Fetal Cardiac Interventions

Indications:
- Aortic stenosis developing HLHS (hypoplastic left heart syndrome)
- Hypoplastic left heart syndrome with restricted atrial septum
- Pulmonic stenosis developing hypoplastic right ventricle

Aortic Stenosis Developing into Hypoplastic Left Heart Syndrome

Intervention – Aortic valve dilation
Goal:
- Prevent
- Reverse
- Minimize degree of

Hypoplastic left heart syndrome

Critical aortic stenosis or aortic atresia
Progression of ultrasound findings
- Dilated left ventricle
- Echogenic endocardium
- Poor left ventricle contractility
- Small noncontractile left ventricle

Obstruction of blood flow through left ventricle
Damage to left ventricle myocardium
Poor left ventricle contractility & growth
Hypoplastic left heart syndrome

Aortic Stenosis progressing to HLHS

20 weeks
One week later
Aortic stenosis developed into HLHS
31 weeks

Hypoplastic left ventricle

Aortic Stenosis Developing into Hypoplastic Left Heart Syndrome

Procedure: Aortic valve dilatation
Preop assessment
  Full fetal survey
  Karyotype
  Left ventricular size
  Left ventricular contractility
  Left ventricular fibroelastosis
  Flow across aortic valve
  Width of aortic valve

Before procedure

Endocardial Fibroelastosis
Aortic stenosis Eccentric jet of flow

Before procedure

Before procedure

Before procedure

Dist = 0.24cm
Aortic Stenosis Developing into Hypoplastic Left Heart Syndrome

Procedure: Aortic valve dilatation
- Position fetus
- Paralyze & anesthetize fetus
- Set needle approach
- Insert needle into left ventricle pointing towards aortic valve
- Exchange trocar with wire
- Guide wire across aortic valve
- Pass balloon catheter across valve
- Inflate balloon

Aortic Valve Dilation

Fetal position must be optimal

Paralyze & Anesthetize the Fetus

Inject thigh or buttocks

Fetal Position

23 weeks
22 weeks
Needle Insertion

Use continuous ultrasound guidance
Select needle entry site
Select angle
Modify insertion as needle is advanced

Wire Insertion

Remove trocar
Insert wire
Pass wire across aortic valve

Balloon Catheter

Pass catheter over wire across valve
Inflate balloon
After Removing the Needle

Assess flow across the valve

Immediately after procedure

Blood flowing in the aorta
**Challenges**

- Fetal positioning (must be ideal)
- Difficulty entering thorax
- Left ventricular collapse
- “White out” of left ventricle
- Wire does not cross aortic valve
- Stiff, atretic valve
- Needle not pointing at the valve
**Complications**

- Fetal bradycardia requiring resuscitation
- Pericardial effusion
- Pleural effusion
- Fetal demise
- Balloon rupture

**Hypoplastic Left Heart with Restricted Atrial Septum**

- Obstructed pulmonary venous return
- High Perinatal Mortality

**Goal of procedure:**

- Create channels through the atrial septum
- To improve pulmonary blood flow
- To allow pulmonary venous return to right heart across septum

**Postprocedure bradycardia & pericardial effusion**

**Bradycardia requiring resuscitation**

**Pleural effusion postop day 1**

**Hypoplastic Left Heart with Restricted Atrial Septum**

- Left to right flow across atrial septum
- Necessary for survival after birth
- Oxygenated pulmonary blood must reach systemic circulation
- Right ventricle pumps blood for both pulmonary and systemic circulations
- After birth, intervention to enlarge atrial septal defect
**Hypoplastic Left Heart with Restricted Atrial Septum**

In utero develop high pulmonary arterial and venous pressure
Causes pulmonary cystic changes from dilated lymphatics
Causes pulmonary hypertension
Limited flow through pulmonary circulation in utero
Persistent limited flow after birth

**Intervention**

- Create hole in atrial septum

**Goal:**

- Open pathway for blood returning from lungs to reach right ventricle
- Decompress pulmonary veins to prevent pulmonary hypertension and cystic changes in lung

**Procedure: Atrial septostomy**

- Position, paralyze & anesthetize fetus
- Set needle approach
- Insert needle into right atrium towards or across atrial septum
- Exchange trocar with wire
- Position wire across septum
- Advance balloon catheter across septum
- Inflate balloon

**HLHS & restricted atrial septum – 31 weeks**

**HLHS & restricted atrial septum – 31 weeks**

**HLHS & restricted atrial septum – 30 weeks**

**Dilated pulmonary veins**
**Needle Insertion**

- Use continuous ultrasound guidance
- Select needle entry site
- Select angle
- Modify insertion as needle is advanced

**Wire & Balloon Insertion**

- Remove trocar
- Insert wire
- Pass wire into left atrium or pulmonary vein
- Insert balloon
- Inflate balloon
22 weeks HLHS with restricted atrial septum

Flow from LA to RA

29 weeks HLHS with restricted atrial septum

HLHS Preop 24 weeks

Postop Septotomy
**Stent Placement**

Pass stent catheter over wire to straddle septum
Insert balloon to expand stent
Remove cannula, wire, & catheter

**Immediately after procedure**

**Stent placed across septum 31 weeks**

**Stent placed across septum 31 weeks**

**Stent catheter across septum**
Evolving HLHS with restricted septum
Stent placement at 30 weeks

Flow from LA to RA

Pulmonic Stenosis/Atresia Developing into Hypoplastic Right Heart

Pulmonic atresia (or critical stenosis) diagnosed prenatally
~ two-thirds will have single ventricle after birth hypoplastic right ventricle

Prevent
Reverse
Minimize degree of

Hypoplastic right heart

Intervention – Pulmonic valve dilation
Goal:
Hypoplastic RV

Pulmonic atresia

Pulmonic atresia intact ventricular septum

Total Experience – 193 cases (202 procedures)
Aortic valve dilation (138 in 136 patients)
  115 Successful technically
  23 Unsuccessful technically
Atrial septostomies (35)
  32 Successful technically
  3 Unsuccessful technically
Pulmonic valve dilation procedures (14)
  9 Successful technically
  1 Partially successful technically
  4 Unsuccessful technically
Mitral valve dilation procedures (2)
  2 Successful technically
Rescue procedures (13 in 9 patients)

First 100 Aortic Valve Dilation Procedures
77 technically successful procedures
  35 – two ventricles (not HLHS)
  35 – hypoplastic left heart syndrome
  7 – demise or TAB
23 technically unsuccessful procedures
  3 – two ventricles (not HLHS)*
  11 – hypoplastic left heart syndrome
  3 – demise or termination

*Late procedures, 28w, 28w, & 32w

Success rate improved with experience

68% 78% 78% 88%
First 100 Aortic Valve Dilation Procedures
Outcome improved with experience & better selection criteria

- Demise: 0%
- 1V: 28%
- 2V: 28%
- 3V: 44%
- 4V: 52%

Patient Order in Quartiles

2 ventricles

Thank You!