FROZEN ELEPHANT TRUNK TECHNIQUES FOR CHRONIC TYPE B DISSECTION

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Disclosures

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Evolution of ET

- Aortic arch, DA, TAAA pathologies challenging
- Patients with extensive disease, treatment of multiple anatomical segments simultaneously/staged
- Evolving devices & techniques

cET to FET
cET to FET

- cET simplifies further DA interventions. Arch replaced, free-floating prosthesis in the proximal DA; should not exceed 7-8cm (kinking, graft occlusion, paraplegia)

- Hybrid concept: shorter & less elaborate open supra-aortic trunk debranching with less invasive TEVAR

- cET: wide distal surgical intimal fenestration
  ↑pressurization of the FL and (↓ rate FL thrombosis, ↑interval rupture risk), 30-50% no 2\textsuperscript{nd} stage

- FET technique aims to depressurize and induce thrombosis of the dilated persistent FL

FET

- E-vita open plus
- Thoraflex Hybrid
E-vita
Thoraflex-Hybrid

The ONLY branched Frozen Elephant Trunk Device with Plexus and Ante-Flo™ configurations
Thoraflex Hybrid – 4 branch graft

- Grafts sizes 26-40 D for the stented portion, 100 mm or 150 mm L
- Proximal unstented and distal stented parts are available in different sizes
- DLZ of at least 2 to 3 cm with 10-20% oversizing of the distal DA

Courtesy of Vascutek, Terumo Cardiovascular Systems
Thoraflex Hybrid
antegrade deployment
Technique

- R axillary conduit, 5000 u heparin, 8-10mm graft, arterial inflow
- Median sternotomy, pericardium inverted “T”
- Arch vessels controlled with slings (LSA nylon tape)
- Systemic heparinisation

- Central or peripheral CPB cannulation
- Right atrium: twin lumen venous cannula for venous return
- LV vented by catheter in R superior pulmonary vein, cardioplegia
- Cardiopulmonary bypass, HCA active cooling to 22°C, ice to cranium
- Selective antegrade/retrograde cerebral perfusion
- Aortic cross-clamping; arch opened and resected; TL/flap fashioning
Technique

- Antegrade device delivery and deployment in DA (with or without wire access)
- Distal arch anastomosis first – collared skirt, 4/0 prolene reinforced Teflon strip
- LCCA branch re-implantation and start reperfusion with rewarming
- LSA and Innominate re-implantation 5/0 prolene
- Completion of the proximal anastomosis – Teflon
- Post-rewarming 37°C haemostasis
- Pericardial drains, pacing wires
- Packing--> vacuum 50mmHg
Tips & Adjuncts

- Careful pre-op CTA evaluation: locate re-entry tears, extend of disease & LZs
- Aim for HCA temperature below 27°C
- HCA shortening (restart systemic perfusion with rewarming asap after distal aortic arch anastomosis)
- Spinal cord protection: selective spinal drainage & MAP>80-90, consider MEPs
- Collared skirt sutured to adventitia to optimise fixation/seal
- 2-stage approach when Tx necessitates coverage beyond T6-8
- LSA – if origin extremely distal, R C-S, ligate, Gore Hybrid, FEN

- INVOS cerebral oximetry, NIRS
- CO2 insufflation
- TOE
- Endoscopic view of aorta during device implantation
FET Outcomes

**Mortality (30d)**
- 4-5% single center
- 15.9% E-vita Registry (n=500)
- 5-7% Thoraflex (CTAC)

**Stroke**
- 4.7%
- 65-70% survival at 10yr f/u
- 82.3% FFre-Ix
- 96% branch patency
- 75% FL thrombosis pre-d/c

**SCI**
- cET: 0.4 - 2.8%
- FET: >10% (0-21%)
- Prolonged HCA
- Intercostals
- T10 DLZ
### Table 2: Observational studies from a single centre experience that compare the frozen elephant trunk procedure with conventional arch repair

<table>
<thead>
<tr>
<th>Authors</th>
<th>Aortic centre</th>
<th>Number of patients (surgical procedure)</th>
<th>Aetiology</th>
<th>Hospital mortality rate</th>
<th>Spinal cord injuries</th>
<th>Follow-up survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acute type A dissection</td>
<td>Chronic dissection</td>
<td>Degenerative Aneurysm</td>
<td></td>
</tr>
<tr>
<td>Jakob [37] 2008</td>
<td>Essen, Germany</td>
<td>FET: 22 (E-vita Open, Jotec) CAR: 23 (ET)</td>
<td>FET: 100%</td>
<td>–</td>
<td>–</td>
<td>FET: 9%</td>
</tr>
<tr>
<td>Uchida [38] 2009</td>
<td>Hiroshima, Japan</td>
<td>FET: 65 (Z-shaped stent, William Cook) CAR: 55 (transverse arch)</td>
<td>FET: 100%</td>
<td>–</td>
<td>–</td>
<td>FET: 3%</td>
</tr>
<tr>
<td>Sun [26] 2011</td>
<td>Beijing, China</td>
<td>FET: 291 (Gianturco-type, Microport Medical) CAR: 120 (ET)</td>
<td>FET: 50.9%</td>
<td>FET: 49.1%</td>
<td>–</td>
<td>FET: 0.7%</td>
</tr>
<tr>
<td>Leontiev [39] 2013</td>
<td>Leipzig, Germany</td>
<td>FET: 46 (E-vita Open, Jotec) CAR: 125 (ET)</td>
<td>FET: 17.4%</td>
<td>FET: 4.3%</td>
<td>FET: 58.7%</td>
<td>FET: 8.7%</td>
</tr>
<tr>
<td>Di Eusano [40] 2014</td>
<td>Bologna, Italy</td>
<td>FET: 21 (E-vita Open, Jotec) CAR: 36 (ET)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Vallabhajosyula [41] 2014</td>
<td>Philadelphia, USA</td>
<td>FET: 62 (GoreTAG, WL Gore &amp; Associates) CAR: 180 (transverse arch)</td>
<td>FET: 100%</td>
<td>–</td>
<td>–</td>
<td>FET: 10%</td>
</tr>
<tr>
<td>Shrestha [19] 2015</td>
<td>Hannover, Germany</td>
<td>FET: 180 (Thoraflex™ Hybrid, Vascutek, E-vita open, Jotec; Chavan- Haverich, Curative GmbH) CAR: 97 (ET)</td>
<td>FET: 26.1%</td>
<td>FET: 28.3%</td>
<td>FET: 34.4%</td>
<td>FET: 12%</td>
</tr>
</tbody>
</table>

ET: elephant trunk; FET: frozen elephant trunk; CAR: conventional arch repair; ER: endovascular repair; OR: surgical repair.
Indications

- Extensive TA/TAAA when 2\textsuperscript{nd} procedure, open/endovascular in downstream aortic segments anticipated (EACTS IIa)
- For Type B Dissections: when primary TEVAR is not feasible or the risk of retrograde type A is high (EACTS IIb)
- Particularly recommended for dilated aortic arch
- Unfavourable arch anatomy for TEVAR (PLZ arch >40mm, arch angulation, dissected LSA)
- Treat Type Ia endoleaks TEVAR
- Acute Type A/IMH/PAU
- Arch aneurysms
- Preventive repair for a moderately dilated descending aorta (Cleveland clinic: early survival benefit, mortality 0.8%)
Advantages

• Definitive proximal repair
• Reduced dissection & surgical preparation of the distal arch (nerve, bronchial, GI, lymph)
• Shortened clamp times

• No need to clamp proximal to LSA, trifurcated graft and HCP (↓ embolization)
• Selective cerebral & body perfusion techniques
• ↓ retrograde ascending aortic dissection risk
• ↓ stroke rates compared with arch hybrid
Case example 1 – staged

42yr old female chronic TBAD

<table>
<thead>
<tr>
<th>PRE-OP</th>
<th>STAGE 1 FET</th>
<th>STAGE 2 TEVAR</th>
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London
Case example 1-TL compression
Case example 1 f/u

<table>
<thead>
<tr>
<th>At d/c</th>
<th>6-months</th>
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</thead>
<tbody>
<tr>
<td><img src="image1" alt="At discharge image" /></td>
<td><img src="image2" alt="Six months post-discharge image" /></td>
</tr>
</tbody>
</table>
Case example 2-staged
61yr old male chronic TBAD
Case example 2
septum fenestration
Case example 2 f/u

At d/c

6-months
Total endovascular approach?

- Czerny 2018
- STROKE RATE 13.3%
- ENDOLEAK 6.7%
Summary

- Specifically designed FET prosthesis (4 branches)
- Simplifies procedure and adds flexibility
- Definitive repair proximally, permits further extension
- Modern HCA techniques combined with selective antegrade cerebral perfusion make this approach safe
- Encouraging short & long-term outcomes: mortality, stroke, re-lx
- SCI a concern- consider staging