Aortic valve repair

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DISCLOSURES

Conflicts of interest: none
Valve Repair = Ring Annuloplasty + Leaflet Reconstruction
Indications and Limitations of Aortic Valve Reconstruction

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To elucidate the value of conservative operation for aortic regurgitation, all consecutive patients operated on between July 1988 and July 1990 were reviewed. Of 251 patients with aortic regurgitation, 107 (42.6%) had non-prosthetic operation. The mean age was 23 years, and 90 patients (84.1%) were rheumatic. Two techniques were used: repair (annular and leaflet plasties, 69 cases) and cusp extension with glutaraldehyde-treated pericardium (25 bovine, 13 autologous). There were two hospital deaths (1.8%), both in the repair group, and no late deaths or embolic events. Only 5 patients (4.7%) were anticoagulated. In the repair group there were 12 reoperations, four (5.9%) due to aortic and eight to mitral dysfunction. In the cusp extension group there were two reoperations due to mitral dysfunction. Echocardiographic follow-up showed better results with cusp extension. In conclusion, conservative operation for aortic regurgitation is possible in a high percentage of young rheumatic patients and does not require anticoagulation. Cusp extension is more reliable than repair in terms of early results, although its long-term durability is not yet known.

## History of Aortic Valve Repair

### Remodeling
- 1 proximal suture line  
  *(predisposition to bleeding)*
- Absence of subannular sutures  
  *(predisposition to annular dilation)*
- Billowed graft  
  *(more natural leaflet motion)*
- More rapid and less complex

### Reimplantation
- 2 proximal suture lines  
  *(more secure hemostasis)*
- Presence of subannular sutures  
  *(prevention for annular dilation)*
- Rigid straight graft  
  *(impeding natural leaflet mobility)*
- More technically complicated
General consideration

1. Remodeling or Reimplantation are to be considered like two different technique to re-build the new walls of the aorta

2. None of the two procedures has any direct effects on the leaflets

3. If in doing the chosen procedure we distort the leaflets we must correct them!

4. If the leaflet are, per se, prolapsing or damaged we must fix them!
History of Aortic Valve Repair

Hans-Joachim Schaefers

Gebrine El Khoury
Aortic Valve Repair - Difficulties

Dimensions - of aortic root/(ring)
Configuration/coaptation of cusps
Vision from outflow

Geometry altered by non-filled state!
Aortic Valve Repair - Solutions

Geometry altered by non-pressurized state!

Commissural stay sutures!
History of Aortic Valve Repair

Adding a ring pre from splaying of the

Internal ring annuloplasty


External Ring Annuloplasty
History of Aortic Valve Repair

External ring annuloplasty (Schaefers)

Subcommissural Suture Annuloplasty (Cabrol)
History of Aortic Valve Repair

Early Results After Implantation of a New Geometric Annuloplasty Ring for Aortic Valve Repair

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Department of Cardiovascular Surgery, German Heart Center Munich, Munich, Germany; Centennial Medical Center, Vanderbilt University, Nashville, Tennessee; and Texas Heart Institute, Houston, Texas

High-Resolution CT Angiography
11 Patients undergoing Coronary Screening
With Normal Aortic Valves
High-Resolution CT Angiography

The Normal Aortic Root is not Expansile
Suggesting the Utility of a Rigid Titanium Ring
Hemispherical Aortic Annuloplasty Reconstructive Technology
Geometric Ring Annuloplasty

Tri-Leaflet

Bicuspid
Why Go to the Effort to Convert One’s Practice to Aortic Valve Reconstruction?
Valve Recommendation For Aortic Stenosis

• Age 18 to 39
  – Mechanical Valve
  – (Ross Operation)
  – No good xenograft solution

• Age 40 to 59
  – Mechanical Valve
  – Can biologic be recommended?

• Age 60 to 70
  – Biological or Mechanical

• Age > 70
  – Biological
  – TAVR
1. Results of Aortic Valve Replacement are Terrible

Hammermeister et al. JACC 2000;36:1152
Gaca et al. JHVD 2013;22:810
Long-term outcomes after elective isolated mechanical aortic valve replacement in young adults

Ismail Bouhout, et al JTCVS 2014 Volume 148, Issue 4, Pages 1341-1346.e1

<40 years old 1:10 dead by 10 years
Long-term outcomes after elective isolated mechanical aortic valve replacement in young adults

Ismail Bouhout, et al. JTCVS 2014 Volume 148, Issue 4, Pages 1341-1346.e1

1:4 will experience MAPE by 10 years

Major adverse prosthetic events
- Endocarditis
- Thrombosis
- Dysfunction
- Hemorrhage
- Thromboembolism
The Perimount Valve in the Aortic Position: Twenty-Year Experience With Patients Under 60 Years Old

Between 40-60 years of age

70% by 20 years will have a prosthetic dysfunction
Twenty-year durability of the aortic Hancock II bioprosthesis in young patients: is it durable enough?
Dai Une Marc Ruel Tirone E. David
European Journal of Cardio-Thoracic Surgery 2014;46:825–830,

1: 5 dead within 10 years

Most 50-60 and 30% below 50

<table>
<thead>
<tr>
<th>Age group</th>
<th>Survival (%)</th>
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</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>16% (47/304)</td>
</tr>
<tr>
<td>40-49</td>
<td>25% (77/304)</td>
</tr>
<tr>
<td>50-59</td>
<td>59% (180/304)</td>
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</table>
3. Survival is Better with Aortic Valve Repair

If one can do it, you can do it too. If no one can do it, you must do it and teach how to do it.

Japanese Proverb with a twist

Aatul Palandurkar

The learning curve... the stumbling block.

- Starting point (first procedure)
- Slope (rate of learning)
- Plateau (approaching expert level)

Experience of surgeon (e.g., number of procedures performed)
OCC initial experience Valve Repair

15 patients (17-68)

3 Marfan’s (one with Barlow’s) (HAART + sSR +AscAR )
3 A root aneurysm – symmetric (HAART + sSR +AscAR )
1 A. Root + Asc.Ao Aneurysm (HAART + AscAR )
1 Asc. Ao An. & cusp prolapse & fenestration (HAART 300)
3 BAV (2 leaflet repair, 1 sub/com)
2 A root aneurysm – asymmetric (asym. Root Remodelling)
1 An.AscAo and single sinus dilatation (sSR +AscAR )
1 A Root aneurysm A. Root Remodelling
Worries

- RCA ostium adjacent to R-N comissure
- Asymmetric sinuses
- Intermediate type BAV - Non-Conjoined ≤160
- R. sinus with high A-V junction
- Not available HAART 200 in Europe
- Glutaraldehyde availability and standardized protocol

"Intermediate-Type" BAV

Protocol for the use of Glutaraldehyde (0.625%) for pericardial preparation
Patient

38 Year-Old Female
Full Stigmata of Marfan Syndrome
NYHA Class II CHF
5.0 cm Aortic Root Aneurysm
Grade 3 Aortic Insufficiency
Grade 3 Mitral Insufficiency (Barlow’s)
### TTE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal</th>
<th>Actual</th>
<th>Normal</th>
<th>Actual</th>
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<tbody>
<tr>
<td>A. Root</td>
<td>20 - 38 mm</td>
<td>42</td>
<td>EDD LV</td>
<td>36 - 56 mm</td>
</tr>
<tr>
<td>LA</td>
<td>19 - 39 mm</td>
<td>36</td>
<td>ESD LV</td>
<td>25 - 37 mm</td>
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<tr>
<td>RVOT</td>
<td>7 - 25 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IVS</td>
<td>7 - 11 mm</td>
<td>8</td>
<td>EF LV</td>
<td>&gt; 55%</td>
</tr>
<tr>
<td>Post. W</td>
<td>7 - 11 mm</td>
<td>9</td>
<td>PA</td>
<td>m/sec</td>
</tr>
</tbody>
</table>

**Doppler**

- **Mitral**
  - **E**: 0 m/sec
  - **Am**: m/sec
  - **DTE**: m/sec
- **Aortic**
  - **Max Vel**: m/sec
- **Tricuspid**
  - **PASP**: 35 mmHg
  - **PA Max Vel**: m/sec

**Aortic sinus Valsalva**: 42mm

**Sinotubular junction**: 38mm.

**A. Aorta**: 45mm

**Aortic valve**: Dysplastic. Probably R-NC BAV

**Mitral valve**: normal

**Doppler study**:
- Moderate - severe A. Regurgitation.
- Mild Mitral regurgitation
- Mild Tricuspid regurgitation PASP=35mmHg.
OCC initial experience Valve Repair
OCC initial experience Valve Repair
OCC initial experience Valve Repair
**OCC initial experience Valve Repair**

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### Doppler

<table>
<thead>
<tr>
<th></th>
<th>Ect: 0 m/sec</th>
<th>Am: m/sec</th>
<th>DTE: nsec</th>
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</thead>
<tbody>
<tr>
<td>Mitral</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Aortic</td>
<td>Max Vel:</td>
<td>m/sec</td>
<td></td>
</tr>
<tr>
<td>Tricuspid</td>
<td>PASP: mHg</td>
<td>PA Max Vel: m/sec</td>
<td></td>
</tr>
</tbody>
</table>

- **Aortic sinus Valsalva**: 52mm, enlarged, non-cor. sinus
- **Sinotubular junction**: 40mm.
- **Asc Aorta**: 42mm
- **Arch**: normal, 23mm
- **Aortic valve**: tricuspid valve
- **Mitral valve**: normal, prolapsing

### Doppler study:
- No A Regurgitation.
- Mild Mitral regurgitation
OCC initial experience Valve Repair
OCC initial experience Valve Repair
Important Considerations

1. Managing Asymmetry
2. Liberal Downsizing
3. Position Ring Post Deep into Sub-Commissural Space
4. Uniform Lateral Suture Fixation
Advantages of Ascending Aortic/Root “Restoration”

1. Deep Root Dissection is not Required
2. Geometric Valve Repair at the Beginning
3. Complex Leaflet Reconstruction is Facilitated
4. Procedure is Simple and Reproducible
4. Can be Applied to Most Pathologies
6. Intermediate-Term Outcomes Seem Excellent
Tri-Leaflet and Bicuspid Ring Annuloplasty

Geometric ring annuloplasty as an adjunct to aortic valve repair: clinical investigation of the HAART 300 device


Abstract

OBJECTIVES: This study assessed the safety and efficacy of an internal geometric annuloplasty ring in a regulatory trial of aortic valve re-construction (ClinicalTrials.gov identifier: NCT01400841).

METHODS: Sixty-five patients with predominant moderate-to-severe trileaflet aortic insufficiency (AI) underwent aortic valve repair with an average age of 63 ± 13 years (mean ± SD). All had initial implantation of an internal aortic annuloplasty ring to correct annular dilatation and facilitate leaflet repair. Leaflet prolapse was performed for prolapse in 80% of patients, and more complex leaflet procedures, usually employing autologous pericardium, were required in 22%. Ascending aortic and/or root aneurysms were replaced in 62%.

RESULTS: Follow-up was for a maximum of 3 years and a mean of 2 years. No in-hospital operative mortalities, major complications or early or late valve-related events occurred. The annular diameter before repair was 26.3 ± 2.3 mm, and the average ring diameter used was 21.5 ± 1.6 mm. The preoperative AI grade (0–4) was 2.9 ± 0.8 and improved after repair to 0.6 ± 0.7 (P < 0.0001), as did the NYHA class. The mean valve gradient was 8.8 ± 8.8 mmHg, and at 3 years, the Kaplan–Meier survival rate was 95%, with no valve-related mortality. Over the 3 years, aortic valve replacement was required in 7 patients (10.8%) for reasons usually related to surgical technique. Most repair failures occurred early, and results stabilized after 6 months. No structural complications of the rings were observed.

CONCLUSIONS: Geometric ring annuloplasty was a safe and effective adjunct to aortic valve repair. Initial correction of annular dilatation seemed to facilitate overall reconstruction. Because most early repair failures were technical, increasing experience with geometric ring annuloplasty for aortic valve reconstruction has the potential to standardize and improve outcomes.

Keywords: Aortic annuloplasty • Aortic valve repair • Aortic Insufficiency

A Regulated Trial of Bicuspid Aortic Valve Repair Supported by Geometric Ring Annuloplasty

Domenico Mazzitelli, MD, Steffen Pfeiffer, MD, J. Scott Rankin, MD, Theodor Fischlein, MD, Yeong-Hoon Choi, MD, Thorsten Wahlers, MD, Christian Nöbauer, MD, Christian Schreiber, MD, and Rüdiger Lange, MD

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Background. Annular stabilization is important during bicuspid aortic valve (BAV) repair to obtain the best long-term results. This report describes the early outcomes of a novel bicuspid annuloplasty ring for this purpose.

Methods. Under regulatory supervision (NCT02071849), a geometric bicuspid annuloplasty ring was used during valve repair in 16 patients. Three patients had Sievers type 0 valves, 11 had Sievers type 1, and 2 had Sievers type 2. Thirteen patients had left-right coronary cusp fusion, 1 had right-non-coronary cusp fusion, and 2 had both. Moderate to severe aortic insufficiency (AI) was present in 13 of 16 patients, and 3 had mild AI with aortic aneurysms. Ascending aortic aneurysms, root aneurysms, or both were replaced in 7 of 16 patients. The Dacron-covered titanium ring had circular base geometry and two outwardly flaring subannular posts positioned opposite on the circumference. The ring was implanted into the annulus beneath the valve, and then leaflet repair was performed.

Results. Immediate postoperative echocardiograms showed grade 0 residual AI in all patients, with good cusp mobility and effective height and satisfactory gradients. There were no in-hospital or late mortalities. Two patients experienced leaflet tears from long annular sutures tails, requiring late valve replacement. After implementation of a lateral suture fixation technique, no more failures occurred. At a mean follow-up time of 9 months, the remaining 14 patients were in New York Heart Association class I, with predominant grade 0 AI.

Conclusions. As a technique for BAV repair, internal ring annuloplasty produces major annular remodeling and stabilization. Annular reduction and resecuring to a 50/50 symmetric circular geometry facilitates leaflet repair and enhances cusp coaptation. Geometric ring annuloplasty could have useful applications in BAV repair.

Reconstruction of Leaflet Defects

Leaflet Repair Techniques

- Leaflet Plication for Prolapse
- CUSA Release of Retracted Nodulus
- Double Pericardial Patches for Hole
- Double Pericardial Strips for Ruptured Commissure
Avoiding Potential Pitfalls

Preventable Iatrogenic Defects

A. Untied Prolene Post Suture and Dehiscence of Ring Post

B. Long Suture Tail Possibly Tearing Adjacent Leaflet
Avoiding Potential Pitfalls

Management of Annular Sutures

A. Leaflet Suture Tied With 8 Knots

B. Needle Passed Through Lateral Pledget

C. Suture Tied Again and Cut Short

D. Suture Tails and Knots Are Buried Behind Pledgets
Leaflet Lacerations - Annular Suture Tails

Leaflet Tears from Long Suture Tails
New Applications

“Intermediate-Type” BAV
New Applications

Endocarditis
Future Applications
Rheumatic and Calcified Stenotic Valves

Stented Tri-Leaflet Autologous Pericardial Aortic Valve
Ozaki Procedure
Tri-Leaflet Glutaraldehyde-Fixed Autologous Pericardial Aortic Valve
New Applications

Valve-in-Ring Procedures
New Applications

Minimally Invasive Aortic Valve Repair
Aortic Valve Reconstruction