Aortic Aneurysm Treatment: Past, Present and Future
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Aortic Aneurysm: 101
• Aneurysms are defined as a focal dilation of at least 50% larger than the expected normal
• The definition of abdominal aortic aneurysm is at least 3 cm and for a common iliac 1.8 cm
• Normal diameter in the thoracic aorta is 28 mm and in the abdominal aorta 20 mm

Aneurysm Treatment: Past, Present and Future
• Introduction to aortic aneurysms: 101
• Treatment “Back in the Day”
• History of and progression of endograft aneurysm treatment
• Future of aortic aneurysm repair
Abdominal Aortic Aneurysm: 101

- Abdominal aortic aneurysm are the common type of true aneurysms
- 15\textsuperscript{th} leading cause of death overall, 10\textsuperscript{th} most common cause in men over 55
- Underestimation because 30 to 50\% of patient die from rupture before reaching the hospital

Abdominal Aortic Aneurysm: 101

- Nearly all AAAs involve the infrarenal aorta but only 5\% involve the suprarenal aorta
- 25\% involve the iliac arteries but less than 1\% are isolated iliac aneurysms
- Concomitant thoracic aneurysms occur in up to 12\% of cases

Abdominal Aortic Aneurysm: Pathogenesis

- Degenerative disease not atherosclerotic
- Loss of elastin with fragmentation of fibers with transmural inflammation
- Proximal thoracic aorta 60 to 80 layers, infrarenal aorta with 28 to 32 layers
- Up to 20\% of AAA in familial clustering
Abdominal Aortic Aneurysm: Epidemiology

- Generally a disease of elderly white men, five times more common than in women and 3.5 times more common than in African-Americans
- Smoking increases risk of aneurysm by 5.6 fold
- Risks increase significantly with the number of years smoking

Other related factors:
- Hypertension
- Atherosclerosis
- Hypercholesterolemia
- Chronic obstructive pulmonary disease

In younger patients causes such as Marfan’s and Ehlers-Danlos are more prevalent

Mortality Caused by Aortic Aneurysm
Aortic Aneurysm: Risk of Rupture

- Very much related to diameter – “SIZE DOES MATTER”
- Studies show a transition in the 5 to 6 cm range
- Risk of rupture of a 6.5 cm aneurysm is 8-10% a year and 7.5 cm aneurysm 31%
- Those less than 5 cm in diameter have a risk of rupture less than 3% a year

Aortic Aneurysm: Clinical Presentation and Diagnosis

- Most present with minimal symptoms – that is what makes aneurysms dangerous
- Symptoms include those of expansion and embolization
- Physical examination can detect but in obese patients this is difficult
- Ultrasound is by far the best screening tool, CT angiography has its place
Aortic Aneurysm: Screening

- Aneurysms are hard to detect and this leads to rupture and death
- Recommendations to screen all men over 65 with history of smoking
- Screening also recommended for close family members of patients with aneurysms
- Expansion rate of 10% yearly in larger aneurysms, again smoking increases expansion rate
- Recommendations of yearly ultrasound in patients with known aneurysm
Aortic Aneurysm: Early Treatments

- Aortic ligation was the first treatment with many failures
- Thrombosis with intraluminal wires placed and electrical current sent through
- Wrapping with reactive cellophane to induce a fibrotic reaction
- Albert Einstein was treated with this and lived for 6 years following
Aortic Aneurysm: Open Treatment

- Durable results did not occur until resection with graft replacement in 1951
- Aortic homografts (cadaveric) were the first used
- DeBakey et al used the first artificial material with Dacron in the late 1950s
- Standard technique of endoaneurysmorrhaphy with intraluminal stent placement
- Transperitoneal versus Retroperitoneal
Aortic Aneurysm: Open Treatment
Complications

- Hemorrhage
- Renal failure 5-12%, dialysis dependent 3%
- Death 5%
- Pulmonary complications 8-12%
- Myocardial infarction 2-8%
- Leg and/or colon ischemia 2%

Aortic Aneurysm: Endograft Repair

- Parodi et al described the first successful endograft repair in 1991
- Over the past 25 years the techniques and devices have exponentially improved
- The majority of aneurysm repairs are now done via an endovascular approach

Aortic Aneurysm: Endograft Repair

- Performed via common femoral or iliac access which can be done percutaneously
- Angiography required
- Anatomical considerations include:
  - Neck diameter
  - Tortuosity
  - Neck angulation
  - Iliac artery anatomy
Aortic Aneurysm: Endograft Repair Complications

- Contrast induced nephropathy
- Access artery injury/thrombosis
- Ischemic complications – colon, renal, etc
- Infectious complication
- Late complications:
  - Limb thrombosis
  - Endoleak
Endograft Repair Complications: Treatment

- Most Type II endoleaks can be observed
- If there is sac expansion one can proceed with coil embolization or glue injection
- Type I and III endoleaks should be treated with additional graft placement
- Sometimes open explantation and graft placement the only option
Aortic Aneurysm: Follow-up of Endovascular Repair

- CT angiography the “gold standard”
- MRA/MRI worthless
- Ultrasound has surpassed CT angiography in most practices
- We perform CT angiography at 1 month, then ultrasound at 6 and 12 months and then years
- More intense imaging for those with issues

Aortic Aneurysm: Endovascular versus Open Repair

- Involved 1252 patients over 5 years
- Mortality rate from surgery 1.8% in endovascular group and 4.3% in open group
- Long term survival similar
- The overall costs were higher in the endovascular group
- More interventions in the endovascular group

Recent Advances in Endograft Repair

- More recent studies have confirmed both a decreased mortality along with complication rate in endovascular repair
- Costs are decreasing as length of stay decreases (average now less than 2 days)
- Ability to treat older and more chronically ill patients
  - Severe COPD
  - Poor operative risk
  - Ability to perform procedure under local anesthesia

NEJM 2010; 362: 1863-1871
Endovascular Treatment in the Elderly

- Meta-analysis of 15 studies
- Efficient procedure with success in greater than 95% of cases
- Aneurysm related deaths of 0 to 3.4%
- Late survival of up to 90%
- Improved results compared to open repair
- More flexibility in the elderly and ill patient


Endovascular Treatment in the Elderly

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>n (EVAR)</th>
<th>n (open)</th>
<th>30-day mortality</th>
<th>30-day morbidity</th>
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<tr>
<td>Sicard, et al.</td>
<td>2001</td>
<td>52</td>
<td>38</td>
<td>EVAR: 1.9%</td>
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<td>Patel, et al.</td>
<td>2003</td>
<td>36</td>
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<td>EVAR: 0%</td>
<td>open: 3.3%</td>
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<td>Leon, et al.</td>
<td>2005</td>
<td>351</td>
<td>1400</td>
<td>EVAR: 1.7%</td>
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<td>Dake, et al.</td>
<td>2007</td>
<td>32</td>
<td>22</td>
<td>EVAR: 1.1%</td>
<td>open: 0.0%</td>
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<tr>
<td>Patel, et al.</td>
<td>2008</td>
<td>85</td>
<td>49</td>
<td>EVAR: 0.0%</td>
<td>open: 0.0%</td>
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<tr>
<td>Schumacher, et al.</td>
<td>2009</td>
<td>6589</td>
<td>6586</td>
<td>EVAR: 4.4%</td>
<td>open: 9.8%</td>
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<td>DeDonato, et al.</td>
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<td>Paolini, et al.</td>
<td>2008</td>
<td>81</td>
<td>120</td>
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<td>Schierhorn, et al.</td>
<td>2009</td>
<td>NR</td>
<td>NR</td>
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<td>Schierhorn, et al.</td>
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<td>1434</td>
<td>351</td>
<td>EVAR: 1.2%</td>
<td>open: 0.3%</td>
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Fenestrated Endografts

- Supraaortic Aortic
- Para-aortic Aortic
- Juxtarenal Aortic
- Infrarenal Aortic
Fenestrated Endografts

- Involved 55 patients (all chronically ill) with 88 renal arteries, 35 superior mesenteric arteries and 5 celiac
- No operative deaths but substantial morbidity
- Long term complications:
  - Loss of target vessels – 9 patients
  - Stent fractures – 15 patients
  - Late reinterventions – 12 patients
- Complications similar to open studies but these patient’s overall health worse
- Very close follow-up required in these patients

Eur J Vasc Endovasc Surg 2013; July: 54-59.
Treatment of Ruptured Abdominal Aortic Aneurysms

- At least 30-50% of patients with a ruptured AAA die before reaching the hospital
- Another 30% of those surviving die without undergoing operation
- The operative mortality is still in the best series close to 40% for an overall mortality of 80%
- Early days of endograft repair rupture was considered a contra-indication
Treatment of Ruptured Abdominal Aortic Aneurysms

- Recent study compared 10,998 patients
- Average age was 78 years and 72.4% were males
- Mortality rates of 48% in the open group and 33% in the endovascular group
- Long term mortality also improved in endovascular group
- Reintervention rate of approximately 10% in the endovascular group


Compartment syndrome can be seen in endovascular repair of ruptured AAA
Total Percutaneous Treatment

- Risks of wound infection in endovascular repair with common femoral/iliac artery exposure up to 10%
- Lymphocele risk in 5 to 8% of cases which may require drainage
- Neuropathy with medial thigh numbness seen in the majority of patients
- Percutaneous access without incision possible
Total Percutaneous Treatment

- Successful in up to 98% of cases
- Risk of catastrophic complications including massive hemorrhage and death
- Recent study showed 32% of patients undergoing this procedure could be discharged same day
- Traditional EVAR patient stay is now less than 48 hours
- No cost savings seen yet with percutaneous repair

<table>
<thead>
<tr>
<th>Lead Author, year</th>
<th>Number of Arteries</th>
<th>Sheath Sizes (French)</th>
<th>Success Rate (%)</th>
<th>Device Type</th>
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<td>Haas, 1999</td>
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<td>16–22</td>
<td>100</td>
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<td>Traul, 2000</td>
<td>29</td>
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<td>Teh, 2001</td>
<td>82</td>
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<td>Howell, 2002</td>
<td>148</td>
<td>16</td>
<td>94.4</td>
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<tr>
<td>Kennedy, 2003</td>
<td>35</td>
<td>16</td>
<td>80</td>
<td>Prostar XL</td>
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<td>Tawakho, 2005</td>
<td>27</td>
<td>14–24</td>
<td>86.6</td>
<td>Prostar XL</td>
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<td>Morash, 2004</td>
<td>94</td>
<td>12–18</td>
<td>85.1</td>
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<tr>
<td>Lee, 2008</td>
<td>432</td>
<td>18–24</td>
<td>94.4</td>
<td>Proglide</td>
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<tr>
<td>UVA (unpublished)</td>
<td>86</td>
<td>12–25</td>
<td>100</td>
<td>Proglide</td>
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</table>
Treatment of Common Iliac Artery Aneurysms

- Isolated common iliac artery aneurysms are rare but up to 25% of abdominal aortic aneurysms will involve the iliac arteries
- Can complicate endovascular treatment
- The hypogastric arteries (internal iliac) are important for pelvic perfusion and at least one must be preserved
- There are a number of endovascular options

Treatment of Common Iliac Artery Aneurysms

- Ligation of both hypogastric arteries can be problematic
- Buttock claudication
- Skin necrosis
- Pelvic ischemia with rectal necrosis and perineum necrosis
- There are a number of endovascular options
Conclusions

• Aneurysmal disease remains a major cause of mortality and morbidity
• With the aging population more patients with aneurysms will be seen and need treatment
• Chronically ill patients need less invasive treatments

Conclusions

• Screening in select patients very important
• Endovascular repair is now considered the "gold standard" for aneurysm treatment
• Age and health not an exclusion for repair
• New technologies are improving results and outcomes