Aortic Endografts: A Surgeon’s Perspective of Aortic Repair and Beyond

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Disclosure
- Consultant
  - Cook Medical
  - Medtronic

Objectives
- Review of aortic pathologies
- EVAR/TEVAR and endograft concepts
- EVAR/TEVAR and specific anesthesia considerations
- Beyond aneurysm repair
- Future directions in endovascular aortic repair

Aortic Disease

- Congenital
  - Coarctation
  - Genetic Disorders
    - Marfan’s Syndrome
    - Ehlers-Danlos
    - Turner’s Syndrome
    - Polycystic Kidney Disease
- Acquired
  - Occlusive
  - Aneurysmal
  - Dissection
  - PAU/IMH
  - Inflammatory
  - Traumatic

Aortic Disease

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Congratulations
Prevalence of TAAA
- 10 new aneurysms per 100,000 persons/yr
- 10-20% 5 yr survival for patients remaining untreated
- For every 1 cm of growth over 5 cm in the descending thoracic aorta, the risk of rupture nearly doubles!
- Patients with TAAAs > 7 cm, 43% will eventually progress to dissection or rupture

Prevalence of AAA
- In the US, AAA causes almost 14,000 deaths each year and accounts for 63,000 hospital discharges

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9 - 4.9 cm</td>
<td>1.3%</td>
<td>0%</td>
</tr>
<tr>
<td>75-84</td>
<td>12.5%</td>
<td>5.2%</td>
</tr>
</tbody>
</table>

Risk factors associated with aortic disease
- Older age
- Male sex
- Family hx
- Smoking
- Hypertension
- Dyslipidemia
- Atherosclerotic disease
- COPD

Diagnostic Modalities
- Chest radiography
- Computed Tomography (CT)
- Helical CT
- Multidetector CT
- 64-slice CT
- Echocardiography
- Thoracic
- Transesophageal
- Magnetic resonance imaging
- Angiography
- Intravascular Ultrasound

Abdominal Aortic Aneurysms

Crude Zones 2005 (According to stent graft, suitable for aneurysm)

Xi Jinping Classification, 2006 (According to primary tear, suitable for dissection)
AAA: Pathophysiology

- Initiation
  - Smoking
  - HTN
  - Genetic predisposition
- Progression
  - Cytokine and chemokine mediated
  - Proteolytic enzymes
  - Biomechanical stress
- Rupture
- Biomechanical stress


Endovascular Aortic Repair

- Dr. Charles Stent (1807-1885)
- Stent a person not a word
Randomized Clinical Trials

- DREAM: Dutch Randomized Endovascular Aneurysm Management (Netherlands)
- Over: USA Open vs Endovascular Repair (US)
- EVAR 1 and 2: UK Endovascular Aneurysm Repair (UK)
- Eurostar (European Registry)

Operative Mortality 4.6% in open vs. 1.2% in EVAR
Combined mortality and complications 9.8% in open vs. 4.7% in EVAR
Cumulative survival at two years 89.6% for open vs. 89.7% for EVAR
Aneurysm related deaths, 5.7% for open vs. 2.1% for EVAR
Survival free of complications, 65.9% for open vs. 65.6% for EVAR

1257 patients with mean aneurysm size of 6.5 cm
30-day operative mortality 4.7% in open arm vs. 1.7% in EVAR
Secondary interventions 5.6% in open arm vs. 9.8% in EVAR
Overall mortality 7.7 vs. 7.5 deaths per 100 person years in open vs. EVAR
Overall aneurysm related mortality 1.2 vs. 1.0 per 100 person years in open vs. EVAR
Graft related complications 2.5 vs. 12.6 per 100 person years in open vs. EVAR
Secondary interventions 1.7 vs. 5.1 per 100 person years in open vs. EVAR
Endovascular aneurysm repair and outcome in patients unfit for open repair of abdominal aortic aneurysm (EVAR trial 2):

<table>
<thead>
<tr>
<th>Event</th>
<th>EVAR</th>
<th>No intervention</th>
<th>Mean difference</th>
<th>% of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary hospital admission</td>
<td>2095</td>
<td>1999</td>
<td></td>
<td>2.3</td>
</tr>
<tr>
<td>Mortality</td>
<td>474</td>
<td>102</td>
<td>-372</td>
<td>-275</td>
</tr>
<tr>
<td>Aneurysm rupture</td>
<td>16</td>
<td>5</td>
<td>11</td>
<td>5.3</td>
</tr>
<tr>
<td>Secondary procedures, adverse events, scans</td>
<td>1539</td>
<td>849</td>
<td>690</td>
<td>82.0</td>
</tr>
<tr>
<td>Other adverse events</td>
<td>237</td>
<td>32</td>
<td>-205</td>
<td>-74.8</td>
</tr>
<tr>
<td>Angiography CT scan/angiography imaging</td>
<td>599</td>
<td>96</td>
<td>-403</td>
<td>-67.7</td>
</tr>
<tr>
<td>Total</td>
<td>13,021</td>
<td>3,929</td>
<td>9,092</td>
<td>231.5</td>
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</table>

*15% of VA patients received primary AAA repair in the EVAR group and 42% of CTA patients received primary AAA repair in the no intervention group. Smaller number of EVAR follow-up appointments, CT and angiography scans estimated from survey form counts.

Table 6: Estimated costs (UK£) over 6 years of follow-up based on intention to treat.

Conclusions:

EVAR offers early mortality benefit
All Cause Mortality will catch up in time
EVAR has more secondary interventions
There is NO level I evidence showing that any device outperforms any other when used according to IFU!!

Criticism

20% of patients undergoing open repair would not undergo surgery again
No endograft outperforms another
By the time adequate data is available, technology has changed and results are no longer applicable
Radiation safety

Aortic Psuedoaneurysm/PAU

- History:
  - 83 YO M with steroid and O2 dependent COPD, HTN, CAD
  - CC: sudden onset mid lumbar back and abdominal pain

30 day mortality was 0.5% in the EVAR vs 3.0% in the open surgery group
Aneurysm related mortality lower in EVAR than Open and this holds at 2yrs!
4.1% in EVAR vs 4.9% in open
At 2 yrs, no difference in erectile dysfunction or health-related QOL
Indications:

- Aneurysms
- Intramural hematoma
- Dissections acute and chronic
- Penetrating aortic ulcers and pseudoaneurysm
- Traumatic aortic transection
- Aortobronchial or aortoesophageal fistulas
- Repairs following coarctation repair
- Hybrid procedures “Elephant trunk” procedures

Randomized Clinical Trials

- IRAD
  - International registry of acute aortic dissections
- INSTEAD
  - Prospective Multicenter European trial of medical vs. surgical treatment for Type B dissection

Acute Type B Dissection

- History
  - 46 YO MO male BMI 56, with PMHx HTN, CAD, OSA
  - CC: severe chest, back and abdominal pain
**Thoracic Aortic Aneurysm**
- History:
  - 76 YO MO male with PMHx HTN, CAD, COPD
  - CC: None
  - Incidental finding of

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**Aorto-pulmonary Fistula**
- History:
  - 38 YO male s/p Aorto-aortic bypass
  - CC: several weeks of small volume hemoptysis
  - No fevers, WBC nrml, ESR/CRP nrml, blood cultures negative
### Anesthetic Considerations: Acute Aortic Syndromes

#### Preoperative
- Risk for paraplegia
- Lumbar drainage
- Neuro-monitoring
- Somatosensory evoked potentials
- Motor evoked potentials
- Transcranial Doppler

#### Preoperative
- Malperfusion
- Severe acidosis
- Oliguria
- Paraplegia/paresis
- Hemothorax
- Compromised ventilation
- Tube Thoracostomy

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**Table 1: Risk Factors for Paraplegia and Spinal Cord Ischemia**

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**Table 2: Risk Factors for Paraplegia and Spinal Cord Ischemia**

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Preoperative

- Coagulopathy
- Massive transfusion protocol
- Positioning
  - Bump under left chest to open distal arch
- Access
  - Arterial line
  - Pulmonary artery catheter
  - Percutaneous endovascular access
- Impulse control therapy
  - HR <80 bpm
  - SBP <120 mm Hg

Intraoperative

- Deployment
  - Reduction of antegrade flow
  - MAP ≤60 mm Hg with vasodilators
  - Adenosine for asystolic arrest
  - Inflow occlusion
  - Rapid ventricular pacing (HR > 180)

Anesthetic considerations:

Acute Aortic Syndromes

Postoperative

- Hemothorax
  - Place tube thoracostomy
- Neurologic exams
  - Paraplegia
  - Paresis
  - Stroke
- Malperfusion
  - Hypertension with motor deficits
  - Maintain renal perfusion

Stent Grafts- Beyond aneurysm repair

- Occlusive disease
- Complex hybrid repairs
- Fenestrated repairs
- Snorkel and chimney repairs
- Branched repairs
- Thoraco-abdominal repairs
- PMEG-Physician modified endografts
The Results: Pre-operative

- Cohort 11 patients (2008-2013)
  - M: 8  F: 3
  - 10 Elective
  - 1 Ruptured
- Claudication 100%, CLI 33%
- Preoperative ABIs:
  - Bilateral → 0.65

Results: Procedural

- 100% Technical success
- 36% of patients had complete iliac occlusions
- 64% of patients with critical iliac stenosis
- 27% of patients with aortic stenosis

Hybrid TAAA repair

- History:
  - 75 YO male s/p infrarenal tube graft repair for AAA
  - CC: none
  - Continued enlargement of suprarenal aspect of AAA
Fenestrated EVAR

- History:
  - 70 YO male juxtarenal AAA
  - CC: none
  - Elective repair

Extent III Ruptured TAAA

- History:
  - 68 YO female s/p infrarenal tube graft AAA repair
  - CC: two days of severe midscapular and chest pain
  - Previously paralyzed during first operation
Thoraco-abdominal repair
Nelix Endovascular Concept

- Novel Sac Anchoring Platform
  - Endoframes deployed to pave lumens to distal anatomy
  - Endobags filled with biostable polymer
  - Same procedure in standard or complex anatomy

- Design Targets
  - Conform to the aneurysm anatomy
  - Eliminate migration, lateral movement, and all endoleak types
  - Reduce secondary procedures
  - Reduce follow-up CT surveillance

EVAR Using the Nelix Sac-anchoring Endoprosthesis: Treatment of Favourable and Adverse Anatomy


Nelix Implant Procedure
Case Overview
6.0cm AAA with 20mm Length Neck and 3.5cm RCA

Pre-Operative
Post-Operative
1-Year

Case Overview
5.0cm Bi-Lobe AAA with Sac Mural Thrombus
Pre-Op
1 Month
1 Year

Continued implant stability with thrombus reduction

Fenestrated/Branched Endografts
- Device design and delivery challenges
Emerging Technologies:

• "The scenario will be one in which the surgeon performs the virtual operation on the patient’s image, edits the procedure until it is perfect, then pushes the ‘operate’ button, and a ‘perfect’ operation is performed, with all the errors edited out. This will take surgery from the Industrial Age, or ‘typewriter mentality’ of today and into the ‘word processor’ stage of the Information Age."
Thank You......

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