Stroke in the Young: Extracranial and Intracranial Arterial Dissections

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Arterial dissections

Pathogenesis?

Diagnosis and mimics?

Natural history?

Predictors of deterioration?

Thrombolytic treatment?

Endovascular treatment?
Arterial dissections

Pathogenesis?

Diagnosis and mimics?

Natural history?

Predictors of deterioration?

Thrombolytic treatment?

Endovascular treatment?
Arterial anatomy
(Re: Miley JT. From eds Qureshi AI, Georgiadis AL. Textbook of Interventional Neurology, Cambridge, UK).

Extracranial artery  Intracranial artery
Dissection - Disruption of layers of arterial layer

- **Lumen narrowing**
- **Intimal flap**
- **Thrombosis**
- **False lumen**
Dissection - Disruption of layers of arterial layer

- Lumen narrowing
- Intimal flap
- Thrombosis
- False lumen
- Pseudo-aneurysm
- Sub-arachnoid hemorrhage
Arterial vulnerability (mobile-fixed junctions)
(Re; From eds Qureshi AI, Georgiadis AL. Textbook of Interventional Neurology, Cambridge, UK).
Clinical presentation in population based studies

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head and neck pain</td>
<td>80%</td>
</tr>
<tr>
<td>Cerebral ischemia</td>
<td>50%</td>
</tr>
<tr>
<td>Horner's syndrome</td>
<td>25%</td>
</tr>
</tbody>
</table>

Diagnostic criteria at ZQSRC

1. Age atypical for stenosis secondary to an atherosclerotic lesion
2. Clinical symptoms such as neck pain or signs of Horner’s syndrome suggestive of dissection
3. Disruption of the arterial vessel wall on imaging studies: stenosis, intimal flap, false lumen, mural thrombus, and pseudoaneurysm
4. Location of lesion at high vulnerability arterial junctions
5. Absence of changes suggestive of atherosclerosis such as calcification
6. Exclusion of vessel hypoplasia and pseudo-dissection

Diagnostic modalities
(From eds Qureshi AI, Georgiadis AL. Textbook of Interventional Neurology, Cambridge, UK).

1. Clinical history and examination
2. Cerebral angiogram, magnetic resonance angiography (MRA) or a computed tomography angiography (CTA). Source images for calcification.
3. Fat suppression T1 weighted MRI sequences
CTA/CT versus MRA/MR
(Vertinsky AT et al. AJNR Am J Neuroradiol. 2008 Oct;29(9):1753-60.)

CTA/CT identified more intimal flaps, pseudoaneurysms, and high-grade stenoses than MR imaging/MRA.
Aneurysmal form of dissection
Touze E et al. Stroke. 2001 Feb;32(2):418-23

Seen in 50% of dissection patients
30 of 42 aneurysm on symptomatic arteries

3 year follow-up
46% unchanged
54% resolved/decrease
No clinical events
Multi-vessel dissection (1/3rd of cases)


Right vertebral artery

Left vertebral artery
Pseudo-dissection in cervical ICA
(flow in stagnant blood flow segment)

Re: Siddiq F: J Neuroimaging 2012: Dec 10 [Epub ahead of print]
Pseudo-dissection
Intracranial-cervical junction of ICA

Pre-recanalization

Post-recanalization
Arterial dissections

Pathogenesis?
Diagnosis and mimics?
Natural history?
Predictors of deterioration?
Thrombolytic treatment?
Endovascular treatment?
Pathophysiological changes with arterial dissection

Subintima exposure (0-3d)

Passivation (3-30d)

Re-endothelialization (>30 d)

Thrombogenicity

Ischemic event free survival in 69 patients with neurovascular dissection
(Re: Hassan AE. J Stroke Cerebrovasc Dis 2011 Nov 12 [E pub])

Event free survival

Follow up (days)

38%
5 yrs
Ischemic event free survival in 69 patients with neurovascular dissection

NOT A BENIGN ENTITY

Previous studies:
1. Excluded pts with early stroke/death
2. Include pts. without ischemic events at baseline
3. Focused on cervical dissection

38%
Ischemic event free survival in 69 patients with neurovascular dissection

Which one do you believe?

Current study:
1. Included pts with early stroke/death
2. Include pts. with intracranial dissection
3. Included TIAs as events
Arterial dissections

Pathogenesis?

Diagnosis and mimics?

Natural history?

Predictors of deterioration?

Thrombolytic treatment?

Endovascular treatment?
Day 0-NIHSS 2
Started on dual antiplatelets
Day 1-NIHSS 20 (deterioration)
Subsequently underwent unsuccessful IA thrombolysis
Day 1-NIHSS 20 (deterioration)
Underwent unsuccessful IA thrombolysis

Can these pts be identified early and undergo endovascular treatment?
## Predictors of neurological deterioration

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Subjects (n=69)</th>
<th>In hospital neurological deterioration (n=11)</th>
<th>Neurological deterioration within 1 year (n=15)</th>
<th>Log-Rank (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>45</td>
<td>5 (11%)</td>
<td>7 (16%)</td>
<td>3.9 (0.04)</td>
</tr>
<tr>
<td>Women</td>
<td>24</td>
<td>6 (25%)</td>
<td>8 (33%)</td>
<td></td>
</tr>
<tr>
<td><strong>Involve both vertebral arteries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5</td>
<td>2 (40%)</td>
<td>2 (40%)</td>
<td>4.8 (0.02)</td>
</tr>
<tr>
<td>No</td>
<td>64</td>
<td>9 (14%)</td>
<td>13 (20%)</td>
<td></td>
</tr>
<tr>
<td><strong>Intracranial vs. extracranial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intracranial</td>
<td>23</td>
<td>6 (27%)</td>
<td>8 (35%)</td>
<td>4.9 (0.02)</td>
</tr>
<tr>
<td>Extracranial</td>
<td>44</td>
<td>5 (11%)</td>
<td>7 (16%)</td>
<td></td>
</tr>
</tbody>
</table>

(Re: Hassan AE. J Stroke Cerebrovasc Dis 2011 Nov 12 [E pub])
Arterial dissections

Pathogenesis?

Diagnosis and mimics?

Natural history?

Predictors of deterioration?

Thrombolytic treatment?

Endovascular treatment?
The effect of underlying arterial dissections on outcomes in thrombolytic treated ischemic stroke patients (Nationwide Inpatient Sample 2005-2008)  
Re: Qureshi AI. Arch Neurol 2011;68:1536-42

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Un-adjusted</th>
<th>Adjusted for age, gender, risk factors and hospital teaching status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% C.I.)</td>
<td>P value</td>
</tr>
<tr>
<td>Minimal disability</td>
<td>0.7 (0.4 - 1.1)</td>
<td>0.16</td>
</tr>
<tr>
<td>Moderate to severe disability</td>
<td>1.3 (0.8 - 2.1)</td>
<td>0.2</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>1.0 (0.5 - 2.0)</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Ischemic stroke patients with underlying arterial dissection ARE LESS LIKELY TO RESPOND to IV thrombolytic treatment

Re: Qureshi AI. Arch Neurol 2011;68:1536-42

- Higher rate of flow limiting non-thrombotic lesions
- Higher levels of platelet activation and aggregation resulting in platelet rich thrombo-embolisms
- Involve multiple segments or arteries—limit the potential to develop collateral flow.
Ischemic stroke patients with underlying arterial dissection ARE LESS LIKELY TO RESPOND to IV thrombolytic treatment

Re: Qureshi AI. Arch Neurol 2011;68:1536-42

• Additional treatment modalities after thrombolytic treatment to reduce the rate of poor outcomes.
• Similar to endovascular treatment following intravenous thrombolytic treatment in patients with ≥NIHSS score of 10 or hyperdense middle cerebral artery sign.
Arterial dissections

Pathogenesis?

Diagnosis and mimics?

Natural history?

Predictors of deterioration?

Thrombolytic treatment?

Endovascular treatment?
Mechanism of beneficial effect of stent

- Distal embolization
- Superimposed thrombus
- Hypoperfusion

Remodeling reduces thrombogenicity

Restore diameter of vessel to improve perfusion
Endovascular treatment of spontaneous extracranial internal carotid artery dissection

One year follow up - Results are sustainable

Intravascular ultrasound
Systematic review (4 studies) – stent placement for dissection
(Re: Hassan AE. J Neurotrauma 2012;29:1342-53)

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Pre-procedure stenosis</th>
<th>Post-procedure stenosis</th>
<th>Adverse events during follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 spontaneous</td>
<td>71%</td>
<td>6%</td>
<td>11%</td>
</tr>
<tr>
<td>11 traumatic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 iatrogenic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ASA/AHA Council guidelines: Candidates for endovascular treatment


- Symptomatic patients refractory to medical management;
- or
- Asymptomatic dissections with persisting hemodynamically (> 70%) significant stenoses, unstable intimal flaps, or enlarging pseudoaneurysm.
Conclusions

• Neurovascular dissection remains an understudied and less understood cause of cerebral ischemic and hemorrhagic events.

• The natural history of extracranial and intracranial dissections may be worse than initially thought.

• The management of dissections need to revisited in the current era of thrombolytics and stents.
Thank you

Zeenat Qureshi Stroke Research Center 2012
Characteristics of patients with multivessel dissection
Re: Hassan AE. AAN annual meeting. 2010; Toronto, CA

<table>
<thead>
<tr>
<th>Characteristics of patients</th>
<th>Pts with single dissection (n = 37)</th>
<th>Pts with multiple dissections (n=9)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiographic severity of stenosis</td>
<td>63 ± 28%</td>
<td>71 ± 21%</td>
<td>0.44</td>
</tr>
<tr>
<td>Presence of pseudoaneurysm</td>
<td>12 (33%)</td>
<td>8 (89%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Fibromuscular dysplasia (FMD)</td>
<td>3 (8%)</td>
<td>3 (33%)</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Patients treated with thrombolytics according to presence or absence of underlying arterial dissection (Nationwide Inpatient Sample 2005-2008)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients treated with thrombolytics without underlying arterial dissection (n=47411)</th>
<th>Patients treated with thrombolytics with underlying arterial dissection (n=488)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean age (±SD)</strong></td>
<td>69.01±14.6</td>
<td>50.13±13.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Medical complications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ICH (%)</strong></td>
<td>6.4</td>
<td>6.9</td>
<td>0.7987</td>
</tr>
<tr>
<td><strong>Procedures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cerebral angiography (%)</strong></td>
<td>23.4</td>
<td>64.1</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Carotid stent (%)</strong></td>
<td>3.0</td>
<td>19.3</td>
<td>0.0015</td>
</tr>
<tr>
<td><strong>Intracranial stent (%)</strong></td>
<td>1.5</td>
<td>4.1</td>
<td>0.1727</td>
</tr>
<tr>
<td><strong>Hospital outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean hospital charges (±SD)</strong></td>
<td>$62,431±63,479</td>
<td>$101,203±85,875</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
## Categories of dissection (ZQSRC criteria)

<table>
<thead>
<tr>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inbound</td>
<td>Mixed</td>
<td>Outbound</td>
</tr>
<tr>
<td>Lumen compromise</td>
<td></td>
<td>Protruding lesions</td>
</tr>
</tbody>
</table>

**Time**

Extracranial $\gg\gg\gg$ Intracranial
# Predictors of neurological deterioration

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<th>Log-Rank (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multivessel involvement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>60</td>
<td>9 (15%)</td>
<td>11 (18%)</td>
<td>3.01 (0.0832)</td>
</tr>
<tr>
<td>Multi</td>
<td>9</td>
<td>2 (22%)</td>
<td>4 (40%)</td>
<td></td>
</tr>
<tr>
<td><strong>Severity of stenosis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50 %</td>
<td>18</td>
<td>2 (11%)</td>
<td>2 (11%)</td>
<td>1.59 (0.2069)</td>
</tr>
<tr>
<td>≥50 %</td>
<td>46</td>
<td>9 (20%)</td>
<td>12 (26%)</td>
<td></td>
</tr>
<tr>
<td><strong>Pseudoaneurysm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>20</td>
<td>2 (10%)</td>
<td>4 (20%)</td>
<td>0.16 (0.6903)</td>
</tr>
<tr>
<td>No</td>
<td>46</td>
<td>9 (20%)</td>
<td>10 (21%)</td>
<td></td>
</tr>
</tbody>
</table>
Endovascular treatment of arterial dissection—Questions

• Does angiographic success result in clinical benefit?

• Who are the patients most likely to benefit from endovascular treatment?

• Is waiting for medical treatment failure a valid approach?
Rates of various outcomes following arterial dissection

<table>
<thead>
<tr>
<th>Events</th>
<th>Total number of pts.</th>
<th>Pts. with events (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 month death and disability</td>
<td>463</td>
<td>138 (30%)</td>
</tr>
<tr>
<td>Recurrent ischemic events</td>
<td>632</td>
<td>30 (5%)</td>
</tr>
<tr>
<td>Symptomatic intracranial hemorrhage</td>
<td>627</td>
<td>5 (0.8%)</td>
</tr>
</tbody>
</table>

## Rates of various outcomes following arterial dissection

<table>
<thead>
<tr>
<th>Events</th>
<th>Proportion of pts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution of stenosis 3-6 m</td>
<td>90%</td>
</tr>
<tr>
<td>Recanalization of occluded segment 3-6 m</td>
<td>50%</td>
</tr>
<tr>
<td>Resolution/decrease aneurysm</td>
<td>40%</td>
</tr>
<tr>
<td>Unchanged aneurysm</td>
<td>50%</td>
</tr>
</tbody>
</table>

(Re: Redekon GJ. Can J Neurol Sci. 2008 May;35(2):146-52)
Pseudo-dissection