Aortic Valve (and BAV) Repair and Reimplantation for Root Aneurysm:
Rocky Valve Montana 2019

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Candidates for David V Valve Sparing Reimplanation Operation?

- Any patient with an aortic root aneurysm and normal aortic cusps.
- Acute Type A Aortic dissection—difficult but durable.
- Patients with root aneurysm and abnormal cusps that are repairable.
- Bicuspid aortic valve—controversial.
- Severe aortic insufficiency heightens the difficulty (esp. cusp pathology).
Marfan Root (41 yr. old Man) with 9 1\textsuperscript{st} Order Relatives with either Dissection, Death from Rupture, or Replaced Roots!

Near Prophylactic Replacement
Dimensions of Native Aortic Valve

Natural L/D ratio

Goal: Restore (even fix) Geometry and Reduce Stress for long lasting repair

T. Gleason; Univ Penn
Can We Spare more Complicated Clinical Aortic Valve Presentations?

And Why is this so Important!
The Pure AI BAV Patient with Dilated/Aneurysmal Proximal Aorta

NOTE; Pure AI, No Calcified Leaflets

Still frames to depict anatomy

Key Point: Almost all Sievers 1 BAV will have asymmetric anatomy and will require cusp repair (100% in our series)
2002 to 2018: 1356 patients with Bicuspid Aortic Valve Disease (the surgical practice BAV universe)

Valve Pathology (N= 1356)

- *AS ± AI or AI for isolated AVR (N=884) EXCLUDED AVR, Bentall, Wheat*
- AI ± aortic root aneurysm (N=472)
  - Primary Leaflet Repair ± Ascending Aorta Replacement (N=104) Since 2005
  - Primary Leaflet Repair + Root Reimplantation (N=85)
  - Bentall or Proximal Aortic Reconstruction (N=283) 2006-2017
David V/ Bicuspid Valve: Sievers 0
180/180 ….. Beautiful Valve!!

Because we can’t throw Valves like this in the BUCKET!!
BAV Repair Philosophy: The Basics for AI

In Evolution!
Einstein: Make everything as simple as possible ...... But No Simpler!!
Surgical Repair BAV AI Classification: Fundamentally we are discussing Ib and c with II

Most Common combination

<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>Ib</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ic</td>
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<td>Id</td>
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</tbody>
</table>

Mechanism

<table>
<thead>
<tr>
<th>Repair Techniques (Primary)</th>
<th>STJ remodeling</th>
<th>Aortic Valve sparing: Reimplantation or Remodeling with SCA</th>
<th>Ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascending aortic graft</td>
<td>Aortic Valve sparing: Reimplantation or Remodeling with SCA</td>
<td>Patch Repair</td>
<td>Prolapse Repair</td>
</tr>
<tr>
<td></td>
<td>Ascending aortic graft</td>
<td>Autologous or bovine pericardium</td>
<td>Plication Triangular resection Free margin Resuspension Patch</td>
</tr>
<tr>
<td>(Secondary)</td>
<td>SCA</td>
<td>STJ Annuloplasty</td>
<td>Ring</td>
</tr>
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<td></td>
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<td>SCA</td>
<td>SCA</td>
</tr>
</tbody>
</table>

BAV Ib + II usually associated with 15-25% larger annulus than standard for BSA

Ascending Aorta - Root (Sinus segment) Phenotype

- **Root aneurysm**
  - Valve size 2/6 mm

- **Supra coronary aneurysm**
  - Valve size 4/6 mm

- **Isolated Al**
  - Al diameter 2/4 cm

Adapted from E. Lansac, Paris, France

Carpentier et al. JTCVS 1983, El Khoury et al. Curr Opin Cardiol 2005, Lansac et al. EJCTS 2008; Adapted from E. Lansac
At this time we almost never replace an insufficient Mitral Valve – Repair

- So …. For AI Aortic Valves
- Repair and Preserve Native Cusp (leaflet) tissue
- Restore the “Normal” 3D Geometry of the Root or the “Functional Aortic Annulus” (the Annulus and STJ)
Bicuspid Aortic Valve AI and the 3 Main presentations

- BAV with AI and relatively normal Root diameters
- BAV with AI and relatively normal Root diameters but Ascending Aneurysm
- BAV with AI and Root Dilation

• Problem: different therapeutic procedures for each presentation??
BAV AI with Normal Sinus and STJ Diameters: very dilated annulus
Preoperative TEE: BAV, Severe AI, Normal Aorta Diameters but Very Large annulus
Bicuspid Aortic Valve AI and the 3 Main presentations

• BAV with AI and relatively normal Root diameters
• BAV with AI and relatively normal Root diameters but Ascending Aneurysm
• BAV with AI and Root Dilation

• Problem: different therapeutic procedures for each presentation??
So … We still have a Major Dilemma: What do we do with THIS!!!! …. To “Root” or “Not to Root”
Normal Sinus Diameter

55.62 mm²
Bicuspid Aortic Valve AI and the 3 Main presentations

• BAV with AI and relatively normal Root diameters
• BAV with AI and relatively normal Root diameters but Ascending Aneurysm
• BAV with AI and Root Dilation

• Problem: different therapeutics procedures for each presentation??
The Pure AI BAV Patient with Dilated/Aneurysmal Proximal aorta

NOTE; Pure AI, No Calcified Leaflets

Fairly large opening, no AS

Still frames to depict anatomy
DV BAV with Root Aneurysm

But ....What kind of Leaflet Repair and Reconstructive Operation are we Talking about?
Case
- 34 yo ♂ Bicuspid Aortic Valve
- Surgical Indication: 1º Aortic
  - Aortic Root & Ascending Aorta Dilation
  - SOV: 4.73 (patient elected surgery)
  - Positive 1st Order relative with a Dissection
  - [2º: 2+ Aortic Regurgitation]
- Note
  - No LV dilation
  - Preserved EF
BAV Sievers 1 Valve assessment: Aneurysm Resected

Excellent Motion of the Posterior (non-fused) cusp; No calcification; No fenestrations; Asymmetric leaflet free margins; “cleft” and raphe
Different angles of the Sievers 1 BAV (120-180 degrees) 
Need the TEE 

About 160-170 degrees
Measuring the Amount of excess leaflet to resect (or plicate) for Leaflet Free Margin Equality
Measuring the Amount of excess leaflet to resect (or plicate) for **Leaflet Free Margin Equality**

**Treating the Prolapse**

Another case: Sievers 1 BAV: Severe AI
Raphe release; Better Motion (?)
Cleft Repair/Plication for Free Margin equality
BAV Repair with **Resection** (not Plication) of calcified thickened Raphe
Valve repair analysis: Ensuring Good Motion and No prolapse
Excellent and Equal Free Margin Length
Decision on Repair Geometry of ValSalva Graft

Coronary Buttons are cut. 210/150 perimeter and Leaflet surface area ratios.

This is when we make 210/150 vs 180/180 decision!
Post-Repair Evaluation: For Margin Equality, Perimeter assessment

Another case: This is when we make 210/150 vs 180/180 decision!
SCA BAV repair: mild billowing, asymmetric leaflet surface area
Key Concept:

The 210/150 Orientation and “Billowing”:
It is really an Asymmetric Leaflet Surface Area Issue
Placement of Subannular sutures 2mm below the Leaflet insertion site

8-9 Geometrically placed Subannular Stabilization sutures (annular reduction 15-20%)
180°/180° Repair
Freedom from AI >2+ (180/180 vs. 150/210)

Data thru 4/2018; partial update; Vallabhajosyula, Bavaria, et al; EJCTS 2014

No difference in Results of 180/180 Repair vs 210/150
About 50/50 in our practice

Key is Selection!
Preparation of the Root for Subannular Suture Placement and Re-Implanation Procedure
150°/210° commissural orientation
Reimplantation of Aortic Neoroot
BAV 180/180
Repair for Sievers 1
(undeveloped Raphe)
Postoperative valve function = **NO** residual AI

Notice excellent Leaflet motion
Coaptation = 9 mm
Annulus = 22 mm
Ø Prolapse below annulus
Ø AR
S/P AORTIC ROOT REPLACEMENT, VALVE SPARING

Vmax: 164 cm/s
Vmean: 110 cm/s
Max PG: 11 mmHg
Mean PG: 6 mmHg
VTI: 28.6 cm

PAT T: 37.0°C
TEE T: 38.5°C

75mm/s 110bpm
Echo Evaluation of BAV Repair/Reimplantation

• Annular Diameter; In the OR – How much of a REDUCTION in Annular Diameter (15-20%)

• Coaptation Zone Length (> 5 mm, best is 10 mm)

• Leaflets (and Coaptation) in relation to Valve plane (Above, Same level, or Below)

• STJ to Annular Ratio

• Description of AI jet(s), LVESD/LVEDD
Supra coronary aneurysm

Isolated Al

Adapted From E. Lansac, Paris, France

Carpentier et al. JTCVS 1983; El Khoury et al curr opin cardiol 2005; Lansac et al EJCTS 2008; Adapted from E. Lansac
So .... We still have a Major Dilemma: What do we do with these Presentations !!!! .... To “Root” or “Not to Root”
Do We have a New Solution for BAV AI with Ascending Aneurysm but normal Root diameter??

... 360 Sub-Annular Ring

Repair of the BAV Valve WITHOUT a Root Procedure
Place Sub-annular exactly like the Reimplantation (DV) but for external ring only: The Root is normal
Preoperative TEE
Preoperative TEE: BAV, Severe AI, **Normal** Aorta Diameters but Very Large annulus
Examining the valve: R/N cleft: Excellent mobility of the left cusp

Examining the valve
A large cleft, due to incomplete fusion of the right-non leaflets, can be seen
Trimming the right/non leaflet raphe
(Very thickened but NON-Calcified)
Still frames – cleft; to be closed
Repairing (closing) the right-non cleft at the raphe

Repairing the right-non cleft
5-0 prolene is used in an interrupted fashion
Completed cleft repair

Excellent LEFT (Non-Conjoined) cusp Motion and nice equality of free margin length
Dissecting the aortic root for eventual Ring annuloplasty (Sub-Coronary)

Dissecting aortic root parallel to LVOT to achieve subannular stabilization
Using careful cautery and making sure to isolate the coronary arteries
Subannular Dacron ring: Usually will get internal diameter 5-7 mm smaller
Completed subannular reduction

And Arch release for Aortic Closure

This is where you need to RE-ASSESS the Valve. Often an additional plication suture will be required on EITHER side to ensure Free margin equality and to reduce prolapse.
Postoperative TEE
Postoperative TEE

Excellent motion of “Non-Conjoined” cusp
Postoperative TEE

Coaptation Zone: 10.5 mm
Postoperative TEE

Annulus: 20.9 mm
Post-Repair gradient peak = 6 mmHg
Penn Series Data

BAV VSRR vs other BAV techniques
Outcomes with BAV Repair + Root Reimplantation:

How do they compare to our institutional tricuspid aortic valve root reimplantation?
Freedom from AI >2+ (%)
100% of BAV VSRR had Leaflet Repair

5 years
Log-Rank P = 0.7

Hemodynamic Results of an Algorithmic Three-Pronged Approach to Bicuspid Aortic Valve Repair

Mary A. Siki, BS, Andreas Habertheuer, MD, PhD, Prashanth Vallabhajosyula, MD, MS, Caroline Komlo, BS, Melanie Freas, DNP, CRNP, Rita K. Milewski, MD, PhD, Nimesh D. Desai, MD, PhD, Wilson Y. Szeto, MD, Joseph E. Bavaria, MD
Bicuspid Aortic Valve with Insufficiency

Calcification
- Extreme fenestration
- Decreased leaflet surface area
- Geometric height < 18 mm

Annulus ≤ 27 mm

Root Aneurysm or Dilation

YES

AVR ± proximal aortic repair
(Bio-Bentall, Mechanical Composite, Wheat Procedure)

NO

Annulus ≤ 27 mm

YES

BAV repair + SCA

NO

BAV repair + ESAR

VSRR

STS/EACTS Latin America Cardiovascular Surgery Conference 2018
Long-term Outcomes

Freedom from AI > 2+

Freedom from Re-operation

Product-Limit Survival Estimates
With Number of Subjects at Risk

Survival Probability

Logrank p=0.7641

Repair type:
1: Valve Sparring Root Reimplantation
2: External Subannular Aortic Ring
3: Subcommissural Annuloplasty

Product-Limit Survival Estimates
With Number of Subjects at Risk

Survival Probability

Logrank p=0.0966

Repair type:
1: Valve Sparring Root Reimplantation
2: External Subannular Aortic Ring
3: Subcommissural Annuloplasty
Reimplantation Conclusions: **Bicuspid Aortic Valve Repair +/- Ascending Aneurysm**

- BAV repair with Re-implantation is very feasible with very good mid-term outcomes
  - With minimal leaflet Calcification
  - Good motion of the “normal” cusp
  - Either 210/150 or 180/180 orientation is reasonable depending on pre-operative perimeter assessment (50/50 in our practice)
- Annular Stabilization is **Critical**
  - Re-Implantation (or **Sub-annular Ring**) accomplishes this goal.
  - Simple SCA in pre-op Annular diameters >27 should be abandoned
  - **Reconstructive principles need to be vigorously upheld**
Thomas Eakins: Gross Clinic (1878@JEFF) and Agnew Clinic (1888@PENN)

Great Progress in 10 years!

Thank You