Aortic valve repair: Techniques and Pitfalls

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Take Away Points

1. Valve anatomy is essential to assess repair

2. Unique Decisions with Aneurysm/AI
   1. Valve Sparing Root Replacement
   2. Replace valve with Bentall vs. BioRoot
   3. “Ignore” valve with STJ Remodeling

3. Should Decisions Change in TAVR era?
AHA / ACC Guidelines

• No Class I or IIa Indication to fix Moderate AI

• Class IIb
  - Moderate AI in patients undergoing Aortic Procedure

• Class III
  - AVR not indicated for asymptomatic patients with moderate AI and EF>50% when LVEDD <70mmHg
Why Does AI Occur?

1. Dilatation of Aorto-Ventricular Junction

2. Sinotubular Junction Dilation
   a. Generally a disease of the elderly

3. Cusp Abnormalities
   a. Fenestrations
   b. Prolapse
   c. Broken leaflets
Goals of Therapy

1. Eliminate the risk of Aortic Wall Dissection
2. Eliminate Aortic Insufficiency
3. Achieve reproducibly low Morbidity and Mortality
4. Attain excellent Long-Term Durability
   - In the world of TAVR, we need a perfect open chest result
   - Remember that a BAV repair is a contra-indication for TAVR
## All AI is Not Created Equally

<table>
<thead>
<tr>
<th>AI Class</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal cusp motion with FAA dilatation or cusp perforation</td>
<td>Cusp Prolapse</td>
<td>Cusp Restriction</td>
</tr>
<tr>
<td></td>
<td>Ia</td>
<td>Ib</td>
<td>Id</td>
</tr>
<tr>
<td>Mechanism</td>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Repair Techniques (Primary)</td>
<td>STJ remodeling Ascending aortic graft</td>
<td>Aortic Valve sparing: Reimplantation or Remodeling with SCA</td>
<td>Patch Repair Autologous or bovine pericardium</td>
</tr>
<tr>
<td></td>
<td>SCA</td>
<td>SCA</td>
<td>SCA</td>
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<tr>
<td>Repair Techniques (Secondary)</td>
<td>SCA</td>
<td>STJ Annuloplasty</td>
<td>SCA</td>
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</tbody>
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Basic Mechanisms of Repair

• **Subcommisural annuloplasty**
  – Reduction of area in sub-commisural triangle
    • Figure-of-eight or pledgetted stitches
    • Must be a mid-portion of triangle

  – **Planar reduction**
    • Mattress stitches under annulus to reduce circumference
    • Use graft if root or band if primary repair
    • May use dilator to assess EOAI
    • Mathematical equations and calipers may be used
Basic Mechanisms of Repair

Leaflet Intervention

1. Goal is to improve coaptation
2. Plication (start with Fenton stitch)
   • 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
Can it be Reproducible?

Stewart Valsalva Test
Rough Sketch

to stop cock and saline source
VSRR Implant Tool (3f Sizer)
Sample Case
Moderate AI, 5.7cm Root
Options

1. Perform Valve-Sparing Root Replacement

2. Perform Mechanical Valve Bentall Procedure

3. Perform a Bio-Root

4. Implant a Tube above graft above the STJ
A little more Information

- 2-3+ Central AI
- Mild Dilatation of LVEDD
- Clean Cath
- No Significant Co-Morbidities
One More Thing...

She is 81 years old.
Tube graft may be enough
We Chose #1

1. **Perform Valve-Sparing Root Replacement.**

2. Perform Modified Bentall Procedure?

3. Perform Bio-Root?

4. Replace Aorta with a Tubed Graft?
Valve Sparing Root

- Valve-Sparing Root
  - Primary Repair of Non-coronary leaflet fenestration
  - Plication of Left/Non-coronary commissure

- X-clamp time: 97 min
- Bypass time: 114 min
- Blood Tx: 0 units

- Post-op AI: 0
- Hospital Stay: 5 days with discharge to home
Did we make the right decision?

Sometimes you need more data...
Post-op we met her Family

- her 104 year-old Mother &
- her 103 year-old Aunt.
Inherent Surgeon Bias?
“In My Hands...”
Is Valve-Sparing or Root Replacement better for concomitant Aortic Valve Disease and Aneurysm?

24 Large Studies (All retrospective)

- NO Study Focuses on Moderate AI
- NO randomized controlled Trials
- NO Meta-analysis

How long will it Last?
Freedom from Moderate or Severe AI in Patients who had Reimplantation of the Valve and Remodeling of the Root

Range of Reports

- Valve-Sparing Root replacement (reimplantation)
  10-year freedom from Re-op: 85-97%

- Aortic Root Replacement
  10-year Survival: 67-88%
  10-year freedom from Re-op: 78-85%

Repair or Replace?

• Equivalent results in Literature

• Must weigh: Rate of Failure vs. Clinical Result

• Quality of Life metrics important but Poorly Studied
<table>
<thead>
<tr>
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<th>Valve-Sparing (n=196)</th>
<th>CBG (n=278)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age (years)</td>
<td>52.8 (range 16-83)</td>
<td>63.2 (36-88)</td>
</tr>
<tr>
<td>Pre-op: 0-2+ AI</td>
<td>58%</td>
<td>40%</td>
</tr>
<tr>
<td>Mean CPB time</td>
<td>121 min</td>
<td>153 min</td>
</tr>
<tr>
<td>Mean X-Clamp time</td>
<td>89 min</td>
<td>74 min</td>
</tr>
<tr>
<td>Freedom from Post-op: 2+ AI</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Freedom from Re-op AVR</td>
<td>99%</td>
<td>97%</td>
</tr>
<tr>
<td>Mortality</td>
<td>0</td>
<td>1%</td>
</tr>
</tbody>
</table>
We can make some Assumptions
Valid Considerations

Replace

Severe Leaflet Damage
Severe Annular Dilatation (>32mm)

Repair

Young Patient
Isolated Pathology
Normal Leaflets
“Real-time” Repair Algorithm

1. Can valve be Repaired? (Yes/No)
   - Yes: Should it be Repaired? (Yes/No)
     - Yes: Repair
     - No: Should it be Replaced? (Yes/No)
       - Yes: Replace
       - No: “Ignore”
   - No: Reimplantation

2. Should it be Repaired? (Yes/No)
   - Yes: Repair
   - No: Remodeling

3. Should it be Replaced? (Yes/No)
   - Yes: Replace
   - No: BioRoot

4. Options for replacement:
   - BioRoot
   - Mechanical Conduit
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
Considerations for Bicuspid Valves

• Advantages
  – Only one coaptation plane versus multiple
    • Easier to reestablish perfect coaptation
    • Plenty of leaflet tissue to improve zone of coaptation
  – Leaflet tissue usually thicker
    • Allows for sutures to gain good purchase
Considerations for Bicuspid Valves

• Disadvantages
  – Repaired valve is still conceptually flawed
  – There will be some degree of post-repair AS
  – There will be some degree of flow turbulence
Many repair techniques for BAV
Bicuspid: Important Considerations

- Leaflet repair
  - Stay sutures lateral to medial will exploit the prolapse
  - Easier and safer to plicate rather than resect
  - Resect to mid-point of valve if need be
Bicuspid Valves: Important Considerations

• Achieve 210/150 geometry
• Aggressively dissect the AP window to fat
  – L/NC to R/NC is where plication improves height
  – Multiple mattress sutures to reduce annulus
  • Band vs graft
Pitfalls of Repair

1. Spend time examining each leaflet
   • More than one leaflet with damage predicts early failure

2. Bicuspid valves with moderate calcification will fail early

3. Plicate the cusp in the thickest area to avoid sutures ripping free
   • Typically this is adjacent to Node of Arranti
Pitfalls of Repair

4. Overcorrecting prolapse will cause AS

5. Sometimes fixing the prolapsed leaflet will create mal-coaptation of non-repaired leaflet

6. Leaving the OR with AI will predict early re-op

7. A bad repair is not better than a good replacement
When should we Abandon Repair?

- Marked leaflet Asymmetry
- Multiple leaflet Fenestrations
- “Broken leaflets”
- Bicuspid Patients
  - Significant Thickening
  - Prolapse
  - Calcification
  - Multiple Fenestrations
- Connective Tissue Patients
  - Data is unclear
  - Be cautious in repairing the attenuated & severely prolapsing valve
How About Teaching Valve repair?
# Patient Characteristics

**Columbia Univ Medical Center 2005-2009**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>81 male</td>
</tr>
<tr>
<td></td>
<td>20 female</td>
</tr>
<tr>
<td>M:F Ratio</td>
<td>4:1</td>
</tr>
<tr>
<td>Age</td>
<td>55.1</td>
</tr>
<tr>
<td>Type A Dissection</td>
<td>10 (9.9%)</td>
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<tr>
<td>Emergent</td>
<td>5 (5.0%)</td>
</tr>
<tr>
<td>Bicuspid Valve</td>
<td>22 (21.8%)</td>
</tr>
<tr>
<td>Previous AVR</td>
<td>4 (4.0%)</td>
</tr>
<tr>
<td>Mean Aortic Root Diameter</td>
<td>5.8cm</td>
</tr>
</tbody>
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Thoracic Surgery Residents 2005-2009

VSRR Cases per Resident

Number of VSRRs

Resident
Mean Cardiopulmonary Bypass and Aortic Cross Clamp Times

Resident

Mean CPB Time  Mean Aortic Xclamp Time

p = 0.25, 0.71
Valve-Sparing Root Outcomes

- No patients with 2+ AI post-op
- Two CVAs (2%)
- Median LOS: 5 days (4-49)
- Two reoperations for AVR after discharge
  - Both endocarditis
Thoughts about teaching repair

1. Valve-sparing aortic root replacements can be taught and performed safely

2. The learning curve is steep

3. Normal root anatomy should be better appreciated before repair is undertaken

4. Aortic valve repair surgeons must become echocardiographers
Conclusions about Valve Repair

1. Aortic Valve Repair is Feasible

2. The learning curve is steep but beneficial

3. Aortic Valve Repair can be performed by more than just a select few and taught to others

4. Repairs should be anatomically based, described in detail, and fastidiously followed