Open Repair of Type A Aortic Dissection: The Penn Approach

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Perspective: Where we were ……80s-90s

- Rudimentary understanding of the Circulation Management complexity

- Classical arch algorithm ……
  - Clamped Ascending, go into Arch IF “tear” extended past clamp

- Massive blood product administration
  - A lot of Dead RV’s

- We admitted to ICU, had 4% mortality while waiting for OR

Result: Worldwide High Mortality and CVA
A Safe Therapeutic Operation for Type A Dissection
(circa early-mid 1990’s)

• Address High Morality, massive bleeding and poor neurologic outcomes

• Femoral cannulation
• Circ arrest in all cases
• No Aortic clamping until circ arrest
• OPEN anastomosis
• Re-cannulation of Graft
PENN Integrated Approach to Aortic Dissection

- Rapid Admission to OR via PENNSTAR helicopter (Level I Trauma model)

- Routine TEE/Neuro-Cerebral Monitoring: OR as Diagnostic and Therapeutic suite

- Root Sparing Techniques (less complex proximal repair)

- Routine Open Arch repair (typically Hemiarch with HCA/RCP) using Central Aortic cannulation
When We Replace the Root at Penn  
(20% of Type A)

Connective tissue disorder (5-10%):  
Marfan or Loeys-Dietz syndrome

Aortic root (sinus of Valsalva segment)  
aneurysm (10%)

Bicuspid valve or primary leaflet abnormality  
–Not absolute indication if normally functioning BAV

NUANCE: Intimal tear extending into sinus of Valsalva, especially if coronary ostium involved
Most patients have a NORMAL root dimensions prior to Type A

Acute Changes in Aortic Diameter At time of acute dissection

Max Diameter Ascending:
40.1 to 52.9 cm
30% acute increase!

Root:
40.4 to 41.4 cm
Minimal change

Rylski Desai et al
JACC 2014
Aortic Valve Resuspension and Neo-Media Reconstruction

Select Dacron graft within 10-15% of Annular diameter
Case Presentation

58 yo M with CP/stroke symptoms

4.1 cm sinus segment
Aortic Valve Resuspension
No visible felt
Completion Repair
17 patients (3%) required proximal reoperation:
- 10 for AI, including 3 with concomitant pseudoaneurysm
- 2 with root aneurysm
- 6 pseudoaneurysm
- 1 for graft infection.
Late Failure in Hemi-Arch: Scope of the Problem

- Optimal repair for the dissected Arch in Acute DeBakey I remains controversial

- Late aortic complications are a REAL concern
  - Bavaria, Ishihara, DeBartolomeo
    - 25-35% late reop

BUT... huge competing risk of mortality...

Rylski, Bavaria, Desai JTCVS
Arch Strategies in Type A Dissection

Standard Hemiarch

- Simple, can be done by most surgeons
- Short HCA – can use RCP
- May have poor late TEVAR options, residual malperfusion, Arch dissection

Hemiarch + Antegrade FET

- Simple Hemiarch anastomosis
- More hemostatic, may improve malperfusion
- May have residual Arch/supra-aortic dissection
- May place stent unnecessarily (20% thrombose spontaneously)—paraplegia risk, SINE, FL placement
Arch Strategies in Type A Dissection

Zone 2 Arch with delayed Branched TEVAR

- Simpler Distal Anastomosis than Zone 3
- Can address most complex arch tears and eliminate flap in proximal head vessels
- Definitive TEVAR options
- Less risk of Recurrent laryngeal nerve injury than Zone 3, no paralysis

Total Arch +/- ET or FET

- Most complex, longest ACP time
- Can address most complex arch tears and eliminate flap in proximal head vessels
- Definitive TEVAR options, DTA open repair without circ arrest
- Higher Laryngeal nerve, Paraplegia risk

EVITA, Thoraflex Registries
Mean Circ Arrest Time >70min
# Results: Procedural Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Hemi-arch</th>
<th>Hemi-arch + TEVAR</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>N=430</td>
<td>N=70</td>
<td>N=40</td>
<td>N=22</td>
<td></td>
</tr>
<tr>
<td>In-hosp. mortality(%)</td>
<td>63 (15)</td>
<td>10 (14)</td>
<td>4 (10)</td>
<td>6 (27)</td>
<td>0.35</td>
</tr>
<tr>
<td>Re-exploration for bleeding</td>
<td>50 (12)</td>
<td>9 (13)</td>
<td>7 (18)</td>
<td>3 (14)</td>
<td>0.65</td>
</tr>
<tr>
<td>Stroke</td>
<td>47 (11)</td>
<td>3 (4)</td>
<td>5 (13)</td>
<td>2 (9)</td>
<td>0.32</td>
</tr>
<tr>
<td>Paraplegia/Paraparesis</td>
<td>2 (0.4)</td>
<td>3 (4)</td>
<td>0 (0)</td>
<td>1 (5)</td>
<td>0.67</td>
</tr>
<tr>
<td>Dialysis</td>
<td>62 (14)</td>
<td>8 (11)</td>
<td>6 (15)</td>
<td>4 (18)</td>
<td>0.85</td>
</tr>
<tr>
<td>ICU stay (+/-days)</td>
<td>4 (6)</td>
<td>3 (4)</td>
<td>6 (6)</td>
<td>3 (14)</td>
<td>0.28</td>
</tr>
<tr>
<td>In-hosp stay (+/-days)</td>
<td>11 (11)</td>
<td>12 (11)</td>
<td>16 (14)</td>
<td>9 (11)</td>
<td>0.15</td>
</tr>
</tbody>
</table>
### Cox Regression of Survival

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hazard Ratio</th>
<th>95% CI</th>
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</thead>
<tbody>
<tr>
<td>Age &gt;60</td>
<td>2.46</td>
<td>1.8-3.3</td>
</tr>
<tr>
<td>Hemi+TEVAR</td>
<td>0.91</td>
<td>0.5-1.4</td>
</tr>
<tr>
<td>Zone 2 Arch</td>
<td>0.36</td>
<td>0.1-0.9</td>
</tr>
<tr>
<td>Zone 3 Arch</td>
<td>1.69</td>
<td>0.8-3.5</td>
</tr>
<tr>
<td>Male</td>
<td>0.85</td>
<td>0.6-1.1</td>
</tr>
<tr>
<td>Prev.Cardiac Surg</td>
<td>2.31</td>
<td>1.5-3.7</td>
</tr>
<tr>
<td>Pre-Op AI</td>
<td>1.20</td>
<td>0.9-1.6</td>
</tr>
<tr>
<td>Penn Class BC</td>
<td>2.58</td>
<td>0.9-7.1</td>
</tr>
<tr>
<td>Penn Class B</td>
<td>1.53</td>
<td>1.1-2.1</td>
</tr>
<tr>
<td>Penn Class C</td>
<td>1.94</td>
<td>0.9-4.2</td>
</tr>
</tbody>
</table>

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*Penn Medicine*
Distal Reintervention was more common in Zone 2 and Zone 3 Arch operations

- Likely related to better TEVAR options in these patients.
Open Zone 2 Repair for Acute Type A

53 yo male
Acute DeBakey I Dissection

Preoperative CTA
Zone 2 Arch with Single Branch TEVAR

- With the availability of Branched Grafts, we embarked on a systematic approach to performing Zone 2 Arch with later single branched TEVAR.
# Early Results: Zone 2 Arch+Branched TEVAR

## Pre-op Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N=15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of either arch/DTA tear</td>
<td>100% (15)</td>
</tr>
<tr>
<td>Malperfusion</td>
<td></td>
</tr>
<tr>
<td>Cerebral</td>
<td>33.3% (5)</td>
</tr>
<tr>
<td>Renal</td>
<td>20% (3)</td>
</tr>
<tr>
<td>Limb</td>
<td>26.7% (4)</td>
</tr>
<tr>
<td>Dissected Supra-Aortic Vessels</td>
<td>33.3% (5)</td>
</tr>
</tbody>
</table>

## 30 Days Post-Op

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N=15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>0%</td>
</tr>
<tr>
<td>Post-Op CVA</td>
<td>0%</td>
</tr>
<tr>
<td>Paralysis(any)</td>
<td>0%</td>
</tr>
<tr>
<td>Rec. Laryngeal n. Injury</td>
<td>0%</td>
</tr>
<tr>
<td>Dialysis</td>
<td>0%</td>
</tr>
<tr>
<td>FL thrombosis at level of Stent</td>
<td>100%</td>
</tr>
<tr>
<td>FL Thrombosis Below Stent</td>
<td>13%</td>
</tr>
</tbody>
</table>

Mean ACP time: 34 min

Zone 2 Acute Dissection - Post Op False Lumen Thrombosis

[Graph showing thrombosis rates over time]
Conclusions

• Root-sparing Surgery is associated with good long-term outcomes in Acute Type A Dissection

• Among more complex arch strategies (more than hemiarch), Zone 2 Arch was associated with the shortest HCA times and superior late survival after emergent repair for DeBakey I Dissection

• Novel approaches such as single-branched TEVAR completion in a Zone 2 repair may provide a robust long-term solution for DeBakey I Dissection