Atrial Septostomy in HLHS and ECMO: Indications, Technique and Outcome

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Atrial Septostomy in HLHS

• Goals of therapy
  • Unobstructed systemic output
  • Balance of the pulmonary and systemic circulations
  • Unobstructed egress from the LA
Atrial Septostomy in HLHS

• Goals of therapy
  • Unobstructed systemic output
  • Balance of the pulmonary and systemic circulations
  • Unobstructed egress from the LA

• Spectrum of disease
  • Identifying atrial septal abnormalities early
  • Understanding anatomical variants
  • ? Using the pathophysiology to your benefit
Stating the Obvious...

- Atrial Septal Interventions – Atrial restriction
  - Milder forms - mitigate against pulmonary overflow
- Norwood surgery – Surgical septectomy

- Intact septum needs immediate attention

- Atrial septal interventions – Hybrid Era
Fetal Intervention – Indications

• Described by Marshall et al 2004 \(^1\)

• Fetal Echocardiography
  – HLHS with intact septum/tiny (<1mm) ASD
  – Prominent flow reversal in the pulmonary veins
    » ↓ vasoreactive response to maternal hyperoxygenation
      suggests abnormal pulmonary vasculature - clinically important restriction at the foramen ovale
  – Dilated LA
  – Atrial septal thickness
  – Decompressing vein

• 2014 AHA Guidelines – IIb/C

Technique

- Adequately sized dilation catheter
- Correct position of the balloon across the septum
- Minimal recoil of the septum following dilation
- Maternal anesthesia
- Fetal Narcotic, Atropine and Relaxant

18G Introducer – accommodates larger balloon
- Right atrial approach
- 0.014” wire in pulmonary vein – Balloon
- Stent (Thick Atrial Septum/Failure of Ballooning)
Fetal Atrial Septal Interventions - Technique
Outcomes

Fetal BAS


- 21 Attempts (6 years)
- 19 Technically Successful
  - Balloon Diameter 2.5-4.5mm
- Fetal complications (38%)
- No Maternal Complications
- Atrial Opening
  - Unchanged n=8
  - Medium n=7
  - Large n=6
- 12 – Urgent decompression
- Stage I Norwood (n=19) (58%)
  - Decompression group (42%)
  - Routine Stage I (86%)

Attempted Stent Placement

*Catheterization and Cardiovascular Interventions 84: 77–85 (2014)*

- Fetuses with HLHS/IAS (n=9)
  - Primary stent placement (fetuses 2, 5, 6-9)
  - Septal pre-dilation and stent placement (fetus 1)
  - Stent placement after unsuccessful balloon septoplasty (fetuses 3 and 4)
  - Technically Successful (fetus 5)
  - Technically Unsuccessful (fetus 1)
  - Technically Unsuccessful (fetus 5)
  - Technically Unsuccessful (n=0)
  - Technically Unsuccessful (n=0)
  - Successful balloon septoplasty (fetuses 6 and 7)
  - Unsuccessful balloon septoplasty (fetus 5)
  - Fetal Demise (fetus 9)

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The Restrictive Atrial Septum – Indications

• ~ 22% of neonates with HLHS
• Identification
  • Fetal Diagnosis (Previous Markers)
  • Clinical condition (SaO2, Cardiac Output)
  • Mean Doppler PG across septum
• Norwood surgery vs Hybrid strategies
  • Majority pre-Norwood and post Hybrid
  • Post Hybrid
    – Mean Doppler Gradient > 6mmHg
    – Feeding Difficulties
    – Saturations <80%

Standard vs Complex Atrial Septal Anatomy

Restrictive Atrial Septum - Technique

2.89Kg Postnatal Dx – Mitral and Aortic Atresia.
Initial Lactate 7.5. Hybrid Procedure D4 of Life
D2 Post Hybrid – Atrial Septostomy
Crossing the Septum/Balloon Inflation
Initial Septostomy
Final Pullback
Final Assessment

Extubated the Following Day
More Complex Interventions
Outcomes

Boston Data (Control Group)
- N = 33 (11% of HLHS Pts)
  - Control n = 66
- Intervention
  - TS puncture (n=27 (82%))
  - Balloon dilation (n=28 (85%))
  - BAS (n=7 (21%))
  - Blade septostomy (n=1 (3%))
  - Stent placement (n=4)
- LAP – 24.8±6.1 – 13.6±4.3
- 12 months survival
  - 34% Intervention Group
  - 72% Controls

Columbus Data
- N = 56 (67 procedures)
  - Standard (33)/ Complex (23)
- Intervention
  - BAS (n=52/67 (77.6%))
  - Static balloon (n=18 (26.9%))
  - Cutting balloon (n=12 (18%))
  - RF Perforation (n=8 (11.9%))
  - Stent placement (n=4)
- Complications (n=24-35.8%)
  - Minor 18/Major 6
- Survival – Stage II
  - Standard anatomy (72.8%)
  - Complex anatomy (56.6%)

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The Intact Atrial Septum

• 5-10% of patients with HLHS
  • Poor outcomes (50%)

• Three types of morphology

  A Morphology – Large LA with thick SS and thin SP

  B Morphology – Small LA with thick muscular septum without distinction between septum primum and secundum

  C Morphology – Giant LA with thin septum (severe MR)

(J Am Coll Cardiol 1999;34:554–60)
Planned Delivery and Immediate Intervention
Intact Atrial Septum (Postnatal Dx) - Technique
RF Perforation of Atrial Septum
Advancing the Coaxial System across the Septum
Confirmation of LA Position
Atrial Septostomy – ECMO – Indications

• Despite AV Cannula – Pulmonary venous flow

• LV may not eject ➔ LA hypertension

• Septostomy - decompress LA (Class 1/LOE C)
  – “Atrial septostomy is indicated for the decompression of left atrial hypertension, for example, in patients on ECMO support and with evidence of severe pulmonary edema or if there is poor cardiac return from the extracorporeal membrane oxygenation circuit and low venous saturations”
Technique

• Location – Transport is challenging

• ? Intact septum

• Anticoagulation

• Imaging

• Defining success
Outcomes

• Limited exclusive published data

• 10 patients
  • Median age 3 years
  • Femoral venous approach n=10
  • Transseptal puncture n=9
  • Blade septostomy n=10 with static balloon (9) and septostomy (1)
  • Mean LA mean pressure dropped from 30.5 – 16mmHg

• Complications
  – Needle perforation of the LA
  – VF
  – Hypotension

• 7 patients survived ECMO run (no repeat atrial interventions required)

Conclusions

• Have guides for when to intervene

• Atrial restriction - not ideal in HLHS

• Simplest intervention to provide desired outcome

• ECMO – don’t be pushed into intervention
ARIA
LAS VEGAS

SAVE THE DATE
SEPTEMBER 18-21, 2015