Aortic valve repair vs valve replacement

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In aortic insufficiency: shall we repair or replace the aortic valve?

- Is the valve repairable? (e.g. calcification, multi-fenestration)
- Are benefits of native valve preservation proven?
- Provide a physiological functioning aortic valve
- How relevant is valve pathology (e.g. bicuspid, annular dilatation,)
- Can we avoid anticoagulation?
- How should we measure outcomes? (e.g. survival, echo, patient reported, cost)
- Can we ensure the treatment is compatible with patient demographics? (e.g. age, level of activity)
- Do we need to avoid re-operation?
- Is the valve repairable?
Outline of presentation

• What the Guidelines for AR management say?
• What are the challenges?
• What are the techniques of AV repair?
• How should we measure outcome?
• Do different patient groups affect outcome?
Indications for Aortic Valve Replacement for Chronic Aortic Regurgitation

Current guidelines do not incorporate AV repair
Challenges in making conclusions from current studies

• Paucity of comparative groups/studies
  • There are no two patient groups/valvular pathologies are not the same
  • Researchers avoid comparing apples and oranges
• AV repair mostly limited to highly specialised centres
• Heterogeneity of patient population: congenital vs acute vs elderly
• Lack of objective reporting
  • Echocardiographic: LV remodelling
  • Patient reported outcomes
Heterogeneity of target populations

Congenital
- Monocuspid
- Bicuspid
- Connective tissue disease
- Supra-aortic stenosis

Acquired
- Acute aortic dissection
- Infective endocarditis
- Redo cases
- Degenerative cusp
More than half a century ago, the first mitral valve procedure was performed to correct a leaking valve under open heart conditions (McGoon, 1960).

Initial technique based on leaflet corrections alone.

Mitral valve repair today calls for a combination of:
- leaflet correction
- annular procedures
- implantation of an annuloplasty device.

Mitral repair is now gold standard for treatment of MR.
### Functional classification of aortic root/valve abnormalities and their correlation with etiologies and surgical procedures

**El Khoury 2005**

**Current opinion in Cardiology**

<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>la</td>
<td>la</td>
<td>la</td>
<td>la</td>
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<td>lb</td>
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**Mechanism**

- **Aim of repair**
  - To restore matching between cusps and AV orifice
  - To create an optimal coaptation, stable over time

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

<table>
<thead>
<tr>
<th>Repair Techniques (Secondary)</th>
<th>SCA</th>
<th>STJ Annuloplasty</th>
<th>SCA</th>
<th>SCA</th>
<th>SCA</th>
</tr>
</thead>
</table>
Expert guidance on specific repair strategies:

<table>
<thead>
<tr>
<th>Type</th>
<th>Type 1a</th>
<th>Type 1b</th>
<th>Type 1c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of disease</td>
<td>STJ</td>
<td>Root</td>
<td>Annulus</td>
</tr>
<tr>
<td>Therapy</td>
<td>Ascending aorta replacement</td>
<td>Valve sparing root replacement</td>
<td>Annuloplasty</td>
</tr>
</tbody>
</table>
Expert guidance on specific repair strategies:

Type 1D AR: cusp perforation (no cusp prolapse or restriction)

Surgical therapy: patch repair techniques e.g. bovine/autologous pericardial patch
**Type 2 AR: cusp prolapse**

**Type 2 lesions (prolapse)**
- Free margin elongation
- Fenestration (large/ruptured)
- Commisure disruption

**Repair technique**
- Central plication/GTx resuspension
- GTx resuspension/ Patch
- Trusler stitch

**Expert guidance on specific repair strategies:**
Type 3 AR: restrictive cusp motion

### Type 3 lesions (restrictive)

<table>
<thead>
<tr>
<th>Repair techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Raphe in BAV</td>
</tr>
<tr>
<td>• Unicuspid valve</td>
</tr>
<tr>
<td>• Calcification</td>
</tr>
<tr>
<td>• Resection/direct closure/patch</td>
</tr>
<tr>
<td>• Patch</td>
</tr>
<tr>
<td>• Leaflet replacement with patch</td>
</tr>
</tbody>
</table>
How should we measure outcomes?

<table>
<thead>
<tr>
<th>Authors</th>
<th>Period</th>
<th>Cohort</th>
<th>Technique</th>
<th>FF AV Reop</th>
<th>FF recurrent AR &gt;2+</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. Schaff JTCVS 2014</td>
<td>1986-2011</td>
<td>331</td>
<td>Cusp 100% Sparing 0%</td>
<td>10 y 80%</td>
<td>10 y 75%</td>
</tr>
<tr>
<td>T. Kunihara JTCVS 2012</td>
<td>1995-2007</td>
<td>640</td>
<td>Cusp 80% Sparing 50%</td>
<td>10 y 88%</td>
<td>10 y 80%</td>
</tr>
<tr>
<td>J. Price ATS 2013</td>
<td>1995-2010</td>
<td>475</td>
<td>Cusp 68% Sparing 50%</td>
<td>10 y 86%</td>
<td>10 y 85%</td>
</tr>
<tr>
<td>T. David JTCVS 2014</td>
<td>1988-2010</td>
<td>371</td>
<td>Cusp 50% Sparing 100%</td>
<td>10 y 97%</td>
<td>10 y 93%</td>
</tr>
</tbody>
</table>

Recurrence impacts patient functional class
Re-operation has significant burden on patient quality of life
But most of these studies mainly root pathology
Recent Meta-Analysis by our group...

- Only root papers, repair vs replacement
- 34 studies, years 2003-2018, 7,313 patients (2,944 valve sparing, 4,369 Bentall)
- Valve sparing favoured for both operative mortality and 5-year survival
- Reoperation rates: no difference between repair and replacement groups
How can we select groups for comparison?

- Aortic root pathologies excluded i.e. focus on aortic valve only
- Propensity matched 44 vs 44
- Direct comparison of AV repair vs replacement in AR
- 85% trileaflet, 15% bicuspid

- Improved overall survival in repair group 87 vs 60% (p<0.05)
- Re-operation rate 8% vs 2% (higher in repair group but non-significant)
Valve repair improves the outcome of surgery for chronic severe aortic regurgitation: A propensity score analysis

Christophe de Meester, MS, MD, PhD, a,b Agnès Pasquet, MD, PhD, a,b Bernhard L. Gerber, MD, PhD, a,b David Vancraeynest, MD, PhD, a,b Philippe Noirhomme, MD, a,c Gébrine El Khoury, MD, a,c and Jean-Louis J. Vanoverschelde, MD, PhD a,b

• AV repair acceptable rate of re-operation (8% at 9 years)
Bicuspid valves: a patient group requiring its own attention

Siever’s Classification of BAV

<table>
<thead>
<tr>
<th>main category: number of raphes</th>
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</thead>
<tbody>
<tr>
<td>0 raphe - Type 0</td>
</tr>
<tr>
<td>1 raphe - Type 1</td>
</tr>
<tr>
<td>2 raphes - Type 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1. subcategory: spatial position of cusps in Type 0 and raphes in Types 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>lat</td>
</tr>
<tr>
<td>13 (4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. subcategory:</th>
</tr>
</thead>
<tbody>
<tr>
<td>V A L V U L A R</td>
</tr>
<tr>
<td>FUNCTION</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>B (i + S)</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

|                                  | 1 (0.3)                             | 15 (5)    | 7 (2)     | 2 (1)     | 2 (1)         |
Mayo clinic experience

Repair of the bicuspid aortic valve: A viable alternate replacement with a bioprosthesis

Elena Ashikhmina, MD, PhD, Thoralf M. Sundt III, MD, Joseph A. Dear, Heidi M. Connolly, MD, Zhuo Li, MS, and Hartzell V. Schaff, MD

- Equivalent survival
- Reoperation rate not significantly higher in repair group
What repair factors are predictors of recurrence?

• COAPTATION HEIGHT

• De Waroux 2009 and Aicher 2011:

• lower coaptation height is a predictor of higher AR recurrence
Predictors of reoperation rate

- Aicher 2011
- Lower coaptation height is a predictor of AR recurrence and reoperation
AV repair: BAV vs TAV (freedom from re-operation)

- Does valve pathology affect outcome?
  - BAV
    - 84% (7 y) Casselman JTVCS 1999
    - 81% (10y) Aicher EJCTS 2010
    - 81% (10y) Price ATS 2013
  - Trileaflet
    - 94% (12y) David JTCVS 2010
    - 93% (10y) Aicer EJCTS 2010
    - 89% (10y) Price ATS 2013

- Most studies show longer durability with trileaflet repairs compared to bicuspid repairs
- There are no comparative studies comparing BAV and TAV repairs with matched cohorts
AV repair: Type 1&2 vs Type 3

Does valve pathology affect outcomes?

Higher recurrence if type 3 (restrictive) pathology

M. Boodhwani, JTCVS 2009

? Due to patch material

M. Boodhwani, JTCVS 2010
Can newer technologies impact outcomes?

Circumferential prosthetic annuloplasty (for type 1C)
1. Partial external band
2. External ring
3. Suture annuloplasty
4. Internal ring
Internal ring - HAART ring

- **Material**: computermilled from one-piece Titanium blocks and covered with a thin layer of Dacron cloth to promote rapid endothelialization.

- **Design**: Base geometry of the ring is elliptical with a 2:3 minor-to-major diameter ratio and three equidistant subcommissural posts that flare 10° outward.

- **Rationale**: The ring is based on the concept that the permanent restoration of normal annular circumference and elliptical shape will facilitate the quality of valve repair in tri-leaflet aortic valves.

Phase 1 trial 2013
Multicentre trial 2015 – 65 patients
Geometric ring annuloplasty as an adjunct to aortic valve repair: clinical investigation of the HAART 300 device


- June 2015: multicentre trial, trileaflet AV insufficiency
- 65 patients, zero operative mortality
- 7 re-operations (early repair failures)
- 95% survival at 3 years
- preoperative AI grade (0–4) was 2.9 ± 0.8 and improved after repair to 0.6 ± 0.7 (P < 0.0001)
Does patient population affect outcome?

Repair or replace in acute aortic dissection?

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Cohort</th>
<th>Groups</th>
<th>30 d mortality</th>
<th>Overall survival</th>
<th>Freedom from reop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beckman</td>
<td>2016</td>
<td>119</td>
<td>David b/m. Bentall</td>
<td>12.8% 32/22%</td>
<td>84.1% 61/61%</td>
<td>95.2% 100/92.5%</td>
</tr>
<tr>
<td>Rylski (all BAV)</td>
<td>2015</td>
<td>66</td>
<td>Resuspen. Replace.</td>
<td>15.4% 15.1%</td>
<td>68% 65%</td>
<td>NS</td>
</tr>
<tr>
<td>Skripochnik</td>
<td>2013</td>
<td>70</td>
<td>VSRR Bentall</td>
<td>8% 13.3%</td>
<td>92% 79%</td>
<td>100% unreported</td>
</tr>
<tr>
<td>Subramanian</td>
<td>2012</td>
<td>208</td>
<td>David/Yacou Bentall</td>
<td>16/15% 27%</td>
<td>65/80% 66%</td>
<td>NS</td>
</tr>
<tr>
<td>Yang</td>
<td>2018</td>
<td>135</td>
<td>David Bentall</td>
<td>3% 13%</td>
<td>98% 57%</td>
<td>100% 98%</td>
</tr>
</tbody>
</table>

- All studies demonstrating equivalent freedom from recurrence and re-operation
- Most studies showing survival not worse after repair of valve vs replacement
- Two studies (Beckman and Yang) showing improved overall survival in repair groups (although groups were younger)
Does patient population affect outcome?

Repair vs replace in infective endocarditis

- Schafers group 2011
- Active native valve endocarditis
- N = 33 repair vs 67 replacement
- Repair group demonstrated:
  - Improved survival in repair group
  - Lower re-operation rate (due to re-endocarditis)
- Predictors of late failure in repair group
  - Bicuspid pathology
  - Use of large pericardial patches
Other outcomes to consider: quality of life

- Zacek et al 2016 N=139
- Aicher et al 2011
- Three groups: i) repair, ii) mechanical AVR, iii) Ross
- VSRR used as AV repair model
- Mostly young patients
- Short Form Health Survey’s used
- Follow up times varied (3-24 months Zacek study, 1-6 years Aicher study)

- Repair and Ross groups had better physical and anxiety related QOL outcomes than mechanical AVR groups
- Both studies attributed this to anticoagulation
- Improved QOL compared to age-matched population: readjustment after coping with major life event (cardiac surgery)
Cost effectiveness of AV repair?

• No studies reporting improved cost effectiveness at present

• Future studies should account for:
  • cost of prosthesis
  • Hospital stay
  • Return to work for patient
  • Cost of re-operation/valve related complications

• Sample studies have compared TAVR with SAVR
  • TAVR was projected to provide a lifetime gain of 0.32 quality-adjusted life-years ([QALY]; 0.41 LY with 3% discounting.
  • Lifetime incremental cost-effectiveness ratios were $55,090 per QALY gained and $43,114 per LY gained.
Does the outcome depend on the performance centre?

- AV repair is considered a specialised treatment
- Momentum gained only in last 2 decades
- Research output and operative practice still concentrated in centres where pioneers developed its techniques

- AV repair is reproducible, learning curve approx. 40-60 cases
- Efficacy consistent over the period of training
- Safety and efficiency improves as more cases are performed
  - Lesser safety incidents, improved x clamp time
Conclusions

Repair or replace?

• Treatment of aortic insufficiency should not be dealt with using a “one size for all” policy
• In good hands, AV repair can provide equivalent survival, haemodynamic and functional outcomes for young patients as prosthetic valves
• In valve sparing root replacement with AI – re-suspension of valve commisures is the durable technique
• Outcomes for repair in trileaflet valves are currently more favourable than bicuspid
• In infective endocarditis, opting for repair can reduce the chances of re-endocarditis compared with introducing a prosthesis
• Repair in aortic dissection can convey equivalent or improved survival outcomes in the right patients
• Mechanical prosthesis and anticoagulation have a measurable negative effect on outcome and QOL – hence repair should be seriously considered as a viable alternative if valve longevity is required
• AV repair is limited to specialised centres: Improved pathways for training surgeons in aortic valve repair is needed, if this technique is to enter the cardiac surgeon’s armamentarium
• Larger comparative studies required
  • varying sub-groups
  • novel outcome measures