AJNR PODCAST – FEBRUARY 2020

Editor's Choice Selections

Spiral T1 Spin-Echo for Routine Postcontrast Brain MRI Exams: A Multicenter Multireader Clinical Evaluation

Structural postcontrast T1-weighted sequences are a fundamental component of routine MR imaging examinations. Cartesian 2D T1 spin-echo (SE) is widely used as the standard-of-care, though it is relatively slow due to its single phase-encoding per shot k-space coverage and it is not compatible with parallel imaging due to strong free-induction decay artifacts from the refocusing radiofrequency pulse. A routine option to increase speed is Cartesian 2D T1-SE with partial-Fourier k-space coverage, but this is at the cost of reduced SNR. Alternatively, Cartesian 2D T1-TSE uses an echo- train to cover multiple k-space lines per shot, but at the cost of reduced T1 contrast. A challenge common to all Cartesian methods is flow artifacts originating from CSF and blood, which manifest as a classic coherent ringing in the phase-encoding direction. Flow artifacts are further exacerbated in contrast-enhanced scans due to the hyperintense vascular signal. Spiral MR imaging, a non-Cartesian technique that uses a spiral k-space trajectory provides several advantages over routine Cartesian MR imaging. A primary benefit is scan efficiency due to the longer acquisition duration (t) per shot, which enables a concurrent decrease in scan time or an increase in SNR. Spirals are also more robust to artifacts such as flow, fold over aliasing, geometric distortions, and Gibbs ringing; this feature is due to the inherently reduced gradient moments of the spiral trajectory, center of k-space oversampling, nondedicated phase encoding direction, and incoherent dispersion of unwanted signal changes between spiral arms.

Spiral MR imaging has demonstrated unique advantages across a wide range of applications, including diffusion, perfusion, and fMRI. These and previous studies were predominantly performed in research settings, on healthy volunteers, and required specialized hardware/reconstruction approaches that are not

practical in a high-throughput clinical environment. Despite its benefits, spiral MR imaging has not gained widespread clinical adoption due to its greater demand on system fidelity and reconstruction complexity.

Here, the authors performed a multicenter clinical evaluation of spiral MR imaging as an alternative to Cartesian MR imaging for routine structural brain examinations.
Spiral 2D T1-SE is compared with Cartesian 2D T1-SE/TSE protocols that are representative of standard-of-care postcontrast brain MR imaging. The study assessed relative performance based on 10 metrics of image quality, artifact prevalence, and diagnostic benefit. Seven clinical sites acquired 88 total subjects. For each subject, sites acquired 2 postcontrast MR imaging scans: a spiral 2D T1 spin-echo, and 1 of 4 routine Cartesian 2D T1 spin-echo/TSE scans. Nine neuroradiologists independently reviewed each subject, with the matching pair of spiral and Cartesian scans compared side-by-side, and scored the subject on 10 image-quality metrics.

Spiral was superior to Cartesian in 7 of 10 metrics (flow artifact mitigation, SNR, GM/WM contrast, image sharpness, lesion conspicuity, preference for diagnosing abnormal enhancement, and overall intracranial image quality). It was comparable in 1 of 10 metrics (which was motion artifact), and inferior in 2 of 10 metrics (susceptibility artifacts, overall extracranial image quality).

The authors conclude that spiral 2D T1 spin-echo for routine structural brain MR imaging is feasible in the clinic with conventional scanners and was preferred by neuroradiologists for overall postcontrast intracranial evaluation.

Long-Term Outcome of Patients with Spinal Dural Arteriovenous Fistula: The Dilemma of Delayed Diagnosis

Spinal dural arteriovenous fistulas are rare but serious. They are characterized by variable clinical presentations that make a determination of specific predictive factors for the long-term outcome more difficult. Early diagnosis is vital for a better neurologic outcome. However, despite major developments in noninvasive diagnostic tools in the past decades,

the diagnosis of sdAVF remains markedly delayed. Symptoms caused by sdAVF include gait disturbances with or without paresis, sensory disturbances in the lower extremities, pain, and sphincter and erectile dysfunction. In this study, the authors studied clinical and radiologic features and well as follow-up information on microsurgically treated dAVF in order to advance knowledge and hopefully increase awareness in order to provide faster diagnosis and treatment.

The authors retrospectively analyzed their medical database for all patients treated for spinal dural arteriovenous fistula at their institution between 2006 and 2016. They evaluated patient age, neurologic status at the time of diagnosis, the duration of symptoms from onset to diagnosis, and follow-up information. They also analyzed extent of medullary T2 hyperintensity, intramedullary contrast enhancement, and elongation of perimedullary veins on MR imaging at the time of diagnosis.

Data for long-term outcome analysis was available for 40 patients with a mean follow-up of 52 months. The mean age at the time of diagnosis was 69 years (median, 71 years; range, 53–84 years) with a male predominance (80%). The mean duration of symptoms was 20 months.

There is still lack of knowledge about and awareness of dural AV fistulas among physicians, which continues to result in delayed diagnosis. The authors state that the current study may raise the awareness of this rare disease and emphasize the importance of early diagnosis in these patients.

Assessment of a Bayesian Vitrea CT Perfusion Analysis to Predict Final Infarct and Penumbra Volumes in Patients with Acute Ischemic Stroke: A Comparison with RAPID

CTP is an imaging technique used to quantify infarct and penumbra tissue in patients with acute ischemic stroke (AIS) evaluated for endovascular thrombectomy. CTP hemodynamic features include CBV, CBF, TTP, MTT, (Tmax), and delay time, which are compared between contralateral hemispheres to identify ischemic tissues. Various perfusion thresholds can be

used for each hemodynamic parameter to identify tissues as infarct and penumbra. Infarct is irreversibly damaged tissue that cannot recover in the event of reperfusion. Penumbra represents tissue deficient in blood flow but that can be salvaged through reperfusion. The American Heart Association recommends that ischemic volume estimations be used for selection of patients with AIS for mechanical thrombectomy when symptom onset is beyond 6 hours.

In this study, the authors aimed to assess the accuracy of a Bayesian CT perfusion algorithm, Vitrea, in determining penumbra and final infarct volumes.

This was a retrospective study in which the authors collected data for 105 patients with acute ischemic stroke (55 patients with successful recanalization and large-vessel occlusions and 50 patients without interventions). Final infarct volumes were calculated using DWI and FLAIR 24 hours following CTP imaging. RAPID and the Vitrea Bayesian CTP algorithm (with 3 different settings) predicted infarct and penumbra volumes for comparison with final infarct volumes to assess software performance.

RAPID and Vitrea default settings had the most accurate final infarct volume prediction in patients with interventions. Default Vitrea was the most accurate and RAPID was the least accurate in determining final infarct volume for patients without an intervention.

The authors conclude that compared with RAPID, the Vitrea default setting was noninferior for patients with interventions and superior in penumbra estimation for patients without interventions.

Fellows' Journal Club

Artery of Davidoff and Schechter Supply in Dural Arteriovenous Fistulas

The artery of Davidoff and Schechter is a dural branch of the posterior cerebral artery that can supply the meninges close to the falcotentorial junction. It is usually not identified on angiography except when enlarged in the setting of a dural AVF or meningioma. The impact

on treatment of the artery of Davidoff and Schechter supply to a fistula is not well-described in the literature.

In this study, the authors performed a retrospective analysis of patients with dural AVFs treated between 2006 and 2018. They found 6 patients (out of 173) with dural AVFs receiving supply from the artery of Davidoff and Schechter. All patients were initially treated by transarterial embolization using liquid embolic agents. Three patients required a second endovascular procedure partly due to residual supply from this artery.

The authors conclude that Dural AVFs supplied by the ADS are rare and difficult to treat by surgical or endovascular means. Endovascular treatment can be successfully undertaken by incorporating detailed anatomic assessment with risk-reduction strategies. Recognition of the ADS supply to falcotentorial junction fistulas is key to avoiding iatrogenic posterior circulation stroke.

Delayed Leukoencephalopathy: A Rare Complication after Coiling of Cerebral Aneurysms

Endovascular coiling is an effective procedure for preventing aneurysm rupture. However, a small percentage of patients experience complications, including thromboembolic events (incidence rate of 5%–12.5%) and aneurysm rupture (incidence rate of 2.0%–9%), along with posterior reversible encephalopathy syndrome and perianeurysmal edema, which may be indicative of symptomatic inflammatory reactions. Recently, delayed leukoencephalopathy has been described as a new type of complication after coiling. In the literature this has several different names, such as delayed leukoencephalopathy, delayed enhancing lesions, and delayed multiple white matter lesions. The various suggested etiologies include granulation reaction caused by foreign body emboli from the hydrophilic coating of procedural devices, contrast-induced encephalopathy, and nickel or bioactive polyglycolic/polylactic acid coil sensitivity.

In this study the authors analyzed 1754 endovascular coiling procedures. In sixteen procedures there was delayed leukoencephalopathy on follow-up FLAIR MR imaging. This

occurred after a median period of 71.5 days. This appeared as hyperintensity in the white matter at locations remote from the coil mass. All imaging-associated changes eventually improved. Seven patients had headaches or hemiparesis, and 9 patients were asymptomatic. In addition, the authors found an association between delayed leukoencephalopathy and the number of microcatheters used per procedure, along with evidence suggesting that these procedures required larger median volumes of contrast.

The authors conclude that delayed leukoencephalopathy after aneurysm coiling may have multiple etiologies such as foreign body emboli, contrast-induced encephalopathy, or hypersensitivity reaction to foreign bodies.

Renal Excretion of Contrast on CT Myelography: A Specific Marker of CSF Leak

Spinal CSF leaks resulting in intracranial hypotension are an important cause of chronic postural headaches in young and middle-aged individuals. There are iatrogenic causes (including surgery, epidural injections, spinal interventions) and noniatrogenic traumatic injury to the dura, degenerative changes (ie, osteophytes), and the recently described CSF-venous fistula (CVF). Imaging plays a central role in establishing the diagnosis of intracranial hypotension and in identifying the location of a CSF leak. However, despite the advances in imaging, the number of cases without an identifiable cause remain high – up to 55% of cases in spontaneous intracranial hypotension (SIH). For optimal management of these patients, it is important that a firm diagnosis of intracranial hypotension and causative CSF leak be established, even in the absence of an overt leak.

In this study, the authors performed a retrospective review of postmyelogram CT scans from 49 consecutive patients seen between January 2009 and August 2018 with imaging and/or clinical findings related to intracranial hypotension. Each scan was evaluated for the presence of contrast in the renal excretory system. A similar assessment was performed on 90 consecutive control subjects who underwent CT myelography for alternate indications.

Among the 49 patients with suspected CSF leak (43%) had an overt CSF leak on postmyelogram CT and (57%) did not. Overall, renal contrast was identified in 7/49 patients (14.3%). Renal contrast was not seen in any of the 90 controls on postmyelogram CT.

Renal contrast was exclusively seen in patients with a clinically or radiographically suspected CSF leak. The authors state that identification of this finding should prompt a second look for subtle myelographic contrast extravasation or an underlying CSF-venous fistula.