High Resolution MRI Imaging of Intracranial Arterial Vessel Walls in Moyamoya Disease

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Financial Disclosures

- Research supported by NINDS RO1 NS051631
- Imaging center supported by NCRR 1 UL1 RR024992-01, 1 TL1 RR024995-01 and 1 KL2 RR 024994-01
- No industry funding or conflicts of interest.
Moyamoya Phenomenon

- Two distinct processes:
  - Severe stenosis of terminal carotid arteries (arrow)
  - Secondary formation of lenticulostriate collaterals (asterisk)

- Etiology of the basal occlusive disease not known

- May be multifactorial
Pathology of Basal Occlusive Disease

• Autopsy studies of moyamoya patients:
  • Microthrombi – endothelial disruption
  • Infiltration of inflammatory cells rare (Burke 2009)
  • Lipid deposition and atherosclerosis generally absent (Fukui, 2000)
• However, these studies limited to patients with long – standing disease – little data on patients with subacute or acute vasculopathy
• One case report described moyamoya phenomenon arising secondary to an arteriosclerotic plaque (Ashley 2008)
MR Vessel Imaging

- Area of active investigation
- Focused on imaging atherosclerotic plaque (Wasserman 2011, Swartz 2011, Ashley 2008)
- Improving technology and technique allows study of smaller vessels
Purpose

- Pilot study utilizing new MR vessel imaging sequences to examine the terminal internal carotid arteries in a cohort of patients with moyamoya phenomenon
Methods: Patients

• Twenty patients:
  • All diagnosed based on clinical history and Digital Subtraction Angiography (DSA)
    • 5 unilateral disease, 2 with prior ischemic event
    • 15 bilateral disease, 11 with prior ischemic event
  • 7 male, 13 female
  • Age 30 – 59 years
  • Patients imaged an average of 41.8 months post-diagnosis
  • 4 Patients with previous EDAS surgery
Method: Imaging

- Identified the location of stenosis on DSA
- 3T MR TOF images obtained centered on the stenotic segment to delineate carotid lumen
- T2-weighted 3D-CISS sequence in the same volume
- Vessel diameter and wall thickness measured for bilateral carotid arteries
- Basilar artery used as control
Method: Measurement Technique

- Basilar artery (control) and both ICAs measured for each patient.

- **Vessel Diameter:**
  - Measured outside wall – outside wall on CISS

- **Vessel Wall Thickness:**
  - Lumen diameter measured on TOF

\[
\text{Thickness} = \frac{\text{Vessel Diameter} - \text{Lumen Diameter}}{2}
\]
Results: Patients

- Imaging protocol capable of providing detailed vessel measurements in all patients
- No evidence of arteriosclerotic plaque at any point along the basal arteries
- Prominent lenticulostriate collaterals visualized
Results: Analysis

Vessel Diameter 95% CI

Bilateral Disease

Unilateral Disease

International Stroke Conference 2012
Results: Analysis

Vessel Wall Thickness 95% CI

Bilateral Disease

<table>
<thead>
<tr>
<th></th>
<th>Basilar Artery</th>
<th>ICA</th>
<th>Basilar Artery</th>
<th>Diseased ICA</th>
<th>Unaffected ICA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td></td>
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<tr>
<td></td>
<td>Vessel Wall Thickness (mm)</td>
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<td>0.20</td>
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Results: Relationship with Symptoms

Carotid Vessel Diameter 95 % CI

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<tr>
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<th>Unilateral Disease</th>
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<tbody>
<tr>
<td>Asymptomatic</td>
<td>N = 4</td>
<td>N = 3</td>
</tr>
<tr>
<td>Previous Event</td>
<td>N = 11</td>
<td>N = 2</td>
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Carotid Vessel Wall Thickness 95 % CI

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Summary of Findings

• In patients with moyamoya phenomenon:
  • Affected terminal carotid arteries significantly reduced in diameter, but similar vessel wall thickness to the basilar artery or uninvolved carotid arteries.
  • No evidence of arteriosclerotic plaque or other vessel lesion at the site of ICA stenosis.
  • Clinical history did not correlate to carotid dimension
Conclusion

- Our findings in patients with moyamoya phenomenon
  - No evidence of a macroscopic intramural process causing luminal narrowing
  - This suggest that terminal carotid stenosis, in the chronic stage, may be caused by atrophy or remodeling
- More data during the acute or active occlusive vasculopathy needed
- New MR sequences may be useful in distinguishing arteriosclerotic from other causes of basal artery occlusion
References


