Hybrid Procedures in Congenital Heart Disease

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"I've missed more than 9,000 shots in my career. I've lost almost 300 games. 26 times I've been trusted to take the game winning shot and missed. I've failed over and over and over again in my life. And that is why I succeed."

~ Michael Jordan
On November 29, 1944, students and professors crowded into the double-deck observation gallery above the eighth-floor operating room in the Halsted Clinic. Because there was a danger of losing the child Eileen before the operation began, Dr. Merel Harmel decided not to use a strong anaesthetic and put her slowly to sleep with a diluted mixture of ether and oxygen.
Survival with CHD

Decade Born with CHD

1990 - 90%
1980 - 80%
1970 - 75%
1960 - 40%
1940 - 20%

Percent Survival to 18 Years Old

Should Survival Still be THE Benchmark Outcome Variable for Patients with CHD?
Hybrid

Definition:
“anything derived from heterogeneous sources, or composed of elements of different or incongruous kinds”
Benefits

• Avoiding CPB

• Facilitate Access Issues in Smaller Patients

• Facilitate Access in Older Patients with Complex Anatomy

• Assessing Immediate Post-Operative Anatomy
Challenges

• Varying Perspective
  • Surgeon vs Interventionalist
  • Patient must be the focus

• Environment & Equipment
  • Must be designed with both disciplines in mind

• Anatomical and Physiological Correction
  • Ensure support before embarking on new endeavors

• Communication at all time-points
The Original “Hybrid” Approach

Hybrid Approach in 2.3Kg Neonate
PDA sizing

A: 6.8mm
B: 11.6mm
C: 10.0mm
PDA stenting
Outcomes - Toronto

Baba K et al. Circulation. 2012;126:S123-31
Rush Experience

• 13 Patients
  – Median age: 8 days (2-46 days)
  – Median weight: 3.4 kgs (2.3-4.6 kgs)
  – No procedural mortality
  – Overall survival further surgical palliation: 62% (86%)
  – Three patients underwent biventricular repair
  – Follow-up (Median 24 months) – PA intervention

* Neurodevelopmental Outcomes*
Perventricular VSD Closure

• VSD – Most Common CHD Defect
• >70% - Perimembranous
• Large Muscular Defects <10%
Perventricular VSD Closure

A

RA  RV  LV

LA

C

RV  LV

D

RV  LV

RA  RV  LV

LA

B

RV  LV

RA  RV  LV

LA

RV  LV

RA  RV  LV

LA

RV  LV

RA  RV  LV

LA

RV  LV

RA  RV  LV

LA
Perventricular VSD Closure
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Perventricular VSD Closure Multi-center Study

- Retrospective, multicenter, cohort study
- 12 US pediatric cardiology centers
- Inclusion criteria:
  - All patients who had an attempted perventricular device closure of a mVSD (hybrid procedure)
  - 1/2004 – 1/2014
- Core lab for echocardiographic studies (Utah)
Results

N=47

Simple VSD: N=22

Complex VSD: N=25

- Mid-muscular
- Apical
- 'Swiss-cheese'

14% 7%

20%
## Demographics and Acute Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Simple VSD (N=22)</th>
<th>Complex VSD (N=25)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Surgery (mo)</td>
<td>5.3 (IQR 4.2-6.5)</td>
<td>5.2 (IQR 0.4-16.8)</td>
<td>0.80</td>
</tr>
<tr>
<td>Wt. at Surgery (kg)</td>
<td>5.1 (IQR 4.3-5.8)</td>
<td>5.1 (IQR 4.0-9.2)</td>
<td>0.06</td>
</tr>
<tr>
<td>VSD Size (mm)</td>
<td>9.5 ± 2.7</td>
<td>7.3 ± 2.7</td>
<td>&lt;0.01</td>
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<tr>
<td>Device Size (mm)</td>
<td>10 (range 6-16)</td>
<td>8 (range 4-14)</td>
<td>0.01</td>
</tr>
<tr>
<td>ICU LOS (days)</td>
<td>2 (IQR 1-3)</td>
<td>8.5 (IQR 2-15)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Hospital LOS (days)</td>
<td>4 (IQR 3-8)</td>
<td>14.5 (IQR 6-34)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

### Procedural details
- Performed in OR with TEE Guidance 91% (43/47)
- > 1 Device Placed 9% (4/47)
- ASA at D/C 90% (40/44)
Simple VSD - Outcomes

- **Successful device deployment:** 100% (22/22)
- **Composite adverse outcome:** 14% (3/22)
  - Significant residual VSD
  - Surgically repositioned
  - LV pseudoaneurysm
  - Mortality 0% (0/22)

- **Minor adverse events:** 2
  - Short run of VT: Meds for 6 months (4.3 yrs. f/u)
  - Seizure post-op: No treatment or sequelae (2.8 yrs. f/u)
Complex VSD–Outcomes

– Successful device deployment : 80% (21/25)

– Composite adverse outcome: 28% (7/25)
  • Failed deployment N=4
    – Surgically closed (2)
    – CHB during device implant (2)
  • Significant residual VSD N=1
  • Device malposition N=1
  • LV Perforation by delivery sheath N=1

• Mortality/Tx: 16% (4/25)
  – Arch + mVSD – Died in OR (mucus plug)
  – D-TGA + mVSD – Died POD#155 (respiratory cause)
  – D-TGA + multiple VSDs – Died POD#24 (on ECMO)
  – CAVC + multiple VSDs + MV/LV hypoplasia – OHTx POD#70
Hybrid Pulmonary Valve Replacement
Perventricular Hybrid PVR: RVOT Assessment
Perventricular Hybrid PVR – RVOT Pre-stenting
Perventricular Hybrid PVR – Angiogram Post Pre-stent
Perventricular Hybrid PVR: Melody Implantation
Perventricular Hybrid PVR – Final Angiogram
Hybrid Pulmonary Valve Replacement
Hybrid Approach in Dilated Native RVOT
RVOT Post Plication

A: 18.5 mm
B: 23.2 mm
C: 23.1 mm
RVOT Reassessment - Post Stenting

- Measurement: B: 20.2mm, C: 20.2mm, D: 4.2mm, A: 20.5mm
Melody Valve Delivery and Final Result
ICE Imaging
RV Remodeling
Transcarotid Interventions
PA/VSD
Ductal Stenting
Final Result
CoA in 1.2Kg Infant
Transcarotid Balloon Valvuloplasty for Critical Aortic Valve Stenosis at the Bedside Via Continuous Transesophageal Echocardiographic Guidance

Howard S. Weber, MD, Christopher R. Mart, MD, and John L. Myers, MD

We describe the first two successful cases of transcarotid balloon aortic valvuloplasty for critical aortic valve stenosis in the neonate utilizing continuous transesophageal echocardiographic guidance performed at the bedside. This method obviates the need for transporting a sick and hemodynamically unstable neonate to the catheterization laboratory and additionally reduces costs without compromising clinical care. Cathet. Cardiovasc. Intervent. 50:326–329, 2000.

Key words: transcarotid valvuloplasty; neonate; transesophageal echocardiography
Transcarotid balloon valvuloplasty for critical aortic stenosis in a premature neonate weighing 1100 g

Martin Koestenberger,¹ Albrecht Beitzke,¹ Igor Knez,² Wolfgang Raith³ and Bert Nagel¹
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Catheterization and Cardiovascular Interventions 77:112–114 (2011)

Transapical Aortic Balloon Valvuloplasty in a 890-Gram Infant: Hybrid is Better!

Nicola Maschiettom,¹ MD, Vladimiro Vidam,¹ MD, and Ornella Milanesi,¹

Balloon aortic valvuloplasty has become in many centers the treatment of choice for neonates with critical or severe aortic stenosis. Usual approaches both antegrade and retrograde can be problematic in preterms extremely low birth weight babies. We describe a novel approach for dilating the aortic valve in an 890 grams baby.

Key words: closure; vascular access; pediatric interventions; valvular heart disease
Hybrid CoA Stent – Femoral Artery

9Kg Female (HLHS) with 21mmHg gradient
Stent Deployment
Hybrid PA stenting

6 y/o single ventricle with disconnected LPA supplied by 4mm BT Shunt
Ballooning
Upper Lobe Stent
Lower Lobe Access
Lower Lobe Stenting
Intra-operative Angiography
Congenital & Structural Heart Disease

• Mitral paravalvar leaks

• Transcatheter tricuspid/mitral/aortic valve replacement

• Per-atrial ASD closure

• Intraoperative PA stent dilation
Summary

• Collaboration and Trust – Key!!

• Get the Environment Right for the Surgeon

• Start with simpler cases

• Prepare well!
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