Results of Aortic Valve Preservation and Repair

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Institutional experience in AV preservation and repair

- Study cohort: 475 consecutive patients
  - Elective AV repairs (1995-2010)

- Postoperative management:
  - Hospitalisation: low dose of LMWH, Aspirin not systematically, Coumadin for other indication than AV repair,
  - FU: antiplatelet and anticoagulation at discretion of referent cardiologist

- Mean FU 5 years, 98% complete, 93% TT echo
## Patients characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>n=475</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>53 ± 16.1</td>
</tr>
<tr>
<td><strong>Male sex</strong></td>
<td>386 (81.1%)</td>
</tr>
<tr>
<td><strong>NYHA class</strong></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>187 (39.4%)</td>
</tr>
<tr>
<td>II</td>
<td>208 (43.8%)</td>
</tr>
<tr>
<td>≥ III</td>
<td>79 (16.6%)</td>
</tr>
<tr>
<td><strong>Prior Cardiac Surgery</strong></td>
<td>47 (10%)</td>
</tr>
<tr>
<td><strong>Indication for surgery AR</strong></td>
<td></td>
</tr>
<tr>
<td>Aortic aneurism</td>
<td>91 (19%)</td>
</tr>
<tr>
<td>AR + aortic aneurism</td>
<td>218 (46%)</td>
</tr>
<tr>
<td>other</td>
<td>3 (1%)</td>
</tr>
<tr>
<td><strong>Grade of AR 0 – 1+</strong></td>
<td></td>
</tr>
<tr>
<td>2+</td>
<td>109 (22%)</td>
</tr>
<tr>
<td>3+</td>
<td>275 (58%)</td>
</tr>
<tr>
<td><strong>AV morphology</strong></td>
<td></td>
</tr>
<tr>
<td>Bicuspid</td>
<td>163 (34.3%)</td>
</tr>
<tr>
<td>Tricuspid</td>
<td>307 (64.6%)</td>
</tr>
<tr>
<td>Quadricuspid</td>
<td>5 (1.1%)</td>
</tr>
<tr>
<td><strong>LVEF &gt;50%</strong></td>
<td>420 (88.4%)</td>
</tr>
</tbody>
</table>
The Functional Aortic Annulus
Pathophysiology of AR

- FAA Pathology: Dilation
- Cusp Pathology: Prolapse or Restriction
Classification of Aortic Insufficiency

- Apply to all anatomic subtypes of AI
- Provide a standard communication tool between cardiologists, surgeons, anesthesiologists
- Guide the potential surgical treatment
- Assess the long-term efficacy of different types of surgical repair
Repair-Oriented Classification of Aortic Insufficiency

<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>Ic</td>
</tr>
<tr>
<td>Mechanism</td>
<td><img src="image1" alt="Image of Type Ia mechanism" /></td>
<td><img src="image2" alt="Image of Type Ib mechanism" /></td>
<td><img src="image3" alt="Image of Type Ic mechanism" /></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</td>
</tr>
<tr>
<td></td>
<td>STJ remodeling</td>
<td>Aortic Valve sparing: Reimplantation or Remodeling with SCA</td>
<td>SCA</td>
</tr>
<tr>
<td></td>
<td>STJ remodeling</td>
<td>Patch Repair Autologous or bovine pericardium</td>
<td>SCA</td>
</tr>
<tr>
<td></td>
<td>STJ remodeling</td>
<td>Prolapse Repair Plication Triangular resection Free margin Resuspension Patch</td>
<td>SCA</td>
</tr>
<tr>
<td></td>
<td>STJ remodeling</td>
<td>Leaflet Repair Shaving Decalcification Patch</td>
<td>SCA</td>
</tr>
<tr>
<td></td>
<td>STJ remodeling</td>
<td>SCA</td>
<td>SCA</td>
</tr>
</tbody>
</table>

STJ – Sino-tubular Junction; SCA – Sub-Commissural Annuloplasty

JTCVS 2009;137:286-94
Fundamental Principles of Valve Repair

- Preserve or restore normal motion

- Create a large surface of coaptation

- Remodel and stabilize the annulus

Leaflets

Close functional relationship (functional unit)
Fundamental Characteristics of Functional Unit

- **Leaflet motion**
  - Relationship between:
    - New Free Margin Length (FML) = Motion Insertion Length (IL)
    - Optimal for tricuspid > bicuspid > unicuspid

- **Coaptation**
  - New Free Margin = shorter than Both Individual leaflet margins

- **Annulus**
  - The annuloplasty should have an “selective “effect on the anterior part !!! The posterior fibrosis easily moldable!!!
Fundamental Characteristics of Functional Unit

Leaflet motion and AVJ

Leaflet motion

Reduction of AVJ, annuloplasty, improve motion with compensates «gradient risk» mainly in BAV

Coaptation

Leaflet motion and STJ:

Dilation: restrictive motion

Annulus

Overreduction: excess motion and prolaps

Small prosthesis or prosthesis not respecting the spatial commissural configuration
Fundamental Characteristics of Functional Unit

**Coaptation**: mid-sinus height, into aortic root

**Leaflet motion**

Reserve of coaptation:
bigger the reserve, more the dilatation needed to induce AR

**Coaptation**

Coaptation should usually be at the level of the free margin, instead of the body of the leaflet without free margin contact

→ OVERSHORTENING !!!
Type Ia repair : Sino-tubular junction remodeling

Sino-tubular junction dilatation
Type Ib repair: Aortic root reimplantation

- Aortic root aneurysm
- Deep Root Dissection
- Proximal Suture Placement
- Prosthesis Sizing
- Prosthesis Scalloping
- Final Result
Type II repair

Cuspal prolapse

Triangular Resection

Central Plication

Free-edge Reinforcement
Type Ia + II repair

- Valve Analysis
- Subcommissural Annuloplasty
- Central Plication
- Prosthesis Implantation
Type Ib + II repair
The primary goal of aortic valve repair is to restore a functional surface of coaptation.

1. Repair or preserve the leaflet tissue
2. Restore and stabilize the proximal and distal borders of the native stent (the FAA)
# Operative techniques

<table>
<thead>
<tr>
<th></th>
<th>n=475</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic cusp repair</td>
<td>13 (3%)</td>
</tr>
<tr>
<td>Subcommissural annuloplasty</td>
<td>22 (5%)</td>
</tr>
<tr>
<td>Aortic cusp repair + SCA</td>
<td>124 (26%)</td>
</tr>
<tr>
<td>Asc Ao replacement</td>
<td>79 (17%)</td>
</tr>
<tr>
<td>+ SCA</td>
<td>68 (86%)</td>
</tr>
<tr>
<td>+ Aortic cusp repair</td>
<td>34 (43%)</td>
</tr>
<tr>
<td>Valve sparing Root replacement</td>
<td>235 (50%)</td>
</tr>
<tr>
<td>Remodeling technique</td>
<td>48 (20%)</td>
</tr>
<tr>
<td>Reimplantation technique</td>
<td>187 (80%)</td>
</tr>
<tr>
<td>VSRR + Aortic cusp repair</td>
<td>154 (65%)</td>
</tr>
<tr>
<td>Introperative AV re-exploration</td>
<td>26 (2.2%)</td>
</tr>
<tr>
<td>Concomitant procedures</td>
<td>149 (31.3%)</td>
</tr>
<tr>
<td>ACC time (min)</td>
<td>95.4 ± 39.9</td>
</tr>
<tr>
<td>CPB time (min)</td>
<td>114.2 ± 62.1</td>
</tr>
</tbody>
</table>

- MV plasty 65 (44%)
- CABG 53 (36%)
- TV repair 15 (10%)
- Ao Arch replac 13 (8.7%)
- MV replac 8 (5%)
- PFO closure 8 (5%)
- AF ablation 5 (3%)
- Dor operation 3 (2%)
- LA myxoma 3 (2%)
- VSD closure 2 (1%)
<table>
<thead>
<tr>
<th>Variable</th>
<th>n=475</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital mortality</td>
<td>4 (0.8%)</td>
</tr>
<tr>
<td>AV reoperation</td>
<td>7 (1.5%)</td>
</tr>
<tr>
<td>Permanent pacemaker insertion</td>
<td>13 (2.7%)</td>
</tr>
<tr>
<td>Stroke</td>
<td>5 (1.1%)</td>
</tr>
<tr>
<td>TIA</td>
<td>3 (0.6%)</td>
</tr>
</tbody>
</table>
Results: Survival

At 10 years:
- Valve related death: 90%±3%
- Cardiac death: 80%±4%
- Overall Survival: 73%±4%
Results: Structural valve dysfunction

At 10 years:
85%±3%
Results: AV reoperation (n=28)

No mortality

At 10 years:
86%±3%
Results: AV reoperation (n=28)

At 10 years:
- Bicuspid: 81%
- Tricuspid: 89%

Pts at risk:
- Bicuspid: 163, 101, 81, 51, 26, 10
- Tricuspid: 312, 217, 140, 83, 44, 24

p-value: 0.21
Outcomes in Different AI types

Freedom from AI > 2+

HR = 2.6 [1.1 - 11.6]

p = 0.03

Patients at risk:

<table>
<thead>
<tr>
<th>Months</th>
<th>Type I/II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>159</td>
<td>39</td>
</tr>
<tr>
<td>12</td>
<td>125</td>
<td>26</td>
</tr>
<tr>
<td>24</td>
<td>97</td>
<td>19</td>
</tr>
<tr>
<td>36</td>
<td>70</td>
<td>11</td>
</tr>
<tr>
<td>48</td>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td>60</td>
<td>39</td>
<td>26</td>
</tr>
</tbody>
</table>

5 years:

Type I/II: 90 ± 9%
Type III: 79 ± 14%
Results: AV replacement

8 AV re-repairs

At 10 years:

90% ±3%
Results: TE event (n=23)

9 TIA
14 strokes, no death, 11 (78%) full recovery
10 (44%) context of AF

At 10 years:
90%±3%

Linearized rate:
1.1% / year
(late TE event 0.7%/year)
Results: Bleeding event (n=5)

3 gastrointestinal
1 cerebral bleeding after AV replacement by mechanical prosthesis
1 abdominal wall

At 10 years:
98%±1%

Linearized rate:
0.23 % / year
Results: Endocarditis (n=4)

2 antibiotics only
2 surgery needed (AVR with homograft & re-repair)

At 10 years:
98% \pm 1%

Linearized rate:
0.19 % / year
## Results

<table>
<thead>
<tr>
<th>NYHA:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>80%</td>
<td>(336)</td>
</tr>
<tr>
<td>Class II</td>
<td>19%</td>
<td>(78)</td>
</tr>
<tr>
<td>Class III</td>
<td>0.5%</td>
<td>(2)</td>
</tr>
<tr>
<td>Class IV</td>
<td>0.5%</td>
<td>(2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cardiac rhythm:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>89%</td>
<td>(384)</td>
</tr>
<tr>
<td>AF</td>
<td>4.5%</td>
<td>(19)</td>
</tr>
<tr>
<td>PM</td>
<td>6.5%</td>
<td>(28)</td>
</tr>
</tbody>
</table>

## Antiplatelet – anticoagulation:

- None: 26% (108)
- Aspirin or (Clopidogrel): 65% (269)
- Coumadin (or LMWH): 8% (33)
- Aspirin + Coumadin: 1% (5)
Supracoronal Ascending Aortic Aneurysms
(Type 1A)
Freedom from AV Reoperation

No. at risk:

- 0 months: 55
- 24 months: 41
- 48 months: 28
- 72 months: 10
- 96 months: 3

Months:

- 0
- 24
- 48
- 72
- 96
Aneurysm Involving the Aortic Root (Type 1b)
Freedom from AV Reoperation - Replacement

- AV reoperation
- AV replacement

8 years

93±5%
90±7%

Patients at risk: 164 122 87 53 33 18
Cusp Prolapse Repair
(Type 2)
Freedom from AV Reoperation

<table>
<thead>
<tr>
<th>Years</th>
<th>Isolated</th>
<th>Associated</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50</td>
<td>61</td>
</tr>
<tr>
<td>2</td>
<td>43</td>
<td>56</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

No. at risk

- Isolated: 50, 43, 30, 18, 11, 7, 7
- Associated: 61, 56, 35, 17, 7, 4

8 years

- Isolated: 100%
- Associated: 93 ± 4%
Bicuspid Aortic valve

- Between 1995-2010: **161 elective BAV repairs**

- Type of FAA annuloplasty:
  - No annuloplasty (cusp repair only) $n=5$
  - SCA $n=48$
  - Asc ao replacement ± SCA $n=17$
  - Root Remodeling ± SCA $n=17$
  - Valve sparing Reimplantation $n=74$
Overall Survival

No. at risk:

- 0 months: 119
- 24 months: 93
- 48 months: 68
- 72 months: 41
- 96 months: 20

Survival rate at 8 years: 97 ± 2%
Freedom from Aortic Valve Reoperation

No. at risk:
- AV Reoperation: 122, 92, 68, 41, 20
- AV Replacement: 92, 68, 41, 20

Months:
- 0, 24, 48, 72, 96

%:
- AV Reoperation: 100 %
- AV Replacement: 94 ± 2 %, 90 ± 5 %
- Late AV Reoperation: 98 ± 2 %, 87 ± 5 %

5 years:
- AV Reoperation: 94 ± 2 %
- AV Replacement: 96 ± 2 %
- Late AV Reoperation: 98 ± 2 %

8 years:
- AV Reoperation: 83 ± 5 %
- AV Replacement: 90 ± 5 %
- Late AV Reoperation: 87 ± 5 %
Thromboembolism and Bleeding

8 years

96 ± 2%

No. at risk

119  93  68  41  20
Freedom from Recurrent Aortic Insufficiency (>2+)

<table>
<thead>
<tr>
<th>Months</th>
<th>No. at risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>115</td>
</tr>
<tr>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>24</td>
<td>85</td>
</tr>
<tr>
<td>36</td>
<td>69</td>
</tr>
<tr>
<td>48</td>
<td>59</td>
</tr>
<tr>
<td>60</td>
<td>44</td>
</tr>
<tr>
<td>72</td>
<td>31</td>
</tr>
</tbody>
</table>

5 years

94 ± 3%
Aim of the study

To assess the role of VAJ in BAV repair

→ Retrospective patient-matched comparison

Group 1

No VAJ annuloplasty, or subcommissural annuloplasty (SCA)

Non-circumferential VAJ annuloplasty

Group 2

Valve sparing root replacement with the Reimplantation technique

Circumferential VAJ annuloplasty
Overall survival

- Group 1: 98±3%
- Group 2: 98±3%

No. at risk
Group 1: 53, 50, 42, 39, 31, 26, 23, 19, 14
Group 2: 53, 42, 30, 26, 23, 15, 10, 6, 3

p=0.9
6 years
Freedom from BAV reoperation

<table>
<thead>
<tr>
<th>Months</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>12</td>
<td>46</td>
<td>42</td>
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<tr>
<td>24</td>
<td>37</td>
<td>30</td>
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<tr>
<td>36</td>
<td>35</td>
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<td>48</td>
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<td>23</td>
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<tr>
<td>60</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>72</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>84</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>96</td>
<td>13</td>
<td>3</td>
</tr>
</tbody>
</table>

No. at risk

Group 1      53        46        37         35         29        24         21        17         13
Group 2      53        42        30         26         23        15         10          6           3

- Group 1: 90±8%
- Group 2: 100%

p=0.025

6 years
Freedom from AI ≥ 3+

- **Group 1**: 77±14%
- **Group 2**: 100%

6 years

*p=0.002*

No. at risk

<table>
<thead>
<tr>
<th>Months</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>53</td>
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<tr>
<td>12</td>
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<tr>
<td>84</td>
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<td>6</td>
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<tr>
<td>96</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>
Freedom from TE, bleeding or endocarditis

- Group 1: 95±6%
- Group 2: 90±10%

No. at risk
Group 1: 53 50 42 39 31 26 23 19 14
Group 2: 53 42 30 26 23 15 10 6 3

p=0.65
6 years
Conclusions

- Aortic valve repair is associated with low mortality, acceptable durability, and a low risk of valve-related complications.

- In this relatively young cohort of patient, AV repair seems to have low rate of TE and bleeding in comparison to mechanical valve.

- These data can aid in the decision making of repair versus replacement in patients eligible for AV repair. However, follow-up beyond 10 y is necessary to compare long term durability with tissues valve.
Thank you