

# 41st Annual Meeting of the American Society of Neuroimaging Austin, TX, February 2018 Presented Abstracts

## 1. Preexisting White Matter Disease Burden Impacts Cognitive Outcome after Inpatient Rehabilitation for Ischemic Stroke

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**Background and Purpose:** White matter hyperintensities (WMH) have been shown to impact functional outcomes after ischemic stroke. However, their role in cognitive recovery after ischemic stroke is unclear. Therefore, it is important to evaluate if WMH can predict the degree of cognitive recovery after inpatient rehabilitation.

**Methods:** We retrospectively studied 162 patients admitted to inpatient rehabilitation after an acute ischemic stroke. We reviewed patient demographics, presence of comorbidities, infarct volume, preadmission Modified Rankin Scale, Trial of org 10172 acute stroke treatment criteria, acute interventions for their stroke, rehabilitation length of stay, and Functional Independence Measure (FIM) scores (motor and cognitive) at admission and discharge from rehab. WMH were graded according to the Fazekas scale based on visual assessment in both periventricular and subcortical areas.

**Results:** Of the 162 patient charts reviewed, 53 were excluded due to primary intracerebral hemorrhage and insufficient imaging. Total of 109 patients were included in the final analysis. Multiple linear regression analysis revealed that, when adjusted for infarct volume, National Institute of Health Stroke Scale, and age, severity of WMH as graded on Fazekas scale independently predicted FIM cognitive scores at discharge ( $P < .0084$ ). WMH severity did not predict FIM motor scores.

**Conclusions:** In this retrospective analysis, we found that severity of WMH hyperintensities as graded by Fazekas scale is an independent predictor of cognitive FIM scores after inpatient rehabilitation for acute ischemic stroke.

## 2. A Survey of Intersocietal Accreditation Commission Accredited MRI Facility Safety Practice

*Presenter: Marge Hutchinson*

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**Background and Purpose:** MRI is considered one of the safest diagnostic imaging tests; that is until something goes wrong. Serious accidents are rare, but the risk of injury from the magnet is real. Experts estimate that 85% of injuries are preventable. MRI accidents can be avoided by strict adherence to safety standards. In the past, there have been calls for accreditation organizations to be more involved in compelling facilities to follow MRI safety standards. The IAC Standards and Guidelines for MRI Accreditation (Standards) are the foundation of the Intersocietal Accreditation Commission (IAC) accreditation process. To become accredited, facilities must have written policies and procedures that ensure patient and personnel safety.

Laboratories must enforce and review safety policies annually as part of required quality improvement activities. The effect of IAC-required safety measures on facility operation is unknown. The aim of this survey is to assess accredited facilities' perception of the impact of the IAC Standards and accreditation process on awareness of MRI safety.

**Methods:** In June 2017, an electronic survey was sent to 605 technical directors of IAC-accredited MRI facilities. The survey comprised 23 questions related to safety (7), quality improvement (QI) (9), and demographic information (7).

**Results:** There were 193 respondents to the survey (31.9%). A majority of those surveyed (84.7%) agreed the IAC Standards and accreditation process led to an increased awareness or scrutiny of their facility's MRI safety practices. Before accreditation, 31.2% of respondent facilities did not have a QI plan to assess MRI safety. Also, 19.4% of respondent facilities had never carried out QI activities before seeking accreditation, and 8.3% only assessed QI every 2-3 years. Further, 44.1% of facilities did not hold quality improvement meetings to discuss the results of QI assessments. Related to safety, 7.8% of facilities did not have a written policy for identifying patients or other individuals with potential contraindications for the MRI environment. Of laboratories that administer gadolinium contrast, 10.2% did not have a written screening policy for contraindications, renal toxicity or allergies.

**Conclusion:** The results of a survey of IAC-accredited MRI facilities demonstrates that most respondents believe the IAC Standards and the accreditation process led to an increased awareness and scrutiny of MRI safety practices. Facilities without formal MRI safety policies or that did not assess MRI safety before seeking IAC accreditation are now required to assess safety regularly.

## 3. Improved Quality at Intersocietal Accreditation Commission Carotid Artery Stenting Facilities

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**Background and Purpose:** The Intersocietal Accreditation Commission (IAC) began accrediting carotid artery stenting (CAS) facilities in the year 2011. The accreditation process rigorously evaluates staff qualifications, facility operation, equipment quality control, safety, appropriate patient selection, procedure performance, clinical outcomes, and quality improvement. Accreditation is determined based on compliance with the IAC Standards for Carotid Stenting Accreditation. To date, a small number of facilities performing CAS have achieved accreditation. The aim of this abstract is to report accreditation findings of the first facilities applying for IAC CAS accreditation.

**Methods:** The IAC database was used to extract the peer review findings of case studies and quality improvement of facilities applying for CAS accreditation and subsequent reaccreditation 3 years later. Eight neurologic testing issues and five procedure performance issues were assessed. The number and percentage of facilities with issues at the time of first accreditation were compared to reaccreditation.

**Results:** Between the year 2012 and 2013, eight facilities applied for IAC CAS facility accreditation with six successfully achieving accreditation. Of those six accredited facilities, all completed the reaccreditation process between the year 2014 and 2015. At the time of initial accreditation, approximately two-thirds of the case studies demonstrated neurologic testing using the National Institute of Health Stroke Scale (NIHSS) pre-CAS, post-CAS, and at 30-day follow-up (71%, 71%, and 63%, respectively). At the time of reaccreditation, the number of cases measuring NIHSS pre-CAS and post-CAS increased (pre-CAS, 93%, post-CAS, 90%). The performance of NIHSS at 30-day follow-up did not change appreciably (1st accreditation, 63%, reaccreditation, 64%). At the time of initial accreditation, the number of cases with neurologic status measurement using the Modified Rankin Scale (mRS) pre-CAS, post-CAS, and at 30-day follow-up was low (13% for all three). However, at reaccreditation, measurement of mRS rose considerably (85%, 78%, and 61%, respectively). Unfortunately, the data for 30-day follow-up and imaging at 30-day follow-up were not available for initial accreditation. However, at reaccreditation, for 91% of the cases, patients were evaluated at 30-day follow-up and of those, 87% had imaging performed at 30-day follow-up. For procedure

performance, no change was seen between initial accreditation and reaccreditation for appropriate patient selection, reporting of intracranial vasculature, and accurate % stenosis (75% for all measurements). At initial accreditation, adequate image quality of digital subtracted angiography was found in 50% of facilities. That number rose to 75% at reaccreditation. At first time accreditation, only 25% of facilities documented both the pre- and post-CAS anterior-posterior and lateral intracranial images. At reaccreditation, the number rose to 50%.

**Conclusion:** Although few facilities have achieved IAC CAS accreditation, facilities that completed the accreditation process demonstrated meaningful improvement in quality related to neurologic testing and procedure performance. However, continued improvement is needed in several areas.

## 4. Benedikt's Mimic Syndrome in Thalamic Infarction

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"Benedikt syndrome" by definition is typically caused by a pathology in the tegmentum of the paramedian midbrain affecting the oculomotor fasciculus, peduncle, and the red nucleus that leads to a contralateral choreoathetoid movements, ataxia, and hemiparesis with an ipsilateral ptosis. We present a 63-year-old right-handed African American male who had an acute onset involuntary left upper extremity choreoathetosis and associated with a right-sided ptosis; however, the MRI showed a right anterior thalamus infarction. Anterior thalamus is supplied by the tuberothalamic artery (TTA) which also feeds the hypothalamus. We believe that our patient's presentation was a result of concomitant insult to the thalamus and hypothalamus for the TTA territory infarction, which mimicked the Benedikt syndrome. His right-sided ptosis was secondary to a partial Horner's syndrome from the hypothalamus injury and his left-sided choreoathetosis was from right thalamus involvement. Our case is highlighting that TTA territory infarction including anterior thalamus and partially hypothalamus can also mimic the Benedikt syndrome and, to our knowledge, this is the first case report of this mimicked syndrome in the thalamus lesion.

## 5. Neuromuscular Ultrasound in the Evaluation Peripheral Nerve Sheath Tumors in Neurofibromatosis Type 1

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**Background and Purpose:** Neurofibromatosis type 1 (NF1) is a neurogenetic disorder in which individuals may develop a variety of benign and malignant tumors. Peripheral nerve sheath tumors are encountered most frequently in this patient population. Previous literature has proposed whole body MRI as the reference standard to identify nerve sheath tumors in NF1. Evaluation of peripheral nerve with high-resolution ultrasonography (HRUS) has been explored in asymptomatic or minimally symptomatic individuals with NF1. Our study reports a series of four individuals with NF1, all with varying phenotypic presentations of cutaneous findings, who had relatively unremarkable electrophysiologic studies. HRUS was used to visualize peripheral nerves in these patients. The objective is to determine ultrasonographic peripheral nerve involvement in patients with NF1.

**Methods:** Four patients with NF1 were included in this study to detect asymptomatic abnormalities of the upper and lower extremity nerves. Patients underwent clinical examination, nerve conduction studies with needle electromyography, along with HRUS using a Terason 15L4 linear array transducer at the highest frequency (15-10 MHz), with nerve visualization in both the transverse and longitudinal planes. Power Doppler was applied to evaluate for any vascular anomalies and/or hyperemia within the nerve.

**Results:** We present the ultrasonographic imaging findings of peripheral nerves anomalies in a series of four patients with NF1. All patients underwent ultrasound examination of the median, ulnar, radial, brachial plexus, sciatic, tibial,

peroneal, and sural nerves in all extremities. Neuromuscular ultrasound made the diagnosis of NF1 for one patient with minimal cutaneous findings which showed diffuse plexiform neurofibromas in nearly every peripheral nerve imaged. Two siblings with genetically confirmed NF1 were also evaluated. One sibling showed multiple neurofibromas and nonspecific fascicular enlargement along the multiple peripheral nerves. Peripheral nerve imaging in the other sibling showed minimal changes of fascicular enlargement in multiple nerves without neurofibromas, as well as an ulnar neuropathy across the elbow (compressive site). One patient with striking cutaneous fibromas had a nearly normal ultrasound examination of her peripheral nerves; with only mild nonspecific fascicular enlargement in a few nerves. There was no increase in vascularity on power Doppler in any of the visualized neurofibromas or plexiform neurofibromas. Electrophysiologic correlation was performed.

**Conclusion:** In our case series of four individuals with NF1, of varying clinical phenotypes, we evaluated peripheral nerves using HRUS. Peripheral nerve abnormalities, including evidence of neurofibromas, plexiform neurofibromas, and abnormal fascicular patterns, were seen in all four individuals. Interestingly, the most prominent nerve changes were seen in the individual with the least clinically evident neurofibromatosis, whereas the patient with marked cutaneous findings had minimal changes on peripheral nerve ultrasound examination. Neuromuscular ultrasonography is a cost- and time-effective diagnostic tool that can assist the electromyographer in the localization of nerve pathology, and should be used in the evaluation of peripheral nerve sheath tumors in individuals with NF1.

## 6. Neurosonographic Diagnosis of Lückenschädel and Lemon Sign in Neonates

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Lückenschädel and lemon sign are thought to result from intracranial hypotension with subsequent dysplasia of the membranous skull. Both conditions have been described in neural tube defects and encephalocele. Lückenschädel typically lies in thickest part of the frontal, parietal, and upper occipital bone forming groups of round, oval, or finger-shaped pits on the inner surface of the cranial vault. Lemon sign is an inward scalloping of the frontal bone resulting from abnormal frontal bone development. Both conditions are self-limiting with the lemon sign disappearing early and Lückenschädel typically resolving after 6 months of age. Postnatal neurosonographic diagnosis of lemon sign and Lückenschädel has never been attempted. Cranial ultrasounds of infants with encephalocele or myelomeningocele performed shortly after birth over the last 5 years were reviewed. The anterior, posterior, and temporal windows were obtained. Mean gestational age was 36 weeks with studies done at mean age of 1.6 days. Neurosonographic evaluation was obtained in 14 infants: 10 had Chiari 2 with myelomeningocele; 2 had Chiari 3 with encephalocele; and 2 had isolated encephalocele. Ventriculomegaly was present in 12 infants. Lemon sign was best appreciated through the posterior fontanelle. All three windows were necessary to appreciate Lückenschädel. In 2 infants with mild Lückenschädel, lemon sign was absent while in all infants with moderate to severe Lückenschädel, lemon sign was present. We conclude that in the neonates, neurosonography allows for effective noninvasive recognition of lemon sign and Lückenschädel. Moreover, the lemon sign appears to persist longer in infants with moderate to severe Lückenschädel.

## 8. Remote Transcranial Doppler Monitoring for Carotid Interventions: Feasibility and Efficacy

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**Background and Purpose:** Transcranial Doppler (TCD) is an important tool in monitoring carotid interventions. One of the limitations is the need of a neurosonology expert during procedures. This observational study is intended to address two issues: (1) can the TCD headframe be placed by a nonexpert with remote advice from the expert, and (2) can the remote expert observe the monitoring and communicate with the surgeon effectively.

**Methods:** With the VisitOR1<sup>®</sup> teleproctoring technology (Karl Storz Endoscope, Tuttlingen, Germany), a neurosonology expert in a remote place, and a nonexpert physician in the operating room monitored 10 carotid procedures with TCD. We registered if the nonexpert was able to place the headframe and obtained a proper middle cerebral artery signal. We classified interactions of the remote expert as (1) major, if the interaction influenced in technical aspects of the surgery, and (2) minor, in the rest of the cases. As safety endpoint, we registered stroke or death of any cause until the patient was discharged. Besides, we asked the participants to complete an experience survey.

**Results:** The monitoring was completed in 9 of the 10 cases. Mean value of major interactions per procedure was 1.22 (range, 0–2) and mean value of minor interventions was 6.78 (range, 1–15). No stroke or death of any cause was registered. The participating parties evaluated the experience as positive with an overall grade of satisfaction from 90% to 100%.

**Conclusions:** Remote TCD monitoring proved to be a useful modality. This technology demonstrated that it can be used to teach the basic skills to conduct TCD monitoring. This study also showed that is a safe alternative when a neurosonology expert is not available to perform an onsite TCD monitoring in the operating room.

## 9. The Breath Hold Acceleration Index: A New Index to Evaluate Cerebrovascular Reactivity

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**Background and Purpose:** Cerebrovascular reactivity (CVR) is an ideal biomarker to detect cerebrovascular damage. CVR can be quantified by measuring changes in cerebral blood flow velocity (CBFV) in response to a CO<sub>2</sub> challenge. These changes are detected using transcranial Doppler (TCD) in the middle cerebral artery (MCA), often during breath-holding (BH). The BH index (BHI) is the maximum percentage increase in CBFV divided by BH time. Despite the convenience of BH methodology, BHI has high variability. In addition, changing body position may change CVR. It is important to determine if CVR changes in different body positions. The aims of this study were: first, to propose an alternative index to evaluate CVR using the BH maneuver; and second, to investigate the effect of body position in CVR using a head-up (HUT) and head-down (HDT) tilt table.

**Methods:** Ten healthy young volunteers (21.4 ± 1.7 years) held their breath for 30 seconds on a tilt table. CBFV data were collected from the MCAs using TCD at five body positions (45, 30, 15 degree (deg) HUT, supine position and 15 deg HDT). The mean velocity ( $V_m$ ) was calculated by averaging the CBFV samples within each cardiac cycle. CVR was calculated using two methods: the standard BHI, and the BH acceleration index (BHAI), a new index obtained by linear regression of the most linear portion of the CBFV envelope during the BH maneuver. The regression represents acceleration as it is the change in blood flow velocity per unit time.

**Results:** The mean coefficient of variation was 82.5% lower in BHAI in comparison with BHI. Values of BHAI and BHI were not statistically significant between body positions ( $P = .24$  and  $P = .5$ ).

**Conclusions:** In this study, we proposed a new index (BHAI) to assess CVR using a BH maneuver. This index has considerably less variability in comparison with the conventional standard BHI. Additionally, we demonstrated that CVR does not significantly change due to body position. This is interesting considering cerebral perfusion pressure may be higher in HDT due to induced gravity-dependent shifts in blood volume distribution.

## 10. Role of Thin-Sliced Reformatted CT Imaging for Acute Ischemic Stroke Patients: Do We Need CT Angiography before Acute Neurointervention?

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**Background and Purpose:** Thin-sliced reformatted noncontrast CT head are not considered sensitive enough for thrombus detection. CT angiography is done to confirm large vessel occlusion. CTA adds extra radiation and contrast. Through this study, we want to investigate if thin-sliced reformatted noncontrast CT scans could be reliably used to detect and measure size of the thrombus in patients with large vessel occlusions (LVOs).

**Methods:** Retrospective analysis of patients who underwent acute endovascular intervention for LVOs at a community-based, university affiliated comprehensive stroke center during 2-year period (January 2015–December 2016) was done. The raw data of nonenhanced CT scans and CTAs were collected. All raw data were reconstructed with thin slices of .625 mm using standard general electric software. Vessel diameter and clot length were measured on both CT and CTA (5-mm maximum intensity projections of the thin slices on CT and axial/coronal projections on CTA). Each patient's CT and CTA were paired for length and diameter in millimeters. Paired two-sample hypothesis test was run on SPSS.

**Results:** A total of 926 patients presented with acute ischemic stroke during the specified time period. Of those, 99 were LVOs that received endovascular treatment of which, 37 had both CT and CTA done and had intracranial lesions. Mean clot length was 13.99 (SD 5.34) on thin slices CT and 14.18 (SD 5.64) on CTA. Vessel diameter was 2.83 (SD .54) on thin sliced CT and 2.55 (SD .51) on CTA. There was no significant difference in estimated clot length done on CT as compared with CTA ( $P = .601$ ). There was significant difference in estimated vessel diameter on CT as compared with CTA.

**Conclusion:** Thin-sliced reconstructions of standard cranial nonenhanced CT raw data can be reliably used to detect and measure the thrombus size in LVOs. It does slightly overestimate the vessel diameter but still making intervention planning possible. Larger multicenter trials are needed to validate our data.

## 11. Transcranial Doppler Studies in the Post-Code Stroke Embolectomy Setting

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**Background and Purpose:** Transcranial Doppler (TCD) is a noninvasive bedside tool for evaluating in real time the circulation in the large arteries of the Circle of Willis. Mechanical embolectomy for intracranial clot retrieval and stenting of extracranial carotid artery lesions are becoming tools for rapid therapy in Code Stroke patients. This study looks at TCD findings in Code Stroke patients that underwent emergent neuroendovascular embolectomy 1–6 hours postprocedure from January 2017 through September 2017 at a Level 1 trauma center.

**Methods:** Twenty-four patients with focal neurologic deficits were studied between 1 and 5 hours postmechanical embolectomy with bedside TCD. Mean velocities were measured in the large arteries of the Circle of Willis, with analysis of the waveform shapes, and the presence or absence of microemboli, documented. Patients were categorized as: (1) rapidly improved, (2) minimal improved, (3) no improvement, and (4) cerebral circulatory arrest.

**Results:** Ten (42%) patients showed rapid improvement. Three of these patients had both stented extracranial internal carotid arteries and embolectomy in the ipsilateral

middle cerebral artery. All 10 patients had mean flow velocities within the normal range. Five of the 10 patients had microembolic events detected flowing through the repaired arteries. Six (25%) patients showed minimal improvement. All had normal TCD studies except for microembolic events detected in 4 of the 6 flowing through the repaired arteries. Five (21%) patients showed no improvement with 2 having normal TCD studies and 3 showing restenosis. Three (12.5%) patients had reverberatory TCD waveforms, relatable to cerebral circulatory arrest.

**Conclusions:** TCD following emergent embolectomy is an excellent tool for assessing postprocedure outcomes. Rapidly improving patients had normal TCD studies. The presence of native embolic events in this patient group was surprising and supports the importance of intensive follow-up medical management.

## 12. Multifocal Recurrent Strokes in Cerebral Vasculitis and Intravascular Large B-Cell Lymphoma

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Cerebral vasculitis or primary angitis of the central nervous system (PACNS) is a rare disorder affecting both medium- and small-sized vessels. About 700 cases have been published worldwide. Major symptoms of PACNS are stroke, headache, and encephalopathy. Neither neuroradiological findings nor laboratory tests allow a definite diagnosis of the disorder. PACNS can be mimicked closely in clinical presentation as well as neuroradiological manifestations by a group of disorders and also neoplasms including intravascular lymphocytic B cell lymphoma (IVBCL). IVBCL is poorly understood with nonspecific presentations, and lack of specific noninvasive diagnostic tests. It is often not considered in vivo and usually diagnosed on autopsy. Brain biopsy is the diagnostic procedure of choice in suspected IVBCL affecting the CNS, as cerebrospinal fluid analysis, brain MRI/CT scans, MR angiography, and even conventional cerebral angiography lack specificity to differentiate IVBCL from cerebral vasculitis. We report four cases, two of which are biopsy-proven primary angitis of CNS and two cases of IVBCL, diagnosed through biopsy in vivo. All four cases had similar clinical presentation and mimicked similar radiologic findings. Our case series implies that it is integral to differentiate PACNS and consider IVBCL in differentials early on, because treatment with steroids or immunosuppressive treatment may critically delay the diagnosis of IVBCL due to transient remission of neurological symptoms and result in fatal outcomes.

## 13. Safety and Clinical Outcomes after Transverse Venous Sinus Stenting for Idiopathic Intracranial Hypertension: Single Center Experience

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**Background and Purpose:** Idiopathic intracranial hypertension (IIH) is a disorder characterized by signs and symptoms of increased intracranial pressure without structural cause seen on conventional imaging. Unilateral or bilateral transverse sinus or transverse-sigmoid junction stenosis is a very common finding in these patients. There is ongoing debate whether venous sinus stenosis is the cause of IIH or result of it. Multiple case reports and case series have proven venous sinus stenting to be very effective in medically refractory IIH. Through this study, we want to share our experience with venous stenting in patients with

IIH who had transverse sinus or transverse-sigmoid sinus junction stenosis.

**Methods:** All patient with medically refractory IIH who underwent venous sinus stenting (VSS) at our university affiliate community comprehensive stroke center in 2017 were analyzed.

**Results:** Our neuro-ophthalmology services identified four patients that had medically refractory IIH and underwent VSS or angioplasty. Mean age was 47. Seventy-five percent of patients were women ( $n = 3$ ). Headache was the most common symptom (100%) followed by transient visual obscurations (75%,  $n = 3$ ) and pulsatile tinnitus (25%;  $n = 1$ ). All patients were found to have bilateral papilledema. Mean lumbar opening pressure was 36.25 (SD = 4.65; 95% CI = 30.98-41.5). All patients were on maximum doses of acetazolamide and diuretics. Half of the patients had right transverse sinus stenosis with hypoplastic left transverse sinus stenosis ( $n = 2$ ) and other half had bilateral transverse sinus stenosis ( $n = 2$ ). Mean pressure gradient across the transverse sinus was 17 (32 ± 15). Three patients were treated with transverse sinus stenting and 1 with angioplasty. All patients were able to come off their medications with significant improvement in symptoms and visual fields (Mann-Whitney test;  $P$ -value = .028). No complications occurred during intervention. **Conclusion:** Transverse sinus angioplasty ± stenting is a safe and effective means of treating IIH. Larger studies are required to support our results.

## 14. Perfusion Imaging in the Management of Delayed Cerebral Ischemia after Subarachnoid Hemorrhage

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Perfusion imaging by CT or MR has been proven to be useful for prediction and early detection of delayed cerebral ischemia (DCI) after subarachnoid hemorrhage, attributed to vasospasm. Only recently have systematic reviews differentiated prognostic models from early detection of subclinical ischemia. Here, we distinguish the value of perfusion imaging in (1) prognostication of DCI, (2) early detection of DCI, (3) quantifying ischemia to gauge therapeutic response to hemodynamic augmentation, (4) targeting regions at higher ischemic risk for angioplasty or intraventricular nicardipine, (5) ascertaining blood-brain-barrier leakage to measure the risk of reperfusion injury and hemorrhagic insult, and (6) identifying blood-brain-barrier dysfunction responsible for edema and perfusion metabolic decoupling. We use an alarm system based on age, clinical status, and clinical measures including blood pressure, fever/systemic inflammatory response syndrome, salt wasting, transcranial Doppler, and intracranial pressure. When suspicion of ischemia is raised, CT perfusion is performed to confirm and characterize the lesion—including focal versus global, proximal versus distal, punctate versus territorial, cortical versus subcortical ischemia—and guide therapeutic management. For example, only ischemic foci with risk of imminent infarction and proximal narrowing will undergo angioplasty. This protocol leads to (1) less premature recourse to prostatic management with intravenous fluids, hemodynamic monitoring, and neuroimaging, (2) judicious use of neurocognitive scales, quantitative EEG, and intracranial monitoring, and (3) tailored treatment between hemodynamic augmentation and endovascular therapy based on severity of DCI. Perfusion imaging is not the panacea for DCI detection if used indiscriminately, as poor sensitivity and specificity have been reported. However, it is a tremendously useful tool when used discriminately along with other modalities for evaluating DCI. Perfusion imaging may become the gold standard for diagnostic confirmation and characterization of ischemia, leading to targeted therapeutic strategy.

## 15. Carotid Ultrasound with Concurrent Transcranial Doppler in Risk Stratification of Carotid Artery Stenosis

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**Background and Purpose:** Patients with transient ischemic attack (TIA) require carotid imaging to evaluate for symptomatic internal carotid artery (ICA) stenosis. This can be performed with carotid ultrasound (CUS) or CT angiography (CTA). The decision to proceed with carotid revascularization can sometimes be challenging in cases where the degree of stenosis falls within the “moderate range” (50-69%).

**Case:** A 71-year-old male on aspirin presented with recurrent episodes of transient right-sided numbness and weakness. Initial CUS revealed 50-69% ICA stenosis bilaterally, correlating with CTA demonstrating a 65% on the right and a 67% stenosis on the left. The patient was initiated on dual antiplatelet therapy, although had recurrent events 7 days later, and a repeat CUS was ordered with concurrent transcranial Doppler ultrasound (TCD). During insonation of the left ICA, multiple microembolic signals were observed in the left middle cerebral artery on TCD. The patient simultaneously experienced a recurrent episode of right-sided numbness and weakness during insonation. The patient was referred for left carotid endarterectomy. Following successful intervention, the patient has not experienced another episode consistent with TIA.

**Conclusion:** The use of CUS with concurrent TCD has, to our knowledge, not been previously reported. Our case raises consideration of a novel approach to stratifying the risks of recurrent stroke in symptomatic patients with moderate ICA stenosis using TCD.

## 16. Lateral Projection is Superior to Oblique Groin Projection in Femoral Angiography for Identification of Arteriotomy Sites

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**Background and Purpose:** Femoral arteriography is the critical initial conduit for catheter-based cerebral angiography. After securing access, angiography is performed over the groin in oblique projection through sheath to evaluate for desired arteriotomy site below the inguinal ligament and above the common femoral artery bifurcation. Knowledge of site insertion is also needed to determine suitability of closure device. However, the exact entry point may not be frequently visualized due to catheter-vessel or vessel-vessel overlap. Hardware and implants may also obscure the field. We investigated whether lateral projection was superior to oblique projection in the groin for accurate identification of the arteriotomy site.

**Methods:** We performed groin angiography in oblique and lateral projections after securing femoral access in patient undergoing cerebral angiography procedures. Best representative images of angiographic runs in oblique and lateral projections from 115 patients were interpreted in blinded fashion by an interventional neurologist. Data were recorded whether insertion site was precisely identified in oblique and lateral projections. The reason for inability to identify site of insertion was also identified.

**Results:** Precise site of insertion was identified in 111/115 (96.5%) lateral projection angiograms compared to 87/115 (75.6%) oblique projection femoral angiograms ( $\chi^2 = 20.90$ ,  $P < .05$ ). Oblique projection frequently had catheter-vessel overlap (18.2%), vessel-vessel overlap (3.4%), or hardware obscuration of field (2.6%). In lateral projection, we encountered only 2 cases each (1.74%) of catheter-vessel overlap and vessel-vessel overlap. None of the lateral projection angiograms were obscured by hardware and implants. In lateral projection, common femoral artery (74.7%) was the most common site of insertion followed by femoral bifurcation (10.4%), superficial femoral artery (9.5%), and deep femoral artery (1.7%).

**Conclusion:** Lateral projection is superior to oblique projection in femoral angiography for accurate assessment of arteriotomy site and entry of sheath.

## 17. Peri-ictal Neuroimaging Changes during Seizures May Mimic Stroke

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**Background and Purpose:** Neuroimaging plays an important role in the work up of many neurological conditions, including stroke and epilepsy. Stroke is often described as a hypodensity or hypoattenuation of signal on CT head, or as a diffusion restriction lesion with T2 fluid-attenuated inversion recovery (FLAIR) hyperintensities on MRI brain. In epilepsy, neuroimaging is often used to identify brain pathologies that lead to a seizure focus. During seizures, peri-ictal changes on neuroimaging have been described, including effacement of gyral markings that may be confused as brain tumors, stroke, or encephalitis. The current case study shows peri-ictal changes on neuroimaging that may mimic stroke in a patient that presents with stroke-like symptoms.

**Case:** This is a 39-year-old female with history of epilepsy, hypertension, dihydrolipoamide dehydrogenase deficiency, and type A aortic dissection status postrepair with replacement of the ascending aorta, resuspension of the aortic valve, and bypass to the innominate artery who was admitted for redo of aortic replacement with preceding subclavian-carotid transposition. During the surgery, pump time was 188 minutes, and clamp time was 122 minutes. No complications were noted during surgery. Postoperatively, the patient developed sudden onset of left hemiplegia concerning for stroke. Initial CT of the head imaging showed sulcal effacement of the right frontal-parietal cortices. CT angiography of the head and neck was also performed which showed a large arterial dissection involving the right common carotid artery but no evidence of large vessel occlusion. Given her recent aortic replacement surgery, no evidence of large vessel occlusion, and her last known well time was beyond the 4.5-hour window, patient was not a candidate for IV tissue plasminogen activator or mechanical thrombectomy. MRI brain without contrast showed diffusion restriction, FLAIR signal abnormality, and mass effect within the right middle cerebral artery territory. Right-sided claustrum FLAIR signal abnormalities support the possibility of seizure activity. Repeat CT of the head 2 days later showed persistent effacement of the right temporal lobes. Patient was started on Versed drip and started on Keppra and Vimpat. Electroencephalogram (EEG) showed diffuse slowing along with periodic lateralized discharges and epileptiform discharges suggestive of electrographic seizure activity. Doses of Keppra and Vimpat were increased. EEG eventually improved. Patient improved with no focal neurological deficits after seizures were treated.

**Conclusion:** Peri-ictal imaging findings are important to know as it may mimic other disease pathologies that may lead to different treatment and work up.

## 18. Variability of Extracranial Flow Velocity Measurements in Sonographic Vasospasm Screening

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**Background and Purpose:** Transcranial Doppler (TCD) is routinely used to screen for vasospasm in subarachnoid hemorrhage (SAH). The diagnosis of sonographic vasospasm relies in part on velocity measurements in the extracranial internal carotid arteries (eICA) and vertebral arteries (eVA) in order to determine intracranial/extracranial velocity ratios (such as Lindegaard and Soustiel ratios). Variability in vessel tortuosity between individuals may impact these measurements. We sought to determine the variability of extracranial mean flow velocity (MFV) measurements that could impact vasospasm grading.

**Methods:** We included all TCD studies performed for SAH in which measurements of the eICA and eVA MFV at two depths (5-10 mm apart) were available. Most patients had at least three measurements, and the average MFV was computed for the analyses. We calculated the mean

absolute and mean percentage difference between the MFVs at the two depths in the eICA and eVA, respectively, as well as the average absolute and average percentage deviation from the mean. We used Pearson's test to determine the normality of MFV distribution and two-tailed paired Student's *t*-test to compare the mean values.

**Results:** We included 25 patients (mean age 59 years; 69.2% female) with serial TCDs for vasospasm screening. SAH etiologies included aneurysm (80.7%), trauma (3.8%), and unknown etiology (15.3%). There was no significant difference between the two-depth MFVs for the eVA (3.3 cm/s [-1.7; 8.3]; *df* = 52; *P* = .19) or eICA (-0.49 cm/s [-5.2; -2]; *df* = 50; *P* = .8). Mean absolute and percent difference between the two depths were normally distributed (*P* > .1). There was no significant difference between the left and right eVA (0.51 cm/s [-.9; 1.9], *df* = 47, *P* = .47) and, respectively, left and right eICA (-0.06 cm/s [-1.24; 1.12]; *df* = 48; *P* = .9) mean absolute differences. However, the mean absolute difference between eVA and eICA was statistically significant (-1.43 cm/s [-2.3; .51]; *df* = 98; *P* = .002). The mean percentage difference between the eVA and eICA was also significant (-7.93 [-11.1; 4.6]; *df* = 98; *P* < .0001). Average absolute deviation from the mean (-.7 [-1.3; .08], *t* = -2.2, *df* = 94, *P* = .02) and average percent deviation from the mean (-5.29 [-7.6; 2.9], *t* = -4.4, *df* = 94, *P* < .0001) were significantly less in the eICA compared to eVA.

**Conclusion:** We found that eVA velocities were significantly more variable than eICA velocities. The commonly used intracranial/extracranial MFV ratios to screen for vasospasm might be subject to this variability. Our study suggests that multiple sampling of extracranial vessels might be important in sonographic vasospasm monitoring, especially in the vertebral arteries.

## 19. Functional Neurocognitive Imaging to Assess Concussion Biomarkers to Treat Dysregulation of Neurovascular Coupling in Postconcussion Syndrome

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**Background and Purpose:** Scientists have questioned the reliability of functional magnetic resonance imaging (fMRI) in assessing postconcussion syndrome (PCS) because it is considered an indirect measure of neuronal activation. However, current research shows that the predominant source of chronic PCS results from a pathological dysregulation of neurovascular coupling (NVC). Since fMRI is a direct measure of NVC, it provides a unique and reliable method for assessing and treating mild traumatic brain injury (mTBI) in PCS patients. Functional neurocognitive imaging (fNCI) is a task-related form of fMRI that localizes dysregulation of NVC by measuring the blood oxygen level-dependent signaling during the performance of neuropsychological evaluations. We have discovered areas of the brain with specific abnormal patterns of activation which reliably correlate with PCS pathology. We assess these concussion "biomarkers" using fNCI and compare them to a healthy control to compute a Severity Index Score (SIS). The SIS is used to design enhanced performance in cognition (EPIC) treatment, a week-long, all-day "boot camp" system designed to combine cardiovascular, neuromuscular, and cognitive therapies. fNCI has proven to be a successful diagnostic tool to assess and treat PCS.

**Methods:** Total of 551 concussed patients participated in fNCI scanning and EPIC treatment. PCS severity was measured objectively using the SIS and subjectively using a self-reported postconcussion symptom scale (PCSS) score. Initial PCSS and SIS scores were used to develop individualized, targeted, sustained, and cyclical week-long EPIC therapy incorporating cognitive, occupational, and neuromuscular modalities. These scores were also used to establish pretreatment benchmarks and measure posttreatment improvement.

**Results:** PCSS and SIS changes were assessed and calculated in percent change from pre- to posttreatment. PCSS scores showed a mean improvement of 65.7%,  $\sigma = 23.3$ . Objective SIS findings showed a mean improvement of 76.5%,  $\sigma = 23.3$ . Longitudinal reassessment of patients

shows maintained SIS improvement as measured in an average of 7.6 months posttreatment.

**Conclusions:** fNCI provides a reliable assessment of concussion biomarkers and measurement of dysregulation of NVC, allowing for identification of concussion pathology. Additionally, fNCI-derived SIS scores direct tailored EPIC therapy to restore NVC and subsequently resolve chronic PCS resulting from mTBI.

## 20. The Role of MRI in the Diagnosis of Motor Neuron Disease

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**Background and Purpose:** Motor neuron diseases (MNDs) are a group of devastating neurological disorders that cause specific damage to motor neuron cells. The diagnosis of MNDs remains clinical. Neurophysiological studies play an integral ancillary diagnostic role, yet diagnostic delays and uncertainty still exist in many cases. The role of imaging remains limited to exclusion of other pathologies. MRI findings specific for MNDs remains controversial as it lacks sensitivity and specificity. Advanced MRI sequences have more promising results and may confirm a MND when diagnosis is in doubt.

**Methods:** We present two case reports and a review of the literature illustrating the role of MRI in aiding in the diagnosis of MNDs. The first case is a 63-year-old female patient with progressive bilateral lower extremity weakness and difficulty swallowing for 6 months. Her examination revealed diffuse muscle weakness in all four extremities with no atrophy or fasciculations. Though an upgoing plantar was noted on the right, there were no clear upper motor neuron findings, otherwise (normal upper extremity reflexes and absent lower extremity reflexes). Her electromyography (EMG) study demonstrated an axonal polyneuropathy. There was chronic and active motor denervation out of proportion to the polyneuropathy suggestive of motor neuron disease, but some diagnostic uncertainty remained. The second case describes a 52-year-old female patient with a complicated medical presentation with many confounding variables. As part of her presentation on exam, she had upper motor neuron findings, such as a brisk jaw jerk and hyperreflexia in the arms not explained by conventional imaging. EMG did not reveal new or evolving lower motor neuron changes. The possibility of primary lateral sclerosis superimposed on her other medical conditions was raised clinically, but difficult to tease out given the confounding variables of the case.

**Results:** Conventional MRI T2 susceptibility image of the first case showed a hypointense rim in the right precentral gyrus. The diffusion tensor imaging showed decreased fractional anisotropy in Brodmann area 4 (motor) on the left as well as decreased motor fibers in the body of corpus callosum bilaterally with bilateral motor cortical thinning on T1 three-dimensional reconstruction. The conventional MRI of the second case did not show any abnormality, but the advanced imaging of this patient also displayed bilateral motor cortical thinning on T1. Additionally, tractography showed asymmetric truncation of motor fibers. Based on the advanced MRI findings, the diagnosis of amyotrophic lateral sclerosis in the first patient and primary lateral sclerosis in the second became more likely.

**Conclusion:** Incorporating advanced MRI imaging techniques with the current diagnostic criteria of MNDs might increase the sensitivity and specificity of both and help in providing an earlier and more confident diagnosis of the disease.

## 21. Not All That is Bright is an Abscess and Not All That Enhances is a Lymphoma: Biopsy Proven Acute Hemorrhagic Leukoencephalitis

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**Background and Purpose:** We present the evolution of neuroimaging findings from diagnosis to treatment in a rare case of biopsy proven acute hemorrhagic encephalomyelitis

that originally raised concerns for an intracerebral abscess and later in the hospital course, a central nervous system (CNS) lymphoma.

**Case:** A 52-year-old Vietnamese male presented to the emergency department with a 2-week history of left-sided weakness, numbness, headache, and dizziness. On exam, the patient had left-sided hemiplegia and left facial droop. MRI brain revealed a 3.4-cm peripherally enhancing lesion at the right thalamocapsular junction with perilesional edema and mass effect with leftward midline shift.

Diffusion-weighted imaging showed restricted diffusion with an apparent diffusion coefficient correlate. The patient was started on broad-spectrum antibiotics for suspicion of an intracerebral abscess. Initial lumbar puncture showed white blood cells 63 (92% lymphocytes), 2 red blood cells, 100 glucose (serum glucose was 296), and protein of 41. The patient continued to clinically worsen and thus a biopsy was obtained which showed lymphocytic infiltration with abundant macrophages, microglial and astrocytic activation, myelin pallor and loss, and flecks of hemosiderin suggesting microhemorrhages, which was consistent with a hemorrhagic encephalomyelitis (AHEM). The patient was started on high dose intravenous steroids. Repeat MRI brain showed new contrast enhancing hyperintensities near the occipital horn of the right ventricle concerning for seeding of a possible CNS lymphoma. Repeat biopsy was done which confirmed the initial findings of AHEM and no evidence of a lymphoma. MRI brain done after five cycles of plasmapheresis and cyclophosphamide infusions over 6 months showed significant reduction in the lesion size and enhancement.

**Conclusions:** AHEM is a rare condition with a high mortality and morbidity if not diagnosed and treated early. Neuroimaging can be effectively utilized to narrow the diagnosis in this high acuity illness.

## 22. Fetal MRI, MRA, and Ultrasound in Facial Hemangioma

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At 33-week gestation, multiplanar fetal MRI was performed to evaluate a very large facial mass contiguous with the orbit noted on intrauterine ultrasound. At delivery, repeat MRI and MR angiography confirmed the clinical diagnosis of a large congenital facial hemangioma. The imaging will serve as the basis for a discussion of the use of fetal MRI as well as the optimal techniques to achieve diagnostic images. Correlation will be made with the ultrasound as well as the postdelivery photographs. The MRI and ultrasound differential diagnosis will also be discussed.

## 23. Tarlov Cysts: The Underlying Etiology of Persistent Genital Arousal Syndrome

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**Background and Purpose:** Persistent genital arousal syndrome (PGAS), a newly recognized condition, can be described as persistent physiological arousal in the absence of conscious feelings of sexual desire. PGAS consists of extended periods of sexual excitement that neither diminish on their own nor resolve with ordinary orgasmic experiences. The majority of PGAS cases have been identified in women, 73.9% of whom had a Tarlov cyst in the sacral spine. Cysts most commonly arise at the sacral spinal nerve segment S2 or S3 junction of the dorsal nerve root ganglion and can compress the S2 nerve root, which innervates the clitoris.

**Methods:** A 52-year-old woman presented with perineal numbness along with a spontaneous sensation of orgasm without actually achieving it. This sensation was noted to occur in nonsexual situations and was causing her significant discomfort. The abnormal sensation was not associated with position, activity, thoughts, physical stimulation of the genitals, or time of day. It occurred 4–7 times a day and would last as long as 20 minutes.

**Results:** MRI lumbar spine showed a bilateral S2 sacral Tarlov cysts. Lumbar puncture was performed which was unremarkable. Needle electromyography showed abnormal spontaneous activity in the right S1 and S2 paraspinal muscles.

**Conclusion:** This case demonstrates the importance of MRI in patient with PGAS to evaluate for the presence of Tarlov cysts, which occur predominantly at the S2-S3 levels of the spine.

## 24. Lumbar Puncture as a Treatment for Intraventricular Hemorrhage

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**Background and Purpose:** Isolated intraventricular hemorrhage (IVH) in the absence of an identifiable parenchymal or subarachnoid component is only seen in 3% of ICH cases. Treatment of such patients remains quite variable and includes observation, external ventricular drainage (EVD), and EVD combined with fibrinolysis.

**Methods:** A 57-year-old male with history of hypertension presented with a severe headache, nonfocal neurological examination, and malignant hypertension. Head CT showed IVH with mild obstructive hydrocephalus. CT angiography head was negative for arteriovenous malformation or aneurysm. Neurosurgery declined EVD placement due to Glasgow coma scale of 14 and a nonfocal neurological exam. Lumbar puncture was performed to reduce the intraventricular blood burden and alleviate the obstructive hydrocephalus. Cerebrospinal fluid (CSF) opening pressure was 34 cm H2O and after removal of 28 mL of bloody CSF the closing pressure was 17 cm H2O. A second lumbar puncture was performed on the following day and 15 mL of bloody CSF was removed. Ultimately, the patient improved and was transferred out of the intensive care unit and later to home with home health.

**Results:** This patient's overall good neurological exam did not justify EVD placement but the extensive IVH placed him at risk for worsening obstructive hydrocephalus and possible shunt placement. Serial lumbar puncture was able to reduce the intraventricular blood burden while minimizing the procedural risk to the patient.

**Conclusion:** Treatment of patients with large IVH and good neurological examination remains unclear. Serial lumbar puncture may serve as option in patients in whom the procedural risk of EVD placement would not be justified due to the patient's good neurological exam.

## 25. Flat-Panel Cone Beam Computed Tomography is a Not a Reliable Predictor of Early Changes in Ischemic Stroke with Large Vessel Occlusions

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**Background and Purpose:** ASPECTS is a standardized tool to quantify the core infarct in middle cerebral artery (MCA) territory stroke. CBCT (Cone Beam CT) is a new C-arm system with 3D functionality that extends the capability of C-arm imaging to include soft-tissue applications by facilitating the detection of low-contrast objects. Through this study, our goal was to evaluate for early ischemic signs on CBCT.

**Methods:** All acute ischemic stroke patients who had CBCT prior to intervention at our university affiliated community-based comprehensive stroke center were retrospectively analyzed from the years 2011–2016.

**Results:** Of a total of 221 patients, 5 (females;  $n = 3$ ) received CBCT prior to intervention. Four out of 5 patients had proximal MCA occlusion and one had distal vertebral artery occlusion. Mean age was 81.2 years. Note that 60% were females. All patients had CT head prior to CBCT. Separate ASPECTS were calculated and compared based on CT head and CBCT. Mean ASPECTS for all MCA occlusion was 9. Three (75%) MCA occlusion had early changes in deep structures (caudate, internal capsule, lentiform nucleus, insular cortex) and 1 (25%) had M3 hypodensity based on CT head. None of the CBCT showed early ischemic changes in deep structures. CBCT did show the M5-M6 hypodensity.

**Conclusion:** We concluded that the CBCT could provide useful information for early infarcts in M1-M6 areas of MCA. Early deep cortical infarcts can be easily missed. A large population-based prospective study is needed to analyze future use of CBCT to expedite decision making.

## 26. Dysphagia and Tongue Deviation: Collette-Sicard Syndrome after Blunt Head Trauma

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**Background and Purpose:** The jugular foramen and the hypoglossal canal are both apertures located at the base of the skull. The jugular foramen contains the cranial nerves, IX, X, and XI, involved in normal cough and gag reflex. The hypoglossal canal contains the cranial nerve XII, responsible for movements of the tongue. Therefore, multiple lower cranial nerve palsies tend to occur with injuries to these structures. The pattern of injuries tends to correlate with the combination of nerves damaged.

**Case:** A 28-year-old male was involved in an AVP injury while crossing the highway. Patient was brought to a local Level I Trauma Center. On admission, he was complaining of a headache and inability to swallow his own saliva. Exam showed a Glasgow coma scale of 15, awake, alert, and oriented to date, place, and person, with dysphagia, tongue deviation to the right, uvula deviation to the left, and a depressed palate. No other abnormal findings were noted. Initial imaging showed B/L frontal traumatic subarachnoid hemorrhage, left frontal epidural hematoma, and a basilar skull fracture. On HD 4, he was transferred out of the intensive care unit with persistent tongue deviation and inability to swallow. Initial radiology read by a radiologist did not reveal any further structural abnormalities then the ones stated above. Neurology was consulted and imaging was reviewed by neuroimaging-trained neurologist, which demonstrated injury to the wall of the jugular foramen and the hypoglossal canal. Nasogastric tube feeding was initiated and patient had percutaneous endoscopic gastrostomy tube placed on HD 17 and discharged home. At 3-month follow-up, patient's tongue normalized to midline and his dysphagia resolved.

**Conclusion:** Collette-Sicard syndrome is a rare condition/syndrome characterized by unilateral palsy of CN: IX, X, XII, and XII first described by Dr. Collette in 1915 and by Dr. Sicard. This condition was historically attributed to tumors of the skull base, coiling and dissections of the internal carotid artery, multiple myeloma, vasculitis, carotid fibromuscular dysplasia, shotgun injuries, idiopathic cranial polyneuropathy, atlas fractures, and occipital condyle fractures. This condition has been rarely described as a consequence of blunt head trauma. Injuries to the jugular foramen and the hypoglossal canal are rare as most blunt head traumas resulting in basilar skull fracture involve the condyles. In most cases, the condition is self-limiting with patients regaining most to all of their neurological functions within 6 months. Several theories have been proposed for the pathophysiology of this syndrome. Nerve traction injuries and soft tissue edema compressing the cranial nerves are the leading two hypotheses. In conclusion, injuries with focal neurological deficits which were not apparent on initial imaging should be reviewed by relevant experts with concomitant knowledge of the patient's history.

## 27. High Grade Critical Basilar Stenosis Associated with Systemic Lupus Erythematosus and Basilar Migraine

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We present this challenging case of a 49-year-old female with history of systemic lupus erythematosus (SLE), chronic migraine, basilar migraine, and depression. She presented with a stroke in 2003 and was later discovered to have basilar artery stenosis. A follow-up CT angiogram in 2015 showed a very small caliber, proximal two-thirds basilar artery. CT perfusion showed hypoperfusion with prolonged time to peak enhancement, bilaterally in the posterior inferior cerebellar artery territory. The superior cerebellar

artery and posterior cerebral arteries appear normally perfused. The basilar tip was normal in appearance due to collateral flow from large posterior communicating arteries. The distal left posterior cerebral artery is narrow causing stroke in this vascular territory. The patient was treated with Coumadin for SLE-induced coagulopathy and has not had a second stroke. She continues to have syncopal events thought to be from basilar migraine however. She is currently maintained on Topiramate for chronic migraine and remains stable. She does have exacerbation of her lupus which is being treated with prednisone and Plaquenil. We review the neuroimaging this patient and the challenges with her management.

## 28. Recurrence of Pineal Germinoma with Drop Metastasis

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**Background and Purpose:** Pineal tumors are rare and account for <1% of intracranial neoplasms. The majority of these tumors have a germ cell line origin. These tumors generally present due to mass effect with headache, nausea, vomiting, lethargy, and a dorsal midbrain (Parinaud) syndrome. Treatment includes radiation, to which pineal tumors are exquisitely sensitive. Prognosis is good with survival rates of 79–90%. Rates of recurrence intracranially or spinally are dependent on pathology but spinal progression of disease is relatively uncommon. **Case:** This is a 36-year-old man with a history of treated pineal germinoma. Pathology was thought to be benign. Over the course of a year, he developed progressive weakness and sensory disturbances. At the time of presentation to the emergency room, he was using a walker to ambulate. MRI of his lumbosacral spine showed an enhancing mass that filled the entire thecal sac to about lumbar vertebra L2. He received radiation therapy and subsequently chemotherapy due to inadequate response. **Conclusions:** This case reiterates drop metastases as an importance, though rare complication of pineal tumors.

## 29. The Road Less Traveled: Unusual Trajectory of Intracardiac Thrombi with Bilateral Common and Internal Carotid Artery Occlusion

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**Background and Purpose:** Among all incidents of ischemic stroke, cardioembolic phenomena are responsible for approximately 14–30% of the cases. This etiology of stroke is especially challenging owing to its associated increased risk of early and long-term stroke recurrence, persistent neurologic sequelae at hospital discharge, and high mortality rate. We present a unique case of cardioembolic stroke in a patient with bilateral carotid artery occlusion.

**Methods:** Case report and review of the literature. **Results:** A 86-year-old female with history of mitral valve prolapse and anteroseptal infarct was admitted due to acute 4-day history of slurred speech, left-sided facial droop, and confusion. Neurological examination was remarkable for dysarthria and left-sided facial paralysis. Unenhanced MRI of the brain demonstrated multiple small infarcts in the right cerebral hemisphere, and CT angiography of the head and neck showed complete occlusion of the common and internal carotid arteries bilaterally. Transthoracic echocardiogram revealed anteroseptal wall akinesis, a left ventricle thrombus measuring 1.7 × 0.8 cm, and ejection fraction of 30–35%. Warfarin was initiated and bridged with intravenous low-molecular-weight heparin, with no planned intervention. On day 5 of hospitalization, the patient experienced a new onset of left-sided hemiparesis and visual neglect. Repeat unenhanced CT head revealed no new acute finding, and CT angiogram was unchanged. No additional treatment was initiated beyond continued anticoagulation. Patient was subsequently transferred to inpatient rehabilitation and eventually discharged on day 21 of hospitalization with lifelong warfarin therapy to a skilled nursing facility due to persistent neurological deficits.

**Conclusions:** Imaging findings such as combined anterior and posterior circulation infarcts are highly suggestive of cardioembolism. The current case illustrates a unique presentation of cardioembolic ischemic stroke in a patient with complete blockage of the carotid arteries. Prompt diagnosis via physical examination and neuroimaging is imperative to determining the most appropriate treatment for optimal clinical outcome.

## 30. Postpartum Bifrontal Intracerebral Hemorrhage: Where's the Thrombus?

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Pregnancy-associated stroke affects approximately 34 of 100,000 pregnancies. The delivery and postpartum period confer the greatest risk of pregnancy-associated stroke, with a higher number of hemorrhagic than ischemic strokes. Intracerebral hemorrhage (ICH) accounts for approximately 7.1% of all pregnancy-related maternal deaths. Pregnancy-related ICH that is bilateral or multifocal is even more rare.

We report a case of a postpartum 23-year-old previously healthy African American female with bifrontal ICH of unclear etiology. A 23-year-old African American female who was 1 week postpartum was found unconscious after complaining of a sudden onset headache hours prior. On arrival, patient was Glasgow coma scale 4T with extensor posturing. Noncontrast CT of the head showed large bifrontal parenchymal hematomas with pronounced mass effect. CT angiography was negative for vascular abnormalities. She underwent an emergent right hemispherectomy. Diagnostic cerebral angiogram and venogram were performed, showing narrowing of the anterior segment of the superior sagittal sinus (SSS). Clot retriever device was deployed with no return of thrombus; however afterwards, SSS appeared to be widely patent. Repeat imaging 2 days later again demonstrated filling of the anterior SSS with persistent abrupt transition to a larger sinus posteriorly, but now also noted diffuse vasospasm. Therapeutic anticoagulation was deferred since no definitive dural sinus thrombosis was identified. Urine toxicology screen was negative. There was no clear hematologic or rheumatologic pathology though her von Willebrand factor and rheumatoid factor levels were mildly elevated. Throughout her hospital stay, she was noted with episodes of hypertension and sinus tachycardia, which were attributed to sympathetic storming and improved with clonidine patch. She underwent tracheostomy and percutaneous endoscopic gastrostomy placement. Her condition gradually improved to a point where she completed acute rehabilitation and was discharged home, communicative, and able to perform most activity of daily living. Nearly 6 weeks after discharge, she presented again with pulseless electrical activity arrest and subsequent diffuse anoxic brain injury in the setting of a possible seizure after running out of her seizure medications. Patient ultimately passed away on comfort care. The majority of pregnancy-related ICH is caused by a preexisting vascular lesion such as an aneurysm or arteriovenous malformation. Less frequent causes include preeclampsia/eclampsia, coagulopathy, trauma, cerebral venous thrombosis, reversible cerebral vasoconstriction syndrome, and autoimmune vasculitis. We perform an extensive literature review of pregnancy-related ICH, particularly focusing on risk factors, pathophysiology, and radiological features of the differential diagnoses of our patient's ICH.

## 31. An Infant with a Ruptured 2 cm MCA Aneurysm with Subarachnoid Hemorrhage and Subdural Hematoma: CT, CTA, MRI and MRA

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A 7-month-old infant was brought to the emergency department after her mother described as "she was sitting at home and suddenly fell flat on her face seizing." She was a full-term infant with history of an uncomplicated delivery. At birth, a bulging fontanelle was noted although cranial ultrasound was unrevealing. She

presented to the ED with generalized tonic-clonic seizures for which a CT was obtained demonstrating a round 2 cm diameter high density in the left middle cerebral artery (MCA) region along with a subarachnoid hemorrhage and left hemispheric subdural hematoma. This was promptly confirmed on MRI, MR angiography (A), and CTA to represent a 2-cm diameter ruptured left MCA aneurysm. Very shortly after the imaging work-up was completed, she had a decompressive craniectomy and aneurysm clipping. The patient remains stable although with a large left MCA territory infarct. Ruptured aneurysms in children are extremely rare, accounting for less than 1% of all subarachnoid hemorrhages. Aneurysms in children tend to be larger at presentation than those in adults. Theories for their etiology include congenital defects, birth trauma, or connective tissue disorders. Additional data on pediatric aneurysms, comprehensive multimodality imaging, and a literature review will all be incorporated into this oral or poster presentation. This case is educational by way of:

- (1) the extreme rarity of ruptured aneurysms in this age,
- (2) presentation with subdural hematoma (in addition to subarachnoid hemorrhage), and
- (3) the rapid multimodality imaging evaluation prior to emergency surgery that did NOT include a catheter angiogram.

## 32. Neuroimaging Outcomes of a Cognitive Rehabilitation Training Program

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Cognitive training has shown promise in the remediation of cognitive skill deficits resulting from injury or neuropathology. It is presumed that intensive cognitive training can drive neuroplasticity and thus is the mechanism underlying associated gains. MRI is a noninvasive technique by which the manifestation of changes in neuroplasticity can be assessed, and while most MRI studies assessing cognitive training outcomes are group studies, MRI techniques may be sensitive enough to assess effects of a robust cognitive training program, such as ThinkRx, at the single subject level. ThinkRx (LearningRx®) is an intensive, 60+ hour, one-on-one, clinician-delivered cognitive training program based on the Cattell-Horn-Carroll theory of cognitive abilities, and targets multiple cognitive skills including attention, working memory, processing speed, logic and reasoning, auditory processing, and visual processing. Observational results in a traumatic brain injury (TBI) population ( $n = 273$ ) found a mean increase of 10 points in intelligence quotient score, and a retrospective chart review of 11 soldiers with brain injury found a mean increase of 23 points, as well as reliable and clinically significant change. To investigate if aberrant brain connectivity and changes in brain connectivity (a neuroimaging marker of neuroplasticity), were evident prior to and after completion of a robust cognitive training program, a series of case studies were carried out in subjects with varying degrees of traumatic brain injuries ( $n = 5$ ) and cognitive impairment ( $n = 5$ ). An MRI image acquisition protocol optimized for single subject imaging and sensitive enough to allow for repeat visualization of the resting-state default mode network (DMN) was developed on a 3T Siemens Skyra MR system and included acquisition of the following: a T1-weighted sequence for high-resolution anatomical imaging, a diffusion-weighted sequence for identification of white matter fiber tracts, and an echo planar imaging blood oxygen-level dependent sequence (repetition time = 3 seconds, 240 acquisitions, scan time = 12 minutes) for assessment of resting-state brain connectivity. MR exams were acquired on all subjects prior to and upon completion of the cognitive training program. MRI data were processed and analyzed using FreeSurfer and the CONN toolbox. In addition to MR exams, all subjects completed pre-/postneuropsychological testing (WJ-IV) and condition-specific rating scales. For all cases and a control subject, the DMN was visualized and within network connectivity quantified. Pretraining scans of the more severely impaired cases revealed varying degrees of aberrant DMN connectivity, including hyperconnectivity, hypoconnectivity, and a loss of anticorrelated (or negative) connectivity. Pretraining scans of the less impaired cases did not suggest the involvement of the DMN nor vastly abnormal brain connectivity. As such, pre-/postscans of the more homogeneous least impaired cases were analyzed at

the group level. For all cases, neuropsychological testing and qualitative outcomes measures increased, supporting that the robustness of the training program held for each imaged case study. Normalization of DMN connectivity, including decreased hyperconnectivity and reoccurrence of anticorrelated activity, was evident in the most severe TBI case. At the group level, significant training-induced changes in neural connectivity were identified. Two of the notable changes included (1) a significant ( $p\text{-FDR} = .002$ ) increase in anticorrelated activity between the posterior cingulate and the left anterior temporal fusiform, and (2) a significant increase ( $p\text{-FDR} = .007$ ) in language network connectivity specifically between the right frontal gyrus and the left supramarginal gyrus. In conclusion, quantitative and qualitative gains across subjects suggest that ThinkRx is a robust cognitive rehabilitative training program. Further, these results support the hypothesis that MRI can be used to visualize default mode network connectivity, even at the single subject level, and to quantify changes in resting-state brain connectivity at both the single subject and group level.

### 33. A Space-Occupying Lesion in the Brain Associated with Testicular Carcinoma

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**Background and Purpose:** Encountering space-occupying lesion (SOL) of the brain poses a diagnostic challenge clinically, radiologically, and pathologically; hence, it is often misdiagnosed. We report a case of SOL of the brain in a patient with a recent history of testicular cancer posed a diagnostic dilemma.

**Case:** A 38-year-old male with a past medical history of testicular seminoma (2015) status postright orchiectomy and chemotherapy with bleomycin presented with cough with shortness of breath for 2 days. Physical examination was unremarkable. CT chest revealed ground glass infiltrates on both upper and lower lobes, and patient was started on levofloxacin for atypical pneumonia. In the emergency department, he had a period of mild confusion prompting a CT brain which showed small enhancing lesion. MRI brain demonstrated two new small enhancing masses in the frontal and temporal lobe. Considering the high susceptibility of testicular metastasis in brain, CT abdomen/pelvis, beta-subunit of human chorionic gonadotropin, and alpha-fetoprotein were obtained as a part of metastatic workup, which came out negative. Patient remained asymptomatic at that time and was discharged with hemato-oncology and neurosurgery follow-up. Three months later, patient was readmitted with an episode of seizure without any neurological deficit. MRI brain revealed interval increase in the size of the lesions. Brain biopsy was negative for malignancy and revealed reactive gliosis and focal fibrinoid necrosis. He was started on levetiracetam. He was readmitted after 1 month with cough and shortness of breath without significant physical finding. CT chest showed extensive bilateral infiltrates. Infectious disease was consulted and suggested human immunodeficiency virus (HIV) workup despite the patient denying all the risk factors of HIV. HIV screen was positive with total CD4 suppressed at 18. Additional serologies revealed positive toxoplasma IgG and the brain biopsy was rechecked with immunologic stain came back positive for toxoplasmosis. He was subsequently treated with pyrimethamine for toxoplasma encephalitis.

**Conclusion:** HIV remains the leading cause of mortality despite significant treatment advancement. There are still significant barriers in early disease recognition and timely diagnostic approach. Although our patient did not have any risk factors of HIV, high index of clinical suspicion should always be exercised to avoid devastating consequences. Given the wide differential diagnosis of ring-enhancing space occupying lesions in the brain imaging including metastatic lesions, glioma, abscess, and toxoplasmosis, a brain biopsy is required to confirm the diagnosis. We recommend obtaining the HIV screening test early in SOL of the brain before advancing for any invasive procedure.

### 34. Role of Flat Panel Cone Beam CT in Detecting Intracranial Hemorrhage: Single Center Experience

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**Background and Purpose:** Symptomatic intracerebral hemorrhage occurs in about 6–10% of thrombectomy cases. Intracranial hemorrhage is a known complication of other neuroendovascular procedures like aneurysm embolization. Conventionally, a CT head is done postprocedure especially thrombectomy to rule out periprocedure hemorrhage. A new C-arm system with 3D functionality extends the capability of C-arm imaging to include soft-tissue applications by facilitating the detection of low-contrast objects on Cone Beam CT (CBCT). Our goal was to evaluate the application of this technology in detection of intracranial hemorrhage in patients undergoing neurointervention.

**Methods:** Between the years 2011 and 2016, CBCT was performed in 8 patients during neurointervention procedures at our university affiliated community-based comprehensive stroke center, for early detection of intracerebral hemorrhage.

**Results:** Of a total 221 stroke patient that received acute stroke intervention, a total of 8 patients received CBCT. Six of 8 patients (75%) patients presented with acute ischemic stroke, 1 with cerebral aneurysm, and 1 with subarachnoid hemorrhage. Mean age was 73 years (range 49–93); 62.5% (5/8) were females. With the use of CBCT intraoperatively, left basal ganglia hemorrhage, intraventricular hemorrhage with midline shift was detected in patient who underwent left internal carotid artery stenting and left M1 mechanical thrombectomy. SAH patient's CBCT revealed worsening diffuse SAH with hydrocephalus. All patients had thin sliced CT head prior and after procedure for comparison of intracerebral hemorrhage with CBCT. These findings were confirmed on thin sliced CT.

**Conclusion:** We found that implementation of CBCT was successful in detecting intracranial hematomas. Our study was limited due to small population. Given the opportunity for expediting decision making in this critical setting, the use of intraoperative CBCT for inclusion or exclusion of hemorrhage warrants further large population-based prospective trial.

### 35. Copper Deficiency Myelopathy: A Penny for Your Thoughts

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**Background and Purpose:** We present a case of copper deficiency myelopathy and a literature review of the clinical and imaging findings associated with different etiologies of long segment T2 hyperintense dorsal column lesions.

**Methods:** Case report and literature review.

**Results:** We present the case of a 41-year-old female with history of hyperthyroidism and anxiety presenting with vague complaints of transient episodes of numbness primarily affecting her extremities. Sensory neurologic examination was unremarkable, however, MRI revealed a discrete T2/short T1 inversion-recovery hyperintense lesion involving the cervical vertebrae C1-C7 posterior columns bilaterally, without enhancement or cord edema. Labs were sent to evaluate for vitamin deficiencies, autoimmune, and postinfectious etiologies. Results included an undetectable copper level and low normal B12 level. On return visit 6 months later both B12 and copper levels had normalized with symptom improvement. In the interim, patient had been taking both oral B12 replacement and over the counter multivitamins, thus the underlying etiology was still unclear. Ultimately, close examination of the imaging characteristics played a significant role in diagnosing the patient with copper deficiency myelopathy.

**Conclusion:** The underlying etiology of long segment T2 hyperintense dorsal column lesions identified on imaging are classically determined on serum testing. Confounding variables, however, such as lab error, replacement of multiple nutrients simultaneously, or insufficient history can occasionally make identifying an underlying etiology difficult. This case illustrates the importance of understanding the subtle clinical and imaging findings associated with different etiologies of long segment T2 hyperintense dorsal column lesions when serum testing is not clearly diagnostic.

### 36. Full Body MRI in Neurofibromatosis Type I

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We present a 26-year-old female with past medical history of relapsing remitting multiple sclerosis (MS) early onset at age of 13. During her diagnostic investigations for MS, imaging studies of her spine at this age showed significant abnormalities that were diagnostic of Neurofibromatosis Type I (NF1). She was also noted to have cutaneous manifestations of NF1 including café au lait spots, axillary freckles, and surgically confirmed neurofibromas. There was no family history of NF1 and she was thought to have a spontaneous mutation. A full body scan was ordered which showed extensive changes of neurofibromatosis with bulk of disease in the lower extremities, pelvis extending in to the paraspinous lumbar region. Extensive neurofibromatosis was found tracking along the sciatic nerve and lumbar paraspinous soft tissues. The right leg is affected more than the left leg. The brain showed prominent cerebrospinal fluid spaces with chronic hydrocephalus. The bulk of the disease is centered on the lower extremities and paraspinous regions of the lumbar and to a lesser extent the thoracic spine. Intercostal regions showed significant disease and in paraspinous regions in the thorax extending into the neural foramina. No cord compression is seen. The cutaneous manifestations of disease are present but appear less extensive than the deeper involvement particularly in the lower extremity which is primarily posterior along the expected location of the sciatic nerve. Interestingly, she is noted to have limited symptoms given the bulk of her disease, but it is monitored in follow-up with whole body MRIs.

### 37. Aortotracheo/pulmonic Fistula from Squamous Cell Carcinoma Leading to Cerebral Air Embolism

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**Background and Purpose:** Cerebral air embolism is most often associated with invasive procedures or surgery. Spontaneous cerebral air embolism is an uncommon occurrence.

**Methods:** A 64-year-old female with a history of coronary artery disease, chronic obstructive pulmonary disease, hypertension, diabetes mellitus-II, and tobacco abuse presented to the emergency department after being discovered comatose by her family with last known well 1-hour prior. Head CT showed subarachnoid air consistent with cerebral air embolism. CT angiography of the chest revealed a 7 × 8 cm mediastinal mass, with supraclavicular lymphadenopathy. Biopsy of the mass confirmed the diagnosis of squamous cell carcinoma. Neurological examination continued to decline as the patient had a ST-elevation myocardial infarction and repeat head CT revealed diffuse cerebral edema. Family chose to pursue comfort care.

**Results:** Cerebral air embolism is often quickly considered in the perprocedural period when acute neurological change is noted. In patients presenting with acute neurological change in which there is no antecedent procedure, pulmonary vascular imaging should be considered to identify the source of the cerebral air embolism.

**Conclusion:** Primary pulmonary sources of cerebral air embolism are rare and should be considered when there is no antecedent procedure.

### 38. Tolosa Hunt Syndrome: Important Diagnosis Often Missed with Incorrect MRI Sequences

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**Background and Purpose:** The Tolosa Hunt syndrome is defined as “unilateral orbital pain associated with paresis of

one or more of the IIIrd, IVth, and/or Vth cranial nerves caused by a granulomatous inflammation in the cavernous sinus, superior orbital fissure or orbit." The estimated prevalence of Tolosa Hunt syndrome is one in a million. When the disorder involves the orbital apex without the cavernous sinus, neurologists sometimes refer to it as "orbital pseudotumor." It usually presents as retro-orbital pain radiating to the back of the head. Neurologists often do not suspect Tolosa Hunt as the cause of the headache, until ophthalmoplegia develops a few days later. A new onset of a severe headache in these patients usually leads to an MRI of brain with and without contrast; however, this study often misses the inflammation in the small region of orbital apex and/or cavernous sinus, leading to false reassurance to clinicians and patients about the benign nature of headache. Special MRI sequences, which may not be available in all hospitals, show improved sensitivity in detecting Tolosa Hunt syndrome. The objective is to review the clinical presentation, radiographic features, and treatment response of two patients with Tolosa Hunt syndrome.

**Methods:** Case series from a tertiary medical center.

**Results:** Patient 1: A 28-year-old woman presented to an outside hospital with left retro-orbital pain and diplopia. After a negative MRI brain with and without contrast, the neurology and ophthalmology services diagnosed diabetic third nerve palsy due to newly discovered hyperglycemia. Subsequently, her ophthalmoplegia worsened and MRI of orbits with and without contrast at our hospital showed abnormal enhancement along the lateral margin of the left orbital apex extending along the dural margin of the adjacent cavernous sinus and sphenoid bone, leading to the diagnosis of Tolosa Hunt syndrome. Her pain improved after 24 hours of steroid treatment and her ophthalmoplegia improved a few weeks later. Four months later, an MRI showed complete resolution of the enhancement.

Patient 2: A 51-year-old woman presented with 4 days of headache and 2 days of diplopia. Neurologic examination found a complete third nerve palsy with partial pupillary involvement, and partial sixth nerve palsy. After an unremarkable MRI of the brain without contrast, an MRI brain and orbits with contrast showed focal soft tissue enhancement at the left orbital apex involving the optic canal and orbital apex. Her headache improved within 2 days of starting steroid treatment and her ophthalmoplegia started improving within a week of starting steroids. Each of these patients underwent an extensive evaluation to exclude other etiologies of retro-orbital inflammation, including serum and cerebrospinal fluid analysis for inflammatory, rheumatological, vascular, metabolic, neoplastic, autoimmune, and infectious etiologies.

**Conclusions:** Neurologists should consider Tolosa Hunt syndrome in the differential diagnosis of patients presenting with retro-orbital pain with or without ophthalmoplegia. MRI is the mainstay of diagnosis. MRI sequences of orbits along with MRI of brain, with and without contrast, which is available in most hospitals, improve the chances of detection of Tolosa Hunt syndrome, which is often misdiagnosed as diabetic ophthalmoplegia when MRI brain does not show any abnormalities. Correct identification and steroid treatment leads to rapid improvement of headache, and gradual resolution of ophthalmoplegia.

### 39. Rapid Growth of New Neurovascular Ultrasound in an Urban Comprehensive Stroke Center

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#### Background and Purpose:

- The establishment of a Comprehensive Neurovascular Ultrasound Lab which allows for neurophysiologic studies with established safety, efficacy, and clinical relevance.
- Utilization of transcranial Doppler (TCD) and carotid Doppler ultrasound (CDUS) to assist with treatment diagnosis and stroke prevention of patients.
- Our goal was to identify where our services were needed and how to provide results in a timely manner, while also increasing our service line within the hospital.

#### Methods:

- We researched whether our services were provided elsewhere and how accurate and timely they were completed.
- We started with one machine in the neurology department, accumulated a patient log and added that data to our findings.
- We then took our findings to the neurology leadership followed by the hospital budget committee to obtain updated equipment and expand our services.
- We partnered with other departments such as vascular surgery and neuroendovascular services to expand carotid ultrasound services.
- We worked with administration, IT, Biomed, scheduling, and billing to continue the growth of our lab.

#### Results:

- September 2010, we started with Sonosite Turbo for performing transcranial color Doppler (TCCD) and completed 34 studies for the neurology intensive care unit that year.
- December of 2011 we added CDUS and did a total of 11 patients. Our volume of TCD studies increased to 260 patients with the addition of a new TCD machine (Spencer ST3).
- The year 2012 we had a significant increase in volume by adding vascular and cardiothoracic surgery departments to our service line. Volume of CDUS was 153 and TCD was 428 for that year.
- As we continued to grow, and more departments became aware of our lab, in the year 2016 we completed, 631 TCDs and 386 CDUS.

In 2017, vascular surgery opened their own lab and has resulted in a decrease in volume of CDUS. TCD volume is driven by subarachnoid hemorrhage admission and appears to be down from the year 2016.

#### Conclusions:

- TCD and CDUS can serve as an extension of the neurology/neuroimaging department for the care of our patients. Moreover, the Neurovascular Ultrasound Lab can enhance the clinical care of patients and expand the service line for the department.
- Hurdles to overcome included leadership buy-in, budget limitations, and skeptical physicians about the usefulness of neurovascular ultrasound. Educational and technical meetings with leadership, and treatment teams helped explain the utility of the Neurovascular Ultrasound Lab.
- Grassroots efforts by the neurovascular ultrasound technologist and physician director to highlight growth potential and educate hospital administration and physicians led to a major growth in volume of clinical procedures and contributed to the mission of the Comprehensive Stroke Center.

### 40. Primary Diffuse Large B-Cell Lymphoma of the CNS in an Immunocompetent Patient Presenting with Abulia and Falls Tanner Anderson, Sunil Mutgi Gundersen Health System, La Crosse, USA

**Background and Purpose:** Primary central nervous system lymphoma (PCNSL) is a rare malignancy representing approximately 2% of all central nervous system (CNS) malignancies. Early identification and management of this condition are crucial. Establishing this diagnosis is often challenging due to the diverse clinical presentation. We present an unusual case of a patient with PCNSL exhibiting prominent abulia and falls.

**Methods:** A 70-year-old man presented to movement disorder clinic with a 6-month history of falls, tremor, and progressive loss of interest. On examination he demonstrated diffuse paratonia and hyperreflexia. He had right-sided apraxia but no other focal neurological features. His affect was flattened, and he displayed complete indifference to his current situation. He continued to rapidly decline over the following 2 weeks becoming more withdrawn, near catatonic in appearance, and was admitted for further evaluation. While awaiting results of testing he continued to decline. He underwent a trial of steroid therapy without improvement. Ultimately, he was discharged with hospice and succumbed to his illness.

**Results:** MRI brain demonstrated edema in the posterior fossa with nodular parenchymal and curvilinear leptomeningeal enhancement as well as subtle

leptomeningeal enhancement along the precentral gyrus of the left hemisphere. MR angiography brain demonstrated subtle nonspecific vascular irregularity. Lumbar puncture pathology demonstrated mild lymphocyte-predominant mononuclear pleocytosis without evidence of malignant cells on flow cytometry analysis. Brain biopsy demonstrated diffuse large cell B-cell lymphoma, germinal center cell phenotype.

**Conclusion:** PCNSL is a rare malignancy with unique diagnostic challenges. Our patient demonstrated symptoms that could easily be mistaken for a neuropsychiatric condition. This case provides the opportunity to review an atypical presentation of PCNSL and to review the benefits of MRI imaging when used in conjunction with other testing to aid in diagnosing this clinically diverse condition.

### 41. Advanced Neuroimaging of a Rare Chordoid Glioma of the Third Ventricle

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A 67-year-old female presented with persistent nonproductive cough and nasal discharge. Her neurological exam was unremarkable. CT of the sinuses showed a well-defined hyperdense mass of the anterior aspect of the 3rd ventricle. MRI showed a T2 and fluid-attenuated inversion-recovery hyperintense heterogeneous abnormality measuring 22 x 30 x 23 mm which enhanced with gadolinium and showed no diffusion restriction or abnormal susceptibility weighted imaging signal. The lateral ventricles were moderately enlarged, and moderate mass effect was seen with displacement of the optic chiasm, pituitary stalk, and both A1 segments. 3D arterial spin labeling showed no abnormal hyperperfusion. MR spectroscopy showed low metabolite levels with relative lower n-acetyl aspartate and higher choline. Diffusion tensor imaging and tractography showed poor visualization of the anterior commissure. The overall appearance was suggestive of a noninfiltrative tumor. PET scan showed hypermetabolism in the mass, like behavior of the low end of a high-grade gliomas. Endoscopic biopsy was obtained and verified choroid glioma of third ventricle. Chordoid gliomas are rare, slow-growing, well-circumscribed low-grade tumors that arise from the anterior wall or roof of the third ventricle. Given the low grade of this tumor and lack of clinical symptoms on this patient, surgical resection was delayed, and patient will be monitored clinically with repeat neuroimaging.

### 42. MRI to Evaluate a Postoperative Internal Acoustic Canal Mass after Microvascular Decompression Surgery

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**Background and Purpose:** Microvascular decompression is the mainstay in medical treatment for both trigeminal and glossopharyngeal neuralgia in medically refractory cases. One of the postoperative complications includes cranial neuropathy due to accidental nerve damage or compression from a hematoma. We report a case of facial nerve palsy as a postoperative complication of microvascular decompression surgery of 5th and 9th cranial nerves and discuss the role of MRI and special sequences to diagnosing the pathology.

**Case:** We describe a 46-year-old female with medically refractory trigeminal and glossopharyngeal neuralgia who underwent microvascular decompression surgery with Teflon placement. Postoperatively patient awoke with a left-sided facial palsy which was suspected to be intraoperative facial nerve damage. MRI of the brain, however, demonstrated a mass within the left internal acoustic canal (IAC) which was thought to be either a blood clot or a dislodged piece of the Teflon. MRI of the brain with special sequences which included IAC drive superimposed with MR angiography, axial, and coronal 3D fluid-attenuated inversion-recovery images, coronal diffusion-weighted imaging, susceptibility weighted sequences, and 3D T1 sequences were utilized to differentiate a clot from the Teflon. Furthermore, the serial images at immediate postoperative period, at 1 month and



3 months, demonstrated the evolution and resolution of the clot with subsequent clinical improvement.

**Conclusion:** MRI of the brain with special sequences is an important tool in detecting and differentiating postoperative intracranial pathology secondary to microvascular decompression surgery in the posterior cranial fossa.

### 43. Marchiafava–Bignami Disease.

#### A Rare Cause of Callosal Damage

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**Background and Purpose:** Marchiafava–Bignami (MB) disease is characterized by demyelination and later necrosis of the corpus callosum seen mainly in alcohol misuse. In the acute presentation there is a risk of seizures and coma. In most cases, the lesion occurs in the body of the corpus callosum; however, cases have been reported with lesions in the genu and splenium. About 8% of cases are fatal; with prompt treatment there is recovery to some degree, but with majority of patients showing some long-term disability. MRI findings in MB include T1-weighted hypointensity and T2-weighted and fluid-attenuated inversion recovery (FLAIR) hyperintensity within the corpus callosum; acute cases show restricted diffusion on diffusion-weighted imaging sequence.

**Method:** A case report of a 38-year-old woman without stroke risk factors presents after being discharged from another hospital without a clear diagnosis; she has several months of declining cognition and appetite, and 2 weeks of

impaired speech and gait. She is cachectic, with dysarthria, spasticity, and ataxia.

**Results:** MRI of the brain shows restricted diffusion in the splenium with a corresponding hypointense region on apparent diffusion coefficient sequence. T1 sequence shows hypointensity in the splenium with corresponding hyperintensity on T2 and FLAIR sequences. A contrasted study did not show enhancements. Serum studies revealed low B1 level, otherwise no gross abnormality; likewise, cerebrospinal fluid evaluation was unremarkable. She was diagnosed with MB disease, treated with high dose intravenous vitamins, and over a course of several weeks regained her speech and gait, and was discharged home. **Conclusions:** Although MB disease is rare, with only several hundred reported cases, it is imperative to consider it in the differential diagnosis of the encephalopathic patient with a callosal lesion as early diagnosis and treatment may decrease mortality and lead to better recovery.

### 44. Superior Sagittal Sinus

#### Thrombus Initially Misdiagnosed as an Ischemic Stroke

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**Background and Purpose:** Cerebral venous thrombosis (CVT) is an infrequent diagnosis made in the emergent hospital setting. The presentation of CVT widely varies, with common symptoms of headache, seizures, motor/sensory deficits, and encephalopathy to name a few. This requires the provider to take a careful history and exam with supplementary diagnostic imaging to exclude common mimickers of this disorder. We report the case of a

postmenopausal woman with Superior Sagittal Sinus Thrombosis (SSST), who was initially misdiagnosed with an ischemic stroke for a questionable focal hypodensity in the right frontal lobe on noncontrast CT that was later again reviewed by radiology and confirmed to have a hyperdensity of the Superior Sagittal Sinus.

**Methods:** A 69-year-old woman presented with progressively worsening headache. Her headache began following 2 days of diarrhea while returning from vacation on a cruise. She was brought in a stroke-alert after she was found down, unresponsive, with left-sided gaze preference, and right-sided weakness with a National Institute of Health Stroke Scale of 23. A CT scan revealed a hyperdensity of the superior sagittal sinus, however, was overlooked and was otherwise read as an acute infarct in the right frontal lobe.

**Results:** Further work-up for her presentation with CT angiography/CT perfusion, did not reveal stenosis, aneurysm, ischemic core, or penumbra. Emergent electroencephalogram did not show patient in status epilepticus. Additionally, lumbar puncture performed at the bedside was unremarkable. MRI with and without contrast revealed abnormal signal in the sagittal sinus consistent with SSST. After formal review of the case, it was disclosed that the diagnostic imaging and studies were excessive following the initial noncontrast CT, which indicated hyperdensity of the sagittal sinus to confirm immediate diagnosis. The patient subsequently improved back to her baseline following anticoagulation and thrombolysis.

**Conclusions:** SSST can be an elusive diagnosis given the variability in clinical presentation. Noncontrast CT can present a dense triangle sign as was seen in this case, however, initially misread by on call radiologist.

Postcontrast CT scan additionally demonstrates an empty delta sign. CT venography, MRI, and MR venography are extremely sensitive for diagnosis of SSST. Medical management with anticoagulation is first-line treatment and can be complemented with thrombolysis in medically refractory cases.