How to manage aortic arch pathology: Open, Hybrid, Chimney or Fenestration

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I do not have any potential conflict of interest.
Summary of "Aortic Arch. The Final Frontier in Cardiac Surgery."

Aortic arch pathologies such as acute aortic dissection and aneurysmal disease represent surgical challenges. Various emerging techniques and surgical prostheses have expanded the therapeutic armamentarium over the last years with one principal objective; to simplify the operation and reduce the surgical time. Besides the classic elephant trunk which has been regarded as an evolutionary leap in the treatment of extensive thoracic disease, other novel surgical approaches such as the frozen elephant trunk, the thoracic endovascular aortic repair (TEVAR) and the hybrid open branched stent grafts have been introduced. This brief review aims to evaluate the surgical alternatives used in the management of complex aortic arch and proximal descending aorta pathologies with particular consideration given to the contemporary approaches which endorse...
Current Approaches for Arch Repair

- **Open Repair**
  - Total arch replacement

- **Hybrid Techniques**
  - Hybrid arch replacement
  - Debranching + TEVAR
  - Extra-anatomic bypass + TEVAR

- **Total Endo Techniques**
  - Fenestrated stent-graft
  - Branched stent-graft
  - Chimney technique
Outcomes of Fuwai Hospital

1997-2018 Volume of Aortic Surgery in Fuwai Hospital

Bar chart showing the volume of aortic surgery and endovascular aortic stent-graft procedures from 1997 to 2018.
Outcomes of Fuwai Hospital

2018 Aortic Surgery for Different Aortic Segment in Fuwai Hospital

- **Abdominal Aorta**: 178
- **Thoracico-abdominal Aorta**: 44
- **Descending Aorta**: 356
- **Aortic Arch**: 443
- **Aortic Root**: 450
- **Others**: 0
- **Total Aorta**: 0
TEVAR in Fuwai Hospital & Second Xiangya Hospital (Nov2015-Nov2018)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total TEVAR</td>
<td>1467</td>
</tr>
<tr>
<td>Arch branch revascularization</td>
<td>518</td>
</tr>
<tr>
<td>Single Chimney</td>
<td>192</td>
</tr>
<tr>
<td>Double Chimney</td>
<td>22</td>
</tr>
<tr>
<td>Triple Chimney</td>
<td>2</td>
</tr>
<tr>
<td>Single Fenestration</td>
<td>203</td>
</tr>
<tr>
<td>Double Fenestration</td>
<td>28</td>
</tr>
<tr>
<td>Triple Fenestration</td>
<td>9</td>
</tr>
</tbody>
</table>

![Pie chart showing distribution of TEVAR procedures]
Total arch replacement
—Long operation time with huge trauma

four branch prosthesis vessel implantation

LCCA reconstruction

proximal anastomosis
heart resuscitation

LSA IA reconstruction

procedure completed
Hybrid Arch Replacement

Case characteristics:
- Entry tear near the LSA;
- Diameter of the ascending aorta was 4.6cm
- Aortic valve disfunction

Strategy:
- Avoided DHCA, regular CPB
- Extended landing zone in prosthetic graft, reduce retrograde TAAD
- Antegrade and retrograde delivery could be selected
- Reduced complication compare with total arch replacement
Hybrid Arch Replacement
Hybrid II: Debranching + TEVAR

Advantages

1. Extension of landing zone for healthy aorta
2. One-stage repair supra-aortic branches pathologies
Branched Stent-grafts
Fenestration Technique

Fenestration

In Vitro Fenestration

In Situ Needle Fenestration

In Situ Laser Fenestration

In Situ Fenestration

Customized Fenestration

On-the-table Fenestration

In Situ Needle Fenestration

In Situ Laser Fenestration
On-the-table Fenestration

Advantage:
✓ Reduce the operation time: < 45 minutes
✓ More fit to the anatomy of the aortic arch
✓ Less endoleak
Fenestration for Aortic dissection combined with Aberrant subclavian artery
Small fenestration and balloon expansion to make accurate fenestration size

Case characteristics:
- Entry tear close to the LSA
- LSA close to LCCA (Easily covered by chimney graft)
Double fenestration for both the LCCA and LSA
Double fenestration for both the LCCA and LSA
➢ Aneurysm combined with local dissection
➢ Whole aortic arch involved
In-situ Fenestration

Balloon expandable puncture needle
In-vitro Fenestration for LCCA and In-situ Fenestration for LSA

- LSA was involved by the huge aneurysm
- LCCA was close to the LSA
- Stent-graft should be placed proximal to the LCCA
The aneurysm was well sealed without endoleaks.
Triple Fenestration

✓ In-vitro Fenestration for IA and LCCA
✓ In-situ Fenestration for LSA
Fenestration technique, branched stent-graft are promising, what can we use before that?

Search for a method featured:

- Easy to accomplish by current device
- Could be used in bailout situation
- Minimal invasive
- Less complication

Chimney Approach

Special designed Skirt-Stenting Graft
Chimney + Snorkel

Case characteristic:

- 80 years old man
- Thoracic aortic aneurysm
- Type III aortic arch
- LSA stenosis

Chimney for LCCA and Snorkel for LSA
Chimney is very useful for aged patients
First experience with the double chimney technique in the treatment of aortic arch diseases

Tun Wang, MD, PhD, Chang Shu, MD, PhD, Quan-ming Li, MD, PhD, Ming Li, MD, PhD, Xin Li, MD, PhD, Kun Fang, MD, PhD, Alan Dardik, MD, PhD, Hao He, MD, PhD, Alan Dardik, MD, PhD, and Jian Qiu, MD, PhD, Changsha and Beijing, China, and New Haven, Conn

ABSTRACT

Objective: The objective of this study was to summarize our initial experience using the double chimney technique to treat aortic arch diseases.

Methods: From December 2009 to October 2016, 23 patients with aortic arch diseases, including 20 acute aortic dissections, 2 aortic arch aneurysms, and 1 type I endoleak after thoracic endovascular aortic repair (TEVAR), were treated using a double chimney technique. An emergent operation was performed in only one patient with an acute aortic dissection for severe left lower extremity ischemia. All patients were observed after TEVAR with computed tomography scans at 2 weeks, at 3 and 6 months, and annually thereafter.

Results: In all patients, aortic arch lesions were covered, and supra-aortic branches were patent without morbidity. In 22 patients, the innominate artery (IA) and left common carotid artery were reconstructed with the proximal landing zone in zone 0 in 1 patient, the left common carotid artery and left subclavian artery were reconstructed. During the procedure, there were three (13.0%) type I endoleaks. Chimney stent graft migration occurred in one (4.3%) patient perioperatively, compression of a chimney stent graft occurred in one (4.3%) patient 4 days after TEVAR. There were no type II endoleaks or perioperative mortality. Median follow-up was 28.0 ± 19.8 (range, 3-84) months, with no TEVAR-related deaths. Partial compression of the chimney stent graft in the IA occurred at 3 months after TEVAR in one (4.3%) patient; three patients had persistent but asymptomatic type I endoleaks.

Conclusions: TEVAR using a double chimney technique to reconstruct the supra-aortic branches provides a safe and minimally invasive alternative procedure associated with low postoperative mortality. The main perioperative complications included type I endoleak and compression of the chimney stent grafts in the IA. More experience with long-term results is needed to evaluate the effectiveness and durability of this advanced endovascular procedure.

122 cases reported from our center

Overall results:

Technical Success Rate: 98.6%
84.2% free from any EL
80.6% free from any adverse events
Chimney in Marfan Syndrome Patients

Case Characteristic:

- Female, Marfan Syndrome
- Previous Bentall surgery, recurrence of back pain after 8 years
- The entry of tear is located at the opening of the LSA

*TEVAR + Chimney for LCCA*
Fenestration in Marfan Syndrome Patients

Case Characteristic:

- Male, Marfan Syndrome
- Previous Bentall surgery, recurrence of B-type dissection after 5 years
- The entry of tear is located at the opening of the LCCA

TEVAR + Fenestration for IA & LCCA
Chimney with Endoleaks

Endoleaks can be observed for a few months

6 months

18 months later

Endoleaks can be observed for a few months
Newly designed chimney graft
The Skirt Stent-graft

- Designed for eliminating the endoleak of parallel stent
- Multi-center clinical trial is about to begin
First In Man Cases

May 14th 2018 in Indonesia
First In Man Cases

May 14th 2018 in Indonesia
First In Man Cases

Performed in Yunnan Fuwai Hospital
August 21\textsuperscript{th} 2018
Conclusions

➢ Conventional open surgery has gradually been replaced.

➢ Hybrid technique could be chosen for pathologies involving the ascending aorta or the aortic root.

➢ Fenestration technique is well-accepted, while Chimney is still a promising method, branch stent-graft is in developing.

➢ Total endovascular repair to treat aortic arch pathologies is the wave of the future.
Thanks for your attention!

The 4th China Vascular Congress (CVC 2019)
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Welcome You!
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