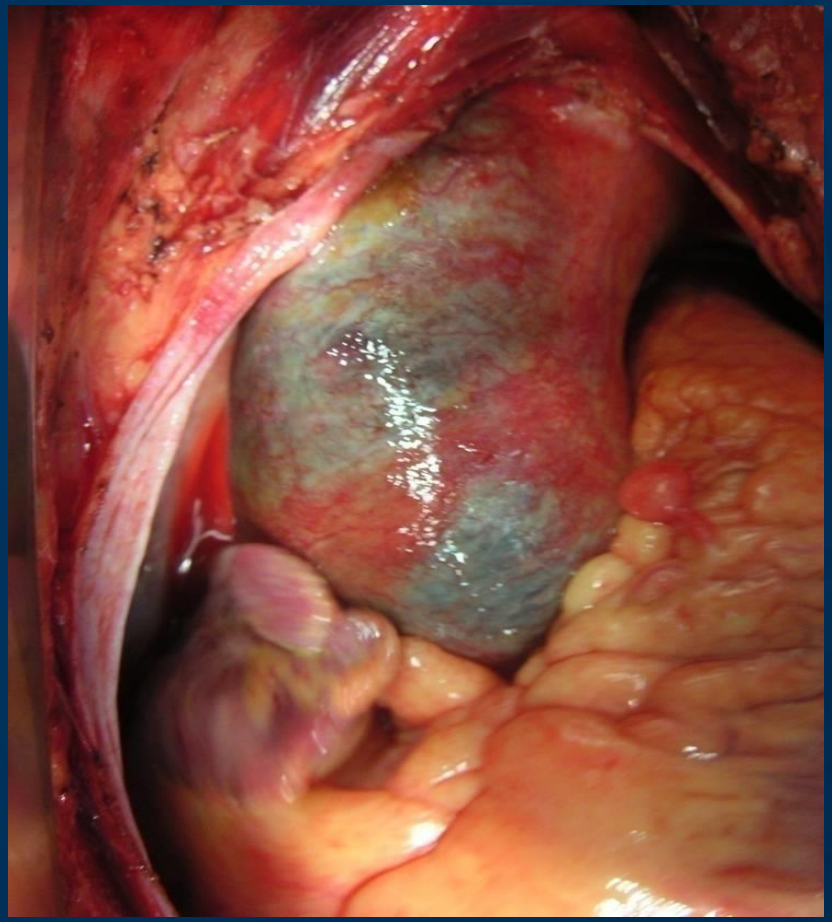
The Dilated Aorta and Complicating Dissection



Allan Stewart, MD
Director, Center for Aortic Disease
Mount Sinai Health System

DEFINTIONS

AORTIC ANEURYSM

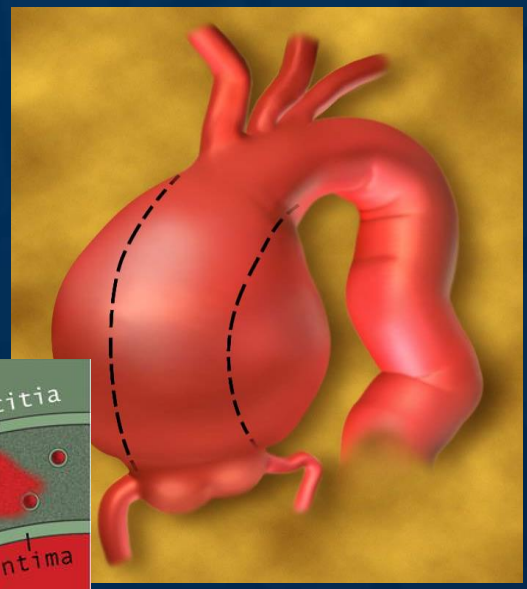
Full thickness weakness of aortic wall

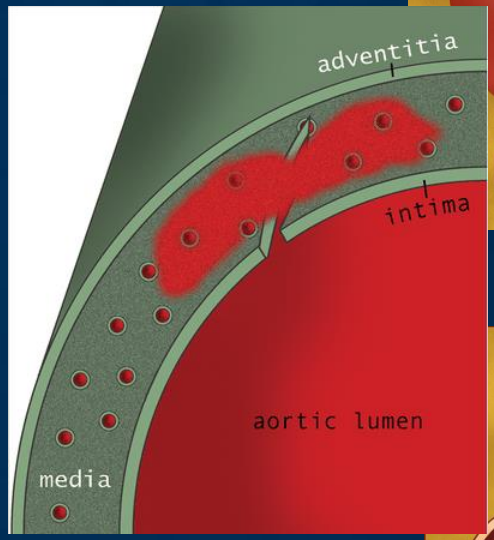
AORTIC DISSECTION

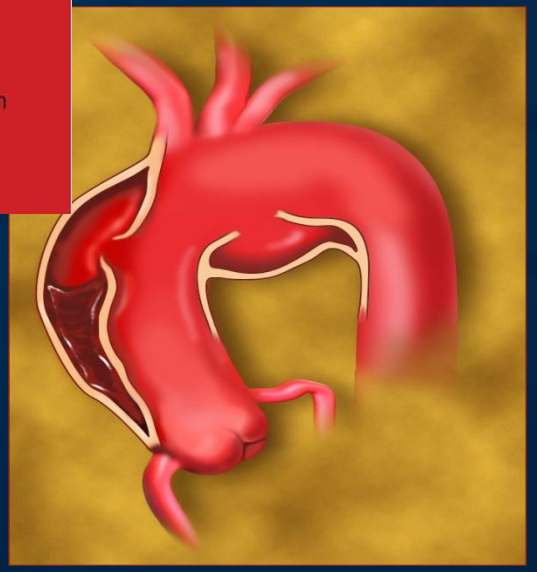
Tear in the intima and separation of the media along a trajectory of the aorta

AORTIC PSEUDOANEURYSM

Partial thickness weakness of aortic wall







Science Behind Aneurysm Formation

- Localized dilatation of >50% normal diameter

- Medial Degeneration
  - Loss of Elastic Fibers
  - Loss of Vascular Smoot Muscle Cells
  - Deposition of Proteoglycans
- Increase in Matrix Metalloproteinases (MMP)
- TGF-B found to modulate MMP activity

- Aneurysm formation increase wall tension

  LaPlace's Law T=PR

Five Causes of Dissection Death

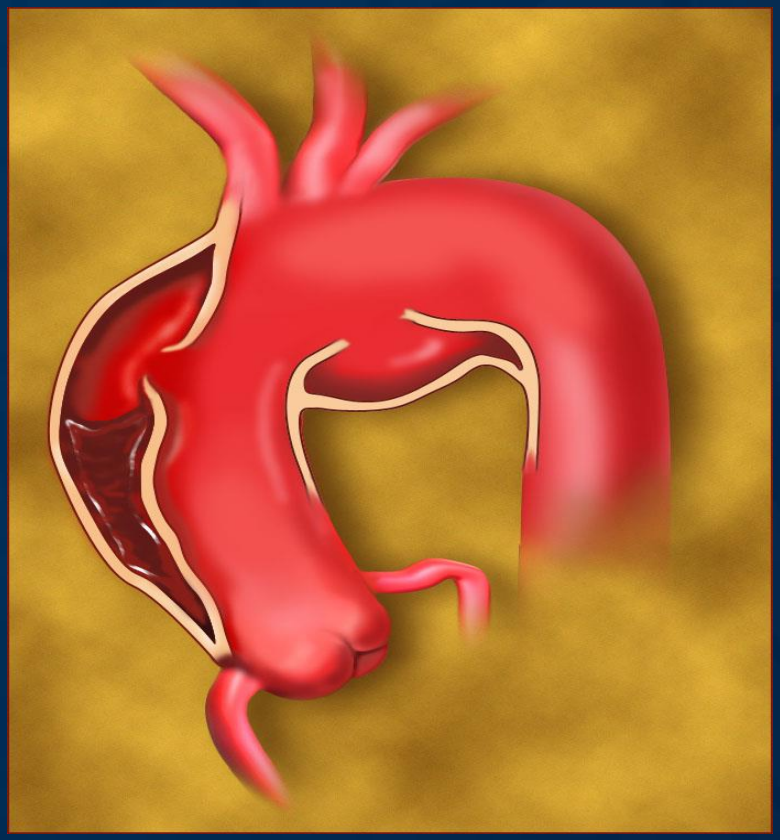
1. Pericardial Tamponade
   a. Rupture
   b. Aortic “Sweating”

2. Congestive Heart Failure
   a. Acute Aortic Insufficiency
   b. Coronary Impingement

3. Stroke
   a. Arch Dissection into Carotid Artery
   b. Embolus of False Lumen Clot

4. Myocardial Infarction
   a. Coronary ostial dissection
   b. Generally RCA. LMCA doesn’t make it hospital alive

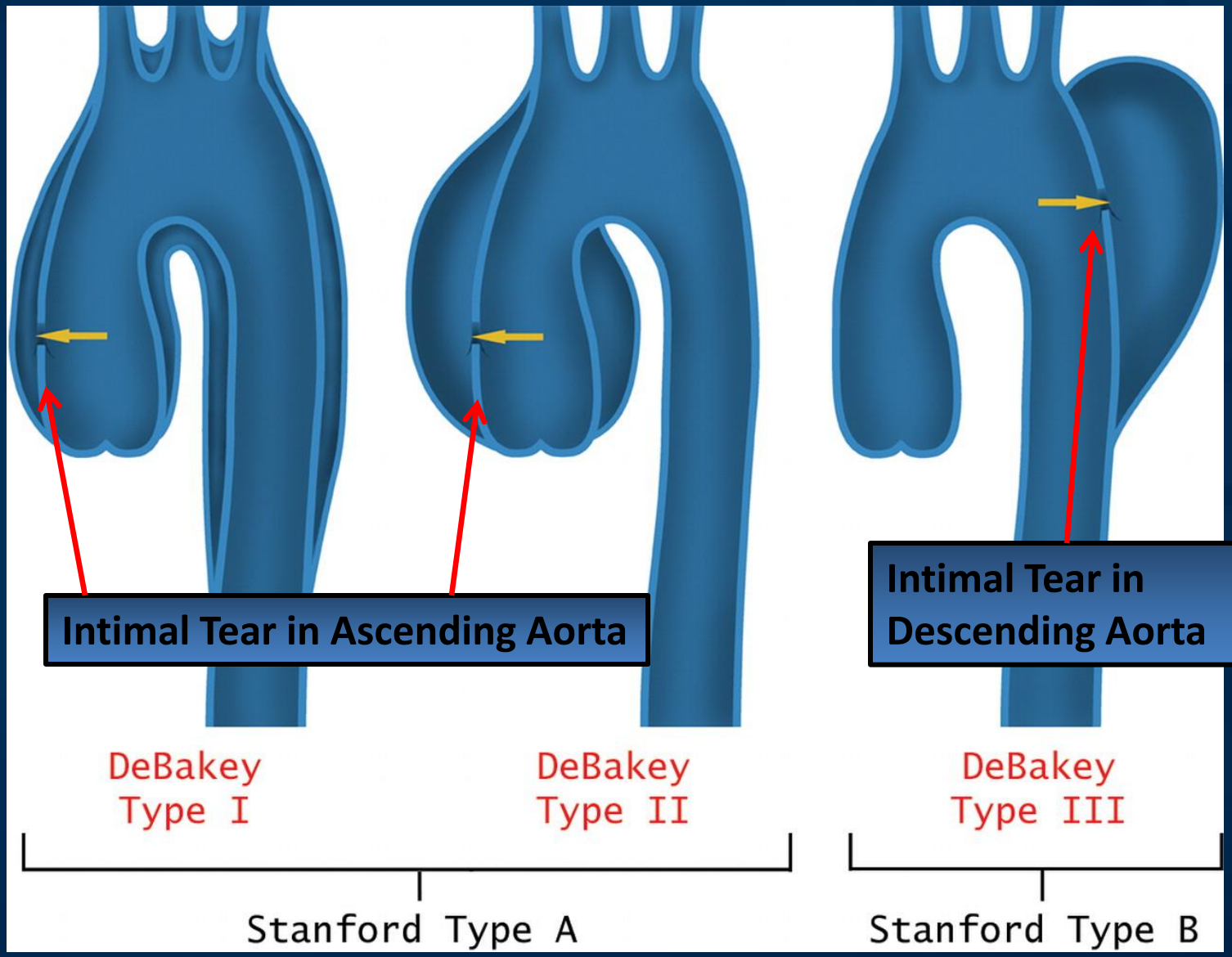
5. Malperfusion Syndrome of the Visceral Vessels



Risk Factors for Aortic Dissection

- Conditions Associated with Medial Degeneration
  - Marfan's, Loes-Dietz, BAV, Familial Aneursm, etc
    - 11-19% of patients with aneurysm or dissection have 1st degree relative with aneurysm or dissection
- Conditions that Increase Wall Stress
  - Hypertension
  - Pregnancy
  - Cocaine Use
  - Weight lifting
  - Smoking

Aortic Dissection Classification



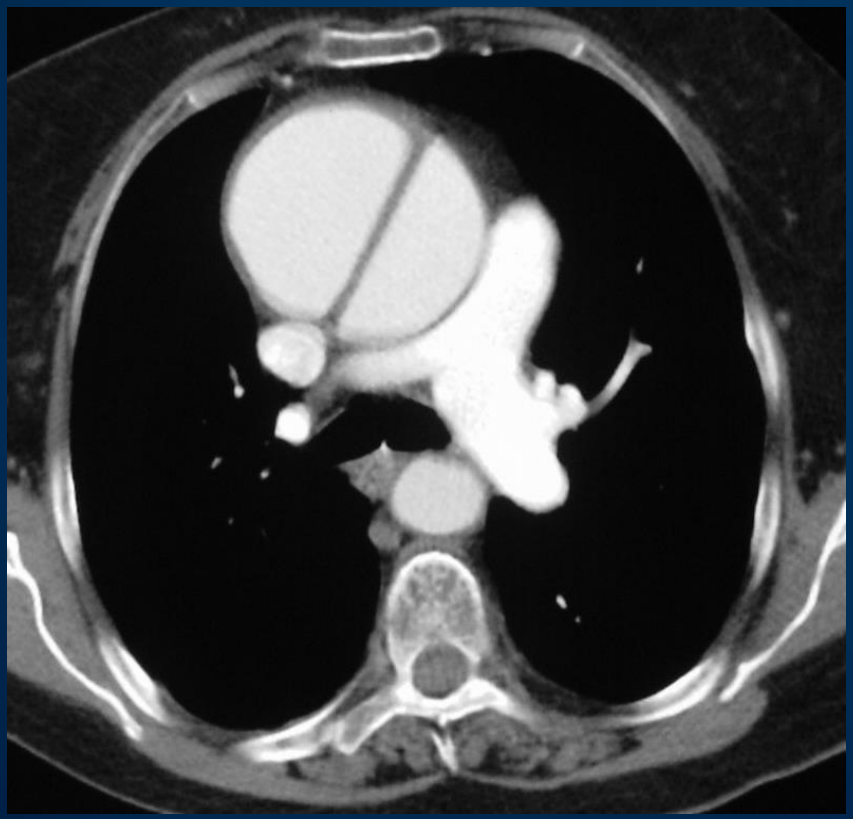
SURGICAL EMERGENCY

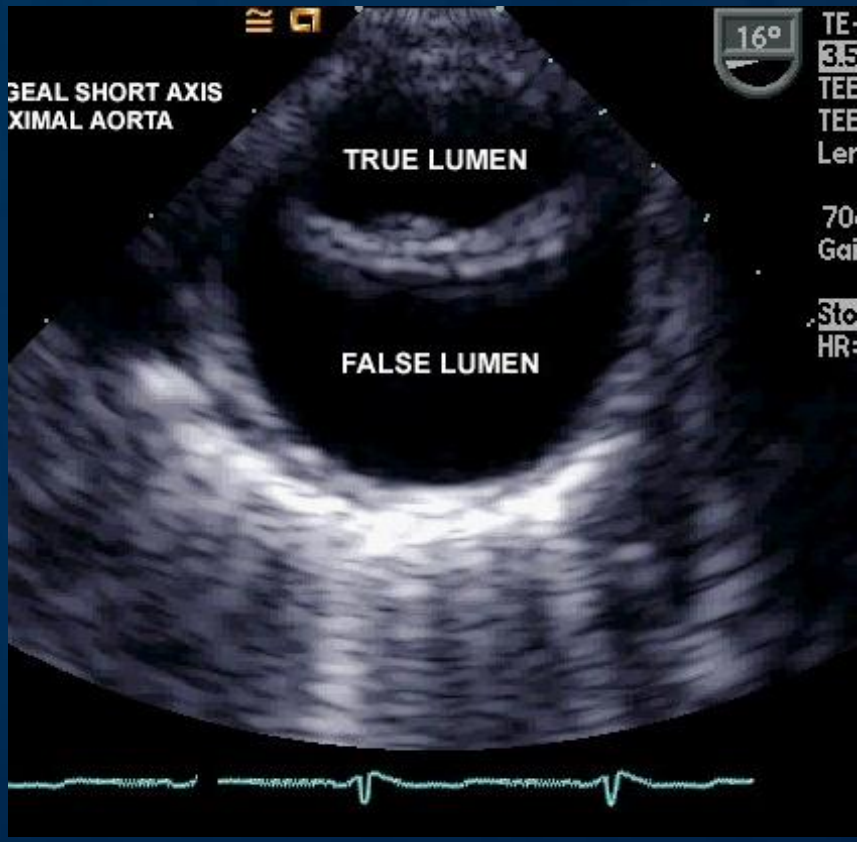
MEDICAL MANAGEMENT

Path of Blood in Dissection

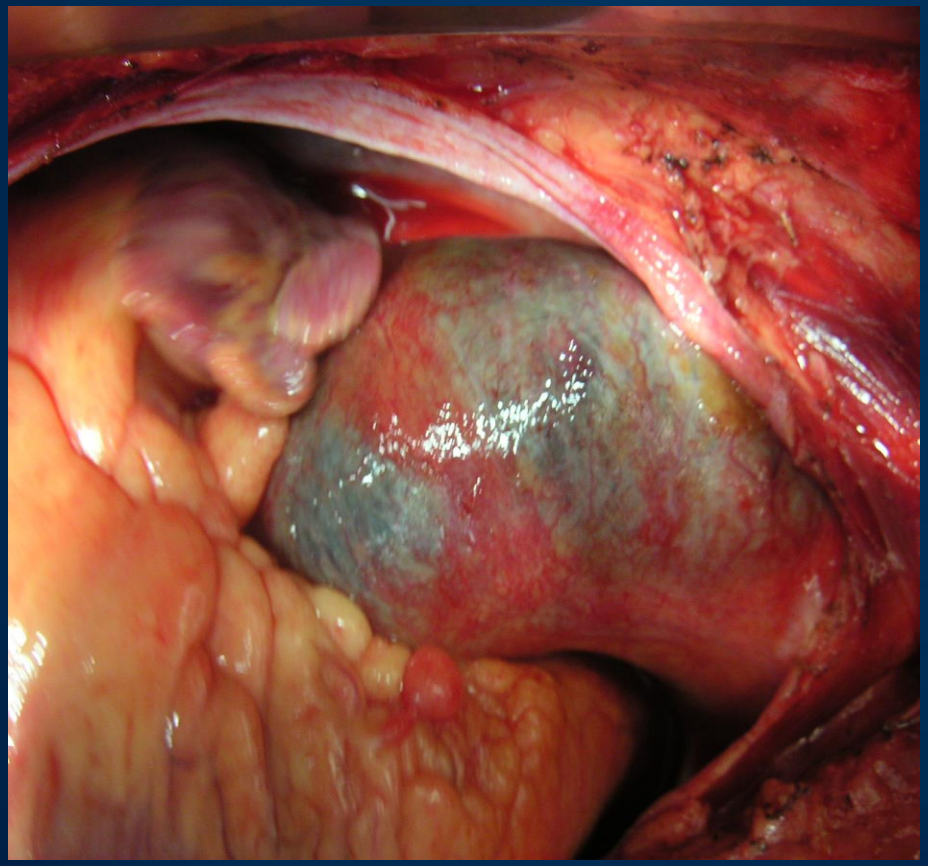
- Tear in intima at “entry point”
  - Media is split along direction of flow
  - This split creates a false channel
  - Spirals around thoracoabdominal aorta
- Pressure/Mechanical Stress on branch vessels
  - Branch can tear leading to flow from false lumen
    - These small tears can cause fenestrations
  - Branch can close off, creating malperfusion

CTA has 99% Sensitivity and Specificity





Aortic Dissection
Untreated Natural History (IRAD)



Mortality of 1-2%/hour for 48hrs

80% are dead within 48 hours

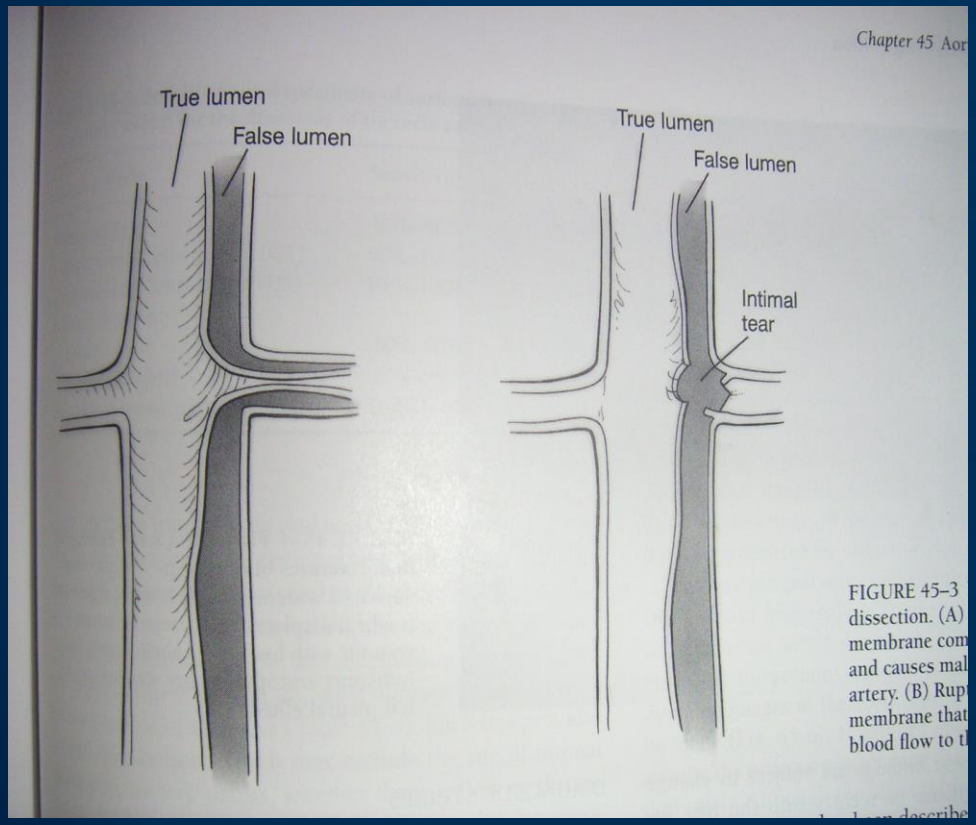
More than 90% dead at 1 year.

27% In-hospital mortality in patients who make it to surgery

Who Does Poorly?

- Patients Over 80 years-old
- Patients Presenting in Shock
- Patients Presenting with Neuologic Deficit
  - 50% mortality with pre-op coma
- Patients who present late after onset
  - 47% of patients incorrectly diagnosed in first 48hrs

What is meant by “Perfused by False Lumen?”



Clinical Presentation

- PAIN
  - Media has a high concentration of nerve fibers
  - Ripping, tearing, migratory pain is the rule
  - The more atherosclerosis in media, the less pain
  - Pain becomes dull when the dissection is complete
  - Flank Pain may imply kidney malperfusion
- Neurologic Deficit
  - Implies Arch Dissection
- Shock (Tamponade vs. Coronary Dissection)
  - Poorly perfused extremities
  - Venous hypertension
  - Sweaty, clammy appearance
- Pulseless Extremity

Diagnosis

- Start with high index of suspicion

- Screening tests include ECG and CXR
  - ECG may reveal inferior changes c/w RCA issues
  - CXR may reveal:
    - widened mediastinum
    - Enlarged cardiac silhouette
- CTA with contrast
- TEE if Necessary
  - Often can be done in OR to confirm diagnosis

Physical Examination

- Listen to the heart
  - Muffled heart sounds
  - Loud diastolic murmur
- Compare pulses in each arm
- Need to document a pulse exam in all extremities
- Need to document a thorough neurologic exam

Pre-Operative Management

1. Pre-Op Cath is Contra-Indicated!
   a. CT Imaging may allow for necessary coronary info
   b. Major problem with Cath before Diagnosis
      - Lytics, Antiplatelet agents, etc
      - Instrumentation of dissected aorta can be catastrophic

2. Reduce dP/dT

   Nipride or Esmolol, NOT NTG

1. Definitive Operative Correction After Diagnosis

   No Role in Pre-op Stabilization

Operative Indications

- Any Presence of Ascending Aortic Involvement
  - IMH and Type A Dissection are synonmymous
- Type B Dissection
  - Failure of medical management to control HTN
  - Malperfusion syndrome
  - Aortic Rupture
  - Aneurysm formation
  - Patients with connective tissue disorders
- Treatment of Choice for Complicated Type B is Endograft, Not open surgery

Sample Case

Allan Stewart, MD
Director, Aortic Surgery Program
Co-Director, Valve Reference Center
Department of Cardiothoracic Surgery

Mount Sinai

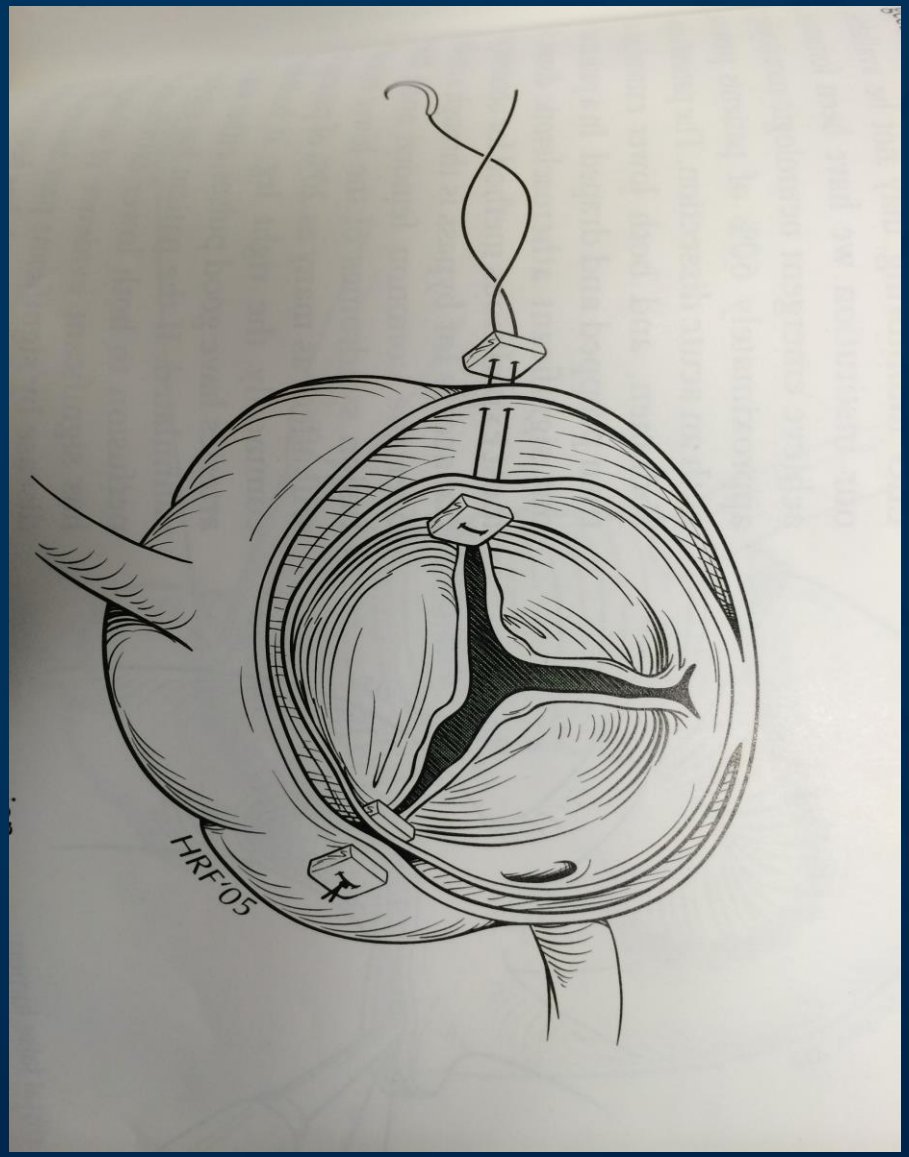
Personal Experience
1/1/05-7/1/13

- 108 Consecutive Patients with No Hospital Mortality
  - STS Database: 12-16% operative mortality

- 108 Consecutive Patients with No stroke
  - STS Database: 5-8 % Stroke rate

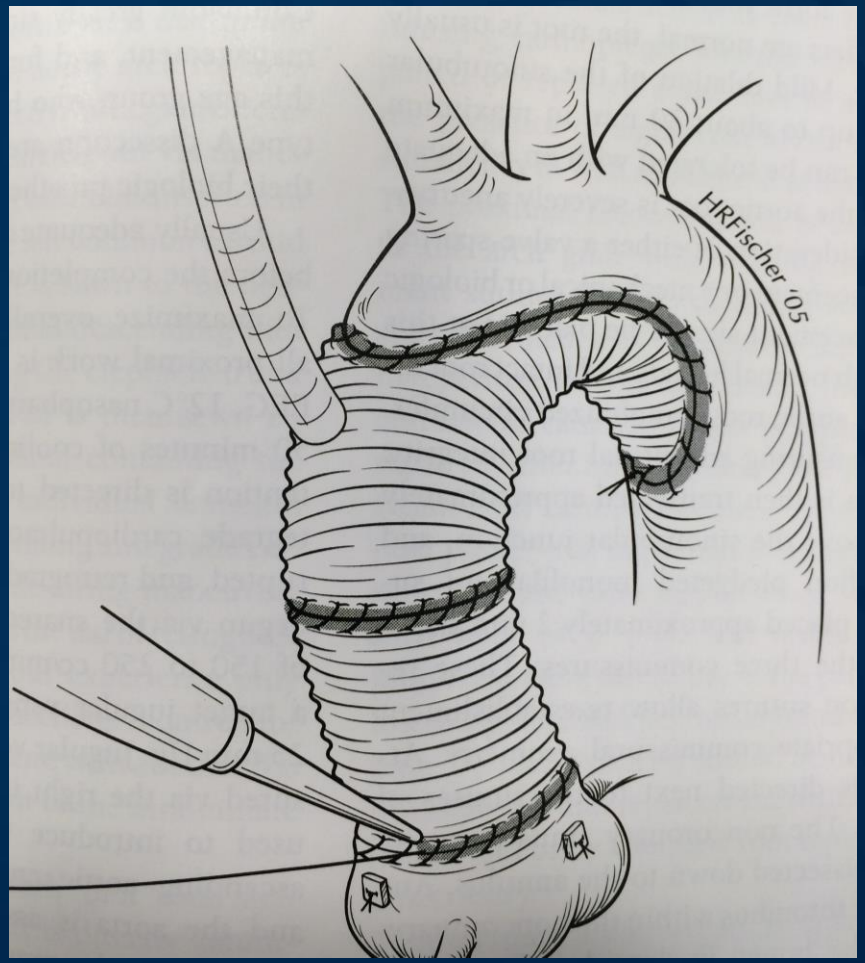
Average ICU Stay: 2.6 days
Average Hospital Stay: 7.8 days
No exogenous blood or products in 76% patients

What is Resuspension of the Valve?



Requirements for a Successful Repair

1. Reconstructed or Replaced Root
2. A well functioning Aortic Valve
3. A completely Replaced Ascending Aorta
4. A completely or partially replaced arch
5. A Chronic type B Dissection



Post-Operative Care

- No sedation until the patient wakes up
- Serial Lactate, LFTs, Amylase/Lipase
- PT/PTT, CBC
  - Consumption of platelets and factors as false lumen clots
- CK levels to assess for rhabdomyolysis

Long-Term Follow Up

- Need to Follow for Development of TAAA
  - Patent false lumen predicts aneurysm development
  - CT Scan/MRI at 6 months, then yearly
- Echo every six months
- Losartan for Marfan's patients

How Can You, As Cardiologists, Prevent Aortic Dissection

Lifestyle Modifications

- Encourage Cardiovascular Exercise
- Discourage Weight Lifting with Straight Bar

- Stress Management
- Avoid stimulant drugs/medications

- Aggressive Blood Pressure Control
  - No data supporting B-blockers in prevention of dissection
  - Losartan for Marfan Patients (50-100mg/day)

- Weight Reduction
- Smoking Cessation
  - Increased risk of dissection, twice the rate of growth
- Aggressive Monitoring if patient becomes pregnant

Surveillance Imaging

- The patient has an aneurysm <5cm
  - CT Scan or MRA each year
    - If no growth for 3 consecutive years, than every two yrs
    - If significant growth (0.5cm) than every six months
  - Echocardiogram every 6 months

- The patient has an aneurysm ≥5cm
  - CT Scan or MRA every six months
  - Echo every six months

Intervening Before the Tear Occurs

Why Is the Patient Really Referred: Non-Scientific Reasons

- Formal CT report says the word: aneurysm
- Patient or spouse is psychologically distraught
- Work restrictions prevent patient from making a living
- Fear of lawsuit by not documenting referral

Case Presentation

45 y.o. athletic male with newly diagnosed hypertension, who was training for a triathlon last month and started to experience dizziness and shortness of breath during a warm-up swim. He underwent chest MRI last month revealing a thoracic aortic aneurysm measuring up to 5.0 cm at the level of the right main pulmonary artery and 4.6 cm at the level of Valsalva

PMHx: Father with history of type A Dissection

Physical Examination:

Constitutional: Fit appearing man

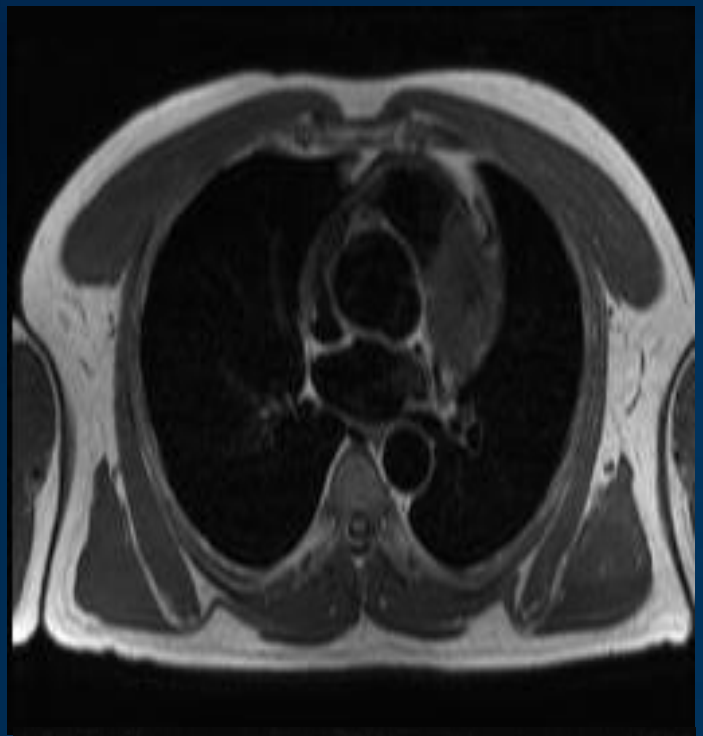
Vitals: HR: 71 BP: 140/90 RR: 16

Lungs; CTA B/L

Heart: S1, S2 low pitched diastolic murmur

Abd: soft NT/ND +BS

Ext: WNL



Dilemna

- 2014 ACC/AHA Guidelines do not support surgery at this time

- Patient wishes to compete in Lake Placid Ironman (with his surgeon!) in 2015

- Would you allow Ironman without surgery?
- Would you allow Ironman after surgery?
- Do you advocate for earlier surgery with +FH?

When Should We Address the Aorta

Disease Process	Diameter(cm)
Marfan Syndrome	> 4.5
Chronic Dissection	> 4.5
Bicuspid AV with LV Dysfunction	> 4.0
Degenerative disease with AV insufficiency	> 4.5
Degenerative disease without AV insufficiency	> 5.5
Other cardiac surgery	> 4.5

Ergin MA, et al Ann Thorac Surg 1999; 67:1834.

Are We Intervening too Late?

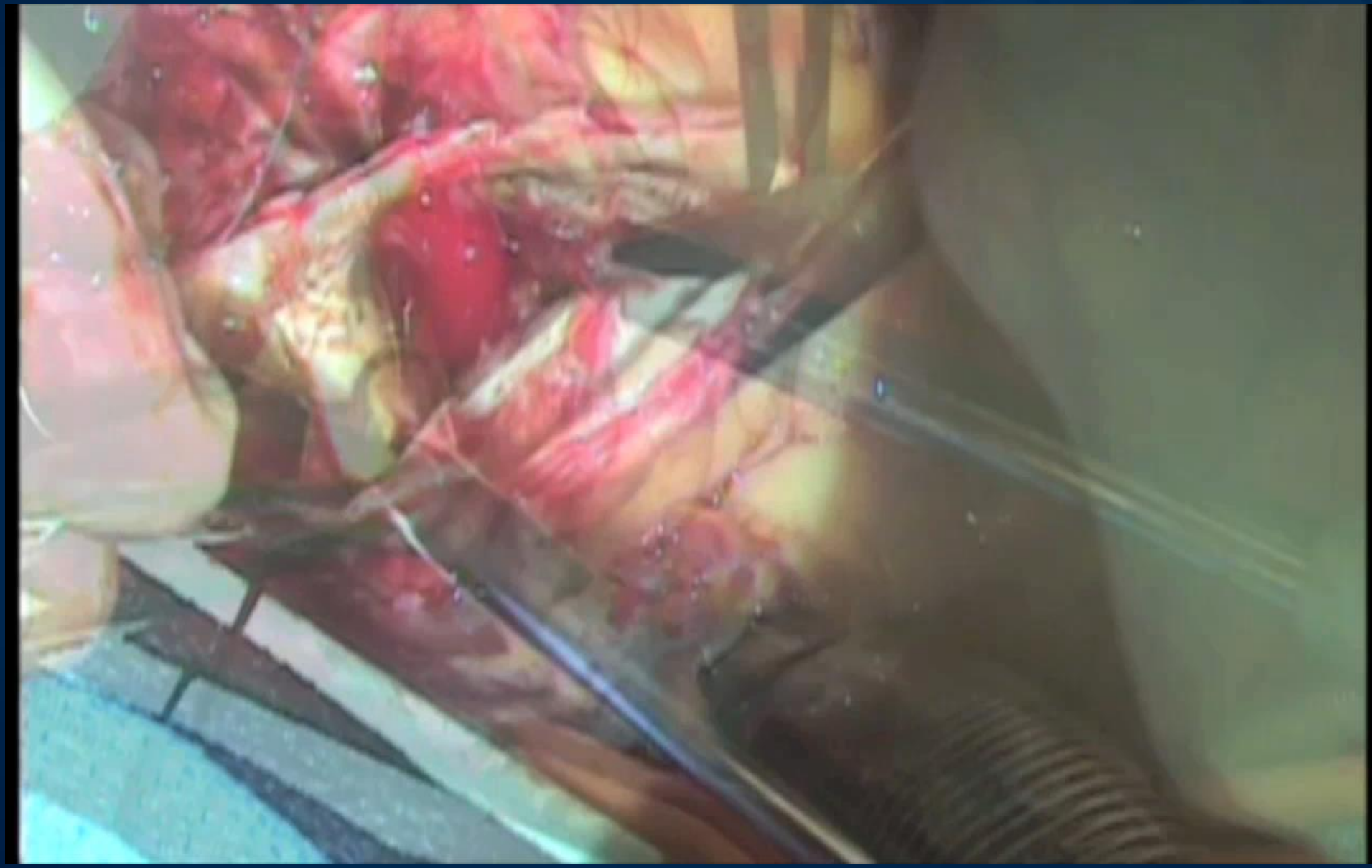
- Valve Issues Alone:
  - Does long-standing AI wreck the valve leaflets?
  - Can bicuspid patients have more physiologic repair before calcification
  - Should we intervene on annular size alone (> 27mm)

- Aneurysmal Root:
  - Many centers operating at less than 5cm for BAV
    - No evidence to support this notion at present

- What will the new paradigm be for TAVR with aneurysm?

Aortic Valve Repair

- Advantages:
  - Potential for Curative Surgery
  - Potential for Warfarin Free Survival
  - All Bio-roots have a limited lifespan
  - Safe and Reproducible Procedure



Basic Mechanisms of Repair

Leaflet Intervention

1. Goal is to improve coaptation
2. Plication
   - May be used to restore prolapsed leaflet
   - 5-0 prolene adjacent to Node of Arranti
3. Free margin resuspension
4. Commisural plication
   - Pledgetted stitches to draw in excess
5. Cusp Augmentation
   a. High rate of failure
   b. Ideal substance does not exist yet

Does it pass the "Look Test"?

- Aortic Leaflet Integrity
  - High Failure Rates in…
    - Severe AI
    - Multileaflet Prolapse
    - Multiple Fenestrations
  - Great results in supple leaflets
  - Great results with normal annular size
  - Bicuspid and trileaflets both have good 10-year data

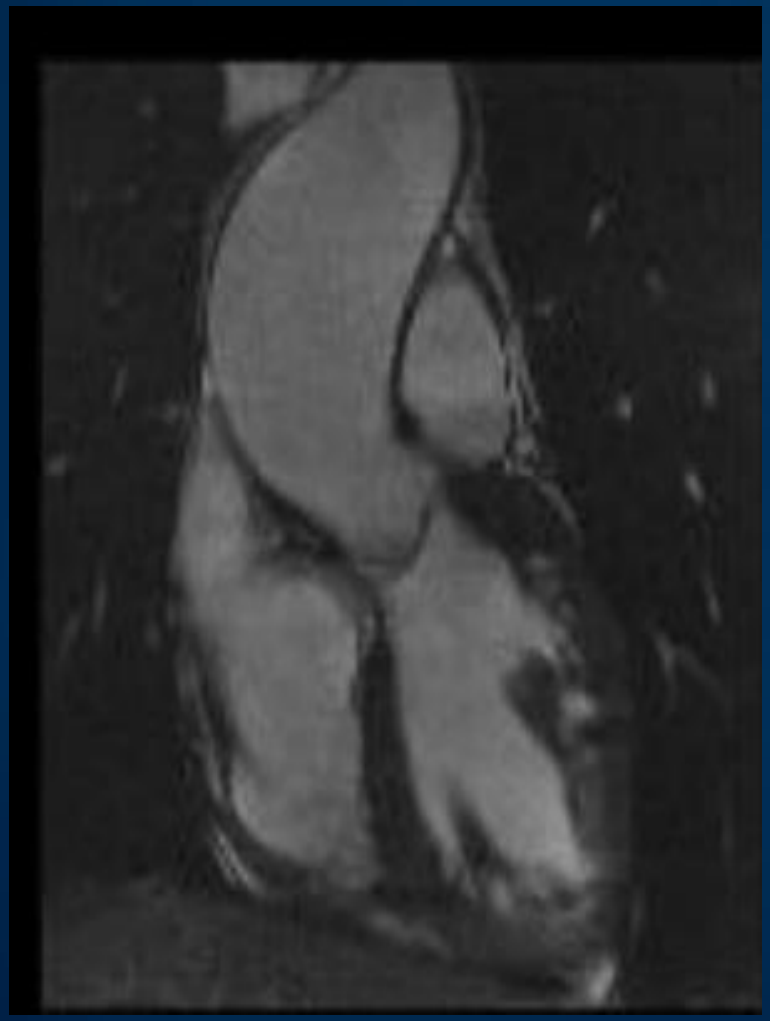
Case Presentation

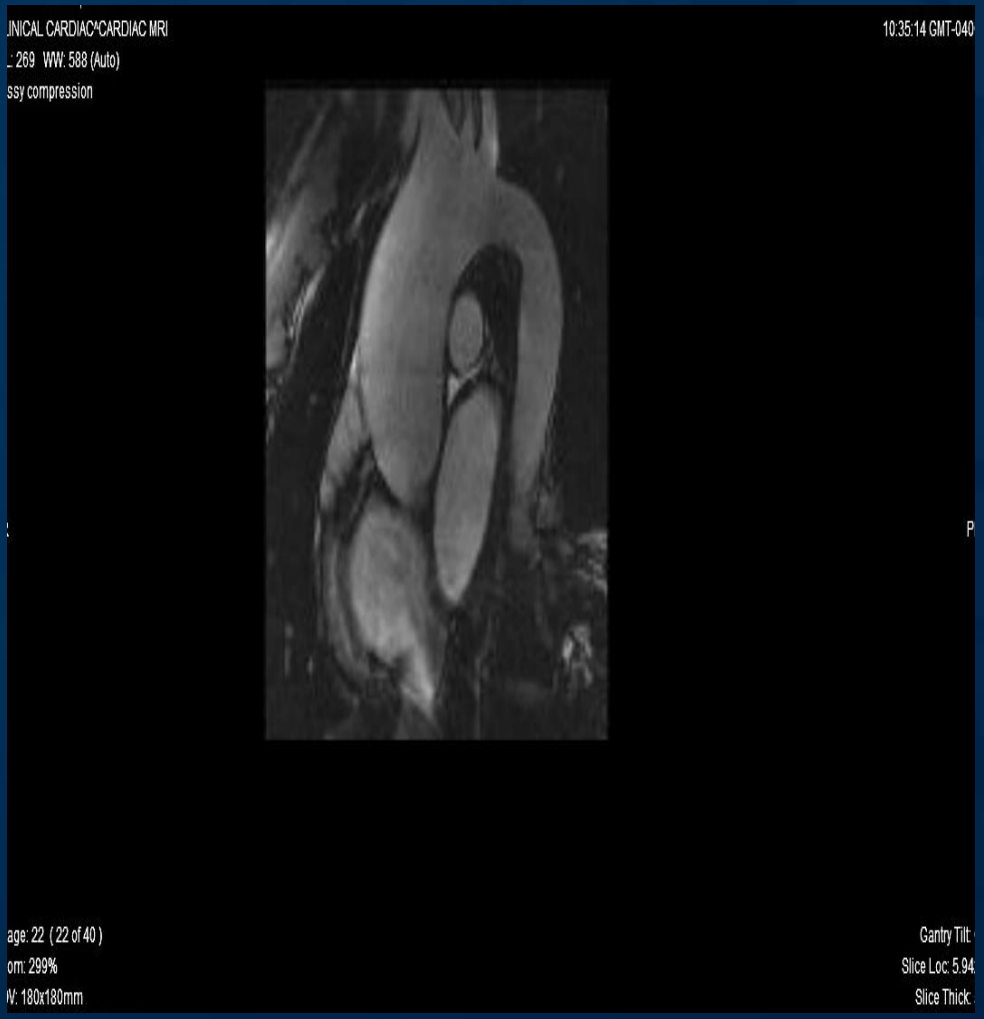
23-year-old Man with known bicuspid valve disease, followed with serial imaging. His most recent cardiac MRI revealed a 5.2cm aortic root. Patient has noticed he was more short of breath than usual during his workouts for the past year. He is an active person and plays competitive ice hockey at college. He was advised to limit stop playing hockey.

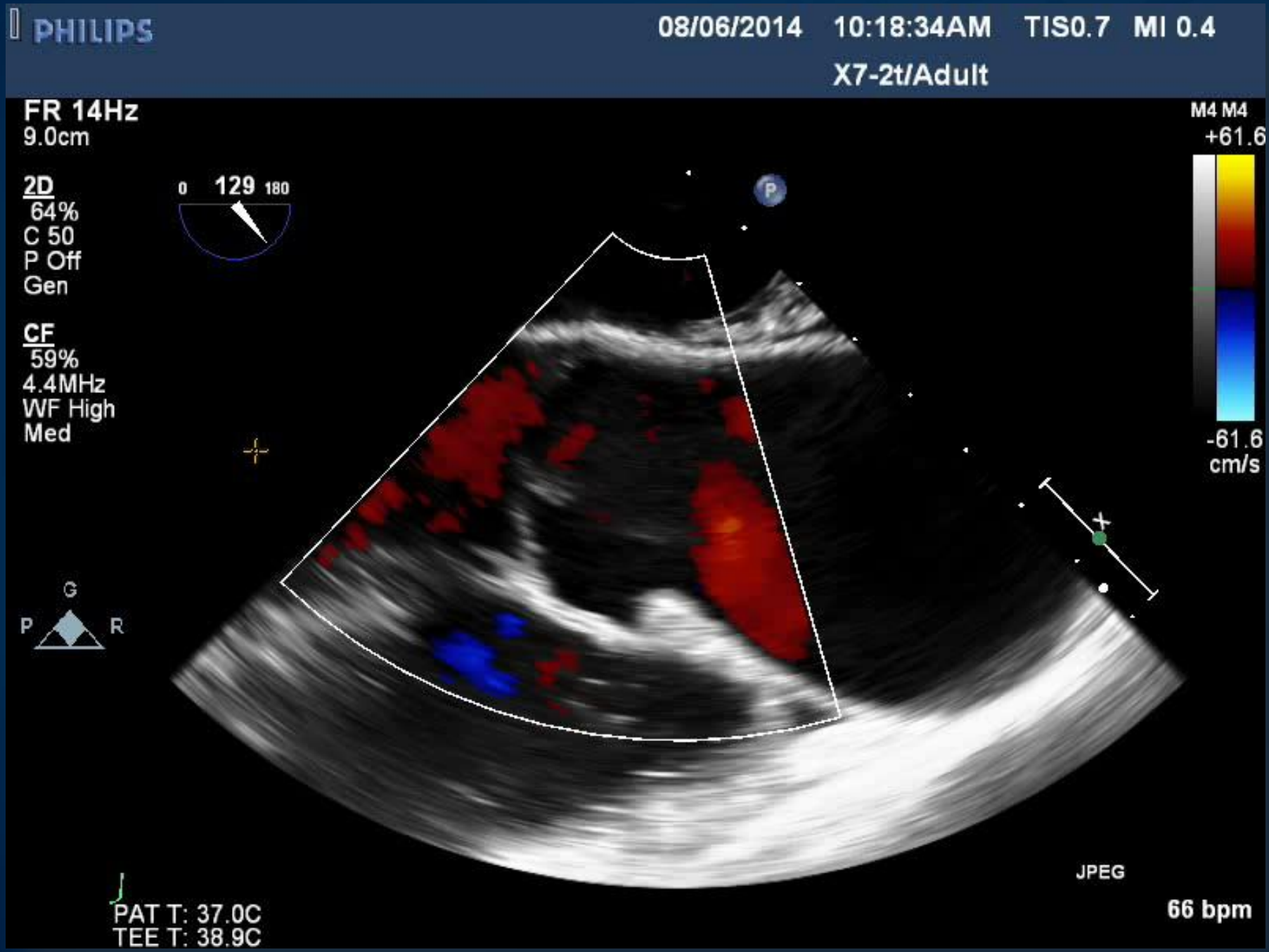
Physical Exam:

Constitutional: well appearing young man who looks his stated age.
Vitals: HR: 68 BP: 110/60 RR: 16
HEENT: no signs of connective tissue disease
Sternum: Normal size and shape
Lungs: CTA B/L
Heart; S1, S2 low pitched diastolic murmur
Abd: soft NT/ND +BS
Ext: WNL

Cardiac MRI



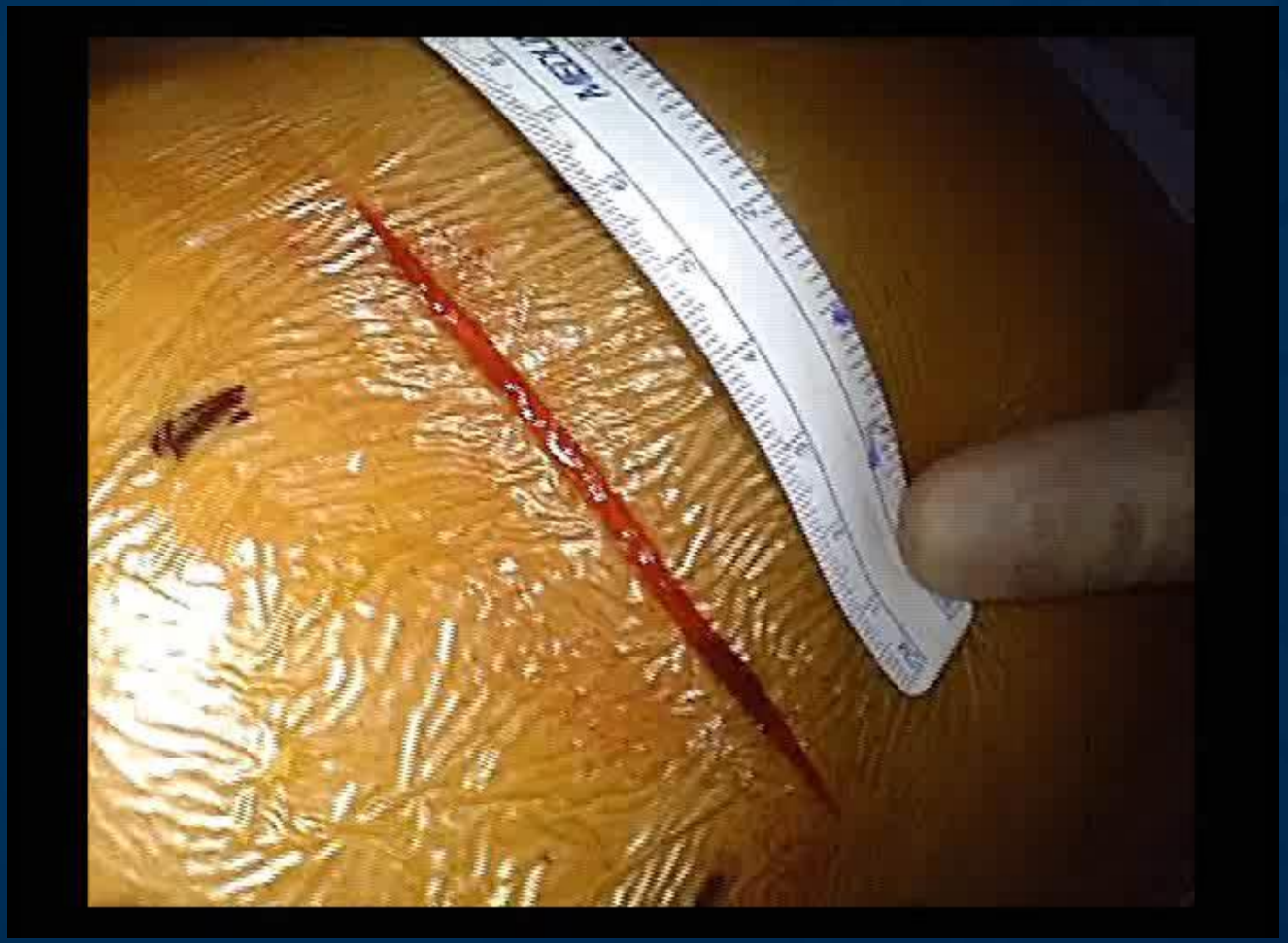

UNICAL CARDIAC^CARDIAC MRI
10:35:14 GMT-040
L: 269 WW: 588 (Auto)
ssy compression
age: 22 (22 of 40)
om: 299%
W: 180x180mm
Gantry Tilt
Slice Loc: 5.94
Slice Thick


PHILIPS
08/06/2014 10:18:34AM TIS0.7 MI 0.4
X7-2t/Adult
FR 14Hz
9.0cm
2D
64%
C 50
P Off
Gen
0 129 180
CF
59%
4.4MHz
WF High
Med
M4 M4
+61.6
-61.6
cm/s
G
P
R
JPEG
PAT T: 37.0C
TEE T: 38.9C
66 bpm

Operative Details

- Intended Procedure:
  - Minimally Invasive Ascending Aortic Replacement

- Gross findings:
  - Bicuspid Aortic Valve (Type I, L/R, 0)
  - 23mm LVOT (sized with 3f sizer)
  - Dilated Ascending Aorta with attenuated wall
  - 28mm STJ with normal aortic root tissue



Questions for Discussion

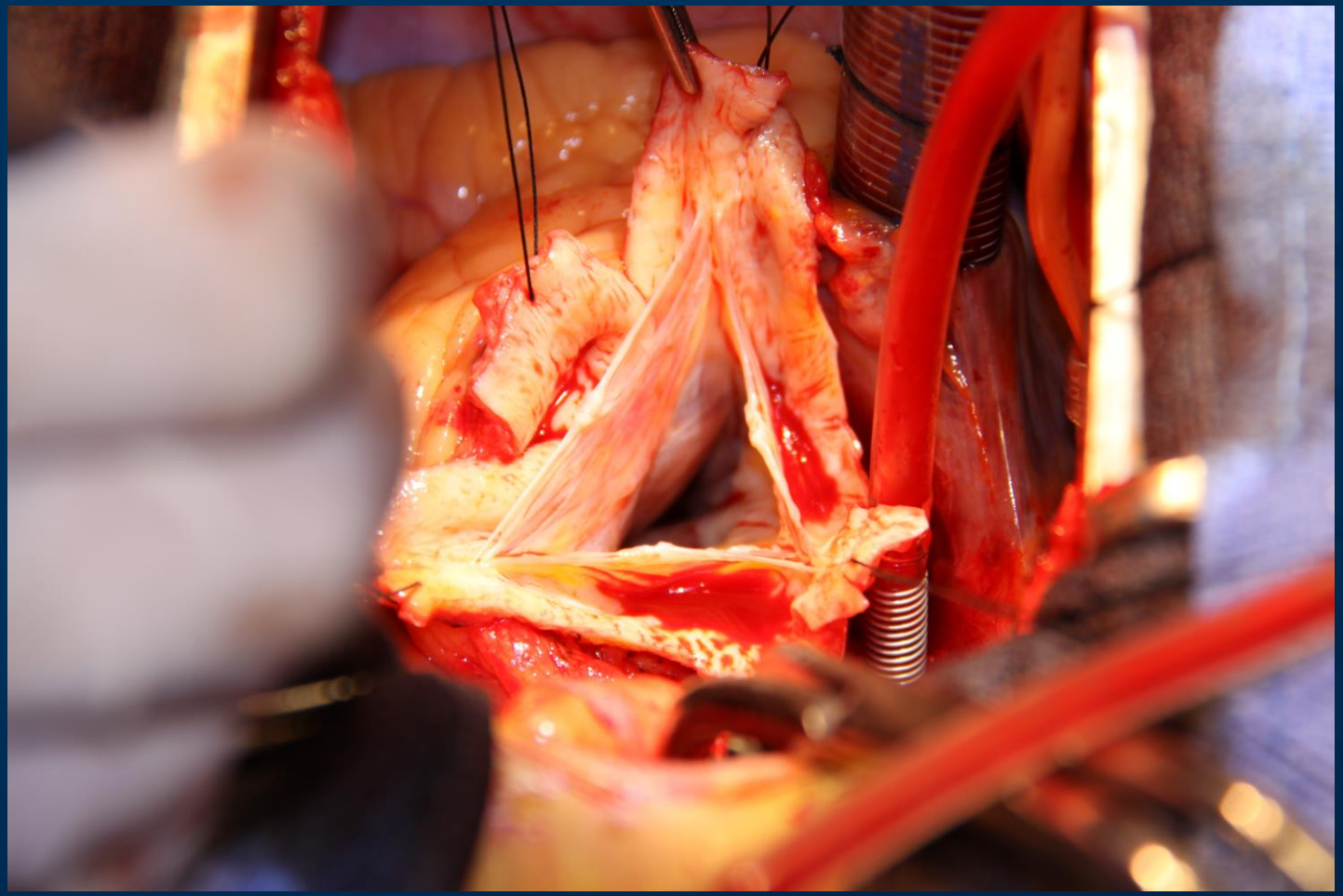
1. In bicuspid patients, what is the optimal surgery?

2. Is there a need to manage the annulus in bicuspid patients

3. Would anyone have advised him to just give up hockey vs operating against guidelines?

Does It Last???

Combating Surgeon Bias?
“In My Hands…”



Aortic Valve-Sparing Operations in 220 Patients

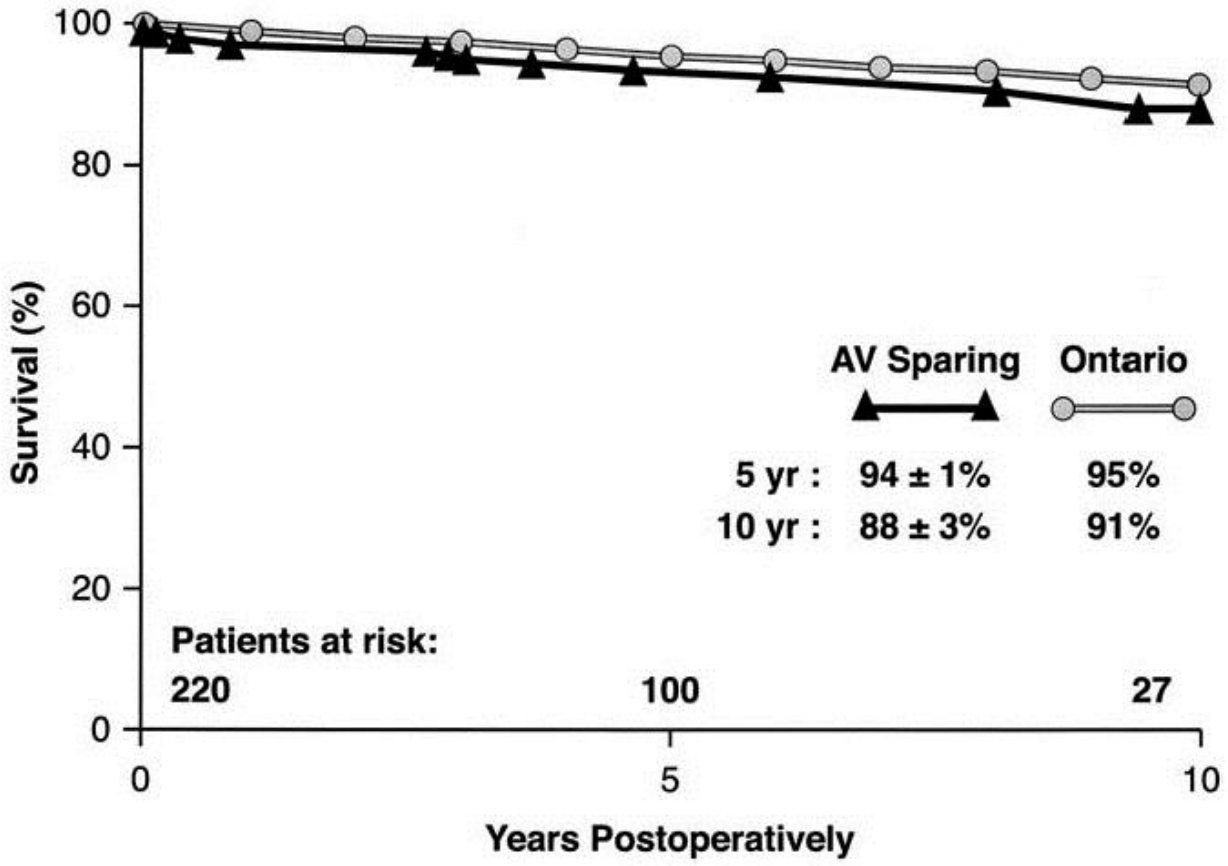


Figure 1. Survival of patients after aortic valve-sparing operations compared with survival of age- and sex-matched general population of Ontario.

David et al, J Thorac Cardiovasc Surg 2006;132:347-54

Aortic Valve-Sparing Operations in 220 Patients

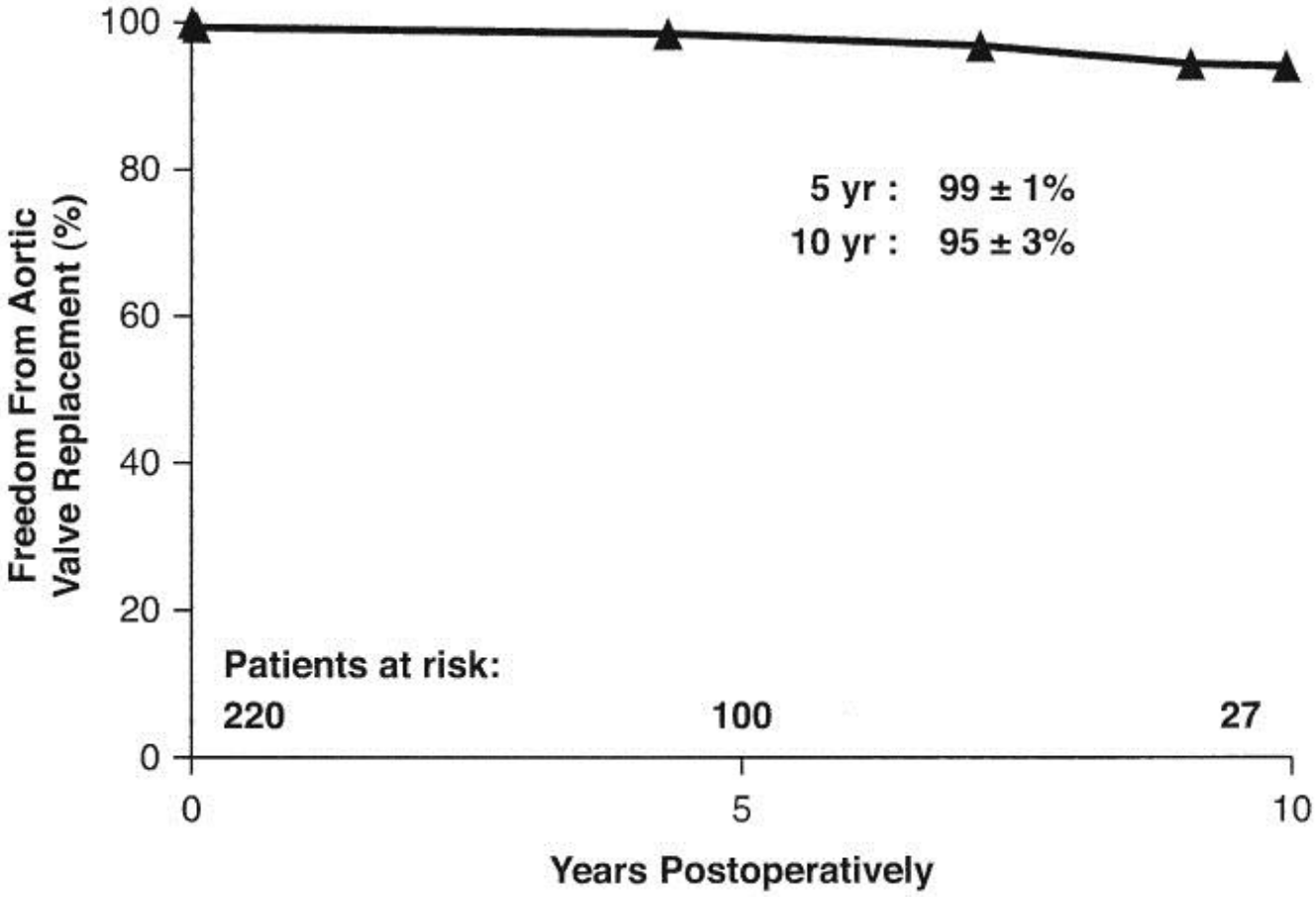


Figure 4. Freedom from aortic valve replacement after aortic valve-sparing operations in all patients.

David et al, J Thorac Cardiovasc Surg 2006;132:347-54

Search for the Ideal Composite Graft

1. Excellent Hemodynamics
2. Long-term Durability
3. Low Thromboembolic Risk
4. No Need For Long-Term Anticoagulation
5. Low Risk For Re-Intervention

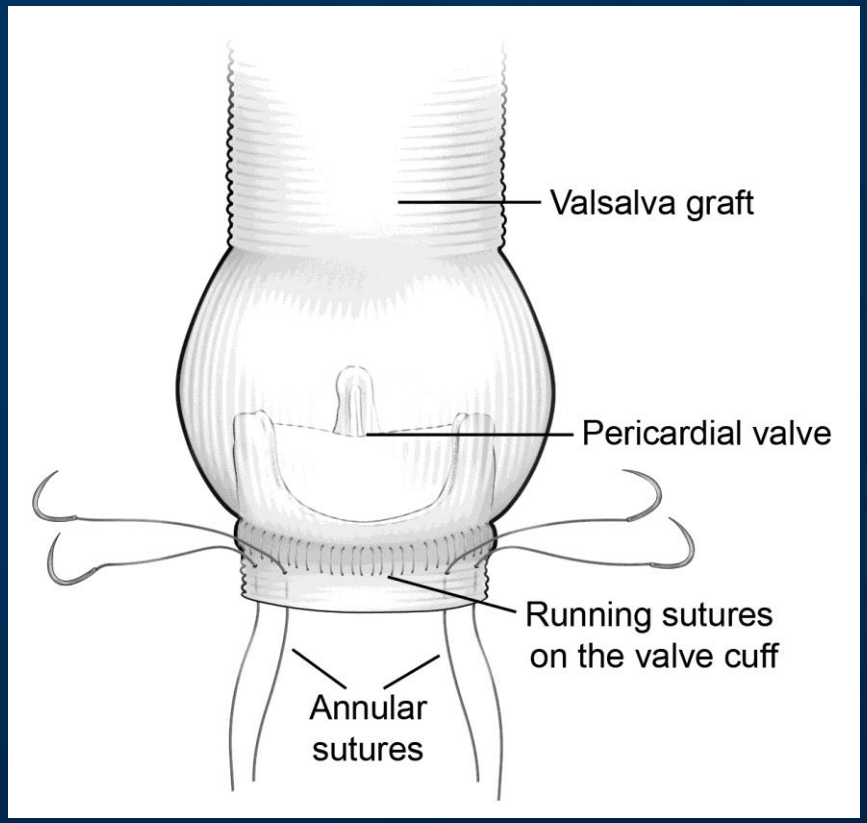
Modified Bentall Operation With Bioprosthetic Valved Conduit: Columbia University Experience

Minoru Tabata, MD, MPH, Hiroo Takayama, MD, Michael E. Bowdish, MD, Craig R. Smith, MD, and Allan S. Stewart, MD

Division of Cardiothoracic Surgery, Columbia University College of Physicians and Surgeons, New York, New York

A conduit was made by sewing a bovine pericardial valve into a graft conduit with the pseudo-sinuses of Valsalva. The graft collar below the valve cuff ring was sewn to the aortic annulus with interrupted pledgeted sutures. From August 2005 to February 2008, 68 patients underwent aortic root replacements with this technique. Operative mortality was 2.9% (2 acute aortic dissection patients died). During median follow-up of 11 months, 1 patient had reoperation for conduit failure due to infectious endocarditis. This technique is safe and feasible with favorable early outcomes. Because the valve is sewn above the outflow tract, superior hemodynamics are achieved. Reoperation may be accomplished by removal of the valve rather than full root re-replacement.

(Ann Thorac Surg 2009;87:1969–70)

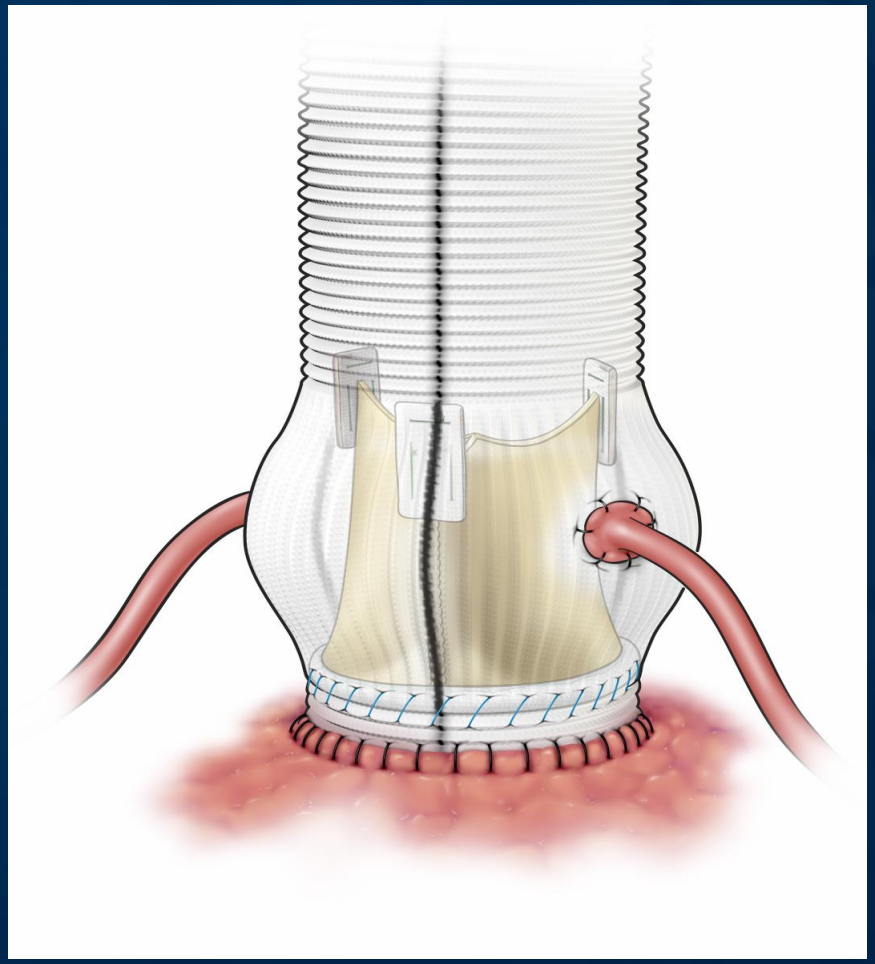


Stented CBG

Baseline demographics	
Cohort size (n)	243
Age (years)	64.6 +/- 13.3
Male(n, %)	184 (75.7)
Prior sternotomies (n, %)	27 (11.1)
Diabetes (n, %)	43 (17.7)
CAD (n, %)	38 (15.6)
Hypertension (n, %)	147 (60.5)
COPD (n, %)	21 (8.6)
Ejection Fraction*	53.4 +/- 9
Operative Details	
Cardiopulmonary bypass time (minutes)	143.8 +/- 40
Cross-clamp time (minutes)	103.6 +/- 28
Length of intensive care unit stay (days)	3.6 +/- 3
30 day mortality (n, %)	3 (1.2)
Re-operation during follow-up	3(1)

Composite Bioroot

- "One Size Fits All"
  - 21mm-46mm Annulus
  - Pre CPB Construction
- Reproducible Procedure
  - Continuous Proximal Suture
  - Easy Button Repair
  - Easier MV Repair
- Superior Hemodynamics
- Possible Improved Longevity by Design
- Potential for Transcatheter Rescue



Stentless 3f CBG

Baseline demographics	
Cohort size (n)	226
Age (years)	61.6 +/- 13.9
Male(n, %)	170 (75.2)
Prior sternotomies (n, %)	19 (8.4)
Diabetes (n, %)	17 (7.5)
Hypertension (n, %)	134 (59.3)
COPD (n, %)	22 (9.8)
Stroke (n, %)	2 (0.9)
CAD (n, %)	57 (25.1)
Ejection Fraction*	52 +/- 9
MR 2+ or greater (n, %)	6 (2.8)
AI 2+ or greater (n, %)	66 (29)
Albumin*	4.04 +/- .07
Creatinine*	1.2 +/- 1.6
BUN*	24.3 +/- 79.9
Operative Details	
Cardiopulmonary bypass time (minutes)	128.4 +/- 55
Cross-clamp time (minutes)	91.9 +/- 35
Length of intensive care unit stay (days)	3.9 +/- 6.3
30 day mortality (n, %)	5 (2.2)
Re-operation during follow-up	4(1.7)

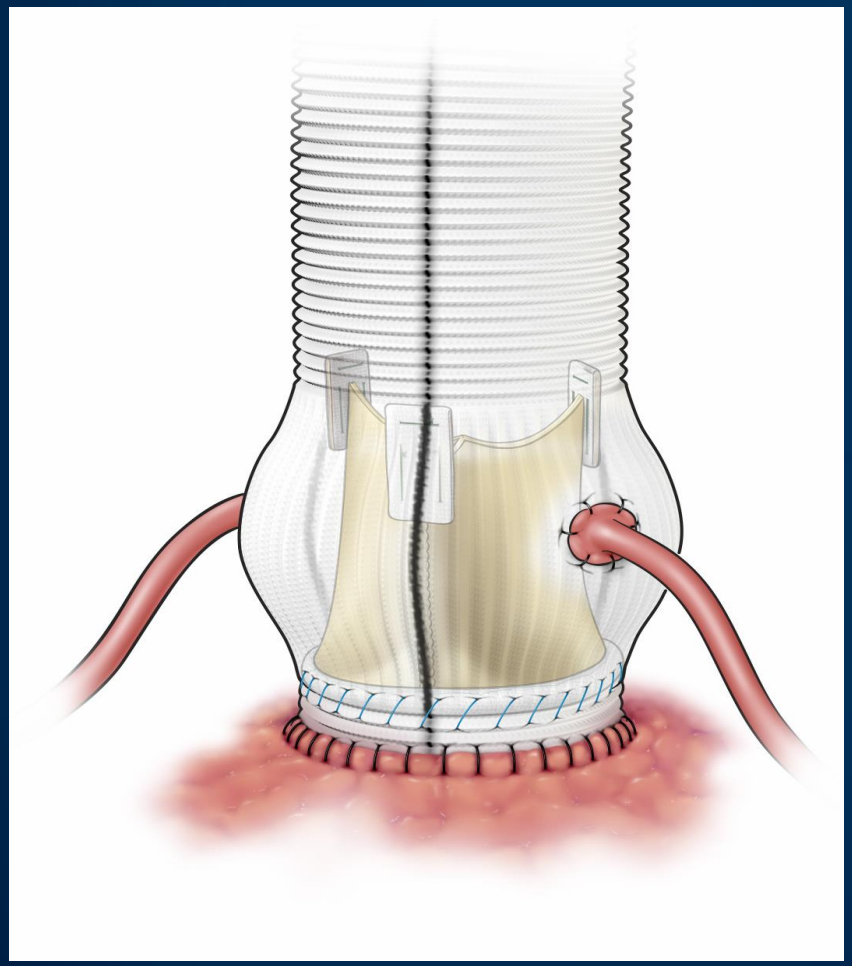
Case Presentation

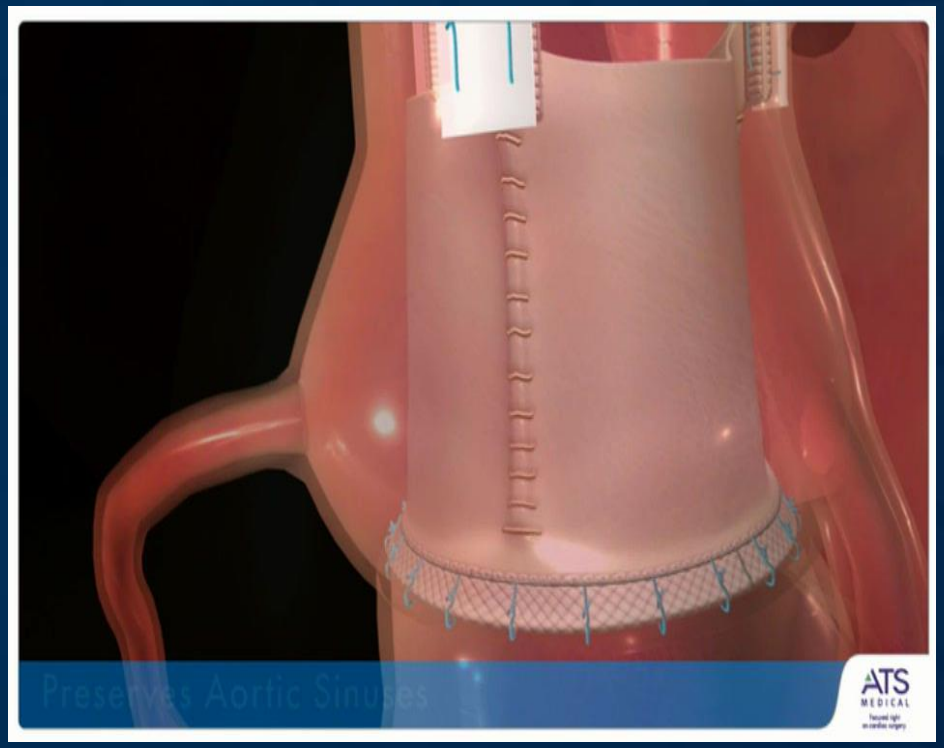
28 y.o. athletic male with known bicuspid valve disease, who was training for a pitching in collegiate baseball who developed dyspnea on exertion and two episodes of syncope.
Echo revealed bicuspid valve (type I, L/R, S) with and AVA 0.7cm2.
Chest CT revealed an aortic aneurysm measuring up to 5.2 cm.

PMHx: Unremarkable

Physical Examination:
Constitutional: Fit appearing young man
Vitals: HR: 62 BP: 140/90 RR: 16
Lungs; CTA B/L
Heart: S1, S2 loud SEM
Abd: soft NT/ND +BS
Ext: WNL

3f Composite Biologic Graft





Informed Consent

- Biological vs. Tissue at this age
  - Composite Biological Graft vs Ross
  - Which Biologic Valve to Use

- At what age do you start speaking about TAVR rescue?

Conclusions

- Aortic Dissection is Still a horrifying event
  - Can be prevented with aggressive cardiology care
  - Death may be mitigated in aortic centers of excellence

Myriad of Options for Addressing Aortic Root Aneurysms

Valve Sparing Aortic Root Replacement:

- Young, active patients who wish to avoid Coumadin
- Patients with connective tissue disorders
- Patients with bicuspid valve disease
- Patients with normal tri-leaflet valves and root aneurysms
- 15 year data is encouraging