Percutaneous AAA Repair: Indications, Techniques, and Results

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INTERVENTIONAL CARDIOLOGY
History

• 1st stent graft performed by Dr. Juan Parodi in Buenos Aires in 1990

Core Knowledge

- Know indications and anatomic obstacles to success
- Be able to recognize and manage complications
- Understand endoleak nomenclature and clinical significance
- Understand radiation exposure issues and increasing concerns with CT follow-up
Multidiscipline Team and Laminar Flow Hybrid Lab
Abdominal Aortic Aneurysm

- 13th leading cause of deaths in US
- 9,000 deaths per year in US
- Ruptured AAA
  - Surgical mortality approximately 50%, but
    - Only 20% - 50% make it to a hospital alive
    - Thus, true mortality = 75% - 90%
  - Significant morbidity among survivors
- Mortality for elective repair = 1% - 5%
- Which patients should be repaired electively?
Risk Factors for Development of AAA

• Major risk factors
  – Age, male gender, smoking, family history

• Minor risk factors
  – Hypertension, dyslipidemias

• Not associated or possibly protective
  – Diabetes
AAA Rupture Risk

Survival Without Rupture

Time in Years

AAA Touches Lives
Indications

• “Single threshold diameter (for treatment) can’t be generalized to all patients”

  – RCTs suggest 5.5 cm is appropriate threshold for the average patient

  – Expansion at > 0.5 cm in 6 months on serial duplex should be treated

  – Smaller aneurysms (5 cm to 5.5 cm) may be reasonable to treat in high-risk patients at experienced centers
Patients at Higher Risk of Rupture from UK Small Aneurysm Trial

- Female gender (3 X risk)
- Large initial diameter (2.9 X risk per cm larger)
- Current smoking (1.5X)
- COPD with <0.6 per L FEV1
- Higher BP (1.02x per mmHg)

Note: Previous studies have also shown family history of rupture to be a risk factor as well

Procedure Planning

• A high quality CT is needed for precise measurements to answer the following questions:
  – Does the patient meet the current IFU for available stent grafts?
  – What is the best graft length and landing zone diameters?
  – Is femoral access possible?
Centerline Method Improves Accuracy of Length Measurements

Non-centerline underestimated lengths
Further length accuracy can be obtained by “shortest path” measurements.

Note: L1 = 6 mm, L2 = 12 mm, and θ₂ - θ₁ = 13°, resulting in 6.3-mm flow lumen displacement after endovascular repair.

Cloud method of finding centerline and shortest path to the contrast-enhanced lumen by using a point-cloud rendering.

Patient Selection (Geometry)

- Neck angulation < 60 degrees
- Neck length > 1.5 cm (1 cm if suprarenal fixation)
- Neck diameter < 28 mm
- Common iliac landing zone diameter (graft specific)
- Common femoral and external iliac minimum diameter for delivery system
Characterization of Neck

- **Straight Neck**
  - Best

- **Reverse Taper**
  - Worst

- **Tapered Neck**
  - Okay, but neck needs to be a little longer

Why Are These Measurements Important?

- Risk factors for sac enlargement:
  - Aortic proximal neck >28 mm
  - Aortic neck angle >60 degrees
  - Common iliac diameter >20 mm

Graft Design

• Graft is composed of a biocompatible fabric (polyester, ePTFE, polycarbonate or polyurethane) that is secured to a self-expanding (ie, Elgiloy, nitinol) or balloon-expandable (ie, stainless steel, Tantalum) stent frame

• Variations
  – Supra- versus infrarenal fixation
  – Modular versus unibody
  – Fenestrated
Modular vs Unibody
Infrarenal Fixation

Suprarenal Fixation

Better for short or angulated neck
Fenestrated Grafts

- Alternative for pararenal involvement
Common Iliac Aneurysm
Internal Coil Iliac Occlusion to Obtain External Iliac Landing Zone Seal

• Unilateral is well tolerated
• If contralateral internal iliac occlusion present then
  – ED will be seen in 17%
  – Buttock claudication in 28%
  – Mesenteric ischemia can be seen if mesenteric occlusion already present
• If both iliacs need to be coiled then this should be staged to reduce risk of ischemic bowel, spinal cord ischemia, etc.

Considered “off-label” use.
Access

• CFA and external artery size
  – Minimum diameter in mm is >0.34 x delivery catheter diameter (Fr)
    • Note: sheaths defined by ID not OD so the actual OD is generally 0.34 x Fr size of delivery sheath plus around 0.25 mm
    • Presence of circumferential calcium and internal iliac tortuosity increases access failure and risk of rupture
Key Points on Complications

- Patients with CKD have a 20% chance of worsening to another stage after grafting
- Endoleak is the most common complication
- Spinal cord ischemia should occur in <1 in 400 and is due to embolization or interruption of collaterals via internal iliac occlusion
Endoleak

**Type Ia:** Leak around proximal attachment

**Type Ib:** Leak around a distal iliac limb

**Type II:** Retrograde flow into sac from lumbar or inferior mesenteric

**Type III:** Graft at limb attachment or perforation from stent endoskeleton

**Type IV:** Fabric porosity

**Type V:** Endotension

Endoleak Clinical Cliff’s Notes

- **Type I**: Most concerning and highest risk of rupture
- **Type II**: Most common and generally treated percutaneously or observed
- **Type III**: Uncommon and often responds to graft placement at the point of failure
- **Type IV**: Was seen with early dacron and ePTFE grafts but less common today
- **Type V**: Serous diffusion across the graft causing slow sac expansion

*Circulation. 2008;117:1738-1744*
Example of Type II

Lumbar feeder

Filling of aneurysm sac via lumbar Type II

Small collaterals

Catheter advanced through an internal iliac collateral into a feeder for a lumbar Type II leak
Microcatheter tip navigated into the sac via a collateral

Silhouette of radiopaque embolic material (ONYX) injected into lumbar and collateral feeder
Type III Endoleak

Stent Graft Surveillance

• CTA requirements from societies and IFUs vary, but in general CTs are recommended at 1, 6, and 12 months after implant. In the absence of endoleak and sac expansion, annual CT can be performed.

Concerns About CT Follow-Up

• 5-year effective radiation dose of approximately 145-205 mSv and for a 50-year-old this equates to a lifetime attributable cancer risk of 0.73%-1.03%

• Patients are at higher risk of long-term renal failure post-EVAR compared to open repair and this is likely related to repeat contrast from CTs. There may also be a component from atheroemboli during implant and contrast from repeat procedures for endoleak

• There are significant long-term costs from CTA that equate to over half the overall stent graft cost

Trials

- EVAR vs open
  - DREAM trial: 351 pts, asymptomatic >5 cm. 30-day mortality 1.2% EVAR and 4.6% OS but better event-free post 30-day outcomes with OS
  - EVAR 1 trial: similar to above but >5.5 cm and 1082 pts. Similar results as above but mortality similar at 4 years. Much higher re-intervention rate with EVAR
Trials

• EVAR 2: 358 pts >60 YO deemed non-surgical, randomized EVAR vs medical RX. High cross-over, very high mortality in both groups (64%) and poor trial execution, but showed no benefit in mortality at 4 years
Summary of All Data from NICE

- Compared with OSR, EVAR reduced operative mortality (OR 0.35; 95% CI 0.19 to 0.73) and aneurysm-related mortality over the medium term (OR 0.49; 95% CI 0.29 to 0.83), but offered no significant difference in all-cause mortality at medium term.
- EVAR was associated with an increased rate of complications and re-interventions.
- There was limited RCT evidence comparing EVAR with non-surgical management in patients unfit for OSR. Although the EVAR 2 trial found no differences in mortality outcomes between groups, this finding should not be taken as definitive.
US Medicare Patient EVAR Data

• Open vs EVAR: 22,830 patients
  – EVAR
    • Utilized for older, sicker patients
    • Lower morbidity and mortality (1.4% vs 4.8%)
    • Late reintervention mostly minor (endoleaks) vs laparotomy for open surgical repair
  – Overall mortality rates for elective and ruptured AAA are decreasing
  – Survival advantage in older patients

Summary

- The ideal stent graft patient has a straight, non-tapered neck measuring <28mm diameter and >1.5cm length with access vessels that will accommodate the delivery system and normal renal function
- Type II endoleak is the most common late complication unless there is baseline CKD, then, it is worsening renal function
- Type I endoleak is the worst to have. Note: Both Type I and III must be fixed while the others can be followed if no graft expansion
- You need to educate patients about the risk of radiation and contrast from F/U CTAs