Bridging the Gap Between MR and ER

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Neurological Emergencies: MR vs CT

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MR imaging is an essential tool for evaluation and management of the patient with neurological compromise, and indications for MR imaging of the brain and spinal cord include suspicion of vascular, infectious/inflammatory, traumatic and neoplastic pathologies, among others. Though MR imaging if often performed on an urgent basis for patients presenting with neurological symptoms and signs, how often is MR truly indicated as an “emergent” study? This question will be the focus of this presentation.

When the spinal cord is compromised, patients may present with the acute onset and rapid progression of motor and sensory symptoms, as well as bladder and bowel dysfunction. If the inciting problem cannot be identified and treated promptly, then the patient may be more likely to suffer permanent neurological disability. Hence the words “rule out cord compression” typically get a rapid response from the on-call radiologist, and emergent MR is performed if no contraindications to MR are present. Patients with spinal column and spinal cord trauma may also require emergent imaging if this will affect operative triage, but most of these patients are imagined urgently but not emergently, as the initial steps in management generally do not depend on the MR imaging results.

With regard to the brain, indications for urgent MRI are many, but for truly emergent imaging the indications are few. This is because CT is very effective at assessing intracranial mass lesions (including intra- and extra-axial hematomas) and brain herniation, and this allows efficient urgent triage of patients. In addition, certain diagnoses that were often made based on MRI/MRA/MRV or catheter angiography in the past such as vascular dissection and venous thrombosis can now be made by CT/CTA/CTV, which can be performed quickly and safely in most patients (though radiation is certainly a downside of CT imaging). Potential categories of disease where urgent or possibly emergent MR imaging of the brain is indicated include:

1. **Vascular**: MR with diffusion-weighted imaging is far more sensitive to acute ischemia/infarction than CT, and emergent MRI/MRA/MRP (perfusion) may be indicated in a patient who will be triaged to transarterial intervention in the NeuroInterventional suite for acute stroke. In addition, it is impossible to confirm a diagnosis of infarction in some locations on CT, and MR can definitively diagnose the infarct (e.g. a medullary stroke in an acutely dizzy patient). TIA is also a potential indication for urgent MR imaging, as TIA precedes ~25% of completed strokes. Concern for vascular dissection may also be an indication for urgent MR imaging, but rarely is the indication truly emergent. Similarly, MRI/MRV can be very useful in the assessment of venous thrombosis and brain injury on this basis, though it is not clear that MR imaging is better

than CT and CTV in the majority of patients for making this diagnosis, though MR is certainly better at assessing the extent of brain parenchymal injury.

2. **Infection**: many serious and potentially deadly infectious processes can affect the CNS, and MR is usually the imaging study of choice. As CT can generally be used as a first-line modality to assess, for example, brain herniation associated with a brain abscess, MR is typically indicated urgently but not emergently. Herpes encephalitis has a characteristic appearance on MR, but its treatment (acyclovir) should commence before imaging is even obtained, so the imaging often does not affect the initial emergent treatment of the patient (unless the patient has an atypical presentation or a physician who does not consider the diagnosis). Subdural empyema often requires emergent decompression and antibiotic therapy, but the initial assessment of mass effect and brain herniation is often done with a CT scan.

3. **Trauma**: traumatic brain injury is typically assessed acutely with CT scanning, with MR imaging reserved for the subacute phase if the patient fails to improve as expected. In addition, as trauma patients are often difficult to accurately screen and may have metallic foreign bodies embedded in their tissues, MR imaging is problematic in this population. There may be a role, however, for MR assessment in the ED of unconscious trauma patients with negative head CT.

4. **Neoplasm**: brain MR is the study of choice for assessing CNS neoplasms, but rarely is it indicated emergently. One exception may be a tumor located deep in the posterior fossa: in this circumstance, CT may be very limited due to beam hardening and poor soft tissue resolution, and the patient may be *in extremis* due to brain stem compression.

5. **Pediatrics**: though MR imaging is often more difficult in children due to a lack of cooperation, the increasing concern over CT-related radiation in children is forcing a re-examination of MR imaging for many indications in children. MR has long played an important role in the assessment of non-accidental trauma in children, but it is not necessarily indicated emergently. MR may come to play an increasing role in the assessment of children with possible shunt failure and hydrocephalus, however, and some of these studies may be emergently indicated.

6. **Pregnancy**: the pregnant patient presents a unique set of considerations in the CT vs MR triage decision tree

Suggested Readings:

1. Hess CP, Barkovich AJ. Seizures: emergency neuroimaging. *Neuroimaging Clin N Am* 2010; 20: 619-37.

2. Quint DJ, Provenzale J, Deveikis JP. Emergency MR imaging of the central nervous system. *Emergency Radiology* 1999; 6: 133-142.

3. Rothwell PM, Warlow CP. Timing of TIAs preceding stroke: time window for prevention is very short. *Neurology* 2005; 64: 817-820.

4. Wieseler KM, Bhargava P, Kanal KM, Vaidya S, Stewart BK, Dighe MK. Imaging in pregnant patients: examination appropriateness. *Radiographics* 2010; 30:1215-1229.

5. You JS, Kim SW, Lee HS, Chung SP. Use of diffusion-weighted MRI in the emergency department for unconscious trauma patients with negative brain CT. *Emerg Med J* 2010; 27:131-2.