A Rare Case of Spinal Endometriosis

M Hermann¹, G Shah¹
¹University of Michigan, Ann Arbor, MI

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-weight 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.
EE-07

6:00AM - 2:45PM

Arterial Spin Labeling MRI Perfusion Acetazolamide Challenge for Assessing Cerebrovascular Reserve in Moya-Moya

A Sung1, D Shin2, E Wong2, T Liu2, R Lee3, J Chen4

1University of California, San Diego, San Diego, CA, 2University of California, San Diego, La Jolla, CA, 3UCSD/VA Medical Center, San Diego, CA, 4San Diego VA / UCSD Med. Center, La Jolla, CA
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 artfactually 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)

R Clarke1, L Klesse1, B Braga1, V Rajaram1, K Koral1
1University of Texas Southwestern Medical Center and Children's Health, Dallas, TX

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.

EE-50

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

S Sundararajan¹, R Garg¹, G Gupta², S Schonfeld¹, S Roychowdhury¹
¹Department of Radiology, Rutgers-Robert Wood Johnson Medical School, New Brunswick, NJ, ²Department of Neurosurgery, Rutgers-Robert Wood Johnson Medical School, New Brunswick, NJ
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

S Chan¹, A Lignelli²
¹Columbia University Medical Center, New York, NY, ²Columbia University Medical Center, New York City, NY

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 meningioma or schwannoma.
Cerebral Amyloid Angiopathy-Related Inflammation (CAA-RI); Characteristic Presentation and Imaging Findings.

N Zakhari¹, S Chakraborty²
¹The Ottawa Hospital, Ottawa, Ontario, ²The Ottawa Hospital, Ottawa, Ontario

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

A Vossough¹, D Licht², R Ichord², M Kirschen²
¹University of Pennsylvania-CHOP, Philadelphia, PA, ²Children's Hospital of Philadelphia, Philadelphia, PA

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.
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.

J Acharya¹, M Law¹, A Rajamohan¹, J England²  
¹University of Southern California, Keck School of Medicine, Los Angeles, CA, ²LAC+USC Medical Center/Keck Hospital of USC, Los Angeles, CA

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 Pathophysiologival Implications

R Modi

Hartford Hospital, Rocky Hill, CT

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 systematic 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**
C Vemulapalli¹, A Krishnan¹, R Jain²
¹Beaumont hospital, Royal Oak, MI, ²Beaumont Hospital, Royal oak, MI

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
PORTLAND , OR
Diagnosis and management of a rare sphenoid wing mass with clinical findings mimicking a carotid cavernous sinus fistula

M Chen¹, S Chen¹, V Sahani¹
¹Baylor College of Medicine, Houston, TX

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. Workup 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.
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.

F Oyedeji¹, V Agarwal¹, M Hughes¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA

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 Sestamihi 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.
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 CMs (2), 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

M Flores¹, B Liu¹, E Derrick¹, D Warden¹, S Messina²
¹Florida Hospital Radiology, Orlando, FL, ²Florida Hospital Neuroradiology; Radiology Specialists of Florida, Orlando, FL

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

A Vossough1, K Gwal2, K Jakchairoongruang3

1University of Pennsylvania-CHOP, Philadelphia, PA, 2Children's Hospital of Philadelphia, Cherry Hill, NJ, 3King Chulalongkorn Memorial Hospital, Bangkok, Pathumwan

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

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

S Ali¹, R Sharma¹, E Stein¹
¹Maimonides Medical Center, Brooklyn, NY

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.
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.

N Wnuk¹, J Pollock², V Phalke²

¹Oregon Health and Science University, Portland, OR, ²OHSU, Portland, OR

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

Figure 1. T2W axial MR images demonstrating interval progression of disease during a 3 month period. T2 hyperintense signal deep and subcortical white matter with thinning of the corpus callosum upon admission (A). The patient’s repeat MRI brain image demonstrated diffuse progression in findings with interval cortical thinning and continued diffuse white matter signal abnormality (B).

(Filename: TCT_EE-53_VanishingWhiteMatter.jpg)
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

K Roxo¹, W Renolds²
¹Uniformed Services University of the Health Sciences, Bethesda, MD, ²Mike O’Callaghan Federal Medical Center, Nellis Air Force Base, NV

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.

C Hilditch¹, S Biswas², S Mathur¹
¹Royal Preston Hospital, Preston, United Kingdom, ²The Walton Centre, Liverpool, Merseyside

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 muscle, 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.
MR Findings in a Case of Injuries to the Triangle of Guillain-Mollaret, Bilaterally

D Chow¹, J Narvid², W Dillon²
¹University of California, San Francisco, San Francisco, CA, ²UCSF, San Francisco, CA

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.

P SHAH\textsuperscript{1}, W Zelkovich\textsuperscript{2}, B Liu\textsuperscript{3}, E Russell\textsuperscript{2}

\textsuperscript{1}Northwestern University Feinberg School of Medicine, CHICAGO, IL, \textsuperscript{2}Northwestern University, Chicago, IL, \textsuperscript{3}Northwestern University Feinberg School of Medicine, Chicago, IL

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.

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EE-31

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

Y ANIK¹, B YILDIRIM¹, A KAYA¹
¹Kocaeli University, Kocaeli, Turkey

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

R Niblett¹, S Patel², B Griffith¹
¹Henry Ford Health System, Detroit, MI, ²Henry Ford Hospital, Detroit, MI

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.
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EE-42

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Neuroimaging findings of Dive-related Decompression Sickness in Brain and Spine
Y Chng\textsuperscript{1}, E Smorodinsky\textsuperscript{1}, S Karnezis\textsuperscript{1}
\textsuperscript{1}Ronald Reagan UCLA Medical Center, Los Angeles, CA

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.

M Ramírez-Guzmán¹, G Godoy-Brewer¹, R Riascos², L García-Posada³, R Madero⁴, E Bonfante⁵, R Quiroz-Saavedra⁶
¹The University of Texas Health Science Center at Houston, Houston, TX, ²UTHSC-Houston, Houston, TX, ³Diagnostico Especializado por Imagen, Zapopan, Jalisco, ⁴The University of Texas Health Science Center at Houston, Houston, TX, ⁵University of Texas Health Science Center Houston, Houston, TX, ⁶Hospital Civil de Guadalajara "Fray Antonio Alcalde", Guadalajara, Jalisco

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 immunomodulatory 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 is observed with alterations on the signal intensity because of the edema, extending from C2 to the cervico-dorsal union, etc.
Neuroschistosomiasis of the Temporal Lobe

M Nguyen1, P Jeffrey1
1Oregon Health & Science University, Portland, OR

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.
 Orbital Floor Fracture with Potentially Treacherous Orbital Venous Loop Herniation

M Bashir1, G Avey1, A Weiland1, M Lucarelli1, L Gentry2
1University of Wisconsin, Madison, WI, 2University of Wisconsin Hospitals, Madison, WI

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

A Shea¹, D Zimmerman¹
¹Hartford Hospital, Hartford, CT

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

R Stoffey¹, C Sitton², R Riascos³, M Bhattacharjee⁴
¹University of Texas at Houston, Houston, TX, ²The University of Texas Health Science Center at Houston UTHealth, Houston, TX, ³UTHSC-Houston, Houston, TX, ⁴University of Texas Health Science Center Houston, Houston, TX

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

S Koenig1, C Bazan1
1University of Texas Health Science Center at San Antonio, San Antonio, TX
Purpose
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

N Brauner, M Gulati, M Shiroishi, E Grant, K Chang, J Bakhsheshian, E Christian, G Zada, I Lekht

1Keck School of Medicine of the University of Southern California, Los Angeles, CA

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 hemisphere (arrow). B. Corresponding relative cerebral blood flow (rCBV) color map shows region of interest (ROI) within the lesion anteriorly (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 that is lower than the contralateral normal-appearing white matter suggestive of low-grade glioma. D. Side-by-side iCEUS (left) images of the tumor (dashed arrow) with time-intensity curve (below). Region of interest on the tumor (dashed arrow) displays relatively short time-to-peak (TTP) and steep wash-in-slope (WIS) suggestive of higher grade glioma.
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

M Hoch¹, A Wolf², S Chung¹, K Chen¹, N Ben-Eliezer¹, D Kondziolka², T Shepherd¹
¹NYU Medical Center, New York, NY, ²NYU Medical Center, New York, NY

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 pathways.

CISS w/ neurovascular compression

TDI w/ decreased CN

DEC-TDI w/ small spinal complex

EMC T2 of pontine nuclei
EE-45

Radiation Induced Dacryocystocele with Intense Iodine-131 Uptake: A Diagnostic Conundrum in a Metastatic Thyroid Cancer Patient

Y Chen¹, R Perini², L Loevner¹, S Mandel¹, S Mohan¹
¹Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, ²Merck Research Laboratories, Merck and Co., Inc., North Wales, PA

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.

Table 1: Quantitative TDI values of the right and left trigeminal spinal segments

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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 dacryocystocele, likely from radiation-induced lacrimal duct stenosis, with excretion of I-131 through the lacrimal system into the dacryocystocele. 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).
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 a 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

X Wu¹, S Cha¹
¹University of California, San Francisco, San Francisco, CA

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

A Barot1, K Shah1, S Sundararajan1, R Dow1, M Censullo1, G Gupta1, S Roychowdhury1
1Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ

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 plyers 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

D Adamo1, J Morris1
1Mayo Clinic, Rochester, MN

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

A Tuan¹, Y Chen¹, E Cottrill¹, J Kearney², D Nointin², J Huang², L Loevner³, K Learned⁴
¹Hospital of the University of Pennsylvania, Philadelphia, PA, ²Pennsylvania Hospital, Philadelphia, PA, ³University of Pennsylvania, Philadelphia, PA, ⁴Univ. Pennsylvania Health System, Philadelphia, PA

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

A McClelland¹, A Mamourian¹
¹University of Pennsylvania, Philadelphia, PA

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
symmetric pulvinar T1 hyperintensity along with T1 shortening in the dentate and globus pallidus.

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

L Watson1, J Larson1, M Schecht1, J Wu1, K Arkun1, S Jeyapalan1, N Madan2
1Tufts Medical Center, Boston, MA, 2Tufts Medical Center, Boston, MA

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.
EE-18

Thinking Outside the Intracranial Box

A Faulkner\textsuperscript{1}, P Mehta\textsuperscript{1}, J Go\textsuperscript{2}

\textsuperscript{1}University of Southern California, Los Angeles, CA, \textsuperscript{2}LAC/USC Medical Center, Los Angeles, CA
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 brachiocephalic 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 brachiocephalic venous stent. Real time ultrasound performed postprocedure lead to the discovery of high arterialized flow of the AVF accentuated by stenosis of the brachiocephalic 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 brachiocephalic 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 brachiocephalic 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

J Stein¹, B Pukenas¹, S Mohan¹
¹Hospital of the University of Pennsylvania, Philadelphia, PA

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

Y Sun¹, S Bobra¹, M Tenner¹, H Mehta¹, B Rigney¹, A Arneja¹

¹Westchester Medical Center, Valhalla, NY

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 temporo-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.
Purpose
This abstract shows the spectrum of imaging findings in a case of anti-Gad 65 autoimmune 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/creatinine 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
combination of features can help us aide our neurological and neurosurgical colleagues in identifying a possible inflammatory source.

EE-12

Wolfram Syndrome: Classic Imaging Findings of an Uncommon Disease

E Carolan\textsuperscript{1}, J Morris\textsuperscript{1}

\textsuperscript{1}Mayo 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

J Cross1, M Pinho2, A Madhuranthakam1
1UT Southwestern, Dallas, TX, 2University of Texas Southwestern, Dallas, TX

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 myopathy on MRI. Coronal 3D T1W VISTA sequences, precontrast (A) and postcontrast (B), show abnormal enhancement in the superior wall of the right middle cerebral artery. The diagnosis was syphilis vasculitis.

**Bottom Row:** 27 year old female with history of fibromuscular dysplasia presented with stroke-like symptoms and infarcts on MRI. Axial (C) and coronal (D) 3D T1W images show circumferential T1 hyperintensity in the wall of the carotid artery with luminal narrowing, consistent with acute/subacute dissection.
A Case-Based Review Illustrating Characteristic Neuroimaging Findings in Different Causes of Dementia

A Desai, P Patel, Z Zhang, S Ifthikharuddin
1Rochester General Hospital, Rochester, NY, 2rochester general hospital, Rochester, NY

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:
  - 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.
  - 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) 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.

(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).
EdE-34

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.
EdE-13

Big Whorls and Little Whorls: A Diagnostic Approach to Balo's Concentric Sclerosis Based on a Meta-Analysis of 68 Patients

M Agarwal1, J Ulmer2, A Klein2, I Agarwal3, S PAMARTHY4, L Mark2, M BHALLA5, B Graner6
1Medical College of Wisconsin, Milwaukee, WI, 2Medical College of Wisconsin - Froedtert Hospital, Milwaukee, WI, 3NorthShore Evanston Hospital, Evanston, IL, 4MEDICAL COLLEGE OF WISCONSIN, MILWAUKEE, WI, 5MEDICAL COLLEGE OF WISCONSIN, MILWAUKEE, WI, 6Medical College of Wisconsin - Froedtert Hospital, Milwaukee, WI

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.
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.
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 fossa consistent with a tuberculoma. (B) Axial FLAIR image of the same patient shows prominent signal intensity surrounding the lesion representing CNS TB-IRIS after initiation of HAART. (C) Sagittal contrast MRI image in a different patient demonstrating avid leptomeningeal enhancement at the skull base consistent with TB meningitis. (D) Diffusion weighted imaging of the second patient demonstrates restricted diffusion in the bilateral basal ganglia consistent with infarction from TB meningitis induced vasculitis.
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
6:30AM - 2:45PM

Diffuse Weighted Imaging – Beyond Stroke

S Mills¹, M Bhojak², M Radon³
¹The Walton Centre NHS Foundation Trust, Liverpool, Merseyside, ²The Walton Centre, Liverpool, Merseyside, ³The Walton Centre, Liverpool, United Kingdom

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 opportunist 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
6:30AM - 2:45PM

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

G Kapinos¹, M Sheikh¹, H Sy¹
¹Hofstra North Shore-LIJ School of Medicine, Manhasset, NY

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 dysperfusive nuanced insult.

Results
In our practice, when suspicion for cerebralischemia 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**

R Gallagher¹, A Thomas¹, R Lenthall¹

¹Nottingham University Hospitals NHS Trust, Nottingham, Nottinghamshire

**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**
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.
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

G Calles¹, T Uribe², U Kudrath³, r eldaya¹, J Pham¹, S Herrmann⁴, J Rivera⁵, A Durgam¹
¹University of Texas Medical Branch, Galveston, TX, ²Baylor College of Medicine, Galveston, TX, ³University of Texas of Medical Branch, Galveston, TX, ⁴UTMB, League City, TX, ⁵Baylor College of Medicine, Houston, TX

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 pitfalls 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.
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

Identifying Acute Venous Infarcts: Causes and Imaging Characteristics

S Li¹, N Madhuripan²
¹Baystate Medical Center-Tufts University, Springfield, MA, ²Baystate Medical Center, Springfield, MA
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.
Acute venous infarct due to right transverse sinus thrombosis in a pregnancy patient

EdE-29

Imaging Characteristics of Primary Gliosarcomas of the Brain

C Rydberg, D Black, J Gilbertson, C Wood

Mayo Clinic, Rochester, MN
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

C Prasad¹, A Mahadevan¹, M Bhat², D Srinivas³
¹National Institute of Mental Health and Neurosciences, Bangalore, Karnataka, ²National Institute of Hental Health and Neurosciences, Bangalore, Karnataka, ³National Institute of Mental Health and Neurosciences, Bangalore, Karnataka
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-15
6:30AM - 2:45PM
Intracranial Dural Arteriovenous Fistulae: Key Cross-Sectional Imaging Features and Angiographic Correlation

D Murph1, S Kralik1

1Indiana University, Indianapolis, IN

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.
Intracranial Hemangiopericytoma: What the Radiologist and Clinician Need to Know Regarding Hemangiopericytoma

H Nakamura¹, M Doi², Y Tanaka³, M Takagi⁴, Y Nakajima⁴
¹St.Marianna University of medicine, Kawasaki, Japan, ²St. Marianna University of Medicine, Kawasaki, Kanagawa, ³St. Marianna Univesity of Medicine, Kawasaki, Kanagawa, ⁴St. Marianna University of Medicine, Kawasaki, Kanagawa

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 meningioma, 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 meningioma.

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

M Jurkiewicz¹, S Gholami¹, I Nasrallah¹, J Stein¹, K Learned¹, L Loevner¹

¹University of Pennsylvania Health System, Philadelphia, PA,
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.
Isolated Intraventricular Hemorrhage (IVH) in Adults: A Pictorial Review of Underlying Causes

I Barnaure\textsuperscript{1}, A Liberato\textsuperscript{1}, G Gonzalez\textsuperscript{1}, J Romero\textsuperscript{1}

\textsuperscript{1}Massachusetts General Hospital, Boston, MA
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

R Said1, N Buisson2, D Suki2, J Weinberg3, J Debnam4
1The University of Texas MD Anderson Cancer Center, Houston, TX, 2The University of Texas MD Anderson Cancer Center, Houston, TX, 3MD Anderson Cancer Center, Houston, TX, 4UT MD Anderson Cancer Center, Houston, TX

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

J Gonzalez¹, K Kazmi¹, V Potigailo¹, R Koenigsberg¹
¹Hahnemann University Hospital, Philadelphia, PA

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

T Massoud¹, J Ananta¹, R Paulmurugan¹
¹Stanford University School of Medicine, Stanford, CA
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

M Kong1, H Morales1

1University of Cincinnati, Cincinnati, OH
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

T Massoud¹, A Sheahan¹, R Paulmurugan¹
¹Stanford University School of Medicine, Stanford, CA

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
6:30AM - 2:45PM

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

J Hardman¹, A Bandyopadhyay², A Mohammadi¹, A Sloan³, G Barnett¹, S Jones⁴
¹Cleveland Clinic, Cleveland, OH, ²Cleveland Clinic, Cleveland , OH, ³University Hospitals Case Medical Center, Cleveland, OH, ⁴Cleveland Clinic, Shaker Heights, OH

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).

S TIWARI1, J Saini1, A Nalini1, P Kumar1, C Prasad2
1National Institute of Mental Health and Neurosciences, BANGALORE, Karnataka, 2National Institute of Mental Health and Neurosciences, Bangalore, Karnataka
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 patients 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

S Bravo-Grau¹, L Arraño¹, J Errázuriz¹, J Cruz¹, I Huete¹
¹P. Universidad Católica de Chile, Santiago, Chile

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 contours.
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.
Fig 1a,b: Axial and Coronal T2WI of case 1 showing pontine hypointensities (elbow arrow) and hyperintensities of the median raphe (black arrow) and lateral pons.

Fig 2a,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**

**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

M White\(^1\), Y Zhang\(^2\), P Bierman\(^2\), J Helvey\(^2\), M Keiper\(^3\), D Poage\(^2\)

\(^1\)University of Nebraska Medical Center, Omaha, NE, \(^2\)University of Nebraska Medical Center, Omaha, NE, \(^3\)UNMC, Omaha, NE

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, heterogenous 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.
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

1Ganesh Diagnostics and Imaging, Ganesh Educational Institute and Research Centre, NEW DELHI, India, 2Bridgeport Hospital, Bridgeport, CT, 3Bridgeport Hospital, Yale New Haven Health System, Bridgeport, CT, 4Bridgeport Hospital, Milford, CT, 5Saint Vincent’s Medical Center, Bridgeport, CT, 6Yale New Haven Health System at Bridgeport Hospital, Bridgeport, CT

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.
Relative Diffusion Restriction - A New Framework for the Interpretation of the Apparent Diffusion Coefficient in Clinical Brain MRI

J Butman¹
¹NIH, Bethesda, MD

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.
Revealing the Thalamo-Amygdaloid Connection of the Human Brain

A Kamali¹, R Riascos², A Chaudhry³
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 multislice 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)

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EdE-06

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.
The Falx Cerebri: A Pictorial and Educational Review of Common and Uncommon Neuroimaging Findings

T Massoud¹, A Kalnins¹
¹Stanford University School of Medicine, Stanford, CA

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**

R Bert¹, D Gilden², M Nagel²

¹University of Louisville, Louisville, KY, ²University of Colorado, Aurora, CO

**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 Miller1, D Boulter2, B Gans2, X Nguyen3, L Prevedello3, M Luttrull2, W Slone2, A Ajam4, T Shujaat3, A Alfieri2, E Bourekas5

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
6:30AM - 2:45PM

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
Craniostenosis 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 cararisynostosis – 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 cranietomy," 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

Diagnostic Dilemma: Osteoradionecrosis Versus Recurrent Head and Neck Cancer

J Davenport1, I Schmalfuss2
1University of Florida, Gainesville, FL, 2NF/SG Veterans Administration, Gainesville, FL
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 cartilage. The corresponding CT image (A) reveals low soft tissue attenuation around the left arytenoid cartilage 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.
H&N Vascular Anomalies and Syndromes: Why Image?

M Ho1, S Cofer1, K Balakrishnan1, M Tollefson1, H Bjarnason1, D DeLone1
1Mayo Clinic, Rochester, MN

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

A Traore¹, S Kralik¹, N Koontz¹, K Mosier¹
¹Indiana University, Indianapolis, IN

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.

Multimodality Evaluation of Head and Neck Cancers After Treatment
H Tore¹, M Gencturk¹, R Gawande¹, J Froelich¹, Z Cayci¹
¹University of Minnesota, Minneapolis, MN

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

D Zipkin¹, V Jain²
¹Metrohealth Medical Center, Cleveland, OH, ²MetroHealth Medical Centre, Cleveland, OH
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

M Gule-Monroe\textsuperscript{1}, N Chasen\textsuperscript{1}, L Ginsberg\textsuperscript{2}
\textsuperscript{1}M.D. Anderson Cancer Center, Houston, TX, \textsuperscript{2}MD Anderson Cancer Center, Houston, TX

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.
EdE-48 6:30AM - 2:45PM

Untangling the Brachial the Plexus: Understanding MR Anatomy of the Normal and Pathologic Brachial Plexus

S Frost¹, J Brucker², A Grayev³, T Kennedy⁴
¹University of Wisconsin Hospital and Clinics, Madison, WI Wisconsin, ²University of Rochester, Rochester, NY, ³University of Wisconsin Hospital and Clinics, Madison, WI, ⁴University Of Wisconsin Hospital, Madison, WI

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

Variant Causes of "Third Window" Phenomenon

s cantrell\textsuperscript{1}, H Harnsberger\textsuperscript{1}, R Gurgel\textsuperscript{1}, K Salzman\textsuperscript{2}, R Wiggins\textsuperscript{2}

\textsuperscript{1}University of Utah, Salt Lake City, UT, \textsuperscript{2}University Of Utah, Salt Lake City, UT

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

H Kim¹, Y Kim¹, K Park¹, H Kim¹, J Cha¹
¹Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea, Republic of

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/8.52 ms; 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?

p gopalan
Leeds and Bradford Teaching Hospitals, Wakefield, United Kingdom

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 paralaysis fro skull base to mediastinum.
VOCAL CORD PARALYSIS (VCP): LOSING YOUR VOICE – HOW HIGH AND LOW TO LOOK FOR

Dr P Gopalan, Dr S Viner
Leeds and Bradford Teaching Hospitals NHS Trust, United Kingdom

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 causal 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 anterolateral to the thoracic aorta. The left RLN exits from the vagus nerve at the level of the aortic arch, then courses posteromedially beneath it, through the aorticopulmonary window posterior to the ligamentum arteriosum. It 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 posterolaterally under the artery at the level of the tracheaobronchial bifurcation. It has a short mediastinal course, coursing obliquely towards the right tracheoesophageal groove over the surface of the apical pulmonary 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 piriform sinus dilatation
- Medial rotation and thickening of left aryepiglottic fold
- Ipsilateral laryngeal vestibule dilatation
- "Sat sign" of laryngeal airway

(a) Axial CT image showing dilation of the left pyriform sinus (arrow), medial position of the thickened left ipsilateral aryepiglottic fold (asterisk), (b) Axial CT image reveals dilated left laryngeal ventricle (arrow), (c) Axial CT image shows anteromedial deviation of the left arytenoid cartilage (d) Axial CT image in a patient with left VFP demonstrates atrophy of the left posterior cricoarytenoid muscle (arrow) compared to the contralateral normal posterior cricoarytenoid muscle (arrowhead). (e) Axial CT at the level of the true vocal folds demonstrates fatty atrophy of the ipsilateral thyroarytenoid muscle (arrow) in a patient with right VFP. Contrast this with the normal, non-paralyzed left thyroarytenoid muscle (asterisk).

IMAGING OF VCP
CT and MRI can be used.
CT – fast and high-resolution. Quiet respiration with vocal cords in intermediate position. Skull base to APW with contrast.
PET-CT: unilateral VFP shows asymmetric increase in the normal vocal fold, with no uptake in the paralyzed vocal fold.

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

Brain stem and skull base pathologies
- Lateral medullary infarct (Wallerian syndrome).
- Metabolic haemorrhage and vascular malformations.
- Metastases, glomas, and lymphomas affecting nucleus ambiguous.
- Demyelinating diseases.
- Tumors, infections, trauma of skull base.
- Paragangliomas, schwannomas, meningiomas.
- Primary tumors or metastases involving jugular foramen.

Suprathyroid neck pathologies
- Benign and malignant tumors, inflammatory process, and vascular anomalies such as ICA dissection or aneurysms within carotid triangle.
- Paragangliomas/glomus vagale, and vagal schwannomas in post-stylodih parafaryngeal space.

Infrathyroid neck pathologies
The close proximity of the recurrent laryngeal nerve to the esophagus, trachea and thyroid in the tracheo-oesophageal groove makes it vulnerable to pathologies.
- Carcinoma of oesophagus.
- Thyroid malignancies and thyroid surgery.
- Tracheal tumours and diverticulitis.
- Prolonged intubation and anterior cervical discorectomy.
- Cervical trauma.

Mediastinal causes
- Lung carcinoma.
- Aortic aneurysm, pulmonary artery enlargement.
- Mediastinal lymphadenopathy around right subclavian A or APW.

TEACHING POINTS
RLN can be paralyzed anywhere along its course, from the brainstem to the inferior margin of the nerve. Careful evaluation of findings at CT examination, which should include the upper mediastinum and skull base.
The left VFP is 1.75 times more frequent than right VFP due to longer infrathyroid course.

INTERESTING CASES
CASE 1: 5yr old male with 3-month history of hoarseness and right vocal cord palsy. Ultrasonic scan showed submucosal mass with flow voids, suggestive of thyroid nodule.
CASE 2: 24yr old female with 2-week history of right neck lump. CT neck showed a right tractus esophageusangiography. CT chest confirmed esophageal tumor.
CASE 3: Vocal cord palsy with no obvious lesion.
CT neck showed a right tractus esophageus angiography.
CASE 4: Left neck mass with reduced appetite. CT showed an Inflamed soft tissue mass.
CASE 5: 41yr old female presented with hoarseness and left vocal cord palsy. US demonstrated lobular lesion with infiltrative features. Core biopsy unremarkable in literature. Malignant thyroid.
CASE 6: Known treated lung cancer present.
Mediastinal recurrent laryngeal nervăe paralysis.

Reference:
Hypertension D. Recurrent laryngeal nerve paralysis: Anatomy and etiology.
Development of a Neuroradiological Concept-Based Template in a Report Editor for Radiological Information System

C Valencia1, A Arbelaez1, J Florez2, F Restrepo1

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

"Kinks and Clefts" - Congenital and Acquired Brainstem Abnormalities

B Adams¹, D Warren², D Saunders³, J Macmullen-Price³, S Currie³, I Craven³
¹Leeds Teaching Hospitals, Leeds, West Yorkshire, ²Leeds Teaching Hospitals Trust, Leeds, West Yorkshire, ³Leeds Teaching Hospitals Trust, Leeds, West Yorkshire

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

Brainstem Lesions in Pediatric Patients: Differential Diagnosis

N Sgarbi¹, O Telis², T Wozniak³
¹Hospital de Clínicas, Montevideo, Montevideo, ²Hospital de Clinicas, Montevideo, Uruguay, ³Hospital de Clinicas Dr Manuel Quintela, Montevideo, Montevideo

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

M Bhat¹, C Prasad²
¹National Institute of Mental Health and Neurosciences, Bangalore, Karnataka, ²National Institute of Mental Health and Neurosciences, Bangalore, Karnataka

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 parietooccipital 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
Cribriform 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.

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EdE-65
Extraocular Orbital Lesions in the Pediatric Population
K Carey¹, C Shah²
¹Mayo Clinic, Jacksonville, FL, ²Wolfson Children’s Hospital, Jacksonville, FL

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

High-Field 3T Intraoperative MR Imaging with Diffusion-Tensor Imaging in Lesional and Nonlesional Epilepsy Surgery

M Flores¹, K Lee², J Baumgartner³, S Messina⁴
¹Florida Hospital Radiology, Orlando, FL, ²Florida Hospital Pediatric Neurology, Orlando, FL, ³Florida Hospital Neurosurgery, Orlando, FL, ⁴Florida Hospital Neuroradiology, Orlando, FL
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.
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.

EdE-63
Imaging of the Pediatric Optic Nerve Lesions

P Patel¹, T Deshmukh², M Maheshwari², D Patel³
¹Medical College of Wisconsin Affiliated Hospital/ Children's Hospital of Wisconsin, Morton Grove, IL, ²Children's Hospital of Wisconsin/ Medical College of Wisconsin, Milwaukee, WI, ³Wayne State University, School of medicine, Morton Grove, IL

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.
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.
Neuroimaging Findings of Ischemic Stroke in Children

S Lindner¹, D Cummings², R Nardone³, G Zuccoli²
¹University of Pittsburgh School of Medicine, Pittsburgh, PA, ²Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, ³Franz Tappeiner Hospital, Merano, Italy
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
Pre and Postnatal MRI Imaging Appearance of Intrauterine Myelomeningocele Repair

C Sitton1, R Patel2, H Katrina1, S Fletcher3, R Riascos4, J Johnston1, E Bonfante5
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.
Revisiting MRI of the Fetal Brain: A Pictorial Structured Approach to Fetal Central Nervous System Disorders

G Cervantes¹, G Matheus¹, M Spampinato²
¹Medical University of South Carolina, Charleston, SC, ²Medical University Of South Carolina, Charleston, SC

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

P Patel¹, T Deshmukh², A Wagner³, A Foy³, M Maheshwari², D Patel⁴
¹Medical College of Wisconsin Affiliated Hospital/ Children's Hospital of Wisconsin, Morton Grove, IL, ²Children's Hospital of Wisconsin/ Medical College of Wisconsin, Milwaukee, WI, ³Medical College of Wisconsin Affiliated Hospital/ Children's Hospital of Wisconsin, Milwaukee, WI, ⁴Wayne State University, School of medicine, Morton Grove, IL

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
6:30AM - 2:45PM
Spinal Sweepstakes: A Quiz on Multimodality Pitfalls of Pediatric Spine

o atar¹, M Tenenbaum¹
¹Baystate Medical Center, Springfield, MA

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.

(Filename: TCT_EdE-72_PediatricSpine.JPG)

EdE-62
6:30AM - 2:45PM

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 brainstem (1E). Other common areas of involvement included the brainstem (1F) and periventricular white matter T2 abnormalities (1G and 1H).

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Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-5

Education Exhibit Poster (EdE) - Spine
EdE-82
Columnar Anatomy of the Spinal Cord and Medullary Spinal Cord Lesions at MRI

L Furusawa-Stratton¹, L Finkelstone¹, K Cauley¹
¹Columbia University Medical Center / New York-Presbyterian Hospital, New York, NY

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

A Aquino¹, A Ajam¹, D Boulter¹, X Nguyen¹, M Luttrull¹, H Mashaly¹, E Mendel¹, E Bourekas¹
¹The Ohio State University Wexner Medical Center, Columbus, Ohio

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

J Starcevich\textsuperscript{1}, B Hart\textsuperscript{1}, J Hallstrom\textsuperscript{1}, M Bartlett\textsuperscript{1}, E Reese\textsuperscript{1}, L Morrison\textsuperscript{1}

\textsuperscript{1}University of New Mexico, Albuquerque, NM
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!

A Moore¹, A Srinivasan¹, S Mukherji², F Rivas-Rodriguez¹
¹University of Michigan Health Systems, Ann Arbor, MI, ²Michigan State University, East Lansing, MI

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

M Hamidi¹, I Omar¹, T Gallagher¹, K Blount¹, M Kliot¹, B Liu¹
¹Northwestern University Feinberg School of Medicine, Chicago, IL

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

J Huckabee¹, A Cardenas¹, M Jorquera², I Martin², A Sayah¹
¹Medstar Georgetown University Hospital, Washington, DC, ²Clinico San Carlos University Hospital, Madrid, Spain

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.
Lumbar Spine Surgery Complications

D Durand¹, V Kalra¹, X Wu¹, A Malhotra²
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.


(Filename: TCT_EdE-78_Slide1.gif)
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.
EdE-76
6:30AM - 2:45PM

Spinal Cord Stimulation - What the Radiologist Needs to Know

M Radon¹, K Tambirajoo¹
¹The Walton Centre, Liverpool, United Kingdom
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 (CPRS). 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

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

J Moretz¹, K Tong¹, J Suh¹, U Oyoyo¹
¹Loma Linda University Medical Center, Loma Linda, CA

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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<th>Conventional MRI</th>
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<td>Normal</td>
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<td>Edema</td>
<td>12</td>
<td>8</td>
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<td>Contusion</td>
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<td>Hemorrhage</td>
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Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-01
electronic Education Exhibit (eEdE) - Adult Brain
eEdE-53
6:30AM - 2:45PM

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

M Rischall¹, J Morris², J Matsumoto²
¹Mayo Clinic, Rochester, MN, ²Mayo Clinic, Rochester, MN

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 workflow 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
6:30AM - 2:45PM

4D CTA: Techniques and Current Clinical Applications

K Moulton1, J Shewchuk2, J Chew3
1University of British Columbia, Vancouver, British Columbia, 2University of British Columbia, Vancouver, BC, 3University of British Columbia, Vancouver, BC,

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-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.

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

M Drabkin¹, S Lev¹
¹Nassau University Medical Center, East Meadow, NY

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.

A Practical Approach for the Differential Diagnosis in Trigeminal Nerve Involvement

D Fragoso¹, T Scoppetta¹, A MAIA¹, R Nunes¹, F Pacheco¹, A da Rocha¹
¹Irmandade da Santa Casa de Misericordia de São Paulo, São Paulo, Brazil

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 leukencephalopathy 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. Post-contrast axial T1WI shows abnormal enhancement along the cisternal segment extending to the spinal trigeminal nucleus on the same side (white arrow).

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 abnormal enhancement along the intra-axial 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).
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 ascending pharyngeal artery; 4, portion of the odontoid arch system; 5, hypoglossal branch and 6, jugular branch of the neuromeningeal trunk of the ascending pharyngeal artery; 7, medial branch of the lateral clival artery; 8, posteoinferior hypophyseal artery.

Filename: TCT_eEdE-25_Pharygealascendingartery.jpg
Auricular branches of the auricular posterior 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

**Bx:** +Left temporal lobe glioma

**eEdE-94**

6:30AM - 2:45PM

**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.
At Risk: Opportunistic Infections and Complications Arising From an Immunocompromised State

C Chan¹, B Bachert¹, P Piana¹, L Nagae², B Devenney-Cakir¹, J Li¹
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.

**Immune Reconstitution Inflammatory Syndrome (IRIS)**

- Progression of signal abnormality and development of enhancement in the setting of positive serology for the herpes 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 peripheral enhancement is suggestive of PML-IRIS.

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

6:30AM - 2:45PM
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.
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

W Lindstrom¹, S Alick¹, W Altmeyer²
¹UTHSC-San Antonio, San Antonio, TX, ²UTHSCSA, San Antonio, TX

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 lateraledized 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

T Rizvi1, S Mukherjee1
1University of Virginia Health System, Charlottesville, VA

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.
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

S Kumar¹, P Appuhamy², h koay³, F Hui¹
¹National Neuroscience Institute, Singapore, Singapore, ²National Neurosciences Institute, Singapore, Singapore, ³national neuroscience institute singapore, novena, singapore

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

Brain White Matter Lesions; New Insights in our Understanding of Leukoaraiosis

M Salehi Sadaghiani, M Hsieh, I Nasrallah, R Verma, D Parker, G Erus, S Mohan, E Botzolakis, R Bryan

1University of Pennsylvania, Philadelphia, PA, 2HUP, Philadelphia, PA

Purpose
Teaching points: 1- Radiologic findings of white matter lesions (WML). 2-
Pathophysiologial "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 iceberg". 4- Functional correlations based on tractography and resting state functional magnetic resonance imaging (fMRI).

Materials and Methods
This educational exhibit reviews the pathophysiologial 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- Pathophysiologial "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 pathophysiologial 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 FLAR 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 and cerebral blood flow for aged, relatively healthy participants from a large study of cardiovascular disease (CARDIA) calculated mean penumbral tissue 0-2 mm surrounding WML or normal appearing white matter. The measurements reinforce the idea that WML are 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

R Goff1, C Holder2, B Soares3, S Neill, M.D.4, D Wrubel, M.D.4, J Velazquez, MD4
1Emory University, Atlanta, GA, 2Emory Univ. School Of Med., Atlanta, GA, 3Emory Univ. Hospital, Atlanta, GA, 4Emory, Atlanta, GA

Purpose
Congenital hemangiomas and venous malformations, previously know 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
¹Hershey Medical Center, Hershey, PA

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
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

T Scoppetta¹, r barhum², D Ribeiro³, L SCOPPETTA⁴
¹Santa Casa de Misericórida de São Paulo, São Paulo, Brazil, ²hospital sao camilo pompeia, sao paulo, Brazil, ³São Camilo, São Paulo, São Paulo, ⁴SAO CAMILO HOSPITAL, Sao Paulo, Brazil

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).
Axial MR FLAIR shows trombosis of the superior sagittal sinus and cortical veins (arrows) complicated with subarachnoid hemorrhage (arrow) 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).

**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.

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.

Charaterization of Intracranial Atherosclerotic Stenosis Using High-Resolution MRI

S Bickley¹, S Stalcup¹, T Turan², T LeMatty², M Spampinato³
¹Medical University of South Carolina, Charleston, SC, ²MUSC, Charleston, SC, ³Medical University Of South Carolina, Charleston, SC
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
6:30AM - 2:45PM

Chronic Effects of Traumatic Brain Injury
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.

eEdE-38

CNS Vasculitides: Imaging Spectrum

R Nikam¹, R Kakkar¹, A Patil¹, S Desai¹
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, tuberculosis, 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 angioendotheliotmasis. 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.

Conquer the Centrally Located Masses

J Qian¹, J Nickerson¹
¹University of Vermont Medical Center, Burlington, VT

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

A Rajput¹, J Bai¹, R Matthews¹, R Peyster¹, A Chaudhry², G Fatterpekar³, L Bangiyev¹
¹Stony Brook University Hospital, Stony Brook, NY, ²Johns Hopkins Medicine, Elkridge, MD, ³NYU School of Medicine, New York, NY

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 pseudoresponse 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

L Rachakonda¹, T Moritani¹, p watal¹, T Sato¹, A Jones¹, J Kademian¹, A Capizzano¹
¹University of Iowa Hospitals and Clinics, Iowa City, IA

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

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

eeldaya1, S Herrmann2, o eissa1, a durgam3, r hunaid4, T Uribe5
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.
Idiopathic intracranial hypertension

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Subependymal giant cell astrocytoma, TS

(Filename: TCT_eEdE-14_Subependymalgiantscellastrocytoma.jpg)
Current Concept: Imaging Findings of Idiopathic Intracranial Hypertension: Cause or Consequence?

V. Andreu¹, G. Barest¹, A. Mian¹, Q. Malabeth¹, O. Sakai¹

¹Boston Medical Center, Boston University School of Medicine, Boston, MA

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.

eEdE-72

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

S Nabavizadeh1, A Mamourian2, A Vossough2, L Loevner3, R Hurst2
1University of Pennsylvania, Philadelphia, PA, 2University of Pennsylvania, Philadelphia, PA, 3University of Pennsylvania, Philadelphia, PA

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

S Lin\textsuperscript{1}, J Dorr\textsuperscript{1}, R Pandit\textsuperscript{1}
\textsuperscript{1}Santa Clara Valley Medical Center, San Jose, CA

Purpose
The purpose of this study is to present the computed tomography (CT) and magnetic
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

A Bryant¹, T Moritani¹, A Capizzano¹, P Kirby², J Kademian³
¹Department of Radiology, University of Iowa Hospitals and Clinics, Iowa City, IA, ²Department of Pathology, University of Iowa Hospitals and Clinics, Iowa City, IA, ³University of Iowa Hospitals and Clinics, Iowa City, IA

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
6:30AM - 2:45PM
Don't-miss Emergent Intracranial CTA Diagnoses for First-Time Residents on Call

D Kazimirko¹, P Farley², E Parker²
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

S Yoon¹, S White¹, L Nagae², J Li¹, B Devenney-Cakir¹
¹Einstein Medical Center, Philadelphia, PA, ²University of Colorado, Aurora, CO,

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.
70 year old female with sudden onset left hemiparesis

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 temozololomide 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 glioma 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.

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eEdE-98

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

J Song1, O Narin2, A Mustafa1

1Yale University, New Haven, CT, 2Yale New Haven Hospital, New Haven, CT
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 flow (arrowheads). Periods of flow cessation result in ghosting artifacts that emerge in phase intervals in the phase-encoding direction. (B) Sagittal GRE images of the brain demonstrate increased signal in the ipsilateral (arrowhead) and skull entry section phenocopies due to new protons entering the image during acquisition. Understanding of this artifact is critical when interpreting this signal suppression. (C) In a 2D TOF MRA image, the left vertebral artery is visualized (yellow arrow), revealing complete opacification of the arterial lumen. (D) The retrograde filling of a high-grade stenosis in the left subclavian artery reveals complete opacification of the left vertebral artery, confirming patency.

**Functional Correlates of Gyral Anatomy: Lessons from the Works of Oliver Sacks**
S Wright¹, R Fitzgerald¹
¹University of Arkansas for Medical Sciences, Little Rock, AR

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.

Functional MRI (fMRI) – Primer for Radiologist

S Kanekar¹, A Agarwal²
¹Penn State MiltonHershey Medical Center, Hershey, PA, ²Hershey Medical Center, Hershey, PA

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
clinical practice particularly in the neurodegenerative disease and for presurgical planning. 3. To understand the challenges and limitations of fMRI.

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.

eEdE-86

GBCAs 2016 - A Safety Update on the Gadolinium Chelates

V Runge

1Inselspital, University Hospital Bern, Bern, Switzerland
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**

W Altmeyer¹, A Singh², B Tantiwongkosi¹, V Nguyen¹  
¹UTHSCSA, San Antonio, TX, ²UT Health Science Center San Antonio, San Antonio, TX

**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

V Kumar¹, L Chavali², B Gogia³, S Prabhu², R Colen⁴, D Schomer¹, L Hayman⁵, A Kumar⁶

¹U.T. MD Anderson Cancer Center, Houston, TX, ²U.T. MD Anderson Cancer Center, Houston, TX, ³UT M.D. Anderson Cancer Center, Houston, TX, ⁴MD Anderson Cancer Center, Houston, TX, ⁵Anatom-e, Houston, TX, ⁶Md Anderson cancer center, HOUSTON, TX

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.

eEdE-23

6:30AM - 2:45PM

Hey Brain, Let’s Have an Art-to-Art: A Radiologist's Role in Subcranial-Intracranial (SC-IC) Cerebral Bypass

M Wong¹, D Langer¹, R Ortiz¹, C Filippi², B Pramanik¹, J Lee¹
¹Lenox Hill Hospital, New York, NY, ²North Shore University Hospital, New York, NY

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

Z Clark¹, A Scarano¹, E Hartman¹, K Johnson², 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 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.
Hypertrophic Olivary Degeneration: Lesions and Lessons

S Salehian¹, L Hoang¹, J Tran¹, N Mahabadi², M Toliyat¹, M Pinho³
¹UT Southwestern, Dallas, TX, ²A.T. Still University School of Medicine, Mesa, AZ, ³University of Texas Southwestern, Dallas, TX

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
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)

M Zotin¹, G Simão¹, A Mello¹, M Cintra¹, K Bezerra¹, N Calixto¹, O Pontes-Neto², A
Santos³
¹School of Medicine of Ribeirão Preto - University of Sao Paulo, Ribeirão Preto, SP, 
Brazil, ²School of Medicine of Ribeirão Preto - University of Sao Paulo, Ribeirao 
Preto, São Paulo, ³School of Medicine of Ribeirão Preto - University of Sao Paulo, 
Ribeirao Preto, SP, Brazil
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.
Imaging Features in Cerebral Amyloidosis

A Ramos¹, A Hilario¹, L Koren², E Salvador¹, N Guerrero³, J Molto¹, P Martin¹, F Ballenilla¹, J Millan Juncos¹
¹Hospital 12 de Octubre, Madrid, Spain, ²Hospital 12 de Octubre, madrid, spain, ³hospital 12 de octubre, Madrid, Spain

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

G BATHLA¹, P Nagpal², S Gupta³, t moritani⁴
¹University of Iowa hospitals and Clinics, IOWA CITY, IA, ²University of Iowa hospitals and Clinics, iowa city, IA, ³University of Iowa hospitals and Clinics, Iowa city, IA, ⁴university of iowa hospitals and clinics, iowa city, IA

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

Synchronous GBM

Primary dural GBM

Gliosarcoma
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
6:30AM - 2:45PM
Imaging of the Sella and Parasellar Region: What the Surgeon Wants to Know

A Patel¹, V Patel¹, M Wintermark¹
¹Stanford University, Stanford, CA

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

J Pohlman¹, J Ulmer², A Klein², S Quinet¹
¹Medical College of Wisconsin, MILWAUKEE, WI, ²Medical College of Wisconsin - Froedtert Hospital, Milwaukee, WI

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.
In or Out? A Quantitative Approach to Intra- and Extra-axial Posterior Fossa Tumors: 10 year UCSF Experience

A Thaker¹, C Starr¹, T Tihan¹, S Cha¹
¹University of California San Francisco, San Francisco, CA

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
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

V Kumar1, D Schomer1, L Chavali2, B Gogia3, A Kumar4, F Lang3, L Hayman5, R Bezerra6, K Shah3
1U.T. MD Anderson Cancer Center, Houston, TX, 2MD Anderson Cancer Center, Houston, TX, 3MD Anderson Cancer Center, Houston, TX, 4Md Anderson cancer center, HOUSTON, TX, 5Anatom-e, Houston, TX, 6MD Anderson, Houston, TX

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.

(Filename: TCT_eEdE-84_Precentralimage.jpg)

eEdE-07
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.

**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 bodies
<table>
<thead>
<tr>
<th>Protein</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-amyloid</td>
<td>Alzheimer disease (AD)</td>
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<tr>
<td>Taupathies</td>
<td>Progressive supranuclear palsy</td>
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<td></td>
<td>Pick disease (PiD)</td>
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<td></td>
<td>Corticobasilar degeneration (CBD)</td>
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<td>α-synucleinopathies</td>
<td>Parkinson disease (PD)</td>
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<td></td>
<td>Lewy body disease (LBD)</td>
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<td></td>
<td>Multiple system atrophy (MSA)</td>
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</table>
### Protein Aggregates In Neurodegenerative Disorders

<table>
<thead>
<tr>
<th>Protein</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyglutamate (polyQ) repeat diseases</td>
<td>Huntington disease (HD)</td>
</tr>
<tr>
<td></td>
<td>Spinobulbar muscular atrophy</td>
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<tr>
<td></td>
<td>Dentatorubro-pallidoluysian ataxia (DPLA)</td>
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<td></td>
<td>Spinocerebellar ataxia (SCA)</td>
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<tr>
<td>Superoxide dismutase (SOD)</td>
<td>Amylotrophic lateral sclerosis (ALS)</td>
</tr>
<tr>
<td>Prion Protein (PrPres)</td>
<td>Creutzfeld-Jakob Disease (CJD)</td>
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**eEdE-09**

6:30AM - 2:45PM

**MR Findings of Various Acute Toxic and Acquired Metabolic Encephalopathies**

E Lee

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.
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, thalam, 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 callosum, 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

J Hardman1, A Bandyopadhyay1, A Mohammadi1, A Sloan2, G Barnett1, S Jones1
1Cleveland Clinic, Cleveland, OH, 2University Hospitals Case Medical Center, Cleveland, OH

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

Neurodegeneration or Hereditary Tumor Syndrome? The Butterfly Effect of Mutated Genes Encoding Mitochondrial Enzymes

P Vibhute¹, V Gupta¹, G Fatterpekar²
¹Mayo Clinic Florida, Jacksonville, FL, ²NYU School of Medicine, New York, NY

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 leiomyoma 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 male with headache after an in-game injury. (A) Head CT on presentation in 6:30AM - 2:45PM. Follow up MRI imaging shows parenchymal hemorrhage.

56-year-old female with a history of multiple head injuries with complaints of fogging and disturbance. (C) Imaging is unremarkable other than mild cerebral volume loss. DTI demonstrates fractional anisotropy on the right side of the corpus callosum, presumably post-traumatic.

eEdE-36

Neurologic Complications of Systemic Disorders

S Kanekar
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.

**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.
Not Just Another Bleed in the Head

A Chukus\textsuperscript{1}, C Carcano\textsuperscript{1}, A Malik\textsuperscript{1}, S Rastogi\textsuperscript{2}  
\textsuperscript{1}Mount Sinai Medical Center, Miami Beach, FL, \textsuperscript{2}Kaiser Permanente, San Diego, CA

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 Chan¹, B Bachert¹, P Piana¹, J Li¹, B Devenney-Cakir¹
¹Einstein Medical Center, Philadelphia, PA
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

V Kumar¹, L Chavali², B Gogia³, A Kumar⁴, L Hayman⁵
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...
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

L Tibana¹, N Abdala², L Wanderley³, R Rivero⁴, R Mendonca¹, E Gaspareto⁵, E Alves⁵, F Pacheco⁵, M Silva⁵, A Tibana²
¹DASA - Sao Paulo, Sao Paulo, Sao Paulo, ²UNIFESP, Sao Paulo, Sao Paulo, ³DASA - SP, Sao Paulo, Sao Paulo, ⁴DASA - Sao Paulo, Sao Paulo, Sao Paulo, ⁵DASA, Sao Paulo, Sao Paulo

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

L Nagae1, J Honce1, E Nyberg1, S Ojemann2, C Drees2
1University of Colorado, Aurora, CO. 2University of Colorado School of Medicine, Aurora, CO

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 temporal.
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.
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

T Rizvi¹, S Mukherjee¹
¹University of Virginia Health System, Charlottesville, VA

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

B Foley¹, N Akle¹, A Karam¹, L Ramos¹, J Gavito¹
¹Texas Tech University El Paso, El Paso, TX

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

J Fang1, W Altmeyer2, B Tantiwongkosi1, A Singh3
1University of Texas Health Science Center at San Antonio, San Antonio, TX, 2UTHSCSA, San Antonio, TX, 3UT Health Science Center San Antonio, San Antonio, TX

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

S Nabavizadeh1, A Vossough2, Y Chen3, S Kumar4, L Loevner5, S Mohan2
1University of Pennsylvania, Philadelphia, PA, 2University of Pennsylvania, Philadelphia, PA, 3Hospital of the University of Pennsylvania, Philadelphia,
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.

Spectrum of IgG4-Related Disease

A Chaudhry¹, M Gul²
¹Johns Hopkins Medicine, Elkridge, MD, ²National Institute of Health, Elkridge, MD

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

S Salehian¹, M Pinho², J Tran¹, L Hoang¹, W Moore², E Stehel¹
¹UT Southwestern, Dallas, TX, ²University of Texas Southwestern, Dallas, TX

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
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.

eEdE-71

6:30AM - 2:45PM

Stop Touching Me! Imaging Features of Neurovascular Compression

M Cathey¹, T Kennedy², G Avey³, L Gentry⁴
1Naval Medical Center, San Diego, San Diego, CA, 2University Of Wisconsin Hospital, Madison, WI, 3University of Wisconsin, Madison, WI, 4University of Wisconsin Hospitals, Madison, WI

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

S Calle1, R Riascos2, C Sitton3
1University of Texas Health Science Center at Houston, Houston, TX, 2UTHSC-Houston, Houston, TX, 3The University of Texas Health Science Center at Houston UTHealth, Houston, TX
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

S Bhabad¹, V Bachhav², D LHeureux³, M Jhaveri⁴
¹RUSH UNIVERSITY MEDICAL CENTER, Chicago, IL, ²Rush university medical center, chicago, IL, ³Rush University Medical Center, Chicago, IL, ⁴Rush University Medical Center, chicago, IL

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 brainstem 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**

A Hagiwara1, C Andica2, M Hori3, M Yoshida2, K Kumamaru2, K Kamagata2, M Suzuki4, M Nakazawa2, K Tsuruta2, S Aoki2

1Juntendo University School of Medicine, Tokyo, Japan, 2Juntendo University School of Medicine, Tokyo, Tokyo, 3Juntendo University, Tokyo, 000, 4Juntendo University, Tokyo, Japan

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**

M Wong¹, J Lee¹, S Najjar¹, C Filippi², S Mandel¹, B Pramanik¹
¹Lenox Hill Hospital, New York, NY, ²North Shore University Hospital, New York, NY

**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
A Carlson1, N Sicotte2, B Zipser3, N Salamon4, B Yoo1
1UCLA, Los Angeles, CA, 2Cedars Sinai Medical Center, Los Angeles, CA, 3Olive View-UCLA Medical Center, Sylmar, CA, 4David Geffen School Of Med. at UCLA, Los Angeles, CA

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

k paramesh1, A Mazumder2, P Holmes3, A Siddiqui4
1Guys and St Thomas Hospital, London, United Kingdom, 2Guy's & St Thomas' Hospital, London, United Kingdom, 3Guy's & St Thomas, London, London, 4King's College Hospital, London, London
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 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.

The Immunocompromised Host: Imaging Patterns of CNS Infections

1Hospital 12 de Octubre, madrid, spain, 2Hospital 12 de Octubre, Madrid, AK, 3Hospital 12 de Octubre, Madrid, Spain
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.

eEdE-89
6:30AM - 2:45PM

The Multifaceted Imaging Appearance of Primary CNS Lymphoma

C Starr¹, A Thaker¹, S Cha¹
¹University of California San Francisco, San Francisco, CA

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, neurosarcoïdosis, 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

J Romano

Montefiore Medical Center, Bronx, NY

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.
Ultimatum Game—conflict between dual systems: cognitive ‘accept’ and emotional ‘reject’

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.

The Unusual Suspect: Benign Dilations of Perivascular Spaces and More Sinister Pathologic Entities. A Radiologist’s Guide

J Rudie¹, A Rauschecker¹, S Nabavizadeh¹, S Mohan²
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

D Strauchler¹, D Berlin², J Platnick³, X Wu⁴, A Malhotra¹
¹Yale New Haven Hospital, New Haven, CT, ²Neurology Group Bergen, Ridgewood, NJ, ³Radiology Associates of Ridgewood, Waldwick, NJ, ⁴Yale University School of Medicine, New Haven, CT

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

K Sharma¹, B Mathew¹, T Jeyakumar¹, N Gupta¹, J Sapire²
¹St. Vincent's Medical Center, Bridgeport, CT, ²Yale New Haven Health System at Bridgeport Hospital, Bridgeport, CT

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

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<th>RCVS</th>
<th>Vasculitis</th>
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<td>CSF</td>
<td>Acute</td>
<td>Subacute progressive headache</td>
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<td>MRI</td>
<td>Normal</td>
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<td></td>
<td>Usually normal, can see infarcts, SAH</td>
<td>Abnormal-multifocal infarctions</td>
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<td>Angiography</td>
<td>Medium-large vessel</td>
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<td>Treatment</td>
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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.
Treatment Related MR Imaging Findings in Patients with High Grade Glioma After Radiotherapy and Chemotherapy

X Li¹, F Moron¹

¹Baylor College of Medicine, Houston, TX
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

Trephine Syndrome and Paradoxical Brain Herniation: A Review of Clinical and Imaging Features in Post-Cranietomy Patients

6:30AM - 2:45PM
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
craniectomy 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

O Rapalino1, J Pinto2, S Prakkamakul3, T Witzel4, K Heberlein5, A van der Kouwe4, E Ratai4, B Rosen4, A Kiruluta6, G Gonzalez6, P Schaefer6
1Massachusetts General Hosp., Boston, MA, 2Instituto Estadual do Cerebro, Rio de Janeiro, Brazil, 3King Chulalongkorn Memorial Hospital Thai Red Cross Society, Bangkok, Thailand, 4Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, MA, 5Siemens Medical Solutions, Charlestown, MA, 6Massachusetts General Hospital, Boston, MA

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.

eEdE-27

6:30AM - 2:45PM

Usefulness of the DynaCT Digital Angiography for the Study of Pathologies of the External Carotid Artery Branches

E Bravo, F Torres, J Caro, C Pinto

1INSTITUTO DE NEUROCIURGIA DR. ASENJO, SANTIAGO, Chile, 2Instituto de Neurocirugía Dr. Asenjo, SANTIAGO, Chile

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 atheropathies) 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**

J Gastala¹, T Moritani², P Kirby², A Capizzano¹

¹University of Iowa Hospitals and Clinics, Iowa City, IA, ²University of Iowa, Iowa City, IA
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.

Utility of fMRI in Evaluation of Depression

6:30AM - 2:45PM
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

p watal¹, t moritani², P Kirby³, L Rachakonda³, A Capizzano⁴
¹university of iowa hospital and clinics, iowa city, IA, ²university of iowa hospitals and clinics, iowa city, IA, ³University of Iowa, Iowa City, IA, ⁴University of Iowa Hospitals and Clinics, Iowa City, IA

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.
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.

eEdE-44

What do You Think of When You See a Corpus Callosum Lesion? Differential
Diagnosis Based on the Sagittal Midline MR Image

R Ames¹, M Amunugama¹, L Causil¹, F Sepulveda¹, M Castillo¹
¹Univ. Of North Carolina School Of Medicine, Chapel Hill, NC

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 oligodentroglioma. 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.

(Filename: TCT_eEdE-44_FSEMRT2WIsagittalplaneSusacssyndromeanypartofthecorpuscallosummaybeinvolvedthecallosallesionstypicallyinvolvethecentralfiberswithrelativesparingoftheperiphery.jpg)

eEdE-01

6:30AM - 2:45PM

What the Neuroradiologist Needs to Know From Anatomy to Functional Imaging of Movement Disorders

P Devgun¹, S Kanekar¹
¹Penn State MiltonHershey Medical Center, Hershey, PA

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 key symptoms: Tremor, Rigidity, Bradykinesia (slowed movement), and 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
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>Neck</th>
<th>Temporal bone</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>
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<tr>
<td></td>
<td>jugulotympanicum</td>
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<td></td>
<td>Dehiscent semicircular</td>
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<td></td>
<td>Paget disease</td>
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<tr>
<td></td>
<td>Aberrant/dehiscent IC</td>
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<tr>
<td></td>
<td>Persistent stapedral atheroma</td>
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<td></td>
<td>High riding/dehiscence</td>
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Intracranial

<table>
<thead>
<tr>
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<th>Dehiscent semicircular</th>
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<tbody>
<tr>
<td>Benign intracranial hypertension(pseudotumor cerebri)</td>
<td>Paget disease</td>
</tr>
<tr>
<td></td>
<td>Aberrant/dehiscent IC</td>
</tr>
</tbody>
</table>

Dura Mater

<table>
<thead>
<tr>
<th>DAVF</th>
<th>Persistent stapedral atheroma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stenosed dural sinus</td>
<td>High riding/dehiscence</td>
</tr>
<tr>
<td>Aberrant sigmoid sinus</td>
<td></td>
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</table>

(Filename: TCT_eEdE-107a_PulsatileTinnitusTable1.jpg)

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
1University of Iowa, Iowa City, IA, 2Massachusetts Eye and Ear Infirmary/Harvard Medical School, Boston, MA, 3University of Wisconsin Hospitals, Madison, WI, 4SUNY Downstate Medical Center, Brooklyn, NY, 5University Of Iowa Hospitals & Clinics, Iowa City, IA

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.
S McCann¹, D Ginat¹, G Christoforidis¹
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 (MRI), 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

M Robinson¹, S Slasky², O Tairu²
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 lesions. 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.

About Face! - Causes of Non-traumatic Facial Swelling

A Spiro¹, J Burns¹, A Friedman¹, M Neimark², M Scheinfeld¹, R Dym¹
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

M Gelbman1, Z Chadnick2, S Lev3

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 cribriform 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**

**Anterior Cranial Fossa Imaging in the Era of Endoscopic Endonasal Surgery**

B Tantiwongkosi¹

¹University of Texas Health Science Center at San Antonio, San Antonio, TX

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 diagnose 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

R Lobo¹, A Crum¹, D Kim², J Cramer¹, E Quigley¹
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.

Build-A-Box: A Stepwise Approach to Middle Ear Anatomy

J McCarty¹, J Dornhoffer¹, R Riascos², E Angtuaco¹, R Fitzgerald¹
¹University of Arkansas for Medical Sciences, Little Rock, AR, ²UTHSC-Houston, Houston, TX
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.

Closing the Knowledge Gap: Imaging of Orofacial Clefts

G Avey\textsuperscript{1}, T Kennedy\textsuperscript{2}, L Gentry\textsuperscript{3}
\textsuperscript{1}University of Wisconsin, Madison, WI, \textsuperscript{2}University Of Wisconsin Hospital, Madison, WI, \textsuperscript{3}University of Wisconsin Hospitals, Madison, WI

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.

eEdE-170

Compliance of British Thyroid US “U” guidelines- Are we all speaking the “Universal” Thyroid language

p gopalan

1Leeds and Bradford Teaching Hospitals, Wakefield, United Kingdom

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, microcalcification

Intra-nodular vascularity

Shape (taller > wide) (AP > TR)

2.32 cm

3.06 cm

(Filename: TCT_eEdE-170_Slide2.jpg)
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 Atat¹, S Yazbek¹, A Haddad¹, S Abi Khalil¹, S Slaba¹, C Robson²
¹Hotel Dieu de France Hospital, Beirut, Lebanon, ²Boston Children's Hospital, Boston, MA

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

Halo, iso-echoic / mildly hyper-echoic
Cystic change +/- ring down sign (colloid)
Micro- cystic / spongiform

(Filename: TCT_eEdE-170_Slide6.jpg)
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.
Craniopharyngeal Canal and Notochord at the Craniocervical Junction and Skull Base: Spectrum of Pathology and Variant Anatomy

A Copelan¹, M Bhatt¹, S Noujaim¹, L Bahoura¹, K Chaiyasate¹, A Khan¹
¹Beaumont Health System, Royal Oak, MI

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; infrasellar 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

D Ginat¹, J Melotek², D Haraf²
¹University of Chicago, Chicago, IL, ²University of Chicago, Chicago, IL

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

J Errázuriz¹, S Correa¹, S Bravo-Grau¹, J Cruz¹, I Huete¹
¹P. Universidad Católica de Chile, Santiago, REGIÓN METROPOLITANA

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, suprathyroid 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 suprhyoid 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.

K Owens¹, A Narayan², D Zander³
¹Albany Medical Center, Albany, NY, ²Community Care Physicians, Albany, NY, ³Massachusetts Eye and Ear Infirmary/Harvard Medical School, Boston, MA

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.

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**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?**

S Moum\(^1\), A Korutz\(^1\), A Karagianis\(^1\), C Voelker\(^1\), A Nemeth\(^1\)

\(^1\)Northwestern University, Feinberg School of Medicine, Chicago, Illinois

**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.

Facial Nerve Pathologies and Imaging Characteristics

A Mohandas1, M Haider2, M Le3, T Khairalseed4, K Shah5
1Detroit Medical Center, Wayne State University, Detroit, MI, 2Detroit Medical Center/Wayne State University, Detroit, MI, 3Wayne state university, detroit, MI, 4Dmc/Wayne state university, Melvindale, MI, 5Detroit Medical Center / Wayne State University, Detroit, MI

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

H&N Vascular Anomalies and Syndromes: Why Image?

M Ho, S Cofer, K Balakrishnan, M Tollefson, H Bjarnason, D DeLone

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

S Rahim¹, L Vidal¹, I Patel¹, D Nakamoto¹, M Coffey¹
¹University Hospitals Case Medical Center, Cleveland, OH

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 cased-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.

J Sachs¹, C Lack², M Zapadka¹, T Martin³
¹Wake Forest Baptist Health, Winston Salem, NC, ²Wake Forest School of Medicine, Winston-Salem, NC, ³Wake Forest Baptist Health, Winston-Salem, NC

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
6:30AM - 2:45PM
Imaging Approaches and Differential Diagnoses for Pulsatile Tinnitus

D Ginat¹
¹University of Chicago, Chicago, IL

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 Hoss\textsuperscript{1}, J Faircloth\textsuperscript{1}, J McCarty\textsuperscript{1}, E Angtuaco\textsuperscript{2}, R Fitzgerald\textsuperscript{1}, R David\textsuperscript{3}, M Kumar\textsuperscript{4}, R Ramakrishnaiah\textsuperscript{1}, R Van Hemert\textsuperscript{4}, R Samant\textsuperscript{4}

\textsuperscript{1}University of Arkansas for Medical Sciences, Little Rock, AR, \textsuperscript{2}Univ. Of Arkansas for Medical Sciences, Little Rock, AR, \textsuperscript{3}University Of Arkansas for Medical Sciences, Little Rock, AR, \textsuperscript{4}UAMS, LITTLE ROCK, AR

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 ophthalmpathy, metastasis from unusual primary malignancies and rare infectious process such as mucormycosis and aspergillosis. Other common orbital apex lesions such as meningeoma, 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 of a fat-saturated axial T1-weighted image of a 28-year-old male with vision loss, showing a circumscribed, ovoid mass at the right orbital apex, compressing the right optic nerve. Pathology returned a diagnosis of angioleiomyoma. Subsequent coronal fat-saturated T2-weighted imaging 8 months after surgical resection revealed localized atrophy of the right optic nerve manifested by asymmetric T2 hyperintensity within the optic canal (dashed arrow).](TCT_eEdE-120_Angioleiomyoma.JPG)

**eEdE-140**

**Imaging of CSF leaks in the setting of Idiopathic Intracranial Hypertension: Pearls and Pitfalls**

M Reddy¹, K Baugnon², A Aiken¹, P Hudgins²

¹Emory University Hospital, Atlanta, GA, ²Emory University, Atlanta, GA

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.

eEdE-131
6:30AM - 2:45PM

Imaging of Pediatric Temporomandibular Joint Disorders
A Vossough¹, R Assadsangabi², A Cahill², D Zarnow²
¹University of Pennsylvania-CHOP, Philadelphia, PA, ²Children's Hospital of Philadelphia, Philadelphia, PA

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 OZGEN¹, D Bajin², G Atay², L Sennaroglu²
¹Hacettepe University, Ankara, Turkey, ²Hacettepe University, Ankara, -

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

L Gentry¹, J Mueller², C Smittkamp³, D Reede⁴, W Smoker⁵
¹University of Wisconsin Hospitals, Madison, WI, ²University of Iowa, Iowa City, IA, ³Radiology Consultants of Mid-America, PC, Belleville, IL, ⁴The Long Island College Hosp, Brooklyn, NY, ⁵University Of Iowa Hospitals & Clinics, Iowa City, IA

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.
Diagnosis?

Sphenoid Mucocele
Lesion is centered on, and has completely replaced, the sphenoid sinus. Additional expansion has eroded adjacent bone and encroaches 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.

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eEdE-145

6:30AM - 2:45PM

Imaging the TMJ: A systematic approach and pictorial review

N Madhuripan¹, S Li²
¹Baystate Medical Center, Springfield, MA, ²Baystate 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.
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.

Intracranial Pathology of Visual Pathway: anatomy, pathology and application of newer imaging techniques

6:30AM - 2:45PM

1University of Southern California, Los Angeles, CA, 2LAC/USC Medical Center, Los Angeles, CA

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 newer imaging techniques especially
diffusion tensor imaging (DTI) and functional magnetic resonance imaging (fMRI) in imaging of visual loss.

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.

**Lacrimal Gland Masses: Multimodality Imaging Appearance and Clinical Features**

M Stone¹, P Doshi¹

¹Henry Ford Hospital, Detroit, MI
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.
Lacral 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
D) Homogenously enhancing bilateral lacrimal masses with muscular and intraconal extension in a patient with H

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eEdE-160

6:30AM - 2:45PM

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
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

J Spoont1, N Nagornaya1, R Bhatia1, A Morgado1
1University of Miami/Jackson Memorial Hospital, Miami, FL

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 Bhatt, P Patel
1Rochester General Hospital, Rochester, NY

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.

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
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.
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.

Multimodality Imaging Overview of Pathologically-Proven Common and Uncommon Parotid Space Masses

W Finke1, N Koontz1, S Kralik1
1Indiana 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.
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

J Brucker1, M Bashir2, J Thelen1

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 affection 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

A Al Hashem\(^1\), R Aljubeilan\(^2\), S Kristjansson\(^3\), M Nicolas Jilwan\(^3\)
\(^1\)Prince Sultan Military Medical City, Riyadh, Saudi Arabia, \(^2\)Kinh Fahd Specialist Hospital (Buraidah), Buraidah, Al-Qassim, \(^3\)King 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.

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Pediatric Cystic Neck Lesions: A practical, detailed, and pragmatic approach for diagnosis based imaging features and neck space.
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.
Pediatric Facial Masses: A Guide to Radiologic Diagnosis

M Neimark¹, J Burns², J Bello², K Shifteh²
¹Montefiore Medical Center/Albert Einstein College of Medicine, Bronx, NY, ²Montefiore Medical Center, Bronx, NY

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?

N Supakul¹
¹Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

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.

S. Tufik, U. Passos, F. Cevasco
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 postoperative 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.
(A) Normal bilateral prosthesis implant

(B) Strikes

(C) Pneumolabyrinth

(D) [Image not visible]
Reference points for the assessment of the course of the anterior and posterior ethmoid arteries by multislice CT.

S Souza1, M Souza2, R Rivero1, R Guimaraes1, L Wanderley1, F Pacheco3, R Mendonca1

1Diagnóstico das Américas S/A, Sao Paulo, Brazil, 2USP - ENT Department, Sao Paulo, Brazil, 3Diagnóstico das Américas S/A, Sao Paulo, Brazil

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

C Larson1, D Gridley1

1Maricopa Integrated Health System, Phoenix, AZ
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

- Mucoepidermoid: 29%
- Adenoid Cystic Carcinoma: 14%
- Adenocarcinoma NOS: 22%
- Carcinoma Ex PSA: 5%
- Other Malignant Neoplasms: 14%
- Acinar Cell Carcinoma: 16%

Role of Cross-sectional imaging in the Preoperative Evaluation of Laryngeal Cancer.

A Desai¹, A Bhatt¹, S Ifthikharuddin¹, Z Zhang¹, P Patel²
¹Rochester General Hospital, Rochester, NY, ²rochester general hospital, Rochester, NY

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**: Anterior extension increases chances of thyroid cartilage involvement and extralaryngeal spread. Posterior extension increases incidence of postcrioid 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.
(a) Glottic carcinoma with invasion of the anterior commissure (arrow), (b) the tumor is also noted to be eroding the thyroid cartilage (arrow)

(a) Supraglottic carcinoma (black arrow) with normal appearance of the pre-epiglottic fat (white arrow), (b) follow up CT after 2 years shows transglottic spread of tumor (black arrow) with new soft tissue density replacing the pre-epiglottic fat, consistent with tumor invasion (white arrow)

(a) Soft tissue density in the left posterior subglottic region (arrow), consistent with subglottic carcinoma (b) the tumor is also noted to be eroding the posterior cricoid cartilage (arrow)

**T staging of Laryngeal Carcinoma**

<table>
<thead>
<tr>
<th>T1</th>
<th>Tumor limited to the vocal cord(s) with normal vocal cord function</th>
</tr>
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<tbody>
<tr>
<td>T1a</td>
<td>Tumor limited to one vocal cord</td>
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<tr>
<td>T1b</td>
<td>Tumor involves both vocal cords</td>
</tr>
<tr>
<td>T2</td>
<td>Tumor extends to supra- and/or subglottic supraglottis (with or without impaired vocal cord function)</td>
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<tr>
<td>T3</td>
<td>Tumor limited to the larynx with vocal cord</td>
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<tr>
<td>T3a</td>
<td>Tumor limited to the larynx with vocal cord and paraglottic space, and/or minor thyroid cartilage erosion</td>
</tr>
<tr>
<td>T3b</td>
<td>Tumor invades tissues beyond the larynx and trachea, deep intrinsic tongue muscles, stra</td>
</tr>
<tr>
<td>T4a</td>
<td>Tumor invades prevertebral space, encases mediastinal structures</td>
</tr>
<tr>
<td>T4b</td>
<td>Tumor invades prevertebral space, encases mediastinal structures</td>
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**Glottic Carcinoma**

**Supraglottic Carcinoma**

**Subglottic Carcinoma**

Data obtained from the AJCC (American Joint Committee on Cancer) 8th edition
Role of imaging in the evaluation of cutaneous symptoms in the region of the cheek

A Mahajan1, G Mongelluzzo2, S Meng3, E Kier4
1Yale University, New Haven, CT, 2Yale University School of Medicine, New Haven, CT, 3ChristianaCare, Newark, DE, 4Yale University, New hAVEN, CT

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 afflicting 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.
Rosai-Dorfman Disease within the Head, Neck, and Brain: A Case Series and Review of Imaging Findings and Clinicopathologic Features

M Stone¹, P Doshi¹, M Rheinboldt²
¹Henry Ford Hospital, Detroit, MI, ²Henry Ford Hospital, Detroit, MI

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 hemangioma.
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**

6:30AM - 2:45PM

The journey is as important as the destination; review of an important conduit.
The external auditory canal and its pathologies.

**U Chaudhry¹, M Naidich², E McComb³**

¹Northwestern University, Chicago, IL, ²Northwestern Memorial Hospital, Chicago, IL,
³Northwestern Memorial hospital, Chicago, IL

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.

P Lee¹, V Nguyen², C Kirsch³
¹North Shore-LIJ Health System, Manhasset, NY, ²North Shore LIJ Medical Ctr, New Hyde Park, NY, ³NSLIJ, Manhasset, NY

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

Figure 1. Axial arterial phase CT image demonstrates a septated, cystic lesion deep to the left hemithyroid. Pathology showed a cystic parathyroid adenoma.

Figure 2. Sagittal arterial phase CT image demonstrates an enhancing lesion deep to the inferior pole of the left hemithyroid, compatible with a parathyroid adenoma (red arrow). Note oblique linear calcification and a high density window (red arrow) adjacent to the adenoma (blue arrow).

(Filename: TCT_eEdE-166_ASNRParathyroid.jpg)

eEdE-167

Thyroid Cancer Care Collaborative: A Computerized Clinical Decision Support System for Management of Thyroid Nodules

V Mai-Tran¹, J Shen¹, O Khalilzadeh¹, A Khorsandi²
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

M Chapman¹, V Andreu¹, Q Malabeth¹, K Memon², B Liu³, O Sakai¹
¹Boston Medical Center, Boston University School of Medicine, Boston, MA, ²Northwestern University, Chicago, IL, ³Northwestern University Feinberg School of Medicine, Chicago, IL

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.

To Find an Adenoma: Common and Uncommon Locations for Parathyroid Adenomas on 4DCT

M Kuruva1, R Samant1, R David1, M Kumar1, R Van Hemert1, E Angtuaco1, R Fitzgerald1
1University of Arkansas for Medical Sciences, Little Rock, AR

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.
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
improve the quality of the radiologist's interpretation and significantly impact clinical management.

(Filename: TCT_eEdE-108_nothyroidcartilageinvasion.jpg)

eEdE-168

Unlocking the Parathyroid Puzzle: A Detailed Look at the Multimodality Options
A Faulkner1, W Gibbs2
1University of Southern California, Los Angeles, CA, 2University of Southern California, Keck School of Medicine, Pasadena, CA

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.
Usual and Unusual Lesions of The Cerebellopontine Angle

J Ovalle\textsuperscript{1}
\textsuperscript{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 Haider\textsuperscript{1}, A Mohandas\textsuperscript{2}, T Khairalseed\textsuperscript{3}, K Shah\textsuperscript{4}
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.

Vascular Complications of Head and Neck Infections

E Supsupin¹, M Guirguis¹, B Bingham¹, J Choi¹, M Mallery¹, E Bonfante¹
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

R Khan¹, J Probst², C Harms², H Albasha³, J Wang², D Reyes², R Squires⁴, G CHOU DHARY⁵, M Lemole²
¹University of Arizona Medical Center, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³The University of Arizona College of Medicine - Tucson, Oro Valley, AZ, ⁴University of Arizona College of Medicine - Tucson, Tucson, AZ, ⁵Banner university medical center, TUCSON, AZ

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.
Monday
6:30AM - 2:45PM
Washington Marriott Wardman Park, Hall B-03

electronic Education Exhibit (eEdE) - Informatics
eEdE-174
6:30AM - 2:45PM

"Unravelling a bundle of nerves?"

D Saunders¹, B Adams¹, I Craven¹, D Warren¹, J Macmullen-Price¹, S Currie¹
¹Leeds 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

E O'Connor¹, J Fried², S Reddy³, P Shah⁴, J Hogg⁵, P Lewis², T Zeffiro⁴, V Agarwal⁶, N McNulty²
¹Lewis Katz School of Medicine at Temple University, Philadelphia, PA, ²Geisel School of Medicine at Dartmouth, Hanover, NH, ³University of Southern California Keck School of Medicine, Los Angeles, CA, ⁴Temple University, Philadelphia, PA, ⁵West Virginia University School of Medicine, Morgantown, WV, ⁶University of Pittsburgh Medical Center, Pittsburgh, PA

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

Manual Refining of Segmentation with Pen Displays: Increasing Speed and Accuracy in 3D Printing Labs

R Javan¹, S Majidi¹, A Tangestanipoor¹
¹George Washington University Hospital, Washington, DC

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
The 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**

6:30AM - 2:45PM

Our Experience in Writing an MCQ eBook Using Apple’s iBooks Author App

D Takhtani¹, A Ulano¹

¹University of Massachusetts Medical School, Worcester, MA

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

eEdE-178
Arteriovenous Malformations and Diffuse Proliferative Arterial Disorders: Differences That Neuroradiologists Need to Know

L Causil¹, R Ames¹, F Sepulveda¹, M Amunugama¹, M Castillo¹, H Alvarez¹
¹Univ. Of North Carolina School Of Medicine, Chapel Hill, NC

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 angiomorphicology, 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

S Woolen¹, A Srinivasan¹
¹University of Michigan, Ann Arbor, MI

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 discussed 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

S Youn¹, H Lee², H Kim³
¹Catholic University of Daegu, Daegu, NC, ²Kyungpook National University Hospital, Chapel Hill, NC, ³Catholic University of Daegu, los altos, CA

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
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

L Eisenmenger1, R Wiggins2, E Huo1
1University of Utah, Salt Lake City, UT, 2University Of Utah, Salt Lake City, UT

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

F Chang¹, C Luo¹, C Lin², H Lee¹, W Guo¹
¹Taipei Veterans General Hospital & National Yang Ming University, Taipei, Taiwan, ²Taipei Veterans General Hospital, Taipei, Taipei
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.
Algorithm of endovascular management of PCAS

Dash line: indicates close follow-up after initial management.

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eEdE-175

6:30AM - 2:45PM

The Role of Hemodynamics in Assessing Risk of Growth and Rupture of Intracranial Aneurysms

W Chang¹, A Chien¹, P Villablanca¹

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

¹University of Southern Denmark, Odense, Denmark

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.
Antibody-Associated Encephalitis in Children: Exploring the Clinical-Radiologic Paradox

S Little¹, D Grattan-Smith¹, L Hayes¹, S Palasis¹, A Alazraki², B Philbrook², D Wolf²
¹Children's Healthcare of Atlanta, Atlanta, GA, ²Emory University & Children's Healthcare of Atlanta, Atlanta, GA

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.**
R Aljubeilan1, A Al Hashem2, S Kristjansson3, M Nicolas Jilwan3
1King Fahd Specialist Hospital, Buraidah, Al-Qassim, 2Prince Sultan Military Medical City, Riyadh, AK, 3King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia

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 methyl glutaconic 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.
Brain MRI findings in Chiari II Malformation. Evolving from Fetal to Neonatal

E Bonfante1, H Katrina2, R Patel2, C Sitton2, J Johnston2, S Fletcher3, K Moise4, R Riascos2
1University of Texas Health Science Center Houston, Houston, TX, 2The University of Texas Health Science Center at Houston UTHealth, Houston, TX, 3University of Texas Health Science Center at Houston, Mischer Neuroscience Institute, Houston, TX, 4The University of Texas Health Science Center at Houston UTHealth, Houston, TX

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.

S Ferraciolli¹, S Tufik², A Oliveira Neto³, C Commander⁴, E Feitosa⁵, M MATSUOKA⁶, L Lucato⁷, C Leite⁸, M Castillo⁹
¹InRad - HC- FMUSP, Sao Paulo, Brazil, ²HCFMUSP, São Paulo, SP, ³Hospital das Clínicas da Universidade de Sao Paulo, Sao Paulo, Sao Paulo, ⁴University of North Carolina, Chapel Hill, NC, ⁵University of Sao Paulo, Sao Paulo, FL, ⁶Child Institute - Clinics Hospital of Sao Paulo University, SAO PAULO, Brazil, ⁷Instituto de Radiologia do HC-FMUSP, Sao Paulo, Brazil, ⁸University Of Sao Paulo, Sao Paolo, Brazil, ⁹Univ. Of North Carolina School Of Medicine, Chapel Hill, NC

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 cerebra 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 a 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.
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 (CT) (A) and diffusion MR image (B) show multiple acute infarcts in most of the lobes and distributions. Although CT clearly shows hemispheric infarcts the involvement of the callosum was not appreciated.

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eEdE-188

Childhood acute encephalopathy: A neuroimaging review.

K TLILI-GRAIESS¹, N MAMA.², A Zeeshan¹, N Adwani³, N Al Khuraish³, F Thabet³
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

A Alazraki¹, B Soares¹, N Desai², S Palasis³
¹Emory University & Children's Healthcare of Atlanta, Atlanta, GA, ²Texas Children's Hospital Baylor College of Medicine, Houston, TX, ³Emory University & Children's Healthcare of Atlanta, Atlanta, GA

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.

P HANAGANDI¹, F Gonçalves², P Krishnan¹, C Raybaud¹, M Shroff¹
¹THE HOSPITAL FOR SICK CHILDREN, TORONTO, CANADA, ²Hospital da Criança de Brasília José Alencar (HCB), BRASILIA, BRAZIL

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

6:30AM - 2:45PM
A Poretti¹, E Boltshauser², N Wolf³, T Huisman⁴
¹The Johns Hopkins University School of Medicine, Baltimore, MD, ²University Children's Hospital, Zurich, MD, ³VU University Medical Center and Neuroscience Campus, Amsterdam, MD, ⁴Johns Hopkins, Baltimore, MD

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).

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.
Imaging Characteristics, Pathological Features, and Prognoses of the Molecular Subgroups of Medulloblastoma.

L Dawson¹, R Murtagh², J Kucera³
¹University of South Florida, Tampa, FL, ²USF Morsani College of Medicine, Tampa, FL, ³All Children's Hospital, St. Petersburg , FL

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. Wingeless 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**

G Joshi1, S Selvarajan2, B Midkiff3, R Balsubramanya3, 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
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**

S Rambhia¹, P Lee², A Wright³, M Atlas³, C Filippi⁴  
¹North Shore Long Island Jewish Health System, Manhasset, NY, ²Hofstra North Shore-LIJ School of Medicine, Manhasset, NY, ³Cohen's Childrens Hospital-LIJ, New Hyde Park, NY, ⁴Hofstra North Shore-LIJ School of Medicine, Manhasset, NY

**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 frontopareital 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

S Sogge¹, K Thamburaj¹

¹Penn State Hershey Medical Center, Hershey, PA
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
1Children Hospital of Eastern Ontario, Ottawa, Ontario

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, Devics 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.

**Neonatal and early infantile epilepsy due to Inherited metabolic disorders: Clinical and neuroimaging correlation**

K TLILI-GRAIESS¹, N MAMA.², M GAHA², M Al Enezi¹, N AlKhuraish³, B Tabarki¹
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 participate 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 6:30AM - 2:45PM

Neonatal and Perinatal Extra-axial and Extracranial Hemorrhage

S Chan¹, N Marks¹, K Cauley¹
¹Columbia University Medical Center, New York, NY

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.
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

M Wagner¹, A Poretti², T Bosemani², J Benson³, T Huisman⁴
¹Johns Hopkins Hospital, Baltimore, MD, ²The Johns Hopkins University School of Medicine, Baltimore, MD, ³The Johns Hopkins University School of Medicine, Baltimore, MD, ⁴Johns Hopkins, Baltimore, MD

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
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 Zucconi¹, T Hashemi-Zonouz¹, D Spencer¹, R Bronen¹

¹Yale 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

Pediatric Myelination Patterns & Disorders

M Duan Meservy¹, S Cambron², L Palifka¹
¹Dartmouth-Hitchcock Medical Center, Lebanon, NH, ²Tristan 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.

eEdE-210
6:30AM - 2:45PM

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**

**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.

Review of utility of Susceptibility weighted imaging in pediatric emergencies.

G Joshi\textsuperscript{1}, S Selvarajan\textsuperscript{2}, B Midkiff\textsuperscript{3}, R Balsubramanya\textsuperscript{3}, B Asha\textsuperscript{4}, V Kapare\textsuperscript{5}, S Prabhu\textsuperscript{6}
\textsuperscript{1}Saint Vincent Hospital, Worcester, MA, \textsuperscript{2}Thomas Jefferson University, philadelphia, PA, \textsuperscript{3}Mercy Hospital, City., MA, \textsuperscript{4}Thomas Jefferson University Hospital, Philadelphia, PA, \textsuperscript{5}University of Kentucky, Lexington, KY, \textsuperscript{6}Boston 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
The structural connectome in children, made easy

A Meoded¹, J Vogelstein², G Kiar², W Roncal², T Huisman¹, A Poretti¹
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.
Uncommon Presentations of Posterior Fossa Tumors and Mimics.

D Bui¹, P Sanchez²
¹University of California Davis, Sacramento, CA, ²UC 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.

![Image](TCT_eEdE-206_CoronalT1postabscess.jpg)

**eEdE-204**

**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
6:30AM - 2:45PM
“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 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/alter 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>
<th>Recommendation</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
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.

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**

R Hosker, N Mariwalla, A Corey, a fountain

1Emory University School of Medicine, Roswell, GA, 2Emory University, Decatur, GA, 3Emory, Fayetteville, GA, 4emory, atlanta, GA

**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

S Rothenberg¹, R Whiting², M Morris¹, S Boateng¹, B Saboury¹, R Tu²
¹University of Maryland Medical Center, Baltimore, MD, ²George Washington University, Washington, DC

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

L Eisenmenger¹, t hutchins², L Shah³
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 presyrinix 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-Baíllo¹, 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.

Beyond the Spinal Cord: Imaging of the exiting Nerve Roots, Brachial Plexus, and Lumbar Plexus

L Rachakonda¹, T Moritani¹, P Watal¹, 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.
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 interventions. 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.

(Filename: TCT_eEdE-249_Image_abstract.jpg)

eEdE-222

Cauda Equina: An overview of embryology, anatomy, and diseases

P Masood¹, V Hill², J Tsay¹
¹Cleveland Clinic Foundation, Cleveland, OH, ²Cleveland 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
6:30AM - 2:45PM

Cone in on the cord tip: A pictorial review of conus medullaris lesions

C Pluguez-Turull¹, X Zhang¹, W Altmeyer¹, M Walters¹
¹UTHSCSA, San Antonio, TX

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

S Bhuta¹, L Meehan², G Kwan³, C Hsu³
¹Gold Coast University Hospital, Gold Coast, Australia, ²louis.doherty@live.com, Southport, N/A, ³Gold Coast University Hospital, Southport, N/A

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

R Ramakrishna1, S Ali1, A Alexander1, C Yang1
1University of Chicago Medical Center, Chicago, IL

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 Boikov\textsuperscript{1}, L Loevner\textsuperscript{2}, K Learned\textsuperscript{3}
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.

Diffuse Involvement of the Cauda Equina Nerve Roots in Adult: a Practical Approach to Differential Diagnosis

A Alamer¹, M Cortes¹, D Tampieri¹
¹Radiology Department, Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada
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

¹University of New Mexico, Albuquerque, NM

**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.
Imaging of Typical and Atypical Infections of the Spine

Y Guo¹, J Dorr¹, M Patel¹, R Pandit¹

¹Santa Clara Valley Medical Center, San Jose, CA
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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Imaging the nerve roots on MRI: a practical guide to MR myelogram and root neurography

J Starkey¹, Y Numaguchi²
¹St. Luke’s International Hospital, Tokyo, Japan, ²St. Luke’s International Hospital, Tokyo, Tokyo

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 rootography 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

v kunam¹, D Reede², W Smoker³, V Velayudhan⁴, M Bobinski⁵, S Pulitzer⁶
¹SUNY Downstate University hospital, Brooklyn, NY, ²SUNY downstate University Hospital, Brooklyn, NY, ³University 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:

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>
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<tbody>
<tr>
<td>Central</td>
<td>Segmental loss of pain and temperature, weakness greater in arms than legs</td>
<td>Syringomyelia, intracranial tumor, hyperextension cervical spondylosis</td>
</tr>
<tr>
<td>Ventral</td>
<td>Loss of pain and temperature, weakness, bladder dysfunction</td>
<td>Spinal cord infarction, 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 Sequard, myelopathy, epidural multiple sclerosis</td>
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<tr>
<td>Brown-Sequard</td>
<td>Ipsilateral weakness and loss of proprioception, contralateral loss of pain and temperature</td>
<td>Knife or bullet injury, malignancy, multiple sclerosis</td>
</tr>
<tr>
<td>Conus medullaris</td>
<td>Bladder or rectal dysfunction, saddle anesthesia</td>
<td>Disc herniation, cancer, infection, trauma</td>
</tr>
<tr>
<td>Cauda equina</td>
<td>Asymmetric multiradicular pain, leg weakness and sensory loss, bladder dysfunction</td>
<td>Disc herniation, tumor, lumbar spondylosis</td>
</tr>
</tbody>
</table>
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 pseudomass effect in left paraspinal musculature with adjacent ill-defined T1 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.
ImmersiveTouch® Platform
(Filename: TCT_eEdE-223_FGLPSim.jpg)

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 for patient care, litigation and payment. 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

D Chow¹, J Talbott², A Uzelac¹
¹University of California, San Francisco, San Francisco, CA, ²UCSF, San Francisco, CA

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?

K Hooda¹, J Sapire¹, G Muro¹, P Kochar², Y Kumar¹, D Hayashi¹
¹Yale New Haven Health System at Bridgeport Hospital, Bridgeport, CT, ²Ganesh Diagnostics and Imaging, Ganesh Educational Institute and Research Centre, New Delhi, India

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

R Khosla¹, J NAIR², T Powell³, C Torres⁴, R Del Carpio⁴
¹Mcgill University Health Centre, Montreal, Quebec, ²McGill University Health Centre, Montreal, Quebec, ³Mcgill University Health Centre, Montréal, Qu'ebec, 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?

M Qandeel\(^1\), S Ali\(^1\), A Al-Saraf\(^6\), E Ramos\(^1\), S Lee\(^1\)

\(^1\)University 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.

C Cox¹, R Murtagh²
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.
eEdE-229

Role of Imaging in Minimally Invasive Spine Interventions

N Peri¹, R Rojas², J Nagda³

¹Beth Israel Deaconess Medical Center, Newton, MA, ²Beth Israel Deaconess Medical Center, Boston, MA, ³Beth Israel Deaconess Medical Center, Brookline, MA
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?**

R Gaddikeri¹, K SHARBIDRE², S Gaddikeri³, M Jhaveri⁴, S Byrd⁵
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**  
6:30AM - 2:45PM

**Spine Interventions: Different Goals, Similar Techniques**

S Salehian¹, V Lopez¹, J Fernandez¹, J Tran¹, L Hoang¹, J Cross¹

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

6:30AM - 2:45PM

Spine Oncology: Required Reading for the Neuroradiologist

W Gibbs¹, E Chang¹, P Hsieh¹, P Kim¹, M Law¹

¹University of Southern California, Keck School of Medicine, Los Angeles, CA
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

R Ceulemans¹, S Patel¹, H Marin², T Aho³, J Corrigan³, B Griffith³
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

K Moulton¹, J Shewchuk¹, J Chew²
¹University of British Columbia, Vancouver, British Columbia, ²University of British Columbia, Vancouver, BC, Vancouver, BC

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.
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

R Gershon¹, N Swaminathan¹, E Parker¹
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 Craniovertebral Junction: an Overview of Relevant Biomechanical Characteristics Regarding Ligamentous Anatomy and Injury Patterns in Relation to Blunt Force Trauma.

J Fang¹, W Altmeyer², A Singh³, B Tantiwongkosi¹
¹University of Texas Health Science Center at San Antonio, San Antonio, TX, ²UTHSCSA, San Antonio, TX, ³UT Health Science Center San Antonio, San Antonio, TX

Purpose
To enhance understanding of injury patterns of the craniovertebral junction (CCJ) through analysis of its ligamentous anatomy and biomechanics during blunt force trauma.

Materials and Methods
Knowledge of craniovertebral 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 craniovertebral junction, with an emphasis on the craniovertebral 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 craniovertebral 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.

**eEdE-231**

**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.
A New, High Resolution, Dynamic Interactive Neuro Anatomic Atlas for Brain Imaging

W Gibby¹, S Cvetko², W Gibby³
¹George Washington University, Arlington, VA, ²Novarad Corporation, American Fork, UT, ³University of California San Diego, San Diego, CA

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.
A Voxel-based morphometry study in diabetes mellitus type II compared to healthy controls. Preliminary results of the PRECISED study.

D Pareto¹, J López², P Delgado¹, R Simó², J Bañeras¹, D Garcia-Dorado², À Rovira¹
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 established 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>
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<tr>
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<td>9</td>
<td>5.2</td>
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Mean ± SD: 4.7 ± 2.0* 10.1 ± 4.6

*: Significantly different than the AR (P<0.05)

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**ADC Quantification of Definite and Probable Creutzfeldt-Jakob Disease Compared to Controls**

E Zan1, O Osman2, J Probasco3, C Pardo-Villamizar4, I Izbudak1

1Johns Hopkins University, Baltimore, MD, 2George Washington University, Washington DC, DC, 3Johns Hopkins Hospital, Baltimore, MD, 4Johns Hopkins Hospital, Baltimore, MD

**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 cerebrospinal 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.
Admission Insular Infarction in Acute Minor Stroke with Proximal Artery Occlusion is Associated with Early Neurological Deterioration due to Infarct Growth

J KIM¹, K Kang¹, Y Shinohara², M Lev², J Saver³
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
6:30AM - 2:45PM

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
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.
Voxel Based Morphometry

Fractional Anisotropy

Mean Diffusivity

Radial Diffusivity

Z Statistic
For Diffusion Tensor Imaging

12
5
Neg Pos Neg Pos
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 map generated by the Ensight. (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 Control vs AD flow 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

S Mills¹, G Whitfield², J Helbrow²
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.

Applications of diffusion tensor MR imaging in multiple sclerosis.

M GAHA¹, A Mahjoubi², A Hassine³, K Tlili-Graiess²

¹MGO, ²SOM, ³OUCS
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 temporarily. 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.
Arterial spin labeling as a biomarker for the detection of early stages of Parkinson’s disease

K Yamashita¹, A Hiwatashi¹, O Togao¹, K Kikuchi¹, R Kamei¹, H Honda¹
¹Kyushu University, Fukuoka, Fukuoka

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

M Schertz¹, B Law-Ye², D Leclercq³
¹Pitié Salpêtrière, Paris, France, ²Pitié-Salpêtrière Hospital, Paris, AK, ³Pitié 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 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
6:30AM - 2:45PM

ASL Perfusion Imaging as a Surrogate Marker of Intracranial In-Stent Stenosis in the Setting of Stent Assisted Coiling; A Pilot Study.

B Graner1, J Ulmer1, B Fitzsimmons1, A Klein1, L Mark1
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.

D Gachechiladze¹, F Todua², D Miminoshvili², R Kharadze²
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>
<thead>
<tr>
<th></th>
<th>ASL</th>
<th>MRA</th>
<th>ASL Adjusted</th>
</tr>
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<tbody>
<tr>
<td>True Positive</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>False Positive</td>
<td>2</td>
<td>15</td>
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<tr>
<td>True Negative</td>
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</tr>
<tr>
<td>False Negative</td>
<td>3</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Sensitivity</td>
<td>50.0%</td>
<td>100.0%</td>
<td>75.0%</td>
</tr>
<tr>
<td>Specificity</td>
<td>89.5%</td>
<td>21.1%</td>
<td>90.5%</td>
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<td>Positive Predictive Value</td>
<td>60.0%</td>
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</tr>
<tr>
<td>Accuracy</td>
<td>80.0%</td>
<td>40.0%</td>
<td>88.0%</td>
</tr>
</tbody>
</table>

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**

6:30AM - 2:45PM

**Attenuation Differences in Subdural Effusion and Acute Subdural Hematoma Following Administration of Iodinated Contrast**

R Kelley¹, J Talbott², A Uzelac²

¹University of California, San Francisco, San Francisco, CA, ²University of California, San Francisco and San Francisco General Hospital and Trauma Center, San Francisco, CA

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>
<tr>
<th></th>
<th>CSF (mean)</th>
<th>SDE (mean)</th>
<th>Ac (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Contrast</td>
<td>6.8 (2.0)</td>
<td>21.1 (8.5)</td>
<td>61.7 (2.5)</td>
</tr>
<tr>
<td>3-8.5h After Contrast</td>
<td>7.8 (1.9)</td>
<td>46.7 (12.2)</td>
<td>74.1 (12.4)</td>
</tr>
<tr>
<td>8.5-24h After Contrast</td>
<td>7.7 (2.5)</td>
<td>33.5 (11.6)</td>
<td>69.4 (11.9)</td>
</tr>
</tbody>
</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 (1). Real-time PC imaging was achieved with echo planar imaging readout, parallel acceleration in the temporal direction, and shared velocity encoding (2). 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 obtained using the conventional cine
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.

Automating the Parametric Response Map Provides Treatment Response Biomarker for Routine Clinical Use

L Keith1, X Guo2, D Guest3, C Galban3, T Chenevert3, B Zhao2, 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.
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 (fMRI) 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 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

H Lee¹, S Hung²
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

M Kitajima¹, M Azuma¹, H Nakamura¹, Y Iryo¹, Y Yamashita¹
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 mm^2/s) was higher than of metastatic tumors (mean 1.05 x 10^-3 mm^2/s) and glioblastomas (mean 1.16 x 10^-3 mm^2/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 PAMARTHY, J Ulmer, M BHALLA, A Klein, S Quinet, L Mark, N ALAM, K McAvoy

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.

Changes in Permeability Detected by DSC Perfusion MRI Predict Survival in Recurrent Glioblastoma Treated with Bevacizumab

A Hilario¹, E Salvador², L Koren³, J Sepulveda², A Hernandez-Lain², A Perez-Nuñez³, A Lagares², A Ramos²
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

K Hooda¹, D Hayashi¹, G Muro¹, J Sapire¹, Y Kumar¹, N Parikh¹
¹Yale New Haven Health System at Bridgeport Hospital, Bridgeport, CT

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**

Clinical Evaluation of Silent MRI and MR Angiography based on Rapid Radial
Acquisition

S Holdsworth1, S Macpherson1, K Yeom1, M Wintermark1, G Zaharchuk1

1Stanford University, Stanford, CA

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

S Patro1, C Lum1, R Thornhill2, H Lesiuk1, D Iancu1
1The Ottawa Hospital, Ottawa, Ontario, 2The Ottawa Hospital University of Ottawa, Ottawa, Ontario

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

N Tomura1, T Saginoya2, Y Kikuchi2
1Southern Tohoku Research Institute for Neuroscience, Southern Tohoku General Hospital, Koriyama, Japan, 2Southern Tohoku Research Institute for Neuroscience, Southern Tohoku General Hospital, Koriyama, Fukushima

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 contrasted-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 extracellular 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.

**Comparison of MRA Techniques for Calcification Detection**

M Mossa-Basha¹, H Liu¹, D Hippe¹, N Balu¹, J Sun¹, D Shibata¹, C Yuan¹
¹University of Washington, Seattle, WA
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 to TOFMRA 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, supraclinoid 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.

![Image](TCT_eP-108_calcfigasnr.jpg)

eP-07
6:30AM - 2:45PM

**Contemporary Use of Hybrid PET-MR Brain Imaging in Dementia**

A Rajput¹, T Ahluwalia², A Rajput³, R Matthews¹, L Bangiyev¹
¹Stony Brook University Hospital, Stony Brook, NY, ²Winthrop University Hospital, Melville, NY, ³University of Pittsburgh, Melville, NY

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 (8%), 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.

eP-35
6:30AM - 2:45PM
Contrast Enhanced Susceptibility Weighted Imaging of Glioma

S Bhuta¹, G Kwan², C Hsu²
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

Correlation of CT and MR Perfusion Parameters for Intracranial Tumors

K Greenlaw¹, J Shankar¹
¹Dalhousie University, Halifax, Nova Scotia

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.

Correlation of imaging features on arterial spin labeling and digital subtraction angiography for vascular evaluation of meningiomas

M Ma$^1$, S Holdsworth$^2$, J Heit$^2$, M Iv$^2$

$^1$Santa Clara Valley Medical Center, San Jose, CA, $^2$Stanford University Medical Center, Stanford, CA

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.
Cortical thinning in Multiple Sclerosis is associated with reduced Health-Related Quality of Life as measured by Patient Reported Outcomes.

S Hwang¹, E Nyberg², L Nagae², J Honce²
¹Chonbuk National University and Hospital, Jeonju, CO, ²University of Colorado, Aurora, CO

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

F Kellner-Weldon¹, M El-Koussy¹, M Jossen¹, P Klinger-Gratz², R Wiest¹
¹University Hospital Berne, Berne, Switzerland, ²University of Basel, Basel, Switzerland

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

M Martinez¹, J Knitter², D Brown³, R Deleacy², J Fifi³, K Nael²

¹Mount Sinai, New York, NY, ²Icahn School of Medicine at Mount Sinai, New York, NY, ³Mount Sinai Hospital, New York, NY

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.

N Liu¹, G Zhu¹, H Chen¹
¹Military General Hospital of Beijing PLA, Beijing, Beijing

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 VASOSPASM DETECTION AND PREDICTOR FOR DELAYED CEREBRAL ISCHEMIA IN THE CONTEXT OF ANEURYSMAL SUBARACHNOID HEMORRHAGE

F Pacheco¹, C ALVES², A MAIA¹, A da Rocha³
¹Santa Casa de São Paulo School of Medicine, São Paulo, Brazil, ²SAMARITANO DE SÃO PAULO, SAO PAULO, SAO PAULO, ³IRMANDADE SANTA CASA DE MISERICORDIA DE SAO PAULO, Sao Paulo, Sao Paulo

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.
**CTP in Stroke: Bayesian-based Deconvolution vs oSVD**

N Titelbaum¹, I Corcuera-Solano¹, A Andrle², Y Chaibi², A Mitulescu², B Bucciarelli², L Tanenbaum³

¹Icahn School of Medicine at Mount Sinai, New York, NY, ²Olea Medical, La Ciotat, Provence-Alpes-Côte d'Azur, ³RadNet Eastern Division, Baltimore, MD

**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.

G Verma¹, S Mohan¹, J Lee², S Chawla², S Wang², A Maudsley³, S Brem², H Poptani⁴
¹University of Pennsylvania, Philadelphia, PA, ²Hospital of the University of Pennsylvania, Philadelphia, PA, ³University of Miami, Miami, FL, ⁴University of Liverpool, Liverpool, AK

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

M Schertz1, A ARRIGO2, m majer3
1CHU Martinique, Martinique, France, 2CHU Martinique, Fort de France, Martinique, 3CHU Martinique, Paris, Martinique

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

J Narvid1, B Rehani1, J Talbott1
1UCSF, San Francisco, CA
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.

eP-107

6:30AM - 2:45PM

Differentiating and predicting true progression versus pseudoprogression: Comparing ASL, DSC, DCE and MRS

A Shaaban¹, N Elshafeey¹, A Hassan¹, H Liu¹, P Hou¹, A Kumar¹, N Leeds¹, R Colen¹
¹MD Anderson Cancer Center, HOUSTON, TX

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 PsD.

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

A Le¹, B Ades-Aron¹, H Patel¹, J Golomb¹, H Rusinek¹, A George¹
¹New York University School of Medicine, New York, NY

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 ± 0.65mm, (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.
eP-74
6:30AM - 2:45PM

Differentiation Between Neoplastic and Non-Neoplastic Intracranial Lesions Using Diffusion Tensor Imaging and Arterial Spin Labelling Technique

S Kumar¹, N SONI², K S³, r kumar⁴, J Kalita⁵, U Misra⁵, S Behari⁵
¹SGPGIMS, LUCKNOW, Uttar Pradesh, ²SGPGIMS, LUCKNOW, India, ³S, LUCKNOW, lucknow, ⁴UCLA, Los Angeles, CA, ⁵SGPGIMS, LUCKNOW, Uttar pradesh
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.

**eP-41**

6:30AM - 2:45PM

**Differentiation between progressive disease and treatment related changes in patients with glioblastoma using DCE-MRI**

o aizenstein¹, M Artzi¹, G Liberman¹, G Nadav¹, D Blumenthal¹, F Bokstein¹, D Ben Bashat¹

¹Tel Aviv Sourasky Medical Center, Tel-Aviv, Israel

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

T HIRAI¹, M Azuma², M Kitajima³, K Yamada⁴, S Yamashita⁴, M Ikeda⁴, Y Yamashita⁵, Y Wang⁶
¹University of Miyazaki, Miyazaki, Select, ²Kumamoto University, Kumamoto, Kumamoto, ³Kumamoto University, Kumamoto, Japan, ⁴Kumamoto University, KUMAMOTO, Kumamoto, ⁵Kumamoto University, Kumamoto, -- SELECT --, ⁶Weill Cornell Medical College, New York, NY

Purpose
Because symptoms of dementia with Lewy bodies (DLB) can closely resemble other more commonly known diseases like Parkinson's disease (PD), it currently is 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

B Ades-Aron, S Yeager, E Fieremans, A George, J Golomb

1New York University School of Medicine, New York, NY

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 extra-axonal 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 across 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 across 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

S Vyas1, V Govind2, N Khandelwal3, V Gupta3, A Sharma3, K Arheart2, M Kumar2
1Postgraduate Institute of Medical Education and Research, Chandigarh, Chandigarh, 2University of Miami, Miami, FL, 3Postgraduate Institute of Medical Education and Research, Chandigarh, India., Chandigarh, INDIA

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

A Meoded¹, L Boyd², R Dave³, J Estrada-Veras⁴, W Gahl⁵

¹National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD, Baltimore, MD, ²National Human Genome Research Institute Medical Genetics Branch Section on Human Biochemical Geneti, Bethesda, MD, ³NIH/NINDS, Bethesda, MD, ⁴Genetics NIH - National Human Genome Research Institute Medical, Bethesda, MD, ⁵National Human Genome Research Institute, Bethesda, MD
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.

Diffusion Tensor Imaging of Optic Nerve in Patients of Vitamin B12 Deficiency Before and After Treatment

N SONI1, S Kumar2, D Dubey3, J Kalita4, S Bhoi3, U Misra4
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 imaging 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?

G Bennett¹, J Lavie², M Al Hasan², J Milburn²
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?

A Namini1, J Acharya1, W Gibbs2, A Rajamohan2

1University of Southern California, Los Angeles, CA, 2University of Southern California, Keck School of Medicine, Los Angeles, CA

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)

N ALAM1, M BHALLA2, J Ulmer2, A Klein2, B Fitzsimmons2, S PAMARTHY1, S Quinet2, K McAvoy1
1MEDICAL COLLEGE OF WISCONSIN, MILWAUKEE, WI, 2Medical College of Wisconsin - Froedtert Hospital, Milwaukee, WI

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 (TGFβ1) is a potent fibrogenic agent that has been shown to promote post-hemorrhagic fibrosis and chronic communicating hydrocephalus. Moreover, TGFβ1 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 TGFβ1 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

L Zhao¹, W Dai², S Soman¹, D Hackney¹, D Alsop¹
¹Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, MA, ²Binghamton University, Binghamton, NY

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...
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.
Etiologies and Magnetic Resonance Imaging Patterns of Isolated Lesions of the Medulla Oblongata

S Prakkamakul1, P Schaefer2, G Gonzalez2, O Rapalino3
1King Chulalongkorn Memorial Hospital Thai Red Cross Society, Bangkok, Thailand, 2Massachusetts General Hospital, Boston, MA, 3Massachusetts General Hosp., Boston, MA

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.

j_sain1, S Sinha2, B Shankara3

1NIMHANS, BANGALORE, Karnataka, 2NIMHANS, Bangalore, Karnataka, 3National institute of Occupational Health, Bangalore, Karnataka
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

K Byrns1, G Fatterpekar1, J Hu1, J Babb1, A Davis1

1NYU Langone Medical Center, New York, NY

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.
### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Single energy</th>
<th>Dual energy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>40.2 ± 12.8</td>
<td>39.3 ± 13.1</td>
</tr>
<tr>
<td></td>
<td>p = 0.66</td>
<td></td>
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<tr>
<td><strong>CDTI (mGy)</strong></td>
<td>45.72 ± 0.57</td>
<td>47.35 ± 0.01</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.001</td>
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</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Image Quality Criteria</th>
<th>Reader 1</th>
<th>Reader 2</th>
<th>DF</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>DE ratio</td>
<td>p-value</td>
<td>DE ratio</td>
</tr>
<tr>
<td>Visualization of the pons</td>
<td>0.89</td>
<td>0.001</td>
<td>0.75</td>
</tr>
<tr>
<td>Cerebellar gray-white differentiation</td>
<td>0.84</td>
<td>0.004</td>
<td>0.75</td>
</tr>
<tr>
<td>Visualization of the basal ganglia</td>
<td>0.72</td>
<td>0.096</td>
<td>0.58</td>
</tr>
<tr>
<td>Visualization of insular cortex</td>
<td>0.72</td>
<td>0.096</td>
<td>0.58</td>
</tr>
<tr>
<td>Cerebral grey-white differentiation</td>
<td>0.67</td>
<td>0.238</td>
<td>0.65</td>
</tr>
<tr>
<td>Visualization of cerebral cortex</td>
<td>0.61</td>
<td>0.481</td>
<td>NA</td>
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<tr>
<td>Overall quality</td>
<td>0.68</td>
<td>0.167</td>
<td>0.65</td>
</tr>
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DE ratio = ratio of number of pairs for which dual energy was preferred out of total number of pairs.

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**Fat Embolism Syndrome**

C Tramontini\(^1\), J MORA\(^2\), A QUINTERO CORREDOR\(^3\), C Rivera\(^4\), D Segura\(^5\), J Mazraeh\(^6\)

\(^1\)Clinica Universitaria Colombia, Bogota, Cundinamarca, \(^2\)CLINICA COLOMBIA, BOGOTA, Colombia, \(^3\)CLINICA REINA SOFIA, BOGOTA, Colombia, \(^4\)Clinica Universitaria Colombia, bogota, Colombia, \(^5\)Fundacion Universitaria Sanitas, Bogota, Colombia, \(^6\)Landeskrankenhaus Feldkirch, Feldkirch, Feldkirch

**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.
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.
Functional brain imaging of pain modulation by Virtual Reality (VR) distraction during burn wound care using Tc 99m-ethyl cysteinate dimer (ECD) SPECT

D Lewis¹, C Zacharias¹, M Bermo¹, H Hoffman¹, D Patterson¹, A Wilson¹, S Minoshima², S Sharar¹
¹University of Washington, Seattle, WA. ²University of Utah, Salt Lake City, UT

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

L Hoang¹, T O'neill¹, S Salehian¹, Z Yetkin¹
¹UT Southwestern, Dallas, TX

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 in the posteromedial left temporal lobe. Axial (c) and sagittal (d) images with threshold subtraction 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 in the left superior temporal gyrus demonstrates strong correlation ($R_{\text{mean}} = 0.501 \pm 0.010$, $R_{\text{max}} = 0.613$) with a cluster in the left operculum in a similar location to the activation for Wernicke’s area as identified in the sentence completion analysis.
**Functional disconnection of posterior cingulate cortex contributes to cognitive impairment in patients with symptomatic carotid artery disease**

D Meng\(^1\), A Hosseini\(^1\), R Simpson\(^1\), R Dineen\(^1\), D Auer\(^1\)

\(^1\)Radiological Sciences, Division of Clinical Neuroscience, School of Medicine, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom

**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

T Tran¹, o boyko²
¹Huntington Medical Research Institutes, Pasadena, CA, ²University of Southern California, Los Angeles, CA

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.

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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

b addicott¹, N Monga², D Pettersson³
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.
eP-83

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.
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

W Guo1, C Lin2, F Chang1, K Chen3, F Wu4, S Hung1, W Chu5, D Zheng6
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 peri-stenting 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
6:30AM - 2:45PM

M BHALLA1, J Ulmer1, A Klein1, S PAMARTHY2, B Fitzsimmons1, L Mark1, K McAvoy2, N ALAM2
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?**

C Bouzad¹, P Roux², H Picard², A Gueguen², F Maizeroi-Eugène³, J Savatovsky²
¹Val-de-Grâce Military Hospital, Paris, Ile de France, ²A. de Rothschild foundation, Paris, Ile de France, ³s.a.r.l. IMAGE ET, MORDELLES, 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 4 800 (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.
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.
<table>
<thead>
<tr>
<th>Details of brain lesions in SLE patients</th>
<th>SLE patients with brain lesions (n=9), No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large territorial infarctions</td>
<td>1 (11)</td>
</tr>
<tr>
<td>Lacunar infarctions</td>
<td>6 (67)</td>
</tr>
<tr>
<td>Localized cortical infarctions</td>
<td>1 (11)</td>
</tr>
<tr>
<td>Borderzone infarctions</td>
<td>5 (55)</td>
</tr>
<tr>
<td>Large perforator infarctions</td>
<td>2 (22)</td>
</tr>
</tbody>
</table>

(Filename: TCT_eP-25_hyou.jpg)
Figure A

Diffusion weighted image shows acute infarction in right deep white matter.

(Filename: TCT_eP-25_FigA.jpg)
T1 weighted CUBE shows the VWL in M1 segment of right MCA.
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 SAIGA\textsuperscript{1}, H Yokota\textsuperscript{1}, H Mukai\textsuperscript{1}, T Horikoshi\textsuperscript{1}, T Uno\textsuperscript{1}

\textsuperscript{1}Chiba 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)>. 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.

Low-signal-intensity rim on susceptibility-weighted imaging is not a specific finding to progressive multifocal leukoencephalopathy

M Umino1, M Maeda1, Y Ii2, H Tomimoto1, H Sakuma1
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 layers of the identified SWI appeared onset 312 days after the event.

(Filename: TCT_eP-43_Fig1.jpg)

eP-111

Measurement of Cerebral Venous Susceptibility in Healthy Volunteers Using Quantitative Susceptibility Measurement Techniques

P Eaton¹, P Kim¹, C Toensing¹, J Jacobson¹
¹Loma Linda University Medical Center, Loma Linda, CA
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 6:30AM - 2:45PM
Measuring iron deposits within focal lesions in patients presenting clinically isolated syndrome
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
A Krishnan¹, H Marin², S Margiewicz¹, R Silbergleit¹, R Ceulemans², J Wilseck¹, A Wang³
¹Beaumont Hospital, Royal Oak, MI, ²Henry Ford Hospital, Detroit, MI, ³Beaumont Hospital, Royal Oak, MI

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?

S Stock¹, M Hussain¹, K Uchino¹, S Winners¹, S John¹, R Cerejo¹
¹Cleveland Clinic, Cleveland, OH
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>
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</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>
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</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>25</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)
Z Hutchinson¹, S Clifford¹, N Tubridy¹, S O'Riordan¹, J Kinsella¹, C McGuigan¹, R Killeen¹
¹St. Vincent's University Hospital, Dublin 4, Ireland

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)
18 year old female with a background of Neurofibromatosis 1 presented with laughter-induced syncope. Diagnosed with moyamoya syndrome- left-sided involvement of the left internal carotid artery and MCA (D).

Same 18 year old female following a direct surgical revascularization procedure anastomosing the left superficial temporal artery (E) to the middle cerebral artery (D). The patient is now 3 months post-procedure, the laughter-induced syncope has not recurred since the surgery.

Axial MIP CTA

(Filename: TCT_eP-20_Slide4.jpg)
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 SphereTM 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

6:30AM - 2:45PM

MRI Characteristics of Sporadic and Von Hippel-Lindau Syndrome-Associated Spinal Hemangioblastoma

R Kelley\textsuperscript{1}, T Tihan\textsuperscript{1}, S Cha\textsuperscript{1}

\textsuperscript{1}University of California, San Francisco, San Francisco, CA
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-tailed t-tests were performed to compare the mean values.

<table>
<thead>
<tr>
<th></th>
<th>sHB subtype</th>
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<tbody>
<tr>
<td></td>
<td>Sporadic</td>
<td>VHLS</td>
<td></td>
</tr>
<tr>
<td>Nodule</td>
<td>Size (mm)</td>
<td>21.9</td>
<td>19.1</td>
</tr>
<tr>
<td>Cyst</td>
<td>Size (mm)</td>
<td>40.8</td>
<td>22.1</td>
</tr>
<tr>
<td></td>
<td>Ratio (Cyst/Nodule)</td>
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<td>1.4</td>
</tr>
<tr>
<td>Edema</td>
<td>Size (mm)</td>
<td>126.9</td>
<td>126.3</td>
</tr>
<tr>
<td></td>
<td>Ratio (Edema/Nodule)</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.

eP-50
6:30AM - 2:45PM

MRI evaluation of cerebral changes following hyperosmolar therapy in patient with cerebral venous sinus thrombosis.

j saini¹, R Sidhu²
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.

(Filename: TCT_eP-50_fig2.jpg)

eP-52

6:30AM - 2:45PM

MRI Evaluation of Stroke: Does Contrast Imaging of the Brain Add Diagnostic Value?

M Lanfranchi1, N Madan2, S Kalli2, W Mehan2

1Massachusetts General Hospital, Boston , MA, 2Tufts Medical Center, Boston , MA

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**

R Nunes¹, A da Rocha¹, L do Amaral², M Warmuth-Metz³, A Osborn⁴

¹Irmandadade Santa Casa de Misericordia de Sao Paulo, Sao Paulo, Brazil, ²MEDIMAGEM - Hospital da Beneficencia Portuguesa de Sao Paulo, Sao
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

D MacDonald¹, J Shankar¹
¹Dalhousie University, Halifax, Nova Scotia

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

Neuromyelitis Optica: Looking at the Brain for Clues

C Lincoln¹, K Carril¹, R Mahmoud¹, P Fata¹, D Variyam¹, G Hutton¹, T Acosta¹
¹Baylor College of Medicine, Houston, TX

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

6:30AM - 2:45PM

New Bone Formation over Dehiscent Superior Semicircular Canals after Transmastoid Cartilage Cap Resurfacing

L Lundy¹, R Pooley¹, P Vibhute¹, V Gupta¹, D Zapala¹
¹Mayo Clinic Florida, Jacksonville, FL

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.

(Filename: TCT_eP-58_Pre-op.jpg)
Optimization of Bolus Visualization in Dual Energy Head CT angiography: effect of monochromatic imaging, iterative reconstruction, and concentration of the iodine bolus

D Zhang¹, M Palmer¹, C Wilcox¹, D Hackney¹
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.

Table 1

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<th>CT Number in DECT at Different keV and Iodine Concentration</th>
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Fig. 1

(CNR vs. keV
NON MARS ATOM SS0)

Fig. 2

(Filename: TCT_eP-114_ASNR_2016_bolus_visualization_DECTA_20151210_21h40m.png)

eP-23
Optimizing MRA Evaluation of Supraclinoid Aneurysms. A Comparison in Detecting Supraclinoid Aneurysms Using Whole 3D MRA MIPs Versus Half 3D MRA MIPs.

S Margiewicz¹, A Krishnan¹, C Kazmierczak¹
¹Beaumont Hospital, Royal Oak, Michigan

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

A Batouli\textsuperscript{1}, D Monks\textsuperscript{1}, S Mirza\textsuperscript{1}, M Goldberg\textsuperscript{1}, E Kanal\textsuperscript{2}, M Spearman\textsuperscript{1}
\textsuperscript{1}Allegheny Health Network, Pittsburgh, PA, \textsuperscript{2}Univ of Pittsburgh Med Ctr, Pittsburgh, PA

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

D Drumsta1, B Soares2, A Saindane1, D Qiu1, J Willie1, D Drane1, R Gross1
1Emory University, Atlanta, GA, 2Emory Univ. Hospital, Atlanta, GA

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

Y TSAI¹, R Yuan², B BISWAL²
¹CHANG-GUNG MEMORIAL HOSPITAL, CHIAYI, Taiwan, ²New Jersey Institute of Technology, Newark, NJ

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 subjects 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.
Preliminary data: T1 volume interpolated GRE improves visualization of arteries and veins compromising the trigeminal nerve

S Siemonsen¹, D Kutzner², J Sedlacik², J Regelsberger², J Fiehler³
¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ²University Medical Center Hamburg-Eppendorf, Hamburg, Hamburg, ³University Medical Center Hamburg-Eppendorf, Hamburg, AK

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

J Rutland¹, B Delman¹, P Balchandani¹, L Marcuse¹, M Fields¹, R Feldman¹
¹Icahn School of Medicine at Mount Sinai, New York, NY

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 patients (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.

S Mirbagheri¹, A Kamali², h sair¹
¹Johns Hopkins University, Baltimore, MD, ²Johns Hopkins University Hospital, Baltimore, MD

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 journal 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 total (primary axis) and relative proportion (secondary axis) of articles published from 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

A Santos¹, D Zanatta¹, C Rondinoni², G Pamplona², C Salmon², P Rossi³, C Del-Ben¹
¹School of Medicine of Ribeirão Preto - University of São Paulo, Ribeirão Preto, Brazil, ²Faculty of Philosophy, Sciences and Letters at Ribeirão Preto – University of São Paulo, Ribeirão Preto, Brazil, ³School of Medicine - University of São Paulo, São Paulo, Brazil

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](TCT_eP-08_FEMDD-restingState.png)

**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.**

**Table 1.** zICA values in difference areas between groups. Numbers in bold font indicate mean z-ICA values significantly different from zero (t-test, p<0.05).

<table>
<thead>
<tr>
<th>Region</th>
<th>Brodmann</th>
<th>CTR  zICA (SD)</th>
<th>FEMDD zICA (SD)</th>
<th>t test p-value</th>
<th>Voxel</th>
<th>x</th>
<th>y</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Occipital</td>
<td>BA18/19</td>
<td>-0.38 (0.42)</td>
<td>0.10 (0.26)</td>
<td>0.000168</td>
<td>8643</td>
<td>-33</td>
<td>-70</td>
<td>-3</td>
</tr>
<tr>
<td>Left Occipital</td>
<td>BA18/19</td>
<td>-0.52 (0.64)</td>
<td>-0.08 (0.26)</td>
<td>0.002713</td>
<td>8563</td>
<td>-34</td>
<td>-74</td>
<td>-7</td>
</tr>
<tr>
<td>Left Inferior Frontal</td>
<td>BA11/47</td>
<td>-0.53 (0.29)</td>
<td>-0.04 (0.39)</td>
<td>6.86E-05</td>
<td>6170</td>
<td>-33</td>
<td>29</td>
<td>-13</td>
</tr>
<tr>
<td>Left DLPFC</td>
<td>BA9/44</td>
<td>-0.40 (0.38)</td>
<td>-1.14 (0.60)</td>
<td>4.98E-05</td>
<td>3945</td>
<td>-51</td>
<td>17</td>
<td>22</td>
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<tr>
<td>Anterior Cingulate</td>
<td>BA9/10/32</td>
<td>0.22 (0.46)</td>
<td>0.84 (0.64)</td>
<td>0.001302</td>
<td>11220</td>
<td>41</td>
<td>41</td>
<td>1</td>
</tr>
</tbody>
</table>

(Filename: TCT_eP-08_FEMDD-restingState.png)
Retrospective Study to Compare the MRI Appearance of Thalamic Gliomas and Thalamic Subacute Infarcts.

P SHAH¹, B Liu²
¹Northwestern University Feinberg School of Medicine, CHICAGO, IL, ²Northwestern University Feinberg School of Medicine, Chicago, IL

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.

H Maresky¹, M Levitt², A Kossar², D Zucker¹, S Tal¹
¹Assaf Harofeh Medical Center, Zrifin, HaMerkaz (Central), ²Assaf Harofeh Medical Center, Zrifin, Israel

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.
eP-16

Rheumatoid Pachymeningitis. Relevant MRI findings, Monitoring Treatment and Follow-up with Conventional MRI and Arterial Spin Labeling.

A Mas-Bonet¹, D Quiñones Tapia², J Fernadez Melon¹, M Picado Valles³, A Marin Quiles⁴, N Calvo Rado¹, A Moll Servera¹, C Gassent Balaguer⁵

¹Hospital Son Espases, Palma de Mallorca, Spain, ²Hospital del Rosario, Madrid, Madrid, ³Hospital son Espases, Palma de Mallorca, Spain, ⁴Hospital Son Espases, Palma de Mallorca, Spain, ⁵Hospital Son Espases, Palma de Mallorca, Illes Balears
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

S Sogge¹, A Agarwal¹, S Kanekar¹
¹Penn State Hershey Medical Center, Hershey, PA

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

P Aldinger¹, M Bazerbashi¹, Z Rost¹, M Buhler¹, T Lewis¹, R Schneider²
¹University of Toledo, Toledo, OH, ²The 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 brainstem 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.

J Berger¹, M Goyal², C Derdeyn³, M Miller-Thomas⁴, K Vo⁴, T Madaelil⁴
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**

6:30AM - 2:45PM

**Subcortical T2/FLAIR Hypointensity on MRI: Symptomatic Neurologic Associations**

D Wannemacher¹, H Morales¹

¹University of Cincinnati, Cincinnati, OH

**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.
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 subcortical hypointense signal within the right posterior temporoparietal regions 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.
G Healy1, H Fleming1, C Redmond1, A Carroll1, C McGuigan1, R Killeen2, R Kavanagh3
1St Vincent's University Hospital, Dublin, Dublin, 2Royal Victoria Eye and Ear Hospital, Dublin, Dublin, 3St Vincent's University Hospital, Dublin 4, Ireland

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 intra-orbital.

Conclusions
Routine T2 sagittal brain imaging with 4mm slice thickness has poor sensitivity but high specificity for optic neuropathy.
The CT and MR perfusion weighted imaging are useful in differentiating high grade gliomas masquerading as acute cerebral stroke from true stroke lesions--Eight-year experience in a single institution

X Liu¹, W Tian¹, H Wang²
¹University of Rochester Medical Center, Rochester, NY, ²University of Rochester Medical Center, Rochester, NY

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)
(Filename: 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.

E Lambert¹, s holmes²
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.

Figure 2: A case with non-enhancing anaplastic astrocytoma showed increased CBV in the white matter (yellow arrow) in MR perfusion imaging, which suggested tumor infiltration.
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 heath 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

C Gibby1, S Cvetko2, L Nguyen3, W Gibby4
1Baylor College of Medicine, Houston, TX, 2Novarad Corporation, American Fork, UT, 3Novarad Corp., American Fork, UT, 4University of California San Diego, San Diego, CA

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
<table>
<thead>
<tr>
<th>Structure</th>
<th>Average Activation</th>
<th>Patient Activation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusiform Gyrus</td>
<td>1.75 ± 1.24</td>
<td>1.28</td>
<td>Primary visual processing</td>
</tr>
<tr>
<td>Primary Visual Cortex</td>
<td>1.92 ± 1.31</td>
<td>1.09</td>
<td>Primary visual processing</td>
</tr>
<tr>
<td>Visual Association Cortex</td>
<td>3.04 ± 1.07</td>
<td>1.37</td>
<td>Complex object recognition</td>
</tr>
<tr>
<td>Medial Frontal Gyrus</td>
<td>0.84 ± 0.85</td>
<td>1.36</td>
<td>Attention control</td>
</tr>
<tr>
<td>Inferior Frontal Gyrus</td>
<td>1.33 ± 1.18</td>
<td>1.75</td>
<td>Left frontal language areas</td>
</tr>
</tbody>
</table>
### Cvetko-Gibby Atlas
#### Volumes by Region

<table>
<thead>
<tr>
<th>Region</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal Ganglia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cingulate Gyrus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frontal Pole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fusiform Gyrus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hippocampus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior Frontal Gyrus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior Parietal Lobule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior Temporal Gyrus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insula</td>
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</tr>
</tbody>
</table>
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)
Epileptic seizures: overcoming diagnostic dilemmas with multimodal MRI

M Patel¹, J Zhang², G Mazibrada³, N Davies³, V Sawlani⁴
¹University Hospitals Birmingham NHS Foundation Trust, Birmingham, United Kingdom, ²Huashan Hospital, Shanghai, -³University Hospitals Birmingham NHS Foundation Trust, Birmingham, West Midlands, ⁴University Hospitals Birmingham, Birmingham, United Kingdom

Purpose
Epileptic seizures are a common neurological disorder characterized by abnormal electrical activity in the brain. The diagnosis can be challenging due to the episodic nature of seizures and the variability in clinical presentation. Multimodal magnetic resonance imaging (MRI) can provide valuable information, but its utility in the diagnosis of epileptic seizures is not widely recognized. In addition, current evidence is confusing and sometimes conflicting, leading to inaccurate interpretation.

Materials and Methods
We performed a retrospective review of 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 epileptic seizures. 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 epileptic seizures 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
Epileptic seizures 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.
Use of Dual Energy CT to Determine Valve Settings of Programmable Shunts: Ex Vivo Testing.

K Hsieh¹, A Mamourian¹
¹University of Pennsylvania, Philadelphia, PA

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.

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**

A Korutz¹, C Oustwani², M Lester³, Y Kianirad⁴, T Simuni⁴, T Hijaz⁵

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

6:30AM - 2:45PM

Venous Epidural Hematoma: Distribution and Venous Sinus Complications

B Aldred1, R Wiggins2, E Quigley1
1University of Utah, Salt Lake City, UT, 2University Of Utah, Salt Lake City, UT

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, torcula, 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
6:30AM - 2:45PM

Whole-brain echo planar spectroscopic imaging distinguishes recurrent tumor versus pseudoprogression in glioblastoma patients.

G Verma¹, S Mohan¹, S Chawla², S Wang², A Maudsley³, S Brem², R Wolf⁴, H Poptani⁵
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 $2.57 \pm 0.63$ times higher in the contrast-enhancing area of TP patients compared to the contralateral region. Elevation in Cho/NAA was less ($1.70 \pm 0.48$) 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>Region</th>
<th>Median Cho/NAA</th>
<th>PsP (N=7)</th>
<th>TP (N=7)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancing Region</td>
<td>1.70 ± 0.48</td>
<td>2.57 ± 0.63</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>Peritumoral</td>
<td>1.70 ± 0.58</td>
<td>2.32 ± 0.89</td>
<td>0.176</td>
<td></td>
</tr>
<tr>
<td>Distal Peritumoral</td>
<td>1.21 ± 0.30</td>
<td>1.85 ± 0.65</td>
<td>0.052</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Median Cho/Cr</th>
<th>PsP (N=7)</th>
<th>TP (N=7)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancing Region</td>
<td>1.30 ± 0.27</td>
<td>2.02 ± 0.88</td>
<td>0.062</td>
</tr>
<tr>
<td>Peritumoral</td>
<td>1.26 ± 0.43</td>
<td>1.84 ± 0.91</td>
<td>0.183</td>
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<tr>
<td>Distal Peritumoral</td>
<td>1.18 ± 0.28</td>
<td>1.60 ± 0.60</td>
<td>0.147</td>
</tr>
</tbody>
</table>

Figure 2

A: Pseudoprogression Enhancing Region
B: True Progression Enhancing Region
A Novel Imaging Measurement Identifying Patients with Orbital Floor Fracture Requiring Surgical Repair

M Taheri¹, M Rudolph¹, D Brown², T Mansour³
¹George Washington University, Washington, DC, ²George Washington University, Washington, DC, ³George Washington University Hospital, Washington, DC

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

a abdel razek
1Mansoura faculty of medicine, mansoura, WY

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!

D Kim1, G Franco2, H Shigehara3, J Asaumi3, P Hildenbrand1
1Lahey Hospital and Clinics, Burlington, MA, 2Commonwealth Radiology Associates, Brockton, MA, 3Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama, Okayama
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 nintey-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".
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
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

N Ray¹, S Vyas², R Bansal¹, N Khandelwal³
¹Postgraduate Institute of Medical Education and Research, Chandigarh, India., Chandigarh, INDIA, ²Postgraduate Institute of Medical Education and Research, Chandigarh, Chandigarh, ³Postgraduate Institute of Medical Education and Research, Chandigarh, INDIA

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

R Khan1, J Probst2, U Udayasankar2
1University of Arizona Medical Center, Tucson, AZ, 2University of Arizona, Tucson, AZ

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
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 rabdomyosarcoma 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

Imaging Patterns of Skull Base Encephaloceles

M Labib¹, B Delman¹
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?**

N Emmanuel¹, E Kari¹, J Go²
¹Keck USC School of Medicine, Los Angeles, CA, ²LAC/USC Medical Center, Los Angeles, CA

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**

Z Guan¹, M Ibrahim¹, M Adix², M Spector¹, A Srinivasan¹
¹University of Michigan, Ann Arbor, MI, ²St John Providence, Paradise Valley, AZ

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**

H Curtin¹, K Leung², A Juliano¹

¹Massachusetts Eye and Ear Infirmary, Boston, MA, ²Brigham and Women's Hospital, Boston, MA

**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**

MRI 3-D Reconstruction of the Internal Auditory Canal and Inner Ear. Can we eliminate CT?

D Salgado1, R Glikstein1, M Ojiaku1, M dos Santos1, M Kingstone1, T Almansoor1
1University of Ottawa, Ottawa, Ontario

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.

MRI of Facial Cosmetic Injectable Filters: an Analytic Approach to Identification of Injected Substance, Complications and Symmetry of Injected Sites.

S Tal¹, H Maresky¹, T Bryan¹, L Heller¹
¹Assaf Harofeh Medical Center, Zrifin, HaMerkaz (Central)

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

X Wu¹, C Glastonbury¹
¹University of California, San Francisco, San Francisco, CA

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 digastric 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 digastric, 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 digastric 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 digastric 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. (Fig. 1: Abnormal T2 hyperintensity and enhancement within the left posterior belly of the digastric muscle, compatible with tumor involvement in a patient with previously treated left palatine tonsil squamous cell carcinoma and oral tongue recurrence.)

Conclusions
Muscular tumor spread along the posterior belly of the digastric 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

H Lee¹, S Youn²
¹Kyungpook National University Hospital, Chapel Hill, NC, ²Catholic University of Daegu, Daegu, NC

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

Y Kaichi¹, K Tanitame², H Itakura¹, H Ohno¹, M Yoned¹, Y Takahashi³, Y Akiyama³, K Awai¹
¹Hiroshima University, Hiroshima, Japan, ²Chugoku Rosai Hospital, Kure, Japan, ³Hiroshima University Hospital, Hiroshima, Japan

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
6:30AM - 2:45PM

Radiologic Differences between Human Papillomavirus (HPV)-related Compared to HPV-Unrelated Oropharyngeal Carcinoma on Diffusion Weighted Imaging

M Chan¹, S Symons², P Maralani²
¹University of Toronto, Toronto, Ontario, ²Sunnybrook Health Sciences Centre, Toronto, Ontario

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.

eP-142

6:30AM - 2:45PM

Retinography: Molecular Imaging to Quantitate and Monitor Retinal Ganglion Cells in a Glaucoma Model

L Le Roux¹, X Qui¹, D Ramos¹, L Flores¹, D Schellingerhout¹, D Piwnica-Worms²
¹UT MD Anderson Cancer Center, Houston, TX, ²MD Anderson Cancer Center, Houston, TX

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 RCGs.

eP-140

Role of Adaptive Statistical Iterative Reconstruction (ASIR) in Lowering Radiation Dose for Pediatric Head CT

A Tabari¹, S Singh¹, s Rincon², P Caruso², d singh², M Gee¹
¹Massachusetts General Hospital, Boston, MA, ²MGH, Boston, MA

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
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.

6:30AM - 2:45PM

The Accuracy of Computed Tomography in Predicting Clinical Impairment of the Inferior Rectus Muscle in Patients with Orbital Floor Fractures

L ZHANG1, T Mansour2, B Sianati1, M Taheri1

1Department of Radiology, George Washington University Hospital, Washington, DC, 2Department of Ophthalmology, George Washington University Hospital, Washington, DC

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
6:30AM - 2:45PM
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
1Hacettepe University, Ankara, -; 2Hacettepe University, Ankara, Turkey

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>
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<td>Tm Total/temporalis</td>
<td>≥1.18</td>
<td>92</td>
<td>100</td>
<td>100</td>
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<td>Tm Min/temporalis</td>
<td>≥1.09</td>
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<td>100</td>
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<td>41</td>
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<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)

(Filename: TCT_eP-124_ScreenShot2015-12-09at122749.png)
The Diagnostic Value of CT Angiography for the Diagnosis of Glomus Tumors in the Neck

Aqu Zen1, O Akca2, A Dolgun2, S Hosal3, N Suslu2
1Hacettepe University, Ankara, Turkey, 2Hacettepe University, Ankara, -, 3Liv 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 (CTAVlesion) and of its non-necrotic portion (CTAVsolid). Region of interest (ROI) measurements also were obtained from the sternocleidomastoid muscle (CTAVscm) for calculation of CTAVlesion/CTAVscm and CTAVsolid/CTAVscm 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 CTAVlesion (205.26±69.6 HU) and mean CTAVsolid (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 CTAVlesion/CTAVscm ratios (3.05 HU ±1.12) and the mean CTAVsolid/CTAVscm 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.
Utility of 4D-CT and Multimodality Imaging for Parathyroid Adenoma Detection and Localization.

J Acharya¹, D Maceri¹, A Namini¹, D Lu¹, C Ugwueze¹, M Shiroishi¹, J Go¹, M Law¹, A Lerner¹
¹University of Southern California, Keck Medical Center of USC, Los Angeles, CA

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
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 diluted 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

J Lozano¹, K de Macedo Rodrigues¹, A Kühn¹, M Howk¹, C Brooks¹, M Perras¹, D Rex², F Massari¹, M Gounis¹, A Wakhloo¹, A Puri¹
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 Yakes¹

¹Vascular 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

¹The 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.

eP-153
6:30AM - 2:45PM

Geometric and Hemodynamic Change after Aneurysm Rupture: A Case Study

C Putman¹, B Chung², F Hamzei-Sichani³, J Cebral²
¹Inova Fairfax Hospital, Falls Church, VA, ²George Mason University, Fairfax, VA, ³Icahn School of Medicine, Mount Sinai Health System, New York, NY

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 post-rupture 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

T Chaudhry¹, Z Lu², M Rozenfeld³, G Christoforidis², S Lee⁴
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 post-installation 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

E Pomero1, C Perazzini2, A Biondi3
1Besançon University Hospital, Besançon, France, 2Besançon University Hospital, Besançon, France, 3Besançon University Hospital, Besançon, France
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.

**eP-158**

**Rescue mechanical intracranial thrombectomy following cardiovascular and orthopedic surgery**


**CHU 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 YO1
1Gangeung Asan Hospital, University of Ulsan College of Medicine, Gangneung-si, Gangwon-do

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.

Ultra-Low Contrast Volumes Reduces Contrast-Induced Nephropathy in Patients With Chronic Kidney Disease Undergoing Neurointerventional Procedures

A Swarnkar

1Upstate Medical University Hospital, Jamesville, NY

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

S Palasis1, R Jones1, J Wu2, N Esiashvili2, E Schreibmann2, C Mazewski1, D Aguilera1, D Qiu2
1Children's Healthcare of Atlanta & Emory University School of Medicine, Atlanta, GA, 2Emory University School of Medicine, Atlanta, GA
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

P Raghavan¹, L Jiang², C Sours², D Metwally², R Gullapalli²
¹University of Maryland School of Medicine, Baltimore, MD, ²University of Maryland School of Medicine, Baltimore, MD

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

J Angel¹, J Harrel²
¹St. Jude Children's Research Hospital, University of Tennessee/Methodist Healthcare, Memphis, TN, ²St. Jude Children's Research Hospital, Memphis, TN

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

Application of Normative Occipital Condyle-C1 Interval (CCI) Measurements to Detect Atlanto-occipital Injury in Children

B Corcoran¹, L Linscott¹, J Leach¹, S Vadivelu¹
¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH

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.
Assessment of gadolinium deposition pediatric patients who received multiple doses of gadopentetate dimeglumine

D Burrowes¹, S Garcia¹, P Nelson¹, J Deng¹
¹Lurie Children's Hospital, Chicago, IL

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 ration 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 Harty¹, A Parikh¹, A Pollock², S Pruthi¹, A Bhatia¹
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 brainstem 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**

**6:30AM - 2:45PM**

**Black Bone MRI of the skull in pediatric traumatic brain injury: Can MRI replace CT?**

M Dremmen¹, M Wagner¹, A Poretti², T Bosemani², A Tekes¹, T Huisman³

¹Johns Hopkins Hospital, Baltimore, MD, ²The Johns Hopkins University School of Medicine, Baltimore, MD, ³Johns Hopkins, Baltimore, MD

**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.

Can Multiparametric MRI Reliably Grade Choroid Plexus Tumors?

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.
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 post-Diamox (pre-CBF average: 59.5 ml/100g/min, post-CBF 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.

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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 Altaye7, 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 Shekdar\textsuperscript{1}, M ALSUHAIBANI\textsuperscript{2}, M Santi\textsuperscript{3}, E Schwartz\textsuperscript{4}
\textsuperscript{1}Children's Hospital of Philadelphia, Philadelphia, PA, \textsuperscript{2}CHILDRENS' HOSPITAL OF PHILADELPHIA, PHILADELPHIA, PA, \textsuperscript{3}Children’s Hospital of Philadelphia, Philadelphia, PA, \textsuperscript{4}Children's Hosp. Of Philadelphia, Philadelphia, PA

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

G Cervantes\textsuperscript{1}, M Yazdani\textsuperscript{1}, T Larrew\textsuperscript{1}, R Eskandari\textsuperscript{1}, M Spampinato\textsuperscript{2}
\textsuperscript{1}Medical University of South Carolina, Charleston, SC, \textsuperscript{2}Medical University Of South Carolina, Charleston, SC
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

Fetal Brain MRI Super Resolution Processing

J Maffie¹, J Grinband²
¹New York Presbyterian, New York, NY, ²Columbia University, New York, NY

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

Fetal Hydrocephalus: Causal Factors and Associated Abnormalities in Obstructive Hydrocephalus on Fetal MR in Early and Late Gestation.

P Krishnan1, P HANAGANDI1, P Shannon2, S Blaser1, C Raybaud1
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.

eP-181
6:30AM - 2:45PM

Fetal MR Imaging of Craniosynostosis: Impact on Diagnostic, Prognostic and Pathophysiology

J Alves¹, X Mu², A Foster-Barber², O Glenn²
¹Centro Hospitalar do Porto, Porto, Portugal, ²University Of California, San Francisco, San Francisco, CA
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.

How reliable are prenatal tractography results? A postnatal in vivo follow-up DTI study

J Song1, J Patsch2, G Gruber2, D Prayer2, G Kasprian2
1Yale University, New Haven, CT, 2Medical University of Vienna, Vienna, Austria

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), corticospinal tracts (green, left; yellow, right) of a 29 gestational week fetus with a midline posterior parietooccipital cyst shows intact fibers. The posterior aspect of the body and splenium of the corpus 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.
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

K Wang¹, D Lin¹
¹Johns Hopkins School of Medicine, Baltimore, MD

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

Iterative Reconstruction Technique for Reducing Brain CT Radiation Dose: A Study in Pediatric Patients Following Brain Trauma.

J Becker1, A Janicek1, U Udayasankar1, E Krupinski2, W Erly1

1University of Arizona, Tucson, AZ, 2Emory University, Atlanta, GA

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

D Freitas¹
¹Hospital Aliança, Salvador, Brazil

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.
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 ± 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.

(Filename: TCT_eP-161_Fig1.jpg)
Prevalence and Outcomes of Cavernous Malformations Following Cranial Radiation in Pediatric Cancer

B Huston¹, Y Khakoo², V Hatzoglou²
¹NYP-Weill Cornell Medicine & Memorial Sloan-Kettering Cancer Center, New York, NY, ²Memorial Sloan-Kettering Cancer Center, New York, NY

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
6:30AM - 2:45PM

Role of Cerebrospinal Fluid (CSF) Flow Imaging in Evaluating Distribution of Infused Agents from the Fourth Ventricle to the Total Spine.

R Patel¹, C Sitton¹, M Kerr², S Fletcher³, M Shah³, D Sandberg³
¹Department of Diagnostic and Interventional Radiology, University of Texas Health Science Center, Houston, TX, ²Department of Pediatric Surgery, University of Texas Health Science Center, Houston, TX, ³Department of Pediatric Surgery and Neurosurgery, University of Texas Health Science Center, Houston, TX

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

K Cecil¹, J Hugentobler¹, C Quatman-Yates¹, P Gubanich¹, M Altaye¹, S Wade¹, T Beckwith¹, B Kurowski¹
¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH

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 LCMRModel 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

D Davidson¹, M Whitehead²
¹George Washington University Hospital, Washington, DC, ²Children's National Medical Center, Washington, DC
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

M Gencturk¹, H Tore¹, D Nascene², C Truwit³, A McKinney¹
¹University of Minnesota, Minneapolis, MN, ²University of Minnesota, Minneapolis, MN, ³HCMC, Minneapolis, MN

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.
Tortuosity of vertebral and basilar artery: A new finding in patients with Mucopolysaccharidosis Typ IVa

Y Tanyildizi¹, W Müller-Forell²
¹Neuroradiology JG University Mainz, Mainz, Germany, ²Neuroradiology JG University Mainz, Mainz, Germany

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

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) 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 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.
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

F Ucisik-Keser¹, Y Hamid¹, W Wei¹, T Chi²
¹University of Texas MD Anderson Cancer Center, Houston, TX, ²M.D. Anderson Cancer Center, Houston, TX

Purpose
Gadobutrol is a relatively new gadolinium-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**

B Winegar¹, U Rassner¹

¹University of Utah, Salt Lake City, UT

**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.
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

L Busby1, W Dillon1, B Rehani1
1UCSF, San Francisco, CA

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.
The Impact of Airway Management Strategies on the Quality of Central Nervous System MR Imaging

D Ferson¹, F Ucisik-Keser¹, Y Hamid¹, T Chi²
¹University of Texas MD Anderson Cancer Center, Houston, TX, ²M.D. Anderson Cancer Center, Houston, TX

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

C Pinnix¹, D Cachia², K Woodman³, T Chi⁴
¹MD Anderson Cancer Center, Houston, TX, ²Medical University of South Carolina, Charleston, SC, ³University of Texas MD Anderson Cancer Center, Houston, TX, ⁴M.D. Anderson Cancer Center, Houston, TX

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

R Riascos-Castaneda¹, E Bonfante², J Choi², J MORA³, C Sitton⁴, S Spence⁵
¹The University of Texas Health Science Center at Houston., Houston, TX, ²University of Texas Health Science Center Houston, Houston, TX, ³CLINICA COLOMBIA, BOGOTA, Colombia, ⁴The University of Texas Health Science Center at Houston UTHealth, Houston, TX, ⁵UT Medical School at Houston, Houston, TX

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 lumar, three cervical- thoracic and one sacrum. The location within the spinal canal 54% anterior, 45% thoracic 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.

P Sanchez1, D Bui2

1UC Davis Medical Center, Sacramento, CA, 2University of California Davis, Sacramento, CA

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.
**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 maps for $V_p$ and $K_{trans}$. The cases shown correspond to the spinal metastatic lesions originating from primary breast carcinoma. Comparison of perfusion maps shows greater enhancement for $V_p$ and $K_{trans}$ in metastatic lesions when compared to atypical hemangiomas.

(Filename: TCT_eP-196_Slide1.GIF)
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.

(J Peacock$^1$, V Timpone$^2$)

(Filename: TCT_eP-196_Slide2.GIF)
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.

*eP-201*  
6:30AM - 2:45PM

**Imaging of Congenital Lumbar Spinal Stenosis: Comparison of Three Measurement Techniques for Greater Diagnostic Yield**
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 (α) measurement technique; 
\( \alpha = 48.6 \) degrees in this patient with CLSS
Measuring cervical cord atrophy in multiple sclerosis patients. A longitudinal MRI study

F Aymerich\textsuperscript{1}, C Auger\textsuperscript{1}, D Pareto\textsuperscript{1}, M Alberich\textsuperscript{1}, J Sastre-Garriga\textsuperscript{1}, X Montalban\textsuperscript{1}, À Rovira\textsuperscript{1}
\textsuperscript{1}Vall d'Hebron University Hospital, Barcelona, Barcelona

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.

eP-198
6:30AM - 2:45PM
Patient reported outcomes and clinical success of symptomatic percutaneous lumbar facet synovial cyst rupture at various time points

D Pastel¹, M Ghadiali¹, N NA², S Haider¹
¹Dartmouth-Hitchcock Medical Center, Lebanon, NH, ²Geisel School of Medicine - Dartmouth College, Hanover, NH

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 Score, 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

A Swaminathan¹, J Saini², C Prasad³, P Kumar², N Atchayaram¹
¹National Institute of Mental Health And Neuro Sciences, Bangalore, Karnataka, ²National Institute of Mental Health and Neurosciences, BANGALORE, Karnataka, ³National Institute of Mental Health and Neurosciences, Bangalore, Karnataka

Purpose
GNE myopathy is an autosomal recessive disease caused by mutations in UDP N-acetylglucosamine 2-epimerase/N-acetylmannotosamine 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

N Settipalle¹, M Boakye¹, A Amini¹, M Negahdar¹, K Nosova¹, R Bert¹
¹University of Louisville, Louisville, KY

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

Role of Spinal Diffusion Tensor Imaging in Predicting Post-Operative Outcome in Cervical Spondylotic Myelopathy: A Systematic Review
F Chokshi¹, R Rindler², J Malcolm², S Eshraghi², M Mossa-Basha³, J Chu², F Ahmad²
¹Emory University School of Medicine-Department of Radiology & Imaging Sciences, Atlanta, GA, ²Emory University School of Medicine-Department of Neurological Surgery, Atlanta, GA, ³University of Washington School of Medicine-Department of Radiology, Seattle, WA

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

A Gupta1, H Penderkar2, A Ramalingaiah3, C Prasad4, j saini5, G Medhi3, G Ananthram3

1National Institute of Mental Health and NeuroSciences (NIMHANS), Bangalore, Karnataka, 2National Institute of Mental Health and NeuroSciences, Bangalore, Karnataka, 3National Institute of Mental Health and NeuroSciences, Bangalore, Karnataka, 4National Institute of Mental Health and Neurosciences, Bangalore, Karnataka, 5NIMHANS, BANGALORE, Karnataka

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

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 demonstrated 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

E Lis¹, G Kro¹
¹Memorial Sloan Kettering Cancer Center, NY, NY

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 ration 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

Use of Lower Back Pain Interventions in the Back pain Outcomes using Longitudinal Data (BOLD) Cohort

F Chokshi1, S Rundell2, J Friedly2, Z Bauer3, P Suri4, L Gold3, B Comstock5, A Gellhorn6, S Nedeljkovic7, A Avins8, D Nerenz9, S Mandel10, J Jarvik3
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

J Acharya¹, A Namini¹, A Rajamohan¹, S Metting¹, W Gibbs¹

¹University of Southern California, Keck School of Medicine, Los Angeles, CA
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

K Kamimura¹, M Nakajo¹, Y Fukukura¹, T Iwanaga², T Saito², M Sasaki², T Fujisaki², H Hirano¹, A Takemura³, T Okuaki⁴, C Choi⁵, T Yoshiura¹
¹Kagoshima University Medical and Dental Hospital, Kagoshima, Japan, ²Kagoshima University Hospital, Kagoshima, Japan, ³Philips Electronics Japan, Kagoshima, Japan, ⁴Philips Healthcare, Kagoshima, Japan, ⁵University of Texas Southwestern Medical Center, Dallas, TX

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.

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3D Texture Analyses of Quantitative Susceptibility Maps to Differentiate Alzheimer’s Disease from Cognitive Normal and Mild Cognitive Impairment

S Park¹, G Jahng¹, W Choi²
¹Kyung Hee University Hospital at Gangdong, College of Medicine, Kyung Hee University, Seoul, AK, ²Kyung Hee University Hospital, Seoul, TX

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.
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 Wada, O Abe, T Shizukuishi, Y Watanabe, J Kikuta, H Yamada, H Haradome, Y Imamura
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
¹Virginia Tech-Wake Forest University School of Biomedical Engineering & Sciences, Winston Salem, NC, ²Division of Public Health Sciences, Department of Biostatistical Sciences, Winston Salem, NC, ³Wake Forest School of Medicine, Winston Salem, NC, ⁴Wake Forest School of Medicine, Winston-Salem, NC, ⁵University of Texas Southwestern, Dallas, TX, ⁶Wake Forest University School of Medicine, Winston-Salem, NC

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 x3 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 significantly decreased 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

C Fountain¹, M Johnston², Y Jung¹, C Whitlow³
¹Wake Forest School of Medicine, Winston-Salem, NC, ²Wake Forest University Biomedical Engineering, Winston-Salem, NC, ³Wake Forest School Of Medicine, Winston-Salem, NC

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)
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 probability map showing an example region of significance in age group analysis.

A table showing correlation coefficients, p-values, and $R^2$ values for the regression analysis of different age groups. The table compares RICA, LICA, and BA across various categories:

<table>
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<th></th>
<th>RICA</th>
<th>LICA</th>
<th>BA</th>
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</table>
Characterization of Primary Central Nervous System Lymphoma Using Arterial Spin Labeling Imaging

T Wu1, O Kaneko2, S Amukotuwa2, D Born2, N Fischbein3, M Iv4
1Stanford School of Medicine, Stanford, CA, 2Stanford Hospital and Clinics, Stanford, CA, 3Stanford University, Stanford, CA, 4Stanford University Medical Center, Stanford, CA

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  
6:30AM - 2:45PM

Chondrosarcoma of the Head and Neck

L Yen¹, O Tairu², H Lee³
¹Rutgers- New Jersey Medical School, West Orange, NJ, ²Rutgers- New Jersey Medical School, Newark, NJ, ³New Jersey Medical School, Rutgers University, Newark, NJ

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.
Clinical Application of High Resolution Intracranial Vessel Wall Magnetic Resonance (MR) Imaging for Stroke by Using 3 Dimensional MR Sequences

s suh1, W Seo1, I Ryoo1, H Seol1
1Korea university Guro Hospital, seoul, Korea

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 verbrobasilar 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.
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.
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.
P-41

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

Detection of Acute Subarachnoid and Intraventricular Hemorrhage Using 3T MRI: Comparison of FLAIR Vs T2*-GRE

H CHANG¹, C Sohn²
¹Keimyung University Hospital, Daegu, Kyungsangpook Do, ²Seoul National University Hospital, Seoul, Seoul

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

J Lally\(^1\), S Choi\(^1\), O Hope\(^1\), D Wan\(^1\)
\(^1\)University of Texas Health Science Center, Houston, TX

Purpose
\([\text{18}F]\) 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

K Ahn¹, J Jang², h Choi², S Jung², B Kim²
¹Seoul St. Mary's Hospital, The Catholic University of Korea, Seoul, Korea, Republic of, ²Seoul St. Mary's Hospital, The Catholic University of Korea, Seoul, IA

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

J Lee¹, K Ahn²
¹Hanyang University Hospital, Seoul, Korea, Republic of; ²Seoul St. Mary's Hospital, Seoul, Seoul

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 oligodendrogial tumors from nonoligodendrogial astrocytomas.
Comparison of perfusion parameters between oligodendroglial and nonoligodendroglial tumors.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OT (n=30)</th>
<th>NOT (n=56)</th>
</tr>
</thead>
<tbody>
<tr>
<td>nCBVmean</td>
<td>1.93±0.7</td>
<td>2.51±1.4</td>
</tr>
<tr>
<td>nCBV90</td>
<td>3.66±1.1</td>
<td>4.60±2.3</td>
</tr>
<tr>
<td>nCBV98</td>
<td>5.63±1.5</td>
<td>6.64±2.9</td>
</tr>
<tr>
<td>ktransmean</td>
<td>0.037±0.04</td>
<td>0.061±0.05</td>
</tr>
<tr>
<td>ktrans90</td>
<td>0.091±0.1</td>
<td>0.136±0.1</td>
</tr>
<tr>
<td>ktrans98</td>
<td>0.19±0.1</td>
<td>0.22±0.1</td>
</tr>
<tr>
<td>AUCmean</td>
<td>0.09±0.06</td>
<td>0.15±0.13</td>
</tr>
<tr>
<td>AUC90</td>
<td>0.19±0.15</td>
<td>0.29±0.23</td>
</tr>
<tr>
<td>AUC98</td>
<td>0.33±0.19</td>
<td>0.42±0.3</td>
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<tr>
<td>Vpmean</td>
<td>4.0±2.0</td>
<td>6.0±4.4</td>
</tr>
<tr>
<td>Vp90</td>
<td>7.9±3.4</td>
<td>11.6±7.5</td>
</tr>
<tr>
<td>Vp98</td>
<td>14.47±5.8</td>
<td>17.68±10.2</td>
</tr>
<tr>
<td>Vmean</td>
<td>11.36±11.32</td>
<td>26.89±35.8</td>
</tr>
<tr>
<td>Ve90</td>
<td>27.31±26.1</td>
<td>58.32±70.7</td>
</tr>
<tr>
<td>Ve98</td>
<td>51.74±32.31</td>
<td>95.94±99.7</td>
</tr>
</tbody>
</table>

(Filename: TCT_P-23_comparisonofparametersbetween2groups.jpg)
 Discrimination of Patients with Clinically Isolated Syndromes and Healthy Controls using MRI Volumetry. Is it possible?

M Vaneckova¹, J Krasensky¹, L Sobisek², D Horakova³, T Uher⁴, A Burgetova⁵, M Masek⁵, T Hrebikova⁵, E Havrdova⁴, Z Seidl⁵
¹Charles University In Prague, Prague 2, Czech Republic, ²University of Economics in Prague, Prague, no, ³Charles University in Prague, Prague 2, Czech Republic, ⁴Department of Neurology, Prague 2, Czech Republic, ⁵Department of Radiodiagnostics, Prague 2, Czech Republic

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*  
¹Taihng Veterans General Hospital, Taichung, Taiwan, ²Taihng Veterans General Hospital, Taichung, -

**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.

P-24

Elderly Patients with Newly Diagnosed Glioblastoma: Can Preoperative Imaging Descriptors Improve the Predictive Power of a Survival Model?

S Lee¹, S Ahn², M Park¹
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>
<tr>
<td>Model 2: Clinical + Imaging Model</td>
<td>HR</td>
<td>95% CI</td>
</tr>
<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.
Figure. Time-dependent ROC curve analysis for prediction of overall survival for 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 Yetkin¹, L Yang¹, T O'Neill¹, D Mendelsohn¹
¹UT 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>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>25, F RIGHT</td>
<td></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>
<td></td>
</tr>
<tr>
<td>35, F LEFT</td>
<td>Left posterior frontal and anterior parietal lobe encephalomalacia, likely related to prior infarct or trauma</td>
<td>13/12</td>
<td>Intercital Left occipital sharp and slow wave</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36, M RIGHT</td>
<td>Febrile seizures, left mesial temporal sclerosis</td>
<td>2 months/36</td>
<td>left temporal onset</td>
<td></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 ANBIDEXTEROUS</td>
<td>Traumatic brain injury with resultant Post-traumatic encephalomalacia involving bilateral frontal lobes and left temporal, parietal, and occipital lobes.</td>
<td>16/30</td>
<td>Left anterior temporal lobe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25, M RIGHT</td>
<td>Brain MRI shows hyperintense F/AIR signal within the left parieto-occipital lobe</td>
<td>8/17</td>
<td>Left Temporoparieto occipital</td>
<td></td>
<td>The mapping revealed arm sensory in the posterior parietal at Gris 15B, 20, graspesthesia at 14 &amp; 19, and visual agnosia in the posterior temporal at Strip A2,3</td>
<td>Resection was limited to part of the left parietooccipital cortical surface (Griss 1-15, 2, 16-18), as well as the mesial and basal portions of the posterior left hemisphere, but sparing the posterior temporal region and the occipital pole</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32, M RIGHT</td>
<td>Meningitis at age 2 1/2, and left-sided mesial temporal sclerosis</td>
<td>7/25</td>
<td>Left mesial temporal</td>
<td></td>
<td>Left anterior temporal lobectomy</td>
<td></td>
<td>None</td>
<td>During a follow up on 07/2009 patient reports no seizures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33, M LEFT</td>
<td>Cerebral palsy, left hemisphere porencephalic cyst/schizencephaly and large right fronto-temporal presumed glioma</td>
<td>5/23</td>
<td>No EEG change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32, F RIGHT</td>
<td>Left frontal cavernous angiomata.</td>
<td>14/18</td>
<td>No EEG change but presumed to be left frontal because of the</td>
<td></td>
<td>Left frontal cavernous angiomata lesionectomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37, M LEFT</td>
<td>3 x 4 cm, non-enhancing mass in his left frontoparietal ecrual region</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19, F RIGHT</td>
<td>Head trauma after a car accident in 2001</td>
<td>18/1</td>
<td>Independent bitemporal (perhaps more on the left)</td>
<td></td>
<td>Left anterior temporal lobe resection</td>
<td></td>
<td>None</td>
<td>Patient is not seizure free but is having less frequent seizures compared to prior to surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37, M LEFT</td>
<td>Cortical dysplasia</td>
<td>1.5</td>
<td></td>
<td></td>
<td>Left parietal resection</td>
<td></td>
<td>None</td>
<td>Transient speech deficits</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 aphonic 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 subtraction 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

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.
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 Sastry¹
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.

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.

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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. Leukoaraiosis 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.
Leukoencephalopathy Induced by Low Dose Oral Methotrexate in a Patient with Rheumatoid Arthritis

M Salhab¹, J Adair¹, K SantaCruz¹
¹University of New Mexico Hospital, Albuquerque, NM

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.
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6:30AM - 2:45PM
Magnetic Resonance Spectroscopy Findings in Primary Central Nervous System Lymphoma

N Sgarbi¹, T Wozniak², O Telis³
¹Hospital de Clinicas, Montevideo, Montevideo, ²Hospital de Clinicas Dr Manuel Quintela, Montevideo, Montevideo, ³Hospital de Clinicas, Montevideo, Uruguay

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.
Metal Artifact Reduction in Cone-Beam CT Images of Cerebral Aneurysms Treated with Stents and Coils

Y Takasugi1, M Hiramatsu1, K Sugiu1, T Hishikawa1, J Haruma1, Y Shinji1, S Nishihiro1, I Date1
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.
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.

P-27
6:30AM - 2:45PM
Papillary Craniopharyngioma Presenting as a Purely Intraventricular Lesion in an Adult

R Stoffey¹, C Sitton², R Riascos³, M Bhattacharjee¹
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 Seifert\textsuperscript{1}, J Wiener\textsuperscript{2}, D DeOrchis\textsuperscript{2}

\textsuperscript{1}VCU, Richmond, VA, \textsuperscript{2}Boca 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 noninvasively 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 contrast enhanced T1WI (b). MTR$_{asym}$ within the enhancing tumor was...
Quantitative Susceptibility Mapping in Patients with Alzheimer’s Disease and Mild Cognitive Impairment

W Choi¹, S Park², G Jahng², H Kim³
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, precuneu, 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

D Schomer¹, L Chavali², B Gogia³, J Johnson⁴, L Ketonen⁵, J Hunter⁶, L Hayman⁷
¹U.T. MD Anderson Cancer Center, Houston, TX, ²MD Anderson Cancer Center, Houston, TX, ³MD Anderson Cancer Center, Houston, TX, ⁴MD Anderson, Houston, TX, ⁵M.D. Anderson Cancer Center, Houston, TX, ⁶Texas Children's Hospital, Houston, TX, ⁷Anatom-e, Houston, TX

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)

P-31

6:30AM - 2:45PM

Response Assessment to Tumor Treating Fields in Patients with Glioblastoma Using Physiological and Metabolic MR Imaging

S Chawla1, S Wang1, G Verma2, A Skolnik2, S Sheriff3, K Reilly2, L Desiderio2, A Maudsley3, S Brem1, K Peters4, H Poptani5, S Mohan2

1Hospital of the University of Pennsylvania, Philadelphia, PA, 2University of Pennsylvania, Philadelphia, PA, 3University of Miami, Miami, FL, 4Duke University Medical Center, Durham, NC, 5University of Liverpool, Liverpool, AK

Purpose

Despite advances in multimodality treatment strategies, the prognosis of patients with glioblastoma (GBM) remains poor. Recently (1), tumor treating fields (TTFields), a new frontier in cancer therapy, has shown promise in patients with both treatment naïve and recurrent GBMs. Several studies (2, 3) have shown the potential of diffusion tensor imaging (DTI), perfusion-weighted imaging (PWI) and proton MR spectroscopy in evaluating treatment response to different therapeutic regimens in patients with gliomas. However, no study has investigated the treatment response to TTFields. The purpose of present study was to monitor the effects of TTFields in GBM patients using DTI, PWI and 3D-echoplanar spectroscopic imaging (EPSI).
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\textsubscript{max} were observed at follow-up relative to baseline.
Solitaire Brain Metastases vs GBM: new strategies.

N Sgarbi¹, O Telis²
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)?

T Lim¹, Z Xu², H Lee³, W Yu⁴
¹Neuroradiology, National Neuroscience Institute, Duke-NUS, Singapore, Singapore, ²Neurology, National Neuroscience Institute, Singapore, Singapore, ³Pathology, Tan Tock Seng Hospital, Singapore, Singapore, ⁴Neuroradiology, National Neuroscience Institute, Singapore, Singapore

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

H Chen¹, W Lin²
¹Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan, ²Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan

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

The Activity Ratio of 18F-Fluorodopa Uptake in Midbrain - Occipital Separates Patients with Parkinson Disease from non-Parkinson

K Naeini¹, D Silverman²

¹Texas Tech University, El Paso, TX, ²UCLA, Los Angeles, CA

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 suggest that MOR can be used as an imaging biomarker in the diagnosis of PD.

The Neuroimaging Investigation of Neuroanatomical and Microstructural Alternations and Functional Connectivity in the Elderly and Alzheimer’s Disease Patients

C Chen1, J Chai2, H Chen2
1Taichung Veterans General Hospital, Taichung, Taiwan, 2Taichung Veterans General Hospital, Taichung, -

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 para-hippocampal 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.
The White Gray Sign: a Highly Reproducible Method for Identifying the Central Sulcus on T1 High-Resolution Images.

O Kaneko¹, M Zeineh²
¹Stanford Hospital and Clinics, Stanford, CA, ²Stanford University, Stanford, CA

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

M Han¹, J Choi¹

¹Ajou University Medical Center, Suwon-si, Gyeonggi-do
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

D Pareto1, F Aymerich2, J Sastre-Garriga1, C Auger1, M Tintoré3, X Montalban4, À Rovira1
1Vall d'Hebron University Hospital, Barcelona, Barcelona, 2Vall d'hebron University Hospital, Barcelona, Barcelona, 3Vall d'hebron University Hospital, Barcelona, Barcelona, 4Vall d'Hebron University Hospital, Barcelona, Barcelona

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
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

G Hyun¹, P Sander¹, E Allam¹, C Hasiak¹, Y Zhou¹
¹Saint Louis University School of Medicine, St. Louis, MO

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

c agostinis¹, F Brenna¹, c Villa², M Mandalà¹, b merelli¹, G Bonaldi¹
¹Ospedale Papa Giovanni XXIII, Bergamo, BERGAMO, ²Ospedale Papa Giovanni XXIII, Bergamo, Bergamo

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 cases 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.

(Filename: TCT_P-57_sag1con1.jpg)

(Filename: TCT_P-57_cor1con2.jpg)

P-54

CT and MR Dacryocystography for the Evaluation of Functional Disorders of the Lacrimal System: Can we Replace Dacryoscintigraphy?
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
¹Fleury Group/ Sao Luiz Hospital, SAO PAULO, BRASIL, ²Fleury Group/ Sao Luiz Hospital, SAO PAULO, BRASIL, ³Federal University of Sao Paulo, SAO PAULO, BRASIL, ⁴FLEURY GROUP, HOSPITAL SAO LUIZ, SAO PAULO, -- SELECT -- sao paulo

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).

(Filename: TCT_P-59_Fig01.jpg)
Fig. 2 - Axial CT image shows avulsed right canine, central lateral incisors with alveolar ridge fracture (arrow).
Fig. 3 – Axial CT shows right medial orbital wall fracture and orbital emphysema. (A) soft tissue window and (B) bone window.
Fig. 4 – Coronal CT image demonstrate bilateral condylar fracture with medial dislocation.

(Filename: TCT_P-59_Fig04.jpg)

P-60

6:30AM - 2:45PM

Giant Cell Tumors: Not Just for Long Bones (Craniospinal Manifestations of Osteoclastomas)

J Carmichael¹, V Potigailo², A Krishnamoorthy³
¹Hahnemann University Hospital/DUCOM, Philadelphia, PA, ²Hahnemann University Hospital, Philadelphia, PA, ³Swedish Conventent Hospital, Chicago, IL
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

Influence of Clinical History on MRI Interpretation of Optic Neuritis

N Bansal¹, M Hagiwara¹, M Borja¹, J Babb¹, S Patel¹
¹NYU Langone Medical Center, New York, NY, USA

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 (κ=0.427 without clinical history, κ=0.505 with clinical history provided), and postcontrast T1-WI (κ=0.271 without clinical history, κ=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 (κ=0.4-0.42 without clinical history, κ=0.44-0.69 with clinical history) and postcontrast T1-WI (κ=0.17-0.40 without clinical history, κ=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.

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 as negative.
Literature Review: Can the Size of Oral Tongue Cancer Measured by Pre-operative MRI Predict the Presence of Metastatic Cervical Lymph Nodes?

A Abdelazim^1, N Sadeghi^2, A Joshi^1, D Brown^3, M Taheri^4

^1The George Washington University, Washington, DC, ^2The George Washington University Hospital, Washington, DC, ^3George Washington University, Washington, DC, ^4George Washington University Hospital, Washington, DC, DC

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.
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.

P-51

Using Texture Analysis to Differentiate Osseous Changes Between Sickle Cell Disease from Normal Bone Density Controls on Head CT

A Fujita¹, K Buch², Y Kawashima³, B Li⁴, H Sugimoto⁵, O Sakai⁴

¹Boston Medical Center, Boston University School of Medicine/Jichi Medical University, Shimotsuke, Tochigi, ²Boston Medical Center, Boston University School of Medicine/Massachusetts General Hospital, Boston, MA, ³Boston Medical Center, Boston University School of Medicine/Nihon University School of Dentistry, Matsudo, Chiba, ⁴Boston Medical Center, Boston University School of Medicine, Boston, MA, ⁵Jichi Medical University School of Medicine, Shimotsuke, Tochigi

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

H KWAK¹, S Jeon², G Chung³
¹Chonbuk National University Medical School and Hospital, Jeonju-si, Korea, Republic of, ²Wonkwang University School of Medicine & Hospital, Iksan, AZ, ³Chonbuk National University Medical School and Hospital, Jeonju-si, Korea

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
6:30AM - 2:45PM
Continuous Clot Aspiration under Flow Control Improve Recanalization and Clinical Outcome of Acute Internal Carotid Artery Stroke: Retrospective Single Center Experience

S Youn¹, H Kim², H Lee³
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

LVIS Jr. “Shelf” Technique: An Alternative to Y Stent-Assisted Aneurysm Coiling

J Shankar¹, E Du²
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>Technique 2</th>
<th>ROI</th>
<th>Ref (ophthalmic artery)</th>
<th>2 (retina)</th>
<th>3 (supra)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Delivery of Total</td>
<td>80.0 ± 22.1%</td>
<td>% Delivery of Total</td>
<td>85.7 ± 9.6%</td>
<td>60.9 ± 26.6%</td>
<td>14.3</td>
<td></td>
<td></td>
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</tbody>
</table>

(Filename: TCT_P-62_RB_asnr_final.jpg)

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</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 – 2.49)</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 (-2.0 – 7.0)</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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</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>9 (37.5)</td>
<td>8 (32.0)</td>
<td></td>
</tr>
<tr>
<td>TICI 2B or greater – No. (%)</td>
<td>10 (41.7)</td>
<td>13 (52.0)</td>
<td>1.38 (0.322 – 5.40)</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 – +19)</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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.8</td>
<td>0.8</td>
<td>+0.080 (-0.650 – 0.240)</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 – +12)</td>
</tr>
<tr>
<td>Interquartile range</td>
<td>-2 – +43</td>
<td>-1 – +26</td>
<td></td>
</tr>
</tbody>
</table>

(Filename: TCT_P-63_Table.jpg)

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

Printed Poster (P) - Pediatrics
P-67
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 cranio cervical 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.
Correlative Pre and Postnatal MR Imaging of Interhemispheric Cysts Associated with Callosal Anomalies.

H Moore¹, S Ponrartana², A Panigrahy³, H Lai⁴
¹Keck School of Medicine of the University of Southern California, Pasadena, CA, ²Children’s Hospital Los Angeles, Los Angeles, CA, ³Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, ⁴Children'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

6:30AM - 2:45PM

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
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
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.
Hyperintense CSF Artifact Reduction on FLAIR MR Images in Sedated Children: Usefulness of Magnetization-Prepared FLAIR Imaging

S Ahn

Gangnam severance hospital, Seoul, NA

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.
Is Prone MRI Useful in the Evaluation of Tethered and Re-tethered Cord?

M Stamates\textsuperscript{1}, D Frim\textsuperscript{1}, S Ali\textsuperscript{1}
\textsuperscript{1}University 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 discordant 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 x3 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 ≤ 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>
<thead>
<tr>
<th>Table. DTI, DKI and WMTI group differences (mean ± SD)</th>
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1MD, RD, AD and De_rad are expressed in μm²/ms; all other metrics are dimensionless.
2Analysis of co-variance, with subject age as a co-variante.

(P-80)

Central Canal and/or Anterior Median Fissure: MR Imaging in Multiple Sclerosis Patients Versus Control

E Peak1, L Wang1, T Tomsick1
1University 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
7:30AM - 7:55AM
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  
7:55AM - 8:25AM

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
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<th>Session</th>
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<tr>
<td>2A-2</td>
<td><strong>Pediatric Brain Imaging Pearls and Pitfalls</strong></td>
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<td><strong>Birth Trauma &amp; HII: What You Need to Know</strong></td>
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<td>2A-4</td>
<td><strong>Pediatric Head &amp; Imaging Pearls</strong></td>
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<td><strong>Questions and Answers</strong></td>
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Monday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Washington 4/5/6

2B-ASHNR Programming: Update on Temporal Bone Imaging
2B-1

Contemporary Imaging of Hearing Loss
Salzman, K.
University Of Utah
Salt Lake City, UT

2B-2

Inflammatory Disease of the Temporal Bone
Shatzkes, D.
Lenox Hill Hospital
New York, NY

2B-3

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

Radiology's Role in Value Based Care
Krishnaraj, A.
University of Virginia Health System
Charlottesville, VA

2C-2

9:00AM - 9:25AM

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

9:25AM - 9:50AM

Utilizing Midlevel Professionals

Chokshi, F.
Emory University School of Medicine
Atlanta, GA

2C-4

9:50AM - 10:00AM

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). Univariate/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

Aneurysm Location and Size Predict Rupture in Patients with Multiple Intracranial Aneurysms
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 (1). 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
Volume, Surface Area and Surface Area to Volume Ratio: A Potentially Useful Measures in the Management of Patients with Small Intra-cranial Aneurysms.

J Kim1, G Sandhu1, D Sandhu1, R Tummala1, B Jagadeesan1
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, saccular morphology, ≤7 mm maximum aneurysm diameter and no intervening treatment. Ruptured aneurysms were included in the analysis if they were saccular 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 mm$^3$, <1.5/m, >71.4 mm$^2$, 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 Brinjikji¹, B Chung², D Kallmes¹, C Jimenez³, C Putman⁴, J Cebral²
¹Mayo Clinic, Rochester, MN, ²George Mason University, Fairfax, VA, ³George Mason University, Washington, DC, ⁴Inova 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.
O-6

Hemodynamic Differences Between Basilar Tip and Internal Carotid Bifurcation Aneurysms

R Doddasomayajula\textsuperscript{1}, B Chung\textsuperscript{1}, F Hamzei-Sichani\textsuperscript{2}, C Putman\textsuperscript{3}, J Cebral\textsuperscript{1}

\textsuperscript{1}George Mason University, Fairfax, VA, \textsuperscript{2}Icahn School of Medicine, Mount Sinai Health System, New York, NY, \textsuperscript{3}Inova Fairfax Hospital, Falls Church, VA
Purpose
Test the hypothesis that basilar tip (BAtip) aneurysms and internal carotid artery bifurcation (ICAbif) 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

J Cebral¹, A Robertson², J Frosen³
¹George Mason University, Fairfax, VA, ²University of Pittsburgh, Pittsburgh, PA, ³Kuopio University Hospital, Kuopio, Kuopio

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.
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</td>
<td>12 (8)</td>
<td>10 (13.3)</td>
<td>2 (2.7)</td>
<td>0.016</td>
</tr>
<tr>
<td>Complication:</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>1 (0.7)</td>
<td>1 (1.3)</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Any Peri-Operative</td>
<td>27 (18)</td>
<td>12 (16)</td>
<td>15 (20)</td>
<td>0.67</td>
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<td>Resulting in mRS ≥3:</td>
<td>8 (5.3)</td>
<td>6 (8)</td>
<td>2 (2.7)</td>
<td>0.28</td>
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<td>4 (5.3)</td>
<td>2 (2.7)</td>
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<td>1 (1.3)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Any Treatment-Related</td>
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<td>8 (10.7)</td>
<td>2 (2.7)</td>
<td>0.049</td>
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<td>Complication Resulting in mRS ≥3:</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.

In-stent Stenosis in Flow Diverting Implants (PED, p64): Infrequent and Transient

O-11

9:05AM - 9:08AM
H Henkes¹, M Aguilar Pérez¹, R Martínez Moreno¹, E Henkes¹, H Bäzner¹
¹Klinikum Stuttgart, Stuttgart, BW

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
9:08AM - 9:11AM

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

H Henkes¹, R Martinez Moreno¹, M Aguilar Pèrez¹, H Bázner¹, E Henkes¹
¹Klinikum Stuttgart, Stuttgart, BW

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 Wagner¹, C Strother², D Niemann², C Mistretta²
¹University of Wisconsin Madison, Madison, WI, ²University 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.
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

A Kemmling¹, P Schramm¹
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.
Patterns of Noncontrast-Enhancing Tumor in Glioblastoma

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

8:35AM - 8:43AM
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.
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)

R Valenzuela¹, A Hayman², L Chavali³, A Kumar⁴, M Ramirez-Guzman⁵, G Godoy-Brewer⁵, R Riascos⁵, B Gogia⁶

¹The University of Texas, Houston, TX, ²Anatom-e Systems, LLC Houston, TX, Houston, TX, ³UT MD Anderson Cancer Center, Department of 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 astroctoma

Aphasic 2.6 cm BA39 GBM (GIV glioma)
Different Diagnostic Values of Imaging Parameters to Predict Pseudoprogresison in Glioblastoma Subgroups Stratified by MGMT Promoter Methylation

R Yoon¹, H Kim², W Paik³
¹Catholic Kwandong University International St. Mary's hospital, Incheon, Korea, Republic of, ²Asan medical center, Seoul, Korea, Republic of, ³Dankook University Hospital, Cheonan-si, Korea, Republic of

Purpose
To determine whether diffusion and perfusion imaging parameters demonstrate different diagnostic values for predicting pseudoprogresison 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 pseudoprogresison (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 pseudoprogresison 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 pseudoprogresison in glioblastoma patients with a methylated MGMT promoter than patients with an unmethylated MGMT promoter.
MGMT promoter methylation

ADC10 ≥0.94 (n=22)

ADC10 <0.94 (n=12)

nCBV90 ≥4.02 (n=11)
Multivariate Logistic Regression Analysis for Predicting Pseudoprogression Using MGMT Promoter Methylation Alone and in Combination with the Indicated Imaging Parameters for Both Readers.

<table>
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<tr>
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<th>Odds ratio of MGMT methylation</th>
<th>Odds ratio of imaging parameter</th>
<th>(P) value of imaging parameter</th>
<th>AUC</th>
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<tr>
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<tr>
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<td>22.17 (2.70–182.21)</td>
<td>89.27 (9.62–828.74)</td>
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<tr>
<td>nCBV90 &lt; 2.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MGMT promoter methylation +</td>
<td>5.22 (1.55–17.57)</td>
<td>26.72 (5.21–137.06)</td>
<td>0.001</td>
<td>0.85</td>
</tr>
<tr>
<td>IAUC90 &lt; 20.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

### Pseudoprogresison 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 cutoff value of nCBV; IAUC90 = 90th percentile cutoff value of IAUC. Parentheses in 95% CI of AUC indicate confidence interval.

(Filename: TCT_O-20_Fig_ASNR2.jpg)
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

Y Mardor\(^1\), D Daniels\(^2\), D Guez\(^3\), D Last\(^3\), D Nass\(^3\), A Taliantski\(^3\), S Salomon\(^3\), A Kanner\(^4\), D Blumenthal\(^5\), F Bukstein\(^4\), S HarNoif\(^6\), Z Cohen\(^2\), L Zach\(^2\), C Hoffmann\(^6\), G Tsarfaty\(^2\)

\(^1\)Sheba Medical Center and Tel-Aviv Univ, Ramat-Gan, Israel, \(^2\)Sheba Medical Center and Tel-Aviv University, Ramat-Gan, AK, \(^3\)Sheba Medical Center, Ramat-Gan, AK, \(^4\)Tel-Aviv Medical Center, Tel-Aviv, AK, \(^5\)Tel Aviv Sourasky Medical Center, Tel aviv, AK, \(^6\)Sheba 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)
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 criteria. 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, $K^{\text{trans}}$ and rCBV pattern matched with num in 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><strong>ADC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interval increase</td>
<td>16/19</td>
<td>-</td>
<td>$P=0.020$</td>
</tr>
<tr>
<td>Interval decrease</td>
<td>-</td>
<td>6/10</td>
<td></td>
</tr>
<tr>
<td><strong>$K^{\text{trans}}$</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interval increase</td>
<td>-</td>
<td>10/10</td>
<td>$P=0.015$</td>
</tr>
<tr>
<td>Interval decrease</td>
<td>13/19</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>rCBV</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interval increase</td>
<td>-</td>
<td>8/10</td>
<td>$P=0.001$</td>
</tr>
<tr>
<td>Interval decrease</td>
<td>17/19</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Responders: n=19  
No response: n=10  
(Filename: TCT_O-24_Mets-Table.jpg)

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**O-25**

9:39AM - 9:47AM

**Use of Susceptibility –Weighted Imaging to Assess Hemorrhage in the Brain Metastases**

F YILDIRIM DONMEZ\(^1\), F Kural\(^1\), M HABERAL\(^1\), M Agildere\(^1\)  
\(^1\)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

S Desai¹, A Hong², J Kalapurakal², B Liu²
¹Northwestern Memorial Hospital, Chicago, IL, ²Northwestern University Feinberg School of Medicine, Chicago, IL
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
9:55AM - 10:03AM

Maximum Intensity Projection Improves Detection of Small Brain Metastases.

F Sepulveda¹, R Ames¹, S Wagner¹, A Abello¹, C Commander¹, L Causil¹, M Castillo¹
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 Hwang1, C Holder2, L Poisson3, A Flanders4
1St Jude Children's Research Hospital, Germantown, TN, 2Emory University School Of Medicine, Atlanta, GA, 3Henry Ford Health System, Detroit, MI, 4Thomas Jefferson Univ. Hosp., Philadelphia, PA

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
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(MRIs) 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  
8:35AM - 8:43AM

Cumulative effect of MRIs on cardiac rhythm management devices

E Motuzko¹, J Schmitt², S Jha², T Brunker³, S DIXIT⁴, L Desiderio², L Loevner⁵, H Litt⁶, S Mohan²
¹Cooper University Hospital, Camden, NJ, ²University of Pennsylavnia, 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 predominately 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. 
Resing-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>
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<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></th>
<th>Successful rs-fMRI</th>
<th>Failed rs-fMRI</th>
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</thead>
<tbody>
<tr>
<td>Successful tb-fMRI</td>
<td>54</td>
<td>25</td>
</tr>
<tr>
<td>Failed tb-fMRI</td>
<td>26</td>
<td>3</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, undergoing operative histological evaluation. Resting-state fMRI (A) and accompanying task-based fMRI (tb-fMRI) (B). Areas of activation bilaterally and Wernicke’s activation on the left are shown.

Figure 2- Utilization rate of rs-fMRI from January 2014-June 2016.
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.

D Pareto¹, J Sastre-Garriga¹, J Alonso¹, I Galan¹, M Arévalo¹, M Renom¹, C Auger¹, X Montalban², À Rovira¹
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, 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 Spondylotic 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 Zaid¹, R Anil¹, I Hassan¹, W Wei¹, R Sawaya¹, A Kumar¹, P Zinn², R Colen¹
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%). Gliomblastoma 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 multiform 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.
<table>
<thead>
<tr>
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<th>Sex</th>
<th>Handedness</th>
<th>Tumor location</th>
</tr>
</thead>
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<td>36</td>
<td>F</td>
<td>right handed</td>
<td>Left frontal</td>
</tr>
<tr>
<td>32</td>
<td>M</td>
<td>right handed</td>
<td>Left parietal</td>
</tr>
<tr>
<td>67</td>
<td>M</td>
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<td>Left frontal</td>
</tr>
<tr>
<td>54</td>
<td>F</td>
<td>Left handed</td>
<td>Left parietal</td>
</tr>
<tr>
<td>51</td>
<td>M</td>
<td>right handed</td>
<td>Left insular</td>
</tr>
<tr>
<td>53</td>
<td>M</td>
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<tr>
<td>69</td>
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<td>right handed</td>
<td>Left temporal</td>
</tr>
<tr>
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<td>M</td>
<td>right handed</td>
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<td>right handed</td>
<td>Left caudate nucleus, internal capsule+Left temporal</td>
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<td>43</td>
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<td>right handed</td>
<td>Left frontal ( crossing midline)</td>
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<td>43</td>
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<td>Right frontal and left temporal</td>
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<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 from 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

<p>| | |</p>
<table>
<thead>
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<tbody>
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<td>Age (years)</td>
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<tr>
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</tr>
<tr>
<td>% Male</td>
<td>94.7</td>
</tr>
<tr>
<td>Race (caucasian)</td>
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</tr>
<tr>
<td>Current CD4 (cells/mm3)</td>
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</tr>
<tr>
<td>CD4 nadir</td>
<td>209±1</td>
</tr>
<tr>
<td>% Undetectable viral load</td>
<td>100</td>
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<tr>
<td>Years since diagnosis</td>
<td>21.5±</td>
</tr>
</tbody>
</table>

O-37

Evaluation of response to stereotactic radiosurgery in brain metastases using multimodal MRI

R Flintham\textsuperscript{1}, P Sanghera\textsuperscript{1}, A Peet\textsuperscript{2}, V SAWLANI\textsuperscript{1}, N Davies\textsuperscript{1}
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 tumor 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

1Keck 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.
3A-ASHNR Programming: Update on Cranial Nerve Imaging

3A-1
10:30AM - 11:00AM
Evaluation of the Patient with Facial Pain
DeLone, D.
Mayo Clinic
Rochester, MN

3A-2
11:00AM - 11:30AM
Understanding Perineural Tumor Spread
Stambuk, H.
Memorial Sloan-Kettering Cancer Ctr
New York, NY

3A-3
11:30AM - 12:00PM
Lower Cranial Nerve Imaging
Reede, D.
SUNY Downstate University Hospital
Brooklyn, NY

Monday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Washington 4/5/6


3B-1
10:30AM - 10:55AM
Future Trends in Organized Medicine
3B-2

Neuroradiology: Today, Tomorrow, and the Day After

Mukherji, S.
Michigan State University
East Lansing, MI

3B-3

Technology Disrupters and the Impact of Social Media

Kotsenas, A.
Mayo Clinic
Rochester, MN

3B-4

Questions and Answers

Monday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Washington 1/2/3

3C-PARALLEL PAPER SESSION: Spine: Imaging and Intervention
O-39

MR Angiographic Diagnosis of Spinal Epidural Arterio-Venous Fistulas with Perimedullary Reflux
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 Gailloud, L Gregg, M Pearl, D San Millan
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.
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.

(Filename: TCT_O-42_SpinalAngio.jpg)
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, Louisivlle, 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>GMI>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

M Dahse1, B Behzad2, R Riascos2, C Sitton2, R Patel2
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

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 workup 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

11:34AM - 11:42AM

Correlation between MRI Findings and Outcomes from Lumbar Therapeutic Facet Joint Injections

A Namini\textsuperscript{1}, K Kazmi\textsuperscript{2}

\textsuperscript{1}University of Southern California, Los Angeles, CA, \textsuperscript{2}Hahnemann 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

P Sherman¹, J Bernot¹

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 non-Gaussian 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 orbito-frontal, 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>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>R: 1.43±0.19</td>
<td>R: 1.75±0.49</td>
<td>R: 20.3%</td>
</tr>
<tr>
<td></td>
<td>L: 1.33±0.29</td>
<td>L: 1.70±0.60</td>
<td>L: 24.9%</td>
</tr>
<tr>
<td>AxD</td>
<td>R: 1.93±0.21</td>
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<td>RD</td>
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<td>L: 1.08±0.26</td>
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<td>MK</td>
<td>R: 0.81±0.06</td>
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<td>AK</td>
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<td>L: 0.68±0.07</td>
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<td>RK</td>
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<td>L: 1.01±0.12</td>
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<td>L: 0.32±0.04</td>
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<td>Normalized Total Hippocampal Volume [%]</td>
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<td>Mean SUV_l</td>
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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 decreases in normalized total hippocampal volume. R = Right, L = Left.

O-52

10:36AM - 10:39AM

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

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Determining the Accuracy of Resting-State Functional Magnetic Resonance Imaging in Lateralizing Language Dominance

J Mathews¹, M Miller-Thomas¹, G Guzman Perez-Carrillo¹, B Speidel², J Shimony¹, E Leuthardt²
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)

<table>
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<th>Reader</th>
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<tr>
<td>Expert 1</td>
<td>28/34 patients</td>
<td>82.4%</td>
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<td>Expert 2</td>
<td>25/34 patients</td>
<td>73.5%</td>
</tr>
<tr>
<td>Expert 3</td>
<td>25/34 patients</td>
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Table 1: Accuracy of resting state fMRI in lateralizing 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.

J Nystedt¹, P Mannfolk², P Sundgren²

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 non-Hanly 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-Åsberg 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.
Improved T1 Weighted Black Blood Vessel Wall Imaging using Distributed Spirals, Variable Density Sampling and Constrained Reconstruction: Initial Clinical Experience.
K Johnson1, L Rivera2, S Rebsamen2, P Turski3
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

C Cantrell¹, P Vakil², D Cantrell³, S Ansari³, T Carroll¹
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-oxyhemoglobin 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.
\[ P(t) = A e^{-\frac{t}{V_r \times C}} \]

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\[ R^2 = 0.525 \]
Usefulness of Transit Time Corrected Arterial Spin Labeling: Correlation with Dynamic Susceptibility Contrast Perfusion MR

T Yun1, C Sohn1, R Yoo2, K Kang2, S Choi2, J Kim2, S Park3, M Hwang4, M Lebel5
1Seoul National University Hospital, Seoul, Republic of Korea, 2Seoul National University Hospital, Seoul, Republic of Korea, 3Seoul National University Boramae Medical Center, Seoul, Republic of Korea, 4GE Healthcare Korea, Seoul, Republic of Korea, 5GE Healthcare Canada, Calgary, Canada

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

J Narvid¹, L Rosenberg², M Mandelli¹, M Gorno-Tempini¹
¹UCSF, San Francisco, CA, ²Weill Cornell Medical School, New York, NY

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 ($R^2 = .36$, $p<.05$).
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.

K Naeini¹
¹Texas tech University, El Paso, TX

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

Y Lui¹, E Fieremans², J Rath², J Smith², S Flanagan³, J Babb³, S Chung²
¹NYU School of Medicine, New York City, NY, ²New York University School of Medicine, New York, NY, ³NYU Langone Medical Center, New York, NY

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/μm²) up to 60 directions (FOV = 220×220mm², resolution = 2.5×2.5×2.5mm³, 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).

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

J Conklin¹, C Heyn¹, M Roux², M Cerny², M Wintermark³, C Federau³
¹Sunnybrook Health Sciences Centre, Toronto, Ontario, ²CHUV, Lausanne University Hospital, Lausanne, Switzerland, ³Stanford University, Stanford, CA

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>
<thead>
<tr>
<th>No. of b values</th>
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<tr>
<td>8</td>
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</tr>
<tr>
<td>6</td>
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<td>200, 500, 900</td>
</tr>
<tr>
<td>2</td>
<td>200, 900</td>
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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.

J Becker\textsuperscript{1}, A Abdelaziz\textsuperscript{1}, R Avery\textsuperscript{1}, U Udayasankar\textsuperscript{2}, K Johnson\textsuperscript{3}
\textsuperscript{1}University of Arizona, Tucson, AZ, \textsuperscript{2}University of Arizona Medical Center, Tuscan, AZ, \textsuperscript{3}Siemens Medical Solutions USA, Inc, Malvern, PA

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

P Sherman¹, J Bernot¹
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
10:30AM - 10:38AM

Cumulative Subconcussive Head Impact Exposure in Youth Football Results in Microstructural Changes in Corpus Callosum

N Bahrami1, E Davenport2, Y Jung3, J Urban2, J Stitzel2, J Maldjian4, C Whitlow2
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 (RWECP) (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>
<thead>
<tr>
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<th>R²</th>
<th>P-value</th>
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<tbody>
<tr>
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<td>0.0214</td>
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<tr>
<td>MD vs RWECP</td>
<td>0.2416</td>
<td>0.0032</td>
</tr>
<tr>
<td>RD vs RWECP</td>
<td>0.1470</td>
<td>0.0255</td>
</tr>
<tr>
<td>AD vs RWECP</td>
<td>0.2237</td>
<td>0.0043</td>
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(Filename: TCT_O-66_Untitled.jpg)
Season of High School Football Increases MEG Low-Frequency Brain Waves

E Davenport¹, J Urban¹, P Santiago², R Moran³, B Wagner⁴, M Espeland¹, C Whitlow¹, J Stitzel¹, J Maldjian⁵
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

Incidence of Microhemorrhages in High School Football Players over a Season of Play

C Lack1, E Lowther2, J Maldjian3, C Whitlow4
1Wake Forest School of Medicine, Winston-Salem, NC, 2GHS Radiology, Greenville, SC, 3University of Texas Southwestern, Dallas, TX, 4Wake Forest School Of Medicine, Winston-Salem, NC

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

P Caruso¹, S Rincon¹, S Murphy², A Duhaime³
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

N Lall¹, R Radhakrishnan¹, C Stevenson¹, Z Masood², B Zhang¹, Y Zhang¹, B Kline-Fath¹
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

J Gadde1, V Haughton2, V Shah3
1University of Wisconsin, Madison, WI, 2University of Wisconsin School of Medicine and Public Health, Oconomowoc, WI, 3University of California San Francisco, San Francisco, CA

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 craniovertebral decompression.

(Filename: 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

11:26AM - 11:34AM

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 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.
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>2.8 ± 3.8</td>
<td>47.1 ± 68.6</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>Lens (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 ± 15.9</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>0.6 ± 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>0.6 ± 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>2.8 ± 3.8</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 ± 8.2</td>
<td>21.8 ± 11.8</td>
<td>2.8 ± 4.7</td>
<td>17.4 ± 8.2</td>
</tr>
<tr>
<td>Hydrocephalus/VP shunt</td>
<td>5.3 ± 2.5</td>
<td>1.0 ± 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 in CTDIvol) in 2011 to 2015 are plotted in this figure. Figure 1a summarizes the lowest radiation dose for craniosynostosis, hydrocephalus/VP shunt, paranasal sinus, face, and contrast head CT. Figure 1b illustrates the overall temporal trend of pediatric head and neck CT radiation dose with a 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 craniosynostosis. Scan parameters of 80 kVp and 20 mAs resulted in an estimated effective dose of 0.08 mSv. Low-dose scan was performed at 0.06 mSv.

(Filename: TCT_O-76_Cranio-CT.jpg)
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
11:45AM - 12:00PM
Panel Discussion/Q&A

Monday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Marriott Ballroom

4A-Olfaction Audience Response (AR) Self Assessment Module (SAM)
4A-1
1:15PM - 1:55PM
Central Processing of Odor

Naidich, T.
Icahn School of Medicine at Mount Sinai
New York, NY

4A-2
1:55PM - 2:30PM
Current Concepts of Olfaction From Odorant to Olfactory Bulb: How We Use It, Its Embryology and Anatomy

Som, P.
Icahn School of Medicine at Mount Sinai
New York, NY

4A-4
2:30PM - 2:45PM
Questions and Answers
Monday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Washington 4/5/6

4B-Young Professional Programming: Practical Post-Treatment Neuroimaging

4B-1
1:15PM - 1:40PM
Post Treatment Brain

Cha, S.
University of California San Francisco
San Francisco, CA

4B-2
1:40PM - 2:05PM
Post Treatment Neck

Mukherji, S.
Michigan State University
East Lansing, MI

4B-3
2:05PM - 2:30PM
Post Treatment Spine

Shah, L.
University Of Utah
Salt Lake City, UT

4B-4
2:30PM - 2:45PM
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  
1:15PM - 1:35PM  
**Imaging Diagnosis of Cerebrovascular Injury and How We Image**  
Chapman, M.  
Boston University Medical Center  
Boston, MA

4C-2  
1:35PM - 1:55PM  
**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  
1:55PM - 2:15PM  
**Current Trends of Treatment of BCVI - Treatment Strategies Outcomes**  
Hetts, S.  
University of California, San Francisco  
San Francisco, CA

4C-4  
2:15PM - 2:35PM  
**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>DSC</th>
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<tbody>
<tr>
<td><strong>Study First Author and Year</strong></td>
</tr>
<tr>
<td>Alexiou 2014</td>
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<td>Baek 2012</td>
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<tr>
<td>Barajas 2009</td>
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<tr>
<td>Cha 2014</td>
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<tr>
<td>Gasparetto 2009</td>
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<tr>
<td>Hu 2009</td>
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<td>Hu 2010</td>
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<td>Hu 2012</td>
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<td>Kim 2010</td>
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<td>Kim 2014 (Dec)</td>
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<td>Kim 2014 (Mar)</td>
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<td>Kong 2011</td>
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<td>Mangla 2010</td>
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<td>Martinez 2012</td>
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<td>Park 2015</td>
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<td>Prager 2015</td>
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<td>Seeger 2013</td>
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<td>Young 2013</td>
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(Filename: TCT_O-77_DSC.jpg)
O-77

1:18PM - 1:21PM

Combined MR Perfusion and Diffusion for Differentiation of Post-treatment Changes from Recurrent High Grade Glioma

P Belani¹, J Knitter¹, A Doshi¹, A Hormigo¹, I Germano¹, K Nael¹

¹Icahn School of Medicine at Mount Sinai, New York, NY

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.
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>
</tr>
</thead>
<tbody>
<tr>
<td>ADC (10^{-5} \text{mm}^{2}/\text{s})</td>
<td>1360</td>
<td>1150</td>
<td>0.02</td>
<td>0.82/69/84</td>
</tr>
<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>

O-79
1:21PM - 1:24PM

**Multi-Center Study demonstrates Dynamic Contrast Enhanced Permeability MRI differentiates pseudoprogression from true disease progression in primary high-grade gliomas and metastatic melanoma**

A Kammen¹, S Lingala¹, B Mordkin², S Cen³, J Arevalo-Perez⁴, A Thomas⁴, K Peck⁴, T Kaley⁵, M Law⁶, R Young⁴, K Nayak¹

¹USC Medical Center, Los Angeles, CA, ²USC, Los Angeles, CA, ³University of Southern California, Keck School of Medicine, Los Angeles, CA, ⁴Memorial Sloan Kettering Cancer Center, New York, NY, ⁵memorial Sloan Kettering Cancer Center, New York, NY, ⁶Keck Medical Center of USC, Los Angeles, CA

**Purpose**

To determine if dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) permeability Ktrans 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 (Ktrans) 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
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
1:24PM - 1:27PM
High Resolution DCE MRI permeability differentiates pseudoprogression from true disease progression in primary high-grade gliomas and metastatic melanoma

A Kammen¹, A Kammen¹, B Mordkin², S Cen³, S Lingala¹, M Law⁴, K Nayak¹
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

The change in the apparent diffusion coefficient values predicts survival after
intra-arterial bevacizumab administration in patients with recurrent
glioblastomas

N Galla¹, G Chiang², S Chakraborty³, R Singh¹, A Tsiouris², J Boockvar³, ikovanlikaya²
¹Weill Cornell Medical College, New York, NY, ²New York-Presbyterian - Weill
Cornell Medical Center, New York, NY, ³North Shore-LIJ Health System, New York,
NY

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.

R Delfanti1, N Farid2, K Leyden2, D Piccioni3, A Krishnan2, N White2, A Dale2, C McDonald2
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 in the post-bevacizumab image, ADC conspicuity is low at both the pre- and post-bevacizumab timepoints.
Perfusion spectral imaging (PSI) in human brain tumors

B Ellingson¹, K Leu¹, W Pope¹, T Cloughesy¹
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.
O-84

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

Z Moritz¹, J Windschuh², J Meissner², S Goerke², D Paech², A Radbruch²
¹German Cancer Research Center, Heidelberg, ²German Cancer Research Center, Heidelberg, CA

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

I Littig¹, L Poisson², B Griffith², J Chen³, R Jain⁴
¹New York University, New York, NY, ²Henry Ford Health System, Detroit, MI, ³San Diego VA / UCSD Med. Center, La Jolla, CA, ⁴NYU School of Medicine, New York, NY

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 on 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.

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O-88

1:48PM - 1:51PM

Diffusion Kurtosis Imaging in Differentiation of Peritumoral Edema Between Brain Metastases and Primary Glioblastomas

A Tonoyan¹, T Ovcharenko², L Shishkina¹, I Pronin³
¹Burdenko Neurosurgery Institute, Moscow, Russian Federation, ²Pirogov Russian National Research Medical University, Moscow, Russian Federation, ³Burdenko Neurosurgery Institute, Moscow, Russian Federation

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.

A Kapadia\textsuperscript{1}, J Conklin\textsuperscript{1}, S Symons\textsuperscript{2}, G Stanisz\textsuperscript{3}, A Sahgal\textsuperscript{4}, H Soliman\textsuperscript{4}, C Heyn\textsuperscript{2}

\textsuperscript{1}Department of Medical Imaging, Sunnybrook Health Sciences Centre, Toronto, ON, Canada., Toronto, Ontario, \textsuperscript{2}Sunnybrook Health Sciences Centre, Toronto, Ontario, \textsuperscript{3}Department of Medical Biophysics, University of Toronto, Toronto, ON, Canada., Toronto, ON, \textsuperscript{4}Department of Radiation Oncology, Sunnybrook Health Sciences Centre, Toronto, ON, Canada., Toronto, Ontario
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

B Hamilton¹, P Ambady², G Nesbit², E Neuwelt³
¹Oregon Health and Sciences University, Portland, OR, ²Oregon Health and Science University, Portland, OR, ³Oregon Health & Sciences University, Portland, OR

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.
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.

N Brauner¹, M Gulati¹, M Shiroishi¹, E Grant¹, J Bakhsheshian¹, K Chang¹, E Christian¹, G Zada¹, I Lekht¹
¹Keck School of Medicine of the University of Southern California, Los Angeles, CA

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

Utility of 
Intracranial 
Resection

A. Side-chain 
scan with 
convolution 
US (left) 
showing 
metallic 
brain 
region 
and 
the 
tumor 
and 
metal 
arrowed 
parenthesis. 
Curves 
for 
data 
showing 
region 
B. Side-chain 
(left) 
(resected) 
(right) 
(resected) 
region 
of ultrasound 
examination 
resected 
iCEU 
as 
layer 
fluid 
(resected 
area) 
(arrowed)
Neuroimaging and Laser Interstitial Therapy

J Chang¹, P Schaefer², O Rapalino³, G Gonzalez²
¹MGH, Boston, MA, ²Massachusetts General Hospital, Boston, MA, ³Massachusetts General Hosp., Boston, MA

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

Intraoperative 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

*(Filename: TCT_O-92_Slide12.jpg)*

**Monday**
1:15PM - 2:50PM
The temporal appearances of intracranial aspergillosis

D Saunders¹, B Adams¹, H Cliffe¹, S Currie¹, J Macmullen-Price¹, D Warren¹, I Craven¹
¹Leeds Teaching Hospitals Trust, Leeds, West Yorkshire

Purpose
Aspergillosis is an uncommon infection which predominantly affects immunocompromised subjects. Intracranial infection is rare but carries significant morbidity and mortality. Early diagnosis is key to prompt initiation of appropriate, potentially lifesaving treatment; yet the clinical presentation is often non-specific and the reporting radiologist may be the first to suspect a fungal aetiology. We present the temporal imaging changes in a case of successfully treated intracranial aspergillosis.

Materials and Methods
A five year old male who was undergoing chemotherapy for acute lymphocytic leukaemia and who was being investigated for febrile neutropenia developed flaccid right arm weakness. Initial imaging demonstrated multiple non-specific intracranial lesions but none to account for his symptoms. Aspergillus was the only positive blood culture. Despite high dose antibiotic / antifungal therapy there was an initial, significant deterioration in imaging and clinical symptoms with progression to quadriplegia and associated respiratory compromise. Following a protracted admission there was almost complete neurological recovery with only minor residual weakness, mirrored by on-going radiological improvement.

Results
Initial cross sectional imaging demonstrated multiple poorly-enhancing intracranial and intramedullary lesions which showed avid diffusion restriction. Repeat studies performed at 8 and 27 days demonstrated evolution with ring enhancement and a double rim sign of restriction and susceptibility. Several of the lesions contained a central, non-enhancing crenation highly suspicious for atypical infection. Following 2 months of high dose antifungal therapy repeat imaging demonstrated interval improvement with abscess maturation including thickening of the capsule, decreased diffusion restriction and increased peripheral T1 signal.

Conclusions
The incidence of intracranial aspergillosis is increasing, carrying significant morbidity and mortality. Awareness of the suggestive imaging findings is an important adjunct
to maintaining a high index of suspicion which is essential to optimise the chance of successful management. This case serves as an extremely useful illustrative example.

(Filename: TCT_E-01_intracranialaspergillosis.jpg)

**E-02**

1:20PM - 1:25PM

**Microarteriovenous Malformations of Hereditary Hemorrhagic Telangiectasia: Utility of Arterial Spin Labeling Perfusion MRI**
N Lall1, J Leach1, L Linscott1, E Alvarado1, T Abruzzo1, A Hamill1
1Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose
Cerebral microarteriovenous malformations (micro-AVMs) are defined as AVMs less than 1 cm in size. Though seen in less than 10% of patients with sporadic AVMs, micro-AVMs may occur in up to 50% of patients with intracranial AVMs associated with Hereditary Hemorrhagic Telangiectasia (HHT). The small size of these lesions contributes to their classic description as occult on CT and MRI and their frequent initial presentation with intracranial hemorrhage. While prior studies have confirmed the value of pCASL (pseudo-continuous arterial spin labeling) perfusion MRI in screening and surveillance of AVMs, none have specifically evaluated its ability in detecting these potentially "occult" micro-AVMs. This case series highlights our initial experience with pCASL as an enhancement to traditional non-invasive imaging evaluation of micro-AVMs in HHT.

Materials and Methods
Four patients with known HHT underwent MRI/MRA of the brain to screen for intracranial AVMs, with addition of pCASL perfusion sequence. The patients later underwent conventional angiography, which was correlated with the findings on MRI.

Results
Angiographically proven or suspected micro-AVMs demonstrated focally increased perfusion on the pCASL images, with high conspicuity compared to the normal background parenchymal perfusion. On post-contrast 3D T1-weighted images, these lesions were often inconspicuous if not completely occult; millimetric foci of enhancement were present in association with these lesions, though in some instances were only identifiable restrospectively. Attached images demonstrate a right frontal micro-AVM on pCASL MRI, post-contrast T1 MRI, and arterial and parenchymal phase DSA. Larger left perisylvian AVM is also shown on the MRI images.

Conclusions
Given the frequency of micro-AVMs in patients with HHT and their near occult appearance on non-invasive imaging techniques, pCASL may serve as a useful adjunct to conventional MR sequences in screening and surveillance of such patients.
Developmental Venous Anomalies (DVAs) Mimicking Neoplasm on 11C-Methionine PET and DSC Perfusion MRI.

J Harreld¹, J Angel¹, B Shulkin¹, M Doubrovin¹
¹St. Jude Children's Research Hospital, Memphis, TN
Purpose
Sensitivity and specificity of 18FDG-PET CT for brain tumor assessment are limited by high background activity of normal brain. Radiolabeled amino acids such as 11C-methionine, a marker for elevated amino acid transport and metabolism in proliferative cells, may be more sensitive and specific. However, we have noticed increased uptake on 11C-methionine-PET (Met-PET) associated with developmental venous anomalies (DVAs), which could mimic tumor and misdirect biopsy. DVAs also show increased relative cerebral blood volume (rCBV) on dynamic susceptibility contrast (DSC) perfusion MRI, also frequently associated with higher-grade tumors. We illustrate the Met-PET, DSC perfusion and MR imaging features of DVAs in three children imaged for brain tumors at our institution.

Materials and Methods
Three patients with developmental venous anomalies incidentally noted on MRI -- a 16-year-old female with residual posterior fossa low-grade glioma, a 19-year-old male with right frontal high-grade glioma, and a 9-year-old female with multifocal low-grade gliomas -- underwent both Met-PET and brain MRI with DSC perfusion. ROIs were placed in areas of increased signal on Met-PET and CBV maps associated with DVAs and in contralateral normal brain; width of anomalous veins were measured on post-contrast T1WI. Ratios of DVA:normal brain 11C-methionine uptake (rSUV), rCBV and DVA width were compared (Pearson correlation).

Results
11C-methionine uptake was elevated in cortex overlying the DVAs (mean rSUV=1.31, range 1.11-1.63) and increased with size of DVA (r=0.926) and rCBV (r=0.949); correlation of DVA size with rCBV was less consistent (r=0.760). All DVAs were visible on post-contrast T1WI; one was visible on non-contrast T1WI; and none were visible on non-contrast CTs accompanying Met-PET.

Conclusions
Because DVAs are not readily visible on CT, prevention of misdirected biopsy in patients with focally elevated 11C-methionine and rCBV relies on analysis and registration to MRI with contrast to exclude non-neoplastic etiologies.
Primary Leptomeningeal Atypical Teratoid/Rhabdoid Tumor: Case Report

A Mamere1, C Cavalcante1, M Matsushita1, G Almeida1, E Silva1

1Barretos Cancer Hospital, Barretos, SP

Purpose
To report a rare pathology-proven case and to show the imaging findings of a primary leptomeningeal atypical teratoid/rhabdoid tumor.

Materials and Methods
A 20-month-old girl presented with a 1-month history of unilateral ptosis and quadriparesis. Magnetic resonance imaging (MRI) showed diffuse leptomeningeal disease. Cerebrospinal fluid analysis was not performed. Serological tests for infectious diseases were all negative. Surgical meningeal biopsy in the lumbar region was performed and the pathological findings were consistent with atypical teratoid/rhabdoid tumor.

Results
MRI of the neural axis showed diffuse leptomeningeal thickening and enhancement in the whole brain (white arrows in A and C), circumferential enhancement in the spinal cord (white arrow in D), nerves roots and cauda equina. Diffuse cranial nerve thickening and enhancement (specially the trigeminal nerves and the optic chiasm) were also observed (white arrow heads in B and C). No focal primary mass was present. The subarachnoid space and the cerebral ventricles were slightly enlarged.

Conclusions
In the absence of a primary mass, leptomeningeal thickening and enhancement are most commonly due to infectious or inflammatory disorder and in cases where the primary neoplasm is known, leptomeningeal carcinomatosis is the principal diagnosis. Atypical teratoid/rhabdoid tumor is a rare aggressive malignant tumor (WHO grade 4) occurring most often in young children (usually younger than 3 years old). Typically, it presents as an intra-axial mass, which can be infra or supratentorial, with heterogeneous contrast enhancement. Leptomeningeal dissemination may occur and is associated with poorer prognosis. Primary leptomeningeal atypical teratoid/rhabdoid tumor, without a focal mass, is even rarer. The first case was described in 2010. In our literature review, we have found only four cases previously reported. Despite its extreme rarity, this tumor should be included in the differential diagnosis in young children with leptomeningeal disorder.
Central Nervous System Imaging Findings in Bannayan-Riley-Ruvalcaba syndrome (BRRS)

D Johnson¹, V Lehman¹, J Morris¹
¹Mayo Clinic, Rochester, MN

Purpose
Bannayan-Riley-Ruvalcaba syndrome (BRRS) is a rare autosomal dominant syndrome that represents part of the PTEN Hamartoma Tumor Syndrome (PHTS) spectrum, along with Cowden syndrome (CS), Proteus syndrome, and Proteus-like syndrome. BRRS and the far more common CS may represent variable manifestations of the same mutation, as they can co-occur in the same family. No formal diagnostic criteria for BRRS have been set, but cardinal features suggesting the diagnosis include macrocephaly, hamartomatous intestinal polyposis, lipomas, and pigmented macules of the glans penis. The full scope of neuroradiological findings in BRRS has yet to be defined.

Materials and Methods
A 3-year-old boy with a family history of BRRS due to known PTEN mutation presented with global developmental delay and stereotyped episodes concerning for seizure activity. Physical examination demonstrated macrocephaly.

Results
Brain MRI revealed a left anterior frontal lobe cortical migration anomaly with prominent cerebral veins overlying the anomaly, as well as several tiny abnormal veins running through the involved cortex. A marked abnormal white matter tract running along the expected course of the superior fronto-occipital fasciculus (SFOF) which blunted the left caudate head superiorly was visible on anatomic images and confirmed with diffusion tensor imaging (DTI). Prominent perivascular spaces were noted in the parietal lobes bilaterally.

Conclusions
Cystic-appearing dilated parietal perivascular spaces, as seen in our patient, have been previously reported to occur in 100% of a series of seven patients with BRRS, and represent the most common focal intracranial abnormality associated with this condition. This finding should prompt consideration of BRRS in a pediatric patient with unexplained macrocephaly. The additional findings seen in our patient, including cortical dysplasia which has been previously described in a single case report and the markedly enlarged white matter tract, which to our knowledge has not been
previously reported, represent a portion of the expanded spectrum of BRRS-associated intracranial abnormalities.
Positional CSF Leakage Into the Lumbar Subdural Space

B Salehi¹, D Park², B Yoo¹
¹UCLA, Los Angeles, CA, ²UCLA, Los Angeles, CA

Purpose
To report a unique case of a positional CSF leak into the subdural space.

Materials and Methods
A 36-year-old woman underwent an L4-5 and L5-S1 microdiskectomy that was complicated by epidural hematoma requiring subsequent surgical evacuation. 10 days after surgery, the patient began to experience postural headaches suggestive of intracranial hypotension. An MRI of the lumbar spine was performed to evaluate for a potential CSF leak, which revealed a small subdural fluid collection in the lower lumbar spinal canal. A subsequent MRI one week later demonstrated near resolution of the subdural fluid collection. A lumbar myelogram and post-myelogram CT of the lumbar spine was then performed to confirm and localize the presence of a CSF leak. Surprisingly, the myelogram demonstrated a large, ventral and dorsal subdural fluid collection extending from L2 to S1, resulting in significant effacement of the thecal sac and crowding of the lumbar nerve roots. The fluid collection was slightly hyperdense relative to CSF, suggesting diluted myelographic contrast within the collection. The patient did not report new symptoms of lower back pain or nerve root compression at the time of the myelogram. An MRI of the lumbar spine was performed the next day, which demonstrated near resolution of the subdural fluid collection, and slightly increased epidural fluid. The patient then underwent a revision laminectomy at L4-5 and L5-S1 for repair of a dural tear. Intraoperatively, it was noted there were 2, 1-2 mm dorsal dural tears with associated subarachnoid blebs that ruptured under the epidural fat, with intact lamina directly dorsal. The leak was intermittent and positional and would tamponade as the dura expanded against the lamina. The dural tears were surgically repaired; postoperatively, the patient's postural headaches resolved.

Results
A. MRI of the lumbar spine demonstrates a small dorsal subdural fluid collection. B. MRI performed one week later demonstrates near resolution of the subdural fluid collection. C. CT myelogram of the lumbar spine demonstrates marked increase in the subdural collection, resulting in significant effacement of the thecal sac. D. Subsequent MRI demonstrates resolution of the subdural fluid collection.

Conclusions
We report a unique case of a positional CSF leak into the subdural space from
incidental durotomy from spinal surgery. The dynamic nature of the subdural leak is likely related to the position of the dural tears in relation to the lamina; we hypothesize, based on the patient's position, the dural tears would tamponade against the adjacent lamina, preventing leakage of CSF into the epidural space and forcing CSF to dissect into the subdural space, resulting in transient subdural fluid collections as demonstrated by serial imaging. In conclusion, while CSF leakage from spinal dural tears most commonly present as extra-dural CSF collections, it is important to be aware that leakage into the subdural space can occur.
Lateral Meningocele Syndrome: Imaging Findings of a Rare Disorder

S Lin¹, J Dorr¹, Y Guo¹, R Pandit¹, M Patel¹
¹Santa Clara Valley Medical Center, San Jose, CA

Purpose
Lateral Meningocele Syndrome (LMS), also referred to as Lehman Syndrome, is a rare genetic disorder with only approximately 10 reported cases in the literature. It is characterized by multiple lateral meningoceles, dural ectasia, skeletal abnormalities, and facial dysmorphism. In this report, imaging of a mother and daughter with findings compatible with LMS is presented. A review of the 3 layers of the meningeal membranes within the thecal sac is also accomplished.

Materials and Methods
A case of LMS in a female diagnosed in her early teens is presented. She had already undergone surgical excision of an inferior lumbar arachnoid cyst due to lower extremity weakness. She has le voscoliosis of the thoracolumbar spine, and exhibits many craniofacial, skeletal, and auditory findings associated with LMS. Due to her diagnosis, the patient's mother was subsequently imaged and noted to have similar imaging findings, also compatible with LMS. This suggests a genetic etiology for this syndrome.

Results
Figures 1-2 are of the daughter; Figures 3-4 are of the mother. - Figure 1: Sagittal CT image of the lumbosacral spine demonstrating prominent posterior scalloping, widening of the spinal canal, and elongated and partially fused vertebrae. - Figure 2: Sagittal T2-weighted MR image of the lumbar spine with inset axial T2-weighted slice. Dural ectasia and large lateral T2 hyperintense collections compatible with meningoceles are seen. The spinal cord is displaced anteriorly. - Figure 3: Axial T2-weighted MR image at the L2-3 level demonstrating large lateral meningoceles. - Figure 4: Coronal (left) and sagittal (right) T2-weighted MR images of the inferior thoracolumbar spine depicts multi-level lateral meningoceles and foraminal expansion.

Conclusions
Although originally described by Lehman et al. as "familial otosclerosis," the lateral meningoceles identified in subsequent patients in the literature resulted in a shift in the syndrome label. The imaging and clinical features of Lateral Meningocele Syndrome affecting a daughter and mother are presented. An autosomal dominant or X-linked dominant inheritance pattern is suggested.
Close your windows at night! An unusual cause of cauda equina enhancement

R Lobo¹, D McCorquodale¹, D Wynn¹, S Mcnally², S Ansari¹
¹University of Utah, Salt Lake City, UT, ²University of Utah, Salt Lake City, UT

Purpose
This case presents a rare cause of cauda equina enhancement from rabies. It has rarely been extensively imaged. Our case report presents the imaging and pathological findings along with a fascinating clinical history.

Materials and Methods
A 77 year old woman with several days of muscle pain, stiffness and weakness who presented to an outside hospital with a "flu like" illness after a fall. She had dysarthria and dysphagia with aspiration of water in the emergency department. She was transferred to our hospital for a more complete work up with suspicion of Guillain Barre Syndrome. She was intubated for respiratory distress. Clinical history that came to light later shortly after admission revealed a prior history of waking up at night (5 weeks prior to admission) with a bat on her face. There was no bite mark identifiable, and the bat was not captured. Rabies became the most likely diagnosis and additional lumbar punctures, skin biopsy and serum samples were all sent to CDC confirming rabies virus in all compartments. Despite IVIG administration, the patient's condition worsened. Care was withdrawn and the patient expired shortly thereafter.

Results
Mild cauda equina enhancement without additional abnormality in the spine. Diffuse dural enhancement and moderate enhancement of the right greater than left preganglionic trigeminal nerves.

Conclusions
This excerpt presents an unusual cause of nerve enhancement. The clinical history eventually revealed rabies as a cause, with positive samples from skin, CSF and serum all confirmed within 2 hours of arriving at CDC (Atlanta, GA).

Blastomycosis of Lumbar Spine with Iliopsoas Abscess: TB or not TB.

S Emamian¹, D Boatman¹, F Allard¹, M Fox¹
¹University of Virginia Medical Center, Charlottesville, VA
Purpose
To present a case report and illustrate blastomycosis as a differential diagnosis for tuberculosis (TB). Endemic to Southeast and Midwest North America, Blastomyces dermatitidis is a fungus that can cause skin and lung infection. If disseminated, blastomycosis can involve the lumbar spine and present with abscess along the iliopsoas muscle. The distinguishing features between TB and blastomycosis in our case will be discussed.

Materials and Methods
We present a 43 year old white male with lumbar spine blastomycosis. In December 2013, the patient had a chest CT, following an abnormal chest x-ray, which revealed a right upper lobe infiltrate and hilar lymphadenopathy. Due to concern for malignancy, a PET-CT was performed which demonstrated a focal hypermetabolic area at L5-S1. The patient was lost to follow-up. The patient then presented to our institution in June 2015 with a right groin and thigh mass, back pain and subjective fever, but normal lab results to include WBC and ESR. CT demonstrated destructive change of the right L1-L5 vertebral bodies, the sacrum bilaterally, and enlargement of the right iliopsoas muscle. MRI revealed a rim enhancing collection in the right iliopsoas extending inferiorly into the presacral space bilaterally and into the right inguinal region. Due to the constellation of a lung lesion, hilar lymphadenopathy, multiple lumbar vertebral body lesions and an iliopsoas collection, the diagnosis of tuberculosis was entertained. CT guided biopsy of the iliopsoas was performed with appropriate precautions for tuberculosis utilized, including a performing the biopsy in a negative pressure room. Histologic evaluation demonstrated numerous intracellular yeast forms within histiocytes. The three main differential diagnoses for intracellular yeast forms are cryptococcus, blastomyces and histoplasma. The size of the yeast forms, patterns of budding, lack of a mucicarmine-positive capsule, PCR sequencing and fungal culture were all confirmative of Blastomyces dermatitidis. The collection was percutaneously drained and the patient was started on IV amphotericin for 6 weeks followed by oral itraconazole.

Results
PET-CT (1a) from December 2013 demonstrated hypermetabolic lesion on the right side of L5 and S1. CT and MRI (1b, 1c and 1d) from June/July 2015 demonstrated destruction of right side of L1-L5 vertebral bodies with abscess along the right iliopsoas muscle presenting as a protruding mass in the right groin. There was also involvement of the sacrum with bilateral presacral abscesses. It is difficult to distinguish between TB spondylitis and Blastomycosis based on imaging alone, since vertebral body destruction and iliopsoas abscess are common between the two entities. However, the lack of significant disc space involvement and a normal ESR in our patient is somewhat unusual for TB.

Conclusions
Blastomycosis can present with spinal bony destruction and an iliopsoas abscess.
Overlap between the imaging features of blastomycosis and TB can occur and, in endemic areas, blastomycosis should be considered in the differential diagnosis of suspected spinal tuberculosis.
Idiopathic Hypertrophic Pachymeningitis of the Cervical Spine

R Sharma¹, S Ali¹, E Stein¹
¹Maimonides Medical Center, Brooklyn, NY

Purpose
To outline a case of idiopathic hypertrophic spinal pachymeningitis (IHSP) involving the cervical spine and the radiographic findings.

Materials and Methods
A 55-year old female with multiple comorbidities presents with dizziness and progressive right-sided extremity weakness and myelopathy. The patient had decreased right-sided sensation to light touch with positive Hoffman sign and clonus. Further work-up revealed an extradural posterior fossa and cervical spine mass extending to C6/7 with marked spinal canal stenosis and cord compression from C1 to C4. The patient underwent C4 laminectomy and biopsy of the extradural mass.

Results
MRI of the brain and cervical spine with intravenous gadolinium contrast revealed nodular thickened enhancement of the dura overlying the occipital bone to the level of the transverse sinus and over the clivus to the level of the sella. The enhancement extended into the cervical spinal canal to the level of C6/7 with severe cord compression from C1 to C4. This mass was very low in signal intensity on T1/T2-weighted imaging as well as FLAIR. There was diffuse enhancement with more intense enhancement peripherally. Additionally, there was high signal within the cord compatible with myelomalacia. These imaging findings were suggestive of a fibrous process like IHSP. Other possibilities included meningioma, lymphoma, tuberculosis, sarcoidosis, and amyloidosis.

Conclusions
This case highlights a patient presenting with progressive right-sided myelopathy with a dural-based nodular mass extending into the cervical spine with cord compression. Surgical biopsy and decompressive laminectomy was performed and the patient clinically improved. Pathology revealed IgG4-negative fibrous tissue showing chronic inflammation with mixed inflammatory infiltrate. IHSP is a chronic progressive inflammatory fibrosis of the dura that can cause similar symptoms of compression of neural structures as IgG4-related sclerosing spinal pachymeningitis. IHSP is a diagnosis of exclusion after infectious and malignant etiologies have been ruled out.
Chondroblastic Osteosarcoma of the Pelvis: A Rare Variant with Cartilaginous Imaging Features

J Williams¹, J Morris¹
¹Mayo Clinic, Rochester, Minnesota

Purpose
To review the imaging findings of a sacral chondroblastic osteosarcoma, a rare variant whose imaging features are not well described in the literature. To demonstrate that this rare subtype of osteosarcoma has imaging features similar to a chondrosarcoma, but is typically seen in a younger patient population.

Materials and Methods
A 22 year-old female with past medical history of acute lymphoblastic leukemia diagnosed at age 4, treated with radiation and autologous bone marrow transplantation, presented with pain and numbness in the left lower extremity. After a failed trial of conservative therapy, an MRI was obtained which demonstrated a large infiltrative sacral mass extending into the epidural space and across the SI joint into the ilium. Biopsy demonstrated a grade III chondroblastic osteosarcoma.

Results
MRI demonstrated a T1 hypointense, T2 hyperintense, infiltrative sacral mass with speckled enhancement pattern which crossed the left sacroiliac joint into the ilium. An associated soft tissue component extended into the parasacral region and epidural space. CT demonstrated a sclerotic nondestructive lesion, with associated chondroid matrix adjacent to the left sacroiliac joint (Figure 1).

Conclusions
The markedly hyperintense T2 signal, avid speckled enhancement pattern, and chondroid matrix of this tumor make its imaging appearance similar to a chondrosarcoma. However, a chondrosarcoma at this patient's age would be atypical. Despite its rarity as a subtype, higher grade osteosarcomas in the pelvis are more likely to be the chondroblastic variant than those in the extremities (Saab et al. 2005), particularly in patients with a history of radiation exposure as a child. The neuroradiologist should be aware of the chondroblastic subtype of osteosarcoma, which should be included in the differential diagnosis of an aggressive-appearing cartilaginous tumor in a younger patient.
A Case of Multiple Intra-spinal Melanocytic Tumours Mimicking Radiological Features of Neurofibromatosis Type II

N Saleem¹, S Currie¹, C Derham², A Chakrabarty²
¹Leeds General Infirmary, Leeds, West Yorkshire, United Kingdom, ²Leeds General Infirmary, Leeds, West Yorkshire

Purpose
Illustrate the key imaging features of multiple spinal melanocytic tumours of uncertain malignant potential (MelTUMP), so as to allow radiological differentiation from multiple meningiomata and schwannomas.

Materials and Methods
A 37-year old female presented with gradual deteriorating lower limb weakness and bowel and bladder dysfunction. MRI demonstrated multiple intraspinal extramedullary lesions, which were initially considered to represent multiple meningiomata and schwannomas. There was no clinical suspicion of malignant disease and a staging CT of the thorax, abdomen and pelvis was negative for malignancy. There were no clinical parameters to indicate an underlying diagnosis or family history of neurofibromatosis type 2. At the time of surgery for a large compressive lesion at T12, dark brown/ black pigmentation of the spinal dura was observed and histology of the resected lesion was consistent with MelTUMP.

Results
Magnetic resonance imaging demonstrated multiple (six) discrete durally-based extramedullary lesions of varying sizes in the thoracolumbar spine. Some of the lesions occupied the neural exit foramina while others were sited within the spinal canal. The lesions were iso- to slightly hyperintense on T1 and isointense to hypointense on T2 weighted sequences relative to the spinal cord and demonstrated homogenous contrast enhancement. The enhancement pattern was identical to that of meningioma/schwannoma however slight T1 hyperintensity and T2 hypointensity indicated the presence of melanin in the lesions.

Conclusions
Spinal MelTUMPs are rare; to our knowledge only a few cases (< 100) of spinal melanocytomas are reported in the literature; but no case of multiple spinal MelTUMP has been reported to date. Our case demonstrated multiple intra-spinal melanocytomas which mimicked multiple spinal meningiomata on standard structural imaging. This case also highlights that reporting radiologists should consider MelTUMP in the
differential diagnosis of multiple spinal lesions, particularly if these lesions exhibit T1 hyperintensity and T2 hypointensity relative to the spinal cord.

E-13

2:15PM - 2:20PM

A Case of Chronic Lymphocytic Inflammation with Pontine Perivascular Enhancement Responsive to Steroids (CLIPPERS) with Diffuse CNS Involvement

S Lee¹, R Kumar², T Ebbert²
¹University of Wisconsin School of Medicine and Public Health, Madison, WI, ²Gundersen Lutheran Hospital, La Crosse, WI

Purpose
To present an unusual case of chronic lymphocytic inflammation with pontine perivascular enhancement responsive to steroids (CLIPPERS) with diffuse involvement of the spinal cord, brainstem, cerebellum and supratentorial brain including basal ganglia, periventricular and subcortical white matter.

Materials and Methods
A 74 year-old Caucasian male presented with a two-month history of progressive bilateral lower extremity weakness, gait ataxia, diplopia, dysphagia, dysarthria, urinary incontinence, and mild cognitive impairment. The patient was diagnosed with CLIPPERS based on MRI findings, brain biopsy and response to a trial dose of IV methylprednisolone. He was then started on prednisone oral 60 mg once daily and methotrexate 10 mg once weekly. After discharge, the patient struggled with medication compliance and was re-hospitalized three months later for bilateral lower extremity weakness and gait ataxia.

Results
MRI of head, cervical spine, and thoracic spine revealed punctate and curvilinear enhancement with associated high T2 signal diffusely involving the spinal cord, brainstem, basal ganglia and white matter, including cerebellar and supratentorial white matter. The enhancement was most densely concentrated within the pons and cerebellum. The enhancement improved after treatment with IV steroids.

Approximately one month later, repeat MRI showed progression of abnormal enhancement throughout the brain and spine in the setting of medication non-compliance.

Conclusions
CLIPPERS is an inflammatory central nervous system disorder that was first defined in 2010. It is a challenging diagnosis and imaging plays a key role in confirming it. Early recognition of CLIPPERS along with initiation of long-term steroid therapy is important because it results in significant clinical improvement. Therefore, awareness
of this entity by the radiologist is important in expediting diagnosis and treatment. Our case demonstrates MRI findings that are atypical in their extent when compared to other cases described in the literature.

E-14

Chemotherapy-Induced Myelopathy after Intrathecal Chemotherapy; Magnetic Resonance Imaging Findings.

N Zakhari1, C Torres2
1The Ottawa Hospital, Ottawa, Ontario, 2The Ottawa Hospital, Ottawa, Ontario

Purpose
Intrathecal (IT) chemotherapy is used for prophylaxis and treatment of the central nervous system (CNS) in patients with hematological malignancies. Myelopathy following IT chemotherapy is a rare complication. Differentiation of this condition from neoplastic infiltration of the CNS significantly impacts patients' management given the different treatment strategies for each entity. We describe the distinctive imaging pattern of myelopathy following IT chemotherapy on serial MR examinations.
Materials and Methods
82 year-old man diagnosed with testicular Diffuse Large B-Cell Lymphoma, completed a course of R-CHOP and intrathecal cytarabine with methotrexate chemotherapy in January, 2015. In February 2015, he presented with gradually progressive inability to walk, legs incoordination, urinary retention and bowel incontinence. A lumbar puncture was negative for infectious or lymphomatous involvement and cord/cauda equina compression was excluded on imaging. He was started on corticosteroids and high-dose folinic acid with some improvement of motor function.

Results
At presentation, two MRIs -three weeks apart- were unremarkable. Abnormalities manifested on MR at 6weeks (Fig. A) and worsened at 8 weeks (Fig. B-D) despite treatment initiation. Long segment T2 hyperintensity was seen centrally and involving the posterior columns with mild cord expansion (Fig. A-C) and subtle enhancement (Fig. D) extending from the mid thoracic cord at T5-T6 level to the conus.

Conclusions
Chemotherapy-induced myelopathy after IT chemotherapy is a rare complication of unclear underlying pathophysiology that develops over variable time range after exposure to chemotherapy. MRI is the best modality for assessment in this situation with a characteristic involvement of the posterior columns. However, the MRI findings may lag behind the clinical presentation and MRI cannot exclude the diagnosis. Awareness of the typical imaging findings is crucial to avoid misinterpretation as neoplastic infiltration in this clinical context. The findings remain nonspecific and other etiologies of posterior spinal columns signal change needs to be excluded.
A Case of Hirayama Disease.

R Yu\textsuperscript{1}, H Kale\textsuperscript{2}
\textsuperscript{1}University of Pittsburgh Medical Center, Pittsburgh, PA, \textsuperscript{2}University of Pittsburgh Medical center, Pittsburgh, PA

Purpose
Hirayama disease, also known as juvenile muscular atrophy of the distal upper extremity, is a rare condition mainly in young males between the ages of 15 and 25 years, characterized by progressive asymmetric muscle weakness and atrophy in the upper extremities, followed by spontaneous arrest within several years. We present a case of Hirayama disease and describe the imaging features on both neutral and flexion magnetic resonance images.

Materials and Methods
A previously healthy 18-year-old male baseball player presented with a one year history of progressive weakness in his left grip without associated sensory deficit. There was no history of trauma or family history of neurologic disease. The clinical examination revealed atrophy of the left first dorsal interosseous muscle. Fasciculation was not seen. Electromyography showed borderline low normal amplitude of the ulnar nerve and normal amplitude of the median nerve, without conduction abnormalities or sensory impairment. MRI of the cervical spine including neck-flexion images revealed findings compatible with Hirayama disease.

Results
(A) Neutral position sagittal T2-weighted image of the cervical spine show a cervical cord normal in signal and morphology, within a patent central canal. (B) Neutral position axial gradient-echo image at the level of C7-T1 shows loss of attachment of the dorsal dura with the lamina (arrow). (C, D) Sagittal and axial T2-weighted images in flexion shows forward displacement of the dura with associated multiple prominent curvilinear flow voids within the dorsal epidural space (arrows). The neural foramen were patent.

Conclusions
Although Hirayama disease is a self-limiting disease, early diagnosis is needed as early intervention can stop disease progression. The diagnosis of Hirayama disease should be considered in young patients with a clinical history of asymmetric upper extremity weakness and atrophy. Careful attention for suspicious findings on neutral-position MR imaging is necessary, and additional neck-flexion MR imaging should be performed to confirm the diagnosis.
Paralysis in Morquio Syndrome: Catastrophic Consequence of Untreated Cervical Instability

J Dorr¹, M Patel¹, R Pandit¹
¹Santa Clara Valley Medical Center, San Jose, CA

Purpose
Morquio Syndrome, also known as Mucopolysaccharidosis (MPS) type IV, is a lysosomal storage disorder due to an enzymatic deficiency with an autosomal recessive inheritance. Although it affects multiple organs, abnormalities of the bones, ligaments, and connective tissue are most prominent. Of particular concern is instability at C1-2 and thoracolumbar kyphosis that predisposes patients to spinal cord compression. In this report, characteristic imaging findings in a young male with MPS IV is presented.

Materials and Methods
A 19 year-old male with a history of MPS IV presented after mechanical fall resulting in lower extremity weakness that was increased from baseline. Plain film, CT, and MR imaging revealed characteristic findings of dysostosis multiplex. Although severe spinal stenosis, cord compression, and likely myelomalacia were also identified, the patient refused surgical decompression. Six months later he again presented after repeat fall, this time resulting in tetraplegia.

Results
Figure 1: Sagittal CT (left) and subsequent sagittal T2-weighted MR (right) images through the cervical spine after the patient's initial fall demonstrating odontoid hypoplasia, platyspondyly, and severe stenosis with cord compression (arrows) at the craniocervical junction with suggestion of increased cord signal. Figure 2: Sagittal T2-weighted MR image through the cervical spine after the second fall, when the patient presented with tetraplegia, demonstrates increased T2 hyperintensity (arrow) in the cord at the level of stenosis, compatible with myelomalacia. Figure 3: Companion sagittal STIR MR image with abnormal signal suggesting ligamentous injury. Figure 4: Frontal chest (top) and abdomen (bottom) plain film images demonstrating characteristic dysostosis multiplex.

Conclusions
MPS IV is an autosomal recessive lysosomal storage disorder with certain characteristic image findings. Some of the spinal abnormalities, including cervical instability, predispose to paralysis as highlighted in this case report. Recognition of
the pattern of imaging findings can assist with guidance of proper management and preventative treatment.
Non-traumatic Cervical Spinal Subarachnoid Hemorrhage from a Radiculomedullary Artery Pseudoaneurysm

P SHAH1, M Potts2, T Hijaz3, S Ansari2, B Liu4
1Northwestern University Feinberg School of Medicine, CHICAGO, IL, 2Northwestern University, Feinberg School of Medicine, Chicago, IL, 3Feinberg School Of Med., Northwestern Univ., Chicago, IL, 4Northwestern University Feinberg School of Medicine, Chicago, IL

Purpose
1. Describe a case of non-traumatic subarachnoid hemorrhage in the cervical spine secondary to rupture of a partially thrombosed radiculomedullary artery pseudoaneurysm. 2. Discuss the causes of non-traumatic cervical spinal subarachnoid hemorrhage.

Materials and Methods
A 48-year-old woman with rheumatoid arthritis and two prior episodes of right knee hemarthrosis of undetermined etiology presented with new onset neck pain and right upper extremity weakness. The patient was on prophylactic warfarin anticoagulation with an INR of 1.8 for a recent total left knee arthroplasty. MRI of the cervical spine demonstrated extensive subarachnoid hemorrhage. A focal area of enhancement within the hemorrhage raised concerns for a vascular lesion. Subsequent conventional spinal angiography confirmed the presence of a 2-3 mm fusiform aneurysm involving the C5 radiculomedullary branch of the right vertebral artery associated with a vertebral artery dissection. On a repeat cervical spine MRI performed two days later, the majority of the pseudoaneurysm had thrombosed spontaneously, and the patient was managed conservatively.

Results
1. Extensive ventral intradural subarachnoid hemorrhage of the cervical spine (Figure 1). 2. Fluid-debris or fluid-fluid level (Figure 1) with the nondependent compartment exhibiting avid contrast enhancement (Figure 2) and an associated linear tail of enhancement (Figure 3) suggestive of vascular etiology. 3. Small fusiform aneurysm of the C5 radiculomedullary artery arising from the right vertebral artery (Figure 4), subsequently supplying the anterior spinal artery.

Conclusions
Non-traumatic cervical spinal subarachnoid hemorrhage secondary to a pseudoaneurysm of a cervical radiculomedullary artery is an exceedingly rare presentation of a rare entity. Auto-thrombosis of the radiculomellary pseudoaneurysm
is rare. We present MR and conventional spinal angiographic imaging to demonstrate the imaging appearance of this diagnosis and discuss various other causes of non-traumatic cervical spinal subdural hemorrhage, including radiculomedullary artery dissections, cervical spinal dural or pial/perimedullary AVFs, and AVMs.

Supratentorial Intracerebral Schwannoma: Very Rare Variant Location of an Otherwise Common Tumor

J Chua-Tuan¹, C Li¹, J Chen², S Imbesi¹, D Amaro³

¹University of California, San Diego, San Diego, CA, ²San Diego VA / UCSD Med. Center, La Jolla, CA, ³University of California, San Diego, San Diego, CA, San Diego, CA
Purpose
To describe a rare presentation of supratentorial intracerebral schwannoma: a common tumor found in an unusual location.

Materials and Methods
Patient is a 34-year-old male in his usual state of health who presented after falling while playing basketball and hitting the back of his head, without loss of consciousness. He experienced immediate headache associated with seeing bright lights and blurry vision that resolved in a few minutes, though his headache persisted. The patient was otherwise asymptomatic prior to this episode. Thus, he presented to the emergency room for clinical and imaging workup.

Results
Noncontrast head CT (Figure, A) demonstrated a mass lesion within the anterior pole of the left temporal lobe with rim calcification and mild peritumoral edema. Subsequent MRI examination (Figure, B-D) demonstrated apparent intra-axial location of the mass with well-defined and mildly lobulated margins and rim of magnetic susceptibility due to calcification. The lesion was slightly low signal intensity on T1-weighted images and high signal intensity on T2/FLAIR. There was also peripheral hyperintensity on T2-weighted images representing peritumoral edema or gliosis. Postcontrast sequences demonstrated homogenous avid enhancement of the mass. Quantitative cerebral blood flow with arterial spin labeling technique was markedly elevated, consistent with neoplasm.

Conclusions
Our case represents a rare presentation of pathologically proven supratentorial intracerebral schwannoma, a benign tumor that is diagnosed predominantly in children and young adults. On surgical and pathological report, the tumor was actually extra-axial in location, either within a perivascular space or deep within a sulcus. The histogenesis of these lesions remains unclear, as Schwann cells are not normally present within the supratentorial brain parenchyma to a significant degree. Multiple theories of their origin have been proposed including presence of Schwann cells within perivascular vasa nervorum within the subarachnoid spaces, displaced neural crest cells forming foci of intraparenchymal Schwann cells, and differentiation of pial cells to Schwann cells. Imaging features are nonspecific, though commonly described characteristics include cyst formation, calcification, and peritumoral edema or gliosis, findings common to many low-grade neoplasms. Though rare, it is important to recognize intracerebral schwannoma in the differential diagnosis of supratentorial benign tumors in young adults, as surgical resection is essentially curative.
Ecchordosis Physaliphora: Imaging Characteristics of a Benign Retroclival Embryologic Notocord Remnant

J Dorr¹, R Pandit¹, M Patel¹
¹Santa Clara Valley Medical Center, San Jose, CA

Purpose
Ecchordosis physaliphora (EP) is a benign remnant of notochord cells that is typically discovered as an asymptomatic incidental finding. It is most commonly located in the prepontine cistern, although can be seen anywhere along the craniospinal axis. The lesion typically has a midline intradural component that is connected via stalk or pedicle to the dorsum of the clivus. The purpose of this report is to describe the imaging characteristics of this benign lesion to facilitate differentiation from other retroclival lesions such as chordoma, arachnoid cyst, and dermoid and epidermoid cysts.

Materials and Methods
A 62 year-old female presented for MR imaging to evaluate symptoms of vertigo. A non-enhancing round lesion was noted anterior to the medulla, with imaging characteristics compatible with EP. A pituitary microadenoma was also seen, which permitted subsequent longitudinal monitoring of the EP lesion over four years.

Results
Figure 1: Axial CT (left) and MR FIESTA (right) images at the level of the Dorello canal (arrowheads) demonstrate a well-defined lesion of the dorsal clivus (arrows). Figure 2: Axial MR FIESTA image which shows a tiny stalk (arrowhead) which connects the clival lesion to the round intradural lesion (arrow) anterior to the medulla. Figure 3: Axial T2-weighted FLAIR MR image showing typical T2 hyperintensity of the intradural component of EP (arrow). Figure 4: Sagittal T1 pre-contrast (left) and post-contrast (right) MR images through the brainstem demonstrating lack of enhancement of the pre-medullary lesion (arrows), compatible with EP.

Conclusions
Ecchordosis physaliphora is a benign uncommon retroclival lesion which may be distinguished from other lesions such as chordoma, also of notochordal origin, by location and imaging characteristics. In this report, the differential of retroclival lesions is discussed and specific imaging findings of EP are presented. Balanced steady-state free precession sequences such as FIESTA, can assist with identifying the unique features of EP.
Distinct Morphological Changes Found in Longitudinal Comparison of Growing vs. Stable Aneurysms

A Chien¹, Q Yu¹, V Lau¹
¹David Geffen School of Medicine at UCLA, Los Angeles, CA
Purpose
Aneurysm growth is a key factor influencing aneurysm rupture risk. Properly predicting aneurysm growth can have positive contributions to treatment planning and rupture prevention. This study investigates and compares morphological characteristics between growing and nongrowing stable aneurysms.

Materials and Methods
Internal carotid artery (ICA) aneurysm CTA images were segmented using the threshold method to generate 3D models. A total of 37 ICA aneurysm cases: seven ophthalmic aneurysms, six superior hypophyseal aneurysms, and 24 posterior communicating artery (Pcom) aneurysms were analyzed. Each aneurysm case was analyzed using images collected at three distinct time points, with average separation time of 1.2 ± 0.5 year. Aneurysm neck size ranged from 1.8 to 12.1 mm, with an average of 4.6 ± 2.0 mm. Eleven out of 37 total cases were identified as showing growth: two ophthalmic aneurysms, two superior hypophyseal aneurysms and seven Pcom aneurysms. Mean follow-up time after each exam time point for the growing group was 1.3 ± 0.6 year, and 1.2 ± 0.5 year for the stable group. Several morphological parameters such as aneurysm volume, surface area, aspect ratio, and size ratio were investigated. Because a nominally stable aneurysm's shape may change while the maximum dimension remains the same, we studied additional shape indices which describe the irregularity of aneurysm shapes (nonsphericity index, NSI), volume ratio (AVSV), and surface ratio (AASA).

Results
For the group of growing aneurysms, the average rate of increase for aneurysm volume was 31.4 ± 27.8% per year, and 4.8 ± 4.2% per year for neck diameter. To assess the consistency of measurements, aneurysm neck size was compared for each case in the stable group and found to not significantly differ between the first and last time points (p = 0.705). In general, growing aneurysms showed 16.0% and 28.6% increases in aspect ratio and size ratio, respectively, and a 6.5% decrease in NSI over the three time points. Stable aneurysms showed 4.0% and 10.6% increases in NSI and AASA, respectively, over the three time points. The changing rates of AASA versus volume for growing aneurysms and stable aneurysms, on average -0.0011 and 0.038, respectively, are significantly different (p = 0.0485).

Conclusions
Results suggest that growing aneurysms have a higher tendency to develop a spherical shape over time.

O-94  

1:23PM - 1:31PM

Association of Aneurismal Rupture with the Lunar Cycle

J Banfield¹, J Shankar²
Purpose
Popular conception supposes that the risk of intracranial aneurysm rupture varies across phases of the moon. One study found an increased risk of rupture during new moon (1). Larger studies, however, found no association (2, 3). These studies analyzed the eight qualitative moon phases and none were conducted in North America. The purpose of this study was to review cases from our Canadian institution to assess any association between aneurysm rupture and the lunar cycle.

Materials and Methods
We retrospectively reviewed all cases of subarachnoid hemorrhage secondary to ruptured aneurysm treated with endovascular coiling in our institution from October 2005 to October 2015. We included only cases with a known rupture date. We used degree of illumination of the moon to quantitatively code the lunar cycle. We grouped together patients whose aneurysms ruptured when the moon was illuminated by: 1) .0-.20, 2) .21-.40, 3) .41-.60, 4) .61-.80, and 5) .81-1.0. We used 0.41-0.60 as baseline. Odds of aneurysm rupture in other periods were calculated using likelihood ratio and Wald test. 95% confidence interval and p values were calculated.

Results
A total of 213 cases were included in our analyses. Results are presented in the table below.

Conclusions
Odds of aneurysm rupture were greater when the moon was least (new moon) and most (full moon) illuminated, compared to the middle of the lunar cycle. However, we did not include ruptured aneurysms that were not treated with endovascular coiling, which may not be distributed equally across the lunar cycle. Regardless, our findings could help optimize hospital staffing decisions.

<table>
<thead>
<tr>
<th>Amount of illumination</th>
<th>n</th>
<th>Odds of rupture (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>.00-.20</td>
<td>58</td>
<td>2.76 (1.69-4.45)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>.21-.40</td>
<td>33</td>
<td>2.05 (1.21-3.48)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>.41-.60</td>
<td>22</td>
<td>1.24 (0.70-2.19)</td>
<td>0.35</td>
</tr>
<tr>
<td>.61-.80</td>
<td>27</td>
<td>1.24 (0.70-2.19)</td>
<td>0.35</td>
</tr>
<tr>
<td>.81-1.0</td>
<td>73</td>
<td>3.48 (2.13-5.67)</td>
<td>&lt;0.00</td>
</tr>
</tbody>
</table>

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Canadian Registry of LVIS Jr for Treatment of Intracranial Aneurysms (CaRLA)

J Shankar¹, D Iancu², A Quateen³, S Patro², R Fahed⁴, Z Kaderali⁵, M Cortes⁶, D Tampieri⁷, C Lum², A Weill⁸
¹Dalhousie University, Halifax, Nova Scotia, ²The Ottawa Hospital, Ottawa, Ontario, ³Dalhousie University, Halifax, Halifax, Nova Scotia, ⁴CHUM, Montreal, AR, ⁵Health Sciences Centre Winnipeg, Winnipeg, Manitoba, ⁶McGill University, Montreal, Quebec, ⁷Radiology Department, Montreal Neurological Institute, McGill University, Montreal, Quebec, ⁸CHUM Montreal QC, Montreal, QC

Purpose
Stents confer a statistically significant decrease in the rate of angiographic recurrence. The newest stent for intracranial use is Low Profile Visible Intraluminal Support Device (LVIS Jr). The purpose of this study was to assess the efficacy of the new stent in a multicenter retrospective registry.

Materials and Methods
Centers across Canada utilizing LVIS Jr were contacted to participate in a retrospective registry of patients treated with LVIS Jr for intracranial aneurysms between January 2013 and July 2015.

Results
A total of 89 patients (65 females; Age-56.43 ± 10.66 years) were treated with LVIS Jr stent in five centers in Canada. Mean maximum diameter of dome and neck of the aneurysm and dome to neck ratios were 7.08±4.03 mm, 4.24±1.78 mm and 1.72±0.79 respectively. The stent was used as a bail out situation in 22 (25%) cases. A "Y" stent construction was used in 10 (11.5%) cases. Angiographic complications were noted in 22 (26%) patients but clinical complications were noted only in 10 (16%) patients. On follow up, the mortality and morbidity were 2.6% and 9.2%. Angiographic and clinical complications were higher in patients with ruptured aneurysm (odds ratio- 5.98 and 3.06) and when LVIS Jr was used as a bail out scenario (odds ratio- 3.34 and 2.87). Clinical complications were higher when a dyna CT was not used to confirm the opening of the stent (odds ratio- 3.23). Class 1, 2 and 3 results were respectively seen in 50.57%, 36.78% and 12.64% immediately after coiling and 57.97%, 26.09% and 15.94% on the last follow up.

Conclusions
The LVIS Jr stent is a promising device for stent-assisted coiling but continues to be technically challenging. Higher complications were associated with use in ruptured aneurysm; in bailout situation and when opening was not confirmed with dynaCT.
Initial experience with a low profile-microcatheter and small flow diverter device, Fred Jr.

J CHUDYK¹, C Bleise², E Scrivano³, R Ceratto², J Chudyk⁴, P Lylyk⁵
¹Instituto Médico ENERI - Clínica Sagrada Familia, BUENOS AIRES, Buenos Aires, ²Instituto Médico ENERI - Clínica Sagrada Familia, Buenos Aires, CABA, ³Instituto Médico ENERI - Clínica Sagrada Familia, Buenos AIRES, Buenos Aires, ⁴Instituto Médico ENERI - Clínica Sagrada Familia, Buenos Aires, Buenos Aires, ⁵Clinica ENERI, Buenos Aires, Buenos Aires

Purpose
Flow diversion is a well-recognized technique for the treatment of wide neck and complex proximal aneurysms, especially for large and giant aneurysms. Recently, the indications have been expanded to include distal and small aneurysms. Most flow diverted devices use large microcatheters, which can make treatment difficult in small arteries. Fred Jr. represents the first flow diverter (FD) available for smaller microcatheters, specifically the headway 21. We report our initial experience using Fred Jr for the treatment of aneurysms and dissections in small arteries.

Materials and Methods
Since June 2015 to October 2015, four patients with three aneurysms and one symptomatic ICA dissection were treated with Fred Jr. Two aneurysms were previously treated with coils. Two aneurysms were small in size. Clinical and angiographic follow up was performed at 24 hours and 3 months after treatment.

Results
All patients were treated successfully with Fred Jr. One device was required for each aneurysm. For the ICA dissection, three devices were used because of the extension of the lesion. All patients were treated with dual antiplatelet drugs. No ischemic or hemorrhagic complications were observed during treatment or the follow up stage. Occlusion rate at 3 months was 66%. Morbidity and mortality rate was 0%.

Conclusions
In this small series of patients, Fred Jr. showed promising results. It seems to be a reasonable strategy for lesions located in small arteries. More cases and longer follow up are needed to prove its safety and efficacy.
Computation of the Change in Length of a Flow Diverter when Deployed in Realistic Vessel Models

J Blasco Andaluz¹, L San Roman², H Fernández³, R Kale⁴, I Larrabide⁵, L Serra⁶, N Macias², O Chirife⁷, F Zarco⁸, W Mailaender⁹, J Macho²
¹Interventional Neuroradiology, BARCELONA, -- SELECT --, ²Hospital Clinic of Barcelona, Barcelona, Barcelona, ³Galgo Medical, Barcelona, Barcelona, ⁴Galgo Medical, Barcelona, Barcelona, ⁵Galgo Medical / Pladema-CONICET, Barcelona, Barcelona, ⁶Galgo Medical, Barcelona, Barcelona, ⁷Hospital Clinic of Barcelona, Barcelona, Barcelona, ⁸Hospital Clinic of Barcelona, Barcelona, Barcelona, ⁹Acandis GmbH, Pforzheim, Mannheim

Purpose
The Derivo® Embolization Device (Acandis GmbH) is a nitinol-based braided flow diverter (FD) which allows intracranial aneurysm treatment by redirecting the flow and subsequent thrombosis of the aneurysm sac. Based on two individual cases in which a 3D silicon model was created based on the 3DRA images acquired some weeks before the treatment, we analyzed the behavior of the FD in terms of final length and positioning of: 1) a virtually deployed FD, 2) the FD deployed inside the silicon model and 3) the FD position after the real procedure. The main purpose of the study was to evaluate the accuracy prediction of the virtual deployment of the FD and the one on the silicon model.

Materials and Methods
Three dimensional RA images of aneurysmatic patients were segmented and virtual deployment of a FD was performed with the Fast Virtual Endovascular Treatment (FVET®) software. Landing zone and final length of the real deployment of the
device after the procedure were compared with virtual deployment and with the 3DRA images acquired after the deployment of the same device in a 3D silicon model from a 3D printer, in order to evaluate the accuracy prediction of both methods.

Results
The length of the simulated stent was accurately consistent with the deployed stent during the patient intervention, being the accuracy prediction of the software about 97% on average in the two cases analyzed. In the first case, Derivo1(P2), a higher distance was observed between the length of the FD deployed in the patient and the length of the stent deployed in the silicon model: being the FD inside the silicon model about 6 millimeters longer. The diameter of the silicon model was 400 micrometers lower than the vessel diameter of the patient, thus exhibiting a larger FD length. On the other hand, in the second model, both vessel geometries presented a similar diameter; therefore, the FD lengths were almost equal between them. Despite the fact that silicon models are printed from 3DRA images of patient anatomy, these models could present deviations in the vessel diameter, which may affect the FD deployment. In the cases studied, a difference of 400 microns in vessel diameter led to 6 millimeters difference in the final stent length. The computational method seems to overcome this limitation as long the vessel geometry is accurately extracted from the 3DRA images, leading to a better estimation of the FD length and therefore final positioning.

Conclusions
Silicon models provide a realistic environment for the planning and training of FD intervention, which faces the interventionist with the actual difficulties (geometry, navigation, etc.) to be found in the patient. Nevertheless, an accurate prediction of the final FD position can be hampered by the accuracy of the reconstructed vessel geometry (modeling, fabrication and 3D printing). Alternatively, the algorithm of FD deployment software has a time cost in the order of few seconds and showed an accuracy of 97%, which makes it a promising technique for the support of clinical decisions in real time.

O-99
2:03PM - 2:11PM

Intra-Operative Rupture with Balloon-Assisted Coiling is Associated with a High Rate of Good Clinical Outcome

Y Kayan¹, J Delgado Almandoz¹, J Fease¹, J Scholz¹, A Milner¹, M Mulder¹
¹Abbott Northwestern Hospital, Minneapolis, MN

Purpose
Intra-operative rupture of an intracranial aneurysm during coil embolization is a potentially devastating event. Historically, large series of intracranial aneurysm
embolizations have reported poor outcomes after intra-operative rupture. We hypothesize that intra-operative rupture in the setting of balloon-assisted coiling (BAC) is not associated with poor outcomes.

Materials and Methods
A retrospective review of our prospectively acquired database of endovascular intracranial aneurysm treatments was completed for embolizations performed between December 20, 2007 and December 9, 2015. The pre-operative rupture status, treatment modality, presence of intra-operative aneurysm rupture, discharge disposition and 6-month follow up modified Rankin Scale (mRS) were recorded. Clinical outcomes of intra-operative aneurysm rupture were compared between BAC and non-BAC coil embolization procedures using Fisher's exact test with p < 0.05 accepted as statistically significant.

Results
A total of 36 intra-operative ruptures occurred among 962 coil embolizations (3.7%). Of these, 34 were aneurysm ruptures (3.1%) and two were vessel ruptures. Among the 669 BAC's (70% of treatments), there were 26 aneurysm ruptures (3.9%), 14 in the setting of subarachnoid hemorrhage (SAH) and 12 in non-SAH patients. Among the 293 non-BAC coil embolizations (30% of treatments), there were eight aneurysm ruptures (2.7%), two in the setting of SAH and six in non-SAH patients. Clinical outcomes of BAC and non-BAC procedures are compared in the Table. Among non-SAH patients, there was a 37% increased rate of good clinical outcome after intra-operative aneurysm rupture with BAC compared to non-BAC, though this did not achieve statistical significance (p = 0.245).

Conclusions
While intra-operative rupture of intracranial aneurysms during endovascular treatment has the potential to be a devastating event, control of bleeding with balloon tamponade, regardless of pre-operative rupture status, is effective at maximizing the rate of a good clinical outcome.
Table. Comparison of clinical outcomes of intra-operative aneurysm ruptures during coil embolization with and without balloon-assistance.

<table>
<thead>
<tr>
<th></th>
<th>BAC (n = 669)</th>
<th>Non-BAC (n = 293)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-operative aneurysm ruptures</td>
<td>26 (3.9%)</td>
<td>8 (2.7%)</td>
</tr>
<tr>
<td>SAH patients</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Discharge disposition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Death</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>• Skilled nursing facility</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>• Rehabilitation center</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>• Home</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>6-month mRS 0, 1 or 2</td>
<td>10 (71%)</td>
<td>2 (100%)</td>
</tr>
<tr>
<td>Non-SAH patients</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Discharge disposition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Death</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• Skilled nursing facility</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>• Rehabilitation center</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>• Home</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>6-month mRS 0 or 1</td>
<td>11 (92%)</td>
<td>4 (67%)</td>
</tr>
</tbody>
</table>

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O-100

2:11PM - 2:19PM

Patient Outcomes, Aneurysm Occlusion, and Cerebral Infarction Following Endovascular Treatment of Dissecting Vertebral Artery Aneurysms
Purpose
Subarachnoid hemorrhage (SAH) secondary to rupture of an intradural dissecting vertebral artery aneurysm (DVAA) results in significant morbidity and mortality. Prior studies have suggested favorable outcomes following endovascular treatment of ruptured DVAA most commonly by parent vessel occlusion or stent-assisted coil embolization, but postprocedural cerebral infarction related to endovascular treatment is less well characterized. We determined patient outcomes and cerebral infarction following endovascular treatment of ruptured DVAA.

Materials and Methods
We retrospectively reviewed all consecutively patients presenting to our neurovascular referral center over a 10-year period with with SAH due to a ruptured DVAA. Patient demographic, treatment, and outcome data were determined from the medical record. Digital subtraction angiography (DSA), CT, and MRI studies were reviewed for DVAA characteristics and cerebral infarction. Statistical analysis was performed using XLSTAT; p-value of 0.05 was considered significant.

Results
Ruptured DVAA were identified in 30 patients (11 males and 19 females; p=0.3) with an average age of 56 years (range 35-86 years). Dissecting vertebral artery aneurysm affected the right vertebral artery in 20 patients (67%; p=0.2), the nondominant vertebral artery in 18 patients (60%; p=0.4). Parent vessel occlusion was performed in 25 patients, stent-assisted coiling in four patients, and flow diversion in one patient. Aneurysm occlusion was achieved in 27 patients (90%). Symptomatic vasospasm requiring endovascular treatment occurred in 12 patients (35%). Cerebral infarction occurred in nine patients (30%) following endovascular treatment, which were secondary to vasospasm in five patients (56%), parent vessel occlusion in two patients (22%), and a combination of vasospasm and parent vessel occlusion in two patients (22%). No other complications were identified. Eight patients (27%) had a good clinical outcome (mRS 2) at discharge, which increased to 18 patients (60%) at 3-months of follow up. Five patients (17%) died as a result of their ruptured DVAA. Presenting Hunt and Hess scale greater than 3 (p=0.003) was associated with a poor clinical outcome (mRS >2 or death). Patient sex, age, hypertension, hyperlipidemia, diabetes, coronary artery disease, smoking, illicit drug use, alcohol abuse, a family history of aneurysms, presenting Fisher grade, and the development of vasospasm requiring endovascular treatment did not correlate with clinical outcome.

Conclusions
Endovascular DVVA treatment results in a high rate of aneurysm occlusion and good clinical outcome in a majority of patients. The rate of cerebral infarction related to
endovascular parent vessel occlusion is high. Further studies are warranted to
determine if ruptured DVVA treatment by flow diversion results in acceptable rates of
aneurysm occlusion and lower rates of post-treatment cerebral infarction compared to
endovascular parent vessel occlusion.

O-101

Real-time Fluoroscopic Evaluation of Ommaya Reservoir Integrity

J Heit¹, M Hayden¹, L Shuer¹, A Moraff¹
¹Stanford University, Stanford, CA

Purpose
Ommaya reservoirs are surgically implanted catheter systems that allow for repeated
access to the cerebrospinal fluid (CSF) and intrathecal chemotherapy administration.
Ommaya reservoirs may develop blockage or leakage due to damage of the reservoir
or catheter components, which may result in nontarget delivery of chemotherapy or
the development of an extra-axial fluid collection. Surgical replacement of the
Ommaya may be required in the setting of Ommaya reservoir compromise, and there
is an increased risk of infection and bleeding complications in this patient population
that frequently is neutropenic and thrombocytopenic. Neuroimaging of Ommaya
reservoir integrity is challenging given the need for high temporal and spatial
resolution when interrogating the system. Computed tomography (CT) or magnetic
resonance imaging (MRI) may determine the location of the Ommaya catheter tip and
identify extra-axial collections following placement. However, these techniques do
not evaluate the dynamic flow of fluid through the Ommaya reservoir, which limits its
ability to detect tubing blockage or the site of leakage. Radioisotopes may be
introduced through the Ommaya to assess for CSF flow blockage or Ommaya
leakage, but this technique has poor spatial and temporal resolution. To prevent
unnecessary Ommaya replacement when compromise of the reservoir or tubing is
incorrectly suspected, better minimally invasive dynamic diagnostic testing of
Ommaya system integrity is needed. We describe real-time fluoroscopic interrogation of Ommaya reservoir integrity in a patient with a symptomatic enlarging extra-axial collection.

Materials and Methods
The Ommaya reservoir was accessed with a needle in a neuroendovascular suite with biplane fluoroscopy. Five ml of Omnipaque-300 was injected into the Ommaya reservoir. Contrast transit was monitored with continuous low dose fluoroscopy. There was progressive filling of the Ommaya reservoir, catheter, and ventricle system. No contrast leakage was identified. Dyna CT demonstrated no evidence of contrast leakage into the subdural space or other location outside of the Ommaya reservoir or normal CSF space.

Results
Real-time fluoroscopic evaluation of contrast transit through the Ommaya system demonstrated integrity of the Ommaya reservoir without evidence of blockage or leakage of the system. A Dyna CT performed after contrast injection demonstrated opacification of the Ommaya tubing and ventricles without evidence of contrast extension into the subdural space. These findings were consistent with normal function of the Ommaya system. Given the results of this study, the patient underwent uncomplicated evacuation of the subdural collection without replacement of the Ommaya reservoir and made an excellent recovery.

Conclusions
Real-time fluoroscopic evaluation of Ommaya reservoir integrity by iodinated contrast injection may be performed safely to evaluate integrity of the catheter system. This technique may offer superior evaluation of Ommaya integrity relative to CT and MRI studies in the setting of presumed blockage, and future studies may evaluate this possibility.
Anatomy of the basilar artery tip in the presence of a persistent trigeminal artery. What can we learn about the origin of posterior cerebral, superior cerebellar and basilar tip perforating arteries.

A Galinato\(^1\), H Marin\(^1\), B Griffith\(^1\), M Kole\(^1\)

\(^1\)Henry Ford Health System, Detroit, MI

Purpose
There is considerable individual variability in the appearance of the basilar tip bifurcation, posterior cerebral arteries, and origin of the superior cerebellar arteries and basilar tip perforating arteries. Development of these vessels is intricately linked to fusion of the posterior longitudinal arteries, the timing of the involution of persistent trigeminal arteries, and posterior communicating arteries. Our hypothesis is that if there is a persistent trigeminal artery, there is either symmetrical or asymmetrical ipsilateral caudal fusion pattern of the posterior longitudinal arteries. We also hypothesize that the superior cerebellar artery arises as a single vessel in the cranial fusion pattern and as duplicated vessel in the caudal pattern. In case of asymmetrical fusion, the basilar tip perforators arise asymmetrically from the cranial fusion side.

Materials and Methods
We reviewed our 12-year radiology angiography archive to identify all cases where there was a persistent trigeminal artery. Each case was reviewed carefully for side and size of the PTA, configuration of the basilar tip, superior cerebellar and posterior cerebral arteries, and appearance of the basilar tip perforating vessels. We classify the basilar tip bifurcation in the two posterior cerebral arteries as 'symmetrical fusion' if the P1 segments are similar in size and configuration, and "asymmetrical fusion" if there is difference in caliber or morphology between the P1 segments. We also classify basilar tip bifurcation as "cranial fusion" configuration if there is a 'T' shape of the tip of the basilar artery with SCA arising from the distal basilar and as "caudal fusion" configuration if there is a 'V' shape of the tip of the basilar artery with the SCA arising from the proximal P1 segment.

Results
Thirty cases with PTA were identified in which basilar tip bifurcation configuration could be classified. Symmetrical cranial fusion was seen in 17 cases and symmetrical caudal fusion was seen in one case. Asymmetrical fusion with caudal type ipsilateral to the PTA was seen in one case. Our hypothesis that a duplicated SCA arises from the caudal fusion side was confirmed in one case.
Conclusions
Our study confirms the hypothesis that the side of a PTA influences the origin and appearance of the superior cerebellar arteries. These findings are likely valid also in cases where there is no PTA. The careful analysis of the appearance of the BA can predict the side of dominant origin of the basilar tip perforators in cases with an asymmetrical appearance allowing assessment of endovascular or surgical treatment risks in cases of basilar tip aneurysms.

O-463
2:35PM - 2:43PM

Automated and Quantitative Angiographically Based Assessment of Pial Collaterals during Acute Ischemic Stroke

C Haddad1, G Christoforidis1, M Giger1, T Carroll2
1University of Chicago, Chicago, IL, 2Northwestern University, Chicago, IL

Purpose
This work aims to develop a novel, automated, and quantitative angiographic-based method for evaluating leptomeningeal collaterals in acute ischemic stroke.

Materials and Methods
Digital angiographic images (Philips AlluraXper System) from six patients with acute ischemic stroke due to MCA occlusion acquired at six frames/sec were analyzed using an in-house computerized quantitative image analysis program. Contrast-time curves were generated for each pixel in the image and filtered using smoothing splines. Quantitative features were extracted automatically from the filtered contrast-time curves and included: arterial arrival time (AAT), time-to-peak (TTP), and the maximum value of the first derivative of each curve [Contrast Uptake Rate (CUR)]. Color-coded angiographic parameter maps were generated, yielding AAT-map images, TTP-map images, and CUR-map images (Fig.). Using these three parameters with unsupervised fuzzy C-means (FCM) cluster analysis, summary metrics were determined within five circular regions of interest (ROIs) that spanned the ischemic vascular territory, yielding information on major vessels, pial collateral blush, and background.

Results
Computer-extracted angiographic CUR, AAT and TTP parameters appear to correspond to pial collateral scores derived from patients (Fig.). Fuzzy C-means was able to distinguish capillary blush from vessels within the ROIs (Fig.). During the development of the algorithm for this analysis, pitfalls were identified and will be discussed. Among the three features, CUR and TTP appeared least susceptible to these pitfalls compared to AAT.
Conclusions
Preliminary work indicates that an automated, quantitative angiographic-based computerized method for evaluating leptomeningeal collaterals in acute ischemic stroke is feasible and appears to compare favorably to semiquantitative pial collateral assessment methods.
Figure: Example parametric & FCM DSA analyses in a patient with occlusion. Other parameters studied included AAT & TTP. Specific analysis for arteries & capillaries is possible following FCM cluster.
Monday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Marriott Ballroom

5A-ASPNR Programming: Pediatric Epilepsy 2016

5A-1
3:00PM - 3:20PM
Brain Malformations and Epilepsy: New Concepts Using Molecular Pathways as a Guide

Barkovich, A.
UCSF Benioff Children's Hospital
San Francisco, CA

5A-2
3:20PM - 3:40PM
Advanced Imaging in Pediatric Epilepsy

Grant, P.
Children's Hospital Boston
Boston, MA

5A-3
3:40PM - 4:00PM
Advances in Clinical Epilepsy Management

Dlugos, D.
The Children's Hospital of Philadelphia
Philadelphia, PA

5A-4
4:00PM - 4:20PM
Advances in Surgical Epilepsy Management

Madsen, J.
Children's Hospital Boston
Boston, MA
Monday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Washington 4/5/6

5B-AOSNHR Programming: Advances in Vascular Imaging: Diagnosis and Treatment Implication

5B

Introduction

5B-1
Advances in the Imaging of Moyamoya Disease

Yun, T.
Seoul National University Hospital
Seoul

5B-2
Current Clinical Applications of Intracranial Vessel Wall Imaging

Tsuchiya, K.
Tokyo Teishin Hospital
Tokyo
Clinical Application of 3D T1-Weighted Black-Blood MRI in Head and Neck Arterial Lesions

Maeda, M.
Mie University School of Medicine
Tsu, Mie

Intracranial Arterial Stenosis: MR Patterns and Outcomes of Management

Chang, F.
Taipei Veterans General Hospital & National Yang Ming University
Taipei, Taiwan

Monday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Washington 1/2/3

5C-Evidence Based Medicine Programming: Speed Journal Club to Review New Evidence in the Literature on Hot Topics in Neuroradiology
5C-1
3:00PM - 3:25PM

Brain

Sanelli, P. · Gupta, A.
Northwell Health · New York-Presbyterian Hosp/Weill Cornell Med Ctr
New York, NY

5C-2
3:25PM - 3:45PM

Spine
Jarvik, J.
Univ of Washington
Seattle, WA

5C-3

Head and Neck

Anzai, Y.
University of Utah
Salt Lake City, UT

5C-4

Pediatric

Medina, L.
Miami Children's Hospital
Miami, FL

5C-5

NIR

Hirsch, J.
Massachusetts General Hospital
Boston, MA

Monday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Roosevelt 1-3

5D-PARALLEL PAPER SESSION: Turbo Talks - CNS Tumors: Biomarkers, Genomics, and Radiomimics
O-103

Preclinical Validation of Radiogenomics in Glioblastoma
R Colen¹, F Zandi¹, A Kotrotsou¹, M Hatami¹, S Singh¹, M Luedi¹, G Thomas², A Elakkad¹, E Sulamn¹, F Lang¹, D Piwnica Worms¹, P Zinn¹
¹MD Anderson Cancer Center, Houston, TX, ²The University of Texas MD Anderson Cancer Center, Houston, TX

Purpose
A plethora of magnetic resonance imaging (MRI) features have been correlated to cancer genomics to date; however, none have established causality. Here, we present an in vivo xenograft RNA interference validated, potentially clinically applicable test method termed "magnetic resonance radiomic sequencing" (MRRS) for the noninvasive detection of cancer genomics in glioblastoma. Magnetic resonance radiomic sequencing comprehensively assesses the entire tumor mass using imaging texture based algorithms that generate thousands of variables (features) inherent to the tumor.

Materials and Methods
Two independent glioblastoma stem cells (GSC1 and GSC3) harboring doxycycline inducible short hairpin RNA against Periostin (POSTN), a gene previously identified in our radiogenomic screen, were implanted at orthotopic location in nude mouse brain (n=30). The T2 and T1 post MRI texture features, in edema/tumor invasion and contrast enhancement phenotype features were compared between doxycycline (POSTN knockdown) and sucrose (control) group of mice using T test statistics. The significant features were included in a Stepwise Forward Logistic Regression analysis to build the final predictive model. The accuracy of the model was tested using ROC cure analysis.

Results
In vivo knockdown of >90% and ~60% POSTN gene was achieved in GSC3 and GSC1 respectively. In GSC3 mice cohort, 117 features were significantly (p-value<0.05) different between the doxycycline and sucrose groups. The significant features were included in a Stepwise Forward Logistic Regression analysis, 2 textures features (#234 of edema T1 edema/tumor-invasion and #251 of edema/tumor-invasion T2) were selected to be included in the final predictive model. The AUC of the model for prediction of high POSTN group with leave one out cross validation method was 100%.

Conclusions
Our results therefore describe the first mouse model derived MRRS signature to describe a causal link of gene alteration to MRRS. This novel test method may open an avenue for human mouse matched co-clinical trials and noninvasive Radiogenomic diagnostics.

O-104 3:03PM - 3:06PM
Association of angiogenesis microstructure characteristics with molecular genomic biomarkers and their survival predictive value in patients with glioblastoma - A study using ROI-based measurement and voxel-based histogram analysis of MR dynamic susceptibility contrast perfusion weighted imaging

X Liu¹, W Tian¹
¹University of Rochester Medical Center, Rochester, NY

Purpose
Glioblastoma is the most common malignant primary brain tumor in adults. Angiogenesis is one of the key pathology features in glioblastomas, and plays an important role in tumor proliferation and invasion, which is associated with poor survival outcome. Magnetic resonance (MR) dynamic susceptibility contrast perfusion-weighted imaging (DSC-PWI) is a major imaging tool investigating hemodynamic changes of glioblastomas in vivo. The purpose of this study is to evaluate association between molecular genomic biomarkers and multiple MR-DSC-PWI parameters, and their performance of predicting survival outcome in patients with glioblastomas.

Materials and Methods
Forty-one cases (mean age is 62.32±12.09 years) with new pathology confirmed glioblastomas were enrolled in this study. Region of interest (ROI)-based approach and voxel-based histogram analysis were used to measure mean and maximal rCBV ratio of the enhancing tumor (rCBVmean and rCBVmax), and maximal rCBV ratio of peri-enhancing tumor area (rCBVperi-tumor) as well as 15%, 25%, 50%, 75%, 85% quantiles and the interquartile range (IQR) in the enhancing tumor. The association between MR-PWI parameters and Ki-67 labelling index, isocitrate dehydrogenase (IDH), mammalian target of rapamycin (mTOR), and epidermal growth factor receptor (EGFR) was assessed, the Cox regression was used to evaluate their implication on overall survival time (OS). The difference of clinical and imaging parameters, and molecular genomic biomarkers between the patients who survived less than 14 months and more than 14 months was compared.

Results
The rCBVmax, and 50%, 75%, 85% quantiles and IQR had significant association with mTOR, (p =0.047). The rCBVperi-tumor showed significant difference in the group comparison between patients survived less or longer than 14 months (p =0.002), the age and 15% quantiles showed the trend of significant difference (Fig.1). The Cox regression analysis showed that rCBVperi-tumor and age were the two strongest predictors of OS (hazard ratio= 1.29 and 1.063; p =0.003 and 0.005 separately). The combination of rCBVperi-tumor and age improved the prediction of OS with specificity of 78.9% and sensitivity of 81.8% (Fig. 2).
Conclusions
The quantitative rCBV parameters are associated with mTOR-EGFR pathway biomarkers, which may suggest that mTOR-EGFR pathway moderates angiogenesis process in the tumor proliferation and vasculature infiltration in glioblastomas. And rCBV peri-tumor had better prognostic value than molecular genomic biomarkers alone. Combination of ROI-based measurement and voxel-based histogram analysis is useful for better understand of angiogenesis characteristics in glioblastomas.

Figure 1: Histogram group comparison between glioblastoma patients
(Filename: TCT_O-104_Figure1---ASNR2015---Glioblastoma--mTORhistogramcomparison.jpg)
Figure 2: combination of rCBV\textsubscript{peri-tumor} and age had better area under the curve in the ROC analysis compared single biomarker alone

(Related image: TCT_O-104_Figure2--ASNR2015---mTOR--glioblastoma---ROCresult.jpg)

O-105

Radiogenomic Mapping in Enhancing Volume Phenotype Identifies Novel Drivers in Glioblastoma Proliferation: Comprehensive Genomic, Proteomic, MicroRNA and Pathway Analysis

G Thomas\textsuperscript{1}, Y Abu Eleneen\textsuperscript{1}, H Abouhatab\textsuperscript{1}, S Abrol\textsuperscript{2}, A Kotronou\textsuperscript{2}, S Singh\textsuperscript{3}, P Zinn\textsuperscript{4}, R Colen\textsuperscript{2}
Purpose
Glioblastoma (GBM) is the most common and most aggressive primary malignant brain tumor in adults. It accounts for 20% of all the intracranial malignancies. Currently, the survival of patients diagnosed with GBM remains less than 2 years despite extensive therapy. So time has arrived to look into newer, more focused methods of biomarker discovery and target identification that would help to develop molecular-targeted therapies and address the issue of tumor heterogeneity. We have been successful in harnessing magnetic resonance imaging (MRI) to identify different imaging phenotypes and assessing the genotypic background responsible for these phenotypes in the newly emerging field of imaging genomics. In this study, we identify the novel genes, pathways and networks relating to the contrast enhancement volume phenotype.
Materials and Methods
We retrospectively analyzed 106 patients from the TCGA (The Cancer Genome Atlas) with imaging obtained from the Cancer Imaging Archive (TCIA). Over 13,000 genes and over 500 microRNA were analyzed in each patient and patients were stratified on the basis of their contrast enhancement volume phenotype by grouping them based on survival using Kaplan –Meier statistics. Contrast enhancement volumetrics were obtained using 3D Slicer software. Discovery and Validation were employed to reduce false discovery. Differentially expressed genes, miRNAs and proteomics were analyzed using gene pattern software (MIT Broad institute) and ingenuity pathway analysis.
Results
Pathways and networks associated with a high contrast enhancing volume phenotype versus a low contrast enhancing volume phenotype were identified. The top proliferative genes were identified as novel molecules involved in driving tumor proliferation in glioblastoma. The upstream regulators previously not described in relation to GBM were found. Further in vitro studies will be ongoing to validate our in silico finding.
Conclusions
Radiogenomic discovery of potential molecules describing physiologic imaging phenotypes were identified; similar to our published paper (Zinn et al PLOS One 2011), we can expect our in vitro and in vivo validation to confirm our findings and open the door to personalized medicine and therapeutics.
Fast whole brain multispectral pH-weighted molecular MRI in human gliomas using multi-echo amine CEST EPI

B Ellingson¹, R Harris¹, K Leu¹, W Pope¹, T Cloughesy¹
¹University of California Los Angeles, Los Angeles, CA

Purpose
Decreased extracellular pH within the tumor microenvironment has been shown to result in increased tumor proliferation, increased genetic alterations, immune privilege, and resistance to antineoplastic therapies. We recently have demonstrated that amine chemical exchange saturation transfer (CEST) imaging can be used to identify and characterize acidic tumor tissue by targeting amine protons on neutral amino acids including glutamine (1). In the current study we have dramatically improved this technique to obtain whole brain coverage and a multi-echo echoplanar readout (2-gradient echoes, 1-asymmetric spin echo, and 1-spin echo), allowing interrogation of different water populations and correction of CEST data with respect to transverse relaxation effects.

Materials and Methods
The multi-echo CEST sequence was first applied in phantoms of 100 mM glutamine at varying pH to verify its pH sensitivity. Five glioma patients then underwent multi-echo pH-weighted CEST magnetic resonance imaging (MRI) using a pulse train of three 100 ms, 6 μT saturation pulse with 29 spectral points centered around -/+ 3 ppm and 0 ppm. An image with identical parameters but no saturation pulse (S₀) was acquired for normalization. The readout consisted of two gradient echo (GRE) measurements at 14.0 and 34.1 ms, an asymmetric spin echo (aSE) measurement at 58.0 ms, and a spin echo (SE) measurement at 92.4 ms. Following B₀ inhomogeneity correction, the asymmetry at 3.0 ppm was calculated for each voxel by MTRasym = [S(-3ppm) – S(+3ppm)]/S₀. An image corrected for T₂ and T₂* decay was calculated using T₂ and T₂* maps obtained from fitting the SE and GRE echoes, respectively. Maps of MTRasym for each contrast (four echoes and one corrected image) were observed qualitatively and the distribution of MTRasym then was pulled from the tumor region for each patient and contrast.

Results
The multi-echo sequence had equivalent sensitivity to pH due to a single water pool present in the phantoms, with the different contrasts providing similar values of MTRasym in water (Fig. 1A). Histograms from a patient with a glioma showed different CEST characteristics for different echo readouts, suggesting proton exchange was different for different water pools within the tissue (Fig. 1B). The CEST data corrected for transverse relaxation provided different localization of acidic regions within the tumor (Figs. 1C and D). Histopathological data from stereotactic biopsies also were compared with corrected and noncorrected CEST data.
Conclusions
Multi-echo CEST EPI is a novel technique to acquire fast, whole brain, high density pH information in brain tumors and neuropathologies.

(Filename: TCT_O-106_Slide1.jpg)

O-107
3:12PM - 3:15PM

Relationship of Subventricular Zone with Tumor Genomics and Survival in Gliomas: A TCGA/TCIA Project

B Griffith¹, L Poisson¹, J Chen², R Jain³
¹Henry Ford Health System, Detroit, MI, ²San Diego VA / UCSD Med. Center, La Jolla, CA, ³NYU School of Medicine, New York, NY
Purpose
Prior studies have shown glioblastoma (GBM) location relative to the subventricular zone (SVZ) to be associated with worse prognosis. The purpose of this study was to determine whether this difference in prognosis is seen in all glioma grades. We also assessed whether SVZ-related survival differences correlated with IDH mutation and chromosome 1p/19q co-deletion status in lower grade gliomas (LGG) given their distinct prognosis paths.

Materials and Methods
Three hundred fifty-six patients with untreated LGGs (WHO Grade 2 and 3) and GBMs, molecular information assayed by the TCGA, and presurgical imaging collected by the TCIA were included (LGG, n=153; GBM, n=203). Tumor location (T2/FLAIR for LGGs; contrast-enhancing lesion for GBMs) was classified as follows: involving both SVZ and cortex (Group I), SVZ only (Group II), cortex only (Group III), neither SVZ nor cortex (Group IV). Overall survival (OS) trajectories were determined using Kaplan-Meier estimates. Group differences were assessed by log-rank test.

Results
There was a statistically significant difference in OS for GBMs with SVZ involvement compared to those with only cortex involvement (median 0.81 versus 1.28 years, p=0.004) (Fig. 1B). There was suggestion of shorter OS in LGGs (median 5.3 versus 11.1 years, p=0.079) (Fig. 1A) with a more apparent difference for Grade II gliomas (no deaths observed versus median 7.3 years, (p=0.108)) (Fig. 1B). For LGGs, there was no evidence that T2/FLAIR location is associated with IDH mutation (p=0.839) or 1p/19q co-deletion status (p=0.178).

Conclusions
Involvement of the SVZ is associated with worse overall survival in both low and high grade gliomas, most notably Grade II and IV. This difference is not driven by molecular profiles associated with LGG evolution paths delineated by IDH mutation or 1p/19q loss, nor are definite molecular markers seen in GBMs. Subventricular zone involvement may represent a prognostic imaging biomarker independent of tumor grade or molecular classification.
**FIG 1A.** Overall survival for Grade II/III disease

**FIG 1B.** Overall survival for glioma by grade.

(Filename: TCT_O-107_LGGSVZFigure.jpg)
Prognostic Imaging Markers in Triple Negative Lower Grade Gliomas: A TCGA/TCIA Project

B Griffith1, L Poisson1, J Chen2, R Jain3
1Henry Ford Health System, Detroit, MI, 2San Diego VA / UCSD Med. Center, La Jolla, CA, 3NYU School of Medicine, New York, NY

Purpose
Triple-negative lower grade gliomas (TN-LGGs) demonstrate clinical behavior similar to glioblastoma and are associated with poor overall survival. The purpose of this study was to determine whether MR imaging characteristics could prospectively identify this subset of LGGs and provide prognostic information.

Materials and Methods
Patients with untreated LGGs, molecular information assayed by The Cancer Genome Atlas, and presurgical imaging collected by The Cancer Imaging Archive were included (n=150). IDH 1/2 mutation, chromosome 1p/19q deletion, P53 mutation, and clinical data were available from prior publication. Pre-operative MR images were scored with determination of T2/FLAIR location, subventricular zone (SVZ) and cortex involvement, enhancement, and multifocality. Categorical variable association was assessed by Fisher's exact test. Overall survival (OS) and progression-free survival (PFS) curves were constructed by Kaplan-Meier estimation. Log-rank tests compared survival curves between groups. Cox regression, with likelihood ratio test, was used for multivariable survival models.

Results
Histologic tumor diagnoses were 48 astrocytoma, 36 oligoastrocytoma, and 66 oligodendroglioma. IDH 1/2 mutation was found in 116 (77.3%), 1p19q co-deletion in 41 (27.3%), and P53 mutation in 79 (52.7%). Twenty-six tumors (17.3%) had none of these (TN-LGGs). Triple negative lower grade gliomas were neither more likely to enhance (p>0.99) nor to be multifocal (38% versus 34%, p=0.656). Triple negative lower grade gliomas were less likely to occur in the frontal lobe compared to other classes (23% versus 76% IDHmut/codel, Forty-three percent IDHmut/noncodel, p=0.009). Triple negative lower grade gliomas without SVZ involvement demonstrated better OS (median 11.1 years versus 1.22 years, p=0.030) and PFS also trended towards improvement (median 1.43 years versus 0.55 years; p=0.086) (Fig. 1). Subventricular zone involvement remained a significant predictor of OS even after adjusting for grade (p=0.018).

Conclusions
Triple negative lower grade gliomas demonstrate clinical behavior and molecular characteristics similar to GBM. However, those tumors without SVZ involvement demonstrated improved OS indicating that this feature may represent an important prognostic imaging biomarker for this aggressive subset of LGGs.
T2-FLAIR Mismatch, a Potential Imaging Biomarker for IDH Mutant Status in Lower Grade Gliomas: A TCGA/TCIA Project

S Patel, L Poisson, A Franceschi, B Griffith, R Jain

1 NYU Langone Medical Center, New York, NY, 2 Henry Ford Health System, Detroit, MI, 3 NYU Medical Center, New York, NY, 4 NYU School of Medicine, New York, NY

Purpose
Lower grade gliomas (LGGs) comprise a genetically heterogeneous group of tumors. Relative signal suppression of FLAIR compared to T2-WI is a little reported imaging feature described in low grade brain neoplasms (1). The purpose was to assess

FIG 1. Overall survival and progression free survival for TN-LGGs according to S.

(Filename: TCT_O-108_TNLGGFigure.jpg)
whether this "T2-FLAIR mismatch" sign represents a distinct imaging biomarker for a subset of lower grade gliomas.

Materials and Methods

Patients with untreated LGGs, molecular information assayed by The Cancer Genome Atlas, and presurgical imaging (including FLAIR imaging and/or double echo T2-WI) collected by The Cancer Imaging Archive were eligible for inclusion (n=117). IDH 1/2 mutation, chromosome 1p/19q deletion, P53 mutation, and clinical data were available from prior publication (2). Pre-operative MR images were scored with determination of T2-FLAIR mismatch sign (yes/no). The T2-FLAIR mismatch sign was present if a lesion showed predominantly hyperintense signal on T2-WI, and large area of central signal loss with peripheral hyperintense rim on the FLAIR sequence. Categorical variable association was assessed by Fisher's exact test. Overall survival (OS) and progression-free survival (PFS) curves were constructed by Kaplan-Meier estimation. Log-rank tests compared survival curves between groups.

Results

Of the 117 cases, 30 (25.6%) were IDH mutated/1p19q co-deleted, 63 (53.8%) were IDH mutated/1p19q nonco-deleted, and 24 (20.5%) were IDH wild type. The T2-FLAIR mismatch sign was found in 17 (14.5%) cases. All cases with T2-FLAIR mismatch sign (17/17, 100%) were IDH mutated/1p19q nonco-deleted. Fisher's exact test indicated an association between T2-FLAIR mismatch sign and IDH mutated/1p19q nonco-deleted genotype (p<0.0001). There was no statistically significant difference in OS or PFS between glioma patients without and with the T2-FLAIR mismatch sign.

Conclusions

Amongst LGGs, the T2-FLAIR mismatch sign appears to represent a specific imaging biomarker for a subset of IDH mutant/1p19q nonco-deleted gliomas.
Predilection of Genomic Markers and Contrast-Enhancement of Lower Grade Gliomas by Anatomic Lobe: A TCGA/TCIA Project

J Chen¹, L Poisson², B Griffith², R Jain³
Purpose
Lower grade (WHO grades 2 and 3) gliomas (LGG) have known lobar predilections, but the WHO plans tumor reclassification based on gene expression instead of histology. This study's purpose was to determine the lobar predilection of lower grade tumors based on genomic markers and contrast enhancement.

Materials and Methods
Patients with untreated LGGs, molecular information assayed by The Cancer Genome Atlas, and presurgical imaging collected by The Cancer Imaging Archive were included (n=150). IDH 1/2 mutation and chromosome 1p/19q deletion were available from prior publication (1). Pre-operative MR images were scored by consensus for lobe of tumor center and presence of contrast enhancement. Survival differences were assessed by log-rank test. Categorical contrast-enhancement associations were assessed by Fisher's exact test.

Results
Tumor genetics were 41 IDHmutant 1p19q co-deleted (27.3%), 75 IDHmutant noncodeleted (50%), 34 IDH wild-type (22.7%). Seventy-two (47%) tumors were centered in the frontal lobe, 24 (16%) parietal, 43 (28%) temporal, two (1%) occipital, and 12 (8%) insular. Tumors originating in the frontal lobe were more likely IDHmutant regardless of 1p19q status (89%) than IDHwt (11%). IDHmutant 1p19q co-deleted tumors preferred the frontal lobe (78%) to the temporal (12%) or parietal (12%) lobes; none occurred in the occipital or insular lobes. Rare LGGs originating in the occipital lobe (1.3%) were divided evenly between IDHmutant non-1p19q codeleted and IDHwt; none were 1p19q codeleted. IDHwt tumors showed no lobar preference. Contrast enhancement was associated with primary location (p=0.0094), least likely in the insula (27%), more likely in the frontal (75%), parietal (82%), temporal (62%) and occipital lobes (100%).

Conclusions
Lobar location may provide useful information regarding IDH mutation status and enhancement in LGGs. LGGs rarely occur in occipital lobe, whereas IDHwt LGGs may arise anywhere. Insular tumors are the least likely LGGs to demonstrate contrast enhancement and were more likely to be non-1p19q co-deleted.

O-112
3:27PM - 3:30PM
Reliability of Noncontrast-Enhancing Tumor as a Biomarker of IDH1 Mutation Status in Glioblastoma

A Lasocki1, A Tsui2, F Gaillard2, M Tacey2, K Drummond2, S Stuckey3
Purpose
Glioblastomas with IDH1 (isocitrate dehydrogenase-1) mutations are associated with a better prognosis. The literature suggests that these mutations may be associated with frontal lobe tumors with significant nCET (noncontrast-enhancing tumor)(1), but the results are mixed. Our purpose was to examine the imaging features of IDH1-mutated tumors, concentrating on the predictive value 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 and sufficient histological material for IDH1 mutation analysis were included. Pre-operative magnetic resonance images (MRIs) were reviewed, primarily based on the VASARI feature set (2), focusing on nCET.

Results
One hundred fifty-three patients met the inclusion criteria. Tumors frequently demonstrated >5% nCET (89 patients, or 59%), with 34 patients having >33% nCET. Five patients had IDH1 mutations (3%). Three patients with IDH1 mutations also had >33% nCET, but the association between nCET and IDH1 mutation status was not statistically significant (p=0.209). Two of the five patients with IDH1 mutations had a frontal lobe tumor, not significantly different to the incidence of 36% for IDH1-wild type tumors (p=0.848). Of note, the 12 frontal lobe tumors with >33% nCET all had wild type IDH1.

Conclusions
Our results suggest that the association between frontal lobe glioblastomas with significant nCET with IDH1 mutations is not as strong as previously believed. IDH1-mutated glioblastomas frequently have substantial nCET, but this feature is also present in many IDH1-wild type glioblastomas, thus nCET is not sufficiently predictive of IDH1 mutation status given the low incidence of the mutation.

O-113
3:30PM - 3:33PM
FLAIR Imaging Pattern can Predict IDH Status in Lower Grade Gliomas.

R Delfanti1, C McDonald2, K Leyden2, A Krishnan2, D Piccioni3, N Farid2
1University of California, San Diego, San Diego, CA, 2Multimodal Imaging Laboratory, La Jolla, CA, 3University of California, San Diego, La Jolla, CA

Purpose
Tumor genotyping in neuro-oncology holds tremendous promise in helping to
differentiate otherwise histologically similar tumors and in providing key prognostic information. This is of particular relevance given the recent discovery that isocitrate dehydrogenase (IDH) status is highly correlated to tumor behavior and prognosis in lower grade gliomas, with the wildtype (WT) tumors behaving clinically analogous to glioblastoma. Therefore, we aim to determine if there are distinct imaging features which can predict IDH status in lower grade gliomas.

Materials and Methods
Pretreatment brain magnetic resonance images (MRIs) were analyzed for 44 patients with pathologically proven lower grade gliomas (WHO grade II or III). A board-certified neuroradiologist (with 6 years of experience) who was blinded to the pathologic diagnosis and IDH status of the patients performed qualitative evaluation of the FLAIR, postcontrast, and diffusion-weighted sequences, assigning each a numerical value based on a predesignated scale. The Fisher exact test was used to evaluate the relationship of these parameters as well as tumor location with respect to IDH status.

Results
An infiltrative pattern on FLAIR was associated significantly with IDH WT tumors, whereas the IDH mutant tumors demonstrated either well defined or ill defined borders on FLAIR (p < 0.001). Degree of contrast enhancement and presence of diffusion restriction were not associated with IDH status. Among the 26 unilobar tumors, IDH mutant tumors were more likely to be located in the frontal lobe (p < 0.05).

Conclusions
IDH WT lower grade gliomas are more likely to demonstrate an infiltrative pattern on FLAIR compared to IDH mutants. Furthermore, IDH mutant gliomas had a predilection for the frontal lobes. Given the aggressive clinical course of these tumors, this finding has the potential to provide essential prognostic information at initial imaging diagnosis and to possibly influence treatment making decisions prior to patients undergoing surgery and chemoradiation.
The top panel demonstrates axial FLAIR, T1 post-contrast, and diffusion-weighted imaging (DWI) from a patient with a left superior temporal anaplastic astrocytoma (WHO grade III) which was IDH mutant. The bottom panel demonstrates axial FLAIR, T1 post-contrast, and DWI from a patient with a left insular/frontotemporal lobe tumor, also an anaplastic astrocytoma (WHO grade III) which was IDH wildtype. Both patients demonstrate minimal contrast enhancement and lack of restricted diffusion. However, they demonstrate discrete imaging patterns on FLAIR with the IDH mutant tumor showing relatively well-defined borders in contradistinction to the IDH wildtype tumor’s ill-defined and infiltrative borders.
Correlation Between MR Imaging Features and IDH Mutational Status in Lower Grade Gliomas

J Villanueva-Meyer¹, S Cha²
¹University of California - San Francisco, San Francisco, CA, ²University of California San Francisco, San Francisco, CA

Purpose
Lower grade gliomas (LGGs) are a heterogeneous group of tumors with unpredictable clinical behavior and prognosis. Upcoming WHO classification will include molecular markers such as IDH to better characterize LGGs. The purpose of our study was to determine qualitative and quantitative MR imaging parameters that can discriminate an aggressive subtype of LGG that is characterized by IDH-wildtype status.

Materials and Methods
We evaluated 99 adult cases of pathologically confirmed LGG with molecular testing for IDH mutation. Presurgical magnetic resonance images (MRIs) were analyzed for qualitative imaging characteristics including tumor location, volume, cortical involvement, hemorrhage or mineralization, and contrast enhancement. Quantitative diffusion and perfusion MRI also were assessed. Logistic regression and receiver operating characteristic analyses were used to assess MRI metrics to distinguish IDH mutational status. Clinical data including patient sex, age, treatment, performance status, and outcomes were collected. Kaplan-Meier curves were used to evaluate the association between IDH mutational status and clinical outcomes.

Results
Of the evaluated tumors, 32 were IDH-wildtype and 67 were IDH-mutated. Lower grade gliomas with IDH-wildtype status showed a significantly lower incidence of cortical involvement (p<0.005) and lower apparent diffusion coefficient (ADC) values (p<0.005). No significant difference was observed in other qualitative characteristics or in quantitative perfusion measures. Multiple logistic regression analysis showed cortical involvement and minimum ADC values as independent predictors of IDH-wildtype LGG. Receiver operating characteristic showed a minimum ADC threshold value of 1.0 x 10⁻³ mm²/s provided a sensitivity of 94% and a specificity of 64% in classifying IDH mutation status. IDH-wildtype LGGs were associated with significantly decreased time to progression and overall survival relative to IDH-mutated LGGs.

Conclusions
IDH-wildtype LGGs are associated with lower ADC values and lack of cortical
involvement on MR examination and with a clinically aggressive phenotype. Minimum ADC values with a threshold of less than or equal to 1.0 x 10^{-3} \text{ mm}^2/\text{s} may be predictive of IDH-wildtype LGGs.
Figure 1. 19-year-old woman presenting with stroke symptoms (A, B). Axial FLAIR (A) and ADC map (B) MR images demonstrate an infiltrative left temporal mass with low signal on ADC map. At pathology this represents an IDH-wildtype lower grade glioma.

55-year-old man presenting with seizures (C, D). Axial FLAIR (C) and ADC map (D) MR images demonstrate an infiltrative left frontal mass with high signal on ADC map. At pathology this represents an IDH-mutant lower grade glioma.
Radiomics differentiate between true progression and pseudoprogression in GBM patients.

S Abrol¹, G Thomas², A Hassan³, A Kotrotsou¹, P Zinn⁴, R Colen¹
¹MD Anderson Cancer Center, Houston, TX, ²The University of Texas MD Anderson Cancer Center, Houston, TX, ³Md Anderson cancer center, HOUSTON, TX, ⁴Baylor College of Medicine, Houston, TX

Purpose
The benign imaging changes that occur as a result of radiation therapy often are difficult to distinguish from true progression of the tumor. Pseudoprogression (PsP) can potentially complicate the management of the patients if mistaken for treatment failure. This study was conducted to assess the potential of radiomics to differentiate PsP from true progression (PD) of brain tumors with histopathological evidence.

Materials and Methods
We evaluated 100 brain tumor patients retrospectively, with new or increased enhancement after surgical resection of primary tumor followed by radiation therapy uncertain for PsP versus true progression. All patients had undergone biopsy or resection with histopathological evidence of PsP or recurrent tumor. Volumetrics and texture analysis were performed of the enhancing lesion(s) in question. Demographics were collected. Gene expression was determined and relationship to enhancement pattern was studied.

Results
Eighty patients had histopathological evidence of PD and 20 evidence of PsP. There were five texture features that predicted whether a patient had PsP or PD. The ability to discriminate between the two was 97%. The sensitivity and specificity was 90% and 86%, respectively. Patients with PsP had higher methylation of MGMT

Conclusions
Radiomic analysis has the ability to discriminate between those patients with PsP versus recurrent tumor in those patients with increase or new enhancing lesions.

Radiographic patterns of progression with associated outcomes after bevacizumab therapy in glioblastoma patients
N Elshafeey¹, D Cachia², M Hatami¹, C Kamiya Matsuoka¹, K Alfaro-Munoz¹, J Mandel³, J de Groot¹, R Colen¹  
¹MD Anderson Cancer Center, HOUSTON, TX, ²Medical University of South Carolina, Charleston, SC, ³Baylor College Medicine, HOUSTON, TX

Purpose
To determine the radiographic patterns of progression and their association with outcome. Patterns of progression following bevacizumab (bev) treatment and associated outcomes remain poorly characterized in patients with glioblastoma (GB).

Materials and Methods
Sixty-four patients treated at MD Anderson matched the predetermined inclusion criteria. Tumor progression after bev treatment was assessed according to the RANO criteria and patients categorized into groups based on previously published data: Group 1: exclusively T2-diffuse hyperintense tumor (T2-diffuse), Group 2: initial decrease and subsequent flare-up of contrast enhancement (CE) at progression (cT1 Flare-up), Group 3: no decrease in CE or development of new lesions at first follow-up imaging (nonresponders), Group 4: exclusively T2-circumscribed hyperintense tumor progression (T2-circumscribed). In addition, we screened for new diffusion-restricted lesions or precontrast T1-hyperintense lesions or both (double-positive).

Results
Patients were categorized into Group 1: 11%, Group 2: 33%, Group 3: 45%, Group 4: 11%. Sixteen patients had T1-hyperintense lesions and 37 had restricted diffusion; 10 patients had double-positive lesions. There was no significant difference in time-to-initiation of Bev treatment in the four groups. After starting Bev, median OS and PFS (months) was Group 1: 8.6, 4.2; Group 2: 12.3, 3.9; Group 3: 5.6, 1.4; Group 4: 7.0, 3.2 respectively. Comparing nonresponders versus the rest of the groups (responders), OS from initiation of Bev was 5.6 versus 10 months (p=<0.001). OS from diagnosis of GB was not significantly different between the four groups. Postprogression on Bev, OS was: Group 1: 3.9; Group 2: 6.4; Group 3: 3.8 and Group 4: 3.0. Patients with restricted diffusion had worse OS (23.4 versus 7.4 months). There was no difference in survival based on presence/absence of T1-hyperintense or double-positive lesions.

Conclusions
Compared to nonresponders, cT1 Flare-up have better PFS/OS after Bev initiation. Postprogression on Bev, cT1 Flare patients lived significantly longer than T2-diffuse and nonresponder. Though T2-diffuse and T2-circumscribed have a better PFS after Bev initiation compared to nonresponders, no OS benefit was seen. Restricted diffusion was a radiographic marker of worse outcomes.
Quantitative Features of High-grade Gliomas Predictive of Treatment Response to Anti-PD-1 Immunotherapy

P Chang1, A Dubey1, F Iwamoto1, A Lassman1, A Lignelli1
1Columbia University Medical Center, New York City, NY

Purpose
Anti-PD-1 immunotherapy agents represent a promising new drug class in treatment of high-grade gliomas (HGG) (1-3). Given recent introduction of these agents into clinical trials, there are, to date, no known quantitative magnetic resonance (MR) tumor features associated with treatment success. Such prognostic features may be used as imaging criteria to guide future patient selection.

Materials and Methods
As part of an IRB-protocol, HGG patients receiving an anti-PD-1 monoclonal antibody (Nivolumab or Pembrolizumab) for at least two treatment sessions were identified. Treatment response was determined by new immunotherapy-RANO guidelines (4), including a minimum 3-month confirmatory exam in cases of disease progression. Based on iRANO criteria, patients were labeled as nonresponders (progression) and responders (stable or response for minimum of 3 months). A fully automated software algorithm was used to quantify absolute volume of contrast-enhanced tumor (CET), relative volume of CET with respect to FLAIR abnormality, necrosis and peritumoral FLAIR abnormality, as well as enhancement avidity and margin irregularity. Significance was assessed with a two-tailed t-test. All segmentation masks were inspected for accuracy by a board-certified neuroradiologist blinded to results.

Results
A total of 13 patients met inclusion criteria: six nonresponders and seven responders to PD1-immunotherapy. Prior to immunotherapy, PD1-responders demonstrated larger absolute (58.3 versus 21.8 cm3, p=0.021) and relative (31% versus 20%, p=0.0054) volumes of CET. A trend towards significance was seen for larger initial total tumor volume (165 versus 118 cm3, p=0.089) and greater initial enhancement avidity (2.5 versus 1.9, p=0.25) of PD1-responders in this small sample size. Necrosis, peritumoral FLAIR and margin irregularity were insignificant predictors of treatment response.

Conclusions
Preliminary data suggests that absolute and relative proportion of enhancing tumor prior to initiation of anti-PD-1 immunotherapy were predictors of good response, with a threshold of >25% CET associated with 86% sensitivity and 100% specificity in this small sample size. These findings may suggest an association between programmed-death (PD-1) ligand expression and contrast enhancement. One hypothesis for this finding may be found in studies showing lower PD-1 expression with proneural GBM
(1), a molecular subtype associated with lower CET (5). Currently we have not included clinical response criteria in our analysis, nor have we accounted for concomitant therapies and their effects. Further analysis of clinical response criteria and effects of concomitant therapies will follow.
Figure 1. Imaging Appearance of Anti-PD-1 Therapy Non-Responders and Responders

Axial FLAIR (left) and post-contrast (right) images in two representative patients: one anti-PD-1 therapy non-responder (top; minimal contrast enhancement) and one responder (bottom; significant contrast enhancement). On the left, FLAIR masks are outlined in green. On the right, contrast-enhancing margins (green) and necrosis (red) masks are outlined.
Application of Iterative Reconstruction Algorithms to Perform Sub-millisievert CT of the Facial Bones and Paranasal Sinuses

A Tabari\textsuperscript{1}, S Singh\textsuperscript{1}, s Rincon\textsuperscript{2}, P Caruso\textsuperscript{2}, d singh\textsuperscript{2}, M Gee\textsuperscript{1}

\textsuperscript{1}Massachusetts General Hospital, Boston, MA, \textsuperscript{2}MGH, Boston, MA

Purpose
Computed tomography (CT) radiation dose optimization is crucial for children. Several dose reduction strategies are available, including tube current modulation, lowering of tube potential based on body size as well as newer iterative reconstruction (IT) algorithms. Since the 1970s, filtered back projection (FBP) algorithm has been used in all commercial CT scanners for reconstructing CT images. For the past several years, newer IR algorithms have been introduced to lower CT dose with cautious selection of settings to fine tune image quality. The purpose of this study was to evaluate pediatric para-nasal CT image quality and dose reduction with IR, as compared to FBP.

Materials and Methods
Our study was HIPPA compliant and written informed consent was waived by the IRB. All consecutive pediatric para-nasal sinus CT performed on IR capable scanner [Discovery 750 HD with Adaptive Statistical Iterative Reconstruction (ASIR), GE Healthcare] were included in the study cohort; the control group was comprised of FBP images. Effective dose was calculated as per the ICRP103 guidelines. Detailed subjective image quality including image noise, sharpness of bony edges, and visibility of nasal septum, middle turbinate, lamina papyracea, cribiform plate, optic nerve, inferior rectus muscle, and ocular globe 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 contrast to noise ratio (CNR) was measured in the axial plane for the right globe (vitreous), right masseter muscle, and in air within the center of the right maxillary sinus. Statistical analysis was performed with the Student's t-test.

Results
The study cohort, included 97 para-nasal CT examinations performed on 60 children
(average age, 12.0 ± 4.0 years; F:M 28:32) with IR capable scanner (ASIR), whereas the control group included 13 para-nasal CT examinations (average age 10.7 ± 5.0, M: F 2:8) with standard FBP reconstruction. There was no significant difference between ASIR and FBP for age and facial diameter (14.2 ± 2 cm compared to 14.5 ± 2 cm) (p = 0.05, p = 0.05, respectively). Clinical indications for para-nasal sinus or facial CT included; lump or mass (n=39), difficulty opening mouth (n=12), developmental jaw deformity (n=11), and osteosarcoma (n=7). ASIR algorithm was set at 90% settings (available from 10-100% with 10% increments). ASIR90 resulted in 73% reduction in CT radiation dose (CTDIvol 5.5 ± 7.2 mGy, DLP 91.6 ± 120.0 mGy.cm, 0.2 mSv), as compared to FBP (20.2 ± 13.1 mGy, 320.1 ± 170.6 mGy.cm, 1 mSv, respectively) (p < 0.001). Objective image noise measured at the masseter and maxillary sinus air on ASIR90 images 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
Para-nasal sinus CT can be performed with 70% reduced radiation dose with iterative reconstruction algorithms without affecting image quality.
Cracking the Code of Temporal Bone and Skull Base Anatomy with 3D Printing: A Conceptual Approach

R Javan¹, A Abdelazim²

Figure 1:
Axial and Coronal face CT images acquired at low-dose reconstructed with ASIR 90% technique (A1, A2) and Standard-dose with FBP (B1, B2) in a 5 year-old boy with right intraorbital subperiostral abscess (yellow arrows).
Low-dose scan was performed at a radiation dose of 0.51 mSv (CTDIvol: 3.2 mGy) as compared to effective dose of 0.78 in Standard-dose scan (CTDIvol: 14.6) mGy.
Purpose
The purpose of this exhibit is to utilize 3D printing to conceptually simplify understanding the complex three-dimensional anatomy and neurovascular contents of the temporal bone and skull base as they pertain to neuroradiologists.

Materials and Methods
The temporal bone and skull base along with their subsections and their contents, including the middle ear, pterygopalatine fossa, petrous apex, middle cranial fossa, Meckel's cave and cavernous sinus are represented as cube-shaped rooms and their communications as hallways, doors and windows. A 3D printed model then is created with its 'rooms' having been de-roofed. This approach simplifies the three-dimensional understanding, by providing an alternative method of visualization from within the cavity itself and identifying structures as isolated objects. Initially, simple computer enhanced hand-drawn illustrations were created with proper perspective view to provide the 'big picture'. Subsequently, graphics design software, Autodesk 3D Studio Max 9.0, was used to create volumetric meshes of the conceptualized structures. The middle ear structures include the ossicles, scutum, chorda tympani nerve, facial canal, tensor tympani, cochlear promontory, round and oval windows, tympanic membrane, tympanic canaliculus, aditus ad antrum, facial recess, sinus tympani and pyramidal eminence surrounded by internal carotid artery, internal jugular vein, facial nerve and inner ear elements. The petrous apex, Meckel's cave and cavernous sinus contents emphasize the relative location of the cranial nerves with respect to anatomical landmarks such as the petroclinoid ligament and cavernous ICA. The pterygopalatine fossa has the surrounding connections of pterygomaxillary and superior orbital fissure, sphenopalatine foramen and the palatine canals which connect via the foramen of rotundum and vidian canal to the middle cranial fossa containing the foramina of ovale and spinosum as well as the petrous portion of the carotid canal.

Results
An enlarged physical model of the temporal bone and skull base was created with individual structures portrayed conceptually for the specific use of teaching complex anatomy. The incredible customizability that 3D printing technologies afford the radiologist in designing educational tools is discussed.

Conclusions
An alternative approach to learning the intricate three-dimensional anatomy of temporal bone and skull base was designed as abridge between anatomy books and cross-sectional imaging. A detailed understanding of the specific anatomical spaces and structures is a crucial first step in identifying and distinguishing pathologic conditions by neuroradiologists. The necessary software and the available options for acquiring 3D models also are discussed.
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?

N Emmanuel¹, E Kari², J Go³
¹University of Southern California, Los Angeles, CA, ²Keck USC School of Medicine, Los Angeles, CA, ³LAC/USC Medical Center, Los Angeles, CA

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 (MR) imaging have become routinely used to evaluate CI as a viable option. For assessment with high resolution T2-weighted images, there should be sufficient CSF in the IAC to evaluate the VIIth/VIIIth nerve complex. To date, it has not been reported if CT and MR 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 MR 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 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 MR.

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 MR, and MR 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 MR pulse sequences to obtain clinically useful information in the shortest time possible.
Purpose
Meniere's disease is a disorder of the inner ear, which is characterized by recurrent attacks of vertigo. Currently it remains difficult to differentiate between different causes of dizziness. Cone beam computed tomography (CT) or magnetic resonance imaging (MRI) enhanced by invasive contrast agents such as gadolinium nowadays are investigated as a possible diagnosis for Meniere's disease. Here, an alternative approach is taken using readily available and conventional MRI scans. Lately, the evidence is increasing that with new imaging processing and analysis techniques, more information can be gathered from standard imaging modalities. This so-called radiomics approach does not necessarily rely on features perceptually visible by the (neuro)radiologist, but it instead relies on the extraction and analysis of quantitative image features. The main objective of this pilot study was to investigate whether a quantitative image analysis of the labyrinth in conventional MRI scans using a radiomics approach showed differences between patients with Meniere's disease and the control group.

Materials and Methods
Magnetic resonance imaging scans of the affected labyrinths of 24 patients with Meniere's disease were compared to the MRI scans of labyrinths of 29 patients with an asymmetrical sensorineural hearing loss (best hearing side). The 1,5T and 3T MRI scans previously had been made in a clinical setting, without contrast enhancement. 3D Slicer 4.4 (http://slicer.org) was used to extract several substructures of the labyrinth from the original MRI scans. A quantitative analysis of the normalized radiomic image features was performed in Mathematica 10 (Wolfram Research). The image features of the two groups were compared statistically.

Results
In numerous image features, there was a statistically significant difference between the Meniere's disease group and the control group. These differences were localized in all substructures of the labyrinth (the cochlea, the area containing the reuniting duct and the semicircular canals).

Conclusions
A quantitative analysis of the labyrinth on conventional MRI scans shows statistically significant differences between patients with Meniere's disease and the control group. This demonstrates that there is a difference between the two groups in the distribution of the intensities on MRI.
Detection of Endolymphatic Hydrops in Meniere’s Disease Using Traditional MR Imaging Sequences

J Keller¹, B Branstetter¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
To determine whether Meniere's disease (MD) is detectable using unenhanced T2-weighted MR sequences by comparing endolymphatic and perilymphatic spaces in the inner ear.

Materials and Methods
We identified patients with documented MD who had a high-resolution T2-weighted or SSFP MRI of the temporal bones within 1 month of diagnosis. Patients were compared to age- and sex-matched controls. Cross-sectional area, maximum length, and maximum width of the bony vestibule and utricle were measured in all imaged ears along with the width of the basal turn of the cochlea and its contained endolymphatic space. Absolute values and ratios of endolymph to perilymph size were compared across affected, contralateral, and control ears using analysis of variance and post-hoc pairwise comparisons.

Results
Eighty-five case-control pairs were enrolled in this study. Mean utricle areas for affected, contralateral, and control ears were 0.038 +/- 0.012 cm², 0.037 +/- 0.11 cm², and 0.033 +/- 0.009 cm², respectively. Mean utricle-to-vestibule area ratios for affected, contralateral, and control ears were 0.32 +/- 0.07, 0.32 +/- 0.08, and 0.29 +/- 0.07, respectively. There was a statistically significant difference between groups as determined by one-way ANOVA: for utricle area, F (2, 337) = 9.44, p = 0.0001, and for utricle-to-vestibule ratio, F (2, 337) = 11.2, p = 0.00002. Post-hoc comparisons revealed no difference between affected and contralateral ears in Meniere's patients, while control ears were different from both affected and contralateral ears in the patients with MD. All other measurements failed to show a significant difference between groups.

Conclusions
Increases in utricle area and utricle-to-vestibule area ratios in MD can be detected using conventional high-resolution T2-weighted MR sequences. This data support the use of MRI as a diagnostic tool in the evaluation of suspected MD and suggests that the use of intratympanic contrast may be unnecessary.
Skull Base Hemangioma Masquerading as Vascular Tumors

D Landry¹, C Glastonbury²
¹University of Montreal, Montreal, Quebec, ²University Of California, San Francisco, San Francisco, CA

Purpose
Vertebral body "hemangiomas" are common benign bone lesions which, in most cases, are incidental and require no follow up or intervention. When they occur in the skull base, they can be readily confused with vascular bone tumors including jugular paraganglioma. We present the imaging findings of six patients with these vascular lesions.

Materials and Methods
We report six cases, collected between June 2014 and November 2015, at two institutions where these skull base lesions caused diagnostic consternation.

Results
Intra-osseous hemangiomas are benign vascular malformations and are recognized most frequently in the vertebral bodies and calvaria (1). These cavernous hemangiomas typically have a, "polka-dot" appearance on high-resolution computed tomography (CT) due to trabeculae and show T2 hyperintensity and avid enhancement on magnetic resonance imaging (MRI). Jugular paraganglioma, or glomus tumors, usually are confined to the jugular foramen but erode adjacent bone, producing a moth-eaten appearance. Because of their increased vascularity and propensity to bleed, they often have a salt-and-pepper appearance on T1 MRI2.

Differentiation between hemangioma and vascular masses such as paraganglioma on MRI can be challenging, however, high-resolution CT can clarify the intraosseous location and the absence of bone destruction (2, 3) (Figs. 1a-d).

Conclusions
Hemangiomas can occur in the skull base bone as well as the well recognized calvarial and vertebral body locations and, on MRI, may mimic vascular tumors including jugular paraganglioma. Skull base CT scan is a valuable tool to differentiate a benign vascular lesion from an erosive tumor.
Dural Metastases: A Form of Recurrence in Uncommon Sinonasal Malignancies

R Valenzuela¹, L Ginsberg², R Riascos³, M Ramirez⁴, D Ruiz⁵, D Shatzkes⁶, C Sitton⁵, M Michel⁷, L Loevner⁸, E Hanna⁹

¹The University of Texas, Houston, TX, ²MD Anderson Cancer Center, Houston, TX, ³UTHSC-Houston, Houston, TX, ⁴The University of Texas Health Science Center at Houston. Department of diagnostic and intervention, Houston, TX, ⁵The University of Texas Health Science Center at Houston UTHealth, Houston, TX, ⁶Lenox Hill Hospital, New York, NY, ⁷Medical College Of Wisconsin/Froedtert Hosp., Milwaukee,
Purpose
Demonstrate dural metastases (DM) as an unusual form of tumoral spread, from treated sinonasal malignancies. Show the different imaging presentations of DM arising from primary sinonasal malignancies.

Materials and Methods
A review of 20 DM cases diagnosed during routine postoperative follow-up imaging is presented, occurring on a group of sinonasal malignancies, treated by anterior craniofacial resection (CFR).

Results
Dural metastases was observed in 12 cases of sinonasal undifferentiated carcinoma (SNUC), seven olfactory neuroblastoma (ONB) and one adenoid cystic carcinoma (ACCa). Dural metastases appeared on an average 7.3 years after treatment on ONB. The maximum DM size was 4.3 cm on SNUC and 2.5 cm on ONB. The maximum distance from primary tumor to DM was 7.9 cm for ONB and 4.3 cm for SNUC. Dural metastases was observed at the Burr Hole on 50% of SNUC and 29% ONB. Dural metastases presented as nodular, multinodular, cystic or plaque pattern, 75% presented nodular form and 43% the cystic form.

Conclusions
Dural metastases may arise from direct extension or hematogenous spread. With the exception of one case published of dural metastases related to ONB, reported by Bogucki, et al. we are not aware of any sinonasal malignancies DM-related series. Sinonasal malignancies represent a small proportion of head and neck tumors, in which 80% accounts for squamous cell carcinoma (SCC) and 10% for ACCa. Less common malignancies includes SNUC and ONB. The presence of a cystic DM was observed only in relation to ONB. A local mechanism could be considered in the DM development, involving the dural venous plexus as a pathway of tumor spread, when surgical or tumoral ACF breach is present. Dural metastases is an unusual form of sinonasal malignancies spread. There are different forms of DM spread, shown on MR imaging. Dural metastases is associated with unusual malignancies other than SCC, in which brain MR could be necessary as complement in the follow up.
Purpose
Primary intraosseous meningiomas represent an exceedingly rare subtype of both primary extradural meningiomas and osseous lesions, with unclear radiographic features and outcomes.

Materials and Methods
Radiographic details and clinical course were examined for all patients with a diagnosis of intraosseous meningioma from Partners Healthcare hospitals, confirmed by pathologic and operative findings. Patients with dural-based lesions that demonstrated intraosseous involvement were excluded.

Results
Nine patients had a diagnosis of primary intraosseous meningioma, as confirmed by radiographic, pathologic, and operative findings. Five presented with neurologic
deficits, two presented with asymptomatic physical changes, and two were diagnosed incidentally; at a median lesion size of 3.0 cm in greatest dimension (range 1.8 - 6.0 cm). Primary intraosseous meningioma demonstrated a predilection for calvarium and sphenoid wing, and often manifested radiographically as homogenous expansile ground-glass calcific densities with well margined bony excresences into neighboring soft tissues and irregular cortical margins. Approximately half of lesions demonstrated sclerotic features on computed tomography (CT), whereas the remainder displayed lytic changes; with isointense to mildly-hypointense T1 sequence features on magnetic resonance imaging (MRI). In most cases initial CT impressions often favored metastasis, although integration with MRI findings highlighted meningiomas in the differential.

Conclusions
Primary intraosseous meningiomas represent a rare benign skull lesion with mixed CT features, whose diagnosis markedly benefits from the integration of CT and MRI findings and should be remembered in the differential for slow-growing expansile intraosseous lesions of the skull.

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4:04PM - 4:12PM

Unusual Extramedullary Plasmacytoma of the Head and Neck: A Case Series

M Labib¹, P Som¹
¹Icahn School of Medicine at Mount Sinai, New York, NY

Purpose
Extramedullary plasmacytomas are immunoglobulin-secreting neoplasms that arise from a monoclonal proliferation of plasma cells. Nearly 80% of these tumors arise in the head and neck and the risk of developing multiple myeloma in these patients is between 33.3%-50% (1, 2). These tumors also may occur in an intramedullary location and they can develop as isolated lesions or as part of multiple myeloma. Overall, plasmacytomas are uncommon tumors, with extramedullary plasmacytoma (EP) representing less than 1% of all malignancies of the head and neck (3). Additionally, these tumors tend to occur in unusual locations and demonstrate a varied appearance on imaging (4). As such, plasmacytomas tend to pose a diagnostic challenge. The successful head and neck radiologist should be familiar with their typical imaging characteristics in order to successfully identify these lesions should they arise.

Materials and Methods
A retrospective review of the magnetic resonance imaging (MRI) and computed tomography (CT) examinations of the head and neck performed at our institution was conducted over the past 5 years. Attention was given to patients with a known
diagnosis of multiple myeloma and to those with imaging findings suggestive of the diagnosis.

**Results**

Six patients were identified with both a histological diagnosis of multiple myeloma and the presence of plasmacytoma in the head and neck. Among these cases, extramedullary plasmacytomas were identified localizing to the parapharyngeal space, the masticator space, the orbit, the antrum, and the larynx. An intramedullary plasmacytoma also was identified at the mandible. The imaging appearance of each of these lesions was reviewed in turn.

**Conclusions**

Given their infrequency and varied imaging appearance, plasmacytomas of the head and neck pose a diagnostic challenge. We describe six cases of plasmacytoma of the head and neck, reviewing the imaging characteristics of each lesion in turn. Through this review we highlight some of the common locations and imaging characteristics of this uncommon disease.

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Migration of Bone Wax into the Dural Venous Sinuses Following Posterior Fossa Surgery

K Byrns¹, A Khasgiwala¹, S Patel¹
¹NYU Langone Medical Center, New York, NY

**Purpose**

Bone wax is a biologically inert mixture of beeswax, paraffin, and a wax-softening agent that commonly is used during surgery of the posterior fossa for achieving hemostasis or packing violated mastoid air cells (1). A rare complication of its use is migration into the dural venous sinuses via emissary vein channels (2, 3). On imaging, migrated bone wax appears as a computed tomography (CT) hypodense (attenuation between fat and simple fluid) or magnetic resonance (MR) hypointense (owing to its semicrystalline solid nature) filling defect. Our goal was to review retrospectively imaging studies performed for patients who had undergone posterior fossa surgery to identify instances of this complication.

**Materials and Methods**

A query of our radiology report database identified reports containing the terms "suboccipital," "retrosigmoid," or "mastoidectomy" generated over a 6-month period. Scans of the 451 resultant patients then were reviewed to identify cases that had in fact undergone surgery and for which contrast-enhanced CT or MR imaging was performed. This yielded 212 patients. The morphology of the filling defect, the ability to trace it to an emissary vein channel or the surgical bed, and the signal/attenuation...
characteristics were used to identify likely instances of migrated bone wax and a chart review was performed for each.

Results
Of the 212 patients reviewed, we identified eight cases that met criteria for bone wax migration into the transverse or sigmoid sinuses (Table 1). For six cases, both MR and CT imaging was available (Table 2). Patient age ranged from 30 to 78 years and indications for surgery included three cranial nerve schwannomas, three meningiomas, a cerebellar hemangioblastoma, and a cerebrospinal fluid (CSF) leak repair. The interval between the initial operation and the MR study varied from immediately postop to over 6 years. The operative note specifically mentioned the use of bone wax in six cases. In no instance was a negative clinical outcome attributed to bone wax migration or re-operation performed for this reason.

Conclusions
Migration of bone wax into the dural venous sinuses is a rare complication of posterior fossa surgery that radiologists should recognize and be prepared to differentiate from more serious complications, such as venous sinus thrombosis. The finding may persist for many years postoperatively and, as in our series, may not have any associated negative clinical outcome.
### Table 1

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Gender</th>
<th>Bone wax mentioned in operative note?</th>
<th>Interval between operation and most recent scan (days)</th>
<th>Surgical approach</th>
<th>Lesion type</th>
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<td>60</td>
<td>M</td>
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<td>1213</td>
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<td>2</td>
<td>78</td>
<td>F</td>
<td>Yes</td>
<td>1134</td>
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<td>3</td>
<td>39</td>
<td>F</td>
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<td>30</td>
<td>F</td>
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<td>58</td>
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<td>Jugular fossa</td>
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<td>30</td>
<td>F</td>
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<td>F</td>
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<td>Petrous apicis</td>
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<td>7</td>
<td>61</td>
<td>M</td>
<td>Yes</td>
<td>2273</td>
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<td>CSF leak</td>
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<tr>
<td>8</td>
<td>36</td>
<td>F</td>
<td>No</td>
<td>63</td>
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<td>Hemangioma</td>
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### Table 2

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<th>MR</th>
<th>CT</th>
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<td>8</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
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</tbody>
</table>

(Images of MR and CT scans for cases 1 to 8 are shown, with arrows indicating the location of the lesion.)
The CT Prevalence of Arrested Pneumatization of the Sphenoid Sinus in Patients with Sickle Cell Disease

A Prabhu¹, B Branstetter¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Arrested sphenoid pneumatization is an incidental radiologic finding on computed tomography (CT) and magnetic resonance imaging (MRI) that may be confused with more aggressive pathologic conditions. No definite etiology for arrested sphenoid pneumatization has been established, although changes in regional blood flow during childhood, as is seen with sickle cell disease (SCD), have been proposed. The purpose of our study was to compare the prevalence of arrested pneumatization of the sphenoid sinus in patients with and without SCD.

Materials and Methods
We retrospectively identified 146 patients with SCD who had undergone CT scans of the skullbase between January 1990 and May 2015. We then identified 292 control patients without SCD, matched for age and sex in a 2-to-1 ratio. We tabulated the prevalence of arrested pneumatization along with the location and size of the lesions. We used Fisher's exact test to correlate SCD with arrested pneumatization of the sphenoid sinus and Student's t test to correlate SCD with lesion size.

Results
Of the 146 patients with SCD, 14 (9.6%) had arrested pneumatization of the sphenoid sinus. In the 292 control patients, six (2.1%) had arrested pneumatization. Patients with SCD had a statistically significantly higher rate of arrested pneumatization compared to patients without SCD (p < 0.001). There was no statistically significant correlation between lesion size and diagnosis of SCD.

Conclusions
Patients with SCD have a greater prevalence of arrested pneumatization of the sphenoid sinus than patients without SCD. This supports the theory that regional blood flow anomalies cause arrested sinus pneumatization.
O-129a

Dynamic contrast enhanced MRI derived intracellular water lifetime (tau_i): a prognostic marker for patients with squamous cell carcinomas of head and neck.

Figure. Axial contrast-enhanced CT image shows a nonexpansile lesion (arrows) located at a normal left sphenoid sinus pneumatization site with a thin cortical margin, internal fatty content, and curvilinear internal calcifications. This is the characteristic appearance and location for arrested pneumatization of the sphenoid sinus.
Purpose
Shutter-speed pharmacokinetic analysis of dynamic-contrast-enhanced (DCE)-MRI allows estimation of volume transfer constant (Ktrans) of contrast agent exchange between intravascular plasma and tumor interstitium compartments as well as transcytoplasmic water exchange characterized by intracellular water molecule lifetime (τi). While Ktrans reflects tumor perfusion and permeability, τi reflects cell membrane permeability. Ktrans has shown great potential in predicting local treatment response and short-term survival in patients with head and neck squamous cell carcinomas (HNSCC). Some studies have demonstrated that τi may be used as a prognostic imaging biomarker in hepatocellular carcinomas, and breast cancers. Prognostic significance of τi in HNSCC has not been explored. In this study, we sought to investigate the prognostic value of Ktrans and τi in predicting short (< 5 years), and long-term (>10 years) survival in HNSCC patients.

Materials and Methods
Seventy-two patients with HNSCC were recruited. Three patients were excluded because they underwent upfront neck dissection, and 9 patients were excluded either due to suboptimal DCE-MRI data or being lost to follow-up. Survival was evaluated in remaining 60 patients from the end date of chemo-radiation therapy. The date of death, or the date of last clinical follow-up was used as end point. Pretreatment Ktrans, τi, and volume were computed from the largest metastatic node, and median values of these indices were used to divide patients into 2 groups (at or above the threshold value [group I] and below the threshold value [group II]. Overall survival was analyzed by Kaplan-Meier method, and the results were compared by using a log rank test. A P value < .05 was considered significant.

Results
For short-term analysis, 15 of 60 patients had died by the last follow-up period. Patients with higher Ktrans (p=0.03) and τi (p=0.01) had prolonged survival compared to those with lower Ktrans and τi. For long-term analysis, 18 of 60 patients had died by the last follow-up period. Patients with higher τi had prolonged survival compared to patients with lower τi (p=0.03). A trend towards prolonged survival was observed for patients with high Ktrans (p=0.06). No significant differences in nodal volume (p>0.05) were observed in predicting survival.

Conclusions
Though both Ktrans and τi predicted short-term survival, τi was the most effective prognostic biomarker in predicting long term survival in patients with HNSCC. Using rat 9L-epigastric tumors, Koch et al. suggested an inverse correlation between τi and
EF5, a marker of hypoxia. They also observed that elevated \( \tau_i \) regions were associated with high blood flow. Earlier studies support the notion that tumors with relatively higher blood flow are associated with increased oxygenation resulting in better access to chemotherapeutic drugs and radio-sensitivity. Since \( \tau_i \) is affected by sodium-potassium channels as well as mitochondrial metabolism and inhibition of mitochondrial metabolism by lonidamine results in reduced cellular ATP and increased \( \tau_i \). Taken together, these studies and our observations provide evidence that the higher degree of hypoxia, probably due to a combination of reduced mitochondrial metabolism and blood flow, results in low \( \tau_i \) which indicates an adverse tumor microenvironment affecting overall survival. Conclusion: Patients harboring higher pretreatment \( \tau_i \) had prolonged survival compared to those with lower \( \tau_i \).

Monday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Roosevelt 4

5F-PARALLEL PAPER SESSION: Spine: Trauma & Techniques
O-130

Cervical Spine Clearance After Blunt Traumatic Injury: A Meta-Analysis

X Wu\(^1\), V Kalra\(^1\), D Durand\(^1\), R Liu\(^1\), R Bronen\(^1\), K Abbed\(^1\), H Forman\(^1\), A Malhotra\(^1\)

\(^1\)Yale University School of Medicine, New Haven, CT

Purpose
Magnetic resonance imaging (MRI) frequently is performed for clearance of cervical spine (CS) injury in blunt trauma patients. Several meta-analyses have been done in the past assessing the utility of MRI, with interestingly opposing conclusions (1-4). The purpose of this meta-analysis is to quantify the rate of unstable injuries detected by MRI missed on computed tomography (CT), and assess the utility of MRI in CS clearance in blunt trauma patients.

Materials and Methods
We undertook a systematic review and meta-analysis of the worldwide evidence across five major medical databases produced since 2000, including studies with obtunded patients and those with alert patients. Studies were included if they reported the number of unstable injuries or enough details for the instability to be inferred. Variables assessed included severity of injury, CT/MRI specifications, timing of imaging and outcome/follow up. Pooled incidence of unstable injury detected on follow up weighted by inverse of variance among all included as well as among obtunded or alert patient subgroups was reported. Heterogeneity of the literature was assessed.
Results
Of 407 unique citations, 23 studies proved eligible, with 5,286 patients found, and 16 unstable injuries reported in five different studies. The overall pooled incidence is 0.0029%. Among studies that only reported obtunded patients, the pooled incidence is 0.017%. In alert patients the incidence is 0.011%. All positive findings were critically reviewed, and only 11 could be considered as truly unstable. The I2 statistics demonstrate significant heterogeneity.

Conclusions
The overall positive finding rate is extremely low in both obtunded and alert patients. There is significant heterogeneity in the literature regarding the use of further imaging after a negative CT in patients with blunt injury. The use and role of "confirmatory" tests to detect unstable injury shows wide variations. Although MRI frequently is performed, its utility and cost-effectiveness needs further study.

CSF Pulsations in the Spinal Canal in Acute Traumatic Spinal Stenosis Patients: Evidence of Interstitial Movement of Fluid and Spinal Cord Sources and Sinks

N Settipalle¹, M Boakye¹, A Amini¹, M Negahdar¹, R Bert¹
Purpose
We have used cardiac-gated magnetic resonance imaging (MRI) phase contrast cine to study cerebospinal fluid (CSF) pulsations in patients with acute traumatic spinal stenosis and compared the CSF and spinal cord time-flow curves at, above and below the level of spinal cord injury.

Materials and Methods
After IRB approval, nine patients with acute cervical spine injury aged 18-57 years and of both genders were scanned with prospective cardiac gating: 1.5T/TE/TR=6/60ms, flip angle=70, slice thickness=6mm, FOV=160mm, 5+phases. VENCs were customized to 5, 10, 15 or 20cm/s to avoid aliasing. Transverse scans were above, below and at the level of maximal spinal canal stenosis. Cine flow images analysis used custom software based on Matlab. Mean flow, velocity, ROI area were measured at each cine timepoint for the CSF and cord interstitial flow, with delta and net flow calculated.

Results
Flow waveforms both above and below stenoses were affected by the presence and degree of the stenosis. Flow caudal to the stenosis fell into three types: normal same phase if stenosis was incomplete, normal same phase if stenosis was complete and cord interstitial flow present, phase change and present if stenosis incomplete and no vertebral artery dissection. In cases of complete stenosis and no arterial dissection, instantaneous flow exceeded the continuity equation.

Conclusions
Cerebrospinal fluid flow pulsations are affected by the presence of an acute spinal stenosis. Flow pulsations can persist below the level of even when CSF effacement is complete, either by transmittance of flow through cord interstitial spaces or by regeneration from arterial pulsations within the distal cord. We currently are evaluating prognostic implications of high versus no interstitial flow with complete stenosis and the impact of vertebral arterial dissection on pulsations.
Isolated Increased STIR signal of the Posterior Atlanto-occipital and Atlanto-axial Membranes: A Reliable Indicator of Acute C1-C2 Fractures on MRI

Y Chang¹, N Peri², G Kim², E Papavassiliou², R Rojas², R Bhadelia³
¹Beth Israel Deaconess Medical Center, Newton, MA, ²Beth Israel Deaconess Medical Center, Boston, MA, ³Beth Israel Deaconess Medical Center, Boston, MA

Purpose
Diagnosis of acute C1 and/or C2 (C1-C2) fractures on magnetic resonance imaging (MRI) may be challenging secondary to a lack of associated elevated STIR marrow signal (1, 2). The purpose of this study was to determine the value of increased STIR signal in the posterior atlanto-occipital and/or atlanto-axial membranes (PAOM/PAAM) in predicting acute C1-C2 fractures on MRI.

Materials and Methods
Our institutional imaging database was reviewed from 2008-2015 to identify patients with C1-C2 fractures that had both computed tomography (CT) and MRI performed within a 24-hour span. Presence of acute C1-C2 fractures was determined by CT and clinical examination. Two control groups were selected: (1) No fracture (NF) group
with trauma history but negative CT, and (2) Other fracture (OF) group with acute cervical spine fractures other than C1-2. Elevated PAOM/PAAM signal on midline sagittal STIR images was assessed by consensus between two neuroradiologists. Patients with abnormal ligamentous signal at other levels (with or without PAOM/PAAM signal) and those without signal abnormality were considered negative. Sensitivity, specificity and positive predictive value (PPV) of increased signal isolated to the PAOM/PAAM was determined for acute C1-C2 fracture versus patients in NF and OF groups.

Results
Isolated increased PAOM/PAAM signal was seen in 23/36 (64%) of C1-C2, 1/37 (3%) of NF, and 1/19 (5%) of OF patients. Isolated increased PAOM/PAAM signal at C1-2 had 64% sensitivity, 97% specificity and 96% PPV versus NF, and 64% sensitivity, 95% specificity and 96% PPV versus OF.

Conclusions
The presence of isolated increased PAOM/PAAM signal on STIR images is a reliable indicator of an acute C1-C2 fracture on MRI. This may be a useful imaging sign for occult acute C1-C2 fractures on MRI in patients without prior CT for comparison.

O-133

Comparative diagnostic evaluation of CT vs MR with management/outcomes in cervical spine trauma based on age and injury appearance pattern

D Durand¹, V Kalra¹, X Wu¹, A Malhotra²
¹Yale University School of Medicine, New Haven, CT, ²Yale New Haven Hospital, New Haven, CT

Purpose
Advances in computed tomography (CT) and magnetic resonance imaging (MRI) necessitate revaluation of these modalities presumed complimentary roles in blunt cervical trauma. Radiation dose, cost, and throughput considerations weigh against performing both CT and MRI if management/outcomes are not changed significantly. We perform subgroup analysis based on age and injury appearance pattern.

Materials and Methods
Seven hundred seventy-eight patients who underwent both CT and MR for blunt cervical spinal trauma from late 2013 to late 2015 were included. Magnetic resonance imaging was performed within 24 hours of the CT. Most common indications were fall, MVC, and assault. Injury patterns were subgrouped into increased anterior angulation, increased posterior angulation, AP translation, lateral translation, unilateral facet perching, unilateral facet dislocation, bilateral facet perching, bilateral facet dislocation, and avulsion.
Results
Of the total of 778 patients, 260 had positive CT findings. Sixty-four of these (24.6% of the CT positive group and 8.2% overall) had negative MR findings, while 196 (75.4% of the CT positive group and 25.2% overall) had positive MR findings. Five hundred eighteen of the 778 total patients had negative CT findings. Of these, 405 also had negative MR (78.2% of the negative CT group and 52.1% overall) and 113 had positive MR findings (21.8% of the negative CT group and 14.5% overall). Using either modality positive as a reference, CT showed sensitivity of 69.7% and negative predictive value of 78.2% and MR demonstrated sensitivity of 82.8% and negative predictive value of 86.4%.

Conclusions
Computed tomography and MR demonstrate varying diagnostic sensitivities and specificities based on patient and injury appearance pattern. Using either modality positive as a reference, CT showed sensitivity of 69.7% and negative predictive value of 78.2% and MR demonstrated sensitivity of 82.8% and negative predictive value of 86.4%.
## MR findings in relation to CT findings

<table>
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<th>Description</th>
<th>Count</th>
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<tbody>
<tr>
<td>Total positive cervical spine CTs</td>
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</tr>
<tr>
<td>Total positive cervical spine CTs with negative cervical spine MRIs</td>
<td>64</td>
</tr>
<tr>
<td>Total positive cervical spine CTs with positive cervical spine MRIs</td>
<td>196</td>
</tr>
<tr>
<td>Total negative cervical spine CTs</td>
<td>518</td>
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<td>Total negative cervical spine CTs with negative cervical spine MRIs</td>
<td>405</td>
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<tr>
<td>Total negative cervical spine CTs with positive cervical spine MRIs</td>
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**O-134**

3:32PM - 3:40PM

Atlas-based quantitative analysis of T2 signal abnormality in the spinal cord predicts outcome in acute flaccid paralysis.

D McCoy¹, J Talbott¹, M Mamlouk², J Cohen-Adad³, J Narvid¹
Purpose
To investigate the use of a T2-weighted anatomical template and probabilistic atlas of the spinal cord (SC) to quantitatively evaluate the percentage of gray matter (GM) and white matter (WM) affected by lesion in acute flaccid paralysis (AFP).

Materials and Methods
Spinal cord imaging for nine patients presenting with AFP were analyzed using the Spinal Cord Toolbox MRI processing tool. A semi-automated pipeline was developed to identify and segment the spinal cord, register each patient image to the anatomical template, warp the patient image with the template and extract data on lesion involvement in GM and WM.

Results
Percent GM and WM affected by lesion, calculated as the weighted average of lesion involved in probabilistic GM and WM voxel space, was calculated for each patient at three regions of interest i). center axial slice of lesion ii). lesion segment area, and iii.) full spinal cord. Gray matter metrics extracted at the lesion center significantly associated with both clinical outcomes and the Medical Research Council (MRC) Scale for Muscle Strength Scores.

Conclusions
Recent advances in quantitative imaging have led to the development of a robust anatomical template and probabilistic atlas of the spinal cord. With these new tools, spinal cords now can be registered to a common reference and morphological differences quantified at both a group and individual level for comparison. This is the first research study to quantify spinal cord lesions with the Spinal Cord Toolbox and correlate metrics with clinical outcomes.

O-135
3:40PM - 3:48PM
Paraspinal Edema on Unenhanced MRI is Highly Sensitive for the Detection of Lumbar Spinal Epidural Abscess

A Shifrin¹, Q Lu², M Lev³, T Meehan⁴, R Hu⁴
¹Mount Auburn Hospital, Cambridge, MA, ²Zhongda Hospital, Southeast University, Jiangsu, China, ³Massachusetts Gen'l Hosp./Harvard Med. Schl., Boston, MA, ⁴Massachusetts General Hospital, Boston, MA

Purpose
Spinal epidural abscess (SEA) is a neurosurgical emergency. Although contrast-enhanced spine magnetic resonance imaging (MRI) is the mainstay for diagnosis of
SEA, unenhanced MRI typically is obtained in patients with nonspecific symptoms or insufficient clinical information. We evaluated the sensitivity/specificity of imaging features suggestive of SEA on unenhanced spine MRI.

Materials and Methods
Our study was IRB approved. We searched for contrast-enhanced lumbar spine MRI exams from 01/01/2000-08/01/2014 with "epidural abscess" in the report. We included 68 patients >18 years with an enhancing epidural collection on MRI and surgical (62%), microbiologic (19%) or clinical (19%) confirmation of SEA. Sixty-eight age/sex-matched controls without SEA also were selected. Three readers scored unenhanced MRI images on the degree of psoas/paraspinal muscle edema, extent of bone marrow edema, and abnormal disk signal. Location/dimensions of SEA on contrast MRI also were recorded.

Results
Paraspinal edema was highly sensitive (97%) for SEA, with lower sensitivities for psoas, bone marrow, and disk edema (54, 65, and 66%, respectively). Each of these markers was highly significant in univariate analysis (p<0.001). A multivariate logistic regression model adjusting for age and gender found that paraspinal (p<0.001) and bone marrow edema (p=0.006) were significant independent predictors of SEA, with a trend toward significance for psoas edema (p=0.07) and abnormal disk signal (p=0.07). Psoas muscle edema was the most specific (96%) for presence of SEA.

Conclusions
Paraspinal edema is highly sensitive for SEA. Familiarity with the unenhanced MRI findings of SEA could help expedite further, definitive evaluation when contrast is not administered.
Figure 1A. 58-year-old female with no significant past medical history with 5 days of severe low back pain and fevers. Sagittal T2WI demonstrates nonspecific prominence of the ventral epidural space and possibly dilated epidural venous plexus, with T2 hypointense material posterior to the vertebral space that has the appearance of a disc extrusion. There was no significant endplate irregularity or abnormal disc signal.
Figure 1B. Right parasagittal STIR image demonstrates extensive paraspinal edema in the lumbosacral region.

(Filename: TCT_O-135_Figure1B.jpg)
Figure 1C. Sagittal T1WI post-gadolinium image demonstrates an epidural collection in the ventral epidural space extending contiguously on axial imaging (not shown) from the L3-4 to L5-S1 interspace. Blood cultures were positive for staphylococcus aureus, and the patient was treated with antibiotics with subsequent clinical and imaging improvement.
Bone texture analysis of lumbar spine on CT to detect early finding of multiple myeloma: Comparison of control subjects with normal bone density, patients with osteoporosis, and patients with multiple myeloma

T Kakigi¹, K Hassan², M Qureshi², M Chapman², B Li², O Sakai²
Purpose
To evaluate the difference in control subjects with normal bone density, patients with osteoporosis, and patients with multiple myeloma using texture analysis, and to identify possible early lesions of multiple myeloma before a "punched out" lesion is seen.

Materials and Methods
This study was IRB-approved and HIPAA-compliant with a waiver of the need for informed consent. Fifteen control subjects (8 males and 7 females; mean age 68.9 years old, ranged from 53 to 88 years old), 13 osteoporotic patients (1 male and 12 females; mean age 66.5 years old, ranged from 55 to 91 years old), and 10 myeloma patients (6 males and 4 females; mean age 69 years old, ranged from 56 to 86 years old) were enrolled. The L3 vertebral body on contrast-enhanced CT examinations was evaluated by texture analysis. Differences in 42 texture parameters including 13 histogram features, 5 gray-level co-occurrence matrix (GLCM) features, 11 gray-level run length (GLRL) features, 4 gray-level gradient matrix (GLGM) features, and 9 Law's features were examined in each two groups (control subjects and osteoporotic patients, control subjects and myeloma patients, and osteoporotic patients and myeloma patients) using Student's t-test and a false discovery rate (FDR) correction.

Results
Twenty-nine, 26, and 31 out of 42 parameters demonstrated statistically significant differences in each two groups (P < .05). After using FDR correction, 24, 26, and 29 parameters were significant in differentiating between each two groups (Q < .05).

Conclusions
Bone texture analysis may enable us to differentiate control subjects from osteoporotic patients. Some parameters in texture analysis also showed significant differences between osteoporotic patients and myeloma patients. This means that it is possible to differentiate normal osteoporosis from osteoporosis due to myeloma. Bone texture analysis could be useful as one of the imaging markers of multiple myeloma without visible bone lesions.
Purpose
To determine the prevalence and neuroimaging appearance of spinal and sacral osseous involvement in patients diagnosed with sarcoidosis at a single quaternary referral center.

Materials and Methods
After IRB approval the medical record, pathology and radiology databases were searched for patients carrying the diagnosis of sarcoidosis or related sarcoid terms over the last 15 years. This list was cross referenced with patients who had a magnetic resonance imaging (MRI) or computed tomography (CT) dedicated to or containing the spine/sacrum. Five hundred thirty-five patients were identified. Patients without a definitive diagnosis of sarcoid were excluded leaving 396 patients. The neuroimaging of these patients was reviewed.

Results
Forty-six of the 396 were found to have osseous abnormalities involving the spine and sacrum. Forty-five out of 46 patients had a MRI and 44 had CT scans. Twenty-six cases had radiographic abnormalities on CT. Nineteen were lytic, five were sclerotic, one had a diffuse mottled appearance, and one was mixed lytic and sclerotic. Thirty-two patients had multilevel well circumscribed lesions in the vertebral bodies. On CT three of these were sclerotic, 12 were occult, and 15 were lytic. Three patients had diffuse marrow replacement of multiple levels. Two patients had diffuse involvement of one level. Nine patients had multilevel patchy, less well defined areas of involvement (Fig. 1). Thirteen patients initially presented with neuroradiographic abnormalities in the spine/sacrum which ultimately led to the diagnosis of sarcoid. Four patients had osseous spinal involvement as their only finding of sarcoidosis. Nineteen of 46 (41%) patients underwent spine/sacral biopsies of involved areas. Twelve of 19 (63%) of the biopsies were positive, and six (33%) were negative.

Conclusions
While most patients have other supportive findings of sarcoidosis some may present with intraosseous involvement of the spine. Neuroradiologists should be aware of the varied appearance of sarcoid in the axial skeleton which may avoid unnecessary biopsies or help solidify the diagnosis of sarcoidosis.

O-138
The effect of lytic lesions on the kinematic response of human thoracolumbar spines

R Alkalay¹, D Hackney²
¹Beth Israel Deaconess medical Center, Boston, MA, ²Beth Israel Deaconess Medical Center, Boston, MA
Purpose
This study investigated the effect of simulated lytic metastases (LM) in the vertebral body and the posterior elements on the kinematic response of thoracic and lumbar cadaveric human spines in response to flexion and extension loading. The results may guide vertebral augmentation strategies to reduce the risk of pathologic fracture.

Materials and Methods
Twenty-three three-level thoracic and lumbar spinal motion units were instrumented with optical markers for measurement of inter-segmental motion. Using a six degree of freedom test frame, each segment was exposed to axial compression (200N) and increasing magnitudes of either flexion or extension moment. Angular rotations and axial displacements were measured throughout each test. Large defects were created in the vertebral body with or without ipsilateral destruction of the pedicle and facet joint. Kinematic testing was repeated. Repeated measure ANOVA (V 11. JMP, SAS, NC) was used to test the effect of lytic defects and spine region (thoracic versus lumbar) on the response of the motion segments.

Results
Response to flexion moments the LM spines showed higher angular motion ($\theta_X$: flexion-extension, Fig. 1) at lower moment values whilst exhibiting lower angular motion at higher moment values, these differences being significant in comparison to the intact spine ($p<0.01$). This pattern was mirrored for the axial displacement along the spine's axial ($\Delta Z$: $p<0.01$, Fig. 1) and sagittal ($Y$ axis, $p<0.05$, respectively) anatomical axes as well as the pattern of coupled rotational angular motions (Extension: $p<0.01$ and Flexion: $p<0.05$).

Conclusions
Lytic metastases defect significantly affected both primary (flexion-extension) and coupled (axial torsion) motions with the spine showing significant changes in intervertebral displacements. These observed increases, and the observed regional specific changes in this pattern may form an important part of fracture risk in patients with vertebral metastatic disease.
Diagnostic Quality of 3D T2-SPACE Compared to T2 2D-FSE in Evaluating Cervical Spine MRI Anatomy

F Chokshi¹, G Sadigh¹, W Carpenter¹, J Allen¹
¹Emory University School of Medicine, Atlanta, GA

Purpose
To compare the diagnostic quality of 3D T2-SPACE with 2D T2-FSE sequences in visualization of cervical spine (C-spine) anatomy. We predict 3D T2-SPACE will be equivalent or superior to T2-FSE for visibility of cervical spine anatomy.

Materials and Methods
Consecutive patients undergoing noncontrast C-spine MRI with T2-FSE and T2-SPACE sequences for radiculopathy or myelopathy between September 2014 and February 2015 were included. Two blinded, subspecialty-trained radiologists [musculoskeletal (R1) and neuroradiology (R2)] independently assessed visibility of 12 anatomical structures using a 5-point scale (0 = not visible and 4 = excellent visibility) and CSF flow artifact using a 4-point scale (0 = severe artifact and 3 = no artifact) on sagittal view and 6 axial levels from C2-T1 on T2-FSE; 2 weeks later and after randomization, T2-SPACE was evaluated. Diagnostic quality for each structure and cerebrospinal fluid (CSF) flow visibility in both sequences was compared using t-test. Inter-observer agreement was calculated (kappa).

Results
Forty-five patients included (mean age, 57; 40% male); 8,190 visibility scores per reviewer. Per Table 1, average scores for intervertebral disk signal, neural foramina,
ligamentum flavum, ventral rootlets and dorsal rootlets were higher for T2-SPACE compared to T2-FSE for both reviewers (p<0.001). Average scores for remaining anatomical structures were either not statistically different or superiority of one sequence was discordant between both reviewers. T2-SPACE showed less degree of CSF flow artifact (p<0.001). Interobserver variability ranged between -0.02 to 0.20 for T2-SPACE and -0.02 to 0.30 for T2-FSE consistent with slight to fair agreement. Conclusions
1. T2-SPACE may be superior to T2-FSE for evaluation of some, but not all, evaluated c-spine anatomical structures and shows less degree of CSF flow artifact. 2. Slight to fair interobserver agreement may be related to a learning curve in acclimating to this sequence.
Table 1. Average visibility score for anatomic structures and CSF flow artifact of FSE vs. T2-SPACE sequences. FSE, Fast Spin Echo; SPACE, Sample Perfection Application-optimized Contrasts using different flip-angle Evolution.

<table>
<thead>
<tr>
<th></th>
<th>Reviewer 1 (MSK)</th>
<th>Reviewer 2 (Neu)</th>
<th>P-Value</th>
<th>Reviewer 1 (MSK)</th>
<th>Reviewer 2 (Neu)</th>
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<tbody>
<tr>
<td>Bone marrow signal</td>
<td>2.10</td>
<td>2.00</td>
<td>&lt;0.001</td>
<td>2.94</td>
<td>2.96</td>
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<tr>
<td>Intervertebral Disc</td>
<td>2.00</td>
<td>2.50</td>
<td>&lt;0.001</td>
<td>2.85</td>
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<td>Facet Joints</td>
<td>1.95</td>
<td>1.95</td>
<td>0.85</td>
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<td>3.07</td>
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<td>Neural Foramina</td>
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<td>1.97</td>
<td>&lt;0.001</td>
<td>2.87</td>
<td>3.29</td>
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<td>Anterior Longitudinal Ligament</td>
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<td>0.004</td>
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<td>2.92</td>
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<td>Posterior Longitudinal Ligament</td>
<td>0.69</td>
<td>0.50</td>
<td>&lt;0.001</td>
<td>2.91</td>
<td>3.00</td>
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<td>Ligamentum Flavum</td>
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<td>2.90</td>
<td>2.99</td>
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<tr>
<td>Interspinous Ligament</td>
<td>1.15</td>
<td>1.36</td>
<td>&lt;0.001</td>
<td>1.99</td>
<td>2.00</td>
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<td>Spinal Cord Signal</td>
<td>1.93</td>
<td>1.98</td>
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<td>Ventral Rootlets</td>
<td>0.39</td>
<td>1.43</td>
<td>&lt;0.001</td>
<td>0.41</td>
<td>1.67</td>
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<tr>
<td>Dorsal Rootlets</td>
<td>0.50</td>
<td>1.87</td>
<td>&lt;0.001</td>
<td>0.55</td>
<td>2.35</td>
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<tr>
<td>Dorsal Root Ganglia</td>
<td>1.38</td>
<td>1.88</td>
<td>&lt;0.001</td>
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<td>2.64</td>
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<td>CSF Flow Artifact**</td>
<td>1.65</td>
<td>2.93</td>
<td>&lt;0.001</td>
<td>1.69</td>
<td>2.80</td>
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</table>

**Please note higher scores of CSF flow artifact corresponds to less degree of**
Monday  
4:45PM - 6:15PM  
Washington Marriott Wardman Park, Marriott Ballroom

6A-Advanced Imaging Programming: Demystifying Advanced Imaging

6A-1
4:45PM - 5:15PM

Demystifying Diffusion

Berman, J.
Children's Hospital of Philadelphia
Philadelphia, PA

6A-2
5:15PM - 5:45PM

Demystifying Perfusion

Field, A.
Univ. Of Wisconsin Hospital
Madison, WI

6A-3
5:45PM - 6:15PM

Demystifying MR Spectroscopy

Shungu, D.
Weill Cornell Medical College
New York, NY

Monday  
4:45PM - 6:15PM  
Washington Marriott Wardman Park, Washington 4/5/6

6B-CSI Programming: Electronic Meetings and Publishing: Putting It All Together

6B-1
4:45PM - 5:05PM

Gathering Data: Polls
Gibbs, W.
University of Southern California, Keck School of Medicine
Los Angeles, CA

6B-2
5:05PM - 5:25PM
Conducting A Meeting: Ways to Do This Over the Internet (Video Conferencing)

Quigley, E.
University Of Utah
Salt Lake City, UT

6B-3
5:25PM - 5:45PM
Planning a Meeting or Research Project? Using Google Spreadsheets

Go, J.
LAC/USC Medical Center
Los Angeles, CA

6B-4
5:45PM - 6:05PM
E Publishing

Takhtani, D.
University of Massachusetts Medical School
Worcester, MA

6B-5
6:05PM - 6:15PM
Questions
Monday
4:45PM - 6:15PM
Washington Marriott Wardman Park, Washington 1/2/3

6C-Evidence Based Medicine Programming: Appropriateness of Neuroimaging and Clinical Decision Support in the Emergency Department

6C-1
4:45PM - 5:05PM
Impact of Clinical Decision Support on the Volume and Appropriateness in the Emergency Department

Mukundan, S.
Brigham & Women's Hospital
Boston, MA

6C-2
5:05PM - 5:25PM
Emergency Medicine Physician Perspective on Using Clinical Decision Support

Raja, A.
Massachusetts General Hospital
Boston, MA

6C-3
5:25PM - 5:45PM
Value Based ER Radiology

Seidenwurm, D.
Sutter Health
Sacramento, CA

6C-4
5:45PM - 6:05PM
Legal Implications of Clinical Decision Support Tools

Bello, J.
Montefiore Medical Center
Bronx, NY
An Investigation of Visualization Improvement Algorithms Using Color Transformation Techniques for Clinical Pediatric Spinal Cord MRI Images in Healthy Subjects and Patients with Spinal Cord Injury

M Alizadeh¹, P Shah¹, D Middleton¹, C Conklin², S Faro³, M Mulcahey², F Mohamed²
¹Temple University, Philadelphia, PA, ²Thomas Jefferson University, Philadelphia, PA, ³Temple University School Of Medicine, Philadelphia, PA

Purpose
To determine a reliable visualization improvement method based on a T2-weighted gradient echo (GRE) images of pediatric spinal cords, and evaluate the performance of the method(s) in healthy subjects and patients with various severity of spinal cord injury as determined by both diagnostic and clinical examination.

Materials and Methods
A total of 15 subjects (10 healthy and five spinal cord injury patients) were recruited for this study with a mean age of 11.41 years. All patients were assessed clinically using the motor and sensory examinations of the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI); severity of injury was determined according to the American Spinal Injury Association Impairment Scale (AIS) (1). The magnetic resonance imaging (MRI) scans were performed using a 3.0T Siemens Verio MR scanner with 4-channel neck matrix and 8-channel spine matrix coils. The axial T2 gradient echo (GRE) scan was prescribed from the sagittal T2-weighted image to cover the entire cervical spinal cord (C1-C7 levels). Following data
acquisition, axial T2-weighted GRE images then were converted to the color images (Fig. 1) by using five different proposed techniques including Hue-Saturation-Value (HSV), Rainbow, Red-Green-Blue (RGB) and two RGB techniques incorporated with different enhancement approaches using image normalization (2) (RGB1) and intensity inhomogeneity correction (3) (RGB2). Performance of these techniques was scored visually by two independent board certified neuroradiologists with a combined experience of 30 years (22 and 8 years) and quantified using signal to noise ratio (SNR) and contrast to noise ratio (CNR).

Results
Visual inspection: The control subjects showed mean ± standard deviation GRE = 0.78 ± 0.17, RGB = 0.67 ± 0.17, RGB1 = 0.86 ± 0.17, RGB2 = 0.83 ± 0.17, Rainbow = 0.66 ± 0.16 and HSV = 0.59 ± 0.22. The subjects with SCI showed reduced values: GRE = 0.67 ± 0.21, RGB = 0.56 ± 0.19, RGB1 = 0.73 ± 0.23, RGB2 = 0.73 ± 0.22, Rainbow = 0.56 ± 0.18 and HSV = 0.5 ± 0.31 (Figs. 2 and 3). Reliability tests showed moderate to strong agreement between the two examiners. The ICCs and their 95% CIs were GRE [ICC= 0.73, CI (0.69–0.77)], RGB [ICC= 0.83, CI (0.58–0.65)], RGB1[ICC= 0.85, CI (0.75–0.83)], RGB2 [ICC= 0.81, CI (0.74–0.82)], Rainbow [ICC= 0.79, CI (0.58–0.66)] and HSV [ICC= 0.91, CI (0.49–0.6)]. The averaged SNR and CNR values were: GRE [SNR= 76.92 (1:1), CNR= 45.1 (1:1)], RGB [SNR= 130.6 (1.7:1), CNR= 14.76 (0.33:1)], RGB1 [SNR= 50.58 (0.66:1), CNR= 61.35 (1.36:1)], RGB2 [SNR= 110.69 (1.44:1), CNR= 38.27 (0.85:1)], RAINBOW [SNR= 82 (1.07:1), CNR= 4.84 (0.11:1)] and HSV [SNR= 97.29 (1.26:1), CNR= 22.51 (0.5:1)]. RGB, RGB2, rainbow and HSV techniques show improvement in the SNR by 70%, 44%, 7% and 26% respectively compared to conventional GRE images and RGB1 shows improvement in CNR by 36%.

Conclusions
It was determined that the color mapping techniques improved image quality for CSF homogeneity, delineation of cord/CSF interface and separation of the GM and WM in the spinal cord and may help in the diagnosis along with the conventional grayscale MRI images.
S SAKSENA1, D Middleton2, L Krisa1, P Shah2, S Faro3, R Sinko1, J Gaughan3, J Finsterbusch4, M Mulcahey1, F Mohamed1

1Thomas Jefferson University, Philadelphia, PA, 2Temple University, Philadelphia, PA, 3Temple University School of Medicine, Philadelphia, PA, 4University Medical Center Hamburg-eppendorf, Hamburg, Hamburg

Purpose
The purpose of this study was to (a) investigate the feasibility of obtaining reliable diffusion tensor imaging (DTI) parameters along the entire cervical and thoracic spinal cord (SC) in typically developing (TD) healthy children and children with spinal cord injury (SCI) using an inner field of view (FOV) sequence, (b) examine the reproducibility of DTI parameters, (c) determine whether microstructural changes quantified by DTI are associated with clinical neurological deficits.

Materials and Methods
Twenty-two TD children (mean age, 11.03 years) without evidence of SC pathology and 15 patients (mean age, 11.42 years) with chronic SCI were recruited. ISNCSCI were used to define the clinical level and severity of injury in SCI patients. Subjects underwent two identical scans (minimum time between scans=2 h) using 3T Verio MR scanner with 4-channel neck matrix and 8-channel spine matrix coils. The protocol consisted of conventional T1- and T2-weighted structural scans and axial DTI scans based on inner FOV sequence described previously (1). Diffusion tensor images were acquired axially using two overlapping slabs, to cover the cervical (C1-upper thoracic region) and thoracic (upper thoracic-L1) SC. The imaging parameters: three averages of 20 diffusion directions, six b0 acquisitions, b=800s/mm2, voxel size=0.8x0.8x6mm3, axial slices=40, TR=7900ms, TE=110ms, and acquisition time=8:49min and no gating. Data Analysis: A central mask was applied to the raw DTI images to eliminate the anatomy outside the SC. A mean b0 image was calculated, generated from the coregistration of all 6 b0 acquisitions. After motion correction, the diffusion-weighted images were corrected for motion using a rigid body correction algorithm (2). Tensor estimation was done on a voxel-by-voxel basis using in-house software developed in MATLAB. For robust diffusion tensor estimation, RESTORE technique was used (3). Regions of interest (ROIs) were manually drawn on the whole cord on grayscale FA maps along the cervical and thoracic SC for both scans. Analysis of covariance for repeated measures was performed to compare data from TD and SCI. Test-retest reliability was calculated using the intra-class correlation coefficient (ICC) (4).

Results
The images obtained with inner FOV sequence showed excellent delineation of both cervical and thoracic SC with minimal distortions (Fig. 1). Fractional anisotropy (FA) values were significantly lower while radial diffusivity (RD) was significantly higher
along the SC in patients with SCI compared to TD; however, mean diffusivity (MD) and axial diffusivity (AD) values were not statistically significant (Table 1, Fig. 2). There was a strong reliability for all DTI parameters along the SC in all subjects (ICC: 0.79-0.94). MD, AD and RD showed the greatest number of correlations with ISNCSCI followed by FA indicating that better neurological function is associated with greater unidirectional diffusion.

Conclusions
This study demonstrates that DTI has a potential to be used as an imaging biomarker for evaluating the extent of injury, which may be useful to prognosticate as well as monitor patients with SCI.

<table>
<thead>
<tr>
<th></th>
<th>FA</th>
<th>MD</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD</td>
<td>0.56±0.09</td>
<td>1.05±0.25</td>
<td>1.78±0.38</td>
</tr>
<tr>
<td>SCI</td>
<td>0.47±0.12</td>
<td>1.09±0.29</td>
<td>1.68±0.37</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-142_Table1.jpg)
Reduced FOV Diffusion Tensor MR Imaging and Fiber Tractography of the Pediatric Cervical Spinal Cord

M Alizadeh¹, A Intintolo¹, D Middleton¹, C Conklin², S Faro³, M Mulcahey², F Mohamed²
¹Temple University, Philadelphia, PA, ²Thomas Jefferson University, Philadelphia, PA, ³Temple University School Of Medicine, Philadelphia, PA

Purpose
The purpose of this study was to (a) evaluate the feasibility of generating diffusion tensor tractography (DTT) images of the cervical spinal cord in pediatric, (b) to measure the diffusion tensor imaging (DTI) indices as well as tract specific information using regions of interest (ROIs) generated at every axial slice location along the entire cervical spinal cord based on DTT images, and (c) to investigate if
there are differences in these values between the typically development (TD) subjects and patient group with SCI.

Materials and Methods
Twenty volunteers (mean age of 14.85 years) including 10 healthy subjects who had no evidence of spinal cord injury (SCI) or pathology and 10 subjects with SCI in the cervical area were recruited. The magnetic resonance imaging (MRI) scans were performed using a 3.0T Siemens Verio MR scanner with 4-channel neck matrix and 8-channel spine matrix coils. Diffusion tensor images were acquired axially in the same anatomical location prescribed for the T2-weighted images using a reduced FOV (rFOV) DTI sequence. The DTI parameters used were: number of directions=20, b=1000s/mm2, voxel size=1.2×1.2×3.0mm3, matrix size= 36×208, axial slices=35-45 (depending on the subject's height), TR=6100-8000ms, TE=115ms, number of averages=3 and acquisition time=7min.

Results
The mean fractional anisotropy (FA) values in the controls and patients were 0.6±0.13 and 0.45±0.14, respectively. Fractional anisotropy values were decreased significantly in the patients with SCI (p=0.0003). Apparent diffusion coefficient (ADC) values in the controls and patients were 0.738±0.181×10⁻³mm²/sec and 0.767±0.237×10⁻³mm²/sec, respectively, however they were not statistically significant. These FA and ADC values in controls and patients with SCI were comparable to what is published in the current literature (1-3). The mean number of fiber tracks in the controls and patients were 1157±156.1 and 750±259.4, respectively and was significantly decreased in the SCI group (p=0.00001). However, the mean length of fiber tracks (24.30±15.85mm and 23.06±15.11mm in the controls and patients, respectively) did not show significant differences. Previous studies on adult subjects demonstrate that FA values of injured cords were much lower than those of uninjured normal cord and ADC values do not differ between abnormal and normal cords in patients and controls (1, 4). However, the mean FA and ADC values of the cervical spinal cord observed in this pediatric study are different from the values quoted in the literature for adult population. The difference in the values may be primarily due to the biologic developments associated with white matter maturation, namely axonal growth and myelination (5). Figures 1 and 2 show tractography images of the entire cervical spinal cord of a normal subject and a patient with SCI, respectively.

Conclusions
These results show that DTI and DTT could be used a surrogate marker for quantification and visualization of the injured spinal cord and has the potential to improve our understanding of damage and recovery in diseases of the spinal cord.
Atrophy and DTI in Pediatric Spinal Cord Injury: Correlation of DTI Metrics to Spinal Cord Cross Sectional Area

D Middleton1, S Shahrampour1, S Faro2, S SAKSENA3, M Alizadeh1, C Conklin3, G Nair4, W Liu5, L Krisa3, M Mulcahey3, F Mohamed3
1Temple University, Philadelphia, PA, 2Temple University School Of Medicine, Philadelphia, PA, 3Thomas Jefferson University, Philadelphia, PA, 4National Institutes of Health, Bethesda, MD, 5University of Maryland, College Park, MD

Purpose
The goal of this study was to examine correlations between diffusion tensor imaging (DTI) metrics and spinal cord cross-sectional area (SCCSA) in pediatric subjects with spinal cord injury (SCI).

Materials and Methods
Nine pediatric subjects (mean age 11.8) with chronic SCI were scanned using a 3T Siemens Verio MR scanner. Diffusion tensor imaging data (Fig. 1a) was acquired with an axial inner-FOV sequence(1) with parameters: voxel = 0.8 x 0.8 x 6 mm3, slices = 40, 3 averages, 20 directions, b = 800 s/mm2, TE = 110 ms, TR = 7900 ms, TA = 8:49. Data for SCCSA measurement was acquired with a sagittal 3D-TSE T2
sequence (Figure 1b) with parameters: voxel = 1 x 1 x 1 mm³, TE = 122 ms, TR = 1500 ms, TA = 3:21. Two acquisitions were obtained per subject to provide full cord coverage. Spinal cord cross-sectional area measurement was performed using a newly developed technique where automatic segmentation and cross-section measurement is performed in the axial plane (2). Diffusion tensor images were corrected for motion (3) and tensor estimation was performed. Whole cord regions of interest (ROIs) were drawn on axial slices at each vertebral level.

Results
The DTI parameters and SCCSA were calculated (Fig. 2) and correlations were examined between averaged values for the full cord. A strong and statistically significant correlation was found between FA and SCCSA (Spearman's $r = 0.75$ and $p < 0.02$). Moderate but not significant correlations were found with AD ($r = 0.50$, $p = 0.12$) and RD ($r = -0.58$, $p = 0.07$).

Conclusions
It is possible normal appearing tissue is functionally unaffected, correlation of decreased FA and atrophy suggests that this is not necessarily the case since remaining tissue shows decreased directionality with loss of volume. This suggests that DTI may be a critical compliment to conventional methods when assessing SCI.
O-145

Accuracy of Neuroimaging to Detect Retinal Pathology in Children Suffering From Accidental and Non-accidental Trauma; Can Ophthalmic Ultrasound Serve as a Screening Tool?

B Riggs1, C Kraus1, B Shivakumar2, C Trimboli-Heidler3, J Cohen4, M Repka5, A Tekes6

1Johns Hopkins School of Medicine, Baltimore, MD, 2Johns Hopkins University, Baltimore, MD, 3Children's National Health Systems, Washington, DC, 4Children's National Health System, Washington, DC, 5Johns Hopkins, Baltimore, MD, 6Johns Hopkins Hospital, Baltimore, MD

Purpose

At least one-third of abusive head trauma (AHT) cases are not identified upon initial presentation to the emergency department (ED) (1, 2). Abusive head trauma has a mortality rate of 30%, and 80% of survivors suffer permanent neurological damage (2-4). Retinal manifestations of AHT are identified in 80% of victims by dilated fundus exam (4). We propose that ophthalmic ultrasonography (5) can identify retinal pathology, faster and more accurately than head computed tomography (CT) or head magnetic resonance imaging (MRI) when compared with dilated fundus exam.

Materials and Methods

Retinal pathology was evaluated by dilated fundus exams in all patients. A GE LOGIQ E ® ultrasound machine with a high frequency linear array 10-22 MHz probe was used. No sedation was required. Each globe was evaluated on 37 ophthalmic ultrasounds, 35 head CTs, and 27 head MRIs.

Results

Thirty-seven patients, 27 males and 10 females, 5 days to 5 years of age were enrolled in this IRB approved prospective observational cohort. Abusive head trauma was diagnosed in 27 patients and accidental trauma in 10 patients. According to fundus exams (gold standard), 22 patients had significant bilateral retinal hemorrhages, one had unilateral retinal hemorrhages, and 14 patients had no retinal pathology. Relative to hospital arrival time, ophthalmic ultrasounds were obtained within 3.2 hours (±2), head CTs within 4 hours (±4.7), head MRIs within 59 hours (±77), and dilated fundus exams within 70 hours (±62). Compared with fundus exam sensitivity and specificity for each modality were as follows (with 95% confidence intervals): head CT sensitivity 23% (CI: 9-43.6) and specificity 100% (CI: 66-100), T2 weighted MRI images sensitivity of 42.9% (CI: 22-67) and specificity of 100% (54-100), susceptibility-weighted imaging (SWI) sensitivity of 62% (CI: 38-82) and specificity...
of 66.7% (CI: 22-95.7), ophthalmic ultrasound sensitivity 100% (CI: 88-100) and specificity of 100% (CI: 66-100).

Conclusions
Ophthalmic ultrasound is an accurate, rapid, radiation-free, bedside imaging modality which can be used as a screening tool to identify retinal pathology in children with suspected AHT.

O-146

5:00PM - 5:03PM

Bridging veins rupture correlates with subdural hemorrhages in abusive head trauma: a volumetric SWI study

G Zuccoli¹, M Tamber¹, I Amoddeo¹, A Khan¹, S Bartoletti¹, A Panigrahy¹
¹Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA

Purpose
Bridging vein thrombosis (BVT) is described in abusive head trauma (AHT) in infants. Susceptibility-weighted imaging (SWI) related hypo-intensity and the deformation of the bridging veins resembling a "tadpole" is felt to reflect BVT in the setting of AHT. We aimed to verify whether the tadpole sign truly reflects thrombosis or just traumatic deformation of the bridging veins by using a volumetric SWI approach.

Materials and Methods
Seventeen patients were evaluated retrospectively based on a final multidisciplinary diagnosis of AHT. Images were evaluated by two experienced pediatric neuroradiologists for the presence of the tadpole sign or bridging vein thrombosis on 2-3 mm skip 1 mm SWI axial images. By using the localizer tool (Philips Isite Radiology) we localized the affected bridging veins on coronal volumetric (1mm skip) SWI images. Contingency table analysis was used to evaluate the strength of association between the presence of BVT on axial versus coronal SWI images.

Results
Among 17 patients that met study criteria, the median age was 8 (IQR 4-13) months, and 53% were male. Eleven out of 17 cases (65%) were identified with possible thrombosis on axial SWI 2mm images [5 = tadpole sign (29%), 6 = thrombosis (35%)]. Among patients showing findings consistent with thrombosed cortical veins on axial imaging, volumetric coronal SWI confirmed the presence of findings consistent with BVT in only four out of 11 patients (36%). The presence of the tadpole sign on axial images did not predict the presence of thrombosed veins on volumetric SWI [OR=0.3 (0.02, 5.01), p=0.538]. Volumetric coronal SWI showed patency of the lumen in 13 out of 17 cases. However, volumetric acquisition disclosed additional irregularities of the bridging veins' walls, a finding that was associated with
the presence of subdural hematoma on MR imaging (p=0.03), suggesting traumatic injury.

Conclusions
In our patient population, axial SWI images overestimated findings consistent with thrombosis of the bridging veins as demonstrated by volumetric SWI coronal sequences. Our findings suggest that confounding factors such as volume averaging artifacts may account for previously described findings in the literature, with thrombosis of the bridging veins being confirmed only in a minority of the cases. On the other hand, diffusely irregular contours of the veins observed on volumetric SWI in AHT was a major finding supporting traumatic injury. Further studies using volumetric SWI are warranted to confirm our preliminary findings.

O-147

Repeated Exposure to Gadolinium-based Contrast Material is Associated with Increased Unenhanced T1 Signal Intensity in the Pediatric Brain.

T Flood1, N Stence2, J Maloney2, D Mirsky2
1University of Colorado Denver - Anschutz Medical Campus, Aurora, CO, 2Children's Hospital Colorado, Aurora, CO

Purpose
Gadolinium-based contrast agents have been shown to deposit in the adult brain and result in increased unenhanced parenchymal signal intensity; however, a rigorous pediatric analysis is lacking (1-5). We conducted a controlled analysis to determine the effect of gadolinium exposure on the pediatric brain.

Materials and Methods
This is a single center retrospective study. Pediatric patients with a history of multiple contrast-enhanced exams (≥ 3) using a linear gadolinium-based contrast agent (gadopentetate dimeglumine) and age-matched contrast-naïve controls were analyzed. Unenhanced axial T1 MR sequence region of interest signal intensity measurements from the globus pallidus (GP), thalamus (TH), dentate nucleus (DN), and pons (PN) were obtained. GP:TH and DN:pons ratios were calculated. Neuroanatomical signal intensity ratios were compared within and between subjects, relative to contrast-naïve patient and control brains, respectively. The relationship between signal intensity and age, gender, and the total number and mean duration between contrast-enhanced exams were investigated. Analysis included Student's T test and Spearman's correlation coefficient.

Results
Pediatric patients (n=40; age range: 6 months – 18 years) receiving multiple gadolinium-based contrast-enhanced exams (mean: 4.8 exams/patient) demonstrated
increased signal intensity ratios within the GP and DN relative to within subject, contrast-naïve brains (p < 0.001 for GP:TH; p < 0.01 for DN:PN; Student's T test, paired). Between subject analysis, relative to contrast-naïve age-matched controls, demonstrated an increased signal intensity ratio within the DN (p < 0.01) but not within the GP (p = 0.61; Student's T test, unpaired). There was no significant relationship between signal intensity and patient age, gender, number of contrast-enhanced exams, or mean duration between contrast-enhanced exams.

Conclusions
Pediatric brain signal intensity increases with exposure to gadolinium-based contrast material. This is the first controlled pediatric study, demonstrating findings consistent with the adult literature (1-5). Additional studies evaluating the clinical significance in this vulnerable population, with a potential lifetime of repeated gadolinium exposure, are needed.
Intracranial Gadolinium Deposition in the Pediatric Population Following Contrast Enhanced MRI.

R McDonald, J McDonald, M Jentoft, D Murray, M Paolini, E Williamson, D Kallmes, L Eckel

1Mayo Clinic, Rochester, MN, 2Mayo Clinic, Rochester, Rochester, MN

Purpose
To determine if repeated intravenous exposures to gadolinium-based contrast agents (GBCAs) are associated with deposition of elemental gadolinium in neuronal tissues within the pediatric population.

Materials and Methods
Following antemortem consent and IRB-approval of this single center study, we compared post-mortem neural tissue samples on three pediatric patients who underwent gadolinium-enhanced brain magnetic resonance imagings (MRIs) between 2004-2014 (contrast exposed group) to three pediatric patients who underwent at least one unenhanced brain MRI during their lifetime yet were never exposed to a GBCA (control group). All contrast exposed patients received gadodiamide (Omniscan). Neuronal tissues from the dentate nuclei, pons, globus pallidus, and thalamus of these six deceased pediatric patients were retrieved from our institutional biospecimen archive. Gadolinium tissue concentrations were quantified by inductively coupled mass-spectrometry (ICP-MS) and localized using transmission electron microscopy with energy dispersive x-ray spectroscopy (TEM-EDS). Associations between cumulative gadolinium dose and ICP-MS tissue gadolinium concentrations were assessed by Spearman's rank correlation coefficient (ρ).

Results
All contrast-exposed patients (6-13 years) underwent MRI for evaluation of a primary CNS neoplasm whereas control patients (5-7 years) underwent MRI for non-neoplastic intracranial processes. All contrast-exposed patients had normal renal and hepatobiliary function near the time of gadolinium exposure. Following 4-11 intravenous gadolinium doses, neuronal tissues of the contrast exposed group contained between 0.1-3.0 mg gadolinium/g tissue in a significant dose-dependent trend (dentate nucleus: rho = 0.99, p < .0001). Control group patients had undetectable levels of gadolinium in all sampled neuroanatomical locations. Gadolinium deposition in the capillary endothelium and neural interstitium was observed only in the contrast-exposed group using TEM-EDS.
Conclusions
In the pediatric population, intracranial deposition of gadolinium in neural tissues from intravenous administration of GBCAs occurs in a dose-dependent manner in the setting of normal renal and hepatobiliary function and an intact blood-brain barrier.

O-149
5:09PM - 5:12PM
Retention of Linear Gadolinium-based Contrast Agents in the Dentate Nuclei and Globus Pallidus in Pediatric Patients with CNS Neoplasm Who Are Long-term Survivors

V Lau1, M Atlas2, C Filippi3
1North Shore LIJ, Manhasset, NY, 2Cohen Children's Medical Center, New Hyde Park, NY, 3Hofstra North Shore-LIJ School of Medicine, Manhasset, NY

Purpose
The purpose of this study is to detect increased signal within the dentate nuclei and globus pallidus in long-term surviving pediatric patients with CNS neoplasm as evidence of retention of linear gadolinium-based contrast agents (GBCA).

Materials and Methods
In this retrospective, IRB-approved study, 13 pediatric patients, 5 boys, 8 girls, average age 6.2 years, range 1-11 years at the time of diagnosis, who are all long-term survivors of central nervous system neoplasm. None had neoplasm involving the posterior fossa or deep gray nuclei. All had over six contrast-enhanced brain magnetic resonance (MR) scans (average 15.8 scans, range 6-31 scans), all of which used the identical linear gadolinium-based contrast agent (GBCA). Follow up, on average, was 5.7 years (range 3-9 years). Signal intensity on axial T1-FLAIR images, all performed on the same GE 1.5 MR scanner, were obtained using identical region of interest (ROI) measurements of the dentate nucleus bilaterally and globus pallidus bilaterally; ROIs were obtained of the thalami and pons as reference standards. Regions of interest were placed by a diagnostic radiology resident and a neuroradiology attending with certificate of added qualification. Interobserver and intraobserver reliability for the values obtained for the SI exceeded 0.85 (85%) for the dentate, globus pallidi, pons, and thalami. The signal intensity (SI) ratios of dentate to pons and globus pallidus to thalamus were obtained on the first and final exams to assess for changes of T1 shortening (GBCA retention), and independent two-tailed t-tests were used to assess for changes in the ratio and significance was set to p < .05.

Results
The SI ratio of dentate to pons averaged 1.03 +/- .03 on initial MR exams and 1.12 +/- .05 on the final MR exam. The change in SI ratio of dentate to pons over time was significant (p < .0002). The SI ratio of globus pallidus to thalamus averaged 1.02 +/-
.06 on the initial and 1.13 +/- .06 on the final exam. The change in SI ratio of globus pallidus to thalamus over time was significant (p < .002). Figure 1 shows an example of increasing SI in the dentate from baseline MR scan in 2003 to MR scan in 2011. Conclusions
This study shows increased SI in the dentate and globus pallidus from linear GBCA retention in these pediatric patients who are long term cancer survivors. Consideration should be given to the use of macrocyclic GBCAs which is not yet associated with brain retention, and the clinical significance of this observation on brain development remains unknown at this time.

7 year old female patient with increasing T1 retention in the dentate nuclei from 2003 MR scan on the left to MR scan from 2011 on the right (the 19th contrast-enhanced brain MR exam) in this patient with craniopharyngioma

(Filename: TCT_O-149_Slide1.jpg)
In pediatric patients, increased T1 signal intensity in the dentate nucleus on unenhanced T1-weighted MR images correlates to number of previous gadolinium contrast administrations

G Bolles¹, B Marebwa¹, A Chatterjee¹, T Brown², D Roberts¹
¹Medical University of South Carolina, Charleston, SC, ²Medical University of South Carolina, Charleston, SC

Purpose
Recently, there have been reports of gadolinium accumulation in the brain of adult patients with normal renal function who have undergone multiple gadolinium contrast administrations. Here we describe a series of pediatric patients who, following multiple contrasted magnetic resonance imaging (MRI) exams, demonstrated progressive hyperintense signal on unenhanced T1-weighted imaging involving the dentate nucleus, a finding which previously has been shown to represent gadolinium deposition in adults.

Materials and Methods
In this retrospective case series at a single large academic institution, we measured signal intensity of the dentate nucleus and pons on unenhanced T1-weighted images in 17 pediatric patients (range 2 months-15 years, median 6 years) who had undergone contrasted MRI exams (on average 9.75 exams, SD 5.23) using a linear contrast agent. Clinical presentations ranged from supratentorial or extra-cranial neoplasms, cerebrospinal fluid (CSF) leaks, vascular malformations and infectious processes, not involving the posterior fossa. None of the 17 patients had renal failure. Eight of the 17 patients received chemotherapy. Eight of the 17 patients had undergone radiation therapy. To avoid subjectivity of region of interest selection, we used an automated software system called "SUIT" to define the dentate nucleus. SUIT is a high-resolution atlas template of the human cerebellum and brainstem based on the SPM-toolbox (http://www.icn.ucl.ac.uk/motorcontrol/imaging/suit.htm). We calculated the dentate-to-pons ratio and performed a repeated measures ANOVA to test if the main effect of scan repetition was significant.

Results
The dentate-to-pons ratio showed a significant correlation with the number of previous gadolinium contrast administrations (p=0.038) (Fig. 1).

Conclusions
The clinical significance of gadolinium accumulation in the human body is currently unknown but is of concern, particularly in pediatric patients who have a lifetime to manifest any potential adverse consequences. Therefore, research is needed to address the clinical significance, if any, of gadolinium deposition in the developing pediatric brain.
Asymptomatic gadolinium deposition in the dentate and other deep grey nuclei in children and adults: influence of cumulative dose and radiochemotherapy

S Kinner¹, T Schubert¹, S Rebsamen¹, R Bruce¹, S Reeder¹, H Rowley¹
¹University of Wisconsin Madison, Madison, WI

Purpose
T1 hyperintense signal has been noted on magnetic resonance imaging (MRI) in deep gray nuclei after multiple doses of gadolinium-based contrast agents (1-4). The aim of this study was to determine whether T1 shortening also is observed in children, and to analyze the anatomical patterns and clinical profiles seen in affected patients.

Materials and Methods
In this IRB-approved, single-center study, we reviewed all patients with normal renal function who had received at least four gadobenate dimeglumine enhanced MRIs since 08/09. Amongst 326 children, 76 had solely gadobenate (4-20 injections, mean: 8); 16 had brain tumors and radiochemotherapy (RCTX). Amongst 3567 adults, of the top 349 cases with the most injections (n=9-34) analyzed to date, 100 had solely gadobenate (all but four with RCTX). T1 signal change of the dentate between first and last MRI was measured and signal intensity ratios (SIR) for dentate-to-pons (DNP) calculated and correlated in the pediatric group.

Results
Twelve of 16 pediatric patients with tumors and RCTX had dentate hyperintensities while only 2/60 children without these confounders showed signal increase. Eighty-six of 100 adults with high cumulative exposures showed dentate hyperintensities. A statistically significant increase in SIR change for number of injections (p<0.001) as...
well as the amount of gadolinium (p=0.008), but not for inter-scan-time interval (p=0.35) was noted. There was a significant difference in average change in SIR over time in favor of those with RCTX (p<0.001). Hyperintensities in other deep nuclei including the globus pallidus, pulvinar, and red nucleus also were observed (Fig.). Chart review revealed no referable neurological deficits in any subject.

Conclusions
Children and adults show a similar pattern of asymptomatic T1 hyperintensity in the dentate and other deep gray nuclei after multiple injections of gadobenate. The appearance in children may have a later onset, and is accelerated by radiochemotherapy.

Non-contrast T1-weighted images from a 16 year old girl with neurofibromatosis and hypothalamic glioma, treated with RCTX, who received over 22 contrast-enhanced MRIs since age 3. Hyperintense signal changes are seen in the dentate, red nucleus, substantia nigra, globus pallidus, and thalamus.

(Filename: TCT_O-151_ASNRimage.gif)
M DeLano¹, B Betz¹, M Hicks², A Nash¹
¹Michigan State University, Advanced Radiology Services, PC, Spectrum Health System, Grand Rapids, MI, ²Michigan State University College of Human Medicine, Grand Blanc, MI

Purpose
Increased awareness of the potential for gadolinium-based contrast deposition in the brain after repeated exposures prompted a retrospective review of our pediatric brain imaging data. Since 2008 our institution has been using gadobenate dimeglumine for brain magnetic resonance (MR) studies. Since no known harm has been described in patients with contrast-related persistent hyperintensity, we focused on those <3 years of age as they would have the greatest risk of time dependent adverse events. Our aim was to determine if our patients have imaging evidence of persistent gadolinium contrast in brain tissues after four or more exposures to contrast.

Materials and Methods
Forty-eight subjects were identified that had four or more Gd doses (range 4-15 doses) before 3 years of age. Nine of these subjects had 10-15 Gd doses before 3 years of age. Imaging was performed with T1 FLAIR techniques. Occasional conventional spin echo also was provided. Qualitative assessment of the brain by visual inspection and quantitative assessment of selected regions of interest in the dentate nucleus, globus pallidus, thalamus and pons was performed. Total contrast volume administered, renal function, primary diagnosis, and any exposure to radiation therapy was documented.

Results
Patient exposure to gadobenate dimeglumine varied considerably as it is administered by patient weight. No instances of residual T1 hyperintensity were identified in the brain by visual inspection or quantitative interrogation of regions of interest. T1 hyperintensity was not identified in our patient cohort.

Conclusions
Standard MR imaging does not reveal evidence of residual gadolinium-based contrast in the brain of 48 children <3 years of age who have been exposed to 4-15 doses of gadobenate dimeglumine. Additional attention to the influence of the choice of T1 pulse sequence should be given. Background cerebellar and internal capsule white matter hyperintensity may mask the identification of subtle T1 hyperintensity putatively related to contrast administration.

Placental vascular pathology correlates with MRI in perinatal ischemic stroke

P Caruso¹, M Naqvi¹, D Roberts¹
Purpose
Perinatal ischemic stroke (PIS) is a leading cause of cerebral palsy (CP). Recent studies of PIS suggest that a definite causative risk factor is established in only 50% of cases. Placental disorders are highly plausible risk factors for PIS. Our study seeks to determine if placental fetal vasculopathy correlates with radiographic and clinical findings in radiologically proven cases of PIS.

Materials and Methods
We searched the MGH pathology database from 1994-2015 for the clinical history of PIS. The obstetrical, neonatal, and pediatric follow-up records were reviewed. The imaging was reviewed by a pediatric neuroradiologist; the imaging findings were grouped into arterial ischemic stroke (AIS), cerebral sinovenous thrombosis, presumed perinatal ischemic stroke, and periventricular venous infarction, in keeping with recent published groupings. In cases of AIS, the arterial vascular territory was recorded. The placental pathology was reviewed by perinatal pathologist: placental pathology was grouped into three categories: fetal vascular malperfusion (FVM), fetal inflammatory pathologies (FIP), and other.

Results
Sixteen cases of radiologically proven PIS with placental pathology were found. The obstetrical, neonatal, and pediatric follow-up data are presented in the attached table. All neonates presented by the third day of life with signs of hypoxia or seizure. All 16 cases fell into the category of AIS. The location of the IPS in all cases was the middle cerebral artery. Twelve of the 16 cases of AIS showed placental fetal vascular pathology. Fetal vascular malperfusion, five cases, FIP, six cases, and other placental pathology, three cases, were found. Placentas classified as FVM trended with earlier clinical presentation of IPS (p =0.13).

Conclusions
Of the 16 cases of radiologically proven perinatal AIS, 12 showed evidence of placental fetal vasculopathy. Although not associated with specific outcomes, our study supports a role for placental factors in the pathophysiology of IPS.

O-155
5:27PM - 5:30PM

Texture analysis features reveal selective vulnerability of thalamic nuclei in mice after hypoxic-ischemic injury

M Wagner1, M Wurnig2, A Narayan3, T Huisman4, F Northington5, A Poretti5
1Johns Hopkins Hospital, Baltimore, MD, 2University Hospital Zurich, Zurich, AK, 3Johns Hopkins Hospital, Baltimore, MD, 4Johns Hopkins, Baltimore, MD, 5The Johns Hopkins University School of Medicine, Baltimore, MD
Purpose
Neonatal hypoxic-ischemic injury (HII) damages the thalamus, with the ventrolateral nuclei being a selectively vulnerable target. We aimed to identify thalamic nuclei damage in HII mice to assess the role of hypothermic management using texture analysis (TA) features of diffusion tensor imaging (DTI) data.

Materials and Methods
Hypoxic-ischemic injury was induced at postnatal day 10 by a right carotid artery ligation followed by 45 minutes of hypoxia. Mice were randomized to a healthy control group (N=20) and a hypothermia (31˚C) (N=32) or normothermia (36˚C) (N=25) group following HII. Diffusion tensor imaging data were acquired at postnatal (p) day 11, 18, and 30. Fractional anisotropy (FA) and mean diffusivity (MD) maps were generated. Single slice regions of interest were drawn manually to cover the entire thalamus at its greatest diameter on FA and MD maps. Nineteen TA features were calculated using a MATLAB based semi-automated algorithm.

Results
Quantitative evaluation of TA features of the right thalamus on both FA and MD maps revealed statistically significant results (p< 0.005) for 1st, 2nd, and 3rd order texture features comparing p11, p18, and p30 control mice and 1) mice with hypothermia therapy and 2) mice with normothermia therapy. Statistically significant differences were predominant in 3rd order texture features including short and long runs emphasis (SRE/LRE), gray level nonuniformity (GLN), run percentage (RP), and long run high gray level emphasis (LRHGE). Homogeneity (2nd order feature) was significantly different comparing p18 mice with hypothermia and normothermia.

Conclusions
Texture analysis identifies thalamic injury in mice after HII. Our results most likely reflect the selective vulnerability of the ventrolateral nuclei. Immunohistochemistry is needed to confirm these findings and human studies are needed to determine relevance of these findings. In addition, studies correlating TA features with neurodevelopmental outcome of children with HII are needed to assess the potential role of TA measures as outcome biomarker of neonatal HII.

O-156
5:30PM - 5:33PM

Brain Injury Detected with MRI scan in Neonates with Hypoxic-Ischemic Encephalopathy and Seizures

B Kline-Fath, P Horn, M Schapiro
1Cincinnati Children's Hospital Medical Center, Cincinnati, OH
Purpose
Seizures are common in neonates with hypoxic-ischemic encephalopathy (HIE). Our aim was to determine the magnetic resonance (MR) brain imaging findings in neonates with HIE with seizures (HIESz+) compared to those without seizures (HIESz-).

Materials and Methods
EPIC medical record was reviewed for all term (> 36 weeks) neonates with HIE admitted to our institution between 2008 and 2013. Subjects with acceptable MRI scans obtained within 2 weeks of birth were included: 23 HIESz- and 46 HIESz+. Charts were reviewed for demographic, clinical and laboratory variables. Neonates were imaged with conventional T1, proton density, T2-weighted, gradient echo, and diffusion-weighted sequences at 1.5T or 3T. Images were rated using a MRI injury grading score (higher scores more abnormal): brainstem, cerebellar, white matter, cortical, hippocampal, parenchymal hemorrhage, basal ganglia, posterior limb of internal capsule (PLIC), intraventricular hemorrhage, watershed, and ventriculomegaly.

Results
There were no significant group differences (Student's t tests or Fisher's Exact test, where appropriate) in gestational age, birth weight, sex, age at MRI scan, or arterial and cord pH and base excess. HIESz- required more resuscitation at birth (p=0.0004), and had lower 5 minute Apgar score (p=0.0164) and a greater percentage received therapeutic hypothermia (p=0.0179). HIESz+ had significantly more injury within white matter (p=0.00025), basal ganglia (p=0.004), PLIC (p=0.0421), and watershed (p=0.0091) when compared to HIESz-. In neonates who received therapeutic hypothermia (19 HIESz- and 24 HIESz+), HIESz+ had an abnormal distribution of ratings compared to HIESz- for white matter (p=0.004), basal ganglia (p=0.0258), and PLIC (p=0.0181), but not watershed (p=0.1396).

Conclusions
Despite better Apgar score and less resuscitation, HIESz+ surprisingly had more injury in the white matter, basal ganglia and PLIC than HIESz-. Seizures themselves may cause brain damage. However, it is possible that confounding factors (such as not receiving therapeutic hypothermia) lead both to seizures and brain injury.
HIE MRI Injury grading

- **Brainstem injury**
  0 = none
  1 = focal
  2 = diffuse

- **Cerebellar injury**
  0 = none
  1 = less than 3 punctate lesions (<2 mm)
  2 = more than 3 punctate lesions or confluent large areas

- **White matter injury**
  0 = normal
  1 = minimal (3 or less white matter lesions)
  2 = moderate (>3 lesions, bilateral)
  3 = severe (multiregional lesions/watershed)

- **Cortical injury**
  0 = normal
  1 = single focal infarction
  2 = abnormal cortex anterior or posterior
  3 = abnormal cortex in both anterior and posterior watershed zone
  4 = extensive cortical injury

- **Hippocampal injury**
  0 = none
  1 = unilateral
  2 = bilateral

- **Parenchymal hemorrhage – not grade 4**
  0 = negative
  1 = positive microhemorrhage
  2 = positive hemorrhage greater than 2mm

- **Posterior Limb of the internal capsule**
  0 = negative/myelination present
  1 = impaired myelination
  2 = myelination absent with reversed/abnormal signal on T1 or T2

- **Basal Ganglia**
  0 = normal
  1 = abnormal signal thalamus
  2 = abnormal signal in thalamus and lentiform
  3 = abnormal signal thalamus, lentiform, periventricular
  4 = extensive

- **Intraventricular hemorrhage**
  0 = none
  1 = grade 1
  2 = grade 2
  3 = grade 3
  4 = grade 4

- **Watershed**
  0 = Normal
  1 = Single focal infarction
  2 = Abnormal signal in anterior or posterior white matter
  3 = Abnormal signal in anterior or posterior white matter
  4 = Abnormal signal in both anterior and posterior white matter
  5 = More extensive cortical involvement

- **Ventriculomegaly**
  0 = normal
  1 = mild (10-15mm)
  2 = moderate (10-15mm)
  3 = obstructive hydrocephalus

(Filename: TCT_O-156_HIEMRIInjurygrading.gif)
Carotid MPRAGE Improves Detection of Simultaneous Bilateral Stroke Sources

M McLaughlin¹, S Kim¹, A DeHavenon¹, G Treiman¹, D Parker¹, S McNally¹
¹University of Utah, Salt Lake City, UT

Purpose
The presence of bilateral acute ischemic stroke often is assumed to be secondary to cardiac emboli, especially in the absence of severe bilateral carotid stenosis or other lumen markers of vulnerable plaque. Carotid intraplaque hemorrhage (IPH) is an essential predictor of ipsilateral ischemic stroke, and is reliably detected by the MPRAGE sequence. The purpose of this study was to determine if carotid MPRAGE detection of IPH was additive to the predictive value of conventional lumen markers in the setting of simultaneous bilateral stroke.

Materials and Methods
In this retrospective cross-sectional study, patients undergoing evaluation for acute stroke were imaged with brain and carotid magnetic resonance imaging (MRI). Acute ischemic stroke was determined using the standard AHA definition of cerebral infarction aided by diffusion-weighted imaging. Patients with noncarotid source strokes (e.g., cardiac sources) and complete or near-complete carotid occlusion were excluded. A total of 425 patients were analyzed. Carotid lumen imaging characteristics were recorded including stenosis, plaque thickness, ulceration, intraluminal thrombus, and IPH. Patient clinical factors including cerebrovascular risk factors and medications also were recorded. Receiver operating characteristic (ROC) curve analysis was performed to determine if information on bilateral carotid IPH increases the predictive value for bilateral carotid stroke sources compared to lumen markers.

Results
Of the 425 patients imaged, 112 had an acute ischemic stroke, 17 of which were bilateral. Carotid IPH was present in 89/425 of cases, and was bilateral 27.0% of the time (24/89). Bilateral carotid IPH was associated with bilateral stroke (AUC=0.808, 95%CI 0.690-0.925) (Figs. 1A and 1B), and was a better predictor than either bilateral ≥70% stenosis (AUC=0.523, p<0.001) or bilateral plaque ulceration (AUC=0.625, p=0.011). In addition, bilateral carotid IPH improved the predictive value of a model including bilateral average stenosis and bilateral ulceration (AUC=0.891 versus 0.800, p=0.001). Receiver operating characteristic results are displayed in Fig. 2, with the...
blue curve representing bilateral ulceration combined with average bilateral stenosis and the green curve showing the improved predictive value of including bilateral IPH.

Conclusions
Bilateral carotid IPH is highly associated with simultaneous bilateral stroke, even in the absence of severe bilateral stenosis or ulceration. The carotid MPRAGE sequence provides critical information in determining sources of simultaneous bilateral stroke in patients without cardiac sources.
The susceptible vessel sign (SVS) for detection of arterial occlusive thrombosis on Susceptibility Weighted Images (SWI) in acute stroke patients: correlation with infarct volume.

S Payabvash¹, J Benson², S Taleb¹, B Hoffman³, M Oswood³, A McKinney¹
Purpose
To determine the diagnostic accuracy of susceptible vessel sign (SVS) for detection of arterial occlusive thrombosis on susceptibility-weighted (SWI) sequence in patients presenting with acute ischemic stroke, as well as its correlation with clinical outcome and infarct volume.

Materials and Methods
The medical and imaging records of all patients presenting with acute ischemic stroke to two university affiliated hospitals from 1/2011 to 12/2014 were reviewed. Those patients who underwent a magnetic resonance imaging (MRI) with a SWI acquisition within 24 hours of witnessed symptom onset or last-seen-well were included in this study. Simultaneous MRA (or CTA performed within 3 hours of MRI) was used as the gold standard to determine the presence of intracranial arterial occlusion. Infarct volumes were also measured on diffusion-weighted imaging (DWI).

Results
A total 192 patients with an average age of 63.4±16.5 years were included in this study. The MRI scan was performed within 14±7 hours after symptom onset or last-seen-well. On simultaneous MRA/CTA, 45 (23.4%) patients had arterial occlusion. The SVS was seen on SWI scan of 22 patients – including three false positive subjects without arterial occlusion. The SVS had 42.2% sensitivity, 98.0% specificity, 84.7% negative predictive value, and 86.4% positive predictive value for detection of the arterial occlusion, with an area under the receiver operating characteristics (ROC) curve of 0.701 (p<0.001). The SVS was almost equally sensitive for detection of thrombosis in ICA, MCA, and PCA (Table). Among patients with arterial occlusion, those with SVS had significantly larger infarct volume compared to those without (177.9±169.9 mL versus 86.3±125.6 mL, p=0.048). However, there was no significant difference between patients with SVS versus those without, in terms of the admission and discharge NIHSS scores, as well as for the 3-month modified Rankin score.

Conclusions
The SVS is highly specific (98%), but is only moderately sensitive (42.2%), in the detection of arterial occlusive thrombosis in acute stroke patients. Among stroke patients with arterial occlusion, those with positive SVS have significantly larger infarct volume compared to those without SVS. Hence, SWI is a useful adjunct in the acute stroke MRI evaluation.
Imaging-based venous biomarkers in acute stroke patients

J Puig\(^1\), M Hernandez-Perez\(^2\), G Blasco\(^3\), J Daunis-i-Estadella\(^4\), M Terceño\(^5\), J Serena\(^5\), Y Silva\(^6\), C van Eendenburg\(^5\), M Wintermark\(^6\), B Menon\(^7\), S Pedraza\(^3\), J Munuera\(^2\)

\(^1\)Imaging Research Unit, IDI-IDIBGI, Hospital Dr Josep Trueta, Girona, Spain, \(^2\)Hospital Universitari Germans Trias i Pujol, Badalona, None, \(^3\)Imaging Research Unit, IDI-IDIBGI, Hospital Dr Josep Trueta, Girona, None, \(^4\)University of Girona, Girona, None, \(^5\)Hospital Dr Josep Trueta, IDIBGI, Girona, None, \(^6\)Stanford

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<table>
<thead>
<tr>
<th>Arterial occlusion</th>
<th>SVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA</td>
<td>3/5 (60%)</td>
</tr>
<tr>
<td>MCA</td>
<td>12/29 (41%)</td>
</tr>
<tr>
<td>ACA</td>
<td>0/1 (0%)</td>
</tr>
<tr>
<td>Basilar artery</td>
<td>0/1 (0%)</td>
</tr>
<tr>
<td>PCA</td>
<td>4/9 (40%)</td>
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</tbody>
</table>

Rate of SVS among patients with cerebral arterial occlusion
Purpose
Although endovenous thrombolysis is the treatment of choice within 4.5 hours of stroke onset, mechanical thrombectomy also has proven useful recently. The role of the venous system in ischemic stroke is unclear. Imaging-based venous biomarkers would detect alterations in brain perfusion from the dynamic viewpoint or secondary to optimization of oxygen consumption mechanisms (misery perfusion). We aimed (1) to correlate potential imaging-based venous biomarkers, such as hypodense internal cerebral vein ratio (rHdV), between pathological and contralateral), hypointense vein on T2* (HVt), and asymmetrical venous drainage (AVd), with hypoperfusion of the ischemic territory, and (2) to assess possible relationships between imaging-based venous biomarkers and functional outcome.

Materials and Methods
We analyzed two patient groups with anterior ischemic stroke within 12 hours of onset: (1) Patients treated with endovenous thrombolysis [computed tomography (CT) group], who underwent perfusion CT and CT angiography and (2) candidates for mechanical thrombectomy [magnetic resonance imaging (MRI) group], who underwent diffusion-weighted imaging, T2*, susceptibility-weighted imaging, and dynamic magnetic resonance angiography (Olea Sphere V.3.0). We analyzed demographics, stroke etiology, National Institutes of Health Stroke Score (NIHSS), modified Rankin Scale at 3 months, infarct volume, and arterial recanalization (Thrombosis in Myocardial Infarction criteria).

Results
In the CT group (n=123; 45 women; mean age: 78 years; 54% cardioembolic; baseline NIHSS=18) rHdV correlated negatively with penumbra volume (r=-0.42), and rHdV ≥0.83 predicted good functional outcome at 90 days (p <0.001) and arterial recanalization (p=0.005). In the MRI group (n=25; 16 women; mean age: 65 years; 41% cardioembolic; baseline NIHSS=17), 96% had HVt, 16% had AVd in deep veins, and 52% had AVd in superficial sinuses; HVt was associated with greater penumbra volume (p=0.002).

Conclusions
Imaging-based venous biomarkers are associated with increased hypoperfused tissue volume, worse recanalization rate, and poor functional outcome.
Quality of Resident MRI Preliminary Reports following a 6-Minute MRI Stroke Protocol in the setting of hyperacute stroke.

J Becker¹, S Hur¹, W Erly¹, K Nael²

¹University of Arizona, Tucson, AZ, ²Icahn School of Medicine at Mount Sinai, New York, NY

Purpose
To evaluate the quality of resident magnetic resonance imaging (MRI) preliminary reports in patients presenting with hyperacute stroke symptoms. Residents at all levels of training provide a preliminary report for all patients undergoing our 6-minute MRI protocol in the setting of acute stroke. This study has been performed to prove that
these preliminary reports are accurate, not only for assessment of findings related to the acute stroke symptoms, but also for evaluation of other intracranial pathologies. To our knowledge this has not been performed previously.

Materials and Methods
The preliminary reports for 1153 consecutive patients undergoing MRI for symptoms of acute stroke over a 1-year period were evaluated by two attending neuroradiologists. There were no exclusions.

Results
Acute infarcts were present in 215 (19%). Two hundred two of these were correctly identified by our residents (94%), with 13 (6%) overlooked. The resulting resident sensitivity is 94%, with specificity of 99%. This is excellent, and compares very favorably with errors in resident computed tomography (CT) reports in acute stroke and for errors in resident magnetic resonance imaging (MRI) reports of other body parts (2, 3). The overlooked infarcts were most likely to be tiny, single, peripheral cortical infarcts (10/13 cases) or symmetrical hypoxic basal ganglia/ thalamic infarcts without a clear history (3/13 cases). Nine hundred thirty-eight did not have an acute infarct. Nine hundred thirty-one (99.3%) of these were reported correctly. Seven (0.7%) infarcts were overcalled. These were all peripheral cortical or posterior fossa artifacts, mimicking an acute tiny, single embolic type infarct. Evaluation for other nonstroke related pathology resulted in a clinically significant discrepancy rate of 1.8%.

Conclusions
The resident MRI preliminary reports for patients presenting with acute stroke are of excellent quality with a specificity of 99%, and sensitivity of 94%.

O-162

Role of Prothrombin Complex Concentrate (PCC) in Acute Intracerebral Hemorrhage with Positive CTA Spot Sign: An Institutional Experience at a Regional and State Designated Stroke Center

R REHMANI¹, A Han², J Hassan³, J Farkas⁴
¹NYU LANGONE, NEW YORK, NY, ²AT Still University of Osteopathic Medicine in Arizona, Huntingdon Valley, PA, ³St George's University, Brooklyn, NY, ⁴NYU Langone, Brooklyn, NY

Purpose
Our objective is to identify the effect of prothrombin complex concentrate (PCC) in acute intracranial hemorrhage (ICH) patients by evaluating intracranial hematoma expansion between initial head computed tomography (CT) and follow-up CT at 5-24 hour, in patients with positive CTA spot sign. Computed tomography angiography
spot sign is an independent predictor of hematoma growth (1). Acute ICH regardless of etiology, can present with quick mental status decline and pose as a neurosurgical emergency, requiring urgent surgical intervention, often resulting in irreversible brain damage. Hematoma expansion appears to be a modifiable predictor of clinical outcome and an appropriate target for medical therapy. Clinical trials in the past have shown reduction in hematoma growth with the use of rFVII in ICH patients (2); however without significant improved clinical outcomes, likely due to its thromboembolic effects. Researchers in S. Korea have used positive CTA spot sign as a guide for surgical evacuation of hematomas (3). This trial was shown to lower mortality rates but increased the length of inpatient stay and complications due to it being an invasive procedure (3). Prothrombin complex concentrate is a procoagulant containing factors II, VII, IX, X, Protein C, and Protein S. Advantages of PCC include smaller fluid volumes, rapid reversal of INR <1.5 within 30 minutes of administration and better clinical outcome when compared to rFVII (4). Disadvantages include risk of thromboembolic complications (4). Limited data comparing PCC and FVII suggests better clinical response with PCC regarding bleeding cessation, albeit slower changes in INR, likely due to a greater portion of the clotting cascade (4). We propose that PCC is a promising noninvasive, easily administered quick tool to contain hemorrhage in critical patients with ICH regardless of etiology.

Materials and Methods
We retrospectively reviewed patients with ICH at our NY State designated Stroke Center from November 2013 to September 2015. Out of 85 patients, 23 received PCC, of which eight had positive CTA spot sign (E=8). Out of the remaining 62 patients without PCC, four had a positive spot sign (C=4). ICH volume was measured on the initial head CT and follow-up CT at 5-24 hours using ABC/2 formula, which is an accurate predictor of ICH volume (5). Inclusion criteria were acute ICH (within 24 hours) and positive CTA spot sign (any age, sex, cause or size). Exclusion criteria were negative spot sign, lack of follow up or death or surgical intervention, only infratentorial/intraventricular hemorrhage and use of platelets/FFP. A T test for correlation was performed.

Results
Control group (C) showed increase in mean ICH volume of 46% (SD=37.3%), whereas experimental group (E) showed a decrease of 13% (SD=29.9%), (p value =0.012).

Conclusions
We found a strong statistical correlation favoring our hypothesis. In patients with active ICH denoted by positive CTA spot sign, use of PCC resulted in overall decrease in the mean hematoma size at 24 hours, whereas the control group showed an overall increase. We propose randomized controlled trials to further evaluate the effectiveness and safety of PCC use.
### Group Statistics

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
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### Independent Samples Test

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<th>t-test for Equality of Means</th>
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<tr>
<td>Test PCC</td>
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### Volume Change Comparing ICH Patients that received PCC vs No PCC

- **Control**
  - Initial Volume on Admission: 15.8750
  - Initial Standard Deviation (SD) on Admission: 6.00
  - 24-Hour Follow Up Volume: 24
  - % Change: 46.47%
  - % Change SD: 37.30

- **Experimental**
  - Initial Volume on Admission: 26.48
  - Initial Standard Deviation (SD) on Admission: 19.69
  - 24-Hour Follow Up Volume: 23.76
  - % Change: -13.97%
  - % Change SD: 29.86
Utility of diffusion and perfusion MRI for predicting perihemorrhagic edema growth after intracerebral hemorrhage

J Puig¹, G Blasco², J Daunis-i-Estadella³, G Carbo², V Cuba², M Terceño⁴, Y Silva⁴, C van Eendenburg⁴, J Serena⁴, B Menon⁵, M Wintermark⁶, P Salvador²

¹Imaging Research Unit, IDI-IDIBGI, Hospital Dr Josep Trueta, Girona, Spain, ²Imaging Research Unit, IDI-IDIBGI, Hospital Dr Josep Trueta, Girona, None, ³University of Girona, Girona, None, ⁴Hospital Dr Josep Trueta, IDIBGI, Girona, None, ⁵Calgary Stroke Program, Department of Clinical Neurosciences, Calgary, Alberta, ⁶Stanford University, Stanford, CA

Purpose
Intracerebral hemorrhage (ICH) is a devastating disease. Intracerebral hemorrhage volume is the main predictor of poor outcome, but growing evidence suggests that perihematomal edema (PHE) contributes to secondary brain injury. Methods for predicting PHE growth in clinical scenarios are lacking. We aimed to determine the utility of diffusion (DWI) and perfusion (PWI) magnetic resonance imaging (MRI) indexes for predicting PHE growth in patients with ICH.

Materials and Methods
We prospectively studied 25 patients with spontaneous ICH admitted within 12 hours
of symptom onset. Patients underwent MRI including DWI and PWI sequences on admission and at 72 hours. We measured ICH and PHE volumes on fluid-attenuated inversion recovery images; we used Olea Sphere V.3.0 to determine apparent diffusion coefficient (ADC), cerebral blood volume (CBV), cerebral blood flow (CBF), mean transit time (MTT), and time to peak (TTP). To measure ICH and PHE growth, we calculated the difference between volumes on baseline and 72-hour follow-up studies. We also considered age, sex, blood pressure, National Institutes of Health Stroke Score (NIHSS), and Rankin Scale score.

Results
Perihematomal edema growth correlated with NIHSS at baseline (r=0.430; p=0.036), PHE-MTT values (r=0.486; p=0.026), and PHE-ADC values (r=0.632; p=0.001). We found no significant correlations for ICH growth. Multivariate linear regression identified baseline PHE-ADC as an independent predictor of increased PHE volume at 72 hours (p=0.024).

Conclusions
Our preliminary results suggest that DWI can be useful for predicting PHE growth in the first 72 hours and therefore should be evaluated further as a potential imaging biomarker to guide therapeutic strategies in ICH.

Predicting Motor Outcome in Acute Intracerebral Hemorrhage

J Puig¹, G Blasco², M Terceño³, J Daunis-i-Estadella⁴, M Hernandez-Perez⁵, V Cuba², G Carbo², J Serena³, C van Eendenburg³, A Alberich-Bayarri⁶, G Schlaug⁷, B Menon⁸, M Wintermark⁹, Y Silva³, P Salvador²

¹Imaging Research Unit, IDI-IDIBGI, Hospital Dr Josep Trueta, Girona, Spain, ²Imaging Research Unit, IDI-IDIBGI, Hospital Dr Josep Trueta, Girona, None, ³Hospital Dr Josep Trueta, IDIBGI, Girona, None, ⁴University of Girona, Girona, None, ⁵Hospital Universitari Germans Trias i Pujol, Badalona, None, ⁶Hospital Universitario y Politécnico La Fe-QUIVIM, Valencia, None, ⁷Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, ⁸Calgary Stroke Program, Department of Clinical Neurosciences, Calgary, Alberta, ⁹Stanford University, Stanford, CA

Purpose
Over half of patients have residual motor deficits 3 months after intracerebral hemorrhage (ICH). Accurate prediction of motor outcome within hours after ICH would enable realistic goal-setting and efficient resource allocation, guide therapeutic management, and help design more efficient rehabilitation programs. Given the lack of studies in the hyperacute phase, we aimed to determine whether combining clinical
scores and diffusion tensor imaging (DTI)-derived measures from the first few hours after symptom onset improves prediction of motor outcome in patients with ICH.

Materials and Methods
We prospectively studied consecutive patients within 12 hours of onset of primary ICH. Patients underwent multimodal magnetic resonance imaging (MRI) including DTI. We assessed ICH and perihematomal edema location and volume, and corticospinal tract (CST) involvement by ICH. We calculated ratios of affected-to-unaffected CST for fractional anisotropy (FA), mean diffusivity, and axial and radial diffusivities (Olea Sphere V.3.0). Paresis was graded by the motor subindex scores of the modified National Institutes of Health Stroke Score (mNIHSS). Motor outcome at 3 months was classified as good (mNIHSS 0-3) or poor (mNIHSS 4-8). Poor functional outcome was defined as modified Rankin Scale>2.

Results
Of 62 consecutive patients, 49 were included in the study (37 men; median age 69.5 years, IQR 59-76). At admission, median NIHSS was 11.5 (QR5-17), and 25 (71.4%) patients had some motor deficit [median mNIHSS 4 (IQR2-7)]. At 3 months, 13 (22.41%) had poor motor outcome. Independent predictors of motor outcome were NIHSS, mNIHSS, rFA of the whole CST, posterior limb of internal capsule (PLIC) involvement by ICH, 72h-NIHSS, and 72h-mNIHSS. The sensitivity, specificity, and positive and negative predictive values for poor motor outcome at 3 months by combined mNIHSS>6 and PLIC-involvement<12h were 84%, 80%, 64%, and 94%, respectively (AUC=0.91,CI=0.82-0.99).

Conclusions
Combined assessment of motor function and PLIC damage during hyperacute ICH may predict functional motor outcome.
Diagnostic Value of the MRI in Spontaneous Subarachnoidal Hemorrhage of Unknown Origin

H Schemuth¹, C Deuschl², S Göricke³, C Moenninghoff², A Ringelstein³
Purpose
Spontaneous subarachnoidal hemorrhage (SAH) of unknown origin is reported in up to 27% of all cases in the first digital subtraction angiogram (DSA). The aim of this study was to investigate the value of cerebral and spinal magnetic resonance imaging (MRI).

Materials and Methods
We retrospectively analyzed 122 patients with a SAH of unknown origin in at least one negative DSA who received a cerebral and spinal MRI including a time of flight (TOF) angiography, transversal FLAIR, transversal T2-weighted turbo spin echo, transversal T1-weighted turbo spin echo, and sagittal T2-weighted turbo spin echo of the spine.

Results
In a total of three cases (2.5%) the origin of the DSA-negative SAH could be detected only with the MRI. In these cases the MRI showed two cavernomas and one spontaneous spinal bleeding. The cavernomas caused one perimesencephalic SAH and one nonperimesencephalic SAH, the spinal bleeding was proven by a blood-positive CSF.

Conclusions
Additional cerebral and spinal MRI for patients with a spontaneous SAH can determine the cause of the SAH in 2.5% of the cases, however in two of three cases we found, the origin of the SAH may need a surgical treatment. The bleeding pattern of the SAH does not help determine whether an additional MRI should be performed. Therefore we think, an additional cerebral and spinal MRI for patients with at least one negative DSA should be performed.

O-166
5:57PM - 6:05PM

Changes in Cerebral Perfusion with Induced Hypertension in Aneurysmal Subarachnoid Hemorrhage

A Murphy¹, L Manoel², R Macdonald³, A Baker², T Marotta², W Montanera¹, R Aviv⁴, A Bharatha¹
¹University of Toronto, Toronto, ON, ²St. Michael’s Hospital, Toronto, ON, ³St. Michael’s Hospital, Toronto, On, ⁴Sunnybrook Research Institute, Toronto, Ontario

Purpose
Induced hypertension (IH) is a common therapeutic intervention used to treat delayed
cerebral ischemia (DCI) following subarachnoid hemorrhage. The goal of this treatment is to maintain or improve cerebral blood flow (CBF) by increasing cerebral perfusion pressure to the brain. Despite suggestions that IH may result in improved outcomes, recent studies have been equivocal. The potential for induced hypertension to improve outcomes may be dependent on early cerebral perfusion status. The objectives of this investigation are: (1) determine if there are differences in CBF and mean transit time (MTT) at baseline and after induced hypertension; (2) evaluate differences in DCI, infarction and clinical outcome between patients with and without induced hypertension.

Materials and Methods
A retrospective analysis of aneurysmal subarachnoid hemorrhage patients presenting to a single tertiary care center identified 24 patients who had CT perfusion (CTP) imaging performed early (<72 hours after aneurysm rupture) and late (7-10 days after aneurysm rupture). We compared patients who underwent induced hypertension (IH) with those that had no induced hypertension (no-IH). For each group, CBF and MTT were quantified in both the early and late CTP images. Differences in CBF and MTT were quantified between the IH and no-IH group, and between the early and late CTP images in each group. Cerebral infarctions were assessed on magnetic resonance imaging (MRI) or computed imaging (CT) prior to discharge. Clinical DCI was assessed. Clinical outcome was defined as good [modified Rankin score (mRS) ≤ 2] or poor (mRS > 2) at 3 months.

Results
There were 13/24 patients that received norepinephrine (IH group, 54%) and 11/24 patients that did not (no-IH group 46%). Norepinephrine was started in the IH group after the early CTP in all cases (5.2 ± 3.2 days). Early MTT was significantly higher in the IH group (6.8 ± 1.2 sec) compared to the no-IH group (5.7 ± 0.8 sec) (p = 0.001), but there was no difference in early CBF between the two groups. In the IH group, CBF significantly increased and MTT significantly decreased after norepinephrine was started. The IH group had a significantly higher incidence of DCI (11/13 versus 0/12; p<0.0001). There was no difference in the incidence of infarction (5/13 versus 2/11) or poor outcome (3/11 versus 6/13) between the IH and no-IH groups respectively (p > 0.05).

Conclusions
Aneurysmal SAH patients that received norepinephrine to induce hypertension had higher MTT prior to treatment than patients who were not treated. The use of IH was associated with DCI in most cases. IH improved CT perfusion parameters, but differential clinical outcomes were not demonstrated in this small sample. Early MTT increase may be an indicator of patients that will develop DCI and may benefit from induced hypertensive therapy, but relationship of improvements in cerebral perfusion to clinical outcome remains to be established. Therapies to prevent DCI and improve
clinical outcome may need to be initiated earlier, when cerebral perfusion abnormalities are first identified.

O-167

6:05PM - 6:13PM

Correlation of Histological Evidence of Remote Hemorrhage and Susceptibility-Sensitive MRI for the Assessment of Rupture Risk in Brain AVM

E Meram¹, T Tihan², H Kim², H Su², C Hess²
¹Koc University School of Medicine, Istanbul, Turkey, ²University of California San Francisco, San Francisco, CA

Purpose
Brain arteriovenous malformations (bAVMs) cause significant morbidity and mortality, especially when associated with acute hemorrhage. Quantifying the risk of rupture is critical for determining the timing and choice of treatment. Hemosiderin, an iron storage product developing after recent or remote hemorrhage, can be recognized readily on histological evaluation and identified on susceptibility-sensitive magnetic resonance imaging (MRI). We previously have demonstrated a strong association between bAVM rupture and silent intralesional microhemorrhage as detected by tissue hemosiderin deposition. The aim of this study was to assess the relationship between susceptibility-sensitive MRI and the histological presence of hemosiderin in surgically resected bAVMs in patients without clinical history of hemorrhage.

Materials and Methods
To detect evidence of prior hemorrhage in patients prior to undergoing surgical bAVM resection, we used susceptibility-weighted angiography (SWA) (GE, Waukesha, WI) with the following parameters: 2.8 mm partition thickness with 0.4 mm x 0.4 mm in-plane resolution, TR/TE=40/25 msec, flip angle 10°, and approximately 4 min. scan time. Resected tissue specimens were analyzed for the presence of hemosiderin and other histological variables postoperatively. Radiological and histological evidence of prior hemorrhage then were correlated with clinical parameters.

Results
Thirty-two subjects with no prior hemorrhage were identified, 29 had both MRI and pathology available for review. Sensitivity and specificity for detecting hemosiderin with SWA were 45% (5/11 patients) and 100% (0/18 patients), respectively. There was significant association between hemosiderin deposition in tissue and MRI detection of susceptibility (Fischer's exact p=0.004).

Conclusions
While the number of subjects in this study was small, these results suggest that SWA has high specificity for the presence of hemosiderin deposition on histological
analysis. The sequence may be useful to identify patients with higher incipient risk of hemorrhage.

O-380

6:13PM - 6:21PM

The effects of glioma in corticospinal tract area on motion function: evaluation with diffusion tensor imaging

B Gao

1Keck School of Medicine, University of Southern California, Los Angeles, CA

Purpose
To explore the influence of glioma in the area of corticospinal tract (CST) on muscle strength using quantitative parameters based on diffusion tensor imaging (DTI) and provide a reliable imaging assessment evidence to CST injury as well as motion function.

Materials and Methods
Forty-five patients with postsurgical pathologically confirmed glioma were included in this prospective study. Manual muscle testing (MTT) method was used to measure in all patients. According to Lovett staging classification (Robert Lovett taxonomy), the contralateral knee joint muscle strength were classified. Fractional anisotropy (FA) values and relative FA (rFA=injured FA/contralateral FA) of injured and contralateral side in posterior limb of internal capsule were measured. The damages from brain tumor close to CSF were divided into three grades (grade 1: displacement, grade 2: displacement and infiltration, grade 3: displacement and disruption). The fiber density index (FD) and relative FDi (rFDi=injured FDi/contralateral FDi) of injured and contralateral CST were measured. Bilateral CSTs were tracted manually and the values of injured and contralateral CST FA, relative FA (rFA), CST fiber density (FD) and relative FDi (rFDi) were measured. The correlations between muscle strength and damage grade of CST, rFA, injured FDi and relative FDi were calculated using Pearson rank correlation analysis, rFA and rFDi values of different groups were analyzed with one-way ANOVA analysis of variance.

Results
Muscle strength was negatively correlated with injury degree of CST (r=-0.840, P<0.001). Muscle strength was positively correlated with rFA, FD and rFA (r values were 0.615, 0.643, 0.567 respectively, P<0.001). Except the differences of rFA between grade 3 and 4 groups muscle strength, of rFDi in grade 2 and 3 groups, grade 4 and 5 groups of muscle strength had no significant difference (P>0.05), the remaining groups all were of significant difference (P<0.05).

Conclusions
Diffusion tensor imaging and tractography based on DTI can accurately reflect
damage degrees of CST and are also helpful in the accurate evaluation of limb dysfunction degrees pre-operatively.

Tuesday
7:30AM - 8:30AM
Washington Marriott Wardman Park, Marriott Ballroom

7A-Tuesday Morning SAM - Spine - Audience Response (AR) Self Assessment Module (SAM)
7A-1

Unusual Spine Pathology

Torres, C.
The Ottawa Hospital
Ottawa, Ontario

7a-1a

Questions and Answers

7A-2

Imaging of Spinal Cord Lesions

Lincoln, C.
Baylor College of Medicine
Houston, TX

7a-2a

Questions and Answers
Tuesday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Marriott Ballroom

8A-ASPNR Programming: Pediatric Vascular Disease
8A-1

Congenital Vascular Disorders

Severino, M.
IRCCS Istituto Gianniana Gaslini
Genova

8A-2

Arteriopathy in Pediatric Stroke

Wintermark, M.
Stanford University
Stanford, CA

8A-3

Pediatric Stroke: The Neurologist's Perspective

deVeber, G.
Hospital for Sick Children
Toronto, Ontario

8A-4

Pediatric Venous Disorders

Girard, N.
Hospital Nord
Marseille
Tuesday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Washington 4/5/6

8B-Young Professional Programming: Utilizing Advanced Imaging in Your Practice

8B-1
Vessel Wall Imaging

Mossa-Basha, M.
University of Washington
Seattle, WA

8B-2
A Practical Guide to Developing a Clinical fMRI Service

Saindane, A.
Emory University
Atlanta, GA

8B-3
Interventional Spine Service: Beyond LP's & Myelos

Shah, V.
University of California San Francisco
San Francisco, CA

8B-4
Discussion

9:50AM - 10:00AM
Tuesday
8:35AM - 10:03AM
Washington Marriott Wardman Park, Washington 1/2/3

8C-PARALLEL PAPER SESSION: Multiple Sclerosis / Adult Brain MRI
O-168

T1 Relaxation Times in Multiple Sclerosis Lesions improve correlation with clinical disability in Multiple Sclerosis patients: A longitudinal survey.

C Thaler¹, T Faizy¹, J Sedlacik¹, J Stellmann², C Heesen², J Fiehler¹, S Siemonsen¹
¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ²University Medical Center Hamburg-Eppendorf, Hamburg, Hamburg

Purpose
Hyperintense fluid attenuated inversion recovery (FLAIR) lesions (FLAIR-L) in multiple sclerosis (MS) are thought to indicate a wide spectrum of histopathological changes, ranging from edema and mild demyelination to glial scars or liquid necrosis. However, clinical-radiological correlations are still limited. As just recently shown by this research group, assessing MS lesions by its T1 relaxation time (T1-RT) helps to increase correlations with disability. We therefore hypothesized, that longitudinal changes of lesional T1 values are associated with changes in Expanded Disability Status Scale (EDSS) scores.

Materials and Methods
Magnetic resonance imaging (MRI) was performed in 18 MS patients at baseline and after 12 months including 3D-FLAIR, T1-weighted magnetization prepared rapid gradient echo (T1-W MPRAGE) before and after gadolinium injection and double inversion-contrast magnetization-prepared rapid gradient echo (MP2RAGE) sequences. T2 hyperintense lesions were semi-automatically segmented on FLAIR images using an open source lesion segmentation software (LST: Lesion Segmentation Tool). Additionally, T1 hypointense lesions [commonly known as 'black holes' (BH)] were detected by two raters on MPRAGE images. Lesion maps for FLAIR-L and BH were registered to MP2RAGE images at baseline and after 12 months and T1-RT differences (T1-RT-diff) were calculated for all lesion regions of interest (ROIs). Also, changes in clinical status were assessed by using the EDSS at both dates (EDSS-diff).

Results
At baseline and after 12 month, mean T1-RT-diff were obtained for all lesion ROIs patient wise and differences ranged from -132.11 to 87.32 ms (-10.3 to 6.7 %) in FLAIR-L and -280.53 to 65.02 ms (-18.6 to 4.1 %) in BHs. Correlations between T1-RT-diff and EDSS-diff were found significant for values measured in FLAIR-L
Spearman rank coefficient = 0.62; p = 0.003 (Fig. 1) but were not significant for those derived from BHs (Spearman rank coefficient = 0.399; p = 0.09)

Conclusions

T1-RT alterations were found in all patients after 12 months compared to baseline. Our findings suggest, that longitudinal changes in T1-RT values seem to be more pronounced within FLAIR lesions and changes for these therefore are associated more closely with longitudinal changes in disability than those changes only detected in black holes. In conclusion, assessing MS lesions by its T1-RT might lead to a better lesion classification and helps to increase clinical-radiological correlations.
Figure 1: Correlation of T1-RT-diff and EDSS-diff
T1-RT-diff = T1 relaxation time difference, EDSS-diff = Expanded Disability Status Scale difference
Reproducibility of Cortical Lesion Detection on Double Inversion Recovery MRI applying the MAGNIMS-Criteria in Multiple Sclerosis Patients Within a 16-Months Period

T Faizy¹, T Ceyrowski¹, C Thaler¹, J Stellmann¹, K Stuerner¹, C Heesen¹, J Sedlacik¹, J Fiehler¹, S Siemonsen¹
¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany

Purpose
In patients with multiple sclerosis (MS), double inversion recovery (DIR) magnetic resonance imaging (MRI) can be used to detect and evaluate cortical lesions (CL). Since the identification of cortical lesions in DIR is challenging, consensus recommendations for MS cortical lesion scoring using DIR MRI were established. Nevertheless, longitudinal studies assessing the repeated reproducibility of cortical lesions are rare. We therefore sought to evaluate the reproducibility of intracortical lesions on DIR identified by applying the MAGNIMS criteria longitudinally.

Materials and Methods
Double inversion recovery images were analyzed for 10 MS patients, all receiving a 3T-MRI (Siemens, Skyra) at 12 time points (TP) within 16 months as part of a phase IIa clinical trial (scans were conducted at months 1-7, 9-12 and 16). Initially, CLs were marked on each scan separately, blinded to previous scans and total lesion numbers were obtained for each scan-timepoint and patient. In a second run, each previously marked lesion on baseline scans was monitored for reproducibility in every follow-up scan and visibility (yes/no) was documented for each time-point. Additionally, the evolution of new lesions during the time-course was noted.

Results
We found a cumulative number of n=80 CLs in 10 MS patients over 12 TPs. Sixty-five percent of CLs were found to be reproducible in all 12 TPs, while 8.75% of CLs were detected in 11 of 12 TPs. 17.5% of CLs were reproducible in less than six TPs. 7.5% (n=6) lesions were found to be newly developed over time and reproduced in at least three of the following TPs. Ninety percent of CLs showed reproducibility in at least two immediately consecutive TPs. 13.75% of CLs that initially were reproducible in at least three consecutive TPs and not reproducible in all following scans were considered as genuine, but during the time course disappearing CLs.

Conclusions
The application of the MAGNIMS criteria for the identification of CLs on DIR led to a high reproducibility of the majority of MS lesions in 12 follow-up scans within 16 months and therefore seems to be a valid system. Lesions that were not reproducible seem to be characterized by lower signal intensity, smaller size or resulted to be artificial.
O-170

T1 dark blood technique increases sensitivity for detection of contrast enhancing lesion in MS

S Siemonsen¹, T Schneider², D Kutzner², J Fiehler³, J Sedlacik²
¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ²University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ³University Medical Center Hamburg-Eppendorf, Hamburg, AK

Purpose
In multiple sclerosis (MS) the sensitivity for detection of contrast enhancing lesions (CEL) in T1-W scans is essential for diagnostics and therapy decisions. The purpose of our study was to evaluate the sensitivity of T1mprage scans in comparison to T1 dark blood technique (T1-DB) for CEL in MS.

Materials and Methods
Twenty-one MS patients received 3T MRI with T2-weighted imaging and T1mprage pre (T1nat) and postgadolinium (T1-GD) sequences. After GD application, the T1-DB scan was performed prior to T1-GD. From pre and post T1mprage GD scans, subtraction images (SUB) were calculated. The number of CEL was determined separately on T1-GD and T1-DB by two raters independently. Lesions only detected on T1-DB scans then were verified on SUB images. Only lesions detected by both raters were included in further analysis.

Results
Twenty-three of 21 T1-GD lesions were detected by rater 1/2. In comparison, 8/7 more lesions were detected on T1-DB; all of these lesions could be verified on SUB images. In retrospective evaluation, CEL only detected in T1-DB were lesions that became hypo- or iso-intense on T1-GD in comparison to T1nat. In 13 patients, no CEL was detected in any of the sequences.

Conclusions
The application of T1-DB technique increases the sensitivity for CEL in MS, especially for those lesions that show a subtle increase in intensity after GD application but remain hypo- or iso-intense to surrounding tissue.
Regional quantitative susceptibility mapping of the thalami, not volumes, is associated with clinical disability in multiple sclerosis

J Hu¹, G Chiang¹, Y Wang¹, S Gauthier¹

¹Weill Cornell Medical College, New York, NY

Purpose
Studies using susceptibility-weighted imaging techniques have described increased phase or R2* in the thalamus of multiple sclerosis patients compared to normal controls, suggestive of increased iron. Similarly, thalamic atrophy compared to normal controls has been described as an early event in multiple sclerosis. The purpose of our study was to determine how measures of thalamic iron and volumes relate to clinical disability, measured by the Expanded Disability Status Scale (EDSS), and disease duration.

Materials and Methods
One hundred twelve patients with relapsing-remitting multiple sclerosis underwent 3T magnetic resonance (MR) imaging with a standardized protocol that included quantitative susceptibility mapping (QSM) to assess iron concentration and a 3D T1 SPGR sequence for volumetric analysis. Four regions of interest (ROIs) were delineated manually on the QSM image of the thalamus to encompass the pulvinar nucleus, dorsomedian nucleus (MD), the ventral anterior/lateral nuclei (VAL), and ventral posterior medial/lateral nuclei (VP). Thalamic volumes were obtained using Freesurfer software. Multivariate regression analyses were performed to identify associations between thalamic volumes and QSM of substructures with EDSS and disease duration.
Results
Quantitative susceptibility mapping of the pulvinar was significantly associated with EDSS (coeff=6.5, p=0.01) and disease duration (coeff=-1.4, p=0.03), adjusting for age, gender, use of multiple sclerosis disease-modifying agents, and steroids. Quantitative susceptibility mapping of the VP also was associated with EDSS (coeff=1.9, p=0.02), whereas QSM of the MD and VAL were associated marginally with EDSS (coeff=3.0, p=0.05; coeff=1.5, p=0.07). There was no significant association between thalamic volumes, adjusted for total intracranial volumes, and EDSS or disease duration. In addition, QSM of thalamic substructures were not associated with thalamic volumes.

Conclusions
Quantitative susceptibility mapping of thalamic substructures may be a better measure of clinical disability in multiple sclerosis patients than thalamic volumes.

O-172
9:07AM - 9:15AM

Comparison of quantitative cerebral blood flow between pseudo-Continuous Arterial Spin Labelling and Bookend perfusion imaging in Relapsing Remitting Multiple Sclerosis

S Hojjat1, R D'Ortenzio1, R Vitorino1, C Cantrell2, P O’Connor3, A Feinstein1, L Lee1, T Carroll2, R Aviv1

1Sunnybrook Research Institute, Toronto, Ontario, 2northwestern university, Chicago, IL, 3St. Michael's Hospital, Toronto, Ontario

Purpose
Quantitative cerebral blood flow (CBF) usage as a biomarker for cognitive impairment and disease progression in multiple sclerosis (MS) is potentially a powerful tool for longitudinal patient monitoring. Dynamic susceptibility contrast perfusion with Bookend T1-calibration (Bookend Technique) and pseudo-continuous arterial spin labeling (ASL) recently have been used for CBF quantification in relapsing-remitting MS. The noninvasive nature of pseudo-continuous ASL is potentially advantageous over gadolinium-based techniques in relapsing-remitting MS (RRMS) but correlation between the techniques is not well established.

Materials and Methods
We compared pseudo-continuous ASL CBF to the Bookend technique in a prospective cohort of 19 healthy controls, 19 relapsing-remitting MS subjects without cognitive impairment and 20 relapsing-remitting MS subjects with cognitive impairment on a voxel-wise and Brodmann regional basis. Linear Pearson correlation, SNR and coefficient of variation were tested.
Results
Voxel-wise paired T-tests revealed no significant CBF differences between techniques. Highest Pearson correlations were observed in deep gray matter (GM) structures (average r = 0.69 basal ganglia, and r = 0.63 thalamus) but remained robust for cortical GM and white matter (WM) (average r = 0.53 each). Brodmann regional correlations were significant for all groups. All correlations were maintained in healthy controls and in RRMS disease. Highest SNR was present in Bookend perfusion while the highest coefficient of variation was present in WM.

Conclusions
Agreement between pseudo-continuous ASL and Bookend technique CBF measurements is demonstrated in healthy controls and RRMS patients, supporting the potential use of pseudo-continuous ASL CBF as a potential noninvasive biomarker of RRMS patients.

O-173

Molecular Imaging Profiling of Treatment Effects in Experimental Multiple Sclerosis Reveals a Novel Mechanism of Action of Interferon-beta

B Pulli\textsuperscript{1}, R Forghani\textsuperscript{2}, G Wojtkiewicz\textsuperscript{1}, C Wang\textsuperscript{1}, M Zeller\textsuperscript{1}, J Chen\textsuperscript{1}
\textsuperscript{1}Massachusetts General Hospital and Harvard Medical School, Boston, MA, \textsuperscript{2}Jewish General Hospital and McGill University, Montreal, Quebec

Purpose
Treatment effects of interferon beta (IFN) and glatiramer acetate (GA), two first-line agents used in multiple sclerosis (MS), are similar as evaluated by conventional magnetic resonance imaging (MRI). Myeloperoxidase (MPO) is a pro-inflammatory and oxidative enzyme secreted by inflammatory myeloid cells. In vivo MPO activity can be noninvasively measured with MPO-Gd, an activatable molecular MR imaging probe sensitive and specific to MPO (1). The purpose of this study was to profile and study the effects of IFN, GA, and ABAH (a preclinical MPO inhibitor) on the innate immune response in vivo using MPO-Gd.

Materials and Methods
Thirty-five female SJL mice were injected with proteolipid protein to induce experimental autoimmune encephalomyelitis, a mouse model of MS, and treated with IFN (1 μg/day), GA (150 μg/day), MPO inhibitor ABAH (0.8 mg/day), or saline. Mice underwent MRI at 4.7T with MPO-Gd at disease peak (day 12). Lesion volume, number, contrast-to-noise ratio (CNR), and total MPO-Gd enhancement were quantified on delayed images. Mechanistic in vitro experiments and EAE experiments with wildtype and MPO knockout mice were performed.
Results
Contrast-to-noise (MPO activity in vivo) was decreased with ABAH and IFN, but not with GA. Lesion volume, lesion number, and total MPO-Gd enhancement (defined as product of CNR and lesion volume) was decreased with all three agents (Fig. A-B). These findings reveal unique imaging signatures for both GA and Ifn-β, where Ifn-β demonstrates an imaging signature similar to the MPO inhibitor ABAH. However, direct enzymatic inhibition was found only with the MPO inhibitor ABAH, but not with IFN or GA. When primary neutrophils were stimulated to secrete MPO, we observed a surprising decrease in MPO activity with IFN, similar to ABAH (C), while GA did not have a similar effect (C). Myeloperoxidase can be inactivated by certain reactive oxygen species. Indeed, when neutrophils were incubated with IFN, we found increased superoxide anion production (as measured by dihydroethidium fluorescence). Conversely, inhibition of superoxide anion production by apocynin (an inhibitor of NADPH oxidase) resulted in the restoration of MPO activity from stimulated neutrophils. Spectrophotometry revealed that IFN-mediated superoxide anion production abolished absorbance of MPO at 430 nm, consistent with irreversible destruction of the iron-containing prosthetic group. On immunohistochemistry, less demyelination was seen in wildtype mice treated with IFN compared to vehicle, similar to vehicle-treated MPO knockout EAE mice (D), suggesting that inactivation of MPO by IFN protects from demyelination.

Conclusions
Molecular imaging profiling with MPO-Gd reveals differential treatment effects of the two first-line drugs used in the treatment of MS, and led to the discovery of a novel mechanism of action of IFN: IFN triggers superoxide anion production in myeloid cells to irreversibly inactivate MPO and ameliorate demyelination. In the future, molecular imaging profiling with imaging agents that probe the immune response could open up a new avenue to study the effects of current and future novel therapeutic drugs for MS.
Sodium MRI in Multiple Sclerosis: A Biomarker for Intracellular Sodium Accumulation in Acute Lesions of the Brain?

A Biller1, I Pflugmann1, S Badde2, R Diem1, B Wildemann1, A Nagel3, J Jutta3, J Kleesiek1

1University of Heidelberg, Heidelberg, MA, 2University of New York, New York, NY, 3German Cancer Research Center (DKFZ), Heidelberg, MA

Purpose
Sodium magnetic resonance imaging (MRI) can provide different image contrasts, which reflect the average tissue sodium concentration (average tissue sodium signal; ATS), and sodium ions with short relaxation times thereby achieving a weighting towards the intracellular sodium compartment (intracellular-weighted sodium signal; IWS). Based upon preclinical findings (1, 2) and results of previous sodium MRI studies in MS patients (3, 4) we hypothesize that the IWS signal provides new information to estimate intracellular sodium accumulation, and differs between acute and chronic lesions due to the diverging expression of sodium channels.

Materials and Methods
We enrolled relapsing-remitting MS patients with acute and/or chronic cerebral lesions. Brain sodium MRI data were acquired at 7T providing ATS and IWS signals. Segmentation of MS lesions was performed on clinical routine proton MRI assessed at 3T (Fig. A). Lesion type was defined by the presence or absence of contrast enhancement. Generalized linear mixed models were applied to predict lesion type; thus controlling for varying numbers of lesions among patients. Several factors possibly associated with lesion type like e.g. disease duration were additionally controlled for by including them into the prediction model.

Results
Three hundred two 302 MS brain lesions were detected and analyzed. Thereby, we defined 232 lesion as chronic and 70 as acute. Hierarchical model comparisons revealed that ATS ($\chi^2(1)=27.89, p<0.001$) and IWS signal ($\chi^2(1)=5.76, p=0.016$) improved lesion type classification. Both sodium MRI signals were elevated significantly in acute compared to chronic lesions (Figs. A and B).

Conclusions
In this study, we are able to demonstrate that sodium MRI reveals new information on MS lesions compatible with the pathogenetic events of MS leading to intracellular sodium accumulation. Sodium MRI information is very specific whereas conventional MRI yields a nonspecific T2 signal of MS lesions and even contrast-enhancement is
considered nonspecific because it is a marker of blood-brain barrier disruption, not inflammation (5). Therefore, sodium MRI could serve as biomarker for diagnostic assessment of MS, and as readout parameter in trials promoting attenuation of chronic inflammation. If confirmed in further studies, sodium MRI could serve as biomarker for diagnostic assessment of MS, and as readout parameter in trials promoting attenuation of chronic inflammation.
Figure: Axial proton and sodium MRI images of an exemplary patient demonstrating an acute right-temporal MS lesion with contrast enhancement and elevated T2-FLAIR, ATS and IWS signals (A). Statistical analyzes revealed that both ATS and IWS signals improve prediction of lesion type; both signals were significantly increased in acute compared to chronic brain MS lesions; the scatterplot visualizes these findings (B) showing a near perfect discrimination between lesion types which is, of course, not achieved in every case. Sodium MRI information is very specific whereas conventional MRI yields a non-specific T2 signal of MS lesions and even contrast-enhancement is considered non-specific because it is a marker of blood-brain barrier disruption, not inflammation [5]. Therefore, sodium MRI could serve as biomarker for diagnostic assessment of MS, and as readout parameter in trials promoting attenuation of chronic inflammation.
Imaging CNS inflammation in patients with genetic mutations in the essential immune checkpoint inhibitor, Cytotoxic T-lymphocyte Antigen-4 (CTLA4).

M Schindler¹, G Uzel¹, S Pittaluga¹, D Reich¹, I Cortese¹
²NIH, Bethesda, MD

Purpose
Genetic mutation in cytotoxic T-lymphocyte antigen-4 (CTLA4), leads to systemic immune dysregulation with autoimmune cytopenia, abnormal lymphoproliferation in lymphoid organs, hypogammaglobulinemia, and infiltrative lymphocytosis in nonlymph organs (gut, lungs, and brain), as recently described (Kuehn et. al., Science 2014). The extent of central nervous system (CNS) involvement and imaging features in this newly described disease are not known.

Materials and Methods
A retrospective review and prospective imaging study of patients with CTLA4 mutations followed at the National Institutes of Health between 2009 and present. Of 30 genetically confirmed CTLA4 patients, 17 had brain magnetic resonance images (MRIs) available for review.

Results
The average age of onset of neurologic signs, symptoms, or imaging findings was 19 years (range 9 to 35 years). Focal inflammatory lesions were present in the supratentorial white matter (11 patients), infratentorial compartment (7), and spinal cord (2), including one longitudinally extensive lesion. Many lesions were large (>64mL) and most enhanced with gadolinium, but many showed little to no distortion of the surrounding tissue. Leptomeningeal enhancement was seen in five patients, including one in whom focal enhancement developed in advance of parenchymal signal change. Lesions responded quickly to steroids with dramatic shrinkage and little residual abnormal signal. Clinically, the most common symptoms were headache (9) and seizure (6). Few patients had focal neurologcal deficits, and those noted were subtle, in stark contrast to the imaging findings. Limited biopsy samples showed lymphocyte or histiocyte infiltration without overt tissue destruction.

Conclusions
Imaging patients with CTLA4 mutations captures an important feature of neuroinflammation in this disease, i.e., immune-cell infiltration in the relative absence of associated neural-destruction in contradistinction to other CNS inflammatory diseases, like multiple sclerosis. Studying rare genetic syndromes, like CTLA4...
haploinsufficiency, therefore may be of value for understanding the pathological basis of MRI signal changes in neuroinflammatory disease.

O-176

9:39AM - 9:47AM

Imaging biomarkers in Neuropsychiatric Lupus- Are they robust enough?

J Chaganti1, B Brew2
1St Vincents Hospital, Sydney, NSW, 2ST VINCENT'S HOSPITAL, SYDNEY, NSW

Purpose
Aim: to identify the cytoarchitectural changes in the clinically early neuro psychiatric SLE using multiparametric MRI techniques.

Materials and Methods
We evaluated 21 female patients (20-49 years) with lupus with mild neuro psychiatric symptoms and equal number of normal volunteers to identify and detect early ultrastructural changes in different parts of the brain. All the patients underwent MRS (2DCSI), ASL (pCASL) and diffusion tensor imaging (DTI) (32 directions) using Philips 3T-Ingenia. Diffusion metrics ADC, FA were measured in in the regions of all the major association fibers as well as commissural fibers (FSL) and cerebral blood flow (CBF) was measured from splenium of corpus callosum, cingulate gyrus, and dorsolateral prefrontal cortex (FSL). Magnetic resonance spectroscopy (MRS) was done using 2D CSI with long TE and the basal ganglia, fronto parietal cortex and centrum semiovale and the peritrigonal white matter were evaluated (LC MODEL). All patients underwent repeat MRI after 1 year. Statistical analysis was done using SPSS version22 using one way ANOVA

Results
The conventional MR images of patients are normal in four patients while the rest demonstrated small bright foci in the central white matter on FLAIR Imaging. Diffusion tensor imaging (DTI)/ASL/MRS measurements: All the patients have demonstrated statistically significant DTI abnormalities and correlated well with MRS. The ASL was equivocal in four patients and demonstrated reduced CBF in five patients and borderline abnormality in 12. Spectroscopy was uniformly abnormal with high Choline to Creatine ratio and mildly reduced NAA to Creatine ratio in nine patients. Correlation: All patients who had abnormal MRS in NAA/CH and NAA/CR have shown clinical correlation with activity of the disease based on symptoms as well as immune markers. Diffusion tensor imaging metrics were favorably compared with clinical abnormality and mostly associated with reduced FA and increased MD in the superior longitudinal fasciculus (SLF) and splenium of the corpus callosum as well as posterior cingulate. The ASL showed no significant correlation with disease
activity but correlated well with MRS and DTI in those subgroups where there is more reduction in NAA and high mean diffusivity.

Conclusions
The diagnosis of NP-SLE often is clinical and the imaging biomarkers are not well recognized. We have used the three most reproducible imaging modalities to identify the ultrastructural changes and could be used as markers to measure the disease response with the treatment.

O-177

Diagnostic Value of Apparent Diffusion Coefficient for the Accurate Assessment and Differentiation of Postoperative Intracranial Abscesses

E Lotan¹, S HarNof¹, O Komisar¹, A Fardman¹, C Hoffmann¹
¹Sheba Medical Center and Tel-Aviv University, Tel-Aviv, Israel

Purpose
Current radiologic knowledge employs the presence of restricted diffusion as a hallmark of brain abscess in contrast to a cystic tumor. However, it can lead to misdiagnosis in the postoperative setting. The purpose of this study was to compare apparent diffusion coefficient (ADC) values of intracranial abscesses that occurred without ("spontaneously") and after a primary neurosurgical procedure ("postoperatively") and to assess their diagnostic value.

Materials and Methods
This retrospective comparative study was approved by the local institutional review board. The requirement to obtain written informed consent was waived. A total of 73 consecutive patients who underwent a pre-operative magnetic resonance (MR) imaging with diffusion-weighted imaging (DWI) from February 2005 to May 2015 were divided into two cohorts depending on whether the abscess identified after a primary neurosurgical procedure (n=43) or not (n=30). Abscesses were assessed for ADC values by two readers independently. ADC values were described with median and interquartile range (IQR). Chi-square and Mann-Whitney tests were used to compare ADC values between the two cohorts. Correlation between continuous variables was calculated by Spearman's rank correlation coefficient. Chi-squared automatic interaction detection analysis was used to classify the ADC values into categories according to the cohorts.

Results
Apparent diffusion coefficient value of postoperative abscesses [1.34 (1.00-1.62) x10^{-3}mm^2/s, (median, IQR)] was significantly higher than ADC value of spontaneous abscesses [0.68 (0.58-0.79) x10^{-3}mm^2/s, P<0.001]. Eighty-three percent (n=24) of abscesses with ADC value <0.79x10^{-3}mm^2/s were found to be spontaneous, while
only 27% (n=6) of abscesses with ADC value between 0.79 to 1.33 x10^{-3}\text{mm}^2/\text{s} and no abscesses with ADC value above 1.33 x10^{-3}\text{mm}^2/\text{s} were spontaneous (P<0.001). There was significant correlation between interval from the initial surgery to re-operation for abscess drainage and the abscess's ADC values (r=-0.352, P=0.026), hence lower ADC values were associated with longer period after the initial surgery.

Conclusions

There are significantly higher ADC values of postoperative abscesses compared to spontaneous abscesses. Longer interval from the initial surgery to re-operation for abscess drainage was associated with lower ADC values. Although DWI with an ADC map is an excellent tool for diagnosis spontaneous brain abscesses, it is not sufficient for excluding postoperative intracranial abscess. Clinical suspicion of abscess should not be negated by absence of restricted diffusion in DWI and high ADC value in the ADC map.
O-178

Imaging of Intracranial Central Nervous Complications after Solid Organ Transplantation

Y Chen¹, M Chan¹, W Kucharczyk²

¹University of Toronto, Toronto, Ontario, ²Toronto General Hospital, Toronto, ON
Purpose
To investigate the imaging spectrum and temporal course of intracranial central nervous system (CNS) complications after solid organ transplantation.

Materials and Methods
Institutional ethics approval was obtained for this retrospective study. The medical records and brain imaging data of 125 consecutive solid organ transplant patients (age 52.6+/−13.5 years; 48.4% females) who had positive CT and/or MRI brain findings between January 2010 and November 2015 were reviewed. Central nervous system (CNS) complications were divided into four categories: vascular (including infarct and hemorrhage), toxic/metabolic, infectious/inflammatory and neoplastic. The onset of CNS complications was grouped into four post-transplantation intervals including acute (< 1 month), early subacute (1-3 months), late subacute (3-12 months), and chronic (> 1 year).

Results
Patients with acute intracranial findings on imaging included 50 post-liver (40%), 36 post-lung (28.8%), 16 post-cardiac (12.8%), 19 post-renal (15.2%), and 4 post-multi-organ (3.2%) transplants. Vascular disorders were the most common etiology overall (69, 55.2%), followed by toxic/metabolic (38, 30.4%), infectious/inflammatory (10, 8%), and neoplastic (8, 6.4%) disorders. The average time between acute imaging findings and transplant is 3.2+/−6 years, with 55 cases occurring within 1 month (44%), 11 between 1 and 3 months (8.8%), 13 between 3 months and 1 year (10.4%) and 46 more than 1 year (36.8%). In the acute < 1 month group, 54.6% of cases were post-liver and 27.2% post-lung transplants. Vascular disorders were the most common etiology during the acute period (30, 54.6%), followed by metabolic encephalopathy (22, 40%). In the chronic > 1 year group, 34.8% of the cases were post-renal and 26.1% post-lung transplants. Vascular disorder remained the most common etiology (31, 67.4%), followed by neoplastic disorders (6, 13%).

Conclusions
The etiology of CNS complications after solid organ transplant changes depending on the time post-transplant. Vascular and metabolic disorders were the most common in the acute period whereas vascular and neoplastic disorders were the most common in the chronic period.
Tuesday  
8:35AM - 10:00AM  
Washington Marriott Wardman Park, Roosevelt 1-3

8D-PARALLEL PAPER SESSION: Turbo Talks - Traumatic Brain Injury / Epilepsy Advances  
O-179  
8:35AM - 8:38AM

Standard versus Extended CT Protocols in Head Trauma: radiation dose versus workflow considerations from a Level I Trauma Center

M Pinho\textsuperscript{1}, J Pond\textsuperscript{1}, B Boren\textsuperscript{1}  
\textsuperscript{1}University of Texas Southwestern, Dallas, TX

Purpose
Although the standard head computed tomography (CT) covers only the skull base to vertex, our medical center uses a dedicated trauma protocol that extends coverage below the mandible. The rationale is that some patients may eventually need a maxillofacial CT, which can be reconstructed from the original dataset without a second scanning session, facilitating workflow and potentially avoiding duplicated radiation exposure where the brain and face overlap. Additional coverage also enables screening of clinically unsuspected facial lesions. In this study we compare benefits and disadvantages of the two head CT protocols in trauma patients, considering radiation dose and impact to workflow in a level I trauma center.

Materials and Methods
We performed a chart review of 378 consecutive patients that had head CTs performed for trauma, corresponding to a span of 1 month. Maxillofacial CTs for

<table>
<thead>
<tr>
<th>Pathology Category</th>
<th>#</th>
<th>Percent</th>
<th>Liver</th>
<th>Lung</th>
<th>Heart</th>
<th>Renal</th>
<th>Multi-organ</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infarct</td>
<td>42</td>
<td>33.6%</td>
<td>7</td>
<td>19</td>
<td>5</td>
<td>10</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>27</td>
<td>21.6%</td>
<td>14</td>
<td>3</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Toxic/metabolic</td>
<td>38</td>
<td>30.4%</td>
<td>26</td>
<td>8</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Infectious/inflammatory</td>
<td>10</td>
<td>8%</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Neoplastic</td>
<td>8</td>
<td>6.4%</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>125</td>
<td>100%</td>
<td>50</td>
<td>36</td>
<td>16</td>
<td>19</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
these patients also were computed and we reviewed all clinical and imaging data to determine whether it was reconstructed from the head CT data retrospectively (ordered after the head CT) or at the time of the scan (ordered with the head CT). Head and maxillofacial CT reports were reviewed for traumatic findings. CTDIvol and DLP were recorded for all 378 patients and compared to average radiation doses of a separate sample of 30 consecutive patients who underwent standard head CTs and 60 consecutive patients who underwent maxillofacial CTs.

Results
Of the original 378 patients, 67 (17.7%) also had a dedicated maxillofacial CT. Sixty of these maxillofacial CTs were ordered at the same time as the head CT. Seven CTs were ordered later and reconstructed from the original extended head coverage. All seven patients had evidence of facial trauma on clinical exam and the lack of a prospective maxillofacial CT order was uniformly a clinical oversight. The average radiation dose saved for each of the seven patients was 598 mGycm (24% 4186 mGycm total); however, the mean dose for the extended head protocol is significantly higher compared to the routine protocol (p<.0001). The average added dose to the remaining 311 patients (extended head CT protocol without maxillofacial CT) was 427 mGycm each (30% 132,821 mGycm total) resulting in a net added dose of 128,636 mGycm (29%) to the entire group. Eight trauma-related facial findings were detected incidentally in the 311 patients without dedicated maxillofacial imaging due to extending coverage. None of these patients required additional treatment but ophthalmology consultation was requested in two cases.

Conclusions
To our knowledge, the advantages and disadvantages of a "standard" versus "extended" head CT trauma protocol have not been evaluated systematically in the literature. Our results demonstrate that the extended protocol results in a workflow advantage and radiation dose savings for a small fraction of patients (2.2%), but imparts significantly increased (29%) radiation dose on average to the entire group. These results suggest that extended coverage (from vertex to mandible) is justifiable only in patients with prospectively ordered head and maxillofacial studies based on clinical findings.
Longitudinal White Matter Changes Following Traumatic Brain Injury

J Ware¹, J Detre¹, J Kim²
¹University of Pennsylvania, Philadelphia, PA, ²The City College of New York, New York, NY

Purpose
Traumatic brain injury (TBI) is a leading cause of morbidity and disability in the United States, and functional outcomes for patients with TBI remain heterogeneous. Patient stratification based on advanced neuroimaging eventually may lead to more appropriately tailored and/or effective rehabilitation strategies. Diffusion tensor imaging (DTI) in particular has demonstrated the ability to detect white matter changes which occur as a result of shear injury in patients with TBI, though the evolution of DTI changes and their relationship to functional recovery are only
beginning to be characterized. In this study, we investigated longitudinal changes in
white matter DTI abnormalities following TBI to determine their relationship to
longitudinal changes in disability and brain function.
Materials and Methods
Eighteen adults with at least moderate traumatic brain injury were examined at 3, 6,
and 12 months following injury. At each time point, each subject was assessed with
DTI as well as the Disability Rating Scale (DRS), Glasgow Outcome Scale-Extended
(GOSE), and a test of processing speed (PSI from WAIS-IV). Subject-specific maps
of white matter fractional anisotropy (FA) and radial diffusivity (RD) were co-
registered and converted to Z-score maps of DTI abnormality based on a control
population of 34 normal subjects matched for demographic characteristics, then
thresholded to determine regions of abnormally low FA and abnormally high RD. The
total number of abnormal voxels derived from each subject's thresholded Z-score map
was used to quantify the extent of white matter abnormality for each time point in
each subject. Repeated measures analysis of variance and paired t-tests were used to
test for significant differences in clinical and imaging measures between time points.
Results
All subjects demonstrated several regions of abnormally reduced FA and abnormally
increased RD (|Z|>2, cluster size p<0.05) within otherwise normal-appearing white
matter. Over the three time points, there was significant longitudinal improvement in
both processing speed (p=0.001) and disability scores (p=0.02). Across all subjects,
there was a correspondingly significant increase in the number of abnormal RD voxels
(p=0.006) over time, however there was no significant longitudinal change in the
number of abnormal FA voxels. The number of abnormal FA and RD voxels at the 3
month time point were predictive of disability score at the 12 month time point
(p<0.05).
Conclusions
Despite persistent changes in DTI indices suggesting tract disruption (FA) and
progressive dysmyelination (RD) up to 12 months following TBI, there was
significant group improvement in function and reduction in disability over time. These
findings suggest that functional recovery may depend primarily on compensatory
mechanisms rather than normalization of microstructural white matter changes.
Opposing Patterns of Altered Microstructure in Anterior Versus Posterior Cerebral White Matter After Mild Traumatic Brain Injury

E Yuh¹, D McCoy¹, A Ferguson¹, D Ramanan², F Ezekiel¹, M Vassar¹, G Manley¹, P Mukherjee³
Purpose
We used topological data analysis (TDA), a powerful technique for querying massive data sets for patterns that may not be apparent using more conventional analysis techniques, to analyze diffusion tensor imaging (DTI) data in the subacute time frame after mild traumatic brain injury (mTBI). We also used region of interest (ROI) methods in conjunction with TDA techniques to assess for tract-specific alterations in DTI parameters after mTBI.

Materials and Methods
We studied 3T DTI data from 76 adults at 11.2±3.3 days after mTBI. Patients were enrolled at San Francisco General Hospital as part of the Transforming Research and Clinical Knowledge in Traumatic Brain Injury study. Tract-based spatial statistics were used to align each subject's fractional anisotropy (FA) and mean diffusivity (MD) data to a white matter skeleton. We used the TDA software Iris (Ayasdi, Menlo Park, CA) to search for patterns in the DTI data. For the ROI analysis, 45 white-matter-skeleton ROIs were delineated using the JHU ICBM-DTI-81 White Matter Labeled Atlas. For each subject, we calculated global FA and MD based on the entire white matter skeleton, and then normalized FA and MD in each voxel by the subject's global value. For each ROI, we compared the normalized mean FA and MD in that ROI in mTBI versus controls using two-tailed t-tests.

Results
Region of interest analysis: Using normalized FA values, we observed geographic-tract-specific variations in the alterations in DTI parameters. Statistically significant increases in FA in mTBI patients were observed only in anterior tracts (anterior corona radiata, p=3 x 10^-6; anterior limb of internal capsule, p=8x10^-4; superior fronto-occipital fasciculus, p=0.03) while significant decreases in FA were observed only in posterior tracts (splenium, p=7x10^-8; posterior corona radiata, p=0.03; posterior limb of internal capsule; p=0.06). Topological data analysis: We also used TDA to demonstrate the presence of striking subdivisions within traditional tractography-defined tracts. For example, Figures A and B show the spatial dependence of Principal Components 1 and 2 for FA within the splenium. Regions with highly coherent FA values across all 126 patients and control subjects have similar PC1 and PC2 values, and are manifested as regions of coherent color (encircled regions in Figures A and B). Figure C shows the effect size of alterations in complicated mTBI versus control subjects (red denoting the largest size effects and blue denoting the smallest). Comparison of Figure C to Figures A and B shows that the largest effect sizes in FA differences (red regions in Figure C) are in the same regions with the highest magnitudes of PC1 and PC2 (red regions in Figures A and B).
Conclusions
We demonstrate geographic variations in changes in FA and MD at a subacute
timepoint after mTBI. Statistically significant decreases in FA were seen only in
anterior tracts, and significant increases only in posterior tracts. We also used TDA to
demonstrate the presence of substructures within JHU ROIs; these may be a basis for
new ROI schemes that complement traditional tractography-based ROIs for DTI
analysis.

(Filename: TCT_O-181_ASNR2016-FigureFinal.png)

O-182
8:44AM - 8:47AM

Blood in the brain: MRI Differentiation of cerebral fat embolism (CFE) from
diffuse axonal injury (DAI)

A Rutman1, E Rapp1, D Hippe1, M Mossa-Basha1
1University of Washington, Seattle, WA

Purpose
In the setting of high impact trauma with long bone fractures, a diagnostic challenge
may arise as the magnetic resonance imaging (MRI) findings of cerebral fat embolism
(CFE) can mimic those of diffuse axonal injury (DAI). Our study attempts to
differentiate the findings of CFE and DAI using the size, shape, location and number
of intracranial lesions with MR imaging.

Materials and Methods
Adult patients with CFE and DAI were selected retrospectively upon review of the
radiology database at an adult Level 1 trauma center between 1/1/07 and 7/30/14. Selection
criteria of CFE patients were according to Gurd's criteria, with initial GCS of 14-15 and latent decline to <6T, and presence of long bone fractures. Diffuse
axonal injury patients had evidence of hemorrhagic lesions on MRI, initial GCS<6T
and no long bone fractures to exclude the possibility of concomitant CFE. Two
independent, blinded raters evaluated the MRI examinations for number, shape, and
size of hemorrhages on susceptibility-weighted imaging (SWI) and gradient recall echo (GRE) sequences at the following anatomical stations: frontal, parietal, temporal, and occipital white matter, corpus callosum, striatocapsular/insular, thalamus, brainstem, and cerebellum. Hemorrhage shape was round/elliptical or linear and size was characterized as punctate (0-3mm), small (4-10mm), medium (11-20mm), or lobar (>21mm). Statistical analysis was performed with Mann-Whitney test for number of hemorrhages at each station, and Fisher's exact test for hemorrhage shape and size. P-values were adjusted for multiple comparisons across stations to maintain a false discovery rate<5%.

Results
Seven patients with CFE and 20 with DAI were selected based on inclusion/exclusion criteria. There was overall good interobserver agreement between the two raters, with ICC between 0.66 and 0.88 for number of hemorrhages at the various stations. Of the patients with hemorrhages, cases of CFE had an overall tendency to have more hemorrhages than DAI. Specifically, there were significantly more hemorrhages in the parietal (mean: 120±55 versus 13±11, p=0.005) and occipital lobes (mean: 103±67 versus 3±2, p=0.025), the corpus callosum (mean: 98±46 versus 20±20, p=0.022), and cerebellum (mean: 82±32 versus 12±10, p=0.025). Number of hemorrhages in the frontal and temporal lobes, brainstem, thalamus, and striatocapsular/insular regions, while greater in CFE cases, did not reach statistical significance compared to DAI. Cerebral fat embolism microhemorrhages were typically punctate and round when present, while patients with DAI were significantly more likely to have small or medium-sized hemorrhages (100% versus 0%, p<0.001). Additionally, the presence of linear hemorrhages was significantly more prevalent in DAI (85% versus 0%, p<0.001).

Conclusions
Cerebral fat embolism can be differentiated from DAI with MR imaging. Specifically, CFE patients demonstrate more hemorrhages in parietal and occipital white matter, corpus callosum and cerebellum. Additionally, linear hemorrhages and nonpunctate hemorrhages are both significant indicators of DAI.
Patients with DAI demonstrate small and medium sized hemorrhages as well as linear-shaped hemorrhages (b), while cases of CFE dem. numerous round and punctate white matter hemorrhages (c).

O-183
8:47AM - 8:50AM

Prevalence of Microhemorrhages, White Matter Changes, and Cavum Septum Pellucidum in Fighters: Part of the Professional Fighters Brain Health Study

J Lee1, S Jones2, P Ruggieri3, M Massand1, M Modic1, S Banks4, C Bernick4, J Wu1
1Cleveland Clinic, Cleveland, OH, 2Cleveland Clinic, Shaker Heights, OH, 3Cleveland Clinic Foundation, Cleveland, OH, 4Cleveland Clinic, Las Vegas, NV

Purpose
Multiple sports such as boxing, mixed martial arts, football, and soccer involve cumulative head trauma over many years, some of whom have developed neurodegenerative disease. Multiple studies have attempted to describe magnetic resonance imaging (MRI) findings associated with repetitive head trauma but these studies usually involve a small number of patients and use advanced imaging techniques such as diffusion tensor imaging (DTI), perfusion, and connectivity. The purpose of this investigation is to study a large number of patients with well defined
multiple mild head trauma and investigate imaging findings seen using conventional MRI techniques.

Materials and Methods
A total of 495 patients who were martial artists, mixed martial artists, or boxers were compared to a cohort of 25 control patients using conventional MR at 3T. Conventional T1, T2, FLAIR, and susceptibility-weighted imaging (SWI) were obtained and evaluated for microhemorrhages, cavum septum pellucidum (CSP), and white matter changes. All studies were reviewed by four neuroradiologists with an average 20 years of experience and a neuroradiology fellow. All statistics were obtained by SPSS using Fisher exact test and Student's t-test.

Results
The average age of the fighters and controls was 30 and 29, respectively. White matter changes were present in 116 (23%) fighters and five (20%) controls. Cerebral microhemorrhages were present in 34 (6.9%) fighters and 0 controls (p=0.176 by Fisher exact test, p=0.000 by T-test). Cavum septum pellucidum was present in 95 (19%) fighters and one (4%) control (P=0.037). Fighters with microhemorrhages had a higher average of total fights than those without microhemorrhages (79 versus 47, p=0.029). Similarly fighters with CSP had a higher average of total fights (80 versus 42, p=0.000). Fighters with white matter changes trended toward having a higher average of total fights (60 versus 46, p=0.098).

Conclusions
This study presents the largest number of subjects who have been exposed to cumulative head trauma, demonstrating a significantly higher prevalence of microhemorrhages and CSP in fighters than controls. However, a limitation of this study includes selection bias from fighters that volunteered to be imaged. Study of traumatic brain injury is reaching a new pinnacle given the advanced imaging techniques now available and larger databases of patients that are being studied. Given the number of fighters and the increasing popularity of combat sports, conventional MR remains an important tool to continue to monitor and try to prevent sequelae of repetitive head trauma. This study shows that microhemorrhages and CSP are more prevalent with more fights. Whether these MR findings result in future neurodegenerative disease or observable neuropsychiatric adverse outcomes is still up for debate.

O-184
8:50AM - 8:53AM

Splenial Axonal Diffusion in Patients with Mild Traumatic Brain Injury.

G Parikh¹, S Chung¹, E Fieremans², J Smith³, S Flanagan⁴, Y Lui¹
¹NYU Medical Center, New York, NY, ²New York University School of Medicine, New York, NY, ³New York University, New York, NY, ⁴New York University, New York, NY
Purpose
Mild traumatic brain injury (mTBI) is an under-reported public health problem for which there is the need for more informative diagnostic imaging. The corpus callosum is vulnerable to diffuse axonal injury in the setting of shear-strain and tensile forces with the splenium of the corpus callosum frequently being affected because of its close proximity to the falx (1,2). The known microstructural changes in TBI seen in histopathology are not appreciated on conventional imaging; however, diffusion imaging is sensitive to these changes. Many groups have observed alterations with diffusion tensor imaging (DTI), namely in the fractional anisotropy (FA) and mean diffusivity (MD) in the white matter (WM) after injury (3). Recently, diffusion kurtosis imaging (DKI) combined with biophysical modeling allow us to specifically study intra-axonal diffusion (Daxon), a potential marker of axonal injury (4). We also have visually observed a focal, rounded area of relatively high Daxon centered in the splenium of the corpus callosum (sCC) on axial parametric maps, we termed the "splenial dot", in control subjects. We hypothesize here that Daxon may be a more sensitive marker of WM injury than the empiric measure FA. Therefore, we set out to compare mTBI patients with normal controls using both visual inspection and quantitative analysis of FA and Daxon parametric maps in the sCC.

Materials and Methods
Approval for conducting the study was obtained from the institutional review board and informed consent was obtained from all subjects. Eighteen patients (36±11 years; 8 male) with well-characterized, recent (<2 weeks) mTBI as defined by American College of Rehabilitation Medicine and 16 healthy controls (32±8 years; 9 male) underwent DKI on a 3T MR scanner (Skyra, Siemens). The region of sCC was extracted by using the JHU WM label atlas (5) after nonlinear registration using the FA template and was corrected manually for each subject. Student's t-test was performed. Two observers (one neuroradiology attending with >10 years of subspecialty experience and one neuroradiology fellow) blinded to the clinical information, also visually reviewed Daxon parametric maps in all subjects and assessed for presence or absence of the splenial dot.

Results
Comparing with controls, patients with TBI showed significantly lower FA (0.54±0.05 versus 0.50±0.05; p=0.021) and Daxon (1.18±0.05 versus 1.10±0.07mm2/s; p=0.001) in the sCC. The splenial dot was observed visually in 50% of the TBI group and in 50% of the healthy control group and is not found to be statistically significant.

Conclusions
Mild traumatic brain injury is associated with lower FA and intra-axonal diffusion in the sCC. Differences in Daxon were greater and more statistically significant than differences in FA between MTBI and controls. Although there is a clear quantitative
difference using group analysis, the change was not easily discerned on visual inspection of parametric maps with regard to individual subjects.

Figure 1: Axial $D_{\text{axon}}$ map (A) in a 33-year-old female control shows a focal rounded relative hyperintensity within the splenium of the corpus callosum (arrow). $D_{\text{axon}}$ at a similar level in a 28-year-old male with recent mild traumatic brain injury shows the “splenial dot”. Although we found a clear quantitative difference in splenial $D_{\text{axon}}$ between groups, the splenial dot was not reproducibly discerned on visual inspection using parametric maps.

(Filename: TCT_O-184_Spleniumdotimage_JPEG.jpg)

O-185

Altered Default Mode Network Connectivity and Task-related Deactivation in Patients with Mild Traumatic Brain Injury
Purpose
Mild traumatic brain injury (mTBI) is a substantial public health problem. Difficulty in working memory (WM) and attention frequently is reported in patients with TBI (1). The default mode network (DMN) is active at rest and suppressed during tasks that require attention and decision making. Several functional magnetic resonance imaging (fMRI) studies revealed disruption of resting state DMN connectivity and alterations of brain activation during WM task in mTBI patients, but very few studies addressed on the task-related deactivation in mTBI (2). In this study, we investigated the mTBI effect on the DMN, by means of both resting state functional connectivity and task-related deactivation.

Materials and Methods
This study was approved by the local research ethics committee. Thirty-six patients (male/female: 11/25; age: 33.6±8.6; 22-49 years) with mTBI and 24 normal controls (NCs) (male/female: 7/17; age: 34.5±8.9; 21-49 years) were recruited. All participants underwent resting state fMRI and task fMRI (1-back verbal working memory task) sequentially in a 3T MRI scanner within 1 month after injury. Resting state DMN connectivity was estimated by a seed-based correlation method (4) with the seed centered at posterior cingulate cortex (PCC) (3). The brain activity (represented by beta values) during the 1-back WM condition was obtained by using the general linear model approach in SPM8. The areas showing negative beta values were considered as deactivation regions. Region of interest (ROI) analysis was carried at the core regions of the DMN, including PCC, inferior parietal lobule (IPL) and medial prefrontal cortex (mPFC). We used one sample t test for the first level group analysis, two sample t test for the second level group comparison and Pearson's correlation coefficient for correlation analysis in the study.

Results
The resting state DMN connectivity in mTBI patients and NCs were presented in Figure 1. Voxel wise group comparison indicates that the patients had increased connectivity to the left inferior frontal gyrus compared to the NCs. However, ROI analysis of the connectivity within the PCC, MPFC and bilateral IPCs revealed no significant group difference between patients and NCs. Figure 2 shows the brains deactivate predominantly in the DMN regions during 1-back WM condition both in the patients and NCs. The patients had more profound deactivation. Region of interest analysis showed that the patients had more deactivation in right IPL (p = 0.047) and left IPL (p = 0.00012). Correlation analysis revealed significant correlation (r = -0.638, p = 0.00079) between the mean connectivity and the mean deactivation within the DMN ROIs in healthy controls, while no correlation in the patients (r = 0.143, p = 0.405) (Fig. 3).
Conclusions
We found alterations in resting state DMN connectivity and task-related deactivation in mTBI patients. Significantly more profound task-related deactivation in the patients may imply more attention needed on performing the WM tasks. Furthermore, significant correlation between resting state connectivity and task-related deactivation of DMN was found in NCs but this rest-task correlation was disrupted in the patients.

(Filename: TCT_O-185_Figure1.jpg)
Figure 2. Task-related Deactivation.

(Filename: TCT_O-185_Figure2.jpg)
Evaluation of Cerebrovascular Injuries in Blunt Trauma Patients at a Level 1 Trauma Center; the Usefulness of CT Screening

M Dahse¹, C Sitton¹, R Patel¹, B Behzad¹
¹The University of Texas Health Science Center at Houston UTHealth, Houston, TX

Purpose
Injury to the cerebrovasculature can occur in blunt trauma patients and can result in devastating consequences. The incidence of injury in blunt trauma patients has been reported to range from 0.9-2.7% in the literature (1). It has been reported that the risk of stroke from untreated carotid dissections with flow limiting stenosis range from 32-67% and mortality rate from 17-38% (2). Early recognition and early intervention is necessary to avoid neurologic morbidity (3). In order to avoid these devastating outcomes, our institution has instituted an aggressive screening protocol for trauma patients with computed tomography (CT) angiography to evaluate for vascular injury. Our indication for screening is much broader then the traditional Denver criteria (4). The purpose of this study is to evaluate the incidence of cerebrovascular injuries in...
blunt trauma patients at a level one trauma center. We also want to investigate the
grades of vascular injury to determine if there is a significant difference in the
detection rate compared to the reported literature.

Materials and Methods
Utilizing software to search the electronic medical record, we were able to isolate
blunt trauma patients who underwent CT of the cervical spine and CT angiography of
the head and neck. A total of 446 trauma patients from January 2014 to June 2014
were included in the patient population and a retrospective review of the imaging
reports was performed. A database was created to document the findings on cervical
spine CT and head and neck CT angiography. Radiology reports utilizing the vascular
injury grading scale (5) for each vascular injury were analyzed and the pertinent
findings were documented. The location of the vascular injury and any spine fracture
or soft tissue injury also was documented. Analysis of the database to determine the
incidence of vascular injury and the breakdown of the grades of injury was performed.

Results
Four hundred forty-six total patients were evaluated and 83 CT angiograms were
positive for vascular injury, for a total of 117 injuries. The incidence in our population
for a vascular injury was 18.6%. Of the injuries reported, 53.8% were Grade 1, 24.8%
were Grade 2, 9.4% were Grade 3, and 11.9% were Grade 4.

Conclusions
Evaluation of the neck vasculature using CT angiography is extremely important in
blunt trauma patients to prevent devastating outcomes of untreated injuries. We found
a detection rate for vascular injuries of 18.6%, much higher than previously reported
rates of 0.9% to 2.7%. We suspect this increased rate may have been secondary to a
high number of grade one injuries, but when grade one injuries were excluded, the
rate was still 12.1%. Another explanation for the increased incidence may be a bias
toward more severely injured patients at our large level one trauma center with a
helicopter ambulance. Further evaluation of the database will be performed for future
projects such as evaluation of the progression of injury on subsequent CT angiograms.

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<th>Grade 3</th>
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(Filename: TCT_O-186_Table1.jpg)
Imaging Atlas of Type I and Type II Focal Cortical Dysplasia

E Morimoto\textsuperscript{1}, H Yokota\textsuperscript{1}, A Yogi\textsuperscript{1}, H Ullman\textsuperscript{1}, Y Hirata\textsuperscript{1}, I Orosz\textsuperscript{2}, M Linetsky\textsuperscript{1}, B Ellingson\textsuperscript{3}, N Salamon\textsuperscript{2}

\textsuperscript{1}David Geffen School of Medicine at UCLA, Los Angeles, CA, \textsuperscript{2}UCLA, Los Angeles, CA, \textsuperscript{3}University of California Los Angeles, Los Angeles, CA

Purpose

Focal cortical dysplasia (FCD) is one of the most common causes of intractable epilepsy. Many examples of type I FCD and some of type II FCD are subtle and
difficult to detect with magnetic resonance imaging (MRI). Precise identification of
the site of FCD is important in obtaining improved surgical outcomes and seizure
freedom. The purpose of this study was to create an atlas of different types of FCD to
better understand its topographic distribution and to facilitate more accurate diagnosis.
Materials and Methods
Twenty-six cases of pathologically proven FCD (Type I and Type II) were included.
Cases with multilobar FCD were excluded. Regions of interest were generated
manually for all 26 cases on T2-weighted images with reference to hypometabolic
areas on FDC-PET using Analysis of Functional NeuroImages (AFNI). All regions of
interest (ROIs) were spatially normalized and registered to Montreal Neurological
Institute (MNI) brain atlas. Existence frequency of FCDs in each lobe was calculated
and corrected by the known percentage of the gray matter volume in the lobe relative
to that of the whole brain.
Results
The distribution atlas demonstrates that the frontal lobes are the most frequent
location of FCD (all types); however existence frequency per volume for FCD type I
is highest in the temporal lobes (Fig. 1). In FCD type II, the corrected frequency in
temporal lobes (30.5%) was similar to frontal lobes (33.3%) and occipital lobes
(23.7%, Fig. 1). Within the temporal lobes, four of the six FCD type I cases and one
of the 3 FCD type II cases were in the mesial portions of the temporal lobes (Fig. 2).
Conclusions
Existence frequency per volume for subtle type I FCD is highest in the temporal lobe
while Type II FCD is distributed relatively equally. The use of a FCD radiographic
atlas may aid in the localization and diagnosis of FCD.
Figure 1. Corrected frequency of FCDs in each lobe.

Figure 2. Location difference of FCDs in the temporal lobes.
O-188  

Discrepancy between MRI and FDG-PET on focal cortical dysplasia

H Yokota¹, E Morimoto¹, I Orosz², Y Hirata¹, A Yogi¹, H Ullman¹, N Salamon³  
¹David Geffen School of Medicine at UCLA, Los Angeles, CA, ²UCLA, Los Angeles, CA, ³David Geffen School Of Med. at UCLA, Los Angeles, CA

Purpose
Magnetic resonance imaging (MRI) and FDG-PET are essential tools to detect focal cortical dysplasia (FCD). However, discrepancy between MRI and FDG-PET often are observed and confuses diagnosis. We revealed characteristics of the discrepancy by visual assessment.

Materials and Methods
We evaluated pathologically proven 41 type I and type II FCD of 40 patients (2-55 years; mean age, 18.0 years; woman 23, man 17), from the UCLA epilepsy program focal cortical dysplasia cohort between 2004-2014. Focal cortical dysplasia extending multiple lobes were excluded. All patient had nonictal PET scan. Using MRI-PET coregistration, the area of abnormality on MRI and zone of PET hypometabolism were delineated manually. The cases were divided into three groups. Group A: PET hypometabolism is larger than the MRI lesion. Group B: PET hypometabolism zone is same as MRI abnormality. Group C: PET hypometabolism zone is smaller or less evident in the area of MRI abnormality.

Results
Fifteen cases showed larger hypometabolism, 23 cases showed equivalent PET and MRI abnormality and two cases showed no obvious PET hypometabolism. Most of Group A cases was in temporal lobe. Although FCD type I and II were classified significantly as group A and B, respectively (p=0.04), FCD type I was major in temporal lobe (12 of 14). All 14 FCDs of temporal lobe were located in anterior part (pole 11, superior temporal gyrus 1, middle temporal gyrus 1, inferior temporal gyrus 1). On temporal lobe, hypometabolic area on PET was extended mainly along medio-basal part, lateral part or both parts (7, 1 or 6, respectively). Some of the frontal lobe FCD shows no obvious hypometabolism.

Conclusions
PET hypometabolism is larger than MRI abnormality in temporal lobe. Frontal lobe FCD does not always demonstrate hypometabolism. This may reflect of seizure propagation network. FDG PET will be a helpful modality to identify temporal lobe FCD when the MRI is not obvious.
Hybrid PET/MR shows reduced CBF and glucose uptake in Subdural Electrode Identified Seizure Foci

X Zong1, H Shin1, S Park1, X Cao2, S Todorova1, V Jewells1, S Hung3, W Lin1, D Shen4
Purpose
Recent availability of hybrid positron emission tomography/magnetic resonance (PET/MR) scanners have offered new opportunities to assess structural, functional, and metabolic abnormalities in patients with neurological diseases. To this end, we evaluated how hybrid PET/MR may aid routine clinical workup for identifying epileptic foci by simultaneously assessing MR cerebral blood flow (CBF) and PET glucose metabolism in epilepsy patients. Specifically, we directly evaluated cerebral blood flow (CBF) and glucose uptake in brain regions that were clinically proven epileptic foci using intra-operatively placed subdural electrodes (SDE).

Materials and Methods
Seven patients underwent pre-operative clinical PET/MRI using the Siemens mMR Biograph. Positron emission tomography images were acquired 30-45 min after intravenous infusion of ~5mCi FDG. Cerebral blood flow images were acquired using a pseudo-continuous arterial spin labelling sequence. After subdural electrode (SDE) placement, CT scans were performed to determine the anatomical locations of the electrodes. The CT images then were registered onto pre-op PET/MR images using a framework developed by our group capable of accurately registering the implanted electrodes onto pre-op PET/MR images. The seizure foci then were determined using the SDE. Regions with reduced FDG uptake were identified on PET images. Cerebral blood flows and body-weight-normalized standardized uptake value (SUVbw) of FDG were calculated in regions of interest (ROIs) (~125 mm3) around the electrodes indicating seizure foci. Cerebral blood flows and SUVbw at the homologous regions in the contralateral hemisphere also were obtained for comparison.

Results
Two patients were excluded due to inconsistent voxel size and failure to obtain consent for data analysis. Representative CBF and FDG-PET maps from a patient with left medial temporal lobe epilepsy are shown. With the exception of one patient, all patients showed decreased CBF and FDG uptake on the lesion foci identified by EEG (see asterisks) when compared to the homologous regions (see '+' signs) in the contralateral hemisphere. In contrast, one patient (RAT0207) who had both temporal and parietal-occipital lobe foci showed increased CBF and glucose uptake. Finally, all patients exhibiting decreased CBF and glucose uptake at the epileptic foci achieved good surgical outcomes (see the Table).

Conclusions
Our results suggest that hybrid PET/MR may provide clinically relevant information on localizing epileptic foci.
Coupling of FDG uptake and CBF using simultaneous MR-PET measurements in human temporal lobe epilepsy

X Zong¹, H Shin¹, S Park¹, X Cao², S Todorova¹, V Jewells¹, S Hung³, W Lin¹, D Shen⁴
¹University of North Carolina at Chapel Hill, Chapel Hill, NC, ²Northwestern Polytechnical University, Chapel Hill, NC, ³Taipei Veterans General Hospital, Taipei, Taipei, ⁴UNC School of Medicine, Chapel Hill, NC

Purpose
Whether or not there is an uncoupling between cerebral blood flow (CBF) and glucose metabolism (CMRglu) at the epileptic foci remains controversial in the literature (1, 2). One highly plausible explanation for the inconsistent results in the literature may be time-dependent changes of CBF and CMRglu at the epileptic foci since these two measurements typically were acquired at two separate sessions. To this end, simultaneous PET and MR images were acquired using a hybrid PET/MR scanner allowing simultaneous assessments of CBF and glucose metabolism in temporal lobe (TL) epilepsy patients.

Materials and Methods
Ten patients with clinically confirmed unilateral TL epilepsy were included in the study. Interictal FDG-PET and MRI images were acquired on a Siemens mMR Biograph. After intravenous infusion of ~5 mCi of FDG, patients were kept in a quiet room for 30-45 min prior to PET/MR imaging. Cerebral blood flow images were acquired using a pseudo-continuous arterial spin labelling sequence. High resolution T1-weighted images were acquired for segmenting the temporal lobes bilaterally.
Cerebral blood flow and body-weight-normalized standardized uptake value (SUVbw) of FDG were obtained for the ipsi-lesional and contra-lesional TLs.

Results
Figure (A) shows representative CBF and SUVbw maps overlaid with the TL masks in a left TL epilepsy patient. The left TL shows reduced CBF and SUVbw. The group-averaged CBF and SUVbw both were decreased significantly on the ipsi-lesional TL when compared to the contra-lesional TL (p = 0.028 (CBF) and 0.057 (SUVbw); paired t-test). In addition, a strong correlation was observed between the SUVbw and CBF across the patients (R = 0.53; p = 0.016), as shown in Figure (B). No apparent difference was observed for the CBF versus SUVbw relationship between the ipsi- and contra-lesional hemispheres, suggesting a coupling between CBF and glucose metabolism in both TLs.

Conclusions
Our results demonstrate that although significant CBF and marginally significant SUVbw reductions in the ipsi-lesional TL were observed, the CBF and glucose metabolism remained coupled.

(A) CBF  FDG-SUVbw  (B)

(Filename: TCT_O-190_Fig2.jpg)

O-191

Amygdala Enlargement in Temporal Lobe Epilepsy

A Capizzano¹, N Mallak¹, P Kirby², M Werz³, T Moritani¹
¹Department of Radiology. University of Iowa Hospitals and Clinics, Iowa City, IA, ²Department of Pathology. University of Iowa Hospitals and Clinics, Iowa City,
Purpose
Amygdala enlargement (AE) on brain magnetic resonance imaging (MRI) ipsilateral to the seizure focus recently has been recognized as a biomarker of a new subtype of mesial temporal lobe epilepsy (mTLE) (1). The purpose of this study is to review clinical, imaging and pathological features in a series of mTLE patients with AE without mesial temporal sclerosis (MTS) and to compare them to a group of mTLE without AE but with pathologically proven MTS.

Materials and Methods
Institutional Review Board approval was obtained for this retrospective study. Amygdala enlargement patients were selected based on clinical diagnosis of mTLE without MTS and enlarged uncus including the amygdala ipsilateral to the video EEG defined seizure focus. Patients with mass lesions or with MTS were excluded. Eleven patients with AE were entered in the study (4 women, 7 men) with mean age of 35.5 years. An age-matched group of 16 mTLE patients followed up for a minimum of 2 years after anterior temporal lobectomy with pathologically proven MTS without AE with favorable seizure outcome (Engel class I, II or III) was compared to the AE group.

Results
Amygdala enlargement patients were older at seizure onset (27.2 versus 11.3 years, p<0.01) and had less prevalence of childhood febrile seizures (p<0.05) compared to MTS patients. Amygdala enlargement had predominantly complex partial seizures with limbic auras, followed by generalized convulsions. No significant difference in seizure type was noted between groups. Ten AE patients had unilateral AE and one had bilateral AE. For the 10 unilateral AE, ADC of the ipsilateral amygdala was 828.4 mm2/s versus 803 mm2/s in the contralateral side (p<0.05). FLAIR signal of the ipsilateral amygdala normalized to the corpus callosum was higher compared to the contralateral one (1.9 versus 1.75, p<0.01). Five AE patients are seizure free on medications, while six had refractory seizures. Four of the latter underwent ipsilateral anterior temporal lobectomy. The figure shows pre-operative coronal FLAIR with arrows pointing to the abnormal side. Pathology disclosed amygdala dysplasia in three and gliosis in one. These 4 AE patients became seizure free with a mean follow up of 21 months.

Conclusions
Amygdala enlargement may represent the only imaging abnormality in a subset of mTLE patients. The most common pathologic underpinning of AE is cortical dysplasia (2). As reported, AE patients have lower prevalence of febrile childhood seizures and later onset of seizures (2). A significant proportion of patients are well controlled on medications and therefore do not become surgical candidates (3, 4). On
imaging, AE has to be distinguished from tumors of the uncus or transient postictal changes. Amygdala enlargement appears as an asymmetric bulging of the uncus imperceptibly merging with the adjacent temporal lobe with homogeneously high FLAIR signal compared to the normal contralateral side. Apparent diffusion coefficient values are slightly higher on the abnormal side suggesting lower cellular density. In conclusion, neuroradiologists should search for features of AE in mTLE patients without MTS, which is particularly important in patients evaluated for surgery for refractory seizures in whom AE can be the only MRI finding.
Differentiation of Seizure and Other Seizure Mimickers: Clinical Utility of Arterial Spin Labeling Perfusion MRI
Purpose
Various diseases including acute ischemic stroke may mimic seizure in practice. Our aim was to evaluate the utility of arterial spin labeling perfusion-weighted imaging (ASL-PWI), a noninvasive perfusion imaging technique with no need for contrast administration, in differentiating seizure from other seizure mimickers.

Materials and Methods
One hundred and seventy-one consecutive patients, who underwent MR imaging including diffusion-weighted imaging and ASL-PWI with the suspicion of seizure in the acute setting, were included. Perfusion abnormality was analyzed for: (1) pattern (hypo- or hyperperfusion relative to the gray matter of normal contralateral parenchyma), (2) multifocality (focal, multifocal, or hemispheric), and (3) territory (territorial or non-territorial). Normalized CBF (nCBFlesion=CBFlesion / CBFgray matter) was calculated. Fisher exact test and unpaired t test were used to compare the perfusion abnormality.

Results
Final diagnoses included seizure (n=133), stroke (n =1), poststroke seizure including stroke onset seizure (n=19), and nonseizure, nonstroke group (n = 18).

Hyperperfusion was significantly more common in peri-ictal scans (n=42) than in interictal (n = 77) scans (62% versus 26%, respectively; P < .001). Incidence of hyperperfusion did not significantly differ between patients who presented with convulsive symptoms and those with nonconvulsive symptoms in both peri-ictal (P = .501) and interictal scans (P = .100). Hypoperfusion, multifocality, and territorial distribution were significantly more common in stroke onset seizure (n = 12) than in seizure (P <.001; P = .024; P <.001). Mean nCBFlesion was significantly higher in seizure than in stroke onset seizure (2.359 +/- 0.973 versus 1.318 +/- 1.405, respectively; P = .006). In addition, hyperperfusion was significantly more common in seizure than in the nonseizure, nonstroke group (38% versus 0%, respectively; P < .001).

Conclusions
Arterial spin labeling-perfusion-weighted imaging may provide a convenient and noninvasive means of delineating transient perfusion abnormality in seizures and thus assist in discriminating seizures from other seizure mimickers.
Predicting Laterality of Seizure Onset Zone by Diffusion Tensor Tractography of Intracranial Depth Electrodes in Patients with Temporal Lobe Epilepsy

I Orosz¹, D Woodworth¹, S Weiss², A Yogi³, H Ullman⁴, J Qiao⁵, V Patel¹, I Fried⁶, J Stern², B Ellingson⁷, N Salamon¹

¹Department of Radiological Sciences, Section Neuroradiology, UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA, Los Angeles, CA, ²Department of Neurology, UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA, Los Angeles, CA, ³Department of Radiological Sciences, Section Neuroradiology, UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA, ⁴Department of Radiological Sciences, Section Neuroradiology, UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA, ⁵Department of Radiology, UCLA, Los Angeles, CA, ⁶Department of Neurosurgery, UCLA, Los Angeles, CA, ⁷Department of Radiological Sciences, UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
The success of temporal lobe epilepsy (TLE) surgery relies on accurate lateralization of the seizure onset zone (SOZ). In patients with multiple SOZs, extended electroencephalogram evaluation with intracranial electrodes is needed for further SOZ localization. Previous diffusion tensor imaging (DTI) studies have demonstrated white matter degeneration beyond the presumed epileptogenic zones, which can help to localize the SOZ. The purpose of this study is to determine whether DTI tractography of the intracranial electrodes can complement conventional presurgical evaluations of SOZ localization in TLE. This is the first DTI study performed in conjunction with intracranial electrodes, providing an evaluation of the closest white matter bundles underlying to the epileptogenic zone.

Materials and Methods
Nineteen adult patients (mean age 40.57 years, sd=3.4) with intractable TLE and without hippocampal sclerosis were analyzed retrospectively. All patients underwent stereotactic, MR-guided implantation of four to eight intracranial electrodes in each hemisphere with the majority placed into mesial temporal structures. The SOZ was determined according to the intracranial EEG recording, and patients were divided into unilateral and bilateral TLE subgroups. Tract analysis was performed by
manually drawing seed regions of interest (ROIs) around each intracranial electrode and calculating the mean fractional anisotropy (FA) along the traversing streamlines.

**Results**
In patients with unilateral TLE (n=10), we demonstrated significantly increased mean FA (p=0.02, paired two tailed t-test) in the tracts computed from the intracranial electrodes under the epileptogenic zone compared to the homologues electrodes of the contralateral hemisphere. No significant difference of mean FA was found in the SOZ versus non-SOZ of the contralateral hemisphere in patients with bilateral TLE (n=9).

**Conclusions**
White matter regions near the SOZ appear to have increased axon directional coherence and density compared with nonepileptogenic regions as evidenced by altered diffusion characteristics. This information pursued by our method may be valuable to localize epileptogenic brain regions in TLE patients.

**O-194**
9:20AM - 9:23AM

**Registering Post-Op CT and Pre-Op MR Images for Accurate Localization of Intraoperative EEG Electrodes**

S Park¹, X Cao², S Hung³, X Zong¹, V Jewells¹, W Lin¹, H Shin¹, D Shen¹
¹University of North Carolina at Chapel Hill, Chapel Hill, NC, ²Northwestern Polytechnical University, Shaanxi, China, ³Taipei Veterans General Hospital, Taipei, Taipei

**Purpose**
Accurate localization of subdural electrodes on multimodality images is necessary for detection of brain subregion connectivity of epilepsy patients to accurately localize seizure onset foci. However, localization is challenging because the brain is significantly displaced due to craniotomy, atmospheric pressure, edema and intracranial hemorrhage. Accordingly, the electrodes shown in post-op computed tomography (CT) images often are localized to incorrect positions with conventional registration methods. To address this problem, we propose a novel two-step registration method.

**Materials and Methods**
We developed a framework capable of aligning post-op CT images to the pre-op MR images in six epilepsy patients who were imaged using MR pre-operatively and underwent intra-operative placement of electrodes and subsequent CT/MR imaging. The developed framework included several steps. First, post-op CT images were aligned to the pre-op magnetic resonance (MR) images by using a rigid registration method (Flirt registration). Although most structures were aligned correctly, electrodes near the seizure zone could not be registered to the correct positions by
rigid registration due to large local deformations. To mitigate this problem, we performed skull stripping on both the post- and pre-op MR images, and then further aligned them using nonrigid registration (Demon registration) to correct for the registration errors resulted from Flirt. In addition, subdural hematoma regions were removed during the skull stripping, followed by visual inspection and manual editing if needed. Based on the deformation fields, the post-op CT image was aligned to the pre-op MR images allowing extraction of the coordinates of the electrodes to provide a direct link between electrode location and pre-op MR images. Finally, to evaluate accurate localization, we measured the average error distance between the coordinates of electrodes and the closest surface of brain tissue.

Results
The average error distance was obtained as 3.63mm for the Flirt method, while 1.45mm for our method from all six images. The aligned CT images using the Flirt registration and our method are shown in the left and middle of Figure 1, respectively, and the pre-op MR image overlying the electrodes is shown on the right. The crosses and squares indicate the positions of electrodes obtained by the Flirt registration and our method, respectively. It is apparent that our proposed method was much more robust for edema/subdural hematoma compared to the simple rigid registration method.

Conclusions
The newly developed registration method successfully localized the subdural electrodes to the appropriate positions on brain tissue even in very ambiguous regions with edema and subdural hematoma. Continuing refinements focusing on completely automating the procedures are ongoing. This technique can serve as an important basis where all of pre-operative MR results can be combined accurately with information obtained from electrodes.
8E-Quantitative Imaging

8E-1

Quantitative Imaging in Context

Herskovits, E.
University Of Maryland
Baltimore, MD

8E-2

Neuroimaging Analysis

Shen, D.
UNC School of Medicine
Chapel Hill, NC

8E-3

A Local Level Learning Health System for Head and Neck Radiation Oncology

McNutt, T.
Johns Hopkins University
Columbia, MD

8E-4

Applications of Imaging Quantification

Bhagavatheeshwaran, G.
NINDS, NIH
Bethesda, MD

8E-5

Tools For High - Throughput Neuroimage Analysis and Personalized Medicine

9:09AM - 9:26AM
9:26AM - 9:43AM
9:43AM - 10:00AM
Faria, A.
Johns Hopkins University
Baltimore, MD

Tuesday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Roosevelt 4

8F-1

Presentation of the J. Arliss Pollock Memorial Award

8F-1a

8:45AM - 9:05AM

The Dawn of a New Day: Goodbye SGR, Hello MACRA

Hirsch, J.
Massachusetts General Hospital
Boston, MA

8F-2

9:05AM - 9:30AM

Diving Deep on APMs and Succeeding with MIPS

Nicola, G.
Hackensack Radiology Group
River Edge, NJ

8F-3

9:30AM - 10:00AM

How Imaging 3.0 Fits into New Paradigm for Neuroradiologists
Tuesday
10:30AM - 11:00AM
Washington Marriott Wardman Park, Marriott Ballroom

9-ASNR Annual Business Meeting (Members Only)
Tuesday
11:00AM - 12:00PM
Washington Marriott Wardman Park, Marriott Ballroom

9A-1
11:00AM - 11:30AM
Updates from CMS

Goodrich, K.
Centers for Medicare and Medicaid Services
Baltimore, MD

9A-2
11:30AM - 12:00PM
News from the FDA

Krainak, D.
FDA
Silver Springs, MD

Tuesday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Marriott Ballroom

10A-ASHNR Programming: Update on Orbital Imaging Audience Response (AR) Self Assessment Module (SAM)
10A-1
1:15PM - 1:40PM
Visual Loss: Understanding the Patterns
Kennedy, T.
University Of Wisconsin Hospital
Madison, WI

10A-2
Diplopia: Anatomy and Pathology
Schmalfuss, I.
NF/SG Veterans Administration
Gainesville, FL

10A-3
Orbital Infections: What You Need to Know
Avey, G.
University of Wisconsin
Madison, WI

10A-4
Questions & Answers

Tuesday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Washington 4/5/6

10B-ESNR Programming: Cases
10B-1
Cases
Van Goethem, J. · Thurnher, M. · Kucharczyk, W.
University Hospital Antwerp · Medical University Of Vienna · Toronto General Hospital
Antwerp · Vienna · Toronto, ON

Tuesday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Washington 1/2/3

10C-Healthcare Policy Programming: Challenges Along the Road from Volume to Value
10C-1
1:15PM - 1:45PM
Management of Incidental Thyroid Nodules: ACR White Paper and Controversies

Hoang, J.
Duke University Medical Center
Durham, NC

10C-2
1:45PM - 2:15PM
A Surgeon’s Perspective on Incidental Thyroid Nodules

Sosa, J.
Duke Cancer Institute and Duke Clinical Research Institute
Durham, NC

10C-3
2:15PM - 2:45PM
ACR Perspective on the Shift from Volume to Value

McGinty, G.
Weill Cornell Medicine Radiology
New York, NY
Human lifespan age-related changes of the brain proton density by quantitative MRI

H Kuno¹, O Sakai¹, H Jara¹
¹Boston Medical Center, Boston University School of Medicine, Boston, MA

Purpose
Calibrated proton density (PD) measurements using quantitative MRI (qMRI) approximate the mobile water content in the human brain (1). Noninvasive, quantitative PD (qPD) mapping has demonstrated the ability to provide important disease-related parameters associated with focal or global change in tissue water homeostasis (2-4). Prior qPD studies used weighting inversion with cerebrospinal fluid (CSF) calibration have hinted age-related changes over the human lifespan (5). In this work, we use a more accurate qPD technique based on T1 relaxometry.

Materials and Methods
The protocol was approved by the IRB of our institution, and all subjects were consented following NIH HIPAA guidelines. The brain data of 63 healthy subjects (28 males and 35 females; median age, 24.5 years; age range, 0.5 to 87 years) were obtained with the mixed-TSE pulse sequence with a 1.5T MR unit. The whole brain including cerebrospinal fluid (CSF), white (WM), gray matter (GM), and meninges were segmented using a 3-channel dual-clustering algorithm programmed in Mathcad (PTC, Needham, MA). PD histograms of the whole brain were generated and resolved into specific tissues (CSF, GM, and WM) by Gaussian functions.

Results
Subjects younger than 2 years of age and older than 78 years of age, had unimodal PD histograms. All other subjects had bimodal histograms with differentiated WM and GM peaks. Peak PD values for GM and WM as a function of age are plotted (Fig.):

PD of GM decreased from 0 to 20 years of age and remained approximately stable during adulthood and senescence periods. PD of WM also decreased in the 0-to-20 year range, stabilized during early adulthood, and increased thereafter.

Conclusions
Proton density age-related changes of the normal brain tissues have been studied
throughout life. These results could contribute to establishing a quantitative mapping of water content baseline of the normal brain, covering the full human life span.
Structural Connectivity of Distributed Cortical Association Networks Reflects Cognitive Reserve in Autosomal Dominant Familial Alzheimer's Disease

J Prescott¹, J Petrella¹
¹Duke University Medical Center, Durham, NC

Purpose
To assess whether structural connectivity changes in distributed cortical association networks predict cognitive reserve, as determined by estimated years until onset (EYO) of dementia in cognitively normal (pre-symptomatic) autosomal dominant Alzheimer mutation carriers, and to determine whether such changes precede known functional connectivity changes in this population.

Materials and Methods
We studied all cognitively normal subjects enrolled in the Dominantly Inherited Alzheimer's Network (DIAN) who had T1-weighted magnetic resonance imaging (MRI), resting state functional (f)MRI, and diffusion tensor (DT) imaging MRI at baseline. The T1 images were segmented using an empirically derived standard atlas of seven resting-state networks in FreeSurfer. Figure 1 demonstrates a standard parcellation of the human cortex into seven separate distributed cortical association networks based on resting state fMRI from 1000 young healthy subjects; example networks of interest for this study include the ventral attention network (purple), default mode network (red), and frontoparietal control network (orange). Structural connectivity of each of the seven networks was calculated as the weighted global efficiency of structural connections calculated from tractography of DT images; tractography was performed using DSI Studio. The weighted global efficiency is the average inverse shortest path length between any two nodes in the network. Functional connectivity was calculated as the average timeseries correlation between the nodes of each region in each resting state network. General linear models were created for mutation carriers (M+) and noncarriers (M-), which examined the relationship between cortical functional connectivity and EYO, and white matter structural connectivity and EYO, after covarying for sex, education, cognitive performance (mini mental state examination - MMSE), ApoE4 allele status (positive or negative), and normalized white matter volume. A p-value less than 0.05 was considered significant.

Results
There were 75 subjects analyzed: 37 mutation carriers and 38 controls (no mutation). Among cognitively normal mutation carriers, there was a significant change in white matter structural connectivity versus EYO in the default mode network, ventral attention network, and frontoparietal control network (p < 0.05), but not in any other network. There was no significant change in functional connectivity. There was no
significant change in either structural or functional connectivity versus EYO in the controls.

Conclusions
Significant decreases in white matter structural connectivity with decreasing EYO in mutation carriers, but not in controls, in the default mode network, ventral attention network and frontoparietal control network, suggest that the pathologic underpinnings of AD disrupt the cognitive substrate early and progressively in those with an autosomal dominant genetic mutation corresponding to early onset AD.

(Filename: TCT_O-196_Presentation1.png)
Personalized genetic prediction of age-associated Alzheimer’s disease risk

R Desikan¹, C Fan², W Dillon¹, D Wilson¹, C Hess¹, A Dale²
¹UCSF, San Francisco, CA, ²UCSD, San Diego, CA

Purpose
Identifying individuals at risk for developing Alzheimer disease (AD) is of clinical and societal importance. Genetic risk factors may be useful for predicting the age-specific risk for developing AD.

Materials and Methods
Using genotype data from 11,840 AD patients and 10,931 cognitively normal older individuals from the Alzheimer's Disease Genetics Consortium, we developed a polygenic hazard score (PHS) for predicting age of AD onset. We integrated known AD associated single nucleotide polymorphisms (SNPs) into a Cox proportional hazards model. For each individual, we calculated the AD hazard rate conditioned on the polygenic profile using established population-based incidence proportion and the hazard ratios from our final Cox model.

Results
Using age of onset and polygenic profile, we were able to quantify a single individual's risk (hazard) for developing AD. Between 60 and 95 years, increasing PHS strongly predicted decreased median age of AD onset. Accounting for established population incidence, we additionally found that the PHS could inform AD incidence proportion in the US population. The PHS strongly correlated with intracranial neurofibrillary tangles and amyloid plaques, magnetic resonance imagina (MRI) measures of medial temporal lobe volume loss, CSF amyloid-β1-42 levels and baseline CDR-Sum of Box scores.

Conclusions
We have developed and validated a polygenic hazard score for predicting AD age of onset. Quantification of genetic risk in AD may prove useful for early detection, disease prevention, determining prognosis, and cohort enrichment in clinical trials.
Apolipoprotein E Genotype and Mesial Temporal Atrophy: Two-year Follow-up in Patients with Stable Mild Cognitive Impairment and with Conversion from Mild Cognitive Impairment to Alzheimer’s Disease

B Stevens¹, M Spampinato², S Bickley¹
¹Medical University of South Carolina, Charleston, SC, ²Medical University Of South Carolina, Charleston, SC

Purpose
To examine the relationship between Apolipoprotein E (APOE) genotype and mesial temporal atrophy in patients with mild cognitive impairment (MCI) with and without conversion to Alzheimer disease (AD).

Materials and Methods
We evaluated 172 MCI patients with (N = 85, 60 APOE4-positive) and without (N = 87, 36 APOE4-positive) AD conversion. Longitudinal magnetic resonance imaging (MRI)-based hippocampal volume (HV) and entorhinal cortex (ERC) thickness measurements were obtained using FreeSurfer V4 software. The Clinical Dementia Rating Sum of Boxes (CDR-SB) score was used for cognitive assessment. APOE genotype was determined from peripheral blood DNA.

Results
We found a significant effect of APOE4 (F = 5.1, p = 0.025) and clinical course of the disease (stable MCI versus MCI-AD conversion, F = 18.5, p < 0.001) on longitudinal HV measurements. There was a significant effect of the clinical course (F = 14.9, p < 0.001), but not of APOE4 (F = 1.374, p = 0.244), on serial ERC thickness measurements. There were significant differences in cognitive performance measured using CDR-SB scores between patients with and without MCI-AD conversion but not between APOE4 carriers and noncarriers.

Conclusions
The trajectory of HV is influenced by the APOE genotype to a greater extent than the trajectory of ERC thickness in patients with MCI. The effects of APOE4 on structural MRI biomarkers such as HV and ERC thickness should be considered when designing clinical trials that rely on neuroimaging measures of disease progression.
Purpose
Disregulation between the striatum and other neo-cortices have been found to be related to clinical impairments associated with Parkinson's disease (PD). By using structural covariance for assessing large-scale structural covariant networks (LSSCN), we had demonstrated that altered striato-cortical networks are an important hallmark in PD. In present study, we used independent component analysis (ICA) to explore the whole brain LSSCN in PD and to examine the usefulness and reproducibility of LSSCN in the diagnosis of PD.

Materials and Methods
High resolution T1-weighted magnetic resonance imaging was performed in 72 patients with idiopathic PD (mean age, 61.08 years) and 73 healthy subjects (mean age, 58.96 years). The whole brain LSSCNs were extracted using spatial ICA with 70 components. With the forward stepwise feature selection scheme, we identified the set of LSSCNs which provided the most predictive accuracy among 70 components. The leave-one-out cross-validation test, a relatively unbiased estimation, tested the practicability and reproducibility of the PD classifier. Receiver operating characteristic analysis was used to determine the diagnostic performance of the classifier. Pearson correlation analysis was further performed to correlate the outcome measurement of the PD classifier with disease severity.

Results
We found that the LSSCN achieved a well predictive power in the diagnosis of PD (sensitivity 93%; specificity 84%, and accuracy 88%). Further leave-one-out cross-validation tests revealed a high reproducibility of LSSCN in the diagnosis of PD (the mean sensitivity 82%, specificity 77%, and accuracy 79% respectively). Alterations of LSSCN in cerebellar network, executive networks, posterior network, default mode network, and limbic network were associated with higher risk of PD (Fig. 1). Furthermore, outcome measure of this regression model was associated with disease severity.

Conclusions
Consistent with network degeneration hypothesis, brain LSSCN with multiple logistic regression modeling can be a complementary tool in the diagnosis of PD.
Dentate Nucleus Iron Deposition Is a Potential Biomarker for Tremor-dominant Parkinson’s Disease

N He¹, F Yan¹, C Liu²
Purpose
Parkinson disease (PD) is a heterogeneous neurodegenerative disorder with variable clinicopathologic phenotypes and underlying neuropathologic mechanisms. Tremor is the most frequent initial motor symptom of PD and is the most difficult symptom to treat. The dentate nucleus (DN) is a deep iron rich nucleus in the cerebellum and may be involved in PD tremor. In this study, we test the hypothesis that DN iron may be elevated in tremor dominant PD patients using quantitative susceptibility mapping.

Materials and Methods
Forty-three patients with PD [19 tremor dominant (TD)/24 akinetic-rigid dominant (AR)] and 48 healthy gender- and age-matched controls were recruited. Multi-echo gradient echo data were collected for each subject. Similar to our prior study [cite], susceptibility values were obtained using the quantitative susceptibility mapping method [cite]. Bilateral DNs were drawn manually on the susceptibility maps using MRIcro software (www.mricro.com) by two neuroradiologists who were blinded to the diagnosis of each subject. The volume of the DNs was determined by multiplying the sum of voxels within the entire structure by the size of each voxel (0.86×0.86×1.0mm3). Inter-group susceptibility and volume differences in bilateral dentate nucleus were investigated and correlations of clinical features with susceptibility also were examined.

Results
In contrast to the AR group, the TD group was found to have increased susceptibility in the bilateral DN, when compared to healthy controls. In addition, susceptibility was positively correlated with tremor score in TD patients. And other clinical features, such as disease duration, akinetic rigidity score, and Unified Parkinsonian Disease rating scale (UPDRS)-III score were correlated moderately with bilateral DN susceptibility in the TD group. No significant difference in DN volume was found among the PD groups and healthy control group.

Conclusions
These findings indicate that iron load within DN may make an important contribution to motor phenotypes in PD.
Sex Differences in the Association Between Glycemic Control and Cerebral Blood Flow in African Americans with Type-2 Diabetes: The African-American Diabetes Heart Study MIND

Y Nguyen1, N Bahrami2, J Divers1, J Xu3, Y Jung1, B Freedman3, J Maldjian4, C Whitlow5

1Wake Forest School of Medicine, Winston-Salem, NC, 2Virginia Tech-Wake Forest University School of Biomedical Engineering & Sciences, 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
Growing evidence suggests that women suffer more end-organ complications of type-2 diabetes (T2D) compared to men. Hemoglobin A1C (HA1c) is a biomarker reflecting glycemic control over a 2-3 month period used to gauge the effectiveness of T2D clinical management. This study aimed to characterize the relationship between HA1c and whole brain gray matter (GM) cerebral blood flow (CBF) in the understudied African American population with well controlled T2D. We hypothesized that higher levels of HA1c would be associated with reduced cerebral blood flow (CBF) in GM, and that this relationship would be stronger in women compared to men.

Materials and Methods
African Americans with reasonably well controlled T2D (%HA1c Mean±SD; 8.2±2.1) were recruited as part of an IRB approved NIH funded study. We included 449 participants (268 women and 180 men) in our analysis who had HA1c and measures of CBF using pseudocontinuous arterial spin labeling (PCASL) magnetic resonance imaging (MRI). Magnetic resonance scanning with PCASL was performed with a 3TSiemens Skyra. Regression analysis of the entire cohort (males and females) was conducted to characterize the overall relationship between whole brain GM CBF and HA1c levels (adjusted for age, body mass index, hypertension, education, and diabetes duration), and then repeated separately for males and females.

Results
No statistically significant difference in HA1c was identified between males and females. There was also no statistically significant relationship between HA1c and whole brain GM CBF in the total cohort or among men separately. There was, however, a statistically significant linear relationship between HA1c and whole brain
GM CBF among women, with higher HA1c associated with lower rates of CBF (p<.04).

Conclusions

Hemoglobin A1C is associated with global rates of CBF in African American women, but not men, despite similar between-sex levels of HA1c that were all within the clinically recommended range for management of T2D. One concerning interpretation of these findings is that recommended guidelines for glycemic control based upon HA1c are inadequate for African American women, who may need more aggressive management to avoid brain end-organ complications and cognitive sequelae.

O-202

1:36PM - 1:39PM

Quantitative Gray Matter Calculations in Antiphospholipid Antibody Syndrome: A Novel Tool for Early Detection

s cantrell1, E Quigley2, J Anderson1
1University of Utah, Salt Lake City, UT, 2University Of Utah, Salt Lake City, UT

Purpose

We present the spectrum of intracranial findings associated with antiphospholipid antibody syndrome (AAS) with emphasis on early identification of parenchymal volume loss. We propose that quantitative methods may aid in early detection of subtle volume loss in patients with known AAS and may help distinguish volume loss in AAS from other etiologies such as CADASIL, multiple sclerosis and Alzheimer disease.

Materials and Methods

Retrospective review of MR images of patients with AAS presenting to a tertiary academic institution from 2012-2015 was performed. Quantitative gray matter volume calculations were performed using open source toolboxes for MATLAB (SPM 12b, Wellcome Trust). All patients with available MPRAGE images with at least 2x2x2 mm isotropic resolution and history of AAS were included. Gray matter segmentation (SPM12b, normalized to MNI space) was performed and number of gray matter voxels within 116 regions of the AAL brain atlas was compared to an age-matched database.

Results

Sequela of antibody mediated vascular endothelial damage including recurrent thromboses, strokes and advanced microvascular changes related to arteriolosclerosis were identified. Additionally, characteristic biparietal volume loss was observed, helping to differentiate AAS from CADASIL and Alzheimer, both of which characteristically demonstrate early involvement of the temporal lobes. Quantitative gray matter maps were helpful in detecting subtle, disproportionate biparietal volume
loss, which may be difficult to discern on conventional sequences. Given the growing variety of prophylaxis for the CNS manifestations of AAS, including immune modulating drugs and anticoagulants, early detection of CNS manifestations may become increasingly relevant.

Conclusions
Quantitative volumetric analysis may assist in detecting subtle volume loss not readily apparent on conventional sequences. In a patient with suspected AAS, early detection may prove clinically relevant given the opportunity for new therapeutic intervention and prevention of CNS manifestations. Additionally, when confronted with a patient with dementia or thrombotic sequela advanced for age, characteristic biparietal volume loss may prompt testing for antiphospholipid antibody syndrome.

O-203
1:39PM - 1:42PM

Brain Volume and Cell Volume Fraction in Adult Survivors of Pediatric Acute Lymphocytic Leukemia measured by Quantitative 23Na MR Imaging at 9.4 Tesla

N Narayan¹, I Atkinson¹, D Choi¹, M Schmidt¹, K Thulborn¹
¹University of Illinois at Chicago, Chicago, IL

Purpose
Long term survivors of pediatric acute lymphocytic leukemia (ALL) have been demonstrated to have a slightly decreased neuropsychological performance compared to age-matched healthy controls but the biological basis of this difference is not known (1). Our hypothesis is that the treatment of ALL with both systemic and intrathecal chemotherapy and sometimes whole brain radiation results in a decrease in brain tissue cell density and brain volume due to tissue cell death although often conventional anatomical MR images are not revealing. We have measured tissue sodium concentration (TSC) and its derived parameter of cell volume fraction (CVF) using quantitative 23Na MR imaging at 9.4T (2) in a group of ALL survivors and age-matched control subjects and correlated tissue loss with TSC and CVF.

Materials and Methods
Adult ALL survivors (N=10, 40% male, age range 19-29 years, age at diagnosis 2-17 years) and age-matched healthy controls (N=8, 50%M, age range 21-30 years) provided signed informed consent in IRB and FDA approved protocols. Magnetic resonance imaging (MRI) was performed on a customized 9.4T magnet equipped with a head gradient set and 23Na volume head coil (2). Quantitative sodium imaging was performed using a ultrashort TE twisted projection imaging (TPI) pulse sequence with both B0 and B1 corrections on each subject and a three compartment sodium calibration phantom (30, 70 110 mM aqueous NaCl) to obtain TSC maps from which
CVF maps were derived. The spatial resolution was nominally 2.5 x 2.5 x 2.5 mm³ with an acquisition time of 10 minutes providing a signal to noise ratio (SNR) of greater than 12. The B0 and B1 mapping each required additional 10 minute acquisitions. The TSC values for the frontal, parietal, temporal and occipital lobes and of the basal ganglia and thalami were measured by customized software and summarized by means and standard deviations (SD). The TSC maps also were used to measure the fraction of cerebrospinal fluid (CSF) space within the calvarium occupied by the cerebral hemispheres. Fractional CSF volumes were compared between ALL survivor and control groups by two-tailed t-test. Linear correlations were performed between regional TSC values and fractional CSF values for both groups.

Results
The fractional CSF volume of the ALL survivor group was statistically larger than the control group (p<0.015) indicating the decreased brain volume of the survivor group. The TSC values for the frontal and parietal lobes and for the basal ganglia and thalami but not of the occipital and temporal lobes showed significant linear correlations with increasing TSC values for the ALL survivor group. In contrast, the normal group showed constant TSC and CVF values across all regions of the brain.

Conclusions
The ALL survivors have smaller brain volumes that show statistically significant trends of increased TSC and decreasing CVF in the frontal lobes, parietal lobes, basal ganglia and thalami compared to age-match normal controls. These results suggest that the disease or its treatment during childhood has a measurable impact on regional brain structure. This trend may relate to age of diagnosis.

O-204
1:42PM - 1:45PM

Practical Low SAR Protocol at 1.5T using Two Magnet Systems for Patients Undergoing Staged DBS Insertion

A Franceschi¹, G Wiggins¹, A Mogilner², T Shepherd¹, S Chung¹, Y Lui¹
¹NYU Medical Center, New York, NY, ²NYU, New York, NY

Purpose
Obtaining high-resolution brain magnetic resonance imaging (MRI) in patients with previously implanted deep brain stimulator (DBS) has been challenging and avoided by many centers due to safety concerns relating to implantable devices. Pre-operative MR sequences routinely used for DBS placement guidance include a high-resolution T1-weighted sequence, used to identify standard anatomical landmarks such as the anterior and posterior commissures, as well as high-resolution T2-weighted MR imaging routinely used to target the subthalamic nucleus (STN), the most common structure targeted in DBS for Parkinson's disease. We present our experience using a
practical clinical MR protocol optimized for both therapeutic image quality in patients with implanted DBS electrodes and lowest possible SAR on two 1.5T magnet systems.

Materials and Methods
We reviewed MRI studies performed with minimal SAR protocol in patients with DBS in place at our institution between 2/1/2012-8/1/2015. Our initial tests showed that at SAR=0.1W/kg and 0.4W/kg the quality of the study was insufficient for stereotaxis. At SAR of ~0.7W/kg SAR we were able to achieve images adequate for intra-operative stereotaxis and the following protocol was set up: MPRAGE obtained in the axial plane with the following parameters: TR=1870ms, TE=4ms, FA=15, Nav=1, FOV=260x260mm, Matrix size 256x256, slice thickness=1.5mm, 176 slices; T2-weighted sequence obtained in the axial plane with the following parameters: TR=2500ms, TE=80-83ms, FA=150, Nav=4, FOV=260x260mm, Matrix size=256x256, slice thickness=2.5mm). Images were reviewed by a neuromodulation neurosurgeon and a neuroradiologist for adequacy.

Results
Twenty-nine patients (22 Parkinson's disease, six dystonia, one essential tremor) were imaged with at least one neuromodulation implant in situ (Medtronic, Minneapolis, MN). There were 25 subthalamic and four globus pallidus implants. Average imaging time was 6 minutes 17 seconds for MPRAGE and 12 minutes and 16 seconds for T2. Average SAR deposition for MPRAGE was 0.114 ±0.021 for the Avanto system, 0.090±0.001 for the Aera system and 0.109±0.021 overall. Average SAR deposition for T2 weighted sequence was 1.037±0.214 for the Avanto system, 0.828±0.091 for the Aera system and 0.987±0.210 overall. SAR deposition for both MPRAGE and T2-weighted sequences were significantly lower on the Aera system; p=0.012 and p=0.03, respectively with lower standard deviation. All pre-operative studies were adequate for guidance of second DBS placement. There were no complications.

Conclusions
Low SAR MRI protocol can be used to obtain high quality and high-resolution preoperative images for DBS surgical guidance safely in patients with a previously implanted electrode. In our multi-year experience with average T2 head SAR of 0.987 (less than a third of usual SAR limit), there were no recorded adverse effects to date. Optimized coil design, such as the incorporation of a multi-element receive array in a geometry that still allows for use of the stereotactic frame, could further improve image quality without increasing SAR.
Intracranial Gadolinium Deposition Following Contrast Enhanced MRI in Adult Patients with Normal Brain Pathology.

R McDonald¹, J McDonald¹, M Jentoft¹, D Murray¹, M Paolini¹, L Eckel², E Williamson¹, D Kallmes¹
¹Mayo Clinic, Rochester, MN, ²Mayo Clinic, Rochester, Rochester, MN

Purpose
Recent reports have detected gadolinium deposits in neural tissues of patients with intracranial pathology following intravenous gadolinium-based contrast agent (GBCA) exposure. In the current study, we sought to determine if this deposition might be related to blood-brain barrier integrity by studying adult patients with normal brain pathology.

Materials and Methods
After obtaining antemortem consent and IRB-approval for this single center study, we compared post mortem neuronal tissue samples on five patients who received between four and 16 gadolinium-enhanced abdominal magnetic resonance imaging (MRI) exams between 2005-2014 (contrast exposed group) to 10 gadolinium-naïve patients who underwent at least one MRI exam during their lifetime (control group). All contrast exposed patients received gadodiamide (Omniscan). Neuronal tissues from the dentate nuclei, pons, globus pallidus, and thalamus of these 15 deceased patients were harvested from our institutional biospecimen archive and analyzed by inductively coupled mass-spectrometry (ICP-MS), transmission electron microscopy.
with energy dispersive x-ray spectroscopy (TEM-EDS) and light microscopy to quantify, localize, and assess the effects of gadolinium deposition.

Results
Tissues from the four neuroanatomical regions of gadodiamide-exposed patients contained between 0.1-19.4 μg gadolinium/g tissue in a significant dose-dependent relationship (globus pallidus: rho: 0.90 p = .04). In contradistinction, control group patients had undetectable levels of gadolinium using ICP-MS. All contrast exposed (47-72 years) and control group patients (56-92 years) had normal brain pathology at the time of autopsy. Two of the five contrast exposed patients had borderline renal function (eGFR ~ 30) and hepatobiliary dysfunction at the time of MRI examination(s). Gadolinium deposition in the contrast-exposed group was localized to the capillary endothelium and neuronal interstitium using TEM-EDS.

Conclusions
Gadolinium deposition in neural tissues following GBCA administration occurs in the absence of intracranial pathology that might affect the permeability of the blood-brain barrier. These findings challenge our understanding of the biodistribution of these contrast agents and their safety.

O-206
Longitudinal Monitoring of Gadolinium Retention in the Dentate Nucleus and Globus Pallidus in Multiple Sclerosis Patients Within a 16-Months Period

S Siemonsen¹, J Stellmann², K Stuerner², C Heesen², J Fiehler³, J Sedlacik²
¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ²University Medical Center Hamburg-Eppendorf, Hamburg, Hamburg, ³University Medical Center Hamburg-Eppendorf, Hamburg, AK

Purpose
Recent studies showed an increase in signal intensity (SI) of the dentate nucleus (DN) and globus pallidus (GP) in association with the serial application of gadolinium-based contrast agents (GBCAs). Nevertheless, most of these studies are cross-sectional and data monitoring SI increase longitudinally is rare. The purpose of this analysis was to longitudinally assess the SI increase of the DN and GP on native T1-weighted (T1-W) images in multiple sclerosis (MS) patients and its association with the number of gadolinium administrations for magnetic resonance imaging (MRI).

Materials and Methods
Native T1-W images were analyzed for 16 MS patients, who all received 3T MRI for 12 time points within 16 months as part of a phase II clinical trial (scans were conducted at months 1-7, 9-12 and 16). The average T1-W SI of the DN, the GP and the cerebrospinal fluid (CSF) was obtained, and the DN-CSF and GP-CSF SI-ratio
(SIR) was calculated for each scan. Signal intensity ratio was correlated with the number of MR scans and not time, since no GBCA was administered between the scans, even if they were more than 1 month apart. A linear GBCA (gadopetamimeglumin; Magnograf) was used.

Results
The SIR for DN-CSF and GP-CSF was significantly increased in comparison to the baseline scan beyond the fifth scanning time point (p<0.01) and showed an overall contiguous increase towards the twelfth scan. The DN-CSF and GP-CSF SIR showed a significant positive correlation with the cumulative number of MR scans (for all p<0.01).

Conclusions
Our data suggest a linear increase of the DN and GP signal intensity on native T1-W scans in MS patients, caused by serial application of a linear GBCA within a relatively short period of time of 16 months. Figure Caption: Boxplots and regression line displaying the longitudinal increase of the SIR of the DN-CSF (A) and GP-CSF (B) for each MRI scan.
High T1 Signal Intensity of Brain Parenchyma after Repetitive Gadobenate Dimeglumine Administration: Evaluation of Multiple Sclerosis versus Tumor Patients

S Metting¹, B Bigjahan¹, o boyko², J Acharya¹, M Shiroishi¹, S Cen¹, W Gibbs³, G Ho², L Amezcu¹, M Law¹, A Lerner¹
¹University of Southern California, Keck School of Medicine, Los Angeles, CA, ²University of Southern California, Los Angeles, CA, ³University of Southern California, Keck School of Medicine, Pasadena, CA

Purpose
High T1 signal intensity (SI) in the brain parenchyma has been implicated as an indirect sign of gadolinium (Gd) deposition in patients administered gadolinium-based contrast agents (GBCA) (1). Patients with intracranial neoplasms (IN) and multiple sclerosis (MS) have been studied (1, 2). Recent dynamic contrast enhanced magnetic resonance imaging (DCE MRI) permeability studies revealed increased regional permeability in normal appearing white matter (NAWM) of MS patients suggesting diffuse derangements in blood-brain barrier (BBB) (3, 4). Abnormal permeability in the globus pallidus (GP) and dentate nucleus (DN) is possible, but not yet confirmed. Regions of increased vascular permeability in MS consequently may be more susceptible to Gd deposition than patients with only local BBB derangement. We assessed for increased T1 signal after multiple doses of gadobenate dimeglumine in MS and IN patients, and evaluated for group differences possibly related to BBB derangements.

Materials and Methods
Retrospective analysis of MS and IN patients was performed. Only patients with five consecutive administrations of gadobenate dimeglumine were included. Whole brain radiation was an exclusion criterion and irradiated regions of interest (ROIs) were excluded from measurement. Seventy patients were selected. Regions of interest measured SI on T1-W axial scans immediately prior to consecutive dosing, after five doses, and on the last scan. The ratios obtained were GP:thalamus (TH), DN:pons, white matter (WM):TH, and WM:pons. When possible bilateral measurements were averaged. Linear trajectory slopes of SI ratio were created for change per 10 units GBCA and change per year. The difference in trajectory slopes was compared using the interaction term.

Results
Initial analysis of 16 MS and 15 IN patients revealed a trend for increased DN:pons SI per units of GBCA in the IN group (p = 0.1), but not in the MS group. The slope interaction approached significance (p = 0.1). The DN:pons SI change per year in the
IN group was significant (p = 0.03), but not in the MS group. The slope interaction was significant as well (p =0.03). The slopes for GP:TH in MS and IN were positive, but the trend was weak. The interaction terms were not significant for GP:TH. No significant increase of WM:TH or WM:pons SI was identified for MS and IN patients, and the interaction term was not significant.

Conclusions
Our study shows a significant increase of DN SI in IN patients per year and a strong trend per units GBCA, which was not seen for MS patients. A significant difference between the groups exists counter to our expectations based on recent DCE MRI permeability studies for SI to be greater in MS. Greater frequency of GBCA dosing for IN patients could overwhelm clearance mechanisms such as glymphatics or perhaps chemotherapy plays a role. Additionally, no difference between groups was found in the GP and WM. Given previously analyzed data in MS patients at our institution and by Ramalho et al. demonstrating no signal change related to gadobenate dimeglumine in the GP, and only a trend in the DN 5, this may further evidence suggesting Gd deposition is more a function of neuroanatomical location and stability of the Gd agent (1, 5).

O-208

Comparison of Tissue Deposition Rates in Multiple Murine Organs Following Intravenous Administration of Linear vs Macrocyclic Gadolinium Chelates

R McDonald¹, J McDonald¹, D Dai¹, D Schroeder¹, B Cao¹, R Kadirvel¹, L Eckel², D Kallmes¹
¹Mayo Clinic, Rochester, MN, ²Mayo Clinic, Rochester, Rochester, MN

Purpose
Recent studies of gadolinium deposition in neural tissues following intravenous administration of gadolinium-based contrast agents (GBCAs) suggest deposition rates
may vary with chelate stability, yet little data exist using direct methods to quantify tissue deposition (1-3). In the current study, we compared gadolinium tissue deposition in multiple murine organs following injection of more stable macrocyclic chelates [gadobutrol (Gadavist)] to linear chelates [gadobenate dimeglumine (Multihance), gadodiamide (Omniscan)] that have intrinsically lower stability.

Materials and Methods
Healthy rats received 20 intravenous injections of 2.5 mmol Gd/kg (gadolinium-exposed group) or saline (control group) over a 26-day period. Unenhanced T1 signal intensities of the dentate nucleus were measured from MR exams performed prior to the initial GBCA injection and 4 days after the final injection. Murine brain, renal, hepatic, and splenic tissues were harvested post mortem 7 days after the final injection and subjected to inductively coupled plasma mass spectrometry (ICP-MS) for elemental gadolinium quantification and transmission electron microscopy (TEM) for characterization of gadolinium deposits (4).

Results
Brain tissue deposition of gadolinium varied with GBCA, with a median concentration of 1.6 ug Gd/g brain tissue (95% CI 0.9-4.7) in Gadavist-injected rats (n=5), 4.7 ug/g (3.5-6.1) in Multihance-injected rats (n=3), and 6.9 ug/g (6.2-7.0) in Omniscan-injected rats (n=5) (Fig. A). Similar relative differences in gadolinium deposition were observed in renal, hepatic, and splenic tissues, albeit at much higher tissue concentrations (Fig. B). No significant tissue deposition was observed in control rats (n=6). Gadolinium deposits were visualized directly in the endothelial capillary walls and neural interstitium in GBCA injected rats, but not in control rats (Figs. C, D).

Conclusions
In this murine model, organ tissue deposition of gadolinium was 2-4 fold higher following administration of the linear agents Omniscan or Multihance compared to the macrocyclic agent Gadavist. These findings suggest organ tissue deposition is reduced but not eliminated by using more stable macrocyclic GBCA chelates in lieu of less stable linear chelates.
Diffusion Tensor Analysis of white matter effects of Gadolinium Deposition

A Paul¹, J Pinto², P Schaefer¹, G Gonzalez¹, O Rapalino³
Purpose
To characterize changes in diffusion tensor analysis (DTI) metrics of anatomically relevant white matter tracts in patients with different levels of gadolinium exposure compared to age-matched controls.

Materials and Methods
Twenty MR datasets obtained from patients without prior gadolinium administration (control group) or after different levels of previous gadolinium administration (<5, 5-10 and > 10 scans) were identified retrospectively and collected for analysis. Magnetic resonance (MR) studies were obtained using a 1.5T MR scanner (Signa, GE Healthcare, Waukesha, WI) and for different clinical indications. Scans with pathologies potentially affecting the target white matter tracts were excluded from the analysis. T1 signal measurements were obtained from the pons, dentate nuclei, thalami and globi pallidi using uniform regions of interest (ROIs). Diffusion tensor measurements (FA, ADC, longitudinal and radial diffusivity) also were obtained from the central pons, middle cerebellar peduncles, superior cerebellar peduncles, dentate nuclei, cerebellar white matter, red nuclei and ventrolateral thalami using the NordicICE software (NordicNeuroLab, Bergen, Norway) with the same template of ROIs. Measurements and subsequent analysis were blinded to the group assignments. Paired t-test analyses were performed between the gadolinium and control groups.

Results
Relative ratios of T1 signal intensity in the dentate nuclei in relation to the pons were increased significantly in the groups with prior gadolinium administration compared to the control group (p < 0.05). There was no significant difference in the relative ratios of T1 signal between the globi pallidi and thalami. There also were no statistically significant differences in the DTI metrics (FA, ADC, radial and longitudinal diffusivity) between the different gadolinium groups and the control group.

Conclusions
Despite the demonstration of increased T1 signal in the dentate nuclei after multiple gadolinium administrations, there were no significant abnormalities in the diffusion parameters of the main white matter tracts connected to these anatomical structures.

O-210

How are Radiologists Responding to Gadolinium Deposition?

R Fitzgerald¹, V Agarwal², J Hoang³, F Gaillard⁴, A Dixon⁵, E Kanal⁶
Purpose
Deposition of gadolinium within the brains of patients with normal renal function following the repeated administration of at least some gadolinium-based contrast agents (GBCAs) was reported initially in 2013. Intracranial gadolinium retention/accumulation now is recognized as a dose-dependent consequence of exposure manifested by T1 shortening within several brain regions including the dentate nuclei. The potential clinical implications of gadolinium deposition are not yet understood. The purpose of this study was to determine radiologists' reporting practices in response to these recent findings.

Materials and Methods
We conducted an anonymous online survey of radiologists using https://www.surveymonkey.com over 17 days spanning November-December 2015. The questionnaire was distributed by study authors using social media. Questions included basic respondent characteristics such as practice type/location, frequency of detection of gadolinium deposition, and reporting habits.

Results
Our study sample included 94 respondents (50% academic; 27% private practice; 23% hybrid) from 30 different countries (USA 18%). Detection of brain gadolinium deposition was reported by 62% of surveyed radiologists. Most respondents (71%) reported never or rarely (<1/month) detecting dentate T1 shortening as a marker of gadolinium deposition. Among those who reported detecting gadolinium deposition, 58% do not include the finding in the radiology report; only 13% report the finding in the impression of their reports. The most common reason for not reporting gadolinium deposition was the risk of provoking unnecessary patient anxiety (29%). Recent data on gadolinium deposition have led to a reported change in practice in 28% of respondents.

Conclusions
Recognition of and attitudes toward brain gadolinium deposition were inconsistent in this worldwide sample. More than three quarters of radiologists do not routinely report dentate T1 shortening as a marker of gadolinium deposition and only a small minority include this finding in their report impressions. Fear of provoking patient/clinician anxiety and an incomplete understanding of the implications of gadolinium deposition contribute to inconsistencies in reporting.

Tuesday
1:15PM - 2:51PM
Plural-contrast 3D multi-echo GRE for TOF MR angiogram of the Pediatric Brain.

B Lanzman¹, S Holdsworth¹, M Iv¹, K Yeom²
¹Stanford University Medical Center, Stanford, CA, ²Lucile Packard Children's Hospital, Palo Alto, CA

Purpose
T2* imaging often is used for clinical brain magnetic resonance imaging (MRI). 3D multi-echo GRE (ME-GRE) is a type of T2* technique that can generate multiple (or 'plural') tissue contrasts from a single sequence (1-3), including a susceptibility-weighted image (SWI), R2*map, local field map, and quantitative susceptibility map (QSM). Additionally, time-of-flight angiogram (pTOF) can be generated from 3D ME-GRE. We sought to assess clinical performance of pTOF versus conventional TOF-MRA.

Materials and Methods
We retrospectively identified 80 consecutive children (ages 0.01-17 years) presenting for 3T brain magnetic resonance imaging (MRI) who obtained both pTOF and TOF-MRA. 3D ME-GRE used six echoes with a TE ranging from 4.3 ms -37 ms, TR = 40.8 ms (5.44 min). The pTOF images were produced from maximum intensity projection over the first echo. Two neuroradiologists independently and blindly reviewed each image (pTOF and TOF-MRA) and assessed for vascular lesion. Additionally, the readers scored for two categories: lesion conspicuity and diagnostic confidence, using a 5-point Likert scale.

Results
Thirty-two children had vascular pathology (moyamoya disease, vascular dysplasia, AVM, and aneurysm). The readers were in substantial agreement for the specific ratings between the sequences (kappa: lesion conspicuity 0.66; diagnostic confidence 0.71). Sample pTOF and TOF-MRA are shown in Figure 1. For lesion conspicuity, the scores did not differ statistically between pTOF and TOF-MRA. For diagnostic confidence, the readers rated TOF-MRA significantly higher than pTOF. The readers were in perfect agreement (kappa = 0.98) for lesion count. Significantly more lesions were found on pTOF versus TOF-MRA (43% of patients versus 40%, respectively, p = 0.005).

Conclusions
This is the first study to show potential clinical utility of pTOF angiogram generated
from a 3D ME-GRE technique. Our results suggest pTOF may be a suitable alternative MR angiogram method without incurring additional scan time when 3D ME-GRE is performed for clinical T2* imaging.
Hemorrhage at BG infarct

BG brighter from edema

Focal R MCA lesion

Focal R MCA lesion
3T MRA Cavernous ICA Segment Anatomy

D Davidson¹, M Whitehead²
¹George Washington University Hospital, Washington, DC, ²Children's National Medical Center, Washington, DC

Purpose
3T time-of-flight (TOF) magnetic resonance angiography (MRA) is a sensitive technique for detection of normal arterial branch vessels not visible at lower field strengths. It is important that origin of normal cavernous ICA branches not be confused with vasculopathy or aneurysms. The purpose of this study is to evaluate number, size, and course of normal cavernous internal carotid segment branch vessels using 3D TOF MRA at 3T.

Materials and Methods
One hundred seventy-five consecutive MRAs from different patients performed over a 2-year period were reviewed. Motion artifact, incomplete coverage, vascular and brain abnormalities were exclusion criteria. Cavernous ICA segments were assessed for the presence of branch vessels. Each ICA was evaluated separately to tabulate unilateral and total ICA vessel scores weighted by conspicuity. Kruskal-Wallis and Student's t-test were performed when appropriate to assess the association between variables; Spearman's rank coefficients were used to evaluate correlations. P values < 0.05 were considered significant.

Results
One hundred six exams met inclusion criteria (60 female, 46 male; mean 9.6 +/- 5.6 years, range 3 days to 20 years). Right and left inferolateral trunk origins were visible in 22% and 26%; right and left meningohypophyseal trunk origins were visible in 63% and 59%. No other cavernous ICA branch vessels were detectable. Age and score were positively correlated (p=0.02). Right- and left-sided scores were not significantly different (p=0.61).

Conclusions
Normal inferolateral and meningohypophyseal arteries commonly are visible on 3D TOF MRA at 3T. It is important that the origin of these vessels not be mistaken for aneurysms.
Normal Quantitative Luminal Metrics of the Major Intracranial Arteries in Infants, Children, & Young Adults

M Chang¹, L Linscott¹, T Abruzzo¹
¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose
To establish the normal range of quantitative luminal metrics for the major cerebral
arteries in the pediatric population, across different age groups from infancy to young adulthood.

Materials and Methods
The radiology database of a large tertiary care children's hospital was queried for patients 18 years or younger with normal brain MRI performed for indications of seizure, headache, or hearing loss from January 2010 to May 2015. Axial and coronal T2-weighted fast spin-echo (FSE) images were analyzed to determine the luminal diameter of the major intracranial arteries (cavernous and communicating segments of internal carotid artery (ICA), M1, basilar artery). Measurements were made perpendicular to the long axis of each index vessel. Imaging was performed at 1.5T or 3T magnetic field strength with a slice thickness of 3 mm and 0 mm gap. Cases were classified into 23 age groups ranging from 3 months of life to 18 years. The mean and standard deviation of each metric were calculated for each age group.

Results
Three hundred eighteen patients (147 males, mean age: 99 months) met study criteria. No less than 10 cases were evaluated in each age group. Luminal diameter shows moderate variability (mean variability: 23%; range: 10-42%) in each age group, and demonstrates a marked increase during the first 18 months of life. The growth curve for the cavernous segment of the ICA is provided as an example (Fig.). Luminal diameter shows a small increase between 18 months and 12 years of life, and plateaus thereafter.

Conclusions
Quantitative luminal metrics of the major cerebral arteries, as assessed by magnetic resonance imaging (MRI), demonstrate a relatively predictable growth trajectory in normal children, which closely approximates previously reported head circumference growth reported by the WHO (1). Magnetic resonance imaging criteria for quantitative luminal metrics should be evaluated as a biomarker for pediatric cerebral arteriopathies.
Improved Visualization of Pediatric Brain Arteriovenous Malformations Using High-Resolution Vascular MRI and Blood Pool Agent (Ferumoxytol)
Purpose
Ferumoxytol, an ultrasmall superparamagnetic iron oxide nanoparticle, has been used widely as a blood pool contrast agent in MR angiography with most applications described in adults outside of the central nervous system (1-4). In this study, we compare ferumoxytol-enhanced high-resolution vascular magnetic resonance imaging (MRI) with time-of-flight (TOF) angiography and the gold standard, digital subtraction angiography (DSA), for the visualization and grading of brain arteriovenous malformations (AVMs) in children.

Materials and Methods
In this IRB-approved retrospective study, we identified 16 children with a diagnosis of brain AVM who had MRI and DSA between April 2014 and June 2015. Magnetic resonance imaging included time-of-flight (TOF) angiography and post-ferumoxytol 3D T1-weighted SPGR sequence using minimum repetition time (TR) and echo time (TE) (Fig. 1). Three experienced raters (two neurointerventionalists and one board-certified diagnostic neuroradiologist) graded AVMs using Spetzler-Martin criteria (5) and assessed for peri-nidal aneurysms on TOF, SPGR, and DSA. Lesion conspicuity (LC), diagnostic confidence (DC), and diagnostic confidence to treat (DCT) were assessed with a 5-point Likert scale. Inter-rater reliability also was calculated.

Results
The distribution and percentages of AVMs assigned each Spetzler-Martin grade were similar between SPGR and DSA in contrast to TOF (Fig. 2). Kappa agreement between readers in assigning grades for DSA, SPGR, and TOF was 0.72, 0.48, and -0.18, respectively. Using a 5-point Likert scale, scores for LC, DC, and DCT based on imaging appearance of AVMs were significantly higher with SPGR (with scores closer to those obtained with DSA) than with TOF across all readers (p<0.001). Amongst all readers, no peri-nidal aneurysms were identified on either SPGR or TOF. However, all readers detected a 4 mm intranidal aneurysm in one subject on DSA.

Conclusions
Ferumoxytol-enhanced high-resolution vascular MRI improves visualization over TOF and yields accurate grading of brain AVMs in children.
Pediatric Acetazolamide Perfusion Challenge Using Magnetic Resonance Arterial Spin Labeling Perfusion with and without Sedation.

A McAllister1, J Leach1, L Linscott1, M Sjoblom1, S Vadivelu1
1Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose
To describe our initial clinical experience with the acetazolamide (ACZ) challenge using arterial spin labeling (ASL) perfusion in pediatric patients to investigate cerebral vascular reserve without and with sedation. Evaluating cerebral vascular reserve is an essential part of the workup for cerebrovascular steno-occlusive disease, particularly in cases of bilateral disease, and potentially direct future revascularization procedures. Acetazolamide challenge is a well known method of determining cerebral vascular reserve in adults typically coupled with nuclear medicine perfusion techniques, computed tomography (CT) perfusion, magnetic resonance imaging (MRI) perfusion, or xenon CT (1). Radiation exposure and time requirements (i.e., most of these methods require the study be performed at two separate times, usually on two separate days) may be considered key impediments in pediatric practice. Limited data are available on the use of ASL perfusion in a quantitative fashion in children (2). Second, there is no data on the effects of sedation on the ACZ challenge, which often is required in pediatric patients.

Materials and Methods
A retrospective review of our clinical experience with ACZ challenge using MRI ASL perfusion performed between 2012 and 2015. Cases performed both with and without sedation were included. Clinically implemented PCASL ASL technique was used, using 1025 ms PLD, and 4mm slice thickness for whole brain coverage. Identical baseline and post ACZ ASL sequences were obtained (20 minutes after 14 mg/mg ACZ infusion). Standardized regions of interest were placed in each hemisphere and changes in cerebral blood flow (CBF) in each region calculated using clinically available software.

Results
A total of 15 MRI ASL ACZ perfusion studies were performed on 10 patients (ages 3-17 years, mean 9 year). Five patients had follow-up examinations. Five examinations were performed under sedation, two with dexmedetomidine and three with propofol. Seven patients had unilateral (4) or bilateral (3) ICA stenoocclusive disease. Other indications were: marked arterial tortuosity, large DVA, and prior MCA infarct with residual MCA stenosis. Six subjects were classified as having abnormal responses
(<15% increase in CBF in > one ROI, 2 bilateral), three subjects had normal but asymmetric responses, one had normal symmetric response. Mean CBF increases in ROIs of between 13% and 102% (mean 42%) were noted in hemispheres with normal vascular supply, compared with -11% to 99% (mean 27%) in hemispheres with abnormal vascular supply. Mean CBF increases were similar in patients under sedation (50% in hemispheres with normal vasculature, 26% in hemispheres with abnormal vasculature) as those awake (38% and 24% respectively). Three patients underwent revascularization procedures (2 bilateral) partly on the basis of individual acetazolamide study results.

Conclusions
Acetazolamide challenge using ASL perfusion can be performed successfully in the pediatric population to evaluate cerebral vascular reserve with or without sedation.

O-216

Assessment of Arterial Spin Labeling (ASL) Sequence in the Pediatric Population Presenting with Hemiplegic Migraines.

M Yasrebi1, V Kandula2, Y Akyol3, N Jambhekar4, A Choudhary5
1AI DuPont Hospital for Children/Nemours, Wilmington, DE, 2AI duPont Hospital for Children/Nemours, Wilmington, DE, 3Thomas Jefferson University Hospital, Philadelphia, PA, 4New Jersey Medical School, Newark, NJ, 5AI duPont Hospital for Children/Nemours, Wilmington, DE

Purpose
Hemiplegic migraine typically is a clinical diagnosis. Arterial spin labeling (ASL) is a magnetic resonance (MR) perfusion imaging sequence which is noninvasive and does not require contrast. The aim of this study is to investigate the efficacy of the ASL sequence in diagnosing hemiplegic migraines in the pediatric population.

Materials and Methods
IRB approval was obtained. From 4/2012 to 5/2015, 23 MRI brain exams (8 Males, 15 Females, Mean age: 13.7 years) with ASL sequences were conducted at AI duPont Hospital for Children in patients presenting with hemiplegic migraines. The ASL sequences were assessed for hyperperfusion, hypoperfusion, versus normal perfusion, particularly focusing on the area of intracranial concern.

Results
On the ASL sequences, 17/23 cases demonstrated hyperperfusion in the area of intracranial concern within 18.6 hours of clinical symptoms (Range: 4 hours-72 hours), 3/23 demonstrated hypoperfusion in the area of intracranial concern within 7 hours of clinical symptoms (Range: 4 hours-11 hours), and 3/23 studies demonstrated no areas of hyper/hypoperfusion in the area of intracranial concern on ASL sequences.
within 241 hours of clinical symptoms (Range: 4 hours- 20 days). The remainder of
the sequences, including the diffusion-weight imaging (DWI), demonstrated no
abnormalities.

Conclusions
Preliminary data suggest that when evaluating ASL sequences in the pediatric
population presenting with hemiplegic migraines that the radiologist should search for
areas of hypoperfusion in the area of intracranial concern during the acute setting and
for areas of hyperperfusion in the area of intracranial concern during the subacute
setting. Arterial spin labeling sequences should be considered as a sequence to be used
for patients with hemiplegic migraines.

O-437

2:03PM - 2:11PM

Evidence Based Imaging in Pediatrics: the Yield of MR Imaging in Investigating
Isolated Pediatric Nystagmus.

V Batmanabane¹, E Heon¹, T Dai¹, P Muthusami¹, A Reginald¹, M Shroff¹
¹The Hospital for Sick Children, Toronto, Ontario

Purpose
1. To assess the yield of magnetic resonance imaging (MRI) in isolated pediatric
nystagmus. 2. To define a management algorithm to minimize avoidable MRI
referrals and to streamline MRI protocols.

Materials and Methods
Chart review of 148 children who underwent neuro MR imaging for isolated
nystagmus between January 2008 and September 2014 was conducted. Age at onset
of nystagmus, clinical characteristics such as nystagmus direction and symmetry also
were noted and compared with the MRI features and visual electrophysiology (VE)
results.

Results
Eighty-five boys and 63 girls (average age at MR imaging 4.24 ± 4.19 years) were
included. Only 10 (6.75%) children had medically significant intracranial findings on
MRI that was responsible for or related to the nystagmus which included optic
pathway glioma (2.02%; n=3), and Chiari I malformations associated with end-gaze
nystagmus (2.02%; n=3). The time of onset of nystagmus was found to be a weak
predictor of abnormal MRI (p=0.07). Seventy patients underwent VE testing but this
test could not predict abnormality in MRI (p=0.51).

Conclusions
Less than 7% of children with isolated nystagmus have significant findings on MRI,
but neither the clinical characteristics of nystagmus nor the VE results allow
prediction of intracranial pathology. We were unable to formulate a management
algorithm for the optimal sequence of investigations (MRI preceding VE or vice versa) but suggest a limited sequence protocol for MRI study of isolated pediatric nystagmus to optimise resource utilization.

Table 1. Abnormal intracranial MR imaging findings of children with isolated nystagmus

<table>
<thead>
<tr>
<th>Abnormal MRI*</th>
<th>Cases</th>
<th>Percentageb (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astrocytoma</td>
<td>1</td>
<td>0.67%</td>
</tr>
<tr>
<td>Optic pathway glioma</td>
<td>2</td>
<td>1.15%</td>
</tr>
<tr>
<td>Chiari malformation</td>
<td>3</td>
<td>2.02%</td>
</tr>
<tr>
<td>Optic nerve atrophy</td>
<td>1</td>
<td>0.67%</td>
</tr>
<tr>
<td>Septo-optic dysplasia</td>
<td>1</td>
<td>0.67%</td>
</tr>
<tr>
<td>Diffuse hypomyelination</td>
<td>1</td>
<td>0.67%</td>
</tr>
<tr>
<td>Periventricular leukomalacia</td>
<td>1</td>
<td>0.67%</td>
</tr>
</tbody>
</table>

a- refers to those with medically significant intracranial findings on MRI that was responsible for or related to the nystagmus.
b- refers to percentage of the total included patients (n=148).

(Filename: TCT_O-437_MRI.jpg)
Normal MRI (n=138)

- VEU positive = 27
- VEU negative = 41
- VEU not done = 70

(Filename: TCT_O-437_fig1a.JPG)

Abnormal MRI (n=10)

- VEU negative = 2
- VEU not done = 8

(Filename: TCT_O-437_fig1b.JPG)

O-219
Aberrant Regional Cerebral Cortical Blood Flow Following Preterm Birth

M Bouyssi-Kobar¹, M Brossard-Racine¹, J Murnick¹, C Loucas¹, T Chang¹, C Limperopoulos¹
¹Children's National Health System, Washington, DC

Purpose
The role of altered perfusion on emerging cerebral cortical networks important for socio-cognitive development in very preterm (VPT) infants currently is unknown. The aim of this study was to compare regional cerebral cortical perfusion in VPT infants with/without parenchymal brain injury (BI) at term-equivalent age (TEA)] with healthy full-term (FT) newborns.

Materials and Methods
We prospectively enrolled 155 VPT infants [gestational age (GA) at birth <32 weeks; birthweight <1500 g] and 40 healthy FT controls. We performed unsedated 3T brain magnetic resonance imaging (MRI) studies and acquired a 3mm pseudocontinuous arterial spin labeling sequence. We quantified cerebral blood flow (CBF) using neonatal specific parameters (units=mL/100g/min; software=Functool) and coregistered the anatomical T2-weighted images to the CBF maps (software=IRTK). Regions of interest included right/left: medial/dorsal prefrontal cortex (mPFC, dPFC), anterior/posterior cingulate cortex (ACC, PCC), insular cortex, perirolandic cortex (PRC), posterior parietal cortex (PPC), and hippocampus (Fig. 1). We compared regional relative CBF for each cortical area (regional CBF/global CBF) controlling for GA at MRI.

Results
Fifty-seven VPT infants had parenchymal BI and 58 had a normal MRI [noBI] (Table 1). Global cerebral perfusion was the highest in VPT infants without BI (global CBF=20.7±3.9), followed by VPT infants with BI (global CBF=17.6±3.6); and FT newborns have the lowest global CBF (global CBF=12.9±2.7) (All p<.05). Relative regional cerebral cortical CBF was decreased significantly in the mPFC, ACC, insula, and hippocampus; and significantly increased in the PRC of VPT infants with/without BI compared to FT controls (Fig. 2).

Conclusions
We report for the first time altered regional CBF patterns in VPT infants, in a number of cortical areas that are an integral part of the salience network (ACC; insula) and default-mode network (mPFC; hippocampus) known to mediate socio-cognitive processing. These data suggest early aberrant maturation of the neurocognitive networks involved in higher-order cognitive skills in VPT infants by TEA. These novel findings offer promising avenue towards implementing early imaging biomarkers of impaired cerebral cortical development. The impact of altered cerebral
cortical perfusion on socio-cognitive disturbances in surviving VPT infants currently is under investigation.

**Table 1. Clinical characteristics of the cohort.**

<table>
<thead>
<tr>
<th></th>
<th>VPT-BI N=57</th>
<th>VPT-noBI N=58</th>
<th>FT control N=40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth GA (weeks), means±SD</td>
<td>25.8 ± 2.6</td>
<td>27.3 ± 2.5</td>
<td>39.5 ± 1.1</td>
</tr>
<tr>
<td>Birthweight (grams), means±SD</td>
<td>823 ± 306</td>
<td>902 ± 293</td>
<td>3327 ±390</td>
</tr>
<tr>
<td>Vaginal delivery, n (%)</td>
<td>25 (45%)</td>
<td>21 (36%)</td>
<td>30 (75%)</td>
</tr>
<tr>
<td>Female gender, n (%)</td>
<td>28 (49%)</td>
<td>31 (54%)</td>
<td>21 (52%)</td>
</tr>
<tr>
<td>GA at MRI (weeks), means±SD</td>
<td>40.3 ± 1.5</td>
<td>40.3 ± 1.7</td>
<td>41.3 ± 1.2</td>
</tr>
</tbody>
</table>

^: Between groups: All p-value <.05
#: Between groups: p-value (VPT-noBI vs. FT) <.05 and p-value (VPT-BI vs. FT) <.05

(Filename: TCT_O-219_mbouyssi-kobar_abstract_1527_table1_300dpi.GIF)
**Figure 1.** Cerebral cortical regions of interest overlaid on cerebral blood flow map (top row) and aligned anatomical T2-weighted image (bottom row).


(Filename: TCT_O-219_mbouyssi-kobar_abstract_1527_figure1_300dpi.GIF)
Impaired Preoperative Brain Metabolism in Newborns with Congenital Heart Disease

M Wien¹, G Vezina¹, J De Asis-Cruz¹, S Bauer¹, D Lanham¹, C Limperopoulos¹

¹Children’s National Health System, Washington, DC

Purpose
Neonates with congenital heart disease (CHD) are at increased risk of neurological deficits. Recent studies have demonstrated that CHD neonates have extensive structural and metabolic brain abnormalities that precede surgical correction. The aim of our study was to compare brain metabolic profiles in a cohort of term neonates with...
congenital heart disease and healthy controls using quantitative proton magnetic resonance spectroscopy (1H-MRS).

Materials and Methods
We prospectively evaluated a cohort of CHD and healthy control newborns using single voxel 1H-MRS. Patients with suspected CHD were recruited as part of a larger research protocol at the time of prenatal imaging. Those with confirmed fetal CHD (by fetal echocardiogram) were recruited as cases while those with normal fetal echocardiograms were recruited as controls. We performed single voxel MRS using the point resolved spectroscopy (PRESS) technique obtained with a region of interest in the basal ganglia and thalamus. Quantitative analysis of spectroscopy data was processed retrospectively using LCModel. We specifically quantified ratios of metabolites: N-acetylaspartate (NAA), Creatine (Cr), Choline (Cho), [tNAA/tCr, tNAA/tCho, tCr/tCho, and tCho/tCr] as well as the presence of lactate (marker of anaerobic metabolism). Lactate was processed using predetermined criteria for percent certainty. Clinical data were obtained from the electronic medical record and correlation with spectroscopy data were made. ANCOVA analyses were used to evaluate the differences in tNAA/tCho, tNAA/tCr, and tCr/tCho between the two groups relative to gestational age (GA).

Results
We analyzed data from 150 1H-MRS spectra: 73 acquired from neonates diagnosed with CHD (mean GA ± std: 39.29 ± 1.32 weeks, range: 36.29-44.71) and 77 obtained from healthy neonates (mean GA ± std: 41.42 ± 1.59, range: 36.57-46.43). Of those neonates with CHD, 22/94 (34%) have single ventricle CHD and 59/94 (63%) have cyanotic CHD. Newborns with CHD showed significantly lower tNAA/tCho and tNAA/tCr pre-operatively compared to healthy controls (p < 0.05). The ratio of tCr/tCho was not significantly different between the two groups. Lactate was present in 15 neonates, all of which had cyanotic CHD. One third (33%) of neonates with CHD also have structural (intraparenchymal) injury on magnetic resonance imaging (MRI).

Conclusions
Newborns with CHD show decreased concentrations of NAA and increased lactate compared to healthy controls when evaluated with quantitative spectroscopy analysis, suggesting neuronal injury and anaerobic metabolism that precede surgical correction. Aberrant cardiac physiology with hemodynamic impairment likely plays a central role in pre-operative alterations in cerebral metabolism. Our data suggest that quantitative MRS may be useful for studying metabolic profiles in neonates at risk for cerebral hypoxic-ischemic injury prior to cardiac repair.
Default Mode Network (DMN) Activation in Children with Sickle Cell Disease (SCD) Using a Word-Stem Paradigm

S Palasis¹, B Sun², C Brown¹, L Hayes², R Jones¹
¹Children's Healthcare of Atlanta & Emory University School of Medicine, Atlanta, GA, ²Children's Healthcare of Atlanta, Atlanta, GA

Purpose
The purpose of this abstract is to present the findings of our study on default mode network (DMN) activation in children with sickle cell disease (SCD) as compared to normal controls following a word-stem paradigm.

Materials and Methods
The study was performed on a 3T Siemens Trio scanner using the standard head coil. The repetition time was 3 seconds and sufficient slices were acquired to cover the whole brain. This study used a block functional magnetic resonance imaging (fMRI) word-stem paradigm during the activation blocks and a cross-hair during the control blocks. Each block consisted of 10 images (30 seconds) and a total of five control and five activation blocks were acquired for each subject (11 controls, 12 sickle cell patients). There was no significant difference in the ages of the two groups and all the subjects were African-Americans. A T1-weighted anatomical volume was acquired to permit inter-subject registration. The data were processed using FSL 5.06 and contrast masking was used to separate the activation and DMN responses. A spherical region of interest (ROI) was drawn within the area showing statistically significant differences in the DMN deactivation (signal decreases during the activation blocks) between the two groups. This region then was registered to each subject to allow the time course of the signal response to be derived for each subject and hence allow a mean time course to be obtained. The signal from the ROI was fitted to a linear function to estimate the mean signal and this was used to allow an estimation of the percent change in signal.

Results
The SCD subjects showed a pattern of less extensive and attenuated activation, however, there was only one small area that was statistically significant between the two groups. For the DMN there was a similar pattern of less extensive and attenuated deactivation, however, there was a prominent area in the precuneus/posterior cingulate gyrus that showed a statistically significant difference between the two groups (Fig. 1). The mean time-course for each of the groups is shown in Figure 2 with the timing of the activation periods shown in orange.

Conclusions
For the control group, compared to the sickle cell subjects, the signal level can be seen to be higher during the rest (cross-hair) periods and with more significant deactivation occurring during the active periods. The DMN deactivation (signal decreases during
the activation blocks) showed a prominent statistically significant area in the precuneus/posterior cingulate in the SCD group as compared to normal controls. We have two hypotheses for the observed difference between the two groups: 1) Differences in the vascular hemodynamics of the two groups, with the higher baseline flow in the SCD group resulting in changes to the hemodynamic response, notably in deoxyhemoglobin levels and/or cerebral blood volume. 2) The precuneus/posterior cingulate have the highest metabolic activity of any area in the brain and it may be that, even with the elevated blood flow levels in SCD patients, the oxygen delivery is insufficient to fully maintain the DMN activity, leading to an attenuated DMN response.

(Filename: TCT_O-221_Figure1.jpg)
Identification of Novel Gene-Specific Bioimaging Markers in Autism Spectrum Disorder

J Gadde¹, J Yu²

¹University of Wisconsin, Madison, WI, ²University of Wisconsin-Madison, Madison, WI

Purpose
To develop novel gene-specific diffusion tensor imaging (DTI) biomarkers in the assessment and characterization of autism spectrum disorder (ASD).
Materials and Methods

Ex vivo imaging methods were used in male rats to examine the structural differences in a Fmr1 and Pten genetic model of ASD (derived from outbred Sprague Dawley rats; n = 4) as compared to age-matched male controls (outbred Sprague-Dawley rats; n = 4). At PND 45, animals were deeply anesthetized with isoflurane and were transcardially perfused with fresh 4% paraformaldehyde (PFA). Fixed brains were removed and stored in 4% PFA until imaging, whereupon they then were rinsed in 0.9% saline for 48 hours prior to imaging to minimize attenuating effects of fixative on the magnetic resonance imaging (MRI) signal. The brains were placed in a custom-built holder and immersed in Fluorinert (FC-3283, 3M, St. Paul, MN, USA) for image acquisition. For ex vivo diffusion tensor imaging acquisition, brains were simultaneously imaged for ~7 h using a 4.7-T Agilent magnetic resonance imaging (MRI) system and 3.5-cm diameter quadrature volume RF coil. A series of multi-slice, diffusion-weighted, spin echo images were acquired with three nonweighted (b ~ 0) and 30 diffusion weighted (b ~ 1200 s/mm^2), using noncolinear weighting directions. Other imaging parameters were TE/TR = 24.17/2000 ms, FOV = 30 × 30 mm^2, matrix = 192 × 192 reconstructed to 256 × 256, slice thickness = 0.5 mm, number of slices = 35 and two signal averages. Diffusion tensor imaging maps were created offline using a combination of FSL software and custom MatLab code. Subsequent region of interest (ROI) analysis was performed in the native imaging space. Diffusion tensor imaging values of the corpus callosum (CC) and other principle white matter tracts were performed.

Results

Animals harboring the Fmr1 and Pten deletions demonstrated widespread changes in gray and white matter structure and organization. These include areas of significant change in FA as previously reported in the superior and inferior colliculus, cerebral cortex of the frontal lobe, and in several areas within the deep gray nuclei including the globus pallidus and thalamus. Significant differences between our Fmr1 and Pten genetic models of ASD as compared to wild-type animals also were noted in our region of interest (ROI) analysis including the corpus callosum and several white matter tracts including the medial longitudinal fasiculus, internal capsule, forceps minor, and occipitotemporal tracts.

Conclusions

The etiology of ASD remains elusive. The development of advanced structural and functional MR imaging-based methodologies, including fMRI and DTI, has spurred tremendous interest towards their application in ASD research, especially towards the identification of a neuroimaging biomarker. Our results are the first to demonstrate a truly cogent gene-specific neuroimaging marker in the assessment of ASD on DTI. As further work proceeds with the identification of additional gene-specific DTI neuroimaging markers in other gene-specific knockouts, the collective sum of these
findings will allow for the identification of cogent gene-specific neuroimaging biomarkers, which can contribute to the diagnosis and treatment of ASD.

**Tuesday**
**1:15PM - 2:45PM**
**Washington Marriott Wardman Park, Roosevelt 4**

**10F-CSI programming: The Neuroradiology Work Environment**

**10F1**

**Mistakes and How to Avoid Them**

Torres, C.
The Ottawa Hospital
Ottawa, Ontario

**1:15PM - 1:35PM**

**10F-2**

**How to Avoid Interruptions in the Work Place**

Yu, J.
University of Wisconsin-Madison
Madison, WI

**1:35PM - 1:55PM**

**10F-3**

**Structured Reporting**

Wiggins, R.
University Of Utah
Salt Lake City, UT

**1:55PM - 2:15PM**

**10F-4**

**Image Sharing with Patients**

Phillips, C.
Weill Med. College Of Cornell/NY Presby'n
New York, NY

**2:15PM - 2:35PM**
Tuesday 3:00PM - 4:30PM
Washington Marriott Wardman Park, Marriott Ballroom

11A-ASFNR Programming: Advanced Neuroimaging Techniques in Brain Tumor: Current Updates (AR) (SAM)

11A-1 3:00PM - 3:15PM
Proton MR Spectroscopy
Barker, P.
Johns Hopkins Univ. School Of Medicine
Baltimore, MD

11A-2 3:15PM - 3:35PM
Functional MRI Pre-Treatment Planning for Brain Tumor: Pitfalls and Progress
Welker, K.
Mayo Clinic
Rochester, MN

11A-3 3:35PM - 3:55PM
Perfusion: Treatment Response from Pseudoprogression
Boxerman, J.
Rhode Island Hospital
Providence, RI
11A-4

Diffusivity and Genomics: Current Thoughts and Metrics

Pope, W.
David Geffen School Of Medicine at UCLA
Los Angeles, CA

11A-5

Questions and Answers

Tuesday
3:00PM - 4:36PM
Washington Marriott Wardman Park, Washington 4/5/6

11B-PARALLEL PAPER SESSION-Stroke: Advanced CT and MR Techniques
O-222

Combined noncontrast CT (NCCT) ASPECT score and CTA collateral score could predict a small DWI lesion with high specificity.

R Hakimelahi¹, K Buch², T Leslie-Mazwi¹, J Hirsch², G Gonzalez², P Schaefer²
¹massachusetts general hospital, Boston, MA, ²Massachusetts General Hospital, Boston, MA

Purpose
Small initial diffusion-weighted imaging (DWI) lesion volume is a significant predictor of favorable outcome following intra-arterial (IA) thrombectomy and has been used for patient selection in multiple clinical trials. We sought to investigate if NCCT ASPECT and/or CTA collateral scores could predict a small DWI lesion volume.

Materials and Methods
We identified 135 consecutive patients with initial CTA showing ICA and/or
proximal MCA occlusions who underwent DWI immediately afterward and within 8 hours of stroke symptom onset. Diffusion-weighted imaging lesion volumes were measured and dichotomized to small (≤ 70 ml) and large (> 70 ml). Collateral vessels were categorized into five groups: 0: no collaterals, 1: minimal collaterals, 2: < 50% of the MCA territory, 3: > 50%, but < 100% of the MCA territory, 4: = contralateral (CL) MCA vascularity and 5: > CL MCA vascularity. Logistic regression and receiver operating characteristic (ROC) curve analyses were performed to measure predictive value of NCCT ASPECT and CTA collateral scores for a small DWI lesion volume.

Results
Sixty-five of 135 patients were female. Mean (range) were: age 69 (18 - 97) years, NIHSS 17 (8-30), time from stroke onset to MRI 236 (46-480) minutes, DWI volume 53 (0.5 -319) ml, NCCT ASPECT score 8 (1-10) and collateral score 3 (0-5). 97/135 cases had DWI < 70 ml. Age, NIHSS and time to MRI were not significant predictors (p > 0.05) of a small DWI volume. Both NCCT ASPECT (OR 2.68, coefficient 0.98, P<0.0001) and collateral scores (OR 2.95, coefficient 1.08, P<0.0005) significantly contribute to prediction of a small DWI lesion. Receiver operating characteristic curve analysis showed AUC of 0.91 (95% CI 0.85 to 0.96). For a specificity > 80% to predict DWI volume < 70 ccs, different combinations of ASPECT and collateral scores could be used: ASPECT ≥7 with collateral score ≥ 3 (specificity 81.6%, sensitivity 79.4%), ASPECT ≥ 8 with collateral score ≥ 2 (specificity 92.1%, sensitivity 75.3%), and ASPECT ≥ 9 with collateral score ≥ 2 (specificity 97.3%, sensitivity 54.6%).

Conclusions
Combined NCCT ASPECT and single phase CTA collateral scores can predict a small DWI lesion volume with high specificity and relatively high sensitivity. This method potentially could be used to help select patients likely to benefit from intra-arterial thrombectomy if MRI is not available.

O-223

Evaluation of a clinical prototype software for rapid automated display and density measurement of ASPECTS regions on CT images

K Busch¹, L Aulmann¹, P Schramm², A Kemmling²
¹Universitätsklinikum Lübeck, Lübeck, DEUTSCHLAND, ²Universitätsklinikum Lübeck, Lübeck, Germany

Purpose
The Alberta Stroke Program Early CT Score (ASPECTS) is the primary rater-based scoring system for extent of early cerebral infarction. However, interobserver reliability of ASPECTS is limited. We systematically examined a novel imaging
prototype that uses a probabilistic ASPECTS template registered onto individual computed tomography (CT) images to improve rater consistency and provide automated ASPECTS by topographical density measurements.

Materials and Methods
A population based probabilistic ASPECTS atlas was created by manual segmentation of ASPECTS region in 200 cranial CT of healthy subjects followed by affine registration to standard MNI space with nonlinear refinement. The ASPECTS atlas was integrated into a clinical software prototype for automated display and assisted ASPECTS scoring. ASPECTS scoring with and without software-assisted atlas overlay was performed in 99 admission CT images of patients with anterior circulation stroke. Interobserver reliability was evaluated by kappa statistics. Automated ASPECT scoring was accomplished in every region by logistic regression analysis using atlas-based density measurement and rater-based scores. Performance of Auto-ASPECTS was assessed by area under ROC-curve analysis (AUC).

Results
Interrater reliability of ASPECTs rating was intermediate and improved significantly with display of registered ASPECTS template (kappa 0.72 versus 0.83, respectively). Mean ASPECTS user rating without software assisted atlas overlay was 4.8, with overlay 4.9. Mean Auto-ASPECTS was 5.3 with a root mean squared error of 1.2 from reference score. Discriminative power of Auto-ASPECTS to predict infarct in individual ASPECTS regions was good (ROC AUC range 0.73 to 0.91).

Conclusions
Rapid automated display and overlay of ASPECTS atlas improves interrater reliability of ASPECTS rating in early stroke CT. Automated ASPECTS prediction in CT by atlas based density measurement is reliable. This may help standardize patient stroke triage.
Angiographic Reconstructions From Whole-Brain Perfusion CT for the Detection of Large Vessel Occlusion and Recanalization in Acute Stroke

J Zhang

1Huashan Hospital, Shanghai, -

Purpose
The aim of this study is to assess the value of angiographic thin-slice volume perfusion computed tomography (CT) reconstructions for the detection of intracranial large vessel occlusion and recanalization after receiving intravenous thrombolytic therapy in patients with stroke.
Materials and Methods
Twenty-five patients with acute cerebral infarction treated by recombinant tissue plasminogen activator (rt-PA) were enrolled in this study. They all underwent admission and 24-hour whole-brain perfusion CT. All images were obtained on a 256-slice multidetector CT scanner. Dynamic 3D CT angiographic images (4-dimensional CTA) generated from perfusion source data were obtained in all patients. Images were assessed for the presence of intracranial vessel recanalization. The cerebral hemodynamics changes in distribution of ischemic lesions were analyzed on perfusion parameter maps.

Results
Of 25 patients with an infarct on follow-up imaging, 19 had infarcts in the middle cerebral artery territory, five had infarcts in the posterior cerebral artery territory, and one had an infarct in the internal carotid artery territory. Average image quality scoring of baseline CT angiography (CTA) was the same as one of 24-hours volume perfusion CTA (VPCTA) (P>0.05), four cases with middle cerebral artery occlusion and one case with internal carotid artery received partial recanalization on 24-hours VPCTA.

Conclusions
In acute stroke, whole-brain PCT may be an optimal method to evaluate patients for thrombolysis, detect intracranial arterial recanalization of cerebral arteries after receiving intravenous thrombolytic therapy, and have the potential to decrease radiation dose and contrast media by substituting for intracranial CTA in stroke CT.

O-225

Whole Brain CT Perfusion In Acute Stroke Patients With Mild Neurological Symptoms Identifies Ischemic Events

S Chakraborty1, R Frank1, G Stotts2
1University of Ottawa, The Ottawa Hospital, Ottawa, Ontario, 2The Ottawa Hospital, Ottawa, Ontario

Purpose
More than half of ischemic stroke patients present as minor strokes (NIHSS<6). A lack of thrombolysis guidelines for this population leads to untreated strokes and erroneously treated stroke mimics, producing adverse outcomes. Data suggest that whole brain computed tomography (CT) perfusion (WB-CTP) improves detection of ischemia, offering a potential method of ameliorating diagnostic uncertainty in these patients. HYPOTHESIS: WB-CTP can guide clinical decisions by identifying patients with ischemic episodes that would benefit from thrombolysis or early intervention.
Materials and Methods
This retrospective chart review enrolled 524 consecutive patients receiving WB-CTP with a Toshiba 320 detector scanner, for acute stroke less than 6 hours from onset and NIHSS<6, and who showed no evidence of intracranial hemorrhage. Patients were excluded for nondiagnostic (n=25) or unreported (n=8) scans and nonischemic pathologies (7). For diagnostic accuracy calculations, the reference standard was the final clinical impression suggesting ischemic events during follow up, as only 51% had follow-up imaging. Subgroup analyses were performed in patients receiving follow-up imaging.

Results
A total of 484 patients (age 17-101, 54% men, mean NIHSS 2.48) were included. Follow-up imaging was performed in 249 patients; 148 underwent magnetic resonance imaging (MRI) with diffusion-weighted imaging (DWI). Whole brain CTP is highly specific with a high positive predictive value in all groups and has moderate to high negative predictive value. Positive and negative likelihood ratios were 21.24 and 0.5 in the primary analysis. Diagnostic accuracy of WB-CTP against different reference standards are shown in detail in Table 1.

Conclusions
Positive WB-CTP findings may warrant early intervention, including thrombolysis, while negative findings alone are not a sufficient basis upon which to confidently withhold interventions.

<table>
<thead>
<tr>
<th>Reference Standard</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>LR+</th>
<th>LR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Diagnosis: Acute Ischemic Event</td>
<td>51</td>
<td>98</td>
<td>98</td>
<td>41</td>
<td>21.24</td>
<td>0.50</td>
</tr>
<tr>
<td>F/U Scan</td>
<td>55</td>
<td>91</td>
<td>98</td>
<td>24</td>
<td>6.27</td>
<td>0.49</td>
</tr>
<tr>
<td>No F/U Scan</td>
<td>44</td>
<td>100</td>
<td>100</td>
<td>53</td>
<td>N/A*</td>
<td>0.56</td>
</tr>
<tr>
<td>MRI DWI</td>
<td>61</td>
<td>91</td>
<td>89</td>
<td>67</td>
<td>6.94</td>
<td>0.43</td>
</tr>
</tbody>
</table>

*no false positives; undefined

(Filename: TCT_O-225_Capture.PNG)

O-226

CT Perfusion in Acute Lacunar Infarct: Detection Capabilities Based on Infarct Location

J Benson¹, S Payabvash², S Mortazavi², B Hoffman³, M Oswood³, A McKinney²
Purpose
Recently studies indicate that computed tomography (CT) perfusion (CTP) has superior diagnostic value to noncontrast CT/CT angiography (NCCT/CTA) alone in the detection of lacunar infarcts. The purpose of this study was to compare the accuracy of CTP to NCCTA/CTA in lacunar stroke detection based on infarct location.

Materials and Methods
We completed a retrospective review of 1087 CTP examinations performed over a 5.5-year period for patients with acute stroke symptoms, selecting for studies in which patients underwent CTP imaging within 4.5 hours and magnetic resonance imaging (MRI) within 30 days of symptom onset. Selected studies had either 1) lacunar infarct <2 mm on diffusion-weighted imaging (DWI) or 2) no acute infarct on DWI. Patients with co-existing infarcts >2 mm on DWI were excluded. CTP postprocessing was automated by a single delay-corrected algorithm, DC-SVD. Three blinded reviewers were given patients’ NIHSS scores and symptoms. Presence or absence of infarct was recorded based on NCCT/CTA, CBF, CBV, MTT, TTP, and DWI.

Results
One hundred fifty-nine patients met inclusion criteria (51.6% male). Lacunar infarcts were present on DWI in 62/159 (39.0%); 97/159 (61.0%) had no infarct on DWI. On CTP, lacunar infarcts appeared as regional perfusion defects larger than the infarcts observed on DWI. Interobserver kappa ranged from 0.35 (CBV) to 0.68 (TTP) for CTP, depending on perfusion parameter; interobserver kappa was 0.85 for DWI. Sensitivity of infarct detection on CTP ranged from 17.7% (CBV) to 35.5% (MTT and TTP); specificity ranged from 97.9% (CBF and MTT) to 99.0% (CBV and TTP). Area under the curve for MTT (0.67) and TTP (0.67) was significantly higher than NCCT/CTA (0.52) (p < 0.001 for both). CTP was most sensitive for infarcts within the cortex and/or subcortical white matter (30.0-53.3%), followed by periventricular white matter (14.3-35.7%); infarcts within the thalamus or basal ganglia were not identified correctly in any patients (0/9).

Conclusions
CTP has added value to NCCT/CTA for the detection of acute lacunar infarcts. The sensitivity of CTP is highest within the cortex and/or subcortical white matter; lacunar infarcts in the basal ganglia and thalamus were not detected.
High Accuracy of MR T2*W Sequences compared to CTA for Detection of Intracranial Vessel Thrombus in Middle Cerebral Artery Stroke

A Liberato¹, S Shah¹, I Barnaure¹, N Maza¹, G Gonzalez¹, J Romero¹
¹Massachusetts General Hospital, Boston, MA

Purpose
Rapid detection of vessel occlusion is pivotal in the intra-arterial (IA) treatment of patients with acute stroke. Magnetic resonance imaging (MRI) has been demonstrated to detect intravascular thrombus but its diagnostic accuracy compared to computed tomography (CT) angiography (CTA) is not well established. We set out to determine the accuracy of 1.5 T MR T2-W sequences compared to CTA as the reference imaging modality for detection of IA thrombus in patients with acute MCA infarction.

Materials and Methods
Two investigators reviewed DWI and T2-W sequences (GRE/GRE-EPI) for the presence of infarction and susceptibility vessel sign (SVS) (Figure), on consecutive cases with MCA stroke who presented over a period of 20 months. SVS was compared to the corresponding arterial segments on CTA (intracranial internal carotid artery (ICA), M1 and M2 segments of the MCA). Accuracy, sensitivity, specificity, positive and negative predictive values (PPV/NPV) were calculated.

Results
Seventy-one consecutive patients with proven MCA territory stroke were screened. Fifty-one patients who underwent CTA and MRI within 12 hours of clinical symptom onset were included in the study. Forty patients had IA thrombus on CTA and the mean time interval from stroke onset to CTA was 4.2 +/- 2.3 hours (range, 0.4-12 hours). The mean time interval from CTA to MRI was 29.5 +/- 11.1 min. Twenty-six patients showed M1 thrombus on CTA. Of these, 22 patients had corresponding SVS on T2-W sequences and four had no abnormality on MRI. In the remaining 25 patients without M1 thrombus on CTA, no M1-SVS was detected on T2-W sequences. We found an accuracy of 92%, sensitivity of 85%, specificity of 100%,
PPV of 100% and NPV of 86% for M1 occlusion. The interobserver agreement was \( k=0.79 \).

Conclusions
T2-W sequences demonstrate high accuracy and strong interobserver agreement for detection of thrombus in the M1 segment of the MCA in patients with acute MCA ischemic stroke.
Does Cerebrovascular Reserve measured by CT Perfusion using Acetazolamide challenge predict future Stroke/TIA in Cerebro-vascular Steno-occlusive Disease

S Biswas¹, C Denby¹, K Das¹
¹The Walton Centre, Liverpool, Merseyside

Purpose
To retrospectively assess whether changes in cerebrovascular reserve (CVR) values following acetazolamide (ACZ) challenged CT perfusion (CTP) in patients with steno-occlusive disease has the ability to predict future cerebrovascular events versus stroke and transient ischemic attack (TIA).

Materials and Methods
Twenty-six patients who underwent CTP with acetazolamide challenge for cerebrovascular steno-occlusive disorders (including moyamoya disease, carotid artery stenosis and occlusion) were studied retrospectively. We gathered together the following diagnostic and clinical information: symptomology, clinical diagnosis, degree of stenosis, number of ACZ procedures, post-ACZ complications, pre- and post-ACZ CBV, CBF and TTP values and CVR percentage change. Information regarding mode of further management (surgical versus conservative) as well as of future cerebrovascular events (stroke or TIA) at 3, 6 or 12+ month intervals was obtained.

Results
On the basis of CBV or CBF values, out of the 26 patients, 19 patients (73%) had normal CVR and seven patients (27%) had decreased CVR. Of the 19 patients with normal reserve, six patients (32% of patients with normal reserve) had a cerebrovascular event (TIA=6, stroke=0). Of the nine patients with decreased reserve one patient had a cerebrovascular event (stroke=1, TIA=0). The association between status of CVR and outcome (TIA/stroke) was not shown to be statistically significant (p>0.5). Out of the six patients having a TIA, two of six patients had undergone revascularization. The patient having a documented stroke had not undergone revascularization. Five patients in our study had coronary artery bypass graft surgery and none of them had any cerebrovascular event during our follow up.

Conclusions
No correlation is established between status of CVR and cerebrovascular outcome. Measurement of CVR, independently, is unable to predict the risk of future TIA/stroke. It therefore appears that the outcome is determined by a number of
clinical factors. Decisions regarding management (e.g., surgical versus conservative management) should not be based solely on presence or absence of CVR.

O-229

Performance of User-independent CT Perfusion Software in Predicting Vasospasm After Aneurysmal Subarachnoid Hemorrhage.

B Knepper¹, S Dehkharvani², R Beck³, B Howard³, A Prater³, J Allen³
¹Emory University Hospital, Atlanta, GA, ²Emory University Hosp, Atlanta, GA, ³Emory University, Atlanta, GA

Purpose
Vasospasm due to aneurysmal subarachnoid hemorrhage (aSAH) is a significant source of morbidity and mortality. Computed tomography (CT) perfusion (CTP) has been advocated as a screening tool for vasospasm, although CTP interpretation requires significant user experience. We examined the power of a custom, user- and vendor-independent perfusion analysis tool configured for prediction of cerebrovascular ischemia to predict significant vasospasm detected on digital subtraction angiography (DSA).

Materials and Methods
Patients with aSAH and CTP performed to assess for vasospasm within 12 hours of DSA were included (n=57). Degree of vasospasm on DSA report was dichotomized: (1) none, minimal, or mild; or (2) moderate or severe. CTP were processed retrospectively using our software. Patients were classified into presence or absence of tissue with Tmax values of > 4s, > 6s, > 8s, and > 10s. Prior studies have proposed Tmax > 4-6s threshold value in the trial setting as a robust predictor of at-risk tissues in the setting of acute ischemia, although this has not been validated in the setting of aSAH. Therefore, a wider range of Tmax values was investigated. Sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) of the presence of ischemic tissue on CTP to predict moderate or severe vasospasm using DSA as the gold standard were calculated.

Results
Forty-one patients (72%) had moderate or severe vasospasm on DSA. Using Tmax > 6s threshold, 34 patients (60%) had ischemic tissue estimated by CTP (mean ischemic volume of 63 cc) and 24 of these patients had moderate or severe vasospasm on DSA with a PPV of 0.71 (true positive mean ischemic volume of 61 cc). However, NPV for Tmax > 6s was only 0.26. Remaining test characteristics and values for other Tmax thresholds tested are shown in Table 1.

Conclusions
Estimation of ischemic tissue using automated CTP analysis software had relatively
good PPV in predicting moderate to severe vasospasm on DSA across Tmax threshold values (0.70-0.76). However, NPV was poor (0.26-0.33).

**Table 1.** Test characteristics of CTP predicting DSA vasospasm

<table>
<thead>
<tr>
<th>Tmax &gt; 4s</th>
<th>Estimated Value (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.85 (0.70-0.94)</td>
</tr>
<tr>
<td>Tmax &gt; 6s</td>
<td>0.58 (0.42-0.73)</td>
</tr>
<tr>
<td>Tmax &gt; 8s</td>
<td>0.54 (0.38-0.69)</td>
</tr>
<tr>
<td>Tmax &gt; 10s</td>
<td>0.39 (0.25-0.55)</td>
</tr>
</tbody>
</table>

White matter lesion penumbra shows abnormalities on structural and functional MRI in the CARDIA study

**I Nasrallah**¹, **M Hsieh**¹, **H Battapady**¹, **G Erus**¹, **L Launer**², **D Jacobs**³, **C Davatzikos**¹, **R Bryan**¹

¹University of Pennsylvania, Philadelphia, PA, ²NIA/NIH, Bethesda, MD, ³University of Minnesota, Minneapolis, MN

**Purpose**

White matter lesions (WML) are readily visible on structural magnetic resonance imaging (MRI) of the brain and have been linked to future stroke and other neurologic complications. Studies, mainly in the elderly, indicate that WML are associated with broader white matter abnormality. We hypothesized that surrounding 'penumbral' tissue, which is not clearly abnormal by visual inspection, would show abnormalities that are quantifiable by MRI even in young, healthy subjects. We evaluated signal abnormalities in WML penumbra using structural parameters, diffusion tensor imaging, arterial spin label cerebral blood flow (CBF), and blood oxygen level dependent cerebral vascular reactivity (VR).

**Materials and Methods**

The IRBs of participating institutions approved this study and written informed consent obtained prior to the start of this HIPAA compliant retrospective study of data.
acquired prospectively from 8/19/2010 to 8/31/2011. Four hundred sixty-three subjects, mean age 50 years, from the Coronary Artery Risk Development in Young Adults (CARDIA) longitudinal observational cohort study participated. White matter lesions were defined using the established White Matter Lesion Segmentation (WMLS) technique. Voxel-based analysis defined 0-2mm and 2-4 mm penumbral tissue surrounding WML and distant normal appearing white matter (dNAWM), regions shown in color on a FLAIR image in the Figure, top left. Mean signal intensity for FLAIR, T1, fractional anisotropy (FA), mean diffusivity (MD), CBF, and VR were measured. Group comparisons were made using Kruskall-Wallis and pairwise t-tests. Correlations between parameters were calculated using Pearson's R.

Results
White matter lesions volumes averaged 0.550 +/- 0.751 cm³ (range 0-6.79 cm³). Only one subject had no tissue classified as WML while 84% of the sample had greater than 0.1 cm³ defined as WML. Mean signal intensity for FLAIR and MD were increased while T1, FA, and CBF were decreased in WML versus dNAWM. Penumbral tissues show graded intermediate values (corrected p< 0.001 for all group and parameter comparisons); the Figure box plots show these significant differences for FLAIR, MD, and CBF. VR showed little activation in lesional and nonlesional white matter. There was no consistent correlation among parameters between the four regions except between MD and FA.

Conclusions
Even in healthy, normotensive subjects with small WML burden, significant abnormalities are detected in MRI structural and functional imaging parameters in penumbral tissue. Findings suggest that white matter injury onset starts by middle age and is more widespread than evident from WML burden visualized on structural imaging. Integrating multiple MRI parameters may provide more detailed delineation of injured white matter compared to traditional approaches.
O-231

4:12PM - 4:20PM

Acquiring and Validating Temporal Information in 4D DSA Reconstructions

J Xu¹, G Shaughnessy¹, J Jiang², S Schafer¹, C Mistretta³, C Strother³
Purpose
Four dimensional DSA generates time-resolved 3D vascular volumes. Blood flow can be quantified if pulsatility in time-attenuation curves is unperturbed by contrast injection parameters. Goals: 1) evaluate a novel quantitative method for detecting time-attenuation curve pulsatility and, 2) evaluate the impact of injection parameters on time-attenuation curves.

Materials and Methods
Forty-seven studies were performed in six canines with carotid artery vein patch aneurysms. Doppler measurements were acquired proximal, and distal to the aneurysms. Injection rate, catheter size, and injector rate-rise were varied. Rotational acquisitions were acquired and reconstructed as 4D volumes. EKG was recorded during the acquisitions. For each 4D reconstruction, time-attenuation curves were analyzed at locations corresponding to the Doppler measurements. The curves were scored qualitatively on pulsatility by two blinded reviewers using a binary scale. A Fourier Transformation was done to determine signal power at each frequency and was compared with EKG and Doppler heart rate measurements. To optimize pulsatility recognition, the peak power and six adjacent points were used to calculate a sideband ratio (SBR). Sideband ratio magnitude was compared to reviewer scores.

Results
EKG/US and Fourier Transformation calculated heart rates were highly similar (102.3 versus 105.3, p=0.44). Sideband ratios between 5-10, and greater than 10 had average reviewer scores of 0.902, and 0.944 respectively. Sideband ratios below five had an average score of 0.567. The nine cases with the highest SBRs and scores were acquired with injection parameters of 2.5-3 ml/s, catheter size of 5-6F, and a rate-rise >0.3 sec.

Conclusions
There was excellent concordance between heart rates and Fourier Transformation pulsatility detection. High correlation between reviewers' scores and SBR provides an automatic method to evaluate pulsatility - a SBR > 5 indicates an acceptable waveform. Injection rates of 2.5-3 ml/s, 5-6F catheter, and a longer rate-rise provided consistently preserved temporal information.
1. For each 4D reconstruction, time-attenuation curves were analyzed at locations corresponding to the Doppler Measurements.

2. At each location 4 samples were taken for qualitative and quantitative analysis.
 Improved T1 weighted, black blood, vessel wall imaging using distributed spirals, variable density sampling and constrained reconstruction: Initial clinical experience.

K Johnson¹, L Rivera-Rivera¹, T Kennedy¹, P Turski¹
¹University 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) pure T1 contrast.

Materials and Methods
During a variable flip angle fast spin echo readout, samples are collected with spiral arms which are distributed onto kxy with the kz phase encode set continuously in a pseudo-random fashion. These arms are interleaved in a fashion such that flow suppression is 3 dimensional (3D) and T2 decay manifests as a diffuse artifact rather than blurring. Using acceleration in three directions, this artifact can be removed by a constrained reconstruction which learns the echo train signal evolution from the data allowing recovery of images at each echo time (2). Here we present our experience for high resolution intracranial imaging with a practical scan time of ~5 minutes.

Results
In phantom experiments, the spiral image acquisition shows less directional sensitivity and an overall improvement in flow suppression (median black blood suppression of 0.93 for spiral versus 0.69 for Cartesian). The figure shows images of one of the volunteer subjects. The constrained reconstruction, fit to echo train signal evolution, provides image contrast that progresses from T1 dominated (Figure 1, Echo 1) to T2 dominated (Figure, Echo 24). Utilizing the first echo 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 vessel wall imaging with increased spatial resolution, suppression of intravascular flow signal, and simultaneous depiction of T1 and T2-weighted contrasts; without the incorporation artifact prone black blood preparation modules.
O-232a

4:28PM - 4:36PM

Intracranial Vessel Wall MRI: Recommendations for Clinical Practice

D Mandell1
1University of Toronto, Toronto, Ontario

Purpose

Materials and Methods

Results

Conclusions

Tuesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Washington 1/2/3

11C-Incidental Findings
11C-1

**General Overview of Incidental Findings**

Poussaint, T.
Boston Children's Hospital
Boston, MA

11C-2

**Incidental Findings in CT Angiography Neck Examinations**

Chapman, P.
University of Alabama Birmingham
Birmingham, AL

11C-3

**Incidental Findings in 10,000 Research Volunteer MR Exams**

Rowley, P.
University of Wisconsin
Madison, WI

11C-4

**Best Practices: Clinical and Research Incidental Findings**

Zaharchuk, G.
Stanford University
Stanford, CA

11C-5

**Questions and Answers**
Tuesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Roosevelt 1-3

11D - PARALLEL PAPER SESSION: Turbo Talks-16 Shades of Grey and White Matter
O-233

Comparison of 3D FLAIR and 3D T2-w Fast Spin-Echo Sequences for Detection of Infratentorial Multiple Sclerosis Lesions

X Wu¹, S Mansourian¹, V Kalra¹, N Makhani¹, A Malhotra¹
¹Yale University School of Medicine, New Haven, CT

Purpose
Infratentorial lesions predict long-term disability prognosis in patients with multiple sclerosis (MS). FLAIR has been considered suboptimal for posterior fossa evaluation and for this reason, imaging protocols include conventional T2-W sequences in additional to FLAIR. We assess the intra- and interobserver agreement for posterior fossa lesion detection among MS patients of 3D FLAIR versus 3D T2-W fast spin echo (FSE) at 3T magnetic resonance imaging (MRI).

Materials and Methods
Fifty patients with clinically definite MS with both 3D FLAIR and 3D T2-W FSE sequences were evaluated retrospectively for number of brainstem and cerebellum lesions, confidence score for each lesion, and overall image sequence quality by two neuroradiologists independently. Statistical analysis was performed to assess for differences between the results of the two sequences. Intra- and interobserver agreements were calculated using the Wilcoxon Signed-Ranked Test and Spearman's Rank Correlation.

Results
Three dimensional FLAIR identified more brainstem and cerebellar lesions compared to 3D T2-W FSE for both readers, however this was only statistically significant for the number of cerebellar lesions (p = 0.001) for both readers. The confidence score is statistically significantly higher on FLAIR than on T2 for Reader 1 at brainstem and both readers at cerebellum. There is no significant difference in quality score, except for a higher quality T2 from Reader 2 at brainstem, with detailed confidence and quality scores presented in Table 1. The interobserver agreement has a slightly higher correlation coefficient on T2 (brainstem: 0.83; cerebellum: 0.92) than on FLAIR (brainstem: 0.81; cerebellum: 0.87).
Conclusions

Three dimensional FLAIR identified more infratentorial lesions than 3D T2-W FSE for both brainstem and cerebellum. Conventional T2-W may not need to be performed for MS patients. Additional studies with reference standard lesions would help further investigate the utility of FLAIR compared to T2.

<table>
<thead>
<tr>
<th></th>
<th>Reader 1</th>
<th></th>
<th>Reader 2</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>T2</td>
<td>FLAIR</td>
<td>p</td>
<td>T2</td>
</tr>
<tr>
<td>Mean brain stem lesion confidence score</td>
<td>3.88</td>
<td>4.12</td>
<td>0.019</td>
<td>3.98</td>
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<td>Mean brain stem lesion quality score</td>
<td>4.58</td>
<td>4.58</td>
<td>1.000</td>
<td>4.22</td>
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<td>Mean cerebellum lesion confidence score</td>
<td>3.88</td>
<td>4.14</td>
<td>0.017</td>
<td>3.88</td>
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<tr>
<td>Mean cerebellum lesion quality score</td>
<td>4.54</td>
<td>4.58</td>
<td>0.648</td>
<td>4.64</td>
</tr>
</tbody>
</table>

(O-234)

3:03PM - 3:06PM

Absolute quantification of normal appearing and lesional tissue in Relapse Remitting Multiple Sclerosis with and without cognitive impairment

S Hojjat¹, M Kincal¹, R Vitorino¹, C Cantrell², A Feinstein¹, L Zhang¹, L Lee¹, P O’Connor³, T Carroll², R Aviv¹

¹Sunnybrook Research Institute, Toronto, Ontario, ²northwestern university, Chicago, IL, ³St. Michael's Hospital, Toronto, Ontario

Purpose

The role of gray matter in multiple sclerosis (MS) is increasingly evident, however conventional magnetic resonance (MR) images demonstrate limitations in cortical lesion (CL) identification. Perfusion imaging appears sensitive to changes in tissue type and disease severity in MS. We sought to utilize bookend perfusion to quantify parameters in healthy controls (HC), normal appearing and lesional tissue at different relapse remitting MS (RRMS) stages.

Materials and Methods

Thirty-nine RRMS patients and 19 age-matched HC were prospectively recruited. MACFIMS battery was used to assess cognitive performance. Perfusion parameters including cerebral blood flow (CBF) and volume (CBV) and mean transit time (MTT) were compared for HC, normal appearing and lesional tissue for all study groups. Dispersion of perfusion measures for white matter lesion (WML) and CLs was assessed.
Results
Twenty of the 39 RRMS patients were cognitively impaired (RRMS-I). Significant differences were displayed between all RRMS subgroups and HC except for normal appearing gray matter (NAGM) CBV between HC and RRMS-NI and for all normal appearing white matter (NAWM) perfusion parameters between HC and unimpaired RRMS patients (RRMS-NI). White matter lesion but not CL perfusion was significantly reduced in RRMS-I versus RRMS-NI. Perfusion reduction with disease progression was greater in NAGM and NAWM compared to CL and WML. Smaller dispersion was observed for CLs compared to WML for each perfusion parameter.

Conclusions
Quantitative GM and WM analysis demonstrates significant but disproportionate WML, CL, NAWM and NAGM changes present between healthy controls and RRMS patients with and without cognitive impairment necessitating absolute rather than relative lesion perfusion measurement.

O-235 3:06PM - 3:09PM

Can Sequential MR diffusion weighted imaging be used to detect active multiple sclerosis lesions and reduce potential risk of gadolinium deposition in patients with multiple sclerosis?

W Tian¹, X Liu¹, H Wang²
¹University of Rochester Medical Center, Rochester, NY, ²University of Rochester Medical Center, Rochester, NY

Purpose
Multiple sclerosis (MS) is the most common neurodegenerative disease and one of the leading causes of neurological disability in adults in the United States. Postcontrast T1-weighted imaging (T1WI) is standard imaging protocol for detection of MS activity. However, recent studies suggested that repeated administration of intravenous gadolinium-based contrast agents could induce gadolinium deposition in neuronal tissues in the setting of relatively normal renal function. Therefore, it is important to use noninvasive MR technique to clarify activity status so that to avoid unnecessary injection of MR contrast agents and subsequently reduce potential risk of gadolinium deposition in patients with stable MS lesions. The purpose of our study is to evaluate the screening performance of diffusion imaging to select optimal patients with active MS lesions for further postcontrast T1WI examination.

Materials and Methods
We retrospectively reviewed MR imaging examinations (including postcontrast T1WI and DWI sequence) of 200 MS patients from 2008 to 2014. We only selected the new MS lesions which had prior MR examination(s). The imaging characteristics of these
new MS lesions, including enhancing patterns, and signal intensity changes on diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) were evaluated. Fisher's exact test was performed to determine whether the DWI and ADC abnormalities are associated with enhancement status in these new MS lesions. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated to assess the accuracy of DWI and ADC in predicting MS activity.

Results

Ninety-eight new MS lesion in 45 patients were enrolled in this study, and there were 92 new enhancing lesions and six new nonenhancing lesions. All 98 new lesions presented as hyperintensity on DWI image. Compared to the previous baseline MR examinations, 97 new MS lesions presented as new appearance of hyperintensity on DWI image, and one new MS lesion presented enlarged hyperintensity on DWI image. On ADC maps, 52 enhancing lesions and four nonenhancing lesions showed hyperintensity (54.2% and 4.2%), 35 enhancing lesions and two nonenhancing lesions as isointensity (36.5% and 2%) and five enhancing lesions as hypointensity (5.1%), Figure 1. The hyperintensity on DWI is significantly associated with lesion enhancement (P<0.001). The sensitivity, accuracy and PPV of new and/or enlarged hyperintensity on DWI to predict MS enhancing status were 100%, and 93.9%, 93.9% respectively. The sensitivity and specificity of new and/or enlarged hyperintensity on DWI to predict MS activity status were 100%.

Conclusions

Our preliminary study suggests that lesions with new and/or enlarged hyperintensity on DWI are associated with MS activity, and sequential DWI examination can be used for selecting patients with active MS lesions for further postcontrast T1WI sequences. This may lead to an updated imaging strategy based on appearance of new and/or enlarged hyperintensity on DWI, that could avoid repeated intravenous exposures to the patients with stable MS lesions.
Natalizumab-PML-IRIS: Multiparametric MRI Findings and Time Course

D Titelbaum¹, J Katz², E Lathi², R Dhillon³, E Schwartz¹
¹Shields Health Care, Brockton, MA, ²The Elliot Lewis Center for MS Care, Brighton, MA, ³Sturdy Memorial Hospital, Attleboro, MA

Purpose
During the diagnosis and initial treatment of natalizumab-progressive multifocal leukoencephalopathy (NTZ-PML), imaging leads to difficulty in distinguishing between immune reconstitution inflammatory syndrome (IRIS) and continued PML. We sought to characterize the expected imaging findings and time course of post-treatment IRIS by using multiparametric magnetic resonance imaging (MRI) assessment.

Figure 1: Compared to baseline MR examination (upper row), the new ring-enhancing lesion presented hyperintensity on DWI and ADC images (red arrow)
(Filename: TCT_O-235_Figure1-ASNR2016.jpg)
Materials and Methods
Six patients with diagnosed NTZ-PML were followed by MRI, including FLAIR, T1W, diffusion-weighted imaging, gadolinium enhancement, with some patients also undergoing MR spectroscopy (MRS) and diffusion tensor imaging (DTI). Multiparametric timeline maps were created to identify patterns of changes during early and peak IRIS.

Results
IRIS typically began 3-4 weeks after diagnosis of PML independent of whether patients received plasma exchange, and was accompanied by clinical deterioration that resolved with corticosteroid treatment. Peak IRIS occurred at 7-12 weeks, and resolved to final baseline in 3-6 months (Fig. 1). Early IRIS was seen as worsening FLAIR abnormality in the bed of PML, gadolinium enhancement often involving perivascular space enhancement, and diffusion hyperintensity. Peak IRIS was characterized by maximal FLAIR hyperintensity and gadolinium enhancement, well-demarcated subcortical T1 hypointensity, progression of diffusion hyperintensity from subcortical to deep white matter, decreased fractional anisotropy (FA), and elevated lipid-lactate peak. Cortical laminar necrosis was identified on T1W images shortly after peak IRIS. Resolved IRIS showed contraction of FLAIR abnormality to stable gliotic-appearing residua, resolved enhancement and diffusion abnormality, resolved lipid-lactate, and in some cases improved fractional anisotropy.

Conclusions
Worsening of MR appearance following initial management of PML is an expected manifestation of IRIS, and can be confused with worsening PML. Familiarity with the multiparametric appearance during evolution of PML-IRIS will facilitate accurate diagnosis and management.
Early MRI Characteristics of Cerebral Lesions in Asymptomatic Boys with X-linked Adrenoleukodystrophy: Focus on the Hot Spots

P Caruso\textsuperscript{1}, A Liberato\textsuperscript{1}, R Aziz-Bose\textsuperscript{1}, A Lauer\textsuperscript{1}, P Musolino\textsuperscript{1}, F Eichler\textsuperscript{1}

\textsuperscript{1}Massachusetts General Hospital, Boston, MA

Purpose
X-linked adrenoleukodystrophy (ALD) is caused by mutations in the ABCD1 gene leading to accumulation of very long chain fatty acids in plasma and tissues. Its most severe manifestation is childhood cerebral ALD (CCALD), a rapidly progressive form of inflammatory demyelination. Identification of cerebral lesions prior to onset of
symptoms is paramount in selecting patients who will benefit from rescue therapies. We set out to analyze cerebral lesions in a unique cohort of asymptomatic boys with CCALD.

Materials and Methods
We reviewed 193 brain magnetic resonance images (MRIs) from 44 neurologically asymptomatic (Neurologic Functional Scale=0) boys with biochemical or genetically confirmed ALD followed at Massachusetts General Hospital between 2001 and 2015. Only scans of patients with no history of hematopoietic stem cell transplantation were included. Two neuroradiologists blinded to clinical information recorded the number of patients with lesions, the Loes score1, the pattern of white matter involvement, and the presence and pattern of enhancement.

Results
Of the 44 boys, 59% (26) showed brain lesions (median age 6.7 years; range 3.6-15.5 years). The median Loes score found was 3.0 points (range 0.5-11). The most frequent lesion pattern was parieto-occipital white matter and splenium of corpus callosum (15) followed by frontal white matter and genu of corpus callosum (5), frontopontine and corticospinal tracts (4), and combined splenium and genu of corpus callosum (2). Among all patients with lesions, 85% (22/26) had contrast enhancement, either at baseline (50%) or on follow-up MRI (50%). Rim, patchy and solid lesion enhancement patterns were seen. Ten patients showed normal baseline MRI and subsequently converted to CCALD (median age 6.4 years).

Conclusions
Magnetic resonance imaging can detect brain lesions and development of disease in the absence of neurological symptoms. As newborn screening is implemented, familiarity with the characteristics of early lesions will help improve disease detection and guide monitoring and treatment in ALD.
The Current MRI Scoring System for Cerebral Adrenoleukodystrophy does Not Reliably Reflect Disease Progression in Early Lesions

A Liberato¹, P Caruso¹, A Lauer¹, R Aziz-Bose¹, F Eichler¹, P Musolino¹
¹Massachusetts General Hospital, Boston, MA

Purpose
The magnetic resonance imaging (MRI) Loes scale¹ (0-34 points) quantifies the extent of white matter lesions in patients with cerebral adrenoleukodystrophy (ALD). Higher scores represent greater disease burden. It currently is used to assess cerebral ALD severity, progression, and to guide treatment. However, evaluation of disease progression using volumetric measurements of cerebral lesions in asymptomatic patients has not been studied. We set out to evaluate the MRI Loes scale in asymptomatic boys with ALD by comparing the Loes scores to volumetric measurements of cerebral lesions.

Materials and Methods
We reviewed 193 brain MRIs from 44 neurologically asymptomatic (Neurologic Functional Scale=0) boys with biochemical or genetically confirmed ALD followed at Massachusetts General Hospital between 2001 and 2015. Only scans of patients with no history of hematopoietic stem cell transplantation were analyzed. Two neuroradiologists, blinded to clinical information, recorded the Loes scores and lesion volumes for all MRI scans. Lesion progression was defined as Loes score increase of ≥ 1 point and lesion volume increase ≥ 30%, in sequential follow-up scans.

Results
Of the 44 boys, 59% (26) showed brain lesions (median age 6.7 years; range 3.6-15.5 years). The median Loes score found was 3.0 points (range 0.5-11). Lesion progression by Loes was present in 48% of patients (12/25) over a follow-up period of 14.2 months (range 0-90.2 months). Twenty patients had sequential MRI scans with unchanged Loes scores during follow-up and 50% displayed lesion volume progression. Of these, the rate of progression was higher among the patients with unchanged Loes score of ≤ 1 (9) compared to the patients with other unchanged Loes scores (1; p=0.0011).

Conclusions
Our results showed that cerebral ALD lesions may progress even despite stable Loes scores in follow-up imaging. The current MRI Loes scale for cerebral ALD does not reliably reflect lesion progression in asymptomatic boys with early disease.

O-240

Volumetric and Diffusion Tensor Imaging Outcomes Associated with Adult Measures of Criminality in a Cohort with Childhood Lead Exposure
Purpose
The purpose is to determine if an association exists between measures of adult criminal behavior and neuroanatomical structure in a birth cohort with childhood lead exposure longitudinally followed for nearly 30 years. International epidemiological studies of childhood lead exposure report positive relationships between blood lead concentrations with juvenile delinquency and adult criminality.

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=105, 44 male, mean age at imaging 26.8 +/- 1.1 y). Blood lead levels were measured every 3 months for the first 5 years of life, every 6 months from 5 - 6.5 years of age, at 15 years of age, and at the time of imaging. Criminal arrest records since turning 18 years old were electronically assessed from local, public databases to determine violent arrests and total arrests. Voxel-based morphometry (VBM) utilized Statistical Parametric Mapping (SPM) software. Voxel-based analyses of DTI employed custom software in IDL. Statistical analyses of VBM and DTI outcomes were performed with multiple regression analyses employing a log (x+1) function of total arrest and violent arrests, respectively, as dependent variables, the log of blood lead at 78 months as an independent variable with evaluation of additional confounders such as age at imaging, sex, gestational age, socioeconomic status, full-scale IQ, maternal IQ, and prenatal exposure to cigarettes, alcohol and marijuana considered when constructing the final models.

Results
Gray matter loss was observed in the left middle frontal gyrus for all participants in relation to violent arrests, and white matter loss in the left paracentral lobule for males in relation to total arrests. Diffusion tensor imaging data presented patterns of altered myelin structure (such as elevated radial diffusivity) primarily in ascending and descending white matter pathways in relation to total arrests. Similar patterns were observed in relation to total violent arrests with the inclusion of abnormalities in the frontal and temporal lobes. The four-part figure illustrates representative examples of neuroimaging outcomes associated with violent arrests.

Conclusions
The results of this study suggest that elevated arrest rates associated with childhood lead exposure may be influenced by altered brain structure and organization, especially in white matter.
Determining tumor infiltration in the normal appearing white matter using radiomic characterization.

A Kotrotsou\textsuperscript{1}, G Thomas\textsuperscript{2}, S Abrol\textsuperscript{1}, P Zinn\textsuperscript{3}, R Colen\textsuperscript{1}

\textsuperscript{1}MD Anderson Cancer Center, Houston, TX, \textsuperscript{2}The University of Texas MD Anderson Cancer Center, PEARLAND, TX, \textsuperscript{3}Baylor College of Medicine, Houston, TX

Purpose
To determine whether computationally derived MR image-based texture radiomic features can identify infiltrating cancer cells in the peritumoral normal appearing white matter (NAWM). Glioblastoma (GBM) harbors infiltration beyond the region of nonenhancing T2/FLAIR hyperintense component of the tumor (aka NAWM). We hypothesized that texture features obtained from the peritumoral NAWM that contain infiltrating cells, will be different from other white matter regions distant from the tumor.

Materials and Methods
Forty patients with newly diagnosed GBM were identified from The Cancer Genome Atlas (TCGA) database. Presurgical gadolinium-enhanced T1 and FLAIR MR images were obtained from The Cancer Imaging Archive (TCIA). We investigated peritumoral white matter in regions defined by the radiologists as normal nonpathological tissues, but which were adjacent to the tumor boundaries. To assess this texture-captured microinfiltration, we defined one region-of-interest (ROI) adjacent to the tumor beyond the border of edema/invasion, and another on the contralateral hemisphere. All ROIs were carefully selected to include only white matter avoiding signals from adjacent tissues. Prior to feature extraction, an intensity normalization process was carried out to control for scanner/acquisition induced variations. Three hundred second-order textural features (Haralick gray level features) for each ROI along with the corresponding volumes were computed using an in-house software. A support vector machine (SVM) classifier acting on z-score normalized features was used to classify ROIs into peritumoral or contralateral. Performance of the classifier was tested using 80% of the data for training and 20% for testing (100 bootstrap copies).

Results
Overall, we found that SVM-based classification of texture patterns is a promising approach for identifying regions with microinfiltration. The binary SVM classification accuracy, sensitivity, and specificity, assessed by bootstrap analysis, were 84\%, 84\%, and 85\% respectively.
Conclusions
Texture features classified these regions in a distinct class from other white matter regions, thus suggesting that invisible infiltrating cells could be captured by radiomic texture analysis. In the future, correlation with histological image-guided biopsies can be done to further elucidate the pathological infiltrating and genomic characteristics in this region (when obtained in passé at the trajectory towards tumor).

O-242

3:27PM - 3:30PM

Altered White Matter Metabolite Concentrations in Diabetic Patients with and without Diabetic Ketoacidosis.

C Fleischer¹, G Umpierrez¹, X Hu¹, S Dehkharghani², J Doan¹, S Moffat³, J Allen¹
¹Emory University, Atlanta, GA, ²Emory University Hosp, Atlanta, GA, ³Georgia Institute of Technology, Atlanta, GA

Purpose
Diabetes is associated with metabolic changes detectable with 1H-MR spectroscopy (MRS). The impact of hyperglycemic crises on brain metabolites in adults is not known. We compared metabolite concentrations in diabetic patients with and without a history of diabetic ketoacidosis (DKA), the most common hyperglycemic emergency.

Materials and Methods
Patients with a history of >3 DKA episodes (n=11) and <72 hours after admission for acute DKA were imaged, along with diabetic controls without DKA history (n=11) and healthy subjects (n=9) on a 3T Siemens Prisma using multivoxel MRS (TR=1700 ms, TE=35 ms, 10 x 10 x 15 mm^3 voxel size, 3 averages). A 2 x 3 voxel grid spanning the bilateral centrum semiovale was used to obtain metabolite concentrations (Fig. 1). LC Model (v6.3-1H) was used to estimate absolute metabolite concentrations and concentrations normalized to creatine plus phosphocreatine (/Cr). Values with Cramer-Rao lower bound values >20% were excluded. One-way ANOVA followed by a post-hoc Tukey's test between groups was used to determine significance (p<0.05).

Results
Metabolite concentrations are shown in Table 1. Bilateral myo-inositol (Ins) concentrations were increased significantly in both diabetic controls and DKA subjects versus healthy controls. Significant increases in bilateral Ins/Cr concentrations were detected in diabetic versus healthy controls. Right-sided, normalized N-acetylaspartate (NAA/Cr) concentrations were decreased significantly in DKA subjects versus healthy controls. No significant differences were detected between DKA subjects and diabetic controls.
Conclusions
We detected metabolic changes related to DKA, which may represent a biomarker of neurologic injury. Increased Ins concentrations observed in diabetic controls and DKA subjects may reflect glial cell proliferation or increased size, which may occur during inflammation. This has been described previously in diabetes but not in adult patients with DKA. While alterations in NAA concentrations, a measure of neuronal integrity, have not been reported consistently in diabetes, our findings indicate a measurable decrease in NAA in adult patients with DKA.

<table>
<thead>
<tr>
<th>Metabolite</th>
<th>F values</th>
<th>Control (c) vs Diabetic (d)</th>
<th>Control (c) vs DKA (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Ins</td>
<td>F(2,30)=8.78 p=.001</td>
<td>c&lt;d p=.001</td>
<td>c&lt;∞ p=.027</td>
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<tr>
<td>Right Ins/Cr</td>
<td>F(2,30)=4.47 p=.021</td>
<td>c&lt;d p=.016</td>
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</tr>
<tr>
<td>Right NAA/Cr</td>
<td>F(2,30)=4.01 p=.029</td>
<td>as</td>
<td>c&lt;∞ p=.034</td>
</tr>
<tr>
<td>Left Ins</td>
<td>F(2,30)=8.98 p=.001</td>
<td>c&lt;d p=.001</td>
<td>c&lt;∞ p=.037</td>
</tr>
<tr>
<td>Left Ins/Cr</td>
<td>F(2,30)=5.80 p=.008</td>
<td>c&lt;d p=.006</td>
<td>ns</td>
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</tbody>
</table>

Figure 1. Bilateral voxels used in analysis. Table 1. Group-wise comparison of absolute and normalized concentrations. (Filename: TCT_O-242_Figure1DKA.jpg)

O-244

The Widened Sulcus: A New Imaging Sign for Detection of Meningoencephalocele

F Oyedeji1, S Hegde1, B Branstetter1, J Mettenburg1, T Rath1
1University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Acquired meningoencephalocele and persistent cerebrospinal fluid leak (CBF) are potentially life threatening diseases placing patients at risk for intracranial infection and necessitating surgical repair. Identification of meningoencephalocele can be diagnostically difficult due to small size and similar imaging appearance to paranasal sinus and temporal bone inflammatory opacification. Secondary imaging features such as a widened sulcus ("widened sulcus sign"), displaced gyrus ("fallen gyrus sign") and ipsilateral ex-vacuo ventricular dilatation may be useful to confirm the presence of a meningoencephalocele. The purpose of this study was to evaluate the accuracy of the widened sulcus sign, fallen gyrus sign and ipsilateral ventricular dilatation sign in the diagnosis of meningoencephalocele.

Materials and Methods
A retrospective review of magnetic resonance imaging (MRI) and/or computed tomography (CT) scans in patients who were referred for possible
meningoencephalocele or CSF leak was performed. Patients with substantial distortion of the brain from prior surgery or trauma were excluded. Images were analyzed by a single CAQ-certified neuroradiologist for the presence of a widened sulcus sign, a fallen gyrus sign, or ipsilateral ventricular dilatation. The reference standard was surgical repair of a meningoencephalocele or negative endoscopic evaluation with negative beta-2 transferrin assay.

Results
Twenty-eight patients met inclusion criteria. Meningoencephalocele was confirmed surgically in 23 patients. Five patients had no CSF leak or meningoencephalocele following beta-2 transferrin testing and endoscopic evaluation. The sensitivity of the widened sulcus sign, the fallen gyrus sign and the ipsilateral ventricular dilatation sign for meningoencephalocele were 87% (20/23), 45% (10/22) and 27% (6/22), respectively. In patients with a false negative widened sulcus sign (n=3), the fallen gyrus sign and ipsilateral ventricular dilatation sign also were negative. In all five patients without meningoencephalocele, the three signs were all negative (100% specificity).

Conclusions
The widened sulcus sign is a highly accurate but previously unreported sign for meningoencephalocele. In patients with paranasal sinus opacification or temporal bone opacification adjacent to the skull base, or clinically suspected CSF leak, the widened sulcus sign should be sought to improve detection of meningoencephalocele.
Microstructural changes within the basal ganglia differ between Parkinson disease subtypes

L Nagae¹, J Honce¹, J Tanabe¹, E Shelton¹, S Sillau¹, B Berman¹

¹University of Colorado School of Medicine, Aurora, CO
Purpose
Tremor dominant (TD) and postural instability/gait difficulty (PIGD) subtypes of Parkinson's disease (PD) patients are known to differ in their clinical course, with the PIGD subtype generally having a more severe course and greater association with nonmotor symptoms. Our study aims to investigate differences in microstructural changes in the basal ganglia between TD and PIGD subtypes of PD patients and controls utilizing diffusion tensor imaging (DTI).

Materials and Methods
Twenty-one patients diagnosed with idiopathic PD (12 TD and 9 PIGD) and 20 age-matched healthy controls were evaluated. Diffusion tensor imaging parameters of fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD), and radial diffusivity (RD) were extracted from bilateral caudate, putamen, globus pallidus and substantia nigra with automated regions of interest (ROIs) placement using structural probabilistic atlases (Fig. 1). Fractional anisotropy, MD, AD and RD values were compared across all groups using an analysis of variance (ANOVA) with unequal variance F test followed by pairwise comparisons among the groups using a Tukey-Kramer adjustment for multiple comparisons. A two-sample t-test also was used to compare FA, MD, AD and RD values between PD patients versus controls, and partial Spearman's correlations adjusted for age were used to check for post hoc correlations between FA and MD and clinical measures of disease duration, disease stage, and motor severity.

Results
A significant reduction in FA (p=0.007) and increases in MD (p=0.029) and RD (p=0.017) were seen in the left SN when comparing all groups, changes driven by the PIGD subtype. Parkinson's disease and controls differed by reduced FA in the right SN (p=0.020); increased MD in the SN (left: p=0.039; right: p=0.020) and globus pallidus (left: p=0.020; right: p=0.049); increased RD in the right SN (p=0.022) and bilateral globus pallidus (left: p=0.026; right: p=0.049) (Fig. 2). In the PIGD group, MD in the globus pallidus showed a positive correlation with disease stage (right: r=0.764, p=0.027) and motor severity (left: r=0.814, p=0.014).

Conclusions
Our results support that DTI can detect microstructural alterations in the SN and globus pallidus of PD patients, and suggest that such changes within the SN may be able to differentiate PIGD and TD motor subtypes. In addition, our findings suggest that diffusivity changes in the globus pallidus are particularly relevant to patients with the PIGD motor subtype and may more accurately reflect motor severity and disease stage than changes affecting the SN.
Figure 1. Representative axial fractional anisotropy (FA) maps from one subject illustrating the locations of the ROIs after transformation to subject space. Blue – caudate nucleus, Red – thalamus, Green – globus pallidus; Yellow – substantia nigra.
Figure 2. (A.) DTI measures from left substantia nigra across groups showing significant differences ($p<0.05$, corrected for multiple comparisons using Tukey-Kramer adjustment). (B.) Significant partial correlations adjusted for age between mean diffusivity (MD) in the right globus pallidus and H&Y disease stage ($r=0.764, p=0.027$) and between MD in the left globus pallidus and MDS-UPDRS III scores ($r=0.814, p=0.014$).
Absence of the “Checkmark” Sign in Patients with Parkinson’s Disease.

M Peckham¹, Y Miura¹, M Lee¹, B Bartnik-Olson¹, S Harder¹  
¹LLUMC, Loma Linda, CA

Purpose
To determine whether the "checkmark" sign, a mineralized pattern in the region of the dorsolateral substantia nigra, is present or absent in patients with Parkinson's disease (PD). Background: Multiple studies have characterized normal and abnormal midbrain mineralization patterns, specifically in the setting of Parkinson's disease (PD). One pattern seen in normal subjects is a T1 and T2 hyperintense ovoid area within the dorsolateral aspect of the substantia nigra (swallow tail sign). Multiple studies have shown a loss of this hyperintense region in the setting of PD. Another regional pattern, a mineralized "checkmark" extending from the dorsolateral substantia nigra, has never been characterized before in normal or PD subjects (Fig. 1). Because of the checkmark's proximity to the swallow-tail region, we hypothesize that this mineralization pattern will be present in normal subjects and absent in PD.

Materials and Methods
Brain magnetic resonance imagings (MRIs) performed on a 3.0 T magnet of 30 PD and 40 age-matched control subjects were evaluated retrospectively by two investigators. The presence or absence of the checkmark sign, evaluated on SWI, was documented.

Results
A bilateral checkmark sign was significantly associated with disease state [Pearson Chi-square statistic 8.303 (df 1), p = 0.004], where the PD group more often had an absence of the checkmark sign bilaterally compared to the control group. When evaluated for laterality, the absence of the checkmark sign was significantly associated with the left side [Pearson Chi-square statistic 9.65 (df 1), p=0.002] in the PD group.

Conclusions
We describe a novel mineralization pattern in the midbrain – a "checkmark" extending from the dorsolateral substantia nigra, the same region as the previously described "swallow-tail" sign. This pattern was found to be absent more often in the PD group.
Purpose
To describe a new noninvasive magnetic resonance imaging (MRI)-guided technique for the treatment of essential tremors and describe the computed tomography (CT) and MRI findings post-treatment.

Materials and Methods
MRI-guided focused ultrasound (MRgFUS) thalamotomy is an emerging "noninvasive" treatment for essential tremor. The ultrasound energy is delivered across the intact skull, resulting in the thermal lesioning within the target. During the sonication, there is continuous MRI thermal monitoring which guides treatment. Subtherapeutic sonication allows for clinical testing and precise target identification prior to final therapeutic lesioning. Computed tomography and MRI are obtained.
postprocedure for documentation of the lesioning effect and to exclude hemorrhagic complications.

Results
Treatment effects are immediate with the thalamotomy resulting in significant improvement of tremor. CT (Fig. 1) obtained following the procedure demonstrates the left thalamotomy and excludes hemorrhage. Magnetic resonance imaging obtained within 24 hours demonstrates the small thalamotomy with restricted diffusion on diffusion-weighted imaging (Fig. 2), abnormal susceptibility on susceptibility-weighted imaging (Fig. 3) and evidence of edema on FLAIR imaging (Fig. 4) within the thalamus and surrounding the lesion.

Conclusions
Magnetic resonance focused ultrasound allows for the noninvasive treatment of patients with essential tremors with immediate clinical results. The radiologist should be aware of the immediate imaging findings as the technique becomes more available.
In-vivo T2 Quantification of Brainstem Nuclei in Normal Subjects at 3-T.

M Hoch¹, N Ben-Eliezer¹, S Chung¹, K Chen¹, E Ben-Avi¹, M Bruno², T Shepherd¹
¹NYU Medical Center, New York, NY, ²New York University, New York, NY
Purpose
We have implemented a new clinically feasible and quantitative brainstem magnetic resonance imaging (MRI) protocol that is an improvement over conventional 3T MRI in the direct visualization of brainstem substructures. Using echo modulation curve (EMC) T2 fitting software we sought to generate normal T2 values of brainstem nuclei in living subjects.

Materials and Methods
Six healthy right-handed subjects (Mean age 27.8 years, 2 Male) underwent noncontrast MRI of the head using a 20-channel head and neck coil on a 3T MRI (Skyra, Siemens Healthcare, Erlangen, Germany) using our brainstem protocol (1). For quantitative T2 mapping the multiecho spin echo sequence included 15 echoes at 10 ms intervals (TE = 10-150 ms, TR 5100 ms, Matrix 384 x 234, 2-slice acceleration, 2 mm slice thickness, 2 averages) and required 6 min. T2 and proton density (PD) maps of the brainstem were postprocessed from the multispin echo (MSE) datasets using a recently developed EMC T2 fitting software package, which relies on accurate Bloch simulations to model the exact signal evolution in MSE pulse-sequences by employing the exact radiofrequency pulse shapes and other experimental parameters (2, 3). The software package is custom-written in MATLAB and C++, then executed with MATLAB scripts and a graphical user interface. Manual regions of interest (ROIs) were placed over bilateral brainstem nuclei (Fig. 1) to generate T2 (in ms) and PD values compared within groups.

Results
The quantitative results are summarized in Table 1. Correlation with histology also is provided (4). Values for inferior brainstem nuclei were less reproducible given spin echo blood vessel pulsation artifacts. The lowest T2 value was seen in the red nucleus (RN). The highest PD value was the hypoglossal nucleus (XII). These results need to be validated with a larger group of subjects.

Conclusions
Quantification of directly visualized small brainstem structures was possible at 3T in normal subjects. This method could serve as a future tool for generating potential biomarkers to help diagnose and monitor neurodegenerative disease.
Table 1: EMC T2 and PD values of brainstem nuclei correlated with histology

<table>
<thead>
<tr>
<th>Brainstem Nuclei</th>
<th>Avg T2 ms</th>
<th>95%CI</th>
<th>Avg PD</th>
<th>95%CI</th>
<th>Dominant Histology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuneate Nucleus (CU)</td>
<td>92.8</td>
<td>+/-21.5</td>
<td>0.43</td>
<td>+/-0.03</td>
<td>Pleomorphic cells ganglionic</td>
</tr>
<tr>
<td>DMN Vagus (DMX)</td>
<td>78.7</td>
<td>21.8</td>
<td>0.46</td>
<td>0.05</td>
<td>3 types of medium-size and large multipolar</td>
</tr>
<tr>
<td>Gracile Nucleus (GR)</td>
<td>75.2</td>
<td>17.9</td>
<td>0.48</td>
<td>0.04</td>
<td>Pleomorphic and scattered</td>
</tr>
<tr>
<td>Hypoglossal Nucleus (XII)</td>
<td>80.2</td>
<td>12.6</td>
<td>0.49</td>
<td>0.04</td>
<td>Large multipolar motoneurons</td>
</tr>
<tr>
<td>Inferior Colliculus (IC)</td>
<td>69.1</td>
<td>9.7</td>
<td>0.42</td>
<td>0.03</td>
<td>Marked cellularity and perivascular spaces</td>
</tr>
<tr>
<td>Inferior Olive (IO)</td>
<td>57.6</td>
<td>7.0</td>
<td>0.44</td>
<td>0.02</td>
<td>Uniform density, early aging</td>
</tr>
<tr>
<td>Locus Coerules (LC)</td>
<td>86.6</td>
<td>8.6</td>
<td>0.44</td>
<td>0.02</td>
<td>Dorsal cellularity w/ glial and myelin</td>
</tr>
<tr>
<td>Medial Vestibular Nucleus (MVN)</td>
<td>63.9</td>
<td>11.6</td>
<td>0.48</td>
<td>0.05</td>
<td>Scattered, variable size and shape</td>
</tr>
<tr>
<td>Mesencephalic Reticular Formation (MRF)</td>
<td>59.7</td>
<td>1.4</td>
<td>0.38</td>
<td>0.02</td>
<td>Small cells with glial and myelin</td>
</tr>
<tr>
<td>Motor Trigeminal Nucleus (MoV)</td>
<td>69.0</td>
<td>7.0</td>
<td>0.38</td>
<td>0.03</td>
<td>Large multipolar motoneurons</td>
</tr>
<tr>
<td>Oculomotor Nucleus (III)</td>
<td>64.3</td>
<td>2.1</td>
<td>0.39</td>
<td>0.01</td>
<td>Large multipolar motoneurons</td>
</tr>
<tr>
<td>Periaqueductal Grey (PAG)</td>
<td>76.5</td>
<td>6.1</td>
<td>0.47</td>
<td>0.01</td>
<td>Small cells peripheral, perivascular spaces</td>
</tr>
<tr>
<td>Red Nucleus (RN)</td>
<td>55.5</td>
<td>2.9</td>
<td>0.34</td>
<td>0.01</td>
<td>Medium cells mixed with glial and myelin</td>
</tr>
<tr>
<td>Solitary Nucleus (SOL)</td>
<td>57.0</td>
<td>8.1</td>
<td>0.44</td>
<td>0.02</td>
<td>Irregularly arranged and gliotic</td>
</tr>
<tr>
<td>Spinal Trigeminal Nucleus (SpV)</td>
<td>61.4</td>
<td>7.3</td>
<td>0.42</td>
<td>0.03</td>
<td>Small, closely packed, perivascular spaces</td>
</tr>
<tr>
<td>Substantia Nigra (SN)</td>
<td>56.3</td>
<td>5.1</td>
<td>0.41</td>
<td>0.02</td>
<td>Large cells w/ abundance and perivascular</td>
</tr>
<tr>
<td>Superior Colliculus (SC)</td>
<td>70.5</td>
<td>6.7</td>
<td>0.41</td>
<td>0.01</td>
<td>7-layer laminated structure</td>
</tr>
</tbody>
</table>
Tuesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Maryland A/B/C

11E-Young Professional Programming: Social Media Programming: Career and Social Media
11E-1

Becoming a Leader in Private Practice

Barr, R.
Mecklenburg Radiology Associates, P.A.
Charlotte, NC

11E-2
Becoming a Leader in Academics

Glastonbury, C.
University Of California, San Francisco
San Francisco, CA

11E-3

WHY all Radiologists Should Use Social Media Professionally

Hoang, J.
Duke University Medical Center
Durham, NC

11E-4

The Nuts and Bolts of Social Media: AKA How Do I Use This Stuff?

Lall, N.
Cincinnati Children's Hospital Medical Center
Cincinnati, OH

11E-5

Social Media Super-Users Panel

McGinty, G. · Fitzgerald, R. · Chokshi, F. · Tomblinson, C.
Weill Cornell Medicine Radiology · University of Arkansas for Medical Sciences ·
Emory University School of Medicine · Mayo Clinic
New York, NY · Little Rock, AR · Atlanta, GA · Phoenix, AZ

Tuesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Roosevelt 4

11F-ASSR Programming: Advanced Interventional Spine Procedures
11F-1
Regenerative Spine Medicine: A Primer for Neuroradiologists

Johnson, B.
Center for Diagnostic Imaging
Minneapolis, MN

11F-2

The Future Spine Radiologist: Integrating Imaging and Procedures for Precision Diagnosis and Treatment

Lawler, G.
Neuroimaging and Interventional Spine Services
Danbury, CT

11F-3

The Spine Clinic: Moving Toward ABR Pain Medicine Certification

Ortiz, A.
Winthrop University Hospital
Mineola, NY

11F-4

Interventional Pain Management in Failed Back Surgery Syndrome

Georgy, B.
North County Radiology
San Diego, CA

11F-5

Discussion
Tuesday  
4:45PM - 6:15PM  
Washington Marriott Wardman Park, Marriott Ballroom  

12A-ASPNR Programming: Cased Based Competition (AR)  
Tuesday  
4:45PM - 6:15PM  
Washington Marriott Wardman Park, Washington 4/5/6  

12B-Drugs and Bugs: Global Disasters  
12B-1  
4:45PM - 5:10PM  
Outbreak: Illicit Drugs and Infective Bugs  
Lim, T.  
National Neuroscience Institute  
Singapore  

12B-2  
5:10PM - 5:35PM  
Bugs and Drugs: CNS Manifestations Associated with Illicit Drugs and Infections in Brazil  
Brandão, L.  
Clínica Felippe Mattoso  
RIO DE JANEIRO, RJ  

12B-3  
5:35PM - 6:00PM  
Drugs and Bugs: Look What the Boeing Dragged In  
Tsiouris, A.  
New York-Presbyterian - Weill Cornell Medical Center  
New York, NY  

12B-4  
6:00PM - 6:15PM
Tuesday
4:45PM - 6:15PM
Washington Marriott Wardman Park, Washington 1/2/3

12C-Organizational Dynamics
12C-1
4:45PM - 5:20PM
Radiology Group Dynamics-Moving from Dysfunction to Fun Using Leadership and Citizen Training
Lexa, F.
Wharton School, Univ. of Pennsylvania
Philadelphia, PA

12C-2
5:20PM - 5:55PM
There are Many Groups in your Radiology Group: Leading Them to Success
Simon, A.
Seton Hall University
South Orange, NJ

12c-3
5:50PM - 6:15PM
Discussion

Tuesday
4:45PM - 6:15PM
High Levels of Gadolinium Deposition in the Skin of a Patient with Normal Renal Function

D Roberts1, K Maravilla2, C Welsh1, S Lindhorst3, W Davis4
1Medical University of South Carolina, Charleston, SC, 2Univ. of Washington, Seattle, WA, 3Medical University of South Carolina, Charleston, SC, 4National Institute of Standards and Technology, Charleston, SC

Purpose
Our objective is to raise awareness concerning the potential deposition of high levels of gadolinium in the skin of patients with normal renal function, based on estimated glomerular filtration rate (eGFR) values greater than 59 ml/min/1.73 m2, following exposure to large cumulative doses of gadolinium-based contrast agents (GBCAs).

Materials and Methods
Here we present a patient with normal renal function who underwent 61 contrasted brain magnetic resonance imaging (MRI) scans over the course of 11 years. Skin biopsies from the forearm and lower extremity were analyzed with inductively coupled plasma mass spectrometry (ICP-MS), laser ablation ICP-MS (LA-ICP-MS), and hydrophilic interaction liquid chromatography ICP-MS (HILIC-ICP-MS).

Results
Inductively coupled plasma mass spectrometry demonstrated high levels of gadolinium deposition (14.5±0.4 microg/g), similar to previously reported gadolinium levels within the skin of patients with nephrogenic systemic fibrosis. Laser ablation ICP-MS demonstrated deposition of gadolinium within the deep layers of skin. Speciation analysis using HILIC-ICP-MS demonstrated the presence of intact gadolinium-chelate species. Light microscopy demonstrated increased CD34 immunoreactivity in the connective tissue septations of the subcutaneous adipose tissue. The patient had no history of skin disorders, but did have severe joint contractures of unknown etiology.

Conclusions
Our results, in contradiction to published literature, suggest that in patients with normal renal function, exposure to GBCAs in high cumulative doses, can lead to significant gadolinium deposition in the skin. This finding is in line with more recent reports of gadolinium deposition in the brain of patients with normal renal function. Future studies are required to address possible clinical consequences of gadolinium deposition.
deposition in the skin, brain and other organs in patients with normal renal function. We recommend, in addition to following FDA and ACR guidelines based on eGFR values, that caution be used when administering large cumulative doses of GBCAs and that total cumulative dose is recorded in the patient's medical record.

O-250

Prospective Observational Post-marketing Study on the Safety of Gadoterate Meglumine - Final Results in the pediatric cohort of over 1,600 children.

A Gottschalk¹, B Kress¹
¹Krankenhaus Nordwest, Frankfurt am Main, Germany

Purpose
To assess the safety profile of gadoterate meglumine (DOTAREM®) in a broad patient population scheduled for contrast-enhanced magnetic resonance imaging (MRI). Secondary objectives were to detect any case of nephrogenic systemic fibrosis (NSF) suspicion and to collect efficacy data (image and diagnosis quality).

Materials and Methods
This global observational study recruited 35,499 patients scheduled for gadoterate meglumine-enhanced MRI. A large pediatric subpopulation of 1,631 patients [53.5% male, mean (±SD) age of 10.2 (±4.9) years] from nine countries and including 106 children (6.5%) less than 2 years old was analyzed. Magnetic resonance imaging indications, risk factors and adverse events were recorded. A specific follow up of at least 3 months was planned for detection of any NSF suspicion in patients with moderate to severe renal impairment (3 children among 514 patients). Image quality was analyzed in five classes (very poor, poor, fair, good and very good) and ability to come to diagnosis was assessed.

Results
The main MRI indication for the pediatric population was imaging of the central nervous system (80.4%) followed by musculoskeletal system imaging (11.1%). The most frequent risk factors were nervous system disorders (16.6%), any stage of renal impairment [9.8%; with a mean estimated creatinine clearance or eGFR of 74.1 mL/min (/1.73 m²), (range: 28-89)] and allergies (5.2%). Only one adverse event (mild nonserious vomiting) that was deemed doubtfully related to gadoterate meglumine was described in a 2-year-old child (<0.1%) with brain tumor. No suspicion of NSF was reported. Good to very good image quality was obtained for more than 98% of the pediatric patients and diagnosis could be established for 99.6% of the patients.

Conclusions
The SECURE study confirmed the very good safety profile of gadoterate meglumine
in a large pediatric population as well as its efficacy in terms of image and diagnosis quality in routine practice.

O-251

4:51PM - 4:54PM

Safety of MRI in patients with implantable cardiac electronic devices.

S Mohan¹, J Schmitt¹, H Litt¹, E Motuzko², N Lerner¹, T Brunker¹, S DIXIT¹, L Desiderio¹, L Loevner¹, S Jha¹
¹Perelman School of Medicine of the University of Pennsylvania, Philadelphia, PA, ²Cooper University Hospital, Camden, NJ,

Purpose
A patient with implantable cardiac electronic device (ICED) has a 50-75% lifetime chance of needing an magnetic resonance imaging (MRI) (1, 2). Device-related complications from MRI are speculative. We assess the safety of MRI in patients with ICEDs who needed MRI for clinical management.

Materials and Methods
Between 2008 and 2015, 600 patients with ICED had MRI at 1.5T under an interdisciplinary protocol consisting of pre-approval by an attending radiologist, pre and postprocedure device interrogation and reprogramming, and intraprocedure monitoring. We performed a chart review to search for adverse events within 1 year of MRI. Adverse events were defined as death, arrhythmia requiring urgent treatment during MRI, and permanent device malfunction.

Results
Most patients had MRI of the brain and spine (46%), or heart (44%). There were 32 deaths within 1 year of MRI, all except one was adjudicated as not related to MRI; there was insufficient information concerning one patient to determine cause of death. Two patients with ICDs were removed from the scanner and shocked for symptomatic ventricular tachycardia, one patient developed symptomatic atrial fibrillation during the MRI and was admitted to the hospital. However, in no patient did the ICED malfunction.

Conclusions
With careful patient selection, preparation and monitoring, the adverse event rate related to MRI in patients with implanted devices is very low.

O-252

4:54PM - 4:57PM

RISE (Radiology International Student Education): Creation and Utilization of Virtual Online Classroom for Global Neuroradiology Education
Purpose
One of the major challenges facing international neuroradiology is a lack of available neuroradiology fellowship training. For example, the entire continent of Africa has no neuroradiology fellowship training available within the region. International travel to complete fellowship training presents financial challenges for trainees and is in practice unsustainable as a routine method of neuroradiology training. We created an innovative solution by designing a virtual classroom, which allows residents from around the world to tune in live during dedicated neuroradiology lectures at UCSF.

Materials and Methods
A virtual classroom was created at UCSF Medical Center to enable international radiology residents to tune in live to a series of dedicated neuroradiology lectures given at UCSF. The pilot project was launched with Kenyatta National Hospital, University of Nairobi, Kenya. Kenyatta National Hospital has 45 radiology residents. Specifically, the live lectures involve two-way audio and video communication with interactive technologic solutions to annotate shared slides. The limitations in internet access, equipment availability, and cross platform technologies were solved with support of local IT staff and the Center of Digital Health and Innovation at UCSF.

Results
The impact of the virtual classroom was studied with close monitoring using pre and postlecture online exams. Advanced result analytics to assess the longitudinal performance of each radiology resident at University of Nairobi is being performed to assess the improvement in knowledge gap in neuroradiology. For asynchronous teaching, the RISE platform provides continuous online access to the recorded lecture database for access across different time zones.

Conclusions
The lack of international subspecialty training in neuroradiology demands innovative solutions to meet the demand for neuroradiology training. Live and interactive online virtual classrooms represent a cost effective and practical method for expanding neuroradiology training to regions with no available fellowship training. In the future, the aim is to expand the RISE curriculum to include other countries around the world for live virtual education in neuroradiology, as well as to develop a defined neuroradiology curriculum.
Making Stroke Imaging Better around the World? Global Survey of Radiologists in 20 Countries

I Brown¹, L Busby¹, C Mutch², W Dillon¹, D Cooke¹, B Rehani¹
¹UCSF, San Francisco, CA, ²University of California, San Francisco, San Francisco, CA

Purpose
Stroke poses a major health challenge in today's world. "Time is Brain" in stroke and every minute counts in stroke management. To what extent are we able to provide timely imaging to these patients globally and if not what can be done? Our aim was to survey radiologists across developing countries in Asia, Europe and South America to assess the stroke care and find out what in their opinion are the most effective ways to improvise imaging and management.

Materials and Methods
A standardized questionnaire containing 18 questions was sent to radiologists in 25 developing countries across the world. Radiologists from 20 countries responded (response rate = 80%). These include Kenya, Algeria, Rwanda, Sri Lanka, Malaysia, Costa Rica, Macedonia, Bulgaria, Mexico, China, India, Uruguay, Burma and Venezuela among others.

Results
Survey results indicated that most of the countries (72%), lack access to computed tomography (CT) scanners. Intravenous tissue plasminogen activator (tPA) is the standard of care of ischemic stroke and cannot be given unless hemorrhage is excluded on CT. Also, this only can be administered for a specific time window after symptom onset. To maximize patients who can benefit from thrombolysis, the key is to have a short Emergency Room Door to CT scan time. Unfortunately, Door to CT scanner time is more than 30 minutes in 83% (95% CI being 80.5-85.4%). Moreover, 77% of the countries had shortage of the drug tPA. Overall, radiologists rated their knowledge as "average" in reading stroke imaging and 77% (95% CI being 74.5-79%) believed that further training would be helpful. Minority had access to neurointerventionalist (33%) and Telestroke services (27%). When questioned about the three most powerful ways to improvise stroke imaging in their respective countries, the highest rated choices were: training programs on stroke imaging to improvise knowledge among radiologists, campaigns to increase awareness in the community and improvising access to CT.

Conclusions
This survey helps radiologists around the world communicate the imaging needs in stroke in their respective countries and how they can be met. This can help radiologists who want to reach out in their humanitarian efforts to improve imaging around the world.
Centralization Management in Endovascular Treatment of Aneurismal Subarachnoid Hemorrhage The 10 Years Experience of Oversea Transfer in Martinique

M Schertz

1Pitié Salpetrière, Paris, France

Purpose
Hospital procedural volume of endovascular therapy is related with outcome in aneurysmal subarachnoid hemorrhage (aSAH). Because of a low volume of patients in Martinique, the further management of SAH consists in transferring overseas by plane patients with aSAH, to a reference center in Paris for endovascular treatment. The aim of this study was to evaluate the cost, the safety and the outcome related to this unique management.

Materials and Methods
We retrospectively identified all patients with aSAH in Martinique from 2004 to 2014. Medical reports were analyzed. Mean cost estimation was done using data from our institution.

Results
In the 10 years study period 120 patients had aHSA in Martinique. Ninety-one of them (76%) were transferred by plane to Paris. Among the transferred patients, 89 had an endovascular treatment of aneurysm (98%) with an average time from diagnostic to treatment of 2 days. Eight transferred patients died within 30 days (Mortality rate = 8.8%). No patients died during the transportation. Total 30 days mortality in Martinique was 25%. Total transportation procedure was estimated at 18,000 euros per transfer.

Conclusions
Long distance plane transfer of aSAH to high volume specialized center is a safe management. This management can be used in isolated areas with low volume of aSAH. It results in a normal regional mortality rate for an acceptable cost.

The Use of High-Risk Criteria in Screening Patients for BCVI: A Survey

X Wu, V Kalra, D Durand, R Liu, R Bronen, K Abbed, H Forman, A Malhotra

1Yale University School of Medicine, New Haven, CT
Purpose
Blunt cerebrovascular injury (BCVI) is uncommon, but delayed detection can have disastrous consequences. Multiple screening criteria are proposed for detection of BCVI, among which Denver criteria is the most commonly used (1). We aim to examine the utilization of screening criteria in the emergency department (ED) of our institution, and assess whether patients with risk factors were imaged.

Materials and Methods
A survey questionnaire was sent out to radiologists in a large, academic institution. Upon the approval of our Institutional Review Board, a search was performed in the database for the use of computed tomography angiography (CTA) and magnetic resonance imaging angiography (MRA) among patients with risk factors. Patients from the last 11 years were included (January 2004 - December 2014).

Results
The survey was sent to a total of 173 radiologists with 41 responses, out of which 35 were complete. Most of the physicians (30 out of 35) surveyed selected CTA as their preferred modality to screen for BCVI whereas the remaining selected MRA. Digital subtraction angiography (DSA) was not preferred by any of the respondents. None of the respondents reported routine use of the screening criteria or Denver Grading scale in their readouts. Only five selected risk factors listed in the Denver criteria correctly.
In the institution search, among the 1,069 patients with blunt trauma and risk factors for BCVI, 122 underwent at least one angiographic study, giving a screening rate of 11.4%. There was an increase in the screening rate after February 2010 in all four risk factors, but only statistically significant among patients with foramen transversarium fractures and C1 – C3 fractures.

Conclusions
Both the Denver screening criteria and grading scale of vascular injury have been underutilized in the ED for patients with risk factors. Greater awareness and utilization of imaging potentially can result in decreased incidence of subsequent stroke in patients with blunt injury.

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Screening Rate Before Feb, 2010</th>
<th>Screening Rate After Feb, 2010</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skull base</td>
<td>28.1</td>
<td>37.2</td>
<td>0.005</td>
</tr>
<tr>
<td>Foramen transversarium</td>
<td>70.8</td>
<td>85.3</td>
<td>0.001</td>
</tr>
<tr>
<td>LeFort</td>
<td>23.0</td>
<td>29.8</td>
<td>0.05</td>
</tr>
<tr>
<td>C1 – C3</td>
<td>27.5</td>
<td>36.1</td>
<td>0.004</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-255_TableforASNR.jpg)
Cost-Effectiveness Analysis of MRI in Cervical Spine Clearance After Blunt Trauma

X Wu¹, V Kalra¹, D Durand¹, R Liu¹, R Bronen¹, K Abbed¹, H Forman¹, A Malhotra¹
¹Yale University School of Medicine, New Haven, CT

Purpose
There has been significant controversy on the utility of magnetic resonance imaging (MRI) in cervical spine (CS) clearance after blunt trauma and negative computed tomography (CT) (1-5). This cost-effectiveness analysis aims to assess the utility of MRI by taking many pertinent factors into consideration – including negative predictive value of initial CT, MRI false positive rate, the costs of delayed injury detection.

Materials and Methods
A modeling-based economic decision analysis was performed from a payer's perspective using TreeAge Pro Suite 2014. The two strategies being compared were no follow up after a normal CT, MRI follow up, and Markov model with an annual 3% discount rate was used. Most of the clinical parameters were derived from past literature and a meta-analysis by the authors. Two sets of analyses were carried out using Medicare costs and institutional costs.

Results
Magnetic resonance imaging follow up has an expected cost of $423 and utility of 18.14 QALY per patient, whereas no follow up has an expected cost of $1,736 and utility of 18.15 QALY per patient. Magnetic resonance imaging is the more cost-effective strategy, but the difference in effectiveness is minimal. When we assumed the negative predictive value from the pooled meta-analysis average by the inverse of variance, the cost of no follow up drops to $29.6. In Monte Carlo simulation, no follow up is a better strategy in 40.0% of all iterations. When institutional cost of MRI is used, no follow up is more cost-effective in 99.1%. Sensitivity analyses demonstrate that MRI is the less optimal strategy in most clinical settings and that the percentage of missed ligamentous/soft tissue injury developing into cord injury has the largest impact on the conclusion.

Conclusions
Although MRI has been used as the gold standard to clear CS, its high false positive rate and the rarity of missed injuries on CT render MRI a less cost-effective strategy than no follow up.
Utilization of Inpatient Neuroimaging MRI Studies: Do We Need Guidelines Beyond Existing American College of Radiology (ACR) Appropriateness Criteria?

M Del Guzzo¹, P Mehta¹, S Brown¹, K Mortele¹, R Rojas¹, R Bhadelia¹
¹Beth Israel Deaconess Medical Center, Boston, MA

Purpose
There is increasing concern about over-utilization of high-cost imaging studies such
as magnetic resonance imaging (MRI) during hospital admissions. Judicious and appropriate use of inpatient MRI services may affect duration of hospital stay and overall healthcare-related costs. Our purpose was to perform a pilot study to assess if existing American College of Radiology (ACR) appropriateness criteria for neuroimaging may be sufficient to identify MRI studies that were performed inappropriately in the inpatient setting.

Materials and Methods
We retrospectively reviewed inpatient MRI scans performed for neurological indications over 1-month period at our tertiary care center. We determined the appropriateness of neuroimaging MRI orders based on the existing ACR appropriateness criteria as well as consensus online medical record review. All inpatient studies were classified as: (1) Appropriate: ACR rating of 4 or more and record review suggesting importance in immediate clinical management. (2) Inappropriate: ACR appropriateness criteria of 4 < and/or a record review suggesting that it could be performed as an outpatient study without altering immediate clinical management. (3) Redundant: If the clinical question had already been answered by another imaging modality.

Results
Of the 293 inpatient MRI studies performed, 235 (80.2%) were considered appropriate, 48 (16.4 %) inappropriate and 10 (3.4 %) redundant. Several additional studies could have been classified as inappropriate provided: (1) there had been a prospective dialogue between the radiologist and referring physician, (2) patient convenience was not accommodated (inpatient MRI to exclude metastasis in the absence of neurologic symptoms), (3) there existed a defined appropriateness criteria for inpatient indications (total spine screening MRI for bacteremia without back pain).

Conclusions
Our results suggest that one out of every five inpatient MRI performed for neuroimaging at our institution was either inappropriate or redundant. Inpatient studies could be further decreased if there were specific criteria for inpatients along with ongoing direct involvement of a radiologist.

O-258

5:12PM - 5:15PM

Prevalence of Repetitive CT and MR Imaging of the Brain at a Tertiary Care Academic Medical Center

D Friedman¹, R Gorniak²
¹Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, PA, ²Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, PA
Purpose
Increasing radiation exposure to the population as a result of medical imaging [especially computed tomography (CT)], as well as recently described gadolinium deposition in the brain with repeated use of gadolinium-based contrast agents (as few as four scans), are hot topics in radiology. We assessed the prevalence of repetitive CT and MR imaging of the brain at a tertiary care academic medical center.

Materials and Methods
A radiology database at a tertiary care academic medical center was interrogated for a 45 month period (12/2010 – 9/2014) and then for an additional 12 months through 9/2015 (57 month period). Repetitive imaging was defined as six or more scans for either of these time periods. For CT imaging, the number of patients having 6-10 scans, 11-20 scans, 21-50 scans, and >50 scans was determined for the two time periods; CT/CTA brain performed at the same sitting was counted as one scan. For magnetic resonance imaging (MRI), the number of patients having 6-10 scans, 11-20 scans, and >20 scans was determined for the two time periods; MRI/MRA brain performed at the same sitting was counted as one scan. Scans were performed in emergency department, outpatient office, and/or inpatient settings.

Results
Regarding CT brain imaging, a total of 57,041 patients were scanned during the 45 month time period; 1520 had 6-10 scans; 346 had 11-20 scans; 40 had 21-50 scans; four had greater than 50 scans. A total of 1,910 patients (3.3%) had repetitive CT imaging of the brain during the shorter, 45 month study period. A total of 70,143 patients were scanned during the 57 month time period; 2009 had 6-10 scans; 448 had 11-20 scans; 60 had 21-50 scans; five had greater than 50 scans. A total of 2,522 patients (3.6%) had repetitive CT imaging of the brain during the longer study period; by simply extending the study period by 1 year, an additional 612 patients (+32.0%) were identified. Regarding MR brain imaging, a total of 32,067 patients were scanned during the 45 month time period; 487 had 6-10 scans; 141 had 11-20 scans; four had >20 scans. A total of 632 patients (2.2%) had repetitive MR imaging of the brain during the shorter, 45 month study period. A total of 40,468 patients were scanned during the 57 month time period; 713 had 6-10 scans; 216 had 11-20 scans; 21 had >20 scans. A total of 950 patients (2.3%) had repetitive MR imaging of the brain during the longer study period; by simply extending the study period by 1 year, an additional 318 patients (+50.3%) were identified. An additional 3,568 patients had 3-5 MRI scans during the 57 month time period.

Conclusions
Although repetitive CT and MR imaging of the brain occurred in a small percentage of patients, the absolute number of patients affected was substantial. These data underestimate the prevalence of repetitive imaging, as studies performed at outside facilities in this patient population were not captured; moreover, lengthening the study period by only 1 year captured considerably more patients. Repetitive imaging raises
concerns regarding cumulative radiation dose, accumulation of gadolinium-based contrast agents in the brain, cost effectiveness, and outcomes.

O-259

5:15PM - 5:18PM

Interphysician Variation in the Use and Yield of Non-contrast CT Head Examinations at an Academic Tertiary Emergency Department

Y Chen¹, G Bandiera¹, D Mackinnon¹, D Deva¹, B Gray¹

¹St. Michael's Hospital, University of Toronto, Toronto, Ontario

Purpose
The evaluation of variation in test ordering may be a more accurate assessment of quality than solely measuring utilization. We sought to examine the variation in the use and yield of noncontrast computed tomography (CT) head among our institution's Emergency Physicians (EPs).

Materials and Methods
Institutional ethics board approval was obtained. A cross-sectional retrospective study was conducted on 1512 consecutive ED patients who underwent noncontrast CT head examinations. Radiology report data were extracted from our institution's RIS PACS software (Syngo Imaging, Siemens) based on a targeted search of all noncontrast CT head reports from July to December 2013. Utilization rates and positivity rates for full-time individual EPs were calculated and correlated with both years of experience, gender and training certification.

Results
One hundred seventy-four of the 1512 patients (11.5%) evaluated by noncontrast CT head were positive for acute intracranial findings, divided into 43% hemorrhage, 27% infarct, 17% tumor, and 13% other. There was significant variation among full-time EPs in noncontrast CT head use (mean 4.1 +/- 1.3 scans per 100 patients seen, range 1.7 to 6.3 scans) and yield (mean 10.8 +/- 5.6%, range 0 to 22.6%). There was weak correlation between use and yield (Pearson's r = 0.12, p = 0.56). There was no statistically significant correlation between EP years of experience and use (Pearson's r = - 0.37; p= 0.06), and yield (Pearson's r = 0.06; p = 0.78). Furthermore, use and yield were not significantly different between male and female EPs (p = 0.35 for use, p = 0.32 for yield), nor between EPs with emergency medicine certification by the Royal College (FRCP) versus by the College of Family Physicians of Canada (CCFP-EM) (p = 0.27 for use, p = 0.09 for yield).

Conclusions
Considerable interphysician variability exists for both use and yield of noncontrast CT head examinations at our institution. Results from our study suggest an opportunity...
for a more standardized approach to the use of noncontrast CT head examinations among our EPs.

**Non-contrast CT Head Use among Emergency Physicians**

![Box plot for non-contrast CT head use among EPs with mean 4.1 per 100 patients seen.]

**Non-contrast CT Head Yield among Emergency Physicians**

![Box plot for non-contrast CT head yield among EPs with mean 10.8% positive.]

(Filename: TCT_O-259_FigureVariation.png)

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**O-260**

5:18PM - 5:21PM

Collaboration or Confrontation in a Radiology Utilization Management Program - How Often Do Providers and Radiologists Disagree on the Need for Advanced Imaging Studies?

D Friedman¹, N Smith²

¹Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, PA, ²Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, PA

**Purpose**

To determine how often providers and radiologists participating in a collaborative
utilization management (UM) program fail to agree on the need for advanced imaging studies.

Materials and Methods
Using evidence-based guidelines, a UM program (RadConsult) provides peer-to-peer decision support for providers ordering high cost, outpatient imaging studies (CT, MRI, PET, nuclear medicine) on patients enrolled in multiple health plans. After consultation between RBM personnel (tier I, customer service representative; tier II, nurse) and the provider's staff, studies not meeting appropriateness criteria are referred to a radiologist (tier III) for further review. Only a small percentage of cases screened at tiers I/II are referred to tier III. The radiologist can approve the study based upon electronic chart review, or call the provider for more information; determination of appropriateness then is made. If a suitable person cannot take the call, and there is "no callback" in two business days, the study is administratively withdrawn. Studies are not denied. We analyzed the rate of "study approved, but no consensus" after discussion between the provider and radiologist. In this circumstance, although the radiologist felt that the study (1) was not indicated, (2) was not indicated at that time, or (3) should be changed to a different study, the provider still wanted to obtain the study. Aggregated data for all provider specialties enabled comparison to results for each specialty. Approximately 45 radiologists participated in the UM program; 75% were subspecialty trained academic radiologists and 25% were private practice radiologists (some subspecialty trained). Project period was 5 years (7/09-6/14). Studies ordered by cardiologists were excluded, as many were reviewed by cardiologists, not radiologists. We also tracked complaints issued by providers due to interactions involving tiers I, II and III for a 4.5 year period (1/11- 6/15). Complaint data prior to 2011, or for individual tiers, was unavailable.

Results
A total of 168,915 studies ordered by all specialties were reviewed at tier III; 10,068 (6.0%) were approved without consensus. Primary care providers had the highest rates of "no consensus": pediatrics (10.3%); family practice (8.2%); internal medicine (6.6%). Surgical subspecialists had the lowest rates of "no consensus": orthopedic surgery (2.4%); neurosurgery (2.8%); ophthalmology (2.9%); otorhinolaryngology (3.4%); thoracic surgery (3.5%). A total of 6.17 million studies were reviewed in the 4.5 year period; 350 complaints (.006%) were filed by providers during this time.

Conclusions
Peer-to-peer discussion in this UM program achieved consensus in the vast majority of cases; the provider and radiologist "agreed to disagree" regarding the appropriateness of a study in just one of 17 cases. Results were achieved without denials. Despite advice offered by largely subspecialty trained radiologists, disagreements with primary care providers were more frequent than with surgical subspecialists. Rarely, providers filed complaints about interactions with UM personnel.
Neuroradiology Reading Room Interruptions - Workflow Analysis and Optimization

A Schemmel¹, M Lee¹, T Hanley², B Pooler¹, T Kennedy³, A Field⁴, D Wiegmann², J Yu⁵
¹University of Wisconsin Hospital and Clinics, Madison, WI, ²University of Wisconsin Madison, Madison, WI, ³University Of Wisconsin Hospital, Madison, WI, ⁴Univ. Of Wisconsin Hospital, Madison, WI, ⁵University of Wisconsin-Madison, Madison, WI

Purpose
Workplace interruptions and resultant task switching can have deleterious effects on patient safety and quality outcomes (1). By virtue of the varied and complex responsibilities incumbent on radiologists, the radiology workplace is particularly vulnerable to interruptions (2). Anecdotal experiences at our institution suggest that reading room interruptions and ancillary tasks consume a significant portion of the workday in the neuroradiology reading room. The purpose of this study was to: 1) quantify the nature and frequency of the myriad tasks performed in the reading room, 2) dichotomize reading room activities into two distinct workflows: image-interpretive tasks (IIT) and all noninterpretive tasks (NIT), and 3) trial of a new dedicated "Consult Fellow" (CF) to address all reading room NIT.

Materials and Methods
A prospective, randomized, observational investigation of the neuroradiology reading room was performed at our institution. One-on-one observation was performed by two trained observers (AS, TH) over 1 month. Activities were recorded using a time and motion methodology, quantifying the nature and duration of tasks (NIT and IIT) performed by radiologists in the main neuroradiology reading room. As the principal coordinators of reading room workflow, the primary reading room neuroradiology fellow was observed in shifts (8a-12p, 1p-5p), for a total of 48 hr 49 min.

Results
Neuroradiology fellows spent 54% and 46% of their time on IIT and NIT, respectively. There was a mean of 11.2 task switches per hour, with a maximum of 84 task-switching events during a single shift. The median time spent on image interpretation was 3:15 (min:sec) before a task-switching event occurred. Median time spent answering a phone call or responding to a page totaled 0:56, while discrete instances of study protocoling lasted 2:17. In-room consultations, either radiologist-to-radiologist or with referring providers, lasted a median of 1:44. Tasks of the longest duration included staff-out (median 6:07) and out-of-office episodes (median 9:03), which included interventional procedures, direct patient care, and meetings.
Conclusions
Noninterpretive tasks and reading room interruptions place a measurable burden on neuroradiology trainees at our institution consuming up to 46% of their total reading room time. The frequency of these NIT and interruptions, up to 84 in one four-hour span, results in rapid task switching and short duration of time spent per task (e.g., median 3:15 for IIT and 6:07 for trainee staff-out before task-switching event), which may have negative implications for overall reading room efficiency. These data informed the creation of a CF, designed to ameliorate the degree of interruptions trainees experience and to allow for increased time for IIT.

O-262

5:24PM - 5:27PM

Culture Change in Customer Service in an Academic Radiology Department: Paving the Road to Success in a Competitive Outpatient Radiology Market

T Donovan¹, J Bisanti¹, S Williams², J Gross³, M Keiper⁴
¹University of Nebraska Medical Center, Omaha, NE, ²University of Nebraska Medical Center, omaha, NE, ³University of Nebraska, Omaha, NE, ⁴UNMC, Omaha, NE

Purpose
To evaluate the most effective methods to enact culture change in customer service in an academic radiology department in order to maintain competitive advantage in outpatient radiology services.

Materials and Methods
Multiple programs directed at improving customer service to patients and referring clinicians were implemented over a 2-year period in order to develop and consolidate a uniform culture of dedication to service in an academic radiology department. Radiology exam volumes were followed over that time period to determine if the programs had any effect on overall business development. Programs included scheduled retreats for staff and employees, employee engagement programs, clinical website development, customer survey optimization, and development of radiology blog for staff and employees. Programs were tailored to specific customer service issues identified by optimized electronic patient satisfaction surveys.

Results
Radiology staff and employee retreats introducing a new paradigm of dedication to customer service were scheduled and were possible without disruption to daily workflow. Retreats were successful in establishing a foundation of culture change of service to patients and referring clinicians. The retreats were effectively reinforced with multiple employee engagement programs designed to sustain and consolidate the new culture. These programs included video contests, development of staff and
employee radiology blogs and distribution of radiology news and information on a new radiology clinical website. The new clinical website was successfully developed and introduced as a showcase to the new commitment to customer service. Radiology imaging volumes increased by 14% over the 2-year period in which the culture change was initiated and programs completed. No additional substantive changes in service initiatives, economic variables or market force occurred during that time period to otherwise account for the change in radiology volumes.

Conclusions
Academic radiology practices compete with highly motivated and aggressive outpatient radiology centers in which radiology marketing and promotion is a primary source of radiology business development. By establishing a culture change of complete dedication to customer service and reinforcing these concepts with concrete employee engagement programs and a clinical website, an academic radiology department can remain competitive in outpatient radiology and ultimately realize increased imaging volumes.

O-263
5:27PM - 5:30PM

The Argument for Radiology Business and Marketing Training for Residents in an Academic Radiology Department: Radiology's Future Depends On It

T Donovan¹, S Williams², J Bisanti¹, J Gross³, M Keiper⁴
¹University of Nebraska Medical Center, Omaha, NE, ²University of Nebraska Medical Center, Omaha, NE, ³University of Nebraska, Omaha, NE, ⁴UNMC, Omaha, NE

Purpose
To investigate the utility and potential long-term benefits of dedicated radiology marketing and business training in a radiology residency program as an adjuvant to traditional noninterpretive skill development.

Materials and Methods
All residents in an academic radiology residency were exposed to didactic radiology marketing conferences, marketing retreats and direct training through business case scenario exercises over a 1-year period. Residents were taught basic radiology marketing program development, sales techniques and participated in radiology department retreats with radiology staff. Best practices in customer service emphasizing impeccable service to referring clinicians and patients were emphasized as the highest priority in training.

Results
Radiology marketing and sales training was successfully implemented as an adjuvant program to resident noninterpretive skills development. Residents were able to
demonstrate knowledge regarding basic radiology marketing and sales principles as a result of training, applying this knowledge in real life scenario training exercises. The necessity for best practices in customer service to referring clinicians and patients was actively emphasized as was the requirement for impeccable service initiatives for the ultimate success of a radiology practice. Residents were versed in the need for a national consolidated effort in radiology to be best in service and practice as a competitive advantage over other nonradiology-based entities providing imaging services.

Conclusions
Dedicated radiology marketing and sales training provides an effective adjuvant to traditional noninterpretative skills development for radiology residents. Training future radiologists through these programs is essential in ensuring the long term success of radiology practices and the overall health of radiology as a specialty in a competitive imaging market.

Tuesday
4:45PM - 6:15PM
Washington Marriott Wardman Park, Maryland A/B/C

12E - Study Group - Intracranial and Cervical Vessel Wall Imaging (non-CME)
Tuesday
4:45PM - 6:21PM
Washington Marriott Wardman Park, Roosevelt 4

12F-PARALLEL PAPER SESSION: Interventional: Vascular Malformations
O-265 4:45PM - 4:53PM

Sensitivity and Positive Predictive Value of MRI in Hereditary Hemorrhagic Telangiectasia Patients

M Mabray¹, C Glastonbury², M Conrad¹, M Dickey¹, H Kim¹, S Hetts²
¹University of California San Francisco, San Francisco, CA, ²University Of California, San Francisco, San Francisco, CA

Purpose
Hereditary hemorrhagic telangiectasia (HHT) is an autosomal dominant genetic condition characterized by arteriovenous malformations (AVMs) and telangiectasias affecting the skin, mucosa, lungs, liver, and brain. We aim to determine the prevalence of brain AVMs in our HHT cohort and to determine the sensitivity and positive predictive value of MRI as compared to catheter angiography.
Materials and Methods
Retrospective electronic medical record review was performed on our HHT clinic cohort (n=146) to determine if a brain MRI and cerebral angiogram had been performed and to determine the number of AVMs prospectively reported on each imaging study. For patients who had both imaging studies performed, we determined the number of true positives, false negatives, and false positives on a per lesion basis by magnetic resonance imaging (MRI) as compared to cerebral angiography. True negatives were not determined, as patients who had negative MRIs typically did not go to angiography.

Results
One hundred twenty-four of 146 patients (84.9%) underwent brain MRI. Eighty-seven of these MRIs were reported as negative for AVM and 37 MRIs (25.3%) were reported as positive for AVM. Thirty-three patients had both an MRI and an angiogram. There were 33 true positive, 26 false negative, and five false positives on a per lesion basis. Sensitivity of MRI compared to angiography thus was 59.4% (33/59, 95% CI 42.5-68.6%) and positive predictive value was 86.8% (33/38, 95% CI 71.1-95.1%). Overall 27/146 patients (18.5%) had an angiogram-confirmed AVM (60 lesions total). Most of the AVMs were small (<1 cm). Eighteen (30%) of these lesions had been treated in 16 patients (8 with gamma knife, 7 with surgery, and 3 with endovascular and surgical treatment). Only one AVM presented with hemorrhage.

Conclusions
Magnetic resonance imaging is only moderately sensitive (~60%) for the identification of AVMs in HHT patients but the positive predictive value is high (~87%). Not all of these generally small lesions go on to treatment (30% in our cohort).

O-266

Comparison of the Diagnostic Utility of 4D DSA with Conventional 2D and 3D DSA

C Sandoval-Garcia1, P Yang2, S Till1, S Schafer3, A Ahmed1, C Strother1
1University of Wisconsin School of Medicine and Public Health, Madison, WI, 2Changhai Hospital, Second Military Medical University, Shanghai, Shanghai, 3Siemens Medical Solutions, USA, IL, USA

Purpose
Digital subtraction angiography (DSA) evaluations often require multiple 2D DSA acquisitions. These account for the majority of x-ray exposure. Four dimensional DSA provides 3D time resolved vascular volumes viewable at any time of bolus passage at any desired viewing angle. Our purpose was to assess the ability of 4D DSA to
provide diagnostic imaging information equivalent to that of conventional 2D and 3D DSA.

Materials and Methods
Twenty-six consecutive patients who had one or more 4D DSA as part of their evaluation were selected. There were 10 aneurysm, six avms/avfs, three stenosis and seven normals. The 4D DSAs were reviewed independently by two experienced clinicians. No clinical information was provided. An electronic evaluation form containing essentials e.g., aneurysm measurements, avm angioarchitecture, required in a clinical report was completed for each case. Diagnosis, diagnostic confidence, i.e., abnormality present: definitely not, probably not, unsure, probably yes and definitely yes; and the abnormality characteristics derived from the evaluation forms were compared with the clinical evaluations. The numbers of 2D DSA acquisitions acquired were compiled from PACS.

Results
Paired t-test between the 4D reviewer's scores and between clinical and 4D diagnosis showed no significant difference (p = 0.82 and p = 0.74 respectively). Agreement between the clinical and 4D diagnosis was found in 24/26 cases. Disagreement was due to poor 4D image quality (1x) and 4D aiding in diagnosing minor occlusive disease (1x). Characteristics, such as aneurysm dimensions, nidus size and stenosis degree were similar to clinical reporting.

Conclusions
In this small study, the information content of the 4D DSAs was, by large, comparable with that of the combined 2D 3D DSA studies. Utilization of 4D-DSA should reduce the requirement for 2D-DSA acquisitions.
Safety of Conventional Cerebral Angiography in Patients with High-risk for Contrast-induced Nephropathy.

J Kim¹, D Sandhu¹, G Sandhu¹, B Jagadeesan¹, R Tummala¹
¹University of Minnesota, Minneapolis, MN

Purpose
The incidence of contrast-induced acute kidney injury (CI-AKI) is low for general population (~2%). However in patients with high risk factors such as estimated glomerular filtration rate (GFR) < 60 mL/min with diabetes mellitus, this incidence can reach up to 50%. There is paucity of data on patients with high risk features for CI-AKI who underwent conventional cerebral angiography (CCA). We present data on our experience with patients with high risk factors for CI-AKI who underwent CCA at two large tertiary care hospitals.
Materials and Methods
We conducted a retrospective review of clinical and laboratory data on 1913 consecutive CCA procedures performed at our institutions from January 2012 to November 2015.

Results
One hundred sixty-three of 1913 procedures were included in the analysis. All 163 patients had eGFR of < 60. Mean age across the group was 63 years, 68 were male, mean estimated GFR was 45 and 36/163 had eGFR < 30. Visipaque 320 was used in all patients and mean contrast volume injected was 68 cc. Mean 48-72 hours post CCA estimated GFR was 51.6. None of the patients had acute kidney injury (AKI) defined by creatinine increase of 0.5 mg/dL or at least 25% from baseline within 48 to 72 hours post exposure to contrast.

Conclusions
In our experience, CCA is acceptably safe even in patients at high risk for CI-AKI. All our high risk patients received volume expansion (normal saline at 100 cc per hour) prior to and after the procedure for at least 2 hours. Catheters were aspirated after each run to minimize volume of contrast injected. Rotational 3D angiography was avoided whenever possible. Our data suggest that CCA should not be avoided automatically in patients considered high risk for CI-AKI.

O-268

Outcomes Associated with Treatment of Unruptured Cerebral Arteriovenous Malformations

J Tejada¹, K Riley²
¹Indiana University, Indianapolis, IN, ²Indiana University School of Medicine, Indianapolis, IN

Purpose
In early 2013, patient enrollment in a randomized trial of unruptured brain arteriovenous malformations (ARUBA) was discontinued earlier than planned after an interim analysis revealed statistically significant outcome differences between the treatment groups. At 33 months, it was reported that the incidence of stroke and death was more than three times higher in the intervention group (30.7%) than the nonintervention group (10.1%). In light of the preliminary findings of ARUBA, a retrospective analysis was performed to determine the rates of stroke and death in the population of patients that underwent treatment for unruptured arteriovenous malformations (AVMs) at Indiana University since 2001.

Materials and Methods
A multi-institutional, retrospective search of radiology reports from Indiana
University and its affiliated institutions generated between 2001 and 2015 was performed to identify all patients with arteriovenous malformations. The following data were collected: initial clinical symptoms, presence of hemorrhage at presentation, location, size, drainage pattern (superficial versus deep), treatment (medical management only versus endovascular therapy, surgical excision, radiotherapy, or a combination of these interventions), and subsequent stroke/death. For cases in which these data were not available in the dedicated radiology reports, the corresponding images were assessed directly and the patients' electronic medical records were referenced to collect any excluded information. An analysis was performed to determine the rates of stroke and death in the population of patients that underwent treatment for unruptured arteriovenous malformations.

Results
Four hundred seventy AVMs were identified, 169 (36%) of which were unruptured at diagnosis. Of the unruptured AVMs, 59% presented with headache and 20% presented with seizure. Six percent of AVMs were discovered incidentally and 13% presented with nonspecific symptoms such as altered mental status and dizziness. By the Spetzler-Martin Grading Score, 17% of cases were classified as grade I, 33% grade II, 30% grade III, 16.5% grade IV, and 3.5% grade V. One hundred twenty-nine of the initially untreated AVMs underwent intervention shortly after diagnosis and 40 were treated with conservative medical management alone. Only four of the medically managed AVMs later ruptured. Of the unruptured AVMs that underwent intervention, 14% were embolized, 16% were treated with radiosurgery, and 13% were surgically resected. The remainder were treated with a combination of the above therapies. Following intervention 12.4% experienced subsequent stroke. No deaths were reported.

Conclusions
The results of this study demonstrate a much lower rate of stroke or death following intervention compared to the results of the ARUBA trial (12.4% versus 30.7%). Complication rates for patients treated with intervention in this study (12.4%) were similar to those treated with medical management alone in ARUBA trial (10.1%). These findings suggest that negative patient outcomes following intervention may not be as extreme as suggested in ARUBA.

O-269

Endovascular Management of Intracranial Arteriovenous Malformations with Various Angioarchitecture Features in the Pediatric Population: Is Spetzler-Martin Grading Predictive?

A Honarmand¹, S Ansari², M Hurley¹, M Potts², B Jahromi², A Shaibani²
Purpose
We performed this study to investigate the potential predictors of long-term outcome in endovascular management of intracranial arteriovenous malformations (AVMs) with/without surgical resection in the pediatric population.

Materials and Methods
Consecutive pediatric patients (<18 years) presenting with intracranial AVMs verified by CT/MR/DSA imaging studies were enrolled in the study. Baseline demographics, presenting symptoms, angioarchitecture characteristics [location, compact/diffuse nidus type, maximum nidus diameter, superficial/deep drainage, associated flow-induced aneurysm and/or venous varix/stenosis/ectasia, number of arterial feeders/draining veins, Spetzler-Martin Grading (SMG) scores, and ruptured/unruptured lesions], treatment strategy (endovascular embolization and/or surgical resection versus conservative management), procedural complication, recurrence, and long-term functional outcome were obtained. Ninety days modified Rankin Scale score of ≤2 and achieving developmental milestones were used to determine good functional outcome as appropriate. Independent samples T test, chi square, and logistic regression analyses were performed for statistical analyses.

Results
Fifty-eight cases (m/f: 38/20; mean age [(range)±SD: 10.99(0.5-17)±4.09 years] presented with 29 ruptured versus 29 unruptured AVMs. Presenting symptoms included severe headaches (35.8%), occasional mild-moderate headache (22.6%), incidental finding (22.6%), seizure (9.4%), focal neurological deficits (15.1%), and loss of consciousness 20.8%), respectively. Single or multi-session endovascular embolization was performed either alone or prior to surgical resection while three cases were managed conservatively. Procedural complication and lesion recurrence were encountered in 6.9% and 5.2% of cases, respectively. Good functional outcome was achieved in 49 (84%) of cases. Angioarchitecture features of the lesions are presented in the table. No significant association was observed between SMG and final outcome (P=0.80). Regression analysis of clinical presentation, lesion characteristics, and treatment-related variables revealed that rupture and severe onset of headache were independent predictors of poor long-term functional outcome (P=0.006, OR:3.5). Seven out of nine cases with poor clinical outcome presented with ruptured AVMs with unfavorable preprocedural mRS score in eight of them.

Conclusions
In our study, size, eloquent location, and complex angioarchitecture of intracranial AVMs were not predictors of outcome while presentation and ruptured/unruptured status of the lesions were significant predictors of long-term clinical outcome in treatment strategy with endovascular approach.
<table>
<thead>
<tr>
<th>Nidus Type (n, %)</th>
<th>Compact: 52 (89.7%) / Diffuse: 6 (10.3 %)</th>
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</thead>
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<tr>
<td>Nidus Location (n, %)</td>
<td>Eloquent: 33 (56.9%) / Non-Eloquent: 25 (43.1%)</td>
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<tr>
<td>Lesion ≥ 3cm (n, %)</td>
<td>22 (33.9%)</td>
</tr>
<tr>
<td>Drainage (n, %)</td>
<td>Superficial: 26 (44.9%) / Deep: 15 (25.8%) / Superficial and Deep: 17 (29.3%)</td>
</tr>
<tr>
<td>Lesions with Multiple Arterial Feeders (n, %)</td>
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</tr>
<tr>
<td>Lesions with Multiple Draining Veins (n, %)</td>
<td>27 (46.6%)</td>
</tr>
<tr>
<td>Intranidal Aneurysm (n, %)</td>
<td>15 (25.9%)</td>
</tr>
<tr>
<td>Venous Stenosis (n, %)</td>
<td>12 (20.7%)</td>
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<tr>
<td>Venous Varix (n, %)</td>
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<tr>
<td>Venous Ectasia (n, %)</td>
<td>20 (34.5%)</td>
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</table>

(Filename: TCT_O-269_table.jpg)

O-270 5:25PM - 5:33PM

Headway Duo Microcatheter for Cerebral Arteriovenous Malformation Embolization with n-BCA

J Heit1, A Faisal1, N Telischak1, O Choudhri2, H Do1
1Stanford University, Stanford, CA, 2University of California San Francisco, San Francisco, CA
Purpose
Cerebral arteriovenous malformations (AVMs) are uncommon vascular lesions, and hemorrhage secondary to AVM rupture results in significant morbidity and mortality. Arteriovenous malformations may be treated by endovascular embolization, and technical advances in microcatheter design are likely to improve the success and safety of endovascular embolization of cerebral AVMs. Here we describe our early experience with the Headway Duo microcatheter for embolization of cerebral AVMs with n-butyl-cyanoacrylate (n-BCA).

Materials and Methods
Consecutive patients treated by endovascular embolization of a cerebral AVM with n-BCA delivered intra-arterially through the Headway Duo microcatheter (167 cm length) were identified. Patient demographic information, procedural details, and patient outcome were determined from electronic medical records.

Results
Ten consecutive patients undergoing cerebral AVM embolization using n-BCA injected through the Headway Duo microcatheter were identified. Presenting symptoms included headache, hemorrhage, seizures, and weakness. Spetzler Martin grades ranged from 1 to 5, and AVMs were located in the basal ganglia (2 patients), parietal lobe (4 patients), frontal lobe (1 patient), temporal lobe (1 patient), an entire hemisphere (1 patient) and posterior fossa (1 patient). Fifty arterial pedicles were embolized, and all procedures technically were successful. There was one postprocedural hemorrhage that was well-tolerated by the patient, and no other complications occurred. Additional AVM treatment was performed by surgery and radiation therapy.

Conclusions
The Headway Duo microcatheter is safe and effective for embolization of cerebral AVMs using n-BCA. The trackability and high burst pressure of the Headway Duo make it an important and useful tool for the neurointerventionalist during cerebral AVM embolization.
CyberKnife Stereotactic Radiosurgery for Brain Arteriovenous Malformations: Single Center Retrospective Review of Safety and Efficacy.

D Eddins¹, E Jacek², S Shah¹, T Sivapatham¹, T Eden¹, D Huisenga¹, G Zoarski¹, S Satti¹
¹Christiana Care Health System, Newark, DE, ²Jefferson University, Philadelphia, PA

Purpose
Stereotactic radiosurgery is an effective way to eradicate cerebral arteriovenous malformations (AVMs) (1). Previous studies on safety and efficacy have focused on the Gamma Knife Radiosurgery System. This study was performed to determine the safety and efficacy of the CyberKnife Robotic Radiosurgery System in the treatment of cerebral AVMs. The advantage of CyberKnife Robotic Radiosurgery over the Gamma Knife Radiosurgery System is patient comfort as the former does not require use of a metal head frame to be bolted to the patient during treatment; rather the volume targeted is based on bony landmarks.

Materials and Methods
We performed a 7-year retrospective review of imaging studies of all 17 patients who underwent CyberKnife Radiosurgery for the treatment of cerebral AVMs at the Helen F. Graham Cancer Center of the Christiana Care Health System in Delaware between 2008 and 2014. All patients underwent catheter angiography and MRA prior to CyberKnife Radiosurgery. Follow-up imaging included MRA at 1 and 2 years after Cyberknife Radiosurgery. Catheter angiography was performed to confirm eradication of the AVM when MRA demonstrated no residual nidus. Primary endpoints included: 1. Angiographic cure. 2. Complications. 3. Rate of hemorrhage.

Results
Seventeen patients were treated over a 7-year period. Eight patients had prior embolizations, of which one also had a surgical resection, and one had prior radiosurgery. Eight patients (47%) presented to our institution with hemorrhage; nine patients (53%) had unruptured AVMs. Catheter angiography demonstrated high risk features in eight patients (47%): six patients (35.3%) had aneurysms and two (11.8%) had venous stenosis. The average Spetzler-Martin grade was 2.56 (2). Obliteration was confirmed at 1 year in four of 14 (28.6%) treated patients, and in nine of 12 (75%) patients within 2 years. No treated patients suffered a new or recurrent hemorrhage. One patient developed radiation necrosis. Another suffered a stroke, which was considered to be unrelated, more than 2 years after treatment. Three of 17 patients (18%) did not complete/were lost to follow-up imaging protocol and two patients are still within 2 years of treatment.
Conclusions
Our preliminary results suggest CyberKnife Radiosurgery System compares favorably to published Gamma Knife Radiosurgery results in terms of safety and efficacy (1).

O-272
5:41PM - 5:49PM

Head and Neck Endovascular Repair of Vascular Malformations

W Yakes

1Vascular Malformation Center, Englewood, CO

Purpose
To determine the efficacy of ethanol embolotherapy of extracranial head and neck vascular malformations of all types, particularly after failure of other endovascular and surgical treatments.

Materials and Methods
One hundred sixty-six patients (64 males, 102 females; mean age: 38 years) presented with extracranial arteriovenous malformations (AVMs) of the head and neck area. Over half of the patients had undergone previous failed therapies. All patients underwent ethanol embolotherapy under general anesthesia. Forty-five patients had AVMs and 121 patients had venous malformations (VM).

Results
Of 45 AVM patients, 36 are cured (mean follow-up 2 ½ years); of 121 venous malformation patients, 65 are at end-therapy (mean follow-up 4 ½ years). The remaining patients are not at end-therapy and are being treated for their residual malformations. In AVM follow up, arteriography is the main imaging modality to determine cure or residual AVM as magnetic resonance (MR) is less sensitive in the evaluation of residual AVM. In VM follow up, MR is the main imaging tool, particularly with T-2 fat suppression and/or STIR imaging. All patients demonstrated improvement post-therapy. Complications were 4.5%, to include bleeding (self-limited), partial 7th nerve palsy (with recovery), skin injury (not requiring skin grafts), infection, and pain.

Conclusions
Ethanol has proven its consistent curative potential at long term follow up for high-flow AVMs and low-flow VM lesions at long term follow up as lesions in the periphery. Complication rates remain low. The procedures are tolerated well by the patients and done on an out-patient basis. Prior surgery and embolization procedures can cause difficulty in lesion access, but does not obviate further ethanol endovascular treatment.

O-273
Mandibular AVM Diagnosis and Curative Endovascular Treatment

W Yakes

Vascular Malformation Center, Englewood, CO

Purpose
To determine optimal management strategies for the treatment of mandibular arteriovenous malformations (AVM).

Materials and Methods
Thirteen patients (10 females, 3 males), age 9 -14 years; mean age 10 years, underwent endovascular therapy to treat their mandibular AVMs. Nine patients had distinct intraosseous AVMs. Three had multiple facial and intramaxillary AVMs requiring treatment. Outside institutions recommended massive hemifacial resections in these patients. Four patients had prior PVA and gel foam embolization, one patient had a lip graft, one had prior mandible surgery, all that had failed.

Results
All thirteen patients have demonstrated MR and angiographic cure of their AVMs. One patient's therapy is not completed and is on-going. The patients mandibular AVM is cured, a third AVM in this patient in the infratemporal fossa is still undergoing treatment. The follow-up range is 11 months – 41 months, with a mean follow up of 29 months. No complications were noted in treatment of mandibular AVMS. One patient required a minor gingival surgery after treatment of an additional intramaxillary AVM.

Conclusions
Endovascular approaches to manage mandibular AVM can be curative. The intraosseous variety is largely a fistula between artery and vein within the bone. All responded well to endovascular ethanol therapy alone. Surgery was not required in any patient. Surprisingly no complications were encountered in this patient series. Long term cures are noted in this patient series with endovascular approaches alone. No massive surgical resections in any patient, even in patients with multiple AVMs of the soft tissues, mandible and maxilla, was required to effect cure. In patients who suffered hemorrhages from floating teeth, bone formed and stabilized the teeth and no further hemorrhages occurred. Ethanol sclerotherapy proved curative in mandibular intraosseous AVMs in patients who had additional facial soft-tissue AVMs and intramaxillary AVMs that were cured as well at long term follow up.

O-274

Endovascular MR Guided Embolization Using a Magnetically Assisted Remote Controlled (MARC) Catheter System
Purpose
The aims of our preclinical study are two-fold while advancing toward the goal of translating the magnetically assisted remote controlled (MARC) catheter system for clinical use. First, our study will assess feasibility for performing a simple endovascular interventional procedure (i.e., renal artery embolization) in vivo using the MARC catheter system under magnetic resonance imaging (MRI) guidance. Second, the same procedure will be performed using x-ray guidance to determine the value added by using MRI guidance, and to pinpoint specific areas where the MARC system can be improved.

Materials and Methods
In concordance with IACUC protocol, in vivo renal artery navigation and embolization was tested in three farm pigs (43±2 kg) under real-time bSSFP imaging at 1.5T. The MARC catheter device was constructed using a 1.2mm diameter intramural copper braided catheter (Penumbra, Inc, Alameda, CA) connected to a laser-lithographed saddle coil (UCSF, San Francisco, CA) at the distal tip. The copper wires were connected to an in-room MRI-compatible cart (UCSF, San Francisco, CA) that allowed the interventionalist to determine the magnitude and polarity of electrical current delivered to create a magnetic moment and deflect the catheter tip in the MR scanner. Contralateral kidneys were embolized similarly under x-ray guidance using standard clinical catheters and guidewires. Changes in renal artery flow and perfusion were assessed pre- and postembolization (for both x-ray-guided and MR-guided procedures) using velocity-encoded MR imaging and perfusion scans of the renal parenchyma. Catheter navigation times, renal parenchymal perfusion, and renal artery flow rates were determined for MR-guided and x-ray-guided embolization procedures and presented as means ± standard deviations in our small pilot study.

Results
The catheter tip position was visible under MRI guidance. In addition, in vivo injections of microspheres were successful in all six swine kidneys and demonstrated under either x-ray or MRI. Under MR, overall mean catheterization time was 93±56 seconds, change in perfusion rates was 4.9±0.8 A.U./sec, and change in renal flow rate was 2.1±0.2 ml/min/g. X-ray- and MR-guided embolization produced comparable results.

Conclusions
Using a MARC catheter for renal artery catheterization and embolization under real-time MRI in vivo is feasible; it provides a novel opportunity to perform endovascular procedures in interventional MRI environment. Future versions of this technology will
be directed at embolization of tumors in the head and neck as well as endovascular stroke treatment with real-time diffusion-weighted imaging feedback.

**Navigation**

(Filename: TCT_O-274_MARCRenalNavigation.jpg)

**O-275**

6:05PM - 6:13PM

Stentrode: minimally invasive endovascular stent-electrode array for high-fidelity, chronic recordings of cortical neural activity
Purpose
High-fidelity intracranial electrode arrays for recording and stimulating brain activity have facilitated major advances in the treatment of neurological conditions over the past decade. Traditional arrays require direct implantation into the brain via open craniotomy, which can lead to inflammatory tissue responses; thus, there is a need to develop minimally invasive approaches that avoid brain trauma. Here, we demonstrate the feasibility of chronically recording brain activity from within a cerebral vein using a passive stent-electrode recording array (stentrode). We were particularly interested in the feasibility of targeting superficial cortical motor areas that may prove useful in brain-machine interface systems.

Materials and Methods
We fabricated stentrodes on intracranial stent technology currently in clinical use. Self-expanding stents (Solitaires) were used as scaffolds for the attachment of 750 µm diameter, laser-cut platinum disk electrodes. We used an angiography-based co-axial catheter technique to deliver a 4F catheter to the 2 mm diameter target vessel in a sheep cerebral angiography model. The process of incorporation of the stentrode into the vessel wall was investigated with synchrotron imaging and impedance spectroscopy. Brain signals recorded from the stentrode were analyzed as functions of both time since implantation and electrode location, and were validated against commercially available surface electrocorticography arrays by assessing somatosensory evoked potentials, theta burst suppression ratios, and maximal bandwidth.

Results
We achieved implantation of the stentrode into a superficial cortical vein overlying the motor cortex via catheter angiography and demonstrated neural recordings in freely moving sheep for up to 190 days. Vessel-wall incorporation of the stentrode into the sheep superior sagittal sinus occurred as early as 6 days. A spatial resolution of at least 2.4 mm (electrode spacing) was achievable with neural recordings from within the blood vessel wall. The maximal bandwidth of the stentrode was 189 Hz. Our findings demonstrate that the performance of the stentrode, measured by spectral content and bandwidth, was similar to an epidural array and marginally inferior to a subdural array. Venous internal lumen patency was maintained for the duration of implantation.
Conclusions
We report the first intracranial stentrode array, deployed via minimally invasive catheter angiography within a cerebral vein to achieve chronic recordings in freely moving sheep for up to 190 days. Early incorporation of the stentrode into the vessel wall was associated with an improvement in recording sensitivity. The recording performance was comparable to epidural electroencephalography. An endovascular neural interface offers a method for safe, reliable and chronic neural recordings. We envisage that future applications of endovascular arrays may include motor cortex sensors in brain-machine interfaces, seizure prediction in epilepsy, and endovascular deep brain stimulation.

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Wednesday
7:30AM - 8:30AM
Washington Marriott Wardman Park, Marriott Ballroom

13A-Wednesday Morning SAM - Pediatrics - Audience Response (AR) Self Assessment Module (SAM)
13A-1

Pediatric Brain Cases

Poussaint, T.
Boston Children's Hospital
Boston, MA
13A-2

Questions and Answers

7:55AM - 8:00AM

13A-3

Going With the Flow: Pediatric Vascular Disease

Mirsky, D.
Children's Hospital Colorado
Aurora, CO

8:00AM - 8:25AM

13A-4

Questions and Answers

8:25AM - 8:30AM

Wednesday
8:30AM - 9:00AM
Washington Marriott Wardman Park, Marriott Ballroom

14-General Session: Future of Neuroimaging / Neuroscience Research
14-1

NIH and the Future of Neuroimaging for Neuroscience Research

Koroshetz, W.
NIH/NINDS
Bethesda, MD

8:30AM - 9:00AM
Imaging Findings in Pediatric Intracranial Hypertension

M Salmela\textsuperscript{1}, S Khanipour Roshan\textsuperscript{1}, A McKinney\textsuperscript{1}, D Nascene\textsuperscript{1}
\textsuperscript{1}University of Minnesota, Minneapolis, MN

Purpose
To evaluate the imaging findings in pediatric intracranial hypertension.

Materials and Methods
A retrospective search of the electronic medical record was performed to identify pediatric patients who were suspected of having intracranial hypertension and had undergone brain imaging. Clinical features evaluated were height, weight, BMI, presenting symptoms, opening cerebrospinal fluid (CSF) pressure, and presence of papilledema. Imaging features evaluated were the presence and location of cerebral venous stenosis, optic nerve sheath dilation, optic nerve tortuosity, posterior globe flattening, optic disk cupping, slit ventricles, partially empty sella, venous distension sign, and Chiari 1 malformation.

Results
Eighteen patients were identified (aged 1-17.8 years, mean age: 10.4 years; 9 male, 9 female). Presenting symptoms included headache (n=12, 67%), visual symptoms (n=10, 56%), and vomiting (n=2, 11%). Sixty-seven percent (n=12) of patients had elevated CSF pressure > 20 cm H2O; 28% (n=5) were obese; and 83% (n=15) had papilledema. Eighty-three percent (n=15) had cerebral venous stenosis. Locations of cerebral venous stenosis included the transverse-sigmoid sinus junction (n=13), sigmoid sinus (n=3), transverse sinus (n=2), distal straight sinus (n=1), superior sagittal sinus just above the torcular (n=1), and high internal jugular vein (n=1). Two of three patients who did not have venous stenosis had clinical features with known association with intracranial hypertension including renal failure and reduction in steroid dosing. Other imaging findings included optic nerve sheath dilation (n=15, 83%), posterior globe flattening (12, 67%), venous distension sign (n=8, 44%), tortuous optic nerves (n=7, 39%), Chiari 1 malformation (n=4, 22%), partially empty sella (n=3, 17%), optic disk cupping (n=1, 6%), and slit ventricles (n=0, 0%).

Conclusions
The most common imaging findings in pediatric intracranial hypertension found were cerebral venous sinus stenosis, optic nerve sheath dilation, and posterior globe flattening.
flattening, all occurring in at least half of cases. If present, the cerebral venous stenosis usually was located at the transverse-sigmoid sinus junction. Partially empty sella and optic disk cupping were rare, and slit ventricles were not seen.

O-289

Prevalence and Clinical Significance of Unilateral Absent Flow in a Transverse Dural Sinus (TDS) on MR Venography

J Kim1, R Rojas2, Y Chang3, R Bhadelia4

1Beth Israel Deaconess Medical Center, Brighton, MA, 2Beth Israel Deaconess Medical Center, Boston, MA, 3Beth Israel Deaconess Medical Center, Newton, MA, 4Beth Israel Deaconess Medical Center, Boston, MA

Purpose

Unilateral absence of flow signal in a transverse dural sinus (TDS) frequently is observed on MR venography (MRV) but its exact prevalence and clinical significance is not known. Our purpose was to determine: (1) prevalence of unilateral absence of TDS flow signal on MRV, (2) its clinical significance by assessing thrombosis on contrast-enhanced magnetic resonance imaging (MRI)/CTV, and (3) if asymmetry in TDS size explains the phenomenon of absent flow on MRV.

Materials and Methods

Patients who had both MRV (2D time-of-flight and/or 3D phase-contrast) and gadolinium-enhanced 3D-MPRAGE images or computed tomography (CT) venography between January 2014 and October 2015 were included. All the images were reviewed to determine (1) the number of patients with complete absence of flow in a TDS (Figure 1 a-b), (2) presence of thrombosis on MRI/CTV, and (3) asymmetry between the lateral most portion of the transverse sinuses as measured on postcontrast images (Figure 1c). T-test was used to determine the differences in size of TDS between those with and without absent flow on MRV.

Results

Of the 123 patients, 25 (20.3%) had absence of flow in one TDS on MRV. The absent TDS flow was seen on the left in 15 and on the right in 10 patients. Comparison with postcontrast images (116 MPRAGE; 7 CTV) showed only 5/25 (20%) of patients with unilateral absence of TDS flow had signs of thrombosis on postcontrast images. Patients with absent TDS flow had significant asymmetry of size compared to those without (P<0.001).

Conclusions

Unilateral absence of TDS flow is common on MRV examinations, and is a false positive finding in 80% of the patients. Size asymmetry appears to contribute to the phenomenon of absent unilateral TDS flow.
Purpose
Accurate and precise technique that allows quantitative characterization of differences in the intracranial venous system is a critical diagnostic tool for evaluation of occlusion degree. The purpose of this study was to develop and test a novel quantitative diagnostic technique allowing characterization of dural sinuses anatomy in idiopathic intracranial hypertension (IIH) patients.

Materials and Methods
An automated and validated algorithm to quantify vessels cross-sectional changes was applied (1). The method consists of several steps, which include an automatic vessel...
extraction and segmentation from the normalized to standard space brain volume of interest, volumetric skeletonization of the vessel object, numerical definition of cross-sectional planes at each skeleton point, and rendering of vessel cross-sectional circumference based on specially developed clustering technique (Fig. 1). Four large sinuses were tested (right and left transverse sinuses, superior sagittal sinus, and straight sinus). The cross-sectional area and shape measurements were evaluated in three control subjects and four IIH patients [before and after lumbar puncture (LP) treatment with the specific intention of removing 30-40 ml of CSF] (Fig. 2). Three dimensional affine registration based on finite difference optimization was applied to match and align the 4-sinuses skeletons. To this end one control skeleton was chosen as a reference. Iterative closest point matching (2) was applied to register the rest of the skeletons with the reference one. The before and after LP and healthy control matching cross-sectional data were plotted along the length of the sinuses according to its position starting from confluence point. The comparison of the cross-sectional area was performed with a T test. p-value less than .05 was considered significant.

Results
In agreement with previous studies (3-4), it demonstrated an increase in venous diameter after LP due to normalization of intracranial hypertension. All four investigated principal cranial blood sinuses had significant cross-sectional area increase after LP (p ≤ .05) (Table 1). There was no significant difference between after LP and control in cross-sectional area data.

Conclusions
The presented technique allows quantitative characterization of differences in the intracranial venous system and evaluation of occlusion degree based on the pathology and normal data comparison. Implementation of this technique in neuroimaging could help better characterize differences in the intracranial venous system and aid differentiating pathology and normal.
Transverse Sinus Effacement is the most sensitive MR sign of Pseudotumor Cerebri

P Morris\textsuperscript{1}, D Black\textsuperscript{1}
\textsuperscript{1}Mayo Clinic, Rochester, MN
Purpose
Various magnetic resonance (MR) imaging findings of pseudotumor cerebri have been described, including optic nerve sheath redundancy, optic nerve tortuosity, optic nerve head flattening, empty sella, etc. each with variable sensitivity. We hypothesized that neuroradiologic interpretation of pseudotumor is restricted by the limitations of these signs and that our awareness of this disease entity can be improved by focusing on the stenoses of the transverse sinuses found in this condition.

Materials and Methods
Medical records and imaging of 65 patients with the diagnosis of pseudotumor cerebri according to the Modified Dandy Criteria were reviewed with IRB approval. Parameters including BMI, CSF opening pressure, and fundoscopic findings were gathered. Magnetic resonance imaging and MRV images were reviewed for established signs of elevated ICP. Gadolinium-bolused MRV images were evaluated for TS stenosis using a 4 point categorical scale in 25% increments distally and proximally, and also using a calipers-tool for millimeter measurements in two planes. Coronal postgadolinium images were evaluated on a categorical scale for presence or absence of (1) bilateral TS stenosis/effacement, and (2) prolapse/herniation of temporo-occipital tissue into the expected location of the TS.

Results
Bilateral distal > 50% stenosis of the transverse sinuses, using the proximal sinus as a reference, was the most consistent and sensitive indicator of pseudotumor cerebri (p<.0001 Wilcoxon Signed Rank matched-pairs). Bilateral TS stenosis was present in 86% of patients on MRV and in 84% of patients on coronal T1 post-gadolinium images (Fig. 1). This surpassed the sensitivity of other signs such as empty sella 54%, optic nerve sheath dilatation 65%, DWI spot sign at the optic nerve head 10%, flattening of the optic nerve head 34%. Retrospectively, in 33% of patients MRV interpretation on at least one occasion during the period of review ignored the findings of TS stenosis, and in the absence of other signs of PC, therefore did not draw attention to the diagnosis.

Conclusions
In this series, transverse sinus stenosis was the most reliable MR finding in patients with pseudotumor cerebri. Sinus stenosis can be discerned with similar sensitivity on both the gadolinium-bolused MRV sequence and the postgadolinium coronal T1 sequence. Therefore, detection of TS stenosis on MR imaging need not depend on having access to an MRV sequence. Other established MR signs of pseudotumor are less sensitive, and their absence appears to contribute to a significant rate of radiologist oversight of this condition in this series. An awareness of the sensitivity of coronal T1 imaging to TS stenosis and of the lower sensitivity of previously established MR signs of pseudotumor cerebri will enhance the neuroradiologist's interpretation of this diagnosis.
Transverse Sinus Cross Sectional Areas in Pseudotumor Cerebri: A potential Venturi Phenomenon argues for the validity of Stent Treatment

P Morris1, D Black1, J Port1, N Campeau1, H Cloft1, G Lanzino1, A Alexander1
1Mayo Clinic, Rochester, MN

Purpose
Transverse sinus (TS) narrowing is observed in over 80% of patients with pseudotumor cerebri (PC) (1), previously reported in broad increments of percentage narrowing compared with the more proximal sinus. We hypothesized that direct measurement of the cross-sectional area (CSA) of the transverse sinuses in multiple locations and comparison with a control population of non-PC patients would give more precise evaluation of the degree and hemodynamic conditions of the stenoses seen in this disease state, with implications for the treatment options available.
Materials and Methods
Magnetic resonance imaging (MRI)/MRV examinations from 65 PC patients were reviewed with IRB approval and compared with those of 97 non-PC control patients. The caliber of the distal stenotic segment of the TS was compared with that of the more proximal segments using, firstly, a 4-point nominal scale indicating 25% degrees of incremental stenosis, previously described (1). Secondly, orthogonal direct measurements of the TS were obtained from the MRV raw data, using a calipers tool, and the CSA of the TS was calculated as the area of a triangle, height x ½ width. Intrasubject and between-group comparisons were made using parametric ANOVA and pairwise nonparametric statistics.

Results
Transverse sinuses of PC patients were narrowed significantly distally compared with controls using the nominal scale (p<0.005) and using the calculated CSA (p<0.0001). Both scales yielded results in broad agreement, although CSA estimates were more statistically significant. The left transverse sinus distally measured 2.9 mm² (SD 2.09) compared with 24.03mm² (SD 10.6) in controls(Fig. 1), while the right distal TS measured 4.2mm² (SD 4.18) compared with 29.89mm² (SD 11.3) in controls. The stenotic effect also was evident to a lesser degree in the proximal right TS; PC proximal TS mean CSA 28.5mm², SD 14.6mm², Control 37.4mm² SD 15.9mm² (p< 0.004). The left side proximally did not demonstrate a significant difference: TS left proximal mean CSA PC 23.6mm² vs control 24.7mm² (p=0.81). Transverse sinuses measurements were not significantly influenced by age or gender (p = 0.04).

Conclusions
Transverse sinuses narrowing in PC patients is more severe than can be reflected in a 4-point categoric scoring system. The severe, focal nature of TS stenosis in PC patients presumably begins as a compressive phenomenon, secondary to elevated intracranial pressure. However, the stenotic conditions conform to that of a Venturi tube whereby the drop in pressure at the level of the stenosis becomes an aggravating factor, further exacerbating the collapse of the dural sinus wall. Therefore, for as long as ICP surpasses the intraluminal pressure of the distal transverse sinus, the sinus will remain collapsed. We suggest that the Venturi phenomenon may be a significant factor in perpetuating this "strange attractor" or "entrapment" condition, arguing that the most effective therapeutic method to reverse this state might be, therefore, an intravascular stent.
Sagging of the Tentorium in Pseudotumor Cerebri, a correlate of Transverse Sinus Collapse

P Morris¹, D Black¹, J Port¹, N Campeau¹
¹Mayo Clinic, Rochester, MN

Purpose
Effacement or stenosis of the transverse sinuses is seen in >84% of patients with pseudotumor cerebri (PC). We conjectured that such an effect could not take place unless there was a downward shift of the tentorium cerebelli bringing about this change in the configuration of the venous sinuses. Because the apex of the tentorial incisura is fixed medially at the point of attachment of the falx cerebri and laterally at the margins of the transverse sinuses, we hypothesized that a downward vector of
force on the tentorium would be detectable as a downward "sling" or "hammock" curvature of the tentorium on its midpoint in pseudotumor patients.

Materials and Methods
Coronal T1-weighted postgadolinium magnetic resonance (MR) images were analyzed with IRB approval in 50 patients with pseudotumor cerebri and compared with 40 control subjects. An arc of curvature was defined between the points of attachment of the tentorium at the apex of the incisura and laterally at the insertion into the transverse sinus. The perpendicular height of the arc was measured at the point of maximal curvature (Fig. 1), using which the radius of curvature and area of the segment defined by the chord and curvature of the tentorium were calculated.

Results
Pseudotumor patients showed a significantly higher height of the arc and area of the defined segment than did the control group. The mean height of the arc in the pseudotumor group was 13.5 mm (S.D. 1.8) on the right side, 13.2 mm (S.D. 2.06) on the left, compared with controls 11.93 mm (S.D. 2.04) and 11.6 mm (S.D. 1.76) respectively, p = .0001 (Fig. 2). The pseudotumor group showed a mean area of the segment on the right side of 629.72 mm² (S.D. 106.21) and on the left side 615.98 mm² (S.D. 119.78) compared with controls; Right 527.14 mm² (S.D. 106.2) and Left 512.78 mm² (S.D. 101.70), p<.0001 (Fig. 3). The calculated radii of curvature on either side showed no significant difference between the two groups.

Conclusions
Our results support the hypothesis that an alteration in the configuration of the tentorium cerebelli is present in patients with pseudotumor cerebri, likely occurring in conjunction with changes in the configuration of the transverse sinuses. The tentorium appears to demonstrate a greater degree of downward bowing in pseudotumor, compared with control subjects. This would suggest that the primary genesis of the pressure effects in pseudotumor cerebri is supratentorial/hemispheric, acting from above-down. The narrowing of the transverse sinuses seen in this condition may, therefore, result from a downward translation of the tentorium, rather than being due simply to a diffuse elevation of ICP compressing the transverse sinuses nondirectionally.
Pericatheter VP shunt catheter fluid collections in adults. Infection, shunt malfunction or worse? Correlation of CT/MR findings with Indium-111 Disodium Pentetate (In-111 DTPA) scan.

S Hegde¹, H Kale², A Muthukrishnan³, V Agarwal³

¹University of Pittsburgh, Pittsburgh, PA, ²University of Pittsburgh Medical center, Pittsburgh, PA, ³University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Chronic fluid collections with edema along ventriculo-peritoneal (VP) shunt catheter
tracts in adults are rare (1, 2) and are seen more frequently in children (3, 4, 5). The cause of these collections frequently is unclear and represents a diagnostic dilemma. In search of the radiology literature, there are no previous studies correlating these findings on CT/MRI with nuclear medicine scans. We hypothesize that when seen in adults, these CT/MR findings represent VP shunt catheter failure.

**Materials and Methods**
We retrospectively evaluated computed tomography (CT)/magnetic resonance (MR) and Indium-111 Disodium Pentetate (In-111 DTPA) scan findings in six patients with peri-VP shunt catheter collections who presented at our institution. Patients who had recently placed catheters and pericatheter hemorrhage were excluded. All patients selected had prior (immediate postoperative or remote) CT/MRI scans which did not reveal any collection.

**Results**
In the series of cases presented here, a majority of patients demonstrated absence of radiotracer reflux into the ventricles on the In-111 DTPA scan. Also, there was focal accumulation of radiotracer corresponding to the loculated fluid collection on correlation with head CT or MRI images. In some, there was good passage of the radiotracer through the distal portions of the tubing which should not be mistaken for a well-functioning shunt system, especially in the absence of ventricular reflux and presence of an intracranial loculated collection of radiotracer activity. We believe this rare finding of pericatheter collection may represent complete or early partial obstruction of the catheter which will ultimately result in shunt failure.

**Conclusions**
Collections around VP shunt catheters in adults are rare. All of the cases evaluated by us demonstrate that findings on CT/MR represent a malfunction of the VP shunt catheter. A combined interpretation of the findings of nuclear medicine scans and CT/MRI may be useful in differentiation of this rare but important complication of VP shunt catheter placement in adults in order to prevent incorrect diagnosis of abscess or tumor and eliminate the need for unnecessary biopsy.
Image 2(b) Anterior view

(Filename: TCT_O-295_Image2bAnteriorView.jpg)

O-297

9:47AM - 9:55AM
Hyperdense Paraspinal Vein Sign: A Marker of CSF-Venous Fistula in Spontaneous Intracranial Hypotension

P Kranz¹, T Amrhein¹, L Gray¹
¹Duke University Medical Center, Durham, NC

Purpose
Cerebrospinal fluid (CSF)-venous fistula is a cause of spontaneous intracranial hypotension (SIH) that may occur in the absence of myelographic evidence of CSF leak, but has only been reported previously in one small case series of three patients. Identification of these lesions can be challenging, but is important for treatment. The purpose of this report is to describe three additional cases of CSF-venous fistula and to report on a novel imaging sign that may aid in its detection and localization.

Materials and Methods
We retrospectively reviewed cases of patients with SIH treated at our institution in order to identify cases caused by or associated with surgically confirmed CSF-venous fistulae. Pre-operative imaging was reviewed to determine the appearance of these lesions on conventional or digital subtraction myelography and CT myelography (CTM). The presence of abnormal paraspinal blood vessels on CTM was assessed. Attenuation values from regions-of-interests drawn over the paraspinal vessels on pre-myelographic CT and post-myelographic CT were compared. Image postprocessing using automated attenuation-thresholded color overlays was performed on CTM images.

Results
Three cases of CSF-venous fistulae were identified. Myelography with or without digital subtraction was performed in two cases, demonstrating the location of the fistula; the third case was confirmed intra-operatively based on suspicion from the pre-operative CTM. A hyperdense paraspinal vein was observed in all cases ipsilateral to and at the same level of the fistula. The average density of the vessel measured 27.5+/-6.4 HU on pre-myelographic CT, and 105.7+/-23.0 HU on post-myelographic CT. Postprocessing with attenuation-thresholded color overlays increased conspicuity of the hyperdense vessel in all three cases. In all three cases, targeted epidural patching failed, necessitating surgical ligation of the fistula. All patients had resolution of symptoms of SIH following surgery.

Conclusions
Cerebrospinal fluid-venous fistulae are a newly recognized cause of SIH that can occur without myelographic evidence of CSF leak. The presence of a hyperdense paraspinal vein on CTM can help identify these lesions, and recognition may be facilitated with image postprocessing using attenuation-thresholded color overlays. Identification of this sign on CTM is important in that it may help guide subsequent
confirmatory imaging tests, and based on our preliminary experience, suggests the need for surgical intervention rather than epidural patching.

(Filename: TCT_O-297_AbstractfigureKranz.jpg)

O-298

Unsupervised Characterization of Adult Hydrocephalus using CSF Flow and Volumetrics

J Shin¹, G Pagé², A Moghekar¹, O Balédent³, A Blitz¹

¹Johns Hopkins Medical Institutions, Baltimore, MD, ²Centre Hospitalier Universitaire d'Amiens, Salouël, Salouël, ³Université de Picardie Jules Verne, Amiens, Amiens

Purpose
Adult hydrocephalus (AH, including idiopathic normal pressure hydrocephalus and other etiologies) is a curable cause of dementia. Adult hydrocephalus is defined phenotypically by abnormal building up of cerebrospinal fluid (CSF) in the ventricular system, thus indeed represents a heterogeneous group of diseases with diverse etiology, manifestation, prognosis and response to treatments. Systematic categorization and characterization of AH have not been achieved yet, due to a limited number of subjects and difficulty in the volumetric and hydraulic quantification of CSF in the ventricular system. Here, we analyze a large number of subjects using unbiased mathematical approaches to classifying and characterizing AH.

Materials and Methods
We used an unsupervised cluster-based approach to integrating the 70 parameters from the volumetric analysis and the 14 parameters from the aqueductal flow analysis from 495 subjects (mean age: 58.7 years) with varying degree of ventricular enlargement. Volumetric analysis of the ventricles and brain parenchyma was
performed using Freesurfer software package. Dedicated CSF flow postprocessing software (Bio Flow Image, CHU Amiens) was used to quantify CSF flow through the cerebral aqueduct including stroke volume and maximal velocity. Subjects were classified based on unsupervised clustering and compared with clinical data including gait abnormality measured by Tinetti and TUG (Timed Up and Go) scores, urinary symptoms, and MMSE (Mini-Mental State Examination) scores. The resulting parameters were merged to determine correlations between over 100 parameters from the volumes of different brain segments, aqueductal flow characteristics and clinical data.

Results
1. Evan's ratio is a poor predictor for the extent of ventricular volume enlargement. 2. Unsupervised clustering of volumetric data provided consistent results to a clinical magnetic resonance imaging (MRI) classification scheme. 3. Cross correlation tables are presented from the results of volumetric analysis and phase contrast imaging and reveal clusters of associated variables (e.g., there is a high correlation between the volume of 4th ventricle and the maximal flow rate through cerebral aqueduct).

Conclusions
Our study used an unbiased mathematical approach to define relationships between data derived from two MRI methods, phase-contrast CSF flow imaging and volumetrics. These relationships provide important insights of various forms of adult hydrocephalus and require further study.
Wednesday
9:00AM - 10:00AM
Washington Marriott Wardman Park, Marriott Ballroom

14A-Mini Stroke - Acute Triage
14A-1

A New Standard for Acute Stroke Therapy

Albers, G.
Stanford University
Palo Alto, CA

14A-2

Stroke Triage: Patient Selection Beyond the 6 hour Window

Chaudry, M.
Medical University of South Carolina
Charleston, SC

Wednesday
9:00AM - 10:00AM
Washington Marriott Wardman Park, Washington 4/5/6

14B-MR Safety-Updates in 2016
14B-1

Update on Retained GBCA

McDonald, R.
Mayo Clinic
Rochester, MN

14B-2

Anthropogenic GBCA and Status of GBCA Expose

9:15AM - 9:30AM
Kanal, E.
Univ of Pittsburgh Med Ctr
Pittsburgh, PA

14B-3

The American Board of MR Safety Standardization

Kanal, E.
Univ of Pittsburgh Med Ctr
Pittsburgh, PA

14B-4

Questions/Answers and Audience Feedback

Wednesday
9:00AM - 10:00AM
Washington Marriott Wardman Park, Washington 1/2/3

14C-Dementia
14C-1

Molecular and Functional Imaging Techniques in Preclinical Alzheimer's Disease: Implications for Prevention Trials

Sperling, R.
Brigham and Women's Hospital and Massachusetts General Hospital
Boston, MA

14C-2

Title: Brain Aging and Biomarkers of Alzheimer's Disease
Establishing a New Susceptibility-Age Baseline to Assess Iron Content in Basal Ganglia and Midbrain Nuclei of Healthy Adults

K Ghassaban¹, M Liu¹, C Habib¹, E Haacke¹
¹Wayne State University, Detroit, MI

Purpose
Non-heme brain iron content generally increases in normal aging (1) and is more pronounced in neurodegenerative diseases. Due to its paramagnetic properties, non-heme iron can be detected by magnetic susceptibility mapping. In this study, we present a new approach aimed to establish a baseline of magnetic susceptibility change as function of age in subcortical gray matter structures.

Materials and Methods
Seven basal ganglia and midbrain nuclei, including the caudate nucleus, globus pallidus, putamen, thalamus, pulvinar thalamus, substantia nigra, and red nucleus have been assessed in 175 healthy subjects (89 males/86 females, age range 20-69) using magnetic resonance imaging (MRI). Multislice regions of interest have been manually traced (Fig. 1) on quantitative susceptibility maps (QSM) (2), reconstructed by SPIN software (Detroit, MI). Mean susceptibility in each structure was evaluated as a function of age, also known as global analysis. The upper bound of 95% prediction interval in global analysis then was used to determine age-related thresholds defining high iron content region (RII); for each structure, any pixel value higher than the specified threshold was considered as RII. Susceptibility-age correlation also was analyzed in RII region for each structure (known as regional analysis).

Results
The global analysis showed linear increasing trend in mean susceptibility as a function of age in most of the structures, which is in agreement with the current literature (3) (Fig. 2. Right hemispheres). Linear ascending susceptibility-age correlations also were
seen in regional analysis, even in globus pallidus whose iron content is believed to have no relationship with age (Fig. 3. Right hemispheres). However, these linear trends in RII appeared to be much tighter (higher PCC value) with slopes almost double those in global analysis (Table 1).

Conclusions
Regional analysis has been shown to provide a much more sensitive baseline which can be used to assess abnormal high levels of iron content in neurodegenerative diseases (4).

(Filename: TCT_O-276_Fig1_ROIs_Fig2_Global_Fig3_Regional_Fig4_LinearReg.jpg)

O-277

Sub-mSv Cerebral CT Perfusion Imaging using Prior Image Constrained Compressed Sensing: A Prospective Comparison of Image Quality at Reduced Dose versus Standard Dose Imaging

K Li1, P Yang2, M Cathey1, J Tang3, H Rowley4, P Turski5, V Prabhakaran1, C Strother6, G Chen1
A prospective clinical study was conducted to assess whether cerebral CT perfusion (CTP) imaging can be achieved at sub-millisievert (mSv) radiation dose level by using the prior image constrained compressed sensing (PICSS) reconstruction algorithm. Following standard dose (SD) CTP acquisition, 31 patients (median age, 62 years; 15 M/16 F; median BMI, 27) underwent an additional reduced dose (RD) CTP acquisition at 20% of standard dose level. Three algorithms (PICCS, ASIR, and FBP) were used to reconstruct the CTP source images of the RD series. SD-FBP served as the reference standard. Two clinical observers scored CTP maps using a five-point qualitative scoring system (1: nondiagnostic; 5: excellent), and quantitative noise measurements were performed. Statistical analyses were performed to infer conclusions from qualitative and quantitative assessments.

The CTDIvol and effective dose for the RD series was 44.5 mGy and 0.75 mSv respectively, compared with 222.6 mGy and 3.74 mSv respectively for the SD series. The average image quality scores of the RD-PICCS series were 3.8±0.7 for CBF, 3.5±0.9 for CBV, 3.9±0.9 for MTT. In comparison, subjective image quality scores of SD-FBP were 3.5±0.8 for CBF, 3.5±0.9 for CBV, 3.3±0.8 for MTT. The average noise of RD-PICCS (CBF, 5.8±1.9 mL/100 g/min; CBV, 0.74±0.26 mL/100 g; MTT, 5.5±1.2 s) were lower than those of SD-FBP (CBF, 8.1±2.5 mL/100 g/min; CBV, 0.86±0.28 mL/100 g; MTT, 6.4±1.2 s) with statistical significance (p < 0.001). Both subjective scores and objective noise of RD-ASIR and RD-FBP were significantly inferior to those of SD-FBP (p < 0.001).

Prior imaging constrained compressed sensing enables sub-mSv cerebral CT perfusion imaging without compromising diagnostic image quality.
A Dedicated Cone-Beam CT System for Detection of Acute Intracranial Hemorrhage at the Point of Care

H Dang¹, J Xu¹, A Sisniega¹, W Zbijewski¹, J Stayman¹, X Wang², D Foos², N Aygun¹, V Koliatsos¹, J Siewerdsen¹
¹Johns Hopkins University, Baltimore, MD, ²Carestream Health, Rochester, NY

Purpose
Prompt detection of acute intracranial hemorrhage (ICH) offers potential benefit to diagnosis and management of neuropathology, including traumatic brain injury (TBI) and stroke. Noncontrast-enhanced multidetector CT reliably detects acute ICH but requires patient transport to a radiology suite, increasing time and risk of adverse events. This work reports development of a dedicated cone-beam CT (CBCT) system offering a level of image quality sufficient for detection of ICH in a mobile form consistent with point-of-care application in, for example, the neuro intensive care unit (ICU).

Materials and Methods
The system was designed according to task-based image quality models for optimal performance in ICH detection at 10-25 mGy dose. Image artifacts are diminished using software corrections of x-ray scatter (via GPU-accelerated Monte Carlo scatter simulation), beam hardening, veiling glare, and detector lag. Furthermore, an iterative model-based reconstruction (MBR) method was developed to improve image quality.
at reduced dose. Performance was evaluated in CBCT phantom and cadaver studies simulating ICH (50 HU contrast, 1.5-12 mm diameter).

Results
The system design guided development of a prototype with system configuration including a rotating anode x-ray source with 15 kW power and 0.6 focal spot size and 43 cm × 43 cm flat-panel detector at source-detector distance of 1000 mm and magnification 1.8. Cupping artifacts were strongly reduced by scatter correction, and blooming and streak artifacts were mitigated by beam-hardening, glare, and lag corrections. The resulting images demonstrated major reduction in artifacts that conventionally plague CBCT, yielding uniformity ~10 HU across the image, including regions adjacent to the cranium, where artifacts can impede detection of epidural hemorrhage. Studies with simulated ICH indicated reliable detection of fresh blood lesions as small as 3 mm diameter using the artifact correction framework combined with MBR algorithm. Cone-beam artifacts also were strongly reduced in MBR images, particularly about the skull base and cervical vertebrae.

Conclusions
A dedicated CBCT system has been designed and a clinical prototype suitable for clinical studies has been realized. Initial studies indicate image quality characteristics beyond conventional limitations of CBCT and are consistent with reliable detection of millimeter-scale acute ICH. These findings support and motivate investigation of feasibility and performance in point of care applications for imaging TBI and stroke, with clinical studies in the neuro ICU now underway.
Displacement Encoding with Stimulated Echoes (DENSE) MRI for Noninvasive Assessment of Intracranial Pressure Status

A Saindane¹, J Holbrook¹, D Qiu¹, J Oshinski¹, B Bruce¹, V Biouss², N Newman¹, T Lancaster², B Dale³, X Zhong⁴
Purpose
Intracranial pressure (ICP) is estimated invasively using lumbar puncture (LP) with cerebrospinal fluid (CSF) opening pressure (OP) measurement. Displacement encoding with stimulated echoes (DENSE) is a magnetic resonance imaging (MRI) technique sensitive to brain motion as low as 0.01 mm. This study utilized DENSE to measure brain displacements in patients with high OP before LP (Pre-LP), after a reduced closing pressure (CP) following LP and CSF removal (Post-LP), and in healthy controls.

Materials and Methods
Seven patients with suspected elevated ICP and nine healthy controls were included in this IRB-approved study. Patients and controls underwent 3T MRI (Tim Trio, Siemens, Erlangen, Germany) in the supine position with peripheral pulse unit gated segmented EPI cine DENSE sequence through the mid-sagittal brain with the following image parameters: displacement encoding frequency $k_e=1.5$ cycle/mm, through-plane dephasing frequency $k_d=0.08$ cycle/mm, $TE=8.9-10.4$ ms, $TR=55-59$ ms, EPI factor=8, segments=16, pixel size=$1.2\times1.2$ mm$^2$, slice thickness=7 mm, averages=4, frames=13-16. Motion was measured in the foot-to-head and anterior-to-posterior directions in separate acquisition and combined in postprocessing to create a displacement magnitude. Patients with suspected elevated ICP underwent standardized protocol of DENSE, LP with OP (within 30 minutes of DENSE), post-CSF removal CP measurement, then repeat DENSE (within 30 minutes of CP). Phase-reconstructed images were processed offline and regions of interest were placed in various brain structures. Patient data were analyzed first with an analysis of covariance (ANCOVA) to determine any effects of brain regions and pressure. To determine treatment effects, control and patient data collectively underwent analysis of variance (ANOVA) to determine the main effects of clinical status and brain regions, where clinical status was pre-LP, post-LP, or control status.

Results
All seven patients with suspected elevated ICP had elevated OP (mean 33.1 cm water) that was decreased by removal of cerebrospinal fluid (CSF) to mean CP of 15.6 cm water. Patients and controls demonstrated no intracranial abnormalities on MRI. For brain displacement in patients, measured pressure had a marginally significant ($p=0.0141$) effect with every unit decrease in pressure leading to $2.22\times10^{-4}$ mm increase in brain displacement. For collective control and patient data, clinical status ($p=0.0021$) had significant effects on brain displacement; controls had significantly larger peak displacements than the Pre-LP group. Post-LP patients had intermediate displacements not significantly different from either control or Pre-LP groups. Please
refer to the figure for representative change in brain displacement from reduction of pressure in a patient, and for effects of clinical status on brain displacement.

Conclusions
This study establishes a relationship between peak brain displacement from DENSE MRI and measured pressure obtained contemporaneously by LP, providing a potential method for noninvasively assessing ICP status.
Pre-LP
(OP = 46 cm water)

Post-LP
(CP = 19 cm water)

Healthy Control

Post-LP
(Mean CP = 15.6 cm water)

Pre-LP
(Mean OP = 33.1 cm water)

(Filename: TCT_O-279_Figure.jpg)
Towards quantification of hemodynamic parameters in saline perfusion MRI

a mian1, C Farris1, O Sakai2, H Jara1

1Boston University/Boston Medical Center, Boston, MA, 2Boston Medical Center, Boston University School of Medicine, Boston, MA

Purpose
Gadolinium-based contrast agents can have risks including nephrogenic systemic fibrosis, allergic reactions and limitation of use during pregnancy. Recent literature also has suggested gadolinium deposition in neural tissue in patients with normal renal function. Normal saline (NS) is a nontoxic sodium chloride water solution that can significantly alter the MR relaxation properties of blood by hemodilution. Saline perfusion magnetic resonance imaging (MRI) is novel approach to perfusion MRI which is much safer than currently used contrast agents. The purpose of this study is to develop tools for hemodynamic quantification parameters.

Materials and Methods
This HIPAA compliant prospective study was approved by the IRB of our hospital. Magnetic resonance imaging was performed at 1.5T (Achieva, Philips Healthcare): head array and body coil for RX/TX. Ten patients were scanned with a dynamic inversion recovery turbo spin echo sequence. The IR-TSE pulse sequence was run during and after the NS injection for up to 5min: 100cc of NS were power injected via antecubital veins at 3-4cc/s. Images were processed with Mathcad (2001i, PTC, Needham, MA) algorithms to map maximum enhancement (maxENH), area under the curve (AUC), time-to-peak (TTP), and mean-transit-time (MTT). We further refined the software to generate quantitative maps proportional to cerebral blood volume (CBV), cerebral blood flow (CBF) and MTT.

Results
Normal saline injection-related enhancement effects were observed in all patients, particularly in highly vascular intra and extracranial tissues. Maps of CBV, CBF and MTT are shown in Figure 1 demonstrating different MR perfusion parameters for brain. All recruited patients completed the NS injection plus the dynamic-IR-MRI scan without any adverse effects, or expressing discomfort.

Conclusions
Preliminary maps of CBV and CBF have been generated using NS as an intravascular contrast agent. This work would have implications for validating saline as a perfusion contrast agent in the brain.
Diffusion Corrected Aneurysm Wall Permeability Correlates with Rupture Risk

C Cantrell¹, P Vakil², S Ansari³, T Carroll¹
¹northwestern university, Chicago, IL, ²University of Illinois Chicago, Chicago, IL, ³Northwestern, Chicago, IL

Purpose
Intracranial aneurysms (IA) affect 2-6% of the population (1). Rupture carries a mortality rate of 50% and devastates the lives of many otherwise healthy people. Unruptured IAs often are discovered incidentally and given the inherent risks
associated with surgical clipping or coiling, treatment remains controversial. The purpose of this study was to quantify IA wall permeability \((k_{\text{trans}}, v_L)\) using a diffusion corrected Tofts' model \((2)\). While previous work has shown \(k_{\text{trans}}\) to be associated with wall thinning and IA rupture risk, as defined by various anatomical, imaging and clinical risk factors, it employed a Tofts' based permeability model \((3)\). For aneurysmal modelling, a diffusion model \((4)\) more accurately represents physiology and provides better resolution of wall thickness and bleb formation zones.

Materials and Methods
We employ a finite element model (FEM), to quantify leakage and compare to more traditional Tofts modeling. The FEM model improves on the Tofts model by allowing contrast to flow from regions of high concentration towards low concentrations. \(k_{\text{trans}}\) and \(v_L\) were evaluated as markers of rupture risk by comparing against established clinical (symptomatic lesions) and anatomical (size, location, morphology, multiplicity) risk metrics and evaluated against values obtained through the Tofts' Model. One patient opted out of surgical intervention and was imaged 18 months after initial evaluation. Twenty-seven symptomatic, unruptured IAs in 23 patients \((M/F, 10/13, = 60.7 \pm 12.3)\) were imaged with dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI), and wall permeability parameters \((k_{\text{trans}}, v_L)\) were calculated in regions adjacent to the aneurysm wall. \(k_{\text{trans}}\) and \(v_L\) were calculated using both a Tofts' permeability model as described in \((2)\) and a finite-element diffusion model. Correlation and mean values were compared to test the hypothesis that FEM analysis corrects for parenchymal diffusion of the contrast agent.

Results
All IAs had a pronounced increase in wall permeability compared to the paired healthy MCA \((p<0.001)\). Regression analysis demonstrated a significant trend toward increased \(k_{\text{trans}}\) with increasing aneurysm size \((p<0.05)\). Diffusion corrected \(k_{\text{trans}}\) and \(v_L\) values correlate strongly with the Tofts' Model \((p<.001)\) (Fig. 1a-b). Diffusion corrected values showed greater permeability distinction between aneurysm wall and healthy vessel \((p<.001)\) (Fig. 1d).

Conclusions
We found contrast agent permeability across the aneurysm wall correlated significantly with both aneurysm size as well as size-independent anatomical risk factors. Moreover, we note the diffusion correction shows greater distinction between permeable regions \((i.e., \text{leaky aneurysmal wall})\) and healthy tissue which can been seen in Figure (1d). Additionally we see, in Figure (1a-c), distinct regions of faster leakage even within a single aneurysm. Intuitively this makes sense, as we know physiologically aneurysms can be nonuniform. Figure 2 shows a 61-year-old male who decided to forgo surgical intervention. For this anecdotal case, both methods provided similar results that lined up exceptionally well with future bleb formation.
O-282

Relationship of Brain Temperature and Cerebrovascular Reserve in Patients with Chronic Steno-Occlusive Disease

S Dehkharghani¹, C Fleischer², D Qiu², S Park³, J Wu², F Nahab²
¹Emory University Hosp, Atlanta, GA, ²Emory University, Atlanta, GA, ³Georgia Institute of Technology, Atlanta, GA

Purpose
To demonstrate the utility of magnetic resonance imaging (MRI) and noninvasive brain thermometry in patients with chronic steno-occlusive disease to characterize the relationship between brain temperature and cerebrovascular reserve (CVR).

Materials and Methods
Six patients underwent a two-day MRI scan protocol on a Siemens Magnetom Trio 3.0 T clinical scanner with acetazolamide (ACZ) challenge (1 g slow IV infusion over 3-5 minutes). Arterial spin labeling (ASL) and blood oxygen level-dependent imaging (BOLD) scans were acquired pre- and post-ACZ as previously reported (1). MR spectroscopic imaging-based thermometry scans were acquired with the semiLASER sequence (2) (TR=1700; TE=35 ms; averages=3; 10x10x15 mm^3 voxels; 8x8 voxel region of interest) and processed using LCModel (3) and custom software written in
Matlab (Mathworks). Voxel-wise relationships between CVR calculated from ASL and BOLD scans and temperature difference (post-ACZ – pre-ACZ, ΔT) were determined with least squares regression analysis.

Results
A representative ΔT map is shown in Figure 1. Significant global voxel-wise correlations were observed between ΔT and ASL CVR (r = 0.30, p < .001). Significant correlations were observed between ΔT and ASL CVR (r = 0.39, p < .001) and BOLD CVR (r = 0.39, p < .001) for ipsilateral voxels and between ΔT and ASL CVR (r = 0.38, p < .001) and BOLD CVR (r = 0.21, p = .03) for contralateral voxels. Interestingly, the ipsilateral relationship between ΔT and ASL CVR was quadratic while the contralateral relationship for the same parameters was linear suggesting disparate mechanisms relating perfusion and temperature in normal versus impaired tissues.

Conclusions
We report the first use of MRI and brain thermometry to correlate CVR with a dynamic temperature response. These findings suggest that brain temperature is a potential biomarker in patients with chronic steno-occlusive disease and compel further studies exploring the intersection of blood flow, cerebral metabolism, and brain temperature.

Figure 1. Representative brain ΔT map. Color bar ranges from -5 to 2 °C. Image is displayed in the radiological convention.

(Filename: TCT_O-282_Fig1_withcaption_300ppi.jpg)

O-283

3D Printing of Diffusion Tensor Tractography: Brave New World of Educational and Surgical Models.

E Quigley\textsuperscript{1}, R Lobo\textsuperscript{1}, J Cramer\textsuperscript{1}, t hutchins\textsuperscript{2}, U Rassner\textsuperscript{1}, L Shah\textsuperscript{3}
Purpose
To demonstrate the utility, feasibility, and application of 3D printing techniques to diffusion tensor imaging (DTI) derived tractography data.

Materials and Methods
Using open source and commercially available software packages (Trackvis, Massachusetts General Hospital, Boston, Mimics 3-Matics, Materialise, Plymouth MI), multidirectional DTI data sets are converted to tractography splines. Subsequently, these spline coordinates were converted to representative 3D volumetric models. These 3D models then are used to create physical models of the white matter tracts. These can be printed in a variety of materials and colors with various transparency of superficial and deep brain anatomy. Selected normal anatomy, anatomical variant, pathologic cases, and high resolution tractography libraries were utilized.

Results
3D models of DTI tractography data can be generated to create useful teaching models. These can add to the demonstration of normal anatomy, anatomical variants such as callosal agenesis, pathologic states such as corticospinal tract displacement by tumor, and models for demonstrating brain connectivity. These can be employed for resident and fellow education, consultant use, patient education, and surgical planning.

Conclusions
Conventionally, diffusion tensor imaging data has been used to extract mathematical splines to represent white matter pathways. We demonstrate that these diffusion tensor representations can be converted to 3D printable models. These models can be used to demonstrate normal anatomy, show white matter variation in anatomical variants, portray displacement or disruption of white matter pathways in pathological states, and generate tangible teaching models. These models provide a novel modality for trainee, consultant, patient education and surgical planning.

O-284
9:24AM - 9:27AM

Opening the Blood-Brain Barrier via Transcranial Sonication Using a Clinical Body MR-guided Focused Ultrasound System

R Airan1, N Ellens1, A Partanen2, K Farahani3
1Johns Hopkins Medical Institutions, Baltimore, MD, 2Johns Hopkins Medical Institutions, Philips Healthcare, Baltimore, MD, 3Johns Hopkins Medical Institutions, NCI/NIH, Baltimore, MD
Purpose
Blood-brain barrier (BBB) opening via magnetic resonance (MR)-guided focused ultrasound (MRgFUS) has gained recent attention for its promise to enable therapeutic agent delivery to the brain for devastating diseases such as gliomas and Alzheimer disease (1). A tacit assumption is that for all intracranial focused ultrasound applications, a 'neuro' focused ultrasound transducer is necessary. However, for practical reasons, an institution may only have access to a 'body' system designed for abdominal, pelvic, and extremity applications. We sought to build on our prior simulations (2) and use a clinically relevant model to experimentally demonstrate that a body MRgFUS system may be used for transcranial low power/duty cycle applications, like BBB opening.

Materials and Methods
A degassed dorsal human cranium was mounted in degassed water over a clinical body MRgFUS transducer (256 elements, operated at 1 MHz; Sonalleve V2, Philips Healthcare, Vantaa, Finland). A lipstick hydrophone (Onda Corp., Sunnyvale, CA) mounted to a 3D moveable stage made measurements both in free water and transcranially in three orientations at 3-4 depths each; Figure top left and right. 40-cycle sonications at 1 MHz were applied at acoustic powers of 5-20 W in free water, and 20-500 W transcranial. The 3D full-width at half-maximum (FWHM) and the peak negative pressure were measured. The hydrophone was replaced with a living rat (n=3) with dorsal scalp depilated, positioned supine, and under isoflurane anesthesia; Figure bottom left. After planning T2-W MRI (Philips Achieva 3T), microbubbles (0.02 mL/kg, Definity, Lantheus Medical, N. Billerica, MA) were injected via a 24g tail-vein catheter. Simultaneously, 10 ms ultrasound pulses were applied at 1 Hz pulse repetition frequency for 120 s. The acoustic power was chosen to generate an estimated in situ pressure of 0.44-0.60 MPa, based on the prior hydrophone results. Contrast (0.2 mL/kg; Magnevist, Bayer, Pittsburgh, PA) then was injected and T1-W MRI was performed. Animals then were sacrificed and their scalps were examined for signs of external damage.

Results
The ultrasound pressure attenuation ranged -5.8-9.3 dB. The axial FWHM ranged 1.83-3.79 mm. Maximal attenuation occurred with a dorsal midline approach as the beam passed through sutures. Angled, parietal approaches demonstrated less attenuation for most targets. Generally, the insertion loss decreased as the focus was moved away from the skull surface. Postcontrast T1-W MRI indicated successful BBB opening; Figure bottom right. The region of BBB opening did not appear to be shifted from the desired target. For higher estimated in situ pressures (>0.55 MPa), the disruption region was larger and less uniform; left of Figure bottom right. Even without refocusing, the targeting precision appeared adequate. There was no physical or imaging evidence of damage to suggest supra-therapeutic or off-target sonication.
Conclusions
Transcranial, low power/duty cycle MRgFUS applications, such as BBB opening and neuromodulation, can be accomplished with a clinical body MRgFUS system, in agreement with our prior simulation results (2).

(Filename: TCT_O-284_Airan_tcBBB_ASNR2016.jpg)

O-285
Targeted Release of Anesthetic Agents with Focused Ultrasound

(Filename: TCT_O-284_Airan_tcBBB_ASNR2016.jpg)

0.58 MPa  0.44

Blue oval outlines the desired

9:27AM - 9:30AM
Purpose
Pre-operative localization of functional brain regions would ideally involve safe and reversible application of a neuromodulatory agent to a spatially compact brain target that is defined by image guidance. We believe that we can accomplish this with a nanoparticle system that allows release of a drug cargo upon application of focused ultrasound (FUS). This technology would capitalize on the recent successes of magnetic resonance (MR)-guided FUS (MRgFUS), which has received much recent attention for its successful use in clinical deep-brain target ablation for essential tremor (1) and more recently for a clinical blood-brain barrier opening (2). As a first implementation, we have made such a nanoparticle system that allows focused ultrasound mediated targeted release of the small molecule anesthetic agent propofol.

Materials and Methods
We modified prior described protocols for perfluorocarbon nanoemulsion preparations (3). Micelles of polymer (50 mg; PEGylated poly-caprolactone, PEG-PCL, or PEGylated poly-L-lactide, PEG-PLLA) and propofol (5 mg) were made by dissolving each into 1 mL of anhydrous tetrohydrofuran (THF), then mixing in 1 mL of PBS, and then vacuum evaporation of the THF. Micelles then were diluted 1:5 and perfluoropentane (PFP) was added to a net 1:4 polymer:PFP ratio. The mixture then was placed into a cup sonicator and sonicated at 60% amplitude until the PFP was visibly emulsified, up to 60 sec. The resultant mixture then was washed twice in hexane to remove free propofol. Resultant particle size was assessed. To test particle release capability, the particles were sonicated using a tip sonicator (20 kHz) continuously for 0, 1, 5, or 10 sec; or, using a focused ultrasound transducer (1 MHz) using 10 ms pulses every 1 sec for up to 2 min and nominal in situ pressures of 0, 0.5, 1, or 2 MPa. Released propofol was extracted with hexane and quantified using UV fluorescence at 280 ex/310 em.

Results
Particle diameter was 300-400 nm. Upon sonication particles are expected to undergo a phase transition, which increases their diameter 5-6x thereby inducing drug release (3) (Figure, top). This yields a maximal particle diameter after release of 2.4 μm, suggesting the particles are safe for intravascular applications, with no significant risk of embolization. Sonication at both 20 kHz and 1 MHz was sufficient to induce release of free propofol, with a dose response found with either total sonication time or sonication pressure (Figure, bottom). PCL-based particles had more robust and reliable release than PLLA-based particles.
Conclusions
We have developed a nanoparticle drug delivery system that permits release of drug upon application of focused ultrasound in a sonication dose dependent manner. The individual components of the particles are each FDA-approved for clinical use. When combined with existent clinical MR-guided focused ultrasound systems, this technology may enable image-guided, targeted, safe, and focal delivery of anesthetics to the brain, potentially enabling noninvasive focal neuromodulation of an awake patient. We currently are evaluating the in vivo potential of this technology.
Visualization of CSF Dynamics using 4D time Spatial Spin Labeling Magnetic Resonance Imaging

S Yamada¹, M Yui², S Shimizu³, N Sakashita², T Yamamoto⁴, T Suzuki³
¹Toshiba Rinkan Hospital, Sagamihara, Tokyo, ²Toshiba Medical Systems Corp., Otawara, Tochigi, ³Toshiba Medical Systems Corp., Chuo-Ku, Tokyo, ⁴Toshiba Medical Systems Corp., Minatoku, Tokyo

Purpose

Cerebrospinal fluid (CSF) dynamics was investigated with time-spatial labeling inversion pulse (Time-SLIP) magnetic resonance imaging (MRI). This technique allows CSF itself to serve as an endogenous tracer using special RF pulses. In other words, Time-SLIP allows us to perform a tracer study without introducing an external tracer. This technique enables CSF dynamics to be depicted with time resolutions that no other technique can provide. Cerebrospinal fluid dynamics as observed by Time-SLIP have been found to significantly differ from CSF physiology established by prior research and published textbooks. To date, however, Time-SLIP was limited to 2D cine imaging and 3D static imaging. Here, we present the latest findings using 4D (3D imaging with time axis) Time-SLIP.

Materials and Methods

A series of 3D volumes with incremental inversion recovery times was obtained by 3T MR scanner using Time-SLIP sequence with respiratory-gated segmented gradient echo sequence. The scanning conditions were FOV = 25 x 25 cm, acquisition matrix = 192 x 192, slice thickness = 2mm, TR/TE = 4.8/1.5, FA = 3, initial inversion time (TI) = 138ms, TI step = 230ms.

Results

Cerebrospinal fluid dynamics was observed using 4D Time-SLIP MRI. There was active CSF exchange between the lateral ventricle and third ventricle through the foramen Monro. Large CSF displacement was observed at prepontine cistern. Cerebrospinal fluid displacement was observed predominantly in spinal subarachnoid CSF when subject was in the supine position. These CSF displacements were associated with respiration. Cerebrospinal fluid displaced cranio-caudally during expiration and caudo-cranially during inspiration in the entire CSF space in the central nervous system.

Conclusions

Visualization of 4D CSF dynamics was achieved with 4D time-SLIP sequence.
Smartphone controlled, angle-adjusted external ventricular drainage insertion

F Burn¹, C Eisenring¹, M Baumann¹, J Beck¹, A Raabe¹, M Oertel¹

¹Department of Neurosurgery, University Hospital of Berne, Berne, Switzerland

Purpose
Twenty to 40% of external ventricular drainages (EVD) are reported as suboptimally placed on imaging controls. Therefore, the authors evaluated the feasibility and accuracy of smartphone-guided angle-adjusted EVD implantation in both a human artificial cranium and a cadaveric head.

Materials and Methods
A trajectory was drawn from Kocher's point to the center of the ipsilateral ventricular frontal horn according to the horizontal and vertical diameter. Intracranial length and angle of the trajectory towards the midline were measured. A commercially available protractor app of a sterile packed smartphone to adjust the insertion angle was implemented. In total, 20 EVD were inserted, eight of 20 into a human artificial cranium and 12/20 into a cadaver head. Additionally, consecutive CT imaging datasets of 23 patients before EVD insertion were analyzed to determine relevance and influence of ventricle width on application and accuracy of the method.

Results
Twenty of 20 EVD were inserted successfully within the ipsilateral ventricle by first attempt. The mean deviation of the intended trajectory was 2.76° with a standard deviation (SD) of 1.98. We measured a tip deviation from the ventricular center of 0.4 cm (SD 0.26) and a maximal deviation of 0.86 cm. 20/23 ipsilateral ventricles analyzed on CT images had a diameter above 0.86 cm. The average duration of measurement of implantation angles and intracranial EVD lengths was 3 min, and of sterile packing, smartphone calibration and angle-adjusted EVD insertion 4 min, respectively.

Conclusions
Results of the current ex vivo study show that smartphone-guided EVD placement is feasible with high accuracy. An ipsilateral ventricular frontal horn diameter above 0.86 cm allowed more optimal EVD insertion. Whether this innovative, easily applicable and broadly available method will be in vivo implementable in clinical routine remains to be investigated.
Wednesday  
9:00AM - 10:00AM  
Washington Marriott Wardman Park, Maryland A/B/C

14E-Subspecialty & Regional Society Papers, Dyke Award, Foundation of the ASNR Papers  
14E-1  
9:00AM - 9:10AM  
Awards Announcements

14E-2  
9:10AM - 9:18AM  
A Method to Quantify Injury to White-Matter Pathways Using Diffusion MRI - Norma E. Leeds Award (ENRS)

Ahmadi, E.  
Massachusetts General Hospital  
Boston, MA

14E-3  
9:18AM - 9:26AM  
Automated Adaptive Multiplane-Multiangle Oblique (AAMO) Rendering Volumetric Spine CT

Titelbaum, N.  
Icahn School of Medicine at Mount Sinai  
NEW YORK, NY

14E-4  
9:26AM - 9:34AM  
CSF Venous Fistula and Renal Contrast in SIH Patients Without CSF Leak at CT Myelography - Louis A. Gilula, MD Mentor Award (ASSR)
Clark, M.
Mayo Clinic
Rochester, MN

14E-5
9:34AM - 9:42AM
Altered Excitation-Inhibition in Knee Osteoarthritis - Gabriel H. Wilson Award (WNRS)

Foerster, B.
Ann Arbor VA Health System
Ann Arbor, MI

14E-6
9:42AM - 9:50AM
Tales From the Crypt: When Vertebral Augmentation Goes Very Wrong - Southeastern Neuroradiology Society (SENRS) Award

Jensen, M.
University of Virginia Health Systems
Afton, VA

14E-7
9:50AM - 9:58AM
Structural Connectivity of Distributed Cortical Association Networks Reflects Cognitive Reserve in Autosomal Dominant Familial Alzheimer's Disease - 2016 Cornelius G. Dyke Award

Prescott, J.
Duke University Hospital
Durham, NC

Wednesday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Marriott Ballroom

15A-SNIS Programming: Point-Counterpoint: Drip-and-Ship vs. Mothership - The NeuroInterventionalist’s Role in Large Vessel Occlusion Therapy (AR) (SAM)
Large Vessel Occusion (LVO) Therapy: What is the Current Evidence
Jayaraman, M.
Rhode Island Hospital
Providence, RI

Point: Drip-and-Ship for Acute Ischemic Stroke: What is the Evidence?
Hussein, M.
Cleveland Clinic
Cleveland, OH

Counterpoint: Mothership for Acute Ischemic Stroke: What is the Evidence?
Baxter, B.
Tennessee Interventional Associates
Chattanooga, TN

Speaker Rebuttals

Does the Mobile Stroke Unit (MSU) Change the Rules? Incorporating MSU in Stroke Therapy
Rasmussen, P.
Cleveland Clinic
Cleveland, OH

15A-6
11:45AM - 12:00PM
Questions and Answers

Wednesday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Washington 4/5/6

15B-WHO's Next and What's New? The 2016 World Health Organization Update on Brain Tumors: What Neuroradiologists Need to Know
15B-1
10:30AM - 11:15AM
Updates on Brain Tumors

Osborn, A.
University of Utah
Salt Lake City, UT

15B-2
11:15AM - 12:00PM
What is Next in Pathology

Kleinschmidt-DeMasters, B.
University of Colorado School of Medicine
Aurora, CO

Wednesday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Washington 1/2/3
15C-ASFNR Programming: Resting State Connectivity: Ready for Primetime?

15C-1

Resting State Connectivity in Language Function

Stufflebeam, S.
Massachusetts General Hospital
Boston, MA

15C-2

What We Know About Resting State Connectivity in Children

Fulbright, R.
Yale University Medical Center
New Haven, CT

15C-3

- Resting Connectivity and the Connectome

Shimony, J.
Washington University School of Medicine
Saint Louis, MO

15C-4

Resting State Connectivity in Neurodegenerative Disease: Biomarker Potential

Sair, H.
Johns Hopkins Medicine
Baltimore, MD

15C-5

Discussion
**Functional Brain Connectivity is Altered in Fetuses with Congenital Heart Disease**

J De Asis-Cruz¹, A Yarish¹, M Donofrio¹, G Vezina¹, A Du Plessis¹, C Limperopoulos¹
¹Children's National Health System, Washington, DC

**Purpose**
Infants with complex congenital heart disease (CHD) are at elevated risk for neurodevelopmental disabilities. Identifying early deviations from normal brain development and function thus is critical to ensure proper surveillance and timely intervention. Using resting-state functional connectivity magnetic resonance imaging (rs-fcMRI), our objective was to determine whether differences in brain function between CHD and healthy fetuses are detectable in utero. We hypothesized that these differences would manifest in brain regions that are components of complex resting state networks (RSNs).

**Materials and Methods**
We used noninvasive rs-fcMRI to assess in utero brain function in 52 fetuses [26 diagnosed with CHD (mean±std: 33.34±3.42; 11 single ventricle, 15 two ventricle) and 26 gestational age-matched controls (32.77±3.58)] with no structural brain anomalies. Blood oxygen level dependent (BOLD) signals measured from 90 cortical/sub-cortical regions of interest (45 ROIs per hemisphere) were measured and Fisher z' transformed temporal correlations between regions were computed and compared between cohorts.

**Results**
We found robust between-hemisphere functional connectivity (t-test, p < 0.05) for the majority of ROIs in the CHD (33 out of 45 ROIs) and healthy fetal brain (32/45 ROIs). In both groups, the most highly correlated regions included medially located ROIs: superior frontal gyrus, anterior to mid cingulate regions, medial orbitofrontal
regions, among others. The strength of connectivity between corresponding bilateral structures did not significantly differ between groups, however, inter-regional connectivity was decreased in some association and paralimbic areas of the CHD brain. Specifically, connectivity between the middle orbitofrontal cortex-supplementary motor area, medial orbitofrontal cortex-rectus gyrus, supramarginal gyrus (SMG)-angular gyrus (ANG), SMG-paracentral lobule was decreased in CHD compared to control fetuses (t-test, p < 0.05).

Conclusions
We report for the first time that functional connectivity between corresponding bilateral brain regions is intact in CHD fetuses, but connectivity in some association and paralimbic brain regions is decreased compared to controls. Further studies are needed to elucidate how early functional alterations in association regions involved in multimodal integration (i.e., SMG and AG) impact neurodevelopment in CHD.
Figure 1. Superior, lateral and medial views of the brain (A) show strength of connectivity (z(r)) corresponding bilateral regions in healthy and CHD fetuses. Connectivity pattern is highly similar: medial areas are more strongly connected (red) than lateral regions (blue). (B) shows areas where connectivity is decreased in the CHD cohort: supplementary motor area (SMA)-orbitofrontal cortex, middle (ORBmed) cortex, medial (ORBmed)–rectus gyrus (REC), supramarginal gyrus (SMG)-angular gyrus (ANG), posterior cingulate lobule (PCL). Brain parcellation and abbreviations are from Shi et al (2011).
Validation of In Utero Tractography with Histology-based Structure Tensor Analysis in the Human Fetal Brain

C. Mitter1, A. Jakab1, P. Brugger1, G. Ricken1, G. Gruber1, D. Bettelheim1, A. Scharrer1, D. Prayer1, G. Kasprian1
1Medical University of Vienna, Vienna, Austria

Purpose
Diffusion tensor imaging (DTI) offers the unique ability to visualize the developing white matter neuroanatomy of the human fetal brain in vivo and in utero. However, in order to establish in utero DTI as a clinical imaging tool, an anatomical validation of macroscopic imaging results with microscopic histology data in identical subjects is needed. The aim of this study was to validate normal as well as abnormal in utero tractography results of commissural and internal capsule fibers in human fetal brains using postmortem histological structure tensor (ST) analysis (Budde et al. 2012).

Materials and Methods
We included histopathological specimens of two structurally unremarkable and four abnormal fetal brains, for which in utero DTI [1.5T magnetic resonance imaging (MRI)], 16 directions, reconstructed voxel size 0.94mmx0.94mmx3mm, b-values of 0 and 700sec/mm2) had been performed within a 2 week timespan prior to fetal demise. The internal capsule, the corpus callosum, as well as the Probst bundles in three subjects with agenesis of the corpus callosum were defined anatomically using a multiple region of interest (ROI) approach and visualized using a FACT algorithm (Philips Extended MR WorkSpace 2.6.3.3). For histological validation of in utero tractography results, whole hemisphere tissue sections of the same subjects were stained with antibody against neural cell adhesion molecule (NCAM) to identify axonal tracts and digitized using a high resolution scanner. Structure tensor analysis (using OrientationJ for ImageJ) was performed on the digitized histological sections to directly visualize fiber orientation and anisotropy on a microscopic scale. To overcome limitations in correlating in utero tractography to postmortem histology data, an approach to perform deterministic tractography in histological sections was implemented.

Results
Histological ST analysis and histology-based tractography of fetal brain sections enabled the direct assessment of the anisotropic organization and main fiber orientation of the transient layers of the fetal telencephalic wall. Structure tensor analysis successfully validated abnormal in utero tractography findings of
commissural fibers in subjects with agenesis of the corpus callosum, and revealed additional information about the internal fiber architecture of Probst bundles. The potential for cross-validation of abnormal in utero tractography results of the internal capsule was demonstrated in two subjects with malformations of internal capsule fibers. Potential limitations of DTI-based in utero tractography could be demonstrated in several brain regions.

Conclusions
Histology-based tractography of commissural and internal capsule fibers in NCAM-stained human fetal brain sections corresponds remarkably well to many of the results of in utero tractography. Combining the three-dimensional nature of DTI-based in utero tractography with the microscopic resolution provided by histological ST analysis ultimately may facilitate a more complete morphologic characterization of axon guidance disorders and other malformations of white matter fiber tracts at prenatal stages of human brain development.
Neuronal Injury and Impaired Metabolism in Fetuses with Congenital Heart Disease

E Mahdi1, G Vezina1, J De Asis-Cruz1, M Donofrio1, D Lanham1, S Bauer1, A Du Plessis1, C Limperopoulos1
1Children's National Health System, Washington, DC

Purpose
Neurodevelopmental dysfunction is common in infants with congenital heart disease (CHD). There is growing evidence that impaired brain development and metabolism has its origins in the fetal period. However, the exact mechanism of abnormal prenatal brain development is unclear. The aim of this study was to delineate fetal metabolic biomarkers associated with CHD using proton magnetic resonance spectroscopy (1H-MRS).

Materials and Methods
We prospectively studied a large cohort of pregnant women with healthy and CHD fetuses between 17-39 weeks gestational age (GA) using single voxel 1H MRS. The resultant MR spectra were preprocessed retrospectively and quantified using LC Model. Ratios of the main metabolites: N-acetyl aspartate -NAA; Choline-Cho; Creatine-Cr [tNAA/tCho, tNAA/tCr, and tCr/tCho] and presence of lactate (anaerobic marker) were quantified. The correlation strength between GA and metabolites ratios was measured using Fisher z' transformed Pearson Coefficients. ANCOVA analyses were performed to determine differences in the slope of the fitted regression line for each metabolite/group.

Results
We acquired 302 1H-MRS spectra: 82 CHD fetal spectra (mean GA 31.9 +/-4.25 weeks) and 220 healthy controls (mean GA 31.4 +/-5.25 weeks). Among CHD fetuses, 64% had cyanotic CHD and 41% had single-ventricle (1v) physiology. In healthy fetuses, ratios of all measured metabolites increased with advancing GA (p<0.001). In CHD fetuses, tNAA/tCho and tCr/tCho also correlated with increasing GA (p <0.001); however, tNAA/tCr did not. The relationship between tNAA/tCho and tNAA/tCr, and advancing GA was significantly lower in CHD compared to healthy fetuses (p<0.001, for each). There was no difference between the two groups for tCr/tCho. Lactate was detected in 38% of CHD fetuses (39% had 1V, and 57% were cyanotic). The prevalence of minor structural brain injury on fetal MRI was 21% in CHD fetuses, and included prominent subarachnoid spaces and mild ventriculomegaly/ asymmetry.
Conclusions

We report a high prevalence of cerebral lactate and decreased NAA concentrations in fetuses diagnosed with CHD suggesting anaerobic metabolism and neuronal injury. These data suggest that metabolic alterations in CHD fetuses may be an important early biomarker for subsequent brain injury in this high-risk population.

O-303

10:42AM - 10:45AM

Robust gestational age prediction framework for cerebral cortical development in healthy and high-risk fetuses

S Dahdouh¹, G Vezina¹, C Limperopoulos¹
¹Children's National Health System, Washington, DC

Purpose

Accurate gestational age (GA) prediction is critical for determining normal and aberrant fetal brain development during pregnancy. Our objective was to examine the accuracy of a novel machine learning framework for automatically predicting GA using fetal cortical indices.

Materials and Methods

Using a cerebral cortical framework (1), fetal cortical surfaces from congenital heart disease (CHD) and control fetuses were parceled into 12 regions per hemisphere. A novel local signature composed of a mean: local gyrification index, cortical depth and cortical thickness per region was defined. The sum of these local signatures comprises a global brain signature. The brain signatures then were 'learned' using Regression Forests, a machine learning approach that maps a complex input space (set of multi-dimensional signatures) to a continuous output (e.g., age) based on a training dataset (Fig. 1). First healthy fetuses GA were predicted. Then, fetal CHD cortices were 'learned" and a prediction was carried out. Finally, CHD type (i.e., cyanotic versus acyanotic; 1- versus 2-ventricle CHD) was compared and a final GA prediction was performed.

Results

A total of 119 fetal brains: 61 CHD/58 controls (mean GA: 29.9±3.1 versus 31.0±3.5 weeks, respectively) were studied. GA prediction for healthy fetuses had a mean accuracy of <5 days, with a variability of 0.5 weeks, for an overall accuracy of 8 days. For CHD fetuses, the mean GA accuracy was 7 days, with a variability of 0.8 weeks, with a global accuracy of <13 days. Stratification of the CHD fetuses (1- versus 2v/cyanotic versus acyanotic) does not change the global prediction accuracy.

Conclusions

We present for the first time a novel, fully automated GA prediction framework in healthy and high-risk fetuses. Our data suggest a highly accurate GA prediction,
particularly for healthy fetuses. The wider GA global accuracy in CHD fetuses likely reflects greater variability in cortical development. Future work will extend this framework for diagnostic prediction and quantifying local cerebral cortical delays.

Figure 1: Age prediction framework based on local cortical signatures
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O-304

Normal Developmental Globe Morphology on Fetal MR
Purpose
Age-dependent structural changes occur in the globes over the course of gestation. In the second and early 3rd trimester, the posterolateral globe margins bulge outward, and the eyes are conical in the sagittal plane. Later, the globes are ellipsoid. The purpose of this study is to establish normal developmental fetal globe morphology.

Materials and Methods
The fetal magnetic resonance (MR) database at an academic children's hospital was queried for all brain MRIs performed over 8 years. Motion artifact, brain/craniofacial/globe malformations, and chromosomal defects were exclusion criteria. Two board certified neuroradiologists evaluated examinations in consensus. Logistic regression and Spearman's rank coefficients were used to evaluate correlations among variables.

Results
Twelve hundred forty-three exams from 1177 patients were identified. Six hundred eighty-two exams met inclusion criteria (17-39 weeks). Nonelliptical globes with posterolateral protrusions were universal up to 22 weeks. Thereafter, globes gradually assumed an elliptical shape, present in nearly all patients over 29 weeks. The hyaloid vasculature was visible in most patients up to 19 weeks, and occasionally up to 24 weeks. Subsequently, the hyaloid vasculature was no longer detectable. Receiver operating characteristic (ROC) analysis showed that age was highly predictive of globe shape (AUC=0.99) and visibility of fetal vasculature (AUC=0.94). There was a weak negative association between hyaloid visibility and elliptical globe shape (Spearman's rank coefficient= -0.36).

Conclusions
Physiologic nonspherical globe shapes are normal up to 29 weeks gestation, and should not be misinterpreted as pathologic. Thereafter, globes are generally elliptical. The timing of this process coincides with the resolution of the primary vitreous, and may be related.
Spectrum of Systemic Disorders in Fetuses with Orbital Lesions and their Associations with Cerebral Anomalies.

A Maddocks¹, A Pollock², B Coleman¹, T Feygin¹
¹Children's Hospital of Philadelphia, Philadelphia, PA, ²Children's Hospital of Philadelphia, Philadelphia, PA

Purpose
Fetal orbital anomalies may be associated with an underlying systemic disorder. The purposes of this study include: 1. Description of fetal imaging appearance of orbital anomalies. 2. Assessment of congenital disorders associated with orbital anomalies, with focus on a spectrum of cerebral pathology in each disorder.
Materials and Methods
With IRB approval, retrospective selection of fetal orbital anomalies was performed using keywords "microphthalmia", "coloboma", "cataract", "fetal". Cases were selected from fetal ultrasound and fetal magnetic resonance (MR) imaging performed at our institution from 2008-2015 for assessment of suspected fetal anomalies on obstetric ultrasound. Available imaging in the selected cases was reviewed independently by three neuroradiologists, and one senior sonographer.

Results
Evaluation of MRI/US examinations and patient's charts revealed 11 patients with confirmed vitreous coloboma; 36 patients with microphthalmia and three patients with cataracts. Orbital lesions were diagnosed during work up of suspected fetal central nervous system anomalies. The gestational age at the time of imaging was between 16 -36 weeks. The lesions were diagnosed on obstetric ultrasound and fetal MRI. All colobomas and microphthalmia were seen equally on fetal MRI and ultrasound. Cataracts were detected on ultrasound only. No single case of isolated coloboma nor cataract was evident in our study, although four cases of seemingly isolated microphthalmia were revealed. Cases with detected coloboma were associated with a variety of underlying syndromes, including three cases of PHACES, two cases of CHARGE, two cases of Walker-Warburg, two cases of Aicardi, one case of Wolf-Hirschhorm syndromes and one case of unclassified multiple congenital anomalies. Two cases with detected cataract were associated with Walker-Warburg syndrome and one case was associated with CHARGE syndrome. Thirty-two cases with detected microphthalmia were associated with multiple underlying syndromes, most often with unclassified multiple congenital anomalies and trisomy 13. The spectrum of cerebral anomalies in cases with orbital lesions extensively varied and among others included abnormal corpus callosum, holoprosencephaly and migrational cortical anomalies.

Conclusions
Detection of fetal orbital lesions should prompt a diligent search for associated birth defects arising at the same time or sharing the same progenitor cell. Fetal orbital anomalies may be helpful as a discriminator in order to narrow a long list of underlying systemic disorders. Precise assessment of associated cerebral anomalies is very important for decision making and future planning.
Purpose
Agenesis of the corpus callosum is one of the most frequently diagnosed brain malformations prenatally, but most studies focus on complete absence rather than hypogenesis. The aim of this study was to characterize brain MR findings in fetuses with hypogenesis of the corpus callosum (HCC), pointing out similarities and differences to fetuses with complete agenesis, and to assess the impact of fetal MR information on diagnosis and postnatal outcome of the children.

Materials and Methods
Out of 44 fetuses with potential HCC, brain magnetic resonance (MR) findings were reviewed retrospectively in those without bilateral severe ventriculomegaly and whose callosal length was below normal reference values.

Results
Twenty-one fetuses with HCC were included in this study, with a median gestational age of 23 years, 14 weeks at the time of fetal MRI. Prenatal ultrasound suspected a callosal abnormality in 48% of cases. On fetal MR, HCC was associated with other brain abnormalities in 81% of fetuses, including mild ventriculomegaly (n=9), interhemispheric lesions (n=9), sulcation delay (n=9), abnormal sulcal morphology (n=8), infratentorial anomalies (n=7), periventricular heterotopia (n=5) and thalamic fusion (n=1). Extracranial abnormalities were detected in seven fetuses. Out of six children with postnatal follow-up, three had good neurodevelopmental outcome and three poor outcome. None of the three children with a good outcome had abnormal sulcal morphology.

Conclusions
Fetal MR was a valuable tool in the diagnosis of unsuspected cases of HCC and showed that associated brain abnormalities are common and phenotypically heterogeneous. Although sulcation delay was present in a moderate proportion of cases, it was less frequent than what has been reported in complete agenesis, supporting the hypothesis that it may be secondary to abnormal comissuration and not an independent brain malformation. Information provided by fetal MR helps to clarify its etiology in some individual cases and constitutes an invaluable tool in assessing neurodevelopmental prognosis and parental counseling.

O-307

Neuroimaging findings in Chiari II malformation on fetal and postnatal MRI

U Nagaraj1, K Bierbrauer1, J Peiro1, B Kline-Fath1
1Cincinnati Children's Hospital Medical Center, Cincinnati, OH
Purpose
To examine neuroimaging findings in fetuses with open spinal dysraphisms and compare with postnatal imaging features.

Materials and Methods
A single center HIPPA compliant and institutional review board approved retrospective analysis was performed of magnetic resonance imagings (MRIs) of fetuses with open spinal dysraphism from 1/2004 through 7/2015 with available postnatal imaging. Images were reviewed by two board certified fellowship-trained pediatric neuroradiologists. Corresponding obstetrical ultrasound and clinical/operative reports were reviewed.

Results
One hundred eight fetal MRIs of open spinal dysraphisms with available postnatal neuroimaging and clinical/neurosurgical follow up were included. Average gestational age at fetal MRI was 23.9 ± 3.7 weeks. Cerebellar ectopia was seen in 90.7% (98/108) of fetuses, 86.7% (85/98) severe (grade 3) and 13.3% (13/98) moderate (grade 2). 90.7% (98/108) of fetuses had effacement of the pre-pontine cistern. In utero repair was performed in 30.6% (33/108) of fetuses, 81.8% (27/33) with severe Chiari II malformation. 97.2% (105/108) had postnatal brain MRI within the first year of life at average age of 26.2 ± 57.9 days. 14.8% (16/108) of patients had postnatal effacement of the pre-pontine cistern. Of 10 fetuses without cerebellar ectopia, 20% (2/10) developed ectopia postnatal (p=0.08). Of nonprenatal repaired severe cases 58.6% (34/58) were stable, 37.9% (22/58) had improved Chiari II, and 3.4% (2/58) had resolved cerebellar tonsillar ectopia postnatal. In fetuses with severe Cihari II that underwent in utero repair 74.1% (20/27) had no cerebellar ectopia, 11.1% (3/27) had improved Chiari II, and 11.1% (3/27) had no improvement by postnatal imaging.

Conclusions
In fetuses with open spinal dysraphism and severe Chiari II malformation that do not undergo prenatal repair, majority (58.6%) have no change in the severity of Chiari grade, however the majority (82.8%, 48/58) have improved mass effect on the brainstem postnatal. In fetuses that had in utero repair majority (74.1%, 20/27) had no postnatal imaging findings of cerebellar ectopia.
Fetal MRI Assessment in Rhombencephalosynapsis

J Alves¹, A Barkovich², X Mu³, D Xu³, A Foster-Barber³, O Glenn³
¹Centro Hospitalar do Porto, Porto, Portugal, ²UCSF Benioff Children's Hospital, San Francisco, CA, ³University Of California, San Francisco, San Francisco, CA
Purpose
Rhombencephalosynapsis (RS) is a likely underestimated brain malformation and its pathogenetic mechanisms remain largely unknown. We describe prenatal brain magnetic resonance imaging (MRI) findings in a large cohort of fetuses with RS, showing how this imaging technique can improve our understanding of this pathology.

Materials and Methods
Review of prenatal MR features in an institutional cohort of 16 fetuses with prenatally diagnosed RS.

Results
The prevalence of fetal RS in our institution was 1.2%. Nine fetuses had complete RS and seven had partial RS. The cerebellum was small in 81% and the pons anteroposterior diameter was reduced in 69%. The most common supratentorial associated findings were ventriculomegaly (n=14), absence of septal leaflets (n=13) and partial or complete agenesis of the corpus callosum (n=8). Abnormalities outside the brain were found in half of our fetuses, including two cases of lumbar myelomeningoceles and one with cervical meningocele, all without cerebellar or brainstem herniation through the foramen magnum.

Conclusions
Rhombencephalosynapsis is more common than originally considered and likely an underdiagnosed entity, in part due to the fact that a vermian remnant is found in a substantial number of cases. Fetal MR accurately characterizes cerebellar abnormal morphology and associated brain findings. Our results show that RS is frequently part of a more extensive malformation complex that includes neural tube defects, mesencephalon- and diencephalosynapsis and holoprosencephaly and that these entities likely share some common biological mechanisms, involving midline dorsoventral patterning defects.

O-309
11:00AM - 11:03AM

Placental Structural Evolution in Healthy and Congenital Heart Disease Fetuses using MRI

S Yewale1, S Dahdouh2, J De Asis-Cruz3, D Bulas1, S Bauer3, D Lanham3, C Limperopoulos3

1Children's National Medical Center, Washington DC, DC, 2Children's National Medical Center, Washington, DC, 3Children's National Health System, Washington, DC
Purpose
Placental insufficiency remains a common cause of perinatal mortality and neurodevelopmental morbidity. In utero congenital heart disease (CHD) may result in alterations in oxygen delivery and blood flow in the fetal and placental circulation. The extent to which placental structure is altered in CHD fetuses is unknown. We sought to characterize global and regional placental structural evolution in healthy and CHD fetuses using volumetric and texture-based magnetic resonance imaging (MRI) analyses.

Materials and Methods
We prospectively studied singleton pregnancies with healthy and CHD fetuses who underwent fetal MRI between 18- 40 weeks gestational age (GA). Manual segmentation of maternal and fetal compartments was carried out. We measured: (1) total, maternal and fetal placental volumes, (2) normalized entropy (nentrop), a descriptor of textural randomness, and (3) normalized variance (nvar), a measure of textural variability. An ANCOVA analysis was performed to study the evolution of all descriptors with regard to GA and condition. Partial correlation analysis between nvar, nentrop and volume also was performed.

Results
Placenta data from 200 fetal MRI scans, 84 CHD (mean GA ± sd: 30.83 ± 4.89 weeks) and 116 healthy controls (30.99 ± 4.89 weeks) were analyzed. Placental volume, nentrop and nvar for total, maternal and fetal compartments increased linearly with advancing GA for control and CHD fetuses (p<0.01). Maternal placental volume was significantly lower in CHD fetuses compared to controls (p=0.001) throughout gestation. The difference in slopes between CHD and control fetuses was significant for nvar in the fetal compartment only (p= 0.03). Normalized entropy correlated with placental volumes (p=0.0014) in healthy fetuses, while both nentrop (p=0.0020) and nvar correlated with CHD placental volume (p=0.04).

Conclusions
We report for the first time that global and regional maternal/fetal placental growth and textural variability increase with advancing GA in healthy and CHD fetuses. We demonstrate that regional maternal placental volumes are reduced significantly in CHD fetuses. The lack of correlation between placental volume and nvar in healthy fetuses likely reflects an evolving placental textural pattern evident with increasing GA, that is nonevident in CHD placenta. The functional significance of these intriguing preliminary placental findings in CHD fetuses awaits further study.

O-310

MRI texture analysis in sickle cell disease

P Croal1, P Kosinski2, M Shroff1, A Kassner1
Purpose
Up to 40% of children with sickle cell disease (SCD) are afflicted with silent cerebral infarcts (SCI) (1), associated with cognitive decline (2, 3) and increased stroke-risk (4); however the pathophysiology remains poorly understood. Here, we propose the application of texture analysis (TA) in children with SCD with and without SCI, to assess whether SCI are associated with widespread white matter (WM) changes. We focus on the watershed areas due to increased risk of ischemic damage in SCD, with the internal watershed damage thought to arise from chronic hemodynamic compromise, and external watershed damage from acute microembolic events (5).

Materials and Methods
Data were acquired on a 3T magnetic resonance imaging (MRI) system as part of a larger study and retrospectively analyzed. T1-weighted (TR/TE=2300/2.96ms, resolution=1×1×1mm and T2-weighted (TR/TE=2500/13ms, resolution=3.4×3.4×4.5mm) were acquired and reviewed by an experienced neuroradiologist (MS). Data from 14 patients were analyzed; seven subjects with SCI (14.4±2 years) and seven subjects without (14.5±3 years). Gray-level co-occurrence matrix (GLCM) based TA was applied to T1-weighted data in four slices (Fig. 1). Features were compared between SCI and non-SCI patients using a Student's t-test (corrected for multiple comparisons).

Results
For the internal watershed area, significant differences were observed in 10/11 features (p <0.05) across all pixel distances. There were no significant group differences in texture features for the external watershed area.

Conclusions
Results suggest that microscopic structural changes in normal appearing WM occur in addition to focal damage, although not yet visible on structural scans. Differences were observed in internal but not external watershed areas, supporting the notion that SCI in children with SCD are associated with chronic hemodynamic compromise rather than acute microembolic events. Texture analysis is a cost-effective image processing method which may provide additional insight into low-grade WM damage in SCD. By better understanding how damage is associated with SCI, it may become possible to predict SCI occurrence and better target therapeutic intervention.
Figure 1: Texture analysis pipeline. External and internal border interest were identified on $T_1$-weighted anatomical images, and occurrence matrix (GLCM) texture analysis applied. If silent cerebro were identified on $T_2$-weighted anatomicals, these voxels were excluded analysis.
Altered Temporal Dynamics in BOLD Measurements of Vascular Reserve in Children with Sickle Cell Disease

J Leung1, J Duffin2, A Kassner1
1The Hospital for Sick Children, Toronto, Ontario, 2University of Toronto, Toronto, Ontario

Purpose
Cerebrovascular reactivity (CVR) is a measure of the change in cerebral blood flow (CBF) in response to a vasoactive stimulus, such as carbon dioxide (CO2). However, the response of cerebral blood vessels is limited by both a temporal lag and a period of transient increase (1, 2) (Fig. 1). Recently, a method that accounts for such delays into CVR analysis was introduced, known as transfer function analysis (TFA), which uses frequency analysis instead of a direct temporal correlation (2). In this study, we compared TFA to standard temporal correlation for BOLD-CVR calculation in children with sickle cell disease (SCD) as they have known cerebrovascular impairment (3). We hypothesize that the maps computed with TFA will exhibit higher CVR than with standard correlation, and this improvement will be more pronounced in SCD compared to healthy controls.

Materials and Methods
Data from 62 children with SCD (age 10 to 18 years) and 35 age matched healthy controls were analyzed for this study. Subjects were scanned on a 3T clinical magnetic resonance imaging (MRI) (MAGNETOM Tim Trio, Siemens Healthcare, Erlangen Germany) with a 32-channel head coil. BOLD data were acquired using a gradient-echo EPI (TR/TE=2000/30ms, FOV=220mm, matrix=64×64, slices=25, slice=4.5mm, time=8min) in synchrony with a CO2 stimulus. The gas stimulus cycled between 60 seconds of normocapnia (CO2=40mmHg, O2=100mmHg) and 45 seconds of hypercapnia (CO2=45mmHg, O2=100mmHg). In addition, a high resolution anatomical scan was acquired. BOLD images were corrected for motion using FSL and the CO2 waveforms were temporally aligned to the BOLD data. Using the TFA tool, voxel-wise Gain and Phase maps were generated. Standard CVR maps computed from temporal correlation also were calculated. The anatomical images were segmented into gray and white matter regions using FSL. CVR, Gain, and Phase maps for each subject were co-registered to anatomical space and averaged across gray and white matter regions. Group differences were determined with a Student's t-test. A linear regression analysis was performed between CVR and Gain and we tested for
significant differences between slopes in the patient data versus control data (4). A p-value < 0.05 was considered statistically significant.

Results
Representative slices from CVR, Gain, and Phase maps for a SCD patient are provided in Figure 2. We see that CVR maps underestimate the CBF response compared to the Gain maps, especially in the white matter where the Phase maps indicate a delayed response. Group averages comparing CVR and Gain exhibit the same pattern in both groups, as shown in Table 1. Figure 3 plots CVR versus Gain for patients and controls, showing that the slope for patients is significantly higher in both grey and white matter with p < 0.01 in both cases.

Conclusions
Using TFA, a more robust measure of CVR can be obtained as it is less sensitive to small variations in BOLD response time. We found that the difference between CVR and Gain is more prominent in children with SCD compared to healthy controls, suggesting that the disease may be affecting the response time of the cerebral vasculature.

Figure 1. Diagram illustrating the sources of BOLD temporal delay in response to a step increase in CO2.

(Filename: TCT_O-311_TFA_Figure1.jpg)
Figure 2. Example slice of a (a) CVR, (b) Gain, and (c) Phase map of a representative brain region.

(Filename: TCT_O-311_TFA_Figure2.jpg)

Figure 3. Mean CVR plotted against mean Gain in the (a) grey matter and (b) white matter. Trend lines have been added in black to show differences in slope between the patient and control groups.

(Filename: TCT_O-311_TFA_Figure3.jpg)
Physiological Fluctuations in the White Matter of Children with Sickle Cell Disease

J Leung1, B MacIntosh2, Z Shirzadi3, A Kassner1
1The Hospital for Sick Children, Toronto, Ontario, 2Sunnybrook Health Sciences Centre, Toronto, Ontario, 3The University of Toronto, Toronto, Ontario

Purpose
Sickle cell disease (SCD) is a genetic hemoglobinopathy affecting oxygen transport throughout the body due to the transformation of red blood cells into a rigid sickled shape. This leads to a cascade of physiological changes, including vascular impairment in the brain. Cerebrovascular dysfunction in SCD may be further exacerbated by arterial stiffness, which is a potential biomarker for cardiovascular mortality (1). One of the potential consequences associated with poor arterial compliance is increased intracranial pulsatility. Stiff arterial walls are unable to act as an elastic buffer to convert arterial pulsatile flow into steady peripheral flow (2). This effect has been observed in studies on small vessel disease and adult dementia, and has been termed physiological fluctuation in the white matter (PFwm), and can serve as a proxy of cerebrovascular dysfunction (3). Using resting state blood-oxygen level dependent (BOLD) magnetic resonance imaging (MRI) the fluctuations can be detected as temporal variations in the white matter (WM) signal, as defined by the equation in Figure 1. In the present study, we acquired PFwm data in children with SCD, and compared them to healthy controls. We hypothesize that SCD patients will exhibit greater WM fluctuations reflecting their underlying pathophysiology.

Materials and Methods
Nine pediatric patients with SCD (5 male, 4 female, age 10-17 years) and six age-matched healthy controls were imaged on a clinical 3T MRI scanner (MAGNETOM Tim Trio; Siemens Medical Solutions, Germany) using a 32-channel head coil. Baseline fluctuation data were acquired using a BOLD sequence (TR/TE =

<table>
<thead>
<tr>
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<th>SCD Patients</th>
<th></th>
<th>Healthy Controls</th>
<th></th>
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<tbody>
<tr>
<td>CVR</td>
<td>Gain</td>
<td>p-value</td>
<td>CVR</td>
<td>Gain</td>
</tr>
<tr>
<td>GM</td>
<td>0.134 ± 0.058</td>
<td>0.191 ± 0.076</td>
<td>2.13 × 10^-7</td>
<td>0.187 ± 0.052</td>
</tr>
<tr>
<td>WM</td>
<td>0.086 ± 0.034</td>
<td>0.127 ± 0.041</td>
<td>1.13 × 10^-11</td>
<td>0.116 ± 0.029</td>
</tr>
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Table 1. Regional group mean ± standard deviation for CVR and Gain.
2000/40ms, FOV = 220mm, matrix size = 64×64, slices = 25, slice thickness = 4.5mm, volumes = at least 120). In addition, a T1-weighted image (MPRAGE, voxel = 1 mm isotropic) was acquired for anatomical information. A WM mask was generated by segmenting the T1-weighted data and coregistered into the BOLD space using AFNI. The BOLD data were corrected for motion (MCFLIRT, FSL) and the temporal mean and variance across the time-series in each voxel was computed. Next, we calculated the spatial average of the variance and mean within the regions defined by the WM mask. Thermal noise variance was calculated from a region drawn outside of the brain. Differences in PFwm between groups were calculated using Student's t-test, with significance defined as p < 0.05.

Results
Figure 2 shows representative PFwm maps superimposed onto anatomical slices comparing a SCD and healthy subject. The mean PFwm was significantly higher in children with SCD (0.182 ± 0.096) compared to the control group (0.085 ± 0.019), with p = 0.016. A plot comparing the two groups is provided in Figure 3.

Conclusions
The increased WM pulsatility in SCD patients supports a possible link between PFwm and cerebrovascular dysfunction. This increase may be driven by the combination of anemia-induced vasodilation and reduced nitric oxide bioavailability (4), each contributing to arterial stiffening. Our results show that PFwm has the potential to be a clinically relevant tool in the assessment of SCD and other cerebrovascular diseases.

\[
PF_{wm}^2 = \frac{\sigma_{wm}^2 - \sigma_{thermal}^2}{\mu_{wm}^2}
\]

Figure 1. Equation for Physiological Fluctuation, where \(\sigma^2\) is the temporal variance and \(\mu\) is the temporal mean.
Figure 2. Representative PFwm maps in a sickle cell and healthy subject.
(Filename: TCT_O-312_PFwm_Figure2.jpg)
Quantification of Global Phase-based Venous Oxygenation in Children with Sickle Cell Disease

P Croal¹, M Serafin², J Leung¹, A Kassner¹
¹The Hospital for Sick Children, Toronto, Ontario, ²The University of Toronto, Toronto, Ontario

Purpose
Venous oxygen saturation (Yv) enables quantification of oxygen extraction fraction (OEF) and cerebral metabolic rate of oxygen (CMRO2). In this study we compare two approaches for global quantification of Yv based on clinically available magnetic resonance imaging (MRI) sequences. Firstly, the infinite cylinder (IC) method (1), the most commonly used MR-susceptometry technique and secondly, the forward field (FF) method (2), a recent modification of the IC method which accounts for specific
vessel geometry of each subject. We implement these methods in children with sickle cell disease (SCD), in whom oxygen dynamics are likely to be disrupted, due to high risk of overt ischemic stroke in children.

Materials and Methods
Eleven SCD patients (8M/3F, 13.5±3 years) and eight healthy controls (4M/4F, 13.8±3 years) were imaged on a 3T MRI system. Magnitude and phase data were acquired using an SWI sequence (TR/TE=28/20 ms, FA=15°, 0.8×0.7×1.2 mm3, 5 minute). Regions of interest (ROIs) were drawn on the magnitude image; (i) within and (ii) around the superior sagittal sinus (SSS), and applied to the filtered phase image to calculate the phase difference (Fig. 1). For both methods, Yv was quantified from phase difference according to Equation 1, assuming a susceptibility difference between tissue and deoxyhemoglobin of ΔΧdo =0.27 ppm (cgs) and a gyromagnetic ratio γ=2.675x10 for 3T. Hematocrit (Hct) was assumed to be 0.41 for healthy males, 0.39 for healthy females, and obtained via a blood sample for patients. The IC method was applied in five slices in which the SSS was most parallel to the main magnetic field (B0), such that A ≈ 1/3, where A is a geometric scaling factor accounting for shape. For the FF method, Δφ was calculated in slices where the SSS was clearly visible, and a forward field calculation (3) applied to estimate field perturbation within the SSS, from which A was calculated, accounting for SSS geometry.

Results
Figure 2 shows a significant elevation in Yv in SCD patients in comparison to healthy controls, as quantified with the FF method. The IC method showed a trend for increased Yv in SCD patients in comparison to controls. For both groups, Yv was significantly higher when quantified with the IC method in comparison to the FF method.

Conclusions
Here we observed elevated Yv in children with SCD in comparison to controls, demonstrating both the first implementation of the FF method in a clinical population. This was significant only for the FF method, suggesting that by capturing individual variations in venous shape, sensitivity to pathophysiological changes in Yv is increased. The FF method therefore may be preferable to the IC method in clinical populations.
Improvement of Neurocognitive Function, BOLD fMRI Activation and Transcranial Doppler Velocities in Pediatric Sickle Cell Anemia Patients Treated with Hydroxyurea

K Helton¹, A Jones¹, P Zou¹, J Hankins¹, J Schreiber¹, R Ogg¹
¹St. Jude Children's Research Hospital, Memphis, TN
Purpose
Sickle cell anemia (SCA) is a hereditary hemoglobinopathy, associated with cerebral vaso-occlusive disease, elevated transcranial doppler (TCD) velocities, silent infarctions, and stroke. Even with normal appearing brains by magnetic resonance imaging (MRI) declining neurocognitive function is well described in school aged children with SCA. We previously have shown that Intelligence Quotient (IQ) was associated with the blood oxygenation level-dependent (BOLD) MRI response to visual contrast stimulus (VCS) in children with SCA. This study utilizes BOLD functional magnetic resonance imaging (fMRI) and TCD velocities to compare hydroxyurea-treated and untreated groups of children with SCA to evaluate the effect of therapy on brain function.

Materials and Methods
After informed consent, untreated pediatric SCA patients without clinical history of stroke were enrolled in an Institutional Review Board approved prospective neuroimaging study. Patients underwent laboratory, BOLD functional MRI with VCS, TCD velocities and neuropsychological testing at baseline and after 12±3 months. Patients were divided into two groups based on treatment status: hydroxyurea (HU) treated (n=15, mean age 12.7 ± 3.4 years) and untreated (n=9, mean age 11.4 ± 2.9 years).

Results
All measures improved in the treated group: [increased BOLD response to VCS (p=0.032), decreased middle cerebral artery (MCA) TCD velocities (p=0.005), increased IQ score (p=0.018)] compared with baseline examinations. All measures systematically declined in the untreated group [decreased BOLD response (p=0.352), increased MCA TCD velocities (p=0.191), decreased IQ score (p=0.130)] compared with baseline examinations, but the differences were not significant.

Conclusions
One year of hydroxyurea therapy leads to measureable improvement of global IQ in previously untreated children with SCA. Corresponding improvement in MCA velocities and visual cortex BOLD response suggest that improved brain function after hydroxyurea therapy is mediated in part by normalization of neural-hemodynamic coupling. Hydroxyurea therapy may not only prevent decline, but actually improve neurocognitive function in patients with SCA.
HU treated

untreated

[Image of brain scans with color-coded areas labeled as baseline, +1 year, and overlap widow, T > 4.6, p < 0.05 (Family-Wise Error Corrected)]

(Filename: TCT_O-314_HeltonASNR2016_v2.jpg)
Wednesday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Maryland A/B/C

15E-CSF Programming: Normal Pressure Hydrocephalus (NPH) and Chiari I

15E-1
10:30AM - 10:55AM

Diagnosis and Management of Chiari

Rekate, H.
The Chiari Institute
Great Neck, NY

15E-2
10:55AM - 11:20AM

Computational Flow Dynamics of Chiari

Haughton, V.
University of Wisconsin School of Medicine and Public Health
Oconomowoc, WI

15E-3
11:20AM - 11:45AM

PC-MRI in Evaluation of NPH

Bradley, W.
USD Medical Center
San Diego, CA

15E-4
11:45AM - 12:00PM

Discussion
Development and Optimization of a Bayesian Expert System for Diagnosis Support in Neuroradiology

E Botzolakis¹, S Mohan¹, I Nasrallah², H Kundel¹, E Herskovits³, R Bryan¹
¹University of Pennsylvania, Philadelphia, PA, ²HUP, Philadelphia, PA, ³University Of Maryland, Baltimore, MD

Purpose
Applications capable of providing diagnosis support in neuroradiology currently are limited. We therefore aimed to develop a novel diagnosis support system which takes as input key features (KFs) extracted from brain magnetic resonance images (MRIs) and outputs a rank-ordered differential diagnosis (DDx) using a Bayesian network. We hypothesized that a Bayesian expert system could distinguish a nearly comprehensive list of adult neuroradiology diseases with better performance than a radiology resident.

Materials and Methods
A naïve Bayesian network (BN) was developed based on expert beliefs, which incorporated 123 diseases (including normal) and 13 KFs (brain MRI signal and spatial characteristics, and patient age). To evaluate network performance, 450 brain MRIs were selected randomly from our imaging archives (77 diseases represented thus far), with ground truth (GT) determined after review of clinical, radiologic, and pathologic records. Six readers (2 neuroradiology attendings, 2 neuroradiology fellows, and 2 radiology residents) reviewed each case, extracted KFs, and provided a "top 3" DDx for each case. Reader-extracted KFs were entered into the BN, which also generated a DDx for each case. We compared reader and BN DDx to GT using receiver operating curve (ROC) analysis. Partial area under the curve (pAUC) from 0 to 0.15 was calculated based on reader and BN ability to identify GT among their top 3 DDx. To improve network performance, reader-extracted KFs were used to "train" the expert BN using established machine learning algorithms, resulting in a hybrid data-driven network composed partly of probabilities calculated from observed KFs, and partly from expert beliefs for disease entities where data were sparse.

Results
Performance of the readers improved with higher levels of training (attendings,
fellows, and residents had overall accuracy rates of 54%, 45%, and 32% and pAUCs of 0.06, 0.04, and 0.02, respectively). Performance of the preliminary expert BN also was dependent on training level of radiologist extracting the KFs, but with decreased performance at all levels compared to the radiologists themselves (overall accuracy rates of 32%, 26%, and 23% and pAUCs of 0.02, 0.01, and 0.01 for attending-, fellow-, and resident-extracted KFs, respectively). Performance of the hybrid BN improved compared to the expert BN (overall accuracy rates of 48%, 40%, and 32% and pAUCs of 0.03, 0.02, and 0.01 for attending-, fellow-, and resident-extracted KFs, respectively).

Conclusions
Bayesian networks represent a promising approach to neuroradiology diagnosis support. Using a combination of expert beliefs and reader-extracted KFs from brain MRIs, we demonstrated that a hybrid BN can achieve diagnostic performance as good as a radiology resident regardless of KF source, and similar to neuroradiology fellows with attending-level KF extraction. With further optimization, we anticipate BNs can achieve even higher levels of diagnostic performance.

O-316
10:38AM - 10:46AM
Validation of an Expert-Based Bayesian Network for Discriminating Diseases Affecting the Basal Ganglia and Thalamus

E Botzolakis1, I Nasrallah2, H Kundel1, E Herskovits3, R Bryan1, S Mohan1
1University of Pennsylvania, Philadelphia, PA, 2HUP, Philadelphia, PA, 3University Of Maryland, Baltimore, MD

Purpose
Diseases affecting the basal ganglia and thalamus are challenging to diagnose on imaging, requiring consideration of multiple imaging features and often complex clinical history. Several studies have demonstrated the potential utility of Bayesian networks (BNs) for assisting imaging interpretation, reflecting their ability to integrate large amounts of probabilistic information for the purposes of generating a differential diagnosis. We aimed to develop an expert-based BN capable of discriminating diseases affecting the basal ganglia and thalamus, with the potential of eventually providing neuroradiology diagnosis support.

Materials and Methods
Using commercially available software (Netica, Norsys Software, Vancouver, Canada), a naïve BN was generated consisting of a parent "disease" node connected to multiple daughter "key feature" (KF) nodes. The disease node contained a broadly inclusive list of 52 diseases affecting the basal ganglia and thalamus in adults. A total of 26 KF nodes included magnetic resonance imaging (MRI) signal and spatial
characteristics, plus patient age and symptom acuity. Conditional probabilities, defined as KF probability given a particular disease, were generated from a combination of expert opinion and literature review. Bayesian network performance was evaluated using 120 clinically proven cases randomly selected from the imaging archives of our tertiary care university hospital, including 30 normals. A neuroradiology attending and fellow extracted KFs from these cases and entered them into the BN. By comparing the BN differential diagnosis to ground truth (GT) for each case, a confusion matrix was generated and used to evaluate BN performance.

Results
Of the 52 diseases represented in the BN, 34 were included within the set of test cases, with the number of cases per disease ranging from 1 to 4. When the highest probability diagnosis for each case was compared to GT, the expert-based BN demonstrated overall accuracy of 0.73, with sensitivity and specificity of 0.65 and 0.97, respectively. However, when the BN "top 3" differential diagnosis for each case was compared to GT (i.e., when the BN was given three chances to make the correct diagnosis), sensitivity increased to 0.85, with specificity unchanged. Based on sensitivity analysis, the five most discriminating KFs were (in decreasing order of entropy reduction): acuity of clinical presentation, mass effect, FLAIR signal, diffusion signal, and T1 signal.

Conclusions
An expert-based BN was developed with high discriminatory capacity for diseases affecting the basal ganglia and thalamus using reader-extracted KFs. With further parameter and structural optimization, we anticipate this BN eventually could be used for real-time neuroradiology diagnosis support.

O-318
10:54AM - 11:02AM
Natural Language Processing to Identify Type 1 Modic Endplate Changes in Older Adults

H Huhdanpaa1, K Tan1, S Rundell1, P Suri2, F Chokshi3, B Comstock1, P Heagerty1, K James1, A Avins4, S Nedeljkovic5, D Nerenz6, J Jarvik7

1University of Washington, Seattle, WA, 2VA Puget Sound Health Care System, Seattle, WA, 3Emory University School of Medicine, Atlanta, GA, 4Kaiser Permanente, Northern California - Division of Research, Oakland, CA, 5Brigham and Women's Hospital, Boston, MA, 6Henry Ford Health System, Detroit, MI, 7Univ of Washington, Seattle, WA

Purpose
Natural language processing (NLP) has the potential to extract meaningful data from free-text such as radiology reports. One use would be to identify potential subjects for
clinical trials. Recent work from Albert et al (1), implicate Propionibacterium as an infectious agent possibly associated with Type 1 Modic endplate changes. Their single center randomized trial indicated that some patients might benefit from antibiotic therapy. Our goal was to determine the validity and predictive value of an NLP algorithm to identify patients with Type 1 Modic endplate changes.

Materials and Methods
We annotated 154 randomly selected lumbar spine MR reports from a prospectively assembled cohort of older adults with back pain (2). Two annotators identified all reports that contained Type 1 Modic endplate change, and a senior neuroradiologist adjudicated discrepancies to create the reference standard. We then applied a rule-based NLP algorithm using Regular Expression, a string matching algorithm easily implemented in Python (Table 1). We calculated sensitivity, specificity, positive and negative predictive values (PPV and NPV).

Results
The prevalence of Type 1 Modic endplate changes was 6%. The sensitivity and negative predictive value of rule-based NLP were perfect, although the positive predictive value was only 67%. Most of the false positives were due to fracture-associated edema.

Conclusions
Rule-based NLP is a feasible approach for identifying patients with Type 1 Modic endplate change if the emphasis is on case finding and there is low concern regarding false-positives. If the research question requires better PPV, then consider other approaches, such as machine-learning NLP. We also plan to report how this approach performs in a larger cohort with greater age diversity, the Lumbar Imaging with Reporting of Epidemiology (LIRE) study.

M Morris¹, B Saboury¹, J Hostetter¹, S Boateng¹, R Whiting², S Rothenberg¹, R Tu³, E Siegel¹
¹University of Maryland Medical Center, Baltimore, MD, ²George Washington University, Washington, DC, ³George Washington University Hospital, Washington, DC

Purpose
Spine laterality and disk level mistakes are critical reporting errors with potential major consequences affecting patients safety. In computed tomography (CT) or
magnetic resonance imaging (MRI) studies of the spine laterality and disk level of an abnormality guide the procedural approach and therefore accurate reporting is essential (1, 2). It was evaluated whether computer-aided reporting through the use of "smart annotations" and natural language generation (NLG) could provide accurate and reproducible structured reports for spinal disease according to the new Combined Task Force (CTF) standardized nomenclature.

Materials and Methods
Standardized annotation tracking with annotation image markup (AIM) can provide a method for computational processing of radiologist annotations as common data elements (CDEs) (3). A nearest neighbor mathematical algorithm is utilized in order to define the laterality and disk level based on annotation of the vertebral bodies. These CDEs then are formatted as xml and populated into a web-based graphical user interface to assign standard descriptors. The radiologist reviews the web form and adds additional observations. When the form is submitted, a structured report is generated according to the updated standardized CTF spine nomenclature.

Results
Computer-aided reporting of spinal disease allows for reliable structured reporting of the laterality and level of spine pathology, which is critical. A simple to use web interface was created and allowed for structured reporting using the standardized CTF nomenclature for spine disease through natural language generation.

Conclusions
This smart annotation tool for spine imaging can be used to extract essential report elements in real time during radiologist interaction with spine CT and MRI in a reliable and convenient way. Standardized reporting is essential to communicate consistent findings, to reduce misinterpretation of the intent of the radiologist, to reduce errors in medical settlements/judgements, and disability payments.

O-320
11:10AM - 11:18AM

Interrogating Log File Data to Understand the Effect of Imaged Body Region on the Occurrence of Repeated and Terminated Sequences.

J Andre¹, T Amthor², C Hall³, W Cohen¹, N Beauchamp¹
¹University of Washington, Seattle, WA, ²Philips Research Europe, Hamburg, Germany, ³Philips Healthcare, Bothell, WA

Purpose
Modality log files, like a "black box" used in modern aircraft, track metrics of magnetic resonance (MR) scanner efficiency including repeated sequences and patient table motion. We sought to document the effect of scanned body region on the
probability of sequence repetition and termination as a function of time during the examination.

Materials and Methods
We retrospectively interrogated the log files of two identical 3T MR systems (Ingenia, Philips Healthcare, Best, The Netherlands) over a 2-year period (06/29/2013 – 09/10/2015). Log file data were evaluated and analyzed using in-house Python scripts. Statistical analysis was performed using a Wilson score to determine 95% confidence intervals for all probabilities.

Results
There were 4479 head and/or brain, 1540 spine, 438 abdomen, 1656 liver, and 962 leg/knee examinations evaluated. Log file-based probabilities are depicted as a function of the time the patient spends inside the magnet bore in Figure 1A-C, where the bars indicate the probability of a sequence begun within the respective time interval to be repeated. For head and/or brain exams, there is a higher repetition probability at the beginning of the exam, a clear minimum near 2.5-10 minutes, followed by a general trend of rising scan repetition probability as the scan approaches 30 minutes. However, this trend is not followed for spine and leg/knee exams suggesting that the shape of the motion curve varies based on scanned anatomical region, and may be potentially influenced by sequence-specific sensitivity to motion (secondary to the employed readout method), as well as patient position within the bore of the magnet (feet-first positioning routinely used for abdomen, liver and leg exams, and head-first positioning used for brain, head and spine exams). Figure 1D depicts the cumulative ratio of repeated and aborted sequences relative to scanned anatomical region (where "scan" = sequence).

Conclusions
The use of log files can detect patterns of scanner and exam performance, that may vary based on anatomical region scanned, and may be useful in identifying pitfalls to diagnostic imaging in a clinical environment.
Radiological Assessment of Patient Motion Correlated with the Incidence of Repeat Sequences Documented by Log Files.

J Andre¹, T Amthor², C Hall³, W Cohen¹, N Beauchamp¹
¹University of Washington, Seattle, WA, ²Philips Research Europe, Hamburg, WA, ³Philips Healthcare, Bothell, WA

Purpose
Modality log files, like a "black box" used in modern aircraft, track metrics of MR scanner efficiency including repeated sequences and patient table motion. We sought to compare the radiological assessment of motion with the incidence of repeated sequences documented by scanner log files.

Materials and Methods
One neuroradiologist, blinded to all patient history and log file data, retrospectively evaluated one full calendar month (August 2014) of sequentially obtained clinical MR exams of the head and/or brain for the presence of motion artifacts using a previously defined clinical grading scale (1). All exams were acquired on one of two identical 3T MR systems (Ingenia, Philips Healthcare, Best, The Netherlands). Log file data from these exams were analyzed using in-house Python scripts. Statistical calculations included a Wilson score to determine 95% confidence intervals for the score ratios, and Welch's t-test to exclude the hypothesis of equal means.

Results
Two hundred fourteen examinations of the head and/or brain, comprising 1600 sequences, were evaluated. Radiological motion assessment scores (0, none – 4, severe), evaluated as a function of time within the magnet bore, varied over the course of the exam generating the following trend: initially higher motion score near the beginning of the exam, a minimum at 5 to 10 minutes, and a steady rise in subsequent motion scores. Figure 1 depicts the average motion score per brain and head exams (cumulative scores divided by the number of sequences), relative to the log file documented incidence of repeated sequences within an examination. The hypothesis of equal means was rejected for the samples with 0 and 1 (p= 0.0009), and 0 and 2 (p=0.022) repetitions, respectively, but not for samples with 1 and 2 repetitions (p=0.26). The number of exams with 0, 1, and 2 repetitions were 186, 18, and 4, respectively.

Conclusions
Log file data may help predict patterns of scanner and exam performance in a clinical environment, particularly with respect to patient motion.
Accessible and Cost-effective 3D Printing in Neuroimaging.

A Krishnamoorthy¹, T Burtonwood²
¹Swedish Convenant Hospital, Chicago, IL, ²School of the Art Institute of Chicago, Chicago, IL

Purpose
The excitement surrounding open source three-dimensional (3D) printing is based primarily on how accessible desktop 3D printers have become in the past few years. Despite this trend, anatomical 3D printing in radiology for the most part remains a high cost endeavour which limits its accessibility. We present results from a 3D printing service started at a radiology practice that utilizes relatively low cost, widely available 3D printing equipment.

Materials and Methods
Anatomical data from computed tomography (CT) and magnetic resonance images (MRIs) of the brain, spine, and head and neck were translated into segmented anatomical models using Slicer (slicer.org). These models subsequently were processed for 3D printing utilizing a free open source software tool chain including
MeshLab (meshlab.sourceforge.net), ReplicatorG (replicat.org), Slic3r (slic3r.org) and GPX (github.com/whpthomas/GPX). The 3D printer employed was a Flash Forge Creator Pro (flashforge-usa.com) which can print with two materials simultaneously, produce structures with resolution of up to 0.1 mm, and has a build area suited for most head/neck and spine models. The plastic filament material used for model fabrication was polylactic acid (PLA) with polyvinyl alcohol (PVA) used occasionally for support material.

Results
So far, 17 anatomical 3D models of the head, neck and spine have been printed from CT and MR data since the acquisition of the equipment 7 months previously with increasing interest among our clinical colleagues. These life size, physical anatomical models have served as an adjunct to currently available computer graphic 3D renderings of anatomical data and were utilized primarily to assist with surgical planning and communicating planned procedures with the patient.

Conclusions
The popularity of 3D printing in large part is due to its accessibility and affordability, and we demonstrate how this model of open source 3D printing can be applied to medical imaging and specifically in a neuroimaging practice.
Demystifying the Course of the Facial Nerve Utilizing 3D Printing

D Davidson¹, M Bansal¹, A Choudhri², M Taheri³, R Javan¹
¹George Washington University Hospital, Washington, DC, ²University of Tennessee Health Center, Memphis, TN, ³George Washington University, Washington, DC, DC

Purpose
The goal of this exhibit is to demonstrate the methodology of designing a highly detailed custom educational physical 3D model depicting the complex three-dimensional course of the facial nerve. This is achieved by utilizing 3D printing from high-resolution computed tomography (CT) images combined with custom graphic design.

Materials and Methods
Images from a normal high-resolution CT of the temporal bone was used to three-dimensionally reconstruct the bony anatomy using Materialise Mimics 17.0, after manually perfecting the segmentation of bony anatomy on each thin slice of the scan. This 3D model was imported in Autodesk 3D Studio Max 2013 and split with a curved plane (craniocaudal) along the course of the facial nerve from its cisternal portion extending to the stylomastoid foramen. The parotid gland and retromandibular vein were added as landmarks for the extracranial portion of the course. The facial nerve itself also is graphically designed to fit the anatomical facial canal. The intracanalicular portion is designed to demonstrate the cross-sectional appearance relative to the Vestibulocochlear nerve branches. Subsequently 3D printing was performed through commercially available services utilizing rapid prototyping technology on polyamide material with minimum detail of 0.3 mm. Magnets also were embedded in the model for assembly. An additional small dual-material model was created with bone tissue represented as transparent material and the facial nerve as opaque color material.

Results
An enlarged detailed multipart physical model of the temporal bone was created with intricate detail for the specific use of teaching the complex course of the facial nerve.

Conclusions
Highly customized physical models easily can be developed for very specific teaching purposes. This exhibit is to demonstrate an example of such 3D printed models for a concept that is commonly difficult to grasp and visualize by radiology trainees, i.e., the three-dimensionally complex course of the facial nerve. This technique can be applied to numerous other areas of the head and neck, such as the pterygopalatine
fossa and the cavernous sinus, to simplify understanding complex anatomy with specifically tailored physical models. Knowing the exact course also helps the interpretation of pathologic conditions, such as trauma to the temporal bone or abnormal enhancement of the facial nerve when interpreting MRIs in the setting of peri-neural spread of tumor, clinical concern for Bell's palsy or presence of a nerve sheath tumor.

O-324

11:42AM - 11:50AM

Efficacy of Double-Blinded Peer Review in Neuroradiology

E O'Connor¹, M Cousar¹, J Lentini², M Castillo³, K Halm⁴, T Zeffiro⁵
¹Lewis Katz School of Medicine at Temple University, Philadelphia, PA, ²Temple University Hospital, Philadelphia, PA, ³Univ. Of North Carolina School Of Medicine, Chapel Hill, NC, ⁴American Journal of Neuroradiology, Oak Brook, IL, ⁵Temple University, Philadelphia, PA

Purpose
The American Journal of Neuroradiology (AJNR) uses double-blinded peer review to minimize potential reviewer bias concerning content, quality and recommendations. However, in a relatively small medical subspecialty such as neuroradiology, there are potential reasons why this process may be limited by reviewers' prior knowledge of the authors' work or ongoing studies at associated institutions. We sought to investigate the efficacy of blinding reviewers in AJNR and to determine the impact that unblinding may have on outcome of submitted manuscripts.

Materials and Methods
For manuscripts submitted to AJNR, from January through June 2015, AJNR reviewers completed a brief anonymous questionnaire after their blinded reviews. Questions assessed whether reviewers were familiar with the research prior to their reviews and their knowledge of the authors or institutions from which the work originated (Appendix A).

Results
Response rate for a total of 1,079 questionnaires offered to reviewers was 98.8%. 12.7% of reviewers knew or suspected that they knew the manuscript's author(s) and 15.1% knew or suspected that they knew the institution(s) from which the work originated. Reviewers who made guesses, correctly identified the author(s) of the submitted manuscripts in 90.3% of cases and correctly stated the institution(s) in 86.8% of cases. Unblinding resulted from self-citation in 34.1% of occurrences for both authorship and institutions. The rate of acceptance when reviewers knew or suspected they knew the author(s) was 57/137 (41.6%) and the rate of acceptance when reviewers did not identify the authors was 262/929 (28.2%). A binomial test
comparing proportions showed that familiarity with authors was associated with greater acceptance for manuscripts (p < .0019). Familiarity with institution also was associated with greater acceptance (p<.046).

Conclusions
The process of double-blinded peer review utilized by AJNR is largely effective in minimizing reviewer bias. Unblinding of authors is associated with a higher rate of manuscript acceptance.

<table>
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**AJNR Reviewer Questionnaire**

1. Can you identify principal author/s of manuscript reviewed?  
   (A) I know I could  
   (B) I suspect I could  
   (C) I do not think I could

2. Can you identify the institution/s from which the reviewed work originates?  
   (A) I know I could  
   (B) I suspect I could  
   (C) I do not think I could

3. Can you identify either the author/s or institution/s?  
   (A) I know I could  
   (B) I suspect I could  
   (C) I do not think I could

4. If you answered (A) or (B) for the above question, please enter the suspected author, institution or both.

5. Were you familiar with the research finding before review?  
   (A) Yes  
   (B) No  
   (C) Not sure

(Filename: TCT_O-324_QuestionnaireTable.jpg)

**O-325**

Comparison of Citation Frequency and Almetric Score in Articles Published by the American Journal of Neuroradiology

H Kelly¹, A Choudhri², J Ross³
Purpose
Our purpose was to evaluate the top articles from AJNR in altmetric score (a measure of online and social media mentions of an article) and citation frequency and to determine the characteristics of each of these groups of articles.

Materials and Methods
A SCOPUS search was used to identify the top 50 articles with the highest number of citations published in AJNR between January 2012 and December 2015. An Altmetric Explorer search was performed to identify the 50 AJNR articles with the highest altmetric scores. These groups were cross-referenced to identify any articles that appeared in both categories. Characteristics including citation data, altmetric score, topic and article type were compared.

Results
Only one article appeared in both the top 50 most cited and top 50 highest altmetric score groups. The most frequently cited articles averaged 10.8 citations/year compared to 3.1 citations/year for the articles with the highest altmetric scores (p<0.00001). The average altmetric score in the top 50 articles was 41.9 compared to 0.8 for the 50 most frequently cited articles (p<0.03). There was no correlation between the altmetric score and the rate of citations per year in either the top altmetric score group or the most frequently cited group (R = 0.08 and 0.16 respectively).

Conclusions
The most frequently cited articles published in AJNR are not the most likely to be mentioned online. There is no significant correlation between citation frequency and altmetric score, suggesting that online and social media mentions do not influence citation patterns and vice versa. These metrics may be independent measures of impact for neuroradiology articles.

O-326

It’s about time: A Time-Activity Study in Neuroradiology

A Al Yassin1, M Salehi Sadaghiani2, S Mohan2, E Botzolakis2, R Bryan2, I Nasrallah2
1New York Institute of Technology, Glen Cove, NY, 2University of Pennsylvania, Philadelphia, PA

Purpose
Although efficiency is critical to modern radiology practice, the specific distribution of activities performed by neuroradiologists at the workstation remains poorly understood. Indeed, knowledge of the timing and steps leading to final report
generation is essential for workflow optimization and departmental staffing decisions. We measured the time spent on each step from study opening to report signing to identify potential targets for optimization. Furthermore, we evaluated how these patterns differed between attendings and trainees.

Materials and Methods
In this prospective observational study, radiologists were timed while interpreting 201 brain magnetic resonance images (MRIs) in a tertiary care academic practice over 5 weeks. We measured the total duration from study opening to report signing and time spent on five distinct activities during this period: image review, report transcription, obtaining correlative clinical data, trainee education, and other. Attendings, fellows and residents reading studies independently and attendings over-reading trainee-previewed studies were observed. ANOVA and t-tests were performed for statistical analysis.

Results
Attendings, fellows, and residents respectively spent a total of 13 +/- 8, 20 +/- 9 and 23 +/- 6 minutes (mean +/- standard deviation) when independently generating a brain MRI report. Mean duration was significantly different between attendings and fellows (p=0.0002) or residents (p=0.003) but not between fellows and residents. Although slightly less, mean duration for attendings reading independently was not significantly different from attendings over-reading trainees, with offsetting time spent on transcription/obtaining clinical data versus trainee education between the two settings. Attendings spent the same time on image viewing (mean 4.4 min) with or without trainees. Mean attending transcription time was shortest when over-reading trainees (about 1.2 min, with or without trainees present at the time of the attending read) and longest when reading independently (3.3 min), showing benefit of having a draft report. Fellows and residents had longer mean times for image viewing (7.2 min and 12.3 min, respectively) and transcription (about 7 min). Measurements of reading times showed high agreement between different observers.

Conclusions
Neuroradiologist time/activity distribution for brain MRI studies was measured, establishing a benchmark for future efforts to improve efficiency and decrease reporting times, specifically showing precedent for decreasing attending transcription time with the availability of a draft report. Furthermore, we show differences in total duration of report generation by level of training due to longer observation, transcription, and clinical correlation reporting times in trainees compared to attendings.
* p < 0.01 versus Attending: independent reading with trainee present, all others not significant

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Wednesday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Marriott Ballroom

16A-SNIS Programming: Trauma and the NeuroInterventionalist: The Management of the Endovascular Emergency
16A-1

Diagnostic Neuroradiology in the Setting of Trauma of the Head and Neck: Spotting the Problem
16A-2  
Management of Traumatic Dissections of the Great Vessels of the Neck: Current Level of Evidence

Ansari, S.
Northwestern University, Feinberg School of Medicine
Chicago, IL

16A-3  
Acute Management of the Traumatic CCF

Armonda, R.
MedStar Health
Washington, DC

16A-4  
Acute Endovascular Management of Trauma of the Face and Neck

Gandhi, C.
Rutgers New Jersey Medical School
Newark, NJ

16A-5  
Panel Discussion
Wednesday  
1:15PM - 2:45PM  
Washington Marriott Wardman Park, Washington 4/5/6

16B-TBI - Advanced  
16B-1

1:15PM - 2:45PM  
Advanced Biomarkers of Traumatic Brain Injury for Precision Medicine  

Mukherjee, P.  
San Francisco VA Med Ctr  
San Francisco, CA

16B-2

1:15PM - 2:45PM  
Brain Imaging and Subconcussive Impacts in Sports-related mild TBI  

Maldjian, J.  
University of Texas Southwestern  
Dallas, TX

16B-3

1:15PM - 2:45PM  
Radiology Findings in Military TBI Using Advanced MR Imaging  

Riedy, G.  
The National Intrepid Center of Excellence  
Arlington, VA

Wednesday  
1:15PM - 2:45PM  
Washington Marriott Wardman Park, Washington 1/2/3

16C-ASFNR Programming: Cutting Edge Functional Imaging in Neurodegenerative Disorders: New Concepts  
16C-1

1:15PM - 1:35PM  
Advanced Translational Approach to Functional Connectivity MRI in Neurodegenerative Disorders
16C-2

Functional MR in Alzheimers Disease

Petrella, J.
Duke University Medical Center
Durham, NC

16C-3

Models of Graph Spread Can Predict the Spatio-Temporal Distribution of Neurodegenerative Disorders

Raj, A.
Weill Cornell Medical College, Cornell University
New York, NY

16C-4

Metabolic Connectivity Pathways in Neurodegenerative Disease

Eidelberg, D.
The Feinstein Institute for Medical Research
Manhasset, NY

16C-5

Discussion
Purpose
Spontaneous intracranial hypotension (SIH) secondary to spinal cerebrospinal fluid (CSF) leaks causes significant neurological morbidity. While nontargeted lumbar epidural blood patch (EBP) can be an effective treatment for many, precise diagnostic localization of the CSF leak site and targeted treatment often is required in patients that fail EBP. The purpose of this study is to describe novel interventional neuroradiology techniques in the treatment of challenging spinal CSF leak cases, including working closely with neurosurgery to achieve cure through the least invasive approach. Specifically, we describe the use of pre-operative and intra-operative CT myelography to localize the leak and also targeted ventral epidural blood patch for ventrally located leaks.

Materials and Methods
Herein, we report a case series of eight patients undergoing diagnosis and subsequent treatment of spontaneous intracranial hypotension (SIH) secondary to spinal CSF leak. Each patient's clinical course through diagnosis and various treatment modalities is reported, as is the outcome for each patient. The novel techniques of ventral epidural blood patch (VEBP) and intra-operative CT myelography also are presented.

Results
We identified eight patients (mean age 37 years) diagnosed with spontaneous intracranial hypotension secondary to spinal CSF leak with diagnostic imaging. Localization of the leak site in our series was cervical in one case, thoracic in seven, with multiple sites in three. Utilizing a multidisciplinary approach to treatment, five cases underwent autologous blood patch, including two ventral epidural blood patches. During VEPB, iodinated contrast material was added to the autologous blood to delineate the extent of the autologous blood patch postinjection. Three of five...
patients undergoing blood patch had resolution of symptoms not requiring further interventions. Three patients underwent neurosurgical intervention from a posterior approach. Intra-operative myelography was performed in two of these three cases. Reasons for patients undergoing surgical treatment included post-traumatic etiology of leak or failure of conservative management. Seven of eight patients reported a good outcome (resolution or significant improvement of symptoms) at a mean follow up of 8 months. Complications of treatment included development of hydrocephalus requiring shunting in one patient and possible concomitant skull base CSF leak in another patient.

Conclusions
In addition to the critical diagnostic role of identifying and localizing a spinal CSF leak, the neuroradiologist has an integral role in the treatment of spinal CSF leaks, as many patients may be treated successfully in the Interventional Suite alone. Our series demonstrates that VEBP appears to be an effective intervention for ventrally located leaks which are challenging to reach through open neurosurgical approaches. Also, intra-operative CT myelogram may be invaluable in cases requiring open neurosurgical leak repair. While SIH remains a diagnostic and therapeutic challenge, our series illustrates novel interventional neuroradiology techniques to supplement a multidisciplinary approach.
Figure 1. CT myelogram demonstrating a calcified disk/osteophyte complex at C5 ventral to the dural sac, consistent with a dural tear/CSF leak at C5-6.
Figure 2. Contiguous axial CT images during injection of contrast confirming epidural needle tip, within the ventral fluid collection.
Figure 3. CT myelogram demonstrating a collection ventral to the dural sac, consistent with an intervertebral disc tear/CSF leak at T8-9. At surgery, this was found to be due to the T8-T9 disc herniation.
Evaluation of the Intraforaminal Location of Prominent Anterior Radiculomedullary Arteries Using Flat Panel Catheter Angiotomography.

L Gregg¹, P Gailloud¹, D Sorte²
¹Johns Hopkins University School of Medicine, Baltimore, MD, ²University of New Mexico, Albuquerque, NM

Purpose
Flat-panel catheter angiotomography (FPCA) acquired during the selective injection of intersegmental arteries (ISA) has enabled multiplanar visualization of anterior spinal artery (ASA) contributors within the neural foramen. Unwarranted injection and/or injury of ASA contributors during transforaminal epidural steroid injections (TFESI), can result in spinal cord damage (1). Prior evaluations of the intraforaminal...
location of these arteries have been limited to either the anteroposterior view (2) or to examination of cadaveric material (3, 4). The purpose of this study was to document the in vivo intraforaminal location of prominent thoracolumbar anterior radiculomedullary arteries using FPCA acquisitions.

Materials and Methods
Ninety-four FPCA acquisitions obtained during the selective injection of ISAs providing an anterior radiculomedullary artery were reviewed. Measurements were obtained in a sagittal view (Figs. 1 and 2) and converted into a scatter plot visualization (Fig. 3). Patients' age, gender, site of injection, and level of injection were recorded.

Results
The intraforaminal location of the ASA contributors could be ascertained in 78 of the 94 FPCA acquisitions (33 women and 45 men, with ages ranging between 22 and 82). Fifty-three (68%) acquisitions were on the left and 25 (32%) on the right, at vertebral levels extending from T2 to L3. The anterior radiculomedullary arteries were found in the anterosuperior quadrant of the neural foramen in 76 (97%) cases (Fig. 3, Q4) and in the posterosuperior quadrant in two (3%) cases (Fig. 3, Q1). No contributors were located in the inferior quadrants. No differences in location were observed with age, gender, site of injection, or vertebral level.

Conclusions
Anterior radiculomedullary arteries were found in the superior half of the neural foramen (100%), particularly in its anterosuperior quadrant (97%). Avoiding needle placement in these areas can reduce the likelihood of injury to the spinal arterial system during TFESI. Figure 1. FPCA, left L1 ISA injection, sagittal reconstruction, documenting the location of an anterior radiculomedullary artery within the neural foramen (white arrow). Figure 2. Illustration of measurements and quadrants corresponding to Figure 1. The neural foramen height (B to B’) was defined as the long axis from the posterior edge of the vertebral pedicle to the superior edge of the pedicle below. The neural foramen was divided into quadrants (Q1-4) by measuring the width (C to C’) at the midpoint of the height. ASA contributor location was evaluated by measuring the distance from the center of the artery to the superior (D) and anterior (E) wall of the neural foramen and the vertical (F) and horizontal (G) distance to the quadrant divisions. A = anterior, P = posterior, S = superior, I = inferior. Figure 3. Scatter plot of measurements in millimeters. Zero values for the x and y-axis represent the approximate center of the neural foramina (n = 78).
C1-2 Puncture: Prevalence of High-Risk Vascular Variants

W Gibbs¹, A Rajamohan¹, M Law¹
¹University of Southern California, Keck School of Medicine, Los Angeles, CA

Purpose
Lateral C1-2 puncture for collection of cerebrospinal fluid or injection of myelographic contrast or chemotherapy is perceived to be more dangerous and difficult to perform than lumbar puncture. Computed tomography (CT) guidance diminishes the risk of cord puncture, but injury to an anomalous origin or low-lying loop of the posterior inferior cerebellar artery (PICA) or a variant vertebral artery course overlying the posterior third of the spinal canal remains a concern. The purpose of this study was to investigate the prevalence of these variants on CT angiography in order to assess the risk of vascular injury in lateral C1-2 puncture.

Materials and Methods
Three hundred ten consecutive CT angiography studies were evaluated. Characteristics that would contraindicate C1-2 puncture (elevated intracranial pressure, Chiari malformation, craniocervical mass or stenosis) prompted exclusion. In each subject the inferior extent of the PICAs (or AICA-PICA loop) and the PICA origins were characterized as intracranial, below the foramen magnum but above the inferior margin of C1, or below C1. The location of the vertebral artery at the C1-2 level was characterized as anterior to the canal, overlying the anterior 2/3 of the canal, or overlying the posterior 1/3 of the canal.

Results
Three hundred three patients met criteria. In eight patients (2.6%) a PICA originated below the foramen magnum but above C1. No patients had a PICA origin at or below C1. In 34 patients, 38 PICAs (11.2%) extended below the foramen magnum but remained above the inferior C1 margin. The PICA did not extend below C1 in any patient. No patients had vertebral arteries overlying the posterior third of the canal at the C1-2 level.

Conclusions
The most feared complication of C1-2 puncture is injury to the PICA or vertebral artery. In this study no variants were found that would put these patients at risk of vascular injury in a properly performed lateral C1-2 puncture.
O-330

1:24PM - 1:27PM

Percutaneous CT Guided Laminotomy and Fenestration for Treatment of Symptomatic Lumbar Synovial Cysts.

A Bress¹, B Pukenas²
¹University of Pennsylvania, Philadelphia, PA, ²Hospital Of the Univ. Of Pennsylvania, Philadelphia, PA

Purpose
To report on the effectiveness and need for subsequent surgery on in patients treated with a novel technique – computed tomography (CT)-guided percutaneous laminotomy and synovial cyst fenestration.

Materials and Methods
This retrospective study was conducted on patients from December 2011 to November 2015. Electronic medical record and PACS were reviewed. Patient demographics, symptoms, location, short-term results (within 1 week of treatment),
long-term results (up to 2 years), and surgical treatment were recorded. All patients had monitored anesthesia and procedures were performed utilizing CT fluoroscopy. Direct injection of 1-3 cc of diluted Isovue M200 contrast was injected into the facet joint in order to visualize cyst. Then a manual (Bonopty) or mechanical (On-Control) bone drill was used to create a laminotomy in order to directly fenestrate the cyst. Next, the cyst was ruptured by injecting contrast until seen in the epidural space. Then 1-2 ml of 1% lidocaine and 2 ml dexamethasone (10mg/cc) was injected.

Results
A total of 38 patients were included in our study. Immediate follow up was not documented in four patients and five patients had no documented long-term follow up. All cysts were fenestrated successfully and there were no complications from the procedure. Ages ranged from 42-82 years old with mean of 63.4 and median of 64. There were 19 males and 19 females. The levels treated were L3-4 (7 patients), L4-5 (28 patients), and L5-S1 (three patients). Immediately postprocedure 29/38 (76.3%) significantly improved. A total of 14/38 (36.8%) patients had some or complete recurrence of symptoms. Surgery was performed in 9/38 (23.7%) patients. There were four patients who had a repeat procedure and only one of them eventually went to surgery while the other three improved.

Conclusions
Percutaneous CT guided laminotomy and synovial cyst fenestration is a minimally invasive, safe, and effective treatment that eliminated the need for surgery in 76% of our patients.
Left L3-4 Synovial Cyst Fenestration

Pre-treatment axial T2 MRI

22g Spinal Needle with injection outlining the cyst

11g On-Control Laminotomy Needle into the cyst

Post injection through Laminotomy Needle flows along left nerve root and dural sheath fenestration.

(Filename: TCT_O-330_Fenestration_Images.gif)

O-331

Cervical Percutaneous Vertebroplasty: 13 years' Experience in a Single Center

F Clarençon¹, E Cormier¹, R Fahed¹, L Mollet-Benhamou¹, V Degos¹, J Chiras¹

¹Pitié-Salpêtrière Hospital, Paris, France
Purpose
To present our experience in cervical percutaneous vertebroplasty (cPVP).

Materials and Methods
From January 2001 to October 2014, 141 cPVP procedures (170 vertebrae) were performed in 134 consecutive patients (91 females, 43 males; mean age = 56 years). Among the treated lesions, 76.1% were bone metastases (mostly from breast cancer), 9% were related to a hemopathy and 14.9% were nonmalignant lesions (hemangiomas, aneurysmal bone cyst, ...). Procedure-related complications (minor and major) were recorded systematically. Effectiveness in terms of analgesia was evaluated using a semi-quantitative grading scale at 1-month follow up.

Results
One fatal complication was reported due to cement migration in the vertebrobasilar system. Three cervical hematomas were recorded, one having required a prolonged oral intubation. One case of vertebral artery spasm was observed, without any clinical consequence. At 1 month, pain reduction was observed in more than 80% of the cases.

Conclusions
Cervical percutaneous vertebroplasty is a safe technique with an acceptable major complication rate. Its effectiveness in terms of analgesia is good at midterm follow up.

Effect of Systemic Therapies on Outcomes Following Vertebroplasty Among Patients with Multiple Myeloma

J McDonald¹, R McDonald¹, D Kallmes¹, V Lehman¹, F Diehn¹, J Wald¹, K Thielen¹, P Luetmer¹
¹Mayo Clinic, Rochester, MN

Purpose
Published clinical evidence in support of vertebral augmentation of pathologic fractures in the myeloma population remains limited. With this study we seek to better define the effectiveness of vertebroplasty for myeloma associated fractures and determine if outcomes and complications are dependent upon procedure timing relative to initiation of systemic therapy.

Materials and Methods
In this single center retrospective study, we retrieved demographic and clinical data on 172 multiple myeloma patients treated with vertebroplasty since October 2000. Laboratory and medication data were retrieved to determine the extent of myeloma and presence of systemic therapy at the time of vertebroplasty. Quantitative outcome data including the Roland Morris Disability Questionnaire (RDQ) and numerical
rating scale (NRS) for pain and qualitative outcome data (self-reported pain, mobility, narcotic use) were collected pre-operatively, immediately postoperatively and at 1 week, 1 month, 6 months, and 1 year following treatment. Peri- and postoperative complications also were collected.

Results
Significant improvements in all outcome measures were observed postoperatively and throughout the duration of follow up. Significant median improvements in RDQ (0-23), and analogue pain scale (0-10) rest and activity of 15, two, and six points respectively (p < .0001) persisted at 1 year without significant change from immediate postoperative scores (p > .36). Patients on systemic therapy for myeloma at time of procedure were more likely to achieve responded status when compared to patients not on systemic therapy, with no difference in complication rates between groups.

Conclusions
Vertebroplasty is an effective therapy for myeloma patients with symptomatic compression fractures. Favorable outcomes more likely are to be achieved when spinal augmentation is performed after systemic therapy is initiated. Complication rates are not affected by timing of systemic therapy.

O-333
1:33PM - 1:36PM
Vertebral Augmentation for Myeloma-Related Spinal Fractures: A 2002-2012 Population-Based SEER-Medicare Study

F Chokshi1, D Howard2, R Duszak1, J Jarvik3
1Emory University School of Medicine, Atlanta, GA, 2Emory Rollins School of Public Health, Atlanta, GA, 3Univ of Washington School of Medicine, Seattle, WA

Purpose
To evaluate trends in the use of vertebral augmentation (VA) among Medicare beneficiaries with myeloma-related spinal fractures.

Materials and Methods
Using the SEER-Medicare database [Medicare claims linked with Surveillance, Epidemiology and End Results (SEER) tumor registry records] (1), we identified myeloma patients age 65 and older who had a pathological fracture between 2002 and 2012. From claims, we identified those undergoing VA. We used logistic regression to estimate the impact of patient age, gender, race, education and poverty level (both by ZIP code), comorbidity count, and year of fracture on the receipt of VA.

Results
Of 25,516 myeloma patients, 4,725 had pathological spinal fractures; of these, 653 (13.8%) underwent VA. Similar to studies of osteoporotic fractures (2, 3), procedure volume increased from 2002-2007 and plateaued in 2008-2011. Patients who had a
spinal fracture before a myeloma diagnosis (959; 20.3%) were more likely to undergo VA than patients who had a spinal fracture after their myeloma diagnosis (3,766; 79.7%). Use of VA was 7.6 percentage points lower among black patients (p<0.0001), but other socioeconomic variables had little or no effect on the receipt of VA. Patients with less comorbidity were more likely to undergo VA (p=0.003).

Conclusions
1. National trends in VA in myeloma patients follow trends in its use in patients with osteoporotic fractures. Practitioners may be applying results of two RCTs focused on osteoporotic fractures (2, 3) to patients with myeloma. 2. Patients experiencing a fracture before an established myeloma diagnosis may be being treated as those having osteoporotic fractures. 3. Black patients may have less access to vertebral augmentation compared to Caucasians. 4. Interventionalists and surgeons may be selecting healthier patients for performing vertebral augmentation.
Figure 1: Trends in Use of Vertebral Augmentation in Myeloma Spinal Fractures

SOURCE: Authors' analysis of SEER-Medicare.

Figure 2: Subgroup Trends in the Use of Vertebral Augmentation in Myeloma Spinal Fractures

SOURCE: Authors' analysis of SEER-Medicare.
Detection of Stellate Ganglion and Thoracic Sympathetic Chain Ganglia on Noncontrast CISS MRI

A Chaudhry¹, A Kamali², A Blitz³
¹Johns Hopkins Medicine, Elkridge, MD, ²Johns Hopkins University Hospital, Baltimore, MD, ³Johns Hopkins, Baltimore, MD

Purpose
Three-dimensional constructive interference in steady state (3D-CISS) refocused-gradient-echo magnetic resonance imaging (MRI) sequence is a high spatial resolution imaging technique. The technique generates images using the ratio of T2 relaxation time: T1 relaxation time, generating what appears to be heavily T2-weighted images (3). Currently, this technique is being used widely to evaluate small intracranial structures most notably the cranial nerves and spinal nerve roots. In our experience, we found that 3D-CISS provided comprehensive in vivo evaluation of the sympathetic chain ganglion. In this retrospective study, we aim to evaluate the normal anatomy of the stellate ganglion as well as thoracic sympathetic chain ganglia and assess the detectability of each of the thoracic sympathetic chain ganglion (SCG) on precontrast CISS images.

Materials and Methods
In this IRB-approved HIPPA compliant study, 300 normal thoracic sympathetic chain ganglion were evaluated in 25 patients. The detectability of the sympathetic chain ganglion was evaluated using precontrast-enhanced 3D-CISS MR imaging. Confirmation of stellate and SCG was made ensuring connection of the ganglia with spinal nerves and interconnection within the SCG chain. Measures of central tendency were performed as well as t-test were performed for statistical analysis. Additionally, kappa test was performed to evaluate for inter-rater reliability.

Results
In our cohort of 13 males and 12 females (mean age 45 years), stellate ganglion and thoracic chain ganglia were identified successfully in all patients except at T10-T11 and T11-T12 level. Precontrast CISS demonstrated stellate ganglia to be isointense relative to gray matter noted in the spinal cord. Stellate ganglion was found inferomedial to the subclavian artery inferior to the transverse process of C7 in all patients. Thoracic SCG were identified ventral to the costovertebral junction. There is strong interobserver agreement with Kappa-value > 0.80. Mean size of stellate ganglia was 35.75 mm² while thoracic SCG ranged from 6.5 mm² to 17.4 mm².
Conclusions
Thoracic sympathetic chain ganglia can be seen readily and well characterized on precontrast 3D-CISS MRI. This technique can aid in initial evaluation of potential stellate and/or SCG pathology as well allow for post-treatment follow up.
A comparison of contrast-enhanced portal venous phase CT vs MRI in the assessment of lumbar spinal canal stenosis

R Kavanagh¹, A Carroll¹, R Killeen¹, E Heffernan¹
¹St. Vincent's University Hospital, Dublin 4, Ireland

Purpose
Magnetic resonance imaging (MRI) is the gold standard imaging modality for lumbar spinal canal assessment. However, in certain patients, MRI is contraindicated and an alternative imaging modality is required. The usual next option for assessment is formal or computed tomography (CT) myelography, which have been shown to be
highly sensitive and specific for the diagnosis of lumbar spinal stenosis (1); however, myelography requires a lumbar puncture and injection of contrast into the subarachnoid space and reported complications from this procedure, although uncommon, include headache, infection, bleeding, adverse contrast reaction and seizures (2). We postulate that with the high spatial and contrast resolution of modern CT scanners, IV contrast-enhanced CT alone may be useful in the assessment of lumbar spinal stenosis and the aim of this study was to assess if portal venous phase CT is accurate in assessing the lumbar spinal canal as compared to MRI as the gold standard.

Materials and Methods
Sample size calculation gave a result of n=202 for the detection of a 10% difference in the measurements with 90% power at a significance level of 0.05. A total of 202 lumbar spinal levels were assessed in 60 consecutive patients who underwent contrast-enhanced portal venous phase CT scanning and MRI of the lumbar spine within 28 days of each other. The mean time between scans was 6.6 days. The cross-sectional area of the thecal sac was measured on equivalent slices at the level of the intervertebral disks on the axial/oblique axial images from the CT and T2-weighted MRI sequence and the results were compared. Student's t-test was used to assess difference of means, correlation coefficient was calculated and the Bland-Altman method was used to assess the agreement between the two modalities (3).

Results
The mean thecal sac area on MRI was found to be 1.77cm^2 and on CT was found to be 1.79cm^2, with p=0.30 indicating no significant difference between these measurements. A scatter plot demonstrates good correlation between the measurements with a correlation coefficient of 0.94. Bland-Altman plot also demonstrates good agreement between the measurements with 95% of the CT measurements lying within +/- 0.4cm^2 of the MRI measurements. Previous research has defined lumbar spinal canal stenosis as a thecal sac area <1cm^2 (4); using this figure our results show contrast-enhanced portal venous phase CT has a sensitivity of 75% and specificity of 99% in the diagnosis of lumbar spinal stenosis with a positive predictive value of 94% and negative predictive value of 97%.

Conclusions
Contrast-enhanced portal venous phase CT is a reliable modality in the assessment of lumbar spinal canal stenosis.
O-336

1:42PM - 1:45PM

Cranio-Spinal CSF Redistribution Following Lumbar Puncture in Patients with Idiopathic Intracranial Hypertension

N Alperin¹, A Bagci¹, B Lam¹, S Lee¹

¹University of Miami, Miami, FL
Purpose
The physiologic effect of lumbar puncture (LP) in idiopathic intracranial hypertension (IIH) has not been studied adequately and automated quantitation of cerebrospinal fluid (CSF) volumes in the entire cranio-spinal system by magnetic resonance imaging (MRI) is lacking. We characterized the physiologic effect of LP by determining the change of cranio-spinal CSF distribution before and after LP. To achieve this aim, we developed a new automated method for delineating spinal CSF spaces.

Materials and Methods
The study subjects consists of eight young overweight women with newly diagnosed untreated IIH (Age 29±5.9 years, BMI 34±6.7). Research cranio-spinal MRIs were performed immediately before and immediately after the diagnostic LP to establish IIH (opening pressure 33±9.1 cm water). Magnetic resonance imaging included T1W MPRAGE and T2W SPACE sequences of the brain and two separate T2W SPACE sequences covering the upper and lower portions of the spinal canal. Ventricular and cranial CSF volumes were quantified using FreeSurfer and SPM software packages, respectively. The segmentation of the spinal CSF spaces was achieved using an iterative approach to overcome the effect of potential image nonuniformity associated with imaging of a large field of view. The automated segmentation approach made use of a 2D-matched filter to detect the size and position of the cord and an active contour algorithm. Cranio-spinal CSF volumes prior and following LP were compared to the amount of CSF withdrawn.

Results
The enclosed Figure is an example of the merged MRI image of the entire CNS CSF with the superimposed segmented cranial and spinal CSF spaces. The reduction of the CSF volume following CSF withdrawal by LP was predominantly from the spinal canal and was localized near the region of the LP. Cranial CSF volume was nearly unchanged. Spinal CSF and cord volumetric automated measurements were highly reproducible with mean variability of less than 1%, -0.7±1.4%, -0.7±1.0%, respectively. The pre-to-post CSF withdrawal differences in the cranio-spinal CSF volumes were consistently smaller and strongly correlated with the CSF amounts removed (R=0.86, p=0.006). The smaller measured pre-to-post LP CSF differences compared to the CSF amount withdrawn can be accounted for by assuming a net CSF formation of 0.41±0.18ml/min.

Conclusions
An automated method for delineation of the spinal CSF spaces has been developed and applied to study the effect of lumbar CSF withdrawal on the cranio-spinal CSF redistribution in IIH. The study reveals that the drop in the opening pressure following CSF withdrawal is primarily related to an increase in the spinal canal compliance caused by reduction in spinal CSF volume localized to the lumbar region. The study demonstrates the central role of the spinal compartment in ICP regulation and the
automated method developed will permit future longitudinal studies to assess cranio-spinal CSF volumetry to further elucidate the pathophysiology of IIH and other CSF-related diseases.
Influence of Normative Data on Diffusion Tensor Imaging Metric Comparisons in Cervical Spondylotic Myelopathy

K Wang\(^1\), O Idowu\(^2\), I Izbudak\(^2\)
\(^1\)Johns Hopkins School of Medicine, Baltimore, MD, \(^2\)Johns Hopkins University, Baltimore, MD

Purpose
The use of diffusion tensor imaging (DTI) in evaluating cervical spondylotic myelopathy (CSM) is limited by the lack of standardized methods for data acquisition and postprocessing analysis. For example, when comparing DTI metrics of patients with CSM to those of controls, studies differ in the vertebral segments chosen for designated control groups. For instance, disk levels utilized as control groups have included C2-C3, C2-C5, C5-C6, and C4-C7 in healthy volunteers, and nonstenotic levels (e.g., C2-C3) in CSM patients. It is uncertain to what extent such variation affects interpretation of DTI metrics. In this study, we aim to use receiver operating characteristic (ROC) curves to characterize the influence of the intervertebral disk levels chosen as controls on DTI metrics' ability to discriminate between patients with CSM and controls.

Materials and Methods
Magnetic resonance (MR) imaging of the cervical spinal cord was performed in eight CSM patients and in five healthy volunteers on a 3T MR scanner. For each patient, fractional anisotropy (FA) and mean diffusivity (MD) were measured at the level of maximal stenosis and regions of interests (ROIs) were placed to approximate the lateral white matter, posterior white matter, and anterior gray matter. Fractional anisotropy and MD also were measured in larger ROIs that provided near-entire interrogation of the sagittal cord and hemi-axial cord. For each control, similar ROIs were placed at intervertebral disk levels as utilized in prior studies (ex. C2-C3, C2-C5, C2-C6). Receiver operating characteristics analysis was used to assess the discriminatory ability of FA and MD when utilizing different disk levels as control groups. Differences in areas under the curve across the controls groups were considered statistically significant if \( p < 0.05 \).

Results
The highest area under the curve (AUC) in MD was 0.80 when analyzing the hemi-axial cord region and utilizing level C4-C7 in healthy volunteers as a control. There were statistically significant differences in the area under the curve when analyzing the MD measure in the hemi-axial cord across the control groups with varying chosen
intervertebral disk segments (p=0.040). No significant differences in AUC among the control groups were noted for MD or FA when analyzing other regions of the spinal cord, including posterior white matter, lateral white matter, and anterior gray matter.

Conclusions
There may be significant differences in discriminatory power depending on which region of interest of the cord is analyzed. Consistent with a prior study (1), highest AUCs were demonstrated with MD, suggesting diagnostic utility of MD may be superior to that of FA. There also may be significant differences in discriminatory power depending on the intervertebral segments chosen as controls, as suggested by the significant differences in AUC when analyzing the MD measure in the hemi-axial cord across the different control groups. Being mindful of the influence of using differing disk levels in designating controls groups, which have been highly variably in prior studies, may allow for more accurate interpretation DTI data in the evaluation of CSM.

O-338
1:48PM - 1:51PM

Better Look Twice: Incidental Findings in the Extra-Spinal Soft Tissues on Outpatient Thoracic Spine MRI

S Sogge1, K Diehl1, T Ouyang1, C Jamis-Dow1, D Nguyen1
1Penn State Hershey Medical Center, Hershey, PA

Purpose
An incidental finding is defined as an asymptomatic lesion found on an imaging exam performed for an unrelated reason. These findings are occasionally more clinically significant than the original reason for the examination. The purpose of this research was to examine the prevalence of both clinically and nonclinically relevant extra-spinal incidental findings in patients that undergo magnetic resonance imaging (MRI) of the thoracic spine and evaluate the rate of undetected findings in radiology reports.

Materials and Methods
The study was approved by our Institutional Review Board and was HIPAA complaint. Our PACS (GE Centricity Radiology Information System) was searched for thoracic spine MRI exams without contrast performed between July 1 2012 and June 30 2013. Only adult patients between the ages of 18 and 99 years of age were included. Patients with known malignancy were excluded to avoid over detection of extra-spinal malignancy. Three board certified radiologists reviewed 187 MRIs. Extra-spinal abnormalities were classified according to a modified CT colonography Reporting and Data System (C-RADS). Incidental findings were categorized using C-RADS criteria reported elsewhere: E0 - exam compromised by artifact, examination severely limited. E1 - Normal exam or anatomical variant. E2 – clinically unimportant
finding without work up indicated. E3 – likely unimportant finding that is incompletely characterized. E4 – potentially important finding, communicate to referring physician as per local practice guidelines.

Results
Overall, 48.6% (91 of 187) of patients had ESFs. There were a total of 139 incidental ESFs, with some patients having more than one ESF. Among studies with more than one ESF, the findings may fit into more than one C-RADS category. 50.2% (94 of 187 scans) had no discernible extra-spinal findings (E1). Two patients with incidental normal variants also were classified into the E1 category. These were retro-aortic left renal vein and aberrant right subclavian artery. Of the 48.6% of patients with ESFs, 11.7% had clinically significant abnormalities, a large portion (75%) of which was not reported originally. Figure A: Heavily weighted T2 myelogram sequence showing sample E3 findings including large bilateral glenohumeral joint effusions (white arrows) along with large hiatal hernia (open white arrow). Also seen are renal (white arrowhead) and hepatic simple cysts (red arrow) which are E2 findings. Figure B: Left paraspinal mass, a sample E4 finding.

Conclusions
Incidental extra-spinal findings are common on thoracic MRI and can be overlooked easily. Our findings are similar to studies in the lumbar spine including a high nondetection rate of potentially clinically significant incidental findings. A mental checklist or structured reporting system may help to identify more of these findings. Consensus for further recommendation and work up of the potentially significant incidental findings are not available universally, but communication with the referring services and a multidisciplinary approach could improve patient care by aiding early diagnosis.
<table>
<thead>
<tr>
<th>Type of E3 finding</th>
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<tbody>
<tr>
<td>Sub-centimeter thyroid nodules</td>
<td>3</td>
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<tr>
<td>Complicated liver cyst</td>
<td>5</td>
</tr>
<tr>
<td>Simple pleural effusion</td>
<td>8</td>
</tr>
<tr>
<td>Complicated renal cyst with well-defined borders and no solid component</td>
<td>5</td>
</tr>
<tr>
<td>Dilated bile ducts</td>
<td>3</td>
</tr>
<tr>
<td>Splenomegaly</td>
<td>2</td>
</tr>
<tr>
<td>Renal atrophy</td>
<td>1</td>
</tr>
<tr>
<td>Dilated esophagus</td>
<td>2</td>
</tr>
<tr>
<td>Hiatal hernia</td>
<td>5</td>
</tr>
<tr>
<td>Para-costal cystic lesion</td>
<td>1</td>
</tr>
<tr>
<td>Patchy airspace disease</td>
<td>3</td>
</tr>
<tr>
<td>Enlarged central pulmonary arteries</td>
<td>1</td>
</tr>
<tr>
<td>Mediastinal cyst</td>
<td>1</td>
</tr>
<tr>
<td>Ectatic (but non-aneursymal) thoracic aorta</td>
<td>1</td>
</tr>
<tr>
<td>Prominent bowel loop</td>
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<tr>
<td>Para-spinal muscle atrophy</td>
<td>1</td>
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<tr>
<td>Shoulder/bursal effusion</td>
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</table>

<table>
<thead>
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<th>Type of E4 finding</th>
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<tr>
<td>Adrenal nodule &gt; 1 cm</td>
<td>5</td>
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<tr>
<td>Thyroid nodule &gt; 1 cm</td>
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<tr>
<td>Chest wall mass (NSCLC)</td>
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<tr>
<td>Lung nodule &gt; 5 mm</td>
<td>7</td>
</tr>
<tr>
<td>Mediastinal lymphadenopathy</td>
<td>2</td>
</tr>
<tr>
<td>Loculated pleural effusion</td>
<td>1</td>
</tr>
</tbody>
</table>
The Clivoaxial Angle Measured on High-Resolution T2-Weighted MR Images in Normal Adult Volunteers with both Flexion and Extension

E Munoz¹, F Berkowitz², A Sayah³
¹Georgetown, Washington, DC, ²Georgetown University Hospital, Washington, DC, ³Medstar Georgetown University Hospital, Washington, DC

Purpose
The clivo-axial angle currently is used by spine surgeons to predict potential benefit of occipitocervical fusion, and need for surgical correction of clivo-axial deformities. Normal clivo-axial angles range from 150 degrees to 180 degrees in a neutral position. Recent literature demonstrates that the clivo-axial angle is affected by patient positioning at time of imaging. The purpose of this study is to determine a range of normal values for the clivo-axial angle using high-resolution magnetic resonance (MR) imaging of healthy adults during neck flexion and extension.

Materials and Methods
High-resolution T2-weighted MR images of the cervical spine in 10 adult volunteers were reviewed. Inclusion criteria included ages 18 and older. Exclusion criteria included a history of cervical spine injury, prior cervical spine surgery, neck pain, and degenerative spondylosis. The clivo-axial angle was measured as the angle subtended by a line drawn along the dorsal surface of the clivus and a second line drawn along the dorsal surface of the odontoid process. The clivo-axial angle was measured on midline sagittal images in the following neck positions: supine extension, supine flexion, prone extension, and prone flexion.

Results
The mean clivo-axial angle (in degrees) was as follows: 160.0 for supine extension, 140.0 for supine flexion, 166.8 for prone extension, 139.6 for prone flexion, 139.8 for all flexion, and 163.4 for all extension. The minimum clivo-axial angle recorded was 124.0 (n=40). The maximum clivo-axial angle recorded was 178.6 (n=40).

Conclusions
Anthropometric data of normal adult volunteers reveal a clivo-axial angle range from 124.0 to 178.6 degrees, with angles less in neck flexion than in extension, irrespective of spine or prone positioning. These values likely will be helpful for the surgeon deciding on potential occipitocervical fusions, and may be applicable to general brain MR and CT imaging.
Diffusion Tensor Microscopy of Human Intervertebral Disc-interrogation of mechanics and structure relationships in complete human discs

R Alkalay¹, D Hackney²
¹Beth Israel Deaconess medical Center, Boston, MA, ²Beth Israel Deaconess Medical Center, Boston, MA

Purpose
This study investigated the association between structural parameters computed from diffusion tensor magnetic resonance (MR) images (DTI) of intact human disks and the
viscoelastic response of the disks to a loading condition simulating standing (700N) posture.

Materials and Methods
Six lumbar L2-L3 disks from human donors age 49-70 years were imaged (9.4T BioSpec 4.7T, Bruker BioSpin Inc., MA) using 72mm coil (Bruker BioSpin) with the disk's transverse (TR) and caudal-cranial (C-C) axes aligned with the imager Z, X-Y axes. 3D spin-echo echo-planar (SE-EPI) diffusion tensor image data were acquired using 30 noncollinear directions with 2 averaged b0 images, b value: 670 s/mm², (TE/TR: 29/700) ms, NEX = 2, FOV: (56 x 50 x 16) mm, matrix: (500 x 500 x 16), reconstructed resolution: (500 x 500 x 1000)µm. The disk was segmented (3Dslicer 4.1, www.slicer.org) and tensor data computed from the diffusion-weighted images. Diffusion tensor imaging parameters computed were mean diffusivity (MD), eigenvalues, (\( \lambda_1, \lambda_2, \lambda_3 \)), axial (\( \lambda_1 = \lambda_1 \)) and radial diffusivity (\( \lambda_t = (\lambda_2 + \lambda_3)/2 \)), fractional anisotropy (FA) and anisotropy projected with respect to the axial (RIAMax-E(Z)) and radial (RIAMax-E (X)) component of \( \lambda_1 \). General linear models (JMP 8.0, SAS, NC) tested for association of MR parameters with degenerative grade.

Results
The disk’s instantaneous (E1) and long term (E2) stiffness were positively associated with the following annular parameters, magnitude of radial (E: p<0.01, E2: p<0.001), \( \lambda_1 \) (E: p<0.001, E2: p<0.001), \( \lambda_t \) (E: p<0.01, E2: p<0.01), RIAMax-E(Z) (E: p<0.05, E2: p<0.01), RIAMax-E (X) (E: p<0.001, E2: p<0.0001) diffusivity and TR (E: p<0.01, E2: p<0.001). The viscous damping (\( \eta_1 \)) was positively associated with the magnitude of radial diffusivity (p<0.01) and RIAMax-E (X) (p<0.01) and negatively associated with magnitude of radial (p<0.05) diffusivity.

Conclusions
Magnetic resonance DTI parameters can predict disk mechanical performance. This information should functional derangements the spine due to degenerative disk disease and may assist in analyzing back pain and the expected natural history of this disease.

O-341

Can STIR “Claw Sign” Differentiate Infectious and Degenerative Intervertebral Disc Space Disease?

S Shrot1, A Sayah2, F Berkowitz3
1Medstar Georgetown University Hospital, Washington, DC, 2Medstar Georgetown University Hospital, Washington, DC, 3Georgetown University Hospital, Washington, DC
Purpose
Recently, the diffusion-weighted "claw sign" was proposed to discriminate between infection and degenerative changes involving the intervertebral space. Our hypothesis was that the "claw sign" was caused by Modic I changes at the interface between normal marrow and Modic III changes. If this is the case, then the "claw sign" also should be visible on STIR images. Our purpose was to test if the STIR "claw sign" can be used to differentiate between infection and degenerative disease in cases where imaging is suspicious for diskitis.

Materials and Methods
Seventy-two consecutive patients with imaging features of suspicious or probable diskitis (T2 hyperintense signal within the intervertebral disk) and available clinical follow up were reviewed blindly for appearance of vertebra marrow edema "claw sign" on sagittal STIR images. A STIR "claw sign" was defined as well marginated, linear, area of hyperintensity situated within the vertebral bodies with an interface of hypointense marrow signal adjacent to the suspicious intervertebral space (Figure: Cervical spine CT (Right) and MRI (Left) showing C6-C7 Modic III changes with STIR "claw sign"). When available, concurrent CT studies were evaluated for Modic III changes. Clinical follow up including blood culture and bone biopsies were used as the standard of reference.

Results
Of our cohort, 47 patients had clinical diagnosis of infectious diskitis. STIR "claw sign" appeared in 11 patients, four with clinical diagnosis of diskitis and seven of noninfectious degenerative endplate changes. Sensitivity and specificity of STIR "claw sign" for diagnosis of noninfectious endplate changes were 63.6% and 70.5%, respectively. The negative predictive value was 91.5%. Eight out of 11 patients with STIR "claw sign" had concurrent CT study demonstrating sclerotic endplates changes.

Conclusions
The STIR "claw sign" is not sufficiently reliable to exclude infection. It often represents Modic I changes (edema) adjacent to Modic III changes (sclerosis). Infection also can cause endplate sclerosis with adjacent edema resulting in the "claw sign".
Cervical MRI vs. CT Myelography: Is That the Anterior Median Fissure or the Central Canal?

V Perez1, E Peak1, L Wang2, T Tomsick1

1University of Cincinnati, Cincinnati, OH, 2University of Cincinnati Medical Center, Cincinnati, OH

Purpose
Hyperintense foci (HIF) and the anterior median fissure (AMF) on axial T2 cervical MR images have been shown to be associated with identification of a T2 hyperintense line simulating a channel on T2 sagittal images. We hypothesize that the HIF may represent the central canal of the spinal cord, or the base of the AMF in some instances. Our aim is to compare the ability of computed tomography myelography (CTM) versus magnetic resonance imaging (MRI) to identify HIF and AMF, and aid
in distinguishing not only the central canal versus AMF, but also sagittal lines as a manifestation of the central canal versus an AMF channel.

Materials and Methods
Cervical MRI and CTM from 34 consecutive patients who underwent both studies from 2012-15 were reviewed retrospectively. The images for each study (3mm T2 fast-spin-echo axial and sagittal MR, 2.5 mm soft-tissue algorithm axial CTM with 3 mm sagittal reconstruction) were reviewed initially separately by a neuroradiologist and a neuroradiology fellow, and then were reviewed jointly and adjudicated for the presence or absence of HIF, AMF, and sagittal lines on MRI and CTM.

Results
Magnetic resonance identified more HIF than AMF/pt. (191 versus 103, ratio 1.85), with sagittal lines in 19/34 (55.9%) patients (Table 1). Lines were associated with HIF and AMF (7.6 versus 3.5 patients, respectively), and none were identified in their absence. Computed tomography myelography demonstrated far fewer total HIF than AMF (16 HIF versus 123 AMF, ratio 0.13), with two short sagittal lines. Fifty of 103 (48.5%) MR AMF demonstrated concordant demonstration of CT AMF at the same patient level. Twenty-eight of 191 (14.7%) MR HIF were associated with CTM AMF at the same level. Of 16 CTM HIF, 15 were continuous with the base of the AMF; only one was an isolated focus unassociated with AMF. Six of 15 were associated with MR AMF as well, and 10 with MR HIF.

Conclusions
Concordant demonstration of MR and CTM AMF was common, confirming reliability in identification of AMF. Magnetic resonance HIF were identified in the absence of identified MR AMF, yet associated with CTM AMF at the same level. The presence of CT AMF associated with MR HIF without MR AMF suggests some AMF may be present in conjunction with MR HIF, but not resolved on MR imaging. Hyperintense foci were uncommonly identified on CTM, and almost exclusively as a continuation of an AMF. These observations are evidence that some MR HIF and MR sagittal lines may represent the base of a CTM-demonstrated AMF, and not the central canal of the spinal cord. While not conclusive, data supports previous observations that MR HIF and AMF may represent portions of the same structure, the AMF, which may appear as a sagittal line or channel in some instances. It is further hypothesized that this sagittal channel may more rarely be wider, and mimic hydromyelia.
Wednesday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Maryland A/B/C

16E-SILAN Programming: Cerebral Venous System: Update in Diagnostic and Novel Treatments

16E-1
1:15PM - 1:20PM

Introduction: What is SILAN?

Diaz, O.
The Methodist Hospital
Bellaire, TX

16E-2
1:20PM - 1:40PM

Diagnosis of Venous Infarct: Where Do We Stand?

Gonzalez, R.
Massachusetts General Hospital
Boston, MA

16E-3
1:40PM - 2:00PM

Venous Sinus Stenting for Endovascular Treatment of Idiopathic Intracranial Hypertension

<table>
<thead>
<tr>
<th>Table 1</th>
<th>CT AMF (n=122)</th>
<th>CT HIF (n=16)</th>
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<td>MR AMF (n=103)</td>
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<td>MR HIF (n=191)</td>
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16E-4
2:00PM - 2:20PM

Endovascular Treatment of Venous Lesions of the Head and Neck

Berenstein, A.
Mount Sinai Hospital
New York, NY

16E-5
2:20PM - 2:40PM

Current State of Endovascular Treatment of Acute Dural Venous Sinus Thrombosis

Delgado, J.
Consulting Radiologists, Ltd
Minneapolis, MN

Wednesday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Roosevelt 4

16F-PARALLEL PAPER SESSION: Pediatric Brain Tumors: Pre- and Post-Treatment
O-343
1:15PM - 1:23PM

Assessment of Brain Tumors in Pediatric Patients with Amide Proton Transfer MRI: Preliminary Experience

J Curran1, A Pokorney1, J Chia2, H Hu1, J Miller1, J Keupp3
1Phoenix Children's Hospital, Phoenix, AZ, 2Philips Healthcare, Cleveland, OH, 3Philips Research Laboratories, Hamburg, Germany

Purpose
The purpose of this study is to evaluate the feasibility and clinical utility of a nongadolinium contrast amide proton transfer (APT) magnetic resonance imaging
(MRI) technique in assessing pediatric brain tumors. Amide proton transfer MRI is particularly sensitive to amide proton groups, which are prevalent in gadolinium contrast positive brain tumors (1-4).

Materials and Methods
This pilot APT study was approved by our institutional review board and conducted on two 3T Philips Ingenia MRI platforms with dual channel RF transmission and 32 channel head coils. To date, we have successfully acquired APT MRI data in 15 pediatric patients and our study is ongoing. In the following presentation, we will particularly focus on four pediatric case examples with positive findings of brain tumors. The patients underwent both APT MRI and standard brain MRI examinations with gadolinium (Dotarem, Guerbet) contrast agent. The first patient was a 9-month-old male with a large lobulated right cerebellar hemisphere and vermian mass. The second patient was a 11-year-old male with two intra-axial masses of metastatic Ewing's sarcoma, one in the right temporal lobe, the other in the right parietal lobe. The third patient was a 4-year-old male with a large solid and cystic mass centered in the hypothalamus, and findings are consistent with a craniopharyngioma. The fourth patient was a 11-year-old male with a malignant neoplasm of the right parietal lobe. Two pediatric neuroradiologists assessed the diagnostic utility of the APT data by comparing it to conventional T1, T2, and postgadolinium images. Regions of interest (ROIs) analysis was performed on the APT-weighted images to quantify the asymmetric magnetization transfer ratio (MTRasym), a recently reported potential biomarker of tumor activity and underlying tissue protein content. Regions of interest were drawn in tumor and adjacent healthy brain tissue for comparison. The APT technique was based on a 3D turbo-spin-echo pulse sequence. The protocol consisted of 9-12 slices of 4.4mm thickness, with a 180-220 mm field-of-view, an in-plane voxel size of 1.8mm, and an approximate TE/TR of 6.2ms/5s. APT scan time was between 4-5 min.

Results
The figure illustrates data from patients #3 (top) and #4 (bottom). Amide proton transfer color maps of the tumor are shown for one slice, although the data acquisition was 3D. The color bar is a scale of the MTRasym metric. Postgadolinium images illustrate tumor enhancement (arrows) in each case. Note the evident signal contrast in the tumor APT signal versus background normal appearing gray and white matter in patient #4. The signal contrast is subtle but still visible in patient #3 (dashed oval). Amide proton transfer tumor signal measures in the 4-6% range, whereas healthy gray matter signal measures in the 1-2% range and healthy white matter shows minimal signal.

Conclusions
Our preliminary experience with nongadolinium contrast APT MRI in pediatric patients suggest promising clinical feasibility of the technique in the assessment of
contrast-enhancing brain tumors. Amide proton transfer may eventually supplement or potentially supplant traditional gadolinium-based imaging for brain tumor imaging.
MRI Evaluation of Non-Necrotic T2 Hyperintense Foci in Pediatric Diffuse Intrinsic Pontine Glioma

Z Patay¹, O Clerk-Lamalice¹, Y Li¹, A Edwards¹, J Glass¹, W Reddick¹
¹St. Jude Children's Research Hospital, Memphis, TN

Purpose
The conventional magnetic resonance imaging (MRI) appearance of diffuse intrinsic pontine glioma (DIPG) suggests intralesional histopathological heterogeneity. Previous publications have described and elucidated the putative nature and significance of various distinct lesion components, including T2-hypointense foci and "occult" enhancement. In this paper, we report the prevalence, conventional MRI semiology, and advanced MRI features of non-necrotic T2-hyperintense foci within DIPG.

Materials and Methods
Twenty-one patients with DIPG were included in this study (F:M=12:9; mean age, 7.77 years; age range, 2.08-17 years). All MRI studies were performed at 3T by using routine conventional and advanced MRI (DSC-perfusion, DCE, and DTI) sequences. Perfusion (CBV), vascular permeability (ve, Ktrans) and diffusion (ADC) metrics were calculated and used to characterize non-necrotic T2-hyperintense foci in comparison with other lesion components, namely necrotic T2 hyperintense foci, T2-hypointense foci, peritumoral edema, and normal brainstem (from a cohort of patients without posterior fossa pathology). Statistical analysis was performed by using Kruskal Wallis testing and pairwise comparisons.

Results
Sixteen non-necrotic T2-hyperintense foci were found in 12 tumors. In non-necrotic T2-hyperintense foci, apparent diffusion coefficient (ADC) values were significantly higher than those in either T2-hypointense foci (p<0.002) or normal parenchyma (p<0.0001), and relative CBV values were significantly lower than those in either T2-hypointense (p<0.001) or necrotic T2-hyperintense (p<0.006) foci. Ktrans in T2HrF was lower than that in T2-hypointense (p<0.0006) or necrotic T2-hyperintense (p<0.0348) foci.

Conclusions
Non-necrotic T2 hyperintense foci are common, distinct lesion components within DIPG. Surrogate advanced MRI biomarkers indicate that those are characterized by relatively low cellularity yet somewhat increased vascular permeability, the latter suggesting an early stage of angioneogenesis with leaky vessels. We speculate that these foci may correspond to poorly understood biological events in tumor evolution,
possibly representing clones of transforming cell populations evolving towards foci of anaplasia.

<table>
<thead>
<tr>
<th></th>
<th>ADC ((x \ 10^{-3} \ mm^2/s)) (Mean ± SD)</th>
<th>relCBV (\text{Mean ± SD})</th>
<th>(K^{\text{trans}}) ((\text{min}^{-1})) (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal brainstem ((n=17))</td>
<td>0.75 ± 0.04</td>
<td>1.36 ± 0.21</td>
<td>NA</td>
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<tr>
<td>Peritumoral edema ((n=22))</td>
<td>1.42 ± 0.27</td>
<td>1.04 ± 0.31</td>
<td>0.0028 ± 0.0020</td>
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<tr>
<td>Non-necrotic (T2^{\text{HrF}}) ((n=16))</td>
<td>1.48 ± 0.41</td>
<td>1.38 ± 0.68</td>
<td>0.0034 ± 0.0025</td>
</tr>
<tr>
<td>(T2^{\text{HoF}}) ((n=13))</td>
<td>0.82 ± 0.16</td>
<td>3.82 ± 1.32</td>
<td>0.0112 ± 0.0071</td>
</tr>
<tr>
<td>Necrotic (T2^{\text{HrF}}) ((n=9))</td>
<td>1.47 ± 0.23</td>
<td>3.61 ± 1.63</td>
<td>0.0108 ± 0.0072</td>
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O-345

Embryonal tumor with multilayered rosettes: Correlation between Radiographic, Clinical, Histopathologic, and Molecular Findings.

J Pavaine\(^1\), P Sin-Chan\(^2\), A Huang\(^2\), S Laughlin\(^1\)
\(^1\)Department of Diagnostic Imaging, The Hospital for Sick Children, Toronto, Ontario, \(^2\)Division of Hematology-Oncology, Arthur and Sonia Labatt Brain Tumor Research Centre, Toronto, Ontario

Purpose
Some of the known rare pediatric high grade embryonal tumors including embryonal tumor with abundant neuropil and true rosettes (ETANTR), ependymoblastoma (EPB), medulloepithelioma (MEPL) and central nervous system primitive neuro-ectodermal tumor (CNS-PNETs) with variable differentiation have been shown to have common molecular features including amplification of 19q13.42 and LIN28A immunoexpression and a single diagnostic category of embryonal tumor with multilayered rosettes (ETMR) for these has been suggested (1, 2). We reviewed the imaging features of these rare tumors to see if they also were similar and to assess if these were distinct from other more common malignant pediatric brain tumors.

Materials and Methods
Eighteen cases of the rare, highly aggressive embryonal CNS neoplasms were histopathologically diagnosed as ETANTR, ependymoblastoma, medulloepithelioma and CNS-PNETs with variable differentiation at the Hospital for Sick Children in Toronto, Canada from 1981 to 2015. For 14 of these cases, a molecular diagnosis of
ETMR was available based on gene expression profiling, copy number analysis, C19MC FISH, and/or LIN28 expression. Magnetic resonance (MR) and computed tomography (CT) imaging features were assessed for each of these tumors and separately for supratentorial and infratentorial tumors in correlation with clinical, histopathological and molecular findings.

Results
The tumors occurred in children younger than 4 years of age with an almost 2:1 female predominance and were more frequently supratentorial than infratentorial. Common MR imaging features for ETMR supratentorial tumors included large size at presentation, features of hypercellularity, heterogeneity with solid and cystic components including predominantly low T1 and isointense or slightly hyperintense T2 signal relative to cortex for the solid components and intratumoral areas of cystic/necrotic change and a patchy pattern of enhancement. Most did not demonstrate frank tumor vascularity but often an encased enhancing vessel coursing through the solid component of the tumor was seen (Fig. 1). Figure 1. MR imaging of the supratentorial ETMR histological subtypes. Coronal T2-weighted images for ETANTR (A), EPB (B), recurrent PNET (C), MEPL (D).

Conclusions
Our study found similar imaging features and overlap between the rare pediatric high grade embryonal tumors including ETANTR, EPB, MEPL and CNS-PNETs with variable differentiation at the time of presentation and when these recurred and is supportive of the previously suggested single ETMR entity based on unifying molecular features.
Radiographic Response of Tectal Gliomas Following Proton Radiotherapy

P Caruso¹, J Ryan Alkasab², A Baer¹, B Buchbinder¹, Y Torunn¹, S Rincon¹
¹Massachusetts General Hospital, Boston, MA, ²University of Massachusetts Medical School, Worcester, MA

Purpose
Proton radiotherapy is an effective modality for the treatment of brainstem tumors and in pediatric neurooncology offers the advantage of high conformal control that limits radiation dose to the developing brain. While the imaging findings in tumors treated with proton radiotherapy have been described, distinguishing between radiographic response and tumor progression in the early post-treatment period remains an important but challenging task: many tumors including tectal gliomas may respond to proton radiotherapy initially by increasing in size, and this may be misinterpreted as tumor progression. The purpose of our study is to assess the quantitative response of tectal gliomas by performing serial magnetic resonance imaging (MRI) measurements of tumor volume over time in order to identify a predictable trend in tumor response to proton radiotherapy.

Materials and Methods
Following IRB approval, a retrospective search of clinical and imaging databases was performed for patients with tectal gliomas. Patients ages 0 through 25 years with tectal gliomas who underwent proton beam radiotherapy were included. Patients with tumors previously treated with radiotherapy or surgical resection were excluded. Cubic volume measurements were obtained from FLAIR MRI scans at all available timepoints.

Results
Five subjects met inclusion criteria with median age 14.4 years (average, 16.2 years; range, 12.6-20.8 years). Median imaging follow-up was 2.6 years (average, 3.0 years; range, 1.4-5.4 years) with a median of eight post-treatment timepoints (average, 7.6; range, 4-10). Each of the five tumors followed a pattern of post-radiotherapy enlargement followed by reduction in size. The peak tumor volume occurred at a median of 7.0 months (average, 6.3 months; range, 3.6-8.3 months) from initiation of radiotherapy (Figure 1).

Conclusions
Following proton radiotherapy, tectal gliomas demonstrate a predictable trend of enlargement and subsequent reduction in tumor size. This trend may be helpful in distinguishing between expected radiographic response and tumor progression in tectal gliomas.
Subject 1

Pretreatment  Peak volume  Final volume
(7.0 months)  (65.1 months)

[Images of brain scans]

<table>
<thead>
<tr>
<th>Months from Treatment Initiation</th>
<th>Tumor Volume (cm³)</th>
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<tr>
<td>0</td>
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<tr>
<td>10</td>
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Imaging characteristics of pediatric diffuse midline gliomas based on the presence of a poor prognostic marker histone H3 K27M mutation

M Aboian1, D Solomon1, E Felton1, S Mueller1, S Cha1
1University of California San Francisco, San Francisco, CA

Purpose
The molecular basis underlying pediatric gliomas is distinct from adult gliomas. One unique molecular alteration that has been identified in pediatric gliomas is K27M missense mutation in histone H3 variants and presence of this mutation correlates with poor prognosis. The forthcoming 2016 WHO Classification will include "diffuse midline gliomas with histone H3 K27M mutation" as a new diagnostic entity. We identify imaging characteristics of diffuse midline gliomas in pediatric patients based on the presence or absence of histone H3 K27M mutation.

Materials and Methods
We identified 31 pediatric patients (<18 years old) with diffuse gliomas with available magnetic resonance imaging (MRI). Histopathologic subtypes included diffuse astrocytoma, anaplastic astrocytoma, and glioblastoma. We evaluated the imaging patterns of these diffuse gliomas based on their location, enhancement pattern, and necrosis.

Results
In these 31 patients, tumors were supratentorial in origin in 42% of cases, infratentorial in 52%, and cervical spine in 6%. Seventy percent of the tumors were midline (thalamus, pons, or spinal cord) with 90% of these harboring K27M mutation. All of the tumors arising supratentorially in the cerebral hemispheres had wild type histone H3 and were associated with a high amount of necrosis (p<0.003). Both of the two cervical spine tumors were K27M positive and demonstrated distal subependymal metastases within the lateral ventricles on follow-up imaging at 5-13 months. When comparing histone H3 mutant to wild type diffuse gliomas, there was no statistically significant correlation between enhancement or border characteristics, infiltrative appearance, presence of edema, or ADC value.

Conclusions
The majority of diffuse midline gliomas originating in the thalamus, pons, or spinal cord were found to harbor histone H3 K27M mutation and showed a propensity for distal metastatic spread, particularly for those arising in the cervical cord. In contrast, diffuse gliomas arising in the cerebral hemispheres were uniformly negative for K27M mutation and were more likely to demonstrate necrosis.
Use of ADC Histogram Metrics in Characterization and Survival Prediction in Pediatric Brain Tumors: A Report from the Pediatric Brain Tumor Consortium
S Vajapeyam1, D Brown1, K Ricci2, M Kocak3, A Onar4, M Fouladi5, T Poussaint1
1Boston Children's Hospital, Boston, MA, 2Massachusetts General Hospital, Boston, MA, 3University of Tennessee Health Science Center, Memphis, TN, 4St. Jude Children's Research Hospital, Memphis, TN, 5Cincinnati Children's Hospital, Cincinnati, OH

Purpose
To characterize pediatric brain tumors based on apparent diffusion coefficient (ADC) histogram metrics, and explore correlations of these metrics with survival for various tumor types.

Materials and Methods
A framework for quantitative ADC histogram analysis was developed using a retrospective review of 121 patients in five newly diagnosed brainstem glioma (BSG) treatment protocols (1). The methodology was applied to a cohort of 14 patients in a non-NF1 optic pathway/low-grade glioma (LGG) protocol to test feasibility in a different tumor type. Postcontrast T1 images and ADC maps were registered to the corresponding FLAIR images using a mutual information algorithm in FSL2. Three dimensional regions of interest (ROIs) comprising FLAIR and enhancement tumor volumes were generated automatically using a thresholding feature available in Fiji3. Quantitative histogram analysis of the FLAIR and enhancing tumor volumes also was done using Fiji, using a uniform bin width and uniform range of ADC values chosen to limit the ADC values to solid tumor. For each histogram, the following metrics were assessed for FLAIR and enhancement volumes: number of peaks, mean ADC, standard deviation (SD), mode, median ADC, skewness and kurtosis. For bimodal distributions, metrics for each peak were assessed separately.

Results
In our previous work, ADC histogram metrics in the BSG cohort demonstrated significant correlations with survival, with lower mean, mode and median baseline ADC, higher skewness, and presence of enhancement associated with shorter survival (1). The same histogram technique was translated easily to a small LGG cohort, proving the versatility of the technique and ease of use for other pediatric brain tumor types. The LGG cohort typically showed baseline high ADC mean values.

Conclusions
Apparent diffusion coefficient histogram metrics in pediatric brain tumors provide a 3D analysis of tumor volume diffusion characterization, which recently has been applied in children with diffuse intrinsic brainstem glioma (1). This technique can be used in other brain tumor types and future work will evaluate associations with treatment and survival.

O-349
Utility of Post-contrast FLAIR Imaging in Pediatric Brain Tumors: Initial Experience

G Zuccoli¹, M Tamber², M Utz², F Kamal¹, G Mason¹, I Pollack¹, A Panigrahy¹
¹Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, ²University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Spoiled gradient echo contrast-enhanced T1-weighted imaging (T1-WI) is used routinely for initial evaluation and re-evaluation of pediatric brain tumors. Postcontrast volumetric fluid attenuated inversion recovery (FLAIR) has emerged as a useful sequence in evaluating both morphology of the primary lesion and the presence of intracranial metastases. On postcontrast FLAIR images, edema and nonenhancing parenchymal tumor appear hyperintense. Since FLAIR imaging nulls the signal of cerebrospinal fluid (CSF) in the subarachnoid spaces, we believe that postcontrast FLAIR also has utility in the evaluation of leptomeningeal dissemination of tumor. Our study compares the performance of postcontrast volumetric FLAIR imaging compared to T1-WI in depicting the local extent and leptomeningeal seeding of primary brain tumors.

Materials and Methods
IRB approval was obtained. A retrospective review of the radiology database was performed for patients with a history of a primary brain tumor. Patients were included if they had a study which had both postcontrast SPGR and postcontrast volumetric FLAIR sequence. A total of 46 patients were included. The age, sex, and diagnosis were collected from the electronic medical record. Two reviewers reviewed each study, a pediatric neuroradiologist with 15 years of experience, and a neuroradiology fellow. Each reviewer recorded the number of lesions observed on precontrast axial 2D FLAIR, postcontrast SPGR, and postcontrast volumetric FLAIR. Thirty lesions was used as a maximum cutoff, beyond which they were considered too many to individually count. The Wilcoxon signed rank-test was used to compare the number of lesions visualized on postcontrast SPGR and postcontrast volumetric FLAIR. Each reviewer also decided whether postcontrast FLAIR depicted better extent of parenchymal tumor into the extra-axial spaces.

Results
A total of 46 studies were reviewed. Ten studies (19.6%) had lesions which were seen on postcontrast FLAIR but not on SPGR. The median number of lesions was 3.5 on postcontrast FLAIR (IQR 1.75-16.5) and one on SPGR (IQR 0.75-5.5), which was a statistically significant difference (p=0.011). Two studies demonstrated lesions on postcontrast FLAIR and no lesions on SPGR (ependymoma and low grade glioma). Two studies had lesions that were better seen on SPGR (germinoma and glioblastoma...
multiforme). A full assessment of the inter-rater reliability of the quantification of additional lesions on postcontrast FLAIR is in progress.

Conclusions

In conclusion, our preliminary results show that postcontrast FLAIR may represent an additional tool in depicting new lesions in intracranial metastases or tumor recurrence in children affected by primary brain tumors. Our results suggest that postcontrast FLAIR can have a significant clinical impact by discovering lesions not identifiable on standard volumetric postcontrast imaging.

O-350

Intracranial Inflammatory Germinoma: A Pathologic and Imaging Pitfall

R Lobo1, G Hedlund2, C Palmer1, A Osborn1
1University of Utah, Salt Lake City, UT, 2Primary Children's Hospital, Intermountain Healthcare, Salt Lake City, UT

Purpose

Inflammatory changes associated with extra central nervous system (CNS) germinomas are well recognized. That intracranial germinomas can be associated with granulomatous inflammation is less well recognized with only a few scattered case reports in the literature. In this paper we identify and characterize the imaging and pathologic spectrum of intracranial germinoma-associated inflammatory changes.

Materials and Methods

An IRB-approved query of our imaging databases for "germinoma" and MR brain yielded 28 pathologically-proven cases. Demographic, clinical and laboratory data were documented and imaging findings (tumor location, size, signal intensity, enhancement, and presence/extent of T2/FLAIR hyperintensity outside the enhancing neoplasm's margin) were tabulated. Surgical pathology including the presence of associated inflammatory and/or granulomatous change was recorded.

Results

Fourteen tumors were located in the pineal gland, 11 in the pituitary/infundibulum/hypothalamus, and three in the basal ganglia/thalami. Seven cases had multiple sites of involvement. Twelve of 14 pineal lesions (86%) exhibited T2/FLAIR hyperintensity that extended beyond the enhancing tumor margin, most commonly into the thalami (83%), tectum (75%), midbrain (42%) and pons (25%). Extratumoral extent varied from minimal (2mm) to striking (7 mm). Histopathology in six cases specifically referenced inflammatory changes infiltrating along the tumor including lymphocytes, lymphoplasmacytic cells, or nests of inflammatory cells that in some cases almost completely obscured the neoplasm. Initial biopsy in three cases disclosed only granulomatous change/inflammatory cells "without evidence of
Repeat biopsies were all positive for germinoma. All cases were treated with steroids, chemotherapy and/or radiation with subsequent imaging showing retracting tumoral enhancement together with complete resolution of the pre-operative T2/FLAIR abnormalities in the adjacent parenchyma.

Conclusions

Inflammatory reaction commonly is associated with intracranial germinoma and is seen as confluent T2/FLAIR hyperintensity extending beyond the enhancing tumor into the adjacent parenchyma. Initial biopsy in inflammatory germinoma may be negative, showing only inflammatory cells. Repeat biopsy should be performed as robust lymphoplasmacytic infiltrates may obscure neoplastic cells.
incidence, time to development, and imaging characteristics of radiation therapy-induced cerebral microbleeds in pediatric patients with brain tumors treated with proton radiotherapy.

Materials and Methods
Following institutional review board approval, a retrospective review of clinical and radiologic data was performed on 16 consecutive pediatric patients with primary brain tumors who had undergone cranial proton beam radiotherapy from January 2010 to October 2012, and had clinical and MR imaging follow up performed at our institution with susceptibility-weighted imaging (SWI) sequences. Radiation therapy-induced cerebral microbleeds were defined as focal areas of susceptibility artifact in the brain parenchyma which did not correspond to normal vessels, were not present on initial presentation imaging, and which did not correspond to hemorrhage within residual tumor or at the resection site. A review of clinical data and the SWI sequence was performed to determine the incidence of microbleeds, number of microbleeds per patient, new or progressive enlargement of microbleeds, time from radiation therapy to development of microbleeds, and imaging follow-up duration.

Results
The median patient age at time of brain tumor diagnosis was 6 years (range 1.5 -18 years). All of the patients underwent MR imaging prior to radiation therapy and none of them were found to have microbleeds prior to treatment. A total of 14/16 (87.5%) of patients developed microbleeds with median time to development of 2.6 years (range 0.75-4.1 years). All of these patients demonstrated multiple microbleeds rather than a single lesion. The largest cerebral microbleed was 1.1 cm with a median size of 0.65 cm (range 0.1-1.1 cm). A total of 2/16 (12.5%) patients did not develop cerebral microbleeds following radiation therapy with median follow-up duration of 3.5 years (range 3-3.9 years).

Conclusions
The majority of pediatric patients with primary brain tumors treated with proton radiotherapy develop multiple cerebral microbleeds. The incidence of radiation therapy-induced microbleeds in pediatric patients treated with proton therapy radiation may be greater than patients treated with conventional radiation therapy.

O-352
Clinical Validation of Synthetic Brain MRI in Children

H West¹, J Leach², B Jones², S Serai², M Care², R Radhakrishnan³, E Alvarado³, A Merrow²
¹CCHMC, Cincinnati, OH, ²Cincinnati Children's Hospital Medical Center, Cincinnati, OH, ³Cincinnati Children's Hospital, Cincinnati, OH
Purpose
To determine the diagnostic accuracy of synthetic magnetic resonance (MR) sequences generated using postacquisition processing of a single sequence that measures inherent R1, R2 and PD tissue properties [multi-dynamic and multi-echo sequence (Qmap)] compared with conventionally acquired sequences as part of a routine clinical pediatric brain MR exam (1).

Materials and Methods
Thirty-two patients (mean age 10.4 years) underwent routine clinical brain MRI with both conventional and synthetic sequences (22 abnormal). Exams were performed at 3T(18) and 1.5T(13) (GE Healthcare, Waukesha, WI). Synthetic axial T1, T2 and T2 FLAIR or PD sequences were made to match the comparable clinical sequences in each case (1). Two exams (conventional and synthetic) for each patient were de-identified. Four blinded reviewers each reviewed eight patients and were asked to generate clinical reports on each exam at two different times with different sequence origin (synthetic or conventional) separated by a mean of 33d. Exams were rated for overall and specific finding agreement (synthetic/conventional and compared to gold standard consensus review by two senior reviewers with knowledge of clinical report), quality and diagnostic confidence.

Results
Overall agreement between conventional and synthetic exams was 97%. Agreement with consensus readings was 84% (conventional) and 81% (synthetic), p=0.61. There were no significant differences in sensitivity, specificity or accuracy for specific imaging findings involving the ventricles, cerebrospinal fluid (CSF), brain parenchyma, or vasculature between synthetic or conventional exams (p>0.05). Although there were some subtle differences between exams, no significant difference in exam quality or diagnostic confidence (sufficient or better for diagnosis) or significant difference in noise/artifacts (that would compromise diagnosis) was noted comparing studies with synthetic or conventional sequences (p<0.0001).

Conclusions
Diagnostic accuracy and quality (sufficient for diagnosis) of synthetically generated T1, T2, T2 FLAIR and PD sequences is comparable to conventionally acquired sequences as part of a standard pediatric brain exam. Further confirmation in a larger study is warranted.

O-353


E Yang1, J Vaughn1, P Hill1, J Schulte1, P Ketwaroo1, J Frost1, G Colleran1, T Meehan2, C Stamoulis1, S Prabhu1
Purpose
Detection of longitudinal change is a fundamental task performed by all neuroradiologists. However, day to day differences in proscribed imaging planes can frustrate accurate comparison of features (e.g., ventricle size or lesion load). These day to day variations can be corrected using image registration software though such software has received limited clinical use to date. We investigated the feasibility of using real time rigid body image registration on a thin client module attached to our PACS system. This real time registration was studied using ventricle check magnetic resonance images (MRIs) and analysis of speed, confidence, and accuracy of interpretation by seven trainee radiologists.

Materials and Methods
Thirty ventricle check MRIs (HASTE or T2-weighted with extended echo train length) from 24 individuals were compared to other ventricle check MRIs or T2-weighted series from diagnostic brain MRIs at a different point in time. After manual and software-assisted review by two attending pediatric radiologists with a total of 12 years experience, consensus for changes in the ventricle system was determined (timepoint A, timepoint B, or unchanged). After removing subjects who were presented more than twice and choosing a range of comparison difficulty (6 "easy", 5 "medium", and 17 "hard"), a total of 28 image pairs from 22 subjects remained (mean age 8.2 years) with a mean comparison interval of 116 days. Seven trainee radiologists (5 fellows, 2 residents) compared the images from the two time points in randomized order, indicating larger time point (or neither) and confidence in rating (1="completely uncertain" to 5="certain"). A subset of five "hard" cases were separately timed. Subsequently, the same exercise was performed using the Synapse 3D "Fusion" module opened from the Synapse PACS.

Results
Using PACS only, the concordance of the seven trainee radiologists was in the range 71.4%-89.3% (median = 82.1%, (25th, 75th) quartiles = (73.2%, 82.1%) whereas with image registration assisted review, it was in the range 82.1%-89.3% (median =85.7%, (25th, 75th) quartiles = (82.1%, 88.4%). The median time of interpretation for the five timed cases was 122 seconds by eye [(25th, 75th quartiles) = (83.8, 179.3)] seconds and 97 seconds with software assistance [(25th, 75th quartiles) = (82.0, 119.5)] seconds. Despite trends favorable for the utility of the coregistration-assisted image review, there was no statistically significant advantages in speed of interpretation or accuracy. For interpretative confidence, statistically significant increases in confidence were demonstrated for four of seven subjects only.

Conclusions
Although diagnostic superiority cannot be asserted based on the available data, this
study indicates the feasibility of performing real time image registration in a clinical
environment. Caveats of this work include potential for geometric distortion between
scans and obscuration of parenchymal features due to use of nonisotropic data sets.

**Wednesday**
3:00PM - 4:30PM
Washington Marriott Wardman Park, Marriott Ballroom

**17A-SNIS Programming; New Devices in NeuroInterventional Space**

**17A-1**

3:00PM - 3:20PM

**The FDA and the NeuroInterventional Space: Helping to Define New Horizons**

Jensen, M.
University of Virginia Health Systems
Afton, VA

**17A-2**

3:20PM - 3:40PM

**Quality and Training in the World of New Devices: Who is Responsible?**

Prestigiacomo, C.
Neurological Institute Of New Jersey
Newark, NJ

**17A-3**

3:40PM - 4:00PM

**New Devices for Hemorrhagic Stroke (Aneurysm and AVM): A Synopsis**

Turk, A.
Med. Univ. of So. Carolina
Charleston, SC

**17A-4**

4:00PM - 4:20PM

**New Devices for Ischemic Stroke: A Synopsis**
Rai, A.
West Virginia University
Morgantown, WV

17A-5
Panel Discussion

Wednesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Washington 4/5/6

17B-ASSR Programming: Advanced Imaging of the Spine (AR) (SAM)
17B-1
MR Neurography: Plexus and Peripheral Neurography
Carrino, J.
Hospital for Special Surgery
New York, NY

3:00PM - 3:20PM

17B-2
Optimized Imaging of the Instrumented Spine
Tanenbaum, L.
RadNet, Inc.
Baltimore, MD

3:20PM - 3:40PM

17B-3
Spinal Cord Imaging: Advanced Techniques

3:40PM - 4:00PM
Law, M.
Keck Medical Center of USC
Los Angeles, CA

17B-4

Spinal 4D MRA

Chokshi, F.
Emory University School of Medicine
Atlanta, GA

17B-5

Questions and Answers

Wednesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Washington 1/2/3

17C-PET-MR
17C-1

Introduction to PET/MRI Neuroimagers

Zaharchuk, G.
Stanford University
Stanford, CA

17C-2

PET/MRI of Dementia
Nasrallah, I.
HUP
Philadelphia, PA

17C-3
Multimodality Imaging of Epilepsy: Role of PET/MRI

Stufflebeam, S.
Massachusetts General Hospital
Boston, MA

17C-4
Panel Discussion

Wednesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Roosevelt 1-3

17D-PARALLEL PAPER SESSION-Turbo Talks-Acute Stroke: Imaging and Intervention
O-354

3:00PM - 3:03PM
Differences in neuroimaging utilization in acute stroke: A population based study

A Vagal1, P Sanelli2, H Sucharew3, K Alwell4, J Khoury4, P Khatrī5, M Flaherty4, B Kissella4, O Adeoye4, F De Los Rios La Rosa4, S Martini4, J Mackey4, D Kleindorfer4
1Univ. Hosp./Univ. Cincinnati College Of Medicine, Cincinnati, OH, 2North Shore - LIJ Health System, Manhasset, NY, 3Cincinnati Childrens Hospital Medical Center, Cincinnati, OH, 4University of Cincinnati, Cincinnati, OH, 5University Of Cincinnati Medical Center, cincinnati, OH
Purpose
Rates of diagnostic work up in stroke have increased over time. However, less is known about differences in utilization of neuroimaging for stroke from a population perspective. Our primary objective was to assess whether race-, sex- and age-related differences exist in neuroimaging utilization in a population-based study.

Materials and Methods
Stroke (ischemic and hemorrhagic) and transient ischemic attack (TIA) patients were identified in a metropolitan population of 1.3 million served by 15 different inpatient hospitals in the Greater Cincinnati area in calendar years of 2005 and 2010. Patient charts and imaging records were abstracted by research nurses and reviewed by study physicians. The proportion of imaging use within 2 days of stroke/TIA onset or hospital admission date including noncontrast head CT (NCCT), magnetic resonance imaging (MRI) head, computed tomography (CT) angiogram (CTA), (MR) angiogram (MRA), digital subtraction angiogram (DSA) and carotid ultrasound was computed. Multivariable logistic regression was used to examine the odds of advanced imaging utilization (CTA/MRI/MRA) adjusting for insurance, baseline NIHSS, ED presentation and hospital type (academic versus community).

Results
In 2005, there were 3471 stroke/TIA events with imaging data available in 3226 patients and, in 2010, there were 3431 stroke/TIA events with imaging data in 3213 patients. A higher proportion of males received MRI (55% versus 51%) and MRA (36% versus 31%) as compared to females in both 2005 and 2010 with no gender differences in utilization of NCCT, CTA, DSA or carotid ultrasound. A higher proportion of blacks received NCCT (96% versus 92%), MRI (59% versus 51%), MRA (42% versus 41%) as compared to whites (P<0.01) with no racial difference in CTA and DSA. All imaging utilization except NCCT and carotid ultrasound was higher in younger (<55 years) as compared to older patients (>55 years) (P<0.01). Multivariable regression demonstrated that the odds of receiving NCCT did not differ significantly by age, sex, and race. Adjusting for covariates, younger age (<55) was associated with higher odds of additional advanced imaging (CTA/MRI/MRA) compared to older age (>55) patients, and white race was associated with lower odds of additional advanced imaging compared to black race patients. (Table).

Conclusions
In a large population-based study, age, racial and gender related differences exist in the utilization of neuroimaging for patients with acute stroke. The differences may be partly driven by age, with younger patients getting more extensive work ups. However, further understanding of the contributors can provide an important basis for newer lines of inquiry into environmental, socioeconomic and access to health care issues.
<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Age</td>
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<tr>
<td>&lt;55 years</td>
<td>1.90 (1.63, 2.22)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Sex</td>
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<tr>
<td>Female</td>
<td>0.95 (0.85, 1.06)</td>
<td>0.32</td>
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<tr>
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<tr>
<td>Whites</td>
<td>0.79 (0.67, 0.93)</td>
<td>&lt;0.01</td>
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<tr>
<td>Percentage below poverty</td>
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<tr>
<td>≥20%</td>
<td>0.85 (0.69, 1.03)</td>
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<tr>
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<td>1.43 (1.20, 1.71)</td>
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<tr>
<td>ED event</td>
<td>1.95 (1.65, 2.29)</td>
<td>&lt;0.01</td>
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<tr>
<td>Insurance</td>
<td>0.91 (0.70, 1.18)</td>
<td>0.47</td>
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<tr>
<td>Baseline NIHSS</td>
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<tr>
<td>Event type (TIA reference)</td>
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<tr>
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<tr>
<td>Infarct</td>
<td>2.51 (2.19, 2.88)</td>
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<td>Seen by stroke team or neurologist</td>
<td>2.33 (2.07, 2.63)</td>
<td>&lt;0.01</td>
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<tr>
<td>Study year</td>
<td></td>
<td></td>
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<tr>
<td>2010</td>
<td>1.66 (1.48, 1.85)</td>
<td>&lt;0.01</td>
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</table>

O-355

ESCAPE to reality: Post-trial outcomes in an ESCAPE centre

A Nixon\textsuperscript{1}, M Jamison\textsuperscript{2}, I Rennie\textsuperscript{1}, P Flynn\textsuperscript{1}, A Hunter\textsuperscript{1}, P Burns\textsuperscript{1}

\textsuperscript{1}Royal Victoria Hospital, Belfast, AK, \textsuperscript{2}Royal Victoria Hospital, Belfast, AK
Purpose
The Royal Victoria Hospital, Belfast provides the regional neuroendovascular service for Northern Ireland and was an enrolling center for the ESCAPE endovascular stroke trial. Our endovascular service for acute ischemic stroke continues to be time limited. The purpose of this study was to assess outcomes for patients presenting with acute stroke following discontinuation of trial enrollment at our center.

Materials and Methods
We collected data on all patients presenting with acute stroke between Nov 1st 2014 and Oct 31st 2015 who received endovascular treatment or received IV thrombolysis (IV-tPA) alone. ESCAPE eligibility of each patient was assessed. Presenting and discharge National Institute for Health Stroke Scale (NIHSS) score was recorded. The primary outcome was modified Rankin Score (mRS) at 3 months. Favorable mRS was defined as a score of ≤2 at 3 months.

Results
One hundred thirty-two presented with acute stroke symptoms during the time period. Seventy-three of 132 (55.3%) patients were treated with IV-tPA only. Of these 73 patients, 45 (61.6%) had identified thrombotic occlusion [via CT angiography or hyperdense vessel on unenhanced computed tomography (CT)]. Fifty-nine of 132 (44.4%) patients received endovascular treatment. Forty-six of 59 (78.0%) patients treated with endovascular treatment were considered ESCAPE eligible and 17/73 (22.3%) patients treated with IV-tPA were considered ESCAPE eligible. Of the patients considered ESCAPE eligible, 27/46 (58.7%) patients had mRS ≤2 at 3 months following endovascular treatment. Four of 17 (23.5%) patients considered ESCAPE eligible had mRS ≤2 at 3 months following IV-tPA treatment only, of which six died (35.3%). Thirteen of 59 (22.0%) patients who had endovascular treatment were considered ESCAPE ineligible (basilar occlusion, n=6; M2 occlusion, n= 6, M1 occlusion with ASPECTS <6 n=1). Of these patients, 6/13 (46.2%) patients had mRS ≤2 at 3 months. Fifty-six ESCAPE ineligible patients were treated with IV-tPA only, of which 27 (48.2%) had identifiable thrombotic occlusion. Eleven of 27 (40.7%) patients with identifiable thrombotic occlusion had mRS ≤2 at 3 months. Twenty-three of 29 (79.3%) of ESCAPE ineligible patients without definite thrombotic occlusion had mRS ≤2 at 3 months.

Conclusions
ESCAPE eligible patients in our center had a favorable outcome rate comparable to the published trial data. ESCAPE ineligible patients tended to do slightly less well, but still much better than the favorable outcome rates achieved with IV-tPA alone. There is potentially a wide discordance between the threshold for futility and trial eligibility criteria when considering endovascular treatment for acute ischemic stroke.

O-357
Establishing the first Mobile Stroke Unit in Argentina.

C Bleise¹, J CHUDYK², J Cirio², J Chudyk³, R Ceratto¹, P Lylyk⁴
¹Instituto Médico ENERI - Clínica Sagrada Familia, Buenos Aires, CABA, ²Instituto Médico ENERI - Clínica Sagrada Familia, BUENOS AIRES, Buenos Aires, ³Instituto Médico ENERI - Clínica Sagrada Familia, Buenos Aires, Buenos Aires, ⁴Clinica ENERI, Buenos Aires, Buenos Aires

Purpose
We present the first mobile stroke unit (MSU) in Argentina. New units and trials have been developed in the last 10 years starting with the German concept. We develop this unit as an emergency support for pre hospital stroke management of our institution with a competitive medical and paramedic staff.

Materials and Methods
The MSU is equipped with a mobile CT scanner, a telemedicine program (was develop as a stroke telemedicine/teleneurology software) and point of care laboratory. Since March 2015 to July 2015, 10 patients were evaluated with a primary diagnosis of acute ischemic stroke (AIS). Only three patients were diagnosed with a stroke. One patient was treated with iv-tPA, other with iv-tPA plus mechanical thrombectomy (bridging technique), and the last one only with mechanical thrombectomy.

Results
The use of the MSU resulted in faster times to evaluation and treatment, compared to traditional models. Telemedicine and point of care laboratory were the key points for the diagnosis and treatment. All the treatment options were analyzed directly with the hospital neurologist via telemedicine, allowing us to minimize the treatment times.

Conclusions
The first MSU in Argentina has been introduced in Buenos Aires, after about one year of preparation. Major obstacles to establish the MSU were obtaining funding, licensure, documenting radiation safety protocols, and establishing a locally tailored communication with the emergency system. Preliminary data during a run-in phase indicate no complications. Further studies are in progress to determine the time savings, clinical outcomes, telemedicine reliability, and cost effectiveness of the MSU strategy.
Stent Retriever Based Endovascular Reperfusion Therapy in Octogenarians

J Gomori¹, J Cohen², R Leker²
¹Hadassah Hebrew University Medical Center, Jerusalem, Israel, ²Hadassah Hebrew University Medical Center, Jerusalem, NA

Purpose
Endovascular reperfusion therapy (ERT) may be beneficial in a subset of patients with large hemispheric stroke. Previous studies concluded that favorable outcomes are far less frequent in older patients but have not explored outcomes in the era of newer generation stent retrievers.

Materials and Methods
Consecutive patients with large hemispheric stroke treated with stent retriever-based ERT (SERT) were included. We compared neurological and functional outcomes between patients younger and older than 80 years.

Results
We included 16 patients older than 80 years (22.5%, mean age 84.1±4.4 years, 56% females) and compared them to 55 patients that were younger than 80 years (77.5%, mean age 63.1±12.5 years, 51% females). Cerebrovascular risk factor profile, admission NIH stroke scale scores, stroke etiology and procedure-related variables including excellent target vessel recanalization (thrombolysis in cerebral infarction score 2b-3) did not differ between the groups. Favorable outcome at 90 days (modified Rankin Score ≤2) was more common in younger patients (77% versus 23%; p=0.031). In contrast mortality rates were higher in octogenarians (40% versus 7%; p=0.01). Logistic regression analysis adjusting for neurological severity and collateral state identified age over 80 years (OR 0.15 95% CI 0.03-0.75; p=0.02) and
reperfusion state (OR 7.4 95% CI 1.1-49.9; p=0.04) as significant modifiers of favorable outcome. Similarly, age over 80 years was identified as a positive predictor of mortality (OR 8.1 95% CI 1.8-36.7; p=0.007).

Conclusions

Very old patients have higher chances of mortality and a lower probability of achieving functional independence even after SERT. Nevertheless, because some elderly patients do achieve favorable outcomes the cost-effectiveness of SERT in this population needs to be studied further.

O-359

3:15PM - 3:18PM

Acute Ischemic Infarct Topology: Correlation with Lesion Volume and Severity of Clinical Symptoms

S Payabvash1, J Benson2, S Taleb1, A McKinney1

1University of Minnesota, Minneapolis, MN, 2University of Minnesota, St. Paul, MN

Purpose

To determine the correlation between acute ischemic infarct location and lesion volume and severity of stroke symptoms at presentation.

Materials and Methods

Patients with acute ischemic stroke who underwent magnetic resonance imaging (MRI) within 24 hours of symptom onset or last-seen-well between 1/2011 and 12/2014 in two university-affiliated hospitals were included in this study. The infarct lesions were segmented on admission diffusion-weighted imaging (DWI) scans and were coregistered on standardized MNI-152 brain map. The clinical severity was determined by the admission National Institute of Health Stroke Scale (NIHSS) score. The Voxel-based Lesion Symptom Mapping (VLSM) analysis was used to determine the correlation between the infarct location with lesion volume, admission NIHSS, and the NIHSS/volume ratio.

Results

A total of 238 patients were included. On voxel-based analysis, ischemic infarct in bilateral striatocapsular nuclei, insular ribbons, central corona radiata and the right precentral gyrus was associated with larger infarct volume, and higher admission NIHSS. The average volume of ischemic infarcts involving aforementioned regions (76.7 ± 125.6 mL) was higher than infarcts sparing these regions (16.4 ± 24.0 mL, p<0.001). However, infarction of brainstem (i.e., midbrain, pons, and medulla) and/or thalami was associated with higher NIHSS/volume ratio. While the average volume of ischemic infarcts involving the brain stem/thalami (21.5 ± 35.1 mL) was less than infarcts sparing these regions (43.6 ± 92.1mL, p=0.010); patients with
brainstem/thalami infarction had higher admission NIHSS (median: 6, interquartile: 3 – 11) compared to the rest of patients (median: 4, interquartile: 2 – 7, p=0.006).

Conclusions
Ischemic infarcts with larger volume and worse clinical presentation tend to involve the insular ribbon, lentiform nuclei, and central corona radiata. On the other hand, ischemic infarcts of brain stem and thalami are associated with worse clinical presentation despite a small volume. These findings can explain recent reports underscoring the role of insular ribbon infarction as a biomarker for stroke prognostication. These regional findings potentially can be integrated to develop a hazard atlas of the brain for prediction of acute ischemic stroke clinical outcome and treatment triage.

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O-360

Slice Accelerated Isotropic Diffusion Imaging (SAIDWI) of the brain in acute ischemic stroke.
Purpose
To evaluate the utility of slice accelerated isotropic diffusion imaging of the brain (SAIDWI) in acute stroke compared with conventional diffusion weighted imaging (DWI).

Materials and Methods
Two hundred fifty consecutive patients presenting with acute symptoms of acute stroke underwent both conventional diffusion imaging and slice accelerated isotropic DWI (SAIDWI) at 3T (Skyra; Siemens Medical Systems, Erlangen, Germany) using a 20 Channel head and neck receive only coil. SAIDWI images were obtained by using a slice accelerated spin-echo single-shot echo-planar (EPI) sequence and a monopolar diffusion gradient scheme for reduced echo time. Multiple slices were acquired simultaneously with a blipped CAIPIRINHA technique with individual slices reconstructed using a Slice GRAPPA reconstruction method. Imaging parameters were as follows: TR/TE of 4400/75 ms, FOV of 27x27 cm, an acquisition matrix of 124 x 124, and section thickness of 2.2 mm with an intersection gap of 0 mm. Voxel Size 2.2 x 2.2 x2.2 interpolated to 1.1 x 1.1 x 2.2. Seventy four axial slices were obtained using an iPat factor 3 in-plane, and a slice acceleration factor of 2, Diffusion-weighted MR images were acquired with diffusion-weighted factor of 0 and 950 s/mm². Axial, sagittal and coronal DWI and ADC maps were generated. Scanning time was 2:34 minutes.

Results
SAIDWI demonstrated superior signal to noise ratios for acutely restricted lesions compared with conventional DWI, demonstrating significantly more DWI positive lesions than conventional DWI. This allowed for the diagnosis of acute stroke rather than TIA in four cases. SAIDWI also enabled confident diagnosis of small peripheral infratentorial and cortical infarcts that had been mistaken for artifacts on conventional DWI.

Conclusions
SAIDWI is superior to conventional DWI in evaluation of acute ischemic infarcts in patients presenting with acute stroke.

O-361
3:21PM - 3:24PM

TraveStroke (Therapeutic recanalization after vascular events in acute Stroke) Prototype – a clinical software prototype to predict voxelwise time-dependent infarct probability in an acute stroke setting
Purpose
TraveStroke is a novel imaging prototype aiming to support physicians in acute stroke settings. A patient's individual infarct probability map, considering stroke severity, patient's characteristics, radiological images and time between onset and endovascular treatment is calculated. Results can be displayed as a probability map or a visualization of infarct core and penumbra with changing expected time of recanalization. This visualization shows the predicted patient's individual benefit of endovascular treatment. We evaluated the prototype to test the reliability of the probability maps and the clinical feasibility.

Materials and Methods
The software prototype calculates voxelwise infarct probability from CT perfusion parameter maps using a multivariate logistic regression model published by Kemmling et.al. (1). The algorithm integrates further information with effect on infarct probability (e.g., tissue specific susceptibility to ischemia) into perfusion space. Global variables including age and gender are read automatically out of the imaging dicom-header. The clinical user enters NIHS-Score (National Institutes of Health Stroke Scale), time of stroke onset and approximated time of recanalization. Patient specific infarct probability maps then are calculated and displayed as infarct core and tissue at risk with changing expected time of recanalization. The prototype was tested in 36 patients with proximal occlusion in anterior circulation. For each patient, the final lesion was segmented manually in a follow-up CT and registered onto the initial CT. Predicted infarct probability maps were binarized by stepwise increasing thresholds and compared to the final lesion by ROC curve analysis. Area under the ROC curve (AUC) was used to test the discriminative power of calculated infarct probability maps to predict infarct lesions.

Results
Automated calculation of the CT perfusion parameter maps (5mm slice thickness) and registration was reliable (88 sec). Treatment time dependent infarct probability maps predicted binary infarct lesions reliably with a ROC-AUC of 0.79 at an optimal probability cut-off of 10% with sensitivity of 71.5% and specificity of 74.2%.

Conclusions
The TraveStroke software prototype rapidly calculates and displays infarct probability maps from CT perfusion imaging that depict infarct core and tissue at risk as a function time to recanalization. The evaluated clinical software prototype may help
physicians in acute stroke triage to estimate individual treatment benefit especially in patient’s with prolonged treatment intervals.

Figure 1: Time-dependent infarct prediction of a patient with acute middle cerebral artery occlusion, NIHSS of 18 and onset 2.5 hours ago. The different pictures show the infarct outcome after successful recanalization (TICI 2b-3) with different delays between onset and recanalization (top left: 2.5h, top right: 3.5h, bottom left: 5.5h, bottom right: 7.5h).

(Filename: TCT_O-361_fig1.jpg)
Purpose
Establishing a timeline of acute infarct is prone to uncertainty but remains important in selecting time-sensitive treatments. In an acute stroke animal model, T1 Rho increased linearly in the first 6 hours after middle cerebral artery occlusion, making it possible to objectively date stroke onset. In this feasibility study, we show that a rapid, noncontrast T1 Rho MR sequence during acute stroke can be obtained, and T1 rho values in infarct core and surrounding brain tissue can be quantified in humans.

Materials and Methods
This prospective IRB-approved study included seven acute stroke patients scanned at 3T. Standard diffusion-weighted imaging (DWI) was obtained. T1 Rho MR used a whole-brain 3D technique with spin lock times (TSL) of 1, 10, 30, 50 and 70 ms at spin lock frequency of 300 Hz (acquisition time ~ 7 minutes). Postprocessing used FSL and Matlab. Each spin lock time was registered linearly to the first time point (TSL = 1 ms), and mono-exponential decay was applied to the 5 TSLs to generate a T1 Rho map. Regions of interest were drawn around the infarct on DWI and coregistered to T1 Rho images. Peri-infarct ROIs also were created on T1 Rho images using a mask dilation method. Contralateral normal brain parenchyma served as within subject controls. Mean T1 Rho were quantified and compared using a Student's t-test.

Results
Mean T1 Rho within the infarct ROI were significantly higher compared to contralateral normal brain ROI (p<0.005, 111.16 +/- 13.4 and 94.13 +/- 14.8 ms, respectively). Mean T1 Rho within the peri-infarct ROI were higher compared to the corresponding contralateral region but not significant (p<0.08, 105.89 +/- 16.36 and 94.65 +/- 22.06 ms, respectively).

Conclusions
T1 Rho is feasible and can both detect and quantify acute ischemic stroke in humans. A trend of abnormal peri-infarct T1 Rho signal suggests that T1 Rho may be able to assess penumbra. Longitudinal measurements to document how T1 Rho changes with infarct progression are needed.
Natural fate of ischemic penumbra is less time dependent and more a measure of collateral flow

A Vagal¹, R Aviv², H Sucharew³, M Reddy⁴, H Hua⁵, P Michel⁶, T Jovin⁷, M Wintermark⁸, P Khatri⁹
¹Univ. Hosp./Univ. Cincinnati College Of Medicine, Cincinnati, OH, ²Sunnybrook Research Institute, Toronto, Ontario, ³Cincinnati Childrens Hospital Medical Center, Cincinnati, OH, ⁴University Of Cincinnati Medical Center, Cincinnati, OH, ⁵University of Virginia, Charlottesville, VA, ⁶University of Lausanne, Lausanne, AL, ⁷University of Pittsburgh, Pittsburgh, PA, ⁸Stanford University, Stanford, CA, ⁹University Of Cincinnati Medical Center, Cincinnati, OH
Purpose
Perfusion and collateral imaging is being used increasingly in the evaluation of acute ischemic stroke with ischemic penumbra as a potential therapeutic target, particularly in later time windows. However, the natural history of the fate of penumbra without reperfusion treatment is understudied. We sought to determine how time from stroke onset to imaging and collaterals affect penumbral salvage in untreated stroke patients.

Materials and Methods
We analyzed all untreated acute stroke patients (without IV tPA or endovascular treatment) who received baseline CT angiogram (CTA) and CT perfusion (CTP) within 24 hours and follow-up CTA or MR angiogram within 24-48 hours utilizing a large, prospectively collected, multicenter acute stroke registry. Baseline CTA was reviewed for arterial occlusion and collateral status, and follow-up CTA/MRA was reviewed to determine recanalization status. Baseline CTP was assessed for ischemic core (rCBF<30%) and penumbra volume (Tmax >6). Final infarct volume (FIV) was measured on follow-up computed tomography (CT) and magnetic resonance imaging (MRI). Penumbra salvage was defined as Penumbra−FIV and penumbral fraction was defined as Penumbra / Penumbra + Ischemic core volume. Associations were assessed between penumbral salvage and time from onset to imaging and collaterals.

Results
Among 110 untreated ischemic stroke subjects, 16 had nondiagnostic perfusion studies. Among 94 remaining subjects, mean age was 65 years, median NIHSS was 13, and median (range) time from stroke onset to baseline imaging was 2.9 (0.4-23) hours. The median (range) of ischemic core volume was 31 (0.4-172), penumbra 42 (0.4-412) FIV 9.8 (0-253) cc. There was no significant correlation between salvaged penumbra and time (r= 0.06; p=0.56). There was a trend towards a positive correlation between penumbral fraction and time (r=0.20; p=0.05) without statistical significance. Better collaterals were associated with larger salvaged penumbra (r=0.32, p<0.01).

We further analyzed the data by stratifying according to recanalization status. There was no evidence of an association between spontaneous recanalization and collateral score (median: 1 versus 2, p-value = 0.54), baseline ASPECTS (median: 14 versus 13, p-value = 0.57), penumbral salvage (median: 0 versus 0, p-value=0.35) or penumbral fraction (median: 0.54 versus 0.54, p-value = 0.85).

Conclusions
In this multicenter cohort of untreated acute stroke patients, we found no evidence of time dependence of the natural tissue fate of penumbra, but rather an association with collateral flow. Larger studies are warranted to understand natural history of penumbra that can inform future trials and could have treatment implications particularly in delayed or unknown onset time.

O-365
MR Perfusion to Determine the Status of Collaterals in Patients with Acute Ischemic Stroke: Look Beyond Perfusion Time-maps

K Nael¹, J Knitter¹, A Doshi¹, J Mocco¹, R Deleacy¹, J Bederson¹, T Naidich¹
¹Icahn School of Medicine at Mount Sinai, New York, NY

Purpose
Collateral flow is an independent predictor of reperfusion, infarct size, and clinical outcome in patients with acute ischemic stroke (AIS). Magnetic resonance perfusion time-maps show delayed perfusion but are unable to differentiate antegrade from collateral flow if used alone. In this study, using a multiparametric approach, we aimed to identify a perfusion biomarker that can represent the extent of collaterals in comparison to angiographic findings.

Materials and Methods
Acute ischemic stroke patients with anterior circulation proximal occlusion who had baseline MR perfusion and cerebral angiography were evaluated. MR perfusion data were processed using Bayesian method to generate arterial tissue delay (ATD) maps at thresholds of 2, 6 seconds. The volume of delayed perfusion (Vol-ATD2sec), critical hypoperfusion (Vol-ATD6sec), and hypoperfusion (Vol-ATD 2sec-6sec) in addition to corresponding values of rCBV and rCBF were calculated using volume-of-interest (VOI) analysis. Collateral status was dichotomized to poor (TICI 1-2a) or good collaterals (TICI 2b, 3), using baseline cerebral angiography. The association of perfusion biomarkers was assessed with the status of collaterals using repeated measure of analyses. Receiver operating characteristic (ROC) analysis was performed to determine the optimal parameters and threshold for predicting the status of collaterals.

Results
In 37 patients included, 20 (54%) had good collaterals (TICI≥ 2b) using cerebral angiography. After controlling for age, baseline NIHSS and infarct volume, multivariate logistic regression analysis identified rCBV (p=0.001) and hypoperfused volume (Vol-ATD 2sec-6sec) (p=0.01), but not rCBF (p=0.08), Vol-ATD 2sec (p=0.3) or Vol-ATD 6sec (p=0.07), as independent predictors of good collaterals. For rCBV, ROC analysis showed the greatest AUC (0.89) at the threshold > 2.1 with sensitivity/specificity of 85%/90%. For Vol-ATD 2sec-6sec, ROC analysis showed the greatest AUC (0.78) at a threshold > 51 ml with sensitivity/specificity of 70%/82%. Hypoperfused tissue volume (Vol-ATD 2sec-6sec) multiplied by its rCBV, termed hypoperfused tissue collateral index, remained an independent predictor of good collaterals, with improved diagnostic accuracy over each measure alone (AUC: 0.96 at a threshold > 90, sensitivity/specificity of 91%/100%).
Conclusions
Multiparametric MR perfusion can be used to assess the status of collaterals in patients with AIS. Hypoperfused tissue collateral index defined as hypoperfused volume (Vol-ATD 2sec-6sec) x rCBV is a new perfusion index with diagnostic accuracy of 96% compared to angiographic findings to predict status of collaterals.

O-366

Recanalization and Outcome Comparisons in Acute Ischemic Stroke Patients Treated with Mechanical Thrombectomy Selected by CT/MR Perfusion Imaging Versus CT Angiography

A Honarmand¹, A Shaibani², M Hurley², M Potts², B Jahromi², S Ansari²
¹Northwestern University Feinberg School of Medicine, Chicago, IL, ²Northwestern University, Feinberg School of Medicine, Chicago, IL

Purpose
Several randomized controlled trials, have demonstrated improved percentages of independent clinical outcomes with computed tomography (CT)/magnetic resonance (MR) perfusion selection in acute ischemic stroke (AIS), albeit with more stringent patient exclusion. Conversely, preprocedure CT angiography (CTA) is gaining increasing credence among neurointerventionalists for documenting emergent large vessel occlusion and as a surrogate for tissue selection via collateral imaging. In this study, we compared the level and times to recanalization as well as clinical outcomes in patients selected for endovascular thrombectomy based on their perfusion versus single phase CTA imaging selection.

Materials and Methods
We performed a prospective IRB approved multicenter study of consecutive AIS patients presenting <6 hours from symptom onset that underwent mechanical thrombectomy. Patients were selected after CTA/MRA confirmed ICA/MCA M1-M2 occlusion and either CTP/MRP (favorable mismatch ratio/core infarct volumes) or CT/CTA (ASPECTS > 6 and pial collaterals > 2/3 MCA) imaging selection. Patient demographics, baseline NIHSS score, THRIVE score, symptom onset to groin puncture times, and the type of thrombectomy devices utilized for recanalization were studied. Modified Rankin Scale score of 0-2 at 90 days defined good functional outcome. Recanalization was delineated by the neurointerventionalist at the end of the thrombectomy according to modified TICI classification. Ordinal recanalization scores of 0, 1, 2, 3, and 4 were assigned to TICI classification of 0, 1, 2a, 2b, and 3, respectively for further evaluation of recanalization/reperfusion level. TICI scores of 2b and 3 defined successful recanalization. Chi-square, student t test, Mann-Whitney U, and Kruskal–Wallis tests were utilized for statistical analysis as appropriate.
Results
Seventy patients (37 F/33 M, mean age±SD of 64.43±15.08 years) were recruited into the study. Based on preprocedure imaging, consecutive patients were selected for endovascular thrombectomy either by CTA (n=35) or perfusion studies (n=35). Both groups were comparable in terms of demographics, NIHSS score, THRIVE score, and thrombectomy devices utilized for recanalization. Symptom onset to groin puncture time was significantly lower in the CTA group (mean= 138.50 min in CTA VS. 224.25 min in perfusion groups, P=0.012). Recanalization scores were not significantly associated with the type of thrombectomy devices (P=0.782). Although recanalization scores were significantly higher in patients selected by CTA compared with perfusion imaging (P=0.020), successful recanalization (TICI 2b/3) was not significantly different (P=0.155). There was a nonstatistically significant trend for good functional outcome in CTA group (P=0.07). Good functional outcome was associated significantly with successful recanalization (P<0.005).

Conclusions
Mechanical thrombectomy patients selected by CTA or perfusion imaging demonstrated no difference in successful recanalization rate, but higher level of recanalization/reperfusion and a trend of improved outcomes with CTA selection that may be attributed to improved treatment times.

O-367
Clinical Utility of Arterial Spin Labeling Perfusion Images in the Emergency Department for the Work-up of Stroke-Like Symptoms

K Buch¹, W Copen², O Wu¹, G Gonzalez¹, P Schaefer¹
¹Massachusetts General Hospital, Boston, MA, ²Massachusetts General Hospital, Boston, MA

Purpose
Discrimination between acute stroke and stroke-like conditions can be a diagnostic dilemma. While diffusion-weighted imaging (DWI) is highly sensitive and specific for diagnosing acute stroke, arterial spin labeling (ASL) imaging may improve the differentiation of stroke from stroke mimics and may improve risk stratification.

Materials and Methods
Arterial spin labeling and DWI images from 282 consecutive magnetic resonance imaging (MRI) examinations performed in the emergency department were reviewed. Diffusion-weighted images were evaluated for presence of restricted diffusion, and lesion volumes were calculated. FLAIR and GRE sequences were evaluated for additional abnormalities. Arterial spin labeling-derived cerebral blood flow (CBF) maps were evaluated for decreased, normal or increased CBF, and volumes of lesions
with decreased CBF were calculated. NIHSS, length of hospital stay, and incidence of future neurologic events were extracted from medical records. Correlations between abnormalities on ASL and NIHSS and clinical outcomes were evaluated using a two-tailed T-test.

Results

Of 282 MRI exams reviewed, 95 patients had a final diagnosis of acute infarction, 20 of seizures, and 167 of transient neurologic symptoms. Eighty-two patients had an ASL abnormality and 200 had no ASL abnormality. Arterial spin labeling showed elevated CBF in 29 patients, and decreased CBF in 53 patients. Of the 29 patients with elevated CBF, 26 had reperfusion hyperemia in the setting of infarction, and none of these infarcts grew substantially on follow-up imaging. Three had normal DWI with hyperemia due to seizures. Forty-seven of 53 patients with low CBF had acute infarction with a diffusion abnormality. Ten of 47 had a CBF/DWI mismatch (ratio of > 1.8 CBF/DWI). In follow-up imaging, those with a mismatch demonstrated significantly larger lesion growth (P <0.05) compared to those without a mismatch. Six of 53 had low ASL without a diffusion abnormality. Two of six developed a DWI abnormality on follow-up. The negative predictive value (NPV) of the ASL in predicting a neurologic event requiring hospital admission was 93.5%. The NPV of ASL related to an abnormality detected on other MRI sequences was 91.3%.

Statistically significant differences were seen in the NIHSS (median 6.0 versus 1.0, P<0.0001), length of hospital stay (mean 5.7 versus 1.0 days, P< 0.0001), and incidence of a future neurologic event (71% versus 6.0%, P = 0.003) in patients with versus without an ASL abnormality.

Conclusions

Arterial spin labeling is highly useful in the evaluation of patients with stroke-like symptoms in the emergency setting. Patients with acute neurologic deficits and normal ASL are unlikely to require hospital admission, to have abnormalities identified on other MRI sequences, to have major neurologic deficits, to require a lengthy hospital stay or to have future neurologic deficits. Arterial spin labeling may demonstrate low CBF in patients with normal DWI, thereby confirming that a lesion is due to ischemia and not a stroke mimic. Patients with an CBF/DWI mismatch have significantly more infarct growth, compared to those without a mismatch.

O-368

3:42PM - 3:45PM

Noninvasive assessment of quantitative oxygen extraction fraction in ischemic stroke by MRI susceptibility: a pilot study

A Fan1, A Khalil2, J Fiebach2, A Villringer3, G Zaharchuk1, K Villringer2, C Gauthier4
Purpose
The ability to noninvasively quantify oxygen extraction fraction (OEF) would provide meaningful metabolic data to inform diagnosis and selection of therapy for patients with stroke (1). However, this measurement is technically challenging and no standard method currently exists to image OEF by magnetic resonance imaging (MRI). This study tests a new MRI approach, quantitative susceptibility mapping (QSM) (2, 3), to measure absolute OEF (%) along cerebral veins in patients with ischemic stroke at baseline and follow up.

Materials and Methods
Five patients (ages 60-86 years) were scanned on average 18.2 hours after stroke onset at 3T. Patients were admitted with median NIHSS score of 8 and discharged with median score of 4. Flow-compensated gradient echo phase images were acquired for OEF assessment: TR/TE = 20/12ms; 0.63x0.63x0.8mm3; bandwidth = 220Hz/pixel; 2x GRAPPA acceleration; scantime ~5 min. Each patient received a follow-up QSM scan on average 3.8 days after the first scan; two of five patients received thrombolysis between the two scans. Bolus-tracking perfusion and T1-weighted scans also were collected after gadolinium injection to look at mean transit time (MTT) and vascular anatomy, respectively. For preprocessing, background fields were first removed from the phase images with a spherical harmonic approach. Quantitative susceptibility maps then were reconstructed through a dipole inversion of the phase map with an L1-norm smoothness prior (4). On these maps, susceptibility values in veins ($\chi_{\text{vein}}$) are sensitive to oxygenation levels due to the presence of paramagnetic deoxyhemoglobin molecules in venous blood. We identified two of three cortical veins near the infarct and three veins in the contralateral hemisphere for OEF assessment. We quantified OEF=$1 - (\chi_{\text{vein}} - \chi_{\text{water}})/(\Delta\chi_{\text{do}} \times \text{Hct})$ where $\chi_{\text{vein}}$ was estimated from the 10% brightest voxels in the vessel, $\Delta\chi_{\text{do}} = 0.27$ppm, and $\chi_{\text{water}}$ was estimated from cerebrospinal fluid (CSF).

Results
Bright signals on QSM maps corresponded to venous structures seen on gradient echo magnitude and postcontrast T1 scans (Fig. 1). Patients with larger areas of MTT delay (Case 1) tended to have higher OEF in areas of stroke relative to the normal hemisphere; patients with smaller areas of MTT delay tended to have more similar OEF between affected and unaffected areas (Case 2). In all patients, the OEF ratio between the symptomatic and contralateral hemispheres was $\geq 1$ (Table 1). In two patients, this OEF ratio normalized between the baseline and follow-up scans, while in all other patients this OEF ratio remained stable between the two time points.
Conclusions
Quantitative OEF assessment by susceptibility mapping in veins is feasible for stroke patients and is consistent with previous qualitative vessel assessment in patients (5). Ongoing work focuses on the relationship between longitudinal OEF changes and clinical and imaging metrics, to better characterize tissue metabolism at various stages of stroke progression.

Table 1: Oxygen extraction fraction (OEF) from area of stroke and contralateral hemisphere

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<th>Patient</th>
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<th>Follow-up</th>
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O-369

Extent of Insular Infarct on CT as a Prognostic Indicator of Intraarterial Treatment for Acute MCA Occlusion

J Gadde\textsuperscript{1}, A Iaia\textsuperscript{2}, C Flores\textsuperscript{2}, R Hu\textsuperscript{3}, M Lev\textsuperscript{3}, S Kamalian\textsuperscript{3}

\textsuperscript{1}University of Wisconsin, Madison, WI, \textsuperscript{2}Christiana Care Health System, Newark, DE, \textsuperscript{3}Massachusetts General Hospital, Boston, MA
Purpose
The purpose of this study was to determine whether the extent of insular infarct on admission computed tomography (CT) in patients with acute MCA occlusion can predict clinical outcome after intra-arterial treatment.

Materials and Methods
A retrospective review was performed of patients treated for acute MCA infarct as a Stroke Code or Stroke Alert at our institution. Inclusion criteria included patients who received intra-arterial treatment (IAT), documented NIHSS at presentation and discharge and mRS at discharge and 90 days. Two independent CAQ certified neuroradiologists categorized the degree of insular infarction on noncontrast CT exam as <25%, 25-50%, or >50% involvement. A consensus reading was reached between the two reviewers. A TICI score of 2b or 3 was used as the definition of recanalization.

Results
Twenty-eight patients met the inclusion criteria. Patients with insular infarct of <50% had significant clinical improvement after recanalization (p=0.005), and those with insular infarct >50% did not have significant improvement (p=0.87). However, multivariate analysis demonstrated no significant interaction of insular infarct and recanalization on overall patient outcome.

Conclusions
In this cohort of IAT patients with acute MCA occlusion, the greatest clinical benefit of IAT was seen in the subgroup of patients with "small" insular infarcts on admission CT. We currently are investigating whether the extent of insular infarct on CT is an independent outcome marker compared to admission ASPECTS, and/or whether the difference in predictive value between CT-insula score and diffusion-weighted imaging (DWI)-insula score can be attributed to the different time sensitivities of these modalities.

Wednesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Maryland A/B/C

17E-PARALLEL PAPER SESSION: Brain Tumors: Diffusion and Perfusion Techniques
O-370

A MULTI CENTRIC 3T MR ASSESSMENT OF T2 PERFUSION AND T1 PERMEABILITY IN BRAIN GLIOMAS (MAPPING STUDY): comparison of diagnostic accuracy in preoperative grading.
Purpose
Dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) recently has demonstrated to have similar accuracy to dynamic susceptibility contrast (DSC) MRI in glioma grading, but still lacks standardization for MRI data acquisition and analysis. This prospective study aims to verify the diagnostic accuracy of both DCE and DSC techniques for glioma grading applying a definite protocol for data acquisition and processing in a multicentric setting.

Materials and Methods
This prospective study included 92 patients with newly diagnosed gliomas; pre-operative MR studies were performed on 3T magnets in seven centers. Histologic diagnosis was obtained for all the patients through a biopsy or surgery procedure (26 WHO II and 66 III/IV WHO). The acquisition protocol included two injections of 5 ml of gadobutrol one for DCE and one for DSC MR imaging in the same setting. Perfusion data were analyzed with NordicIce (NordicNeuroLab, Bergen, Norway). Parametric maps of Ktrans, Vp, Ve and area under concentration curve (AUC) were obtained from DCE data sets; parametric map of relative CBV (rCBV) from DSC data sets. For each parameter the maximal abnormality through hotspots-based method was evaluated. Diagnostic accuracy was assessed using receiver operating characteristic (ROC) analysis.

Results
In differentiating low- from high-grade astrocytomas, the accuracy of Vp, Ktrans, Ve, AUC and rCBV (area under the curve = 0.88, 0.90, 0.90, 0.91, 0.90 respectively) resulted to be very similar. Cutoff values of Vp, Ktrans, Ve, AUC and rCBV (1.73%, 0.025 min-1, 1.75%, 0.049, 3.67 ml/100g respectively) showed a sensitivity and specificity of 83%, 81% for Vp, 83%, 88% for Ktrans, 88%, 85% for Ve, 86%, 85% for AUC and 85%, 88% for rCBV.

Conclusions
A definite DCE and DSC protocol is feasible for multicentric studies with different MR equipments and central analysis. The results confirmed the high diagnostic accuracy of DCE and DSC for glioma grading.

O-371

3:08PM - 3:16PM
Correlation between Histopathology Defined Percentage Tumor Recurrence, Dynamic Contrast Enhanced (DCE), and Dynamic Susceptibility Contrast (DSC) Perfusion Parameters in Treated High Grade Gliomas.

N Zakhari1, T Nguyen2, A Boivin3, G Jansen4, J Woulfe2, G Cron2, R Thornhill2
1The Ottawa Hospital, Ottawa, Ontario, 2The Ottawa Hospital University of Ottawa, Ottawa, Ontario, 3University of Ottawa, Ottawa, Ontario, 4The Ottawa Hospital University of Ottawa, Ottawa, Ontario

Purpose
New enhancing lesions after surgery and chemoradiation for high grade glioma commonly contain variable proportions of tumor recurrence (TR), tissue necrosis and treatment-related changes. Our purpose is to determine whether magnetic resonance (MR) perfusion parameters correlate with the percentage of TR in these lesions.

Materials and Methods
Patients with treated high grade gliomas who developed a newly enhancing lesion on follow-up MRI and who underwent re-resection were enrolled prospectively. Each patient underwent dynamic contrast-enhanced (DCE) and dynamic susceptibility contrast (DSC) perfusion MR. Histogram and hot spot analysis were performed for each parametric map (Ktrans, AUC, Vp, uncorrected cerebral blood volume (CBV) and leakage corrected CBV. Tumor recurrence percentage was defined histopathologically. The lesions were categorized into predominant TR (=tumor>50%), predominant treatment related changes (T=<20%) and mixed lesions (20 %< T=<50%). Spearman's rho correlation coefficient was used to express the correlation between TR percentage and perfusion parameters. Differences between the groups were assessed via Kruskal-Wallis and Mann-Whitney U tests.

Results
There were 25 predominant tumors, three predominant treatment-related lesions and four mixed lesions. Moderate correlation with TR percentage was seen only with corrected CBV values on hot spot analysis (r = 0.53, 95% CI 0.23 to 0.74, p= 0.002) (Fig.1) and noncorrected CBV peak height position on histogram analysis (r= 0.41, 95% CI 0.07 to 0.66, p=0.022). Statistically significant difference was seen only for hot spot corrected CBV between the three groups (p=0.048), mainly between the mixed and predominant tumor groups (median (IQR) 2.31 (1.69 - 2.42) versus 3.23 (2.44 - 4.31); p=0.046) (Figs. 2 and 3). Other parameters showed no statistically significant difference between the groups and weaker or no statistically significant correlation with TR proportion.

Conclusions
Leakage-corrected CBV might be useful in predicting the TR proportion and to differentiate between the different causes of abnormal enhancing lesions in post-treatment high grade gliomas.
Scatter diagram shows moderate correlation between the TR percentage and the corrected CBV values on hotspot analysis.
Prognostic Utility of Diffusion Tensor Imaging and Dynamic Susceptibility Contrast MR Perfusion in Patients with Brain Metastases

Y Chen¹, S Wang¹, S Chawla¹, L Loevner¹, M Alonso-Basanta¹, H Poptani², S Mohan¹
¹Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, ²University of Liverpool, Liverpool, United Kingdom

Purpose
Graded prognostic assessment [GPA (1)] and recursive partitioning analysis [RPA (2)] generally are used clinically for prognosis in patients with brain metastases. A recent study reported borderline significant survival differences (p≈0.04–0.05) in patients grouped by mean diffusivity (MD) (3). Besides MD, diffusion tensor imaging (DTI) (measure of anisotropy) and dynamic susceptibility contrast (DSC) MR perfusion (measure of vascularity) are biomarkers of tumor micro-environment that may be more biologically relevant. This study evaluated the prognostic potential of DTI, along with cerebral blood volume (CBV), which has not been reported previously in brain metastases.

Materials and Methods
Magnetic resonance imaging (MRI) from 101 patients (49 M:52 F, age 59±12 years) diagnosed with brain metastases in 2006–2013 were analyzed retrospectively. Primary tumor was lung (n=56), breast (n=15), and other (n=30). All patients had brain MRI with DTI and DSC prior to any treatment for brain metastases. Six patients were excluded from DSC analysis due to susceptibility artifacts. Clinical data included tumor type, Karnofsky Performance Scale (KPS), GPA, RPA, and length of survival after initial diagnosis of brain metastasis. Diffusion tensor imaging metrics and CBV (based on DSC) were quantified from enhancing areas of dominant metastasis segmented semi-automatically (4). Diffusion tensor imaging metrics included MDmin (average of lowest 10% of segmented voxels), as well as fractional anisotropy (FA) and linear (CL)/planar (CP)/spherical (CS) anisotropy coefficients [average of lowest 25% (Q25) and average of highest 25% (Q75) of segmented voxels, to account for tumor heterogeneity]. Relative CBVmax (rCBVmax) was average of highest 10% of segmented voxels normalized to contralateral white matter. For each metric, patients were placed into two groups [based on literature (3) for MDmin and preliminary results for other metrics]: 1) MDmin – above and below median MDmin; 2) FA/CL/CP/CS – above and below first quartile of respective metric; 3) rCBVmax – above and below third quartile of rCBVmax. Kaplan-Meier analysis was used to detect significant group differences in survival (p<0.05).

Results
Median KPS score was 80 and median survival was 301 days. Survival differences by GPA class (p<0.001) and RPA class (p<0.001) were significant, indicating a valid
cohort. Survival by tumor type (lung/breast/other) was not significantly different (p=0.23). Significant group differences in survival were seen with MDmin (p=0.013), FA Q25 (p=0.009), CL Q25 (p=0.049), and CP Q25 (p=0.009) (Figure). However, CS did not predict survival. In addition, no significant group difference in survival was observed with rCBVmax (Figure).

Conclusions
This study suggests that brain metastases with lower FA/CL/CP (lower anisotropy suggesting disorganized tumor micro-environment) have a more favorable prognosis. In contrast to primary brain tumors, rCBVmax did not predict survival in brain metastases. These findings need to be validated in a multi-institutional setting to evaluate prognostic utility of DTI in this patient population.
Figure. Kaplan-Meier survival analysis shows significant group differences in survival with $\text{MD}_{\text{min}}$ (A), FA Q25 (B), and CP Q25 (C) (similar result with CL Q25, not shown). In contrast, no significant group difference in survival was seen with $r\text{CBV}_{\text{max}}$ (D). For each metric, patients were placed into two groups as defined in the Materials and Methods section.
Perfusion Weighted Imaging in the Study of Brain Gliomas: Reproducibility and Comparison of Data Obtained by Using Two Different Software Platforms

g conte1, a castellano2, A Iadanza3, M Cadioli3, N Anzalone3, A Falini3
1San Raffaele Hospital, Milan, Italy, 2San Raffaele hospital, milan, CA, 3San Raffaele Hospital, Milan, CA

Purpose
The aim of this study was to evaluate the effect of using different softwares on reproducibility of perfusion parameters in a group of gliomas. We evaluated intra- and interobserver reproducibility (intrasoftware reproducibility) and intersoftware reproducibility.

Materials and Methods
We retrospectively evaluated dynamic contrast-enhanced magnetic resonance imaging (MRI) (DCE) and dynamic susceptibility contrast MRI (DSC) data sets of 20 patients with gliomas (8 WHO II, 4 WHO III and 8 WHO IV) using a 3.0T magnet. Perfusion data were postprocessed with two software: NordicIce (NordicNeuroLab, Bergen, Norway) and Olea Sphere (Olea Sphere, Olea Medical Solutions, La Ciotat, France); in Olea Sphere both automatic and manual detection of vascular input function (VIF) was used. Parametric maps of Ktrans and Vp were obtained from DCE data sets; parametric map of cerebral blood volume (CBV) from DSC data sets. For each parameter we evaluated the maximal abnormality through hotspots method. All patients were analyzed by two independent observers blinded to the histological grade using both softwares. Each observer repeated the analysis after 1 month to evaluate intra-observer reproducibility. Additionally, in each patient we compared DCE and DSC parameters obtained selecting the same regions of interest (ROIs) with the two softwares. To assess reproducibility of data we used intraclass correlation coefficient (ICC) and Bland-Altman analysis.

Results
Intraclass correlation coefficient for intra- and interobserver reproducibility was higher than 0.8 in almost all cases for each parameter and each software suggesting almost perfect agreement. Intraclass correlation coefficient for intersoftware reproducibility ranged from 0.3 to 0.6 suggesting poor to moderate agreement; we obtained similar results selecting same ROIs with the two softwares.

Conclusions
Our results show that each software guarantees almost perfect intra- and interobserver reproducibility. Best reproducibility is obtained when automatic detecting of VIF is
selected in Olea Sphere. The finding of low intersoftware reproducibility suggests that caution should be taken when comparing results obtained with different softwares.

O-374

3:32PM - 3:40PM

Arterial Spin Labeling Perfusion in Differentiation of Primary and Secondary Glioblastomas

A Tonoyan¹, T Ovcharenko², L Shishkina¹, I Pronin³

¹Burdenko Neurosurgery Institute, Moscow, Russian Federation, ²Pirogov Russian National Research Medical University, Moscow, Russian Federation, ³Burdenko Neurosurgery Institute, Moscow, Russian Federation

Purpose

Glioblastoma (GBM) is the most frequent malignant primary brain tumor in adults. Glioblastomas are subdivided into two groups based on their origin and genetic alterations: primary and secondary GBMs (1, 2). It is believed that secondary GBMs have better prognosis than primary. Due to the fact that vascularization increases with higher glioma malignancy grade (3), we were interested whether primary and secondary GBMs exhibit different tumor tissue perfusion values. Therefore, our purpose was to investigate with the use of arterial spin labeling (ASL) if there is a correlation between tumor blood flow (TBF), clinical data, and origin of GBMs.

Materials and Methods

We studied 37 patients with histologically proved GBM: 14 primary and 23 secondary GBMs. Then these patients were reformed into two groups based on the duration of symptoms: 24 patients had a clinical history less than 3 months, 13 − more than 3 months. Absolute and normalized (to contralateral normal white matter) maximum (aTBFmax, nTBFmax) and mean (aTBFmean, nTBFmean) values of tumor blood flow were measured for each patient in the contrast-enhanced tumor areas. All of these parameters were compared in the groups of patients using the Mann-Whitney test.

Results

The values of aTBFmax, aTBFmean, nTBFmax, nTBFmean tend to be higher in primary GBMs (169 ± 72 ml/100g/min, 115,1 ± 36,5 ml/100g/min, 11,1 ± 6,6 ml/100g/min, 7,3 ± 3,6 ml/100g/min respectively) compared to secondary GBMs (152,2 ± 65,4 ml/100g/min, 103,9 ± 48,8 ml/100g/min, 8,4 ± 4,5 ml/100g/min, 5,6 ± 3,1 ml/100g/min respectively), but without any statistic significance (p>0,05). The values of aTBFmax, aTBFmean, nTBFmax, nTBFmean were higher in GBMs with clinical history less than 3 months (153,5 ± 55,2 ml/100g/min, 109,1 ± 54,2 ml/100g/min, 9,1 ± 5 ml/100g/min, 6,4 ± 3,1 ml/100g/min respectively) compared to GBMs with clinical history more than 3 months (147 ± 64,5 ml/100g/min, 98,1 ± 55,2
ml/100g/min, 8.9 ± 4.8 ml/100g/min, 5.8 ± 3.5 ml/100g/min respectively), but also without any statistic significance (p>0.05).

Conclusions
It is well known that tumor vascularization and blood flow values significantly increase with higher glioma malignancy grade. In spite of that fact tumor blood flow values obtained by ASL cannot be used as reliable criteria for differentiation of primary and secondary GBMs and do not depend on aggressiveness of GBMs.
A study of high signal intensity on using ASL outside the contrast-enhanced area in brain tumors using a DSC perfusion technique.

T Abe¹, H Kabasawa², T Matsuda², M Harada³
¹Tokushima University Graduate School, Institute of Biomedical Sciences, Tokushima, Tokushima, ²GE Healthcare Japan, Hino, Tokyo, ³Tokushima University Graduate School, Tokushima, Tokushima

Purpose
We previously reported the finding of high signal intensity on an arterial spin labelled (ASL) image, outside a contrast-enhanced (CE) area [ASL-dominant (ASL-d), Figure 1, arrow] in an intra-axial brain tumor, which suggested glioma and lymphoma, but not metastasis (T Abe, et al. Magn Reson Med Sci. 2015. doi:10.2463/mrms.2014-
In this study, we investigated the changes in perfusion parameters observed in dynamic susceptibility contrast (DSC) magnetic resonance (MR) imaging.

Materials and Methods
We examined images from 13 consecutive patients with malignant glioma who underwent ASL, DSC, and CE-MR imaging using a 3T MR scanner. CBV, CBF, MTT, and Tmax from DSC data and CBF from ASL data (ASL-CBF) were obtained. Using relative CBV (rCBV), each parameter was normalized using brain parenchyma that appeared unaffected. A maximum of eight round-shaped regions of interest (ROIs), each with an area of 60 mm2, were selected on the ASL-d and CE images of each tumor. We investigated the correlation between the perfusion parameters in ASL-d and CE areas. In addition, the differences in each perfusion parameter between the ASL-d and CE-d areas were assessed using the Mann–Whitney U test, with a p-value < 0.05 required to achieve significance.

Results
The rASL-CBF on ASL-d area correlated with rCBV, rCBF, and rMTT (R = 0.67, 0.64, and 0.29 respectively). However, rASL-CBF correlated with rCBF, and rTmax on CE area (R = 0.41, −0.46, respectively). Difference: rASL-CBF was significantly higher on the ASL-d area compared with the CE-d area, whereas rCBF did not show a significant difference. The parameters, rCBV, rMTT, and rTmax were significantly lower on the ASL-d area. The value of rMTT and rTmax on ASL-d area was 1.04 and 1.01, respectively, which is almost the same as the normal appearing brain parenchyma.

Conclusions
The ASL-d area showed different perfusion characteristics compared with the CE area, and some perfusion parameters were almost the same as the normal appearing brain parenchyma. This indicates that the vessels on the ASL-d area have relatively natural features, probably resulting in these impressive imaging findings.
A study of high signal intensity on using ASL outside the contrast-enhanced area in brain tumors using a DCE permeability imaging.

T Abe¹, T Matsuda², H Kabasawa², M Harada³
¹Tokushima University Graduate School, Institute of Biomedical Sciences, Tokushima, Tokushima, ²GE Healthcare Japan, Hino, Tokyo, ³Tokushima University Graduate School, Tokushima, Tokushima

Purpose
We previously reported that presence of high signal intensity outside the contrast-enhanced (CE) area on arterial spin labeling (ASL) images of intra-axial brain tumor indicated glioma and lymphoma, and not metastasis (T Abe, et al. Magn Reson Med Sci. 2015. doi:10.2463/mrms.2014-0083). Here, we used dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) to investigate characteristics of vessels in areas showing ASL hyperintensity in regions outside the CE area (ASL-d areas).

Materials and Methods
We examined images from 16 patients with malignant glioma who underwent ASL, DCE, and CE-MR imaging on a 3T MR scanner. We acquired parameters for permeability (Ktrans), extravascular extracellular volume (Ve), and fractional plasma volume (fPV) from DCE data, and CBF from ASL data (ASL-CBF). A circular region of interest (ROI) of 60 mm² was set on each tumor. Up to eight ROIs were set in the ASL-d and CE areas for each tumor. Regions of interest also were set on brain parenchyma of normal appearance. We performed correlations between parameters and tested for significance using the Mann–Whitney U test at P < 0.05.

Results
Arterial spin labeling CBF from ASL-d areas correlated with fPV (R = 0.41) but not with any other parameters. Arterial spin labeling CBF from the CE area did not correlate with any parameters. Arterial spin labeling CBF, Ktrans, Ve, and fPV from ASL-d and CE areas were significantly higher than those from normal brain parenchyma, and Ktrans and Ve from CE areas were significantly higher than those from ASL-d areas. Arterial spin labeling CBF and Ve from CE areas indicated a nonsignificant trend towards higher values than in ASL-d areas.

Conclusions
Within ASL-d areas, fPV was significantly higher than in normal appearing brain parenchyma, although not significantly different from CE areas. Ktrans and Ve were higher than in normal appearing brain parenchyma, but significantly lower than that
from CE areas. This suggested that the ASL-d finding resulted from an enlarged vascular bed that was otherwise relatively normal in structure.

O-377

Additive value of Arterial Spin-Labeling (ASL) to Diagnose Residual or Recurrent Meningioma

K Kikuchi\textsuperscript{1}, A Hiwatashi\textsuperscript{1}, O Togao\textsuperscript{1}, K Yamashita\textsuperscript{2}, R Kamei\textsuperscript{1}, H Honda\textsuperscript{1}  
\textsuperscript{1}Kyushu University, Fukuoka, Fukuoka, \textsuperscript{2}Kyushu University, Fukuoka, Japan

Purpose
Arterial spin-labeling (ASL) imaging is useful to evaluate tumor blood flow. Arterial spin labeling could be useful in the detection of hyper vascular tumor. The purpose of this study was to evaluate the additive value of ASL on conventional postcontrast T1-weighted images (CE-T1-WI) to diagnose residual or recurrent meningiomas.

Materials and Methods
This retrospective study included 25 patients with residual or recurrent meningioma (20 females and 5 males; age range 32-85 year, median 65 years) and 25 sex- and age-matched controls without intracranial masses. Arterial spin labeling was obtained using pseudo-continuous method with labeling time of 1650 ms and post labeling delay of 2000 ms. Other imaging parameters were as follows: TR/TE = 4200/8.6 ms, EPI factor = 35, FOV = 240 x 240 mm\textsuperscript{2}, matrix = 64 x 64, slice thickness = 6 mm, slices= 20, total scan time = 4 m 40 s. Seven independent observers (four radiology residents and three neuroradiologists) took part in two reading sessions. In the first session, the observers read only conventional CE-T1-WI. In the second session, they read simultaneously ASL along with CE-T1-WI. We evaluated sensitivity and diagnostic performance for detecting residual or recurrent meningiomas. Diagnostic performance was assessed with figure-of-merit (FOM) calculated by jackknife free-response receiver-operating characteristic (ROC). Statistical analysis was performed by paired t-test. A p value < 0.05 was considered significant.

Results
Using only CE-T1-WI, the sensitivity and FOM for the residents, neuroradiologists and all readers were 69.0/97.7/81.3% and 0.80/0.95/0.86, respectively. Using CE-T1-WI with ASL, the sensitivity and FOM for the residents, neuroradiologists and all readers were 79.3/100/88.2% and 0.88/0.99/0.93, respectively. All but neuroradiologists showed statistically significant improvement when adding ASL to diagnose (p < 0.01).

Conclusions
It is beneficial to add ASL to diagnose residual or recurrent meningiomas on postcontrast T1-WI.
O-378

Anaplastic Astrocytoma versus Glioblastoma Histological Grading with MRI DSC Perfusion Technique: Cerebral Blood Volume versus Cerebral Blood Flow Utilizing Standard, Time Insensitive and Bayesian Deconvolution Methods

I Littig¹, G Fatterpekar², A Francheschi³, A Davis⁴
Purpose
Tumor cerebral blood volume and blood flow has been shown to broadly differentiate low-grade from high-grade gliomas (1, 2). However, there is sparse literature on utilization of magnetic resonance imaging (MRI) perfusion techniques to distinguish grade III anaplastic astrocytomas from grade IV glioblastoma (3). This might be related to MRI perfusion techniques utilizing simplistic area under the curve algorithms and single arterial input function limiting detailed analysis. Time insensitive and Bayesian models and multiple arterial input function measurements have been shown to improve accuracy (4, 5). We revisited the investigation using these models to determine which method and perfusion index might best differentiate grade III from IV glioma.

Materials and Methods
A HIPAA compliant IRB approved prospective study was performed. Surgical pathology and radiology reports were reviewed to identify 20 GB and 12 AA patients with MR dynamic susceptibility contrast (DSC) perfusion performed prior to surgical or medical treatment. Studies marred by artifact or significant co-synchronous pathology were eliminated. Perfusion analysis with standard (sSVD), time insensitive (oSVD), and Bayesian algorithms were performed. Four standardized intra-tumoral regions with greatest values were averaged. Statistical analysis using receiver operating characteristic (ROC) analysis was performed.

Results
Receiver operating characteristic analysis demonstrates that both rCBV and rCBF differentiate AA from GB (AUC 0.892 to 0.992). Varying algorithms conferred no difference within rCBV analysis although oSVD was the most superior rCBF analysis. Utilizing a 4.73 rCBV and a 5.42 rCBF threshold provides a 91.7% and 100% sensitivity and 100% and 95% specificity respectively of differentiating AA from GB.

Conclusions
Our study demonstrates that both rCBV and rCBF can be utilized to clearly differentiate anaplastic astrocytoma from glioblastoma utilizing MR DSC technique.
Progressive bevacizumab induced diffusion-restricted lesions indicate coagulative necrosis surrounded by non-enhancing tumor and are associated with decreased survival in recurrent glioblastoma patients

P LaViolette¹, H Nguyen¹, S Hurrell¹, J Connelly¹, E Cochran¹, S Rand¹
¹Medical College of Wisconsin, Milwaukee, WI

Purpose
The current standard of care for recurrent glioblastoma (GBM) patients is treatment with bevacizumab. In a subset of patients diffusion-restricted lesions have been seen on apparent diffusion coefficient (ADC) maps. The presence of these lesions has been associated with both increased and decreased overall survival (OS) in discrepant studies. This study investigates these lesions at autopsy to determine the underlying histology and their impact on OS.

Materials and Methods
Seven patients with recurrent GBM and progressive diffusion-restricted lesions were recruited for brain donation. To reduce tissue distortion during fixation and to align
brain slices with pre-mortem imaging, patient-specific 3D-printed molds and slicing jigs were created (Fig. 1). Tissue specimens were taken from regions identified radiographically as diffusion-restricted, H&E stained, digitized, and pathologically interpreted (Fig. 2). A second dataset from a retrospective patient population of 64 GBM bevacizumab cases was analyzed to assess the effect of diffusion restriction on OS. Patients were separated into three groups: no diffusion restriction (NDR), progressive diffusion restriction (PrDR), and stable diffusion restriction (StDR). A Kaplan-Meier analysis was performed.

Results
Six of the seven patients had progressive DRN at time of death while the seventh patient had recurrent tumor elsewhere. These lesions were comprised of coagulative necrosis surrounded by nonenhancing hypercellular tumor. Fig. 3 shows the survival curves comparing NDR, PrDR, and StDR, where StDR patients had significantly greater OS and PrDR had significantly lower OS than NDR patients (both p<0.05).

Conclusions
We found diffusion-restricted lesions were coagulative necrosis. Importantly, PrDR further indicated that the necrotic region was surrounded by viable nonenhancing tumor. StDR was associated with greater OS while PrDR indicated decreased OS compared to NDR patients. Our autopsy results double the number of diffusion-restricted necrosis cases reported in current literature, but further research is needed to establish the biological basis for bevacizumab causing DRN.
Pretreatment Diagnosis of Suprasellar Papillary Craniopharyngioma and Germ Cell Tumors of Adult Patients

H Lee¹, F Chang¹, W Guo¹
¹Taipei Veterans General Hospital & National Yang Ming University, Taipei, Taiwan

Purpose
Suprasellar papillary craniopharyngiomas and germ cell tumors in adults share some clinical and imaging similarities but have different therapeutic strategies and outcomes. This study aimed to evaluate the pretreatment diagnosis of these two tumors to improve the therapeutic outcome.
Materials and Methods
We retrospectively enrolled 18 adults with papillary craniopharyngiomas and 17 with germ cell tumors. The magnetic resonance imaging (MRI) findings were evaluated, including signal change and anatomical extension. The medical records were reviewed to collect clinical findings, management, and outcomes.

Results
The clinical findings of papillary craniopharyngiomas versus germ cell tumors were as follows: age: 46 +/- 13.9 years versus 23 +/- 7.1 years (P < .0001); diabetes insipidus: 2/18 (11%) versus 11/17 (65%) (P < .001); recurrence 13/16 (81%) versus 4/17 (24%) (P = .0031). The MR imaging findings of papillary craniopharyngiomas versus germ cell tumors were as follows: pituitary stalk thickening: 1.6 +/- 0.4 mm versus 5.4 +/- 4.2 mm (P < .0001); vertical infundibular extension: 1/18 (6%) versus 16/17 (94%) (P < .0001); sagittal spheric shape: 17/18 (94%) versus 1/17 (6%) (P < .0001); diffusion restriction: 1/17 (6%) versus 8/12 (67%) (P = .0009).

Conclusions
Younger age, diabetes insipidus, MR imaging characteristics of restricted diffusion, and vertical infundibular extension favor the diagnosis of germ cell tumors. Spheric shape without infundibular infiltration provides clues to papillary craniopharyngiomas, which originate from the pars tuberalis and are located outside the third ventricle. We suggest that suprasellar germ cell tumor is possibly an intraventricular lesion. Appropriate treatment planning can be initiated according to the diagnosis and anatomical location.

Location:

Wednesday
3:00PM - 4:30PM
Washington Marriott Wardman Park, Roosevelt 4

17F-PARALLEL PAPER SESSION: Pediatrics: Epilepsy, Autism, & Development
O-381

Is heterogeneity of cortical tubers useful for predicting the epileptogenicity in tuberous sclerosis complex (TSC) patients?: The preliminary results.

A Yogi1, Y Hirata1, P Pan1, H Ullman1, E Morimoto1, H Yokota1, I Orosz1, M Linetsky1, G Mathern2, N Salamon1
1Department of Radiology, David Geffen School of Medicine at UCLA, Los Angeles, CA, 2Department of Neurosurgery, David Geffen School of Medicine at UCLA, Los Angeles, CA
Purpose
It is challenging to identify the epileptogenic tubers in tuberous sclerosis complex (TSC) patients presurgically. This study aims to test whether the heterogeneous magnetic resonance (MR) feature of tubers can help predicting epileptogenic tubers.

Materials and Methods
Twenty-two consecutive patients with intractable epilepsy who underwent presurgical MRI including diffusion tensor imaging (DTI) between 2004 and 2013 were selected retrospectively from UCLA TSC cohort. Epileptogenic tubers were defined by presurgical work up with FDG-PET/MRI fusion, magnetoencephalography, intra-operative electrocorticography, and postoperative seizure outcome. A total of 33 epileptogenic tubers were selected as well as 92 nonepileptogenic tubers. Minimum, maximum, mean, median, and standard deviation (SD) of apparent diffusion coefficient (ADC) values in each tuber were measured. We categorized the tubers' spatial heterogeneity according to the classification shown in Table 1 and Fig.1. We used the Mann-Whitney U test to compare all quantitative variables between epileptogenic and nonepileptogenic groups and performed Pearson's correlation test to examine the correlation between SD and other parameters. Subsequently, we used analysis of variance (ANOVA) with the Kruskal-Wallis test to evaluate differences in frequency of epileptogenic tubers among the classes. We also used receiver operating characteristic (ROC) analysis for standard deviation (SD) of ADC and the classes of tubers, and the area under the curve (AUC) values were calculated.

Results
Maximum, minimum, and SD of ADC showed significant difference (p < 0.01, p = 0.03, and p < 0.001, respectively). Standard deviation of ADC positively correlated with maximum ADC of tuber (r²=0.86, p<0.001). Sixty-one, 29, 10, six, and 19 tubers were classified from classes one to five, respectively (Fig. 2). ANOVA demonstrated that the frequency of epileptogenic tubers was significantly different among each class (p<0.01). The AUC value of SD of ADC and five scales were 0.67 and 0.77, respectively.

Conclusions
Assessments of tubers' heterogeneity, especially spatial heterogeneity, may help to identify epileptogenic tubers in presurgical patients with TSC.
Table. 1 Five categories for spatial heterogeneity of tubers

<table>
<thead>
<tr>
<th>Categories</th>
<th>Imaging characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Mildly hyperintense on T2WI and FLAIR and isointense on T1WI</td>
</tr>
<tr>
<td>Type 2</td>
<td>Homogenous hyperintense on T2WI and FLAIR and hypointense on T1WI</td>
</tr>
<tr>
<td>Type 3</td>
<td>Heterogeneous hyperintense on T2WI and FLAIR and hypointense on T1WI</td>
</tr>
<tr>
<td>Type 4</td>
<td>Hyperintense on T2WI and hyperintense with a internal hypointense area degeneration on FLAIR</td>
</tr>
<tr>
<td>Type 5</td>
<td>Hyperintense on T2WI and hyperintense with multiple internal hypointense cystic degenerations on FLAIR</td>
</tr>
</tbody>
</table>

Fig. 1 An example of tuber’s spatial heterogeneity

(a) T2WI (b) FLAIR

Fig. 2 The result of spatial heterogeneity analysis

\[\text{Ep.: 9 Non-ep.: 52}\]

\[\text{Ep.: 8 Non-ep.: 21}\]

† The tuber in left parietal lobe was isointense on T1WI (not shown) so that it was categorized as type 1.
Predicting the epileptogenic tubers in tuberous sclerosis complex (TSC) patient using machine learning.

A Yogi¹, H Ullman¹, Y Hirata², E Morimoto¹, H Yokota¹, I Orosz¹, M Linetsky¹, B Ellingson¹, N Salamon¹
¹Department of Radiology, David Geffen School of Medicine at UCLA, Los Angeles, CA, ²David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
It is challenging to identify the epileptogenic tubers presurgically in patients with tuberous sclerosis complex (TSC). This study aims to predict epileptogenic tubers by applying a machine learning method to diffusion tensor imaging (DTI) parameters and positron emission tomography (PET) with 2-deoxy-2-[fluorine-18]fluoro- D-glucose integrated (FDG PET) uptake.

Materials and Methods
Between March 2007 and January 2014, 33 patients with 605 tubers received MRI examinations including DTI. Of these, 14 patients with 300 tubers who underwent FDG-PET imaging were selected retrospectively from the TSC cohort. Epileptogenic tubers were defined by presurgical work up, including FDG-PET/MRI fusion, magnetoencephalography, intra-operative electrocorticography, and postoperative seizure outcome (Table). Two observers manually generated regions of interest (ROIs) of all of the tubers in consensus, and ROIs were inflated by 4mm to generate the ROI of tuber plus perituberal tissue (ROI tuber+perituber). Minimum, maximum, mean, and median values of all DTI parameters and the FDG uptake values in all ROIs were compared between epileptogenic and non-epileptogenic groups. Logistic regression models were built from the DTI and FDG-PET data. Class weights were adjusted to obtain different degrees of sensitivity and specificity. The models were evaluated by a leave-one-out cross-validation procedure, and the performance of the different modalities was compared using receiver operating characteristics (ROC) analysis.

Results
Maximum ADC, RD, and AD, mean ADC, and minimum FA showed significant differences between the epileptogenic and nonepileptogenic groups (p<0.001, 0.01, 0.05, and 0.05, respectively). None of FDG measurements showed significant difference. Receiver operating characteristic curves for predicting epileptogenic tubers are shown in figures. Receiver operating characteristic curves of both machine learning models of FDG-PET and DTI were improved compared to those of
maximum ADC or minimum FDG uptake. AUC values in both models of DTI and FDG-PET were 0.65 and 0.74.

Conclusions
Machine learning method, where multiple measurements could be added for the comparison, may help predicting epileptogenic tubers more effectively.
### Table. The number of epileptogenic and non-epileptogenic tubers

<table>
<thead>
<tr>
<th></th>
<th>No. of patients</th>
<th>No. of epileptogenic tubers</th>
<th>No. of epileptogenic tubers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with DTI</td>
<td>33</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Patients with FDG-PET</td>
<td>14</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

### Figures. ROC curves predicting the epileptogenic tubers

(A) maximum ADC value  
(B) Minimum FDG uptake value  
(C) DTI and FDG-PET values by machine learning
Brain Network Architecture Predicts Global Intelligence in Pediatric Patients with Localization-related Epilepsy

Z Chu¹, W Zhang¹, F Golriz¹, M Paldino¹
¹Texas Children's Hospital, Houston, TX

Purpose
The biologic basis for intelligence rests to a significant degree on the capacity for efficient integration of information across the cerebral network. As a result of advances in computational neuroscience and magnetic resonance imaging (MRI), network architecture of the brain now is accessible to systematic study. The clinical value of such techniques has yet to be realized, however, in large part because the physiologic meaning of network metrics has not been established in the setting of cerebral pathology. Normal rewiring of the cerebral network during development as well as the known impact of anesthesia on the MR measurement of brain networks further complicate the situation in children. We therefore sought to measure: 1. the relationship between network architecture and intelligence in the pediatric, epileptic brain; 2. the impact of anesthesia during MRI on this relationship.

Materials and Methods
This cross-sectional study was IRB approved. Patients were identified retrospectively with the following inclusion criteria: 1. A diagnosis of localization related epilepsy; 2. MRI of the brain acquired at 3T, including a resting state functional MRI sequence; 3. Global IQ measured (according to an age-appropriate version of the Wechsler Intelligence Test) by a pediatric neuropsychologist. Patients with prior brain surgery were excluded. Resting-state time series were co-registered to a T1-weighted image, corrected for motion, and high-pass filtered (0.01 Hz). Network nodes then were defined based on subdivision of the brain into 800 gray matter volumes of interest. Voxel-wise blood oxygen level dependent (BOLD)-signal time series were averaged over each node. The strength of an edge (connection) between two nodes was defined as the absolute value of the correlation between their BOLD time series. For each weighted, undirected connection matrix, the following network properties were calculated using matlab scripts provided in The Brain Connectivity Toolbox (http://www.brain-connectivity-toolbox.net): clustering coefficient, transitivity, modularity, path length, small worldness, and global efficiency. A machine learning algorithm was used to: 1. measure the independent contribution of each metric to IQ after adjusting for the contribution of all other metrics; 2. model the impact of anesthesia on this contribution.
Results
Twenty-eight patients met criteria (age: 7-18 years). Path length and small worldness independently predicted global intelligence after accounting for all other variables (Fig. 1). Direct and inverse relationships were observed to IQ for small worldness (p=0.008) and path length (p=0.004) respectively. Administration of anesthesia did not impact the metrics contributing intelligence.

Conclusions
We report two main findings in this cohort of pediatric epilepsy patients: 1. Two metrics of network integration strongly contributed to full scale IQ; 2. These relationships to intelligence were robust to anesthesia. These findings support the physiologic relevance of imaging-based metrics of network architecture in the abnormal, developing brain.
Whole-Brain MEG-Recorded Delta Activity Decreases During Normal Pediatric Brain Maturation

E Libove¹, E Davenport¹, M Espeland¹, J Urban¹, J Stitzel¹, J Maldjian², C Whitlow¹
¹Wake Forest University School of Medicine, Winston-Salem, NC, ²University of Texas Southwestern, Dallas, TX

Purpose
Delta waves are low frequency (0-4 Hz) signals produced by brain that traditionally have been detected via electroencephalography (EEG), and are emerging as an important biomarker of brain injury and disease. The purpose of this investigation was to characterize whole brain delta wave activity using magnetoencephalography (MEG) in healthy pediatric subjects, thus providing normal baseline data for comparison.

Materials and Methods
Ninety-eight healthy male subjects (ages 9 to 18 years) were recruited as part of a larger study investigating brain structure/function in youth and high school football players. Eight minutes of eyes open continuous resting-state MEG data were acquired using a 275 channel radial gradiometer whole-head CTF Omega 2005 (VSM MedTech Ltd., Coquitlam, Canada) at a sampling rate of 600 Hz and acquisition bandwidth of 0.25–150 Hz. Magnetic resonance imaging (MRI) data were acquired for each subject immediately after MEG on a 3T Siemens Skyra scanner. Whole brain mean delta wave power was computed from band-limited source space projections using a scalar beamformer. Structural T1 images were segmented into gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF), normalized to Montreal Neurologic Imaging space, and processed to generate volumetric tissue maps using SPM8 in the VBM8 toolbox for evaluating normal developmental changes in GM volume.

Results
Regression analysis revealed a significant inverse linear relationship between age and delta wave activity (p < 0.0001, R² = 0.189). Age-related decreases in delta wave activity correlated with normal developmental decreases in whole brain GM volume (p < .0001, R² = 0.199).

Conclusions
We demonstrate that MEG-recorded delta wave activity decreases with increasing age in healthy pediatric subjects, and is associated with developmental associated decreases in GM volume, which extends previous studies reporting similar findings using EEG. It is possible that normal developmental changes in delta wave activity
may reflect synaptic pruning and could be useful as a biomarker for mTBI, as well as other neurological diseases that are otherwise occult to conventional neuroimaging.

O-385

3:32PM - 3:40PM

Construction of a 3D Printed MEG Phantom for Validation of MEG Source Localization

E Davenport¹, P Brown¹, L East¹, J Urban¹, B Wagner², M Espeland¹, R Moran³, P Santiago⁴, C Whitlow¹, J Stitzel¹, J Maldjian⁵

¹Wake Forest University School of Medicine, Winston-Salem, NC, ²University of Texas Southwestern, 5323 Harry Hines Blvd., TX, ³Virginia Polytechnic & State University, Roanoke, VA, ⁴Wake Forest University, Winston-Salem, NC, ⁵University of Texas Southwestern, Dallas, TX

Purpose

The purpose of this study is to design an anatomically accurate magnetoencephalography (MEG) compatible phantom that will allow for validation testing of inversion source localization methods across a range of source locations.

Materials and Methods

From an ongoing study of youth football, a normal subject's MEG and magnetic resonance imaging (MRI) scans were chosen as models for the MEG phantom. The MRI was segmented using SPM8. The Slicer 3D software was used to clean and smooth the cortical surface mask. The 3D reconstruction was imported into Geomagic Studio (v14.1.0 Geomagic, Research Triangle Park, NC), and a hollow mold-like model of the brain surface was created. Supports, spouts to fill the brain with gelatin, and a mechanism to connect the two halves were designed in Solidworks. Physiologically relevant dipoles holders were placed at anatomically predetermined locations (e.g., amygdala, default mode nodes) based on literature values and MNI coordinates. The final 3D model was printed using PolyJet by Stratasys Direct Manufacturing (Valencia, CA). Dipoles were constructed from semi-rigid coaxial cable (8216 Coax- RG-174/U Type, Belden) in accordance with Leahy et al. (2) The halves were joined and the model then was filled with a saline-gelatin mixture. The mixture was prepared with 0.75mg/ml concentration saline solution and gelatin at 0.6% by weight to provide a conductivity matching that of gray matter. A computed tomography (CT) was acquired of the phantom for localization of the physical dipoles. Specific currents at prespecified dipole locations were constructed using MATLAB and the Simulink toolbox with a frequency ranging from 1-50Hz and amplitude range of +/-5μA in order to mimic true neuronal signals. Continuous MEG signals, sampled at a rate of 600 Hz, were recorded using a 275 channel radial gradiometer whole-head CTF Omega 2005.
Results
The phantom was successfully constructed. The CT measured dipole locations served as ground truth for testing inversion techniques. The error between the intended and the ground truth dipole location was an average of 8.2mm with a standard deviation of 1.6mm. Currents were generated and measured by the MEG on the same scale of human neuronal signals; several issues related to electrical noise and digital-to-analog converter (DAC) performance were identified.

Conclusions
This study demonstrates the construction and use of one of the most geometrically advanced and anatomically accurate MEG phantoms to date. Source localization errors were on the order of 1 cm. Improvements in DAC performance and electrical noise are expected to further refine source localization.
Hemispheric Asymmetry of White Matter Microstructure and Language Ability in Autism

M Hwang\textsuperscript{1}, L Blaskey\textsuperscript{1}, J Owen\textsuperscript{2}, T Roberts\textsuperscript{1}, J Berman\textsuperscript{1}

\textsuperscript{1}Children's Hospital of Philadelphia, Philadelphia, PA, \textsuperscript{2}UCSF, San Francisco, CA
Purpose
The hemispheric specialization of language and leftward lateralization of the superior longitudinal fasciculus (SLF) volume is a well known finding in normally developing children. In autism spectrum disorder (ASD), language circuits develop abnormally and some research indicate that structural and functional asymmetry is absent or even reversed (1). It is largely unknown how abnormal patterns of lateralization impact language ability and if compensatory mechanisms exist. This study investigates the relationship between SLF microstructural asymmetry of diffusion MR metrics and language ability in ASD.

Materials and Methods
The study included 30 controls (mean age 10.6 ± 2.5 years) and 61 age-matched children with ASD [prior diagnosis made by expert clinician, confirmed by Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2) and parent report measures] (mean age 10.5 ± 2.5 years). Diffusion tensor imaging (DTI) was acquired at 3T (Siemens Verio) with 2mm isotropic resolution, b=1000s/mm2, and 30 diffusion directions. Atlas-based SLF regions of interest (ROIs) were placed on each subject's TBSS generated skeleton of diffusion maps (2). Asymmetry of fractional anisotropy (FA), mean diffusivity (MD), and radial diffusivity (RD) were calculated. The association of microstructural asymmetry with language ability, as measured on the Clinical Evaluation of Language Fundamentals (CELF-4), was examined.

Results
Degree of leftward lateralization of FA and rightward lateralization of RD were predictive of language ability (CELF-4) in controls (p<0.05, each) (Fig.). In ASD, the correlation slope between DTI metrics (FA and RD) and CELF-4 was significantly different than in controls (p<0.05 each). In ASD, there was a trend of positive correlation between rightward FA and CELF-4 and negative correlation between leftward RD and CELF-4, indicating a possible reversal of the modulating effect of SLF microstructure on language ability.

Conclusions
The abnormal and possibly reversed relationship between SLF asymmetry and language function in ASD suggests a compensatory role of the right SLF in language function. This altered structure-behavior relationship in ASD may underlie the heterogeneity of language ability in ASD.
In Vivo Assessment of Phase One Pharmacological Intervention Using GABA Spectroscopy in Awake Children with Single Gene (NF1) Autism.

S Stivaros\textsuperscript{1}, M Tziraki\textsuperscript{2}, S Garg\textsuperscript{2}, H Haroon\textsuperscript{2}, A Kapasi\textsuperscript{2}, S Williams\textsuperscript{2}, J Green\textsuperscript{3}
Purpose
Neurochemical disregulation is thought to have potential as a basis to model developmental abnormalities in autism. The most common noninvasive technique used to acquire measures of neurochemistry in vivo is proton magnetic resonance spectroscopy (1HMRS). Simvastatin is an HMG-CoA reductase inhibitor. There is extensive clinical experience of its use in young children with disorders such as familial hypercholesterolemia and Smith Lemli Opitz syndrome. Our aim was the in vivo 1HMRS quantitation of GABA using a preparation and scanning protocol which allowed us to acquire a range of neurochemistry measures in nonsedated children with neurofibromatosis type 1 (NF1) single gene model autism who were undergoing a phase 1 trial of Simvastatin intervention.

Materials and Methods
The children with single gene (NF1) autism were acclimatized to awake MRI scanning using a social story and 2 weeks of exposure to mp3 recordings of specific MRI scan sequence noises at specified time points during the day when both awake and during sleep preparation. Scanning was performed at time zero, then again following 12 weeks treatment of placebo or Simvastatin. We measured the concentration of GABA and other neuro-metabolites in the left frontal white matter and deep gray nuclei. We applied a single-voxel MEGA-PRESS sequence, TR/TE 2000/68 ms, FA 90°, NSA 4, phase cycles 4, samples 1024, spectral BW 2000 Hz, VOI size 30×30×30 mm3, dynamics 44, dynamics interval 8 s, BASING pulse MEGA basic, pulse duration 15 ms, water freq 4.68 ppm, pulse 1 freq 1.9 ppm, pulse 2 freq 7.6 ppm, pulse FA 180°, water suppression by excitation. Nonwater suppressed spectra also were acquired in both locations for quantification purposes. Datasets were analyzed using the jMRUI v.5 software; AMARES, was utilized to calculate metabolite concentration with tissue percentages extracted from a participant's T1 image for partial volume correction.

Results
In total 32 children presented for imaging, 24 males. The mean age was 7.9 years (range 4.6-10.4 years). Time zero scans were obtained successfully in the deep gray nuclei in 24 and in the frontal white matter in 27. Following drug/placebo treatment successful scanning was performed in 21 children in the deep gray nuclei and 19 in the frontal white matter. Comparison of the GABA values at time zero and at week 12 demonstrated no significant difference in GABA measurements in the frontal white matter (p=0.19) or deep gray nuclei (p=0.66).

Conclusions
We have demonstrated that in this age group, made more challenging by the diagnosis of autism, careful patient preparation can result in successful quantitative GABA
assessment. The results of our GABA imaging demonstrate stability over time validating its use in the assessment of the Ras-Raf-MEK-ERK pathway in this age group during this phase one phamaco-intervention study. We also present the changes seen in the neurochemistry of these children following simvastatin intervention.

O-389

4:04PM - 4:12PM

Negative Brain Connectivity: A General Maladaptive Trait and Imaging Biomarker For Neurodevelopmental Disorders

A Mallik¹, L Shah², J Anderson¹
¹University of Utah, Salt Lake City, UT, ²University Of Utah, Salt Lake City, UT

Purpose
Abnormal brain functional connectivity MRI (fc-MRI) findings now have been demonstrated in numerous neurodevelopmental and neuropsychiatric disorders. For example, evidence for an abnormal ratio of excitation and inhibition in autism is thought to contribute to brain hyperconnectivity (Supekar et al. 2013). Studies that span different neurodevelopmental disorders have been proposed as a mechanism to study brain phenotypes that may be shared across disorders (Research Domain Criteria, Cuthbert 2015).

Materials and Methods
We examined connectome wide fc-MRI relative to age-matched controls for autism (autism=447, control=517, ABIDE), ADHD (n=248; 476, ADHD-200), Down syndrome (n=21,16, University of Utah), pediatric bipolar disorder (n=32,48, University of Utah) and adult schizophrenia (n=60, 68, COBRE). Functional connectivity MRI correlations were organized by distance between 7266 regions of interest (ROIs) and by calculated strength of those connections in 476 typically developing (TD) young adults (Human Connectome Project, HCP). We calculated a negative connectivity score (NCS) consisting of the average correlation for all "connections" for which the Human Connectome Project sample averaged functional connectivity less than zero.

Results
All pediatric neurodevelopmental and neuropsychiatric disorder patient groups demonstrated increased correlation in typically negative connections relative to age-matched controls (p<0.05), while adult schizophrenia did not. These findings suggest a common shared pathophysiology of increased connectivity in negative connections across these neurodevelopmental disorders, as can be seen with decreased inhibition. In TD young adults, increased connectivity among negative functional connections was correlated with impaired performance on behavioral metrics involving executive function and attention (q<0.05, FDR).
Conclusions
The NCS may be a useful diagnostic imaging biomarker or prognostic metric for the evaluation of patients for neurodevelopmental disorders. Findings in TD young adults suggest a novel diagnostic or prognostic tool for patients with suspected mood disorders.

(Filename: TCT_O-389_mallik_anderson_ASNR_figure_4.gif)

O-390
4:12PM - 4:20PM
Childhood Cerebral Adrenoleukodystrophy: MR Perfusion Measurements and their Use in Predicting Clinical Outcome after Hematopoietic Stem Cell Transplantation
Purpose
To prospectively measure magnetic resonance perfusion (MRP) parameters in patients with cerebral adrenoleukodystrophy (cALD) pre and posthematopoietic stem cell transplantation (HSCT), and to correlate those measurements with the clinical outcome.

Materials and Methods
Ten cALD patients prospectively underwent DSC-MRP at <45 days pre-, 30-60 days post-, and 1 year post-HSCT. Magnetic resonance perfusion measurements in the 10 cALD patients and eight controls were obtained from the parietooccipital WM (POWM), callosal splenium (SCC), leading edge of enhancement (LEE), and normal-appearing frontal white matter (NAFWM). Magnetic resonance severity (Loes) scores, neurologic function scores (NFS), and neurocognitive scores also were obtained. Magnetic resonance perfusion values were analyzed in the cALD patients at each time point, and compared to controls. Correlations were calculated between the pre-HSCT MRP values and 1-year clinical scores, with p-value adjustment for multiple comparisons.

Results
Pre-HSCT (baseline) in cALD patients, both rCBV and rCBF within the SCC and POWM significantly differed from controls (p=0.005-0.031), and remained so at 1 year post-HSCT (p=0.003-0.005). Meanwhile, no MRP parameter within the LEE differed significantly from controls (p=0.074-0.999), nor significantly changed by 1 year post-HSCT (p=0.142-0.887). The baseline Loes scores correlated with the 1 year NFS (r=0.813, p<0.0001), while SCC rCBV significantly correlated with the 1 year NFS and neurocognitive scores (r=-0.730-0.815, p=0.007-0.038).

Conclusions
Leading edge of enhancement MRP measurements likely remain normal post-HSCT in cALD, which suggests local disease stabilization. Meanwhile, the POWM and SCC rCBV and rCBF values worsen, suggesting irreversible injury. This study found that certain baseline (pre-HSCT) MRP values may predict the eventual outcome following HSCT.
Inherited Disorders of Sulfite Metabolism: evolution of brain MRI findings

P Caruso¹, P Musolino¹, R Aziz-Bose¹, D Loes², F Eichler¹
¹Massachusetts General Hospital, Boston, MA, ²Suburban Radiologic Consultants, Ltd., Burnsville, MN

Purpose
Isolated sulfite oxidase deficiency (ISOD) and molybdenum cofactor deficiency (MOCD) are genetic disorders that lead to rapid neurodegeneration due to
intracellular accumulation of sulfites. While both gray and white matter are known to be affected, the timing and extent of injury remains poorly understood.

Materials and Methods
Twenty patients with proven biochemical and/or genetic defects for ISOD or MOCD were screened. Of the cohort, 18 patients (3 with ISOD and 15 with MOCD) with magnetic resonance imaging (MRI) were included in the study. All MR images were reviewed by two experienced neuroradiologists and two neurologists for the location and timing of gray and white matter injury, cavitations, atrophy, and malformations.

Results
Forty-three brain magnetic resonance scans in the 18 patients were reviewed. Fifteen patients presented in the first year of life (classic infantile form) and three patients presented between 12 months and adulthood (late onset type). Of the classic infantile patients, MRI showed diffuse multilobar white matter lesions in all patients, white matter cavitation in 6/15 (40%), and an abnormally long posterior fossa in 14/15 (93%). Subsequent imaging showed cavitation in 13/15 (86%) patients. Cavitations developed within an average of 35 days (range 15-96 days). Among the late-onset group, only one patient had a deep gray matter cavitation; one patient had a completely normal MRI; and the posterior fossa was normal in all three patients.

Conclusions
Brain MR abnormalities in ISOD and MOCD exhibit two patterns: the classic pattern where onset occurs in the infantile period and progresses over weeks to months to diffuse panlobar white matter cavitation, and the other, a late onset pattern, associated with a more mild course. Interventions before or during the acute phase may impact the onset and severity of the disease.

Wednesday
4:45PM - 6:15PM
Washington Marriott Wardman Park, Marriott Ballroom

18A-One Stop Shop Symposium
18A

Introduction

18A-1
4:50PM - 5:10PM
Technology Enabling Multimodality Imaging in the Angiography Suite
Chen, G.  
University of Wisconsin-Madison  
Madison, WI

18A-2  
5:10PM - 5:30PM
Rationale and Feasibility of Multimodality Imaging in the Angiography Suite.  
How This Adds Value

Dörfler, A.  
University of Erlangen  
Erlangen

18A-3  
5:30PM - 5:50PM
The Erlangen Experience with Multimodality Imaging in the Angiography

Struffert, T.  
University of Erlangen-Nuremberg  
Erlangen

18A-4  
5:50PM - 6:10PM
Capabilities of Mult-Modality Imaging Using Cone-beam CT

Aagaard-Kienitz, B.  
University of Wisconsin Hospital and Clinics  
Madison, WI

18A-5  
6:10PM - 6:15PM
Wrap-up
18B-CSI Programming: 3D Print
18B-1
4:45PM - 5:15PM
Incorporation of 3D Printing into a Quaternary Referral Center: Emphasis on Craniomaxillofacial

Morris, J.
Mayo Clinic
Rochester, MN

18B-2
5:15PM - 5:45PM
3D Printing for Pediatric Neurosurgical Surgical Simulation

Prabhu, S.
Boston Children's Hospital
Boston, MA

18B-3
5:45PM - 6:15PM
Using 3D Printing in the Creation of Plastic Surgery Guides and Maxillofacial Prosthetic Molds

Liacouris, P.
Walter Reed National Military Medical Center
Bethesda, MD
Imaging Biomarkers for AD - PET and MRI

Johnson, S.
University of Wisconsin Madison
Madison, WI

18C-2

Amyloid PET and IDEAS Study

Nasrallah, I.
HUP
Philadelphia, PA

18C-3

Clinical Dopamine Imaging in Movement Disorders

Seibyl, J.
Yale University
New Haven, CT

Wednesday
4:45PM - 6:15PM
Washington Marriott Wardman Park, Roosevelt 1-3

18D-PARALLEL PAPER SESSION: Turbo Talks - Head and Neck: All Neck Extravaganza
O-392


M Kraft¹, A Srinivasan¹, M Ibrahim¹, M Spector¹
¹University of Michigan, Ann Arbor, MI

Purpose
To compare lesion margin, enhancement, conspicuity, and staging amongst dual-
energy computed tomography (DECT) derived iodine overlay maps, virtual keV monochromatic series, and single-energy CT (SECT) in squamous cell carcinomas of the head and neck (HNSCC).

Materials and Methods
This retrospective study included 33 patients with histopathologically proven HNSCC who underwent DECT scanning from 2008-2015. Dual-energy CT scans were processed to create three monochromatic series (40, 45, and 50 keV) and iodine overlay series. Two blinded board-certified neuroradiologists compared these images against a control series of either SECT images (if performed within 1 month) or 70 keV DECT derived monochromatic series. The images were randomized and evaluated ordinally (1-poor, 2-adequate, and 3-excellent visualization) for lesion margin, enhancement, and overall conspicuity. Additionally, each cancer was staged, and an image preference was chosen. Results were compared using a Wilcoxon signed-rank test.

Results
The 45 and 50 keV images were significantly better (p-values 0.003 to <0.001) than the controls in determining lesion enhancement, margins, and overall conspicuity for both readers. The iodine overlay was not significantly better than the controls in nearly all assessments, and one reader found the conspicuity worse. The monochromatic series performed better in tumor staging for reader 1, while having the same accuracy as SECT for reader 2. Both readers most preferred the 50 keV monochromatic series, with the 45 and 40 keV images as the second and third most preferred image series, respectively. No reader preferred the iodine overlay images.

Conclusions
The improved lesion margin, enhancement, and conspicuity in HNSCC on the 40, 45, and 50 keV monochromatic series can be crucial for a comprehensive evaluation of lesion extent and accurate staging. The 50 keV series was the most preferred series, suggesting this may have the best balance of image noise and enhancement of the lesion.

O-393

Image quality and radiation dose of third generation dual-energy CT of the head and neck compared with a standard acquisition.

S Suntharalingam1, E Stenzel2, A Wetter2, N Guberina2, A Ringelstein3, M Forsting2, K Nassenstein2

1University Hospital Essen, Essen, Germany, 2University Hospital Essen, Essen, NRW, 3Institute of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, NRW
Purpose
To evaluate the radiation dose and image quality performance of head and neck imaging between a third-generation dual-energy CT (DECT) and a standard acquisition (SECT).

Materials and Methods
For the baseline exam 30 cancer patients underwent SECT with automated tube current modulation and automated tube voltage selection. The follow-up CT was performed on DECT (80 and Sn150 kVp). Radiation doses and attenuation measurements of the internal jugular vein, submandibular gland and sternomastoid and tongue muscles were compared. Objective image noise was compared at five anatomical levels. Image quality also was visually evaluated by two radiologists.

Results
CTDIvol was 54 % lower with DE than with SECT (4.2 versus 9.2 mGy; p = 0.002). Median objective noise was lower in DECT at all anatomical levels (nasopharynx: 4.3 versus 6.2 HU; p = 0.02 - floor of mouth: 3.2 versus 4.5 HU; p = 0.02 – arytenoids: 3.5 versus 4.9 HU; p = 0.08 – lower thyroid: 4.7 versus 30.2 HU; p = 0.03 – arch of aorta: 6.6 versus 27.1 HU; p: 0.002). No different attenuation measurements were observed between DECT and SECT in submandibular gland (106.1 versus 119.6 HU; p = 0.85), in sternomastoid (65.8 versus 70.0 HU; p=0.38) and tongue muscles (77.5 versus 76.4 HU; p = 0.42). Only signal intensity in internal jugular vein was lower in DECT (196.4 versus 263.2 HU; p=0.002). Visual image quality showed no significant differences between both examinations.

Conclusions
Head and neck imaging with third-generation DECT can reduce radiation dose significantly, while maintaining excellent image quality.

O-394
4:51PM - 4:54PM

Quantitative Assessment of Variation in CT Scanning Parameters on Texture Features: Pilot Study Using a Non-Anatomic Phantom

K Buch1, B Li2, M Qureshi2, S Anderson2, O Sakai2
1Boston Medical Center/Massachusetts General Hospital, Boston, MA, 2Boston Medical Center, Boston University School of Medicine, Boston, MA

Purpose
Texture analysis is becoming increasingly used in the field of radiology given that it is a quantitative, noninvasive, postprocessing, multimodality technique. The objective of this study is to evaluate how changes in computed tomography (CT) scanning parameters results in variations in texture features.
Materials and Methods
Serial CT scans were performed on two cylindrical acrylic phantoms containing a randomized mixture of air, fat, and solid cereal rings of varying size using both 64-multidetector row CT and 16-multidetector row CT scanners. Computed tomography scan parameters including the mA, kVp, slice thickness, helical pitch, ASIR setting, and acquisition mode were varied. A total of 42 texture features were extracted from each scan using an in-house developed Matlab program including histogram, gray level co-occurrence matrix (GLCM), gray level run-length (GLRL) and Law's features. A two-tailed t-test was performed to evaluate for differences in texture features.

Results
Statistically significant differences were seen in the histogram features with variations in phantom size, acquisition mode, and number of detectors (P<0.0001-P=0.044). Gray level co-occurrence matrix features of entropy, correlation, and energy demonstrated significant differences with variations in slice thickness, kVp, pitch and phantom size (P<0.001). Gray level run-length features significantly varied with differences in the acquisition mode (axial versus helical scanning), and slice thickness. The Law's features demonstrated statistically significant differences for all tested variations in CT scanning parameters. Changing mA had no significant effect on the texture parameters.

Conclusions
Subtle changes in image texture become significantly different based on changes in basic CT scanning parameters. While these changes may not affect image interpretation with the human eye, quantitative assessments such as texture analysis are impacted significantly by alterations in these parameters. Therefore, during the noninvasive quantitative assessment of pathology on CT, standardized CT scanning parameters are of paramount importance.
CT texture analysis potentially predicts local failure in head and neck squamous cell carcinoma treated with chemoradiotherapy

H Kuno\textsuperscript{1}, B Li\textsuperscript{1}, M Qureshi\textsuperscript{1}, M Chapman\textsuperscript{1}, V Andreu\textsuperscript{1}, M Truong\textsuperscript{1}, O Sakai\textsuperscript{1} \\
\textsuperscript{1}Boston Medical Center, Boston University School of Medicine, Boston, MA

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(Filename: TCT_O-394_CTTexturetable.jpg)
Purpose
Human papillomavirus (HPV) positive head and neck squamous cell carcinomas (HNSCC) are known to have a good response to chemoradiotherapy (1-3), yet treatment failure has been reported (4). The purpose of this study is to assess various texture features of a primary lesion from pretreatment computed tomography (CT) to predict potential local failure in HNSCC patients treated with chemoradiotherapy.

Materials and Methods
Forty-seven patients (40 men, 7 women; 31–80 years; median age, 57 years) diagnosed with primary HNSCC (25 oropharynx, 7 hypopharynx, 13 larynx and 2 oral cavity, including 20 HPV-positive and 19 HPV-negative) who underwent contrast-enhanced CT for staging between March 2008 and March 2014 followed by chemoradiotherapy were reviewed retrospectively. Segmentations of the primary lesion were performed manually, and an in-house developed MATLAB-based texture analysis program extracted 42 texture features from each segmented volume (5). Mann-Whitney U test was used to compare locally controlled patients with patients who developed local failure. A P value of less than 0.05 was considered statistically significant.

Results
Seventeen patients developed local failure (follow-up periods; 2 to 23 months), and the remaining 30 showed local control (12 to 76 months). There were eight gray-level run-length (GLRL) features that demonstrated significant difference (P < 0.007; Fig. a) between these two groups. Among 20 HPV positive patients, five patients (4 oropharynx and 1 larynx) developed local failure, and seven GLRL features were significantly different such as long run emphasis (P = .016; Fig. b) and short run emphasis (P = .026) features.

Conclusions
The results suggest that the GLRL matrix features from CT texture analysis may serve as a potential indicator of local failure in HNSCC treated with chemoradiotherapy or radiotherapy regardless of HPV status. Additional studies are needed to investigate the clinical significance of these findings with larger sample size.
Using texture analysis to differentiate between nasopharyngeal carcinoma and age-matched normal adenoid controls

A Tsai¹, K Buch², A Fujita³, B Li⁴, M Qureshi⁴, M Truong⁴, O Sakai⁴
Purpose

Early nasopharyngeal carcinoma (NPC) may have subtle imaging findings on contrast-enhanced computed tomography (CECT), making it difficult to differentiate from normal adenoid tissue. Texture analysis has been employed increasingly as a postprocessing image analysis tool, which extracts quantitative texture features from an image to evaluate subtle pathologic changes not easily perceived by the human eye. The purpose of this study was to investigate the use of texture analysis applied to CECT to aid in the differentiation of NPC from normal adenoid tissue.

Materials and Methods

Following IRB approval, 13 patients with NPC and 13 age-matched normal adenoid controls, who underwent CECT between 2010-2014 were included in this study. The adenoid tissue of NPC and control patients was contoured manually, segmented, and imported to an in-house developed texture analysis program, which extracted 42 texture features from each segmented volume. These texture features included spatially independent features (histogram features) as well as spatially dependent features (gray-level co-occurrence matrix (GLCM) and gray-level run length (GLRL) features). Statistically significant differences in the texture features between NPC and controls were evaluated using a two-tailed t-test.

Results

Statistically significant differences (p<0.05) between NPC and controls were seen in all but two of the 42 extracted texture features. In particular, all of the spatially dependent texture features demonstrated statistically significant differences between the NPC and control groups. Only histogram features median (p=0.52) and test (p=0.71) did not demonstrate statistically significant differences.

Conclusions

Significant differences were seen in spatially dependent texture features suggestive of a specific tissue architecture seen in NPC that is not present in normal adenoid tissue. Texture analysis may therefore aid in differentiating early NPC from normal adenoid tissue.
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</tr>
<tr>
<td>L9</td>
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<td>0.0010</td>
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</tbody>
</table>
Texture analysis of CT in the larynx between normal subjects and patients with localized amyloidosis

T Kakigi¹, K Hassan², M Qureshi², M Chapman², B Li², J Berk², O Sakai²
¹Boston Medical Center, Boston University/Kyoto University Graduate School, Boston, MA, ²Boston Medical Center, Boston University School of Medicine, Boston, MA

Purpose
Calcification often is seen in lesions of head and neck amyloidosis, however detection of noncalcified amyloid lesions is difficult on computed tomography (CT) as noncalcified lesions demonstrate similar density to normal tissue. The purpose of this study was to evaluate the difference between noncalcified amyloid lesions and normal tissues in the larynx using texture analysis of CT.

Materials and Methods
This study was IRB-approved and HIPAA-compliant with a waiver of the need for informed consent. Fourteen patients with biopsy-proven AL amyloidosis (5 males and 9 females; mean age 57.2 years, ranged from 35 to 72 years) and 14 control subjects without amyloidosis (4 males and 10 females; mean age 51.4 years, ranged from 24 to 81 years) who underwent noncontrast neck CT were included in the study. The glottis on nonenhanced CT was evaluated using texture analysis. Differences in 42 texture parameters were examined in these groups using Student's t-test and a false discovery rate (FDR) correction.

Results
Thirty-one parameters (excluding standard deviation, entropy, harmonic mean and test of the histogram feature, gray-level co-occurrence matrix (GLCM) entropy, short-run emphasis (SRE), long-run emphasis (LRE), gray-level nonuniformity (GLN), run-length nonuniformity (RLN), high gray-level-run emphasis (HGRE), and short-run low gray-level emphasis (SRLGE) of the gray-level run length (GLRL) texture feature, (harmonic mean and test) demonstrated statistically significant differences between the groups (P < .05). After using FDR correction, 30 parameters (excluding fourth moment of the histogram feature) showed significant differences (Q < .05).

Conclusions
Amyloidosis of the head and neck may be the first clinical sign of systemic disease. We need to diagnose head and neck amyloidosis in the early period before it develops systemic manifestations. Texture analysis of CT imaging is a noninvasive procedure
that has the potential to differentiate noncalcified amyloid lesions from normal tissue in the larynx.

O-398

Preoperative 18F-FDG-PET/CT versus contrast-enhanced CT to identify regional metastasis among patients with head and neck squamous cell carcinoma

J Cho1, T Ow2, A Lee2, N Schlecht1, R Smith2, B Schiff2, A Tassler2, J Lin1, R Moadel2, J Bello2, K Shifteh2

1Albert Einstein College of Medicine, Bronx, NY, 2Montefiore Medical Center, Bronx, NY

Purpose
For head and neck squamous cell carcinoma (HNSCC), metastasis to the cervical lymph nodes portends a worse prognosis (1). Imaging is used to help identify suspicious lymph nodes pre-operatively. The primary aim of this study is to compare the accuracy of positron emission tomography (PET)/computed tomography (CT) to contrast-enhanced CT (CECT) in the detection of cervical lymph node metastasis when compared to histopathology as the gold standard.

Materials and Methods
Of 214 patients who received neck dissection for primary staging and treatment of newly diagnosed HNSCC from 1999 to 2014, 73 patients had reviewable pre-operative PET/CT and CECT studies within 6 months prior to surgery. All PET/CT and CECT studies were reviewed independently by board-certified specialists, blinded to pathology reports and cancer stage. A lymph node satisfying any one the following criteria: (1) necrosis, (2) extra-capsular extension (ECE), (3) round or irregular shape with enhancement and >0.5cm, (4) round or irregular in shape without enhancement and >1.0cm, (5) oval shape with enhancement and >1.0cm, (6) oval shape without enhancement and >1.5cm, or (7) grouping of three or more suspicious lymph nodes, was determined positive on CECT (2, 3). Any lymph node with abnormally increased focal tracer uptake was determined positive on PET/CT (4). The neck level or neck side was designated positive if at least one lymph node was suspected within the defined borders (5). Concordance between radiology and histopathology was measured both by neck level and by neck side. The sensitivity, specificity, overall accuracy, positive predictive value (PPV), and negative predictive value (NPV) were calculated for each modality and compared using a two-sample proportion with significance set to a p-value of 0.05 or less.

Results
Eighty-three of 579 (14%) neck levels and 53 of 116 (46%) neck sides were positive for metastasis on histopathology (Table 1). By neck level, PET/CT was significantly
less specific than CECT (85 versus 90%, p=0.007). On analysis by neck side, PET/CT was significantly more sensitive (87 versus 66%, p=0.022), while CECT showed higher specificity (79 versus 51%, p=0.001). A significant difference was not found between the modalities in overall accuracy by neck side (p=0.39). However, CECT tended to have higher overall accuracy, an association that did not quite reach significance by neck level (86 versus 82%, p=0.056). Twenty-seven of 73 (37%) patients ultimately were staged N0 by histopathology. In the N0 cohort, nodal involvement was detected falsely by PET/CT in 17 of 27 patients (63%) and falsely detected by CECT in eight of 27 patients (30%).

Conclusions
Our data suggest that PET/CT is more sensitive than CECT to rule out cancer involvement of a given neck side prior to surgery. However, CECT appears to be more specific overall, with fewer false positive results. Although CECT showed higher overall accuracy, the trend did not reach statistical significance. One must consider these distinct but perhaps complementary attributes when using results of these modalities for clinical decision making.

<table>
<thead>
<tr>
<th>Imaging Modality</th>
<th>TP (n)</th>
<th>FP (n)</th>
<th>FN (n)</th>
<th>TN (n)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Accuracy (%)</th>
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<tbody>
<tr>
<td>Neck Level (n = 579)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PET/CT</td>
<td>53</td>
<td>77</td>
<td>30</td>
<td>419</td>
<td>64 (53, 74)</td>
<td>85 (81, 88)</td>
<td>82 (78, 85)</td>
</tr>
<tr>
<td>CECT</td>
<td>49</td>
<td>48</td>
<td>34</td>
<td>448</td>
<td>59 (48, 70)</td>
<td>90 (87, 93)</td>
<td>86 (83, 89)</td>
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<tr>
<td>p value</td>
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<td></td>
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<tr>
<td>Neck Side (n = 116)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PET/CT</td>
<td>46</td>
<td>31</td>
<td>7</td>
<td>32</td>
<td>87 (74, 94)</td>
<td>51 (38, 63)</td>
<td>67 (58, 76)</td>
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<td>CECT</td>
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<td>50</td>
<td>66 (52, 78)</td>
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</table>

PPV: Positive Predictive Value, NPV: Negative Predictive Value.

(O-399)

PET/CT in patients treated for advanced head and neck cancer: what do you say when the tumor improved, but didn’t completely resolve?

P Wangaryattawanich1, T Rath1, B Branstetter1

1University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Positron emission tomography (PET)/computed tomography (CT) performed for surveillance of head and neck cancer has demonstrated a wide range of false positive and false negative rates, depending on imaging and interpretation protocols. One
potential area of confusion is in patients who present with bulky disease that is treated with chemoradiation, and has dramatic improvement in tumor size without complete resolution. The purpose of this study was to evaluate the accuracy of initial post-treatment PET/CTs in patients with advanced head and neck squamous cell carcinoma (HNSCC), when the examination demonstrates marked improvement but not complete resolution of tumor mass or fluorodeoxy glucose (FDG) avidity.

Materials and Methods
We performed a retrospective chart review to identify patients with HNSCC who initially presented with bulky tumor and were treated with chemoradiation. We selected patients whose first post-treatment PET/CT was interpreted as showing marked improvement in tumor size and FDG avidity, but with residual tumor mass or faint residual FDG avidity. Seventy-nine such patients were identified. These patients were followed clinically and radiographically for 2 years after to determine recurrence rates. Treatment failure was confirmed by histopathology or unequivocal disease progression on subsequent imaging or clinical evaluation.

Results
Seven of the 79 patients (9%) experienced locoregional treatment failure within 2 years after definitive treatment, yielding a negative predictive value of 91.1%.

Conclusions
In patients with advanced HNSCC treated with chemoradiation, a first post-treatment PET/CT showing dramatic improvement in tumor volume has a high negative predictive value, even when there is a residual tumor mass. The negative predictive value of these PET/CTs is high at 91%, similar to literature values for initial complete response post-treatment PET/CTs.

O-400

Should we evolve from whole body 18F-FDG-PET-CT protocol to more disease tailored HN -PET -CT in the management of head and neck cancers?

P gopalan

1Leeds and Bradford Teaching Hospitals, Wakefield, United Kingdom

Purpose
18F-FDG positron emission tomography (PET) computed tomography (CT) plays a significant role in the management of head and neck (H&N) malignancies. The main indications of PET-CT in H&N cancers are: For unknown primary, pretreatment staging, and following tumor recurrence/relapse. Whole body PET CT protocol is used unanimously for all purposes. The study looked at significant findings above and below diaphragm in view of changing to more disease tailored PET CT protocols, as
there has been recent suggestions that half-body (above diaphragm) PET CT may be sufficient for the management of head and neck cancer patients.

Materials and Methods
Sixty-six consecutive patients suspected of having head and neck malignancy (48 men, 18 women; age range, 22–94 years) that underwent standard whole-body PET/CT in 1-year period (2014-2015) were selected retrospectively. Patients who were referred for identifying unknown primary lesions in the setting of nodal enlargement were (n=29) and who had known primaries were (n=37). The patients referred for staging of known malignancies (n=13) and for detecting recurrence of treated malignancies (n=32), which included both known and unknown primaries. Of the known 37 proven malignancies: 23 patients had oropharyngeal cancer, four had nasopharyngeal cancers, two had oral cavity tumors, two had hypo pharyngeal cancers, and three had laryngeal cancers. Of the 29 unknown primaries, five were probable nasopharyngeal, 14 oropharyngeal, two were lymphomas, one metastatic adenocarcinoma and in six no primaries were identifiable.

Results
Results demonstrated 10.6% significant findings above diaphragm, which predominantly included lung nodules (n=18) the remainder were: Mediastinal nodes, activity in thyroid, esophagus, lung, bone and vocal cords. Significant activity was found only in three cases below diaphragm, which includes nodal disease in lymphoma and metastatic adenocarcinoma and a patient with known renal cancer. The rest were benign adrenal uptake, suspected liver, bone and splenic flexure activity, which were not of any pathological significance on subsequent investigations. Other causes of benign activity below diaphragm includes colonic and marrow activity.

Conclusions
This study cohort did not demonstrate significant findings below diaphragm pertaining to squamous cell carcinoma of head and neck. Considering the proven disease pattern spread of HNSCC and nasopharyngeal cancers, worth switching to more disease tailored PET CT protocols. Propositions: Index scans for staging all head and neck cancers should continue to be whole body PET to identify distant metastasis and concurrent primaries. Follow-up scans for HNSCC can be switched to half body (above diaphragm) particularly if they were low-grade tumor and in the lower spectrum of TNM staging. This is more so in the management of SCC compared to nasopharyngeal cancer. If there is specific question of nodal recurrence then dedicated HN PET CT should be considered rather than using whole body PET CT. Switching the follow-up scans from whole body PET CT to dedicated HN PET CT may improve sensitivity in picking up nodal recurrence.
Recurrence Rates Among Category 2 “Questionable Recurrence” Lesions Using NI-RADS Head and Neck Squamous Cell Carcinoma Surveillance Imaging Template: Initial Experience.

G Nayak1, D Krieger2, A Corey3, K Baugnon1, P Hudgins1, J Beitler4, A Aiken5
1Emory University, Atlanta, GA, 2Emory University School of Medicine, Atlanta, GA, 3Emory, Fayetteville, GA, 4Winship Cancer Institute of Emory University, Atlanta, GA, 5Emory University Hospital, Atlanta, GA

Purpose
To determine the incidence of local and regional recurrence among lesions scored as "Questionable recurrence," or category 2, using the previously described NI-RADS scoring system in post-treatment contrast-enhanced computed tomography (CECT) surveillance of squamous cell carcinoma (SCC) of the head and neck (HN).

Materials and Methods
This study was classified as a quality improvement project by the IRB. A multidisciplinary team at our institution developed NI-RADS, a standardized template for reporting results on surveillance CECT of the neck in patients previously treated for HN cancer (1). This includes a numerical assessment of suspicion for recurrence, rated 1 through 4, linked to specific management recommendations, both for the primary site and for cervical lymph nodes. Category 2, our "questionable recurrence" category is reserved for ill-defined, non-discrete abnormalities, and if performed with PET, have only intermediate or low fluorodeoxyglucose (FDG) uptake. Category 2 recommendations include direct visualization for mucosal lesions (category 2a), short interval follow up with PET/CECT or CECT for deeper primary site abnormalities (2b if < 1cm, or 2c if> 1cm), or biopsy if a target is identified and is clinically indicated.

An EMR database search yielded 500 consecutive cases using the NI-RADS template. Cases without a numerical score or with non-SCC primary tumors, new primary tumors, and primary SCC outside of the HN and skin were excluded. A total of 403 cases were included. The EMR was reviewed to determine the subsequent management, pathology results and outcome of clinical and radiologic follow up.

Results
The incidence of a Category 2 score was 13.6% (55/ 403 cases) with a total of 62 targets identified, 41 at the primary site and 21 in the neck. Eleven of 62 (17.7%) Category 2 targets underwent biopsy and/or surgery following the index study, 9/11 for lesions at the primary site and 2/11 for neck disease. Two of 11 (18.2%) biopsies, both at the primary site were positive for recurrence, and nine were negative. An additional seven Category 2 lesions demonstrated progression during follow up. Therefore, 9/62 (14.5%) target lesions (5 primary and 4 nodal) demonstrated pathology proven recurrence or clear imaging/clinical recurrence during follow up (average follow-up time: 9 months).
Conclusions
13.6% scans (55/403) were scored as Category 2 with a total of 62 lesions. The overall rate of recurrence for targets categorized as "questionable recurrence" was 14.5% (9/62). The relatively low positivity rate reflects that the Category 2 lesions represent an intermediate risk group. This also reinforces that ill-defined abnormalities without significant FDG uptake are often non-neoplastic treatment-related changes and short interval follow up is often the best course of action, with biopsy indicated only in the minority. Knowledge of recurrence rates in this group will be helpful to counsel patients and to further refine surveillance and management recommendations.

O-402
5:15PM - 5:18PM
Recurrence Rates in Category 3 “Highly Suspicious” Lesions Using the NI-RADS Head and Neck Squamous Cell Carcinoma Surveillance Imaging Template: Initial Experience

D Krieger1, P Hudgins2, G Nayak2, K Baugnon2, A Corey3, J Beitler4, A Aiken5

1Emory University School of Medicine, Atlanta, GA, 2Emory University, Atlanta, GA, 3Emory, Fayetteville, GA, 4Winship Cancer Institute of Emory University, Atlanta, GA, 5Emory University Hospital, Atlanta, GA

Purpose
To determine the incidence of local and regional recurrence among lesions scored "High Suspicion" or Category 3 using the previously published NI-RADS scoring system in post-treatment contrast-enhanced computed tomography (CECT) surveillance of squamous cell carcinoma (SCC) of the head and neck (HN).

Materials and Methods
A multidisciplinary team at our institution developed NI-RADS, a standardized template for reporting results on surveillance neck CECT in patients previously treated for HN cancer (1). This process includes a discrete numerical assessment of suspicion for recurrence, rated into four main categories, linked to specific management recommendations, both for the primary site and for cervical lymph nodes. Category 3 "highly suspicious" lesions are defined as new or enlarging, discrete abnormalities (with significant FDG uptake if performed with PET/CT) with biopsy recommended if clinically indicated. This study was classified as a quality improvement project by the IRB. An EMR database search yielded 500 consecutive cases using the NI-RADS template. Cases without a numerical score or with non-SCC primary tumors, new primary tumors, as well as primary SCC outside of the HN and skin were excluded, leaving 403 evaluable studies. The EMR was reviewed to
determine the subsequent management, pathology results and outcome of clinical and radiologic follow up.

Results
The incidence of a Category 3 score was 7.2% (29/403 cases), with a total of 33 Category 3 targets identified (4 patients received 3’s for both primary and nodes), 22 at the primary site and 11 in the neck. Twenty-one of 33 (63.6%) Category 3 targets had pathologic investigation by subsequent biopsy and/or salvage surgery (13/33 primary site, 8/33 nodal). The pathologically confirmed true positive rate was 47.6% (10/21), 30.8% (4/13) at the primary site and 75.0% (6/8) at nodal sites. The remaining 12/33 targets did not have pathological confirmation; eight because it would not affect management, three because no correlate could be found when biopsy was attempted, and one without explanation. Seven of 12 (58.3%) had clinical or radiological evidence for recurrence (6 primary site lesions and 1 nodal site), defined as progression at the target site on subsequent imaging or clinically obvious tumor. Overall, the positive predictive value of recurrence (pathologic or clinical/radiologic) among Category 3 lesions was 17/33 (51.5%): 10/22 (45.5%) at the primary and 7/11 (63.6%) nodal sites.

Conclusions
7.2% (29/403) scans were scored with Category 3 lesions, with a total of 33 lesions, 17 of which had definitive or clinical evidence of recurrence. The low rate of biopsy recommendation and relatively high yield was considered a favorable initial benchmark for the performance of NI-RADS in this clinical setting. The higher PPV for neck nodes (63.6%) compared with primary site (45.5%) is expected, given the complex appearance of post-treatment changes and mucositis at the primary site. Knowledge of recurrence rates in this subcategory will be helpful to counsel patients and to further refine surveillance and management recommendations.

O-403
5:18PM - 5:21PM

Testing Susceptibility Weighted Imaging and Double Inversion Recovery Sequences in the Evaluation of Oropharyngeal Squamous Cell Carcinoma

A Richardson¹, M Bashir², N Dunlap¹, R Rebecca¹, R Bert¹
¹University of Louisville, Louisville, KY, ²University of Wisconsin, Madison, WI

Purpose
Staging and treatment strategies for oropharyngeal squamous cell carcinoma (OPSCCa) depend upon radiologic guidance with significant implications for patient morbidity and mortality. Hypoxia and tumor microstructure may be important predictors of treatment failure in OPSCCa by identifying resistance to radiation and chemotherapy. Susceptibility-weighted imaging (SWI) is a magnetic resonance...
imaging (MRI) technique utilizing tissue magnetic susceptibility differences that can demonstrate deoxyhemaglobin in tissues. Double inversion recovery (DIR) is a MRI sequence which employs two inversion pulses to suppress signal from two different tissue types, possibly better delineating tumor boundaries. We hypothesized that such features of SWI and DIR may be of clinical utility in the staging of OPSCCa, adding prognostic value and guiding therapy. We have begun testing of SWI and DIR in patients with OPSCCa.

Materials and Methods

After obtaining IRB approval, six patients with P16+, HPV+ OPSCCa were enrolled and imaged (3T MAGNETOM Skyra) before and 2 weeks following initial chemoradiation treatment. Isotropic 3D SWI imaging parameters: voxel size=1.5mm, TR=27ms, TE=20ms, NSA=1, bandwidth=120, FA=15, PE steps=222. 3D DIR imaging parameters: slice thickness=1.4mm, TR=5000ms, TE=202ms, T1a=2200ms, T1b=300, NSA 2, Echotrain=193, bandwidth=870Hz, FA=120, PE steps=213. Susceptibility-weighted imaging and DIR images were compared to conventional structural images (T1 conventional spin echo pre and postcontrast fat-sat and DWI). Contrast/noise ratios were calculated for mean regions of interest (ROIs) from tumor and control tissues using OSIRIX software.

Results

Six OPSCCa patients successfully underwent pre/post-treatment SWI and DIR imaging. Only one patient did not undergo pretreatment postcontrast FST1 imaging (patient 5). Representative pre/post-treatment DIR and SWI images are shown below, demonstrating the often drastic and rapid diminution in tonsillar and nodal tumor burden as early as 2 weeks post-treatment. Contrast to noise ratios (CNRs) are shown in the table below with corresponding delta values reflecting patients with both interval increased and decreased CNRs. The wide variability in these values potentially may be prognostically relevant, however additional follow up is necessary.

Conclusions

Susceptibility-weighted imaging and DIR MRI are potentially useful tools in the staging and therapeutic decision-making of OPSCCa if proven directly relevant to chemotherapeutic/radiation treatment resistance. Our initial optimization of these sequences in a small population of OPSCCa patients supports their clinical feasibility/utility, and further research is planned into their prognostic value.
<table>
<thead>
<tr>
<th>Patient</th>
<th>Pre-Rx SWI</th>
<th>Post-Rx SWI</th>
<th>Δ</th>
<th>Pre-Rx T1FS w/</th>
<th>Post-Rx T1FS w/</th>
<th>Δ</th>
<th>Pre-Rx DIR</th>
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<tr>
<td>Patient 1</td>
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<td>6.5</td>
<td>3.8</td>
<td>57.7</td>
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<td>81.2</td>
<td>57.1</td>
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</table>
Determination of Oropharyngeal Wall Thickness: Implications for Transoral Laser Microsurgery

C Tomblinson\textsuperscript{1}, G Fletcher\textsuperscript{1}, A Patel\textsuperscript{1}, J Hoxworth\textsuperscript{1}

\textsuperscript{1}Mayo Clinic, Phoenix, AZ
Purpose
While conventional oropharyngeal cancer resection employs wide local margins, the margins in transoral laser microsurgery with margin mapping are limited by the thickness of the oropharyngeal wall, which has not been well defined. Oropharyngeal wall thickness was measured on magnetic resonance imaging (MRI) to determine the extent of variability in the general population and whether it changes as a function of age and gender.

Materials and Methods
This retrospective study was approved by the institutional review board, and the need for informed consent was waived. The radiology database was queried to identify consecutive neck MRIs which were stratified by decade and gender to ensure equal sampling (10 patients per decade per gender were enrolled between 20 and 80 years; i.e., 240 sides). Patients with a history of head and neck surgery, irradiation, malignancy, and neurologic disorders were excluded. Oropharyngeal wall thickness was measured on axial T2-weighted fast spin echo sequences (3 mm slice thickness) posterior (P), between (B), and lateral (L) to the styloglossus (arrow) and stylopharyngeus (arrowhead) muscles. Statistical analysis was performed to assess for potential correlation between oropharyngeal wall thickness, age and/or gender.

Results
The oropharyngeal constrictor measured (mean ± standard deviation) 3.7 ± 0.9 mm (P), 1.9 ± 0.6 mm (B), and 5.1 ± 2.0 mm (L). The distance between the styloglossus and stylopharyngeus muscles at the point of insertion into the constrictor was 5.5 ± 1.5 mm. Multivariate regression suggests that P may decrease slightly with age and the distance between the styloglossus and stylopharyngeus muscles increases with age (p<0.01). The remaining constrictor measurements did not vary with age, and no significant gender effects were identified.

Conclusions
Oropharyngeal wall thickness is relatively constant in healthy subjects except that the distance between the styloglossus and stylopharyngeus muscles increases with age and posterior wall thickness slightly decreases with age. These results suggest that the classically taught 5 mm negative margin thought necessary for oropharyngeal cancer resection may not be routinely obtainable with transoral laser microsurgery because the constrictor thickness frequently measures less than 5 mm.
Correlation of neck CT finding of piriform sinus morphologic abnormality with Otolaryngology direct visualization: How specific are we?

K Hassan1, M Chapman2, B Setty1, O Sakai1
1Boston Medical Center, Boston University School of Medicine, Boston, MA, 2Boston University Medical Center, Boston, MA

Purpose
Hypopharyngeal squamous cell carcinomas (SCCa) account for 5% of head and neck malignancies (1), with 70% of cases involving the piriform sinus (2). Cancers here are clinically "silent," with small or early stage tumors producing no or mild clinical symptoms (3). Tumors often are large at diagnosis, reflecting the significant morbidity and mortality associated with these cancers (4-5). Partial or completely effaced piriform sinuses are often found during computed tomography (CT) evaluations of the neck. Radiologists often recommend direct inspection to avoid missing treatable cancer. The purpose of this study is to evaluate piriform sinus abnormalities on CT, and to correlate with findings seen on direct inspection.

Materials and Methods
We retrospectively reviewed our patient database to identify patients with documented piriform sinus abnormalities on CT examinations including the neck [CT neck, cervical spine, and neck positron emission tomography (PET)/CT] from January 2009 through December 2010, utilizing "piriform" and "pyriform" as a keyword search. Imaging studies and medical records were reviewed.

Results
9,175 CT examinations were performed during that time. Two hundred eleven patients (2.3%) demonstrated abnormal piriform sinus morphology (60% male (n=127), 40% female (n=84); 58% smokers (n=116) and 56% with history of alcohol use (n=110)). Ninety-nine (47%) underwent visualization with fiberoptic examination or rigid laryngoscopy. Fifty-seven percent (n=120) of abnormalities were left-sided, 25% (n=53) were right-sided, and 10% (n=38) were bilateral. Thirty-five (17%) patients with visualization demonstrated hypopharyngeal or laryngeal abnormality, with four (2%) patients diagnosed with biopsy proven malignancy, all of which were SCCa. Additional features on neck CT scans analyzed included lymphadenopathy and hypermetabolism on neck PET/CT scans. Seventy-six (36%) patients demonstrated cervical lymphadenopathy and 12 (14%) of those who underwent neck PET/CT scans demonstrated hypermetabolism in the piriform sinuses.
Conclusions
Morphologic abnormalities of the piriform sinuses commonly are found on CT. Direct inspection of the abnormalities may find a small number of early treatable cancers.

O-406 5:27PM - 5:30PM

Accuracy of Preoperative CT in Detecting Pathologic Nodal Extracapsular Spread in Oropharyngeal Squamous Cell Carcinoma.

J Telleria¹, P Hudgins¹, K Magliocca¹, M Patel¹, J Beitler¹, J Arora¹, A Aiken¹
¹Emory University, Atlanta, GA

Purpose
Nodal extracapsular spread (ECS) carries a higher risk for locoregional recurrence and distant metastases in head and neck squamous cell carcinoma (SCC), although the significance of ECS in HPV P16+ tumors is debated (1-2). Recent management trends for oropharyngeal (OP) SCC rely on pretreatment radiographic ECS (rECS) evaluation where imaging specificity is critical. Imaging in predominantly non-HPV SCC has demonstrated sensitivities of 63%-81% and specificities of 60%-91% (3-4). A recent study examining HPV P16+ (predominantly OP) SCC reported sensitivities of 47-55% and specificities of 70-85%, but did not subdivide pathologic ECS (pECS) into microscopic (<1mm) and macroscopic (>1mm) ECS (5). Our purpose was to determine if imaging accuracy is improved using macroscopic ECS as the pathologic gold standard. We also assessed the predictive value of individual nodal imaging features for macroscopic pECS.

Materials and Methods
This retrospective study included 24 consecutive patients who underwent primary TORS and neck dissection for OP SCC. Two CAQ-certified neuroradiologists independently reviewed pre-operative contrast-enhanced CT (CECT) images to evaluate the largest suspicious lymph node. For each case, the radiologist recorded lymph node size and features: matted appearance, lobular contours, perinodal stranding (subtle versus gross), necrosis (small versus >75% or "cystic"), invasion of adjacent structures, and overall impression of rECS. Radiographic results were correlated with pathology.

Results
Radiographic ECS was reported in 13/24 and 12/24 patients by radiologist 1 and radiologist 2, respectively. Pathologic examination revealed that 8/24 (33%) had pECS, with five having macroscopic ECS. Imaging sensitivity for all pECS was 100% for both readers. Specificity for all pECS was 69% and 75% for radiologist 1 and 2, respectively, but decreased to 58% and 63%, respectively, for macroscopic ECS. Interobserver agreement was high for all ECS, lobular contours, all stranding, and all
necrosis. Interobserver agreement was poor when stranding was subdivided into subtle or gross. On logistic regression analysis, size [OR 45.8, p=.003, 95% CI ([2.1, 999])] and lobular contours [OR 25.2, p=.003 CI (3.9-999)] demonstrated a positive correlation with macroscopic ECS. All stranding (C-index 0.79) and all necrosis (C-index 0.76) also demonstrated positive correlation with macroscopic ECS, however, were not statistically significant. Subtle stranding was not a predictor of macroscopic ECS.

Conclusions
This study found a much higher sensitivity (100%) of imaging for detecting pECS in OP SCC than previously reported, but with low specificity, especially for macroscopic ECS (58%-63%). Therefore, when applying criteria used for ECS in non-HPV SCC, the false positive rate is unacceptably high to base treatment decisions. We hypothesize that using subtle stranding as a criterion for macroscopic rECS in HPV P16+ nodal disease may result in false positives due to the inflammatory reaction present on pathologic examination which may mimic ECS radiographically. Size and lobular contours best predicted macroscopic ECS.

O-407

Choi Criteria as a measure of treatment efficacy in patients with metastatic head and neck squamous cell cancer patients treated with axitinib

E Dickerson¹, P Swiecicki¹, E Bellile¹, F Worden¹, A Srinivasan¹
¹University of Michigan, Ann Arbor, MI

Purpose
Axitinib is a small-molecule inhibitor of VEGFR and EGFR which has been evaluated for treatment of metastatic head and neck squamous-cell carcinoma (mHNSCC). The most frequently used tool for assessing response to chemotherapy, response evaluation criteria in solid tumors (RECIST), evaluates tumors by size. However, size alone may not reflect underlying intermediate tumor changes such as tumor necrosis. An alternate means of evaluation, the Choi Criteria, assesses factors including attenuation and size on CT. This was a retrospective, exploratory study assessing the utility Choi Criteria in assessing the response of HNSCC to axitinib.

Materials and Methods
This study examined radiologic and clinical data from a phase II clinical trial of axitinib for the treatment of unresectable recurrent or metastatic HNSCC. Forty-two patients initially were recruited to this trial of which 30 had imaging which could be assessed for disease response and 29 had computed tomography (CT) imaging of neck, chest, and/or abdominal metastasis for which Choi Criteria could be applied in a
retrospective, exploratory analysis. Outcomes were evaluated by Kaplan-Meier survival-analysis.

Results
By RECIST, 2/29 (6.9%) patients demonstrated partial response (PR) at any point and the disease control rate (CR, PR or stable disease) was 23/30 (76.7%). Applying Choi Criteria, 19/29 (65.5%) patients demonstrated PR at any point with a disease control rate of 21/29 (72.4%). No patients had complete response to therapy. Exploratory estimate of survival demonstrated a statistically significant difference between Choi responders versus nonresponders (63% versus 20% respectively, p=0.03). Common reasons for patients leaving the trial included disease progression (31/42; 73.8%), unacceptable toxicity (6/42; 14.3%), or noncompliance (2/42; 4.8%).

Conclusions
This analysis suggests that the Choi Criteria are useful in evaluating response to axitinib therapy in patients with mHNSCC. They merit consideration as a means of evaluating response to therapy in future prospective clinical trials.
Comparing overall survival among Choi criteria responders and non-responders
Increased Conspicuity of a Skull Base Meningioma Using ASL vs. DSC Perfusion

A Sung¹, R Lee², N Farid³
¹UC San Diego, San Diego, CA, ²UCSD/VA Medical Center, San Diego, CA, ³University of California, San Diego, San Diego, CA

Purpose
To demonstrate the advantages of arterial spin labeling (ASL) in imaging a skull base meningioma.

Materials and Methods
59 year-old female with right skull base meningioma status-post subtotal resection and fractionated radiation treatment presents for routine follow-up MRI.

Results
Axial T1 contrast enhanced image shows an enhancing right skull base mass involving the right cavernous sinus, Meckel's cave, and pre-pontine cistern, consistent with residual meningioma. Dynamic susceptibility contrast (DSC)-derived cerebral blood flow (CBF) map shows high cerebral blood flow within the right skull base meningioma. (ASL)-derived CBF map also demonstrates high cerebral blood flow within the right skull base meningioma, with much greater conspicuity compared to the DSC-derived CBF image.

Conclusions
Perfusion imaging at the skull base is particularly challenging with traditional MR perfusion techniques, such as dynamic susceptibility contrast (DSC), due to the high susceptibility artifacts that are produced with echo planar imaging (EPI). ASL perfusion imaging is an emerging technology that is becoming popular in the clinical setting. With recent advances in ASL technology, we are now able to perform whole brain 3D volumes using fast spin echo sequences, which are advantageous in imaging areas of high susceptibility, such as the skull base. Recently, ASL has been shown to be useful in distinguishing between meningiomas and schwannomas at the skull base. We present this case as a direct comparison between DSC and ASL perfusion in imaging a skull-base meningioma. The increased conspicuity on ASL stems from the
use of fast spin echo (FSE) imaging, which produces less susceptibility artifact compared to EPI.

E-21
4:55PM - 5:00PM

Tracheal Chondrosarcoma, Imaging and Clinical Features of a Rare Entity

M Neimark¹, A Spiro², J Bello², K Shifteh²
¹Montefiore Medical Center/Albert Einstein College of Medicine, Bronx, NY, ²Montefiore Medical Center, Bronx, NY

Purpose
To describe a case and to review the clinical and imaging findings of tracheal chondrosarcoma.

Materials and Methods
76 year old man with chronic tobacco use presented to the ED with 1 month history of worsening shortness of breath. On exam, there was a mobile nontender mass above the right clavicle. Tracheostomy was performed due to severe narrowing of the trachea seen on imaging. Sample biopsy was taken and sent to pathology which resulted in low grade chondrosarcoma. Patient returned to the operating room one week later for tracheal resection, hemithyroidectomy, and tracheal anastomosis.

Results
CT demonstrates a 4.9 cm hypodense, partially calcified mass, with invasion of and extension into the posterior trachea, severely narrowing it at the level of the thoracic inlet. The lesion appears to arise from the right thyroid lobe. There is no evidence of metastatic disease including lymphadenopathy, bone lesions, or lung nodules.

Conclusions
Tracheal chondrosarcoma is a rare entity with, including this case, 23 reported cases.
9 cases, including the last six consecutive cases, involved the upper 1/3 of the trachea. The tumor arises from the cartilaginous rings of the trachea. Differential entities include local extension from thyroid, esophageal, and lung masses, and primary squamous cell carcinoma or adenoid cystic carcinoma of the trachea. Tracheal chondrosarcoma occurs overwhelmingly in male patients (95%), and tends to occurs in older patients, with mean age 64. Two cases were associated with Maffucci syndrome, and one case was associated with remote radioiodine therapy for papillary thyroid carcinoma. CT usually describes a polypoid mass extending into the tracheal lumen, often significantly narrowing it. Calcification was present in 75% of cases, distinguishing it from most primary tumors of the trachea including squamous cell carcinoma and adenoid cystic carcinoma.
E-22

Myxofibrosarcoma of the Retropharyngeal Space

B Goldner¹, B Hamilton²

¹Oregon Health & Sciences University, Portland, OR, ²Oregon Health and Sciences University, Portland, OR
Purpose
We present a rare case of a primary myxofibrosarcoma of the retropharyngeal space (RPS) and discuss the anatomical and diagnostic considerations.

Materials and Methods
A 55 year old man presented with dysphagia.

Results
Modified barium swallow showed anterior displacement of the hypopharynx and cervical esophagus. Axial (Figure 1A) and sagittal MPR (Fig. 1B) enhanced neck CT demonstrated a 6 cm rounded midline RPS mass. The presence of a thin fat plane along the superior and inferior border of the mass (thick arrows, Fig. 1), along with the lower density (asterisk, Fig. 1) compared to prevertebral muscles and pharynx (thin arrows, Fig. 1) localized this mass to the RPS. Preoperative F-18 FDG PET showed minimal radiotracer uptake. Biopsy and subsequent excision revealed high-grade myxofibrosarcoma.

Conclusions
The usual contents of the RPS include fat and lymph nodes and therefore there is a very limited differential for RPS pathology. The key to diagnosis is recognizing that a lesion is within the RPS. This case demonstrates classic localizing imaging findings of a RPS lesion including preservation of fat planes, midline location within the neck and different enhancement from the pharynx and pre-vertebral muscles. The primary consideration RPS lesions include fluid, lymphoid tissue, and less commonly sarcomas. A solid RPS mass that is morphologically dissimilar to lymphoid tissue is virtually pathognomonic of a sarcoma.
Importance of MR imaging for guiding management in traumatic abducens nerve palsy: A case report.

P SHAH¹, A Langguth², A Karagianis³
¹Northwestern University Feinberg School of Medicine, CHICAGO, IL, ²Northwestern University, Chicago, IL, ³Northwestern University, Feinberg School of Medicine, Chicago, IL

Purpose
1. Describe imaging findings in abducens nerve avulsion with emphasis on CISS and SPACE/CUBE/VISTA MRI sequences. 2. Review the causes of traumatic abducens nerve palsy. 3. Understand the importance of early and accurate MRI diagnosis in guiding surgical management.

Materials and Methods
84 year-old female presented with diplopia after sustaining a fall and hitting the left side of her head without loss of consciousness. CT brain and face obtained at the time
of fall showed scattered subarachnoid hemorrhage and left periorbital and premaxillary soft tissue swelling without skull base or facial fracture. Upon examination, the patient was normal except for a profound (-4) abduction deficit in the left eye. A subsequent MRI orbit demonstrated a left abducens nerve avulsion. Given the imaging findings, return of patient's left lateral rectus muscle function was deemed unlikely. Thus, a decision was made to proceed with a split tendon vertical rectus transposition surgery.

Results

1. CT brain and face showed small parenchymal contusion and scattered subarachnoid hemorrhage in the right parietal lobe without acute fractures. 2. MRI brain showed a left abducens nerve avulsion. The proximal cisternal segment arising from the pons and the distal cisternal segment entering Dorello canal were present with absent intervening segment.

Conclusions

A traumatic abducens palsy may be the result of abducens nerve avulsion. It may also occur in the setting of skull base fracture, prepontine hemorrhage, increased intracranial pressure and brain herniation, among other causes. In majority of the cases, abducens nerve palsy may be initially treated conservatively, as most cases improve partially or completely within 6 months. Surgery is usually delayed if there is no improvement after 6 months. With a complete abducens nerve avulsion, return of lateral rectus muscle function is highly unlikely, and an accurate imaging diagnosis of this entity enables early surgical management, as in our case.
MR Findings in Wyburn-Mason Syndrome, a Rare Syndrome of Multiple Vascular Malformations of the orbit, brain and face.

M Gule-Monroe1, N Chasen1, L Ginsberg2
1M.D. Anderson Cancer Center, Houston, TX, 2MD Anderson Cancer Center, Houston, TX

Purpose
Describe the MR imaging findings in a patient with Wyburn-Mason Syndrome (WMS), a rare phacomatosis characterized by unilateral retinal, cerebral vascular malformations and vascular skin lesions.

Materials and Methods
A 19 year old male initially came to medical attention at the age of 3 when he
presented with proptosis of the left eye. On ophthalmologic exam he was found to have a large vascular lesion with dilated loops of vessels in the medial conjunctiva with tortuous retinal vessels. MR imaging of the brain and face demonstrated the presence of left orbital, left frontal scalp and intracerebral vascular malformations consistent with WMS. Three years after the initial presentation, at the age 6, the patient developed intracerebral hemorrhage. Since that time, the patient has experienced continued slow increase in left eye proptosis. Visual function has remained stable and thus, further surgical management of the orbital vascular malformation is being deferred.

Results
MR imaging of the face and orbits demonstrates a large, enhancing retrobulbar mass with hemorrhage and fluid-fluid levels, consistent with a vascular malformation. In the left frontal scalp a serpiginous T2 hyperintense, enhancing facial vascular malformation is identified. MRI brain and MRA brain demonstrates a vascular malformation in the left vermis with arterialized venous drainage. Diffuse vascular congestion of the left occipital and temporal lobes with corresponding cerebral volume loss is also seen. Several cavernous malformations, most prominently within the pons, left temporal and occipital lobes are identified.

Conclusions
WMS is a rare, sporadic neurocutaneous disorder characterized by unilateral vascular abnormalities of the orbit, typically the retina, facial soft tissues and brain. Clinically the patients present with sequela related to compression or rupture of intracerebral vascular malformations or ocular symptoms. Imaging with angiography is the gold standard for diagnosis with MR and CT, playing an important adjunct role, particularly with respect to anatomic characterization and imaging of complications.
Schwannoma of the Oral Tongue

C Davidson¹, J Kim¹
¹University of Kentucky, Lexington, KY

Purpose
To present a case of an oral tongue schwannoma. Given that oral tongue lesions are uncommon in the pediatric patient, differential considerations for this case will be reviewed.

Materials and Methods
A 17-year-old male presented with a history of a tongue mass which was discovered incidentally when it was seen by someone else. He described occasional dysphagia to solids, otherwise he was asymptomatic. Physical exam revealed a 2-3 cm
nontender, soft mass in the musculature of the left lateral oral tongue, and was thought clinically to be a minor salivary gland inclusion cyst. MRI of the face was obtained for further characterization. Submucosal excision was performed due to the potential of the lesion to affect speech and swallowing. Pathology revealed a schwannoma with classic Antoni A and B fibers.

Results
MRI of the face without and with contrast revealed a 2.6 cm well-circumscribed, homogeneously enhancing mass within the dorsum of the oral tongue. The mass demonstrated mild prolongation on T2-weighted images relative to the oral tongue, with prolongation on precontrast T1-weighted images.

Conclusions
Oral tongue schwannomas are relatively rarely reported and examples of imaging of these lesions in case reports are even less common. Oral cavity schwannomas represent as little as 1% of schwannomas of the head and neck, although the tongue is the most common site for schwannomas in the oral cavity. Most lesions are seen in patients between the ages of 10-40 years old. This example followed typical imaging characteristics of a schwannoma, although other differential considerations for a pediatric patient included rhabdomyoma, vascular lesion, granular cell myoblastoma, sarcoma, or minor salivary gland tumor. Even though lesions on imaging have a nonspecific appearance, imaging still has a role in diagnosis and treatment planning. Additionally, familiarity with differential considerations of pediatric oral tongue lesions, which in daily practice are uncommon, may facilitate care.
A Neonatal Maxillary Mass: Characterization with Time Resolved MRA

J Coburn¹, G Avey²
¹University of Wisconsin Hospitals and Clinics, Madison, WI, ²University of Wisconsin, Madison, WI

Purpose
To explore the differential diagnosis of congenital maxillary masses, and demonstrate the utility of time-resolved MR angiography for lesion characterization and surgical planning.

Materials and Methods
A 13 day old female born via spontaneous vaginal delivery presented for evaluation a left maxillary mass and associated weight loss. The mass was present at birth. The mass interfered with feedings, resulting in weight loss. At the time of presentation the patient was at the 5th percentile for weight and 95th percentile for height. Physical examination revealed a 2 cm left maxillary alveolar mass covered with normal appearing, but thinned mucosa. The anterior face of the mass was soft & boggy on palpation. Laboratory evaluation was significant for thrombocytopenia. Urine catecholamine levels were normal. A clinical differential diagnosis of melanotic neuroectodermal tumor of infancy, congenital hemangioma, rhabdomyosarcoma, and congenital epulis was entertained.

Results
Figure 1: Maxillofacial CT without contrast demonstrates a solitary expansile mass involving the left maxillary alveolus, measuring 1.7 x 2.6 x 2.2 cm in size (A-P, transverse, cranio-caudad). There is a permeative appearance of the maxillary alveolus, with no evidence of overlying periosteal reaction. Figures 2 and 3: MRI of the mass with and without contrast demonstrates no change in the size of the mass over the intervening two weeks. The mass is T2 hyperintense, isointense to muscle on T1, and has homogenous contrast enhancement. There is no associated diffusion restriction. Figure 4: Time-resolved MR angiography demonstrates a very vascular mass, with rapid progressive enhancement of the mass. Homogenous enhancement is achieved approximately 20 seconds after contrast administration. Time-resolved MR angiography confirms hypertrophy of the internal maxillary artery, as well as demonstrating that the dominant arterial supply to the mass arises from the greater palatine artery, with a lesser contribution from the posterior superior alveolar artery.

Conclusions
We present the case of a 13 day old female infant who presented with concern for an enlarging left maxillary mass, which on imaging evaluation was noted to be highly vascular. Time-resolved MR imaging delineated that the mass was fed primarily by an enlarged left greater palatine artery. A combined procedure with plastic surgery and otolaryngology was performed with ligation of the greater palatine artery and open
biopsy of the mass. Pathology results were consistent with a congenital hemangioma (rapidly involuting versus non-involuting). The safety of the procedure and care of the patient were greatly enhanced by recognizing the vascular nature of the lesion and precisely identifying the source of the arterial supply prior to surgical biopsy. Time-resolved imaging can greatly assist in the diagnosis and identification of the arterial supply of congenital vascular anomalies, thereby enhancing safe and successful management of these lesions.

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E-27
5:25PM - 5:30PM

MR Imaging of an Acute Contrast Reaction with Oropharyngeal Angioedema

R McDonald¹, C Rydberg¹
¹Mayo Clinic, Rochester, MN

Purpose
Allergic reactions to gadolinium based contrast agents (GBCAs) are observed at a frequency of 0.7% to 0.004% with severe anaphylactoid reactions occurring in 0.01% to 0.001% of cases (1). Radiologists must be able to identify and treat these reactions emergently, particularly those reactions associated with respiratory and/or circulatory system compromise. Imaging correlates to these reactions are rarely observed and reported. We present MR imaging of oropharyngeal angioedema during an acute contrast reaction.

Materials and Methods
A 46 year old female developed diffuse hives, facial erythema, throat pain, hoarseness, and difficulty swallowing within minutes of intravenous administration of
0.1 mmol/kg gadobutrol (Gadavist) for a contrast enhanced MRI of the brain. She did not report symptoms until the exam was completed. Supportive measures were initiated and included oxygen administration via facial mask, intravenous administration of 1L of 0.9 normal saline, 50 mg of IV diphenhydramine, and 40 mg of IV methylprednisolone. Despite some degree of patient distress, vital signs remained stable and there was no evidence of respiratory or cardiovascular compromise. These symptoms gradually resolved over the next hour while under close observation.

Results
Post-contrast T1 images of the MRI demonstrate bilateral edema and prominent mucosal enhancement of Waldeyer's ring predominantly affecting the palatine tonsils bilaterally (Fig A & B). These findings developed after contrast administration, as evidenced by the evolution of findings on the pre and post-contrast images (Fig C & D).

Conclusions
We present an unusual case of an acute allergic reaction to GBCA administration manifesting as oropharyngeal angioedema without associated airway compromise that developed and was observable on MR imaging. These findings illustrate the diverse manifestations of allergic contrast reactions after GBCA administration and may help the radiologist better identify these reactions during the MRI exam.
Multiple Myeloma Involving the Thyroid Cartilage: Case Report.

A Mamere\textsuperscript{1}, L Feltrin\textsuperscript{1}, R Fava\textsuperscript{1}
\textsuperscript{1}Barretos Cancer Hospital, Barretos, SP

Purpose
To report a rare pathology-proven case and to show the imaging findings of diffuse involvement of the thyroid cartilage in a patient with multiple myeloma.

Materials and Methods
A 75-year-old man with a background of IgA-kappa type multiple myeloma presented with increasing hoarseness 1 year after diagnosis. A mass in the region of the thyroid cartilage was observed on the computed tomography (CT) examination. Percutaneous imaging-guided core-biopsy was performed and the pathological findings were consistent with diffuse plasma cell infiltration.

Results
CT examination of the neck showed homogeneously enhancing solid mass diffusely involving the thyroid cartilage. Slight narrowing of the laryngeal airway was also noted.

Conclusions
Extraosseous myeloma refers to a rare manifestation of multiple myeloma where there is plasma cell proliferation outside the skeletal system and it can potentially affect any organ system. Lymph node is the most common extraosseous site of involvement. The presence of extraosseous myeloma generally implies a poorer prognosis. Involvement of the thyroid cartilage by multiple myeloma is even rarer. In our literature review, we have found only fifteen cases previously reported. Differential diagnosis includes other laryngeal malignancies, chondroma and low-grade chondrosarcoma. These chondroid tumors typically demonstrate chondroid calcifications which are not present in plasma cell tumors. The most likely mechanism suggested for cartilaginous involvement in cases of multiple myeloma seems to be that of osseous metaplasia of the cartilage with subsequent myelomatous involvement of this extraskeletal marrow. Despite its extreme rarity, thyroid cartilage plasma cell infiltration should be included in the differential diagnosis in patients with multiple myeloma presenting with cervical mass and/or hoarseness and it may be the first manifestation of the disease.
Dentures Mimicking Traumatic Pharyngeal Blood on a Cervical Spine CT.

I Ikuta¹, J Ewell¹, F Yang¹
¹Norwalk Hospital, Norwalk, CT

Purpose
While the appearance of oral dentures have been described on CT, the appearance of ectopic denture prosthetics can be difficult to identify and may mimic the appearance of blood. We provide an example to demonstrate dentures in the setting of trauma as an imaging pitfall, and review the imaging characteristics of dentures.

Materials and Methods
A 43-year-old man presented to the Emergency Department with massive facial lacerations and head trauma, status post assault. A CT of the cervical spine was ordered to evaluate the extent of trauma. The radiology resident was present at the CT scanner when the patient arrived, and upon direct visual inspection noticed a large volume of blood covering the patient's head. The patient was unconscious upon arrival and intubated, and was therefore unable to provide any additional history.

Results
The CT of the cervical spine soft tissue windows demonstrated high-attenuation material initially appearing to layer within the dependent portion of the posterior oropharynx (top left image). Given the clinical history, the high attenuation material was believed to represent hemorrhage, which seemed to be a reasonable consideration in the setting of facial and oral trauma with copious hemorrhage. Upon further evaluation, portions of the high-attenuation material demonstrated an S-shaped morphology with some portions in an anti-dependent location, not the expected appearance for hemorrhage (top right image). On examination of the sagittal multiplanar reformatted images, the posterior cephalad end of the high-attenuation structure demonstrated a hooked appearance, which would also be atypical for a hemorrhagic collection (bottom left image). Review of the lateral localizer image demonstrated that the patient was edentulous, which raised the possibility of denture prosthetics (bottom right image). The high-attenuation material is also not readily visible on the lateral localizer image.

Conclusions
Dentures have an attenuation which may mimic blood, and in the setting of trauma it presents a potential imaging pitfall. Careful evaluation of the gastrointestinal tract (including the posterior oropharynx) and airways (trachea and bronchi) may reveal a high-attenuation material concerning for hemorrhage; however, when a morphology is not characteristic of blood, ectopic location of dentures in an edentulous patient may
be suspected and direct visualization recommended. The radiolucent polymer of dentures may not be readily appreciated on x-ray and CT localizer images, and note of an edentulous or partially edentulous patient may be one of the few clues to help avoid this imaging pitfall.
Supraglottic Laryngeal Paraganglioma

Y Sun\textsuperscript{1}, S Bobra\textsuperscript{1}, H Mehta\textsuperscript{1}, M Tenner\textsuperscript{1}, B Rigney\textsuperscript{1}, A Arneja\textsuperscript{1}

\textsuperscript{1}Westchester Medical Center, Valhalla, NY

Purpose
Paragangliomas are highly vascular, slow growing and often benign tumors that arise from neural crest cell derivatives with a low malignant transformation potential. Together with tumors of epithelial origin, they comprise the majority of laryngeal neuroendocrine neoplasms. Laryngeal paraganglioma is exceedingly rare and it is the only laryngeal neuroendocrine tumor that has a female predilection with a reported female-to-male incidence ratio of 3:1 (1). We present a novel case of a 63 year-old female with supraglottic laryngeal paraganglioma.

Materials and Methods
A 63-year-old female presented with a large anterior neck mass and long standing history of progressive dysphonia. Patient underwent a tracheostomy for airway protection and subsequently underwent transpharyngeal/translaryngeal excision of the tumor. Pathology revealed paraganglioma.

Results
CT of the neck demonstrates a large avidly enhancing mass lesion in the supraglottic larynx that measures approximately 4.5cm CC x 4.4cm TV x 2.8cm AP. There is severe effacement of the aerodigestive tract. MRI demonstrates prominent vascular flow voids along the periphery of the avidly enhancing mass. Selective right external carotid artery catheter angiogram shows a large tumor blush in the anterior midline of the neck with arterial supply mainly from the right superior and inferior thyroid arteries. A second tumor blush is noted near the left vertebral artery origin with arterial supply from branches of the left thyro-cervical trunk.

Conclusions
Laryngeal paragangliomas are rare with roughly 80% supraglottic and 20% infraglottic in location. Less than 10% of the paragangliomas are extra-adrenal in location and less than 1% localize to the head and neck region (2). CT and MRI are essential for characterization. T1-weighted image may show a "salt and pepper" appearance; representing blood products from internal hemorrhage and flow voids secondary to increased vascularity. Preoperative angiography and possible embolization are important imaging/management considerations. Surgical excision is the treatment of choice (3).
Dual Energy CT Cisternography in the Evaluation of CSF Leaks: A Novel Approach

A Alfieri1, D Boulter2, W Slone2, X Nguyen3, B Gans2, M Luttrull1, E Bourekas4, E Miller5, L Prevedello3
1The Ohio State University Wexner Medical, Columbus, OH, 2the Ohio State University Wexner Medical, Columbus, OH, 3Ohio State Wexner Medical Center, Columbus, OH, 4The Ohio State University, Columbus, OH, 5Ohio State University, Columbus, OH

Purpose
Cerebrospinal fluid (CSF) leaks pose a serious threat to patients as they represent an unchecked communication between the subarachnoid space and the external environment. Potential complications include meningitis, stroke, stupor, and death. Accurate localization of leakage site is essential for treatment planning. We describe the novel utilization of dual energy CT technology in cisternography for the evaluation of CSF leaks.

Materials and Methods
A 66 year old female presented with tinnitus and positional right nasal drainage while recumbent for the past several months. The patient denied any associated symptoms. She had a history of right CSF otorrhea status post surgical repair via craniotomy with dural patching in the 1980s and reported no similar complaints during the interim. A brain MRI performed at an outside institution suggested the possibility of a CSF leak and recommended cisternography for further evaluation.

Results
Following intrathecal injection of iodinated contrast, high-resolution dual energy CT of the skull base revealed contrast filling the extra-axial CSF spaces. Focal fluid opacification of the right olfactory recess was noted on standard linearly blended images (60% of 80 kVp tube, 40% of 140 kVp tube with tin filter). Noise-optimized monoenergetic reconstructions at 40 keV markedly increased the attenuation and conspicuity of fluid in the right olfactory recess, confirming iodinated contrast leakage. Iodine overlay map fused on anatomic images further increased conspicuity of contrast leakage. Dual energy reconstructions simplified separation of contrast leakage from adjacent structures and allowed for clear visualization of a direct pathway of CSF communication.

Conclusions
CSF leaks have important clinical complications, and accurate diagnosis of leak
presence and location are critical to surgical planning. While conventional CT cisternography allows for accurate identification of CSF leakage in many cases, the addition of dual energy CT may significantly improve visualization of leakage without considerably altering radiation exposure.
Rare case of bilateral hypoglossal nerve enhancement in Guillain Barre syndrome

M Ma¹, S Lin¹, R Pandit¹
¹Santa Clara Valley Medical Center, San Jose, CA

Purpose
Guillain-Barre syndrome (GBS) is an acute autoimmune post infectious or inflammatory demyelination of peripheral nerves. Cranial nerve involvement of GBS is most commonly seen in the facial nerves, followed by bulbar and trigeminal nerves (1,2). Review of literature shows that involvement of the hypoglossal nerve is rare in GBS clinically (3), with only 1 previously reported case with imaging abnormalities (4). We present an unusual case of GBS variant with extensive bilateral cranial nerve enhancement, including that of CN XII.

Materials and Methods
42 yo previously healthy female was admitted with 1 week of bilateral ascending numbness, parasthesia, and pain in her extremities. This was accompanied by dysphagia, dysarthria, blurred vision, and progressive ascending weakness. She underwent 2 courses of IVIG and recovered some motor function. However, 3 weeks following initial presentation, she developed new left facial weakness, right facial parasthesia, and increased difficulty speaking. On exam, she had dysarthria, left upper and lower facial droop, right V1-V3 decreased facial sensation, gaze evoked nystagmus with lateral gaze bilaterally, and mild sensory ataxia. Tongue protrusion was midline. She had diffuse muscle weakness and decreased sensation, greater in the lower extremities, and she was areflexic throughout. CSF studies showed albuminocytologic dissociation, and microbiology studies were unremarkable. AntiGq1b serology was negative (5). EMG showed axonal loss in the lower greater than upper extremities and prolonged latency, consistent with GBS.

Results
T1 post contrast fat saturated images show extensive long segment enhancement of CN VII from the intracannicular through parotid portions bilaterally. In addition, the patient has enhancement of bilateral CN V from the cavernous segment to its divisions in foramen rotundum and the vidian canal, of bilateral CN IX-X complex at the jugular foramen, and of bilateral CN XII as they traverse the hypoglossal canal. No intraparenchymal lesions are identified. Spinal imaging was not performed.

Conclusions
This patient is best described as a case of GBS variant, given her presentation of delayed onset of multiple cranial neuropathies. Although cranial nerve involvement is a well described manifestation of GBS, our case is unique in that bilateral CNXII involvement has only rarely been observed. Understanding the spectrum of disease...
presentation is valuable in evaluating acute inflammatory neuropathies and may have prognostic implications (1).

5:55PM - 6:00PM

Masticator Space Parasitosis: Rare Presentation for a Common Infection

M Ramírez-Guzmán¹, L García-Posada², E Sarda-Inman², R Valenzuela³, G Godoy-Brewer¹, D Ruiz⁴, R Riascos⁵

¹The University of Texas Health Science Center at Houston, Houston, TX, ²Diagnostico Especializado por Imagen, Zapopan, Jalisco, ³The University of Texas, Houston, TX, ⁴The University of Texas Health Science Center at Houston UTHSC, Houston, TX, ⁵UTHSC-Houston, Houston, TX

Purpose
• Presenting a rare case of a middle age female, who demonstrated inflammation of
the left cheek. The ultrasound (US) and magnetic resonance (MR) images demonstrated a cystic lesion in the left masseter muscle compatible with cysticercosis.

• To contribute with our imaging findings to consider cysticercosis in masseter muscle in future cases as a differential diagnosis of cyst mass.

Materials and Methods
Female patient in her mid-thirties. No medical background, who assists claiming volume increase on the lower left face region since three months ago, during the physical exam, a volume increase on the left parotid region was evidenced, firm, nodular, no adhesion to deep planes, painful when touched. An echographic and MR study was requested under the suspicion of a parotid tumor. After imaging studies cysticercosis diagnosis was made. The patient was treated with Albendazole 50mg/Kg day per 14 days, showing clinical improvement within the following days. The control US and MR studies showed no cyst mass.

Results
Gray scale and color Doppler US shows a cyst lesion on the left masseter muscle with heterogenic appearance irregular edges, echogenic center, and peripheral vascularization. MR demonstrated in T1, T2 with fat suppression, FIESTA, and T2 with heavy contrast where a well-defined round lesion was shown localized on the left masseter muscle, hypointense behavior on T1 hyperintense on T2 and a nodular image with less intensity to the periphery, compatible with the scolex.

Conclusions
Cysticercosis is one of the most common parasitic infections worldwide. A rare case of an isolated cysticercosis lesion in the left masticator space was presented, diagnosed by US and MR imaging, where cysticercosis characteristics are shown, such as the scolex. A clinical improvement was shown after the treatment with oral Albendazole, and Praziquantel might be used as well, with the disappearance of the edema and symptoms. It is important to be familiar with the uncommon manifestations of the infection and consider this entity as a part of the differential diagnosis when we see cystic intramuscular lesions.
Figure 1 Gray scale (A) and doppler (B) ultrasound. Where an heterogeneous intramuscular lesion is observed, presenting cystic areas and solid material to the periphery, showing an echogenic area in its interior.

Figure 2 Sagittal images on MR potenced on T1 (A) and T2 with fat suppression (B). Where a cystic lesion can be seen on the left masseter muscle, well defined, no perilesional edema.
Unique Arterial Cause of Fallopian Canal Enlargement in a Patient with PHACES

J Lam1, M Cunnane2, D Zimmerman3
1Hartford Hospital, Middletown, CT, 2Massachusetts Eye and Ear Infirmary, Boston, MA, 3Hartford Hospital, Hartford, CT

Purpose
We describe a PHACES patient showing a vascular phenomena with respect to the left tympanic facial nerve canal from the sequelae of a developmentally hypoplastic left internal carotid artery (ICA).

Materials and Methods
A 9 years old female with PHACES syndrome was presented for further evaluation of an extensive vascular facial birthmark and possible segmental hemangioma. Her initial study revealed a hypoplastic left ICA. Progressive narrowing of the left supraclinoid ICA with incidental dilation of the right internal auditory canal (IAC) was noted on subsequent imaging. Thus, a dedicated computed tomography scan (CT) of the temporal bone was ordered to better delineate the structures of the posterior fossa.

Results
The tympanic segment of the left facial nerve (FN) canal is abnormally enlarged (Top right image). An aberrant vascular channel is seen communicating with it at the level of the oval window niche, descending into the skull base, medial to the mastoid segment of the FN canal (Bottom right image: the stylomastoid artery comes off from the posterior auricular artery). Reviewing prior magnetic resonance (MR) angiography with the CT, a prominent vascular structure communicates between the anterior portion of the tympanic facial canal near the geniculate ganglion (Top left image). This vessel represents a prominent superficial petrosal (SP) artery. MR time of flight reveals an anastomosis between the SP branch of the middle meningeal artery (MMA) and enlarged stylomastoid artery within the tympanic segment of the fallopian canal. Incidentally, the patient also has a persistent stapedial artery, a known vascular phenomenon in patients with PHACES syndrome (Bottom left image).

Conclusions
Intracranial vascular anomalies have been observed in conjunction with PHACES syndrome in many instances.1 The petrosal artery (PA) is commonly the first branch off the MMA after it exits the FS.2-5 It travels with the greater superficial petrosal nerve (GSPN) through the GSPN hiatus. The superior tympanic artery, the second
branch off the MMA, can sometimes joins with the PA or continues into the facial canal with the lesser petrosal nerve.2-4 The stylomastoid artery from the posterior auricular artery goes through the stylomastoid foramen to supply the mastoid segment and later joins the PA in the tympanic segment of the FN.3,4 Consequently, because the left ICA of this patient is developmentally hypoplastic, this anastomosis between the SP artery and the SM artery persisted, resulting an enlarged left tympanic segment FN canal. The findings of all three occurrences are extremely rare, but explainable due to the known abnormal vasculature that can occur in patients with PHACES syndrome.

(Filename: TCT_E-34_PHACES.jpg)

E-35

Don’t Pop This Pimple: Facial Varix, a Rare Entity

P Shah¹, J Huang¹, V Yedavalli²
¹ Advocate Illinois Masonic Medical Center, Chicago, IL, ² Illinois Masonic Medical Center/ University of Chicago, Chicago, IL
Purpose
Varices of the facial vein are extremely rare, with only a handful of cases being reported in the literature. We present a case of symptomatic varix of the facial and angular vein with suspected arteriovenous fistula.

Materials and Methods
A 69 year old female with history of a thrombosed giant right middle cranial fossa aneurysm status post right craniectomy and right external carotid artery to right middle cerebral artery bypass presented with two weeks of progressive pain, swelling and ecchymosis in the right periorbital region. She reported no history of trauma, malignancy, or infection. Due to history of prior aneurysm and patient's presentation, underlying vascular etiology was suspected and computed tomography angiography (CTA) of the head and neck was performed.

Results
CTA revealed a large tubular soft tissue structure in the region of swelling in the right periorbital region with contrast in its inferior aspect that communicates with the right external jugular vein, thus representing a partially thrombosed facial varix. Doppler ultrasound was performed to further characterize flow dynamics. This revealed mixed arterial and venous Doppler waveforms, raising suspicion for underlying arteriovenous malformation. The patient was then discharged with close follow up for future conventional cerebral angiography and possible endovascular intervention.

Conclusions
Facial varices are rare causes of facial swelling and are typically thrombosed upon diagnosis. Typically overlooked, vascular etiologies should also be considered in addition to infectious and inflammatory causes of focal facial swelling.
Spontaneous Regression of a Large High-Flow Intracranial Dural Arteriovenous Fistula

A Yen\textsuperscript{1}, S Hetts\textsuperscript{1}

\textsuperscript{1}University of California, San Francisco, San Francisco, CA

Purpose
Intracranial dural arteriovenous fistulas (DAVFs) are rare vascular malformations that connect meningeal arteries to dural venous sinuses or cortical veins. Few DAVFs have been reported to resolve spontaneously since the phenomenon was first described in 1976. The mechanism for spontaneous closure is unknown, although some possibilities have been proposed. Here we describe a case of spontaneous resolution of a large DAVF in a patient with a hypercoagulable state.

Materials and Methods
A 47-year-old female with a history of rheumatoid arthritis was seen at an outside institution and found to have a large transverse sinus DAVF with high-flow fast arteriovenous shunting. One year prior to discovery of the DAVF, she underwent work-up at an outside institution for a seven-year history of daily occipital headaches and was found on MRI to have left-sided transverse and sigmoid sinus thromboses. She was clinically deemed to have a hypercoagulable state and was prescribed warfarin at the time. After continued headaches and the development of low-pitched ringing in her ears, a catheter angiogram showed a large transverse sinus DAVF, supplied by the left occipital artery and the left middle meningeal artery and drained by the right-sided transverse sinus, sigmoid sinus, and internal jugular vein. She was referred to our institution for embolization of her DAVF. Although the patient was prescribed a low molecular weight heparin injection bridge between her usual warfarin and the time of angiography at our institution, that prescription was not filled. Thus, the patient's warfarin was stopped four days prior to her procedure with no anticoagulant bridging. Her prior diagnostic angiogram and her angiogram performed at our institution were separated by 8 months. Although her initial angiogram clearly showed a large DAVF, the second diagnostic angiogram demonstrated that her DAVF had spontaneously resolved. As a result, no embolization was performed. No treatment was given thereafter. The patient was recently contacted for follow-up but did not respond.

Results
Image 1 (DSA, 2012) - Left external carotid artery lateral angiogram demonstrates a high flow DAVF shunting to the sigmoid sinus with antegrade drainage to the internal
jugular vein. Image 2 (DSA, 2012) - Right occipital artery anteroposterior angiogram demonstrates supply to the contralateral left transverse sigmoid sinus junction DAVF. Image 3 (DSA, 2013) - Left external carotid angiogram demonstrates spontaneous resolution of the DAVF. Image 4 (DSA, 2013) - Right occipital artery anteroposterior angiogram demonstrates no residual supply to previously seen left transverse sigmoid sinus junction DAVF.

Conclusions
In this report, we described a case of a very large DAVF that spontaneously resolved. Despite our institution's extensive familiarity with DAVFs, this is the largest that we have seen to resolve on its own. Although the exact mechanism of why this occurred is unknown, it is likely related to the patient's underlying hypercoagulable state and the high-flow nature of the DAVF.
Wednesday
4:45PM - 6:15PM
Washington Marriott Wardman Park, Roosevelt 4

18F-Study Group - Imaging Genomics (non-CME)

Thursday
7:30AM - 8:30AM
Washington Marriott Wardman Park, Marriott Ballroom

19A-Thursday Morning SAM - Head and Neck Audience Response (AR) Self Assessment Module (SAM)

19A-1
Salivary Glands
Eliahou, R.
Hadassah Medical Center
Reut

19A-1a
Questions and Answers

19A-2
Deep Spaces of the Neck
Hagiwara, M.
NYU Langone Medical Center
New York, NY

19a-2a
Questions and Answers

Thursday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Marriott Ballroom

20A-SNIS Programming: Difficult Dilemmas: Safe Solutions for Challenging Situations in the Cavernous Sinus
20A-1
8:35AM - 9:00AM
Cavernous Sinus Anatomy and Its Endovascular Implications

Prestigiacomo, C.
Neurological Institute Of New Jersey
Newark, NJ

20A-2
9:00AM - 9:20AM
Intra-arterial Approaches to Cavernous Sinus Lesions: Is the "Direct" Route Always the Best?

Amans, M.
UCSF
San Francisco, CA

20A-3
9:20AM - 9:40AM
Transvenous Approaches to Lesions of the Cavernous Sinus: The "Indirect Solution to a Complex Problem

Amuluru, K.
Rutgers New Jersey Medical School
Newark, NJ
20A-4

Deconstruction Methods and Alternatives to the Treatment of Vascular Lesions of the Cavernous Sinus

Hui, F.
Johns Hopkins University
Baltimore, MD

Thursday
8:35AM - 10:00AM
Washington Marriott Wardman Park, Washington 4/5/6

20B-Advanced Neuroimaging and Bioinformatics in Neuropsychiatric Disease

20B-1

Substance Use Disorder and Neuroimaging

Tanabe, J.
University of Colorado School of Medicine
Aurora, CO

20B-2

MS Spectroscopy in Neuropsychiatric Disorders

Port, J.
Mayo Clinic
Rochester, MN

20B-3

Imaging Genetics of 22q11 Deletion Syndrome

Schmitt, J.
University of Pennsylvania
Philadelphia, PA
20B-4

9:20AM - 9:35AM

Systems Neuroscience, Neuroimaging and Neuropsychiatric Disease

Yu, J.
University of Wisconsin-Madison
Madison, WI

20B-5

9:35AM - 9:50AM

Overview of Functional Neuroimaging in Neuropsychiatric Disease

Sugrue, L.
UCSF
San Francisco, CA

20B-6

9:50AM - 10:00AM

Discussion

Thursday
8:35AM - 10:03AM
Washington Marriott Wardman Park, Washington 1/2/3

20C-PARALLEL PAPER SESSION: Head and Neck: Parathyroid, Thyroid, and Salivary
O-408

8:35AM - 8:43AM

Diagnostic Accuracy of Parathyroid Imaging: Comparing 4D-CT, Ultrasonography, MIBI and 4D-CT/MIBI Fusion.

B Tantiwongkosi¹, V Nguyen¹, F Yu¹, U Salman¹, H White¹, W Altmeyer², A Singh³, F Miller¹, C Hands¹, O Boyce¹, A Santillan-Gomez¹
Purpose
The purpose of this study is to assess the diagnostic accuracy of four dimensional computed tomography (4D-CT) for localizing pathologically proven hyperfunctioning parathyroid glands, as compared to ultrasound (US), MIBI and 4D-CT/MIBI fusion.

Materials and Methods
Retrospective review of 4D-CT, US, MIBI and fusion parathyroid imaging at a tertiary referral center between 2011 and 2015 is performed with radiological, surgical and pathological correlation. Inclusion criteria are availability of intra-operative report, pathology and performance of pre-operative imaging. Histology, surgical findings, reduction of intra-operative parathyroid hormone levels are used as gold standards. Accuracy of 4D-CT is determined by including laterality and quadrant of the pathologically proved lesions as compared to US, MIBI and fusion study.

Results
Sixty-eight patients with hyperparathyroidism have 82 glands removed and proven to have parathyroid adenomas or hyperplasia. Sixty-eight, 38, 32 and 24 patients have 4D-CT, US, MIBI, and 4D-CT/MIBI fusion respectively. The accuracy of 4D-CT, US, MIBI and 4D-CT/MIBI fusion are 79%, 64%, 76% and 83% in quadrant localization and 89%, 65%, 78% and 93% in lateralization respectively. When utilizing combination of imaging modalities, the accuracy increases up to 91% and 92% in quadrant localization and lateralization accordingly.

Conclusions
Four dimensional CT is a novel robust method in localization of hyperfunctioning parathyroid glands with high accuracy as compared to conventional imaging.

O-409
8:43AM - 8:51AM

Confidence Grading System for Parathyroid 4D-CT: How Well Does Radiologist Confidence Predict Surgical Findings?

S Kuzminski1, M Bahl1, A Sepahdari2, J Sosa1, J Hoang1
1Duke University Medical Center, Durham, NC, 2UCLA, Santa Monica, CA

Purpose
Several studies have shown four-dimensional (4D) parathyroid computed tomography (CT) to have superior sensitivity to ultrasound and scintigraphy. Another advantage of 4D-CT is the ability to provide a confidence score based on a combination of imaging findings. The Duke 4D-CT grading system was developed to standardize reporting.
The purpose of this study was to evaluate the performance of this grading system in predicting intra-operative parathyroid lesion location.

Materials and Methods
We retrospectively reviewed 174 consecutive pre-operative 4D-CT scans from UCLA and Duke University in patients with primary hyperparathyroidism who on final surgical pathology were demonstrated to have parathyroid adenomas or hyperplasia. Lesions were categorized according to the Duke 4D-CT grading system based on three enhancement patterns (Types A-C) and three secondary findings (polar vessel, size ≥ 1 cm, cystic change) (Bahl, Sepahdari, Sosa, & Hoang, 2015). "Consistent with" was defined as Type A or B enhancement with at least one secondary finding. "Suspicious" was Type A or B enhancement without a secondary finding or Type C enhancement with at least one secondary finding. "Possible" was Type C enhancement without a secondary finding. We calculated and compared the sensitivity, prevalence, and positive predictive values (PPV) for each confidence grading system category.

Results
One hundred seventy-four patients had 229 parathyroid lesions. All lesions could be categorized by the grading system (Table 1). "Consistent with" was the most common classification, with a prevalence of 39%, sensitivity of 97%, and positive predictive value (PPV) of 97%. "Suspicious" represented 36% of lesions and had a sensitivity of 88% and PPV of 91%. Finally, "possible" represented 25% of lesions and had the lowest sensitivity of 68% and a PPV of 81%.

Conclusions
The Duke 4D-CT grading system performs as intended in reporting parathyroid lesions on 4D-CT. The system is reliable in helping the surgeon decide if further imaging is required and if surgery can be performed using a minimally invasive or focused technique.
Table 1. Enhancement patterns and secondary signs of parathyroid adenomas and hyperplasia on 4DCT.

<table>
<thead>
<tr>
<th></th>
<th>Parathyroid Lesions (Prevalence)</th>
<th>False Positive</th>
<th>Positive Predictive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of lesions</td>
<td>229</td>
<td>23</td>
<td>89%</td>
</tr>
<tr>
<td>Single</td>
<td>154 (67%)</td>
<td>18</td>
<td>88%</td>
</tr>
<tr>
<td>Multiglandular</td>
<td>75 (33%)</td>
<td>5</td>
<td>91%</td>
</tr>
<tr>
<td>Enhancement Pattern *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type A – higher attenuation</td>
<td>37 (16%)</td>
<td>1</td>
<td>97%</td>
</tr>
<tr>
<td>than thyroid on arterial phase with decreasing attenuation on delayed phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type B – same attenuation</td>
<td>79 (34%)</td>
<td>4</td>
<td>95%</td>
</tr>
<tr>
<td>as thyroid on arterial phase but lower in attenuation than thyroid on delayed phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type C – similar in</td>
<td>113 (49%)</td>
<td>18</td>
<td>81%</td>
</tr>
<tr>
<td>attenuation to thyroid on both contrast phases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary findings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size ≥1 cm</td>
<td>116 (51%)</td>
<td>10</td>
<td>91%</td>
</tr>
<tr>
<td>Cystic component</td>
<td>37 (16%)</td>
<td>3</td>
<td>93%</td>
</tr>
<tr>
<td>Polar vessel</td>
<td>71 (31%)</td>
<td>10</td>
<td>86%</td>
</tr>
<tr>
<td>Grading Scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistent with – Type A/B enhancement and 1 or more secondary findings</td>
<td>90 (39%)</td>
<td>3</td>
<td>97%</td>
</tr>
<tr>
<td>Suspicious – Type A/B enhancement without secondary findings or Type C enhancement with ≥1 secondary findings</td>
<td>82 (36%)</td>
<td>10</td>
<td>91%</td>
</tr>
<tr>
<td>Possible – Type C enhancement without secondary findings</td>
<td>57 (25%)</td>
<td>10</td>
<td>81%</td>
</tr>
</tbody>
</table>

* All enhancement patterns required the adenoma to be lower in attenuation than the thyroid gland on the noncontrast phase.

4D MRI for Preoperative Localization of Parathyroid Adenomas: 2 Year Experience

K Nael¹, S Hur², J Becker², P Pawha¹, P Som¹

¹Icahn School of Medicine at Mount Sinai, New York, NY, ²University of Arizona, Tucson, AZ

Purpose

Recently dynamic magnetic resonance imaging (MRI) has been used for identification and characterization of parathyroid adenomas (PTA) with success (1). The purpose of
this study was to assess the diagnostic performance of 4D MRI for pre-operative localization of patients with PTA in comparison to surgical pathology.

Materials and Methods
From Sep 2013 to Sep 2015, patients with the diagnosis of primary hyperparathyroidism who had surgery and pre-operative MRI were reviewed. Magnetic resonance imaging was performed with inclusion of a high spatial (1.3 x 1.3 x 2 mm) and high temporal resolution (5.5 sec) dynamic contrast-enhanced acquisition. Images were reviewed by a CAQ-certified neuroradiologist who was blinded to the results of surgical pathology. A lesion was identified as PTA if it was in the expected location of parathyroid tissue (orthotopic or ectopic), was T2 hyperintense and demonstrated early arterial enhancement. The location (left or right, superior or inferior gland) as well as the number of PTAs was recorded. If more than one candidate was identified on initial analysis, the reader was instructed to use dynamic information (rapid arterial enhancement, rapid wash-in and washout) to confirm suspicion of a PTA versus other structures such as lymph node. Diagnostic accuracy of 4D MRI was measured against surgical pathology for both side and quadrant location.

Results
A total of 75 patients were reviewed. Thirteen patients were excluded (nondiagnostic dynamic MRI, n=4, unavailable surgical pathology n=5, parathyroidomatosis in re-operative patients, n=4). Among 62 included patients, no lesions were found in three patients (5%) at surgery. A total of 74 PTAs were identified in 59 patients including five patients with multiglandular disease. Among 74 PTAs identified, 66 lesions were correctly localized by 4D MRI (89%). Four dimensional MRI correctly identified unilateral versus bilateral disease in 53/59 (91%) patients. The overall sensitivity was 94% for single gland disease versus 69% for multiglandular disease. For 11 lesions, a second potential candidate was considered initially (based on conventional imaging), that was differentiated correctly and identified as cervical lymph node using dynamic information including rapid washin and washout.

Conclusions
Four dimensional dynamic MRI can be used for pre-operative localization of PTAs with diagnostic accuracies rivaling those with 4D CT. If its potential is realized, 4D MRI can be used as an alternative diagnostic modality in pre-operative parathyroid imaging.

O-411

Survey of Radiologists on Parathyroid 4D-CT: Variability in Practice Patterns and Protocol

K Williams¹, J Hoang¹, F Gaillard², J Sosa¹, A Dixon³
Purpose
Several studies show parathyroid four-dimensional CT (4D-CT) to be more sensitive than scintigraphy and ultrasound for pre-operative localization of parathyroid adenomas, but based on the literature, there is high variability in the imaging protocols and role of 4D-CT in pre-operative planning worldwide. The aim of this study was to describe the current practice role and trends in utilization of 4D-CT.

Materials and Methods
A survey was designed to query radiologists about their different institutional practices with regard to 4D-CT in the pre-operative evaluation of hyperparathyroidism. The survey was distributed by Radiopaedia.org, ASHNR and ASNR in January 2015. The survey questions sought to understand four main categories of practice: primary role of 4D-CT at the institution, details about 4D-CT protocol, volume and trends in utilization, and shared reporting practices among radiologists.

Results
Three hundred sixty radiologists responded. Two hundred of 360 (55.3%) stated that 4D-CT was used in their practices. Nineteen (9.5%) reported that 4D-CT plays a primary role in parathyroid imaging, 155 (77.5%) reported that 4D-CT plays a secondary role, and 26 (13%) reported that it is performed routinely with ultrasound and scintigraphy. A three-phase protocol was most common (50.5%), but imaging also was performed with 4 and 2 phases. In the majority of practices (148/200, 74%), <5 4D-CT studies were performed each month. Overall, 143/200 (71.5%) practices have performed the exam for ≤ 3 years, and 4D-CT volume was perceived to be increasing over time according to 91/200 (45.5%) respondents. Ninety of 200 (45%) radiologists indicated that only one or two radiologists in their practices reported 4D-CT. A first line role for 4D-CT in the evaluation of hyperparathyroidism was more likely if the study had been performed for >3 years and with increasing and larger 4D-CT practice volumes.

Conclusions
More than half of radiologists who responded to the survey perform 4D-CT, and nearly half report increasing utilization of 4D-CT in pre-operative evaluation of hyperparathyroidism. The 3-phase protocol is used most commonly in practice. The majority of radiologists reported that 4D-CT still plays a secondary role.
S Bhuta1, G Kwan2, C Hsu2
1Gold Coast University Hospital, Gold Coast, Australia, 2Gold Coast University Hospital, Southport, N/A

Purpose
To describe the utility noninvasive technique of dynamic 4D CT imaging of the larynx in assessment of vocal cord palsy.

Materials and Methods
Dynamic imaging of the larynx was performed with 320 slice mean diffusivity (MD)CT (Toshiba Aquilion One, Japan). Laryngeal imaging was performed in 15 patients with detector ray to scan of 8 cm and 10 cm Z-axis volume to minimize the radiation dose. Acquisition was at 0.5mm and reconstructed at 1 mm slice thickness interval with 350 ms gantry rotation speed. Gantry angulation was used to reduce artifact from mandible FOV from hyoid to upper trachea – 1st or 2nd tracheal ring (Fig.1). Intravenous (IV) contrast was not administered. Patients were rehearsed in a breathing protocol. Multiple phases are acquired as Quiet Breathing, EEE Phonation and Sniff Test. Imaging technique was compared with endoscopy findings.

Results
Vocal cord palsy was well detected on 4D CT. Volume and surface rendering technique was used. Virtual endoscopy also was performed. Widening of the laryngeal ventricle, medial deviation and thickening of the aryepiglottic fold and dilatation of the piriform sinus was observed consistently in all patients. Dynamic assessment using breathing techniques showed the expansion of the pyriform sinus with no change in respiratory phase, similarly alerted cord mobility was visualized directly on cine loop images.

Conclusions
Dynamic vocal cord assessment is innovative and quick and noninvasive imaging test. No IV contrast is required and radiation dose is minimal. Imaging findings are comparable to direct visualization of the larynx. Study can be repeated to assess improvement after voice training and or after surgery.
Increasing Incidence of Thyroid Cancer: Impact of Neck Imaging Utilization

G Ma¹, M Makary¹, G Abdalhalim¹, S Erdal², L Prevedello¹, T Shujaat¹, X Nguyen¹
Purpose
Thyroid cancer incidence has nearly tripled in recent decades, with varying magnitude of increase across different demographic groups. Increased detection of asymptomatic thyroid cancers likely contributes to this trend, but few studies directly assess the impact of imaging utilization on rising thyroid cancer incidence. This study quantifies neck CT imaging utilization rates and their relationship with thyroid cancer incidence as a function of age, sex, and race.

Materials and Methods
Medical records of over one million patients receiving care from 2004 to 2011 at our institution were analyzed retrospectively to quantify neck CT utilization, defined as the proportion of patients having at least one neck CT or CTA study. The United States National Cancer Institute's Surveillance, Epidemiology and End Results database was used to compute thyroid cancer incidences from 2004 to 2011 and to calculate fold-change of thyroid incidence over the past 30 years. Both patient populations were partitioned into demographic subgroups of varying age, sex, and race.

Results
Of the three demographic variables, age demonstrated the greatest variability in thyroid cancer incidence and neck imaging utilization, both of which peaked in the 65-74 age group (Fig. 1a). When stratifying by age, neck CT utilization correlated very strongly with national thyroid cancer incidence (R = 0.97) and with 30-year fold change in thyroid cancer incidence (R = 0.87). Across all demographic subgroups, there was moderate correlation between neck imaging utilization and 30-year fold change in thyroid cancer incidence (R = 0.46), greater for whites (R = 0.63) and blacks (R = 0.53) than other races (R = 0.07) (Fig. 1b).

Conclusions
Differences in neck CT utilization account for a large portion of the variation in thyroid cancer incidence among demographic subgroups. The data support a role of increased imaging detection in the observed rise in thyroid cancer incidence.
Imaging of Anaplastic Thyroid Cancer

S Ahmed¹, M Ghazarian², T Vu¹, J Debnam¹, N Chasen³
¹UT MD Anderson Cancer Center, Houston, TX, ²UT Houston Medical School at Houston, Houston, TX, ³M.D. Anderson Cancer Center, Houston, TX

Purpose
While anaplastic thyroid cancer (ATC) accounts for less than 3% of thyroid cancer cases, there is rapid progression of tumor with significantly higher mortality when comparing to differentiated thyroid cancer which comprises 85-90% of thyroid cancer cases and typically has an indolent course. The aim of this study is to describe the imaging characteristics on contrast-enhanced computed tomography (HRCT) of the neck, in patients with biopsy proven anaplastic thyroid cancer.
Materials and Methods
Hospital database was queried for diagnosis of ATC between 6/2004 and 7/2015. Those patients with pretherapy CT imaging were included. HRCT images were reviewed by CAQ'd neuroradiologists specializing in head and neck imaging. The primary tumor was evaluated for 1) extent of involvement, 2) size, 3) margins, 4) extra-thyroidal extension, 5) morphology, 6) calcifications, 7) esophageal invasion, 8) tracheal invasion, 9) laryngeal invasion, 10) carotid encasement, 11) internal jugular vein (IJV) encasement/invasion, and 12) intrathoracic extension. The presence of central, lateral, and lateral retropharyngeal lymphadenopathy (LAD) was documented. Lateral compartment LAD was assessed for calcification, necrosis, and cystic change.

Results
Query yielded 205 cases of ATC. Fifty-eight of 205 patients had pretherapy CT imaging, and three patients were excluded for poor image quality. Male=28/55, Female=27/55. Age range: 21 to 82 years (Mean=64 years, Median=65 years). Extent of involvement: one lobe=12/55 (22%), one lobe plus isthmus=13/55 (24%), both lobes=30/55 (54%). Size: Mean=5.1 x 4.5 cm, Median=4.9 x 4.1 cm (AP x Transverse). Tumor margins: Ill-defined=45/55 (82%), well-defined=10/55 (18%). Extra-thyroidal extension=50/55 (91%). Morphology: Solid=10/55 (18%), cystic=0/55 (0%), mixed solid and necrotic=45/55 (82%). Calcification: present=34/55 (62%). Of the 34 tumors with calcification, coarse calcifications =19/34, punctate/stippled=19/34, eggshell=5/34. Intrathoracic extension=23/55 (42%), esophageal invasion=34/55 (62%), tracheal invasion=31/55 (56%), laryngeal invasion=16/55 (29%). Carotid artery encasement=22/55 (40%), IJV involvement=23/55 (42%). Central LAD=30/55 (55%), Lateral LAD=4/55 (62%). Lateral retropharyngeal LAD=7/55 (13%). Lateral compartment LAD: necrosis=21/34 (61%), calcification=0/34 (0%) had calcification, cystic=3/34 (8%).

Conclusions
Anaplastic thyroid cancer typically presents in an older patient as a large (>= 5 cm) solid mass with necrosis involving more than one lobe of the thyroid, and with extracapsular extension. The esophagus and trachea are involved more commonly than the larynx, and there is propensity for vascular encasement/invasion. Majority of the cases will have cervical lymphadenopathy, often with necrosis. It is important for the radiologist to be aware of the above imaging characteristics, and suggest a specific diagnosis of ATC when these features are present in a patient with a thyroid mass, to ensure accurate diagnosis and prevent delays in therapy.

O-415

Purpose
There can be significant variation in the imaging approach for the evaluation of sialolithiasis. In this study, we performed a survey in order to evaluate the variations in contemporary practice for salivary imaging and evaluated the accuracy of dual energy CT (DECT) virtual unenhanced images (VUE) derived from a contrast-enhanced acquisition for detection of salivary stones.

Materials and Methods
IRB approval was obtained for this study. To evaluate practice variations, a 4-question survey was distributed to the membership of the American Society of Neuroradiology. A search of the CT scan database and reports then was performed at our institution in order to identify scans that were performed using the salivary gland protocol, including both an unenhanced (UE) and a contrast-enhanced (CE) acquisition, with the CE phase performed in DECT mode. Cases positive for at least one major salivary gland stone then were identified and matched with an equal number of cases without any stones, as negative controls. Virtual unenhanced images then were created from the 65s CE acquisition. The UE, VUE, and CE series then were mixed using a randomizer and displayed individually in random order. A head and neck radiologist evaluated each series for the number and minimum size of the stones detected. The number of stones on the UE study was considered as the gold standard. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for detection of stones on VUE, using the true UE series as gold standard reference.

Results
Among the 280 respondents to the survey, 53.4% indicated using a different imaging protocol for referrals requested to rule out salivary stones compared to those for work up of gland swelling or mass, whereas 46.6% used the same protocol. For the work up of sialolithiasis, 92.9% use CT as first line imaging modality, 4.6% use ultrasound, and the rest other techniques. The most common CT protocols used were an UE CT followed by a single phase CE acquisition (35.3%), an UE CT only (28.1%), or a CE acquisition only (28.1%). For the evaluation of stones, 26 patients having a total of 52 obstructive or nonobstructive major salivary gland calcifications were identified, matched with another 26 patients without any salivary stones. On a per patient basis, the VUE images had 100% sensitivity and specificity. On an individual calcification basis, the VUE had a sensitivity of 96%, specificity of 96%, PPV of 98%, and NPV of 93%. The false negative cases corresponded to clinically insignificant, nonobstructive
parenchymal calcifications in the parotid glands. Stones not seen on the VUE images measured 2 mm or less although in many cases stones as small as 1 mm were visible on VUE images.

Conclusions
There is significant practice variation in the imaging approach and CT protocols used for the evaluation of sialolithiasis. An approach using a single CE dual energy CT acquisition with reconstruction of VUE images may represent an attractive alternative and enable the elimination of the true UE phase and associated radiation exposure.

O-416

9:39AM - 9:47AM

Instantaneous Responses of Parotid Glands to Gustatory Stimulation Evaluated by High Temporal Resolution Echo-planar Diffusion-weighted Imaging

C Juan1, T Chiu2, Y Liu3, H Chang4, K Hsu5
1National Defense Medical Center and Tri-Service General Hospital, Taipei, Taiwan, 2Taipei Medical University, Taipei, nil, 3Feng Chia University, Taichung, nil, 4The University of Hong Kong, Hong Kong, nil, 5National Defense Medical Center, Taipei, nil

Purpose
To evaluate instantaneous responses of parotid glands to gustatory stimulation using echo-planar diffusion-weighted imaging (DWI).

Materials and Methods
This prospective study was approved by a local institutional review board. Written informed consent was obtained from 21 enrolled healthy volunteers [14 men and 7 women; age of 45.2 ±12.9 years (mean ± standard deviation)]. All participants underwent 1.5T fat-saturated echo-planar DWI with a temporal resolution of 4 seconds per scan. Imaging quality on T2WI (b = 0 s/mm2) and DWI (b = 200 s/mm2) was qualitatively assessed. Signal intensity of T2WI, DWI and apparent diffusion coefficient (ADC) of parotid glands was analyzed quantitatively. One way ANOVA with post-hoc group comparisons with Bonferroni correction were used for statistical analysis. P < 0.05 was considered statistically significant.

Results
Substantial to almost perfect interobserver agreement was achieved (kappa ≥ 0.656) in qualitative analysis. Free from perceptible magnetic susceptibility artifact at the baseline and at the end of scans on all images, parotid glands were partially involved by artifact on DWI during swallowing in three volunteers. Reduced signal intensity of parotid glands on T2WI and DWI and increased ADC occurred immediately after oral administration of lemon juice. Maximal signal change of ADC (24.8 ± 10.8%) was significantly higher than that of T2WI (-10.1 ± 5.2%; P<0.001). Recovery ratio of
ADC (100.71% ± 42.34%) also was significantly higher than that of T2WI (22.36% ± 15.54%; P<0.001).

Conclusions
Echo-planar DWI allows evaluation of instantaneous responses of parotid glands to gustatory stimulation at a high temporal resolution of 4 seconds per scan.
CT and MRI Characteristics of Benign versus Malignant Palpable Parotid Masses

M Bashir¹, C Britt², G Hartig², L Gentry², T Kennedy³
¹University of Wisconsin, Madison, WI, ²University of Wisconsin Hospitals, Madison, WI, ³University Of Wisconsin Hospital, Madison, WI

Purpose
Parotid gland masses account for 70-85% of all salivary gland tumors, and have a rate of malignancy approaching 15-25%. The palpable, asymptomatic parotid mass presents a common problem for the clinician regarding need for resection. Currently, there is no treatment algorithm for managing palpable, asymptomatic parotid masses, particularly when surgery is wished to be avoided. We examined palpable, asymptomatic parotid masses in order to identify high-risk features within a larger available patient population that may aid in guiding appropriate management for these lesions.

Materials and Methods
This IRB-approved retrospective study evaluated computed tomography (CT) and magnetic resonance (MR) imaging (132 and 27 masses, respectively) of randomized patients between 2007 and 2013 with palpable, asymptomatic parotid gland masses who underwent surgery. Two interpreting radiologists were blinded to the pathology results. The evaluated CT imaging characteristics of the parotid masses included contrast-enhancement, size, location within the gland, density, margins, and calcifications. The evaluated MR imaging characteristics included contrast-enhancement, size, location, T1 and T2 signal intensity. Diffusion characteristics and FDG imaging were included where available. Data analysis was performed using Fisher exact test with the Monte Carlo correction to determine whether or not there is a difference between the benign and malignant groups, as well as to determine if very hyperintense T2 signal (similar to that of cerebrospinal fluid) can help in identification of pleomorphic adenomas versus all other parotid gland masses in this study.

Results
Of the different CT and MRI characteristics evaluated, the presence of irregular margins on both CT and MRI proved to be statistically significant in distinguishing malignant from benign pathology (p=0.04, p=0.04). Pathology for the malignant lesions included acinic cell carcinoma, carcinoma ex pleomorphic adenoma, and lymphoma, among others. The majority of benign masses were pleomorphic adenomas and Warthin tumors. In addition, T2 signal was significantly different for pleomorphic adenomas (p=0.01) compared to other lesions; very hyperintense T2 signal was seen only in pleomorphic adenomas. The degree of enhancement, size, location, or individual MR signal characteristics were not independently useful in distinguishing benign from malignant pathology. Image 1: A) Axial STIR MR image

Conclusions
The presence of irregular margins on CT and MRI can help distinguish high risk palpable, asymptomatic parotid masses.
Purpose
Background: Neck adiposity tissue volume (NATV) accumulation, is an indicator for metabolic syndrome and cardiovascular disease (CVD). Neck circumference is a poor measure of NATV, and a quantifier for this entity has not yet been established. Aim: To evaluate volumetric quantification by multidetector computed tomography (MDCT) as a reproducible anthropometric tool to measure NATV and airway volume (AWV), and to correlate these measurements with several comorbidities and overall mortality.

Materials and Methods
We retrospectively and volumetrically analyzed the neck fat and airways of all patients who underwent head and neck CT in our hospital within 1 year (2013). Included scans were all noncontrast CT (NCCT) and all CT angiography (CTA). Postprocessing 3-dimensional (3D) tissue reconstruction was performed on all patients' neck scans, and their cervical adipose tissue (CAT) and airway volumes (AV) were quantified volumetrically. Neck circumference was traced semi-automatically and expressed as cross-sectional area (mm^2). Information on BMI, hypertension, and smoking was obtained, sleep apnea "STOPBANG" questionnaires were gathered.

Results
A total of 431 necks were analyzed, corresponding to the completed questionnaires, including 72 NCCT and 359 CTA. Subjects were grouped into three categories based upon STOPBANG score (0-2, 3-4, 5-8), with 135 considered "low risk" (43 NCCT, 92 CTA), 165 "intermediate risk" (18 CT, 147 CTA), and 131 "high risk" (11 CT, 120 CTA) for sleep apnea. Low risk STOPBANG subjects were at a median age of 49 years, with 9,928 mm^3 NCSA, mean CAT:AV ratio of 21.3. Intermediate risk patients had a median age of 64 years, 14,388 mm3 NCSA, mean CAT:AV ratio of 32. High risk patients were at a mean age of 64 years, 16,147 mm3 NCSA, mean CAT:AV of 33.5. Mean CAT:AV by scan type, NCCT and CTA were 21.2 and 39.4, respectively (p<0.001). Patients were followed for 670 days, and the top quartile of all CAT:AV patients displayed a significant propensity for overall mortality (7.5%, p=0.032).
Conclusions
Patients with high CAT:AV ratios showed a higher likelihood to suffer from sleep apnea, display stroke-like symptoms on presentation, and a higher predilection for mortality. Further research is warranted to fully understand the anatomical relationship between cervical adiposity and airway volumes, specific comorbidities, and overall mortality. Volumetric quantification of NATV and AWV is a reproducible and prognostic anthropometric tool; future research may further advance our understanding of this phenomenon.

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
The purpose of our study was to evaluate recent trends in extracranial carotid artery imaging and intervention from 2006 to 2013 in the Medicare fee-for-service population.

Materials and Methods
Data from the national Medicare part B Physician/Supplier Procedure Summary Master files were used for this study. The Medicare part B files represent the largest database of its kind on Medicare patients, and covers patients enrolled in traditional fee-for-service Medicare (37.3 million patients in 2013). Volume of CEA, CAS, and carotid ultrasound were studied by physician specialty from 2001-2013.

Results
Carotid ultrasound volumes increased from 2,293,866 in 2001 to 2,680,479 (17% increase) in 2013. Radiologists performed the largest number of carotid ultrasound studies, performing 903,688 or 34% in 2013. Cardiologists were the second largest group, performing 785,187 studies or 29% in 2013. Carotid endarterectomy volumes also are increasing: the total volume of carotid endarterectomy was 353,041 in 2001, rising to 445,221 in 2013 (an increase of 26%). Vascular surgeons perform most CEAs in the United States Medicare population, performing 408,173 surgeries in 2013 or 92%. The percentage of carotid endarterectomies performed by vascular surgeons also is increasing: vascular surgeons performed 73% of all carotid endarterectomy surgeries in 2001, increasing to 92% in 2013. Carotid artery stenting also is showing a trend towards an increase in the volume of procedures, with most CAS performed by cardiologists as shown in a recent publication (1).
Conclusions
The volume of extracranial carotid imaging and intervention is increasing. Radiologists perform the majority of carotid ultrasound (34%), with cardiologists a close second (29%). Carotid endarterectomy appears to be the preferred method of revascularization in the U.S. Medicare population, and vascular surgeons performed 92% of these procedures in 2013.

CT- Angiography Evaluation of Acute Ischemic Stroke- Study From a Tertiary Care Hospital of North India

g rastogi1, S GROVER1
1VARDHMAN MAHAVIR MEDICAL COLLEGE, SAFDARJUNG HOSPITAL, DELHI, INDIA
Purpose
(1) To assess intracranial arterial circulation in acute ischemic stroke patients by computed tomography angiography (CTA). (2) To evaluate the impact of CTA diagnosis on management decisions.

Materials and Methods
Thirty consecutive patients clinically presenting with acute stroke and diagnosed as ischemic stroke on non-contrast CT (NCCT) within 6 hours of onset of symptoms were included in the study. Computed tomography angiography was performed in all patients immediately. Computed tomography angiography was analyzed for territorial distribution, plaques and arterial lumen stenosis. Patients were directed for emergency thrombolysis, carotid endarterectomy, carotid artery stenting and medical management as per CTA findings. Post-treatment 1-year clinical follow up was obtained.

Results
Young strokes were seen in 13% patients who were less than 40 years old with significant male predilection (p=0.02). Fifty-eight percent of patients were hypertensive with deranged lipid profile in 26% and diabetes in 12%. Atherosclerotic plaque was the most common etiology with 65% in extracranial segment of internal carotid artery (ICA) and both intracranial and extracranial segments of ICA in 42% patients. Seventy percent of patients were directed for emergency thrombolysis, out of which 46% had successful treatment with excellent clinical recovery. Seventy-five percent of patients had severe stenosis, among them 60% underwent carotid endarterectomy and carotid artery stenting. On one-year clinical follow up only 20% had recurrent attack. One patient with suspected tubercular vasculitis was treated with anti-tubercular therapy and had uneventful post-treatment for 1 year. Remaining were advised conservative medical management.

Conclusions
Computed tomography angiography provides rapid, noninvasive, life saving, comprehensive evaluation in acute stroke and contributes in definitive treatment planning. It reduces morbidity significantly and therefore can be recommended in the standard investigative protocol of this neurological catastrophe even in a developing country like India.

O-421

International, Multicenter Phase 3 Blinded Study (GEMSAV) of the Structural Visualization, Diagnostic Efficacy and Safety of Gadobutrol (Gadavist) Enhanced MRA of the Supra-aortic Vessels compared to Time-of-Flight MRA using CTA as the standard of reference

J Agris¹, D Haverstock², C Di Casoli², E Melhem³
Purpose
The purpose of the study was to compare the performance of a contrast-enhanced magnetic resonance angiography (CE-MRA) with gadobutrol, a high relaxivity, macrocyclic agent, to 2D time-of-flight (ToF) MRA using computed tomography angiography (CTA) as the standard of reference. Some key primary objectives were to evaluate the superiority for structural delineation and noninferiority for diagnosis of clinically significant vascular disease (50-99% stenosis).

Materials and Methods
Four hundred eighty-seven patients (mean age 68 years, 65% male) suspected of stroke or other supra-aortic disease underwent MRA with gadobutrol at a dose of 0.1 mmol/kg and ToF as well as CTA. The evaluations were based on central blinded read (BR) by three radiologists and investigator reads of the 21 supra-aortic vessel segments including the carotid and vertebral arteries. Exact vessel/stenosis measurements were performed.

Results
Gadobutrol-enhanced MRA demonstrated statistically significant improvement in visualization of vascular segments when compared to ToF 95.0% versus 72.7% (P < 0.0001). In the BR, noninferiority for sensitivity was shown for gadobutrol MRA (CE-MRA) compared to ToF MRA (60.1% versus 54.4%) as well as superiority for specificity (96.1% versus 87.3%). The sensitivity improved by 5.7% with CE-MRA and the specificity improved significantly by 8.8%. The corresponding values for the site evaluation were 60.9% sensitivity for CE-MRA and 39.1% for ToF MRA, demonstrating superiority, and 98.1% specificity for CE-MRA versus 89.0% ToF MRA. The gadobutrol MRA vessel measurements were more precise than those in the ToF MRA (0.01mm gadobutrol versus 0.29mm ToF for error in stenosis measurements) shown in Fig 1. Relatively fewer vertebral stenoses were present, but sensitivity was similar to that of the larger carotid arteries. In addition, diagnostic confidence increased and fewer additional imaging studies were recommended with gadobutrol-enhanced MRA.

Conclusions
Gadobutro-enhanced MRA was superior to 2D ToF MRA for delineation of the vascular segments as well as exclusion of disease. Furthermore it showed high accuracy with minimal error in the vascular measurements (Fig. 1). Gadobutrol-enhanced MRA of the supra-aortic vessels has superior visualization, more accurate measurements and is a valuable alternative to CTA without any ionizing.
Exploring Other Vascular Dimensions: Comparison of 3-dimensional vs. 2-dimensional Vessel Wall Imaging Techniques for the Evaluation of Large Artery Vasculopathies

M Mossa-Basha¹, M Alexander², J Maki³, W Cohen¹, D Hippe¹, H Huhdanpaa¹, C Yuan¹, T Saam⁴
Purpose
Takayasu and giant cell arteritis are chronic, inflammatory large artery vasculopathies (LAV), that necessitate early diagnosis as prompt initiation of treatment can prevent or delay the onset disease-related morbidities including blindness, limb ischemia, and hemorrhage secondary to chronic vessel stenosis, occlusion, aneurysm formation, and the harmful side-effects of overtreatment in later stage disease. Unfortunately, early detection is difficult due to the vague nonspecific clinical presentation and lack of early luminal imaging findings. There has been a recent focus on MR vessel wall imaging techniques (VWI) to establish vessel wall involvement by the presence or absence of enhancement indicative of active inflammation (1-5). This study performs a quantitative and qualitative comparison between a modified 3D T1 VISTA with EKG gating and breathing navigation and 2D T1 double inversion recovery (DIR) black blood imaging of the upper thoracic aorta and cervical arteries to determine the differential quality of each technique in patients referred for suspicion of LAV.

Materials and Methods
Patients referred for potential LAV who received both modified 3D T1 VISTA with EKG gating and breathing navigation and 2D VWI MRI w/wo contrast were included. Two dimensional and 3D sequences were performed in random order after contrast. Blinded independent review was performed by two radiologists. Blood signal suppression, image quality and diagnostic confidence each were rated using a four-point scale. The ratings from each radiologist were averaged for the data analysis. A separate rater evaluated vessel wall and soft tissue signal to noise ratio (SNR) and contrast to noise (CNR) for cervical and aorta images for both techniques. Two-tailed paired t-tests were performed to compare differences between 2D and 3D techniques.

Results
Eight patients were included. Cervical arteries were imaged in all patients while the superior thoracic aorta was imaged in six of eight. Two dimensional VWI demonstrated significantly increased SNR and CNR of the vessel wall (.031 and .026) for images of the cervical arteries. Three dimensional images had better soft tissue SNR (p=.005) for the thoracic aorta. Blood suppression, overall image quality and diagnostic confidence ratings of the cervical images were significantly higher for the 3D versus 2D images. For the aorta, blood suppression and image quality ratings were significantly higher for the 3D versus 2D images, with a trend towards higher diagnostic confidence (p=0.054). Three dimensional provided increased coverage relative to 2D imaging. Three dimensional VWI scan time was shorter compared to 2D VWI.
Conclusions
Three dimensional VWI for evaluation of LAV should be a clinical consideration based on radiologist-perceived advantages and improved coverage in a shorter scan time.
Non-Contrast, Inflow Enhanced Inversion Recovery with 3D Fast Spin Echo (IFIR-FSE) with Fast Image Acquisition using Compressed Sensing (CS) technique has potential to be a Viable Alternative to Contrast-Enhanced MRA (CE-MRA) for the evaluation of neck vasculature.

S Lee¹, M Qandeel¹, C Yang¹, S Ali¹, K Jahangir¹
¹University of Chicago Medical Center, Chicago, IL

Purpose
To evaluate the image quality of the neck vasculature with inflow-enhanced inversion recovery with 3D fast spin echo (IFIR-FSE) with compressed sensing (CS) technique, a noncontrast magnetic resonance angiography (MRA) technique.

Materials and Methods
This study was approved by institutional IRB. Six patients who consented to participate were included. Contrast-enhanced MRA (CE-MRA) and IFIR-FSE 3D MRA with combinations of two set of inversion recovery time and three sets of compressed sensing (CS) were obtained on a 1.5T scanner (Optima MR450w, GE) [A (TI=1600, CS=1.0), B (TI=1600, CS=1.5), C (TI=1600, CS=2.0), D (TI=2000, CS=1.0), E (TI=2000, CS=1.5), and F (TI=2000, CS=2.0)]. Three board-certified neuroradiologists blindly reviewed the anonymized image sets using a third party viewer (Visage7®, Visage Imaging, CA, USA). Arterial segments for the semiquantitative image quality assessment included: aortic arch, brachiocephalic trunk, left subclavian artery and bilateral CCAs, ICAs and ECAs. The scoring scale used for image quality assessment was: 4 (excellent; sharply defined arterial borders, diagnostic), 3 (good; minor inhomogeneities not influencing vessel delineation, diagnostic), 2 (fair; ill-defined vessel borders with suboptimal quality, nondiagnostic) and 1 (poor; barely visible lumen, nondiagnostic). For quantitative image analysis, the contrast to noise ratio (CNR) was measured between the right CCA and adjacent soft tissue using [(SIv-SI0)/SD0] formula.

Results
A total of 37 MRA image sets in six patients were obtained. All IFIR-CS MRA image sets and CE-MRAs received a diagnostic quality score (3 or higher). Mean cumulative score for 10 vascular segments and mean scan times of A-F image sets were: A=3.86 (4:37min), B=3.86 (3:31min), C=3.82 (2:57min), D=3.83 (4:37min), E=3.84 (3:31min), F=3.85 (2:57min) and CE-MRA=3.78 (1:03min). All IFIR-FSE MRAs did not show a statistically significant difference in CNR compared to CE-MRA except image set F which showed better CNR than CE-MRA.

Conclusions
Noncontrast-enhanced neck MRA using IFIR-FSE with CS technique demonstrates
high quality images comparable to CE-MRA in reasonably short acquisition time. Considering the benefits of avoiding gadolinium, this technique has potential to be a viable alternative to CE-MRA for the evaluation of neck vasculature.

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O-424

8:50AM - 8:53AM

Reducing Radiation Exposure and Optimizing Cervicocerebral CT Angiographic Quality in Acute Stroke Patients

J Jordan¹, Y Jordan², K Ragland³, J McPherson⁴
¹Providence Little Company of Mary Medical Center, Torrance, CA, ²Washington University St. Louis School of Medicine, St. Louis, MO, ³Long Beach Memorial Medical Center, Long Beach, CA, ⁴Providence Little Company of Mary Medical Center, Marina Del Rey, CA

Purpose
To assess the radiation dose exposure using various computed tomography angiography (CTA) protocols for brain and neck imaging in the diagnosis of acute stroke; and to assess the image quality and optimize protocols by reducing the radiation dose, while maintaining diagnostic efficacy.

Materials and Methods
Computed tomography angiography was performed of the brain and/or cervical carotid arteries as part of an institutional acute stroke management protocol. Seventytwo patients were evaluated and separated into four groups based on variations in tube voltage. KVPs of 135, 120, 100, and 80, (groups 1-4 respectively) were utilized while holding MAS constant. Image quality was assessed quantitatively and qualitatively.
Regions of interest (ROIs) were used to determine maximal vascular enhancement across groups, and calculate signal to noise (SNR) and contrast to noise (CNR) ratios. Effective radiation doses also were calculated for each study. The image quality was also graded qualitatively on a 5 point scale (1=non-diagnostic, 5= excellent diagnostic quality) by two experienced readers. Statistical analysis of the results was performed using analysis of variance (ANOVA) and nonparametric inferential methods. Interobserver agreement also was tested applying Cohen's kappa statistical measures.

Results

Compared with group 1 (140 kvp), the effective dose was 4.3 times higher than group 4 (80 kvp). The effective dose of group 1 was also 1.4 and 2.2 times higher than group 2 (120 kvp), and group 3 (100 kvp) respectively. Visual image scoring showed excellent concordance between readers (k= 0.89, SE .04, p< .001), with good to excellent diagnostic quality consistently demonstrated for groups 1-3, and fair to poor quality consistently shown for group 4. Mean signal to noise and contrast to noise ratios were lowest for group 4 versus group 1, but comparable between groups 1, 2, and 3, despite incremental increases in noise for the lower kvp groups (p<.0001).

Conclusions

Substantial reductions in patient radiation exposure for cervicocerebral CTA can be achieved by reducing tube voltage to as low as 100 kvp, without compromising image quality. At 100 kvp, a 55% reduction of radiation dose was calculated versus 27% for the 120 kvp group, but as both protocols demonstrated good to excellent image quality, the 100 kvp protocol was deemed superior because of the greater radiation exposure reductions achieved.

**O-425**

8:53AM - 8:56AM

**Radiation Dose Reduction in 4-dimensional Intracranial CT angiography by Individualized Estimation of Cerebral Circulation Time**

M Radon¹, A Chandran¹, M Bhojak¹, K Das¹
¹The Walton Centre, Liverpool, United Kingdom

Purpose

Four-dimensional computed tomography angiography (4D-CTA) provides a noninvasive technique for dynamic assessment of the intracranial vessels. Its use has been limited by a high radiation dose. Prior descriptions of the technique use a fixed exposure time protocol of up to 22 seconds. This study examines the potential for dose reduction by individualizing exposure time to patient physiology with the use of recently described time-enhancement curve techniques for CT angiography and venography.
Materials and Methods
Four dimensional CTA examinations performed at our institution were retrospectively reviewed. Two imaging techniques were compared. Method 1 determined start of exposure from peak arterial enhancement and exposure duration was based on radiologist discretion. Method 2 used dual arterial and venous time-enhancement curves from which exposure start time and duration were measured. Data were reconstructed at 500 ms intervals for both methods with method 1 using 750 ms temporal resolution, and method 2 1000 ms with reduced tube current.

Results
One hundred fifty-two examinations were completed using method 1, and 55 with method 2. Method 2 acquired fewer total volumes (method 1: 31, method 2: 19; \( p<0.05 \)) representing a reduction in exposure time of 39%, fewer precontrast arrival frames (6 versus 1; \( p<0.05 \)), fewer postvenous phase frames (2 versus 0 ; \( p<0.05 \)) but had reduced peak venous enhancement (370 versus 324 HU; \( p=0.019 \)). Subjective quality score was not different between groups 4.7 versus 4.8 (\( p=0.29 \)). Studies with inadequate temporal coverage were 11 (7.2%) in method 1 versus 2 (3.8%) in method 2. Positive finding rate was not different between studies 36.2% versus 36.5% (\( p=0.63 \)). Mean dose-length product was 2993 mGy.cm in method 1 and 1508 mGy.cm in method 2.

Conclusions
Exposure time in 4D-CTA can be reduced by use of a dual arterial-venous time-enhancement curve method to match exposure to patient physiology without degrading study adequacy. Subjective study quality was not reduced by the use of the lower temporal resolution technique, suggesting that a higher temporal resolution may not be justifiable against radiation dose.

O-426
8:56AM - 8:59AM

Usefulness of carotid wall imaging for early detection of carotid plaque and intraplaque hemorrhage as a screening tool for outpatients

H KWAK\(^1\), S Jeon\(^2\), G Chung\(^3\)
\(^1\)Chonbuk National University Medical School and Hospital, Jeonju-si, Korea, Republic of, \(^2\)Wonkwang University School of Medicine & Hospital, Iksan, AZ, \(^3\)Chonbuk National University Medical School and Hospital, Jeonju-si, Korea

Purpose
To assess the usefulness of carotid magnetization-prepared rapid acquisition with gradient-echo (MPRAGE) added to routine contrast-enhanced carotid magnetic resonance angiography (CE-MRA) as a screening tool for early outpatient detection of carotid plaque and intraplaque hemorrhage (IPH).
Materials and Methods
From November 2012 to November 2014, we recruited 1737 outpatients evaluated with carotid MPRAGE and CE-MRA for detection of carotid plaque and IPH. A carotid plaque was defined as wall thickness greater than 2 mm in at least two consecutive slices of the carotid artery on MPRAGE imaging. Intraplaque hemorrhage was defined as carotid plaques with high signal intensity on MPRAGE more than 200% that of the adjacent wall. The location of IPH within the carotid artery was divided into three areas: common carotid artery (CCA), carotid bifurcation, and internal carotid artery (ICA).

Results
Among the studied population, 291 carotid plaques of 226 subjects (1.3%) were detected on MPRAGE imaging. Of these patients, 146 carotid plaques (50.2%) of 118 subjects (52.2%) demonstrated MR-positive IPH. Among the carotid plaques, 101 (34.1%) had normal angiographic findings on CE-MRA. In 43 of the carotid plaques, IPH was detected in subjects with normal angiographic findings on CE-MRA. Among subjects with IPH in the CCA, 29 (90.6%) had normal angiographic findings on CE-MRA. Normal angiographic findings on CE-MRA were significantly more common in subjects with CCA IPH than in patients with ICA IPH.

Conclusions
Carotid MPRAGE imaging is a useful screening tool for the early detection of carotid plaque and IPH.

O-427
8:59AM - 9:02AM
Vulnerable Carotid Plaque Imaging and Histopathology Without a Dedicated MRI Receiver Coil

N Berkovitz1, L Fitzpatrick2, N Majeed1, M dos Santos3, R Glikstein1, S Chakraborty1, J Venoit1, G Stotts1, A Berthiaume1, R Chatelain1
1The Ottawa Hospital, Ottawa, Ontario, 2The University of Ottawa, Ottawa, Ontario, 3The Ottawa Hospital, Ottawa, Ontario

Purpose
Stroke is associated with vulnerable carotid artery plaques showing specific histopathologic characteristics, namely a lipid-rich necrotic core, intraplaque hemorrhage, and thin fibrous cap. While ultrasound (US) and computed tomography (CT) can accurately identify carotid plaques and determine the extent of stenosis, magnetic resonance imaging (MRI) can further delineate plaque vulnerability. We examined the imaging and histopathology for three patients with symptomatic carotid plaques to determine whether these vulnerable features can be detected on MRI without a dedicated receiver coil.
Materials and Methods
Three patients presenting with symptomatic carotid artery plaques with 50-70% stenosis on US underwent CT angiography and MRI, followed by carotid endarterectomy and en-bloc excision of the plaque. A dedicated MRI receiver coil was not used.

Results
All three patients were found to have vulnerable carotid plaque features on histopathologic examination. Computed tomography and ultrasound were used to localize the plaques and assess the degree of stenosis. Vulnerable plaque characteristics were easily identifiable on MRI without a dedicated receiver coil in all three cases. The pre and postcontrast T1W sequences were most useful for identifying the lipid-rich necrotic core and thin fibrous cap, respectively. Plaque ulceration was best appreciated on CE-MRA. Direct comparison of TOF and CE-MRA allowed for distinction of hemorrhage from gadolinium. Overall, the 3T images had superior spatial and contrast resolution compared to the 1.5T images for all sequences.

Conclusions
While US and CT can identify carotid artery plaques, MRI allows for further characterization of vulnerable plaques in moderately stenotic vessels without the use of a dedicated receiver coil. Magnetic resonance imaging has great potential to be used for noninvasive risk stratification given its widespread availability, especially in resources limited centers. Future studies on plaque vulnerability and risk stratification should consider MRI for routine clinical use.
Purpose
Carotid near occlusion is full (Fig. A) or partial (Figs. B-D) collapse of the internal carotid artery (ICA) lumen distal to a tight stenosis. Near occlusions are known from prior study to vary from severe stenoses in criteria for stroke-prevention treatment. Although a tight carotid stenosis with very low or unmeasurable flow velocity is...
specific for near-occlusion, the majority of near-occlusions have high peak systolic flow velocities (PSV), mimicking conventional 50-99% carotid stenosis. We aimed to explore if Doppler parameters other than PSV can be used to distinguish near-occlusion and conventional stenoses.

Materials and Methods
Dual-site retrospective study. Patients were included (n=84) if they had near occlusion or conventional 50-99% stenosis, a carotid Doppler and carotid CT angiogram performed within 30 days of each other, and a PSV of $>150$ cm/second in the stenosis. Computed tomography angiograms were reviewed by two blinded expert readers. Velocity measurements in the ICA stenosis and mid common carotid artery (CCA) were recorded. Mean velocity, pulsatility index and ratios were calculated, giving 12 Doppler parameters for analysis.

Results
Of the 84 patients, 49 had conventional stenosis and 35 had near-occlusion on CT angiography. Of the 12 Doppler parameters, nine significantly differed between the near-occlusion and conventional stenosis groups. No single parameter had a high sensitivity and specificity for diagnosing near-occlusion. Several combinations of variables increased sensitivity and specificity. The best combination was pulsatility index of the ICA stenosis ($>1.7$) and end-diastolic velocity (EDV) ratio (EDV stenosis/EDV CCA) ($>7.1$) as it could distinguish near-occlusion from conventional stenosis with a sensitivity of 94% and a specificity of 58%.

Conclusions
Near-occlusion may be distinguished from conventional stenosis using Doppler parameters other than PSV. This can improve management decisions for overlooked cases. Optimal parameter combination and threshold values need to be validated before clinical use.
Carotid Artery Web and Ischemic Stroke: A Case-Control Study

D Mandell¹, J Coutinho², S Derkatch¹, A Potvin¹, L Casaubon¹, F Silver¹
¹University Health Network, Toronto, Toronto, Ontario, ²Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

Purpose
A carotid artery web is a thin shelf of fibrous tissue that extends from the wall of the
carotid artery into the lumen. The lesion is likely developmental in origin. It has been hypothesized that blood stasis along the downstream surface of a web may lead to thrombus formation and thromboembolic stroke (1). However, evidence of an association between carotid web and ischemic stroke has been only anecdotal. We conducted a case-control study to determine whether carotid artery web is a risk factor for ischemic stroke.

Materials and Methods
Patients with ischemic stroke of undetermined etiology (TOAST definition) (2), in a unilateral internal carotid artery territory, were identified from a prospective registry of stroke patients admitted between January 2012 and March 2015. Control subjects were identified from a prospective registry of patients admitted with a brain arteriovenous malformation, cerebral aneurysm, or primary intracerebral hemorrhage during the same time period. Additional inclusion criteria were age under 60 years, and computed tomography (CT) angiography of the neck during admission. A neuroradiologist diagnosed carotid webs according to published criteria (1). We tested for differences in age and sex between groups using a Student's t-test and chi-square test, respectively. We report the strength of association between carotid artery web and ischemic stroke as an odds ratio with 95% confidence interval (CI). We used logistic regression to adjust for age and sex, and also report the adjusted odds ratio.

Results
Sixty-two patients with cryptogenic ischemic stroke and 219 control subjects were included. Control subject diagnoses were aneurysm (n=160), arteriovenous malformation (n=38), or primary hemorrhage (n=21). Patients with stroke were older (mean age 49 versus 45 years; p=0.004) and had a lower proportion of women (34% versus 60%; p<0.001) than controls. A carotid web was present in 8.1% (5/62) of cases compared with 0.9% (2/219) of controls (unadjusted OR = 9.5, 95% CI = 1.8 to 50.3). After adjusting for age and sex, the association remained statistically significant (adjusted OR = 13.7, 95% CI = 2.4 to 78.6). In all five cases with a carotid web, there was a web located in the artery supplying the territory of the stroke. Three patients also had a contralateral web. NIH Stroke Scale scores ranged from two (minor stroke) to 21 (severe stroke).

Conclusions
There is an association between carotid artery web and ischemic stroke in patients who lack an alternative cause of stroke. Carotid web is likely an under-appreciated risk factor for stroke.

O-431

Silent Brain Infarction in Patients with Asymptomatic Carotid Artery Atherosclerotic Disease
Purpose
Silent brain infarctions (SBIs), strokes in completely asymptomatic patients, confer a two-fold increased risk of incident stroke; however, their relationship with carotid atherosclerosis remains unclear. We tested the hypothesis that unilateral extracranial internal carotid artery (ICA) stenosis results in a greater prevalence of SBI in the cerebral hemisphere ipsilateral to ICA disease compared to the unaffected, contralateral side.

Materials and Methods
We identified patients with unilateral extracranial ICA stenosis ≥ 50% on CT or MR angiography by NASCET criteria by screening studies from January 2008 through December 2014. We included patients who were asymptomatic without a prior history of stroke or transient ischemic attack and with a recent brain magnetic resonance imaging (MRI). While blinded to the results of angiographic imaging, we evaluated for presence of anterior circulation SBIs both ipsilateral and contralateral to the index diseased carotid artery. Silent brain infarction was defined as either a cavitory lacunar infarction in the white or deep gray matter (Fig. 1, A&B) or cortical infarction defined by T2 hyperintense signal in the cortical gray matter (Fig. 1, C&D). The Wilcoxon signed rank sum test was used to compare SBI downstream from ICA disease versus the unaffected side. Cohen's Kappa was used to assess inter-rater reliability of SBI assessment.

Results
Among the 104 asymptomatic patients with unilateral ICA disease causing luminal stenosis of ≥50%, we found a higher prevalence of SBIs ipsilateral to ICA disease (33%) compared to the contralateral side (20.8%)(p=0.0067). There was no significant difference in the prevalence of the lacunar subtype of SBI (including both white and deep gray matter lacunar infarctions) between hemispheres (p=0.109), but there were significantly higher prevalence of cortical SBIs occurring downstream from ICA disease (p=0.0045). High inter-rater reliability was observed (kappa=0.818).

Conclusions
Asymptomatic patients with ICA disease demonstrate higher prevalence of SBI downstream from their site of ICA atherosclerotic disease compared to the contralateral side, but only of the cortical and not lacunar SBI subtype. Our findings suggest that silent artery-to-artery embolism is responsible for a significant burden of silent brain infarctions in asymptomatic carotid disease. Further studies are warranted to determine whether these patients should be treated more aggressively with stroke prevention measures, including potential consideration of surgical revascularization procedures.
Hemodynamic Changes Before and After Stenting Evaluated with Quantitative Digital Subtraction Angiography in Patients with Carotid Stenosis

M TENG¹, Y Kao², C Lin³
¹Cheng Hsin General Hospital, Taipei, Taiwan, ²National Yang Ming University, Taipei, Taiwan, ³Taipei Veterans General Hospital, Taipei, Taiwan

Purpose
The absolute and relative time to peak (TTP) were used in evaluation of hemodynamic changes in digital subtraction angiograms for patients with arterial
stenosis receiving stenting treatments. We studied more hemodynamic parameters for clinical application.

Materials and Methods
Digital subtraction angiograms of 35 patients with carotid stenosis receiving stenting treatments were analyzed retrospectively. Nine regions of interest (ROIs) were placed on the arterial and venous vessels on the PA and lateral views. Hemodynamic parameters including TTP, bolus arrival time (BAT), full width half maximum (FWHM), wash in (WI) slope, wash out (WO) slope, maximum enhancement (ME), and area under curve (AUC) were measured from the time-concentration curves of these ROIs. The dependent t-test for paired samples was applied to the parameters before and after the stenting treatment.

Results
We found that the stenting procedure significantly reduced TTP, BAT, FWHM, WO at all arterial ROIs and at some arterial ROIs for AUC. In addition to all arterial ROIs, BAT also showed significant difference in the venous ROIs including PV and SSS. The ME and WI did not show significant changes after the stenting treatment. The carotid stenosis caused in longer transit time not only at the segment containing the stenosis, but also in the distal intracranial segments.

Conclusions
In addition to TTP and rTTP, we found more hemodynamic parameters could be used for evaluation of the integrity of cerebral blood flow at arterial and venous vessels. Bolus arrival time has the potential to be used in future study of brain circulation at arterial and venous sites especially when TTP could not be measured because of incomplete time-concentration curve.

O-433
9:17AM - 9:20AM

ASL derived CBF Changes Post Carotid Intervention Predicts Post-Operative Cognitive Impairment

S Soman1, W Dai2, E Hitchner3, W Duan2, P Massaband4, D Alsop1, A Rosen5, W Zhou6
1Harvard Medical School, BIDMC, Boston, MA, 2State University of New York at Binghamton, Binghamton, NY, 3Stanford University, Palo Alto Veterans Affairs Hospital, Palo Alto, CA, 4Stanford, Veterans Affairs Palo Alto Healthcare System, Palo Alto, CA, 5Stanford University, Veterans Affairs Palo Alto Health Care System, Palo Alto, CA, 6Stanford, Veterans Affairs Palo Alto Health Care System, Palo Alto, CA

Purpose
Carotid stenosis significantly increases the risk for stroke. Carotid revascularization
surgeries have been shown to reduce this risk, but also can be associated with cognitive impairment that is not clearly linked to cardiovascular risk factors or peri-operative complications (1-4). We performed baseline, 24 hours and 6 month postsurgery arterial spin labeling (ASL) brain cerebral blood flow (CBF) imaging, with baseline and 1 month postop neuropsychological testing to evaluate if CBF change patterns can predict cognitive impairment postsurgery.

Materials and Methods
Patient enrollment: Under institutional guidelines, 55 male veterans scheduled to undergo carotid intervention for a single carotid vessel (CAS or CEA) were enrolled. Seven of these subjects were re-enrolled in the study when undergoing surgery on the contralateral carotid vessel, for a total of 62 subjects. Imaging: Patients were imaged as part of a clinical acquisition using the product GE 3D PC-ASL imaging sequence (PLD=2.5 ms, 6-8 arms, 4-5mm slice thickness, 3-4 NEX) using a 3T MRI (Discovery MR 750 Software Rev. 23, GE Medical Systems, Milwaukee, WI, USA). Imaging was performed within a month prior to surgery (PRE), within 24 hours after surgery (POST), and again 6 months after surgery (6MO). Neuropsychological Testing: All subjects underwent cognitive testing prior to and 1 month after surgery that included the Rey Auditory Verbal Learning Test (RAVLT), which is a measure of episodic memory recall for verbal information that tests encoding, consolidating, storing and retrieval of verbal information. Image Analysis: Cerebral blood flow maps were generated from product ASL images. Cerebral blood flow maps then were normalized using the method outlined by Dai et al (5). All images were flipped so the side of surgery was on the left, and then an 8 mm smoothing kernel was applied. Next GLMs were computed using SPM 8.

Results
PRE to POST: The cerebral hemisphere ipsilateral to the side of vessel repair experiences significant increased CBF, but less than the opposite hemisphere (p=0.001). CEA subjects also demonstrated significantly increased CBF on the hemisphere of vessel surgery compared to CAS (p=0.05) on PRE versus POST imaging. Lower increases in CBF from PRE to POST also were associated with greater decline at 1 month of RAVLT short delay. Lower increases from PRE to POST in CBF demonstrated a trend for decline at 1 month on RAVLT sum of trials (p=0.093). POST to 6MO: There was a significant decrease in CBF (p=0.05). PRE to 6MO: There was no significant difference in CBF (p=0.05). Demonstrating greater CBF increase from PRE to 6MO was associated with greater decline at 1 month on the RAVLT long delay (p=0.05). Additionally, greater increase in CBF from PRE to 6MO were associated with cognitive decline on the RAVLT long delay at 1 month (p=0.05).

Conclusions
Our finding that subjects with greater increase in CBF from baseline to 6 months after surgery is associated with greater decline on the 1 month RAVLT long delay exam
portion suggests that patients who do not normalize CBF back to presurgical levels may have impaired dynamic cerebral autoregulation.

(Filename: TCT_O-433_Figure1.jpg)

O-434

Correlation of Vitamin D levels with Quantitative Analysis of Carotid Intraplaque Hemorrhage and Local Vitamin D Receptor Expression

B Aldred¹, T Burton², M McLaughlin¹, S Kim¹, D Miller³, A De Havenon², D Parker¹, G Treiman¹, S Mcnally¹

¹University of Utah, Salt Lake City, UT, ²Univerity of Utah, Salt Lake City, UT, ³University of Utah, Intermountain Healthcare, Murray, UT

Purpose

Patients with carotid intraplaque hemorrhage (IPH) have a high stroke risk despite standard medical therapy. There is a critical need to identify new treatments in this
high-risk population. Vitamin D is an endogenous inhibitor of the angiotensin system, a known stimulator of IPH in animal models. Recently we found that low vitamin D was associated with carotid IPH. The purpose of this study was to build on initial results by evaluating the relationship between vitamin D level and carotid IPH volume quantitatively measured on MRI, and carotid IPH area calculated on histology and VDR receptor expression levels.

Materials and Methods
In this IRB-approved prospective cross-sectional study, 65 patients, with carotid disease were recruited for carotid MRI and vitamin D analysis. Intraplaque hemorrhage volume was determined quantitatively using a volumetric MPRAGE sequence. In addition, 35 underwent carotid endarterectomy and carotid IPH area was determined on histology and VDR counts were determined with quantitative immunohistochemistry. Linear regression was used to determine the association of vitamin D levels with carotid IPH volume, IPH area and VDR counts. To account for up to two carotid arteries per patient, we analyzed the in vivo MRI data using a multivariable GEE Poisson regression model. To account for multiple histologic sections per plaque, we used a repeated measures analysis accounting for data grouped within patients.

Results
Low vitamin D (<30ng/mL) was correlated significantly with MPRAGE-detected IPH volume ($r=0.26, p=0.003$) after adjusting for maximum plaque thickness. Low vitamin D also correlated with IPH area on histology ($r=0.22, p=0.03$) when adjusting for total plaque area. VDR expression was dependent on vitamin D level (normal versus low, $r=0.34, p<0.001$) when adjusting for plaque area. Representative images demonstrated VDR expression in areas of carotid plaque vulnerability.

Conclusions
Vitamin D levels are highly correlated with MRI-detected IPH, histology-detected IPH, and total VDR receptor counts. Notably, VDR is highly expressed in areas of vulnerable carotid plaque. Low vitamin D may be a contributing factor to vulnerable carotid plaque, and given local VDR expression, this may represent a potential prevention measure or treatment target against carotid IPH.
Thursday
8:35AM - 10:03AM
Washington Marriott Wardman Park, Roosevelt 4

20F-PARALLEL PAPER SESSION: Pediatrics: Brain Imaging Advances
O-435

LAMA1 mutation analysis in cerebellar dysplasia with cysts

A Poretti\textsuperscript{1}, A Micalizzi\textsuperscript{2}, M Romani\textsuperscript{2}, E Valente\textsuperscript{2}, E Boltshauser\textsuperscript{3}
Purpose
Cerebellar dysplasia with cysts and abnormal shape of the fourth ventricle, in the absence of significant supratentorial anomalies and of muscular involvement, defines recessively inherited Poretti-Boltshauser syndrome (PBS, OMIM 615960). Clinical features are also homogeneous and comprise nonprogressive cerebellar ataxia, intellectual disability of variable degree and language impairment, ocular motor apraxia and frequent occurrence of myopia or retinopathy. Recently, loss-of-function mutations in the LAMA1 gene were identified in six probands with PBS. We aimed to report the detailed clinical, neuroimaging and genetic characterization of 17 children with PBS from 14 unrelated families.

Materials and Methods
Information about neurological and cognitive functions were collected from review of the clinical history and follow-up examinations. All magnetic resonance imaging (MRI) studies were evaluated retrospectively for cerebellar structural abnormalities. LAMA1 sequencing analysis was performed in all children.

Results
At the last follow up at the mean age of 7.2 years (range 1.5 to 14.0 years), all children older than two years (n=16) had cerebellar ataxia. All patients but one (94%) had mild or moderate intellectual disability. Eye involvement was present in nine patients (53%), including myopia in eight (47%) and retinal dystrophy in four (24%). Cerebellar dysplasia with cortical-subcortical cysts were present in all children. Hypoplasia of the cerebellar vermis was found in 10 patients (59%). The fourth ventricle was enlarged in 14 children (82%) and elongated in 13 (77%). Biallelic LAMA1 mutations were identified in all families. Sixteen different mutations were identified, which were all novel. In particular, the frameshift mutation p.R979Gfs*4 recurred in six unrelated families on a shared haplotype, suggesting a founder effect.

Conclusions
There is a strong correlation between the clinical and neuroimaging phenotype of PBS and LAMA1 mutations. Brain MRI clearly points to the correct diagnosis of PBS by showing the peculiar association of cerebellar dysplasia, cerebellar cysts and abnormally shaped/sized fourth ventricle.

O-436

8:43AM - 8:51AM

White and gray matter abnormalities in children with LAMA2-related muscular dystrophy: more than meets the eye.
Purpose
LAMA2-related congenital muscular dystrophy (LAMA2-CMD) is caused by partial or complete laminin α2 deficiency. The affected children present with generalized hypotonia, muscle weakness and atrophy, and contractures. Qualitative evaluation of conventional magnetic resonance imaging (MRI) sequences typically show extensive, confluent, and nonprogressive white matter changes sparing the corpus callosum, internal capsule, brainstem, and cerebellum. To date no quantitative evaluation of white and gray matter structures has been reported in children with LAMA2-CMD. In this study, we assessed microstructural and volumetric changes of gray and white matter structures in children with LAMA2-CMD compared to age- and gender-matched controls.

Materials and Methods
We performed tract-based spatial statistics (TBSS) of fractional anisotropy (FA) and mean (MD), axial (AD), and radial diffusivity (RD) maps and voxel-based morphometry (VBM) of 3D-T1WI in children with genetically confirmed LAMA2-CMD and age-matched controls.

Results
Fifteen patients (median age 9.8 years) and 15 age- and gender-matched controls (median age 9.7 years) were included in this study. Tract-based spatial statistics revealed reduced FA and increased MD, AD, and RD in major supratentorial white matter tracts in patients compared to controls. In addition, FA and AD were reduced in cerebellar white matter tracts. Voxel-based morphometry showed reduced volume of cerebellum, basal ganglia, temporal operculum, and cingulate cortex in patients compared to controls.

Conclusions
Quantitative analysis of diffusion tensor imaging (DTI) data confirms extensive supratentorial white matter abnormalities in children with LAMA2-CMD. Changes in DTI metrics within the supratentorial white matter suggest demyelination as the underlying pathomechanism. Quantitative DTI analysis revealed changes of e.g. the cerebellar white matter that remained undetected by qualitative evaluation of conventional MRI sequences. Changes in DTI metrics suggest axonal degeneration as the underlying pathomechanism for cerebellar white matter abnormalities. In addition, VBM showed changes in volume of gray matter structures that may be caused by neuronal loss secondary to white matter disease.
Interhypothalamic Adhesions: No Longer Just a Pediatric Finding

A Harrell¹, D Nascene¹
¹University of Minnesota, Minneapolis, MN

Purpose
Interhypothalamic adhesions are a recently described anatomical finding in which a connection of tissue can be visualized in the third ventricle connecting the hypothalami. Previous studies have suggested an association of these adhesions with midline abnormalities in pediatric patients. This study aimed to analyze interhypothalamic adhesions in a broader population to further understand its significance.

Materials and Methods
Retrospective review of 779 patients who underwent MRI for evaluation of hearing loss from 2008 to 2014 was performed. The patient ages ranged from 7 months to 95 years old. The presence of interhypothalamic adhesions was characterized, and clinical data were recorded.

Results
Interhypothalamic adhesions were identified in 41 out of 779 patients. The incidence in this patient population is higher than those previously estimated in the pediatric population. Furthermore, the presence of interhypothalamic adhesions could not be correlated with any disease state. This study did reveal three patients with more than one interhypothalamic adhesion.

Conclusions
There does not appear to be an association between interhypothalamic adhesions and midline abnormalities in a broader patient population. Interhypothalamic adhesions may represent an asymptomatic anatomical variant. The presence of interhypothalamic adhesions may be more common than previously estimated, approximately 5%. While certain variants of this anatomical anomaly appear to be more common, the significance of the type, size, and associated disease states remains unknown.
Malformations of Cortical Development in HHT

G Palagallo¹, S McWilliams¹, A White², M Goyal¹
¹Mallinckrodt Institute of Radiology, Washington University School of Medicine, Saint Louis, MO, ²Washington University School of Medicine, Saint Louis, MO

Purpose
Since 2007, we routinely include a high resolution MPRAGE sequence on brain magnetic resonance images (MRIs) to evaluate children with hereditary hemorrhagic telangiectasia (HHT). The purpose of this study was to determine the incidence of malformations of cortical development (MCD) in children with HHT.

Materials and Methods
We identified 116 pediatric patients--being evaluated in the HHT Clinic at St. Louis Children's Hospital--who underwent a brain MRI that included at least one high resolution 3D sequence. Of the 116, 72 had definite HHT according to Curacao criteria. Each MRI was evaluated specifically for the presence or absence of MCD by a neuroradiology fellow. Positive cases then were confirmed by a board-certified neuroradiology attending.

Results
Fourteen of 116 (12.1%) patients were found to have MCD. Of the 14 positive cases, 13 had definite HHT by Curacao criteria, and one had possible HHT. There were 12 cases of polymicrogyria and two cases of bifrontal periventricular nodular heterotopia. Polymicrogyria was seen unilaterally in a perisylvian and parietotemporal distribution in 10 cases, and unilaterally in the frontal lobe in two cases. One case lined a large porencephalic cyst and another was adjacent to a previously resected arteriovenous malformation. Additionally, one patient had epilepsy.

Conclusions
When evaluated by a high resolution brain MRI sequence, children with HHT are found to have a high prevalence of MCD, most frequently polymicrogyria.
Predicting Motor Outcome after Hemispherotomy using Pre-surgical FDG PET

H Ullman¹, I Orosz², M Linetsky¹, G Mathern¹, N Salamon³
¹David Geffen School of Medicine at UCLA, Los Angeles, CA, ²UCLA, Los Angeles, CA, ³David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
Hemispherotomy can be considered in patients with refractory seizures and multiple
onset zones. While the procedure is effective in controlling seizures, cognitive and motor deficits often are pronounced. In this study we aimed to predict the degree of motor deficit after hemispherotomy based on pre-operative FDG PET. A higher degree of hypometabolism was thought to be a positive predictor of outcome.

Materials and Methods

Materials: Nineteen patients went through FDG PET as part of their presurgical evaluation at UCLA medical center. The patients had refractory epilepsy on the basis of hemimegalencephaly, Rasmussen's encephalitis or perinatal infarction. Clinical motor outcome was graded as relative to presurgical functioning on a scale from -2 to +2 where negative values indicated worsening functioning and positive values indicated an increase in function. Motor function was divided into general motor function, upper limb function and gait function.

Methods: A hemispheric ratio was calculated by dividing the FDG uptake in the affected hemisphere with the healthy hemisphere. This ratio represented the degree of hypometabolism in the affected hemisphere and thus the degree of hemisphere malfunction. The ratio subsequently was correlated with postsurgical motor outcome.

Results

The ratio of FDG PET hypometabolism correlated inversely with general motor outcome (rho=-0.67, p=0.001) and gait (rho=-0.53, p=0.018) but not with hand function (rho=-0.37, p=0.11).

Conclusions

The degree of hypometabolism in the affected hemisphere is a strong predictor of motor outcome. A pattern with marked hypometabolism indicates tissue dysfunction prior to resection and predicts absence of new motor deficits. FDG PET is a good tool for predicting new motor deficits after hemispherotomy.

O-441

9:23AM - 9:31AM

Morphometric Measurements of the Thalamus in the Pediatric Population

R Hourani¹, R Tutunji¹, L Nasr¹, M El Homsi¹, M Hourani¹

¹American University of Beirut Medical Center, Beirut, Beirut

Purpose

Observations of thalamic atrophy in children are done subjectively. No normative measures exist for aiding objective diagnosis formation. We aimed to determine normative 2D measurements of the thalamus in the developing brain, and create a general guide for radiologists to use for objective assessments.

Materials and Methods

Magnetic resonance images (MRIs) of 200 patients scanned at the American University of Beirut Medical Center between 2008 and July 2015 were collected.
retrospectively for examination. Measurements were taken on the axial and coronal slices showing the thalamus for each participant. Participants were selected based on normal brain MRIs. Exclusion criteria included: i) presence of a brain tumor, ii) history of repeated seizures and epilepsy, iii) Lesions around and in the thalamus and gray matter, iv) periventricular lesions, v) brain infarcts or hemorrhage. Participants who met the criteria had their images uploaded to a database where the measurements were later taken. The diameter of the thalamus was measured in the anterior-posterior, transverse, and craniocaudal dimensions. We expected the measurements to increase until the age of 12, where by measurements would reach those similar to those of adults.

Results
There was a significant increase in the size of the thalamus on the anterior-posterior diameter from 23.91 mm to a plateau of ±33mm by the age of 11. Transverse diameters increase from 14.04mm to plateau in the 21mm range by the age of 13. Coronal diameters increase in the first year of life and remain stable in the 20 mm range with no obvious increasing patterns. There was a significant between-group difference as seen by an ANOVA conducted for all measurements (P<0.01).

Conclusions
The thalamus increases in size in its transverse and anterior-posterior diameters in the developing brain. No such pattern was discernible in the coronal measurements. Our measurements can be used while diagnosing to identify whether pediatric patients of different ages have normally sized thalami, and also gives us a glimpse as to how the brain develops in children.
Effect of Venous Oxygenation on Cerebral Venous Susceptibility Imaging in Pediatric Patients

C Toensing¹, P Kim¹, P Eaton¹, J Jacobson¹

¹Loma Linda University Medical Center, Loma Linda, CA
Purpose
General anesthesia and conscious sedation have increasing utilization for the acquisition of diagnostic imaging, particularly for pediatric patients. This project was undertaken as an initial effort to understand the effect that these methods of image acquisition have on the images themselves, specifically on cerebral venous systems as quantified by susceptibility-weighted imaging (SWI).

Materials and Methods
All pediatric brain magnetic resonance imagings (MRIs) from June 2013 to May 2014 were queried. Those that were interpreted as "Normal MR findings of the brain," or a variation thereof, were included. Exclusion criteria include history of cardiac, central nervous system and pulmonary disease. Categories included: no sedation (NS), conscious sedation (CS), and general anesthesia (GA). Anesthesia, laboratory and nursing data were acquired. Susceptibility-weighted imaging maps were created with SPIN software (MR Institute, Detroit). Quantitative susceptibility measurements (QSM) of the deep and superficial cerebral venous structures were obtained by placing a region of interest (ROI) along the long axis of the veins and recording the highest value in parts per billion (ppb). Deep venous structures included the bilateral internal cerebral veins (ICV) and the straight sinus (SS); superficial venous structures included the most prominent vein in the bilateral MCA territories (MCA). Standard data analysis was performed, including independent-samples Kruskal-Wallis tests.

Results
Ninety-seven patients were enrolled in our study. The mean age of the CS and GA groups were lower than that of the NS group (GA 4.9 years ± 3.9, CS 12.2 years ± 3.4, NS 5 years ± 4.4). Average venous oxygenation levels also were significantly higher for the GA group than the sedation or NS groups (GA 85%, CS 24%, NS 21%). Quantitative susceptibility measurements were statistically significantly lower for general anesthesia as compared to the no sedation group in all venous territories (p < 0.000). Quantitative susceptibility measurements also were statistically significantly lower for GA compared to CS in the right ICV, left ICV and right MCA (p < 0.000, p < 0.000, p = 0.076, respectively), though were not statistically significant in the SS and left MCA. Quantitative susceptibility measurements were statistically significantly lower for CS compared to NS in the straight sinus, right MCA, left MCA and the left ICV, though were not significant in the right ICV (p = 0.006, p = 0.005, p = 0.005, p = 0.04, p = 0.1, respectively).

Conclusions
Higher venous oxygenation levels had statistically significant effects on the QSM of cerebral venous systems in pediatric patients, primarily when general anesthesia was utilized. This suggests that altered venous oxygenation has an effect on the images themselves. The extent of this effect, and whether or not there are qualitative differences in the images acquired, warrants further study.
Susceptibility-weighted Imaging as a Non-contrast Technique in the Diagnosis of Developmental Venous Anomalies in Children

R Goel¹, A Young², A Poretti³, T Huisman⁴, T Bosemani³
¹Johns Hopkins Hospital, Baltimore, MD, ²John Hopkins School of Medicine, Baltimore, MD, ³The Johns Hopkins University School of Medicine, Baltimore, MD, ⁴Johns Hopkins, Baltimore, MD

Purpose
Developmental venous anomalies (DVAs) are the most common type of cerebral vascular malformation. Gadolinium-enhanced T1-weighted magnetic resonance imaging (MRI) is the gold standard for diagnosis. Gadolinium deposition in the brain (particularly in the dentate nuclei) regardless of renal or hepatobiliary dysfunction has been shown. Susceptibility-weighted imaging (SWI) detects paramagnetic deoxyhemoglobin as hypointense signal within low flow venous vasculature without the need of gadolinium injection. We evaluated the sensitivity of SWI in the diagnosis of DVAs and their complications in children.

Materials and Methods
Inclusion criteria for this study were 1) the diagnosis of DVA based on gadolinium-enhanced T1-weighted MRI and 2) availability of SWI data and T2-weighted magnetic resonance imaging (MRI) (for comparison). T1 postcontrast imaging was used as the reference standard for the diagnosis of DVA. Susceptibility-weighted imaging and T2-weighted MRI were evaluated individually for the diagnosis of DVA. In addition, SWI and T1 postcontrast imaging were evaluated individually for DVA location, morphology, drainage pattern, presence of cavernoma, and associated hemorrhage by an experienced pediatric neuroradiologist.

Results
Fifty-seven children with DVAs (mean age 11.2 years; range 0-18 years) were included in this study. Fifty-one DVAs were classic and six were solitary. Susceptibility-weighted imaging identified 42/57 DVAs with a sensitivity of 73.68%. Five of 15 cases not visible on SWI were related to hyperoxygenation of the patient. T2-weighted MRI could identify 15 DVAs with a sensitivity of only 26.3%. Susceptibility-weighted imaging detected 100% (12/12) of the cavernomas whereas T1 postcontrast revealed only 50% (6/12). Hemorrhage was noted in 4/57 patients, visible on both SWI and T1 postcontrast.

Conclusions
Susceptibility-weighted imaging identifies DVAs with moderate sensitivity. In addition, it is superior to T1 postcontrast imaging in detecting occult cavernomas.
Susceptibility-weighted imaging may be a valuable pulse sequence that obviates the need for gadolinium.

O-444

The Evolution of Pituitary Cysts (PC) in Children With Growth Hormone Deficiency (GHD) and Idiopathic Short Stature (ISS)

R Noto1, N Swiecka1, A Parlapalli1, M Tenner1
1New York Medical College, Valhalla, NY

Purpose
In this study, we analyzed the change of cyst volume (CV) in short children treated with growth hormone.

Materials and Methods
Materials: Magnetic resonance imaging (MRI) with postgadolinium contrast.
Methods: Brain MRIs with special attention to the pituitary gland of 642 growth hormone deficient and idiopathic short stature patients were reviewed for the presence of pituitary cysts (PC). Seventy-two patients were found to have a pituitary cyst, of these, 24 underwent multiple MRI studies for analysis. Presence of PC, CV, pituitary volume (PV), and the percentage of the pituitary gland occupied by cyst (POGO) were measured and calculated. Large cysts (LPC) were considered to be when more than 15% of the PV was occupied by cyst. All patients were treated with growth hormone during the observation period.

Results
From initial MRI studies of the 24 patients, 14 (58%) patients demonstrated a small cyst (SPC) and 10 (42%) demonstrated a LPC. Analysis from the first to second MRI demonstrate the following: the mean, median, and range change in CV for all patients were 2.07 cu.mm.±18.4, -7.53%, and CV varied from -84.70% to +680.0%. The mean, median, and range change in POGO by the cyst for all of the patients were 5.27 cu.mm.±14.85%, -2.37%, and POGO varied from -60.41% to +7.02%. The mean, median, and range change in CV for patients with a SPC were 90.11% ± 137.97, 21.02%, and CV for SPC varied from -77.48% to +439.6%. The mean, median, and range change in POGO by the cyst for patients with SPC was 0.26% ± 4.81, 0.24%, and POGO varied between -7.4% to +7.02%. The mean and median change in CV for patients with a LPC was +41.82 ±259.55% and -49.94% respectively, with a CV range of -92.1% to +680%. The mean, median, and range change in POGO by the cyst for patients with a LPC was -20.12 ± 16.28% -13.7% respectively, and POGO varied from -60.01% to -7.0%. The total mean between follow-up dates was 2.96 ± 2.24 years. For patients with two sequential MRIs, analysis of change in POGO in time demonstrated that one of the patients with SPCs
developed into LPCs and six patients with LPCs diminished in size into SPCs. Of the 72 patients, nine had three sequential MRIs. Five of these patients had a SPC, while four had a LPC. None of the patients with a SPC developed into a LPC. The percentage change in CV from the first to second MRI in patients with a LPC was between -20.5% to +40.3%. From the second to third MRI, the range was -34.7% to +77.9%. When comparing groups, the growth hormone deficient patients versus idiopathic short stature (ISS) patients in the male versus females subjects showed significant differences in POGO (Table 1).

Conclusions
Patients with a SPC over short periods of time will unlikely develop into a LPC. However, patients with a LPC can show major changes and should be tracked for CV change in time.
Atypical Diffusion Restriction Patterns in Pediatric Cerebral Malaria

T LoStracco¹, G Birbeck², S Kampondeni³, K Seydel⁴, T Taylor⁴, M Tivarus⁵, M Potchen⁵
¹University of Rochester, Rochester, NY, USA, ²University of Rochester, Rochester, NY, ³Malawi MRI Center, Blantrye, NY, ⁴Michigan State University - College of Osteopathic Medicine, East Lansing, MI, ⁵University of Rochester, Rochester, NY

Purpose
Six hundred thousand children per year are diagnosed with pediatric cerebral malaria (CM). Despite a case fatality rate of 15 to 25%, only recently has massively increased brain volume, detected using magnetic resonance imaging (MRI) technology, been identified as a strong predictor of mortality in children with CM (1). One third of CM survivors experience neurologic sequelae (2). Serial MR imaging may offer insights into the evolution of the disease and mechanisms of brain injury that might aid in the identification of potential interventions.

Materials and Methods
Children admitted to the Blantyre Malaria Project with retinopathy-confirmed CM underwent brain MRIs on admission and then daily until death or recovery using a 0.35T GE Signa Ovation MRI. Follow-up studies were obtained at 1 month or later. NeuroInterp (3) was used by interpreting radiologists to systematically capture radiographic data. Diffusion-weighted imaging (DWI) abnormalities on serial imaging are described.

Results
One hundred eighty-two consecutive consented pediatric patients with CM between 2009 and 2014 were imaged. Acute DWI abnormalities were seen in 39/182 (21%). Among these, 31/39 (79%) had diffuse white matter involvement; 14 (36%) showed changes in the corpus callosum; 16 (41%) in the basal ganglia, four (10%) in cortical areas including one (3%) in the hippocampus. Of those with DWI abnormalities on admission, 28/39 had follow-up MRI at least 5 days after their acute presentation. Two paradoxical findings were evident: total resolution of admission restricted diffusion without associated residual structural abnormalities [13/28 (46%) with 11/13 (85%) involving the white matter], while four children had prolonged restricted diffusion persisting greater than 14 days.

Conclusions
Magnetic resonance imaging findings in pediatric CM demonstrated unusual patterns including transient restricted diffusion localized to the white matter without residual structural abnormalities. This phenomenon is consistent with transient sequestration of parasitized red cells in the cerebral microvasculature. Conversely, restricted diffusion that persists after recovery from coma was seen, similar to findings following anti-angiogenic drug therapy, and may indicate prolonged endothelial injury.
Thursday  
10:30AM - 12:00PM  
Washington Marriott Wardman Park, Marriott Ballroom  

21A-ASSR Programming: Oncologic Spine Imaging and Interventional Procedures  

21A-1  
10:30AM - 10:50AM  
Oncology: The New Frontier for the Spinal / Pain Interventionalist  
Wong, W.  
UCSD  
San Diego, CA  

21A-2  
10:50AM - 11:10AM  
MR Perfusion of Spinal Metastatic Disease: Implications for Treatment and Response to Therapy  
Karimi, S.  
Memorial Sloan-Kettering Cancer Center  
New York, NY  

21A-3  
11:10AM - 11:30AM  
Tumor Albation and Vertebral Augmentation for Spinal Metastatic Disease  
Jennings, J.  
Washington University  
St. Louis, MO  

21A-4  
11:30AM - 11:50AM  
Endovascular Treatment of Spinal Metastatic Lesions  
Do, H.  
Stanford University  
Stanford, CA
21A-5

Discussion

11:50AM - 12:00PM

Thursday
10:30AM - 12:00PM
Washington Marriott Wardman Park, Washington 4/5/6

21B-CSF Programming: Normal Pressure Hydrocephalus (NPH) and Pseudotumor

21B-1

Physiology and Imaging of CSF Flow

Blitz, A.
Johns Hopkins Hospital
Baltimore, MD

10:30AM - 10:55AM

21B-2

TimSLIP in Evaluation of NPH

Law, M.
Keck Medical Center of USC
Los Angeles, CA

10:55AM - 11:20AM

21B-3

Idiopathic Intracranial Hypertension

Dillon, W.
UCSF
San Francisco, CA

11:20AM - 11:45AM
Purpose
Orbital masses represent a spectrum of benign and malignant lesions in adults and children that can be challenging to diagnose and treat. Imaging plays an important role in diagnosis, due to a potentially limited clinical examination and risks associated with biopsy. Magnetic resonance imaging (MRI) is a powerful tool for imaging the globe, due to the excellent tissue contrast it provides. Yet conventional MRI has a limitation in discriminating the benign from malignant lesions. Diffusion-weighted imaging (DWI) is noninvasive rapid technique uses the water diffusion produce contrast among different kinds of tissues. Our propose was to assess the role of DWI and calculated apparent diffusion coefficient (ADC) values in characterization of the orbital masses regarding benignity or malignancy.

Materials and Methods
Fifty-one patients with recently diagnosed orbital masses and who underwent pre-operative conventional MRI and DWI were included in this study. The orbit was divided into six compartments: the eye globe, retro-ocular fat, optic nerve, lacrimal system, bony boundaries and extra-ocular muscles. The average ADC obtained from each tumor was compared with the histo-pathological diagnosis determined from subsequent surgical sample.
Results
Twenty female and thirty-one male patients with orbital masses were included in this study. Their ages ranged from 1 month to 65 years. The globe is the seat of more than one fifth of these lesions (21.6%) followed by optic nerve (17.6%). Thirty (58.8%) of cases was diagnosed as having malignant masses and 21 (41.2%) of cases have benign lesions. The mean ADC value of the malignant orbital tumors (0.82 ± 0.69 x 10^-3 mm²/s) was significantly (P = 0.001) lower than that of the benign orbital lesions (1.48± 0.55 x 10^-3 mm²/s). Receiver operating characteristic (ROC) analysis showed a sensitivity of 83.33 % 90.5% and a specificity of 83.3% when using an optimal cut off ADC value of 0.89 x 10^-3 mm²/s for differentiating malignant from benign lesions.

Conclusions
Apparent diffusion coefficient values provide an accurate, sensitive, fast, and noninvasive means of characterization of pediatric orbital tumors. A prior tumor characterization is useful in timing and treatment planning for orbital tumors.

O-447
Using DWI Thermometry to Measure Globe Temperature Differences: Retrospective Case-Control Study of Orbital Cellulitis

J Derakhshan1, L Loevner2, F Wehrli1
1University of Pennsylvania, Philadelphia, PA, 2University of Pennsylvania, Philadelphia, PA

Purpose
Diffusion-weighted imaging (DWI)-based thermometry is a new technique (1), which uses the diffusion coefficient in regions of nonrestricted diffusion to measure temperature (2). Prior studies are limited to studying the "core brain temperature" in the lateral ventricles (3, 4) and the technique has not been studied in the orbit. The purpose was to assess the ability to perform DWI thermometry in the orbits using existing DWI data by measuring globe temperature in patients with and without orbital cellulitis.

Materials and Methods
A retrospective case-control study was performed at our institution from all studies in our database. The database (Montage Healthcare Solutions v2.0) was mined for all magnetic resonance imaging (MRI) studies with orbital cellulitis. Inclusion criteria included a diagnosis of pre or postseptal orbital cellulitis by MRI as well as having both DWI and apparent diffusion coefficient (ADC) maps. Exclusion criteria were bilateral disease, prior surgery, trauma, radiation, stroke, seizure, severe artifacts on DWI and aspherical globe. A circular region of interest (ROI) was drawn in the center
of the orbit at the level of the optic nerve insertion and the mean ADC value was recorded, taking care to avoid clear artifacts on the corresponding DWI images. The ADC was converted to temperature using equation 2 in Ota et al (5). Twice the number of cases of age-matched controls were identified with a "normal brain MRI", excluding patients with sinus disease. Paired t-tests were performed in Matlab to assess globe temperature differences in both the cases and controls. Nonpaired t-test was used to assess the difference in globe temperatures between the cases and controls.

Results
A sample ADC map obtained in one of the cases is provided in Fig. 1a showing the circular ROIs superimposed. Fig. 1b provides the globe temperature differences for all cases (n=6) and controls (n=11). Globe temperatures are provided for all cases (Fig 1c) and controls (Fig 1d). The mean globe temperature in the ipsilateral eye of the cases was 37.5 ± 2.6°C. The mean globe temperature in the contralateral globe was 34.8 ± 1.7°C. The globe temperature was increased in the ipsilateral eye in all cases with a mean difference of 2.7 ± 2.1°C, which was highly significant (p=0.003, paired one-sided t-test). In the controls, the mean globe temperature in the warmer eye was 37.7 ± 2.2°C while in the cooler eye was 37.2 ± 2.0°C. The mean difference in globe temperature was 0.6 ± 0.5°C, which was significant (p=0.02). The mean difference in globe temperature between the cases and controls was highly statistically significant (p=0.003). Using a globe temperature difference threshold of 1°C (arrow), there was 83% sensitivity and 91% specificity for the diagnosis of orbital cellulitis.

Conclusions
Diffusion-weighted imaging thermometry can be used to measure differences in globe temperature in patients with and without orbital cellulitis revealing significant differences. Diffusion-weighted imaging thermometry has high sensitivity and specificity for the diagnosis. Future studies are warranted to study other infectious, inflammatory and vascular pathologies using DWI thermometry in the globe.
Infra-orbital nerve involvement on MRI in European patients with IgG4-related ophthalmic disease.

A Lecler

Fondation Rothschild, Paris, France

Purpose

To measure the frequency of infra-orbital nerve involvement (IONE) on magnetic resonance imaging (MRI) in European patients suffering from IgG4-related orbital disease (IgG4-ROD), as compared to patients suffering from non-IgG4 orbital inflammation (non-IgG4-OI).
Materials and Methods
Between January 2006 and April 2015, 132 patients consulted and/or were admitted for non-lymphoma, non-thyroid-related orbital inflammation in our tertiary center. Among these patients, 38 had both pretherapeutic orbital MRI and histopathological IgG4 immunostaining. We conducted a systematic retrospective of their medical charts and MRI images. Fifteen patients were classified as cases of IgG4-ROD and 23 patients were classified as cases of non-IgG4-OI. Two readers performed blinded analysis of MRI images. The main criterion for this study was infra-orbital nerve enlargement (IONE), defined as a diameter of the infra-orbital nerve superior to the diameter of the optic nerve in coronal section. Prevalence of IONE was compared between IgG4-ROD patients and non-IgG4-OI patients.

Results
Infra-orbital nerve involvement was present in 53% (8/15) of IgG4-ROD cases whereas it was never (0/23) present in cases of non-IgG4-OI (p<0.0001). Infra-orbital nerve involvement was present only in cases where on MRI, inflammation of the inferior quadrant was present and in direct contact with the infra-orbital nerve canal.

Conclusions
In European patients suffering from orbital inflammation, presence of IONE on MRI is a specific sign of IgG4-related etiology. Recognition of this pattern may facilitate definite diagnosis for clinicians and allow adequate management and appropriate care.

O-449

Correlation of Quantitative Measurements of Intraorbital Optic Nerve and Clinical Features in Thyroid Eye Disease Patients Using Diffusion Tensor MRI

H Seo¹, H Lee², Y Lee², s suh³
¹Korea University Ansan Hospital, Ansan-si, Korea, Republic of, ²Korea University Ansan Hospital, Ansan-si, Gyunggi-do, ³Korea univeristy Guro Hospital, seoul, Korea, Republic of

Purpose
To compare the quantitative measurements of intra-orbital optic nerve in thyroid eye disease (TED) patients and age-sex matched control using diffusion tensor magnetic resonance imaging (DTI MRI) and analyze the correlation between DTI parameters and clinical features in TED patients.

Materials and Methods
Twenty TED patients (M:F=8:12, mean age=44.3±9.3 years) and age- and sex-matched 20 controls (M:F=7:11, mean age=44.2±10.5 years) were included. Diffusion tensor MRI and thyroid function test including thyroid-stimulating immunoglobulins were performed. Visual field analysis was conducted with and mean deviation (MD)
was measured. Fractional anisotropy (FA), apparent diffusion coefficient (ADC), axial diffusivity (Ax), and radial diffusivity (Rad) values were obtained at the intraorbital optic nerves in diffusion tensor MRIs and compared between two groups (Fig.1). The correlation between these DTI values and clinical features of TED (lower eyelid retraction, lagophthalmos, exophthalmos, and extraocular movement limitation), MD in the visual field analysis, clinical activity score (CAS), and modified NOSPECS score, and medial rectus muscle diameter measured on CT scans were assessed.

Results
Diffusion tensor imaging analysis showed that the average FA was larger in patients with TED than in controls (0.5486±0.0779 and 0.4968±0.0505 x10-2/mm2/s) and the difference was statistically significant (p < 0.000) (Table 1). On the contrary, the average ADC was smaller in patients with TED than in controls (0.1166±0.0232 and 0.1312±0.0162 x10-2/mm2/s, p = 0.001) (Table 1). There was a significant correlation between FA and CAS(r = 0.353, p = 0.030). Modified NOSPECS score showed significant negative correlation with ADC (r = -0.408, p = 0.011) and positive correlation with FA (r = 0.419, p = 0.009) (Table 2). The diameter of the medial rectus muscle showed significant negative correlation with ADC and RD (r = -0.406, p =0.011 and r = -0.332, p = 0.042 each) and positive correlation with FA (r = 0.458, p =0.048). Thyroid eye disease patients were subdivided with and without enlarged medial rectus muscle and the comparison of DTI parameters between these groups showed that ADC and RD was statistically larger in medial rectus muscle enlarged group.

Conclusions
Changes of DTI parameters reflected the axonal degeneration and ischemic changes of the intra-orbital optic nerve in patient with TED although there was no evident DON. Disease activity and severity with enlarged medial rectus muscle may have a role in changes of DTI parameters.

(Filename: TCT_O-449_Figure1.jpg)
Table 1: Comparison of DTI parameters between control and TED patients

<table>
<thead>
<tr>
<th>DTI parameters</th>
<th>TED</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>0.1166 ± 0.0232</td>
<td>0.1312 ± 0.0162</td>
</tr>
<tr>
<td>FA</td>
<td>0.5486 ± 0.0779</td>
<td>0.4968 ± 0.0505</td>
</tr>
<tr>
<td>Ax</td>
<td>0.1984 ± 0.0184</td>
<td>0.2086 ± 0.0191</td>
</tr>
<tr>
<td>Rad</td>
<td>0.0793 ± 0.0186</td>
<td>0.0925 ± 0.0161</td>
</tr>
</tbody>
</table>

by paired t-test

* p-value < 0.05

(Filename: TCT_O-449_Table1.jpg)
Table 2 | Correlation of DTI parameters and clinical characteristics

<table>
<thead>
<tr>
<th></th>
<th>ADC</th>
<th></th>
<th>FA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-value</td>
<td>r</td>
<td>P-value</td>
</tr>
<tr>
<td>Exophthalmometry</td>
<td>0.475</td>
<td>0.119</td>
<td>0.130</td>
</tr>
<tr>
<td>CAS score</td>
<td>0.728</td>
<td>-0.058</td>
<td>0.030*</td>
</tr>
<tr>
<td>Modified NOSPECS score</td>
<td>0.011*</td>
<td>-0.408</td>
<td>0.009*</td>
</tr>
<tr>
<td>MD</td>
<td>0.492</td>
<td>-0.115</td>
<td>0.119</td>
</tr>
</tbody>
</table>

by paired t-test

* p-value < 0.05

(Filename: TCT_O-449_Table2.jpg)

O-450

11:02AM - 11:10AM

Normal Optic Pathway Value Ranges for Routine Pediatric MRI

T Bartsikhovsky¹, I Bekerman², S Tal², A Ben Ely², H Maresky³, S Nagieva²
¹Assaf Harofeh Medical Center, Ramat Gan, Israel, ²Assaf Harofeh Medical Center, Tzrifin, Tzrifin, ³Assaf Harofeh Medical Center, Zrifin, HaMerkaz (Central)

Purpose
To establish objective age-related normal diameter values of the optic pathway in the pediatric population using magnetic resonance imaging (MRI).
Materials and Methods
We retrospectively reviewed all brain MR studies performed from January to June 2015 of pediatric patients referred for reasons unrelated to orbital pathology and were interpreted as normal. The examinations were performed on a 1.5T or 3T Siemens MR system using routine imaging protocols. Orbital optic nerves (OON), prechiasmatic optic nerves (PON) and optic tracts (OT) were measured on T2 axial sequences. Measurements of OON were performed 10 mm posterior to optic disk, without including the optic nerve sheath. PON were measured 5 mm posterior to optic canal. Measurements of each OT were performed at the level of the anterior border of the cerebral peduncle. The optic chiasm (OC) was measured on T2 coronal fat saturated sequences on a slice where its maximal width was identified. All measurements were performed manually. The final study population included 137 studies (72 male, 65 female, average age = 7.7 years). Patients were stratified into five age groups: (I) 0-1.5 years, (II) 1.5-3 years, (III) 3-6 years, (IV) 6–12 years, (V) 12-18 years.

Results
The observed value range of OON mean diameter was 2.7 mm (IQR = 2.4-2.9), PON was 3.2 mm (IQR = 3.05-3.5), OT 2.6 mm (IQR = 2-2.9). A strong positive correlation was established between age and mean diameter of OON (r=0.73, p<0.001), PON (r=0.59, p<0.001), OT (r=0.72, p<0.001), OC weight (r=0.55 p<0.001). A significant difference in mean OON diameters was found between age groups I-II (d=0.3, p=0.01), II-III (d=0.5, p<0.001), III-IV (d=0.5, p<0.001) followed by a plateau between IV-V (d=0.10, p=0.19). Orbital optic nerves/optic tracts ratio maintained a steady mean value 1 (IQR =0.93-1.1) regardless of age (p=0.7).

Conclusions
Size of optic pathways was found to increase as a function of age, with consistent correlation between nerve and tract for all ages.

O-451
11:10AM - 11:18AM

Prognostic CT Finding for Diplopia after Surgical Repair of Pure Orbital Blowout Fracture

H Jung¹, J Byun², G Park³
¹Samsung medical center, Sungkyunkwan University School of Medicine, Seoul, Korea, Republic of; ²Kangnam St. Mary's Hospital, The Catholic University of Korea, Seoul, Korea, Republic of; ³Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea, Republic of
Purpose
To evaluate the prognostic computed tomography (CT) finding for diplopia after surgical repair of pure blowout fracture.

Materials and Methods
We retrospectively reviewed CT images of 181 patients with pure orbital blowout fracture who had at least 6 months postoperative follow up. We evaluated the following factors: (1) site of fracture (orbital floor, medial wall of the orbit, or both), (2) fracture type, (3) fracture size, (4) volume of herniated orbital soft tissue, (5) (volume of herniated orbital soft tissue / fracture size) ratio (6) presence of extraocular muscle (EOM) thickening, (7) EOM swelling ratio, (8) presence of displacement of EOM, (9) presence of deformity of EOM, (10) presence of tenting of EOM, and (11) number of points of contact between EOM and bony edge. The association between diplopia at 6 months after surgical repair and various risk factors was analyzed using logistic regression models in univariable- and multivariable analysis.

Results
Deformity and tenting of EOM, large volume and (volume of herniated orbital soft tissue/fracture size) ratio were found to be statistically significant risk factors for diplopia at 6 months after repair (all P < 0.05). Among them, patients who showed tenting or deformity of EOM on CT images had a 5.22 or 10.85 times greater probability of new or residual diplopia after surgery, respectively (P <0.001 and P = 0.026; 95% confidence interval of odds ratio, 2.071–13.174 and 1.323–88.915, respectively).

Conclusions
Prognosis of patients was approximately predicted through the evaluation of CT findings. Patients who have deformity or tenting of EOM, or high (volume of herniated orbital soft tissue/fracture size) ratio on CT scan are more likely to have postoperative diplopia.
lacrimal fossa lesions were retrospectively included between 2003 and 2015. All patients underwent CDFI, with a qualitative and quantitative analysis of the vascularization. All patients had lacrimal gland surgery. Definitive diagnosis was based on pathological examination.

Results
The study included 47 nonepithelial lesions (NEL) and 15 epithelial lesions (EL), with 24 (39%) malignant lesions and 38 (61%) benign lesions. Nonepithelial lesions were significantly more likely to present with septa (p<0.001), hypoehogenicity (p<0.001), high vascular intensity (p<0.001), specific vascularization pattern (p<0.05) and a low resistance index (RI) (p<0.0001). Epithelial lesions were significantly more likely to present with the presence of cysts (p<0.001), and a higher RI. Receiver operating characteristic curves (ROC) identified a RI value of 0.72 as the best cut-off to differentiate NEL from EL, with a sensitivity and specificity of 100%.

Conclusions
Color Doppler flow imaging is a simple, valuable and reliable tool in the differential diagnosis of lacrimal fossa lesions. Resistance index measurement enables perfect segregation of epithelial and nonepithelial lesions, thus providing crucial data for surgical management.

O-453
11:26AM - 11:34AM
Effects of MR Imaging Technique on “Classic” MRI Findings of Venous Malformations

M Alexander1, N Hughes1, D Cooke1, C Hess1, I Frieden1, A Phelps1, C Dowd2, R Darflinger1, F Settecase1, A Nicholson1
1UCSF, San Francisco, CA, 2Univ. Of California San Francisco, San Francisco, CA

Purpose
Magnetic resonance imaging (MRI) is the best imaging modality for characterization of venous malformations (VMs). Classically, phleboliths suggest a VM, while the fluid-fluid levels (FFLs) suggest a lymphatic malformation (LM) is more likely than a VM. Magnetic resonance technology has advanced considerably since the first description of these key findings. This study seeks to re-examine these traits to see if rates of trait detection have changed as technology and techniques have evolved.

Materials and Methods
A prospectively maintained database from the multidisciplinary birthmarks and vascular anomalies clinic at a major academic medical center was queried. Patients with final diagnosis of VM-based on clinical, radiologic, and vascular anomalies group consensus, who had reviewable contrast-enhanced MRIs were identified. From this group, patient with the oldest and newest MR studies were chosen to identify...
equal numbers of patients from the temporal extremes. Imaging was reviewed to assess for presence of FFLs, phleboliths, and presence of enhancement. Enhancement was quantified by measuring signal in the same location of the lesion on both pre and postcontrast sequences, tabulating three enhancement values for each lesion. Such comparison was made with the same MR sequences performed before and after contrast administration. The most avidly enhancing segment of the lesion was targeted for measurement of signal. Percent enhancement was calculated by the formula \( \frac{(\text{postcontrast signal} - \text{precontrast signal})}{\text{precontrast signal}} \). Time elapsed between contrast injection and image acquisition was noted. Chi-square analysis was performed to compare rates of visualization of FFL, phleboliths, and enhancement between the cohorts. Independent sample t-test was performed to compare percent enhancement between the cohorts. Pearson's coefficient was performed to evaluate the correlation between percent enhancement, time to contrast, and date of imaging.

Results
Forty patients were identified for analysis. Twenty studies were performed between 1995 and 2006; 20 studies were performed between 2011 and 2012. The new imaging cohort had higher rates of FFL visualization (55% versus 5%, \( p=0.001 \)). Phlebolith visualization occurred at similar rates between groups (55% versus 50%, \( p=0.50 \)). Higher average percent enhancement was seen on the older cohort (245% versus 59%, \( p<0.001 \)). Correlation was found between time to imaging following contrast and degree of enhancement (\( r=0.60, p<0.001 \)). Inverse correlation was found between scan date and time to contrast (\( r=-0.50, p=0.001 \)) and scan date and degree of enhancement (\( r=-0.364, p=0.021 \)).

Conclusions
With advanced MR technology, fluid filled levels can be seen more commonly with VMs than classically reported. Fluid filled levels should not be considered exclusionary for diagnosis of VMs. Visualization of phleboliths maintains specificity for VMs using contemporary techniques. Timing following contrast administration should be maximized to increase degree of enhancement to confirm the diagnosis of VMs. Further analysis is needed given limitations in this retrospective study, including heterogeneous protocols, and differences in gadolinium chelates.

M Adin\textsuperscript{1}, A Blitz\textsuperscript{2}, N Aygun\textsuperscript{3}  
\textsuperscript{1}Silvan state hospital, Turkey, diyarbakir, Turkey, \textsuperscript{2}Johns Hopkins Hospital, Baltimore, MD, \textsuperscript{3}Johns Hopkins University, Baltimore, MD

Purpose  
To demonstrate whether contrast-enhanced CISS imaging adds value to postcontrast T1-weighted imaging in distinction of oculomotor nerve from adjacent skull base tumors.

Materials and Methods  
We retrospectively reviewed medical records of 324 (168 Female, 156 Male) consecutive patients who were referred to our institution between February 2010 and July 2013 for various skull base tumors (pathologies are listed in the table) for a dedicated high-resolution skull base imaging including submillimetric precontrast and postcontrast T1-weighted (VIBE) and heavily T2-weighted (CISS) sequences. Eighty-one cases met the criteria for inclusion to this study. Radiological

\begin{tabular}{|l|c|c|c|c|}
\hline
 & Old MRI \textit{(n=20)} & New MRI \textit{(n=20)} & All Patients \textit{(n=40)} & p-value \\
\hline
Male & 7 & 11 & 18 & 0.214 \\
Mean Age (Years) & 21.4 & 10.0 & 15.7 & 0.000 \\
Pediatric & 10 & 16 & 26 & 0.049 \\
Max Dimension (cm) & 10.5 & 16.0 & 13.2 & 0.087 \\
FFL & 1 (5\%) & 11 (55\%) & 12 (30\%) & 0.005 \\
Enhancement & 20 (100\%) & 20 (100\%) & 40 (100\%) & - \\
Mean \% Enhancement & 245\% & 59\% & 152\% & <0.001 \\
Phleboliths & 10 (50\%) & 11 (55\%) & 21 (46.7\%) & 0.500 \\
\hline
\end{tabular}
interpretations were done independently by two radiologists (NA with 15 years of post-training experience and MEA sixth year in radiology training) who were blinded to clinical information. Visibility of CN III and distinction from space occupying lesions were assessed on postcontrast series of both high-resolution T1 weighted VIBE images, and CISS images using a 4-tiered visual scoring system (0= invisible CN III or indistinguishable from mass, 1= poor visualization, 2= good visualization, 3= excellent visualization). The relationship between the lesion and CN III was investigated on five segments (cisternal, dural cave, interdural, foraminal and extraforaminal) of the CN III separately.

Results
Our study showed a statistically significant difference between contrast-enhanced T1-weighted VIBE and CISS techniques in favor of postcontrast CISS images. A chi square test showed a statistically significant difference between overall score distributions in two methods (p value< 0.0001). Statistical analyses of each segment were performed using Kolmogorov-Smirnov Two-Sample Test and Kuiper Test for variable rating classified by variable methods, which again demonstrated the superiority of postcontrast CISS images over postcontrast VIBE images for each segment (p value< 0.0001). Contrast material administration significantly increased the visibility of the oculomotor nerve and also improved separation of the oculomotor nerve from skull base tumors.

Conclusions
Postcontrast CISS images significantly improve radiologist's ability to identify the oculomotor nerve and to differentiate the oculomotor nerve from the adjacent tumors.
Significance of Severity of Vascular Compression and Vessel Type with Symptoms in Patients with Trigeminal Neuralgia.

J Job¹, M Hughes¹, S Fakhran², L Alhilali³, B Branstetter¹, R Sekula¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA, ²Banner Health and Hospital System, Phoenix, AZ, ³Barrow Neurological Institute, Phoenix, AZ

Purpose
Trigeminal neuralgia is a debilitating disease most commonly caused by vascular compression of the 5th cranial nerve. Asymptomatic vascular compression is known to be common with rates reported between 10-71% (Maarbjerg et al., 2014). However, with improved MR imaging techniques the severity of vascular compression can now be graded. For example, deformity of the nerve by the offending vessel is detectable with thin section SSFP imaging. The purpose of this study is to determine whether the rates of vascular compression, arterial compression, and nerve deformity were higher...
in symptomatic trigeminal nerves when compared to asymptomatic nerves in patients with trigeminal neuralgia.

Materials and Methods
The study includes 104 patients with a history of unilateral trigeminal neuralgia. Patients underwent a dedicated 3T magnetic resonance imaging (MRI) using cranial neuralgia protocol MRI with three-plane thin section steady state free precession imaging. All films were evaluated retrospectively by one of two CAQ-certified neuroradiologists blinded to the laterality of symptoms. The presence of any vessel compressing the trigeminal nerve and whether the culprit vessel was an artery or vein then was recorded. The degree of vascular compression was categorized as contact or deformity. Vascular contact is defined as vessel abutment without mass effect on the trigeminal nerve. Vascular deformity is defined as abutment and associated concave contour deformity of the trigeminal nerve (see Fig. 1). Categorical variables are presented with frequency distributions and the Chi square test was used to assess associations with laterality of symptoms.

Results
Out of a total of 104 symptomatic patients, 94% (98/104) had vascular compression on the symptomatic side. Vascular deformity was present in 61% (60/98) and 39% (38/98) had vascular contact. On the asymptomatic side, vascular compression was less common 64% (66/104). Vascular deformity was seen in only 14% (9/66) and vascular contact in 86% (57/66) on the asymptomatic side. Of the patients who had vascular compression on the symptomatic side, the culprit vessel was an artery in 78% (76/98), a vein in 13% (13/98), and both an artery and vein in 9% (9/98). Of the patients who had vascular compression on the asymptomatic side, the culprit vessel was an artery in 59% (39/66), a vein in 39% (26/66), and both an artery and vein in 2% (1/66). In summary vascular compression, an arterial culprit vessel, and deformity was present more frequently on the symptomatic side. Deformity is uncommon on the asymptomatic side. Chi square tests of association revealed statistically significant rates of association between the symptomatic side and the presence of any vascular compression, an arterial culprit vessel, and deformity of the nerve (p<0.05).

Conclusions
Vascular compression, compression by an artery, and nerve deformity are more commonly seen on the symptomatic side in patients with trigeminal neuralgia. Further studies to correlate the utility of imaging findings such as vascular deformity with surgical outcomes are necessary to best select patients for surgery.
**Thursday**
10:30AM - 12:00PM
Washington Marriott Wardman Park, Roosevelt 1-3

21D-PARALLEL PAPER SESSION: Turbo Talks - Intracranial Vascular Procedures

O-457

10:30AM - 10:33AM

The Effect of General Anesthesia on Pressure Gradients in Transverse Sinus Stenosis: Initial Observations

F Hui1, M Luciano2, S John3, A Blitz4

1Johns Hopkins University, Baltimore, MD, 2Johns Hopkins, Baltimore, MD, 3Cleveland Clinic, Cleveland, OH, 4Johns Hopkins Hospital, Baltimore, MD

**Purpose**
The use of transverse sinus stenting in the setting of idiopathic intracranial hypertension has gained increasing acceptance as a management modality in medically refractory patients. Diagnostic manometry prior to stent placement often is used to ascertain whether or not a physiologically significant gradient is present, though operators may differ in their minimum threshold. Given that most intracranial stenting procedures are performed under general anesthesia, differences in the intracranial environment may affect gradients, and thus therapeutic decisions and diagnostic conclusions.

**Materials and Methods**
Prospectively collected data on patients undergoing diagnostic manometry and stent placement under anesthesia was reviewed for patients that received manometry both before and after anesthesia, and before stent placement were reviewed. There were five patients identified that had appropriate data. Demographics, management, outcome metrics and procedural records were assessed. The change in venous pressures and gradients were recorded before anesthesia, after anesthesia and after stent placement.

**Results**
Initial pressure gradient across the stenosis was 32 mmHg. After anesthesia, there was reduction in measured gradient across the stenosis in all patients 5/5 (100%), with a mean reduction of 16.4 mmHg ranging from 1 mmHg to 28 mmHg. There was also a reduction of Torcular pressure of 12 mmHg ranging from 0 – 28 mm Hg. The IJ measurement of pressure was increased by 2.4 mmHg postanesthesia. In one case (1), there was apparent resolution of both the gradient (to 5 mmHg) as well as near
resolution of the stenosis. In a second case (3), the intervention was initially performed under local sedation and the stenosis was severe enough such that the stenosis could not be crossed with the stent or intermediate catheter. After anesthesia was induced, the minimum luminal diameter increased from 2 to 4 mm. There was reduction of angiographically measured degree of stenosis in two of five of the patients (40%). In contrast, after stent placement, the pressure gradient across the prior stenosis was 2.4 mmHg, reduced from an initial mean of 32 mmHg. The mean IJ pressure was 18.4 mmHg after anesthesia, up from 11.6 mmHg.

Conclusions
In this limited sample, there was a clear effect of measured torcular pressures in the sample set in which the pressure gradient across the stenosis decreased by a mean value of 12 mmHg after anesthesia, and, in two cases, evidence of reduced degree of stenosis. Use of manometry to determine eligibility for transverse sinus stenting should account for the effect of anesthesia. Furthermore, poststent manometry should be interpreted in light of these findings, as elimination of gradient may in part reflect an anesthetic effect rather than merely stent efficacy.

O-458

The Clot Thickens: A Large Single Center's Experience with Dural Venous Sinus Thrombosis

W Reyenga1, E Nyberg1
1University of Colorado, Aurora, CO

Purpose
Dural venous sinus thrombosis (DVST) is an uncommon condition which can result in venous infarct with or without intracranial hemorrhage and carries the possibility of permanent neurological deficit. The mainstay of treatment is systemic anticoagulation with heparin or low molecular weight heparin, but data regarding interventional therapy with intrasinus thrombolysis or thrombectomy is limited to a few case reports and case series suggesting an increased incidence of hemorrhagic complications. The purpose of this study was to analyze a larger series of consecutively treated patients than is available in previously published series and to analyze any differences in outcomes between patients receiving anticoagulation alone versus those also receiving endovascular therapy.

Materials and Methods
Institutional Review Board approval was obtained for this retrospective study. The electronic medical record was queried based on ICD-9 code for patients treated for DVST at our institution from 2009 to 2015. For each patient, we recorded the clinical presentation, treatment, and clinical course. Follow-up clinical and imaging reports
were reviewed to assess for new hemorrhage or infarct after the initiation of therapy. We compared outcomes of patients receiving and not receiving interventional therapy at discharge and at 90 days after discharge. Statistical significance was assessed using the chi-squared test and unpaired t-test.

Results
Sixty-eight patients were treated for DVST from 2009 to 2015. Thirty-five (51%) of these developed infarct with or without hemorrhage. Thirty-seven (54%) patients were treated with systemic anticoagulation alone. Twenty-nine patients (43%) were treated with endovascular thrombolysis using tissue plasminogen activator (tPA), and 22 of those patients (32%) also were treated with mechanical thrombectomy. Two patients underwent endovascular therapy without tPA administration or thrombectomy, one having a stent placed, and one treated with balloon angioplasty, and were excluded from the outcome comparison. New intracranial hemorrhage or infarct after initiation of therapy was seen in nine (31%) of the patients who underwent endovascular therapy and none of the patients receiving systemic anticoagulation alone (p<0.001). The mean modified Rankin Scale (mRS) at discharge was 1.62 for the endovascular group compared to 1 for the anticoagulation group (p=0.0802), and the mean mRS at follow up was 0.87 for the endovascular group versus 0.84 for the anticoagulation group (p=0.901). Similarly, there was no statistically significant difference between the two groups in the percentage of patients with mRS of 2 or less at discharge and at follow up.

Conclusions
Endovascular treatment of DVST was associated with a higher incidence of new, postprocedural intracranial hemorrhage or infarct compared to patients treated with anticoagulation alone. Possible explanations for this finding, including differences in preprocedural clot burden and clinical status between the treatment groups, will be explored in the discussion. Despite this, both groups had statistically similar good outcomes.

O-459
10:36AM - 10:39AM

ARTS (Aspiration-Retriever Technique for Stroke)

F Massari¹, N Henninger¹, J Lozano¹, A Kuhn¹, M Gounis¹, A Wakhloo¹, A Puri¹
¹University of Massachusetts, Worcester, MA

Purpose
New generation of highly navigable large-bore aspiration catheters and retriever devices for intracranial mechanical thrombectomy has markedly improved recanalization rates, time and clinical outcomes. We report a collected clinical data utilizing a new technique based on combined large lumen aspiration catheter and
partially resheathed stent retriever (ARTS: Aspiration Catheter and Stent Retrievers Technique for Stroke). This technique is applied, especially in presence of bulky/rubbery emboli, when resistance is felt while retracting the stent retriever; at that point the entire assembly is locked and removed in-toto under continuous aspiration with additional flow arrest.

Materials and Methods
A retrospective data analysis was performed to identify patients with large cerebral artery acute ischemic stroke treated with ARTS. The study was conducted between August 2013 and February 2015 at a single high volume stroke center. Procedural and clinical data were captured for analysis.

Results
Forty-two patients (median age 66 years) met inclusion criteria for this study. The ARTS was successful in achieving Thrombolysis in Cerebral Infarction (TICI) ≥2b revascularization in 97.6% of cases (TICI 2b = 18 patients, TICI 3 = 23 patients). Patients median NIHSS score at admission was 18 (6–40). Three-month follow-up mRS value of 0–2 was achieved in 65.7% of the successfully treated patients (average 2.4). Two patients (4.8%) developed symptomatic intraparenchymal hemorrhages. Six procedure unrelated deaths were observed.

Conclusions
We found that ARTS is a fast, safe and effective method for endovascular recanalization of large vessel occlusions presenting within the context of AIS.

O-460

Single Center Experience with the Trevo XP 6x25 mm. as a Primary Device in Acute Ischemic Stroke Patients with Large Vessel Occlusion.

J Blasco Andaluz¹, L San Roman², N Macias², F Zarco³, O Chirife⁴, L Saenz², S Amaro², X Urra², L Llull², J Macho²
¹Hospital Clinic of Barcelona, BARCELONA, -- SELECT --, ²Hospital Clinic of Barcelona, Barcelona, Barcelona, ³Hospital Clinic of Barcelona, Barcelona, barcelona, ⁴Hospital Clinic of Barcelona, Barcelona, Barcelona

Purpose
To report our early experience with the Trevo XP 6x25 mm. as a primary device in patients with acute ischemic stroke (AIS) and large vessel occlusion at a single comprehensive stroke center.

Materials and Methods
We retrospectively analyzed the safety and efficacy of the Trevo XP 6x25 mm in 45 consecutive patients with proximal vessel occlusions treated between April and November 2015.
Results
Since April 2015 until November 2015, 45 consecutive AIS patients with proximal vessel occlusions were treated with the Trevo XP 6x25 mm. as the primary device. Mean age was 68 years, mean NIHSS at baseline was 17, mean symptom onset to puncture was 225 min. Occlusion site was as follows: 20% terminal internal carotid artery, 53% M1, 7% M2, 11% basilar artery, and 9% tandem lesion with M1 occlusion. Median overall procedure time was 44 minutes with a median number of passes of two needed to achieve good revascularization rate (TICI 2b-3). Good revascularization rate was obtained in 86% of the patients, achieving this reperfusion in just one to two passes in 68% of the patients. In two patients a different stent retriever device was used, not achieving TICI 3-2b in any of them. Vasospasm was not infrequently detected but with no clinical consequences. In one case rupture of the device at the level of the stent retriever-guidewire connection precluded retrieval of the device. Clinical outcome at 90 days was available in 22 patients at submission of this abstract, and was 45.4 % mRs 0-2.

Conclusions
Our initial data suggest that the use of Trevo XP 6x25 in LVO AIS patients is safe and feasible, achieving high revascularization rates with very few number of passes. These results should be confirmed in larger series in order to determine the primary target of this 6 mm device.

O-461
10:42AM - 10:45AM

With MR Selection, Improved Outcomes after Successful Thrombectomy Beyond 6 Hours in Anterior Circulation Large Vessel Occlusion Stroke

B Cristiano¹, M Pond¹, U Oyoyo², S Basu¹, J Jacobson¹
¹Loma Linda University Hospital, Loma Linda, CA, ²Loma Linda University, Loma Linda, CA

Purpose
The benefit of thrombectomy among patients with anterior circulation large vessel occlusion (ACLVO) stroke is unclear beyond 6 hours (1-5). Here we sought to ascertain whether or not successful thrombectomy performed greater than 6 hours after stroke onset is beneficial compared with no intervention.

Materials and Methods
A cohort of 30 patients undergoing thrombectomy after magnetic resonance (MR) selection for ACLVO stroke from 11/1/2012 until 5/15/2015 was studied retrospectively. Patients were selected for thrombectomy based on diffusion-restricted core volume ≤ (100 - patient's age) mL. Patients who presented beyond 6 hours from symptom onset who achieved TICI≥2B recanalization (n=21) were compared against
patients with failed thrombectomy at any time (n=9), with final infarct volume the primary outcome.

Results
Baseline characteristics were similar (failed versus late thrombectomy), including admission NIHSSS (IQR 11 – 19 versus 11 – 18). The median symptom onset to access time for the late thrombectomy group was 10.6 hours (IQR 7.8 – 14.4). Patients with successful late thrombectomy had significantly smaller median final infarct volume [20 mL versus 53 mL, estimated difference -34 mL (95CI: -211 – +1), p = 0.045], median infarct growth [+4 mL versus +43 mL, estimated difference -32 (95CI: -192 – +1), p = 0.036], and were more likely to have a favorable outcome defined as discharge home or to rehab [14/21, 66.7%, versus 2/9, 22.2%, odds ratio 7.14 (95% CI: 1.26 – 34.5), p = 0.046].

Conclusions
Successful thrombectomy performed beyond 6 hours of ACLVO stroke onset with MR selection is likely beneficial compared with no intervention.
Outcomes with successful late MR-selected thrombectomy in ACLVO stroke. Patients with successful late thrombectomy had increased favorable outcomes (67% vs. 22%), decreased unfavorable outcomes (29% vs. 56%) and death (5% vs. 22%) compared with failed thrombectomy.
The Categories of Hyperperfusion Syndrome after Carotid Stenting

H Lee¹, F Chang¹, W Guo¹
¹Taipei Veterans General Hospital & National Yang Ming University, Taipei, Taiwan

Purpose
Hyperperfusion syndrome (HPS) occurred only in 0-3% of the patients after carotid endarterectomy or carotid artery stenting (CAS). Impaired autoregulation of intracranial arteries may account for its mechanism. The imaging abnormalities range from slight brain edema to intracranial hemorrhage. Typical clinical presentation includes the triad of headache, seizure and focal neurological deficit. However, atypical symptoms with behavior or emotional change, such as agitation and hypertalkativity, have never been reported. We retrospectively evaluated the cases of symptomatic HPS in our institute and proposed a new category system for the outcomes.

Materials and Methods
Between the years 2000 to 2015, 980 cases of CAS were done in our institute. Of them, 28 patients (2.55%, 25 males and 3 females) after CAS with abnormal symptoms and/or imaging findings of HPS were included. Three categories of symptomatic HPS were classified according to the imaging findings: type I "Hemorrhagic" HPS with intraparenchymal, subarachnoid, or subdural hemorrhages; type IIa "Severe, nonhemorrhagic" HPS with focal brain edema; type IIb "Slight, nonhemorrhagic" HPS with no abnormal findings on plain CT or MR including T2 FLAIR and diffusion-weighted images. Clinical symptoms, neurological deficits, outcomes and imaging studies before, during and after procedure were reviewed for comparison.

Results
The clinical symptoms of the 11 patients of type I, eight patients of type IIa and nine patients of type IIb HPS were: consciousness disturbance [n= 3 (27%), 2 (25%), 0 (0%)], headache [n= 2 (18%), 2 (25%), 2 (22%)], muscle weakness [n= 2 (18%), 1 (13%), 2 (22%)], convulsion [n= 1 (9%), 3 (38%), 0 (0%)], quadriplegia or hemiplegia [n= 1 (9%), 2 (25%), 1 (11%)], dizziness [n= 2 (18%), 0 (0%), 2 (22%)], agitation [n= 0 (0%), 2 (25%), 5 (56%)], and hypertalkativity [n= 0 (0%), 0 (0%), 1 (11%)]. In 30 days after CAS, 3 (27%) patients of type I HPS had morbidity or mortality. One (9%) patient of type I HPS and 2 (25%) patients of type IIa HPS had dysarthria or hemiplegia. None (0%) of type IIb HPS had related neurological deficits.

Conclusions
We provide a new category system to describe the varied scope of HPS of CAS. The
patients of type IIb "Slight, nonhemorrhagic" HPS can present with emotional or behavior change which was under-recognized before. Early diagnosis and aggressive management with strict blood pressure control can prevent the slight HPS progress to the advanced categories.
Fig. A 79-year-old woman presented with sudden onset of dysarthria, headache and seizure one day after left carotid stenting. MR T2 FLAIR shows edematous change at left parieto-temporal region (right, arrows) and resolved one week later (}
Pial Artery Supply as a Treatment Risk for Intracranial Dural Arteriovenous Fistulas

1University Of California, San Francisco, San Francisco, CA, 2University of California, San Francisco, San Francisco, CA, 3UCSF, San Francisco, CA, 4Univ. Of California San Francisco, San Francisco, CA

Purpose
Intracranial dural arteriovenous fistulas (DAVFs) are rare vascular malformations that connect meningeal arteries to dural venous sinuses or cortical veins, accounting for 10-15% of all intracranial arteriovenous lesions. Although DAVFs are supplied by dural branches of the internal carotid, external carotid, and vertebral arteries, they also can be fed by pial arteries that also supply the brain. We sought to determine the frequency of neurological deficits following treatment of intracranial dural fistulas with and without a component of pial supply.

Materials and Methods
A retrospective review of 123 patients who underwent embolization for intracranial DAVFs at our hospital from 2008 to 2015 was conducted. Clinical information was derived from electronic medical records and radiologic imaging data. Patients were examined for postembolization neurological deficits, and those patients with deficits were evaluated for evidence of infarction and for clinical improvement. Data were analyzed using multivariate logistic regression.

Results
Of the 123 treated patients, 30 patients (24.4%) had DAVFs that were supplied by pial arteries and 93 patients (76.4%) had DAVFs supplied by nonpial vessels. Of the 30 patients with pial artery supply, four (13.3%) had post-treatment neurological deficits, compared to two patients (2.2%) out of the 93 patients without pial artery supply. Imaging demonstrated three patients with pial artery supply (10%) had foci of cerebral ischemia, compared to only one patient without pial artery supply (1.1%).

Conclusions
Patients with DAVFs supplied by pial arteries were more likely to experience post-treatment neurological deficits including strokes than patients with no pial artery supply.
High-Resolution Vessel Wall MRI in the Evaluation of Ruptured Cranial Dural Arteriovenous Fistulas: Preliminary Experience

C Matouk¹, B Cord¹, J Yeung¹
¹Yale University School of Medicine, New Haven, CT

Purpose

High-resolution vessel wall magnetic resonance imaging (VW-MRI) is increasingly being used to characterize intracranial vascular disease. Recent studies have begun to explore its utility in the evaluation of ruptured intracranial aneurysms (1-3). For example, we previously demonstrated that VW-MRI could identify the site-of-rupture in patients with SAH and multiple, intracranial aneurysms (1). We hypothesized that VW-MRI also may be useful in the evaluation of a more complex, angioarchitectural vascular malformation; namely, ruptured cranial dural arteriovenous fistulas (dAVFs). Herein, we report for the first time VW-MRI in patients with ruptured cranial DAVFs.

Materials and Methods

A retrospective review was performed of cranial DAVFs treated by a single practitioner (CCM) between December 2011 and December 2015. Patients were included if they underwent VW-MRI in addition to conventional sequences (CT, CTA, MRI, MRA, and catheter angiography) prior to definitive treatment. Vessel wall MRI was performed on a Verio 3.0T scanner with a 32-channel head coil (Siemens Healthcare). The T1-weighted black blood vessel wall sequence (TSE acquisition with FOV=16x16cm, acquired matrix=512x512; slice thickness=2mm; total slab thickness=4-6cm; repetition time/echo time 590/10ms) was performed before and after the administration of gadolinium (with constant scan parameters). Each vessel wall sequence was performed in the axial and coronal planes.

Results

Of six patients treated with ruptured cranial dAVFs, three patients underwent VW-MRI in addition to conventional imaging prior to definitive treatment. Case #1. This 39-year-old man presented with spontaneous, focal SAH adjacent to the medulla secondary to a ruptured cranial dAVF of the left hypoglossal canal (Borden Type III). Conventional sequences demonstrated a venous varix at the epicenter of the focal SAH. Vessel wall MRI demonstrated thick enhancement of the wall of the ruptured venous varix. Case #2. This 87-year-old woman presented with spontaneous fourth ventricular hemorrhage secondary to a ruptured posterior fossa dAVF (Borden Type III). Conventional sequences demonstrated a bi-lobed venous varix at the floor of the fourth ventricle. Vessel wall MRI demonstrated thick enhancement of the wall of the anterior lobe projecting into the fourth ventricular clot, but not the posteriorly-directed lobe pointing away from the clot. Case #3. This 54-year-old man presented in extremis with a spontaneous, acute subdural hematoma requiring emergent evacuation
and decompressive craniectomy. Conventional sequences demonstrated a cranial dAVF related to an occluded R transverse sinus (Borden Type III). The presumptive site-of-rupture was a venous varix subjacent to the evacuated subdural hematoma and contiguous with a small intraparenchymal hemorrhage. Vessel wall MRI demonstrated thick enhancement of the wall of the ruptured venous varix and contiguity with the parenchymal clot.

Conclusions
The site-of-rupture in cranial dAVFs demonstrates thick vessel wall enhancement and contiguity with the hemorrhage on high-resolution VW-MRI. These data may be useful in clinical decision-making.

O-466

Anterior Ethmoidal Dural Arterio-Venous Fistulas (dAVF): Endovascular Treatment Through the Ophthalmic Artery

C Perazzini¹, E Pomerio², A Malakhia², A Biondi²
¹Besançon University Hospital, Besancon, France, ²Besançon University Hospital, Besançon, France

Purpose
Anterior ethmoidal dural arteriovenous fistulas (dAVF) are rare intracranial lesions fed by ethmoidal branches arising from the ophthalmic arteries. The venous drainage is through cortical veins most often draining into the superior sagittal sinus or through the deep leptomeningeal venous system draining into the basilar vein. Dilated venous pouches often are observed. These lesions are associated with a high risk of intracranial hemorrhage (ranged from 62% to 91% of cases). The endovascular treatment of the anterior ethmoidal dAVFs is feasible, however the approach through the ophthalmic arteries (OAs) remains a delicate procedure because of the risk of ischemic complications leading to retinal damage. We report our experience in the treatment of these lesions.

Materials and Methods
Retrospective evaluation was carried out on five patients (3 women and 2 men, mean age 67.6 years) with an anterior ethmoidal dAVF. Two patients (cases 1 and 5) presented with an intracranial hemorrhage, one patient (case 4) with papilledema due to increased intracranial pressure and in two patients (cases 2 and 3) the dAVF was diagnosed incidentally on a MR study performed because of endocarditis in one case and vertigo in the other one. The two patients in whom the dAVF was revealed by intracranial hemorrhage underwent transarterial embolization through the right ophthalmic artery; the patient presenting with vertigo underwent transarterial embolization through both ophthalmic arteries. The 80-year-old patient (case 4)
affected by papilledema refused consent to treatment and the patient (case 2) with endocarditis died because of cardiac failure before any treatment. In case 1, transarterial embolization was performed using glue (Glubran), in case 3 using Onyx (right ophthalmic artery) and Glubran (left ophthalmic artery) and in case 5 using only Onyx. In all cases, transarterial administration of nimodipine (50% diluted in normal saline) including selective infusion in the ophthalmic artery was performed during the endovascular procedure in order to prevent vasospasm of the ophthalmic artery (leading to temporary hypoperfusion of the central retinal artery and subsequent retinal ischemia) due to the maneuvers of microcatheter removal.

Results
After endovascular treatment, complete occlusion of the anterior ethmoidal dAVF was obtained in all cases. No technical or clinical complications (especially regarding a visual deficit) occurred. The angiographic follow-up at 1 year confirmed the persistent occlusion of the lesion. Treated patients were asymptomatic at follow up.

Conclusions
The endovascular treatment of the anterior ethmoidal dAVFs using a transarterial approach through the ophthalmic artery allows the occlusion of these lesions at high risk of neurological complications. The risk of an ischemic damage of the retina due to a vasospasm or an occlusion of the ophthalmic artery due to embolic material reflux must be considered. The precise retinal tolerance time to acute ischemia is still undefined (<4 hours). The selective periprocedural administration of nimodipine is crucial to avoid vasospasm.

O-467 11:00AM - 11:03AM

Imaging Characteristics after Intra-arterial Cytoreductive Chemotherapy for Lacrimal Adenoid Cystic Carcinoma

S Williams¹, B Snellling¹, S Sur¹, N Nagornaya²
¹University of Miami, Miami, FL, ²University of Miami/Jackson Memorial Hospital, Miami, FL

Purpose
Primary lacrimal adenoid cystic carcinoma is a rare, aggressive malignant epithelial cancer. It is a difficult lesion to treat due to its proclivity for perineural spread with intracranial extension, soft tissue and bone infiltration, as well as hematogenous and lymphatic invasion. Despite maximal surgical and medical therapy, recurrence rates of 55-88% within 5 years of diagnosis have been reported. For these reasons, a multimodality treatment approach is required. In our institution neoadjuvant intra-arterial chemotherapy (IAC) usually is performed prior to surgical management to enhance local disease control. Transient post-treatment changes on follow-up imaging
can be extensive and confused for tumor spread. To our knowledge, this is the first evaluation of post-treatment imaging findings after IAC for this disease.

**Materials and Methods**

Retrospective chart review of all patients receiving intra-arterial chemotherapy for lacrimal adenoid cystic carcinoma. Imaging obtained at the time of diagnosis and pre- and post -IAC were reviewed. Imaging features evaluated include tumor size, perineural spread, and changes in the adjacent bone and soft tissue. Timing of imaging in relation to therapy, vessel catheterized during IAC, number of IAC treatments, chemotherapy agent and dosage utilized, as well as possible concurrent chemoradiation at the time of imaging was evaluated.

**Results**

Fifteen patients received IAC for lacrimal adenoid cystic carcinoma at a single institution from 2010-2015. Thirteen patients received MR and or CT imaging of the orbits before and after IAC.

**Conclusions**

Imaging evaluation of adenoid cystic carcinoma plays a critical role in management given the aggressive nature of the disease. Extensive edema and enhancement can be seen on the treated side, especially of the infratemporal fossa, several weeks after IAC that improves on subsequent imaging. Awareness of these findings is important for the neuroradiologist to help differentiate post-treatment changes from disease progression.

**Eye lens doses imparted during interventional and non-interventional neuroimaging techniques**

N Guberina, C Mönninghoff, A Ringelstein

1Institute of Diagnostic and Interventional Radiology and Neuroradiology, Essen, NRW, 2Institute of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, NRW

**Purpose**

To assess and compare eye lens doses imparted during interventional and noninterventional imaging techniques for the examination of intracranial vessels.

**Materials and Methods**

We performed a phantom study on an anthropomorphic phantom (ATOM dosimetry phantom 702-D; CIRS, Norfolk, Virginia, USA) and measured eye lens doses with TLD-s Type 100 (LiF:Mg,Ti) during interventional (3D rotational angiography, 2 plane DSA a/p and lateral projections) and noninterventional neuroimaging techniques [CT-angiography (CTA) with and without lens protectors, with and
without prior assessment of unenhanced cranial CT-protocols (nCT)]. Eye lens doses were calculated following recommendations of the ICRP 103.

Results
In the noninterventional setting following absorbed eye lens doses are measured: (I) CTA 3.9 mGy; (II) CTA with lens-protector 2.3mGy; (III) CTA in combination with prior nCT 31.9mGy; (IV) CTA with +nCT (nCT including head tilt) 16.1mGy; (V) CTA with nCT with lens-protector 23mGy. Eye lens doses for the interventional setting were distributed as follows: (VI) 3D rotational angiography 1mGy (VII) 2 plane DSA p/a+lat.4.5mGy (VIII) 3D rotational angiography and 2 plane DSA 5.5mGy.

Conclusions
Eye lens doses are lower during 3D rotational angiography compared to 2 plane DSA. Gantry angulation in the noninterventional setting and 3D rotational angiography bear considerable capacity for eye dose savings.

O-469

Estimation of radiation exposure of children undergoing superselective intra-arterial melphalan therapy for retinoblastoma treatment

N Guberina1, S Göricke2, C Mönninghoff2, S Sirin2, S Suntharalingam3, A Ringelstein2

1Institute of Diagnostic and Interventional Radiology and Neuroradiology, Essen, GA, 2Institute of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, NRW, 3University Hospital Essen, Essen, Germany

Purpose
The purpose of this study was to examine the radiation exposure of children undergoing melphalan therapy for retinoblastoma treatment in the neurointerventional setting.

Materials and Methods
In a retrospective study design the radiation exposure of children undergoing superselective intra-arterial melphalan therapy for retinoblastoma treatment was examined. All neurointerventional procedures were performed on the flat panel angiography system Allura Xper (Philips, Eindhoven, The Netherlands) at University Hospital Essen. Altogether 63 neurointerventional procedures could be included in the time period from 04/2011 till 08/2015. We differentiated patients according to the following variables: age group (infant 1-12 months, child 13-36 months), indication (bulbus preserving first line therapy or in relapse), used microcatheter-system and number of individual melphalan therapies. Fluoroscopy time and dose area product
(DAP) were assessed with dose monitoring software Radimetrics Enterprise platform (BayerHealthcare, Leverkusen, Germany).

Results
In detail, the following data were acquired: (I) fluoroscopy time 16.7 min. (II) DAP 9.3 Gycm². (III) effective dose 1.1 mSv. (IV) average number of individual melphalan therapies 1.5 and (V) successful neurointerventional procedure in 49/63 cases.

Reasons for not carried out melphalan therapy were an unsuccessful microcatheterization and meningeal anastomoses.

Conclusions
This is the first data acquisition of radiation exposure during superselective intra-arterial melphalan therapy of a pediatric cohort at the German Retinoblastoma Referral Centre. The assessment of radiation exposure in a larger population and comparison to international standards are the next necessary step for the determination of diagnostic reference levels.

O-470

A Novel System Using Multiple Radiophotoluminescence Glass Dosimeters For Radiation Measurements During Diagnostic Cerebral Angiography And Therapeutic Neurointerventional Procedures

K Futatsuya¹, S Kakeda², T Moritake², L Sun², J Moriya², S Ide², N Ohnari², K Fujimoto², E Futagami², J Yamamoto², S Nishizawa², Y Korogi²
¹University of Occupational and Environmental Health, School of Medicine, Kitakyushu, Japan, ²University of Occupational and Environmental Health, School of Medicine, Kitakyushu, Fukuoka

Purpose
There has been a growing concern regarding the detrimental effects of radiation to the patients during neurointerventional procedures. Furthermore, according to the 2011 ICRP statement, the threshold of the crystalline lens dose decreased from 5 to 0.5 Gy. Recently, we developed the direct measurement system (RADIREC) for calculating entrance skin dose (ESD) using multiple radiophotoluminescence glass dosimeters (RPLGDs) set on the surface of the patient's head and neck (Fig.1). The aim of this study was to evaluate the actual radiation exposure of the crystalline lens, the maximum ESD, and distribution of the ESDs during diagnostic cerebral angiography and therapeutic neuro-interventional procedures.

Materials and Methods
By using RPLGDs set, crystalline lens doses, the maximum ESD, and distributions of ESDs were evaluated prospectively in 28 consecutive adult patients (35 sessions
consisting of 22 diagnostic procedures and 13 therapeutic procedures). The crystalline lens doses and the maximum ESD were compared with the dose-area product (DAP).

Results
The mean maximum ESD was 440.2 ± 293.1 mGy (range; 67-1464). The mean doses of the crystalline lens were 48.6 ± 35.7 (1-128) mGy on the right side and 18.3± 10.6 (1-46) mGy on the left side; in all patients, the right side dose was higher than the left side dose. For the dose distribution, 24 procedures (22 patients) (68.6%) showed the maximum ESD in the right occipital regions. Although the maximum ESD showed significant positive correlations with the DAP (r = 0.67, p<0.01), there were no correlations between the crystalline lens dose and the DAP (r= 0.04, p=0.82).

Conclusions
RADIREC is an epoch-making system which can evaluate radiation exposure of the crystalline lens and the distribution of ESD precisely. In contrast, the DAP seems not useful to predict radiation exposure of the crystalline lens.

O-471

11:12AM - 11:15AM

Significant Dose Reduction During Neurointerventional CT Cases Using Table Side Parameter Controls

A Bress¹, S Metzler¹, C Plastaras¹, B Pukenas²
¹University of Pennsylvania, Philadelphia, PA, ²Hospital Of the Univ. Of Pennsylvania, Philadelphia, PA
Purpose
The purpose of this abstract is to show how computed tomography (CT)-guided neurointerventional procedures can be performed safely and effectively utilizing low dose radiation with and without a preplan CT scan. Altering a few basic radiation parameters with the side table control panel has shown marked reduction in dose length product (DLP) when comparing with the previous institutional CT scanner. In our experience, many CT-guided neuro-interventional procedures can be performed with only a scout image and low-dose CT-fluoroscopy when prior imaging is available. Our aim is to demonstrate how relatively simple alterations in the CT scanner parameters can be used in order to significantly decrease radiation exposure to the patient, operator, and staff during the majority of CT-guided procedures. Throughout our presentation we will show how we apply these techniques in several cases depicting how simple and effective these radiation sparing techniques are for guiding the needle(s) to the desired target.

Materials and Methods
A total of 141 patients undergoing CT neuro-interventional procedures were included in this retrospective data analysis study from July 1, 2014 to June 30, 2014. The patients underwent various CT-guided neuro-interventional procedures including spinal biopsy, aspiration, cyst fenestration, vertebral augmentation, epidural injection, epidural blood patch, nerve block and cyst fenestration. The dose-length products (DLP) were obtained from the postprocedural dose report which routinely are uploaded to our institutional PACS system. Only one patient did not have a dose report uploaded to PACS. The patients then were separated into three groups: AS+N (SENSATION 64 slice, Siemens, replaced in January 2015), AS+Y (SOMATOM Definition AS+ 128 slice, Siemens) with pre-plan CT, and AS+Y without preplan CT. Then, the mean DLP and diagnostic sampling rate was compared between the groups.

Results
Groups were divided as follows: 54 patients in the AS+N group, 51 in the AS+Y pre-plan CT group, and 35 in the AS+Y no pre-plan CT group. The mean DLP (± SD) for the AS+N was 815.84 +/- 246.53, the AS+Y pre-plan CT 233.00 +/- 220.78, and the AS+Y no preplan CT 27.64 +/- 33.75. Diagnostic biopsy sampling rates were 43/47 (91.5%), 37/39 (94.9%), and 28/30 (93.3%), respectively.

Conclusions
Many CT-guided neuro-interventional procedures can be performed using only a scout image for planning purposes, augmenting the mAs and kV for CT fluoroscopy, and reviewing prior imaging. A preplanning CT prior to performing a CT-guided procedure is necessary only for complex cases particularly when the known targeted region cannot be identified confidently using prior imaging and the scout image. Our biopsy yields are consistently over 90% regardless of the chosen technique. Utilizing these relatively simple measures can provide significant radiation dose reduction to
everyone involved as well as adhere to ALARA (As Low As Reasonably Achievable) and Image Gently guidelines.

L2 Vertebral Body Lesion Biopsy

![Prior CT](image1.png)  
![Prior PET/CT](image2.png)

![Procedure Scout](image3.png)  
![Procedure CT fluoro](image4.png)

Dx: Metastatic carcinoma – mucoepidermoid  
DLP = 28 mGy*cm, KV – 120, mAs - 8

(Filename: TCT_O-471_Images.gif)

Thursday  
10:30AM - 12:00PM  
Washington Marriott Wardman Park, Roosevelt 4

21F - Excerpta - III
Hemorrhagic Wernicke's Encephalopathy

H Oligane¹, F Oyedeji², J Mettenburg³, M Hughes¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA, ²University of Pittsburgh Medical Center, Murrysville, PA, ³UPMC, Pittsburgh, PA

Purpose
Wernicke's encephalopathy is a serious neurologic disorder characterized by vitamin B1 deficiency. Recognizing typical and atypical imaging characteristics is imperative because of the potential reversibility of this condition. Petechial micro-hemorrhage is a common pathologic finding on autopsy in patients with Wernicke's encephalopathy (1). However, intracranial hemorrhage identified by imaging is very rare and has only been described in non-radiologic literature in a handful of case reports (2, 3).

Materials and Methods
The patient is a 48 year old male who was found unresponsive in his home. Per his family he had a three week history of dizziness, hypersomnia, excessive vomiting, severe anorexia, and progressive mental deterioration. He had a past medical history of coronary artery disease, obesity, myocardial infarction, and diabetes mellitus type II, but there was no history of alcohol abuse or illicit drug use. CSF samples were negative. Initially an MRI was performed at an outside institution and interpreted as bilateral thalamic infarctions and intraventricular hemorrhage. The patient was transferred to our institution. The studies were re-interpreted as an unusual case of Wernicke's encephalopathy complicated by intraventricular hemorrhage. There was no arterial or venous thrombosis on vascular imaging. The patient's vitamin B1 level was found to be critically low. With parenteral thiamine supplementation, the patient's altered mental status gradually improved and he was eventually discharged home.

Results
CT of the Head: Acute intraventricular hemorrhage within the third ventricle and bilateral occipital horns (Figure 1 & 3). Noncontract MRI of the brain: Symmetric abnormal T2 FLAIR signal within the bilateral thalami (Figure 2), mammillary bodies (Figure 3), and periaqueductal region (Figure 4). No abnormal restricted diffusion was present (not shown).

Conclusions
Intracranial hemorrhage is an atypical imaging characteristic of Wernicke's encephalopathy, which is a potentially treatable life threatening condition. Radiologists must be aware of both the typical and atypical imaging characteristics of this disorder, as early identification and initiation of treatment can prevent devastating consequences.
MRI Findings in Thallium Toxicity

D Johnson¹, P Morris¹
¹Mayo Clinic, Rochester, MN

Purpose
Thallium salts are extremely toxic to animals, and were formerly widely used as rodent poison. Because thallium salts are colorless, odorless, and tasteless, human deaths from thallium poisoning, both accidental and purposeful, have been reported. This has fortunately become quite rare, as thallium use is now closely restricted in many countries. Central nervous system manifestations of thallium toxicity include delirium, visual disturbance, seizure, and often coma leading to death in severe cases. Alopecia is a characteristic sign of thallium toxicity, but it often does not occur until other symptoms are well established. Because the vast majority of cases of thallium toxicity occurred prior to the advent of CT or MRI, little is known about the neuroradiological manifestations of this condition.

Materials and Methods
A young adult presented with two weeks of progressive paresthesia, diplopia, and abdominal pain. During the evaluation of these symptoms, the patient experienced a rapid neurological decline, becoming lethargic, non-ambulatory, and non-communicative over several days. Extensive evaluation was nondiagnostic until the patient began to develop alopecia, at which time blood and urine thallium levels were found to be extremely elevated.

Results
An MRI at the onset of neurological symptoms was unremarkable. A repeat study two weeks later demonstrated new restricted diffusion in the splenium of the corpus callosum (upper left) and the right cingulate gyrus as well as new patchy enhancement in the white matter of the bilateral frontal lobes with corresponding increased FDG uptake on PET. Soon after this, the patient began to develop alopecia (upper right). By one week later the restricted diffusion had progressed to include the deep grey nuclei and multiple regions of cortex (lower left). FLAIR hyperintensity was seen throughout the periventricular white matter, with extension into the brainstem (lower right).

Conclusions
Thallium toxicity is an uncommon cause of rapid neurological decline. Treatment with hemodialysis and oral Prussian blue can limit the severity of disease, though delays in diagnosis may allow irreversible damage to occur prior to the initiation of
these measures. Awareness of the neuroradiological manifestations of this condition may allow earlier diagnosis and appropriate therapy.
A Case of Phosphomannomutase 2 deficiency (CDG-Ia): Neurologic and Ophthalmologic Findings

J Guerin¹, M Ho², A Parvinian²
¹Mayo Clinic, Rochester MN, Rochester, MN, ²Mayo Clinic, Rochester, MN

Purpose
To demonstrate a case of phosphomannomutase 2 deficiency (CDG-Ia) with several classic neurologic and ophthalmologic imaging features.

Materials and Methods
Phosphomannomutase 2 deficiency (CDG-Ia), caused by mutation in the gene encoding PMM2, is the most common congenital disorder of glycosylation (CDG). The clinical spectrum is highly variable with more severe forms seen in infancy and more mild phenotypes in those that survive to adolescence and adulthood. The more classic neurologic form with cerebellar dysfunction related to cerebellar hypoplasia/atrophy is nearly always observed in older patients. Other common findings include hypotonia, ataxia, seizures and developmental delay as well as retinitis pigmentosa and nystagmus. We feature a 25 year-old man with the first diagnosed case of this disorder at Mayo, initially discovered in 1993 at the age of three when he presented global developmental delay, ataxia and partial seizures. As an adult, he continues to have drug-resistant epilepsy, chronic global static encephalopathy, myoclonus and movement disorder, demyelinating peripheral neuropathy and progressive retinitis pigmentosa. Patient underwent initial brain MRI in 2014 for his epilepsy. Notable imaging features include severe cerebellar and midbrain atrophy, idiopathic intracranial hypertension, hypomyelination, retinitis pigmentosa and bilateral staphylomas. On MR spectroscopy there is also a characteristic myoinisitol peak and decreased NAA related to neuronal loss and gliosis.

Results
Selected collage of images. A: Coronal T2 FLAIR demonstrates severe cerebellar and more mild cerebral volume loss with increased T2 FLAIR signal and relative decreased white matter. B: Axial T2 sequence shows posterior scleral flattening as can be seen with idiopathic intracranial hypertension. Subtle outpouching of the posterolateral globes, off center from the optic disks, compatible with staphylomas. Severe midbrain atrophy. C: MR spectroscopy from a cerebellar voxel shows elevated myoinisitol peak and decreased NAA peak related to neuronal gliosis. D: Fundoscopic
photograph demonstrates a pale optic disk, scattered retinal pigment deposits and thinned blood vessels; these findings are seen with retinitis pigmentosa.

Conclusions
Case report of a 25 year-old man with phosphomannomutase 2 deficiency (CDG-Ia), the most common congenital disorder of glycosylation, with characteristic neurologic and ophthalmologic MRI, MR spectroscopy and fundoscopic findings.
Woodhouse Sakati Syndrome

E Lindgren¹, V Lehman¹
¹Mayo Clinic, Rochester, MN

Purpose
Demonstration of Woodhouse Sakati Syndrome (WSS) with MRI findings in an adult female. Woodhouse Sakati is an uncommon inherited condition which results in extrapyramidal symptoms, alopecia, mild deafness, intellectual disabilities and hypogonadism.

Materials and Methods
We submit a case of a 38 year-old female from the Middle East who had a normal birth and development, but at the age of 13, started developing muscle weakness with dystonia. She subsequently experienced a progressive decline in health: she never developed any secondary sexual characteristics, nor reached menarche. Later, she experienced difficulty opening her mouth, markedly impaired verbal communication, and developed alopecia and hearing impairment. Family history revealed 4 of her 7 siblings, male and female, had similar symptoms. All children were the product of a consanguineous marriage (first cousins). MRI findings are detailed below. The genetic test for Woodhouse-Sakati syndrome was positive (DCAF17 mutation).

Results
MRI demonstrated innumerable areas of T2 hyperintensity within the subcortical and deep white matter of both cerebral hemispheres; this had progressed since an MRI 8 years prior. There was marked low susceptibility signal within both globi pallidi and the pars reticulata of both substantia nigra, which was compatible with brain iron accumulation.

Conclusions
Previously reported MRI findings have ranged from normal to patchy and confluent periventricular white matter abnormalities and centrum semiovale signal intensities on T2 images suggesting iron accumulation to pituitary abnormalities. To our knowledge, none has shown findings consistent with iron accumulation on susceptibility weighted images (SWI). Moreover, reportedly normal cases previously did not include SWI. Radiologists should consider the use of SWI when WSS is suspected as imaging findings can help prompt genetic testing in the appropriate clinical scenario.

E-41

A Case of Adult-Onset Adrenoleukodystrophy

F Baffour¹, C Carr¹, L Eekel¹
Purpose
To review the MRI imaging findings in Adult-Onset Adrenal Leukodystrophy.

Materials and Methods
34 year old Caucasian male with traumatic brain injury and quadriplegia after a motor vehicular accident at the age of 33. He presented to the emergency department with tachypnea, hypoxia and fevers and was transferred to the intensive care unit where he was intubated due to hypoxic respiratory failure. A brain MRI was obtained due to acute worsening of his mental status with findings supporting a diagnosis of adult onset adrenoleukodystrophy. He failed to wean from mechanical ventilation and comfort care measures were initiated after 9 days on admission. The patient passed away 4 days later. The medical history is pertinent for chemically diagnosed adrenoleukodystrophy at age 11 with symptoms of adrenal insufficiency. He had no neurological symptoms and several brain MRIs were negative. The patient's younger brother was diagnosed with adrenoleukodystrophy at age 9, and has since passed away (age 11).

Results
MRI of the brain demonstrates extensive T2 hyperintensity with some areas demonstrating profound enhancement throughout the cerebral white matter symmetrically, involving the periventricular white matter, internal capsules, corpus callosum, and cortical spinal tracts with extension into the brainstem. No mass effect is demonstrated.

Conclusions
Adult cerebral adrenoleukodystrophy is a relatively rare presentation and compromises between 2% and 5% of all patients with adrenoleukodystrophy. More commonly adults with this disorder present with adrenal myeloneuropathy, characterized by progressive paraparesis, sphincter dysfunction, and adrenal insufficiency. There are reports of head trauma initiating rapidly progressive adult-onset cerebral adrenal leukodystrophy in some patients. Unfortunately there is no treatment for this disorder once the cerebral degeneration has begun. The key imaging features include abnormal white matter signal intensity, primarily within the centrum ovale, pyramidal tracts in the brainstem and internal capsule. No postgadolinium enhancement is seen due to the intact blood-brain barrier.

E-42

10:55AM - 11:00AM

Venous signal on cervical TOF MRA due to “venous subclavian steal”

B Winegar1, E Quigley2, U Rassner1

1University of Utah, Salt Lake City, UT, 2University Of Utah, Salt Lake City, UT
Purpose
Review causes of high venous signal on TOF MRA with a case of "venous subclavian steal" as an example
Materials and Methods
89 year old female presented to the Emergency department with right sided vision loss. A stroke workup was performed including MRI of the brain and MRA of head and neck. Ultimately the case of vision loss was found to be total retinal detachment
Results
Brain MRI showed senescent changes without signs of ischemic stroke. MRA showed no flow limiting stenosis. Axial 2D time of flight (TOF) of the neck and 3D TOF of the brain showed flow related enhancement in the left transverse and sigmoid sinus as well as in the left jugular vein. Brain MRI showed senescent changes without signs of ischemic stroke. MRA showed no flow limiting stenosis. Axial 2D time of flight (TOF) of the neck and 3D TOF of the brain showed flow related enhancement in the left transverse and sigmoid sinus as well as in the left jugular vein. Venous signal on TOF MRA can be seen with arteriovenous shunting lesions (e.g. AV fistulas), thrombus with T1 shortening, or following the administration of gadolinium contrast agents. Flow reversal, in which venous blood signal is not suppressed by the saturation band cranial to the image slice, is an additional source of increased venous signal. Venous phase post contrast MRA images showed occlusion of the left brachiocephalic vein resulting in reversed flow in the left internal jugular vein.
Conclusions
While venous signal on TOF MRA is commonly seen with AV fistulas or T1 bright thrombus, reversed flow has to be considered. Understanding the physics behind TOF MRA can be important in correct interpretation of venous signal on TOF MRA. This case had reversal of flow in the internal jugular vein due to occlusion of the left brachiocephalic vein, leading to a flow phenomenon akin to arterial steal.

M Sondag\textsuperscript{1}, C Kim\textsuperscript{1}, S Futterer\textsuperscript{1}, B Liu\textsuperscript{1}
\textsuperscript{1}Northwestern University Feinberg School of Medicine, Chicago, IL

Purpose
To present a case of progressive multifocal leukoencephalopathy (PML) with MR spectroscopy (MRS) and perfusion (MRP) imaging mimicking neoplasm, specifically gliomatosis cerebri.

Materials and Methods
47-year-old-man with two months of progressive vision loss and cognitive difficulties. Physical exam revealed absence of light perception, left hemineglect and prosopagnosia. Notable lab values include HIV antibody positivity, HIV viral load 190,000 (normal <20), and absolute CD3/CD4 count 37 (normal >340). MR imaging was performed demonstrating findings mimicking gliomatosis cerebri. Subsequent brain biopsy yielded pathology consistent with PML.

Results
MRI: Nonenhancing confluent FLAIR hyperintensity centered in the right temporal white matter and extending across the splenium of the corpus callosum to involve the left cerebral white matter. PERFUSION: Elevated relative cerebral blood volume (rCBV) ratio approximating 2.5 in regions of bilateral parietooccipital FLAIR hyperintensity. SPECTROSCOPY: Elevated Cho/NAA ratio approximating 1.8 in regions of right parietooccipital FLAIR hyperintensity.

Conclusions
Advanced imaging modalities such as MRS and MRP may assist in differentiating neoplasms from non-neoplastic brain lesions. We present a case of PML mimicking gliomatosis cerebri with false-positive findings on MRS and MRP. Prior studies investigating MRP have demonstrated specificity and positive predictive values (PPV) ranging from 0.58-0.92 and 0.87-0.93, respectively, to diagnose neoplasm using an elevated rCBV threshold of 1.5-1.75 \cite{1,2}. Combined MRP and MRS criteria have yielded specificity and PPV as high as 0.92 and 0.93, respectively, for neoplasm using thresholds of rCBV 1.5 and Cho/NAA 1.64 \cite{1}. A variety of non-neoplastic lesions may demonstrate increased Cho/NAA \cite{3,4}, however PML is not a well-known false-positive entity. This case reviews the variable MRS findings \cite{5} and MRP findings in PML. Discriminating between PML and gliomatosis is important for diagnosis, treatment guidance, and in some cases, prevention of brain biopsy. Recognizing that
PML may show false-positive MRS and MRP findings resembling neoplasm is essential for radiologists.

(Filename: TCT_E-43_Perrypicture2.jpg)

E-44 11:05AM - 11:10AM

Pure Alexia and Palinopsia From Glioblastoma Involving Left Inferior Occipital Gyrus Evaluated with fMRI and DTI Tractography

S Fung
1Houston Methodist Hospital, Houston, TX

Purpose
Lesions involving visual word form area (VWFA) and inferior longitudinal fasciculus (ILF) can cause pure alexia. Palinopsia is a visual disturbance typically caused by occipitoparietotemporal cortical lesions involving the postgeniculate visual pathway. An unusual case of glioblastoma presenting as pure alexia and palinopsia is described, evaluated with language fMRI and DTI tractography.

Materials and Methods
A 67-year-old woman developed acute onset of difficulty recognizing whole words,
which she described as strings of scrambled characters, although she maintained the ability to spell and write and eventually learned to recognize words using letter-by-letter reading, symptoms consistent with pure alexia. She also complained of seeing persistent afterimages of objects lasting several seconds in her visual field after looking away, symptoms consistent with palinopsia.

Results
MRI showed 1.9 cm minimally-enhancing nodular mass involving and mildly expanding the cortex and subcortical white matter in the left inferior occipital gyrus. fMRI evaluating language was performed using silent word generation and reading comprehension tasks, which were visually presented as block design consisting of 17 periods of 30 s each with 9 control and 8 active conditions arranged in alternating sequence. Functional activation was relatively consistent across both runs of word creation and reading comprehension tasks. Left-lateralized frontal, temporal, and parietal language activation supported left hemispheric language dominance. Activation corresponding to VWFA was centered in the left fusiform gyrus/inferior occipital gyrus along the anterior margin of the tumor. DTI with 25 diffusion gradient directions was obtained using spin-echo EPI with b-value 1000 s/mm². DTI tractography was then performed using second-order Runge-Kutta propagation algorithm, 35° angle threshold. The vertical segment of the left arcuate fasciculus was just anterior to the margin of the mass. The left ILF and left optic radiation traversed in close proximity to the medial margin of the mass.

Conclusions
VWFA generally localizes to the region of fusiform gyrus and lateral occipitotemporal sulcus, typically in the dominant hemisphere for language involved in identifying words and letters from lower-level shapes. ILF courses along the lateral aspect of the inferior and posterior cornua of the lateral ventricle connecting occipital and temporal lobes and is part of the ventral visual association pathway crucial for object identification. In the dominant hemisphere, ILF is thought to carry afferent and efferent fibers to the VWFA. Lesions involving the VWFA and ILF can cause pure alexia, also known as alexia without agraphia. Patients have difficulty reading but can spell and write, although some can recognize words using letter-by-letter reading. Palinopsia is a visual disturbance with persistent or recurrent images after the stimulus is removed. Lesions are typically in the non-dominant occipitoparietotemporal region involving the postgeniculate visual pathway, although lesions can involve the dominant hemisphere, as in this case.
Toxic Meningoencephalopathy after Intrathecal Gadolinium Administration

J Chetta¹, S Kumar², P Diaz-Marchan¹

¹Baylor College of Medicine, Houston, TX, ²BCM, Houston, TX
Purpose
Intrathecal gadolinium is safe and useful in clinical imaging when administered in low doses. Only three case reports exist citing neurotoxicity when intrathecal gadolinium is used in high doses. We report a rare case of toxic meningoencephalopathy following a MR myelogram.

Materials and Methods
A 64-year-old male presented to our emergency department (ED) with altered mental status following an MR myelogram. He had a history of spinal surgeries and postsurgical seroma which required routine imaging. Ten hours prior to arrival the patient underwent intrathecal administration of gadolinium at an outside facility for a MR myelogram. He was in his usual state of health. After the intervention, the patient reported progressively worsening headache, malaise, and exhibited neurologic decline. Upon entry to our ED, he was febrile and tachycardic. His exhibited somnolence, global aphasia, nuchal rigidity, and dense quadriplegia. Cell counts and blood chemistries were unremarkable. Blood cultures were negative. A head CT was performed. Cerebrospinal fluid (CSF) analysis showed a mild lymphocytic pleiocytosis. CSF cultures were negative although the lumbar puncture was performed after antibiotics were given. The patient returned to his baseline over 24-48 hours and discharged within the week.

Results
A head CT performed on admission showed diffuse opacification of the subarachnoid spaces and cisterns. A head CT performed 12 hours later showed new complete effacement of the cerebral cortical sulci and basal cisterns, consistent with diffuse cerebral edema. A brain MRI performed on hospital day four showed no abnormalities.

Conclusions
Intrathecal gadolinium is a safe and useful tool for diagnostic imaging purposes. The patient presented to the ED following intrathecal contrast administration. The differential diagnosis included infectious or chemical meningitis however his rapid recovery is inconsistent with an infectious meningoencephalitis. Toxic meningoencephalopathy is a rare complication of intrathecal gadolinium administration.
Purpose
We describe the imaging findings and clinical characteristics of an intracranial foreign body reaction resulting from the use of bovine pericardial duraplasty material in a patient who underwent surgery for meningioma recurrence.

Materials and Methods
We present a case of a 56-year-old woman with imaging findings suggestive of recurrence of a left frontal meningioma leading to repeat surgical resection. During the surgery, a portion of the native dura mater was resected, and the resulting defect was closed at the end of the surgery using bovine pericardial duraplasty material. Delayed post-operative follow-up imaging revealed extensive left frontal lobe edema, an increase in the size of an epidural fluid collection, and local abnormal meningeal enhancement. Given the absence of clinical signs of infection, the patient was treated
solely with a course of oral steroids. After treatment, there was significant improvement in the imaging appearance compatible with a foreign body inflammatory reaction to the dural graft material.

Results
Noncontrast head CT (7 weeks after surgery): When compared to immediate postoperative imaging, there was an increase in size of an epidural fluid collection beneath the craniotomy and development of new extensive vasogenic edema in the left frontal lobe. Contrast-enhanced brain MRI (7 weeks after surgery): MR imaging confirmed the increase in size of the aforementioned epidural fluid collection and also demonstrated new restricted diffusion within it. Also noted was new hyperintense T2/FLAIR signal in the left frontal lobe and accompanying new abnormal overlying pachymeningeal and leptomeningeal enhancement. Contrast-enhanced brain MRI (9 weeks after surgery and following oral steroid therapy): Compared to the MRI from 2 weeks prior, there was a decrease in size of the epidural fluid collection beneath the craniotomy. Furthermore, hyperintense T2/FLAIR signal in the underlying brain and local abnormal pachymeningeal/leptomeningeal enhancement also substantially decreased.

Conclusions
Extensive efforts have been made to find a graft material to optimize outcomes in patients requiring a duraplasty. Initial efforts began with rubber and gold foil, and later autologous, heterologous, and synthetic graft materials were employed. Bovine pericardium has generally been considered nonreactive in its use as a cardiac graft and has led to its emergence as a dural graft material. Bovine pericardium has been shown to be a suitable option with favorable outcomes and good surgical ease of use, generally lacking the local tissue effects seen with older graft materials. Nevertheless, rare associated foreign body reactions have been reported in the neurosurgical literature. Our case is unique in that it documents the clinical and imaging findings seen in both the development of such a foreign body inflammatory reaction and their improvement following oral steroid therapy alone.
Amnesia, seizures, and the limbic system - anti-LGI1 Limbic Encephalitis: An evolving clinical syndrome.

N Cross¹, G Aguirre¹, E Botzolakis¹, J Stein¹, S Mohan¹
¹University of Pennsylvania, Philadelphia, PA

Purpose
Anti-LGI1 (Anti-leucine-rich glioma inactivated-1) limbic encephalitis is an uncommon clinical disorder often characterized by memory loss, seizures, and confusion. Whether of primary autoimmune, or more rarely paraneoplastic cause, early diagnosis allows prompt initiation of immune modulatory therapy and a search for possible underlying malignancy.

Materials and Methods
A 61 year old gentleman presented after an evening of more than a dozen episodes of lightheadedness during which he uttered inappropriate, bizarre comments. Each
episode resolved quickly and was followed by a short 30-60 second period of confusion. There was no associated headache, weakness, loss of consciousness, diplopia, or shaking. The episodes continued, approximately hourly and were accompanied by body chills, feeling cold, whole body numbness and tingling, and progressive anterograde amnesia. For short periods, all of the patient's hairs would become erect during "chills" which were unrelated to room temperature. The combination of clinical symptoms including amnesia, pilomotor seizures, and imaging findings was considered diagnostic for limbic encephalitis and confirmatory labs were obtained including positive results for anti-LGI1 (Anti-leucine-rich glioma inactivated-1). Whole body imaging was negative for malignancy. Inpatient IVIG and steroid treatment, followed by rituximab, has resulted in gradual improvement in memory and function.

Results
MRI of the brain demonstrated mildly expansile and slightly asymmetric T2/FLAIR hyperintensity throughout the bilateral hippocampi and mesial temporal structures. There was no definite enhancement visualized, and mild diffusion restriction was present in the mesial left temporal lobe. The remainder of the brain and cerebellum was unremarkable.

Conclusions
Bilateral mesial temporal signal abnormality with the appropriate clinical presentation including anterograde or retrograde amnesia, and possible seizures should suggest limbic encephalitis. Many of these cases are autoimmune, previously attributed to antibodies to voltage gated potassium channels; the true antibody target is LGI1. The paraneoplastic subset of limbic encephalitis is important because this diagnosis can prompt the search for an otherwise occult malignancy.
E-48

CNS Graft Versus Host Disease: Clinical and Radiologic Considerations in Diagnosis and Treatment

S Montoya¹, J Brucker², A Hussain³, M Khadir¹
¹University of Rochester Medical Center, Rochester, NY, ²University of Rochester, Rochester, NY, ³University of Rochester Medical Center, Rochester, NY

Purpose

We present an interesting neuroradiologic case to help illustrate the imaging findings of CNS graft versus host disease (GVHD), as correlated to features of its pathophysiologic and clinical progression, and presented in contrast to other leukoencephalopathies that are commonly encountered in this patient population.

Materials and Methods

The patient is a 30-year-old female who presented with night sweats and increasing fatigue in January 2013. At the time of presentation, the white cell count was markedly elevated at 203.4 with a correspondingly low hemoglobin of 7.5. A bone marrow biopsy was performed and confirmed the diagnosis of acute myelomonocytic leukemia. Subsequently, the patient underwent leukapheresis and induction chemotherapy, followed by multiple cycles of high dose cytarabine. A follow-up bone marrow biopsy performed in February 2014 revealed minimal residual disease. The patient continued treatment with a peripheral blood stem cell transplant and total body irradiation. In June 2015, the patient was readmitted with mild encephalopathy, associated with focal neurologic findings of left homonymous hemianopia, left sided sensory deficit, and left pronator drift. An EEG was consistent with seizure activity and CSF analysis was negative for malignancy. However, an MRI demonstrated high T2 FLAIR-weighted signal involving the white matter lateral to the right caudate head, along the external capsule. Serial follow-up MRI examinations continued to show significant progression of T2 FLAIR signal abnormalities throughout the majority of the deep cerebral white matter and central brainstem, as well as the deep gray nuclei, despite plateaued Tacrolimus levels and initiation of steroid therapy. A brain biopsy was performed at the end of October, which revealed inflammation, but no evidence of malignancy or demyelination. Currently, the leading differential is CNS graft versus host disease.

Results

MRI Brain, June 2015: (A) Nonspecific high T2 FLAIR-weighted signal involving the white matter lateral to the right caudate head along the external capsule. There was no associated restricted diffusion or enhancement. MRI Brain, August 2015: Interval
progression of the high T2 FLAIR-weighted signal abnormalities, now involving the deep cerebral white matter and central brainstem. Of note, the corpus callosum, basal ganglia, and thalami show increased T2 FLAIR-weighted signal. MRI Brain, October 2015: Significant progression of the hyperintense T2 FLAIR-weighted signal abnormalities both cerebral hemispheres, deep gray nuclei, and the brainstem. Conclusions CNS graft versus host disease is a challenging clinical and radiologic diagnosis that can mimic many other white matter processes in the oncologic patient population. Accurate and timely diagnosis has significant effect on management and clinical outcomes. We review the pertinent features of CNS GVHD to help facilitate recognition of this important clinical entity.
(A) Nonspecific high T2 FLAIR-weighted signal involving the white matter laterally and caudate head along the external capsule (→). There was no associated restricted diffusion enhancement. (B) Interval progression of the high T2 FLAIR-weighted signal progression now involving the deep cerebral white matter and central brainstem. Of note, the splenium of the corpus callosum, basal ganglia, and thalami (→) show increased T2 FLAIR-weighted signal abnormality. Significant progression of the hyperintense T2 FLAIR-weighted signal abnormalities involving both cerebral hemispheres, deep gray nuclei (→), and the brainstem.
Post-Radiosurgery Cyst Formation in Brain, a Rare and Delayed Complication

G Parikh\textsuperscript{1}, M Hoch\textsuperscript{2}, D Kondziolka\textsuperscript{3}, R Jain\textsuperscript{4}
\textsuperscript{1}New York University, Secaucus, NJ, \textsuperscript{2}NYU Medical Center, New York, NY, \textsuperscript{3}NYU Medical Center, New York, NY, \textsuperscript{4}NYU School of Medicine, New York, NY
Purpose
Post-radiosurgery cyst formation is a rare and delayed complication. This case report displays two patients with cyst formation status post radiosurgery following arteriovenous malformation (AVM) treatment (which has been previously described) as well as a patient following atypical meningioma treatment (which has not been previously described in the literature).

Materials and Methods
Patient A is a 26 year old female status post LINAC radiosurgery (standard dose is of approximately 16Gy) of left parietal AVM in 2008. In 2015, approximately 6.5 years following radiosurgery, patient developed worsening seizures with negative cerebral angiogram with MR revealing cystic findings in radiosurgery bed. Patient B is 72 year old female status post gamma knife radiosurgery (standard dose is of approximately 16 Gy) of right parietal anaplastic meningioma in 2002. In 2015, approximately 8 years following radiosurgery, patient had follow-up MR revealed findings in radiosurgery bed.

Results
Patient A: There is 3.6 cm well defined lesion within the left parietal radiosurgical bed causing mass effect with surrounding edema. It is hyperintense on T2, and hypointense T1 without enhancement compatible with a multiloculated cyst. There is a thin peripheral rim of enhancement within the radiosurgical cavity. There is a punctate focus of enhancement along the superior margin of the cavity compatible with gliosis. Due to worsening seizures, this cystic lesion was drained and with tissue sampling revealing a cyst. Patient B: There is a 3.0 well-defined lesion within the right parietal surgical bed causing mass effect with surrounding edema. It is hyperintense on T2, and hypointense T1 without enhancement compatible with a multiloculated cyst. There are stable peripheral and nodular areas of enhancement surrounding the cavity compatible with gliosis.

Conclusions
The imaging findings reveal the well known simple cyst characteristics: well-defined, thin walled, fluid MR characteristics (T2 hyperintense and T1 hypointense), and no enhancement. A cyst can produce mass effect and have associated edema. This picture of a new or enlarging cystic lesion causing mass effect and edema with in the setting of postoperative changes (peripheral and nodular enhancement of cavity margins, encephalomalacia and gliosis) confuses the picture and may raise the suspicion for tumor recurrence. Post-radiosurgery cyst formation may occur several years after treatment and that if a new cystic lesion occurs in the radiosurgical bed that this implied 'fluid is good' or a benign entity rather than an aggressive entity such as tumor recurrence.
The Utility of Intraoperative Contrast-Enhanced Ultrasound in the Evaluation of Intracranial Meningiomas.

N Brauner¹, M Gulati¹, M Shiroishi¹, E Grant¹, K Chang¹, J Bakhsheshian¹, E Christian¹, G Zada¹, I Lekht¹
¹Keck School of Medicine of the University of Southern California, Los Angeles, CA

Purpose
Meningiomas are common intracranial neoplasms that encompass a variety of histopathologic subtypes (1). Preoperative MRI offers excellent anatomical characterization of these tumors however limitations remain. Here we highlight two separate cases of meningioma where utilization of intraoperative contrast-enhanced ultrasound (iCEUS) provided additional information, which aided in resection.

Materials and Methods
Two patients presented with headaches and were found to have intracranial masses on diagnostic imaging. The first patient, SK, reported three years of headaches and subjective facial weakness. The second patient, RG, reported 6 months of worsening headaches, blurry vision and a recent syncopal episode. Given tumor location and symptomatology, surgical resection was planned. Intraoperatively SK was found to have a well-circumscribed lesion which was easily resected, whereas RG was found to have an infiltrative tumor which was adherent to the overlying dura and underlying brain parenchyma, necessitating subtotal resection. Final histopathologic diagnosis for both lesions was WHO grade I meningioma.

Results
Preoperative MRI in RG showed a right frontotemporal, dural-based, extra axial lesion with avid enhancement and minimal adjacent vasogenic edema. Preoperative MRI of patient SK showed a similar lesion along the left frontal convexity. No significant enhancement was noted in the bulk of either tumor on iCEUS examination, likely resulting from devascularization of the meningial blood supply during craniotomy. However, whereas patient SK showed no abnormal peritumoral contrast enhancement, patient RG had a thick rim of abnormally enhancing tissue adjacent to the devascularized tumor, suggestive of infiltrative growth.

Conclusions
iCEUS can serve as a useful adjunct in the pre-resection imaging of meningiomas. It may be especially useful in detecting and guiding resection of infiltrative components, which can be occult on MRI.
MRI and iCEUS appearance of two meningioma cases: A. T2-weighted axial MR showing left frontal, T2 hyperintense extra-axial mass (arrow) with minimal surrounding edema. B. Corresponding grayscale US (left) and iCEUS (right) tumor bulk (circle) with clear differentiation between the tumor edge and normal brain parenchyma (square). Abnormal tumor is thought to result from devascularization during craniotomy. C. T2-weighted axial MR of a different patient showing fronto-temporal, T2 hyperintense, dural based, extra-axial mass (arrow) with minimal adjacent edema. D. Correspoding grayscale US (left) and iCEUS (right) shows devascularized tumor bulk (circle), with a thick rim of enhancement adjacent to the infiltrative normal brain parenchyma (square).
Brain Metastases with Pure Cystic Imaging Appearance Mimicking Neurocysticercosis

p_watal1, A Capizzano2, t moritani2, L Bruch2, L Rachakonda3
1university of iowa hospital and clinics, iowa city, IA, 2university of iowa hospitals and clinics, iowa city, IA, 3University of Iowa, Iowa City, IA

Purpose
To illustrate a pathology proven case of non-enhancing, non-edematous purely cystic brain metastases from lung adenocarcinoma with dramatically favorable response, after whole brain radiation and erlotinib, on imaging follow-up.

Materials and Methods
A 52 year male presented with headache and occasional dizziness. He had been diagnosed in the past with advanced lung adenocarcinoma which was managed with chemotherapy and radiation. No brain radiation had been administered. There was history of exposure to pigs. The patient was mildly immunosuppressed. A prior MRI brain from two years before was completely unremarkable. A biopsy of the left temporal lesion on H and E stained section shows a single layer of malignant columnar cells lining brain tissue. The immunophenotype (CK7+, TTF-1+) of these cells was consistent with metastasis from a lung primary.

Results
Multiple intra-axial peripheral cystic lesions involving both the supra and infratentorial compartments were demonstrated on brain MRI, isointense to CSF on FLAIR sequences and without any sign of contrast enhancement or vasogenic edema. The differentials offered were cryptococcosis and neurocysticercosis with metastases considered highly unlikely in view of non-enhancing appearance. Follow up sequential imaging post whole brain radiation and erlotinib treatment showed reduced number and size of the lesions. On the most recent MR imaging, 7 months after whole brain radiation, there was complete resolution of cystic lesions with no evidence of new lesions.

Conclusions
The complete lack of contrast enhancement and vasogenic edema constitute an exceptional imaging appearance of metastatic disease to the brain, which may therefore be confounded with more common cystic lesions such as parasitic diseases. A truly cystic lesion appears isointense to CSF on all imaging sequences and may display rim enhancement. Brain metastases typically show contrast enhancement and vasogenic edema from increased permeability of the blood brain barrier on imaging.
In rare instances, Brain metastases can have pure cystic imaging appearance as in the setting of adenocarcinoma, thus mimicking infective cystic lesions like neurocysticercosis.

(E-52)

Primary Leptomeningeal Gliomatosis - Radiologic and Genetic Correlation of a Rare Disease
C Li\(^1\), S Imbesi\(^2\), M McCrate\(^2\), J Chen\(^3\)
\(^1\)UC San Diego Health System, San Diego, CA, \(^2\)University of California, San Diego, San Diego, CA, \(^3\)San Diego VA / UCSD Med. Center, La Jolla, CA

**Purpose**
To provide genomic correlation with imaging of a rare case of primary leptomeningeal gliomatosis (PLG) and review proposed disease pathology in the context of the new genetic information.

**Materials and Methods**
Otherwise healthy 36-year-old male presented with nausea, vomiting, headache, bilateral vision loss, hiccups, global weakness and weight loss, progressing to confusion and visual hallucination. During the work-up a brain MRI demonstrated communicating hydrocephalus and transependymal flow of CSF and extensive leptomeningeal enhancement without a focal intraparenchymal brain lesion. Cerebrospinal fluid analysis revealed elevated protein and decreased glucose without atypical cells on cytopathology or growth on cultures. Sural nerve and gastrocnemius biopsies did not reveal evidence of sarcoidosis or other granulomatous disease. A biopsy of material within the fourth ventricle revealed spindle cell proliferation in the choroid plexus, S-100 and GFAP positivity, consistent with leptomeningeal gliomatosis. Single nucleotide polymorphism (SNP) analysis revealed loss of heterozygosity at 1P, 3P and proximal 3Q, 10P and distal 10Q, distal 11q, 13 (including RB1), and 18p, with copy number gains at 1Q, and H3F3A mutation.

**Results**
MR images revealed communicating hydrocephalus with surrounding white matter T2 prolongation compatible with transependymal flow of CSF (Figure, A) and diffuse leptomeningeal enhancement (Figure, B) without a focal primary intraparenchymal mass.

**Conclusions**
Primary leptomeningeal gliomatosis is a rare and rapidly fatal disease, which may mimic infection, inflammation and other neoplastic processes. It is thought to arise from neoplastic transformation of heterotopic glial nests in the leptomeninges (1), though some have postulated drop metastases from an undetected intraparenchymal primary (2). In our case, SNP analysis revealed a genetic profile different than usually associated with the Verhaak classification subtypes (3), and raises the possibility that PLG is pathophysiologically distinct and not simply CSF-seeding of a missed intraparenchymal glioma.
Mycotic Aneurysm from Cardiac Myxoma Emboli: Characterization with High Resolution Vessel Wall MR Imaging

M Fitzgibbons¹, B Yoo¹, B Salehi¹
¹UCLA, Los Angeles, CA

Purpose
1. To present a rare case of mycotic aneurysms from cardiac myxoma emboli
2. To illustrate the utility of high-resolution vessel wall MR imaging for mycotic aneurysm characterization
Materials and Methods
A 71-year-old woman presented to an outside hospital in 2010 with TIA symptoms. An MRI was performed at that time, which revealed scattered foci of restricted diffusion in a pattern compatible with embolic infarctions. Her stroke work-up revealed a left atrial myxoma, which was surgically resected in 2010. She subsequently developed numerous, distal fusiform aneurysms, which progressively enlarged over multiple years. The largest aneurysm was located in a left M2 branch and measured up to 10 mm in maximal dimension in 2015. A neurosurgical consultation was obtained for consideration of surgical bypass of this aneurysm. To determine the feasibility and safety of performing a vascular bypass procedure, high-resolution vessel wall MR imaging was performed to assess for adjacent vessel wall infiltration and integrity.

Results
A large, fusiform mycotic aneurysm is seen arising from a left M2 branch within the Sylvian fissure. High resolution, fat-saturated T1-weighted post-contrast images with black blood technique demonstrate marked thickening and enhancement of the aneurysm wall. Additionally, there is thin, linear enhancement extending proximally and distally to the aneurysm, suggesting vessel wall infiltration in adjacent, non-dilated segments.

Conclusions
Mycotic aneurysm from myxoma emboli is a rare, known complication of cardiac myxomas, with approximately 40 cases reported in the literature. The mechanism by which these aneurysms develop is unclear; a proposed mechanism is the direct invasion of tumor cells into the arterial wall, resulting in destruction of arterial wall architecture and aneurysm formation, as histopathologic studies have demonstrated myxoma cells within the aneurysm wall. In this case, high-resolution vessel wall imaging was performed to evaluate for potential infiltration in arterial segments adjacent to the aneurysm to assess for feasibility and safety of performing a vascular bypass procedure. Given the extension of enhancement into adjacent, non-dilated arterial segments, a surgical bypass was not pursued, and the patient will undergo radiation therapy instead. This unique case demonstrates a novel application of high-resolution vessel wall MR imaging in mycotic aneurysm characterization.
A case of secondary degeneration in the striatum subsequent to MCA territory infarction

A Tsukabe¹, Y Watanabe², M Sakai¹, K Nakanishi¹, M Sakaguchi², N Tomiyama²
¹Osaka Medical Center for Cancer and Cardiovascular Diseases, Osaka,
²Osaka University Graduate School of Medicine, Suita, Osaka

Purpose
The secondary degeneration in the substantia nigra and the thalamus subsequent to middle cerebral artery (MCA) territory infarction has been well discussed. However the degeneration in the striatum has been little discussed. Only a few reports discussed
the degeneration in the striatum subsequent to external capsule hemorrhage and superior tentorial operation. We present a case of transneuronal degeneration in the striatum subsequent to MCA territory infarction.

Materials and Methods
A 16 year old boy with left MCA territory infarction due to unilateral moyamoya disease was transferred to our hospital. On the MRI 8 days from ictus, the abnormal signal in the ipsilateral striatum emerged without the worsening symptoms. This finding was temporal and resolved without atrophy on the follow-up MRI. There was neither epilepsy nor worsening of symptoms. Therefore the signal change of the striatum was considered as degeneration subsequent to the infarction.

Results
At the day of ictus, MR Angiography showed signal decrease in left internal carotid artery and MCA. DWI showed high intensity in the cortex and the deep white matter in MCA territory (figure A, B). MR Angiography one week later showed the recovery of MCA signal by development of collateral flow. The signal intensity of high intensity lesion seen on MRI at the day of ictus decreased. DWI and FLAIR images showed high signal intensity involving the whole ipsilateral striatum (figure C). On follow-up MRI after three months, the abnormal signal of the striatum had resolved (figure D). There was no apparent atrophy.

Conclusions
Secondary degeneration could involve the striatum. We should be aware of the secondary degeneration in this area and avoid mistaking it for a new lesion, such as an infarction.
Thursday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Marriott Ballroom

22A-Multiple Sclerosis (AR) (SAM)

22A-1

MS Diagnosis and Therapy: State of the Science
Calabresi, P.
Johns Hopkins Hospital
Baltimore, MD

22A-2

Advanced Neuroimaging in MS
Reich, D.
NIH
Bethesda, MD

22A-3

Differential Diagnosis in MS Imaging
Field, A.
Univ. Of Wisconsin Hospital
Madison, WI

22A-4

Questions and Answers

2:30PM - 2:45PM
Thursday
1:15PM - 2:45PM
Washington Marriott Wardman Park, Washington 4/5/6

22B-SNIS Programming: Seeing Aneurysms a Whole New Way: Biophysics and Computational Fluid Dynamics of Aneurysms

22B-1
1:15PM - 1:35PM
Designing Aneurysms: A Primer on Advanced Computational Fluid Dynamics

Malek, A.
Tufts Medical Center
Boston, MA

22B-2
1:35PM - 1:55PM
Merging Biomathematics and CFD: From Equation to Patient Care

Prestigiacomo, C.
Neurological Institute Of New Jersey
Newark, NJ

22B-3
1:55PM - 2:15PM
Patient-Specific CFD: Personalized Medicine in Aneurysm Therapy?

Gounis, M.
University of Massachusetts
Worcester, MA

22B-4
2:15PM - 2:35PM
CFD and Device Assessment: Can We Predict the Optimal Treatment

Cebral, J.
George Mason University
Fairfax, VA
Quantitative Imaging Analysis of Glioblastoma on Magnetic Resonance Imaging for the Demonstration of Extant Intratumoral Heterogeneity, Tumor Margins, Hypoxic Malignant Cell Populations and Identification of Subtype Habitats

J Kim¹, O Stringfield², N Raghunand², R Gatenby²
¹H. Lee Moffitt Cancer and Research Center, Royal Australian New Zealand College of Radiologists, Tampa, FL, ²H. Lee Moffitt Cancer and Research Center, Tampa, FL

Purpose
Glioblastoma (GBM) has characteristic macroscopic complexity as function of blood flow, and intratumoral molecular variations currently represented by four subtypes of genetic expression (Proneural, Classical, Neural, Mesenchymal), each with prognostic significance. This spatial heterogeneity in hypoxia and molecular properties is a potentially causal factor that limits the effectiveness of therapies for GBM. We present imaging analytic techniques to quantitatively illustrate the intratumoral heterogeneity of perfusion, edema, structural organization, enhancing tumor margins, regions of hypoxia, and zonal distribution of GBM subtypes.

Materials and Methods
From 27 GBM patients, 80 MRI-guided biopsies were obtained. Prebiopsy diagnostic magnetic resonance (MR) sequences (T1Gd, FLAIR, ADC) were coregistered, the brain segmented, and signals standardized by two-point-normalization. Biopsy coordinates were mapped onto these images for intensity analysis of the surrounding 10x10mm square. GBM subtypes were determined using RNA sequencing on 15 primary and 11 recurrent tumor biopsies.
Results
There was intraregional heterogeneity of signals within the contrast-enhancing (CE) regions (SD of T1Gd, FLAIR, ADC; 1101, 192, 1750) and the nonenhancing (NE) regions (SD 1200, 207, 1041). Mean FLAIR signal was higher in CE than NE (1312 versus 1289), with positive correlation between the degree of enhancement and FLAIR-signal within CE. A subregion of low-T1Gd, low-FLAIR is identified at the border of poorly enhancing tumor center and enhancing rim. Classical and mesenchymal subtypes were only seen in CE, while neural and proneural subtypes were seen in both CE and NE.

Conclusions
Intraregional heterogeneity of MRI signals exists within CE and NE of GBM. The transition from CE to NE is indistinct; automated delineation of enhancing margins may solve this surgical planning problem. Using quantitative analysis, a hypoxic, nonedematous core of cellular proliferation is identified as a focus of potential treatment resistance. A zonal distribution of GBM subtypes exists; classical and mesenchymal subtypes are only found in CE, while proneural and neural subtypes are found in both CE and NE.
Quantification of Heterogeneity in Peritumoral Edema in Long-Term Glioblastoma Survivors: Correlation With ADC and FLAIR Histogram Metrics.

P Chang¹, Y Esterson², A Demopoulus³, B Pramanik⁴, J Lee⁵, M Schulder³, D Chow⁶, J Boockvar⁷, C Filippi⁸
¹Columbia University Medical Center, NEW YORK, NY, ²North Shore LIJ Health System, Manhasset, NY, ³Hofstra North Shore-LIJ School of Medicine, Manhasset, NY, ⁴Lenox Hill Hospital, New York, NY, ⁵North Shore-Long Island Jewish Health System, Lenox Hill Hospital, New York, NY, ⁶University of California, San Francisco, San Francisco, CA, ⁷North Shore-LIJ Health System, New York, NY, ⁸Hofstra North Shore-LIJ School of Medicine, Manhasset, NY

Purpose
Long-term survival of glioblastoma (GBM) patients is rare. We hypothesize that such patients exhibit less infiltration of nonenhancing tumor (nCET) into the peritumoral region, a known marker of poor prognosis (1-2), thus increasing the yield of gross total resection (3-4). Furthermore we hypothesize that this decreased nCET infiltration will result in higher, more homogenous FLAIR signal and apparent diffusion coefficient (ADC) value typically associated with pure edema, findings that can be quantitatively captured using histogram metrics.

Materials and Methods
After IRB approval, an institutional database was searched for GBM patients with MR imaging between 2006 and 2013. Long-term survivors (12 men, 7 women, average age 62.4 +/- 7.9 years) were defined as those with minimum survival of 2 years after resection (average survival 4.1 years, range 2.2-9.0 years). This cohort was compared to an age- and sex-matched group of GBM patients (12 men, 17 women, average age 67.1 +/- 8.2 years) with typical, poor survival (average survival 6.2 months, range from 0.5-13.8 months). Both cohorts were limited to those who had gross total resection followed by identical postresection therapy of temozolomide and radiation. Pre-operative MR images were analyzed to find predictors of long-term survival. A fully automated algorithm identified volumetric masks corresponding to enhancing tumor (CET), nonenhancing tumor (nCET), necrosis, and peritumoral edema. Histogram analysis of FLAIR and ADC was performed within the peritumoral region (nCET + edema), including mean, standard deviation (SD), skewness and kurtosis. Statistical significance was assessed with a two-tailed t-test. All segmentation masks were inspected for accuracy by a board-certified neuroradiologist blinded to results.
Results
Long-term survivors demonstrated significantly decreased nCET (31.7% versus 49.9%, p = 0.006) and increased mean normalized FLAIR intensity (2.86 versus 2.06, p = 0.0036) compared to controls. In addition significant differences in peritumoral heterogeneity were seen both for FLAIR (SD, p = 0.0029; skewness, p = 0.0084; kurtosis, p = 0.019) and ADC (SD, p = 0.0053; kurtosis = 0.014) histogram metrics.

Conclusions
Long-term GBM survivors demonstrate overall increased FLAIR signal and ADC value within the peritumoral region, with associated changes in histogram metrics reflecting a more homogenous distribution of signal intensity. These findings suggest that FLAIR and ADC histogram metrics can be used as quantitative biomarkers to estimate infiltrative nCET tumor burden and inform treatment decisions, management, or prognostication.

Figure: MRI and FLAIR histogram plots for long-term survivors (top) and poor outcome (below). On the left, masks corresponding to peritumoral region (green) and nCET (red) are shown. On the right, masks corresponding to contrast-enhancing margin (green) and necrosis (red). In general, long-term survivors tend to exhibit decreased nCET volume. Based on FLAIR signal intensity histograms, long-term survivors demonstrate overall higher intensity (“pure”) edema signal with narrow standard deviation compared to the heterogenous broad signal distribution in the poor outcome group.
Role of MRI Texture Analysis in Differentiating Post-treatment Changes from Tumor Recurrence in Patients with High Grade Gliomas.

F Essbaiheen¹, R Thornhill¹, M Kontolemos¹, J Woulfe¹, A Boivin¹, G Cron¹, B Manouchehri¹, T Nguyen¹
¹The Ottawa Hospital University of Ottawa, Ottawa, Ontario

Purpose
In patients with high grade gliomas who developed a newly enhancing lesion following chemoradiation, we evaluated the performance of quantitative texture features to differentiate between tumor progression and post-treatment changes (nonprogression).

Materials and Methods
This prospective study included 38 consecutive patients with a high grade glioma (grade 3-4) treated with chemoradiation presenting with a new enhancing lesion on gadolinium-enhanced magnetic resonance imaging (MRI). Patients underwent a subsequent MR examination on a 3T MR scanner (Trio, Siemens Medical Solutions) including axial VIBE T1 postcontrast images (TR=8.48 ms, TE=3.21 ms, flip angle=12°, voxel size=1x1x1mm). These images were resampled with a 5mm thickness. Enhancing lesions were manually segmented under the supervision of a neuroradiologist and saved as volumes-of-interest (VOI) in ImageJ (National Institutes of Health, USA) for subsequent texture analysis. We extracted textural features for each 3D VOI using MaZda® version4.6 (PM Szczypiński, Institute of Electronics, Technical University of Lodz, Poland) (1). Tumour progression was classified based on histopathological analysis obtained from surgical resection revealing predominantly viable tumor or clinical deterioration associated with progressive increase in size of the lesion(s) on follow-up MRI. Patients were classified as post-treatment changes based on histopathological analysis showing predominantly radiation necrosis or stability or decrease in size on follow-up MRI without any clinical deterioration. Differences in textural features between progression and nonprogression were assessed via Mann-Whitney U tests. Stepwise logistic regression analysis identified feature sets that would discriminate between the two groups (area under the receiver operating characteristic (ROC) curve (AUC) significantly greater than 0.5, P<0.05) and these sets subsequently were used to generate support vector machine (SVM) classifiers (The Unscrambler® X (v.10.1, CAMO Software). We evaluated classification generalizability and performance using 10-fold cross-validation.

Results
There were 29 patients with tumor progression and nine patients with post-treatment...
changes (nonprogression). Length of follow up ranged from 5-23 months. Representative volumes of interest (VOIs) for (a) nonprogression and (b) tumor progression groups are displayed in Fig. 1. The AUC and classification performance for each texture model are summarized in Table 1. Patients in the tumor progression group showed greater variance and statistically significant less skewness. The SVM classifier trained using a combination of these two features with the gray-level co-occurrence (f11), run-length nonuniformity (RLNU) and gray-level nonuniformity (GLNU) resulted in a sensitivity of 93% and a postcross validation accuracy of 76% for identifying tumors with progression. Classifiers trained using variance, skewness and f11 alone resulted in a specificity of 89% and a similar accuracy.

Conclusions
In this prospective study, we have identified a number of quantitative textural features related to MRI gray-level variation that may assist in identifying patients with tumor progression.

<table>
<thead>
<tr>
<th>Model</th>
<th>AUC ± SE a</th>
<th>P</th>
<th>Criterion</th>
<th>Se (%)</th>
<th>Sp (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance + Skewness + f11 + RLNU + GLNU</td>
<td>0.81 ± 0.10</td>
<td>0.004</td>
<td>&gt;0.64</td>
<td>93</td>
<td>67</td>
</tr>
<tr>
<td>Variance + Skewness + f11</td>
<td>0.76 ± 0.10</td>
<td>0.01</td>
<td>&gt;0.80</td>
<td>62</td>
<td>89</td>
</tr>
<tr>
<td>Variance + Skewness + f11 + GLNU</td>
<td>0.79 ± 0.10</td>
<td>0.004</td>
<td>&gt;0.67</td>
<td>86</td>
<td>67</td>
</tr>
<tr>
<td>Variance + Skewness + f11 + RLNU</td>
<td>0.79 ± 0.10</td>
<td>0.004</td>
<td>&gt;0.67</td>
<td>86</td>
<td>67</td>
</tr>
</tbody>
</table>

a SE = standard error of the AUC, computed by the method of DeLong; b accuracy of the SVM classifier following leave-one-out validation.
FIGURE 1: (a) non-progression and (b) progression.

(Filename: TCT_O-474_Figure1ASNR.jpg)

O-475

Machine learning prediction of 1p19q deletion status in low grade gliomas

B Erickson¹, J Sedlar¹, Z Akkus¹, L Coufalova²

¹Mayo Clinic, Rochester, MN, ²Military University Hospital Prague, Prague, MN
Purpose
1p19q status of low grade gliomas (LGGs) is an important predictor of response to certain therapies. Some have reported on visual features that predict 1p19q status, but this is subjective. We evaluated machine learning methods to predict 1p19q status in a cohort of 85 LGGs.

Materials and Methods
We did a database search and collected 85 consecutive cases of low grade gliomas for which 1p19q status was known. We then removed cases with mixed deletion status or supernumary copies—that is, either both 1p and 19q deleted (d/d) or both maintained (n/n). The distribution was 24 oligodendrogliomas (OD): 23 d/d, 1 n/n, 54 oligoastrocytomas (OA): 31 d/d, 23 n/n, and 7 astrocytomas (AC) 1 d/d, 6 n/n. This represents a sampling bias towards oligodendrogliomas compared to all astrocytomas, as most astrocytomas did not have 1p19q testing performed. We manually segmented the tumors on the T2-weighted image obtained for stereotactic planning purposes. The T1 postcontrast image was aligned with the T2. The brain extraction tool (BET) was used to remove nonbrain tissues, and confirmed by a human. The following standard texture features were computed within the segmented tumor shape in T1 and in T2: local binary patterns (LBP), Gabor filters, Laplacian of Gauss (LoG), intensity-based features (IBF), and gray-level co-occurrence matrix (GLCM). To analyze also the sharpness of tumor boundary, we inspected inner and outer rings along the tumor boundary (excluding parts near the brain boundary) and computed the ratio of intensity variance within and between them ("boundary sharpness"). To evaluate classification of the 1p19q status by individual features, we computed the receiver operating characteristic (ROC) curve and the area under the curve (AUC) on the dataset of 85 cases. The scores were computed by random permutations cross-validation ("shuffle and split") in 10 iterations with 80% train and 20% test split.

Results
Table 1 shows the features that were found to be most predictive of 1p19q status, and include previously described visual features (edge sharpness) as well as texture features that do not have familiar visual features (e.g., LoG). Figure 1 shows that both support vector machine (SVM) learning and Naive Bayes (NB) perform well, with the overall accuracy of SVM being 95%. This appears superior to previously published results for visual and machine learning methods, though we do not have the exact prior algorithms implemented for this data set.

Conclusions
Our research suggests that objective machine learning of readily computable features from T1- and T2-weighted images of low grade gliomas can accurately predict 1p19q codeletion. This work was supported by CA-160045 and EU project FNUSA-ICRC.
Value of Amide Proton Transfer Imaging in Correlation with Histopathological Grades of Adult Diffuse Gliomas: Comparison and Incremental Value with Dynamic Susceptibility Contrast-Enhanced MRI and Diffusion Weighted Imaging

S Ahn¹, S Lee², Y Choi³, J Kim³, H Lee³
¹Yonsei University College of Medicine, Seoul, Korea, Republic of, ²Yonsei University College of Medicine, Seoul, Seoul, ³Yonsei University College of Medicine, Seoul, AK

Purpose
To investigate the diagnostic value of amide proton transfer (APT) compared with those of apparent diffusion coefficient (ADC) and relative cerebral blood volume (rCBV), and incremental diagnostic value of APT over ADC and rCBV for predicting histopathological grade in diffuse gliomas in adults, with clinically optimized APT imaging protocols.

Materials and Methods
The study cohort consisted of 39 adult patients with histopathologically proven diffuse glioma who underwent pre-operative APT imaging, with 34 patients available for pre-operative dynamic susceptibility contrast (DSC) magnetic resonance imaging (MRI) and diffusion-weighted imaging (DWI). Regions of interest (ROIs) were obtained from circles manually placed at the area with high signal in APT and rCBV map, and low signal in ADC map. Amide proton transfer signal was compared according to WHO grade or low versus high grade of glioma. Diagnostic ability to discriminate high grade glioma from low grade glioma was compared between APT, ADC, and rCBV by using receiver operative characteristic (ROC) analysis, and incremental diagnostic value of APT over ADC and rCBV were assessed by using.
integrated discrimination index. Also, the correlation between APT values and Ki-67 labeling index (LI) was assessed by linear regression.

Results
The APT SI values were 0.82 ± 0.36% in grade II gliomas, 1.73 ± 0.86% in grade III, and 2.62 ± 0.78% in grade IV gliomas, which showed significant difference between grade II and III (p=0.018), III and IV (p = 0.010), as well as II and IV (p < 0.001). The diagnostic value to discriminate between high and low grade glioma was not significantly different between APT, ADC and rCBV, with area under the ROC curve (AUC) of 0.890, 0.917, and 0.947, respectively (p > 0.05 for each comparison). Incremental diagnostic value of APT was significant over ADC (p = 0.003), and not significant over rCBV (p=0.066). Amide proton transfer signals were significantly correlated with Ki-67 LI. (p=0.001, R-squared = 0.26).

Conclusions
Amide proton transfer imaging can be useful, and have incremental value over ADC for predicting the histopathological grades of adult diffuse gliomas. Amide proton transfer SI can be correlated with Ki-67 LI.
Table 1. Incremental diagnostic value of APT over ADC and rCBV to discriminate high- and low-grade gliomas, measured by NRI and IDI (n=34)

<table>
<thead>
<tr>
<th></th>
<th>AUC (95%CI)</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>IDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over ADC</td>
<td>ADC</td>
<td>0.917 (0.791 - 0.977)</td>
<td>86.4%</td>
<td>75.0%</td>
<td>82.4%</td>
</tr>
<tr>
<td></td>
<td>ADC + APT</td>
<td>0.955 (0.842 - 1.000)</td>
<td>90.9%</td>
<td>91.7%</td>
<td>91.2%</td>
</tr>
<tr>
<td>Over rCBV</td>
<td>rCBV</td>
<td>0.947 (0.798 - 1.000)</td>
<td>81.8%</td>
<td>91.7%</td>
<td>85.3%</td>
</tr>
<tr>
<td></td>
<td>rCBV + APT</td>
<td>0.947 (0.833 - 0.993)</td>
<td>90.9%</td>
<td>91.7%</td>
<td>91.2%</td>
</tr>
</tbody>
</table>
Noninvasive tracking the kinetic phases of distribution and tumor targeting of EGFRvIII-specific chimeric antigen receptor T cells via MRI

X Chen¹, W Zhang², T Xie²
¹Daping Hospital, Third Military Medical University, Chongqing, China, ²Daping Hospital, Third Military Medical University, Chongqing, none

Purpose
Glioblastoma (GBM) is the most common primary malignant brain tumor in adults and is uniformly lethal. T-cell-based immunotherapy offers a promising platform for treatment given its potential to specifically target tumor tissue while sparing the normal brain. However, the challenge of monitoring the therapy in real time has been continually ignored. To address this issue, we developed MR imaging approaches to evaluate a recently reported novel CAR strategy for adoptive immunotherapy against glioma xenografts expressing EGFRvIII.

Materials and Methods
T cells, isolated from the peripheral blood of healthy donors, were transduced by EGFRvIII-specific human CAR (EGFRvIII-CAR). Flow cytometry was used to detect CAR expression on transduced T cells. Elevated concentration of USPIO was labeled CAR T cells. The biological properties of these cells were detected. Cytoxicity assay and cytokine production were analyzed in vitro. Then, USPIO-CAR T cells were transplanted into the nude mice bearing U87-EGFRvIII glioma. Magnetic resonance imaging (MRI) and immunohistochemistry were performed.

Results
We successfully labeled EGFRvIII-CAR T cells with USPIO without any influence on the biological properties and toxicity to tumor of these cells. After intravenous administration into glioma-bearing nude mice, the USPIO-EGFRvIII-CAR T cells specifically homed to gliomas and could be reliably tracked by 7.0 T MR as early as 1 day after transplantation, causing hypointensity on T2-weighted images. Prussian blue staining and CD3 immunohistochemistry staining confirmed the MRI findings. Infusion with EGFRvIII-CAR T cells led to cures in all mice with brain gliomas.

Conclusions
This therapeutic strategy offered efficient therapy effect to EGFRvIII+-glioma-bearing mice and implied that MR imaging is a highly useful tool in tracking the kinetic phases of CAR T cells distribution and monitor its therapeutic effect.

O-478

Volumetric and Progression-Free Interval Analysis of post MRI-guided Laser Induced Thermal Therapy (LITT) for Intracranial Neoplasms
Purpose
Laser induced thermal therapy (LITT) is a novel, minimally invasive method of treating metastatic intracranial neoplasms using thermal ablation. As this technique gains momentum as an adjunct tool in managing intracranial neoplastic burden, it is important that neuroradiologists recognize typical post-LITT imaging characteristics and size fluctuations. The purpose of this project is to assess volume changes pre- and 24 hours postablation and estimate a typical progression-free interval post-LITT. It is expected that this data will allow for better recognition of expected post-thermal ablative changes and foster better communication between neuroradiology and referring neurosurgeons.

Materials and Methods
Patients (n=20) who have undergone LITT for various intracranial metastatic neoplasia were assessed retrospectively. Lesion anatomy was reviewed on thin section, postcontrast SPGR magnetic resonance imaging (MRI) sequences pre- and 24 hours postablation. Three volume raters drew lesional regions of interest (ROIs) using the program 3D Slicer. Interrater volumes were averaged and statistically analyzed using a two-tail T test. Subsequent patient scans available in our PACS were reviewed to catalogue the number of days post-therapy a given lesion was progression-free in size. Progression was defined by the product of maximal bi-axial dimensions equating 1.5 times that of the pre-ablation dimensions.

Results
Patient primary malignancy types included eight with lung, five with breast, two with colon, two with renal, one with cervical, one with testicular, and one with melanoma. All lesions demonstrated the owl's-eye target appearance postablation (Fig. A). Pre and posttherapy 3D models were subsequently reviewed (Fig. B). Each patient's lesion demonstrated statistically significant interval increase in size 24 hours following LITT (p<0.0007). Average lesional size increased by approximately 500 mL on 24 hour follow-up MRI (Fig. C). Fifteen of the 20 patients showed no significant interval growth in lesion size post-therapy, with follow-up time ranging from 32 to 736 days following ablation. Five patients demonstrating progression of disease included two breast primary (65 and 272 days post-LITT), two lung primary (146 and 217 days post-LITT), and one cervical primary (85 days post-LITT).

Conclusions
Our study demonstrates statistically significant volumetric changes pre- and postablation in patients with metastatic intracranial lesions, despite primary sources. We believe immediate postablation volumes are higher mostly due to thermal-induced tissue expansion. A smaller component of this expansion may be related to edema, as
postprocedural edema resolved on follow-up scans, with LITT responders demonstrating maintained ablation zone sizes on follow-up imaging. Our data shows that survival time ranging to 2 years post-laser ablation is feasible. This study demonstrates the potential for LITT to be utilized despite varying metastatic source, given the spectrum of primary neoplasms treated and analyzed in this retrospective review. Long-term follow up and analysis of larger patient population outcomes managed with this technique will be necessary to further validate these conclusions.
Growth dynamics and measurement bias in pre-operative, treatment naïve human glioblastoma

B Ellingson¹, T Cloughesy¹, W Pope¹
¹University of California Los Angeles, Los Angeles, CA

Purpose
Little is known about the natural growth characteristics of untreated glioblastoma prior to surgical or therapeutic intervention because patients are rapidly treated after preliminary radiographic diagnosis. The purpose of the current study was to explore the growth dynamics in a cohort of untreated glioblastoma patients.

Materials and Methods
Nintey-five glioblastoma patients had measurable enhancing disease on >2 magnetic resonance imaging (MRI) scans prior to surgery. Growth rates were quantified four different ways (percentage change per day, absolute rate of change per day, estimated volumetric doubling time, and radial expansion rate) using three different approaches (bidirectional product, enhancing disease, and total lesion volume).

Results
Median volumetric doubling time was 21.1 days, percentage change in tumor volume was 2.1% per day, and rate of change in total lesion volume was 0.18 cc per day. Follow-up time between MRI examinations should be >28 days to detect progressive disease with high specificity. Small initial tumor sizes (< 3cm diameter) are biased toward large percentage change at follow up. IDH1 mutant glioblastomas had a longer doubling time compared with wild type tumors. A linear relationship was observed between degree of 1p deletion and doubling time. Age, and absolute rate of change in total tumor volume were significant predictors of OS.

Conclusions
Presurgical, treatment naïve glioblastoma growth dynamics can be estimated in a variety of ways with similar results. Growth rates are dependent on baseline tumor size, the time interval between scans, molecular features of the tumor, and are prognostic for overall survival.
Quantitative T1 mapping for therapy monitoring of patients with glioblastoma

A Mueller¹, A Jurcoane¹, B Maedler², H Schild¹, E Hattingen¹
¹University Clinic Bonn, Bonn, Germany; ²Philips Healthcare, Best, The Netherlands

Purpose
Therapy monitoring of patients with glioblastoma (GBM) in conventional magnetic resonance imaging (MRI) is done visually and therefore reader-dependent. Quantitative (q) MRI measures the dynamics of all tumor-associated changes and the
damage of the blood-brain barrier objectively. Peritumoral edema and infiltrating tumor lead to prolongation of the relaxation time T1. We performed qT1 mapping 1) to compare the visibility of damage of the blood-brain barrier with conventional MRI and 2) to monitor the dynamics of noncontrast qT1 during radiochemotherapy.

Materials and Methods
The study was approved by the local institutional review board and informed written consent was obtained from all patients. Twelve GBM patients were examined with standard T1-weighted spin-echo sequences and qT1 mapping using a 3D-IR-TFE sequences (TR = 4,88 ms; TE = 2,41 ms; TI = 150, 350, 750, 1200, 2300 ms) pre and postcontrast administration on a 3.0 T MR scanner (Achieva, Philips Healthcare, The Netherlands). The sequence protocol also included conventional FLAIR and T2 TSE sequences. GBM patients were examined before radiochemotherapy (timepoint 0, TP0), and in 6-week intervals (TP1,..., TPx). The median overall observation interval was TP5 [range (TP3; TP8)]. We generated co-registrated differential maps of 1) T1-W and qT1 pre and postcontrast application and 2) noncontrast qT1 at TP0 and TPx. In the contrast-enhanced maps we determined the percentage shortening of qT1 (DqT1) and the percentage signal increase (DSI) in the T1-W images. Region of interests (ROI) were drawn manually in the differential maps. The differential noncontrast qT1 maps show areas with T1 increase while unchanged tumor areas are suppressed. Treatment response was assessed using the RANO criteria in the conventional MRI at each TP.

Results
1) At TP1 eight patients showed areas of qT1 shortening also outside the solid enhancing tumor area. This appeared as "cloudy" enhancement (DqT1 =20.66 % in cloud-ROI versus DqT1 =13.69 % in contralateral control-ROI, p = 0.005). In the T1-W differential maps the signal intensity of the identical ROI fluctuated around zero (DSI = -1.68% in cloud-ROI versus DSI = -3.14% in contralateral control-ROI, p = 0.0187). The "cloudy" enhancement appeared in patients with and without tumor progression. A persisting cloud (for more than one TP) only occurred in patients with tumor progression. 2) In GBM patients without progression the peritumoral areas with noncontrast qT1 prolongation increased at only one TP and regressed at the following TP. In contrast in GBM patients with tumor progression the areas with noncontrast qT1 prolongation increased from TP to TP.

Conclusions
QT1 mapping detects subtle ("cloudy") blood-brain barrier damage compared to conventional T1-W images. Persisting "clouds" seem to correlate with progressive disease. T1 prolongation seems to be a sensitive and objective marker of any tumor-associated change.

O-481
Purpose
This study assesses the feasibility to utilize uniform magnetization transfer in chemical exchange saturation transfer (uMT-CEST) contrast imaging technique measuring the myoinositol (MI), creatine (Cr), and amide proton transfer (APT) endogenous metabolites in patients with brain tumors with correlation to MR perfusion maps (rCBV) as well as FDG uptake (SUV) data obtained from hybrid MR-PET. This study hopes to determine the sensitivity and specificity of uMT-CEST to accurately grade these tumors, differentiate tumor from treatment effects as well as be useful as a surveillance tool for treatment response.

Materials and Methods
Seven treatment naive brain tumor patients were examined on a 7T whole-body scanner (Siemens, Erlangen, Germany) with a volume-transmit, 24-element receive head coil array. For the off-resonance pre-saturation, a train of ten 100 ms long Gaussian and cosine modulated Gaussian pulses (B1,rms = 1.4 μT and 1.9 μT) were used to perform uMT-CEST; the frequency offsets being varied from -2500 Hz to 2500 Hz with a step size of 100 Hz. The modulation frequency of the cosine-modulated Gaussian pulse was 1.5 kHz. For imaging, a single shot GRE acquisition with centric phase encoding order was used with Flip Angle = 9°, TR = 12 ms, TE = 3.5 ms, dwell time = 15 μs, FOV = 200 × 200mm2, slice thickness = 5 mm, matrix size = 192 × 192. Regions of interest (ROIs) were drawn on enhancing brain tumor as well as normal appearing white matter (control). A total of nine lesions were measured (low grade glioma = 2, radiation necrosis =1, metastatic = 6). Positron emission tomography/magnetic resonance (PET/MR) imaging was performed on three patients, using an integrated 3T MR-PET system (Biograph mMR; Siemens Healthcare), which acquires simultaneous PET and MR data. Magnetic resonance perfusion imaging also was performed on these three patients.

Results
One patient underwent uMT-CEST prior to and following gamma knife surgery of the brain metastatic lesion from breast carcinoma. This patient had interval decrease in all metabolites MI, Cr, and APT concentrations in the metastatic lesion following gamma knife: MI=0.97+3.33 (from 8.14+3.18), Cr=-0.39+2.9 (from 0.73+2.2), and APT=-0.73+2.89 (from -0.09+2.06) (see Fig. 1). Two low grade gliomas: MI=4.05+1.45, Cr=3.34+0.64, APT=0.13+1.35. Five metastatic lesions: MI=4.78+1.78, Cr=2.37+1.76, APT=0.77+1.96. One radiation necrosis: MI=4.19+4.01, Cr=-0.93+2.70, APT=0.12+2.90 (see Table 1). Three patients underwent PET and MR
perfusion. One patient with radiation necrosis showed: MR-PWI (rCBV) of 1.94±1.29, and 18F-FDG (early SUV) of 3.4. One patient with metastasis showed: MR-PWI (rCBV) of 2.19±0.98 and 18F-FDG (early SUV) of 5.1 (Max=9.2). One patient with low grade glioma showed: MR-PWI (rCBV) of 1.87±0.48 (Max=3.4) and 18F-FDG (early SUV) of 4.5.

Conclusions
This study was successful in measuring MI, Cr, and APT endogenous metabolites on these brain tumor patients on a 7T magnet demonstrating the feasibility of performing uMT-CEST on humans. There is potential for uMT-CEST to be useful for grading tumors, differentiating tumor from treatment effects and used as a surveillance tool for treatment response.
Voxel-level Assessment of Cellularity in Recurrent Glioblastoma: A Multiparametric Radiologic-Histopathologic Study

P Chang¹, P Yang¹, S Bowden¹, H Malone¹, B Gill¹, J Samanamud¹, D Chow², J Grinband¹, L Schwartz¹, J Bruce¹, P Canoll¹, A Lignelli¹
Purpose
Radiographic interpretation of a newly enhancing lesion in post-treatment glioblastoma (GBM) remains an unsolved challenge (1-2). One limitation is that current approaches categorically label the entire enhancing lesion as treatment effects or recurrent tumor, while histopathologic studies show both components often coexist in varying proportions (3). We propose a novel technique to map the heterogeneous distribution of recurrent tumor cellularity by combining voxel-level signal intensity on DSC-perfusion (rCBV), ADC and FLAIR sequences.

Materials and Methods
As part of an IRB-protocol, stereotactic biopsies were obtained in GBM patients with a newly enhancing lesion suspicious for pseudoprogression or recurrence. For each biopsy site, cell count (per 40x high-power-field) and corresponding signal intensity (rCBV, ADC and FLAIR) were recorded. Image preprocessing included linear coregistration (4) and intensity normalization (5). Single (y=β0+β1x) and multiple (y=β0+β1x1+β2x2+β3x3) linear regression models were used to estimate tumor cellularity based on signal intensity.

Results
A total of 32 biopsy samples were obtained. All samples had ADC and FLAIR imaging; a subset of 16 samples had corresponding DSC-perfusion. By univariate regression, rCBV was most correlated with recurrent tumor cellularity (r=0.827), followed by ADC (r=0.661) and FLAIR (r=0.580). A multivariate model combining ADC and FLAIR improved overall cellularity correlation (r=0.746); this model weighted ADC (β1=-165.8±45.7) slightly more than FLAIR (β2=-44.5±16.6). A multivariate model combining rCBV, ADC and FLAIR yielded highest overall correlation (r=0.869); this model weighted rCBV (β1=110.6±41.8) more than ADC (β2=-55.8±35.9) or FLAIR (β3=8.1±15.1).

Conclusions
Voxel-level radiologic-histopathologic correlation demonstrates that changes in recurrent tumor cellularity cause corresponding signal changes in rCBV, ADC and FLAIR, a relationship that may be modeled with multiple linear regression and used to noninvasively map tumor cellularity throughout the entire lesion (Fig. 1). Further investigation is needed to translate this postprocessing technique into a robust method to differentiate pseudoprogression from tumor recurrence.
Figure 1. Multiparametric Cellularity Map For Recurrent Glioblastoma

Superimposed upon a new area of enhancement is a color map indicating relative cellularity. The estimate is based upon a multiple linear regression combining signal intensity on ADC, FLAIR and rCBV sequences calibrated on stereotactic histopathologic specimens. Within this single lesion, areas of low cellularity (blue) are seen intermixed with areas of high cellularity (red), demonstrating heterogeneous composition of GBM lesions after chemoradiation therapy.
Clot Composition and Sensitive MRI Sequences. An In Vitro Analysis with Predetermined Clot Components

A Narata¹, K Janot², L Barantin³, G Fromont-Hankard², J Cottier², I Filipiak⁴
¹University Hospital of Tours, Tours, France, ²University Hospital of Tours, Tours, Indre et Loire, ³INSERM, Tours, Indre et Loire, ⁴Plateform CIRE, Tours, Indre et Loire

Purpose
Stroke treatment has presented an enormous evolution in the last few years. Recent studies comparing intravenous thrombolysis versus IV thrombolysis + thrombectomy, showed the superiority of the second group. As "time" is still one of the most important prognostic factors, the necessity to perform IV thrombolysis before thrombectomy should be reconsidered in some cases as recanalization rates of IV thrombolysis remain still lower than mechanical thrombectomy. In vitro studies demonstrated that high fibrin concentration could indicate lower responsiveness to IV thrombolysis and erythrocyte-rich clots should be dissolved more easily by thrombolytic. Concerning mechanical thrombectomy, clot composition could affect device performance and clinical recovery. Preselection of patients might be interesting in terms of clot composition and therapeutic decision, and take part of thrombectomy techniques developments. In this study, we used five different thrombus (one unknown composition) and magnetic resonance imaging (MRI) to evaluate erythrocyte and fibrin presences in each sample. We assessed the hypothesis that MRI used for ischemic stroke diagnosis can detect and characterize thrombus composition providing a scale that could be useful to quantify erythrocyte and fibrin compounds.

Materials and Methods
Five different experimental clots were prepared from ovine blood (Neuravi Ltd, Galway, Ireland): 100% fibrin, 80% RBC, 20% RBC, 50% RBC, one with unknown composition. All clots were submitted to histological analysis to validate MRI data. Clots were fixed in a phantom prepared with gelatin and manganese to obtain equivalent T1 and T2 human gray matter values. Measurements were performed on a 3T whole body MR scanner (Verio, Siemens, Erlangen, Germany) using a MRI protocol: 3D T1- and T2-weighted, T2EG-weighted gradient recalled echo imaging,
susceptibility weighted imaging (SWI), fluid-attenuated inversion recovery imaging (T2Flair) and diffusion-weighted imaging (DWI) with apparent diffusion coefficient (ADC) cartography. We have reported all clots "signal intensity" (SI) on each sequence to create an index "n". Statistical analysis were performed with R software (2.15.1 version, R Foundation, Vienna, Austria). All measures were expressed as mean +/- standard deviation (SD). We performed a t-test to compare index "n" of RBC and fibrin clots for each sequence, unpaired t-test and repeated measure analysis of variance (ANOVA) was used to examine the differences of mean of RBC index for each sequence. A p value of <0.05 was considered significant.

Results
We found a significant difference between fibrin and RBC-rich clots in ADC map (A), T2EG (B), SWI (C) and T1 (D) (Fig. 1). The mean concentration of RBC could be detected and differentiated in ADC map, SWI and T2EG. Magnetic resonance imaging and histological analysis showed that clot with unknown composition was rich in red cells.

Conclusions
Thrombus composition can be evaluated by standard MRI protocol. T1, T2EG, SWI and ADC map can differentiate fibrin from RBC-rich clots. T2EG, SWI and ADC map can quantify RBC based on a gray scale.
Comparison of FLAIR hyperintense vascular sign and leptomeningeal collateral on catheter angiography in 100 patients with anterior cerebral artery stenosis or occlusion

H Liu¹, Y Lin¹, C Lee¹, Y Wang¹, Y Chen¹
¹National Taiwan University Hospital, Taipei, Taiwan

Purpose
To compare the appearance of FLAIR hyperintense vascular (FHV) sign and cerebral collateral circulation shown on catheter angiography.

Materials and Methods
We reviewed the magnetic resonance (MR) images of the last 100 patients diagnosed with anterior cerebral vascular stenosis or occlusion (ICA, MCA, ACA) and catheter angiography was performed in them. Patients diagnosed as moyamoya disease were excluded. The location of FLAIR hyperintense vascular (FHV) sign recorded as: intra-sylvian, temporo-occipital, high frontoparietal, and combination. The collateral score designed by ASITN/SIR were applied for the grading of cerebral collateral on catheter angiography (grade 0 to grade 4, whole grade 0 = no collateral, grade 4 = rapid and complete collaterals in occluded vascular territory) and we also recorded the direction of collateral (antegrade or retrograde).

Results
FLAIR hyperintense vascular sign found in 37 patients with major cerebral vessel severe stenosis or occlusion (30 in chronic and seven in acute cases). The FHV sign was found as intra-sylvian in 25, temporo-occipital in 16, high frontoparietal in 12. All patients with FHV had anterior cerebral vascular stenosis/occlusion, and three in ICA, 26 in MCA alone, one in ACA alone, and five in ICA+MCA. Antegrade collateral associated with FHV noted in 12, retrograde collateral in 25. We also found 10 patients with leptomeningeal collateral without FHV sign, and two patients with FHV without leptomeningeal collateral on catheter angiography.

Conclusions
FLAIR hyperintense vascular sign is not definitely comparable to the leptomeningeal collateral on catheter angiography in patients with anterior cerebral artery stenosis or occlusion.
Progression of Intracranial Atherosclerosis: a 3D High-resolution Vessel Wall MRI Study

X ZHANG¹, H Yang², l liu², y zhang², E Guallar², B Wasserman², Y Qiao²
¹Johns Hopkins School of Medicine, Baltimore, MD, ²Johns Hopkins School of Medicine, Baltimore, MD

Purpose
Recent advances in high-resolution black blood magnetic resonance imaging (BBMRI) have enabled the reliable detection and characterization of intracranial atherosclerotic disease (ICAD) (1, 2). We sought to determine the reliability of this technique to determine the progression of ICAD in an asymptomatic population.

Materials and Methods
Twenty-three asymptomatic participants (9 male; mean age, 79.2 years, ranges, 71 to 86 years) with identified ICAD were recruited from a population-based study, who underwent high resolution vessel wall MRI. All baseline MRI was performed at a 3T Siemens scanner with a standardized brain MRI protocol that consisted of a 3D time-of-flight (TOF) MRA and 3D high isotropic resolution BBMRI (2). The repeated MRI was performed on a 3T Philips scanner with mean time interval of 2.3±0.49 years since baseline. Two MRI protocols were matched with acquired resolution (TOF, 0.5mmx0.5mmx0.55m; BBMRI, 0.5 isotropic mm) and the image coverage. Two trained readers independently analyzed MRI images and were blinded to dates and order of the exams. Plaque presence by vessel segment was recorded for both visits. Change from baseline for each identified plaque was categorized as progression, regression and no change based on the lumen (stenosis) and vessel wall assessments. Reliability was assessed by kappa statistics and intraclass correlations (ICC).

Results
A total of 134 and 149 plaques were identified at baseline and follow up, respectively (Table 1). New plaques (n=15) were detected in 11 participants. Among 134 plaques identified at baseline, 26 progressed, two regressed and 106 had no detectable change. Reader reliability [kappa or ICC, (95% CI)] was 0.71(0.62, 0.81) for plaque presence, 0.81 (0.70, 0.92) for plaque progression, 0.80 (0.54, 0.93) for maximum wall thickness and 0.65 (0.32, 0.88) for mean wall thickness.

Conclusions
Vessel wall MRI provides reliable MRI measurements of intracranial vessels, and enables studying the natural history of ICAD in general population.
### Table 1. Characteristics of Study Population (n=134)

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Follow</th>
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<tbody>
<tr>
<td>Age (mean ±SD)</td>
<td>75.9±5.0</td>
<td>79.1±5.0</td>
</tr>
<tr>
<td>Male sex</td>
<td>--</td>
<td>9 (39%)</td>
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<tr>
<td>Total no. of plaques</td>
<td>134</td>
<td>149</td>
</tr>
<tr>
<td>Plaque location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior cerebral artery</td>
<td>9 (7%)</td>
<td>11 (7%)</td>
</tr>
<tr>
<td>Internal carotid artery</td>
<td>44 (33%)</td>
<td>44 (30%)</td>
</tr>
<tr>
<td>Middle cerebral artery</td>
<td>33 (25%)</td>
<td>36 (24%)</td>
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<tr>
<td>Basilar artery</td>
<td>14 (10%)</td>
<td>16 (11%)</td>
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<tr>
<td>Posterior cerebral artery</td>
<td>23 (17%)</td>
<td>27 (18%)</td>
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<tr>
<td>Vertebral artery</td>
<td>11 (8%)</td>
<td>15 (10%)</td>
</tr>
<tr>
<td>New plaques</td>
<td>--</td>
<td>11 (52%)</td>
</tr>
<tr>
<td>Plaque progression</td>
<td>--</td>
<td>12 (48%)</td>
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<tr>
<td>New plaques and plaques progression</td>
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</table>

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**O-486**

Utility of Intracranial Vessel Wall Imaging to Identify Culprit Atherosclerotic Lesions: A Systematic Review and Meta-Analysis
H Baradaran¹, H Kamel¹, A Gupta¹
¹New York-Presbyterian Hosp/Weill Cornell Med Ctr, New York, NY

Purpose
Plaque inflammation within intracranial atherosclerosis is a well known cause of ischemic stroke and potentially may be characterized by a relatively simple, qualitative imaging biomarker - enhancement on high resolution magnetic resonance (MR) imaging. While this method for characterizing intracranial atherosclerotic plaque is promising, most early studies to date have been small, retrospective studies which have made it difficult to draw firm conclusions about the role of this emerging imaging technique. We therefore performed a systematic review and meta-analysis to evaluate the association between intracranial plaque enhancement on high resolution MR imaging and cerebrovascular ischemic events.

Materials and Methods
We performed a comprehensive literature search evaluating the association between intracranial plaque enhancement on in vivo, high resolution MR imaging and cerebrovascular ischemic events. The included studies were studies with patients who had undergone pre and postgadolinium based contrast-enhanced high resolution MR imaging of intracranial vessels with techniques allowing for the evaluation of the vessel wall. All studies were of patients with a prior recent history of ischemic cerebrovascular event. We extracted data on the prevalence of postcontrast vessel wall/plaque enhancement in culprit atherosclerotic lesions compared to the prevalence of enhancement in nonculprit plaques. A meta-analysis with assessment of study heterogeneity was performed. Results were presented in a forest plot and summarized using a random-effects model (Fig. 1).

Results
Six studies with a total of 123 patients met the inclusion criteria for systematic review and meta-analysis. Amongst the 198 plaques analyzed in these studies, 64 of 102 culprit plaques enhanced compared to 16 of 96 nonculprit plaques. We found a significant positive relationship between the presence of enhancement within intracranial atherosclerotic plaque and that plaque being the culprit plaque for a recent ischemic cerebrovascular event with a pooled random-effects odds ratio (OR) of 12.67 (95% CI, 5.12 – 31.39, p<0.001). Our analysis showed no evidence of statistically significant heterogeneity (I² statistic = 0, 95% CI, 0 - 79.8; p = 0.42).

Conclusions
Vessel wall enhancement is strongly associated with culprit as compared to nonculprit atherosclerotic plaque in patients with recent ischemic cerebrovascular events. Accurate identification of culprit intracranial atherosclerotic lesions with vessel wall imaging could improve our ability to find an etiology for strokes currently considered cryptogenic. Future prospective studies are warranted to confirm the ability of
gadolinium enhancement to identify culprit plaques, especially in patients with nonstenosing lesions potentially causing ischemic stroke.

### Meta-analysis

<table>
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<th>Study</th>
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<th>Controls</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>Z</th>
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<td>Klein 2006</td>
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<td>-</td>
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<td>van der Kolk 2011</td>
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<td>4/26</td>
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<td>Kim 2012</td>
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<td>0/8</td>
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<td>0.592 to 248.502</td>
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<td>Vakil 2013</td>
<td>7/10</td>
<td>1/12</td>
<td>25.667</td>
<td>2.207 to 298.508</td>
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<td>Qiao 2014</td>
<td>19/21</td>
<td>10/45</td>
<td>33.250</td>
<td>6.595 to 167.627</td>
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<tr>
<td>Total (fixed effects)</td>
<td>64/102</td>
<td>16/96</td>
<td>13.581</td>
<td>5.652 to 32.632</td>
<td>5.832</td>
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<tr>
<td>Total (random effects)</td>
<td>64/102</td>
<td>16/96</td>
<td>12.674</td>
<td>5.118 to 31.385</td>
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Intracranial calcification and stenosis and their association with stroke

M Mossa-Basha¹, B Quiney², S Ying³, D Hippe¹
¹University of Washington, Seattle, WA, ²St. Paul's Hospital, University of British Columbia, Vancouver, British Columbia, ³University of Manitoba, Winnipeg, Manitoba

Purpose
Intracranial calcifications are commonly seen on CTA during the work up of acute stroke. Their significance has received increased attention recently and the cumulative effect with stenosis is not well known. This project evaluated the risk of stroke when intracranial calcifications were seen with and without stenosis.

Materials and Methods
We retrospectively reviewed the radiology database for CTA stroke exams performed from 1/2010-4/2010 and included those with ischemic stroke presumed to be secondary to intracranial atherosclerosis. Imaging studies were reviewed by two independent readers on a per vessel basis to record the presence of calcification and/or stenosis. Stenosis was identified as >30% narrowing relative to proximal or contralateral normal segment. Cerebrovascular events were confirmed by presence of infarct on magnetic resonance imaging (MRI) performed or clinical evidence of stroke. All vessels proximal to the location of stroke were considered as potential culprits. Associations between stroke, calcification and stenosis were analyzed using logistic regression based on generalized estimating equations to account for repeated measures. All models were adjusted for sex, age, prior stroke, coronary artery disease, hypertension, hyperlipidemia, smoking and diabetes.

Results
Ninety-nine patients (1287 vessels) fulfilled our criteria and were included. Nineteen percent of patients had stroke (54 proximal vessels). Fifty-eight percent of patients had intracranial calcification (172 vessels) and 43% had stenosis (99 vessels). Calcification and stenoses were most common in the cavernous (54% and 22%, respectively) and suprACLainoid (24% and 6.1%) ICAs, followed by the vertebral arteries (21% and 19%). Compared to normal vessels, vessels with calcification only (OR=2.2, p=0.049), stenosis only (OR=6.7, p<0.001) and both stenosis with calcification (OR=3.9, p=0.003) were each significantly associated with stroke downstream, though noncalcified stenoses tended to imply higher risk than calcified stenoses (OR: 6.7 vs. 3.9, p=0.25).

Conclusions
The presence of intracranial stenosis alone, calcification alone or both is strongly associated with the risk of stroke.
Cryptogenic Stroke Downstream of Nonstenosing Intracranial Atherosclerotic Lesions

H Baradaran1, H Kamel1, G Gialdini2, A Giambrone2, B Navi3, M Lerario3, J Min3, C Iadecola3, A Gupta1
1New York-Presbyterian Hosp/Weill Cornell Med Ctr, New York, NY, 2Weill Cornell Medical College, New York, NY, 3New York Presbyterian Hospital-Weill Cornell Medical College, New York, NY

Purpose
Many strokes categorized as "cryptogenic" may result from large artery atherosclerosis that goes unrecognized because it does not cause ≥50% luminal stenosis. To test this hypothesis, we compared the prevalence of nonstenosing atherosclerotic plaques upstream of cryptogenic cerebral infarcts versus the unaffected side.

Materials and Methods
In a prospective stroke registry, we identified patients with cerebral infarction limited to the territory of one internal carotid artery (ICA). We included patients with stroke of undetermined etiology and, as controls, patients with cardioembolic stroke. We used noncontrast computed tomography (CT) to measure calcification in both intracranial ICAs both qualitatively using the Modified Woodcock Visual scale and using a semi-automated quantitative approach by manually drawing regions of interest (ROIs) around ICA calcification and measuring Agatston-Janowitz scores. Within subjects, the Wilcoxon signed rank sum test for nonparametric paired data was used to compare the calcium burden in the ICA upstream of the infarction versus the ICA on the unaffected side.

Results
We obtained 440 calcium measures from 110 ICAs in 55 patients. Among 34 patients with stroke of undetermined etiology, we found substantially greater calcium in the ICA upstream of the infarction (mean Modified Woodcock Visual Score, 6.7 ± 4.6) compared to the unaffected side (5.4 ± 4.1) (P = 0.005). Among 21 patients with cardioembolic stroke, we found no difference in calcium burden upstream of the infarction (6.7 ± 5.9) versus the unaffected side (7.3 ± 6.3) (P = 0.13). Results were similar using quantitative calcium measurements.

Conclusions
In patients with strokes of undetermined etiology, the burden of calcified intracranial large-artery plaque was associated with downstream cerebral infarction. These findings suggest that undiagnosed, nonstenosing large-artery atherosclerotic lesions...
may explain some proportion of cryptogenic strokes and more aggressive therapies should be considered for these patients.

Differential Diagnosis of Dissection and Atherosclerosis of intracranial Vertebral Artery on High Resolution Vessel Wall MRI

Y Heo¹, H Jeong²

¹Busan Paik Hospital, Inje University, Busan, Korea, Republic of, ²Busan Paik Hospital, Inje University, Busan, others
Purpose
The purpose of this study was to compare the vertebral arterial dissection (VAD) and atherosclerosis involving intracranial vertebral artery.

Materials and Methods
We retrospectively reviewed 24 patients suspected VAD and atherosclerosis who underwent 3.0 T high resolution vessel wall magnetic resonance imaging (MRI). Two neuroradiologists independently reviewed high resolution MR images and compared with final diagnosis based on clinicoradiologic findings. Magnetic resonance imaging findings of remodeling index, dissecting flap, contrast enhancement, accompanying cerebellar infarction and intramural T1 hyperintensity, suggesting intramural hematoma were evaluated.

Results
We finally diagnosed 18 patients as VAD and six patients as atherosclerosis. Remodeling index of dissection (1.79 ± 0.46) of VAD was significantly larger than atherosclerosis (1.17 ± 0.21). Dissection flap was observed in 10 patients and all of the patients were finally diagnosed as VAD. Accompanied cerebellar infarction was more frequently observed in VAD with clinical significance. Vessel wall enhancement and T1 high signal intensity on arterial wall were not significantly different between VAD and atherosclerosis.

Conclusions
High resolution vessel wall MR imaging is useful in differentiation of VAD and atherosclerosis.
High-Resolution MRI Vessel Wall Imaging: Changes in Atherosclerosis and Moyamoya disease in Follow-up Period

Y Heo¹, H Jeong²
¹Busan Paik Hospital, Inje University, Busan, Korea, Republic of, ²Busan Paik Hospital, Inje University, Busan, others

Purpose
High resolution magnetic resonance imaging (HRMRI) has been widely used in the evaluation of intracranial artery walls. It has an advantage in defining vessel wall characteristics of intracranial vascular disease. We investigated HRMRI arterial wall characteristics of atherosclerosis and other vascular disease to determine wall pattern changes during a follow-up period.
Materials and Methods
From October 2012 to December 2015, we prospectively performed initial and follow-up HRMRI for the patients with stenosis involving anterior circulation. The HRMRI protocol included 3D proton density, oblique sagittal proton density, T1, contrast-enhanced T1-weighted black blood MRI, time-of-flight MRA of the circle of Willis. Follow-up HRMRI were performed after taking lipid lowering agents and antiplatelet medications. Vessel wall characteristics including wall enhancement, character of wall thickening, and luminal narrowing were evaluated.

Results
Twenty-four patients with atherosclerosis and five patients with moyamoya disease were included. In the atherosclerosis group, 20 patients showed eccentric wall enhancement and thickening. On follow-up HRMRI, 10 patients showed decreased extent of plaque and enhancement of vessel wall and 14 patients showed no significant interval change of the vessel wall. In the moyamoya disease group, all of the patients showed concentric wall thickening and enhancement. On follow-up HRMRI, three patients showed increased plaque volume, one patient showed no significant interval change and one patient showed decreased plaque volume.

Conclusions
Postgadolinium intracranial HRMRI appears to be a useful tool in the evaluation of vessel wall morphologic changes in atherosclerosis and moyamoya disease during a follow-up period.

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Quantifying Intracranial Plaque Permeability with Dynamic Contrast Enhanced MRI

P Vakil1, C Cantrell2, T Carroll2, S Ansari3
1University of Illinois Chicago, Chicago, IL, 2northwestern university, Chicago, IL, 3Northwestern University, Feinberg School of Medicine, Chicago, IL

Purpose
The purpose of this pilot study was to quantify contrast permeability of intracranial atherosclerotic disease (ICAD) plaques in symptomatic patients and to compare these parameters against existing markers of plaque volatility using black blood magnetic resonance imaging (BBMRI) pulse sequences.

Materials and Methods
We received IRB approval and informed consent for a prospective study of contrast uptake dynamics in the major intracranial vessels proximal and immediately distal to the circle of Willis using dynamic contrast-enhanced (DCE) MRI, specifically in patients with symptomatic ICAD. Using the standard Tofts model we extracted
transfer constant (ktrans) and fractional plasma volume (vp) parameters from plaque enhancement curves. We compared these parameters against time from symptom onset as well as intraplaque hyperintensity (IPH) and postcontrast enhancement (IPE) derived from T1 SPACE, a specific BBMRI vessel wall imaging pulse sequence, using regression analyses.

Results
We completed this analysis in 10 patients. Ktrans and vp measurements were higher in plaques versus healthy white matter and similar or less than values in the choroid plexus. Only ktrans correlated significantly with time from symptom onset (p=0.02). Dynamic contrast-enhanced MRI parameters were not found to correlate significantly with IPE or IPH (p=0.4 and p=0.17 respectively).

Conclusions
The elevated ktrans and vp values found in ICAD lesions versus healthy white matter suggest that DCE-MRI is a feasible technique for studying vessel plaque characteristics in the intracranial vessels proximal and immediately distal to the circle of Willis. The significant correlations between ktrans and symptom onset which was not observed on T1 SPACE– derived metrics suggest that ktrans may be sensitive to acute and symptom-associated pathological changes in ICAD plaques.
Arterial-Spin Labeling for Non-Invasive Follow-Up of Cerebral AVMs Following Stereotactic Radiosurgery Treatment.

N Thakur¹, G Zaharchuk¹, M Iv², N Fischbein¹, J Heit¹
Purpose
Stereotactic radiosurgery (SRS) is an effective treatment for brain arteriovenous malformations (AVMs), but AVM obliteration following SRS may take 2 years or longer. Long term imaging follow-up is necessary to ensure complete AVM obliteration and to guide the need for additional treatment in the event of incomplete AVM obliteration. Digital subtraction angiography (DSA) remains the gold standard in brain AVM assessment, but DSA is invasive, carries procedural risks, involves ionizing radiation, and is relatively costly. Magnetic resonance imaging/magnetic resonance angiography (MRI/MRA) with conventional sequences has been shown to have predictive value in evaluating for obliteration of AVM post-SRS, but its sensitivity and specificity is inferior to DSA. Arterial spin labeling (ASL) is a noncontrast MRI sequence that has been shown to be sensitive in the detection of arteriovenous shunting by brain AVMs and dural arteriovenous fistulae. The purpose of this study was to determine the sensitivity and specificity of ASL in the detection of residual AVMs at least 2.5 years post-SRS, using DSA as the reference standard.

Materials and Methods
This study was approved by our institutional review board. We retrospectively reviewed our neurointerventional database and identified 241 consecutive patients who had undergone DSA for AVM evaluation from 6/2010-6/2015. Patients met inclusion criteria if they had 1) Undergone SRS for brain AVM treatment, 2) had a follow-up MRI with ASL at least 30 months after SRS, 3) had a DSA within 3 months of the follow-up MRI with ASL, and 4) had no intervening treatment between the MRI and DSA. Four neuroradiologists independently reviewed the MRIs for the presence of abnormal venous ASL signal suggestive of arteriovenous shunting. Reviewers were blinded to the results of the follow-up DSA, which was independently and blindly reviewed by an interventional neuroradiologist. Patient demographics, presentation, and imaging characteristics of the AVM were reviewed. Spetzler-Martin (SM) grading was determined from the oldest DSA before SRS. Statistical analysis was performed using XLSTAT.

Results
Fifteen patients (3 males and 12 females, mean age 29 years) met inclusion criteria. There were 12 cerebral AVMs, including SM 1 (1 patient), SM 2 (4 patients), SM 3 (2 patients), SM 4 (3 patients), and SM 5 (2 patients), and posterior fossa AVMs (3 patients). Digital subtraction angiography demonstrated complete AVM obliteration in five patients, and residual AVM in 10 patients. The sensitivity and specificity of venous ASL signal for predicting residual AVM on follow up DSA was 100% and 95%, respectively. Interobserver agreement was 0.92.
Conclusions
Arterial spin labeling with abnormal venous signal is highly accurate in identifying residual AVM following SRS treatment, with a sensitivity and specificity that approached that of DSA. Given the improved accuracy over previously reported conventional MRI sequences, ASL should be included in all MRI studies evaluating AVMs following SRS. Future studies should investigate whether MRI with ASL may be used to triage patients to DSA to guide additional AVM treatment.
Detailed Analysis of the Persistent Trigeminal Artery

O Narin\(^1\), J Song\(^2\), A Malhotra\(^1\)
\(^1\)Yale New Haven Hospital, New Haven, CT; \(^2\)Yale University, New Haven, CT

Purpose
Persistent trigeminal artery (PTA) is the most common of the persistent carotid-vertebrobasilar anastomoses, which was originally classified into two predominant types by Saltzman in 1959. The purpose of this study was to evaluate the incidence of the different types of PTA, the incidence of associated vascular anomalies including aortic arch anomalies and other arterial anomalies such as aneurysms, and the correlation of aortic arch anomalies with other arterial anomalies in PTA cases.

Materials and Methods
A retrospective review of the imaging database at a tertiary academic center was performed to identify all the patients with a persistent trigeminal artery identified by computed tomography angiography (CTA) imaging. Over a 5-year period (1/1/2010-12/1/2015), 42 patients were found to have a PTA on CTA examinations. Patients who did not have any diagnostic imaging studies involving the aortic arch were excluded from the study. Cases were reviewed retrospectively by two radiologists. Data collection included demographic information, classification of the Saltzman type of PTA (type 1 versus type 2), presenting symptoms, presence and type of aortic arch anomalies, and presence of aneurysms. Subsequently, data analysis was performed.

Results
Of 42 patients with PTA, 12 were excluded from the study (8 patients had no imaging of the aortic arch; 4 patients had no evidence of PTA on re-review of the cases). Among 30 patients with PTA, 18 were female and 12 male. Fifty-four percent (n=16) of the PTAs were on the left side and 46% (n=14) on the right. Type 1 was the most common Saltzman type (84%, n=25). Among 30 patients, eight had concurrent aortic arch anomalies (26.7%): six cases of common origin of the right brachiocephalic artery and the left common carotid artery and two cases of left vertebral artery arising from the aortic arch. Seven patients (23.3%) had concurrent aneurysms: three had saccular aneurysms at the origin of the PTA (42.9%) and one (14.3%) had an aneurysm of the extracranial ICA, two anterior communicating artery aneurysm (28.5%) and one contralateral middle cerebral artery aneurysm (14.3%). Eight (26.7%) cases were identified incidentally in asymptomatic patients, whereas 22 cases (73.3%) presented with neurological symptoms. There was no statistically significant
correlation between the aortic arch anomalies and concurrent arterial aneurysms in patients with PTA (p= 0.89).

Conclusions
This study showed a higher female predilection for persistent trigeminal artery (PTA) and overall a higher incidence of Saltzman type 1 PTA. The high incidence of associated aortic arch anomalies and arterial aneurysms suggests that there may be a common route of error during arterial vascular development. However, no statistically significant correlation was seen between aortic arch anomalies or concurrent arterial aneurysms in patients with PTA. It is important for the interpreting radiologist to understand variations and associations of cerebrovascular anatomy to understand mechanisms of disease, presenting symptoms, and to develop optimal treatment plans.
A) Coronal CTA MIP image demonstrating a persistent trigeminal artery (yellow arrow) and connection between the right ICA and the basilar artery. The right sided PTA joins the basilar above the origin of the superior cerebellar artery (blue arrow), compatible with Saltzman type 1. Fused fusiform aneurysm (red arrow) of a left posterior (white arrow) seen on axial CTA MIP (B) and sagittal CTA images.