MULTIDISCIPLINARY APPROACH TO COMPLEX AORTIC SURGERY

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DISCLOSURES

• None
WHAT DEFINES “COMPLEX AORTIC SURGERY”?  

• Bavaria: “If it involves the arch, it’s complex”

• If it looks like a duck, swims like a duck, and quacks like a duck, then it probably is a duck (J. deVaucanson 1730s)

• Justice Potter Stewart in Jacobellis v. Ohio (1964) while describing hard-core pornography
  – “I shall not today attempt further to define the kinds of material I understand to be embraced within that shorthand description; and perhaps I could never succeed in intelligibly doing so. But I know it when I see it”
WHAT DEFINES “COMPLEX AORTIC SURGERY”?  

• Anatomic  
  - Multiple aortic segments  
  - Malperfusion  

• Procedural  
  - Reoperations  
  - Concomitant procedures  
  - Use of cerebralspinal protection strategies / hypothermia  
  - Staged procedures  
  - Urgency  
  - Technical complexity  

• Comorbid conditions  

• Outcomes  
  - Elevated risk of death and complications  
  - Extended LOS / recovery period  

• Surgeon and Center experience  
  - ?relative to some standard
EVOLUTION OF THE “TEAM”

• Previously treatment was surgeon-driven
  – Planning, execution, postop care, long-term followup
  – Ascending replacement, elephant trunk, TAA/TAAA repair

• Newer techniques and treatment modalities
  – Vascular surgeons
  – Anesthesiologists
  – Intensivists
  – Radiologists
ACUTE TYPE A DISSECTION
CLASSIFICATION OF AORTIC DISSECTION

STANFORD
Type A
Type B

DEBAKEY
Type I
Type II
Type III

NORMAL
ASCENDING AORTIC REPLACEMENT

- Developed in the early 1960s by DeBakey
- Cooley: open distal anastomosis
- Excludes entry tear, protects from rupture, valve dehiscence, coronary dissection
- Outcomes
  - 90% hospital survival
  - 50%-70% 5 years survival
  - ~50% mortality at 48h without surgery
- Late complications
  - Pseudoaneurysm
  - Expansion – patent false lumen, true lumen area <30%
  - Reoperation – 25%
HEMIARCH REPLACEMENT

• Additional exclusion of affected arch tissue

• Survival
  – 90% hospital survival
  – 80%, 68%, 51% @ 1, 5, 10 years survival

• Freedom from reintervention
  – 99%, 97%, 90% @ 1, 5, 10 years
  – Predictors:
    • Marfan’s
    • Persistent false lumen

Bartosz et al., JTCVS 2014, 148:6
FALSE LUMEN PATENCY
FATE OF THE DISTAL AORTA

• Patency of the false lumen: 31%-89%
  - Secondary entry tears – natural vs iatrogenic
  - Anticoagulation

• Distal aortic dilation
  - Early and late occurring
  - 1 – 3 mm per year ***
  - False lumen patency
  - Hypertension and lack of beta blockade
  - Diameter > 4cm or false lumen area >70%

• Freedom from reoperation: 77% @ 10 years
  - Marfan’s
  - Survival following reoperation: 80-90%

Kirsch et al., Archives of Cardiovascular Disease (2011) 104, 125—130
TOTAL ARCH REPLACEMENT AND THE ELEPHANT TRUNK PROCEDURE

• Converts a potential 3-stage intervention to 2-stage
  - Ascending aortic replacement
  - Arch replacement
  - Descending thoracic aortic replacement / thoracoabdominal

• Compared to hemiarch
  - Longer circulatory arrest and cross-clamp times
  - Increase neurologic morbidity
  - Increased mortality: 40% → 20%
  - Unchanged freedom from reoperation

• Reserved for younger pts and connective tissue disorders

Borst (1983)
Roselli et al., JTCVS (2015) 149:2S, S117
NEUROPROTECTION

• RCP (Lemole, 1982)
  - Used with femoral cannulation with minimal alteration of the CPB circuit
  - No need to clamp great vessels
  - Surface cooling but poor capillary perfusion
  - Cerebral edema (CVP > 20 mmHg)
  - Evacuation of emboli

• ACP (Kazui, 1989)
  - Physiologic flow with excellent capillary perfusion
  - Cumbersome to implement
  - Obstructed operative field
  - Superior to RCP for longer circ arrest times
CANNULATION STRATEGIES

• Femoral
  - Quick and simple via cutdown or percutaneous approach
  - Proximal malperfusion
  - Favored in unstable patients
  - Cannulate the side with the weaker pulse

• Axillary artery cannulation
  - Typically not involved
  - Direct vs side-arm graft
  - Simplifies unilateral ACP
  - Minimal cerebral ischemic time

Sabik et al., JTCVS 1995;109:885-90
ALTERNATIVE CANNULATION STRATEGIES

• Left common carotid artery via sidearm
• Left subclavian artery via sidearm
• Ultrasound and wire-guided cannulation of the proximal aorta
  - Bleeding around cannula
  - Rupture
• LV transapical
ADVANCEMENTS IN GRAFT TECHNOLOGY
NEWER TECHNIQUES
COMPLETION REPAIR (OPEN)
COMPLETION REPAIR (OPEN)

• Thoracotomy or thoracoabdominal incision
• Single lung ventilation
• Spinal cord ischemia
  – CSF drain, reimplantation of important intercostals, distal perfusion (Left heart bypass vs full CPB)
• Pulmonary injury
• Splenic/renal injuries
• Bowel, hepatic, renal ischemia
• Technically demanding
• Long postop recovery
• 19%-60% of pts never returned; 12-25% of pts died awaiting completion
TEVAR (THORACIC ENDOVASCULAR AORTIC REPAIR)

• Pioneered by Volodos (1986) and Parodi (1990) → FDA approval in 1999

• TEVAR – Dake (1992) → FDA approval in 2005

• Dependent on adequate landing zones (>2cm)

• Access vessels
TEVAR DEVICES

WL Gore cTAG
Cook Alpha
Medtronic Valiant
Bolton Relay
ADVANTAGES OF TEVAR

• Minimally invasive
• Shorter procedure times
• Decreased blood loss / transfusion
• Decreased LOS
• Faster recovery
• Results from the Gore TAG trial (140 TEVAR vs 94 open pts)
  - 30d mortality 2.1% vs 11.7%
  - SCI: 2.9% vs 13.8%
  - 5yr aneurysm related mortality: 2.8% vs 11.7%
  - Vascular complications: 14%; Endoleak @ 1yr: 6%
TEVAR FOR DISSECTION

• INSTEAD trial
  - TEVAR in uncomplicated acute or chronic Type B dissection
  - “Negative” trial: no difference in mortality @ 2yrs
  - Higher early mortality with TEVAR
  - TEVAR: favorable false lumen thrombosis, aortic remodeling, aorta specific mortality at 5 yrs

• ADSORB trial
  - TEVAR in uncomplicated acute Type B dissection
  - Improved false lumen thrombosis and reduction in rupture rate and aortic size @ 1 yr

• Similar findings from single center studies
RETROGRADE TEVAR

• First reported by Miller (1995) using a custom endograft
• Replaces open 2\textsuperscript{nd}/3\textsuperscript{rd} stage procedure
• Avoids thoracotomy
• Suitable for inoperable patients
• 15\% mortality at 2yrs
• Transient paraparesis
• Caudal migration

Greenberg et al., Circulation. 2005;112:2619-2626
HYBRID DEBRANCHING
HYBRID DEBRANCHING

- Creates an adequate proximal landing zone
- No need for CPB
- Intact Circle of Willis
- Cerebral oximetry
- Minimizes the extent of surgical dissection
- Less bleeding
- Earlier 2nd stage completion
FROZEN ELEPHANT TRUNK

- First reported by Kato (1996)
- Antegrade deployment of TEVAR device via the open aortic arch during 1\textsuperscript{st} stage arch procedure
- Proximal end of the TEVAR device sutured to arch graft
- Eliminates the need for 2\textsuperscript{nd} stage retrograde TEVAR
- Creates proximal landing zone for subsequent procedures
FROZEN ELEPHANT TRUNK OUTCOMES

• Leontyev et al. (2013)
  - 30d mortality 7.8%, stroke 11.8%, paraplegia 19.6%
  - Temp ≥28°C and circ arrest time >45min

• Tian et al (2013)
  - Meta-analysis of 17 reports
  - Mortality 8.3%, stroke 4.9%, SCI 5.1%, 5yr survival 63%-88%

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COMPOSITE FET DEVICES (INVESTIGATIONAL)
THORAFLEX HYBRID (INVESTIGATIONAL)

- Hannover experience
  - 34 pts
  - Thoraflex Hybrid
  - Acute dissection and aneurysms

- US trial currently enrolling (exp completion July 2021)
FENESTRATED ENDOVASCULAR AORTIC REPAIR (FEVAR)
ASCENDING AORTIC AND ARCH GRAFTS (INVESTIGATIONAL)
ASCENDING AORTIC AND ARCH GRAFTS
SUMMARY

- Multiple factors contribute to the complexity of aortic disease
- Significant progress has been made in surgical technique, neuroprotection, conventional and endovascular graft technology
- Increasing complexity more readily manageable with multimodal approaches
- Await results of the Thoraflex Hybrid trial
- Future directions: Ascending aortic and branched arch grafts
QUESTIONS?