Stroke Imaging

John P. Karis, MD

Lecture Outline:
- Provide a clinical overview of stroke:
  - Risk
  - Prevention
  - Diagnosis
  - Intervention
- Illustrate how MRI is used in the diagnosis and management of stroke.
- Illustrate how competing modalities are used in the diagnosis and management of stroke.

Controllable Risk Factors
- High BP, A. Fib, High Cholesterol, DM, Smoking, ETOH, Physical Inactivity, Obesity

Uncontrollable Risk Factors
- Age, Gender, Race, Family Hx, TIA’s or Prior Stroke, FMD, R to L shunt

Stroke Risk

Stroke Prevention

- Imaging work-up of vascular stenosis
  - Clinical Signs & Symptoms
  - Vascular Screening (advancing age + risk factors)
- Pharmacologic and Surgical Prevention
  - BP, Statins, Anti-platelets
  - Endovascular (Angioplasty vs. Stent)
  - Surgical (Endarterectomy vs. Bypass)

Stroke
Cerebrovascular Accident (CVA)

Sudden diminution or loss of consciousness, sensation, and voluntary motion caused by rupture or obstruction of a blood vessel of the brain.

Disclosures: None
Pathophysiology of Stroke
Artery rupture- hypertensive hemorrhage
Arterial stenosis/Systemic hypoperfusion
Arterial occlusion
- Embolic
  - Cardiac
    - Atrial fibrillation
    - Right to left shunt- patent foramen ovale
  - Carotid
- Thrombotic (large vs. small vessel)
Venous occlusion- hemorrhagic

Hypertensive Hemorrhage
10-20% of Stroke
>50,000/yr in U.S.
GM nuclei, Pons

Hypoperfusion Stroke
Vascular territory-
proximal large vessel stenosis results in the inability for the brain to autoregulate flow in the setting of hypotension.
Global (severe systemic hypotension)

Artery Occlusion- Thrombotic
60% of Stroke
300,000/yr in U.S.
Vascular territory

**Artery Occlusion- Embolic**

25% of Stroke  
125,000/yr in U.S.  
Vascular territory

**Venous Occlusion Stroke**

50-100x less common than arterial stroke

- Edema typically involving the underlying WM
- Enhancement / Hemorrhage
- BBB breakdown secondary to elevated venous pressure

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**Imaging for Stroke Prevention**

\[ \text{% Stenosis} = \left(1 - \frac{\text{Minimal lumen diameter}}{\text{Distal lumen diameter}} \right) \times 100\% \]

North American Symptomatic Carotid Endarterectomy Trial (NASCET)  

European Asymptomatic Carotid Surgery Trial (EACST)  
≥70% carotid stenosis if the surgery can be performed with ≤3% risk of perioperative complications

Consensus statement by the American Academy of Neurology & the American Board of Internal Medicine February 2013

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**Surgery vs. Stent**

The Carotid Revascularization Endarterectomy versus Stenting Trial (CREST)  

↑d risk of stroke with CAS & ↑d risk of MI with CEA

The Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy (SAPPHIRE) Trial  
Gurm HS, Yadav JS, Fayad P, & SAPPHIRE Investigators.  

No long term outcome difference for high risk patients

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**Vascular Assessment**

- Conventional Angiography
- CT Angiography (CTA)
- MR Angiography (PC, TOF, Bolus)
- Doppler/US

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**Anatomic Vascular Assessment**

- Conventional Angiography
- CT Angiography (CTA)
- MR Angiography (PC, TOF, Bolus)
- Doppler/US
Physiologic Vascular Assessment

• Conventional Angiography
• CT Angiography (CTA)
• MR Angiography (PC, TOF, Bolus)
• Doppler/US

Vascular Assessment - DSA

Anatomic & Physiologic Test

Advantages
- Superior spatial resolution
- Superior temporal resolution
- Anatomic and Physiologic

Disadvantages
- Stroke risk
- Cost
- Requires contrast
- Ionizing radiation

Vascular Assessment - CTA

Anatomic Test

Advantages
- Intermediate spatial resolution
- Fast and readily available

Disadvantages
- Purely anatomic
- Ionizing radiation
- Requires contrast
- Temporal resolution
- Obscured by calcium

Vascular Assessment - MRA

Physiologic & Anatomic Test

Advantages
- Physiologic test
- No ionizing radiation
- Not obscured by calcium

Disadvantages
- Poor temporal resolution
- Turbulent flow
- Less available
- Requires contrast

2D vs. 3D TOF MRA Tradeoffs

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<th>2D</th>
<th>3D</th>
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<tr>
<td>Flow related enhancement</td>
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<td>Intravoxel Dephasing</td>
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<td>Resolution</td>
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Acetazolamide Imaging of the Brain

Acetazolamide (DIAMOX) - carbonic anhydrase inhibitor

Kidneys excrete bicarbonate, decreasing blood pH

The brain equates blood acidity with CO2 concentration

The perceived excess of CO2 results in:
- Deeper and increased rate of breathing
- Vasodilation of the arterioles feeding the brain

Effect of Acetazolamide on Cerebral Blood Flow and Cerebral Metabolic Rate for Oxygen

Cerebral Vascular Reserve: Blood flow to brain is tightly regulated. Blockage of inflow.

Acetazolamide has no effect on arterioles that are already maximally vasodilated.

Thresholds of Focal Cerebral Ischemia in Awake Monkeys

CT vs. MRI

Acute Stroke Imaging

CT vs. MRI

Acute Stroke Assessment
Stroke: Risk, Prevention, Dx, & Intervention

Use of MRI in the diagnosis and management of stroke.

Non-MRI modalities in the diagnosis and management of stroke.