Imaging and Decision Algorithms for Interventions

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Presenter Disclosure Information

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FINANCIAL DISCLOSURE:
No relevant financial relationship exists.

UNLABELED/UNAPPROVED USES DISCLOSURE:
MR Perfusion imaging is an off-label use of gadolinium-based contrast agents.

Acknowledgement

Albert J. Yoo, MD
Director of Acute Stroke Intervention
Division of Neuroradiology
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Recanalization Therapy: Imaging Criteria
Intravenous tPA: Clear

Clinically a candidate?
• Time since LSW
• NIHSS

☐ No bleed
☐ No large hypodense infarct
☐ No obvious other problem

Recanalization Therapy: Imaging Criteria
Intra-arterial therapies: Not so clear

Clinically a candidate?
☐ Arterial occlusion?
☐ Extent of infarction?
☐ Regional hemodynamics?
1. Exclude hemorrhage
2. Vessel imaging: Can you treat?
3. Parenchymal imaging: Should you treat?

Exclude hemorrhage
Ruling out hemorrhage: CT vs. MRI

<table>
<thead>
<tr>
<th></th>
<th>CT+</th>
<th>CT-</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute hemorrhage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI+</td>
<td>25</td>
<td>4</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>MRI-</td>
<td>167</td>
<td>148</td>
<td>&lt;.001</td>
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</tbody>
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Kidwell CS et al., Comparison of MRI and CT for detection of acute intracerebral hemorrhage. JAMA 2004; 292: 1823-1830.

Either is okay. CT is faster and may be easier to interpret.
Vascular Imaging: Can you treat?

- Modality choices
  - CTA
  - MRA
  - DSA in the embo suite

Vessel imaging: CTA vs. MRA

- **CTA**
  - vs. DSA: 98.4% sens, 98.1% spec, 98.2% accuracy for proximal artery occlusion (JCAT 2001; 25:520-8)
  - Facilitated by thick section, overlapping MIPs
  - High interobserver reliability

- **MRA**
  - Suboptimal evaluation of M2 branches
  - Prone to motion and flow artifact
  - Can’t reliably evaluate vessels distal to stenosis or occlusion
  - Moderate interobserver reliability (κ=0.5)

CTA is preferable. MRA is probably acceptable.
Parenchymal Imaging: 
*Should you treat?*

- **Infarct Core**
  - Brain tissue with irreversible ischemic damage
  - Reperfusing the core can’t help
  - Reperfusing the core *may* hurt
- **Edema**
- **Hemorrhage**

Finding the Infarct Core: DWI

Normal gray matter

Finding the Infarct Core: DWI

Normal gray matter
Finding the Infarct Core: DWI

Normal gray matter

Finding the Infarct Core: DWI

Normal gray matter

Finding the Infarct Core: DWI

Normal gray matter  Cytotoxic edema
Finding the Infarct Core: DWI

Extremely sensitive, very specific


DEFUSE 2: 30-day mRS outcomes

Age & baseline DWI lesion volume were the only independent predictors of favorable clinical response.

Courtesy of Dr. Greg Albers
What if you don’t have an MR scanner?

Percentage of U.S. Emergency Departments with 24/7 scanner access (2008):

**CT:** 94%
**MRI:** 13%


Finding the Infarct Core: NCCT

Cytotoxic edema

Finding the Infarct Core: NCCT

Cytotoxic edema
Finding the Infarct Core: NCCT

Cytotoxic edema

Finding the Infarct Core: NCCT

Cytotoxic edema

Finding the Infarct Core: NCCT

Cytotoxic edema

Ionic edema (immediate)
Vasogenic edema (6+ hours)
Finding the Infarct Core: NCCT

Perfusion imaging cannot be used to find the infarct core.
Perfusion imaging cannot be used to find the infarct core


Perfusion imaging cannot be used to find the infarct core

Spontaneous reperfusion:

16% within eight hours.¹
33% within 48 hours.²
42%-60% within one week.³⁻⁴
77% within two weeks.³

blood volume mismatch, 390, 2012, 219

"Core" ischemia can be defined accurately by perfusion CT depending on equipment and programming. Various studies have used different...
Parenchymal Imaging: Should you treat?

• Perfusion imaging: Current hemodynamic status of the brain
• Patients with large penumbra are better candidates for intervention?

“Penumbra” is used to refer to brain tissue that ______________.

(A) has reduced blood flow, and is at risk for infarction.
(B) has reduced blood flow, and is electrically silent, but not at risk for infarction.
(C) has normal blood flow, but delayed blood arrival.
(D) has normal blood flow, but prolonged vascular transit time.
(E) All of the above.
“Penumbra” has no particular meaning.

What physiology can we study with perfusion imaging?

Regional hemodynamics:
- Cerebral blood volume (CBV)
- Cerebral blood flow (CBF)
- Mean transit time (MTT)
- Arrival time (Tmax)
Cerebral Blood Volume (CBV)

Units:
- Percentage
- mL blood per 100 mL tissue

Cerebral Blood Flow (CBF)

Units:
- mL blood per 100 mL tissue per minute
- mL blood per 100 g tissue per minute
Potential uses for perfusion imaging in perfusion disorders

- Establish diagnosis of perfusion disorder
  - TIA
- Etiology
  - Lacune vs. embolus
- Has the infarct reperfused?
- Blood pressure management
- Other “collateral therapies”
- Fluids and electrolytes
  - Finding the infarct core
  - Finding the “penumbra”
- Selecting patients for IA therapy?

The MGH Acute Stroke Imaging Algorithm