Techniques For Endovascular Aortic Arch Repair

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San Camillo-Forlanini Hospital, Rome
Disclosure

Speaker name: Mario Lachat
- Endospan, Jotec, Medtronic, Gore
Agenda

• Paralell Grafts
• Hybrid Repair
• Arch devices
Parallel Grafts TECH
Periscope Endograft Technique to Revascularize the Left Subclavian Artery During Thoracic Endovascular Aortic Repair

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Purpose: To present early and midterm results of the periscope endograft (PG) technique to maintain left subclavian artery (LSA) blood flow in thoracic endovascular aortic repairs (TEVAR) involving zone 3.

Methods: From April 2010 to January 2013, 14 consecutive high-risk patients (11 men; mean age 70.9 years; range 59-87) underwent TEVAR with the PG technique for 10 thoracic aortic aneurysms (TAA), 2 traumatic aortic ruptures, and 2 aortic dissections without a suitable landing zone (≥2 cm distal to the LSA). Five procedures were performed emergently for rupture (3 TAA and the 2 trauma cases). Two patients had a periscope deployed in an aberrant right subclavian artery. The periscope endografts were sized 1 to 2 mm larger than the branch anatomy at the intended landing zone. The caudal end was extended distal to the intended distal landing site of the thoracic stent-graft, which was usually deployed after the PG. Both the PG and thoracic stent-grafts were generally molded using the kissing balloon technique. Outcomes analyzed were immediate technical success, perioperative mortality and morbidity, aneurysm diameter change, and periscope endograft patency.

Results: Immediate technical success was 100%, with all procedures completed as planned. Perioroperatively, once periscope occluded and one of the ruptured TAA patients died. One percutaneous access site herniation required only conservative management. At a mean follow-up of 24 ± 9 months (range 9–37), there was no additional PG occlusion. The Kaplan-Meier estimate of PG patency was 93% at 2 years.

Conclusion: The periscope endograft is a simple technique to maintain perfusion to the LSA in cases where the aortic stent-graft crosses its ostium. The PG technique can be performed transanatomically and even percutaneously, and it can be applied to all supra-aortic branches. Early and midterm results are encouraging, but more experience and long-term results are mandatory before this technique can be widely recommended.

Keywords: thoracic aortic, thoracic aortic aneurysm, dissection, arch aneurysm, thoracic endovascular aortic repair, stent-graft, left subclavian artery, periscope graft, deployment technique, proximal landing zone.

Figure 4 – Follow-up CT (dorsal view of the aortic arch) performed 14 months postoperatively shows the distal (1) and proximal (2) ends of the patent periscope endograft.

Figure 5 – Freedom from occlusion for the periscope grafts (PG); standard error exceeds 10% at 25 months.

N= 14
Mean follow-up of 27 months (range 9–37)
3 or 4 Parallel Grafts (chimney, periscope)
Sizing with PG

A chimney in the left subclavian artery, following inadvertent coverage of its ostium in a patient treated for a Type B aortic dissection. Retrograde access to the vessel was achieved via a left brachial approach.
A chimney in the left subclavian artery, following inadvertent coverage of its ostium in a patient treated for a Type B aortic dissection. Retrograde access to the vessel was achieved via a left brachial approach.
Actual Sizing PG TECH ARCH @ USZ

Diameter Aorta + 20% + ½ diameter PG

Example: (Aorta 30mm) and PG to LSA (13mm)
Regular sizing aortic stentgraft = 36mm
Sizing aortic stentgraft with PG=45
(30+6+6,5= 42.7mm)
Title: “Over-SIRIX”: a new method for sizing aortic endografts in combination with the chimney grafts. Early experience with aortic arch disease.

Stefano Fazzini¹*, Metteo Orrico¹, Sonia Ronchey¹, Vittorio Alberti¹, Barbara Praquin¹, Ombretta Martinelli², Nicola Mangialardi¹

OSIRIX EVALUATION

Oversizing &

A: STENT 8 mm
B: STENT 11 mm
C: STENT 9 mm (ostio dei TSA)
Technique to reduce diam of PG and/or aortic stress
Intended PG size: 13mm
Intended PG size: 13mm

10mm PG parked

ASG parked
Intended PG size: 13mm

10mm PG parked

ASG parked
ASG deployed
Intended PG size: 13mm

10mm PG parked

ASG parked
ASG deployed

10mm PG deployed
Intended PG size: 13mm

10mm PG parked
ASG parked
ASG deployed
10mm PG deployed
Extension with 13mm PG
Intended PG size: 13mm

10mm PG parked
ASG parked
ASG deployed

10mm PG deployed
Extension with 13mm PG

Primary relining with wallstent
Summary

2 different SG sizes
- As small as possible in aortic LZ
- 10% oversize in target vessel
Primary relining with wallstent

- To reinforce PG
- To reduce endoluminal infolding (2nd PG)
Similar approach for all SAV
Moulding ASG
Moulding PG
CHIMNEY ORIENTATION

VESSELS TAKE-OFF

REDUCE INTERACTION IN THE ASCENDING
• Longer chimney $\rightarrow$ reduce EL (gutters)

• Bad landing zone $\rightarrow$ curvature/graft LZ
RETROGRADE TYPE A

Day 4 sudden death
DO THEY WORK?

Chimney Technique for Aortic Arch Pathologies: An 11-Year Single-Center Experience

Nicola Mangialardi, MD; Eugenia Serrao, MD; Holta Kasemi, MD; Vittorio Alberti, MD; Stefano Fazzini, MD; and Sonia Ronchey, MD, PhD

Department of Vascular Surgery, San Filippo Neri Hospital, Rome, Italy.

- TECHNICAL SUCCESS 39/39 100%
- MORTALITY 4 10.2%
- PROCEDURE REL COMPLICATIONS 4 10.2%
  - MINOR STROKE (2 RUPT-1 ELECT) 3
  - PARAPARESIS 1
  - EARLY TYPE I EL 0

J Endovasc Ther. 2014;21:312–323
Median FUP of 36 months
European Multicenter Registry for the Performance of the Chimney/Snorkel Technique in the Treatment of Aortic Arch Pathologic Conditions

Michel J. Bosiers, MD,* Konstantinos P. Donas, MD,* Nicola Mangialardi, MD, Giovanni Torsello, MD, Vincent Riambau, MD, Frank J. Criado, MD, Frank J. Veith, MD, Sonia Ronchey, MD, PhD, Stefano Fazzini, MD, and Mario Lachat, MD

95 PTS → 48 EMERGENCY

- TECHNICAL SUCCESS 89.5%
- 30 DAYS MORTALITY 9.5%
  (NONE AORTA RELATED)
  MAJOUR STROKE 2%
- TYPE I EL 10.5%
  (SOLVED SPONTANEOUSLY 50%)
- PRIMARY PATENCY 98%
- REINTERVENTION RATE 5.8%
Parallel Grafts ARCH@USZ

(all Gore TAG/Viabahn/Excluder)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>30d mortality</th>
<th>CVA/SCI</th>
<th>EL</th>
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<td></td>
<td>68</td>
<td>12%</td>
<td>9%</td>
<td>18%</td>
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</table>

40% acute patients
49% redo thoracic aorta
USZ Long-Term Study

- 41 first ARCH PG-EVAR patients treated up to May 2014
Mean FUP $22$ (0-65; 17) months
Mean FUP 22 (0-65; 17) months
Parallel Grafts - Conclusions

Parallel grafts used in the aortic arch

• Off-The-Shelf repair technique

• Safe in selected patients

• Behave durable up to 3 years mean follow-up
  • Taking into account substantial number of reinterventions to maintain seal or branch patency
ARCH devices
## Aortic Arch Devices: Results @ 30days

<table>
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<th>Fabric</th>
<th>n</th>
<th>30d mortality</th>
<th>CVA/SCI</th>
<th>EL</th>
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<tr>
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<tr>
<td>Zone 0-1</td>
<td>7</td>
<td>0</td>
<td>29%</td>
<td>NA</td>
</tr>
<tr>
<td>Zone 2</td>
<td>23</td>
<td>0</td>
<td>4%</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Medtronic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zone 2</td>
<td>9</td>
<td>0</td>
<td>33%</td>
<td>0</td>
</tr>
<tr>
<td><strong>Bolton</strong></td>
<td></td>
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</tr>
<tr>
<td>Single Branch</td>
<td>8</td>
<td>25%</td>
<td>13%</td>
<td>17%</td>
</tr>
<tr>
<td>Double Branch</td>
<td>26</td>
<td>12%</td>
<td>4%</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Cook</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arch</td>
<td>38</td>
<td>5%</td>
<td>16%</td>
<td>11%</td>
</tr>
</tbody>
</table>
Fixation zone of the ascending module (3cm)

Separation forces of the modules: mean 20N (SD 3) [ref 10N]
Sealing zone of the ascending module (2cm)
RO Markers

«B» markers for orientation (3)

Dot markers for position (8)

Ring marker for connection (1)
+ Supraaortic Fenestration
Delivery system

- 20 Fr
- Pre-curved, Pre-shaped
  - Delivery system and tip

Nexus Main Module (NMM)

Nexus Ascending Module (NAM)
Implantation technique

Trough & Trough GW
20 Fr sheath

Heparin bolus 300 IU/kg BW (ACT>300")
Anti-Trendelenburg for deployment
Implantation technique

Rapid Pacing
Clinical History

• 61 y
• Male
• Former Smoker
• Hypertension
• Dislypedimia
• IRC
• CAD
• TIA (15 y ago, unknown)
Plan

• Pre Nexus procedure (7 - 14 days before):
  • Bypass RCC-LCC-LSA 09.03.17 ✓

• Nexus procedure:
  • Gore Tag deployed in the Descending.
  • Main module deployed in the BCT
  • Oriented ASC module deployed in Ascending.
Assembly scheme

Surgical occlusion pre Nexus

RCC-LCC - LSA By pass

Endovascular plug post Nexus

Nexus Main Module Single

Nexus ASC Oriented Module

Gore Tag Extension-deployed before the main module

Distal landing of Gore TAG should be Th11
Main Module – option A
recommended sizes (red circles ○)

$\varnothing_{\text{BCA}} - 14/17/20 \text{ mm}$

$L_{\text{BCA}} - 20/30/40 \text{ mm}$

NO LCC fenestration

$L_{\text{DESC}} - 180 \text{ mm}$

$\varnothing_{\text{DESC}} - 32/36/40/44 \text{ mm}$
landing zone above the celiac
Gore TAG recommended sizes (red circles ○)

**Table 34. Sizing Guide**

<table>
<thead>
<tr>
<th>Intended Aortic Inner Diameters (ID) (mm)</th>
<th>Endoprosthesis Diameter (mm)</th>
<th>Endoprosthesis Lengths (cm)</th>
<th>Recommended GORE® Introducer Sheath Size (Fr)</th>
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<tbody>
<tr>
<td>23 - 24</td>
<td>26</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>24 - 26</td>
<td>28</td>
<td>10 / 15</td>
<td>20</td>
</tr>
<tr>
<td>26 - 29</td>
<td>31</td>
<td>10 / 15</td>
<td>20</td>
</tr>
<tr>
<td>29 - 32</td>
<td>34</td>
<td>10 / 15 / 20</td>
<td>22</td>
</tr>
<tr>
<td>32 - 34</td>
<td><strong>37</strong></td>
<td>10 / 15 / 20</td>
<td>22</td>
</tr>
<tr>
<td>34 - 37</td>
<td>37</td>
<td>10 / 15 / 20</td>
<td>24</td>
</tr>
<tr>
<td>37 - 42</td>
<td>40</td>
<td>10 / 15 / 20</td>
<td>24</td>
</tr>
</tbody>
</table>

Gore tag- Distal landing zone
ASC Module, Oriented - option A

Recommended sizes (red circles ○)

ØASC – 36/40/43 mm

Lnom – 40/55/70

TBD
From screening to Implantation

- Candidate CT Screening - Initial evaluation of major anatomical parameters
  - Candidate Suitable
  - Candidate Rejected

- Initial Model
- Plaster Model
- Elastomer Model

- Creation of exact elastomer 3D reconstruction model of candidate’s anatomy

- Simulated Implantation at Endospan

- Pre-Op Simulated Implantation session at physician site: presentation and training
Patients (31)

- Male 25 (80%)
- Age 73 years (52-85, SD:9)

Aortic pathology

- Aneurysm 17 (55%)
- Dissection 14 (45 %, all chronic)
  - Type A 10 (9 post ascending repair)
  - Type B 3
  - Non-A-Non-B 1

- Max Aneurysm Diameter: 63 mm (46-105; SD:13)
Patients @ our center 5

- 4 monobranch
- Male 100%
- Age 69 years

**Aortic pathology**

- Aneurysm 3
- Dissection 2
  - Type A 1 (post ascending repair)
  - Type B 1

1 Paraparesis (regressive)

1 Type II Endoleak (Uneffective LSA occl)

Mortality 0%

Type I EL 0%
N (31)
Results

<table>
<thead>
<tr>
<th>n</th>
<th>30d mortality</th>
<th>30d CVA/SCI</th>
<th>30d EL I/III</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 (Z0)</td>
<td>13%</td>
<td>10%</td>
<td>13%</td>
</tr>
</tbody>
</table>

100% technical success rate (conversion free implantation)

Mean FUP 12 months (SD9; 1-29)

Aneurysms sac behavior

Survival
Nexus - Conclusions

- Nexus is a promising alternative for total EV aortic arch repair
- Good Technical Outcomes and clinical outcomes
- Branch + Fen design is more challenging
- Precannulated fenestration could be an alternative
### Patient selection

Stépan Haulon. EVT Nov. 2014

#### Anatomic and Physiologic Criteria for Endovascular Arch Repair

**Anatomic Criteria:**
- Arch aneurysms and chronic dissections, no previous mechanical aortic valve replacement
- Ascending aortic length $\geq 50$ mm
  (measured from sinotubular junction to origin of innominate artery)
- Sealing zone in the ascending aorta $\geq 40$ mm in length and $\leq 38$ mm in diameter
- Sealing zone in the innominate artery $\geq 20$ mm in length and $\leq 20$ mm in diameter
- Access able to accommodate 22- or 24-F sheaths

**Physiologic Criteria:**
- Minimum of 2-year life expectancy
- Negative stress test (cardiology clearance required in the setting of positive stress test)
- No class III or IV congestive heart failure
- No stroke or myocardial infarction in the last year
- No significant carotid bifurcation disease
  ($\geq 75\%$ stenosis by North American Symptomatic Carotid Endarterectomy Trial criteria)
- Estimated glomerular filtration rate by modification of diet in renal disease method $\geq 45$ mL/min/1.73 m$^2$
Vallabhajosyula et al. Type II arch hybrid debranching procedure
Zone Zero unfit for TEVAR (ectasy)
Ascending TD >35mm
The wrapping TECH

Prolen mesh premarked to circumference

\[ \pi \times \text{intended diameter} \]

11cm for ID of 35mm
Treatment of isolated ascending aortic aneurysm by off-pump epiaortic wrapping is safe and durable

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Abstract

OBJECTIVES: Isolated ascending aortic aneurysm (IAA) is usually treated by open graft repair requiring sternotomy, cardiopulmonary bypass (CPB) and cardioplegia. This approach carries significant mortality in older patients or those presenting with comorbidities. We report an original series of patients presenting with IAA and treated with epiaortic wrapping by using a synthetic mesh. This less invasive aortic repair technique allows reducing the aortic diameter to a predefined value and is performed without CPB.

METHODS: Data from patients presenting with an IAA and treated with the wrapping technique (WT) by polypropylene/polyester mesh from November 2006 to July 2015 were collected. The end-points that were analysed included maximal aortic transverse diameter, perioperative mortality and morbidity, survival, freedom from reinterventions and aortic valve function during follow-up. The maximal aneurysm transverse diameter was analysed based on contrast-enhanced computed tomography (CTA) or magnetic resonance (MR) performed preoperatively, and during the follow-up.

RESULTS: The off-pump WT was used in 33 cases with no perioperative mortality. The median radiological follow-up was 33.47 (range: 1–106) months. Overall, the WT achieved a 30% diameter reduction. The mean preoperative and postoperative ascending aortic transverse diameter was 5.5 cm (standard deviation (SD): 0.6) and 3.7 cm (SD: 0.30), respectively (P = 0.001). In addition, CTA or MR follow-up showed stable diameters at the level of the aortic root and the distal ascending aorta. No death occurred during the follow-up. At 5 years, the estimated freedom rate from reinterventions of the aortic root and ascending aorta was 94%.

CONCLUSIONS: This series shows that the WT with a polypropylene/polyester mesh allows safe off-pump treatment of patients with IAA. Mid- and long-term results are promising. This technique could be an attractive alternative, especially for patients unfit for aortic surgery with CPB and cardioplegia.

Keywords: Off-pump • Ascending aorta • Graft repair • Mesh (polypropylene/polyester) • Wrapping girdling • Aortic valve insufficiency

Figure 3: CT findings. (A) Preoperative 5.5 cm ascending aortic aneurysm. (B) Ascending aortic postoperative transverse diameter measurement. (C) Four year ascending aorta and aortic root transverse diameter measurement showing no significant variation in size with postoperative findings. CT: computed tomography.

Figure 4: Survival and freedom from reintervention. SE does not exceed 10% at 5 years for the survival curve (SE: 1.7; CI: 101–106) and the freedom from reintervention curve (SE: 4.5; CI: 95–109); 2D: standard error; CI: confidence interval.
SA debranching
-Generally BCT and LCCA
SA debranching
- Generally
  - BCT E/E or E/S running suture
  - LCCA with VORTEC
TAG Zone 4
And
LSA PG sandwich
66yo male

Wrap & SADB
3.5h (teaching case)
No transfusion

No transfusion

PG-TEVAR
0.5h
No transfusion
Hybrid TEVAR w. PG

N= 26
30d M: 8%
Mean follow-up 34 (SD 20) months
Vallabhjosyula et al. Type II arch hybrid debranching procedure

Modified less invasive Type II HR
Vallabhajosyula et al. Type II arch hybrid debranching procedure

- Normal root
- Normal AV function
- Ascending diam < 70mm

When ever possible!!!
<table>
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<tr>
<th>Author</th>
<th>Year</th>
<th>Pts (n)</th>
<th>30-day results</th>
<th>Long-term results</th>
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<td></td>
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<td>mortality (%)</td>
<td>Stroke (%)</td>
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<td>Tokuda</td>
<td>2016</td>
<td>58</td>
<td>2 (2.6)</td>
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<tr>
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<td>2016</td>
<td>7</td>
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<td>1 (14.3)</td>
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<tr>
<td>Kang</td>
<td>2016</td>
<td>35</td>
<td>2 (5.7)</td>
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<tr>
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<td>2015</td>
<td>45</td>
<td>1 (2.2)</td>
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<tr>
<td>Ockert</td>
<td>2015</td>
<td>47</td>
<td>6 (12.8)</td>
<td>-</td>
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<tr>
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<td>179</td>
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<td>67</td>
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<td>38</td>
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<td>2012</td>
<td>66</td>
<td>6 (9.1)</td>
<td>3(4.5)</td>
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<td>24</td>
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<td>2008</td>
<td>73</td>
<td>5 (6.8)</td>
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<td><strong>Total</strong></td>
<td></td>
<td>889</td>
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Literature review ARCH Repair

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<th>Death (%)</th>
<th>CVA/SCI (%)</th>
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<th>Survival (%)</th>
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<td>31</td>
<td>10</td>
<td>9</td>
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<td>40</td>
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<td>20</td>
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<td>5</td>
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<td>3</td>
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<td>85%@2y</td>
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<td>Chimney</td>
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<td>26</td>
<td>5</td>
<td>3</td>
<td>16</td>
<td>6</td>
<td>8</td>
<td>94%@1y</td>
</tr>
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</table>

30d Results

F/L

Survival (Surv)
Hybrid Tech- Conclusions

• HR techniques and results significantly improved during last years

• More recent series show lower mortality & morbidity rates and repair durability

• Valuable option in selected patients
Conclusions

- Hybrid, PG tech & Arch devices are three safe means to treat arch pathology

- Superiority cannot be shown for none of them due to different target population

- Wise indication selection/ capability to combine the technique is probably the way to go