Atrioventricular Valve Regurgitation in Functional Single Ventricles

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Key Questions – AV Valve Regurgitation in Functional Single Ventricles

Is AV Valve regurgitation important?
Is repair Necessary?
Does Stage II Volume Unload the Ventricle?

Repair Tools
Video
Why is Single Ventricle Valve Regurgitation Important?

Valve Repair Fontan Stage

Valve Replacement

Imai Y. et al.; J Thorac Cardiovasc Surg 1997;113:262-269

Impact of BCPA on AVVR

AV Regurgitation moderate to severe - n=36/576

Time 0 = BCPA
Years: 1989-2000

The presence of significant AVVR before BCPA was not significantly associated with hospital survival or intermediate-term freedom from death or transplantation.

<table>
<thead>
<tr>
<th>Patient and Procedure-Related Variables</th>
<th>Hazard Ratio</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Later year of BCPA</td>
<td>0.81</td>
<td>0.75–0.87</td>
<td>&lt; 0.001$^b$</td>
</tr>
<tr>
<td>Significant AVVR</td>
<td>0.53</td>
<td>0.16–1.72</td>
<td>0.20</td>
</tr>
<tr>
<td>Valve morphology$^a$</td>
<td>1.07</td>
<td>0.81–1.41</td>
<td>0.49</td>
</tr>
<tr>
<td>Female gender</td>
<td>0.99</td>
<td>0.66–1.47</td>
<td>0.95</td>
</tr>
<tr>
<td>Age at BCPA</td>
<td>0.91</td>
<td>0.67–1.23</td>
<td>0.54</td>
</tr>
<tr>
<td>Prior Norwood procedure</td>
<td>1.25</td>
<td>0.68–2.30</td>
<td>0.46</td>
</tr>
<tr>
<td>Valvuloplasty</td>
<td>2.5</td>
<td>0.78–8.25</td>
<td>0.12</td>
</tr>
<tr>
<td>Heterotaxy</td>
<td>1.02</td>
<td>0.43–2.44</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Caveats

Moderate to Severe AVVR - n=36

6 had repair at BCPA
10 patients later had AVVR
16 – no leaflet pathology
6/16 (38%) improved

None of those with dysplasia improved

Followed just over 2 years

Is Volume Unloading with Stage II a Myth?

Qp:Qs - MRI Flows

Stage II: 0.93 ± 0.26
Stage III: 1.27 ± 0.16

Aortopulmonary Collaterals After Bidirectional Cavopulmonary Connection or Fontan Completion Quantification With MRI

Lars Grosse-Wortmann, MD; Abdulmajeed Al-Otay, MD; Shi-Joong Yoo, MD

Background—Aortopulmonary collaterals (APCs) have been associated with increased morbidity after the Fontan operation. We aimed to quantify APC flow after bidirectional cavopulmonary connections and Fontan completions, using phase-contrast MRI, and to identify risk factors for the development of APCs.

Methods and Results—APC blood flow was quantifiable in 24 of 36 retrospectively analyzed MRI studies. Sixteen studies were performed after the bidirectional cavopulmonary connections (group A) and 8 after the Fontan operation (group B). APC blood flow was calculated by subtracting the blood flow volume through the pulmonary arteries from that through the pulmonary veins. The ratio of pulmonary to systemic blood flow (Qp/Qs) was 0.93 ± 0.26 in group A and 1.27 ± 0.16 in group B. APC flow was 1.42 (0.58 to 3.83) L/min/m² and 0.82 (0.50 to 1.81) L/min/m² in groups A and B, respectively. The mean inaccuracies corresponded to 7.9 ± 14.5% and 7.1 ± 13.6% of ascending aortic flow in groups A and B, respectively. Qp/Qs was negatively correlated with a younger age at the time of the bidirectional cavopulmonary connections operation (r = 0.62, P = 0.01) and positively correlated with the age at the time of the Fontan completion (r = 0.81, P = 0.01). Patients with a previous right-sided modified Blalock-Taussig shunt had more collateral flow to the right lung than those without.

Conclusions—APC blood flow can be noninvasively measured in bidirectional cavopulmonary connections and Fontan patients, using MRI in the majority of patients and results in a significant left-to-right shunt. (Circ Cardiovasc Imaging. 2009;2:219-225.)
HLHS TV Morphology

• 12% - bileaflet
• 35% - moderate to severe dysplasia
• Abnormal Septal attachments accessory papillary muscles

Stamm, Anderson, Ho EJTCS 1997:12;587-592
HLHS TV Morphology

- Dysplasia of TV more common with mitral stenosis
- Mitral Atresia – septal concavity

Stamm, Anderson, Ho EJTC 1997:12;587-592
Carpentier Type I
Normal Leaflet Motion

- Annular Dilation

Carpentier Type II Prolapse

- Chordal Elongation
  - Edge to Edge/ Commissural Closure
  - Closure of Zone of Coaptation

Ando and Takahashi; Ann Thorac Surg 2007;84:1571-1577
Carpentier Type II Leaflet Prolapse

- Alfieri Approach

Clover Technique

Alfieri O. et al.; J Thorac Cardiovasc Surg 2003;126:75-79
Carpentier Type II Leaflet Prolapse

- Alfieri Approach

Clover Technique TV

Alfieri O. et al.; J Thorac Cardiovasc Surg 2003;126:75-79
**Edge to Edge vs Other**

49 Patients

- Common AVV – 26
- Tricuspid Valve -23

12% mortality

8 reoperations

Ando and Takahashi; Ann Thorac Surg 2007;84:1571-1577
Carpentier Type I
Normal Leaflet Motion

Leaflet Defect

Or type III restriction

Carpentier Type II
Leaflet Prolapse

- Chordal Elongation
  - Goretex Chordae
  - Chordal Transfer

Chordae at 12 Years

Sickkids – Almost all have Anatomic Problems

Cleft

Leaflet Dysmorphism

Local Annuloplasty
Edge to Edge for prolapse
Functional or actual commissuroplasty

Dysplastic Leaflet

Yanagawa – drawings – resident cardiovascular surgery
Timing of Repair

• Philosophy
  – Protect dilation of Ventricle

• Unusual Stage I
• Most Commonly Stage II
• Interstage
• Fontan
• Post Fontan
DORV – Absent Left AV Connection

2 Jets – Moderate Insufficiency
Cleft Closure, Edge to Edge, Local Annuloplasty
Postoperative Mild Regurgitation
CCTGA Mitral Atresia
Systemic Tricuspid Valve

Mild + Insufficiency
1st Do No Harm…….
Repair “TV” Valve – CCTGA and Mitral Atresia

1st do no harm!
Postoperative Findings

Took most of repair down – left a local annuloplasty

Patients (n)

10 yrs 1998-2008
422 – SV
13.7% (58) - AVV repair
Age at repair: 31+/-46 months
(med 6.8 months, 8 d - 17.4 yrs)
Primary mechanism of regurgitation

- Dysplasia: 35%
- Prolapse: 46%
- Annular dilatation: 15%
- Cleft: 2%
- Restriction: 2%
### Repair techniques

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Annuloplasty</td>
<td>85%</td>
</tr>
<tr>
<td>Partial Annuloplasty</td>
<td>96%</td>
</tr>
<tr>
<td>Artificial ring (3 cases)</td>
<td>4%</td>
</tr>
<tr>
<td>Commissuroplasty</td>
<td>54%</td>
</tr>
<tr>
<td>Valvuloplasty</td>
<td>22%</td>
</tr>
<tr>
<td>Chordal repair</td>
<td>4%</td>
</tr>
<tr>
<td>Cleft closure</td>
<td>33%</td>
</tr>
<tr>
<td>Edge-to-edge repair (Alfieri stitch)</td>
<td>7%</td>
</tr>
<tr>
<td>Papillary muscle repair</td>
<td>2%</td>
</tr>
</tbody>
</table>
Intraoperative post-repair findings
Transesophageal echo

Residual regurgitation

- Moderate: 13%
- Mild: 61%
- None or trivial: 26%

Stenosis

- None: 83%
- Mild: 15%
- Moderate: 2%

Mild: mean inflow gradient <10mmHg
Moderate: 10-15mmHg
Freedom from death or transplant
Valve repair group vs. case match control

Survival Functions

Case match control
Valve repair group
Log-rank: p=0.004
Survival by valve repair result

Freedom from death or transplant

Group 1: good repair/good function
- Normal ventricular function
- <mild regurg/stenosis>

Group 2: bad repair/good function
- Normal ventricular function
- >moderate regurg/stenosis

Group 3: good repair/bad function
- <mild regurg/stenosis
- >moderately reduced function

Group 4: bad repair/bad function
- >mod regurg/stenosis
- >mod reduced function

Log rank: p = 0.02

Survival Functions

Cum Survival

Time from valve repair to death or transplant
Summary

• Failing Valves – Failed morphology

• Ventricular Function is an important determinant of outcomes

• Good repair and good function – likely good outcome

• Prefer repair at Stage II to prevent feedback dilation