**NEUROIMAGING UPDATE: THE STUDIES AND SEQUENCES YOU SHOULD KNOW**

Matthew Siket, MD, MS, FACEP

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The world of emergency neuroimaging is evolving and increasingly influencing time-sensitive treatment decisions. A basic understanding of the imaging studies and sequences you may be asked to obtain in the ED may help you better manage your patients. Four imaging modalities will be discussed (CT, CTA, Perfusion, and MRI)

1. CT:
   1. The most common brain imaging study obtained in the ED is a non-contrast CT scan (NCCT). The “Blood Can Be Very Bad” mnemonic (credit: Andrew D. Perron, MD) can help the ED provider quickly and thoroughly review a NCCT
   2. You should know of the CT ASPECTS score which grades early ischemic hypodensities along the anterior circulation using a 10-point scale. In this case, a higher score is better and portends a better outcome. Generally, patients with low scores (0-4) are considered poor reperfusion candidates
   3. In cases of intracerebral hemorrhage (ICH), the ICH volume may be useful to communicate to consultants. A volume >30cc is associated with poorer outcome at 30-days compared to <30cc and this is a component of the ICH score. Volume can be easily calculated using the ABC/2 method:
      1. Measure the hematoma at its largest axial cut in two perpendicular dimensions (A and B) in cm. Then determine the number of slices on which blood can be seen in cm (most traditional NCCT studies are 5mm thickness slices, so if seen on 7 slices, then [7 x 0.5]). This C. Multiple AxBxC and divide the product by 2 (approximate volume of an ellipsoid)
   4. Be able to detect a dense vessel sign (MCA or Basilar) as early recognition can result in faster treatment and in some cases, patients can forgo additional vessel imaging
2. CTA:
   1. CT angiography is useful in cerebrovascular emergencies such as when stroke, dissection, aneurysm or vasculitis/vasospasm are suspected.
   2. CTA can be single phase or multiphase (early arterial, late arterial and venous)
      1. Multiphase CTA adds slightly more radiation, but no additional contrast and can increase the sensitivity of the study for an occlusion
3. Perfusion Imaging:
   1. Can be CT or MR-based and typically involves highly sophisticated post-processing software that measures:
      1. Cerebral blood volume (CBV)
      2. Cerebral Blood Flow (CBF)
      3. Mean Transit Time (MTT)
      4. Time To Peak (TTP)
   2. Increased CBV with decreased CBF suggests a favorable imaging pattern suggestive of ischemic penumbral tissue that may be potentially salvageable
   3. Increasingly, perfusion imaging modalities are being used as a surrogate to time in wake-up stroke when the LKW is unknown
4. MRI:
   1. A hyperacute MRI for stroke can be completed in 6-10 minutes. The sequences obtained include:
      1. Diffusion-weighted imaging (DWI)
      2. Apparent Diffusion Coefficient (ADC)
      3. T2-weighted Fluid Attenuated Inversion Recovery (T2FLAIR)
      4. Gradient Echo (GRE) or Susceptibility Weighted Imaging (SWI)

DWI identifies cytotoxic edema formation that begins very early on in a stroke. Within 3 hours of onset, T2FLAIR change will appear in 95% of cases. An acute ischemic stroke should appear bright on DWI and dark on ADC. GRE and SWI are sensitive for the detection of hemorrhage.

* 1. A diffusion/flair mismatch has been proposed to be a surrogate to time in cases of wake-up strokes

For further reading:

1. Perron AD. How to Read a Head CT Scan: <https://www.downeastem.org/downeastem/2016/11/19/how-to-read-a-head-ct-andrew-perron-md>
2. Smith AG and Hill CR. Imaging assessment of acute ischaemic stroke: a review of radiological methods. Br J Radiol. 2018;91:1083
3. Albers GW et al. New Engl J Med 2018;378:708-18
4. Thomalla G et al. New Engl J Med 2018; 379(7):611-22