Expanding Relevance of Aortic Valve Repair
Is Earlier Operation Indicated?

RM Suri, V Sharma, JA Dearani, HM Burkhart, RC Daly, LD Joyce, HV Schaff

Division of Cardiovascular Surgery, Mayo Clinic, Rochester, Minnesota
Expanding Relevance of Aortic Valve Repair
Is Earlier Operation Indicated?

RM Suri, V Sharma, JA Dearani, HM Burkhart, RC Daly, LD Joyce, HV Schaff

Division of Cardiovascular Surgery, Mayo Clinic, Rochester, Minnesota
Disclosure Mayo Clinic Division of Cardiovascular Surgery

Research funding
Edwards Lifesciences
St. Jude Medical
Sorin Group

Current technology licensing agreements
St. Jude and Sorin Group

Principle Investigator
FDA Perceval Trial – Sorin Group

Co-Investigator
Edwards PARTNER II, Abbott COAPT
Chronic Severe Aortic Regurgitation

**Clinical evaluation + Echo**

- **Symptoms?**
  - Yes: **Class I**
  - No: **Equivocal**

- **Exercise test**
  - No symptoms: Normal EF
  - Symptoms: EF or 50% or less

- **LV function?**
  - Normal EF: RVG or MRI
  - EF borderline or uncertain: SD 45-50 mm or DD 60-70 mm
  - EF 50% or less: SD >55 mm or DD >75 mm

- **LV dimensions?**
  - SD <45 mm or DD <60 mm: Stable?
  - SD 45-50 mm or DD 60-70 mm: Stable?
  - SD 50-55 mm or DD 70-75 mm: Stable?

- **Stable?**
  - No, or initial study: Reevaluate and echo 3 mo
  - No, or initial study: Reevaluate and Echo 3 mo
  - Yes: Consider hemodynamic response to exercise

- **Reevaluation every 6-12 mo Echo every 12 mo**

ACC AHA guidelines 2006
Chronic Severe Aortic Regurgitation

Reevaluation

Symptoms?

No

Equivocal

Yes

Symptoms

Class I

Class I

AVR

LV dimensions?

SD >55 mm or
DD >75 mm

Stable?

Yes

No, or
initial study

Reevaluate
and Echo

3 mo

Clinical eval
every 6 mo
Echo every 12 mo

LVESD 50-55 mm or
LVEDD 70-75 mm

Abnormal

Consider hemodynamic response to exercise

Clinical eval
every 6 mo
Echo every 6 mo

Class IIb

LVEDD 70-75 mm

Class IIa

EF 50% or less

Initial study

Reevaluate

and Echo

3 mo

Clinical eval
every 6 mo
Echo every 12 mo

LV function?

Normal EF

EF borderline or uncertain

RVG or MRI

Symptoms

Class I

ACC AHA guidelines 2006
Pericardial / Homograft AVR - Explants

Aortic valve repair is currently in transition from surgical improvisation to a reproducible operation and an option for many patients with aortic regurgitation.
Conclusions: Aortic valve repair can be performed with low risk and excellent freedom from valve-related morbidity and mortality...a good option for young patients who wish to avoid chronic anticoagulation and warfarin.
Objectives

• Determine early safety and efficacy of aortic valve repair

• Study long-term durability and reoperation risk

• Understand whether timing of repair influences late survival
Inclusion

• 1986 – 2011
• Aortic valve repair for AR
• Indications for surgery
  • Symptoms
  • LV dysfunction or dilation
  • Severe AR
  • < Severe AR plus concomitant procedure
Exclusions

- <18 years of age
- Prior aortic valve repair
- Prior or concomitant valve-sparing root
- Active endocarditis
- Aortic dissection
- VSD
- Emergent
Methods

• Studied 331 pt undergoing aortic valve repair for AR

• Divided into 4 pathoanatomic categories
Operative Data
Etiology of Aortic Valve Regurgitation

- Cusp Perforation: 6% (23)
- Annular Dilation: 1% (2)
- Tricuspid Valve with Cusp Prolapse: 23% (77)
- Bicuspid Valve: 41% (133)
Results
## Preoperative Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-Bicuspid (%)</th>
<th>Bicuspid (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
<td><strong>n = 198</strong></td>
<td><strong>n = 133</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Age (yr)</strong></td>
<td>61±15</td>
<td>42±14</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Sex (Male)</strong></td>
<td>138 (70)</td>
<td>116 (87)</td>
<td>NS</td>
</tr>
<tr>
<td><strong>NYHA class III/IV</strong></td>
<td>81 (39)</td>
<td>22 (17)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Smoking</strong></td>
<td>48 (24)</td>
<td>33 (26)</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td>98 (48)</td>
<td>38 (30)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Diabetes Mellitus</strong></td>
<td>20 (10)</td>
<td>9 (8)</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Connective tissue disorders</strong></td>
<td>10 (5)</td>
<td>1 (0.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Prior MI</strong></td>
<td>20 (9)</td>
<td>1 (0.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Prior cardiac surgery</strong></td>
<td>12 (6)</td>
<td>1 (0.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Atrial fibrillation</strong></td>
<td>52 (26)</td>
<td>12 (9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Prior endocarditis</strong></td>
<td>17 (9)</td>
<td>1 (0.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>LVEF &lt;50%</strong></td>
<td>59±7</td>
<td>61±9</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Severe AR</strong></td>
<td>97 (49)</td>
<td>99 (74)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>LVESD (mm. mean ± SD)</strong></td>
<td>38±8</td>
<td>39±8</td>
<td>0.014</td>
</tr>
<tr>
<td><strong>LVEDD (mm. mean ± SD)</strong></td>
<td>58±9</td>
<td>60±9</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Operative Data

Repair Techniques

Annular Dilation
- 81% Commissural plication

Bicuspid Valve
- 32% Partial cusp resection or plication

Tricuspid Valve with Cusp Prolapse
- 31% Resuspension or cusp shortening

Cusp Perforation / Other
- 10% Cusp shaving
- 7% Cusp perforation closure
## Operative Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiopulmonary bypass time (min)</strong></td>
<td>60 ± 30</td>
</tr>
<tr>
<td>Isolated AVR&lt;sub&gt;ep&lt;/sub&gt;</td>
<td>46 ± 21</td>
</tr>
<tr>
<td><strong>Cross clamp time (min)</strong></td>
<td>44 ± 21</td>
</tr>
<tr>
<td>Isolated AVR&lt;sub&gt;ep&lt;/sub&gt;</td>
<td>32 ± 17</td>
</tr>
<tr>
<td><strong>Major associated procedure, n (%)</strong></td>
<td>180 (78)</td>
</tr>
<tr>
<td>Mitral valve repair</td>
<td>60 (33 )</td>
</tr>
<tr>
<td>Mitral replacement</td>
<td>6 (3)</td>
</tr>
<tr>
<td>CABG</td>
<td>47 (26 )</td>
</tr>
<tr>
<td>Ascending aorta replacement</td>
<td>38 (21 )</td>
</tr>
<tr>
<td>TV procedure</td>
<td>8 (4)</td>
</tr>
<tr>
<td>Others</td>
<td>21 (13 )</td>
</tr>
</tbody>
</table>
# Early Postoperative Outcomes

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early mortality</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Bleeding</td>
<td>8 (2.4)</td>
</tr>
<tr>
<td>CVA/TIA</td>
<td>6 (1.8)</td>
</tr>
<tr>
<td>Prolonged ventilation</td>
<td>9 (2.6)</td>
</tr>
<tr>
<td>Early AV re-intervention</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Re-repair</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Replacement</td>
<td>2 (0.5)</td>
</tr>
</tbody>
</table>
Survival Versus Matched U.S. Population

Survival (%)

0 20 40 60 80 100

Years

0 5 10 15

Cardiac – 98%, 95% and 91%

Observed

Expected

P = 0.5
## Predictors Late Mortality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Univariate</th>
<th></th>
<th></th>
<th>Multivariate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>P</td>
<td>OR (95% CI)</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Age (per 5 yr)</td>
<td>1.3 (1.2 – 1.5)</td>
<td>&lt;0.001</td>
<td>1.3 (1.2 – 1.5)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>EF (per 5%)</td>
<td>0.7 (0.6 – 0.8)</td>
<td>&lt;0.001</td>
<td>0.8 (0.7 – 0.9)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>LVESD (per 5 mm)</td>
<td>1.2 (1.1 – 1.2)</td>
<td>&lt;0.001</td>
<td>1.5 (1.2 – 1.8)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Bicuspid valve</td>
<td>0.2 (0.1 – 0.5)</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NYHA class III/IV</td>
<td>1.9 (1.1 – 3.2)</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EF &lt; 50%</td>
<td>3.5 (2.1 – 5.8)</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVESD &gt; 50mm</td>
<td>2.1 (1.1 – 4.1)</td>
<td>0.036</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Late Survival by Preoperative EF

Survival (%) vs Years

- EF > 50%
- EF ≤ 50%

P < 0.001

HR = 3.5

Years

Survival (%)

0 100
20 80
40 60
60 40
80 20
100 0

271 166 96
51 35 17
Late Survival by Preoperative LVESD

Survival (%) over Years

- LVESD < 50 mm
- LVESD ≥ 50 mm

P < 0.001
HR = 2.1

Years

0 5 10

Survival (%)

0 20 40 60 80 100

Patients:
- LVESD < 50 mm: 300
- LVESD ≥ 50 mm: 17

Follow-Up:
- LVESD < 50 mm: 183
- LVESD ≥ 50 mm: 14
Freedom from Aortic Valve Reoperation

Severe preoperative AR  HR 1.99 P=0.04
>Mild AR at Dismissal  HR 5.87 P=<0.0001
Freedom from > Moderate Aortic Regurgitation

Free from > Moderate AR (%)

87%
77%
62%

Years
0 5 10 15
327 140 62 11
### Valve Related Events by Pathologic Groups

<table>
<thead>
<tr>
<th></th>
<th>Annular Dilation (n = 77)</th>
<th>Bicuspid (n = 133)</th>
<th>Tricuspid Prolapse (n = 96)</th>
<th>Perforation (n = 23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic reoperation (%)</td>
<td>10 (13)</td>
<td>12 (9)</td>
<td>17 (18)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Time to Reop (yr)</td>
<td>2.6</td>
<td>7.7</td>
<td>5.3</td>
<td>5.0</td>
</tr>
<tr>
<td>AR &gt; Moderate</td>
<td>13 (17)</td>
<td>13 (10)</td>
<td>23 (24)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Death</td>
<td>23 (28)</td>
<td>6 (4.5)</td>
<td>25 (26)</td>
<td>4 (17)</td>
</tr>
<tr>
<td>Valve events (bleeding, CVA, Endocarditis)</td>
<td>7 (9)</td>
<td>5 (4)</td>
<td>9 (9)</td>
<td>0</td>
</tr>
<tr>
<td>Warfarin</td>
<td>23 (30)</td>
<td>21 (16)</td>
<td>23 (24)</td>
<td>4 (17)</td>
</tr>
</tbody>
</table>
Conclusions

• Aortic valve repair safe – 0.6% early mortality
  • Bicuspid – 0%

• Normalizes late survival

• Freedom from aortic reoperation and valve-related events comparable to bioprosthetic devices

• Predictors improved survival: preserved EF, smaller LVESD and younger age

• Mortality risk increases 3 fold with EF ≤50% and 2 fold with LVESD >50mm
Clinical Implications

• Aortic valve repair - young patients prior to the onset of LV ES dilation or dysfunction

• Bicuspid valves, cusp perforation and young patients with leaflet prolapse clearly benefit

• Advantage in older patients with poor tissue quality or cusp degeneration remains unclear
Division of Cardiovascular Surgery