ENDOVASCULAR REPAIR OF DESCENDING THORACIC AORTIC ANEURYSMS (DTAA)

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DESCENDING THORACIC AORTIC PATHOLOGIES

• pose a challenging problem for cardiovascular surgeons

• DTAA, dissections, tears, ulcers potentially morbid entities with an increasing incidence in the latest years. (1,2,3,4,5)
  • For TAAs is 10 cases per 100,000 people per year
  • 30 - 40 % occurring exclusively in the DTA
  • Aortic dissection is affecting 9000 patients per year in the United States alone.

Natural history of descending thoracic aortic aneurysms

If left untreated, is devastating:
• expansion
• rupture
• vital organ ischemia
• cardiopulmonary collapse due to blood exsanguination
• ultimately death

Actuarial 1- and 5-year survivals:
• for patients with DTA, not operated on, are 60% and 20%, respectively. 1

The annual risk of rupture, dissection, or death (6 cm DTAA) is over 14%. 2

STANDARD TREATMENT

- open resection and graft interposition (via a left thoracotomy) after the first successful attempt from DeBakey ME and Cooley MA in 1953.  
  
- has been found to improve survival when compared with medical therapy alone. 

Even with the advent of cardiopulmonary bypass, profound hypothermia, circulatory arrest, spinal cord protection and ICU support, the results slightly improved. 1-8
ENDOVASCULAR APPROACH

- **Advent of endovascular AAA stent-grafts**: Parodi in 1991, 1
- **So, Volodos was the pioneer in endovascular treatment of DTA in 1991.** 2
- **Soon afterwards Dake et al in 1992 used homemade devices that combined polyester grafts and modified Gianturco Z-stents with promising results.** 3
- **Since then, many studies have shown the technical feasibility and effectiveness of DTAA endovascular repair, as well as the potential complications.** 3-28

ADVANTAGES OF ENDOVASCULAR REPAIR

well documented

- avoidance of major thoracic or thoracoabdominal incisions
- decreased need for general anesthesia
- shorter operative time
- minimal blood lose and need for transfusions
- lack of aortic crossclamping, avoidance of cardiopulmonary bypass
- less postoperative pain
- shorter hospital and ICU stays and quicker recuperation.
- 30-day mortality
- Morbidity
- paraplegia

especially
<table>
<thead>
<tr>
<th>OPEN vs EVAR</th>
<th>Open surgery&lt;sup&gt;1-10&lt;/sup&gt;</th>
<th>EVAR (DTAA)&lt;sup&gt;11-36&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centers of excellence</td>
<td>All reports (25 Centers)</td>
<td></td>
</tr>
<tr>
<td><strong>30-day mortality</strong></td>
<td><strong>8-20%</strong> (elective)</td>
<td><strong>10%</strong> (0-25%)</td>
</tr>
<tr>
<td></td>
<td><strong>60%</strong> (ruptured)</td>
<td></td>
</tr>
<tr>
<td><strong>Morbidity</strong></td>
<td><strong>50%</strong></td>
<td><strong>10 %</strong></td>
</tr>
<tr>
<td><strong>Paraplegia</strong></td>
<td><strong>Up to 8%</strong></td>
<td><strong>0%</strong> (only 7 out of 25 reports with approximately 5% paraplegia).</td>
</tr>
<tr>
<td><strong>5–year survival</strong></td>
<td><strong>60-70%</strong></td>
<td><strong>To be determined (equal or increased with K-M analysis)</strong></td>
</tr>
</tbody>
</table>

DISADVANTAGES OF ENDOVASCULAR REPAIR

- long-term data is still lacking.

- Endoleak, migration, material fatigue and sac pressurization are all potential complications of descending thoracic aortic pathology endografting, which should be dealt with caution and special consideration, making strict follow-up mandatory.
## Materials-Methods

### Criteria for endovascular repair of descending TAA


<table>
<thead>
<tr>
<th>Criteria</th>
<th>Number of patients fulfilling the criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descending thoracic aneurysm &gt; 5.5 cm in diameter</td>
<td>4</td>
</tr>
<tr>
<td>Aneurysm 4.5–5.5 cm with increase in size by 0.5 cm in last 6 months or twice size normal</td>
<td>1</td>
</tr>
<tr>
<td>Symptomatic / ruptured aneurysm</td>
<td>2 / 0</td>
</tr>
<tr>
<td>Saccular aneurysm</td>
<td>0</td>
</tr>
<tr>
<td>Nonaneurysmal proximal aortic neck &gt; 20 mm in length that measures between 22 and 40 mm (dependent on device availability)</td>
<td>7</td>
</tr>
<tr>
<td>No extension of aneurysm into abdominal aorta (distal neck at least 20 mm above celiac) that measures between 22 and 40 mm (dependent on device availability)</td>
<td>7</td>
</tr>
<tr>
<td>Patent iliac or femoral arteries that allow introduction of 22–25 F delivery sheath (device dependent)</td>
<td>7</td>
</tr>
<tr>
<td>Life expectancy at least 12 months</td>
<td>7</td>
</tr>
<tr>
<td>Able to consent for appropriate trials and follow-up protocols</td>
<td>7</td>
</tr>
<tr>
<td>Absence of general contraindications for every endovascular procedure: age &lt; 18, allergy to contrast medium, coagulopathy, pregnancy-lactation, creatinine level &gt; 1.7 mg/dl, groin infection and connective tissue disease.</td>
<td>7</td>
</tr>
</tbody>
</table>
“Endofit” (Endomed, Phoenix, AZ, USA)

Endoskeleton: bare proximal stent and internal stents made of nitinol

The first covered stent is doubled to increase radial force and sealing

Fabric: ePTFE in 2 layers that encapsulates the stent skeleton with a thermal process that avoids the need for fixation sutures (no interface of metallic stent with either the blood, the aortic wall or the incoming wires).
Shape: tubular (30 - 30mm .... 42 - 42mm) or tapered (36 – 24mm .....40 – 24mm)
Sheath: hydrophyllum/flexible (maximal trackability through tortuous or calcified iliacs / arch)
Package: preloaded or cartridge
Deployment: self-expanding device
PROCEDURE
Preparation

Both groins and left arm are prepared

In a fully image guided OR
Access

Surgical exposure of right femoral and left brachial artery
7 Fr sheath
Guide wire or Terrumo 260cm
6 / 7 Fr sheath
Guide wire or Terrumo 150cm
6 / 7 Fr Angiographic catheter
• 7Fr Angiographic catheter over the guide wire

• The guide wire is exchanged with a Supra core extra stiff 260cm wire

17 cm soft and flexible tip, specially designed for thoracic arch trackability and stability
Initial DSA

External landmarks are set if necessary
Sheath positioning

An “empty” 22-24Fr Endomed hydrophyllum sheath with dialator over the supra core wire and advanced proximally to the desired position

Simultaneous DSA assists positioning
The Endofit graft comes in a simple cartridge which is loaded over the wire in the sheath and advanced proximally with the “pusher” (dilator upside down).
Graft deployment

The pusher is held still

The sheath is withdrawn

Simultaneous DSA assists accurate deployment

BP should remain 80-90 mmHg during deployment
If a second graft is needed

- Another DSA is performed through the 7 Fr angio catheter which is inserted via the valve of the endomed sheath
- New landmarks are set
- And the second graft is delivered and deployed with the same manner
Completion DSA

Absence of proximal endoleak

Absence of distal endoleak
Endoleak type I distal (1st month), repaired with an extension
Frame kinking at the proximal bare stent / Surveillance

Preoperative and postoperative plain chest radiogram. No graft migration was identified. On the contrary the proximal bare stent was slightly kinked, probably because of the arch morphology, causing no further complications.
A-B fistula
### Comparison to other cohorts

<table>
<thead>
<tr>
<th>Series</th>
<th>Device</th>
<th>Number of patients</th>
<th>Procedural success</th>
<th>Paraplegia</th>
<th>Other morbidity</th>
<th>Length of stay</th>
<th>30-Day mortality</th>
<th>Endoleak</th>
<th>F/U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dake [37] '92-'94</td>
<td>Home-made</td>
<td>13</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>4.8 d</td>
<td>0%</td>
<td>15%</td>
<td>12 m</td>
</tr>
<tr>
<td>Ehrlich [38] '97</td>
<td>Talent</td>
<td>10</td>
<td>100%</td>
<td>0%</td>
<td>10%</td>
<td>6 d</td>
<td>10%</td>
<td>20%</td>
<td>6 m</td>
</tr>
<tr>
<td>Mitchell [39] '92-'97</td>
<td>Home-made</td>
<td>103</td>
<td>73%</td>
<td>3%</td>
<td>25%</td>
<td>8 d</td>
<td>9%</td>
<td>24%</td>
<td>22 m</td>
</tr>
<tr>
<td>Temudom [40] '97-'98</td>
<td>Vanguard/Gore</td>
<td>14</td>
<td>78%</td>
<td>0%</td>
<td>14%</td>
<td>2.9 d</td>
<td>14%</td>
<td>14%</td>
<td>6 m</td>
</tr>
<tr>
<td>Grabenwoger [41] '96-'99</td>
<td>Talent/Gore</td>
<td>21</td>
<td>100%</td>
<td>0%</td>
<td>9.5%</td>
<td>9.8 d</td>
<td>9.5%</td>
<td>5%</td>
<td>n/a</td>
</tr>
<tr>
<td>Taylor [42] '97-'00</td>
<td>AneuRx/Gore</td>
<td>23</td>
<td>100%</td>
<td>0%</td>
<td>4.3%</td>
<td>4 d</td>
<td>8.7%</td>
<td>13%</td>
<td>18 m</td>
</tr>
<tr>
<td>Greenberg [43] '93-'97</td>
<td>Cook</td>
<td>25</td>
<td>88%</td>
<td>4%</td>
<td>n/a</td>
<td>n/a</td>
<td>25%</td>
<td>12%</td>
<td>15 m</td>
</tr>
<tr>
<td>Bortone [44] '99-'00</td>
<td>Gore</td>
<td>11</td>
<td>100%</td>
<td>0%</td>
<td>9%</td>
<td>n/a</td>
<td>9%</td>
<td>0%</td>
<td>6 m</td>
</tr>
<tr>
<td>White [45] '97-'99</td>
<td>AneuRx</td>
<td>16</td>
<td>94%</td>
<td>6%</td>
<td>6%</td>
<td>5 d</td>
<td>12%</td>
<td>12%</td>
<td>9 m</td>
</tr>
<tr>
<td>Won [46] '94-'99</td>
<td>Tae-woong</td>
<td>11</td>
<td>100%</td>
<td>0%</td>
<td>9%</td>
<td>n/a</td>
<td>0%</td>
<td>0%</td>
<td>14 m</td>
</tr>
<tr>
<td>Cambria [47] '96-'01</td>
<td>Cook/Gore</td>
<td>18</td>
<td>100%</td>
<td>0%</td>
<td>28%</td>
<td>n/a</td>
<td>5.5%</td>
<td>21%</td>
<td>11 m</td>
</tr>
<tr>
<td>Thompson [48] '00-'01</td>
<td>Gore</td>
<td>23</td>
<td>100%</td>
<td>0%</td>
<td>23%</td>
<td>5 d</td>
<td>4%</td>
<td>8%</td>
<td>9 m</td>
</tr>
<tr>
<td>Totaro [49] '00-'01</td>
<td>Gore</td>
<td>7</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>10 d</td>
<td>0%</td>
<td>30%</td>
<td>12 m</td>
</tr>
<tr>
<td>Najibi [50] '99-'00</td>
<td>Gore/Talent</td>
<td>19</td>
<td>95%</td>
<td>0%</td>
<td>16%</td>
<td>6 d</td>
<td>5%</td>
<td>0%</td>
<td>12 m</td>
</tr>
<tr>
<td>Ciado [51] '99-'02</td>
<td>Talent</td>
<td>31</td>
<td>97%</td>
<td>0%</td>
<td>15%</td>
<td>n/a</td>
<td>3%</td>
<td>13%</td>
<td>18 m</td>
</tr>
<tr>
<td>Herold [52] '99-'01</td>
<td>Talent</td>
<td>7</td>
<td>100%</td>
<td>0%</td>
<td>9%</td>
<td>3 d</td>
<td>0%</td>
<td>0%</td>
<td>8 m</td>
</tr>
<tr>
<td>Chabbert [53] '97-'01</td>
<td>Talent/Gore</td>
<td>14</td>
<td>100%</td>
<td>7%</td>
<td>9%</td>
<td>n/a</td>
<td>21%</td>
<td>25%</td>
<td>11 m</td>
</tr>
<tr>
<td>Fattori [54] '97-'02</td>
<td>Talent</td>
<td>18</td>
<td>94%</td>
<td>0%</td>
<td>5%</td>
<td>5 d</td>
<td>0%</td>
<td>16%</td>
<td>25 m</td>
</tr>
<tr>
<td>Scharrer [55] '97-'02</td>
<td>Talent/Gore</td>
<td>45</td>
<td>100%</td>
<td>0%</td>
<td>9%</td>
<td>8 d</td>
<td>7%</td>
<td>18%</td>
<td>24 m</td>
</tr>
<tr>
<td>Lamme [56] '98-'02</td>
<td>Gore/Talent</td>
<td>17</td>
<td>100%</td>
<td>6%</td>
<td>17%</td>
<td>6 d</td>
<td>0%</td>
<td>11%</td>
<td>24 m</td>
</tr>
<tr>
<td>Lepore [57] '99-'01</td>
<td>Gore/Talent</td>
<td>21</td>
<td>100%</td>
<td>5%</td>
<td>19%</td>
<td>n/a</td>
<td>10%</td>
<td>19%</td>
<td>17 m</td>
</tr>
<tr>
<td>Krogh [58] '00-'02</td>
<td>Gore/Talent</td>
<td>12</td>
<td>100%</td>
<td>0%</td>
<td>11%</td>
<td>n/a</td>
<td>0%</td>
<td>11%</td>
<td>11 m</td>
</tr>
<tr>
<td>Lambrecht [59] '00-'02</td>
<td>Talent/Gore</td>
<td>31</td>
<td>90%</td>
<td>4%</td>
<td>14%</td>
<td>n/a</td>
<td>6%</td>
<td>4%</td>
<td>15 m</td>
</tr>
<tr>
<td>Ellozy [60] '98-'02</td>
<td>Talent/Gore</td>
<td>51</td>
<td>100%</td>
<td>0%</td>
<td>10%</td>
<td>6 d</td>
<td>0%</td>
<td>25%</td>
<td>n/a</td>
</tr>
<tr>
<td>Czerny [61] '96-'02</td>
<td>Talent/Gore</td>
<td>54</td>
<td>94%</td>
<td>n/a</td>
<td>n/a</td>
<td>9 d</td>
<td>4%</td>
<td>29%</td>
<td>38 m</td>
</tr>
<tr>
<td>Melissa [62] '02</td>
<td>Endomed</td>
<td>9</td>
<td>100%</td>
<td>0%</td>
<td>11%</td>
<td>n/a</td>
<td>9%</td>
<td>33%</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Other morbidity refers to cardiopulmonary, renal, infectious, and neurologic complications. Endoleaks include those found during follow-up CT scanning and requiring secondary intervention for resolution. F/U indicates length of mean follow-up in months for each individual series.

*Abbreviations:* d, days; m, months.