The Endovascular Era is here
Disclosures

Consultant: Cook Medical, Bolton Medical, Medtronic Inc, Volcano, WL Gore
Speakers’ Bureau: Bolton Medical, Medtronic Inc., WL Gore
Scientific Advisory Board: Medtronic Inc., Mellon Medical, Volcano
Arch repair

Objectives

1. describe the technical innovations in endovascular arch repair

2. Explore the 4 methods of endovascular arch repair:
   1. Hybrid procedures
   2. Parallel grafts
   3. In situ fenestrations
   4. Branched or Fenestrated devices
Arch repair

Background

Up to 50% of TEVAR will require deployment in Zones 0, 1 or 2

Ishimaru aortic arch zones
Arch repair

Background
Arch repair

Background
78 year old male patient
Ruptured 8cm arch aneurysm
Hypotensive, transferred to hybrid room
On table CPR
Arch repair

Case study

Predeployment arch study with laser in LCA and endograft in the arch

Endograft deployed and retrograde angiogram of the laser fenestrated and stented LCA
Arch repair

Case study

Placement of EndoAnchors at the inner curve

Completion arch study with patent LCA fenestration and no endoleaks

Patient discharged neurologically intact and now at 1 year follow up without reinterventions
Arch repair

Hybrid approach

Arch Debranching with TEVAR

- LSA debranching
- Hemi arch debranching
- Total arch debranching

Courtesy of Gustavo Oderich MD
“The early and midterm outcomes of hybrid arch TEVAR for aortic arch aneurysm were satisfactory. Hybrid arch TEVAR has the potential to be a less invasive alternative for conventional TAR”
Pooled analysis of operative outcomes showed that Hybrid TEVAR improves operative mortality compared to open total arch repair.

Surgical strategy for aortic arch aneurysm should be chosen on the basis of the patient’s characteristics.
TEVAR with parallel grafts technique offers a readily available off the shelf and highly customizable method of endovascular arch repair. Chimneys can interfere with the sealing goal of endografts at the proximal or distal landing zones and increase the risk of type I endoleaks.
Arch repair

Parallel Grafts or Chimneys

70 years old female patient
Expanding ascending aortic pseudoaneurysm
s/p Ascending and aortic root replacement
CAD with positive NST
COPD with emphysema
Referred by CTS

Reversed Hemi arch debranching
LSA to RCA bypass
LCA transposition
Arch repair
Parallel Grafts or Chimneys

Arch Study Predeployment

Transient AI from delivery cone and wire in LV

Patent LSA chimney and LVA
Arch repair

Parallel Grafts or Chimneys

Completion angiogram after EndoAnchors:
AI resolved, no endoleak, patent SATs

CTA @ 6 months
Arch repair

Parallel Grafts or Chimneys

101 arch branches in 94 patients
Operative mortality 3.2%
Stroke rate 5.3%
Patency 100%
TEVAR with in situ fenestration technique offers a readily available off the shelf and highly customizable method of endovascular arch repair.

Quick and simple
Eliminates the need for rotational alignment
Less catheter manipulations
Can be a bail out
Arch repair
In Situ Fenestration
Arch repair

In Situ Fenestration

Operative mortality: 4.5% (1/22)
No stroke
Paraplegia: 4.5% (1/22)
No major fenestration related complications
No type I or III endoleak
100% patency of LSA stents (1 asymptomatic stenosis)

Background: Reoperative laser fenestration of the left subclavian artery (LSA) during emergent thoracic endovascular aortic repair (TEVAR) is a relatively simple endovascular method of endograft modification to revascularize aortic arch lesions, particularly after failed or incomplete TEVAR with laser fenestration to revascularize the LSA as an alternative to debranching. We report our experience with laser fenestration during TEVAR for acute type B aortic dissection.

Methods: One hundred and thirty-five patients underwent TEVAR with laser fenestration. The laser fenestration was performed using a Dacron (DuPont, Wilmington, Del) endograft over the LSA orifice. Laser catheter fenestration of the graft was performed through the aortic arch using a 5F sheath, followed by balloon expandable covered stent deployment through the fenestration to traverse the endograft and LSA. Routine postoperative follow-up imaging with computed tomography angiography was performed to assess TEVAR and LSA fenestration patency, endoleaks, and in-stent/thrombosis exclusion.

Results: In situ laser fenestration was successfully performed in 22 patients (12 men; mean age, 57 years) in an urgent or emergent setting secondary to unremitting symptoms or rupture. Twelve patients had large symptomatic thoracic aortic aneurysms (8 had secondary to chronic dissection) and 10 patients had acute symptomatic type B aortic dissection, and all patients had an intramural hematoma or penetrating aortic ulcer, or both. An average of two endografts and 1.4 fenestrations were deployed. The covered stents were 8 to 10 mm in diameter. Mean operative time was 154 ± 66 minutes. Average hospital length-of-stay was 12 ± 7 days. No major fenestration-related complications occurred. One patient developed a stroke, no deaths occurred. One patient died during the immediate postoperative period; no in-hospital mortality rate was 4.5%. Two patients died of non-TEVAR-related causes at a mean follow-up of 18 months, (range, 1-40 months), prior to in-stent thrombosis in the LSA.

Conclusions: In situ fenestration is a feasible and effective option for LSA revascularization during TEVAR for acute and chronic type B aortic dissection. The high technical success, low fenestration-related morbidity, and excellent outcomes have supported the use of fenestration during endograft modification.
Arch repair

**Single branch device**

2 current ongoing IDE trials

Medtronic Valiant Mona LSA branch stent-graft

Gore thoracic branch endoprosthesis
Arch repair

**Single branch device**

**Medtronic Valiant Mona LSA branch stent-graft**

- **Early Feasibility Study**
  - 11 patients
  - 100% Technical success

- **Phase 1 Mona LSA Trial**
  - 18 patients
  - Stroke rate = 0%
Arch repair

Single branch device

Gore thoracic branch endoprosthesis Trial

Zone 2: 28 patients
100% Technical success
Stroke rate: 3.6%
Branch occlusion: 3.6%

Zone 0-1: 8 patients
100% Technical success
Stroke rate: 25%
Arch repair

Single branch device

CASTOR Branched Aortic Stent-Graft System

11 centers in China
73 patients with aortic dissection
98.6% Technical success
Unibody design with main body and LSA branch
Arch repair

**Multi branch device**

|-----------|-----------|-----------|

- Lt. Carotid access
- Large diameter sheath (24-26Fr)
- External branches
- Limited space for catheterization
- Internal branches
- Double reducing ties
- Self-oriented to outer curvature
- More space for catheterization
Arch repair

Multi Branch device

- Double inner branch
- Multicenter Study, 2009-2013
- 38 patients
- Technical success = 32/38
- Mortality = 13%
- Neuro events = 16%

Haulon et al

Global experience with an inner branched arch endograft

Stéphan Haulon, MD, PhD, Roy K. Greenberg, MD, Rafaëlle Spear, MD, Matt Eagleton, MD, Cherrie Abraham, MD, Christos Lioupis, MD, Eric Verhoeven, MD, PhD, Krassi Ivancev, MD, Tilo Köibel, 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

J Thorac Cardiovasc Surg 2014
Total endovascular arch repair with dual branch device
Arch repair
Multi branch device

Three-center experience demonstrated an improvement in patient outcome when compared with the early global experience of the technique published in 2014.
Arch repair

Multi branch device

• Based on the Relay Plus NBS platform
• Off the shelf with variable MSG diameter
• Large single aperture with 1 or 2 internal tunnel(s)
  • Single: innominate
  • Double : innominate & LCA
• Engaging lock mechanism for the branch stent graft
Arch repair

Multi branch device

Worldwide experience with double branch

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<th>Investigator</th>
<th>City</th>
<th>Country</th>
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<tr>
<td>Ospedale San Camillo Forlanini</td>
<td>Prof. Cao</td>
<td>Roma</td>
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<tr>
<td>Ospedale G. Brotz</td>
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<td>Prof. F. Moll – Dr. Van Herwaarden</td>
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<tr>
<td>Linköping University Hospital</td>
<td>Dr. C. Forssell</td>
<td>Linköping</td>
<td>Sweden</td>
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<table>
<thead>
<tr>
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<td>N</td>
<td>26</td>
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<tr>
<td>Male</td>
<td>69.2%</td>
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<tr>
<td>Mean Age</td>
<td>72y</td>
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<td>TAA</td>
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<td>Type B Dissection</td>
<td>15.4%</td>
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<td>Procedure completed</td>
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<td>Freedom from endoleak</td>
<td>92.3%</td>
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<td>Perioperative overall death</td>
<td><strong>11.5%</strong></td>
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<tr>
<td>Perioperative procedure related death</td>
<td><strong>3.8%</strong></td>
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Arch repair

Fenestrated device

383 patients in 35 centers
Zone 0 in 94.7%
Mean operative time = 161 min
Initial success = 95.8%
30 day mortality = 1.6%
Stroke rate = 1.8%
Arch repair

Ancillary device

Therapeutic use of EndoAnchors for proximal type I endoleak 1 yr after TEVAR & 4 vessels FEVAR for Type I TAAA
Acute repair  
Ancillary device

Placement of Endo Anchors at inner curvature for type I endoleak

Type Ia endoleak
Persistent endoleak after redo TEVAR & LCA fenestration
EndoAnchors deployed at inner curve
Type Ia endoleak resolved
Summary

Open arch repair is associated with significant operative morbidity and should be reserved for young and good risk patients.

Creative approaches for endovascular arch repair, such as parallel grafts or in situ fenestrations can be used safely with satisfactory early technical success.

Single or dual branch devices will offer a total endovascular solution to arch pathologies.
The endovascular era is here

The trouble with our times is that the future is not what it used to be.

Paul Valery