Total Endovascular Repair of the Aortic Arch

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Disclosures

Grant/Research Support:
• Medtronic
• Gore
• Bard

Medical/Scientific Boards:
• Gore
• Bard
Open Arch Repair

- Technically demanding
- Complex circulatory management
- Deep hypothermic circulatory arrest (DHCA)
- Morbidity and mortality
“Classic Debranching Procedure”
Endovascular Approach

- Less Invasive
- Faster Recovery
- Decreased Morbidity/Mortality
- Ease of Repair/Durability
  - Alignment/Cannulation of arch vessels
  - Arch contour, composition, tortuosity
  - Durability of branches/Structural fatigue
- Most still need some type of extraanatomic bypass

What are our Options?
Chimney/Snorkel

- Endograft to exclude aneurysm
- Parallel covered graft placed alongside endograft to maintain perfusion to branch vessel(s)

Concerns
  - Durability of branch stent
  - Durability of repair—“gutter leak”

**AIM:**
The endovascular debranching with chimney stents provides a minimally invasive alternative to open surgery with readily available devices and has extended the option of endoluminal therapy into the realm of the aortic arch. But a critical observation at the use of this technique at the aortic arch is important and necessary because of the lack of long-term results and long term patency of the stents. Our study aims to review the results of chimney grafts to treat arch lesions.

**METHODS:**
A systematic health database search was performed in December 2014 according to the Prisma Guidelines. Papers were sought through a meticulous search of the MEDLINE database (National Library of Medicine, Bethesda, MA) using the Pubmed search engine.

**RESULTS:**
Twenty-two articles were eligible for detailed analysis and data extraction. A total of 182 patients underwent chimney techniques during TEVAR (Thoracic Endovascular Aneurysm Repair). A total of 217 chimney grafts were implanted: 36 to the IA, 1 to the RCCA, 91 to the LCCA and 89 to the LSA. The type of stent-graft used for TEVAR was described in 132 patients. The type and name of chimney graft was described in 126 patients. In 53 patients information was limited to the type. Primary technical success, defined as a complete chimney procedure was achieved in 171 patients (98%). In 8 patients it was not clearly reported. The overall stroke rate was 5.3%. The overall endoleak rate, in those papers were it was clearly reported, was 18.4% (31 patients); 23(13,6%) patients developed a type IA endoleak, 1 patient (0.6%) developed type IB endoleak and 7 patients (4.1%) developed a type II endoleak

**CONCLUSION:**
The total endovascular aortic arch debranching technique represent a good option to treat high-risk patients, because it dramatically reduces the aggressiveness of the procedure in the arch. Many concerns are still present, mainly related to durability and material interaction during time. Long-term follow-up is exceptionally important in light of the interactions of the stents, the thoracic endograft, the aortic arch, and every variation in systolic and diastolic pressure. Actually this technique has acceptable short and mid-term results. Long term data are available just from a very small number of patients and more data from a wider number are needed in order to embrace this method as a safe one.
Thoracic Endovascular Aortic Repair for Challenging Aortic Arch Diseases Using Fenestrated Stent Grafts From Zone 0

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Background. Although previous reports have described the repair of distal aortic arch aneurysms through debranching and chimney techniques, these methods invariably involve surgical management of the carotid artery. We report clinical results of thoracic endovascular aortic repair (TEVAR) using fenestrated stent grafts in the treatment of aortic arch aneurysms located less than 15 mm from the left common carotid artery.

Methods. A semi-custom-made fenestrated stent graft designed to fit aortic arch tortuosity and preserve blood flow at least into the brachiocephalic and left common carotid arteries was placed from zone 0.

Results. From 2017 through 2013, TEVAR from zone 0 was performed on 37 high-risk patients for open surgery (mean age 78.2 years). The mean length between the left common carotid artery and aortic aneurysm was 11.1 mm (range, 5 to 15 mm). The left subclavian artery was preserved for 26 patients (70.3%) through surgical reconstruction in 19) and graft fenestration in 7). The early mortality rate was 0%. Postoperative strokes and spinal cord ischemia occurred in 2 (5.4%) and 3 (8.1%) patients, respectively. Although type 1 endoleaks at discharge were noted in 12 (32.4%) patients, aneurysm enlargement was noted during follow-up in 6 (16.2%). Four patients (10.8%) underwent secondary interventions consisting of 3 coil embolization procedures; 2 re-TEVARs and 1 open conversion. There were no aorta-related late deaths. Survival and aorta-related event-free rates at 2 years were 86.3% and 88.8%, respectively.

Conclusions. Thoracic endovascular aortic repair using fenestrated stent graft from zone 0 can be considered as one of therapeutic options for high-risk patients with aortic arch diseases.

Table 3. Early Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. (%)</th>
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<tbody>
<tr>
<td>Thirty-day mortality (%)</td>
<td>0/37 (0)</td>
</tr>
<tr>
<td>Success of head-vessel preservation through fenestrations (%)</td>
<td>37/37 (100)</td>
</tr>
<tr>
<td>Perioperative stroke (%)</td>
<td>2/37 (5.4)</td>
</tr>
<tr>
<td>Spinal cord ischemia (%)</td>
<td>3/37 (8.1)*</td>
</tr>
<tr>
<td>Type 1 endoleak at discharge (%)</td>
<td>12/37 (32.4)*</td>
</tr>
<tr>
<td>Other complications:</td>
<td></td>
</tr>
<tr>
<td>AAA rupture</td>
<td>1</td>
</tr>
<tr>
<td>Renal &amp; leg ischemia due to embolism</td>
<td>1</td>
</tr>
<tr>
<td>Iliac injury</td>
<td>1</td>
</tr>
</tbody>
</table>

*One patient who showed temporary paraparesis was included among these 3 patients. b All 12 patients with endoleak were discharged without any additional treatment.

AAA = abdominal aortic aneurysm.
Complete endovascular debranching of the aortic arch: A report of two cases

Joseph Anderson¹, Madeline Nykamp², Tyler Remund² and Patrick Kelly³

Abstract
Patients suffering from aortic arch aneurysms continue to encounter few treatment options. Because most are deemed to not be open surgical candidates, the two cases presented here demonstrate an approach in the care of an arch aneurysm complicated by dissection. Even though final graft design differed slightly between the two cases, all three great vessels were successfully de-branched through standard endovascular aneurysm repair techniques and modifications to off-the-shelf devices. Aorto- and/or other-mentalized the ascending aorta at or near the level of the sinotubular junction. This was done with assembled endografts. One of these lumens was dedicated to the descending aorta, while the other two were divided into three channels used to stent the great vessels. Completion angiography demonstrated patent stented vessels, and descending aorta. No endoleaks have been reported. Although data is limited, this promising technique is being further evaluated.
BoltonThoracic Branch Technology with Relay® NBS Plus

- Based on Relay® NBS (Non-Bare Stent) Plus platform
- Large single window for ease of cannulation w/1 or 2 internal tunnel(s)
  - Single: innominate
  - Double: innominate and L CCA
- Intended for Zone 0 deployment combined with extra-anatomic arch branch bypass as required
Worldwide Clinical Experience

Single Branch (n=11):
- Patients treated via Custom Made Program
- 5 patients from initial feasibility experience (5 centers)
- 6 patients since the initiation of the Double Branch phase

Double Branch (n=57):
- Patients treated via Custom Made Program (12 centers)
• **COOK**
• Innominate/L Carotid
• +L Car-Subclavian bypass
Global experience with an inner branched endograft

Stéphan Haulon, MD, PhD, Roy K. Greenberg, MD, Rafaelle Speer, MD, Matt Engleman, MD, Cherrie Abraham, MD, Christos Liopis, MD, Eric Verhoeven, MD, PhD, Krassi Ivancev, MD, Tilo Köbel, MD, PhD, Brendan Stanley, MD, Timothy Resch, MD, Pascal Desgranges, MD, PhD, Blandine Maurel, MD, Blayne Roeder, PhD, Timothy Chuter, MD, and Tara Mastracci, MD

Background: Branched endografts are a new option to treat arch aneurysms in high-risk patients.

Methods and results: We performed a retrospective multicenter analysis of all patients with arch aneurysms treated with a new branched endograft designed with 2 inner branches to perfuse the supra aortic trunks. Thirty-eight patients were included. The median age was 71 years (range, 64-74 years). An American Society of Anesthesiologists score of 3 or 4 was reported in 89.5% (95% confidence interval [CI], 79.7-99.3) of patients. The 30-day mortality rate was 13.2% (95% CI, 2.2-24.2). Technical success was obtained in 32 patients (84.2% [95% CI, 77]).

Early cerebrovascular complications were managed on electronic medical records.

Conclusion: The early experience of a novel branched endograft for arch aneurysm resection and arch reconstruction was safe and feasible in high-risk patients. Further studies are needed to confirm these results.

Table 6: Comparative analyses between first 10 patients (early experience group) and next 28 patients (late experience group)

<table>
<thead>
<tr>
<th></th>
<th>Early experience (n = 10)</th>
<th>Late experience (n = 28)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early mortality</td>
<td>3 (30.0; 0.0-60.0)</td>
<td>2 (7.1; 0-16.9)</td>
<td>.066</td>
</tr>
<tr>
<td>Overall mortality</td>
<td>3 (30.0; 0.0-60.0)</td>
<td>6 (21.4; 5.9-36.9)</td>
<td>.67</td>
</tr>
<tr>
<td>Technical failure</td>
<td>3 (30.0; 0.0-60.0)</td>
<td>3 (10.7; 0.0-22.5)</td>
<td>.15</td>
</tr>
<tr>
<td>Type 1 endoleak</td>
<td>3 (30.0; 0.0-60.0)</td>
<td>2 (7.1; 0-16.9)</td>
<td>.066</td>
</tr>
<tr>
<td>Intraoperative complications</td>
<td>4 (40; 8.0-72.0)</td>
<td>3 (10.7; 0.0-22.5)</td>
<td>.04</td>
</tr>
<tr>
<td>All secondary procedures</td>
<td>4 (40; 8.0-72.0)</td>
<td>3 (10.7; 0.0-22.5)</td>
<td>.04</td>
</tr>
<tr>
<td>Early secondary procedures</td>
<td>2 (20; 0.0-46.1)</td>
<td>0 (0)</td>
<td>.015</td>
</tr>
<tr>
<td>All secondary procedures</td>
<td>3 (30.0; 0.0-60.0)</td>
<td>0 (0)</td>
<td>.014</td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>3 (30.0; 0.0-60.0)</td>
<td>3 (10.7; 0.0-22.5)</td>
<td>.15</td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>3 (30.0; 0.0-60.0)</td>
<td>1 (3.6; 0.0-10.6)</td>
<td>.019</td>
</tr>
<tr>
<td>Stroke</td>
<td>0 (0)</td>
<td>2 (7.1; 0-16.9)</td>
<td>.38</td>
</tr>
<tr>
<td>Operative time, min</td>
<td>320 (271.5-360)</td>
<td>248.3 (199.0-270.0)</td>
<td>.03</td>
</tr>
<tr>
<td>Radiograph duration, min</td>
<td>120 (52.8-264.5)</td>
<td>39 (30.0-59.4)</td>
<td>.007</td>
</tr>
<tr>
<td>Volume of contrast media</td>
<td>150 (136.0-220.0)</td>
<td>150 (86.0-206.25)</td>
<td>.34</td>
</tr>
<tr>
<td>Ascending aorta diameter</td>
<td>4 (40; 8.0-72.0)</td>
<td>7 (25; 5.7-41.3)</td>
<td>.37</td>
</tr>
</tbody>
</table>

Values for operative time, radiograph duration, and volume of contrast media injected are given as median (quartile 1-quartile 3). Other values are given as n (%); 95% confidence interval. Boldface indicates P values < .05.
Endospan-Nexus Arch Device

9 patients
100% Technical success

Courtesy of Endospan
Gore

Courtesy of WL Gore
Impediments to Endovascular Repair

• Complex arch
  • aberrant branches
  • significant tortuosity
  • complex arch-branch vessel spatial relationship

• Ascending aorta-diseased, short

• Access to arch vessels
Conclusions

• Open Repair still the gold standard
  • Endovascular Repair
    • No established therapy
    • Durability unclear

• Endovascular Repair-Beneficial for older, sicker patients
  • Avoids large open operation
  • Avoids sternotomy for hybrid procedure

• Endovascular Repair will become the procedure of choice
Total Endovascular Repair of the Aortic Arch

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