a right pontine hemorrhage in the region of the right central tegmental tract as well as the right superior cerebellar peduncle (Fig. 1A). Both the inferior olivary and dentate nuclei were intact at initial MRI exam (Fig. 1B). Magnetic resonance imaging 4 months later revealed both hypertrophy of the right olivary nucleus (Fig. 1C) as well as atrophy and T2 hyperintense signal of the right dentate (Fig. 1D).

Results
Axial susceptibility-weighted MRI demonstrates a right pontine hemorrhage (A). A coronal T2-weighted image demonstrates normal appearing inferior olivary nucleus and dentate (B). Follow-up MRI 4 months later reveals ipsilateral hypertrophy of the right inferior olivary nucleus (C) as well as atrophy and T2 hyperintense signal of the right dentate (D).

Conclusions
Injury to central tegmental tract may result in hyperexcitation and subsequent hypertrophy of the ipsilateral inferior olivary nucleus (2). Injury also may result in atrophy of the contralateral dentate (1). In our case, right-sided inferior olivary
hypertrophy was seen, however a heretofore underappreciated change also was seen consisting of abnormal signal and atrophy of the ipsilateral dentate nucleus 4 months after injury to the efferent right central tegmental tract and the afferent left limb of the superior cerebellar peduncle. Familiarity with this pathway is important for the neuroradiologist for accurate diagnosis.

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Purpose
1. Describe the magnetic resonance imaging (MRI) findings in a patient who underwent MRI of the brain immediately after intravenous iron therapy. 2. Review various intravenous iron products available in the USA and understand the pharmacodynamics and pharmacokinetics of these agents. 3. Discuss the importance of delaying or altering protocols for magnetic resonance neuroimaging after the infusion of intravenous iron products for a varied time period based on pharmacokinetic properties.

Materials and Methods
A 61-year-old female with a history of chronic kidney disease, coronary artery disease and diabetes received an intravenous infusion of 510 mg Ferumoxytol for anemia. During the infusion, she had an anaphylactic reaction which was treated with diphenhydramine, methylprednisolone and epinephrine. After the initial episode, she had persistent slurred speech and left-sided weakness which was concerning for stroke. She underwent an MRI and MR angiogram of the head 8 hours and 48 hours after iron therapy respectively.

Results
1. Diffuse susceptibility artifact is noted along the vessels within the basal cisterns and the sulci on gradient recalled echo (GRE) and diffusion-weighted imaging (DWI) MRI sequences due to the intravascular superparamagnetic iron oxide. 2. The vascular flow voids appear more prominent on T2-weighted turbo spin echo MRI sequence. 3. No artifacts are evident on T1 and T2 FLAIR MRI sequences. 4. Time of flight MR angiography of the head was aborted due to severe susceptibility artifacts.

Conclusions
This case report illustrates that GRE, DWI and T2-weighted MRI sequences should be avoided after intravenous iron product Ferumoxytol. This raises two important questions. The first question pertains to the length of time MRI imaging is adversely affected by the presence of intravascular Ferumoxytol. The second question is...
whether this applies to other IV iron products. We propose reasonable answers to these questions based on their pharmacodynamics and pharmacokinetics.

<table>
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MR Myelography Can Detect Subtle Postoperative CSF Leak

S Hegde¹, G Lagemann¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
We report MR myelography's use in identifying the site of subtle cerebrospinal fluid (CSF) leak in a post-Chiari decompression patient. computed tomography (CT) myelography previously had failed to identify the site of leak.

Materials and Methods
A 24-year-old female presented with persistent, severe headaches following Chiari
decompression 2 years prior. A lumbar puncture revealed opening pressure of zero cm H2O. An extensive work up including CT myelogram failed to identify site of CSF leak. Magnetic resonance (MR) myelography was performed with 0.3 mL intrathecal MultiHance. A subtle CSF leak was identified along the lateral margin of suboccipital cranioplasty at the margin of the patient's surgical mesh. Her headaches persisted even after blood patches targeted at the identified site of CSF leak. Surgical exploration confirmed CSF leak as identified and characterized on MR myelography.

Results
Axial fat-saturated T1-weighted image following intrathecal administration of gadolinium demonstrates leak of CSF along the left suprolateral margin of the previous suboccipital surgery (red arrow).

Conclusions
To the best of our knowledge, this is the first report describing the utility of MR myelography in detecting site CSF leak in the postoperative setting.
MRI findings of Acute Wernicke's Encephalopathy

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Purpose
Wernicke's encephalopathy is an acute neurologic disorder that results from thiamine (vitamin B1) deficiency. Although classical clinical triad consist of ocular signs, altered consciousness, and ataxia, new clinical diagnostic criteria require two of four items; dietary deficiencies, oculomotor abnormalities, cerebellar dysfunction, and an altered mental state or mild memory impairment. Symmetric signal intensity alterations in the thalami, mamillary bodies, tectal plate, and periaqueductal area are the classical MRI findings, where as signal intensity alterations in the cerebellum, cerebellar vermis, cranial nerve nuclei, red nuclei, dentate nuclei, caudate nuclei, splenium, and cerebral cortex are atypical locations. Herein we present magnetic resonance imaging (MRI) findings of acute Wernicke's encephalopathy in a 51-year-old woman with t-cell lymphoma who developed clinical alterations in consciousness and ataxia.

Materials and Methods
A 51-year-old woman developed alterations in consciousness and ataxia. She has been under chemotherapy treatment for t-cell lymphoma. Cranial MRI was ordered to identify her mental impairment. On cranial MRI there were symmetric increased signal intensity on T2-weighted and decreased signal on T1-weighted images in the thalami, mamillary bodies, periventricular region of third ventricle, tectal plate, and periaqueductal area. No enhancement was seen following contrast media injection. Diagnosis of acute Wernicke's encephalopathy was made according to MRI findings. Following treatment with thiamine, the patient's altered consciousness normalized gradually.

Results
Fig. 1: Coronal FLAIR images demonstrate symmetric increased signal a. periventricular region of third ventricle and b. in mamillary bodies. Fig. 2: Increased signal intensity is seen in the thalami, mamillary bodies, periaqueductal gray matter and tectal plate on sagital T2-weighted images.

Conclusions
The pathogenesis of Wernicke's encephalopathy is proposed to be related to thiamine deficiency. Many clinical conditions can cause impaired absorption of thiamine, like in our patient- including prolonged vomiting, chemotherapy. The prognosis depends
on the time of onset of thiamine supplementation. Thus prompt diagnosis and treatment are required. Neuroimaging studies especially MRI findings are powerful in supporting the diagnosis and distinguishing from other neurologic disorders. T2-weighted images are the most sensitive sequences. Demonstration of symmetric signal alterations in the thalami, mamillary bodies, tectal plate, and periaqueductal area are typical.

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EE-34

Multiple System Atrophy with Predominant Parkinsonism (MSA-P): Classic Imaging Features of a Rare Disorder

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Purpose
Multiple system atrophy (MSA) is a rare adult onset fatal neurodegenerative disorder. Although its etiology long has been unknown, recent studies conclude that MSA is actually a transmissible neurodegenerative disease caused by a unique strain of α-synuclein prions. This excerpt describes a rare case of MSA predominated by Parkinsonian features (MSA-P), demonstrating the development of classic imaging features and briefly discussing the emerging role of prions in its development.

Materials and Methods
We present the case of a 67-year-old female with a history of rapidly progressive Parkinsonism. The patient initially presented with complaints of balance and gait difficulty resulting in multiple falls and trouble using her hands. A trial treatment of both dopamine agonists and Carbidopa-Levodopa was attempted, but the patient was nonresponsive. Within 3 years, the patient was unable to ambulate and was experiencing dysphagia and urinary incontinence. Given the rapidly progressive clinical course, failed medical therapy, and the imaging findings described below, the patient was diagnosed with MSA-P.

Results
Magnetic resonance imaging (MRI) of the brain at the time of initial presentation was essentially unremarkable with the exception of mild chronic ischemic changes. Repeat imaging over the next 3 years demonstrated the development of classic imaging features, including putaminal atrophy with development of T2 hypointense signal at the dorsolateral aspects and blooming artifact on diffusion-weighted imaging (DWI) (Fig. 1). In addition, the MRI showed progressive atrophy of the midbrain, pons, and cerebellum.

Conclusions
MSA-P is an adult onset neurodegenerative disorder characterized by rapidly progressing parkinsonian features. Although no treatment exists, recent studies implicate a unique strain of α-synuclein prion as a transmissible etiology. Given its poor prognosis and difficulty in making a definitive clinical diagnosis, imaging plays an important role in diagnosis and this case illustrates the development of the classic imaging features.
EE-42

6:00AM - 2:45PM

Neuroimaging findings of Dive-related Decompression Sickness in Brain and Spine
Purpose
Demonstration of characteristic imaging findings associated with decompression sickness (DCS) of both the spinal cord and brain, infrequently seen in the same patient.

Materials and Methods
We present a case of acute Type II DCS in a 22-year-old female with bilateral upper and lower extremity weakness after scuba diving to a maximum depth of 107 ft for 22 minutes on air, with marked alteration of consciousness at 18 ft safety stop. The patient subsequently received hyperbaric chamber therapy and was airlifted to our institution with magnetic resonance imaging (MRI) performed ~20 hours subsequent to the incident. There was persistent lower extremity weakness and neurogenic bladder at the time of imaging.

Results
Magnetic resonance imaging brain was remarkable for bilateral confluent subcortical white matter T2/FLAIR hyperintensity, predominantly in the perirolandic region (Fig. A), with subtle associated cortical restricted diffusion relative to normal brain (Fig. B). No hemorrhage or mass effect was seen. Magnetic resonance imaging of the cervical and thoracic spine demonstrated patchy, long segment cervical and thoracic cord T2 hyperintensities predominantly involving the dorsal columns without cord expansion or hemorrhage (Figs. C, D).

Conclusions
We present a case of type II DCS with a characteristic constellation of MR imaging findings in both the brain and spinal cord in the same patient, which is seen infrequently. Specifically, extensive subcortical white matter T2 hyperintensities with associated cortical diffusion abnormalities were seen in the perirolandic regions, which have been reported to be partially reversible in divers and high-altitude pilots (1, 2). Additionally, our findings of patchy cervical and thoracic cord white matter T2 hyperintensity with dorsal cord preference has been attributed to higher regional fat content in posterior columns as a reservoir for dissolved nitrogen under pressure, versus venous congestion/infarction (3, 4). No hemorrhagic changes were seen, which has been associated with improved prognosis (1).
Neuromyelitis Optica (NMO) Associated To Hepatitis C. A Pediatric Case Report.

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Purpose
• Present a case of a 14-year-old male patient presenting simultaneously with NMO and Hepatitis C. • Demonstrate the imaging evolution of NMO after treatment with Rituximab.

Materials and Methods
A previously healthy 13-year-old male patient, who developed an acute lumbar pain for 4 days with partial response to analgesics. Posteriorly, superior limb weakness (0/5), along with urinary incontinence, abolished osteotendinous reflexes, sensitive level on T10-T11 with superficial pain. As a background, both parents had positive serology for Hepatitis C virus (HCV). Lumbar puncture showed increased proteins, glucose, no blood cells were present. Abnormal somatosensorial potentials on tibial nerve bilaterally, up to T12.

Results
The initial spinal MR showed generalized thickening of the cervical, thoracic and lumbar cord, along with hyperintensities on T2 and FLAIR. Blood work showed positive markers for Hepatitis C and positive serology for AQP4 antibodies. Regression of the medullar lesions, with a reduction on size and extension of the lesions, and well defined clinical improvement was demonstrated on the following months, after treatment with Rituximab.

Conclusions
Rare association between NMO and HCV has been reported, we present the first case to our knowledge of this assessment in a pediatric patient. The MR helps the diagnosis and following of the patients with medullar lesions. Treatment with inmunomodulary medication showed clinical improvement. Radiologists must be aware of the changes associated with NMO in order to get an accurate diagnostic.
Fig. 1. a) axial T2, b) axial FLAIR. Where no demyelinating lesions are observed in the brain parenchyma, neither on the optic nerves.

Fig. 2 a) Sagittal T1 FLAIR of the cervicodorsal region and b) Sagittal T2 of the dorsal column where a cord thickening with alterations on the signal intensity because of the edema, extending from C2 to the cervico-dorsal union, co...
Neuroschistosomiasis of the Temporal Lobe

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Purpose
Neuroschistosomiasis is the most severe presentation of the parasitic disease caused by blood flukes of the genus Schistosoma, endemic to sub-Saharan Africa and South America and increasingly seen worldwide. Schistosomiasis is under recognized as an encephalic disease given its well studied predilection for the intestine and bladder, and its variable neurological manifestations depending on where eggs deposit in the brain. Ancillary testing of serum, stool, and urine are not validated yet. Exposure history and recognition of different neuroimaging presentations of cerebral schistosomiasis therefore are imperative to guiding diagnosis.

Materials and Methods
We report the case of a 24-year-old previously healthy female who resided in rural Malawi over the past year, with recent travel through Turkey at the time of her first generalized tonic-clonic seizure. She reported difficulty with word-finding for several weeks preceding the seizure. Cerebral angiogram was unremarkable. Extensive laboratory workup of CSF, serum, urine and stool was normal except for positive schistosoma antibody. She was started on a prophylactic corticosteroid regimen, followed by praziquantel.

Results
Magnetic resonance imaging (MRI) revealed a linear stippled enhancement along the lateral aspect of the anterior inferior left temporal lobe, with associated vasogenic edema (Figs. 1, 2). Follow-up MRI study 1 month later redemonstrated the abnormal focus of T2 hyperintensity involving the left amygdala and adjacent superior left temporal lobe. In addition, two new regions of abnormal parenchymal T2 hyperintensity with associated stippled enhancement were seen in the peripheral right superior lobe and the left parahippocampal gyrus (Figs. 3, 4).

Conclusions
Neuroschistosomiasis can manifest as a nonspecific granulomatous lesion which is isointense on T1-weighted MR images and hyperintense on T2 as a host response to the ova. Prognosis depends largely on early treatment, and corticosteroids and anti-schistosomal drugs often are initiated before the diagnosis can be confirmed on tissue biopsy.
Figure 1. Axial T1 post contrast image shows stippled enhancement along the left temporal lobe along the middle central gyrus.

Figure 2. Axial T2 image demonstrates subcortical hyperintensity along the left temporal lobe.

Figure 3. Contrast enhanced axial T1 image demonstrates subtle enhancement of the left temporal lobe.

Figure 4. Axial T2 image through the level of the midbrain demonstrates cortical and subcortical hyperintensity involving the left parahippocampal gyrus.
Purpose
We present the case of orbital venous loop herniation as a rare, previously unreported complication of an orbital floor blow-out fracture. Prompt recognition of such a complication by imaging is important to prevent life-threatening hemorrhage upon attempted repair. In this case, there was a substantial change in management with coordinated efforts by the neuroradiology, oculoplastic, neurosurgery, and otolaryngology teams for a successful outcome.

Materials and Methods
Our patient is a 58-year-old man who was driving a lawnmower while intoxicated. He struck a tree a branch which injured his left eye. The globe appeared intact on clinical evaluation with no corneal or scleral laceration. Dilated fundus exam showed no evidence of ocular injury or vitreous hemorrhage. There was inferior rectus muscle restriction. A computed tomography (CT) scan of the orbit and face then was performed to determine the extent of orbital injury, which demonstrated blowout fractures involving greater than 75% of the left orbital floor as well as a large portion of the left medial orbital wall. The CT scan corroborated the clinical suspicion of entrapment of the inferior rectus muscle from herniation into the maxillary sinus. To our astonishment, there was also herniation of a large orbital venous loop into the maxillary sinus, connected to both the superior and inferior ophthalmic veins. The vascular loop was noted to be in a very hazardous position that would likely lead to its injury if medial and inferior orbital wall reconstruction was attempted. There was great concern that injury of this vascular loop during orbital wall repair could result in massive intraorbital or maxillary sinus hemorrhage if this fragile venous loop were severed in an uncontrolled situation. The neuroendovascular service was consulted to provide pre-operative embolization and occlusion of the prolapsed veins, but a safe venous approach for embolization could not be achieved. The Otolaryngology service then was consulted to isolate and close the prolapsed vessels as part of a joint surgical procedure. They performed a sublabial maxillotomy (Caldwell-Luc procedure) and were able to clip and ligate the vessels. The Oculoplastic service then performed an uneventful transconjunctival orbital floor repair. Following the surgery, the patient's
ophthalmologic exam was stable, and he was discharged with close follow up with Oculoplastic Surgery.

Results

Figure 1: Contrast-enhanced coronal (A), oblique sagittal (B), and oblique coronal (C) orbital CT images. There is a large orbital floor fracture with marked caudal displacement of the inferior rectus muscle through the orbital floor fracture. A small amount of retrobulbar hemorrhage is noted. An enhancing orbital venous loop has herniated through the orbital floor fracture into the maxillary sinus. An intra-operative photograph (D) confirms the presence of an orbital venous loop extending below the orbital floor fracture into the maxillary sinus.

Conclusions

Prolapsed intra-orbital vasculature into the maxillary sinus requires prompt recognition to prevent massive intra-orbital or maxillary sinus hemorrhage.
Ossifying Fibromas Presenting as Obstructing and Incidental Sinonasal Masses in Two Adolescents

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Purpose
Sinonasal ossifying fibromas are rare fibro-osseous lesions which often are locally
invasive and require complete surgical resection to prevent recurrences. Two case reports of aggressive sinonasal ossifying fibromas are presented in order to highlight the unique imaging features of this benign but invasive tumor which can help distinguish this mass from fibrous dysplasia and osteosarcoma.

Materials and Methods
Patient 1 is a 13-year-old female who presented following a 6-month history of headaches, nasal obstruction, and intermittent nose bleeds. Physical examination revealed a large vascularized mass in the patient's right nasal cavity which displaced the right middle turbinate and nasal septum. Patient 2 is a 12-year-old female who presented after being struck in the face with a dodgeball and experiencing acute right eye swelling and pain. On physical examination, significant proptosis of the patient's right eye was noted. Both patients underwent imaging of the sinonasal region for further evaluation with revealed large sinonasal tumors. Both masses were resected completely and the final pathologic reports were consistent with psammomatoid ossifying fibromas. The findings of these imaging studies are described in detail in the following section.

Results
Patient 1: Contrast-enhanced magnetic resonance imaging (MRI) of the sinuses demonstrated a large T1 isointense and T2 hypointense homogeneously enhancing mass centered in the right nasal passage without restricted diffusion. There was proptosis of the right globe secondary to mass effect on the medial wall of the right orbit. The mass extended through the cribriform plate but did not traverse the dura.

Patient 2: Contrast-enhanced maxillofacial computed tomography (CT) demonstrated a large heterogeneously enhancing mass centered in the right nasal passage with an irregular calcific rim. There was marked leftward deviation of the nasal septum along with bowing of the medial walls of the right orbit and right maxillary sinus with smooth bony remodeling. There was no intracranial extension. On subsequent MRI of the brain/orbits, this mass was T1 isointense and T2 hypointense without restricted diffusion. There was avid enhancement on postcontrast imaging.

Conclusions
While slow growing, the aggressive psammomatoid ossifying fibroma often becomes locally invasive and may result in destruction of the sinuses, orbital floor, and cranial base (1). Differentials include fibrous dysplasia, giant cell tumor, osteoblastoma, and osteosarcoma. Distinguishing ossifying fibromas from fibrous dysplasia is critical as fibrous dysplasia demonstrates a benign self-limited course whereas ossifying fibromas require surgical resection to prevent progressive enlargement of this benign but aggressive tumor (2). The margins of fibrous dysplasia are poorly circumscribed with infiltration into osseous structures via a ground glass matrix (3). This is in contrast to ossifying fibromas which typically demonstrate distinct margins with an eggshell rim of bone. Despite surgical resection, recurrence rates for ossifying fibromas remain elevated at 30-56% (4).
Papillary Craniopharyngioma Presenting as a Purely Intraventricular Lesion in an Adult

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Purpose
We present a case of papillary craniopharyngioma presenting as a third ventricular mass in an adult patient.

Materials and Methods
A 35-year-old male presented with a 2-day history of falls and confusion. Further history on admission revealed a 2-year course of progressive short-term memory loss and general decline in cognitive functions. More recently he had developed worsening positional headaches, 10/10, associated with nausea and vomiting. The patient
underwent uneventful shunting and subtotal resection of the intraventricular mass. The final neuropathologic diagnosis was papillary craniopharyngioma - WHO Grade I.

Results
Magnetic resonance imaging (MRI) demonstrated a 51 x 34 x 35 mm solid mass lesion arising within the third ventricle extending through the foramen of Monro into both lateral ventricles. The mass was felt to originate from the left anterior margin of the third ventricle. There was marked expansion of the third ventricle and with obstructive hydrocephalus, probably at the level of the foramen of Monro, resulting in effacement of the basilar cisterns and downward translation of the posterior fossa structures. The mass enhanced homogeneously and did not demonstrate restricted diffusion. It was intermediate signal intensity on both T1- and T2-weighted images. There were scattered areas of susceptibility within the mass. Calcifications were noted in the mass on a noncontrast head computed tomography (CT). The pre-operative diagnosis was ependymoma.

Conclusions
We present a case of papillary craniopharyngioma isolated to the third ventricle in an adult. The imaging appearance and clinical presentation are similar to the two case reports available in the literature. The differential diagnosis of adult intraventricular masses includes a number of neoplasms including ependymoma, central neurocytoma, subependymoma, meningiomas, choroid plexus papillomas and carcinomas, germ cell tumor, and metastases. While 40% of papillary craniopharyngiomas may involve a third ventricular cavity secondarily; primary involvement of the third ventricle without extension from the parenchyma is rare, accounting for fewer than 1% of such masses in adults. Nonetheless, they should be considered in the differential diagnosis of adult third ventricular masses when a homogeneously enhancing papillary mass is present without restricted diffusion.
Pituitary and Hypothalamic Hemorrhage: A rare CNS manifestation of Hemophagocytic Lymphohistiocytosis

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Hemophagocytic lymphohistiocytosis (HLH) is a rare life-threatening disorder of uncontrolled immune system activation, characterized by proliferation of benign histiocytes resulting in nonmalignant diffuse infiltration of multiple organs by lymphocytes and histiocytes. The condition has both congenital and secondary forms, and commonly involves the liver, spleen, lymph nodes, bone marrow and central nervous system (CNS). Common CNS manifestations include seizures, ataxia, coma, cranial nerve palsy, hemorrhage, hemiplegia, and in some, cerebrospinal fluid (CSF) abnormalities. Our purpose is to present a unique case of pituitary/hypothalamic hemorrhage/infarct associated with HLH, as well as to provide a brief review the imaging findings of this rare condition which can be helpful in the diagnosis, staging, and prognosis of the disease.

Materials and Methods
Patient T.W. was a 62-year-old man with a history of prostate cancer status postprostatectomy and hypertension who initially presented with complaints of headaches and gum bleeding. With severe acute thrombocytopenia, anemia, and reticulocytosis, he was thought to have secondary to autoimmune hemolytic anemia (AIHA) and immune thrombocytopenia (ITP). After treatment and splenectomy, his condition was complicated by leukopenia, neutropenic fever, upper gastrointestinal bleed with melena, and hypotension despite the aggressive interventions. A repeated bone marrow biopsy was suggestive of HLH. In the following 30 days, the patient developed respiratory failure, pituitary/hypothalamic hemorrhage, altered mental status, acute respiratory distress syndrome (ARDS), and septic shock from pseudomonas aeruginosa, acinetobacter baumannii, and candida glabrata bacteremia/fungemia. Autopsy findings confirmed remote pituitary hemorrhage/infarct, and indicated acute to subacute cerebellar subarachnoid hemorrhage (SAH) which was not visualized on available neuroimaging.

Results
Upon initial altered mental status, the patient's computed tomography (CT) head findings were normal. However, a dedicated magnetic resonance (MR) further demonstrated focal T1/T2 hyperintensity in the pituitary and hypothalamus with associated gradient susceptibility, consistent with subacute pituitary/hypothalamic hemorrhage. Postcontrast images of the sella also demonstrated a focal small pituitary microadenoma. The most common CNS imaging findings in HLH are nonspecific periventricular white-matter abnormalities, brain-volume loss, and enlargement of extra-axial fluid spaces. Few cases of scattered inflammatory and demyelinating lesions have been reported.

Conclusions
Hemophagocytic lymphohistiocytosis is a complex hematologic disorder with multisystem effects, including upon the CNS. This case provides rare imaging findings of pituitary/hypothalamic hemorrhage and infarct, likely sequelae of anemia.
and thrombocytopenia, as well as a concomitant pituitary microadenoma in this patient with HLH. It is important to understand the expected imaging findings in this rare disorder to assist clinicians in supportive care, expectant management, and in some cases to aid in diagnosis.
Prediction of Glioma Grade Based on Preoperative Imaging, Intraoperative Contrast-Enhanced Ultrasound Compared to Perfusion Magnetic Resonance Imaging

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Purpose
Histopathologic grading of gliomas carries important prognostic implications for patients. Currently, pre-operative magnetic resonance imaging (MRI) perfusion is used to predict glioma grade based on blood flow to the tumor of interest (1). Intra-operative contrast-enhanced ultrasound is a new modality, and recent investigations have suggested it may be more accurate at predicting tumor grade than MRI perfusion (2, 3). Here we describe a case report of glioma characterization with pre-operative iCEUS and MR perfusion and their corresponding accuracies in predicting the final histopathologic grade.

Materials and Methods
BE was a 71-year-old female with a history of prior right frontal meningioma resection. On follow-up imaging she was found to have a progressively growing mass in the left frontotemporal region. Pre-operative MRI with perfusion data suggested a diagnosis of low grade glioma. iCEUS revealed perfusion characteristics suggestive of a higher grade glioma, which correlated more closely to the final pathologic diagnosis of anaplastic astrocytoma.

Results
Pre-operative MRI showed ill-defined T2/FLAIR hyperintensity within the subcortical and deep white matter of the right temporo-occipital region. No significant enhancement was appreciated. MR perfusion examination showed mildly increased relative cerebral blood volume (rCBV) with a ratio of 1.6 compared to normal parenchyma. These findings were suggestive of low grade glioma. iCEUS examination showed a relatively rapid time to peak (TTP) and wash-in slope (WIS) consistent with a higher grade glioma.

Conclusions
iCEUS is a useful new tool for evaluating glioma grade in the intra-operative setting. This case report demonstrates how iCEUS was more sensitive than a pre-operative MRI perfusion scan at predicting histologic grade of an anaplastic astrocytoma. Future
prospective studies are needed to determine iCEUS utility in predicting tumor grade and how iCEUS's predictive value compares to MRI perfusion examinations.
Comparison of MRI perfusion and iCEUS: A. Axial FLAIR image shows FLAIR hyperintensity in the right posterior (arrow). B. Corresponding relative cerebral blood flow (rCBV) color map shows region of interest (ROI) with hyperintense (dashed arrow). Perfusion is obtained in the contralateral normal brain for comparison (arrow). C. (ROI) analysis demonstrates that the anterior portion of the FLAIR hyperintense mass demonstrates an rCBV contralateral normal-appearing white matter suggestive of low-grade glioma. D. Side-by-side iCEUS (left) (right) with time-intensity curve (below). Region of interest on the tumor (dashed arrow) displays relatively short transit time (TTP) and steeper wash-in-slope (WIS) suggestive of higher grade glioma.
Progressive Paranasal Sinus Expansion and Enophthalmos Secondary to Chronic Low Intracranial Pressure

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Purpose
While immediate complications related to cerebrospinal fluid shunting are well documented, long-term complications related to chronically decreased intracranial pressure from excessive shunting rarely are encountered. Alterations in intracranial pressure have been reported to lead to remodeling of the paranasal sinuses, enophthalmos, and calvarial thickening (1, 2). We report a unique case of progressive enophthalmos and paranasal sinus enlargement in the setting of chronically lowered intracranial pressure.

Materials and Methods
A 44-year-old man with a history of resected central neurocytoma 6 years prior, which was complicated by intraventricular hemorrhage requiring ventriculoperitoneal shunting, presented with somnolence after complaining of severe headaches immediately prior to arrival. Emergent imaging revealed tension pneumocephalus. The ventriculoperitoneal shunt was externalized and the patient's neurologic status returned to baseline.

Results
Emergent noncontrast computed tomography (CT) examination of the head demonstrated tension pneumocephalus. Given the nontraumatic presentation and lack of recent surgical intervention, dehiscence of the markedly enlarged frontal sinuses was suggested as the etiology. Compared to studies from 6 years prior, there had been progressive development of enophthalmos, paranasal sinus enlargement, and calvarial thickening. High-resolution paranasal sinus CT further demonstrated marked thinning of the superior and posterior walls of the frontal sinuses bilaterally. Of note, CT cisternography was not able to demonstrate a cerebrospinal fluid (CSF) leak.

Conclusions
Progressive paranasal sinus enlargement, enophthalmos, calvarial thickening, and spontaneous pneumocephalus are rare complications of chronic intracranial hypotension (1). This constellation of findings is thought to represent the effect of negative intracranial pressure, in this case from the ventriculoperitoneal shunt, and a CSF leak. Due to a proposed "ball-valve" mechanism, cisternography may fail to
demonstrate the site of CSF leak (2). Familiarity with these imaging findings is important for the neuroradiologist to appropriately identify lowered intracranial pressure before a more serious complication such as pneumocephalus develops.
Figure 1. Progressive paranasal sinus expansion and enophthalmos over 6 years. (A, C) Axial contrast CT at time of initial presentation with central neurocytoma in soft tissue and bone (B, D) Axial non-contrast CT 6 years later when patient presented with spontaneous tension pneumothorax demonstrates enophthalmos (white arrow), marked enlargement of the frontal paranasal sinuses with thinning of the posterior wall (white arrowhead), and diffuse calvarial thickening (D, black arrowheads).
Quantification of the Trigeminal Spinal Pathway after Gamma Knife in a Patient with Trigeminal Neuralgia

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Purpose
Aside from the trigeminal cisternal segment, conventional magnetic resonance imaging (MRI) poorly demonstrates changes related to trigeminal neuralgia and its treatment. This case depicts substructure differences within the sensory trigeminal spinal pathway using our newly devised quantitative 3T MRI brainstem protocol.

Materials and Methods
An 86-year-old male had two prior gamma knife radiosurgeries (GKRS) for persistent right trigeminal neuralgia secondary to basilar artery neurovascular compression. He underwent our 3T MRI brainstem protocol which includes new quantitative echo modulation curve (EMC) T2 mapping (1) and super-resolution track density imaging (TDI) (2). Diffusion parameter changes in the treated trigeminal nerve have been described previously (3); however quantitative EMC T2 and TDI changes including the trigeminal spinal pathway now were revealed.

Results
Conventional imaging including an axial CISS sequence showed the dolichoectatic basilar artery compressing the right trigeminal nerve and no appreciable changes in the brainstem. Track density imaging and direction-encoded-color (DEC) TDI showed decreased track density and apparent fiber density (AFD) within the right trigeminal sensory pathway compared to the normal left side (Fig. 1). A summary of the quantitative TDI values measured by manual ROI within the nerve root, spinal tract/nucleus complex at the pontine and medullary levels is provided in Table 1. EMC T2 values showed a similar right versus left asymmetry.

Conclusions
Quantitative imaging of pathologic changes within trigeminal brainstem sensory pathway is possible at 3T. This may serve as a possible in vivo tool to monitor radiosurgery treatment effects in a larger group of future patients.
Fig 1: Multiparametric maps of right trigeminal spinal pathway

CISS w/ neurovascular compression

DEC-TDI w/ small spinal complex

TDI w/ decreased CN

EMC T2 of pontine nuc
Radiation Induced Dacryocystocele with Intense Iodine-131 Uptake: A Diagnostic Conundrum in a Metastatic Thyroid Cancer Patient

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Purpose
Atypical dacryocystocele may be a diagnostic conundrum in the setting of metastatic disease. We present a patient with history of metastatic papillary thyroid carcinoma who presented with a medial canthus soft tissue mass with intense iodine-131 (I-131) uptake. Work up led to diagnosis of dacryocystocele that resolved after endoscopic dacryocystorhinostomy (DCR).

Materials and Methods
A 60-year-old male with stage IVc papillary thyroid carcinoma, presented with left hip metastasis. He underwent total thyroidectomy and left hip arthroplasty, followed by I-131 therapy (199 mCi) and radiation to the left hip. Five years later, patient had rising thyroglobulin levels, prompting additional I-131 treatment (333 mCi). On the seventh post-therapy day, SPECT/CT demonstrated a left medial canthus soft tissue mass with intense tracer uptake. On magnetic resonance imaging (MRI) of the orbits it was hyperintense on T1 and T2 with peripheral enhancement, with imaging characteristics most suggestive of a dacryocystocele rather than metastasis.
Endoscopic DCR and silicone stent placement was performed with complete resolution of the mass.

Results
Single photon emission computed tomography (SPECT)/CT on the 7th day of I-131 treatment demonstrated a left medial canthal mass (Fig. A) with intense tracer uptake (Fig. B). On MRI it was hyperintense on T1 (Fig. C) and T2-WI (Fig. D) with peripheral enhancement (not shown).

Conclusions
Dacryocystoceles typically present as hypoattenuating cystic mass at the medial canthus but may appear as a soft tissue mass on CT, potentially leading to a diagnostic conundrum in metastatic work up. We believe that our patient had developed an acquired dacrocystocele, likely from radiation-induced lacrimal duct stenosis, with excretion of I-131 through the lacrimal system into the dacrocystocele. This report illustrates our team's diagnostic approach for clarifying the nature of a medial canthus soft tissue mass with intense iodine-131 uptake in a metastatic thyroid cancer patient, leading to diagnosis of dacryocystocele that resolved after DCR.
**Figure.** Seven days post iodine-131 therapy SPECT/CT demonstrates soft tissue attenuating mass in the medial left canthus (arrow) on low dose CT (A) demonstrating intense tracer uptake (B – fused SPECT/CT). MRI shows the mass to be hyperintense on T1 (C) and T2 (D) weighted images with peripheral enhancement on T1-weighted post-contrast images (not shown).
Radiation induced spinal cord arteriovenous malformation following treatment of nasopharyngeal carcinoma

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Purpose
Treatment for head and neck malignancies typically includes radiation therapy alone or in combination with chemotherapy, surgery, or both. Potential complications resulting from radiation therapy are variable with wide temporal range, which may be seen within months or multiple years following treatment (1). We present a case of radiation-induced cervical spine arteriovenous malformation (AVM) leading to an intramedullary hemorrhage, hematomyelia. While intracranial radiation-induced vasculopathy has been reported, to our knowledge this is the first case of radiation-induced hematomyelia in a patient treated for head and neck cancer.

Materials and Methods
A 36-year-old male with history of nasopharyngeal carcinoma treated with radiation therapy in 1999 presented in June of 2015 with acute right paraparesis. Magnetic resonance imaging (MRI) at time of presentation demonstrated holocord edema and expansion centered surrounding a focus of susceptibility, which was confirmed to be a hemorrhagic AVM on subsequent catheter angiography. In retrospect, review of prior imaging revealed a focus of susceptibility without cord edema on an cervical spine MRI acquired March 2015, which was not present 3 years prior at December 2012. Patient underwent subsequent embolization for his AVM. Postprocedurally, patient reports steady recovery of his plegia with improvement in strength.

Results
Axial T2-weighted image in December 2012, acquired during surveillance head and neck imaging, reveals no abnormality at the C2-3 level of the cervical cord (Fig. 1A). A follow-up axial T2-weighted image acquired in March 2015 during surveillance demonstrates a new focus of susceptibility in the right lateral hemicord (Fig. 1B). Emergent sagittal T2 image of the cervical spine in June 2015 demonstrates interval holocord edema and expansion centered surrounding the focus of susceptibility at the C2-3 level (Fig 1C). Corresponding digital subtraction angiography revealed a radiculomedullary-feeding artery to this lesion (Fig. 1D), which was consistent with an intramedullary AVM.
Conclusions
Commonly reported complications following radiation therapy to the neck have included mucosal irritation, osteoradionecrosis of bony structures, myelopathy, and radiation induced neoplasms. However, radiation-induced vasculopathy to the spine rarely has been reported. In review of the literature, there have been two other reported cases of radiation-induced intramedullary spinal cord hemorrhage, which includes a patient with thoracic spine Ewing sarcoma and another with breast malignancy, both treated with radiation therapy (2, 3). Spinal cord hemorrhage typically presents with myelopathy with sudden back pain (4). Knowledge of this potential complication in patients treated with radiation therapy is important for recognition and prompt diagnosis.
Radiologic and Pathologic Manifestations of Neuro-Behcet Disease: An Illustrative Case Series

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Purpose
Behcet disease (BD), a rare systemic inflammatory vasculitis of unknown cause, is primarily diagnosed clinically by the combination of recurrent oral ulcerations with two or more additional characteristic genital, ophthalmic and skin findings. However, patients with BD also can develop neurological symptoms as their initial presentation. Here, we present magnetic resonance imaging (MRI) findings of three patients who initially presented with vague neurological symptoms and were eventually diagnosed with BD. Two patients had brain biopsies as a part of their testing. These cases illustrate several characteristic MRI features in neuro-Behcet disease and provide pathologic correlations for these findings.

Materials and Methods
Patient A is a 60-year-old Asian male who presented with worsening seizures and sub-acute cognitive decline over 8 months. His cerebrospinal fluid (CSF) demonstrated inflammatory changes and his brain biopsy yielded perivascular lymphocytic infiltrates. He eventually was found to have oral and genital ulcerative lesions, biopsies of which also supported a diagnosis of BD. Patient B is a 58-year-old Caucasian female who presented with two episodes of headache and encephalopathy. Biopsy of her brain lesions yielded perivascular inflammatory infiltrates and areas of necrosis. She eventually developed recurrent ulcers and skin lesions that led to a diagnosis of BD. Patient C is a 16-year-old Caucasian male who presented with multiple episodes of memory loss and cognitive decline, initially after a viral illness at 15 years of age. He eventually developed recurrent oral ulcers and uveitis that led to a diagnosis of BD.

Results
Patient A's MRI examination was notable for diffuse leptomeningeal enhancement and FLAIR signal abnormality, most predominant over the left frontal lobe. These changes improved over the course of 2 months with treatment. Patient B was found to have multiple mass-like areas of white matter signal abnormality in the bilateral supratentorial brain, midbrain and pons. Many lesions were subcortical in location and demonstrated faint patchy enhancement. These findings significantly improved after treatment. Patient C had numerous scattered foci of nonenhancing T2 hyperintensity
in his bilateral hippocampi and putamen, as well as right caudate. These findings remained stable across time and likely reflect vasculitis-related ischemic changes.

Conclusions

We present three patients who presented to our institution with neurological complaints and abnormal MRI findings that, in combination with clinical history, eventually led to diagnoses of BD. As a part of their diagnoses, two patients underwent brain biopsies that yielded nonspecific perivascular inflammatory changes compatible with BD. By careful consideration of medical history and characteristic MR imaging features, accurate diagnosis of BD can be made and impact the therapeutic strategy. (Fig. 1) Left frontal leptomeningeal enhancement in patient A. (Fig. 2) Multifocal subcortical FLAIR signal abnormality in patient B. (Fig. 3) Diffuse pontine FLAIR signal abnormality in patient B. (Fig. 4) Caudate and putaminal T2 signal hyperintensity in patient C.
Removal of a Traumatic Skull Base Nail after Internal Jugular and Internal Carotid Artery Embolization

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Purpose
1. Present an interesting case of a 52-year-old male who had a penetrating nail injury to the skull base with tip embedded in the cerebellum. 2. Demonstrate the steps of successful interventional removal of a nail from the skull base after internal jugular and internal carotid artery embolization. 3. Discuss literature review of skull base nail injuries regarding approach to removal and clinical outcomes.

Materials and Methods
A 52-year-old male fell off the roof holding a pneumatic nail gun and accidentally shot himself with a nail through the right frontal neck region. Based on computed tomography angiography (CTA) and cerebral angiography, the nail penetrated the right sternocleidomastoid muscle. It extended intracranially through the right occipital condyle with its tip embedded in the cerebellum. The nail coursed between the right internal jugular vein and right internal carotid artery. There was no evidence of vascular injury on initial cerebral angiography. The studs of the nail were abutting the right sigmoid sinus making for high risk of intracranial hemorrhage from potential sigmoid sinus tear upon nail removal. Therefore, preventative coil embolization of the right dural venous occipital sinus, sigmoid sinus, and jugular bulb was performed prior to nail removal. In the neurointerventional angiography suite using biplane fluoroscopy, a Hick needle was advanced into the course of the embedded skull base nail and orthopedic screw removal pliers were successful in snaring the head of the nail. Upon initial removal attempt, the head of the nail injured the right cervical internal carotid artery requiring coil embolization. The patient had intracranial collaterals via the anterior communicating artery without evidence of ischemic stroke after the procedure. The nail then was extracted successfully from the neck without significant postprocedural hemorrhage. There was delayed occlusion of the right ophthalmic artery evident by right visual loss that had mildly improved on outpatient follow up. Patient's rightward tongue deviation related to the initial injury also had progressively improved.

Results
A) 3D reconstruction of source CTA imaging demonstrates nail extending through
right occipital condyle with tip embedded in right cerebellum. B) Prophylactic coil embolization of right internal jugular bulb, right sigmoid sinus, and right occipital sinus was performed to prevent potential sinus thrombosis formation and propagation. C) Successful biplane fluoroscopically guided removal of nail with orthopedic screw removal plyers. D) Preserved cerebral venous sinus run after nail removal.

Conclusions
We present a unique approach to skull base nail extraction in a 52-year-old male preceded by coil embolization of dural venous sinuses on the right and the internal carotid artery on the right. Despite improving right visual loss related to the ICA embolization, no focal neurologic deficits were evident on the patient's one-month outpatient follow up.
Segmental Artery Mediolysis Involving the Internal Carotid Artery: An Uncommon Diagnosis

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Purpose
To review the clinical and imaging features of segmental arterial mediolysis (SAM).

Materials and Methods
A 53-year-old female presented to her local emergency department for left upper quadrant abdominal pain. Computed tomography (CT) scan of the abdomen revealed a splenic infarction. Further investigation with laboratory analysis and CT angiography lead to a diagnosis of segmental artery mediolysis (SAM) involving both renal, both gastroepiploic, and the left gastric arteries. The patient subsequently experienced multiple episodes of tingling and twitching of her right forehead, nose, cheek and eyelid. An MRI/MRA of the head and neck was obtained to evaluate her neurologic symptoms.

Results
Magnetic resonance imaging/magnetic resonance angiography (MRA) of the head and neck demonstrates a focal dissection in the left cervical ICA with associated 5 mm pseudoaneurysm (A), a 3 mm left supraclinoid ICA aneurysm (B), and long segment dilatation of the right ICA (C). Computed tomography angiography (CTA) of the abdomen demonstrated an irregular beaded dilatation of the renal arteries, right gastroepiploic (D), left gastric and left gastroepiploic arteries.

Conclusions
SAM is a rare nonatherosclerotic and noninflammatory arteriopathy of unknown etiology characterized histologically by lysis of smooth muscle within the media of muscular arteries in middle-aged and elderly patients. The necrosis of the smooth muscle results in arterial wall defects which lead to the characteristic imaging features of focal dissection, aneurysm, stenosis or occlusion. SAM most commonly affects the intra-abdominal and retroperitoneal arteries; however involvement in the head and neck is seen in approximately 20% of patients, most frequently affecting the carotid or vertebral arteries. There is significant overlap in the histology and arterial distribution of SAM and fibromuscular dysplasia (FMD), which has led some to speculate that SAM is a variant of or evolutionary precursor to FMD. However, the clinical presentations of the two entities remain distinct. Fibromuscular dysplasia often presents asymptptomatically in younger females, whereas SAM presents as abdominal pain, vascular occlusion or hemorrhage in older adults. Histology further helps
delineate SAM from vasculitides such as polyarteritis nodosa, as there is a lack of inflammatory change. As such, corticosteroid therapy is not helpful, and often is thought to be counterproductive. Aneurysm rupture of abdominal, retroperitoneal, or intracranial arteries is a life-threatening complication with mortality near 50%, and thus treatment is aimed at preventing hemorrhage. Endovascular coiling of large aneurysms is the mainstay of therapy. Imaging thus plays a crucial role in diagnosis, identification of complications, and targeting therapy in SAM.
Simply Diffuse Bilateral Thyroid Gland Colloid Cysts? Surprise! Zebra Lymphoepithelial Cysts

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Purpose
Lymphoepithelial cysts of the thyroid are a very rare entity that may present as an enlarging neck mass or may be found incidentally.

Materials and Methods
The patient is a 66-year-old man with hypothyroidism, enlarging thyroid goiter, and recent FNA with findings suspicious for but not conclusive of malignancy. The patient noted increasing dysphagia and marked enlargement of the left side of his neck, and he subsequently underwent computed tomography (CT) and thyroid ultrasound evaluation. Since the patient was symptomatic from the enlarging mass, he elected for a total thyroidectomy. Intra-operatively, the thyroid appeared to be composed almost entirely of numerous 1-3 cm tense and thin-walled cystic structures. While removing the right thyroid lobe, several of these cysts burst with even gentle retraction on the gland leading to considerable "deflation" of the lobe. The left lobe had a similar cystic appearance. Pathology demonstrated complete replacement of the entire thyroid gland by lymphoepithelial cysts without any residual normal thyroid tissue.

Results
Shown is a contrast-enhanced axial CT image through the inferior pole of the thyroid gland, along with corresponding ultrasound images obtained in the transverse plane through the inferior pole. On the CT image, there is multiseptated cystic appearance of the enlarged thyroid gland, which correspond to alternating mass-like areas of varying echogenicity on ultrasound, some of which sonographically appear complex cystic and solid rather than purely cystic.

Conclusions
Lymphoepithelial cysts of the thyroid gland are very rare and histologically similar to branchial cleft cysts. There are less than five reported cases with bilateral lymphoepithelial cysts, and there is no reported case in which the entire thyroid parenchyma has been replaced completely by multiple lymphoepithelial cysts, leaving...
not even a rim of normal thyroid tissue. Familiarity with this clinical entity is helpful in achieving its correct diagnosis with confidence.

EE-01

Steroid-Responsive Encephalopathy Associated with Autoimmune Thyroiditis: Findings on Catheter Angiography and Evolution of MRI abnormalities
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Purpose
Steroid-responsive encephalopathy associated with autoimmune thyroiditis (SREAT) aka Hashimoto's encephalitis is a well recognized but poorly understood complication of autoimmune thyroid disease. This electronic excerpt demonstrates a case of Hashimoto's encephalitis with migratory encephalitis on magnetic resonance imaging (MRI) and angiographic findings associated with this disease. This excerpt also reviews previous literature on this topic.

Materials and Methods
A 41-year-old female presented with a few week history of difficulties with word finding and fluency. Past medical history was significant for hypertension and right-sided vision loss at age 19 secondary to acute zonal occult outer retinopathy. Magnetic resonance imaging performed the day of presentation revealed a focus of increased T2 signal within the cortical and subcortical inferior left temporal lobe. No associated enhancement or diffusion restriction was present. The patient's language difficulties abated spontaneously 1 week after her initial presentation. She presented to the emergency room 85 days after her initial presentation after suffering a generalized tonic clonic seizure. Magnetic resonance imaging demonstrated complete resolution of the previous left temporal lobe lesion with a new, similar-appearing process within the cortex and subcortical white matter of the right frontal and temporal lobes. Serology demonstrated elevated anti-thyroid peroxidase antibody levels of >1300 U/ml (reference range < 60 U/mL) and elevated anti-thyroglobulin antibody levels of 373 U/mL (reference range < 60 U/mL). Catheter angiography performed the following day demonstrated increased perfusion and decreased transit time within the right frontal lobe corresponding to the abnormality seen on MRI. The patient was maintained on steroids and was asymptomatic at most recent outpatient follow up.

Results
Intermittent MRIs from 2/19/2015-7/24/2015 demonstrated transient regions of increased T2/FLAIR signal within the cortical and subcortical frontal and temporal lobes consistent with a migratory encephalitis. Catheter angiography on 5/21/2015 demonstrated a focal parenchymal abnormality with edema and arteriovenous shunting in the right posterior temporal lobe, corresponding to the MR abnormality. No angiographic evidence of change in arterial caliber was identified to suggest medium or large vessel vasculitis. After treatment with steroids, MR imaging of 10/24/2015 demonstrated near complete resolution of the previously identified encephalitis.

Conclusions
Imaging findings of SREAT are nonspecific; yet, the combination of clinical presentation, imaging findings, laboratory analysis and response to steroids help steer
toward the diagnosis. While the pathogenesis of SREAT remains unclear, biopsy findings and steroid responsivity suggest a potential vasculitic process. Findings of lesional hyperperfusion on catheter angiography are supportive of an underlying microvascular abnormality. As such, further investigation of perfusional imaging abnormalities may provide insight into the pathophysiology of SREAT.
EE-11

6:00AM - 2:45PM

T1-Weighted Hyperintensity in the Pulvinar: NOT Diagnostic of Fabry Disease

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Purpose

T1-weighted hyperintensity in the pulvinar nuclei of the thalamus was reported as a characteristic imaging finding of Fabry disease (1). However, recent reports have shown that intrinsic T1 shortening is evident in the brain after multiple injections of gadolinium contrast in the dentate nuclei of the cerebellum and globus pallidus (2). To illustrate the potential diagnostic challenge that this creates, we present a patient with an imaging appearance suggestive of Fabry disease but with a history of numerous prior contrast-enhanced magnetic resonance imaging (MRI) scans who demonstrates...
Materials and Methods
This 48-year-old woman with medullary thyroid cancer had a brain MR evaluation for suspected brain metastasis. In the 6 years prior to this study, the patient received gadolinium-based contrast 28 times, primarily for abdominal MR, to evaluate liver metastasis progression. During this time, the patient received a cumulative dose of 108.4 g gadobenate dimeglumine over 27 administrations, and a single administration of 1.8 g gadoxetate disodium. Prior to the diagnosis of thyroid cancer the patient was otherwise healthy without history of metabolic disorder such as Fabry disease, liver disease, or renal impairment. At the time of brain MRI, there was no focal neurologic deficits and kidney and liver function were normal.

Results
Evaluation of precontrast T1-weighted images demonstrates prominent symmetric T1 hyperintensity in the dentate nuclei of the thalami, the midbrain, the globi palladi, and the pulvinar nuclei of the thalamus. There is no associated abnormal T2-weighted signal, restricted diffusion, susceptibility, mass effect, or contrast enhancement. Conclusions
Although increased T1-weighted signal in the pulvinar has been reported as a characteristic finding of Fabry disease, we suggest that this appearance may be seen in patients without Fabry disease or other metabolic disorder who had multiple prior gadolinium contrast injections. It is important to recognize this potential pitfall whenever T1 shortening in the pulvinar is seen along with T1 shortening elsewhere in the basal ganglia and cerebellum in order to avoid diagnostic confusion and unnecessary testing for Fabry disease.
The Vanishing Tumor: Glioblastoma Multiforme Mimicking CNS Lymphoma in Response to Steroids

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Purpose
We present a case of a left parietal brain mass initially suspected to be central nervous system (CNS) lymphoma, but eventually diagnosed as glioblastoma multiforme (GBM). We discuss initial presentation, imaging findings, and ultimate diagnosis following biopsy and excision, with pathologic correlation.

Materials and Methods
A 61-year-old woman presented after noticing mild clumsiness and difficulty manipulating small objects. Initial imaging demonstrated a left parietal lobe mass, suspicious for GBM. The patient was placed on steroids and scheduled for presurgical functional magnetic resonance imaging (fMRI). The fMRI performed 3 weeks later demonstrated resolution of contrast enhancement with decreased tumor size and surrounding FLAIR hyperintensity. Her surgery was cancelled and steroids were tapered, with high suspicion for lymphoma. She presented a few weeks later to
an outside hospital with word finding difficulty, at which time an MRI showed an
increase in tumor size with new peripheral enhancement. She was restarted on steroids
and transferred to our institution, with a biopsy for probable CNS lymphoma. Biopsy,
however, demonstrated a hypercellular glial neoplasm with GFAP immunopositive
tumor cells with mitoses and necrosis, consistent with GBM. The patient then
underwent tumor resection, which confirmed the diagnosis of GBM.

Results
Computed tomography (CT) at initial presentation (A) showed a 4.5 cm
predominantly hyperdense mass centered in the left parietal lobe and an MRI (B)
demonstrated a heterogeneous, predominantly enhancing left parietal lobe mass
isointense to parenchyma on apparent diffusion coefficient (ADC), with small areas of
nonenhancement centrally and surrounding FLAIR hyperintensity. The presurgical
MRI (C) showed near complete resolution of enhancement and decrease in size of the
mass and surrounding abnormal FLAIR signal. An MRI performed after onset of new
symptoms and off steroids (D) showed an increase in size of the mass with
development of thick and nodular peripheral enhancement and progression of
surrounding FLAIR hyperintensity.

Conclusions
Resolution of contrast enhancement following treatment with steroids does not
preclude the diagnosis of GBM. This mass did not demonstrate restricted diffusion,
which may help in differentiating GBM from lymphoma.
Thinking Outside the Intracranial Box

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Purpose
This presentation will discuss the importance of clinical history and relevance of awareness of the patient's past medical and surgical history in relation to image problem solving.

Materials and Methods
A 53-year-old female with 6 month history of progressive blurry vision in the right eye was referred for time of flight (TOF) magnetic resonance angiogram (MRA) of the head and neck and magnetic resonance imaging (MRI) of the orbit. Initial work up raised concern for a dural arteriovenous fistula given flow-related signal of the venous sinuses on initial MRA and prominence of the cortical veins on MRA and subsequent computed tomography (CT) venogram. Conventional angiogram excluded the diagnosis of dural arteriovenous fistula (AVF); however, the persistent cortical vein prominence, nonvisualization of expected dural venous drainage and visualization of left brachiophephalic stent on scout image in the setting of prior renal failure with arteriovenous fistula placement in left arm discovered on preprocedure history and physical, prompted further investigation into the evaluation of the patency of the patient's left arm fistula and brachiophephalic venous stent. Real time ultrasound performed postprocedure lead to the discovery of high arterialized flow of the AVF accentuated by stenosis of the brachiophephalic venous stent resulting in flow reversal of the left internal jugular vein extending into the intracranial dural venous sinuses.

Results
Time of flight MRA demonstrated prominent veins within the left temporal extra-axial space, as well as flow related signal within the left transverse and sigmoid sinus, which raised the possibility of a left temporal dural arteriovenous fistula. Subsequently, a CT angiogram and venogram was performed which demonstrated persistent prominence of the left temporal cortical veins as well as prominent venous drainage of the left pterygoid plexus and enlargement of the foramen of Vesalius. No obvious dural arteriovenous fistula was identified. Symmetric contrast enhancement of the dural sinuses was appreciated excluding the possibility of dural sinus venous thrombosis. A conventional angiogram of the head was performed confirming the absence of a dural arteriovenous fistula; however, absence of the typical visualization of the dural sinuses during the early draining phase was noted. Instead, prominent cortical veins again were seen, as well as prominent venous drainage to the pterygoid plexus via an enlarged emissary vein. A brachiophephalic stent was visualized on the angiogram scout image. After the procedure, a real-time ultrasound was performed, which demonstrated high arterialized flow of the AVF exacerbated by brachiophephalic venous stent stenosis with resultant flow reversal of the left internal jugular vein extending into the intracranial dural venous sinuses.

Conclusions
The importance of good clinical information such as the patient's prior medical history
must not be overlooked. In the setting of patients with known renal dysfunction and arteriovenous fistula, consideration of their patency and distal venous patency is warranted to avoid unnecessary testing and delayed treatment of an extracranial problem.
Unilateral manifestation of deep cerebral vein thrombosis

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Purpose
Deep cerebral vein thrombosis (DCVT) typically results in bilateral involvement of the thalami and other deep gray nuclei. We present a case of DCVT with striking left-sided involvement that prompted an initial diagnosis of neoplasm. Neuroradiologists should be aware of the rare unilateral presentation of DCVT so that appropriate imaging and intervention are initiated.
Materials and Methods
A 71-year-old woman with recently diagnosed acute myelogenous leukemia was brought to her local hospital after initially being found unresponsive at home, unable to move her right side, and with speech difficulty. Head computed tomography (CT) and brain magnetic resonance imaging (MRI) showed a lesion involving the left thalamus and basal ganglia with hemorrhage, edema and mass effect. She received steroids and anti-epileptics. Her mental status declined, requiring endotracheal intubation and ventricular drain placement. At our institution, she was found to be in status epilepticus, neutropenic, thrombocytopenic and febrile. She was covered with broad spectrum antibiotics, but bacterial and fungal blood cultures were negative. Repeat brain MRI demonstrated DCVT with left-sided hemorrhagic venous infarct. Venography confirmed this diagnosis. Successful mechanical thrombectomy was performed in the straight sinus and left transverse sinus. Despite these measures, the patient remained comatose throughout her hospitalization and died after withdrawal of care.

Results
Initial head CT showed expansile hypoattenuation in the left thalamus and basal ganglia, hemorrhage in the left caudate head, and density in the straight sinus and vein of Galen. Follow-up brain MRI demonstrated progressive left basal ganglia and thalamic hemorrhage, cytotoxic edema, and surrounding vasogenic edema in the left cerebral white matter and splenium. Susceptibility-weighted along with thin-section T1-weighted images depicted subacute clot in the straight sinus, proximal right internal cerebral vein and basal veins, and occluded left internal cerebral vein, findings confirmed on CT venography. Conventional venography showed thrombosis of the straight sinus extending into the left transverse sinus with good reflux of contrast following thrombectomy.

Conclusions
Deep cerebral vein thrombosis is associated with multiple conditions that may have played a role in this case, including coagulopathy, malignancy, dehydration and infection. Deep cerebral vein thrombosis typically arises from propagation of more widespread dural sinus thrombosis. Due to shared straight sinus drainage, there is usually bilateral if variable involvement of the deep gray nuclei. This case is rare for its striking asymmetry, and findings initially were thought to reflect neoplasm. Note that vasogenic edema and hemorrhage are primary early manifestations of venous infarct. Involvement of multiple arterial territories is also a clue to diagnosis. Finally, 3D T1-weighted imaging was obtained as part of a protocol for surgical navigation. In our experience, these sequences may be quite useful and compliment other methods in depicting cerebral, dural or cavernous sinus thrombosis.
Unilateral Posterior Reversible Encephalopathy Syndrome (UPRES) in a Patient with Sickle Cell Disease

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Purpose
Cerebrovascular involvement in patients with sickle cell disease (SCD) most commonly results in infarct or hemorrhage. Patients with severe SCD often take Tacrolimus for immunosuppressive therapy following hematopoietic transplant. Tacrolimus-induced posterior reversible encephalopathy syndrome (PRES) is a rare but known phenomenon. PRES in SCD patients is exceedingly uncommon. In general, unilateral variant of PRES (UPRES) only accounts for 3% of PRES patients (1). We present a 12-year-old male with right-sided UPRES.

Materials and Methods
A 12-year-old male with history of SCD is admitted to the hospital for scheduled haploidentical stem cell transplant. On post-transplant day 20, the patient developed sudden onset of severe headache, visual disturbance and hypertension. Patient's clinical and radiologic presentations are highly compatible with UPRES.
Results
Computed tomography (CT) of the head shows hypodensity in the right posterior temporal region. Magnetic resonance imaging (MRI) reveals T2 hyperintensity on FLAIR sequences that are present in the subcortical distribution in the right tempor-occipital region, consistent with right-sided UPRES. There also is left cerebral hemisphere volume loss. Concurrent MR angiography shows left internal carotid artery occlusion with preservation of the left posterior circulation. Follow-up MRI 2 weeks later demonstrates complete resolution of the right-sided UPRES.

Conclusions
Posterior reversible encephalopathy syndrome is a well known complication of certain immunosuppressive therapy. Patients with severe SCD often take Tacrolimus following hematopoietic transplant. PRES has been classically characterized as symmetric white matter changes predominantly involving the parietooccipital regions. Although the leading theory behind the pathophysiology of PRES is the loss of autoregulatory capability of the cerebral vasculature resulting in hyperperfusion and subsequent capillary leakage and edema (2), the etiology for unilateral presentation of PRES in our patient is unclear. Certain modifying factors such as left internal carotid artery occlusion or chronic left cerebral infarct may have played a role to give this unique presentation.
When the immune system attacks the brain: anti-GAD 65 spectrum of imaging findings

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Purpose
This abstract shows the spectrum of imaging findings in a case of anti-Gad 65 auto-immune cerebritis. Positron emission (PET)/computed tomography (CT), angiography, and magnetic resonance imaging (MRI) including advanced imaging (spectroscopy, perfusion) all were utilized in the work up.

Materials and Methods
A 71-year-old man with 1 month gradual onset of aphasia and a single seizure. Past medical history shows only hypertension. No surgical or oncologic history. Social history was unremarkable. Computed tomography and MRI imaging (as well as direct angiography) were utilized in the work up of the seizures/aphasia, with initial suspicion of arterial ischemia as a possible cause. Additional evaluation with PET/CT and advanced MR techniques (spectroscopy and perfusion) also were performed. Three separate lumbar punctures were completed, and ultimately a brain biopsy under stereotactic guidance was done. Despite multiple medical interventions (including plasmapheresis, steroids, and IVIG), the patient's condition worsened and he expired approximately 1 month after admission.

Results
Multiple cortically based T2/FLAIR hyperintense nonenhancing lesions with masslike expansion of the gyri. These same regions are hypodense on the unenhanced CT exam. Positron emission tomography/CT shows increased FDG avidity when compared to the adjacent (unaffected) brain parenchyma. Magnetic resonance spectroscopy reveals suppression of the normal NAA peak and mildly depressed choline/creatine ratio. There is a prominent lactate doublet. Perfusion analysis shows mildly increased rCBV at the margins of the T2/FLAIR signal abnormality. Concurrent CT chest/abdomen/pelvis studies were negative. On repeat MR imaging, there was continued expansion of T2/FLAIR signal abnormality despite attempted medical management. Findings were consistent with progression of disease.

Conclusions
This abstract shows the spectrum of imaging findings in a rare auto-immune cause of cerebritis. Though many of the imaging characteristics are nonspecific, the
A combination of features can help us aide our neurological and neurosurgical colleagues in identifying a possible inflammatory source.

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**EE-12**

**Wolfram Syndrome: Classic Imaging Findings of an Uncommon Disease**

E Carolan¹, J Morris¹

¹Mayo Clinic, Rochester, MN

**Purpose**
To review the imaging findings and clinical presentation of a case of Wolfram syndrome.

**Materials and Methods**
A 33-year-old female with a past medical history significant for optic nerve atrophy (age 5), type 1 diabetes (age 8), seizures (age 10), and urinary incontinence (age 14) presented to the ER with altered mental status and underwent neuroimaging. Later it also was revealed she began experiencing ataxia, cognitive difficulties, and swallowing difficulties beginning at age 30.

**Results**
Marked atrophy of the pons, cerebellum, and middle cerebellar peduncles without atrophy of the superior cerebellar peduncles or cerebral cortices.

**Conclusions**
Clinical history combined with the imaging was consistent with a diagnosis of Wolfram syndrome, a rare autosomal recessive condition described by Wolfram and
Wagener in 1938 (1). Patients present with insulin-dependent diabetes and optic nerve atrophy in early childhood and diabetes insipidus, neurologic dysfunction, and sensorineural deafness in the teenage years (2). These collective clinical findings of diabetes insipidus, diabetes mellitus, optic atrophy, and deafness give rise to the alternative name DIDMOAD (2). Neuroimaging findings are scant but include atrophy of the brain stem, cerebellum, and middle cerebellar peduncles (3, 4, 5). Neuroradiologists should add this to the differential of brain stem atrophic conditions such as spinocerebellar ataxia, multiple system atrophy, and dentatorubral pallidoluysian atrophy.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-1

Education Exhibit Poster (EdE) - Adult Brain
EdE-33

3D Intracranial Vessel Wall Imaging - Technical Considerations, Clinical Implementation, and Case-Based Review

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Purpose
Several MR imaging techniques, such as time-of-flight, phase contrast and bolus contrast-enhanced MRI, are currently available for diagnosis and treatment planning of neurovascular disorders. Despite their value, these techniques share a common limitation with conventional angiograms: they are mainly "luminograms" and provide limited information about the vessel wall itself, which is commonly the initial site of several disease processes. High resolution intracranial vessel wall MR imaging (IVWMRI) using 3D turbo spin echo (TSE) is an emerging technique that shows promise in assessing vascular pathology. The purpose of this exhibit is to present an educational review of the technical and practical concepts underlying VWMRI.

Materials and Methods
The first section of this exhibit will focus on the technical aspects and physical principles of high resolution IVWMRI, as well as options for clinical protocols. The second part will showcase the experience of our institution utilizing a 3 Tesla 3D isotropic TSE "black blood" protocol, including optimization trade-offs, acquisition strategy and normal findings. The third section will describe an interpretation framework for vessel wall pathology and discuss clinical applications utilizing clinical
cases. Lastly, we will comment on some pitfalls and limitations of this technique and discuss future directions.

Results
Requirements for successful IVWMRI acquisitions include isotropic, high spatial resolution, good soft tissue contrast, multiplanar capabilities and adequate suppression of intravascular flow. These goals can be accomplished successfully with modern TSE based, low refocusing flip angle 3D acquisitions. Main implementation trade-offs include coverage, acquisition time, SNR and spatial resolution.

Conclusions
Intracranial vessel wall MRI is a relatively new technique that shows great promise to complement the traditional "luminographic" information obtained with MR angiographic techniques in neurovascular disorders. With the advent of the latest hardware and software improvements to MRI scanners, IVWMRI has reached maturity to become standard in the diagnostic toolkit of neuroradiologists.
**Top Row:** 50 year old man presented with altered mental status and mild headache on MRI. Coronal 3D T1W VISTA sequences, precontrast (A) and postcontrast (B) imaging reveal abnormal enhancement in the superior wall of the right middle cerebral artery. The final diagnosis was syphilis vasculitis.

**Bottom Row:** 27 year old female with history of fibromuscular dysplasia presenting with ischemic stroke like symptoms and infarcts on MRI. Axial (C) coronal (D) 3D T1W VISTA sequences, precontrast shows circumferential T1 hyperintensity in the wall of the carotid artery with luminal narrowing, consistent with acute/subacute dissection.
Purpose
To describe characteristic brain MRI findings in patients presenting with dementia.

Materials and Methods
Accurate and timely diagnosis of dementia is important to guide treatment and provide appropriate support to the patient and their families. Signal change and proper characterization of cerebral atrophy can be used to identify diagnostically relevant imaging features, which greatly aid in the clinical diagnosis of dementia. While no particular imaging finding has perfect sensitivity and specificity, this case-based review describes characteristic brain MRI findings that provide a fairly high positive predictive value to narrow the differential diagnosis for dementia.

Results
Early diagnosis of dementia depends on timely identification of the underlying cause. This case-based review will illustrate characteristic neuroimaging findings in the following causes of dementia:

- Alzheimer disease: global cerebral atrophy, primarily involving the mesial temporal lobe and the posterior cortex (parietal/occipital).
- Frontotemporal lobar degeneration: seen in Pick's disease and corticobasal degeneration. Asymmetric cerebral atrophy primarily involving the frontal and temporal lobes.
- Vascular dementias: these are further classified into - o Small vessel disease (Binswanger's disease): multiple/confluent areas of T2/FLAIR hyperintensities involving more than 1/4th of the white matter. Temporal lobe involvement is seen in CADASIL. o Large vessel disease (Strategic infarcts): T2/FLAIR hyperintensities with corresponding T1 hypointensities in strategic locations such as arterial territories, association areas and watershed carotid territories.
- Parkinson's disease: loss of high T2*/SWI signal in the substantia nigra/nigrosome – "absent swallow tail sign".
- Creutzfeldt-Jakob disease: T2/FLAIR hyperintensity with high DWI signal in the basal ganglia, especially the putamen, and the thalami – "hockey stick or pulvinar sign".
- Progressive supranuclear palsy: atrophied midbrain and a preserved pons gives the brainstem the appearance of a humming bird on the sagittal view – "humming bird sign".
- Olivopontocerebellar atrophy: disproportionate atrophy of the brainstem and cerebellum, especially involving the olivary nuclei and...
the middle cerebellar peduncle. • Normal pressure hydrocephalus: ventriculomegaly, upward bowing of the corpus callosum and narrowing of the posterior aspect of the cingulate sulcus compared to the anterior – "cingulate sulcus sign". • Wernicke-Korsakoff syndrome: T2 hyperintensity in the mammillary bodies, dorsomedial thalami, tectal plate, periaqueductal gray matter and around the third ventricle.

Conclusions
Identification of characteristic neuroimaging findings is key to early diagnosis of dementia. Interpretation of these findings in the correct clinical context provides a high diagnostic value and aids in the differentiation between various causes of dementia.
High signal in the periaqueductal region (arrow), seen in Wernicke-Korsakoff dementia

(a) Widened cingulate sulcus anteriorly (white arrows), and (b) posteriorly (white arrows) is consistent with Normal Pressure Sulcus sign™, there is associated ventriculomegaly (red arrow).

(a) High signal in the caudate nuclei and putamen (arrows) and (b) high signal within the cortex (arrows) on DWI images is consistent with Creutzfeldt- Jakob Disease.

Loss of normal high signal in on GRE sequences is seen in swallow tail sign™.
Arterial Spin Labeling: Hypoperfusion, Hyperperfusion, and Beyond

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Purpose
To discuss advanced interpretation and applications of arterial spin labeling (ASL), using a case-based and image-rich format.

Materials and Methods
Arterial spin labeling (ASL) is a noncontrast MRI technique that enables quantification of absolute cerebral blood flow (CBF). In this exhibit, we will review the underlying physical principles and technical approaches. Next, we will present normal variants and pitfalls important to recognize and avoid diagnosing as pathology. Clinical applications of ASL will be discussed using a case-based format. Three major categories will be covered: Hypoperfusion, Hyperperfusion, and Beyond. Through investigation of advanced cases, this presentation will highlight the subtleties and nuances of ASL interpretation, as well as cutting-edge clinical and research applications of this technique.

Results

Conclusions
Arterial spin labeling (ASL) is a convenient and noninvasive technique for CBF assessment with diverse applications including stroke/vasculopathy, vascular malformations, tumors, dementias, epilepsy, and CSF flow. Following review of advanced cases, the neuroradiologist will better appreciate the intricacies and pitfalls of ASL interpretation, and be equipped to apply this technique to novel clinical/research scenarios.
Big Whorls and Little Whorls: A Diagnostic Approach to Balo's Concentric Sclerosis Based on a Meta-Analysis of 68 Patients

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Purpose
Balo concentric sclerosis (BCS) is a distinct but lesser known form of demyelinating disease characterized by concentric layers of demyelination and relative myelin preservation. If left untreated, BCS classically results in rapid clinical deterioration and a high rate of mortality. Balo concentric sclerosis may occur in concert with or independent of multiple sclerosis (MS). At imaging, BCS often is mistaken for a neoplasm, resulting in biopsy. The purpose of this study is to formulate a diagnostic approach to BCS using imaging, lab, and clinical criteria through a meta-analysis of 68 patients described in the literature, in order to avoid unnecessary surgical biopsies.

Materials and Methods
Sixty-eight patients diagnosed with BCS between 1995 and 2015 were studied. Data were collected for the clinical presentation and course, imaging, spinal fluid analysis, treatment, and outcome.

Results
Concentric layered appearance on T2-weighted imaging (T2WI) was present in 91% of patients. Characteristic arc-like or concentric enhancement was seen in 97% of patients. In two patients, classic features were seen only after follow-up imaging on T2WI and after contrast administration. Spectroscopy revealed an elevated Cho/NAA consistent with tumor or demyelination in 100% of patients imaged. Cerebrospinal fluid (CSF) analysis revealed oligoclonal bands in only 30% of patients tested. Patients showing oligoclonal bands on CSF analysis either had known MS, or imaging features suggestive of MS. An acute or subacute clinical presentation was present in 97% of patients. Progressive clinical deterioration prior to treatment was seen in 30% of patients. A significant improvement (87%) or deterioration (7%) in the subacute therapeutic window (high dose steroids) was seen in 94% of patients, with a more moderate tumor-like response in only six percent. Only two patients succumbed to the...
disease. Despite the classical imaging patterns and clinical features in the majority of cases, 17 (25%) underwent a biopsy.

Conclusions
Complete/near complete recovery is possible in cases of BCS with early diagnosis and therapy. Our analysis suggests that the best predictors of BCS are concentric rings and classic enhancement patterns on T2W and T1W imaging respectively, acute or subacute clinical presentation, and a dramatic change in clinical status after high dose steroid administration. Cerebrospinal fluid analysis is of limited value and MR spectroscopy (MRS) is of no value in differentiating BCS from tumor. A mindfulness of these imaging and clinical parameters can be used to formulate an algorithm (figure) to minimize biopsy of BCS well below the current 25% rate.
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EdE-39

6:30AM - 2:45PM

Clinical Applications of Susceptibility Weighted Imaging in the Neuroimaging

J Lee¹, Y Lee², D Park³
Purpose
Susceptibility-weighted imaging (SWI) now is commonly used in clinical neuroimaging. Susceptibility-weighted imaging can provide important information in the vascular pathology, stroke, traumatic brain injury, and neurodegeneration with brain iron accumulation. Therefore, our study was to understand the principle of SWI and demonstrate the various imaging features using SWI.

Materials and Methods
1. Understanding of SWI. 2. Susceptibility-weighted imaging of vascular pathology. 3. Susceptibility-weighted imaging in the setting of stroke. 4. Susceptibility-weighted imaging of traumatic brain injury and intracranial hemorrhage according to the stage. 5. Susceptibility-weighted imaging of neurodegeneration with brain iron accumulation. 6. Updated data about SWI and QSM.

Results
1. Susceptibility-weighted imaging of vascular pathology: - Vascular malformation. - arteriovenous malformation. - cavernous malformation. - developmental venous anomaly. - imaging of cerebral venous thrombosis. 2. Susceptibility-weighted imaging in the setting of stroke. - Imaging of acute infarction with prominent vessel sign. 3. Susceptibility-weighted imaging of traumatic brain injury and intracranial hemorrhage according to the stage. - Imaging of diffuse axonal injury. - Susceptibility-weighted imaging shows much more multiple intracranial hemorrhages than the gradient echo imaging and the location and pattern is slightly different from the simple microhemorrhages. The pattern shows the curve-linear pattern along the axonal fiber. - Imaging of intracranial hemorrhage in each stages. 4. Susceptibility-weighted imaging of neurodegeneration with brain iron accumulation. - Parkinson's disease. - Amyotrophic lateral sclerosis. - Iron deposition is well demonstrated in the precentral motor cortex. 5. Updated data about SWI and QSM. - Demonstration of SWI and QSM. - The usefulness of QSM.

Conclusions
Susceptibility-weighted imaging can play an important role for the demonstration of hemorrhages and differentiation of calcification and hemorrhage in neuroimaging.
CNS Tuberculosis

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Purpose
Though reported cases of mycobacterium tuberculosis (TB) are declining in the U.S., TB remains a major global health issue infecting up to 33% of the world's population (WHO Data 2013). With a reported mortality rate up to 20%, TB is not only the leading cause of death in HIV+ patients, but also the second leading cause of death globally from a single infectious cause. TB also is associated with significant morbidity including severe neurological deficits in fifty per cent of those affected with TB meningitis (1, 2, 3). The purpose of this exhibit is to demonstrate the varying imaging manifestations of central nervous system (CNS) TB so as to help lead to timely identification and treatment of disease, in turn reducing patient morbidity and mortality.

Materials and Methods
Multiple cases of CNS TB infection were reviewed with magnetic resonance imaging (MRI) images presented to demonstrate the various forms of CNS TB as well as their associated complications. Signal, diffusion, enhancement and proton MR spectroscopy characteristics were compared to differentiate the variable presentations of CNS TB from each other as well as from other bacterial and fungal infection.

Results
Central nervous system TB includes infection of the brain, spine or both. Brain TB may be further subcategorized into parenchymal and meningeal disease depending on whether the bacteria initially rupture into the parenchyma itself and/or the subarachnoid spaces. Parenchymal disease includes tuberculomas, cerebritis, abscess and TB immune reconstitution inflammatory syndrome (TB-IRIS). Tuberculomas can be further broken down into noncaseating lesions, caseating lesions with solid caseation and caseating lesions with central liquefaction – each with a distinct imaging appearance. Brain meningeal disease can result in significant complications including hydrocephalus, raised intracranial pressures, vasculitis with/without associated infarcts (4), cranial nerve palsies and secondary parenchymal disease.

Spine TB may be subcategorized into cord, meningeal and vertebral body/disc disease. Cord disease includes tuberculomas, abscess, edema and ischemia. Meningeal
disease includes both the cord and nerve roots/arachnoiditis. Diskitis/osteomyelitis
disease may include paraspinal and epidural abscesses.

Conclusions
Tuberculosis remains a serious worldwide malady with significant associated
morbidity and mortality. Central nervous system TB may involve the brain
parenchyma, leptomeninges, spinal cord, disk space and epidural space with a
multitude of different imaging appearances. Knowledge of its various manifestations
is paramount for prompt and accurate diagnosis as well as timely treatment.
Figure 1: (A) Sagittal contrast enhanced MRI brain shows a large enhancing lesion in the posterior part of the right hemisphere consistent with a tuberculoma. (B) Axial FLAIR image of the same patient shows prominent signal intensity surrounding the tuberculoma consistent with lesion representing CNS TB-IRIS after initiation of HAART. (C) Sagittal contrast MRI image in a different patient demonstrates avid leptomeningeal enhancement at the skull base consistent with TB meningitis. (D) Diffusion weighted imaging demonstrates restricted diffusion in the bilateral basal ganglia consistent with infarcts from meningitis induced vasculitis.
EdE-27

Common and Uncommon Imaging Features of Central Nervous System Lymphoma on Traditional and Advanced Imaging

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Purpose
Although central nervous system (CNS) lymphomas demonstrate some characteristic magnetic resonance imaging (MRI) findings, their MR imaging features can vary with immune status, histological type and location and often overlap with other intracranial tumors making definitive diagnosis challenging. In this educational exhibit, we depict common and uncommon imaging features of central nervous system (CNS) lymphoma on traditional and advanced imaging.

Materials and Methods
Lymphoma of the CNS consists of two major subtypes: secondary CNS involvement by systemic lymphoma and primary CNS lymphoma (PCNSL). We present common and uncommon examples of PCNSL in immunocompetent and immunocompromised patients, as well as variable MR appearance of secondary CNS lymphoma.

Characteristic imaging findings with advanced imaging techniques also are depicted.

Results
Approximately two-thirds of secondary CNS lymphoma present with leptomeningeal spread and one-third, with parenchymal disease. Neuroimaging findings suggestive of leptomeningeal metastases include leptomeningeal, subependymal, dural, or cranial nerve enhancement. Parenchymal metastases from lymphoma often appear as single or multiple enhancing lesions and can be accompanied by leptomeningeal metastases. PCNSL often has a characteristic appearance on both CT and MR imaging due to its hypercellularity, high nuclear/cytoplasmic ratio, disruption of the blood-brain barrier, and its predilection for the periventricular and superficial regions, often in contact with ventricular or meningeal surfaces. Typical MR imaging features of PCNSL in immunocompetent patients are characterized by their periventricular locations, well-defined margin, moderate or marked edema, and intense and homogeneous nodular enhancement. Lack of enhancement or heterogenous enhancement, hemorrhage, necrosis and calcifications are unusual imaging features in immunocompetent patients. Internal hemorrhage and necrosis present in immunocompromised individuals. Immunocompromised patients with PCNSL often are diagnosed with multifocal lesions with irregular or peripheral, and ringlike enhancement. Atypical locations of PCNSL include brainstem, cavernous sinuses, pineal gland and pituitary-
hypothalamic axis. Primary dural lymphoma is a rare subtype of PCNSL which presents as single or multiple extraaxial masses like meningioma. Advanced imaging techniques such as diffusion-weighted imaging, perfusion MR imaging, MR spectroscopy and high-resolution susceptibility-weighted imaging may help to differentiate CNS lymphomas from other lesions of the brain.

Conclusions

Central nervous system lymphoma is a chemosensitive and radiosensitive tumor and an early diagnosis may shift the treatment from extensive surgery to radiotherapy. The accurate diagnosis of CNS lymphoma is crucial for proper management and prognosis in both immunocompetent and immunocompromised individuals. These imaging features may allow earlier recognition of CNS lymphoma and facilitate optimal treatment.

EdE-40

Diffuse Weighted Imaging – Beyond Stroke

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Purpose

The role of diffusion-weighted imaging (DWI) in the diagnosis of cerebral ischemia is widely known. However, DWI has an important role in the diagnosis of a wide variety of nonischemic neurological and neurosurgical pathologies, with which the radiologist needs to be familiar.

Materials and Methods

This presentation will review the role of conventional DWI in the evaluation of these nonischemic pathologies. A brief overview of the principles of the physics underlying DWI will be included, in addition to the physiology behind the diffusion findings in the different pathologies. Diffusion-weighted imaging findings in pathologies including intracranial infections, seizure disorders, central nervous system (CNS) neoplasia, hypoxic-ischemic injury, hyperammonemia, posterior reversible encephalopathy syndrome, Creutzfeldt-Jakob disease, metabolic/mitochondrial disorders and demyelination will be presented.

Results

Particular emphasis will be given to differential diagnosis and recognition of infective disorders including encephalitis, abscess and opportunistic infections in the immunosuppressed; and diagnosis and follow-up of both primary and secondary CNS tumors, including lymphomas. The case for including a simple diffusion-weighted sequence as part of the routine imaging protocol for all brain studies will be discussed.
Conclusions
Diffusion-weighted imaging should not be considered solely as a tool for detection of cerebral ischemia, and the radiologist should be aware of its wide role beyond stroke.

EdE-41

Distinctive Multipurpose Value of Perfusion Imaging in the Management of Delayed Cerebral Ischemia After Subarachnoid Hemorrhage

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Purpose
Perfusion imaging by CT or MR is proven to be useful for prediction and early detection of delayed cerebral ischemia (DCI) after subarachnoid hemorrhage (SAH), originally ascribed to vasospasm.

Materials and Methods
We hereby review our institutional practice where we distinguish the value of perfusion imaging in 1) prognostication of DCI, 2) prognostication of functional outcome, 3) early detection of subclinical DCI, 4) confirming the diagnosis of significant hypoperfusion, 5) quantification in volume and depth of hypoperfusion, 6) targeting regions at higher infarctional threat for angioplasty or intraventricular nicardipine, 7) measuring the risk of reperfusion injury and hemorrhagic insult by ascertaining blood-brain barrier (BBB) leakage, and 8) objectifying BBB dysfunction responsible for not only edematous injury but also volume/flow decoupling as dysperusive nuanced insult.

Results
In our practice, when suspicion for cerebral ischemia is high we use CTP to confirm the diagnosis and to guide therapy (focal versus global, proximal versus distal, punctiform versus territorial, cortical versus subcortical, mild versus severe ischemia). For instance, only focal clinical deficits matching a territorial ischemia with imminent infarction and matching proximal narrowing are angioplastied. This protocol leads to: 1) less inappropriate refusal of aneurysmal occlusion in coma, 2) less premature recourse to neuroimaging, 3) a judicious use of quantitative EEG and intracranial monitoring, 4) less premature hemodynamic augmentation (HDA), 5) a tailored treatment between HDA and angioplasty, 6) adjustment of HDA to the severity of DCI, and 7) less dilution of the therapeutic effect, whereby patients are better selected for one adequate tool out of our diagnostic and therapeutic armamentarium.

Conclusions
Perfusion imaging is not the panacea for DCI detection, if used indiscriminately for a global purpose. However, if used distinctively, as part of an escalation management
for DCI, with diverse diagnostic, prognostic and therapeutic purposes, it averred
tremendously useful in diagnostic confirmation and calibration of ischemia or
dysperfusion.

EdE-30

6:30AM - 2:45PM

Edema-like Change in the Optic Tracts on MRI: More than Meets the Eye

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Purpose
Once postulated as a finding specific for craniopharyngiomas, it now is recognized
that T2 hyperintense edema-like change in the optic tracts may be caused by a range
of pathologies. These include other pituitary region tumors, primary CNS tumors
arising in adjacent structures, vascular lesions and neuroinflammatory diseases. This
educational poster is designed to illustrate the wide range of underlying pathologies in
order to provide a comprehensive differential diagnosis.

Materials and Methods
A pictorial review of the MRI appearances of edema-like change within the optic
tracts and examples of causative pathologies.

Results
Pituitary region tumors which can elicit edema-like change in the optic tracts include
craniopharyngioma, pituitary adenoma and metastases from a distant primary
malignancy (e.g., breast cancer). Similar appearances also may be observed with other
types of tumor encroaching on the para- or supra- sellar region. For example, a
glioblastoma involving the anterior corpus callosum or primary CNS lymphoma
involving the basal ganglia. Vascular lesions, including aneurysms and cavernomas in
the vicinity of the optic tracts also may cause such change. This could be secondary to
hemorrhage within the lesion or treatment related effects. Edema-like change in the
optic tracts also maybe associated with neurosarcoidosis and demyelinating disease. It
has been reported previously that the distribution of the optic tract involvement does
not always correspond to the degree of visual disturbance. Recognition of this
radiological sign may therefore prompt formal visual function testing in cases where
there is subclinical visual impairment.

Conclusions
A wide range of pathologies can cause edema-like changes within the optic tracts
including tumors, vascular lesions and neuroinflammatory diseases. These changes
also may be treatment related. Recognition of the radiological appearances can
provide an explanation for visual disturbance and prompt formal visual function
testing in cases where the deficit is subtle.
1. Craniopharyngioma with hemorrhagic change and bilateral optic tract edema
2. Left paraophthalmic artery aneurysm with bilateral optic tract edema
3. Bilateral optic tract change in a patient with demyelination
4. Cavernoma involving the right temporal stem and cerebral peduncle post stereotactic radiosurgery with edema in the right optic tract and chiasm

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EdE-36

6:30AM - 2:45PM

Elevated rCBV on Perfusion MR Imaging of Brain Masses: Not Always a Sign of Malignancy
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Purpose
MR perfusion techniques have been reported to be reliable for the discrimination of benign and malignant brain masses. In our practice we have repeatedly encountered cases of brain masses that demonstrated elevated relative cerebral blood volume (rCBV) suggesting malignancy but proved to be nonmalignant. We have collected some of these cases to illustrate this potential pitfall on magnetic resonance imaging (MRI).

Materials and Methods
All cases were imaged with MR prior to biopsy or resection. Scans included dynamic susceptibility contrast MRI (DSC-MRI) and dynamic contrast-enhanced MRI (DCE-MRI) techniques on a 3T magnet using separate boluses. Kinetic analysis of the first pass DSC-MRI bolus data were used to generate a permeability map and relative cerebral blood volume map (rCBV). Dynamic contrast-enhanced MRI data were used to generate permeability and plasma volume maps. From our broad experience with both malignant and benign masses, cases of benign lesions with elevated rCBV were selected.

Results
A series of cases of benign lesions with elevated rCBV were identified from our clinical practice. These include brain abscesses, tumefactive demyelinating disease, multiple sclerosis, and radiation necrosis. Several cases of vascular lesions such as capillary telangiectasia are included since they also may show elevated rCBV. All cases have been proven by biopsy or follow-up imaging.

Conclusions
Recognition of the spectrum of lesions, both benign and malignant, that may have abnormal perfusion findings can increase the likelihood of arriving at the correct diagnosis and in some cases avert unnecessary surgery. Using DSC-MRI and DCE-MRI in the context of the entire MRI exam can help avoid misdiagnosis.

EdE-08

Fractional Anisotropy as a Quantitative Biomarker for Assessment of Nicotine Related Brain Changes: Differential Impact of Sub-component Diffusivity Metrics

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Purpose
Fractional anisotropy (FA) is widely employed in clinical research as a quantitative tool for assessing white matter integrity. The majority of the neurodegenerative conditions have been associated with a reduction in white matter FA. However, there have been recent studies demonstrating both elevated FA and decreased FA in association with neuroaxonal pathology, particularly in relation to smoking-associated brain changes (1-3). One potential explanation is the multifactorial determination of FA from subcomponent diffusivity metrics, namely axial and radial diffusivity. We conducted a systematic review of recently published literature for preliminary assessment of the number of studies that report and apply subcomponent assessment of diffusivity metrics for interpretation of FA changes.

Materials and Methods
We conducted a Medline search for studies investigating brain changes associated with nicotine exposure or tobacco smoking using diffusion tensor imaging (DTI). We found 46 abstracts using numerous key word combinations and selected 12 abstracts that addressed nicotine/tobacco-associated brain changes with nicotine exposure. As a random comparative sample we also reviewed 25 recent nonsmoking DTI studies published in the past year.

Results
We found seven studies (58%) that demonstrated reduction in white matter FA with smoking/nicotine exposure, compared to five studies, (42%) demonstrating an opposing elevation in FA associated with nicotine/smoking exposure. Notably only two (16%) of the studies performed concurrent subcomponent diffusivity analyses utilizing axial and radial diffusivity estimates. Compared to the smoking literature, the nonsmoking DTI literature was heavily weighted towards reduction in FA with disease groups (88%), however even in the nonsmoking literature only 36% reported subcomponent diffusivity analyses.

Conclusions
There is wide variability in FA directionality in the published literature particularly relevant to the influence of nicotine on neuroaxonal structural integrity with both elevation and reduction in FA reported. Although technique, subject demographics, chronicity and anatomical topology are some of the confounding factors, the effects of opposing directionality of subcomponent diffusivity metrics namely, axial and radial diffusion, also is highly plausible and often not taken into consideration. Attention to these metrics may aid further understanding of chronology, relativity and temporal evolution of changes in neuroaxonal structural integrity.

EdE-10

6:30AM - 2:45PM
From the Olfactory Bulbs to the Medulla Oblongata, a Comprehensive and Practical Pictorial Review of the Cranial Nerves Origin and Exit from the Skull with Companion Pathology

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Purpose
Review of the radiological anatomy of the cisternal segments of the 12 cranial nerves utilizing 3T high resolution isotropic acquisitions magnetic resonance imaging (MRI). Describe common pitfalls in the diagnosis of cranial nerve pathology.

Materials and Methods
Provide radiological imaging of the 12 cranial nerves in multiple MRI sequences emphasizing the radiologic and anatomical landmarks that demarcate the expected locations of these nerve segments. Provide examples for each cranial nerve specific pathology. Provide a summary table with the recommended MRI sequence, and the radiologic and anatomical landmark for the cisternal segment of each cranial nerve that medical students, residents-in-training and radiologists should be familiar with.

Results
This pictorial review describes the normal appearances of the cisternal segments of the 12 cranial nerves, emphasizing the radiologic/anatomical landmarks that demarcate the expected locations of these nerve segments, common pitfall described for each cranial nerve and recommended MRI sequences to assess each cisternal cranial nerve along with multiple MRI samples of cranial nerve pathology (from a variety of entities including neoplastic, infectious, and idiopathic diseases.) cases in order to reinforce the educational exhibit highlights.

Conclusions
Awareness of the anatomical location of each cranial nerve on brain imaging will increase the comfort identifying potential cranial nerve pathology. When interpreting neuroimaging, the approach for evaluating the cranial nerves should be systematic, objective and correlated with the clinical context, so the radiologist will be able to provide reliable and consistent information that can change the management to the benefit of the patient. Abnormal cranial nerve thickening and/or enhancement on MRI may sometimes be the first or only indication of an underlying disease process.
Figure 2. Axial T1WI with contrast. Optic nerve pathology sample case:
Red arrow demonstrates a diffuse thickening and enhancement along the left optic nerve within the optic canal.

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Figure 3. Axial T1WI with contrast. Oculomotor nerve pathology sample case:

Red arrow points to a nodular thickening and enhancement of the left cranial nerve III as it exits the midbrain in its proximal cisternal segment.
Figure 4. Axial T1WI with contrast. Abducens nerve pathology sample case:

Red arrow highlights a focal solid enhancement along the right abducens nerve in a patient with multiple metastasis.
Figure 5. Axial T1WI with contrast. Facial nerve pathology sample case:
Red arrow points to an enhancement without expansion of the distal canalicular segment of the right facial nerve.

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EdE-20

6:30AM - 2:45PM

Identifying Acute Venous Infarcts: Causes and Imaging Characteristics

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Purpose
Acute venous infarcts are much more rare than acute arterial infarcts in the brain. Their clinical presentations are different from the counterpart arterial ones. Their onsets often are more insidious. The underlying etiology and related clinical conditions are much more diverse. The aim of this exhibit is to give a general review of acute venous infarcts of the brain: their clinical features, diagnostic imaging findings, and associated secondary conditions. Pictorial examples of acute venous infarcts and their different underlying conditions are presented. Differential diagnoses also are discussed.

Materials and Methods
1. Related cases will be provided with initial presenting clinical symptoms and signs. Associated secondary conditions will be identified. 2. Case-based demonstration of characteristic imaging findings for the underlying pathology, including but not limit to dural sinus thrombosis, cavernous sinus thrombosis, cortical vein occlusion, etc. Secondary conditions also are discussed, including trauma, pregnancy, dehydration, tumor, bacterial infection, malignancy, chemotherapy, hypercoagulable states/coagulopathies, etc.

Results
1. Discuss causes of venous infarcts and their clinical presentations. Pictorial examples of underlying conditions will be provided. 2. Discuss imaging characteristic for the underlying pathology, including but not limit to dural sinus thrombosis, cavernous sinus thrombosis, cortical vein occlusion, etc. Secondary conditions also are discussed, including trauma, pregnancy, dehydration, tumor, bacterial infection, malignancy, chemotherapy, hypercoagulable states/coagulopathies, etc. 3. Discuss advantages and disadvantages of various imaging modalities/techniques, which may include computed tomography (CT) versus magnetic resonance imaging (MRI), noncontrast versus contrast-enhanced CT, CT venogram versus MRV, etc. 4. Discuss identification of secondary signs other than direct clot visualization. 5. Discuss complications of venous thrombosis, which may include venous infarct, hemorrhage, and hydrocephalus. 6. Discuss differential diagnosis and pitfalls of interpretations. 7. Discuss importance of treatment, plans of intervention, and characteristic imaging findings during post-treatment and resolution phase.

Conclusions
Acute venous infarct often is a challenging diagnosis. The underlying causes are diverse. An understanding of the clinical correlating conditions and imaging diagnosis are important for its identification, search of underlying etiology and treatment. At the end of the presentation, the viewer will become familiar with all different aspects of the acute venous infarcts: their causes, clinical findings, diagnostic imaging features, pitfalls of interpretations, and plans of treatment.
EdE-29

Imaging Characteristics of Primary Gliosarcomas of the Brain

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Purpose
To present the magnetic resonance imaging (MRI) and computed tomography (CT) diagnostic imaging findings in a large series of patients with primary cerebral gliosarcomas.

Materials and Methods
Retrospective, IRB approved, review (2001-2014) identified 26 patients with primary brain gliosarcomas who had pretreatment imaging available for review.

Results
The 26 patients diagnosed with gliosarcoma included 15 males and 11 females with a median age of 58 years (age range 40-70). MR imaging and CT were available in 14 cases; MRI alone in 11, and CT alone in one case. Thirteen tumors originated in the temporal lobes, 10 in the frontal lobes, and three in the parietal lobes. The tumors were large at diagnosis with a median maximal diameter of 5 cm (range 1.3-8.1 cm). Enhancement pattern was heterogeneous in all cases except for the smallest tumor which enhanced uniformly. On follow-up imaging, this untreated tumor showed rapid growth, heterogeneous enhancement, and cystic changes. Cysts were identified in the tumors in 9 of 12 CTs and 14 of 25 MRIs. Evidence of hemorrhage was present on 1 CT and 13 of 25 MRIs. One tumor had a small focus of calcification on CT. T2 hyperintensity surrounding the tumor ranged from 0.2 cm to 6.5 cm with a median of 3.0 cm. Diffusion imaging was available in 21 patients and was restricted in 14. Regional blood volume was increased in the two cases where perfusion imaging was performed. The cortex was involved in 20 of 26 tumors with dural enhancement in one patient. Tumor abutted the ventricle in 22 cases with ependymal spread in four.

Conclusions
Gliosarcomas have significant overlap in appearance with the more common glioblastoma. A slight preference for temporal lobe location and cortical involvement was observed but no particularly distinguishing characteristics were identified.

EdE-15
6:30AM - 2:45PM

Imaging Findings in Three Pathologically Proven Cases of Human Coenurosis Caused by Taenia Multiceps

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Purpose
Imaging findings in three pathologically proven cases of human coenurosis caused by Taenia multiceps.

Materials and Methods
Reports of imaging features of coenurosis are very sparse in literature. We describe imaging features of three cases of pathologically proven coenurosis.

Results
On MR imaging lesions were cystic in all the cases. A septate lesion was located in the left cerebral fronto-parietal lobe in one case. It was located in the fourth ventricle in the other. Multiple cystic lesions were present in the third case which were located both supra and infratentorially. Multiple eccentric mural nodules were seen on the luminal side of the cystic lesions in two cases. These eccentric nodules were of variable sizes. The lesion located in the fourth ventricle had a relatively large eccentric nodule. Multivoxel MR spectroscopy (MRS) was obtained in two cases, which revealed a tall succinate peak in both as described in the literature (1). In addition, alanine peak was present in one of the cases. Postcontrast enhancement was present in one of the cases. All cases demonstrated facilitated diffusion on diffusion-weighted imaging (DWI). Computed tomography (CT) was performed in one case which demonstrated multiple large chunky calcifications involving both supra and infratentorial brain parenchyma.

Conclusions
Multiple eccentric/large nodule in a cystic lesion should raise the suspicion of this extremely rare infection, particularly when MRS is highly suggestive of a parasitic lesion.
EdE-18

6:30AM - 2:45PM
Intracranial Dural Arteriovenous Fistulae: Key Cross-Sectional Imaging Features and Angiographic Correlation

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Purpose
Intracranial dural arteriovenous fistulas (DAVF) are pathologic shunts, typically between transosseous-extracranial and/or meningeal arteries into the wall of a thrombosed dural venous sinus, potentially resulting in hypertensive venous congestion and venopathy, with variable clinical course. Dural arteriovenous fistulas are distinguished from pial-parenchymal arteriovenous malformations by the predominance of dural arterial supply and the absence of a parenchymal nidus. The majority of dAVFs present in adulthood and are located in the transverse or sigmoid sinuses, however pathologic arteriovenous shunts may exist along any dural margin with varying consequences. The purpose of this exhibit is to review the cross-sectional imaging appearance typical or suggestive of intracranial dural arteriovenous fistulas and their subsequent angioarchitecture in select cases.

Materials and Methods
A retrospective analysis was conducted identifying all patients from Jan 2001 - Dec 2015 with intracranial dural arteriovenous fistulas confirmed by catheter angiography, performed at Indiana University Health Hospitals. Illustrative cases were selected.

Results
Intracranial dAVFs present with a range of symptomatology which correlates with both anatomical location and regional venous drainage pattern (Cognard classification). In our review of cases, cross-sectional imaging features often were subtle, missed, or misinterpreted. Nonenhanced CT imaging featured dilated transosseous calvarial vascular channels with associated permeative, erosive changes in some cases. CT angiography demonstrated serpiginous, dilated, and hypertrophied arterial feeders closely apposed to dural surfaces and dural venous sinuses; flow-related aneurysms; dilated draining veins and varices; dural sinus stenosis and thrombosis. Computed tomography angiography (CTA) with the addition of maximum intensity projection images and 3D reformats proved useful in static depiction of angioarchitecture. MR imaging (MRI) demonstrated anomalous flow void phenomena, increased in number or in abnormal locations, notably in arterialized early draining veins when present; T1-, T2-, and FLAIR isointense dural sinus thrombosis with variable dural sinus wall enhancement, post-contrast; T2* blooming of thrombosed dural sinuses. Time-resolved contrast-enhanced MRA and MRV proves useful in estimating angiographic dynamics such as flow reversal in draining veins when present.
Conclusions
Intracranial dural arteriovenous fistulas (dAVF) are pathologic arteriovenous shunts with a range of cross-sectional imaging features reflective of their morphology and physiology when correlated with conventional angiography.

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EdE-28
Intracranial Hemangiopericytoma: What the Radiologist and Clinician Need to Know Regarding Hemangiopericytoma

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Purpose
In this article, we will demonstrate the imaging findings of the hemangiopericytoma (HPC), which appears similar to those of meningioma and the characteristic clinical features.

Materials and Methods
We experienced three cases of pathology proven HPC from 2007 to 2014. We demonstrate three case reports and the imaging findings, especially differentiating points from meningioma and the important clinical points.

Results
Pericytoma in the central nervous system was regarded as angiomatous meningioma. It now is widely accepted that this tumor arises from meningeal capillary pericytes and current WHO criteria classifies HPC into the group of meningeal, mesenchymal nonmeningotheial tumors with uncertain malign potential or borderline of malignancy. In the general pathology community, HPC is considered part of solitary fibrous tumor. However, this classification approach has not been embraced yet by neuropathologists and is still under debate. The radiological appearance of HPC appears to resemble that of meningioma. There are certain specific routine MRI findings that are different from those of menigioma, including 1) aggressive behavior such as parenchymal invasion, irregular borders, bone erosion, and heterogeneous contrast enhancement 2) flow voids are more common, 3) generally iso-intense with cortical gray matter on both T1WI and T2WI. Magnetic resonance spectroscopy shows high myo-inositol and CT perfusion study shows high cerebral blood volume. There are different clinical characteristics between HPC and meningioma. HPC usually occurs more commonly in males and the average age is lower than that of menigioma.

Conclusions
For radiologists, it is difficult to differentiate HPC from meningioma, but useful to imply the possibility of HPC pre-operatively, because embolization before an operation to prevent the risk of hemorrhage enables the neurosurgeons to perform the total resection and thereby can reduce the possibility of recurrence.
EdE-04

Isolated Cranial Nerve XII Palsy Due to Internal Carotid Artery Dissection: A Common Diagnosis with an Uncommon Presentation

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Purpose
1) Review the pathophysiology of internal carotid artery dissection (ICAD) and isolated cranial nerve XII (CNXII) palsy. 2) Demonstrate the anatomy of CNXII and imaging findings of CNXII palsy. 3) Help neuroradiologists maintain a high index of suspicion for ICAD in patients presenting with clinical or imaging findings of CNXII dysfunction.

Materials and Methods
Five patients with ICAD, confirmed with noninvasive vascular imaging, presenting with associated isolated CNXII palsy are presented. Imaging findings of dissection on CTA and MRA are reviewed, as are imaging findings of CNXII palsy, which may go undetected clinically.

Results
Spontaneous ICAD occurs in patients of all ages, and is responsible for a higher proportion of strokes in young and middle-aged patients. Recognition of ICAD is critical to initiate appropriate treatment and prevent or lessen embolic-ischemic complications. Intimal tears allow for intramural hematoma and false lumen formation. Separation of the tunica media and adventitia can give rise to dissecting aneurysms. CTA or MRA readily identify vessel contour irregularities, luminal narrowing and crescentic intramural thrombus (Fig. 1); however, findings may be subtle and overlooked without appropriate suspicion and directed search. ICAD often presents with headache, ipsilateral neck pain, Horner's syndrome and/or cerebral ischemic symptoms. Less common manifestations include bruits, dysgeusia and cranial nerve palsies. One series of 190 patients with ICAD identified cranial nerve palsies in 12% (1). Lower cranial nerve palsy (IX through XII) was found in only 5%, with isolated CNXII palsy in only three patients (1, 2). While CNXII palsy is a rare manifestation of ICAD, it may be the only presenting sign of this diagnosis.

Symptoms include dysarthria, impaired tongue movement and difficulty swallowing. Acutely, the involved hemi-tongue may be swollen with geographic T2 hyperintensity and enhancement. Chronically, mild volume loss and fatty infiltration in the involved tongue can be identified. In acute and chronic tongue denervation, the base of tongue protrudes into the oropharyngeal lumen often mimicking a mass (Figs. 2 and 3). Skull base lesions are the most common cause of CNXII palsy, especially in older patients. But vascular causes should be considered especially in younger and middle-aged patients. CNXII courses in close proximity to the cervical ICA from the hypoglossal canal to the level of the mandibular angle. ICAD may cause neural stretching or compression by pseudo-aneurysm formation, or may compromise blood supply to the nerve (1).

Conclusions
ICAD is not uncommon. Characteristic noninvasive imaging findings usually make the diagnosis straightforward when the diagnosis is clinically suspected. While CNXII
palsy is a rare manifestation of ICAD, it may be the only presenting sign of this diagnosis clinically or radiologically. Radiologists must be aware of the radiological findings of CNXII palsy, and have a high index of suspicion for ICAD in this setting so that this important diagnosis is not missed.
EdE-19

6:30AM - 2:45PM

Isolated Intraventricular Hemorrhage (IVH) in Adults: A Pictorial Review of Underlying Causes

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Purpose
To illustrate the etiological background of isolated intraventricular hemorrhage (IVH) in adults.

Materials and Methods
The varied causes of isolated IVH are reviewed through illustrative cases with a multimodal imaging approach (CT/CTA, MRI/MRA, conventional angiography).

Results
Intraventricular hemorrhage often is found as a complication of intraparenchymal or subarachnoid hemorrhage. Isolated IVH is rare in adults. Formerly only discovered at autopsy, its diagnosis has become more frequent with the advent of CT imaging, and sometimes incidental. After elimination of a traumatic cause, numerous etiologies for IVH remain possible. Computed tomography angiography (CTA), MRI and conventional angiography may be of significant help in approaching the final diagnosis and to guide proper patient management. The most frequently found underlying lesions are AVMs and aneurysms, but other vascular causes also should be sought, including dural arteriovenous fistulas, cavernomas, carotid occlusive disease including moyamoya disease, vasculitis and fibromuscular dysplasia. Hypertension, anticoagulant use and coagulopathies as well as certain toxic substances such as cocaine also are associated with isolated IVH, making a correlation with clinical information crucial. Finally, isolated IVH may be caused by primary or secondary intraventricular tumors. In a high number of cases the cause remains unknown.

Conclusions
A variety of pathologies can be responsible for isolated IVH. Vascular and nonvascular causes should be sought through a thorough imaging work-up and the correlation with clinical information to yield a diagnosis and potentially guide treatment.

EdE-32
6:30AM - 2:45PM

Lateral Ventricular ADC Measurements in Patients with GBM that Developed LMD

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Purpose
Current methods of diagnosing leptomeningeal disease (LMD) remain insensitive. Diffusion-weighted imaging (DWI) has broad applications in stroke and tumor
imaging. We sought to determine if apparent diffusion coefficient (ADC) values in the ventricular system vary among patients with a glioblastoma (GBM) who subsequently developed LMD compared to patients with a GBM that do not develop LMD and to controls.

Materials and Methods
The study included three groups for a total of 66 patients: (group 1) - 22 patients with a GBM who subsequently developed LMD confirmed by cytological evaluation of the cerebrospinal fluid; (group 2) - 22 patients with a GBM that did not develop LMD; and as a control (group 3) 22 patients with a history of cancer, but no clinical or radiological evidence active disease or LMD. Apparent diffusion coefficient measurements were taken by two reviews independently in the frontal horns, mid body, and atrium of the lateral ventricles, as well as in the 3rd and 4th ventricles. First, Pearson correlation coefficients were used to determine the interobserver variability for the ADC values between the three groups. Second, Analysis of Variance (ANOVA) was used to detect difference of ADC values among the three groups. If a significant difference was found, the Bonferroni method was used to adjust for multiple comparisons. Third, the volume of the ventricular system was calculated using MIM Software (Cleveland, OH). Pearson correlation coefficient and linear regression analysis determined if there is association between the ADC values and the ventricular size.

Results
First, the interobserver agreement level was high overall (most coefficients were >0.8). Second, a significant difference was found between the ADC values in the body of the ventricles bilaterally (right p=0.02-0.006; left p= 0.02-0.003) in patients with a GBM that subsequently developed LMD (group 1) and the control group (group 3). Third, no significant association was found between the ADC values and ventricular size among the three groups.

Conclusions
Apparent diffusion coefficient values in the bodies of the lateral ventricle are significantly different in patients with a GBM that subsequently develop LMD compared to controls. This difference is unrelated to ventricular size. Further study will be necessary to determine if ADC values in the lateral ventricle can be predictive of the subsequent development of LMD.

EdE-05
6:30AM - 2:45PM

Magnetic Resonance and Diffusion Tensor Imaging of Cerebellum – An Anatomical Review

P Sharma¹, P Kochar², S Sharma³, N Bhatt³, N Gupta⁴, Y Kumar³
Purpose
The purpose of this presentation is to: 1. Review the cerebellar anatomy on MRI and
diffusion tensor imaging (DTI). 2. To highlight the clinical applications. 3. To
describe the limitations of the imaging techniques.

Materials and Methods
The study was performed using Discovery MR750w 3.0T GE machine and generating
high resolution axial, coronal and sagittal T1- and T2-weighted images. The diffusion
tensor MRI was performed and color-coded vector maps were generated. The DTI-
MRI data were prepared and analyzed using anatomically-guided tractography
methods to reconstruct the various cerebellar tracts including spino-cerebellar (SC),
vestibule-cochlear (VC), dentate-rubro-thalamo-cortical (DRTC), and cortico-ponto-
cerebellar (CPC) including fronto-ponto-cerebellar (FPC), parieto-ponto-cerebellar
(PPC), temporo-ponto-cerebellar (TPC) and occipito-ponto-cerebellar (OPC)
pathways.

Results
The cerebellum consists of three lobes anatomically, namely the flocculo-nodular
lobe, the anterior lobe and the posterior lobe with the anterior and posterior lobes
further divided in a midline cerebellar vermis and right and left cerebellar
hemispheres. The lobes are divided into fissures better seen on sagittal images. The
vermis is divided into various lobules according to the classification systems. The
neuronal output of cerebellum is provided by four deep nuclei namely dentate,
fastigial, emboliform and globose nuclei and these nuclei are encased in the white
matter and the gray matter forms the convoluted cerebellar cortex. Functionally, the
cerebellar white matter is connected to the central nervous system via the SC
(connecting the spinal cord to cerebellum), VC (connecting the inner ear to
cerebellum), and cerebro-cerebellar tracts (CC – connecting the anterograde and
retrograde connections between cerebrum and cerebellum including the CPC tracts of
cortical origin and the DRTC tracts of cerebellar origin). The clinical applications of
knowing these tracts is in neurosurgery planning, developmental CNS disease,
posterior fossa malformations, stroke, neurodegenerative diseases, side effects of
drugs like phenytoin and in multiple sclerosis.

Conclusions
Precise knowledge of anatomy is a key to accurately localize and interpret lesions of
cerebellum. Moreover, it helps in accurate interpretation of DTI. The DTI is a useful
tool to better understand various developmental and acquired cerebellar disorders.
This exhibit will help the radiologist to understand the anatomy of cerebellum, its DTI
and thereby encourage them to utilize DTI as a tool to evaluate the cerebellum and its pathologies.

**EdE-09**

**Magnetic Resonance Spectroscopy: Clinical Applications**

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**Purpose**

Present the basics in technique and multiple current application of magnetic resonance spectroscopy (MRS) of the brain as an adjunct tool in clinical practice for diagnosis and management decision.

**Materials and Methods**

A literature search was performed for information on current technique and clinical use of MRS. A series of different cases from two institutions were collected to depict the imaging characteristics of MRS in some of the most relevant pathologies.

**Results**

MR spectroscopy (MRS) provides a measure of brain metabolites, different from magnetic resonance imaging (MRI) that provides anatomical images. MR spectroscopy shows a spectrum of chemical information based on the chemical shift properties of water protons. It is considered a complement to MRI for diagnosing, monitoring progression and evaluating response to therapy.

**Conclusions**

MR spectroscopy is a noninvasive means to evaluate in vivo tissues with a positive impact in patient management. It can be used for tumor versus stroke differentiation, serially monitor biochemical changes in tumors, stroke, epilepsy, metabolic disorders, infections, and neurodegenerative diseases. MR spectroscopy is an adjuvant tool that requires correlation with other studies to be valid.

**EdE-25**

**MicroRNA Research for the Neuroradiologist: An Educational Review of Basic Principles and Relevance to Molecular Imaging and Therapeutics for Glioblastoma**

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Purpose
There is a need to develop more effective treatments for glioblastoma (GBM). Recently, the role of microRNAs (miRNAs) in regulating cancer cell functions, e.g., cell proliferation, differentiation, invasion and migration, has come under scrutiny. In this exhibit, we present an overview of current research in miRNA targeted GBM treatment. Future applications will be important in both diagnostic and endovascular molecular neuroimaging techniques.

Materials and Methods
We provide a pictorial and educational overview of miRNA research in GBM for the neuroradiologist.

Results
MicroRNAs (miRNA) are short noncoding RNAs that regulate gene expression in health and disease. They bind to recognition sequences of target messenger RNA (mRNA), resulting in mRNA degradation or translational suppression, thus acting either as tumor suppressors or promoting oncogenesis. Indeed, dysregulated miRNA expression is commonly reported in GBM, with more than 300 upregulated or downregulated miRNAs. Oncogenic miRNAs include miRNA-21, miRNA-10b, miRNA-221/miRNA-222, and the cluster (miRNA-17, miRNA-18a, miRNA-19, miRNA-20a and miRNA-92a), all upregulated in GBM. Several other miRNAs are over expressed, possessing a functional role in GBM. A number of miRNAs with tumor suppressive capabilities also have been identified in GBM, including miRNA-7, miRNA-128, and miRNA-137. Targeting of miRNAs represents an interesting novel therapeutic strategy for regulating pathogenic gene expression. In principle, oncogenic miRNAs should be amenable to in vivo inactivation through delivery of their antisense sequences, i.e., anti-miRNAs (antagomiRs), and tumor suppressor miRNAs could be augmented with delivery of their sequences.

Conclusions
The ability of individual miRNAs to target multiple genes and pathways could be a significant advantage in GBM treatment. The biggest obstacle in developing miRNA-based therapies for GBM is achieving effective delivery to the brain. With the advent of nanoparticle miRNA packaging and localized delivery strategies such as convection-enhanced and intra-arterial delivery, the use of miRNAs will offer promising new strategies in future GBM treatment.

EdE-43
6:30AM - 2:45PM
Mimics and Pitfalls in Emergency Neuroradiology: Beyond the Usual Suspects

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Purpose
Our goal is to promote recognition of mimics and pitfalls in emergency neuroradiology.

Materials and Methods
Through illustrative cases, this exhibit will describe mimics of common pathologic processes to include stroke, hemorrhage, spinal infection and fractures (focusing on face and temporal bone). We will highlight key concomitant findings on computed tomography (CT) or magnetic resonance imaging (MRI), thus helping the radiologist in the diagnosis of unusual cases.

Results
1. Neoplastic processes, encephalitis, toxic/metabolic entities or demyelination, can mimic stroke on CT or MRI. Recognition of vascular territories among other clues is paramount in these cases. 2. Congenital vascular anomalies, tumors, and in some cases diffuse or focal edema can mimic parenchymal or subarachnoid hemorrhage on CT. Awareness of the distinct causes of hyper densities on CT is helpful to rule out areas of pseudo-hemorrhage. 3. Evaluation of acute diskitis-osteomyelitis is not uncommon in the ER setting. Chronic inflammatory diseases or malignancies can mimic an acute infectious process. 4. Vascular channels and sutures can mimic fractures. Recognition of main anatomical landmarks or ossification centers is important in the setting of trauma.

Conclusions
It is not uncommon to face atypical lesions or "mimics" in the emergency setting. In these cases, recognition and accurate interpretation is critical. Our illustrative poster will help provide knowledge of alternative diagnosis beyond the usual suspects in the Emergency Neuroradiology setting.
EdE-03

6:30AM - 2:45PM

Misfolding Proteopathies of the Brain: An Educational Overview of Molecular Mechanisms and Neuroimaging Correlates

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Purpose

Proteopathies are diseases in which proteins are structurally abnormal, often because they are incorrectly folded. Aberrant protein folding represents the molecular basis of...
many important brain disorders. In this exhibit, we present an overview of the basic molecular principles of protein misfolding, and discuss the neuroimaging correlates of these diseases. We also provide a futuristic glimpse of how misfolding of any protein could be detected using innovative molecular neuroimaging techniques.

Materials and Methods
We provide a pictorial overview of protein folding and misfolding for the neuroradiologist.

Results
The 'protein folding problem' remains one of the more perplexing quandaries in biology. At first, it seems implausible that many diverse brain disorders would be all different versions of the same basic disease. However, protein misfolding represents the molecular foundation of a growing list of brain diseases, including: Alzheimer (amyloid beta and tau), Parkinson's (alpha synuclein), Huntington's (glutamine repeats), prion diseases (prion), ALS (superoxide dismutase), CADASIL (notch3), Alexander disease (GFAP), other neurodegenerative disorders, and glioblastoma (p53). Misfolded proteins are toxic owing to a gain of toxic function or loss of normal function. Often cells accumulate aggregates of misfolded proteins, e.g., Lewy bodies, and neurofibrillary tangles. Advances in molecular therapeutics will lead to potential new drugs to treat these disorders by reducing protein misfolding or by breaking up misfolded proteins. Drug discovery likely will be aided by 'biosensors' of protein (mis)folding based on novel molecular imaging techniques that can be used in high throughput screening of novel compounds as well as in vivo evaluation of new drug candidates in small animal models of these diseases.

Conclusions
Protein folding research may lead to new drug treatments for many important brain diseases that currently have no cure. Neuroradiologists will likely play a pivotal role in future evaluation of novel small molecule drugs to combat these neurological disorders.

EdE-24

MRI Imaging Characteristics of Recurrent Glioblastoma After Treatment with Laser Interstitial Thermal Therapy

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Purpose
Laser interstitial thermal therapy (LITT) has been used for the past 15 years for
minimally invasive treatment of lesions that were hard to treat with conventional techniques. Recent technological advances have led to the development of commercial systems that allow for real time magnetic resonance imaging (MRI) thermography, which provides live monitoring of thermal tissue damage not only to the targeted tissue but to the surrounding tissues. This presentation will describe detailed MRI findings and complications for patients with recurrent glioblastoma (GBM) in the immediate postoperative period to 168 days after treatment.

Materials and Methods
Seven patients with recurrent GBM were treated using Neuroblate system (Monteris Medical, Winnipeg, MB). Preoperative MRI was performed for each patient. Follow-up MRI was performed immediately postoperatively, then 1, 2, 3, 7, 14, 28, 56, 84 and 168 days after treatment. Diffusion, ADC, T1W, T2W, FLAIR, GRE, postcontrast T1W and rCBV sequences were obtained for each exam.

Results
The laser-induced thermotherapy region immediately forms a lesion with a necrotic core, secondary to thermocoagulation. This educational exhibit demonstrates typical MRI findings of the formation, evolution, and characteristics of these lesions, In summary these include a central cavity surrounded by a rim of edema adjacent to undamaged parenchyma. The treatment region findings are best characterized on the T1 postcontrast, volumetric T2 and apparent diffusion coefficient (ADC) sequences. The rim of edema demonstrates intrinsic rim enhancement that is not as high as intrinsic tumor enhancement. Rim enhancement and elevated CBV always are present after treatment and become more conspicuous with time becoming well defined by 4 weeks. At 48 hours, the cavity characteristics typically are well defined. Over 168 days, the overall cavity was either stable or decreased in size.

Conclusions
We describe detailed MRI findings after treatment of recurrent GBM with laser interstitial laser therapy using a commercially available system. The resulting lesions have an architecture of a central cavity with a rim of edema that is well defined after 48 hours.

EdE-22
6:30AM - 2:45PM

Neuroimaging Clues to Diagnosis of CARASIL (Cerebral Autosomal Recessive Arteriopathy With Subcortical Infarcts And Leukoencephalopathy).

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Purpose
To illustrate brain MRI findings for genetically diagnosed cases of CARASIL (cerebral autosomal recessive arteriopathy with subcortical infarcts and leukoencephalopathy) and stress on importance of microbleeds in these cases.

Materials and Methods
Three patients with homozygous HTRA1 mutations (from 2 Indian families) and 2 asymptomatic siblings with heterozygous HTRA1 mutation included in this study. MRI brain and Spine of these patient were evaluated. Importance of imaging in heterozygous family members were also evaluated.

Results
Patients with homozygous mutation of HTRA1 genes (3 patients) presented in their third decade with behavioural changes and memory impairment, progressive memory loss and spastic gait. MRI of all these patients revealed extensive T2 hyperintensity in the periventricular to subcortical white matter with distinct sparing of the U fibers. Abnormal signal changes in the posterior limb of internal capsule, external capsule, thalamus, pons, middle cerebellar peduncle and dentate hilus were seen. Extensive microhemorrhages were demonstrated in both supratentorial and infratentorial neuroparenchyma. FLAIR images revealed inverting regions, predominantly in the frontal lobe. One of the heterozygous asymptomatic subject showed discrete T2 hyperintensities in frontal white matter, small single microbleed in left insula and early disc desiccation at cervical level. The other subject who had symptoms of generalized tics had normal MRI brain but showed lumbar spondylosis.

Conclusions
Presence of extensive microbleeds and diffuse white matter signal changes with sparing of "U" fibers are characteristic MRI findings for CARASIL and maybe useful for selecting patients for genetic testing. Presence of microbleed in one of the asymptomatic relative of proband with heterozygous mutation and lumbar spondylosis deformans in the other, stresses the importance of genetic screening of family members.
24 years old presented with CARASIL - Fig a& b. Diffuse T2 & FLAIR hyperintense signal changes in bilateral cerebral hemisphere with sparing of subcortical u fibers, involvement of pons. Fig. c. shows Multiple microbleed in the supratentorial neuroparenchyma. Fig.d shows features of lumbar spondylosis.

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EdE-16

6:30AM - 2:45PM

Non-Neoplastic Pathology of the Sellar Region: Common and Unusual Diseases

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Purpose
Present a pictographic review of different non-neoplastic diseases affecting the sellar region, including common and unusual diseases.

Materials and Methods
We reviewed common and unusual non-neoplastic sellar pathology and its imaging characteristics in computed tomography (CT) and mainly magnetic resonance (MR). We also reviewed how the imaging findings in other body segments, as well as the clinical features, can provide valuable tools to get to the correct diagnosis.
Results
A pictorial review based in clinical cases it is presented, including: - Inflammatory diseases, such as, lymphocytic hypophysitis, IgG4 disease and Langerhans cells histiocytosis. - Infectious entities, i.e., tuberculosis, abscess and neurocysticercosis. - Granulomatous diseases, such as, granulomatosis with polyangiitis (ex-Wegener) and sarcoidosis. - Congenital diseases, such as, Rathke's cleft cyst, arachnoid cyst, epidermoid/dermoid cyst, aplasia/hypoplasia/ectopia. - Vascular diseases, i.e., internal carotid artery (ICA) aneurysm, carotid cavernous fistula and cavernous sinus thrombosis. - Miscellaneous: Hyperplasia, hemocromatosis.

Conclusions
Knowledge of non-neoplastic sellar pathology is essential in order to accurately diagnose this group of entities, prompting adequate treatment and avoiding unnecessary procedures. Familiarity with thoracic, abdominal and neuroradiological findings in systemic diseases affecting the sellar region is critical in optimizing diagnosis.
Granulomatosis with polyangeitis (Wegener). MRI nodular thickening of pituitary stalk, enlarged pituitary with irregular peripheral enhancement.
Chest CT: cavitated nodules with irregular contour.
Purpose
To review and describe the imaging features in five patients of ARSACS and describe one additional novel observation.

Materials and Methods
We describe the MRI findings in five cases of ARSACS syndrome that presented to our institution with ataxia, spasticity, and seizures. In addition, the third patient had mental subnormality and the third and fifth cases had limb tremors. All the patients underwent MRI brain and three had spine imaging performed either on a 1.5 or 3T clinical MRI scanner. Diagnosis was made based on classical clinical and imaging findings.

Results
The MRI of all the patients showed cerebellar atrophy, particularly of the superior vermis and pontine T2 and FLAIR hypointensities. The median raphe of the pons and lateral pons was hyperintense on T2WI in all patients (Fig. 1). Cervicodorsal cord atrophy was noted in patients 2, 4 and 5. Lateral thalamic T2 hyperintensities also were seen in all patients. These findings have been described previously (1, 2).

Previous studies have demonstrated that the T2 hypointensities in the pons represent the strangulated corticospinal fibers by the increased number of transverse pontine fibers. The hypointensity has been attributed to the tight packing of the fibers (2). In all of our five patients we observed that the corticospinal tract, starting from the posterior limb of internal capsule to the pyramids in the medulla were hypointense. This was observed well on coronal images (Fig. 2). In view of this novel observation we propose that the hypointensity may be due to the accumulation of some material within the fibers which is responsible for the T2 hypointensity. Pathological studies have revealed the presence of lipofuscin within thalamic and cerebellar neurons and skin of patients with Charlevoix Saguenay syndrome (3, 4). Pathological confirmation of this theory is required.

Conclusions
Hypointensity of the suprapontine and infrapontine corticospinal tract is a novel observation in ARSACS which may be due to the accumulation of a material like lipofuscin. This needs pathological corroboration.
Fig1a,b: Axial and Coronal T2WI of case 1 showing pontine hypointensities (elbow arrow) and hyperintensities of the median raphe (black arrow) and lateral pons. Fig2a,b: Coronal and axial T2WI of case 4 showing champagne glass hypointensity of the corticospinal tract (white arrows) and pyramids (thick blue arrow).

(Filename: TCT_EdE-01_charlevoixasnr.jpg)

EdE-37

6:30AM - 2:45PM

Pearls and Pitfalls of Symmetry in Neuroimaging: A Resident Training Initiative

S Kantharia¹, J Shah¹, E Greif³, T Alberico¹, E Stein¹
¹Maimonides Medical Center, Brooklyn, NY
Purpose
1. Review symmetric brain pathologies with a discussion of specific etiologies, pathophysiology and potential complications. 2. Pictorial case review of symmetrical brain pathologies from our collection and a review from the literature. 3. To emphasize optimal methods of detecting symmetric pathologies which often are missed due to the lack of asymmetry in findings.

Materials and Methods
Looking for symmetry in the interpretation of a brain scan is part of the traditional approach in finding evidence of neuropathology. It is therefore easy to overlook even the most glaring findings on neuroimaging if they are symmetric or midline. This is particularly true of residents in training who lack the experience and expertise to discern these sometimes confounding findings.

Results
We present a pictorial review of sundry neurological conditions that have either midline or symmetric findings for which the usual model of interpretation can prove misleading. For example, anoxic brain injury can present with a generalized loss of gray-white matter differentiation. Similarly, leptomeningeal enhancement in the setting of a generalized process such as cryptococcal meningitis often is bilateral and diffuse. Anatomical landmarks can be camouflaged when they are bilaterally abnormal. For example, Wernicke's encephalopathy will demonstrate restricted diffusion within the bilateral thalami. Subtle findings such as bilateral putamen and caudate head hyperintensities can be seen in rare disorders such as Leigh syndrome.

Conclusions
The examples presented in this pictorial case review should help residents in training develop a more sophisticated algorithm for the interpretation of neurological conditions that present with symmetrical findings. It is important to keep in mind the normal appearance of brain structures in all modalities and sequences to avoid missing bilateral or balanced abnormalities.
Primary Central Nervous System Post-Transplant Lymphoproliferative Disorders: the Spectrum of Imaging Appearances

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Purpose
Primary central nervous system post-transplant lymphoproliferative disorder (PCNS-PTLD) encompasses a heterogeneous group of diseases characterized by abnormal proliferation of lymphoid tissues occurring in recipients of solid organ transplants or bone marrow transplants. Although uncommon, PCNS-PTLD represents the third most common CNS complication of transplantation and can lead to significant morbidity and mortality. The purpose of this educational exhibit is to present the imaging features of PCNS-PTLD with computed tomography (CT) and magnetic resonance (MR) imaging. Examples of the differential diagnostic considerations including PCNS lymphoma, cerebral abscess, metastatic disease and glioblastoma multiforme (GBM) are illustrated.

Materials and Methods
CT and MR imaging of pathologically proven PCNS-PTLD, PCNS lymphoma, cerebral abscess, metastatic disease and GBM were collected from the authors' teaching collection and imaging database. The exhibit format utilizes a case-based review of the various imaging features of PCNS-PTLD. A review of the literature was performed and is incorporated in the presentation.

Results
Selected CT and MR images of PCNS-PTLD illustrate the topography of lesions, number of lesions, lesion necrosis and/or hemorrhage, perilesional vasogenic edema, diffusion and perfusion characteristics, and patterns of contrast enhancement. Comparison of these imaging features are made to PCNS lymphoma, cerebral abscess/infection, metastatic disease and GBM. These are the most common pathologies in the imaging differential of PCNS-PTLD. The imaging features can be used to help differentiate and diagnose PCNS-PTLD. More commonly present features of PCNS-PTLD include ring rather than solid enhancement, heterogeneous lesion enhancement and multicentric disease. PCNS-PTLD lesions tend to be located in the deep supratentorial structures including the periventricular regions, involve the basal ganglia and the frontal lobes. Restricted diffusion helps to define the hypercellular regions in PCNS-PTLD. In addition, we present the clinical and
pathologic features of PCNS-PTLD, such as prevalence in organ transplant recipients, Epstein-Barr virus status and immunophenotype. Multiple organisms can cause infection in the transplant patient and these are reviewed. Figure 1 shows typical multiple ring enhancing lesions (arrows in 1a) with extensive edema (arrows in 1b) in the basal ganglia. Figure 2a (diffusion-weighted image) and 2b (ADC map) shows multiple lesions with the restricted diffusion (arrows) in the posterior frontal lobe.

Conclusions
This exhibit enhances knowledge of the imaging characteristics of PCNS-PTLD and its differential considerations. It is important to know the unique imaging characteristics of PCNS-PTLD to optimize early diagnosis and therapy.
EdE-42

Rare Case of Isolated Medial Longitudinal Fasciculus Syndrome Secondary to Acute Lacunar Midbrain Infarct: Review of Imaging, Anatomy and Pathophysiology

P Kochar¹, N Gigauri², N Bhatt³, P Sharma⁴, S Sharma², N Gupta⁵, Y Kumar⁶
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Purpose
The purpose of the exhibit is to discuss the imaging characteristics, pathophysiology and relevant anatomy of isolated medial longitudinal fasciculus (MLF) syndrome, in an attempt to acquaint the neuroradiologists with this condition so as to look carefully at the midbrain in those cases presenting with symptoms of isolated MLF syndrome.

Materials and Methods
Isolated MLF syndrome due to infarction in the midbrain only is rare. Such small infarcts can be missed easily by young neuroradiologists and the trainees. In this review, we discuss the clinical and imaging characteristics of this clinical entity followed by comprehensive review of the anatomy and pathophysiology.

Results
Isolated MLF syndrome is an important cause of impairment of adduction of ipsilateral eye during horizontal gaze and has to be differentiated from partial oculomotor nerve palsy. Ipsilateral adduction abnormality during horizontal gaze with preservation of convergence is suggestive of isolated MLF syndrome rather than partial oculomotor nerve palsy. Careful scrutiny of the brain stem is crucial to recognize such small infarcts, explain the clinical symptomatology and help the clinician to determine the etiology of patient's symptoms.

Conclusions
Isolated MLF syndrome secondary to acute lacunar midbrain infarct is rare. Visualization of such small infarcts is difficult and challenging especially for young neuroradiologists and the trainees. This exhibit will help the radiologist to understand this condition, its pathophysiology and anatomy and to identify such small infarcts in the relevant clinical setting.

EdE-38

54th Annual Meeting & Foundation of the ASNR Symposium 2016
Relative Diffusion Restriction - A New Framework for the Interpretation of the Apparent Diffusion Coefficient in Clinical Brain MRI

J Butman

Purpose
To introduce the concept of "relative diffusion restriction" which provides a language to discriminate amongst pathologies in which T2 and ADC are tightly correlated from those in which this correlation is broken.

Materials and Methods
T2 and ADC values for each voxel in the brain were plotted as joint histograms for 40 consecutive cases which included varying degrees of white matter pathology including vasogenic edema, gliosis, leukomalacia, and leukodystrophies. The patterns of the joint histograms were reviewed.

Results
In most cases, the joint distribution of whole brain ADC and T2 has a comet-shaped appearance. The "head" of the comet corresponds to the majority of tissue which has "normal" ADC and T2 values. The "tail" corresponds to tissues with increasing water content which are associated with higher T2 and ADC values in a highly correlated manner. The size of this tail corresponds to the volume of pathology with various degrees of increasing tissue water (e.g., vasogenic edema or leukoaraiosis). In a few cases, the correlation of T2 and ADC is broken, as can be seen in joint histograms as points above the comet tail. Such voxels have ADC values that are lower than expected given the T2 value of the tissue, even if the ADC may be higher than that of normal tissue.

Conclusions
Because diffusion-weighted imaging combines T2 and diffusion effects, the apparent diffusion coefficient (ADC) typically is computed to remove the confound of T2 and generate a "pure" diffusion measurement. Interpretation of the ADC map typically is referenced to the diffusivity of normal brain. Thus, a region has abnormally low diffusivity (diffusion restriction) if the ADC of the lesion is less than that of normal brain. Conversely a lesion has high diffusivity if the ADC is greater than that of normal brain. This interpretation is overly simplistic, and neglects to take into account the high correlation of T2 and ADC with increasing water content as is seen with interstitial (vasogenic) edema and gliosis. Here we show a number of diverse pathologies in which this correlation is broken, so that the ADC is RELATIVELY low with respect to that expected based on the T2 value of the lesion. In these cases the ADC may still be higher than that of normal brain. Current radiologic interpretation is that the diffusion is elevated in such a lesion. The new proposition is that such lesions
should be considered to have relatively low diffusivity, given the T2 signal. This new concept can help distinguish amongst otherwise similar lesions, particularly in the context of white matter diseases. The pathophysiologic basis of this is as yet unclear.
Current interpretation of ADC

T2

Diffusion
Restriction

High Diffusivity

ADC

Proposed interpretation of ADC

T2

Relative Diffusion
Restriction

Elevated tissue water (edema, gliosis)

Water

Decreased Tissue

Relative High
Diffusivity

ADC
Revealing the Thalamo-Amygdaloid Connection of the Human Brain

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¹Johns Hopkins University Hospital, Baltimore, MD, ²UTHSC-Houston, Houston, TX, ³Johns Hopkins Medicine, Elkridge, MD

Purpose
The purpose of the current study is to demonstrate the feasibility of tracing 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
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 pathway of the human limbic system. 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 and human central nervous system. This work aimed to demonstrate for the first time the feasibility of in vivo quantification and visualization of major thalamo-limbic connections of the human limbic system in relation to the gray matter nuclei using high resolution DTI data on 3T. We also show the ability to separate and quantify the tract volume and corresponding diffusion tensor metrics of these small fiber tracts on five subjects.

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.

Results
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 is clearly distinguishable in relation to the
amygdala, thalamus, 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 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
thalamo-amygdaloid connection of the human limbic system using high resolution
diffusion tensor tractography on 3T.
Figure 1. 3D reconstruction of amygdalo-thalamic tract (pink) and the amygdalofugal tract (red)

(Filename: TCT_EdE-07_Imagesofthalamolimbic-1.gif)

EdE-06

6:30AM - 2:45PM

State of the Art and Emerging MR Spectroscopic Techniques for Brain Imaging

E Ratai¹, O Andronesi², B Rosen², P Caruso³, P Schaefer⁴, G Gonzalez⁴, O Rapalino⁵
Purpose
To present the current state of the art of MR spectroscopy and to describe new and emerging techniques that will revolutionize the role and impact of MR spectroscopy in brain imaging.

Materials and Methods
Current MR spectroscopic techniques are described, including single voxel spectroscopy (SVS) and magnetic resonance spectroscopy imaging (MRSI) techniques routinely used in clinical practice. Newer MRS techniques, including localized adiabatic selective refocusing (LASER), spiral MRS, motion-corrected MRS, spectral edited MRS and 2D correlation spectroscopy, are presented in detail, with brief comments about their principles, clinical applications and future prospects.

Results
MR spectroscopy is a very important clinical imaging modality, particularly useful in the identification of abnormal metabolites seen in different genetic and metabolic disorders and the characterization of intraparenchymal lesions, particularly intracranial masses. Newer MR techniques show promise in improving the separation of individual metabolites (e.g., spectral editing) and increase the number of metabolic signatures identified with MRS (2D correlation techniques). Proton echo planar spectroscopic imaging (PEPSI) sequence or spiral trajectories in k-space allow fast encoding of spatial information by using gradient switching during acquisition (1, 2). The implementation of 3D MRSI techniques with Localization by Adiabatic Selective Refocusing (LASER) pulses acquisition is designed to better compensate for chemical shift displacement errors, spatial nonuniformity of radiofrequency excitation and contamination with subcutaneous lipid signal from tissues outside the region of interest (ROI) (2). Motion correction schemes applied in MR technology have brought many practical benefits, e.g., it is possible to prospectively correct motion using image-based navigators (3). Spectral editing techniques such as 2D J-resolved methods allow for the detection of peaks that are otherwise hidden in the MR spectrum. In spectral editing, a selective and nonselective spin-echo spectra are acquired; the difference spectrum contains the target metabolite signal (e.g., 2HG) while all other contributors will be nulled. Another approach to visualize hidden MR resonances are 2D correlation spectroscopy (COSY) and total correlation spectroscopy (TOCSY) imaging experiments (4, 5). These newer techniques promise to transform MR spectroscopy in a very powerful for noninvasive diagnosis of many diseases affecting the central nervous system (CNS).

Conclusions
Currently available MR spectroscopic techniques are very helpful for the
characterization of many pathological processes. Newer sequences that are currently in development promise to significantly increase the diagnostic capabilities of MR spectroscopy by removing many of the technical barriers currently hindering this technique and by increasing the number of metabolites potentially identified in the brain.

(Filename: TCT_EdE-06_2HG.jpg)
A. Anaplastic astrocytoma (IDH1<sup>R132C</sup>)

B. Primary glioblastoma (wt-IDH1)

C. Healthy volunteer (wt-IDH1)
The Falx Cerebri: A Pictorial and Educational Review of Common and Uncommon Neuroimaging Findings

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Purpose
Numerous diseases can involve the falx cerebri and its surroundings owing to its histology, large size, and proximity to many important structures. Scant attention has been paid to date to comprehensive classification of the neuroimaging manifestations of dural and nondural falcine abnormalities. In this educational exhibit we review in detail the neuroimaging findings of common and less commonly reported pathologies involving the falx.

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

Results
We first describe the imaging anatomy of the falx including its little known falcine venous plexus, and the rare persistent falcine sinus. Then we discuss congenital lesions, e.g., rare agenesis, hypoplasia, and fenestration. Acquired benign pathologies include incidental physiological calcification, falcine fat, and more rarely, ossification. Rarer causes of a calcified falx include lamellar calcification in Gorlin-Goltz syndrome, Hajdu-Cheney syndrome, Fahr syndrome, and in children with lissencephaly and pseudohypoparathyroidism. Benign neoplastic lesions include meningioma, and more uncommon lesions, e.g., chondroma, osteoma, angiomyxoma, angioleiomyoma, solitary fibrous tumor, and schwannoma. Malignant lesions include metastases, and more uncommonly hemangiopericytoma, leukemic extramedullary tumor, malignant ectomesenchymoma, chondro- and osteosarcoma, plasmacytoma and other bone-derived tumors, and primary neuroblastoma (the falx is derived from the neural crest). Several infective and inflammatory diseases also affect the falx, either diffusely, e.g., in pachymeningitis (including idiopathic), or discretely, e.g., tuberculoma. Vascular abnormalities include subdural and rare interdural hematomas, AVMs, AVFs, and cavernous malformations.

Conclusions
Common falcine physiological calcification, meningiomas, dural metastases, and meningeal thickening in intracranial hypotension seldom present difficulties in differential diagnosis. However the more uncommon lesions involving the falx vary
substantially, and can be both unexpected and challenging on neuroimaging. This presentation will aid in differentiating the many imaging appearances of lesions in this region.

EdE-11

Varicella-Zoster Virus: One Pathogen with Multifaceted Pathophysiological Spread, Clinical Expressions and Imaging Presentations

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Purpose
This review discusses the epidemiology and pathophysiology of varicella-zoster virus (VZV) infection, vaccine to prevent varicella and zoster and provides a foundation for understanding when disease is likely to occur and what imaging features predominate.

Materials and Methods
A literature review was obtained through pubmed and google inquiries, guided by the coauthors extensive experience in this field, to discuss varicella-zoster virus VZV epidemiology and pathophysiology, vaccine to prevent varicella and zoster, and provides a foundation for understanding when disease is likely to occur and what imaging features predominate. An organizational chart is presented with selected illustrative imaging cases demonstrating the protean neurological manifestations of VZV infection of the nervous system.

Results
Imaging examples include: Chronic VZV ganglionitis. Imaging shows contrast enhancement in the L2-3 dorsal root ganglion. Varicella-zoster virus trigeminal ganglionitis. Axial CT scan with contrast reveals a homogeneously enhancing mass in the left Meckel's cave. Ramsey Hunt syndrome. Imaging shows enhancement of the intracanalicular left 7th and 8th nerve, enhancement and enlargement of the genu of the 7th nerve, the greater petrosal nerve and the horizontal portion of the 7th nerve. Varicella-zoster virus-associated enhancement of the sclera and retrobulbar optic neuritis. Case shows enhancement of the left sclera in a shrunken globe, "tram-track" enhancement of the left optic nerve sheath. Optic nerve enhancement in second patient. Varicella-zoster virus brachial plexitis and myelitis before and after antiviral treatment of cervical zoster. Brachial plexus and spinal cord show initial widespread increased T2 signal and mild enhancement resolving after antiviral treatment. Varicella-zoster virus-induced venous sinus thrombosis. Imaging shows thrombus in the left transverse and sigmoid sinus. Varicella-zoster virus vasculopathy: White matter changes. Imaging demonstrates multifocal white matter changes in subcortical white matter, particularly at gray-white junctions, in a patient with anti-VZV IgG
antibody in cerebrospinal fluid (CSF). Varicella-zoster virus vasculopathy: resolution after antiviral therapy. MR imaging vessel wall imaging in patient with strokes and anti-VZV IgG in CSF before/after treatment shows initial avid enhancement and stenosis in the right paraclinoid ICA with resolution after treatment. Varicella-zoster virus vasculopathy: spinal cord infarction. Thoracic spinal cord imaging shows a small focus of enhancement, widespread increased T2 signal in central gray matter and multifocal central gray restricted diffusion.

Conclusions
Zoster develops in one in three adults during their lifetime. Latency develops even in children who are vaccinated, so neurological complications are likely to continue. The imaging manifestations of VZV reactivation (ganglionitis, neuritis, plexitis, meningitis, myelitis, encephalitis, venous sinus thrombosis and vasculopathy resulting in infarcts) develop in both immunocompetent and immunocompromised individuals and can occur even in the absence of a rash. The occurrence of these complications in close temporal proximity to zoster should alert both neuroradiologist and neurologist to this possible diagnosis and lead to CSF studies for VZV.
Purpose
To explore the gamut of intra and extracranial vascular pathology that can be diagnosed by utilizing evolving black blood magnetic resonance imaging (MRI) techniques that obtain volumetric T1 acquisitions in time-judicious clinical settings.

Materials and Methods
Within the past year, our institution has modified our basic magnetic resonance angiography (MRA) protocol to now include a dedicated black blood sequence with every clinical study. These sequences are obtained at both 1.5T and 3.0T using isotropic-resolution three-dimensional (3D) fast spin echo acquisitions with variable flip angles (GE CUBE) and without dedicated surface coils. Since adopting this new sequence, we have amassed a large collection of educational cases that demonstrate the added utility of vessel wall imaging in making otherwise difficult or ambiguous diagnoses.

Results
Although black blood MRI has been utilized in research settings over the last decade, its adoption and usage in dedicated clinical settings has somewhat lagged. Although these techniques have been shown to adequately delineate vascular plaque morphology and to even identify vulnerable vascular lesions (1-5), the original pulse sequences utilizing double inversion recovery techniques have been technologically difficult to implement in clinical settings due to lengthy scan times and the necessity of expensive/cumbersome surface coils. Many of these constraints have been ameliorated with newer 3D volumetric sequences such as CUBE, which have the potential to induce the rapid proliferation of black blood imaging into clinical settings throughout the country. Since many institutions have limited experience in interpreting these studies, we offer a representative sample of cases (along with relevant follow-up studies when necessary) to demonstrate key imaging findings and their significance in making difficult vascular diagnoses.

Conclusions
Rapidly-evolving black blood MRI techniques will provide neuroradiologists with yet another tool in their arsenal to assess the vasculature. Drawing from our clinical experience with CUBE, we offer cases and insights to aid in their diagnostic acumen.
**What Can This New Scanner Do? Dual Energy CT Applications in Neuroradiology and Head and Neck Imaging**

E Miller, D Boulter, B Gans, X Nguyen, L Prevedello, M Luttrull, W Slone, A Ajam, T Shujaat, A Alfieri, E Bourekas

1Ohio State University, Columbus, OH, 2The Ohio State University Wexner Medical, Columbus, OH, 3Ohio State Wexner Medical Center, Columbus, OH, 4The Ohio State University Wexner Medical Center, Columbus, OH, 5The Ohio State University, Columbus, OH

**Purpose**
As dual energy CT has become increasingly available, a variety of clinical applications in neuroradiology have emerged relating to improved discrimination of materials such as iodine and calcium, enhancement of signal to noise ratios and artifact reduction. Our purpose is to illustrate the breadth of clinical uses of dual energy CT in routine neuroradiology practice.

**Materials and Methods**
Dual energy CT scans were obtained on dual source CT scanners from a single vendor. Dual energy processing was performed using vendor provided software.

**Results**
Case 1) Patient immediately status postcardiac catheterization with decline in mental status underwent noncontrast head CT to exclude hemorrhage prior to anticoagulation. Areas of hyperdensity were noted in the brain parenchyma, which were confirmed to be iodinated contrast staining rather than hemorrhage with dual energy virtual noncontrast and iodine overlay images (Fig. 1). Case 2) Patient was transferred from an outside facility with a diagnosis of intracranial hemorrhage on CT. Upon arrival, dual energy head CT virtual noncalcium images and calcium map confirmed the finding to be mineralization rather than hemorrhage. Case 3) Patient with acute stroke underwent intra-arterial thrombolysis. Dual energy virtual nonenhanced images and iodine overlay maps differentiated contrast staining from hemorrhagic transformation. Case 4) Patient with a newly diagnosed hypopharyngeal squamous cell carcinoma. Virtual monoenergetic reconstructed images at 40 keV revealed necrosis and hyperenhancement within two lymph nodes that appeared normal on blended images. Case 5) Patient with a history of previously clipped anterior communicating artery aneurysm underwent dual energy CTA. Maximum intensity projection images were difficult to interpret due to clip artifact. Dual energy assisted subtraction of the aneurysm clip and skull allowed easy visualization of recurrent aneurysm.
Conclusions
Dual energy is a powerful addition to the capabilities of CT with a variety of applications to neuroradiology and head and neck practice.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-2

Education Exhibit Poster (EdE) - Head and Neck
EdE-55

Approach to Benign Jaw Lesions: 3D CT and MR with Surgical-Pathologic Correlation

M Ho¹, D Schembri Wismayer¹, J Yetzer¹, K Arce¹, C Viozzi¹, J van Ess¹, D DeLone¹
¹Mayo Clinic, Rochester, MN

Purpose
To present an approach to cross-sectional imaging diagnosis of jaw lesions, based on correlation to radiography, 3D/surgical findings, and pathology.

Materials and Methods
Basic concepts of dental radiographic acquisition and interpretation will be discussed, along with the indications for obtaining CT (cone-beam versus diagnostic) and magnetic resonance imaging (MRI). Pathophysiology and nomenclature of jaw lesions will be reviewed. A wide spectrum of jaw pathology will be presented in differential diagnostic groups: simple cystic; complex cystic (septations, soft tissue, calcification); and sclerotic. Elements of the diagnostic approach include: patient demographics and symptoms, location in the jaw, cortex and tooth destruction, margin definition,
morphology of septations, soft tissue components, and matrix calcification. Computed tomography (CT)/MR imaging will be correlated with panorex, 3D models, surgical findings, and gross/microscopic pathology specimens. Implications for management (local recurrence, malignant transformation) and approaches to surgery (curettage, subtotal resection, radical en bloc excision) also will be discussed.

Results


Conclusions

The neuroradiologist's standardized approach to benign jaw lesions should include assessment of clinical presentation as well as lesion location, margination, and composition. Simple cystic lesions have characteristic radiographic appearances, and typically require no/minimal intervention. Complex cystic and sclerotic/mixed lesions benefit from cross-sectional imaging for detailed characterization and surgical planning. CT should be obtained for evaluation of bone detail including mass effect, margination, septations, and matrix calcification. Magnetic resonance imaging (MRI) also can be helpful in characterizing soft tissue components, fluid-blood levels, and marrow/nerve involvement. Through review of advanced cases with cross-sectional imaging and pathologic correlation, the radiologist will be equipped to provide informed differential diagnoses and assist in appropriate management of these diverse lesions.
EdE-59

Calcifications of the External, Middle, and Inner Ear

M Utz¹, B Branstetter¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Otologic complaints are the third most common reason for evaluation by a primary care physician. Patients that require further evaluation by an otolaryngologist may receive computed tomography (CT) or magnetic resonance imaging (MRI) for pre-operative planning. Calcifications are a frequent finding in any CT examination. Calcifications in the middle ear may represent a normal variant, sequela of prior inflammation, or other conditions. It is imperative that the neuroradiologist is familiar with both common and unusual calcifications throughout the ear to guide proper patient management.

Materials and Methods
Retrospective review was performed of CT examinations over the past 10 years with ear calcifications. Calcifications were included which both related to the chief complaint, and incidentally noted. Relevant anatomy is reviewed.

Results
Calcifications of the external ear include exostoses, petrified auricle, and temporal osteochondroma. Middle ear calcifications include sequela of prior/chronic infection and inflammation. Inner ear calcifications include labrynthitis ossificans, degenerated schwannoma, and endolymphatic sac tumor.

Conclusions
Calcifications throughout the ear are not an uncommon finding. It is essential that the neuroradiologist be familiar with the various etiologies of ear calcification in order to guide proper management.

EdE-51

Craniosynostosis: Diagnosis, Pitfalls, and Management. What the Radiologist Needs to Know

S Rahman¹, K Chaiyasate¹, S Noujaim¹
¹Beaumont Health System, Royal Oak, MI
Purpose

Craniosynostosis is an important clinical entity in the pediatric population resulting in significant cosmetic and health effects. Radiologic evaluation including diagnosis and characterization is important as surgical correction techniques have improved, resulting in decreased morbidity and improved outcomes. In addition to plain radiographs, advanced imaging techniques including 3D CT scans are essential for accurate diagnosis, surgical planning, and post-treatment evaluation.

Materials and Methods

The authors briefly review the clinical and radiologic features of craniosynostosis, including the sporadic forms, syndromic forms (Crouzon and Apert syndromes), as well as secondary forms. Plain radiographs and CT scans with 3D reconstructions from our institution will be used to illustrate the radiologic appearance of the spectrum of abnormalities seen in craniosynostosis, as well as postoperative findings.

Results

The cranial sutures naturally fuse at varying age ranges, but none of the sutures should fuse prior to 19 months of age (with the exception of the metopic suture). The various deformities resulting from craniosynostosis – such as scaphocephaly, trigonocephaly, brachycephaly, cloverleaf cranium, etc. – depend on the number and type of sutures involved. When multiple sutures are involved, the deformity depends on the order of suture fusion. Common findings associated with various forms of craniosynostosis include hypertelorism, hypotelorism, harlequin eye, etc. Findings related to craniosynostosis need to be differentiated from plagiocephaly (positional versus acquired) and other deformities. Multiple additional congenital deformities are seen in syndromic craniosynostosis, examples of which will be presented. Treatment options usually include surgical management for primary craniosynostosis, and conservative management for secondary craniosynostosis. Illustration of common surgical techniques including "strip craniectomy," and "barrel-stave osteotomies" will be presented.

Conclusions

The authors review the natural history of physiologic fusion of the cranial sutures and closure of fontanelles, and present a pictorial review of radiologic findings of faulty closure in sporadic, syndromic, and secondary forms of craniosynostosis with review of associated incidental findings and related anomalies. Treatment options and postsurgical changes are discussed as well.

EdE-54

6:30AM - 2:45PM

Cystic Lesions of the Aerodigestive Tract: Anatomic Relationships and Differential Diagnosis

M VonLoh¹, G Lorenzo¹
Purpose
This educational exhibit will discuss an anatomically-based differential diagnosis for cystic lesions of the aerodigestive tract and present an algorithmic and anatomically-based diagnostic approach for their evaluation.

Materials and Methods
Cystic lesions of the aerodigestive tract are common findings on magnetic resonance imaging (MRI) and computed tomography (CT) imaging of the neck. The spectrum of aerodigestive tract cystic lesions is broad and their clinical significance is varied widely. Differentiation of these lesions based on anatomical relationships can be helpful in guiding management. This educational exhibit will discuss an anatomically-based differential diagnosis for cystic lesions of the aerodigestive tract and present an algorithmic anatomically-based diagnostic approach for these cysts.

Results
An anatomically-based approach to aerodigestive tract cysts is helpful in arriving at an appropriate differential diagnosis. Some cystic lesions of the aerodigestive tract are diagnosed based on their location and morphology. Furthermore, imaging can guide management by identifying clues to the cyst's origin. Some of the lesions described within this educational exhibit such as the Torwalt cyst, submucosal cyst and congenital entities such as a median clival canal should be identified as clearly benign and therefore incidental. However, some cystic lesions carry surgical implications such as a sphenoidal cephalocele; alternatively their presence may indicate underlying malignancy such as a laryngocele. Developmental cystic lesions such as the thyroglossal duct remnant or branchial cleft cyst may be benign and yet become symptomatic with superimposed infection.

Conclusions
A broad spectrum of pathology can result in cysts involving the aerodigestive tract. An anatomical-based algorithm may permit an accurate diagnosis and thereby guide appropriate treatment.

EdE-52
6:30AM - 2:45PM
Diagnostic Dilemma: Osteoradionecrosis Versus Recurrent Head and Neck Cancer

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EdE-52
6:30AM - 2:45PM
Diagnosis of Osteoradionecrosis Versus Recurrent Head and Neck Cancer

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Purpose
This educational exhibit will review the spectrum of imaging findings of osteoradionecrosis (ORN) in the head and neck as seen on computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET). Emphasis will be placed on imaging features that help distinguish ORN from recurrent malignancy, a frequent diagnostic dilemma. In addition, this exhibit will discuss the epidemiology, pathophysiology, risk factors, and treatment options for ORN as it applies to each location.

Materials and Methods
A literature review was performed on the imaging manifestations of ORN in the head and neck and its differentiating features to malignancy, as well as on its epidemiology, pathophysiology, and clinical management. The teaching database of a senior neuroradiologist specializing in head and neck imaging was used for selection of qualified patients. All selected patients were treated with radiation therapy for head and neck cancer, and were diagnosed with ORN via biopsy, surgical debridement, or clinical and imaging followup. Multimodality imaging (CT, PET, and/or MRI) was performed in several patients.

Results
Osteoradionecrosis is a well recognized and feared complication of radiation therapy for primary head and neck malignancy. Osteoradionecrosis is the result of radiation-induced hypocellularity and hypovascularity of osseous and cartilaginous tissues within the irradiated field. The end result is osteonecrosis or chondronecrosis depending on the site involved, which can lead to structural compromise such as airway collapse in case of laryngeal chondronecrosis and can predispose to superimposed infection. The mandible and larynx are the most well known sites of involvement by ORN; however, this process can affect any other bony and cartilaginous structures of the head and neck such as maxilla, temporal bone, styloid process, and hyoid bone. Some neuroradiologists might not be familiar with the imaging signs of ORN in these unusual locations and may mistake them as recurrent tumor. Knowledge of the spectrum of imaging findings of ORN in common and uncommon head and neck locations and its distinguishing features from recurrent malignancy is critical as these diagnoses imply radically different management.

Conclusions
Neuroradiologists involved in the care of head and neck cancer patients should be cognizant of ORN as a complication of therapy and its imaging features in common and uncommon locations. The radiologist may be the first physician to suggest this diagnosis, which may avoid unnecessary biopsies and lead to timely initiation of appropriate therapy.
Post radiation therapy CT and fused PET images (A and B) show expected post treatment edema with localized marked FDG uptake centered around the sclerotic left arytenoid. The corresponding CT image (A) reveals low soft tissue attenuation around the left arytenoid similar to the remaining laryngeal edema indicating radiation necrosis related FDG uptake rather than recurrent tumor. This is confirmed with the CT and fused PET images (C and D) showing interval sloughing of the left arytenoid cartilage and no residual FDG uptake.
Purpose
The purpose of this abstract is to provide a practical overview of multiple standard and nonstandard head and neck biopsy approaches in order to improve the confidence of the viewers in planning and performing biopsies within the deep spaces of the head and neck.

Materials and Methods
We have accumulated numerous cases to demonstrate the various possible approaches to lesions of the deep spaces of the head and neck; both those that do and do not follow traditional trajectories. These include, but are not limited to, sub-zygomatic, para-maxillary, sub-mastoid, and trans-thyroid approaches as demonstrated in the attached images. We intend to exhibit these cases with particular attention to the "danger zones" of the head and neck along with the associated anatomy. We also will provide practical advice for each of the biopsy approaches that we exhibit. We will provide unique anatomical images useful for visualizing the reviewed biopsy pathways.

Results
With the widespread adoption of computed tomography (CT), the utilization of imaging guidance for biopsies of the deep spaces of the head and neck has drastically increased. Neuroradiologists are able to biopsy, with a minimally invasive technique, lesions that previously required complicated and drawn out surgeries. This has drastically increased medical efficiency and cut down on possible surgical morbidity. There are numerous standard biopsy approaches that have been described in the literature. These approaches allow access to the deep spaces of the head and neck while avoiding major vascular and nervous system structures. However, at times, new approaches are required for especially difficult lesions. In order to plan out and follow an appropriate needle pathway for biopsy, advanced knowledge of the anatomical structures of the head and neck is required, especially the arterial, venous, and nervous system structures. Not all practitioners feel comfortable with the standard biopsy approaches, and we believe that a practical review would be helpful to many physicians in their practices.

Conclusions
Neuroradiologists are able to achieve adequate approaches to nearly all head and neck...
lesion biopsies with appropriate preparation and anatomical knowledge. These biopsies may eliminate the need for drawn out and complicated surgeries. Careful planning and a fundamental knowledge of the already well described biopsy approaches allow radiologists to sample most of these lesions and, at times, devise new approaches for lesions in unconventional locations.
EdE-50

H&N Vascular Anomalies and Syndromes: Why Image?

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Purpose
To highlight the role of imaging in diagnosis and therapy of head/neck vascular anomalies (VA), using a case-based approach with dermatologic and otolaryngologic correlation.

Materials and Methods
The International Society for the Study of Vascular Anomalies (ISSVA) classification will be introduced and utilized as a framework for discussion. We will discuss the radiologist's collaborative role in VA workup including: when and why to image, appropriate choice of modality, key neuroimaging features, and stigmata of syndromic disease. Accompanying dermatologic and otolaryngologic color photos will emphasize the complementary roles of imaging and clinical examination. Ideally, VA patients should be evaluated and managed by a multidisciplinary team of specialists.

Results

Conclusions
Diagnosis and management of VA requires close collaboration between clinicians and radiologists. Familiarity with the spectrum of head/neck cases will enable neuroradiologists to select the appropriate imaging modality, identify key diagnostic
features of vascular lesions/syndromes, and correlate with dermatologic/otolaryngologic findings.
Imaging Approach to Fibro-Osseous Lesions of the Midface

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Purpose
Fibro-osseous lesions of the midface include heterogeneous pathologies characterized by replacement of the bone by cellular fibrous tissue with varying degree of ossification and calcification. Although fibro-osseous lesions of the midface may have similar imaging appearances, certain imaging features can provide diagnosis and/or support clinico-pathologic diagnosis. This review will provide an image-centered approach to fibro-osseous lesions of the midface by comparing and contrasting common fibro-osseous lesions.

Materials and Methods
This review will compare and contrast imaging features of common midface fibro-osseous lesions including fibrous dysplasia, periapical cemental dysplasia, florid cemento-osseous dysplasia, condensing osteitis, chronic osteomyelitis, central giant cell granuloma, brown tumor and ossifying fibroma.

Results
Fibro-osseous lesions of the midface have been subdivided into five categories: bone dysplasias, cemento-osseous dysplasias, inflammatory/reactive disorders, metabolic disorders and neoplastic processes (1). Histopathology can provide the diagnosis of some fibro-osseous lesions; however, some lesions require a combination of clinical, microscopic and radiographic evaluation to reach a specific diagnosis. Lastly, radiologists should be familiar with features of some fibro-osseous lesions which the diagnosis can be made with the imaging appearance alone combined with location.

Conclusions
This review provides a radiologist with an understanding of common fibro-osseous lesions encountered in the midface and an organized approach to distinguishing common fibro-osseous lesions, specifically: fibrous dysplasia, periapical cemental dysplasia, florid cemento-osseous dysplasia, condensing osteitis, chronic osteomyelitis, central giant cell granuloma, brown tumor and ossifying fibroma.
Purpose
Management of head and neck cancers require a multidisciplinary approach. Neuroradiology plays a pivotal role in clinical decision making in regards to diagnosis, staging and post-treatment evaluation. Complicated anatomy of the head and neck region following treatment makes interpretation even more challenging. Advanced imaging techniques which incorporate the metabolic information to anatomical imaging has improved evaluation of this region. We present the key points in evaluation of post-treatment head and neck cancers on CT, MR and PET/CT.

Materials and Methods

Results
Evaluation of post-treatment head and neck cancers are affected greatly by the type of the treatment. Anatomical alterations following surgery and/or radiation therapy make the image interpretation challenging. Obtaining the appropriate imaging modality at optimal timing following treatment is the key to success in achieving the correct diagnosis. In addition, the quantitative criteria obtained from FDG-PET and DWI provide more objective assessment of treatment response.

Conclusions
Understanding the surgical approaches, expected radiation-related effects, possible post-treatment complications, the variable appearances of recurrences and knowing when to image the patients following treatment is crucial for the neuroradiologists' success in yielding accurate interpretation.

EdE-45

Penetrating Neck Trauma on MDCTA

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Purpose
Penetrating neck injuries carry a high morbidity risk and a mortality rate of up to 10%. With the invention of multidetector computed tomography angiography (MDCTA) there has been a shift from surgical exploration and catheter angiography to more conservative management in hemodynamically stable patients over the last several years. It has therefore become important to adequately recognize both vascular and nonvascular life threatening injuries and complications on CTA neck.

Materials and Methods
A case by case review of both gunshot wounds and penetrating knife wounds to the neck demonstrates the typical critical vascular and aerodigestive injuries. Vascular injuries visualized and discussed include pseudoaneurysm, arteriovenous fistula, vessel transection, intimal injury, dissection, active extravasation, and occlusion of either the carotid or vertebral arteries. Tracheal injury causing subcutaneous emphysema and esophageal injury causing mediastinitis are shown and discussed as well.

Results
The increased use of MDCTA in the acute care of penetrating neck trauma patients has created a need for radiologists to be familiar with the complications and imaging characteristics of penetrating injuries to the neck. Multidetector CTA does not replace surgical exploration in the hemodynamically unstable patients nor does it replace conventional angiography in select patients. Conventional angiography also continues to have the added benefit of potential intervention in patients where clinical suspicion may warrant immediate intervention. However this leaves many patients who have suffered an acute traumatic injury where further evaluation is warranted and MDCTA is a cheap, effective, noninvasive, fast, and accurate method to rule out both vascular and nonvascular injuries.

Conclusions
Multidetector CTA is an accurate modality to further evaluate hemodynamically stable patients who have suffered an acute traumatic injury. It has therefore become important for radiologists to understand the common injuries and their complications.

EdE-47
6:30AM - 2:45PM

The Spaces and Faces of Head and Neck Venous Malformations

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Purpose
1. Review of clinical features and pathophysiology of head and neck venous
malformations (VM). 2. Discuss and demonstrate the imaging hallmarks of head and neck VM.

Materials and Methods
Review of key imaging features and pathophysiology of VM in the head and neck using multimodality imaging examples from our institution.

Results
Venous malformations of the head and neck, also known as cavernous hemangiomas, are low-flow vascular malformations. They are relatively common in the head and neck. Venous malformations are considered non-neoplastic with growth proportional to body size and responsive to hormonal changes. Patients often present with facial deformity or pain as a result of mass effect. Lesion enlargement with the Valsalva maneuver is characteristic of VM. Tortuous vascular channels with stagnant blood flow gives rise to the classic appearance of phleboliths, found in as many as 48% of cases and easily identified on CT. MR imaging allows for the best delineation of spatial extent of the lesion. A VM is typically T2 hyperintense on MR with early heterogeneous and delayed homogenous enhancement. Fluid-fluid levels and heterogeneous signal secondary to hemorrhage/blood pooling may be seen. The most common locations of VM in the head and neck include the buccal, masticator and sublingual spaces as well as the orbit. When a VM is present in more unusual locations such the retropharyngeal space, they must be differentiated from more sinister lesions. Treatment of a VM generally is performed on symptomatic lesions and commonly involves sclerotherapy.

Conclusions
Venous malformations are the most common vascular malformation of the head and neck. They frequently are encountered on routine imaging. Familiarity with typical imaging features of a VM will help aid in early and accurate diagnosis and allow for differentiation from more sinister lesions.
Untangling the Brachial the Plexus: Understanding MR Anatomy of the Normal and Pathologic Brachial Plexus

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Purpose
The aim of this exhibit is to provide a comprehensive anatomic review of the brachial plexus in order to facilitate recognition of both normal and abnormal appearance on MR imaging.
Materials and Methods
Utilizing detailed diagrams, cadaveric images, dynamic MRI sequences and strong case examples the complex anatomy of the brachial plexus will be reviewed with emphasis placed on landmark recognition.

Results
The brachial plexus represents a complex neurovascular structure bundled into a tightly confined space and it plays a major role in motor and sensory innervation of the shoulder, upper extremity and upper chest. Various traumatic, mechanical, inflammatory and neoplastic conditions disrupt the brachial plexus; with all ages groups represented. The superior soft tissue detail of MRI has become a vital tool in the recognition of brachial plexus abnormalities. Thus, radiologists must have a strong understanding of the complex anatomy of the brachial plexus in both the normal and abnormal state. While it is imperative to know the intrinsic anatomy of the roots, trunks, divisions, cords and branches with respect to the adjacent venous and arterial anatomy it is the surrounding osseous, ligamentous and muscular anatomy that provide the key to understanding the anatomic layout of the brachial plexus. This becomes especially important as patient body habitus and positioning can vary widely. Furthermore, with the increasing use of dynamic arm up/arm down imaging in the setting of thoracic outlet syndrome it is important to understand normal anatomic appearance in multiple planes and positions. To that end, we plan to solidify brachial plexus anatomy with the use of detailed diagrams, cadaveric images and dynamic MRI images of normal and abnormal subjects.

Conclusions
The objective of this exhibit is to familiarize radiologists with complex anatomy of the brachial plexus with respect to MR imaging in order facilitate accurate diagnosis in a multitude of brachial plexus abnormalities.

EdE-58
6:30AM - 2:45PM

Variant Causes of "Third Window" Phenomenon

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Purpose
To describe and define frequently missed and misinterpreted lesions causing "third window" phenomenon.

Materials and Methods
A retrospective review of temporal bone CT examinations from a tertiary academic center from 2010 to 2015 was performed to identify etiologies of "third window" phenomenon secondary to an anatomical structure (not attributed to thinning or
dehiscence of the superior semicircular canal roof). Cases were reviewed and anatomical etiologies of variant causes of SSCD are described with clinical and surgical correlation.

Results
Seven patients with clinical "third window" phenomenon were found to have otic capsule changes other than the classic thinning or dehiscence of the superior semicircular canal bony roof. Six cases of superior petrosal vein associated semicircular canal dehiscence were identified. In two of these six cases, other anomalous collateral venous structures were seen notching the inner ear. The seventh case involved an arachnoid granulation that dehisced into the superior semicircular canal. Discussion: Not all "third window" symptoms are due to the classic dehiscence of the superior semicircular canal bony roof. When a causal venous or arachnoid granulation lesion is present, radiologists often do not recognize the associated rare and/or subtle changes to the otic capsule. These variant lesions must be recognized and reported as they may alter surgical management. In the case of superior petrosal sinus notching of the SSC, some neurotologists will favor a transmastoid approach (as opposed to a middle cranial fossa approach) for repair of superior petrosal sinus associated semicircular canal dehiscence. Knowledge of collateral venous lesions may further aid in surgical planning to ensure that defects are repaired. In the case of the SSD caused by an arachnoid granulation, the dehiscence affected the posterior limb of the superior semicircular canal as opposed to the classic dehiscence of the SSC bony roof, which more commonly occurs along the arcuate eminence.

Conclusions
Recognition and reporting of variant lesions causing SSCD may aid in surgical planning to ensure that all defects are repaired. Figure 1: 56-year-old referred to otolaryngology with chief complaint of dizziness with hearing loud noises. Axial bone algorithm temporal bone CT (A) demonstrates a benign appearing smooth bony defect, which dehisces the posterior limb of the superior semicircular canal. Correlating thin section CISS image demonstrates CSF signal intensity within the lesion (B) with minimal enhancement of the lesion periphery (C) on postcontrast thin-section T1-weighted images. The patient was referred to surgery for repair of semicircular canal dehiscence caused by an arachnoid granulation. The patient went on to operative repair via a middle cranial fossa approach and the causal arachnoid granulation (D) was readily identified and the bony margin reinforced to allow resolution of symptoms.
Visualization of Extracranial Branches of Cranial Nerves on Three-Dimensional High-Resolution MR Imaging

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Purpose
Recently, 3D high-resolution sequences such as 3D double-echo steady-state (DESS) sequence and 3D reversed fast imaging with steady-state precession with diffusion-weighted imaging (PSIF-DWI) have been applied to cranial nerve imaging (1-5). The purpose of this exhibition is to present the usefulness and limitations of those MR imaging techniques in the visualization of the extracranial components of the cranial nerves, especially trigeminal, facial, and lower cranial nerves.

Materials and Methods
After addressing the basic principles of 3D DESS and 3D PSIF-DWI, we present the examples of MR images applied for visualization of extracranial peripheral cranial nerves. All MR examinations used in this exhibition were performed on a 3T unit (Magnetom Skyra; Siemens, Erlangen, Germany) by using a commercially available 32-channel head coil. The precise parameters of the 3D DESS-WE and 3D PSIF-DWI sequence are as follows: TR = 13.62 ms/8.52ms; TE = 5 ms/4.2 ms; flip angle = 30°/35°; FOV = 200 x 200 mm/220 x 220 mm; matrix = 384 x 250/384 x 250; effective section thickness = 0.5 mm/0.5 mm; number of acquisitions = 1/1; scan time = 4m 15s/6m 48s, respectively.

Results
On conventional MR images, the extracranial components of the cranial nerves can hardly be identified in most cases. To delineate the anatomy of the extracranial course of the cranial nerves, the images should be acquired with high resolution and high contrast, which is enough to distinguish nerve tissue from other solid structures. Recent advance of 3D high-resolution MR imaging techniques has visualized successfully the peripheral branches of trigeminal and facial nerves ([1-4). By virtue of combination of PSIF, which has a dominant T2 contrast compared with other spoiled or refocused gradient-echo technique, and DWI, which increases signal intensity of the anisotropic structure such as peripheral nerve, 3D PSIF-DWI can visualize the peripheral cranial nerves. The 3D DESS sequence, which combines the signals that were generated during both the free induction decay gradient echo used in the FISP sequence and the spin-echo used in the PSIF sequence during each TR, can
obtain the high-resolution images with increased signal-to-noise ratio (SNR). Because of a dominant T2 contrast of the PSIF sequence, DESS sequence shows the nerve itself as a high signal intensity structure. High SNR enables it to visualize small branches of the extracranial cranial nerves. Both PSIF-DWI and DESS sequences use 3D Fourier-encoding with high spatial resolution, which can display clearly, anatomical details with multi-planar reconstruction capability.

Conclusions
3D DESS and 3D PSIF-DWI are useful techniques for the visualization of the extracranial components of the cranial nerves. They have the potential for diagnosing pathologies of peripheral cranial nerves.

EdE-53

Vocal Cord Paralysis: Losing Your Voice - How High and Low Should We Look for Causes?

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Purpose
Radiological analysis of vocal cord paralysis (VCP) with some interesting cases. Any offending lesion in the course of the vagal and recurrent laryngeal nerves, between the medulla oblongata and the aortic arch, can cause vocal cord paralysis.

Purpose/Clinical relevance: Vocal cord paralysis may be the tip of the iceberg of a severe pathology. Radiologists must understand and assess carefully from brain stem to mediastinum along the course of nerves to look for causative lesions and thereby avoid missing any significant underlying pathology.

Materials and Methods
• Introduction, • Interesting as well as common cases causing vocal cord paralysis, • Anatomy of the vocal cords and their innervation by the vagal and recurrent laryngeal nerves, • Imaging strategy including FDG PET/CT, • Imaging characteristics of VCP, • VCP with causes, differential diagnosis, • VCP with no identifiable cause, • Mimics of VCP.

Results
1) Fifty-two-year-old female with 3-month history of hoarse voice. Index CT showed permeative appearance of the right jugular foramen and an enhancing lesion. Subsequent MR demonstrated avidly enhancing mass with flow voids, suggestive of a glomus jugulare tumor. 2) Two week history of right neck lump with associated hoarseness and right vocal cord palsy. Ultrasound demonstrated suspicious thyroid mass, which on biopsy turned out to be a rare mantle cell thyroid carcinoma. 3) Vocal cord palsy with no obvious laryngeal lesion. CT neck showed a right trachea
esophageal groove lesion with Lung nodules. CT chest confirmed esophageal tumor with widespread metastases. 4) Left neck mass with reduced appetite. Dysphonia and fixed vocal cord. CT showed an infiltrative soft tissue mass in the neck, suspicious for a metastatic deposit. This turned out to be metastatic adenocarcinoma. 5) 41 year old female presented with diffuse thyroid goiter and left vocal cord palsy. Ultrasound (US) demonstrated a large left thyroid lobe lesion with infiltrative features. Core biopsy diagnosed an unusual case in literature; Malignant thyroid paraganglioma. 6) Recurrent laryngeal nerve paresis following radiotherapy to tongue base tumor. Further more causes including Internal jugular vein thrombus, mediastinal collection and skull base metastasis.

Conclusions
This collection of cases helps to review the causes of vocal cord paralys is fro skull base to mediastinum.
VOCAL CORD PARALYSIS (VCP): LOSING YOUR VOICE – HOW HIGH AND LOW TO LOOK FOR

CLINICAL RELEVANCE
Vocal cord paralysis may represent a severe underlying pathology. Any offending lesion in the course of the vagus and recurrent laryngeal nerves, between the medulla oblongata and the aortic arch can cause vocal cord paralysis. Radiologists must understand and assess carefully from brain stem to mediastinum along the course of nerves to look for causative lesions and avoid missing any significant underlying pathology.

ANATOMY
Left vagus nerve exits the skull base through the jugular foramen. It descends in the carotid sheath into the mediastinum, descending anterolaterally to the thoracic aorta. The left RLN exits from the vagus nerve at the level of the aortic arch, then courses posteriorly beneath the aortic arch, and then ascends vertically through the aortopulmonary window posterior to the ligamentum arteriosum, then ascends vertically through the superior mediastinum to reach the tracheoesophageal groove. The right vagus nerve descends with the carotid sheath into the upper mediastinum. The right RLN exits from the vagus nerve anterior to the subclavian artery and courses posteriorly under the artery at the level of the tracheoesophageal bifurcation. It has a short mediastinal course, coursing obliquely towards the right tracheoesophageal groove over the surface of the apical parietal pleura. Red arrows: the relation between cervical segments of the vagus nerve and the carotid artery. Yellow arrows: show the relation between the superior laryngeal nerve and the carotid artery.

IMAGING SIGNS OF VOCAL CORD PARALYSIS
- Ipsilateral perifront sinus dilatation
- Medial rotation and thickening of left aryepiglottic fold
- Ipsilateral laryngeal ventricle dilatation
- "Sat sign" of laryngeal airway

VCP CAUSES
- Surgical trauma: thyroid, anterior cervical discectomy, carotid or chest surgery
- Malignant invasion of either the vagus or recurrent laryngeal nerve - skull base tumors, thyroid cancer, lung cancer, oesophageal cancer and metastases to the mediastinum
- Blunt trauma to the neck or chest
- Idiopathic - when a clear-cut etiology for the unilateral vocal fold paralysis (UVP) is not found. Presumed viral or inflammatory process.

Brain stem and skull base pathologies
- Lateral medullary infarct (Wallenberg syndrome), medullary haemorrhage and vascular malformations
- Malignancies, gliomas, and lymphomas affecting nerve sheath tumours
- Demyelinating diseases
- Tumours, infections, trauma of skull base
- Parangangiomas, schwannomas, meningiomas
- Metastases or tumours involving jugular foramen

Suprathyroid neck pathologies
- Benign and malignant tumours, inflammatory process, and vascular anomalies, such as ICA dissection or aneurysm within carotid triangle
- Parangangiomas/gliomas vagale, and esophageal schwannomas in post-surgical parapharyngeal space

Infrahyoid neck pathologies
The close proximity of the recurrent laryngeal nerve to the esophagus, trachea, and thyroid in the tracheoesophageal groove makes it vulnerable to pathologies
- Carcinoma of esophagus
- Thyroid malignancy and thyroid surgery
- Trauma and tumours and diverticulum
- Pneumonia and anterior cervical discectomy
- Cervical trauma

Mediaclinal causes
- Lung carcinoma
- Aortic aneurysm, pulmonary arteriography
- Mediastinal lymphadenopathy around right subclavian a. or ARW

TEACHING POINTS
RLN can be paralyzed anywhere along its course, from the brainstem to the thoracic and abdominal levels. Carotid dissection, aortic aneurysm, mediastinal infection, thyroid mass, and lung cancer, are all potential causes. PET-CT: unilateral VFP shows asymmetric increase in the normal vocal fold, with no uptake in the paralyzed vocal fold.

Interesting cases
CASE 1: 68 year old female with 3-month history of hoarseness and right vocal cord paralysis. CT neck showed a right tractus esophagea and lymph nodes. CT neck confirmed esophageal and widespread metastases.

CASE 2: Vocal cord palsy with no obvious cause. CT neck showed a right tractus esophagea and lymph nodes. CT neck confirmed esophageal and widespread metastases.

CASE 3: Vocal cord palsy with no obvious cause. CT neck showed a right tractus esophagea and lymph nodes. CT neck confirmed esophageal and widespread metastases.

CASE 4: 41 year old female presented with hoarseness and right vocal cord paralysis. Ultrasound demonstrated a lobe lesion with infiltrative features. Core biopsy showed no unusual features. Malignant thyroid.

CASE 5: Known treated lung cancer present mediastinal recurrence which was the cause of laryngeal nerve palsy.

References:
Development of a Neuroradiological Concept-Based Template in a Report Editor for Radiological Information System

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¹Link, Diagnostico Digital, Medellín, Antioquia, ²Universidad de Antioquia, Medellín, Antioquia

Purpose
To use standardized templates that provide advantages in terms of clarity and completeness of the content, homogenized findings, and useful for future data mining. Following best practices guidelines in structured reporting an in-house report editor was used to develop a neuroradiological concept-based template for Radiological Information System.

Materials and Methods
Thanks to an initiative for improving radiology practices of the Radiological Society of North America (RSNA), the format, content and structure of the radiology report was standardized in templates. The reference model used for concepts was RadLex Lexicon (RL) defining semantics of the terms in radiology domain. Brain templates for both modalities computer tomography (CT) and magnetic resonance imaging (MRI) were tested. Templates were structured in four sections: clinical information, technique, findings and conclusion. For our own records we include radiological diagnostic coded to tag reports. For each anatomical structure, choices to answer normal or abnormal with options for describing abnormalities were included. Predefined values to each answer were made by consensus between neuroradiologists using their natural language style.

Results
For neuroradiological findings, RL terms do not cover all outcomes, then to enrich language to describe all in details was necessary. So, controlled vocabularies such as LOINC, SNOMED-CT, CIE10 and HL7 from Unified Medical Language System (UMLS) were included. The implementation of radiological and medical knowledge is an advantage compared with the narrative conventional style. Thanks to its structure all anatomy is included, helping to avoid errors and decrease the time for report. Those characteristics made reports precise, complete and the content is normalized.
Conclusions
Including terminologies from several vocabularies allows contents to come into different domains. Each semantic content could express the same concept in different terminology for patients, radiologists or referring physicians. Additionally coding of these concepts would support data mining for research and educational purposes.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-4

Education Exhibit Poster (EdE) - Pediatrics
EdE-64
6:30AM - 2:45PM
"Kinks and Clefts" - Congenital and Acquired Brainstem Abnormalities

B Adams¹, D Warren², D Saunders³, J Macmullen-Price³, S Currie³, I Craven³
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Purpose
In recent years advances in genetics and neuroimaging have led to renewed interest in brainstem malformations. These disorders have a plethora of causes ranging from inherited and de novo genetic mutations to acquired in utero insults and can be associated with supratentorial and cerebellar malformations (1). Given these recent advances, neuroradiologists need to be aware of the characteristic findings of these rare disorders.

Materials and Methods
A user-friendly educational exhibit is presented that incorporates high-quality illustrations and radiological images to demonstrate some important pathological findings of mid and hindbrain malformations. Our educational exhibit will present a number of contemporary cases that have come through our tertiary center for pediatric neuroimaging.

Results
To aid pattern recognition, our cases will be divided into pathology associated with the midbrain, the pons and the medulla. Focus will be on more recognized malformations associated with oculocerebrocutaneous syndrome, pontocerebellar hypoplasia and Joubert syndrome but also will include confirmed congenital causes including ROBO-3 mutations and POMPGNT1. We will attempt to differentiate known structural phenotypes from acquired in utero conditions with no genetic etiology.
Conclusions
Neuroradiologists with an interest in pediatric neuroimaging need to be aware of what they may encounter in this rapidly evolving area. Our case review illustrates the breadth of appearances that you may be confronted with as well as a description, when appropriate, of the relevant underlying genetics. Our aim is to stimulate interest in this difficult but rewarding area of neuroradiology.

EdE-68
6:30AM - 2:45PM
Brainstem Lesions in Pediatric Patients: Differential Diagnosis

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Purpose
Review the spectrum of brainstem disease in pediatric population with special interest in mass-like lesions and the relevance of functional magnetic resonance imaging (MRI) techniques for differential diagnosis.

Materials and Methods
For our propose we reviewed MRI findings in a group of pediatric patients studied in our Institution between 2013 and 2015 with initial diagnosis of brainstem mass. We highlighted the findings in conventional sequences and functional techniques: diffusion and ADC maps, 3D tractography, susceptibility-weighted images, perfusion and spectroscopy. The lesions were classified in tumors, inflammatory/infectious, vascular and miscellaneous.

Results
In the group of analyses we found frequent lesions and less common ones. In the first group we included brainstem gliomas with different subgroups, cavernous angiomas and inflammatory and infectious lesions. Less common lesions were vascular pathology with seudotumoral presentation, metabolic disease and brainstem lesions in patients with neurofibromatosis. The routine use of functional and advanced techniques improved the overall performance of MRI in definitive diagnosis mostly perfusion and spectroscopy. The concept of diffusion perfusion mismatch (restriction with low levels of cerebral blood volume) was very helpful in the distinction between tumor and inflammatory/infectious disease.

Conclusions
Brainstem mass lesions are frequent in pediatric population with brainstem gliomas being the most common pathology. The detail analysis of conventional sequences and the findings on functional sequences and advance techniques were of particular interest in making the correct diagnosis. It is of great importance to make the correct
diagnosis because of the complex anatomy of the brainstem and the eventual complications of biopsy to reach the final diagnosis. We propose to include perfusion techniques and spectroscopy in routine protocols for patients with brainstem lesions with special emphasis in correlation with diffusion techniques.

EdE-66

6:30AM - 2:45PM

Cribriform Appearance of the Brain in Canavan Disease - An Uncommon Imaging Finding

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Purpose
To study the cribriform appearance of brain on magnetic resonance imaging (MRI) in four cases of canavan disease in the context of its pathophysiology.

Materials and Methods
We describe four cases of canavan disease that presented with macrocephaly and developmental delay. All cases underwent MRI brain comprising conventional sequences and 1H-MRS. The diagnosis was confirmed in three by performing urine organic acid analysis and in one by genetic testing.

Results
All four patients had typical conventional imaging features of canavan disease with elevated NAA peak on magnetic resonance spectroscopy (MRS). They also demonstrated multiple, small, round to oval T2 hyperintense lesions which inverted on fluid-attenuated inversion recovery (FLAIR). In case one, few cysts were located in the lobar white matter and centrum semiovale. Few were in the posterior periventricular areas. In case two the cysts were more extensive. Case three had larger cysts, fewer in number and scattered in the posterior periventricular white matter. Case four showed cysts in the frontal and parietoccipital periventricular white matter (Figs.1a,b,c,d). In coronal and sagittal planes the cysts appeared to elongate and showed a radiating pattern suggestive of Virchow Robin (VR) spaces. A similar imaging pattern has been described before in two individual case reports (1, 2). Pradhan et al have suggested the dilatation of VR spaces could be secondary to the leukodystrophy or an additional postnatal event. Pathological evidence of frequent enlargement of VR spaces has been described by Kondo A and Suzuki K. They have ascribed it to the demyelination process. We propose that in addition, these patients may have some genetic basis which needs to be authenticated.
Conclusions
Cribiform appearance of the brain in our patients was due to enlarged VR spaces. Canavan disease should be added in the differential diagnosis of neurometabolic diseases with cysts. This unusual imaging phenotype requires further genetic evaluation.

(Filename: TCT_EdE-66_asnrmaya2016l300.jpg)

EdE-65

Extraocular Orbital Lesions in the Pediatric Population

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Purpose
There is a wide variety of extraocular lesions of the orbit in the pediatric population which are distinct from adults. These lesions most commonly manifest with the clinical finding of proptosis and prompt diagnosis and treatment is necessary to
preserve vision. Neuroradiologists play a vital role in helping to correctly diagnose both benign and malignant pediatric orbital pathology. The purpose of this educational exhibit is to review various pediatric extraocular orbital tumors and tumor-like lesions which may manifest with proptosis and review computed tomography (CT) and magnetic resonance (MR) findings of these entities.

Materials and Methods
We retrospectively reviewed MR and CT images from multiple nonconsecutive pediatric patients with extraocular orbital pathology diagnosed at our tertiary care children's hospital. We illustrated disease entities using 3.0T and 1.5T MRI equipment. Differential diagnostic considerations for the imaging findings and salient imaging features of each entity are discussed. In particular, the differential for entities which can present with the clinical signs of proptosis were focused on. We also performed a literature review with an emphasis on advanced imaging of the disease entities.

Results
Many pediatric extraocular orbital tumors and tumor-like lesions exist and these may present clinically with rapid development of proptosis. Although most pediatric orbital tumors are benign, the most common tumor of childhood is rhabdomyosarcoma which can invade or arise in the orbit in young children. Many benign and malignant entities share imaging features with rhabdomyosarcoma including vasculogenic, infectious, and traumatic processes. We review the imaging features as well as clinical and prognostic features of each of these categories of lesions with specific example cases. Cases include but are not limited to rhabdomyosarcoma, dermoid cyst, infantile hemangioma, venous-lymphatic malformations, and subperiosteal hemorrhage.

Conclusions
Awareness of the disease processes and diagnostic imaging features of pediatric extraocular orbital tumors and tumorlike lesions is vital for neuroradiologists. All of the discussed entities typically manifest with proptosis and knowing the distinguishing radiologic features of each is imperative as treatment and prognosis vary greatly.

EdE-67
6:30AM - 2:45PM
High-Field 3T Intraoperative MR Imaging with Diffusion-Tensor Imaging in Lesional and Nonlesional Epilepsy Surgery

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Purpose
Intra-operative MR imaging (iMRI) is becoming a valuable adjunct to neuronavigation for patients undergoing lesional and nonlesional epilepsy surgery (LNES), allowing for greater surgical precision and improved surgical outcomes (1-4). The real-time incorporation of functional MR imaging (fMRI) during neurosurgery into navigational data sets has allowed for better identification of eloquent brain areas, resulting in reduced postoperative neurological deficits (5). Similarly, the use of intraoperative diffusion tensor imaging (DTI) may be of value in nonlesional epilepsy surgery to confirm complete transection of target fibers following disconnection surgery.

Materials and Methods
Following a Montage search, we reviewed intra-operative imaging from 50 patients who underwent lesional or nonlesional epilepsy surgery within our hospital system over the last 7 years. We discuss a representative sample of patients in which intra-operative imaging was critical in neurosurgical decision making.

Results
The use of iMRI and intra-operative DTI adds invaluable information during epilepsy surgery, allowing for re-evaluation of brain structures during lesion resection and confirmation of fiber transection during disconnection surgeries. Intra-operative confirmation of surgical goal may reduce the need for subsequent neurosurgical intervention. Figure 1A demonstrates pre-operative plan for a posterior disconnection in a nonlesional case. Following subdural EEG lead monitoring and identification of the seizure nidus, it was determined that a posterior disconnection would be the best option to potentially decrease seizure occurrence. Figure 1B is an intra-operative T1-weighted sagittal image demonstrating incision line following the pre-operative plan. Figure 2A is an intra-operative T1-weighted image demonstrating transection of the basal frontal cortex, which is a critical component to document, as residual contralateral connections may still exist through the anterior commissure. Figure 2B is a directionally encoded FA map in the same patient demonstrating completed corpus callosotomy. To ensure success of posterior and anterior disconnection surgeries, as well as functional hemispherectomies, documentation of transected critical white matter tracts with DTI while still in the OR is invaluable.

Conclusions
Successful lesional and nonlesional epilepsy surgery requires extensive multidisciplinary pre-operative planning. The increasing use of intra-operative 3T MR neuroimaging helps in achieving neurosurgical goal and improves patient outcome. This exhibit serves to expose neuroradiologists to advances in high-field intra-operative MR neuroimaging and expected findings following epilepsy surgeries.
EdE-74

6:30AM - 2:45PM

Imaging Evaluation of Pediatric Cervical Spine Trauma – Tips and Common Pitfalls
Purpose
To describe and illustrate the radiologic manifestations of pediatric cervical spine trauma. To discuss how the development, biomechanics and mechanisms of injury set the pediatric population apart from the characteristic findings in adult cervical spine trauma.

Materials and Methods
This exhibit will illustrate the radiographic manifestations of cervical spine trauma in the pediatric population. Understanding this topic would be facilitated by a brief discussion of the normal development of the cervical spine. Furthermore, the biomechanics and mechanisms of injury unique to children also will illuminate the basis for these unique findings. The best protocol for evaluation of the pediatric cervical spine in the setting of trauma is still a source of debate, hence we will outline the benefits and downsides of the various imaging modalities used in this setting. In addition to illustrating common cervical spine injuries seen in children, common pitfalls in the interpretation of pediatric cervical spine imaging will be discussed.

Results
Every year trauma results in over 1,000 cervical spine injuries according to the National Pediatric Trauma Registry. More disheartening is that in the pediatric population, these injuries can present as spinal cord injury without radiographic abnormality (SCIWORA) in nearly 20% of patients. Pediatric cervical spine trauma results in fractures in over 50% of cases. The standard of care has varied between radiographic evaluation of the cervical spine and computerized tomographic (CT) evaluation in cases of blunt trauma. Due to the unique cervical spinal biomechanics in children, pediatric cervical spine trauma usually results in upper cervical spine injuries, rather than lower cervical spine injuries, as seen in adults. The developing pediatric cervical spine vastly differs from the adult cervical spine, which leads to several pitfalls where normal appearance can mimic fracture or subluxation.

Conclusions
Interpretation of pediatric cervical spinal imaging in the setting of trauma remains a challenging area of pediatric neuroimaging. Review of the mechanisms of trauma, cervical spinal biomechanics in children and the development of the cervical spine will improve the understanding, create a conceptual diagnostic approach and help in better management of pediatric cervical spine trauma cases.
Imaging of the Pediatric Optic Nerve Lesions

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Purpose
To describe and illustrate the various optic nerve pathologies seen on imaging evaluation of pediatric patients, including developmental, infectious, inflammatory, neoplastic, and traumatic etiologies.

Materials and Methods
This exhibit will illustrate various pathologies of the optic nerve in the pediatric population and the correlating imaging findings. Understanding this complex topic will be facilitated by a brief discussion of the embryology of the optic nerve. To better organize such a broad topic, the various diagnoses will be classified by etiology, as outlined above. The benefits and shortcomings of various modalities available for evaluation of the optic nerve will be presented. Representative cases of various pediatric optic nerve pathologies will be presented.

Results
Like other aspects of medicine, the differential diagnosis for optic nerve pathologies in children is vastly different than in adults. The etiologies of optic nerve pathology can be classified into neoplastic, traumatic, developmental, infectious and inflammatory pathologies. More than 90% of primary optic nerve tumors are benign gliomas of childhood, of which nearly 30-40% are associated with NF1. However, there are numerous space-occupying lesions within the brain that affect the optic nerve more frequently. In cases of ocular primary tumors, it is not uncommon to see the optic nerve secondarily involved. For instance, optic nerve invasion can be found in 24% of patients with retinoblastoma. In children, blunt trauma can lead to optic nerve injuries, especially when skull base fractures are present. Hypoplasia and colobomatous cysts are common developmental disorders affecting the optic nerves in children. Metabolic disorder like Krabbe disease presents with diffuse optic nerve enlargement. Optic neuritis, which has an incidence of 1–5 in 100,000 per year, is a common manifestation of neuromyelitis optica and multiple sclerosis.

Conclusions
Pathology of the optic nerve is an uncommon diagnosis in pediatric neuroimaging, but one that has the potential to dramatically impact the patient if the diagnosis is missed or delayed. Better understanding of the pathology and key imaging features will aid in prompt and accurate diagnosis of these conditions in children.
Multimodality Imaging Overview of Abusive Head and Cervical Spine Trauma

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Purpose
The purpose of this presentation is to provide an imaging overview of the common findings seen with abusive intracranial and cervical spine trauma.

Materials and Methods
A HIPAA-compliant retrospective review was performed of patients with clinical diagnosis of abusive head and/or cervical spine trauma. Imaging findings on computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound (US) of the head and cervical spine were reviewed. Additionally, a review of the current medical literature was performed.

Results
Imaging findings characterizing the common findings of abusive head and cervical spine trauma will be included, including hyperdense, mixed density, and hypodense subdural fluid collections, skull fractures including 3D reconstructions, cerebral infarcts, venous injury, white matter contusional tears, and cervical spine hemorrhage and ligamentous edema. We also will contrast findings of abusive head trauma with findings of benign enlarged subarachnoid spaces of infancy. Physical exam and skeletal survey findings also will be included.

Conclusions
Abusive head trauma is the third leading cause of all head injuries in children in the United States. It is important to recognize the common imaging findings of abusive head trauma as well as to be cognizant of cervical spine trauma in these patients, and when to alert clinicians to possible cases of child abuse.
EdE-61

Neuroimaging Findings of Ischemic Stroke in Children

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Purpose
Stroke is increasingly recognized as an important cause of morbidity and mortality in children. Since cerebrovascular disorders in children are less common than in adults, awareness for this potentially disastrous event is usually low. Various modalities of neuroimaging provide differing amounts of information about the etiology of stroke. Use of a combination of neuroimaging may be required to effectively identify the etiology of stroke. Therefore, an understanding of the range of imaging findings in ischemic stroke with different neuroimaging tools is vital.

Materials and Methods
In this poster we review the most frequent conditions underlying ischemic stroke in children including cardioembolic disorders, viral infections, arteriopathies, vasculopathy, post-traumatic craniocervical arterial dissections, cerebral sinovenous thrombosis, primary angiitis of the central nervous system and secondary central nervous system vasculitides. Then we include the diagnostic workup and describe the neuroradiological aspects for each single pathology.

Results
We provide clinically representative and previously unpublished neuroimaging of each condition. In general for most conditions, magnetic resonance imaging (MRI) was more sensitive for early ischemic changes, but other forms of imaging provide information unique to each disease. Digital subtraction angiography, magnetic resonance angiography (MRA) and computed tomography angiography (CTA) provide enhanced visualization of cerebral vascular anatomy. Magnetic resonance imaging also has higher sensitivity and specificity in detecting underlying pathologies that can lead to strokes. Improved understanding of the clinical utility of various neuroimaging modalities in different clinical situations will allow the radiologist to provide the highest quality input on clinical decision making in pediatric ischemic stroke.

Conclusions
Recent advances in clinical radiologic methods have important implications for the investigation of stroke in children. When a particular pathology is suspected, it is helpful to consider which imaging modalities are most appropriate. This review highlights the crucial role of neuroradiological investigations in the early diagnosis of pediatric stroke and the important role of neuroimaging in identification of the underlying causes.

EdE-69

6:30AM - 2:45PM

Pre and Postnatal MRI Imaging Appearance of Intrauterine Myelomeningocele Repair

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Purpose
1. Pictorial essay with depiction of the typical imaging appearance of fetal and neonatal magnetic resonance imaging (MRI) in patients before and after intrauterine repair of myelomeningocele (MMC). 2. To summarize MR imaging features present a cohort of postoperative patients at our institution as a possible parameters for future studies and to discuss our experience.

Materials and Methods
Using a database provided by the fetal surgery department, we reviewed patient imaging jackets on all of the intrauterine MMC repairs performed at our institution. Fetal MRI images were identified by tracking the mother's identifying information through the social work note in the child's medical record. Out of a total of 31 patients, 23 had prenatal MRI imaging. We found a total of eight individuals who had both prenatal and postnatal MRI examination of the spine. Images were reviewed, and imaging characteristics noted as below.

Results
Overall, both prenatal and postnatal image quality was diagnostic. Three of the patients were examined near or after one year of age under general anesthesia with improvement in image quality. The length of the bony dysraphism ranged between four and six segments and the skin was intact in all patients. All of the patients exhibited cord tethering to some extent. Four of the patients demonstrated a syrinx in the cord, one of which did not develop until a second study at two years of age. Two of the patients demonstrated widening of the terminal ventricle at the region of tethering. Two of the patients demonstrated cystic scarring associated with the tethering. One patient had a pseudomeningocele. Three patients demonstrated persistent herniation of the cerebellar tonsils.

Conclusions
Postnatal MRI imaging of fetal MMC repair demonstrates, in our opinion, a stereotypical appearance of off-midline posterior tethering with much variability in the presence and extent of additional cord findings. Practitioners should be familiar with the stigmata of this procedure as these patients enter the general imaging population. Fetal surgery before 26 weeks of gestation mitigates many of the complications of MMC. However, it does not appear to eliminate radiographic cord tethering. Magnetic resonance imaging is practical in this population and may prove to be a valuable biomarker of operational success as surgical technique is modified; especially if it can be correlated with long-term neurologic outcomes. Electronic
medical records and radiology information systems will need to develop robust methods to deal with tracking fetal patients from their prenatal imaging to their postnatal followup.

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Revisiting MRI of the Fetal Brain: A Pictorial Structured Approach to Fetal Central Nervous System Disorders

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Purpose
Fetal magnetic resonance imaging (MRI) is an increasingly used diagnostic tool in the evaluation of the fetal central nervous system (CNS), when an abnormal finding is suspected on sonography. We will demonstrate a systematic approach to the interpretation of fetal CNS MRI using interesting cases from our teaching file.

Materials and Methods
Our didactic exhibit will include: 1) An introductory section on the embryology of the cerebral mantle and sulcal/gyral maturation; 2) An overview of standard biometric...
markers to be included in the radiology report, with examples of biometric measurements in normal and abnormal brain development; 3) A discussion of a checklist approach to reading fetal CNS MRI, illustrated by examples of fetal CNS pathology from 9 years of experience at our institution.

Results

Fetal MR imaging has the capability to evaluate the developing brain with unprecedented detail. Magnetic resonance imaging overcomes the limitations of sonography in the assessment of the developing cortex and sulcation pattern. Furthermore, MRI can evaluate and characterize better than sonography a variety of developmental abnormalities and brain injury patterns, including corpus callosum dysgenesis, cerebellar dysplasia, porencephaly, intraparenchymal and intraventricular hemorrhage, among other entities. We will demonstrate a structured approach to the diagnosis of fetal CNS disorders, based on the methodology proposed by Yazbek et al. as follows: 1) Evaluation of the ventricles; 2) Evaluation of the sagittal midline; 3) Evaluation of the gyri; 4) Evaluation of the brain parenchyma; 5) Evaluation of the face/neck; 6) Evaluation of the spine.

Conclusions

The main teaching point of our pictorial exhibit is to highlight the importance of a structured methodology in the interpretation of fetal CNS imaging. A standardized approach to the review of fetal CNS MRI will decrease the chance of overlooking subtle but important abnormal findings, which will have an impact on prenatal and perinatal care.

EdE-71

6:30AM - 2:45PM

Role of Fetal MRI in the In-Utero Management of Neural Tube Defects

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Purpose

To illustrate the value of magnetic resonance imaging (MRI) in the detection and characterization of developmental malformations of the fetal spine. To discuss the role of fetal MRI in the presurgical planning of in utero repair of myelomeningocele.

Materials and Methods

This exhibit will briefly discuss various developmental malformations of the neural tube. Fetal MRI frequently is used in cases of neural tube defects for prenatal
diagnosis, assessment of severity and detection of other associated abnormalities. Characteristic imaging findings of myelomeningocele and associated central nervous system (CNS) abnormalities on fetal MRI will be discussed with illustrative examples.

Results
With the advent of routine sonographic obstetric evaluation and advances in such technology, fetal myelomeningoceles can be detected early on in pregnancy. Studies show beneficial outcomes when the defects are surgically repaired in utero rather than correcting them after birth. In patients who undergo prenatal surgical repair, the rate of actual ventricular shunt placement is reduced by half and the rate of moderate to severe hindbrain herniation is reduced by two-thirds. Fetal MRI helps with better delineation of the relevant anatomy for optimal patient selection and surgical planning. It also helps with optimal evaluation of the rest of the CNS, bony spine and for the detection of any other associated abnormalities. We will discuss several key imaging features that affect the surgical decisions. The radiologist interpreting a presurgical fetal MRI must comment on these key features in the diagnostic report.

Conclusions
Congenital neural tube defects such as myelomeningocele can result in debilitating outcomes. Benefits of in utero surgical repair of selected cases of myelomeningocele outweigh the associated risks. Fetal MRI provides critical information that guides patient selection and surgical planning. The radiologist interpreting a presurgical fetal MRI must include this information in the diagnostic report.

EdE-72

Spinal Sweepstakes: A Quiz on Multimodality Pitfalls of Pediatric Spine

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Purpose
Pediatric spine pathology imaging is not always a straightforward one. Imaging offers a valuable tool to aid in this diagnostic challenge. Radiologists must be familiar with common presentations of pediatric spine pathology, their imaging characteristics, and the best way to further evaluate challenging clinical presentations.

Materials and Methods
The information will be provided in a quiz format, followed by an answer/discussion section subsequent to each question.

Results
Not only will the radiologist be allowed to serve as a valuable asset to the treating physician in choosing the most appropriate imaging modality, but will also help in accurate diagnosis, all the while ensuring the "image gently" principle.
Conclusions
At the end of the exhibit, the viewer will become familiar with common pediatric spinal pathology, as well as their typical clinical presentation.

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EdE-62

The Spectrum of Imaging Findings in POLG-Related Disease
Purpose
Pathogenic variants have been reported throughout the mitochondrial DNA polymerase gamma gene (POLG) (1) that result in a wide range of clinical manifestations. Polymerase gamma gene-related diseases include autosomal dominant progressive external ophthalmoplegia, juvenile spinocerebellar ataxia-epilepsy syndrome, sensory ataxia, neuropathy, dysarthria, and ophthalmoparesis (SANDO), Parkinsonism, and Alpers syndrome (2-5). The various imaging findings in POLG-related disease will be outlined.

Materials and Methods
A survey of PubMed was performed with the terms POLG and magnetic resonance imaging (MRI), yielding 34 relevant articles on the imaging of POLG-related disease. The MR imaging findings of our institutional series of eight pediatric patients with POLG-related disease are described and correlated with those described in the literature.

Results
Common MRI findings in our patients diagnosed with POLG-related disease included migrating areas of restricted diffusion that did not follow arterial territories (Figs. 1A and 1B). There was a predilection of restricted diffusion to involve the cortical ribbon (Fig. 1C), cerebellar white matter (Fig. 1D), and deep gray structures (Fig. 1E). Other common areas of involvement included the brainstem (Fig. 1F), and occipital cortex (Figs. 1A and 1B). These findings are consistent with those described in the literature.

A few reports have noted diffuse or focal/periventricular white matter T2 abnormalities (Figs. 1G and 1H), as findings seen in two of our patients.

Conclusions
POLG-related disease can be mistaken for a wide variety of conditions, most commonly arterial ischemic stroke or venous infarction. Knowledge of the unique imaging findings may be helpful in alerting the clinician to the potential diagnosis of POLG-related disease.
Figure 1. Common MRI findings in our patients diagnosed with POLG-related disease included migrating areas of restricted diffusion territories (1A and 1B). There was a predilection of restricted diffusion to involve the cortical ribbon (1C), cerebellar white matter (1D), and thalamus (1E). Other common areas of involvement included the brainstem (1F) and periventricular white matter T2 abnormalities (1G and 1H).
Columnar Anatomy of the Spinal Cord and Medullary Spinal Cord Lesions at MRI

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Purpose
To review the columnar anatomy of the (cervical) spinal cord and correlate with magnetic resonance imaging (MRI) to illustrate how more detailed knowledge of cord columnar anatomy can result in more complete reporting.

Materials and Methods
The known columnar anatomy of the spinal cord is reviewed. Several cases of medullary cord lesions illustrate how knowledge of columnar anatomy can result in a more complete diagnostic radiology report.

Results
Current clinical nonenhanced MRI provides sufficient contrast to delineate gray and white matter. Further, knowledge of columnar anatomy can permit localization of medullary cord lesions to specific areas of gray matter or white matter tracts within the spinal cord, with clinical implications. Figure 1: Normal anatomy. Gray matter (outlined in gray), descending efferent pathways (outlined in red), and ascending afferent pathways (outlined in blue). Case 1: 40-year-old woman with rapidly developing weakness diagnosed with amyotrophic lateral sclerosis. There is increased T2 signal and atrophy of the lateral columns. Case 2: 33-year-old woman with history of multiple sclerosis presents with left arm, trunk, and leg numbness. There is a left anterolateral column focal lesion which contains afferents responsible for crude touch, pain, and temperature. Case 3: 10-year-old male with febrile encephalopathy and lower extremity weakness without identified etiology, diagnoses of acute disseminated encephalomyelitis. There is increased T2 signal in gray matter which improved with steroids.

Conclusions
Current MR imaging can illustrate the columnar anatomy of the spinal cord. Knowledge of columnar anatomy and physiology of the spinal cord can enable more complete reporting of lesion location, with possible clinical implication.
Complications of Percutaneous Vertebroplasty: What To Do, and What Not To Do

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Purpose
Percutaneous vertebroplasty, in experienced hands, is a very safe procedure for the treatment of pain related to compression fractures of any etiology, including osteoporosis, tumors (benign and malignant) and even trauma. The purpose of this educational exhibit is to discuss common and uncommon, symptomatic and asymptomatic, potential serious and not so serious complications of percutaneous vertebroplasty.

Materials and Methods
We will present cases of vertebroplasty complications, some of which we were referred for the treatment of the complications of vertebroplasty, most discovered incidentally on subsequent imaging, and a few that we have experienced in our large academic medical center.

Results
We will discuss and show imaging examples of the complications of vertebroplasty including: cement (PMMA, poly-methyl methacrylate) migration into the epidural space without and with cord compression (Fig. 1); cement migration into the neural foramina with or without radiculopathy; cement migration into disks or adjacent soft tissues (spikes); cement migration into vessels including the IVC (Fig. 2), azygous vein, and pulmonary artery; cement pulmonary embolus (Fig. 3); infection (Fig. 4); adjacent vertebral body fracture; further compression fracture after vertebroplasty and pneumomediastinum. Fat pulmonary embolism, pneumothorax, rib fractures, bleeding and vascular injury also will be discussed. Tips and techniques to reduce complications, including antibiotic use, accurate needle placement, high quality fluoroscopic imaging including biplane, adequate density of cement and low pressure delivery of viscous PMMA will be reviewed.

Conclusions
Vertebroplasty procedures have proven to have significant benefit in the symptomatic relief of pain in patients with vertebral compression fractures, with low risk of complications. Most complications are asymptomatic, but some are potentially serious and require treatment.
Imaging Appearances of Spinal Cavernous Malformations

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Purpose
Cavernous malformations (CMs) of the spinal cord are uncommon in the general population but have a higher incidence in autosomal dominant CM populations. Findings may be subtle or confusing, especially in acute settings. We present the range of imaging findings, common pitfalls and problem solving techniques based on a large genetic population as well as literature review.

Materials and Methods
We reviewed magnetic resonance imaging (MRI) findings from 32 patients with cavernous malformations of the spinal cord and present representative cases of the range of findings.

Results
Medium-size lesions usually are located peripherally and have mixed-signal intensity with peripheral hemosiderin deposition oriented longitudinally. Small lesions often are subtle, demonstrating signal characteristics of hemosiderin. Multiple lesions, though considered rare, were encountered several times in our genetic population. Venous anomalies, strongly associated with sporadic brain CMs, are not a feature of spine CMs. Typical multispin-echo techniques for spinal imaging are insensitive for small CMs, and gradient-based techniques are important in evaluating suspected spinal CMs. A sagittal volume gradient-based acquisition permits multiplanar reconstruction. Use of fat saturation on postcontrast images of spinal cord lesions may falsely suggest enhancement. Acutely hemorrhagic spinal CMs are particularly difficult, demonstrating blood layers, hematomyelia cranial or caudal to the CM, and edema. The differential diagnosis is broad, including high-flow vascular lesions and hemorrhagic tumors; we illustrate some of these. Magnetic resonance imaging of the brain, with appropriate susceptibility sequences, is valuable since the presence of concurrent cerebral CM affirms the diagnosis of spinal CM with a high likelihood. Brain MRI is similarly helpful in pediatric and nerve root cases. We illustrate examples of these conditions.

Conclusions
Spinal cord CMs occur in both sporadic and familial patterns and may be more common than previously reported. Radiologists should be aware of strategies to facilitate diagnosis and of the varied MRI appearances.
Imaging Diagnosis Approach to Spinal Neoplasms: The Where and When!

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Purpose
1. To present an easy and reliable method to categorize spinal neoplasia by anatomical location with a resultant narrow differential diagnosis. 2. To discuss most common differential diagnoses in each anatomical compartment according to age of the patient at the time of presentation.

Materials and Methods
1. Anatomical compartments of the spine. 2. Categories of spine neoplasia according to anatomical location: intradural intramedullary, intradural extramedullary, extradural, osseous/cartilage. 3. Strategies to differentiate neoplastic from non-neoplastic entities within the intradural intramedullary compartment. 4. Differential diagnosis of spinal neoplasia within each anatomical compartment according to patient's age.

Results
Spinal neoplasias represent a minority of all central nervous system tumors and may
pose a diagnostic challenge for the radiologist. Classic teaching includes precise anatomical localization of the center of the tumor within one of four compartments: intradural intramedullary, intradural extramedullary, extradural and osseous/cartilage. In this exhibit, we will discuss a broad differential diagnosis within each anatomical compartment, including strategies on how to distinguish benign from malignant entities. For example, in the intradural intramedullary compartment, we will present cases of ependymoma, astrocytoma, hemangioblastoma, metastatic disease in contrast to sarcoid, transverse myelitis, and spinal cavernous malformation. The differential for intradural extramedullary lesions is even broader, and we will include examples of mixopapillary ependymoma, paraganglioma, sarcomatoid degeneration of neurofibroma and lymphoma. The age of the patient at the time of presentation is an important clue to narrow the differential diagnosis, as most of these spinal neoplasias have a clear age predilection.

Conclusions
Imaging interpretation of spinal neoplasia offers a narrow, if not precise pathologic diagnosis. When anatomical compartmentalization of lesions and age at presentation are taken into account, the pre-operative imaging evaluation of these entities becomes more comprehensive and helpful for operative planning.

EdE-80
6:30AM - 2:45PM

Imaging of Peripheral Nerves, Neuropathies, and Peripheral Nerve Tumors

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Purpose
This pictorial essay will demonstrate the utility of both conventional and advanced magnetic resonance (MR) neurography in evaluating and diagnosing peripheral neuropathies and peripheral nerve tumors. Approaches to imaging and findings on high resolution MR imaging of peripheral nerves will be highlighted for various peripheral nerve disorders. Additionally, the emerging roles of diffusion tensor imaging (DTI) and high resolution ultrasound (HRUS) in the characterization of peripheral nerve disorders will be examined.

Materials and Methods
Cases of peripheral nerve disorders that exemplify key imaging findings for a range of peripheral nerve disorders were selected retrospectively. The utility of HRUS and DTI as complementary tools to conventional and advanced MRI will be introduced in the context of peripheral nerve injury, neuropathy, tumor, treatment planning, and recovery.
Results
Characterization of peripheral nerve disorders may best be achieved by a multimodality approach including state-of-the-art MRI sequences along with HRUS. Nerve size, signal intensity and enhancement are the mainstay of peripheral nerve analysis, which are better evaluated with high-resolution 3D techniques. Diffusion tensor imaging affords unique structural and quantitative insight to the organization of nerves and nerve disorders.

Conclusions
Magnetic resonance and HRUS can effectively evaluate a wide range of peripheral nerve pathologies, including inflammatory conditions, traumatic nerve injury and peripheral nerve tumors, as well as the postoperative evaluation of peripheral nerve repair. Emerging 3D MR sequences and DTI hold great promise for more intricate analysis of peripheral nerve anatomy, pathology, treatment planning and recovery.

EdE-83
6:30AM - 2:45PM

Imaging Review of the Conus Medularis and Cauda Equina: What Radiologists Should Know

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Purpose
"The conus terminates at approximately the L1 vertebral body level" may be the only mention of this important structure in a dictation of the lumbar spine. However, the conus medullaris and the cauda equina are complex anatomical structures with their own unique sets of pathologies that can cause significant disease. The purpose of this educational exhibit is to review the importance of individual pathologies associated with the conus and cauda equina by highlighting the embryology and normal anatomy while showcasing high quality images of a variety of associated pathologies.

Materials and Methods
A review of the literature was done and unique images from two university hospitals were highlighted for the purposes of this exhibit. Embryology and anatomy are discussed as well as pathologies including congenital anomalies, inflammatory/infectious conditions, traumatic etiologies, and neoplasms.

Results
A review of the embryology and normal anatomy is crucial for a complete understanding of the complex pathologies that can plague the conus medullaris and cauda equina. Particularly, congenital anomalies including a tethered cord, diastematomyelia, filum terminale lipoma, and ventriculus terminalis will be featured.
Our discussion and imaging review then will turn its attention to infectious/inflammatory pathologies including epidural abscess, tuberculous arachnoiditis, neurocysticercosis, tranverse myelitis of the conus, cryptococcus, sarcoidosis, Guillian Barre, and noninfectious arachnoiditis. We then will focus on traumatic etiologies including subarachnoid hemorrhage and epidural hematomas before we conclude our review with neoplasms, which will include metastasis, neurofibromas, myxopapillary ependymomas, paragangliomas, schwannomas, and lymphoma.

Conclusions
A variety of pathologies and conditions can affect the conus medullaris and the cauda equina and a fundamental understanding of the embryology, anatomy, congenital anomalies, infectious/inflammatory conditions, traumatic etiologies, and common neoplasms can aid in a deeper understanding of these anatomically complex, and often underappreciated, structures. The review and images presented in this presentation will help the radiologist with rapid diagnosis of these complex pathologies.
Ventriculus terminalis

Neurocysticercosis

Schwannomas (NF 2)

Epidural hematoma

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EdE-78
Lumbar Spine Surgery Complications

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1Yale University School of Medicine, New Haven, CT, 2Yale New Haven Hospital, New Haven, CT

Purpose
Back pain affects 80% of the population in their lifetime, and the frequency of complex lumbar spine surgery for spinal stenosis is increasing. Complication rates are closely related to the extent and complexity of surgery. Compared to simple decompression, complex fusions have higher rates of life-threatening complications and rehospitalizations within 30 days. Cross-sectional imaging techniques play a central role in evaluation after lumbar surgery. Utilization of optimal techniques to reduce metallic hardware artifacts is necessary to evaluate hardware placement, fusion and alignment, and to detect complications arising in the postoperative course.

Materials and Methods
This exhibit presents several imaging examples of common and uncommon lumbar spinal surgery complications in a pictorial format. A discussion of each type with imaging correlation follows, with emphasis on diagnostic pitfalls.

Results
Several complications may present intraoperatively or in the early postoperative period. Malpositioned hardware most often involves improper screw depths and intracanalicular pedicle screw placement, which can injure nerve roots or radicular arteries, or result in spinal instability and malalignment. Postoperative fluid collections include seromas, hematomas, abscesses, and cerebrospinal fluid (CSF) collections which include pseudomeningocele, CSF fistulas, and nerve root herniation with incidental durotomy. In the case of retroperitoneal/abdominal approaches during laparoscopy or anterior fusion, injury to the vessels, lumbosacral plexus, or bowel may occur, which can rarely cause pseudoaneurysm, hemorrhage, erectile dysfunction, and fistulas. Delayed surgical complications include hardware loosening, infection, pseudoarthrosis, and abnormal motion/strain which can lead to hardware failure/fracture and injury to adjacent vertebral levels. New or recurrent symptomatic disk herniation, bone marrow graft extrusion, heterotopic bone formation, peridural/epidural fibrosis, arachnoiditis, and radiculitis may also occur, and can contribute to failed back surgery syndrome (FBSS). Imaging techniques to reduce metallic artifact during CT image acquisition include increasing tube voltage, decreasing pitch, and decreasing slice thickness; all of which increase patient radiation dosage. Postprocessing options include use of soft tissue kernels, thicker section reconstructions, and adjustment of the Hounsfield scale. New techniques include dual-energy CT and sinogram inpainting. MR metallic artifact reduction techniques include
use of a lower-Tesla magnet, fast spin echo and STIR sequences (rather than frequency-selective fat suppression), decreasing field of view (FOV), thinner sections, and use of a high-resolution matrix. Advanced techniques include view angle tilting and slice encoding for metallic artifact correction, among others.

Conclusions
Early detection of lumbar spine surgery complications is critical for patient management. This exhibit serves to review several common and uncommon complications to promote confident diagnoses and prompt recognition of abnormal postoperative findings.

65 yo female with scoliosis. Presented to ED with abdominal > back pain and drainage from posterior incision, 2 months s/p T10-pelvis anterior-posterior spinal fusion (APSF) with L3-4, L4-5, L5-1 interbody spacers and L2/L3 laminectomies.

Several malpositioned pedicle screws along medial pedicular cortex (T11, L2, L3)

New collapse of L4
New grade 1 anterolisthesis of L3 on L4.

Large subfascial fluid collection extends along T12 - L5/ S1 posterior elements, 6 cm in greatest transverse dimension. Streak artifact precludes assessment for any thecal sac compression. ➔ Abscess.


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EdE-79

6:30AM - 2:45PM

Spanning the Spine: A Comprehensive Review of Vertebral Masses, from Clivus to Sacrum
S Herrmann\textsuperscript{1}, r eldaya\textsuperscript{2}, J Rivera\textsuperscript{3}, e xia\textsuperscript{2}, T Uribe\textsuperscript{4}
\textsuperscript{1}UTMB, League City, TX, \textsuperscript{2}University of Texas Medical Branch, Galveston, TX, \textsuperscript{3}Baylor College of Medicine, Houston, TX, \textsuperscript{4}Baylor College of Medicine, Galveston, TX

Purpose
Multiple etiologies can be found in the vertebrae including infectious, malignant/benign masses, traumatic or vascular. These entities can be focal/diffuse or acute/chronic adding to the challenge for residents in making the best diagnosis and differential. This presentation will be an overview of various pathology that can be seen in the spine based on location and clinical histories in order to strengthen resident and non-neuroradiologist comprehension of the various pathology that can be seen in a large academic center.

Materials and Methods
Summarize and highlight multiple cases with clinical history including infectious, malignancy (multiple myeloma, metastasis), benign lesions (paget's) and vascular abnormalities through computed tomography (CT) and magnetic resonance imaging (MRI).

Results
The wide variety of pathology in the vertebrae can be challenging for residents and it is important to have a systemic approach to vertebral masses based on clinical history and location. Having a strong grasp of this is important for residents and neuroradiologists to understand common and rare pathology that can be encountered. Cases will be presented with corresponding clinical history through multiple modalities to aid residents in making an accurate diagnosis and appropriate differential.

Conclusions
Vertebral masses have a wide spectrum of pathology and it is important for residents to distinguish both common and rare entities that can be encountered. This presentation will provide multiple vertebral pathology as well as the clinical history in order to improve residents ability to make an accurate diagnosis and differential.
Spinal Cord Stimulation - What the Radiologist Needs to Know

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Purpose
Spinal cord stimulation (SCS) is a treatment for chronic neuropathic pain, such as in failed back surgery syndrome (FBSS) and complex regional pain syndrome (CRPS). A number of different SCS systems are available for implantation with different properties. The radiologist needs to be aware of the types of system available and recognize any complications which may occur.

Materials and Methods
In this exhibit we review the main indications for spinal cord stimulation, the presurgical imaging assessment, trial lead placement, baseline and follow-up imaging of spinal cord stimulation systems. In addition, we summarize the magnetic resonance imaging (MRI) safety data for these devices.

Results
We will illustrate the key components of SCS systems and the differences between low and high frequency systems, as well as a variety of electrode configurations and adaptors. Complications such as lead disconnection, electrode migration and pulse generator inversion will be discussed.

Conclusions
Spinal cord stimulation is being used increasingly as an option for chronic pain. As radiologists are likely to encounter patients which such implanted systems, it is important that they be able to recognize the systems, and potential complications.

EdE-81

6:30AM - 2:45PM

Susceptibility Weighted Magnetic Resonance Imaging in Cervical Spinal Cord Injury; Improved Detection of Spinal Cord Hemorrhage

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Purpose
Susceptibility-weighted imaging (SWI) has been shown to be exquisitely sensitive at the detection of deoxyhemoglobin due to microhemorrhage in the brain. Spinal cord hemorrhage is known to have associated severe morbidity/mortality. Additionally, cord hemorrhage carries a worse prognostic implication when compared to edema and contusion. However, there is limited research on SWI detection of hemorrhage in the spinal cord. The purpose of this study was to evaluate SWI imaging in the context of traumatic spinal cord injury to the cervical spine.

Materials and Methods
In a prospective, inception-cohort study, patients being evaluated for traumatic spinal cord injury with conventional magnetic resonance imaging (MRI) were studied using high resolution SWI [gradient-echo (GRE) T2* sequence]. Conventional MRI with
and without SWI then were compared to evaluate hemorrhage detection. The cases also were reviewed by a board-certified neuroradiologist, a neuroradiology fellow, and a radiology resident with 2 years training. The cervical cord then was divided into four categories: normal, edema, contusion, or hemorrhage.

Results
One hundred eighty-one patients (108 M/73 F; range 2 months – 89 years, average age 31 years) with clinical history of trauma were imaged prospectively from 7/2011-11/2012. The most frequent clinical etiologies included motor vehicle accidents (77) and falls (41). Fifteen patients demonstrated abnormal cord signal. On the basis of conventional MRI, 12 patients were diagnosed with cord edema, four with contusion, and 0 with hemorrhage. With the addition of SWI, four of the patients diagnosed with edema were found to have susceptibility changes consistent with cord hemorrhage and two patients diagnosed with contusion were upgraded to hemorrhage. These findings are presented in Table 1.

Conclusions
Recently, a small study by Wang et al. (N = 23) demonstrated SWI to be a highly sensitive sequence for the detection of spinal cord hemorrhage in the context of traumatic spinal cord injury. As the type of SCI progresses from edema to hemorrhage the prognosis worsens. Therefore appropriate early characterization of the extent of injury is helpful and has prognostic implications. Additionally, there was an increase in interobserver correlation with the addition of SWI. Without SWI, our study showed some degree of variability in the final diagnosis particularly in less experienced reviewers. Our study demonstrates that SWI provides a more sensitive way to evaluate spinal cord injury compared to conventional MRI techniques (particularly less experienced imagers). Limitations of our study include the lack of pathological correlation and limited follow up to determine if indeed patients suffered worse long-term outcomes when susceptibility changes were present in the cord compared to edema or contusion. However, given the low incidence of spinal cord hemorrhage (~4%), technical and patient factors reducing SWI image quality in many patients, and the length of acquisition, we currently cannot justify routine post-trauma SWI imaging. We hope that future developments will rectify these limitations.

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<tr>
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<th>Conventional MRI</th>
<th>SWI</th>
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<tr>
<td>Normal</td>
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<tr>
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<td>8</td>
</tr>
<tr>
<td>Contusion</td>
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<td>Hemorrhage</td>
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electronic Education Exhibit (eEdE) - Adult Brain
eEdE-53

3D Printing of the Intracranial Arterial Vasculature: Pearls and Pitfalls

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Purpose
To discuss the rapidly evolving role of 3D printed patient-specific models for pre-operative/endovascular planning, physician training, and patient education. Multiple imaging modalities and printing techniques have been used alone or in combination to recreate the intracranial vessels, each of which has its own benefits and limitations. Thus, we aim to review current strategies for optimizing 3D-modeling of the intracranial arteries.
Materials and Methods
After IRB approval we retrospectively reviewed the intracranial vascular cases that our hospital-based 3D printing lab created. The imaging modality, segmentation time, print time, and print technologies were evaluated. Our techniques were compared to those in the literature and our work flow was evaluated. The limitations and benefits of each imaging modality, the segmentation process and postprocessing techniques, as well as available print technologies were reviewed.

Results
The ideal 3D model provides a true-to-life recreation that can be produced in a time and cost-effective manner. Computed tomography angiography (CTA), magnetic resonance angiography (MRA) and 3D rotational catheter angiogram (3D-RA) have been used successfully at our institution; however, the segmentation time between modalities ranges from 10 minutes to 2 hours. 3D-RA has been used most commonly due to its high spatial resolution, limited artifact and minimal postprocessing time; however, it necessitates invasive testing (1-2). Computed tomography angiography and MRA are both widely available noninvasive techniques, but are subject to more involved postprocessing and increased artifact (3). Printing techniques including FDM, SLA, Polyjet, SLS, and inkjet binder jetting have been used each with their own individual benefits and drawbacks. Support material removal varies widely amongst these techniques making some unsuitable for printing hollow vessels.

Conclusions
There is an ever expanding repertoire of techniques to create 3D replications of the intracranial vasculature. Knowledge of current image acquisition and printing methods and their limitations is essential to creating accurate and readily applicable in vitro models.

eEdE-59

4D CTA: Techniques and Current Clinical Applications

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Purpose
To review techniques and current clinical applications of 4D (time-resolved) computed tomography angiography (CTA) in the context of common neurovascular diseases.

Materials and Methods
A review of the literature was performed. Relevant articles pertaining to
neurovascular applications of 4D CTA were retrieved and reviewed in full. Findings were synthesized into an interactive presentation, which highlights the fundamental principles of 4D CTA, the relative strengths and weaknesses of 4D CTA compared with conventional angiography and CTA, potential clinical applications of 4D CTA, and a brief summary of the available evidence in support of these applications. Several local cases were integrated to illustrate the potential usefulness of 4D CTA.

Results
Four-dimensional CTA is a novel CTA technique designed to noninvasively evaluate flow dynamics. Four-dimensional CTA demonstrates several promising neurovascular applications. These broadly fall into the categories of vascular malformations (AVMs, dural AVFs, and developmental venous anomalies), ischemic stroke, hemorrhagic stroke, and chronic arterial disease. A high-quality 4D CTA examination may offer valuable information over conventional CTA, and, in select cases, obviate the need for conventional angiography. However, current evidence supporting the use of 4D CTA is largely limited to single-center retrospective reviews (Level III evidence). In addition, inferiority to conventional angiography - with respect to spatial and temporal resolution - and conventional CTA - with respect to availability and familiarity - present themselves as barriers to more widespread utilization.

Conclusions
Four-dimensional CTA is a promising and potentially valuable problem-solving tool for the evaluation of neurovascular disease.

eEdE-106
6:30AM - 2:45PM

A Comedy of Errors: Identifying, Classifying, and Preventing Cognitive and Perceptual Errors in Neuroradiology

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Purpose
To review and classify causes of errors in diagnostic neuroradiology, via a case-based approach, with a focus on strategies for error prevention for the on-call resident.

Materials and Methods
Various systems for the classification of radiologic diagnostic errors have been proposed, encompassing perception, interpretation, communication and technical factors. We retrospectively reviewed our database of resident-attending discrepancies of emergency and trauma cases at our level-1 trauma center over a span of 10 years. We then organized and classified the cases based on several criteria. Errors were first divided into two groups, perceptual and cognitive. We further divided cognitive errors
into false positives, false negatives, and misjudgments in which the abnormality was identified but misinterpreted.

Results
It is imperative to both perceive and accurately interpret abnormal findings in order to facilitate appropriate and expeditious radiologic work up and clinical management. Perceptual errors are related to scanning, fixation, satisfaction of search, and the inherent characteristics of the human visual system, such as subjective contour formation and the Mach effect. The Mach effect represents an optical illusion created when normal structures appear brighter due to surrounding low density; this explains the phenomenon of pseudo-subarachnoid hemorrhage, among others. A major contributor to cognitive false positive and false negative errors is misconstruing normal variants, especially pertaining to bony and vascular anatomy; errors in interpretation frequently involve infarcts and hemorrhages. One notable example is a "post-traumatic" parenchymal bleed due to a previously unrecognized aneurysm, which ruptured. Another example demonstrates how one might be less inclined to attribute cerebral edema to an underlying mass if the stated history were "rule-out CVA." These types of misjudgments may be caused by incomplete knowledge, misleading clinical history, and anchoring bias. The adverse consequences of such misinterpretations include prolonged hospitalization, unnecessary testing and procedures, and needless patient anxiety. Strategies for improvement include maintaining a missed-case database which can be drawn from as an opportunity for learning. It is essential to communicate with referring physicians, assess for distinguishing radiologic features and consider all possible etiologies, however unlikely.

Conclusions
By utilizing our novel system of error classification in conjunction with maintaining an organized case database, institutions may be able to provide an instant upgrade in neuroradiologic diagnostic quality.

eEdE-46

A Practical Approach for the Differential Diagnosis in Trigeminal Nerve Involvement

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Purpose
Involvement of trigeminal nerve and spinal trigeminal nucleus can occur in a wide range of diseases. Besides vascular, inflammatory and infectious causes, neoplastic and metabolic also should be contemplated. Our purpose is to review the trigeminal
nerve anatomy briefly, followed by review and discussion about the usual and unusual lesions located in brainstem and in the cisternal segment that lead to trigeminal nerve dysfunction.

Materials and Methods
After reviewing our institution teaching files, we selected cases demonstrating trigeminal involvement on magnetic resonance imaging (MRI). The lesions were classified according with their imaging pattern. Patient selection and data collection were performed using the electronic patient's database.

Results
The trigeminal anatomy is complex, exhibiting multiple branching and anastomotic patterns. Clinical and laboratorial data are essential to narrow the diagnostic possibilities and to allow appropriated imaging approach. The main pathological conditions affecting the trigeminal pathway (isolated or associated with other neurological deficits) are vascular, inflammatory, and infectious conditions. Specific findings related to some conditions can sustain the diagnosis. First, the size and extent of the lesion should be evaluated. Smooth and regular trigeminal enhancement favors the diagnosis of inflammatory and infectious conditions. Mass effect and infiltrative involvement supports neoplasia. Restricted diffusion affecting a specific vascular territory indicates an acute stroke. Other vascular conditions, like arteriovenous malformation, display a typical imaging appearance, similar to anywhere else in the brain, and do not pose diagnostic challenge. Metabolic conditions, although rare, should be included in the differential diagnosis, such as metachromatic leukodystrophy and leukoencephalopathy with involvement of the brainstem and spinal cord and elevated lactate.

Conclusions
The approach of trigeminal involvement requires a thorough understanding of its anatomy and function. There are a wide variety of disorders that affect the trigeminal pathway. Knowledge of the imaging features of usual and even unusual pathologic conditions can prevent their misinterpretation and facilitate the correct diagnosis.
Figure 1: Rhombencephalitis caused by *Listeria monocytogenes* with striking involvement of trigeminal nerve (arrowhead) extending to the spinal trigeminal nucleus on the same side (white arrows).

Figure 2: Left trigeminal Herpes Zoster: Coronal FLAIR image shows the craniocaudal extension of brainstem signal abnormality along the left spinal trigeminal tract (white arrows).

Figure 3: Intra-axial trigeminal involvement in Multiple Sclerosis. Axial FLAIR image demonstrates involvement of the intradural segment of the left trigeminal nerve (white arrow).

Figure 4: Tumoral spread along the left trigeminal nerve. Post-contrast axial T1WI reveals abnormal enhancement of an enlarged left trigeminal nerve. Intra-axial and cisternal segment involvement is also depicted (arrowhead).

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**Anatomical Atlas of the External Carotid Artery and its Branches Using DynaCT Digital Angiography**

E Bravo¹, F Torres¹, J Caro¹, C Pinto²

¹INSTITUTO DE NEUROCIRUGIA DR. ASENJO, SANTIAGO, Chile, ²Instituto de Neurocirugía Dr. Asenjo, SANTIAGO, Chile
Purpose
Learn and understand the normal anatomy of the external carotid artery (ECA) and its branches, using DynaCT digital angiography (Siemens, Erlangen, Germany).

Materials and Methods
Retrospective evaluation of DynaCT digital angiography studies of the ECA and its branches, in patients with brain, head and neck pathologies, without injuries of these arteries, made in the Dr. Asenjo Institute of Neurosurgery between August 2013 and November 2015. We did injections from 10 to 15 cc of an isosmolar, nonionic, iodinated contrast agent (Visipaque R) using a biplane flat-panel detector angiographic suite (AXIOM Artis FD Biplane Angiosuite with DynaCT). A DynaCT acquisition was obtained by using the following parameters: 20-second rotation; 0.4° increment; 1024 × 793 matrix; 217° total angle; ∼11°/s, ∼30 frames/s, system dose 1.2 μGy/frame, total of 538 projections and field of view of 48 cm. Image reconstruction was performed on a workstation (X-Leonardo). The volume dataset produced with typical voxel size 0.4 mm by X-Leonardo was manipulated interactively in orthogonal planes. Radiation dose was up to 60 mGy.

Results
We evaluated a total of 110 patients (57 women and 53 men; age range, 2-72 years; mean 39.5 years) with different pathologies (tumors, dural fistulas, arteriovenous malformations, aneurysms) that underwent DynaCT digital angiography and show branches and normal courses of the superior thyroid, lingual, facial, ascending pharyngeal, occipital, posterior auricular, internal maxillary and superficial temporal arteries. We identified all the main branches of the ECA, and most of the secondary branches and its anastomosis, as well as their relationships with the bone structures of the skull base and the face. Most of the anatomical knowledge of the ECA’s branches is secondary to micro dissection studies. The conventional angiography is the gold standard method for the study of the vascular anatomy in vivo, but it does not allow to clearly determine its relations with the bony structures. The study of the anatomy of the ECA with DynaCT digital angiography solves this problem.

Conclusions
We believe that the DynaCT digital angiography with MPR reconstructions is an excellent method for learning and integrating, in a tridimensional form, the vascular anatomy of the fine branches of the external carotid artery and their relations with the bone structures of the skull and face.
The epidural arterial network of the clivus (posterior view): 1, C-3 collateral of the vertebral artery; 2 and 3, arterial branches of the C-3 portion of the odontoid arch system; 5, hypoglossal branch and 6, jugular branch of the neuromeningeal trunk of the ascending cervical artery; 9, postoinferior hypophyseal artery.
Application of Positron Emission Tomography-MR Imaging in Neuroradiology
A Chaudhry¹, M Gul², R Matthews³, L Bangiyev³, R Peyster⁴
¹Johns Hopkins Medicine, Elkridge, MD, ²National Institute of Health, Elkridge, MD, ³Stony Brook University Hospital, Stony Brook, NY, ⁴Stony Brook University Hospital, Stony Brook, NY

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

Materials and Methods

Results
1. Physical principles and techniques of PET-MRI: Relevant concepts involving image acquisition, postprocessing and interpretation will be provided. 2. Overview of clinical applications of PET-MRI in neuro-oncology patients: An overview of initial tumor diagnosis, discussion of tumor biology and its effect on tumor imaging (e.g., tumor metabolism, angiogenesis, cellularity, etc.), post-treatment follow-up imaging evaluation and its role in therapy selection will be provided. 3. Role of PET-MRI in evaluation of neurodegenerative and inflammatory conditions. 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
Positron emission tomography-magnetic resonance imaging 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.

**Case:** 40 year old with seizure. MRI reviews enhancing lesion with diffusion with +FDG avidity

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**eEdE-94**

**Arterial Spin Labeling: Hypoperfusion, Hyperperfusion, and Beyond**

M Ho¹, T Kaufmann¹, P Morris¹, R Witte¹, C Jack¹

¹Mayo Clinic, Rochester, MN

**Purpose**
To discuss advanced interpretation and applications of arterial spin labeling (ASL), using a case-based and image-rich format.

**Materials and Methods**
Arterial spin labeling (ASL) is a noncontrast MRI technique that enables quantification of absolute cerebral blood flow (CBF). In this exhibit, we will review
the underlying physical principles and technical approaches. Next, we will present normal variants and pitfalls important to recognize and avoid diagnosing as pathology. Clinical applications of ASL will be discussed using a case-based format. Three major categories will be covered: Hypoperfusion, Hyperperfusion, and Beyond. Through investigation of advanced cases, this presentation will highlight the subtleties and nuances of ASL interpretation, as well as cutting-edge clinical and research applications of this technique.

Results


Conclusions

Arterial spin labeling (ASL) is a convenient and noninvasive technique for CBF assessment with diverse applications including stroke/vasculopathy, vascular malformations, tumors, dementias, epilepsy, and CSF flow. Following review of advanced cases, the neuroradiologist will better appreciate the intricacies and pitfalls of ASL interpretation, and be equipped to apply this technique to novel clinical/research scenarios.
Crossed cerebellar diaschisis

Hemiplegic migraine

Arterialized DVA with seizure

Alzheimer dementia
At Risk: Opportunistic Infections and Complications Arising From an Immunocompromised State

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¹Einstein Medical Center, Philadelphia, PA, ²University of Colorado, Aurora, CO

Purpose
The prevalence of patients in an immunocompromised state continues to rise with an increased rate of solid organ failure, transplant, cancer and HIV survival as well as the increased use of immunomodulators for therapy. Immunocompromised patients are predisposed to a variety of opportunistic infections and other complications/neoplasms that affect the central nervous system. Imaging plays a pivotal role in the diagnosis and management of these opportunistic infections and complications arising from an immunocompromised state. By reviewing a series of cases from our institution, we hope to enhance the radiologists' awareness of the spectrum of pathologies to allow for prompt diagnosis and treatment.

Materials and Methods
A retrospective, pictorial review of a wide spectrum of findings at our institution will be presented. We will categorize these cases based on type of immunosuppression including: Diabetes, renal failure, hepatic failure, HIV, immunomodulation therapy (in demyelinating, inflammatory and transplant patients), and chemotherapy. This exhibit will be a multimodality review, with emphasis on computed tomography (CT) and magnetic resonance imaging (MRI).

Results
We will present a spectrum of findings based on the type of immunosuppression: Mucor sinusitis with intracranial extension and malignant external otitis in diabetes; diskitis/osteomyelitis and intracranial fungal abscess in renal failure; hepatic encephalopathy in liver failure; manifestations of atypical infections (based on CD4 count), PML, IRIS and malignancy in HIV/AIDS; and PML, PRES, lymphoma and atypical infections due to immunomodulation therapy/chemotherapy. We also will present a chart of the common opportunistic infections relative to CD4 level.

Conclusions
Opportunistic infections and complications arising from an immunocompromised state encompass a wide spectrum of pathology; radiologists play an integral role in the diagnosis of these pathologies. When evaluating an immunocompromised patient, radiologists should therefore be aware of and have a high clinical suspicion for these
entities in order to have prompt management and treatment, thereby improving overall patient outcome.

**32 year old female presents with right-sided weakness.**

- **Initial presentation for right sided weakness.**
- **6 weeks after initiation of HAART therapy with worsening right sided weakness and.**

**Initial MRI demonstrates patchy T2 hyperintensity in the left posterior frontal cortex and adjacent white matter (A) without significant mass effect or enhancement (B).**

During hospitalization, the patient is found to be **HIV positive** with a CD4 count of 54 and demonstrated positive serology for the **JC virus**. Given the clinical picture, these imaging findings are consistent with **progressive multifocal leukoencephalopathy (PML)**.

**Subsequent MRI reveals confluent T2 hyperintensity predominantly in the frontal lobe and involvement of the subcortical U fibers and peripheral patchy T2 hypointensity with regions of patchy and nodular enhancement (C and D).**

Given the imaging findings, **recent initiation of JC virus positively, findings are consistent with recent reconstitution inflammatory syndrome (IRIS).**

**Imune Reconstitution Inflammatory Syndrome (IRIS)**

- Progression of signal abnormality and development of enhancement in the setting of positive serology for JC virus and recent initiation of HAART (usually 2-12 weeks) is imperative to make the diagnosis.
- Different morphologies of IRIS occur depending on the co-existing infection. PML is the most common and can be seen with other opportunistic infections.
- In this case, the interval increase in expansile signal abnormality and new patchy nodular and periventricular enhancement is suggestive of PML-IRIS.

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eEdE-37

**Autoimmune Encephalitis: A Pictorial Review of an Often Overlooked Diagnosis and its Mimickers**

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6:30AM - 2:45PM

54th Annual Meeting & Foundation of the ASNR Symposium 2016
Purpose
Autoimmune encephalitis is a relatively rare, but important cause of encephalitis. Given its response to therapy, timely diagnosis is critical as delayed or inappropriate treatment can lead to poor outcomes. Unfortunately, the clinical presentation is nonspecific with definitive diagnosis often requiring specialized testing. As such, magnetic resonance imaging (MRI) often is the initial study of choice – and therefore, radiologists play a critical role in raising the possible diagnosis. The purpose of this exhibit is to provide a pictorial review of imaging features seen in cases of autoimmune encephalitis, as well as potential mimickers, while providing ancillary diagnostic studies that can help narrow the differential diagnosis.

Materials and Methods
• Using case files, we will show examples of cases of autoimmune encephalitis, including: Voltage-Gated Calcium Channel (VGCC) Antibody-Mediated Encephalitis (Fig. 1), Hashimoto's Encephalopathy, and Anti-NMDA Receptor Encephalitis. • We also will show potential mimickers of autoimmune encephalitis, including herpes encephalitis, Creutzfeldt-Jakob disease, status epilepticus, Wernicke's encephalopathy, hypoglycemic encephalopathy, and global anoxic injury. • We will discuss clinical features and additional diagnostic tests that can help in formulating an appropriate differential diagnosis.

Results
The clinical work up and imaging findings in patients with autoimmune encephalitis can be challenging. This exhibit will display key imaging features seen in autoimmune encephalitis and its mimickers, demonstrating common lesion locations, signal characteristics, and enhancement patterns.

Conclusions
Autoimmune encephalitis is a relatively rare, but treatable cause of encephalitis. Due to its nonspecific clinical presentation, radiologists can play an important role in helping to establish the diagnosis by alerting clinicians to the possibility. Radiologists also must be aware of those entities that may mimic autoimmune encephalitis on imaging. This exhibit offers a pictorial review of key imaging features of autoimmune encephalitis and its mimickers to assist radiologists and clinicians alike, in arriving at a final diagnosis.
Basics and Clinical Application of Ultrashort TE MRA Combined with Arterial Spin Labeling Algorithm - Silent MRA -

M Suzuki¹, R Irie², N Takano³, M Yamamoto², M Hori², K Kumamaru⁴, K Kamagata⁴, A Hagiwara¹, T Tabata², H Oishi², S Aoki⁴
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Purpose
To determine the basic principles of ultra-short-echo-time MR angiography (UTE-MRA), its current usefulness in clinical neuroimaging, and the pitfalls of UTE-MRA based on its principles.

Materials and Methods
Silent MRA (GE Healthcare) consists of a combination of UTE and arterial spin labeling. Principally, images are compared with conventional time-of-flight (TOF) MRA and digital subtraction angiography (DSA), retrospectively. We also assessed the technical characteristics using a blood circulation phantom to confirm an accuracy of Silent MRA.

Results
A technical review of silent MRA and its recent application for cerebrovascular disease are presented. Our experience in applying silent MRA in patients with
cerebral aneurysms (pre, postcoil embolization, poststent-assisted coil embolization, and postclipping), dissecting cerebral aneurysms, moyamoya disease, intracranial carotid occlusion, and several types of dural arteriovenous fistula are presented.

Patients treated with PIPELINE stent, and PIPELINE-assisted coil embolization were enrolled.

Conclusions
In a present study, important factors, including differences from TOF MRA, further applications in clinical practice, and pitfalls for interpretation, are presented. Generally, Silent MRA images showed strong flow signal compared with conventional TOF MRA, regardless of neighboring metallic material, flow direction and quite small flow. Silent MRA seemed to show 'true flow'.

**eEdE-22**

6:30AM - 2:45PM

**Beyond the MRI: Case-Based EEG Primer for the Neuroradiologist with MR Correlation of Findings**

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Purpose
Appropriate treatment of the epilepsy patient is a multidisciplinary effort necessitating consistent communication between the epileptologists, neuropsychologist, neurosurgeon, and neuroradiologists. It is increasingly important for each subspecialty to have baseline comprehension of the other's area of expertise, as it pertains to patient workup and cohesive management. We hope to familiarize the neuroradiologist with the basics of the electroencephalogram (EEG) findings, and provide correlation with the MR findings in a case-based format.

Materials and Methods
The epilepsy surgical case logs at a NAEC level 4 epilepsy center were searched retrospectively from 2007-2015. The PACS system then was searched for pre-operative imaging of these patients. The imaging findings then were correlated with presurgical ictal and interictal EEG findings, as well as Video EEG when available. EEG selection and review was performed by the senior Epilepsy fellow. Cases were selected for presentation based upon correlation of EEG and MR findings, video EEG seizure manifestations, and their interesting nature.

Results
Seizure protocol MRI and EEG are critical components in the workup of patients with epilepsy. Individuals with refractory focal (partial) seizures display a multitude of EEG abnormalities, which may be lateralized or localized. Interictal EEG abnormalities are many and may include lateralized or localized delta/theta slowing,
spike or sharp wave discharges, PLEDs, polyspikes, changes in amplitude or frequency, disruption of background rhythm or normal sleep architecture or periodic discharges. Interictal and ictal EEG patterns then are correlated with clinical seizure semiology, neuropsychology, and imaging to formulate a sound hypothesis as to the epileptogenic zone. Commonly, magnetic resonance imaging (MRI) can help visualize a lesion, although at times they may be subtle, or not even represent the true epileptogenic focus. In adults, seizures most commonly have an acquired cause, with the most common etiologies being trauma, stroke, mesial temporal sclerosis, and neoplasms. Childhood causes of localized epilepsy are commonly congenital, with causes including cortical dysplasias, heterotopic gray matter, and tuberous sclerosis.

Conclusions
While a precise seizure focus always cannot be ascertained after a thorough neurologic workup, there are many circumstances when a lesion amenable to surgical intervention can be found on MRI, particularly when it corresponds with findings on EEG, ictal semiology, neuropsychological assessment, and other advanced imaging modalities (SISCOM, PET, MEG). In the multidisciplinary approach to medical problem solving, it is therefore of utmost importance for the neuroradiologist to be familiar with EEG findings and the approach of other subspecialties.
Brain Death: To Be, or Not to Be, That is the Question. Imaging Techniques, Role in Diagnosis and Limitations

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Purpose
1. Review the different imaging techniques employed at our institution for radiological confirmation of diagnosis of brain death. 2. Review diagnostic criteria and ancillary tests for brain death diagnosis. 3. Review imaging manifestations of brain death. 4. List the limitations of imaging techniques used in diagnosis of brain death.
Materials and Methods
We reviewed cases of brain death referred to the Radiology department from July 2005 to July 2015 for radiological confirmation of brain death. Brain perfusion scan employing 99mTc HMPAO or ECD scintigraphy, computed tomography (CT) head with CT angiography, CT perfusion, magnetic resonance imaging (MRI) brain and MR angiogram head were used for confirming the diagnosis of brain death as part of the ancillary criteria. The images from these cases were reviewed.

Results
"Brain death" according to the President's Commission (1) is an irreversible cessation of functions of the entire brain, including the brain stem. The diagnosis of brain death is made on clinical grounds and neurologic exam. In the United States, clinical criteria set by the American Academy of Neurology (2) emphasize three clinical findings to confirm brain death: coma, absence of brainstem reflexes and apnea. Ancillary tests are needed when neurologic examination or apnea test cannot be performed (3). These include confirmation of electrical activity loss by EEG and demonstration of loss of cerebral blood flow by radiological studies. On 99Tc-HMPAO or ECD nuclear scintigraphy, there is lack of intracranial radiotracer uptake, a finding compatible with brain death. The modality is limited at times by round-the-clock lack of isotope and technician availability. On CT angiography, there is lack of intracranial arterial and venous opacification using a 4 point scale (4). On CT perfusion, there is lack of cerebral blood flow and blood volume in brain stem (5). Residual brain perfusion can occur with reduced intracranial pressure as in decompressive craniectomy leading to false positive results. On magnetic resonance imaging (MRI), there can be massive brain edema with herniations, poor gray/white matter differentiation, diffuse diffusion restriction and nonvisualization of intracranial vessels on MRA. The difficulty of obtaining MRI on ventilated patients and length of scanning time are limitations.

Conclusions
Radiological studies can demonstrate lack of intracranial blood flow helping in recognizing or excluding brain death.
Brain MRI in Patients with Vagus Nerve Stimulation (VNS): Troubleshooting and Improving Quality

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Purpose
Vagus nerve stimulation (VNS) is an adjunctive treatment for adult and pediatric patients with epilepsy refractory to medical and other surgical management. Patients with the VNS system are likely to need magnetic resonance imaging (MRI) examinations of the brain for epilepsy management. The VNS is an MR conditional device that poses limitations to the adequate evaluation of these patients. This exhibit will review the conditions and tips to image the brain in patients with VNS stimulation systems.

Materials and Methods
Configuration of the VNS therapy system. Imaging of patients with intact VNS. Imaging of patients with explanted VNS. Limitations of MRI and optimizations of sequences.

Results
Vagus nerve stimulation system consists of a lead (electrodes and anchor tethered to the left vagus nerve) and a pulse generator (single receptacle or dual receptacle) implanted in a pocket in the chest wall. The VNS Therapy System is an MR conditional device. The potential risks of performing MRI on patients with an implanted VNS Therapy System include heating effects around the VNS with potential for soft tissue damage, inadvertent modification of device settings, image distortion and artifacts, magnetic field interactions, device malfunction or damage. Magnetic resonance examinations can be performed in patients with intact VNS, however exclusion zones and limitation in the specific absorption rate (SAR) are some of the technical challenges that need to be addressed prior to imaging acquisition. Patients with partially explanted VNS systems have different limitations and conditions for MR imaging, which require pre scan evaluation and sequence planning.

Conclusions
Knowledge of the available options and limitations for brain MR imaging in patients with epilepsy with the VNS system facilitates the timely acquisition of images and improves patient care.
Brain Parenchymal Contrast Staining After Mechanical Thrombectomy for Acute Ischemic Stroke

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Purpose
To increase awareness of brain parenchymal contrast staining following intra-arterial injection of iodinated contrast for mechanical thrombectomy in the treatment of acute stroke. On the post-thrombectomy plain computed tomography (CT) scan of the brain the contrast extravasation appears hyperdense and mimics hemorrhagic conversion. This may alter antithrombotic treatment and should be recognized.
Materials and Methods
We retrospectively reviewed serial CT scan images of 30 consecutive patients who underwent mechanical thrombectomy using retrievable stents for treatment of acute stroke between 1 Jan 2015 and 10 Dec 2015. We observed the incidence and evolution of new hyperdensities that appeared on CT scan performed within 24 hours of the procedure.

Results
Six out of 30 patients who underwent mechanical thrombectomy for the treatment of acute stroke, had new hyperdensities within 24 hours of the procedure, on the CT scan. One patient did not undergo a CT at 24 hours. Site of occlusion included MCA, ICA and basilar artery. In two patients the hyperdensities resolved within 48 hours. In two patients the hyperdensities reduced initially and subsequently increased. In the remaining two patients the hyperdensities persisted beyond 48 hours. In all cases, the pattern was of diffuse parenchymal hyperdensity. In one patient there was additional gyriform hyperdensity. Newly appeared hyperdensities seen on a CT scan after mechanical thrombectomy may be secondary to hemorrhage and/or contrast extravasation. The physiology behind contrast staining of parenchyma in stroke is not clearly understood. Lack of sufficient revascularization at the capillary level in cerebral infarction, and thus a lack of blood flowing through the territory at the capillary levels to "wash out" contrast, could be a contributing factor to contrast staining of brain parenchyma. Although some believe it to predict subsequent hemorrhagic transformation, other studies have shown that these do not carry an increased risk of symptomatic hemorrhage or negative prognosis. In our experience contrast staining does not always predict hemorrhagic transformation or clinical deterioration.

Conclusions
It is important to recognize contrast staining in the early (within 24 hours) CT scan after intra-arterial thrombectomy. Contrast staining shows marked reduction in density on the follow-up CT scan within 48 hours.

eEdE-100
6:30AM - 2:45PM
Brain White Matter Lesions; New Insights in our Understanding of Leukoaraiosis

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Purpose
Teaching points: 1- Radiologic findings of white matter lesions (WML). 2-
Pathophysiological "hypothesis" of WML formation and magnetic resonance imaging (MRI) correlates. 3- Penumbra concept: Normal-appearing white matter surrounding the lesions is statistically abnormal which indicates lesions are "tip of the ice berg". 4- Functional correlations based on tractography and resting state functional magnetic resonance imaging (fMRI).

Materials and Methods
This educational exhibit reviews the pathophysiological hypothesis of leukoaraiosis formation. Moreover, we will elaborate on the radiologic findings of WMLs along with the progression pattern of the lesions. Then we will discuss the concept of penumbra and the lesions that represent the "tip of the iceberg" of white matter damage. Finally we will discuss the radiologic approaches to investigate WML and their effects on brain connections and brain function using tractography and resting state fMRI.

Results
1- Introduction to WML: clinical importance and manifestations. 2- Pathophysiological "hypothesis": vascular damage results in white matter damage that can be quantified on functional and structural MRI. 3- Structural imaging manifestations of WML. 4- Tip of the iceberg: WML as an indicator of more diffuse white matter injury. 5- Functional correlations of WML: Relationship and effects of WML on white matter tracts/tractography and functional connectivity of the brain as measured by resting state fMRI.

Conclusions
The pathophysiological hypothesis of white matter lesions formation and their functional correlations based on tractography and resting state fMRI is discussed. White matter lesions extend beyond the apparent lesions in FLAIR image and radiologic approaches can be utilized to investigate the nature and extent of the disease.
The bar graphs illustrate the signal intensity for FLAIR, cerebral blood flow for CBF, and fractional anisotropy for FA in various brain regions: WML, 2mm penumbra, 2-4mm penumbra, and Distant NAWM. The measurements suggest that WML are the tip of the iceberg of overall white matter abnormality. (* = p ≤ 0.05).

WML: white matter lesion, NAWM: normal appearing white matter
Cavernous Sinus Hemangiomas: Spectrum of Imaging Findings, Pitfalls, Differential Diagnosis, and Treatment

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Purpose
Congenital hemangiomas and venous malformations, previously known as hemangiomas, are common vascular lesions, encountered in many organ systems in the body. Cavernous sinus hemangiomas (CSH) are an unusual site of occurrence, accounting for approximately 2% of cavernous sinus masses. Despite their benign histology, these lesions present unique treatment challenges due to their high propensity for intra-operative bleeding and their relationship to important neurovascular structures. The goal of this exhibit is to educate radiologists on the spectrum of imaging appearances of these lesions through a series of cases that presented to our institution. Both classic and atypical imaging appearances will be reviewed. Relevant anatomy, imaging pitfalls, differential diagnoses, and treatment strategies will be discussed.

Materials and Methods
A series of five pathologically confirmed cases of CSH at our institution are used to review both classic and atypical appearances. Relevant cavernous sinus anatomy is illustrated through high resolution magnetic resonance imaging (MRI) and drawings. We discuss imaging pitfalls of these lesions and distinguishing characteristics of important differential diagnoses. Finally, we briefly address current treatment strategies with both surgical and radiation oncology perspectives.

Results
Magnetic resonance imaging findings in our series were variable, showing both typical and atypical findings with respect to other reports in the literature. Consistent findings across all patients, and in keeping with classical CSH, included circumscribed margins without narrowing of the cavernous internal carotid artery. Magnetic resonance imaging signal characteristics were, however, highly variable. While some lesions demonstrated commonly described marked T2-hyperintensity and avid enhancement, others showed T2-hypointensity with avid enhancement or T2-hyperintensity with minimal enhancement. The histologic basis for these various imaging features seem to be related to the amount of fibrous tissue and/or vascular channel thrombosis. Pathology showed noninfantile, GLUT-1 negative, capillary...
hemangiomas (congenital hemangiomas) in both pediatric patients and cavernous hemangiomas (venous malformations) in the three adults. The differential diagnosis of CSH primarily includes meningioma and schwannoma but also comprises aneurysm, pituitary tumors, chondrosarcoma, chordoma, and metastasis, and idiopathic inflammatory processes, such as sarcoidosis and Tolosa-Hunt. Certain imaging features can help differentiate these entities. Treatment of cavernous sinus hemangiomas often requires a multidisciplinary approach with both neurosurgery and radiation oncology. Surgical resection was traditionally the treatment of choice for these lesions but the operative risk has shifted the treatment paradigm in favor of radiosurgery.

Conclusions
Treatment of cavernous sinus hemangiomas often requires a multidisciplinary approach with both neurosurgery and radiation oncology. Surgical resection was traditionally the treatment of choice for these lesions but the operative risk has shifted the treatment paradigm in favor of radiosurgery.
Cerebral Arteriovenous Malformations: The Simplicity of Routine MRI & MRA and Conventional Angiogram for Follow-Up After Gamma-Knife-Radiosurgery

C Weber¹, L Bagley², J Lee³, M Alonso-Basanta³, L Loevner⁴, K Learned⁵

Purpose
Gamma knife radiosurgery is a well established option for the treatment of cerebral arteriovenous malformations (AVM). Postradiosurgical MR imaging follow up oftentimes is a diagnostic challenge due to the uncertainty of nidus obliteration, expected post-treatment change and complications. We will highlight the specifics of representative cases to enable viewers to navigate through pre- and post-radiosurgical imaging of cerebral AVMs.

Materials and Methods
Review of the Spetzler-Martin Grading system for brain AVM, the principles of gamma knife radiosurgery, and patient selection criteria will be highlighted, using clinical cases from a single institution over 10-year period. Postradiosurgical longitudinal imaging follow up of AVM will be discussed, with emphasis on the value of magnetic resonance imaging (MRI), magnetic resonance angiography (MRA) and angiography. The evolution of the treated nidus and the surrounding brain changes, complications and correlation of MR findings with angiogram are illustrated. Finally, the correlation between the clinical status with imaging findings will be included.

Results
Magnetic resonance imaging and MRA successfully evaluate the postradiosurgical angioarchitecture of AVM and the surrounding brain parenchyma, providing additional information that reaches outside the scope of conventional angiography. Nidus obliteration was defined on MR by regression to nonvisualization of flow-voids on T2-weighted image and vascular enhancement on enhanced T1-weighted images. Nidus obliteration typically occurs 1.5-3 years after radiosurgery. Therefore, angiogram is reserved to confirm/deny obliteration after this period. The parenchymal FLAIR hyperintensity, enhancement and/or mass effect reflect radiation sequela and alteration of local perfusion from post-treatment hemodynamic change. These imaging findings often are present in patients without clinical deterioration. Routine MRI/MRA follow-up is appropriate and conventional angiogram is indicated if there is acute hemorrhage and may be indicated in the setting of neurological decline.
Conclusions
Routine brain MRI-MRA represents an acceptable imaging modality to follow AVM patients after radiosurgery. It is a widely available, noninvasive modality to assess the nidus and post-therapeutic complications.

eEdE-16

Cerebral Microbleeds: Causes, Pathophysiology, Clinical Relevance and Imaging Approach

L Stratchko¹, S Kanekar¹
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Purpose
1. To discuss the brief physics of susceptibility-weighted imaging (SWI). 2. To discuss the various causes of cerebral microbleeds (CMBs) and discuss their clinical significance.

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

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

Conclusions
1. We discuss in brief the physics of SWI sequence and its role in detection of cerebral microbleeds. 2. We give an algorithmic approach in evaluation and mapping of CMBs with respect to their clinical significance.

eEdE-65

Cerebral Proliferative Angiopathy (CPA): Not Your Garden Variety Arteriovenous Malformation
M Mallery, E Supsupin

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Purpose
Cerebral proliferative angiopathy (CPA) is a rare but important vascular disorder distinct from the "classical" arteriovenous malformation of the brain (BAVM). Making the distinction between CPA and BAVM is crucial because of differences in their recommended treatment.

Materials and Methods
We aim to draw contrast between CPA and BAVM, emphasizing their angioarchitectural and neuroangiographic differences. The typical clinical presentation, pathophysiology, and natural history of CPA are reviewed. The treatment implications of its angiomorphology are addressed.

Results
Cerebral proliferative angiopathy is typically not associated with increased risk of bleeding at initial presentation. If hemorrhage occurs, however, the existence of normal intervening brain tissue makes treatment of CPA challenging. Embolization, vascular neurosurgery, and radiosurgery all carry the risk of permanent neurologic damage attributable to interspersed normal neural tissue. Nevertheless, all three treatment strategies have been attempted with variable success. In the series of Lasjaunias and colleagues, treatment indications were set very strictly and were limited to hemorrhage, identifiable fragile angioarchitecture (such as intranidal aneurysmal ectasias), intractable seizures, and disabling headaches.

Conclusions
The clinical presentation, pathophysiology, natural history, and angioarchitecture of CPA are distinct. Knowledge of its salient neuroangiographic features helps make the distinction from the "classical" BAVM, and ultimately direct appropriate management.
Cerebral Venous Thrombosis: Pictorial Essay and Literature Review

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Purpose
Cerebral venous thrombosis (CVT) is a serious disease with diverse clinical presentation, defined by occlusion of the vessels responsible for the venous drainage of the brain, including the dural venous thrombosis, cortical vein and deep vein thrombosis. Although rare, it is a leading cause of stroke in young women. Our
objective is to illustrate and discuss the main imaging findings of CVT, and perform a brief review of the literature.

Materials and Methods
We have used the images of the studies from our Radiology Service. A literature review on CVT was held.

Results
The main factors involved in CVT, include oral contraceptives, pregnancy and postpartum, malignancy, local infectious processes, pro-thrombotic factors, trauma and neurosurgical procedures. Any cause is identified in up to 25% of cases. Clinical manifestations depend mainly on the location, extent and possible complications associated with cerebral venous thrombosis. The clinical is nonspecific, the headache being most common symptom, present in 75-95% of cases. The four major clinical syndromes described in patients with cerebral thrombosis are isolated intracranial hypertension (20-40%), focal neurological deficits, seizures and decreased level of consciousness. Therefore, research imaging plays a key role for the correct diagnosis. Diagnosis of CVT may be suspected by computed tomography (CT), but the preferred method is the brain magnetic angiorresonância (Angio-MRI). A noncontrast cranial CT is used as the initial method of investigation in many services. The primary sign of acute CVT on a noncontrast CT is hyperdensity of a cortical vein or dural sinus. The angio-CT is a noninvasive method and demonstrates the filling defect in the dural sinus (signal "empty delta"). Magnetic resonance imaging (MRI) has high sensitivity and specificity for demonstrating the intramural thrombus. The thrombus signal characteristics depend on the hemoglobin degradation stage contained therein. It also is used to follow up and reveal the adverse outcomes throughout the surveillance. Digital angiography is the gold standard, it is an invasive method and reserved for specific cases.

Conclusions
Early diagnosis and treatment are crucial as they allow reverse process and significantly reduce the risk of acute complications and long-term sequelae.
Axial CT with contrast shows a thrombosis of the posterior portion of the superior sagittal sinus. It is referred as a dense triangle, the dense delta sign (arrow).
Axial RM FLAIR - weighted shows nucleocapsular bilateral venous infarction (arrow).

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Axial MR FLAIR shows trombosis of the superior sagittal sinus and cortical veins (arrows) complicated with subarachnoid hemorrhage (arrows) and left parietal intraparenchymal hematoma (triangle arrow)
Axial MR FLAIR-weighted shows the superior sagittal sinus thrombus (arrows) complicated with subarachnoid hemorrhage (dashed arrow) and venous infarction left front (triangle arrow).

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eEdE-12

6:30AM - 2:45PM

Cerebrospinal Fluid Abnormalities: A Discussion of How Things Flow Around Your Brain

E Bass¹, B Stevens¹, A Chatterjee¹, G Matheus¹

¹Medical University of South Carolina, Charleston, SC
Purpose
From his original study of cerebrospinal fluid (CSF) flow dating back to 1913, Dr. Walter Dandy created a classification system that still forms the basis for our understanding of hydrocephalus. Since the advent of computed tomography (CT) and magnetic resonance imaging (MRI), the understanding of CSF-flow dynamics and its pathology has extended far beyond the original classification system of Dandy to include such phenomenon as normal pressure hydrocephalus, idiopathic intracranial hypertension, intracranial hypotension, sinking brain syndrome, and scalp flap syndrome to name a few. This presentation aims to provide the most current updated definition of these CSF flow-related pathologies in the context of a unified model of normal CSF-flow physiology. In addition, an update on the most sensitive and specific imaging modalities will be presented for each pathology with numerous key examples of positive image findings and potential pitfalls.

Materials and Methods
Retrospectively reviewing patients in our teaching file with clinically validated CSF-flow related pathology and brain imaging studies, characteristic imaging features of obstructive and communicating hydrocephalus, shunt malfunction, normal pressure hydrocephalus, intracranial hypotension, idiopathic intracranial hypertension, sinking brain, and scalp flap syndrome have been evaluated for greatest instructive value and correlation with clinically described pathology.

Results
The reviewed imaging cases demonstrate the key imaging findings as well as potential diagnostic pitfalls described in the current research literature in the field of CSF-flow physiology, its variants, and numerous congenital, acquired, and iatrogenic pathologies.

Conclusions
For the practicing radiologist, the proposed presentation aims to deepen the understanding of physiologic CSF flow, increase sensitivity and specificity for detection of various CSF flow-related pathologies, and clarify the description of these pathologies with an illustrative and instructive approach.

**eEdE-26**

6:30AM - 2:45PM

**Cervicocephalic Vascular Occlusion: Thinking Beyond Atherosclerosis**

S Frost1, Y Li2, B Aagaard-Kienitz2, T Kennedy3

1University of Wisconsin Hospital and Clinics, Madison, WI Wisconsin, 2University of Wisconsin Hospital and Clinics, Madison, WI, 3University Of Wisconsin Hospital, Madison, WI
Purpose
The aim of this exhibit is to provide a brief overview of pathophysiology, etiology, imaging features and treatment of nonatherosclerotic cervicocephalic vascular injury.

Materials and Methods
A brief review of the pathophysiology, hallmark imaging findings and relevant treatment and triage strategies of idiopathic, traumatic and vasculopathy associated cervicocephalic vascular injury will be discussed.

Results
Nonatherosclerotic cervicocephalic vascular injury represents an important cause of stenosis and occlusion within the major vasculature of the head and neck. With an incidence of 2.5-3 per 100,000, all age groups are represented and peak age is 40 years old. While cervicocephalic dissection is responsible for 2% ischemic strokes, it represents 10-25% of ischemic strokes in middle-aged individuals without significant underlying vascular disease. Because presenting symptoms often can be nonspecific, imaging plays a critical role in diagnosis. Initial evaluation often is with computed tomography (CT) angiography or magnetic resonance (MR) angiography. On MR, additional T1 or PD sequences should be included to the vascular imaging sequences to assess for the presence of thrombus along the vessel wall. Digital subtraction angiography (DSA), historically considered the gold standard for vascular assessment, now is often reserved for equivocal/difficult cases and treatment. Classic imaging hallmarks such as intimal flap, double lumen sign and eccentric thrombus are not always present. Thus, more careful analysis of morphology, location, multiplicity, adjacent traumatic injury or lack of background atherosclerotic disease can serve as important diagnostic clues. Finally, understanding medical, surgical and endovascular treatment options will serve to highlight the importance of providing clinically useful information to our referring physicians.

Conclusions
Cervicocephalic vascular occlusion related to dissection is a significant cause of stroke in young and middle-aged individuals. The radiologist must have a thorough understanding of the pathophysiology, etiology, imaging characteristics and treatment of cervicocephalic vascular injury in order to facilitate timely diagnosis and management of these patients.

eEdE-56
6:30AM - 2:45PM

Characterization of Intracranial Atherosclerotic Stenosis Using High-Resolution MRI

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Purpose
Intracranial atherosclerotic disease is a leading cause of ischemic stroke worldwide and particularly in Asia. Despite its significant impact, the biology and characteristics of symptomatic intracranial arterial stenosis still are incompletely understood. There is growing interest in noninvasive imaging techniques able to assess and characterize in vivo intracranial atherosclerotic plaques. Our goals are to review high resolution magnetic resonance imaging (HRMRI) in the assessment of intracranial atherosclerotic stenosis and to examine the imaging features of intracranial plaque components.

Materials and Methods
We will review HRMRI cases obtained in patients currently enrolled in the Characterization of Intracranial Atherosclerotic Stenosis using High-resolution MRI (CHIASM) study at the Medical University of South Carolina. The selected cases will demonstrate HRMRI features of intracranial atherosclerotic plaques, with an emphasis on MRI acquisition of high-resolution arterial wall images. Content will be presented in the form of a didactic electronic exhibit.

Results
Intracranial atherosclerotic disease is most common among Asians, making it possibly the most common cause of ischemic stroke in the world. Although less common within Western populations, intracranial atherosclerotic disease is responsible for 8–10% of strokes in North America. Recent advances in MRI techniques have led to the development of intracranial vessel wall MR imaging. High resolution MRI has the potential to study intracranial atherosclerotic plaque development and progression, which could lead in the future to new stroke prevention treatments. At our institution the HRMRI protocol is performed on 3T MRI scanners equipped with a 32-channel head coil and includes high resolution T1-weighted, T2-weighted, and FLAIR sequences, as well as post-gadolinium T1-weighted images. Total scan time is approximately 40 min. In this exhibit we will review the imaging features of intracranial plaques, including intra-plaque hemorrhage, lipid core, fibrous cap, and ruptured fibrous cap.

Conclusions
This exhibit will detail the imaging characteristics of intracranial plaque components using HRMRI. Special attention will be given to tailoring imaging acquisition parameters for optimization of high-resolution images at a difficult anatomical location prone to artifact.

eEdE-107

Chronic Effects of Traumatic Brain Injury

6:30AM - 2:45PM
Purpose
Traumatic brain injury (TBI) affects results in an estimated 2.5 million ED visits a year in the United States (1). With advances in acute neuro critical care, the effects of long-term sequelae are more pertinent than ever and significantly impact the overall cost to society relating to TBI. Here we review the array of neurological disease relating to a prior head injury and illustrate what to look for on imaging.

Materials and Methods
After a review of the literature, we describe and illustrate chronic sequelae of TBI, divided into six major categories: vascular, seizure-related, movement, cognitive, behavioral and affective disorders.

Results
Vascular: A ten-fold risk of stroke in TBI patients has been shown and proposed mechanisms include the hyper-coagulation due to inflammatory cascade activation, vasospasm, vascular compression, and direct injury to the vessel. Seizure-related: Seizures can occur after trauma. Seizures occurring acutely after injury correlates with injury severity. Post-traumatic epilepsy (PTE) results when there is continued seizure disorder and risk factors include GCS <10 during the first 24 hours), multiple contusions, >5mm midline shift, dural penetration and injuries requiring surgical intervention (2). Imaging helps to predict post TBI seizure risk. Cognitive and behavioral: Post TBI cognitive deficits include abnormalities of attention, memory and other executive functions. Diffuse white matter injury is implicated as one of the main injury mechanisms for which higher field MRI and advances in diffusion imaging are more sensitive than conventional imaging. Affective: Higher prevalence of psychiatric diagnoses, including depression, has been reported in TBI patients (3), possibly from alteration in the prefrontal cortex, hippocampus or anterior cingulum depression (4, 5).

Conclusions
Traumatic brain injury is a common disorder that can result in a wide breadth of disease. Familiarity with post-traumatic sequelae and their associated imaging findings is important that these have implications with respect to risk stratification, outcome prediction and management.
Purpose
Central nervous system (CNS) infections remain an important cause of morbidity and mortality. They are not uncommon in any emergency radiology service and require prompt diagnosis and treatment. We will focus our electronic exhibit on CNS infections including meningitis, cerebritis, encephalitis, ventriculitis, abscess, PML, toxoplasmosis, cryptococcal infection, subdural empyema, postoperative infections, spinal cord abscess, epidural abscess, tuberculosis, cysticercosis, a rare case of listeria rhombencephalitis, intracranial extension of infections from sinusitis and mastoiditis. The purpose will be to familiarize with the imaging findings, review the pertinent differential diagnosis, review the imaging pearls and discuss the pitfalls to avoid misdiagnosis.

Materials and Methods
Authors will review the PACS data over past seven years of computed tomography (CT) and magnetic resonance imaging (MRI) of brain and spine and show representative cases of the above-mentioned pathologies to familiarize with the imaging findings and discuss the imaging pearls and pitfalls. We also will propose a diagnostic checklist and discuss the differential diagnosis to help reach the correct diagnosis. Key points to aid in detection of subtle findings will be reviewed. We will emphasize the differential diagnosis and show the salient features which lead to a specific diagnosis. We also will discuss how to add value in the report by reporting beyond what is obvious, using case examples. We compiled a collection of studies to cover meningitis, cerebritis, encephalitis, ventriculitis, abscess, PML, toxoplasmosis, cryptococcal infection, subdural empyema, postoperative infections, spinal cord abscess, epidural abscess, tuberculosis, cysticercosis, a rare case of listeria rhombencephalitis, intracranial extension of infections from sinusitis and mastoiditis. These cases will be presented with relevant clinical history and biochemical findings as visually enhanced powerpoint presentation. An example can be found in the Images/Table section of this abstract.

Results
The radiological findings of CNS infections often are subtle in the beginning and may be missed or misdiagnosed unless carefully looked for with due diligence. Familiarity with the subtle imaging findings, differential diagnosis, pitfalls and knowledge of the available advanced imaging techniques help in diagnosing and management of these conditions.

Conclusions
Timely and accurate diagnosis is paramount in CNS infections. Authors present an educational exhibit containing several representative examples of these cases and
discuss imaging pearls, potential pitfalls, checklist, differential diagnosis and key imaging findings.
Purpose
Central nervous system (CNS) vasculitides represents a heterogeneous group of inflammatory diseases that may affect large, medium sized, small and variable sized blood vessels. Central nervous system vasculitides are classified as primary, confined to the CNS and secondary, occurs in context of systemic inflammatory or infectious processes. Correlation of imaging findings with clinical manifestations and laboratory test results aid in establishing the etiology of CNS vasculitis.

Materials and Methods
A variety of neurologic insults may cause CNS vasculitis, including infection, malignancy, ionizing radiation, cocaine ingestion, and autoimmune disease. Primary angiitis of the CNS, systemic lupus erythematosus, polyarteritis nodosa, giant cell arteritis, and Sjogren syndrome comprise the majority of autoimmune conditions associated with CNS vasculitis. Few unusual cases of vasculitis such as HIV arteriopathy and angiotrophic large cell lymphoma also can present as vasculitic process and are discussed here.

Results
HIV arteriopathy: In patients with AIDS, cerebral vasculitis is a less common cause of infarction than opportunistic infections such as varicella zoster virus, cytomegalovirus, tuberculous, cryptococosis and toxoplasmosis. Vasculitis associated with unusual viruses such as Chikungunya: Chikungunya is a neurotrophic virus leading to encephalitis, gliosis, perivascular cuffing and vasculitis. Tuberculous Vasculitis: Multiple acute infarcts are seen in commonly middle cerebral artery and anterior cerebral artery territories with basal exudates. Sarcoidosis: Nonenhancing white matter lesions seen can be attributed to the vasculitic process. Rarely involvement of large vessels such as internal carotid artery causing pseudoaneurysms can be seen. Vasculitis associated with collagen vascular disorders: Various collagen vascular diseases such as SLE, Polyarteritis nodosa, giant cell arteritis, and Sjogrens syndrome causes various lesions located in the subcortical white matter, cortical grey matter, deep gray matter, deep white matter, and cerebellum. Radiation and Post Chemotherapy changes: Radiation and chemotherapy causes arteritis with secondary ischemic changes. The complete spectrum includes radiation necrosis, leukomalacia, angiopathy and radiation-induced demyelination. Vasculitis associated with neoplasia: Angiotrophic large cell lymphoma is an aggressive intravascular neoplasm that primarily affects small parenchymal and leptomeningeal vessels resulting in multifocal ischemic lesions. It also is referred to as intravascular lymphomatosis or malignant angioendotheliomatosis. Primary Vasculitis of CNS: Multiple subcortical infarcts with occasional large hemorrhagic lesions are seen predominantly in the middle cerebral artery territory. Multiple enhancing nodular lesions along the perivascular spaces also are seen.
Conclusions
Magnetic resonance imaging is an excellent tool with high sensitivity for CNS vasculitis. Interpreted along with the relevant clinical and laboratory data, a fairly specific differential diagnosis can be arrived.

(Filename: TCT_eEdE-38_AngiotrophicLymphoma.jpg)

eEdE-90

Conquer the Centrally Located Masses

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Purpose
Centrally located brain masses can have perplexing similar appearance on magnetic resonance imaging (MRI). The radiological differential considerations are highly dependent on the anatomical location in addition to characteristic imaging
manifestations. Furthermore, certain features in conjunction with history and demographics may help narrow the differential considerations.

Materials and Methods
For this exhibit, we will present a self-contained education module that: 1) Guides the users through imaging anatomy and provide users with the ability to directly interact with the imaging graphics. 2) Present typical imaging appearance of pathology related to the anatomical structure. 3) Discuss the relevant clinical and pathological information. 4) Discuss the differential diagnosis related to the imaging features. We use Microsoft PowerPoint as the main information delivery platform for the education purposes. The unit is self-contained with animated navigation throughout the module. Each pathology has corresponding companion cross-sectional images whose importance in making the diagnoses is discussed. A list of differential diagnoses also is provided and related pathology discussed.

Results
We purposefully provide cases with similar imaging appearance. Emphasis is made on the associated structures: a. septum pellucidum – central neurocytoma, subependymal giant cell astrocytoma, b. corpus collosum – glioblastoma, CNS lymphoma, c. sella and suprasellar space – pituitary gland neoplasms, optic chiasm masses, meningioma, Rathke's cleft cyst, craniopharyngioma, hypothalamic tumor (hamartoma or astrocytoma), d. choroid plexus – papilloma, carcinoma, metastatic disease, e. ventricular wall – ependymoma, subependymoma, f. pineal gland - pineal gland neoplasms, germ cell tumors, g. cribriform plate - ethesioneuroblastoma, h. posterior fossa - choroid plexus metastasis, meningioma, medulloblastoma, astrocytoma and ependymoma, i. brain stem - glioma, capillary telangiectasia, cavernoma, central pontine myelinolysis, j. misc - colloid cyst, epidermoid cyst, skull base tumor(chordoma, plasmacytoma, chondrosarcoma, metastasis).

Conclusions
Centrally located brain lesions can appear very similar on the initial glance, especially when the pathology is large that surrounding anatomy is grossly distorted. Careful localization to the origin of the brain anatomy in a systematic approach is critical and familiarity with the typical image findings of each entity can help radiologists to become comfortable at narrowing the differential diagnosis. Residents can benefit from going through the interactive and comprehensive learning module using today's computer technology.
Contemporary Imaging Follow Up of High Grade Gliomas

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Purpose
The purpose of this educational exhibit is to review the standard treatment follow up of high grade gliomas with focus on contemporary, state-of-the-art imaging tools that currently are available and used in clinical practice. Using anatomical imaging, physiologic and functional information, we can obtain the necessary detail needed for assessment of treatment, prognosis, and management.

Materials and Methods
Utilizing high-resolution conventional magnetic resonance imaging (MRI) sequences and advanced imaging techniques we will discuss in exquisite detail contemporary approach to follow up of high grade gliomas. This educational exhibit will demonstrate a relevant case-based review of the advanced imaging techniques with examples of immediate postoperative and follow-up imaging which are used in evaluation of residual tumor, treatment response, or tumor progression. The following advanced imaging techniques will be presented: diffusion-weighted imaging (DWI), MR spectroscopy (MRS), dynamic susceptibility contrast (DSC) imaging, and positron emission tomography (PET)-MRI.

Results
Gliomas are the most common malignant primary brain tumors in adults. Imaging plays a vital role in the assessment and management of these tumors. Magnetic resonance imaging (MRI) is the primary modality for evaluation and follow up of high grade gliomas. Limitations of anatomical imaging include characterization solely based on the morphologic appearance, size, and enhancement patterns, which often are nonspecific. Magnetic resonance imaging has evolved into a comprehensive tool with advanced imaging techniques. A comprehensive understanding of these entities will help the reading radiologist offer appropriate recommendations in regard to follow up and further management. The discussion will include a brief review of the standard treatment for high grade gliomas including surgery followed by chemotherapy and radiation and role for anti-angiogenesis medication such as bevacizumab. Further discussion will include imaging assessment in tumor follow up...
using Macdonald and Response Assessment in Neuro-Oncology (RANO) criteria. Pseudoprogression and pseudeoresponse also will be discussed.

Conclusions
The evaluation in high grade glioma biology and prognosis has evolved substantially. The use of advanced imaging plays an integral part in imaging follow up and treatment assessment of high grade gliomas. A comprehensive understanding of these techniques will help the reading radiologist offer appropriate recommendations in regard to follow up and further management.
Creutzfeldt-Jakob Disease: What Neuroradiologists Need to Know

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Purpose
The purpose of this educational exhibit is to demonstrate the clinical features, imaging findings, and management in patients with Creutzfeldt-Jakob Disease (CJD) which neuroradiologists need to know.

Materials and Methods
We reviewed the clinical and imaging features of CJD, drawing upon institutional experience and the literature. We discuss epidemiology, genetics, pathology, pathophysiology, clinical course, laboratory data, diagnostic criteria, and corresponding imaging findings of computed tomography (CT), magnetic resonance imaging (MRI) including diffusion-weighted imaging (DWI) and nuclear medicine. Management considerations, including safe technique and protocol for lumbar punctures in patients with suspected of CJD are discussed.

Results
Creutzfeldt-Jakob disease is the prototypical transmissible spongiform encephalopathy due to infection by a protein particle that lacks DNA or RNA ("prion"), resulting in misfolding of the normal host protein. Four types of CJD have been described: Sporadic (sCJD), iatrogenic, genetic, and variant (vCJD). Creutzfeldt-Jakob disease is rare, with an annual incidence between one and two cases per million. The classic CJD phenotype and the Heidenhain, Oppenheimer-Brownell, cognitive, and affective sCJD variants differ by age at disease onset, survival time. In addition to imaging, laboratory analysis of CSF and EEG are critical in making the diagnosis. Computed tomography is not sensitive or specific. On MRI, high T2/FLAIR and diffusion restriction in the cerebral cortex, thalamus, and/or basal ganglia are typical.
features. Thalamic involvement is common and predominant in vCJD (pulvinar sign, hockey-stick sign). When MRI including DWI is not sensitive in the detection of the disease, MR spectroscopy, SPECT, and PET may help in the diagnosis. Special precautions must be taken when performing a lumbar puncture in patients with suspected CJD. Care must be taken handling of the cerebral spinal fluid, to minimize the risk of transmission to healthcare providers.

Conclusions
We illustrate clinical features, imaging findings, and management of CJD which neuroradiologists need to know. Special precautions must be taken when performing a lumbar puncture in patients suspected of CJD.
Sporadic CJD

Variant CJD

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eEdE-14

6:30AM - 2:45PM

CSF a Pathophysiology Review: The obstructed, Non-obstructed, Not-understood, and the Leaky

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Purpose
Cerebrospinal fluid (CSF) pathology is common but poorly understood among radiology residents with primary and secondary extrinsic and intrinsic pathophysiology. The purpose of this exhibit is to discuss obstructive and nonobstructive pathology of CSF through pictorial guide with emphasis on classic imaging findings and pathophysiological correlation.

Materials and Methods
Cerebrospinal fluid anatomy, production, pathway, and absorption. Cases of obstructive hydrocephalus (Foramen of Monroe, Sylvian Aqueduct, extrinsic mass effect, intrinsic mass effect). Cases of nonobstructive hydrocephalus (NPH, etc.). Cases of CSF flow dynamic changes (idiopathic intracranial hypertension, intracranial hypotension, etc.)

Results
Cerebrospinal fluid flow is one of the more challenging concepts of neuroradiology given the CSF dynamic nature and complex normal pathway. In addition its complex, varied, and rich pathology makes it a very challenging topic for radiology residents and non-neuroradiologists. Furthermore, poorly understood pathologies such as normal pressure hydrocephalus, idiopathic intracranial hypertension, and intracranial hypotension add to the complexity of the topic. Appreciation of these limitations while understanding the classical imaging findings of the pathologies and their associated complications is integral in appreciating CSF and its pathologies. The purpose of this exhibit is to expose the radiology resident to the most common pathologies with emphasis on pathognomonic imaging findings and most plausible pathophysiology of each entity.

Conclusions
Abnormalities within the CSF system are complex ranging from simple straightforward obstructive lesions to abnormalities without definitive underlying lesions. Appreciation of this complexity helps in detecting CSF abnormalities and strengthens the radiology resident's grasp of this topic.
Colloid cyst

(Filename: TCT_eEdE-14_collidcyst.jpg)
Idiopathic intracranial hypertension

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Subependymal giant cell astrocytoma, TS

(Filename: TCT_eEdE-14_Subependymalgiantscellastrocytoma.jpg)
Purpose
Idiopathic intracranial hypertension (IIH), or pseudotumor cerebri (PTC), is a neurological disorder that is characterized by increased intracranial pressure resulting in well known imaging findings such as posterior sclera flattening and papilledema, empty sella, optic nerve tortuosity and optic nerve sheath enlargement, and narrowing of the transverse sinuses. If medical treatment does not relieve the symptoms, lumbar
puncture and/or ventriculoperitoneal or lumboperitoneal shunt is performed. We illustrate the imaging findings in IIH before and after treatment.

Materials and Methods
We retrospectively reviewed computed tomography (CT) and magnetic resonance imaging (MRI) studies of patients with IIH, with special attention to previously reported imaging findings associated in IIH. Recent literature was reviewed. Changes of imaging findings before and after treatment were carefully evaluated.

Results
In patients with IIH, documented findings in the literature were seen such as flattening of the pituitary gland, prominence/widening of Meckel's caves, elongation/tortuosity of the optic nerves, widening of the optic nerve sheaths with prominent cerebrospinal fluid (CSF) space, and narrowing of the distal portions of the transverse sinuses. Recent literature suggests these findings are not diagnostic of IIH, and their presence is not required for the diagnosis of IIH. The diagnosis of definite IIH requires typical clinical findings such as papilledema. In patients with resolution of clinical findings after successful treatment by medical management or surgical intervention, follow-up imaging demonstrated improvement of the aforementioned findings. In a subset of cases, follow-up MRI shows increase in diameter of the transverse sinuses.

Conclusions
Typical imaging findings often are seen in patients with IIH. However, the diagnosis of IIH should not be made by imaging alone. Increase in diameter of the transverse sinuses after successful treatment supports the theory that venous stenosis can be a consequence of IIH rather than the cause. Consideration of clinical and imaging findings is critical for proper diagnosis.

Developmental Venous Anomaly and its Mimickers: Spectrum of Imaging Findings, Complications, and Diagnostic Pitfalls

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Purpose
The purpose of this educational exhibit is to demonstrate imaging findings of developmental venous anomalies (DVA) with and without associated cavernoma in different imaging modalities.

Materials and Methods
The conventional and advanced MRI imaging findings of DVAs on different imaging modalities including brain computed tomography (CT) scan, computed tomography
angiography (CTA), conventional and advanced magnetic resonance imaging (MRI) sequences and cerebral angiogram will be described. In addition, imaging findings of symptomatic DVAs including DVA with parenchymal signal abnormalities, thrombosed DVA with intraparenchymal hemorrhage, symptomatic DVA due to mechanical obstruction-stenosis, symptomatic DVA due to abnormal flow in DVAs secondary to arterial shunting will be discussed.

Results
Developmental venous anomalies are the most common incidental cerebrovascular malformations and usually are asymptomatic. Morbidity is largely ascribed to coexisting cavernoma or other mixed vascular malformations. In rare cases, DVA can be symptomatic due to thrombosis, AV shunting, mechanical obstruction, or local mass effect of the DVA on adjacent structures.

Conclusions
Given the high prevalence of DVA and widespread use of advanced imaging techniques, familiarity of radiologists with the imaging findings of DVA and associated findings is essential.
Diabetic Striatopathy: CT and MR Imaging Appearance of a Rare Movement Disorder Associated with Uncontrolled Diabetes Mellitus

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Purpose
The purpose of this study is to present the computed tomography (CT) and magnetic
resonance (MR) imaging findings of diabetic striatopathy, and review the associated clinical signs of hemichorea-hemiballism in nonketotic hyperglycemia.

Materials and Methods
A retrospective search of CT head and MR brain studies in the hospital's PACS was performed. Those patients whose imaging features and clinical presentation were consistent with diabetic striatopathy were identified for inclusion in this study. The goals of this study are to: Describe the specific CT and MR imaging characteristics in diabetic striatopathy, and present imaging from patients with this disorder. - Define the clinical signs of hemichorea-hemiballism in nonketotic hyperglycemia. - Discuss the differential for both the imaging features and clinical picture, and consider proposed pathophysiology. - Review treatment and clinical course.

Results
Figure 1: Axial noncontrast CT image depicting hyperattenuation of the right lentiform nucleus (arrow) in a 56-year-old diabetic woman presenting with involuntary movements of the left upper arm and leg. Figure 2: Axial T1-weighted precontrast (left) and postcontrast (right) MR images in the same patient demonstrate relatively homogeneous T1 hyperintensity in the right basal ganglia which does not enhance. Figure 3: Axial T1-weighted (left) and T2-weighted (right) MR images demonstrating T1 hyperintensity and T2 isointensity in the left putamen in a 73-year-old female presenting with right lower extremity jerking movements. Figure 4: Axial noncontrast CT images in the same patient at the time of presentation (left) and 2.5 years after symptoms improved with stringent blood glucose control (right). With appropriate management of diabetes, the imaging abnormalities improve over time.

Conclusions
The spectrum of diseases demonstrating CT hyperattenuation and T1 hyperintensity in the striatum are limited. When seen in a diabetic patient with poorly-controlled blood glucose presenting with the characteristic movement disorder, the diagnosis of diabetic striatopathy should be entertained. In this study, the imaging features and clinical signs of this rare disorder are reviewed.
Diffusion and Perfusion Imaging of High Grade Gliomas — Imaging Pitfalls and Pathological Correlations

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Purpose
Evaluating response to therapy of high grade gliomas (HGGs) is a topic of ongoing
clinical research which has major implications regarding decisions of care for this patient population. Treatment advances have made marginal improvements in survival while complicating assessment of post-treatment response. Current response criteria are based on areas of contrast enhancement and T2/FLAIR signal abnormality on MRI, with no standardized method for interpreting diffusion and perfusion exams. This exhibit will review the current barriers to developing these standardized criteria, while also providing an approach to interpretation using radiology-pathology correlates as examples. The goal of this exhibit is to provide an introductory-level overview of MR diffusion and perfusion techniques for residents and fellows, while also providing practicing neuroradiologists an up-to-date review.

Materials and Methods
A review of current literature combined with our own institutional experience will be presented. Topics will include: (1) genetics/epigenetics and pathophysiology of HGGs with regards to imaging characteristics and selection of treatment, (2) current standards of therapy including surgery, external radiation, temozolomide, bevacizumab, and chemotherapeutic wafer implantation, (3) tumor progression versus treatment-related changes and treatment response versus pseudoresponse, (4) and the current role for MR diffusion and perfusion imaging including dynamic susceptibility contrast and dynamic contrast enhancement. Lastly, radiology-pathology case modules will be used to help reinforce the ideas presented in this exhibit.

Results
MR diffusion and perfusion imaging are valuable tools in evaluation of post-treatment response for HGGs. Multiple factors including the biology of the underlying tumor and the chosen treatments have a profound effect on image findings. While standardized criteria for evaluating tumor progression using advanced imaging techniques do not currently exist, an understanding of these basic concepts will improve image interpretation and patient management.

Conclusions
There are numerous advantages and pitfalls to MR diffusion and perfusion imaging which the practicing neuroradiologist must take into account when evaluating HGGs. After reviewing this exhibit, the resident or fellow will have a basis for interpreting perfusion and diffusion MRI, and neuroradiologists will have an up-to-date review of current barriers to post-treatment HGG imaging.

eEdE-66

Don't-miss Emergent Intracranial CTA Diagnoses for First-Time Residents on Call

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Purpose
Interpretation of intracranial computed tomography angiography (CTA) can be daunting for novice residents on call, particularly in the fast-paced setting of a busy level 1 trauma center and stroke center. This interactive exhibit will familiarize residents with crucial imaging findings and pertinent clinical features of emergent intracranial CTA diagnoses.

Materials and Methods
Interactive case-based review of common and uncommon emergent intracranial CTA diagnoses encountered on call by residents at a level 1 trauma center and stroke center. Cases will be presented as unknowns with follow-up questions and explanations of key imaging and clinical points.

Results
Cases will focus on detection and interpretation of findings on noncontrast CT brain and intracranial CTA. Catheter angiography images will be included for cases indeterminate on CTA, with emphasis on limitations of CTA versus dynamic catheter angiography. Follow-up interactive questions will focus on pertinent clinical features and management, with emphasis on critical information to communicate to referring providers. Topics covered will include (but will not be limited to) ruptured and nonruptured aneurysms, carotid artery dissection, vertebral artery dissection, dural venous sinus thrombosis, carotid-cavernous fistula, and strokes associated with intracranial occlusions and stenoses.

Conclusions
Participation in this interactive exhibit will increase residents' familiarity with and comfort level for rapid and accurate interpretation of intracranial CTA.

eEdE-24

Don’t Blink: Unexpected and Edge of the Film Findings

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Purpose
Evaluation of an imaging study generally is focused on directly addressing the clinical indication for the examination. However, it is essential that the radiologist evaluates beyond the scope of the clinical indication of the examination to evaluate for unexpected and edge of the film findings. These findings may be pertinent to addressing the clinical indication as well as represent potentially important clinically
significant pathology. By reviewing a series of cases from our institution, we hope to enhance the radiologists' awareness of the spectrum of unexpected and edge of the film findings by highlighting the blind spots and pitfalls of neuro-imaging to allow for prompt diagnosis and treatment.

Materials and Methods
A retrospective, pictorial review of a wide spectrum of unexpected and edge of the film findings at our institution will be presented. We will categorize these cases based on the anatomical structure imaged: brain, spine, head and neck, and vascular type studies as well as pertinent neuroradiology findings on body imaging. This exhibit will be a multimodality review, with emphasis on computed tomography (CT), magnetic resonance imaging (MRI) and angiography.

Results
We will present a spectrum of unexpected and edge of the film findings ranging from common entities, such as incidentally discovered neoplasms, vascular findings such as pulmonary emboli on contrast-enhanced neck CT angiogram and vertebral artery dissection on cervical spine MRI as well as nasopharyngeal carcinoma on temporal bone CT and parotid neoplasm on head CT to rare pathologies including an incidental type A dissection visualized only on the contrast bolus tracker image of a brain CTA and a breast metastasis to the pituitary gland on a neck CT. We also will present common blind spots on routine neuroimaging studies including loss of the T2 vascular flow void on MRI brain imaging, nasopharyngeal and sellar lesions on head CT, abnormalities on scout, localizer and tracker images, intracranial extension of disease on sinus imaging, solid organ masses and metastases on spine imaging as well as calvarial fractures which require dedicated arterial and venous phase imaging. An additional section will be dedicated to incidental neuroradiology findings visualized on body imaging. Important diagnostic implications for treatment and management also will be described.

Conclusions
Unexpected and edge of the film findings encompass a wide spectrum of pathology. Radiologists are expected not only to answer the clinical question but also to identify unexpected and incidental clinically significant findings. Awareness of common blind spots and imaging pitfalls can have an impact on prompt management and treatment.
Figure A: Axial CT angiogram image of the brain demonstrates markedly asymmetric attenuation of the cavernous segments of the internal carotid arteries suggesting hypoperfusion on the right (yellow arrow).

Figure B: Axial CT angiogram image of the brain demonstrates early loss of gray-white matter differentiation in the right middle cerebral artery territory consistent with early infarction (yellow arrows) as well as a paucity of distal right middle cerebral artery branches in the right middle cerebral artery territory.

Figure C: Contrast bolus tracker image for CT angiogram brain demonstrated the unexpected finding of type A aortic dissection (green arrow).

Figure D: Coronal reconstructed image from a subsequent CT angiogram of the chest confirms finding of Type A aortic dissection (green arrow).

Teaching Point: In the setting of acute stroke it is important to do a CTA of the head and neck to exclude possible aortic pathology.

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eEdE-78

Emerging Electrical Therapy for Malignant Gliomas: Impact of Tumor Treating Fields and the Role of the Neuroradiologist

A Skolnik¹, H Poptani², S Chawla¹, S Wang¹, G Verma³, S Brem¹, S Mohan³
Purpose
Glioblastoma (GBM) is an aggressive malignancy with limited survival despite triple modality treatment approach of surgery, chemotherapy and radiation therapy. A novel fourth treatment modality, tumor treating fields (TTFields), has been shown to improve outcomes in GBM. As we learn to harness the potential of this innovative and rapidly expanding treatment modality, the neuroradiologist has the opportunity to play a key role in the use of these devices and the assessment of patients undergoing TTFields therapy.

Materials and Methods
To review and discuss the following aspects of TTFields: -Historical timeline. -Scientific basis. -Existing clinical data. -Role of the neuroradiologist. -Imaging assessment. -Patient and family experience. -Future projections.

Results
TTFields have been under active investigation with rapid ascent from the lab to clinical trials leading to FDA approval for recurrent GBM on April 8, 2011 and for newly diagnosed GBM on October 5, 2015. This technology employs alternating electric fields from a portable external device to disrupt cell division, most notably by interfering with microtubule organization during metaphase of mitosis, resulting in disordered division and/or immunogenic cell death. Major clinical trials have shown TTFields extend progression free and overall survival by approximately 3 months in newly diagnosed GBM, and equivalent survival to physician's choice chemotherapy in the recurrent GBM setting. There is dose dependent treatment efficacy observed with compliance of over 18 hours per day of treatment time. The day and night use and associated equipment are overall well tolerated, though add some challenges to the lives of these patients and family members. To date, there are no publications on imaging of these patients in the radiology literature. Therefore, there is a need for neuroradiologists to define imaging features of treatment response in TTFields. Efforts are underway to utilize advanced imaging techniques such as MR perfusion, diffusion, spectroscopy and metabolic imaging at ultra-high fields (7 Tesla chemical exchange saturation transfer) complemented by peripheral blood markers (circulating tumor microvesicles) to better understand underlying tumor physiology and treatment response. The neuroradiologist also may function as the certified prescriber of this therapy to treat patients directly, perhaps adding another dimension to "interventional" neuroradiology. These devices will likely become more convenient for use and increasingly tailored for the patient's tumor.

Conclusions
The current data indicates that TTFields should be offered as the standard of care with temozolomide and radiation therapy following maximal safe resection of the newly
diagnosed GBM and also supports the efficacy of TTFields in the recurrent setting. The indications for use in other malignancies likely will expand, and the incorporation into combination therapies will continue to be optimized. The neuroradiologist has the unique opportunity to add value to TTFields patients by understanding the technology and associated imaging evaluation for response assessment.

![Figure 1: MRI contrast-enhanced T1-weighted images of 51 year old woman with glioblastoma multiforme centered in the left thalamus before TTFields therapy (a) and after approximately 2.5 months of TTFields therapy (b) shows interval decrease in size of peripherally enhancing mass.](TCT_eEdE-78_figure1TTF.jpg)

**eEdE-98**  
**Flow-Related Artifacts and Pitfalls in Magnetic Resonance Imaging/Angiography in Neuroradiology**

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Purpose
It is critical to recognize magnetic resonance imaging (MRI) and angiography (MRA) artifacts related to flow in neuroradiology. The unique properties of flowing blood make it susceptible to dephasing from complex or turbulent flow. The interpreting radiologist should recognize these artifacts, as they can otherwise be interpreted as pathology or obscure underlying anatomy, resulting in misdiagnosis. In this educational exhibit, we discuss commonly encountered flow-related artifacts in magnetic resonance imaging and angiography and discuss the underlying physics behind the formation of the artifact as well as how to optimize images.

Materials and Methods
We discuss artifacts related to flow that are commonly encountered in neuroradiology in the following four categories: Motion, Flow-related, Magnetic field inhomogeneity, and Post-processing related artifacts. For each type of artifact, we present imaging examples, discuss the underlying physics, and describe methods to correct or minimize these artifacts.

Results
A frequently encountered artifact due to motion includes pulsation artifact from vessels and CSF flow (Fig. 1A). Flow-related artifacts include entry section phenomenon (Fig. B) flow-reversal artifact (Fig. C-D), in-plane saturation artifact, and slow flow artifact. Artifacts and pitfalls due to magnetic field inhomogeneity includes susceptibility artifact related to ferromagnetic objects, such as vascular clips and coils, and pseudostenosis artifact related to susceptibility from residual contrast in veins. Finally, several commonly encountered post-processing artifacts related to reconstruction of maximum intensity projections include stair step artifact, venetian blind artifact, and shine-through artifacts.

Conclusions
As MRI and MRA become more versatile and complex, it has become imperative for the interpreting neuroradiologist to have a fundamental understanding of the physics that underlie image formation and ability to recognize the artifacts for accurate interpretation of the examination.
(A) A basilar tip aneurysm (red arrowhead) identified on T1-weighted spin echo GRE images (demonstrates pulsatile signal intensification, red arrowheads). Periodic pulsations result in ghosting artifacts in phase-encoding direction. (B) Sagittal GRE images of the brain demonstrate increased signal in the region of the aneurysm (arrowhead) and skull entry section phenomenon. This artifact is due to new protons entering the blood vessels and creating signal due to new protons entering the blood vessels and creating signal suppression from previous image acquisition. (C) In a 2D subtraction image, the left vertebral artery is visualized (yellow arrow) with signal suppression from a high-grade stenosis of the left vertebral artery (red arrow). (D) The retrograde flow of a left subclavian artery (red arrow) reveals complete opacification of the left vertebral artery, confirming patency (red arrow).

**eEdE-19**

6:30AM - 2:45PM

**Functional Correlates of Gyral Anatomy: Lessons from the Works of Oliver Sacks**
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Purpose
To present an imaging and case-based presentation demonstrating functional gyral neuroanatomy.

Materials and Methods
Our presentation will borrow from the literature of the late Dr. Oliver Sacks in order to develop a series of neuropathologic/neuroradiologic cases that exemplify the concepts of functional brain anatomy. We will use original anatomical drawings with correlating magnetic resonance (MR) images to display both normal anatomy and pathology. Clinically pertinent functional information will be presented for each discussed gyrus.

Results
In order to properly understand the clinical concerns and patient presentations in neurology and neurosurgery, the radiologist should understand the expected clinical sequelae of a given lesion. By coupling anatomical and functional/clinical information in a case-based format, we hope to facilitate improved understanding of the anatomical basis of brain function. Using notable examples of clinical cases will serve to maximize the interest in the topic among the audience and maximize retention of the presented information.

Conclusions
Familiarity with a patient's pathology during interaction with specialist clinicians is an important contributor to the value radiology can provide to referring clinicians. Our goal is to develop an imaging and case-based presentation which will systematically demonstrate the topic of cerebral gyral neuroanatomy and function while being engaging and memorable.

\textbf{eEdE-30}

6:30AM - 2:45PM

\textbf{Functional MRI (fMRI) – Primer for Radiologist}

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Purpose
1. To discuss the principles and physics of BOLD functional magnetic resonance imaging (fMRI) technique. 2. To illustrate with examples fMRI application in the
Materials and Methods

Functional magnetic resonance imaging is an advanced imaging technique which helps us to visualize the neuronal activity of the human brain. The fMRI has been used extensively for investigating various brain functions, including vision, motor, language, and cognition. One of the primary indications for fMRI is evaluation of eloquent areas of the brain in relation to a focal parenchymal brain lesion such as neoplasm or arterial venous malformation. The fMRI also is used to localize language centers, visual pathways and in analyzing the episodic, semantic and working memory. The fMRI has gained significant importance over a decade due to collateral advances in the noninvasive-/microneurosurgical techniques. Increasing indications also are seen in the evaluation of epilepsy and dementia patients, making it even more important for radiologist to understand and when indicated to incorporate this high end modality technique in our practice.

Results

We classify this exhibit into five parts. Part I explains the various fMRI techniques, with detail physiology, and principle of BOLD imaging. Part II of the exhibit explains in details the various commonly employed tasks which include: a) Visual, b) Auditory, c) Motor (finger tapping, foot movement, and leg movements) d) Speech language (word generation, verb generation and sentence composition) and e) Memory testing. Part III illustrates in short the normal relevant cortical brain anatomy, Part IV discuss and explain with examples the application of fMRI in various (neurology and neurosurgery) clinical patients. Part V of the exhibit discusses the challenges and limitations of fMRI.

Conclusions

1. Functional MRI is a very powerful method to map brain functions with relatively high spatial and temporal resolution. 2. We illustrate with examples the application and limitations of this technique for various neurology and neurosurgical conditions. 3. For participants, this exhibit will be core learning module to understand the principles and basic physics of BOLD fMRI technique and how to perform and interpret the fMRI.

GBCAs 2016 - A Safety Update on the Gadolinium Chelates

V Runge

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Purpose
This presentation will review the basic chemical, physical, and safety related properties of the clinically available gadolinium based MR contrast agents (GBCAs). Acute minor and major (anaphylactoid) reactions will be reviewed briefly, together with the interference in laboratory analysis of serum calcium and iron known to occur following administration of several agents. The focus, however, will be on updates regarding two important current topics, nephrogenic systemic fibrosis (NSF) and deposition of gadolinium in the dentate nucleus.

Materials and Methods
Reference sources include the ACR Manual on Contrast Media Version 10 (2015) and the European Society of Urogenital Radiology Guidelines on Contrast Media 10.0 (2015). Acute reactions and the interference in laboratory tests will be discussed on the basis of a brief review of the published literature. Recent relevant publications concerning NSF, specifically establishing the safety of several agents in the renal failure patient population, will be summarized subsequently. The research articles published to date investigating gadolinium deposition in the dentate nucleus (and elsewhere in the brain, in normal renal function) then will be discussed in depth.

Results
MR contrast media, specifically the gadolinium chelates, are in general very safe and lack the nephrotoxicity associated with intravenous administration of the iodinated agents. Minor adverse reactions are infrequent and include nausea, taste perversion, and hives. The agents cannot be differentiated on the basis of these mild adverse effects, however they can be differentiated on the basis of chelate stability. Due to the advent of NSF, three agents (gadodiamide, gadoversetamide and gadopentetate dimeglumine) are contraindicated in several clinical situations, including specifically severe chronic kidney disease. More recently, gadodiamide, gadopentetate dimeglumine and gadobenate dimeglumine have been established to be associated with dentate nucleus hyperintensity. Initial tissue studies show correlative Gd deposition, with animal models of this process now also published. The more stable agents, specifically the macrocyclic gadolinium chelates (gadobutrol, gadoterate meglumine and gadoteridol), are strongly recommended due to both NSF and the more recent observation of gadolinium deposition in the dentate nucleus (with linear agents). Awareness of these issues has led to marked preferential use of the macrocyclic agents in developed countries.

Conclusions
The established class of intravenous contrast media today for MR is that of the Gd chelates. These can be differentiated on the basis of stability (safety) and effective enhancement (relaxivity and formulation). A greater understanding of stability in vivo, together with the role of essential metals in the brain, is needed, due to the advent of NSF and recognition - in normal renal function - of gadolinium deposition.
in the dentate nucleus. The likely end result will be withdrawal of the less stable agents from the clinical market.

**Get Smart. A Radiologist's Guide to SMART Syndrome**

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**Purpose**
Stroke-like migraine attacks after radiation therapy (SMART) is a fascinating, rare syndrome first described in 2002. This educational exhibit will review the clinical presentation, pathophysiology, and radiographic features of SMART syndrome.

**Materials and Methods**
The exhibit commences with a literature review of SMART syndrome. We will detail clinical history, patient presentation, pathophysiology, and prognosis. The imaging appearance of this disorder will be discussed in detail, with an emphasis on the specific radiographic findings that differentiate SMART syndrome from other considerations. We will end the presentation with two cases of confirmed SMART syndrome from our institution.

**Results**
SMART syndrome is a delayed complication of whole-brain radiation clinically characterized by severe headaches and/or seizures. Particularly interesting is the long time interval (years or even decades) between radiotherapy and the development of SMART syndrome. The radiographic hallmarks of SMART syndrome include cortical thickening, gyriform enhancement, and increased T2 signal. The subjacent white matter is relatively spared. Previously, SMART syndrome had been characterized as a completely reversible disease but new research suggests permanent neurologic deficits in some patients.

**Conclusions**
SMART syndrome is a rare complication of whole brain radiation characterized by headaches and seizures. It is important for the neuroradiologist to be familiar with the imaging appearance of SMART syndrome in order to achieve the correct diagnosis.
Gliomas of the Limiting Sulcus of the Insula: 3D Analysis of What the Neurosurgeon Needs to Know

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Purpose
The standard trans-Sylvian surgical approach to insular tumors cannot successfully remove tumor which has extended beyond the limiting sulcus. The pre-operative imaging consultation must carefully define this inaccessible tumor extension and highlight the anatomy needed to plan a successful alternate approach. The purpose,
therefore, is to prepare case-based interactive 3D video presentations which focus on the difficulties of removing gliomas which straddle the junction between the insula and the fronto-parietal opercula.

Materials and Methods
A sample of 75 insular gliomas were reviewed retrospectively and examples with tumor infiltration beyond the limiting sulcus were selected for reconstruction with the Anatom-e system (Houston, TX). In consultation with neurosurgical co-authors, Anatom-e system was used to display the pertinent sulcal anatomy and relate it to adjacent functional areas. This resulted in a collection of tutorials which were subdivided into four clinically important tumor groups using the Brodmann areas (BA). The locations were: BA 45-47, 44, 43 and 6. Examples of complete versus subtotal resections were selected and included in the discussions.

Results
A 3D narrated presentation, tailored to emphasize the anatomical features distinctive to each of the four locations of gliomas in insulo-opercular junction is illustrated. This teaching material is suited for the construction of an information-rich multimedia report which can assist neurosurgeons in presurgical planning.

Conclusions
Expanding the role of neuroradiology into pre-operative planning requires: 1. Continuing educational tutorials which focus on what the surgeon needs to know and 2. The construction of novel methods of display and delivery which provide the surgeon with a unique and knowledgeable analysis of the patient's imaging studies.

Hey Brain, Let’s Have an Art-to-Art: A Radiologist's Role in Subcranial-Intracranial (SC-IC) Cerebral Bypass

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Purpose
1. To review subcranial-intracranial (SC-IC) cerebral bypass via internal maxillary artery (IMax)-to-middle cerebral artery (MCA) anastomosis as an alternative to extracranial-intracranial (EC-IC) bypass approaches. 2. To discuss the role of peri-operative imaging and its role in presurgical planning, determining graft patency, and evaluating for complications.

Materials and Methods
Using retrospective cases performed at our institution as examples, we illustrate the relevant information and imaging modalities that radiologists should be aware of
when interpreting pre-operative and postoperative studies in patients undergoing SC-IC bypass procedures.

Results
In this exhibit, we explore the SC-IC approach via anastomosis between the IMax and the MCA and contrast this technique with other EC-IC bypass methods, such as the cervical carotid approach. This presentation will focus on peri-operative imaging, including presurgical planning with vascular mapping and flow analysis using the Non-invasive Optical Vessel Analysis software (VasSol Inc, River Forest, IL), the postsurgical anatomy, and pitfalls in differentiating potential complications versus expected postoperative appearances of the surgical graft.

Conclusions
Although controversies exist regarding the indication and methodology used for EC-IC cerebral bypasses, its efficacy in treating patients remains significant. Imaging plays a critical role in pre-operative planning and in the postoperative setting by quantifying graft patency, characterizing efficacy of the bypass, and evaluating potential complications. Understanding the altered anatomy, the underlying physiology, and the purpose of the different types EC-IC bypasses, in this case the SC-IC approach, may prove beneficial to radiologists in developing a strategy for more effective interpretations and recommendations when evaluating these studies.
How to See the “Writing on the Wall”: MRI Vessel Wall Imaging of Arterial and Venous Disease Using Contrast Enhanced Black Blood MRI Techniques

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Purpose
This exhibit reviews current and emerging 3D volumetric magnetic resonance imaging (MRI) techniques for contrast-enhanced black blood vessel wall imaging and demonstrates the increasing importance of these methods for the diagnosis of arterial and venous disease. The expanding clinical applications will be demonstrated using a case-based approach.

Materials and Methods
Current implementations of black blood MRI and approaches to suppression of the blood signal will be reviewed. A novel spiral fast-spin echo (FSE) black blood method, which eliminates any residual intravascular signal, will be introduced. The exhibit will present cases in which contrast-enhanced black blood vessel wall imaging identified clinically important findings related to vasculitis, aneurysms, atherosclerotic vascular disease (ASVD), venous sinus thrombosis, and tumor encasement of vessels.

Results
Vessel wall imaging has been an area of active research in diseases such as vasculitis, ASVD and intracranial aneurysms. Many authors have proposed that vessel wall enhancement serves as a surrogate imaging biomarker for wall inflammation. In addition to vasculitis, wall inflammation appears to play a role in intracranial aneurysm growth and rupture, atherosclerotic plaque hemorrhage and venous thrombosis. Recent implementation of contrast-enhanced 3D FSE T1 black blood imaging into routine MR exams at our institution has been valuable for improving characterization of aneurysms, intracranial atherosclerotic plaque, vasculitis, dural sinus thrombosis, and tumor-vessel relationships.

Conclusions
Volumetric (3D FSE) T1 black blood imaging of vessel wall enhancement improves detection and risk stratification of vascular disease by identifying the inflammatory reaction associated with vasculitis, intracranial aneurysms, vulnerable/culprit atherosclerotic plaque and a variety of venous diseases.
6:30AM - 2:45PM

Hypertrophic Olivary Degeneration: Lesions and Lessons

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Purpose
The purpose of this educational exhibit is to review and discuss the phenomenon of hypertrophic olivary degeneration with select case examples from our institution. This exhibit will serve as an educational review of the literature regarding the process of

Figure 1. Imaging findings

A. Enhancing right internal carotid artery aneurysm in the left M2 artery in a patient with fever and septic encephalopathy. B. Small left internal carotid artery aneurysm in a patient presenting with subarachnoid hemorrhage.

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hypertrophic olivary degeneration to the reader, and will expound on this with
demonstration of case lesions from our institution.

Materials and Methods
Firstly, a review of the literature will provide an overlay for the construct of the
educational review exhibit. The various elements pertaining to hypertrophic olivary
degeneration will be discussed in an instructional manner, highlighting the critical and
doctrinal aspects of the phenomenon itself. The anatomical and trans-synaptic
apparatus comprising the triangle of Guillain and Mollaret will be discussed and
presented with the use of figures and pictorial descriptions. The instructional exhibit
will make concurrent use of lesions within the elements of this complex triangle, and
demonstrate with detail the lessons to be learned in hypertrophic olivary degeneration.

Results
Hypertrophic olivary degeneration is a unique trans-synaptic phenomenon
characterized by a pattern of enlargement of the inferior medullary olive in association
with lesions in the dentatorubral tract and the central tegmental tract. A triangle of
networked connections exists which includes the red nucleus, the ipsilateral inferior
olivary nucleus, and the contralateral dentate nucleus--termed the triangle of Guillain
and Mollaret. The hallmark of this entity is vacuolation of neurons in the inferior
medullary olive when a causative lesional source exists in the contralateral
dentatorubral tract and/or the ipsilateral central tegmental tract. Lesions involving the
olivodentate fibers are not known to effect pathology to the inferior olivary nucleus.
Select case examples from our home institution are provided to the reader for further
exercise.

Conclusions
Hypertrophic olivary degeneration is a distinct entity which requires understanding of
the underlying neuronal tracts and the configuration of the triangle of Guillain and
Mollaret.

**eEdE-101**

6:30AM - 2:45PM

**Image-Guided Etiologic Approach to Acute Ischemic Stroke: Making the Most of
Computed Tomography Angiography (CTA)**

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Purpose
A thorough approach to ischemic stroke patients depends on its etiologic classification, which usually is multifactorial and dictates ictus and post-ictus treatment, prognosis and risk of recurrence. TOAST and ASCOD are systems proposed to phenotype patients with acute stroke. ASCOD also aimed to better describe the overlap between diseases underlying encephalic ischemic events. The main etiologic subtypes of ischemic stroke according to these classifications are: large-vessel atherosclerosis, small-vessel disease, cardiac pathology, dissection, among others. Computed tomography angiography (CTA) from aortic valve to vertex is used widely as part of acute stroke imaging protocols, playing a major role in immediate therapeutic decision. Moreover, in the set of acute ischemic stroke, CTA also may provide useful phenotypic information, beyond the usual location and extension of arterial stenosis or occlusions, allowing earlier etiologic classification of stroke, with direct influence in prognosis and therapeutics. Our goal is to exemplify CTA imaging findings that indicate different etiologic possibilities for stroke, raising awareness for atypical findings.

Materials and Methods
Computed tomography angiography images from acute stroke patients between 01/2015 and 12/2015 were reviewed and examples of atypical imaging findings suggestive of each etiologic subtype were selected and classified according to ASCOD’s causality grades, assigning a degree of likelihood of causal relationship (1- potentially causal, 2- causal link is uncertain, 3- causal link is unlikely, but the disease is present).

Results
The following CTA imaging findings of atherothrombotic stroke subtype are exemplified: ipsilateral stenosis >50% supplying the ischemic field (A1), stenosis <50% with an endoluminal thrombus supplying the ischemic field (A1), ipsilateral arterial occlusion in with evidence of underlying atherosclerotic plaque supplying the ischemic field (A1), mobile thrombus in the aortic arch (A1), aortic plaque ≥4 mm without mobile lesion (A2), and aortic plaque <4 mm without mobile thrombus (A3). Likewise, in the cardiac subtype, CTA findings such as mechanical valve (C1), mural thrombus in the left cavities (C1), dilated or hypertrophic atrium (C1), incidental pulmonary embolism and interatrial communication (C3) also are exemplified. Other cases of vasculitis (O1) and dissection (D1) also are portrayed.

Conclusions
Computed tomography angiography is a widely available imaging method in acute stroke protocols that provides useful information for immediate therapeutic decisions, and plays a major role as part of stroke etiologic investigation. Neuroradiologists and general radiologists should be aware of the importance of stroke etiologic classification for correct patient treatment, and should actively search CTA images for subtle findings with useful causality links.
1. Left atrium appendage thrombus
2. Thrombus in the aortic arch
3. Ulcerated plaque in ascending aorta

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eEdE-45

6:30AM - 2:45PM

Imaging Features in Cerebral Amyloidosis

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Purpose
Amyloidosis is a generic term that includes a group of diseases with one common feature: the progressive deposition of β-amyloid peptide, an extracellular protein, insoluble and resistant to proteolysis. The amyloid deposition may take many forms in
central nervous system: the cerebral amyloid angiopathy (CAA), the amyloid angiitis variant and the pseudotumoral form or amyloidoma.

Materials and Methods
We review radiological findings of the various forms of cerebral amyloidosis admitted to our hospital during the past 5 years.

Results
Cerebral amyloid angiopathy is characterized by progressive deposition of β-amyloid peptide in the walls of small- to medium-sized arteries, arterioles, and capillaries of the cerebral cortex and overlying leptomeninges. Intracranial hemorrhage is the most common pathological manifestation. It usually occurs sporadically but sometimes is associated with Alzheimer disease, Kuru or Creutzfeldt-Jakob. In amyloid angiitis, patients develop vascular and perivascular inflammatory changes that radiologically manifest as vasogenic edema, leptomeningeal enhancement and microbleedings. The differential diagnosis should be done with primary CNS vasculitis, posterior reversible encephalopathy and progressive multifocal leukoencephalopathy. The pseudotumoral variant or amyloidomas are focal amyloid deposits that can become large with little or no mass effect. They behave like slow-growing tumors and differential diagnosis must be done indeed with brain neoplasms.

Conclusions
The term amyloidosis refers to a group of diseases characterized by extracellular deposition of β-amyloid peptide. The cerebral amyloid angiopathy, the amyloid angiitis and the pseudotumoral variant or amyloidoma are the diverse forms whose radiological manifestations are different from each other and the radiologist must know.

EEdE-87

Imaging Glioblastoma: When Multiforme Sounds Like an Understatement

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Purpose
• To briefly discuss the epidemiology, clinical features, presentation and varied imaging appearance of glioblastoma multiforme (GBM).
• To describe both common and rare manifestations of GBM variants and emphasize salient imaging features.

Materials and Methods
The authors aim to review the imaging appearance of various atypical presentations of GBM. This will involve a brief discussion of the entity, imaging findings, differential
lesions and helpful clues for diagnosis. A brief overview of imaging findings in GBM would be followed by individual description of the following entities (with illustrative examples): • Synchronous tumors, • Metachronous tumors, • GBM arising over a background of gliomatosis, • GBM arising over a background of neuroglial tumors, • Posterior fossa and spinal GBM, • Intraventricular GBM, • GBM in twins, • GBM with craniospinal metastases, • GBM with systemic metastases, • Gliosarcoma.

Results
Glioblastoma multiforme often present as space occupying lesions within the central nervous system (CNS) and are fairly easy to diagnose on imaging. Uncommonly, the tumors may have an atypical or even bizarre appearance. They may mimic infective lesions, leptomeningeal pathology or even nonglial tumors. These can be a source of considerable confusion, both clinically and on imaging. It is important for the radiologist to be aware of these entities and consider them on imaging where appropriate.

Conclusions
Glioblastoma multiforme is the most common primary brain neoplasm and accounts for about half of glial tumors. On imaging, the most common manifestation is a necrotic, enhancing intra-axial mass. There are however, a number of atypical, less common and even rare presentations which may mimic other pathologies and cause diagnostic uncertainty. It is useful, both for the general trainee and sub-specialty radiologist to be aware of the varied appearance of this heterogenous tumor, and keep them in mind when faced with bizarre intracranial masses.
GBM with dural metastases

Primary dural GBM

Synchronous GBM

Gliosarcoma
Imaging of Solitary Fibrous Tumor/Hemangiopericytoma Spectrum in Brain, Head & Neck, And Spine—Pathological Correlations

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Purpose
Both solitary fibrous tumors (SFT) and hemangiopericytomas (HPC) are generally part of a histologic spectrum of fibroblastic-type mesenchymal neoplasms. Accurate diagnosis on imaging has implications for management. The purpose of this exhibit is to demonstrate variable imaging findings with pathologic correlations of SFT/HPC in the brain, head & neck, and spine, and differential diagnosis.

Materials and Methods
Magnetic resonance imaging (MRI) including diffusion/perfusion and susceptibility-weighted imaging, computed tomography (CT), radiograph, and nuclear medicine were reviewed and correlated with the clinical presentations, sites of occurrence, histopathology, and immunohistochemistry. We will discuss imaging characteristics, pitfalls and the differential diagnosis.

Results
Histologically, SFT/HPC have cellular component (monotonous appearance and thin-walled branching vessels), fibrous component (alternating fibrous areas and hyalinized thick-walled vessels), or both components with variable degrees. Based on recent genetic analysis (NAB2-STAT6 fusion gene), intracranial SFT/HPC are considered a true counterpart of soft tissue SFT/HPC. High grade components can be seen in SFT/HPC. Intracranial SFT/HPC show a relatively narrow dural base mass with or without underlying lytic bony changes. On CT, SFT/HPC generally are mildly or moderately hyperdense and enhancing corresponding to cellular or fibrous component. On MRI, low T2 signal correlates with fibrous content, and high T2 correlates with cellular component. Multicystic changes and flow voids may be seen. Signal characteristics on diffusion-weighted imaging (DWI) and low apparent diffusion coefficient (ADC) correlate with cellularity and fibrous content. Perfusion-weighted image shows an early enhancement pattern. Differential diagnosis includes meningioma, metastasis, and other primary benign or malignant tumors. Regarding management, gross or subtotal resection of SFT/HPC typically is performed.
Conclusions
SFT/HPC form a histopathologic spectrum. Accurate diagnosis on imaging directly affects management. This educational exhibit illustrates imaging findings with pathologic correlations and differential diagnosis of SFT/HPC.

**eEdE-80**

**Imaging of the Sella and Parasellar Region: What the Surgeon Wants to Know**

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**Purpose**
1. Understand cross-sectional sella and parasellar anatomy. 2. Review an appropriate magnetic resonance imaging (MRI) sella protocol. 3. Recognize the characteristic pre-operative imaging findings of various sella and parasellar pathologies. 4. Avoid common pitfalls when interpreting postoperative sella and parasellar imaging.

**Materials and Methods**
Provide an overview of sella and parasellar anatomy and sella protocol MRI. Use a case-based approach to illustrate the essential pre-operative computed tomography (CT) and MRI findings of sella and parasellar pathologies classified into tumors, tumor-like lesions, cysts, and miscellaneous conditions. Accompany cases with the relevant clinical presentation, laboratory results, management, and pathologic correlation. Recognize some commonly encountered pitfalls when reviewing postoperative sella and parasellar exams.

**Results**

**Conclusions**
This exhibit will familiarize the reader with the essential pre-operative imaging findings of various sella and parasellar pathologies allowing him or her to provide a more complete assessment of sella/parasellar disease extent. Comprehensive disease characterization with sella protocol MRI allows for superior pre-operative planning and therefore may help surgeons avoid potential complications.
Improved Perception of Preoperative Functional Brain Networks Through 3D Printing

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Purpose
Pre-operative brain mapping is an effective technique to define complex spatial relationships between brain lesions and functional brain networks. Multilayered 2D data are optimal for diagnosis, but lack intuitive visualization of 3D spatial relationships. Similarly, explaining complex data and treatment strategies to patients is largely ineffective. A promising tool to overcome both of these challenges is 3D printing. Our purpose is to illustrate effective, work-flow efficient, strategies to allow greater neurosurgical and patient understanding of functional relationships through 3D printing.

Materials and Methods
Imaging data from brain MRI, fMRI, DTI, and CT were used to generate surface models for 3D printing. Segmented structures include cortical veins, arteries, gray matter, white matter, and brain lesions (i.e., tumors). Computer-aided design (CAD) software was used to create dissection planes, which resulted in multi-part models, to increase appreciation of anatomical and functional relationships. Additionally, colors were applied to surface models using CAD software to demonstrate white matter, directional anisotropy, and areas of eloquent cortex. Final, patient-specific, full-color, physical models were generated for neuroradiologist, neurosurgeon, and patient feedback.

Results
Previous articles have suggested that intra-operative utilization of 2D and 3D images are less efficient than patient-specific 3D physical models, particularly for highly complex interventions (1). The process of segmenting brain parenchyma, vascular structures, areas of cortical activation, and separation of color-coded DTI data into red-green-blue segments required less than 30 minutes of tech time. Ninety minutes of tech time was required to optimize surface models for 3D printing. Once printed, these models allowed greater perception of functional relationships, judged superior to image data alone.

Conclusions
Integrating data from several pre-operative imaging studies into a unified impression
is difficult at best. Conveying this information to neurosurgeons and patients can be even more challenging. In light of this difficulty, 3D printing of functional brain relationships offers a viable enhancement to neurosurgical care.
Purpose
This educational exhibit will review essential and specific magnetic resonance imaging (MRI) characteristics of posterior fossa neoplasms in adults and children. The exhibit will illustrate various MR imaging features of both common and rare posterior fossa tumors in pictorial and tabular format, with a quantitative and systematic approach to differentiate intra-axial and extra-axial neoplasm.

Materials and Methods
The exhibit will utilize a comprehensive 10-year cohort of pathology proven posterior fossa brain tumors at UCSF Medical Center from 2004-2013 and focus on characteristic MRI features that distinguish specific entities. The spectrum of tumors discussed will include meningioma, cerebellar metastasis, hemangioblastoma, pilocytic astrocytoma, medulloblastoma, ependymoma, nerve sheath tumor, GBM, brainstem glioma, as well as more rare entities. Particular focus will be made to the critical distinction between intra- and extra-axial location, which can be more challenging in the posterior fossa.

Results
In our review of over 400 surgical pathology proven cases of posterior fossa neoplasms in adults and children, the following key imaging features on MRI are reproducible and reliable for narrowing differential diagnosis: -Intra- or extra-axial location, as determined by degree of fourth ventricular rotation, -ADC values of solid component, -Enhancement pattern, -Presence of cysts, -T2 signal characteristics. Attention to these specific imaging features may improve diagnostic accuracy over more basic qualitative morphologic descriptors.

Conclusions
Posterior fossa neoplasms are common in adults and children and require a systematic approach to differential diagnosis. Whether the mass is "in or out" (intra-axial or extra-axial) represents a critical first step, and attention to fourth ventricle morphology and rotation may be a more reliable sign than traditional descriptors such as cerebrospinal fluid (CSF) cleft sign. Measurement of absolute apparent diffusion coefficient (ADC) values also may increase diagnostic accuracy. This educational exhibit illustrates the most essential imaging features of posterior fossa neoplasms and
describes quantitative parameters that can improve pre-operative diagnosis and guide surgical approach.

In or Out? A Quantitative Approach to Intra- and Posterior Fossa Tumors: 10-year UCSF Experience

Incomplete Pre-Central Sulcus: A Common and Confusing Site of Glioma

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Purpose
The precentral sulcus forms the boundary between the precentral gyrus and the three frontal gyri. It lies rostral and roughly parallel to the central sulcus and it is rarely continuous. In 48% of right hemispheres and 64% of left hemispheres it consists of two parts, an upper and lower, which are separated by a un-named transverse cortical connection (TCC) between the precentral and the middle frontal gyrus. In 12% of right hemispheres and 16% of left hemispheres a third small sulcus is present between the upper and lower parts of the precentral sulci. Rarely there are four sulci (1). The
purpose of this exhibit to describe six cases of glioma which arose in the transverse cortical connection (TTC) between the upper and lower parts of the precentral sulcus. Materials and Methods The pre-operative MR images of 60 gliomas in or near the motor cortex were reviewed retrospectively on reconstructed curved images of the convexity. Five of these showed glioma in the TTC was analyzed retrospectively while one prospective case was done and the motor cortex was mapped intra-operatively. For purposes of display, and to orient the surgeon, the superior frontal sulcus, the central sulcus and the sections of the precentral sulci were marked manually on the 2D images using the deformable anatomical templates in the Anatom-e analysis program (Houston, TX) as a guide. Results Ten percent of the gliomas in or near the motor cortex were located in the TTC between the precentral and middle frontal gyri. Knowledge of this anatomical feature simplified interpretation. In one prospective case, the intra-operative stimulation uncovered a gap in the motor strip at the junction with the TCC. Conclusions Pre-operative planning must include convexity reformations annotated by individuals familiar with commonly encountered sulcal variations. To the best of our knowledge, the preference of gliomas for the TTC as a tumor site has not been described previously and the factor(s) responsible for this observation may be present at other sites.

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eEdE-07

6:30AM - 2:45PM
Lesion Localization in Neuroradiology: Classic Neurologic Exam and Neuroimaging Correlates

J Coburn¹, T Kennedy², J Yu¹
¹University of Wisconsin Hospital, Madison, WI, ²University Of Wisconsin Hospital, Madison, WI

Purpose
To provide a clinically driven and image-rich interactive presentation featuring key neuroanatomical landmarks for the neuroradiologist-in-training. Illustrative examples will feature an in-depth discussion of pertinent neuroimaging landmarks with commonly encountered lesions and their clinical presentation.

Materials and Methods
Ten image-rich case presentations will highlight key neuroanatomical landmarks within the adult brain. Each case presentation will feature a review of pertinent neuroanatomy followed by a succinct case report with a concise history, examination findings, and key images. A brief discussion follows, highlighting the neuroanatomical region of interest and the relationship between the location of the lesion and the neurologic examination findings. A brief self-quiz concludes the exhibit.

Results
Many pathologic processes affect the central nervous system in characteristic locations producing predictable neurologic examination findings (1). An understanding of common neurologic presentations can aid the neuroradiologist in targeting their search pattern to hone in on pathology that may otherwise go undetected. Our exhibit will feature commonly encountered lesions throughout the adult brain with an in-depth review of the pertinent neuroanatomy and the salient clinical exam findings associated with each neuroanatomical landmark. Among others, clinical examples to be featured include internuclear ophthalmoplegia (2) and transient global amnesia (3). Our exhibit also will feature short vignettes highlighting the role of neuroimaging in directing referring providers to assess for clinical signs and symptoms that may otherwise go unrecognized (4). The neuroradiologist adds value not only by recognizing pathologic imaging features, but also by understanding the clinical examination findings that may result from what they observe, and likewise using findings from the clinical exam as a guide to accurately localize pathologic lesions.

Conclusions
Identifying and understanding key neuroanatomical landmarks and their contribution to the neurologic examination can aid the neuroradiologist in developing a targeted approach to lesion localization.
Purpose
Sickle cell disease (SCD) is a form of hemolytic anemia and is an inherited autosomal recessive disease. The disease entity can affect any organ system and therefore, the clinical presentation can vary. The aim of this presentation is to inform the audience of the different manifestations of the disease in the nervous system as evaluated by radiology.

Materials and Methods
A search was done of all studies performed for symptoms of SCD. Cases were narrowed down to studies performed of the head and spine. The studies were then cross-referenced with patients' medical records to review the clinical course. The various manifestations of SCD in the brain, head/neck, and spine, and the pathophysiology and imaging appearance of SCD were reviewed.

Results
Patients with SCD not only battle with chronic anemia but also suffer through two other manifestations of the disease: the vaso-occlusive process and the increased possibility of infections. There is significant morbidity and mortality associated with the disease and the neurological manifestations contribute to a major portion of it. Twenty-five percent of all patients with SCD will suffer from its neurological manifestations in their lifetime. Neurological manifestations of SCD range from silent ischemia, infarctions, and vasculopathies to intracranial hemorrhage. The involvement of the maxillofacial bones and inner ear also is documented in patients with SCD. When the inner ear is involved, patients may present with sensorineural hearing loss. Skeletal abnormalities due to SCD range from bone infarcts/osteonecrosis to osteomyelitis. The osseous structures also play an important part in marrow expansion due to the chronically anemic states. Blood exchange transfusion is an important tool in the management of patients with SCD. Other treatments include bone marrow allografts, and hydroxyurea.

Conclusions
Neurologic sequela of SCD may be ischemic or hemorrhagic, but share a common pathophysiology resulting from changes in vessels, which can cause stenosis, aneurysm, and often the formation of moyamoya vessels. Osseous changes include bone marrow expansion, infarcts and osteomyelitis. Learning the pathophysiology of
SCD (vaso-occlusive disease, chronic anemia and infection) is key in understanding the different neurological manifestations.

**eEdE-06**

6:30AM - 2:45PM

**Molecular Pathogenesis of Neurodegenerative Disorders: Chaperones and Associates on Strike?**

V Gupta¹, P Vibhute¹

¹Mayo Clinic Florida, Jacksonville, FL

**Purpose**

1. To describe the genetics and molecular biology underlying accumulation of abnormal proteins in the central nervous system, and their potential mechanisms of neurotoxicity in neurodegenerative disorders. 2. To review the role of protein misfolding and aggregation in the pathogenesis of specific neurodegenerative disorders. 3. To correlate the imaging findings of neurodegenerative disorders with molecular and histological pathology.

**Materials and Methods**

Molecular and cytogenetic pathogenesis, and radiologic-pathologic correlation of the following neurodegenerative disorders is reviewed: 1. Alzheimer disease (AD); 2. Frontotemporal dementia, Pick disease (PiD); 3. Parkinson disease (PD); 4. Huntington disease (HD); 5. Amyotrophic lateral sclerosis (ALS); 6. Prion protein disease.

**Results**

Current research has unraveled that a diverse group of neurodegenerative disorders such as Alzheimer disease, Parkinson disease, Creutzfeldt-Jakob disease, amyotrophic lateral sclerosis and others shares a common underlying molecular pathogenesis. Progressive accumulation of intracellular and extracellular protein aggregates (e.g., beta-amyloid in Alzheimer disease) related to abnormal processing of misfolded proteins overwhelms the quality control processes of the cell (cellular homeostasis), a mechanism which unifies these disorders on etiopathogenic basis both in familial as well as sporadic types. This review describes the specific genetic mutations leading to subsequent loss of cellular molecular controllers (Chaperone system) responsible for proper polypeptide folding by suppressing or unfolding 'incorrect' structures, and consequent accumulation of toxic proteins finally responsible for ultrastructural and histopathological abnormalities and functional deficits. The imaging spectrum correlating with the characteristic histopathological abnormalities is illustrated for each disorder.

**Conclusions**

Aggregation and deposition of misfolded proteins serves as a common pathogenetic
mechanism toward the development of neurodegenerative disorders such as Alzheimer disease, Parkinson Disease, Prior protein disease and others. Identification of mutations that lead to abnormal processing of these misfolded proteins has provided new insight into the disease pathogenesis. This review examines the mechanisms regulating cellular processing of proteins and specific derangements leading to their abnormal aggregation in various neurodegenerative disorders, along with key histological and radiological features. Improved understanding of molecular and ultrastructural basis of these disorders is crucial to innovation in imaging strategies and treatment options.
Pathogenesis
Protein Misfolding and Fibrillation

Insoluble, filamentous polymers

Crossed-β-pleated sheaths

β-Amyloid
Deposition in:

Extracellular Aggregates
Ex: Senile plaques

Intranuclear inclusions
Ex: Huntington disease

Intracytoplasmic inclusions
Ex: NFT, Lewy body
## Protein Aggregates in Neurodegenerative Disorders

<table>
<thead>
<tr>
<th>Protein</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-amyloid</td>
<td>Alzheimer disease (AD)</td>
</tr>
<tr>
<td>Taupathies</td>
<td>Progressive supranuclear palsy</td>
</tr>
<tr>
<td></td>
<td>Pick disease (PiD)</td>
</tr>
<tr>
<td></td>
<td>Corticobasilar degeneration (CBD)</td>
</tr>
<tr>
<td>α-synucleinopathies</td>
<td>Parkinson disease (PD)</td>
</tr>
<tr>
<td></td>
<td>Lewy body disease (LBD)</td>
</tr>
<tr>
<td></td>
<td>Multiple system atrophy (MSA)</td>
</tr>
<tr>
<td>Protein</td>
<td>Disease</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| Polyglutamate (polyQ) repeat diseases | Huntington disease (HD) 
Spinobulbar muscular atrophy 
Dentatorubro-pallidoluysian atrophy 
Spinocerebellar ataxia (SCA) |
| Superoxide dismutase (SOD) | Amyotrophic lateral sclerosis (ALS) |
| Prion Protein (PrPr\textsubscript{res}) | Creutzfeld-Jakob Disease (CJD) |

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eEdE-09

6:30AM - 2:45PM

MR Findings of Various Acute Toxic and Acquired Metabolic Encephalopathies

E Lee\textsuperscript{1}
Purpose
To review and illustrate the characteristic magnetic resonance imaging (MRI) features of common and uncommon toxic-acquired metabolic encephalopathies and correlate with their clinical features.

Materials and Methods
When a patient presents with toxic or metabolic encephalopathy, the differential diagnosis is initially broad. Arriving at the correct diagnosis is often a diagnostic challenge. Magnetic resonance imaging plays a major role for the diagnosis of many acute toxic or metabolic encephalopathies. Diffusion-weighted imaging and MR spectroscopy may provide additional information. The following conditions are covered in this review: hypoglycemic encephalopathy, hypoxic ischemic encephalopathy, nonketotic hyperglycemia, hepatic encephalopathy, hyperammonemic encephalopathy, diabetic uremic syndrome, Fahr's disease, osmotic myelinolysis, posterior reversible encephalopathy syndrome and acute exposure to toxic agents (carbon monoxide, methanol, ethylene glycol, ethylene oxide, metronidazole, and cyclosporine toxicity).

Results
The term 'encephalopathy' refers to a clinical scenario of diffuse brain dysfunction, commonly due to a systemic, metabolic, or toxic derangement, including drug intoxication, electrolyte abnormalities, hypoxemia, and uremia. The brain is greatly susceptible to damage from products of altered metabolism and various toxins. The basal ganglia, thalami, cerebral cortex, and hemispheric white matter are common targets of various toxic and acquired metabolic encephalopathies. Due to their high metabolic activity, bilateral basal ganglia changes are more evident in the majority of cases. Magnetic resonance imaging is the imaging method of choice in evaluating these conditions. Knowledge of characteristic imaging appearances of toxic and acquired metabolic encephalopathies may help narrow the differential diagnosis in a case of acute encephalopathy.

Conclusions
Toxic and acquired metabolic encephalopathies make a definite diagnosis difficult for the radiologist. However, understanding the characteristic MR imaging features, in combination with detailed clinical history, can often aid in quickly establishing the correct diagnosis. Since toxic-metabolic encephalopathies may be reversible, timely detection can help the referring clinician initiate early treatment to prevent further or permanent neurologic dysfunction. Keywords: Encephalopathy, Metabolic, toxic.
Purpose
Brain death is the irreversible cessation of function of the brain, including the brain stem. Diagnosis of brain death is based primarily on clinical criteria which include coma or unresponsiveness, absence of brainstem reflexes, and apnea. The magnetic resonance imaging (MRI) has been used as an ancillary tool in the diagnosis of brain death. Previous tests used to establish the diagnosis of brain death are nuclear medicine studies, conventional cerebral angiography, electroencephalography or Doppler ultrasound. Our purpose was to delineate the common and important MRI findings that provide an early diagnosis of brain death which is particularly useful in preserving organ viability for transplant and prognostication at the earliest.

Materials and Methods
We reviewed MRI findings in five cases clinically diagnosed as brain death. We evaluated conventional brain sequences (T2- and T1-weighted imaging, FLAIR) and advanced MRI sequences like susceptibility-weighted imaging (SWI), diffusion-weighted imaging (DWI) and MR angiography (MRA).

Results
Magnetic resonance imaging showed tonsillar herniation, absent intracranial vascular flow void in both conventional MRI and MRA, diffuse cortical high signal intensity and swelling of the cerebral sulci on T2WI, prominent superior ophthalmic veins, diffuse hemispheric hyperintensities on DWI due to cytotoxic edema, diffusion restriction of cortex due to cytotoxic edema. Additional described signs include hyperintensity of the substantia nigra, periventricular/subependymal diffusion restriction, transcerebral vein sign, cortical vein sign and Basal ganglia hyperintensity or hemorrhage.

Conclusions
Spectrum of MR imaging findings are very useful in early diagnosis of brain death and MRI can be used as an adjunct to the other tests.
MRI Findings In Acute Ethylene Glycol Toxicity

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¹Yale University School of Medicine, New Haven, CT, ²Yale New Haven Hospital, New Haven, CT

Purpose
To describe both characteristic and previously unreported magnetic resonance imaging (MRI) findings that may be seen in cases of acute ethylene glycol toxicity.

Materials and Methods
A search of the RIS system for radiology reports including the words "ethylene" and "glycol" was performed. Images were analyzed, and the patients' electronic medical records were reviewed to obtain correlative histories and laboratory findings.

Results
Characteristic MRI findings following ethylene glycol intoxication include bilaterally symmetric signal hyperintensity involving the basal ganglia, thalami, amygdala, hippocampi, and brainstem. Restricted diffusion may be seen rarely in the deep white matter. In addition to these previously reported findings, we present two cases with extensive restricted diffusion involving the posterior limbs of the internal capsules, the splenium of the corpus collosum, the middle cerebellar peduncles, and the dentate
nuclei in one case and another involving the cerebral cortex and subcortical white matter in a posterior distribution reminiscent of PRES. Findings were shown to be reversible in both cases.

Conclusions
Knowledge of the characteristic and not so characteristic imaging findings that may be found in cases of ethylene glycol ingestion may aid the radiologist in arriving at a correct and timely diagnosis. In the comatose patient in particular, awareness of possible findings may lead to vital early diagnosis and treatment before it is otherwise clinically suspected and have a significant impact on patient outcome.

eEdE-88
6:30AM - 2:45PM

MRI Imaging Characteristics of Recurrent Glioblastoma After Treatment with Laser Interstitial Thermal Therapy

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Purpose
Laser interstitial thermal therapy (LITT) has been used for the past 15 years for minimally invasive treatment of lesions that were hard to treat with conventional techniques. Recent technological advances have led to the development of commercial systems that allow for real time magnetic resonance imaging (MRI) thermography, which provides live monitoring of thermal tissue damage not only to the targeted tissue but to the surrounding tissues. This presentation will describe detailed MRI findings and complications for patients with recurrent glioblastoma multiforme (GBM) in the immediate postoperative period to 168 days after treatment.

Materials and Methods
Seven patients with recurrent GBM were treated using Neuroblate system (Monteris Medical, Winnipeg, MB) . Pre-operative MRI was performed for each patient. Follow-up MRI was performed immediately postoperatively, then 1, 2, 3, 7, 14, 28, 56, 84 and 168 days after treatment. Diffusion, ADC, T1W, T2W, FLAIR, GRE, postcontrast T1W and rCBV sequences were obtained for each exam.

Results
The laser-induced thermotherapy region immediately forms a lesion with a necrotic core, secondary to thermocoagulation. This educational exhibit demonstrates typical MRI findings of the formation, evolution, and characteristics of these lesions. In summary these include a central cavity surrounded by a rim of edema adjacent to undamaged parenchyma. The treatment region findings are best characterized on the T1 postcontrast, volumetric T2 and ADC sequences. The rim of edema demonstrates
intrinsic rim enhancement that is not as high as intrinsic tumor enhancement. Rim enhancement and elevated CBV is always present after treatment and become more conspicuous with time becoming well defined by 4 weeks. At 48 hours, the cavity characteristics typically are well defined. Over 168 days, the overall cavity was either stable or decreased in size.

Conclusions
We describe detailed MRI findings after treatment of recurrent GBM with laser interstitial laser therapy using a commercially available system. The resulting lesions have an architecture of a central cavity with a rim of edema that is well defined after 48 hours.

eEdE-03
6:30AM - 2:45PM

Neurodegeneration or Hereditary Tumor Syndrome? The Butterfly Effect of Mutated Genes Encoding Mitochondrial Enzymes

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Purpose
A group of mitochondrial disorders shows remarkable phenotypic diversity despite sharing a common gene defect. 1. To review the role of mitochondrial enzyme pathway in the pathogenesis of neurodegenerative disorders and tumor syndromes. 2. To describe the cytogenetics and the molecular biology of the mitochondrial disorders. 3. To correlate the imaging findings with histopathology and phenotype characteristics.

Materials and Methods

Results
A group of mitochondrial disorders shows remarkable biological diversity despite sharing a common gene defect. While the homozygous mutations in the genes that encode SDH and FH enzymes result in neurodegenerative disorders such as Leigh's syndrome, MELAS and MERRF; the heterozygous mutations of the same genes cause inherited neoplastic syndromes such as multiple paraganglia syndrome. This exhibit
examines the molecular genetics and biochemical basis of the phenotypic expression
of these disorders followed by a comprehensive review of radiological and
pathological spectrum of each of these inherited conditions. A detailed understanding
of these disorders helps not only appropriate clinical imaging and screening of the
subjects, but also development of novel treatment and preventive strategies.
Conclusions
Homozygous mutations of the genes that encode mitochondrial SDH and FH enzymes
result in neurodegenerative disorders, while heterozygous mutations of the same
genes cause inherited neoplastic syndromes.

- **HPGL**: Hereditary paraganglioma syndrome
- **HLRCC**: Hereditary cutaneous & uterine leiomyomatosis renal cell carcinoma syndrome
Neuroimaging in Concussion and Mild Traumatic Brain Injury

I Jones¹, J Honce¹, L Nagae¹, E Nyberg¹

¹University of Colorado, Aurora, CO
Purpose
Concussion and mild traumatic brain injury (mTBI) are common occurrences, particularly among athletes and military personnel, with estimated incidence of sports-related concussion in the millions annually. Determining when to image and what type of imaging to perform following trauma where there is suspected concussion or mTBI is oftentimes a challenging decision. Radiologists familiar with the current evidence for the various available neuroimaging techniques will be better able to guide clinicians in exam selection and guide interpretation of these studies. In this exhibit, we present an overview of the strengths and limitations of various neuroimaging techniques for the evaluation of patients with suspected concussion or mTBI.

Materials and Methods
Medical society recommendations for when imaging is appropriate are summarized. Common traumatic brain injuries visible on conventional computed tomography (CT) and magnetic resonance imaging (MRI) are reviewed. We discuss advanced neuroimaging techniques including ultra-high field structural imaging, DTI, fMRI, CT/MR perfusion, SPECT, PET, and MR spectroscopy. Example cases from our institution are reviewed to illustrate relevant points regarding strengths and weaknesses of these techniques.

Results
Computed tomography is the most common imaging performed following suspected mTBI as it is widely available, and sensitive for fracture and intracranial injuries which might require neurosurgical intervention. Conventional MRI is more sensitive for subtle intracranial injuries compared with CT and may be used for the identification of suspected injury when CT is negative or when symptoms persist. Advanced imaging techniques have demonstrated microstructural, functional, metabolic, and perfusion derangements which occur in trauma, and are of particular interest in identifying further injury in those patients in whom conventional imaging is normal. Whether these more advanced techniques have relevance in individual patients is discussed.

Conclusions
Following concussion or mTBI, conventional CT or MRI may be obtained in appropriate clinical settings. More specialized neuroimaging techniques also may identify changes related to brain injury. While their use remains predominantly investigational, in the future, these techniques will likely play a significant role in diagnosis, clinical management, and prognostication.
18-year-old healthy female with headache after an in-game injury. (A) Head CT and (B) MRI T1-weighted axial presentation imaging showing right parietal lobe hemorrhage. Follow up MRI imaging shows right parietal lobe parenchymal hemorrhage.

56-year-old female with a history of multiple head injuries with current complaints of dizziness, fogginess and memory disturbance. (C) MRI imaging shows a small right parietal lobe lesion other than mild atrophy of the left cerebral volume. (D) DTI demonstrates fractional anisotropy (FA) on the right side of the corpus callosum, presumably post-traumatic.

eEdE-36

Neurologic Complications of Systemic Disorders

S Kanekar

6:30AM - 2:45PM
Purpose
1. To identify the various neurological complications and their corresponding neuroimaging patterns related to various systemic disorders. 2. To understand the clinical implications of these findings. 3. To understand the application of newer imaging techniques for the diagnosis of a specific neurological complication.

Materials and Methods
It is important to recognize that the function of all organ systems is essential for normal functioning of the brain. Any disruption of the systemic organs can cause central and peripheral nervous system dysfunction. It is important to understand the mechanisms contributing to neurological dysfunction as well as the various imaging findings associated with it. Many a time radiologists may be the first to discover the underlying systemic illness and its neurological complications thus giving a lead to the clinician. Therefore, it is important for radiologists to be familiar with various neurological complications associated with various systemic disorders. We retrospectively reviewed the imaging studies from our picture archiving and communication system (PACS) of 122 patients with neurological complications due to various systemic disorders, which form the basis of this exhibit. All patients had computed tomography (CT) and magnetic resonance imaging (MRI) exams of brain. In addition, 34 patients had advanced imaging that includes magnetic resonance spectroscopy (MRS), perfusion imaging, and diffusion tensor imaging (DTI).

Results
For ease of understanding, this exhibit is reviewed under eight broad categories of systemic disorders: renal (encephalopathy, disequilibrium syndrome, hemorrhagic stroke, subdural hemorrhage, osmotic myelinolysis, and dialysis dementia), hepatic (portal encephalopathy and acute liver failure), fluid and electrolyte [hyponatremia, hypernatremia, syndrome of inappropriate antidiuretic hormone secretion (SIADH), hypercalcemia, and hyperkalemia], endocrine (hyperthyroidism, hypothyroidism, Hashimoto's encephalopathy, hypoglycemia, and Cushing's), systemic vasculitis [systemic lupus erythematosus (SLE), polyarteritis nodosa (PAN), antiphospholipid syndrome, and rheumatoid], blood [vitamin B12 deficiency, sickle cell disease (SCD), polycythemia vera, hemorrhagic disorders, thrombotic thrombocytopenic purpura (TTP), and disseminated intravascular coagulation (DIC)], gastrointestinal (pancreatic encephalopathy, celiac disease, Whipple's disease, and limbic encephalitis), and cardiovascular and respiratory systems [subacute bacterial endocarditis (SBE), cardiac defects, stroke, and hypoxia].

Conclusions
1. We illustrate the various imaging findings of the neurological complications due to systemic disorders with examples. 2. For participants, this exhibit will be a core
learning module to understand the mechanism of neurological dysfunction, associated various imaging findings, and its clinical implications.

**eEdE-49**

6:30AM - 2:45PM

**Neuroradiological Emergencies: The Spectrum of MRI Findings Related to Exogenous Agents Toxicity**

R PINCERATO¹, C Ferreira Alves², P PINHO², A AYRES², C GRASEL²

¹HOSPITAL SAMARITANO, SÃO PAULO, Brazil, ²HOSPITAL SAMARITANO, SAO PAULO, SAO PAULO

**Purpose**

Toxic encephalopathies can be secondary to the exposure to a wide variety of exogenous agents, including chemotherapy, antiepileptic agents, drugs of abuse, and environmental toxins. The purpose of this study was to describe the relationship between characteristic magnetic resonance (MR) findings and exogenous agents toxicity.

**Materials and Methods**

We report five patients at time of onset of neurologic dysfunction after exposure to a neurotoxic agent. The average patient was 32 years of age (range, 4-78 years). Magnetic resonance imaging (MRI) was performed on 1.5T MR scanners. Toxic encephalopathy which arises following the interaction between central nervous system (CNS) and chemical compound including topotecan, methotrexate, carbamate, etambutol and vigabatrin, has been described.

**Results**

A wide range of chemical substances endogenous or exogenous can be neurotoxic, having mechanisms that affect the CNS either directly or indirectly by means of alterations to cerebral or systemic homeostasis induced by the substance in question. It is still unclear why some CNS structures are affected to a greater extent than others, however it is probable that differences in tissue affinity to the toxic substance are implicated. Magnetic resonance imaging usually discloses bilateral and symmetric white matter areas of hyperintense signal on T2-weighted and fluid-attenuated inversion recovery images, and signs of restricted diffusion are associated in the acute stage. In some circumstances other areas of the central nervous system also can be affected. The main causes of brain damage include: oxidative energy depletion, deficit of the substrate for cerebral activity, alterations in cell membrane integrity, enzyme deficit, alterations to the electrolytic equilibrium and neurotransmission damage. Neuroradiological emergencies are linked most frequently to external exogenous toxins. Intoxication requires immediate diagnosis and treatment in order to prevent brain damage becoming irreversible or fatal.
Conclusions

A high suspicion should be maintained whenever a patient presents recent onset of neurologic deficit, searching the risk of exposure to a neurotoxic agent. In these patients, getting to know the most frequent MR appearances is critical for guiding correct therapy, improving outcome.
New Vascular Anatomy Teaching Tool Using Virtual Reality: "Walking Along the Vessels"

N Salamon¹, I Orosz¹, D Woodworth², K Desmarais³, n martin⁴
¹UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA, Los Angeles, CA,²UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA, Los angeles, CA,³UCLA Medical Center, Los Angeles, CA, ⁴ucla, Los angeles, CA

Purpose
Learning vascular anatomy in multidimensional fashion is challenging. Recent advancements in virtual reality (VR) technology have made high resolution, low latency headsets available in the consumer marketplace. The purpose of this exhibit is to demonstrate novel teaching tool to learn vascular anatomy using immerse VR environment.

Materials and Methods
DICOM images of the normal and pathological computed tomography angiography (CTA) and magnetic resonance imaging (MRI) were transferred to the VR platform (VRStadium). The image data were rendered into real time spherical, large room size, model that can be viewed from any angle while "walking" or "flying" inside the anatomy using a VR headset. We will demonstrate example of imaging fusion between MRI and CTA to visualize trajectory of the vessels with relationship to the
surrounding structures such as thalamus, basal ganglia or brainstem. Pathological cases will include intra- or extra-axial neoplasms, vascular malformations and aneurysms. The findings were compared to the MRA and conventional angiogram. Interactive process can help identifying the intracranial vessels in different angles. The name of the artery is demonstrated within the major arteries.

Results
When wearing the VR headset in the VRStadium, vascular structures will be seen surrounding the users; the user can literally stand between arteries and the neoplasm. VR users can tour multiple fused data sets such as postprocessed DTI tractography fused with vascular data from a CTA. The user then can walk into the space between a corticospinal tract and pathology such as AVM nidus and able to assess less invasive approach regarding the margins to preserve surrounding eloquent functional structures. Furthermore, the VR user physically can walk down a planned surgical path or minimally invasive corridor, to obtain the safest and less invasive surgical approach. The VRStadium allows for multiple users, represented as green avatars in the VR scene (Fig 1).

Conclusions
The VRStadium is a new frontier of teaching tool and presurgical planning modality. The system will provide better understanding of vascular anatomy and surgeons will obtain less invasive access with greater accuracy. This will be cost-effective for the health system shortening the patient's hospital stay. The neuroradiologists will play an essential role in development of this system as a potential future research.
Purpose
This exhibit will demonstrate: * Various disease processes that cause intracranial hemorrhage. * Noninvasive multimodal CT/MR imaging presentations of various intracranial bleeds. * Distinguishing imaging features most associated with a specific diagnosis.

Materials and Methods
Noninvasive computed tomography (CT) and magnetic resonance (MR) imaging are key in establishing the diagnosis of intra-cranial hemorrhage. In addition to simply detecting the presence of blood, specific imaging features especially in the presence of supporting clinical history can lead to the diagnosis which can be quite varied and have significant implications for patient management. Though at times subtle, intracranial bleeds have diagnostic clues on noninvasive imaging that can help
radiologists make an accurate diagnosis. We present abnormalities that can be seen on CT, CT angiography (CTA), MR, MR angiography (MRA), and dynamic 4D MRA/CTA studies. Our examples include: dural arteriovenous fistulas (DAVFs), posterior reversible encephalopathy syndrome (PRES), arteriovenous malformation (AVM), reversible cerebral vasoconstriction syndrome (RCVS), dural sinus thrombosis, benign perimesencephalic hemorrhage, aneurysm, amyloid angiopathy, herpes encephalitis, coagulopathies, and hemorrhagic metastases.

Results
Noninvasive imaging features of DAVFs associated with parenchymal hemorrhage include enlargement of external carotid artery branches, abnormal enhancement of engorged parenchymal veins, abnormal cluster of flow voids in the subarachnoid space, engorgement of the cavernous sinuses, enlargement of the superior ophthalmic vein, and direct visualization of the DAVFs on 4D CTA/MRA. A serpiginous hyperdense structure adjacent to a hematoma on nonenhancing CT (NECT) and absent flow voids of the dural sinuses on MRA suggests venous sinus thrombosis with hemorrhagic transformation. Imaging features of hemorrhagic PRES include patchy cortical/subcortical lesions in the posterior circulation with multifocal small cortical petechial-type bleeds in a hypertensive patient. Cortical/subcortical hemorrhage and microbleeds in a normotensive patient suggest amyloid angiopathy. Enhancing lesions in the gray-white matter interface that bloom on GRE sequence are concerning for hemorrhagic metastasis. A growing hematoma with fluid-fluid level and iso-/mildly hyperdense clot may indicate coagulopathy. Bilateral and asymmetric edema and bleed involving the limbic system is seen with herpes encephalitis. Intraventricular hemorrhage extension on NECT and honeycomb of flow voids on MRI should raise concern for arteriovenous malformation. Parenchymal or small cortical subarachnoid hemorrhage on NECT and diffuse segmental arterial constriction on CTA/MRA suggest RCVS.

Conclusions
In addition to simply detecting the presence of blood, it is important for the radiologists to recognize additional imaging findings most associated with a specific diagnosis. Awareness of the noninvasive imaging features of various disease processes that cause intracranial bleeds is crucial for prompt diagnosis and early management.
**Old School/New School – Spectrum of Neuroradiological Findings of Substance Abuse**

C Chan\(^1\), B Bachert\(^1\), P Piana\(^1\), J Li\(^1\), B Devenney-Cakir\(^1\)

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Purpose
Substance abuse and addiction are prevalent conditions throughout the world with new substances produced frequently. Complications of both old and new substances often arise with patients commonly presenting to the Emergency Department after abusing drugs. Oftentimes, their presentation prompts imaging of the brain and spine. While we are better aware of the imaging features of central nervous system (CNS) complications from the more commonplace and established drugs, imaging features of new, emerging drugs are less recognized. Despite this gap, radiologists should become aware of the neuroimaging findings related to the use of these emerging substances. We present a series of CNS manifestations on imaging of new emerging substances, focusing on K2, a synthetic marijuana product also known as "Spice", as well as a review of neuroimaging features of older, more common drugs.

Materials and Methods
A retrospective, pictorial review of a wide variety of imaging findings at our institution will be presented. Cases will be organized by substance, including common drugs, including heroin, cocaine, alcohol, inhalants, and phencyclidine (PCP) as well as new and emerging drugs, including K2. Multiple modalities will be presented, with emphasis on computed tomography (CT) and magnetic resonance imaging (MRI).

Results
We will present a spectrum of CNS complications seen on neuroimaging frequently encountered with various abused drugs. Cases that will be included involve sequela of emerging drugs, such as hypoxic-ischemic injury, basal ganglia demyelination, stroke and acute parenchymal hemorrhage caused by K2, as well as complications of common substances such as hepatic encephalopathy and Wernicke encephalopathy in alcohol abuse; leukoencephalopathy, osteomyelitis/diskitis and epidural abscess from heroin use; ischemic stroke, intracranial hemorrhage, internal carotid artery dissection, aneurysm formation, aneurysmal rupture, vasculitis, and PRES in cocaine use; toluene-induced white matter changes; cerebral edema, stroke, and intracranial hemorrhage after PCP use; and subacute combined degeneration in the spinal cord due to inhaled polysubstance vapor. Chronic complications of drug abuse also will be discussed.

Conclusions
Drug abuse and addiction are prevalent issues frequently encountered in society today with an increasing number of patients presenting to the Emergency Department suffering from complications after abusing various substances. Diagnostic imaging modalities such as CT and MR play crucial roles in the diagnosis of these complications. Therefore, it is critical for the radiologist to recognize imaging features and patterns related to complications of both new drugs as well as older, more common substances.
Orienting the Surgeon/Radiation Therapist to Deformities of Eloquent Brain Areas in Cases with Large Cranial Masses

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Purpose
Deciding which eloquent areas are at risk in patients with large cranial masses can be difficult. In addition, large cranial masses displace eloquent areas of brain in patterns that are difficult to convey to the physicians planning surgery/radiotherapy. To validate the usefulness of new software that defines eloquent areas at risk and custom deforms them for presentation as a 3-dimensional (3D) model.

Materials and Methods
Patients with cranial masses judged large enough to displace one or more eloquent areas were selected for analysis. The Anatom-e workstation (Houston, TX) was used to fit deformable anatomical templates (DATs) into patient's brain. Manually circling the area of the mass on the embedded template provided suggestions of eloquent areas which should be considered for mapping. The extensive database assured a comprehensive list of eloquent areas for consideration. In addition, the patient's symptoms could be analyzed by the software to produce regions of interest which could be embedded to customize the DATs. In the final step, the DATs were deformed to accommodate the mass. Anchor points on the axial images were used to obtain the best local fit. For the example provided, the lateral geniculate and the chiasm were used to guide placement of the visual tracks. After applying the deformation the results were converted into a 3D model, which then were video-taped and shared with the surgeons and radiotherapists, as a 2-minute presentation.

Results
For this case, the deformation of eloquent areas was judged as valid by the surgeon. The addition of Broca speech area was suggested by the program for the example shown below. Surprisingly, the display was judged very useful for patient education.

Conclusions
Software which embeds deformable anatomical templates (DATs) into brains deformed by large masses can improve the selection and display of eloquent areas at risk for injury during radiotherapy/surgery. It was unexpectedly useful for patient education, as well.
3D reconstructions of the visual tract deformed medially by the large
Pathology Spectrum of the Medulla Oblongata: A Neuroimaging Review

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Purpose
The medulla oblongata is a complex structure which is of vital importance to autonomic function. Because of the essential role in controlling functions of respiration, circulation, and reflexes crucial to survival, it is important for the radiologist to recognize multiple pathologic entities which involve the medulla oblongata. In this presentation, the authors will discuss a spectrum of pathology highlighting the neuroimaging findings that will facilitate an accurate and timely diagnosis of clinically important disease processes affecting the medulla oblongata.

Materials and Methods
The authors will discuss a broad spectrum of pathology involving the medulla oblongata utilizing neuroimaging examples with computed tomography (CT), computed tomography angiography (CTA), magnetic resonance imaging (MRI) including MR spectroscopy and MR perfusion, and digital subtraction angiography. The spectrum of entities discussed will include an array of disease processes within the categories of trauma, demyelination, neurodegeneration, vascular insult and abnormalities, hypoxia, primary and metastatic neoplasm, congenital malformation, mitochondrial disorder and infection.

Results
Common and uncommon pathologies will be demonstrated, including interesting cases of multiple sclerosis, hypertrophic olivary degeneration, traumatic brain injury, multisystem atrophy, ischemia/infarction, hypoxic ischemic encephalopathy, arteriovenous fistula, cavernous malformation, metastasis, primary glioma, viral encephalitis, Chiari malformation and Leigh disease. Pertinent imaging findings will be clearly highlighted and explained.

Conclusions
After viewing this presentation, the reader will become familiar with the spectrum of pathology involving the medulla oblongata and recognize pertinent neuroimaging findings leading to the appropriate diagnosis. By gaining further understanding of the pathology involving the medulla oblongata, the radiologist will facilitate timely and appropriate treatment for affected patients.
Patterns of Brain Iron Accumulation

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Purpose
The objective of this paper is to review the main sites of iron accumulation through a pictorial essay, defining characteristic image patterns in different etiologies.

Materials and Methods
Pictorial Essay
Results
Many diseases present with intracranial iron accumulation. While neurodegeneration with brain iron accumulation (NBIA) prioritize iron deposit in globus pallidus and eventually in the striatum, repetition subarachnoid hemorrhage course with impregnation of the meninges and hemolytic anemia (or hemochromatosis) prefer to deposit the iron in the anterior pituitary and choroid plexus. T2* effects related to abnormal iron accumulation were seen clearly at all field strengths and (as expected) were accentuated with greater degrees of T2 or T2* weighting. There is a striking correlation between the presence of mutations in PANK2 and the eye-of-the-tiger sign on brain MR imaging. All of the NBIA disorders feature iron deposition in the globus pallidus but differ in the co-occurrence of other findings. A number of new subtypes of NBIA recently have been described, some of them with distinct neuroradiologic and clinical features. Beta-propeller protein-associated neurodegeneration (BPAN) features T1 hyperintensity of the substantia nigra with a central band of T1 hypointensity. Mitochondrial membrane protein-associated neurodegeneration may demonstrate T2-weighted images hyperintense streaking of the medial medullary lamina between the globus pallidus interna and externa. Neuroimaging features of aceruloplasminemia include homogeneous involvement of the caudate, putamen, globus pallidus, thalamus, red nucleus, and dentate.

Conclusions
The different patterns of brain iron accumulation in MR imaging may help to clarify the disease process and facilitates clinical diagnosis.

eEdE-21
6:30AM - 2:45PM

Pearls and Pitfalls in Imaging MRI-guided Laser Interstitial Thermal Therapy in Epilepsy

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Purpose
Magnetic resonance imaging (MRI)-guided laser interstitial thermal therapy (MRgLITT) is emerging as an alternative minimally invasive treatment of refractory epilepsy. We present a pictorial review of intra-operative MR during MRgLITT and on followup, with a brief technical review, and depict some imaging pitfalls and highlights.

Materials and Methods
Intraoperative images may include diffusion-weighted imaging (DWI), post-contrast T1-weighted, susceptibility-weighted and T2-weighted images. Patients are imaged
during the procedure with a stereotactically-placed laser probe which enables real
time temperature monitoring and delivery of laser ablation.

Results
Imaging of MRgLITT in multiple pathologic scenarios, including mesial temporal
sclerosis, neurofibromatosis type I, and malformations of cortical development, will
be presented, highlighting common appearances of the treatment bed during and after
ablation. Potential pitfalls will be highlighted, including a case associated with
incorrect programming of patient position. In this case, an artifact along the phase
direction demonstrated apparent increased signal on diffusion-weighted image in the
cerebral peduncle with indeterminate signal on ADC map, concerning for acute
infarct. Acquisition of a repeat DWI sequence during the procedure without the
concerning finding and clinical correlation with an intact patient after the procedure
disproved an acute infarct (Fig. 1).

Conclusions
MRgLITT is an alternative, minimally invasive technique for treatment of refractory
epilepsy with particularities in imaging that will be addressed in this pictorial essay.
FIG 1: intraoperative MRI for right temporal mesial thermoablation. a) axial DWI signal in the area of ablation and right cerebral peduncle; b) ADC map with low ablation site, consistent with restricted diffusion, right cerebral peduncle lesion indeterminate; c) post-contrast enhancement in the right mesial temporal structures DWI and ADC maps no longer showing abnormal DWI signal in the right cerebral FLAIR with heterogeneous peripheral increased signal in the right mesial temporo
Purpose
Focusing on infarcts, aneurysms, arteriovenous malformations (AVMs) and dural arteriovenous fistulas (dAVFs), magnetic resonance imaging (MRI) technique and pearls important for image acquisition and interpretation are discussed. A case approach is used, facilitating as well a further understanding of these disease processes and image interpretation therein.

Materials and Methods
Slightly more than 20 clinical cases are systematically presented, depicting the utility of MR flow techniques in the evaluation of infarcts, aneurysms and AVMs (as well as dAVFs). The exhibit begins with a brief discussion of physics, discussing flow, spin echo versus gradient echo technique, and time-of-flight (TOF) magnetic resonance angiography (MRA). In the discussion of clinical cases, in most instances comparison is made to computed tomography angiography (CTA) and digital subtraction angiography (DSA).

Results
Flow on unenhanced T1-weighted scans can appear markedly different on gradient as opposed to spin echo images. 3T offers a substantial advantage over 1.5T in the depiction of flow within vessels, and in particular with time-of-flight (TOF) technique. Important caveats to recognize include the absence of a normal flow void (including the corresponding appearance on TOF magnetic resonance angiography (MRA) and that TOF does not depict leptomeningeal collaterals well. In ischemia, TOF MRA can depict vessel occlusions, recanalization, and focal stenoses. One caveat is the resolution limitation of the technique, as typically applied, with this illustrated in moyamoya. Aneurysms are discussed according to location, subtypes (infectious, giant), and treatment. The presentation of vascular lesions includes AVMs, dAVFs, and vertebrobasilar dolichoectasia (with clot). Imaging approaches critical to the evaluation of these lesions includes TOF (both pre- and post-contrast), phase contrast angiography, and CTA, with VRT and thick MIP processing of high value for image display and interpretation.

Conclusions
MR flow techniques are critical to the evaluation of cerebrovascular disease. Not to be neglected are attention to technique optimization and approaches beyond standard TOF imaging. Important incremental value can be gained by phase-contrast MRA and post-contrast TOF MRA, together with appropriate postprocessing, with this entire area advanced substantially by the use of 3T.
Pocket Book of MR Angiography: Techniques and Clinical Applications
Purpose
- To recognize MR angiography techniques and its basic physical principles.
- To describe the advantages, limitations and potential pitfalls of each technique.
- To develop a practical diagnostic algorithm depending on the clinical context.

Materials and Methods
Cerebrovascular imaging studies are being used with greater frequency for the assessment of headaches, stroke work-up and evaluation of the various vascular malformations of the head and neck. Magnetic resonance imaging (MRI) angiography is one of the most commonly used noninvasive techniques for imaging of the cerebrovascular system.

Results
Neurovascular studies by MRI can be performed by different techniques: 1. Phase contrast sequences, without contrast. It uses magnetization differences between flowing blood and stationary tissues. Thus, the vascular anatomy can be assessed, and the speed and direction of the blood flow can be quantitatively determined. Three-dimensional (3D) acquisition is used for depicting venous thrombosis and as a noncontrast technique. 2. 3D time-of-flight (TOF) sequences, with and/or without contrast. They derive contrast between flowing blood and stationary tissues by manipulating the magnitude of the magnetization. 3D TOF sequence commonly is used in the evaluation of the circle of Willis. It presents limitations in peripheral small vessels, giant or thrombosed aneurysm and in those treated with stent. 3. Contrast-enhanced MR angiography, as either dynamic (time-resolved) or fixed single-phase (arterial or venous) imaging. It is not affected by complex or slow flow, provides high quality images with fewer artifacts and large fields of view can be imaged in a short acquisition time.

Conclusions
MR angiographic techniques are used routinely in neurovascular imaging. A better understanding of its physical principles, advantages, limitations and pitfalls will allow to obtain different diagnostically useful images in each clinical situation.

eEdE-70
6:30AM - 2:45PM

Posterior Reversible Encephalopathy Syndrome-NOT!

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Purpose
Posterior reversible encephalopathy syndrome (PRES) is not always or only posterior, not reversible without (or always with) treatment, and not always associated with encephalopathy. It often but not always is associated with hypertension. We will review the many risk factors, clinical presentation, and pathophysiology; present typical and "atypical" imaging features; and discuss the prognosis and differential diagnosis of PRES.

Materials and Methods
A review of the literature and presentation of imaging examples from our institution of PRES will be exhibited.

Results
PRES is a misnomer as an acronym. Although the most common distribution is parieto-occipital, "atypical" imaging findings are not uncommon and include frontal and temporal lobe, thalamic, basal ganglia, corpus callosum, brain stem, cerebellar and spinal cord involvement. Hemorrhage, diffusion restriction and, rarely, infarction may occur. While imaging findings typically resolve, residual sequela may be seen on follow-up imaging. PRES may recur. Patients are not always encephalopathic.

Conclusions
While the eponymic parietooccipital distribution of PRES is most common, atypical distributions are NOT atypical. Hypertension is a common risk factor, but is not present at toxicity in 20-40% of cases. Awareness of the clinical presentation, myriad risk factors, and diverse imaging appearance of this entity will promote expedient diagnosis and treatment.

eEdE-81

6:30AM - 2:45PM

Seeing the Same Landscape with New Eyes: Imaging Glial Neoplasms in the Era of Newer Imaging Modalities

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Purpose
1. Review role of diffusion-weighted (DWI) and diffusion tensor imaging (DTI) in grading glial neoplasms and pre-operative planning. 2. Review role of perfusion-weighted imaging (PWI) in glial neoplasms. 3. Review role of magnetic resonance spectroscopy (MRS) in glial neoplasm characterization and differentiating from other entities like pseudoprogression. 4. Review role of functional BOLD magnetic resonance imaging (fMRI) in glial neoplasm pre-operative planning employing
different paradigms. 5. Review role of intra-operative MRI (Io MRI) during surgery for glial neoplasms.

Materials and Methods
We reviewed cases of glial neoplasms from our PACS where the newer imaging modalities including diffusion-weighted imaging, diffusion tensor imaging, perfusion-weighted imaging, MRS, BOLD fMRI and intra-operative MRI contributed in providing further details about either the tumor grading or helped in pre- or intra-operative decision making.

Results
Magnetic resonance imaging is the workhorse of brain tumor imaging with conventional imaging providing data about location, signal intensities and enhancement characteristics of mass lesions (1). Newer imaging modalities can yield further refinement of differential diagnosis, improve pre-operative assessment, expand surgical approaches and help in evaluating therapeutic options. With higher tumor grade, there is increased diffusion restriction with lower apparent diffusion coefficient (ADC) (2). With diffusion tensor imaging (DTI), fiber tracking techniques can show relationship between glioma and adjacent white matter tracts (3). Tumor grade can be predicted with higher relative cerebral blood volume (rCBV) on perfusion-weighted imaging (PWI). On MRS, elevated choline signifying increased cellularity and reduced NAA signifying reduction in normal neurons characterize higher grade neoplasms. The extent of resection, a major factor affecting long-term survival in brain tumor patients can largely be determined by proximity of the lesion to the eloquent brain regions prior to resection (1). Eloquent brain regions can be outlined prior to resection with a combination of fMRI and DTI. Intra-operative MRI allows precise navigation and resection of intracranial neoplasms (Fig. 1) (4).

Conclusions
Advanced imaging techniques are being used increasingly to help guide patient management underscoring the central role that radiology plays on the multidisciplinary brain tumor team.
Side Effects May Include...A Pictorial Review of Iatrogenic Drug Related Complications in Neuroimaging

D Chow¹, R Dumont - Walter², C Filippi³, D Wilson²
Purpose
Adverse drug reactions are unfortunately common occurrences in up to 15% of patients, and are expected to become more frequent in the face of increasing polypharmacy \(1, 2\). Many of these complications may adversely affect the central nervous system (CNS) and can be seen with both emergent inpatient and routine outpatient settings. These reactions may represent a diagnostic challenge for referring clinicians given the variability in presentation and timing \(3\). Therefore, it is important for the neuroradiologist to recognize potential iatrogenic complications. The purpose of this educational exhibit is to present a pictorial review of imaging findings of CNS drug-related complications.

Materials and Methods
Our institute's imaging teaching file was queried for CNS-related adverse drug reactions. Clinical presentation, dose and timing of offending agent, and outcome were recorded. In this exhibit, we organized a subset of commonly and uncommonly encountered complications organized by anatomy: (1) Cerebral Hemispheres, (2) Posterior Fossa, (3) Cerebral Vasculature, and (4) Spine.

Results
An organized and illustrative spectrum of CNS-related adverse reactions relevant to neuroradiology is provided. The clinical scenario, representative imaging, and radiologic teaching points will accompany each described drug-related adverse reaction. Many of these complications can be seen on imaging. Familiarity with these imaging features in the context of a patient's ongoing therapy and prescribed medication may allow for accurate diagnosis and cessation of the causative agent.

Conclusions
No medication or therapy is free from side effects. Knowledge of these effects is important for recognition and diagnosis of potentially severe CNS complications.

**eEdE-60**

**Spectrum of Cavernous Malformations**

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Purpose
The purpose of this exhibit is to provide an interactive case-based review of cavernous malformations with a focus on MR appearance and various locations within the
central nervous system (CNS) including intra-axial, extra-axial, familial syndrome, and acute complicated lesions.

Materials and Methods
We present a comprehensive spectrum of cavernous malformations and interesting variants from cases collected from everyday neuroradiology practice at a university medical center.

Results
Cases will be presented as an interactive learning session with images, image description, key facts, and differential diagnosis when applicable. Cavernous malformations can be diagnosed by characteristic imaging features. We will present common and unusual cases including lesions in the brainstem, extra-axial locations, acute complications, and familial syndrome.

Conclusions
This educational exhibit will present common and uncommon cavernous malformations as a review to better understand their appearance locations and clinical issues when encountered.
Spectrum of Intraventricular Neoplasms: Narrowing the Differential Diagnosis

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Purpose
To provide a review of common intraventricular neoplasms and a methodology to narrow the differential diagnosis.

Materials and Methods
After a detailed description of the anatomy of ventricles and periventricular structures, several intraventricular neoplasms will be presented in an image rich manner. Under this background, a number of specific diagnostic characteristics will be utilized to develop a methodology in narrowing the broad differential diagnosis of common intraventricular neoplasms.

Results
Although the differential diagnosis of intraventricular neoplasms can be extensive, analysis of specific imaging and demographic characteristics can greatly narrow the possibilities. Such characteristics which can narrow the differential diagnosis include morphology, enhancement, location, age/gender, and underlying co-morbidities. Utilizing these characteristics, several intraventricular neoplasms including ependymoma, subependymoma, choroid plexus tumors, subependymal giant cell tumor, central neurocytoma, and meningioma can be differentiated better at CT and MR imaging.

Conclusions
The broad differential diagnosis of intraventricular neoplasms can be narrowed dramatically utilizing specific imaging and demographic clinical characteristics.

Spectrum of Wallerian Degeneration Beyond the Corticospinal Tract: Conventional and Advanced MR Imaging Findings

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Purpose
Wallerian degeneration (WD) is progressive demyelination and disintegration of the distal axonal segment following axonal transection or damage to the neuron. Imaging findings of Wallerian degeneration can be challenging, especially outside the corticospinal tracts. In this exhibit, we will elaborate imaging findings of different types of Wallerian degeneration secondary to various pathologies.

Materials and Methods
The conventional and advanced magnetic resonance imaging (MRI) imaging findings of different types of Wallerian degeneration (corticospinal tract, hypertrophic olivary degeneration, pontocerebellar tract, posterior column of the spinal cord, corpus callosum, mammillary body/fornix) particularly diffusion-weighted imaging (DWI), diffusion tensor imaging (DTI) and susceptibility-weighted imaging (SWI) will be described.

Results
Wallerian degeneration occurs throughout various tracts in the central nervous system. Given the more widespread use of advanced MRI sequences, early detection of WD can play an important role in prognostication of different brain pathologies.

Conclusions
Familiarity of radiologists with imaging findings of the different types of WD is essential to make the correct diagnosis and avoid unnecessary workup.

eEdE-35

Spectrum of IgG4-Related Disease

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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
1) Brief review of computed tomography (CT) and magnetic resonance imaging (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 highlighting 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.
Spontaneous Intracranial Hypotension: Vertical Pan-Modality Integrative Understanding

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Purpose
The purpose of this educational exhibit is to provide an instructive learning experience with attention to spontaneous intracranial hypotension spanning across multiple imaging modalities--to include computed tomography (CT), magnetic resonance imaging (MRI), and radionuclide cisternography.

Materials and Methods
Example cases from our institution will provide a teaching apparatus to discuss the

• Ill-defined hyperdense mass in the left orbit with infilling of the left orbit. There is left eye proptosis and thickening of the myelinated nerve at the junction of the extraocular muscles and the orbit. The mass appears to be of high signal on T2-weighted imaging.

• There is sclerosis of the bone of the ipsilateral maxilla, mandible, and base.

• There is suggestion of a mass in the left temporal lobe.
clinical profile, the full gamut of imaging findings, and the favored institutional
treatment for spontaneous intracranial hypotension. Various select cases from our
institution will be presented to the viewer which shall reinforce important teaching
points for the accurate imaging diagnosis of this entity. And finally, we intend to
discuss our institutional experience with the epidural blood patch as a treatment vector
for spontaneous intracranial hypotension.

Results
Spontaneous intracranial hypotension is clinically characterized by a distinctly
spontaneous postural headache in association with low CSF pressures. Per the
literature, the clinical symptomology profile has been known to also include neck
pain, neck stiffness, nausea, diplopia, dizziness, change in hearing, visual blurring or
visual field cuts, photophobia, interscapular pain, and facial numbness. The clinical
profile of such patients often is as variable as the imaging profile. Although imaging
findings are rare, the presence of imaging findings can proscribe a higher index of
diagnostic confidence. Because the source of the low CSF pressures often is thought
to be secondary to a CSF leak, imaging of the entire neuro-axis often is sought. A
whole host of imaging findings exist in association with spontaneous intracranial
hypotension. On computed tomography (CT), imaging features include cerebellar
tonsillar herniation, dural venous sinus distention, and subdural collections.
Computed tomography myelography may be able to discern the site of leakage. On
magnetic resonance imaging (MRI), imaging features include sagging brainstem,
downward drooping of the corpus callosum, subdural effusions, increased peri-optic
fluid, enlarged pituitary, and pachymeningeal enhancement, all of which can be seen
in conjunction with various angular and metric changes. Radionuclide cisternography
may aid in the detection of the leakage site, though has been shown to demonstrate a
characteristic diminished distribution around the cerebral convexities. At our
institution, the epidural blood patch is the mainstay of treatment. We herein provide
an educational discussion for the radiological manifestations of spontaneous
intracranial hypotension and its treatment.

Conclusions
The imaging findings of spontaneous intracranial hypotension are herein described by
way of a vertical pan-modality integrative instructive approach -- CT, CT
myelography, MRI, and radionuclide cisternography. This is done in order to
effectively convey to the reader the full spectrum of key, albeit rare, imaging features
seen in association with spontaneous intracranial hypotension.

Stop Touching Me! Imaging Features of Neurovascular Compression

M Cathey¹, T Kennedy², G Avey³, L Gentry⁴
Purpose
This electronic educational exhibit reviews the clinico-radio-pathologic spectrum of neurovascular compression (NVC) within the central nervous system using a case-based approach to identify the important anatomical characteristics of NVC, potential NVC mimics and applicable treatment strategies.

Materials and Methods
Case-based overview demonstrating the imaging abnormalities associated with a wide variety of syndromes relatable to NVC, particularly those involving cranial nerves. A review of the proposed neuropathic mechanisms leading to these syndromes will be presented. The key anatomical relationships most associated with NVC will likewise be emphasized and illustrated through the use of high resolution MR imaging, including balanced steady-state free precession/heavily T2-weighted sequences.

Results
MR imaging abnormalities associated with various clinical syndromes referable to NVC are encountered increasingly in general practice. Familiarity with these entities allows for protocol optimization and is otherwise helpful in preventing false negative study interpretation. In properly selected patient populations, microvascular decompression has shown promise for durable treatment of clinical symptoms. An understanding of NVC, its mimics as well as its treatment is an important part of a neuroradiologist's practice.

Conclusions
Neurovascular compression is a debilitating disease. If unrecognized, this can lead to misdiagnosis and unnecessary delays in treatment. Sadly, some of the most severe and recalcitrant cases have reportedly been associated with suicide. The neuroradiologist plays a critical role in the diagnosis of NVC and a comprehensive knowledge of these entities is paramount.

Subjective Interpretation of CT Perfusion Imaging: Practical Approach and Utility

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Purpose
- Review common computed tomography perfusion (CTP) parameters and how to relate them to the physiology of acute evolving stroke. - Examine clinical scenarios where CTP maps can aid in the understanding of acute stroke syndromes and stroke mimics contributing to patient management. - Discuss possible future applications of this modality.

Materials and Methods
Our experience as a Certified Stroke Center, that performs an average of 350 perfusion studies annually, suggests a greater value of CT perfusion, as applied to stroke, than has been implied recently. We propose a practical approach to evaluation of CTP employing a graph modified from Nemoto et al. This easy-to-apply method aids in effectively characterizing areas of normal perfusion, oligemia, penumbra and infarct. Demonstrating the application of this graph in multiple clinical scenarios, illustrates the possible utility of this method and its continued role in the emergent evaluation of stroke patients.

Results
Although controversies currently exist regarding CT perfusion and its reliability in selecting patients for intervention, we maintain that the information gained by CTP helps to understand important physiological aspects of stroke that static images cannot provide. The relative hemodynamic significance of an occlusion, as well as whether the obstruction is likely acute or chronic, are additional benefits to performing CTP in the emergent setting. Unlike diffusion-weighted magnetic resonance imaging (MRI), CT perfusion is readily available in most emergency centers. Furthermore, this modality may suggest non-stroke diagnoses. With regular feedback and communication between imagers and clinicians regarding outcomes, confidence and consistency of interpretation can be achieved.

Conclusions
- Perfusion studies can help to understand the hemodynamics and physiology of acute stroke and may aid in nonstroke diagnosis. - Complex processing is not necessary to obtain valuable information regarding the infarct core and the relative severity of hypo-perfusion.
Syndromes and Lesions of Brainstem Nuclei – A Clinical Radiological Correlation

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Purpose
The aim of this study is to understand the basic brainstem anatomy and lesion localization on imaging based on clinical syndromes.

Materials and Methods
The presentation will be case-based. Before presenting the cases, we will provide a brief anatomy of brain stem at the levels of superior colliculus, inferior colliculus, pons, facial colliculus and Medulla. After that we will discuss common brainstem syndromes and localization of subtle lesions on imaging, based on clinical presentation. A question may introduce the case. For each case, we will give a description of the images and make a single take-away teaching point.
Results
We will discuss the following syndromes and demonstrate imaging findings in these clinical settings. 1. Weber syndrome. 2. Benedikt syndrome. 3. Perinaud's syndrome. 3. Internuclear ophthalmoplegia. 4. One and half syndrome. 5. One and eight syndrome. 6. Locked-in syndrome. 7. Facial Colliculus syndrome. 8. Hypertrophic Olivary degeneration. 9. Lateral Medullary syndrome. 10. Medial Medullary syndrome.

Conclusions
Knowledge of clinical presentation of brainstem lesions helps a radiologist to narrow down search and identify subtle lesions. Identifying these subtle lesions on imaging can have a huge impact on patient care.

eEdE-95

6:30AM - 2:45PM

Synthetic MRI: Basic Principles and Clinical Applications

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Purpose
Synthetic magnetic resonance imaging (MRI) is a technique which can be used to synthesize contrast-weighted images based on quantification of the longitudinal T1 relaxation, the transverse T2 relaxation, the proton density (PD), and the amplitude of the local radio frequency B1 field. Echo time (TE), repetition time (TR), and inversion time (TI) of the contrast-weighted image can be freely adjusted retrospectively. The purpose of this poster is to show the basic principles of synthetic MRI and presents the clinical applications of synthetic MRI in the evaluation of brain disorders.

Materials and Methods
1. Synthetic MRI was applied on: a. Brain metastases: maximizing contrast between metastases and parenchyma. b. Meningeal enhancement: using DIR to suppress the signals from brain parenchyma and fat in the bone marrow. c. Pediatric brains: appropriate parameters for each myelination stage. d. Other diseases: using double inversion recovery (DIR) and phase sensitive inversion recovery (PSIR) to detect MS plaques in multiple sclerosis. 2. Limitation of synthetic MRI: partial volume effect, especially for fluid inversion recovery (FLAIR) images.

Results
Synthetic T1IR imaging created better contrast between brain metastases and normal brain parenchyma compared with synthetic T1W or conventional T1IR imaging. The
ability to detect brain metastases was comparable among these imaging. DIR that suppresses unmyelinated white matter and CSF clearly showed myelinated area as hyperintensity. DIR and PSIR nicely showed some MS plaques that are not clear on T2WI and FLAIR.

Conclusions
Synthetic MRI images were useful in the evaluation of brain disorders. With Synthetic MRI, the contrast can be adjusted after the image has been acquired by manipulating TR, TE, and TI to optimize image quality. Limitation of synthetic MRI is the partial volume effect.

eEdE-34

6:30AM - 2:45PM

The Gamut of Autoimmune-Mediated Encephalitis - The Emerging Diagnostic Challenge

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Purpose
1. To familiarize the radiologists with the spectrum of autoimmune-mediated encephalitis (AME) and their variable clinical and imaging presentations. 2. To discuss and provide examples of overlapping imaging features of AME with other central nervous system (CNS) pathologies and to emphasize the need for multidisciplinary approach for accurate diagnosis.

Materials and Methods
Using retrospective laboratory-confirmed cases performed at our institution as case examples and literature review, we illustrate the various imaging findings of different AMEs and contrast them with other CNS disease processes that may have similar imaging characteristics.

Results
In this exhibit, we aim to illustrate the imaging features of various autoantibody-associated AMEs. This presentation will highlight the difficulties in differentiating them from other CNS disease processes and emphasize the need for a multidisciplinary approach to the care and treatment of these patients.

Conclusions
In recent years, autoantibodies targeting intracellular structures and neuronal surface antigens have been increasingly recognized as culprits to paraneoplastic CNS syndromes, limbic encephalitis, mesial temporal sclerosis, and many other neurological and psychiatric diseases. Hence, AME is much more prevalent and complicated than originally suspected. Often, imaging findings are normal, but certain imaging patterns may clue the radiologist to include AME in the differential
diagnosis. Ultimately, cerebrospinal fluid (CSF) serology is needed to make a definitive diagnosis. Nonetheless, imaging remains critical in the overall care in such patients, not only to suggest the possibility of AME, but also to exclude other mimicking CNS diseases as well. Therefore, raising awareness and understanding the intricacies of AME would benefit radiologists in contributing to the care of these often complicated patients.
eEdE-43

The Imaging Differential Diagnosis of Demyelination
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Purpose
To demonstrate differences and commonalities of various demyelinating diseases and mimics across inflammatory, neoplastic, vascular, infectious, toxic-metabolic, and traumatic etiologies with MR imaging to educate the training radiologist and neurologist.

Materials and Methods
Approximately 50 cases were selected from teaching files of various demyelinating diseases and demyelinating mimics across the categories listed above. Videos of pertinent MR sequences for each case were exported from PACS and depersonalized. Using video editing software, videos and case descriptions were compiled. Timed multiple choice questions, answers, and explanations were added to the video. A looping video was completed for all cases and exported in MPEG format.

Results
Demyelinating diseases represent a challenge to diagnose both clinically and by imaging. Various common and rare diseases can mimic demyelinating diseases, and potentially lead to delayed diagnosis, inappropriate treatment or resection, and worse outcomes for the patient. We have created an electronic education exhibit in video format with case descriptions, exported videos of pertinent MR sequences, multiple choice questions, and case explanations for each case to educate the training radiologist and neurologist.

Conclusions
The differential diagnosis of demyelinating disorders is substantial, and both common and rare mimics of demyelinating disease should be considered. Education on the imaging presentation of these diseases and mimics is needed, and an interactive video format is a potentially useful teaching tool.

eEdE-41

6:30AM - 2:45PM

The Imaging Features of Acute HIV Encephalitis - Characteristics and Pitfalls

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54th Annual Meeting & Foundation of the ASNR Symposium 2016
Purpose
At the end of the last century, the prevalence of opportunistic infections was shown to be decreasing, in contrast to the incidence of HIV encephalopathy which was shown to be increasing, possibly due to the increased survival time in the HAART era (1). Over the last 15 years the understanding of this process is improving, and thought to be related to peripheral macrophage infiltration into the brain. Perivascular and parenchymal macrophages fuse with each other and microglia to form multinucleated giant cells, which preferentially affect subcortical white matter, deep white matter tracts and the basal ganglia (2). In contrast, acute HIV encephalitis is rare and can present with a variety of clinical symptoms, including headaches, confusion, ataxia and obtundation (3). It is considered one of the the most severe neurological complications of acute HIV infection, and HAART can favorably change the clinical evolution (4). Some of the HIV invasion into the central nervous system (CNS) can occur prior to antibody tests being positive (5, 6). Thus, early recognition of the imaging findings of this condition may be of benefit.

Materials and Methods
We present an imaging review of the characteristics of acute encephalitis in HIV, with selected patient examples. We show the importance of reviewing the gray and white matter as well as findings of subtle swelling. The temporal features of the findings upon commencing HAART then are shown, with improvement of the gray matter changes earlier than the white matter.

Results
In distinction to HIV encephalopathy, acute HIV encephalitis demonstrates diffuse changes in white and deep gray, brainstem and cerebellar regions, with swelling also seen in some patients. Following HAART, the deep gray changes regressed early, whereas the white matter changes had partial and slow regression.

Conclusions
Recognition of the imaging features of acute HIV encephalitis can be important in initiating HAART early, and are in distinction to those imaging findings of longstanding HIV infection-related encephalopathy.

eEdE-39
6:30AM - 2:45PM
The Immunocompromised Host: Imaging Patterns of CNS Infections

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Purpose
Infections of the central nervous system (CNS) are a common condition with a high morbidity in the immunocompromised host. A compromised immune system not only predisposes the host to a higher incidence of infections but considerably broadens the spectrum of responsible pathogens. Besides the common pathogens in the general population, there are others that are almost exclusive to patients with impaired immunity as Toxoplasma, Cryptococcus or JC virus. Initial symptoms may be nonspecific as these patients may have a reduced response to infection and therefore less clinical and analytical repercussion. Complementary tests such CT and MRI play therefore a key role in the diagnosis. The aim of the exhibit is to review the radiological findings in opportunistic infections of the CNS and determine a possible etiologic classification according to the main finding.

Materials and Methods
We review the imaging tests of immunocompromised patients with CNS infections admitted to our hospital during the past 10 years.

Results
We classify the imaging findings into five categories: mass effect lesions, diffuse involvement of the white matter, meningeal involvement, ventricular involvement and focal parenchymal involvement (encephalitis). Even though different microorganisms can exhibit a wide overlap of imaging features, there are certain patterns that can point to a specific pathogen so depending on the predominant finding we perform a possible etiologic classification.

Conclusions
Central nervous system opportunistic infections are a common condition with high morbidity and mortality rates. Clinical manifestations in the immunosuppressed patient often are nonspecific so it is important that the radiologist is familiar with the imaging findings that allow establishing a diagnosis and an appropriate treatment.

The Multifaceted Imaging Appearance of Primary CNS Lymphoma

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Purpose
The purpose of this educational exhibit is to present the various imaging features of primary central nervous system lymphoma (PCNSL) in immunocompetent patients, as this brain tumor can be a great mimicker of both benign and malignant brain lesions. We will illustrate several key imaging features that are characteristics of PCNSL hence improve the accuracy of pre-operative diagnosis and guide surgical approach.
Materials and Methods
This exhibit will provide multiple cases of PCNSL in immunocompetent patients. This series of PCNSL includes cases that mimic glioblastoma multiforme, meningioma, neurosarcoidosis, tumefactive demyelination, metastatic disease, and other intra- and extra-axial lesions. These examples will be presented in a case-based format with discussion of key imaging features, along with teaching points to help one recognize this rare entity from more common brain lesions.

Results
Primary CNS lymphoma is a rare malignant neoplasm of the brain. It generally is confined to the CNS and is associated with poor overall survival. In immunocompetent patients, this entity can have a range of imaging appearances that mimic benign and malignant brain lesions. Distinguishing CNS lymphoma from other brain lesions can be difficult for radiologists given its relative rarity to other intracranial masses, though is paramount for appropriate clinical prognostication and treatment. Key imaging clues on CT and MRI can be extremely helpful in differentiating CNS lymphomas from other brain lesions: 1) Uniformly hypointense signal on T2. 2) Homogeneous enhancement. 3) Hyperdensity on CT. 4) Hypointense signal on ADC. 5) Intra-axial location (often periventricular).

Conclusions
Primary CNS lymphoma accounts for roughly 2% of all intracranial tumors and is potentially curable with methotrexate-based chemotherapy regimen. It is often thought of as being associated with immunosuppression, particularly from HIV/AIDS. However, its incidence is increasing in the immunocompetent patient population, where it can mimic both benign and malignant brain lesions. It is essential to maintain a high index of suspicion and to recognize its key imaging features to accurately diagnose primary CNS lymphoma for proper surgical and medical management. This educational exhibit illustrates several key imaging features that can improve the pre-operative diagnosis of PCNSL and guide therapeutic strategy.
The Social Network: the Neuroscience of Social Decision Making

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Purpose
Human beings are social creatures genetically equipped to interpret social cues. We can simulate social interactions through "games" defined as a competitive activity where players undertake actions with defined rules resulting in payoffs of defined utility. Each player makes decisions to maximize his utility but his payoff also depends on the decisions and actions of other players. Functional magnetic resonance imaging (fMRI) performed during these "games" provides insight in how we make social decisions. For example, what brain structures are activated during the cooperation and competitive actions during the prisoner's dilemma game? Is brain activity predictive of player responses during subsequent rounds? What brain areas are active during reciprocated trust or during empathy toward another's pain? Does brain activation differ whether our friend or enemy is in pain? Do brain responses demonstrate sex differences? Some study results are nonintuitive such as an fMRI experiment demonstrating faulty sensory perceptions as a consequence of peer
pressure. The purpose of our educational exhibit is to introduce the neuroscience of social decision-making.

Materials and Methods
We review key papers in the fMRI neuroscience literature demonstrating brain structure activity during various social interactions.

Results
Functional MRI-related investigations provide a unique window toward brain functioning during cooperative and competitive activities.

Conclusions
Interpersonal experiments with fMRI have dramatically broadened our understanding of brain function during social activity. We explore critical work done in this field highlighting the power of fMRI to forge insights between neural activity and various social feelings and interactions.
In Ultimatum Game, partner’s task is to divide a sum of money with player who must decide either to accept or reject partner’s offer. With rejected offers neither player receives anything. Standard economic models predict that all non-zero offers should be accepted—some money is better than none, but about half of offers are rejected.
Purpose
Perivascular spaces (aka Virchow-Robin spaces) can pose diagnostic dilemmas for radiologists because of their varied appearance, which can sometimes mimic serious pathology. The purpose of this educational exhibit is to illustrate multiple cases of enlarged perivascular spaces, which are either benign or associated with more worrisome pathological conditions and to review imaging characteristics that can help distinguish between these two possibilities.

Materials and Methods
Multiple examples of benign enlarged perivascular spaces and pathological entities associated with perivascular spaces will be presented in an interactive case-based format with discussion of the available literature. Typical and less typical diagnostic features will be highlighted along with a discussion of their differential diagnoses.

Results
Over a dozen cases seen at the University of Pennsylvania Health System will be included in this interactive educational exhibit. Discussion of the cases will include a review of key imaging concepts, which may aid in distinguishing a lesion as benign or pathologic. The cases discussed fall into the following major categories: 1) Prominent perivascular spaces that mimic pathologic entities, such as simple dilated perivascular spaces in the anterior temporal subcortical white matter (Fig. 1A), tumefactive perivascular spaces mimicking cystic neoplasms (Fig. 1B), lacunar infarcts and low-grade gliomas. 2) Pathologic entities mimicking benign perivascular spaces such as a multinodular and vacuolating neuronal tumor (Fig. 1C), dysembryoplastic neuroepithelial tumor, pilocytic astrocytoma, pleomorphic xanthoastrocytoma and neurocysticercosis. 3) Pathologic entities directly involving perivascular spaces, including sarcoidosis, cryptococcosis, mucopolysaccharidosis and primary central nervous system (CNS) lymphoma. 4) Symptomatic enlarged perivascular spaces causing obstructive hydrocephalus (Fig. 1D).

Conclusions
The varied appearance of perivascular spaces can sometimes pose a diagnostic challenge even for experienced radiologists. Perivascular spaces can have a number of atypical appearances that may mimic pathologic entities. Conversely, certain pathologic entities can occasionally have the appearance of a benign or enlarged perivascular spaces. Accurate diagnosis is imperative in avoiding unnecessary biopsies for normal entities. This exhibit highlights key imaging differences in the appearance of benign versus pathologic processes involving or mimicking perivascular spaces.
Figure 1) Sample Cases of Dilated Virchow Robin Spaces. A) Dilated perivascular space mimicking a cystic neoplasm in the left temporal subcortical white matter with associated surrounding T2 signal change B) Tumefactive perivascular space in the pons mimicking a cystic neoplasm seen on a T1-weighted image C) Multinodular and vacuolating neuronal tumor mimicking a perivascular space seen on a T2-weighted image D) Enlarged perivascular space causing hydrocephalus seen on T2-weighted image.
Thunderclap Headache Beyond Aneurysms- A Clinically Integrated Approach

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Purpose
Define thunderclap headache (TH). Review the differential diagnosis and entities that can present with acute, severe headache. Discuss whether it is possible to clinically distinguish between benign and malignant causes of TH. Review the workup of TH with focus on whether a lumbar puncture is necessary. Present representative cases for each differential diagnosis.

Materials and Methods
Review of literature discussing differential diagnosis and workup of TH with emphasis on whether computed tomography angiography (CTA) can replace lumbar puncture if CT of head is negative. Review of imaging and clinical information for 75 consecutive patients at a single hospital system presenting with TH and receiving CTA or magnetic resonance angiography (MRA) and determining specificity and sensitivity as well as percentage of patients with each diagnosis.

Results
Thunderclap headache is defined as very severe headache which reaches maximum intensity within 1 minute. Thunderclap headache classically is associated with subarachnoid hemorrhage, which is aneurysmal in origin in 85% of cases and can be benign perimesencephalic hemorrhage in 10-15% of cases. Differential diagnosis includes reversible vasoconstrictive syndrome/posterior reversible leukoencephalopathy syndrome, cerebral venous sinus thrombosis/cortical vein thrombosis, arterial dissection, orgasmic/exertional headache, spontaneous intracranial hypotension, pituitary apoplexy, primary thunderclap headache (idiopathic). Results of retrospective review will be presented.

Conclusions
Workup of acute onset, severe headache is complex. Thunderclap headache frequently is caused by subarachnoid hemorrhage, most frequently aneurysmal. We will review the work up of thunderclap headache and controversies involved. The review of differential diagnosis and imaging findings of acute, severe headache will help the reader have a systematic approach towards this diagnosis.
**To Begin at the Beginning: Imaging Features and Embryological Basis of Variants and Anomalies of Cerebral Circulation**

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**Purpose**

The purpose of our exhibit is to present the imaging features of variants and anomalies of cerebral circulation in light of embryological development. The adult intracranial vascular anatomy is essentially a sum of the environmental influences during
embryonic development. The intracranial arterial system is established between 4-8 weeks of gestation beginning as a vascular mesh work within the meninx primitiva followed by formation of choroid plexus. Subsequently, the brain arteries develop from specific choroidal feeder vessels arising from the meningeal vascular mesh work establishing adult arterial pattern by as early as 8 weeks. By contrast, gross venous pattern is recognizable at end of first trimester and continues to adapt passively even after birth. There are several steps in development of cerebral arterial and venous system and deviations from these normal steps of embryological development forms the basis of intracranial vascular variations and anomalies.

Materials and Methods

Our presentation will be a didactic electronic exhibit that will include initial overview of the development of intracranial arterial and venous circulation. This section will succinctly discuss the steps of arterial and venous vascular development with illustrations. Following sections will describe the imaging features of variants and anomalies of cerebral circulation using imaging [computed tomography angiography (CTA), magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA)] examples and correlate the imaging findings with the underlying developmental abnormality.

Results

The imaging cases will include examples of persistent carotid-vertebrobasilar anastomoses, variations of circle of Willis, variations of intracranial internal cerebral artery, anterior cerebral artery, middle cerebral artery, anterior choroidal artery, posterior cerebral artery, vertebral artery and basilar arteries. Some of the venous anomalies such as vein of Galen malformation and developmental venous anomalies will be illustrated with imaging examples.

Conclusions

Variations and anomalies of cerebral circulation commonly are encountered in clinical practice. Understanding the developmental basis of variations and anomalies of cerebral circulation can potentially improve recognition and characterization of these abnormalities on MRI and CT imaging.
eEdE-91

Treatment Related MR Imaging Findings in Patients with High Grade Glioma After Radiotherapy and Chemotherapy

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Purpose
To provide a broad review of the various treatment-related changes and characteristic MR imaging findings in patients with high grade glioma after undergoing radiotherapy (XRT) and chemotherapy.

Materials and Methods
A literature review will be performed to accurately discuss the treatment changes and imaging appearances followed by a pictorial essay of selected examples.

Results
Intracranial and regional radiation to the brain often leads to a number of significant changes that complicate the assessment of post-treatment outcomes. Leukoencephalopathy often is seen post-XRT because white matter (WM) is recognized as the element of the brain most vulnerable to irradiation. Diffusion tensor imaging (DTI) fractional anisotrophy often show decrease in areas of early WM damage. Radiation necrosis and tumor reoccurrence can both present with contrast enhancement, mass effect and vasogenic edema. Radiation necrosis tends to have conversion from no enhancement to enhancement, remote new enhancement, new periventricular enhancement, and soap-bubble/Swiss cheese enhancement. However, involvement of the corpus callosum combined with multiple enhancing lesions tends to favor progressive glioma. Other post-XRT changes include radiation-induced meningioma, cavernous malformation, and optic neuropathy. Chemotherapy treatments also create difficulty in post-treatment response interpretation. Pseudoprogression is nontumoral enhancement likely associated with inflammatory local tissue reaction and edema caused by treatments such as temozolomide. Pseudoresponse is post-treatment decrease in contrast enhancement not associated with true tumor reduction. Bevacizumab (BEV) is an antiangiogenic agent that causes this apparent treatment response likely by improving the blood-brain barrier and reducing the capillary permeability. The combination of radiation therapy and BEV also can result in restricted diffusion as a manifestation of radiation necrosis.

Conclusions
Radiation injuries to the central nervous system (CNS) are well documented and can occur within weeks in the form of vasogenic edema but often have additional delayed effects months to years later including leukoencephalopathy, cerebral atrophy, necrosis, induction of neoplasm and vasculopathy. Chemotherapy has been found to complicate the post-treatment picture by pseudoprogression and pseudoresponse. By understanding the typical post-treatment responses seen in MR imaging, better clinical decisions can be made.

eEdE-104
6:30AM - 2:45PM

Trephine Syndrome and Paradoxical Brain Herniation: A Review of Clinical and Imaging Features in Post-Craniectomy Patients
Purpose
Trephine syndrome (sunken skin flap) and the related entity of paradoxical brain herniation are postcraniectomy complications carrying significant morbidity and mortality. The purpose of this study is to review the clinical and radiographic features of these syndromes and their management.

Materials and Methods
We report clinical history, imaging findings, and management of two patients presenting with features compatible with trephine syndrome and paradoxical brain herniation. A brief review of the literature also is provided.

Results
Patient 1 is a 33-year-old female who presented with new onset seizures 2 months following decompressive hemicraniectomy and ventriculoperitoneal shunting for a posterior communicating artery aneurysm rupture complicated by malignant middle cerebral artery infarction. A noncontrast computed tomography (CT) of the head was obtained (Fig. 1B) that demonstrates a concave deformity to the subgaleal-dural complex at the craniectomy site not present on pre-seizure comparison CT (Fig. 1A). The patient underwent craniotomy with resolution of seizures. Patient 2 is a 37-year-old male who underwent decompressive hemicraniectomy and ventriculoperitoneal shunting for traumatic subdural hematoma and was noted to have new onset bilateral pupil dilation during the hospital course 2 months later. A noncontrast CT of the head (Fig. 2A) demonstrated a sunken appearance to the subgaleal-dural complex with midline shift away from the hemicraniectomy site. The patient underwent craniotomy with resolution of the sunken appearance (Fig. 2B) and clinical improvement.

Trephine syndrome and paradoxical brain herniation are uncommon postcraniectomy complications due to atmospheric pressure. The presence of ventriculoperitoneal shunting is an independent risk factor for paradoxical brain herniation. Both syndromes can present with headache, seizure, sensorimotor deficits, and cognitive or behavioral changes. Ominous signs favoring paradoxical brain herniation include decreased consciousness, autonomic instability, and brainstem release signs. Characteristic CT features including a concave subgaleal-dural complex at the craniectomy site, and the presence of midline shift away from the craniectomy site suggests paradoxical brain herniation, a neurosurgical emergency. Cranioplasty is the definitive treatment, and most patients improve rapidly following cranioplasty.

Conclusions
Trephine syndrome and paradoxical brain herniation are uncommon postcraniectomy complications with characteristic imaging findings. The presence of a depressed flap over the craniectomy site, with or without subfalcine herniation away from the
cranectomy site, should prompt their diagnosis. Early recognition and management with cranioplasty prevents significant morbidity and mortality associated with these entities. This report presents two cases and reviews the clinical and imaging features of these syndromes as well as their management.
Ultrafast Brain MR Imaging: Current and Emerging Techniques

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Purpose
To describe practical protocols for ultrafast brain MR imaging using commercially available sequences and to provide a general overview of new sequences that could further accelerate magnetic resonance imaging (MRI) acquisitions.

Materials and Methods
Optimized MRI protocols for ultrafast brain MR imaging were compiled for different commercially available scanners to provide a practical framework for patients who cannot tolerate long MRI acquisition times, including pediatric cases and patients with altered mental status. Current state-of-the-art MR sequences and promising emerging techniques for ultrafast brain imaging are discussed, including brief descriptions of their physical principles and potential clinical applications.

Results
The combination of parallel imaging, multichannel head coils and optimized MR sequences can result in ultrafast brain MR protocols that can be used for imaging of unstable, critically ill and/or motion-prone patients; for performing dynamic or real time MR imaging or to accelerate the acquisition of basic MR protocols (1). Common commercially available sequences can be optimized to eliminate unnecessary acquisition and processing steps to accelerate routine MR protocols. New MR techniques that promise to further accelerate the acquisition of MR images include Simultaneous Multislice Echo Planar Imaging (2, 3), Magnetic Resonance Fingerprinting (MRF) (4), Compressed Sensing (5), spiral GRAPPA reconstruction, and single-shot spatiotemporally-encoded (SPEN) techniques.

Conclusions
The proper use of multichannel head coils, parallel imaging and careful optimization of commercially available MR sequences can significantly accelerate most clinical MR protocols. There are several MR technologies in the pre-clinical development...
pipeline that promise further reduction of acquisition times with similar or higher diagnostic accuracy.

Usefulness of the DynaCT Digital Angiography for the Study of Pathologies of the External Carotid Artery Branches

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Purpose
To recognize the anatomy of the external carotid artery (ECA) and its branches in different pathologies, using DynaCT digital angiography (Siemens, Erlangen, Germany).

Materials and Methods
Retrospective evaluation of DynaCT digital angiography studies of ECA and its branches, in patients with brain, head and neck pathologies, made in the Dr. Asenjo Institute of Neurosurgery between August 2013 and November 2015. We did injections from 10 to 15 cc of an isosmolar, nonionic, iodinated contrast agent (Visipaque R) using a biplane flat-panel detector angiographic suite (AXIOM Artis FD Biplane Angiosuite with DynaCT; Siemens Medical Solutions, Erlangen, Germany). A DynaCT acquisition was obtained by using the following parameters: 20-second rotation; 0.4° increment; 1024 × 793 matrix; 217° total angle; ~11°/s, ~30 frames/s, system dose 1.2 μGy/frame, total of 538 projections and field of view of 48 cm. Image reconstruction was performed on a workstation (X-Leonardo with DynaCT; Siemens Medical Solutions). The volume dataset produced with typical voxel size 0.4 mm by X-Leonardo was interactively manipulated in orthogonal planes. Radiation dose to patients was up to 60 mGy.

Results
We evaluated a total of 110 patients (57 women and 53 men; age range, 2-72 years; mean 39.5 years) with different pathologies of the brain, head and neck (tumors, dural fistulas, arteriovenous malformations, arterial dissections, moyamoya disease, congenital and inflammatory artheropathies) that underwent DynaCT digital angiography. We made supra selective injections into the branches of the ECA that allowed us to identified and know well their courses, anatomical relationships with the skull and anastomosis, being an important clue for understanding the vascular supply, etiology and the eventual best way of treatment in the investigated entities.

Conclusions
The DynaCT digital angiography is an important radiologic tool in the understanding
of the vascular ultrastructure of the ECA and its branches, in a range of central nervous system, head and neck pathologies.

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eEdE-52

Usual and Unusual Imaging Findings of Herpes Encephalitis – Imaging Pitfalls, Differential Diagnosis, and Pathological Correlations

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Purpose
Herpes simplex encephalitis (HSE) is the most common cause of fatal encephalitis. Untreated, the fatality rate in herpes encephalitis approaches 70 percent and nearly two-thirds of survivors will have significant neurologic deficits. It requires prompt diagnosis and specific antiviral treatment. However, there also are other disorders including human herpes virus 6 (HHV-6) or other viral infections, limbic encephalitis, post-ictal changes, gliomatosis cerebri and lymphoma, which may mimic HSE on magnetic resonance imaging (MRI) and which require different treatments. This educational exhibit will review the pathophysiology, pathology, and demonstrate characteristic multimodal imaging findings and pitfalls in the diagnosis of herpes encephalitis as well as the differential diagnosis.

Materials and Methods
Characteristic findings of HSE will be reviewed with imaging modalities including computed tomography (CT), conventional MRI, diffusion-weighted imaging (DWI), susceptibility-weighted imaging (SWI) and nuclear medicine. Pathology will show the radiopathologic correlation. A review of other disorders which mimic HSE on imaging will be presented.

Results
Herpes simplex encephalitis has been postulated to arise from spread of virus from sensory ganglia to the meninges overlying temporal lobes or from reactivation of latent virus within the brain. Magnetic resonance imaging is the most sensitive and specific imaging modality, especially in the early course of the disease. Typical MR imaging findings include high signal intensity on T2-weighted and FLAIR imaging within medial temporal lobes, inferior frontal lobes, and insula with or without enhancement or petechial hemorrhage. Diffusion-weighted imaging (DWI) is more sensitive for early disease and SWI demonstrates the distribution of bleeding more precisely. Computed tomography will demonstrate a similar distribution of findings on MRI but is only 50 percent sensitive. Asymmetric global involvement can be seen in neonates. Unusual distributions such as isolated frontoparietal or brain stem involvement also can be seen. Other disorders also can involve a similar distribution and should be recognized in the differential.

Conclusions
Herpes simplex encephalitis is a life-threatening disease for which early diagnosis is essential. The radiologist must recognize the characteristic imaging findings and pitfalls as well as be able to distinguish it from mimics to reach the diagnosis.
Usual and Unusual Imaging Presentations of Progressive Multifocal Leukoencephalopathy - Imaging Pitfalls, Differential Diagnoses and Pathological Correlations

E Saad Aldin¹, t moritani², P Kirby³, A Capizzano¹
Purpose
Progressive multifocal leukoencephalopathy (PML) has become more common with the HIV pandemic, increased use of immunomodulatory drugs for the treatment of autoimmune disorders, and various immunodeficiency states. The imaging manifestations are now known to be more diverse and complex than previously described, and are significantly altered by novel treatment of HIV and PML. The purpose of this educational exhibit is to demonstrate various clinicopathologic and radiologic presentations of PML, with a focus on usual and unusual imaging presentations, diagnostic pitfalls, differential diagnoses, and pathological correlations.

Materials and Methods
Using the current literature as well as our institutional experience, the goal of this exhibit is to describe the usual and unusual presentations of PML across different imaging modalities, MRI including diffusion tensor imaging, CT, and PET. Emphasis also will be made to differential diagnoses, pitfalls in diagnosis, and pathological correlations.

Results
Progressive multifocal leukoencephalopathy typically shows white matter lesions on T2WI (starry sky appearance) extending into U-fibers with peripheral reduced diffusion and decreased anisotropy. Recent evidence makes it clear that PML may not have a progressive course, may not be multifocal, and may not be contained within the white matter. It may spread along the corticospinal tract (pseudo-ALS sign). Progressive multifocal leukoencephalopathy is no longer limited to HIV and lymphoproliferative disorders, and an increasing percentage of patients with PML are organ transplant patients or rheumatologic or autoimmune disorders receiving immunomodulatory therapy. Lesional enhancement depends on the immune status and treatment effect. Progressive multifocal leukoencephalopathy has various clinicopathologic and radiologic manifestations, "the chameleon of neuroinflammation". The early diagnosis (e.g., punctate pattern on MRI) is important, especially in the setting of iatrogenic immunosuppression or immunomodulator therapy.

Conclusions
The authors will present an educational exhibit focusing on the various clinicopathologic and radiologic presentations of PML, with a focus on usual and unusual imaging presentation, diagnostic pitfalls, differential diagnoses, and pathological correlations.

eEdE-32

Utility of fMRI in Evaluation of Depression
Purpose
Major depressive disorder (MDD) is a prevalent clinical condition with huge socioeconomic burden on society. Advancement in understanding of pathophysiology and underlying neuromechanisms have led to improved clinical diagnostic criteria and development of a multitude of treatment regimens. Imaging has generally played a secondary role in evaluation of these patients. However, with the rapid evolution of functional magnetic resonance imaging (fMRI), neural systems associated with depression have been uncovered. In this review, we aim to discuss the role of subcortical as well as cortical (particularly prefrontal and cingulate) brain regions (modulated by serotonin and dopamine neurotransmission) as evaluated on resting state functional magnetic resonance imaging (rsfMRI).

Materials and Methods
Discuss pathophysiology of MDD, review role of support emotion processing, reward seeking, regulate emotion and its role in MDD. Review principals of rsfMRI as well as common pearls and pitfalls of this imaging technique. Discuss role of default mode network subregions, lateral frontal areas (within a frontoparietal network associated with cognitive control), basal ganglia, hippocampus, frontal lobe (including the orbitofrontal cortex) and less consistently the cingulate cortex and thalamus as well as the insula, and cerebellum.

Results
Role of dopamine and serotonin pathways in depression.
Pictorial review of rsFMRI findings within the DMN, frontotemporoparietal lobes, as well as deep gray nuclei and cerebellum.
Discuss rsFMRI activation patterns used in evaluation of patients pre and post serotonin reuptake inhibitor therapy.

Conclusions
Resting state fMRI studies in depression can identify pattern of brain regions associated alterations in neuronal connectivity especially within the posterior DMN components (related with self-preferential processing), within the lateral frontal areas (associated with externally directed cognition), insula and basal ganglia. Additionally, rsFMRI can demonstrate alterations in neuronal activity in patients before and after serotonin reuptake inhibitor therapy, which can potentially serve as a guide for monitoring treatment response.

eEdE-51
Variable Imaging Manifestations of Sarcoidosis in Brain, Head and Neck, and Spine

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Purpose
To present a review of the common and uncommon patterns of neuroimaging appearance of sarcoidosis.

Materials and Methods
Imaging studies [magnetic resonance imaging (MRI) including diffusion-weighted imaging and susceptibility-weighted imaging, radiograph, computed tomography (CT) and nuclear medicine] in patients with biopsy-proved or clinically diagnosed sarcoidosis were reviewed with emphasis on variable imaging patterns at different sites, pitfalls and the differential diagnosis.

Results
The common MRI findings of neurosarcoidosis are areas of linear or nodular perivascular or leptomeningeal enhancement, and dural thickening with or without enhancement or T2 dark signals. Multifocal areas of FLAIR hyperintensity or diffusion restriction often are associated with perivascular enhancement. Cranial nerve enhancement can be seen with or without enlargement. The less common involvement are orbital or lacrimal gland mass-like lesions, pituitary stalk thickening, enhancing intramedullary cord lesions associated with edema and cord expansion. Sclerotic bony lesions in the skull base or vertebral bodies at any level can also be seen on x-ray and CT, appearing as enhancing discrete marrow lesions on MRI. Imaging findings can be due to primary disease, associated infections or complications of the treatment.

Identification of the suggestive imaging pattern is followed by appropriate workup for granulomatous infections like tuberculosis, histoplasmosis/fungal infections and inflammatory process like SLE, rheumatoid, Wegener's, Sjogren's, or inflammatory pseudotumor or IgG4 disease depending on clinical presentation. Meningioma, lymphoma, progressive multifocal leukoencephalopathy and leptomeningeal metastases also are a common differential. The distinction from infection is especially critical since steroids and immunosuppressants like methotrexate and azathioprine are the mainstay of therapy.

Conclusions
The knowledge of varied imaging presentations of sarcoidosis helps streamline the diagnostic workup, and optimize patient management.
Vasculitis: Clearing the Confusion - Establishing a Diagnostic Protocol for Vasculitis

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1Vancouver General Hospital, Vancouver, British Columbia

Purpose
Inflammatory stenoses of cerebral blood vessels, although rare, are an important cause of cerebral ischemia in younger patients. Diagnosing this pathology is challenging given that common imaging findings are nonspecific and can mimic a broad variety of pathologies. To optimize time and resources, it is important to define the value of the different diagnostic methods and establish a diagnostic algorithm. Magnetic resonance imaging (MRI) is a recognized method to evaluate these cases and MR angiography (MRA) is useful in the assessment of intracranial stenosis. However, at 1.5 T it is only diagnostic for stenoses of large brain arteries. Conventional angiography is still required in some cases to investigate stenoses of medium and small-sized brain arteries. With the advances in 3T MRI in recent years, MRI can directly demonstrate mural thickening and contrast enhancement in basal brain arteries, potentially reducing the need for biopsy in this patient group.

Materials and Methods
Relevant literature was reviewed in order to evaluate the utility of the diagnostic methods commonly utilized in the assessment of patients with suspected vasculitis, to establish the utility of each method, and to develop an algorithm taking into account the availability or not of 3T MRI. A modified Chapel Hill nomenclature was utilized, according to the size of the affected brain vessels, analogous to the pertinent nomenclature of Primary Systemic Vasculitis. This was used to narrow the range of possible differential diagnoses, since the direct application of the systemic vasculitis classification would deem all intracranial vessels as medium-sized and small vessels. The classification proposed divides the intracranial vessels in large, medium and small vessels.

Results
Magnetic resonance imaging and MRA are valuable noninvasive tools for the diagnosis of cerebral vasculitis, identifying direct and indirect signs of the pathology. In vasculitic disease of the large brain arteries, the demonstration of contrast enhancement in the wall of stenotic vessels may be the most specific test for inflammatory disease, even exceeding that of biopsy (high-resolution T1 at 3T MRI is required). In vasculitis of medium-sized brain vessels, MRA is not sufficient to reliably diagnose vascular stenosis, particularly 1.5T. Digital subtraction angiography (DSA) still may be required in select cases, particularly when DSA would aid in the
selection of a region for biopsy. At present, imaging resolution is not sufficient to
diagnose small vessel vasculitis, where brain biopsy is still useful.
Conclusions
The first imaging test should be MRI/MRA. If this is diagnostic and sufficient to
determine treatment, then no additional imaging is required. If it is negative but there
is high clinical suspicion, DSA could be performed, taking into account that biopsy
might ensue. If MRI/MRA is diagnostic but there is further vascular assessment
needed, DSA can be used.

What do You Think of When You See a Corpus Callosum Lesion? Differential
Diagnosis Based on the Sagittal Midline MR Image

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Purpose
The corpus callosum (CC) is the largest white matter commissure between the
cerebral hemispheres and has four segments (rostrum, genu, body and splenium) and
two borders (upper and lower). It is susceptible to involvement by a variety of
conditions and diseases. Our aim is to demonstrate specific findings on sagittal
magnetic resonance imaging (MRI) that lead to a correct diagnosis.
Materials and Methods
After reviewing our institution teaching files, we selected examples of lesions in the
corpus callosum shown on MRI in which the midline sagittal plane image provided
specific information that lead to a confident diagnosis of the underlying
condition/disease.
Results
Pathology of the CC includes a variety of entities that arise from different causes such
as congenital, inflammatory, tumor, degenerative, infectious, metabolic, traumatic,
vascular and toxic agents. The CC or a specific part of it may be selectively affected.
Magnetic resonance imaging in three planes but especially in sagittal can be used to
detect developmental/acquired lesions. Lesions can be approached based on their
locations as those that affect upper border, central zone and lower border. Focal
lesions that involve its lower border include multiple sclerosis (callosal-septal
interface), ADEM (reaches the upper and lower margins, and frequently affects the
splenium) and lymphoma (typically crosses or involves the CC with ependymal
enhancement). Lesions that involve the central zone most commonly include
Marchiafava-Bignami disease, Susac's syndrome (central lesions) and ischemia
(without involvement of the upper and lower margins). Lesions that affect the upper
border typically are due to hydrocephalus or lipomas which usually are situated in the upper posterior part of the CC and may be asymptomatic. Some lesions that affect the CC in a diffuse manner include glioblastoma and rarely oligodendroglioma. Some lesions may show transient DWI restriction within the splenium such as hypoglycemia, acute withdrawal of the Carbamazepine or various infectious agents, which can completely reverse within 1–2 week. Less common entities also may affect the CC as part of their spectrum of findings with no specific pattern of involvement like adrenoleukodystrophy and mucopolysacharidoses (Virchow Robin spaces). The correct interpretation of the lesions location in the sagittal plane helps narrow the differential diagnosis and allows accurate diagnosis.

Conclusions
Magnetic resonance imaging in sagittal plane of the CC is very useful and may provide clues with respect to patterns and extent of different diseases narrowing the differential diagnosis and facilitating an accurate diagnosis.

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eEdE-01

What the Neuroradiologist Needs to Know From Anatomy to Functional Imaging of Movement Disorders

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Purpose
1. To describe the normal basal ganglia functional anatomy responsible for normal movement co-ordination. 2. To illustrate with examples the role of (structural and molecular) neuroimaging in diagnosis of patients with movement disorders. 3. To discuss the role of deep brain stimulator in the treatment of movement disorder.

Materials and Methods
Retrospective review of the imaging studies of 311 patients with clinical diagnosis of movement disorders forms the basis of this exhibit. All patients had magnetic
resonance imaging (MRI) brain. Twenty percent of these patients had diffusion tensor imaging (DTI) and MR spectroscopy, 17 patients had fMRI and 42 patients underwent DAT scan. For the data analysis and for the purpose of this exhibit we used a Fahn, Marsden, and Jankovic classification of the movement disorders: Hypokinesia (decreased amplitude of movement) and hyperkinesias (excessive movements). Common disorders seen causing hypokinesia include: 1. Parkinson's disease 2. Parkinson syndrome [Diffuse Lewy Body Disease, Multiple Systems Atrophy, Progressive Supranuclear Palsy, Corticobasal Degeneration, Vascular Parkinsonism, Post-traumatic Parkinsonism, Secondary (Toxin, Medication, Metabolic)]. Hyperkinesia includes: Tremors, Chorea, Dystonia, Myoclonus, Ataxia and Dysmetria, Stereotypes and Tics, Akathisia, Myokymia and Synkinesias, Restless Legs, Periodic Hypnogogic Movements (PLMS).

Results
The request for movement disorders (MD) commonly is encountered in a neuroimaging practice. The clinical presentation of movement disorders is complex, often variable, and sometimes even bizarre. Therefore, establishing the correct diagnosis, can be challenging, even in the hands of experienced movement disorder specialists. Movement disorders can be either primary or secondary due to underlying central nervous system (CNS) disease or a primary movement disorder. Imaging of this condition has significantly improved with the advent of molecular/cellular imaging, especially with DTI, MR spectroscopy, fMRI and PET-SPECT-specially DAT scan. Diagnosis of this condition is by detail clinical examination, observation of the movement, and correlation with imaging findings.

Conclusions
1. With the advent of molecular and cellular brain imaging it is possible to demonstrate the associated imaging changes in many of the movement disorders. 2. This exhibit will introduce the viewers to the basic functional anatomy and imaging appearance of the various movement disorders. 3. This exhibit will be core learning tool for imaging of movement disorders.
Idiopathic PD presents with four symptoms: Tremor, Rigidity, Bradykinesia (slowness of movement), Postural impairment.
Whooshing (Wishing) for a Diagnosis: The Increasing Role of Imaging in the Evaluation of Pulsatile Tinnitus

Z Clark¹, K Johnson², Y Wu², P Turski³, T Kennedy⁴
¹University of Wisconsin Hospital and Clinics, Madison, WI, ²University of Wisconsin, Madison, WI, ³University Of Wisconsin, Madison, WI, ⁴University Of Wisconsin Hospital, Madison, WI

Purpose
This educational exhibit will review common causes of pulsatile tinnitus through a case-based approach to characterize the role of imaging in the diagnostic evaluation of pulsatile tinnitus. The objectives of the exhibit are: 1) to describe a differential diagnosis for pulsatile tinnitus, 2) outline where imaging fits into the overall evaluation of pulsatile tinnitus, and 3) review different imaging options (CT, MR, CTA, MRA). The strengths and weaknesses of each imaging modality will be reviewed. Emphasis will be placed on black blood MRI and time resolved contrast-enhanced magnetic resonance angiography (TR CEMRA) techniques using constrained reconstruction and compressed sensing for evaluation of dural arteriovenous fistulas (DAVFs) and arteriovenous malformations (AVMs).

Materials and Methods
There are approximately 16 recognized causes of pulsatile tinnitus, which are best thought of using a compartment-based approach (Table 1). Several example cases from each anatomical region will be shown using multiple modalities such as ultra high-resolution flat panel temporal bone CT, multiphase CTA/MRA of the neck, and 4D contrast-enhanced MRA of the temporal bone.

Results
When a specific pathology is suspected prior to imaging, the exam can be tailored to best characterize the region of interest. For example, otosclerosis is best evaluated using temporal bone CT, while carotid dissection is better evaluated with CTA or MRA of the neck. Vascular malformations with arteriovenous shunting including DAVFs and AVMs are best delineated with DSA but improvements in temporal and
spatial resolution of TR CEMRA have improved our ability to characterize these lesions noninvasively.

**Conclusions**
Pulsatile tinnitus is a common clinical presentation with a variety of causes. The etiology of pulsatile tinnitus is inherently vascular making evaluation of the intracranial and extracranial vessels crucial in imaging evaluation. Time-resolved CEMRA with improved temporal and spatial resolution is emerging as an important tool in characterizing several etiologies of pulsatile tinnitus.

**Table 1.**

<table>
<thead>
<tr>
<th><strong>Neck</strong></th>
<th><strong>Temporal bone</strong></th>
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</thead>
<tbody>
<tr>
<td>Carotid Dissection</td>
<td>Otosclerosis</td>
</tr>
<tr>
<td>Carotid Stenosis</td>
<td>Otospongiosis</td>
</tr>
<tr>
<td>Fibromuscular dysplasia</td>
<td>Glomus tympanicum</td>
</tr>
<tr>
<td></td>
<td>jugulotympanicum</td>
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<tr>
<td><strong>Intracranial</strong></td>
<td>Dehiscent semicircular carotid artery</td>
</tr>
<tr>
<td>AVM</td>
<td>Paget disease</td>
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<tr>
<td>Benign intracranial hypertension (pseudotumor cerebri)</td>
<td>Aberrant/dehiscent ICA aneurysm</td>
</tr>
<tr>
<td><strong>Dura Mater</strong></td>
<td>Persistent stapedial aneurysm</td>
</tr>
<tr>
<td>DAVF</td>
<td>High riding/dehiscent ICA aneurysm</td>
</tr>
<tr>
<td>Stenosed dural sinus</td>
<td>Aberrant sigmoid sinus</td>
</tr>
</tbody>
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**Monday**
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-02
"Hoarsing" around: An anatomic and pathologic review of vocal cord paralysis.

T Sato1, D Zander2, L Gentry3, D Reede4, W Smoker5
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Purpose
With a complex pathway of innervation, vocal cord paralysis (VCP) can arise from a diverse variety of etiologies. It is essential for radiologists to be familiar with the anatomy involved in cases of VCP, both in preparation of the appropriate exam, and in interpretation of the study.

Materials and Methods
- Review typical and variant innervation to the larynx.
- Introduce our typical imaging workup for VCP.
- Illustrate radiographic findings of VCP.
- Present pathology throughout the pathway of laryngeal innervation.

Results
Innervated by the parent vagus nerve, VCP can be caused by lesions in varied locations, including the brainstem, skull base, carotid space, visceral space, and mediastinum. As such, any imaging studies performed for evaluation of VCP should adequately assess each of these locations. Frequently asymptomatic, recognition of features of paresis on routine imaging also is expected. Although damage to the vagus nerve or its recurrent laryngeal nerve branch represent the most common etiologies of VCP, one should be knowledgeable of paresis caused by pathology affecting the external branch of the superior laryngeal nerve. Categorized by location (brainstem, skull base, carotid space, visceral space, and mediastinum), we present a variety of pathologic conditions that resulted in VCP.

Conclusions
Vocal cord paralysis can result from many different pathologies. It is important for the radiologist to recognize imaging features of VCP, and be familiar with the anatomical course of the vagus nerve and its branches to accurately identify the site of pathology.
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¹University of Chicago, Chicago, IL

Purpose
Vascular cutaneous anomalies include a vast and varied collection of abnormalities that have been described in the dermatology and neuroradiology literature. This topic includes and extends beyond the often examined vascular malformations. Radiologists are in a unique position to aid the clinician in synthesizing clinical data and guide the appropriateness of imaging.

Materials and Methods
We will begin with an updated review of the classification of cutaneous vascular anomalies with clinical images and correlative imaging findings. We will review magnetic resonance imaging (MR)I, computed tomography (CT), and ultrasound appearance of these anomalies. Next, in an image-rich format, we will review syndromes associated with vascular malformations of the head and neck with the associated dermatologic appearance, clinical history, and abnormal neuroradiology examples.

Results
Cutaneous vascular malformations in the head and neck can be differentiated between vasoformative lesions based on clinical history and imaging. Once the diagnosis of vascular malformations is made, differentiating slow flow from fast flow lesions is essential. In addition, familiarity with the syndromes associated with the various types of cutaneous vascular anomalies will allow the physician/radiologist to decide what imaging modalities will lead to an accurate diagnosis.

Conclusions
Radiologists can contribute to the care of patients by acting as a consulting service to synthesize dermatologic findings and patient history to guide clinicians to the appropriate imaging modalities for diagnosis as well as follow-up imaging.
A Case Series Illustrating the CT and MRI Imaging Features of Sinonasal Schwannomas

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1Rutgers University- New Jersey Medical School, Newark, NJ, 2Rutgers- New Jersey Medical School, Newark, NJ

Purpose
Schwannomas are slow-growing, benign tumors of the nerve sheath, which, although rare, can be seen in the sinonasal cavity. Based on current literature, schwannomas
involving the sinonasal cavity comprise around four percent of all schwannomas. This exhibit aims to review several cases of surgically proven sinonasal schwannomas in an attempt to identify imaging findings characteristic of this rare entity that also may help differentiate it from other sinonasal tumors.

Materials and Methods
Case presentations of sinonasal masses treated at our institution, including three biopsy-confirmed sinonasal schwannomas, will be presented to demonstrate characteristic radiographic findings. Our findings will be compared to available literature, comprising mainly of case series and case reports describing cases of sinonasal schwannoma, for a more robust assessment of this entity.

Results
The typical location and classically benign features of sinonasal schwannomas described in the literature also were demonstrated in our case series. This included features such as their typical origin in the ethmoid air cells or nasal cavity and mostly noninvasive mass effect on adjacent structures with remodeling of the surrounding bone as noted both on computed tomography (CT) and magnetic resonance imaging (MRI) modalities. The CT imaging findings for the lesions mainly highlight the nondestructive growth pattern of these lesion. On MRI, the lesions were isointense to hypointense on T1-weighted images and mildly hyperintense on T2-weighted images, with the larger lesions appearing more heterogeneous than the smaller lesions. These tumors all demonstrated avid contrast enhancement on MRI with the smaller lesions appearing more homogeneous than the larger lesions. Cystic changes and hemorrhage were seen in the largest lesion, features also described in some of the other case series. All cases demonstrated extension into the anterior cranial fossa, a finding also reported in several other cases reports. In all, although nonspecific, there are characteristically benign features and typical location of the sinonasal cavity schwannomas which can aid prospectively in the imaging diagnosis and pre-operative planning.

Conclusions
Although sinonasal schwannomas represent a small fraction of sinonasal tumors, they occur with enough frequency to warrant some attention by neuroradiologist. An understanding of the imaging features and pattern of growth of these tumors will invariably influence the pre-operative assessment and treatment planning for these lesions.

eEdE-150
6:30AM - 2:45PM

About Face! - Causes of Non-traumatic Facial Swelling
A Spiro¹, J Burns¹, A Friedman¹, M Neimark², M Scheinfeld¹, R Dym¹

1 54th Annual Meeting & Foundation of the ASNR Symposium 2016
Purpose
Facial swelling is a common clinical scenario which may present in the primary care or ED setting. Inflammatory conditions predominate, particularly when there is rapid onset of swelling, though malignant and other acquired etiologies also must be considered. The purpose of this presentation is to present a space-based diagnostic approach to the differential diagnosis of facial swelling, and review both common and rare conditions that may present with this clinical complaint.

Materials and Methods
Content will be presented using a quiz format, beginning with a focused review of anatomy followed by case presentations highlighting the spectrum of nontraumatic pathologies which may cause facial swelling.

Results
Specific entities to be reviewed include: Facial cellulitis, Angioedema, Periorbital cellulitis, Orbital Pseudotumor, Sialoadenitis/sialolithiasis, Odontogenic abscess, Ludwig's angina, Bezold's abscess, Branchial cleft cyst, Pott's puffy tumor, Squamous cell carcinoma, Adenopathy.

Conclusions
Main teaching points include: Recognition of major causes of nontraumatic facial swelling that may present urgently in the ED or urgicare setting. Development of an anatomical approach to the differential diagnosis of facial swelling.

All About that Base: A Radiologist’s Guide to Skull Base Injury

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1Nassau University Medical Center, Brooklyn, NY, 2Nassau University Medical Center, East Meadow, NY, 3Nassau University Medical Center, East Meadow, NY

Purpose
To review and classify the spectrum of skull base fractures, with emphasis on mechanisms and patterns of injury. We address associated trauma to nonosseous structures and the range of acute and chronic complications.

Materials and Methods
We retrospectively reviewed the MDCT findings of patients with skull base trauma admitted through the ED at our Level 1 trauma center. We organize cases according to location; anterior (anterior skull base and frontobasal), middle and posterior cranial fossa. An understanding of the anatomical structures and their intricate relationships
within each compartment will help the radiologist to recognize and predict various potential complications. We emphasize the importance of multiplanar reformats and 3D reconstructions. We further categorize our discussion according to mechanisms and forces of injury (penetrating versus blunt). We highlight the array of specific fracture patterns and explore both acute and delayed complications of skull base trauma.

Results
Skull bases fractures, with high morbidity and mortality, are especially devastating. Fracture patterns, such as those in the orbitofrontal, transsphenoidal and petrotemporal regions are influenced by an array of forces and typically are categorized according to directionality. Associated injuries include those to the vascular structures and cranial nerves, as well as those due to violation of bony barriers and meningeal linings. Vascular injuries include arterial dissections, occlusions and transections, carotid-cavernous fistulas, and venous sinus thromboses. Fractures involving the orbital apex, ethmoids and cribiform plate, clivus, temporal bone and the skull base foramina can potentially result in cranial nerve injuries. Bony compromise and dural injury can result in traumatic encephaloceles, mucoceles, cerebrospinal fluid (CSF) leaks and a range of intracranial infections.

Conclusions
It is imperative for the radiologist to develop a methodical and organized approach to skull base fractures for prompt diagnosis and to recognize and mitigate the adverse consequences of associated injuries.

eEdE-148

6:30AM - 2:45PM

Anterior Cranial Fossa Imaging in the Era of Endoscopic Endonasal Surgery

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Purpose
Anterior cranial fossa has complex anatomy with a wide range of pathology. Some lesions have characteristic imaging findings, i.e., ethisioneuroblastoma, meningioma, encephalocele, etc. Endoscopic endonasal surgery (EES) has become a treatment standard; however, the lesions have to fit certain anatomical and imaging criteria. The purpose of this exhibit is to review the pertinent cross-sectional anatomy, key imaging features of variety of diseases, and critical imaging criteria that radiologists and skull base surgeons need to know.

Materials and Methods
A retrospective review of anterior skull base lesions imaged at a tertiary referral center over a 7-year period was performed, yielding three distinct disease categories:
intracranial, osseous and sinonasal. Images of each entity is presented with

distinguishing imaging features. Importantly indications and contraindications of EES

are reviewed using diagrams, computed tomography, magnetic resonance imaging and

angiography to demonstrate the critical imaging landmarks.

Results
The following diseases are discussed: olfactory/planum sphenoidale meningiomas,

fibrous dysplasia, fractures, encephalocele, cerebrospinal fluid (CSF) leak, mucocele,

allergic fungal sinusitis ethesioneuroblastoma, and other sinonasal neoplasms. Skull

base surgeons may perform EES if the lesions are small and in medial location. The

following findings preclude EES: brain invasion, orbital invasion, lesions arising from

or extensively involving the frontal sinus, lesions displacing the neurovascular

structures ventrally, lesions with major component extending over the orbital roof,

optic canal and inability to reconstruct the skull base defects.

Conclusions
It is crucial for the radiologists to accurately diagnoses anterior cranial fossa lesions,

and delineate disease extension that is suitable for EES.
Approach to Benign Jaw Lesions: 3D CT and MR with Surgical-Pathologic Correlation

M Ho¹, D Schembri Wismayer¹, J Yetzer¹, K Arce¹, C Viozzi¹, J van Ess¹, D DeLone¹
¹Mayo Clinic, Rochester, MN

Purpose
To present an approach to cross-sectional imaging diagnosis of jaw lesions, based on correlation to radiography, 3D/surgical findings, and pathology.

Materials and Methods
Basic concepts of dental radiographic acquisition and interpretation will be discussed, along with the indications for obtaining CT (cone-beam versus diagnostic) and magnetic resonance imaging (MRI). Pathophysiology and nomenclature of jaw lesions will be reviewed. A wide spectrum of jaw pathology will be presented in differential diagnostic groups: simple cystic; complex cystic (septations, soft tissue, calcification); and sclerotic. Elements of the diagnostic approach include: patient demographics and symptoms, location in the jaw, cortex and tooth destruction, margin definition, morphology of septations, soft tissue components, and matrix calcification. Computed tomography (CT)/magnetic resonance imaging (MRI) will be correlated with panorex, 3D models, surgical findings, and gross/microscopic pathology specimens.

Implications for management (local recurrence, malignant transformation) and approaches to surgery (curettage, subtotal resection, radical en bloc excision) also will be discussed.

Results
Osteoid osteoma, osteoblastoma, - Osteoma: Gardner syndrome, - Osteochondroma, -
Osteomyelitis: acute, chronic, proliferative, - Osteonecrosis.

Conclusions

The neuroradiologist's standardized approach to benign jaw lesions should include
assessment of clinical presentation as well as lesion location, margination, and
composition. Simple cystic lesions have characteristic radiographic appearances, and
typically require no/minimal intervention. Complex cystic and sclerotic/mixed lesions
benefit from cross-sectional imaging for detailed characterization and surgical
planning. Computed tomography (CT) should be obtained for evaluation of bone
detail including mass effect, margination, septations, and matrix calcification.
Magnetic resonance imaging (MRI) also can be helpful in characterizing soft tissue
components, fluid-blood levels, and marrow/nerve involvement. Through review of
advanced cases with cross-sectional imaging and pathologic correlation, the
radiologist will be equipped to provide informed differential diagnoses and assist in
appropriate management of these diverse lesions.
Brave new world: 3D printing of the orbit for anatomy, pathology, surgical simulation

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¹University of Utah, Salt Lake City, UT, ²Emory University, Atlanta, GA

Purpose
To demonstrate how 3D printing can be used to produce physical orbit models for the teaching of orbital anatomy, demonstrating pathology, and simulating surgical and interventional procedures.

Materials and Methods
Under IRB approval, clinical cases of orbit anatomy and pathology were selected. Volumetric computed tomography (CT) and magnetic resonance (MR) images of the orbit were obtained on Siemens scanners (Erlangen Germany) as part of facial and orbit examinations. Using commercially available software (Mimics, USA), DICOM images were converted to 3D models. Anatomical data were segmented, simplified, and prepared for 3D printing. Models were printed in PLA (polylactic acid plastic) using 3D printer (Ultimaker 2, Ultimaker BV, Netherlands).

Results
3D models allow trainees to learn anatomy, demonstrate pathology, and test surgical approaches and reconstruction techniques. With hands on models, learners can grasp complex anatomy, manipulate physical representations of patient specific data, and plan surgical approaches.

Conclusions
Creating tangible physical models of anatomy and patient specific pathology allows trainees and clinicians to better visualize the critical and complex anatomy of the orbit. This project demonstrates practical application of novel additive manufacturing to orbital anatomy and pathology.
Purpose
To provide a step-by-step approach that allows learners to better organize the complex anatomy of the middle ear – building the tympanic cavity "box" and all of its contents from the ground up.

Materials and Methods
1. Review the anatomy of the middle ear using original diagrams. 2. Correlate with cross-sectional CT anatomy and 3DVR. 3. Present examples of common middle ear pathology based on anatomical location. 4. Test/reinforce concepts using multiple-choice questions.

Results
The tympanic cavity and all of its contents comprise the middle ear. This cavity is a space within the temporal bone that although irregularly shaped, has been compared to a box with six sides – a floor, roof, anterior wall, posterior wall, medial wall and lateral wall. In actuality, the tympanic cavity roof and floor are more spherical than cubical, bowing outward from the center of the cavity. This educational electronic exhibit provides a stepwise approach to middle ear anatomy and the tympanic cavity box – dividing the middle ear into: ossicles, muscles, ligaments, nerves, walls, spaces, and adjacent structures. Each anatomical structure will be added piece-by-piece to the original box diagram of the middle ear, building the six-sided "bowed box" and filling it with the contents of the middle ear.

Conclusions
The complex anatomy of the middle ear can be simplified using a stepwise build-a-box approach – providing an improved understanding of middle ear anatomy that can be translated to cross-sectional anatomy and common middle ear pathology.

eEdE-128

Closing the Knowledge Gap: Imaging of Orofacial Clefts

G Avey¹, T Kennedy², L Gentry³
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Purpose
Orofacial clefts are the most common developmental malformation of the head and neck, with approximately 7,000 annual cases in the United States. Given the relative frequency of these malformations, neuroradiologists should be familiar with the imaging findings of orofacial clefts, the timing and types of common surgical repairs, syndromic associations, and potential subsequent secondary deformities.

Materials and Methods
A brief review of the embryology and classification of orofacial clefts will be
performed. Subsequently, using a case-based format, pertinent imaging findings of orofacial clefts, syndromic associations, expected postsurgical appearances, and secondary deformities will be explored.

Results
Orofacial clefts are broadly divided into cleft lip (either with or without cleft palate), and isolated cleft palate. Approximately 30% of cleft lip and palate patients are associated with a syndromic cause. While cleft lip and palate often are detected on obstetric ultrasound, isolated cleft palate rarely is detected in utero. Surgical repair of the cleft lip commonly occurs at 10-12 weeks of age. The surgical closure of the hard palate defect typically is performed at 11-12 month of age, with repair of the maxillary alveolus, if necessary, following at 8 to 10 years of age. The initial stages of repair often are performed without the use of imaging. However, orthopantomography, radiography, and computed tomography often are subsequently used to assess patients nearing adolescence, with the choice of modality depending on the clinical question. Imaging plays an important role in assessing maxillary hypoplasia, the volume and integrity of the maxillary alveolus, dental anomalies, oronasal fistula formation and velopharyngeal insufficiency.

Conclusions
Orofacial clefts are common and potentially complex congenital malformations. Imaging plays a valuable role in assessing for associated malformations and secondary deformities. An understanding of the anatomy, typical appearance on imaging, and common secondary deformities will aid the neuroradiologist in providing the best quality care possible for these patients.

Compliance of British Thyroid US “U”guidelines- Are we all speaking the “Universal” Thyroid language

Purpose
Thyroid nodules are a very frequent pathology of the adult population. Incidence of thyroid nodules is estimated to be up to 50% in asymptomatic population; though the risk of malignancy is less than 7%. There are several published guidelines trying to standardize suspicious US characteristics that refer to malignancy. This includes ATA, TIRADS scoring system, AACE, SRUS. British thyroid association introduced new thyroid US guidelines in 2014 to become familiar with a pattern recognition approach as it is easy to adapt by a range of professionals and useful in a busy setting. A coding system of U1 – U5 is used with the spectrum ranging from U1- normal, U2-
benign, U3- indeterminate, U4- suspicious to U5 – malignant. The US characteristics used are echogenicity, composition, shape, margins, calcification and vascularity. Aim and clinical relevance: The study is to look at the compliance of the guidelines in our institution, as it would improve patient management and cost effectiveness by reducing unnecessary FNA and also standardize the care by multidisciplinary team using the same terminology.

Materials and Methods
After the local introduction and education of the BTA guidelines from October-December 2014, a 5-month period of ultrasound reports from January to May 2015 were reviewed retrospectively. Eight hundred and sixty out of 1220 neck scans were thyroid ultrasounds. The index scans, which picked up thyroid nodules were 337, follow up of nodules consisted of 239 and remainder 293 scans detected thyroiditis, MNG, diffuse enlargement and normal thyroid. The compliance of coding system was studied only on index scans that detected thyroid nodules and the follow ups were excluded. The coding of thyroid if it had benign features (U1) and MNG (U2) were studied separately.

Results
Two hundred and forty of 337 scans used the BTA "U" Coding system, which constitutes 71% compliance. The numbers based on "U" classification as follows: U4 (9); U3 (73); U2 (148); U1 (3) and not coded were 97. The compliance of the coding system demonstrated steady improvement over the month's - Jan (27); Feb (48); March (56); April (60); May (49). The vast majority of the scans were performed by sonographers (84%), which are reviewed by radiology consultants and rest by radiology, dental registrars and consultants.

Conclusions
The process of introduction of BTA guideline has been reasonably successful in the department with gradual and steady increase in adaptation of use of BTA guideline in reporting thyroid nodules. The uptake was slow to start with but as the time period progressed the compliance has increased gradually. A stepwise approach with introduction of guidelines only to index presentations has been useful and we plan to introduce the guidelines for the follow-up thyroid nodules during later part of this year. How much reduction in number of FNAC performed with the previous years and pathological outcome FNAC performed on U3 and U4 nodules already is underway in our department and whether these results validate the claims of BTA remain to be seen.
BTA

- U1. Normal.
- U2. Benign:
  - (a) halo, iso-echoic / mildly hyper-echoic
  - (b) cystic change +/- ring down sign (colloid) (c) micro-cystic / spongiform
  - (d & e) peripheral egg shell calcification.
  - (f) peripheral vascularity.
- U3. Indeterminate/Equivocal:
  - (a) homogenous, hyper-echoic (markedly), solid, halo
    ( follicular lesion) (b) ? hypo-echoic, equivocal
    echogenic foci, cystic change
  - (c) mixed/central vascularity.
- U4. Suspicious:
  - (a) solid, hypo-echoic (cf thyroid)
  - (b) solid, very hypo-echoic (cf strap muscle)
  - (c) disrupted peripheral calcification, hypo-echoic (d)
    lobulated outline
- U5. Malignant
  - (a) solid, hypo-echoic, lobulated/irregular outline.
  - micro-calciﬁcation (? Papillary carcinoma)
  - (b) solid, hypo-echoic, lobulated/irregular outline,
    globular
  - calcification (? Medullary carcinoma)
  - (c) intra-nodular vascularity
  - (d) shape (taller >wide) (AP>TR)
  - (e) characteristic associated lymphadenopathy

(Filename: TCT_eEdE-170_Slide1.jpg)
Solid, hypo-echoic, lobulated / irregular outline, micro-calcification

Intra-nodular vascularity

Shape (taller > wide)
(AP > TR)

(Filename: TCT_eEdE-170_Slide2.jpg)
U3

homogenous, hyper-echoic (markedly), solid, halo (follicular lesion).

hypo-echoic, equivocal echogenic foci, cystic change

mixed/central vascularity

(Filename: TCT_eEdE-170_Slide5.jpg)
Congenital Hearing Loss: Hear the Signs.

C Atat\textsuperscript{1}, S Yazbek\textsuperscript{1}, A Haddad\textsuperscript{1}, S Abi Khalil\textsuperscript{1}, S Slaba\textsuperscript{1}, C Robson\textsuperscript{2}

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Purpose
Congenital hearing loss (CHL) affects 2-4 in 1000 babies. It is a major cause of childhood disability. Early diagnosis and treatment is essential for speech, academic and emotional development. Identifying the etiology of the congenital hearing loss...
can improve its treatment and allows for genetic counseling. Temporal bone computed tomography (CT) is usually the study of choice for imaging children with CHL.

Materials and Methods
We present a structured approach to reading a temporal bone CT for CHL going from the external ear into the external auditory canal followed by the middle ear, the inner ear and finally the brain parenchyma.

Results
We first will go through external auditory canal atresia, and middle ear pathologies such as congenital cholesteatoma (Fig.1), ossicular fixation and oval window atresia. We then will navigate through the inner ear, exposing both syndromic and nonsyndromic pathologies, such as incomplete partition type I and II (Fig. 2), enlarged vestibular aqueduct, Branchio-oto-renal, Pendred, Waardenberg and CHARGE syndromes, X-linked hearing loss (Fig. 3), cochlear aperture stenosis and absent cochlear nerve (Fig. 4). Lastly, we describe cerebello-pontine angle masses and parenchymal insults such as congenital CMV infection. Throughout the cases, we will discuss the instances where an magnetic resonance imaging (MRI) is needed as a complement to the CT, and we will identify the causes of CHL where a cochlear implant should be avoided. These etiologies include stenosis and gusher abnormality of the cochlear nerve canal and an absent cochlear nerve.

Conclusions
A patterned approach to reading a temporal bone CT for CHL simplifies the radiological diagnosis of a complex pathology. It also allows identifying the cases where an MRI of the internal auditory canals is recommended and the cases where a cochlear implant should be avoided.

(Filename: TCT_eEdE-126_FigCHL.jpg)
Purpose
To review the embryology, pertinent anatomical structures, and spectrum of pathologies and variant anatomy related to abnormal development of the craniopharyngeal duct as well as the notochord at the craniocervical junction and skull base through a myriad of cases.

Materials and Methods
Utilizing diagrams and original illustrations, we first will examine the embryologic development and key anatomical structures related to the craniopharyngeal duct and the notochord at the craniocervical junction and skull base. Subsequently, we present a variety of cases exemplifying a spectrum of pathology and variant anatomy related to abnormal development of the craniopharyngeal duct and the notochord at the craniocervical junction and skull base at computed tomography (CT) and magnetic resonance imaging (MRI) examination.

Results
Familiarity with the embryologic development and intricate anatomy related to the craniopharyngeal duct and notochord at the craniocervical junction and skull base is paramount to understanding and diagnosing pathology related to abnormal development of these structures. We present a spectrum of pathologic entities and variant anatomy related to the craniopharyngeal duct including, but not limited to: persistent craniopharyngeal canal; Rathke's pouch cyst; infraesellar craniopharyngioma and pituitary macroadenoma; and cephalocele. Additionally, we present a variety of cases exemplifying pathology of the notochord at the craniocervical junction and skull base, including but not limited to: ecchordosis physaliforma; chordoma; fossa navicularis; canalis basilaris medianus; and Thornwaldt cyst.

Conclusions
A thorough understanding of the embryologic development, relevant anatomy, and pathologic entities and variant anatomy related to the craniopharyngeal duct and notochord at the craniocervical junction and skull base not only allows for accurate diagnosis, but also aids in avoiding surgical complications related to resection of nasopharyngeal masses.
Diagnostic Imaging Findings After Radiation Therapy for Skull Base Region Tumors

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Purpose
Radiation oncology plays an important role in the treatment of nasopharynx and skull base carcinomas. The goal of this exhibit is to review the expected and complicated diagnostic imaging findings after radiation therapy for these tumors.
Materials and Methods
Expected diagnostic imaging findings and complications will be reviewed, including skull base remineralization, recurrent tumor and metastases, radiation-induced necrosis, radiation-induced neoplasms, and Eustachian tube dysfunction. In addition, the role of diffusion-weighted imaging and perfusion magnetic resonance imaging (MRI), as well as positron emission tomography (PET) will be discussed.

Results
Interpretation of the postradiation skull base region imaging can be challenging, with the appearances of complications sometimes mimicking recurrent tumor. A basic understanding of the findings encountered after radiation therapy can help the neuropathologist and radiation oncologist in the optimal management of patients.

Conclusions
A wide range of expected and complicated findings can be encountered on diagnostic imaging following radiation therapy for skull base region tumors. Advanced imaging modalities can be useful for problem solving in challenging cases.

eEdE-147
6:30AM - 2:45PM
Diffusion-Weighted Imaging Beyond the Brain: What and Where to Look For

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Purpose
Show the usefulness of diffusion-weighted imaging (DWI) in the depiction of head and neck neoplastic, inflammatory and infectious diseases in routine brain magnetic resonance imaging (MRI), which may be difficult to detect in the other conventional sequences.

Materials and Methods
Collection of prospective cases from June 2014 to August 2015 in which the detection of alterations in DWI was decisive in the imaging diagnosis. Clinical records, laboratory tests, complementary imaging studies and results of surgical biopsies were reviewed. Comparing with previous studies, when available.

Results
Careful review of DWI enable us to detect significant findings outside of the brain parenchyma in routine brain MRI studies. Inflammatory, infectious, neoplastic and vascular pathology compromising the skull base, orbit, suprahoid neck and paranasal sinuses was detected. Including the following: - Vascular: Internal carotid artery and vertebral artery dissection in two different patients. Clivus hemangioma. - Lymphoproliferative disorders: lymphoma (i.e., Burkitt), leukemia. - Other neoplasms: primary and metastatic (i.e., lung cancer). - Infectious: skull base
osteomyelitis, infectious sinusitis (bacterial, fungal). - Inflammatory: sinonasal granulomatosis with polyangiitis disease (Wegener), optic neuritis. Signal intensities alterations in DWI were reviewed and their correlation with other MRI sequences as well as other imaging modalities. Emphasizing the usefulness of DWI in the diagnosis of disease in an anatomical location, that otherwise would be difficult to assess.

Conclusions
Diffusion-weighted imaging may facilitate the detection of head and suprathyroid neck pathology in routine brain MRI. Detailed analysis of DWI can improve the diagnostic yield of diseases in this challenging anatomical location.

Figure 1. Lymphoproliferative compromise of the skull base bone marrow. (a) DWI shows restricted diffusion and (b) T1WI shows only mild hypointensity of the clivus and mandibular condyles.
Don't Choke on Laryngeal Abnormalities: A Case Based Review of Submucosal Pathologies of the Larynx.

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Purpose
The purpose of this educational exhibit is to review the normal anatomy of the larynx, present a categorization system of submucosal laryngeal pathologies, learn imaging features of common and uncommon pathologies affecting this area, and determine the imaging modalities most appropriate for submucosal laryngeal lesions.

Materials and Methods
Following a brief review of the normal laryngeal anatomy, a variety of cases will be presented and discussed, as a case-based review, in order to determine a categorization of submucosal laryngeal pathologies. Where possible, cross-sectional imaging will be supplemented with endoscopy.

Results
The larynx is an essential structure of the anterior neck which extends from the tip of the epiglottis to the inferior cricoid. It provides three main functions including: providing the structural framework of the airway, protection of the airway, and finally phonation. Comprising at least 95% of cancer diagnoses of the larynx, the diagnosis of squamous cell carcinoma often is not difficult, as the lesions are mucosal and readily apparent to the laryngeal endoscopist. However, there often are times that laryngoscopy suggests the presence of a submucosal mass or lesion, which cannot be seen by the eye. In these cases, the radiologist serves a vital role to detect and define any submucosal abnormality. In fact, there are a variety of entities that can affect the larynx which are completely submucosal in location, and may be overlooked by the laryngologist. Differential considerations of submucosal laryngeal pathologies can be divided into the following categories including: congenital, traumatic, inflammatory, and neoplastic. Ultimately, the radiologist plays a pivotal role in the characterization of these lesions, and with the appropriate clinical history, as well as knowledge of laryngeal anatomy, an appropriate differential diagnosis can be achieved.

Conclusions
As demonstrated in this exhibit, there are a limited number of pathologies affecting the submucosa of the larynx. Familiarity with the categorization presented here can
help determine the best imaging approach, which will aid in the development of an appropriate differential diagnosis.

Laryngeal Chondrosarcoma

- Cartilage producing neoplasm most commonly arising from cricoid cartilage (72%), thyroid cartilage (20%), and uncommonly arytenoid cartilage
- Expansile mass with preservation of mucosal surfaces
- +/- ring and arc calcification
- Most common presentations are dysphagia, dysphonia, and/or palpable neck mass
- Mean age of presentation is 64 years old with 4:1 male predilection
- Tx: complete surgical resection

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eEdE-155

Ever Heard of Third Window Hearing Loss?

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Purpose
Unexplained cases of conductive hearing loss have been described in as many as 1 in 3000 patients who have an intact tympanic membrane and no obvious middle ear pathology (1). In the past patients would undergo middle ear explorations and stapedectomy procedures without significant improvement in hearing. Increasing
evidence demonstrates that these cases of hearing loss are caused by unrecognized pathologic third windows of the inner ear (2).

Materials and Methods
The mechanism of normal hearing mechanics (Figure 1A) will be reviewed in addition to the pathophysiology of third windows. A description and classification system for the various pathologic third windows also will be discussed. The data were compiled from a review of the literature. Representative imaging was obtained from cases found upon review of our institutional experience with these syndromes.

Results
A pathologic third window produces conductive and in some cases mixed hearing loss by shunting acoustic energy away from the cochlea and disrupting the normal transmission of sound (Fig. 1B) (2, 3, 4). Third window hearing loss has been associated with discrete inner ear etiologies in the semicircular canals, including superior (Fig. 1C), lateral, or posterior canal dehiscence; the vestibule, including large vestibular aqueduct syndrome (Fig. 1D); and the scala vestibuli, including X-linked deafness (2, 3, 4). Diffuse lesions of the temporal bone, including Paget disease of the temporal bone, also have been described (2).

Conclusions
Pathologic third windows of the inner ear can account for otherwise unexplained cases of hearing loss. By recognizing imaging findings associated with third window hearing loss and alerting referring clinicians to the possibility of this diagnosis, the radiologist will play a pivotal role in patient care. Moreover, heightened awareness of these disorders will help to ensure that patients receive appropriate treatment and avoid the cost and potential morbidity of unnecessary procedures.

**eEdE-154**

**Facial Nerve Pathologies and Imaging Characteristics**

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Purpose
The purpose of this educational exhibit includes the following: to review the embryology and anatomy of the facial nerve with emphasis on key imaging landmarks and to discuss the motor, parasympathetic and sensory branches of the facial nerve in their respective clinical manifestation and to describe and differentiate the imaging characteristics of the pathologies affecting the branches of the facial nerve.
Materials and Methods
Computed tomography (CT) and magnetic resonance imaging (MRI) are used to provide an extensive review of the normal anatomy of the facial nerve to include its branches and motor, parasympathetic and sensory distribution. Additionally, these concepts are reinforced through the illustration of pathologies and their imaging characteristics.

Results
Clinical presentation of the facial nerve pathology is dependent on the location and severity of the disease, which can result from infection, inflammation, neoplasm and demyelination. Here, we discuss the various etiologies affecting the branches of the facial nerve along with their imaging characteristics on multiple imaging modalities.

Conclusions
Knowledge of the normal anatomy of the facial nerve and key landmarks to differentiate its branches are essential to understanding the clinical manifestation of the pathologies of the facial nerve. Furthermore, imaging characteristics of the pathologies of the facial nerve will simplify the differentials.

eEdE-129
6:30AM - 2:45PM
H&N Vascular Anomalies and Syndromes: Why Image?

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Purpose
To highlight the role of imaging in diagnosis and therapy of head/neck vascular anomalies (VA), using a case-based approach with dermatologic and otolaryngologic correlation.

Materials and Methods
The ISSVA (International Society for the Study of Vascular Anomalies) classification will be introduced and utilized as a framework for discussion. We will discuss the radiologist's collaborative role in VA workup including: when and why to image, appropriate choice of modality, key neuroimaging features, and stigmata of syndromic disease. Accompanying dermatologic and otolaryngologic color photos will emphasize the complementary roles of imaging and clinical examination. Ideally, VA patients should be evaluated and managed by a multidisciplinary team of specialists.

Results
ISSVA CLASSIFICATION: - Vascular neoplasms: benign, borderline, malignant, - Vascular malformations: simple (low- versus high-flow), combined. IMAGING MODALITIES: - US, XR, CT, MR, XA. TUMORS: - Congenital hemangioma: RICH, NICH, PICH, - Infantile hemangioma: focal versus segmental, GLUT1+, -
Kaposiform hemangioendothelioma, tufted angioma, - Angiosarcoma.
MALFORMATIONS: - Capillary, - Lymphatic: macro- versus microcystic, - Venous,
- Arteriovenous malformation, - Arteriovenous fistula, - Combined. SYNDROMES:
Tumors, - PHACES, - Neonatal hemangiomatosis (MLT), - PTEN/AKT1: Cowden,
Lhermitte-Duclos, Bannayan-Riley-Ruvalcaba, Proteus, - RAS/MAPK: NF1, Noonan,
Costello, LEOPARD, CFC, Low-flow, - Sturge-Weber, - Cutis marmorata
telangiectactica congenita (CMTC), - Macrocephaly-capillary malformation (M-CM),
- Microcephaly-capillary malformation (MICCAP) - Blue rubber bleb nevus (Bean), -
Gorham-Stout, High-flow, - Wyburn-Mason (CAMS), - Osler-Weber-Rendu (HHT), -
CM-AVM (RASA1).
Conclusions
Diagnosis and management of VA requires close collaboration between clinicians and
radiologists. Familiarity with the spectrum of head/neck cases will enable
neuroradiologists to select the appropriate imaging modality, identify key diagnostic
features of vascular lesions/syndromes, and correlate with
dermatologic/otolaryngologic findings.
Head and Neck Vascular Anomalies: The Importance of MRI and Time Resolved MRA to Determine Diagnosis and Management

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Purpose
To demonstrate the importance of magnetic resonance imaging (MRI) and time resolved magnetic resonance angiography (MRA) in the diagnosis and management of head and neck vascular anomalies. To provide specific imaging protocol information required for distinguishing the different types of vascular anomalies. To briefly discuss treatment methods, focusing in the use of MRI-guided sclerotherapy.

Materials and Methods
This exhibit will present a case-based systematic review of the MRI findings of vascular anomalies involving the head and neck region allowing radiologists and neuroradiologists to familiarize with the MRI appearance of these lesions. Time-resolved MRA videos with detailed explanation of how this technique is essential to help differentiate various types of vascular anomalies also will be available to viewer. Specific imaging protocol for initial and follow-up imaging as well as correct vascular anomalies nomenclature also will be included in the presentation. Finally, a brief review of treatment methods with emphasis in the use of MRI-guided sclerotherapy will be presented.

Results
Vascular anomalies are endothelial disorders affecting capillaries, arteries, veins and lymphatic vessels. These lesions are relatively common affecting 5.5% of the population. Accurate diagnosis of these lesions is confusing given the numerous different types of vascular anomalies, and similar clinical-radiological presentation. Magnetic resonance imaging and time-resolved MRA has become the primary imaging method to diagnose and follow up these lesions. Very often, a radiologist can become an important advisor in a multidisciplinary team and therefore, they should be familiar not only with imaging appearance, but as well with the current nomenclature, imaging protocol and treatment options. Radiologists also have an active participation in the treatment of vascular anomalies performing sclerotherapy under imaging guidance. Although ultrasound/fluoroscopic sclerotherapy technique often is used, sclerotherapy with MR guidance is emerging as a safe and preferable technique given the lack of ionizing radiation exposure. Sclerotherapy is most indicated in the treatment of low flow lesions where the sclerosing agents cause local thrombosis and
inflammatory reaction to block vessels and decrease the size of the lesion. High flow lesions often require angiographic evaluation of feeding vessels with coils or particle embolization used to achieve stasis within the lesion. 

Conclusions
Identification of vascular anomalies by MR can be relatively easy in the eyes of a trained radiologist. Standard MR pre and postgadolinium sequences and time-resolved MRA are essential for these lesions diagnosis and post-treatment follow up. The accuracy of MR in diagnosis allows for best treatment selection decreasing the risk for complications. Many of these lesions can be treated with sclerosing agents under ultrasound or MR guidance to achieve stasis in the vessels, decrease in the lesion size and improve patient quality of life.

**eEdE-149**

**Horner Syndrome: Anatomy of the Oculosympathetic Pathway with Case Review.**

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**Purpose**
To review the anatomy of the oculosympathetic pathway which if disrupted results in a clinical diagnosis of Horner syndrome. After reviewing this educational exhibit the radiologist should have a better understanding of the potential anatomical areas of interest related to Horner syndrome and feel more comfortable in advising clinicians when confronted with questions regarding imaging studies to obtain. 

**Materials and Methods**
The relevant anatomy and clinical features differentiating the syndrome into preganglionic, central, and postganglionic subtypes will be reviewed. A case-based approach will be utilized to illustrate relevant pathophysiologic processes which can potentially contribute to Horner syndrome.

**Results**
Horner syndrome is a clinical triad featuring ipsilateral proptosis, pupillary miosis, and anhidrosis of the face. The dilation of the pupil is controlled by both sympathetically innervated dilator muscles and parasympathetically innervated iris constrictor muscles. Disruption of the sympathetic fibers can lead to unopposed constrictor muscle activation and thus miosis. Disruption of the oculosympathetic pathway can occur anywhere along the pathway between the hypothalamus, brainstem, spinal cord, cervical sympathetic chain, or third order neurons. Understanding the anatomy of this oculosympathetic pathway as well as the clinical
features which differentiate Horner syndrome into the central, preganglionic, and postganglionic subtypes can help the radiologist suggest appropriate initial imaging and assist in lesion localization.

Conclusions
One of the aspects of quality care is efficiency, which will require ever greater efforts to ensure that imaging tests get the most "bang for the buck". By understanding the relevant anatomical and clinical features of this complex syndrome radiologists can suggest the most cost and time-efficient studies to assist in diagnosis and treatment.

eEdE-162

Imaging Approaches and Differential Diagnoses for Pulsatile Tinnitus

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Purpose
The goal of this exhibit is to comprehensively review and illustrate the diagnostic imaging approaches and differential diagnosis for patients that present with pulsatile tinnitus.

Materials and Methods
Overall, radiologic imaging is effective in detecting causes of pulsatile tinnitus in approximately 70% of cases in conjunction with clinical evaluation. High-resolution contrast-enhanced computed tomography (CT) or magnetic resonance imaging (MRI) are reasonable options and are regarded as the imaging modality of choice, although noncontrast temporal CT often can adequately reveal the underlying osseous abnormalities. In the absence of objective pulsatile tinnitus, CTA or MRA are appropriate initial exams. If there is suspicion for arteriovenous fistulas angiography should be performed.

Results

Conclusions
When the appropriate modality is selected, diagnostic imaging can help establish a specific diagnosis in many patients presenting with pulsatile tinnitus.
Imaging Features of the Orbital Apex: Anatomic Review and Correlation of Disease Manifestation.

M Hoss¹, J Faircloth¹, J McCarty¹, E Angtuaco², R Fitzgerald¹, R David³, M Kumar⁴, R Ramakrishnaiah¹, R Van Hemert⁴, R Samant⁴

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Purpose
Orbital apex is a complex anatomical region where multiple neural and vascular structures traverse between neurocranium to faciocranium. Lesions involving the neural structures may present with Rochon–Duvigneaud syndrome and Jacod syndrome. Purpose of the exhibit: 1. Illustrate and review the anatomy. 2. Discuss optimized advanced imaging techniques. 3. Illustrate various common and uncommon pathologies. 4. Discuss the surgical approaches and postsurgical imaging evaluation.

Materials and Methods
IRB exempted retrospective teaching exhibit. Database at a tertiary care university hospital was searched to identify cases of orbital apex lesion with a case-based approach for illustration. The medical records were reviewed for management and clinical outcomes. All patients were scanned on multidetector computed tomography (CT) and high field magnetic resonance (MR) scanners with volumetric data. We will use digital illustrations to review the anatomy and relevant pathological findings to facilitate learning from these cases.

Results
Orbital apex is a narrow bony socket and hence subtle lesions on imaging can be clinically symptomatic. A systematic review is critical to avoid misinterpretation. Rare and common lesions will be illustrated. The lesions will be categorized based on structure of origin (Osseous, vascular, neural and other mesenchymal origin) and based on patient age (Pediatric and adult disease processes). Below is a limited list of rare and academically interesting lesions which will be illustrated: Storage disorder with bone dysplasia causing recurrent orbital apex crowding, angioleiomyoma, multiple myeloma, chordoma, chondrosarcoma, tolosa hunt syndrome, thyroid ophthalmopathy, metastasis from unusual primary malignancies and rare infectious process such as mucormycosis and aspergillosis. Other common orbital apex lesions such as meningoima, cavernomas and varix also will be included.
Conclusions
Viewing this exhibit will increase the participant's knowledge and enhance the critical understanding of the complex anatomy and various pathologies involving the orbital apex to guide clinical management and avoid pitfalls.

Image panel: A fat-saturated axial T1-weighted image of a 28-year-old male with vision loss (A) showed a circumscribed, ovoid mass at the right orbital apex (arrow) compressing the right optic nerve. Pathology returned a diagnosis of angioleiomyoma. Subsequent coronal fat-saturated T2-weighted imaging (B) 6-months after surgical resection revealed localized atrophy of the right optic nerve manifested by asymmetric T2 hyperintensity within the optic canal (dashed arrow).

(Filename: TCT_eEdE-120_Angioleiomyoma.JPG)

eEdE-140
6:30AM - 2:45PM

Imaging of CSF leaks in the setting of Idiopathic Intracranial Hypertension: Pearls and Pitfalls

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Purpose
The clinical diagnosis of Idiopathic Intracranial hypertension (IIH) is increasing in incidence as the body mass index (BMI) of our population continues to rise, and IIH is an increasingly common cause of skull base cerebrospinal fluid (CSF) leaks. Determining the ideal imaging work up and management of IIH-associated skull base defects and leaks can be challenging. The goal of this educational exhibit is to review the diagnostic algorithm for suspected CSF leak, and the characteristic imaging findings in this unique patient population, focusing on potential pitfalls and addressing what the surgeon or treating referrer needs to know.

Materials and Methods
A database of patients with known IIH was searched to find patients with suspected CSF leaks. We surveyed the electronic medical record to gather details of initial presentation, diagnosis, and treatment and reviewed available computed tomography (CT) and magnetic resonance imaging (MRI). Five illustrative cases of IIH and
suspected CSF leak are presented to highlight teaching points, pearls and possible pitfalls in the work up of these patients.

Results
Intracranial hypertension associated characteristic imaging findings include: Empty sella, skull base thinning and scalloping, prominent osseous dural defects and arachnoid pits, meningoencephaloceles, and transverse sinus stenosis. The work up of CSF leaks in these patients can be challenging because: 1. Presence of multiple osseous defects and/or meningoceles complicates determining which site is actively leaking. 2. The clinical presentation may not be typical, as they may present with pneumocephalus or meningitis and not the characteristic rhinorrhea. 3. Recurrent leaks at site of prior repair, or new leaks after successful repair can occur, and the postoperative imaging is complicated. 4. The large body habitus of most IIH patients may make LP and cisternography technically difficult. Cases will be presented to illustrate these challenges, highlight potential pitfalls, and provide tips and techniques to mitigate and alleviate these possible limitations. Emphasis will be on providing information in the report focusing on what the surgeon needs to know.

Conclusions
Patients with IIH are at risk for developing skull base defects and cerebrospinal fluid (CSF) leaks. Familiarity with common imaging findings and potential pitfalls in diagnostic assessment should improve patient care.

Imaging of Pediatric Temporomandibular Joint Disorders

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Purpose
To demonstrate the spectrum of disorders involving the temporomandibular joint (TMJ) in children.

Materials and Methods
The pediatric temporomandibular joint can be involved by a variety of disorders. In this educational exhibit, we first will illustrate briefly the embryology and normal imaging anatomy of the temporomandibular joint region. Next, we will review various congenital, inflammatory, traumatic, and neoplastic disorders involving the temporomandibular joint. Finally, we will illustrate briefly some of the ultrasound and computed tomography (CT)-guided interventional techniques used for diagnosis and treatment of pediatric TMJ disorders.
Results
Congenital and developmental disorders such as syndromes involving the upper branchial arches such as in hemifacial/bifacial microsomia and Goldenhaar syndromes, velocardiofacial syndrome, and Treacher-Collins syndrome often involve the temporomandibular joint in children causing a variety of deformities and symptoms. These developmental disorders and their imaging manifestations will be illustrated. Primary osteoarthritis of the TMJ is uncommon in children. The most common indication for magnetic resonance imaging (MRI) of the temporomandibular joint in children is juvenile idiopathic arthritis (JIA). The temporomandibular joint commonly is involved relatively early in the course of disease, and involvement may precede frank clinical symptoms. Therefore contrast-enhanced MRI of the temporomandibular joints often is utilized in this group of patients. Performing both open and closed mouth often is unnecessary in this population. The various MRI manifestations and severity of involvement of the TMJ will be illustrated and normal variations mimicking arthritis will be shown. Other disorders involving the temporomandibular joint include erosions by aggressive cholesteatomas, heterotopic ossification particularly in the setting of long-standing arthritis, and synovial osteochondromatosis. Traumatic injury and fractures involving the temporomandibular joint is common. Finally, there can be neoplastic involvement of the TMJ by Langerhans cell histiocytosis, metastatic neuroblastoma, and head and neck sarcomas.

Conclusions
Various conditions can involve the temporomandibular joint in children. Familiarity with the normal appearance and various pathologies of this region is essential in accurate evaluation of TMJ imaging findings and will facilitate the sometimes daunting radiological interpretation of these studies. Radiologists also can play an important role in the interventional diagnostic evaluation and treatment of these disorders.

Imaging of the Congenital Inner Ear Anomalies

B OZGEN, D Bajin, G Atay, L Sennaroglu
Hacettepe University, Ankara, Turkey

Purpose
This exhibit will review the updated imaging classification of the inner ear malformations and also will provide a brief look at the histopathology of these anomalies in an effort to understand the underlying pathophysiology. The different
treatment options for each anomaly such as auditory brainstem implants and cochlear
implants also will be discussed briefly.

Materials and Methods
The computed tomography (CT) and magnetic resonance (MR) imaging of the
temporal bones, before and after implantation, will be used to illustrate the pertinent
radiological findings.

Results
Congenital inner ear anomalies are complex developmental disorders that are assessed
with temporal bone CT and MR imaging. The detected abnormalities on sectional
imaging have a large spectrum of findings. These malformations have been classified
by Jackler et al. in 1987, a classification that has been revised in 2002 by Sennaroglu
and Saatci. Since then several modifications and additions have been made to this
classification. Furthermore with advances in imaging and especially with higher Tesla
imaging new unclassified anomalies of the labyrinth are being detected.

Conclusions
In the era of cochlear implantation, the radiologists should be familiar with the
imaging appearance of different inner ear malformations in order to guide the
clinicians to the appropriate implant device and to help with the choice of the
electrode to be implanted.
Imaging the Abducens in the Patient with Diplopia

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Purpose
Double vision (diplopia) is not an uncommon complaint. A palsy of the sixth cranial
nerve (abducens) often leads to diplopia, and such patients typically undergo neural imaging as part of the diagnostic evaluation. As such, it is important for radiologists to be familiar with the anatomy and pathology of the abducens when faced with these cases.

Materials and Methods
This exhibit teaches users the anatomical course of the sixth cranial nerve. Specifically, the exhibit portrays the essential imaging landmarks for identifying the abducens on various cross-sectional imaging modalities. A wide variety of pathologic entities are presented and organized according to the various anatomical segments of the sixth cranial nerve.

Results
The course of the abducens from its nucleus to the lateral rectus muscle is divided into five anatomical segments: nuclear, cisternal, skull base, cavernous sinus, and orbit. The lateral rectus muscle itself also is discussed separately. Segments are reviewed using illustrations and corresponding cross-sectional images to highlight key anatomical landmarks and adjacent structures. This facilitates the development of a conceptual view of the regional anatomy. Knowledge of adjacent structures improves the ability to localize pathology based on clinical findings and, thereby, direct imaging to the appropriate location. After a review of the normal anatomy, multiple cases are presented demonstrating various representative pathologies that may occur in the different segments. Pathologies presented include demyelination, neoplasm, inflammation/infection, trauma, vascular compression, and idiopathic causes.

Conclusions
Double vision (diplopia) secondary to sixth cranial nerve palsy is the most common isolated cranial nerve palsy. It often is accompanied by other clinical findings, the unique combinations of which may help localize lesions to the appropriate segment. Imaging and clinical information reviewed in this module will enhance the user's ability to localize and detect pathology affecting the various segments of the sixth cranial nerve.
Sphenoid Mucocele

Lesion is centered on, and has completely replaced, the sphenoid sinus. Additional expansion has eroded adjacent bone and encroached on bilateral cavernous sinuses.

Homogenous high T1 signal and only mildly high T2 signal signifies the high proteinaceous content.

Cisternal CN VI.
Expected course of CN VI within cavernous sinus.

(Filename: TCT_eEdE-124_CNVI.jpg)

eEdE-145

6:30AM - 2:45PM

Imaging the TMJ: A systematic approach and pictorial review

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\textsuperscript{1}Baystate Medical Center, Springfield, MA, \textsuperscript{2}Baystate Medical Center-Tufts University, Springfield, MA
Purpose
The temporomandibular joint (TMJ) is an infrequently imaged joint with a range of pathologies. The infrequent nature at which this study is performed restricts the radiologist from maintaining familiarity with the systematic approach to interpretation and identification of the most frequently seen abnormalities. This review aims at providing one such systematic approach along with a pictorial review of the important TMJ pathologies. In addition to reviewing intrinsic lesions of the TMJ, focus also was placed on discussing pathologies near and far which secondarily involve the joint.

Materials and Methods
The images used in the review were collected from the Baystate health system. Magnetic resonance (MR) and computed tomography (CT) imaging findings were focused on, being the ideal modes of evaluation. The pathologies reviewed included but were not limited to condyle and meniscus dislocation, meniscus tear, osteomyelitis, neoplasms including benign and malignant such as neurofibroma, adamantinoma, plasmablastic lymphoma, degenerative disease and findings related to trauma. Clinical and radiologic correlation for each of the reviewed pathology was performed. The pitfalls of misinterpreting normal findings were analyzed and reviewed.

Results
A systematic approach makes the evaluation of the TMJ easy, quick and straightforward. The topic was divided into: 1. Review of the normal joint anatomy and the normal MR, plain film and CT appearance. 2. Protocols for MR and CT image acquisition and the selection of the appropriate imaging modality in different scenarios. 3. Normal variants mimicking pathology. 4. Review of intrinsic and secondary pathologies with clinical correlation. 5. Suggested follow up for imaging findings.

Conclusions
With familiarity of normal imaging findings, this uncommonly encountered imaging study can be tackled with finesse.
eEdE-165

Infectious and Inflammatory Disorders of the Temporal Bone: A Pictorial Review

N Emmanuel¹, J Go²
Purpose
This exhibit will familiarize the attendees with the infectious and inflammatory disorders of the temporal bone.

Materials and Methods
Using the teaching files at a major academic institution in Southern California and from a prominent Otology Clinic in the United States, this exhibit will review the pathophysiology and imaging findings of infectious and inflammatory disorders which may involve the temporal bone and describe possible complications which may occur. The major areas covered are the external auditory canal and periauricular region, the middle ear cavity, the inner ear, and the mastoid portion of the temporal bone.

Results
Infectious and inflammatory processes may primarily or secondarily involve the temporal bone. This exhibit will describe the imaging findings on high resolution computed tomography (CT) and magnetic resonance imaging (MRI) so that the attendee will be able to make a reasonable diagnosis of these entities. At times, some of these conditions may be mistaken for neoplasm and this exhibit will help the attendee tell these two entities apart.

Conclusions
Infectious and inflammatory disorders may primarily or secondarily involve the temporal bone. This exhibit has systematically described the underlying pathophysiologic and imaging findings of these conditions in the various areas of the temporal bone and utility of different imaging modalities in evaluating these entities.

eEdE-116

6:30AM - 2:45PM

Intracranial Pathology of Visual Pathway: anatomy, pathology and application of newer imaging techniques

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Purpose
1. To learn the anatomy of the visual pathway and its imaging appearance on conventional imaging. 2. To illustrate various intracranial pathologies leading to visual defects. 3. To highlight the application of nerver imaging techniques especially
Materials and Methods
Ophthalmologic symptoms depend on the site of the lesion affecting visual pathway structures. The most important symptom is loss of visual acuity, whether acute or slowly progressing. Variety of intracranial lesions affects the visual pathway. Imaging pattern and approach largely depend on the type of clinical presentation which mainly include monocular blindness, bitemporal hemianopia and various patterns of homonymous visual defects. Today MRI enables us to examine the entire visual pathway along its course from the inner aperture of the optic canal to the occipital pole. Retrospectively reviewed the imaging studies of 223 patients with acute and slowly progressing visual loss, which forms the basis of this exhibit. All patients had MRI brain and orbit with and without contrast. In addition 43 patients also had advanced imaging which include MR spectroscopy, perfusion, fMRI and DTI.

Results
Exhibit is presented as per the clinical presentation: (1) Monocular blindness (neuritis, ischemic neuropathy, neoplastic inflammatory, MS, infective and vascular lesions); (2) Bitemporal hemianopia/optic chiasm (pituitary lesions, craniopharyngioma, hypothalamic glioma, ICA aneurysm, pituitary apoplexy); (3) Homonymous Visual defects [optic tracts, lateral geniculate ganglion (LGN), optic radiations, primary visual cortex]:neoplasm (ependymoma, lymphoma), vascular (PCA infarcts, intra and subarachnoid hemorrhage, Sturge Weber syndrome, PRES) white matter lesions (MS, ADEM), postradiation and -surgery, trauma and periventricular leukomalacia. Exhibit discusses the application of DTI and fMRI in the patients with Homonymous Visual defects.

Conclusions
1. Imaging plays an important role in the diagnosis of the intracranial visual pathway pathologies but clinical examination and localization is very important to tailor the imaging study. 2. Exhibit illustrates the importance of never imaging techniques specially DTI and fMRI in imaging of visual loss.

eEdE-121

Lacrimal Gland Masses: Multimodality Imaging Appearance and Clinical Features

M Stone1, P Doshi1
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Purpose
This exhibit will review the differentiating imaging findings and clinical features of lacrimal gland masses.

Materials and Methods
Multimodality imaging findings of common and uncommon lacrimal gland masses will be illustrated with case-based examples. Differentiating features and differential diagnoses will be discussed. Relevant clinical and prognostic information also will be illustrated.

Results
Lacrimal gland lesions typically present as palpable masses in the superomedial orbit. Approximately 50% are benign and 50% are malignant. Epithelial neoplasia typically presents as a unilateral mass. Pleomorphic adenoma is the most common benign epithelial tumor, often demonstrating moderate enhancement and smooth bony scalloping. Adenoid cystic carcinoma is the most common malignant epithelial neoplasm, occasionally presenting with pain and paresthesia secondary to perineural spread. Bony destructive changes and diffuse enhancement are common. Benign and malignant lymphoproliferative disease is another common cause of lacrimal gland lesions. Reactive lymphoid hyperplasia (RLH) represents the benign end of the spectrum and typically demonstrates diffuse bilateral lacrimal involvement, generally molding to the confines of the orbit. The most common primary lymphoma to involve the lacrimal gland is the mucosa-associated lymphoid tissue type and tends to present in older patients with painless bilateral masses. Like RLH, lymphomatous masses tend to conform to the confines of surrounding structures. While confident differentiation of RLH from lymphoma is not usually possible, lymphoma tends to be more homogeneous in appearance. Inflammatory lesions of the lacrimal gland are a common cause of palpable abnormality with both infectious and noninfectious etiologies. The most common inflammatory lacrimal disease is sarcoidosis, typically causing diffuse bilateral painless enlargement. Other causes of inflammatory masses include pseudotumor, IgG4-related disease, and Sjogren syndrome.

Conclusions
Imaging evaluation plays a key role in the diagnosis and management of lacrimal gland masses. By recognizing the imaging appearances and clinical features of common and uncommon lacrimal gland lesions, radiologists can provide accurate and concise differential diagnoses and play a vital role in patient care.
Lend Me Your Ears… for a Comprehensive Review of External Ear Anatomy, Development, & Pathology

J McCarty¹, J Dornhoffer¹, E Angtuaco¹, R Fitzgerald¹

¹University of Arkansas for Medical Sciences, Little Rock, AR

6:30AM - 2:45PM

Lacrima Gland Masses

A) Heterogeneously enhancing right lacrimal mass representing a pleomorphic adenoma
B) Infiltrative appearing T2 hypodense left lacrimal mass secondary to Wegener’s granulomatosis
C) Homogeneous right lacrimal mass, slightly hyperdense to the extraocular musculature, representing a primary orbital mass
D) Homogeneously enhancing bilateral lacrimal masses with muscular and intraconal extension in a patient with HIV
Purpose
To review anatomy, embryology, and common pathology of the external ear – using a variety of techniques that are applicable to radiology learners of all levels.

Materials and Methods
1. Review the anatomy of the external ear using original diagrams. 2. Correlate with cross-sectional imaging and 3D volumetric reconstruction. 3. Present examples of common external ear pathology. 4. Test/reinforce concepts using multiple-choice questions.

Results
The ear can be divided into the external, middle, and inner ear. In this exhibit we will focus on the anatomy and pathology external ear, although many external ear pathologies involve the middle and inner ear as well. The pinna and external auditory canal (EAC) comprise the external ear – collecting and funneling sound towards the tympanic membrane. Relative to the middle and inner ear, radiologists often place less emphasis on discussion of the external ear. Though many conditions affecting the pinna are readily identifiable on clinical exam, radiologists add further value through conscientious assessment of the external auditory canal and adjacent structures. Thus an understanding of this anatomy and embryology are crucial to providing useful reports for our referring clinicians.

Conclusions
This educational exhibit aims to review the anatomy, embryology, and pathology of both the pinna and EAC, so that radiologists of all levels may have a deeper understanding and appreciation for the external ear.
Lesions of the Cavernous Sinus

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Purpose
The cavernous sinus (CS) contains critical neurovascular structures that may be affected by lesions of various etiologies, including benign neoplastic, malignant neoplastic, vascular, infectious, and inflammatory lesions. As clinical assessment of the lesions of the CS can be limited, imaging plays a central role in diagnosis, pre-operative evaluation, treatment planning, and follow up. This presentation first will review pertinent regional anatomy followed by a review of multiple CS lesions and...
the specific role and use of imaging modalities for accurate diagnosis, tumor localization, and staging when appropriate.

Materials and Methods

Multiple examples of CS lesions were reviewed with magnetic resonance imaging (MRI) and/or computed tomography (CT) images to demonstrate the various etiologies of lesions of the CS as well as their associated imaging findings and complications.

Results

Lesions of the CS can present a diagnostic dilemma with important therapeutic implications. A firm understanding of the regional anatomy is crucial to recognizing these lesions and their complications. Representative examples will be given of both lesions intrinsic and extrinsic to the CS, as well as of lesions of benign neoplastic, malignant neoplastic, vascular, infectious, and inflammatory etiologies. We will highlight distinguishing imaging characteristics and elucidate key imaging findings that are of particular use to the clinician.

Conclusions

Lesions of various etiologies can affect the CS, including benign neoplastic, malignant neoplastic, vascular, infectious, and inflammatory lesions. Knowledge of CS anatomy as well as of key imaging characteristics of CS lesions is central to accurate diagnosis, treatment, and follow up of CS lesions.
Look at Me Now! A Case Based Review of Common Emergent Orbital Pathologies

A. T1 axial MRI images demonstrating a well-circumscribed T1 hyperintense mass in the cavernous sinus, consistent with a dermoid cyst. B. T2 axial MRI images demonstrating a mass centered in the left cavernous sinus, consistent with a left cavernous sinus hemangioma. C. Post contrast axial MRI images demonstrating large expansile lesions inseparable from cavernous carotid arteries, consistent with bilateral partially thrombosed giant internal carotid artery aneurysms. D. T1 post contrast axial MRI images demonstrating an enhancing mass, which arises from the sella, consistent with an invasive pituitary adenoma with cavernous sinus involvement.

Purpose
"Trauma", "vision changes" and "orbital pain" are common indications for ocular evaluation in the emergency room setting. Knowledge of the orbital anatomy and common associated pathologic entities is needed to provide a fast and accurate diagnosis for these patients. This presentation will review common orbital pathologies seen in the acute setting.

Materials and Methods
This educational exhibit will review normal orbital anatomy using both computed tomography (CT) and magnetic resonance (MR). Pearls and pitfalls in distinguishing...
acute verses nonacute conditions will be reviewed using a case-based approach. Entities such as globe rupture, lens dislocation, fractures, carotid-cavernous fistulas and infection will be discussed.

Results
Evaluation of the orbits in an acute setting can be a daunting task. However, knowledge of normal anatomy on both CT and MR is the first step in differentiating benign entities from acute pathology. Once pathology is identified, it is important to make the correct diagnosis in order to avoid a delay in patient care.

Conclusions
Both CT and MR play a crucial role in diagnosing emergent orbital pathologies. Understanding how to differentiate benign entities from pathologic conditions is key in determining the correct diagnosis to optimize treatment.

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**Carotid-Cavernous Fistula**

The right extraocular muscles are enlarged with associated proptosis and edema in and around the orbit. There is asymmetric enlargement of the right superior ophthalmic vein (yellow arrows) and the right cavernous sinus with enhancement within the right cavernous sinus (red arrow) on the arterial phase. Findings are consistent with a right carotid-cavernous fistula.

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Mimics of Nontraumatic Solid Orbital Tumors: More Than Meets the Eye

A Rajput1, T Ahluwalia2, A Rajput3, L Bangiyev1
1Stony Brook University Hospital, Stony Brook, NY, 2Winthrop University Hospital, Melville, NY, 3University of Pittsburgh, Melville, NY

Purpose
The purpose of this exhibit is to review the incidence, prevalence, clinical presentation, and significance of several nontraumatic orbital pathologies with our main focus on lesions that can mimic solid tumors. Knowing the appearance, clinical history, and physical exam findings of the various orbital lesions will help the reading radiologist to correctly diagnose solid tumors, exclude other differential diagnosis, and prompt treatment to prevent detrimental consequences.

Materials and Methods
Diplopia, proptosis, decreased visual acuity, and eye pain are all very common presenting symptoms in patients with nontraumatic orbital pathology. In addition to clinical examination, frequent imaging modalities are ordered which include computed tomography (CT) and magnetic resonance (MR) of the orbits. It is important for the radiologist to be aware of the vast abnormalities involving the orbits and associated structures, as time is of the essence. Our aim is to discuss the clinical presentation, imaging findings, and consider a differential diagnosis of orbital lesions commonly mistaken for solid tumors in order to prevent potential complications.

Awareness of the key diagnostic features of these lesions will guide further follow-up and aim to prevent unnecessary complications.

Results
The discussion will include a brief review of the orbital anatomy, the normal development of the orbital structures, followed by presentation of several solid orbital tumor mimics with focus on a thrombosed orbital varix. Further discussion will include characteristic CT and MRI findings of these lesions that will guide radiologists to recognize them, look for potential complications, and recommend appropriate management. The exhibit also will demonstrate a case-based review of relevant differential diagnosis including inflammatory, granulomatous, neoplastic and congenital etiologies such as sarcoid, lymphoma, granulomatosis with polyangiitis, multiple myeloma, meningioma, and metastasis. The review will further include imaging characteristics that will help a radiologist to distinguish between these possible considerations and offer appropriate recommendations in regard to follow up and further management.

Conclusions
Although presenting symptoms of solid orbital masses and mimicking lesions overlap, these entities can be distinguished by carefully analyzing clinical findings, imaging
findings, and understanding possible complications. Review of this educational exhibit will enable a radiologist to be familiar with these entities, consider the associated complications, narrow relevant differential diagnoses, and offer appropriate recommendations.

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eEdE-164

MRI and CT Evaluation of Acquired Sensorineural Hearing Loss

6:30AM - 2:45PM
M Johnson1, J Varvarikos2, J Nickerson2
1University of Vermont Medical Center, Winooski, VT, 2University of Vermont Medical Center, Burlington, VT

Purpose
The purpose of this exhibit is to: 1. Briefly review the pertinent inner ear and auditory pathway anatomy. 2. Review the pathology of different forms of acquired sensorineural hearing loss as well as their signs and symptoms. 3. Review the magnetic resonance imaging (MRI) and computed tomography (CT) characteristics of the various forms of acquired sensorineural hearing loss.

Materials and Methods
The presentation will review signs/symptoms as well as underlying etiologies of multiple forms of acquired sensorineural hearing loss. Eight representative cases will be presented highlighting MRI and CT characteristics.

Results
This exhibit will draw upon cases from our institution's Neuroradiology Division at The University of Vermont Medical Center. The poster will highlight: 1. Bony labyrinth abnormalities including otosclerosis, vestibular aqueduct syndrome, and erosive/destructive forms. 2. Membranous labyrinth abnormalities including labyrinthitis, Cogan's syndrome, perilymphatic fistulas, and Ramsay-Hunt syndrome. 3. Extra-axial abnormalities including schwannoma, epidermoid cysts, and sarcoidosis. 4. Intra-axial abnormalities including demyelinating disease, neoplastic lesions, and ischemic lesions.

Conclusions
Sensorineural hearing loss is a frequent dilemma encountered in medicine. With an accurate history and understanding of the various forms of acquired hearing loss, a neuroradiologist can tailor imaging studies to best evaluate abnormalities along the auditory pathway using MRI and/or CT. Becoming familiar with the imaging characteristics of each form is critical in making an accurate diagnosis.

eEdE-111

MRI of the Post-Operative Neck: Revisiting the Expected and Unexpected

R Khan1, J Probst2, A Erman2
1University of Arizona Medical Center, Tucson, AZ, 2University of Arizona, Tucson, AZ
Purpose
To familiarize the reader with the expected and unexpected postoperative neck findings on magnetic resonance imaging (MRI).

Materials and Methods
Electronic educational review.

Results
This educational exhibit will review the MRI findings of the normal and abnormal postoperative neck on 1.5T and 3.0T MRI, to include both conventional MR imaging and advanced imaging with DCE and DWI/ADC. Findings to be covered include a discussion of pre-operative surgical considerations, the various types of flaps and grafts, the anatomical structures that typically are resected, normal postoperative anatomy, graft failure, postoperative infection and abscess, osteomyelitis, fistula formation, osteonecrosis, persistent tumor, local tumor recurrence, and postradiation changes. Ways to improve the MRI neck protocol will be discussed. Many cases will be covered, including cases from the oral cavity, mandible, larynx, hypopharynx, parotid, scalp, and sinonasal cavities.

Conclusions
After the reader has reviewed the presentation, they will be able to recognize the expected MRI appearance of the postoperative neck and the complications that can ensue.

eEdE-139

6:30AM - 2:45PM

Multimodality Imaging Overview of Pathologically-Proven Common and Uncommon Parotid Space Masses

W Finke\textsuperscript{1}, N Koontz\textsuperscript{1}, S Kralik\textsuperscript{1}

\textsuperscript{1}Indiana University, Indianapolis, IN

Purpose
The purpose of this presentation is to provide a comprehensive overview of the imaging characteristics of pathologically-proven common and uncommon parotid space masses, utilizing ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and fluorodeoxyglucose-positron emission tomography (FDG-PET) imaging.

Materials and Methods
We performed a HIPAA-compliant retrospective review of our institution's electronic medical record, including radiology and pathology databases, for illustrative cases of histopathologically-proven parotid masses, highlighting cases with multimodality imaging when possible. Additionally, a review of the current medical literature was performed.
Results
Imaging findings of a variety of parotid space masses with known pathology, including pleiomorphic adenomas, Warthin tumors, metastatic intraparotid nodal disease, mucoepidermoid carcinoma, adenoid cystic carcinoma, acinic cell carcinoma, lymphoma, carcinoma ex-pleiomorphic adenomas, and salivary ductal carcinoma will be discussed. Imaging appearance often is nonspecific, but invasive margins, perineural spread of disease, lymphadenopathy, multifocality, and location within the parotid may be helpful discriminators.

Conclusions
The imaging appearance of parotid space masses is nonspecific, but there are certain findings that can be helpful when creating a differential diagnosis and guiding clinical management.
6:30AM - 2:45PM  

**Nodal Drainage Patterns in the Head and Neck: Recognizing Them and Why Not to Miss Them!**

R Khan¹, J Probst², J Wang², H Albasha³, D Reyes², R Squires⁴, A Erman²
Purpose
To familiarize the reader with nodal metastatic drainage patterns using a multitude of magnetic resonance imaging (MRI) cases of head and neck primary cancers with typical nodal metastatic patterns.

Materials and Methods
Electronic educational review.

Results
This educational exhibit will provide a practical review of patterns of cervical nodal metastatic spread of tumor on both 1.5T and 3.0T MRI. Advanced MR imaging to include DCE perfusion and DWI/ADC will be reviewed in addition to conventional MR imaging of the neck with PET/CT correlates. The anatomical nodal levels will be reviewed utilizing both MRI anatomy and supporting schematic drawings. Many cases will be covered, including cancers of the various subsites of the neck – nasopharynx, oropharynx, oral cavity, larynx, hypopharynx, parotid, scalp, and sinonasal cavities.

Conclusions
After the reader has reviewed the presentation, they will be able to recognize the anatomical drainage patterns for cancers throughout the head and neck and be able to predict such patterns of spread utilizing both conventional and advanced MRI.

eEdE-146

6:30AM - 2:45PM

Nothing to Sniff At: A Radiologic Overview of Olfaction

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¹University of Rochester, Rochester, NY, ²University of Wisconsin, Madison, WI

Purpose
The purpose of this educational exhibit is four-fold: 1) To provide an overview of the anatomical and physiologic basis of olfaction. 2) Categorize the different functional components of normal olfaction, in relation to the etiology of various olfactory disturbances. 3) Present a pictorial review of various pathologic conditions affecting the olfactory tracts, with emphasis on strategies for diagnosis and management.

Materials and Methods
This educational exhibit is meant to serve as an autotutorial for clinical radiologists, and will be broken down into multiple (sub)sections: 1) Anatomy/Physiology of Olfaction; 2) Categorization of Olfactory Processes, a) Conductive, b) Sensorineural,
c) Receptive; 3) Imaging Techniques for Assessing Olfaction; 4) Pictorial Review of Olfaction Cases.

Results
Olfaction is a unique function that relies on the complex interaction between various anatomical, physiologic, and molecular processes, and represents one of the major routes for environmental interaction for most living organisms. Alteration of olfaction can be secondary to a wide range of pathologic conditions - including infection, trauma, toxicity, neoplasm, and neurodegenerative processes. Olfactory disturbances, such as anosmia and dysosmia, therefore can connote significant underlying disease or adverse impact on a person's quality of life.

Conclusions
An understanding and appreciation for the basis of olfaction, as well as the processes that can lead to its alteration, are a useful and practical skill for the clinical radiologist. By the end of this exhibit, the radiologist should be able to: 1) Describe the anatomy and physiology that underlies normal olfactory function. 2) Prescribe an appropriate imaging approach to problems of olfaction. 3) Recognize and describe pathologic conditions that lead to olfactory disturbance.

**Paragangliomas of the Head and Neck: A Pictorial Review**

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¹Prince Sultan Military Medical City, Riyadh, Saudi Arabia, ²Kinh Fahd Specialist Hospital (Buraidah), Buraidah, Al-Qassim, ³King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia

Purpose
Paragangliomas are rare neuroendocrine tumors arising from the paraganglionic cells scattered throughout the body. Paragangliomas of the head and neck represent less than one percent of head and neck tumors. They occur however at predictable locations, have characteristic imaging features and growth patterns, and sometimes suggestive clinical presentations. The purpose of this review is to highlight all the unique properties of these rare tumors, which frequently enable a confident diagnosis. The tendency for multiplicity and risk of metastasis are emphasized and well illustrated.

Materials and Methods
The imaging studies of nine patients with head and neck paragangliomas are presented. Our patients' studies encompass all the range of imaging used in the evaluation of these tumors including computed tomography (CT), magnetic resonance...
(MR), angiography, and nuclear medicine studies. The distinctive imaging features on each of these modalities are pointed out.

Results
The cases we present illustrate all the major distinguishing features of paragangliomas that a neuroradiologist should know. These include: 1. Their typical locations: carotid body, intravagal paragangliomas at or below the nodose ganglion, intravagal paragangliomas of the jugular ganglion at the jugular foramen, glomus jugulare tumors and glomus tympanicum tumors. 2. Predictable growth patterns. 3. Tendency for bilaterality and multicentricity. 4. Risk of metastatic disease. 5. Imaging characteristics. Two of our patients had multicentric tumors and two others had metastatic disease at the time of presentation, underscoring the importance of a thorough search for synchronous tumors, metachronous tumors (on imaging follow up), and for metastatic lesions.

Conclusions
A table summarizing the key characteristics of paragangliomas is presented, including clinical presentation, location, growth pattern, imaging features, tendency for multiplicity, and risk factors for metastasis. It outlines all the information one needs to know for an accurate diagnosis and evaluation of these tumors.

Pediatric Cystic Neck Lesions: A practical, detailed, and pragmatic approach for diagnosis based imaging features and neck space.

Purpose
Pediatric cystic neck masses are relatively common yet challenging diagnoses for residents, non-neuroradiologist or nonpediatric radiologists for multiple reasons including: complex neck anatomy, variety of pathology, and overlapping imaging features. This educational review will serve as a detailed road map for providing a simplified practical approach for diagnosis with imaging and pathological emphasis/correlation.

Materials and Methods
Introduction: Review neck anatomy via computed tomography (CT) and magnetic resonance (MR) images. Provide a table summarizing pediatric cystic neck masses with an emphasis on pathophysiology, differential diagnosis and multimodality.
imaging findings. Summarize and highlight the prior points through ultrasound (US), CT and MR cases highlighting findings in classical and rare but important cases.

Results
Pediatric cystic neck lesions are common entities with a variety of appearances that can be acquired or congenital. While most are nonmalignant, many require some sort of intervention. Imaging plays an integral role in pre-operative management and proper disposition sorting "urgent" from "surveillance" lesions. Furthermore imaging can verify complexity of the cystic lesion, associated complications, and delineate its anatomical borders providing a detailed preoperative road map to maximize favorable outcome. Understanding the imaging features of the common and rare pediatric lesions is essential for making the most accurate diagnosis and aiding in pre-operative management.

Conclusions
Pediatric neck masses can be problematic to radiology residents and general radiologist. Understanding neck anatomy, lesion anatomical preference, and multimodality imaging appearance help in generating a succinate differential diagnosis and guide disposition.
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Pediatric Facial Masses: A Guide to Radiologic Diagnosis

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Purpose
The purpose of this exhibit is 1) To review the differential diagnosis of facial masses in children, a common problem presented to radiologists. 2) To explain how to differentiate between facial masses in children based on anatomical location and by using the imaging modalities most useful in differentiating these lesions: computed tomography (CT) and magnetic resonance (MR). 3) To provide a pictorial review of common and rare pediatric facial masses.
Materials and Methods
A general background on facial masses in children will be provided and a discussion
of when CT or MR is indicated. A useful clinical categorization of facial masses in
children which has been described, will be reviewed as follows: 1) Acute with
inflammation, 2) nonprogressive, 3) slowly progressive, and 4) rapidly progressive.
Differential diagnoses and imaging findings for each of these clinical presentations,
including sample cases for common and rare facial masses will be provided.

Results
Although most acute causes of facial swelling in children do not require imaging,
exceptions include suspicion of an underlying abscess, sinusitis that does not respond
to therapy, or sinusitis with orbital or intracranial complications. In these cases CT is
recommended. A chronic or growing mass, or swelling generally requires imaging.
Differential diagnoses for facial swelling or mass include inflammatory
(sinusitis/puffy pott tumor, lymphadenitis, ondotogenic infections), congenital
(encephelocele, nasal glioma, dermoid/epidermoid cysts), vascular
(lymphocele/vascular malformations), neoplastic (rhabdomyosarcoma, Ewing
sarcoma, osteosarcoma, metastatic neuroblastoma), and other etiologies (Langerhans
cell histiocytosis, fibrous dysplasia).

Conclusions
A clinical, anatomical, and radiographic approach to providing differential diagnosis
for benign and malignant lesions, causes of facial mass and swelling in the pediatric
population is provided.

eEdE-117

Pediatric Leukocoria: What are we looking for?

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Purpose
To demonstrate a step by step approach of interpreting pediatric leukocoria
pathologies based on specific pulse sequences.

Materials and Methods
Leukocoria is an abnormal pupillary light reflection, resulting from intraocular
pathologies. All causes of leukocoria are a serious threat to vision and sometimes a
threat to life. Most common cause is retinoblastoma. Other causes include PHPV,
Coats disease, toxocaral endophthalmitis, ROP, retinal astrocytic hamartoma,
choroidal colobomas, and vitreous hemorrhage. Magnetic resonance imaging (MRI)
plays an important role to differential diagnosis for each disease and plans for further
management.
Results
We will demonstrate several cases of congenital/acquire pediatric leukocorias. Imaging checklists and key imaging findings in each MRI pulse sequences will be highlighted as a tool for interpretation. T1 image checklists include subacute blood product, proteineous content and fat. T2 image checklists include shape and contour of the globe, optic nerves/chiasm details with respect to size/shape and symmetry. Susceptibility-weighted imaging (SWI)/GRE image checklists include hemosiderin and calcification. Diffusion-weighted imaging (DWI) checklist includes potential tumor grading. Additional techniques include reduction of field inhomogeneity during SWI/GRE/DWI sequences and T2 3D technique to increased sensitivity of lesion detection will be discussed. The various pathologies we will demonstrate using this method include retinoblastoma, PHPV, Coats disease, toxocaral endophthalmitis, ROP, retinal astrocytic hamartoma, choroidal colobomas and vitreous hemorrhage.

Conclusions
Cross-sectional imaging, especially MRI, is a valuable tool in diagnosis of pediatric leukocoria. The information will help the clinician make a treatment plan. Understanding the importance of imaging sequences and having a diagnostic checklist in each sequence can improve accuracy in interpretation, assisting clinicians in optimizing patient counseling and management.
**Post-Operatory Evaluation of Otosclerosis: Normal Findings and Complications that Radiologists Should Know and Report.**

S Tufik¹, u passos¹, f cevasco¹
Purpose
The main goal of this electronic educational exhibit is to demonstrate with cases of our institution the normal postoperatory imaging of the most common surgeries used to treat otosclerosis and the most important complications of these procedures. We would like to highlight the importance of computed tomography (CT) in the postsurgical analysis of otosclerosis and show how radiologists should perform it.

Materials and Methods
The CT exams of 37 patients with otosclerosis, treated with surgical procedures, were obtained from our database since 2010 in Centro de Diagnósticos Brasil, in Sao Paulo, Brazil. The images were analyzed by an experienced head and neck radiologist (more than 10 years) for the types of operation performed and the complications encountered. The methodology used in our service to evaluate postsurgical CT exams of these cases also is discussed. The review of the most up-to-date literature regarding otosclerosis was made through compilation of recent articles published in major indexed journals, from PubMed, Embase and the Cochrane Library.

Results
All of the subjects were submitted either to stapedectomy or stapedotomy, both accompanied by prosthesis insertion. Some of the prosthesis used for stapedectomy were made of titanium and others of teflon. The main focus of the pre-operatory analysis is the region involving the stapes, the oval window and the fibrocartilaginous tissue between them, the fissula ante fenestram (also called "cochlear cleft"). Afterwards, it is important to check for eventual spreading to inner ear otic capsule and other portions of the bony labyrinth. Both sides must be investigated, despite clinical presentation. The postoperatory analysis consists in almost the same pattern of investigation, however keeping the surgical complications in mind and, sometimes, leading with strike artifacts. There is a wide spectrum of possible complications. The most frequent ones are characterized by misplacement of the prosthesis, usually due to trauma or technical issues of the surgical procedure. It also is common to observe the penetration of the prosthesis in the oval window and pneumolabyrinth. Other complications also include incus subluxation and fibrous adhesion.

Conclusions
We analyzed multiple cases of our institution and discussed the findings of the normal postoperatory imaging of the most common surgeries used to treat otosclerosis and the most important complications of these procedures. The treatment of fenestral otosclerosis is primarily surgical with stapedotomy and stapes prosthesis insertion to restore the ossicles and, consequently, hearing. CT usually is essential for pre and postsurgical analysis. The radiologist often faces different postsurgical findings and therefore it is important to know the main techniques used in the treatment and most common complications.
Reference points for the assessment of the course of the anterior and posterior ethmoid arteries by multislice CT.

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Purpose
The purpose of this exhibition is: 1. To identify the landmarks of the anterior ethmoidal artery (AEA) on the orbital medial wall and on the lateral wall of the olfactory fossa. 2. To describe the approach to the radiologic landmarks of the posterior ethmoidal artery (PEA).

Materials and Methods
We will describe and show in multislice CT scans: 1. Anterior ethmoidal artery (AEA) course/pathway, Orbit, Anterior ethmoidal foramen, Ethmoid labyrinth, Anterior ethmoidal canal, Anterior ethmoidal sulcus, Olfactory fossa. 2. Posterior ethmoidal artery (PEA), Original anatomical description will be presented. Identification of PEA’s bony landmarks in multislice CT exam.

Results
The medial notch of the orbit (anterior ethmoidal foramen) and the anterior ethmoidal sulcus on the lateral wall of the olfactory fossa were reliable parameters for identifying the course of the anterior ethmoidal artery. The ethmoidal posterior artery landmarks were introduced and further assessment will still establish their reliability.

Conclusions
Multislice CT has reliable parameters for identifying the course of the anterior ethmoidal artery (AEA) helping the surgical planning. There are landmarks for posterior ethmoidal artery (PEA) in multislice CT described here and further assessment will establish their reliability to help surgical planning.

Review of Parotid Gland Masses

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Purpose
Recognition of benign and malignant parotid masses based on their imaging characteristics is crucial to guiding further clinical evaluation and treatment. In addition to providing a succinct, accurate differential diagnosis to ordering providers, recognizing spread of disease is essential for staging of malignant parotid masses.

Materials and Methods
This electronic exhibit reviews the anatomy and key imaging features of the parotid gland using computed tomography (CT) and magnetic resonance imaging (MRI), with an emphasis on distinguishing benign and malignant pathology to direct management.

Results
Educational Goals/Teaching Points: 1. Understand the anatomy of the parotid glands and key imaging landmarks for classifying pathology location. 2. Review the incidence and imaging appearance of the most common benign and malignant parotid masses. 3. Assess the role of imaging in the evaluation of parotid gland masses to direct clinical management. Key anatomical or pathophysiologic issues, imaging findings or imaging techniques: 1. Imaging alone may permit development of a succinct parotid mass differential diagnosis which can be generated to help guide further management. 2. Recognition of important anatomical landmarks, particularly the delineation of the superficial and deep lobes of the parotid gland and facial nerve, is vital for evaluating extent of disease.

Conclusions
Benign and malignant parotid masses may be distinguished based on imaging characteristics on CT and MRI. Recognition of mass location within the parotid gland and disease spread beyond the gland itself is critical for clinical staging and guidance of surgical management. When unable to definitively identify the etiology of a mass based on its imaging characteristics, a succinct and accurate differential diagnosis often can be provided to direct further care.
HIV Lymphoepithelial Cysts

- Typically appear as simple cysts on CT and MR, however may be solid lesions with variable appearance.
- Associated with HIV seropositivity.
- Often seen with cervical and intraparotid lymphadenopathy.
CECT: Multiple well-circumscribed cystic lesions within the left parotid gland with thin, smooth peripheral enhancement.
Malignant Parotid Neoplasms

- CarcinomaEx
  - PSA
  - 5%
- Other Malignant Neoplasms
  - 14%
- Mucoepidermoid
  - 29%
- Adenoid Cystic Carcinoma
  - 14%
- Acinar Cell Carcinoma
  - 16%
- Adenocarcinoma NOS
  - 23%

Role of Cross-sectional imaging in the Preoperative Evaluation of Laryngeal Cancer.

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Purpose
To describe relevant anatomy and review pertinent CT findings in pre-operative staging of laryngeal carcinoma.

Materials and Methods
While laryngoscopy is the gold standard to evaluate the mucosal tumor burden and cord mobility in the setting of laryngeal cancer, cross-sectional imaging is necessary
to delineate the submucosal extent of the tumor, infiltration of surrounding structures and nodal metastasis. This combined information allows the tumor to be classified according to the relevant T staging, which guides treatment. This case-based presentation will review pertinent laryngeal anatomy, as well as important imaging findings in the evaluation of laryngeal cancer.

Results

Treatment options for laryngeal carcinoma involve surgery, radiotherapy and chemotherapy. These can be used alone or in combination with one another. The choice of treatment, response to treatment and patient outcomes depend on the extent of the tumor. Specific imaging findings in the assessment of pre-operative staging of laryngeal carcinoma are as follows: • Tumor volume: Tumor volume is strongly associated with local control following surgery and impacts the T staging. It is an independent predictor of survival. • Relationship to the glottis: This involves classifying the tumor according to the three key anatomical spaces within the larynx, namely, the supraglottis, glottis and subglottis. This classification is extremely important as it determines whether a voice preserving conservative surgery can be performed or not, and if yes, what type. • Submucosal space involvement: Involvement of pre- and paraglottic submucosal spaces upstages the tumor and impacts choice of surgery. • Anterior and posterior extension – This is important at the level of the glottis. Anterior extension increases chances of thyroid cartilage involvement and extralaryngeal spread. Posterior extension increases incidence of postcricoid pharyngeal extension. • Laryngeal cartilage: Involvement of the laryngeal cartilage precludes conservative therapies such as radiotherapy and partial laryngectomy. • Nodal or systemic metastasis: Levels 2-4 lymph nodes in the neck are the most common site. The lungs are the most common site of systemic metastasis. Patients with advanced T staging and paratracheal nodal disease should get Chest computed tomography (CT) as part of pre-operative staging.

Conclusions

Cross-sectional imaging plays a crucial role in the pre-operative staging of laryngeal cancer and careful assessment of specific imaging findings is necessary to optimize the therapeutic strategy.
**T staging of Laryngeal Carcinoma**

### Glottic Carcinoma

- **T1**: Tumor limited to the vocal cord(s) with normal vocal cord mobility.
- **T1a**: Tumor limited to one vocal cord.
- **T1b**: Tumor involves both vocal cords.
- **T2**: Tumor extends to supra- and/or subglottic region with or without impaired vocal cord mobility.
- **T2a**: Tumor limited to the larynx with vocal cord mobility intact.
- **T2b**: Tumor involves the paraglottic space, and/or minor thyroid cartilage.
- **T3**: Tumor involves tissues beyond the larynx and/or trachea, deep intrinsic tongue muscles, strap muscles, mediastinal structures.
- **T4a**: Tumor invades prevertebral space, encases mediastinal structures.
- **T4b**: Tumor invades prevertebral space, encases mediastinal structures.

### Supraglottic Carcinoma

- **T1**: Tumor limited to one subsite with normal vocal cord mobility.
- **T2**: Tumor involves mucosa of more than one subsite with normal vocal cord mobility.
- **T3**: Tumor extends to larynx with vocal cord fixation and/or extralaryngeal invasion including extralaryngeal space (e.g. piriform sinus).
- **T4a**: Tumor involves the trachea, deep intrinsic tongue muscles, strap muscles.
- **T4b**: Tumor invades prevertebral space, encases mediastinal structures.

### Subglottic Carcinoma

- **T1**: Tumor limited to the subglottis.
- **T2**: Tumor extends to the vocal cords with normal vocal cord mobility.
- **T3**: Tumor limited to the larynx with vocal cord mobility intact.
- **T4a**: Tumor involves tissues beyond the larynx and/or trachea, deep intrinsic tongue muscles, strap muscles.
- **T4b**: Tumor invades prevertebral space, encases mediastinal structures.

*Data obtained from the AJCC (American Joint Committee on Cancer)*
Role of imaging in the evaluation of cutaneous symptoms in the region of the cheek

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Purpose
The aim of this presentation is to delineate the imaging anatomy and the range of pathology in patients with symptoms in the region of the cheek. The cheek is supplied by the cutaneous branches of the infraorbital nerve, a branch of the maxillary division of the trigeminal nerve. The current study aims to elucidate the imaging appearances of various disease entities affecting the maxillary nerve and its branches, in order to assist in patient diagnosis and management.

Materials and Methods
We utilized multiplanar CT and MR images to delineate the normal course of the maxillary division of the trigeminal and correlated the imaging with anatomical illustrations. Subsequently, a case-based approach was utilized to exemplify pathologic conditions affecting the nerve.

Results
Imaging findings of 20 patients with cutaneous symptoms in the region of the cheek are described. This presentation will describe a range of pathologies afflicted various segments of the maxillary nerve. Various disease entities affecting the infraorbital nerve, the pterygopalatine fossa, the maxillary nerve in the cavernous sinus and the Meckel's cave are presented. The infraorbital nerve and the maxillary nerve serve as a conduit for perineural spread of tumor from the face including squamous cell carcinoma (Fig. 1). The infraorbital nerve and canal also are subject to trauma involving the floor of the orbit. Other pathologies include tumors like schwannomas and neuromas.

Conclusions
Detailed analysis of the infraorbital nerve, the pterygopalatine fossa, the maxillary nerve, and Meckel's cave is necessary in patients with symptoms in the region of the cheek. Attention to its normal course and enhancement pattern will assist in the evaluation of the patient and help the clinician in patient management.
eEdE-122
Rosai-Dorfman Disease within the Head, Neck, and Brain: A Case Series and Review of Imaging Findings and Clinicopathologic Features

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Purpose
This exhibit will discuss the imaging findings and clinical features of Rosai-Dorfman disease within the head/neck and brain.

Materials and Methods
This exhibit will review the orbital and intracranial manifestations of Rosai-Dorfman disease. Additional involvement within the head and neck will be discussed as well as the relevant clinical features. Three cases will be presented: an infiltrative orbital mass with dural extension, a hemorrhagic cerebellar mass, and an infiltrative subcutaneous facial mass.

Results
Also called sinus histiocytosis with massive lymphadenopathy, Rosai-Dorfman disease is a benign proliferative disease of phagocytic histiocytes most commonly affecting children and young adults. Most patients exhibit painless bilateral cervical lymphadenopathy but a few present with isolated extranodal involvement. More common sites of extranodal involvement include the orbit and eyelid, nasal cavity, respiratory tract, skin, and bone. While intracranial involvement is rare, several cases have been reported. Orbital involvement in Rosai-Dorfman disease in the absence of lymphadenopathy is rare, reported in only 7 of 423 registered cases. Most patients with orbital disease present with proptosis, restricted eye movement, eyelid edema, epiphora, and decreased vision. Unilateral involvement is most common. Imaging typically identifies an infiltrative orbital mass with variable degrees of enhancement. Preseptal and/or postseptal involvement may be seen. Intracranial disease most commonly presents as an enhancing dural plaque, mimicking meningioma. Parenchymal lesions are very rare with few reported cases. Our patient presented with a hemorrhagic enhancing cerebellar mass with surrounding edema.

Conclusions
While isolated extranodal involvement is rare in Rosai-Dorfman disease, orbital, dural, brain parenchymal, and skin involvement may be seen. Knowledge of the clinical manifestations and imaging appearance of Rosai-Dorfman within the head, neck, and brain will aid the radiologist faced with this rare disease.
Manifestations of Rosai-Dorfman Disease

A) Pre contrast T1 MR demonstrates a hemorrhagic right cerebellar hemangiopericytoma

B) Post contrast T1 MR with fat saturation demonstrates an enhancing right cerebellar mass and enhancing dural thickening

C) Post contrast T1 MR with fat saturation demonstrates an infiltrative enhancing mass within the left facial skin and subcutaneous tissues
Purpose
The goal of this exhibit is to provide an overview of texture analysis as it may apply
to the characterization of head and neck tumors.
Materials and Methods
Principles and variables used in texture analysis will be reviewed. Examples of
potential applications of texture analysis in head and neck oncology imaging will be
included.
Results
Many statistical parameters can be employed in texture analysis of diagnostic images,
including entropy, energy, variance, correlation, for example. In addition, there are
different ways of analyzing the lesion of interest, including central slice versus 3D
approaches. The advantages and disadvantages of the different techniques will be
discussed. In addition, clinically relevant examples will be depicted, including
differentiation between HPV positive and negative squamous cell carcinomas of the
aerodigestive tract, differentiation between residual tumor and treatment effects, and
prediction of treatment response.
Conclusions
Texture analysis is beginning to show promise in the realm of head and neck
oncologic radiology as a powerful form of quantitative imaging. Therefore, it is
important to be familiar with the basic concepts and potential applications of this
technique.

eEdE-159

The journey is as important as the destination; review of an important conduit.
The external auditory canal and its pathologies.

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Purpose
The external auditory canal (EAC) has a variety of pathologies and variations. In our
experience, radiologists can overlook this important passageway or underestimate its
significance. Our aim is to make the radiologist, either in-training or in practice,
familiar with the anatomy and imaging of the EAC.
Materials and Methods
An interactive model is used with questions/cases posed before each section. The
embryology, histology and anatomy of the EAC is discussed first, in detail. Next, the
modalities used for imaging are discussed with examples of normal appearances. The
last section deals with variations and pathologies of the EAC. A quiz in the end reinforces the topics discussed earlier.

Results
The EAC has significant physiological and pathological significance. Its physiological roles include conducting sound, giving some degree of frequency selectivity to sound energy, and protecting the tympanic membrane from mechanical injury and changes in the environment. The EAC develops from the pharyngeal arches and continues to acquire an "S"-shaped curve through adulthood. Computed tomography (CT) remains the primary modality for evaluation of the EAC, although magnetic resonance imaging (MRI) may be used in certain instances, such as evaluation of masses or in pediatric populations where clinically significant pathology is suspected. The ideal imaging protocols for these modalities are discussed. The pathologies and cases discussed include, atresia, exostoses of the EAC, osteomas (Fig. 1A), cholesteatoma (Fig. 1B), malignant otitis externa (Figs. 1C and D), keratosis obturans, tumors such as squamous cell carcinoma and adenoid cystic carcinoma, granulomatous processes such as sarcoidosis, and medial canal fibrosis.

Conclusions
A review of cases is shown to reinforce the anatomy and knowledge gained in the previous sections.

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Purpose
- To review the typical locations of parathyroid adenomas, and reported imaging characteristics.
- To describe the imaging pitfalls and challenging cases of parathyroid adenoma localization on time-resolved computed tomography (CT) imaging.

Materials and Methods
A series of multiphase 4D CT scans obtained for pre-operative parathyroid adenoma...
localization performed at our institution were reviewed retrospectively. This study presents cases where pre-operative parathyroid adenoma localization was not straightforward on 4D CT, and analyzes these studies for imaging pitfalls such as artifacts, suboptimal technique and unusual presentations that create diagnostic challenges for radiologists in accurate pre-operative delineation of parathyroid adenomas.

Results

4D parathyroid CT is a diagnostic tool providing excellent spatial resolution for pre-operative localization of parathyroid adenomas. Parathyroid adenomas can be localized to four quadrants and described in relation to the thyroid parenchyma and recurrent laryngeal nerve (Perrier 2009). Various imaging techniques are described in the literature, with commentary that the optimal "4D" protocol has yet to emerge. In this study, a series of multiphase 4D CT images were reviewed retrospectively to assess for pre-operative diagnostic accuracy of parathyroid localization in two imaging phases, arterial and venous, with dose reduction technique. Retrospective analysis of the images demonstrated imaging techniques and artifacts that complicated accurate pre-operative parathyroid adenoma localization on CT. Findings leading to pitfalls in localization included shoulder artifact due to suboptimal patient positioning, retained intravenous contrast, motion artifact, large body habitus and cystic parathyroid adenomas. This presentation delineates important teaching points to aid in diagnostic localization when pre-operatively localizing difficult to find perplexing parathyroid adenomas.

Conclusions

Improved awareness of CT artifacts, how to correct or adjust for them, and unusual presentations of parathyroid adenomas can assist radiologists in pre-operative parathyroid adenoma localization in multiphase parathyroid CT imaging.
The Problematic Perplexing Parathyroid...
Purpose
1. To review current issues with and guidelines for thyroid ultrasound reporting. 2. To describe a computerized clinical decision support system using sonographic thyroid nodule characteristics. 3. To describe the advantages of a computerized database and clinical support system.

Materials and Methods
Ultrasound is the imaging modality of choice for thyroid nodule characterization. However, variation in reporting can lead to confusion about recommendations. Efforts to standardize reporting for risk stratification to inform clinical decision making have been made with the Thyroid Imaging Reporting and Data System (TIRADS) and the American Thyroid Association (ATA) guidelines. The Thyroid Cancer Care Collaborative (TCCC) applies TIRADS to a HIPAA-compliant Internet-based algorithm that generates patient-specific recommendations in accordance to the ATA guidelines for the purposes of risk stratification and individualized treatment.

Results
The multidisciplinary clinical decision-making module has been designed collaboratively by physicians experienced in thyroid cancer diagnosis and treatment to coordinate care and guide patient-specific decisions. The provider inputs clinical data and thyroid nodule sonographic characteristics, which include thyroid nodule composition, echogenicity, shape, size, margins, and echogenic foci, as outlined in the TIRADS lexicon. Based on these sonographic patterns, nodules are stratified according to estimated risk of malignancy for fine-needle aspiration (FNA) guidance.

Conclusions
Studies have demonstrated improvement in practitioner performance with the use of computerized clinical decision support systems. The TCCC is a powerful internet-based database that helps provide patient-specific treatment in keeping with the ATA clinical practice guidelines based on patient and sonographic characteristics. Given that the user selects from a predetermined menu of sonographic characteristics, the database helps standardize thyroid ultrasound reporting. The use of a clinical decision support system using evidence-based recommendations may help minimize potential harm from overtreatment while appropriately identifying and treating higher risk patients. In addition, the graphic depiction of nodules and lymph nodes with respect to anatomical structures in a visual model helps aid pre-operative planning.
Figure 1. After patient data and sonographic features of a thyroid nodule are entered into the Thyroid Cancer Care Collaborative Imaging and Cytology Module (A), an algorithmically-based recommendation is automatically generated in accordance to the American Thyroid Association guidelines (B). Given that the user selects from a menu of sonographic descriptions, this database helps standardize thyroid ultrasound reporting. The visual depiction also aids in preoperative planning.
TMJ imaging beyond Temporomandibular Joint Disorder

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Purpose
Temporomandibular joint (TMJ) magnetic resonance (MR) imaging is mostly performed to evaluate temporomandibular joint disorder (TMD), specifically to evaluate disk morphology and location, condylar morphology, range of motion, and dynamic function. Standard MRI sequences are established, and oblique sagittal proton density-weighted imaging in closed and open mouth position is the key sequence at most institutions. Although the clinical symptoms are similar or almost identical to TMD, TMJ may be affected by a variety of other conditions. We illustrate the current MR imaging technique of the TMJ, and review representative cases of TMD and other conditions that affect the TMJ.

Materials and Methods
We retrospectively reviewed computed tomography (CT) and MR imaging studies in patients with TMJ abnormalities with dedicated MR imaging studies for TMD, as well as in patients with other TMJ abnormalities found on CT and MR imaging studies performed for other reasons.

Results
Dedicated TMJ MR imaging precisely depicts abnormality of disk location and morphology, osteoarthritic changes, abnormal dynamic function and range of motion, and joint effusions. Disadvantages of dedicated TMJ MR imaging includes limited field- of-view and limited sequences, and pathologies outside of the TMJ may be missed. Computed tomography and MR imaging performed for other reasons often show TMJ abnormalities such as degenerative changes, fracture, infection, congenital anomaly, synovial osteochondromatosis, inflammatory conditions such as RA and CPPD, and occasionally malignancy both primary and metastasis. Marrow abnormalities often are seen in patients with systemic disorders/hematological disorders, including anemia, sickle cell disease, leukemia, and chemotherapy. Metastases are seen in the condyle or glenoid fossa.

Conclusions
Temporomandibular joint disorder is not the only condition that affects the TMJ. Temporomandibular joint abnormalities often are seen on studies performed for other
reasons. Incidentally found TMJ abnormalities may be a clue for unrevealed, serious underlying diseases or conditions.

eEdE-169

6:30AM - 2:45PM

To Find an Adenoma: Common and Uncommon Locations for Parathyroid Adenomas on 4DCT

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Purpose

Ectopic thyroid adenomas are one of the most common cause of failed pre-operative localization and surgery for hyperparathyroidism. Traditional imaging modalities such as 99mTc MIBI scintigraphy and ultrasonography yield suboptimal sensitivity for adenoma detection, particularly with respect to ectopic lesions and multi-gland disease. Conventional approach is to define the location of parathyroid adenomas by quadrant approach. Pre-operative localization of parathyroid adenomas is increasingly accomplished with 4DCT. In this educational exhibit we discuss the embryologic development and migration of the parathyroid glands and review typical and atypical locations of parathyroid adenomas from our series of >150 4DCT studies.

Materials and Methods

Our educational exhibit will include discussion of parathyroid development and migration and its importance for the computed tomography (CT)-based detection of adenomas. We also provide a pictorial review of eutopic and ectopic lesions from our institutional experience with 4DCT including single gland and multi-gland disease.

Results

Our series includes parathyroid adenomas in a variety of ectopic locations in addition to eutopic lesions of variable size and with varying 4DCT imaging characteristics. Our pictorial review provides learners with a search pattern that includes high-yield locations plus instruction on where to look on potentially problematic cases such as ectopic lesions, multi-gland disease, and 4DCT in the post-operative patient. Figure A: Cystic left inferior parathyroid adenoma Figure B: Right tracheo-esophageal groove adenoma Figure C: Retro-esophageal double adenoma Figure D: Retro-manubrial adenoma

Conclusions

Our review of parathyroid adenoma location from our series of >150 4DCT cases provides learners with a concise background on parathyroid development and migration, description of high-yield locations on which to focus initial assessment, and multiple examples of adenomas in atypical locations. Our goal is to instill a
methodical, practical, and effective search pattern for adenoma detection and localization on 4DCT.
Treatment Tipping Points in the H&N: Critical Imaging Findings that Alter Cancer Management

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Purpose
While imaging of malignant head and neck (HN) tumors may be considered challenging, there are multiple situations in HN cancer staging where the radiologic findings are key determinants of surgical, radiation and/or medical therapy. We present an image-based review of critical findings on staging CT and MR scans that alter the AJCC tumor staging and/or the choice of therapy.

Materials and Methods
Clinical vignettes will be used to illustrate the utility of different imaging modalities and the specific imaging findings which are critical to tumor staging, to patient management and/or to patient morbidity. Key tipping points in cancer staging often occur when determining the deep extension of tumor or the degree of deep tissue invasion which is not evident on clinical examination. Examples of these include: extrinsic tongue muscle involvement with oropharyngeal or oral cavity tumors, bone invasion with oral cavity malignancies, and thyroid cartilage penetration with laryngeal malignancies. In these situations, imaging evidence of deep invasion determines T4 status. Pre-epiglottic fat invasion delineates a laryngeal tumor as at least T3. The presence of contralateral adenopathy may upstage nodal status, and typically alters the radiation field for pharyngeal tumors. We present 10 critical tipping points that radiologists should be aware of when staging HN malignancies. An included example demonstrates a case where imaging was suggestive but inconclusive of thyroid cartilage invasion on MRI (images A-C), but no cartilage invasion was demonstrated on CT. The patient underwent total laryngectomy with pathology showing no evidence of thyroid cartilage invasion.

Results
While staging HN cancer can be difficult there are specific situations where the imaging findings are critical to clinical decision making. We present a pictorial review of these key tipping points in tumor management and also a review of the optimal imaging techniques and the imaging criteria for correctly establishing these findings.

Conclusions
Awareness of critical 'tipping points' in the staging of head and neck cancer will

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improve the quality of the radiologist's interpretation and significantly impact clinical management.

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eEdE-168

Unlocking the Parathyroid Puzzle: A Detailed Look at the Multimodality Options
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Purpose
This educational exhibit will discuss the multimodality options available for parathyroid imaging, specifically focusing on 4D computed tomography (CT), traditional gray scale and contrast-enhanced ultrasound, magnetic resonance imaging (MRI) and Sestamibi scintigraphy including SPECT/CT.

Materials and Methods
Following a brief discussion of the anatomy and embryology of the parathyroid glands relevant to both diagnostic investigation and surgical approach, the presentation will include a thorough review of the current literature regarding the fundamentals of the available imaging modalities and their utility.

Results
Hyperparathyroidism is a common endocrine disorder with important clinical implications due to the possibility for surgical cure in the setting of primary hyperparathyroidism. Imaging plays a significant role in the work-up of primary hyperparathyroidism with meaningful implications on surgical approach via both the localization of single parathyroid adenomas, the most common cause of primary hyperparathyroidism, and the detection of multiple adenomas or parathyroid hyperplasia, thus leading to high success rates and reduction in morbidity via the utilization of minimally invasive parathyroidectomy techniques. Various techniques are available for the examination of primary hyperparathyroidism from the earliest used and most studied modalities of sestamibi scintigraphy and gray scale ultrasound to the relatively newer modes garnering recent attention, 4D CT and the less commonly implemented use of contrast-enhanced ultrasound and MRI. Each modality has its own set of unique pros and cons leading to differences in their sensitivity and specificity and thus, not infrequently, a complementary imaging approach. Understanding of each technique's principles and limitations is imperative to improving diagnostic accuracy.

Conclusions
Multiple imaging modalities currently are available for the evaluation of hyperparathyroidism, from the traditionally used Sestamibi scintigraphy and now SPECT/CT and gray scale ultrasound to more up and coming uses of 4D CT and contrast-enhanced ultrasound and MRI with each technique having their own strengths and limitations. Familiarity with each option is essential in the evaluation of primary hyperparathyroidism by providing the necessary localization of parathyroid adenomas, thus resulting in improved surgical outcomes.
eEdE-163

6:30AM - 2:45PM
Usual and Unusual Lesions of The Cerebellopontine Angle

J Ovalle¹
¹CEDICAF, Ibagué, Colombia

Purpose
To illustrate the main features on magnetic resonance imaging (MRI) of unusual cerebellopontine angle lesions (CPA) with MR techniques, basic sequences T1, T2, FAT-SAT, gadolinium enhancement and diffusion-weighted imaging.

Materials and Methods
The CPA cistern is a subarachnoid space containing cranial nerves and vessels bathed in cerebrospinal fluid. It is centered by the internal auditory canal (IAC) and extends caudally from the Vth cranial nerve to the IX-X-XIth cranial nerve complex. The pre-operative diagnosis of a CPA lesion is based mainly on imaging. Vestibular schwannomas and meningiomas account approximately 90-95% of all CPA lesions, but we can see unusual lesions such as epidermoid cyst, aneurysm, metastasis, granulomatous diseases, intra-axial lesions involving the CPA angle like lymphoma, glioma, hemangioblastoma, papilloma, ependymoma and skull base lesions such as paraganglioma, chondromatous tumors, chordoma, and endolymphatic sac tumors.

Results
In this exhibition we are going to illustrate with typical cases and schemes the main patterns on MR imaging of these usual and unusual lesions, their main patterns of enhancement and behavior in diffusion-weighted imaging. We can differentiate and classify these lesions in enhancing and nonenhancing lesions. Between enhancing lesions, the main extra-axial lesions such as schwannomas, meningiomas, metastasis, granulomatous diseases, and intra-axial/intraventricular lesions such as glioma, hemangioblastoma, ependymoma. Between nonenhancing lesions we can classify these based on T1 signal, hyperintense on T1 like lipoma, dermoid cyst, neuroenteric cyst, and hypointense on T1 lesions like epidermoid cyst, arachnoid cyst and neurocysticercosis.

Conclusions
A wide variety of lesions can be encountered in the CPA, the systematic approach on imaging includes analysis of the site of origin, shape, intensity, and behavior after contrast media injection.

eEdE-125

Variance in Position of the Globe

M Haider¹, A Mohandas², T Khairalseed³, K Shah⁴
Purpose
To describe the range of normal globe position within the orbit, and review selective pathologies resulting in globe malpositioning.

Materials and Methods
We first reviewed the literature to assess the range of accepted variation in globe positions, including ethnic/racial factors. We used these criteria to identify malpositioned globes including exophthalmos, enophthalmos and hypoglobos resulting from traumatic, infectious, neoplasm, inflammatory and vascular causes.

Results
We describe cases of proptosis secondary to large intra- and extra-cranial tumors such as meningiomas, inflammatory causes such as pseudotumor and sarcoidosis, and vascular causes including carotidocavernous fistulas and cavernous sinus thromboses. We describe enophthalmos occurring in the setting of silent sinus syndrome and after inadequate fixation of facial fractures.

Conclusions
There is a range of normal position of the globe based on patient race and ethnicity. We describe a number of etiologies that may result in malpositioning of the globe.

eEdE-109

Vascular Complications of Head and Neck Infections

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1University of Texas Health Science Center Houston, Houston, TX

Purpose
Vascular complications (VC) of head and neck infections (HNI) are a heterogeneous group of serious and potentially life-threatening conditions. Oftentimes the diagnosis is not suspected, and misdiagnosis or delayed diagnosis may lead to serious morbidity or mortality.

Materials and Methods
A variety of clinical scenarios are used to illustrate the seriousness of VC associated with HNI. Imaging strategies tailored to maximize diagnostic input are discussed, including the strengths and weaknesses of diagnostic modalities appropriate for each condition. Pathology/pathophysiology and their treatment implications are reviewed.

Results
Strokes as a consequence of vasculopathy associated with mycotic infection, mycotic...
aneurysm/pseudoaneurysm, meningogenic vasculopathy, septic brain emboli, inflammatory/infectious arteritis resulting from orbital cellulitis, dural venous sinus thrombosis from skull base osteomyelitis, cavernous sinus thrombosis, thrombophlebitis resulting from mastoiditis, and Lemiere's syndrome are examples of serious vascular complications resulting from HNI. Diagnostic imaging strategies are presented. Specifically, the role of different imaging modalities, i.e., computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine (in select cases), and noninvasive and invasive vascular imaging] in the diagnosis of such conditions is addressed. The treatment implications of the underlying pathology and pathophysiology are discussed.

Conclusions
Imaging plays a key role in the diagnosis of serious vascular complications resulting from head and neck infections. Misdiagnosis or delayed diagnosis oftentimes leads to catastrophic consequences.
Volumetric MRI options for Cranial Nerve Imaging: Knowing the Anatomy and Pathology

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Purpose
To familiarize the reader to cranial nerve anatomy on multisequence high resolution volumetric magnetic resonance imaging (MRI) with supporting pathology.

Materials and Methods
Electronic educational review.

Results
This educational exhibit will provide a practical review of cranial nerve anatomy utilizing high resolution volumetric MR images to include CISS, T2 SPACE, MPRAGE, and T1 SPACE on both 1.5 and 3T scanners and supporting schematic drawings. Radiological pathology with select gross pathological correlation will be shown, including nerve sheath tumors, cerebrospinal fluid (CSF) spread of tumor, and perineural spread of tumor. In addition, cases where diffusion-weighted imaging (DWI) showed focal brainstem infarcts with characteristic cranial nerve neurological deficits will be included for anatomical correlation.

Conclusions
As high resolution MR imaging becomes more prevalent in routine studies of the brain, one must be prepared to recognize the detailed anatomy of the cranial nerves in order to describe abnormalities appropriately. This educational exhibit will review the MR imaging options for high resolution volumetric cranial nerve anatomy with supporting pathology.
"Unravelling a bundle of nerves?"

D Saunders\textsuperscript{1}, B Adams\textsuperscript{1}, I Craven\textsuperscript{1}, D Warren\textsuperscript{1}, J Macmullen-Price\textsuperscript{1}, S Currie\textsuperscript{1}

\textsuperscript{1}Leeds Teaching Hospitals Trust, Leeds, West Yorkshire

Purpose
To provide a radiology-primed educational tool that provides the user with an accessible and comprehensive review of the anatomy and the range of pathology that can affect the cranial nerves.

Materials and Methods
A user-friendly electronic educational exhibit is presented that incorporates high-quality illustrations and radiological images to demonstrate important anatomical concepts and pathologic findings relating to the cranial nerves.
Results
Users are invited into an educational radiological world of cranial nerves where they can set their own learning agenda and set their own pace in which to learn. For brevity an introductory teaching episode provides an overview of cranial nerve anatomy and function, classification of pathologies and imaging approaches. Twelve further sessions are devoted to in-depth coverage of the different cranial nerves. Learning is reinforced by a series of cases using computed tomography (CT) and magnetic resonance imaging (MRI) that illustrates the disease entities that result in cranial nerve dysfunction. Succinct descriptions in a bulleted format empower rapid reading and review. Key learning points are emphasized and summarized.

Conclusions
Every radiologist reading brain MRI should appreciate the course of each cranial nerve from brainstem to endpoint and apprehend the pathologies common to them. This exhibit will serve as a valuable review for neuroradiologists and for other practicing neuroscience clinicians. It also will prove beneficial to students wishing to acquire a solid understanding of the anatomy, function and pathology of the cranial nerves.

eEdE-171
6:30AM - 2:45PM
Implementing a Flipped Classroom for Neuroradiology Instruction

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Purpose
A flipped classroom, also known as reverse education, is a pedagogy where facts and concepts are learned independently outside of the classroom setting, followed by interactive tutorials or workshops that require application of the learned facts. We recently have demonstrated that flipped classroom radiology instruction was associated with increased academic achievement, greater task value and more positive achievement emotions when compared with traditional didactic instruction. This exhibit will lead the instructor through the steps required to construct an interactive flipped classroom in neuroradiology.

Materials and Methods
After defining learning objectives, instructors should identify neuroradiology tutorials
that will provide the knowledge needed for the subsequent in-class interactive workshop. A quiz should be administered prior to the workshop to evaluate if learners are equipped with the factual knowledge they will apply in the workshop. Workshops can be conducted using tablet apps, such as "Two Screens," "Slide Shark" and "Nearpod." Interactive features, such as the ability to draw on images, video presentations and audience response questions embedded in PowerPoint modules, keep learners engaged. Clinical scenarios can be used in the workshop to encourage development of higher order cognitive skills and learned fact consolidation.

Results
Flipped classroom pedagogy is particularly attractive in an age of rapidly increasing biomedical knowledge and a wealth of portable computing resources. It also has strong appeal to millennial learners, because they can use technology to learn at their own pace, followed by active learning exercises that foster application of their newly acquired knowledge. Instruction time can be spent more efficiently by focusing on concepts that present a challenge to the learners.

Conclusions
A flipped classroom is a feasible and inexpensive framework for effective undergraduate and graduate neuroimaging medical education. By using this approach, instructor efficiency is increased and learners are more engaged.

**eEdE-173**

6:30AM - 2:45PM

**Manual Refining of Segmentation with Pen Displays: Increasing Speed and Accuracy in 3D Printing Labs**

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Purpose
Several algorithms have been developed for perfecting automatic and semi-automatic segmentation methods, especially in the setting of three-dimensional (3D) reconstruction, using commercial or open source software. These techniques, however, are inherently limited in their ability to create error-free results due to lack of adequate contrast between tissue interfaces, high degree of anatomical variability in the body or at times suboptimal quality of acquired images. Therefore, manual refining of segmentation becomes an essential step in creating ideal results. The purpose of this exhibit is to demonstrate the use of pen displays in this setting.

Materials and Methods
The most commonly used input device, i.e., the mouse, despite remaining ideal for the daily radiology workflow, falls somewhat short at times for the purposes of performing high-end segmentation. The reasoning behind this issue is two-fold. One
reason is mice's inability to take full advantage of the high level of detail afforded by the dexterity of the fingers in performing remarkably fine tasks. Furthermore, the lines and borders that are being traced are displayed on a monitor, which is separate from the user's surface of interaction, i.e., the mouse pad. Both these limitations may be overcome by the use of pen displays.

Results
Some degree of manual refining becomes necessary for generating accurate and uncontaminated segmentation results for use in 3D printing. We introduce the use of pen displays, which are commonly implemented by graphic artists. Alternative display-based user interfaces to consider are stylus-based touch screens and tablet devices, which are used as comparisons for their advantages and disadvantages.

Conclusions
Display-based user interfaces, specifically pen displays, may improve accuracy and efficiency of manual segmentation. These devices do incur a higher initial cost and the early learning curve is steep for most users, but the long-term benefits likely outweigh these factors especially in high-volume settings. Comparison studies and user surveys are necessary to support this theory.

eEdE-172

Our Experience in Writing an MCQ eBook Using Apple’s iBooks Author App

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Purpose
1. Share our experience in writing a digital book using iBooks Author. 2. Learn the process of using widgets to create stunning interactive pages. 3. Highlight useful features of iBooks Author.

Materials and Methods
A decision was made to write an interactive iBook containing MCQs in neuroradiology. iBooks Author app was downloaded on Mac and MacBook. A list of potential cases was created in an Excel sheet. A folder was created for each quiz to store images and written material. The images were duplicated and annotated. The layouts were modified to create personalized pages. The "Review" widget in iBooks Author was used to create MCQs with four to six choices. The questions were grouped into three categories - easy, intermediate and difficult. Different colors were imparted to the pages to show the grades of difficulty. The answer was inserted into the "Scrolling Sidebar" widget to allow readers to get the contents of each quiz on one page. Once the contents were in place, hyperlinks were established.
Results
The ability to hyperlink not only the contents within the book but also the web pages is a great feature. Each word in the book is hyerlinked to the web by default. There are a number of choices when it comes to design of pages, colors and fonts. The layout in iBooks Author is somewhat rigid and interlinked. Any change in the layout affects all the pages based on that layout, which can create issues later. The book has to be planned meticulously before the contents are added. Widgets are excellent in creating MCQs; however, it does not have the capability to grade the answers. iBooks app allows one to add notes to the book thus enhancing and personalizing the knowledge base.

Conclusions
iBooks Author provides an excellent platform to create highly interactive books. It can be learned with a little effort and is a great tool to publish a digital book for the worldwide audience.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-04

electronic Education Exhibit (eEdE) - Interventional
eEdE-178

Arteriovenous Malformations and Diffuse Proliferative Arterial Disorders: Differences That Neuroradiologists Need to Know

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Purpose
Brain arteriovenous malformations (AVM) are abnormal vascular connections that result in arteriovenous shunting. Many proliferative arterial disorders can manifest with abnormal vessels mimicking an AVM and must be differentiated from them as they require different treatments and have different outcomes. Our purpose is to compare the clinical, epidemiological, pathological, imaging and treatment differences between AVM, cerebral proliferative angiopathy (CPA) and moyamoya, three arterial disorders that may appear similar but are different entities.

Materials and Methods
A retrospective search of brain vascular malformations was performed in our institution database for a period of 10 years. Representative cases of brain AVM, moyamoya and CPA were retrieved from the database. A review of the recent literature was performed using Medline/Pubmed ® looking for epidemiology, clinical
presentation, associated diseases, histopathology features, imaging characteristics, natural histories, treatment and outcome. This search was based on the following subject headings: "Intracranial Proliferative Angiopathy", "Moyamoya disease and Moyamoya syndrome", "Moyamoya MRI characteristics", "Arteriovenous malformations MRI characteristics", "DSA AVMs evaluation", "Proliferative Angiopathy and Hemorrhage" to identify pertinent literature and case reports. We organized a comparison of the most important features of these entities.

Results
Arteriovenous malformations and moyamoya may present with similar clinical manifestations including headache, seizures and neurological deficits due to ischemia or hemorrhage. Even though CPA also may present with seizures, hemorrhage is rare. Presence of hemorrhage should increase the suspicion of hemorrhagic angiopathy and an intranidal aneurysm in an AVM should be excluded. Generally AVMs demonstrate a capillary network connected to dominant feeders, arterialized draining vein, no interimposed brain parenchyma or vascular stenoses. On the other hand CPAs are similar in appearance to AVMs, but lack of dominant feeders and have intermingled brain within the nidus. The presence of extensive neoangiogenesis, transdural supply, stenosis of the feeding arteries and absence of high flow shunting are findings seen in CPAs and moyamoya. In addition incidental findings in all include perfusion disturbances. Moyamoya pattern is easy to recognize and it is associated with sickle cell disease, brain radiotherapy, NF1, and Down syndrome among others. Special care should be taken when deciding a treatment because while AVMs can be treated with microsurgery, non targeted embolization and radiosurgery, this treatment may not be adequate for CPA and moyamoya and results in permanent neurological deficits. For these reasons these vascular disorders may pose a diagnostic challenge for the neuroradiologist.

Conclusions
Cerebral proliferative angiopathy differs from moyamoya and AVM in its angiomorphology, histology, epidemiology, natural history, clinical presentation and treatment. Magnetic resonance imaging with dedicated vascular techniques aids in differentiating these disorders and neuroradiologist should be aware of their imaging characteristics and differences.
Classification, imaging features, and management of vascular head and neck lesions

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Purpose
The management, risks, and prognosis for head and neck vascular tumors and malformations is vastly different between diagnoses, making it high priority to properly identify and classify these lesions. The goals of this exhibit are to discuss the classification of vascular head and neck lesions, highlight the imaging features with emphasis on the weaknesses/strengths of the different modalities, and discuss the management options.
Materials and Methods
This exhibit will begin with an overview on the following information regarding classification: • Mulliken and Glowacki classification system, • Comparison of old versus new terminology, • Subcategorizing lesions into high versus low flow lesions. In the next part of the exhibit, clinical examples of each vascular lesion and where possible, correlation will be provided for the same patient (same lesion) imaged with multiple modalities to graphically highlight strengths and weakness of different modalities. Also, the pertinent scientific literature will be cited to review important prognostic signs on imaging, management, and procedural risks with graphic highlights when applicable. The following vascular pathologies will be reviewed: • Vascular tumors: o Hemangioma, o Paraganglioma. • Vascular malformations: o Venous malformation, o Arteriovenous malformation, o Lymphatic malformation, o Mixed venolymphatic malformation. The modalities that will be discusses include computed tomography (CT), magnetic resonance imaging (MRI), dynamic MR angiography (MRA), catheter angiography and tagged RBC nuclear medicine scan.

Results
When faced with a question of what imaging may be appropriate for a debatable head and neck vascular lesion, the radiologist must be aware of the relative benefits and weakness of angiography, CT, MRI sequences, and dynamic MRA to recommend the best possible test for that situation. For example, in a suspected vascular malformation in a patient who may not be able to undergo invasive catheter angiography, dynamic MRA can help distinguish between an AV malformation and a purely venous malformation by providing images akin to dynamic catheter angiography. Also, in lesions that may be venous malformation but are not accessible to clinical evaluation or a biopsy, a tagged RBC scan can help confirm or refute the diagnosis and provide guidance for further management. In this exhibit, clinical pearls and pitfalls will be provided based on literature and author experience, which will provide learners of the educational exhibit with a practical approach to problem solve frequently encountered clinical scenarios.

Conclusions
By reviewing this exhibit, the learner can get a quick overview of the principles regarding head and neck vascular lesion classification, strength/weakness of imaging modalities, and management options for treating these lesions.
Consideration of vascular anatomy on Endovascular treatment of intractable oronasal bleeding

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Purpose
Severe craniofacial injury or tumor may cause intractable oronasal bleeding, which is refractory to conventional treatments. The main focus of this presentation is to discuss comprehensive understanding for head and neck anatomy related with interventional procedures.

Materials and Methods
Twelve patients between the ages of 19 and 67 years who had intractable oronasal bleeding resulting from severe craniofacial injuries or tumor received treatments of

Figure 1 shows (a) contrast enhanced CT in 6 month old infant with enhancing right neck mass (b) MR T2W image of the right buccal space venous malformation with phleboliths (c) MR T2W image of lymphatic malformation (d) digital subtraction angiography in mid arterial phase of arteriovenous malformation.

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transarterial embolization using Gelfoam, N-Butyl 2-Cyanoacrylate (NBCA), or platinum coils. Then we reviewed their clinical and vascular anatomy retrospectively.

Results
In all but one case, angiography demonstrated bleeding points as extravasation. These bleeding points showed extravasation with pseudoaneurysm formation in 10 cases. Except for bleeding from patient with bleeding tendency, selective embolization was successful. In all cases, intractable oronasal bleeding was controlled. In a few cases, embolization technique should be performed to prevent or control bleeding related with tumor itself or operation. As some arteries of head and neck have dangerous anastomosis with intracranial vessels, radiologists have to have comprehensive understanding for head and neck anatomy.

Conclusions
Endovascular treatment with comprehensive understanding for head and neck vascular anatomy is an acceptable treatment for intractable oronasal bleeding associated with severe craniofacial injuries or tumor.

eEdE-181

6:30AM - 2:45PM

Inexpensive Standardized 3D Printed Simulation Model for Pediatric and Adult Internal Jugular and Subclavian Central Venous Line Placement

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Purpose
To design and build a realistic and affordable 3D printed internal jugular and subclavian vein simulation for educating trainees in ultrasound (US)-guided vascular line placement.

Materials and Methods
A fused filament fabrication (FFF) 3D-printer was used to create acrylonitrile butadiene styrene (ABS) models (Fig. 1) from pediatric and adult imaging data to simulate bone on ultrasound, fluoroscopy, and computed tomography (CT). Fluid-filled silicone tubing was used to simulate major vascular structures. Clear gelatin was used to replicate soft tissues in the models allowing direct visualization of the blood vessel and osseous structures for visual feedback (Fig. 2). The lung apex was simulated with a balloon, providing feedback regarding potential pneumothorax. Positive tactile feedback was provided by the change in resistance of the silicone tubing simulating vasculature compared to the surrounding gelatin (Figs. 3 and 4). Trainees completed a questionnaire regarding their comfort with US-guided central line placement before and after using the simulation model for 1 hour. Instruction and real-time
guidance was provided during the simulation by a CAQ certified interventional radiologist (IR).

Results
All trainees felt more comfortable performing pediatric and adult central venous line placement after using the simulation. All participants felt they would benefit from further training with the model. Overall model cost was less than $15 compared to commercial models costing between $400 to $1000.

Conclusions
Affordable 3D-printed pediatric and adult central venous and arterial line placement models can be used for trainee education and procedural skill improvement without endangering patients. 3D-printed models such as this can be created for training in multiple body parts guidance modalities including ultrasound and CT.
Strategy of endovascular management of post-irradiated carotid blowout syndrome

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Purpose
To improve the outcomes of endovascular management of postirradiated carotid blowout syndrome by evaluation of the therapeutic strategy, including technique, CT diagnosis and patient selection.

Materials and Methods
1. Mechanism: Provide the anatomy of carotid arteries, mechanism of irradiation injury of patients of head and neck cancers and predisposing factors of postirradiated carotid blowout. 2. Computed tomography (CT)/computed tomography angiography (CTA): Review the preprocedural CT/CTA to enhance the early diagnosis of postirradiated carotid blowout syndrome (PCBS). 3. Technique: Describe the deconstructive (embolization) and reconstructive (stent-graft placement) methods of endovascular management of PCBS. 4. Algorithm: We provide an algorithm of patient selection, clinical approach, endovascular management and follow-up of PCBS. 5. Complications and the prevention: Evaluate the complications and their prevention of endovascular management of PCBS, including embolization and stent-graft placement.

Results
1. For embolization technique, lesions located in the branch of external carotid artery had higher technical safety but higher rebleeding than the lesions located in the trunk of carotid artery (ICA to CCA). 2. For carotid trunk lesion, embolization had less complication and rebleeding than stent-graft placement. 3. Patients of slight clinical severity (ongoing PCBS) had better technical and hemostatic outcomes than patients of advanced clinical severity (acute PCBS). 4. Aggressive control of postprocedural clinical disease is of help to improve the survival and hemostatic outcomes. 5. Various technical complications and their prevention will be discussed.

Conclusions
1. Outcomes: We suggest that taking embolization as a prior way of therapy, performing endovascular intervention in slight clinical severity and aggressive management of the postprocedural clinical disease can improve the outcomes of endovascular management of PCBS. 2. Disease evaluation: We suggest evaluate CT/CTA for preprocedural patient selection and postprocedural follow up.
The Role of Hemodynamics in Assessing Risk of Growth and Rupture of Intracranial Aneurysms

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¹UCLA, Los Angeles, CA
Purpose
Cerebral aneurysms are relatively prevalent, affecting approximately 2.3% of the population. While the risk of rupture is relatively low, averaging approximately 1% per year, it carries a high mortality and morbidity, with approximately 50% case fatality rate and complete recovery in only 25% of survivors. Therefore, identifying patients at increased risk for rupture has high clinical utility. Several studies have identified growth as the most important risk factor for aneurysm rupture, with smoking and aneurysm size as other significant factors. Hemodynamic evaluation of aneurysms with analysis of such factors as wall shear stress, flow, and pressure, has been an active area of investigation for some time; however, although several investigators have identified qualitative hemodynamic risk factors that predispose patients to aneurysm rupture, to date there has been no consensus on a set of quantitative hemodynamic parameters that predispose patients to aneurysm growth and rupture. This exhibit will discuss the most recent research in qualitative and quantitative hemodynamic parameters and their clinical utility in evaluating risk of growth and rupture in cerebral aneurysms.

Materials and Methods
Currently, hemodynamic data can be collected from phase contrast magnetic resonance angiography (MRA) data (PC-MRA) which is velocity encoded, or calculated using computational fluid dynamics (CFD) simulations from computed tomography angiography (CTA), magnetic resonance angiography (MRA), or digital subtraction angiography (DSA) data.

Results
There are several prevailing theories regarding the effect of hemodynamics on aneurysm growth and rupture. Multiple groups have hypothesized that elevated wall shear states predispose patients towards aneurysm growth and rupture by leading to endothelial damage and upregulation of nitric oxide synthase and TGF-B1. Several studies have demonstrated that focally increased wall shear stress in aneurysms with inflow jet morphology (Fig. 1a-c) are associated with increased risk of aneurysm rupture. Other investigators have shown that changes in pulsatility as well as heart rate and blood pressure predispose patients towards aneurysm rupture, which is thought to be related to focally elevated WSS and pressure. Conversely, other investigators have shown that low WSS states predispose patients to aneurysm growth and rupture. This also is thought to be secondary to endothelial dysregulation as a certain level of WSS may be necessary to maintain the endothelium. Other parameters that have been shown to be associated with aneurysm growth and rupture include inflammation (as demonstrated by wall enhancement as shown on contrast-enhanced T1 images), complex/disturbed flow patterns, and certain aneurysm morphologies.

Conclusions
The role of hemodynamics in the investigation of aneurysm growth and rupture is an
active area of investigation. This exhibit will delineate the most recent research in the field and how it may affect the assessment of intracranial cerebral aneurysms.

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eEdE-176

6:30AM - 2:45PM

The Role of Jugular Phlebography in the Evaluation of an Angiographically “Occult Inferior Petrosal Sinus”

G Benndorf¹

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Purpose

The "nonfeasibility" of the conventional inferior petrosal sinus (IPS) approach to access the cavernous sinus (CS) for endovascular treatment of dural cavernous sinus fistulas (DCSFs) is observed increasingly in literature reporting more aggressive techniques, such as the direct puncture of the superior ophthalmic vein (SOV), or the CS, or the surgical exposure of a cortical vein. This decision-making frequently is based on the evaluation of cerebral angiograms obtained by arterial injections observing an "occult IPS". The aim of this study is to analyze and compare the angiographic visualization of the IPS-IJV junction obtainable by arterial and venous contrast injections (Arterial digital subtraction angiography (DSA) and Jugular Phlebography).

Materials and Methods

In 17 patients with DCSFs presenting a so-called "occult IPS", a 2D "large volume" phlebogram was obtained and used to evaluate the venous anatomy at the level of the IPS-IJV junction. A 6F-guiding catheter was placed at the level of the jugular bulb just below the expected level of entry of the IPS. A 20 cc syringe was used for manual
injection of non-diluted contrast in 11 patients. In six patients a power injector was used with 2.5cc/sec and 28cc of contrast (300mg) and in two patients an additional 10 sec rotational phlebogram was performed.

Results
When compared to the arterial injections of the standard cerebral DSA, jugular phlebograms revealed far superior opacification of the IPS and its adjacent structures. Venous structures, commonly not visualized on arterial injections, such as the inferior petroclival vein, the internal carotid venous plexus and the anterior condylar confluence are frequently detectable on phlebograms. In cases of arteriographically "occult IPS", 2D and 3D-phlebography documented the sinus as either fully or at least partially patent, allowing for navigation of a microcatheter into the CS in all such cases. In addition, 3D anatomy of the IPS-IJV junction if obtainable improved visualization and understanding of the venous anatomy significantly.

Conclusions
Image analysis of the IPS-IJV junction based on DSA images obtained by arterial injections only is insufficient for complete understanding of the anatomy and for planning of transvenous occlusion of DCSFs. The use of additional jugular phlebography, including rotational 3D data, if obtainable, appears mandatory as it provides significantly more anatomical information for proper decision-making and thus, in the vast majority of cases, facilitates transvenous catheter navigation to the CS and successful transvenous occlusion of DCSFs making more aggressive and potentially harmful approaches unnecessary.
Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-05

electronic Education Exhibit (eEdE) - Pediatrics
eEdE-187

6:30AM - 2:45PM

Antibody-Associated Encephalitis in Children: Exploring the Clinical-Radiologic Paradox

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Purpose
Antibody-associated encephalitis in children often presents with characteristic clinical features accompanied by a mild cerebrospinal fluid (CSF) pleocytosis and/or EEG abnormalities. On the other hand, magnetic resonance imaging (MRI) findings in such
cases are less predictable. In fact, MRI of the brain typically is normal despite prominent psychiatric symptoms, seizures, encephalopathy, movement disorders and/or autonomic instability. When abnormal, reported MRI abnormalities seen in cases of N-methyl-D-aspartate receptor (NMDAR) encephalitis (the most frequent subtype) demonstrate no consistent pattern. This is in sharp contrast to the relatively well defined MRI findings characterizing neuromyelitis optica (NMO), another antibody-associated disorder. The purpose of this exhibit is to share our experience exploring the 'clinical-radiologic paradox' of antibody-associated encephalitis in children.

Materials and Methods
This is a retrospective study performed at two tertiary pediatric hospitals. We searched our radiology database using keywords 'NMDA', 'encephalitis' and 'antibody'. Clinical, laboratory and imaging findings of 23 cases of antibody-associated encephalitis with positive serology for a known anti-neuronal antibody were reviewed.

Results
We identified 23 children (16 female, 7 male; ages 3.1 to 18.0 years) with antibody-associated encephalitis. Cases were distributed as follows: 18 NMDAR, 1 glutamic acid decarboxylase (GAD) 65, 1 voltage-gated calcium channel (VGCC), 2 NMDAR + anti-thyroid, and 1 GAD65 + VGCC + anti-thyroid. One of the NMDAR cases occurred in association with HSV-1 encephalitis. Four teratomas (3 ovarian, 1 mediastinal) were identified in three children with NMDAR encephalitis. Seven of 23 cases (30%) demonstrated focal findings on MRI (5 female, 2 male; age 3.3 to 18.0 years). Magnetic resonance imaging abnormalities were identified in cerebral cortex, deep gray nuclei, hippocampus, white matter, cerebellum, brainstem and sulci/leptomeninges. Neither the presence nor the distribution of such findings correlated with antibody titer or type. Cortical/sulcal findings were consistent with encephalitis, prolonged seizure activity and/or abnormal perfusion. White matter signal abnormalities may have been due to acute excitotoxic brain injury, demyelination and/or a poorly understood derangement of the normal immunologic response.

Conclusions
While the pathogenic role of NMDAR antibodies has been relatively well established, it is less clear what role such antibodies have in producing associated MRI abnormalities. Our experience suggests that a variety of mechanisms are likely responsible for the diverse imaging findings observed in cases of antibody-associated encephalitis in children.

eEdE-186

6:30AM - 2:45PM

Bilateral Lesions of The Basal Ganglia: Clues to Solve The Diagnostic Dilemma.
Purpose
Bilateral lesions of the basal ganglia are a nonspecific magnetic resonance imaging (MRI) manifestation of multiple disorders and not uncommonly remain without a specific diagnosis. We present a wide range of pediatric and adult brain disorders which cause bilateral basal ganglia lesions and point out the characteristic features that help reach a specific diagnosis.

Materials and Methods
We selected the brain MRI of 24 patients aged 6 weeks to 64 years. Included are various inherited metabolic disorders: Wilson disease, biotin responsive basal ganglia disease, 3 methylglutaconic aciduria, L-2 hydroxyglutaric aciduria, type 1 glutaric aciduria, Leigh disease, and MELAS (Mitochondrial Encephalomyopathy, Lactic Acidosis, and Stroke-like episodes). Several cases of acquired metabolic disorders are presented: kernicterus, hepatic failure, and central pontine and extrapontine myelinolysis. Among the neurodegenerative disorders that involve the basal ganglia, we review cases of Parkinson disease, Woodhouse-Sakati syndrome, and Panthotenate kinase-associated neurodegeneration. We present two patients with toxic injury secondary to cyclosporin and methanol respectively. Magnetic resonance images of a child and an adult with hypoxic ischemic injury of the basal ganglia are reviewed. Among the inherited myelin disorders, cases of Canavan disease, Krabbe disease, and molybdenum cofactor deficiency are shown.

Results
The cases we present encompass a wide range of inherited and acquired pathologies that affect the basal ganglia. We selected diseases where the pattern of abnormality of the basal ganglia and/or associated findings enable or at least suggest a specific diagnosis. In cases where a disorder can have various imaging patterns, we presented several patients with the same pathology, to illustrate the full spectrum of imaging manifestations.

Conclusions
We presented a wide range of disorders affecting the basal ganglia in an effort to emphasize that careful attention to the pattern of abnormality and associated findings, along with patient's age and clinical presentation, frequently allow a specific diagnosis to be made.

eEdE-193

6:30AM - 2:45PM
Brain MRI findings in Chiari II Malformation. Evolving from Fetal to Neonatal

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Purpose
1. To depict the imaging findings of Chiari II malformation in fetal and neonatal magnetic resonance imaging (MRI) in patients with intrauterine repair of myelomeningocele (MMC). 2. To discuss the technical challenges of brain MRI in the fetus and neonate, and the tools for optimizing image acquisition. 3. To describe objective measurements and MR imaging features used to evaluate patients with Chiari II malformations in research studies.

Materials and Methods
We reviewed the brain MR imaging findings of 12 patients with Chiari II malformation who underwent intrauterine repair of MMC between 2011 and 2015.

Results
Chiari II malformation is a complex developmental malformation of the central nervous system characterized by small posterior fossa and downward displacement of the cerebellum and brainstem through an enlarged foramen magnum. Myelomeningocele in the lumbar spine is almost always present and believed to be related to the pathophysiology of the intracranial changes. Retrospective and prospective randomized studies suggest that fetal surgery of MMC before 26 weeks of gestation may preserve neuromotor function, reverse hindbrain herniation, and reduce the need for ventriculoperitoneal shunting. However, these studies also demonstrate that fetal surgery is associated with significant maternal and fetal risks. The assessment of features of Chiari II malformation in utero and postnatally is of paramount importance to determine the outcome of surgical repair.

Conclusions
We present a pictorial essay of the imaging findings in 12 patients with fetal and neonatal MRI who underwent fetal repair of MMC, and discuss the expected findings, challenges and pitfalls of fetal and neonatal brain MRI, and the objective measurements and MR imaging features used to evaluate these patients.
Cerebral ischemia in neonates: from sonography to CT to MRI.

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Purpose
Here we review the spectrum of acute cerebral neonatal ischemia from regional infarcts to diffuse anoxia emphasizing the benefits of magnetic resonance imaging (MRI) versus computed tomography (CT) and sonography. Pertinent literature also will be reviewed.

Materials and Methods
We searched the teaching files of two teaching institutions for representative cases of regional and extensive cerebral neonatal ischemia. Cases emphasizing the importance of MRI in each of these settings when compared to CT and sonography were selected.

Results
The imaging findings of focal/regional cerebral ischemia are straightforward and easily diagnosed with MRI. Computed tomography is less helpful than MRI in these instances but still superior to sonography. In cases of diffuse acute anoxia, sonography may show subtle findings such as cortical sulci effacement and increased echogenicity in the central portions of the brain. However, MRI especially with diffusion-weighted imaging (DWI) clearly shows the abnormalities. In this setting, CT does not contribute to the diagnosis significantly. Despite multiple reported findings in the literature, MRI findings of diffuse acute anoxia are highly variable and will be presented here.

Conclusions
Acute anoxic brain injury in neonates results in severe neurologic disability and mortality. Recognition of the typical imaging findings can lead to an earlier diagnosis which may aid in determining therapy, outcome and family counselling. Although sonography is the screening method of choice, findings tend to be subtle and need MRI confirmation in many patients.
FIG 1. Severe hypoxic-ischemic injury in a neonate. Axial T1-weighted pre contrast MR images show lesions characterized by high pre contrast T1 signal enhancement in basal ganglia and thalamus. The cortical ribbon is absent.

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FIG 2. Severe hypoxic-ischemic injury in a neonate. Coronal cranial ultrasound (A) and corresponding T2 MR image (B) obtained only hours apart. MRI shows near complete loss of the cortical ribbon and high signal from deep gray matter while ultrasound shows increased echogenicity in the central brain.

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FIG 3. Severe hypoxic-ischemic injury in a neonate. Axial computed tomography (A) and diffusion MR image (B) show multiple acute infarcts in most posterior distributions. Although CT clearly shows hemispheric infarcts the interruption of the callosum was not appreciated.

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Purpose
Acute encephalopathy is a common pediatric emergency associated with a high risk of morbidity, mortality and long term neurodevelopmental delay in survivors. The presentation is somewhat nonspecific and the differential diagnosis is wide. Neuroimaging plays a key role in the diagnostic work up, management and prognosis of childhood acute encephalopathy. Prompt diagnosis of the cause enables to deliver specific treatment that will improve short and long term outcome. The goal of this exhibit is: 1. to review the differential diagnosis of acute encephalopathy in children. 2. To show how computed tomography (CT) and magnetic resonance imaging (MRI) help to distinguish causes of childhood acute encephalopathy. 3. To provide a pictorial review of common and rare causes of childhood acute encephalopathy.

Materials and Methods
Pediatric cases presented as acute encephalopathy collected in our institutions were analyzed for imaging features and correlated with final clinical diagnosis. In this pictorial review are included the most relevant common and uncommon etiologies that lead to acute encephalopathy with description of the initial radiological approach and illustration of the imaging characteristics. A succinct description of the therapeutic and prognostic information will accompany each case.

Results
Typical neuroimaging patterns of common and uncommon causes of childhood acute encephalopathy will be presented. The selected cases cover the following categories: hypoxic-ischemic (post cardiac arrest), infectious (Encephalitis due to Herpes simplex, West Nile and Enterovirus, tuberculosis, hemolytic uremic syndrome), postinfectious (Acute disseminated encephalitis, Acute necrotizing encephalitis), acquired metabolic derangements (Wernicke's encephalopathy) or inborn errors of metabolism (Leigh encephalopathy, Biotin responsive basal ganglia disease), toxic (carbon monoxide) and others (Posterior reversible encephalopathy syndrome, febrile infection-related epilepsy syndrome (FIRES), status epilepticus).

Conclusions
Many causes of childhood acute encephalopathy have underlying abnormalities that can be identified with CT and MR imaging. Our goal is to provide a case-based overview of several common and uncommon causes of acute encephalopathy in children, describing key imaging features. Knowledge of these imaging characteristics will allow an accurate management and treatment approach of the underlying pathologies.

eEdE-195
Correlation of Multi-Modality Imaging Evaluation of Seizures in Children

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Purpose
Intractable epilepsy is a debilitating condition for patients and their families and poses a significant treatment and management challenge for neurologists. Children who have been refractory to traditional medical therapy for seizures may be candidates for functional neurosurgical resection of the seizure focus in hopes of seizure cure or control. Prior to this definitive intervention, efforts to identify the seizure focus are undertaken by high resolution magnetic resonance imaging (MRI) evaluation of the brain, identification of eloquent cortex on functional (f)MRI, and metabolic assessment with coregistered imaging techniques such as SISCOM (subtracted ictal-interictal SPECT coregistered to MRI), ISAS (ictal-interictal SPECT analysis by SPM), and 18F-FDG PET CT. This presentation will provide our institutional experience with multimodality imaging and provide illustrative examples of the benefits and challenges of these techniques in seizure focus localization in children.

Materials and Methods
Children with intractable epilepsy that were candidates for neurosurgical seizure focus resection were identified prospectively with institutional IRB approval. Chart review of the consented patients was performed to identify which children underwent multimodality imaging including 18F-FDG PET, MRI and ictal and interictal brain SPECT.

Results
Out of 210 PET computed tomography (CT) brain studies, performed from April 2008 through September 2015, we identified 180 patients who had undergone PET CT for seizure localization. All of these patients underwent high resolution epilepsy surgery MRI and 32 also had SPECT imaging. The imaging reports were reviewed for concordance of findings by laterality and focality. Imaging findings were further correlated to the EEG findings.

Conclusions
Our institutional experience supports the value of multimodality imaging for seizure focus localization in children with intractable epilepsy. The children that benefit most significantly from this approach are those with nonlesional epilepsy. It is critical to incorporate fMRI evaluation as part of the decision process of undergoing definitive neurosurgical resection. An identifiable focus may yield a curative result after resection, which can significantly alter the quality of life for these patients and their...
families. Multimodality imaging concordance provides confidence in the approach and decision to pursue surgery.

**eEdE-191**
6:30AM - 2:45PM

**CT and MR Imaging spectrum of lipomatous lesions involving the craniofacial - craniospinal axis.**

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**Purpose**
To highlight the diverse imaging spectrum of cranio-facial and cranio-spinal axis lipomatous lesions and their associations.

**Materials and Methods**
We intend to describe a wide array of imaging features of cranio-spinal and cranio-facial lipomatous lesions from our database with plausible explanation regarding their developmental origin and their various associations.

**Results**
Intracranial lipomas constitute less than 0.1% of intracranial tumors. Their midline/off midline location and relationship with several congenital anomalies can be explained by embryological basis. Usually these lesions are incidental findings but depending on their size and location can become symptomatic and can present with headache, seizures, cranial neuropathies and tethered cord syndrome. Lipomas also are known to be associated with developmental delay, vascular malformations, fronto-nasal dysplasia, hemimegalencephaly, cortical dysplasia, encephalocraniocutaneous, proteus and familial lipomatosis syndromes. The diagnosis of dermoid and teratomas often is facilitated, based on their lipid constituent. Lipomatous transformation of brain neoplasms also is a well described entity. Search of the imaging literature frequently yields numerous results displaying only the intracranial lipomatous lesions with sporadic case reports of cranio-facial and spinal associations. This educational poster is an attempt to collectively display the wide spectrum of lipomatous lesions with emphasis on common and uncommon associations. The lipomatous lesions are categorized as follows: • Interhemispheric and corpus callosal lipomas, • Suprasellar, quadrigeminal, cerebellopontine angle cistern lipomas, • Dermoids and Teratomas, • Calvarial, subcutaneous cranio-facial lipomas. • Syndromic associations of lipomatous lesions, • Spinal lipomas- intradural, intramedullary, epidural lipomatosis, • Lipomatous lesions associated with spinal dysraphism.
Conclusions
Upon completion of browsing this exhibit, the viewer will be able to expand their existing spectrum of common and uncommon associations of lipomatous lesions.

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eEdE-184

Differential Diagnosis of Cerebellar Atrophy in Childhood
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Purpose
Cerebellar atrophy (CA) is a relatively common, but nonspecific finding in pediatric
neurology and neuroradiology. Cerebral atrophy is defined as a cerebellum with
initially normal structures, which displays widened cerebellar fissures (interfolial
spaces) secondary to tissue loss. A long list of pediatric diseases including genetic and
acquired causes has been associated with CA.

Materials and Methods
We reviewed our experience as well as the available literature on diseases associated
with CA in children.

Results
We classified diseases associated with pediatric CA into following groups: 1) hereditary CA due to metabolic or other genetic causes, 2) acquired CA due to pre and
postnatal disorders, and 3) unilateral CA due to pre and postnatal diseases. Based on
the neuroimaging findings, hereditary pediatric diseases with CA may be classified
further in diseases with isolated (pure) CA and diseases with CA associated with other
cerebellar or supratentorial neuroimaging findings ("CA plus"). In addition, diseases
with "CA plus" may be divided into diseases with CA and 1) hypomyelination, 2)
progressive white matter abnormalities (e.g., frontal, periventricular, occipital,
cerebellar, brainstem, and subcortical predominance or diffuse involvement), 3) signal
change of the dentate nucleus, 4) cerebellar cortex T2-hyperintensity, and 5) basal
ganglia involvement (e.g., calcifications, atrophy, or signal changes).

Conclusions
Cerebral atrophy is a common, nonspecific finding in pediatric neurology and
neuroradiology. A neuroimaging based pattern-recognition approach in addition to
patient and family history, clinical findings, and results of additional investigations
may 1) allow to make the correct diagnosis, 2) narrow the list of differential diagnoses
and plan additional targeted investigations, 3) help the interpretation of the results of
laboratory investigations, and 4) in the era of new generation sequencing allow the
reevaluation of the phenotype after the results of genetic tests (reverse phenotyping).

eEdE-201
6:30AM - 2:45PM

Genetics and imaging features of pediatric high grade gliomas: A case based
review of pediatric high grade gliomas based on poor prognostic genetic marker
histone H3 K27M mutation
Purpose
Presence of histone H3 K27M mutation in pediatric high grade gliomas correlates with poor overall survival and will be included in the new WHO classification of pediatric gliomas in 2016. We plan to review the imaging features of pediatric high grade gliomas with respect to their histone H3 K27M mutation status using case-based approach.

Materials and Methods
Imaging characteristics of pediatric high grade gliomas and their metastatic patterns that contain mutation in histone H3 K27M will be reviewed with respect to their main sites of origin – thalamus, pons, cervical spine. These will be contrasted with pediatric gliomas that have wild type histone H3, which are predominantly located peripherally.

Results
High grade gliomas that contain mutation in histone H3 K27M are located mostly along the midline and are found predominantly within the thalamus, pons, and cervical spine. We will present examples of these tumors including right thalamic glioblastoma with extensive recurrence within the posterior fossa within 3 months, two cases of histone H3 K27M mutant pontine glioma with follow up demonstrating extensive local metastatic spread and distal metastatic spread, and cervical spine origin glioblastoma with distal intracranial metastatic spread. High grade gliomas with wild type histone H3 are found predominantly within cerebral hemispheres. We will present a case of peripheral high grade glioma with local recurrence after resection and a case of a thalamic histone H3 wild type high grade glioma.

Conclusions
High grade gliomas that occur in pediatric age group are molecularly different than the adult group and will have new classification by WHO in 2016 based on presence of histone H3 K27M mutation, which is a poor predictive factor. We will present a case-based review of imaging patterns of histone H3 K27M mutant gliomas which occur mostly in the thalamus, pons, and cervical spine. We will contrast this with histone H3 wild type gliomas, which are predominantly peripheral.
eEdE-203
6:30AM - 2:45PM

Imaging Characteristics, Pathological Features, and Prognoses of the Molecular Subgroups of Medulloblastoma.

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Purpose
With the recent discovery of tumor genomics of medulloblastoma, it is important to understand the differing radiographic presentations as well as prognostic data as influenced by these molecular subtypes.

Materials and Methods
Detailed in the exhibit are clinical presentation, epidemiology, imaging features of medulloblastoma demonstrating contrasting geographic locations, and prognoses as influenced by the different molecular subtypes. Example pathological slides are provided as well.

Results
Medulloblastomas are a common malignant brain tumor found within the pediatric population. With the help of tumor genomics we now know medulloblastoma can be grouped into four subtypes: Wingeless type (WNT), Sonic Hedgehog (SHH), Group
3, and Group 4. The specific location of the tumor is strongly influenced by the molecular subtype. Wingless type subgroup is found mostly within the cerebellar peduncle and carries the best prognosis. Sonic Hedgehog is found mostly in the cerebellar hemispheres. Group 3 and Group 4 are found mostly midline arising from the cerebellar vermis with Group 3 having the worst prognosis.

Conclusions
Medulloblastoma can be better evaluated with an understanding of the presentation of the four genomic subtypes as they can have differing imaging locations as well as important prognostic information.

**eEdE-208**

**Imaging spectrum of pediatric posterior fossa tumors**

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**Purpose**
To illustrate imaging features of various pediatric posterior fossa tumors and pseudo tumors including abscess and demyelination.

**Materials and Methods**
We present various typical and atypical imaging features of juvenile pilocytic astrocytoma, medulloblastoma, ependymoma, brainstem gliomas, atypical teratoid/rhabdoid tumors and hemangioblastoma. The unusual presentations of dermoids, and extra-axial tumors will be illustrated. We also will illustrate various nontumor lesions like abscess, demyelination. The utility of tumor perfusion and spectroscopy also will be discussed.

**Results**
We present various typical and atypical imaging features of juvenile pilocytic astrocytoma, medulloblastoma, ependymoma, brainstem gliomas, atypical teratoid/rhabdoid tumors and hemangioblastoma. The unusual presentations of dermoids, and extra-axial tumors will be illustrated. We also will illustrate various nontumor lesions like abscess and demyelination. The utility of tumor perfusion and spectroscopy also will be discussed.

**Conclusions**
Lesions in the posterior fossa of a child have a very different differential diagnosis compared to an adult. Since pre-operative differentiation of various infratentorial
tumors is important for prognosis and treatment, it is imperative to understand the subtle differences, which will help narrow the potential diagnoses.

**eEdE-202**

6:30AM - 2:45PM

**It is What It Isn't: Atypical and Unusual MR Imaging Presentations of Pediatric Ganglioglioma**

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Purpose

Ganglioglioma (GG) is a neoplasm commonly associated with epileptic seizures, located typically in the temporal lobes, and usually presents on magnetic resonance (MR) as a slow-growing, solid, nonenhancing lesion without significant surrounding edema, mass effect, or diffusion restriction. However, ganglioglioma can have atypical and unusual presentations on MR, which have been associated with poorer clinical and postsurgical outcomes.

Materials and Methods

Retrospective IRB-approved review of all pathology-proven pediatric gangliogliomas was performed. Seventeen patients (average age 9.7 years +/- 6.4 years, range 20 days to 17 years, and female/male ratio of 1.8), who had pre-operative MR were included. Tumor signal, peritumoral edema, location, enhancement, and diffusion characteristics noted.

Results

Only two of 17 cases had classic MR imaging features. Fifteen cases had atypical presentations: five cystic masses with mural nodules of enhancement more typical of JPA, two of which with reduced diffusivity, one in primary motor cortex; two cases of multicentric T2 prolongation and multiple enhancing nodules more akin to multicentric glioma; one case of predominant leptomeningeal disease in association with a cortically-based lesion of the Sylvian fissure. Four cases in unusual locations including large cystic/solid suprasellar mass, right brachium conjunctivum lesion, pineal region mass with hydrocephalus, and foramen of Monro mass with hydrocephalus mimicking colloid cyst. One frontoparietal mass with T1 shortening and T2 shortening more typical of subacute hematoma, One case of subtle T2 prolongation and gray-white junction blurring in right parietal cortex more typical of cortical dysplasia, and one large complex cystic mass with septations, enhancement, and marked subfalcine shift.
Conclusions

Atypical MR imaging findings of ganglioglioma occur with greater frequency than expected, and recognition of atypical features may inform guide treatment planning given reports of poorer post-treatment and postsurgical outcomes in these cases.

(A) and (B) 12-year-old female with midline mass centered on the pineal region and encroaching upon the third ventricle causing hydrocephalus.

(B) and (D) 16-year-old male with left temporal lobe solid and cystic mass with adjacent marked leptomeningeal enhancement along the left MCA cistern encasing the left MCA and extending to the left sylvian fissure.

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eEdE-183

Moya Moya Disease on MRI and MRA

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Purpose
To highlight the imaging appearance of various moyamoya disease on magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA).

Materials and Methods
Clinical cases assessed with MRI, MR angiography and cerebral perfusion will be identified and appropriate images will be used to highlight various aspects of imaging appearance before and after treatment.

Results
A brief discussion on etiology, pathophysiology and clinical features will be discussed. Suzuki's classification will be highlighted. Various stages of MRA appearance, type of collaterals will be highlighted. Also, importance of standard MRI sequences will be highlighted. Role of MR cerebral perfusion will be discussed with appropriate images. Postsurgical imaging appearance will be discussed on MRA and MR perfusion.

Conclusions
The goal of this presentation is to provide the reader with an understanding of the various magnetic resonance imaging features of moyamoya before and after treatment which is a must for successful management of these cases.

eEdE-190
6:30AM - 2:45PM

MR Imaging of Encephalitis in Children: Infectious, Non-infectious and Mimics

n abdeen

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Purpose
To illustrate the magnetic resonance (MR) appearance of various causes of noninfectious and infectious encephalitis in children, as well as encephalitis mimics, with focus on differential diagnosis.

Materials and Methods
Pediatric patients with encephalitis were identified through a keyword search of our Radiology Information system. Cases of infectious and noninfectious encephalitis were identified and the MRI findings reviewed. Instructive cases illustrating features of each category were prepared. Mimics of encephalitis also were included.

Results
Cases of noninfectious encephalitis identified included: ADEM, Devic’s disease, Paraneoplastic limbic encephalitis, Autoimmune encephalitis (nonparaneoplastic), Hashimoto’s encephalitis, Rasmussen's encephalitis. Cases of infectious encephalitis included: Herpes simplex virus, Epstein Barr virus, Japanese equine encephalitis.
Mimics included vasculitis, mitochondrial disease and other metabolic disorders, and status epileptics.

Conclusions
Key MR imaging findings in cases of encephalitis in children allow differentiation between the various causes, or shorten the differential diagnosis. These are illustrated using a case-based format.

**eEdE-196**

**Neonatal and early infantile epilepsy due to Inherited metabolic disorders: Clinical and neuroimaging correlation**

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1Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia, 2Sousse Medical School, Sousse, Tunisia, 3Prince Sultan Military Medical City, Riyadh, Saudi Arabia

Purpose
Inherited metabolic disorders are a common cause of early onset epilepsy/epileptic encephalopathy. Occasionally, there are specific clinical signs and distinctive electroencephalographic patterns that may suggest a specific metabolic disease or certain epileptic syndromes including West's syndrome, early myoclonic encephalopathy which are known to accompany particular metabolic disorder (e.g., branched-chain organic acidurias, nonketotic hyperglycinemia), however seizure types are rarely specific for a particular metabolic disorder, nor are EEG findings. Neuroimaging pattern can be highly suggestive in some metabolic disorders and therefore limit the biochemical and genetics work up. This exhibit will aim to: 1. Familiarize the radiologist with the clinical/EEG presentation of early onset epilepsy due to inherited metabolic disorders. 2. Recognize magnetic resonance imaging (MRI) features of the main inherited metabolic disorders causing early onset seizures. 3. Discuss the role of both conventional and advanced MRI techniques, diffusion-weighted imaging and MR spectroscopy (DWI and MRS), in the diagnostic imaging work up of neurometabolic diseases associated with epilepsy.

Materials and Methods
We reviewed the cases of neurometabolic diseases associated with neonatal and early infantile epilepsy collected in our institutions and analyzed for clinical and EEG presentation as well as imaging features. Selected cases will be presented in a case-review format.

Results
Clinical cases of neurometabolic diseases associated with neonatal and early infantile
epilepsy (Mitochondrial respiratory chain disorders, NonKetotic hyperglycinemia, Molybdenum Cofactor Deficiency, Isolated Sulfite Oxidase Deficiency, Urea cycle diseases, branched-chain organic acidurias...) will be presented emphasizing an integrative approach combining clinical and EEG presentation, biochemical and genetic findings, and imaging features using computed tomography (CT) and MRI including DWI and MRS. We will present this exhibit in two main categories: 1. Neonatal and 2. Infantile presentations, emphasizing distinguishing characteristics and differential diagnosis.

Conclusions
Recognition of typical neuroimaging features of some inherited errors of metabolism causing epilepsy in neonates and infants participates in the earlier recognition and management of these disorders. A specific diagnosis of metabolic disorders in epileptic patients may indicate the possibility of specific treatment that can improve seizures and allows genetic counseling.

**eEdE-200**

**Neonatal and Perinatal Extra-axial and Extracranial Hemorrhage**

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Purpose
The purpose of this exhibit is to illustrate, review, and discuss the array of extra-axial to extracranial hemorrhage encountered in the perinatal and neonatal period.

Materials and Methods
This is a case-based review covering extracranial to extra-axial hemorrhage related to bleeding disorders, prematurity, infection, vascular anomalies, nonaccidental trauma and birthing trauma, including prolonged labor and instrument-assisted delivery. A section will describe the various types of vacuum-assisted devices commonly used, its mechanism of injury, and its sequelae. Modalities will include fetal magnetic resonance imaging (MRI), ultrasound, computed tomography (CT) and MRI.

Results
The discussion will highlight key anatomy, imaging findings, differential diagnosis with a comparison case, and clinical outcome if applicable. A portion of the discussion will focus on and will be key to imaging and clinical information that will help differentiate the types of resultant scalp hematomas including caput succedaneum, cephalohematoma, and subgaleal hematoma.

Conclusions
The perinatal to neonatal period is a difficult time for the patient as he or she recovers from birth and possible birth-related trauma while adapting to the outside world.
Neuroimaging exams also are difficult to obtain and interpret due to an uncooperative patient population, difficulty in patient positioning, small-sized anatomy, and added risk of radiation exposure with x-ray and computed tomography. Armed with knowledge, the radiologist should be vigilant for signs and symptoms of extracranial and extra-axial hemorrhage as both findings are vital to patient care.
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eEdE-182
Neonatal Brain Imaging on Ultrasound

N Anand1, I Chiali2, N Gowali3, R Murphy3
1morristown medical center, morristown, NJ, 2Monmouth Medical Center, Long Branch, NJ, 3Morristown Medical Center, Morristown, NJ

Purpose
The purpose of this exhibit is to review the different neonatal brain abnormalities, which can be diagnosed on ultrasound. Sonography, with its lack of ionizing radiation or need for sedation, is an indispensable imaging modality in the diagnosis of acquired and congenital brain pathologies of the newborn. Sonography aids physicians in the diagnosis and evaluation of a wide range of pathologies, including but not limited to germinal matrix hemorrhages. The exhibit aims to provide a review of the ultrasound findings associated with numerous sonographically diagnosable pathologies of the neonatal brain for the discerning radiologist.

Materials and Methods
A search was performed of all the neonatal head ultrasound examinations that were completed between January 8, 2008 to November 12, 2015. This method yielded 2,235 pediatric ultrasound reports. All 2,235 reports were reviewed and pertinent pathological cases were compiled.

Results
Our search of neonatal head ultrasound reports yielded numerous cases of intraventricular hemorrhage (Grades 1-4). Additionally, our search yielded the following cases: cephalohematoma, hydrocephalus, ventriculomegaly, periventricular leukomalacia, multiple cases of agenesis of the corpus callosum, two cases of Arnold Chiari Malformation II, Dandy-walker syndrome, two cases of Vein of Galen Malformation, desmoplastic infantile ganglioglioma, hemimegancephaly, mega cisterna magna, absent septum pellucidum, solitary nodular subependymal tuberous sclerosis, porencephalic cysts, open-lip schizencephaly, and congenital CMV. The educational exhibit will discuss the pertinent anatomy of the neonatal brain. The various brain pathologies will be reviewed with discussions based on epidemiology, imaging findings, and treatments.

Conclusions
To conclude, we would like to make radiologists aware of the sonographic findings of the aforementioned pathologies as well as classification and grading of intraventricular hemorrhages for which neonatal ultrasounds are predominantly performed. Early diagnosis and recognition of these pathologies allow for prompt management without the use of ionizing radiation or sedation.
Neuroimaging findings in pediatric genetic skeletal disorders: a pattern-recognition approach

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Purpose
Genetic skeletal disorders (GSD) are a heterogeneous group of disorders characterized by an intrinsic abnormality in growth and remodeling of cartilage and bone. A large group of GSDs are systemic disorders with involvement of other organs including the central nervous system (CNS). Central nervous system abnormalities usually have an important role in long term prognosis of children with GSDs and should not be missed. Here we provide a pattern-recognition approach for neuroimaging findings in GSDs.

Materials and Methods
The 2010 Revision of the Nosology and Classification of Genetic Skeletal disorders includes 456 conditions. An extensive review of literature reports from PubMed and textbooks on pediatric neuroimaging and skeletal disorders as well as our experience revealed central nervous system (CNS) abnormalities in 165 of 456 diseases.

Results
We propose a classification of GSDs based on a pattern recognition approach based on the following four criteria that characterize bone involvement: 1) pathologic changes in the metaphysis or epiphysis, 2) abnormal size or number of bones of the skull, torso, limbs, and acra, 3) abnormal shape of bones and joints of the skull, torso, limbs, and acra, and 4) dynamic or structural changes of the bones including bone age, mineralization, and ossification. In addition, we emphasize GSDs with CNS involvement that may need acute management. For each disease, skeletal involvement was defined in accordance with OMIM (Online Mendelian Inheritance of Man).

Conclusions
Central nervous system involvement is common in GSDs. A wide spectrum of morphological CNS abnormalities is associated with GSDs. Early diagnosis of CNS involvement is important in the management of GSDs. This pattern-recognition approach aims to be helpful in the diagnostic work up of CNS involvement in children with GSDs and their management.

eEdE-185

6:30AM - 2:45PM

Neuroimaging Manifestations of Drug-related and Exogenous toxins in Pediatric Population
P HANAGANDI1, P Krishnan1, F Gonçalves2, E Widjaja1, S Blaser1

1HOSPITAL FOR SICK CHILDREN, TORONTO, CANADA, 2Hospital da Criança de Brasília José Alencar (HCB), Brasilia, BRAZIL

Purpose
To evaluate the adverse effects of prescribed drugs and exogenous toxins on the central nervous system (CNS) in the pediatric population.

Materials and Methods
Patients who have had neuroimaging manifestations of a variety of prescribed drugs, toxin-mediated effects and teratogens were identified from the neuroimaging database at a tertiary pediatric institution. Patients with inherited metabolic disorders were excluded. The signal characteristics, diffusion changes, location of the magnetic resonance imaging (MRI) abnormality and MR spectroscopy changes were reviewed. The dosage of prescribed drugs was reviewed to determine if the changes occurred within therapeutic levels or whether they occurred with excess dosage. Follow-up imaging also was evaluated to determine if the changes were reversible. The clinical and laboratory findings also were reviewed.

Results
The patterns and distribution of MRI abnormalities were described based on the following categories: • Drugs: chemotherapeutic agents (methotrexate, cyclosporine), antibiotics (Isoniazid, metronidazole), antipyretics (Tylenol), antiepileptics (Vigabatrin, sodium valproate, benzodiazepines). • Toxins: heavy metals, Carbon monoxide, botulism from formula food. • Miscellaneous: Teratogens (isotretinoin), misoprostol, maternal alcohol abuse, accidental ingestion of cocaine and high levels of salt consumption. In some cases, the imaging features overlap with several metabolic, infectious, inflammatory and neurodegenerative etiologies. Relevant clinical history and correlation with laboratory investigations are valuable in clarifying the underlying etiology.

Conclusions
This extensive review provides a wide range of the adverse effects of drugs and toxins in the pediatric central nervous system (CNS). Adverse effects of drugs and toxins should be considered in the differential diagnosis and careful history and correlation with laboratory findings recommended in these patients.
New Perspectives on Malformations of Cortical Development with Imaging and Clinical Correlates

W Zucconi\(^1\), T Hashemi-Zonouz\(^1\), D Spencer\(^1\), R Bronen\(^1\)

\(^1\)Yale School of Medicine, New Haven, CT
Purpose
To review recent advancements in the understanding of various malformations of cortical development (MCDs). Cases presented will highlight the imaging manifestations of MCDs, recently discovered molecular and neurogenetic underpinnings, as well as patient clinicopathologic correlation.

Materials and Methods
Representative patients of the Yale Comprehensive Epilepsy Center who harbor various MCDs were selected on the basis of illustrative and unique cross-sectional imaging features, clinical presentations (ex: seizure semiology) and courses of therapy. Additional genetic data and tissue pathology is presented where available.

Results
An example illustrates a case of focal cortical dysplasia type IIb (FCD IIb). The patient was a 2-year-old male with refractory epilepsy, beginning at 1 month of age as focal seizures without impairment of consciousness. Axial volumetric T1 and axial T2 image (Fig. 1) shows cortical thickening and blurring of the gray-white matter junction (green and blue ovals respectively) along the medial surface of the hemisphere (paracentral lobule and supplemental motor area). In this case, the surgical pathology revealed disordered neocortex with large, bizarre neurons in cortex and white matter. Neurons had irregularly shaped nuclei and prominent dendritic arborization. Occasional cells in white matter were noted with large nuclei with occasional nucleolus and homogenous pink cytoplasm consistent with balloon cells (Fig. 1, black arrows). Focal cortical dysplasia type IIb, along with tuberous sclerosis complex, hemimegalencephaly, and other malformations are a result of abnormal cell proliferation mediated by mutations affecting mammalian target of rapamycin (mTOR) signaling pathways - a central mediator of organism growth (1).

Conclusions
Recently, significant progress has been made in the understanding of malformations of cortical development which impact the classification, and diagnosis of these disorders. Practicing neuroradiologists must be familiar with these advancements, as imaging continues to play an important role in the work up of these patients and in their treatment planning.
Optimizing Pediatric Spine MRI Protocols: Tips, Tricks, and Their Rationale

R Tade¹, F Chokshi¹, N Kadom¹
¹Emory University School of Medicine-Department of Radiology & Imaging Sciences, Atlanta, GA

Purpose
Spine imaging indications in children may differ significantly from those in adults. Optimizing magnetic resonance imaging (MRI) protocols to answer specific clinical questions can help improve diagnostic accuracy. Here we review 10 pediatric MRI spine indications and provide rationales for the use of specific MRI techniques.
Materials and Methods
Literature review and illustrative cases from our institutional practice of 10 pediatric imaging indications: 1) Spine trauma, 2) Scoliosis, 3) Spinal cord disease, 4) Craniocervical junction, 5) Sickle cell disease, 6) Infection, 7) Malignancy, 8) Back pain, 9) Spinal vascular lesions, 10) Fetal spine. For each entity, an MRI protocol, literature-based rationale for the use of specific technique, and tips and tricks will be presented.

Results

Conclusions
Use of MRI protocols dedicated to specific pediatric diagnoses improves the radiologist's ability to answer clinical questions. Designing such MRI protocols requires multiple avenues of knowledge, including clinical scenarios, MRI sequences advantages/disadvantages, their performance in children at 1.5 and 3T, and their ability to demonstrate pediatric spinal pathology.

**eEdE-189**

6:30AM - 2:45PM

Pediatric Myelination Patterns & Disorders

**M Duan Meservy**, S Cambron, L Palifka

*Dartmouth-Hitchcock Medical Center, Lebanon, NH, Tristan Radiology Associates, Hershey, PA*

Purpose
In the first 2 years of life, the human brain undergoes dramatic changes in myelination and the imaging appearance thereof. Familiarity with what is normal for a child's age is crucial to the imaging evaluation of white matter disorders as well as exclusion of potentially time-sensitive brain injuries.
Materials and Methods
A series of neonatal magnetic resonance images (MRIs) from our institutions will be used to demonstrate imaging characteristics of normal and abnormal myelination.

Results
We will review the normal progression of myelination from birth to 2 years, correlating imaging findings with developmental milestones. We then will present cases of abnormal myelination due to trauma, hypoxic-ischemic injury, infection, metabolic disorders, and malformation syndromes.

Conclusions
We provide a review of the normal progression of brain myelination from birth to 2 years and present cases of various processes that disrupt that normal progression.

Pediatric Spinal Ultrasound: Neonatal and Intraoperative Applications

E Alvarado¹, J Leach¹, F Mangano², M Care¹, S O'Hara¹
¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH, ²Cincinnati Children's Hospital, Cincinnati, OH

Purpose
To emphasize and review the utility of ultrasound as a screening tool for spinal diseases in neonates, as well as its intra-operative value in selected neurosurgically treated pediatric disorders.

Materials and Methods
A review of spinal embryology followed by a description of common spinal diseases in neonates detected with ultrasound will be presented based upon case material from a large tertiary care pediatric institution. Indications for spinal ultrasound in neonates, commonly identified conditions, and the importance of magnetic resonance imaging (MRI) in selected cases will be emphasized. Additionally, the use of ultrasound in selected neurosurgical spinal diseases in pediatric patients will be presented with MRI, intra-operative, and pathologic correlation. Technique, limitations, and pitfalls also will be discussed.

Results
Spinal ultrasound in children is performed most commonly in the neonatal period and as an intra-operative tool during spinal surgery. Ultrasound is a useful screening tool in neonates with suspected diseases of the spine, such as tethered cord, closed dysraphism, intraspinal masses, and intraspinal collections. In addition, it can be helpful in guiding lumbar puncture or detecting intraspinal fluid collections after such a procedure. Intra-operative ultrasound is most useful in helping guide posterior fossa decompression of Chiari I anomalies, localization and resection of neoplasms, catheter
placement for syrinx, and evaluation of intraspinal cysts. Optimum technique and understanding of typically encountered pitfalls is important in order to obtain the best results.

Conclusions
Ultrasound is a highly useful tool in neonates with suspected spinal disease and in selected neurosurgical cases of the pediatric spine.

**eEdE-205**

6:30AM - 2:45PM

**Primary Central Nervous System Sarcomas (CNS) in Children and Adolescents: Imaging, Clinical, and Pathological Assessment**

B Wang¹, L Ketonen²

¹MD Anderson Cancer Center, Houston, TX, ²M.D. Anderson Cancer Center, Houston, TX

**Purpose**
To demonstrate the clinical, imaging, and pathological findings of primary central nervous system (CNS) sarcoma in children and adolescents. Our purpose is to raise awareness of the neuroradiology community concerning these uncommon tumors, which to our knowledge have not received much attention in the neuroradiology literature.

**Materials and Methods**
We analyzed a total 21 cases of primary CNS sarcomas in children and adolescents. Material includes sarcomas following irradiation but the following are excluded: primitive neuroectodermal tumor (PNET), gliosarcoma, reticulum cell sarcomas, Ewing's sarcomas, hemangiopericytoma, and malignant meningioma. All cases were studied with computed tomography (CT) and/or magnetic resonance imaging (MRI), and positron emission tomography (PET)-CT in some cases. All diagnoses are confirmed by pathology.

**Results**
Median age at diagnosis was 7 years (range, 1 week–20 years). Many are dural-based lesions but also infiltrate the brain parenchyma and may involve more than one part of the brain. Some lesions show restricted diffusion. Many lesions were associated with hemorrhage at presentation, contrary to typical meningioma or many metastases. Most lesions demonstrate homogenous contrast enhancement. There was no leptomeningeal disease or spine involvement at initial radiological examination. At least two patients upon recurrence had clinical findings suggestive of neuraxis and spine involvement. Involvement of the dura or falx was present in all supratentorial lesions. Calcifications are present in some patients.
Conclusions
We analyzed 21 cases of primary CNS sarcomas and presented the typical image findings. The imaging modalities consisted of CT, MRI and in some cases PET-CT. We evaluated these tumors for size, shape, margins, location, local and distant metastases.

**eEdE-198**

6:30AM - 2:45PM

**Review of utility of Susceptibility weighted imaging in pediatric emergencies.**

G Joshi¹, S Selvarajan², B Midkiff³, R Balsubramanya⁴, B Asha⁴, V Kapare⁵, S Prabhu⁶

¹Saint Vincent Hospital, Worcester, MA, ²Thomas Jefferson University, Philadelphia, PA, ³Mercy Hospital, City, MA, ⁴Thomas Jefferson University Hospital, Philadelphia, PA, ⁵University of Kentucky, Lexington, KY, ⁶Boston Children’s Hospital, Boston, MA

Purpose
Review of utility of susceptibility-weighted imaging (SWI) in pediatric emergencies.

Materials and Methods
We have reviewed multiple emergency magnetic resonance (MR) brain cases performed using SWI sequence. We have categorized patients based on various ER clinical presentations. These presentations include headache, seizure, stroke, accidental and nonaccidental trauma. We have reviewed imaging findings on SWI sequence.

Results
Susceptibility-weighted imaging is very sensitive for detection of hemorrhage and helped in differentiating ischemic versus hemorrhagic strokes. Sino-venous thrombosis can be accurately diagnosed with SWI, which helps in differentiating hemorrhagic venous infarction from periventricular hemorrhage in neonates and infants. The BOLD effect of SWI helped in quantifying penumbra without contrast injection. Susceptibility-weighted imaging helped in identifying vascular anomalies and malformations. This also helped in identifying thrombus in arteries and veins. Traumatic diffuse axonal injuries are better identified as compared to other conventional sequences. Susceptibility-weighted imaging helped in depicting retinal hemorrhages and helped in making the diagnosis of shaken baby syndrome.

Conclusions
Susceptibility-weighted imaging is exquisitely sensitive in detection of hemorrhage and aided in restaging of patients. This sequence plays an important role in management of acute stroke. Accidental and nonaccidental trauma can be diagnosed
with more confidence using this sequence. Susceptibility-weighted imaging sequence should be included as a part of routine pediatric MR brain protocol.

**eEdE-197**

6:30AM - 2:45PM

**The structural connectome in children, made easy**

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¹The Johns Hopkins University School of Medicine, Baltimore, MD, ²Department of Biomedical Engineering, Johns Hopkins University, Baltimore, MD

**Purpose**
The structural connectome is a comprehensive description of the network of elements and connections that form the brain. In the last years, this framework has been used increasingly to investigate the developing brain. This educational exhibit aims to discuss the various steps that are needed to reconstruct the pediatric structural connectome.

**Materials and Methods**
All the different steps required for the reconstruction of the pediatric structural connectome will be outlined in a simple and easy to use fashion. We will start with the required images [diffusion tensor imaging (DTI) and high-resolution T1-weighted imaging] and then will discuss key technical aspects required for the successful connectome reconstruction, analysis, and visualization using current state of the art neuroimaging and neuroinformatic techniques.

**Results**
The ingredients: The key components of structural connectome are nodes (cortical regions) and edges (measurements of structural association between nodes). Several issues make cortical parcellation in neonates and children challenging and age-specific atlases should be used. Knowledge about the age-dependent DTI changes is important to optimize tractography and avoid misinterpretation. The matrix: next step is to generate an association matrix by compiling all pairwise associations between nodes. The metrics: Various measures are used to characterize the topological architecture of the brain's structural connectivity. Connectomes commonly are assessed for their local and global efficiency. The whole picture: An overview of various visualization methods of the structural connectome will be provided.

**Conclusions**
The human connectome is the culmination of more than a century of conceptual and methodological innovation. In this work we outlined the different steps in pediatric connectome reconstruction as an easy to use pipeline.

**eEdE-206**
Uncommon Presentations of Posterior Fossa Tumors and Mimics.

D Bui\textsuperscript{1}, P Sanchez\textsuperscript{2}

\textsuperscript{1}University of California Davis, Sacramento, CA, \textsuperscript{2}UC Davis Medical Center, Sacramento, CA

Purpose
To discuss and highlight uncommon imaging presentations of posterior fossa tumors including their mimickers to improve diagnosis which affects subsequent patient management and prognosis.

Materials and Methods
Introduction: Brief description of infratentorial fossa tumors, prevalence and importance. Tumors discussed include: juvenile pilocytic astrocytoma (JPA), medulloblastoma, ependymoma, brainstem glioma, atypical teratoid-rhabdoid tumor (ATRT) and hemangioblastoma. Mimickers to be discussed include: abscess, infarct, ADEM, hematoma, and leukodystrophies. Each topic will be addressed in the following manner: Clinical presentation: Common presenting symptoms, and epidemiology such as typical age of presentation, and prevalence. Imaging findings: Conventional and advanced magnetic resonance imaging (MRI) features will be discussed for both common and uncommon presentations. Additional caveats may be included to convey knowledge learned from the specific presented cases. Treatment: Different treatment options will be discussed briefly in a basic manner such as chemotherapy versus radiation therapy in order to understand how different diagnoses affect treatment.

Results
Infratentorial fossa tumors account for up to 60% of all pediatric brain tumors and most commonly include JPA, medulloblastoma, ependymoma or brainstem glioma. Diagnosis of these tumors are straightforward when classic imaging findings are present such as a large cyst with solid enhancing mural nodule within a cerebellar hemisphere for JPA. Unfortunately this appearance is seen only in 30-60% of cases and may present less commonly as a solid enhancing mass. It is becoming increasingly crucial that radiologist recognize both the common and uncommon presentation of posterior fossa tumors to provide a quick and accurate diagnosis so as to guide early treatment and prognostic information in helping our pediatric colleagues care for their sick patients and distraught parents. Mimickers of posterior fossa tumors are uncommon, therefore if the radiologist does not recognize them few if any other specialty will. Failure to recognize mimickers leads to delay in diagnosis and inappropriate treatment. Specific mimickers discussed will include abscess, infarct, ADEM, hematoma, and leukodystrophies and how to approach these cases so as to differentiate them from posterior fossa tumors.
Conclusions
Often times diagnosis of posterior fossa tumors are straightforward when they present in the classic presentation. However atypical presentations of these tumors confounded with potential mimickers can confuse the diagnosis and often lead to a long or inaccurate differential which affects management and prognosis. As neuroradiologists we are often the first line and last line of imaging interpretation, therefore must be aware of classic, and atypical presentations and potential mimickers to provide the most accurate diagnosis possible.

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eEdE-204
6:30AM - 2:45PM
Utility of ASL Imaging for Lesion Characterization in Pediatric Neuroimaging

E Alvarado¹, J Leach¹, L Linscott¹, T Abruzzo¹, N Lall²
¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH, ²Cincinnati Children's Hospital, Cincinnati, OH

Purpose
To assess the utility of arterial spin labeling (ASL) sequences in the diagnosis and characterization of vascular and neoplastic conditions encountered in pediatric neuroimaging.

Materials and Methods
Pseudo-continuous ASL perfusion (PCASL technique) sequences have been included as a standard component of brain magnetic resonance imaging (MRI) protocols at our Children's Hospital since July 2011. These sequences have not only provided important diagnostic information pertinent to the evaluation of intracranial vascular pathology and neoplasia, but also have enabled characterization of pathology in the scalp, face, orbits and neck. We will review ASL technique, provide illustrative case...
material from a large, tertiary care pediatric medical center and demonstrate the utility of ASL in characterizing a wide variety of intracranial and extracranial pathology. Vascular anomalies, malformations and tumors as well as soft tissue tumors of the face, scalp, orbit, and neck will be examined. A review of relevant imaging nuances and pitfalls will be presented.

Results
Arterial spin labeling sequences reveal important findings for diagnosis and characterization of vascular anomalies, vascular malformations and tumors found on pediatric MRI neuroimaging studies. Inadequate understanding of ASL technique can lead to misinterpretation and diagnostic errors. Correlation of disease phenotypes with quantitative or semiquantitative ASL biomarkers may help guide patient management.

Conclusions
Arterial spin labeling is a promising tool in the diagnosis and characterization of intracranial and extracranial vascular anomalies, vascular malformations and tumors found on pediatric MRI neuroimaging studies. Performing ASL as a standard sequence in pediatric MRI neuroimaging studies should be considered.

eEdE-212

“Location, location and location” A Systematic Approach to Pediatric Spinal Tumors

Y Xie¹, B Tantiwongkosi², W Altmeyer¹, A Singh³
¹UTHSCSA, San Antonio, TX, ²University of Texas Health Science Center at San Antonio, San Antonio, TX, ³UT Health Science Center San Antonio, San Antonio, TX

Purpose
Review of a systematic approach to pediatric spinal tumors.

Materials and Methods
Systematic approach to pediatric spinal tumors based on their location and imaging characteristics.

Results
There are wide varieties of tumors involving the pediatric spine. Here, we will discuss the relevant anatomy of the pediatric spine and spinal tumors based on their location. Given the wide variety of tumors involving the pediatric spine, it is essential for a radiologist to have a systematic approach to narrow the differentials and provide useful guidance to the referring clinician. The imaging modalities of choice in pediatric spinal imaging are plain radiographs, computed tomography (CT) and magnetic resonance imaging (MRI). The pediatric spinal tumors can be organized based on location into the bony compartment, the extradural space, the intradural extramedullary compartment and intramedullary compartment as well as cauda equina.
and filum terminale. Each location has its own set of differentials, therefore it is important to distinguish the lesions first based on the location and then narrow the differentials based on history, patient's demographics and imaging characteristics. List of lesions: Bony compartment: Aneurysmal bone cyst (Fig. 1), giant cell tumor, osteoblastoma, Ewing sarcoma (Fig. 2), Langerhans cell histiocytosis, chondrosarcoma, chordoma and osseous hemangioma. Extradural compartment: Extradural extension of osseous tumors. Intradural extramedullary: Meningioma, schwannoma, neurofibroma, leptomeningeal metastases. Intramedullary: Ependymoma, astrocytoma (Fig. 3), hemangioblastoma. Cauda equina and filum terminale: Myxopapillary ependymoma, filum lipoma.

Conclusions
There are wide varieties of pediatric spinal tumors, therefore it is essential for a radiologist to have a systematic approach to narrow the differential and provide useful guidance to the referring clinician.
Figure 1

(Filename: TCT_eEdE-212_Aneurysmalbonecyst.jpg)
Figure 2

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Figure 2

(Filename: TCT_eEdE-212_Astrocytoma.jpg)

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-06

electronic Education Exhibit (eEdE) - Socioeconomics
eEdE-215

6:30AM - 2:45PM
Clinical Correlation Required: Appropriate Imaging of Headache

Y Park¹, V Nguyen¹
¹North Shore-LIJ Medical Center, New Hyde Park, NY

Purpose
The purpose of this presentation is to provide a current review of headache imaging with respect to its costs, appropriateness, and wide variety of clinical scenarios that lead to neuroimaging. Given the broad range of pathology that can present with headache, the ACR Appropriateness Criteria for headache will be reviewed to help guide appropriate diagnosis. Concluding this presentation will be a brief overview of ICD-10 changes and coding of studies performed for headache.

Materials and Methods
Current literature on the utilization and cost of headache imaging will be discussed, highlighting the low yield of studies performed for uncomplicated headache at excessive cost to the healthcare system. We will describe common primary headache syndromes which can be diagnosed clinically without additional testing. Clinical "red flags" which are associated with high positive predictive value for pathology on imaging will be discussed, along with summarized guidelines from the ACR Appropriateness Criteria for several common clinical variants of headache.

Results
Headache is one of the most common human ailments, with lifetime incidence up to 60% in adults. Consequently, there is high utilization of neuroimaging for nontraumatic headache, at an increasing annual cost of ~$1 billion. Studies have shown an extremely low positive yield for imaging isolated nontraumatic headache, frequently estimated at 0.4%. The high frequency of headache imaging coupled with a low yield results in a high false positive rate, which can lead to further unnecessary testing and potential harm. As part of an effort to curb this trend, the ACR has chosen "Don't do imaging for uncomplicated headache" as one of its five recommendations for the Choosing Wisely initiative. The ACR also maintains Appropriateness Criteria guidelines for the diagnostic topic of headache, designed to guide physicians when ordering exams and help ensure that patients receive the appropriate scan or therapy for the right indication. Clinical decision support (CDS) software that integrates the Appropriateness Criteria is currently available and will be used widely in the near future as CMS plans to mandate CDS use in 2017. Studies investigating the impact of CDS demonstrate decreases of ~25% in the rate of imaging for studied indications, such as brain magnetic resonance imaging (MRI) for headache. Clinical features associated with headache can be very helpful when deciding to order an imaging study. Features associated with a high positive predictive value include onset of paralysis, papilledema, and loss of consciousness/altered mental status. Presentations
that include more than one of these "red flags" portend the highest yield of relevant pathology at imaging.

Conclusions
- Imaging uncomplicated headache is costly and substantially overused with little evidence to justify the cost. - Historical features can diagnose common primary headache syndromes without further evaluation. - Recognize red flags to prompt imaging work up and refer to ACR Appropriateness Criteria to guide testing. - Clinical information is essential for appropriate imaging and accurate interpretation.
## ACR Recommendations

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<tr>
<th>Society</th>
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<tr>
<td>American College of Radiology</td>
<td>Don't recommend follow-up imaging for clinically inconsequential adnexal cysts.</td>
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<tr>
<td>American College of Radiology</td>
<td>Don't do computed tomography (CT) for the evaluation of suspected appendicitis in children until after ultrasound has been considered as an option.</td>
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<tr>
<td>American College of Radiology</td>
<td>Avoid admission or preoperative chest x-rays for ambulatory patients with unremarkable history and physical exam.</td>
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<tr>
<td>American College of Radiology</td>
<td>Don't image for suspected pulmonary embolism (PE) without moderate or high pre-test probability of PE</td>
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<tr>
<td>American College of Radiology</td>
<td>Don't do imaging for uncomplicated headache.</td>
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### Index Case

- **50 y/o M p/w headache**
- **H&P:** Woke up with *first time, 10/10* bifrontal headache, N/V, photophobia

### Venous Sinus Thrombosis

![CT scan of a patient with venous sinus thrombosis](image-url)
Imaging of Chronic Headache

A Wong¹, A Dmytriw², E Yu², R Forghani³, G Sze⁴, C Poon⁴
¹University of British Columbia, Vancouver, BC, ²University of Toronto, Toronto, ON, ³Jewish General Hospital & McGill University, Montreal, QC, ⁴Yale University, New Haven, CT

Purpose
Headache is a common complaint that triggers request for neuroimaging. The justification for imaging chronic headache is controversial. Many radiologists are less experienced in imaging of chronic headache, including the appropriateness of imaging utilization and findings of uncommon diseases that present as headache. In addition, advanced imaging has demonstrated potential for better understanding and new biomarkers of causes of headache such as migraine. These new developments may contribute to improved patient management. This exhibit provides an updated review on imaging of chronic headache. The specific goals include: 1. To provide updated review on the appropriateness of imaging of chronic headache, including the costs and benefits. 2. To review diseases that may present as chronic headache, emphasizing less-common diseases or those associated with imaging findings not well described previously in literature. 3. To review the value of advanced imaging for chronic headache.

Materials and Methods
Literature review is performed using MEDLINE and Google Scholar search. Articles include publications in radiology, other clinical specialties and health economics. Radiology cases from our own institutions are included in this exhibit for illustration of the spectrum of diseases presenting as chronic headache.

Results
Imaging of chronic headache poses a difficult decision for clinicians. Most cases of chronic headache are not associated with imaging abnormalities. However, in some cases, devastating pathologies such as malignant tumors, intracranial hemorrhage or ischemic diseases are the underlying culprits and delayed diagnosis can be catastrophic. Cost-benefit analysis of imaging for chronic headache is a complex issue. Many older studies recommend imaging only for patients with "red flag" signs and symptoms, but recent analysis suggests there may be benefit even for a "negative" imaging study. In addition, advances in neuroimaging provide new information about chronic headache, such as transient perfusion deficits, and reduced cortical thickness and surface area in regions serving pain processing in migraine patients. These
advances may further favor imaging investigation in a larger patient population. Headache is a nonspecific clinical complaint. Many diagnoses such as tumors and hemorrhage are obvious, but familiarity with the more subtle diagnoses such as intracranial hypotension, intracranial hypertension, vasculitis and temporal arteritis will help radiologists improve their diagnosis.

Conclusions
Chronic headache imposes a significant burden on healthcare, but has not been well described in neuroradiology. This exhibit fills this information gap by providing an updated evidence-based review of the appropriateness of imaging, examples of diseases that may be difficult to diagnose, and new information from advances of neuroimaging.

eEdE-213

6:30AM - 2:45PM

Myelography Coding Update: Revealing the Consequences of Bundling

M Morris¹, R Whiting², S Rothenberg¹, B Saboury¹, S Boateng¹, R Tu³
¹University of Maryland Medical Center, Baltimore, MD, ²George Washington University, Washington, DC, ³George Washington University Hospital, Washington, DC

Purpose
Updates of Current Procedural Terminology (CPT) coding are published annually in the CPT Manual, however the practicing radiologists may be unfamiliar with these revisions. We report the recent updates in spine imaging with intrathecal contrast media both with plain film and computed tomography (CT). The changes are subtle but have significant implications: reporting of findings, coding, and reimbursement. The authors present the first update with case material, vignettes in an interactive quiz format to reinforce practical teaching points and consequences of improper coding.

Materials and Methods
First, a review of the CPT process is presented using myelography as the example. Second, the rationale for the changes by reviewing the historical process that occurred from the Centers of Medicaid and Medicare Services (CMS) and the American Medical Association (AMA), the owner of CPT is detailed. Finally, interactive vignettes and a quiz highlighting the changes and differences between plain film versus CT of the spine with intrathecal contrast is provided.

Results
Myelography was flagged by the Relative Update Committee (RUC) screen where the procedure and Supervision and Interpretation (S&I) were coded together >75% of the time resulting in bundling. Four new codes were added. Coding vignettes highlight areas of potential confusion. Coding between 1 and 2 physicians involved in the
procedure also were changed. Salient updates when CT of the spine is completed after injection are reviewed and distinctions between CT with intrathecal contrast versus plain film are highlighted, hence the -59 modifier application.

Conclusions
Radiologists must understand the definitions in CPT for each procedure they perform. The expansion from 4 to 8 CPT codes in the myelography family with plain film and/or CT, coding changes with one or two physician scenarios are revised. As reviewed in this presentation correct coding is essential for proper payment; this updated understanding will reduce misapplication of the myelographic code set avoiding a visit by a recovery audit contractor.

eEdE-216

Paging Dr. McDreamy...The Neurosurgical Emergency: What the Neurosurgeon Wants to Know from the Imaging

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Purpose
A diagnostic error, as defined by the Institute of Medicine, is the failure to establish an accurate and timely explanation of a patient's health problem (1). With median door to CT scan times reported as low as 11.8 minutes (with images immediately available for viewing) and admission to craniotomy times reported as low as 60 minutes, the radiologist's image interpretation has become vital to obtaining accurate, rapid diagnoses and facilitating emergent treatment planning in the neurosurgical emergency (2, 3). Any cognitive error made by a radiologist in a neurosurgical emergency could compromise patient care (1). It has been suggested that multidisciplinary integration of healthcare professionals into the diagnostic process can improve patient care outcomes (1). In this project we aim to improve patient care by improving the radiologists' knowledge of the clinical considerations and imaging findings for nontraumatic neurosurgical emergencies.

Materials and Methods
In this exhibit, we shall present common (and not so common) nontraumatic neurosurgical emergency cases, ranging from the subdural empyema to late postoperative complications including sinking skin flap syndrome. In an interactive, image rich, and quiz-based format exhibit, readers will be prompted to analyze computed tomography (CT)/magnetic resonance imaging (MRI) images in each clinical vignette and select the neurosurgical emergency. For each diagnosis, information provided to the reader will include: 1. Common clinical presentation,
etiology, and prevalence. 2. Critical imaging findings and how to communicate these
to the referring clinician. 3. Clinical management including neurosurgical criteria for
intervention and treatment options (with intra-operative photography).

Results
All too often, nontraumatic neurosurgical conditions present as acute, life threatening
events that necessitate emergent identification from a radiologic standpoint so that
rapid treatment can be implemented. Without a strong understanding of the clinical
presentation, anatomy, imaging findings and neurosurgical options in these situations,
the radiologist cannot be an effective member of the multidisciplinary healthcare team
and, as a result, patient care suffers. Each case in this exhibit will illustrate what the
neurosurgeon needs to know from the imaging and how the radiologist should
approach each neurosurgical emergency so that patients are appropriately treated.

Conclusions
Understanding nontraumatic neurosurgical emergencies from not only the imaging
perspective, but also from the clinical presentation and the neurosurgical treatment
perspective helps to ensure good patient care.

eEdE-217

6:30AM - 2:45PM

Quality metrics in neuroradiology: review, discussion, and controversies

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Purpose
Amongst the seemingly abyss of medical data, there are certain quality metrics that
give insight into performance. The expectation of quality metrics is to have positive
effect on workflow, diagnostics, and ultimately, patient care. This scientific
presentation reviews current quality metrics involved in neuroradiology reporting
through recent literature review detailing the controversies. This is designed to be an
introduction for trainees and serve as a review for practicing radiologists.

Materials and Methods
Current literature was reviewed on quality metrics with focus on neuroradiology
reporting. The presentation analyzes the benefits, pitfalls, and impact of each of the
following three quality metrics: 1. Cranial reporting requirements. 2. Fluoroscopic
procedures: fluoroscopic time and contrast utilization. 3. Stenosis standards: NASCET
versus ECST.

Results
Why are these metrics important? 1. Cranial reporting requirements must include
hemorrhage, infarct, or mass in order to standardize the reporting of critical findings.
2. Fluoroscopic procedures must record fluoroscopic time in attempt to reduce patient dose. This is a standard set for safety practice. However, fluoroscopic time is not actually reflective of radiation dose or absorbed dose. 3. NASCET and ECST were designed to provide uniform reporting and standardization of carotid artery disease. Other concrete and quantifiable impacts will be from reimbursement linked to providing data on these metrics. During a transition within a fee for service model to a pay for performance model; reimbursement can be withheld by requiring reporting of metrics for completeness. Once in a pay for performance model, metrics can augment reimbursement based on meeting expected procedural standards.

Conclusions
This presentation allow radiologist to enhance reporting to meet the benchmarks of quality with aims on improving performance.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-07

electronic Education Exhibit (eEdE) - Spine
eEdE-235

Altered CSF Flow in Arachnoid Webs: Mechanism for Syringomyelia

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1University of Utah, Salt Lake City, UT, 2University of Utah, Neuroradiology, salt lake city, UT, 3University Of Utah, Salt Lake City, UT

Purpose
The arachnoid membrane is poorly understood in the imaging literature. Different modalities may play complimentary roles in delineating its normal and abnormal appearance as well as its role in spinal canal pathology. Our study focuses specifically on arachnoid webs, intradural extramedullary arachnoid tissue bands that can lead to focal dorsal cord indentation, cerebrospinal fluid (CSF) loculations and flow alterations. The clinical symptoms often are vague, and the standard magnetic resonance imaging (MRI) appearance can be confusing. We describe findings on functional sequences [i.e., phase contrast] and modalities (i.e., myelography, intra-operative ultrasound (US)] that aid in diagnosing as well as understanding the CSF flow dynamics behind arachnoid web static imaging findings.

Materials and Methods
We present a case series of 10 symptomatic patients where standard MRI differential included arachnoid web. Functional imaging modalities of myelography, phase contrast sequences, and real time intra-operative ultrasound in six cases. Abnormal
CSF flow regions were documented with respect to the abnormal T2 spinal cord signal and syringomyelia, when present.

Results

All cases of suspected arachnoid web demonstrated characteristic focal dorsal spinal cord indentation and abnormal T2 hyperintensity (Fig. A). Presyrinx was present in five with syringomyelia in one case. Phase contrast sequences showed segmental altered CSF flow dynamics (Fig. B), and CT myelography demonstrated cord indentation and differential flow. In cases that intra-operative ultrasound (US) was performed (Figs. C, D), all revealed cord tethering at the web level and adjacent hyperdynamic cord motion. At surgery, either a discrete web or tethering was seen in all patients.

Conclusions

Arachnoid membrane abnormalities are associated with alteration in CSF flow dynamics, best seen with functional modalities and MRI sequences reflecting such functional information. Visualizing these dynamic changes helps to diagnose arachnoid webs and provides a window to understanding the development of the presyrinx state and syringomyelia.
Atypical Imaging Findings on Spinal Epidural Space.

A Acosta-Rojas¹, A Ortiz de Mendivil¹, S Garcia Duque¹, J Sánchez-Márquez¹, N Fernández-Baillo¹, V Reyes², J Diamantopoulos¹, J Millán-Juncos¹, A Ramos³
Purpose
The epidural spinal pathology is classified as intrinsic and extrinsic (developmental, traumatic, degenerative, infectious/inflammatory, neoplastic benign and malignant). This review has focused on the less common diseases that represent a major challenge for imaging diagnosis.

Materials and Methods
An attempt has been made to highlight various characteristics based on anatomical location, morphologic features, vascularity, and associated ancillary findings which help in differentiating benign from potentially malignant lesions. Such differentiation is important in terms of determining further follow-up imaging, appropriate patient management, and improving prognosis. However, some cases present with rare conditions that can cause significant neurological deficit and raise serious diagnostic challenges.

Results
Within the intrinsic developmental pathology, a case of extramedullary hematopoiesis, a calcifying pseudoneoplasm of the neuraxis, an extensive long-segment cervicothoracic postoperative spinal epidural hematoma, a spontaneous long-segment epidural hematoma and a giant hernia simulating an epidural abscess are discussed. A recurrence of an epidermoid cyst, an uncomplicated angiolipoma, a hemorrhagic angiolipoma as benign entities and a lymphoma, as malignant, are shown. Among extrinsic and benign pathology, hemorrhagic synovial cysts, a facet joint abscess, hemangiomas, neurofibromas and meningiomas are presented. Among the malignant, malignant bone schwannoma, plasmacytoma, Ewing sarcoma, hemangiopericytoma and chordoma are discussed.

Conclusions
In conclusion, epidural spinal pathology can be benign or malignant in etiology. It is important for the radiologist to be aware of the various imaging features of these rare conditions in order to make an accurate diagnosis. Encroachment on the thecal sac and the spinal cord should be carefully assessed to prevent long term neurological sequelae.

eEdE-238

Beyond the Spinal Cord: Imaging of the Exiting Nerve Roots, Brachial Plexus, and Lumbar Plexus

L Rachakonda¹, T Moritani¹, p watål¹, J Kademian¹
Purpose
While neuroimaging of the spine typically focuses on the contents of the spinal canal, including the spinal cord and cauda equina, significant neuropathology can occur outside of the spinal canal. This exhibit will educate viewers about the anatomy, pathology, and imaging findings related to nerve roots as well as brachial and lumbar plexi.

Materials and Methods
We reviewed clinical features, imaging findings [computed tomography (CT), CT myelogram, magnetic resonance imaging (MRI) including diffusion-weighed imaging and MR myelogram and nuclear medicine] based on our institutional experiences and the literature. Imaging findings related to pathology will be organized by etiology, including benign and malignant neoplasms, as well as infectious, traumatic, inflammatory, demyelinating, and degenerative disease.

Results
The spinal nerve roots have a unique anatomy and imaging characteristics. It is important for radiologists to be aware of anatomical variants of nerve roots and lumbar and brachial plexi. Like the rest of the nervous system, the peripheral nerve can be affected by neoplastic, traumatic, infectious, inflammatory, demyelinating and degenerative and processes. Benign tumors, such as schwannomas, neurofibromas, meningiomas, and hemangioblastomas, and malignant tumors, such metastatic disease, lymphoma and leukemia have a characteristic imaging appearance. Acute and chronic inflammatory demyelinating processes, sarcoidosis and arachnoiditis can affect the nerve root. Infectious agents can be either due to fungal, bacterial, or viral pathogens. Finally, traumatic and degenerative changes affecting the nerve roots and brachial and lumbar plexi have characteristic imaging features.

Conclusions
While neuroimaging of the spine typically focuses on the contents of the spinal canal, including the spinal cord and cauda equina, significant pathology can occur outside of the spinal canal and in particular, involve the exiting nerve roots and brachial and lumbar plexi. When interpreting imaging of the spine, it is important to be cognizant of the normal imaging anatomy of these structures, as well as potential pathologic processes that can affect them.

**eEdE-249**

6:30AM - 2:45PM

**Blunt Cerebrovascular Injuries: Screening Criteria and Appearances**

P Nagpal¹, B Policeni², D Skeete³
Purpose
1. To briefly discuss various screening criteria for blunt cerebrovascular injuries. 2. 
To present various patterns of carotid and vertebral injuries in patients with trauma.

Materials and Methods
The authors aim to review the various screening criteria for detection of blunt 
cerebrovascular injuries (BCVI) in trauma patients. This will involve a brief 
discussion of Memphis criteria, Denver criteria, and recently published Boston 
criteria. A brief overview of imaging findings of various carotid and vertebral injuries 
with illustrative examples will be presented.

Results
Various screening criteria for detection of BCVI have been published that may make 
implementation of a screening protocol challenging for practitioners. It is important 
for the treating clinicians to be aware of the clinical signs that warrant computed 
tomography (CT) or magnetic resonance imaging (MRI) angiography of the neck. 
Similarly, a radiologist also must be aware of high-risk injury patterns that may be 
associated with a higher incidence of BCVI. In these cases, the recommendation for 
further evaluation with angiography should come from the radiologist. Blunt 
cerebrovascular injuries are treated medically or with surgical or percutaneous 
treatments. It is critical to recognize and treat these injuries as permanent 
neurological sequelae can occur if left untreated.

Conclusions
Currently, there is more than one set of published screening criteria for BCVI. More 
studies are needed to better define the high-risk criteria for detection of these injuries. 
It is useful, both for the general trainee and subspecialty radiologist to be aware of 
high-risk injury patterns and varied appearance of these injuries.
Arterial injuries (white arrows) associated with vertebral fractures (black arrows) in different patients with blunt trauma.

(C filename: TCT_eEdE-249 Image abstract.jpg)

eEdE-222

Cauda Equina: An overview of embryology, anatomy, and diseases

P Masood1, V Hill2, J Tsay1

1 Cleveland Clinic Foundation, Cleveland, OH, 2 Cleveland Clinic, Cleveland, OH

Purpose
The cauda equina is affected by a myriad of pathologies that may be difficult to diagnose and differentiate on imaging, which can leave a radiologist confused unless approaching the differential diagnosis with a systematized protocol. Some diseases are found incidentally while others are symptomatic and still others are associated with systemic disorders. The goal of this exhibit is to simplify and depict an approach to diagnosing the variety of cauda equina diseases.

Materials and Methods
The cauda equina behaves as an extension of the central and peripheral nervous systems and disease of both systems will involve with the cauda equina. Using case-
based examples, clinical presentation, and imaging features on magnetic resonance imaging (MRI), we will comprehensively review the various pathologies affecting the cauda equina, broadly included in infectious, malignant and autoimmune categories.

Results
This exhibit is divided in three sections. The initial part will discuss the embryology, development and anatomy of the cauda equina. We then will focus on the various diseases affecting the cauda equina using a case-based approach. Finally, we will present an overview of the approach to forming a cauda equina disease differential diagnosis, taking into account the imaging picture and the clinical scenarios with the most appropriate follow up and management.

Conclusions
By the end of the educational exhibit, readers will become comfortable with differentiating various pathologies affecting the cauda equina and will have a thorough understanding of clinically significant symptoms. They will be able to delineate the most likely diagnosis based on the aforementioned discussion.

eEdE-237

Cone in on the cord tip: A pictorial review of conus medullaris lesions

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Purpose
1. Review the anatomy of the conus medullaris (CM) and adjacent structures. 2. Review the differential diagnosis of CM lesions. 3. Present relevant epidemiologic and clinical associations of CM lesions. 4. Review the pathologies focusing on characteristic imaging features. 5. Present an algorithmic approach towards CM lesion diagnosis.

Materials and Methods
Radiological images and relevant clinical information were 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 central nervous system (CNS) lesions confined or determined to have originated from the CM.

Results
The CM region is a complex region of spinal anatomy that transitions from the central to peripheral nervous system. Certain pathologies have a strong predilection for this region of the body. Conus medullaris lesions include a diverse group of entities arising from vascular, ischemic, demyelinating, infectious, congenital and neoplastic etiologies. Differentiating neoplastic versus non-neoplastic lesions is crucial to determine management as most spinal cord neoplasms are malignant and will require
surgical intervention. Contrast-enhanced magnetic resonance imaging (MRI) currently is the imaging modality of choice in the evaluation of spinal cord masses. Familiarity with the characteristic imaging features of common CM lesions in conjunction with relevant epidemiological and clinical history will aid in establishing an appropriate differential diagnosis that will guide further intervention. This educational exhibit will also present an algorithmic approach to aid narrowing down the differential diagnosis of CM lesions.

Conclusions
Lesions of the CM include neoplastic and non-neoplastic etiologies. Proper differentiation among these pathologies is crucial to guide further intervention. Knowledge of the variety of lesions that occur in the CM, their classic imaging appearance and clinico-epidemiological features will aid in narrowing the radiologic differential diagnosis that will guide treatment. We present an algorithmic approach based on the imaging features to help differentiate these lesions.

eEdE-245

6:30AM - 2:45PM

Congenital Spinal Anomalies of the Pedicle and Articular Facet Complex: Multimodality Imaging to Avoid Diagnostic Pitfalls

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Purpose
To describe the imaging spectrum of congenital anomalies of the spinal pedicles and facet joint complex to avoid diagnostic pitfalls.

Materials and Methods
A five-year retrospective review (between January 2010 to January 2015) of previously reported cases of congenital anomalies of the spinal pedicle and facets. A total of 15 patients were identified from the imaging report database using specific combination of keywords including 'congenital', 'absent', 'pedicle' and 'facets'. Radiographs, computed tomography (CT) and when available magnetic resonance imaging (MRI) studies were reviewed independently by an experienced neuroradiologist and a fellow. Relevant data on clinical outcome were recorded.

Results
A total of 15 cases of congenital anomalies of the pedicle and facets were identified. The spectrum of findings include seven cases of unilateral absent pedicle, five cases of congenital clefts (neurocentral, retrosomatic, pars, retroisthmic and paraspinous) and three case of dysmorphism of the articular facets. Frequently these congenital anomalies pose a diagnostic challenge for reporting and can be misinterpreted as
fractures or facet subluxation. The radiograph, CT and MRI features are presented in a pictorial format with corresponding clinical outcome. Recognizing these key imaging features and making the correct diagnosis is of paramount importance for appropriate clinical management.

Conclusions
Congenital anomalies of the pedicle and articular facet complex may mimic traumatic spinal pathology and lead to diagnostic error. Recognizing a diverse spectrum of imaging findings is vital to prevent misdiagnosis and unnecessary intervention.

**eEdE-224**

6:30AM - 2:45PM

**Curved Needles and Curved Balloons: Indications in Spine Intervention**

E Steckler¹, J Morris¹
¹Mayo Clinic, Rochester, MN

**Purpose**
To illustrate and discuss techniques for optimizing treatment in difficult kyphoplasty or vertebroplasty.

**Materials and Methods**
After IRB approval we retrospectively search the RIMS for the key words curved balloon and curved needle to capture all of the cases at our institution from 2013-2015. Forty-seven cases involved the usage of curved needles and four of these cases also involved curved balloons.

**Results**
Our case review shows that curved balloons and curved needles can be used safely and effectively to produce exceptional results in challenging cases and in several specialized situations. This presentation will explain and show examples to illustrate the following: Curved balloon uses: - Accurately producing a cavity for kyphoplasty in anatomically complex or sensitive areas such as the sacrum, acetabulum, or cervical spine. - Allow access to large lytic defects in the midline sacrum or in the spine via unipedicular approaches. Curved needle uses: - Filling fracture clefts which improves patient outcomes. - Greater control of cement in postablation cases for complete filling of cavity. - Obtaining across midline flow the thoracic spine from a unipedicular approach. - Enabling a unipedicular approach in patients that need to be done on their side. - Improved filling in the sacrum. - Incorporation of native bone into lytic lesions. - Decreased extravasation risk. - Allows multiple sites to be treated with cement though one access needle. - Securing spinal fusion hardware in patients with loosening or osteoporosis. The cases reviewed in this series include: - 18 post RFA or cryoablation, - 16 pathologic fractures, - 15 spinal hardware stabilization procedures, - 80 total levels.
(2 Cervical, 44 Thoracic, 23 Lumbar, and 11 Pelvis), -Extravasation occurred at eight of the 80 treated levels.

Conclusions
Curved needles and balloons provide a multitude of potential benefits in appropriately selected patients beyond what is obtainable with linear devices.
Custom Lumbar Spine Task Trainer for Simulation of Fluoroscopic-Guided Lumbar Punctures

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Purpose
Fluoroscopic-guided lumbar puncture (FGLP) is a frequently performed procedure, proficiency of which is required by not only neuroradiologists but all general radiology residents. The procedure can be challenging to a new learner as it simultaneously requires integration of anatomy, procedural technique, and awareness of radiation dosage. Unfamiliarity with the procedure can lead to undue patient anxiety, pain, and increased radiation, along with increased stress on the learner. The ability to learn this procedure in a controlled environment with simulation prior to patient contact improves both learner competence and patient experience. In this educational exhibit, we demonstrate the design and value of a novel lumbar spine task trainer we have developed for simulation of fluoroscopic-guided lumbar punctures.

Materials and Methods
We developed a uniquely modified lumbar spine task trainer. The mannequin has structures simulating anatomical layers including skin, fascia, and ligamentum flava with realistic tactile response, a radiopaque lumbar spine for visualization under fluoroscopy, and a fluid-filled thecal sac for cerebrospinal fluid (CSF) withdrawal (Fig. 1). The mannequin is durable with easily replaceable parts for extended use. First year radiology residents and nurse practitioners are the primary learners simulating FGLP first by observation and then by guided instruction prior to first FGLP on a patient.

Results
The FGLP simulation improves procedural competency, learner and patient comfort, and decreased fluoroscopic times as well as radiation dosage for the first clinically attempted FGLP.

Conclusions
Simulation is a developing area within radiology that can be invaluable in achieving trainee procedural proficiency essential to our field. We demonstrate the design and utility of a realistic lumbar spine task trainer for simulation for FGLP. Further work will allow use of this model for a variety of spinal interventional procedures and eventual incorporation into residency and fellowship curricula for improving procedural competency and to help fulfill ACGME milestones.
Diagnosis of Spinal Infections

A Boikov¹, L Loevner², K Learned³
Purpose
Diagnosing spinal infection can be difficult – especially in cases where imaging characteristics overlap with other disease processes, such as neoplasms. Additionally, imaging follow up to assess treatment response and therefore, aid in diagnosis, is oftentimes challenging. In this educational exhibit, we will offer a step-wise approach to the diagnosis of spinal infection. We will use specific examples of common and uncommon spinal infections to make the complex task of diagnosing spinal infection more straightforward.

Materials and Methods
A variety of infectious processes can involve the spine. We will review the pathophysiology, clinical presentation, computed tomography (CT) and magnetic resonance imaging (MRI) characteristics, and treatment of these processes in an unknown case-based format. We will highlight overlapping imaging features and distinguishing characteristics that differentiate each entity. In particular, the pertinent clinical presentation, treatment and imaging follow up are highlighted to enhance understanding of the disease process. A review of imaging tips and pitfalls will be discussed to emphasize a clinically relevant radiological interpretation.

Results
Bacterial diskitis-osteomyelitis classically involves two contiguous vertebral bodies and their intervening disk, along with extensive paraspinal soft tissue inflammation. In contradistinction, neoplasm occurs in a noncontiguous fashion with sparing of the disk and often presents with a paraspinal mass. However, direct spread from infectious abdominal stent graft, skull base infection, and rapid multifocal systemic spread in immunocompromised patients may not follow the typical pattern of diskitis-osteomyelitis. Infection can be distinguished from neoplasm by the presence of inflammation and rapid course without appropriate treatment. Certain spinal infections – such as those due to granulomatous processes – can mimic neoplasm, as they tend to not involve the disk space and may be associated with a paraspinal pseudomass. However, these infections typically spread contiguously. Because signal alteration and soft tissue changes in spinal infection have poor correlation with disease status, follow-up imaging should only be obtained to guide clinical decision making. In patients with persistently elevated C reactive protein, leukocytosis, pain and/or neurological symptoms, treatment failure is confirmed by the presence of growing or new epidural or paraspinal soft tissue phlegmon and/or spread to additional spinal levels on follow-up imaging. Additionally, new spinal column fragmentation and/or angulation secondary to progression of infection will identify the need for surgical stabilization, especially in patients with new neurological symptoms.
Conclusions
This review will give the viewer more confidence in diagnosing infections of the spine by reviewing typical imaging findings, distinguishing between typical infection and neoplasm, and highlighting tumor-mimicking granulomatous infections, where follow-up imaging and clinical context play important roles in establishing the diagnosis.

(A) Classic bacterial thoracic diskitis/osteomyelitis; (B) Otitis externa with spread to skull base and C2; (C) Lumbosacral brucellosis.

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eEdE-239

Diffuse Involvement of the Cauda Equina Nerve Roots in Adult: a Practical Approach to Differential Diagnosis

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Purpose
The pathological processes that diffusely affected the cauda equina nerve roots are not uncommon finding in MR imaging of the lumbar spine. Patients usually present with significant neurological impairment like progressive lower limbs weakness, sphincteric dysfunction and pain. The spectrum of the differential diagnoses that have to be considered is very broad and includes congenital, infectious, inflammatory and neoplastic processes. The correct diagnosis requires all pertinent clinical information and is often done by exclusion. The purpose of this educational electronic exhibit is to describe the relevant radiological anatomy of the cauda equina nerve roots using different imaging techniques and to review various pathologies with diffuse involvement of the cauda equina nerve roots.

Materials and Methods
The normal imaging anatomy of the cauda equina is reviewed highlighting various imaging modalities [computed tomography (CT) myelogram and magnetic resonance imaging (MRI)] currently used for evaluation of the cauda equina. Then, a retrospective pictorial review of various pathological conditions that diffusely involved the cauda equina is presented. The cases were collected using the electronic database at our institute, selecting the most typical cases of various pathologies with diffuse involvement of the cauda equina nerve roots. We have found a wide variety of examples of diffuse cauda equina diseases from all pathological categories. Each of these entities will be discussed in detail through case based approach with their own imaging characteristics on cross sectional imaging and clinical presentation.

Results
The goal of our pictorial electronic exhibit is to develop a diagnostic algorithm based on clinical presentation and imaging findings that can be apply by radiologist to facilitate the correct diagnosis. The disease process of the cauda equina nerve roots can involve solitary or multiple nerve roots. Solitary nerve root involvement is much more specific for single diagnosis and its beyond our scope of this exhibit. Diffuse or multiple nerve roots involvement is least specific for single diagnosis and can manifest in MR imaging either as diffuse thickening of the cauda equina nerve roots and/or diffuse enhancement. The pattern of post contrast enhancement can be smooth or nodular which can help to narrow the differential diagnosis taking in consideration smooth enhancement is the most common and the least specific. The cases included, but not limited to the following: 1) Infectious processes, 2) Inflammatory/ granulomatous conditions like sarcoid, 3) Guillain-Barre syndrome, 4) Chronic inflammatory demyelinating polyneuropathy, 5) Spinal stenotic compression, 6) Arachnoiditis, 6) Neoplastic conditions like metastasis, lymphoma and neurofibromatosis and 7) Vascular malformations.

Conclusions
The aim of this exhibit is to illustrate various pathologies that diffusely involved the
cauda equina nerve roots and their clinical presentation in order to suggest a diagnostic algorithm useful for the radiologist to reach the correct diagnosis.

eEdE-246

Don't Lose Your Head

A Mojtahed¹, J Hallstrom¹
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Purpose
• Outline normal anatomy of the craniocervical junction. • Review the Traynelis classification system of atlanto-occipital dislocation (AOD). • Review radiologic parameters useful for diagnosing AOD, including Powers ratio, basion-dens interval, atlantodental interval, Kaufman method, and Wackenheim line. • Summarize key imaging findings in 13 adult and pediatric patients presenting to a level 1 trauma center with AOD.

Materials and Methods
• Review of literature on normal craniocervical relationships and AOD. • Retrospective identification of 13 patients with AOD presenting to a level 1 trauma center.

Results
Case examples discussing clinical and radiologic findings, treatment, and outcomes in 13 adult and pediatric patients presenting to a level 1 trauma center with AOD are reviewed, with emphasis on computed tomography (CT) and magnetic resonance imaging (MRI) findings.

Conclusions
• AOD is a devastating injury; however, more patients are surviving to hospital presentation. • AOD may be overlooked due to lack of neurologic deficits and other spine injuries. • Understanding normal craniocervical anatomy and radiologic criteria for AOD is critical for prompt diagnosis by the radiologist.
Purpose
The purpose of this educational exhibit is to explain the technique of T1 magnetic resonance (MR) myelography and how it potentially can be used to aid in the diagnosis of certain clinical conditions, while also touching on potential complications.

Materials and Methods
There will be an overview given of T1 MR myelography including a description of the procedure. Imaging acquisition parameters and optimization of these also will be discussed. Next proposed clinical indications and potential complications with cases to illustrate these will be shown.

Results
T1 MR myelography with off label intrathecal gadolinium injection and multiplanar T1 fat suppressed images has been shown to aid in the diagnosis of spinal
cerebospinal fluid (CSF) leak in patients with spontaneous intracranial hypotension, although there has been limited clinical use secondary to longer acquisition times and operator dependence. This educational exhibit will give a background and overview of T1 MR myelography with a detailed description of the procedure including imaging acquisition parameters and optimization techniques. There also will be a discussion of other proposed clinical indications as well as potential complications. Cases will be used to illustrate these.

Conclusions
T1 postgadolinium MR myelography is a new technique that may help work up of intracranial hypotension without identifiable CSF leak by other conventional diagnostic modalities.
eEdE-220

Imaging of Typical and Atypical Infections of the Spine

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Purpose
Magnetic resonance imaging (MRI) 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 MRI.

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 disk 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: - Fig. 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. - Fig. 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. - Fig. 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 diskitis-osteomyelitis, most prominent at the L5-S1 level. There also is a large anterior epidural abscess which compresses the thecal sac extending from the inferior L4 through mid-sacral spine levels. - Fig. 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 disk 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.

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(Filename: TCT_eEdE-220_Fig2.jpg)
Imaging the nerve roots on MRI: a practical guide to MR myelogram and root neurography

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Purpose
Magnet resonance imaging (MRI) of the spine is commonly performed. However, the specificity of imaging with regards to patient pain and outcomes is low. One of the most specific findings, however, is nerve root involvement with inflammation. Several lesser-known techniques are available to evaluate the nerve roots and may serve as a useful adjunct to traditional cross-sectional MR imaging of the spine. The purpose of this exhibit is to demonstrate evaluation of the nerve roots using MR myelogram of the entire spine, coronal T2 root neurography of the lumbar spine, and diffusion-weighted root neurography of the cervical and lumbar spine.

Materials and Methods
We begin with a review of the anatomy of the nerve roots. Then we proceed to review the protocol parameters and normal imaging appearance and practical utility of the aforementioned sequences in identifying sites of potential pain, in conjunction with standard T1/T2/STIR images. We finish with review cases.

Results
Contents: #Anatomy: - Review of basic nerve root anatomy, levels and exiting, etc. # MR myelogram: - Normal appearance of the thecal sac; - Normal appearance of the nerve roots; - Narrowing/constriction of the thecal sac; - Nerve root compression. # T2 coronal MRI rootograhy of the lumbar spine: - Normal appearance and course of the nerve roots; - Normal appearance of the vertebral bodies and disks; - Differentiating nerve roots from fluid in the nerve root sleeve; - Nerve root displacement; - Nerve root compression; - Nerve root swelling. # Diffusion-weighted root neurography of the cervical and lumbar spine: - Normal appearance and course of the nerve roots; - Nerve root displacement; - Nerve root compression; - Nerve root swelling; - Differentiating artifacts from pathology.

Conclusions
Using MR myelogram and root neurography can improve imaging of the nerve roots and the ability of the neuroradiologist to diagnose related pathology, which may in turn increase the value imaging adds to diagnosis and treatment of back pain.
Incomplete Cord Syndromes: Imaging, Pathology and Clinical Correlation

6:30AM - 2:45PM

v kunam\textsuperscript{1}, D Reede\textsuperscript{2}, W Smoker\textsuperscript{3}, V Velayudhan\textsuperscript{4}, M Bobinski\textsuperscript{5}, S Pulitzer\textsuperscript{6}
\textsuperscript{1}SUNY Downstate University hospital, Brooklyn, NY, \textsuperscript{2}SUNY downstate University Hospital, Brooklyn, NY, \textsuperscript{3}University Of Iowa Hospitals & Clinics, Iowa City,
Purpose
Purpose of this exhibit is to: 1. Review the location and function of the major tracts that traverse the spinal cord relevant to incomplete cord syndromes. 2. Learn to localize lesions in the spinal cord based on clinical findings. 3. Demonstrate examples of common pathology associated with various incomplete spinal cord syndromes.

Materials and Methods
The normal gross and imaging anatomy of the spinal cord and tracts that traverse it are reviewed. This is followed by discussion of the clinical findings associated with common spinal cord syndromes. Review of common etiology of various syndromes will be done using cross-sectional images and illustrations.

Results
Disorders that affect the spinal cord involve specific structural/functional anatomical regions, and can producing distinct clinical syndromes. Knowledge of spinal cord anatomy and clinical findings associated with common spinal cord syndromes is essential for evaluation and management of these patients. Imaging plays a pivotal role in precise localization of pathology, and treatment guidance. Incomplete cord syndromes, clinical features and cases that are presented with each syndrome include: 1. Dorsal (posterior) cord syndrome: loss of proprioception and vibratory sensation – Multiple sclerosis and subacute combined degeneration. 2. Central cord syndrome: upper limb predominant motor deficit with segmental loss of pain and temperature – Syringomyelia and intramedullary tumor. 3. Ventral (anterior) cord syndrome: loss of pain and temperature sensation, weakness – spinal cord infarction and disk herniation. 4. Brown-Sequard syndrome: ipsilateral weakness and loss of proprioception; with contralateral loss of pain and temperature sensation – Knife injury to the spinal cord, multiple sclerosis and idiopathic transdural cord herniation. 5. Conus medullaris syndrome: bladder and rectal dysfunction, with saddle anesthesia – disk herniation and intramedullary metastases. 6. Cauda equina syndrome: asymmetric multiradicular pain, leg weakness and sensory loss; with bladder dysfunction – myxopapillary ependymoma, arachnoiditis and lumbar spine stenosis.

Conclusions
The radiologist's role as a consultant in the evaluation of patients with spinal cord lesions is greatly enhanced by understanding the clinical, as well as imaging findings associated with various spinal cord syndromes. This exhibit enhances your ability to localize a lesion, based on clinical findings, and to play a significant role in the diagnosis and management of these patients.
<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Typical Clinical Presentation</th>
<th>Common Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>Segmental loss of pain and temperature, weakness greater in arms than legs</td>
<td>Syringomyelia, intraspinal tumor, hyperextension, cervical spondylarthropathy</td>
</tr>
<tr>
<td>Ventral</td>
<td>Loss of pain and temperature, weakness, bladder dysfunction</td>
<td>Spinal cord injury, herniation, radiation, HTLV-1</td>
</tr>
<tr>
<td>Dorsal</td>
<td>Loss of proprioception, vibratory sensation, variable weakness and bladder dysfunction</td>
<td>Tabes dorsalis, Brown-Séquard syndrome, myelopathy, episodic ataxia, multiple sclerosis</td>
</tr>
<tr>
<td>Brown-Sequard</td>
<td>Ipsilateral weakness and loss of proprioception, contralateral loss of pain and temperature</td>
<td>Knife or bullet injury, multiple sclerosis</td>
</tr>
<tr>
<td>Conus medullaris</td>
<td>Bladder or rectal dysfunction, saddle anesthesia</td>
<td>Disc herniation, tumor, lumbar syringomyelia</td>
</tr>
<tr>
<td>Cauda equina</td>
<td>Asymmetric multiradicular pain, leg weakness and sensory loss, bladder dysfunction</td>
<td>Disc herniation, tumor, lumbar syringomyelia</td>
</tr>
</tbody>
</table>

(Filename: TCT_eEdE-236_Table.jpg)
Brown Sequard syndrome

Clinical features
A. Ipsilateral loss of proprioception & vibration
B. Contralateral loss of pain and temperature
C. Ipsilateral complete paralysis

STIR image shows pseudo left paraspinal musculature with adjacent ill-defined T2 signal in right hemicord.

Innovative Virtual Reality Simulation Training for Fluoroscopically Guided Lumbar Punctures

M Qandeel¹, S Ali¹, R Ramakrishna¹, C Yang¹
¹University of Chicago Medical Center, Chicago, IL
Purpose
Proficiency in fluoroscopy-guided lumbar puncture (FGLP) is essential in general radiology and neuroradiology training. Traditionally, this is achieved by performing the procedure under close supervision initially with transition to independency. Performance of the procedure with limited experience is associated with unnecessary patient discomfort as well as increased radiation dose, puncture attempts, and complication rate. We highlight the role of radiology simulation, as we demonstrate the design and utility of a virtual reality simulator for performing FGLP.

Materials and Methods
A FGLP module was developed on an ImmersiveTouch platform, which digitally replicates the procedural environment with a hologram-like projection of anatomy. From CT datasets of healthy adult spines, we constructed a 3D model of the lumbar spine and overlying soft tissues. We assigned different physical characteristics to each tissue type, which the user can experience through haptic feedback while holding a 'virtual' spinal needle. The user can manipulate the 3D image and obtain virtual fluoroscopy to plan the procedure. Through visual and haptic feedback, FGLP is performed. Number of puncture attempts, distance to target, number of fluoroscopic shots and approximate radiation dose is calculated. Preliminary data from users who participated in the simulation - some without prior experience with FGLP - was obtained in a postsimulation survey.

Results
The users felt the simulation was a realistic replication of the anatomy and procedure. They also thought the simulator would be helpful in preparation for performing the actual procedure.

Conclusions
Simulation in healthcare is a developing field which has great potential for procedural training in radiology. Our preliminary data suggests value of a virtual reality simulator for achieving competency in FGLP. Future work will quantify the true benefit of this simulator in terms of reducing patient discomfort and complications, as well as its potential in performing more challenging and uncommon spine procedures.
eEdE-219

Interactive Case Based Review of the Recent Updates to Lumbar Disc Disease Nomenclature

S Boateng¹, M Morris¹, R Whiting², S Rothenberg¹, B Saboury¹, R Tu³
Purpose
The purpose of this exhibit will be to present an interactive, case-based review and quiz of the updates to the recent implementation of standard nomenclature of lumbar disk disease.

Materials and Methods
This educational exhibit aims to educate radiology trainees, radiologists and spine specialists about the updated standardized nomenclature published in 2014 by the Combined Task Force (CTF), a collaborative effort among key opinion leaders of spine disease. A pictorial review of lumbar disk disease will be presented and described using the currently accepted CTF standardized nomenclature. During this review, we will emphasize the clear distinctions between the current CTF nomenclature and previous version. A quiz will be administered at the end of the pictorial to ensure adequate absorption of the presented information.

Results
Standardized nomenclature in radiology reporting is important as broader specialists and medical liability and disability decision makers use the information. Clear, concise, effective and consistent communication among providers is paramount for patient care (1). Since 2001, lumbar disk pathology, bulge, herniation and its variants have been described using standardized nomenclature published by CTF (2). After decades of using this nomenclature, the CTF has updated the nomenclature to reflect the current knowledge of lumbar disk disease (2). While most of the language and format remains unchanged from the original, there are some critical updates including redefinition of lumbar disk pathology and modifications in radiology report style to reflect more accurate language (2). Many clinicians and radiologists are not aware of the recent changes to the CTF standardized nomenclature due to its relative novelty and are therefore at risk of compromising clear communication among specialists, and consequently, compromising effective patient care.

Conclusions
Clear and effective communication is a critical aspect of promoting excellent patient care. It is important to be aware of updated nomenclature in order to clearly and accurately communicate across multiple specialties and promote excellent patient care. As BIRADS in mammography provides uniform communication across multiple clinical specialties, following the updated standardized nomenclature for lumbar disk disease is essential to conveying clear and accurate understanding of diagnoses.

**eEdE-248**

6:30AM - 2:45PM
Mechanism Based Approach to Identifications of Traumatic Spine Injury

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Purpose
There are numerous eponyms or historical jargon encountered with describing traumatic spine injuries and fractures, which unfortunately may create confusion with colleagues and referring physicians. Perhaps more important is their relation to the underlying mechanism of insult, which can assist in both describing and identifying these injuries. The purpose of this exhibit is to review and define common traumatic spine injuries within neuroradiology by their mechanism of injury.

Materials and Methods
Our institute is a level 1 tertiary trauma center and our imaging teaching file was queried for traumatic spine injuries. Clinical presentation, mechanism of injury, and outcome were recorded. In this exhibit, we organized injuries by mechanism: (1) Flexion, (2) Extension, (3) Rotation, (4) Axial Loading, and (5) Combination type injuries.

Results
An organized and illustrative spectrum of traumatic spine injury and relevant to neuroradiology is provided. The clinical scenario, representative imaging, and radiologic teaching points will accompany each described injury. Familiarity with both the underling mechanism and imaging features is important for timely diagnosis given that patients often may be unstable with limited physical exam.

Conclusions
Familiarity with both the underling mechanism and imaging features is important for timely diagnosis. This is especially important given that patients often may be unstable and present with limited physical exam.

eEdE-240

MR Imaging in Spinal Trauma: What a Radiology Resident Needs to Know?

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Purpose
The purpose of this exhibit is: 1. To discuss the indications of magnetic resonance
imaging (MRI) in spinal trauma. 2. To review the various MR sequences for adequate evaluation of spinal trauma. 3. To discuss the MRI findings of ligamentous and spinal cord injuries. 4. To explain the role of MRI in evaluating stable versus unstable spinal injuries and predicting prognosis in spinal cord injury. 5. To review the role of MRI in benign versus malignant vertebral fractures, and acute versus nonacute compression fractures seen on CT.

Materials and Methods
In this electronic exhibit, we will discuss role of MR in spinal trauma with emphasis on the biomechanical basis of injuries.

Results
1. Normal MRI appearances of spinal ligamentous structures. 2. Mechanisms of spinal trauma. 3. When to suspect ligamentous and cord injuries based on CT findings? 4. Review of imaging findings. 5. Sample cases: Anterior longitudinal ligament, posterior longitudinal ligament, ligamentum flavum, facet capsular ligament, interspinous and supraspinous ligament tears; spinal cord contusions- hemorrhagic and nonhemorrhagic; traumatic disk herniation and soft tissue injuries.

Conclusions
The major teaching points of this exhibit are: 1. MR imaging of spinal trauma is very helpful in diagnosing ligamentous and cord injuries. 2. MR imaging helps to classify spinal injuries in stable versus unstable categories due to its ability to accurately diagnose number of columns involved. 3. By differentiating hemorrhagic versus nonhemorrhagic contusions of spinal cord, MRI helps in predicting prognosis of patient in spinal trauma.
Non-Traumatic Emergencies of Spinal Column - A Bird's Eye View

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¹Mcgill University Health Centre, Montreal, Quebec, ²McGill University Health Centre, Montreal, Quebec, ³Mcgill University Health Centre, Montréal, Québec, ⁴McGill University Health Center, Montreal, Quebec

Purpose
1) To have an understanding about the common and uncommon nontraumatic but potentially life threatening conditions of the spinal column. 2) To discuss the
computed tomography (CT) and magnetic resonance imaging (MRI) findings of these emergency conditions and the relevance in patient management.

Materials and Methods
Elaborate search was made for all cases of nontraumatic emergency conditions of the spine from the case database available on PACS from 2005 to 2014. Patients charts were reviewed for clinical history, imaging findings, complications and surgical details.

Results
Discussion will include but not limited to the following conditions: 1. Infection - Diskitis/osteomyelitis, septic facet joint, Epidural abscess. 2. Inflammatory - Transverse Myelitis, Multiple Sclerosis, Neurosarcoïdosis/Gullian-Barre Syndrome, CPPD, Rheumatoid Arthritis. 3. Neoplastic - Burkitts lymphoma, meningioma, paraganglioma, Myxo-papillary ependymoma, Metastasis with epidural Extension. 4. Nonneoplastic - Chiari 1, Dural Venous fistula, Epidural Lipomatosis, Hardware failure, Herniated Disk, Hematoma.

Conclusions
Awareness and knowledge of the imaging findings of common nontraumatic emergency spinal pathologies will play an important role in management of patients.
Retroclival Hemorrhage: Where is the Blood?

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1University of Chicago Medical Center, Chicago, IL
Purpose
Retroclival hemorrhage is rare but can pose a diagnostic dilemma for localization into the subdural, epidural, and subarachnoid compartments (rcSDH, rcEDH, and rcSAH, respectively). In this educational exhibit, we demonstrate an approach to differentiate retroclival hemorrhage into subdural, epidural, and subarachnoid compartments based on computed tomography (CT) and magnetic resonance imaging (MRI) criteria through schematics and series of cases. We also discuss the complex anatomy of this region and pitfalls in diagnosis, including common lesions which can mimic retroclival hemorrhage.

Materials and Methods
We retrospectively reviewed brain and cervical spine CT and MR imaging in 30 patients who presented with retroclival hemorrhage from 2011 and 2015. Two board-certified neuroradiologists independently categorized these cases as rcSDH, rcEDH, and rcSAH with attention to four key imaging criteria: 1) extension beyond retroclival region along the tentorium and falx; 2) integrity of the tectorial membrane 3) confinement of hemorrhage to the attachments of the tectorial membrane and 4) presence of intervening subarachnoid space between the hematoma and brainstem and/or encasement of the basilar artery. Cases of retroclival hyperdensity mimicking hemorrhage also were identified separately.

Results
Imaging features useful in localization of retroclival hemorrhage include 1) rcSDH: extension of hemorrhage beyond retroclival region along the tentorium and falx with intact tectorial membrane; 2) rcEDH: confinement of hemorrhage to the attachment of the tectorial membrane; the tectorial membrane may be disrupted or lifted; 3) rcSAH: absence of intervening subarachnoid space between the hematoma and brainstem and/or encasement of the basilar artery by hematoma. Cases which can mimic retroclival hemorrhage include engorgement of the basilar venous plexus and meningiomas.

Conclusions
Imaging characteristics with attention to four imaging features can be used to categorize retroclival hemorrhage. Accurate diagnosis and localization can appropriately guide further work up and may help in assessing the prognosis.

Review of Lumbar Interbody Fusion and the Role of Neurography in Extreme Lateral Lumbar Interbody Fusion.

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¹University of South Florida, Riverview, FL, ²USF Morsani College of Medicine, Tampa, FL
Purpose
Review the advantages, disadvantages, and imaging characteristics of different approaches to lumbar interbody fusion including anterior, posterior, transforaminal, and extreme lateral lumbar interbody fusion (lateral trans-psoas lumbar interbody fusion). Then focus on the complications of extreme lateral lumbar interbody fusion that result from direct injury to the nerves and demonstrate how neurography can play a role in avoiding these complications.

Materials and Methods
A thorough review of the literature was completed. Then we selected a cohort of patients to perform neurography on before undergoing extreme lumbar interbody fusion.

Results
There are many complications of extreme lateral lumbar interbody fusion that result from damage to the nerves in lumbosacral plexus. Thigh paresthesia, usually in anterior cutaneous branch of femoral nerve, along with iliopsoas and quadricep weakness were among the most common complications. Current standard is for surgeons to use landmarks and intra-operative monitoring during the procedure to avoid damaging the nerves, but these complications are still very common. A recent publication by Quinn, et al, in Spine 2015 used magnetic resonance imaging (MRI) neurography to demonstrate the variability in the course of the lumbosacral plexus traversing the L4-L5 disk space. They found that there was marked variability in the course of the lumbosacral plexus and also that left to right asymmetry was common. This variability is why landmarks are not a reliable approach for pre-operative planning. Neurography provides a more reliable means of pre-operative planning when compared with current approaches and could play a role in the future of pre-operative planning in extreme lumbar interbody fusion.

Conclusions
There are many complications of extreme lateral lumbar interbody fusion that result from damage to the nerves in lumbosacral plexus. Current standard is for surgeons to use landmarks and intra-operative monitoring during the procedure to avoid damaging the nerves, but this approach is likely outdated considering the advancements in imaging techniques. Neurography provides a more reliable means of pre-operative planning and identifying the plexus when compared with current approaches and could decrease the amount of complications of extreme lumbar interbody fusion.
Role of Imaging in Minimally Invasive Spine Interventions

N Peri¹, R Rojas², J Nagda³
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Purpose
(a) To describe the different types of minimally invasive spine interventions useful in
the management of pain, (b) the role of different imaging modalities in planning and
performing procedures and (c) the associated complications.

Materials and Methods
The exhibit will be divided into three sections. Section 1 will describe the different
types of minimally invasive spine interventions for pain management. Section 2 will
describe the role of different imaging modalities in planning, performing and follow
up of these procedures. Section 3 will describe the complications of these procedures
and role of imaging in their management.

Results
There are different types of minimally invasive spine interventions that are performed,
for relief of pain, neuropathic symptoms, etc. These include vertebroplasty, injections
(epidural injections, nerve root blocks, facet injections, dorsal rhizotomy, sacroiliac
injections, etc.). Spinal cord stimulators radiofrequency ablation also are used in the
management of pain. The indications, contra-indications, advantages and
disadvantages of the most commonly performed procedures will be described in
detail. The different imaging modalities such as plain radiographs, fluoroscopy,
computed tomography (CT) and magnetic resonance imaging (MRI) are necessary
and complement each other in planning, performing and follow up of these
procedures. There are complications associated with these procedures and imaging
has an important role in the diagnosis and management of these complications.

Conclusions
The present educational exhibit describes the different types of minimally invasive
spine interventions for pain management, the role of different imaging modalities and
associated complications.

eEdE-227
6:30AM - 2:45PM

**Spinal Regional Anesthesia: What went Wrong?**

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¹Rush university medical center, Chicago, IL, ²RUSH UNIV MEDICAL CENTER,
Chicago, IL, ³University of Washington, seattle, WA, ⁴Rush University Medical
Center, chicago, IL, ⁵Rush University Medical Center, Chicago, IL

Purpose
Spinal regional anesthesia and spinal pain control injections are routinely performed.
Complications related to these procedures are infrequent. Early recognition of these
complications is very important in their management. Imaging plays a crucial role in identifying complications and guiding management associated with these procedures.

Materials and Methods
- Describe relevant spinal anatomy.
- Briefly describe techniques and approaches for various spinal regional anesthesia and pain control procedures.
- Describe predisposing factors and pathophysiology of associated complications and their management.
- Describe imaging features of these complications with emphasis on magnetic resonance imaging (MRI).

Results
Complications of spinal regional anesthesia and spinal pain control injections can occur immediately or may be delayed for a few days following the procedure. Immediate complications such as epidural hematoma, spinal subarachnoid hemorrhage, injury to conus and spinal cord infarction usually are related to direct needle trauma. Delayed complications can be a sequelae of dural puncture itself or due to placement of a foreign body (example: epidural catheter). Delayed complications include intracranial/spinal hypotension of varying severity related to persistent cerebrospinal fluid leak and spinal infections such as epidural abscess, meningitis, and arachnoiditis.

Conclusions
Spinal regional anesthesia and spinal pain injections are relatively safe procedures. Complications, although infrequent can lead to major and sometimes irreversible neurological deficits if not recognized and managed early. Imaging can accurately diagnose these complications and help guide appropriate and timely management.

**eEdE-228**

**Spine Interventions: Different Goals, Similar Techniques**

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¹UT Southwestern, Dallas, TX

Purpose
The purpose of this educational exhibit is to comprehensively describe the technical facets of a multitude of spine interventions including: lumbar punctures, myelograms, intrathecal injections, lumbar drains, epidural blood patches, epidural steroid injections, transforaminal selective nerve root epidural steroid injections, vertebral body biopsy, vertebroplasty/kyphoplasty/vertebral augmentation, radiofrequency ablation, discograms, and disc aspirations—the full gamut of which is routinely conducted by our fellows at our home institution. This fellow driven exhibit shall display the technical formalities and nuances of procedural spine interventions.
Materials and Methods
We herein attempt to discuss the different aspects of the spine procedures routinely done at UT Southwestern. Using select examples from our repertoire of cases, the intent is to provide instruction on the previously mentioned spine procedures. The exhibit shall discuss the various instruments utilized, and various techniques implemented among the multitude of spine interventions. The exhibit shall highlight important anatomic landmarks and approaches throughout these interventions. A single institutional educational experience is presented to the reader interested in the technical aspects of spine interventional radiology.

Results
Fluoroscopically guided lumbar punctures, myelograms, intrathecal injections, and lumbar drain placement are a mainstay of the diagnostic neuroradiologist in training at our institution. We have several new fluoroscopy tables which enable ideal patient positioning and superior image obliquity, allowing us to position our needles and instruments towards our target. The interlaminar approach is routinely undertaken for these procedures. The reader will be provided with instructive pictorial depictions elucidating this classic technique—with a review of pearls and pitfalls. Image guided vertebral body biopsy, vertebroplasty/kyphoplasty/vertebral augmentation, and radiofrequency ablation are conducted by our fellows on a routine basis. Although the intended goal of this variety of procedures are different, the technical approach is identical. The pedicular and extrapedicular approach for these procedures is done at our institution with use of a biplane fluoroscopy system or may be done under CT guidance. A unique approach detailing an anterior cervical disc biopsy and anterior cervical vertebral body biopsy is also described for the interested reader. Image guided discograms and disc biopsies are also done using a C-arm fluoroscopy unit. The plane of acquisition is key in determining procedural success. The facet joint is positioned to project and bisect the disc space. The needle is then typically placed just anterior to this position, and the disc is interrogated.

Conclusions
Neuroradiology fellows at our institution routinely perform a cornucopia of spine interventions. This educational exhibit shall entertain and explore pearls and pitfalls in the technical aspects of spine interventions. Although the goals are of different origin, the techniques are strikingly similar.

eEdE-232

Spine Oncology: Required Reading for the Neuroradiologist

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Purpose
Up to 40% of all cancer patients have spinal metastases. Life expectancy for these patients is increasing and new attention is focused on management in these cases. Treatment is multidisciplinary, multimodal, and individualized for each patient, requiring collaboration between surgeons, radiation and medical oncologists, and neuroradiologists to provide optimized patient management. In order to provide relevant information, the neuroradiologist is required to know far more than the imaging features of spinal metastatic disease. We must be familiar with and able to report upon the most current management paradigms, algorithms, and classification scales used by the multidisciplinary team.

Materials and Methods
This presentation will provide a comprehensive overview of current management algorithms and grading scales used in the multidisciplinary treatment of spinal metastases. Key concepts in surgical and oncologic treatment will be provided with emphasis on information that the neuroradiologist should provide in reports and direct communication with the team. Numerous case examples will show the value we can provide to the treatment team and patient.

Results
The NOMS framework is a treatment paradigm that considers the patient's neurologic, oncologic, and systemic disease as well as mechanical instability. These components are used to guide systemic and radiation therapy and surgery. A vital component of neurologic status is the degree of spinal cord compression. The epidural spinal cord compression scale, ESCC, is used for treatment decisions. Mechanical instability is an indication for surgical treatment regardless of other assessments. The spinal instability and neoplastic score, SINS, uses primarily imaging information to determine the need for surgical consultation.

Conclusions
Neuroradiologists play a vital and increasing role in management of patients with spinal metastatic disease. We have three primary methods of conveying information: reports, personal communication with team members, and participation in multidisciplinary tumor boards. Our ability to provide relevant input in each of these situations requires knowledge of the most current management algorithms, grading systems, and treatment innovations and trends.
That Wasn’t Supposed to Happen: Prevention, Recognition, and Management of Spine Intervention Complications

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¹Henry Ford Hospital, Detroit, MI, ²Henry Ford Hospital, Detroit, MI, ³Henry Ford Health System, Detroit, MI

Purpose
Interventional spine procedures are common in most busy neuroradiology practices. While generally low risk, when complications occur there is potential for significant patient morbidity. As such, understanding potential complications and factors that can precipitate them, as well as prompt recognition and management are essential to minimizing poor outcomes. The purpose of this exhibit is to provide a case-based review of complications potentially encountered during spine interventions, discuss causative factors and techniques for prevention, as well as keys to recognition and management when complications do occur.

Materials and Methods
Using case files, we will show examples of complications encountered during spine interventions, emphasizing keys for recognition. Cases will include: • Vascular complications, including brain and spinal cord infarct due to embolized injectate,
epidural and paraspinal hematomas, and pseudoaneurysms (Fig. 1). • Infectious complications, including epidural abscess and septic arthritis. • Hardware complications, including broken biopsy needles, fractured drainage catheters, and cement leakage during vertebral augmentation. Discuss elements for avoiding complications: • Preprocedural factors, including anatomical details to consider during procedure planning and anticoagulation management. • Intraprocedural factors, including appropriate hardware selection, drug choice, and approach. • Postprocedural management, including appropriate clinical follow up. Discuss management of complications, including imaging evaluation and treatment.

Results
This exhibit discusses complications encountered during spine interventional procedures, including ischemic, hemorrhagic, infectious, and hardware-related. Causative factors of complications were identified, including: 1) Failure to recognize and understand key anatomical details of the spine, particularly vascular anatomy; 2) Suboptimal technique, including lack of sterile manipulation and inappropriate approach; and 3) Poor hardware selection.

Conclusions
Complications of interventional spine procedures are uncommon, but potentially devastating if they occur. Understanding key elements for avoiding complications, including relevant anatomical details, proper technique, and appropriate material selection is essential. In addition, when complications do occur, prompt recognition and management are critical to minimizing poor outcomes.
**Fig 1.** A) Planning image for CT-guided disk aspiration. B) Post-procedure CT showing large paraspinal hematoma. C,D) Angiogram of arteriovenous fistula and pseudoaneurysm pre- and post-embolization.
The Subaxial Injury Classification Scoring System: What the Neuroradiologist Needs to Know

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Purpose
To enhance the attendees understanding of: the clinical and radiologic features of subaxial cervical spine injuries; what constitutes the subaxial classification scoring system (SLIC); how SLIC is used to help manage patients with subaxial cervical spine injuries; imaging findings pertinent to establishing a SLIC score, and; current evidence supporting the clinical use of SLIC.

Materials and Methods
A review of the MEDLINE, EMBASE, CINAHL and Cochrane Library databases using the keyword 'subaxial cervical spine injury classification score' and related terms was performed. Following abstract screening, all relevant scientific publications were retrieved in full and reviewed in detail. An explanation of the SLIC score and a summary of the literature with respect to its clinical performance were incorporated into our presentation. Illustrative case examples were obtained from our local institution and the literature.

Results
Subaxial cervical spine injuries account for the majority of cervical spine injuries and are a major source of morbidity and mortality. These injuries have highly variable clinical outcomes, making an unbiased and accurate assessment of their severity at presentation extremely important. SLIC is an accurate, reliable, and validated scoring system that incorporates radiologic assessment of injury morphology and discoligamentous integrity along with clinical assessment of neurologic status to help guide surgical management. Familiarity with SLIC and its radiologic constituent findings is critical for the accurate communication of injury severity between the neuroradiologist and attending surgeon.

Conclusions
SLIC is an accurate, reliable and validated tool for the assessment of subaxial cervical spine injury severity. Neuroradiologists should be familiar with its constituent radiologic findings.
Thoracolumbar Spine Trauma: Pearls and Pitfalls of the Newer Classification Systems

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Purpose
Thoracic and lumbar spinal fractures commonly are encountered in blunt trauma patients, comprising approximately 50% of all vertebral fractures. Neurologic injury to the spinal cord occurs in 19% to 50% of these patients. Numerous classification systems have been developed to guide clinical and surgical treatment of thoracolumbar (TL) fractures. The early classification systems were based on anatomical structures or inferred mechanism of injury. Currently, the two most commonly used classification systems in TL spine trauma are the AOSpine Thoracolumbar Spine injury Classification System (AOS) and the Thoracolumbar Injury Classification System (TLICS). This exhibit will review the two classifications and discuss the clinical implications of them.

Materials and Methods
Anatomy of the thoracolumbar spine. AOSpine Thoracolumbar Spine injury Classification System. Thoracolumbar Injury Classification System: - Morphology, - DLC integrity, - Neurological Status, What the Clinician Needs to Know.

Results
Computed tomography (CT) and magnetic resonance imaging (MRI) play complimentary roles in the evaluation of spine injuries. The morphology of the injury is identified in the CT examinations, which also allow one to infer some of the soft tissue injuries. Magnetic resonance imaging provides valuable information in regards of the soft tissues including the ligamentous structures, the cord, and the extra-axial spaces. Unstable injuries evolve over time and represent a risk for development or worsening of neurologic damage.

Conclusions
The AOS and TLICS classifications are new efforts to describe and analyze thoracolumbar spinal injuries. Neuroradiologists should be aware of the clinical implications of using these classifications, and how they can provide improvement in patient outcomes.
Those are the Breaks: Don't-miss Cervical Spine Traumatic Injuries for Residents on Call

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¹University of Mississippi Medical Center, Jackson, MS

Purpose
Interpretation of cervical spine CT can be daunting for novice residents on call, particularly in the fast-paced setting of a level 1 trauma center. This interactive exhibit will familiarize residents with crucial imaging findings and pertinent clinical features of traumatic cervical spine injury.
Materials and Methods
Interactive case-based review of common patterns of cervical spine injury encountered on call at a busy level 1 trauma center. Cases will be presented as unknowns with follow-up questions and explanations of key imaging and clinical points.

Results
Cases will primarily focus on detection and interpretation of noncontrast computed tomography (CT) cervical spine findings, with inclusion of additional imaging such as computed tomography angiography (CTA) and magnetic resonance imaging (MRI) as appropriate. Follow-up interactive questions will focus on pertinent clinical features and management, with emphasis on critical information to communicate to referring providers. Various cervical spine fracture classifications (e.g., based on mechanism, location, and morphology) will be reviewed in the context of illustrative cases.

Conclusions
Participation in this interactive exhibit will increase residents' familiarity of and comfort level for rapid and accurate interpretation of cervical spine trauma.

eEdE-241

6:30AM - 2:45PM

Trauma of the Craniocervical Junction: an Overview of Relevant Biomechanical Characteristics Regarding Ligamentous Anatomy and Injury Patterns in Relation to Blunt Force Trauma.

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Purpose
To enhance understanding of injury patterns of the craniocervical junction (CCJ) through analysis of its ligamentous anatomy and biomechanics during blunt force trauma.

Materials and Methods
Knowledge of craniocervical junction anatomy and biomechanics allows a deeper understanding of the injury patterns following blunt trauma. The educational exhibit begins with a discussion of the anatomy of the craniocervical junction, with an emphasis on the craniocervical ligaments, including the transverse ligament, apical ligament, tectal membrane, and posterior atlantooccipital membrane, among others. Following the anatomical review, the exhibit will present the normal biomechanics and movement of the craniocervical junction, as well as in relation to common
craniocervical junction injury patterns. We conclude with a pictorial review of these various patterns of craniocervical junction injury.

Results
Craniocervical junction injury contributes significant morbidity and mortality to trauma patients and rapid recognition of these injuries is essential to their management and ultimately outcomes. The CCJ is a unique articulation which provides not only a conduit for neural tissue to pass from the brain to the spine, but also the mobility for complex head movements. The anatomical relationships of the skull base, axis, and atlas, as well as its ligamentous complex, contribute to injury patterns which manifest during blunt force trauma. A review of the biomechanical characteristics of these ligaments and their relationship to the bony structures can enhance understanding and detection of resultant injury patterns, such as atlanto-occipital dissociation, atlantoaxial distraction, occipital condyle fracture, traumatic rotatory subluxation, alar/transverse ligament rupture, and injuries of the tectal membrane.

Conclusions
The craniocervical junction is a complex and unique articulation which provides the stability necessary for the transmission of neurological tissue from the brain into the spine, while maintaining the mobility needed for complex movements of the head and neck. Understanding the biomechanical characteristics of the craniocervical junction will enhance the radiologist's understanding of injury patterns encountered with blunt force trauma to this important structure.

Vertebral Hemangiomas: Not So Benign After All

A Rajput1, T Ahluwalia2, A Rajput3, L Bangiyev1, Y Edelstein1
1Stony Brook University Hospital, Stony Brook, NY, 2Winthrop University Hospital, Melville, NY, 3University of Pittsburgh, Melville, NY

Purpose
The goal of this educational exhibit is to review incidence, prevalence, and clinical presentation of common and uncommon pathology in patients presenting to the emergency department with back pain and/or myelopathy with focus on aggressive vertebral hemangiomas. Knowing the appearance of this entity and other various pathologies will help the radiologist to correctly distinguish them and recommend appropriate treatment.

Materials and Methods
Back pain is a very common presentation in the emergency department of all ages and a frequent reason for diagnostic imaging. It is important for the radiologist to be aware of the vast abnormalities involving the spine and associated elements, as time is of the
essence. Our aim is to discuss the imaging findings and consider a differential diagnosis of a rare phenomenon, an aggressive vertebral hemangioma. Awareness of this rare lesion is vital as diagnosing it can be difficult due to the absence of typical imaging characteristics.

Results
The discussion will include brief review of anatomy and embryology of development of the spine, followed by presentation of a case of an aggressive hemangioma. Further discussion will include characteristic computed tomography (CT) and magnetic resonance imaging (MRI) findings of an aggressive hemangioma that will lead the radiologist to recognize it as a rare subset of hemangiomas rather than additional aggressive spinal lesions. The exhibit also will demonstrate case-based review of relevant differential diagnosis for this entity including congenital lesions, infections, metastases, and atypical hemangioma. The review will further include imaging characteristic that will help a radiologist to distinguish between possible considerations and offer appropriate recommendation in regard to follow up and further management.

Conclusions
Hemangiomas typically are benign lesions incidentally discovered on imaging. A small subset demonstrate aggressive features with extraosseous involvement producing severe neurological symptoms. Review of this educational exhibit will enable a radiologist to be familiar with this entity, be able to confidently diagnose it, consider and narrow relevant differential considerations, and also offer appropriate recommendations.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B=1

Electronic Poster (eP) - Adult Brain
eP-13

7T MRS NEURONAL MARKERS IN ELDERLY HIV+ SUBJECTS

M Mohamed¹, P Barker¹, H Roosa¹, N Sacktor¹
¹Johns Hopkins Univ. School Of Medicine, Baltimore, MD

Purpose
While high active antiretroviral therapy (HAART) has lengthened the life expectancy of patients infected with human immunodeficiency virus (HIV), the risk of cognitive impairment in the aging HIV+ subgroup has continued to increase (1, 2). Premature aging has been hypothesized as new risk factors for HIV associated neurocognitive
disorders (HAND) (3). The current study was undertaken to investigate the relation between the neurocognitive changes among elderly HIV+ subjects and the brain metabolic markers as measured by 7T magnetic resonance spectroscopy (MRS).

Materials and Methods
Thirty-two elderly (greater than age 50 years) HIV+ subjects (24 male, with mean age of 59.8± 5.8) were stratified into four groups according to their cognitive status. Seven HIV+ individuals with normal cognition, eight with asymptomatic neurocognitive impairment (ANI), 10 with mild neurocognitive disorder (MND) and seven with HIV associated dementia (HAD) were evaluated. All subjects were receiving combination antiretroviral therapy. Twelve HIV- controls (11 male, with mean age of 62.0± 8.8) also were included. Using a 7.0T Philips 'Achieva' scanner and 32-channel head coil, brain magnetic resonance imaging (MRI) and 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 eight to 15 cc (Fig. 1). Spectra were analyzed using LCModel and quantified in millimolar (mM) concentrations, relative to the unsuppressed water signal. Metabolite concentrations and ratios relative to creatine (Cr) were calculated. The data were not distributed normally; therefore, comparisons between the groups were evaluated using nonparametric statistical comparisons for significant differences.

Results
There were no differences in age among our comparison groups. On comparing HIV- versus HIV+, HIV+ showed significant decrease in FWM tNAA (NAA+NAAG), BG tNAA/Cr and Glu/Cr in HIV+ versus HIV-, (P=0.05, 0.01, 0.04 respectively). HIV+ showed significant increase in Precuneus GABA/Cr in HIV+ versus in HIV- (P=0.007). Precuneus myo-inositol (mI) was higher in HIV+ as compared to HIV-; however, it did not reach statistical significance. In comparing HIV+ patients by cognitive status, there were significant decreases in FWM tNAA, NAA, NAA/Cr and posterior cingulate tNAA/Cr with increasing degrees of cognitive impairment (P=0.008, 0.02, 0.03, 0.028 respectively).

Conclusions
The current study shows similar results to previous findings found in younger subjects, namely reduced FWM tNAA, NAA, NAA/Cr in symptomatic HAND (MND and HAD) compared to ANI HIV+ patients (4, 5), besides the significant correlation of the post cingulate tNAA/Cr among HIV+ with the increase severity of the neurocognitive impairment (3). High precision 7T MRS measurements of NAA and Glu can provide reliable biomarkers for differentiating HIV+ from HIV- individuals and the degree of HAND, and may be useful for the study of premature aging and/or disease progression among elderly HIV+ patients.
Figure 1: showing the 5 brain regions and their corresponding spectra from an HIV+ subject.
Purpose
Anatomical atlases have been created by pioneers such as the French neurosurgeon Talairach, who carefully sectioned a single female brain which has been digitized into anatomical sections. The Atlas is used for anatomical mapping and three-dimensional brain images can be translated into "Talairach space" (1). However, brains have wide variations in shape and size and an atlas based on only one brain has limited generalizability. High resolution data-sets such as those created by the Montreal Neurologic Institute (MNI) have taken sub-millimeter magnetic resonance imaging (MRI) data from multiple individuals and fused them into a single idealized brain (2, 3). Unfortunately, the application of the Talairach coordinates to such data yields an imperfect fit since the Atlas must be warped and adapted from a single human brain into the "idealized brain." The Talairach Atlas has 5 mm thick slices, resulting in nonisometric voxels with relatively low resolution. We present the creation of a new atlas based upon a high resolution data set which can be modified to fit specific research requirements such as outlining specific areas of the brain on fMRI which may overlap traditional anatomical demarcations.

Materials and Methods
Advanced segmentation technology was used to subdivide the idealized brain from the MNI 152 Montreal database into 26 focal regions. Regional demarcation of the cortex of the idealized brain was performed followed by subcortical segmentation using a variety of morphological operations such as subtraction of white matter, exclusion operation to eliminate overlap, and growing operation to ensure all gray matter is covered.

Results
A high-resolution atlas was created where the anatomical name and volume can be viewed with the click of the mouse, provided free at the nonprofit site www.GlobalRad.org in.xml format. The attached figure shows activation of the inferior frontal gyrus (light areas).
Conclusions
A new, higher-resolution, fully interactive atlas of brain anatomy has been created with a simple user interface.
Inferior Frontal Gyrus Activation
A Voxel-based morphometry study in diabetes mellitus type II compared to healthy controls. Preliminary results of the PRECISED study.

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¹Vall d’Hebron University Hospital, Barcelona, Barcelona, ²Vall d’hebron University Hospital, Barcelona, Barcelona

Purpose
The goal of this study was to investigate brain volume differences between diabetes mellitus type 2 (DM2) patients and healthy controls.

Materials and Methods
Fifty-eight DM2 patients were included in the study (68% females, mean age (SD)=66.91 (5.91) years). A group of 15 controls also was included (71% females, mean age (SD)=62.71 (7.24) years). Brain volume differences were estimated at a regional level, by using a voxel-based morphometry (VBM) analysis (Statistical Parametric Mapping version 8). Images were segmented and normalized, following the established VBM pipeline. Then, for the statistical comparison differences were considered significant at a p<0.05 Family Wise Error (FWE)-corrected level and an extend threshold of 10 voxels. Age and total intracranial volumes were added as covariates in the statistical comparison.

Results
Diabetes mellitus type 2 patients showed a significant gray matter loss in the right inferior temporal cortex (MNI coordinates = (44,-69,5); p=0.004 and k=61 voxels) and the right supramarginal gyrus ((57,-28,27); p=0.026 and k=57 voxels). No significant differences were found between groups for the segmented white matter.

Conclusions
Diabetes mellitus type 2 patients showed a significant gray matter loss, compared to healthy controls, which affects the right temporal and the parietal lobe. Brain white matter does not seem to show a pattern that differed from healthy controls.

Accuracy of Functional Localization in Pre-surgical Function MRI

I Hassan¹, M Jen², P Hou², G Li³, A Kumar², H Liu², R Colen²
Purpose
To establish a platform for the evaluation of functional localization accuracy in presurgical functional magnetic resonance imaging (fMRI).

Materials and Methods
The presurgical MRI exams of nine right-handed patients (2 females, 7 males; 34-68 years old) with malignant brain tumors at the fronto-parietal region were analyzed retrospectively. All scans were performed on a 3.0T MR scanner (GE Healthcare, Waukesha, WI, USA), consisting of a 3D T1-weighted scan, a 2D T1 scan and a gradient-echo EPI functional scan. The 2D T1-weighted imaging was acquired with the exact slice thickness and location matched with the fMRI. We used a bilateral hand squeeze block-design experiment. For comparison, all fMRI data were spatially transferred to the 3D T1-weighted images with two algorithms: coordinate matching (CM) using the AFNI software (http://afni.nimh.nih.gov/) and automated registration (AR) using the DynaSuite Neuro 3.0 software (Invivo, Gainesville, FL, USA). For the AR, results were obtained both without and with manual adjustment (AR, adjusted). The functional maps for each patient were overlaid on both of the original EPI volume and the 3D T1-weighted image volume, with proper thresholds to optimize visualization of primary motor area (2). An experienced neuroradiologist delineated the detected activation region of interest (ROI) in the same location on 2D T1 images, as those overlays on EPI volume using the Mango software (http://rii.uthscsa.edu/mango/index.html). Then the manually drawn ROIs were transferred to the 3D T1 volume, using the transformation matrix determined by registering the 2D to the 3D T1-weighted image volumes using SPM8 software (http://www.fil.ion.ucl.ac.uk/spm/). The Euclidean distances between the manually drawn activation ROIs and the software generated overlays were determined in the 3D structural image space. The results then were compared by using Wilcoxon matched-pairs signed rank test for each two sets of data.

Results
The Euclidean distance between the centroid of the software generated activation overlay and that of the hand-drawn ROI was found to be 4.7 ± 2.0 mm in CM, 10.1 ± 4.6 mm in AR, and 5.4 ± 2.6 mm in AR, adjusted, respectively. Significant differences were found when comparing results from AR versus CM and AR versus AR, adjusted (P<0.05). No statistical significance was found between CM and AR, adjusted.

Conclusions
This study found that the AR itself could lead to a centroid shift of the activation foci to a distance close to one gyrus, which could be problematic for the surgical planning.
The smaller localization error found with CM was a result from good motion control between the functional and anatomical scans, thus cannot guarantee to succeed in all clinical studies. The results from AR, adjusted, showed significant improvements from the AR alone and were comparable to the CM, suggesting the importance of a user-friendly and accurate manual adjustment function in clinical fMRI software. This study established a platform for the evaluation of functional localization accuracy in presurgical fMRI, and highlighted the necessity of quality control for the AR processing as a clinical routine.
ADC Quantification of Definite and Probable Creutzfeldt-Jakob Disease Compared to Controls

<table>
<thead>
<tr>
<th>Subject No.</th>
<th>CM</th>
<th>AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.0</td>
<td>8.9</td>
</tr>
<tr>
<td>2</td>
<td>4.5</td>
<td>3.7</td>
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<tr>
<td>3</td>
<td>5.6</td>
<td>16.4</td>
</tr>
<tr>
<td>4</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td>5</td>
<td>7.2</td>
<td>15.4</td>
</tr>
<tr>
<td>6</td>
<td>7.7</td>
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<tr>
<td>7</td>
<td>4.4</td>
<td>12.1</td>
</tr>
<tr>
<td>8</td>
<td>1.5</td>
<td>14.6</td>
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<tr>
<td>9</td>
<td>5.2</td>
<td>7.2</td>
</tr>
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</table>

Mean ± SD  
4.7 ± 2.0*  10.1 ± 4.6

*: Significantly different than the AR (P<0.05)

Purpose

Creutzfeldt-Jakob disease (CJD) is a rare, fatal neurodegenerative disease caused by a protein called "prion" that is a product of conformational alteration in a normal cellular protein. Creutzfeldt-Jakob disease is 85% sporadic, 15% genetic and <1%
acquired. The typical clinical course seen commonly in sporadic disease is rapidly progressive dementia, ataxia, myoclonus and death in less than 1 year necessitating a rapid and accurate diagnosis to rule out treatable causes. Autopsy being the gold standard, the diagnostic work up includes cerebrospial fluid (CSF) biomarkers of 14-3-3 protein, tau protein and neuron specific enolase and brain MR imaging. The 14-3-3 protein has a 92% sensitivity and 80% specificity, whereas diffusion-weighted imaging (DWI) magnetic resonance imaging (MRI) has a sensitivity of 91-96% and 92-94% specificity. Diffusion-weighted imaging MRI has the highest diagnostic accuracy with 97% compared to tau 80% and 14-3-3 protein 70% and NSE 71% (1). Our aim is to show the utility of multiregional apparent diffusion coefficient (ADC) quantification in definite, probable and controls.

Materials and Methods
We retrospectively evaluated the brain MR images of eight autopsy proven and 10 probable CJD cases per clinical and imaging criteria (2) and compared the results to 10 controls who had brain MRI for nonprion disease-related diagnoses. The investigated MR features were T2/FLAIR and DWI intensities and ADC values of frontal and parietal gray and white matter, basal ganglia, and pons. Statistical analyses were performed using Fisher's exact test on T2/FLAIR and DWI findings and Wilcoxon Rank Sum test on ADC values.

Results
There were overlaps in imaging findings between the definite and probable CJD cases. Nonetheless, the most common pattern observed in definite and probable CJD was frontal and parietal cortical ribboning with putaminal increased signal on DWI and T2/FLAIR in an asymmetric fashion and was concordant with the literature. No statistically significant difference was found between definite and probable CJD group comparisons. When the definite CJD group was compared to controls there were statistically significant differences in caudate nucleus and putamen T2/FLAIR and DWI hyperintense signals and decreased ADC values (p<0.001, p<0.001 and p<0.003 respectively). In the frontal and parietal gray and white matter, only the DWI signal changes were statistically different for bilateral frontal and parietal cortices (p<0.001 and p<0.003).

Conclusions
Cortical ribboning and basal ganglia diffusion restriction strongly support the clinical diagnosis of CJD. Apparent diffusion coefficient quantification may help the diagnosis particularly in the basal ganglia. Lack of statistical significance of the frontal and parietal cortex ADC values may be secondary to our small sample size, difficulty in measuring ADC in cortical gray matter, and also may suggest that well trained human eyes can better recognize the pattern in the appropriate clinical setting.

eP-56

6:30AM - 2:45PM
Admission Insular Infarction in Acute Minor Stroke with Proximal Artery Occlusion is Associated with Early Neurological Deterioration due to Infarct Growth

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¹Chonnam National University Hospital, Gwangju, NA, ²Massachusetts General Hospital, Boston, MA, ³Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
Previous studies have suggested that large insular infarction is associated with greater stroke severity and large mismatch loss in acute middle cerebral artery stroke. We hypothesize that admission insular infarcts could be associated with early neurological deterioration (END) in acute minor stroke with large vessel occlusion.

Materials and Methods
Using acute and follow-up diffusion weighted imaging (DWI), we assessed the insular involvement and follow-up lesion patterns in 166 consecutive patients with acute minor stroke (NIHSS≤5) due to MCA/ICA occlusion. The follow-up lesion patterns were classified as (1) swelling, (2) new lesions, and (3) progressive lesions. Early neurological deterioration was defined as any increase in NIHSS scores.

Results
Insular infarcts on admission DWI were observed in 82/166 (49.4%) patients. Patients with insular lesions had a higher frequency of cardioembolism, territorial infarct pattern, distal MCA occlusion, and lower ASPECTS (all p≤0.003). Of the three follow-up lesion patterns, progressive lesions were significantly more frequent in patients with versus without insular infarcts (p=0.02). Although END was not significantly different in patients with versus without admission insular infarcts, insular lesion was independently associated with END due to lesion progression (OR 2.54, 95% CI 1.12-5.76, p=0.03) in a multivariate logistic regression analysis.

Conclusions
In acute minor stroke with MCA/ICA occlusion, insular lesions on admission DWI were associated independently with progression and END due to infarct growth. This finding might help to identify patients with higher risk of clinical worsening among acute minor stroke with proximal occlusion.

eP-73

Adult Measures of Psychopathy in a Cohort with Childhood Lead Exposure: Volumetric and Diffusion Tensor Imaging Outcomes

K Cecil¹, T Beckwith², J Wright³, K Dietrich³

6:30AM - 2:45PM
Purpose
Psychopathy is defined as disinhibited and antisocial behavior with diminished remorse or empathy. Genetic and environmental factors are thought to contribute to psychopathy. Given the increase in criminality established with lead exposure, the purpose is to determine if an association exists between measures of adult psychopathy and neuroanatomical structure in a birth cohort with childhood lead exposure longitudinally followed for nearly 30 years.

Materials and Methods
High-resolution, 3-dimensional, anatomical (volumetric) T1-weighted and 32-direction diffusion tensor imaging (DTI) (spin-echo echo planar imaging, b-value 1000 s/mm2) were acquired with a 3T MR scanner from the adult cohort (N=92, 35 male, mean age at imaging 26.7 +/- 1.1 years). Participants electronically completed the Psychopathic Personality Inventory (PPI). Voxel-based morphometry (VBM) utilized Statistical Parametric Mapping (SPM) software. Voxel-based diffusion tensor imaging (DTI) employed custom IDL-based software. Statistical analyses of VBM and DTI outcomes were performed with multiple regression analyses employing a log function of Total PPI scores, as a dependent variable, the log of blood lead at 78 months as an independent variable with evaluation of confounders such as age at imaging, sex, gestational age, race, adult socioeconomic status, full-scale IQ, maternal IQ, and prenatal exposure to cigarettes, alcohol and marijuana considered when constructing the final models.

Results
Reduced white matter volume in the cerebellum was associated with higher total psychopathy scores. In males, reduction of gray matter volume in the left middle frontal gyrus and precentral gyrus was observed. Diffusion patterns indicative of axonal and myelin injury and/or disorganization were associated with higher total psychopathy scores and noted in the cerebellum, frontal, temporal and parietal lobes. The four-part figure illustrates only a small portion of these results. Additional regions revealed increasing fractional anisotropy associated with higher total psychopathy scores.

Conclusions
Increased psychopathy scores correlated with neuroanatomical features (volume loss, white matter disorganization) in a longitudinally followed cohort with childhood lead exposure.
Alterations in Arterial and Venous Flow in Alzheimer’s Disease; a 4D-flow MRI Study

T Schubert¹, L Rivera-Rivera¹, K Johnson², S Johnson¹, O Wieben¹, P Turski³
¹University of Wisconsin Madison, Madison, WI, ²University of Wisconsin, Madison, WI, ³University Of Wisconsin, Madison, WI

Purpose
The evidence that alterations of the cerebrovascular system might play a role in the development of Alzheimer disease (AD) is increasing (1). A well suited approach to comprehensively evaluate blood-flow characteristics in AD patients is 4D-flow magnetic resonance imaging (MRI). The purpose of this study was to compare arterial and venous pulsatility in an AD cohort and age-matched controls using 4D-flow MRI.

Materials and Methods
Twenty-five AD patients (61-89 years, mean=73 years) and 25 age-matched controls (66-89 years, mean=74 years) were enrolled in the study. Magnetic resonance imaging data were acquired on a 3T clinical MRI system with a radially undersampled trajectory for improved spatial resolution (2). Flow measurements were performed in four arterial segments (Fig. 1a, b): cervical ICA and MCA on both sides). Furthermore, four venous segments were evaluated (Fig. 1a, b, c): superior sagittal sinus (SSS), straight sinus (STS), and transverse sinus (TS, bilateral). Pulsatility index (PI) and MCA/ICA PI ratios were calculated. Groups were compared using analysis of variance (ANOVA, statistical significance p<0.05).

Results
Arterial pulsatility in the ICA (p=0.009) and MCA (p<0.001) as well as the pulsatility ratio MCA/ICA (p=0.002) were significantly higher in the AD group compared to age-matched controls. Venous pulsatility in the SSS (p=0.009) and STS (p=0.004) was significantly higher in the AD group. A significant reduction in net flow was found in the ICA and MCA (p<0.001, p=0.04), the flow reduction in the STS (p=0.9), SSS (p=0.11) and TS (0.08) did not reach statistical significance (Fig. 1).

Conclusions
Our results indicate a reduced overall vascular compliance in AD patients compared to normal age-matched subjects. Importantly, the physiological dampening effect of the pulse wave along the arterial tree is diminished in AD patients. Interestingly, the increased arterial pulsatility is equally transferred to the superficial and the deep venous system. Furthermore, arterial net blood flow was reduced significantly in the AD cohort.
**Figure 1**: (a) Segmented view of the middle cerebral artery with blood flow distribution and velocity in blue. (b) Pulsatile flow waveform throughout the cardiac cycle generated by the PC VIPR data. The table below shows p-values of the comparison analysis of Pulsatility Index (PI, left) and flow (right) between the AD-cohort and age matched controls.
An observational study of 2D measures of maximum trans-axial diameter of metastases following treatment with stereo-tactic radiosurgery on 3 monthly surveillance imaging

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¹The Walton Centre NHS Foundation Trust, Liverpool, Merseyside, ²The Christie NHS Foundation Trust, Manchester, Greater Manchester

Purpose
To evaluate typical metastatic tumor response patterns following treatment with stereotactic radiosurgery (SRS) on surveillance imaging.

Materials and Methods
This was a retrospect study of patients in whom intracranial metastases had been treated with SRS. Patients were identified from the database of treated patients between January 2012 and July 2014. Patients were included if they had at least one follow-up study after the initial treatment. Scans performed in set time frames (3 monthly intervals + 2 weeks) were included. Scans performed outside these time frames were excluded. For each metastasis the maximal 2D diameter was measured on the postcontrast T1-weighted imaging and serial measures in the change in tumor size was plotted against the serial scans. Growth patterns for each tumor were assessed, and different types of growth patterns described.

Results
A total of 82 patients with 154 metastases were included in the study. Forty-one patients had two or more metastases treated, the treatments of which were not necessarily concurrent. Five different growth patterns were identified. In patients where only one follow-up scan was performed, only three potential patterns could be described; increase, stable or decrease. Where further studies were performed additional patterns could be seen including initial response with a decrease follow-up by subsequent regrowth and an initial increase in size followed by subsequent response.

Conclusions
A number of patterns of change in tumor size are seen in response to SRS and an initial increase in size of the lesion on the first 3 months post-treatment study does not necessarily equate to a failure in treatment, as continued surveillance may show a subsequent decrease in lesion size.
Aortic Arch Variations and Incidence of Intracranial Aneurysms

F Salehi1, P Johnson1, B Kwan1, M Boulton1, S Lownie1, S Pandey1, D Lee1, D Pelz1, M Sharma1
1Western University, London Health Science Centre, London, Ontario

Purpose
There is an association between A1 vessel asymmetry and anterior communicating artery aneurysm formation, suggesting an anatomical relationship (1). Variations in the origin of vertebral arteries have been suggested to be associated with intracranial vascular anomalies due to variation in blood flow patterns, but there is paucity of data to support this theory (2, 3). To our knowledge, there is no published series to investigate a potential relationship between aortic arch branching patterns and intracranial aneurysm formation.

Materials and Methods
The study included 1300 patients scanned over 1 year who underwent high resolution imaging (computed tomography (CT) angiography, magnetic resonance (MR) angiography, digital subtraction angiography (DSA) of the head and neck arteries, aortic arch and superior mediastinum. Exclusion criteria were patients with suboptimal images, or where imaging did not include all arteries. Patient age, gender, aortic arch branching pattern and the presence, location, number and size of aneurysms were documented.

Results
Preliminary results showed that of 121 patients analyzed thus far (14%) patients had a variant aortic arch branching pattern, none of whom had aneurysms. There were 15 patients with aneurysms (9 Acomm, 3 MCA, 1 Pcom, 1 PICA, 1 SCA), all with a normal aortic arch branching pattern. The most common variant was a common origin of the left common carotid artery and brachiocephalic trunk with or without a direct left vertebral artery (N=8, N=2 respectively) and direct origin of the left vertebral artery (N=7).

Conclusions
In 15 patients with aneurysms, none had any abnormality of aortic arch branching pattern. Aortic arch branching pattern was classic in 86% of patients analyzed, in keeping with the literature.

eP-10

Applications of diffusion tensor MR imaging in multiple sclerosis.

M GAHA1, A Mahjoubi2, A Hassine3, K Tlili-Graiess2
Purpose
In this work, we examine the diffusion tensor imaging (DTI) analysis methods, the results obtained in the various tissues of the central nervous system, and correlations with clinical features and other magnetic resonance imaging (MRI) parameters. The adoption of DTI metrics to assess the outcome of prognostic measures may represent an extremely important step forward in the multiple sclerosis (MS) research field.

Materials and Methods
This work presents a brief history of diffusion-weighted imaging (DWI) and its basic principles and applications in the study of multiple sclerosis, followed by a review of the properties and applications of diffusion tensor MRI and its use in the study of MS.

Results
Multiple sclerosis, a demyelinating disease, occurs principally in the white matter of the central nervous system. Conventional MRI is sensitive to some, but not all, brain changes associated with multiple sclerosis. Diffusion-weighted imaging provides information about water diffusion in tissue and diffusion tensor MRI about fiber direction, allowing for the identification of white matter abnormalities that are not apparent on conventional MRI images. These techniques can quantitatively characterize the local microstructure of tissues. Multiple sclerosis-associated disease processes lead to regions characterized by an increased amount of water diffusion and a decrease in the anisotropy of diffusion direction. These changes have been found to produce different patterns in multiple sclerosis patients presenting different courses of the disease. Changes in water diffusion may allow examination of the type, appearance, enhancement, and location of lesions not readily visible by other means.

Conclusions
Ongoing studies of multiple sclerosis are integrating conventional MRI and diffusion tensor MRI measures with connectivity-based regional assessment, aiming to provide a better understanding of the nature and the location of white matter lesions. This integration and the development of novel image-processing and visualization techniques may improve the understanding of white matter architecture and its disruption in multiple sclerosis.

eP-102

Applying 4D-DSA to Gamma Knife Radiosurgery treatment planning: a feasibility study

K Chen¹, W Guo², C Lin³, W Chu⁴, F Wu⁵
Purpose
Gamma Knife Radiosurgery (GKRS) had been shown to be safe and reliable approach for cerebral arteriovenous malformation (AVM) and intracranial dural arteriovenous fistula (DAVF). Achieving high conformity between target volume and the planned radiated volume is of top priority in GKRS. The current study aims to investigate the feasibility of applying 4D digital subtraction angiography (DSA), developed by Siemens Healthcare, to Leksell gamma knife radiosurgery planning for more panoramic view of nidus retrospectively.

Materials and Methods
Under the approval of institutional review board, patients who were scheduled for GKRS, underwent 4D DSA. Stereotactic frames were installed on patients' head to immobilize their heads during imaging acquisition, as well as serve as registration markers between images from distinct diagnostic modalities. Angiography was performed using a biplane angiography system (Siemens Artis zee biplane, Siemens Healthcare, Forchheim, Germany). The injection protocol was aimed to provide the best opacification of nidus. Twelve-second 260 degree acquisition protocol was adopted to capture the entire contrast bolus. Four dimensional DSA prototype reconstructions, with standard reconstruction kernel (HU normal) and motion correction algorithm applied, were performed. Merged with reconstructed masks (Fig. 1), the 4D DSA volumes were assessed by two trained interventional neuroradiologists who determined the optimal sequence of arterial filling and venous drainage to delineate nidus (Fig. 2). The selected optimal time frame of the 4D volume then is sliced with 3-mm slice thickness along the axial direction without interspacing. The slices then were transferred to Leksell GammaPlan® (Elekta Instruments, Atlanta, Ga., USA), and registered onto the stereotactic MR images that reveal the treatment plan program retrospectively (Fig. 3).

Results
The lower left figure in Figure 4 shows the DICOM outputted by stereotactic DSA, and the rest are from the stereotactic MR. The blue lines are the nidus boundary defined by two orthogonal 2D-DSA images (AP and lateral), and the purple contours are the nidus defined by stereotactic MR images. It can be seem that the 4D DSA alone provides panoramic view of nidus with detailed time resolved contrast dynamics, hence potentially results in better delineation of nidus in terms of size and shape, both spatially and temporally. The registration error of 4D DSA and 2D DSA for this subject is 4mm and 2mm, respectively.
Conclusions
Integration of fully time-resolved DSA data into the gamma knife radiosurgery system for patients with brain AVM and DAVF is feasible. We believe the comprehensive anatomical delineation of nidus provided by 4D DSA will be valuable assets in radiosurgery planning.

(Filename: TCT_eP-102_Figure1.jpg)
Arterial spin labeling as a biomarker for the detection of early stages of Parkinson’s disease

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Purpose
Parkinson disease (PD) is the second most common neurodegenerative disease. Patients with early stages of PD usually show asymmetrical motor deficit impairment. As the disease progresses, asymmetrical symptoms become obscure. Arterial spin labeling (ASL) is recognized increasingly as a noninvasive method for cerebral blood
flow (CBF) measurement in the assessment of stroke, neurodegenerative diseases, and
brain tumors. We hypothesized that ASL could be useful in the detection of early
stages of PD. To test our hypothesis, we evaluated CBF laterality of PD patients with
early stages compared with those with advanced stages.

Materials and Methods
Thirty-eight patients with PD were studied retrospectively. The CBF maps derived
from ASL data were coregistered to the corresponding high-resolution 3DT1WI using
SPM 12 software. Putamen (PT), caudate nucleus (CN), globus pallidus (GP), and
thalamus (TH) were traced manually on the representative axial slices of 3DT1WI.
Subsequently, CBF of PT, CN, GP, and TH were measured using corresponding
pixels on the coregistered CBF maps. A laterality index (LI) was calculated as the
ratio of the contralateral to the primary affected side CBF. Each of the LIs was
compared between early and advanced stages of PD using Mann-Whitney U test.
Trends for the LIs in each stage also were assessed.

Results
There were nine patients in stage I, 10 in stage II, nine in stage III, and 10 in stage IV.
In the CN, the LIs were significantly higher in early stages (mean LI±SD =
1.06±0.14) than in advanced stages (mean LI±SD = 0.94±0.14) (p<0.05). In contrast,
no significant difference was found in the PT, GP and TH. In addition, there was a
trend toward decreased LIs with disease progression.

Conclusions
Assessment of CBF laterality of CN in ASL is feasible for differentiating patients
with early stages of PD from those with advanced stages.
Arterial spin labeling in acute seizure

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\textsuperscript{1}Pitié Salpêtrière, Paris, France, \textsuperscript{2}Pitié-Salpêtrière Hospital, Paris, AK, \textsuperscript{3}Pitié Salpêtrière, Paris, 75013
Purpose
Seizure activity can mimic acute stroke in both imaging findings and clinical presentation. Arterial spin labeling (ASL) is a noninvasive way to measure cerebral blood flow. The objective of this study was to evaluate the characteristics of ASL imaging in acute seizure.

Materials and Methods
Among a cohort of patients presenting with a brutal neurologic deficit addressed for suspicion of stroke in a national specialized stroke center, we retrospectively reviewed 10 cases of stroke-like proven seizures who underwent magnetic resonance imaging (MRI) with ASL perfusion at acute phase.

Results
Hyperperfusion (High relative cerebral blood flow) was found in the cortical epileptogenic zone in eight patients with seizures. With correlation with electroencephalography and clinical findings. Additionally, four patients had a hyperperfused area in the homolateral pulvinar, and one patient had a hyperperfused area related to cerebellar diaschisis. Underlying causing lesions were found in seven cases (ischemic sequelae n = 4, glioblastoma n = 2, subdural hematoma n =1). Associated diffusion abnormalities were found in six cases.

Conclusions
High cerebral blood flow in ASL can be seen in in the cortical epileptogenic zone, in the homolateral pulvinar and in contralateral cerebellum (cerebellar diaschisis) of patients with acute seizure. The mechanism of hyperperfusion due to seizure activity may be related to transient loss of autoregulatory function in the surrounding vasculature. Arterial spin labeling is useful in the differential diagnosis of acute neurologic deficits. This sequence complements the traditional evaluation with electroencephalography (EEG).

eP-21

ASL Perfusion Imaging as a Surrogate Marker of Intracranial In-Stent Stenosis in the Setting of Stent Assisted Coiling; A Pilot Study.

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¹Medical College of Wisconsin - Froedtert Hospital, Milwaukee, WI

Purpose
In-stent narrowing after stent assisted coiling of intracranial aneurysms is a known complication with an incidence of approximately 5% (1-3). While DSA is the gold standard for assessment, patients typically are followed by noninvasive imaging. Magnetic resonance angiography (MRA) evaluation of the stent lumen is inherently limited by metallic susceptibility artifact, giving the appearance of "pseudo-
narrowing." Noncontrast ASL perfusion imaging has been utilized on a case by case basis along with MRA as an indicator of in-stent narrowing. While this practice has been anecdotally beneficial, reliable longitudinal data is lacking. The purpose of this study is to objectively assess the adequacy of ASL perfusion imaging as a reliable surrogate marker for flow limiting in stent narrowing in patients who have undergone stent assisted coiling of intracranial aneurysms.

Materials and Methods
A retrospective medical record review including patients imaged between 1/1/2006 and 4/15/2015 was approved by the internal review board of the investigating institution. Subjects were identified by searching the clinical MR radiology reports for the terms "arterial spin labeling" or "ASL," "stent" and "coil." Data collected from the subjects' medical records included age, gender, vascular comorbidities and aneurysm risk factors. The date and details of the coiling procedures were recorded, as were the dates and results of follow-up noninvasive and conventional angiographic evaluations. Arterial spin labeling and MRA evidence for in-stent stenosis reported in final interpretations were compared with conventional angiographic results. A time interval between magnetic resonance angiography (MRA) and digital subtraction angiography (DSA) evaluations of less than 12 months was considered relevant.

Results
Ninety-nine studies met the search criteria. Twenty-nine of the 99 were excluded, leaving 70 for analysis in 61 patients. Forty-two of the 70 included studies had DSA follow up, 25 of which were completed within 12 months of MRA evaluation. The performance of ASL and MRA for assessment of in stent stenosis as determined by DSA is outlined in Table I. Two of the three false negative ASL exams were explainable by circle of Willis collateral flow. The third false negative showed 35% narrowing at DSA. One of the two false positive ASL exams was explainable secondary to atherosclerotic disease adjacent to the stent. The second false positive was taking clopidogrel for 2 months between the ASL/MRA and DSA; the effect of interval therapy on the stent lumen is unknown. Performance adjusted for ASL false negatives that would not have clinical implications (i.e., collateral flow) is also outlined in Table I. Magnetic resonance angiography evaluation was inherently sensitive, although not specific, as most reports discussed narrowing versus pseudo-narrowing.

Conclusions
This retrospective clinical pilot study suggests that traditional MRA for in stent narrowing has a poor accuracy due to artifact-induced pseudo-narrowing. When controlling for confounding false negative variables that would not have clinical implications, ASL accuracy and negative predictive value approach 90%. The data suggests that downstream perfusion assessed by ASL is a reasonable surrogate of in stent narrowing.

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¹The Research Institute of Clinical medicine, Tbilisi, Georgia, ²Institute of Clinical Medicine, Tbilisi, GA

Purpose
To assess the prevalence of asymptomatic carotid artery stenosis (CAS) in male patients with lower extremity atherosclerosis.

Materials and Methods
Seventy-eight patients mean age 64.6±11.7 years) with symptomatic PAD underwent color Doppler investigation (CDUS) and multidetector computed tomography (CT)angiography (MDCT) of extracranial and aorto-iliac with lower extremity vessels. By CDUS and MDCT the extent, size, type of plaques were assessed. Plaques were classified as soft, intermediate, calcified.

Results
A total 78 of patients had PAD stenosis as detected with MDCT. Stenosis were

<table>
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<tr>
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<th>ASL</th>
<th>MRA</th>
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<td>True Positive</td>
<td>3</td>
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<tr>
<td>Accuracy</td>
<td>80.0%</td>
<td>40.0%</td>
<td>88.0%</td>
</tr>
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Table I: ASL versus MRA in assessment of in-stent narrowing after stent assisted coiling of an intracranial aneurysm as determined by DSA. ASL results were adjusted for false negatives that would have no clinical implication (circle of Willis collaterals).
predominantly located at the aorto-iliac and femoral segments of lower extremities. The chief compliant of PAD patients was claudication 70 (90%), rest pain 5 (6%), ischemic ulcer or gangrene 3 (4%). The mean Ankle-brachial Index (ABI) was 0.76; In 65 (77%) patients presence of CA atherosclerotic plaques were detected. Carotid artery stenosis >50% were detected in 16 (20%) patients. There was an excellent agreement between MDCT and CDUS in the detection of CA stenosis. The presence of carotid plaques and their extension was not correlated with the severity of lower extremity ischemia. The prevalence of calcified CA plaques was observed among patients with extent of PA multisegmental changes. A significant increase of common carotid artery intima-media thickness (IMT) was observed among patients with multisegmental PAD-1.18±0.07mm.

Conclusions
Color Doppler ultrasound study including carotid IMT measurement and plaque structure evaluation may be an effective tool in the screening of patients with PAD. Complex use of CDUS and MDCT gives valuable information about multifocal atherosclerotic changes in patients with PAD.

eP-123

Attenuation Differences in Subdural Effusion and Acute Subdural Hematoma Following Administration of Iodinated Contrast

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Purpose
Blunt head trauma can result in acute subdural hematoma (SDH) and subdural hygroma (SDG), which can be distinguished by their differential attenuations on noncontrast CT (NCCT) brain (1, 2). Trauma patients also may present with pre-existing subdural effusions (SDE), which may be overlooked on initial review due to their low attenuation and chronicity. In addition to NCCT brain, many trauma patients undergo contrast-enhanced computed tomography (CECT) for other injuries. As contrast extravasates into SDE (3, 4, 5), enhancing SDE may be misdiagnosed as acute SDH, prompting unnecessary repeat imaging or intervention. The purpose of this study was to characterize SDE enhancement and determine whether NCCT could differentiate SDE from acute SDH after contrast administration.

Materials and Methods
A retrospective review was performed of 34 patients with SDE on baseline NCCT brain, who then underwent CECT followed by repeat NCCT brain within 24 hours.
The attenuation and size of SDE, synchronous acute SDH (if present), and intraventricular CSF were measured on NCCT brain before and after contrast administration. The studies were stratified by time (precontrast, 3-8.5 hours since contrast, and 8.5-24 hours since contrast), given the tendency to reimage at 8 hours and 12-24 hours.

Results
There is significant enhancement of SDE between precontrast and 3-8.5h postcontrast NCCT brain (p<0.01; Table 1). However, SDE and SDH demonstrate significantly different attenuation on precontrast, and 3-8.5h and 8.5-24h NCCT brain (all p<0.01). There was no significant change in size of SDE (axial short axis: 6.3 mm precontrast, 6.5 mm at 3-8.5h, and 7.7 mm at 8.5-24h; all p>0.1).

Conclusions
Repeat NCCT brain is obtained routinely in the trauma setting. Enhancement of SDE can be seen following relatively low doses (<150 mL Omnipaque 350) of contrast used in CECT. While SDH and SDE both demonstrate enhancement and washout within 24 hours of contrast administration, acute SDH remains significantly greater in attenuation than SDE throughout. In order to avoid mistaking enhancing SDE for interval acute SDH, it is important to account for recent contrast administration when interpreting subdural collections on NCCT brain.
Table 1. Comparison of mean attenuation of CSF, SDE and acute brain before and after the administration of iodinated contrast.

<table>
<thead>
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<th></th>
<th>CSF</th>
<th>SDE</th>
<th>Ac</th>
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</thead>
<tbody>
<tr>
<td>Pre-Contrast</td>
<td>6.8 (2.0)</td>
<td>21.1 (8.5)</td>
<td>61.4</td>
</tr>
<tr>
<td>3-8.5h After Contrast</td>
<td>7.8 (1.9)</td>
<td>46.7 (12.2)</td>
<td>74.3</td>
</tr>
<tr>
<td>(mean=5.8h)</td>
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<td></td>
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<tr>
<td>8.5-24h After Contrast</td>
<td>7.7 (2.5)</td>
<td>33.5 (11.6)</td>
<td>69.5</td>
</tr>
<tr>
<td>(mean=14.9h)</td>
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</table>
Automated Real-Time Quantitative Imaging of Total Cerebral Blood Flow by Phase Contrast MRI

N Alperin¹, A Bagci¹, S Lee¹, N Jin²
¹University of Miami, Miami, FL, ²Siemens Healthcare, Columbus, OH

Purpose
Cine phase contrast (PC) magnetic resonance imaging (MRI) is a well established method to visualize and quantify pulsatile flow. However, pulsatile waveforms obtained using cine PC are an average cycle reconstructed using data acquired over multiple heartbeats. Therefore, this methodology is limited for real-time dynamic imaging and for determining physiologic beat-to-beat variations due to respiration or other manipulations. This work employed a recently developed real-time (RT) cine PC sequence to demonstrate the feasibility of automated real-time measurement of total cerebral blood flow (tCBF) by MRI. A pulsatility based segmentation (PUBS) was employed to overcome the challenge of automated vessel lumen segmentation in the lower image quality and spatial resolution associated with RT PC. Real-time measurements of tCBF were compared with measurements obtained with conventional cine PC.

Materials and Methods
Magnetic resonance imaging data from two healthy subjects was obtained using 3T scanner (Skyra, Siemens Healthcare). Total cerebral blood flow (CBF) was obtained by summation of volumetric flow rate through the internal carotid and vertebral arteries. Automated segmentation of these lumens was achieved using the PUBS method which incorporates temporal information in each voxel to differentiate lumen pixels from background pixels. Real-time PC imaging was achieved with echo planar imaging readout, parallel acceleration in the temporal direction, and shared velocity encoding. Imaging parameters include FOV of 172x196cm, acquisition matrix of 144x96, TR/TE of 129/9.6ms, VENC of 90cm/sec, and acceleration factor of 3. Conventional cine was acquired with higher temporal and spatial resolutions using TR/TE of 44/6ms and in-plane resolution of 0.5mm. Individual cardiac cycles were automatically identified by locating the onset of systole, which corresponds to the location of highest rate of increase in the flow rate. Total CBF and flow amplitude were calculated for each heartbeat.

Results
Plots of the RT CBF waveform (blue) and the mean CBF in each heartbeat (red) are shown together with a representative cardiac cycle obtain using the conventional cine
PC. The mean (SD) values of tCBF measure for this subject were 572 (47.7) mL/min versus 646 mL/min obtained using the conventional cine. The mean (SD) value of the peak-to-peak flow amplitude obtained using the RT cine were 499 (51.5) mL/min, with a range of 368 to 602 mL/min versus 559 mL/min with the conventional cine. Similar correspondence between the RT and the conventional cine measurements were found for the second subject. On average mean RT tCBF values were 11% lower than values obtained with conventional cine. Frequency analyses did not reveal respiratory modulation of tCBF.

Conclusions
The feasibility of automated dynamic measurements of total CBF by MRI has been demonstrated. While RT CBF measurements are slightly lower than flow rates obtained with conventional cine, likely due to lower resolutions, this small difference is well within normal fluctuations at rest. Dynamic quantitative RT imaging of CBF opens possibilities for new paradigms for interrogation of the cerebral hemodynamics.

(Filename: TCT_eP-112_TCBF_waveforms2.jpg)

eP-109

6:30AM - 2:45PM

Automating the Parametric Response Map Provides Treatment Response Biomarker for Routine Clinical Use

X Guo¹, L Keith², D Guest³, C Galban³, T Chenevert³, B Zhao¹, B Ross³
Purpose
Parametric response mapping (PRM) of serially acquired quantitative diffusion-weighted magnetic resonance imaging (MRI) scans (PRMADC) has been shown to provide an early, quantitative biomarker of treatment response for high-grade glioma (1). Routine clinical implementation of PRMADC will require software that can be automated and seamlessly integrated into the neuroradiological workflow. We present results evaluating our PRM software that meet the objective of a semi-automated biomarker.

Materials and Methods
Magnetic resonance imaging data from 49 glioma patients with high-grade glioma were used. Diffusion and post-contrast T1-weighted scans from pretreatment and 3 weeks post-treatment initiation were used to determine the effect of using semi-automated tumor segmentations on PRMADC predictive performance. The tumor segmentation algorithm was performed on the postcontrast T1-weighted images and was initiated by a 2D seed region of interest (ROI). Volumetric segmentation of the contrast-enhancing tumor was calculated automatically from the seed ROI based on region- and edge-based active contour models (2). The percent of tumor volume classified as increased ADC was used to predict 1-year survival. For comparison PRMADC results also were calculated using neuroradiologist drawn tumor contours.

Results
An ROC curve was generated (Fig. 1) which showed similar predictive performance between PRMADC results calculated using manual and automated tumor contours. The results in Table 1 confirm that predictive performances were similar. Additionally, both PRMADC methods (manual and automated) performed at 3 weeks after treatment initialization have predictive performance superior to the Macdonald criteria performed at 10 weeks post-treatment initialization.

Conclusions
The treatment response biomarker PRMADC can be generated using an integrated and automated software application. We anticipate that this advance will provide for practical implementation and use of this imaging biomarker in the time constrained clinical environment. With the goal of advancing the PRMADC imaging biomarker for the management of glioma patients, these results reveal the potential for full automation within the clinical workflow.
(Filename: TCT_eP-109_Figure.png)

eP-12

6:30AM - 2:45PM

L LUNA¹, C KÖHLER¹, B DE FREITAS¹, A CARVALHO¹
¹FEDERAL UNIVERSITY OF CEARA, FORTALEZA, CEARA

Purpose
Bipolar disorder (BD) is associated with a variety of genetic polymorphisms but little is known about how it interferes with the disease's pathophysiology. A systematic review of original studies was conducted to examine the association between the genetic polymorphisms and both structural morphometry and functional magnetic resonance imaging (MRI) findings.

Materials and Methods
Pubmed/Medline, PsycInfo, EMBASE and Scopus databases were searched for studies from inception to June 2015. Two independent viewers assessed the eligibility of each report based on predefined inclusion criteria (DSM or ICD diagnosis of BD, structural and BOLD functional MRI data, genetic findings correlations).

Results
Of 3374 abstracts reviewed, 193 studies met the inclusion criteria, of which 25 had appropriate data for extraction. There were 13 structural imaging and 12 BOLD functional magnetic resonance imaging (fMRI) studies (15 and nine different genes, respectively). The results of the review detail the different brain structures involved. Marked heterogeneity is shown, partly explained by the methods.

Conclusions
We have systematically revised the MRI structural and functional findings associated with genetic polymorphism in BD. This methodical approach will simplify the existing concepts of methods in genetic neuroimaging and lead us toward the development of better diagnostic tools.

eP-60

Brain MR imaging findings of cardiac type Fabry disease with an IVS4+919G>A mutation

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¹Taipei Veterans General Hospital & National Yang Ming University, Taipei, Taiwan, ²Taipei veterans general hospital, Taipei, Taiwan

Purpose
A high incidence of cardiac type Fabry disease with a GLA mutation, IVS4 + 919
G>A, has been identified in the Taiwanese population. The neurological manifestation has not been understood in this specific cardiac variant. This study aimed to investigate the typical imaging features of classical Fabry disease in patients of IVS4 Fabry disease.

Materials and Methods
Twenty-six patients of IVS4 type Fabry disease (20 males and 6 females; age ranges 43 – 71 years; median, 61 years) and 26 age- and sex-matched normal controls (age ranges 44 – 68 years; median, 60 years) were analyzed for white matter hyperintensities, the pulvinar sign, and basilar artery diameter. The volumes of white matter hyperintensities were calculated by comparison with an in-house database of 276 controls.

Results
Infarctions were found in nine patients with IVS4 Fabry disease (35%) and in none of normal controls (P = 0.001). A pulvinar sign was found in eight patients with IVS4 Fabry disease (30%) and in none of the normal controls (P = 0.002). No significant difference was found in Fazekas scores for white matter hyperintensities; however, white matter hyperintensity volume in the deep white matter was higher in patients with IVS4 Fabry disease than in those from the normal control database (P = 0.004).

Conclusions
Along with its involvement of the cardiac system, IVS4 type Fabry disease had similar features as classical Fabry disease and presented higher frequency of deep white matter hyperintensities, a higher incidence of infarctions and pulvinar signs than normal controls.
Cerebellar Tumors in Adults: MR Imaging Findings and Differential Diagnoses

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¹Kumamoto University, Kumamoto, Japan

Purpose
Cerebellar tumors are rare in adults and the major differential diagnoses are metastatic tumor and hemangioblastoma (1). Although other tumors such as gliomas and primary central nervous system lymphomas (PCNSLs) can arise in the cerebellum, due to their rarity, the radiological findings on cerebellar tumors other than hemangioblastomas have not been evaluated fully. The purpose of this study was to evaluate characteristic MR findings on various cerebellar tumors in adults.

Materials and Methods
The electronic medical records and PACS databases from January 2000 to October 2015 were searched for adult patients with solitary cerebellar tumors.

Results
We found 43 patients with histologically or clinically diagnosed cerebellar tumors. These were 13 hemangioblastomas, 11 metastatic tumors, eight glioblastomas, three anaplastic astrocytomas, three PCNSLs, two pilocytic astrocytomas, and one medulloblastoma, ependymoma, and low-grade astrocytoma. Of the 13 hemangioblastomas, nine (69.2%) had a cystic component, seven (53.8%) exhibited a flow void and extensive peritumoral edema, and three (23.1%) were ring-enhanced. All metastatic tumors showed inhomogeneous enhancement and no flow voids. The enhancement patterns of glioblastomas varied widely and included slight enhancement. The extension of peritumoral abnormal intensity of glioblastomas was more localized than of hemangioblastomas and metastatic tumors. One glioblastoma and one anaplastic astrocytoma showed diffuse infiltrative tumor extension and one pilocytic astrocytoma and the ependymoma were ring-enhanced. All PCNSLs exhibited homogeneous enhancement. The ADC of the solid portion of the hemangioblastomas (mean 1.79 x 10^-3 mm²/s) was higher than of metastatic tumors (mean 1.05 x 10^-3 mm²/s) and glioblastomas (mean 1.16 x 10^-3 mm²/s). In two glioblastomas there was an increase in the cerebral blood volume in the nonenhanced area.

Conclusions
A systematic interpretation and familiarity with the characteristic MR findings and their variations are required to narrow the differential diagnosis of cerebellar tumors in adults.
Cerebrovascular Stroke Reporting: Comparison of Neuroradiology Trainee and Faculty Interpretations, an Institutional Review.

S PAMARTHY1, J Ulmer2, M BHALLA2, A Klein2, S Quinet2, L Mark2, N ALAM1, K McAvoy1

1MEDICAL COLLEGE OF WISCONSIN, MILWAUKEE, WI, 2Medical College of Wisconsin - Froedtert Hospital, Milwaukee, WI

Purpose
Diagnostic interpretation of cerebral stroke imaging entails significant attention to the details and complexity of computed tomography (CT) and magnetic resonance imaging (MRI). Our study seeks to evaluate the impact of level of training and experience on the quality of stroke imaging interpretation. Data may be used to supplement and enhance the six ACGME core competencies required of trainees; specifically patient care, medical knowledge, practice-based learning/improvement and systems-based practice. Results may have a greater implication in overall improvement of patient outcomes alongside development of refined neuroradiology training methodologies.

Materials and Methods
Faculty and trainee interpretations from 105 CT and 57 MRI examinations in patients evaluated for cerebrovascular ischemia were reviewed retrospectively. The interpretations provided by trainees in preliminary reports ("wet reads") were compared to the final reports issued by board certified neuroradiology faculty (Fig. 1). Results were analyzed to discern reporting patterns based on level of training and experience.

Results
Forty-seven percent of patients receiving a CT and 46% of patients receiving MRI ultimately were diagnosed with stroke. The specificity of MRI in diagnosing stroke was similar to that of CT, but vastly superior in sensitivity, negative predictive value (NPV) and accuracy (Fig. 1). There was no difference in interpretation sensitivity, specificity, NPV, positive predictive value (PPV) and accuracy between faculty and trainees at various levels of experience (Figs. 2, 3). The poor performance of CT is due primarily to its lack of sensitivity and the high accuracy of MRI is due to its high sensitivity in diagnosing acute stroke.

Conclusions
While subspecialty neuroradiologists may provide higher quality reporting in neurological disease, the accuracy of diagnostic reporting of acute cerebrovascular
ischemia was not influenced by level of training in this pilot study. Emergency radiology reporting of acute stroke by trainees may reliably be used by clinicians as a preliminary guide to patient management in the emergency setting.

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eP-38

6:30AM - 2:45PM

Changes in Permeability Detected by DSC Perfusion MRI Predict Survival in Recurrent Glioblastoma Treated with Bevacizumab

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¹Hospital 12 de Octubre, Madrid, AK, ²Hospital 12 de Octubre, Madrid, Spain, ³Hospital 12 de Octubre, madrid, Spain, ⁴Hospital 12 de Octubre, Madrid, Madrid

Purpose
In glioblastoma, tumor progression appears to be triggered by expression of VEGF, a regulator of blood vessel permeability. Bevacizumab is a monoclonal antibody that inhibits angiogenesis by clearing circulating VEGF, resulting in a rapid decline in the contrast-enhancing tumor, which does not always correlate with treatment response. Our objectives were: 1) to evaluate whether early changes in dynamic susceptibility
contrast (DSC) perfusion magnetic resonance imaging (MRI) derived permeability could predict survival in recurrent glioblastoma, and 2) to estimate whether permeability at baseline was related to treatment outcome.

Materials and Methods
We retrospectively analyzed DSC perfusion MRI in 24 recurrent glioblastomas treated with bevacizumab as second line chemotherapy. Leakage at baseline and changes in maximum leakage between baseline and the first follow-up after treatment were selected for quantitative analysis. Survival univariate analysis was made constructing survival curves using Kaplan-Meier method and comparing subgroups by log rank probability test. A Cox regression model was made for multivariate analysis.

Results
The study included 24 glioblastomas (mean follow up of 11.77 months). Leakage reduction at 8 weeks after initiation bevacizumab treatment had a significant influence on overall and progression-free survival. Median overall and progression-free survival was 2.4 and 2.8 months longer for patients with leakage reduction. Higher leakage at baseline was associated to leakage reduction after treatment and therefore to longer overall and progression-free survival. Multivariate analysis revealed that patient age and leakage were associated independently with overall survival.

Conclusions
Decrease in microvascular permeability predicts overall and progression-free survival in recurrent glioblastomas treated with bevacizumab. Leakage reduction and age also were independent predictors of overall survival, postulating leakage reduction as a potential biomarker for treatment response evaluation. Leakage at baseline predicts response to treatment, but was not associated independently with neither overall nor progression-free survival.

eP-46

Clinical Audit of Head CT in Stroke Alert Cases: Role of Radiology Resident and CT Technician Awareness in improving Head CT reporting time

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Purpose
To reduce time taken to report Head computed tomography (CT) for stroke alert cases by increasing radiology resident and technician awareness. To improve adherence to the National Institute of Neurological Disorder and Stroke (NINDS) critical time goals for Head CT reporting time in stroke alert cases.

Materials and Methods
Audit of time between completion of Head CT and informing the clinical team was
performed within the Department of Radiology between 3/21/12 to 9/5/12. Average
time to report was 11 minutes. Reporting time range was from 2 minutes to 33
minutes with median value of 10 minutes. Although average time adhered to NINDS
critical time goals but was more than our hospital target of 10 minutes. In one case the
reporting time of 33 minutes was more than NINDS goal of 20 minutes. Discussions
were held among residents and attending radiologists and reason for above results was
thought to be lack of awareness of hospital stroke policy and NINDS goals. Therefore,
we aimed to improve the reporting time by making residents and CT technologist
aware of hospital policy and NINDS goals. Audit of time between completion of Head
CT and informing the clinical team was again performed 9/13/12 to 2/9/13 and
average and median reporting times were reassessed.

Results
By educating residents about stroke treatment outcomes and enforcing strict
guidelines about timely reporting, we were able to bring down Head CT reporting
time in stroke patients from average of 11 minutes to 8 minutes and range from 2-33
minutes to 1-17 minutes. This resulted in strict adherence to National Institute of
Neurological Disorder and Stroke critical time goals.

Conclusions
In our study, awareness about NINDS critical time goals and enforcing strict
guidelines about timely reporting, we were able to bring down Head CT reporting
time in stroke patients from average of 11 minutes to 8 minutes and range from 2-33
minutes to 1-17 minutes resulting in strict adherence to National Institute of
Neurological Disorder and Stroke critical time goals and thus betters patient care as
early treatment in stroke patients has been confirmed as key to recovery in large
randomized controlled clinical trials.

**eP-101**

6:30AM - 2:45PM

**Clinical Evaluation of Silent MRI and MR Angiography based on Rapid Radial
Acquisition**

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**Purpose**
Recently, new sequences based on rapid radial acquisition have shown to reduce the
gradient noise associated with magnetic resonance imaging (MRI) (1). Here we
compared the silent T1 post-contrast and MR angiography (MRA) against
conventional sequences for image quality, motion artifacts, and reader preference
comparing silent T1 postcontrast and MR angiography (MRA) with conventional
sequences.
Materials and Methods
The study cohort consisted of: (1) T1 postcontrast imaging in 40 patients with known or suspected brain metastases, and (2) noncontrast intracranial MRA in 51 patients with suspected vascular lesions or cerebral ischemia. Three board-certified neuroradiologists reviewed the images blindly, and rated visual blurriness, signal-to-noise ratio, lesion conspicuity, and motion artifact on a 5-point Likert scale (1=nondiagnostic to 5=excellent). The number of enhancing lesions was recorded for the T1 postcontrast images. After image review, each reader was asked whether they preferred silent or conventional images, or whether they were equivalent.

Results
For T1 postcontrast imaging, the mean ratings were lower for silent imaging versus conventional imaging. On average, slightly more lesions were detected on conventional imaging, however this was not statistically significant, and the two methods agreed in 88% of cases. Most scans (49%) were deemed equivalent, but when a preference existed, it was more commonly for the conventional images (37% versus 14%), primarily due to the better contrast-to-noise and spatial resolution of the conventional sequence. Readers also preferred the conventional MRA images compared with silent imaging (69% conventional; 27% equivalent, 4% silent). In some cases, image artifacts leading to reduced vessel caliber, artificial vessel irregularities, or even absent vessels was noted on the silent images.

Conclusions
Conventional T1 postcontrast and noncontrast MRA sequences were preferred over current radial silent imaging techniques. This suggests additional refinement of the current silent technique would be desirable prior to its mainstream clinical application.
Comparison of Flat Detector Computed Tomography Angiography (FD-CTA) Using Intravenous and Intra-Arterial Contrast Injection in Evaluation of Intracranial Stents and Adjacent Arterial Segments with Digital Subtraction Angiography (DSA) as Gold Standard

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Purpose
Intracranial stents are now used commonly in treatment of aneurysms. Careful follow up is necessary to evaluate the stent patency as in-stent stenosis or residual stenosis is not uncommon. A minimally invasive follow-up imaging technique is always desirable. The aim of this study is to assess the visualization of intracranial stents and adjacent vessels in flat detector (FD)-computed tomography angiography (CTA) after intravenous (IV) contrast injection and compare it with the FD-CTA performed after direct intra-arterial (IA) contrast injection and digital subtraction angiography (DSA).

Materials and Methods
This retrospective study was approved by our institutional research ethics board (REB). Thirty patients with intracranial stents for aneurysm treatment underwent DSA and FD-CTA after intravenous and intra-arterial contrast injection. The image data were evaluated by two experienced readers in consensus for the visualization of the cerebral arterial segments on a 5-point scale (0- vessel cannot be distinguished; 4- excellent image quality). Measurements of the inner and outer diameter and cross section area of the stents were performed. Stenosis was graded as per 3-point scale (0- patent, 1- stenosis and 2- occluded). The Wilcoxon signed-rank test was used for statistical analysis. P < 0.05 was considered to indicate a significant difference.

Results
There was no significant difference in subjective evaluation of the stents on both FD-CTA techniques compared to DSA. No statistical difference in stenosis grading of IV and IA FD-CTA. The depiction of adjacent cerebral arterial segments with both intravenous and IA FD-CTA techniques is comparable.

Conclusions
The results suggest that the visualization of cerebral arteries and stents using noninvasive intravenous FD-CTA compares favorably with IA FD-CTA and DSA.
Comparison of MR-permeability imaging from C-11 methionine PET in differentiating radiation necrosis from recurrent metastatic tumors of the brain after gamma knife radiosurgery

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Purpose
MR-permeability imaging was compared with positron emission tomography (PET) using C-11 methionine (MET) in differentiating radiation necrosis from recurrent tumors in patients with metastatic brain tumors after gamma knife radiosurgery.

Materials and Methods
The study was performed for 19 lesions from 16 patients with metastatic brain tumors who underwent gamma knife radiosurgery. Ten lesions were identified as recurrent tumors by surgery after both MR-permeability imaging and MET-PET. Nine lesions were diagnosed as radiation necrosis because of a lack of change or a decrease in size by >4 months after radiosurgery. Methionine-PET was performed immediately before PET using F-18 fluorodeoxyglucose (FDG-PET) on the same day. After CT, MET was injected and MET-PET was performed 20 min later. Fluorodeoxyglucose FDG-PET was injected 60 min after MET-PET. MR-permeability imaging and diffusion-weighted imaging (DWI) were performed within 1 week before or after PET.

Dynamic contrast-enhanced (DCE)-MRI was acquired using gadolinium contrast medium. A 3-dimensional fast spoiled gradient echo sequence was applied for DCE-MRI. Dynamic contrast-enhanced data were analyzed using commercially available software with the general kinetic model based on a two-compartment model. The transfer constant between intra- and extravascular and extracellular spaces (Ktrans), the extravascular extracellular space (Ve), the transfer constant from the extracellular extravascular space to plasma (Kep), initial area under the signal intensity-time curve (IAUGC), and contrast enhancement ratio (CER) were calculated after setting a region of interest on the solid portion of the lesion. The minimum apparent diffusion coefficient (ADCmin) also was acquired from diffusion-weighted imaging (DWI). On both MET-PET and FDG-PET, the ratio of the maximum standard uptake value (SUVmax) of the lesion divided by the SUVmax of the symmetrical site in the contralateral cerebral hemisphere was measured (MET-ratio and FDG ratio, respectively). Receiver operating characteristic (ROC) analysis was performed to evaluate the utility of those parameters for differentiating radiation necrosis from recurrent tumors.

Results
Area under the ROC curve (AUC) for differentiating radiation necrosis from recurrent
tumors was highest for MET-ratio (0.87) followed by CER (0.80), IAUGC (0.78), Ktrans (0.73), Ve (0.65), ADCmin (0.60), Kep (0.58), and FDG ratio (0.53). The cutoff value for the best combination of sensitivity and specificity was 1.38 with MET ratio, 0.61 with CER, 0.08 with IAUGC, 0.05 with Ktrans, 0.27 with Ve, 0.73 with ADCmin, 0.32 with Kep, and 0.98 with FDG ratio. Significant difference (p<0.05 each) in MET ratio, CER, and IAUGC were evident between radiation necrosis and recurrent tumor.

Conclusions
Methionine-PET is superior to MR-permeability imaging, ADC, and FDG-PET in differentiating radiation necrosis from recurrent tumors after gamma knife radiosurgery for metastatic brain tumors. In MR-permeability imaging, CER and IAUGC are superior to other parameters of MR-permeability imaging.

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eP-108

6:30AM - 2:45PM

Comparison of MRA Techniques for Calcification Detection

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Purpose
There has been increased attention on intracranial vascular calcifications, with evidence that there is increased association with prior/future infarcts and dementia (1-3). Thin-slice computed tomography (CT) is the reference standard for calcification, however considering concerns over radiation exposure, there is value of magnetic resonance imaging (MRI) for this evaluation. Typically with MR, TOFMRA is employed for calcification detection. SNAP (4) is a technique that produces a bright blood MRA and heavily T1-W image for detection of intraplaque hemorrhage. SNAP also contains a PDW reference (Ref), which provides an opportunity for the evaluation of plaque outer boundary and wall calcifications. This study evaluates the ability of SNAP Ref to detect intracranial artery wall calcifications compared 3DTOFMRA relative to thin-slice CTA.

Materials and Methods
Consecutive subjects with CTA, TOFMRA and SNAP imaging of the brain were included. A blinded review was performed by a neuroradiologist with consecutive Ref sequences reviewed in random order followed by TOFMRA and finally CTA images in consecutive days. The arterial segments that were evaluated individually: cavernous, ophthalmic, suprachinoid and terminal ICA, M1 middle cerebral, A1 anterior cerebral, P1 posterior cerebral segments on the right and left and the basilar artery. Sensitivity and specificity for detecting calcification per vessel was computed for SNAP and TOFMRA using CT as the reference. Agreement with CT was assessed using unweighted Cohen's kappa and linearly weighted Cohen's kappa for both SNAP and TOFMRA. Agreement was assessed for presence/absence of calcification per vessel and calcification size category per vessel (none, <50% circumferential involvement and >50% circumferential involvement) based on previously established evaluation (5). Diagnostic performance and agreement metrics were compared between SNAP and TOFMRA using the nonparametric bootstrap, to account for potential dependence between vessels from the same subject.

Results
Eleven subjects were included with 143 segments reviewed (basilar artery and bilateral cavernous carotid, supraclinoid carotid, carotid terminus, A1 and M1 segments). Fourteen segments were not evaluable on all modalities, leaving 129 segments available for analysis. Of the 11 subjects, seven had calcification identified in at least one intracranial segment on CT. Of the 129 vessels evaluated, 19% had calcification by CT, 22% by SNAP and 13% by TOF-MRA. Using CT as the reference standard, SNAP had higher sensitivity (75.0% versus 29.2%, p=0.01) and similar specificity (89.5% versus 90.5%, p=0.8) compared to TOF-MRA. SNAP also had higher overall agreement with CT for calcification presence/absence (kappa: 0.60 versus 0.22, p=0.01) and calcification size categories (weighted kappa: 0.61 versus 0.20, p=0.008) than TOF-MRA.
Conclusions
The utility of Ref images for the evaluation of intracranial calcifications is shown. In comparison to the typically used TOFMRA, Ref more accurately depicted intracranial arterial calcifications. When combined with the MRA and intraplaque hemorrhage SNAP, this technique can potentially provide first line luminal and vessel wall imaging information.

(Filename: TCT_eP-108_calcfigasnr.jpg)

eP-07
6:30AM - 2:45PM

Contemporary Use of Hybrid PET-MR Brain Imaging in Dementia

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Purpose
In this retrospective study, we wish to investigate if there is additive value in simultaneously acquired fluorodeoxyglucose (FDG) positron emission tomography (PET) - magnetic resonance imaging (MRI) in evaluating patients with dementia. Our goal is evaluating the frequency and clinical significance of incidental findings which would not have been recognized on FDG PET or HMPAO-SPECT. Neuroanatomy is evaluated best with MRI and detection of additional findings may lead to a change in clinical management. The anatomical detail with simultaneously acquired FDG PET-MRI not normally obtained with PET- computed tomography (CT) can help localize areas of interest, improve diagnostic accuracy, and provide precise anatomical correlation in hypermetabolic/hypometabolic areas which may represent an underlying cause of patient symptoms.
Materials and Methods
An experienced nuclear radiologist and neuroradiologist retrospectively reviewed 38 FDG PET-MRI scans of the brain on male and female patients evaluated for dementia that were performed at Stony Brook University Medical Center over the past 2 years from 7/13/13 through 7/15/15. Electronic medical records were reviewed to evaluate incidental findings, their significance, and management outcomes. Positron emission tomography (PET)-MRI data then were evaluated to determine correlation between incidental findings and patient presentation.

Results
Thirty-eight patients, 19 male and 19 female, with mean age of 61.1 years, underwent FDG PET-MRI scans of the brain for dementia. FDG PET findings identified 10 patients with no abnormal distribution, 10 with PET pattern consistent with Alzheimer disease (26%), three with Lewy Body dementia (8%), eight with frontotemporal dementia (21%), one with corticobasal degeneration (3%), three with mesial temporal sclerosis (8%), two with semantic dementia (5%), and one with Creutzfeldt-Jakob disease. The corresponding areas of hypometabolism were delineated more accurately on MRI in comparison to PET-CT. Magnetic resonance imaging cortical findings suggestive of Alzheimer disease were identified in eight of 10 patients (80%), Lewy Body dementia in three of three patients (100%), frontotemporal dementia in six of eight patients (75%), semantic dementia in two of two patients (100%), and Creutzfeldt-Jakob disease in one of one patients (100%). Eleven patients had mild chronic small vessel changes and 15 with moderate or severe chronic small vessel changes. Of the 15 patients with moderate or severe chronic small vessel changes, 10 had no abnormal FDG PET findings suspicious for vascular dementia (66%) and two (13%) had findings consistent with normal pressure hydrocephalus. Magnetic resonance imaging also identified three old cerebellar infarcts, one posterior cerebral artery aneurysm, and a temporal lobe contusion. Additional extra-axial MRI findings included two patients with unknown parotid lesions and one with an enlarged pituitary gland.

Conclusions
Fluorodeoxyglucose PET-MRI of the brain increases diagnostic confidence, limits radiation compared to PET-CT, and provides more comprehensive information not normally obtained on PET-CT in patients evaluated for dementia. It can be used to distinguish the myriad of comorbidities contributing to patient symptoms and incidental findings in which further follow up is warranted.

6:30AM - 2:45PM
Contrast Enhanced Susceptibility Weighted Imaging of Glioma

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Purpose
To describe the role of contrast-enhanced susceptibility-weighted imaging (CE-SWI) in grading and characterization of glioma pre and post-treatment.

Materials and Methods
Contrast-enhanced SWI of patients with different histologically grades of glioma were analyzed retrospectively by grading the intratumoral susceptibility signal (ITSS) and tumoral margin. The ITSS is scored on a four grade system as described by Wang et al. The tumoral margin is scored on a three grade system as well defined, intermediate or poor. In a pictorial format we described the application of grading system in depiction of intratumoral neovascularity, hemorrhage/necrosis and defining the border invasion zone pre and post-therapy. These imaging features assisted in targeted open surgical biopsy, pre-operative estimation of histological grade and monitor response of therapy.

Results
Contrast-enhanced SWI assist in pre-operative of assessment tumoral grade/neovascularity and defining the border invasion zone in high grade glioma with greater conspicuity than standard postcontrast T1. In the postoperative setting, CE-SWI monitors intralesional hemorrhage/necrosis, radiation-induced microbleeds and response to anti-angiogenic therapy.

Conclusions
Contrast-enhanced SWI is a valuable tool in pre and postoperative assessment of glioma by providing internal tumoral vascular architecture, hemorrhage/necrosis and better depiction of tumor margin than standard postcontrast T1 sequence.

eP-33

6:30AM - 2:45PM

Correlation of CT and MR Perfusion Parameters for Intracranial Tumors

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Purpose
Perfusion imaging is now standard of care in brain tumor imaging, with magnetic resonance imaging (MRI) perfusion (MRP) as the standard method. Computed tomography perfusion (CTP) has been used primarily for the diagnosis of acute stroke, and is less studied as a method of characterizing brain tumors. The purpose of this study was to compare and establish equivalency between the two methods in the same patient population.
Materials and Methods
Patients presenting with a brain tumor to our institution between March 2014 and March 2015, underwent imaging with both CTP and MRP techniques. Correlation and linear regression of cerebral blood volume (CBV) and cerebral blood flow (CBF) values obtained with the two methods were performed. Comparison was completed using four different regions of interest (ROIs) measurements, including: whole tumor, solid portion, maximum perfusion and contralateral normal white matter.

Results
During the study period, 18 patients completed CTP and MRP, the majority with glioblastoma multiforme (13 patients). Overall the values obtained from MRP were smaller compared to that from CTP. There was a significant correlation between absolute CBV values in the region of maximum perfusion ($r = 0.49$, $p = 0.031$) and relative perfusion values of the whole tumor, rCBV ($r=0.25$, $p=0.02$) and rCBF ($r=0.49$, $p=0.01$). The maximum CBV on CTP could be predicted from MRP by the following equation, $CT = 5.39 + 0.49(MR)$. There was no significant correlation between other absolute or relative CBF or CBV values.

Conclusions
There is linear correlation between absolute CBV values obtained with CTP and MRP when measuring the region of maximum perfusion, but not when measuring the whole tumor or solid portion only. Caution should be used when extrapolating the results from MRP to CTP, and vice versa.

eP-90
6:30AM - 2:45PM

Correlation of imaging features on arterial spin labeling and digital subtraction angiography for vascular evaluation of meningiomas

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Purpose
Arterial spin labeling (ASL) imaging has emerged as a technique to evaluate cerebral blood flow (CBF) in tumors (1). Previous studies have shown a correlation between ASL signal associated with meningioma and tumor vascularity on histopathology (2, 3). However, to date, no direct correlation between features of meningioma on ASL and digital subtraction angiography (DSA) has been established. The purpose of this study is to determine if ASL signal associated with meningiomas correlates with the presence of vascular blush on DSA.

Materials and Methods
In this retrospective IRB-approved study, 32 meningiomas were identified in 27
patients who had MRI with ASL and DSA performed at our institution from January 2008 to October 2015. Two experienced readers drew a region of interest (ROI) around each tumor on postprocessed ASL images to obtain the cerebral blood flow (CBFT) value. Another ROI was drawn in the contralateral gray matter (CBFC) to obtain a normalized CBF ratio (CBFT/CBFC). Inter-reader reliability was calculated.

Results
Average lesion size was 6.1 cm^2. For reader 1, mean CBFT was 92.1±81.1 mL/100g/min and mean CBFT/CBFC was 2.20±2.38. For reader 2, mean CBFT was 102.6±73.6 mL/100g/min and mean CBFT/CBFC was 1.91±1.27. Inter-reader reliability was in near perfect agreement for tumor blush on DSA (k=0.93), very strong agreement for CBFT (r=0.84), and strong agreement for CBFT/CBFC (r=0.67). Both CBFT and CBFT/CBFC have a moderate linear relationship with blush (r =0.52, p<0.001 and r=0.47, p<0.001 respectively). Logistic regression showed that a threshold CBFT/CBFC=1.16 gives a 67% sensitivity and 78% specificity for presence of blush on DSA.

Conclusions
Increased ASL signal in meningiomas significantly correlates with presence of vascular blush on DSA. This is important because preoperative embolization of meningiomas is often performed in lesions demonstrating high vascularity on DSA (4). Arterial spin labeling may be a useful tool to predict which lesions may be seen on DSA and, thus, may be candidates for embolization.

Post-gad  
ASL

(Filename: TCT_eP-90 ASNRimage.jpg)
Cortical thinning in Multiple Sclerosis is associated with reduced Health-Related Quality of Life as measured by Patient Reported Outcomes.

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Purpose
Health-related quality of life (HRQoL) measures are a more comprehensive tool to assess the overall impact of multiple sclerosis (MS) on a patient's life than typically obtained disability scales such as the Expanded Disability Status Scale (EDSS) and Multiple Sclerosis Functional Composite (MSFC). Patients with MS experience reduced HRQoL, despite sometimes having normal or only mild impairment on neurologic examination. Cortical thinning occurs in MS patients compared to controls and correlates with clinical measures of disability (1). It is as of yet unknown if measures of HRQoL correlate with cortical thickness. Therefore, the aim of this study was to investigate the correlation between patient-reported outcome (PRO) measures of HRQoL and cortical thickness in MS.

Materials and Methods
Baseline cross-sectional analysis of 56 patients (41 females, 15 males; mean age 39 ± 9 years, range 18-56 years), 52 with relapsing remitting multiple sclerosis (RRMS) and four with clinically isolated syndrome (CIS) was performed as a post-hoc analysis of data from a recently completed clinical trial at the University of Colorado Denver. All patients underwent 3D T1-weighted imaging on a 1.5T MR scanner and completed the following PROs: Patient Determined Disease Steps (PDDS), Short-Form 36 Health Survey (SF-36), Modified Fatigue Impact Scale (MFIS), and Symptom Inventory Short Form (SI-S). Global and regional cortical thicknesses were measured using Freesurfer software version 5.0.0. Each hemisphere was divided by six regions as follows: frontal, parietal, temporal, occipital, insula and cingulate. Correlations between mean lobar cortical thickness and PRO scores were performed using partial correlation analysis, correcting for age and gender on SPSS version 23.0.

Results
Mean global cortical thickness was significantly correlated with physical component of SF-36 (SF-36 PC) (left hemisphere p=0.025, r=0.330; right hemisphere p=0.038, r=0.0307). The SF-36 PC score significantly correlated with mean cortical thickness of the left frontal lobe (p=0.010, r=0.377) and right frontal lobe (p=0.007, r=0.394). For PDDS, MFIS and SI-S, no significant correlations between mean cortical thicknesses and their scores were observed.
Conclusions
Certain aspects of HRQoL correlate with cortical thickness in various brain regions independent of age and gender. SF-36 PC scale had a positive correlation with cortical thickness of the bilateral frontal lobes. This underscores the known importance of gray matter atrophy in MS and may have a role in assessment of HRQoL in MS patients.

eP-118
6:30AM - 2:45PM
Crossed Cerebellar Diaschisis in Migraineurs with Aura Detected by Dynamic Susceptibility Contrast Perfusion MRI

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Purpose
Migraineurs have an increased risk of cerebellar infarctions, possibly due to hypoperfusion which can appear in the context of crossed cerebellar diaschisis (CCD). We investigated whether CCD can be found in migraineurs.

Materials and Methods
From 2011 to 2013 patients with symptoms suspicious of stroke with a final clinical diagnosis of an episode of migraine, were included if they had a magnetic resonance imaging (MRI) dynamic susceptibility-contrast (DSC) perfusion technique. Patients who demonstrated asymmetrical perfusion on visual assessment in the cerebral hemispheres were further quantitatively analyzed with sixteen regions of interest (ROIs) temporal, frontal, occipital and in the cerebellum. An asymmetry index (AI) was calculated for each ROI for the parameters time-to-peak (TTP), time-to-maximum (TMAX), and relative cerebral blood flow (rCBF). Crossed cerebellar diaschisis pattern was defined as AI >20% for rCBF in the cerebellum and at least three supratentorial ROIs.

Results
In 24 of 191 patients perfusion asymmetry was detected visually. All 24 had a diagnosis of migraine with aura. The rCBF pattern of CCD was found in 10/24 (41.6%) with concomitant prolongation of TMAX in 3/10 patients. Three additional patients had isolated prolonged TMAX without rCBF change. Cerebellar rCBF decrease ipsilateral to the supratentorial decrease was found in only 1/24 with concomitant prolongation of TTP. Time-to-peak did not show AI of >20% in any further cerebellar ROI.

Conclusions
Dynamic susceptibility contrast MRI demonstrated CCD in 41.6% of patients who
presented with supratentorial perfusion abnormalities in acute episodes of migraine with aura.

eP-121

CT Perfusion to Predict Complete Recanalization in Patients with Acute Ischemic Stroke

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Purpose
Complete recanalization is one of the main goals of endovascular stroke therapy and one of the most important determinants of clinical recovery (1, 2). In this study using preprocedural computed tomography perfusion (CTP), we aim to identify CTP parameters that can predict complete recanalization in patients with acute ischemic stroke who underwent mechanical thrombectomy.

Materials and Methods
Patients with acute ischemic stroke (AIS) who underwent CTP followed by catheter angiography and mechanical thrombectomy were included in this study. Computed tomography perfusion data was processed by Bayesian method to generate arterial tissue delay (ATD) maps at thresholds of delayed perfusion (Vol-ATD2sec), hypoperfusion (Vol-ATD 2sec-6sec) and critical hypoperfusion (Vol-ATD6sec). Using voxel-based analysis, the volumes of these thresholds were calculated in addition to corresponding cerebral blood volume (CBV) and cerebral blood flow (CBF). The degree of recanalization was identified on final run of conventional angiography using TICI grading, TICI 3 being indicative of complete recanalization. The association of perfusion biomarkers and status of recanalization was assessed by repeated measure of analyses and receiver operating characteristic (ROC) to determine the optimal parameters for predicting complete recanalization.

Results
Out of a total of 12 patients, seven (58%) had complete recanalization (TICI 3) using cerebral angiography. Logistic regression analysis identified hypoperfused tissue volume (Vol-ATD 2sec-6sec)(p=0.011) and hypoperfused tissue blood flow (Vol-ATD 2sec-6sec x CBF) (p=0.012) but not rCBF (p=0.12), Vol-ATD 2sec (p=0.9) or Vol-ATD 6sec (p=0.06), as predictors of complete recanalization. Receiver operating curve (ROC) analysis showed the greatest area under the curve (AUC) for hypoperfused tissue blood flow (Vol-ATD 2sec-6sec x CBF) with AUC of 0.96 at a threshold > 26.4, sensitivity/specificity of 86%/100%).
Conclusions
Preprocedural CTP parameters including Vol-ATD 2sec-6sec and Vol-ATD 2sec-6sec x CBF can be used to predict favorable outcome of complete recanalization in patients with AIS after mechanical thrombectomy.

eP-119

CT Permeability Imaging Predicts Clinical Outcomes in Acute Ischemic Stroke Patients Treated with Intral-arterial Thrombolytic Therapy.

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Purpose
To determine whether Ktrans maps, a permeability parameter indicating BBB dysfunction, combining with perfusion parameters, can identify the really ischemic penumbra and predict the clinical outcome in acute ischemic stroke.

Materials and Methods
Consecutive patients admitted with signs and symptoms suggesting acute hemispheric stroke. Ktrans maps were calculated from PCT data using prototype software, which uses the Patlak model to assess their BBBP. Then Ktrans maps were loaded into ImageJ 1.47 for Mac OS to draw the regions of interest (ROIs). The agreements between different groups were calculated using Chi-square tests. The radiological calculated both perfusion and Ktrans maps. Multiple logistic regression analyses and linear regression model were conducted to determine independent predictors of 90-day mRS and FUP-FIV, respectively.

Results
Of 98 patients, 46 were female. Mean age of all patients was 65.03±14.1 years. Patients with good outcome had less mean age, NIHSS, PCT-FIV, Ktrans-FIV, FUP-FIV P<0.001). Patients with poor outcome had higher mean SBP on admission (P=0.003) and less opportunity of successful recanalization (P=0.003). In regression analyses, Ktrans-FIV was the most powerful predictor of clinical outcome (P=0.009, OR=1.097), and also the best positive predictors for FUP-FIV (F=75.590, P<0.0001).

Conclusions
Combining PCT and Ktrans maps derived from first-pass of PCT can identify cerebral ischemic tissue at risk more precisely than using perfusion parameters alone.
eP-26

6:30AM - 2:45PM

CTA AS METHOD FOR VASOSPAM DETECTION AND PREDICTOR FOR DELAYED CEREBRAL ISCHEMIA IN THE CONTEXT OF ANEURYSMAL SUBARACHNOID HEMORRHAGE

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Purpose
Correlate detection from moderate and severe vasospasm by computed tomography angiography (CTA) and digital subtraction angiography (DSA). Calculate incidence of delayed ischemic stroke from patients with moderate and severe vasospasm.
Identify possible subgroups of patients with imaging findings that impose more risk to evaluated with stroke after acute subarachnoid hemorrhage (SAH).

Materials and Methods
This study included 36 patients with CT or laboratorial diagnosis of aneurysmal SAH < 72 hours after applied exclusion criteria. Computed tomography angiography study performed in the critical period for vasospasm, 3 - 10 days of ictus, subsequently were correlated with DSA as the gold standard method. The first CT exam was evaluated by two neuroradiologists which later also evaluated the CTA and CT controls. The neuroradiologists were unaware of DSA. Comparative analysis was performed between the methods for moderate or severe vasospasm diagnosis, diameter reduction > 50%, and determined the incidence of delayed ischemic stroke and distribution in subgroups according Fisher graduate. Inclusion criteria: - Patients with SAH diagnosis until 72 hours of ictus. - Perform control study with DSA and CTA between 3 - 10 days of ictus. Exclusion criteria: - Nonaneurysmal SAH. - Control study CTA and DSA later than 72 hours between both. - Patients that did not complete all the proposed protocol.

Results
Twenty-six cases were diagnosed with moderate/severe vasospasm (72.2 %), with agreement between the methods presented 92.8% sensibility and 90.9% specificity for CTA. The presence of ischemia stroke resulting from delayed vasospasm is demonstrated in 14 patients (53.8%). The occurrence of SAH Fisher 3 or 4 related to higher incidence of vasospasm and delayed ischemic stroke. Patients with acute SAH Fisher 1 and 2 showed no moderate/severe vasospasm on CTA or DSA. No patients in this subgroup had delayed ischemic stroke.

Conclusions
The CTA demonstrate high accuracy for detecting vasospasm in moderate and severe presentations, with statistically significant agreement with DSA. The diagnosis of vasospasm (> 50%) with CTA was predictor of delay ischemic stroke. Occurred in about half of patients with moderate/severe vasospasm after acute aneurysmal SAH. The occurrence of SAH, Fisher 3 or 4, demonstrate higher incidence of vasospasm and delayed ischemic stroke. The diagnosis of vasospasm (>50%) with CTA, regardless of the location of the aneurysm, was predictor of delayed ischemic stroke. Patients with acute SAH, Fisher 1 or 2, do not show any case of moderate or severe vasospasm by CTA or DSA. No patient in this subgroup had delayed ischemic stroke.
eP-105

CTP in Stroke: Bayesian-based Deconvolution vs oSVD

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Purpose

CTP techniques rely upon imaging the passage of contrast agent to measure brain perfusion. CTP measures the arterial concentration of the agent from the acquisition by examining the density in larger arteries and then uses this as the basis for perfusion
computation and measurements in the tissue. This involves deconvolution of the arterial input function with the tissue concentration time series, which is inherently poorly conditioned leading to noisy and erroneous solutions. Our aim is to evaluate the quality of two methods by comparing Bayesian-based deconvolution, a new technique, to the oscillar singular value decomposition (oSVD) in stroke patients.

Materials and Methods
Twenty-two stroke patients who underwent CTP were included. CTP studies were postprocessed at 5 mm thickness using Olea Sphere software for each tested method (oSVD and Bayesian) and parametric maps, i.e., cBF, cBV, MTT, TTP and Tmax (oSVD only)/Delay (Bayesian only), were generated from both methods. Two neuroradiologists blinded to the method assessed artifact and overall quality. Quantitative analysis used a region of interest (ROI)-based approach. Identical ROIs were drawn on all parametric maps resulting from both deconvolutions in white matter (WM) and gray matter (GM). Results were compared using Wilcoxon test and the final parametric values were compared to consensual values from the literature.

Results
Qualitative analysis of images showed (CBF)-oSVD was significantly better than CBF-Bayesian, while MTT Bayesian outperformed MTT oSVD. No significant differences were found for CBV and Tmax/Delay. Quantitative analysis demonstrated that CBF WM and MTT WM and GM with oSVD had significantly lower noise than the corresponding maps with Bayesian deconvolution. Bayesian was significantly less noisy than oSVD in CBV WM and TTP WM. No significant differences were found in the other parameters. Bayesian CBF and MTT values are much closer to physiological values found in the literature; cBV values from both deconvolutions are very close to consensual values from the literature (Fig. 1).

Conclusions
Despite Bayesian-computed maps being noisier than oSVD, Bayesian outperformed oSVD, specifically for cBF and MTT computation, as the obtained values are much closer to physiological consensual ones.
Development of a Matlab-based 3D visualization, co-registration and quantification platform for assessing brain tumor physiology across multiple modalities.

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Purpose
The purpose of this study is to develop a three-dimensional (3D) image reconstruction and visualization platform to maximize the utility of advanced 3D techniques like T1/T2-weighted anatomical imaging, diffusion tensor imaging (DTI), perfusion-weighted imaging (PWI) and echo-planar spectroscopic imaging (EPSI). This platform will be particularly relevant in the context of neurosurgical planning and location-sensitive treatments such as Novocure Tumor-treating Fields (TTF).

Materials and Methods
High-resolution, volumetric datasets were obtained from two patient groups.
undergoing separate treatments for brain tumor. Three patients were scanned one day prior to neurosurgery while a separate cohort of four patients undergoing Novocure TTF therapy were scanned prior to using the transducer array and at one-month intervals for a maximum of six months. The common scan protocol consisted of contrast-enhanced T1-weighted imaging, T2-weighted FLAIR, DTI (30 directions, TE=86 ms, TR=5000 ms, 3 avg, 220x220mm2 FOV, 40 slices, 8min), PWI (TE=54 ms, TR=2000 ms, 220x220mm2 FOV, 20 slices, 1:38min) and whole-brain EPSI (TE=17.6ms, TR=1550ms, 280x280x180mm3 FOV, 64x64x32 array size, 15min). All scans were performed using a 12-channel head coil on a Siemens 3T scanner and the full protocol had a 45-minute scan time. The 3D visualization platform reads DICOM/Analyze format data and performs semi-automated co-registration by matching spatial parameters from data headers and anatomical landmarks. Segmented regions-of-interest (ROIs) were drawn by thresholding parameters like mean diffusivity, free anisotropy, relative cerebral blood volume (rCBV) or various metabolite ratios (e.g., Cho/NAA>0.6 or Cho/Cr>1.2). Custom and native Matlab imaging macros facilitated GUI-based zoom and free rotation which then could be captured to image or video.

Results
The visualization platform successfully facilitated co-registration and visualization of datasets across multiple modalities and time-points. Figure 1 shows T1-weighted imaging from a WHO Grade IV glioblastoma patient highlighting the contrast-enhancing volume in red. Figure 2 shows T2-FLAIR from the same patient following 3 months of Novocure TTF therapy, showing slight decrease in enhancing volume (5.8 vs. 8.4ml baseline). Spectroscopic and perfusion data (not shown) showed slight increase at 3-month follow up versus baseline in Cho/NAA (1.07 versus 0.97) and Cho/Cr (0.83 versus 0.66) and decrease in median relative cerebral blood volume (rCBV) (1.56 versus 1.76) in co-registered contrast enhancing regions. Figures 3 and 4 show PWI and EPSI data from a high grade glioma patient undergoing neurosurgery with highlighted regions of interest (ROIs) showing elevated CBV and Cho/NAA ratio, respectively. Coregistration with anatomical imaging revealed agreement between regions of elevated CBV and Cho/NAA and Cho/Cr ratios and areas of T1-contrast enhancement and FLAIR signal abnormality.

Conclusions
The platform combines multiple modalities to paint a 3D anatomical/physiological picture of brain tumor and could assist neurosurgical planning and monitoring of long-term treatments like Novocure TTF.
Diagnostic Accuracy of Non-Contrast Magnetic Resonance Imaging Techniques for Detection of Recurrent Vestibular Schwannomas
Purpose
In this study, we aim to evaluate the diagnostic accuracy of high resolution, noncontrast magnetic resonance imaging (MRI) for the detection of recurrent vestibular schwannomas following resection. If contrast can be avoided while maintaining accuracy, cost and exam time can be reduced without delaying detection of recurrence, and patients can be spared exposure to potentially unnecessary gadolinium.

Materials and Methods
Fifteen patients with vestibular schwannoma recurrence after initial resection, and who had undergone surveillance with serial MR imaging using 3D T2-weighted sequences and gadolinium-enhanced thin section T1-WI after resection for surveillance, were identified. Three blinded fellowship-trained neuroradiologists retrospectively evaluated all of the examinations using 1) only axial 3D T2-weighted images (top left image) and 2) only axial gadolinium-enhanced thin section T1-weighted images (top right image). With each examination, the reviewers were provided with the corresponding 3D T2-weighted images or gadolinium-enhanced thin section T1-weighted images from the patient's initial postoperative exam for comparison and asked assess for the presence or absence of tumor progression. Specificity, sensitivity, intra-observer agreement, and interobserver agreement were assessed.

Results
Between January 2005 and January 2015, 15 patients undergoing surveillance with serial MR imaging status-postvestibular schwannoma resection had at least one recurrence. During imaging surveillance, nine of the patients with postoperative tumor progression underwent gamma knife therapy and one had a second surgical resection. A total of 46 MR imaging exams with axial 3D T2-weighted images and gadolinium-enhanced thin section T1-weighted images were available for retrospective evaluation, representing surveillance following 18 resections (10 surgical, 8 gamma knife). There was consensus among the reviewers regarding the presence or absence of postoperative tumor progression on the gadolinium-enhanced thin section T1-weighted images of 40 of the 46 exams (12 with progression, 28 without progression). Of the exams with a consensus of progression on the gadolinium-enhanced T1-weighted images, three of the three reviewers called progression on 75% of the corresponding 3D T2-weighted images, two of the three reviewers called progression on 17% of the corresponding 3D T2-weighted images, and none of the three reviewers called progression on 8% of the corresponding 3D T2-weighted images (bottom Fig.). In total, of the exams that had a consensus of progression on the gadolinium-enhanced
thin section T1-weighted images, progression was called 83% of the time on the corresponding 3D T2-weighted images.

Conclusions
In the majority of cases, postoperative vestibular schwannoma recurrence can be assessed accurately with either 3D T2-weighted images or gadolinium-enhanced thin section T1-weighted images. Given the already low rate of recurrence, postoperative imaging potentially could be done without contrast enhancement, reserving gadolinium for indeterminate cases.
Diagnostic performance of ASL in the characterization of enhancing brain lesions

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Purpose
Evaluate the diagnostic performance of arterial spin labeling (ASL) in the characterization of the neoangiogenesis of different enhancing brain lesions.

Materials and Methods
The ASL sequence was realized in the initial assessment of 35 brain lesions [10 gliomas high grade, four low-grade gliomas, six meningiomas, five lymphomas, three abscesses, one pseudo tumor lesion (MS) and six metastases] were blindly read by two independent observers. The lesions were classified into hyperperfused [increase in cerebral blood flow (rCBF)] or not hyperperfused. Then the observers have reviewed collegially discordant assessments. These results were compared with the pathological results.

Results
The interobserver concordance was high (33/35). Lesions with neoangiogenesis (high-grade gliomas, meningiomas, metastases) were found mainly with hyperperfusion ASL [sensitivity 91% (20/22), specificity 92%]. Lesions without neoangiogenesis (low grade glioma, lymphomas, MS, abscess) were found mostly without hyperperfusion ASL [sensitivity 92% (12/13), specificity 91%]. The overall performance of the ASL was 91% (32/35).

Conclusions
Arterial spin labeling is a powerful sequence to characterize enhancing brain lesions. It allows the differentiation between neoangiogenesis and disruption of blood-brain barrier by showing increased rCBF for lesions with neoangiogenesis.

Diagnostic performance of brain MRI in immune reconstitution inflammatory syndrome

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Purpose
Central nervous system immune reconstitution inflammatory syndrome (CNS-IRIS) significantly negatively impacts the human immunodeficiency virus (HIV) infected population on combination antiretroviral therapy (cART). We sought to determine the diagnostic performance of several magnetic resonance imaging (MRI) features for CNS-IRIS in a cohort of HIV+ patients recently started on cART.

Materials and Methods
Our radiologic database was searched from January 2003 to September 2014 retrospectively for patients diagnosed with HIV and worsening symptoms on cART. Twenty subjects with HIV were identified; patients were classified as having CNS-IRIS on the basis of established clinical criteria (eight patients; 12 age- and sex-matched controls). Brain MR images were obtained at a single post-cART timepoint during hospitalization for acute neurologic deterioration and blindly interpreted by two experienced neuroradiologists for the presence of four variables: intrinsic T1 hyperintensity, marginal reduced diffusion, and marginal enhancement or perivascular enhancement.

Results
While each individual finding showed moderate predictive accuracy, the combination of MR findings demonstrated good test characteristics: sensitivity 88% (CI 62-98), specificity 79% (58-93), PPV 71% (44-90%), and NPV 83% (CI 52-98%). In addition, this final diagnosis demonstrated good predictive accuracy, area under curve .78 (CI .63-.91) and moderate inter-reader agreement, κ=.55.

Conclusions
Our findings suggest that while each individual MR finding shows only moderate diagnostic performance, the combined assessment of experienced neuroradiologists has good predictive accuracy. The absence of any described MR imaging findings makes the diagnosis of CNS-IRIS highly unlikely.

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Differentiating and predicting true progression versus pseudoprogression: Comparing ASL, DSC, DCE and MRS

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Purpose
To evaluate the predictive value of magnetic resonance spectroscopy (MRS) as well as different magnetic resonance perfusion (MRP) parameters including dynamic susceptibility contrast (DSC), dynamic contrast-enhanced (DCE), arterial spin...
labeling (ASL) in discriminating pseudoprogression (PsP) from true progression (PD) in glioblastoma (GBM) patients.

Materials and Methods

Our Institutional review board has approved this HIPAA compliant retrospective study. We identified a total of 69 patients (45 males: 24 females) (average age = 50 years, median age = 51 years) with pathologically proven GBM. All patients underwent advanced MRI studies (DSC, DCE, ASL and MRS). All patients had pathological proof of either PD or PsP after the advanced MRI studies. For each patient, three board certified neuroradiologists, blinded to the pathology report, evaluated all the advanced imaging features using a designed qualitative questionnaire to determine PD and PsP. The questionnaire included the following parameters: DCE (PEI 3, 60, Curves), DSC (rCBV, NEI, Curves), ASL (CBF), MRS (N-acetylaspartate, choline/creatine, lipid). Statistical analysis was performed to evaluate the ability of each imaging feature in discriminating PD from PsP.

Results

According to the pathology reports, seven patients had PsP while remaining 62 patients had PD. While MRS was the most superior imaging features in accurately discriminating PD from PsP followed by DSC, ASL and DCE respectively, yet, combination of the aforementioned features yielded the best discriminatory results. The ability to predict PsP versus true progression as compared to the gold standard (pathological confirmation) was 97%.

Conclusions

Dynamic contrast-enhanced, DSC, ASL, MRS can be valid reliable imaging markers with statistically significant predictive values to differentiate PD versus PsP. The combination of those different advanced MRI technique eventually can yield an accurate platform for diagnosis of PD versus PsP.

eP-97

Differentiating Normal Pressure Hydrocephalus from Alzheimer Disease and Healthy Controls: Sulcal Depth

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Purpose

There is increasing interest in noninvasive markers to differentiate normal pressure hydrocephalus (NPH) from normal aging (HC) and Alzheimer disease (AD) (1). We sought to identify cortical sulcal patterns through quantitative measurements of sulcal depth across the entire brain surface in order to characterize NPH. We examined a
subset of NPH patients who demonstrated the disproportionately enlarged sulci hydrocephalus (DESH) pattern (2) in addition to NPH patients without DESH.

Materials and Methods
Twenty-two non-DESH NPH and 11 DESH patients were selected from the NYU Adult Hydrocephalus Service; 23 AD and 25 HC patients were obtained from the Alzheimer Disease Neuroimaging Initiative (ADNI) database. High resolution T1-weighted MPRAGE sequences acquired from a 3T magnetic resonance imaging (MRI) system were studied. FreeSurfer was used to create an outer pial envelope and sulcal depth was measured using in-house software written in MATLAB. Vertex-wise t-tests covarying for age and total-intracranial-volume, as well as a clusterwise correction for multiple comparisons were performed using FreeSurfer.

Results
Normal pressure hydrocephalus (non-DESH) demonstrated decreased precentral sulcus depth compared to HC: 10.62 ± 1.94 versus 11.95 ± 1.44 mm, (P***<0.005). Normal pressure hydrocephalus (non-DESH) demonstrated increased central sulcus depth compared to DESH: 9.06 ± 0.85 mm versus 8.11 ± 2.46 mm, (P*<0.05). Normal pressure hydrocephalus (DESH) demonstrated decreased precentral sulcus depth compared to AD: 8.65 ± 2.59 mm versus 10.48 ± 0.79 mm, (P*< 0.05). Normal pressure hydrocephalus (DESH) demonstrated decreased central sulcus depth compared to healthy controls: 7.84 ± 2.47 versus 9.56 ± 0.65 mm, (P***<0.005). Normal versus AD and NPH (non-DESH) versus AD did not show differences.

Conclusions
Normal pressure hydrocephalus and DESH patients exhibiting shallower sulci in the precentral and central sulcus compared to HC and AD patients may reflect the enlarged ventricles from within the brain compressing the gyri against the inner skull. This finding may help differentiate NPH and to improve its diagnosis.
Differentiation Between Neoplastic and Non-Neoplastic Intracranial Lesions Using Diffusion Tensor Imaging and Arterial Spin Labelling Technique

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Purpose
The purpose of this study was to differentiate between non-neoplastic and neoplastic intracranial lesions using diffusion tensor imaging (DTI) and arterial spin labelling (ASL) derived parameters from the enhancing wall/lesion and peri-lesional edema.

Materials and Methods
In a prospective study, 22 patients with intracranial lesions underwent magnetic resonance imaging (MRI) including DTI and ASL sequences. For analysis these patients were divided into two groups (neoplastic and non-neoplastic) based on histopathological, clinical, biochemical and imaging evaluation. In the neoplastic group the lesions were metastasis=7, gliomas=3 and choroid plexus carcinoma=1. In the non-neoplastic group the lesions were tuberculomas=6 and neurocysticercosis=5. The DTI parameters [fractional anisotropy (FA), apparent diffusion coefficient (ADC), axial diffusivity (AD), radial diffusivity (RD)] and ASL derived cerebral blood flow (CBF) were measured in the enhancing wall/lesion and peri-lesional edema. The results were compared between the two groups using independent t-test.

Results
Fractional anisotropy measured in the enhancing wall/lesion was significantly higher in the non-neoplastic group as compared to neoplastic group (0.113±0.047; 0.166±0.055; p=0.023) in neoplastic and non-neoplastic groups respectively. No significant differences in the other DTI derived parameters were found. Significant difference was found in the CBF of enhancing wall/lesion between two groups (p=0.002) using Mann-Whitney test. No significant difference was found in DTI derived parameters and CBF peri-lesional edema of the two groups.

Conclusions
Neoplastic and non-neoplastic intracranial lesions can be differentiated using DTI derived FA and ASL derived CBF measured in the wall/lesion.

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6:30AM - 2:45PM

Differentiation between progressive disease and treatment related changes in patients with glioblastoma using DCE-MRI

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Purpose
Differentiation between progressive disease (PD) and treatment-related changes (TRC) in patients with glioblastoma remains a major clinical challenge (1, 2). The aim
of this study was to differentiate between PD and TRC on a voxel basis, based on dynamic contrast enhancement (DCE) magnetic resonance imaging (MRI).

Materials and Methods
Eighteen patients with biopsy-proven glioblastoma (GB) were scanned longitudinally on a 3.0 T MRI, (total of 60 scans). Scans included: conventional imaging, DCE-MRI and MR spectroscopy (MRS). Patients were labeled retrospectively with PD or TRC based on conventional MRI results at ~6 months. A voxel-wise classification of the enhanced tumor area was performed in all patients using support vector machine (SVM) based on the calculated DCE pharmacokinetic (PK) parameters. Classification results were validated by a senior neuroradiologist, verified by MRS, and sensitivity and specificity were measured based on 2-fold cross validation analysis of the training set.

Results
Significant differences were detected between the manually labeled PD, TRC, and normal appearing white-matter (NAWM) areas (Fig. 1), with higher transfer-constants (ktrans and kep), extra-cellular extra-vascular volume (ve) and plasma-volume (vp) values, detected for the PD compared to the TRC and NAWM. Support vector machine results were supported by MRS, consistent with radiological assessment at follow up, and showed high sensitivity (89.3%) and specificity (89.4%). Figure 2 demonstrates representative results obtained from two patients, at baseline (a,b) and at follow-up scan (c,d); In patient #1, (top row) PD was identified at baseline, and predicted the increase in tumor volume, detected 6 months later. In patient #2 (bottom row) TRC was identified at baseline, with no changes in this at follow-up scans.

Conclusions
This study proposes an automatic method for differentiation between PD and TN in patients with GB, based on DCE-MRI PK parameters. Results of this study may have major clinical importance for diagnosis and therapy response assessment in patients with GB.
Differentiation of dementia with Lewy bodies from Parkinson’s disease with quantitative susceptibility mapping at 3T

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Purpose
Because symptoms of dementia with Lewy bodies (DLB) can closely resemble other more commonly known diseases like Parkinson's disease (PD), it is currently widely underdiagnosed. The purpose of this study was to determine whether quantitative susceptibility mapping (QSM) is useful for differentiating DLB from PD patients.

Materials and Methods
All magnetic resonance imaging (MRI) studies were performed with a multi-echo gradient-echo sequence on a 3.0 T scanner. We studied 7 DLB patients (three females, four males; age range 65-80 years, mean age 74.7 years) and selected age-matched seven PD patients and 10 healthy controls (HC). The mean susceptibility values (MSVs) of the bilateral substantia nigra (SN), red nucleus (RN), caudate nucleus (CN), globus pallidus (GP), putamen (PT) and substantia nigra (SN) were measured on QSM images. In each structure the region of interest (ROI) was placed in the maximal area. To place the region of interest (ROI) in the SN while avoiding contamination of the subthalamic nuclei we used coronal multiplanar reconstruction images with reference to the Schaltenbrand and Wahren atlas. Measurement differences were assessed with the Mann Whitney test; P < 0.05 was considered to indicate a statistically significant difference.

Results
The MSVs of the PT and CN in DLB were relatively higher than those in PD and HC. As regard to the SN, the MSV in DLB was significantly lower than that in PD (p < 0.05). There was no significant difference in the MSV of the SN between DLB and HC groups.

Conclusions
Quantitative susceptibility mapping may be useful for differentiating DLB from PD patients.
Diffusion Kurtosis Along the Corticospinal Tract in Adult Normal Pressure Hydrocephalus

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Purpose
To examine how diffusion and kurtosis parameters vary along the length of the corticospinal tract (CST) and to determine whether microstructure is compromised in patients diagnosed with normal pressure hydrocephalus (NPH). Evidence suggests that ventricular dilatation can change the microstructure of the CST in hydrocephalus, however the details of these changes remain speculative (1, 2). We assume here that CST microarchitecture is altered by mechanical pressure resulting from ventricular enlargement and we hypothesize that this disruption will be greatest in the periventricular region and can be measured using diffusion kurtosis and axonal water fraction (AWF). We aim to study these diffusional properties of the CST in patients with NPH by performing an along-tract analysis and to determine whether this method could be used as a diagnostic tool to differentiate patients with NPH from healthy controls.

Materials and Methods
Diffusion MRI (dMRI) with b = 0, 1 and 2 ms/μm² along 60 directions in total was acquired on a 3T MRI system on 14 NPH patients (age 58 – 87 years, mean 75, m/f: 7/7) and 11 healthy controls (age 60 – 87 years, mean 75, m/f: 6/5) as part of an institutional review board exempt clinical study and analyzed retrospectively. The axonal water fraction, i.e., the fraction of intra-axonal water over intra plus extraxonal water (3), was computed in addition to standard diffusion metrics. Tracts were generated by placing seed regions of interest (ROIs) in the cerebral peduncles and in the precentral gyrus of each subject. Tracts were normalized using cubic spline interpolation and truncated at the brain stem and pial surface to ensure that tracts from different subjects could be compared without individual anatomy biasing results. Parametric diffusion and kurtosis maps were resampled onto tract vertices and 2-way ANCOVA covarying for age was used to measure group differences.

Results
Groups were compared at each point along the tract for both parameters. We found that axial kurtosis is decreased significantly in NPH (p < 0.05) between 40% and 85% of the distance along the tract, this area is located superior to the internal capsule but below the cortex. Figure 1 shows the change in AK as well as an image to demonstrative the anatomical location where group differences occur. Figure 2 shows the change in AWF, which is significantly decreased in NPH in areas correlating with...
changes that occur in AK (between 34% and 54%, and between 70% and 83%).

Figure 3 displays a visualization of the AWF and AK parameters mapped onto the
CST of a subject with hydrocephalus.

Conclusions
We propose an analytical technique capable of localizing the intensity of diffusion
parameters as you move along a neural tract. Axonal water fraction and AK were
chosen because they have the capacity to indicate microstructural changes due to
compression. Lower axonal water fraction indicates a lower axonal density in the
CST. Lower axial kurtosis suggests that axons are more aligned due to compression
(3). The results of this study suggest that the pons and upper periventricular
parenchyma may be microstructurally implicated in NPH.
Figure 1 - Axial Kurtosis
Left: Left Hemisphere data and statistical results. Middle: Right hemisphere data and statistical results. Right: qualitative image used to visualize the location of ANCOVA results. Top row: raw data averaged for each group, solid lines are means and dashed lines are standard deviations. Bottom row: ANCOVA results, points above the red line show statistically significant differences accross groups.

Figure 2 - Axonal Water Fraction
Left: Left Hemisphere data and statistical results. Middle: Right hemisphere data and statistical results. Right: qualitative image used to visualize the location of ANCOVA results. Top row: raw data averaged for each group, solid lines are means and dashed lines are standard deviations. Bottom row: ANCOVA results, points above the red line show statistically significant differences accross groups.

Figure 3 - Mapping parameters onto tracts
Left: Axonal water fraction image of a subject with Hydrocephalus. Right: Axial kurtosis image of a subject with Hydrocephalus. Parameters have been mapped onto the CST for visualization.
Diffusion Kurtosis Imaging of brain in HIV infection in India

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Purpose
Though HIV is spread throughout the brain during chronic infection, its distribution varies across the brain anatomy. Consequently, the degree of alterations to tissue microstructure and metabolite concentration is expected to go along with the viral distributions and/or their infection status within the brain. However, due to the nonavailability of appropriate MR technologies, previous brain MR studies have evaluated the metabolite and microstructural alterations of HIV infection in limited anatomical or mostly in white matter regions. Furthermore, the brain changes in individuals with HIV-1 clade B infection are studied extensively albeit incompletely to identify imaging correlates for the neurocognitive deficits found in them. However, there is scarcity of similar studies in clade C, in particular from India where >95% of infected individuals are with clade C.

Materials and Methods
We used diffusion kurtosis imaging (DKI) to fully characterize the microstructural integrity changes, including the cortical gray matter regions, in individuals with HIV-1 clade C infection. Eight individuals with HIV-1 infection and seven age-matched healthy subjects were scanned at 3T using DKI techniques. Data were analyzed by lobar, anatomical regional and tissue type levels to make between-group comparisons. Metrics compared include mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD), fractional anisotropy (FA), mean kurtosis (MK), axial kurtosis (AK), and radial kurtosis (RK).

Results
Significant between-group differences were found in 62 white matter regions of interest (ROIs) [MK (20 ROIs), RK (19 ROIs) and AK (8 ROIs)] and 9 gray matter ROIs [MD and MK].

Conclusions
Microstructural changes occur in the gray matter and white matter brain regions of adults infected with HIV. Neuroimaging methodology will be useful to evaluate the impact of HIV and its therapeutics throughout the brain.
Diffusion tensor imaging as potential biomarker in Erdheim-Chester disease

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Purpose
Erdheim-Chester disease (ECD) is a rare, systemic non-Langerhans histiocytosis with diverse manifestations. Neurologic involvement is encountered in fewer than 50% of patients. Recently described treatment with vemurafenib induced a dramatic response in patients with ECD harboring BRAF V600E mutations. Therefore, there is a strong need for accurate and sensitive tools to monitor treatment response. To date no quantitative evaluation of white and gray matter has been reported in ECD. Diffusion tensor imaging (DTI) is an advanced magnetic resonance imaging (MRI) technique that allows in vivo evaluation of the microstructure and integrity of white matter tracts. We aimed to assess white matter microstructural changes and gray matter volume in patients affected with Erdheim-Chester disease.

Materials and Methods
We performed voxel-based morphometry (VBM) of 3D-T1WI and tract-based spatial statistics (TBSS) of diffusion tensor imaging (DTI) metrics: fractional anisotropy (FA), mean diffusivity (MD), axial and radial diffusivity (AD, RD) to examine gray matter volumetric and white matter microstructural differences between ECD patients and age-matched controls.

Results
Fifteen patients (median age 50 years) and 15 age-matched controls (median age 51 years) were studied. Tract-based spatial statistics revealed reduced FA and increased MD and RD in major white matter tracts in patients compared to controls. Mean diffusivity and RD were increased in cerebellar white matter tracts in patients compared with controls. No significant change was detected in AD between both groups. Voxel-based morphometry showed reduced volume of cerebellum, right frontal operculum, and left angular gyrus in ECD patients compared to controls.

Conclusions
We found widespread white matter involvement in the supratentorial and infratentorial spaces. Diffusion tensor imaging metrics changes described in this study most likely reflect alterations of white matter microstructure secondary to disrupted myelination. Changes in gray matter volume are focal and may represent a selective vulnerability of certain anatomical structures in ECD. Thus, DTI may be a useful quantitative biomarker for indexing the clinical impairment and monitoring treatment response.

eP-78

Diffusion Tensor Imaging of Optic Nerve in Patients of Vitamin B12 Deficiency Before and After Treatment

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Purpose
Subacute combined degeneration is associated with high frequency of visual evoked potential abnormalities but there is no magnetic resonance (MR) functional study on optic nerve. We assessed and correlated the functional integrity of optic nerves using diffusion tensor imaging (DTI) in patients with B12 deficiency and post-therapy response.

Materials and Methods
Six patients (age range 14-59 years; M: F- 4: 2) of B12 deficiency were subjected to DTI. Patients were diagnosed on the basis of clinical features (sensory ataxia), low serum B12 levels (<211 pg/ml) and somatosensory as well as visual evoked potential changes. Following 3 months of B12 therapy patients were re-evaluated for clinical improvement and DTI changes. Tests of significance were done to detect differences in various DTI parameters [fractional anisotropy (FA), apparent diffusion coefficient (ADC), axial diffusivity (AD) and radial diffusivity (RD)] in pre and post-therapy studies in comparison to controls.

Results
The median duration of illness was 1.75 (1.5-36) months. Sensory ataxia was present in six patients, peripheral neuropathy in three, cognitive abnormalities in one and clinical visual abnormality in none. Independent sample t-test showed statistically significant differences between patients before therapy and controls in the FA (pretherapy 0.498 +0.071 versus control 0.632+0.053, p=0.004) and RD (pretherapy 4.217+0.105 versus control 4.058+0.082, p=0.016). Paired t-test was done to test the mean difference between pre and post-therapy observations of different variables and statistically significant differences were seen in the FA (pretherapy 0.498 +0.071 versus post-therapy 0.622+0.062, p=0.008) and RD (pretherapy 4.217+0.105 versus post-therapy 4.078+0.158, p=0.002). Comparison of post-therapy FA (p=0.818) and RD (p=0.937) with those of controls did not show any significant differences.

Conclusions
Diffusion tensor imagingI parameters are deranged in B12 deficiency patients and show improvement after therapy.

eP-54

Does INR upon presentation predict recanalization failure in acute large vessel occlusion?

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Purpose
We recently had a case of a large vessel occlusion which failed multiple attempts of recanalization despite multiple attempts at thromboaspiration and stent retrieval. Upon chart review we found that the patient had an INR of 2.4. We hypothesized that large vessel occlusions occurring in anticoagulated patients may be less amenable to retrieval by conventional techniques, possibly a result of altered clot composition or underlying stenosis. The purpose of this study was to determine if patients who present for mechanical thrombectomy with elevated INR have an increased rate of recanalization failure.

Materials and Methods
One hundred three consecutive patients who underwent mechanical thrombectomy with thromboaspiration and/or stent retriever were analyzed from 2/16/12 - 3/30/15. Inclusion criteria included the presence of a large vessel occlusion amenable to mechanical thrombectomy and at least one attempt of clot retrieval with aspiration or stent retriever. The electronic medical record was queried for INR values at the time of presentation. The patients were divided into two groups determined by INR. INR greater than 1.5 was considered elevated. One patient had no INR value and was removed from the analysis. Digital subtraction angiography (DSA) images were reviewed by one of two neurointerventionalists (JM, GV) for reperfusion scoring according to the TICI system. Unsuccessful recanalization was defined as TICI 0,1, or 2a and successful recanalization was defined as 2b, 2c, or 3.

Results
Eighty-two patients were recanalized successfully and 20 patients failed recanalization. Two of 20 patients who failed recanalization had an elevated INR. TICI scores were 2a and 0, and INR values were 1.6 and 2.4 in these two failed patients, respectively. Two patients with failed recanalization had INR values 1.3-1.5. There were 11 patients with elevated INR who underwent successful recanalization. There was no association between elevated INR and failed recanalization (OR 0.72, 95% CI 0.15-3.5).

Conclusions
Elevated INR does not predict failure of mechanical thrombectomy in acute ischemic stroke due to large vessel occlusion in our population. Further evaluation with greater sample size should be investigated to best identify patients who are most likely to benefit from interventions.
Does Post Mechanical Thrombectomy Parenchymal Contrast Staining Correlate with Ischemia on Diffusion Weighted Imaging?

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Purpose
Parenchymal hyperdensity following reperfusion therapy in the setting of ischemic stroke, although often seen, is incompletely understood. It has been postulated that it may represent hemorrhage due to reperfusion injury. Other authors believe that this phenomenon is caused by leakage of iodinated contrast into the parenchyma due to disruption of blood-brain barrier. We hypothesized that areas of parenchymal high attenuation also demonstrate restricted diffusion on MRI representing infarcted brain tissue. In light of new research demonstrating effectiveness of mechanical thrombectomy in carefully selected stroke patients with large vessel occlusion, this phenomenon will be encountered more often in the clinical practice, therefore necessitating a deeper understanding of causes and possible prognostic implications of this finding.

Materials and Methods
In this retrospective study, 20 patients with MCA territory strokes who were treated with mechanical thrombectomy were identified. Patients with obvious hemorrhagic transformation were excluded from the study. Preprocedural CT head was evaluated to designate ASPECTS score. Postprocedural CT examination was evaluated for size of parenchymal hyperdensity by manually drawing a region on interest around these areas and measuring the surface area at each slice. The sum of the surface areas was used as an estimate of volume of the parenchymal hyperdensity. The same method was used to measure the volume of brain parenchyma demonstrating restricted diffusion. Electronic medical records were reviewed and relevant clinical data including NIH Stroke Scale, time to reperfusion, and volume of contrast injected during thrombectomy were collected. Reperfusion success also was recorded utilizing the thrombolysis in cerebral infarction (TICI) scale and recanalization of the primary arterial occlusive lesion (AOL) scale. Statistical analysis was performed by linear regression and T-test depending on type of data.

Results
There was no significant correlation between parenchymal hyperdensity and diffusion-weighted imaging (DWI), (p-value = 0.26). There was no significant correlation when comparing NIHSS, SPECTS, TICI and time to reperfusion to size of parenchymal hyperdensity. There was a trend with lower TICI scores associated with larger areas of contrast staining and restricted diffusion, however p-value was not significant at 0.09.
Conclusions
In our practice it is not uncommon to see an apparent match between parenchymal hyperdensity on head CT after mechanical thrombectomy and restricted diffusion on subsequent magnetic resonance imaging (MRI). However, this did not reach statistical significance in our initial patient group. Further studies with larger sample size and volumetric measurements may improve the power of the study and show statistically significant correlation in the study parameters.

(Filename: TCT_eP-120_1.jpg)

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Purpose
Acute stroke requires rapid and accurate diagnosis to direct appropriate management. While computed tomography (CT) remains a first line diagnostic modality, high accuracy and predictive value render magnetic resonance imaging (MRI) a superior tool. The goal of our study is to investigate and optimize clinical imaging algorithms used to support management in stroke patients.

Materials and Methods
An ongoing retrospective cohort encompassing 150 patients (of 1000 planned) receiving both CT and MRI for stroke evaluation within 24 hours of each other is presented. The interval between symptom onset and emergency department (ED) presentation categorized patients into five separate time frames (Fig. 1), and utilization across groups was assessed. The accuracy and positive (PPV) and negative (NPV) predictive values of final CT/MRI interpretations were compared against discharge diagnoses.

Results
Out of 150 patients receiving both CT and MRI to evaluate clinically suspected cerebral ischemia, 73 were diagnosed with stroke. Forty-one percent (of 150) presented within the 4.5 hour IV tPA therapeutic window (Fig. 1). The PPV of CT was not significantly different from MRI beyond the 4.5 hour window. However, CT was inferior to MRI in PPV (83% versus 100%) within 4.5 hours, and in both accuracy and NPV for all groups irrespective of the interval between symptoms and presentation (Fig. 2). The difference in accuracy and predictive values did not change across the interval between CT and MRI acquisitions.

Conclusions
Our preliminary review reveals strikingly low accuracy and predictive values of CT for diagnosing acute stroke during the therapeutic IV tPA window. With the exception of a few clinical scenarios, low accuracy may render CT unnecessary beyond this time frame. The study implies overutilization of CT beyond the acute therapeutic window by ED physicians, potentially causing delay in accurate stroke diagnosis with MRI. Magnetic resonance imaging should be made readily available and encouraged where appropriate for stroke evaluation in the ED setting.
Elevated Transforming Growth Factor Beta Protein Levels in Cerebrospinal Fluid of Patients with Aneurysmal Subarachnoid Hemorrhage Correlate with the Presence of Hydrocephalus and Global Cerebral Edema

J Ivanidze¹, R Ferraro², M Jin², A Gupta³, P Sanelli⁴

Purpose
Transforming growth factor beta-1 (TGFB1) is a potent fibrogenic agent that has been shown to promote post-hemorrhagic fibrosis and chronic communicating hydrocephalus. Moreover, TGFB1 has an important pro-inflammatory role in a multitude of central nervous system (CNS) disease processes, such as Alzheimer disease and encephalitis. The association of TGFB1 with secondary complications of hydrocephalus and global cerebral edema in aneurysmal subarachnoid hemorrhage (SAH) has not been established. Global cerebral edema (GCE) is an important predictor of mortality in SAH in which inflammatory effects are thought to play a role
in its development and chronic hydrocephalus is a long-term manifestation contributing to worse outcomes. The purpose of this study was to correlate poor imaging outcomes of early-stage SAH [hydrocephalus and global cerebral edema (GCE)] with TGFB1 levels prospectively measured in the cerebrospinal fluid (CSF) of SAH patients.

Materials and Methods
In this prospective IRB-approved study, 19 SAH patients underwent noncontrast CT on day 0 after aneurysmal rupture. Computed tomography (CT) was assessed for presence of hydrocephalus and GCE based on established criteria. Hydrocephalus was graded as none, mild, moderate or severe. Global cerebral edema was determined as sulcal effacement and loss of gray-white matter differentiation according to published criteria. Cerebrospinal fluid was collected via ventriculostomy catheter (placed for intracranial pressure management) within 24 hours of NCCT. TGFB1 protein levels were measured in CSF supernatant using multiplex microbead immunoassay technology (Luminex Corp, Austin, TX). Mann-Whitney test was performed to determine statistical significance in mean TGFB1 levels between patients with and without hydrocephalus and patients with and without GCE, respectively.

Results
Stratification of the 19 patients by degree of hydrocephalus resulted in three patients with no hydrocephalus, 10 patients with mild hydrocephalus, four patients with moderate hydrocephalus and two patients with severe hydrocephalus, respectively. To achieve dichotomous stratification, patients were grouped into "none to mild hydrocephalus" (N = 13) and "moderate to severe hydrocephalus" (N = 6). Stratification by presence of GCE resulted in eight patients without GCE and 11 patients with GCE. Mann-Whitney analysis demonstrated that TGFB1 was statistically significantly increased in the CSF of patients with GCE compared to patients without GCE, as well as in patients with moderate to severe hydrocephalus compared to patients with no or mild hydrocephalus, respectively (Fig. 1).

Conclusions
This preliminary study demonstrates statistically significant correlation between poor imaging outcomes of GCE and hydrocephalus with TGFB1 protein levels in the CSF of SAH patients. Given the important role of the TGFB1-driven inflammatory signaling cascade in microvascular obstruction and blood-brain barrier dysfunction, our study suggests a possible pathophysiological link between neuroinflammation and microvascular pathology, and possible diagnostic and therapeutic implications in patients with SAH.
Enhancement of Functional Images using Anatomic Image Information

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Purpose
Functional imaging methods, such as magnetic resonance imaging (MRI) perfusion or positron imaging tomography (PET), can provide hemodynamic or metabolic information. However, often these images have relatively low signal to noise ratio (SNR) and spatial resolution relative to other nonfunctional cross-sectional imaging obtained as parts of a routine clinical protocol. We hypothesized that combining functional and anatomical image information could provide images of superior diagnostic value. In this work, we evaluated the diagnostic characteristics of images that combine arterial spin labeling (ASL) perfusion MRI information with the spatial
data obtained from higher resolution anatomical images, while preserving the original ASL contrast and quantitative signal intensity characteristics over larger spatial scales. Materials and Methods
Arterial spin labeling cerebral blood flow (CBF) images were enhanced by (1) frequency addition (1), (2) frequency multiplication (3), (3) wavelet-based (4), (4) nonsubsample contourlet transform (3) and (5) sharpening by local similarity methods (2). The image enhancement methods were evaluated in patients with brain tumors using acquired ASL, 2D T2, FLAIR and FLAIR T1 with and without Gd contrast and 3DMPRAGE with Gd contrast. Two neuroradiologists assessed a total of seven different exams by a Likert scale (1-5 scale), for ability to visualize (1) brain anatomy around tumor, (2) borders between tumor and normal tissue, and (3) preservation of ASL CBF contrast. Additionally, clinician preference for the enhanced ASL image versus the original ASL image was evaluated.
Results
The frequency multiplication method was scored as having the best rendering of anatomy (4.8 ±0.6, p<0.001 among the methods), and the clearest border between tumor and normal tissue (4.2±1.3, p<0.01), while preserving perfusion information (4.6±0.9). The local similarity method provided slightly lower image quality scores, followed by nonsubsample contourlet, wavelet and frequency addition methods. All the enhanced images were rated as preferable to the original CBF map (p<0.001).
Conclusions
Combining spatial information with functional perfusion information from ASL improved visual interpretation while maintaining the perfusion contrast of the functional images. These methods are adaptable for other modalities (e.g., PET, CT), require limited information regarding the original images and are readily feasible for automatic implementation.
Figure 1: A) Original ASL and its enhancement by frequency multiplication with anatomic information from B) 3D MPRAGE post contrast, C) 2D T2, D) FLAIR T1 and F) FLAIR T1 post contrast. Frequency multiplication images are noted by reviewing neuroradiologists to provide preferable structural and functional information over other algorithms.

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Etiologies and Magnetic Resonance Imaging Patterns of Isolated Lesions of the Medulla Oblongata

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Purpose
Isolated lesions of the medulla oblongata are difficult to diagnose due to their rarity and high biopsy risk (1). Several individual case reports or small series have been published (2-5), but a systematic descriptive study is lacking. Our study aims to provide a practical differential diagnosis, describe characteristic magnetic resonance imaging (MRI) findings and to propose an MRI-based approach to isolated lesions of the medulla oblongata in nonstroke patients.

Materials and Methods
We performed an IRB-approved and HIPAA-compliant retrospective analysis of 34 consecutive cases of isolated medullary lesions from nonstroke causes identified from our imaging database between January 2000 and May 2015. Magnetic resonance imaging (MRI) studies were reviewed independently by two blinded neuroradiologists by consensus. The diagnosis, demographic data and MRI findings were reported using frequencies and proportions. An imaging-based algorithm that can be used for the diagnostic approach of these lesions is proposed based on their MRI characteristics.

Results
Most lesions were neoplasms (47%), followed by vascular malformations (15%), demyelinating/inflammatory processes (15%), infections (3%) and other etiologies (12%). Eight percent of the cases were of unknown etiology despite extensive evaluations. Five MRI patterns were identified; 1) cystic lesion, 2) noncystic exophytic lesion, 3) intrinsic lesion containing T2 hypointensity, 4) enhancing intrinsic T2 hyperintense lesion, and 5) nonenhancing intrinsic T2 hyperintense lesion patterns. All lesions exhibiting patterns 1 and 2 were predominantly neoplastic. All lesions showing pattern 3 were vascular malformations. Patterns 4 and 5 comprised of multiple etiologies.

Conclusions
Neoplasms, predominantly gliomas and hemangioblastomas, are the most common cause of isolated medulla oblongata lesions in nonstroke patients. Other lesions in the differential diagnosis include vascular malformations, demyelinating/inflammatory
lesions and infections. An MRI-based approach can help to differentiate these etiologies and narrow the differential diagnosis.

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eP-03
6:30AM - 2:45PM

Evaluation of brain structural changes in patients with juvenile myoclonic epilepsy using voxel based morphometry and diffusion tensor imaging.

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Purpose
Previous imaging studies in juvenile myoclonic epilepsy (JME) have shown focal abnormalities of thalamus and frontal cortex. White matter (WM) changes also have been described in the frontal lobe WM and corpus callosum. However, few studies have shown more widespread abnormalities. The purpose of this study was to systematically investigate the spatial distribution of morphological changes in the brain white matter using voxel based morphometry and diffusion tensor imaging (DTI).

Materials and Methods
The study included 17 (Mean age 24.5 ± 4.2; M:F 12:5) patients with JME and matched 19 controls. Imaging was performed on an Achieva 3T magnetic resonance imaging (MRI) scanner (Philips Medical Systems, Netherlands) with an 8-channel head coil. Magnetic resonance imaging acquisition included Sagittal 3D T1-weighted turbo field echo [TFE] MR imaging [TR/TE 10/4.3 ms, number of signal-intensity averages 1, matrix 256 x 256, flip angle 8]. Diffusion tensor imaging (DTI) was done using EPI spin echo sequence [TR/TE 8000/120, Slice thickness 2mm, voxel size of 2x2x2 cm, No of directions 15, NSA 1, b=0,1000]. Voxel-based morphometry (VBM) and Tract-based spatial statistics (TBSS) analysis was performed to compare 3DT1 TFE(Turbo field echo) and DTI metrics (Fractional anisotropy, mean diffusivity, radial diffusivity and axial diffusivity) respectively between the patients and controls on a voxel-wise basis using age, sex and intracranial volume as covariates.

Results
Voxel-based morphometry analysis showed no significant gray matter difference between subjects and controls. Significantly decreased fractional anisotropy and increased mean and radial diffusivity were observed in the cerebral WM affecting primarily the corpus callosum, fronto-parietal WM, internal capsule, external capsule, brainstem and cerebellar WM in the JME patients (P<0.05, FWE corrected) after adjusting for age, gender and ICV. Axial diffusivity comparisons did not show any areas of significant difference (p<0.05, FWE corrected).

Conclusions
The study revealed presence of widespread structural WM changes in JME patients and these changes were seen on fractional anisotropy (FA) and radial diffusivity (RD) maps. Extensive WM changes in JME patients and more widespread abnormalities of FA and RD in cerebral WM may be because of impaired WM maturation process due to the underlying seizure disorder.
Evaluation of Single Energy versus Dual Energy Image Quality of Non-contrast Computed Tomography of the Head

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Purpose
Dual energy computed tomography (CT) has potential to confer enhanced image quality as compared with single energy CT secondary to differential tissue x-ray
absorption. Previous work evaluated the subjective advantage of various low and high energy blending ratios of DE technique for noncontrast CT of the head (1-3). However, direct comparison between the two techniques for this indication has not been performed. We investigated whether dual energy (DE) scans provide image quality equivalence as compared with traditional single energy (SE) technique. Materials and Methods HIPAA compliant IRB approved study. Noncontrast head CT studies performed on the same scanner (SOMATOM Force, Siemens, Forchheim) at two locations over a two month period were randomized prospectively to either SE (120kVp) or DE (80kVp-150kVp) technique. Other acquisition parameters were identical. Twenty normal studies with each technique, free from artifact or distracting pathology were compiled. Balanced low and high-energy kV blend (0.5) was utilized. Yoked pairs of SE and DE studies were created with age difference < 5 years. Three blinded practicing neuroradiologists reviewed each pair utilizing identical display parameters and forced selection decision as to superiority or equivalence for six anatomical criteria and overall image quality. Results Age and CTDI (Table 1) were notable for minimally higher CTDI for DE technique. Dual energy studies (Table 2) were chosen as superior for visualization of the pons by one reader (p = 0.001), the cerebellar gray-white interface by two readers (p = 0.004, p = 0.021), and the insular cortex by one reader (p = 0.007). No significant difference was otherwise observed. Single energy studies were not significantly superior for any criteria. Conclusions Dual energy noncontrast head CT reconstructed with a balanced 0.5 blending ratio was found to be significantly superior by some readers for evaluating certain anatomical structures. Otherwise, there was no significant difference or inferiority when compared to SE acquisition, supporting the routine use of this technique.
Fat Embolism Syndrome

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Purpose
The purposes of this poster are: To review the imaging findings in brain magnetic resonance imaging (MRI) in the fat embolism syndrome (FES), based on different
cases that presented at our institutions. To present the different patterns of changes that can be found on MRI. To be able to recognize FES in order to make an early diagnosis and give the appropriate treatment.

Materials and Methods
Electronic presentation reviewing the imaging findings of FES based on different cases of our institution, a review of the literature and recognition of the differential diagnosis.

Results
The FES is secondary to the vascular spread of fat globules that reach the lung and the peripheral circulation after long bone fractures or major trauma, more frequent in closed than in open fractures. Other etiologies include soft tissue trauma, liposuction and bone marrow biopsies. The risk of developing FES after long bone fracture is 1-13% with a mortality that reaches 15%. It is a challenging diagnosis for clinicians and typically it presents 24-72 hours after the initial trauma. The classic clinical triad includes changes in the respiratory pattern, neurologic abnormalities and petechial rash. There is not a clearly known mechanism for its development but the proposed theories include biochemical and mechanical causes; one of them being toxic intermediaries secondary to the fat in the plasma. There are five patterns of presentation on brain MRI: Scattered embolic ischemia, confluent symmetric cytotoxic edema, vasogenic edema, petechial hemorrhage and chronic sequelae.

Conclusions
The FES is secondary to the vascular spread of fat globules that reach the lung and the peripheral circulation after long bone fractures or major trauma, more frequent in closed than in open fractures. Other etiologies include soft tissue trauma, liposuction and bone marrow biopsies. The risk of developing FES after long bone fracture is 1-13% with a mortality that reaches 15%. It is a challenging diagnosis for clinicians and typically it presents 24-72 hours after the initial trauma. The classic clinical triad includes changes in the respiratory pattern, neurologic abnormalities and petechial rash. There is not a clearly known mechanism for its development but the proposed theories include biochemical and mechanical causes; one of them being toxic intermediaries secondary to the fat in the plasma. There are five patterns of presentation on brain MRI: Scattered embolic ischemia, confluent symmetric cytotoxic edema, vasogenic edema, petechial hemorrhage and chronic sequelae.
Same patient in figure 4, three months posttrauma control MRI shows volume loss and demyelination as chronic sequelae from FES

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25 year old man with a traumatic femur bone fracture. Glasgow scale 5/15 was noted at day 1, post trauma and the brain MR imaging SWI (a) shows small hypointensities that were not reported (b) 24 hours after the first MR demonstrate plentiful petechial hemorrhages in the white matter, subcortical and periventricular. Typical of neurological involvement in Fat Embolism Syndrome
Axial FLAIR images demonstrate dot-shaped vasogenic edema (arrows), typical finding of acute – subacute stage

(Filename: TCT_eP-51_Diapositiva3.jpg)
**Purpose**
This study aimed to understand the impact of virtual reality (VR) distraction on subjective pain perception and to identify the loci VR analgesia influences. Tc-99m ECD is a radiopharmaceutical that reflects brain perfusion at the time of injection. It
has a temporal resolution of 30 seconds to 2 minutes and was evaluated as a unique measure of brain activation.

Materials and Methods
Four patients (3 males, 1 female) with cutaneous burn injuries were studied after informed consent. All patients underwent identical wound care on two consecutive days – once with standard analgesia and adjunctive immersive and interactive VR, and once with standard analgesia alone. Tc-99m ECD was injected during wound care when peak pain occurred. Subjective 0-10 scores of pain intensity, time spent thinking about pain, pain unpleasantness, and "fun", as well as opioid equivalent usage were documented. Automated analysis of VR and non-VR brain perfusion SPECT was performed with Neurostat (Minoshima, University of Washington Radiology, www.rad.washington.edu).

Results
For the VR and non-VR conditions, respectively, mean group scores for pain intensity (9.0, 8.8), time spent thinking about pain (5.2, 10.0), pain unpleasantness (5.2, 6.2), fun (6.0, 2.5), and opioid equivalents (7.4, 11.5) were observed. The Neurostat image group analysis demonstrates activation in the right medial frontal lobe extending to the anterior insula and right caudate. There is also activation within the right occipital and bilateral heteromodal auditory cortex and periaqueductal gray. Suppression is visualized in the cerebellum.

Conclusions
Functional imaging during VR analgesia suggests multisensory activation and stimulation of the upper brainstem, in the region of periaqueductal gray, and is associated with overall decreased perception of pain. Suppression of cerebellar activity is also a prominent finding.
Functional Connectivity of Language in Patients with Space-occupying Lesions: Clinical Application

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Purpose
Patients with intra-axial lesions involving eloquent cortex often undergo task-based
functional mapping for pre-operative planning. It is not documented how resting-state networks behave in patients with mass lesions. Characterizing these networks is a vital first step for translation into clinically acceptable utilization of resting state functional connectivity.

Materials and Methods
Retrospective review of eight patients with left-sided intra-axial lesions in whom task-based language tasks and resting-state acquisitions were performed. Activation maps (AFNI software) were examined by three neuroradiologists to identify activation in the inferior frontal gyrus corresponding to Broca's area. Seed-based correlation analysis using the average resting-state timecourse from this region then was performed. Additionally, analysis of DTI data (30 directions, b=1000) was performed with tracts including Broca's and Wernicke's areas as seeds, as identified by both task-based and resting-state analysis, respectively. Mean fractional anisotropy values were compared.

Results
All patients had masses ipsilateral to the side of predominant inferior frontal gyrus activation. Seed-based resting state analysis using the region corresponding to Broca's area identified by task-based analysis demonstrated Broca's homologue and Wernicke's areas in our patient group. As an internal control, mean resting correlation between the canonical resting state language areas (0.742 ± 0.081) and resting state motor areas (0.670 ± 0.065), using the same seed-based method, were equivalent. Despite displacement of Wernicke's area due to mass effect in several patients, there was concordance in the degree of displacement of the resting state language network with task-based language activation.

Conclusions
This study shows a qualitative concordance of resting state language network areas with task-based language areas in our patient group, despite the presence of an intra-axial lesion ipsilateral to the side of language dominance. Persistence of functional language networks in patients with intra-axial lesions increases the clinical relevance of resting state functional connectivity mapping of language areas.
Figure 1. Axial T1 post-gadolinium (a) and axial T2 FLAIR (b) demonstrate a non-enhancing lesion centered in the posteromedial left temporal lobe. Axial (c) and sagittal (d) images with thresholded activation of sentence completion task ($p = 3.6 \times 10^{-4}$) demonstrates activation in the left frontal operculum corresponding to Broca’s area and activation in the posterior left superior temporal gyrus, corresponding to Wernicke’s area which is slightly displaced superiorly and posteriorly by the adjacent mass. Axial (e) and sagittal (f) maps of the resting state data using a seed ROI in the left frontal operculum at the site of a lesion show strong correlation ($R_{\text{mean}} = 0.501 \pm 0.010$, $R_{\text{max}} = 0.613$) with a cluster in the left superior temporal gyrus, in a similar location to the activation for Wernicke’s area as identified in the fMRI analysis.

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Functional disconnection of posterior cingulate cortex contributes to cognitive impairment in patients with symptomatic carotid artery disease

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Purpose
Patients with symptomatic carotid artery disease (CAD) have an increased risk of cognitive impairment but the mechanism has not been well established. Posterior cingulate cortex (PCC) is considered as a critical mode of the default mode network (DMN) which shows abnormality in a wide range of neurological diseases (1). We aimed to investigate the contribution of PCC functional disconnection on global cognitive impairment in CAD and the underlying mechanisms of PCC functional disconnection.

Materials and Methods
Patients with >30% ipsilateral carotid stenosis and recent cerebrovascular events were recruited after giving consent according to locally approved protocol. All subjects underwent the ACE-R cognitive test and 3T magnetic resonance imaging (MRI) brain scans including resting-state fMRI and standard diffusion tensor imaging (DTI). Seed-based analyses were conducted using FEAT (2) to study the association between PCC functional connectivity and global cognitive performance using time series data from supraventricular white matter and ventricles, six parameters obtained by rigid body head motion correction, age and mean relative displacement as nuisance regressors. Severity of PCC tissue damage was assessed by extracting regionally averaged mean diffusivity (MD). Additionally, white matter skeleton MD of each subject was determined to index the extent of white matter tissue injury. Associations between PCC and white matter MD and PCC functional disconnection were studied.

Results
Seventy-four subjects (age: 47-89 years, mean: 74.7 years) were included in this study. Neither acute nor chronic lesions were seen in the PCC. Global cognitive performance was correlated with functional connectivity between PCC and anterior cingulate cortex, left dorsolateral prefrontal cortex and left middle frontal gyrus. The PCC functional disconnection was associated with main white matter skeleton MD (P=0.01) but not with the PCC MD (P=0.09).

Conclusions
Posterior cingulate cortex functional disconnection contributes to cognitive
impairment in CAD, and is linked to global white matter injury suggesting an underlying structural disconnection as putative mechanism.
Gadolinium Deposition in the Dentate Nucleus: An Initial MR Spectroscopy Study

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Purpose
Our initial study utilizes magnetic resonance spectroscopy to detect changes in the dentate nuclei region of patients who have had multiple contrast injections and demonstrate T1 hyperintensity using biomarkers Choline, Myo-inositol, and N-acetyl aspartate.

Materials and Methods
Two subjects (1 brain tumor and 1 multiple sclerosis) with histories of multiple gadolinium-based contrast injections and five patients with no history of gadolinium-based contrast injections underwent magnetic resonance (MR) examinations on a General Electric 1.5T clinical scanner in the region of the dentate nucleus using single voxel point resolved spectroscopy (PRESS) TE 35 msec TR 1500 msec (Fig. 1).

Results
Subjects with histories of multiple gadolinium-based contrast administrations demonstrate increase in mI/Cr compared to normal controls (p < 0.05) (Fig. 2). Cho/Cr also was elevated but minimally.

Conclusions
Currently, there are no noninvasive methods to evaluate metabolic changes in the brains of patients who exhibit T1 hyperintense signal in the dentate nucleus after multiple gadolinium injections. Magnetic resonance spectroscopy has been shown to be a reliable and reproducible method of assessing chemical changes in the brain and potentially can be established as a monitoring tool for metabolic changes in patients receiving medical necessary multiple gadolinium injections.
Figure 2A: Elevated ml/NAA compared to NAA/Cr in patients with bright dentate nucleus compared to normal controls.

Figure 2B: Elevated ml/Cr compared to Cho/Cr in patients with bright dentate nucleus compared to normal controls.

(Filename: TCT_eP-76_graphsmrs.jpg)
Gadolinium Retention in Patients with Normal Renal Function: Observations of Compartmentalization of T1 Shortening Phenomena on Brain and Spine MR Imaging Post Gadolinium on Delayed Imaging

O Boyko¹, L Boyko¹, A Lerner¹, P Kim², S Metting², A Rajamohan², W Gibbs²
¹University of Southern California, Los Angeles, CA, ²University of Southern California, Keck School of Medicine, Los Angeles, CA

Purpose
Observations of gadolinium retention and compartmentalization of T1 shortening signal on postgadolinium magnetic resonance imaging (MRI) on delayed brain and spine imaging.

Materials and Methods
With recent publications on observations of T1 shortening in the brain due to possible gadolinium deposition in the brain, we looked for possible recirculation potential of gadolinium by reviewing 40 patients who had delayed imaging after completion of routine postgadolinium sequence and reviewing 25 brain tumor patients who had follow-up imaging, greater than five injections. Delayed imaging was defined as Acute (short term after completion of routine imaging and less than 75 minutes), Acute/Subacute (75 minutes to 4 hours), Subacute (4 hours to 7 days), Chronic (multiple injections over at least 2 years). Delayed imaging was either T1-weighted or T2-weighted FLAIR imaging.
Results
As expected 37 of 40 cases where imaging was acquired within 75 minutes of contrast administration after last routine imaging demonstrated continued enhancement of lesions including tumor and inflammatory lesions and post-traumatic subdural collections. Unexpectedly five patients imaged 8 or more hours after postcontrast administration demonstrated delayed T1 shortening presumed persisting gadolinium enhancement without complete washout including spinal cerebrospinal fluid (CSF). These included inflammatory lesions (neurocysticercosis), subarachnoid hemorrhage, tumor and pineal cyst. Unexpectedly three chronic brain tumor patients demonstrated progression of T1 shortening in the dentate nucleus after cumulative injections.

Conclusions
T1 shortening phenomena after gadolinium administration suggests a model of compartmentalization of gadolinium on delayed brain imaging possibly due to presumed local concentration gradients resulting in possible gadolinium recirculation can occur, creating the possibility of gadolinium "retention/deposition" in lesions and/or normal anatomy. A possible clinical neuroimaging pitfall of delayed/continued enhancement can occur which is not to be mistaken for blood products and hemorrhage.

eP-28

Gibraltar Sign Predicts Transverse Sinus Dominance

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¹Oregon Health Science University, Portland, OR, ²University of Nevada School of Medicine, reno, NV, ³Oregon Health Science University, portland, OR

Purpose
Anatomical variations of the transverse sinuses (TS) of the head and misdiagnosis of venous thrombosis in the setting of congenitally atretic or hypoplastic TS on time-of-flight (TOF) MR venography (MRV) have been described previously. Described here is a novel method for predicting laterality of congenital TS dominance. We hypothesize that the morphology of the groove for the superior sagittal sinus (gSSS), as it appears on axial T1-weighted turbo spin echo MR images, correlates with laterality of TS dominance. Knowledge of congenital TS dominance may prove useful during interpretation of MRV, helping to avoid misdiagnosis of venous thrombosis.

Materials and Methods
Two reviewers, a neuroradiology attending and a radiology resident, each reviewed separate groups of 50 consecutive brain MRI/MRV exams, excluding cases positive for venous thrombosis. gSSS morphology as seen on axial T1 MR images was categorized as "twin peak" if a bony concavity/groove flanked by two pointed
protuberances was present, or "plateau" if the gSSS had a flat top. A line was drawn either contacting the tips of the two peaks or parallel to the plateau, depending on which morphologic variant was present. The inclination of this line was calculated using the posterior falx as reference line (Fig. 1), to account for the effects of petalia. A gSSS inclination of 90° +/-2° was designated as flat. Outside of this range, obtuse angles opening to the right or opening to the left were designated as "rightward tilt" and "leftward tilt", respectively. The cross-sectional area of each TS at a point 2 cm from the confluence of sinuses was measured using manually drawn regions of interest placed around the flow-related signal on sagittal TOF MRV images. If the cross-sectional area of the bilateral TS differed by less than 5%, the TS were designated as "codominant"; outside of this range, TS anatomy was designated as either "right dominant" or "left dominant." Presuming a rightward tilt of the gSSS was associated with right TS dominance, a leftward tilt with left TS dominance, and flat gSSS with TS codominance, positive predictive values (PPV) of gSSS morphology were calculated.

Results
Of the 100 combined MRI/MRV exams reviewed, the inclination of the gSSS correctly predicted transverse sinus dominance in 91 cases. Positive predictive values of rightward tilt of the gSSS for right TS dominance, leftward tilt for left TS dominance, and flat gSSS for codominant TS was 96%, 88% and 60%, respectively. "Twin peak" and "plateau" morphology of gSSS was seen in 65% and 35% of cases, respectively. Significance of association was tested with Chi Squared Test, p<0.001.

Conclusions
Described here is a new, simple and accurate method for predicating laterality of congenital TS dominance based upon inspection of gSSS configuration on axial T1 MRI. Knowledge of TS dominance can help inform interpretation of brain MRV for TS thrombosis. The "Gibraltar sign" is proposed as a morphologic descriptor for the gSSS on axial imaging, given its likeness to the iconic twin peaked rock.
Figure 1. Coned-in view of the groove for the superior sagittal sinus (gSSS) on axial T1-weighted MRI. The gSSS measured by subtending a line (red) through the peaks of the groove. The posterior falx serves as a reference. This configuration of the gSSS was found to be predictive of right transverse sinus dominance with a positive predictive value of 96%.

GlobalRad Teaching File System: a Better Approach to Radiology Training

C Gibby¹, W Gibby², S Cvetko³
¹Baylor College of Medicine, Houston, TX, ²University of California San Diego, San Diego, CA, ³Novarad Corporation, American Fork, UT
Purpose
Radiology training is an intensely visual process and requires large numbers of cases. Many teaching file approaches have been attempted. These have varied from copied films sold to universities, cases compiled on individual institutions' computers, to several online sites. Institutional teaching files often are kept on difficult to access drives or folders with limited organization. They are almost always only available at that institution, limiting their impact. Online teaching files are kept in many file formats of variable image quality, without their native pixel resolution. This inhibits annotation or manipulation. Often cost is prohibitive, especially outside the United States. An easy to use program for radiologists and trainees to upload and share high-quality teaching cases to a server accessible anywhere is necessary.

Materials and Methods
www.Globalrad.org was built on an HTML5 web-based viewer platform and runs on most browsers and operating systems. Workstations, tablets, and even smartphones can use the site. Donated picture archiving and communication system viewer software was integrated into Globalrad. The image manipulation, annotation and functions such as window/leveling realistically replicate the contemporary radiology workstation. Information is hierarchically organized and simplified into categories of anatomical location and pathology type. Patient privacy is carefully preserved by stripping sensitive data from the header of each DICOM image upon submission. The system is built around simplicity. Cases can be selected, annotated and uploaded within the logical hierarchical framework within seconds to minutes. It also provides a testing module, which allows further interaction with the material. The site is a function of Globalrad, a 501C nonprofit foundation funded from private donations, making teaching files available at no cost to students and medical personnel.

Results
Worldwide response has been encouraging. Approximately 600 cases have been submitted from the United States and many other countries. The figure included shows a sample screen shot of one of the teaching file cases in the collection.

Conclusions
The Globalrad teaching file successfully creates a realistic case-viewing experience, and allows for easy access to cases for learning and teaching. This network, available anywhere, enhances the level of medical diagnostic services worldwide. With minimal effort Globalrad has the potential to logically catalog and ubiquitously distribute hundreds of thousands of shared teaching files.
eP-22

Head to head: Comparison of 3D phase contrast MR venography versus contrast-enhanced brain MRI with volumetric acquisition for diagnosis of central venous thrombosis.

D Gutman¹, A McClelland², J Farinhas¹
Purpose
Cerebral venous thrombosis (CVT) is a potentially lethal condition for which rapid diagnosis is crucial. Phase contrast (PC) MR venography (MRV) is a routinely used method of CVT detection although artifacts can lead to misdiagnosis, diagnostic delay, and further utilization of expensive resources. In this study, we demonstrate that the routine use of contrast-enhanced (CE) magnetic resonance imaging (MRI) with volumetric acquisition results in timely diagnosis of CVT with fewer follow-up studies, increasing imaging efficiency.

Materials and Methods
One hundred patients were identified from our Radiology Information System (RIS) database for which CE MRI and/or PC MRV was obtained to evaluate for CVT. Each study was read separately and independently by two attending neuroradiologists, a neuroradiology fellow, and a senior general radiology resident. Each study was scored as positive, negative, or uncertain for the diagnosis of cerebral venous thrombosis. The number of studies required to reach a final diagnosis, the relative timing of each study, the time from initial presentation to final diagnosis, and the total length of hospital stay was determined for each patient.

Results
We determined that contrast-enhanced MRI resulted in significantly higher frequency of certain diagnoses for CVT than PC MRV. Patients who received contrast-enhanced MRI as their initial study underwent fewer follow-up studies and received definitive treatment earlier.

Conclusions
Contrast-enhanced MRI with volumetric acquisition is a readily available study that can be used routinely for the evaluation of CVT. Use of contrast-enhanced MRI results in more certain and more rapid diagnosis of CVT compared to PC MRV. As delayed diagnosis and treatment of CVT is associated with worsened clinical outcomes, routine use of contrast-enhanced MRI potentially can reduce morbidity and mortality associated with this potentially lethal condition.

**eP-115**
6:30AM - 2:45PM

**High Resolution Imaging with Fast Gray Matter Acquisition T1 Inversion Recovery (FGATIR): Neuroimaging atlas of the basal ganglia circuitry for deep brain stimulation planning**

S Bhuta¹, G Kwan², C Hsu²
Purpose
To describe our initial experience with the FGATIR sequence for deep brain stimulation protocol (DBS) and creation of a high resolution neuroimaging atlas of the basal ganglia circuitry and white matter pathways.

Materials and Methods
Fast gray matter acquisition T1 inversion recovery (FGATIR) sequence with nulled white matter signal intensity which provides improved contrast resolution between the basal ganglia nuclei and the white matter pathways. We described our initial experience of the FGATIR sequence to our existing DBS protocol. Acquisition parameters are as follows, Siemens 3T Skyra MRI system, TR 3000ms, TE 4.39 ms, TI 409 ms, inversion pulse angle 180 degrees, matrix 320x256, FOV 256x192 mm, slices thickness 160x1 mm and bandwidth of 130Hz). High resolution diffusion tensor imaging (DTI) also was performed to understand white matter fiber connections, e.g., Papez Circuit. Diffusion tensor imaging was obtained with FoV read 230 mm, slice thickness of 5.0 mm with 20 different geometric directions. Isotropic diffusion-weighted images, apparent diffusion coefficient (ADC) maps, color-coded fractional anisotropy (FA) maps were calculated.

Results
Accurate placement of deep brain stimulation (DBS) electrode requires visualization of subcortical nuclei and knowledge of its complex circuitry. We were successful in resolving deep gray matter nuclei of the brain with high-resolution images. Comprehensive illustrations of the basal ganglia circuitry as well as the intricate passing white matter fiber connections using tractography were studied in depth and are illustrated in a neuroimaging atlas format.

Conclusions
FGATIR provides high-resolution imaging of the basal ganglia circuitry and may potentially improve lead placement and patient outcome. This comprehensive FGATIR neuroimaging atlas along with white matter fiber tractography provides an indispensable road map for DBS planning.

eP-98
 Immediate Peri-stenting Cerebral Perfusion Imaging by Cone-beam CT- A Pilot Study in Patients with Carotid Stenosis

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¹Taipei Veterans General Hospital; School of Medicine, National Yang-Ming University, Taipei, Taiwan, ²Taipei Veterans General Hospital; School of Medicine,
Purpose
Cone-beam computed tomography (CT) perfusion imaging (CB-CTP) feasibly is used in acute stroke management. The current study was aimed to study immediate peristenting cerebral perfusion in patients with chronic mal-perfused brain due to carotid stenosis by using CB-CTP.

Materials and Methods
The study included 12 patients (8 male and 4 female, age 66 years, 46-88 years old), who had at least 70% stenosis of their extracranial internal carotid arteries due to atherosclerosis in six (group 1, age 73 years, 62-88 years old, four symptomatic) and previous radiation therapy for head and neck cancers in other six (group 2, age 59 years, 46-77 years old, five symptomatic). Cone-beam-CTP was performed immediate before and (18.3, 10.8-38.0 minutes) after carotid stenting. All CB-CTP were performed on a DSA system equipped with flat detectors (AXIOM Artis®, Siemens Healthcare, Forchheim, Germany) and multiple rotational data acquisitions. On the transverse slices of reconstructed volumes of CB-CTP maps, regions of interest (ROIs) were placed on whole brain, hemispheres and middle cerebral arterial territories of a slice at basal ganglia level of both stenotic and contralateral sides homologously. Hemodynamics parameters (CBF, CBV, MTT, and TTP) stemmed from the ROIs were used for peri-stenting quantitative analysis. Paired Student T test and Wilcoxon signed rank test were adopted to evaluate the peri-stenting hemodynamic changes of all 12 patients, groups 1 and 2, respectively. The statistical significance was set at p=0.05.

Results
Group 2 patients were younger than group 1 with modest significance (p=0.06). Cerebral blood flow and MTT of stenotic hemisphere exhibited significant improvement after stenting in all 12 patients; more specific regional analysis revealed MTT and TTP of ipsilateral MCA improved significantly as well. For group 1, both CBV and CBF of global, ipsilateral hemisphere, and contralateral hemisphere showed significance in improvement, while MTT of ipsilateral MCA being the only significant parameter in terms of regional comparison. On the contrary, for group 2 only TTP of ipsilateral MCA was found to be significantly improved. Higher autoregulation reservation might explain the difference in improvement that involved between groups of patients. Among them, group 2 were younger and with less atherosclerotic changes of intracranial arteries and presented better vascular autoregulation.
Conclusions
Quantification of immediate peri-stenting brain hemodynamics changes by CB-CTP is feasible. Difference of carotid stenosis might involve various degree of auto regulation, vascular response and compliance to stenting concerning hemodynamics. Cone-beam CTP provides the niche for first moment assessment of hemodynamics within the angiosuite that is equipped with CB-CTP. Subsequently, the information obtained from the angiosuite setting facilitates patient management and clinical outcome in stenting treatment of carotid arterial stenosis.

eP-55

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¹Medical College of Wisconsin - Froedtert Hospital, Milwaukee, WI, ²MEDICAL COLLEGE OF WISCONSIN, Milwaukee, WI

Purpose
Cerebrovascular ischemia accounts for significant mortality and morbidity with rising incidence as the population ages. Computed tomography (CT) and magnetic resonance imaging (MRI) are competing imaging modalities for acute stroke diagnosis available to emergency department (ED) physicians. The purpose of our study was to examine clinical data that could guide ED utilization of these imaging tools.

Materials and Methods
The medical records of 150 patients (of 1000 planned) suspected of stroke with CT and MRI examinations acquired within 24 hours of one another were reviewed. Age, gender, race, and history of smoking, hypertension, diabetes, and hyperlipidemia were recorded. Computed tomography and MRI positive (PPV) and negative (NPV) predictive values and accuracy were compared to the discharge diagnosis of stroke (49%).

Results
Considering all subgroups, MRI was more accurate than CT in evaluating for stroke (Fig. 1). While CT PPV did not change across age categories, there was an inverse relationship between age and CT NPV (Fig. 2). Computed tomography NPV was similar to MRI below the age of 50 years, but decreased linearly beyond 60 years. Interestingly, CTs of Caucasians had lower NPV and higher PPV compared to African Americans (Fig. 3). There was no difference in CT predictive value across genders. Surprisingly, smokers demonstrated higher CT NPV (73%) and lower PPV (72%)
compared to CT NPV (58%/54%) and CT PPV (91%/100%) for nonsmokers/quitters (Fig. 4). Also, NPV was lowest and PPV highest for patients with hyperlipidemia compared to hypertension and diabetes mellitus (Fig. 4).

Conclusions
Magnetic resonance imaging accuracy and predictive value for stroke evaluation is superior to CT and immune to demographic and risk factors. Computed tomography is most predictive in younger patients and is least predictive in patients with hyperlipidemia. The influence of race and smoking history may be due to underlying white matter disease, but needs further investigation. Patient stratification based on clinical profile may optimize use of competing neuroimaging modalities for stroke evaluation.

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eP-80

6:30AM - 2:45PM

Improving MS Lesions Detection: Towards a Better 3D FLAIR Sequence?

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¹Val-de-Grâce Military Hospital, Paris, Ile de France, ²A. de Rothschild foundation, Paris, Ile de France, ³s.a.r.l. IMAGE ET, MORDELLIES, Bretagne

Purpose
3D FLAIR, now available on most systems, is a key sequence for detecting
demyelinating lesions in multiple sclerosis (MS). Yet, there is no consensus regarding its acquisition parameters. The aim of our study was to compare the diagnostic accuracy of three different set of parameters of 3D FLAIR sequences.

Materials and Methods
Twenty-seven patients with relapsing-remitting MS were enrolled prospectively and underwent a 3T magnetic resonance imaging (MRI) including 3 FLAIR sequences (named after their TR: 4800ms, 8000ms and 10000ms).

Results
Eight thousand five hundred ninety-four lesions were segmented. The FLAIR 8000 and 10,000 sequences detected an average of 16.9 and 16.6 additional lesions per patient compared to the FLAIR 4800 (p=0.024 and 0.032 respectively). This better performance was found in every location except for the posterior fossa. There was no significant difference between the FLAIR 8000 and 10,000. At the cost of a decreased signal to noise ratio, the higher TR sequences offered a better contrast between the lesion and its environment compared to the FLAIR 4800 (p < 1.10-8).

Conclusions
Our study points out the interest of setting up optimal parameters for 3D FLAIR sequences in MS. It advocates for going beyond the standardization of protocols and standardize sequences themselves in order to improve results reproducibility between imaging facilities.
Mean number of lesions in one patient

TR = 4800 ms  TR = 8000 ms  TR = 10000 ms

p = 0.032*
p = 0.024*
p = 0.658

TR = 4800 ms
TR = 8000 ms
TR = 10000 ms
Intracranial Vessel Wall Lesions in Patients with Systematic Lupus Erythematosus

S Ide¹, S Kakeda¹, J Moriya¹, K Futatsuya¹, N Ohnari¹, Y Tanaka², Y Korogi¹
¹Department of Radiology, University of Occupational and Environmental Health, School of Medicine, Kitakyushu, Japan, ²First department of Internal Medicine, University of Occupational and Environmental Health, Kitakyusyu, Japan

Purpose

Previous MR analysis with systematic lupus erythematosus (SLE) (1) revealed various types of brain lesions, of which one manifestation is cerebrovascular disease. However, there are few MR studies investigating intracranial vessel wall lesions (VWLs) in the SLE patients. The aim of this study was to demonstrate prevalence of the VWLs occurring in SLE patients and to assess the relationship between the VWLs and brain lesions.

Materials and Methods

Forty-three SLE patients (mean age 39.1 years, mean disease duration 3631 days) underwent 3T MRI, including 3D vessel wall imaging. The VWLs were defined as a clear thickening compared with the contralateral healthy side or a part of the vessel walls more proximal or distal to the thickened wall (2). For each of 29 segments of the intracranial artery, the VWLs were scored as either positive or negative. We also detected brain lesions on T2-weighted and/or FLAIR images; these were categorized as large territorial, lacunar, localized cortical and borderzone, and large perforator infarctions.

Results

We found 189 VWLs in 37 patients (86%), located primarily in the M2 segments of the middle cerebral artery (MCA) (25/37, 68%). We found a significant positive correlation between the number of the VWLs and the disease durations (r=.57, p<.01). There were 15 brain lesions in nine (21%) patients (Table), and average number of the VWLs was larger in the patients with the brain lesions than without (9.1 versus 3.2, p<.01). In all of the large territorial and large perforator infarctions (Figure), forty-six-year-old woman with SLE with neuropsychiatric SLE), and three of the five borderzone infarctions, the lesion areas corresponded to the arterial territory of the VWLs.

Conclusions

Three dimensional (3D) vessel wall imaging may provide additional insight to the pathogenesis of the brain lesions in SLE patients.
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<th>Details of brain lesions in SLE patients</th>
<th>SLE patients with brain lesions (n=9), No. (%)</th>
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Figure A

Diffusion weighted image shows acute infarction in right deep white matter.

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Figure B

T1 weighted CUBE shows the VWL in M1 segment of right MCA.

(Filename: TCT_eP-25_figb.jpg)
Is Gadolinium Deposition in the Dentate Nuclei Associated With a Change In Metabolic Activity on PET?

M Kuruva1, R Samant1, M Kessler1, R Fitzgerald1, R Van Hemert1, M Kumar1, J McDonald1, E Angtuaco1

1University of Arkansas for Medical Sciences, Little Rock, AR

Purpose
Recent studies have demonstrated retention of gadolinium in the dentate nuclei in patients who received multiple administrations of linear gadolinium-based contrast agents. However, physiological and functional consequences of gadolinium deposition have not been reported in the literature. Our aim is to assess whether this deposition is associated with a change in metabolic activity on PET scans.

Materials and Methods
Retrospective review of magnetic resonance imaging (MRI) scans and FDG PET studies of patients who had baseline and follow-up FDG PET scans (with brain
included in the study) done as a part of whole body imaging protocol prior to and after development of T1 hyperintensities was done. The dentate nuclei on the initial scan and follow-up scan were identified visually and SUV values in the nuclei and ratios with ipsilateral temporal lobes were analyzed. Paired 't' test was used to compare SUVmax values and ratios on baseline and follow-up scans. P value of less than 0.01 was considered statistically significant.

Results
Six females and four males were included in this study. The initial SUVmax value on baseline scans ranged from 3.5-7.2 on left side and 3.3-7.7 on right side. During the follow up the SUVmax value ranged from 2.7-7.7 on left side and 2.7-7.2 on right side. No significant difference was seen in dentate nuclei FDG uptake from baseline to follow-up scan on both sides ; mean Suvmax of 5.26 versus 5.29 with a p value of 0.92 on left and mean SUVmax of 5.24 versus 5.06 with a p value of 0.52 on the right side. Dentate nucleus/temporal lobe (D/TL) ratio of SUVs on baseline ranged from 0.81-1.05 on left side and 0.81-1.09 on right side. Dentate nucleus/temporal lobe ratio of SUVs during follow up ranged from 0.89-1.18 on left side and on 0.82-1.07 on right side. No statistical significant difference was seen between baseline and follow-up D/TL ratios on both sides. Only one patient showed a significant absolute SUV increase, but showed normal dentate to temporal lobe ratios. All of the results are depicted in Table 1.

Conclusions
Our initial experience suggests that accumulation of gadolinium in dentate nuclei does not result in significant changes in metabolic activity of dentate nuclei and may not have functional consequences. However further studies with larger population and dedicated brain imaging protocols need to be done to confirm these results.
### Laterality of the Superior Ophthalmic Veins (SOVs) based on Physiological Findings

A SAIGA¹, H Yokota¹, H Mukai¹, T Horikoshi¹, T Uno¹

¹Chiba university hospital, Chiba, Chiba

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**eP-04**

6:30AM - 2:45PM

Laterality of the Superior Ophthalmic Veins (SOVs) based on Physiological Findings

A SAIGA¹, H Yokota¹, H Mukai¹, T Horikoshi¹, T Uno¹

¹Chiba university hospital, Chiba, Chiba
Purpose
Laterality of the superior ophthalmic veins (SOVs) is sometimes detected on routine
works. We compared laterality of normal SOV and pathological SOV dilation.

Materials and Methods
Two hundred eleven cases without any abnormal findings on brain magnetic
resonance image (MRI) were included. Two radiologists judged the laterality on axial
contrast-enhanced three-dimensional T1-weighted images (1.4 mm thickness).
Diameters of SOV at distal, middle and proximal points were measured. The distal,
middle and proximal points were set at a level of the rear of the eyeball, angular point
of SOV and anterior apex of temporal lobe, respectively. Of the 17 cases of CCF, we
obtained both pre-operative computed tomography (CT) and MR angiography (MRA)
data at slice thickness as thin as possible.

Results
Twenty-two of 211 cases (9.6%) showed laterality. On normal side, diameters at
distal, middle and proximal points were 1.5±0.4, 1.7±0.5 and 1.3±0.3 mm,
respectively. On dilated side, diameters at distal, middle and proximal points were
2.2±0.5, 2.5±0.7 and 1.6±0.5, respectively. The diameters at distal and middle points
were dilated significantly (Wilcoxon signed-rank test, p=0.001> and 0.001>). On
diseased side with CCF, diameters at distal, middle and proximal points were 2.8±1.7,
3.2±2.1 and 2.7±1.9 mm, respectively. Proximal points were significantly thicker than
SOV with normal dilation (Mann-Whitney U test, p=0.005).

Conclusions
Superior ophthalmic vein shows laterality in normal cases, predominantly in distal
part. On the other hand, CCF can have dilations of SOV from the proximal to distal
part. This differences in SOV dilation may lead to notice normal dilation or not.

eP-43

Low-signal-intensity rim on susceptibility-weighted imaging is not a specific
finding to progressive multifocal leukoencephalopathy

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

Purpose
Low-signal-intensity (LSI) rim along deep layers of the cerebral cortex is reportedly a
susceptibility-weighted imaging (SWI) finding in progressive multifocal
leukoencephalopathy (PML) (1). We aimed to evaluate whether this finding can be
identified in diseases other than PML.
Materials and Methods
We retrospectively reviewed brain magnetic resonance (MR) images from 5605 patients who underwent susceptibility-weighted imaging (SWI) at 3 T; 370 patients with various diseases, who showed cortical and subcortical FLAIR high-signal lesions including U-fiber were enrolled. The presence or absence of LSI rim on thin-slice SWI and hyperintense cortical signal (HCS) on T1-weighted images adjacent to LSI rim was analyzed. Signal changes of the LSI rim were assessed on serial SWI, if available.

Results
Twenty-five of the 370 patients (6.8%) showed SWI LSI rim, in infarction (n = 22) and encephalitis (n = 3). Hyperintense cortical signal was apparent adjacent to SWI LSI rim in 17 patients (15 infarction, 2 encephalitis) (Fig. 1). Serial SWI was available for 17 patients, of whom 10 patients (eight infarction, two encephalitis) presented LSI rim later than 45 days after onset.

Conclusions
Low-signal intensity rim can be observed in infarction or encephalitis. Therefore, this finding is not specific to PML. Low-signal intensity rim appears to be associated with HCS.
Fig. 1 A 71-year-old female with cerebral infarction in the right temporo-occipital lobe. Low-signal-intensity rim along deep layer identified SWI appeared onset 312 days after infarction.

(Filename: TCT_eP-43_Fig1.jpg)

eP-111

Measurement of Cerebral Venous Susceptibility in Healthy Volunteers Using Quantitative Susceptibility Measurement Techniques

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Purpose
Quantitative susceptibility measurement (QSM) is a relatively novel extension of traditional susceptibility-weighted imaging. Applications include trauma, stroke and neurodegenerative disease, among others. One method for evaluating these disease processes is quantification of cerebral venous susceptibility. As a novel technology, expected normal values and the range of physiologic response are not known yet. The purpose of this study was to determine the quantitative susceptibility of deep and superficial cerebral venous structures in healthy volunteers, as well as the expected physiologic response to caffeine administration.

Materials and Methods
An experimental study was performed to study the range of normal quantitative cerebral venous susceptibility values in 23 healthy individuals. Quantitative cerebral venous susceptibility values were measured at baseline and following 200 mg of caffeine administration. Susceptibility-weighted imaging maps were created with SPIN software (MR Institute, Detroit). Quantitative susceptibility measurements of the bilateral largest cortical and internal cerebral veins were obtained by placing a region of interest (ROI) along the long axis of the veins and recording the mean value in parts per billion (ppb). Comparison of QSMs at baseline and after caffeine administration also was made between each group using the Wilcoxon Signed Rank test.

Results
Twenty-three subjects participated in the study. We recorded the following average baseline susceptibilities in parts per billion: Straight sinus 475.6 ±136.4; Right internal cerebral vein 283.9 ± 61.7; Left internal cerebral vein 294.3 ± 63.6; Right cortical vein 246.9 ± 78.8; Left cortical vein 218.2 ± 74.4. Following caffeine administration average susceptibilities in parts per billion were: Straight sinus 697.1 ± 237.4; Right internal cerebral vein 398.8 ± 99.9; Left internal cerebral vein 425.7 ± 133.3; Right cortical vein 361.0 ± 100.7; Left cortical vein 375.4 ± 147.4.

Conclusions
While limited by small sample size, our data provide reference values for normal volunteers and the range of expected physiologic response following caffeine administration in healthy volunteers. These values can serve as a framework when studying disease states.

eP-15

Measuring iron deposits within focal lesions in patients presenting clinically isolated syndrome
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Purpose
To evaluate the role of the iron (Fe) deposit within focal lesions visualized on T2-weighted magnetic resonance images (MRIs) in patients presenting with clinically isolated syndrome (CIS).

Materials and Methods
Thirty patients with CIS underwent two 3.0T brain MRI (0-3 and 12 months after first symptoms), including proton density-, T2-weighted, and magnetic susceptibility sequences. Baseline iron content of lesions was measured on filtered-phase SW images as the increase with regard to white matter values in healthy controls for the whole lesion (iFe1B), and the increase and extension in the region with high iron content (iFe2B, and NPB). Correlations of iron measurements with lesion load, new lesions, brain parenchymal fraction (BPF), percentage of brain volume change, EDSS, and disease duration were studied by means of Spearman rank correlation test. Moreover, in all patients we analyzed using Student t-test the presence of differences in iron deposits between groups defined by the fulfillment of MRI criteria for dissemination in time and space (according to multiple sclerosis diagnostic criteria), and conversion to clinically definite MS (new relapse).

Results
Moderate-strong significant correlations were found between NPB and baseline lesion load (LLD), new lesion (NLT2) and BPF at month 12. iFe1B and iFe2B presented moderated significant correlations with LLD of active lesions, iFe1B with the number of NLT2, and iFe2B with the baseline T2 lesion volume and BPF at month 12. Significant differences for the 3 iron variables were found between groups of dissemination in time and space-time, and only in space for NPB, and in new relapses for iFe2B.

Conclusions
We found relation between the iron deposits within baseline lesions and baseline lesion load, the presence of NLT2, and BPF at month 12. The iron deposit allows discriminating those patients with CIS and those with a higher probability to present multiple sclerosis.

eP-24
6:30AM - 2:45PM

Medullary Edema and Enhancement: A Characteristic Manifestation of Dural Arterio-Venous Fistulas on MRI
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Purpose
1. To present a series of patients who manifested with medullary edema and enhancement on magnetic resonance imaging (MRI) that were a result of underlying dural arterio-venous fistulas (AVF). 2. To discuss the clinical presentations, the unusual but characteristic findings on MRI that can be confused with other conditions and lead to delayed diagnosis, and the management of these patients.

Materials and Methods
Five patients between the ages of 35-72 years that presented at two major teaching institutions over the past 5 years with medullary findings from dural AV fistulas are reviewed. All patients initially underwent computed tomography (CT) and MRI examinations. In two patients MR spectroscopy (MRS) and perfusion also was performed. All patients eventually underwent catheter arteriography.

Results
In all five patients, MRI demonstrated edema in the medulla as well as variable but intense enhancement. The edema had a geographic pattern with sparing of linear areas along the periphery of the medulla (Fig, 1). In 4/5 patients, some abnormal vasculature was present (often in retrospect) on initial imaging. However in most of the cases, the vascularity was not very obvious, and in some, distant from the medullary edema. As a result, initial concern was centered on the medullary 'mass-like appearance' and consequently consideration was given to inflammatory and neoplastic conditions. Patients underwent extensive workups and diagnoses were delayed (in two cases for over 6 months). In one patient, despite suspicion being raised on MRI, initial somewhat limited cerebral angiogram was read as negative for a dural AVF and patient continued to undergo workup for presumed tumor. Repeat angiogram with external carotid selective injection delineated the dural AVF. Eventually all patients were suspected to have a dural AVF, and had diagnostic catheter angiography that revealed cerebral (N=4) and spinal (N=1) dural AVFs. Management included endovascular embolization in two, multiple surgeries in one, and combined embolization and surgery in two. Two of the patients had complete resolution of symptoms following treatment. The two with delayed diagnosis (one treated with surgery alone), did not show significant improvement. The most recently treated patient by embolization is currently under follow-up and showed some improvement.

Conclusions
The diagnosis of dural AVF involving the medulla oblongata can be difficult on MRI. This is partly from the prominent parenchymal changes in the medulla (T2 signal
hyperintensity, expansion, and enhancement) relating to the venous congestion, and also as the direct indicators of vascular pathology, namely enlarged tortuous vessels, are sometimes subtle or located away from the fistula site. Failure to recognize this pattern of parenchymal changes (geographic or linear sparing) may lead to significant delay in diagnosis or misdiagnosis as inflammatory or neoplastic pathology with resultant poor outcome from the irreversible effects of venous hypertension. When dural AVFs are suspected, a thorough vascular investigation including external carotid, vertebral and subclavian arteries and branches should be performed.

(Filename: TCT_eP-24_Abstractpicture.jpg)

eP-45

6:30AM - 2:45PM

Mobile Assessment in Acute Stroke: Is portable CT really up to the task?

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Purpose
Assess diagnostic adequacy of portable computed tomography (CT) for initial assessment of patients in the mobile stroke treatment unit (MSTU).

Materials and Methods
Two neuroradiologists retrospectively reviewed 200 portable CT exams performed with the Ceretom (Neurologica, Danvers, MA) on the MSTU between July 2014 and March 2015 in sequential order, assigning Albert Stroke Program Early CT Score (ASPECTS) via consensus interpretation (when an alternate imaging diagnosis was not detected), and rating their confidence in assigning ASPECTS scores on a Likert scale. Clinical data were obtained from a quality assurance registry. Repeat imaging, when available, within 48 hours of the initial scan was reviewed to assess for hemorrhage that may have been missed on the initial CT. One neuroradiologist then independently assessed the first 50 scans and the final 50 scans of those reviewed, in random order, categorizing imaging artifacts and rating their impact on diagnostic quality on a Likert scale. Parametric statistical analysis performed with Z-test.

Results
Portable CT findings are listed in the Table. Of the 200 exams reviewed, 83 had available follow-up imaging performed within 48 hours (40 CT, 43 MR alone). No newly apparent hemorrhage was detected on those follow-up images, including all 19 patients who received IV thrombolysis. Imaging artifacts and distribution of ASPECTS scores were not statistically different between the initial 50 and final 50 portable exams reviewed, but the reviewer's confidence in assigning these scores was higher in the later group ($z=3.7998$, $p=0.002$); this may reflect improved quality not accounted for by the artifact scoring, or it may be a function of viewing the images in sequential order, resulting in a bias based on increased familiarity with typical artifacts seen on portable imaging (Fig.).

Conclusions
Findings support adequacy of portable CT for excluding clinically significant hemorrhage prior to consideration of IV thrombolysis in acute stroke.
<table>
<thead>
<tr>
<th>MSTU Portable CT Findings (N=200)</th>
<th>No. of Cases (N=200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Ischemic Change</td>
<td>18</td>
</tr>
<tr>
<td>Hyperdense vessel sign</td>
<td>4</td>
</tr>
<tr>
<td>Intracerebral Hemorrhage</td>
<td>6</td>
</tr>
<tr>
<td>Subarachnoid Hemorrhage</td>
<td>2</td>
</tr>
<tr>
<td>Subdural Hemorrhage</td>
<td>1</td>
</tr>
<tr>
<td>Mass Lesion (s)</td>
<td>7</td>
</tr>
<tr>
<td>Remote Infarct(s)</td>
<td>68</td>
</tr>
<tr>
<td>Other (chronic)</td>
<td>33</td>
</tr>
<tr>
<td>Essentially normal for age</td>
<td>147</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASPECTS Score Distribution</th>
<th>No. of Cases (N=200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>128</td>
</tr>
<tr>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>&lt;=7</td>
<td>19</td>
</tr>
<tr>
<td>Alternate diagnosis</td>
<td>15</td>
</tr>
</tbody>
</table>

*figure*: Portable scans are susceptible to off-isocenter artifacts due to small gantry aperture (arrowheads), corrected by centering the patient; and are also prone to increased beam hardening from the teeth and skull base due to fixed 90 degree gantry angle (arrows).

(Filename: TCT_eP-45_figure1.PNG)

eP-20

Moyamoya Syndrome in Adults: A Pictorial Review
Purpose
The objective of this pictorial review is to illustrate the characteristic imaging findings of moyamoya syndrome in adults. The background, presentation, prognosis and treatment of adult onset moyamoya also will be discussed. This will enable the reader to recognize and diagnose moyamoya syndrome across a wide range of presentations and imaging modalities.

Materials and Methods
Moyamoya is a cerebrovascular condition classically characterized by progressive stenosis of the distal internal carotid artery with variable involvement of the anterior and middle cerebral arteries (1). The characteristic angiographic appearance of the collateral circulation that develops secondary to the stenosis gives rise to this condition's distinctive name 'moyamoya' which is Japanese for "something hazy, like a puff of cigarette smoke" (1). When used alone, moyamoya is an umbrella term that encompasses both the disease and the syndrome. Moyamoya disease is bilateral in its presentation and seen in those who have no underlying conditions or risk factors while moyamoya syndrome, which is also known as quasi-moyamoya (2), refers to unilateral or bilateral disease in association with other disease entities such as atherosclerosis, neurofibromatosis type 1 (von Recklinghausen disease), sickle cell disease and Down's syndrome or in the setting of prior radiotherapy to the head or neck (2).

Results
This pictorial review uses newly diagnosed cases of moyamoya syndrome identified in adults in our institution over the past 12 months. The characteristic findings of moyamoya syndrome are demonstrated and explained using the modalities of computed tomography angiography (CTA), magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA). Unilateral versus bilateral and untreated versus treated imaging studies are compared.

Conclusions
The reader of this pictorial review will have a better understanding of this condition and will be aware of its typical presentation and the pathology that underlies it. Most importantly they should be able to identify the characteristic imaging findings of moyamoya syndrome and be aware of the imaging modalities which may be employed to aid in the diagnosis.
MRI Axial T2

54 year old female presented with migraine. Diagnosed with moyamoya syndrome-right-sided MCA abnormality. This image demonstrates an abnormal flow void of the right internal carotid artery (A) and smaller flow voids more laterally due to the presence of collateral vessels (a).

(Filename: TCT_eP-20_Slide1.jpg)
42 year old male presented with vertigo and headache. Diagnosed with moyamoya syndrome-involvement of the right internal carotid artery and MCA. Supra-clinoid stenosis is seen in this image (B) and along with small collateral vessels (b).

(Filename: TCT_eP-20_Slide2.jpg)
Axial MIP CTA

54 year old male presented with acute onset dizziness and vomiting. Diagnosed with moyamoya syndrome-bilateral involvement of the internal carotid arteries and MCAs on a background of a basilar artery aneurysm (c). "Puff of smoke" collaterals are seen in this image (C).

(Filename: TCT_eP-20_Slide3.jpg)
MR Imaging Findings of Cerebellar Tonsillar Displacement in Adults: Chiari Type-I Malformation versus Spontaneous Intracranial Hypotension

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Purpose
Downward cerebellar tonsillar displacement or ectopia (CE) might have multiple causes. Chiari malformation (CM) and spontaneous intracranial hypotension (SIH) are important entities presenting with this imaging finding. Differentiating these conditions, sometimes challenging, is of utmost clinical importance. The management
differs significantly with epidural blood patch in SIH and elective sub occipital decompression in some cases of CM.

Materials and Methods
Retrospective review of cases with CE and clinical diagnosis of CM or SIH was performed in our radiology database. Quantitative measurements: length of supraocciput (LSO), diameters of foramen magnum, ponto-mesencephalic angle (PMA), mamillary pontine distance (MPD), among others were performed. Qualitative variables: Effacement of PMA, pituitary prominence (PP), dural enhancement (DE), rounded transverse sinus (RTS), oval shape of foramen magnum (OFM), among others also were recorded. SPSS was used for statistical analysis; t-test and exact test were used for quantitative and qualitative differences between groups, respectively.

Results
Sixty-three cases of CM and 23 cases of SIH were selected. Mean values of LSO: 38±3.9 and 40±5.6 (p< 0.06); PMA: 58±13 and 32±18 (p<0.00); and MPD: 5.5±1.2 and 4±2 (p <0.00), for the CM and SIH groups, respectively showed significant differences. Effacement of PMA was present in 3/64 and 20/26 of CM and SIH, respectively. Similarly, PP: 3/63 and 19/26; DE: 0/63 and 18/23; RTS: 0/63 and 17/23; and OFM: 25/60 and 7/26, were noted in CM and SIH groups, respectively. These qualitative variables showed significant differences between groups (p<0.00).

Conclusions
Decreased LSO and the OFM are characteristics of CM cases, confirming a congenital cause of CE. Effacement of PMA with decreased angle values as well as PP is seen in the majority of SIH cases; rarely in CM. In uncertain cases of CE, particularly when overlapping features of CM and SIH are noted, the use of contrast can be helpful, as DE was not seen in CM. In addition, attention to RTS sign in suspected cases of SIH is helpful, also not seen in CM.
MRI Brain Post-Processing Improves Intracranial Lesion Conspicuity: Fusing Masked Color Images Over Grayscale Underlay for Multiple Sclerosis Plaques and Metastatic Lesions.

F Choudhry¹, B Connolly², A Tarabishy²
Purpose
A novel approach to increase lesion conspicuity on brain magnetic resonance imaging (MRI) using Olea Sphere™ software (displays MRI data in gray scale or color and allows overlay/blending of MRI series using DICOM data for coregistration) is presented. Inherent to the application, but not obvious, is the ability to fuse two "versions" of same sequence without sacrificing voxel range display. Unlike standard PACS software that allows windowing of the data, which emphasizes "brighter" voxels and "darkens" lower intensity voxels, sacrificing dynamic range, composite postprocessed images emphasize only brighter voxels. Essentially you window only the brighter areas of the image. This technique can be combined easily with color scales, displaying the brighter lesions in color against a gray scale background of normal brain tissue. In our experience, this increases lesion conspicuity and allows the radiologist to see greater anatomical detail than what is displayed on a tightly windowed image. The goal of this work is not to prove superiority of this method to traditional gray scale MRI imaging, rather to help show people in our industry the possibilities that exist with current software, and to create interest for similar work by other neuroradiologists and software developers. Work will be presented as electronic poster, where viewers can scroll through composite image series in animated GIF format on PowerPoint slides.

Materials and Methods
IRB on file. Method achieved by tightly windowing the overlay (in gray scale or color) via preset mask, and fusing masked image to normal gray scale image. Method creates a postprocessed image to increase lesion conspicuity without obscuring the normal background voxel values. Composite images created for two clinical scenarios: 1) MS plaques: color FLAIR images using mask (min, max voxel values 300, 500, respectively); 2) multiple metastases (pre-Gamma Knife): gray scale Gd-enhanced T1 MP-RAGE images masked as above in gray scale and color respectively. Alpha-blend ratio of original gray scale images (background)/masked images (foreground)=70/30. Fused images exported to PACS for side-by-side comparison to original MR images. Ten cases in each group, all studies interpreted in 2013 or 2014 without composite postprocessed images.

Results
Postprocessed gray scale and color composite images displayed more conspicuous lesions, in contrast to background than original PACS images, subjectively. The visual contrast of lesion to background was increased when using composite images. When original PACS images were windowed to increase lesion conspicuity, the lower intensity voxels (background) were obscured to a greater extent compared to fused images. Additional lesions missed on initial PACS image interpretation were detected and will be reported.
Conclusions
Gray scale or color postprocessed image overlay fused to an original gray scale image creates a composite image with increased lesion conspicuity without sacrifice. Olea Sphere is used widely and this practice may help identify clinically significant lesions with treatment implications.

(Filename: TCT_eP-40_FLAIRcoloroverlay.jpg)

eP-91

MRI Characteristics of Sporadic and Von Hippel-Lindau Syndrome-Associated Spinal Hemangioblastoma

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Purpose
Spinal hemangioblastomas (sHB) occur both sporadically and as part of Von Hippel-Lindau (VHL) syndrome (VHLS). Sporadic and VHLS sHB are histologically identical and require genetic testing to be differentiated (1). The purpose of this study was to determine whether the sporadic and VHLS sHB subtypes can be differentiated on the basis of their magnetic resonance imaging (MRI) characteristics, potentially obviating the need for genetic testing.

Materials and Methods
A retrospective review was performed on 24 patients from our institution who underwent resection of sHB followed by histologic analysis of the resected lesion and genetic testing; nine patients had sporadic disease and 15 had VHLS. On pre-operative MRI of the spine, sagittal long axis measurements were made of the major MRI features of the sHB: enhancing intradural nodule, perinodular cyst, and surrounding edema (2, 3). In addition, the level (cervical, thoracic or lumbar) of the resected lesion and number of additional sHB lesions were recorded.

Results
The only significant difference in MRI features between the groups was the greater multiplicity of sHB in VHLS compared to sporadic disease (mean number of additional lesions on MRI spine: 5.9 versus 0; p=0.03), as expected given the germline mutation in the VHL tumor suppressor gene. No significant difference was identified between the mean size of the enhancing intradural nodule, perinodular cyst, or surrounding edema in sporadic and VHLS sHB (Table 1). Similarly, no significant difference in the ratio of cyst/nodule size or edema/nodule size was identified (Table 1). Both sporadic and VHLS sHB were found most commonly in the cervical spinal cord (89% versus 60%), with no statistically significant difference in distribution (p=0.28).

Conclusions
We found much higher incidence of multiple sHBs in patients with VHLS, supported by other published studies (3, 4). No other MRI features were unique to sporadic or VHLS sHB. The similarity of MRI (and histologic) features of sporadic and VHLS sHB may be explained by the upregulation of similar angiogenic factors, including hypoxia-inducing factor 1-alpha and vascular endothelial growth factor, in both tumor subtypes (5).
Table 1. Comparison of the mean size of the enhancing solid nodule, cyst, and surrounding edema for sporadic and VHLS sHB lesions. Sizes were measured both in mm and as a ratio of the solid nodule size. Two-sample t-tests were performed to compare the mean values.

<table>
<thead>
<tr>
<th></th>
<th>Sporadic</th>
<th>VHLS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nodule Size (mm)</strong></td>
<td>21.9</td>
<td>19.1</td>
</tr>
<tr>
<td><strong>Cyst Size (mm)</strong></td>
<td>40.8</td>
<td>22.1</td>
</tr>
<tr>
<td><strong>Ratio (Cyst/Nodule)</strong></td>
<td>2.5</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Edema Size (mm)</strong></td>
<td>126.9</td>
<td>126.3</td>
</tr>
<tr>
<td><strong>Ratio (Edema/Nodule)</strong></td>
<td>13.3</td>
<td>8.9</td>
</tr>
</tbody>
</table>
MRI Classification of Hippocampal Sclerosis Based on the International League Against Epilepsy (ILAE)

D Mendoza¹, B Soares¹, N Kadom¹
¹Emory University, Atlanta, GA

Purpose

Hippocampal sclerosis (HS) is the most common pathology seen in surgical candidates with temporal lobe epilepsy. The International League Against Epilepsy (ILAE) classified HS into three histopathology types. Correlation of HS subtypes with surgical outcomes showed that type 1 is more likely to result in a seizure-free outcome. The histopathology types also have been linked to specific magnetic resonance imaging (MRI) appearances. The purpose of our study was to determine whether reliable presurgical classification of HS could be achieved using a standard MR seizure protocol.

Materials and Methods

Seizure MR examinations for refractory epilepsy from June 2015 to October 2015 were included. We excluded MRIs performed postoperatively and those with incomplete or nondiagnostic imaging. Only coronal 3 mm T2-weighted images obtained perpendicular to the long hippocampal axis were reviewed. Two neuroradiologists using the HS classification system reviewed the images independently. They categorized each hippocampus as normal, consistent with HS, or indeterminate. Those classified as consistent with HS were further classified as one of the three HS histopathology types. Cohen's kappa was used to determine inter-reader agreement.

Results

Thirty-one patients met our inclusion and exclusion criteria, for a total of 62 hippocampi evaluated. Mean patient age was 35.7 years, with 20 women and 11 men. Of the 62 hippocampi, Reader #1 classified 42 (67.7%) as normal, 14 (22.6%) as consistent with HS, and six (9.7%) as indeterminate. Reader #2 classified 34 (54.8%) as normal, 20 (32.3%) as consistent with HS, and eight (12.9%) as indeterminate. There were 44 agreements (71.0%) between readers and Cohen's kappa was 0.459 (0.248-0.670, CI 95%). Of the 14 hippocampi that were classified by both readers as consistent with HS, 11 (78.6%) were classified by both as Type 1 and while the other three (21.4%) were in disagreement in classification. The low number of hippocampi rated by both as consistent with HS prevented calculation of meaningful Cohen's kappa.
Conclusions
Use of 3 mm coronal T2-weighted images through the hippocampi provided moderate inter-rater agreement when classifying hippocampi as either normal, hippocampal sclerosis (HS), or indeterminate. Our data show good percentage agreement for further classification into histopathologic subtypes. Given the novelty of the classification scheme, inter-reader agreement may be improved by reinforcement of the diagnostic criteria through joint review at the workstation. Refining MRI techniques to include higher resolution images of the hippocampi may also further improve inter-rater agreement. Achieving reliable agreement in the presurgical classification of HS based on MRI may be of clinical value in terms of its established correlation with surgical outcomes.

MRI evaluation of cerebral changes following hyperosmolar therapy in patient with cerebral venous sinus thrombosis.

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¹NIMHANS, BANGALORE, Karnataka, India, ²NIMHANS, Bangalore, Karnataka, India

Purpose
Hyperosmolar therapy commonly is used to lower intracranial pressure (ICP) in patients with various neurological/neurosurgical disorders associated with raised intracranial pressure. In this study we investigated the effects of Mannitol infusion on cerebral circulation using magnetic resonance imaging (MRI) in patients with cerebral venous sinus thrombosis (CVST).

Materials and Methods
Ten patients with confirmed CVST and without any parenchymal lesions were studied prospectively. Each patient underwent clinical assessment followed by MRI examination of brain. Magnetic resonance imaging examination included axial T1W, T2W, FLAIR, coronal T2W, MR venography, Susceptibility-weighted imaging (SWI), post contrast T1W MP-RAGE (Three Dimensional Magnetization Prepared Rapid Acquisition gradient echo) and pulsed arterial spin labelled (PASL) perfusion sequences. Magnetic resonance venography and postcontrast T1W MP-RAGE were evaluated to establish the diagnosis of CVST. Venous congestion was evaluated using susceptibility-weighted imaging (SWI) while cerebral blood flow was evaluated using PASL. Susceptibility-weighted imaging and perfusion-weighted imaging were repeated 45 minutes after the administration of mannitol (1 gm/kg) and visual assessment of SWI and PASL perfusion-weighted images was done. Quantitative assessment of the cerebral blood flow (CBF) changes also was carried out by drawing
multiple region of interest in both baseline and post mannitol infusion images to calculate the percentage changes in the CBF as compared to the baseline values.

**Results**

Patient age ranged between 20 and 51 (mean 32.50±10.70) years. There were three males and seven females. Headache was unilateral in all except one patient. Baseline magnetic resonance imaging (MRI) confirmed CVST in all 10 patients. Susceptibility-weighted images revealed marked prominence of cerebral veins in the baseline MRI. Following mannitol infusion patient reported significant reduction (six patients), complete relief (two patients) in headache. Postmannitol infusion SWI showed significant reduction in the prominence of cerebral veins. In two patient headache remained unchanged and they showed minimal changes in prominence of the cerebral veins. In all patient hemispheric perfusion (10- 25 % increase) improved.

**Conclusions**

Mannitol infusion results in improved cerebral blood flow, and reduces cerebral venous prominence on SWI possibly due to ICP reduction and improved cerebral oxygenation. Improvement in headache could be due to ICP reduction.

![Magnetic resonance imaging (MRI) of the brain](TCT_eP-50_fig2.jpg)

**eP-52**

**MRI Evaluation of Stroke: Does Contrast Imaging of the Brain Add Diagnostic Value?**

M Lanfranchi¹, N Madan², S Kalli², W Mehan²

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**Purpose**

Gadolinum-enhanced magnetic resonance imaging (MRI) of the brain may be
included in the imaging evaluation of patients with suspected stroke to exclude other etiologies, such as mass lesions and infection (i.e., encephalitis/meningitis). The yield of including gadolinium-enhanced sequences is not defined clearly in the acute setting, and may contribute to prolonged scan times and decreased interpretation efficiency. We hypothesized that conventional sequences without gadolinium would suffice for identifying acute abnormalities in all cases.

Materials and Methods
We reviewed the radiology reports of 250 consecutive patients with gadolinium-enhanced MRIs of the brain for suspected acute stroke from March 2011 to May 2012. The presence or absence of parenchymal, meningeal, vascular, and extracranial enhancement on the contrast-enhanced T1-weighted sequence was recorded. Two independent neuroradiologists blinded to the results interpreted the noncontrast sequences only randomly on a subgroup comprised of 64 of these patients, including 12 with abnormal enhancement. The presence of intracranial and extracranial signal abnormalities was documented. Statistical analysis was performed to assess the accuracy of the noncontrast sequences for detecting the enhancing abnormalities.

Results
Of the 250 patients, 131 were female and 119 male (age-range 20-92 years). Sixteen of 250 (6%) patients had findings of abnormal enhancement on the T1-weighted images. Six of 16 (38%) cases had enhancement related to developmental venous anomalies or extracerebral lesions (i.e., nasopharyngeal carcinoma) that were incidental and noncontributory to the patient's symptoms. The most common pattern of abnormal enhancement was gyriform parenchymal enhancement related to subacute infarction (n=4, 25%). The reader sensitivity for detecting the enhancing abnormality or important extracranial findings was 94%. Interobserver agreement was excellent (κ=0.88).

Conclusions
Our study shows that a relatively small proportion of suspected stroke patients have abnormal enhancement. In most cases, lesions are not clinically significant and are readily detectable on conventional unenhanced sequences. The inclusion of contrast-enhanced sequences may not be necessary for routine stroke evaluation.

eP-84
6:30AM - 2:45PM

Multi nodular and Vacuolating Neuronal Tumor: Imaging Spectrum of a Newly-Described Benign Neuronal Neoplasm

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Purpose
Multinodular and vacuolating neuronal tumor (MVNT) is a newly recognized benign, purely neuronal tumor that will be included in the 2016 updated WHO classification of brain neoplasms. While MVNT has been described in the neuropathology literature, to date it has not been discussed in the neuroimaging literature. The purpose of this paper is to describe the neuroimaging spectrum of MVNT and discuss its imaging differential diagnosis.

Materials and Methods
Fifteen cases were collected from the teaching files of the contributing authors. Clinical data including age, gender, presenting symptoms, and follow-up imaging were recorded. Magnetic resonance (MR) scans were performed in all cases. Location, configuration, lesion size, signal intensity on T1- and T2-WI, FLAIR, DWI, and contrast-enhanced sequences were documented.

Results
Mean age was 36.1 years (range 15-58 years) and the female: male ratio was = 1.7:1. Presenting symptoms were nonspecific and included nonfocal headache (7), possible seizure (5), and weakness, suspected stroke, and psychogenic causes (1 each). In all but one case, the lesions were considered incidental findings. On MR, the lesions consisted of groupings of multiple (3 to > 10) tiny discrete, sharply-marginated, round or ovoid nodules, ranging from 1-5 mm in diameter. All tumors were supratentorial and located on the inner surface of otherwise normal-appearing cortex, often surrounding a sulcus. Mass effect was almost absent. All cysts were isointense to cortex on T1WI, hyperintense on T2-WI and did not suppress on FLAIR. No lesions enhanced or exhibited diffusion restriction. In addition to the "bubbly-appearing" nodules, seven of 15 cases exhibited adjacent confluent T2/FLAIR white matter hyperintensity. Follow-up scans were available in seven cases, ranging from 12-48 months following initial imaging. All were stable without interval change in size or appearance. Initial diagnosis in cases 1-11 included DNET, enlarged perivascular spaces and focal cortical dysplasia. Multinodular and vacuolating neuronal tumor was diagnosed in cases 12-15. Because of their benign appearance and lack of relationship to specific clinical symptomatology, only one case was surgically proven.

Conclusions
Multinodular and vacuolating neuronal tumor has a highly characteristic appearance on MR: Nodular, "bubbly-appearing" lesions along the deep cortex/subcortical white matter that are very hyperintense on T2-WI, do not suppress on FLAIR and do not enhance or cause mass effect. These are benign, nonprogressive, often incidental findings that do not require surgery nor follow-up imaging unless they are demonstrably epileptogenic.
Neuroimaging in Brain Death: CT Perfusion in comparison with other ancillary imaging tests

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Purpose

Brain death confirmation with ancillary testing is highly variable depending on the institutional center's capabilities, and region or country of practice. The common denominator that must be established with all ancillary tests for confirmation of brain death is a lack of whole brain cerebral blood flow. Computed tomography perfusion (CTP) is a relatively new ancillary test that is capable of deriving functional data regarding small vessel perfusion of the brainstem. Internationally, the operational definition of death now includes permanent loss of brainstem function. The purpose of this research was to demonstrate the utility of CTP and its capability in potentially diagnosing brain death compared with other ancillary tests.
Materials and Methods
Archival data were analyzed retrospectively from 2005 – 2015 at our institution for all patients who had undergone imaging brain death confirmation studies. Studies included 22 CTP scans, 20 computed tomography angiograms (CTA), 15 radionuclide angiograms, two cerebral angiograms, one magnetic resonance angiogram, and two stand-alone nonenhanced CT head scans.

Results
Data from 49 patients were examined. Computed tomography perfusion, radionuclide angiograms and cerebral angiograms demonstrated 100% sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) when compared with the gold-standard of clinical confirmation of brain death. Furthermore, CTA demonstrated only 87.5% sensitivity, 100% specificity, 100% PPV, and 67% NPV. In select cases where multiple imaging modalities were used, CTP was able to diagnose brain death earlier. In one patient, the clinical decision of brain death was reversed based on the preserved brain perfusion on CTP.

Conclusions
Computed tomography perfusion performs at a level consistent with ancillary tests of cerebral angiography, radionuclide angiography and appears to be superior to the more widely used CTA for confirmation of brain death. When brainstem perfusion is taken into account, CTP is able to demonstrate brain death earlier compared to CTA.

eP-82
6:30AM - 2:45PM

Neuromyelitis Optica: Looking at the Brain for Clues

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Purpose
Neuromyelitis optica (NMO), a central nervous system (CNS) inflammatory disease, was known initially for its propensity to involve the optic nerves and spinal cord. However, since the 2000's, the diagnostic criteria have undergone several revisions and NMO is now referred to as NMO spectrum disorder (NMOSD). The revisions were prompted largely in part because patients developed symptoms and signs of disease in CNS areas other than optic nerves and spinal cord. The main reason for distinguishing NMOSD from multiple sclerosis (MS) is early initiation of immunosuppressive therapy to prevent attack-related disability, especially since some disease modifying therapies used to treat MS may exacerbate NMOSD.

Materials and Methods
This is a retrospective review of brain magnetic resonance imaging (MRI) performed in our case series of subjects diagnosed with NMOSD either with aquaporin antibody
positivity or utilizing recently revised serum, clinical and/or imaging criteria. This study correlates the intracranial manifestations in our series with recently revised criteria, discussing the heterogeneous intracranial findings associated with NMOSD. We look at a single institution case series of subjects diagnosed with NMOSD. Our goal is to share our experience with findings on intracranial imaging and, where applicable, clinical presentation in order to heighten awareness of the radiologist.

Results
In our case series a good portion of patients had intracranial manifestations involving the areas such as periaqueductal gray, surrounding the third ventricle, and area postrema adjacent to the fourth ventricle and large tumefactive lesions of the corpus callosum.

Conclusions
A working knowledge of the broad intracranial manifestations of NMOSD for the general radiologist and subspecialist is of utmost importance for accurate diagnosis.

eP-58

New Bone Formation over Dehiscent Superior Semicircular Canals after Transmastoid Cartilage Cap Resurfacing

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Purpose
The main goal of this study was to assess radiographic evidence of new bone formation after surgical placement of a cartilage cap over a dehiscent superior semicircular canal.

Materials and Methods
High resolution computed tomography (CT) scans were reviewed on 20 patients, bilaterally. Of these 20 patients, six patients had undergone transmastoid cartilage cap resurfacing surgery for dehiscence, with preop and postop CT scans. Of these 20 patients, 14 had CT scans in the evaluation for SCD, as the control group. All CT scans were reviewed independently by two neuroradiologists. The CT scan images reviewed were limited to focused views of the superior semicircular canal, in the plane parallel and perpendicular to the superior canal. All sets of images were cropped to reduce bias by eliminating evidence of prior surgery. Images were exported as a de-identified separate file for interpretation of a dehiscence. In all reviewed files of images, the two neuroradiologists were blinded to knowledge of prior interpretation and prior surgery for dehiscence.

Results
There were four patients with a dehiscent superior semicircular canal who
postoperatively had an intact bony superior canal after undergoing the cartilage cap surgery. A fifth patient had evidence of bone formation adjacent to the dehiscent site.

Conclusions
There is indirect evidence, by high resolution CT scans, of new bone formation following cartilage cap surgery for a dehiscent superior semicircular canal. It is therefore possible the cartilage cap may stimulate new bone growth with closure of the dehiscence.
Optimization of Bolus Visualization in Dual Energy Head CT angiography: effect of monochromatic imaging, iterative reconstruction, and concentration of the iodine bolus

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Purpose
With the availability of dual energy and iterative reconstruction techniques, the optimization of the imaging protocols of neuroradiological dual energy CT angiography (DE-CTA) has become a multidimensional problem. This paper reports on the investigation of the trade-offs between contrast to noise ratio (CNR) and signal to noise ratio (SNR) of opacified vessels, as functions of iodine contrast concentration, ASiR levels, and monochromatic energy (keV), at different iodine bolus contrast levels.

Materials and Methods
We modified an anthropomorphic phantom (ATOM, CIRS, VA) by drilling holes of varying diameters (0.8 mm to 3.2 mm) into brain-tissue equivalent plugs which were embedded in the head (Fig. 1). The holes were filled with iodine solutions of 4, 6, 8, and 10 mg/cc, to mimic clinically relevant iodine concentration levels. The head phantom was scanned using the dual energy CT angiography (DE-CTA) protocol at our institution on a GE Discovery CT750 HD scanner (GE Healthcare, WI), with the following parameters: GSI preset-30, rotation time=0.8 s, 550 mA, beam collimation=5mm*4, slice thickness=0.625 mm, Head SFOV, DFOV=25 cm, CTDIv=30.7 mGy. In addition, the solutions were imaged separately in 80-mL plastic containers to verify the HU-keV relationship against a theoretical model employed for protocol optimization. Retrospective reconstructions were obtained with Standard kernel, with and without applying GSI ASiR (level 0 and level 100), as well as MARS, and with monochromatic energy settings from 40 to 140 keV in increments of 5 keV. For the analysis of CNR and soft tissue SNR, four pairs of circular ROIs with 3 mm diameter were drawn on the 3-mm-diameter holes and the adjacent "brain-tissue" background, from all the slices in the target region (20 slices total). Signal to noise ratios were calculated from four 3-mm-diameter background regions of interest (ROIs), as well as an ROI of 20 mm diameter near the center of the brain.

Results
The change of CNR from 40 to 65 keV is relatively flat (reduced 11-17% from the maximum CNR achieved at 40 keV), for all iodine concentration levels (Fig. 2). SNR was maximized near 70 keV for all ROIs, but for the optimal contrast levels for visualizing the contrast bolus, lower keV values need to be used: to achieve a target CT number greater 300 HU inside opacified vessels, the required keV ranged from 40 keV to 65 keV for iodine concentration of the bolus from 4 mg/cc to 10 mg/cc (Table 1). Application of ASiR, while affecting absolute CNR and SNR as expected, did not alter this trend of energy dependency.

Conclusions
In this study, we identified a target CT number for visualizing the contrast bolus as a proxy for CNR versus brain tissue, and sought the keV that produces that value. The
required keV is a function of contrast concentration, hence a function of bolus quality. Dual energy CT can be employed to retrospectively optimize a CTA for contrast visibility even with an unideal bolus.
Optimizing MRA Evaluation of Supraclinoid Aneurysms. A Comparison in Detecting Supraclinoid Aneurysms Using Whole 3D MRA MIPs Versus Half 3D MRA MIPs.

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Purpose
Supraclinoid aneurysms can be difficult to detect utilizing magnetic resonance angiogram (MRA) using our institutional protocol. This is partially due to aneurysms in this location being poorly profiled when both right and left cerebral arteries are simultaneously displayed on maximum intensity projection (MIP) images. We hypothesize that by evaluating MIP images of the right and left cerebral arteries individually that the detection rate of supraclinoid aneurysms will improve.

Materials and Methods
This retrospective study had three neuroradiologists evaluate MRA examinations with and without supraclinoid aneurysms, confirmed with conventional angiograms. We included 20 patients with a total of 27 supraclinoid aneurysms. As controls, 15 patients with nonsupraclinoid aneurysms and five patients with no aneurysms were included. MRA data were anonymized and randomized. Reviewers evaluated each study twice, utilizing source 3D time-of-flight (TOF) images with whole cerebral arterial MIPs (Method A) and with separate right and left cerebral arterial MIPs (Method B). The observers indicated if an aneurysm was found and its location. Results were compared to conventional angiogram reports for statistical analysis of supraclinoid aneurysm detection.

Results
Of the 81 total supraclinoid aneurysms between the three reviewers, 54 were found using Method A, and 57 using Method B. Method A performed better in three cases and Method B performed better in six cases. However, there was no statistically different performance between the two methods; a test of marginal homogeneity has p-value 0.655 for Reviewer 1, 0.102 for Reviewer 2, 0.782 for Reviewer 3, and 0.414 for the combined data. Thus, we cannot definitively conclude a difference between the distribution of correct diagnoses for Methods A and B.

Conclusions
While there was no statistically significant difference between the methods, Method B's results were slightly better than Method A's. Method B may be more effective but this remains inconclusive without a larger sample size.
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Parenchyma Nulling T1 Weighted Inversion Recovery: A Novel Sequence that Improves the Contrast Ratio of Enhancing Tumors to Background Brain Parenchyma

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Purpose
Inversion recovery has the power to increase image contrast by nulling signal from selected tissues. The purpose of this study was to compare the effectiveness of a novel parenchyma nulling T1-weighted inversion recovery sequence (PNIR) to that of spin echo magnetization transfer (SEMT) in detecting enhancing brain tumors.

Materials and Methods
Parenchyma nulling inversion recovery sequence parameters were developed to reduce signal from gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF) in a healthy adult volunteer. Forty-one patients with known or suspected brain tumors underwent PNIR and SEMT imaging after the administration of intravenous gadobenate dimeglumine. In patients with confirmed tumors, PNIR and SEMT images were compared for tumor-to-WM, tumor-to-GM and tumor-to-CSF contrast ratio (CR) as well as radiologist rated conspicuity.

Results
There were 23 enhancing neoplastic lesions in 14 of the 41 patients. All tumors were visualized on both contrast enhanced PNIR and SEMT images. Parenchyma nulling inversion recovery images showed a 2.5 fold increase in maximum tumor-to-GM CR (p<0.0001), a 1.4 fold increase in maximum tumor-to-WM CR (p=0.0007), and a 5 fold increase in maximum tumor-to-CSF CR (p<0.0001). Parenchyma nulling inversion recovery images were degraded by flow artifact and signal reduction of nonenhancing tumor components and subacute hemorrhage. Parenchyma nulling inversion recovery did not result in consistent improvement in subjective radiologist determined lesion conspicuity, with improvements only seen in avidly enhancing tumors.

Conclusions
Parenchyma nulling inversion recovery improves lesion-to-background contrast ratio compared to SEMT but does not consistently improve subjective radiologist rated conspicuity. With further modifications to help reduce artifacts and further improve
signal reduction from hemorrhage, PNIR could become a useful addition to the radiologist's toolbox.
Images A and B demonstrate improvement in contrast ratio of several enhancing cerebellar metastases (arrows) on PNIR (A) compared to standard SEMT (B). Greater flow related artifact from the transverse sinuses is also present on PNIR. Image C shows signal loss within subacute hemorrhage on PNIR compared with standard MTSE (D), allowing possible delineation between hemorrhagic tumors and other etiologies of hemorrhage.
Performance of Double Inversion Recovery, T2 and T2-FLAIR Sequences in Patients with Temporal Lobe Epilepsy Responsive to Stereotactic Laser Amygdalohippocampotomy

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Purpose
Mesial temporal lobe epilepsy (MTLE) is often, but not always associated with mesial temporal sclerosis (MTS) on magnetic resonance imaging (MRI) and histopathology. Stereotactic laser amygdalohippocampotomy (SLAH) is a new minimally invasive technique to treat MTLE. The imaging findings in patients who respond to SLAH have not been well studied. The objective of our study was to compare the performance of T2, T2-FLAIR, and double inversion recovery (DIR) sequences to detect and characterize findings of MTS in patients with MTLE responsive to SLAH.

Materials and Methods
A total of 10 subjects were selected that were diagnosed with MTLE based on multidisciplinary assessment (clinical, EEG, MRI, PET, SPECT), that were treated with SLAH, and had good seizure-free outcome at 12 months (Engel 1 or 2). Additionally, 11 control patients with normal MRI exams and no MTLE based on multidisciplinary assessment were selected. T2, T2-FLAIR and DIR sequences from each patient were anonymized, randomized, and evaluated in random order independently by two neuroradiologists (an attending and fellow) blinded to clinical information other than a diagnosis of epilepsy. The neuroradiologists graded each sequence and each side for hippocampal signal intensity, hippocampal volume and anterior temporal lobe abnormal signal (ATLAS). The sequences were graded as normal, probably abnormal, and definitely abnormal.

Results
For hippocampal signal intensity, the perceived abnormality rate in proven epileptogenic hippocampi was 85% on T2-FLAIR, 75% on T2 and 65% on DIR. For hippocampal volume, the perceived abnormality rate in proven epileptogenic hippocampi was 65% on T2-FLAIR, 70% on T2 and 55% on DIR. For ATLAS, the perceived abnormality rate in proven epileptogenic hippocampi was 35% on T2-FLAIR and 40% on DIR. The T2-weighted images were not useful in characterizing ATLAS. The interobserver variability kappa values were 0.693, 0.831, and 0.872 for DIR, T2 and T2-FLAIR sequences, respectively.
Conclusions
T2, T2-FLAIR and DIR sequences are complementary in the evaluation of patients
with MTLE. T2-FLAIR has greater sensitivity to abnormal signal and T2 has greater
sensitivity to volume loss. In concordance with prior reports, DIR proved to be
slightly superior for characterizing ATLAS. The significance of ATLAS in patients
with MTLE needs further investigation.

Plasticity of Brain Subcortical Structure in Patients with Chronic Trigeminal
Neuralgia

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Purpose
Trigeminal neuralgia (TN) is one of the most common facial pains and the
pathophysiology of idiopathic TN still is debated. Neuroimaging has been used to
investigate the changes in brain structure and function associated with TN1234 and
most of these studies evaluated brain responses to experimentally induced pain which
were more likely to represent pathways in the brain involved in pain processing of
acute TN. The current study uses structural MRI to analyze the change of cortical
thickness and subcortical gray matter (GM) volume in patients with chronic idiopathic
TN.

Materials and Methods
Forty-five patients with TN and 20 age-matched healthy subjected were enrolled
prospectively into this study. The study was approved by the Institutional Review
Board of our institution and all patients gave their written informed consent prior to
participation in the study. All magnetic resonance imaging (MRI) data were collected
with a 3 T Siemens Verio MRI system (Siemens Medical System, Erlangen,
Germany). 3D MP-RAGE anatomical images were obtained using a gradient echo
sequence (TR = 1900 ms; TE = 2.98 ms; FOV = 230 mm; matrix = 220 X 256; slice
number: 160, spatial resolution of 0.9 mm x 0.9 mm x 0.9 mm). Both the cortical
thickness and the subcortical volumetric segmentation were measured by FreeSurfer
5.0 (http://surfer.nmr.mgh.harvard.edu). A general linear model was estimated at each
vertex across the cortical surface, with the cortical thinness as dependent variable; the
diagnosis as the predictor; the age as covariates. FDR is used as the multiple
corrections. This approach is implemented in QDEC from the FreeSurfer. The
volumes of subcortical structures were imported into MATLAB. Two sample t-test
was performed with both the age and the whole brain volume as covariates.
Results
There is no significant difference on cortical thickness between TN patients and healthy controls after regressing out the age and overall brain volume. For the subcortical structures, there is a significant reduction (P<0.0029 Bonferroni corrected) of the volume in the left accumbens, putamen, and a significant increase (P<0.0029, Bonferroni corrected) of the volume at the left hippocampus, the right thalamus (Fig. 1). Among the subcortical gray matters, the relative volume of bilateral putamen, bilateral pallidum, right thalamus and right caudate nucleus show modestly positive correlation with duration of TN (P = 0.033, 0.043, 0.049, 0.012, 0.018 and 0.049 respectively; Pearson correlation) (Fig. 2).

Conclusions
Chronic pain leads to cortical reorganization in terms of adaptation mechanisms related to cortical plasticity. This study demonstrated the reorganizations of GM volume in patient with TN. These brain regions are characteristic for processing and integration of pain and also play a central role in the pathophysiology of TN.
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Purpose

Pre-operative visualization of vessel-nerve contact in trigeminal nerve (TN) neuralgia is limited by pulsation artifacts of cerebrospinal fluid (CSF) and blood. We sought to test the feasibility of T1 volume interpolated GRE (T1GRE) to visualize small arteries as well as venous structures and reduce pulsation artifacts.

Materials and Methods

On a 3T Skyra, high-resolution 3D T1vibe postgadolinium (T1GRE-GD) with 32-channel head-coil was tested on 15 patients with trigeminal neuralgia and compared to standard CISS and T1-W (T1GD). Quality of image data and visibility of arteries and veins was evaluated for each sequence. Thirteen patients received microvascular decompression (Jannetta procedure). Of these, seven were images pre and six postsurgery and imaging findigs compared to the intra-operative situation.

Results

In T1GRE-GD, arterial and venous structures were visible in all patients and there were no pulsation artifacts detectable. The TN was clearly definable within the CSF. In one patient the TN was hyperintense in CISS and could not be differentiated from CSF. In addition, on T1GRE-GD, vessel-nerve contacts could be evaluated in various customized reconstructed planes. Especially in patients with previous teflon interposition, nerve and vessels were clearly visible without interference through the teflon material.

Conclusions

The application of T1GRE for visualization of cranial nerves and arterial as well as venous vessels within one sequence to evaluate anatomical proximity seems to be very promising. Findings correlate well with intra-operative observations and the application of this technique therefore might be helpful especially in patients with teflon interposition.
Quantification of Perivascular Spaces at 7T is a Potential Biomarker for Epilepsy Seizure Onset Zone

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Purpose
Epilepsy affects approximately 2.2 million people in the U.S. (1). 7T magnetic resonance imaging (MRI) facilitates the visualization of the brain with unprecedented resolution and contrast, enabling the identification of small structures such as perivascular spaces (PVS), which are less visible at lower fields (2). The distribution of these structures may provide insight into the etiology of the disease (3). The purpose of this research was to determine whether distribution of PVSs might correlate with seizure onset zone (SOZ) laterality.

Materials and Methods
Axial T2 TSE images (TR 6000 ms, TE 69 ms, 0.4x0.4x2.0mm³) were obtained on a 7T MRI scanner (Siemens, Erlangen) for 10 epilepsy patients (32.4± 6.4 years) and 10 healthy subjects (34.7±6.1 years). A subset of nine epilepsy patients had SOZ lateralizable by EEG and semiology to a single hemisphere. Perivascular spaces were marked manually (PVS short axis diameter ≥ 0.5mm); for PVSs that extended through multiple sections, the central representative image with the widest cross-section was marked. The brain was divided into right/left hemisphere and seven regions (Fig. 1A) using 16 anatomical landmarks. The asymmetry index (AI) (4), was calculated as AI = 2*|Sr-Sl|/(Sr+Sl) where Sl and Sr are the area-weighted sum of the PVSs in the left and right hemispheres, respectively. AImax, is the largest AI calculated from each region in the brain. The asymmetry in epilepsy subjects was compared to that of controls and the laterality of the SOZ was compared to asymmetry of PVSs.

Results
There was a significant difference (p=0.012) between the AImax (±SE) in epilepsy subjects (1.0±0.4) and in controls (0.67±0.31) (Fig. 1B). Seven of the nine (78%) subjects with lateralizable SOZ exhibited a prominence of PVSs contralateral to the suspected SOZ (AImax=1.07±0.44). Two out of nine (22%) subjects exhibited prominent PVSs ipsilateral to the suspected SOZ (AImax=0.48 and 0.54).

Conclusions
These findings suggest that epilepsy may result in an asymmetrical distribution of PVS in the brains of patients, with more or larger PVSs clustered contralateral to the hemisphere of the suspected SOZ.
Quantitative assessment of changes of cross cerebellar diaschisis in human brain tumor.

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Purpose
To evaluate the possible lateralization of the fractional anisotropy (FA) values affecting the cortico-ponto-cerebellar (CPC) pathway in patients with supratentorial brain tumor, we selected 41 patients with supratentorial cortical and subcortical tumors. We hypothesized that there would be a statistically significant FA value decrease along the tract, ipsilateral to the tumor side before the CPC tracts cross (at crus cerebri (CC) level) and contralateral to tumor side beyond the crossing of the fiber tract at the level of the pons into the contralateral middle cerebellar (MCP).

Materials and Methods
We included 10 patients with right-sided tumor and 31 patients with left-sided tumor (LST) for which we measured the magnitude of changes in FA values of the CPC tract [using diffusion tensor imaging (DTI) studio software] prior to surgery for brain tumor. Measurements were performed at the level of crus cerebri and middle cerebellar peduncle (MCP). Regions of interest (ROIs) were placed on the lateral side of CC, ROI1 (anterior 1/3), ROI2 (middle 1/3), ROI3 (posterior 1/3), and ROI4 was seeded at the level of MCP. We used module "R" to analyze collected data.

Results
Tumor-sided FA values were decreased along the CPC compared to nontumor-sided CPC in ROI1 (RST P=0.0003, LST P=0.04), ROI2 (RST P=0.22, LST P=0.06), ROI3 (RST P=0.007, LST P=0.058) and ROI4 (RST P=0.95, LST P=0.04). When FA values of nontumor affected CPC tracts on both sides were compared by the right- and left-sided ROIs, there was no significant difference between the mean of FA (P=1.009).

Conclusions
We observed a significant FA value decrease along the course of the CPC tract when there was a cortical/subcortical supratentorial brain tumor affecting the cortical rising fibers remote from the cerebellum, which can lead to functional degradation of the cerebellum known as crossed cerebro-cerebellar diaschisis.
Research Productivity in Brain Tumor Imaging From 1964-2014: Trends in Globalization, Focus, and Funding

D Chow¹, S Cha²
Purpose
Advances in neuro-oncology research continue to transform brain tumor imaging, which provides clinicians and researchers with new information about ongoing pathophysiology and treatment guidance. However, little attention has been given to changes in research productivity over time. Analysis of these trends provide insight into both ongoing advancements and potential deficiencies. The purpose of this bibliometric analysis is to quantify tumor imaging research trends over the last 50 years, including its globalization, methodology, focus, and funding.

Materials and Methods
This retrospective bibliometric analysis of public data was exempt from Institutional Review Board approval. Brain tumor imaging articles published between 1963 and 2014 were identified in the National Library of Medicine MEDLINE database. Country of origin, methodology, topic, and source of funding (for articles originating from the U.S.) were recorded. Growth was analyzed by using linear and nonlinear regression.

Results
Total articles numbered 9,598 during the study period, and demonstrated linear growth throughout the study period (p < 0.001) (Fig. 1). Mean authorship also rose steadily, but demonstrated a logistic growth pattern (p < 0.001). Globally, leading countries of origin included the U.S. (2,663, 27.7%), Japan (990, 10.3%), and Germany (821, 8.6%) (Fig. 2). Among the top 10 global contributors, countries demonstrating rapid growth in productivity included China and South Korea, which each demonstrated exponential growth (p < 0.001) while growth for remaining countries were linear (p < 0.005). Article type was variable between continents. For example, 46% of clinical trials and 41% of comparative studies originated from Europe whereas 52% of review articles originated from North America (Fig. 3). Regarding specialty contribution, departments of radiology, neurosurgery, and neurology represented 52%, 26%, and 6% of first author contributors, respectively. Regarding study topics, articles with diffusion imaging, glioblastoma, and PET imaging saw a dramatic rise, which collectively were a major topic among 21.7% (58/268) articles in 2004 and 39.4% (177/449) in 2014. Lastly, regarding funding, relative contribution of National Institutes of Health (NIH)-funded publications increased steadily from 8.9% (27/304) to 32.9% (175/532) between periods 1985-1989 and 2005-2009, but has since declined to 30.6% (203/664) between 2010-2014 (Fig. 4).

Conclusions
Brain tumor imaging grew steadily throughout the study period and demonstrated increasing number of authors per paper. The latter may reflect increasing complexity
in the field necessitating greater collaboration. Research in this field also demonstrates increasing globalization with variable focus between countries. Among articles originating from the U.S., NIH funding has plateaued and declined over the last five years, which had previously seen a steady rise. This is alarming given that NIH funding is the single greatest predictor of research output within radiology departments (1).
Fig 1 - Graph shows total number of published journal articles (gray diamond, primary axis) and the mean number of authors per paper (black circle, secondary axis) between 1963 and 2014.

Fig 2 - Graph of total brain tumor articles (primary axis) and mean impact factor (JIF, secondary axis) between 1963 and 2014.

Fig 3 - Pie charts demonstrate variations in published articles between Europe (EU), North America (NA), and Asia.

Fig 4 - Graph demonstrating trend (primary axis) and relative proportion (secondary axis) of articles published from 1985 to 2005 with NIH support over 5-year-increments.
Resting-state reveals variations in connectivity inside Default Mode Network in first-episode major depressive disorder with psychotic features patients

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Purpose
Previous results about brain functioning and metabolism indicate that the medial and dorsolateral frontal cortices are involved in major depressive disorder (MDD). Results point to the relationships between cortical dysfunction and decreased metabolic signals in the medial anterior regions of the Default-mode Network (DMN) in MDD patients. Even though these are core areas in the maintenance of brain homeostasis, areas like the anterior cingulate cortex (ACC) play a role in decision making and can be disconnected from default mode network (DMN) healthy volunteers, forming an independent network related with salience of external stimuli. As shown by Seeley et al. (2007), prescan anxiety ratings correlated with intrinsic functional connectivity of the dorsal ACC node of the salience network. Here, we sought to correlate differences in functional connectivity and variations in symptoms severity in patients with a first episode of MDD with psychotic features (FEMDD).

Materials and Methods
Twenty patients (mean age 32.7 years; with a male:female ratio of 15:5) were compared with 20 health controls (mean age 34.5 years; male:female ratio of 8:13). Patients were diagnosed as FEMDD and confirmed by the Structured Clinical Interview for DSM-IV (SCID). Resting state (RS)-functional magnetic resonance imaging (fMRI) were acquired in an 3T MRI scanner using a noise-attenuated EPI sequence. Tridimensional T1-weighted images were acquired for co-registration with functional images. Functional data were submitted to preprocessing and functional connectivity maps were identified by Independent Component Analysis (ICA) in BrainVoyager QX (Brain Innovations, The Netherlands). After group ICA calculations, (Esposito et al., 2005), Default Mode Network maps were identified and groups of maps were submitted to a t test. Difference volumes of interest (VOIs) were identified to extract functional connectivity values for each group, which were tested for differences from zero and between groups. A correlation test was accomplished to
verify the association between treatment duration, period without treatment and symptoms severity with connectivity values inside clusters of difference inside DMN.

Results

Resting-state analysis showed differences for DMN in MFC, DLPFC, IFC and bilateral occipital areas (Fig. 1 and Table 1). Comparison between standardized ICA values of each resulting VOIs showed differences in zICA of areas coincident with the DMN. ACC (BA 9/10/32) and left DLPFC (BA 9/44) showed larger values for patients. Values in medial frontal reached 0.84 zICA for patients and 0.22 for controls. Left Occipital VOIs showed 0.08 for patients and -0.52 for controls. Only severity of symptoms could be shown to associate with DMN connectivity.

Conclusions

Results point to an association between differences in DMN functional connectivity, especially related to the negative counterpart of the network. Also, severity of psychotic symptoms co-vary with z-ICA in MFC, indicating that the more DMN is connected to an emotion-triggering area, larger is the severity of psychotic symptoms. These findings may offer an anatomical target during the progress of the pharmacological treatment, as previously reviewed.

![Figure 1. Maps resulting from the comparison between normal controls and FEMDD patients. Indicated areas show differences of DMN connectivity in comparison between patient and control groups (p<0.05, Family-wise corrected). Positive values indicate clusters that are in phase with DMN and negative, areas anticorrelated with DMN. a. Left dorsolateral prefrontal; b. Left inferior frontal; c. Left occipital; d. Anterior cingulate cortex; e. Left occipital.](TCT_eP-08_FEMDD-restingState.png)

<table>
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<tr>
<th>Region</th>
<th>Brodmann</th>
<th>CTR zICA (SD)</th>
<th>FEMDD zICA (SD)</th>
<th>t test</th>
<th>p-value</th>
<th>Voxels</th>
<th>x</th>
<th>y</th>
<th>z</th>
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<td>Left Inferior Frontal</td>
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<td>-0.53 (0.29)</td>
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<td>6170</td>
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<td>Left DLPFC</td>
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(Filename: TCT_eP-08_FEMDD-restingState.png)
Retrospective Study to Compare the MRI Appearance of Thalamic Gliomas and Thalamic Subacute Infarcts.

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Purpose
Overlap of imaging and clinical features of thalamic primary glial neoplasms and subacute infarctions may lead to unnecessary biopsy and related complications. This study aims to identify magnetic resonance imaging (MRI) features that help differentiate primary glial neoplasms and subacute infarcts of the thalamus.

Materials and Methods
Twenty-four pathologically proven thalamic gliomas (17 males, 7 females; age: 19-79 years) and 15 thalamic subacute infarcts in 14 patients (5 males, 9 females, age: 31-72 years) were identified by utilizing the institutional radiology pathology database. Conventional MR, MR spectroscopy (MRS) and MR perfusion imaging were compared and significance was determined by Fisher's exact test.

Results
Extension into adjacent structures (4/15 infarcts, 21/24 gliomas, p< 0.0003), mass effect (3/15 infarcts, 21/24 gliomas, p< 0.0001) and cystic/necrotic areas (0/15 infarcts, 9/24 gliomas, p = 0.0069) were features more commonly seen in gliomas. An elongated shape was a feature seen with thalamic infarcts (3/15 infarcts, 0/24 gliomas, p = 0.0498). Infarcts typically involved less area of the thalamus. Thirteen of 15 infarcts and 5/24 gliomas showed less than two third involvement of the thalamus (p< 0.0001). The ratio of enhancement area to hyperintense FLAIR signal area size also differentiated between gliomas and infarcts (p = 0.0028). Twelve of 13 enhancing infarcts and only 7/19 enhancing gliomas showed a ratio greater than 2/3. In addition, 4/13 infarcts showed a ratio > 1. Both cases of infarcts with MRS showed an elevated choline:NAA ratio.

Conclusions
Several MRI features may be used to distinguish between thalamic gliomas and subacute infarcts. Some features are more specific such as cystic/necrotic areas and elongated shape, however, other features are not entirely specific such as mass effect. Ratio of lesion enhancement to hyperintense FLAIR signal of greater than 2/3 can differentiate thalamic gliomas and subacute infarcts. In this small sample, MR spectroscopy was not helpful for differentiating both infarct cases from neoplasm.
Revisiting the Prévost sign: Three-dimensional Assessment of Conjugate Gaze Deviation in the Acute Stroke Setting.

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Purpose
To evaluate the use of three-dimensional imaging in ocular gaze deviation as an ancillary tool to assist diagnosis of acute stroke in the emergency setting.

Materials and Methods
All noncontrast computed tomography (CT) scans of patients who presented to the emergency department with single-vessel acute ischemic stroke during the year 2013 were analyzed. Volumetric reconstruction of the eyes was performed using Philips Brilliance software, and "clipped" coronally and tangentially to the orbit, until the lens, roof of the orbit and the zygomatic arch were exposed. A snapshot of the patient's eyes was obtained at this level, and analyzed for conjugate gaze deviation (CGD) using Adobe Photoshop. The strength of the vector was divided by the radius of the globe to adjust for lack of calibration, and expressed as conjugate gaze adjusted length (CGAL). Conjugate gaze adjusted length vectors were compared with clinical National Institute for Health Stroke Score (NIHSS). Conjugate gaze deviation direction was compared to the clinical vascular territory, and kappa agreements were ascertained for right-right and left-left CGD and clinically suspected corresponding vascular territory. Patients without both original biologic lenses were excluded. Follow-up scans for patients who underwent a second scan, were reconstructed using the same technique, and compared to the first snapshot to control for random eye deviation. Follow-up MRI studies were compared with original CGAL for sensitivity and specificity of 3-dimensional deviation. Two and three-dimensional reconstructions were compared for sensitivity and specificity.

Results
One hundred and three patients' eyes were reconstructed. Horizontal deviation was noted in 86% of the patients (48% right, 42% left). Kappa agreements for right-sided CGD and right middle cerebral artery (MCA) territory was 0.85, and left-sided CGD and left MCA territory was 0.72. CGAL vector strength showed a strong correlation with NIHSS (r = 0.72, p = 0.01). Follow-up CT scans for 39 patients were obtained and reconstructed, with an occurrence of CGD of 56%, and right-left kappa agreements of 0.39 and 0.45, respectively. Magnetic resonance imaging was performed on 31 patients, and a high DWI signal was observed in 22 patients. Twenty out of 22 (90%) showed a CGAL of 0.35, and 8/9 (89%) were true negative,
respectively. Axial deviation (over 12 degrees) showed a sensitivity of 77% and specificity of 56%.

Conclusions
Three-dimensional CGD evaluation is a quick and useful tool in the emergency setting, with a high sensitivity and specificity for acute stroke, with strong directional agreement and vector strength association with presenting NIHSS. Examining the eyes volumetrically as opposed to 2-dimensionally which shows a poorer sensitivity and specificity, may be useful as an additional tool in the radiologic assessment of acute stroke.
Rheumatoid Pachymeningitis. Relevant MRI findings, Monitoring Treatment and Follow-up with Conventional MRI and Arterial Spin Labeling.

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Purpose
Rheumatoid pachymeningitis (RP) is a rare complication of rheumatoid arthritis (RA). The magnetic resonance imaging (MRI) findings, associated with a long-standing history of RA or histologic confirmation led to the diagnosis of RP. Complete or sustained remission was achieved with medical treatment. The patients experienced alternating phases of relapse and remission. Our purpose is to describe the most relevant MRI findings at the moment of diagnosis, including arterial spin labeling and also those findings associated with clinical remission and recurrence.

Materials and Methods
We reviewed the MRI imaging findings and ASL patterns in a series of four patients, studied during the last 4 years. There were three women and one man with ages ranging between 40 to 60 years. In two cases the diagnosis was made on basis of imaging findings and clinical history of long standing RA and in the other two patients biopsies were performed. Magnetic resonance imaging was obtained at the moment of diagnosis and repeated on basis of clinical evolution.

Results
All the patients presented a range variety of neurological symptoms. A similar MRI pattern was observed at the moment of diagnosis. On T1 post-Gd a supratentorial focal or multifocal meningeal and cortical enhancement on the pial surface of the giri, with pachymeningeal thickening (the most common lobes involved were the frontal and parietal). FLAIR and FLAIR post-Gd showed cortical hyperintensity with sulcal effacement. Hyperintensity of deep white matter probably related to vasogenic edema. On diffusion (b-1000) we found subarachnoid hyperintensity. Focal hyperperfusion pattern was observed in ASL. With clinical response to treatment we observed a reduction of cortical enhancement, FLAIR hyperintensities and diffusion hyperintensities, as well as normalization of ASL. Two patients presented with persistent clinical response, one with normal MRI and the other with mild giral and dural enhancement without vasogenic edema (pseudonormalization pattern). The other two had clinical course with remission and relapses. During the relapse the dural enhancement increased, as well as FLAIR and diffusion hyperintensities and the focal hyperperfusion pattern in ASL.

Conclusions
Rheumatoid pachymeningitis (RP) is a rare complication of RA. The reported imaging findings with a history of long standing RA is suggestive of the diagnosis of RP. Magnetic resonance imaging with diffusion and ASL is a useful tool in the monitoring and follow up of clinical response (with pseudo-normalization pattern) in these patients with episodes of remission and relapses.
Role of Susceptibility-Weighted Imaging (SWI) and Diffusion-Weighted Imaging (DWI) in Characterizing Vascularity and Histopathology of Intraventricular Tumors

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Purpose
To study the imaging characteristic of intraventricular tumors on susceptibility-weighted imaging (SWI) and diffusion-weighted Imaging (DWI-ADC) and correlate them with histopathology.

Materials and Methods
Forty patients with histologically proven intraventricular tumors were identified retrospectively from our archive system. All patients had undergone contrast-enhanced magnetic resonance imaging (MRI) and computed tomography (CT) scan of the brain. Besides routine MRI brain, high-resolution, three-dimensional, fully velocity-compensated susceptibility-weighted images (SWI) were obtained using both
magnitude and phase data. Postprocessing was applied to enhance the contrast in the
magnitude images between tissues with different susceptibilities. Diffusion-weighted
imaging (DWI-ADC) also was obtained at three b values (0, 500 and 1000) for all
these patients. Studies were (blindly) read by two senior neuroradiologist for SWI
characteristics and ADC values. In addition T1, and T2 signal intensity and contrast
enhancement pattern also were studied and compared. These findings were correlated
with the histopathology diagnosis.

Results
There was a statistically significant difference of intratumoral signal intensity changes
due to bleed on SWI which correlated well with the WHO grade II and III. Highly
vascular tumors like choroid plexus papilloma showed extensive changes on SWI.
These changes were more robust on grade II or atypical choroid plexus papilloma
(Fig. 1) as compared to the grade I choroid plexus papilloma. Susceptibility-weighted
imaging changes were least prominent in poorly vascular nonenhancing tumors, for
example subependymomas. Good pathologic correlations were found for blood
products on SWI. In contrast to the classical observation made in the parenchymal
brain and IV ventricular tumor, DWI-ADC characteristics and values of the
intraventricular tumor were very heterogeneous and inconclusive to differentiate
between the cellular versus noncellular tumors. Lowest ADC values were seen in an
lateral ventricular ependymoma (590-600x10-4) while the highest ADC values were
seen in atypical choroid plexus papilloma (6900-7000 x10-4). Aside from 10 patients
(25%), ADC values were not very helpful in predicting the grade or cellularity of the
supratentorial intraventricular tumors. Legend: Choroid plexus papilloma WHO Gr II:
Axial CT (a), post contrast axial MR (b) and SWI(c) image in a child with choroid
plexus papilloma. Avidly enhancing tumor is noted in the atria of the right lateral
ventricle with no calcification or hemorrhage on CT. SW image demonstrates
extensive signal drop out within the tumor substance correlating with the tumor
vascularity.

Conclusions
Susceptibility-weighted imaging is useful in characterization of vascularity and WHO
grading of the intraventricular tumors because of its superior ability to delineate blood
products and venous vasculature and reveal new internal architecture. In contrast,
ADC values were not very helpful in predicting the grade or cellularity of the
supratentorial intraventricular tumors.
Series of Brain Stem Strokes with Anatomic and Clinical Correlation

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\textsuperscript{1}University of Toledo, Toledo, OH, \textsuperscript{2}The University of Toledo, Toledo, OH

Purpose
The diagnosis of stroke can be clinically challenging and neuroimaging plays a vital role in accurate timely identification and localization of ischemia (1). Posterior circulation strokes are relatively common with vertebrobasilar strokes making up almost one-third of ischemic strokes (2). Multiple endovascular trials have recently demonstrated favorable outcomes of neurointerventional procedures (3). As such it is increasingly vital to correlate clinical deficits of ischemia with brainstem anatomy to make the most accurate diagnosis. With the exception of Wallenberg’s syndrome, classic brain stem stroke syndromes are rare and usually not clinically useful (4). However many brainstem strokes cause unnamed crossed brain stem symptoms that correlate with anatomy. We will use a small case series of focal brain stem strokes to demonstrate brain stem anatomy through correlation with clinical symptoms they cause.

Materials and Methods
The exhibit will use multiple choice questions about clinically relevant brain stem anatomy including which clinical syndrome is caused by each focal brain stem stroke demonstrated on provided clinical images. Epidemiology, pathophysiology, and relevant anatomy of brain stem infarcts will be discussed. Relevant anatomy will be demonstrated using 3D tractography, directional tractography color maps, and additional diagrams.

Results
The focal brain stem strokes in this series resulted in neurological symptoms closely correlated with anatomical structures of the brain stem involved. Additionally, the brain magnetic resonance imagings (MRIs) performed on the patients in this series demonstrated the neuroanatomical areas involved with sufficient detail to facilitate this anatomical and clinical correlation.

Conclusions
Neurologic findings and neuroanatomy can be closely correlated for focal brain stem strokes as demonstrated by brain MRI. Understanding the clinical presentations and anatomy of focal brain stem strokes allow the radiologist to have a logical approach and make the correct and timely diagnosis.
Speed and Accuracy of Hyperacute Stroke CTA Interpretation by Radiology Trainees.

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Purpose
Radiology residents routinely interpret a variety of emergent studies on call utilizing
many imaging modalities in all subspecialty areas of radiology. With the recent
development of successful endovascular thrombectomy therapies for acute ischemic
stroke, there is new emphasis on quickly and accurately diagnosing patients with
hyperacute strokes secondary to large vessel occlusion. Here we evaluate the speed
and accuracy of preliminary head and neck computed tomography angiography (CTA)
results issued by radiology trainees.

Materials and Methods
IRB approval for this study was obtained. Since April 2015, a new resident-driven
rapid CTA protocol was put in place to optimize time to endovascular management of
hyperacute stroke with large vessel occlusion. Radiology residents were asked to note
their initial impressions on note cards present in the CT control rooms and neurology
residents noted the initial CTA findings in their emergency department (ED) notes.
Radiology residents at our institution also provide dictated preliminary reports. Using
this data, we reviewed 100 consecutive hyperacute stroke CT angiograms initially
interpreted by radiology trainees, in comparison to final neuroradiology attending
interpretations as well as angiogram results when available. The time of
communication of the trainee's initial interpretation also was recorded. Discrepancy in
interpretation was categorized as major or minor. We defined a major change to the
initial interpretation as one that might have altered immediate clinical management,
while minor changes included any changes not affecting management of the
hyperacute stroke within the endovascular time window. Statistical analysis was
performed to quantify concordance.

Results
In the time period of this study trainees issued preliminary positive findings at the
scanner in 49 of these examinations and 51 examinations had negative preliminary
findings. The median time from CTA performance to first interpretation was 12
minutes. In cases with preliminary positive findings, there were 0 major changes and
six minor changes to the report impressions after review by the neuroradiology
attending. In cases with preliminary negative findings there were three major and
seven minor changes to the report impression after review by the neuroradiology
attending. The major changes included one missed M1 occlusion and two missed
proximal M2 occlusions. For this cohort strength of agreement was very good with
respect to major discrepancies affecting clinical management (kappa=.94, p<0.005).

Conclusions
Concordance rates are high between the preliminary trainee interpretations and final
attending interpretations of hyperacute stroke CTAs. Preliminary interpretations performed at the CT scanner by radiology residents are fast and generally reliable, though oversight might be helpful for cases initially suspected to be negative for large vessel occlusion.

eP-66

Subcortical T2/FLAIR Hypointensity on MRI: Symptomatic Neurologic Associations

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Purpose

Prior studies have reported the presence of subcortical hypointense signal (SHS) on T2-weighted and FLAIR images and the association of these findings with various acute and chronic conditions, including meningoencephalitis, neoplasm, ischemia/infarction, multiple sclerosis, and Sturge-Weber syndrome. Many of these patients have findings of leptomeningeal enhancement on imaging. Specific neurologic symptomatic associations are not widely recognized in the literature. It is our purpose to retrospectively review cases of SHS abnormalities and correlate these cases with the patients' presenting symptoms and EEG when available to establish whether the presence of the imaging findings can predict patient symptomatology.

Materials and Methods

We performed a retrospective review of cases by searching in our PACS for patients that had MR imaging findings of subcortical hypointense T2/FLAIR signal or leptomeningeal enhancement. The patient's medical records were reviewed for evidence of symptoms at the time of imaging and correlated with EEG reports when available. Qualitative measurement of perceived T2/FLAIR hypointensity, presence or absence of concurrent leptomeningeal enhancement, and the clinical symptoms at the time of presentation and evidence of co-localization with SHS were collected and summarized.

Results

We identified 84 patients with leptomeningeal enhancement and 21 patients with subcortical hypointense signal abnormality (SHS). Approximately 17% of cases containing leptomeningeal enhancement demonstrated SHS, which was most conspicuous on the FLAIR images, followed by T2-weighted images. Conversely, 74% of patients with SHS also demonstrated leptomeningeal enhancement. There was co-localization of SHS with EEG findings in 78% of patients, and co-localization of SHS with focal neurologic deficits in 62% of patients. Fifty percent of cases with SHS but no leptomeningeal enhancement demonstrated co-localization of the SHS with
EEG findings or focal neurologic deficits. Of note, of the patients who received noncontrast MR studies and were found to have SHS, 67% had co-localization of the SHS with EEG findings and focal neurologic deficits.

Conclusions

The presence of subcortical hypointense signal abnormality is a likely under-recognized and unreported finding. Subcortical hypointense signal may have important clinical implications as demonstrated by co-localization with EEG abnormalities and/or focal neurologic deficits. This finding is most conspicuous on FLAIR images, followed by T2-weighted images, often associated with adjacent leptomeningeal enhancement. Even in the absence of leptomeningeal enhancement, SHS abnormality may be associated with clinical symptomatology. On noncontrast studies, the presence of SHS may prompt contrast administration to evaluate for leptomeningeal enhancement. Radiologists should be aware of the relevance of these findings.
eP-18

The accuracy of standard T2 sagittal sequence in the Magnetic Resonance Imaging (MRI) diagnosis of optic neuropathy on routine MRI brain in patients with multiple sclerosis

Imaging findings: T2-weighted image (left) and FLAIR image (middle) demonstrate a subcortical hypointense signal within the right posterior temporoparietal region which is conspicuous on the FLAIR sequence. T1-post contrast image (right) demonstrates subtle pial/leptomeningeal enhancement in this region.

Clinical presentation: Left upper extremity numbness and jerking, left arm Todd's paralysis

EEG findings: Focal slowing (polymorphic delta activity) over the right posterior temporoparietal region, with 10 seizures within the right posterior temporoparietal lobe.
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Purpose
Sagittal T2-weighted magnetic resonance imaging (MRI) is an integral component of the routine radiological assessment of patients with multiple sclerosis. For patients suspected to have optic neuropathy (ON), MRI orbits with coronal short tau inversion recovery (STIR) is used at our institution. This study assessed the accuracy of standard T2 sagittal imaging of the brain for identification of optic neuropathy (ON), using coronal STIR orbits as the gold standard.

Materials and Methods
All patients who underwent MRI brain and orbits including T2 sagittal (with 4mm slice thickness) and coronal STIR (with 3mm slice thickness) sequences, over a 1-year period, were included. A 1.5 T magnet was used for all studies. Each STIR sequence was reviewed by a neuroradiologist and radiology resident, in consensus, in a blinded fashion and assigned as positive or negative for optic neuropathy based on the presence of increased signal within a segment of optic nerve. On a separate occasion, the sagittal T2 sequences of the brain were reviewed in a similar blinded fashion. The location of abnormality was noted (intraorbital, intracanalicular or intracranial).

Results
Forty-one consecutive cases were included. Twelve had ON evident on STIR imaging, eight intra-orbital and four intracanalicular. The T2 sagittal sequence achieved a sensitivity of 42% (95% CI 13.9-70.1) and specificity of 86% (95%CI 73.4-98.6) for ON with positive and negative predictive values of 0.56 and 0.78 respectively. Six of the seven cases of ON missed by sagittal T2 sequence were intraorbital.

Conclusions
Routine T2 sagittal brain imaging with 4mm slice thickness has poor sensitivity but high specificity for optic neuropathy.
Purpose
Stroke mimics could account for 3 - 13% of patients primarily diagnosed and treated as acute stroke, thrombolysis in stroke mimics is not only unnecessary and costly, but will delay a correct diagnose/treatment and may result in complications, including hemorrhage. High grade gliomas could present similar clinical symptom and conventional neuroimaging finding as acute brain stroke. The purpose of this study is to evaluate the value of advanced computed tomography (CT) and magnetic resonance imaging (MRI) perfusion imaging in differential diagnosis between high
grade gliomas masquerading as acute cerebral stroke from true stroke lesions in our clinical practice of 8 years.

Materials and Methods
Computed tomography and/or MR perfusion imaging findings in 1096 cases with suspected acute stroke onset in 8 year period were reviewed. There were 22 cases with pathology confirmed gliomas, presenting acute onset of symptoms and conventional neuroimaging findings similar as acute stroke. The ratios of relative cerebral blood volume (rCBV), relative cerebral blood flow (rCBF), and mean transit time (MTT) were evaluated and compared with these stroke patients.

Results
These 22 stroke-mimicking gliomas are malignant, including 13 anaplastic astrocytomas, WHO grade III; and nine glioblastomas, WHO Grade IV. All these gliomas showed nonenhancement or mild enhancement in postcontrast T1-WI, and increased rCBV, rCBF and MTT compared to contralateral references, (p<0.001, paired t-test). The mean rCBV, rCBF and MTT values of ischemic stroke lesions were significantly lower than contralateral hemisphere (p<0.001, paired t-test). The ischemic lesions with re-perfusion could present mixed decreased and increased perfusion within the lesions. The maximal rCBV ratio (1.83±0.57, p=0.022) and rCBF ratio (2.91±0.82, p<0.001) of gliomas were significantly higher than ischemic lesions with re-perfusion (maximal rCBV ratio 1.16±0.13, maximal rCBF ratio 1.35±0.18; Mann-Whitney U test). Figs. 1 and 2.

Conclusions
Our study shows that the high grade gliomas could present similar symptom and conventional imaging findings compared to acute stroke lesions. Careful interpretation of multi-parameters derived from advanced CT and MRI perfusion imaging is useful in differentiating between gliomas mimicking acute stroke lesions.

![Figure 1: Reperfusion syndrome in a stroke patient showed increased CBF and decreased MTT (arrow)](TCT_eP-88_Figure1-HGG-strokemimics--ASNRabstract.jpg)
THE EFFECT OF THE DELAY BETWEEN THE INITIAL DIAGNOSIS OF INTRACRANIAL BRAIN METASTASIS AND THE GAMMA KNIFE TREATMENT, WITH REGARD TO TUMOR HISTOLOGY AND DOUBLING TIMES, AND THE ULTIMATE TUMOR DOSE AND CONTROL.

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¹Hawaii Advanced Imaging Institute, Honolulu, United States, Hawaii, HI, ²Hawaii Advanced Imaging Institute, Honolulu, HI

Purpose
Metastatic brain tumors compromise the largest group of pathologies at our gamma knife (GK) center and it is apparent that there is a wide spectrum of intervals between the initial date of diagnosis and the date of the GK treatment. One major factor appears to be if the patient is a member of a single health system (Kaiser Medical Center in Honolulu) or not. The purpose is to see if this delay discrepancy is a significant outcome variable in the tumor dosing and patient outcomes, while using the data to provide details on specific tumor doubling times.

Materials and Methods
Evaluated the differences in tumor size and number between the initial diagnostic magnetic resonance imaging (MRI) and the treatment MRI and then attempted to categorize the reason for the delay and the effect on tumor treatment dose and control at 3 months. With known malignancies, the tumor doubling time also was calculated.
and the value of using a double dose 3T MRI for the treatment GK plan. All patients with known brain metastasis and sufficient follow up for data analysis were included.

Results
There is a relative delay in patients from a nonsingle health care system between the initial diagnosis and the GK treatment, and analysis will be provided to document the significance of this delay on tumor dosing and outcomes. When using double dose and 3T MRI, more lesions are detected for GK SRS.

Conclusions
Patients in a single health system with a GK trained neurosurgeon have less of a delay between the initial diagnosis of brain metastasis and GK SRS, and the effect will be analyzed. The use of double dose 3T MRI is an advantage to detect brain metastasis for GK SRS.

eP-79
6:30AM - 2:45PM

The Standardized Brain Function Test: Making Functional MRI Standardized, Fast, and Physician Friendly

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Purpose
Many situations exist where major brain dysfunction exists, but anatomically the brain looks normal. This is the challenge and opportunity for functional magnetic resonance imaging (fMRI), and extends to conditions such as mild traumatic brain injury, autism and ADD, psychiatric illnesses, and senile dementia. For such patients, anatomical imaging rarely offers satisfactory answers. The technology that under-girds functional magnetic resonance imaging (fMRI) was first described by Ogawa et. al. in 1990 (1). This most promising brain imaging technology still is hampered by lack of standards, control data, and clinical applications. Few tangible applications exist outside of presurgical localization. Technical challenges like noise, complex image processing, and poor control data have helped to inhibit progress. Allen et. al. proposed using fMRI to evaluate major brain functions (2).

Materials and Methods
Process improvements were made and then integrated with well developed, standard neuropsychological tests such as the Wechsler Adult Intelligence Scale Reasoning Test; Trail Making Test; picture naming test; long term memory test; short term memory; and verbal fluency test. Data acquisition process improvements included; spiral in/out k-space sampling pulse sequences to improve temporal resolution; and
improved head immobilization with polystyrene vacu-pac beads and air bladders. Image processing tool improvements included: auto-registration with deformable registration to the Montreal MNI152 Atlas for high quality controls (high resolution database of 305 patients averaged to create a "perfect", standard human brain); scalp stripping; advanced statistical analysis including random field theory; restricted maximum likelihood (REML); cubic spline interpolation; automated motion correction; on-the-fly thresholding of t-maps, and the transfer of processing to the GPU (~1000x improvement in processing speed over CPU). These advanced, standardized fMRI tests now can be processed in about 3 min/test.

Results

Brain function tests were applied on more than 50 control patients, quantitatively evaluating key areas described above. All patient data then underwent auto segmentation of the brain into the sub millimeter high resolution Cvetko-Gibby Brain Atlas followed by automated integration of control patient data for quantitative data controls. The results of these tests then were used to create the "standardized brain function test." The following table of normative control data for one of the tests, Picture Naming, is presented with the t-test activation at 1.5T for normative control patients (Table 1). Images of control aggregate and individual patient for the same analysis in the occipital areas are shown in Fig. 1 with data presented in Fig. 2.

Conclusions

A standardized battery of brain function tests was created to provide clinicians and researchers objective functional information using up-to-date fMRI techniques with fully integrated neurocognitive testing.
Normative Control

Patient

(Filename: TCT_eP-79_Figure1Norm_Pt.jpg)
fMRI Activation

Tests: Picture Naming

**Structure: Fusiform Gyrus**
Average Activation: 1.75 ± 1.24
Patient Activation: 1.28  Primary visual processing

**Structure: Primary Visual Cortex**
Average Activation: 1.92 ± 1.31
Patient Activation: 1.09  Primary visual processing

**Structure: Visual Association Cortex**
Average Activation: 3.04 ± 1.07
Patient Activation: 1.37  Complex object recognition

**Structure: Medial Frontal Gyrus**
Average Activation: 0.84 ± 0.85
Patient Activation: 1.36  Attention control

**Structure: Inferior Frontal Gyrus**
Average Activation: 1.33 ± 1.18
Patient Activation: 1.75  Left frontal language areas

(Filename: TCT_eP-79_Fig2StandardBrainTestPatientAREsultsadj.jpg)
## Cvetko-Gibby Atlas
### Volumes by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>cub...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal Ganglia</td>
<td></td>
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<tr>
<td>Cingulate Gyrus</td>
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<td>Frontal Pole</td>
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<td>Fusiform Gyrus</td>
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<td>Inferior Temporal Gyrus</td>
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<td>Insula</td>
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</table>
Traumatic Venous Sinus Thrombosis: Incidence and Risk Factors

E Bilinsky¹, Y Rivaud², M Suberlak³, O Tairu⁴, A Fox³, S Slasky⁴
¹Rutgers NJMS, Newark, NJ, ²Rutgers NJMS, Newark, NJ, ³Rutgers New Jersey Medical School, Newark, NJ, ⁴Rutgers- New Jersey Medical School, Newark, NJ

Purpose
Most of the literature regarding traumatic venous sinus thrombosis is isolated case reports. To our knowledge, there are only three large series investigating the incidence of cerebral venous sinus thrombosis in the setting of skull fractures. The goal of our study was to clarify the incidence of traumatic venous sinus thrombosis, as well as traumatic venous sinus compression from epidural hemorrhage. In addition, we evaluated risk factors such as mechanism, fracture site, fracture type and glasgow coma scale (GCS) on arrival that may assist in predicting the likelihood of dural venous sinus thrombosis.

Materials and Methods
Utilizing PACS and electronic medical records from our inner-city level I trauma center, a retrospective review was conducted to identify all patients with skull fractures crossing a dural venous sinus or the internal jugular vein that underwent computed tomography (CT) venogram evaluation during a recent 10-year period. Each examination was reviewed independently by two neuroradiologists to determine the presence or absence of dural sinus thrombosis and/or external compression. Additionally, fracture site and description, patient age, sex, mechanism of injury and Glasgow coma scale on arrival were collected and considered.

Results
A total of 220 patients met our inclusion criteria over the selected 10-year period. In 51 (23%) of these patients, dural venous sinus thrombosis was identified, with 21 (41%) described as occlusive and 30 (59%) as nonocclusive. External compression of the dural venous sinuses due to epidural hemorrhage was identified in 154 cases (70%). When fracture site was considered, there was a 41% (34/82) incidence of venous sinus thrombosis with a temporal bone fracture compared with a 12% (17/138) incidence with all other fractures (p<0.05). When considering isolated occipital bone fractures, there was a statistically significant lower incidence of venous sinus thrombosis at 14% (14/99) compared with incidence of 30.5% (37/121) in all other fractures (p<0.05).

Conclusions
We determined a 23% incidence of venous sinus thrombosis in trauma patients with
fractures adjacent to dural venous sinuses or the internal jugular vein. In our population, the largest studied to date, the incidence is lower compared to rates previously reported in the literature. Additionally, we demonstrate a statistically significantly increased risk of dural venous thrombosis in patients with temporal fractures when compared with other fracture sites as well as a decreased risk of thrombosis in patients with isolated occipital bone fractures. These results may provide insight as to which trauma patients should be screened with CT venogram.
**a. and b.** Axial CT venogram images in bone and soft tissue windows demonstrate a nondisplaced left occipital bone fracture with adjacent epidural hematoma compressing the left transverse sinus by >50%.

**b. and d.** Axial CT venogram images in bone and soft tissue windows demonstrate a comminuted right petrous temporal bone fracture with diastasis of the right lambdoid suture. A nonocclusive filling defect is seen in the right transverse sinus with adjacent epidural hemorrhage.

(Filename: TCT_eP-57_venousasnr.jpg)
Tumefactive multiple sclerosis: overcoming diagnostic dilemmas with multimodal MRI

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Purpose
Tumefactive multiple sclerosis (MS) is a demyelinating disease in which clinical and imaging findings are indistinguishable from those of neoplasm. It is a rare presentation of the disease and due to diagnostic challenges, many centers will perform biopsy for diagnosis which may lead to unnecessary treatment. Multimodal magnetic resonance imaging (MRI) can be used to aid diagnosis of tumefactive MS; however, this is not widely performed. In addition, current evidence is confusing and sometimes conflicting, leading to inaccurate interpretation.

Materials and Methods
We performed a retrospective review on a series of six patients with features of a neoplastic mass lesion, who presented between the years of 2010 and 2015 at the Queen Elizabeth Hospital Birmingham. Initial CT/MR imaging findings made it difficult to arrive at a diagnosis without biopsy. Patients underwent multimodal MRI with contrast, perfusion, diffusion and spectroscopy.

Results
Spectroscopic and perfusion features were consistent with tumefactive multiple sclerosis (MS). It was found that the near normal N-acetylaspartate/creatine (NAA/Cr) ratio and raised glutamate and glutamine peaks were the more critical findings in distinguishing tumefactive MS from neoplasm. Furthermore, the perivenous enhancement pattern, peripheral restricted diffusion and relatively low central relative cerebral blood volume (rCBV) also were useful adjunct features. Importantly, all six patients avoided biopsy.

Conclusions
Tumefactive MS is a diagnostic challenge and many centers proceed to early biopsy, which may be inconclusive and followed by unnecessary surgery or radiotherapy. Careful interpretation and combination of findings using multimodal MRI is required for accurate diagnosis.
Purpose
Programmable shunts commonly are used because they allow modifying cerebrospinal fluid (CSF) drainage rate without the need for repeat surgery. Establishing the valve settings however requires a specialized hand-held device from that specific vendor or plain film x-rays oriented perpendicular to the valve. These must be performed in addition to the computed tomography (CT) that is considered the standard of care for suspected shunt failure in symptomatic patients. We consider whether volume rendered images of the head, using dual energy metal suppression CT can be used alone to predict the shunt settings in programmable shunts. The purpose of this scientific paper is to investigate whether dual energy CT imaging provides sufficient detail of the valve of a common programmable VPS (Medtronic, Strata), using a skull phantom, to predict the opening pressure of its valve.

Materials and Methods
A Medtronic Programmable Strata valve was applied to a dried skull and then scanned at the five settings allowed by the device. The valve changes were performed and verified using the hardware provided by Medtronic prior to each scan. Computed tomography scans were performed on a Siemens SOMATOM Force CT scanner with each tube at a different kV setting with a CTDIvol of 50 mGy reducing metal artifacts. The source 0.75 mm images were used to create a volume rendered image using TeraRecon 3D software (Foster City, CA). These 3D images were used to create a table of the valve appearances at each setting (0.5-2.5). The skull phantom then was scanned again at the five various shunt settings in random order and this imaging data were presented as a set of unknowns to one of the authors (ACM) without prior knowledge of the settings.

Results
The images using this technique, while having little resemblance to the appearance of the setting as seen on plain film images, had sufficient detail that each of the five settings appeared different on the volume rendered images from the others. This was validated when one author was able to use the table previously generated to correctly determine valve setting in each of the unknown scans.

Conclusions
We demonstrated that modern metal suppression dual energy CT is capable of demonstrating each of the five valve settings on a common programmable shunt ex vivo. Further testing will be performed to validate this result in vivo and whether the other commercial programmable valves allow similar CT demonstration of settings.
This capability using CT alone would be valuable in symptomatic patients when it is important to distinguish between shunt malfunction from valve adjustment since that can occur inadvertently after exposure to powerful magnets.

Figure. 3D volume rendered image on the left of valve at setting of 0.5 and on the right at setting of 1.5 demonstrate different appearances.

(Filename: TCT_eP-99_Slide1.jpg)

eP-31

Usefulness of contrast enhanced 3D T2 FLAIR in cases with meningitis carcinomatosa

K Toyoda¹, T Kanda¹, Y Nakai¹, H Oba¹, S Furui¹
¹Teikyo University School of Medicine, Tokyo, Japan

Purpose
On fluid-attenuated inversion recovery (FLAIR) imaging with a three dimensional
(3D) technique, flow artifacts disappear and the signals from the cerebrospinal fluid (CSF) are better suppressed, compared to 2D FLAIR. In the last annual meeting, we presented contrast-enhanced (CE) 3D T2 FLAIR as being extremely useful in the diagnosis of infectious meningitis. Here, the purpose of our study was to evaluate the usefulness of CE 3D T2 FLAIR in cases with meningitis carcinomatosa, as compared with CE 3D T1-weighted imaging (T1WI).

Materials and Methods
The subjects were 25 consecutive cases diagnosed with meningitis carcinomatosa from April 2012 to September 2015 in which malignant cells were detected on spinal fluid examination or who had meningitis with or without metastatic intra-axial tumors. The origin was lung cancer in 12 cases, breast cancer five, others eight, unknown one. Contrast-enhanced 3D T1WI and CE 3D T2 FLAIR images could be obtained at the same time by 3T MR machines. For T2 FLAIR, the 3D technique was used, and for T1WI, 3D GRE (SPGR or FLASH) or 3D FSE (CUBE or SPACE) T1-weighted techniques were used after administration of Gd-DTPA. Sagittal sections of CE 3D T2 FLAIR and CE 3D T1WI (including reconstruction) were evaluated. Each of the CSF spaces of the cistern and sulci was divided into 13 regions as follows: bilateral frontal lobes, parietal lobes, occipital lobes, temporal lobes, cerebellar hemispheres, vermis, anterior brain stem, and posterior brain stem. An abnormal enhancing effect was considered present when some kind of continuous linear enhancement effect or multiple enhancing nodules were noted in the sulci or cistern. Whether the enhancement effect of meninges of these regions was superior, equivalent (or absent in both) or inferior on FLAIR, compared with T1WI was assessed visually.

Results
In almost all cases, abnormal enhancement effects of the sulci or cisterns were superior or equivalent on CE 3D T2 FLAIR than on CE 3D T1WI; lesions were better depicted on CE 3D T2 FLAIR. Diffuse meningeal enhancement of almost all cerebral and cerebellar sulci and brain stem cistern could be depicted on CE 3D T2 FLAIR in six cases. In the remaining 19 cases, partial meningeal enhancement was noted on CE 3D T2 FLAIR. Multiple small enhancing nodules led to local deformity of the gyri configuration, indicating adhesion or stasis of cerebrospinal fluid. Comparing between infratentorial and supratentorial parts, a more frequent enhancing effect was noted in right cerebellar sulci in 19 cases, and left ones in 18 cases, which were depicted more easily on CE 3D T2 FLAIR than on CE 3D T1WI. In particular, in fissures of the vermis a granular enhancing effect continuous within the cerebellum was characteristic.

Conclusions
Contrast-enhanced 3D T2 FLAIR is useful for the diagnosis of meningitis carcinomatosa and especially is superior in delineating infratentorial lesions. Meningitis carcinomatosa may predominantly occur in the cerebellum. Gd contrast-
enhanced 3D T2 FLAIR imaging plays an important role in diagnosing meningitis carcinomatosa.

**eP-01**

Utility of Susceptibility-Weighted Imaging in Differentiating Patterns of Iron Deposition in Healthy Controls, Parkinson’s Disease, and the Parkinson’s Plus Syndromes

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¹Northwestern University, Feinberg School of Medicine, Chicago, IL, ²Department of Radiology - Northwestern University Feinberg School of Medicine, Chicago, IL, ³Northwestern University, Chicago, IL, ⁴Northwestern University Feinberg School of Medicine, Chicago, IL, ⁵Feinberg School Of Med., Northwestern Univ., Chicago, IL

**Purpose**

Patterns of iron deposition can be depicted readily on susceptibility-weighted imaging (SWI) in patients with Parkinson Disease (PD), Multisystem Atrophy – Parkinsonian Type (MSA-P) and the tau protein-related conditions, Progressive Supranuclear Palsy (PSP) and Corticobasal Degeneration (CBD). The aim of this study is to investigate whether different patterns of brain iron deposition can differentiate between healthy controls and these conditions.

**Materials and Methods**

This was a retrospective, cross-sectional study. Thirteen healthy controls as well as 25, 11, and 10 patients with a clinical diagnosis of PD, MSA-P, and PSP/CBD, respectively, who underwent SWI of the brain were included. Two neuroradiologists produced SWI hypointensity scores based on the background signal intensity of the putamen, globus pallidus, dentate nucleus, red nucleus, and substantia nigra using a five-point scale, with cortical vein intensity=1, cerebrospinal fluid intensity=3, gray matter intensity=5, and intermediate intensities = 2 or 4. Statistical analysis was performed with the intraclass correlation (ICC), Kruskal-Wallis test, and Mann-Whitney U tests with a Bonferroni correction setting the significance threshold at 0.0038.

**Results**

Inter-rater agreement was excellent for all regions (ICC=0.906). In patients with PD, intensity of the globus pallidus and substantia nigra was significantly lower than that of the putamen and dentate nucleus (p <0.001). In patients with MSA-P and CBD/PSP, intensity of the globus pallidus was significantly lower than that of the dentate nucleus (p <0.001). In patients with CBD/PSP, intensity of the substantia nigra was significantly lower than that of the dentate nucleus and red nucleus.
(p=0.001 and 0.002). No statistically significant difference of the intensities of the globus pallidus, putamen, dentate nucleus, or red nucleus were observed in the healthy controls (p = 0.022 to 0.831).

Conclusions
In patients with PD, MSA-P, and CBD/PSP, SWI demonstrates significant differences in the intensities of the globus pallidus and substantia nigra relative to the putamen, dentate nucleus, and red nucleus, as described above. Healthy controls did not demonstrate any statistically significant differences in these regions. Our data suggest that SWI grading of these regions may be helpful in differentiating between healthy patients and patients with a presynaptic dopaminergic neurodegenerative disorder such as PD, MSA-P, CBD, and PSP.

eP-122

Venous Epidural Hematoma: Distribution and Venous Sinus Complications

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Purpose
To describe the varied presentation of venous epidural hematoma or transdural epidural hematoma. Given the clinical impact of a missed venous epidural hematoma, delayed catastrophic hemorrhage, delayed dural venous sinus thrombosis or occlusion, recognizing these subtle injuries on noncontrast and computed tomography (CT) angiogram and venogram is critically important.

Materials and Methods
Under IRB approval, retrospective analysis of epidural hematoma on CT, CTA, CTV, MR, MRV of the brain was performed. One hundred twenty-five cases of epidural hematoma involving dural venous sinuses in the middle cranial fossa, vertex, and posterior fossa were collected. Morphology, size, location, and clinical outcome was characterized.

Results
Venous epidural hematoma was localized to involve predominantly three locations, posterior fossa, middle cranial fossa, and vertex. Middle cranial fossa venous epidurals were frequently clinically managed to resolution. Vertex and posterior fossa venous epidural hematoma had a higher rate of complications involving the superior sagittal sinus, torcular, transverse and sigmoid sinuses. In a percentage of patients, mass effect leads to stenosis or occlusion of the displaced dural venous sinus. Active extravasation or rapid increase in size led to immediate or subacute decompression.

Conclusions
Localization of venous epidural hematoma is critically important for clinical and
surgical management. The relative paradigm shift of managing middle cranial fossa venous epidural hematoma requires accurate diagnosis and surveillance of these injuries. Vertex and posterior fossa epidural hematoma can displace or occlude the dural venous sinuses. It is critical to recognize these injuries. If venous epidural hematoma is recognized, venous imaging may be performed to characterize mass effect or occlusion. These findings may prompt earlier neurosurgical intervention.

**eP-32**

**Whole-brain echo planar spectroscopic imaging distinguishes recurrent tumor versus pseudoprogression in glioblastoma patients.**

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¹University of Pennsylvania, Philadelphia, PA, ²Hospital of the University of Pennsylvania, Philadelphia, PA, ³University of Miami, Miami, FL, ⁴Hospital Of the Univ. Of Pennsylvania, Philadelphia, PA, ⁵University of liverpool, Liverpool, AK

**Purpose**

Glioblastoma (GB) patients receiving radiation therapy with adjuvant temozolomide (TMZ) may exhibit enhancing lesions on magnetic resonance imaging (MRI) within 6 months of treatment. Twenty to 30% of these lesions may be treatment-effect, known as pseudoprogression (PsP), rather than true progression (TP). Accurately characterizing these lesions may directly impact treatment strategies (1), yet is difficult with conventional techniques due to their metabolic heterogeneity. The purpose of this study was to evaluate 3D echo-planar spectroscopic imaging (EPSI) (2) to differentiate PSP from TP, using elevated choline (Cho) [indicative of tumor (3,4)] as a biomarker for TP.

**Materials and Methods**

Twenty-one patients were scanned using 3D EPSI on a Siemens 3T scanner. Seven patients classified as PsP (containing <25% tumor on histology or no biopsy within six months), and seven were classified as TP (>25% recurrent). Four patients yielded inconclusive or low-quality spectra and three patients had not undergone repeat surgery and these seven patients were excluded from the analysis. Echo-planar spectroscopic imaging parameters included: TE/TR=17.6ms/1550ms, 280x280mm FOV, 180mm section thickness, 512 complex points with 616Hz bandwidth and 15min scan time. Data were post-processed using the Metabolite Imaging and Data Analysis System (MIDAS) (2) which zero-filled the acquired 50x50x18 array to 64x64x32 with final effective voxel sizes of 1 ml. Contrast-enhanced T1 and fluid attenuated inversion recovery (FLAIR) T2-weighted magnetic resonance imaging (MRI) facilitated tumor segmentation. Using custom IDL and MATLAB-based
scripts, spectroscopic parametric maps were segmented into three regions: contrast-enhancing voxels, voxels adjacent to enhancement (peritumoral) and voxels separate from enhancement but within hyperintense region on FLAIR images (distant peritumoral). Quantification of Cho, creatine (Cr) and N-acetylaspartate (NAA) was performed using prior-knowledge fitting, with particular focus on the comparison of Cho/Cr and Cho/NAA ratios between segmented regions in the neoplasm and normal contralateral tissue.

Results
Fig. 1 shows registered enhanced T1 and FLAIR images undersampled to match EPSI resolution along with single and multi-slice Cho/Cr maps from a representative EPSI scan of a TP patient. Fig. 2 shows normalized histograms of Cho/Cr from enhancing lesions in PsP (C) and TP (D) compared to contralateral tissue from the same slice level in PsP (A) and TP (B). Table 1 shows the median factor by which Cho/NAA and Cho/Cr ratios were higher in the enhancing, peritumoral and distal peritumoral areas compared to contralateral regions. For example, median Cho/NAA ratio was 2.57 ± 0.63 times higher in the contrast-enhancing area of TP patients compared to the contralateral region. Elevation in Cho/NAA was less (1.70 ± 0.48) among PsP patients, which was significantly different than TP (two-sided Student t-test, p-value of 0.013). General trends of higher Cho/NAA ratios were observed among TP patients compared with corresponding regions in PsP in all regions studied.

Conclusions
Echo-planar spectroscopic imaging can assess metabolic heterogeneity in treatment response, aiding in discrimination of PsP versus TP.
Figure 1

Table 1

<table>
<thead>
<tr>
<th>Median Cho/NAA</th>
<th>PsP (N=7)</th>
<th>TP (N=7)</th>
<th>P-Value</th>
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<td>Enhancing Region</td>
<td>1.70 ± 0.48</td>
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<td>Peritumoral</td>
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<td>Distal Peritumoral</td>
<td>1.21 ± 0.30</td>
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<tr>
<td>Peritumoral</td>
<td>1.26 ± 0.43</td>
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<td>Distal Peritumoral</td>
<td>1.18 ± 0.28</td>
<td>1.60 ± 0.60</td>
<td>0.147</td>
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</table>

Figure 2

Pseudoprosession Enhancing Region

True Progression Enhancing Region
Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B=2

Electronic Poster (eP) - Head and Neck
eP-128

A Novel Imaging Measurement Identifying Patients with Orbital Floor Fracture Requiring Surgical Repair

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Purpose
Current teaching dictates that blowout orbital floor fractures (BOF) >50% require surgical repair. In our experience, this tool appears inaccurate. The purpose of this study is to identify an accurate and reliable computed tomography (CT) measurement that can identify those patients who require orbital floor fracture repair.

Materials and Methods
In this retrospective IRB approved study, we reviewed 99 patients older than 18 years with BOF treated in a level I center during 2011-2015. Of the 31 patients included in the study, 25 had isolated BOF, and six had minor medial wall fractures along with BOF. Patients with more complex facial fractures were excluded. Patients were deemed to require surgery by an ophthalmologist, based on clinical findings of diplopia and/or enophthalmos. We measured the accuracy of the BOF >50% rule in predicting need for surgical repair and compared it to the accuracy of involvement of the inframedial strut (IMS) and to a new measurement, labeled TMD. TMD is the difference between the caudo-cranial dimension of the fractured orbit minus the normal side, measured just posterior to the globe.

Results
The accuracy of BOF >50% for predicting those requiring surgical repair was 48%. The accuracy of IMS involvement was 74%. Using a threshold TMD value of 0.8, the accuracy of TMD was 94%. TMD had a sensitivity of 100% and specificity of 92%. Kappa agreement between the two readers evaluating the CT images was 0.93.

Conclusions
TMD is a dependable measurement, identifying patients with orbital floor fracture requiring surgical repair.
Arterial spin labeling MR imaging of head and neck squamous cell carcinoma

a abdel razek

1Mansoura faculty of medicine, mansoura, WY

Purpose
To evaluate the role of arterial spin labeling (ASL) in head and neck squamous cell carcinoma (HNSCC).

Materials and Methods
Prospective study was conducted upon 37 patients (23M, 14F aged 28-72 years: mean 49 years) with HNSCC. Routine pre and postcontrast, T1 map and ASL of head and neck were done for all patients. Multiphases arterial spin labeling with FEEPI sequence applied. There was reconstruction of 1200 source images. The control images were subtracted from labeled images to obtain mean difference image with calculation of tumor blood flow (TBF).

Results
There was significant difference in TBF between well to moderately differentiated HNSCC versus poorly and undifferentiated HNSCC (P =0.001), grade I, II versus grade III and IV (P =0.001) and patients with and without cervical lymphadenopathy (P =0.001). The cut of TBF used for differentiate well and moderately differentiated from poorly and undifferentiated, stage I, II from stages III and IV and presence of cervical lymphadenopathy were 48.7, 48.7 and 48.7 mL/100g/min with area under the curve of 0.892, 0.833, 0.921 respectively.

Conclusions
we conclude that ASL is a noninvasive imaging technique that can predict stage, degree of differentiation and metastatic cervical lymph nodes in patients with HNSCC.
Assessment of semiquantitative parameters of dynamic contrast enhanced perfusion MR imaging of tumors of the skull base

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Purpose
To assess semiquantitative parameters of dynamic contrast-enhanced (DCE) perfusion magnetic resonance imaging (MRI) in tumors of skull base.

Materials and Methods
Retrospective analysis of 34 (27M, 7F aged 25-72 years: mean 45 years) patients with tumors of the skull base. Dynamic contrast-enhanced gradient-recalled echo MR sequence after administration of gadopentate dimeglumine of the head and neck obtained. The time signal intensity curve (TIC) of the lesion was created with calculation of enhancement ratio (ER), and washout ratio (WR).

Results
The tumors of the skull base were malignant (n=17) and benign (n=12). The mean ER of malignant and benign skull base tumors was 188±49.7 and 120±41.6 respectively. The mean WR of malignant and benign skull base tumors was 28.6±6.8 and 42.7±10 respectively. There was significant difference in ER (P=0.001) and WR (P=0.001) between malignant and benign skull base tumors. The threshold values of ER and WR used for differentiating malignant from benign skull base tumors were 142 and 38 with areas under the curve of 0.937 and 0.895 respectively.

Conclusions
We concluded that ER and WR semiquantitative perfusion parameters help in differentiation of malignant from benign skull base tumors.

Benign Primary Miliary Osteoma Cutis of the face: a Common Incidental CT finding!

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Purpose
Osteoma cutis (cutaneous ossification) of the face represents primary or secondary formation of ossified foci in the facial skin and was described first by Wilekens in 1858. It is distinguished radiologically and pathologically from calcinosis cutis by the deposition of organized matrix while the latter is characterized by the deposition of amorphous calcium salts within the skin. Secondary osteoma cutis has been well described in the radiology and dermatopathology literature. Secondary etiologies include: iatrogenic/traumatic, metabolic (e.g., Albright's hereditary osteodystrophy), inflammatory (e.g., acne or dermatomyositis) and neoplastic (e.g., basal cell carcinoma). Primary or idiopathic osteoma cutis, when sufficiently advanced or extensive to require cosmetic intervention, has been sparsely described in the plastic surgery and dermatology literature. As radiologists, we routinely encounter incidental, small facial calcified nodules on computed tomography (CT) studies performed for a variety of reasons on patients without underlying cause. These incidental facial calcifications have been largely overlooked in the imaging literature. In breast imaging, benign skin calcifications are encountered routinely and thought to be secondary to sebaceous inspissations or low-grade infection. Here, we present a retrospective review of a large CT dataset combined with a cadaveric case series to establish that routinely encountered facial dermal calcification is "Primary Miliary Osteoma Cutis", a common, benign, age-related finding.

Materials and Methods
Thirteen hundred fifteen consecutive sinus CTs obtained during an 8 months period and their associated demographics were reviewed retrospectively. The number of dermal radio-opaque lesions with Hounsfield Unit greater than 150 were counted and the correlation between the prevalence of these lesions and patient's demographics was analyzed using logistic regression methods. Then we compared this data with a prior large cadaveric series of 33 individuals and obtained pathologic specimen.

Results
Five hundred ninety-nine males and 716 females from age 4 to 90 years were included in the study (mean 52 versus 51, p=0.259). Among these, 247 males and 303 females had facial calcified nodules (43.3% versus 40.7%, p=0.332). Logistic regression analysis demonstrated that the patient's age was a statistically significant predictor for having facial calcified nodules (Odds ratio = 1.0178, p<0.001) while the patient's sex was not (p=0.853). Commonly encountered dermal calcifications on head and face CT are similar to benign soft tissue calcifications observed in other body parts in terms of imaging characteristics and age-dependency. Cadaveric pathological specimen revealed concentric, multiple-lamellated, osteoid cortex and adipose medulla, which correlated well with benign, normal bone formation.

Conclusions
Dermal calcified nodules, observed in routine head and face CT imaging, are
common, benign, age-related finding, which has been largely overlooked in the Radiology literature. It is a manifestation of "primary miliary osteoma cutis".

Benign Dermal Calcified nodules on Face
- Radiologists routinely encounter incidental facial calcifications on CT studies performed for a variety of reasons.

Examples of coronal head CT for sinus study.

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eP-145

Clinically Relevant Canals and Crevices of the Temporal Bone: In Sharper Focus with MDCT
Purpose
Temporal bone anatomy is complex with many small canals, foramina, and osseous structures that may be visualized inconsistently on conventional temporal bone computed tomography (CT) due to anatomical variation, technique, or both. We present a review of the less commonly recognized temporal bone structures and anatomical variations which can be a source of confusion, or mistaken for temporal bone pathology.

Materials and Methods
A large bank of cases was reviewed including CT imaging of the temporal bones with discussion of the relevant magnetic resonance imaging (MRI) findings.

Results
Normal Anatomical Structures: • Inferior Tympanic Canaliculus: Arises from the pars nervosa and ascends to the hypotympanum. It may be mistaken for fracture and can be enlarged with certain disease processes and anatomical variants. o Aberrant internal carotid artery (ICA). o Persistent Stapedial Artery. o Glomus Jugulotympanicum: Glomus bodies are found along the course of Jacobson's Nerve. • Mastoid Canaliculus: It transmits Arnold's Nerve (auricular branch of the vagus nerve). • Arcuate Canal (Petromastoid Canal or Subarcuate Canal/Fossa): Courses between the limbs of the superior semicircular canal. • Hiatus of the facial canal (Hiatus for Greater Superficial Petrosal Nerve). • Singular Canal (Foramen Singulare): Runs from the internal auditory canal (IAC) to the posterior semicircular canal. • Canal of the Lateral Ampullary Nerve: Runs from the distal superior aspect of the IAC to the ampulla of the lateral semicircular canal. • Canal of the Saccular Nerve: Runs from the distal IAC to the vestibule. • Vestibular Aqueduct (Vestibular Canaliculus). • Cochlear Aqueduct (Cochlear Canaliculus). Anatomical Variants: • Aberrant ICA, • Persistent Stapedial Artery, • Jugular Bulb Asymmetry, • Dehiscent Jugular Bulb, • Jugular Bulb Diverticulum.

Conclusions
Familiarity with the subtleties of temporal bone anatomy is crucial to avoid mistaking these structures for pathology. Additionally, knowledge of the expected course and appearance of possible vascular variations and anomalies is necessary for appropriate diagnosis and guidance for clinicians and surgeons.

Correlation of tumor blood volume and apparent diffusion coefficient values with the prognostic parameters of head and neck squamous cell carcinoma

Correlation of tumor blood volume and apparent diffusion coefficient values with the prognostic parameters of head and neck squamous cell carcinoma
Purpose
To measure tumor blood volume (TBV) through dynamic susceptibility perfusion-weighted MR imaging (DSC) and apparent diffusion coefficient (ADC) values through diffusion-weighted MR imaging and to correlate these values with the prognostic parameters of head and neck squamous cell carcinoma (HNSCC).

Materials and Methods
Retrospective analysis was performed upon 43 patients (31 M and 12 F, mean age, 65 years) with HNSCC. Diffusion-weighted MR images with b-values of 0, 500 and 1000 s/mm² and contrast MR imaging of the head and neck were performed. The TBV and the ADC values of HNSCC were calculated. The gross tumor volume (GTV) also was calculated. The degree of tumor differentiation was determined through pathological examination.

Results
The HNSCC TBV level was correlated negatively with the ADC value (r = -0.662, P = 0.001). There was a significant difference in the TBV and ADC values at different degrees of tumor differentiation (P = 0.002 and P = 0.001) and with different GTVs (P = 0.133 and P = 0.001). The following prognostic parameter categories were used: (a) poorly differentiated and undifferentiated versus well differentiated to moderately differentiated and (b) HNSCC with GTV < 30 cm³ versus >30 cm³ GTV. The cut-off values for the TBV and ADC for each category were 23.2, 0.93; and 24.6, 1.11, respectively, and the areas under the curve were 0.822, 0.912 and 0.726, 0.795, respectively, for each category.

Conclusions
We concluded that the TBF levels determined using DSC and the ADC values using DWI are well correlated with some prognostic parameters of HNSCC.
Evaluation of MRI diffusion abnormalities of optic nerve head in papilledema and its comparison with clinical grading of papilledema

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Purpose
Diffusion-weighted imaging (DWI) has shown that presence of optic nerve hyperintensity is a very specific sign of papilledema. Our purpose was to evaluate the diffusion abnormality in optic nerve head in various stages of papilledema and correlation of apparent diffusion coefficient (ADC) values of optic nerve head and clinical grades of papilledema.

Materials and Methods
In this institution review board approved prospective study, we have assessed 12 newly diagnosed patients of papilledema irrespective of the cause. Grading of papilledema was done according to the modified Frisén scale. Magnetic resonance imaging (MRI) brain was done with dedicated orbital sequences on a 1.5 T MRI machine (Siemens MR Magnetom Aera). The hyperintensity of optic nerve head was graded and a region of interest (ROI) was drawn over the region of optic nerve head. Apparent diffusion coefficient values of optic nerve heads in 25 normal individuals undergoing MRI for anxiety disorder were calculated and taken as control.

Results
Of the 12 patients evaluated all had bilateral papilledema of variable grades (grade I in 10 eyes, grade II in five eyes, grade III in five eyes and grade IV in four eyes). Out of the 50 control eyes the mean ADC value of optic nerve head was found to be 1990 mm²/sec. The mean ADC value of optic nerve heads for papilledema grade I, II, III and IV were 1595 mm²/sec, 1393 mm²/sec, 1144 mm²/sec and 998 mm²/sec respectively. The correlation between clinical grade and DWI hyperintensity (p=0.03) and clinical grade and ADC value (p=0.02) were statistically significant.

Conclusions
Ischemia to the optic nerve head is the major factor for pathogenesis and disease progression of papilledema as evidenced by the gradually decreasing ADC value with increasing clinical grades. Furthermore when applied to a larger study samples a radiological grading system of papilledema by ADC value of optic nerve head can be generated.
IAC Fundus Enhancing Pseudolesion: First Reported Incidence on Post Contrast 1mm Volumetric T1 SPACE

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Purpose
To determine the incidence of an apparent pseudolesion in the IAC fundus on 1mm volumetric postcontrast T1 SPACE imaging.

Materials and Methods
Small false positive enhancing lesions in the IAC fundus have been described previously (1) but to our knowledge, this is the first report of the incidence of such lesions on 1mm volumetric magnetic resonance imaging (MRI) imaging. One hundred three consecutive patients over a 3-month period were evaluated retrospectively for the presence of an enhancing pseudolesion in the IAC fundus on 1mm volumetric T1 SPACE postcontrast imaging. Ninety patients had the whole brain version of the sequence and 13 had the small field of view IAC version. 0.1mm/kg of gadolinium were injected for each study. Two reviewers independently scored the cases for the presence, indeterminate presence, or absence of the pseudolesion in each IAC. Five patients were excluded due to the presence of leptomeningeal carcinomatosis; in one additional patient, one IAC was excluded due to a mass.

Results
Out of 195 possible sides in 98 patients, after consensus reads, 14 sides were called positive for the pseudolesion (7.2%) and six were called indeterminate (3.1%). Three patients had inconsistent enhancement of the apparent pseudolesions of follow-up studies. No patients had surgery as the gold standard, but this incidence is much higher than expected for IAC fundus schwannoma, and the study excluded patients with leptomeningeal carcinomatosis. Therefore this entity is thought to represent a pseudolesion and not a true lesion.

Conclusions
An apparent focal enhancing lesion in the IAC fundus on high resolution postcontrast T1 SPACE has an incidence of up to 7.2-10.3%, and is unlikely to be a pathological lesion in the absence of leptomeningeal carcinomatosis.

Imaging of peri-neural spread in nasopharyngeal malignancy
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Purpose
Perineural spread in nasopharyngeal malignancy has important prognostic implications, and even if clinically silent, can be radiologically evident. This study analyzed the frequency, radiographic features, and importance of the diagnosis in treatment planning.

Materials and Methods
Radiographic studies of 264 cases of nasopharyngeal malignant lesions were included. Among them 50 cases with perineural tumor spread (PNTS) were identified. Magnetic resonance imaging (MRI) studies were available in all 50 cases. Computed tomography (CT) studies were identified only in 35 cases. Salient radiographic findings were compared with the contralateral normal side. The images were reviewed independently by two radiologists.

Results
The pool of our study was 50 patients (14 female and 36 male) with patients' age ranging from 12 to 83 years. Squamous cell carcinoma was the most common pathology encountered in 31 cases followed by rhabdomyosarcoma in 12 cases, adenoid cystic carcinoma in eight cases of non-Hodgkin lymphoma. Mandibular branch of the trigeminal nerve was the most common nerve affected in 37 cases followed by maxillary branch in 12 cases, facial and hypoglossal nerve in the last two cases. Magnetic resonance imaging was more sensitive in detection compared to CT. Regarding the signs of PNTS in MRI studies: nerve enhancement is the most common sign in the positive case, encountered in 100% of cases followed by nerve thickening encountered in 98.61% of cases. The muscle denervation is encountered only in 19.44% of cases. Regarding the CT signs of PNTS, the abnormal nerve enhancement is the most encountered sign in 91.89% followed by widened foramen (86.4%), nerve thickening is noted in 81.08% of cases. The muscle denervation seen only in 10.8% of the cases.

Conclusions
Cancers of nasopharynx can spread perineurally. Prior radiographic determination, although under reported, is imperative, because diagnosis impacts management and prognosis.

eP-133
6:30AM - 2:45PM

Imaging Patterns of Skull Base Encephaloceles

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54th Annual Meeting & Foundation of the ASNR Symposium 2016
Purpose
Skull-based defects frequently are encountered in the hospital setting. These may develop after trauma or skull base surgery. Additionally, they may be the consequence of infection, tumors, or congenital deformities. They also may develop spontaneously in patients with intracranial hypertension (1). These skull-based defects may manifest in the form of encephaloceles, meningoceles, meningoencephaloceles or as a cerebrospinal fluid (CSF) leak (2). A persistent CSF leak can lead to headache of varying, sometimes debilitating, intensity. Additionally, CSF leaks are associated with an increased risk of meningitis. As such, skull-based defects should be promptly diagnosed and corrected. Determining the precise location of these defects is essential for surgical correction (3).

Materials and Methods
A retrospective review of patients evaluated for skull base CSF leaks at our institution over the past 6 years was performed. These patients were evaluated with either a routine magnetic resonance imaging (MRI) or an MR/computed tomography (CT) fusion consisting of a high-resolution T2 sequence fused onto thin CT images of the skull base. The imaging features of 80 patients were evaluated with particular attention to characteristics that may aid in both diagnosis and localization.

Results
We describe typical locations and imaging patterns of encephaloceles. Features of brain parenchyma, including signal changes, are characterized. When CT is available, this is correlated to characterize skull-based defects.

Conclusions
Following a review of the literature, common features of skull base encephaloceles are described including positive predictive features and pitfalls.

eP-129
6:30AM - 2:45PM

In Pediatric Patients with Hypoplastic Internal Auditory Canals, What is the Utility of Thin-Section T2-Weighted Imaging to Determine the Contents of the IAC?

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Purpose
Hypoplastic internal auditory canals (IACs) may be found in a subset of pediatric patients being evaluated for cochlear implant (CI). Both computed tomography (CT)
and magnetic resonance imaging (MRI) have become routinely used to evaluate CI as a viable option. For assessment with high resolution T2-weighted images, there should be sufficient cerebrospinal fluid (CSF) in the IAC to evaluate the VIIth/VIIIth nerve complex. To date, it has not been reported if CT and MRI are both necessary for assessment of hypoplastic internal auditory canals. The focus of this abstract is to determine if there is a numeric threshold of the internal auditory canal diameter that may be obtained on imaging below which MRI will not be able to yield diagnostic information.

Materials and Methods
Twelve patients with hypoplastic IACs were reviewed retrospectively. The maximal measurement of the IAC midpoint was obtained. Magnetic resonance imaging was used to determine if there was sufficient CSF within the IAC to assess the VIIth/VIIIth nerve complex.

Results
If the maximal measurement of the IAC midpoint is 2.18 mm or less, the VIIth/VIIIth nerve complex cannot be assessed on MRI.

Conclusions
Based on a retrospective review of children with hypoplastic IACs for cochlear implant, there is a numeric threshold (2.18 mm) below which the VIIth/VIIIth cranial nerve complex cannot be assessed on MRI, and MRI should not be obtained. This data may result in reduced costs, optimal resource utilization and not subjecting pediatric patients to risks associated with sedation for these imaging examinations. Further research should be employed to optimize MRI pulse sequences to obtain clinically useful information in the shortest time possible.

eP-144
6:30AM - 2:45PM

Magnetic resonance imaging of parotid gland tumors

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Purpose
The goal of this study was to evaluate the magnetic resonance imaging (MRI) features that can be helpful in distinguishing benign and malignant parotid tumors.

Materials and Methods
This was a HIPAA compliant IRB approved retrospective study with waiver of informed consent. All patients with pathology proven benign and malignant tumors at our institution were included for analysis if they had completed a pre-operative MRI that was available for analysis. Scans with significant motion artifact were excluded. We were able to identify 73 consecutive adult patients from June 2013 to April 2015.
with parotid tumors who satisfied the inclusion and exclusion criteria. Images were evaluated for signal intensity, contrast enhancement, lesion margins, and perineural spread by one board certified neuroradiologist with more than 10 years of experience. In addition to the individual imaging features, the reader also was asked to predict whether tumors were benign or malignant based on the overall analysis. Imaging findings were compared between benign and malignant tumors by the two-proportion Z test.

Results
Patients had a mean age of 57.6 years and 37 were women (50.7%). There were 38 benign tumors (52.1%) and 35 malignant tumors (47.9%), comprising 30 pleomorphic adenomas (41%), 11 squamous cell carcinomas (15.1%), eight acinic cell carcinomas (11.0%), five salivary duct carcinomas (6.8%), four adenoid cystic carcinomas (5.5%), three Warthin tumors (4.1%), three mucoepidemoid carcinomas (4.1%), five other benign tumors (6.8%), and four other malignant tumors (5.5%). The imaging features that distinguished the two groups the best were hypointensity on T2-weighted imaging, presence of ill-defined margins, and perineural spread (p < 0.0001, p < 0.0001, and p = 0.0037 respectively). T1-weighted signal intensity and contrast enhancement were not significantly different between the two groups (p = 0.8026 and p = 0.9283) and not useful in predicting malignancy. Our reader correctly predicted whether tumors were benign or malignant in 58 cases (79.5%); the error rate did not differ significantly between benign and malignant tumors (p = 0.4902).

Conclusions
Parotid tumors are heterogeneous in their T1 signal intensities and enhancement characteristics, which renders these imaging features not helpful in making the distinction between benign and malignant lesions. The features predictive of parotid malignancy in this study were hypointensity on T2-weighted imaging, the presence of ill-defined margins, and perineural spread.

**eP-135**

6:30AM - 2:45PM

**Measurement for detection of incomplete partition-II (IP-II) anomalies on MR**

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**Purpose**
To determine a quantitative measurement of cochlear anatomy for suspected IP-II anomalies in the presence of enlarged vestibular aqueduct.

**Materials and Methods**
Retrospective study of magnetic resonance (MR) temporal bone studies performed
between 2005 and 2015 was performed looking for patients with enlarged vestibular aqueducts. A multiplanar reformat was created from a high-resolution 3D MR sequence in a plane parallel to the lateral semicircular canal, a reproducible landmark. Two observers performed a cochlear measurement between the lateral basilar membrane and the interscalar septum between the distal basal and upper middle turns or in its apparent absence the first band-like signal extending laterally to the cochlear wall at the level of the interscalar ridge. These measurements were compared with normal hearing individuals based on audiology who also had MR temporal bones performed.

Results
In 28 normal hearing individuals with no enlarged vestibular aqueduct, the normal cochlear measurement was less than 1 mm, mean 0.94 mm. Twenty-six patients with enlarged vestibular aqueducts and high-resolution MR were identified. Twenty of 26 patients were identified with cochlear measurements greater than 1.2 mm, mean 1.5 mm. Four of the 20 patients with abnormal measurements did not have prospectively identified cochlear anomalies.

Conclusions
Patients with cochlear measurements greater than 1.2 mm should be suspected as having an IP-II anomaly. Our retrospective analysis found 20% of our patients had an undiagnosed suspected IP-II anomaly suggesting that IP-II anomalies may be under-diagnosed. Using this measurement criteria, IP-II anomalies may be better detected.

eP-136
6:30AM - 2:45PM
MRI 3-D Reconstruction of the Internal Auditory Canal and Inner Ear. Can we eliminate CT?

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Purpose
The purpose of this retrospective analysis was to determine if 3 dimensional (3D) T2-weighted magnetic resonance imagine (MRI) reconstructions of the inner ear were more useful than computed tomography (CT) at identifying the anatomy and pathologies of the inner ear.

Materials and Methods
For this study we used 3T MRI (Siemens). Magnetic resonance images from 161 hearing impaired patients were chosen from the year 2014-2015 from our database at The Ottawa Hospital. A 3D T2-weighted MRI reconstruction of the inner ear was done for each patient. Three neuroradiologists, a neuroradiology fellow, a radiology resident and a third year medical student analyzed these reconstructions using a
scoring system for the semi-circular canals, the cochlea and the internal auditory canal (IAC). Structures also could be described as abnormal including a description of that abnormality.

Results
Of the 161 cases studied, 1% of them could not be reconstructed due to movement artifact. Thirty-four percent of patients had a mass present in their IAC and 1% had a fistula. One percent of IACs were not visible, One percent were seen only partially and 98% were well identified. All cochlea's were identified, 3% were only partially visualized and 97% were well visualized. Two percent of semi-circular canals were not visible, 19% were seen partially and 79% were well visualized.

Conclusions
Our study confirmed the value of 3D MRI reconstructions in evaluation of these patients. It allows detailed visualization of the inner ear structures and is an excellent complimentary test for surgical planning. These reconstructions also may be used for pre cochlear implant evaluation.

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eP-141

MRI of Facial Cosmetic Injectable Filters: an Analytic Approach to Identification of Injected Substance, Complications and Symmetry of Injected Sites.

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Purpose
To investigate the viability of magnetic resonance imaging (MRI) to identify injected substances in the facial region, its symmetry in the face, and complications.

Materials and Methods
Patients with suspected injected filler complications were identified by the plastic surgery service. Patients were scanned with MRI using T1 Dixon noncontrast, T2
Dixon, and T1 Dixon after gadolinium injection sequences. Two independent and blinded radiologists evaluated the images and reported likely injected substance, symmetry, and complications. All patients underwent the same sequence, but their identity was blinded to the interpreting radiologists. Radiologic results were compared with clinical data provided by the plastic surgeon.

Results

Twelve subjects underwent MRI using the above protocol (11 female, 1 male). Six patients underwent polyacrylamide gel injection, two hyaluronic acid, two silicone, and two collagen. Inter-rater concordance of substances between the two readers was 0.8 using Fleiss’ Kappa (substantial agreement) and after consensus between the two readers, Kappa agreement between imaging and clinical data was 0.96 (near perfect agreement). Ten patients (83%) demonstrated objective injectable complications: four demonstrates abscess, four granulomata, and two allergic reactions to injected substance. Kappa agreement between readers for complications was 1.0 (perfect agreement). Asymmetry was identified in six patients (50%) and kappa agreement between readers also was perfect.

Conclusions

Magnetic resonance imaging of the face is a reliable and reproducible tool to identify injected substance, complications, and symmetry of injectable fillers.
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Muscular Tumor Spread Along the Posterior Belly of the Digastric: A Unique Route of Extracapsular Oropharyngeal Squamous Cell Carcinoma Disease Extension

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Purpose
In oropharyngeal squamous cell cancers, level II cervical lymph nodes are most often the initial site of nodal metastasis (1). The posterior belly of the digastic muscle lies in close proximity to the jugulodigastric node group and therefore is potentially involved with extranodal extension of tumor. We describe the imaging findings of muscular spread of tumor along the posterior belly of the digastic, which forms a unique pattern of disease spread in oropharyngeal squamous cell carcinomas and a diagnostic conundrum.

Materials and Methods
An IRB approved, HIPPA compliant retrospective search was conducted through institutional teaching files, identifying pathologically proven head and neck squamous cell carcinoma cases with imaging findings of tumor involvement of the posterior belly of the digastic muscle. These cases were reviewed and their clinical and imaging findings synthesized.

Results
Four cases were identified. One patient had an oral tongue primary while three others had histories of palatine tonsil primaries with ipsilateral nodal metastases. Tumoral infiltration of the posterior belly of the digastic muscle was noted as asymmetric thickening of the muscle borders on T1 precontrast imaging, perimuscular T2 hyperintensity, and ill-defined internal or peripheral muscular enhancement. In one case, tumor recurrence at the mastoid notch developed after primary chemoradiation.

Conclusions
Muscular tumor spread along the posterior belly of the digastic forms a unique pattern of disease extension of oropharyngeal squamous cell carcinomas. This is a potential imaging dilemma as well as an important finding for radiation planning to ensure IMRT tumor coverage.
Natural course of thyroid nodules based on combined the categorical reporting systems between cytology and US: A suggestion of the strategy for repeat fine needle aspiration cytology

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Purpose
Although ultrasonography-guided fine needle aspiration cytology (USFNAC) is an essential diagnostic tool in the management of thyroid nodules, a large number of patients still need a repeat USFNAC. The goal of our study was to investigate the natural course of thyroid nodules based on combined the categorical reporting systems between cytology and US, to establish effect strategy for repeat USFNAC.

Materials and Methods
From June 2001 to December 2014, 1680 patients (F:M= 1526:154), results of repeat USFNAC for thyroid nodules were reviewed. The hazard ratios (HR) of USFNAC results including the Bethesda thyroid cytopathology system, and US category-based
morphological changes with growth rate such as tumor volume doubling time were analyzed by Cox proportional risk model.

Results
One hundred two of 1680 (6.1%) patients had malignancy in mean follow up of 27.75 months. Initial FNAC category of atypia of undetermined significance (HR= 9.00), US category of intermediate (HR=14.09) and probably malignancy (HR=36.70) had high HR for malignancy (P<0.05). Although US categorical worsening and dimensional increase were not significant to indicate malignancy, doubling time was lower in malignancy (p<0.05). More than two benign on cytology without any evidence of malignancy was significant to benign (HR=0.184). When the combined category system with clinical data was applied to result of retrospective data, 2/102 (2.0%) patients were classified as false negative.

Conclusions
Understanding of the natural course of thyroid nodules based on the combined categorical reporting systems between cytology and US could be useful to establish effect strategy for repeat USFNAC.

eP-147a
6:30AM - 2:45PM
Quantitative Evaluation of Volume and Edema of Orbital Fat in Thyroid-Associated Orbitopathy by Using IDEAL

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Purpose
One of our purposes was to assess the reproducibility of quantitative evaluation in the orbital fat on iterative decomposition of water and fat with echo asymmetry and least-squares estimation (IDEAL). The other purpose was to investigate steroid pulse therapy-induced changes of volume and edema in the orbital fat in thyroid-associated orbitopathy (TAO) patients.

Materials and Methods
Orbital IDEAL images at 3T MR system of healthy controls (15 males: 15 females, median age: 29 ± 7.6 years) were acquired twice within a week. Nine TAO patients (2 males: 7 females, median age: 57 ± 12.5 years) underwent IDEAL before and after steroid pulse therapy. We calculated water fraction in the orbital fat from water and fat images and measured the orbital fat volume by separating fat tissue from other structures in all subjects. We performed Bland-Altman analysis to examine measurement reproducibility of the water fraction and volume in the orbital fat in the
controls and compared these values before and after the therapy using paired t-test. Then, we compared the treatment-induced change of these values with those of the interscan difference in the controls using two-sample t-tests.

Results
In the controls, the measurement reproducibility was sufficient (water fraction, $r = 0.71$, 95% confidence interval [CI] bias = -0.007–0.012; volume, $r = 0.99$, 95% CI bias = -0.108–0.242). Steroid pulse therapy significantly reduced the water fraction in the patients ($p < 0.001$) and the treatment-induced reduction was significantly larger than the interscan difference in the controls (right, $p = 0.002$; left, $p = 0.001$). There was no significant difference in the orbital fat volume before and after the therapy (right, $p = 0.37$; left, $p = 0.17$).

Conclusions
The reproducibility of quantitative evaluation was sufficient on IDEAL. IDEAL was useful in the follow up of TAO patients after steroid pulse therapy.

eP-131

Radiologic Differences between Human Papillomavirus (HPV)-related Compared to HPV-Unrelated Oropharyngeal Carcinoma on Diffusion Weighted Imaging

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Purpose
Human papillomavirus-related oropharyngeal carcinoma (HPV+ OPC) is a unique entity with distinct epidemiological and clinical features compared to HPV-unrelated (HPV-) OPC. Previous studies have been inconsistent regarding the differences between HPV+ and HPV- OPCs on diffusion-weighted imaging (DWI) (1, 2). The purpose of this study is to evaluate the association between apparent diffusion coefficients (ADC) values and HPV status in OPCs.

Materials and Methods
A retrospective review of OPC patients with available pretreatment magnetic resonance imaging (MRI) with diffusion-weighted imaging (DWI) was conducted at our institution. HPV status was ascertained by p16 staining. Apparent diffusion coefficient (ADC) values for the primary tumors and lymph node metastases were determined by placing the largest possible circular region of interest (ROI) in the solid portions of the primary tumor and/or metastatic lymph node. Necrotic and cystic portions were excluded.
Results
A total of 40 patients (28 HPV+ and 12 HPV-) were included. Apparent diffusion coefficient values were found to be significantly higher in HPV+ OPC primary tumors (P = 0.013) and lymph node metastases (P=0.013) even when adjusted for age and sex. With a cut-off of 1.072x103 mm2/s in the primary tumor, the area under the curve (AUC) was 0.85. With a cut-off of 1.072x103 mm2/s in the lymph node metastases, the area under the curve (AUC) was 0.90.

Conclusions
The ADC values were noted to be higher in both the primary tumor and lymph node metastases in HPV+ OPC compared to HPV- OPC. Given inconsistencies between our results and previous studies, further studies are needed in order to establish the prognostic value of ADC and verify the correlation, if any, between ADC and HPV status.

Retinography: Molecular Imaging to Quantitate and Monitor Retinal Ganglion Cells in a Glaucoma Model

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Purpose
There are 6.6 million blind or visually impaired people in the U.S. (National Foundation for Blindness 2012 estimates), 2.2 million people with glaucoma (Glaucoma Research Foundation, 2004). The immediate goal of this study is to use a fluorescent molecular nerve imaging probe based on a fast retrograde neural transport mechanism to visualize and quantitate retinal ganglion cell (RGC) neural uptake in a glaucoma model.

Materials and Methods
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. The contralateral control eye received no treatment. Twenty-four hours after the NMDA injection, a fluorescently labeled neural imaging probe consisting of the nontoxic, C-fragment of Tetanus Toxin (TTc790 and TTc546) was injected into the vitreus of both the glaucomatous and normal eye (8 µg TTc fluorescent probe/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). Whole retinal mount fluorescent immuno-histology with antibodies against Gamma-Synuclein was performed. Permanently mounted retinas were imaged using laser scanning confocal microscopy (FV1000 Olympus). Whole eyes were embedded and cryo-sectioned to confirm optical imaging results.

Results
Retinal ganglion cells showed extensive TTc790 and 546 uptake and demonstrated localization of TTc in both the projecting axons, the dendritic inputs and the neuronal cell bodies. This localization could be demonstrated by in vivo imaging in live animals, and was confirmed by ex vivo, fluorescent immuno-histology, illustrating the colocalization of TTc with Gamma-Synuclein, a marker for RGCs. The NMDA-induced model of glaucoma showed greatly reduced uptake and transport of TTc, demonstrated both in living animals and excised tissues. 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, fluorescently labeled nerve imaging probe, TTc, allows the visualization and quantitation of retinal ganglion nerve cells in both the normal and diseased states. Glaucoma decreases neuronal uptake and transport of TTc in a glaucoma model, a condition in which the hallmark pathology is loss of RGCs.

**eP-140**

**Role of Adaptive Statistical Iterative Reconstruction (ASIR) in Lowering Radiation Dose for Pediatric Head CT**

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Purpose
Iterative reconstruction recently has shown promising results for substantial CT dose reduction. However, there are concerns about image quality at very low dose levels and careful selection of settings of the adaptive statistical iterative reconstruction (ASIR) is recommend to achieve optimal image quality. The purpose of this study was to assess the potential benefit of ASIR in low dose pediatric head CT by comparing image quality with standard dose filtered back projection (FBP).

Materials and Methods
Institutional review board approval was obtained for this study and HIPPA guidelines were followed. Study cohort was selected as all consecutive pediatric head CT performed on Discovery 750 HD (GE Healthcare) with ASIR 90%. For comparison, pediatric head CT examinations performed on scanners with standard FBP was
included. Patient demographics, including maximum skin-to-skin transverse head diameter, scanner information (mA, kVp) as well as radiation dose information were recorded. Effective dose was calculated as per the ICRP103 guidelines. Image quality was assessed by measuring image noise as standard deviation of HU values as well as contrast to noise ratio (CNR) for gray white matter. Statistical analysis was performed with Student t-test.

Results
Fifty-six children (average age 12.0 ± 4.0 years, M:F 32:24) underwent head CT examinations with ASIR 90 enabled protocol as compared to 82 head CT (average age 12.7 ± 4.7 years, M:F 46:36) with standard FBP reconstruction. There was no significant difference in head diameter between ASIR90% (166.6 ± 10.5 mm) and FBP {170.5 ± 22.6 mm} (p = 0.07). However, there was significant reduction of radiation dose of 52% with ASIR90% (CTDivol 14.8 ± 10.4, DLP 272.6 ± 217.9 mGy.cm, 0.5 ± 0.4 mSv), as opposed to FBP (CTDivol 31.1 ± 17.4, DLP 593.6 ± 376.9 mGy.cm, 1.2 ± 0.7 mSv) (p <0.001). Furthermore, objective image noise measure in white and gray matter with ASIR90% was found to be similar as FBP (p = 0.5-0.6). In addition, contrast to noise ratio (CNR) was not affected with ASIR90%, when compared to FBP (p = 0.67).

Conclusions
Pediatric head CT could be acquired at 52% lower radiation dose with adaptive statistical iterative reconstruction (ASIR90%) without affecting image noise and contrast to noise ratio.

eP-126
6:30AM - 2:45PM
The Accuracy of Computed Tomography in Predicting Clinical Impairment of the Inferior Rectus Muscle in Patients with Orbital Floor Fractures

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Purpose
Evaluate accuracy and reliability of specific findings of initial computed tomography (CT) obtained in an emergency department (ED) in predicting clinical impairment of the inferior rectus muscle (IRM) in patients with acute orbital floor blowout fractures (BOF) to assist appropriate ophthalmology consultation.

Materials and Methods
In this retrospective IRB-approved study, medical records and orbital CT images of patients older than 18 years presenting to a level I Trauma Center during 2007-2014
with BOF were reviewed. Two radiologists and one ophthalmologist evaluated the CTs for the presence of the following findings: 1) bony fragment impingement into the IRM, 2) shape of the IRM, 3) position of the IRM relative to the level of the orbital floor and 4) relative size of the BOF. Medical records were reviewed for impaired vertical movement of the globe. The data were analyzed using MedCalc statistical software.

Results
The mean age of the 87 patients in the study was 41 (20-93) years. The CT interpreters had near complete agreement for the presence of the four CT findings. Blowout fractures >50% had the highest sensitivity (91.3%). Bony impingement had the best specificity (85%). The vertical appearance of the IRM and dislocation of the muscle below the level of the orbital floor provided a lower predictive value.

Conclusions
Inferior rectus muscle entrapment often is a difficult clinical diagnosis to make upon initial assessment. In this study, presence of BOF >50% offered the highest sensitivity in predicting IRM impairment and would therefore be the best screening tool for appropriate triage to ophthalmology.

**eP-124**

**The Diagnostic Utility of Magnetic Resonance Imaging with Diffusion Weighted Imaging for the Differential Diagnosis of Glomus Tumors**

A Gunes1, B OZGEN2, A Dolgun1, N Suslu1

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Purpose
Glomus tumors are noncapsulated, hypervascular, slow growing tumors of neural crest origin, which are prone to bleeding. Therefore, biopsy usually is not recommended; the diagnosis and treatment plan are preferably established using imaging methods. In the current study we aimed to assess the contribution of signal properties, contrast enhancement patterns and the ADC values of glomus tumors (GT) of the neck to differentiate these lesions from other benign (BT) and malignant neck tumors (MT).

Materials and Methods
Magnetic resonance imaging (MRI) studies of 99 patients who had undergone nasopharynx MRI with the clinical diagnosis of neck mass were evaluated retrospectively. There were 38 paragangliomas, 22 BTs (nerve sheath tumor, meningioma, hemangioma...) and 39 MTs (metastatic lymphadenopathy, lymphoma, granulocytic sarcoma, neuroblastoma...). The apparent diffusion coefficient (ADC) values (mean, maximum and minimum values), signal intensity on trace DW, T1 and
T2W images, contrast enhancement patterns of the lesions were evaluated. Apparent diffusion coefficient ratios also were calculated using ADC value of temporalis muscle (ADCmuscle).

Results
There were significant differences between GTs and MTs in T2 signal properties (p<0.005), heterogeneity (p<0.001), contrast enhancement patterns (p<0.001), diffusion-weighted imaging (DWI) signal properties and signal intensity measurements (p<0.001 and p<0.001) as well as the mean, minimum and maximum ADC values (p<0.012, p<0.030 and p<0.006). The comparison of the ADC ratios (ADCtumor/ADCmuscle) using the total, lowest, and the highest ADC values showed significant differences in terms of the differentiation of GTs from other benign tumors (p=0.043, p=0.021, and p=0.033) and from malignant tumors (p=0.001, p=0.003, p=0.001, respectively).

Conclusions
Apparent diffusion coefficient values, signal properties, and enhancement patterns in MRI may aid in the differential diagnosis of glomus tumors from other malignant tumors of the neck.

<table>
<thead>
<tr>
<th>ADC ratios</th>
<th>Threshold</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive Predictive Value (%)</th>
<th>Negative Predictive Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tm Total/temporalis</td>
<td>≥1.18</td>
<td>92</td>
<td>100</td>
<td>100</td>
<td>62</td>
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<tr>
<td>Tm Min/temporalis</td>
<td>≥1.09</td>
<td>81</td>
<td>100</td>
<td>100</td>
<td>41</td>
</tr>
<tr>
<td>Tm Max/temporalis</td>
<td>≥1.34</td>
<td>92</td>
<td>100</td>
<td>100</td>
<td>62</td>
</tr>
</tbody>
</table>

The ADC ratios, as mean ± SD (minimum - maximum).

(Filename: TCT_eP-124_ScreenShot2015-12-09at122643.png)
The Diagnostic Value of CT Angiography for the Diagnosis of Glomus Tumors in the Neck

B OZGEN\textsuperscript{1}, O Akca\textsuperscript{2}, A Dolgun\textsuperscript{2}, S Hosal\textsuperscript{3}, N Suslu\textsuperscript{2}

\textsuperscript{1}Hacettepe University, Ankara, Turkey, \textsuperscript{2}Hacettepe University, Ankara, -, \textsuperscript{3}Liv Hospital, Ankara, -

Purpose
Glomus tumors (GT) are benign hypervascular tumors, which usually are not biopsied for diagnosis. The purpose of this study was to determine the value of CT angiography (CTA) for the diagnosis of GTs.

Materials and Methods
Computed tomography angiography studies of 27 patients who had histopathologically proven GT were evaluated retrospectively. Eighty patients, scanned with presumed diagnosis of GT but had other histopathological diagnoses (such as meningiomas, peripheral nerve sheath tumors, hemangiomas, papillary thyroid carcinoma metastases ...) were chosen as controls. Computed tomography attenuation values (CTAV) were measured by manual outlining of the entire mass (CTAV\textsubscript{lesion}) and of its non-necrotic portion (CTAV\textsubscript{solid}). Region of interest (ROI) measurements also were obtained from the sternocleidomastoid muscle (CTAV\textsubscript{scm}) for calculation of CTAV\textsubscript{lesion}/CTAV\textsubscript{scm} and CTAV\textsubscript{solid}/CTAV\textsubscript{scm} ratios. Significance of the difference between groups was studied with Mann Whitney-U test. The diagnostic property of the specific threshold levels was evaluated by the ROC curves.

Results
The mean CTAV\textsubscript{lesion} (205.26±69.6 HU) and mean CTAV\textsubscript{solid} (229.81±64.66 HU) of paragangliomas were significantly higher compared to controls (89.61±53 HU; p<0.001) and (100.17±58.89 HU; p<0.001), respectively. Similarly the mean CTAV\textsubscript{lesion}/CTAV\textsubscript{scm} ratios (3.05 HU ±1.12) and the mean CTAV\textsubscript{solid}/CTAV\textsubscript{scm} ratios (3.41 HU ±1.02), were higher than the controls (1.47± 0.92 HU; p<0.001) and (1.63±1.00 HU; p<0.001), respectively. A cut-off CT attenuation value of 115 HU had a sensitivity and specificity of 92% and 83% respectively for diagnosing paragangliomas, whereas a threshold attenuation of 138.50 HU of the solid portion had a sensitivity of 96%, a specificity of 89% and an accuracy of 93%.

Conclusions
The CTA with CTAV measurements is a highly accurate technique for the diagnosis of paragangliomas in the neck.
Purpose
To compare the utility of using a single modality parathyroid evaluation versus multimodality imaging evaluation using various combinations of 4D computed tomography (CT), ultrasound, or Tc-99m Sestamibi imaging. To identify the optimal modality or combination of these modalities for confident detection and localization of parathyroid lesions in patients with proven parathyroid gland pathology. To assess the impact of various clinical and anatomical factors including the presence of lymph nodes, prior neck surgery, intrinsic thyroid pathology and small lesion size on accuracy of these imaging modalities.

Materials and Methods
A total of 29 pathologically proven cases of parathyroid adenoma and hyperplasia were reviewed retrospectively, between January 2012 and July 2015. Only patients with final surgical pathology indicating abnormal parathyroid tissue and pre-operative evaluation with 4D CT were included. No cases were excluded from this group. All 4D CT studies were reviewed by a neuroradiologist, who was blinded to the results of all other studies. Detection and localization confidence utilizing 4D CT, ultrasound, Sestamibi and a combination of these modalities were ascertained, and correlated with the surgical and pathologic results.

Results
Four dimensional CT accurately localized abnormal parathyroid lesion into the correct quadrant in 24 out of 27 cases (89%). Sestamibi accurately localized six out of 21 cases (28.57%) and ultrasound accurately localized 12 out of 27 cases (44%). There was only one case (3.7%) accurately located by Sestamibi but not CT. The Bhapkar's test for homogeneity followed by the pairwise McNemar's test showed that 4D CT is significantly superior compared to ultrasound or Sestamibi p<0.01, for both quadrant of localization and detection confidence. The significant superiority of 4D CT remains even when combining the strength of ultrasound and Sestamibi by taking the maximal accuracy or confidence score between them. A trend showed that the superiority of 4D CT likely occurred in smaller lesions. When the lesion is large, ultrasound and Sestamibi will approach the equal accuracy and confidence comparing to 4D CT.
Conclusions
Four dimensional CT demonstrated a high diagnostic confidence and accuracy for parathyroid disease in this cohort allowing the surgeon to employ a directed operative approach. We found that the optimal imaging approach was a single modality evaluation with 4D CT. Addition of other modalities did not significantly improve localization or detection confidence. When 4D CT is used for evaluation, Sestamibi may be omitted to minimize radiation exposure. Four dimensional CT is particularly useful in cases with confounding imaging factors, such as presence of adjacent lymph nodes, evidence of prior surgery, and intrinsic thyroid pathology as 4D CT sensitivity and specificity is affected less by these factors.
Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B=3

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Assessment of Transarterial Route for Intravenous Embolization of Aggressive DAVF by Liquid Adhesive Agents

A Mironov¹
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Purpose
The dural arteriovenous fistulas (DAVFs) may be completely cured only after occlusion of the venous side. The transarterial embolization may decrease flow but is not likely to obtain cure. Onyx embolization may result in complete cure, nevertheless the distribution is unpredictable and migration into intraparenchymal vessels may occur. The transvenous placement of embolic agents can lead to complete obliteration of DAVF, but aggressive DAVFs with cortical venous drainage (CVD) harboring high risk of hemorrhage or focal neurological deficit may have limited access to venous sinus. Our purpose is to report a technique for successful endovascular treatment of DAVFs with CVD by liquid adhesive agents through an arterial route.

Materials and Methods
Sixteen patients with aggressive DAVFs were treated in 21 procedures by liquid adhesive agents (n-butyl cyanoacrylate, Histoacryl) via a transarterial route. The symptoms included progressive neurologic dysfunction related to intracranial hemorrhage (weakness, aphasia) or to venous congestion (papilledema, seizures, transient ischemic attacks, dementia). In a first stage an arterial embolization of all-accessible arterial feeders was undertaken. In a second stage, a transarterial embolization through the remnant arterial feeder by strong dilated glue (1:6-1:8) was performed.

Results
The first-stage embolization reduced the arterial flow, but achieved no obliteration of nidus and the CVD. The second – stage embolization achieved a deliberately penetration of glue on the venous side into abnormal draining veins. A definitive sustainable anatomical cure was obtained in all cases.

Conclusions
The attempt to "push" glue through the feeding meningeal artery across the nidus into the proximal draining vein may lead to definitive occlusion in cases of DAVF with CVD. This strategy requires security that the feeding artery will be occluded together with the nidus and the proximal venous recipient, and that no more arterial input to the venous recipient from other feeders will persist.
Contrast related encephalopathy in the Neurointerventional Suite: Single center experience and a review of the current literature

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¹University of Massachusetts, Worcester, MA, ²University of Massachusetts, Worcester, MA

Purpose
To present our single center experience of contrast related encephalopathy in the setting of neuroendovascular interventions in both the anterior and posterior circulation and to review the available literature on the topic.

Materials and Methods
Single center retrospective review was conducted from July 2010 until December 2015. Inclusion criteria were age >18 years, patients with an unruptured intracranial aneurysm who underwent elective endovascular coiling (with or without adjunctive devices, i.e., stent assisted or balloon assisted), and new onset of signs and symptoms determined to be related to contrast media induced encephalopathy during their immediate postoperative period.

Results
Two female patients met the inclusion criteria for this retrospective study. Case 1 consisted of a 74-year-old female with an unruptured top of the basilar aneurysm found incidentally. She underwent stent assisted coiling of her aneurysm. While on the postanesthesia recovery unit (PACU) she presented with new onset of right hemianopsia and had mild receptive aphasia. A magnetic resonance imaging (MRI) demonstrated areas of restricted diffusion in the bilateral occipital lobes. By postoperative day #5 she had complete resolution of her symptoms. Case 2 was a 57-year-old female who also underwent elective treatment of her unruptured top of the basilar aneurysm via stent assisted coiling. She too manifested new onset of central vision loss while at the PACU. Magnetic resonance imaging also showed focal areas of restricted diffusion in the bilateral occipital lobes. By postoperative day #3 she had completely resolved her symptoms and was eventually discharged home.

Conclusions
Encephalopathy associated to nonionic contrast medium administration is a poorly understood and rare entity with no current guidelines for diagnosis, treatment, or prognosis. Reports in literature are scarce but nevertheless have indicated that this entity can manifest either in the anterior or in the posterior circulation. Risk factors for this condition are not well understood. Previous reports similar to ours suggests that total contrast volume, type of contrast used, and risk factors such as hypertension may
predispose for this condition. Neurointerventional physicians should be well aware of this condition and consider it within the differential diagnosis when managing patients with similar symptoms in the immediate postprocedural period.

**eP-154**

**Ear Arteriovenous Malformation Management**

*W Yakes*¹

¹*Vascular Malformation Center, Englewood, CO*

**Purpose**

To determine the efficacy of ethanol endovascular repair of ear arteriovenous malformation (AVMs).

**Materials and Methods**

Ten patients (7 female, 3 males; age range 6-39 years; mean age: 22 years) with ear AVMs presented for therapy. Two patients had failed prior embolizations (PVA/coils/nBCA/steroids) and two patients had other therapies (laser/excisions/grafting). All presented with a grossly enlarged painful ear, and five patients had intermittent bleeding. All patients underwent transcatheter and direct puncture ethanol treatments (86 procedures).

**Results**

All 10 patients were cured of their AVM at long term follow up (mean follow up: 52 months). One patient had transient partial VII nerve palsy. Two patients had minor blisters and ear injuries that healed on the outer tragus.

**Conclusions**

Ethanol endovascular repair of Ear AVMs can achieve cures in this vexing lesion that previously were treated with resection of the ear and with high recurrence rates. This series documents long term cures of AVMs of the ear and scalp that were not treatable by endovascular approaches as previously documented in the world's literature. Permanent treatment of the auricular AVMs is documented and no recurrence occurred in any patient. Only one article is published (group from Shanghai, China) emulating this technique, that I taught them.

**eP-149**

**Flow Diverter (FD) Stent Treatment for the Ruptured Blood Blister-like Aneurysms (BBAs)**

*S Patro¹, C Lum¹, H Lesiuk¹, D Iancu¹*

¹*The Ottawa Hospital, Ottawa, Ontario*
Purpose
The ruptured blood blister-like aneurysms (BBAs) of the intracranial arteries are rare in occurrence and have very fragile wall. The treatment is challenging by both surgical and endovascular approaches with high morbidity and mortality rates. In this study, we report clinical and imaging results for treatment of ruptured BBAs using flow diverter stents.

Materials and Methods
We retrospectively reviewed patients who presented with subarachnoid hemorrhages caused by rupture of BBAs and who were treated using flow diverter stents. Clinical and angiographic findings, together with the procedural data and follow-up results, are reported.

Results
Five patients were identified in this study. Blood blister-like aneurysms were located on the supraclinoid internal carotid artery (three patients) and basilar arteries (two patients). Four patients were treated by deployment of a single flow diverter stent and one patient was treated with two flow diverters. The procedures were successful in all cases. One patient had intraprocedural rupture of the middle cerebral artery branch from perforation of wire and died from complications of vasospasm. One patient who had successful FD stent placement, developed worsening hydrocephalus and died from external ventricular drainage (EVD)-related intracranial hemorrhage. The other three patients had good clinical recovery. Control angiographies performed 3 months poststenting revealed complete occlusion of the aneurysms in the surviving patients with good clinical outcome.

Conclusions
The use of endovascular treatment for BBAs is still debated because of limited experience and poor outcome; FD stents may provide a valid alternative approach for treatment of these aneurysms.

Geometric and Hemodynamic Change after Aneurysm Rupture: A Case Study

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Purpose
To evaluate the geometric and hemodynamic consequences of an aneurysm rupture.

Materials and Methods
A 42-year-old man initially diagnosed with multiple aneurysms following an initial
subarachnoid hemorrhage underwent 3D angiography and treatment of the presumed ruptured anterior communicating artery aneurysm suffered a second subarachnoid hemorrhage from an untreated middle cerebral artery aneurysm 4 months later. Images from the initial 3D angiogram and the angiogram postrupture were used to create patient-specific computational fluid dynamic models and run under pulsatile flow conditions. Geometric and hemodynamic variable were calculated and visualizations of shear stress distributions and flow fields were constructed and analyzed.

Results
Geometric variables between pre and postrupture showed reductions in the volume, size, depth, neck area and surface area with only minimal change in the maximal neck size. Hemodynamic variables consistently showed sizable reduction in variables associated with high wall shear stress features, intra-saccular flow rates, and shear concentration. Overall, flow complexity and stability were not changed postrupture.

Conclusions
The process of aneurysm rupture can cause significant changes to the aneurysm geometry which in this case resulted in a reduction in variables associated with high intra-aneurysmal shear and flow and aneurysm size. These findings have significant implications in our evaluation of previous studies relying on the analysis of postrupture geometries.
Image Noise Reduction Technology for Patient Radiation Exposure Is Independent to Operator Factors

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¹Rush University Medical College, Chicago, IL, ²University of Chicago, Chicago, IL, ³Northwestern University, Chicago, IL, ⁴University of Chicago Medical Center, Chicago, IL

Purpose
Image noise reduction technology has shown significant reduction in patient's radiation exposure (PREX) during neuroangiography. However, operator factors may influence the degree of PREX reduction or nullify the impact of the technology. This work evaluates the degree of PREX change in two different operators after the installation of the image noise reduction technology (Allura Clarity®; Philips Healthcare, Netherlands) while controlling for procedure complexity and variability.

Materials and Methods
Patient's radiation exposure of diagnostic cerebral angiography (minimum 4 vessel selection) without intervention independently performed by two senior interventional neuroradiologists were reviewed retrospectively pertaining to the effect of the image noise reduction technology on PREX and its operator dependence. Reviewed operator dependent factors include fluoroscopy minutes, source image distance (SID), number of selected vessels, number of runs, number of images and number of 3D runs. The PREX were compared based on pre-installation and postinstallation period. And the postinstallation PREX analysis was performed in phase 1 (up to 6 months), phase 2 (after 6 months) and combined period. PREX parameters evaluated include total DAP, DAP of Fluoroscopy (DAP-F), DAP of exposure (DAP-E), DAP-fluoroscopy per minute (DAP-FR), DAP-exposure per run (DAP-ER), AP Air Kerma, and Lateral Air Kerma. Wilcoxon rank sum test was performed for statistical significance evaluation.

Results
Overall total DAP reduction was 52.7% following implementation of the system. Between two operators, SID, number of selected vessels and 3D runs showed a statistically significant difference (p<0.05) whereas differences in fluoroscopy time, number of runs and image count between the operators was not statistically significant. After installation of the noise reduction system, both operators independently showed a statistically significant decrease in total DAP, DAP-E, DAP-FR, DAP-ER, Frontal Air Kerma, and Lateral Air Kerma.

Conclusions
Image noise reduction system (Clarity®) may reduce PREX parameters during diagnostic cerebral angiography independent of operator style.
Morbidity of Parent Artery Occlusion in Relation to the Circle of Willis

J King¹, J Shankar¹
¹Dalhousie University, Halifax, Nova Scotia

Purpose
Reconstructive treatment methods such as flow diverting stents for complex intracranial aneurysms is increasing, but the use instead of traditional endovascular parent artery occlusion (PAO) is still debated. The purpose of this study was to examine the clinical and imaging outcomes of patients with intracranial aneurysms treated by PAO from our local institution.
Materials and Methods
Patient records of all endovascular interventions from a single neurointerventional center between 2001 and 2015 were reviewed retrospectively. All patients treated with parent vessel occlusion with the following indications were included: intracranial aneurysm, fusiform arterial dissection, and arterial hemorrhage. Occlusion of both intracranial and extracranial vessels were considered in this analysis. Patients with vessels unintentionally sacrificed were excluded. Patient demographics along with symptoms and imaging findings in the pre-operative, postoperative, and follow-up period were recorded. The primary outcome examined was focal neurologic deficit which included unilateral motor dysfunction or visual field deficit. Complications such as embolic events, hemorrhage, vascular injury, or post-operative neuralgia were monitored.

Results
Clinical presentation included hemorrhage (n=9), neurologic symptoms (n=7), incidental findings (n=2), and elective treatment of asymptomatic pathology (n=4). Vessel occlusion was performed in the carotid (n=9), vertebral (n=5), posterior cerebral (PCA) (n=4), posterior inferior cerebellar (n=2), and middle cerebral (MCA)(n=2) arteries. Parent artery occlusions were performed using coils (n=16), detachable balloons (n=3), and amplatzer vascular plugs (n=3). Three patients (2 PCA and 1 MCA) had permanent neurological deficit secondary to infarction in the arterial territory confirmed on follow-up imaging while one patient had trigeminal neuralgia. One patient had intra-operative, nonocclusive vertebral artery dissection with no postoperative consequences. The patients were divided into two groups - PAO above (n=6) or below (n=16) the level of circle of Willis (CoW). Parent artery occlusions above CoW had an increased chance (odds ratio of 15.1) to have permanent neurological deficits compared to PAO below CoW.

Conclusions
While efficacy and safety of PAO have been described, little data has been presented on PAO in relation to CoW. Although delineating the effect of the presenting disease versus the treatment are difficult without a randomized controlled trial, our study suggests that patients with PAO above the level of CoW have a much higher morbidity (Odds ratio-15.1) compared to those with PAO below CoW.

eP-157

MRI IMAGING IN INTRACRANIAL ANEURYSMS TREATED BY INTRAANEURYSMAL FLOW DISRUPTERS

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Purpose
New devices in the treatment of intracranial aneurysms include self-expandable, intra-aneurysmal flow disrupters. The magnetic resonance imaging (MRI) of these new devices has not been reported. The purpose of our study is to report MR findings in a consecutive series of patients treated with the LUNA™ and the WEB ™aneurysm embolization systems.

Materials and Methods
A total of 24 unruptured aneurysms were treated in 23 patients. Twenty-one lesions were located in the anterior circulation and three lesions were in the posterior circulation. Follow up included digital subtraction angiography (DSA) follow up at 6, 12, 24, 36 months. In addition, all patients underwent 24 hours DSA control and 24-48 hours MR study. Three, 18 months MR FU was available in all patients and 30 MR FU in 12. Magnetic resonance studies were performed on a 3T MR unit. Our MR protocol included DWI, T2 FLAIR, coronal TI, axial PD, axial T2, Angio-MR 3D-TOF. In all patients 1 year MR FU also included enhanced 3D velocity with gadolinium injection. Results were compared with the angiographic findings.

Results
After the procedure, silent lesions on 24-48 hours diffusion-weight imaging (DWI) also were evaluated. The flow disrupters devices present a marked signal void in all sequences. However neck or sac patency can be evaluated also without injection and correlations with angiographic aneurysm occlusion was 80%. The thrombosed aneurysmal sac is evident in PD and T2 sequences. A T1 halo hypersignal is seen in thrombosed aneurysm with a 91.6% correlation with the DSA that we supposed being the thrombosed space in between the device and the aneurysm wall. A "crescent moon sign", due to the device shape is seen in time of flight (TOF) sequences: in case of persistent flow, this appeared modified in the injected sequence.

Conclusions
At the present time, the DSA is mandatory in the follow up of aneurysm treated by intra-aneurysmal flow diversion devices; however, preliminary results suggest the MRI is an efficient and viable tool in assessing the degree of occlusion of the aneurysm treated by the flow disrupters (LUNA™) and the WEB ™devices.

Rescue mechanical intracranial thrombectomy following cardiovascular and orthopedic surgery

Rescue mechanical intracranial thrombectomy following cardiovascular and orthopedic surgery

F EUGENE1, H Raoult1, T Ronziere1, T Langanay1, E Flecher1, H Le Breton1, J Gauvrit1, J Ferre1
1CHU Rennes, Rennes, France
Purpose
Our aim was to evaluate the efficacy and safety of revascularization therapy in patients with stroke occurred after cardiovascular and orthopedic surgery.

Materials and Methods
We retrospectively analyzed 12 consecutive patients presenting with acute stroke with intracranial vessel occlusion secondary to any type of surgery. Eight males were included. Nine patients experienced a stroke after cardiovascular surgery (four post-TAVI or valvuloplasty, three postventricular assistance or heart surgery, two after aortic or carotid surgery). Three patients had stroke after orthopedic surgery or maxillary surgery. All patients were contra-indicated to intravenous thrombolysis due to recent surgery. Clinical outcome was evaluated at 90 days by using the mRS. Mortality and symptomatic intracranial hemorrhage also were reported.

Results
Median age was 67 years (range, 16-82 years). Mean initial NIHSS score was 15.3 +/- 3.7. Eleven (92%) patients had anterior circulation occlusion and one patient had a basilar occlusion. Mean time from stroke onset to revascularization was 264 +/- 130 min. Successful recanalization (TICI 2B/TICI 3) was assessed in 83% of patients and symptomatic intracranial hemorrhage occurred in one patient (8%), leading to death. Two patients (17%) died from cardiac arrest and stroke recurrence. Mean discharge NIHSS score was 8.8 +/- 8.2. After 3 months, mRS 0 was observed in 17% (two patients), mRS 3 in 17% (two patients) and 3< mRS ≤ 5 in 33% (four patients).

Conclusions
As a rescue therapy, mechanical endovascular therapy seems to be safe and effective in stroke with iatrogenic etiology. Knowledge of this therapeutic should be spreaded to potentially involved surgical caregivers.

eP-152

Result of stent-angioplasty with Wingspan stent for symptomatic intracranial stenosis

S YOU

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Purpose
The purpose of this study is to investigate the treatment results, and procedure-related complications of stent for symptomatic intracranial arterial stenosis with Wingspan stent and Gateway balloon.
Materials and Methods
From May 2010 to May 2015, 76 patients (52 males, 24 females, mean age: 66.6±8.9 years) with symptomatic intracranial arterial stenosis were treated. Inclusion criteria are acute and/or subacute symptomatic infarction or repeated transient ischemic attack (TIA) (infarction versus TIA: 39 versus 37) and severe stenosis related to symptoms confirmed with catheter angiography. The numbers of stenotic lesions were 29 cases on ICA, 34 on MCA, and 13 on vertebrobasilar (V-B) artery. All of the used stents for treatment were Wingspan self-expanding stent and Gateway balloon. Mean NIHSS at admission was 1.4±1.9, and mean stenosis rate was 76.8±6.2%. Clinical status (including NIHSS) and angiographic results were assessed retrospectively.

Results
Stents were deployed successfully at first trial in almost all cases except only two cases due to tortuous ICA course (97.4%), and in one case successful stenting was done at second trial (98.7%). Periprocedural complications occurred in 11 cases (14.5%), and symptomatic cases were only six (7.9%) [transient versus permanent: four versus two (5.3% versus 2.6%)]. Of 76 cases 67 were followed clinically over 6 months (88.2%) and the mean follow-up period was 25.8±20.0 months). Angiographic follow up was performed in 57 cases (75.0%. 13.9±11.8 months). The mean NIHSS after stent-angioplasty was 0.8±1.7 and 0.5±1.7 at last clinical follow-up day.
Poststenting residual stenosis was 8.7±13.0%, and 14.8±25.3% at last angiographic follow up. In-stent restenosis over 50% occurred in seven cases (7/57, 12.3%), and six cases were retreated successfully with Gateway balloon (3) or Drug-eluting balloon (3). Symptomatic infarctions occurred in four of 76 (5.3%) patients during the clinical follow-up period.

Conclusions
Stent-angioplasty with Wingspan self-expanding stent appeared to be safe and effective for intracranial arterial stenotic disease. However, it should prompt more strict selection criteria and desperate angiographic follow up for better clinical results.

eP-150 6:30AM - 2:45PM
Ultra-Low Contrast Volumes Reduces Contrast-Induced Nephropathy in Patients With Chronic Kidney Disease Undergoing Neurointerventional Procedures

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Purpose
Patients with impaired renal function are at risk of iodinated contrast-induced nephropathy (CIN) (25% increase in serum creatinine from baseline or 0.5 mg/dL
increase in absolute value, within 48-72 hours). In these populations, CIN has been shown to be dose dependent (4.4% with 14 cc, increasing to 29.8% with 61 cc) (1). We propose techniques that would allow lower contrast doses for neurointerventional procedures.

Materials and Methods
We have selected three representative cases to exemplify our technique. 1: A 49-year-old female (GFR 17) underwent 4-vessel cerebral angiogram (contrast dose-11.5 cc, visipaque-320) 2: A 69-year-old female (GFR 21) underwent stent-assisted coiling of recurrent 8x6 mm recurrent middle cerebral artery aneurysm (14.5 cc Omnipaque-300), 3: A 60-year-old male (GFR 48) treated for symptomatic carotid stenosis by carotid stenting (10 cc Visipaque-320). All patients also had standard CIN preventive measures such as hydration and GFR was checked pre and post procedurally.

Standard angiographic techniques modified to decrease dose of contrast such as selective/superselective catheterization, sharp and short bolus of contrast injection, use of a faster frame rate, targeted imaging and aspiration of excess contrast material from the catheter. These will be discussed in detail.

Results
1: GFR increased from 17 to 20 (17.6% increased – likely hydration related) by day 3 without further impairment. 2: GFR decreased from 21 to 19 (9.5% decrease) on day 3 then returned to normal. 3: GFR increased from day 48 to 56 (16.6% increase related to hydration) by day 2 then returned to baseline. Contrast opacification was good and no technique related complication occurred.

Conclusions
Ultra-low contrast volume neurointerventional angiogram technique could be an additional tool used to prevent contrast-induced nephropathy in susceptible populations.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B=4

Electronic Poster (eP) - Pediatrics
eP-178

Advanced MRI Evaluation of Early Radiation Damage to the Brain in Children With Primary Brain Tumors: Preliminary Findings

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Purpose
The goal of this study is to evaluate the early changes of radiation (RTX)-induced brain injury using the advanced MR technique of diffusion kurtosis imaging (DKI). The overarching goal is to establish a multi-modal biomarker for early RTX induced injury and further our understanding of its pathogenesis.

Materials and Methods
Diffusion kurtosis imaging was performed on a Philips 3T system in addition to the standard of care magnetic resonance imaging (MRI) with a 32-channel head coil. Diffusion kurtosis imaging was performed with multiple b values (0, 1000 and 2500 sec/mm²), 30 gradient directions, TR/TE=7000ms/100ms, FOV=240x240mm, Matrix=96x96 resulting in 2.5mm isotropic resolution. Diffusion metrics obtained with DKI are mean kurtosis (MK), radial kurtosis (RK), fractional anisotropy (FA), mean diffusivity (MD) and color FA map. Each child underwent consecutive short interval MR examinations as standard of care with addition of DKI. Dosimetry was generated on a CT image and all images were co-registered to correct for differences in positioning. Longitudinal changes of the DKI metrics were evaluated with respect to regional RTX dose.

Results
A total of three patients were enrolled successfully in the study. Three patients had consecutive interval follow examinations after the completion of RTX therapy. Fig. 1 shows mean kurtosis image of patient 3 with dose map superimposed. Fig. 2 shows Δk mean as a function of dose. Error bars represent standard error of the mean percentage change. Similar analyses were done for all other DKI metrics. Dose dependent changes can be observed for patient 3 which became progressively worse on follow up.

Conclusions
This is an ongoing study where additional patients with longer term follow examinations and neuropsychological evaluations will be performed. Our preliminary results demonstrate that DKI is sensitive to early RTX induced damage to the brain in children undergoing RTX as part of their brain tumor treatment regimen. Diffusion kurtosis imaging may be a useful early biomarker for RTX damage and could aid in tailored treatment regimens that balance optimum treatment and negative neurocognitive sequelae.
Altered Resting State Functional Connectivity in Neonatal Hypoxic Ischemic Encephalopathy at Term

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Purpose

Structural abnormalities in the basal ganglia and thalami noted on magnetic resonance imaging (MRI) are highly predictive of major neuromotor and cognitive deficits in neonates with hypoxic ischemic encephalopathy (HIE). However up to 40% of infants with HIE who present minimal to no abnormality on structural MRI may still manifest neurological deficits in later life. We hypothesize that functional connectivity at term may be altered and that resting state functional MRI (rsfMRI) may provide deeper insights into the altered nature of these networks in infants with HIE.

Materials and Methods

Nine term infants with HIE and a control group of seven term neurologically intact infants received rsfMRI during natural sleep as a part of a clinically indicated MR examination. The HIE group demonstrated minimal to no abnormalities on conventional MRI. Seed-based functional connectivity analysis was performed with spherical regions of interest (ROIs) (6 mm radius) placed in the bilateral motor, primary sensory, multisensory, prefrontal, and medial temporal cortices and in the thalami. Pearson correlation analysis was used to calculate functional connectivity between ROIs. Fisher's Z transformation was performed on the correlation matrix for
normalization. One-tailed two sample t test was used to compare pairwise functional connectivity differences between the HIE and the control groups.

Results
Infants with HIE demonstrated reduced interhemispheric functional connectivity between the motor, auditory and prefrontal cortices compared to controls. In addition functional connectivity between the thalamus and primary and multisensory cortices was diminished in the HIE group (all p-values <0.05).

Conclusions
Our results provide preliminary evidence that disruption within and between neural networks may be present in infants with HIE despite the absence of significant abnormalities on structural MR imaging. Such disruptions may contribute to the motor and cognitive deficits experienced by these infants in later life. Therefore, the early characterization of such deficits measured by rsfMRI may hold the potential to predict neurodevelopmental outcome.

**eP-179**

**Analyzing Misdiagnosed Metastasis on Imaging Studies**

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Purpose
Accurate detection of leptomeningeal metastasis is critical for appropriate risk stratification and treatment of childhood central nervous system (CNS) tumors. Magnetic resonance imaging (MRI) findings correlate better with survival than cerebrospinal fluid (CSF) analysis, but leptomeningeal metastases may be missed or misdiagnosed on examinations not optimized for pediatric cancer imaging. We investigated the association of missed metastases on outside MRI with technical imaging factors and radiologist qualifications to promote improvements in pediatric cancer imaging and metastasis detection.

Materials and Methods
We retrospectively reviewed reports for outside and in-house brain and spine MRIs performed within 35 days of each other for 86 children presenting to our institution between January 1, 2011 and December 31, 2012 with leptomeningeal-seeding (ependymoma or embryonal) brain tumors. Contemporaneous CSF and/or in-house MRI were considered gold standard for metastasis detection. Outside and in-house MRI techniques and radiologist qualifications were compared for cases of missed/misdiagnosed metastases.
Results
Thirty-one of 86 patients (36%) had leptomeningeal metastases (13 brain, 3 spine, 15 both) by initial in-house MRI ± CSF. Of these, 10 (32%) had metastases undiagnosed by OSH MRI of brain (n=3), spine (n=4), or both (n=3). Of these, two of six brain MRIs did not include DWI; five of six had no postcontrast FLAIR; and one had no IV contrast. Three of seven missed spinal metastases were due to lack of OSH spine MRI; one OSH spine MRI had no postcontrast sequences. In-house and OSH false positive rates were identical (2/55 or 4%). Unlike in-house exams, all outside exams with missed metastases had gaps between slices on one or more sequences; four of 11 (36%) identifiable OSH radiologists had a CAQ in neuroradiology, compared to three out of five (60%) in-house neuroradiologists.

Conclusions
Standardization and optimization of MRI technique, and interpretation by subspecialty-trained neuroradiologists, could promote more accurate pediatric CNS cancer detection and risk assessment.

eP-185
6:30AM - 2:45PM

Application of Normative Occipital Condyle-C1 Interval (CCI) Measurements to Detect Atlanto-occipital Injury in Children

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Purpose
Prior studies have found that widening or asymmetry of the occipital condyle-C1 interval (CCI) on computed tomography (CT) is a sensitive and specific marker for atlanto-occipital dislocation (AOD). Previously reported abnormal CCI values are not age specific, which may lead to false positives in younger children in whom this joint space is normally larger than in adults. This study will assess the utility of applying age-specific normative ranges for the CCI to documented cases of atlanto-occipital injury compared to previously reported abnormal cutoff values.

Materials and Methods
Retrospective review of CT and magnetic resonance (MR) imaging of 14 subjects with atlanto-occipital injury was performed and sagittal and coronal CCI measurements were made for each subject. Sensitivities and specificities of proposed CCI cutoffs of two and three standard deviations above the mean and previously published CCI cutoffs for atlanto-occipital injury then were calculated based on CCI measurements for each subject.

Results
The sensitivities of two and three standard deviations above normative mean, 4.0 mm,
and 2.5 mm were 50%, 50%, 36%, and 93%, respectively. Specificities were age specific; 89% to 100% for two SDs and 95% to 100% for three SDs above normative mean respectively, 100% for 4 mm in all age groups, and 18 to 100% for 2.5 mm (least in the 2-4 year age group).

Conclusions
CCI widening cutoffs used to establish atlanto-occipital injury lack both sensitivity and specificity in children and early teens. Magnetic resonance imaging is necessary to establish a diagnosis of atlanto-occipital injury in children and early teens when the appropriate mechanism of injury is present.

(Filename: TCT_eP-185_Figure3.jpg)

eP-173
Assessment of gadolinium deposition pediatric patients who received multiple doses of gadopentetate dimeglumine

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Purpose
The purpose of this study is to assess whether measuring the change in magnetic resonance (MR) signal intensity ratios of the dentate nucleus (DN) and pons is a reliable indicator of gadolinium deposition in the pediatric brain over time.

Materials and Methods
Images were reviewed retrospectively in 23 pediatric patients with various neurological conditions who received multiple doses of gadopentetate dimeglumine, a gadolinium-based contrast agent (GBCA) for MRI brain exams. The GBCA administration ranged from 8 to 31 total doses per patient, whose ages ranged from 8 months to 17 years at initial dose. Regions of interest were placed over the DN and pons on T1-weighted (T1W) spin echo and T2-weighted (T2W) fast spin echo images before contrast. Dentate nucleus and pons signal intensity ratios were obtained for each study. The averaged T1W and T2W signal intensity ratios were obtained and compared at baseline (dose zero), 1-5 years, 5-10 years and > 10 years from the time of their initial dose. Pearson correlation coefficient (Corr) was calculated between the number of total doses and the signal intensity ratio at 5-10 years interval. Patients who received radiation and chemotherapy were excluded.

Results
DN/pons ratio changes varied among patients, with an overall increase in T1W signals at the 5-10 years interval compared to baseline, whereas no consistent changes were observed for T2W signals. There was a positive correlation (Corr=0.35) between the number of doses and T1W signal ratios, observed from 5 to 10 years after the initial dose, but a weaker negative correlation (Corr=-0.19) observed with T2W signal ratios.

Conclusions
This pilot study showed an increase in the DN/pons ratio over a period of 5-10 years on T1-weighted images in our pediatric patients, suggesting gadolinium deposition. However, T2-weighted signal ratios showed a weaker correlation and therefore were not found to be a reliable indicator for gadolinium deposition.
Atypical Magnetic Resonance Imaging Findings of Posterior Reversible Encephalopathy Syndrome (PRES) in Children

J Harty, A Parikh, A Pollock, S Pruthi, A Bhatia

6:30AM - 2:45PM
Purpose
Posterior reversible encephalopathy syndrome (PRES) is now a well established diagnosis of vasogenic edema secondary to multiple described risk factors that cause neurotoxicity. PRES has been described with classic magnetic resonance imaging (MRI) findings within the brain, including FLAIR hyperintensity within the cortical and subcortical white matter, typically involving the parietal and occipital lobes. PRES has been well documented in the adult population, with descriptions of the most common risk factors and causes. Some of the causes remain the same in the pediatric population; however, other potential risk factors more commonly seen in children, such as infection, may be a more common cause in children. The various stages of the developing brain in children can potentially lead the central nervous system to be more susceptible to injury and the more atypical imaging findings in PRES. The atypical imaging findings in PRES have not been evaluated in children. The goal of the study is to evaluate atypical MRI findings of PRES in the pediatric population, such as enhancement, hemorrhage, reduced diffusion, and evaluate for less commonly involved regions, such as the brain stem and cerebellum. In addition, the risk factors for PRES will be investigated in children.

Materials and Methods
Magnetic resonance imaging (MRI) of the brain of 10 patients with PRES were retrospectively reviewed by two neuroradiologists. The subjects' ages ranged from 7 - 19 years. Electronic medical records were searched for relevant clinical data. Comparisons were performed (when available) with brain MRIs prior to initial imaging for PRES. Follow-up imaging was reviewed in all the patients. Review of imaging studies was performed with special focus on enhancement pattern, reduced diffusion, hemorrhage, and regions of involvement. The frequency of these MRI findings was calculated. A review of the clinical charts was performed for determining the risk factors and potential cause of PRES. All imaging was performed on 1.5 or 3.0T MRI scanners.

Results
Evaluation of MRI examinations revealed six of seven patients had leptomeningeal enhancement. Unfortunately, three of 10 did not have postcontrast sequences performed. Five of 10 patients had hemorrhage on imaging, which varied from mild intraventricular hemorrhage to parenchymal hemorrhage. Reduced diffusion was noted in four of 10 patients. The parieto-occipital lobes were involved in all patients, with the cerebellum being involved in seven of 10.

Conclusions
Although typical and atypical MRI findings in PRES have been described in adults, the atypical MRI findings of leptomeningeal enhancement and reduced diffusion
appear to be more common in the pediatric population. These findings potentially may be related to the increased susceptibility of the developing brain to predisposing risk factors. Further research is needed to determine if the pediatric brain is at increased risk of injury secondary to PRES and how the imaging findings on MRI vary with age.

eP-187

Black Bone MRI of the skull in pediatric traumatic brain injury: Can MRI replace CT?

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Purpose
Head computed tomography (CT) is the neuroimaging tool of choice in the evaluation of pediatric head trauma. The potential cancer risks of CT-related ionizing radiation, however, should limit the use of CT in children. We evaluated the role of black bone magnetic resonance imaging (MRI) compared to CT in detecting skull fracture in children with head trauma.

Materials and Methods
Retrospective evaluation of consecutive 2D head CT and brain MRI studies including black bone sequences of children with head trauma. Two experienced pediatric neuroradiologists in consensus created the standard of reference. One experienced pediatric neuroradiologist blindly evaluated brain MR images and 2D head CT images in two different sessions. The presence of skull fractures and intracranial hemorrhages was evaluated. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) in the diagnosis of skull fractures and intracranial hemorrhages utilizing brain MRI and head CT were measured.

Results
Twenty-eight children (24 boys, mean age 4.89 years, range 6 days to 15.5 years) with head trauma were included. Black bone MRI revealed lower sensitivity (66.7% versus 100%), specificity (87.5% versus 100%), PPV (80.0% versus 100%), and NPV (77.8% versus 100%) in identifying skull fractures compared with 2D CT. Three out of four false negative black bone MRI studies showed linear skull fractures without a significant consequence for the affected children. Magnetic resonance imaging revealed a higher sensitivity (100% versus 72.7%), specificity (100% versus 83.3%), PPV (100% versus 94.1%), and NPV (100% versus 45.5%) in detecting intracranial hemorrhages and a higher diagnostic value for the combined identification of skull fractures and intracranial hemorrhages compared to CT.
Conclusions
Our preliminary results show that brain MRI studies including black bone sequences may be a promising alternative to head CT for the diagnosis of skull fractures and intracranial hemorrhages in children with head trauma.

(Filename: TCT_eP-187_blackbone.jpg)

eP-168

Can Multiparametric MRI Reliably Grade Choroid Plexus Tumors?

a Alrashed1, S Al-Dandan2, R Shanker2
1KFMC - Riyadh, Riyadh, Saudi Arabia, 2KFMC, Riyadh, Riyadh

Purpose
The purpose of this study was to assess the ability of apparent diffusion coefficient (ADC) values and magnetic resonance (MR) spectroscopy to differentiate low from high grade choroid plexus tumors.

Materials and Methods
We analyzed 13 choroid plexus tumors (CPT) (male=8, female=3; pediatric age group=11, adults=2) of which CPP=5, aCPP=5 and CPC=3. All MRI and MRS (CPP=2, aCPP=2, CPC=1) were acquired on three different scanners per accepted protocols. Considering the differences in scanners and acquisition parameters for diffusion-weighted imaging (DWI), we normalized the lesion ADC values (tumor region of interest (ROI) from single representative slices) to normal brain tissue, to obtain ADC/normal ratios (normADC). The normADC ratios were analyzed statistically on Excel. The pooled group mean, SD, and variance were calculated for CPP, aCPP, CPC separately.

Results
The group mean of normADC were 1.3, 1.4 and 0.9; SD 0.48, 0.45 and 0.18; and the variance was 0.23, 0.20 and 0.03 of CPP, aCPP, CPC respectively. The SD appears to
be a strong differentiator of CPP (higher variance) versus CPC (lower variance). The highest MI levels were noted in CPP, intermediate in aCPP and lowest in CPC.

Conclusions
Our findings suggest that ADC values can be a reliable tool in differentiating CPT subtypes.

<table>
<thead>
<tr>
<th>ADC Values</th>
<th>Mean</th>
<th>Variance</th>
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<tr>
<td>papilloma</td>
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</tr>
<tr>
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<td>carcinoma</td>
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<td>0.03</td>
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(Filename: TCT_eP-168_Table_1.jpg)
Cerebral Blood Flow and Non-Contrast Dynamic Angiography with Arterial Spin Labeling MRI: Experience in Pediatric Patients

A Pokorney¹, N Stefani², Z Li³, J Chia², H Hu¹, J Miller¹
¹Phoenix Children's Hospital, Phoenix, AZ, ²Philips Healthcare, Cleveland, OH, ³Barrow Neurological Institute, Phoenix, AZ

Purpose
The purpose of this work was to evaluate the clinical utility of two arterial spin labeling (ASL) pulse sequences in pediatric patients. The first sequence is a 3D cylindrically distributed spiral "static" protocol used to quantify whole brain cerebral blood flow (CBF) (1). The second sequence is a 3D time resolved "dynamic" approach called CINEMA (Contrast inherent INflow Enhanced Multi phase Angio) (2), which provides arterial imaging of the neurovasculature. Both sequences do not require gadolinium contrast administration. With increasing concerns over possible gadolinium deposition in the brain from contrast-enhanced magnetic resonance imaging (MRI) exams (3, 4) in recent months, our pediatric radiology practice has been actively pursuing noncontrast ASL MRI protocols in neuroimaging (5).

Materials and Methods
The technical aspects of the ASL techniques have been described (1, 2). All exams were performed on Philips Ingenia 3T platforms with R5.1.7 software and 13- or 32-channel head coil arrays with local institutional review board approval. While we have successfully performed both 3D "static" spiral and "dynamic" CINEMA ASL in more than 10 and 30 patients, respectively, the combination of the two techniques have been particularly useful in assessing moyamoya disease patients, as the information supplements conventional time-of-flight (TOF) angiography. In this abstract, we describe two moyamoya cases. Patient #1 is an 8-year-old female and patient #2 is a 1-year-old- male. In our magnetic resonance (MRI) protocol, Diamox (acetazolamide, X-GEN Pharmaceuticals, Inc.), a vasodilator, was administered intravenously (15 mg/kg body weight) to assess CBF reserve response. "Static" ASL data were acquired before Diamox administration and repeated 15 minutes after injection. Time-of-flight and "dynamic" CINEMA acquisitions were acquired prior to Diamox injection.

Results
The figure illustrates "static" spiral and "dynamic" CINEMA ASL results from patient #1, along with TOF data. In patient #1, TOF demonstrates impaired flow in the right middle cerebral (MCA) and internal carotid arteries (ICA). CINEMA images show corroborating data of delayed arterial filling on the right side. Colormaps show very little change in the cerebral blood flow pre- and postDiamox (pre- CBF average: 59.5 ml/100g/min, postCBF average: 61.9 ml/100g/min), suggesting limited CBF reserve.
In patient #2, the response to Diamox was moderate, with mean whole brain CBF increasing 11% from 31.4 to 34.9 ml/100g/min. A perfusion defect in the right posterior parietal and temporal lobes was seen and perfusion to it did not improve with Diamox. Time-of-flight confirms a compromised right MCA and ICA, and again CINEMA clearly illustrated hindered flow.

Conclusions
Both 3D spiral "static" and "dynamic" CINEMA ASL provide robust approaches to assess the neurovasculature in pediatric patients without the usage of gadolinium contrast administration. Quantitative CBF maps and time-resolve data yield diagnostically useful information that supports clinical findings from conventional TOF angiography. Further evaluation in patients with seizures, strokes, brain tumors, and arterial-venous malformations is warranted.

(Filename: TCT_eP-159_Figure_CINEMApCASL.png)

eP-177

Detecting White Matter Alterations in Response to a 6-week Occupational Therapy Intervention in Children with Hydrocephalus: a Preliminary DTI Study

B Jones¹, W Yuan¹, J Shimony², R McKinstry², N Weckherlin³, S Powell⁴, H Barnard¹, J Engsberg⁵, D Kadis¹, J Dodd⁶, M Altayé⁷, F Mangano¹, D Limbrick⁸, S Holland¹, S Simpson¹, S Bidwell¹, K Harpster¹
Purpose
Diffusion tensor imaging (DTI) has been found to be sensitive to white matter (WM) alterations after intervention in various patient populations (1-4). In this study, we aimed to test whether DTI could detect underlying WM changes after a 6-week iPad application-based occupational therapy (OT) in children with surgically treated hydrocephalus.

Materials and Methods
Five children (age 6.05-9.10 years, 2F/3M) with surgically treated hydrocephalus completed an intensive iPad-based OT intervention targeting domains of long-term deficits typically observed in children with hydrocephalus (5). The intervention included 6 weekly sessions in OT clinic supplementing home-based sessions of 1 hour/day, 4 days/week. Magnetic resonance imaging (MRI) with 15-direction DTI and neuropsychological assessment were performed before and after the intervention. Diffusion tensor imaging measures were extracted from WM regions determined by the ICBM-DTI-81 WM labels atlas. The primary neuropsychological outcome was the Perceptual Reasoning Index (PRI) of the Wechsler Abbreviated Scale of Intelligence - Second Edition. The changes between pre and postintervention were tested with two-tailed paired t-test. Pearson correlation was used to explore the association between the changes in DTI and neuropsychological outcomes.

Results
After the intervention, 12 WM regions showed statistically significant (p<0.05) or trend level (0.05<p<0.1) increases in fractional anisotropy (FA) and/or decreases in radial diffusivity. These regions included the genu of corpus callosum, the left cingulum and medial lemniscus, the right posterior thalamic radiation, and the posterior limbs of internal capsule, cerebral peduncles, external capsules, and uncinate fasciculi. All participants demonstrated an increased PRI on post-intervention testing (increase magnitude = 14.20±7.56, p=0.014). A significant positive correlation was found between the increase of PRI score and the increase of FA in right posterior internal capsule (p<0.05).

Conclusions
This study provides initial evidence of DTI's sensitivity to detect subtle WM structural changes associated with neuropsychological improvements in response to a 6-week OT intervention in children with hydrocephalus.
ETANTR: a new kid on the block (Embryonal Tumors with Abundant Neuropil and True Rosettes: a newly described CNS embryonal neoplasm)

K Shekdar¹, M ALSUHAIBANI², M Santi³, E Schwartz⁴

Purpose
To present imaging findings in six patients with a rare pediatric central nervous system (CNS) neoplasm called ETANTR. Embryonal tumor with abundant neuropil and true rosettes (ETANTR) is a recently identified variant of primitive neuroectodermal tumor, with fewer than 50 cases reported in the literature to date.

Materials and Methods
We describe a series of six cases with pathologically proven diagnosis of ETANTR. All these cases had MR imaging of the brain with contrast. Three cases had an initial head CT study. In addition all cases had MR imaging of the entire spine with contrast. Tissue diagnosis was obtained from either surgical resection or biopsy.

Results
We will describe six cases of ETANTR at this presentation. Our series of six cases of ETANTR had four located in the posterior fossa and two were supratentorial in location. We will illustrate the computed tomography (CT) and magnetic resonance imaging (MRI) findings of the neuro axis of these cases. The imaging findings are those of a malignant brain tumor, although there may be some findings which can suggest this entity.

Conclusions
ETANTR is a newly described, highly malignant CNS embryonal neoplasm that typically occurs in young children. ETANTRs have microscopic features of neuroblastoma and ependymoblastoma. Clinically, ETANTRs have shown high malignant potential and poor clinical outcome despite aggressive treatment. As more cases get reported a specific imaging pattern may emerge for ETANTRs.

eP-171

Fast Brain Magnetic Resonance Imaging for Non-Hydrocephalic Indications

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Purpose
Fast brain magnetic resonance imaging (FBMRI) with ultrafast T2-weighted imaging, an established MRI technique to assess children with hydrocephalus, has been used increasingly at our institution for nonhydrocephalus indications. Our aim is to evaluate the performance of fast brain MRI in children referred for indications other than known hydrocephalus and shunt follow up.

Materials and Methods
Following IRB approval, we retrospectively reviewed all pediatric FBMRI performed at a tertiary referral hospital for indications other than known hydrocephalus or shunt follow up over a 12-month period. At our institution the FBMRI protocol consists of a half-fourier acquisition single-shot turbo spin-echo (HASTE) pulse sequence, with images acquired in the axial, sagittal, and coronal plane. We also reviewed additional imaging studies performed before or after the FBMRI. A neuroradiologist assessed the scans on diagnostic image quality using a 5-point scoring system, where 1 = nondiagnostic and 5 = excellent diagnostic quality.

Results
Sixty-three patients [average age (S) = 3.5 (5.8) years, 39 males] met our inclusion and exclusion criteria. Thirty-seven patients (58.7%) also had at least one comparison routine brain imaging study performed before or shortly after the fast brain MRI study, while in the remaining 26 patients the FBMRI represented the entire imaging work up. In four patients (6.3%, age range 0 - 4 months) equivocal findings on the FBMRI prompted further assessment with a routine brain MRI. These four cases included the following: suspected intraventricular hemorrhage, intraventricular cyst, cerebellar dysplasia, and subdural collections. All FBMRI studies were deemed of diagnostic quality.

Conclusions
Fast brain magnetic resonance imaging is helpful for the rapid evaluation of nonhydrocephalus conditions. In this series additional MRI studies were needed in a minority of cases. In 42% of the cases, FBMRI represented the entire imaging work up and no additional studies were deemed necessary.

eP-169
6:30AM - 2:45PM

Fetal Brain MRI Super Resolution Processing

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Purpose
Fetal magnetic resonance imaging (MRI) is greatly complicated by fetal motion necessitating repeat imaging and limiting the quality of images obtained. Specifically,
head and body movements cause large distortions of brain images making neuroanatomical diagnosis difficult. As a result, fetal brain MRI images obtained with standard body protocols often are suboptimal, whereas brain specific protocols add additional scan time which is not always clinically feasible. A common approach employed by many institutions is to acquire multiple scans and to select the one with the least head movement for diagnostic purposes. We created a novel super-resolution, post-processing pipeline that utilized brain imaging information gathered in the multiple suboptimal studies to produce an aggregate image with higher effective resolution and less motion-related distortion than the component studies.

Materials and Methods
We selected subjects retrospectively that had prenatal MRI for suspected non-neurologic anomalies based on prenatal ultrasound. These were selected to evaluate the ability of the super-resolution technique to better demonstrate normal neuroanatomy. In addition, we selected patients with agenesis of the corpus callosum to evaluate how super-resolution might aid in the detection of neuroanatomical pathology. The subjects each had between three and seven independently acquired T2 sensitive sequences in all three planes which included a brain. Each sequence was reviewed manually and those deemed to meet minimum quality standards were included for further processing. Inter-slice registration was performed to reduce motion artifacts using FSL-FLIRT. An arithmetic, per-voxel average of all corrected sequence was taken which further reduced motion artifacts. Registration and averaging was fully automated using Matlab.

Results
To evaluate the efficacy of the processing pipeline, the unprocessed sequence independently deemed to be the highest quality was compared to the super-resolution images by independent radiologists blinded to which was the super-resolution image set. Super-resolution images were rated consistently to be of higher quality than unprocessed images. The next steps in this project are to evaluate how this increase in image quality will facilitate diagnostic utility.

Conclusions
By allowing for increased effective resolution and minimizing motion artifacts, super-resolution techniques have the potential to expand the availability and diagnostic power of fetal brain imaging.

eP-183

6:30AM - 2:45PM

Fetal Hydrocephalus: Causal Factors and Associated Abnormalities in Obstructive Hydrocephalus on Fetal MR in Early and Late Gestation.

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Purpose
To characterize specific features and common causal/associated lesions of obstructive fetal hydrocephalus in early and late gestation.

Materials and Methods
REB approved retrospective review. Diagnosis based on magnetic resonance (MR) complementing ultrasound (US) cases selected by searching our Data Base retrieval system (ISYS tm) using "MRI Fetal", "hydrocephalus" and "ventriculomegaly" as key-words, images were reviewed by two neuroradiologists applying the above mentioned criteria. Changes over time were appreciated in a follow-up cohort (9). Cases with callosal agenesis, Chiari 2/cephaloceles, holoprosencephaly, hydranencephaly, L1CAM defect and cobblestone brain were excluded.

Results
Obstructive fetal hydrocephalus was identified in 59 cases. In the mid-gestation cohort (n=47) cerebral developmental disorders predominate: isolated aqueduct stenosis (n=27), rhombencephalosynapsis (n=14), ependymal nodules and heterotopia (n=5), versus hemorrhage (n=4), arachnoid cyst (n=1), AVF (n=1). This is distinct to the causal factors and associated abnormalities seen with late gestation cohort (n=12) where extracerebral/nondevelopmental causes predominate: hemorrhage (n=5), arachnoid cysts (n=4), tumor (n=1), against nodule (n=1), isolated aqueduct stenosis (n=2) hydrocephalus does not seem to impair sulcal development. The degree of ventricular dilatation is more severe in the late onset group with progression on follow up.

Conclusions
Obstructive hydrocephalus can be diagnosed and causal factors evaluated on fetal MR with reasonably high level of accuracy. When diagnosed around midgestation causal factors and associated findings mostly related to spectrum of developmental abnormalities; heterotopias however may be secondary to ependymal damage. Late fetal hydrocephalus is due more commonly to acquired or extracerebral causes.

6:30AM - 2:45PM

Fetal MR Imaging of Craniosynostosis: Impact on Diagnostic, Prognostic and Pathophysiology

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Purpose
Brain abnormalities frequently are associated with syndromic craniosynostosis, but their nature is still poorly understood. Fetal magnetic resonance imaging (MRI), by assessing the brain in an early developmental stage, may help in diagnosing and clarifying this condition. The aim of our study was to assess craniofacial and intracranial MRI findings in fetuses with proved craniosynostosis.

Materials and Methods
Review of prenatal MR brain imaging in four fetuses with syndromic craniosynostosis, three with Apert syndrome and one with probable Pfeiffer syndrome.

Results
All fetuses had abnormal morphology of the skull and facial structures. The cerebrospinal fluid (CSF) distribution and the corpus callosum were anomalous in all cases. All three fetuses with Apert syndrome showed temporal overexpansion and abnormal sulcation in the inferomedial temporooccipital lobes, which in one case extended past the calcarine sulci. These changes were detected as early as 20 weeks of gestational age.

Conclusions
Fetal MR accurately describes brain and craniofacial features associated with craniosynostosis. Temporal lobes overexpansion and temporo-occipital abnormal sulcation are consistent findings in fetuses with Apert syndrome. Our findings support a primary nature for brain involvement in this condition.

eP-170

How reliable are prenatal tractography results? A postnatal in vivo follow-up DTI study

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Purpose
Prenatal detection of abnormal white matter tracts may serve as a structural marker for altered neurodevelopment. Due to many technical and patient-related challenges, the reliability of fetal tractography remains unknown and has not been tested by comparing the same tracts to follow-up postnatal diffusion tensor imaging (DTI) based tractography. We hypothesize that fetal tractography is reliable and predictive of postnatal tractography in pathologic brains.

Materials and Methods
Seventy-five consecutive subjects with prenatal and postnatal magnetic resonance images (MRIs) imaged for cerebral pathology suspected by prenatal ultrasounds were
identified from April 2006 to July 2015. Twelve subjects had paired prenatal (age: 23 – 35 gestational weeks) and postnatal (age: 1 day - 2 years) DTI with no interventions during the interval. Prenatal DTI (1.5T, 5 channel cardiac coil, 16 gradient encoding directions, b-values of 0 and 700s/mm²) was compared to postnatal DTI (1.5T, 8 channel head coil, 16 gradient encoding directions). Using a multiple region of interest (ROI) technique, the corticospinal tracts (CST) and corpus callosum (CC) were segmented using the Philips Intellispace Portal system by two radiologists blinded to either prenatal or postnatal tractography. Qualitative and quantitative comparative analyses were performed.

Results
The prenatal CC was predictive in integrity and morphology of the postnatal CC in 50% (n=6 of 12) of the cases (Fig. 1). The segments of the CC also revealed good predictive qualitative results for the rostrum (42%, n=5 of 12), genu (50%, n=6 of 12), and splenium (50%, n=6 of 12). The body of the CC was the least reliable structure identified by tractography in both fetal (17%, n=2 of 12) and postnatal (25%, n=3 of 12) MRIs. A strong predictive correlation emerged when evaluating the integrity and morphology of the fetal and follow-up postnatal CSTs (right, 75%, n=9 of 12; left, 67% (n=8 of 12)). Additionally, no false positive fibers emerged while segmenting the CC or CSTs on the prenatal and postnatal MRIs.

Conclusions
This study is the first to examine the reliability of prenatal CSTs and CC visualization by fetal in relation to postnatal DTI. Accounting for brain maturation, the results of this study indicate that prenatal visualization of the main projection and commissural tracts can be used clinically as an important predictive tool in the assessment of fetal brain malformations.
Figure 1: (A-B) Tractography of the corpus callosum (blue) and corticospinal tracts (green, left; yellow, right) of a 29 gestational week fetus with a midline posterior parietooccipital cyst shows intact corticospinal tracts. The posterior aspect of the body and splenium of the corpus callosum are intact but displaced by the cyst. (C-D) In a follow-up MRI postnatal, the CC and CSTs are fully intact with similar lateral displacement of the tracts due to the midline cyst.
**Increase in Signal Intensities in the Dentate Nucleus and the Globus Pallidus on Pre-Contrast T1-Weighted Imaging: Evidence in Children**

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Purpose
In recent months, several reports have described residual gadolinium deposition in the brain in subjects undergoing multiple contrast-enhanced magnetic resonance imaging (MRI) exams. These independent findings, mainly in adults, have raised some concerns regarding Gd-based contrast agent (GBCA) usage within the radiology community (1-5). The purpose of this work was to summarize corroborative findings of hyperintense signal intensities in the dentate nucleus and the globus pallidus on precontrast T1-weighted images in a small group of 12 pediatric patients.

Materials and Methods
This retrospective study involved 12 patients, each of whom received more than five MRI examinations (range: 7-32 examinations) with GBCA over the course of their medical treatment for various brain neoplasms and tumors (duration range from first to most recent GBCA exam: 2.4-11.8 years). The patients were between the ages of 3 and 11 years at the time of their first MRI exam at our pediatric hospital institution. All patients had normal renal function test results prior to each of their MRI exam and showed no evident contraindications to receiving gadolinium. At each MRI exam, a standard dose of 0.1 mmol/kg of Magnevist contrast was administered. Regions of interest (ROIs) were manually drawn by a pediatric neuroradiologist in the dentate nucleus and the globus pallidus on 2D multi-slice fast-spin-echo images acquired at 1.5T (TR/TE=450-600/10-15ms). The average signal intensities of these two structures in each patient's data were normalized by those of the corpus callosum genu to account for intrasubject and intersubject variations in T1 tissue contrast, similar to previous studies.

Results
Signal intensity ratios increased between the first and the most recent GBCA MRI exam in all 12 patients (range: -0.8-47.5%) for one or both (i.e., dentate nucleus – 19.1% average, globus pallidus – 12.2% average) brain structures. The figure illustrates paired bar plots of these ratios per patient. The left (black) bars denote the ratios measured at each patient's first GBCA exam. The right (white) bars denote the ratios measured at the most recent GBCA exam. One-sample t-tests were statistically significant (p<0.0001) from zero (i.e., no change). Images show representative...
precontrast images at the first (left) and most recent MRI exams (right) of the dentate nucleus (arrows) from a 3.6-year-old girl who received 19 GBCA scans over the course of 7.6 years. In our small cohort, the degree of signal intensity enhancement did not depend on the total number of GBCA administrations each patient has received to date, the patient's age at the first exam, or the elapsed time between the first and most recent exams.

Conclusions

We have provided data in a cohort of 12 pediatric patients the observation of hyperintense dentate nucleus and globus pallidus structures on pregadolinium unenhanced T1-weighted MR images. Additional studies are needed to determine the significance, the clinical benefit-to-risk ratios, the potential adverse health effects, and the long-term impact, if any, of intracranial GBCA deposition.
Individual Patient Data Meta-analysis of Predictors of Clinical Outcomes in Pediatric Oligodendrogliomas

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Purpose
Oligodendrogliomas are neoplasms rarely diagnosed during childhood. Unlike the adult counterpart, pediatric oligodendroglioma remain a poorly characterized entity with limited prognostic information. The few studies that have identified factors of predictive value are subject to small sample sizes, retrospective design, discrepant inter-study findings, and a lack of accounting for confounding variables. The aim of this study is to apply an individual patient data meta-analysis to existing retrospective studies to elucidate potential predictors of outcome in pediatric oligodendrogliomas.

Materials and Methods
A systematic search strategy was utilized to identify pertinent studies, and publications related to pediatric oligodendrogliomas and associated outcomes were screened for inclusion. Each study was searched for demographic and clinical information of individual patients, including: age of diagnosis, gender, presentation at onset, location of tumor, extent of resection, presence of 1p19q codeletion, tumor grade, diagnosis of mixed or pure pathology, use of postoperative chemotherapy, use of postoperative radiation, and duration of event-free survival (EFS) and overall survival (OS). Multivariable imputation via chained equations model was utilized to impute certain missing demographic and clinical information of individual patients that were not available within all studies. The primary endpoints of interest were hazard ratios (HR) in EFS and OS, as calculated by univariate and multivariate Cox regression.

Results
The search identified 31 relevant articles regarding the study of pediatric oligodendrogliomas. Twenty-three of these articles included clinical and demographic individual patient data characteristics, comprising a total of 217 cases. In the adjusted model, subtotal resection (HR 3.50, 95% CI 1.52-8.04, p=0.004), initial presentation of headache (HR 8.72, 95% CI 2.23-34.14, p=0.003), and location of the tumor in the parietal lobe (HR 4.17, 95% CI 1.48-11.72, p=0.008) remained statistically significant predictors of tumor progression or recurrence. In the adjusted model, subtotal resection (HR 2.57, 95% CI 1.11-5.92, p=0.027) and initial presentation of headache
(HR 4.57, 95% CI 1.63-12.80, p=0.004) remained statistically significant predictors of mortality.

Conclusions
Using an individual patient data approach in meta-analysis to address the small sample size issue widespread in existing retrospective studies investigating pediatric oligodendrogliomas revealed that select factors, including location of the tumor, extent of resection, and initial presentation, may be important predictors of outcome in children with oligodendrogliomas.

**eP-182**

6:30AM - 2:45PM

Iterative Reconstruction Technique for Reducing Brain CT Radiation Dose: A Study in Pediatric Patients Following Brain Trauma.

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Purpose
To evaluate the reduction in radiation dose as a result of iterative reconstruction for computed tomography (CT) brain in pediatric patients presenting following head trauma. And to evaluate the quality of the images in both qualitative and quantitative terms, assessing for SNR and CNR, noise, gray/white matter differentiation and image sharpness. The use of pediatric head CT from the emergency room has increased significantly in recent years. As the pediatric brain is more radiation sensitive than that of an adult, it is imperative that we keep radiation doses as low as possible, without compromising image quality.

Materials and Methods
A cohort of 101 consecutive pediatric patients presenting following head trauma, but without CT finding of parenchymal injury were studied. All had brain CT performed using standard protocols using filtered back projection on a 64-slice Toshiba Aquillion (Toshiba, Tustin, CA) or using iterative reconstruction on a Siemens FLASH or Definition scanner (Siemens, Erlangen, Germany). Two radiologists performed evaluation of CNR and SNR using published formulae. Regions of interest (ROIs) were placed in frontal cortex, frontal corona radiata, caudate head, dentate nuclei and cerebellar white matter. Consensus view between three radiologists was performed for the qualitative analysis.

Results
Dose reductions averaging approximately 50% were seen in patients with CT brain performed using iterative reconstruction. There was no loss of image quality when compared with conventional imaging with comparable CNR, SNR in gray and white matter of the supra and infratentorial brain. Excellent intra- and interobserver
correlation was obtained. Subjective measures also were similar between the two methods.

Conclusions
Iterative reconstruction technique results in significant CT brain dose reduction, averaging approximately 50% in pediatric patients following trauma, without loss of image quality.

eP-163

Neonatal Brain MRI And US Findings: Case Series

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Purpose
To describe the spectrum of brain magnetic resonance imaging (MRI) findings in neonates in a tertiary hospital. To correlate brain MRI findings with available brain ultrasound findings.

Materials and Methods
Fifty brain MR studies of neonates from a tertiary hospital, performed from September 2013 to November 2015, were revised retrospectively. The participants were at risk of hypoxic perinatal injury or presented with abnormal clinical examination. Magnetic resonance imaging findings were correlated with 46 prior ultrasound (US) examinations.

Results
Twenty-seven (54%) neonates presented normal MRI studies. Intracranial hemorrhage, malformations, periventricular leukomalacia, cysts and hydrocephalus were observed in 10 (20%), eight (16%), six (12%), six (12%) and four (8%) individuals, respectively. All of periventricular leukomalacia cases diagnosed by MRI were not visualized in US. Moreover, there was a good correlation between US and MRI in cases of malformations, except in cortical development type. Most of neonates with intracranial hemorrhage were correctly identified by both MRI and US. In two cases, US examination demonstrated intracranial hemorrhage grade I, which was not demonstrated in MRI. In another two cases, MRI demonstrated small foci of hemorrhage in encephalic parenchyma, not identified by US.

Conclusions
In our study, most neonates presented normal MRI exams, in despite of risk of hypoxic perinatal injury. There was a good correlation between US and MRI in cases of intracranial hemorrhage. On the other hand, periventricular leukomalacia was not well demonstrated by US, compared to MRI.
Potential Intracranial Gadolinium Deposition in Children Following Multiple Contrast Enhanced MRI Examinations: Evaluation of Long Term Parenchymal Signal Change

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Purpose
To evaluate if repeated intravenous administrations of gadolinium-based contrast agents (GBCA) are associated with brain parenchymal signal changes in children.

Materials and Methods
A single center, IRB approved retrospective study of 41 subjects under the age of 18 years was conducted. The contrast group included 21 subjects with a mean age of 7.8 years (range 0.3–16.6 years) who underwent more than 4 GBCA magnetic resonance imaging (MRI) studies between 2008 and 2015. The age/sex matched control group of 20 subjects underwent multiple noncontrast enhanced MRIs. On noncontrast T1-W images, region of interest (ROI) markers were drawn over the globus pallidus (GP), thalamus (TH), dentate nucleus (DN) and central pons. Signal ratio of GP:TH and DN:Pons and percent change of signal ratio from the initial and final MRIs were calculated. Two-sample t-Tests were used to determine significance of percent changes between the two groups. Regression analysis was performed to access association between signal ratio and gadolinium contrast dose.

Results
Contrast group underwent an average of $11.7 \pm 5.5$ (range 4–23) GBCA MRI studies with a mean study interval of 4.4 years. The control group without any intravenous GBCA had a mean study interval of 1.7 years. There was no significant difference in percent change of GP:TH and DN:Pons between the contrast and control groups ($p = 0.334$ and $p = 0.585$ respectively) shown in Figs. 1 and 2. In the contrast group, regression analysis demonstrated no significant association between signal ratio of GP:TH or DN:Pons and GBCA doses ($p=0.211$ and $p= 0.185$ respectively). Fig. 1, Percent change in T1 signal (GP:TH) from the first to last MRI tended to decrease as the total number of MRIs increased in both groups, however not statistically significant. Fig. 2, Percent change in T1 signal (DN:Pons) from the first to last MRI tended to increase in the contrast group as the total number of MRI increase in the contrast group and the opposite in the control group. However, these were not statistically significant.

Conclusions
No significant parenchymal MRI signal change was observed after multiple GBCA administration in the pediatric population. Our data differs from recently published
literature in adult subject (1-3) and suggests no significant intracranial deposition of GBCA in children.
Prevalence and Outcomes of Cavernous Malformations Following Cranial Radiation in Pediatric Cancer

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Purpose
Radiation therapy (RT) to the brain in childhood is critical for the treatment of certain malignancies but is not without side effects and has been associated with development of cavernous malformations (CMs). The purpose of this study was to define the prevalence of CMs and associated outcomes following cranial radiation for pediatric cancer at a large volume tertiary care cancer center.

Materials and Methods
We conducted a retrospective chart review of 787 pediatric patients who underwent cranial radiation at our institution between January, 1993 and February, 2015. Patients
without a follow-up brain MRI examination at least 3 months after RT were excluded. A keyword search of the reports from the imaging studies was performed to identify patients with CMs.

Results
A total of 423 pediatric patients met eligibility criteria. There were 50 patients with imaging reports that possibly demonstrated CMs based on the keyword search. After careful review of the images, 39 patients were considered to have CMs that occurred after RT (9.2%). Thirteen had "black dots" (microhemorrhages) on susceptibility weighted imaging (SWI) or gradient recalled echo (GRE) imaging without corresponding signal abnormality on T1 or T2 weighted imaging (type 4 CMs, Zabramski classification). Twenty six patients had SWI or GRE abnormalities with corresponding signal change on noncontrast T1 and/or T2 weighted images (types 1-3 CMs, Zabramski classification). Six of these patients developed brain edema related to hemorrhage of the CMs (15%).

Conclusions
The development of CMs after cranial RT in pediatric cancer patients is common based on our review of the largest such patient cohort to date. Brain edema from bleeding CMs is also common. These findings have important clinical implications for how these patients are managed after RT.

**eP-165**

Role of Cerebrospinal Fluid (CSF) Flow Imaging in Evaluating Distribution of Infused Agents from the Fourth Ventricle to the Total Spine.

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Purpose
For the first time in humans, our institution is infusing chemotherapy directly into the fourth ventricle of the brain to treat recurrent posterior fossa malignant brain tumors in children. To assess distribution of the infused agent throughout the neural axis without requiring a nuclear medicine study, we have used total spine CINE magnetic resonance imaging (MRI) phase contrast cerebrospinal fluid (CSF) flow sequences, which assess flow from the fourth ventricle down to the lumbar spine.

Materials and Methods
In two IRB-approved prospective studies, six patients with a median age of 12 years initially underwent a posterior fossa craniotomy for maximal safe surgical resection of
a recurrent fourth ventricular tumor and implantation of a ventricular access device in
the fourth ventricle. Traditionally the CSF flow distribution is assessed by nuclear
medicine study after injection of radiopharmaceutical into spinal canal by lumbar
puncture. In our study, prior to infusing chemotherapy into the fourth ventricle, we
have used noninvasive CINE MRI phase contrast CSF flow sequences of the brain
and total spine with velocity encoding (VENC) of 10 cm/sec and 20 cm/sec to confirm
CSF flow from the fourth ventricular outlets to the cervical, thoracic, and lumbar
spine. Qualitative CSF flow was assessed by neuroradiologists and was characterized
as present or absent.

Results
All six patients demonstrated CSF flow in the spinal canal with no evidence of
obstruction. All sets of images were of diagnostic quality and there was excellent
concordance between the study readers in their interpretation.

Conclusions
Cerebrospinal fluid flow including the fourth ventricle and the total spine can be
assessed noninvasively with CINE MRI phase contrast sequences. These sequences
are a new alternative to nuclear medicine studies. Advantages over nuclear medicine
studies include avoiding an invasive procedure as well as radiation exposure.

eP-188

Spectroscopic Outcomes Associated with an Aerobic Intervention Following Mild
Traumatic Brain Injury in Adolescents

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Purpose
Mild traumatic brain injuries (mTBI) are a leading cause of morbidity in children and
adolescents with an estimated 3.8 million sports- and recreational-related mTBIs
occurring each year in the United States. An estimated 10-33% of individuals have
persistent symptoms. Recent research indicates that the pathophysiology of mTBI
symptoms is multifactorial, but a primary biologic correlate is dysregulation of
metabolic function. Aerobic exercise is a potentially attractive intervention because it
improves cerebral blood flow, oxygen extraction, glucose metabolism and
neuroplasticity in healthy individuals. The purpose of this study was to evaluate the
effects of an aerobic training intervention in adolescents with prolonged symptoms
after mTBI on metabolite concentrations derived from proton magnetic resonance
spectroscopy (MRS).
Materials and Methods
Adolescents (N=21) ages 11-18 years with 4-16 weeks of persistent symptoms after mTBI completed an up to 10-week randomized controlled trial (RCT) evaluating the efficacy of sub-symptom exacerbation aerobic training (N=10) compared to a stretching intervention (N=11) for management of persistent symptoms. Using the single voxel, point resolved spectroscopic (PRESS) localization MRS technique on a 3T scanner, we evaluated two 8 cc regions at baseline and at 10 weeks: the frontal gray matter including the anterior cingulate cortex and the frontal white matter (left hemisphere). Metabolite levels were determined using LCModel software. Metabolite ratios and literature-based T1 and T2 relaxation corrected concentrations were determined. Clinical response was characterized by the post-concussion symptom inventory scale. Pre- and postintervention differences were compared within and between the aerobic training and stretching intervention groups using the Means Procedure in SAS.

Results
Clinically, participants in both intervention groups improved; however, the aerobic training group improved more quickly than the stretching intervention group. Frontal gray matter concentrations of N-acetyl aspartate (NAA), Creatine (Cr) and Cholines (Cho) assessed pre- and postintervention were significantly different within the aerobic training group. Concentrations tended to be lower in the post evaluation. No differences were observed pre- and postintervention within the stretching group and between groups. No differences were observed in the frontal white matter for either group.

Conclusions
An aerobic training intervention in adolescents with persistent symptoms after mTBI produced minimal changes in frontal gray matter concentrations of NAA, Cr and Cho. Reduction of all three major metabolites postintervention was unexpected; however, this may suggest a potential systemic effect. Study design issues also may be responsible for our findings. Primary limitations include the pilot nature of the study, small sample size, timing of intervention, timing of imaging, and technical factors affecting the acquisition. Further optimization of the intervention and evaluation with other imaging techniques will be necessary in future studies.

eP-176

The Missing Link: Normal T2-FLAIR Myelination Patterns in Children Ages 2-10

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Purpose
Brain myelination advances over the first decade and beyond. Normally, myelination is near complete on T1-WI and T2-WI by 2 years, but T2-FLAIR myelination tends to lag. Previous T2-FLAIR myelination studies have focused on subjects under two. T2-FLAIR may offer a window of opportunity to evaluate late stage myelination deficits. We evaluated T2-FLAIR myelination patterns from a cohort of normal patients ages 2-10 years.

Materials and Methods
Our imaging database was queried for all normal brain MRs performed over 6 months, ages 2-10 years. Prematurity and artifact were exclusion criteria. Eighteen white matter regions were assessed for myelination degree. T2-FLAIR myelination was graded (1-4) by two radiologists in consensus based on signal comparisons to T2-WI and gray matter. Decade specific median scores were calculated. Spearman's test was employed to explore correlations between age and myelination grade; p<0.05 was considered significant.

Results
We reviewed 132 magnetic resonance images (MRIs) from different patients. One hundred thirteen exams met inclusion criteria. Brain myelination was symmetric in all cases. Myelination score positively correlated with age in all areas with the exception of the periatrial white matter, corpus callosum, brainstem, and cerebellum. Juxtacortical white matter of the frontal, temporal, parietal, and insular lobes underwent the most drastic positive myelination changes.

Conclusions
Normal age-related brain myelination on T2-FLAIR sequences spans the first decade of life, and occurs in a predictable sequence. Knowledge of normal T2-FLAIR myelination patterns offers an opportunity to detect myelin pathology beyond 2 years after T1-WI and T2-WI have normalized.
The Utility of Susceptibility-weighted Imaging in the Detection of Retinal Hemorrhages in Pediatric Non-accidental Trauma

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Purpose
To evaluate the use of susceptibility-weighted imaging (SWI) for different types of brain injury in accidental (AHT) and nonaccidental trauma (NAHT) in children, particularly the accuracy of susceptibility-weighted imaging (SWI) in detecting retinal hemorrhages (RH) in NAHT.

Materials and Methods
In this IRB approved retrospective study, two staff neuroradiologists, blinded to the type of trauma, evaluated the head MRIs and CTs of 55 children with blunt head trauma between the years 2008-2015. The two observers checked for the presence of RH on SWI, and calculated its accuracy in detecting RH, in comparison to fundoscopic examination (used as the standard). The observers recorded the presence of intracranial MRI/CT findings such as complex subdural hemorrhage (cSDH), diffuse axonal injury (DAI), hypoxic ischemic injury (HIE), contusion, and skull fracture. Associations were assessed for via odds ratios (OR), regarding the type of injury (AHT versus NAHT) and the presence of RH, as well as with the presence of cSDH, DAI (on SWI), HIE (on DWI), contusion (on SWI), and fracture.

Results
This cohort included MRI studies of 30 males, and 25 females (age range 0-4 years). The sensitivity of SWI in detection of RH was 37.93% while the specificity was 100%; the PPV was 100%, and the NPV was 81%. There was a mild correlation between the presence of RH and HIE (p=0.026,r=0.300 ). Both RH and cSDH alone were highly predictive of NAHT (OR= 10.0 and 10.8, respectively), while HIE alone was mildly predictive of nonaccidental trauma (OR=3.9). A largely unilateral pattern of HIE was present only in NAHT.

Conclusions
Susceptibility-weighted imaging may be a valuable clinicoradiological tool in detecting the presence of RH in children with trauma. The presence of either cSDH and RH are highly predictive of NAHT, while a pattern of "mostly unilateral" HIE is typically present only in NAHT.

eP-172
Tortuosity of vertebral and basilar artery: A new finding in patients with Mucopolysaccharidosis Typ IVa

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Purpose
Mucopolysaccharidosis (MPS) IVa is a lysosomal storage disorder caused by a deficiency of N-acetylgalactosamine-sulfatase. Main symptom is systemic skeletal dysplasia (1). Affection of the intracranial vascular system has not been described yet. The goal of this study is the analysis of the intracranial vascular system in patients with MPS IVa, based on the example of the intracranial segment of the vertebral (V3/V4) and basilar artery (BA).

Materials and Methods
In a retrospective study 42 magnetic resonance imaging (MRI) examinations of 34 patients with MPS IVa aged from 5-49 years (μ 17, 96, median 14) were included. All patients were of small stature (length 106 ±19 cm). All vertebral arteries (VA) in their entire course were analyzed, beginning at the extra-intracranial transition (V3/V4-segment up to the entire intracranial (V4-) segment. The basilar artery was analyzed as well. The 42 MRI examinations, included sag CISS- (constructive interference in steady state-) sequences, time of flight (TOF) angiography and contrast-enhanced (CE) angiography. We defined C or S shaped alterations of the corresponding arteries. A deflection of more than 90 degrees was defined as tortuosity, that of less than 90 degrees as kinking, and arteries with looping shape as coiling, according to Weibel and Fields (2-4).

Results
We excluded nine of 34 patients due to insufficient sequences concerning our target in the MRI examinations with a lack of visualization of the course of the VA and BA. Two of the analyzed 25 patients had a normal course of both VA as well as the BA. Twenty-three patients showed alterations in vessel shape of the VA as well as the BA or both. In 21 of 23 patients we found a C-shaped basilar artery, one of 23 showed a BA kinking. In three of 23 patients a coiling of the intracranial course of the VA was seen. In four of 23 patients (aged 5 – 10 years) a progress of vessel aberration was seen in a period of 1-4 years. Two of four developed a vertebral kinking, while in two an already initially found kinking of the VA developed a progress in deflection angle. One of these got MRI examinations in the following 3 years without any further progress.

Conclusions
As far as we know it is the first time that an arterial vessel tortuosity in patients suffering from MPS IVa is described. Although the etiology is still unknown, we
suggest that this complication could be due to glycosaminoglycane deposition in the aortic intima respectively media, which may be associated with an increased vulnerability of the vascular wall and a rupture of the elastic fibers (5). Therefore, we conclude that the examination of the vascular system should be included in regular follow-up protocols of MPS IVa patients.
Ultra Low Dose 3D CT in Patients with Craniofacial Anomalies

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Purpose
Pre-operative 3D computed tomography (CT) is standard of care in patients with craniofacial anomalies. In these patients, bone structural evaluation is paramount and brain evaluation is not of primary concern. Most of these patients undergo multiple CT studies. The purpose of our study is to document reduction of radiation dose by implementation of ultra-low radiation dose CT protocol in patients with craniofacial anomalies.

Materials and Methods
IRB approved retrospective study at a tertiary care pediatric hospital. Two hundred consecutive patients who underwent head CT for pre-operative evaluation of craniofacial anomalies were selected. The kVp, mA, CT dose index (CTDI), and dose-length product (DLP) was documented from the dose page. Patients were stratified based on age for determining age-specific effective dose and for age matched comparison. The age-specific effective dose was derived by using established conversion factor (1). Standard t-test was performed to determine statistical significance of radiation dose reduction.

Results
Ninety patients had low dose CT and 110 patients had ultra-low dose CT of the head. All patients had diagnostic quality CT studies. The low-dose CT was performed at 120 kVp and 100 mA. The ultra-low-dose CT was performed at 80 kVp and fixed 80mA. The minimum, maximum and mean effective dose before introduction of the ultra-low dose protocol was 0.8 mSv, 6.9 mSV and 2.82 mSv. The minimum, maximum and mean effective dose after introduction of the ultra-low dose protocol was 0.6 mSv, 3.8 mSV and 1.37 mSv. The reduction in the effective radiation dose was statistically significant (standard t-test; p<0.0001).

Conclusions
Ultra-low dose CT head provided diagnostic images with a significantly decreased radiation dose compared to the regular low-dose protocol.
Effective dose with low dose CT protocol

Effective dose with Ultra low dose CT protocol

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B=5
Acute Adverse Reactions to Gadobutrol and Other Gadolinum-Based MRI Contrast Agents: A Two-Year Single Institutional Experience

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Purpose
Gadobutrol is a relatively new gadolinum-based contrast agent (GBCA). Its risk of adverse reactions is less well studied as compared to older GBCAs. We conducted a retrospective review of all adverse reactions to GBCAs, reported at our institution over a 2-year period.

Materials and Methods
After IRB approval, reactions reported to the institutional Patient Safety Network (PSN) within the 2-year period of 2013-2014 were evaluated and the demographics, GBCA type and reaction, treatment and clinical outcome data were recorded. Additionally, all magnetic resonance imaging (MRI) technologists' comment entries (n=21006) were reviewed to uncover any additional unreported adverse reactions. For patients who had serial imaging, each patient was counted only once in each GBCA group. If a patient had reaction to the same agent more than once, only one reaction was included in the analysis.

Results
Records of 72234 contrast injections were reviewed. By counting each patient only once in each contrast group, 42386 injections were included in the final analysis. Fifty-eight reactions were reported to the PSN. Reviewing technologist's comments provided additional 105 reactions. Our preliminary results show that the rates of reported reactions per 1000 injections were 0.7, 1.6, 1.7 and 2.0 with gadopentate dimeglumine (Gd-DTPA), gadobutrol, gadoxetate disodium and gadobenate dimeglumine, respectively. Gadobutrol had a statistically significantly higher rate for reported reactions than Gd-DTPA (p=0.025). We also analyzed a group of patients, who received both gadobutrol and Gd-DTPA. We found that Gadobutrol caused significantly more reactions than Gd-DTPA (p=0.03). Overall, there were four severe reactions and the mortality rate was 0%.

Conclusions
Gadobutrol is a safe GBCA. Our result shows a higher reaction rate when comparing gadobutrol to Gd-DTPA. We believe education of the MRI staff about recognition and
reporting of adverse reactions and use of more standardized forms will provide more efficient and complete documentation of MRI contrast reactions.

eP-193

6:30AM - 2:45PM

Estimation of Displacement Forces of Metallic Foreign Bodies Based on Screening Radiographs

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Purpose
Metallic foreign bodies commonly are seen in patients scheduled to undergo magnetic resonance imaging (MRI). It falls to the radiologist to decide if the patient can proceed with the examination or not. The goals of this study were to compare estimated with measured displacement forces of metallic foreign bodies and potential differences in estimated displacement forces as a consequence of different screening radiograph technique.

Materials and Methods
Three different sized ferromagnetic metallic foreign bodies (a piece of a paper clip and pieces from two different size nails) were taken and placed on the face side of a skull phantom. Radiographs were taken in frontal [both AP and PA projections with a source to image distance (SID) of 40 and 72 inches, respectively] and lateral views. Displacement forces were calculated by measuring the deflection angle in the area of highest spatial field gradient of a 1.5T scanner (Avanto, Siemens). The estimated force was calculated by multiplying the three largest dimensions, as measured on the radiographs with Osirix, by 800 (eight is the density in gm/cm^3 and displacement forces were estimated as being 100 times the force of gravity).

Results
The deflection angles measured 61 to 71 degrees, with calculated displacement forces of 87, 463 and 636 mN. The estimates were 120-189, 295-433 and 560-812 mN, respectively, with the lower value for the 72 inch PA technique and higher value for the AP 40 inch technique due to increased magnification with a smaller SID and the foreign body being farther away from the detector.

Conclusions
Calculating a rough estimate of the displacement forces by multiplying the three largest dimension by 800, while not precise, allows a decent estimate of possible displacement forces. With this data, a more informed decision can be made whether to proceed with a patient MRI scan if a metallic foreign body is present.
NSsaFe study: Observational study on the incidence of Nephrogenic Systemic Fibrosis in patients with renal impairment following gadoterate meglumine administration.

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Purpose
To prospectively determine the incidence of nephrogenic systemic fibrosis (NSF) in patients with renal impairment following gadoterate meglumine (DOTAREM®) administration.

Materials and Methods
The NSsaFe study is a worldwide observational study including hundreds of patients with moderate to severe and end stage renal impairment, scheduled to undergo a routine contrast-enhanced magnetic resonance imaging (MRI) with gadoterate meglumine. Medical history (including renal function), indication for MRI and conditions of administration of the product are recorded for each patient at inclusion. Adverse events (AE) occurring during the MRI examination or the time of usual follow-up postgadoterate meglumine administration are recorded. Patients then are followed up over 2 years with three visits spaced out by at least 3 months, in order to detect any occurrence of NSF.

Results
As of 6 October 2015, data of 540 patients [mean age: 69.6 years (range: 21-95); male: 58.5%] were analyzed. In the study population renal insufficiency was graded as moderate for 69.3% of the patients, severe for 16.1% and end stage for 12.0%. A total of 2.6% of the patients had undergone a previous kidney transplant. The mean (±SD) eGFR was 37.6 (±15.7) ml/min/1.73m2 (range: 4.0-74.2). The main MRI indication was to assess suspected abnormalities of the central nervous system (34.6%) and the mean total volume of gadoterate meglumine injected was 15.8±5.9 mL. A total of 369 patients attended the first follow-up visit (between 3 and 12 months after MRI), 231 patients attended the second (between 13 and 21 months) and 165 patients attended the third (between 22 and 27 months). No AEs related to the administration of gadoterate meglumine were reported. No cases of NSF have been observed.

Conclusions
This interim analysis of the NSsaFe study showed no cases of NSF in patients with renal impairment following gadoterate meglumine administration.
moderate to severe renal impairment after the administration of gadoterate meglumine.

eP-192

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 basic tenets of health care reform, mechanisms by which 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
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.
eP-190

The Impact of Airway Management Strategies on the Quality of Central Nervous System MR Imaging

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Purpose
Sedation and general anesthesia now are used widely during the magnetic resonance imaging (MRI) of the central nervous system (CNS) pathologies. Use of anesthetic agents might negatively impact the image quality by causing relaxation of laryngeal muscles, snoring and thus motion artifacts. Various airway devices are used in an effort to counteract these artifacts. There is paucity of information about which airway strategy is most effective in overcoming motion artifacts. In our retrospective study, we evaluated the image quality of serial MRI studies of nine patients, during which different airway management techniques were used.

Materials and Methods
After obtaining IRB approval, we conducted a review of serial central nervous system (CNS) MRI studies in nine anesthetized patients. Two experienced clinicians reviewed the MRI studies. To determine the image quality, a scoring system was developed and validated. The lowest possible score was six and the highest possible score was 30. Linear mixed model was used to compare image quality scores assigned to each airway management strategy. The anesthesia records were reviewed by an independent anesthesiologist. Data obtained included the demographic information and the use of different airway devices to maintain a patent airway.

Results
There were 85 sequential MRI studies conducted in nine patients. Forty-eight studies (56%) were done without airway device, 27 (32%) were with supraglottic airway, four (5%) with oral airway, four (5%) with nasal airway and two (2%) with tracheal tube. Mean scores were 20, 15, 27, and 29 for oral, nasal, supraglottic, and tracheal airway groups, respectively. During anesthesia sessions using supraglottic airways the MR image quality improved by 5.33 points (from 21.96 to 27.29) over procedures without the use of an airway (p-value <0.0001).

Conclusions
Use of supraglottic airways demonstrated a significant and consistent improvement of image quality in MRI studies done using deep sedation.
Aberrations in Folate Metabolism in the Setting of Myelopathy and Intrathecal Chemotherapy: A Case Report of 11 cases with MRI Findings Mimicking Subacute Combined Degeneration

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Purpose
Systemic and intrathecal methotrexate and Ara-C are used widely to treat hematologic malignancies and have been known to cause neurotoxicity in a small population of patients. Methotrexate, a folate antagonist, causes increased levels of homocysteine, which is thought to be responsible for its neurotoxic effects. Chemotherapy-induced myelopathy mimicking subacute combined degeneration (SCD) has been recognized in case reports, with normal B12 levels in each case. We sought to examine radiographic and clinical factors associated with intrathecal associated myelotoxicity.

Materials and Methods
After institutional review board approval, we retrospectively reviewed patients diagnosed with acute or chronic leukemia that received intrathecal chemotherapy and were evaluated by the neuro-oncology consult service for clinical symptoms suggestive of myelopathy. Laboratory data, magnetic resonance imaging (MRI) findings and clinical features were reviewed.

Results
Between January 2009 and October 2015, we identified 11 patients with radiographic findings of SCD: T2 hyperintensity in the dorsal and lateral columns of the spinal cord, after intrathecal methotrexate and ara-c. All patients treated developed urinary and bowel incontinence, ascending motor weakness and sensory loss in the setting of lateral and dorsal column hyperintensity on T2 magnetic resonance imaging. Six out of nine cases with available data had reduced serum folate levels and/or increased levels of homocysteine, implicating methotrexate as the cause of neurotoxicity. Autopsy was performed in one case, illustrating degeneration of the posterior columns, consistent with Wallerian-like degeneration. In each case additional central...
nervous system (CNS) targeted therapy (systemic and intrathecal chemotherapy and/or radiation therapy) was given prior to recognition of the etiology of myelopathy. Conclusions
Awareness and a higher index of suspicion of this characteristic clinical and radiographic picture in patients with myelopathy may prevent additional neurotoxic therapy. Axial T2-weighted MRI should be acquired in leukemia patients that have received intrathecal chemotherapy who have symptoms of myelopathy. Additional research is needed to identify means to prevent this devastating complication of therapy.

eP-206

Causes of Spinal Hemorrhage in a Level One Trauma Center

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Purpose
The goal of this study was to determine the etiology and characteristics of spinal hematomas; also the effectiveness of the initial images in the diagnosis.

Materials and Methods
Retrospective observational study with a time period of seven months (December 2014- July 2015) was determined, then all patients diagnosed with spine hemorrhage admitted to our hospital were included.

Results
Sixty-one patients diagnosed with spinal hemorrhage, 40 men and 21 women with a median age of 49-53 years were included. It was established as the main mechanism. Trauma 83%, postsurgical 6.5%, insufficiency fracture 3.2%, pathological fracture 3.2% and spontaneous bleeding 3.2%. Were found 53 epidural hematomas and eight subdural hematomas Twenty-two cases were located in the lumbar spine,18 in cervical spine, eight thoracic spine, six thoraco lumbar, three cervical- thoracic and one sacrum. The location within the spinal canal 54% anterior, 45% posterior and 3.2% lateral. The average longitudinal diameter bruising models was 66 mm, with an extension of three vertebral segment on average. Sixty-three percent spinal hematomas has compressive effect and 37% showed no signs of compression. Seventy-seven percent of patients presented vertebral fracture associated with an average of three fractured vertebrae. Sixty-seven percent of patients were taken to magnetic resonance imaging (MRI) as initial diagnostic imaging with 100% achieving
and 33% were taken to computed tomography (CT) and diagnosed 20% of hemorrhage.
Conclusions
It was established as the main etiological factor of spinal bleeding is trauma associated with vertebral fractures, the effective diagnosis is important because most of the hemorrhage has compressive effects on the spinal cord; also MRI proved to be the modality of choice for diagnosis and follow up while CT show has a low sensitivity diagnosed.
Critical Imaging Findings of Craniocervical Junction Injuries for the In-Training Resident.

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Purpose
The purpose of this educational exhibit will be to provide a focused review of the anatomy, mechanisms of injury, and imaging findings of craniocervical junction injuries. An emphasis will be placed on direct and indirect imaging findings critical for the in-training resident to recognize.

Materials and Methods
Common craniocervical junction injury patterns will be reviewed in a case-based pictorial format using cases from a Level 1 trauma center.

Results
Craniocervical junction injuries, while uncommon are of critical importance for the in-training resident to recognize and understand. Evaluation of the craniocervical junction begins with an understanding of the basic anatomy including the main articulations; the middle atlantoaxial joints and the lateral atlantoaxial and atlantooccipital articulations. Several ligamentous structures support these articulations the most crucial of which include the tectorial membrane, alar ligaments, and the transverse ligament. While the biomechanics and mechanisms of injury can be quite complex injury patterns can be generally divided into bony fractures and ligamentous atlanto-occipital/atlantoaxial distraction injuries although in many cases a combination of both may be observed. The modern imaging approach now typically involves computed tomography (CT) first followed by magnetic resonance imaging (MRI). Computed tomography may be used to assess for fracture or joint subluxation as well as secondary signs of craniocervical junction injury such as hematoma, vertebral artery injury, and joint capsule swelling. Normal anatomical values of the craniocervical junction on both plain film radiography and CT may be useful in equivocal cases. Magnetic resonance imaging provides complimentary information with exquisite evaluation of ligaments, prevertebral soft tissues, and spinal cord pathology. After reviewing the basic anatomy and common injury patterns of the craniocervical junction in a case-based format the in-training resident should have a better understanding of the critical findings to make when evaluating for injury.

Conclusions
Craniocervical junction injuries are diverse and varied in mechanism and imaging manifestations. Injuries of the craniocervical are of critical importance for in-training residents to quickly recognize and communicate.
Differentiating Atypical Vertebral Hemangiomas from Vertebral Metastases Using MRI-DCE

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Purpose
To evaluate the utility of dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) perfusion technique to differentiate between atypical hemangiomas and malignant metastatic spine lesions which are otherwise undistinguishable in routine MRI scans.
Materials and Methods
Patients with treatment naïve vertebral lesions who underwent DCE MRI scans from 2011 to 2015 were reviewed. A total of 36 atypical hemangiomas and 79 vertebral metastases were included. The inclusion criteria for hemangiomas were (1) stability for more than 1 year, (2) negative PET-CT scan, (3) presence of characteristic trabecular appearance on CT scan, (4) available pathology results and (5) no prior radiation at the level of the presumed hemangioma. All metastases were histologically confirmed. Magnetic resonance imaging sequences were acquired as a part of standard clinical protocol with a 1.5T or 3T scanner. A bolus of gadobutrol was administrated by a power injector. DCE MRI of the spine was acquired and 10 phases were obtained for pre-injection time delay and thirty phases were obtained for postinjection. Regions of interest (ROIs) were drawn manually by a radiologist on the lesion on the perfusion maps. Dynamic contrast-enhanced MRI perfusion parameters: capillary permeability (Ktrans), plasma volume (Vp), were measured and a Mann-Whitney U test, was performed to establish the significance of perfusion parameters differences observed between the groups.

Results
Our work shows that qualitative inspection of MRI DCE enhancement curves (88% of cases) as well as quantitative analysis of Vp and Ktrans perfusion parameters (P-value <0.001) can differentiate between metastatic lesions and atypical hemangiomas, commonly undistinguishable in routine MRI studies. Median Ktrans for atypical hemangiomas and metastases were 0.07 and 0.17 respectively. Median Vp for atypical hemangiomas and metastases were 1.83 and 9.3 respectively. Vertebral metastatic lesions had significantly higher perfusion parameters (Vp, Ktrans) (p<0.001) when compared with atypical hemangiomas.

Conclusions
Our data demonstrate that quantitative analysis of Vp and Ktrans perfusion parameters can differentiate between vertebral metastatic lesions and atypical hemangiomas. Adding perfusion maps to conventional sequences can improve diagnostic accuracy and clinical management.
Representative Sagittal T1-weighted and the corresponding perfusion $K_{\text{trans}}$, $V_p$, and $K_{\text{trans}}$. The cases shown correspond to the spinal metastatic lesions origin primary breast carcinoma. Comparison of perfusion maps shows greater $V_p$ and $K_{\text{trans}}$ in metastatic lesions when compared to atypical hematomas.
Representative Sagittal T1-weighted and their corresponding perfusion and $K_{\text{trans}}$ parameters. The cases shown correspond to atypical hemangiomas. Significant lower values of $V_p$ and $K_{\text{trans}}$ are observed for atypical hemangiomas.
Purpose
Cauda equina syndrome requires emergent imaging to rule out compressive lesions on the cauda equina which may require surgical decompression. Magnetic resonance imaging (MRI) is the gold standard imaging modality to make this determination. While computed tomography (CT) is sometimes performed as a complimentary imaging modality to evaluate osseous integrity in patients with cauda equina syndrome, the diagnostic yield of CT in detecting significant spinal stenosis and cauda equina impingement is not defined well in the literature. We hypothesized that percentage thecal sac effacement ("PTSE") on CT lumbar spine would have high sensitivity and high negative predictive value in evaluating for significant spinal stenosis and cauda equina impingement.

Materials and Methods
Two independent readers retrospectively analyzed imaging studies for 151 consecutive patients with clinically suspected cauda equina syndrome, who had admission CT-lumbar spine in addition to MR-lumbar spine. PTSE (<50%, ≥50%) was determined on CT and MRI. Presence or absence of cauda equina impingement also was determined on MR cases of PTSE ≥50%. Using MRI as the reference standard, statistical analysis was performed to determine accuracy of CT in predicting significant spinal stenosis (PTSE ≥ 50%) and cauda equina impingement.

Results
Forty of 151 patients had PTSE ≥50% on MRI (22 degenerative, 13 traumatic, three neoplastic, one hematoma, one infection). Nineteen of 40 had cauda equina impingement. Based on analysis of CT-lumbar spine alone, readers determined there was CT-PTSE <50% in 97/151 cases, and CT-PTSE ≥50% in 54/151 cases. Reader sensitivity for detection of significant spinal stenosis (MR-PTSE ≥50%) was 0.98, specificity 0.86, PPV 0.72, NPV 0.99. No cases read as CT-PTSE <50% were found to have cauda equina impingement.

Conclusions
Computed tomography PTSE predicts significant spinal stenosis on MRI in patients with clinically suspected cauda equina syndrome. Computed tomography PTSE <50% appears to reliably rule out cauda equina impingement. This imaging marker may serve as an additional tool to the clinician in deciding whether MRI can be deferred.

Imaging of Congenital Lumbar Spinal Stenosis: Comparison of Three Measurement Techniques for Greater Diagnostic Yield
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Purpose
Congenital lumbar spinal stenosis (CLSS) is a developmental narrowing of the lumbar spinal canal causing chronic back pain, radiculopathy, and neurogenic claudication. It presents with neurogenic claudication at an earlier age than patients without CLSS. We assessed three measurement methods for their correlation with a diagnosis of CLSS on radiographs and cross-sectional imaging. We hypothesized that the Cobb angle method would be the most reliable method of diagnosing CLSS.

Materials and Methods
Radiographs and cross-sectional images [computed tomography (CT) and magnetic resonance imaging (MRI)] were evaluated in 1) 30 patients with symptomatic CLSS, 2) 30 patients without CLSS but with degenerative lumbar disease, and 3) 30 patients presenting with back pain in the absence of imaging pathology. Method 1: determination of the ratio of the antero-posterior (AP) vertebral body (VB) diameter over the AP diameter of the spinal canal at the L3 level on radiographs; Method 2: determination of the ratio of the VB and spinal canal cross-sectional area at the L3 level on MRI; Method 3: measurement of the lumbosacral angle between L1-S1 using the Cobb method on radiographs. Statistical analysis was performed using Fisher exact and multivariate analysis of variance (MANOVA). Age, gender, and body mass index (BMI) were covariates.

Results
Congenital lumbar spinal stenosis had a greater association with male gender (p=0.023), younger age, higher body mass index (BMI), and a smaller lumbosacral Cobb angle (Method 3) (p≤0.0001). Methods 1 and 2 did not show any significant association with CLSS patients.

Conclusions
1. Symptomatic CLSS is associated with younger male patients with increased BMI.
2. Measurement of the lumbosacral Cobb angle may be superior to ratio based techniques for radiologically diagnosing CLSS.
Figure 1: Cobb angle ($\alpha$) measurement technique; $\alpha = 48.6$ degrees in this patient with CLSS
Measuring cervical cord atrophy in multiple sclerosis patients. A longitudinal MRI study

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Purpose
To quantify the cervical atrophy and longitudinal changes in patients with multiple sclerosis (MS), and evaluating its association with clinical disability and other magnetic resonance imaging (MRI) measures.

Materials and Methods
Thirty-one patients with primary progressive MS underwent three brain and cervical cord 1.5T MRI (baseline, 2 and 7 years), including proton density-, T2-, and T1-weighted sequences for brain study, and 3D T1 MPRAGE for cervical cord. The cervical cord was segmented between C1 and C5 using the spinal cord tool included in Jim 6.0 to evaluate the global cross-sectional area (CSA) and their normalized values at C2-C3, C3-C4 and C4-C5 levels. Annualized rates of normalized CSA loss, lesion load in T2, lesion load in T1, the brain parenchymal fraction (BPF) in each time point also were evaluated. EDSS was evaluated as the area under the curve of the values in each time point normalized by the maxima area (AUCNEDSS). Partial correlations controlled for age and sex were performed to evaluate the relationship between cervical cord measurements and radiological or clinical measurements.

Results
Normalized measures of CSA showed moderate significant correlations with AUCNEDSS between −0.4872 and −0.3717 (p<0.05). Annualized rates of normalized CSA loss showed significant correlations with baseline BPF (pyC23n versus BPF: r=−0.4514, p=0.014; pyC34n versus BPF: r=−0.4556; p=0.013), and with second year BPF (r=−0.3688, p=0.049) at C3-C4 level.

Conclusions
Results suggest that development of cervical cord atrophy is associated with increasing disability. Moreover, patients presenting larger baseline BPF seem to show a greater tendency for future spinal cord atrophy development at some cervical levels.
Patient reported outcomes and clinical success of symptomatic percutaneous lumbar facet synovial cyst rupture at various time points

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Purpose
Evaluate patient reported outcomes and clinical success of percutaneous CT rupture of lumbar facet synovial cysts (LFSCs).

Materials and Methods
Patient reported outcomes were evaluated using the Patient Visual Analog Scale (PVAS), the Oswestry Low Back Pain and SF-12 questionnaires. Results were obtained on the day of the procedure, at 1 week, 1 month and 6 months postprocedure in symptomatic patients who underwent a LFSC rupture. Additional objective data points obtained were need for repeat rupture, surgical intervention and need for narcotic pain medication prescription as reported by patients on the questionnaire.

Results
Seventy percent of patients completed the 6-month follow-up questionnaire. Preliminary results demonstrate the average percent of disability decreased from 36 (moderate disability on the Oswestry scale) to 19 (minimal disability on the Oswestry scale). SF-12 Physical and Mental Health Composite Scores (PCS & MCS) were computed using the scores of 12 questions and range from 0 to 100, where a zero score indicates the lowest level of health measured by the scales and 100 indicates the highest level of health. The average SF-12 PCS scores increased from approximately 31 to 38 and the average SF-12 MCS scores increased from approximately 52 to 55 without correcting for age-specific mean differences.

Conclusions
In patients with symptomatic LFSC, a percutaneous rupture can decrease their radicular pain and resultant morbidity as scored by the Pain Visual Analog Scale, Oswestry Low Back Disability and SF-12 questionnaires. As we gather additional responses from patients, additional data points to be included are need for repeat procedure, surgical intervention and need for narcotic pain medication prescription as reported by patients on the questionnaires.
Pattern of muscle involvement in GNE myopathy

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Purpose
GNE myopathy is an autosomal recessive disease caused by mutations in UDP N-acetylglucosamine 2-epimerase/N-acetylmannosamine kinase (GNE) gene. The disorder is typically characterized by adult onset symmetrical/asymmetrical foot drop progressing to involve the proximal muscles. Quadriceps generally are spared even in advanced stages.

Materials and Methods
Genetic confirmation of 17 patients was done by direct sequencing of coding exons 1 to 13 and >10 nucleotides of 5'and 3' intronic sequence. Alamut-Mutation software was used to predict pathogenicity of novel variants. 1.5T AERA MR scanner was used for evaluating 37 muscles on each side. T1-W images were obtained to look for
degree of fibro fatty replacement (Mercuri score) and T2-W STIR for myoedema (Borsato et al).

Results
We examined 17 patients, 16 of them were ambulant. At the time of evaluation the mean duration of illness was 7.2 SD ±6.0 years. The mean age at presentation was 34.1 SD ± 7.1 years and age at onset: 27.0 SD ± 6.3 years. Thirteen patients carried one copy of p.Val727Met mutation in exon 12. Nine patients had novel mutation. Magnetic resonance imaging (MRI) showed severe involvement of Biceps femoris (short head), Gluteus minimus, Tibialis anterior, Extensor hallucis and digitorum longus with moderate involvement of Adductors, Hamstrings, Sartorius, medial Gastrocnemius, Tensor fascia lata which was consistent even in early stages by MRI in typical and atypical presentations also.

Conclusions
High frequency of p.Val727Met mutation is predominant among Indians. Nine new mutations were deciphered. This study also provides the base for using MRI as important tool for diagnosis of clinically suspected cases.

eP-208 6:30AM - 2:45PM

Retrocardiac-Gated Phase Contrast Cine Flow Time Curves in Cervical, Thoracic and Lumbar Regions of Normal Volunteers: Evidence of Spinal Canal Sources and Sinks

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Purpose
The origins of recumbent cerebrospinal fluid (CSF) pulsations in the spinal canal have been debated (1-5). We have used high temporal resolution retrocardiac-gated MR cine flow imaging in human volunteers to correlate through-plane CSF flow at C1-L2 with flow in major arteries and veins.

Materials and Methods
After IRB approval, five healthy volunteers ages 23 – 46 years were scanned. Scanner parameters: External retrocardiac-gated, 3T (Siemens Skyra), TE/TR=6/60ms, flip angle=70, slice thickness=6mm, FOV=160mm, 20 phases over single cardiac cycle). VENCs customized to 5-20cm/s to avoid aliasing. Transverse scans at C1, C4, T1, T7 and L2. Data were analyzed with custom software based on Matlab. The mean flow, velocity, region of interest (ROI) areas were measured at each cine timepoint for the CSF, arterial (descending aorta, CCA, ICA and vertebral) and venous flow (IJ and IVC).
Results
Average mean flow decreased craniocaudally at each time point (Fig.). In diastole, this flow variation was directly proportional to cross-sectional area and length of cord below the level. This finding was less consistent in systole, where T7 was the greatest outlier. At C1, CSF and ICA correlation was .95 in both systole and diastole, but dropped to 0.64 systole and 0.4 diastole at L2 (table). Interestingly, CSF flow at T7 and L2 were better correlated with the aorta during systole, but uncorrelated in diastole. L2 in diastole demonstrated low correlation with all arteries and veins. 
Conclusions
Accounting for diastolic flow reversal, recent publications and the minute pressure differences occurring in CSF during the cardiac cycle, the data support a multicomponent model for the generation of CSF flow pulsations, whereby transmittance of fluid from the cranium into the spinal canal appears supplemented by fluid, possibly arising from the interstitium, along the length of the cord, especially during diastole.

(Filename: TCT_eP-208_Slide2.jpg)

eP-204
6:30AM - 2:45PM
Role of Spinal Diffusion Tensor Imaging in Predicting Post-Operative Outcome in Cervical Spondylotic Myelopathy: A Systematic Review
Purpose
To perform a systematic review evaluating the diagnostic ability of diffusion tensor imaging (DTI) in cervical spondylotic myelopathy (CSM) and its ability to predict postoperative outcome.

Materials and Methods
A systematic PubMed search adherent to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines included clinical studies using DTI in adults undergoing operative management for CSM from 1990 to 2015. Data on pre-operative clinical status, DTI [fractional anisotropy (FA), fiber tractography ratio (FTR), apparent diffusion coefficient (ADC)], and postoperative clinical outcomes were abstracted. Modified Japanese Outcome Assessment (mJOA) and Nurick scale were used to assess myelopathy severity. Short Form-36 (SF-36) and Neck Disability Index (NDI) assessed pain and function. Mean differences in pre-operative FA and ADC between cases and controls were compared.

Results
Six of 562 studies were eligible for detailed review: 112 patients with CSM and 45 healthy controls. Seventy-three (59.8%) CSM patients underwent operative management with mean follow-up time 269.9 (standard deviation 67.7) days. Fractional anisotropy at the level of maximal compression had strong negative correlation with postoperative NDI scores; higher FA was associated with improved function level (rho=-0.61, p=0.04). Pre-operative FTR had a strong positive correlation with postoperative recovery rate (rho=0.6066, p=0.0046); FTR < 60% correlated with recovery rate of < 40%. There was a trend for postoperative FTR to correlate with postoperative JOA scores, but this did not reach significance (r=0.3732, p=0.0526).

Conclusions
1. Diffusion tensor imaging may be a valuable tool in diagnosing patients with CSM, identifying patients in need of surgical decompression, and predicting postoperative outcome (Level 3 Evidence Recommendations). 2. Variability in imaging and outcomes evaluation protocols is high. Future prospective studies are required for choosing optimal DTI parameters, anatomical levels, and acquisition techniques.
SPINAL ANGIOGRAPHIC FEATURES AND ENDOVASCULAR MANAGEMENT OF SPINAL VASCULAR MALFORMATIONS

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Purpose
The purpose of this study was to assess the angiographic characteristics, types of spinal vascular malformations that were investigated and endovascularly treated at a single-center database.
Materials and Methods
Between January 2010 and November 2012, 30 consecutive patients were evaluated at our institution with spinal angiography in patients with suspected spinal vascular malformation based on clinical and radiological findings. Five were females and 27 were males between the ages of 10 and 65 years (mean, 29.5 years). We reviewed the charts of 12 SDAVF, 11 SPAVM, six PMF and one epidural fistula patients. For all patients, the following clinical data were collected: age, sex, symptoms, angiographic findings, type of treatment, complications, degree of angiographic obliteration, recurrence at follow up, and need for retreatment.

Results
Out of 12 SDAVF patients, therapeutic embolization was done in eight patients. NBCA was used in one case and onyx in seven cases. There was complete resolution of the AVF on angiograms in six out of seven cases using onyx. Out of 11 SPAVM patients, therapeutic embolization was done in four patients. Total obliteration was achieved in two patients, subtotal obliteration (tiny remnant) in one and partial obliteration in one patient. These patients were treated by onyx, Glue and Gel foam slurry respectively. Out of six PMF patients, two patients underwent embolization procedure. In both cases, there was complete resolution of the AVF on angiograms. Partial obliteration was achieved by using PVA particles in a single patient of epidural fistula. Neurological morbidity occurred transiently after two procedures. During follow up, two recurrences were detected.

Conclusions
The current range of catheters and microcatheters and the range of embolic agents have contributed to a considerable role for neurointervention in the treatment of spinal vascular malformations. Endovascular treatment of spinal vascular malformations is safe and effective with low permanent morbidity; however, attention must be paid to the technical nuances of and indications for its use to avoid potential complications. A complete understanding of the spinal arterial anatomy is a vital first step to define the type of vascular malformation and thereby to decide about the appropriate therapy.

eP-205
6:30AM - 2:45PM

Spinal Cord Schistosomiasis. MRI Findings

A DUBLIN
UCDAVIS MEDICAL CENTER, SACRAMENTO, CA

Purpose
The imaging findings of spinal cord schistosomiasis will be presented, along with a review of the literature.
Materials and Methods
A 48-year-old female rafting guide with a history of exposure to water borne schistosomiasis developed leg weakness over several months.

Results
The typical pattern of spinal cord schistosomiasis was demonstrate by magnetic resonance imaging (MRI), with cord edema and cord nodular enhancement.

Conclusions
With the appropriate history, spinal cord nodular enhancement with edema should suggest parasitic disease such as schistosomiasis.
Strategies to Optimize Percutaneous Vertebral Body PMMA Augmentation of Lytic Metastasis to Prevent or Minimize Post Kyphoplasty Refracture

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Purpose
Percutaneous balloon kyphoplasty can be quite effective in controlling the mechanical pain associated with vertebral body collapse deformities secondary to metastatic disease. However, patients with large lytic metastasis often have incomplete filling of the vertebral body with the PMMA. This incomplete filling of the vertebral body, potentially allows for further vertebral body collapse, recurrent pain and increased instability, possibly requiring more invasive intervention; surgical stabilization. The
potential for further fracture is complicated by high dose image-guided radiation therapy which also is associated with an increased risk of fracture or fracture progression. By increasing the amount of PMMA infused into pathologically collapsed vertebral body, ideally filling the vertebral body from superior to inferior endplate potentially can prevent any further collapse and the morbidity associated with progressive pathologic fractures.

Materials and Methods
We retrospectively reviewed patient’s with lytic spine metastasis and pathologic collapse deformities that underwent percutaneous balloon kyphoplasty in which the procedure was modified by repositioning the kyphoplasty guide needles to allow more complete filling of the vertebral body with PMMA and who either were treated previously with high dose image guided radiation therapy (IGRT) or had IGRT following the kyphoplasty, (N=12). All patients in this group were intraprocedurally determined to have inadequate filling of the collapsed vertebral body requiring repositioning of either one or both of the kyphoplasty guide needles, with or without the use of additional bone tamps to allow for complete opacification of the vertebral body with PMMA. The use of ipsilateral infusion of PMMA while the contralateral bone tamp remain inflated also was documented and evaluated. The vertebral bodies were assessed for completeness of filling, from endplate to endplate as well as for extraosseous extravasation of the PMMA. Follow up to assess degree progressive collapse also was analyzed.

Results
All patients had good PMMA augmentation of the lytic metastasis with reduction in the mechanical axial load pain. However two patients in which the PMMA did not extend to the endplates did collapse further down to the PMMA. The progressive collapse deformities in these patients remained but did not require any further stabilization.

Conclusions
Employing techniques that allow more complete filling of pathologic vertebral body collapse deformities secondary to lytic metastasis with PMMA may prevent or minimize the potential for further post percutaneous balloon kyphoplasty collapse deformity, potentially preventing any further intervention, surgical stabilization.

eP-203
6:30AM - 2:45PM

Use of Lower Back Pain Interventions in the Back pain Outcomes using Longitudinal Data (BOLD) Cohort

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Purpose
To describe initial 12-month usage of epidural steroid injections (ESI), facet injections, and facet medial branch radiofrequency ablations (RFA) in the back pain outcomes using longitudinal data (BOLD) registry.

Materials and Methods
This study included 4,612 of 5,239 total patients from BOLD that had complete 12-month electronic health record (EHR) data between 6/2011 and 6/2014. BOLD is comprised of older adults (age ≥ 65 years) presenting for a new low back pain (LBP) episode from three integrated health systems (1). Data sources: injections ascertained from the EHR and patient questionnaires [Roland-Morris Disability Questionnaire (RDQ), Brief Pain Inventory (BPI), Numerical Rating Scales (NRS) of average back and leg pain in past 7 days, Patient Health Questionnaire, (PHQ)-4 Depression and Anxiety screen, and the EQ5D]. Patients were assessed at baseline and 3, 6, and 12 months later. Occurrence of a procedure (ESI, Facet Injection, or RFA) was tabulated. Logistic regression examined predictors of receiving an 1) ESI or 2) facet injection/RFA. Covariates: age, gender, race, education, marital status, study site, symptom duration, back pain and health characteristics, and smoking status.

Results
Of 4,612 patients, there were 370 total injections received by 350 patients (mean procedures per patient 2.1, SD 1.6). Of those injections, 87.5% were ESI, 10.3% were facet injection, and 2.2% were RFA. Patients with longer symptom duration (1-5 years) (p=0.01) and those with leg pain or a leg pain diagnosis (p<0.001) are at higher risk of receiving an ESI but not facet injection/RFA. Those with worse RDQ, back pain NRS, and BPI were at higher risk for receiving both ESI and facet injection/RFA (Fig. 1).

Conclusions
1. BOLD registry patients tended to get ESI more often than facet injection or RFA. 2. Patients with worse baseline patient-reported outcomes were more likely to receive any procedure. 3. Patients with chronic leg pain were more likely to receive ESI, possibly reflecting the clinical indications for this procedure.
Utility of a Fast Screening MRI in Patients with Cervical Spine Trauma and a Negative CT

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Purpose
Trauma patients presenting to the emergency room with concern for cervical spine injury commonly receive a cervical spine computed tomography (CT) for their initial evaluation. If this CT is negative, but the patient has high risk factors, such as age 65 or greater, dangerous mechanism of injury, paresthesias in the extremities, or obtundation, magnetic resonance imaging (MRI) should be performed. In some cases, the physicians will order the MRI in the absence of these features. The purpose of this study is to demonstrate that for patients with negative CT cervical spine and absence of high risk features, an abbreviated MRI protocol consisting of only sagittal STIR and axial T2 sequences can identify all significant injuries.

Materials and Methods
Sequential patients with negative CT cervical spine, who went on to MRI and lacked high risk criteria, as determined by the medical record, were selected. Additionally, the patients must be alert and have no neurologic symptoms. Magnetic resonance imaging cervical spine also had to be performed within 72 hours of the initial CT examination. One hundred patients were selected for the study. Two board certified radiologists with a certificate of added qualification in neuroradiology retrospectively evaluated the MRI studies. The radiologists were blinded to the history, as well as prior and subsequent studies. They reviewed only the sagittal STIR and axial T2-weighted images and recorded all findings. Two weeks later, the same MRI studies were reviewed utilizing all sequences (Sagittal T2, Sagittal STIR, Sagittal T1, Axial T2, Axial T1) recording all findings. Findings were categorized as follows: Significant injury (defined as requiring treatment and subcategorized as requiring surgical or conservative treatment), insignificant injury (defined as needing no treatment), and negative.

Results
In our initial 17 cases, neither reader found any new findings on the full MRI study that were not identified on the abbreviated protocol. With the exception of one case, all positive findings on the MRI, nine of 17 (53%) were categorized as insignificant findings. These included: interspinous ligamentous edema, dorsal cervical muscular edema, nuchal edema, or prevertebral edema. Seven of 17 (41%) were negative for traumatic injury. Using the Fast MR protocol, both readers identified one case with intervertebral disk injury, ALL injury, prevertebral edema, and interspinous ligament injury. Retrospective review of the CT study demonstrated abnormal findings, which were missed on the initial interpretation.

Conclusions
An abbreviated Fast MR cervical spine examination consisting of only a sagittal STIR and an axial T2 is sufficient to characterize all significant injuries in trauma patients with negative CT of the cervical spine and absence of high risk features. Eliminating unnecessary sequences significantly decreases imaging acquisition time, improving
through-put. Scanner time is precious, and with fast screening protocols, this time saved can be used for patients with significant pathology who require a full MRI evaluation.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall A

Printed Poster (P) - Adult Brain
P-04
6:30AM - 2:45PM

2-Hydroxyglutarate Detection by Magnetic Resonance Spectroscopy in Isocitrate Dehydrogenase-Mutated Glioma Patients

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Purpose
Mutations of the isocitrate dehydrogenase (IDH) 1 and 2 genes are major genetic alterations in human gliomas, and are known to have prognostic values. Recent reports have shown that noninvasive prediction of the IDH mutations using proton MR spectroscopy (MRS) is feasible through measurement of 2-hydroxyglutarate (2HG), which is an oncometabolite of the IDH mutations, but its clinical utility is not fully established. Our purpose was to test the feasibility of spectroscopic detection of IDH mutations in clinical scanners.

Materials and Methods
Thirty-six consecutive patients (mean age 63.3 years) with pathologically proven gliomas (5 diffuse astrocytomas, 2 oligodendrogliomas, and 29 glioblastomas) were prospectively included. For each tumor, IDH1 mutations were identified by immunohistochemical evaluations. For all patients, pre-operative MR examination was performed using a Philips 3T scanner. Proton MRS using an optimized single-voxel PRESS sequence (TR/TE=2000/97 ms) (1, 2) was performed before contrast injection. The MRS data were acquired over a voxel (2x2x2 cm³) placed within a solid component of the tumor. In addition, an unsuppressed water signal was acquired from the same voxel using a STEAM sequence (TR/TE/TM=20000/13/19 ms) for use as reference in the metabolite quantification. LCModel spectral fitting was performed using model spectra of metabolites calculated incorporating the PRESS volume
localization. The measured 2HG concentration was compared between the IDH wild-type and mutant groups using the Mann-Whitney U test. The receiver operating characteristic (ROC) analysis was used to obtain a cut-off value for the calculation of the sensitivity and specificity to predict IDH mutation.

Results
There were 25 IDH wild type and 11 IDH mutant tumors. The measured 2HG concentration was significantly higher in the IDH mutant tumors (mean 1.79 mM) than in the IDH wild type tumors (mean 1.09 mM) (P=0.005). With a cut-off value of 0.72 mM, the sensitivity and specificity to predict IDH mutation were 100% and 73.1%, respectively.

Conclusions
Our results confirmed that proton MR spectroscopy can detect 2HG in the human glioma with a high sensitivity, and helps predict IDH status pre-operatively.

(Filename: TCT_P-04_Fig1.jpg)

P-38
3D Texture Analyses of Quantitative Susceptibility Maps to Differentiate Alzheimer’s Disease from Cognitive Normal and Mild Cognitive Impairment

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Purpose
Quantitative susceptibility map (QSM) enables quantifying susceptibility-changing materials within a magnetic field. Texture analysis of MR images provides quantitative means for describing tissue properties and physiological and pathological stages in order to reveal overall information about the images that often is invisible to the naked eye. Texture analyses of Alzheimer disease (AD) previously have been run on 3D T1-weighted (T1-W) images, but not on QSM data. To investigate QSM textures in subjects with cognitive normal (CN), mild cognitive impairment (MCI), and AD and to compare the results with those of 3D T1-W images.

Materials and Methods
The study was approved by the local institutional review board, and informed consent was obtained from all subjects. The participants were 18 elderly CN, 18 MCI and 18 AD subjects. A fully first-order flow-compensated 3D gradient-echo (GE) sequence was run to obtain axial magnitudes and phase images and to produce QSM data. Sagittal structural 3D T1-W (3DT1-W) images also were obtained with the magnetization prepared rapid acquisition of GE sequence to obtain brain tissue images. To generate the QSMs, the magnitude and phase images acquired from the 3D GE sequences were processed further using morphology enabled dipole inversion (MEDI). The first and second ordered texture parameters of the QSMs and 3DT1-W images were obtained using MaZda software (http://www.eletel.p.lodz.pl/programy/mazda/, Lodz, Poland) to evaluate group differences using a one-way analysis of covariance.

Results
Figures 1 and 2 show results of the first order texture analysis of QSM (Fig. 1) and the 3 dimensional T1-weighted (3DT1-W) (Fig. 2). For the first-order QSM analysis, mean, standard deviation (SD) and covariance of signal intensity (COVSI) separated the three subject groups (F = 5.191, p = 0.009). For the 3DT1-W images, the means showed no significant differences among the three subject groups (p > 0.07). However, the SD and COVSI showed a significant difference between the subject groups. For the second order QSM textures, AngScMom, contrast, correlation and DifVarnc showed significant differences among the groups. In contrast, for the second order 3DT1-W image texture, AngScMom, entropy, InvDfMom and SumEntrp showed significant differences.
Conclusions
This was the first and the only study to evaluate the textures of QSMs in AD. Mild cognitive impairment (MCI) was better characterized by the QSM textures, which displayed more consistent transitions from CN and AD than did the 3DT1-W images. WM QSM means and COVSIs successfully differentiated MCI from CN and AD from CN.

(Filename: TCT_P-38_Figure1.jpg)
Assessment of the Inferior Petrosal Sinus on T1-Weighted Contrast-Enhanced MRI
Purpose
Evaluation of the target anatomy is crucial during the preprocedural planning stages of any image-guided intervention. In the case of inferior petrosal sinus sampling, accurate characterization of the size and course of the inferior petrosal sinus as well as the neighboring venous structures is crucial to ensure safe and effective intervention. Previous studies have focused on the efficacy of multidetector CT data to evaluate these structures. Due to the likelihood of obtaining MR imaging of the brain during the course of clinical evaluation for pathologies requiring inferior petrosal sinus (IPS) sampling, we believe that an analysis of magnetic resonance (MR) data may provide equally reliable information to help providers plan their interventions efficiently and safely.

Materials and Methods
Retrospective analysis of 60 randomly obtained cases of contrast-enhanced MR studies of the brain in adults revealed 45 studies with postcontrast axial T1-weighted images appropriate for analysis. Qualitative measurements were made regarding extent of visualization (graded as either 1-nonvisualized, 2-partially visualized, or 3-completely visualized) and anatomical variation in course (type A: coursing along the petrous ridge, type B: course entering the petrous ridge).

Results
Evaluation of a total of 45 cases resulted in an analysis of 90 inferior petrosal sinuses (45 left, 45 right). In terms of qualitative identification grading, approximately 52% of sinuses were grade 3, 40% were grade 2, and 7.8% were grade 1. In terms of variant type, approximately 82% were type A, and 18% per type B.

Conclusions
Our analysis indicates that approximately 90% of inferior petrosal sinuses were visualized either completely or partially, with less than 10% proving difficult to assess, demonstrating that MR imaging can be an effective tool for preprocedural planning.

P-08
6:30AM - 2:45PM

Brain Connectivity in Patients with Burning Mouth Syndrome revealed by Graph Theoretical Network Analysis

A Wada¹, O Abe¹, T Shizukuishi¹, Y Watanabe¹, J Kikuta¹, H Yamada¹, H Haradome¹, Y Imamura²
Purpose
Burning mouth syndrome (BMS) is one of the chronic pain disorders with idiopathic burning discomfort or pain affecting with clinically normal oral mucosa, in whom a medical or dental cause has been excluded. The objective of this study was to perform network analysis in BMS base on a brain connectome method.

Materials and Methods
We compared 14 BMS to 14 matched healthy controls (HC). All MR imaging was performed by 1.5T MR unit (Achieva; Philips Medical Systems) with 8-channel phased-array head coil. The brain connectome was calculated by using connectome mapper (http://www.cmtk.org/mapper/) through probabilistic connectivity by 60 axis diffusion tensor imaging and 3D T1- and T2-weighted imaging. The structural connectivity in 83 anatomically defined regions of interest was analyzed by graph theory regarding group differences in regional connectivity and network graph properties. We estimated nodal degree (ND), clustering coefficient (CC), local efficacy (LE) and betweenness centrality (BC) as regional measures and global efficiency (GE) as a global network measure.

Results
Burning mouth syndrome patients exhibited larger ND and lower CC and LE in bilateral rostral anterior cingulate than HC. Significant difference of structural connectivity was recognized between rostral anterior cingulate and prefrontal cortex (p < .05). Global efficiency was not different between MBS patients and HC.

Conclusions
Our results suggest local network disturbance of BMS patients in anterior cingulate, prefrontal area associated with chronic neuropathic pain and psychogenic condition.
Brain Structural White Matter Changes Related to Type-2 Diabetes Disease Duration in African Americans: A TBSS Study

N Bahrami1, J Divers2, J Xu3, Y Jung4, B Freedman3, J Maldjian5, C Whitlow6

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Purpose
The purpose of this study was to characterize the relationship between type 2 diabetes (T2D) disease duration and cerebral white matter (WM) microstructural integrity using diffusion tensor imaging (DTI) in the understudied African American population. We hypothesized that longer T2D disease duration would be associated with a more extensive pattern of lower fractional anisotropy (FA).

Materials and Methods
African American's with T2D were recruited as part of the IRB approved African-American Diabetes Heart Study MIND (AA-DHS MIND) study. We included 413 participants in our analysis who had hemoglobin A1C (HA1C) measures. Magnetic
resonance imaging (MRI) including T1-weighted imaging and DTI was performed on a 3T Siemens Skyra with a high resolution 20 channel head/neck coil, using a 2D single-shot EPI diffusion sequence (2.2 x 2.2 x 3 mm; 15 diffusion directions; b=1000/2000). To evaluate WM microstructural integrity, voxel-wise analyses of the DTI data were carried out using tract-based spatial statistics (TBSS) in FSL (1). Nonlinear registration aligned all FA images to a 1x1x1mm standard space template, with the FMRIB58_FA standard-space image used as the target. A mean WM tract skeleton was constructed using FA from all subjects at a threshold for inclusion set at FA ≥ 0.2 in order to suppress areas with extremely low mean FA, and to exclude regions with substantial inter-individual variability. Whole brain average of skeletonized FA was computed for each subject using FSL. Jackknife technique for outlier detection revealed 29 outliers, who were removed prior to statistical analysis. Linear regression was conducted to characterize the relationship between whole brain skeletonized FA and the duration of disease (in years) using the 'randomize' function from FSL. BMI, sex, hypertension, education, HA1C, and age were used as covariates.

Results
There was a statistically significant linear relationship between whole brain FA (mean = 0.409, STD = 0.021) and duration of T2D (mean = 13.2 year, STD = 7.8 years), such that subjects with a longer duration of disease had lower FA (p = 0.0288, F = 17.7622, R2 = 0.2345). Figure 1 shows the areas of decreased FA related to the duration of disease affecting the whole brain WM.

Conclusions
Our findings suggest that T2D affects the microstructural integrity of cerebral WM as a function of disease duration. These extensive effects on WM microstructural integrity may underlie cognitive effects of T2D, which also are known to vary as a function of disease duration.

Figure 1. TBSS results displayed across all patients. Significant voxels are color coded and overlaid on a WM skeleton with dark red voxels representing threshold free cluster enhancement (TFCE) corrected p < 0.05 and light yellow voxels representing threshold free cluster enhancement p < 0.001. Images are shown in radiologic convention (left = subject’s right). Clusters of voxels containing significant FA (corrected p ≤ 0.05) in all patients related to their disease duration identified by TBSS.
Cerebral Vascular Territory Atlases Using Arterial Spin Labeling: An Analysis of Variation Among Normal Populations

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Purpose
Arterial spin labeling (ASL) is a magnetic resonance imaging (MRI) technique by which perfusion is noninvasively measured using arterial water as a freely diffusable tracer. One exciting clinical application of ASL is perfusion territory mapping. Previous studies have focused on small sample sizes or small age ranges. This study aims to characterize perfusion territory variation in normal populations, specifically as a function of age, sex, or race. We implement a novel vessel encoded-ASL (VE-ASL) technique that allows for the generation of territory maps without operator intervention or the use of complicated algorithms.

Materials and Methods
Images were acquired on a 3T Siemens Skyra scanner. Territory maps were obtained with Fourier encoded ASL scans. All data underwent spatial brain normalization to the Montreal Neurological Institute brain template using statistical parametric mapping. One hundred one subjects without indication of neurological disease were placed into groups based on age [old (n=39) and young (n=62)], sex [male (n=31) and female (n = 70)], and race [black (n=22) and white (n=68)]. Age groups were divided at 25 years of age. Territory maps of the four major arteries feeding the brain, the left and right internal carotid arteries (LICA, RICA) and vertebral arteries (LVA, RVA), were generated. Right vertebral arteries and LVA territories were combined to form one basilar artery (BA) territory. Per voxel probabilistic territory maps then were computed. Statistics involved regression analysis and a per voxel Fisher's exact test for all groups. "P-value maps" were generated by plotting p-values of 0.05 or less.

Results
Regression analysis of territory size and age showed a negative correlation between age and BA territory size, a positive correlation between age and LICA territory size, and no correlation between age and RICA territory size (see Fig. A). Per voxel analysis with Fisher exact tests revealed significant territory differences in age and sex groups, but not in race groups (see Fig. C). In older subjects there was: (1) diminished posterior territory size, which localized to the hippocampus and cuneus; and (2) a
small region of variation anteriorly at the border of anterior and middle cerebral arteries. In female subjects there was: (1) higher probability of collateral blood flow anteriorly, specifically left to right; and (2) a small region of variation posteriorly at the border of posterior and middle cerebral arteries.

Conclusions
Findings suggest that posterior circulation becomes less robust with aging while anterior circulation, most commonly the LICA territory, becomes relatively more robust. Additionally, areas of significant difference suggest underlying vascular or brain matter changes in aging and innate differences between sexes. In general, this study demonstrates the utility of this novel method of vessel encoded-ASL. Future work includes comparing normal populations to those with pathologic processes such as stroke, carotid artery stenosis, or vascular malformations.
A. Table of regression analysis results for age groups. B. Example probabilistic maps: left, old age group; right, young age group; 1, RICA; 2, LICA; 3, BA. C. Map showing an example region of significance in age group analysis.
Characterization of Primary Central Nervous System Lymphoma Using Arterial Spin Labeling Imaging

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Purpose
While perfusion features of primary central nervous system lymphoma (PCNSL) have been well documented with dynamic susceptibility contrast imaging, they remain less defined on arterial spin labeling (ASL) imaging (1-4). Our purpose is to describe the presentation of PCNSL on arterial spin labeling (ASL).

Materials and Methods
In this IRB-approved retrospective study, we identified 11 patients with biopsy-proven PCNSL brain lesions between January 2010 and January 2015 who also had magnetic resonance imaging (MRI) with ASL and T1-weighted postgadolinium images. Lesions greater than 1 cm (n=15) were assessed. Two blinded neuroradiologists independently drew regions of interest (ROIs) around each lesion on the postprocessed ASL map to obtain the cerebral blood flow (CBFPCNSL) value. Cerebral blood flow also was normalized for each lesion by drawing an ROI in a corresponding area in the contralateral hemisphere (CBFcont) and subsequently obtaining CBFPCNSL/CBFcont ratios. Inter-rater reliability was calculated.

Results
For each lesion, we evaluated size, location, and CBF (mean and normalized values). The raters agreed on the location of all lesions (5 deep gray matter, 4 deep white matter, 4 superficial cortical, and 2 cerebellar). For rater 1, the mean lesion size was 27.8 ± 14.3 mm, mean CBFPCNSL was 55.0 ± 21.9 mL/100g/min, mean CBFcont was 39.8 ± 16.2 mL/100g/min, and normalized CBF (CBFPCNSL/CBFcont) was 1.4, 95% CI (1.23-1.62). For rater 2, the mean lesion size was 33.3 ± 16.0 mm, mean CBFPCNSL was 54.2 ± 23.1 mm, mean CBFcont was 40.9 ± 16.2 mL/100g/min, and CBFPCNSL/CBFcont was 1.35, 95% CI (1.12-1.57). The inter-rater reliability as calculated by Pearson coefficient was as follows: (p < 0.01): R(lesion size)=0.94, R(CBFPCNSL)=0.99, and R(CBFcont)=0.95, and R(CBFPCNSL/CBFcont)=0.67.

Conclusions
Although PCNSL presents variably on ASL imaging and there is considerable overlap with signal in normal contralateral brain, CBF of tumor lesions is overall mildly
increased when compared to normal contralateral brain. There is high inter-rater reliability in evaluating CBF of PCNSL lesions using ASL, and this potentially may be a useful tool for diagnosis and characterization of these lesions.

P-20

Chondrosarcoma of the Head and Neck

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Purpose
Chondrosarcomas account for 15% of all primary malignant bone tumors. Most chondrosarcomas arise from the iliac wing, femur or proximal humerus. Chondrosarcomas of the head and neck constitutes 4% of all chondrosarcomas (Inwards, 2007) and are as such extremely rare. According to National Cancer Data Base, only 0.1% of head and neck cancers are chondrosarcomas. Among these, 48% arise from bony structures, 23% from larygotracheal structures, 12% from sinonasal structures and 11% from soft tissues (Koch, 2000). Presenting symptom depends on the structure involved by the tumor. We will report eight cases of chondrosarcomas involving different locations of the head and neck. Understanding the imaging features of these tumors will aid in early diagnosis and preoperative planning.

Materials and Methods
Eight cases of pathologically proven chondrosarcomas of the head and neck were reviewed retrospectively. The distribution of cases are as follows: two cases involve the petrous bone, one case involves the sinonasal cavity, one case involves the maxilla and four cases arise from the larynx. Patient's age ranges from 18 to 50 years old. Computed tomography (CT) and magnetic resonance imaging (MRI) features of these tumors will be reviewed.

Results
Chondrosarcomas of the head and neck appear as lytic expansile masses variably containing foci of calcification on CT. On MRI, the findings are nonspecific with the lesions appearing T1 hypointense and T2 hyperintense with contrast enhancement. The two cases of chondrosarcomas of the petrous bone present as lytic expansile masses involving the petrous apex and extending to the petroclival synchondrosis with destruction of the petrous carotid canal. There also is involvement of cranial nerve VI. The case of sinonasal chondrosarcoma presents as an expansile soft tissue mass centered in the sphenoid sinus extending superiorly to the anterior cranial fossa and eroding the anterior sphenoid body, nasal cavity and right anterosuperior aspect of the
clivus with mass effect on the pituitary gland, pituitary stalk, optic chiasm and cisternal segments of both optic nerves. The case of chondrosarcoma of the maxilla presents as a bone lesion with an associated soft tissue mass involving the medial aspect of the maxilla, medial to the first maxillary molar tooth. The four cases of chondrosarcomas of the larynx all arise from the cricoid cartilage with cricoid cartilage erosion and airway obstruction.

Conclusions
Chondrosarcomas of the head and neck are uncommon. Characteristic imaging findings include soft tissue expansion with variable calcifications or ill-defined osteolytic lesion on CT. The MRI findings are nonspecific with the lesions appearing T1 hypointense and T2 hyperintense with contrast enhancement. Chondrosarcomas of the head and neck occur more often in younger patients than chondrosarcomas of other areas. Two of our cases are of patients younger than age 30. Surgical treatment for chondrosarcoma of the head and neck is challenging and understanding the imaging features of these tumors will aid in early diagnosis and preoperative planning.

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Clinical Application of High Resolution Intracranial Vessel Wall Magnetic Resonance (MR) Imaging for Stroke by Using 3 Dimensional MR Sequences

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Purpose
High resolution (HR) vessel wall imaging (VWI) has been introduced as an emerging and promising technique for evaluation of intracranial vasculopathies. We introduce the clinical experiences of HR VWI in patients with stroke by using 3D MR sequences.

Materials and Methods
We collected the imaging data of stroke patients who had been evaluated by HR VWI at pre or post-treated period. The protocol of HR MR VWI is as follows: 1) 3T MRI machine (Skyra: Siemens, Erlangen, Germany), 2) T2-weighted image, T1-weighted image and contrast (0.1 mmol/kg gadolinium)-enhanced T1 weighted image by isotropic 3D SPACE (sampling perfection with application optimized contrast using different angle evolutions) sequence with blood suppression; multiplanar reconstruction images from coronal acquisition data for middle cerebral artery and intracranial internal carotid artery and axial acquisition data for vertebrobasilar artery.

Results
We present the clinical cases of intracranial HR VWI for the evaluation of stroke as followed: 1) intracranial atherosclerotic disease, 2) dissection, 3) vasculitis, 4) moyamoya disease, 5) cerebral aneurysm, and 6) post-thrombolysis imaging.

Conclusions
Clinical application of 3D MR HR VWI can be expected to enhance the diagnostic performance of the evaluation of stroke and to help the understanding of intracranial vascular pathophysiology.

Comparison among 123I-FP-CIT SPECT, 123I-MIBG Scintigraphy and Neuromelanin MR Imaging to Assess the Severity of Lewy Body Disease Based on Hoehn and Yahr Scale and Unified Parkinson's Disease Rating Scale

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Purpose
To evaluate which is the best examination to assess the severity of Lewy body disease (LBD) based on Hoehn and Yahr (HY) scale and unified Parkinson's disease rating scale (UPDRS) among 123I-FP-CIT SPECT, 123I-MIBG scintigraphy and neuromelanin magnetic resonance imaging (NmMRI) by head-to-head comparison.

Materials and Methods
We retrospectively reviewed 15 patients with LBD who had been assessed the severity with HY scale and UPDRS and undergone 123I-FP-CIT SPECT, 123I-MIBG scintigraphy and NmMRI all for detailed examination of LBD. Bilateral striatal accumulation of 123I-FP-CIT was measured as specific binding ratio (SBR). Cardiac uptake of 123I-MIBG was measured as heart-to-mediastinum (H/M) ratios on early and delayed phases in planar images. Contrast ratios (CRs) of the outer and inner one-third of bilateral substantia nigra pars compacta were measured on NmMRI. Signal intensity of decussation of superior cerebellar peduncles also was measured as control for calculating CRs. We performed correlated analyses between the severity of LBD (HY scale and UPDRS motor score (Part III)) and SBR, H/M ratios and CRs.

Results
Coefficients of correlation between HY scale and SBR, H/M ratios and CRs were -0.30, -0.11 (early), -0.08 (delayed), 0.06 (outer one-third area) and 0.24 (inner one-third area), respectively. Coefficients of correlation between UPDRS-III and SBR, H/M ratios and CRs were -0.38, 0.32 (early), 0.40 (delayed), 0.46 (outer one-third area) and 0.46 (inner one-third area), respectively. The coefficient of correlation of SBR was superior to those of H/M ratios and CRs based on HY scale, and the coefficients of correlation of CRs were superior to those of SBR and H/M ratios based on UPDRS-III.

Conclusions
123I-FP-CIT SPECT is superior to 123I-MIBG scintigraphy and NmMRI based on HY scale, and NmMRI is superior to 123I-FP-CIT SPECT and 123I-MIBG scintigraphy based on UPDRS to assess the severity of LBD.

P-28
6:30AM - 2:45PM
Comparison of Chemical Exchange Saturation Transfer (CEST) Imaging and Relative Cerebral Blood Volume (CBV) Measurements in Differentiating Benign from Malignant Brain Tumors

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Purpose
Amide proton transfer (APT) imaging is a specific type of chemical exchange saturation transfer (CEST) imaging technique. Amide proton transfer imaging can be used in differentiating benign brain tumors from malignancies. The purpose of this study is to determine the comparability of APT imaging and cerebral blood volume (CBV) measurements in differentiating between benign and malignant brain tumors for the pre-operative staging of brain tumors and between treatment-related changes and true recurrences.

Materials and Methods
Twenty-two patients (14 women, 8 men; mean age 50.2 years) with enhancing brain masses underwent both APT imaging and CBV measurements. Sixteen patients were newly diagnosed as brain tumors and six patients were with newly developed enhancing lesions after surgery and chemoradiation therapy. Amide proton transfer imaging and CBV measurements were assessed independently by two neuroradiologists blinded to patients' clinical information. Relative normalized ratios to the contralateral normal white matter were used for both relative APT (rAPT) and CBV (rCBV) measurements. Statistically, Mann-Whitney U-test and ROC curve analysis were used.

Results
Among 16 patients who were newly diagnosed brain tumors, mean rAPT of intratumoral areas of malignancies (n=12) and of benign lesions (n=4) were 1.61 and 1.21, respectively (p<0.01). Mean rCBV of intratumoral areas of malignancies and benign lesions were 4.37 and 1.53, respectively (p=0.025). The differences were statically significant on both studies. On ROC curve analysis, rAPT was superior to rCBV in differentiating benign brain tumors from malignant brain tumors (AUC 0.903 vs 0.857). In six patients with newly developed enhancing lesions after treatment, four came out as tumor recurrences, and two patients were revealed as radiation necrosis. All recurred lesions showed increased rAPT and rCBV (4.37 and 5.54, respectively). In two patients with proven radiation necrosis, rCBVs were increased, however rAPTs were not increased.

Conclusions
Amide proton transfer imaging detects increased amide proteins and peptides in malignant brain tumors. Amide proton transfer imaging could be used as a promising technique to differentiate malignant brain tumors from benign tumors.
Correlation of Callosoforniceal Distance and Intracranial Volume

S Zheng¹, N Alperin², R Riascos-Castaneda³
Purpose
To correlate callosoforniceal distance and intracranial volume in normal and hydrocephalic individuals.

Materials and Methods
Three dimensional T1-weighted isovolumetric 1mm slice acquisitions of eight normal and eight hydrocephalic brains were used. The distance between the inferior margin of the corpus callosum and the superior margin of fornix was measured at the mid thalamic level, angled parallel to the floor of the fourth ventricle. Two independent readers measured the distance. Correlation with volumetric analysis of the lateral ventricles was made.

Results
A positive linear regression relationship exists between lateral ventricular volume and callosoforniceal distance for normal group (r² = 0.96 versus 0.92, p < 0.05), hydrocephalus group (r² = 0.97 versus 0.97, p < 0.05), and combined group (r² = 0.96 versus 0.97, p < 0.05).

Conclusions
Callosoforniceal distance can be used as a sensitive, noninvasive, and quick-to-measure index of intracranial volume. Further correlation with a larger sample size is needed.

P-49
6:30AM - 2:45PM

Detection of Acute Subarachnoid and Intraventricular Hemorrhage Using 3T MRI: Comparison of FLAIR Vs T2*-GRE

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Purpose
Although recently several investigators report magnetic resonance imaging (MRI) can detect acute subarachnoid hemorrhage (SAH) and intraventricular hemorrhage (IVH), the accuracy of MRI for the detection of acute SAH and IVH still is a matter of debate. And all previous reports about SAH were studied in 1.5T or low field strength MR units. FLAIR image is the best sequence that detects acute and subacute SAH and IVH in 1.5T MR unit. Is FLAIR imaging highly sensitive for acute SAH and IVH in 3T MR unit? We hypothesized that T2*-GRE sequence is more sensitive in detection of SAH and IVH, compared to FLAIR sequence in 3T MRI.
Materials and Methods
We compared MR images from 46 SAH patients (mean age, 53 years) and 73 normal control (mean age, 52 years) subjects. Forty-six patients confirmed SAH by CT that served as the gold standard. Among 46 patients, 20 patients had IVH in lateral ventricle. The interval between CT and MR examination was less than 5 hours (mean, 123 minutes). In SAH and IVH group, all MR images were performed within the first 12 hours after symptom onset (mean, 268 minutes). Seventy-three selected normal control cases had no neurological symptom. One experienced neuroradiologist, one neuroradiology fellow and two-year grade resident of radiology, unaware of clinical details, separately evaluated sets of GRE T2*-weighted and FLAIR images. The presence and location of SAH on MRI were assessed separately. One experienced neuroradiologist evaluated presence of IVH in lateral ventricle using sets of FLAIR and T2*-GRE images respectively.

Results
In SAH group, all readers identified SAH with 100% sensitivity (confidence interval 90.4 to 100) and 100% overall accuracy. FLAIR and T2*-GRE images had the same sensitivity and specificity in detecting SAH. The experienced and fellow readers had 100% specificity (confidence interval 93.8 to 100) and Kappa 1 (p=.000, 95% confidence interval), and the resident reader had 97.3% specificity (confidence interval 89.6 to 99.5) and Kappa 0.965 (p= .000, 95% confidence interval). In IVH group (n=20), however, FLAIR and T2*-GRE image had 45% and 100% sensitivity in detecting IVH separately.

Conclusions
At 3T, FLAIR image had decreased IVH detection rate for IVH, compared to that of T2*-GRE image. The cause may be due to relatively prominent shortening of T2 relaxation time of hemorrhagic component of IVH in 3T. T2*-GRE image is more useful imaging sequence for detection of IVH as compared with that of FLAIR in 3T MRI.

P-02
6:30AM - 2:45PM

Development of FDG Hypometabolism in Patients with Temporal Lobe Epilepsy and a Negative Brain MRI

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Purpose
\([18]F\) fluorodeoxyglucose positron emission tomography (FDG PET) brain scan is very valuable for epilepsy evaluation, especially for those patients with negative brain magnetic resonance imaging (MRI). This study aimed to identify a relationship
between the cumulative time a patient has been ictal throughout their lifetime with positivity on FDG PET scan and to suggest a threshold in which FDG PET may be of limited value.

Materials and Methods
Retrospective analysis was performed after identifying 38 patients with negative brain MRIs and concordant findings on electroencephalography (EEG) and brain FDG PET. Factors evaluated included sex of the subject, age of onset, epilepsy duration, seizure frequency, average timing of an ictal event, total number of seizures, cumulative time ictal, and the presence or absence of generalization.

Results
Patients with negative findings on brain FDG PET demonstrated a median of one seizure per month, 84 seizures over a lifetime, and a cumulative ictal time of 96 minutes. This difference is statistically significant when compared to the FDG PET positive group. The FDG PET positive group demonstrated a median of 15 seizures per month, 2520 seizures over a lifetime, and a cumulative ictal time of 2448 minutes (Wilcoxon test, p<0.003, p<0.0022, and p<0.0024). When maximizing the distinguishing power of fisher's exact test to the distribution of cumulative time ictal for both groups, most FDG PET positive patients (20) demonstrated a cumulative ictal time greater than 558 minutes. All FDG PET negative patients were below this threshold.

Conclusions
These results suggest that glucose hypometabolism on FDG PET is influenced by seizure frequency, total number of seizures, and cumulative time ictal. In a patient with a short cumulative ictal time, such as below 558 minutes, FDG PET may be of limited value as it is likely to be negative.

P-21
6:30AM - 2:45PM
Differentiation Between High Grade Gliomas and Metastasis or Lymphoma: The Usefulness of T2 Relaxation Time Differences at Peritumoral Regions

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Purpose
In high grade gliomas, high signal intensities but with intermediate level can be seen at the peritumoral areas. The peritumoral infiltration tendency of glioma is inferred to be a leading cause of this intermediate level signal intensity. We would like to differentiate between high grade gliomas and metastasis or lymphoma with using T2 relaxation time differences.
Materials and Methods
Twenty-six patients with gliomas (15 GBMs, four anaplastic astrocytomas, seven anaplastic oligodendrogial tumors), 12 patients with metastasis and seven patients lymphomas were included in our study. In each patient, T2 relaxation time maps with four slices centered at the mass were generated by using multiple repetitions of various echotimes technique. After co-registration with anatomical images, nonenhancing, peritumoral T2 high signal areas were segmented and whole voxels T2 relaxation times were captured. Histogram analysis was performed, and mean, median, mode, skewness and kurtosis were calculated. Comparisons between two groups were performed for various parameters.

Results
Of the parameters of the histogram analysis, the mode showed most significant results in differentiating them. The mean values of the modes were as follows: metastasis 317 msec, lymphoma 287 msec and high grade gliomas 217 msec. Significant differences between metastasis and gliomas, and lymphoma and gliomas were present (p=0.018 and p=0.047, respectively).

Conclusions
The presences of intermediate T2 high signals at peritumoral areas of gliomas are verified in comparison studies with the edematous T2 high signal intensities of brain metastasis and lymphoma. High grade gliomas, and metastasis and lymphoma can be stratified by using T2 relaxation times at peritumoral regions.

P-23
6:30AM - 2:45PM

Differentiation of Oligodendroglial Tumors from Non-Oligodendroglial Astrocytomas by Multiple Parameters Derived from Perfusion MRI

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Purpose
Differential diagnosis of oligodendroglial tumors (OTs) from nonoligodendroglial astrocytoma (NOAs) has become increasingly important with the recognition that OTs are sensitive to chemotherapy and have better prognosis. The purpose of this study was to investigate the perfusion parameters which could differentiate OTs from NOAs by perfusion magnetic resonance imaging (MRI) with dynamic contrast-enhanced (DCE) and dynamic susceptibility contrast (DSC) images.

Materials and Methods
Dynamic susceptibility contrast and DCE MR images in 86 patients (40 males and 46 females, mean age = 49.91 years, range = 16-82 years) with histologically confirmed
OTs (n=30) and NOAs (n=56) were reviewed retrospectively. Thirty patients with OTs included six oligodendrogliomas, 13 oligoastrocytomas, three anaplastic oligodendrogliomas and eight anaplastic oligoastrocytomas. Fifty-six NOAs encompassed nine diffuse astrocytomas, six anaplastic astrocytomas and 41 glioblastomas. On histogram analysis of DSC and DCE perfusion images, mean, 90 and 98 percentile values of nCBV, ktrans, AUC, Vp, and Ve were calculated and compared between two groups.

Results
The nCBV was not significantly different between OTs and NOAs. The mean and 90% value of ktrans, AUC, Vp and Ve from DCE were significantly higher in NOAs than OTs. Multivariate logistic regression analysis showed that 90% value of Vp was the only independent factor for differentiation. For the diagnostic performance, the mean value of Ve and ktrans showed the highest AUC of 0.70 and 0.69.

Conclusions
Dynamic contrast-enhanced MR imaging derived parameters could be helpful in the differentiation of oligodendroglial tumors from nonoligodendroglial astrocytomas.
Comparison of perfusion parameters between oligodendroglial and nonoligodendroglial tumors.

<table>
<thead>
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<th>Parameter</th>
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<th>NOT (n=56)</th>
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<td>nCBV90</td>
<td>3.66±1.1</td>
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<td>nCBV98</td>
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<tr>
<td>AUCmean</td>
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Discrimination of Patients with Clinically Isolated Syndromes and Healthy Controls using MRI Volumetry. Is it possible?

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Purpose
Identification of magnetic resonance imaging (MRI) volumetric measures with ability to discriminate accurately patients with clinically isolated syndromes (CIS) early after clinical disease onset and healthy volunteers.

Materials and Methods
One hundred sixty-seven patients with CIS and 80 healthy volunteers were examined. The 167 CIS patients were divided into two groups based on occurrence of a new relapse activity over 48 months. Within the group of CIS patients, we identified 80 patients with ongoing clinical disease activity and 87 clinically stable patients. Magnetic resonance imaging assessment included T1-weighted images 3D and FLAIR (fluid attenuated inversion recovery) and was performed within the 4 months after the first clinical symptoms. Magnetic resonance imaging volumetric analysis included assessment of brain parenchymal fraction (BPF), gray matter (GMF), white matter (WMF), corpus callosum (CCF) and thalamic (ThaF) fractions.

Results
Statistically significant differences in GMF, CCF and ThaF (p<0.01) were observed between the CIS patients (both groups) and healthy volunteers. The best accuracies for discrimination between CIS and healthy volunteers were found for CCF and ThaF (67%). Statistically significant difference in WMF was found between stable CIS patients and controls (p<0.01). We did not find any significant differences in MRI volumetric outcomes between clinically active and clinically stable CIS patients (all p>0.05).

Conclusions
Brain atrophy, especially of GM, thalamus and corpus callosum, can be observed already at the time of the first clinical event suggestive of multiple sclerosis (MS). This finding supports the hypothesis that neuro-inflammatory and neuro-degenerative processes precede occurrence of the first clinical symptoms of MS. Our observations
can potentially assist in diagnosis of MS, especially in cases when problems in differential diagnostics occur. However, further studies are needed to confirm our results. The SET study was supported by Czech Ministries of Education and Health (NT13237-4/2012, PRVOUK-P26/LF1/4, RVO-VFN64165/2012) and Biogen Idec. Funding for biostatistical support was provided by Novartis.

**P-40**

6:30AM - 2:45PM

**Effective Classification of Brain Tissues and White Matter Lesions Simultaneously from Multispectral MRI**

C Chen¹, H Chen², J Chai²

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Purpose

Accurate quantification of brain tissues (GM, WM and CSF) and white matter lesions (WMLs) is a neuroimaging problem. However, the brain tissues and white matter lesions can not be segmented simultaneously on these techniques of previous articles (1). A TRIO algorithm integrating three algorithms (ICA+SVM+IFLDA) has been proposed to effectively classify GM, WM and CSF from multispectral MRI in the native coordinate space (2). The aim of this study is to validate the modified TRIO algorithm, combined TRIO with band expansion process (BEP) algorithms (4), for classification of those brain tissues and WMLs simultaneously.

Materials and Methods

Synthetic data from the BrainWeb Database (3) were used to evaluate the accuracy of those brain tissues and WMLs classification by using the modified TRIO algorithm to analyze three sets of T1-WI, T2-WI and proton density images with three different noise levels of 0%, 3%, and 5%. In addition, we further demonstrate the utility of the modified TRIO algorithm in real MR brain images. The imaging protocol included three high-resolution 3D T1-WI, T2-WI and FLAIR images. In this experiment, we combined TRIO with the BEP (4) to resolve the problem of insufficient image information used for effective MRI classification.

Results

Accuracy assessment of the modified TRIO algorithm was performed by using the similarity index (2). The mean similarity of brain tissues and WMLs classification in synthetic MR images with noise levels of 0%, 3%, and 5% were 0.96, 0.93, and 0.92 separately. The classification results for CSF, GM, WM and WMLs in real MRI were shown in Figure.
Conclusions
This experimental results revealed clinical applicability of the modified TRIO algorithm in classification of GM, WM, CSF and WMLs simultaneously.

![Classification Results](TCT_P-40_Fig_classificationresults_r1.jpg)

P-24
6:30AM - 2:45PM

Elderly Patients with Newly Diagnosed Glioblastoma: Can Preoperative Imaging Descriptors Improve the Predictive Power of a Survival Model?

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¹Yonsei University College of Medicine, Seoul, Seoul, ²Yonsei University College of Medicine, Seoul, Korea, Republic of

Purpose
The purpose of this study was to identify independent prognostic factors among pre-operative imaging features in elderly glioblastoma patients and to evaluate whether these imaging features, in addition to clinical features, could enhance the predictive power of survival models.

Materials and Methods
This retrospective study included 108 patients ≥ 65 years of age with newly diagnosed glioblastoma. Pre-operative clinical features [age and Karnofsky Performance Status (KPS)], postoperative clinical features (extent of surgery and postoperative treatment), and pre-operative magnetic resonance imaging (MRI) features were assessed. Univariate and multivariate cox proportional hazards regression analyses for overall survival were performed. The integrated area under the receiver operating characteristic (ROC) curve (iAUC) was calculated to evaluate the added value of imaging features in the survival model.
Results
Eloquent area involvement, multifocality, and ependymal involvement on pre-operative MRI as well as clinical features including age, pre-operative KPS, extent of resection, and postoperative treatment were significantly associated with overall survival on univariate Cox regression. On multivariate analysis, extent of resection and ependymal involvement were independently associated with overall survival and pre-operative KPS showed borderline significance. The model with both pre-operative clinical and imaging features showed improved prediction of overall survival compared to the model with pre-operative clinical features (iAUC, 0.670 versus 0.600, difference 0.066, 95% CI = 0.021-0.121). The model with pre- and postoperative clinical and imaging features showed improved prognostic performance over the model including only clinical features (iAUC, 0.701 versus 0.676, difference 0.026, 95% CI = 0.03-0.06).

Conclusions
Pre-operative imaging features, including eloquent area involvement, multifocality, and ependymal involvement, in addition to clinical features, can improve the predictive power for overall survival in elderly glioblastoma patients.

TABLE. Preoperative prognostic models for overall survival in elderly glioblastoma patients

<table>
<thead>
<tr>
<th>Model 1: Clinical Model</th>
<th>HR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.050</td>
<td>1.007-1.096</td>
</tr>
<tr>
<td>Preoperative KPS</td>
<td>0.985</td>
<td>0.969-1.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 2: Clinical + Imaging Model</th>
<th>HR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.013</td>
<td>0.968-1.061</td>
</tr>
<tr>
<td>Preoperative KPS</td>
<td>0.981</td>
<td>0.965-0.998</td>
</tr>
<tr>
<td>Eloquent area involvement</td>
<td>1.575</td>
<td>1.012-2.454</td>
</tr>
<tr>
<td>Multifocality</td>
<td>1.682</td>
<td>0.980-2.885</td>
</tr>
<tr>
<td>Ependymal involvement</td>
<td>1.89</td>
<td>1.219-2.932</td>
</tr>
</tbody>
</table>

Note.— KPS = Karnofsky performance score.

(Filename: TCT_P-24_ASNR_Table.jpg)
Figure. Time-dependent ROC curve analysis for prediction of overall survival in glioblastoma patients with preoperative clinical features (Model 1), and preoperative clinical and imaging features (Model 2). (The integrated area under the receiver operating characteristic curve, 0.600 vs. 0.670, difference 0.066, 95% CI = 0.021-0.121.
Evaluation of Dynamic Contrast Enhanced MRI as an Early Indicator of Progression After Standard Therapy in Glioblastoma

A Trang¹, K Peck¹, X Lin¹, B Jung¹, R Young¹, A Holodny¹, J Arevalo-Perez¹, J Lyo¹
¹Memorial Sloan Kettering Cancer Center, New York, NY

Purpose
We aim to evaluate dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) as a biomarker for early detection of progression and hypothesize that DCE-MRI may have potential as an early predictor for progression of disease (POD) in glioblastoma patients compared to conventional MRI.

Materials and Methods
We identified 16 patients from 2011 to 2015 with: (1) newly diagnosed primary glioblastoma by histopathology; (2) gross or subtotal resection of tumor; (3) POD confirmed by pathology or change in chemotherapy; (4) at least three DCE-MRI scans prior to POD. Region of interest (ROI) was delineated by a neuroradiologist on the region of tumor enhancement within a single representative slice. The following quantitative data were calculated from the ROIs in the ipsilateral and contralateral hemisphere and assessed for inter-scan changes: (1) Ktrans; (2) blood plasma volume (Vp). A Friedman test was conducted between scans to obtain a Friedman Statistic (FS).

Results
Mean interval between subsequent scans is 57.94 days, with POD-1 representing first scan prior to POD, back to POD-3 representing third scan. The normalized mean Vp values for POD-1, POD-2, and POD-3 are 3.47, 2.20, and 2.05, respectively (Friedman's Statistic (FS) = 22.88, P < 0.0001). The normalized maximum Vp values for POD-1, POD-2, and POD-3 are 3.24, 1.86, and 1.40, respectively (FS = 18.00, P = 0.0001). The normalized mean Ktrans values for POD-1, POD-2, and POD-3 are 0.52, 0.34, and 0.59, respectively (FS = 0.50, P < 0.78). The normalized maximum Ktrans values for POD-1, POD-2, and POD-3 are 0.51, 0.09, and 0.51, respectively (FS = 1.13, P < 0.57).

Conclusions
Despite the limited sample size of our study, it's the first to longitudinally compare quantitative data from DCE-MRI in glioblastoma. Our analysis of the scans leading up to POD correlated with increasing Vp and suggests further investigation of DCE-MRI as a marker for progression is warranted.
Evaluation of fMRI Results in Patients with Epilepsy and Non-Dominant Language

Z Yetkin\textsuperscript{1}, L Yang\textsuperscript{1}, T O'Neil\textsuperscript{1}, D Mendelsohn\textsuperscript{1}

\textsuperscript{1}UT Southwestern, Dallas, TX

Purpose
The purpose is to evaluate the concordance of language lateralization between functional magnetic resonance imaging (fMRI) and Wada tests in patients with epilepsy and right sided language. Functional MRI has been used for presurgical assessment of language lateralization in the past decade. Recent studies have shown that fMRI results were concordant with Wada results in 76\% to 94\% of patients for typical language lateralization. The two techniques were discordant in 40\%-51\% of the patients for right-sided or bilateral language lateralization. The level of discordance was dependent upon multiple factors including subject variables, technical factors, and determination of laterality indices by either method, fMRI tasks and evaluation of the results.

Materials and Methods
Medical charts of patients with intractable epilepsy who underwent Wada and fMRI to evaluate language dominance were reviewed. Patients with right hemispheric language dominance as determined with Wada test were included. Data included demographics, intra-operative cortical mapping findings and outcomes of surgery. Functional MRI results were evaluated independent of the Wada results.

Results
Nine patients (7 male, 2 female, age range: 21-46 years) had right hemispheric language dominance as detected with Wada. Functional MRI protocol to evaluate language included category fluency and word generation tasks. Regions of activation in the inferior and middle frontal gyri, temporal and parietal lobes were included in the evaluation of laterality. Functional MRI showed concordant results in two patients who had bilateral language with right hemispheric dominance and left dominance with strong right language respectively, as detected with Wada.

Conclusions
The results of fMRI compared to Wada was concordant in all cases for both right-sided dominance and bilateral language with one hemispheric dominance. Significantly higher concordance compared to previous studies is likely due to multiple factors including patient selection and study design.
<table>
<thead>
<tr>
<th>Patient Age, Gender, Handedness</th>
<th>Risk factors</th>
<th>Age of onset, Duration of Epilepsy (years)</th>
<th>Scalp EEG ictal onset</th>
<th>Cortical mapping</th>
<th>Surgery</th>
<th>Pathology</th>
<th>Post op complications</th>
<th>Follow up</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>25, F RIGHT</td>
<td>Left posterior frontal and anterior parietal lobe encephalomalacia, likely related to prior infarct or trauma</td>
<td>birth/25</td>
<td>Can't differentiate between left temporal vs. frontal temporal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35, F LEFT</td>
<td>Febrile seizures, left mesial temporal sclerosis</td>
<td>13/22</td>
<td>Intertical Left occipital sharp and slow wave</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36, M RIGHT</td>
<td>Traumatic brain injury with resultant Post-traumatic encephalomalacia involving bilateral frontal lobes and left temporal, parietal, and occipital lobes.</td>
<td>2 months/36</td>
<td>Left temporal onset</td>
<td>Left temporal lobectomy</td>
<td>Mesial temporal sclerosis</td>
<td>None</td>
<td>Continues to be seizure free. Has mild memory impairment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46, M AN/BIDEXTEROUS</td>
<td>Brain MRI shows hyperintense F+AR signal within the left parieto-occipital lobe</td>
<td>16/30</td>
<td>Left anterior temporal lobe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25, M RIGHT</td>
<td>Meningitis at age 2 ½, and left-sided mesial temporal sclerosis</td>
<td>8/17</td>
<td>Left Temporoparieto-occipital</td>
<td>The mapping revealed an sensory in the posterior parietal at Grids 15A, 20, graphesthesia at 14 &amp; 19, and visual agnosia in the posterior temporal at Strip A2-3</td>
<td></td>
<td></td>
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<tr>
<td>32, M RIGHT</td>
<td>Cerebral palsy, left hemisphere porencephalic cyst/schizencephaly and large right fronto-temporal presumed glioma</td>
<td>7/23</td>
<td>Left mesial temporal</td>
<td>Left anterior temporal lobectomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33, M LEFT</td>
<td>Left fronto cavernous angioina.</td>
<td>5/23</td>
<td>No EEG change</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>32, F RIGHT</td>
<td>3 x 4 cm, non-enhancing mass in the left frontoparietal opercular region</td>
<td>14/18</td>
<td>No EEG change but presumed to be left frontal because of the</td>
<td>Left fronto cavernous angioina lesonectomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37, M LEFT</td>
<td>Head trauma after a car accident in 200L</td>
<td>N/A</td>
<td>Independent bitemporal (perhaps more on the left)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>19, F RIGHT</td>
<td>Cortical dysplasia</td>
<td>1.5</td>
<td></td>
<td>Left parietal resection</td>
<td></td>
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54th Annual Meeting & Foundation of the ASNR Symposium 2016
Evaluation of Multimodal MRI Techniques for Differentiating Between True Progression and Pseudo-Progression in Patients with Glioblastoma

V SAWLANI1, R Flintham1, H Poptani2, P Sanghera1, D Parashar3, N Davies1
1University Hospitals Birmingham, Birmingham, UK, 2University of Liverpool, Liverpool, UK, 3Warwick Medical school, Coventry, UK

Purpose

Background: Magnetic resonance imaging (MRI) is used routinely to assess response to chemo-radiotherapy for glioblastoma (GBM). However, distinguishing between treatment effects and disease progression based on standard MRI is difficult. The phenomenon of pseudo-progression (psP) mimicking true progression (tP) is well known in this context. Early accurate diagnosis of tP versus psP is essential to optimize treatment strategies and improve outcome. This feasibility study evaluates multimodal MRI (perfusion, diffusion and spectroscopy) for differentiating between tP and psP. Purpose: This work aims to develop early accurate assessment of treatment response in highly aggressive brain tumor using advanced MRI methods sensitive to tumor biology.

Materials and Methods

Twelve patients with GBM proven by histopathology following surgical resection underwent multimodal MRI using a Siemens Verio 3T scanner, including diffusion-weighted MRI, DSC-MRI and MR spectroscopy in addition to standard MRI at 4-6 weeks following completion of concurrent chemo-radiotherapy. Data were analysed using Olea and Tarquin software to obtain cerebral blood volume (CBV) and apparent diffusion coefficient (ADC) and choline (Cho), creatine (Cr) and N-acetyl-aspartate (NAA) concentrations within the contrast-enhancing lesion. Correlations between multimodal parameters, follow-up MRI and clinical status were investigated.

Results

Follow up suggested 4/10 cases of psP and 6/10 cases of tP at the first post-treatment scan. All six tP cases showed low ADC, high rCBV and high Cho/Cr and Cho/NAA consistent with expectations for tumor progression. There was no consistent pattern for cases of psP, with one case showing high ADC as expected but also high rCBV and Cho ratios.

Conclusions

This study confirms the feasibility of multimodal MRI in GBM within a clinical work-flow. A large two-center study is planned to test the hypothesis that high perfusion and metabolism and low ADC indicate tP.
Imaging Findings in Amyloid-Beta Related Angiitis (ABRA)

M Lacasse¹, A Geraldo¹, R Willinsky¹
¹University of Toronto, Toronto, Ontario

Purpose
Amyloid-beta related angiitis (ABRA) is a distinct entity in the cerebral amyloid angiopathy (CAA) spectrum, with imaging features closely related but often distinguishable from cerebral amyloid angiopathy related inflammation (CAA-RI) and primary angiitis of the central nervous system (PACNS). This pathology is not well documented in the radiologic literature. Awareness of this disease and recognition of its suggestive imaging features is essential in order to prompt early and proper treatment. The purpose of this article is to describe the magnetic resonance (MR) and angiographic imaging findings of ABRA.

Materials and Methods
We retrospectively reviewed the clinical data, imaging findings, pathological reports and outcomes of patients with biopsy-proven or imaging features suggestive of ABRA seen in our institutions, and performed a literature review.

Results
Five patients (3 women; mean age: 69.8 years old, range: 67-84 years old) were included in our case series. A biopsy was performed on three patients and confirmed ABRA in two by showing amyloid deposition within the vessel wall in combination with diffuse wall necrosis. The third biopsy showed an undetermined vasculitic process, currently under review by the pathologist. A biopsy was suggested for the other two patients, for which thorough investigations ruled out other possible diagnosis. Four patients presented with significant progressive cognitive decline and functional impairment. One patient presented with a more acute decline, becoming completely aphonie within months. On imaging, all patients showed chronic periventricular leukoencephalopathy and acute focal infarcts. Two patients presented with acute subarachnoid hemorrhage; two patients showed old parenchymal hemorrhages. On MR, four cases showed diffuse superficial siderosis. Diffuse leptomeningeal enhancement was identified in three cases. Vasculitic changes within the medium or small vessels were found in four of the patients, two on computed tomography angiogram (CTA), one on magnetic resonance angiogram (MRA), and one on digital substraction angiography (DSA). The patient not showing vasculitis did not undergo DSA. The patients were treated mainly with high-dose steroids. Two patients additionally received either cyclophosphamide or azathioprine. One patient died (secondary to untreatable myelodysplastic syndrome with normal cerebrospinal
fluid cytology), two patients improved on treatment, and one patient remained stable without treatment. The last patient was just recently diagnosed with probable ABRA.

Conclusions
Diffuse leptomeningeal enhancement, acute infarction, vasculitic changes in the distal leptomeningeal arteries and superficial siderosis are the main imaging findings in ABRA. Patients with ABRA typically are older than in PACNS, and present with a rapid cognitive decline. Amyloid-beta related angiitis has several overlapping features on imaging with CAA-RI and PACNS, and biopsy may be required to confirm the diagnosis. Early diagnosis with prompt initiation of immunosuppressive therapy may improve the patient's chances of recovery.

P-37
6:30AM - 2:45PM
Initial Evaluation of “Volume of Interest” Prototype Software for Cone-Beam CT Imaging - Phantom Study

M Hiramatsu1, K Sugiu1, T Yamauchi2, Y Takasugi1, T Yamaguchi2, H Onishi2, I Kojima3, C Dahmani3, S Nishihiro1, Y Shinji1, J Haruma1, T Hishikawa1, I Date1

1Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama, Japan, 2Okayama University Hospital, Okayama, Japan, 3Siemens Japan, Tokyo, Japan

Purpose
Cone-beam CT imaging has been used increasingly for the assessment of vessel structures and devices in endovascular procedures. However, long scan time increases radiation exposure. A new "Volume of Interest" cone-beam CT prototype software (VOI DynaCT) was developed to overcome this problem. The purpose of this study was to assess the reduction of radiation dose and the potential change of the image quality of VOI DynaCT images in comparison with conventional DynaCT.

Materials and Methods
First, we performed conventional 20 seconds DynaCT acquisitions as well as VOI DynaCT acquisitions (using a medium and a small fields of view) of a human body equivalent phantom equipped with glass dosimeters and we calculated the radiation dose absorbed by the eye lens. Second, we performed the same set of acquisitions using a human endovascular evaluator under injection of contrast medium into the aneurysm model treated with a stent and a coil. Then we assessed the image quality of vessel structures and devices in the acquired data sets.

Results
The radiation dose into eye lens exposed during VOI DynaCT acquisitions was on average 2.27mGy (medium field of view protocol) and 0.97mGy (small field of view protocol). On the other hand, that from conventional DynaCT was 22.49mGy. We
further observed and confirmed that the images quality of vessel structures and devices in the VOI DynaCT images was equivalent to that of standard DynaCT.

Conclusions
This study suggested that the VOI DynaCT prototype software could reduce radiation dose without changing image quality in comparison with conventional DynaCT.
VOI medium volume-rendering image

Conventional Dyna CT (70keV) volume-rendering image

VOI medium slab MIP image

Conventional Dyna CT slab MIP image
Intracranial Arterial Anatomic Variants: Prevalence by CT Angiography

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1P. Universidad Católica de Chile, Santiago, REGIÓN METROPOLITANA

Purpose
The purpose was to determine the prevalence of anatomical variants in the intracranial arterial circulation using computed tomography angiography (CTA). A secondary objective was to determine possible differences in the prevalence according to age and gender.

Materials and Methods
We did a retrospective research of CTA reported by the same neuroradiologist between January 1st and June 31st, 2014. We reviewed the images and the radiologist report, and compared them. In case of discrepancy, they were reviewed by a second neuroradiologist to get to an agreement. Only the anatomical variants in which CTA permitted a high level of diagnostic certainty were included. Patients with acute strokes and vascular pathologies altering the normal anatomy were excluded. For the estimation of prevalence of the anatomical variants we provide a point estimate and a confidence interval of 95%. To determine the differences according to gender and age we used Chi-square and Fisher exact test.

Results
One hundred fifty patients were included. Seventy-one patients had at least one anatomical variant (47.3%). The more prevalent variants were: fetal configuration of the posterior cerebral artery (20%), fenestration of the A1-A2 segment or anterior communicating artery (11.8%), extradural origin of the posterior inferior cerebellar artery (10.9%); among other 24 types of anatomical variants and anomalies. No significant differences were found according to age or gender.

Conclusions
There is a high prevalence of anatomical variants detected by CTA. In our population it is as frequent to find a patient with a circle of Willis without variants, as one with one or more variants. Computed tomography angiography provides an adequate and noninvasive characterization of the intracranial arterial circulation with the capacity to detect different types of vascular anomalies and variants.
Intracranial Glioblastoma Measurement: What Works? Volumetric Analysis or Volume Estimated from Linear Measurements?

A Sastry
1University Hospital Birmingham, Birmingham, United Kingdom

Purpose
Response assessment for glioblastoma (GBM) often is assessed using the RANO criteria based on linear measurements. However linear measurements may be an inaccurate reflection of volume for tumors with cystic necrotic elements or complex geometric shapes. Automated computer-assisted volumetric analysis may offer a more accurate assessment in such situations. This study explores the differences between linear and volumetric tumor measurements.

Materials and Methods
Twenty patients with heterogeneously enhancing tumors on postcontrast T1 volumetric magnetic resonance imaging (MRI) sequences were selected for this study. Spherical volume of GBM was estimated from 2D measurements (linear) by taking the average of two perpendicular diameters and estimating spherical volume (4/3πr³). Volumetric analysis was performed by manually contouring gadolinium-enhanced sections of tumor on Agfa PACS.

Results
Mean tumor volume was 13.19 cm³ and 10.06 cm³ using linear and volumetric techniques respectively. The nonparametric Wilcoxon signed-rank test (p=0.092) shows the distributions of 2D derived volume and volumetric analysis are different at the 10% significance level. The one-sided nonparametric sign test (p=0.05) shows the 2D derived volume is greater than volumetric analysis for 18 out of 20 observations.

Conclusions
Linear measurements can over estimate the volume of tumors compared to volumetric analysis. Measuring the change in volume may provide a more accurate assessment of response than conventional linear measurements used for existing RANO criteria, particularly for necrotic tumors. The benefit of volumetric analysis to assess response in GBM requires prospective validation. Integration of this technique into a prospective study will be discussed.

P-35
6:30AM - 2:45PM

Iterative Reconstruction (IR) Versus Filtered Back Projection (FBP) for Head CT Scanning: True Noise Reduction or “Just” a Smoothing Algorithm? What’s an Optimal IR/FBP Blend?

A Raza1, J Young1, R Gupta1, J Jones1, S Pomerantz1, M Lev1
Purpose
Iterative reconstruction (IR) is used increasingly to maintain image quality in otherwise noisy reduced-dose head CT protocols. The smooth appearance of IR images compared to filtered-back-projection (FBP) can generate concern that important high contrast resolution details are obscured, especially at higher IR strengths (% IR/FBP blends). Our purpose was to determine the IR strength that provides optimal balance between improved low-contrast resolution and preserved high-contrast spatial detail.

Materials and Methods
A standard ACR cylindrical CT-phantom was imaged on scanners from two vendors using our routine low-dose technique. Images were reconstructed using FBP and four different IR blends for vendor A (ASIR 30%, 50%, 70%, and 90%), and FBP and two different comparable IR blends for vendor B (SAFIRE 2 and 4). Contrast-to-noise ratio (CNR) and modulation-transfer-function (MTF) were calculated for single energy (SECT) and dual energy (DECT) protocols on each scanner, for each IR blend, at two different radiation doses.

Results
At CTDI ~30mGy, vendor A SECT-CNR was 0.9, 1.1, 1.3, 1.5, and 1.8 for FBP, ASIR 30, ASIR 50, ASIR 70, and ASIR 90, respectively (p<0.05). Vendor B SECT-CNR was 1.2, 1.4, and 1.8 for FBP, SAFIRE 2, and SAFIRE 4, respectively (p<0.05). The trend was similar for both vendors for DECT at CTDI~30mGy. SECT-MTF was 7.1 for all blends for vendor A and 7.0 for all blends for vendor B. CNR results at CTDI~40 mGy also were similar for both vendors. At CTDI~30mGy, DECT-MTF was 6.9, 6.8, and 6.7 for vendor B FBP, SAFIRE 2, and SAFIRE 4, respectively, and similar for CTDI~40mGy.

Conclusions
Iterative reconstruction of CT images from an ACR phantom, scanned using a low-dose head CT protocol, results in improved CNR with increasing IR strength, without significant change in MTF. Despite their smooth appearance, higher IR strength is likely to preserve or improve lesion conspicuity with optimal high- and low-contrast resolution compared to FBP or lower IR strengths.

P-45
6:30AM - 2:45PM

Leukoaraiosis as a Predictor of Acute Ischemic Infarction on DWI after Aortic Replacement.

E Obusez1, L Svensson2, J Bullen2, N Obuchowski2, S Jones2
Purpose
Postoperative brain injury is an important cause of mortality and morbidity in patients that undergo aortic replacement. Leukoaraiosis or chronic microvascular white matter ischemic changes (WMIC) has been shown to be associated with ischemic stroke in the general population (1, 2). While WMIC has been shown to be an independent predictor of nonfocal neurocognitive changes, generalized seizures and temporary neurologic dysfunction in patients that undergo aortic replacement (3, 4), it has not been shown to be a risk factor for acute ischemic infarction in this sub-group of patients. We performed a retrospective case-control study to determine if leukoaraiosis is a predictor of acute ischemic infarction on magnetic resonance imaging (MRI) diffusion-weighted imaging (DWI) after aortic replacement.

Materials and Methods
From 2001 to 2014, a total of 5171 patients underwent aortic replacement. Fifty-three patients had neurological signs of acute stroke in the immediate postoperative period and acute ischemic infarcts on postoperative DWI MRI. Using propensity score matching, these patients were matched with 53 control patients that underwent aortic replacement without acute ischemic infarcts on DWI MRI (Table 1). Acute ischemic infarction was reassessed by reviewing DWI sequences on postop MRI. Leukoaraisosis was assessed on FLAIR and T2-WI sequences on both pre-operative and postop MRI. Fazekas scale (5), was used to categorize WMIC as periventricular, deep white matter and total (periventricular and deep) WMIC. To assess for cardiopulmonary bypass and circulatory arrest as predictors of stroke in patients with WMIC, an additional 53 nonmatched patients without acute DWI infarcts were randomly selected and compared with the acute DWI ischemic infarct group. A logistic regression analysis then was performed.

Results
Patients with deep WMIC were more likely to have acute DWI ischemic infarcts after aortic replacement (p = 0.023). However, there was no association between periventricular WMIC and acute DWI ischemic infarcts (P = 0.219). No statistically significant association was observed between acute DWI ischemic infarct and circulatory arrest or circulatory arrest time in patients with deep WMIC (p=0.747 and P=0.235, respectively) or periventricular WMIC (p=0.786 and 0.302, respectively).

Conclusions
Our matched retrospective case controlled study shows deep white matter leukoaraiosis appears to be a predictor of acute ischemic infarction on diffusion-weighted MRI after aortic replacement. Further prospective studies may be warranted.
Table 1: Summary of baseline characteristics in 53 matched pairs*

<table>
<thead>
<tr>
<th></th>
<th>No stroke</th>
<th>Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>69 (± 12) [38, 93]</td>
<td>69 (± 12) [27, 89]</td>
</tr>
<tr>
<td>Male</td>
<td>53% (28)</td>
<td>60% (32)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>92% (49)</td>
<td>92% (49)</td>
</tr>
<tr>
<td>African American</td>
<td>8% (4)</td>
<td>2% (1)</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>0% (0)</td>
<td>4% (2)</td>
</tr>
<tr>
<td>Unknown/Other</td>
<td>0% (0)</td>
<td>2% (1)</td>
</tr>
<tr>
<td>History of diabetes</td>
<td>4% (2)</td>
<td>13% (7)</td>
</tr>
<tr>
<td>History of stroke</td>
<td>28% (15)</td>
<td>23% (12)</td>
</tr>
<tr>
<td>History of hypertension</td>
<td>75% (40)</td>
<td>79% (42)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>85% (45)</td>
<td>91% (43)</td>
</tr>
<tr>
<td>Aorta cross clamp used</td>
<td>98% (52)</td>
<td>98% (52)</td>
</tr>
<tr>
<td>Cross clamp time</td>
<td>84 (± 35) [19, 195]</td>
<td>85 (± 47) [12, 280]</td>
</tr>
<tr>
<td>Circulatory arrest</td>
<td>68% (35)</td>
<td>58% (31)</td>
</tr>
<tr>
<td>Circulatory arrest time</td>
<td>25 (± 13) [6, 63]</td>
<td>31 (± 22) [1, 85]</td>
</tr>
<tr>
<td>Cardiopulmonary bypass</td>
<td>98% (52)</td>
<td>98% (52)</td>
</tr>
<tr>
<td>Cardiopulmonary bypass time</td>
<td>127 (± 50) [29, 264]</td>
<td>130 (± 54) [53, 283]</td>
</tr>
<tr>
<td>History of smoking</td>
<td>64% (34)</td>
<td>69% (35)</td>
</tr>
<tr>
<td>Total cholesterol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desirable (&lt;200)</td>
<td>82% (32)</td>
<td>64% (27)</td>
</tr>
<tr>
<td>Borderline (200-239)</td>
<td>10% (4)</td>
<td>29% (12)</td>
</tr>
<tr>
<td>High (&gt;240)</td>
<td>8% (3)</td>
<td>7% (3)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>2% (1)</td>
<td>6% (5)</td>
</tr>
</tbody>
</table>

(Filename: TCT_P-45_TableStroke.jpg)

P-13

Leukoencephalopathy Induced by Low Dose Oral Methotrexate in a Patient with Rheumatoid Arthritis

M Salhab1, J Adair1, K SantaCruz1

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Purpose

Methotrexate (MTX) is an anticancer and immunomodulatory drug. It is considered the main agent for the treatment of rheumatoid arthritis (RA) and is the choice for initial treatment of patients with moderate to severe RA. It is highly ionized drug with
low lipid solubility. It does not readily cross the blood-brain barrier (BBB). Neurological toxicity has been described when MTX is administered via the intravenous or intrathecal route. Here, we report a patient of RA who developed leukoencephalopathy after starting low dose oral MTX.

Materials and Methods
Literature review was used for preparation of this case.

Results
A 39-year-old female diagnosed with RA was started on oral MTX 10 mg weekly. She presented to the emergency department 7 months after starting MTX with gradually progressive bilateral painless loss of vision over 2 weeks. Past medical history was negative otherwise. Neurological examination showed reactive pupils with no afferent pupillary defect. Extra-ocular muscles were intact bilaterally. Visual acuity was light perception only bilaterally. Comprehensive serum laboratory work up was nonconcerning. Lumbar puncture revealed normal opening pressure. Cerebrospinal fluid (CSF) analysis showed 10 RBCs, two WBCs, glucose was 45 mg/dl, and protein was 57 mg/dl. Oligoclonal bands were not detected. Microbiology studies were negative. Brain magnetic resonance imaging (MRI) showed multiple irregular contrast-enhancing lesions in the bilateral occipital and parietal lobes with involvement of the splenium of the corpus callosum. Patient underwent brain biopsy which showed perivascular T lymphocytic inflammation, abundant macrophages, and reactive astrocytes. Immunostaining with myelin basic protein revealed granular material within macrophages. Immunostaining with neurofilament showed relative preservation of axons. These findings are suggestive of demyelination. MTX was stopped and the patient was temporarily on high dose steroid. Her vision gradually improved over time without any other medications. Follow-up visit after 6 months revealed normal visual acuity (20/20) in both eyes.

Conclusions
Leukoencephalopathy is a well recognized complication of MTX therapy. It commonly is seen after intrathecal or intravenous administration. It ranges from mild reversible leukoencephalopathy, to irreversible and even fatal disseminated necrotizing leukoencephalopathy. The exact relationship between the dose and the route of MTX administration and subsequent development of leukoencephalopathy is not clear and is highly unpredictable. Our patient was started on low dose oral MTX 7 months prior to having symptoms. To our knowledge, there are only nine previously reported cases in the literature of leukoencephalopathy related to oral MTX.
Magnetic Resonance Spectroscopy Findings in Primary Central Nervous System Lymphoma

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Purpose
Our purpose is to analyze the different magnetic resonance imaging (MRI) spectroscopy findings in a group of 60 patients with final diagnosis of primary central nervous system lymphoma.

Materials and Methods
We retrospective analyzed MRI images of 60 patients with special interest in signal intensity in conventional sequences, enhancement pattern with gadolinium, restriction in diffusion-weighted images and metabolic pattern in spectroscopy. Spectroscopy was obtained with different techniques: multivoxel acquisition with intermediate TE (144ms) and monovoxel acquisition with low TE (35ms). The metabolic lectures were obtained within the main lesion, in surrounding edema and in contralateral normal brain parenchyma. The patterns were analyzed with special interest in NAA, Ch and Cr levels, mI peaks and lipids and lactate levels. Then difference ratios were calculated: Ch/NAA, Ch/Cr, NAA/Cr. Finally the authors analyzed the contribution of spectroscopy in making the final diagnosis of primary central nervous system lymphoma and the correlation with histopathological definitive diagnosis.

Results
In 100% of cases we found low levels of NAA with increased concentration of Ch, a typical tumor pattern. Cr peak was elevated only in 27 cases in comparison with contralateral normal brain parenchyma. No significant levels of mI were found in any case. Lipids and lactate peaks were found in 56 of 60 cases (93.3%). Ch/NAA ratio was 2.29 in average with values between 1.03 and 3.65. Ch/Cr ratio was 2.08 (0.68 and 4.5) and NAA/Cr was 1.08 (0.45 and 1.78).

Conclusions
The correct analysis of MRI findings in conventional sequences allows the diagnosis of lymphoma with good levels of sensibility and specificity. In some cases the typical or unusual appearance of these lesion make difficult the diagnosis so the introduction of new techniques could be very helpful. Magnetic resonance spectroscopy is a technique with excellent contribution in patients with brain tumors and in cases of primary central nervous system lymphoma is of particular interest to avoid surgical resection. The presence of a typical tumor pattern with high levels of lipids and lactate in solid portions of the lesion, restriction in diffusion and apparent diffusion coefficient (ADC) maps and strong enhancement with contrast agents are very specific of the final diagnosis of brain lymphoma.
P-42

Metal Artifact Reduction in Cone-Beam CT Images of Cerebral Aneurysms Treated with Stents and Coils

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¹Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama, Okayama

Purpose
Cone-beam CT (CBCT) commonly is used to evaluate stents and vessels after stent-assisted coil embolization. However, the metal artifacts from coil masses represent a critical limitation of CBCT in visualizing relevant structures. To investigate this, we
evaluated the usefulness of a metal artifact reduction prototype software (MAR) that recently was introduced to our institute.

Materials and Methods
We retrospectively reconstructed, with and without MAR, 13 CBCT datasets of cerebral aneurysms treated with stent-assisted coil embolization. Each of the corrected (using MAR) and uncorrected (without MAR) images was evaluated by four neurosurgeons who rated the following aspects: 1) the visibility of stent struts, and 2) the clarity of stent apposition. For this, the observers used a five-point scale (1. Insufficient, 2. Poor, 3. Fair, 4. Good, and 5. Excellent). When the score after MAR processing was increased by two points and more, we considered the image quality as improved.

Results
The mean size of the coil mass was 18.1mm (range: 5.0-30.3mm). Aneurysms were located at ICA (n=6), MCA (n=1), Acom (n=1), VA (n=3), and BA (n=2), respectively. The scores of the corrected images were significantly higher than those of the uncorrected images [pre-MAR and post-MAR median values; question 1: 1 and 3 (p<0.0001), question 2: 1 and 2 (p<0.0001), respectively]. The cases with a coil mass under 15mm of size (diameter) had a higher percentage of usefulness than others (rate of useful cases for sizes under 15mm and over 15mm; question 1: 55 %, 25% (p<0.05), question 2: 55%, 19% (p<0.01)).

Conclusions
This study suggests that the evaluated MAR prototype software can improve the image quality of CBCT images from cerebral aneurysm patients treated with stent-assisted coil embolization. The degree of image quality improvement after MAR correction was attenuated in the cases with larger coil masses.
Coils and stents

Before
Basilar artery aneurysm

After
Anterior communicating artery aneurysm

(Filename: TCT_P-42_Fig.JPG)

P-14

6:30AM - 2:45PM

Multicenter MRI Standardization to Enable Quantitative Metrics in Routine Care of Multiple Sclerosis Patients: The Multiple Sclerosis Partners Advancing Technology and Health Solutions (MS PATHS) Initiative
Purpose
Clinical research typically involves costly data collection from small groups of patients and increased burden on health care providers. MS PATHS is a new multicenter program designed to enable collection of research-quality data, including quantitative imaging metrics, from all patients as part of routine care. This is a collaborative network of multiple sclerosis (MS) centers where every patient will obtain standardized magnetic resonance imaging (MRI) measurements, neuro-performance measures and patient-reported outcomes with minimal impact on provider workflow. The goal is to establish a centralized, de-identified database that functions in real time as a MS learning health system. For imaging, the first challenge is defining and implementing a strategy to collect high quality, standardized, quantitative MRI data from all MS PATHS clinical sites.

Materials and Methods
Lead neuroradiologists from the first three MS PATHS centers and imaging scientists from Biogen and Siemens met regularly to establish a standardized MRI protocol. The protocol was required to be (1) feasible and acceptable for routine use for all MS patients across multiple sites, and (2) optimized for automated quantitative analysis of brain volume and MS lesions.

Results
The MS PATHS brain imaging protocol includes two 1mm isotropic product sequences optimized for Siemens 3T scanners: a 3D precontrast T1-weighted MPRAGE and 3D T2-weighted FLAIR. The combined acquisition time is approximately 12 minutes. Other sequences can be added at each center's discretion. An approved semiquantitative MRI report template has been streamlined, emphasizing the number of new lesions and enhancing lesions. Initial implementation is underway, with network activation expected by the end of 2015.

Conclusions
The MS PATHS initiative represents a unique collaboration that harnesses the independent strengths of MS clinical centers and radiology, pharmaceutical, imaging and information technology industries to create an integrated learning health system to improve clinical care and research.
Papillary Craniopharyngioma Presenting as a Purely Intraventricular Lesion in an Adult

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¹University of Texas at Houston, Houston, TX, ²The University of Texas Health Science Center at Houston UTHHealth, Houston, TX, ³UTHSC-Houston, Houston, TX

Purpose
We present a case of papillary craniopharyngioma presenting as a third ventricular mass in an adult patient.

Materials and Methods
Case Report: A 35-year-old male presented with a two-day history of falls and confusion. Further history on admission revealed a two-year course of progressive short-term memory loss and general decline in cognitive functions. More recently he had developed worsening positional headaches, 10/10, associated with nausea and vomiting. The patient underwent uneventful shunting and subtotal resection of the intraventricular mass. The final neuropathologic diagnosis was papillary craniopharyngioma - WHO Grade I. Image Findings: Magnetic resonance imaging (MRI) demonstrated a 51 x 34 x 35 mm solid mass lesion arising within the third ventricle extending through the foramen of Monro into both lateral ventricles. The mass was felt to originate from the left anterior margin of the third ventricle. There was marked expansion of the third ventricle and with obstructive hydrocephalus, probably at the level of the foramen of Monro, resulting in effacement of the basilar cisterns and downward translation of the posterior fossa structures. The mass enhanced homogeneously and did not demonstrate restricted diffusion. It was intermediate signal intensity on both T1- and T2-weighted images. There were scattered areas of susceptibility within the mass. Calcifications were noted in the mass on a noncontrast head CT. The pre-operative diagnosis was ependymoma.

Results
We present a case of papillary craniopharyngioma isolated to the third ventricle in an adult. The imaging appearance and clinical presentation are similar to the two case reports available in the literature.

Conclusions
The differential diagnosis of adult intraventricular masses includes a number of neoplasms including ependymoma, central neurocytoma, subependymoma, meningiomas, choroid plexus papillomas and carcinomas, germ cell tumor, and metastases. While 40% of papillary craniopharyngiomas may involve a third ventricular cavity secondarily; primary involvement of the third ventricle without extension from the parenchyma is rare, accounting for fewer than 1% of such masses in adults. Nonetheless, they should be considered in the differential diagnosis of adult
third ventricular masses when a homogeneously enhancing papillary mass is present without restricted diffusion.

(Filename: TCT_P-27_image-Axial-T1-Post-1.jpg)

(Filename: TCT_P-27_image-COR-T2-21.jpg)

**P-48**

**Perfusion/Vascular Imaging Can Prevent Unnecessary Treatment in Patients with Acute Stroke Symptoms**

K Seifert¹, J Wiener², D DeOrchis²

¹VCU, Richmond, VA, ²Boca Raton Regional Hospital, Boca Raton, FL
Purpose
Modern imaging equipment and protocols allow for increasingly rapid advanced imaging in the acute stroke setting, yet there has not been enough research done to show the value associated with the additional imaging over clinical-based treatment algorithms alone. The primary goal of stroke imaging is to select patients that can benefit from treatment. Perfusion CTP and MRP) and cross-sectional vascular imaging [computed tomography angiography (CTA) and magnetic resonance angiography (MRA)] have been utilized to provide visualization of at risk ischemic tissue (penumbra) that would benefit from revascularization treatment; however, there is continued controversy as to its value in effecting patient outcome. We evaluated the utilization of advanced imaging and its role in preventing unnecessary treatment in patients without evidence of at risk (salvageable) tissue.

Materials and Methods
We conducted a retrospective review of 239 patients who received advanced imaging for ischemic stroke over a 3-year period. Charts were reviewed to assess the presenting symptoms, hospital course, final diagnosis and clinical outcome. We also evaluated the impact of advanced imaging on the treatment plan by determining whether advanced imaging was used to exclude treatment for those patients who would not benefit. This included patients who had no evidence of ischemia and those who had completed infarctions with no significant penumbra on advanced imaging.

Results
The majority of patients in our study had treatment that was influenced by advanced imaging, independent of the results. The largest group of patients in our study who presented with stroke-like symptoms, had normal perfusion and vascular imaging and ultimately were discharged with other diagnoses. Imaging influenced the decision to withhold the administration of tPA in these 106 patients. In addition, another 58 patients were not treated because they had large vessel occlusion on imaging; however, minimal to no viable tissue based on lack of penumbra on perfusion imaging. Thus overall, advanced imaging excluded therapy in 68% of the patients in our study who presented with history and symptoms of acute cerebral ischemia.

Conclusions
Advanced imaging (rather than just noncontrast CT) can be used in the real world setting as a tool to make definitive diagnosis and direct treatment decisions. Our results show that such imaging would obviate unnecessary costly and potentially dangerous treatment in patients who would not benefit.

P-19
6:30AM - 2:45PM

Preoperative Prediction of Atypical Meningioma Using Amide Proton Transfer Imaging
Purpose
Amide proton transfer (APT) imaging can detect endogenous mobile proteins and peptides without exogenous contrast agents (1). Previous studies showed that APT-weighted signal may be associated with glioma grades and cellularity (2). The aim of this study was to investigate whether there is difference in APT signal between typical meningioma and atypical meningioma and, to correlate between APT signal and other imaging and pathologic characteristics of meningiomas.

Materials and Methods
Forty patients (11 male and 35 female; mean age 54.4 ± 12.4 years) with pathologically diagnosed meningiomas were enrolled. Preoperative magnetic resonance imaging (MRI) was performed including APT imaging as well as conventional imaging. Amide proton transfer imaging was performed with field inhomogeneity correction, and magnetization transfer ratio asymmetry (MTRasym) was evaluated. Regions of interest (ROIs) were placed on within enhancing portion and normal appearing white matter. Magnetization transfer ratio asymmetry was compared between typical and atypical meningioma patients using Student's t-tests. The predicting performance was assessed with receiver operating characteristic (ROC) curve analysis. Correlation analysis between MTRasym and Ki-67 labeling index or mitotic count was performed using Pearson correlation coefficient.

Results
Among 46 patients, nine patients were diagnosed as atypical meningioma and 37 patients as typical meningioma on histopathology. Magnetization transfer ratio asymmetry in atypical meningioma was higher than that in typical meningioma with statistical significance (P value 0.021). The optimal cutoff value to predict atypical meningioma was MTRasym > 2.12 with area under the curve of 0.744, sensitivity of 88.9%, and specificity of 66.7%. Magnetization transfer ratio asymmetry showed positive correlation with Ki-67 labeling index (correlation coefficient 0.31, P value 0.036), whereas mitotic count labeling index was not correlated with MTRasym (P value 0.075).

Conclusions
Preoperative APT imaging can be helpful to predict atypical meningioma noninvasive and guide treatment plan.
**Figure 1.** A 52-year old female with typical meningioma showed high signal intensity on T2WI (a) and homogeneous enhancement on enhanced T1WI (b). MTR$_{sym}$ within the enhancing tumor was...
Quantitative Susceptibility Mapping in Patients with Alzheimer’s Disease and Mild Cognitive Impairment

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1Kyung Hee University Hospital, Seoul, TX, 2Kyung Hee University Hospital at Gangdong, College of Medicine, Kyung Hee University, Seoul, AK, 3Kyung Hee University Hospital, Seoul, AK

Purpose
One of the important characteristics of Alzheimer disease (AD) is the iron accumulations in the brain. A quantitative susceptibility map (QSM) technique can be used to quantify the iron contents. Therefore, QSM may be useful to evaluate the AD brain. The objective of this study, therefore, was to systematically investigate the brain changes in the subjects with cognitive normal (CN), mild cognitive impairment (MCI) and AD by using both voxel-by-voxel based and region of interest (ROI)-based analysis for both QSM.
Materials and Methods

Nineteen CN (mean age = 65.74 years, 14 females and 5 males), 19 MCI (mean age = 71.84 years, 14 females and 5 males), and 19 AD subjects (mean age = 72.84 years, 17 females and 2 males) participated after informed consent. For the QSM data, a 3D gradient-echo sequence was run with seven echoes (first TE/ΔTE/final TE=3.4/5.9/39 ms). Quantitative susceptibility map data were obtained with the morphology enabled dipole inversion (MEDI) software. For the QSM data, the susceptibility value in each voxel was subtracted by the reference values which were estimated by the average of the susceptibility values in the bilateral posterior ventricular region for each subject. A voxel-based statistical group analysis was performed for QSM data using a one-way analysis of variance (ANOVA) test with the gender and age as covariates using SPM8. Regions of interest (ROIs) (well known iron accumulation regions; hippocampus, amygdala, globus pallibus, precuneus, pulvinar, putamen, red nucleus and thalamus/well known amyloid β accumulation regions; neocortex, allocortex, entorhinal cortex, anterior cingulate cortex and posterior cingulate cortex)-based statistical group analysis also was performed for QSM data. Finally, the receiver operating characteristic (ROC) curve analysis was performed to demonstrate sensitivity and specificity of QSM to differentiate among the subject groups for each ROI.

Results

Figure 1 demonstrates the differences of voxel-based statistical analysis of QSM (A) values between the CN and AD groups as well as the mean values of percentage changes of QSM (B) using ROIs-based statistical analysis on the MCI and AD against the CN group. For the voxel-based analyses, increased QSM values in AD compared with CN were found several brain areas, included in the right parahippocampal gyrus, but no differences between other groups. For the ROI-based analyses, QSM values were increased in the MCI and AD groups compared to the CN group for all ROIs. Results of ROC curves analysis showed that QSM values were differentiated significantly among the three groups. Quantitative susceptibility map values were differentiated between CN and MCI groups in the in the neocortex, allocortex, entorhinal cortex, anterior cingulate cortex, posterior cingulate cortex regions.

Conclusions

The susceptibility effects of the QSM data in the pecuneus and neocortex region were attribute to the iron accumulation in patients. The QSM data proved to be more effective to evaluate the early stage for AD. Therefore, the susceptibility effects in the QSM can be used for an early diagnosis for AD. Furthermore, the QSM technique can be used as an imaging biomarker to evaluate AD.
Reassigning Glial Migration to the Perivenous/Subglial Space Explains Clinical Spread Patterns and Opens New Avenues of Research

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Purpose
Background: In vivo histological animal studies document perivascular migration of glial tumor cells. However, they cannot distinguish arterial from venous locations. Clinical magnetic resonance (MR) imaging produces macroscopic tumor maps that can be compared with existing arterial and venous anatomical maps distinguishing arterial from venous routes for tumor spread. Purpose: To present clinical examples of glioma, which support the perivenous location of migrating glial tumor cells.

Materials and Methods
One thousand two hundred gliomas were reviewed. Their shape, location and internal architecture was compared to the venous anatomy and the perivenous/subglial spaces.

Results
The MR scans of gliomas closely matched the location, shape and internal architecture of the venous system. Three major venous features were correlated with the appearance of glial tumors. 1) The venous arcades are a prominent feature of the internal cerebral venous architecture, which matched the triangular shapes of gliomas in these areas. 2) The branching pattern of the surface cortical veins is a prominent feature of the cortical venous architecture. The main branch supplies the cortical surface of the gyrus and the large penetrating branches supply the walls and floor of the gyrus. Fidelity to this pattern creates cortical gliomas which grow into large U-shaped tumors that are confined to the walls and floor of a gyrus. 3) The territory of the basal vein of Rosenthal provides the structure for limbic/paralimbic gliomas, which have been noted not to spread into the internal cerebral vein territory. Very dense venous branching anatomy also may block tumor infiltration and explain predictable tumor junctions.

Conclusions
Conceptualizing glial cell migration to the perivenous/subglial space explains observed glioma infiltration patterns. Dense branching venous anatomy (venous arcades) also may form partial barriers to infiltration. Better understanding of the complex venous anatomy of the brain may help to better define treatment maps for
radiotherapy or surgery. It also suggests new targets that could be disrupted by chemotherapy.

(Filename: TCT_P-33_Venousimage1.jpg)
Materials and Methods

One patient with newly diagnosed GBM and three patients with recurrent GBM previously treated with surgery and chemo-radiation therapy received TTFields (intensity~0.7V/cm and frequency~200kHz). Patients underwent baseline (prior to TTFields) and two follow-up (1 and 2 months postinitiation of TTF) imaging on a 3T MR system. Diffusion tensor imaging parametric maps [mean diffusivity (MD) and fractional anisotropy (FA)] were generated using an in-house developed algorithm and leakage-corrected cerebral blood volume (CBV) maps were reconstructed using Nordic-ICE program. Echoplanar spectroscopic imaging data were processed using metabolic imaging and data analysis system package. MD, FA, CBV, choline/creatine (Cho/Cr) maps and FLAIR images were coregistered to postcontrast T1-weighted images (Fig. 1) and a semi-automated routine was used to segment the contrast-enhancing region of tumor. Median values of MD, FA, relative CBV (rCBV) and Cho/Cr were computed at each time point. The 90th percentile rCBV (rCBVmax) values also were measured. Percent changes of each parameter between baseline and follow-up time points were evaluated.

Results

Clinically, all four patients were stable at 2 month follow up. Percent changes in MD, FA and rCBVmax from baseline to post TTFields at 1 and 2 month follow-up periods are shown in Fig. 1. An increasing trend in MD accompanied with a steady decline in FA was noted in all patients at the 2 month follow up. The rCBVmax was either stable or decreased in three patients and in one patient, it initially increased at 1 month and then stabilized at the 2 month time point. The median Cho/Cr value did not demonstrate any specific trend as it decreased in one and increased in another patient. Using cell lines (4) and cancer xenograft models (5), it has been shown that TTFields arrests neoplastic cellular proliferation during mitosis. A large increase in MD and decrease in FA may be due to the inhibited cellular growth. Reducing trends in rCBVmax at follow up may be associated with reduced vascularity within the tumor bed after the therapy.

Conclusions

Our results indicate the potential value of DTI and PWI in assessing early treatment response to TTFields, a novel therapeutic regimen. However, these early findings need to be corroborated in a larger patient cohort.
Upper Level.
Representative baseline and follow-up images from a newly diagnosed GBM patient treated with TTFIELDS. Left Level.
Percentage variations in parameters from baseline to one and two month follow-up periods from 4 patients with GBM treated with TTFIELDS. Increasing trend in median MD and decreasing trend in FA and \( CBV_{\text{max}} \) were observed at follow-up relative to baseline.
Solitaire Brain Metastases vs GBM: new strategies.

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¹Hospital de Clínicas, Montevideo, Montevideo, ²Hospital de Clínicas, Montevideo, Uruguay

Purpose
The purpose of this scientific work is to analyze the utility of functional magnetic resonance imaging (fMR) sequences in differential diagnosis of solitaire brain metastases and GBM: susceptibility sequences, perfusion techniques and spectroscopy.

Materials and Methods
We retrospectively analyzed the information obtained from 60 MRI studies with conventional sequences and functional ones including susceptibility-weighted images (SWI/SWAN), T2 perfusion techniques with curve analysis and rCBV calculation, and spectroscopy with low and intermediate TE. In spectroscopy we obtained metabolic peaks and ratios in normal contralateral brain and within the primary lesion and in surrounding edema. The two most experienced authors analyzed the information and made the most appropriate diagnosis and then we compared with definitive histopathological result. We obtained predictive positive and negatives values, sensibility and specificity of each technique and finally all of them together.

Results
In the group of patients included 50% was solitaire metastases and 50% GBM confirmed in the histopathological analyses. The group of patients with metastases included lung tumors (11 cases), breast metastases (12 cases), two cases of kidney primary tumors, two testicular cancers, one case of thyroid cancer and two colon cancers. In 53 cases (88.3%) the correct diagnosis was made in initial MRI analyzing the additional information of functional sequences. The other seven cases included four metastases initially named as GBM. Susceptibility-weighted images showed no significant differences between the two groups but in all cases of GBM the distribution of the hemoglobin degradation products was more random and bizarre than in metastases. Perfusion techniques allow the differentiation between metastases and GBM in 57 cases (95%), with three metastases initially consider as GBM. We analyzed the morphology of the curve and the value of rCBV together. In spectroscopy all the metabolic spectra were abnormal with a typical humoral pattern: low NAA, high Ch levels and variable amounts of lipids and lactate. There were no significant differences between the lesion spectra in both groups. But there were
significant differences in the study of the metabolic spectra in surrounding edema between the two groups. In 29 GBM (96.6%) the humoral pattern extends into the edema area with similar ratios in the first 15mm from the tumoral margins. Only three metastases showed these patterns in spectroscopy.

Conclusions
It is very common in clinical practice to have a patient with a solitary brain tumor in which it is important to differentiate between metastases and GBM. The introduction of functional technique has improved the use of MRI in final diagnosis. The combination of perfusion and spectroscopy provide additional information with excellent levels of specificity to differentiate solitary brain metastases and GBM. We propose to include these techniques in routine brain examinations of patients with solitary brain tumor with particular interest in perfusion techniques and spectroscopy in surrounding edema.

Perfusion GBM pattern.
In this case of GBM increase of CBV is not only within the tumor so is in the area of surrounding vasogenic edema with no enhancement on T1).

The curve analysis shows a typical high grade tumor pattern (yellow curve) in comparison with normal brain (red curve)
**Perfusion Metastases pattern.**

In this case of lung metastases increase of CBV is only within the tumor with no significant increase in CBV in the area of vasogenic edema.

The curve analysis shows the most frequent pattern in this kind of tumor (yellow curve).
Subcortical White Matter Hyperintensity on DWI: Neuronal Intranuclear Inclusion Disease (NIID)?

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Purpose
Neuronal intranuclear inclusion disease (NIID) in adults is a rare, progressive
neurodegenerative disease characterized by abnormal eosinophilic hyaline intranuclear inclusions on pathological examination after skin or brain biopsy. Radiologists have described some cases in Japan which showed distinctive hyperintensity of the subcortical white matter on diffusion-weighted imaging (DWI). We describe the DWI findings in presumptive cases of NIID.

Materials and Methods
We reviewed the clinical and magnetic resonance imaging (MRI) features of six patients with presumptive diagnosis of NIID: all patients had 1) presence of subcortical white matter hyperintensity on DWI; 2) clinical presentation consistent with chronic, progressive neurodegenerative disease; 3) no other MRI or clinical features suggesting alternative diagnosis.

Results
All six adult (mean age 75 years, range 65 to 83 years) patients (5 females, 1 male) were admitted to hospital for neurological complaints including dementia, altered mental status; two had multiple episodes of sepsis from urinary infection. None of the patients underwent biopsy. On MRI, all patients had generalized cerebral atrophy with prominent sulci and ventricles. There was moderate or severe confluent white matter hyperintensity on T2-weighted images. On DWI, all had bilateral, asymmetrical, multifocal subcortical white matter hyperintensity (Fig.).

Conclusions
Subcortical white matter hyperintensity detected on DWI is a very striking and distinctive feature. However, a presumptive diagnosis of NIID is difficult to prove in the absence of biopsy and specialized pathological methods, and neuroradiologists should be aware of the possible diagnosis when this distinctive MRI pattern is encountered.
Systemic Inflammation on Cerebral Blood Flow in Obstructive Sleep Apnea

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Purpose
Alteration of regional cerebral blood flow (CBF) and systemic inflammation in obstructive sleep apnea (OSA) had been reported. This study sought to evaluate CBF in OSA patients using arterial spin labeling (ASL) perfusion magnetic resonance imaging (MRI) and to determine its relationship with systemic inflammation.

Materials and Methods
Twenty patients with moderate and severe OSA [apnea-hypopnea index (AHI) > 15,
20 men] and 16 healthy volunteers (AHI < 5, 16 men) were recruited. All 36 participants underwent polysomnography to determine the severity of their sleep apnea. Early or late phase changes in leukocyte apoptosis and its subsets were determined by flow cytometry. Perfusion MRI data were acquired with a pulsed continuous ASL technique. Cerebrospinal fluid (CBF) maps were calculated from the labeled and unlabeled ASL images. The CBF maps were compared using voxel-based statistics to determine differences between the OSA and control groups, with age, TIV and education as covariates. The differences in CBF, clinical severity and leukocyte apoptosis were correlated.

**Results**
Exploratory group-wise comparison between the two groups revealed that patients with OSA exhibited low CBF values in bilateral basal ganglia, right cerebellum, left thalamus, right medial frontal, right superior temporal, right fusiform, right inferior frontal, right superior frontal, and bilateral cingulate gyri. The regional lower CBF values were correlated with higher clinical disease severity and leukocyte apoptosis.

**Conclusions**
Obstructive sleep apnea impairs cerebral perfusion in vulnerable regions, and this deficit is associated with increased disease severity. The possible relevance between systemic inflammation and cerebral perfusion change may represent variant hemodynamic alterations and their consequent in OSA.

**P-09**

6:30AM - 2:45PM

**The Activity Ratio of 18F-Fluorodopa Uptake in Midbrain - Occipital Separates Patients with Parkinson Disease from non-Parkinson**

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**Purpose**
The ratio of striatal 3,4-dihydroxy-6-[18F]-fluoro-L-phenylalanine (18F-FDOPA) activity (representing the terminal projections of nigral dopaminergic neurons including the caudate and putamen) to occipital (SOR) has been used as a quantitative parameter in positron emission tomography (PET) studies in patients with idiopathic Parkinson's disease (PD). In this study we measured SUV ratio between midbrain and occipital (MOR) to explore whether reduction in both ventral and midbrain uptake, including the substantia nigra and midbrain tegmentum, can be used as a biomarker for identifying PD.

**Materials and Methods**
A total of 10 patients were referred by neurologists with FDOPA PET/CT studies visually interpreted as PD in six cases and four non-PD as the controls. A 5-minute
PET acquisition was performed 50-65 minutes after administration of a 10 mCi bolus of 18F-FDOPA. An unpaired t-test was performed to determine whether PD patients had a significantly different MOR from non-PD. Receiver operating characteristic (ROC) analysis also was performed to evaluate the individual diagnostic ability for differentiating PD from controls.

Results
A statistically significant difference was observed between the PD and control groups when examining the MOR. The PD group had a significantly lower MOR than the control group (mean PD MOR = 1.07±0.11, mean MOR = 1.40±0.11, P=0.0017). The cutoff ratio of 1.2, provided complete separation between these two patient groups who had scans that were independently interpreted PD versus non-PD.

Conclusions
In 10 patients with Parkinson's disease, there were significant differences in MOR between PD and non-PD controls. This study suggests that MOR can be used as an imaging biomarker in the diagnosis of PD.

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P-10
6:30AM - 2:45PM

The Neuroimaging Investigation of Neuroanatomical and Microstructural Alternations and Functional Connectivity in the Elderly and Alzheimer’s Disease Patients

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Purpose
This study is designed to elucidate the brain tissue difference between normal aging people and Alzheimer disease (AD) patients in the respect of the neuroanatomical volume analysis, fractional anisotropy (FA) with mean diffusivity (MD) indices of white matter (WM) diffusion tensor imaging (DTI) alternations and changes of
functional connectivity (FC) in resting state functional magnetic resonance imaging (rs-fMRI).

Materials and Methods
In this study, 46 Alzheimer disease patients (mean age 77.5±7.5 years, M/F=15/31) and 52 age-matched normal elderlies were enrolled. The MRI was performed by Siemens Magnetom Area 1.5T MR scanner. The imaging protocol included T1-WI with 3D MPRAGE sequence, T2-WI and fast FLAIR with SPACE technique. The DTI images were obtained with following parameters: TR/TE=10000/107ms, b-value=1000 s/mm², 30 directions, NEX=3 and voxel size=2x2x2mm. Brain region of interest (ROI)-based value of the FA and MD were carried out using FMRIB Software Library v5.0 (FSL) and Statistical Parametric Mapping (SPM). White matter ROIs were created from Susumu Mori. Diffusion tensor imaging (DTI) analysis was performed by using DTI Studio software for image processing and was registered to T1-weighted MPRAGE image. The aforementioned segmented ROI masks of GM and WM maps then were used to define the ROI in DTI. Then, the quantification of the microstructural alternations for each subject was acquired by averaging the FA, MD values within the ROI. All fMRI data were acquired with following parameters: TR/TE=3000/50ms, time point=180, voxel size=0.4x0.4x2.0mm. 37 axial slices, thickness/gap = 4.0/0 mm, in-plane resolution = 64 × 64, flip angle = 90°, FOV = 220 × 220 mm. We applied voxel-wise measurement of functional connectivity of resting fMRI signal in MATLAB. The data process steps followed the DPARSF pipeline.

Results
Concerning regional neuroanatomical volume analysis, WM volume fraction in the frontal, midbrain, sublobar and temporal region of the AD patients was significantly lower than that of the normal elderlies, while there is no significant difference in other regions between these two groups. The DTI indices revealed significantly higher global MD with lower global FA in AD patients. Further analysis of regional WM integrates, AD patients appeared to have higher MD over limbic, mibrain and sublobar region with the lower FA at sublobar region. In the rs-fMRI study, AD patients displayed lower FC within the default-mode network (DMN) in the anterior cingulate cortex, right and left insula and superior temporal cortex, left parahippocampal cortex compared with controls.

Conclusions
According to our experimental results, the investigation of morphometric analysis and DTI MRI alternation is helpful in the revealing the difference of brain abnormalities in normal aging people and AD patients. Resting state FMRI provides relevant information regarding the aging effects and dementia on brain functioning and cognition. Clinically relevant decreased functional connectivity within the DMN was observed in AD.

P-36
The White Gray Sign: a Highly Reproducible Method for Identifying the Central Sulcus on T1 High-Resolution Images.

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Purpose
To describe and validate a new and highly reliable method for identifying the central sulcus. The "white gray sign" refers to increased signal of the cortex along the central sulcus as seen on high resolution axial T1-weighted images, resulting in decreased gray-white contrast.

Materials and Methods
Twenty-five consecutive functional magnetic resonance images (fMRIs) were analyzed and the location of the central sulcus in the nonaffected hemisphere was confirmed by contralateral finger motion task. Cortical segmentations of about 30 pixels were drawn on high resolution axial T1-weighted BRAVO images along both the anterior and posterior cortices of the pre and postcentral gyri, as well as within the gyral white matter. The gray white contrast of the cortices along the central sulcus then was compared to that along the nearby precentral sulcus and postcentral sulcus. To test the reliability of the method, 40 fMRIs (including the 25 above, as well as 10 of which held lesions near the central sulcus) then were rated for the presence/absence of the white gray sign. These 40 fMRIs also were evaluated using four additional previously described methods for identifying the central sulcus (1-5).

Results
Mean gray white contrasts along the central sulcus were 0.218 anteriorly and 0.237 posteriorly compared with 0.320 and 0.295 along the posterior precentral sulcus and anterior postcentral sulcus, respectively. T-test analyses comparing differences around the precentral sulcus and central sulcus and around the central sulcus and postcentral sulcus, yielded p-values of <5x10^-7 and <0.0002. The white gray sign was present in 100% (30/30) of nonaffected hemispheres and in 90% (9/10) of the affected hemispheres. The white gray sign performed equal to the cortical thickness method and better than all other methods.

Conclusions
Reduced gray white contrast around the central sulcus is a highly reliable sign, outperforming many of the previously described signs and methods for identifying the central sulcus. As resolution of routine imaging continues to improve, the most reliable methods for identifying the central sulcus likely will rely more on visualization of inherent differences due to underlying cytoarchitecture rather than variable morphological appearances and gyral patterns.
Value of High-Resolution MR Imaging Compared with MR Angiography for the Follow-Up of Intracranial Vertebral Artery Dissection

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Purpose
High resolution magnetic resonance imaging (HR-MRI) is a useful technique for the diagnosis of intracranial vertebral artery dissection (VAD). The purpose of this study was to evaluate its usefulness in the follow up of the VAD compared with MR angiography (MRA).

Materials and Methods
We retrospectively reviewed consecutive patients who were diagnosed as VAD and performed follow-up examination with HR-MRI and MRA between March 2012 and September 2015. Examinations were evaluated by two independent readers and disagreements were resolved by consensus. Outcome of VAD was assessed with four categories; disease progression, no interval change, improvement, and complete resolution of VAD. The presence of image change on vascular luminal diameter, hematoma and flap also was checked. Interobserver and intermodality agreements were estimated.

Results
Twenty-one patients (median age 47 years, IQR = 39-54) finally were included in this study. The median interval between initial HR-MRI and follow-up imaging was 6 months (IQR = 5-11). Among 21 patients, four (19%) showed disease progression, six (29%) showed disease improvement and seven (33%) showed complete resolution of VAD. Interobserver agreement for assessing outcome of VAD was good for both HR-MRI (κ 0.692, 95% CI 0.48-0.91) and MRA (κ 0.707, 95% CI 0.43-0.99). After consensus reading, intermodality agreement for outcome was good (κ 0.734, 95% CI 0.55-0.92). Diagnostic accuracy of HR-MRI for outcome of VAD, when that was dichotomized as disease progression or not, was 71.4% and that of MRA was 76.2% without significant statistical difference. However, in case of detecting change in detailed finding on vascular luminal diameter, hematoma and dissecting flap, HR-MR imaging was better than MRA (interobserver overall proportion of agreement: HR-MR 81% and MRA 81% for luminal change, HR-MR 90% and MRA 71% for hematoma, and HR-MR 90% and MRA 71% for dissecting flap).

Conclusions
High resolution MRI could be a useful and noninvasive technique for the follow up of patients with VAD. High resolution MRI provides more detailed change of hematoma and flap in VAD compared to the MRA.
Fig. 38-year-old man who complained the posterior headache. Initial MRA and HR-MRI were obtained 7 days after symptom onset. (A) TOF-MRA shows diffuse stenosis and focal aneurysmal dilatation (arrow) at right vertebral artery. Dissection flap and luminal hematoma (arrowheads) is identified on HR-T2WI. (B) On the follow up study after 11 months later, aneurysmal dilatation of previous dissecting lesion is completely resolved. MRA and HR-T2WI show normalized right vertebral artery (dotted arrows)
Volume Estimation of Subcortical Grey Matter Structures in Multiple Sclerosis: Comparison Between NeuroQuant® and FIRST

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Purpose
Volume estimation of subcortical gray matter structures is becoming a field of interest in multiple sclerosis (MS). The goal of this study was to compare volume estimations for subcortical structures obtained with the NeuroQuant® and FIRST in a cohort of clinically isolated syndrome (CIS) patients.

Materials and Methods
One hundred fifteen CIS patients were analyzed. Structural images were acquired on a 3.0 T system using a sagittal 3D T1-weighted gradient-echo (MPRAGE) sequence (TR=2300 ms, TE=3000 ms, voxel size=1.0x1.0x1.2mm³). Volumes for subcortical structures were obtained with Neuroquant® and FIRST -following the described methodology; total intracranial volumes also were obtained. The Intraclass Correlation Coefficient (ICC) between the two estimated volumes (NeuroQuant® and FIRST) was calculated for each of the following structures: (right and left) thalamus, caudate, putamen, pallidum, hippocampus and amygdala. The total intracranial volume also was considered. For each structure, the percentage difference of the volume calculated with FIRST in relation to the volume estimated by NeuroQuant® also was calculated.

Results
The ICC was below 0.45 for the following structures: pallidum (ICC left=0.25, ICC right=0.27), amygdala (ICC left=0.29, ICC right=0.35) and total intracranial volume (ICC=0.44). The ICC ranged between 0.45 and 0.65 for the caudate (ICC left=0.46, ICC right=0.61) and thalamus (ICC left=0.55, ICC right=0.64); and it was higher than 0.65 for the hippocampus (ICC left=0.67, ICC right=0.76) and putamen (ICC right=0.79, ICC left=0.83). FIRST estimated volumes were systematically lower than the volumes obtained with NeuroQuant®, except for the pallidum (both right and left), where FIRST volumes were on average 70% higher than NeuroQuant® volumes. FIRST underestimations ranged between 1% and 12% for (both right and
left) thalamus, caudate, putamen, hippocampus and total intracranial volume; and between 20% and 28% for right and left amygdala.

Conclusions
Structures showing largest disagreement between the two methods were the smallest ones (pallidum and amygdala). For the other subcortical gray matter regions, the agreement on the estimated volumes was moderate to strong.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall A

Printed Poster (P) - Head and Neck
P-55

A Survey of Congenital C1 Arch Anomalies

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Purpose
Congenital C1 anomalies are important entities that may be mistaken for fractures or associated with impaired integrity of the atlas ring. Accurate description of these defects in radiology reports bears clinical importance. However, it is not known how often C1 defects are reported. Furthermore, although described in a number of publications, the incidence of the various C1 anomalies remains incomplete and inaccurate due to relatively small sample sizes. In this study, we investigated the incidence, radiographical features, and clinical significance of congenital C1 anomalies.

Materials and Methods
The cervical spine computed tomography (CT) scans of all patients in a 2-year period were reviewed retrospectively and evaluated for congenital anomalies of the anterior and posterior arches. Radiology reports were reviewed to determine whether the defects had been described.

Results
Out of 3032 subjects, 168 (5.5%) had congenital atlas anomalies, of which 154 had isolated posterior arch defects (5.1% of all subjects) while 14 (0.046%) had combined anterior and posterior arch defects. No isolated anterior arch defects were seen. Sixty-six cases with C1 anomalies were not reported (39.3%). Type A posterior arch defects accounted for 89.3% of all arch anomalies, while types B and C accounted for 9.5% and 1.2% respectively. Among 14 cases with combined anterior and posterior defects
(8.3% of all C1 defects), 11 cases had type A, two cases had type B, and one case had type C anomalies. No type D or E defects were observed.

Conclusions
C1 arch defects, particularly type A, are relatively common radiological findings that frequently are not reported. Approximately 40% of C1 arch defects were not reported. Type D and E posterior defects and isolated anterior nonfusion are extremely rare. Combined anterior and posterior defects occur more frequently than would be expected by the incidence of isolated anterior defects.

P-57
6:30AM - 2:45PM

Autoimmune Hypophysitis Related to Monoclonal Antibody Therapy: MR Findings in Two Cases

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Purpose
Autoimmune hypophysitis (AH) is a rare disease which has been distinguished into two forms: the more frequent lymphocytic type with autoimmune pathogenesis, typically encountered in women in late pregnancy or in the puerperium, and the granulomatous type, with uncertain pathogenesis and epidemiological features and more severe clinical course. However, new inflammatory immune-related conditions, involving different body systems and including AH, have become emerging clinical entities in patients treated for metastatic melanoma with monoclonal antibodies against cytotoxic T-lymphocyte antigen 4 (ipilimumab) and programmed-cell death protein-1 (nivolumab). We describe the magnetic resonance imaging (MRI) findings in two case of AH, observed in the last 6 months at our Hospital in patients affected by melanoma and assuming monoclonal antibody therapy.

Materials and Methods
Two male patients, 25 and 74 years old respectively, underwent brain MRI examination as follow-up evaluation in metastatic melanoma. Both had started routine treatment with ipilimumab (3mg/kg iv every 21 days for four times) and had received three doses. They had reported increasing fatigue over the past few weeks. Laboratory studies were significant for thyroid stimulating hormone deficiency.

Results
Contrast-enhanced magnetic resonance imaging (MRI) revealed in both cases symmetrical enlargement of the pituitary gland with symmetrically inhomogeneous strong enhancement in an intact sella; a thickened stalk coexisted in case one (Fig.). Clinical and radiological findings were attributed to AH. Both patients were treated
with glucocorticoids and thyroid hormone replacement therapy with rapid clinical improvement. A 1-month follow-up computed tomography (CT) scan demonstrated normalization of pituitary volume in both cases.

Conclusions
Imaging features of AH are nonspecific. Nevertheless, the symmetry of pituitary enlargement and enhancement inhomogeneity as well as stalk thickening can help to distinguish it from other conditions, specifically intracranial metastasis, in patients affected by melanoma and treated with monoclonal antibodies. In the adequate clinical setting early MR is recommended to confirm the diagnosis of this treatable condition with favorable outcome.

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P-54
6:30AM - 2:45PM

CT and MR Dacryocystography for the Evaluation of Functional Disorders of the Lacrimal System: Can we Replace Dacryoscintigraphy?
L DE ABREU JR, A Wolosker, M Borri

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Purpose
Study the capability of sectional techniques (CT and MR) for assessing functional disorders of the lacrimal system using instillation of contrast (iodinated or gadolinium).

Materials and Methods
We demonstrate the diagnosis of functional disorders of the lacrimal system in two patients, one of them studied by computed tomography (CT) and the other by magnetic resonance (MR), with contrast instillation. The studies were correlated with findings from conventional dacryocystography and dacryoscintigraphy (in one case).

Results
In both patients the sectional studies showed slowing in the tear transit on the side where there were complaints of excessive tearing. Conventional dacryocystography was normal in both cases, precluding the diagnosis of lacrimal obstruction. The findings of CT and MRI performed with instillation of contrast medium allowed the diagnosis of functional disorder, the same way dacryoscintigraphy usually does.

Conclusions
Computed tomography and MR with contrast instillation may be useful for the evaluation of functional disorders of the lacrimal system, with the advantage of offering better anatomical details than scintigraphy.
Facial Trauma: What the Surgeon Needs to Know. A Pictorial Essay

A Wolosker¹, L Abreu Jr.², M Pereira³, M Borri⁴
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Purpose
The purpose of this study is to described the main features of facial fracture, coexisting injuries and complications.
Materials and Methods
The authors reviewed the multidetector computed tomography (MDCT) of patients with facial trauma with fractures and present the main features that helped establish the correct diagnosis. Particular emphasis was given on what is important for the clinicians, coexisting injuries and complications. The fractures are classified according to anatomical structures as following: nasal, dental-alveolar, frontal, orbital, zygomaticomaxillary complex, Le Fort fractures, nasoethmoidal and mandibular.

Results
Facial trauma with fracture are common reason for presenting at Emergency Department and are associated to different levels of morbidity and also mortality. The most frequent causes are motor vehicle accidents, falls, sports injuries, work accidents, violence and other rare etiologies of blunt trauma. Multidetector CT is the imaging modality of reference in evaluating there injuries, allowing pre-operative information of the affected structures.

Conclusions
Facial fractures are sometimes challenging in emergency room. Knowing the facial fractures presentations and concomitant no facial injuries are important for emergent management. The clinicians should be familiar with the common findings of CT scan.
Fig. 1 - Axial noncontrast computed tomography.
Nasal and septal fracture with leftward nasal deviation.
The nasolacrimal duct is intact (asterisk).
Fig. 2 - Axial CT image shows avulsed right canine, central and lateral incisors with alveolar ridge fracture (arrow).

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Fig. 3 – Axial CT shows right medial orbital wall fracture and orbital emphysema window and (B) bone window.
Giant Cell Tumors: Not Just for Long Bones (Craniospinal Manifestations of Osteoclastomas)

J. Carmichael¹, V. Potigailo², A. Krishnamoorthy³

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Purpose
Presented is a scientific poster investigating digital radiographic, computed tomography (CT), and magnetic resonance imaging (MRI) findings of giant cell tumors (GCTs; osteoclastomas) of the temporal bone, orbit, and cervical spine. These are quite unusual but important sites for GCT involvement (sacrum: 4-9%; skull: 2%). Giant cell tumors usually are benign (5% rate of malignancy) bone tumors typically arising in the metaphysis and epiphysis of long bones, most commonly within the distal femur and proximal tibia. Giant cell tumors often are aggressive, locally destructive, and frequently recurrent, especially if poor marginal resection.

Materials and Methods
CR, CT, and MR features with corresponding images of histologically proven giant cell tumors of the spine and skull (temporal bone and orbit) are presented in comparison to a case of GCT in classic location in the distal femur.

Results
See conclusion section for this scientific poster. This scientific poster is a stepwise pictorial guiding viewers through classic presentation of GCT to GCT of spine to GCT of temporal bone.

Conclusions
Giant cell tumors of the spine, temporal bone, and orbits are rare manifestations of a common neoplasm. These osteolytic bone tumors are predominantly benign, often locally aggressive, and frequently recurrent. Although rare, GCT should be included in the differential diagnosis of lytic lesions in the spine and head and neck.

P-53
6:30AM - 2:45PM

Influence of Clinical History on MRI Interpretation of Optic Neuritis

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Purpose
To evaluate the influence of the clinical history on magnetic resonance imaging (MRI) interpretation of optic neuritis.

Materials and Methods
One hundred seven consecutive orbital MRI scans were reviewed retrospectively by three neuroradiologists. The readers independently evaluated the coronal STIR sequence for optic nerve hyperintensity and/or atrophy (yes/no) and the coronal postcontrast T1-WI for optic nerve enhancement (yes/no). Readers initially evaluated the cases blinded to the clinical history. Following a 2-week washout period, readers
again evaluated the cases with the clinical history provided. Inter-reader and reader-clinical radiologist agreement was assessed using Cohen's simple kappa coefficient.

Results
Inter-reader agreement on the STIR sequence (K=0.427 without clinical history, K=0.505 with clinical history provided), and postcontrast T1-WI (K=0.271 without clinical history, K=0.336 with clinical history provided) was overall fair-moderate. Inter-reader agreement on postcontrast T1-WI was significantly higher when the clinical history was provided compared to without the clinical history (p=0.001); no significant difference in inter-reader agreement on the STIR sequence was demonstrated (p=0.397). Reader-clinical radiologist agreement on the STIR sequence (K=0.4-0.42 without clinical history, K=0.44-0.69 with clinical history) and postcontrast T1-WI (K=0.17-0.40 without clinical history, K=0.15-0.69 with clinical history) also was calculated.

Conclusions
Clinical history appears to influence reader scoring towards a more "real-world" interpretation and improves inter-reader agreement when assessing optic nerve enhancement. These findings suggest the subjective nature of orbital MRI interpretation in cases of optic neuritis and reiterate the necessity of both clinically appropriate imaging decisions and radiologist access to ample clinical information.

![Image](TCT_P-53_figure.jpg)

Figure 1:
Reader 1 without history scored left optic nerve positive on STIR and post-contrast T1.
When provided history, the reader and clinical radiologist both interpreted the optic nerve.

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P-56
Literature Review: Can the Size of Oral Tongue Cancer Measured by Pre-operative MRI Predict the Presence of Metastatic Cervical Lymph Nodes?

A Abdelazim¹, N Sadeghi², A Joshi¹, D Brown³, M Taheri⁴
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Purpose
The purpose of this poster is to review and analyze published data on the accuracy and reliability of pre-operative magnetic resonance imaging (MRI) measurements of oral tongue cancer in predicting presence of metastatic cervical lymph nodes.

Materials and Methods
An extensive search was done on scientific literature written in English for articles specifically reporting a size cutoff of an oral cavity tongue cancer measured by pre-operative MRIs that would predict the presence of lymph node metastases.

Results
Six retrospective studies were included; no prospective study was conducted. The number of patients in each study ranged from 33 to 53. Authors reported a thickness ranging between 6-12.3 mm as a potential cut off, below which the chance of metastatic cervical lymph node was negligible. The way by which the primary tumor was measured varied considerably. Thickness of the tongue cancer was measured at least four different ways. While some attempted to measure the entire thickness, others defined the endo-phytic portion of the tumor directly or indirectly, with respect to different reference lines defined in each study. While some authors show reasonable correlation between thickness of the primary tumor measured by MRI and by histology, others focused on depth of invasion, making direct comparisons among studies difficult. The predictive value of this paradigm ranged from invalid to highly sensitive.

Conclusions
Most studies offered a threshold cutoff below which the presence of metastatic cervical lymph node is negligible. Care must be taken in using any particular threshold measurement for tongue cancer, as different threshold cutoffs could apply depending on the method by which it was measured.

P-58

Postoperative Imaging Findings Associated with the Transpalpebral Craniotomy Approach to the Anterior Cranial Fossa.
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Purpose
The transpalpebral approach is a novel alternative to ciliary or supraciliary incisions typically utilized for a supraorbital frontal craniotomy (1-2). Neurosurgery at our institution utilizes this minimally invasive approach to access the anterior cranial fossa and suprasellar structures while sparing a frontalis muscle incision. This achieves a superior cosmetic outcome, as the resultant scar becomes concealed within the upper eyelid crease. However, with novel surgical techniques come increasing technical challenges and novel postoperative findings.

Materials and Methods
The transpalpebral craniotomy approach as adapted at our institution has been described (1). Following institutional review board approval, a retrospective case review series was performed on 102 patients who underwent transpalpebral craniotomies from 2007 to 2015 at the Allegheny General Hospital. Pre-operative, peri-operative, and postoperative imaging studies were reviewed by radiology residents along with a board certified, fellowship-trained neuroradiologist. In addition, operative notes, postoperative clinical documentation, and surgical pathology reports were reviewed and surgical indication, intra- and peri-operative clinical findings, and subsequent invasive procedures were documented. Imaging findings were classified as benign expected (Type I), atypical findings not requiring further intervention (Type II), or atypical findings requiring additional invasive procedures (Type III).

Results
Patients ranged from 11 to 79 years old (mean 54 years) and 74% were female. Surgical indications included 33 tumors, 74 aneurysms, and two osseous dysplasia. Type I findings occurred exclusively in 46% of patients and included craniotomy hardware, bone cement, small pneumocephalus, minimal extra-axial fluid, and mild periorbital swelling. Type II findings occurred in 37% of patients and included asymmetric globe protrusion, sinus violation, residual aneurysm, cerebral infarction without clinical sequelae, pseudomeningocele, and moderate eyelid hematoma. Type III findings were present in 17% of patients and included pseudomeningocele, residual aneurysm, large pneumocephalus, large eyelid hematoma, and intracranial or eyelid infections. Invasive procedures included lumbar drain, evacuation of eyelid hematoma, and repeat craniotomy.

Conclusions
The transpalpebral approach is a novel minimally invasive surgical technique. Findings such as residual aneurysm occurred at a rate similar to traditional craniotomies (3-4). Nearly half of patients demonstrated expected postoperative findings, which resolved spontaneously. While slightly over a third of patients...
demonstrated atypical findings, these patients also required no further intervention. A minority (17%) of patients required further interventions, many of which were prompted by atypical imaging findings. It therefore is essential that neuroradiologists be familiar with expected and unexpected postoperative findings to effectively communicate with neurosurgeons, direct appropriate imaging follow-up and/or neurosurgical interventions, and improve patient care.

Using Texture Analysis to Differentiate Osseous Changes Between Sickle Cell Disease from Normal Bone Density Controls on Head CT

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Purpose
Sickle cell disease is a hereditary disorder characterized with sickle-shape hemoglobin, which causes vaso-occlusion and chronic anemia. Osseous complications, such as bone marrow hyperplasia, bone infarcts, and osteomyelitis, may occur in sickle cell disease patients. The purpose of this study is to investigate the feasibility of using texture analysis as a postprocessing, objective tool to detect osseous changes of sickle cell disease on head computed tomography (CT).

Materials and Methods
Following IRB approval, 56 patients with sickle cell disease who underwent noncontrast head CT from March 2006 to October 2014 were included in this study and compared to 56 age- and gender-matched controls. Five osseous regions (clivus, bilateral sphenoid triangles and mandibular condyles) were contoured manually, segmented, and imported into the 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 (P<0.05).

Results
Statistically significant differences were found in numerous texture parameters in all five osseous regions. For example, clivus shows statistically significant difference in 36 texture parameters between sickle cell disease versus controls, including 11 histogram (P<0.02), five gray level co-occurrence matrix (GLCM) features (P<0.0001), seven gray level run length (GLRL) features (P<0.0001), nine Law's
features (P<0.0001), and four gray level gradient matrix (GLGM) features (P<0.0001). The statistically significant differences also were shown between the subtypes (HBSS; n=43 vs HBSC; n=10) of the sickle cell disease. 

Conclusions

A majority of texture features demonstrated statistically significant differences between sickle cell disease and normal controls in all five segmented craniofacial bone regions. This study demonstrates that texture analysis on head CT potentially can be a reliable objective tool to detect osseous changes of sickle cell disease.

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall A

Printed Poster (P) - Interventional
P-65

Aspiration Thrombectomy Using Penumbra Catheter of Acute A2 Occlusion: Proximal and Distal Supporting Technique

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Purpose
To assess the efficacy and safety of an aspiration thrombectomy using Penumbra catheter in patients with A2 occlusion through proximal and distal supporting technique.

Materials and Methods
From January 2013 to March 2015, 15 patients underwent a manual aspiration thrombectomy using Penumbra 4-max reperfusion catheters through proximal and distal supporting technique for treatment of A2 occlusion. We evaluated immediate angiographic results and clinical outcomes through reviewing of patient's clinical medical records.

Results
Of these patients, ten had a complete obstruction of distal ICA and five had A2 and M1 occlusion. All patients had a mismatch lesion in the anterior cerebral artery territory. First, all patients underwent aspiration thrombectomy about occlusion of distal ICA and M1. Of these patients, eleven (66.7%) underwent aspiration thrombectomy using Penumbra catheter and achieved successful recanalization (TICI grade ≥ 2b). Median NIHSS score was 17 (range 13-19) at admission and was 3
(range 2-17) at 3 months. Favorable clinical outcomes (mRS score at 3 months ≤ 2) were seen in four patients (36.4%). Three patients died, deaths were related to massive symptomatic hemorrhage, brain edema, and herniation in hospital.

Conclusions
Aspiration thrombectomy appears to be safe and is capable of achieving high rate of successful recanalization in patients with A2 occlusion through proximal and distal supporting technique.

P-64

Continuous Clot Aspiration under Flow Control Improve Recanalization and Clinical Outcome of Acute Internal Carotid Artery Stroke: Retrospective Single Center Experience

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1Catholic University of Daegu, Daegu, Korea, 2Catholic University of Daegu, los altos, CA, 3Kyungpook National University Hospital, Chapel Hill, NC

Purpose
The aim of this study is to evaluate the impact of proximal flow control and continuous thrombus aspiration technique during intra-arterial thrombectomy (IAT) treatment of acute internal carotid artery (ICA) occlusion. Its efficacy and safety were compared to that of the historic control from single center experience without flow control and continuous aspiration.

Materials and Methods
A total of 185 patients were treated by IAT between March 2010 and March 2015 in our institution. Among them, 60 patients of ICA occlusion were identified retrospectively: earlier 41 patients underwent procedure with conventional guide catheter (CGC), whereas latest 19 patients were treated with balloon-guide catheter (BGC) and pump device. Patients were analyzed according to their proximal flow control status for the endpoints of recanalization rate and clinical outcomes, using T-test, Fisher's exact test, and logistic regression analysis.

Results
In BGC group, recanalization was successful in achieving more than thrombolysis in cerebral infarction (TICI) perfusion grade 2A, TICI 2B, and TICI 3 in 89.47%, 68.42%, and 57.89% respectively. In CGC group, recanalization rate of TICI 2A, TICI 2B or TICI 3 flow was achieved in 63.41%, 51.21%, and 31.70% of patients, respectively. Mean TICI grade of BGC group was higher than CGC group (p<0.005). The use of BGC was the independent predictor for achieving TICI 3 recanalization (P<0.005). Total procedure time was shortened in BGC group than that of CGC group (p<0.001). Mean modified Rankin scale (mRS) showed significant difference between
BGC group and CGC group (p<0.005). TICI≥2B (3) was independent predictor of good clinical outcome. The 19.5 % of BGC group, and 60.98% of CGC group were in mRS ≥ 5, respectively (p<0.001). Severe brain edema with herniation was found in 5.3% of BGC group and 41.5% of CGC group (p<0.005).

Conclusions
In historic comparison of single center experience, continuous clot aspiration directly through inflated BGC is an effective tool for recanalizing heavily-burdened ICA stroke with ease, speed, and safety. It could be recommended as first technique to attempt recanalizing acutely occluded ICA, although further prospective multicenter study is mandatory.

P-61
6:30AM - 2:45PM
LVIS Jr. “Shelf” Technique: An Alternative to Y Stent-Assisted Aneurysm Coiling

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¹Dalhousie University, Halifax, Nova Scotia, ²Dalhousie University, Halifax, Halifax, Nova Scotia

Purpose
Y stent has been used for wide neck bifurcation intracranial aneurysms particularly when both branch arteries are incorporated into the aneurysm dome or neck. With the advent of braided stent like LVIS Jr, these stents potentially can be used with the pull and push technique to create a 'shelf' at the neck of the aneurysm that can obviate the need for Y stents. The purpose of our study is to describe this 'shelf' technique with LVIS Jr stents in wide neck intracranial aneurysms.

Materials and Methods
We retrospectively reviewed our prospectively maintained interventional neuroradiology database for use of LVIS Jr stents. We assessed the aneurysms for their size, neck diameter and location. We used the 'shelf' technique in all but one of these patients. We assessed the immediate post-coiling results of these aneurysms. We assessed the peri-operative mortality and morbidity and short term follow up of these patients.

Results
We have total of seven patients (5 Female and 2 Male; mean age: 55 years) with one ruptured, two previously ruptured and four unruptured aneurysms located at anterior communicating (2), Basilar tip (3), para-ophthalmic (1) and internal carotid termination (1). The average diameter of the aneurysm was 7.5 mm (range; 3-12mm). All of these aneurysms were wide neck aneurysms with average diameter of the neck was 5.4 mm (range 3-8 mm) and average dome to neck ratio was 1.4 (range-1-1.8).
One patient had an in-stent thrombosis which dissolved with use of Reopro. One patient needed another stent to jail a stretched coil. None of these resulted in any clinical morbidity or mortality.

Conclusions
Our small study shows that LVIS Jr 'shelf' technique is safe and can obviate the need of Y stent in wide neck intracranial aneurysms.

P-62

Monitoring Intra-Arterial Chemotherapy Delivery to the Retina: A Distribution Study Using Quantitative DSA Analysis to Determine Distribution of Therapy in Pediatric Retinoblastoma Patients

S Kondapavulur1, D Cooke1, A Kao1, F Settecase1, M Alexander1, R Darflinger1, M Amans1, C Dowd1, R Higashida1, B Damato1, V Halbach1, S Hetts1
1UCSF, San Francisco, CA

Purpose
Intra-arterial chemotherapy (IAC) is an important treatment option for retinoblastoma (1,2,3,4). This study aimed to estimate IAC distribution to the target tissue of patients with retinoblastoma using quantitative digital subtraction angiography (DSA) image processing analysis.

Materials and Methods
Patients receiving selective ophthalmic artery chemotherapy under low dose x-ray fluoroscopic guidance at our hospital were analyzed. Ophthalmic artery contrast injections obtained just prior to chemotherapy infusions were used as proxies for chemotherapy delivery. Parametric color-coded DSAs were postprocessed to create pixel density over time curves (Syngo iFlow, Siemens, Forcheim, Germany) and calculate corresponding areas under the curves (MATLAB, customized code) in selected regions of interest (ROIs) using two techniques. In the first approach, two ROIs (preretinal and retinal) with the same area were compared in 42 eyes in 21 patients. Total delivery was defined as the preretinal ROI curve area. In the second technique, four ROIs of the ophthalmic artery, retina, supraclinoid internal carotid artery (ICA, distal reflux), and cavernous ICA (distal microcatheter and potential proximal reflux) were chosen in 40 eyes in 21 patients. Region of interest curve areas were normalized by ROI area, and the retinal ROI was normalized by retinal vessel density (0.35) (5). Total delivery was defined as the sum of the ophthalmic artery and supraclinoid ICA ROI curve areas. Comparisons for each ROI delivery to total delivery were performed in both techniques.

Results
The fraction of chemotherapy delivered to the retinal region via the first method was
calculated to be 80.0%. Percent delivery using the second method was as follows: ophthalmic artery, 85.7%; retina, 60.9%; supraclinoid ICA, 14.3%. The cavernous ICA ROI (encompassing distal catheter) gave a signal equivalent to 8.8% of total delivery. Five/eight cases had greater apparent delivery to the retinal ROI than to the preretinal/ophthalmic artery ROI using the first and second techniques respectively. This is likely due to greater patient retinal vessel density than approximated or dilution of contrast in the ophthalmic artery due to reflux in the ICA. Additionally, 18 cases exhibited greater than 60% delivery to the retinal ROI using the second method.

Conclusions
Parametric color-coded quantitative DSA can be used for patient-specific intraprocedural estimation of chemotherapy delivery to the retina via IAC in retinoblastoma patients.

<table>
<thead>
<tr>
<th>Technique 1</th>
<th>ROI</th>
<th>2 (retina)</th>
<th>% Delivery of Total</th>
<th>80.0 ± 22.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technique 2</td>
<td>ROI</td>
<td>Ref (ophthalmic artery)</td>
<td>% Delivery of Total</td>
<td>85.7 ± 9.6%</td>
</tr>
</tbody>
</table>

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P-63

6:30AM - 2:45PM

MR-Selected Thombectomy Yields Good Outcomes in Anterior Circulation Large Vessel Occlusion Ischemic Stroke Beyond 6-Hours

B Cristiano¹, M Pond¹, U Oyoyo², S Basu¹, J Jacobson¹

¹Loma Linda University Hospital, Loma Linda, CA, ²Loma Linda University, Loma Linda, CA
Purpose
For patients with anterior circulation large vessel occlusion (ACLVO) acute embolic strokes mechanical thrombectomy has been shown to dramatically improve outcomes when patients are treated within 6 hours of symptom onset (1, 2). The association between time to recanalization and outcomes is important, but collateral status may be a greater driver of outcome than time (3-5). We tested the hypothesis that patients with ACLVO stroke who present with a small core infarct on diffusion-weighted imaging (DWI) would show similar good outcomes after thrombectomy, regardless of time from onset.

Materials and Methods
A cohort of 49 patients undergoing thrombectomy after MR selection for ACLVO stroke from 11/1/2012 until 5/15/2015 was reviewed retrospectively, with IRB approval. Patients were selected for thrombectomy based on diffusion-restricted core volume ≤ (100 - patient's age) mL. Patients were divided into early (n = 24) or extended (n = 25) treatment groups based on time of decision to treat (≤ 6 hours = early), and comparisons made, with final infarct volume, final age adjusted core index (core volume (ml)/100 - age in years) and change in core volume the primary outcomes. Discharge disposition was determined by review of the clinical record. Primary safety measures of mortality, hemicraniectomy and symptomatic hemorrhagic conversion were captured and analyzed.

Results
There was no difference in final core volume [median 16 mL versus 22 mL, estimated difference +4 mL (95CI: -13 – +19), p = 0.613] or change in core volume [median +1 mL versus +5 mL, estimated difference +1.0 mL (95CI: -7.0 – +10.0), p = 0.710]. A favorable outcome was noted in 15/24 patients in the early group and 14/25 patients in the extended group [62% versus 56%, odds ratio 1.310 (95CI: 0.368 – 4.50), p = 0.773]. These results were insensitive to adjustment for rates of successful recanalization. For decision to treat up to 20 hours after onset, time did not correlate with final infarct volume [Spearman rank order correlation, rs(46) = 0.085, p = 0.566]. When compared against patients with failed recanalization at any time patients who presented late but had successful recanalization had smaller core volumes at discharge [median 20 mL versus 53 mL, estimated difference -34 mL (95CI: -211 – +1), p = 0.045], changes in core volume [median +4 mL versus +43 mL, estimated difference -32 mL (95CI: -192 – +1), p = 0.036], and were more likely to have a favorable outcome [14/21, 66.7%, versus 2/9, 22.2%, odds ratio 7.14 (95CI: 1.26 – 34.5), p = 0.046] irrespective of baseline characteristics.

Conclusions
Using MR selection in ACLVO stroke, similar good outcomes after successful thrombectomy may be achieved well beyond 6 hours. Patients who received successful late thrombectomy had smaller completed infarcts and more good outcomes compared with patients who had failed thrombectomy at any time.
<table>
<thead>
<tr>
<th>Outcome</th>
<th>6 Hour Group (n = 24)</th>
<th>Extended Group (n = 25)</th>
<th>Odds ratio / estimate median difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Died / Hospice – No. (%)</td>
<td>4 (16.7)</td>
<td>1 (4.0)</td>
<td></td>
</tr>
<tr>
<td>Favorable outcome – No. (%)</td>
<td>15 (62.5)</td>
<td>14 (56.0)</td>
<td>0.763 (0.243 - 2.397)</td>
</tr>
<tr>
<td>Hospital Days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>5</td>
<td>8</td>
<td>1.0 (0.6 - 2.0)</td>
</tr>
<tr>
<td>Interquartile range</td>
<td>3 – 11</td>
<td>3 – 16</td>
<td></td>
</tr>
<tr>
<td>TICI Score – No. (%)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0 (0.0)</td>
<td>1 (4.0)</td>
<td></td>
</tr>
<tr>
<td>2B</td>
<td>5 (20.8)</td>
<td>3 (12.0)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10 (41.7)</td>
<td>13 (52.0)</td>
<td></td>
</tr>
<tr>
<td>TICI 2B or greater – No. (%)</td>
<td>19 (79.2)</td>
<td>21 (84.0)</td>
<td>1.38 (0.322 – 5.51)</td>
</tr>
<tr>
<td>Final core volume – (mL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>16</td>
<td>22</td>
<td>+4.0 (-13 – +11)</td>
</tr>
<tr>
<td>Interquartile range</td>
<td>6 – 93</td>
<td>10 – 61</td>
<td></td>
</tr>
<tr>
<td>Final age adjusted core index – (mL / age - 100)</td>
<td>0.8</td>
<td>0.8</td>
<td>+0.080 (-0.650 - +1.790)</td>
</tr>
<tr>
<td>Median</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interquartile range</td>
<td>0.2 – 2.3</td>
<td>0.5 – 2.1</td>
<td></td>
</tr>
<tr>
<td>Change in core volume – (mL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>+1</td>
<td>+5</td>
<td>+1.0 (-7.0 – +10.0)</td>
</tr>
<tr>
<td>Interquartile range</td>
<td>-2 – +43</td>
<td>-1 – +26</td>
<td></td>
</tr>
</tbody>
</table>
Clinical Neuroradiological Findings and Behavioral Associations in 16p11.2 Deletions and Duplications

J Owen1, P Bukshpun1, N Pojman1, O Glenn1, J Hunter2, E Sherr1, P Mukherjee3
1UCSF, San Francisco, CA, 2Texas Children's Hospital, Houston, TX, 3San Francisco VA Med Ctr, San Francisco, CA

Purpose
In this study, we investigate the neuroanatomical changes seen in 16p11.2 deletion and duplication carriers using qualitative radiological assessments to identify consistent neuroanatomical features that may correlate with behavioral findings and clinical outcomes.

Materials and Methods
This study includes data from 75 deletion carriers, 70 duplication carriers, 56 familial noncarriers (both deletion and duplication families), and 109 healthy population controls. Participants underwent clinically oriented structural magnetic resonance imaging (MRI) scans and completed a battery of cognitive and behavioral assessments. Magnetic resonance images were reviewed qualitatively by three board-certified neuroradiologists, blinded to group in structured reviews. They were asked to evaluate the scans for 16 development-related neuroradiological categories. Differences in frequency and the cognitive and behavioral sequelae of abnormal radiological findings were assessed with statistics.

Results
In comparison to controls (familial noncarriers and population), deletion carriers were found to have enlarged corpus callosum volumes (p<0.001) and greater likelihood of cerebellar ectopia (p<0.002) and craniocervical junction abnormalities (p<0.001). Deletion carriers with either a cerebellar ectopia or a Chiari I malformation had lower scores on the Vineland communication subscore (p<0.007). Deletions with an increased corpus callosum (N=12) had higher SRS scores (p<0.016) and lower Vineland communication (p<0.049) and social (p<0.011) subscores. Duplication carriers had a reciprocally decreased callosal size (p<0.003), decreased white matter volume (p<0.001), and increased ventricular volume (p<0.001). Duplication carriers with at least one of the above findings had lower full scale IQ (p<0.007) and verbal IQ (p<0.004).

Conclusions
The findings indicate that neuroanatomical alterations can be identified both qualitatively by radiological read and may be useful in predicting impairment within CNV patient groups.
Table 1: Frequency and percentage of each radiological finding is shown for the deletion carriers, duplication carriers, familial non-carriers, and population controls. Using a Fisher’s exact test, p-values were calculated to assess differences in frequency between the carrier and non-carrier groups. P-values highlighted in red are p<0.05 and those with * are survive a Bonferroni correction across radiological categories (p<0.05).

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P-68

6:30AM - 2:45PM

Correlative Pre and Postnatal MR Imaging of Interhemispheric Cysts Associated with Callosal Anomalies.

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\textsuperscript{1}Keck School of Medicine of the University of Southern California, Pasadena, CA, \textsuperscript{2}Children’s Hospital Los Angeles, Los Angeles, CA, \textsuperscript{3}Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, \textsuperscript{4}Children's Hospital Los Angeles, Los Angeles, CA

Purpose
Interhemispheric cysts present with varied radiological and clinical presentations, frequently appearing with callosal anomalies and other congenital central nervous
system (CNS) malformations. There is substantial debate about their etiology, development, and general significance. Barkovich et al. has proposed a classification scheme based on morphology to better understand this complex group of disorders (1). However, despite increased use of fetal MRI for prenatal evaluation of these CNS abnormalities, there are no studies that evaluate the ability of fetal MRI to correctly classify interhemispheric cysts. This study assesses the correlation between the fetal MRI and postnatal MR imaging features and subsequent classification of interhemispheric cysts.

Materials and Methods
We performed a retrospective institutional database search (2005-2014) and found 15 cases for which fetal (EGA 21.1-36.1 weeks) and postnatal (age 0-90 days) imaging studies were performed and interhemispheric cysts diagnosed. Studies were reviewed by two board-certified pediatric radiologists for communication with ventricles, loculation, and signal intensity compared to CSF, in addition to head size, agenesis or hypogenesis of the corpus callosum, third ventricle outflow obstruction, and other developmental abnormalities. Cysts were classified according to these features using the scheme published by Barkovich et al. and compared to postnatal MRI as the gold standard (1).

Results
Classification of cysts on fetal MRI was identical postnatally for 13 of the 15 cases. Fetal MRI detected 12 1a, two 1b, and one 2a, while postnatal MRI detected 10 1a, two 1b, and three 2a. In both cases where classification changed (from Type 1 to 2), cysts identified as communicating on fetal MRI were found to be noncommunicating postnatally.

Conclusions
Fetal MR can accurately characterized and classify interhemispheric cysts associated with callosal anomalies. In utero classification of these malformations can improve our understanding of their development and provide prognostic information for parents.

P-76
Craniosynostosis Imaging with T1 Volume Interpolated 3D Gradient Echo Sequence

L Kuusela1, M Timonen2, A Saarikko3, N Brandstack4, J Hukki5, T Autti4
1University of Helsinki, Department of Physics, Helsinki (HUS), Finland, 2HUS Medical Imaging Center, Helsinki, Finland, 3Department of Plastic Surgery, Helsinki University and Helsinki University Hospital, Helsinki (HUS), Finland, 4HUS Medical Imaging Center, Helsinki (HUS), Finland, 5Department of Plastic Surgery, Helsinki University Hospital, Helsinki (HUS), Finland
Purpose
Computed tomography (CT) commonly is used for diagnostic imaging and postoperative follow-up of patient with abnormal skull shape and premature closure of the cranial sutures (craniosynostosis). Because these patients may be imaged several times during their childhood, the usage of nonionizing modality would be preferred. Purpose of the study was to develop a magnetic resonance (MR) sequence suitable for imaging of the skull bone and cranial sutures, which can easily be segmented and visualized in 3D. The sequence development initially was started based on the work by Eley&co, where a basic 3D gradient echo "Black bone" sequence was used.

Materials and Methods
An in-phase T1 volume interpolated 3D gradient echo (VIBE) sequence with fat saturation was acquired on a 3T Siemens Verio (Erlangen, Germany). The acquisition resolution was 1x1x1 mm³ and the acquisition time was approximately 5 minutes. Four patients were imaged using this sequence, but during the whole span of the development process, totally eight patients were imaged. Skull segmentation was performed with 3D-Slicer software, which included basic thresholding, morphological binary closing and erosion image operations. Finally the segmentation was refined manually.

Results
In Fig. 1 is presented 3D rendered images of the skull.

Conclusions
Images with the skull sutures was obtained by using a 3D VIBE sequence. The main challenges were the intensity fluctuation (i.e., bone is not always black) and the chemical shift artifact, which both complicate the image segmentation. We will continue to develop the sequence and strive for a fully automated skull segmentation tool.
P-69

6:30AM - 2:45PM

Evaluation of the Cochlear Aperture: is MRI Comparable to CT?

D DiVito¹, A Durgam¹, S Herrmann², K Raghuram¹
¹UTMB, Galveston, TX, ²UTMB, League City, TX

Purpose
Achieving good outcomes for children with SNHL, a major cause of disability worldwide, requires early diagnosis and treatment with cochlear implantation. Cross-sectional imaging is paramount to such a task however controversy regarding the optimal modality persists. Computed tomography (CT) and magnetic resonance imaging (MRI) have respective pros and cons. In regard to evaluation of the cochlear aperture, we believe both modalities will provide clinically comparable measurement accuracy, and that MRI will provide no more than 0.5mm of variance compared with CT measurement.

Materials and Methods
Retrospective search of our database revealed 24 pediatric cases of SNHL of which only nine cases had CT and MRI studies following our protocol. All MRI studies were completed on a Siemens 3T magnet utilizing 3D SPACE or 3D CISS imaging. Measurements of the cochlear aperture were completed by a junior resident and a faculty member. The MR and CT measurements then were compared and a mean intermodality variance was calculated.

Results
Images were analyzed from nine subjects, three male, six female, with a mean age of 7 years. Comparison of a total of 36 cochlear aperture measurements resulted in a mean variance of 0.36mm with a standard deviation of 0.23mm between CT and MRI.

Conclusions
Our case series suggests that MRI is comparable to CT for the evaluation of the cochlear aperture with clinically insignificant variation in measurements between the two. Therefore we believe MRI alone is suitable to evaluate the cochlear aperture for pre-operative planning in pediatric candidates for cochlear implantation.

P-73

6:30AM - 2:45PM

Extra-Axial Hemorrhage and Cerebellar Growth in Premature Infants

L Tinkleman¹, E Mahdi¹, M Bouyssi-Kobar¹, J Murnick¹, M Brossard-Racine¹, C Loucas¹, T Chang¹, C Limperopoulos¹
Children's National Health System, Washington, DC

Purpose
Cerebellar injury is recognized increasingly in very preterm infants (VPT). The potential neurotoxic effects of extra-axial blood on the surrounding tissue remain poorly understood. The objective of this study was to examine cerebellar growth and delineate clinical risk factors associated with isolated extra-axial hemorrhage (EAH) in VPT.

Materials and Methods
We prospectively enrolled VPT [gestational age (GA) at birth <32 weeks] and healthy term controls and performed unsedated magnetic resonance imaging (MRI) studies at preterm and term equivalent age (TEA). Susceptibility-weighted images and anatomical T2-weighted MRI images were acquired. Using ITK-SNAP software, the cerebellum was segmented manually and global volumes were extracted. Early clinical risk factors were captured through medical record review. Clinical risk factors were compared using Chi-Square analyses and differences in cerebellar volumes were analyzed using ANCOVA.

Results
We studied 69 infants (39 VPT, 10 with EAH; and 30 controls) at a mean GA at MRI of 40.58±2.0wks for VPT and 41.43±1.6wks for term controls. Very preterm infants also underwent a preterm MRI at a mean GA of 33.91±1.9wks. All infants had structurally normal brain MRI studies. Mean cerebellar volumes were lowest among VPT with EAH (17.55±3.8cc), versus VPT without EAH (20.25±3.52cc), and term controls (22.80±3.1cc). Cerebellar volume was significantly reduced in VPT compared to term controls (P=.0008) and borderline significant in infants with versus without EAH (p=.0785). Pressor support (p=.0012), steroids (p<.0001) and clinical sepsis (p=.009) were associated significantly with the presence of EAH in VPT, while birth weight and GA was not (p>.05).

Conclusions
Our preliminary data suggest that infratentorial EAH in VPT is associated with greater illness severity. Very preterm infants at TEA show significant cerebellar growth failure compared to controls at TEA, while cerebellar volumes were borderline lower in the subset of VPT with EAH. A larger sample size will be needed to more precisely delineate the impact of EAH on third trimester cerebellar growth in VPT.

P-66

Fanconi Anemia: Correlating CNS Malformations and Genetic Complementation Groups

B Johnson-Tesch1, R Gawande1, D Nascene1

6:30AM - 2:45PM

54th Annual Meeting & Foundation of the ASNR Symposium 2016

Page 1180
Purpose
Congenital central nervous system (CNS) and skull base abnormalities in Fanconi anemia (FA) patients were characterized radiographically to look for associations with genetic complementation groups.

Materials and Methods
Chart review identified 36 FA patients with available brain MRIs (average age, 11.3 years; range, 1-43; M:F, 19:17), and congenital abnormalities of CNS, skull base, and posterior fossa were identified. These were compared to age- and sex-matched controls (average age, 7.9 years; range, 2-18; M:F=9:10). Genetic and FA complementation group information was available for 27 patients [15 FA-A, 2 FA-C, 3 FA-G, and 7 FA-D1 (BRCA2)].

Results
Of the 36 FA patients, 75% had at least one congenital CNS or skull base abnormality. These included hypoplastic clivus (n=12), hypoplastic adenohypophysis (n=11), pontine hypoplasia (n=4), vermis hypoplasia (n=3), platybasia (n=8), pontocerebellar hypoplasia (n=7), and ectopic neurohypophysis (n=6). Average pituitary volume was significantly less in FA patients (p<0.0001) compared to controls. Basal angle was significantly greater (p=0.0062); however, the basal angle of patients with FA-D1 was not significantly different from controls (p=0.239). Clivus length was significantly less in the FA group (p=0.0021); however, significance was only observed in the FA-D1 subgroup (p<0.0001). Of the seven patients meeting criteria for pontocerebellar hypoplasia, six were confirmed to have FA from biallelic mutations in the BRCA2 gene (FA-D1).

Conclusions
Patients with FA have higher incidences of ectopic neurohypophysis, adenohypophysis hypoplasia, platybasia, and other midline CNS and skull base abnormalities than age- and sex-matched controls. Patients with these abnormal intracranial findings, including pontocerebellar hypoplasia, are more likely to have mutations in the BRCA2 gene (FA-D1).
Figure 1. A and B) Mid-sagittal image demonstrates multiple midline and skull base abnormalities including platybasia, short clivus length, and ectopic neurohypophysis tissue (arrow) with hypoplasia of the adenohypophysis residing within the sella turcica (arrow head). C and D) Pontocerebellar hypoplasia in Fanconi anemia patient with FA D1 (BRCA2) complementation group.
Purpose
Hyperintense cerebrospinal fluid (CSF) hyperintensity in FLAIR magnetic resonance imaging (MRI) often is observed in sedated children. This phenomenon can mimic leptomeningeal pathology and lead to a misdiagnosis. The purpose of this study was to investigate whether magnetization-prepared (MP) FLAIR MRI can reduce hyperintense CSF artifacts and improve image quality compared to conventional (non-MP) FLAIR MRI.

Materials and Methods
Bloch simulation for MP and non-MP FLAIR sequences was performed for tissue contrast between GM, WM and oxygenated CSF. We retrospectively reviewed 85 epileptic children (41 with non-MP FLAIR and 44 with MP FLAIR, using 3D acquisition for both). General anesthesia was maintained during the MRI scan. All patients received supplemental 70-80% oxygen via nasal cannula. Hyperintense CSF artifacts were scored from zero to three points based on degree of CSF signal intensity and compared between two sequences. The CNRs between GM, WM, and CSF were evaluated to assess general image quality from both sequences.

Results
Bloch simulation demonstrated that hyperintense CSF artifacts can be reduced, and image contrast between GM and WM increased in MP FLAIR compared to non-MP FLAIR. Hyperintense CSF artifact scores were significantly lower in MP FLAIR than in non-MP FLAIR (p<0.01). The CNRs for GM-WM, GM-CSF, and WM-CSF were significantly higher in MP FLAIR than in non-MP FLAIR (4.14±1.28 versus 3.28±1.15, 16.14±2.43 versus 12.85±2.79, 13.82±3.16 versus 10.67±2.78, p<0.05).

Conclusions
MP 3D FLAIR MRI can significantly reduce CSF artifacts and can increase tissue CNR beyond the levels achieved with conventional non-MP 3D FLAIR MRI.
P-78

Is Prone MRI Useful in the Evaluation of Tethered and Re-tethered Cord?

M Stamates¹, D Frim¹, S Ali¹
¹University of Chicago Medical Center, Chicago, IL

Purpose
Tethered cord (TC) syndrome is diagnosed by a combination of clinical and radiological findings including identifying a low-lying conus and a lesion involving the cauda equina or filum terminale. Diagnosis of cord re-tethering is particularly challenging, with conventional magnetic resonance imaging (MRI) sequences often demonstrating persistent low-lying conus, and the decision to re-explore primarily relies on clinical findings. Prior studies have clearly shown the ventral motion of the conus on prone MRI in normals, but have questioned its added value in patients with
both TC and re-tethered cord. At our institution, we routinely have obtained prone MRI when TC is suspected, and the purpose of this study is to evaluate its diagnostic utility in a larger sample than currently is available in the literature.

**Materials and Methods**

Retrospective review was performed of 47 patients with cord untethering performed at our institution from 2010 to 2015 with intra-operatively documented TC and available pre-operative MRI with prone sequences. Ventral motion of the conus between supine and prone sagittal T2-weighted sequences was measured by a neurosurgery resident under the supervision of a board-certified neuroradiologist. Also assessed was conus level in the axial images and the etiology of cord tethering, such as prior myelomeningocele repair, occult spinal dysraphism such as lipoma, and others such as prior trauma. Ventral motion measurements also were obtained in an additional group of 33 patients who had an extremely low suspicion for tethered cord and underwent prone MRI; these were classified as normal controls. Spinal canal diameter also was obtained to calculate percentage of ventral conus motion.

**Results**

Forty of 47 patients (median age 10 years; range 1-66) with surgically documented TC demonstrated absent or minimal ventral motion on pre-operative prone MRI sequences (85% sensitivity, 100% specificity). Mean ventral conus motion in TC and re-TC patients was less than 5%. Mean ventral conus motion in the normal group was 19.7±10% (statistically significant difference between TC and normal, p<0.0001). Conus position varied, including cases with normal conus position ("occult TC"). Most patients with prior untethering and available follow-up MRI (mean 6 months post-op) were noted to exhibit absent or minimal motion, presumably related to scarring, despite absence of clinical findings to suggesting re-tethering.

**Conclusions**

In our retrospective analysis, prone imaging was found to be sensitive and specific, and we believe has a role as supportive evidence in the diagnosis of tethered and re-tethered cord. However, if initial follow-up MRI shows absent motion, additional prone images on subsequent MRI studies are not useful. Future work will assess possible inverse correlation of degree of ventral motion with clinical impairment.

**P-70**

6:30AM - 2:45PM

**Morphometric MRI Analysis of Focal Cortical Dysplasia in Medically Refractory Epilepsy**

L Wong-Kisiel¹, D Tovar-Quiroga¹, R Witte¹, G Worrell¹, J Britton¹, B Brinkmann¹

¹Mayo Clinic, Rochester, MN
Purpose
Focal cortical dysplasia (FCD) is a common epileptogenic pathology with distinct magnetic resonance imaging (MRI) features including cortical thickening, abnormal gyration, and loss of gray-white differentiation. However, FCD can be subtle by visual assessment. Voxel-based morphometric MRI analysis quantitatively compares the individual patient with a control group, and can highlight FCD. This study evaluated morphometric analysis in medically refractory epilepsy with pathology-confirmed FCD.

Materials and Methods
We retrospectively analyzed 12 adults and 21 children with pathology-confirmed FCD (male 60%; median age at surgery 15 years). Using statistical parametric mapping (SPM12), an automated morphometric analysis program (MAP) generated z-score maps derived from T1 images and compared cases to healthy adult or pediatric controls (grouped by age 5-9, 10-13, 14-18 years). A dominant MAP-positive (MAP+) focus was determined visually in concert with coregistered T1 or MPRAGE. MAP+ was defined as abnormal extension of gray matter into white matter (extension image) or blurring of the gray-white matter junction (junction image).

Results
Initial radiologist MRI review identified FCD in 17 cases, non-FCD abnormalities in 11, and was MRI-negative in five cases. MAP was negative in 2/33 cases (one non-FCD abnormality and one MRI-negative). Of the 31 MAP+ cases, the MAP+ focus was concordant with the radiologist-identified FCD lesion in 16/17 cases, and concordant with the non-FCD abnormality in 5/10 cases. The MAP+ focus was concordant with the resection area in 16/17 MRI+ FCDs, 4/10 non-FCD abnormalities, and in 3/4 MRI-negative cases. In eight cases with MAP+ focus discordant from radiographic lesion or resection area, four showed T2 MRI abnormalities and two had extensive anatomical abnormalities (ventricular dilation, hemimegalencephaly).

Conclusions
Morphometric MRI analysis can be used to identify FCD in T1-weighted MRI for presurgical evaluation. Caution should be used in applying this method in cases with gross anatomical deformations.

P-71
6:30AM - 2:45PM

Relationship Between Cortical Thickness and Functional Activation in Polymicrogyria

D Montanaro1, M Lenge2, C Barba2, F Frijia1, G Aghakhanyan1, S Pellacani2, A De Ciantis2, F Lombardo1, S De Cori1, P Totaro1, D Chiappino3, R Canapicchi1, R Guerrini2
Purpose
Polymicrogyria (PMG) is a malformation of the cerebral cortex secondary to abnormal migration and postmigrational development. Its pathogenesis is still poorly understood, and its histopathology, clinical features, topographic distribution, and imaging appearance are heterogeneous. Functional studies suggest variability in cortical representation, probably in relation to both the severity of anatomical disruption and the involved modality. Our study aims at evaluating sensorimotor cortical function in PMG using magnetic resonance imaging (MRI) morphometric analysis and functional balance for simple sensorimotor tasks.

Materials and Methods
Three patients with unilateral perisylvian PMG, normal cognitive level and mild motor deficits, underwent MRI volumetric T1-weighted acquisition and fMRI with block-designed paradigm of sensory and motor tasks of hands, feet and mouth. We processed structural images with the FreeSurfer pipeline and used GLM to define morphometric (thickness/gyrification) alterations in PMG cortex with respect to a structural template. BOLD-fMRI data were processed applying AFNI and FSL software. Functional activations were projected on the template to highlight the relationship between morphometric alterations and functional activations.

Results
Surface-based morphometry confirmed PMG to be unilateral only in one patient; in the other two it revealed a bilateral involvement. BOLD-fMRI results identified cortical areas activated by each task, predominantly represented on the contra-lateral hemisphere. In the two patients with bilateral PMG cortex involving the temporal-frontal-parietal cortex, the motor task elicited an intense BOLD activation in the areas of abnormal thickness/gyrification. In the only case with confirmed unilateral PMG involving the temporal-parietal operculum and insular cortex, no BOLD activation was observed in the areas of abnormal thickness/gyrification.

Conclusions
The present study confirms that surface-based image-processing is more sensitive than visual inspection for detecting cortex abnormalities of thickness/gyrification. BOLD responses to motor and sensitive tasks can be observed in polymicrogyric cortex. Our findings confirm possible preservation of cortical function in PMG, which might contribute to the clinical phenotype.
Subconcussive Head Impacts in Youth Football Associated with Picture Memory Performance and Microstructural Changes in the Inferior Longitudinal Fasciculus

N Bahrami1, S Rosenthal2, Y Jung3, J Maldjian4, C Whitlow5

1Virginia Tech-Wake Forest University School of Biomedical Engineering & Sciences, Winston Salem, NC, 2Wake Forest University, Winston Salem, NC, 3Wake Forest School of Medicine, Winston-Salem, NC, 4University of Texas Southwestern, Dallas, TX, 5Wake Forest University School of Medicine, Winston-Salem, NC

Purpose
The purpose of this study was to determine the effects of cumulative subconcussive head impact exposure associated with youth football (age 8-13 years old) on cognitive performance and fractional anisotropy (FA) in specific white matter (WM) tracts known to be undergoing rapid developmental change in this age range and shown to be affected by mild traumatic brain injury (mTBI) (1-3). We hypothesized that post versus preseason changes in cognitive performance would be associated with FA changes in developing WM tracts.

Materials and Methods
Twenty-two male football players (age: 8-13) without a history of concussion prior to or over the football season participated in this IRB approved study. All subjects received pre and postseason magnetic resonance imaging (MRI), including structural and diffusion tensor imaging (DTI). Magnetic resonance imaging was performed on a 3T Siemens Skyra with a high resolution 20 channel head/neck coil using a 2D single-shot EPI diffusion sequence (2.2 x 2.2 x 3 mm; 15 diffusion directions; b=1000/2000). Fiber tracking was conducted via automated fiber quantification (AFQ) (4). We extracted intrahemispheric association fibers of the inferior/superior longitudinal fasciculus (ILF/SLF) and the inferior fronto-occipital fasciculus (IFOF), as these tracts are undergoing relatively rapid developmental changes during this age range and they have been shown to be affected by mTBI (5). Fractional anisotropy measurements across 100 equidistant nodes of the fiber were used to calculate the mean FA within the fiber. The NIH toolbox was used to evaluate cognitive function pre and postseason, including picture (visual vocabulary) memory, working memory and inhibitory control, all of which have been shown to be affected by mTBI. Linear regression analysis was conducted to evaluate the relationship between post-pre FA and cognitive performance, with time between scans and preseason cognitive scores as covariates.

Results
There were no statistically significant associations between delta cognitive score and FA changes in the IFOF and SLF. However, there was a statistically significant linear relationship between delta picture memory performance and change in FA in the left
ILF (p = 0.006) and right ILF (p = 0.018) (Fig. 1), which connects the occipital and anterior temporal lobes.

Conclusions
This study adds to the growing body of evidence that cumulative head impact exposure associated with a single season of football can result in brain MRI and neurocognitive changes, even in the absence of concussion (1-3).

Figure 1. Scatterplot; a) depicts the relationship between delta FA of the left ILF and delta picture memory performance, b) depicts the relationship between the right ILF and delta picture memory performance.
Ultra Low Dose 3D CT in Patients with Craniofacial Anomalies

A komarraju¹, R Ramakrishnaiah², E Ocal³, A Kanfi⁴, A Rowell⁵, M Rettiganti³, C Glasier³
¹University of Arkansas for Medical Sciences, Little rock, AR, ²University of Arkansas for Medical Sciences, Little Rock, AR, ³Arkansas Children's Hospital, Little rock, AR, ⁴Arkansas Children's Hospital, Little Rock, AR, ⁵University of Arkansas for Medical Sciences, little rock, AR

Purpose
Pre-operative 3D computed tomography (CT) is standard of care in patients with craniofacial anomalies. In these patients, bone structural evaluation is paramount and brain evaluation is not of primary concern. Most of these patients undergo multiple CT studies. The purpose of our study is to document reduction of radiation dose by implementation of ultra-low radiation dose CT protocol in patients with craniofacial anomalies.

Materials and Methods
IRB approved retrospective study at a tertiary care pediatric hospital. Two hundred consecutive patients who underwent head CT for pre-operative evaluation of craniofacial anomalies were selected. The kVp, mA, CT dose index (CTDI), and dose-length product (DLP) were documented from the dose page. Patients were stratified based on age for determining age specific effective dose and for age matched comparison. The age specific effective dose was derived by using established conversion factor (1). Standard t-test was performed to determine statistical significance of radiation dose reduction.

Results
Ninety patients had low dose CT and 110 patients had ultra-low dose CT of the head. All patients had diagnostic quality CT studies. The low-dose CT was performed at 120 kVp and 100 mA. The ultra-low-dose CT was performed at 80kVp and fixed 80mA. The minimum, maximum and mean effective dose before introduction of the ultra-low dose protocol was 0.8 mSv, 6.9 mSV and 2.82 mSv. The minimum, maximum and mean effective dose after introduction of the ultra-low dose protocol was 0.6 mSv, 3.8 mSV and 1.37 mSv. The reduction in the effective radiation dose was statistically significant (standard t-test; p<0.0001).

Conclusions
Ultra-low dose CT head provided diagnostic images with a significantly decreased radiation dose compared to the regular low-dose protocol.
Effective dose with low dose CT protocol

Effective dose with Ultra low dose CT protocol

Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall A
Advanced Diffusion Acquisitions of the Cervical Spinal Cord are Feasible and Potentially More Sensitive to Relapsing-Remitting MS Pathology

I de Kouchkovsky¹, E Fieremans¹, M Bruno¹, J Veraart¹, T Shepherd¹
¹New York University School of Medicine, New York, NY

Purpose
Relapsing-remitting multiple sclerosis (RRMS) is a disease of young adults characterized by repeated episodes of inflammation and demyelination, which often progresses to irreversible neurodegeneration. In addition to focal T2-hyperintense lesions, magnetic resonance imaging (MRI) of patients with RRMS demonstrates occult axonal pathology throughout the central nervous system. Diffusion kurtosis imaging (DKI) is a clinically feasible extension of diffusion tensor imaging (DTI) that also models the non-Gaussian diffusion properties of nervous tissue (1). Diffusion kurtosis imaging thus allows for the characterization of compartment specific WM tract integrity (WMTI), including estimations of the axonal water fraction (AWF) and radial extra-axonal diffusivity (De,rad). These novel metrics are potential markers for axonal degeneration and demyelination (2-4). Here we compared DTI- and DKI-derived metrics in the cervical spinal cord of RRMS patients to controls.

Materials and Methods
Nineteen RRMS patients (13 females; mean age 44±10 years) and seven matched controls (5 females; mean age 43±14 years) underwent cervical spinal cord DKI (137 diffusion directions, b-values = 0-2.5 ms/μm², TR/TE 3000/96 ms, FOV 240x800 mm², matrix size 100x30, slice thickness 3 mm, 12 coronal slices, time=7:09 min) using a Siemens Prisma 3-T MRI with parallel transmission technology. T2 lesion burden was quantified on standard sequences. Diffusion tensor imaging [fractional anisotropy (FA), mean, axial and radial diffusivities (MD, AD & RD)], DKI [mean, axial and radial kurtosis (MK, AK & RK)], AWF and De,rad maps were calculated for each subject. Regions of interest (ROIs) of the whole C2-C6 cervical spinal cord were created by thresholding b0, AK and MD maps to isolate nervous tissue. Analysis of co-variance was performed between RRMS and controls; Pearson correlations to the number of T2-lesions were also derived, correcting for age in all instances.

Results
Multi-shell, high angular resolution diffusion acquisitions of the cervical spinal cord were feasible in RRMS patients with new parallel transmission techniques. Diffusion kurtosis imaging and AWF, but not DTI, appeared sensitive to RRMS cervical spinal cord pathology (see Table). In particular, we observed a 7.2% decrease in MK, a
10.3% decrease in RK, and 5.4% decrease in AWF (all \( P \leq 0.05 \)). A 4.5% decrease in AK approached statistical significance. No diffusion MRI parameter correlated with T2-weighted lesion count.

Conclusions
Diffusion kurtosis imaging-derived metrics appeared more sensitive to pathology in RRMS patients compared to conventional DTI-derived metrics. The decrease in RK and AWF likely reflect demyelination, remyelination, axonal size changes and axonal loss, while the observed trend of decreased AK is suggestive of inflammation and gliosis (3, 4). Interestingly, these metrics did not correlate with T2 lesion burden in individual subjects, and therefore may reflect pathology beyond the confines of focal lesions. As such, they may provide novel markers of disease burden and progression in MS.

### Table. DTI, DKI and WMTI group differences (mean ± SD)

<table>
<thead>
<tr>
<th>Model</th>
<th>Metric</th>
<th>Controls</th>
<th>RRMS</th>
<th>% change</th>
<th>P-value$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTI</td>
<td>FA</td>
<td>0.61 ± 0.10</td>
<td>0.61 ± 0.03</td>
<td>0</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>MD</td>
<td>1.10 ± 0.03</td>
<td>1.12 ± 0.05</td>
<td>+1.8</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>RD</td>
<td>0.66 ± 0.01</td>
<td>0.68 ± 0.05</td>
<td>+3.0</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>AD</td>
<td>1.98 ± 0.06</td>
<td>2.01 ± 0.09</td>
<td>+1.5</td>
<td>0.50</td>
</tr>
<tr>
<td>DKI</td>
<td>MK</td>
<td>0.97 ± 0.05</td>
<td>0.90 ± 0.06</td>
<td>-7.2</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>RK</td>
<td>1.65 ± 0.09</td>
<td>1.48 ± 0.15</td>
<td>-10.3</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>AK</td>
<td>0.66 ± 0.04</td>
<td>0.63 ± 0.03</td>
<td>-4.5</td>
<td>0.06</td>
</tr>
<tr>
<td>WMTI</td>
<td>AWF</td>
<td>0.37 ± 0.01</td>
<td>0.35 ± 0.02</td>
<td>-5.4</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>De_rad</td>
<td>1.11 ± 0.07</td>
<td>1.14 ± 0.07</td>
<td>+2.7</td>
<td>0.33</td>
</tr>
</tbody>
</table>

$^1$MD, RD, AD and De_rad are expressed in \( \mu m^2/\text{ms} \); all other metrics are dimensionless.

$^2$Analysis of co-variance, with subject age as a co-variate.

(Filename: TCT_P-79_Table.jpg)

**P-80**

6:30AM - 2:45PM

**Central Canal and/or Anterior Median Fissure: MR Imaging in Multiple Sclerosis Patients Versus Control**

E Peak$^1$, L Wang$^1$, T Tomsick$^1$

$^1$University of Cincinnati, Cincinnati, OH

Purpose
The anterior median fissure and central canal of the spinal cord may be seen on magnetic resonance imaging (MRI) with variable frequency. We hypothesize
differences in incidence and imaging characteristics of the fissure and central canal on MRI in multiple sclerosis patients and controls exist that may aid in distinction of the two structures.

Materials and Methods
Two neuroradiologists retrospectively analyzed cervical MRI of 358 patients from six MR scanners (two 3T, four 1.5T) for a T2WI-hyper-intense (HI) fissure and a central HI-focus on axial images. Data from 182 age- and sex-matched controls and 176 MS patients were analyzed in Excel with Chi square, Student's T, and kappa statistic 2 tests.

Results
More spinal cord HI-foci and fissures on the spinal cord were found in MS patients than in control patients (p=0.0001, p=0.0347, respectively). Post-hoc analysis of 1.5T scans separately from 3T scans also shows more HI-foci and fissures on the spinal cord were found in MS patients than in control patients at 1.5T (p=0.0029, p=0.0221, respectively), and at 3T (p=0.0007, p=0.0286, respectively). Post hoc testing of agreement between neuroradiologists is moderate for identification of sagittal channels (κ =0.55), and substantial for focal HI (κ=0.64) and fissures (κ =0.75). No significant difference in fissure depth and focal HI depth (p=0.500) was measured.

Conclusions
Focal HI and fissures in the cervical spinal cord are more common in patients with MS on cervical MRI. This may indicate cord atrophy. Position alone did not distinguish a focal HI as within the central canal versus the anterior median fissure.
Correlation Between Spinal Cord Demyelinating Plaque Conspicuity on T2 Versus Proton Density and Follow-Up MR Imaging Change in Lesion Size

A Naqvi¹, I Silver¹, J Butler¹, S Grahovac¹, W Hopman², O Islam³
¹Queen's University, Kingston, Ontario, ²Clinical Research Centre, Kingston General Hospital, Kingston, Ontario, ³Queen's University, Kingston, ON - Ontario
Purpose
Studies have shown that STIR-FSE and T2-W sequences with short echo times are better for demonstration of spinal multiple sclerosis plaques compared to proton density (PD) or FLAIR sequences. However, on occasion, spinal cord lesions are better appreciated on PD. The cause for this is unknown. Theoretically, there may exist a difference in lesion biology depending on lesion conspicuity on T2 versus PD. It would be interesting to follow such lesions in order to determine if there is a difference in size change of individual lesion over time based on T2 or PD conspicuity.

Materials and Methods
One hundred cervical spinal cord magnetic resonance imaging (MRI) studies and follow-up examinations performed from 6 months to 3 years in clinically confirmed MS patients were assessed retrospectively and independently by four neuroradiologists for demyelinating lesion conspicuity on T2 and PD. All imaging was performed on a Siemens 1.5T MRI scanner with same imaging parameters. The size and number of lesions were recorded, along with subjective evaluation of lesion conspicuity for each lesion (better seen on T2, equally well seen on T2 and PD, or better seen on PD). The same evaluation was performed on at least one follow-up examination on all patients.

Results
There was no statistically significant correlation of change in lesion size on follow-up MRI examinations with differences in lesion conspicuity on T2 versus PD.

Conclusions
While there may be a biological difference in lesions based on differences in visibility on T2 and PD sequences, there was no relation of difference in lesion size on follow-up MRI examinations between T2 or PD conspicuous lesions. However, for future studies, it would be interesting to assess possible differences in clinical presentation or prognosis depending on lesion conspicuity between T2 and PD sequences.

Monday
7:30AM - 8:30AM
Washington Marriott Wardman Park, Marriott Ballroom

1A-Monday Morning SAM - Vascular - Audience Response (AR) Self Assessment Module (SAM)
1A-1

MRS Surveillance Imaging of Unruptured and Endovascularly Treated Intracranial Aneurysms
Bell, D.
Brigham and Women's Hospital
Boston, MA

1A-1A

Questions and Answers

7:55AM - 8:00AM

1A-2

Selected Vascular Diseases of the Brain and Spine

Tong, F.
Emory University School Of Medicine
Atlanta, GA

1A-2A

Questions and Answers

8:25AM - 8:30AM

Monday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Marriott Ballroom

2A-ASPNR Programming: Pediatric Neuroimaging for the Adult Neuroradiologist
Audience Response (AR) Self Assessment Module (SAM)

2A-1

Congenital Spinal Cord Anomalies: Top 10 Things to Know

8:35AM - 8:50AM
Rossi, A.
IRCCS Istituto Giannina Gaslini
Genova, Genova

2A-2

**Pediatric Brain Imaging Pearls and Pitfalls**

Palasis, S.
Children's Healthcare Of Atlanta
Atlanta , GA

2A-3

**Birth Trauma & HII: What You Need to Know**

Silvera, V.
Boston Children's Hospital
Boston, MA

2A-4

**Pediatric Head & Imaging Pearls**

Robson, C.
Boston Children's Hospital
Boston, MA

2A-5

**Questions and Answers**
Monday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Washington 4/5/6

2B-ASHNR Programming: Update on Temporal Bone Imaging

2B-1
8:35AM - 9:00AM
Contemporary Imaging of Hearing Loss

Salzman, K.
University Of Utah
Salt Lake City, UT

2B-2
9:00AM - 9:30AM
Inflammatory Disease of the Temporal Bone

Shatzkes, D.
Lenox Hill Hospital
New York, NY

2B-3
9:30AM - 10:00AM
Imaging of the Facial Nerve

Wiggins, R.
University Of Utah
Salt Lake City, UT

Monday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Washington 1/2/3

2C-Young Professional Programming: Adding Value to Your Practice

2C-1
8:35AM - 9:00AM
Radiology's Role in Value Based Care
Krishnaraj, A.
University of Virginia Health System
Charlottesville, VA

2C-2

Where are the Opportunities for Neuroradiologists Within the Threats to Us and Our Practices

Lexa, F.
Wharton School, Univ. of Pennsylvania
Philadelphia, PA

2C-3

Utilizing Midlevel Professionals

Chokshi, F.
Emory University School of Medicine
Atlanta, GA

2C-4

Discussion

Monday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Roosevelt 1-3

2D-PARALLEL PAPER SESSION: Turbo Talks - Aneurysms: Imaging and Intervention
O-1

8:35AM - 8:38AM
Younger Patients are at Higher Risk for Rupture when Multiple Intracranial Aneurysms are Present

A Liberato¹, S Shah¹, I Barnaure¹, N Maza¹, G Gonzalez¹, J Hirsch¹, J Romero¹
¹Massachusetts General Hospital, Boston, MA

Purpose
Demographics and cerebrovascular risk factors and their association with aneurysm rupture in patients with single intracranial aneurysm (IA) have been extensively studied. However, correlation between these risk factors and aneurysmal rupture in patients with multiple intracranial aneurysms (MIA) has not been well established. Our purpose is to evaluate the risk factors for aneurysm rupture in patients with MIA.

Materials and Methods
We reviewed our radiology database to identify patients with MIA presenting over a 6.6 year period. Subjects with > 1 saccular intracranial aneurysm (≥ 2.0 mm in largest diameter) were included in the study. Infundibular dilatations were excluded. Two investigators independently reviewed the computed tomography (CT)/CTA images for subarachnoid hemorrhage and aneurysm characteristics. Medical records were assessed for patient's demographics (age/sex), history of smoking, hypertension (HTN), diabetes (DM) and hyperlipidemia (HLD). Correlation between risk factors and aneurysm rupture was analyzed using univariate and multivariable statistical models.

Results
A total of 425 patients and 1080 aneurysms were included in the study. The female to male ratio was 3.5:1. History of smoking, HTN, DM and HLD was found in 61% (260), 70% (297), 15% (64) and 46% (197) of patients, respectively. Patients with ruptured aneurysms (102) were younger (mean 57.5 years) than patients with unruptured aneurysms (mean 61.7 years, p-value 0.006). Multivariable analyses showed that age was a predictor for aneurysm rupture (OR 0.975; 95% CI 0.958-0.992; p-value 0.004). Univariable/multivariable analyses demonstrated no statistically significant correlation between sex, smoking status, HTN, DM, HLD and aneurysm rupture.

Conclusions
Among the studied risk factors only age was associated with aneurysm rupture in patients with MIA. Younger patients were at higher risk for rupture when multiple intracranial aneurysms were present.

O-2
8:38AM - 8:41AM

Aneurysm Location and Size Predict Rupture in Patients with Multiple Intracranial Aneurysms
A Liberato¹, S Shah¹, I Barnaure¹, N Maza¹, G Gonzalez¹, J Hirsch¹, J Romero¹
¹Massachusetts General Hospital, Boston, MA

Purpose
When multiple intracranial aneurysms (MIA) are present, identification of the one at highest risk of rupture is crucial for patient management. Aneurysm location and size have been associated with rupture, but confirmation of these results in a large patient cohort is still lacking. Hence, our aim was to assess aneurysm-related risk factors for rupture in patients with MIA.

Materials and Methods
We reviewed our database to identify patients with MIA presenting over a 6.6 year period. Subjects with > 1 saccular intracranial aneurysm (≥ 2.0 mm in largest diameter) were included in the study. Two investigators independently reviewed computed tomography (CT)/CTA images for subarachnoid hemorrhage and aneurysm characteristics. Site of rupture was established by CT/CTA and conventional angiography. Segments of internal carotid artery (ICA) were assessed according to Shapiro et al. Correlation between risk factors and aneurysm rupture was performed using univariate analyses.

Results
A total of 1080 aneurysms (median size 4.0mm, range 2-57mm) from 425 patients with MIA were included. Most patients (62%) had two aneurysms (range 2-7). Of the aneurysms, 9% (102) were ruptured. Ruptured aneurysms were larger (median 7.0mm) than unruptured aneurysms (median 4.0mm; p<0.001). Larger aneurysms were more prone to rupture (5 - 7mm, OR 3.2; ≥ 7 mm, OR 5.9) compared to smaller aneurysms (<5mm; p<0.001). The most frequently ruptured aneurysms were at the ACom (27%) and PCom arteries (24%) and their rate of rupture was 23% (28/124) and 23% (24/104), respectively. They were more likely to rupture compared to other sites (OR 3.5 / OR 3.3; p<0.001). Most aneurysms (28%, 298) were at the paraophthalmic ICA, but they were not prone to rupture (OR 0.05, p<0.001).

Conclusions
In patients with MIA, ACom and Pcom artery aneurysms and size above 5mm are at higher risk of rupture. Aneurysms located in the paraophthalmic region demonstrate a low risk of rupture.

O-3
8:41AM - 8:44AM

Volume, Surface Area and Surface Area to Volume Ratio: A Potentially Useful Measures in the Management of Patients with Small Intra-cranial Aneurysms.

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Purpose
The management of unruptured, small intracranial arterial aneurysms or SIAs (≤7 mm in size) remains nonuniform and controversial despite the results of observational studies like the ISUIA, in part because SIAs are paradoxically responsible for the majority of aneurysmal subarachnoid hemorrhages (SAH). Recently, there has been growing interest in physical parameters other than maximum aneurysm size such as variables obtained with computational hemodynamics for estimating rupture risk in cerebral aneurysms, however, these analyses are complicated and show confounding results. We report on the differences between stable unruptured SIAs and ruptured SIAs when the volume, surface area, and surface area to volume ratio (SAV) are measured using simple techniques to better quantify risk of rupture as compared to size alone.

Materials and Methods
We retrospectively reviewed the clinical database at our institution from 1/1/2012 to 6/1/2014 and identified patients with unruptured and ruptured SIAs. For unruptured aneurysms, we included patients with stable aneurysm size and morphology at a minimum of 1 year follow up, sacular morphology, ≤7 mm maximum aneurysm diameter and no intervening treatment. Ruptured aneurysms were included in the analysis if they were sacular in morphology and ≤7 mm in size at their maximum diameter. Computed tomography angiography (CTA) or magnetic resonance angiography (MRA) data were used to perform three-dimensional (3D) analysis with Fovia (Palo Alto, CA), MeshLab (Pisa, Italy), and Artec Studio (Luxembourg, Luxembourg) to accurately measure the size, surface area and volume. Results for the two groups were compared using chi-square and Cox-Snell regression modeling.

Results
Of the 100 aneurysms analyzed, 71 were unruptured and 29 were ruptured SIAs. There were no significant differences in demographics between the two groups. Analysis of Cox-Snell revealed that the volume was the best predictor of rupture risk of SIAs followed by SAV and surface area with size being the worst indicator, although the receiver-operating characteristic (ROC) area under curve analyses showed no significant differences between the indices. Decision tree models showed treatment threshold values for volume, SAV, surface area, and size to be >25.4 mm³, <1.5/m, >71.4 mm², and >5.4 mm, respectively, in unruptured SIAs.

Conclusions
The volume, SAV and surface area appear to be better indicators of rupture risk for SIAs than size alone, especially for aneurysm size ranging from 4 to 6 mm. Volume appears to be the best indicator of all indices studied and could be added to existing decision making tools to identify patients with incidentally discovered SIAs who can be managed conservatively versus those in whom treatment may be justified.
Posterior Communicating Artery Aneurysms Exhibit Higher Growth Rate and Aspect Ratio vs. Other Growing Aneurysms

A Chien¹, V Lau¹, Q Yu¹
¹David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
Posterior communicating artery (Pcom) aneurysms often are associated with high rupture risk. This study compares the morphological characteristics between growing Pcom aneurysms and other types of growing aneurysms.

Materials and Methods
A total of 11 growing ICA aneurysm cases were analyzed: two ophthalmic aneurysms, two superior hypophyseal aneurysms and seven Pcom aneurysms. Each aneurysm case had three distinct time points, with average separation time of 1.3 ± 0.6 year. Overall, aneurysm neck size in this study ranged from 1.92 to 9.15 mm, with an average of 5.1 ± 2.2 mm. Posterior communicating artery aneurysm neck size was an average of 5.2 ± 2.6 mm. Other types of aneurysm neck size had an average of 4.8 ± 1.4 mm. Several morphological parameters, such as aneurysm volume, surface area, aspect ratio, and size ratio were investigated.

Results
The average increase rate for Pcom aneurysm volume was 30.8 ± 4.7% per year, and 13.6 ± 5.4% per year for other aneurysms. Posterior communicating artery aneurysms had an average aspect ratio of 0.90 ± 0.041 over three time points, and an average size ratio of 1.83 ± 0.13. Other aneurysm types had an average aspect ratio of 0.71 ± 0.074 over three time points, and an average size ratio of 1.24 ± 0.096. Comparing the Pcom aneurysm group with other aneurysms, on average Pcom aneurysms showed 19.4 ± 5.8% higher aspect ratio and 58.7 ± 3.1% higher size ratio than other aneurysms over three time points.

Conclusions
Results suggest that Pcom aneurysms have higher growth rate per year than other types of aneurysms. Based on morphological measurements, Pcom aneurysms showed a greater height diameter than neck diameter in comparison with other types of aneurysms.
Hemodynamic Differences between Unstable and Stable Unruptured Aneurysms Independent of Size and Location: Pilot Study

W Brinjikji\textsuperscript{1}, B Chung\textsuperscript{2}, D Kallmes\textsuperscript{1}, C Jimenez\textsuperscript{3}, C Putman\textsuperscript{4}, J Cebral\textsuperscript{2}

\textsuperscript{1}Mayo Clinic, Rochester, MN, \textsuperscript{2}George Mason University, Fairfax, VA, \textsuperscript{3}George Mason University, Washington, DC, \textsuperscript{4}Inova Fairfax Hospital, Falls Church, VA

Purpose
To identify distinguishing hemodynamic characteristics between unstable and stable intracranial aneurysms that are independent from aneurysm size and location.

Materials and Methods
A total of 12 pairs of intracranial aneurysms imaged with 3D angiography and followed longitudinally without treatment were studied. Each pair consisted of one stable aneurysm (no change on serial imaging) and one unstable aneurysm (demonstrated growth or shape change or ruptured during follow up) with matching sizes and locations. Patient-specific computational fluid dynamics were created from the 3D images and run under pulsatile flow conditions. Several hemodynamic and
geometric variables were calculated and compared between the unstable and stable aneurysm groups using the paired Wilcoxon test.

Results
The area of the aneurysm under low wall shear stress (LSA) was 2.26 times larger in unstable aneurysms than in stable aneurysms (P=0.049). The mean aneurysm vorticity (VO) was smaller by a factor of 0.57 in unstable aneurysms compared to stable aneurysms (P=0.049). No statistically significant differences in geometric variables or shape indices were found.

Conclusions
This pilot study indicates that there are hemodynamic differences between unstable and stable unruptured cerebral aneurysms that are independent from aneurysm size and location. In particular, the area under low wall shear stress was larger in unstable aneurysms. This result is consisted with previous studies that compared growing and stable as well as ruptured and unruptured aneurysms (1, 2). Since the associations with instability found in this study are independent from size and location, they have the potential of adding extra information valuable for aneurysm risk assessment.
Hemodynamic Differences Between Basilar Tip and Internal Carotid Bifurcation Aneurysms

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Purpose
Test the hypothesis that basilar tip (BAtip) aneurysms and internal carotid artery bifurcation (ICA bif) aneurysms have different hemodynamic characteristics that could explain their different rupture rates.

Materials and Methods
All BAtip and ICA bif aneurysms in our database were analyzed with patient-specific computational fluid dynamics. A total of 117 aneurysms were studied, 63 BAtip (27 ruptured, 36 unruptured, rupture rate=42%) and 54 ICA bif (11 ruptured, 43 unruptured, rupture rate=20%). Several hemodynamic variables (1) were compared between aneurysms at each location and between ruptured and unruptured aneurysms at each location.

Results
In general, ruptured aneurysms had larger inflow concentration (p=0.010), larger inflow rate (p=0.041), larger shear concentration (p=0.011), more complex flows (corelen, p<0.001) and smaller minimum wall shear stress (WSS, p=0.002) than unruptured aneurysms. On average, BAtip aneurysms had more concentrated inflow (p<0.001), larger inflow rate (p<0.001), larger maximum oscillatory shear index (OSI, p=0.003), more complex flows (corelen, p=0.033) and smaller areas under low WSS (p<0.001) than ICA bif aneurysms. Ruptured BAtip aneurysms had larger shear concentration (p=0.011), more complex flow (corelen, p<0.001) and smaller minimum WSS (p=0.012) than unruptured aneurysms. Ruptured ICA bif aneurysms had larger maximum WSS (p=0.017) than unruptured aneurysms.

Conclusions
Aneurysms at the BAtip have different hemodynamic environments, characterized by higher flow conditions, than aneurysms at the ICA bif. Flow conditions associated with rupture are different at the BAtip and the ICA bif, suggesting that the mechanisms responsible for aneurysm rupture may be different between these two locations.
Association of intracranial aneurysm flow conditions with inflammation and degenerative changes of the aneurysm wall

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Purpose
To investigate possible associations between intracranial saccular aneurysm hemodynamics with inflammation and other histological changes of the aneurysm wall.
Materials and Methods
Tissue samples resected during cerebral aneurysm surgery (11 unruptured, 9 ruptured) were studied with histology and immunohistochemistry. Patient-specific computational fluid dynamics models were created from pre-operative CT angiographies. Hemodynamics simulations were carried out under pulsatile flow conditions and several resulting flow variables were compared to histology findings.

Results
Rupture associated with increased inflammation (CD45+, $p=0.031$). Inflammation associated with wall degeneration ($p=0.041$). High wall shear stress (WSS, $p=0.018$), flow stability ($p=0.043$), high vorticity ($p=0.046$), high viscous dissipation (VD, $p=0.046$), and high shear rate (SR, $p=0.046$) associated with increased inflammation. High vorticity ($p=0.034$), VD ($p=0.020$), and SR ($p=0.034$) associated also with lack of intact endothelium, which associated with wall inflammation ($p=0.034$). Although organized luminal thrombosis associated with inflammation ($p=0.018$), organized thrombosis was associated with low minimum WSS ($p=0.034$) but not with the flow conditions that associated with inflammation.

Conclusions
Inflammation of the aneurysm wall associates with rupture, wall degeneration, and high flow conditions that induce high WSS. Endothelial injury may be a mechanism by which flow induces inflammation in the aneurysm wall.
High flow aneurysm

Low flow aneurysm

WSS (dyne/cm²)

100.0
75.0
50.0
25.0
0.0

Inflamed wall

Non-inflamed wall

(Filename: TCT_O-7_fig1_histo.gif)
Growing Aneurysms Show an Increase in Wall Shear Stress Over Time.

A Chien¹, V Lau², Q Yu²
¹UCLA, Los Angeles, CA, ²David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
It is thought that aneurysms develop as a consequence of complex intrasaccular flow patterns that result in the weakening of the vessel wall. The detailed mechanisms that drive aneurysm evolution, however, remain poorly understood. The purpose of this study was to identify hemodynamic predictors of aneurysm growth.

Materials and Methods
A total of 11 longitudinally-followed growing intracranial unruptured aneurysms (size ranging from 1.8 mm to 10.7 mm) were studied against matching stable aneurysms exhibiting no size changes for at least 3 years. Stable aneurysms were selected based on matching location and dome size. Patient-specific hemodynamic analysis and three-dimensional aneurysm shape analysis were used to investigate hemodynamic and morphologic changes during follow-up imaging. Parameters investigated included normalized and maximum aneurysmal wall shear stress, flow pulsatility, and aneurysm volume and surface area.

Results
Growing aneurysms exhibited a trend of mean intra-aneurysmal wall shear stress increase over time, averaging 7.2%, over time that was found to correspond exponentially with aneurysm volume ($R^2=0.70$) and aneurysm surface area ($R^2=0.71$) increase. This is significantly different ($p=0.02$) from the trend of mean intra-aneurysmal wall shear stress decrease, averaging 15.3%, found in stable aneurysms. Growing aneurysms also tended to have a higher maximum, minimum, and mean intra-aneurysmal wall shear stress, respectively, 1.12, 1.05, and 1.06 times that of stable aneurysms, but these trends were not significant. Flow pulsatility was found to be higher in stable aneurysms, about 1.2 times that of growing aneurysms, but this trend was only significant in the neck and dome regions of Pcom aneurysms ($p<0.05$).

Conclusions
Increasing trends of intra-aneurysmal wall shear stress and lower overall flow pulsatility may predispose aneurysm growth.
Long-Term Clinical and Angiographic Outcomes in 140 Patients with 166 Cerebral Aneurysms Treated with the Pipeline Embolization Device: A Multi-Center Cohort Study

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¹Abbott Northwestern Hospital, Minneapolis, MN, ²Clínica El Ávila, Caracas, Venezuela

Purpose
To examine long-term clinical and angiographic outcomes in a consecutive cohort of patients with cerebral aneurysms treated with the pipeline embolization device (PED) in two referral centers.

Materials and Methods
We conducted a retrospective review of all patients with cerebral aneurysms treated with the PED at two referral medical centers between March 10th, 2011 and November 5th, 2015. Baseline patient and aneurysm characteristics, intra-operative, peri-operative and delayed complications were recorded. Aneurysm volumes in initial and follow-up angiographic studies were calculated using AngioCalc. Clinical outcomes were categorized using the modified Rankin Scale (mRS).

Results
One hundred forty patients underwent 150 PED procedures to treat 166 cerebral aneurysms during the study period. 109 patients were women (78%) and 31 men (22%). Mean age was 55 years (range 15-81 years). 87 aneurysms were incidental (52%), 39 recurrent (24%), 23 symptomatic (14%) and 17 ruptured (10%, 11 treated subacutely and 6 treated acutely). 22 aneurysms were fusiform (13%), 7 dissecting (4%) and 6 blister (4%). 125 aneurysms were located in the internal carotid (75%), 15 in the middle cerebral (9%), 10 in the anterior cerebral (6%), 10 in the vertebral (6%), 4 in the basilar (2%) and 2 in the posterior cerebral arteries (1%). Mean aneurysm size was 10.2mm, mean neck was 6.4mm, mean dome-to-neck ratio was 1.6. Mean number of PEDs deployed per aneurysm was 1.1. Adjunctive coiling was performed in 15 aneurysms (9%). Table 1 summarizes the intra-operative, peri-operative and delayed complications, categorized by the first 75 and subsequent 75 PED procedures. There was a statistically-significant decrease in the rate of any intra-operative as well as disabling treatment-related complications between the first 75 and next 75 PED procedures. Similarly, there was a trend toward a decrease in treatment-related mortality between the first 75 and the next 75 PED procedures. Angiographic follow-up was performed in 139 aneurysms (84%), with a mean time to last angiographic follow-up of 18.1 months. At last follow-up, 109 aneurysms were completely occluded (78.4%), 10 had near-complete occlusion (>=90% volume reduction, 7.2%), and 20 aneurysms had <90% volume reduction (14.4%, mean volume reduction 53%).
4 aneurysms were re-treated (2.9%). Among the 16 aneurysms symptomatic from mass effect (10%), symptoms completely resolved in 8 patients (50%), improved in 3 patients (19%), remained unchanged in 3 patients (19%) and worsened in 2 patients (12%). There were 3 postoperative aneurysm ruptures (1.8%), 2 of which occurred in ruptured aneurysms treated acutely with the PED.

Conclusions
The PED is an effective treatment for wide-neck cerebral aneurysms, with high long-term complete/near-complete aneurysm occlusion rates and low retreatment rates. The risk of intra-operative and disabling treatment-related complications decreases significantly with increased experience in device use and patient management.

<table>
<thead>
<tr>
<th></th>
<th>ALL 150 PROCEDURES: (%)</th>
<th>FIRST 75 PROCEDURES: (%)</th>
<th>NEXT 75 PROCEDURES: (%)</th>
<th>p-value:*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Intra-Operative Complication:</td>
<td>12 (8)</td>
<td>10 (13.3)</td>
<td>2 (2.7)</td>
<td>0.016</td>
</tr>
<tr>
<td>Resulting in mRS ≥3:</td>
<td>1 (0.7)</td>
<td>1 (1.3)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Any Peri-Operative Complication:</td>
<td>27 (18)</td>
<td>12 (16)</td>
<td>15 (20)</td>
<td>0.67</td>
</tr>
<tr>
<td>Resulting in mRS ≥3:</td>
<td>8 (5.3)</td>
<td>6 (8)</td>
<td>2 (2.7)</td>
<td>0.28</td>
</tr>
<tr>
<td>Any Delayed Complication:</td>
<td>6 (4)</td>
<td>4 (5.3)</td>
<td>2 (2.7)</td>
<td>0.68</td>
</tr>
<tr>
<td>Resulting in mRS ≥3:</td>
<td>1 (0.7)</td>
<td>1 (1.3)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Any Treatment-Related Complication Resulting in mRS ≥3:</td>
<td>10 (6.7)</td>
<td>8 (10.7)</td>
<td>2 (2.7)</td>
<td>0.049</td>
</tr>
<tr>
<td>Treatment-Related Mortality:</td>
<td>5 (3.6)</td>
<td>4 (5.9)</td>
<td>1 (1.4)</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*P-value for the difference between first 75 and next 75 procedures using Fisher’s exact test. mRS: modified Rankin Scale. Peri-operative complication: occurring up to post-operative day 30. Delayed complication: occurring after post-operative day 30.

(Filename: TCT_O-9_Table1.jpg)

O-11

In-stent Stenosis in Flow Diverting Implants (PED, p64): Infrequent and Transient
Purpose
To evaluate the frequency and significance of in-stent stenoses inside PED and p64 deployed in the neurovasculature.

Materials and Methods
In one institution the follow-up DSA examinations of 609 consecutive patients with 681 target lesions treated with either PED and/or p64 were analyzed retrospectively. Follow-up DSAs were scheduled 3, 9 and 24 months after the flow diverter implantation. Stenoses of >50% lumen loss were considered relevant. In those patients dual antiplatelet medication was continued.

Results
Early stenoses after 3 months were encountered in 3.9%, including 1.3% stenoses of >70% lumen loss. At 9 months, the in-stent stenosis rate increased to 4.7%, including a 1.2% of stenoses >70%. Two years after the treatment, the in-stent stenosis rate decreased to 1.9%, without >70% stenoses. Spontaneous regression of the in-stent stenosis within the first year after the FD treatment was confirmed in 11 out of 27 patients between the first and second follow up, with a further improvement during the second year after the treatment. Early in the series, a total 3.7% target lesions underwent balloon angioplasty during follow-up without issues. Meanwhile asymptomatic in-stent stenoses in FD implants are mostly managed conservatively.

Conclusions
In-stent stenoses within flow diverters are infrequent and mostly benign. They resolve spontaneously. Balloon angioplasty is safe but only required in very severe stenoses.

O-12

Statin Use Does Not Affect Occlusion And Neurological Morbi-Mortality Rates After Pipeline Embolization For Intracranial Aneurysms.

W Brinjikji1, D Kallmes1, H Cloft1

1Mayo Clinic, Rochester, MN

Purpose
Use of statin medications has been demonstrated to improve clinical and angiographic outcomes in patients receiving endovascular stenting of coronary, peripheral, carotid and intracranial stenoses. We studied the impact of statin use on long-term angiographic and clinical outcomes after flow-diverter treatment of intracranial aneurysms.
Materials and Methods
A post-hoc analysis from a pooled patient level dataset from 3 PED studies: IntrePED, PUFS and ASPIRE, was performed. Data were analyzed comparing two subgroups: 1) patients on statin medication, 2) patients not on statin medication, at the time of procedure and follow up. Angiographic and clinical outcomes were compared using Chi-square test, Fisher's exact test, or Wilcoxon's Rank Sum test. A multivariate analysis was performed to determine whether statin use was associated independently with clinical and angiographic outcomes.

Results
A total of 1092 patients with 1221 aneurysms were studied. At baseline, 226 patients were on statin medications and 866 patients were not on statin medications. Patients receiving statin medications were older (64.6±9.6 versus 55.5±14.0 years, P<0.001) and more likely to have hypertension at baseline. (75.5% versus 41.1%, P<0.001) The mean length of clinical and angiographic follow-up was 6.2 ± 16.5 and 28.3 ± 23.7 months, respectively. There were no differences observed in angiographic outcomes at any time point between groups. Rates of complete occlusion were 82.8% (24/29) versus 86.4% (70/81) at 1 year (p=0.759) and 93.3% (14/15) versus 95.7% (45/47) at 5 years (p=1.000) follow-up for statin versus non-statin use groups, respectively. Rates of in-stent restenosis were similar between groups (P=0.14). There were no differences in any complication rates between groups including major morbidity and neurological mortality (7.5% versus 7.1%, P=0.77). The odds of all complications and angiographic outcomes were similar between groups in multivariate logistic regression analysis.

Conclusions
These results suggest that statin use is not associated with improved angiographic or clinical outcomes among patients treated with PED.

O-13
9:11AM - 9:14AM

Hyperresponse to Platelet Antiaggregants: Tailored Dosage, Monitored with the Multiplate Analyzer

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Purpose
The treatment of intracranial aneurysms with stents and flow diverters requires dual platelet anti-aggregation, usually achieved with acetylsalicylic acid and clopidogrel. Hyper-response to either of these drugs is a known but under-reported issue, which might be related to hemorrhagic events and delayed aneurysm obliteration. We
describe the use of the Multiplate Analyzer to identify hyper-responsive patients and for the management of tailored dosage adaptation.

Materials and Methods
Prior to and after the stent or flow diverter-assisted endovascular treatment of intracranial aneurysms, we use the Multiplate Analyzer (Roche) to verify adequate inhibition of the platelet function in all patients. Adenosine diphosphate stimulation (ADP) and Arachidonic acid activation (ASPI) area under curve (AUC) values <5 were regarded as an expression of excessive platelet function inhibition. The aim was an AUC value for both tests in the lower two-digit range. In patients with hyper-responsive platelet inhibition, the dosage of ASA and/or clopidogrel was stepwise reduced in order to achieve a residual platelet function.

Results
During 6 months, 43 patients (35 female, median age 55.5 years) were identified as being hyper-responsive to ASA and/or clopidogrel. In this subgroup of patients five hemorrhagic complications were encountered (three intracerebral hemorrhages, two acute subdural hematomas). Less severe bleeding events (e.g., epistaxis, cutaneous hematomas) were frequent complaints. Tailored dosage reduction, monitored by Multiplate tests, prevented further hemorrhagic issues. The lowest ASA dosage was 12.5 mg daily, the lowest clopidogrel dosage was 37.5 mg every other day. No stent or flow diverter thrombosis occurred.

Conclusions
Hyper-response to ASA and/or clopidogrel is a frequent phenomenon, which is related to severe hemorrhagic complications and can be managed by Multiplate-monitored dosage adaptation of the antiplatelet medication.

O-15

Interventional device guidance using virtual time resolved 3D fluoroscopy and endoscopy - real time and offline application

M Wagner\textsuperscript{1}, C Strother\textsuperscript{2}, D Niemann\textsuperscript{2}, C Mistretta\textsuperscript{2}

\textsuperscript{1}University of Wisconsin Madison, Madison, WI, \textsuperscript{2}University of Wisconsin Madison, Madison, WI

Purpose
Precise positioning of interventional devices is a key element for successful minimally invasive endovascular procedures. Complex vascular structures can make it difficult to find a good working angle for fluoroscopic guidance. We present a real time 3D reconstruction system, which creates, from simultaneous biplane images, virtual time resolved 3D fluoroscopic roadmap views of the device. These can be viewed from arbitrary angles, which can be changed, in real time, without gantry movement.
Additionally virtual endoscopic views also can be created by placing a virtual camera near the tip of the device inside of the vessel structure.

Materials and Methods
A biplane angiography system is used to acquire fluoroscopic images from two viewing angles. The algorithm then segments the device in both images based on a dynamic threshold, where pixels with a value larger than the threshold are considered device pixels. The medial axis then is extracted by successive elimination of border pixels until only a pixel thin centerline is remaining. A path search algorithm connects the pixels considering their location as well as the curvature of the extracted device. The 3D shape of the device then can be determined by backprojecting the corresponding points of both images.

Results
The algorithm is implemented for retrospective reconstruction of clinical fluoroscopy sequences, as well as in a modified version on a real time system. The latter grabs live images directly from a biplane angiography system and displays additional virtual fluoroscopy images in real time, with a frame rate of up to 30 fps and a maximum delay of 120 ms. The algorithm has been applied retrospectively to clinical data sets showing guidewire and catheter manipulations and coiling of aneurysms. In canine studies the real time implementation of the system was tested by insertion of a guidewire and catheter into an experimental aneurysm. Examples for both the real time and the retrospective analysis are shown in Fig. 1. The overall accuracy of the system was shown to be within less than 1 mm (1).

Conclusions
The technique provides a new method for the guidance of endovascular procedures using virtual fluoroscopy images as well as endoscopic 3D displays. This could enhance the ability for exact device placement and navigation in complex cerebrovascular cases and therefore considerably improve workflow, safety and efficacy.
O-16

FLOWMODDA (Flow Models for Deployment of Devices in Aneurysms) - 3D printing of transparent high resolution luminal models of cerebral aneurysms provides low cost patient specific treatment simulation of aneurysmal coil placement

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¹Universitätsklinikum Lübeck, Lübeck, Germany

Purpose
We evaluated patient specific aneurysm models produced by high resolution laser stereolithography (SLA) for simulating coil placement in vitro compared to aneurysm coil placement in real patients.

Materials and Methods
3D rotational angiographic (3D RA) data from 15 aneurysms prior to treatment were processed for printing volumetric models by SLA. Cerebral arterial models were directly printed with transparent photopolymer resin. A simple setup of 3D arterial models connected to PVC tubing with circulating pump (FlowTek) allowed coiling of aneurysms in a real neurological angio suite in an optimal simulated environment. Patient specific 3 models (5 ICA, 4 MCA, 3 basilar, and 3 ACA aneurysms) were filled with coils as used in patients (PC 400 coils, Penumbra, 10 mm x 30 cm to 4 mm x 8 cm; Target coils, Stryker, 4mm x 10cm to 2mm x 2 cm). Feasibility and handling of model coiling was evaluated with respect to real coil embolization.

Results
Patient specific aneurysm models with a very high level of anatomical accuracy allowed simulation of coil embolization using equivalent materials (guide wire, distal access- and microcatheter). Coiling of model aneurysm was possible in all 15 cases with the same coil set as used in patients. Coil deployment and final packing density by digital subtraction angiography (DSA) was similar; however, local packing density at each coil step was different with random coil configuration especially in larger aneurysms and wide neck aneurysms.

Conclusions
Rapid prototyping of high resolution cerebral aneurysm models by SLA allows low cost patient specific treatment simulation of aneurysmal coil placement in a realistic environment.
Model 2: ICA aneurysm

(Filename: TCT_O-16_fig1.jpg)

Monday
8:35AM - 10:11AM
Washington Marriott Wardman Park, Maryland A/B/C

2E-PARALLEL PAPER SESSION: Primary and Metastatic Brain Tumors: MRI Advances
O-17

Patterns of Noncontrast-Enhancing Tumor in Glioblastoma

8:35AM - 8:43AM
A Lasocki¹, F Gaillard², M Tacey², K Drummond², S Stuckey³
¹Peter MacCallum Cancer Centre, East Melbourne, Victoria, ²The Royal Melbourne Hospital, Parkville, Victoria, ³Monash Health, Clayton, Victoria

Purpose
There is growing interest in the presence of noncontrast-enhancing tumor (nCET) in glioblastomas. Using the current broad definition of nCET, tumors with equivalent portions of nCET can have vastly different imaging appearances. The presence of nCET is useful diagnostically, suggesting glioblastoma over other differentials such as metastases, while its morphology can have prognostic value; for example, the presence of a dominant mass in the setting of gliomatosis cerebri has been shown to be associated with isocitrate dehydrogenase-1 mutations (1). We aimed to classify glioblastoma patients by the pattern of nCET.

Materials and Methods
Consecutive patients with a new diagnosis of glioblastoma from September 2007 to March 2011 were identified. Only patients with at least T2 FLAIR and postcontrast imaging were included. Pre-operative magnetic resonance images (MRIs) were reviewed, to identify patients with >33% nCET. These patients subsequently were classified by the predominant patterns of nCET: mass-like expansion, gray matter spread or white matter dissemination.

Results
Of the 153 patients initially identified, 34 patients had >33% nCET. One patient was excluded from further analysis due to the appearance of multicentricity on imaging. White matter dissemination was the most common form of spread, occurring in 17 of the 33 patients (52%). Gray matter spread and mass-like expansion were the dominant pattern of nCET in eight patients each.

Conclusions
A significant nCET component is common in glioblastomas. Its morphology is variable and can be categorized with MRI. White matter dissemination is the most common pattern; however, there often is more than one pattern of spread in a given patient. Subcategorization of nCET has the potential to improve its value as an imaging biomarker.

O-18
8:43AM - 8:51AM

Prognostic Value of Short Term Post-chemoradiation MRI in Patients with Glioblastoma Multiforme

P Lee¹, V Lau², A Demopoulus³, C Filippi⁴
Purpose
The current standard of care for glioblastoma multiforme includes tumor resection followed by radiotherapy and concurrent and adjuvant chemotherapy with temozolomide. Follow-up brain magnetic resonance imaging (MRI) is performed at 1 month and 3 months following completion of chemoradiation. Magnetic resonance imaging performed within 3 months following chemoradiation often shows increased enhancement or cerebral edema. These findings may reflect true progression of disease or post-treatment tumor necrosis (pseudoprogression). Thus, the standard of care is that no decisions regarding treatment changes should be made in the first 12 weeks following radiation therapy. At our institution, an additional MRI is performed within 1 week following chemoradiation. We hypothesize that MRI performed at 1 week and 1 month following chemoradiation may predict true progression of disease at 3 months. If so, treatment, which is ineffective, could be stopped early and novel therapies can be adopted.

Materials and Methods
As part of an IRB-approved protocol, we retrospectively searched an institutional database for GBM patients who underwent brain MRI within 1 week and at 1 month and 3 months following chemoradiation. A total of 18 patients were identified including nine males and nine females. Mean age was 60.2 years with standard deviation of 8.7 years. Tumor progression was evaluated on MRI using Response Assessment in Neuro-Oncology Criteria (RANO). In particular, progression of disease (PD) was defined as increase in enhancing tumor by >25%, stable disease (SD) as increase by <25% or decrease by <50%, partial response (PR) as decrease by >50%, and complete response (CR) as complete resolution of enhancing tumor. Comparison was made between postchemoradiation MRIs and a pretreatment MRI. In addition, comparisons were made between the postchemoradiation MRI. Chi square tests were performed to evaluate the association between tumor progression seen on MRI performed at different time points.

Results
Magnetic resonance imaging performed within 1 week, at 1 month, and at 3 months post-therapy showed signs of progression in 12/18, 5/18, and 11/18 patients respectively. Out of 12 patients who showed signs of progression within 1 week, 8/12 showed progression of disease at 3 months. The association between signs of progression at 1 week and 3 months was not statistically significant (Chi-square statistic=0.171, p=0.68). All five patients who showed signs of progression at 1 month showed progression of disease at 3 months. This indicates that signs of progression at ...
1 month are statistically significantly associated with progression of disease at 3 months (Chi-square statistic=3.93, p=0.0475).

Conclusions
Signs of progression seen on MRI at 1 month post-therapy are associated significantly with progression of disease at 3 months. Therefore, patients who show progression on MRI at 1 month may benefit from early changes in treatment. Signs of progression seen within 1 week do not reliably reflect progression at 3 months and likely reflect pseudoprogression in some patients.

O-19

Primary brain tumors in Language Associated Brodmann Areas (LABA)

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¹The University of Texas, Houston, TX, ²Anatom-e Systems, LLC Houston, TX, Houston, TX, ³UT MD Anderson Cancer Center, Department Diagnostic Radiology Houston, TX, Houston, TX, ⁴UT MD Anderson Cancer Center, Department of Diagnostic Radiology Houston, TX, Houston, TX, ⁵The University of Texas Health Science Center at Houston. Department of diagnostic and intervention, Houston, TX, ⁶MD Anderson Cancer Center, Houston, TX

Purpose
• Correlate tumor grade and size of primary neoplasms arising from Language-Associated Brodmann Areas (LABA), with the development of aphasia. • Determine the prognostic value of aphasia, in correlation with these tumor features.

Materials and Methods
Fifty-two patients with LABA affecting tumors are presented. Aphasia assessment was performed by speech language expert scoring. Magnetic resonance imaging (MRI) was available including gadolinium-enhanced sequences.

Results
Fifty-two cases of tumors that affect LABA of the left brain hemisphere were studied. The percentage of cases that affected sensorial LABA was 67%, specifically involving BA numbers 22, 39, and 40. The BA most commonly affected were BA44 (Broca's) in 31% of cases and BA22 (Wernicke's) on 23%, for a total of 54%. The percentage of tumors affecting LABA presented on patients with aphasia was 60%. Aphasic and nonaphasic presented with similar tumor size; 4.6 cms aphasic and 4.3 nonaphasic. Eighty-four percent of the aphasic group, correlated with grade IV tumors. Seventy-one percent of the nonaphasic correlated with Grade II and III tumors. Grade II tumors presented 91% as nonaphasic.
Conclusions
The majority of cases affected sensorial LABA, particularly BA22 and BA44. Most cases of LABA tumors presented with aphasia. The size seems to be a less relevant factor in the development of aphasia, than tumor grade. A larger than six cms tumor presenting as nonaphasic is likely to represent a grade II or III tumor. A tumor smaller than 4 cms, presenting as aphasic is likely to correspond with grade IV tumor, regardless presence of contrast enhancement. The association in between aphasia and high tumor grade may represent a prognostic factor on LABA tumors.
Non-Aphasic BA22 of 9.2 cm GIII diffuse astrocytoma

Aphasic 2.6 cm BA39 GBM (GIV glioma)
Different Diagnostic Values of Imaging Parameters to Predict Pseudoproggression in Glioblastoma Subgroups Stratified by MGMT Promoter Methylation

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Purpose
To determine whether diffusion and perfusion imaging parameters demonstrate different diagnostic values for predicting pseudoproggression between glioblastoma subgroups stratified by MGMT promoter methylation status.

Materials and Methods
Our institutional review board approved this retrospective study. Seventy-five glioblastoma patients who underwent testing for MGMT promoter methylation and presented with enlarged contrast-enhanced lesions on magnetic resonance (MR) images 1 month after completing concurrent chemoradiotherapy were enrolled. The MR imaging parameters included 10% or 90% histogram cutoffs of apparent diffusion coefficient (ADC10), normalized cerebral blood volume (nCBV90), and initial area under the time signal-intensity curve (IAUC90). The results of the areas under the receiver operating characteristic (ROC) curve (AUCs) with cross-validation were compared between MGMT methylation and unmethylation groups.

Results
Among the 75 study patients, the MGMT promoter was methylated in 34 patients and unmethylated in 41 patients. Each MR imaging parameter demonstrated a trend toward higher accuracy in the MGMT promoter methylation group (cross-validated AUCs = 0.70–0.95) than in the unmethylation group (cross-validated AUCs = 0.56–0.87). On the multivariate analyses, all of imaging parameters independently influenced the incidence of pseudoproggression (P = .041–.001). The combination of MGMT methylation status with imaging parameters improved the AUCs from 0.70 to 0.75–0.90 for both readers in comparison with MGMT methylation status alone. The probability of pseudoproggression was highest (95.7%) when nCBV90 was below 4.02 in the MGMT promoter methylation group.

Conclusions
Magnetic resonance imaging parameters could be strong predictor for pseudoproggression in glioblastoma patients with a methylated MGMT promoter than patients with an unmethylated MGMT promoter.
Multivariate Logistic Regression Analysis for Predicting Pseudoprogession Using MGMT Promoter Methylation Alone and in Combination with the Indicated Imaging Parameters for Both Readers.

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio of MGMT methylation</th>
<th>Odds ratio of imaging parameter</th>
<th>P value of imaging parameter</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGMT promoter methylation</td>
<td>5.36 (1.97–14.54)</td>
<td></td>
<td></td>
<td>0.70</td>
</tr>
</tbody>
</table>

Reader 1

| MGMT promoter methylation + ADC10 $\geq 0.94 \times 10^{-3}$ mm$^2$ sec$^{-1}$ | 4.22 (1.46–12.24) | 4.70 (1.64–13.45) | 0.004 | 0.78 |
| MGMT promoter methylation + nCBV90 $< 4.02$ | 22.17 (2.70–182.21) | 89.27 (9.62–828.74) | $< 0.001$ | 0.90 |
| MGMT promoter methylation + IAUC90 $< 23.39$ | 6.64 (1.91–23.13) | 16.37 (4.09–65.47) | 0.001 | 0.84 |

Reader 2

| MGMT promoter methylation + ADC10 $\geq 0.96 \times 10^{-3}$ mm$^2$ sec$^{-1}$ | 4.62 (1.65–12.94) | 2.88 (1.04–7.96) | 0.041 | 0.75 |
| MGMT promoter methylation + nCBV90 $< 2.76$ | 4.13 (1.29–13.22) | 34.15 (4.11–283.97) | 0.001 | 0.84 |
| MGMT promoter methylation + IAUC90 $< 20.02$ | 5.22 (1.55–17.57) | 26.72 (5.21–137.06) | 0.001 | 0.85 |

Note: AUC = area under the ROC curve; ADC10 = 10th percentile cutoff value of ADC; nCBV90 = 90th percentile cutoff value of nCBV; and IAUC90 = 90th percentile cutoff value of IAUC.

Parentheses indicate the 95% confidence interval.
### Diagnostic Performances of the Imaging Parameters

**Pseudoprogresion in the Subgroups Stratified by MGMT Promoter Methylation**

<table>
<thead>
<tr>
<th>Reader and Parameter</th>
<th>MGMT methylation group (n = 34)</th>
<th>MGMT unmethylation group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AUC</td>
<td>SE of AUC</td>
</tr>
<tr>
<td>Reader 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADC10 ($10^{-3}$ mm$^2$ sec$^{-1}$)</td>
<td>0.85</td>
<td>0.07</td>
</tr>
<tr>
<td>nCBV90</td>
<td>0.95</td>
<td>0.05</td>
</tr>
<tr>
<td>IAUC90</td>
<td>0.86</td>
<td>0.07</td>
</tr>
<tr>
<td>Reader 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADC10 ($10^{-3}$ mm$^2$ sec$^{-1}$)</td>
<td>0.76</td>
<td>0.10</td>
</tr>
<tr>
<td>nCBV90</td>
<td>0.95</td>
<td>0.05</td>
</tr>
<tr>
<td>IAUC90</td>
<td>0.86</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note: AUC = area under the ROC curve; SE = standard error; CI = confidence interval.

ADC10 = 10th percentile cutoff value of ADC; nCBV90 = 90th percentile of nCBV; IAUC90 = 90th percentile cutoff value of IAUC. Parentheses indicate confidence interval.
Prediction of Pattern of Progression and Time to Progression in Recurrent Primary Glioblastoma Multiforme Treated With Bevacizumab

A Bag¹, B BeTriche¹, R Hosch¹

¹UABH, Birmingham, AL

Purpose
Assessment of response of glioblastoma multiforme (GBM) to bevacizumab (Bev)
therapy is challenging. Four different radiologic patterns of tumor progression (PTP) (flare-up of T1 contrast-enhanced volume \([cT1]\), T2-diffuse \([T2D]\), T2-circumscribed \([T2C]\), and primary non-responder \([PNR]\)) have been described following Bev treatment failure of GBM that correlates with outcome. In this research, we investigated if PTP and time to progression (TP) can be predicted from the first follow-up magnetic resonance imaging (MRI).

Materials and Methods
We retrospectively evaluated 29 primary GBM patients at first recurrence, treated with Bev mono-therapy. All patients were treated with standard therapy at initial diagnosis. FLAIR and post-contrast T1-weighted sequences at baseline (within 30 days), at first follow-up (within 60±15 days) of start of Bev treatment were evaluated for response pattern (RP). Magnetic resonance imaging at recurrence was blindly evaluated for PTP. Response pattern was categorized subjectively as complete response (CR: no FLAIR volume (FV) and no cT1), significant response (SR: reduction of >50% cT1 + reduction of >50% of FV), minimal response (MR: reduction of <50% of cT1 or reduction of <50% of FV or both), no response or progression (NRP: Unchanged cT1 or FLAIR volume or worsening of either). Association of RP with PTP was estimated using binomial proportion with exact 95% confidence limits. Kaplan-Meier curves were plotted to estimate the probability of TP from start of Bev as a function of RP; RPs were compared using the log rank test.

Results
Significant response was associated with T2D (95% CI: 51% -97.9%, \(p=0.02\)), MR was associated with cT1 (95% CI: 39.99%-97.19%, \(p=0.09\)), and NRP was associated PNR (95% CI: 45.13%-99.64%, \(p=0.05\)). Median TP of SR was significantly longer compared to MR and NRP (\(p=0.00\))

Conclusions
Response pattern can reliably predict PTPs and PT. This simple evaluation approach may be implemented successfully in the clinical practice for monitoring response of Bev treatment.
Log rank p-value for strata homogeneity 0.0003

2=SR, 3= NRP, 4= MR

(Filename: TCT_O-21_Fig.jpg)
The Application of Standard/Delayed Contrast MRI for Early Prediction of Recurrent High Grade Glioma (rHGG) Response to Bevacizumab

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¹Sheba Medical Center and Tel-Aviv Univ, Ramat-Gan, Israel, ²Sheba Medical Center and Tel-Aviv University, Ramat-Gan, AK, ³Sheba Medical Center, Ramat-Gan, AK, ⁴Tel-Aviv Medical Center, Tel-Aviv, AK, ⁵Tel Aviv Sourasky Medical Center, Tel Aviv, AK, ⁶Sheba Medical Center and Tel-Aviv University, Ramat-Gan, NA

Purpose
We recently have applied a novel technique, in which high resolution treatment response assessment maps (TRAMs) are calculated from magnetic resonance images (MRIs) acquired with a delay of >1 hour, enabling efficient separation between tumor (contrast clearance >1 hour postinjection) and treatment effects (contrast accumulation) with no overlap. The TRAMs previously have been validated histologically in 54 resected patients reaching 100% sensitivity and 93% positive-predictive-value to active tumor. Here we studied the advantages of the TRAMs over standard/advanced MRI methodologies in rHGG patients treated with bevacizumab; Further, we determined MRI-based response/progression patterns and defined predictors of response for clinical decision making.

Materials and Methods
Twenty-four rHGG patients were studied before/during bevacizumab treatment by standard/delayed contrast MRI. A unique, semi-automatic segmentation algorithm was developed to enhance sensitivity to subtle enhancement on T1-Gd. The TRAMs, previously shown to efficiently differentiate tumor/nontumor tissues in brain tumor patients undergoing conventional treatments, were calculated from delayed contrast MRIs. The patients were divided into responders [overall survival (OS)≥1 year] and nonresponders (OS<1 year). The changes in lesions volumes 1 month after treatment initiation, calculated from standard/delayed contrast MRIs, were studied as potential predictors of outcome using log-rank analysis and receiver operating characteristic (ROC) analysis.

Results
Seven patients were responders and 17 nonresponders. Early predictors of response were determined from conventional T1-Gd, TRAMs and perfusion MRI (PWI). Sensitivity/specificity/positive predictive value/negative predictive value were calculated for each predictor, reaching 100%/87.5%/77.8%/100% for TRAMs, 5.7%/87.5%/75%/93.3% for T1-Gd and 75%/78.6%/50%/91.7% for PWI. The benefit of the TRAMs in separating responders/nonresponders was confirmed further using log-rank analysis (T1-Gd: p<0.002, TRAMs: p<0.0001, PWI: p<0.02). Receiver
operating characteristic analysis demonstrated the added value of the TRAMs for prediction of 6 months PFS and 1 year OS.

Conclusions
The benefit of MRI for assessing and predicting response to bevacizumab was demonstrated. The TRAMs increased sensitivity reflects their potential contribution to management of bevacizumab-treated rHGG patients.

(Filename: TCT_O-22_Figure.jpg)
Tumor Recurrence or Radiation Necrosis That Is the Question: A Systematic Review and Meta-Analysis of Advanced Magnetic Resonance Methods

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¹Hospital de Clínicas de Porto Alegre, Porto Alegre, Rio Grande do Sul, ²Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, ³Hospital Moinhos de Vento, Porto Alegre, CA

Purpose
Several studies reported the benefit of magnetic resonance (MR) advanced methods for the treatment response of brain tumor assessment, for distinguishing tumor recurrence from radionecrosis in gliomas and other brain tumors. However, the sample size in each study is relatively small, which becomes difficult to draw conclusions about external validity. We performed a systematic review and meta-analysis of published data to evaluate the accuracy of the advanced MR methods for differentiating recurrence from radionecrosis. Our objective was to determine the diagnostic value of diffusion (DWI), dynamic susceptibility contrast perfusion (PWI DSC), dynamic contrast enhancement perfusion (PWI DCE) and spectroscopy (MRS), and compare the results between the methods.

Materials and Methods
The systematic review included all studies that used MR advanced methods to detect recurrence or radionecrosis in patients followed by brain tumor radiotherapy. The databases selected were MEDLINE and Embase, for published data prior to July 31, 2015. The sensitivities and specificities of individual studies were calculated and the pooled diagnostic accuracies, with 95% confidence intervals (CI), were assessed under a random-effects model. It also was performed heterogeneity test, threshold effect test and meta-regression models for each MR method. A subgroup analysis was performed based on homogeneous subsets of the studies.

Results
Forty-nine articles were included in the quantitative analysis, compromising 1,508 patients (919 with recurrence and 589 with radionecrosis). Five studies assessed DWI, 32 assessed PWI, and 21 assessed MRS. Overall sensitivity (SEN) and specificity (SPE) of DWI were 81.0% (95% CI: 71.0 to 89.0%) and 68.0% (95% CI: 52.0 to 82.0%), respectively. The SEN and SPE of PWI DSC were 83.0% (95% CI: 80.0 to 86.0%) and 81.0% (95% CI: 76.0 to 85.0%) and PWI DCE were 76.0% (95% CI: 66.0 to 85.0%) and 85.0% (95% CI: 74.0 to 93.0%), respectively. The SEN and SPE of MRS were 76.0% (95% CI: 71.0 to 80.0%) and 83.0% (95% CI: 77.0 to 88.0%), respectively. The overall diagnostic odds ratio (DOR) of DWI, PWI DSC, PWI DCE, and MRS were 14.83, 25.81, 14.45, and 27.39, respectively. The point with the highest DOR in the PWI DSC studies was when the relative cerebral blood volume
(rCBV) threshold was equal or higher than 1.8, and the point with the highest DOR in the MRS studies was when the Cho/Cr threshold was equal or higher than 1.3. The MRS DOR value is much higher in the 3T subgroup (40.07, 95% IC: 15.44 to 104.03), compared to the 1.5T subgroup (18.69, 95% CI: 8.32 to 42.02).

Conclusions
This meta-analysis showed that MR advanced methods have moderate to high accuracy in differentiating tumor recurrence from radiation necrosis using DWI, PWI DSC, PWI DCE and MRS. Some subgroup analysis and threshold effect tests demonstrated subsets that have a better accuracy trend.
Response Assessment of Cerebral Metastases Treated With High-Dose Stereotactic Radiation: Looking at the Trend of MR Diffusion and Perfusion Biomarkers
Purpose
Increase in size of cerebral metastases after high dose radiation can be due to treatment effect (pseudoprogression) or true progression, a diagnostic challenge on conventional imaging. The purpose of this study was to assess whether interval change in multiparametric magnetic resonance (MR) perfusion and diffusion biomarkers can differentiate pseudoprogression from growing metastases after treatment with stereotactic radiation.

Materials and Methods
Cerebral metastases that were treated with stereotactic radiation and that demonstrated interval increase in size on T1WC+ images were included in this retrospective analysis; availability of MR diffusion, DSC and DCE perfusion before and after radiation treatment, and at least a 6-month follow-up MRI were required to enter the study. Volume of interest (VOI) of the enhancing lesions were created. Using coregistered images, mean values of the ADC, DCE-derived Ktrans and DSC-derived rCBV were calculated from pre and postradiation MRI scan in each patient. Sequential rCBV, Ktrans and ADC values were scored to assess whether they fitted the expected pattern: 1) Favorable response: interval decrease in rCBV, interval decrease in Ktrans, and interval increase in ADC; 2) No response: plateau or interval increase in rCBV/Ktrans and plateau or interval decrease in ADC. The scores of imaging biomarker trend in responders versus nonresponders were assessed for diagnostic correlation using Fisher's exact test. Final outcome was determined on 6-month follow-up imaging using RECIST criteria1. Interval > 60% decrease in the volume of final lesion from the baseline was classified as "response".

Results
Out of 102 cerebral metastases evaluated (78 patients), 34 lesions showed interval increased in size on postradiation scans. Five of those metastases were excluded due to lack of adequate follow-up imaging and therefore a total of 29 metastases were analyzed. A total of 87 MRIs were evaluated (three per patient). The mean follow-up was 6.4 months after initial scan (range: 4-14). Nineteen lesions (65%) were identified as responded. Using sequential ADC, Ktrans and rCBV scored values, expected response patterns matched response assessment in 22/29 (76%, p=0.02, OR: 8) for ADC; 21/29 (72%, p=0.015, OR=40) for Ktrans, and 25/29 (86%, p=0.001, OR=34) for rCBV (Table 1). While rCBV had the best performance to identify responders (17/19), Ktrans showed best discriminative power for identification of nonresponders. All 10 nonresponders showed interval increase in Ktrans on postradiation scans.

Conclusions
Favorable trend of imaging biomarkers, including interval decrease in rCBV and
Ktrans and interval increase in ADC can predict radiation response in cerebral metastases and identify pseudoprogression independent of lesion volume on conventional imaging.

Table 1. Sequential ADC, K\textsuperscript{trans} and rCBV pattern matched with number of responders vs. non-responders

<table>
<thead>
<tr>
<th></th>
<th>Response</th>
<th>No response</th>
<th>Fisher's exact test</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>Interval increase</td>
<td>16/19</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Interval decrease</td>
<td>-</td>
<td>6/10</td>
</tr>
<tr>
<td>K\textsuperscript{trans}</td>
<td>Interval increase</td>
<td>-</td>
<td>10/10</td>
</tr>
<tr>
<td></td>
<td>Interval decrease</td>
<td>13/19</td>
<td>-</td>
</tr>
<tr>
<td>rCBV</td>
<td>Interval increase</td>
<td>-</td>
<td>8/10</td>
</tr>
<tr>
<td></td>
<td>Interval decrease</td>
<td>17/19</td>
<td>-</td>
</tr>
</tbody>
</table>

Responders: n=19
No response: n=10

Use of Susceptibility – Weighted Imaging to Assess Hemorrhage in the Brain Metastases

F YILDIRIM DONMEZ\textsuperscript{1}, F Kural\textsuperscript{1}, M HABERAL\textsuperscript{1}, M Agildere\textsuperscript{1}

\textsuperscript{1}Baskent University, Ankara, N/A

Purpose
Susceptibility-weighted imaging (SWI) is a three dimensional (3D), high resolution gradient echo sequence that combines the information from both magnitude and phase images and exploits the magnetic susceptibility differences of tissues such as blood, iron, calcification. Our purpose was to evaluate the diagnostic value of precontrast...
SWI for detection of blood products in the brain metastases by comparing to the conventional sequences.

Materials and Methods
Brain magnetic resonance imaging (MRI) of 21 patients (10 males and 11 females, 49-86 years old, mean age: 64 years) with brain metastases which were obtained between April 2014-November 2015 were evaluated retrospectively for presence of hemorrhagic elements. All examinations were performed on a 1.5T Siemens scanner. Our routine protocol included axial T1W, T2W, FLAIR, coronal and sagittal T2W and postgadolinium axial, sagittal T1W and coronal FSE T1W with precontrast SWI sequence. Parameters of SWI were as follows: TR: 50 msec; TE: 40 msec; FA: 15; slice thickness: 2.5 mm; matrix size: 256x320. Total acquisition time was approximately 3 minutes depending on the FOV.

Results
Seventy intraparenchymal metastatic lesions (Range: 5 mm- 3.5 cm) were detected. There was no hemorrhage in 25 lesions (35%). In 12 lesions (16.9%) hemorrhage was detected by T1- and T2-weighted images which also were seen on SWI. One of the 12 lesions were evident only on T1-weighted, whereas two of them were seen on T2-weighted images. Nine of the 12 lesions were visualized on both T1 and T2 weighted images. In 34 lesions (49.29%) hemorrhage was detected by only SWI sequence which were not seen on conventional sequences (In the figures, hemorrhage in the left frontal enhancing lesion is not seen on T1-weighted and T2-weighted images which is evident only on SWI).

Conclusions
Susceptibility-weighted imaging gave better information than T1 and T2 sequences in the evaluation of intratumoral hemorrhage. T1- and T2-weighted images are incapable of detecting hemorrhagic elements, Susceptibility-weighted imaging is needed to prove intratumoral hemorrhage and should be added to the protocol to better characterize the inner structure of the metastasis.
Intracranial Metastases Detection and Gadobutrol Contrast Dose on MRI Prior to Stereotactic Radiosurgery

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Purpose
Gadolinium-based contrast-enhanced T1 3D magnetic resonance imaging (MRI) is the standard protocol for detection of intracranial metastases in planning for stereotactic radiosurgery (SRS). For pre-SRS MRI, increased contrast dose has been shown to correlate with detection of more metastases, however there are limited studies with gadobutrol, a macrocyclic agent.

Materials and Methods
A single-center, retrospective cohort treated with SRS for intracranial metastasis between 1/1/2014-12/31/2014 were studied. All had biopsy proven primary cancer. Sixty-six cases of SRS in 57 patients (ages 36-85, median 61; male 35/female 31) met inclusion criteria. Primary neoplasms included breast (14), colon (3), esophageal (1), gastric (1), hepatocellular (2), lung (23), melanoma (15), ovarian (2), renal cell (3), and sarcoma (2). All patients had initial gadobutrol-enhanced brain MRI using institutional tumor protocol including a 3D T1 postcontrast sequence (0.1 mmol/kg). Subsequently, just prior to SRS, patients received a limited brain MRI including a gadobutrol-enhanced 3D T1 postcontrast sequence (0.2 mmol/kg).

Results
Median contrast dose ratio on pre-SRS MRI and initial MRI was two (range 1.6-2.6). On initial diagnostic MRI, 236 brain metastases were identified. On pre-SRS MRI, 331 brain metastases were identified (87 new metastases). Thirty-eight cases showed no new metastases, however 28 cases did show an increase in lesion number (42% of cases). Average new metastases found of 66 = 1.3 (range 0-9). Average increased metastases in 28 cases = 3.1 (range 1-9). Median days between MRI scans 17.5 (2-61). Fifty-five metastases increased in size.

Conclusions
Double-dose gadobutrol contrast on pre-SRS MRI for brain metastases resulted in an increased number of identified metastases in 42% of cases. This protocol has significant implications for SRS treatment of brain metastases. Additionally, gadobutrol is a macrocyclic gadolinium contrast agent, a potential consideration regarding gadolinium deposition.

O-27

Maximum Intensity Projection Improves Detection of Small Brain Metastases.

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1Univ. Of North Carolina School Of Medicine, Chapel Hill, NC

Purpose
Our purpose was to assess the incremental effect of maximum intensity projection
(MIP) image processing obtained from postcontrast MP-RAGE in detecting small brain metastases.

Materials and Methods
A prospective analysis of 32 patients with known brain metastases was performed, each patient having at least one lesion less than 1 cm. We separated the patients into two groups: those with at least one lesion ≤ 4 mm (N = 26) (group 1), and those with at least one lesion between 4.1 and 9 mm (N = 6) (group 2). We compared 1 mm thick postcontrast MP-RAGE images with the same images adding to them 5 mm thick overlapping MIP reconstructions. Three independent readers analyzed the studies and all were presented in an anonymized and random fashion. Locations and dimensions of additional lesions detected with MIP images were documented. Maximum number of lesions detected by all readers and confirmed by consensus served as the reference standard. McNemar's test then was used to determine if MIP images detected more significantly more nodules than MP-RAGE images on a reader-by-reader basis.

Results
Maximum intensity projection reconstructions resulted in an increased number of detected brain metastases for all three readers. Reader 1 identified 172 metastases with MP-RAGE (sensitivity 0.793) and 200 with MIP images (sensitivity 0.922). Reader 2 identified 191 metastases with MP-RAGE (sensitivity 0.880) and 211 with MIP images (sensitivity 0.972). Reader 3 identified 166 metastases with MP-RAGE (sensitivity 0.765) and 199 with MIP images (sensitivity 0.917). For group 2, the addition of MIP did not result in a difference in the detection of brain metastases for any reader and each reader identified 11 brain metastases with each technique. The increase in sensitivity by adding MIP was observed only in patients belonging to group 1; reader 1 with an increase in the number of lesions detected in 17 patients (65%), reader 2 with MIP increasing the number of lesions detected in 12 patients (46%), and reader 3 detected more nodules in 18 patients (69%) with MIP images than with MP-RAGE alone. For each reader, the 95% confidence interval between sensitivities for each technique did not contain 0, indicating significance. On a reader-by-reader basis, there was a statistically significantly higher number of nodules detected with MIP than with MP-RAGE alone (P < 0.00005 for each reader). The total number of lesions detected by the three readers for patients in group 1 was 529 for MP-RAGE and 610 for MIP images. Eighty-one lesions detected only by MIP images were located in the cortex (N = 43; 53%), subcortical white matter (N = 14; 17%), basal ganglia and deep white matter (N = 12; 15%), and posterior fossa (N = 12; 15%). Cortical metastases were located in the frontal (N = 29; 67%), temporal (N = 6; 14%), occipital (N = 5; 12%), and parietal lobes (N = 3; 7%).

Conclusions
We found that adding MIP reconstructions of previously obtained postcontrast MP-RAGE images improves detection of small brain metastases (≤ 4 mm). The majority of the metastases overlooked by MP-RAGE alone were located in the frontal cortex.
An Image-Centric Data Mining Platform for Applying Machine Learning and Quantitative Image Analysis Algorithms in Radiology – Application to the Prediction of Lower Grade Gliomas in the TCGA Database on the Basis of Morphologic Parameters

S Hwang\textsuperscript{1}, C Holder\textsuperscript{2}, L Poisson\textsuperscript{3}, A Flanders\textsuperscript{4}

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Purpose

1) To further develop a user-friendly and image-centric data mining platform for applying machine learning algorithms and quantitative image analysis to predict other

Table 1

<table>
<thead>
<tr>
<th>Observer</th>
<th>Sensitivity MIP</th>
<th>Sensitivity VR</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ob1</td>
<td>0.922</td>
<td>0.793</td>
<td>0.129 (0.064, 0.193)</td>
</tr>
<tr>
<td>Ob2</td>
<td>0.972</td>
<td>0.880</td>
<td>0.092 (0.044, 0.140)</td>
</tr>
<tr>
<td>Ob3</td>
<td>0.917</td>
<td>0.765</td>
<td>0.152 (0.085, 0.219)</td>
</tr>
</tbody>
</table>

*Data in parenthesis are 95% confidence intervals. Zero does not lie within any intervals implying statistical significance.*
relevant features, e.g., clinical and genomic. 2) To apply quantitative shape analysis to predict genomic subtype as determined by isocitrate dehydrogenase gene (IDH) mutation and 1p/19q co-deletion status.

Materials and Methods
The data-mining platform for applying machine learning and image analysis algorithms is based on NIH ImageJ (http://imagej.nih.gov/ij) enhanced with other open source software such as Weka (machine learning, http://www.cs.waikato.ac.nz/ml/weka) and SimpleITK (image analysis, http://www.simpleitk.org). The software facilitates the accumulation of data, including inputs from multiple radiologists, for training machine learning algorithms to predict both imaging and nonimaging (e.g., clinical and genomic) parameters. In addition to nonincremental machine learning algorithms (e.g., random forests), an incremental method (Hoeffding trees) was added to process large data sets with ongoing accumulation since it updates predictive models/classifiers with new data without reprocessing previous data. Brain magnetic resonance images (MRI) of lower grade gliomas (LGGs, WHO grades I to III) images from The Cancer Genome Atlas database (TCGA, http://cancergenome.nih.gov/) were processed. The Cancer Genome Atlas Research Network demonstrated that IDH mutation and 1p/19q codeletion are key molecular markers, which subdivide LGGs into three clinically relevant subtypes. Tumors with wild type IDH demonstrate clinical behavior resembling glioblastomas. Tumors with IDH mutation and 1p/19q co-deletion are least aggressive and those with IDH mutation but no codeletion are intermediate. The molecular subtypes more robustly stratified clinical outcome than traditional histologic classes. Tumor in the MRIs was identified with semi-automated segmentation using machine learning. Twenty-five of 199 available datasets have been processed so far. Shape parameters including volume, surface area, distance to the surface of the tumor from the centroid, convexity, and solidity were computed. Heterogeneity was assessed using cluster analysis. Associations between morphologic parameters and genomic subtypes were evaluated with ANOVA. Predictive models were generated using the random forest algorithm.

Results
Isocitrate dehydrogenase gene wild type tumors demonstrated lower solidity (p=0.005), defined as the volume of tumor divided by the volume of the convex hull. Tumors, which are round or predominantly convex in morphology, have solidity close to one while irregular morphologies with areas of concavity have solidity significantly less than one. This is in concordance with the observation that more highly aggressive tumors often have a more irregular/infiltrative morphology.

Conclusions
1) A data-mining platform built upon ImageJ provides a user-friendly tool for exploring associations between imaging, clinical, and genomic features. 2)
Quantitative image analysis, in particular shape parameters, may be helpful in noninvasively predicting the molecular subtype of diffuse lower grade gliomas.

Monday  
8:35AM - 10:11AM  
Washington Marriott Wardman Park, Roosevelt 4

2F-PARALLEL PAPER SESSION: Advances in Functional and Structural CNS MRI  
O-28

Cumulative effect of MRIs on cardiac rhythm management devices

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¹Cooper University Hospital, Camden, NJ, ²University of Pennsylvania, Philadelphia, PA, ³Hospital of University of Pennsylvania, Collingswood, NJ, ⁴Hospital of The University of Pennsylvania, PHILADELPHIA, PA, ⁵University of Pennsylvania, Philadelphia, PA, ⁶Perelman School of Medicine of the University of Pennsylvania, Philadelphia, PA

Purpose
To determine the incidence of adverse events and device-related complications from receiving multiple versus single magnetic resonance imaging (MRI) in patients with cardiac rhythm management devices (CRMD).

Materials and Methods
IRB-approved retrospective study compared rate of adverse events and device-related complications in 437 patients with CRMD [pacemakers (PMs) and implantable cardioverter-defibrillators (ICDs) who received single versus multiple (more than four) MRIs on a 1.5T magnet from 2008 to 2015. Any event that occurred during or immediately following the scan that was a change for the patient as compared to the patient's baseline was recorded. Total numbers of scans, preprocedural device parameters, scan duration and intra and short-term postprocedural device complications also were recorded.

Results
Out of 437 patients, 121 patients had multiple and 316 patients had a single MRI (186 brain and spine, 218 cardiac and 33 musculoskeletal MRI). Of those who had multiple MRIs, the number of MRIs they received ranged from 5 to 24. The median duration of the scan was 65 minutes. Eight out of 121 patients (6.6%) who received multiple scans and 26 out of 316 (8.2%) patients who had a single scan had adverse events. All of these events were predominantly transient asymptomatic arrhythmias or EKG
abnormalities, with majority of symptomatic events being noncardiac such as malaise, weakness, lethargy, claustrophobia, musculoskeletal pain and lightheadedness. There were no device-related complications.

Conclusions
The rate of adverse events and device-related complications in patients with CRMDs is not higher in those who have received multiple MRIs. In assessing the risk-benefit of MRIs in patients with cardiac devices, the frequency of MRI may not be a significant consideration.

O-29
Clinical Uses of Resting-State Functional Magnetic Resonance Imaging

G Guzman Perez-Carrillo¹, T Benzinger², M Miller-Thomas¹, A Vellimana³, B Speidel³, J Shimony², E Leuthardt³
¹Mallinckrodt Institute of Radiology, St. Louis, MO, ²Mallinckrodt Institute of Radiology, Saint Louis, MO, ³Washington University in St. Louis, St. Louis, MO

Purpose
To evaluate the clinical presurgical use of resting-state functional magnetic resonance imaging (rs-fMRI) in neurosurgery patients.

Materials and Methods
One hundred fifty-five consecutive patients (137 adult and 18 pediatric) between January 2014 and June 2015 underwent a clinical MRI that included rs-fMRI at 3T. Thirty-one patients had two rs-fMRI sessions and five patients had three rs-fMRI sessions, for a total of 232 sessions. Of these 232 sessions, 83 also had motor and language task-based fMRI (tb-fMRI) (Fig. 1). For each patient, two 6-minute rs-fMRI sequences were obtained, each consisting of 160 volumes. Cases were processed using an in-house developed pipeline utilizing a novel multilayer perceptron algorithm (Hacker et al, 2013). All cases underwent both automated and qualitative physician quality control assessments. Surgical cases then were built into the neurosurgical plans on an intra-operative navigation system (StealthViz, Medtronic).

Results
One hundred eighty-five studies were performed for tumor evaluation, 14 for epilepsy and 33 for vascular malformations or other neurological causes (encephalitis, Creutzfeldt-Jakob disease, obsessive-compulsive disorder, chronic central pain syndrome and cysticercosis). Twenty-eight rs-fMRI failed (See Table 1 for causes). Thirty-two tb-fMRI (See Table 1 and 2 for causes). The failure rate of rs-fMRI of 13% (28/232) was significantly better than the failure rate of task-based fMRI of 38.5% (32/83). At our institution, rs-fMRI can be performed 24/7 during the entire week with minimal staff support, whereas tb-fMRI only can be performed during
regular work hours (Monday-Friday 8 am-5 pm), requiring the presence of both a trained magnetic resonance technician and a neuroradiology fellow. We observed an increasing rate of utilization of rs-fMRI during the time frame of the study (Fig. 2).

Conclusions

Resting-state fMRI is part of our standard protocol for neurosurgical planning. Resting-state fMRI has a lower failure rate than task-based fMRI. Resting-state fMRI can be used in all patients, but is especially useful in individuals that are unable to cooperate with tb-fMRI.
<table>
<thead>
<tr>
<th>Cause of failure</th>
<th>rs-fMRI</th>
<th>tb-fMRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion / cannot follow commands</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Susceptibility artifact</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Incorrect TE</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No activation</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Technical failure NOS / did not pass QA</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>No MPRAGE for co-registration</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 1: Causes of failure of all task-based fMRI (tb-fMRI) and resting-state fMRI (rs-fMRI)

<table>
<thead>
<tr>
<th>Successful</th>
<th>Failed</th>
</tr>
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<tbody>
<tr>
<td>Successful</td>
<td>54</td>
</tr>
<tr>
<td>Failed</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 2: Success and failure of all task-based fMRI (tb-fMRI) with accompanying resting-state fMRI (rs-fMRI)

Figure 1: 62-year-old with left parietal tumor, glioblastoma. The patient was scheduled for operative histological evaluation. Resting-state fMRI (A) and accompanying task-based fMRI (tb-fMRI) (B). Areas of activation are bilaterally and Wernicke's activation on the left are significant.

Figure 2: Utilization rate of rs-fMRI from January 2014-June 2016.
O-30
8:51AM - 8:59AM

**Basal Ganglia Network Functional Connectivity in HIV Infection**

E O'Connor¹, F Mohamed², T Zeffiro³

¹Lewis Katz School of Medicine at Temple University, Philadelphia, PA, ²Thomas Jefferson University, Philadelphia, PA, ³Temple University, Philadelphia, PA

**Purpose**

HIV infection can adversely affect performance in cognitive and motor domains, possibly related to early involvement of basal ganglia nuclei or their axonal connections. Network analysis of striatal circuits allows quantification of HIV neural effects. We used resting state fMRI (rs-fMRI) to investigate changes in inter-regional striatal network structure in untreated HIV infection (HIV+).

**Materials and Methods**

Serologic status of HIV+ participants was confirmed by positive HIV enzyme-linked immunoassay and Western blot or detection of plasma HIV RNA by PCR. In nine treatment-naive HIV+ participants, and nine matched controls (HIV-), we collected structural MRI and 8 min of rs-fMRI data to determine: (1) if resting network connectivity was atypical in untreated HIV infection and (2) whether the changes were most evident in basal ganglia networks known to be affected early in HIV infection.

**Results**

Seed-based basal ganglia connectivity analysis using left and right caudate seeds was used to estimate local efficiency, a measure of local network efficiency, estimated as the average inverse distance among regions connected to a given region. Local efficiency was lower in the HIV+ group in L (t=-6.16) and R (t=-4.10) caudate. The related clustering coefficient, measuring connection density among a node's neighbors, showed similar effects. Betweenness centrality, the proportion of all shortest paths in the network passing through a given node, was higher for HIV+ in R (t=4.54) and L (t=3.90) caudate seeds.

**Conclusions**

Neural synchrony at rest is altered in untreated HIV infection. Network analysis of inter-regional brain connectivity provides promising and practical potential biomarkers for efficient and sensitive detection of HIV infection effects. Our results suggest that rs-fMRI network measures may be useful for longitudinal monitoring of basal ganglia circuit reorganization in small groups, with the potential to serve as a biomarker of subsequent treatment effects in individuals.
Measuring resting-state changes in multiple sclerosis patients after a neurorehabilitation program. A feasibility study using classical block-design functional magnetic resonance studies.

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1Vall d'Hebron University Hospital, Barcelona, Barcelona, 2Vall d'Hebron University Hospital, Barcelona, Barcelona

Purpose
The goal of the study was to explore if functional magnetic resonance studies (fMRI) acquired using the classical block-design, could be reanalyzed in order to characterize the resting-state (RS) networks (RSNs). The final goal was to assess changes in the RSNs of multiple sclerosis (MS) patients after a 5 weeks neurorehabilitation program (NRP).

Materials and Methods
Fifteen MS patients (2 primary progressive, 3 relapsing-remitting, 10 secondary progressive) and five controls were scanned before and after the NRP on a 1.5T system. For each study, the fMRI blocks of rest were merged producing a RS of 3 minutes duration. Resting state studies were analyzed with the MELODIC toolbox, following the published procedure. Finally, a dual regression analysis was applied in order to estimate the longitudinal changes in the RSNs (significance level was set at p< 0.005 uncorrected level and activations above 5 voxels). Patients and controls were analyzed separately as two independent cohorts.

Results
Representative RSN (visual, fronto-parietal, default mode, motor, auditory, executive) could be identified visually from the group analysis for both patients and controls. In the control group, no significant differences were found in any contrast (pre>post, post>pre) in the considered RSN. In the patients group, significant differences were found in the visual (pre>post: right precentral and left middle occipital; and post>pre: right fusiform and left inferior temporal), auditory (post>pre: right precuneus) and executive (post>pre: left fusiform) RSN.

Conclusions
Results regarding the characterization and identification of the RSN indicate that sets of already acquired fMRI studies using a block-design could be reanalyzed as (short) RS. In addition, results suggest that a NRP of 5 weeks duration induces changes in specific RSN of the MS patients studied.
Effect of Geometric Distortion Correction on Thickness and Volume Measurements of Cortical Parcellations

S Siemonsen¹, C Heesen², J Stellmann², J Fiehler³, J Sedlacik²
¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ²University Medical Center Hamburg-Eppendorf, Hamburg, ³University Medical Center Hamburg-Eppendorf, Hamburg, AK

Purpose
To assess the effect of geometric distortion correction in magnetic resonance imaging (MRI) on thickness and volume measurements of cortical parcellations. We hypothesized that the effects of distortion on cortical areas can be in the magnitude of atrophy- or neuroplasticity-related reported changes and are dependent on the anatomical location of the measured region of interest (ROI) relative to the iso-center of the magnetic field.

Materials and Methods
Fifteen healthy subjects were included in the study and received a 3T MRI (Skyra, Siemens) examination of the brain. All subjects gave written informed consent and the study was approved by the local ethics committee. Thickness and volumes of cortical parcellations derived from the FreeSurfer processing stream were calculated from both nondistortion corrected (ND T1-W) and distortion corrected (D T1-W) images which were derived from the same T1-WMP-RAGE data acquisition. Absolute (abs) and relative (rel) differences between volumes (diff-vol) and thickness (diff-thk) of ND T1-W and DT-1-W were calculated. The center of gravity (COG) was defined for each parcellation and differences of x (diff-X), y (diff-Y) and z (diff-Z) coordinates in comparison to the individual's brain masks COG, representing an approximation of the iso-center, were calculated.

Results
All defined parcellations showed differences in volume and thickness when comparing data between ND T1-W and D T1-W images. Rel-diff-vol ranged from -6.4% to 5.7% (mean absolute 2.27%), while rel-diff-thk ranged from -2.3% to 3.0% (mean absolute 1.0%). A significant correlation was found between rel-diff-vol and diff-Y as well as diff-Z and for rel-diff-thk respectively (p<0.01).

Conclusions
Noteworthy differences in cortical thickness and volume can be detected when comparing ND T1-W and D T1-W data. Measurable differences are increasing with distance from iso-center in Y and Z direction. Calculated differences are thereby in the magnitude of changes reported by longitudinal studies on brain atrophy or neuroplasticity and these analyses therefore only should be conducted on distortion.
corrected data. Figure. Histograms showing the frequency-distribution of rel-diff-thk (A) and rel-diff-vol.

![Histograms showing the frequency-distribution of rel-diff-thk (A) and rel-diff-vol.](TCT_O-32_Dist_corr_Figure.jpg)

**O-33**

*Altered Structure in the Brains of Cervical Spondylocytic Myelopathy Patients*

D Woodworth¹, L Holly², N Salamon¹, A Hardy¹, B Ellingson¹

¹Department of Radiological Sciences, UCLA David Geffen School of Medicine, Los Angeles, CA, ²Department of Neurosurgery, UCLA David Geffen School of Medicine, Los Angeles, CA

**Purpose**

Cervical spondylotic myelopathy (CSM) entails compression of the spinal cord and subsequent neurological deficits. One area of active research has been functional activation of the brains of CSM patients and how that differs from that of healthy subjects (1, 2). For this study we performed a preliminary analysis of structural changes that accompany CSM. This was done via cortical-thickness analysis of 3D-T1 magnetic resonance imaging (MRI) data and voxel-wise analysis of diffusion MRI data.

**Materials and Methods**

We scanned eight CSM patients (mean age 55.9±7.3 years) and nine healthy controls (HC, mean age 30.7±5.7 years) with a protocol that included a 3D structural MRI (T1 MPRAGE) and diffusion MRI. Analyses were performed using FreeSurfer for structural scans, and FSL FDT package and AFNI T-test function for the diffusion...
scans. Given our small sample size we did not account for covariates and thresholded at P=0.05, with the diffusion results being further thresholded by a cluster size of 250μL.

Results
For the T1 structural results, cortical thickness displayed prevalence to cortical thinning in CSM patients, with some of the most prominent clusters appearing in the precentral gyrus and sulcus. Fig. 1 (left) displays a cluster of the cortical thickness comparison in the precentral gyrus and the cortical-thickness measurements in that cluster. For the diffusion analysis regions of increased FA (basal ganglia, select white matter fibers) and decreased FA (corpus callosum) appeared. One prominent cluster that resulted from the analysis was that of white matter leading up to the motor cortex, displayed in Fig. 1 (right), along with the mean FA in that cluster.

Conclusions
While cortical thinning suggests atrophy of motor areas, increased FA leading to the motor cortex suggests reorganization of white matter and increased fiber coherence around the superior corticospinal tract. These results offer a glimpse at brain changes accompanying CSM and we will continue to acquire more data in CSM and HC subjects.
Large scale study on multi-modal brain mapping as a predictive tool of focal neural deficit and brain plasticity.

M Zaid\textsuperscript{1}, R Anil\textsuperscript{1}, I Hassan\textsuperscript{1}, W Wei\textsuperscript{1}, R Sawaya\textsuperscript{1}, A Kumar\textsuperscript{1}, P Zinn\textsuperscript{2}, R Colen\textsuperscript{1}
Purpose
In this study, we seek to evaluate the combination of fMRI and DTI tractography to predict postoperative motor deficits in GBM, a neoplasm with a high invasive nature. This would help neurosurgeons to balance extent of resection with preservation of motor function.

Materials and Methods
We obtained IRB approval for this retrospective study. We reviewed patients presenting to MD Anderson Cancer Center from 2004 till 2015 who underwent fMRI. Our inclusion criteria were a pathologically proven diagnosis of GBM, pre- and postoperative full neurological examination, pre-operative task based motor fMRI as well as diffusion tensor imaging (DTI). Two hundred twenty patients met our inclusion criteria. We obtained multiple parameters from fMRI and DTI including lesion to activation distance (LAD) in T1 postcontrast (T1LAD) and T2 FLAIR (FLAIR-LAD). Lesion to activation distance was measured twice, from center of activity to center of lesion and from margin of activity to margin of lesion. Diffusion tensor imaging tractography was done to measure the distance between neoplasms margin, edema margin to corticospinal tract (CST) in T1 postcontrast and T2 FLAIR respectively. Kruskal-Wallis test was used to compare distance between patient groups, all tests were 2-sided and p-values of 0.05 or less were considered statistically significant.

Results
In our selected population 53% of patients were females, 47% were males and the majority showed right-handedness (90%). Glioblastoma multiformes were located in left hemisphere in 63% of patients, 38% in the right, 48% in frontal lobe, 30% and 22.5% in parietal and temporal lobes respectively. Gross total resection was achieved in 70%, while 30% underwent subtotal. Eighty-three percent of patients had pre-op motor deficits while the remaining 17 % had not. After the surgery 50% showed neither improvement nor deterioration in their motor deficits, 35% deteriorated and 15% improved, while new onset postoperative motor deficits emerged in 63%. The most important imaging marker for determining the postoperative status of MFND was the distance between lesion edge and edema edge with the worst prognosis in development of MFND in patients with FLAIR-LAD of less than 1 mm (P=0.0004). The second best marker was T1-LAD when measured from edge of the tumor to edge of activation ROIs; distance below 6.6 mm was associated with deterioration in motor functions (P= 0.002). Similarly, a statistically significant deterioration occurred in T1-LAD less than 29 mm when measured from center of tumor to center of activity (p-value= 0.007). The distance of contrast enhancement and FLAIR signal abnormality
to corticospinal tract did not show statistical significance in predicating patient outcome.

Conclusions
Lesion to activation distance is an important functional imaging marker for detection of MFND in GBM patients. Glioblastoma multiforme has a significant edema portion that contributes to the potential outcome of patients postsurgery.

O-35
9:31AM - 9:39AM

The Effect of Language Task Selection on the Preoperative Mapping of Wernicke’s Area.

K El Salek1, I Hassan1, P Zinn2, W Wei1, S Faro3, F Mohamed3, J Weinberg1, A Kumar1, R Sawaya1, R Colen1
1MD Anderson Cancer Center, Houston, TX, 2Baylor College of Medicine, Houston, TX, 3Temple University School of Medicine, Philadelphia, PA

Purpose
The reliability of functional magnetic resonance imaging (fMRI) as a clinical tool for pre-operative mapping of cortical language areas greatly depends on the speech paradigms being deployed. Different tasks harness distinct abilities to activate various areas related to speech processing, particularly those related to receptive speech classically known as Wernicke's area. By studying our cohort of both healthy volunteers and patients with gliomas, we seek to determine the robustness of localization of Wernicke's area using silent sentence completion (SSC) which provides a reliable covert semantic task as compared to categorical naming (CAT) and word generation (FAS).

Materials and Methods
Fifteen right-handed healthy volunteers and 30 mixed handed patients were included in this study. Our patient population included subjects with various types and grades of gliomas distributed in the frontal, temporal and parietal cortices of the brain. Every subject enrolled performed (1) covert semantic and (2) verbal fluency speech paradigms: SSC, FAS and CAT. Processed functional data then were analyzed using Dynasuite Neuro 3.0 workstation (In vivo Corporation, Gainesville, USA). Our search was focused on the areas of the posterior superior/middle temporal and angular gyrus where the region of interest (ROI) considered to be Wernicke's area by a neuroradiologist was evaluated for activity on the three different speech tasks. Activity was deemed significant in a specific ROI if pbonf<0.05. In addition the genetic profile for each patient also was obtained from the official pathology report in an effort to delineate any association between activity on the three different tasks and any specific genetic marker (IDH1, 1p/19q del, S-100, EGFR, PTEN, p53).
McNemar's test was used to compare FAS and CAT against SSC with respect to detection rate. Fisher's exact test was used to assess association between detection status and biomarker mutation status. All tests were two-sided and p-values of 0.05 or less were considered statistically significant.

Results
Statistical analysis clearly demonstrated the robustness and superiority of SSC in localizing Wernicke's area. SSC detected positive results in all cases (100%) for both cancer and healthy volunteer groups. In our patient population FAS and CAT were both positive in 16.13% (5 of 30) of cases which is significantly less compared with SSC (p < .0001 by McNemar's test). In volunteers FAS and CAT were positive in 31.25% (5/15) and 18.75% (3/15) respectively which is also significantly less compared to SSC (p = 0.004 and 0.003 by McNemar's test, respectively). There was no association between SSC and a specific genetic biomarker. Similarly neither FAS nor CAT results was significantly correlated with any biomarker mutation status.

Conclusions
Silent sentence completion is an adequate and robust task for the localization of Wernicke's area. It's superiority over other language paradigms makes an important noninvasive clinical tool that might be essential for a function preserving surgery, especially in patients with tumors adjacent to areas of eloquent cortex that usually are functionally and topographically identified as language processing areas.
fMRI - ASFNK Sentence_10_10

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(Filename: TCT_O-35_SCCfMRI2.png)
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<th>Age</th>
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<td>M</td>
<td>right handed</td>
<td>Left temporal</td>
</tr>
<tr>
<td>65</td>
<td>F</td>
<td>right handed</td>
<td>Left parietal / left angular gyrus</td>
</tr>
<tr>
<td>45</td>
<td>M</td>
<td>right handed</td>
<td>Left anterior insula and frontal operculum</td>
</tr>
<tr>
<td>19</td>
<td>M</td>
<td>right handed</td>
<td>Left parietotemporal</td>
</tr>
<tr>
<td>33</td>
<td>M</td>
<td>right handed</td>
<td>Left frontal lobe + Left insula + left temporal</td>
</tr>
<tr>
<td>18</td>
<td>F</td>
<td>right handed</td>
<td>Right frontal and left frontal</td>
</tr>
<tr>
<td>39</td>
<td>M</td>
<td>mixed handed</td>
<td>Right insular, frontal and temporal</td>
</tr>
<tr>
<td>62</td>
<td>M</td>
<td>mixed handed</td>
<td>Right frontal and insula</td>
</tr>
<tr>
<td>52</td>
<td>M</td>
<td>right handed</td>
<td>Left caudate nucleus, internal capsule + Left temporal</td>
</tr>
<tr>
<td>43</td>
<td>M</td>
<td>right handed</td>
<td>Left frontal (crossing midline)</td>
</tr>
<tr>
<td>43</td>
<td>M</td>
<td>left handed</td>
<td>Right parietal</td>
</tr>
<tr>
<td>51</td>
<td>F</td>
<td>right handed</td>
<td>Left frontotemporal</td>
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<tr>
<td>51</td>
<td>F</td>
<td>right handed</td>
<td>Left frontal, insular, and anterior temporal</td>
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<tr>
<td>28</td>
<td>F</td>
<td>left handed</td>
<td>Left frontal</td>
</tr>
<tr>
<td>50</td>
<td>M</td>
<td>right handed</td>
<td>Right and left frontal</td>
</tr>
<tr>
<td>31</td>
<td>F</td>
<td>right handed</td>
<td>Superior left temporal lobe</td>
</tr>
<tr>
<td>62</td>
<td>M</td>
<td>left handed</td>
<td>Left temporal lobe</td>
</tr>
<tr>
<td>54</td>
<td>M</td>
<td>right handed</td>
<td>Right frontoparietal + Left temporal</td>
</tr>
<tr>
<td>25</td>
<td>M</td>
<td>right handed</td>
<td>Left temporal</td>
</tr>
<tr>
<td>54</td>
<td>M</td>
<td>right handed</td>
<td>Right frontal and left temporal</td>
</tr>
<tr>
<td>35</td>
<td>M</td>
<td>left handed</td>
<td>Right occipitotemporal and Bifrontal</td>
</tr>
</tbody>
</table>
Distinct Pattern of Cerebral Hypoperfusion Distinguishes Cognitively Impaired HIV Patients

J Narvid¹, D McCoy¹, J Hellmuth¹, V Valcour¹
¹UCSF, San Francisco, CA

Purpose
To investigate whether HIV-associated neurocognitive disorder (HAND) patients demonstrate altered cerebral blood flow (CBF) and whether CBF distinguishes HAND patients from normal controls.

Materials and Methods
Nineteen HIV+ patients underwent 3T MR utilizing ASL and volumetric T1. Patient demographics and virologic markers are listed in Table 1. Nineteen age-, gender-, and education-matched controls' data were obtained form the Alzheimer's Disease Neuroimaging Initiative (ADNI-2 ASL substudy; adni.loni.usc.edu). All data were acquired using the same ASL sequence (QUIPS II on Skyra, Siemens) and a largely automated processing pipeline described previously (1). FreeSurfer (surfer.nmr.mgh.harvard.edu) was used to generate anatomical region of interest (ROI) statistics for CBF and volume. We took an exploratory approach: first with dimension reduction using principle component analysis, second by performing data-driven discriminant analysis, and finally analysis of covariance.

Results
Principle components (PC) 1-6 distinguish HIV+ patients from normal controls with cross-validated discriminant analysis accuracy of 75%. Regions of interest with largest coefficients then were evaluated with ANCOVA. HIV+ patients demonstrate reduced caudate and insular CBF controlling for gray matter volumes (Tukey HSD, p=.004 and p=.009, respectively).

Conclusions
HIV+ patients demonstrate a distinct pattern of cerebral hypoperfusion. Arterial spin labeling perfusion may serve as a potential biomarker for the effects of HIV on the brain.
Table 1. HAND Patients Evaluated at UCSF

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>19</td>
</tr>
<tr>
<td>Age (years)</td>
<td>66.3±1.3</td>
</tr>
<tr>
<td>Education (years)</td>
<td>16.7±2.1</td>
</tr>
<tr>
<td>% Male</td>
<td>94.7</td>
</tr>
<tr>
<td>Race (caucasian)</td>
<td>18/1</td>
</tr>
<tr>
<td>Current CD4 (cells/mm3)</td>
<td>638±23</td>
</tr>
<tr>
<td>CD4 nadir</td>
<td>209±1</td>
</tr>
<tr>
<td>% Undetectable viral load</td>
<td>100</td>
</tr>
<tr>
<td>Years since diagnosis</td>
<td>21.5±1</td>
</tr>
</tbody>
</table>

O-37

Evaluation of response to stereotactic radiosurgery in brain metastases using multimodal MRI

R Flintham¹, P Sanghera¹, A Peet², V SAWLANI¹, N Davies¹
Purpose
Conventional magnetic resonance imaging (MRI) methods are insufficient to differentiate local tumor recurrence and radiation-induced necrosis following stereotactic radiosurgery (SRS) treatment for brain metastases. Advanced MRI techniques such as perfusion, diffusion and spectroscopy have been shown to aid the assessment of response following SRS treatment of brain metastases (1-3). However, the added-value of a multimodal approach has not been investigated. The aim of this preliminary study was to evaluate the use of perfusion, diffusion and spectroscopic imaging (multimodal MRI) for assessment of treatment response in brain metastases.

Materials and Methods
Ten multimodal MRI examinations were performed 6-12 months after SRS for metastatic brain lesions in seven patients with primary malignant diseases: melanoma, n=3; breast, n=3; small cell lung, n=1. Multimodal MRI examination consisted of T1- and T2-weighted structural imaging, dynamic susceptibility contrast (DSC) perfusion imaging, diffusion-weighted imaging (DWI) and both single and multivoxel MR spectroscopy (MRS) (TE = 30 ms). All scanning was performed on a Siemens Verio 3T MRI scanner. rCBV and ADC maps were analyzed using Siemens syngo. Magnetic resonance spectroscopy analysis was performed using Tarquin (4) and peak area ratio of choline to creatine (Cho:Cr) calculated. Correlations between rCBV ratio, ADC, Cho:Cr and radiological/clinical follow up were investigated.

Results
Cho:Cr demonstrates a strong positive correlation with rCBV ratio (r = 0.89, p < 0.01). This is in agreement with previous work which showed a similar correlation in pretreatment metastases (5). No significant correlations were observed between ADC and rCBV or Cho:Cr. Applying a reported threshold for rCBV ratio of 2.1 (1), patients were divided into two groups showing suspected tumor recurrence (n=4) and suspected radiation necrosis (n=3). For a single borderline case (rCBV ratio = 1.9), high Cho:Cr ratio and intermediate ADC (Cho:Cr = 3.6; ADC = 0.000998 mm^2/s) are observed. When all parameters are considered together, the impression becomes one of probable tumor recurrence. This demonstrates the value of multimodal MRI over any single parameter in isolation. Figure 1 shows a case of local tumour recurrence with (a) T1-weighted postcontrast showing multiple contrast-enhancing lesions with location of MRS voxel, (b) rCBV map showing substantially raised rCBV ratio (4.5) in the lesion, corresponding to an area of low ADC (0.000629 mm^2/s) (c). Single voxel MRS (d) shows raised Cho:Cr, low NAA and moderately high lipid signal at TE = 30ms. This is in contrast to a second patient demonstrating low rCBV ratio (0.9), high ADC (0.001479 mm^2/s) and low Cho:Cr (0.96). This patient is clinically stable, with radiologically stable disease on follow-up imaging.
Conclusions
Preliminary results suggest that a combination of high rCBV, low ADC and high Cho:Cr clearly can identify local tumor recurrence and that multimodal MRI may improve accuracy compared with any technique in isolation. The study is ongoing to determine the best multivariate predictors of response to radiosurgery for brain metastases.
Track-Density Images Demonstrates White Fiber Density Changes after Radiosurgical Anterior Capsulotomy for Obsessive Compulsive Disorder

K Chen¹, A Wolf¹, M Hoch¹, S Chung¹, M Bruno¹, D Kondziolka¹, T Shepherd¹
¹NYU Medical Center, New York, NY

Purpose
The anterior limb of the internal capsule has been the major target for ablation in patients with severe medically intractable obsessive compulsive disorder (OCD). The disruption of frontothalamic fibers is hypothesized to reduce thalamic output responsible for OCD symptoms. The purpose of this study is to use high-angular resolution diffusion-weighted imaging to quantify changes in fiber density over time, specifically after radiosurgical anterior capsulotomy for OCD.

Materials and Methods
Two patients received bilateral anterior internal capsule gamma-knife radiosurgery (marginal dose 75 Gy, maximal dose 150 Gy, 4 isocenters). T1-W, T2-W, and FLAIR MRI sequences, along with twice-refocused spin-echo DWI (200 directional gradient, b=2500) were acquired prior and 4-6 months after radiosurgery. Postprocessing included eddy current and susceptibility correction. Fiber orientation was resolved with constrained spherical deconvolution. Tracks were generated from 10 million seeds points and filtered prior to generating track density images (TDI) in grayscale or directionally encoded color images.

Results
We observed decreased fiber density (white arrows) in both subjects on 5-month postoperative TDI images in the anterior limb of the internal capsule at the radiosurgical target. Additionally, small ring-enhancing areas at the radiosurgical target were noted on 5-month postoperative FLAIR images. Yale-Brown Obsessive Compulsive Scale (YBOCS) scores noted improvements from 40 to 38 in one patient and 34 to 31 in the other.

Conclusions
Track-density imaging of radiosurgical anterior capsulotomy results in decreased fiber density. These disrupted frontothalamic fibers may be associated with reduction of OCD symptoms. Future imaging studies are planned on these subjects and will enhance understanding of radiosurgery on fiber density in TDI.
Fig 1: Loss of bilateral anterior limb internal capsule TDI streamlines after GKRS for OCD

T2 treatment plan

FLAIR post GKRS

DEC-TDI pre GKRS

DEC-TDI post GKRS
Cytotoxic Edema in Posterior Reversible Encephalopathy Syndrome: Correlation of MRI Features with Serum Albumin Levels

B Gao

Keck School of Medicine, University of Southern California, Los Angeles, CA

Purpose
Posterior reversible encephalopathy syndrome is a clinicoradiologic entity with typical MR imaging showing predominant vasogenic and occasional cytotoxic edema. It is unclear whether MR imaging correlates with levels of serum albumin. We determined potential risk factors for development of cytotoxic edema in posterior reversible encephalopathy syndrome.

Materials and Methods
Seventy-nine cases with typical clinical symptoms and characteristic neuroradiologic findings conformed to posterior reversible encephalopathy syndrome diagnostic criteria and were included in this study. FLAIR, DWI, and ADC maps were interpreted to evaluate the severity and type of edema. Magnetic resonance imaging was correlated with the levels of serum albumin, and cytotoxic edema was compared with the location and severity of brain edema.

Results
Pure vasogenic edema was found in 53 cases (67.09%), and vasogenic edema complicated with cytotoxic components, in 26 patients (32.91%). There was no difference in serum albumin levels between patients with cytotoxic components and those with vasogenic edema (P = .983). There was a significant difference in the edema scale scores between patients with cytotoxic edema and those with vasogenic edema (P = .006). The percentage of cytotoxic edema located in the area with higher scale scores of edema was significantly larger than that in areas with lower scale scores of edema (P = .002).

Conclusions
Serum albumin may contribute to the development of edema in PRES but is not a decisive factor for edema type. Cytotoxic edema in posterior reversible encephalopathy syndrome is probably related to regional decreased perfusion and arteriolopathy. Further work should be undertaken to discover the pathophysiologic mechanisms involved.

Monday
10:30AM - 12:00PM
Evaluation of the Patient with Facial Pain

DeLone, D.
Mayo Clinic
Rochester, MN

Understanding Perineural Tumor Spread

Stambuk, H.
Memorial Sloan-Kettering Cancer Ctr
New York, NY

Lower Cranial Nerve Imaging

Reede, D.
SUNY Downstate University Hospital
Brooklyn, NY

Future Trends in Organized Medicine
3B-2

Neuroradiology: Today, Tomorrow, and the Day After

Mukherji, S.
Michigan State University
East Lansing, MI

10:55AM - 11:20AM

3B-3

Technology Disrupters and the Impact of Social Media

Kotsenas, A.
Mayo Clinic
Rochester, MN

11:20AM - 11:45AM

3B-4

Questions and Answers

11:45AM - 12:00PM

Monday

10:30AM - 12:00PM

Washington Marriott Wardman Park, Washington 1/2/3

3C-PARALLEL PAPER SESSION: Spine: Imaging and Intervention

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MR Angiographic Diagnosis of Spinal Epidural Arterio-Venous Fistulas with Perimedullary Reflux

10:30AM - 10:38AM
S Mathur¹, S Symons², P Muthuswami¹, W Montanera¹, A Bharatha¹
¹University of Toronto, Toronto, ON, ²Sunnybrook Health Sciences Centre, Toronto, Ontario

Purpose
Spinal epidural arteriovenous fistulas (SEAVFs) are rare spinal vascular malformations. If there is associated radicular-perimedullary venous reflux, these can mimic spinal dural AV fistulas (SDAVF) by causing venous congestive myelopathy. Correct diagnosis and localization is important to facilitate proper treatment. We hypothesize that first pass contrast-enhanced MR angiography can diagnose and localize SEAVFs and distinguish them from SDAVF. We describe the MRA appearance of these rare lesions.

Materials and Methods
Forty-one consecutive patients with a clinical suspicion of spinal arteriovenous fistula underwent pretreatment MRI, MRA and DSA at a single institute between 2000 and 2015. The MRI, MRA and DSA studies were reviewed by two independent blinded observers. Digital subtraction angiography was used as reference standard. IRB approval was obtained.

Results
On MRA, all seven SEAVFs with perimedullary reflux were diagnosed correctly, distinguished from SDAVF, and localized with no interobserver disagreement. The key diagnostic feature was arterialized filling of a venous pouch and/or the epidural venous system. A refluxing radiculomedullary vein was visualized on reconstructions of the MRA images in all the cases. The venous pouch was identified on conventional nonangiographic MR sequences as well.

Conclusions
Contrast-enhanced MRA is a reliable and useful technique for the initial diagnosis and localization of spinal epidural arteriovenous fistulas, and can distinguish these lesions from SDAVF.
Ascending and Descending Thoracic Vertebral Arteries in Man

P Gailloud¹, L Gregg¹, M Pearl², D San Millan²
¹Johns Hopkins University School of Medicine, Baltimore, MD, ²The Johns Hopkins Hospital, Baltimore, MD

Purpose
A thoracic vertebral artery (VA) is an anastomotic chain similar in nature to a VA but found at the thoracic level. A descending thoracic VA originates from the pretransverse segment of the VA, and curves medially and caudally to pass into the last transverse foramen or first costotransverse space. Another type of vessel occasionally found within the upper costotransverse spaces, anatomically identical to a thoracic VA except for its caudal origin from the aorta and ascending course, truly
represents an ascending form of thoracic VA. This report illustrates the angiographic anatomy of ascending and descending VAs (Fig. 1).

Materials and Methods
Nine cases of descending thoracic VA and two of ascending VA were documented angiographically in our service between 2006 and 2015.

Results
A descending thoracic VA was found on the right side in eight cases (88%), on the left side once (11%). The bifurcation of the VA trunk into ascending and descending branches was located at C7-T1 (5 instances) or C6-C7 (4 instance). The descending thoracic VA branched off a significant anterior radiculomedullary artery in five instances (56%). Small bronchial arteries commonly are provided as well. Both ascending thoracic VAs were left-sided, originated from the second thoracic ISA (T2), and entered the second costotransverse space to continue cranially as a normal VA.

Conclusions
Ascending and descending thoracic VAs are important variants characterized by their location within the upper costotransverse spaces. They can have important clinical implications, e.g., during spine interventional or surgical procedures, or as an occult source of hemoptysis through their frequent bronchial contributions. The presence of an ascending thoracic VA of aortic origin, which must be suspected when a normal VA cannot be located, can have a significant impact on the evaluation and treatment of cervicocranial neurovascular pathologies.
Spinal Cord Cavernous Malformations in a Large Familial Population

B Hart¹, M Bartlett¹, E Reese¹, L Morrison¹
¹University of New Mexico, Albuquerque, NM

Purpose
Central nervous system (CNS) cavernous malformations (CMs) occur in spinal cord as well as brain. Previous case series have limited genetic information. We evaluated spinal cord CMs in a large group of patients with documented CCM1 mutation.

Materials and Methods
We reviewed spinal findings in 260 subjects with CCM1-CHM mutation, participating in an IRB-approved, HIPAA-compliant study, for: incidentally-detected CMs in the upper cervical spinal cord from brain MRI; and CMs found on spine MRI performed for clinical indications. We evaluated demographic, clinical and imaging features. Nonparametric correlation analysis was performed regarding correlation of spine CMs with number of brain lesions, patient age, and brain CM-related symptoms.

Results
Spinal CMs were found in 31 patients: 17 with CMs found in upper cervical spinal cord on brain sagittal T1 MPRAGE; and 20 patients, from 5 to 80 years old, with CMs found on clinical spine MRI, eight with more than one spinal CM. Six patients overlapped both groups. There was no correlation with number of brain CMs, gender, or brain CM symptoms. Correlation with age was p=0.625. Common findings ranged from typical mixed-signal CMs to small foci seen only on gradient-based sequences. No venous abnormalities were identified in any patients. Gradient-based imaging was helpful, especially isotropic sequences. Unusual spine CM features included: multiplicity, including 11 spine CMs in one patient; nerve root CMs; and three pediatric cases. Seven patients presented with acute complaints and MRI findings of acute hemorrhage, including layers, edema, and hematomyelia. In multiple acute presentations, brain MRI demonstrated concurrent brain CMs; genetic confirmation followed.

Conclusions
Spinal cord CMs are not uncommon in a population with autosomal dominant CM mutation. Gradient-based sequences should be performed. Acute hemorrhage in the spinal cord should suggest possible CM. We recommend brain MRI be performed in all cases of known or suspected spinal cord CM.
Vascular imaging of the spine in the US Medicare Population: Catheter and MR angiography volumes from 2001 to 2013

M Cox¹, D Levin¹, L Bagley², R Hurst³, L Parker¹, V Rao¹
¹Thomas Jefferson University, Philadelphia, PA, ²Pennsylvania Hospital, Philadelphia, PA, ³University of Pennsylvania, Philadelphia, PA

Purpose
Spinal catheter angiography is the gold standard for the diagnosis of spinal vascular lesions (1). However, spinal MR angiography is gaining acceptance due to its noninvasive nature (2). The purpose of our study was to analyze utilization trends in spinal MR angiography and spinal catheter angiography (CA) in the Medicare population.

Materials and Methods
Data from the Center for Medicare and Medicaid Services Physician/Supplier Procedure Summary Master Files for 2000-2013 were used for this study. The database covers the Medicare fee-for-service population. The Current Procedural Terminology, version 4 codes for spinal MRA (72159) and spinal CA (75705) were used to obtain and analyze the volume of these procedures.

Results
The volume of spinal catheter angiography performed in the U.S. Medicare
population was 3,634 in 2001, peaked at 6,869 in 2012, and dropped slightly to 6,075 in 2013. Overall, the volume of spinal CA increased by 67% from 2001 to 2013 (see Fig. 1). Radiologists performed the majority of spinal catheter angiography procedures, doing 4,157 procedures in 2013 (69% of spinal CAs). Neurosurgeons were the second largest group involved in performing spinal CA, and they did 1,455 procedures or 24% of spinal CAs in 2013 (see Fig. 2). Less than 10 spinal MRAs a year were recorded in the Medicare population prior to 2010. In 2010, 40 spinal MRAs were performed, and this number rose to 94 in 2013. Radiologists were the only specialty involved in the supervision and interpretation of spinal MRAs. Conclusions

Our results show that spinal catheter angiography volumes continue to rise in the Medicare population, and most of the procedures are being performed by radiologists. While spinal MR angiography volumes have started to increase, they comprise only a small fraction of studies performed for vascular evaluation of the spinal canal.
MR Myelography in Rat Spinal Cord Demonstrates Communication Between Interstitial Spaces and the Subarachnoid Space

R Bert¹, M Zhu¹, H Zheng¹, C Ng²
¹University of Louisville, Louisville, KY, ²University of Louisville, Louisville, KY

Purpose
MR myelographic studies have demonstrated communication between cerebrospinal and interstitial fluid within the spinal cord of rabbits (1, 2) and the brain in humans (2). We have further studied the contrast enhancement of the spinal cord gray and white matter occurring with MR myelography in six white rats and studied the washout rates in two.

Materials and Methods
After IACUC approval, MR imaging was performed on an Agilent/Varian 9.4T horizontal bore MRI. Imaging: 2D T1-weighted CSE (TR/TE=400/10 ms; resolution=110x110 μm²; slice thickness=1.0mm; NSA=8). Magnetic resonance myelography was performed on six anesthetized white rats by first diluting Gadoterate Meglumine 10:1-30:1, followed by injection of 0.1 ml into the lumbar thecal sac under CT guidance. Rats were recovered and inverted to mix and pool contrast in the SAS before re-imaging with identical parameters. Data were analyzed using OSIRIX for ROI calculations. Data were compiled from all rats using Excel (Microsoft). Contrast/noise values were normalized by using paraspinal multifidi muscle as baseline, to control for differences in rat positions between subsequent studies.

Results
No adverse effects were detected. T1-weighted images revealed visible penetration of contrast into the spinal cord gray and white matter. Mean contrast/noise for the six rats was 29/16/5/0 for CSF/gray matter/white matter/muscle. Preliminary washout curves show washout rates of CSF>GM>WM and are not well fitted by simple exponentials. Uneven mixing in the CSF studies may have distorted the measurements. All compartments appeared completely washed out at 24 hours.

Conclusions
Gadolinium contrast appears to immediately penetrate the interstitial space of the spinal cord of the rat, when administered intrathecally. Gray matter, despite being more central in the cord, demonstrates higher penetrance, consistent with interstitial communication with CSF through perivascular spaces. Washout appears completed by 24 hours from all compartments but compartment clearance rates may vary. More data are needed for accurate modeling.
Radiological outcome following traumatic grade 1 injury in blunt cerebrovascular injury patients: a retrospective analysis of a level 1 trauma center

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¹University of Texas Medical School at Houston, Houston, TX, ²The University of Texas Health Science Center at Houston, Houston, TX

Purpose
Blunt cerebrovascular injury (BCVI) frequently is associated with head and neck injury and is being detected with increasing frequency due to improved imaging of the
trauma patient (1). The present-day management of the BCVI is to perform follow-up imaging in 7 to 10 days after initial diagnosis. A study by Wagenaar, A.E., et al (1) showed with repeat CTA complete resolution of the injury will be 56% in both carotid and vertebral arteries (2). Since grade 1 injury is the most common form of injury, accepted way, to follow-up of these injuries is still disputable (3, 4). Based on Denver criteria there are five grades of BCVI (5). Grade 1 injury, vasospasm, and normal variation in vessel contour may be difficult to distinguish radiographically, even among experienced readers. The purpose of this study is to find the number of patients with grade 1 injury who remain radiographically abnormal in the follow-up study and the numbers with negative follow-up. We believe it helps us to better understand the false positive grade 1 injury reports compared to true positive and the necessity of follow up CTA's for grade 1 injuries.

Materials and Methods
A retrospective review of CT angiograms on all blunt trauma patients utilizing a software to search the medical record at our institution was performed. we were able to find 446 trauma patients who underwent CT of the cervical spine and CT angiography of the head and neck from January 2014 to June 2014. In this study, we focused on the subgroup of patients with grade 1 injury who have follow-up CTA. Grade 1 injury was defined as a mild intimal injury or less than 25% narrowing of the lumen of an artery (5).

Results
From all 446 CT angiograms, we found 61 cases with grade 1 injury, 29 grade 2, 10 grade 3 and 13 grade 4. Among the cases with positive grade 1 injury 25 had the follow-up images. Sixteen (64%) patients had the negative follow-up CTA and nine (36%) remained positive.

Conclusions
Our study demonstrates a high percentage of grade 1 injuries which appear to be normal at short-term follow up. Possible explanations for this phenomenon would include true resolution of grade 1 dissection, resolution of vasospasm, inter-rater variability in interpretation of vessel contour, or technical factors such as a degree of opacification and scanner type.

O-45
11:18AM - 11:26AM
CT-Guided Lumbar Transforaminal Epidural Steroid Injections: Incidental Extraspinal Findings on Planning Imaging

P Aldred1, G Lagemann1, A Borhani1, A Ghodadra1, V Agarwal1
1University of Pittsburgh Medical Center, Pittsburgh, PA
Purpose
Planning imaging performed during CT-guided procedures may occasionally contain important incidental findings. The purpose of this study is to identify and characterize by clinical relevance the extraspinal findings on CT-guided lumbar transforaminal epidural steroid injections (TFESIs).

Materials and Methods
Four radiologists, in consensus, retrospectively evaluated the planning scout and CT imaging for 489 consecutive CT-guided lumbar TFESIs performed on 400 patients over a one-year period. Incidental extraspinal findings were identified and used to characterize patients by their need for follow up using the Colonography Reporting and Data System (C-RADS), a classification scheme originally developed to characterize incidental findings on CT colonography. C-RADS E4 patients have potentially important findings which should be communicated to the referring physician; C-RADS E3 patients have findings which are likely unimportant, but work-up may be indicated. The electronic medical record and prior imaging were reviewed to determine whether findings were known clinically and reported appropriately.

Results
Eleven of 400 (2.8%) patients were classified as C-RADS E4, most commonly for vascular aneurysm or stenosis (5/400, 1.3%). Twelve of 400 (3%) patients were classified as C-RADS E3, with most common finding being hepatomegaly (4/400, 1%). C-RADS E3 and E4 findings were unknown to clinicians in 22/23 (96%) patients; of these, only 1/22 (5%) was communicated to the requesting physician.

Conclusions
Clinically important incidental extraspinal findings were identified in 5.8% of patients on their planning imaging obtained for CT-guided lumbar TFESIs. When present, these findings often were not previously known to clinicians and were under-reported by the radiologist performing the procedure.

O-46
11:26AM - 11:34AM
CT-Fluoroscopic Lumbar Transforaminal Epidural Steroid Injections: Extraforaminal Needle Tip Position Reduces Risk of Intravascular Injection

R Yu¹, G Lagemann¹, A Ghodadra¹, V Agarwal¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Accidental vascular penetration or injection during lumbar transforaminal epidural steroid injection (TFESI) can result in rare but devastating complications, including spinal cord infarction. The purpose of this study is to determine the safest needle tip
position for CT-guided lumbar TFESIs as determined by the incidence of intravascular injection.

Materials and Methods
We retrospectively reviewed consecutive CT fluoroscopy-guided lumbar TFESIs performed during a 16-month period by the neuroradiology section at our academic hospital. For all injections, needle tip position was categorized by depth relative to the targeted neural foramen. Intravascular injections were identified and categorized by procedural phase containing the intravascular injection, intravascular contrast volume, and needle tip position. Pearson chi-square and logistic regression testing were used to assess differences between groups as appropriate.

Results
Intravascular injections occurred in 9% of procedures (52/606). Of the intravascular injections, 46% were large (24/52), 33% were small (17/52), and 21% were trace (11/52) volume. Fifty-six percent of intravascular injections occurred with the trial contrast dose (29/52), 29% with the steroid/analgesic cocktail (15/52), and 15% with both (8/52). The intravascular injection rate was significantly lower ($P < 0.001$) for extraforaminal needle position (0/109, 0%) compared to junctional (27/319, 9%) and foraminal (25/178, 14%) needle tip positions.

Conclusions
An extraforaminal needle position for CT fluoroscopy-guided lumbar TFESI decreases the risk of intravascular injection and therefore may be safer than other needle tip positions.

O-47

Correlation between MRI Findings and Outcomes from Lumbar Therapeutic Facet Joint Injections

A Namini1, K Kazmi2
1University of Southern California, Los Angeles, CA, 2Hahnemann University Hospital, Philadelphia, PA

Purpose
Facet joint injections have been used widely for symptomatic relief of the lumbar facet syndrome. Pathologic changes of the facet joints are well recognized on MRI. The purpose of this study is to determine if there is a correlation between MRI findings of facet arthritis and/or synovitis and improvement in pain scores following therapeutic facet joint injection in the lumbar spine.

Materials and Methods
This study was approved by our institutional review board. One hundred and ninety-four patients who had facet joint injections were screened retrospectively. Of those, 33
subjects met inclusion criteria. Magnetic resonance images (MRIs) were reviewed for the presence of facet arthropathy or facet synovitis. Facet arthropathy was defined by the presence of marginal osteophytes, subchondral sclerosis or subchondral cysts. Synovitis was defined by the presence of edema in the bone marrow or soft tissues surrounding the facet joints. Preprocedural and postprocedural pain scores were recorded using 1-10 scale. The reduction in pain score was compared between different subgroups and T-test was utilized to assess statistical significance.

Results
Seven patients had facet synovitis, 20 patients had facet arthropathy and 10 had neither. The mean preprocedural pain score and the mean postprocedural pain score were 7.6 and 2.2 respectively. T-test comparisons of pain score change (PSC) among multiple subgroups are shown in the Table.

Conclusions
Our data does not suggest a correlation between MRI findings of facet arthropathy or synovitis and improved PSC from therapeutic lumbar facet injections. While more study would be helpful, this suggests that the current practice of targeting injections based on clinical criteria may be more cost effective than routine pre-operative imaging.
**Prevention of Oxaliplatin-Induced Neuropathy by using Minocycline as a Chemoprotectant: Demonstration by Imaging and Behavioral Assessment**

D Schellingerhout¹, E Vichaya¹, L Flores¹, D Ramos¹, L Le Roux¹

¹UT MD Anderson Cancer Center, Houston, TX

**Purpose**

In this study we evaluate the relationship between oxaliplatin-induced reductions in retrograde transport with the development of symptoms of peripheral neuropathy symptoms in a murine model. We also determine if minocycline, a promising chemoprotectant can be used for preventing chemo-induced neuropathies. The goal is to use neurography, a novel imaging method based on retrograde neural transport of a
molecular nerve imaging tracer, to assess the protective effect of minocycline on the development of Oxaliplatin-induced neuropathy.

Materials and Methods
Female BALB/c mice received one of four treatments: vehicle/vehicle, vehicle/minocycline, Oxaliplatin/vehicle, or Oxaliplatin/minocycline (n=8/group). A 30 mg/kg cumulative dose of Oxaliplatin or dextrose vehicle was given in 10 divided intra-peritoneal doses across 3 weeks using a 5 days of treatment, 5 day rest, 5 day treatment administration paradigm. Animals were treated daily with 50 mg/kg minocycline or 0.9% saline vehicle by oral gavage beginning 48 h prior to the first Oxaliplatin treatment. Both imaging and behavioral data were collected at baseline and weekly for 3 weeks. For each imaging session, animals received fluorescently labeled TTc-Alexa790 (15 ug/20 uL) via intramuscular injection into the calf muscles. Fluorescent imaging (Xenogen IVIS 200) was used to image the distribution of TTc over 60 minutes, with ROI measurements taken over the lumbo-thoracic junction of the spine to quantitate fluorescent uptake. Neurobehavioral assessment for mechanical sensitivity was assessed through the use of von Frey nylon filaments to exert calibrated force on the footpads. The 50% hind paw withdrawal threshold was calculated. At the end of the study tissue was harvested for immuno-histochemical analysis.

Results
Oxaliplatin/vehicle treated animals showed a significant decrease in transport of TTc during the second week of treatment (F (1,12)=39.604, p<0.001), while the TTc transport of the vehicle/vehicle and Oxaliplatin/minocycline remained stable across the experiment. The vehicle/minocycline group saw an increase in transport of TTc during the second week of treatments [F (1,12)=42.533, p<0.001]. Behavioral data indicated that Oxaliplatin treatment resulted in increased mechanical sensitivity, while minocycline treatment abrogated this effect, such that animals in the Oxaliplatin/vehicle group showed increased sensitivity compared to all other groups. This effect emerged within the first week of treatment and remained throughout the study. A linear correlation between paw withdrawal threshold and TTc transport at week 3 was found, with r = 0.7939, p<0.01, such that subjects with reduced TTc transport also displayed reduced mechanical thresholds.

Conclusions
Oxaliplatin causes a decrease in retrograde axonal transport, and this reduction in transport correlates with neurobehavioral impairment due to neuropathy. We show that this effect can be attenuated by a chemo-protectant, minocycline, and that the protectant effect was apparent with both behavioral and imaging readouts.
Neurographic Imaging as a Biomarker for Detecting Radiation Injury to the Spinal Cord

D Schellingerhout1, D Grosshans1, L Le Roux1
1UT MD Anderson Cancer Center, Houston, TX

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 days in animals exposed to either 10 or 80, while animals exposed to 2 Gy remained unaffected. Further, animals exposed to the highest dose also experienced significant weight loss by 9 days and developed posterior paralysis by 45 days. Pathologic changes of radiation damage could be seen in radiated cords after 30 days in mice exposed to 80 Gy.

Conclusions
Radiation of the spinal cord induces dose-dependent changes in the axonal transport mechanism which can be monitored by molecular imaging. This approach suggests a novel diagnostic biomarker to assess radiation-induced cord injury and monitor therapeutic interventions aimed at preventing such injury.

Monday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Roosevelt 1-3

3D-PARALLEL PAPER SESSION: Turbo Talks - Advanced MRI: From Microstructure to Function
O-50
10:30AM - 10:33AM

Flying High – White Matter Integrity in High Altitude Pilots

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1San Antonio Military Health System, Lackland AFB, TX
Purpose
Our goal is to demonstrate microstructural changes in white matter and visual-spatial cognitive ability between U2 pilots (U2P) occupationally exposed to nonhypoxic hypobaria and age and health-matched doctorate controls (DOC). Exposure to nonhypoxic hypobaria has been associated with an increased white matter hyperintensity (WMH) burden and with this increase associated decrements in neurocognitive ability in executive processing, working memory, and processing speed. The mechanism(s) for these macroscopic changes currently is unknown. We hypothesized a correlation between WMH burden and microstructural changes in white matter as quantified by fractional anisotropy (FA).

Materials and Methods
One hundred three U2P and 162 DOC underwent brain MRI on a Siemens 3T Tim Trio magnet with advanced imaging techniques to include diffusion tensor imaging in 55 directions. Additionally, U2P underwent neurocognitive assessment. Whole-brain and tract-wise average FA values were compared between U2P and DOC, followed by comparison with U2P separated into high (hU2P) and low (lU2P) WMH burden groups (based on the median WMH volume in DOC). Neurocognitive measurements were used to help interpret group difference in FA values.

Results
As compared to DOC, U2P had lower whole-brain, averaged FA (p <0.001) with the majority of the difference driven by the hU2P group (p = 0.006) and a smaller group-wise difference found in the lU2P (p = 0.011) group. No correlation between WMH burden and FA were found. U2P has higher FA values (as compared to DOC) in regional tracts positively correlated with visual-spatial performance with significant step-wise differences with DOC < hU2P < lU2P.

Conclusions
Non-hypoxic hypobaric exposure is associated with a global decrease in FA in an otherwise young and healthy population. Although WMH burden did not correlate with global FA values, group-wise differences exist between DOC and U2P, suggesting that the macroscopic and microscopic changes in WM integrity are from distinct pathophysiologic mechanisms. The presence of higher FA of U2P (versus DOC) in tracts associated with visual-spatial processing may reflect either an innate and/or acquired trait of U.S. Air Force pilots.

O-51

Diffusion kurtosis and derived White Matter Tract Integrity (WMTI) Metrics in the Fornix Differ in Beta-Amyloid Positive versus Negative Groups

J Dong¹, I Jelescu¹, B Ades-Aron¹, D Novikov¹, Y Ding¹, T Shepherd², E Fieremans¹
Purpose
The fornix, originating from the hippocampus, constitutes a key element of the limbic circuit and is a core white matter (WM) structure involved in episodic memory (1) that has become the subject of recent research emphasis in Alzheimer disease (AD) and mild cognitive impairment (MCI) (2). We report here changes in the microstructural integrity of the fornix in AD and MCI with respect to beta amyloid (Aβ) evaluated using simultaneous PET and diffusion kurtosis imaging (DKI), a clinical feasible extension of diffusion tensor imaging (DTI) that allows for quantifying nonGaussian diffusion properties, and characterizing WM in terms of compartment-specific WM tract integrity (WMTI) (3) metrics.

Materials and Methods
Twenty-seven subjects were scanned on a 3T MR-PET system (Siemens Biograph mMR, VB20) after obtaining informed consent. 18F-Florbetapir (9 mCi) (Eli Lilly) was injected intravenously and a 20-minute PET image was reconstructed starting at 40 min postinjection using a UTE-based attenuation map. An anatomical MP-RAGE was acquired for cortical and subcortical segmentation using Freesurfer. For DKI, a total of 140 diffusion-weighted images were acquired over 6 b-values (range 0 - 2.5 ms/μm2). Processing: Hippocampal volume was normalized to the estimated total intracranial volume. The standardized uptake values (SUV) in cortical regions known for pathological uptake of Florbetapir (anterior and posterior cingulate, medial orbitofrontal, precuneus, parietal and temporal), normalized to the cerebellum, yielded the mean cortical relative SUV (SUVr) (4). Age- and gender-matched subjects were categorized into Aβ positive (Aβ+) (n = 9, 4 females, age = 68.4 ± 5.5 years old) or Aβ negative (Aβ-) (n = 18, 8 females, age = 69.5 ± 4.6 years old) groups based on a cutoff mean SUVr of 1.1 (4). The fornix (body and crus) was segmented automatically using atlas registration (5). Diffusion kurtosis imaging metrics (fractional anisotropy FA, mean, axial and radial diffusivities MD, AxD and RD, and mean, axial and radial kurtosis MK, AK and RK), and WMTI metrics (axonal water fraction (AWF) and radial extra-axonal diffusivity (De, rad)) were calculated and mean values in the fornix were extracted. Analysis of covariance (ANCOVA) covarying for age was performed to compare 1) the diffusion metrics and 2) the hippocampal volume between the Aβ+ and Aβ- groups.

Results
Compared to the Aβ-, the Aβ+ group was characterized by increased diffusivities and decreased kurtosis metrics, along with increased radial extra-axonal diffusivity and decreased AWF (Table 1). Hippocampal volume between the Aβ- and Aβ+ groups did not differ (Table 1).
Conclusions
The observed changes in AWF and De,rad may indicate demyelination and/or axonal degeneration in early AD potentially related to amyloid deposition. Furthermore, the lack of differences in hippocampal volume between groups suggests that the fornix may be affected early in the AD course, and therefore is a good target for both early diagnosis and monitoring disease progression, as well as for potential therapy using deep brain stimulation (1, 2).

<table>
<thead>
<tr>
<th>Metric</th>
<th>Aβ-</th>
<th>Aβ+</th>
<th>% Difference</th>
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<tr>
<td>MD</td>
<td>R: 1.43±0.19</td>
<td>R: 1.75±0.49</td>
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<td>L: 1.33±0.29</td>
<td>L: 1.70±0.60</td>
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<td>AxD</td>
<td>R: 1.93±0.21</td>
<td>R: 2.29±0.58</td>
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<td>L: 1.81±0.34</td>
<td>L: 2.26±0.72</td>
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<td>R: 1.48±0.45</td>
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<tr>
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<td>L: 1.08±0.26</td>
<td>L: 1.42±0.54</td>
<td>L: 27.2%</td>
</tr>
<tr>
<td>MK</td>
<td>R: 0.81±0.06</td>
<td>R: 0.74±0.09</td>
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<td>L: 0.84±0.08</td>
<td>L: 0.77±0.11</td>
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</tr>
<tr>
<td>AK</td>
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<td>L: 0.68±0.07</td>
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</tr>
<tr>
<td>RK</td>
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<td>R: 0.86±0.14</td>
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<td>L: 1.01±0.12</td>
<td>L: 0.91±0.16</td>
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<tr>
<td>De,rad</td>
<td>R: 1.23±0.16</td>
<td>R: 1.41±0.39</td>
<td>R: 13.8%</td>
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<tr>
<td></td>
<td>L: 1.29±0.31</td>
<td>L: 1.59±0.57</td>
<td>L: 20.6%</td>
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<tr>
<td>AWF</td>
<td>R: 0.32±0.03</td>
<td>R: 0.30±0.03</td>
<td>R: -8.8%</td>
</tr>
<tr>
<td></td>
<td>L: 0.32±0.04</td>
<td>L: 0.30±0.05</td>
<td>L: -6.0%</td>
</tr>
<tr>
<td>Normalized Total Hippocampal Volume [%]</td>
<td>0.25±0.04</td>
<td>0.24±0.06</td>
<td>-4%</td>
</tr>
<tr>
<td>Mean SUVr</td>
<td>0.96±0.04</td>
<td>1.27±0.20</td>
<td>28%</td>
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</table>

Table 1: ANCOVA covarying for age. Compared to Aβ- group, Aβ+ group shows increased DTI metrics (MD, RD), decreased DKI metrics (MK, AK, RK), increased radial extra-axonal diffusivity, and decreased normalized hippocampal volume. R = Right, L = Left.

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O-52

Comparison of arterial spin labeling with [15O]-water PET at baseline and after Diamox by simultaneous PET-MRI
A Fan1, M Khalighi2, P Gulaka1, B Shen1, A Hoehne1, P Singh1, J Park1, D Holley1, H Gandhi1, F Chin1, G Zaharchuk1
1Stanford University, Stanford, CA, 2GE Healthcare, Sunnyvale, CA

Purpose
Cerebral blood flow (CBF) measurements are critical to assessment of many cerebrovascular disorders including stroke. While arterial spin labeling (ASL) magnetic resonance imaging (MRI) has gained traction as a noninvasive way to quantify CBF (1), it has been challenging to validate against the [15O] PET reference standard. These comparisons typically are done in separate imaging sessions such that different brain perfusion states may confound the validation (2, 3). This study compares pseudo-continuous ASL and [15O]-water PET scans collected simultaneously on a hybrid PET-MRI system. We evaluated the CBF response of the brain to Diamox measured concurrently by PET and by MRI; and the CBF scan-rescan reproducibility of each modality.

Materials and Methods
Five healthy volunteers (ages 24-40 years) were scanned on a 3T time of flight PET-MRI (GE Healthcare). Positron emission tomography (PET) imaging with 15-25 mCi of [15O]-water was performed before and after administration of 15mg/kg of Diamox, which increases CBF. Positron emission tomography scans commenced immediately after each tracer injection and coincided with ASL scans. Four subjects received successive repeat PET scans and all subjects received repeat ASL scans at baseline. Image-based arterial input functions were estimated from the first min of dynamic PET frames and corrected for spillover effect by the ratio between vessel volume on the MRI angiogram and PET images. Quantitative CBF maps then were created through a one-compartment model in PMOD software. Arterial spin labeling scan parameters included pseudo-continuous labeling with label duration=1500ms; postlabel delay=2025ms; TR/TE = 4850/10.7ms; slice=4mm; bandwidth=62.5kHz; and spiral readout (8 arms of 512 samples). Quantitative CBF maps were calculated using consensus values for the longitudinal relaxation of arterial blood and tag efficiency (4).

Results
Quantitative CBF maps by PET and ASL are shown from a healthy volunteer (Fig. 1). In this volunteer, absolute gray matter CBF measured by ASL increased from 48.0±8 ml/100g/min at rest to 73.2±12 ml/100g/min after Diamox administration. In comparison, gray matter CBF measured by PET increased from 47.5±4 to 81.3±3 ml/100g/min after Diamox. Across subjects, both modalities revealed comparable CBF augmentation in the gray and white matter due to Diamox (Fig. 2), with slightly higher CBF increase of 44.9% by ASL and 39.9% by PET. The CBF reproducibility of successive scans was slightly better for ASL (COV=11%) than for PET.
(COV=14%) across the brain. COV tended to be higher for white matter, possibly due to the low perfusion signal in those regions.

Conclusions

Hybrid PET-MRI allows simultaneous observations of the same brain perfusion state by ASL MRI and the [15O]-water PET reference standard for validation. Our initial findings suggest that ASL can reliably detect increases in CBF during Diamox administration consistent with PET measurements and with lower COV. Simultaneous PET-MRI offers dual information that can help to validate ASL as a clinical and scientific tool to study brain perfusion, and to improve its measurement by both modalities.
Percent increase in CBF due to Diamox

Gray matter

White matter
Determining the Accuracy of Resting-State Functional Magnetic Resonance Imaging in Lateralizing Language Dominance

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¹Mallinckrodt Institute of Radiology at Washington University in Saint Louis, Saint Louis, MO, ²Washington University in St. Louis, Saint Louis, MO

Purpose
To evaluate the accuracy of resting-state functional magnetic resonance imaging (RS-fMRI) in lateralizing language dominance in comparison to task-based functional magnetic resonance imaging (TB-fMRI).

Materials and Methods
Initially 232 patients were identified that had a RS-fMRI between January 2014 and June 2015 at our institution. Of these, 34 patients successfully underwent a clinical MRI that included both RS-fMRI and TB-fMRI on the same 3.0T scanner with dedicated task presentation system and processing software. Blood oxygen level dependent (BOLD) resting-state images were obtained and underwent seed-based correlation to establish areas of language activation using an in-house developed multilayer perceptron algorithm. Task-based images were obtained using a word generation paradigm. The BOLD sequence was registered to a 3D T1-weighted sequence and was used to generate activation maps using dedicated commercial fMRI processing software. Quality control assessments were obtained using both an automated system and qualitative physician analysis. Three blinded expert readers, consisting of two neuroradiologists and a neurosurgeon, evaluated the resting-state and task-based images for the 34 patients and determined language dominance, characterized as either: left hemispheric dominance, right hemispheric dominance, or equal dominance.

Results
Fleiss' kappa inter-rater reliability was obtained to assess agreement between the three expert readers. A kappa value of 0.55 was obtained, indicating good inter-rater reliability. The three experts lateralized language dominance identically on both resting and task-based images with an accuracy of 82.4%, 73.5%, and 73.5%, respectively, resulting in an average accuracy of 76.5 % with a standard deviation of 4.15%.

Conclusions
Resting-state fMRI can reliably lateralize language dominance. While task-based
fMRI has shown superior sensitivity and specificity in language lateralization, often times it is unsuccessful due to limited patient compliance or technical failures. In such instances when task-based fMRI cannot be obtained, resting-state fMRI has proven to reliably lateralize language dominance.

(Filename: TCT_O-53_JoanneASNR2016.jpg)

O-54

Resting State- fMRI Demonstrate Significant Alterations in Brain Connectivity and Intra-Cerebral Networks in SLE Patients.

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¹Institution of Clinical Sciences, Skåne University Hospital, Lund University, Lund, Sweden, ²Institution of Clinical Sciences, Lund, Sweden
Purpose
To investigate if functional connectivity and cerebral networks in crucial intracerebral regions might be affected and detectable with resting state fMRI (rs-fMRI) in SLE patients.

Materials and Methods
This prospective study included 9 female SLE Hanly A (age 26-49, mean 38.6), 39 female SLE nonHanly patients (age 19-54, mean 37.6) and 21 age-matched healthy female (HC) who all underwent clinical examination and advanced MRI investigation. All patients and controls undertook the central nervous system vital signs (CNSVS) cognitive test (investigating: verbal, executive, visual function and reaction time), the Montgomery-Åsbergs Depression Scale (MADRS-S), Hospital Anxiety and Depression Scale (HAD) and Fatigue Severity Scale (FSS). All patients underwent neurologic and rheumatologic examination. Disease duration and cortison-load was calculated. A rs-fMRI study was conducted to investigate if the Hanly A subtype showed altered functional connectivity compared to the non-Hanly -NPSLE group and to HC. A gradient-echo EPI pulse sequence was used (TR/TE=1850/30 ms, in-plane resolution=3x3 mm2, slice thickness=3 mm, 256 volumes). Preprocessing was performed using an FSL-based pipeline (normalization, physiological noise correction and motion artifact reduction). Preprocessed fMRI data were resampled into 5x5x5 mm3 voxels. Connectivity analysis was performed for all subjects by calculating pairwise correlation between all resampled voxel time courses. Group comparisons were made using permutation tests, controlling for multiple comparisons. The correlation between sum of connectivities and cognitive test scores, as well as disease duration, SLICC and SLE-DAI index, was calculated.

Results
Resting state fMRI showed significant correlation between functional connectivity involving circuits crucial for visual memory between the non-NPSLE group and the Hanly A subgroup. There also was a significant correlation between the Default Mode and disease duration (r: -0.984; p<0.01), processing speed (r: 0.975; p<0.01) and verbal memory (r: 0.777; p=0.014) within the Hanly A subgroup. No such relation was seen when correlated to SLICC or SLE-DAI scores. Our study also demonstrate significant differences between different subgroups of SLE patients which supports the idea of progressive intracerebral changes in SLE patients. Today there is no known method to diagnose preclinical neuropsychiatric progression in SLE patients nor to detect these subclinical changes early on prior to clinical and radiological findings on conventional MRI.

Conclusions
Resting state fMRI can visualize alterations in intracerebral connectivity and crucial networks in the Hanly A group and these alteration might be related partly to disease duration as well as to disease related cognitive dysfunction. Resting state fMRI is a promising tool in identifying signs of cognitive failure in patients with SLE and
thereby intensifying pharmacologic therapy in order to prevent progress of cognitive decline. Further work will be performed, including the analysis of correlates to neuroimaging findings and titers of antibodies in blood and CSF.
O-55

Improved T1 Weighted Black Blood Vessel Wall Imaging using Distributed Spirals, Variable Density Sampling and Constrained Reconstruction: Initial Clinical Experience.
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1University of Wisconsin, Madison, WI, 2U of Wisconsin, Madison, WI, 3University of Wisconsin, Madison, WI

Purpose
Effective black blood imaging is challenging due to complex slow flow resulting in confounding residual intravascular signal. We introduce a variable flip angle, fast spin echo sequence with distributed spiral sampling (1); with the goals of 1) improved suppression of intravascular signal, 2) higher spatial resolution, 3) gating and 4) more pure T1 contrast.

Materials and Methods
During the variable flip angle fast spin echo readout, samples are collected with spiral arms distributed onto kxy with the kz phase encode set continuously in a pseudo-random fashion. These arms are interleaved in a fashion such that T2 decay manifests as a diffuse artifact rather than blurring and leads to 3 dimensional flow suppression. Using acceleration in 3 directions and more frequent sampling of the center of k-space, this artifact can be removed by a constrained reconstruction which uses the echo train signal evolution from the data to generate images with reduced artifacts at each echo time (2).

Results
In phantom experiments, the spiral image acquisition shows less directional sensitivity and an overall improvement in suppression (median black blood suppression of 0.93 for spiral versus 0.69 for Cartesian). The figure shows images from one of the volunteer subjects. The constrained reconstruction is fit to echo train decay and phase evolution providing image contrast that progresses from T1 dominated to T2 dominated. Utilizing the first echoes from the reconstruction, high quality T1-weighted black blood images can be generated; later echoes provide T2-weighted images.

Conclusions
We introduce an innovative variable flip angle distributed spiral fast spin echo sequence for black blood wall images which increases spatial resolution and improves suppression of intravascular flow signal. The sequence can provide both T1-weighted and T2-weighted image contrasts and is well suited for intracranial vascular wall imaging.
Transient Oxygen Exchange Fraction through the Cardiac Cycle as Measure of Cerebrovascular Reserve

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¹northwestern university, Chicago, IL, ²University of Illinois Chicago, Chicago, IL, ³Northwestern, Chicago, IL

Purpose
Cerebral oxygen extraction fraction (OEF) has been shown to be an independent predictor of stroke risk (1). Furthermore, the NIH Progress Review Group recently has named tissue oxygenation imaging as a primary research goal. We have developed a means of quantifying OEF in under 65 ms using a "snapshot" PARSE (2, 3) pulse sequence. In this ongoing work we develop a method by which transit changes in
tissue oxygenation measured throughout the cardiac cycle is quantified for the first time. We develop a physiologic model which calculates cerebrovascular reserve (CVR) from these transient fluctuations using a Windkessel model.

Materials and Methods
Snapshot PARSE transverses a rosette trajectory over 65 ms(2) yielding 2D images of dw, R2* and M0 which are used to calculated OEF in the static dephasing regime (4). In this work, we use independent component analysis (ICA) of the raw frequency signal to extract the physiologic transient effects associated with the cardiac cycle and parameterize these effects in humans with angiographically confirmed neurovascular disease. By acquiring 20 PARSE datasets we observe frequency shifts resulting from increased de-oxymoglobin in the draining veins of the head, similar to BOLD contrast. These 4-10 Hz shifts are de-noised using ICA with spatial coordinates defined as the length along the PARSE readout and temporal domain being the 20 time points separated by 25 ms. Images were reconstructed using an iterative Progressive Length Conjugate Gradient method. Ten symptomatic patients with angiographically confirmed high grade (> 70%) stenosis of the MCA, ACA or PCA arteries were tested (M/F 5/5, = 58.2 ± 9.9 years). A single 2D slice (5.0 mm thick, 220 mm x 220 mm FOV, 96x96 matrix) was acquired in the superior division of the brain to cover the MCA, PCA and/or ACA vascular territories.

Results
Measured mean OEF in nonaffected normal brain parenchyma of 36.87 ± 6.6% with affected regions in symptomatic patients reaching 84.05 ± 4.54% correlate well with literature. Though little can be deduced from the time-course created before de-noising, ICA'd images taken during the first 125 ms of the cardiac cycle in a symptomatic patient with a right ICA stenosis show clear asymmetric hemispheric OEF (right hemispheric 13.06% elevation, Fig. 1a). We also see a nonuniform flush in with a subsequent uneven outflow, unseen in healthy volunteers, suggesting regions of compromised cerebral vascular reserve. This nonuniform draining of deoxygenated blood is fit with a Windkessel model (Fig. 1b), to quantitate hemodynamic compromise. We see in the 10 symptomatic patients statistically significant asymmetric hemispheric reactivity (p<.0179, Fig. 1cd).

Conclusions
We have found that MR-PARSE has detectable sensitivity to frequency shifts induced by transient alterations through the cardiac cycle. Our initial studies have shown a statistically significant hemispheric effect. Our approach to quantify cerebrovascular reactivity represents a new and simple, noncontrast approach to stratifying patients toward therapies to prevent stroke.
\[ P(t) = A e^{-\frac{t}{V_r*c}} \]

### Table

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<tr>
<th>Patient</th>
<th>Gender</th>
<th>Age</th>
<th>Hemispheric Region Diff</th>
<th>Hemispheric Mean Diff</th>
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\( R^2 = .525 \)
Usefulness of Transit Time Corrected Arterial Spin Labeling: Correlation with Dynamic Susceptibility Contrast Perfusion MR

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Purpose

Delayed transit time effect is the main source of errors in the quantitative measurement of cerebral blood flow (CBF) using arterial spin labeling (ASL) perfusion MR imaging. In the present study, we evaluated the usefulness of the transit time corrected CBF maps based on enhanced ASL perfusion MR imaging as compared with dynamic susceptibility contrast (DSC) perfusion MR imaging.

Materials and Methods

Conventional and enhanced ASL and DSC perfusion MR images were acquired in 108 consecutive patients. Internal carotid artery territory-based regions of interest (ROIs) were applied to CBF and time to peak (TTP) maps from DSC and CBF maps from conventional and enhanced ASL. The correlation coefficient (r) between normalized CBFs (nCBFs) from DSC and conventional ASL (or enhanced ASL) was evaluated. In addition, the dependence of the difference between the CBF values from the DSC and conventional ASL (or enhanced ASL) (ΔnCBF) on TTP obtained using DSC also was analyzed.

Results

For both the conventional and enhanced ASL perfusion MR imaging, the nCBF values from the DSC and ASL were strongly correlated (r = 0.7103 and 0.7636, respectively, Bonferroni corrected P < .0002 for both). For the conventional ASL perfusion MR imaging, the TTP delay had a significant positive effect on ΔnCBF (standardized coefficient = 0.183, P = .011). However, for the enhanced ASL perfusion MR imaging, the TTP delay had no significant effect on ΔnCBF (standardized coefficient = 0.140, P = .052).

Conclusions

Our results demonstrate that the use of the transit time corrected CBF maps based on the enhanced ASL technique can overcome the delayed transit time effect on perfusion maps based on ASL perfusion MR imaging. The identification of the delayed transit time effect on CBF maps based on the ASL perfusion MR imaging would facilitate proper interpretation of the ASL perfusion MR images.
Famous Faces and the Right Temporal Lobe in Primary Progressive Aphasia

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Purpose
To identify brain regions responsible for famous face familiarity as opposed to downstream processes such as naming within the extended temporal lobe facial processing system. We hypothesized that gray matter volumes within the right anterior temporal lobe would correlate uniquely with success on a famous face familiarity task. We further hypothesized that degeneration of the inferior longitudinal fasciculus would correlate with differential ability to recognize famous faces on a standardized battery.

Materials and Methods
We investigated the anatomical organization of processing famous faces using voxel-based morphometry (VBM) on structural MRI images of 123 subjects evaluated at the UCSF Memory and Aging Center; we also evaluated structural connectivity on diffusion tensor images in order to identify brain regions responsible for famous face familiarity as opposed to downstream processes such as naming. We did this by constructing a standardized famous faces processing battery and correlating accuracy scores in three tasks which differentially tax separate steps in famous face processing – familiarity, semantic association, and naming. Data were analyzed in the general linear regression model in SPM8. Diffusion tensor metrics in semantic variant primary progressive aphasia (svPPA) subjects were evaluated on the basis of high angular resolution diffusion-weighted imaging (HARDI) datasets. We tracked the inferior longitudinal fasciculus (ILF) using ROIs defined in MNI space and subsequently warped to each patient's native DWI space for tractography.

Results
Our data support the localization of familiarity judgment to the anterior right temporal lobe; the semantic retrieval system to unique volumes within the left middle temporal gyrus; and the naming modules occur more posteriorly than semantic association with left temporal cortex (p<0.05, FWE, corrected for multiple comparisons). A double dissociation is found between mean diffusivity and scores on famous face familiarity and object naming in right versus left association tracts. Significant correlations were found between reduced famous faces familiarity score and mean diffusivity (MD) in the right inferior longitudinal fasciculus in the svPPA patients (R² = .36, p<.05).
Conclusions
These findings reveal an organization of famous face identification within the anterior temporal lobes with the right temporal acting as a presemantic hub prior to famous person recognition. This finding carries prognostic significance for surgical approaches to the right temporal lobe.

O-60
11:00AM - 11:03AM

The activity ratio of 18F-fluorodopa uptake in midbrain-occipital separates patients with Parkinson disease from non-Parkinson.

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Purpose
The ratio of striatal 3,4-dihydroxy-6-[18F]-fluoro-L-phenylalanine (18F-FDOPA) activity (representing the terminal projections of nigral dopaminergic neurons including the caudate and putamen) to occipital (SOR) has been used as a quantitative parameter in PET studies in patients with idiopathic Parkinson's disease (PD). In this study we measured SUV ratio between midbrain and occipital (MOR) to explore whether reduction in both ventral and dorsal midbrain uptake, including the substantia nigra and midbrain tegmentum, can be used as a biomarker for identifying PD.

Materials and Methods
A total of 10 patients were referred by neurologists with FDOPA PET/CT studies visually interpreted as PD in six cases and four non-PD as the controls. A 5-minute PET acquisition was performed 50-65 minutes after administration of a 10mCi bolus of 18F-FDOPA. An unpaired t-test was performed to determine whether PD patients had a significantly different MOR from non-PD. Receiver operating coefficient (ROC) analysis also was performed to evaluate the individual diagnostic ability for differentiating PD from controls.

Results
A statistically significant difference was observed between the PD and control groups when examining the MOR. The PD group had a significantly lower MOR than the control group (mean PD MOR = 1.07+0.11, mean MOR = 1.40+0.11, P=0.0017). The cutoff ratio of 1.2, provided complete separation between these two patient groups who had scans that were interpreted independently PD versus non-PD.

Conclusions
In 10 patients with Parkinson's disease, there were significant differences in MOR between PD and non-PD controls. This study suggest that MOR can be used as an imaging biomarker in the diagnosis of PD.
Performance of Complex Tasks of Working Memory Related to Brain Tissue Microstructure: a Diffusion Kurtosis Imaging Study

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Purpose
There is natural variance across the population with regard to working memory, the system at the core of many cognitive functions and critical to general human intelligence. Though working memory is associated with anatomical correlates, the relationship between facility on certain cognitive tasks and brain structure in normal controls is not well defined. The purpose of this study is to examine the relationship between performance on the WAIS-IV digit span (DS) test (1) (a measure of attention, concentration, working memory) and white matter (WM) microstructure as assessed by diffusion kurtosis imaging (DKI) in a healthy control population. Using track-based spatial statistics (TBSS) (2), diffusion and kurtosis metrics were tested for significant correlations with DS scores.

Materials and Methods
Sixteen normal controls (32±8, 19-50 years; 9 male) underwent the DS test including forward (DSF), backward (DSB), and sequencing (DSS) subtests, which require simple auditory attention, working memory and visuospatial imaging, and simultaneous activation of phonological and semantic information, respectively. Diffusion kurtosis imaging was performed on a 3T MR scanner (Skyra, Siemens) with 6 b-values (0-2.5ms/μm^2) up to 60 directions (FOV = 220×220mm^2, resolution = 2.5×2.5×2.5mm^3, matrix = 88×88, number of slices = 56, TR/TE = 4.9s/95ms, BW/pixel = 2104Hz, GRAPPA/multiband factor of 2). Fractional anisotropy (FA), mean/axial/radial diffusivities (MD/AD/RD) and mean/axial/radial kurtosis (MK/AK/RK) were calculated. Track-based spatial statistics was performed with age and gender used as covariates.

Results
Figure 1 shows the percentage of significantly correlated voxels (P<0.05) from the TBSS. In the DSF, no metrics correlated with performance though in the DSB diffusivity estimates were positively correlated in up to 15% of voxels and in the DSS, kurtosis estimates were positively correlated in greater than 20% of voxels. Even in this small group, a pattern of correlation emerges between WM microstructure and facility on related but differing tasks of increasing complexity.

Conclusions
Performance on the DS test with increasing complexity of these tasks is associated
with a pattern of correlation in WM diffusivity and WM tissue microstructural complexity. Establishing normative data regarding structural associations with working memory is critical to understanding what happens in the aging brain and in pathologic conditions of the central nervous system (CNS).

(Filename: TCT_O-61_figure.png)

O-63

11:09AM - 11:12AM

A Simplified Model for Intravoxel Incoherent Motion MRI of the Brain: Clinical Validation for Perfusion Imaging of Gliomas and Acute Strokes

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Purpose
Recent years have seen resurgent interest in intravoxel incoherent motion (IVIM) magnetic resonance imaging (MRI) for evaluation of brain perfusion, with applications in neuro-oncology and acute stroke (1, 2). Practical challenges remain, including limited signal-to-noise ratio (SNR), complex acquisition protocols (large numbers of b values) and intensive postprocessing requirements. A simplified IVIM method using linear fitting of a subset of higher b values has been applied successfully in other organs (3), but has not been validated for imaging of brain pathology. The purpose of this study was (i) to compare IVIM perfusion measurements using simplified linear fitting to those of conventional biexponential fitting, and (ii) to quantify the effect of reducing the number of b values on SNR of the resulting perfusion maps.

Materials and Methods
Forty-nine patients with brain gliomas and 17 patients with acute strokes were recruited according to previously published criteria (1, 2). Participants underwent 3.0 T MRI including diffusion-weighted EPI spin-echo imaging with 16 b values from 0 to 900 s/mm². For conventional IVIM, the perfusion fraction f was calculated by
nonlinear least squares fitting of the standard biexponential equation using a two-step procedure as previously described (4). For simplified IVIM, the perfusion fraction $f'$ was calculated using linear fitting of the log normalized signal values for $b \geq 200$ s/mm² (5). Calculation of $f'$ was repeated using five combinations of $b$ values from 200 to 900 s/mm² (Table 1). Regions of interest (ROIs) were outlined for normal white matter (WM) and gray matter (GM), tumors (excluding necrotic components), and strokes. Comparison between ROIs was performed using paired or unpaired $t$-tests, as appropriate, with Bonferroni correction for multiple comparisons. Signal-to-noise for each ROI was defined as the mean perfusion fraction across the ROI divided by the standard deviation of a homogeneous ROI positioned in the deep WM. Data for low-grade and high-grade tumors were pooled for SNR calculations.

**Results**

Perfusion maps using simplified linear fitting ($f'$) were qualitatively similar to those of conventional biexponential fitting ($f$), even when as few as 2 $b$ values were used (Fig. 1). The perfusion fraction calculated using both methods was elevated significantly in high-grade ($n=33$) compared to low grade ($n=16$) gliomas, and significantly reduced in strokes ($n=17$) compared to contralateral normal brain, for all combinations of $b$ values (Fig. 2). The SNR of the perfusion maps decreased monotonically with decreasing number of $b$ values for all tissue types (Fig. 3).

**Conclusions**

Intravoxel incoherent motion measurements of common brain pathology can be obtained using a simplified linear fitting of as few as 2 $b$ values, with preservation of clinically relevant perfusion information. As expected, decreasing the number of $b$ values comes at a cost of lower SNR in the resulting perfusion maps. The reduced acquisition time and postprocessing requirements of this simplified approach may facilitate more widespread adoption of IVIM perfusion imaging in clinical and research settings.
Figure 1. Representative images of a low-grade glioma, high-grade glioma and acute infarct

Figure 2. Perfusion fraction compared between ROIs for f and f’

Figure 3. SNR vs number of b values

Table 1. b values used for f’ calculations

<table>
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<th>No. of b values</th>
<th>b values (sec · mm⁻²)</th>
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<tr>
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<td>200, 500, 900</td>
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<td>2</td>
<td>200, 900</td>
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</tbody>
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Highly Accurate Measurement Of Brain T1 Values Prior to and Following Administration of a Gadolinium Based Contrast Agent. A Feasibility Study Using a Modified MOLLI Technique At 1.5 and 3T.

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Purpose
To evaluate the utility of our T1 mapping technique (MOLLI) adapted from cardiac use, for measurement of brain parenchymal T1 values before and after contrast administration. To date magnetic resonance imaging (MRI) analysis of gadolinium deposition in the brain has been measured using signal intensities.

Materials and Methods
1. A phantom was created and scanned at 1.5 and 3T with the modified cardiac MOLLI technique. Multiple T1 values between 300 and 3000 ms were measured and compared to calculated T1 values. 2. Over 4 months, all patients undergoing postcontrast brain MRI at 1.5T and 3T (Aera and Skyra, Siemens Erlangen, Germany), underwent pre and postcontrast 4 slice MOLLI brain imaging. The MOLLI acquisition is a single shot TrueFISP sequence acquired at different inversion times after a single inversion pulse, which enables a pixel-based T1 quantification. Postcontrast MOLLI was performed 10 minutes following administration of Mulithance 0.1 mg/kg (gadobenate dimeglumine, Bracco Diagnostics Inc. Princeton, NJ). Minimum, maximum, mean and standard deviations of T1 values were measured using regions of interest (ROI) placed in standard locations bilaterally in the globus pallidi, putamen, occipital white matter, caudate heads, dentate nuclei and substantia nigra. Exclusions included those with pathology in any of the measured regions.

Results
Our MOLLI technique is highly accurate at T1 measurement with correlation of 0.999 with the calculated phantom values. Over 200 patients have been analyzed at the time of abstract submission demonstrating small changes in parenchymal T1 values following contrast administration in all measured regions of the brain in patients between 2 days and 100 years of age. Intra and interobserver reproducibility were excellent: r>0.9 for both.

Conclusions
Our adapted MOLLI technique is highly accurate and reproducible at measuring T1 values in the brain before and after contrast administration.
High Flight - Acute Effects of a Single High Altitude Exposure on the Brain

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¹San Antonio Military Health System, Lackland AFB, TX

Purpose
Our goal is to characterize the pathophysiologic response of the brain to high altitude exposure to understand its association with previously demonstrated subcortical white matter injury. A single exposure to an extreme hypobaric environment [7,620 m (25,000 ft.)] with or without hypoxia induces transient magnetic resonance imaging (MRI) changes.

Materials and Methods
This study was approved by the 59th Medical Wing Institutional Review Board. The two primary study groups evaluated were the 1) hypobaric and hypoxic (initial altitude chamber training for U.S. Air Force aircrew) group and 2) normal controls without hypobaric or hypoxic exposure. MR imaging was performed on a 3T Siemens Verio magnet 1 day prior, 1 day post, and 3 days postexposure. Magnetic resonance protocol included axial magnetization-prepared rapid gradient-echo sequences, magnetic resonance spectroscopy with TE of 30 and 135 within the frontal white matter and anterior cingulate gyrus, diffusion tensor and Q-space imaging, arterial spin labeling perfusion imaging, and 3-dimensional fluid-attenuated inversion recovery images. Phlebotomy was performed prior to MRI #1, immediately prior to and postaltitude chamber or hypoxic 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 five blood draws at equivalent times during the day as the other three study limbs.

Results
Seventy subjects were imaged, (50 from group 1 and 20 from group 2). Magnetic resonance imaging demonstrates a significantly increased cerebral blood flow to gray matter (p value < 0.01) and white matter (p value < 0.001) 24 hours after altitude exposure, which has not returned to baseline at the 72h scan (p value for gray matter <0.004; p value for white matter < 0.001; comparing MRI #1 to MRI #3). There is potential up-regulation of glutamate/glutamine in the anterior cingulate gyrus, not statistically significant. Diffusion tensor imaging and Q-space analysis are inconclusive at this time. There were no white matter FLAIR changes, as expected. Microparticles and inflammatory markers currently are indeterminate.

Conclusions
Magnetic resonance imaging results suggest that a single altitude exposure to 7,620 m...
(25,000 ft.) results in an increased metabolic demand on the brain and apparent oxidative stress. Further assessment of advanced MRI data and inflammatory markers is required. Quantifying the effects of a single hypobaric exposure on the brain may result in identification of the pathophysiology of hypobaric-associated subcortical white matter injury.

Monday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Maryland A/B/C

3E-PARALLEL PAPER SESSION: Pediatrics: Head Injury, Spine Techniques, and Radiation Dose
O-66

Cumulative Subconcussive Head Impact Exposure in Youth Football Results in Microstructural Changes in Corpus Callosum

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1Virginia Tech-Wake Forest University School of Biomedical Engineering & Sciences, Winston Salem, NC, 2Wake Forest University School of Medicine, Winston-Salem, NC, 3Wake Forest School of Medicine, Winston-Salem, NC, 4University of Texas Southwestern, Dallas, TX

Purpose
The purpose of this study was to determine the effects of cumulative subconcussive head impact exposure associated with youth football (age<13 years old) on microstructural integrity of the corpus callosum (CC), which is one of the most common white matter structures affected by mild traumatic brain injury (mTBI). The CC is the largest WM tract and because of its unique location and composition, it is vulnerable to mTBI (1-3). We hypothesized that repeated head impacts over a single season of football would lead to diffusion changes in the CC, even in the absence of clinically diagnosed concussion.

Materials and Methods
Twenty-two male football players (age: 8-13 years) without a history of concussion prior to or during the football season participated in this IRB approved study. Head impacts were quantified via the Head Impact Telemetry System (HITS), which uses sensors embedded in each player's football helmet to record kinematic data during all practices and games. The biomechanical metric used was the risk weighted cumulative exposure (RWEC) (4). All subjects received pre and postseason MRI, including diffusion tensor imaging (DTI). Magnetic resonance imaging was performed on a 3T Siemens Skyra with a high resolution 20 channel head/neck coil
using a 2D single-shot EPI diffusion sequence (2.2 x 2.2 x 3 mm; 15 diffusion directions; b=1000/2000). Fiber tracking was conducted via automated fiber quantification (AFQ)5. (Fig. 1). Fractional anisotropy (FA), mean diffusivity (MD), linear anisotropy (CL), axial diffusivity (AD), and radial diffusivity (RD) measurements across 100 equidistant nodes of the fiber were used to calculate the mean values within the CC. Percent change in DTI metrics pre versus postseason was computed [100*(post-pre)/pre] for each subject. Linear regression analysis was conducted using age as a covariate to determine the association between RWECP and DTI change in the CC.

Results
There were statistically significant linear relationships between RWECP and percent change in FA, MD, RD, and AD within the CC (p<0.05) (Table 1). There were no statistically significant associations between total RWECP and CL changes in the CC.

Conclusions
Our findings suggest that cumulative subconcussive head impact exposure is associated with microstructural changes in the CC, which is the largest WM tract in the brain, and therefore, may be vulnerable to repeated head impacts. This study adds to the growing body of evidence that a single season of contact sports can result in WM microstructural changes, even in the absence of concussion.

| Table 1. Summary of the statistically significant relationships between changes in DTI metrics in corpus callosum (CC) and cumulative subconcussive head impact exposure (RWECP) |
|-----------------|-----------------|-----------------|
| FA vs RWECP     | 0.1507          | 0.0214          |
| MD vs RWECP     | 0.2416          | 0.0032          |
| RD vs RWECP     | 0.1470          | 0.0255          |
| AD vs RWECP     | 0.2237          | 0.0043          |

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Season of High School Football Increases MEG Low-Frequency Brain Waves

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¹Wake Forest University School of Medicine, Winston-Salem, NC, ²Wake Forest University, Winston-Salem, NC, ³Virginia Polytechnic & State University, Roanoke, VA, ⁴University of Texas Southwestern, 5323 Harry Hines Blvd., TX, ⁵University of Texas Southwestern, Dallas, TX

Purpose
The purpose of this study is to determine if the cumulative effects of head impacts from a season of high school varsity football produce magnetoencephalography (MEG) measurable changes in the brain in the absence of clinically diagnosed concussion.

Materials and Methods
Twenty-four players from a local high school football team (mean age=16.9; no history of concussion) were instrumented with the Head Impact Telemetry System (HITs) during all practices and games. The biomechanical metric computed from the HITs data was risk-weighted cumulative exposure (RWE). 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 (low-frequency or delta spectrum). Head motion and muscle artifacts were removed. Magnetoencephalography data were projected into standard source space using a scalar beamformer. The delta spectrum power was recorded for each voxel and normalized by the estimate of projected noise to remove the center of the head bias. The group mean and standard deviation, of postseason minus preseason, were used to determine total number of abnormal voxels for each subject (>2SD).

Results
Regression analysis revealed a significant relationship (p = 0.0297, R² = 0.29) between RWECP and mean delta wave amplitude, when corrected for age, body mass index (BMI), and time between scans. Secondary analyses demonstrated a significant (p = 0.0216, R² = 0.32) association between RWELin and delta waves, as well as RWERot and delta waves (p = 0.0164, R² = 0.34).

Conclusions
We demonstrate that a single season of football can produce changes in brain delta
wave activity detectible by MEG in the absence of clinical concussion. Similar MEG brain changes have been associated with traumatic brain injury.

(Filename: TCT_O-67_deltavox_RWE_regression.jpg)

O-68

10:46AM - 10:54AM

Incidence of Microhemorrhages in High School Football Players over a Season of Play

C Lack1, E Lowther2, J Maldjian3, C Whitlow4
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Purpose
To determine if nonconcussed high school football players develop microhemorrhages over a season of play.

Materials and Methods
Sixty-seven high school football players without a history of prior concussion were included in this study. The subjects were part of a larger study examining the structural and functional changes on the brain after repetitive subconcussive head impacts during football (1). Subjects were enrolled from a local high school over three seasons. Preseason MRI included susceptibility weighted imaging (SWI). During the football season the players were instrumented with helmet sensors to record impacts during both practices and games. Subjects diagnosed with a concussion received an MRI. At the end of the season all subjects received a postseason MRI. Two neuroradiologists reviewed all of the SWI studies on an independent workstation in a double blind fashion for evidence of microhemorrhage. Microhemorrhages were
confirmed by cross-referencing phase images. Any disagreement between the radiologists was settled in an open review with a third neuroradiologist. Results Two subjects were found to have a small focus of microhemorrhage at baseline for a calculated prevalence of 3.4%. After a season of high school football two nonconcussed subjects were identified who developed a microhemorrhage for a calculated incidence of 3.7% (see Fig. 1). One player was a quarterback with a low impact exposure and the other player a cornerback with an average amount of impact exposure during the season. Five subjects were diagnosed with concussions (6.1% incidence) but no microhemorrhages were identified. Conclusions Our findings suggest that high-school football players can develop brain microhemorrhages over a season of football without suffering a concussion. This adds to a body of literature showing brain changes related to repetitive subconcussive head impacts.
17 year old boy

Preseason

Postseason

16 year old boy
The effect of early MRI in the management of Children with Head Injury Requiring admission to the Pediatric Intensive Care Unit

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1Massachusetts General Hospital, Boston, MA, 2MassGeneral Hospital for Children, Boston, MA, 3Massachusetts General Hospital, Harvard Medical School, Boston, MA

Purpose
While computed tomography (CT) is used most commonly for assessing traumatic head injury, magnetic resonance imaging (MRI) provides increased sensitivity for many traumatic lesions without radiation risk. We sought to determine the diagnostic yield of early MRI (< 3 days following the traumatic event) compared to CT, and the effect of early MRI on the management of pediatric traumatic brain injury by analyzing a consecutive series of 79 children requiring intensive care for traumatic brain injuries who underwent MRI within days of injury.

Materials and Methods
The medical records were reviewed for each patient to determine the indications, MR imaging findings, and whether the study had influenced decisions to escalate, de-escalate, or redirect care. Two neuroradiologists, a pediatric neurosurgeon, and a pediatric intensivist, reviewed the CTs and early MRIs using the NIH Common Data Elements definitions dictionary, to evaluate the diagnostic yield of early MRI versus CT and to evaluate inter-reader variability; kappa statistics were calculated.

Results
In 70% of cases, MRI showed traumatic lesions not seen on CT. The additional MRI findings influenced management in different ways. Magnetic resonance imaging findings escalated management in 27% of cases: mass lesions including hemorrhages and evolving contusions, for example, well delineated on T2 and FLAIR images, led to continued or intensified medical and/or surgical interventions. Magnetic resonance imaging led to de-escalation of care in 59% of cases: findings of diffuse axonal injury with open cisterns led to de-escalation of sedation and monitoring. Early widespread diffusion abnormality or evidence of brainstem herniation or infarction were correlated with redirection of care. Inter-rater reliability (kappa) varied by lesion type.

Conclusions
Early MRI can play an important role in the targeted management of severe traumatic brain injury in children, allowing for prompt understanding of injury type and pathophysiology with acceptable reliability and reduced radiation. Cost effectiveness analyses also will be needed to fully analyze this management approach.
Imaging Factors Predicting Need for Surgery in Chiari 1 Malformation

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¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH, ²University of Cincinnati Medical School, Cincinnati, OH

Purpose
Chiari Type I Malformation is a congenital hindbrain abnormality characterized by inferior ectopia of the cerebellar tonsils below the level of the foramen magnum. Typical surgical indications for posterior fossa decompression rely upon clinical manifestations and syrinx development. Previous studies have correlated such symptomatology with intracranial measurements, such as tonsillar descent, or with detailed volumetric posterior fossa evaluations; however, such analyses have involved primarily adult populations with relatively small patient groups. Understanding such imaging findings may be important as an adjunct to clinical parameters in determining need for operative intervention, possibly allowing for discovery of such a need prior to the development of irreversible deficits. This study aims to better assess the relationship between the need for Chiari I decompression with simple linear measurements of the posterior fossa in the pediatric population.

Materials and Methods
One hundred forty-three patients age 0.5 - 18.8 years with Chiari I malformation who underwent brain MRIs between 2005-2013 and 82 normal control patients from the same time period were selected randomly. Patients were stratified by gender and age (0-6 years, 7-11, and 12-18). Magnetic resonance images were assessed with multiple linear measurements of the posterior fossa (examples on Fig. 1 and 2). Patients with Chiari I malformation were stratified based on those who required posterior fossa decompression (75) and those who did not (68). Chi-square, Fisher exact test, and ANOVA were used to correlate measurements with diagnosis and need for operative intervention.

Results
Degree of ventral and dorsal effacement of the foramen magnum, presence of cervicomedullary kink, and extent of tonsillar herniation showed a significant difference (all p<0.0001) between patients who required surgery and those who did not. Craniocaudal length of the intracranial compartment (p=0.0002) and level of descent of the Obex (p<0.0001) were significantly different in Chiari I patients versus control patients, but not different between those who required surgery and those who did not. Angle of odontoid retroflexion was significantly different in Chiari I patients
who required surgery versus control patients (p=0.0034), but not different between either of the former groups and the Chiari I patients who did not require surgery. Age and gender stratification revealed essentially minimal differences.

Conclusions
In addition to the classical clinical symptomatology and syrinx development which often prompt posterior fossa decompression, extent of tonsillar herniation, effacement of the foramen magnum, and presence of cervicomedullary kink had a strong correlation with need for surgical intervention and warrant detailed evaluation. In addition to tonsillar herniation, which has been repeatedly shown to have a correlation with severity of disease, these latter two metrics also are of prognostic importance and should be closely monitored in Chiari I patients.

O-71

A Multi-Institutional Study of Presyrinx in Chiari I Patients with Emphasis on Spinal Canal Dimensions

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Purpose
Cervical spinal anatomy may contribute to the development of syringomyelia, including the patency of the central canal in the spinal cord and reverse tapering of the lower cervical spinal canal. We studied the presence of these anatomical features in presyrinx, a condition in Chiari I patients that progresses to syringomyelia.

Materials and Methods
At multiple institutions (anonymized for the review process), investigators searched the PACS system for patients with Chiari I, spinal cord edema, and cervical spine MR imaging. In MR imaging, we measured the extent of edema, visibility of the central canal, and C1 to C4 and C4 to C7 tapering, as in previous studies. In two control groups, matched controls with Chiari I (no syringomyelia) and matched controls with normal MR scans, similar measurements were made.

Results
The study includes (to date) seven presyrinx patients, along with matched controls. The central canal was significantly more evident in presyrinx than in control groups (p=0.01 and 0.001 respectively, Fisher exact test). Cervical spinal canal tapering of presyrinx patients demonstrated no statistically significant difference from controls. However, the C4 to C7 taper ratio tends to be larger in presyrinx patients than the normal control group.
Conclusions
Patients with presyrinx more frequently have patency of the central canal and tend to have steeper C4 to C7 taper ratios, suggesting that these factors may play a role in the pathogenesis of this state.

![Figure 1: Sagittal T2 MR imaging of an 18-year-old female presenting with headaches demonstrates edema of the cervical spinal cord and evidence of a patent central spinal canal (white arrow). The cervical spinal cord edema resolved following craniocervical decompression.](TCT_O-71_Fig1Presyrinxcanal.JPG)

O-72
11:18AM - 11:26AM

Spinal Cord Syrinx: Does Gadolinium Aid in The Diagnosis?

A ALHAMMAD¹, S Laughlin², H Branson²
¹The Hospital for Sick Children, Toronto, ON, ²The Hospital for Sick Children, Toronto, Ontario
Purpose
In pediatric spine magnetic resonance imaging (MRI) when a syringohydromyelia is first detected, in the absence of a Chiari malformation it is common clinical practice for a contrast-enhanced MRI to exclude an underlying mass. Our hypothesis is that a spinal cord tumor causing a syringohydromyelia is readily identifiable on the unenhanced scan. Conversely if a tumor is not seen then the additional contrast-enhanced scans do not add further information in the majority of cases.

Materials and Methods
A total of 98 unenhanced pediatric spine MRI scans out of a total of 105 cases (seven were excluded due to motion artefact) between 1999 – 2015 with syringohydromyelia were analyzed by a pediatric neuroradiologist (8 years experience). A second pediatric neuroradiologist (17 years experience) co-read 50 patients. The unenhanced scans were read at a different time to the enhanced scans. The examination was considered positive for tumor if there was a mass, nodularity or thick irregular septations. The contrast-enhanced sequences are the gold standard and statistical analysis was performed.

Results
A total of 98 patients were included in the study (48 male, 50 female) between the ages of 1.5 and 17 years. Imaging sequences reviewed were variable; however all cases had at least a sagittal T2 and postcontrast sagittal T1. Of the 98 patients reviewed there were 13 histologically proven tumors (8 astrocytomas, 3 gangliogliomas, 2 ependymomas and 1 patient with neurofibromatosis type II with a large tumor without surgical pathology). All the tumor cases had septations and cord expansion and were positively identified on the pre and postcontrast imaging. The inter-class correlation coefficient for number of segments was 0.93 (0.88 – 0.96). Of all 98 patients with syrinx the cord was not expanded in 61/98 and expanded in 37/98.

On the 50 cases read by two radiologists the tumor was suspected on the precontrast images in all 14 confirmed tumor cases (14/50) (Kappa=1), sensitivity 100% (73.24 – 100%), specificity (87.68 – 100 %), PPV 100 (73.24 – 100), NPV 100 (87.68- 100). One case was called indeterminate by both radiologists on the precontrast images with no tumor on the postcontrast images. On postcontrast images the tumor was detected by both radiologists in all 14 cases with again a sensitivity 100% (73.24 – 100%), specificity (87.99 – 100%), PPV 100% (73.24 – 100), NPV 100 (87.99 - 100). Of the 35/50 cases of syringohydromyelia that were not caused by an underlying tumor, all were called no tumor on the unenhanced as well as the enhanced scans, Sensitivity 100% (73.23 – 100%), Specificity (87.69 – 100%), PPV 100% (73.24 – 100), NPV 100 (87.69 - 100).

Conclusions
This data supports the hypothesis that all tumor cases were identifiable on the unenhanced scans and conversely if no mass/septation or nodularity is seen the additional use of gadolinium is likely not warranted. Gadolinium can be reserved for
equivocal examinations or to further evaluate those cases of suspected tumor. This will ultimately depend on the experience of the reporting radiologist.

O-73

High Resolution Lumbar Neurography with 3D Turbo Spin Echo MRI: Initial Experience in Children

P Cornejo1, B Cervantes2, A Pokorney1, J Miller1, D Karampinos2, H Hu1

1Phoenix Children's Hospital, Phoenix, AZ, 2Technische Universität München, Munich, Bavaria

Purpose
The purpose of this work is to describe our preliminary experience in pediatric lumbar spine neurography using a 3D fat signal suppressed, cerebrospinal fluid (CSF) signal suppressed, blood signal suppressed, T2-prepared turbo spin echo MRI pulse sequence.

Materials and Methods
The study was approved by the local ethics board to add the neurography pulse sequence to our institution's standard lumbar MRI protocol. The lumbar spine of 15 pediatric patients (age range: 28 days - 15 years) have been scanned to date using a 3T Philips Ingenia MR platform. Our data collection is ongoing. The built-in posterior spine coil was used for signal reception, along with a standard head coil. The patients were receiving medical care at our institution and a routine lumbar spine MRI protocol was ordered. The additional neurography pulse sequence consisted of a fat-suppressed T2-prepared 3D turbo spin echo (TSE) technique. Motion-sensitizing gradients were used in the T2 preparation to suppress blood vessel signals (1, 2). Image blurring effects typically encountered in 3D TSE readouts due to T2 relaxation were minimized by the use of an optimized flip angle train for the refocusing radiofrequency pulses. In prior works in adults, flip angle train optimization has been shown to effectively improve conspicuity of the small lumbar nerve structures (3). Cerebrospinal fluid (CSF) signal in the spinal canal was suppressed by the long flip angle train's ability to dephase moving spins. Typical imaging parameters used in this pediatric study were: 40 slices of 1.4 mm thickness, SPAIR fat suppression, and a scan time of approximately 4 minutes. Two board-certified pediatric neuroradiologists subsequently reviewed the images separately for the presence of artifacts and blurring, the quality of fat suppression, the degree of blood vessel and CSF signal suppression, and the overall appearance of the lumbar nerves along the conus and cauda equina.

Results
The enclosed figure illustrates examples of the lumbar plexus (top row) in a nine-year-old female with no specific findings in the spine and (bottom row) a seven-year-old...
old male with spina bifida. Two thin slice maximum intensity projections, each through approximately 15 slices, are shown that span the spinal cord. In both image sets, note the homogeneous fat suppression as well as the lack of CSF and blood vessel signals. In the spina bifida patient, note the visualization of poorly defined nerves in comparison to the normal case. The 3D TSE neurography scan was implemented successfully in all 15 cases and were deemed by the reviewing neuroradiologists to have diagnostically useful image quality with clear depiction of the lumbar nerves proximal and distal to the ganglions.

Conclusions
In this work, a fat, CSF, and blood vessel signal-suppressed T2-prepared 3D TSE sequence that enables clear delineation of the lumbar nerves with high-spatial-resolution has been demonstrated in pediatric patients, with promising preliminary data for clinical adoption. Our study is ongoing and the protocol is being extended to the cervical and thoracic spines for additional evaluation.
Optimizing the Balance between Radiation Dose and Image Quality in Pediatric Head CT

S Bickley¹, S Tipnis¹, S Stalcup¹, G Matheus¹, M Tyler², K Byington², M Spampinato³
¹Medical University of South Carolina, Charleston, SC, ²MUSC, Charleston, SC, ³Medical University Of South Carolina, Charleston, SC

Purpose
Our aims are to evaluate radiation doses and corresponding image quality, and to make protocol recommendations for pediatric head computed tomography (CT).

Materials and Methods
We retrospectively reviewed all pediatric head CTs obtained at our institution over a 10-month period (age range = <1 – 10 years). Demographic information and CT dose index (CTDIvol) were obtained from PACS. Four neuroradiologists visually assessed image quality at the level of basal ganglia using a 5-point scoring system. Exams with average scores of at least three were considered of acceptable diagnostic quality. Quantitative image quality evaluation was performed by placing regions of interest (ROIs) in the gray and white matter of the basal ganglia region. Contrast-to-noise ratios (CNR) then were calculated. Spearman's rank correlation coefficients were used for statistical analysis. Results were considered statistically significant when p < 0.05.

Results
One hundred twenty-eight pediatric head CTs were included in the study (<1 year N = 40; 1-4 years N = 33; 5-9 years N = 55). The CTDIvol ranged from 9 to 60 mGy. There was a significant correlation between CNR and average image quality ratings (< 1 year old group: rho = 0.654, p <0.001; 1-4 years: rho = 0.684, p <0.001; 5-9 years: rho = 0.733, p <0.001). Computed tomography images were of acceptable quality (average quality score equal to or greater than 3) in the majority of cases with CNR values greater than 1.5 (< 1 year old group: 95.6%; 1-4 year old group: 89.2%; 5-9 year old group: 86.8%). A minimum CTDIvol of 35 mGy was required to generate images with a CNR of at least 1.5.

Conclusions
Pediatric head CT images with a CNR of at least 1.5 were found to be of adequate diagnostic quality. A CTDIvol of at least 35 mGy should be used in in children younger than 10 years of age.
O-75

11:42AM - 11:50AM

The Role of Indication Based Protocols in Reducing Overall Head and Neck CT Scan Radiation Dose in Pediatric Patients

A Botwin¹, S Singh¹, A Tabari¹, X Li¹, B Liu¹, E Grant², M Gee¹, P Caruso¹
Purpose
Approximately 5-9 million pediatric computed tomography (CT) examinations are performed annually. As CT utilization has increased, there is increasing concern regarding potential CT ionizing radiation risks, especially in the pediatric population given its overall higher susceptibility to radiation-induced carcinogenesis compared to adults. Several previous studies reporting efforts to lower pediatric CT dose have demonstrated wide variations in effectiveness depending on institution and scanning protocol. In this study, we assess changes in pediatric head and neck CT radiation doses over time at a single institution utilizing indication-based CT dosing protocols.

Materials and Methods
Radiation dose monitoring software (Radimetrics™ Enterprise Platform, Bayer HealthCare) was used to gather all consecutive pediatric CT scans performed between January 1st 2011 and May 7th 2015. Demographic and scan information, scanning parameters, and radiation dose in terms of CT dose index (CTDIvol) measured in milligrays (mGy), effective dose, as well as organ specific dose were collected. Statistical analysis was performed with Student's t-test and analysis of variance (ANOVA).

Results
Most of the pediatric head and neck CT scans (n=1298 patients, Males:Females 784:514) were performed on 64 slice (n=2229) and 16 slice Multidetector CT (MDCT) scanners (n= 186). Protocols were stratified according to anatomical region and where feasible by clinical indication, including head (n=659), face (n=328), neck (n=119), paranasal sinus (n=96), craniosynostosis (n=53), skull base (n=27), and hydrocephalus/ventriculo-peritoneal (VP) shunt follow-up protocols (n=16).
Noncontrast head CT scans overall were performed with a mean CTDIvol of 24.1 ± 16.7 mGy. In comparison to noncontrast head CT, craniosynostosis CT exams were performed at an 88% lower CTDIvol (2.8 ± 3.8 mGy, P < 0.001), while hydrocephalus/VP shunt protocols were scanned at a 78% (5.3 ± 2.5 mGy, P < 0.001) lower CTDIvol. Between the years 2011-2015, mean CT dose associated with all head and neck protocols was reduced by 25% (P = 0.006), with the largest reduction seen with hydrocephalus/VP shunt and craniosynostosis protocols (70% reduction; P <0.05).

Conclusions
Indication-based CT protocols utilize different iterative reconstruction and tube current optimization settings. They play a crucial role in dose optimization, with up to an 88% lower dose observed for patients with craniosynostosis compared with standard noncontrast head CT. The use of indication-based protocols has led to a 25% overall reduction in pediatric head and neck CT dose from 2011 to 2015.
Table 1: Average (± standard deviation) radiation doses in terms of CTDIvol, dose length product (DLP), and estimated effective dose of various anatomical and clinical indication based protocols for pediatric head and neck CT are summarized. Craniosynostosis and hydrocephalus/VP shunt follow up scans were performed at an 88% and 78% lower radiation dose, respectively, as compared to routine non-contrast head CT protocols.

<table>
<thead>
<tr>
<th></th>
<th>CTDIvol (mGy)</th>
<th>DLP (mGy.cm)</th>
<th>Effective Dose (mSv)</th>
<th>% dose reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head CT</td>
<td>24.1 ± 16.7</td>
<td>439.4 ± 322.0</td>
<td>1.2 ± 0.8</td>
<td></td>
</tr>
<tr>
<td>Face CT</td>
<td>9.4 ± 10.0</td>
<td>164.5 ± 152.2</td>
<td>0.4 ± 0.4</td>
<td>60%</td>
</tr>
<tr>
<td>Neck CT</td>
<td>9.5 ± 9.2</td>
<td>204.9 ± 115.7</td>
<td>1.7 ± 1.7</td>
<td>60%</td>
</tr>
<tr>
<td>Sinus CT</td>
<td>8.6 ± 7.7</td>
<td>107.9 ± 120.7</td>
<td>0.3 ± 0.2</td>
<td>64%</td>
</tr>
<tr>
<td>Craniosynostosis</td>
<td>28.3 ± 3.9</td>
<td>47.1 ± 64.6</td>
<td>0.3 ± 0.2</td>
<td>88%</td>
</tr>
<tr>
<td>Skull base</td>
<td>20.7 ± 9.0</td>
<td>229.9 ± 117.4</td>
<td>0.8 ± 0.5</td>
<td>14%</td>
</tr>
<tr>
<td>Hydrocephalus/VP shunt</td>
<td>5.3 ± 2.5</td>
<td>93.2 ± 52.4</td>
<td>0.4 ± 0.3</td>
<td>78%</td>
</tr>
</tbody>
</table>

* mGy = milligrays, mSv = millisieverts.
DLP = CTDIvol (mGy) x scan length (cm)

Table 2: Average (± standard deviation) organ doses in terms of millisieverts (mSv), including high radiation sensitivity (bone marrow), fairly high radiation sensitivity (skin and organs with epithelial cell lining, such as cornea, oral cavity, and salivary glands), moderate radiation sensitivity (optic lens), fairly low radiation sensitivity (thyroid), and low radiation sensitivity (brain). For similar CTDIvol, scanner output red marrow and thyroid doses were higher for neck CT protocols as compared to face and sinus CT examinations.

<table>
<thead>
<tr>
<th></th>
<th>CTDIvol (mGy)</th>
<th>Red Marrow (mSv)</th>
<th>Skin (mSv)</th>
<th>Salivary Glands (mSv)</th>
<th>Lenses (mSv)</th>
<th>Thyroid (mSv)</th>
<th>Brain (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head CT</td>
<td>24.1 ± 16.7</td>
<td>2.9 ± 2.2</td>
<td>2.6 ± 2.1</td>
<td>20.6 ± 135</td>
<td>19.1 ± 5.9</td>
<td>8.3 ± 13.3</td>
<td>20.6 ± 13.5</td>
</tr>
<tr>
<td>Face CT</td>
<td>9.4 ± 10.0</td>
<td>0.4 ± 1.1</td>
<td>0.9 ± 0.9</td>
<td>6.9 ± 8.7</td>
<td>7.6 ± 8.3</td>
<td>6.2 ± 8.2</td>
<td>6.9 ± 8.7</td>
</tr>
<tr>
<td>Neck CT</td>
<td>9.5 ± 9.2</td>
<td>3.6 ± 2.8</td>
<td>2.4 ± 1.9</td>
<td>5.7 ± 9.1</td>
<td>7.3 ± 8.9</td>
<td>11.7 ± 14.2</td>
<td>5.6 ± 9.1</td>
</tr>
<tr>
<td>Sinus CT</td>
<td>8.6 ± 7.7</td>
<td>0.7 ± 0.8</td>
<td>0.8 ± 0.6</td>
<td>6.2 ± 5.7</td>
<td>6.7 ± 6.6</td>
<td>1.7 ± 2.9</td>
<td>6.2 ± 5.8</td>
</tr>
<tr>
<td>Craniosynostosis</td>
<td>28.3 ± 3.9</td>
<td>0.8 ± 0.7</td>
<td>0.8 ± 0.6</td>
<td>3.5 ± 4.2</td>
<td>3.6 ± 4.9</td>
<td>1.4 ± 1.6</td>
<td>3.6 ± 4.2</td>
</tr>
<tr>
<td>Skull base</td>
<td>20.7 ± 9.0</td>
<td>2.5 ± 1.7</td>
<td>2.0 ± 1.3</td>
<td>17.5 ± 8.1</td>
<td>21.8 ± 13.8</td>
<td>2.8 ± 6.7</td>
<td>17.4 ± 8.2</td>
</tr>
<tr>
<td>Hydrocephalus/VP shunt</td>
<td>5.3 ± 2.5</td>
<td>1.6 ± 1.1</td>
<td>0.9 ± 0.9</td>
<td>5.7 ± 3.5</td>
<td>6.1 ± 3.9</td>
<td>1.5 ± 2.3</td>
<td>5.7 ± 3.5</td>
</tr>
</tbody>
</table>

* mGy = milligrays, mSv = millisieverts

Figure 1: Pediatric head and neck CT radiation dose (measured values in mGy) in 2011 to 2015 are plotted in this figure. Figure 1a summarizes the low radiation sensitivity of craniosynostosis, hydrocephalus/VP shunt, paranasal sinus, face, and skull base CT. Figure 1b illustrates the overall temporal trend of pediatric radiation exposure. The most significant lowering of dose from 2011 to 2015 (P = 0.006).
Craniosynostosis CT at Radiation Dose of Less than 0.1 mSv: Role of Low Tube Potential and Iterative Reconstruction

A Tabari¹, S Singh¹, S Rincon², M Gee¹, P Caruso²
¹Massachusetts General Hospital, Boston, MA, ²MGH, Boston, MA

Purpose
Tube potential (kV) is a common computed tomography (CT) scanning parameter utilized to lower radiation dose, most common being tube current (mA). However, reduction of kV & mA results in increased image noise and hence lowers diagnostic confidence. Careful selection of iterative reconstruction algorithms (IR) settings has shown the lowering image noise and potential of radiation dose reduction. Therefore, the purpose of this study was to evaluate ultralow dose craniosynostosis CT (0.1 mSv) performed at 80 kV and reconstructed with IR.

Materials and Methods
Our study was approved by the hospital IRB and compliant with HIPPA guidelines. All consecutive craniosynostosis CT performed from August 2011 to March 2015 were included in the study cohort. Patient demographics, including age, gender, weight and maximum skin-to-skin transverse head diameter was recorded. ASIR reconstructions are available at different strengths of 10-100%, with 10% increments and we utilized ASIR90 for all reconstructions. Detailed subjective image quality evaluation included image noise, sharpness of cranial sutures, including sagittal, coronal, lambdoid, metopic as well as artifacts. Subjective scores were defined on a scale from 1 (unacceptable noise, nondiagnostic) to 5 (excellent image quality, best diagnostic value). In addition, objective image noise (standard deviation of HU values) and signal to noise ratio (SNR) was measured at the level of clivus.

Results
A total of 47 children {average age, 3.0 ± 4.1 years; F:M 22:25} underwent 51 craniosynostosis CT examinations. Average weight of the study group was 13.4± 10.8 kg with an average head diameter of 13.8 ± 18.9 cm. Lowest available tube potential of 80 kV with scan rotation time of 0.5 seconds, helical pitch of 0.968 was selected on IR capable scanner [Discovery 750 HD with Adaptive Statistical Iterative Reconstruction (ASIR), GE Healthcare]. Average radiation dose measured in terms of CTDIvol was 2.5 ± 1.6 mGy and Dose Length Product of 40.2 ± 25.1 mGy.cm. As per the ICRP103 guidelines, resultant effective dose was 0.08 ± 0.05 mSv.
Conclusions
Craniosynostosis CT can be performed at less than 0.1 mSv radiation dose with 80 kV and iterative reconstruction algorithms.

Figure 1:
Coronal and 3D images of a low-dose head CT reconstructed with ASIR 90% in a 6 year-old girl with multiple suture cures. Scan parameters of 80 kVp and 20 mAs resulted in an estimated effective dose. Low-dose scan was performed at 0.06 mSv.

(Filename: TCT_O-76_Cranio-CT.jpg)

Monday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Roosevelt 4
3F-Neuroradiology Education

3F-1 10:30AM - 10:45AM

Teaching Neuroradiology to Medical Students

Kennedy, T.
University Of Wisconsin Hospital
Madison, WI

3F-2 10:45AM - 11:00AM

Teaching Neuroradiology to Diagnostic Radiology Residents

Bennett, J.
Univ. Of Florida Medical Center
Gainesville, FL

3F-3 11:00AM - 11:15AM

Teaching Neuroradiology to Neuroradiology Fellows

Schaefer, P.
Massachusetts General Hospital
Boston, MA

3F-4 11:15AM - 11:30AM

ACGME/RRC Update

Anderson, J.
Oregon Health & Science University
Portland, OR

3F-5 11:30AM - 11:45AM

ABR Update
Zimmerman, R.
New York Presbyterian Hospital
New York, NY

3F-6
Panel Discussion/Q&A

11:45AM - 12:00PM

Monday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Marriott Ballroom

4A-Olfaction Audience Response (AR) Self Assessment Module (SAM)

4A-1
Central Processing of Odor

1:15PM - 1:55PM

Naidich, T.
Icahn School of Medicine at Mount Sinai
New York, NY

4A-2
Current Concepts of Olfaction From Odorant to Olfactory Bulb: How We Use It, Its Embryology and Anatomy

1:55PM - 2:30PM

Som, P.
Icahn School of Medicine at Mount Sinai
New York, NY

4A-4
Questions and Answers

2:30PM - 2:45PM
Monday  
1:15PM - 2:45PM  
Washington Marriott Wardman Park, Washington 4/5/6

4B-Young Professional Programming: Practical Post-Treatment Neuroimaging

4B-1

Post Treatment Brain

Cha, S.  
University of California San Francisco  
San Francisco, CA

4B-2

Post Treatment Neck

Mukherji, S.  
Michigan State University  
East Lansing, MI

4B-3

Post Treatment Spine

Shah, L.  
University Of Utah  
Salt Lake City, UT

4B-4

Discussion
Monday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Washington 1/2/3

4C-Evidence Based Medicine Programming: Imaging Blunt Cerebrovascular Injury-What is the Evidence?
4C-1

Imaging Diagnosis of Cerebrovascular Injury and How We Image

Chapman, M.
Boston University Medical Center
Boston, MA

4C-2

BCVI Classification - Implications of Treatment for Carotid and Vertebral Arteries

Johnson, M. · Malhotra, A.
Yale Univ. School Of Medicine · Yale New Haven Hospital
New Haven, CT

4C-3

Current Trends of Treatment of BCVI-Treatment Strategies Outcomes

Hetts, S.
University of California, San Francisco
San Francisco, CA

4C-4

Role of Vessel Wall Imaging in Patients with BCVI
Purpose
There has been extensive research interest in the use of magnetic resonance perfusion (MRP) to distinguish between recurrent tumor and treatment change. However, it is unclear if any definitive conclusions can be drawn from the existing literature, including whether MRP-derived parameters can be used as quantitative biomarkers for viable tumor. For this reason, we performed a systematic review and meta-analysis to evaluate if dynamic susceptibility contrast-enhanced (DSC) and dynamic contrast-enhanced (DCE) MRP metrics can discriminate effectively between tumor and treatment change within the enhancing signal abnormality on conventional MRI.

Materials and Methods
We performed a comprehensive literature search focused on DSC and DCE MRP-based differentiation of recurrent tumor and post-treatment changes in patients with
high-grade gliomas. Only studies published in the "temozolomide era" beginning in 2005 were included. Data extracted include study characteristics, MRP imaging and analysis techniques, and MRP parameters evaluated in each study along with any proposed threshold, sensitivity, and specificity values. A meta-analysis of sensitivity and specificity proportions of interest was performed using the more conservative random-effects model along with assessment of publication bias and study heterogeneity.

Results
A total of 1,581 abstracts were screened of which 28 articles met our inclusion criteria for systematic review. Seventeen studies evaluated DSC, eight evaluated DCE, and three evaluated both DSC and DCE. The two most common MRP parameters evaluated were mean rCBV (n=8) and maximum rCBV (n=5). Using mean rCBV with proposed thresholds ranging from 0.9 to 2.15, the pooled sensitivity and specificity for detecting tumor recurrence were both 88% (95% CI 0.81-0.94 and 0.78-0.95, respectively). For maximum rCBV, the pooled sensitivity was 93% (0.86-0.98) and the pooled specificity was 76% (0.66-0.85) with proposed thresholds of 1.49 to 3.1. Given the diversity of MRP parameters in the literature, we also pooled the sensitivity and specificity data where available for the best performing parameter from each study. For DSC, the pooled sensitivity and specificity were 86% (0.80-0.91) and 87% (0.81-0.92), respectively. For DCE, the pooled sensitivity was 89% (0.78-0.96) with a specificity of 85% (0.77-0.91).

Conclusions
Our study shows that within individual studies, MRP metrics separate tumor from treatment change with relatively good sensitivity and specificity using study-specific thresholds. However, more importantly, our study illustrates major limitations of the current literature on quantitative characterization of new post-treatment enhancing lesions by MRP. Optimal imaging techniques and threshold values remain difficult to identify with highly variable proposed cut-off values useful only as general guides at best. Thus, current best evidence does not lend support for routine clinical implementation of any particular quantitative MRP imaging strategy. Based on our study, the added value of quantitative MRP in the care of patients with high-grade gliomas is unclear and requires further investigation.
<table>
<thead>
<tr>
<th>Study First Author and Year</th>
<th>MRP-derived Parameter</th>
<th>Threshold for Tumor in Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexiou 2014</td>
<td>Max rCBV</td>
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<tr>
<td>Baek 2012</td>
<td>Max rCBV</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Mode rCBV</td>
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</tr>
<tr>
<td></td>
<td>Range rCBV</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>% change skewness</td>
<td>0.0127</td>
</tr>
<tr>
<td></td>
<td>% change kurtosis</td>
<td>0.0514</td>
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<td>Barajas 2009</td>
<td>Mean rPH</td>
<td>1.38</td>
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<td></td>
<td>Mean rCBV</td>
<td>1.75</td>
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<td>Mean rPSR</td>
<td>87.3</td>
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<td>Gasparetto 2009</td>
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<td>Peak Height Position</td>
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<td>Maximum Value</td>
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<td>Kim 2014 (Mar)</td>
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<td>Mangla 2010</td>
<td>Mean rCBV</td>
<td>&gt;0% difference between pre- and post RT</td>
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<td>Martinez 2012</td>
<td>Mean rCBV</td>
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<td></td>
<td>Mean rPSR</td>
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</tr>
<tr>
<td></td>
<td>Mean rPH</td>
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</tr>
<tr>
<td>Park 2015</td>
<td>90th% rCBV</td>
<td>3.37</td>
</tr>
<tr>
<td>Prager 2015</td>
<td>Mean rCBV</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>Max rCBV</td>
<td>1.74</td>
</tr>
<tr>
<td>Seeger 2013</td>
<td>Mean rCBF</td>
<td>2.24</td>
</tr>
<tr>
<td></td>
<td>Mean rCBV</td>
<td>2.15</td>
</tr>
<tr>
<td>Young 2013</td>
<td>Max rCBF</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Mean rPH</td>
<td>1.72</td>
</tr>
<tr>
<td></td>
<td>Mean rPSR</td>
<td>0.86</td>
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(Filename: TCT_O-77_DSC.jpg)
Combined MR Perfusion and Diffusion for Differentiation of Post-treatment Changes from Recurrent High Grade Glioma

P Belani\(^1\), J Knitter\(^1\), A Doshi\(^1\), A Hormigo\(^1\), I Germano\(^1\), K Nael\(^1\)
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Purpose
Differentiation of post-treatment changes (PTC) from recurrent tumor (RT) in treated patients with high-grade gliomas (HGG) remains a diagnostic challenge. The purpose of this study was to evaluate diagnostic performance of multiparametric magnetic
resonance imaging (MRI) using a combination of MR perfusion and diffusion for distinguishing PTC from RT in patients with HGG.

Materials and Methods
From January 2013 to September 2015, a total of 42 patients with HGG who developed a new enhancing mass after completion of their standard treatment (gross total resection, radiation and temozolomide) were evaluated retrospectively. Magnetic resonance scans in which enhancing lesions were identified first, were used for image analysis. Volume-of-interest (VOI) of the enhancing lesions were created. Using coregistered images, mean values of the ADC, DCE-derived Ktrans and DSC-derived rCBV were calculated. Statistical analysis was performed by analysis of variance and logistic regression. Receiver operating characteristic (ROC) analysis was performed to determine the optimal parameter(s) and threshold for diagnosis of recurrence versus PTC.

Results
Twenty-nine patients had RT (confirmed by surgical pathology), while 13 patients were identified as having PTC: radiation necrosis, n=6 (confirmed by surgical pathology), pseudoprogression, n=7 (diagnosis made on imaging as the enhancing lesion progressively decreased in size and resolved after initial appearance on multiple sequential MRI exams, mean follow-up time 7 months). Recurrent HGG showed significantly higher rCBV and Ktrans and significantly lower ADC values compared to PTC (Table 1). There was no statistically significant difference in ADC, Ktrans or rCBV mean values between radiation necrosis and pseudoprogression (p > 0.1). Multivariate logistic regression analysis showed significant contribution from rCBV (p=0.01) and Ktrans (p=0.04), but not from ADC (p=0.7) to differentiate PTC from RT. The best discriminative power from an individual classifier was obtained from rCBV at threshold of 2.2 resulting in an AUC of 0.92 with sensitivity/specificity of 90/92% respectively. In a separate model, a combined Ktrans-rCBV classifier resulted in slightly better discriminative power with AUC of 0.98 and odds-ratio of 61 for differentiation of PTC from RT.

Conclusions
Recurrent HGG showed lower ADC, higher Ktrans and higher rCBV in comparison to PTC including both radiation necrosis and pseudoprogression. The combined rCBV-Ktrans had the highest diagnostic performance for differentiation of PTC from RT compared to any individual or combination of other imaging classifiers.
Multi-Center Study demonstrates Dynamic Contrast Enhanced Permeability MRI differentiates pseudoprogression from true disease progression in primary high-grade gliomas and metastatic melanoma

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Purpose
To determine if dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) permeability $K_{\text{trans}}$ imaging can differentiate pseudoprogression and true disease progression in brain tumors in a multicenter study. Pseudoprogression has been well described in patients with high grade gliomas treated with temozolomide and radiation and more recently also in patients with metastatic melanoma treated with ipilimumab immunotherapy. We combined datasets from two institutions and standardized the processing analysis.

Materials and Methods
A total of 62 patients with high grade glioma (glioblastoma and anaplastic astrocytoma) received surgical resection, temozolomide/radiation and six patients with metastatic melanoma received ipilimumab immunotherapy. Time-dependent leakage constant ($K_{\text{trans}}$) and plasma volume (VP) were measured using extended-Tofts pharmacokinetic modeling using region of interest analysis and normalized ratios in both institutions. Lesion outcome was determined by pathology or clinical

Table 1. Mean values, analysis of variance and AUC analysis for differentiation of tumor (RT) from Posttreatment changes (PTC) using rCBV, ADC and $K_{\text{trans}}$

<table>
<thead>
<tr>
<th></th>
<th>PTC (n=13)</th>
<th>RT (n=29)</th>
<th>ANOVA</th>
<th>AUC/Sensitivity</th>
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<td>ADC ($10^{-5}$ mm$^2$/s)</td>
<td>1360</td>
<td>1150</td>
<td>0.02</td>
<td>0.82/69/84</td>
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<tr>
<td>$K_{\text{trans}}$ (1/min)</td>
<td>0.06</td>
<td>0.18</td>
<td>0.002</td>
<td>0.88/93/77</td>
</tr>
<tr>
<td>rCBV</td>
<td>1.8</td>
<td>3.9</td>
<td>&lt; 0.001</td>
<td>0.92/90/92</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-78_PTCVSRT.jpg)
follow up, with pseudoprogression defined as stable or decreasing disease based on RANO criteria.

Results
Patients with pseudoprogression (n=23) had Ktrans (mean ± std) = 2.71 ± 1.42.
Patients with true disease progression (n=45) had Ktrans (mean ± std) = 6.57 ± 3.56.
Compared with true disease tumor progression, pseudoprogression demonstrated lower Ktrans values (p<.001). Dynamic contrast-enhanced MRI also demonstrated lower fractional plasma volume (Vp) in pseudoprogression with Vp=6.28±3.25 than in true disease progression with Vp=2.95±1.44 (p<.0002).

Conclusions
Multicenter brain DCE MRI Ktrans differentiates pseudoprogression from true disease progression in primary high gliomas with standard of care therapy, and metastatic melanoma treated with ipilimumab immunotherapy.

O-80

High Resolution DCE MRI permeability differentiates pseudoprogression from true disease progression in primary high-grade gliomas and metastatic melanoma

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¹USC Medical Center, Los Angeles, CA, ²USC, Los Angeles, CA, ³University of Southern California, Keck School of Medicine, Los Angeles, CA, ⁴Keck Medical Center of USC, Los Angeles, CA

Purpose
To determine if high resolution dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) permeability Ktrans imaging can differentiate pseudoprogression and true disease progression in primary and metastatic brain tumors. Pseudoprogression has been well described in patients with high grade gliomas treated with temozolomide and radiation. More recently pseudoprogression also has been described in patients with metastatic melanoma treated with ipilimumab immunotherapy.

Materials and Methods
Thirty-one subjects were followed, 25 with high grade glioma (glioblastoma and anaplastic astrocytoma) treated with surgical resection, Temozolomide/radiation and six with metastatic melanoma treated with Ipilimumab immunotherapy. Time-dependent leakage constant (Ktrans) were measured using extended-Tofts pharmacokinetic modeling using a region of interest on the Ktrans maps. Lesion outcome was determined by clinical follow up with pseudoprogression defined as stable or decreasing disease based on lesion dimensions (RANO criteria).
Results
Patients with pseudoprogression (n=21) had Ktrans (mean ± std) = 1.74 ± 0.53. Patients with true disease progression (n=10) had Ktrans (mean ± std) = 5.11 ± 0.94. Compared with true disease tumor progression, pseudoprogression demonstrated lower Ktrans values (p=1e-12). Dynamic contrast-enhanced MRI also demonstrated lower fractional plasma volume (vp) in pseudoprogression than in true disease progression (p=0.005).

Conclusions
Brain DCE MRI Ktrans differentiates pseudoprogression from true disease progression in primary high gliomas with standard of care therapy, and metastatic melanoma treated with ipilimumab immunotherapy.

O-81
1:27PM - 1:30PM

The change in the apparent diffusion coefficient values predicts survival after intra-arterial bevacizumab administration in patients with recurrent glioblastomas

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Purpose
Selective intra-arterial (IA) infusion of bevacizumab has emerged as a novel therapy in the treatment of recurrent glioblastomas (GBMs). This study assessed the potential of apparent diffusion coefficient (ADC) values in predicting length of survival after IA bevacizumab and overall survival in patients with recurrent GBMs.

Materials and Methods
Sixty-five patients enrolled in a phase I/II trial of IA bevacizumab for treatment of recurrent GBM were included in this study, 58 of which were deceased at the time of analysis. Magnetic resonance imaging (MRI) with a diffusion-weighted (DWI) sequence was performed pre- and post-treatment. Regions of interest (ROIs) were delineated manually on the enhancing and nonenhancing portions of the tumor, as well as the normal contralateral white matter. Cox and logistic regression analyses were performed to determine ADC values that best predicted survival.

Results
An increase in ADC in the enhancing portion of the tumor after IA bevacizumab therapy was associated with an increased risk of death (hazard ratio = 1.9, p = 0.048), adjusting for age, tumor size, bevacizumab dose, and prior intravenous (IV)
bevacizumab treatments. Similarly, an increase in ADC in the enhancing portion of the tumor after IA bevacizumab therapy was associated with greater likelihood of surviving less than 1 year after therapy (odds ratio = 7.2, p = 0.041). Having previously received IV bevacizumab was associated with increased risk of death (hazard ratio = 4, p< 0.01) and much greater likelihood of surviving less than 1 year (odds ratio = 17.1, p=0.016). The change in ADC in the nonenhancing portion of the tumor, and the pre- and post-treatment ADC values were not associated with survival. Conclusions
The results of this analysis suggest that amongst patients with recurrent GBM treated with IA bevacizumab, a decrease in ADC values in the enhancing portion of the tumor may suggest improved survival due to atypical necrosis.

O-82

1:30PM - 1:33PM

Restriction Spectrum Imaging and EGFR Status Predict Post-Bevacizumab Survival in Patients with High-Grade Glioma.

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¹University of California, San Diego, San Diego, CA, ²Multimodal Imaging Laboratory, La Jolla, CA, ³University of California, San Diego, La Jolla, CA

Purpose
In patients treated with bevacizumab, diffusion-weighted imaging (DWI) has demonstrated promise for evaluating response to therapy; however, it is recognized that the apparent diffusion coefficient (ADC) is a limited surrogate of cellularity as it is influenced by bevacizumab-induced reduction in edema. We demonstrate that restriction spectrum imaging (RSI), an advanced DWI technique, more accurately evaluates therapeutic response in patients treated with bevacizumab because it is less affected by bevacizumab-induced decrease in edema. In a secondary analysis, we evaluated whether EGFR amplification, known to affect downstream processes including angiogenesis, may predict response following bevacizumab.

Materials and Methods
Restriction spectrum imaging (RSI) and ADC maps were analyzed for 40 patients with recurrent high-grade glioma (HGG) prior to and following initiation of bevacizumab. Volumes of interest (VOIs) were drawn for regions of contrast enhancement (CE) and FLAIR hyperintensity (FLAIR-HI). Histogram percentiles within VOIs were calculated for the ADC 10thpercentile (ADC-CE10%, ADC-FLAIR10%) and for the RSI 90thpercentile (RSI-CE90%; RSI-FLAIR90%). Cox Proportional Hazard (CPH) models were used to evaluate the relationship between
each imaging parameter, EGFR amplification status, progression-free survival (PFS) and overall survival (OS) from time of bevacizumab initiation.

Results
Increase in RSI-FLAIR90% following bevacizumab was the strongest predictor of poor PFS and OS (p < 0.05, p < 0.01), whereas decrease in ADC-FLAIR10% showed a weaker association with OS only (p < 0.05). Within the CE region, an increase in RSI-CE90% was associated with poorer OS (p < 0.05). Furthermore, EGFR status was a significant predictor of PFS and OS (p < 0.05, p < 0.05), with amplified patients having an improved outcome; yet it did not add to the predictive model with RSI-FLAIR90%.

Conclusions
Restricted spectrum imaging is less influenced by bevacizumab-induced reductions in edema than ADC, thus conferring an advantage of RSI over ADC for predicting post-bevacizumab outcomes. Furthermore, EGFR amplification may confer a survival advantage following initiation of anti-angiogenic therapy.
58 year old female with a left parietal GBM. Volumes of interest for contrast enhancement (CE) and FLAIR-hyperintensity (FLAIR-HI) are delineated with the white and black contours, respectively. Comparison of MRI 13 days before initiation of bevacizumab and 42 days post-bevacizumab demonstrates decreased volumes of CE and FLAIR-HI. However, on the bevacizumab image, within the region of FLAIR-HI, the restriction spectrum imaging-cellularity map (RSI-CM) demonstrates an increase in signal intensity, suggestive of a poor outcome, validated by the patient's poor overall survival of 93 days post-bevacizumab. On the other hand, although the apparent diffusion coefficient (ADC) signal does decrease on the post-bevacizumab image, ADC conspicuity is low at both the pre- and post-bevacizumab timepoints.
Perfusion spectral imaging (PSI) in human brain tumors

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¹University of California Los Angeles, Los Angeles, CA

Purpose
By applying a combination of novel quadruple-echo (dual gradient-, asymmetric spin-, and spin-echo), simultaneous multi-slice (SMS) echoplanar (EPI) dynamic susceptibility contrast (DSC) perfusion magnetic resonance imaging (MRI) and advanced leakage correction algorithms, we demonstrate the ability to extract a full spectrum of clinically relevant brain perfusion parameters including measures of brain functional connectivity; relative oxygen extraction fraction (rOEF); vascular permeability (Ktrans, kep); arterial, venous, and capillary probability fraction using multifactorial independent component analysis (ICA) (1); mean vessel diameter (MVD) (2) vessel density (3), vascular architectural imaging (VAI) (4); vessel size index (VSI) (5); along with conventional measures of both micro- and macroscopic vessel relative cerebral blood volume (rCBV), flow (rCBF), and mean transit time (MTT).

Materials and Methods
This study was performed prospectively in 10 glioma patients with quadruple-echo DSC-MRI prior to surgical resection. Repetition time was 2,000 ms and echo times were 14.0, 34.1, 58.0, and 92.4 ms. Precontrast T1 maps were used to calculate Ktrans and kep. Perfusion data were collected with an extended baseline run-in for resting-state quantitative fMRI and T2, T2*, and T2' estimation of rOEF, followed by bolus contrast injection and an extended post-injection baseline for permeability estimation. Apparent diffusion coefficients (ADC) were computed for vessel size index estimation. A bidirectional contrast agent leakage correction algorithm was applied for correcting rCBV and Ktrans estimation.

Results
Perfusion spectrum imaging (PSI) demonstrated a breadth of vascular-specific information in each tumor, which was associated strongly with histological features. Patients with low-grade gliomas exhibiting FLAIR hyperintensity and no contrast enhancement had regions of local hypoxia, relatively intact functional connectivity, low rCBV and low Ktrans; however, vessel size index and other advanced vascular parameters were abnormal. Patients with high-grade gliomas demonstrated extremely hypoxic tumors, altered functional connectivity, and abnormal vascular parameters.
Conclusions
Perfusion spectrum imaging enables simultaneously mapping of numerous perfusion, hypoxia, and neurovascular functional biomarkers. This information is clinically useful for characterizing the vascular, metabolic, and neurological status or response in human gliomas.
The Utility of 18F-Fluoroethyl Tyrosine PET CT in the Evaluation of Glioma Recurrence Patterns.

G Deib¹, T Elliot², A Falkov², B Mzende²
¹University of Auckland, Auckland, Auckland New Zealand, ²University of Auckland, Auckland, Auckland

Purpose
Amino acid positron emission tomography (PET) tracers, such as 18F fluoro-ethyl-tyrosine (FET), are emerging as a useful tool in the imaging of brain tumors with particular utility in the assessment of recurrent glioma following treatment. The role of FET PET in defining the pattern of recurrence following radiotherapy is incompletely understood, as is its impact on decisions regarding clinical management.

Materials and Methods
The study was performed in two parts. For the primary outcome, 50 FET PET studies demonstrating recurrent glioma were selected from a local database and retrospectively assessed. The FET PET tracer uptake was compared against the volume treated with radiotherapy and a pattern of recurrence was categorized (central/in-field/marginal/distant). For the secondary outcome, a retrospective review of the medical records was performed to evaluate the impact that FET PET scanning had on clinical decision making at our locality.

Results
Fifty FET PET-CT scans were assessed with 25 (50%) prompting a change in the intended management of the patient. There was a statistically significant association between a positive scan result and an intended change in management. Fourteen tumor recurrence cases were demonstrated. There was no statistically significant association with demographics, diagnosis or treatment. There were eight central recurrences (57.1%), two in-field (14.3%), four marginal (28.6%) and no distant recurrences (0%). The diagnosis was GBM in eight cases (57.1%), oligodendroglioma in four cases (28.6%), and anaplastic oligodendroglioma and anaplastic astrocytoma in one case each (7.1% respectively). Of the 14 patients, 12 were male (85.7%). There was no statistically significant relationship between diagnosis and the recurrence position (p=0.61; using a multicell contingency table and Fisher's exact test). There was no association between gender and recurrence position (p=0.34). There was no significant difference between radiotherapy dose (grouped as a categorical values of 60Gy and 54Gy) and recurrence position, including when in-field and marginal results were grouped (p=0.54, Fisher's exact test). Similarly, there was no relationship
between temozolomide use and recurrence pattern (p=0.65). The mean tumor recurrence volume was 18.5 cm³, with volumes ranging from 0.2-52.6 cm³ and a standard deviation of 16.3 cm³. Of the 51 individual scans, one was excluded after application of the inclusion/exclusion criteria, on the basis of the age. Of the 50 cases remaining, a change to the management plan that was directly attributable to the FET PET CT was present in 25 (50%). A further 16 scans (32%) caused no change in management, whilst nine scans (18%) had an uncertain impact.

Conclusions
Most glioma recurrences occur at the site of primary tumor and within the radiation treatment field, as defined by FET-PET CT. This result is consistent with findings previously reported in the literature. FET-PET CT scan results have the potential to be highly influential in the clinical management of patients with cerebral gliomas, with an alteration in intended management in up to half of cases.

O-85
1:39PM - 1:42PM

Aromatic-rNOE-suppressed amide-CEST-MRI at 7 Tesla provides a unique contrast in human glioblastoma

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Purpose
The CEST effect observed in brain tissue in vivo at the frequency offset 3.5 ppm was assigned to amide protons of the protein backbone. Obeying a base-catalyzed exchange process such an amide-CEST effect would correlate on intracellular pH and protein concentration – correlations that are highly interesting for cancer diagnosis. However, recent experiments suggested that, besides the known aliphatic relayed-nuclear Overhauser effect (rNOE), an additional aromatic rNOE is apparent in vivo resonating as well around +3.5 ppm. In this study, we present further evidence for the underlying aromatic rNOE signal contribution, and we propose a first method that suppresses the aromatic-rNOE contribution to the amide-CEST contrast. Thus, an isolated amide-CEST effect depending mainly on amide proton concentration and pH is generated.

Materials and Methods
The isolation of the exchange mediated amide proton effect was investigated in protein model-solutions and tissue lysates and successfully applied to in vivo CEST images of 11 glioblastoma patients.

Results
Comparison with gdce-T1-weighted images revealed that the aromatic-rNOE-
suppressed amide-CEST contrast forms a unique contrast that delineates tumor regions and shows remarkable overlap with the gadolinium contrast enhancement.

Conclusions
Thus, suppression of the aromatic rNOE contribution might be the important step to yield the amide proton CEST contrast originally aimed at.
Sequential MR Diffusion for Assessment of Tumor Progression in Patients with Low-Grade Glioma

K Nael1, A Doshi1, B Delman1, I Germano1, A Hormigo1

1Icahn School of Medicine at Mount Sinai, New York, NY

Purpose
Conventional imaging using serial magnetic resonance images (MRIs) often is challenging in evaluating progression of low-grade gliomas (LGGs). The purpose of this study was to assess the role of MR diffusion in serial imaging of patients with LGGs as a biomarker of stability versus progression.

Materials and Methods
Patients with histologically proven LGGs were included in this retrospective study if they had consecutive clinical and imaging follow-up from the initial diagnosis until present, or until they showed evidence of high-grade transformation (either by imaging or by surgical pathology). Magnetic resonance imaging (MRI) exams were reviewed by a board-certified neuroradiologist and LGGs were identified as either stable or showing evidence of progression by comparing with prior MR imaging. Interval increase in the extent of FLAIR hyperintensity or development of contrast enhancement was used as an indication of tumor progression. All available MR exams were coregistered and ADC histogram measures determined for each patient using volume of interest (VOI) from the FLAIR hyperintense tumor volume. Normalized ADC-10th percentile values were obtained for each time point, data were plotted over time for each patient and scored to evaluate whether values fit within the expected pattern: Progression (interval decrease in ADC); Stable (plateau, or interval increase in ADC).

Results
Twenty patients (14 men, mean age: 54 years) with histologically proven LGGs (13 oligodendrogliomas, 7 astrocytomas) were followed up for a median of 2.3 years (range, 0.7–5.5 years). A total of 82 MRI studies were evaluated (median number of MRIs per patient = 3). The final designation was stable (n=6) and tumor progression (n=14). Among these 14 progressing tumors, increased FLAIR hyperintensity was seen in 11 and enhancement developed in three. In all patients with tumor progression, sequential ADC analysis showed progressive downward trend with at least 20% decrease in ADC values compared to baseline MRI. When review was limited to just two consecutive MRI studies, six patients whose tumor appeared stable on conventional imaging actually exhibited decrease in ADC values that correctly pointed to progression. In three patients who developed eventual enhancement,
downward trend of ADC values was noted at least 6 months before enhancement could be seen, associated with increased cellularity and predicting progression.

Conclusions
Sequential ADC analysis in patients with LGGs can help to identify tumor progression. Progressive downward trend of ADC values can predict tumor progression despite apparent stability of tumor size and extent on conventional imaging.

O-87

1:45PM - 1:48PM

Relationship of Cerebral Blood Volume with IDH Mutation Status and Survival in Lower Grade Gliomas: A TCGA/TCIA Project

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Purpose
Prior studies have shown correlation between magnetic resonance (MR) perfusion DSC relative cerebral blood volume (rCBV) and glioma grading, patient survival, as well as tumor genomics (1-4). The purpose of this study was to determine whether rCBV values correlate with IDH mutation status and patient overall survival (OS) in lower grade gliomas (LGG). We also assessed whether rCBV values correlate with enhancement status in LGGs.

Materials and Methods
IDH mutation status (IDHmut-codel, IDHmut-non-codel, and IDHwt) and survival data were assayed by the TCGA (The Cancer Genome Atlas), and presurgical imaging collected by the TCIA (The Cancer Imaging Archive) were obtained. Twenty-three patients out of 199 with untreated LGGs (WHO Grade 2 and 3) had good quality DSC T2* data and were included in this analysis. rCBV maximum values were obtained from four regions of interest including enhancing and nonenhancing segments of each tumor. Overall survival (OS) trajectories were determined using Kaplan-Meier estimates. Group differences were assessed by log-rank test.

Results
There was statistically significant difference of rCBV between enhancing and nonenhancing LGGs (No enhancement: 1.27 +/- 0.34; Enhancement: 3.53 +/- 2.27 p=0.0009). There was no statistical difference in rCBV based on IDH mutation status (IDHmut-codel 2.88 +/- 2.10; IDHmut-non-codel 3.01 +/- 2.67; IDHwt 3.30 +/- 1.01) (Fig. 1). As a continuous predictor, there was no sufficient evidence of rCBV being a significant predictor of OS (Cox regression, p=0.31).
Conclusions
Nonenhancing LGGs demonstrated lower rCBV values than enhancing LGGs. rCBV values could not differentiate IDH mutation status. However, IDHwt LGGs demonstrated a trend towards higher rCBV values.

![rCBV by IDH group](TCT_O-87_graph.jpg)

**O-88**

**Diffusion Kurtosis Imaging in Differentiation of Peritumoral Edema Between Brain Metastases and Primary Glioblastomas**

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**Purpose**
Malignant gliomas tend to infiltrate surrounding brain tissue, often without disruption of blood-brain barrier (1). They have indistinct borders on conventional magnetic
resonance imaging (MRI). Unlike gliomas, the peritumoral edema around brain metastases is described as a «pure» vasogenic (2). Using conventional MRI with contrast enhancement, it is hard to differentiate between «pure» vasogenic peritumoral edema and peritumoral edema with microscopic glioma cell infiltration (1). Diffusion kurtosis imaging (DKI) is an advanced extension of diffusion tensor imaging (DTI). Recent studies have shown promising potential of DKI in brain tumor diagnostics (3, 4, 5). The aim of our study was to assess the ability of DKI to differentiate between «pure» vasogenic peritumoral edema and peritumoral edema with microscopic tumor cell infiltration in case of brain metastases and primary glioblastomas.

Materials and Methods
Twenty patients with primary brain glioblastomas and 20 patients with brain metastases underwent 3T MR imaging. All tumors were diagnosed for the first time (no brain radiation or chemotherapy have been used before) and were surrounded by pronounced brain edema. In all cases, diagnosis was confirmed by histopathologic examination. Diffusion kurtosus imaging was performed using b values of 0, 1000 and 2500 s/mm² and 60 gradient directions. Thirteen diffusion parameters were obtained using DKI: mean kurtosis (MK), axial kurtosis (AK), radial kurtosis (RK), kurtosis anisotropy (KA), mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD), fractional anisotropy (FA), relative anisotropy (RA), axonal water fraction (AWF), extra-axonal axial diffusivity (EAD), extra-axonal radial diffusivity (ERD), tortuosity (TORT). All these diffusion parameters were compared between brain metastases and primary glioblastomas in the next peritumoral areas (Fig. 1): 10 mm edema near tumor border, central part of edema, the border of edema with normal white matter, ipsilateral normal white matter, contralateral normal white matter (p<0.05 significance level, Mann-Whitney test).

Results
Statistically significant differences between peritumoral areas of brain metastases and primary glioblastomas were found only in the 10 mm peritumoral edema part near the tumor border. The values of KA, FA, RA and TORT were significantly higher (p<0.05) in primary glioblastomas compared with brain metastases in that area (Fig. 2). Higher figures of anisotropy (KA, FA and RA) and tortuosity in 10 mm peritumoral edema of primary glioblastomas near tumor border may reflect higher cellularity due to microscopic tumor cell invasion.

Conclusions
Diffusion kurtosis imaging demonstrated a potential to distinguish microstructural changes in 10 mm peritumoral edema near tumor border between brain metastases and primary glioblastomas, which may be due to tumor infiltration into peritumoral edema in glioblastomas. No differences between metastases and glioblastomas were found in more distant areas of peritumoral edema, ipsilateral and contralateral normal white matter. The reason might be the fact that the primary glioblastomas grow fast and there is no distant tumor cell infiltration into surrounding brain.
Temporal evolution of IVIM perfusion fraction following stereotactic radiosurgery of brain metastases.

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Purpose
Blood volume measured with dynamic susceptibility contrast (DSC) magnetic resonance imaging (MRI) has been shown to predict outcome for brain metastases treated with stereotactic radiosurgery (SRS) (1). Intravoxel incoherent motion (IVIM) is an established MRI technique that can assess blood volume without intravenous contrast (2). Intravoxel incoherent motion parameters therefore could be useful for serial evaluation of metastatic tumors, and provide a new biomarker to evaluate treatment response. We report, for the first time, the temporal evolution of the IVIM perfusion fraction (f) for brain metastases during the first month after SRS.

Materials and Methods
This REB approved prospective observational study was conducted at a single center. Patients with brain metastases being considered for SRS were enrolled using previously published inclusion and exclusion criteria (3). Patients were scanned at baseline (day 0) and at 1 week and 1 month after SRS. Magnetic resonance imaging was performed on Philips 3T Achieva using an EPI spin-echo DWI sequence with b=0,200,400,600,800,1000 in 3 orthogonal directions (TE/TR/FA=61/5950/90, FOV=200x200 mm, matrix=172x167, slice thickness=5 mm, acquisition time ~4 minutes). The perfusion fraction f was calculated using asymptotic fitting which previously has been validated (4). Diffusion-weighted images were co-registered to gadolinium-enhanced 3D T1-weighted images using the local Pearson correlation method (AFNI; http://afni.nimh.nih.gov). Regions of interest (ROIs) were traced for each tumor on the post-gadolinium T1-weighted images, excluding necrotic/nonenhancing tumor components, and the mean f and apparent diffusion coefficient (ADC) were calculated for each ROI.

Results
A total of 16 newly treated metastases in 12 patients were analyzed. Figures 1A and 1B show a postgadolinium T1-weighted image and parametric map of the IVIM perfusion fraction f for a typical lesion. Figures 1C and 1D show the temporal evolution of ADC and f, respectively, at baseline, 1 week and 1 month after treatment (mean +/- SE). The mean f significantly increased at 1 month post-SRS relative to baseline (paired t-test, p<0.01). No significant difference was found between f at baseline and at 1 week, or between ADC values at any of the three time points.

Conclusions
In the present study, we have shown that the IVIM perfusion fraction is sensitive to relatively small but significant changes in tumor blood volume occurring within the first month after SRS. The observed increase in blood volume at 1 month is consistent with previous work using DSC perfusion (3). Further study of the temporal evolution of f after treatment and its correlation with long-term outcomes is needed to examine the utility of this parameter in evaluating and predicting treatment response.
Ferumoxytol enhanced MRI detection of intracranial metastatic disease

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Purpose
Patients with intracranial metastatic disease require enhanced imaging in order to allow proper diagnosis and aid in treatment planning. Ferumoxytol-enhanced magnetic resonance imaging (FeMRI) shows anatomical enhancement in primary central nervous system malignancies (1) and could be used in place of gadolinium-enhanced MRI (GdMRI) in patients who cannot receive gadolinium-based contrast agents (GBCA) (2). We reviewed all cases of intracranial metastatic disease imaged on three ongoing prospective FeMRI studies in order to assess enhancement patterns and compared to GdMRI.

Materials and Methods
All patients with known or suspected intracranial metastatic disease were retrieved from one of three prospective FeMRI research studies. We retrospectively reviewed pre and postcontrast T1- and T2-weighted imaging in order to characterize enhancement on FeMRI and compared this to enhancement on GdMRI. Due to minor variations in several protocols, some subjects received only FeMRI. Subjects without a research GdMRI had comparison made to a clinically obtained GdMRI if one was available within 30 days of the FeMRI. Cases without enhancing lesions on GdMRI or FeMRI, final diagnosis of radiation necrosis, and lack of comparison GdMRI within 30 days were excluded.

Results
After exclusions, 76 ferumoxytol-enhancing and 69 gadolinium-enhancing masses were found in 18 patients. One gadolinium-enhancing mass was missed with FeMRI, and seven ferumoxytol-enhancing masses were missed with GdMRI. Enhancement sizes and morphologies were similar to GdMRI in all cases having comparison GdMRI (Figure). There were no adverse contrast reactions. Figure demonstrates enhancing right cerebellar metastasis (arrow) on T1W GdMRI (A) with surrounding vasogenic edema visible on noncontrast T2W MRI. Enhancement on T1 FeMRI (C) performed 6 days later shows larger, more intense enhancement. T2 FeMRI (D) performed on the same day as image C shows typical hypointensity within the metastasis due to ferumoxytol uptake. Legend W = weighted.
Conclusions
Metastatic disease to brain is well characterized using FeMRI, with enhancement patterns very similar to GdMRI. FeMRI could be used off-label to allow enhanced MRI in patients having contraindications to GBCA.

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Intraoperative Contrast-Enhanced Ultrasound (iCEUS), its Utility in Cranial Neurosurgery and a Method for Obtaining Quantitative Perfusion Data on Intracranial Tumors and Tumor-Like Lesions.

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Purpose
Intra-operative contrast-enhanced ultrasound (iCEUS) is a relatively new modality in cranial neurosurgery, which shows great promise for improving characterization and resection of brain tumors and tumor-like lesions. Early investigations in Asia and Europe have yielded exciting results, but data interpretation has been largely semiquantitative (1, 2). Here we describe our initial experience with iCEUS in neurosurgical resections/biopsies, as well as a method for quantitatively obtaining perfusion data.

Materials and Methods
After craniotomy, nine patients with tumors/tumefactive lesions received iCEUS examinations prior to their standard-of-care neurosurgical resections and/or biopsy. Examinations were performed with a second generation ultrasound contrast agent, (Definity™). Real-time semiquantitative analysis was performed intra-operatively to evaluate tumor extent and vascular supply, and cine clips were recorded. Postoperatively, time intensity curves were generated from dynamic contrast images and quantitative perfusion characteristics were derived. When available, this data was compared to pre-operative MRI perfusion data.

Results
Intra-operative CEUS was used to evaluate five primary intracranial neoplasms (two meningiomas, three gliomas), three metastatic lesions, and one tumefactive demyelinating lesion. No complications occurred as a result of iCEUS examination. Evaluation of three separate glioma cases revealed variations in perfusion characteristics based on tumor grade, consistent with prior investigations (1, 2). Intra-operative CEUS of one meningioma revealed an invasive component, not seen on pre-operative MRI, which helped guide resection. In one metastatic case, iCEUS revealed active extravasation of contrast into the post-resection cavity (Fig.). This allowed for immediate identification and cauterization of the bleeding site. Finally, in a patient with a previous nondiagnostic biopsy, iCEUS helped guide a successful repeat biopsy and secure a diagnosis of tumefactive multiple sclerosis.
Conclusions
Intra-operative CEUS shows great promise for improving evaluation of intracranial lesions and as a problem solving tool intra-operatively. Quantitative evaluation of iCEUS perfusion data may allow more precise determination of histologic grades and help differentiate neoplastic from non-neoplastic lesions.
Illustrative Case: Utility of iCEUS in Selective Intracranial Anomaly Resection

A. Side-view ultrasound (US) scan of the brain showing a complex mass, likely representing an intracranial mass. The mass is located in the left frontal lobe and measures approximately 3 x 2 cm.

B. Sagittal view of the brain showing the extent of the mass. The mass is located in the left hemisphere and extends towards the midline. The mass is hypoechoic, consistent with a cystic or necrotic lesion.

Curves showing flow data from different regions of interest.

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Neuroimaging and Laser Interstitial Therapy

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Purpose
Laser interstitial thermal therapy (LITT) is a percutaneous thermoablative minimally invasive procedure which delivers local heat to the target lesion using lasers. Our case series includes varied lesions, both benign and malignant, for which patients underwent LITT, secondary to a variety of factors that precluded open surgery. These included inoperability of the lesion secondary to location, and recurrence despite multiple surgeries and stereotactic radiosurgeries. We describe the magnetic resonance imaging (MRI) findings on pre-operative, intra-operative and follow-up images in 20 patients who underwent LITT. We describe common post-treatment findings as well as complications.

Materials and Methods
A retrospective case series study was performed of the patients who had undergone laser interstitial therapy with intra-operative MRI monitoring, of which 20 cases were identified. Demographic information, details of neurologic examination, and clinical outcome were obtained from each patient's chart. Magnetic resonance imaging findings for each patient including pre-operative, intra-operative, and postoperative follow-up imaging were reviewed by a neuroradiology attending and fellow. Typical sequences in the protocol included SPACE FLAIR and T2 and postcontrast MPRAGE sequences in order to achieve 1mm lesion resolution. Volumes of the enhancing portion of the lesion also were separately obtained by a 3D lab.

Results
Cases of intraventricular pilocytic astrocytoma, progressive atypical meningioma, meningioma (benign, and in the context of neurofibromatosis type II), subependymal giant cell astrocytoma with ventricular obstruction, glioblastoma, anaplastic astrocytoma, metastasis, and radiation necrosis were reviewed. Clinical follow-up and radiologic findings varied depending on the initial pathology, location of the tumor, and success of LITT. However, typical findings included heterogeneous to low T2 signal and decreased FLAIR signal hyperintensity with some tumors demonstrating intrinsic T1 hyperintensity. In none of our cases was the entire tumor ablated. In cases in which the goal was to shrink tumor burden, LITT resulted in some cavitation although not significantly decreased tumor size, with relatively unchanged mass.
effect. Based on our case series, there was only minimal decrease, approximately 20%, in tumor volume in relation to the original volume. Other findings included interval tumor progression and tumor dissemination in the subarachnoid space.

Conclusions
Typical findings following LITT include heterogeneous to low T2 signal and decreased FLAIR signal hyperintensity with some tumors demonstrating intrinsic T1 hyperintensity. Complete tumor ablation is unlikely and there is relatively mild decrease in tumor volume following ablation. While LITT may be an alternative therapy for patient's unable to undergo conventional surgery, tumors frequently continue to grow following LITT therapy, likely secondary to the natural progression of the tumor itself.

**NF2 with right anterior parafalcine meningioma, prior subtotal resection 2 years ago, undergoes LITT for meningioma**

Preoperative imaging with
Axial T1 postcontrast
MPRAGE, axial T2, and
Coronal T1 postcontrast
MPRAGE

Intra operative imaging
with Sagittal SPACE T2
weighted sequences with
both laser fibers in place,
coronal T2, and Coronal T1
postcontrast MPRAGE with
one fiber seen in plane

Postoperative imaging with
Axial T1 postcontrast
MPRAGE, axial T2, and
Coronal T1 postcontrast
MPRAGE