Balloon Aortic Valvuloplasty in Infants and Children: Indications, Technique and Outcome

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Disclosure Information

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- (GRS): Grant/Research Support
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pfm Medical: C
Atrium Medical: C
Neurosigma Vascular: AB
NIH Challenge Grant, AHA Innovative Research Grant
History

• First reported by Lababidi in 1984


• Significant adverse event rates in early reports:
  • aortic regurgitation
  • vascular complications
  • death

• Major adverse events and death correlated with patient age
  • 11/204 (5%)
  • death in 5/11 less than 1 yr old

Indication

- Poor Function vs Normal Function
  - Especially in newborns with poor function
  - Gradient is unimportant
- LV Size
  - Need to assure LV is “useable”
  - Adequate Ao valve annulus
- LV normal and Function is normal
  - Peak to peak gradient >65 mm Hg in young children/neonates
  - Peak to peak gradient >65 mm Hg in older children
  - Resting echo gradient >70+mm Hg without symptoms
  - Exercise testing in borderline cases
  - Depends on activity of patient
Technique - General

- Anesthesia
  - General for all very young and sick children
  - Sedation better for diagnosis of aortic stenosis
- Approach
  - Single balloon vs Double balloon
  - Extra arterial line? Transseptal?
- Retrograde
  - Femoral, brachial, carotid
  - Umbilical
- Antegrade
  - Transseptal, PFO
Evolution of Technique

- Recognition of initial balloon:annulus ratio of 0.8-0.9
- Importance of meticulous guidewire position and manipulation to avoid damage to the LV wall
- Use of low profile balloons
- Retrograde approach
- Rapid ventricular pacing
Risk of Aortic Insufficiency

- Increased risk with smaller patients
- Increase risk with larger balloon:annulus ratio – threshold 0.9-1:1 for AR
- Increased risk with bicuspid, unicuspid and asymmetric/thickened valves

Calcific Aortic Stenosis
Valve Morphology by ECHO
Balloon Choices
Technique - Angiography

- High frame rate
- Measure at hinge points during systole
- Consider marker catheters
- Approach – perpendicular to Aortic valve
  - Frontal tube: RAO 30, caudal 30
  - Lateral tube: LAO 60, cranial 30
  - Largest systolic diameter
- “Useable” views
  - AP, lat, LAO
Step 2: Cross the Valve

- Catheter
  - AL
  - Glide
  - JR, JL - shaped
- Prograde catheter trick
- Jet direction
- 180 degree trick
- Wire choice
  - Wholey (glide?)
  - coronary
- Preparation
  - Anesthesia
  - Meds
  - balloon
Technique – Wire Position

• Biggest diameter and stiff as possible
• 180 degree curve in the LV
• Stiff part of wire in the LV
• If hemodynamic instability with balloon crossing
  • Quick dilation with one balloon
  • Prepared with atropine/epi/may need compressions
  • Rapid inflation/deflation
• Consider rapid pacing
  • Always in older children and adults
Step 3: Wire Position and Contrast
Step 4: Balloon
Step 6: Balloon again (optional)
Step 7: Assess
Assessment

- Gradient less than 20 mm Hg
- LVEDP < 15 mm Hg
- Minimal increase in pulse pressure
- Assess AR
  - Aortogram
  - ECHO
- Measure the balloons
Case 2: Aortic Angiogram
Case 2: Measurements

8.5 ± 0.5 mm

8.5 ± 0.5 mm
Case 2: Measurements
Case 2: Crossing the valve
Case 2: Balloon
Case 2: Result
Case 3: Water Polo Player
Case 3: LV-gram prior
Case 3: Assess femoral artery
Case 3: Annulus and Balloon
Case 3: Inflation with pacing
Case 3: POST–Too much AR?
Aortic Stenosis: Results After Balloon Valvuloplasty

• 509 survivors of aortic valvuloplasty with long term follow up
• Excluded early deaths
• Median follow up of 9.3 yrs – maximum 24 yrs
• Freedom from AVR 79% at 10 yrs and 55% at 20 yrs
• Steady hazard for death and a steep acute death hazard
• Bad results are bad!
• Patients with acute moderate to severe AR and gradients greater than 35 mm Hg did worse long term
Aortic Stenosis: Results After Balloon Valvuloplasty

**Figure 1** Competing Risks Outcome Curve

Competing risks outcome curve shows the prevalence of death, aortic valve replacement (AVR), and survival without AVR among 509 patients with congenital aortic stenosis who survived more than 30 days after balloon dilation with biventricular circulation.

**Figure 4** Freedom From Repeat Balloon Dilation

Kaplan-Meier curves depict estimated freedom from repeat balloon dilation after the initial balloon valvuloplasty procedure in neonates and older patients with congenital aortic stenosis.

Brown et al, J Am Coll Cardiol 2010;56:1740–9
Aortic Stenosis: Results After Balloon Valvuloplasty

Table 5: HRs for AVR Among Patients With Different Combinations of Post-Dilation Residual AS and Acute AR

<table>
<thead>
<tr>
<th>Residual Peak AS Gradient (mm Hg)</th>
<th>Acute Post-Dilation AR</th>
<th>HR (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤35</td>
<td>None-trivial</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>1.8 (0.99–3.2)</td>
<td>0.054</td>
</tr>
<tr>
<td></td>
<td>Moderate-severe</td>
<td>4.2 (2.3–7.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&gt;35</td>
<td>None-trivial</td>
<td>2.0 (1.1–4.0)</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>6.3 (3.5–11.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Moderate-severe</td>
<td>9.9 (4.8–20.4)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

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Aortic Stenosis: Results After Balloon Valvuloplasty

Table 3

<table>
<thead>
<tr>
<th>Intervention/Reintervention</th>
<th>Number of Patients (Procedures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any reintervention on the aortic valve</td>
<td>225 (338)</td>
</tr>
<tr>
<td>Repeat BAVP</td>
<td>115 (149)</td>
</tr>
<tr>
<td>Multiple repeat BAVP procedures</td>
<td>30</td>
</tr>
<tr>
<td>Surgical aortic valve reintervention</td>
<td>159 (192)</td>
</tr>
<tr>
<td>Surgical aortic valve repair</td>
<td>65 (65)</td>
</tr>
<tr>
<td>Aortic valve replacement</td>
<td>116 (127)</td>
</tr>
<tr>
<td>Pulmonary autograft</td>
<td>53</td>
</tr>
<tr>
<td>Mechanical valve prosthesis</td>
<td>52</td>
</tr>
<tr>
<td>Homograft aortic root replacement</td>
<td>8</td>
</tr>
<tr>
<td>Bioprosthetic valve</td>
<td>3</td>
</tr>
</tbody>
</table>

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- AR more common in older children but death and reintervention more common in neonatal population
- Other studies:
  - More AR with balloon to annulus rations greater than 0.9-1:1
  - Worse results with less cusps
  - Worse with thicker cusps
  - Much better results when residual AS gradient < 35 mm Hg
  - It was better to have AS < 35 mm Hg with mild+ or moderate AR than to have residual AS > 35 mm Hg with only mild AR
  - ….but really bad to have severe AR
  - Neonates were higher risk for repeat BAV but not higher risk for AVR

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SUMMARY:
Balloon Aortic Valvuloplasty

• Safe and getting easier
• Not ideal but reasonable long term results
• Need better surgical options
• TAVR is changing things for older patients
• Common sense with balloon and patient selection