Percutaneous Approaches to Aortic Disease in 2018

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Case

• 78 year old F
• Lower CP and upper abdominal pain for 1-2 weeks
• GP sent her for abdominal ultrasound
• Possible thoracic aortic aneurysm
• Sent to ER where she was found to be hypertensive
• CT – 5.8 cm thoracoabdominal aneurysm, intramural hematoma, pleural effusions
What is the rate of rupture over a lifespan?

A. 20%
B. 40%
C. 60%
D. 80%
E. 100%

Thoracoabdominal Aortic Aneurysm

- Incidence of thoracic aortic aneurysms is 10 per 100,000 person years
- Natural history of aneurysms is dissection or rupture
  - Up to 80% will eventually rupture
- 10-20% 5-year survival for those untreated
- Females develop TAA later in life than men but have a higher risk of rupture
- Advanced age is a risk for rupture
- COPD increases the risk of rupture by 3.6 times
- Diameter is related to rupture risk
  - Annual risk is 7% when >6 cm
**Classification – Safi’s modification to Crawford**

<table>
<thead>
<tr>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
<th>Type 4</th>
<th>Type 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lt SC to renal arteries</td>
<td>Lt SC to aortic bifurcation</td>
<td>Below 6th space to abdominal</td>
<td>Below diaphragm to aortic bifurcation</td>
<td>Below 6th space to visceral segments</td>
</tr>
</tbody>
</table>

**6th intercostal space**

**Diaphragm**

**Case**

- **Type 1**
  - Distal to subclavian until SMA and celiac, no involvement at renal arteries

- Despite controlling blood pressure repeat CT 2-days later demonstrated 5 mm increase in the intramural hematoma
- Patient remained symptomatic
What would you do?

A. Medical management
B. Intervention (surgery/percutaneous)
Case

- Due to multiple comorbidities, planned for TEVAR

Indications For Repair

- Rupture
- Acute dissection resulting in malperfusion or other life altering complications
- Symptomatic states regardless of size/extent
  - Pain consistent with rupture and unexplained by other causes
  - Compression of adjacent organs
  - 95% occur without symptoms
- Documented enlargement ≥ 1 cm/year or substantial growth approaching absolute size criteria
- Absolute size >6.5 cm or >6.0 cm in patients with connective tissue disorders
  - Absolute size criteria must be adjusted in patients of extreme of size
  - Cutoffs determined based on risk of rupture>mortality of the proposed procedure
Thoracic Endovascular Repair (TEVAR)

- Minimally invasive approach
  - Placing a stent-graft in the thoracoabdominal aorta for the treatment of a variety of thoracic aortic pathologies
  - Devices approved in US differ in terms of metallic support, radial support, flexibility

GORE® TAG®
Cook TX2
Medtronic Valiant
Bolton Relay

TEVAR vs Surgery

- No RCT directly comparing open and endovascular repair of the thoracic aorta

Better outcomes due to:
- lack of sternotomy and thoracotomy
- No need to cross-clamp the aorta
- less blood loss
- lower incidence of end-organ ischemia
- fewer episodes of respiratory dependency
- quicker recovery

*Contemporary Analysis of Descending Thoracic and Thoracoabdominal Aneurysm Repair: A Comparison of Endovascular and Open Techniques*
*Circulation. 2008;118:000-000.*
Indications for EVAR

• Thoracic aortic aneurysms (original approval in 2005)
• Traumatic aortic injury
  • Systemic anticoagulation can be held for those with concomitant head injury
  • Used in younger patients but long-term data is not available and surveillance increases the cumulative radiation dose
• Complicated type B aortic dissection
• Penetrating aortic ulcer/Intramural hematoma
• Aortoesophageal fistula
• Treatment of EVAR complications

Patient Selection

• Initially for those who were not suitable for open surgery
• Individualized approach
  • Age
  • Patient risk factors for perioperative morbidity and mortality

• Not ideal for infected aneurysms or connective tissue disease
• Not for those who do not meet the anatomic criteria to place any of the available endografts
• Inability to comply with surveillance (relative)
Procedural Considerations

1. Aortic anatomy
2. Extent of aortic disease
3. Available landing zones
   - location of attachment and length of coverage relates to the risk and complexity of the procedure as well as component selection and stresses on the devices

Planning - Imaging

- Computed tomography angiography
- Information on
  - external and endoluminal diameter of the aorta at the proximal and distal seal zones
  - length of aortic coverage
  - degree of angulation and tortuosity of the aorta
  - important side branches
  - thrombus burden
  - calcification
- Magnetic resonance angiography can be used but does not demonstrate vessel wall calcification well
Planning

• Generally, a 2-cm length of normal diameter aorta is required to achieve a seal (proximal and distal)
• Device deployment close to or within the arch must closely appose the "inner curve" of the arch
• Increase risk of graft collapse, migration, and failure of aneurysm exclusion if the proximal end of the graft is oriented towards the apex of such a curve -- "bird-beaking"
• Suitable iliac artery morphology is required for delivery
• Specific parameters for individual devices are given in the instructions for use (IFU) for each device

Debranching

• When a graft covers important aortic side branches, open vascular surgery to bypass these vessels may be needed prior to thoracic stent-grafting placement
• Surgery can be avoided by using combined fenestrated or branched abdominal aortic endografts
• in situ fenetration with a needle or laser during emergencies
Post Op Surveillance

• CT angiography
  • within 1 month
  • 6 months
  • Then yearly

Case

• Post operatively, she developed lower limb weakness
• Spinal drain was inserted and she commenced hyperbaric treatment
Complications

- Iliofemoral Access
  - Spinal
  - Cerebrovascular
  - Extremity
  - Visceral

- Ischemic
  - Aortoesophageal
  - Aortopulmonary
  - Leaks
  - Migration

- Post-Implantation Syndrome
  - Infolding/Collapse
  - Separation

- Fistulas

- Device

Perioperative Morbidity and Mortality

<table>
<thead>
<tr>
<th>Perioperative mortality</th>
<th>Elective</th>
<th>1.9-3%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emergent</td>
<td>~20%</td>
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| Iliofemoral Access Complication         | 12%      |

<table>
<thead>
<tr>
<th>Ischemic Complications</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Spinal Chord</td>
<td>3-11%</td>
</tr>
<tr>
<td>- Risk is comparable to open surgery</td>
<td></td>
</tr>
<tr>
<td>- Risk related to amount of thoracic</td>
<td></td>
</tr>
<tr>
<td>coverage, perioperative hypotension and long procedure duration</td>
<td></td>
</tr>
<tr>
<td>- May be reduced with prophylactic</td>
<td></td>
</tr>
<tr>
<td>spinal drain placement</td>
<td></td>
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</table>

| Cerebral vascular                      | 4-8%     |
| - Risk is comparable to open surgery   |          |
| - Risk factors include: proximal      |          |
| deployment of the graft; presence of   |          |
| mobile atheroma in the arch; and prior |          |
| stroke                                 |          |

| Extremity                               | 8-26%    |
| - Risk comes from covering subclavian  |          |
| artery                                  |          |
| - Avoid by bypassing                    |          |
| - However, perioperative mortality and |          |
| other complications may be increased   |          |

| Visceral                                | ~14%     |
| - occurs with coverage of the celiac  |          |
**Post Implantation Syndrome**

- Occurs early postoperative period
- Characterized by leukocytosis, fever, and elevation of inflammatory mediators such as C-reactive protein, IL-6, and TNF-alpha
- Due to endothelial activation by the endoprosthesis
- For thoracic aortic stent-grafts, development of either unilateral or bilateral reactive pleural effusions is not uncommon
  - Incidence of 37-73%
- Treatment: supportive

**Late Complications - Fistulas**

- Aortobronchial
  - 33% mortality
- Aortopulmonary
  - 45% mortality
- Treat with EVAR+surgery

*J Am Coll Cardiol Intv 2009;2: 570–6*
Complications - Endoleak

- 3.9-15.3%

Ultrasound Contrast Improves Diagnosis

Post open aortic graft for AAA

Courtesy: H Leong-Poi
Contrast-enhanced ultrasound (CEUS) versus computed tomography angiography (CTA) in detection of endoleaks in post-EVAR patients. Are delayed type II endoleaks being missed? A systematic review and meta-analysis

8 articles (n = 454 pts)

Pooled sensitivity of CEUS at detecting endoleak is 0.914 (CI 0.866–0.949) and pooled specificity is 0.782 (CI 0.741–0.820).

Types of Endoleaks after EVAR

**Type I**
- Perigraft flow due to inadequate graft seal

**Type II**
- Branch arteries back-bleed because of collateral flow

**Type III**
- Persistent flow between the segments of a modular graft

**Type IV**
- Flow through endograft material (graft porosity)

**Type V (endotension)**
- Expansion of an aortic aneurysm in the absence of demonstrable endoleak
Management of Endoleaks after EVAR

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<td>I – perigraft flow due to inadequate seal</td>
<td>Endovascular repair</td>
</tr>
<tr>
<td>II – branch artery backbleed</td>
<td>Unclear. Observation. If transient (&lt;6 months) no intervention</td>
</tr>
<tr>
<td></td>
<td>If persistent (&gt;6 months) intervene</td>
</tr>
<tr>
<td>III – flow between segments</td>
<td>Endovascular repair</td>
</tr>
<tr>
<td>IV – graft porosity</td>
<td>No intervention. Resolves spontaneously with normalization of coagulation profile</td>
</tr>
<tr>
<td>V - endotension</td>
<td>Exclude undiagnosed leak/thrombus. If no cause discovered, open surgical conversion is required if aneurysm sac grows</td>
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Device Complications – Device Infolding/Collapse

• Occurs primarily in young trauma patients
• Related to severe proximal aortic angulation or to oversizing the device at the time of placement
• Patients present with symptoms of acute aortic occlusion

Device Complications - Migration

• >10 mm caudally
• 1-2.2.8% over 6-12 month period
• Causes
  • excessive over-sizing
  • tortuous seal zone anatomy

J Vasc Surg 2008;48:54-63

Device Complications – Device Separation

• Occurs in cases of multiple overlapping stents

http://dx.doi.org/10.1594/ecr2016/C-0919
Most Device Complications Are Managed with a Second Intervention

- Rate is between 3.6-24% depending on duration of follow-up


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Midterm survival after thoracic endovascular aortic repair in more than 10,000 Medicare patients

- Survival depends on original etiology

_J Thorac Cardiovasc Surg_ 2015;149:808-23
Case

- PEA arrest during hyperbaric treatment
- CXR
Summary

• For patients with or without involvement of the abdominal aorta, endovascular stent-grafting is a reasonable alternative to open surgery

• There is a significant rate of secondary intervention required following stent-grafting for endoleak, graft migration, and progression of the underlying disease that indicated the endograft

• However, due to decreased perioperative morbidity, this approach makes it preferable to open repair for many indications

• Routine follow-up imaging is mandatory

Thank you for listening