Open Repair of Thoracic Aortic Aneurysm: A Cure Instead of Palliation

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University of Colorado
Resident Debate
September 25, 2006
1950-Swan replaces descending aorta with aortic homograft
1953-Bahnson reports series of descending thoracic saccular aneurysms
1954-Debakey introduces the Dacron graft
1955-Debakey and Cooley report surgical treatment of aortic dissection
1968-Bentall introduces the valved conduit aortic root replacement
1986-Crawford reports improved results in descending thoracic aortic surgery with left heart bypass
1994-First report of endovascular stent grafting of the descending thoracic aorta
Pathophysiology

- **Cystic medial necrosis**
  - Media provides elasticity and tensile strength
  - Breakdown of ECM proteins including elastin
  - Results in media degeneration w/ SMC necrosis

- **Law of Laplace** \( T = \frac{P \times r}{2t} \)
  - Loss of elasticity leads to progressive dilatation
  - Increased wall tension

- **Risk factors**
  - Smoking, HTN, Atherosclerosis
  - Connective tissue disorders
Indications for Surgery

- Presence of symptoms
- Diameter 6-7 cm
- Accelerated growth (>10 mm/yr)
- Size > 6 cm associated with
  - 3.6% annual risk of rupture
  - 3.7% annual risk of dissection
  - 10.8% annual risk of death
Spinal cord ischemia

- Aortic cross-clamp time strongest predictor of spinal cord injury
- Aortic cross-clamping causes decrease in distal aortic pressure
- Concomitant rise in CSF pressure can lead to spinal cord compartment syndrome
- Extent of aneurysm also predictive of spinal cord injury
Spinal cord protection strategies

- Distal aortic perfusion
  - Paraplegia/paresis rate of 2-3% reported (Borst et al. JTCS 1994)

- Hypothermia- Active cooling w/ atriofemoral bypass

- CSF Drainage-maintain CSP <10 mmHg
  - Combined w/ distal aortic perfusion rate reduced to 0.9% (Safi et al. ATS 2001)

- Intercostal reimplantation- benefit unclear
Results of Open Repair

300 patients
30-day mortality rate: 8%
Paraplegia: 2.3%
Stroke: 2.1%
Acute renal failure: 4.2%

387 patients
30-day mortality: 2.8%
Paraplegia: 2.6%
Stroke: 1.8%
Acute renal failure: 7.5%

Annals of Thoracic Surgery 2005
Annals of Thoracic Surgery 2004
68% rated their level of health as good or excellent

85% had returned to their preoperative functional status at 12 months

Annals of Thoracic Surgery 2006
Limitations of Stent Grafts

- **Access for delivery systems**
  - Limited by vessel tortuosity
  - Need to access to extraperitoneal iliac arteries
  - Aortic occlusion (Leriche)

- **Landing zone requirements**
  - Proximal: 15-20 mm beyond left subclavian
    - May require carotid-subclavian bypass
  - Distal: 15-20 mm neck proximal to celiac axis
  - Lack of excessive angulation

- **Complex arch/descending disease**

- **Thoracoabdominal aneurysms**
Complications of Stent Grafts

- Endoleak
- Embolization/CVA
- Contrast nephropathy
- Paraplegia
- Stent migration
- Aortic occlusion

Table III. Early and late major adverse events

<table>
<thead>
<tr>
<th>Complications &lt;30 d</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any major</td>
<td>45 (32)</td>
</tr>
<tr>
<td>Bleeding complications—all</td>
<td>12 (9)</td>
</tr>
<tr>
<td>Any endoleak</td>
<td>5 (4)</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>14 (10)</td>
</tr>
<tr>
<td>Cardiac</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Vascular trauma/thrombosis</td>
<td>20 (14)</td>
</tr>
<tr>
<td>Stroke</td>
<td>5 (4)</td>
</tr>
<tr>
<td>Paraplegia/paraparesis</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Death</td>
<td>2 (1.5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Late events</th>
<th>1-y patients (%)</th>
<th>2-y patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migration—proximal*</td>
<td>0/97 (0)</td>
<td>3/68 (4)</td>
</tr>
<tr>
<td>Migration—components*</td>
<td>1/84 (1)</td>
<td>4/61 (6)</td>
</tr>
<tr>
<td>Endoleak rate*</td>
<td>7/97 (7)</td>
<td>6/68 (9)</td>
</tr>
<tr>
<td>Size decrease ≥5 mm*</td>
<td>23/83 (28)</td>
<td>24/64 (38)</td>
</tr>
<tr>
<td>Size increase ≥5 mm*</td>
<td>6/83 (7)</td>
<td>11/64 (17)</td>
</tr>
<tr>
<td>Endovascular revision</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Conversion to open</td>
<td>1 (1)</td>
<td>0</td>
</tr>
<tr>
<td>Ruptures</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aneurysm-related death</td>
<td>2 (1.5)</td>
<td>0</td>
</tr>
</tbody>
</table>

*Core laboratory reports.

Journal of Vascular Surgery 2005
Complications: Endoleak

- Type I: Leak from attachment site
- Type II: Retrograde filling from intercostal artery
- Type III: Leak between modular components
- Type IV: Graft porosity
Complications: Endoleak

Endoleaks after endovascular repair of thoracic aortic aneurysms

Shane S. Parmer, MD, a Jeffrey P. Carpenter, MD, a S. William Stavropoulos, MD, c
Ronald M. Fairman, MD, a Alberto Pochettino, MD, b Edward Y. Woo, MD, a
G. William Moser, MSN, RN, b and Joseph E. Bavaria, MD, b Philadelphia, Pa

- Data from the pivotal FDA trial
- 30% incidence of Endoleaks
- Presence of endoleak impacted regression of aneurysm diameter: 0.13 mm vs 2.9 mm
- Type II endoleak resulted in a mean increase of 2.9 mm of aneurysm diameter
- Larger diameter, longer length of aortic coverage strongly predictive of endoleak formation

### Complications: Increased Stroke Rate

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Rate</th>
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<tbody>
<tr>
<td>Piffaretti</td>
<td>2006</td>
<td>8.5</td>
</tr>
<tr>
<td>Makaroun</td>
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<td>4</td>
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<tr>
<td>Dake</td>
<td>2000</td>
<td>7</td>
</tr>
<tr>
<td>Ricco</td>
<td>2006</td>
<td>2</td>
</tr>
<tr>
<td>Malina</td>
<td>2005</td>
<td>5</td>
</tr>
<tr>
<td>Orend</td>
<td>2005</td>
<td>3</td>
</tr>
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</table>
**Complications: Paraplegia is not prevented**

<table>
<thead>
<tr>
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<th>Year</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricco</td>
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<td>3.6</td>
</tr>
<tr>
<td>Makaroun</td>
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<td>3</td>
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<tr>
<td>Dake</td>
<td>2000</td>
<td>5</td>
</tr>
<tr>
<td>Marin</td>
<td>2001</td>
<td>5.7</td>
</tr>
<tr>
<td>Malina</td>
<td>2005</td>
<td>5</td>
</tr>
<tr>
<td>Criado</td>
<td>2004</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Complications: Renal dysfunction

Frequency and Outcomes of Acute Renal Failure Following Thoracic Aortic Stent-Graft Placement

Holger Eggebrecht, MD^a,*; Frank Breuckmann, MD^a; Stefan Martini, MD^a; Dietrich Baumgart, MD^a; Ulf Herold, MD^b; Peter Kienbaum, MD^c; Jürgen Peters, MD^c; Heinz Jakob, MD^b; Raimund Erbel, MD^a; and Rajendra H. Mehta, MD, MS^d

- 34% incidence of postprocedural ARF
- 100% mortality of pts who required dialysis

American Journal of Cardiology, 2006
Caution for use in aortic dissections

Complications after endovascular repair of acute symptomatic and chronic expanding Stanford type B aortic dissections

Dittmar Böckler, MD, Hardy Schumacher, MD, PhD, Marika Ganten, MD, Hendrik von Tengg-Kobligk, MD, Matthias Schwarzbach, MD, PhD, Christian Fink, MD, Hans-Ulrich Kauczor, MD, PhD, Hubert Bardenheuer, MD, PhD, and Jens-Rainer Allenberg, MD, PhD

- 19% 30-day mortality
- Aortic expansion in 48% of survivors
- Only 44% had successful false lumen thrombosis

<table>
<thead>
<tr>
<th>TABLE 2. Overall survivals of patients with acute, chronic, and overall type B dissection</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 year</td>
</tr>
<tr>
<td>Acute</td>
<td>62</td>
</tr>
<tr>
<td>Chronic</td>
<td>100</td>
</tr>
<tr>
<td>Overall</td>
<td>81</td>
</tr>
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</table>

JTCS, 2006
Dislocation of a Stent-Graft Into the Aortic Arch During Endovascular Repair of a Descending Thoracic Aortic Aneurysm

Complications, continued...

Endovascular repair of proximal endograft collapse after treatment for thoracic aortic disease
Bronchoesophageal fistula after endovascular repair of ruptured aneurysm of the descending thoracic aorta.

Open Aortic Surgical Repair for Left Hemi-Arch Stent-Graft Failure

Fig 2. (A) Type I endoleak after left hemi-arch stent-graft repair. (B, C, D) Incision of the uncovered proximal stent, removal of endograft neck, and selective cannulation for antegrade cerebral perfusion.
Complications, continued..

**Acute Retrograde Aortic Dissection During Endovascular Repair of a Thoracic Aortic Aneurysm**

**Delayed retrograde aortic dissection after endovascular stenting of the descending thoracic aorta**

**Reoperations After Failure of Stent Grafting for Type B Aortic Dissection: Report of Two Cases**
Curative vs. Palliative Treatment

- In 2006, definitive repair can be done with minimal morbidity and mortality
- Freedom from stent graft treatment failure approaches 60% at SIX MONTHS
- Rupture risk not eliminated
- Stent grafting introduces new complications
- Stroke incidence may be increased
- Paraplegia risk not eliminated
- Long-term results not available
- Consider as alternative in selected high-risk patients

Ricco et al., J TCS 2006

Figure 2. Kaplan-Meier curve depicting freedom from failure and complications, i.e., rupture, endoleak, migration, embolism, conversion, and non-stent-related complications, with 95% confidence intervals (dotted lines) and patients at risk for each interval. The cumulative freedom from failure and complications at 6 months was 63% ± 7%.