Late results of aortic root repair & replacement

John Pepper

Imperial College and Royal Brompton Hospital, London, UK.
REPLACEMENT OF ASCENDING AORTA AND ROOT

Interposition graft

Valve sparing

VR + graft

Bentall button
## Marfan: Aortic Root Replacement


<table>
<thead>
<tr>
<th></th>
<th>No. of patients</th>
<th>30-day mortality</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective</td>
<td>235</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urgent</td>
<td>36</td>
<td>2</td>
<td>5.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>271</td>
<td>2</td>
<td>0.7</td>
</tr>
</tbody>
</table>


271 Marfan patients after ARR


Survival

Postoperative Year

89% 81% 76% 67%
Freedom from thromboembolism

Aortic valve repair in Marfan’s syndrome

- Valve conserving operations are feasible
- Early and long term results are encouraging
- Results are better in the absence of dissection
- Prophylactic operation is warranted in high risk patients
CMR of the aorta
Valve sparing

Reimplantation

Remodelling
Late results of valve sparing  
[Yacoub M. JTCS 1998; 115: 1080]

<table>
<thead>
<tr>
<th>Actuarial survival</th>
<th>1yr</th>
<th>5yrs</th>
<th>10yrs</th>
<th>15yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute dissection N=49</td>
<td>72.8</td>
<td>63.4</td>
<td>53.3</td>
<td></td>
</tr>
<tr>
<td>Ch. Aneurysm N=92</td>
<td>96.8</td>
<td>91.2</td>
<td>82.0</td>
<td>60.0</td>
</tr>
</tbody>
</table>
Valve sparing: acute vs. chronic


<table>
<thead>
<tr>
<th></th>
<th>Acute N=55</th>
<th>Chronic N=38</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preop. AR &gt; Grade 2</td>
<td>16 (29%)</td>
<td>14 (37%)</td>
<td>0.432</td>
</tr>
<tr>
<td>Preop. AR &gt; Grade 3</td>
<td>7 (13%)</td>
<td>11 (29%)</td>
<td>0.051</td>
</tr>
<tr>
<td>Replacement of aortic valve</td>
<td>4 (7%)</td>
<td>8 (21%)</td>
<td>0.051</td>
</tr>
<tr>
<td>Reop. on preserved valves</td>
<td>0/43</td>
<td>2/27 (7%)</td>
<td>0.077</td>
</tr>
</tbody>
</table>
Late results of AV sparing for ARA
[David TE. 2007]

• Era: 1988-2002
• 220 patients for Ao.Root Aneurysm (ARA)
• Mean age: 47 +/- 16; Mean FU: 5.2 yrs
• Aetiology: Marfan - 40%
  Type A Dissection - 12%
  Bicuspid AV - 6%
Late results of AV sparing for ARA

[David TE. 2007]

<table>
<thead>
<tr>
<th></th>
<th>1 year</th>
<th>5 years</th>
<th>10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF Death</td>
<td>97%</td>
<td>92%</td>
<td>88%</td>
</tr>
<tr>
<td>FF AVR</td>
<td>99</td>
<td>97</td>
<td>93</td>
</tr>
<tr>
<td>FF ¾ AR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remodel N=69</td>
<td>100</td>
<td>96</td>
<td>56</td>
</tr>
<tr>
<td>Reimplant N=151</td>
<td>99</td>
<td>97</td>
<td>93</td>
</tr>
</tbody>
</table>
### Durability of AV repair

[Cameron D. 2008 Johns Hopkins]

<table>
<thead>
<tr>
<th>Time</th>
<th>Bentall</th>
<th>Remodelling</th>
<th>Reimplantation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1yr</td>
<td>100%</td>
<td>97.4%</td>
<td>100%</td>
</tr>
<tr>
<td>5yr</td>
<td>95.8%</td>
<td>86.1%</td>
<td>100%</td>
</tr>
<tr>
<td>8yr</td>
<td>95.8%</td>
<td>86.1%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Aortic valve repair RBH 2000-2010

- 80 patients
- Average age 62.4 (28-79)
- 8 deaths all in Type A Dissection
### Aortic valve repair RBH
April 2000- April 2010

<table>
<thead>
<tr>
<th>Clinical</th>
<th>Marfan</th>
<th>Non-Marfan</th>
<th>Acute A Dissection</th>
<th>Chronic A Dissection</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>64</td>
<td>16</td>
<td>60</td>
<td>24</td>
</tr>
<tr>
<td>Operation</td>
<td>Remodelling</td>
<td>Remodelling</td>
<td>Resuspension</td>
<td>Resuspension</td>
</tr>
<tr>
<td>30-day</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Late 1-6yrs</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
## Marfan - ARR and valve sparing: meta-analysis [Angeloni E. 2010]

<table>
<thead>
<tr>
<th>Procedure</th>
<th>ARR</th>
<th>VSRR</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1021</td>
<td>413</td>
<td></td>
</tr>
<tr>
<td>F/U yrs</td>
<td>8.0</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Reintervention rate</td>
<td>0.3</td>
<td>1.3</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>[0.1-0.5]</td>
<td>[0.3-2.2]</td>
<td></td>
</tr>
<tr>
<td>T/E rate</td>
<td>0.7</td>
<td>0.3</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>[0.5-0.9]</td>
<td>[0.1-0.6]</td>
<td></td>
</tr>
<tr>
<td>Reimplantation Remodelling</td>
<td>0.7</td>
<td>2.4</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Repair of the bicuspid aortic valve

[Ashikhmina E. JTCS 2010; 139: 1395]
# BAV repair: freedom from reoperation

<table>
<thead>
<tr>
<th>Author</th>
<th>FU yrs</th>
<th>N</th>
<th>Age mean</th>
<th>1yr</th>
<th>5yr</th>
<th>10yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alsoufi</td>
<td>3.5</td>
<td>71</td>
<td>42</td>
<td>97</td>
<td>90</td>
<td>NA</td>
</tr>
<tr>
<td>Casselman</td>
<td>5.1</td>
<td>94</td>
<td>38</td>
<td>95</td>
<td>87</td>
<td>NA</td>
</tr>
<tr>
<td>Davierwala</td>
<td>2.6</td>
<td>44</td>
<td>39</td>
<td>95</td>
<td>91</td>
<td>NA</td>
</tr>
<tr>
<td>Fraser</td>
<td>2.0</td>
<td>72</td>
<td>39</td>
<td>94</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Kin</td>
<td>3.3</td>
<td>19</td>
<td>42</td>
<td>87</td>
<td>76</td>
<td>NA</td>
</tr>
<tr>
<td>Ashikhmina</td>
<td>5.1</td>
<td>108</td>
<td>42</td>
<td>96</td>
<td>89</td>
<td>49</td>
</tr>
</tbody>
</table>
Should VSRR be offered to BAV or severe AR?


<table>
<thead>
<tr>
<th></th>
<th>BAV</th>
<th>TAV</th>
<th>Mod/severe AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>11</td>
<td>51</td>
<td>40</td>
</tr>
</tbody>
</table>

Remodelling: 28 [27.5%]  
Reimplantation: 30 [29.4%]

5-year survival for all patients: 97.8 +/- 1.5%
Should VSRR be offered to BAV or severe AR?


<table>
<thead>
<tr>
<th></th>
<th>ALL</th>
<th>TAV + mild/mod AR</th>
<th>TAV + severe AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF reop. on AV</td>
<td>92%</td>
<td>100%</td>
<td>82 +/- 7.5%</td>
</tr>
<tr>
<td>FF from AR</td>
<td></td>
<td>73 +/- 7.7%</td>
<td>49.9 +/- 16.4%</td>
</tr>
</tbody>
</table>
A word of caution

- Aortic root replacement is the gold standard
- Valve sparing procedures are evolving
- Indications uncertain
- Learning curve
- Long-term antiplatelet therapy advised
- Risk of redo root replacement
Beauty in Nature gives Man’s senses the chance to be skilful

Bertolt Brecht
Repair of regurgitant BAV: a systematic approach

[Boodhwani M. JTCS 2010; 140: 276]

• 1995 – 2008
• N = 122
• Mean age 44 (+/-11)
• Elective repair:
  AR 43%
  ARD 14%
  Both 43%
Repair of regurgitant BAV: a systematic approach

[Boodhwani M. JTCS 2010; 140: 276]

<table>
<thead>
<tr>
<th></th>
<th>5 years</th>
<th>8 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td></td>
<td>97% +/- 3%</td>
</tr>
<tr>
<td>FF re-operation</td>
<td>94% +/- 2%</td>
<td>83% +/- 5%</td>
</tr>
<tr>
<td>FF AV repl.</td>
<td>96% +/- 2%</td>
<td>90% +/- 5%</td>
</tr>
<tr>
<td>FF t/e</td>
<td></td>
<td>96% +/- 2%</td>
</tr>
<tr>
<td>FF AR grade II</td>
<td>94% +/- 3%</td>
<td></td>
</tr>
</tbody>
</table>
Clinical and Echo outcomes after BAV repair

[Boodhwani M. JCTS 2010; 140: 276]
Aortic Wall Abnormalities in Coarctation

[Oliver JM. JACC 2004; 44: 1641]
Response to Glutaraldehyde preserved valves

- Three simultaneous processes
- Post-surgical wound healing
- Non-specific (foreign body) inflammation
- Immune-mediated rejection with associated inflammation
## Natural history of TAA


<table>
<thead>
<tr>
<th>Index cm/m²</th>
<th>Risk of rupture, dissection or death</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.75</td>
<td>4%</td>
</tr>
<tr>
<td>2.75 - 4.24</td>
<td>8%</td>
</tr>
<tr>
<td>&gt;4.25</td>
<td>20%</td>
</tr>
</tbody>
</table>
Views of the aortic valve
Aortic ring to standardise repair

[Lansac E. EJCTS 2010; 38: 147]
A systematic approach [Gebrine El Khoury 2010]

Aortic root size

<45mm

Aortic tissue quality

Good

Leaflet repair Sub-commissural annuloplasty

>45mm

Poor

Leaflet repair Root replacement
A systematic approach
[Gebrine El Khoury 2010]

Leaflet anatomy

- Quality of raphe
  - Calcified/restrictive
  - Raphe resection

- Fibrous/prolapsing
  - Raphe Preservation shaving

Leaflet tissue

- Pericardial patch
  - inadequate

- Primary approximation
  - adequate

Assessment and repair of prolapse
- Free margin plication
- Free margin resuspension
BAV

Indication for operation

Acceptable Morphology I + II

Ao.wall AA>45mm or Di >2.75 Dilated sinus

YES

1. BAV reimplantation
2. BAV repair + AA repl.
3. Bentall
4. BAVR + AA repl.

NO

1. Attempt BAVR
2. BAVR

Non-acceptable Morphology III

Ao.wall AA>45mm or Di >2.75 Dilated sinus

YES

1. Bentall
2. BAVR + AA repl.

NO

BAVR

FU 6-12mts
Stented Valve Mosaic

Stentless Valve Freestyle
Effective orifice area index (EOA index)

EOA index (cm$^2$/m$^2$)

*** overall p between groups <0.001

26% increase in EOA index stentless vs stented group
58% reduction in peak aortic gradient in the stentless vs stented group
Conclusions: CMR

- CMR has corroborated echo data using a much smaller sample
- CMR probably provides better estimation of these parameters
- CMR well tolerated
Failure model of Bio-prostheses

Cumulative survival of 40 year old after AVR

[Grunkemeier GL. J.Ht.Valve Dis. 1999; 8: 466]
Determinants of valve sparing

- Diagnosis
- Operation type
- Immediate post-op AR
- Threshold for reoperation
Survival

Actuarial Survival ($n = 82$)

Survival

1 yr = 93.2%
5 yr = 87.3%
10 yr = 84.3%

No at risk
1 yr = 65
5 yr = 34
10 yr = 17

Days post op
Actuarial Survival (n = 82)

Survival

Chronic Aneurysm

Chronic dissection

Acute dissection

Days post op

No at risk
1 yr = 65
5 yr = 34
10 yr = 17

1 yr 5 yr 10 yr
Asymptomatic vs. Symptomatic (n = 82)

Survival

Asymptomatic (n = 37)
Symptomatic (n = 45)

No at risk
1 yr = 65
5 yr = 34
10 yr = 17
Effect of pre operative B Blockade on survival

Survival

No at risk
1 yr = 65
5 yr = 34
10 yr = 17

B Blockers (n = 47)

No B Blockers (n = 35)
Factors influencing growth in dilated aortic segments

[Bonser RS. Heart 2000; 84: 283]

<table>
<thead>
<tr>
<th>Factor</th>
<th>Median difference</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrombus</td>
<td>1.56</td>
<td>0.78 – 2.45</td>
<td>0.001</td>
</tr>
<tr>
<td>TIA/stroke</td>
<td>2.10</td>
<td>0.57 – 3.70</td>
<td>0.002</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.89</td>
<td>0.17 – 1.70</td>
<td>0.01</td>
</tr>
<tr>
<td>PVD</td>
<td>0.82</td>
<td>0.01 – 1.88</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Aortic stenosis
Poor LV, Aortic stenosis, Previous MI (subendocardial mainly white arrows - but transmural at apex with apical thrombus - red arrow)
Poor LV, Aortic stenosis, Previous MI (–white arrows)
Late results of AV sparing for ARA
[David TE. JCTS 2006; 132: 347]

• Era: 1988-2002
• 220 patients for Ao.Root Aneurysm (ARA)
• Mean age: 47 +/- 16; Mean FU: 5.2 yrs
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  Type A Dissection - 12%
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[David TE. JCTS 2006: 132: 347]

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<th>5 years</th>
<th>10 years</th>
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<td>Remodel N=69</td>
<td>100</td>
<td>96</td>
<td>56</td>
</tr>
<tr>
<td>Reimplant N=151</td>
<td>99</td>
<td>97</td>
<td>93</td>
</tr>
</tbody>
</table>
Aortic valve repair RBH
2008-2010

• 41 patients
• Av age 51.6 [24-73]
• 3 deaths all in acute Type A dissection
# Aortic valve repair RBH 2008-2010

<table>
<thead>
<tr>
<th></th>
<th>Marfan</th>
<th>Non-Marfan</th>
<th>Acute A Dissection</th>
<th>Chronic A dissection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>16</td>
<td>4</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>Remodelling</td>
<td>Remodelling</td>
<td>Re-suspension</td>
<td>Re-suspension</td>
</tr>
<tr>
<td><strong>30-day Death</strong></td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Late re-op</strong></td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Surgical intervention criteria for thoracic aortic aneurysms

[Coady MA. Cardiol Clin 1999; 17: 827]
Aortic valve repair

- Bicuspid valve repair
- STJ tailoring
- Remodelling
- Reimplantation

- Commissure
- Leaflets
- Annulus
- SOV
- STJ