Stroke Imaging Basics

Jeremy Hopkin M.D.
Goals

• Introduce the basic physical properties of imaging used in stroke.
• Understand why each modality is used in the setting of stroke.
• Understand some strengths and weaknesses of each modality.
Modalities Commonly Used For Imaging Stroke

- Non contrast CT
- CT Angiography (CTA)
- CT Perfusion (CTP)
- MRI
X-ray basics

• Energy beam (photons) from a source is passed through the body exposing film/detectors behind the body.
• Different tissues in the body absorb the energy at different rates.
• This creates contrast between tissues and a resulting image.
CT scan

• Used the same basic principles as x-ray
• Images are acquired around the entire surface of the body
• Complex mathematics generates a cross sectional image based on the different absorption of x rays in different tissues
What is CT good for?

• Very good at detecting blood in the brain or around the brain.

• Very good for looking at bone.
What is CT not good at

• OK but not great at looking at brain tissue - Not good at detecting any small or subtle abnormalities in the brain tissue
• OK but not great at looking at soft tissues
• Not good at looking at cranial nerves, arteries or veins
Blood in the brain and surrounding the brain detected by CT. Blood is bright during the acute phase and CT is very good at detection.
As stroke becomes older and if it is large, it can be detected by non contrast CT.
What do we use non contrast CT for?

• Initial imaging for stroke patients
  – Exclude hemorrhage
  – Evaluate for large/older stroke
  – Evaluate for other gross pathology (large tumors, big ventricles etc.)

• Follow up of stroke
  – Evaluate for hemorrhage into stroke
DON’T use non contrast CT for this!

- EXCLUDE or R/O stroke
- Evaluate for non hemorrhagic stroke or stroke mimics.
CT Angiography

• Same basic principles as CT
• Contrast is injected into a vein and tracked until it is in the arteries.
• CT scan is performed while contrast is in the arteries
• Arteries are dense with contrast and project well on the CT
What is CTA good at

- Looking at arteries
  - Occlusion
  - Atherosclerosis
  - Ulcerated plaque
- Looking at veins
  - Clot in dural sinuses
What is CTA not good at

• Essentially the same things as non contrast CT
• Slightly improved evaluation of stroke (but still relatively poor)
• Worse than non contrast head CT when looking for blood (dense contrast can hide dense blood)
What do we use CTA for in the setting of stroke?

• Evaluate for occlusion/narrowing of a large cranial or neck artery by clot or dissection (ICA, MCA and sometimes posterior circulation)

• Limited evaluation of collateral circulation – helps in possible treatment planning.
DON’T use CTA for this!

• EXCLUDE or R/O stroke. It cannot perform this task.
• Evaluate for stroke mimics
CT Perfusion (CTP)

• Similar properties as CT and CTA.
• Multiple scans of the brain are obtained during the passage of contrast from arteries through tissue of the brain and into veins.
• Mathematic models are used to generate “maps” of the brain showing different aspects of how the contrast moves from arteries to veins.
What is CTP good at?

• Evaluating flow patterns with a large vessel occlusion.
• Providing information about collateral pathways of blood flow
What do we use CTP for?

• Help endovascular doctor decide whether or not to go into the brain arteries with a catheter and pull out a clot that is occluding an artery.

• Help decide whether or not to give TPA (very rare)

• Evaluate for large stroke in a patient who can’t have an MRI (rare)
DON’T use CTP for this!

- EXCLUDE or R/O stroke. It can not do this with a high degree of accuracy. A normal CTP does NOT exclude stroke.
- Evaluate for stroke mimics
Why is CTP not ideal for detecting stroke?

• Complex physiology contributes to stroke
  – Flow
  – Oxygen extraction fraction
  – Oxygen requirements of the tissue
  – Temperature
  – Blood pressure

• CTP measures only one of these factors
  – Flow

• There is a correlation between perfusion abnormalities and stroke, but it is not consistent or have a high accuracy
MRI

• Although the circular apparatus looks similar to CT, MRI uses completely different physical properties of image acquisition
• Does not use ionizing radiation
• Utilizes magnetic fields and radiofrequency waves to gather information about tissues in the body.
All protons in the body function as tiny magnets. They align with the magnetic field of the scanner and also spin around this axis like a spinning top.
- Radiofrequency pulse sent into the patient “harmonizes” with spinning protons and flips them into a higher energy state.
- As the proton “relaxes” to its original state it releases its own radiofrequency waves that are read by a receiver.
What is MRI good at?

• The best imaging evaluation of brain tissue. Improved visualization of cranial nerves, contrast between grey and white matter and evaluation of wide range of brain pathology.

• Detecting stroke – Gold standard.
What do we use MRI for?

- EXCLUDE or R/O stroke. If MRI is normal, there is no stroke.
- Evaluate stroke volume with high degree of accuracy
- Provide some information about timing of stroke
- Evaluate for stroke mimics.
Problems with MRI

- Can not be performed in patients with certain medical devices – most commonly pacemakers
- More time consuming than CT
- Loud
- Issues with claustrophobia
- Does not evaluate bone very well
DON’T use MRI for this!

• Emergent imaging to exclude blood in the brain. This should be done with NON CONTRAST CT
• Emergent imaging to evaluate large vessels of neck/brain during work up of acute stroke. This should be done with CT ANGIOGRAPHY.