Transcatheter Intervention in the Neonate with Congenital Heart Disease

March Of Dimes
Women’s Health Symposium II:
Pregnancy and Beyond
November 2009

Dr. Alvaro Galindo
Children’s Heart Center of Nevada
Interventional Catheterization

- Increased interventional procedures in the catheterization laboratory in last 20 years
- In patients as small as 700-900 gm
- Shorter recovery from the procedure and hospital stay compared with surgery
Procedures/lesions

- Balloon atrial septostomy
- Pulmonary stenosis, PA/IVS, TOF
- Aortic stenosis
- Coarctation of the aorta angioplasty
- Palliative procedures for Tetralogy of Fallot
- PDA stenting
- Hybrid Procedure for Hypoplastic Left Heart
Balloon atrial septostomy (BAS)
- Can be performed in cath lab or in NICU with echo guidance

Indications for BAS:
- D-TGA
- Hypoplastic left heart syndrome
- Double outlet right ventricle-Taussig Bing

Risks
- Embolization
- Liver or IVC tear
- Damage to intracardiac structures (mitral, tricuspid, atrial appendage)
INTERVENTIONAL INDICATIONS: BAS
PULMONARY BALLOON VALVULOPLASTY IN THE NEONATE

- **Indications**
  - Critical PS
  - Tetralogy of Fallot
  - PGE 1 adds measure of safety

- **Risks**
  - Perforation of right ventricular outflow tract
  - Damage to tricuspid
  - Embolization
PULMONARY BALLOON
VALVULOPLASTY IN THE NEONATE
AORTIC VALVULOPLASTY IN THE NEONATE

- Indications: critical aortic stenosis
- Approach
  - Femoral artery
  - Femoral vein
  - Umbilical artery
  - Carotid cutdown
- High risk procedure
- Patients often have severe ventricular dysfunction
- AS may be associated with other left heart lesions
- Risks: loss of pulse in leg, embolization, arrhythmias, death
COARCTATION ANGIOPLASTY IN THE NEWBORN

- Surgical repair is the procedure of choice
- Catheter-based intervention should be considered in cases of increased surgical risk
- Balloon angioplasty associated with high recurrence rate
PERFORATION/DILATION OF ATRE蒂C PULMONARY VALVE

- Pulmonary atresia and intact ventricular septum
  - No right ventricular coronary dependence
  - Tricuspid valve z-score >2
- Pulmonary atresia with malaligned VSD (severe Tetralogy of Fallot)
PERFORATION/DILATION OF ATRETEC PULMONARY VALVE
Palliative Interventions in Neonatal Tetralogy of Fallot

The Goal is to Increase Pulmonary blood Flow:

- **Pulmonary Balloon Valvuloplasty**
  - In cases where there is little or no infundibular stenosis
- **Stent Placement in Right Ventricular Outflow Tract**
- **Stent Placement in Patent Ductus Arteriosus**
Tetralogy of Fallot: Pulmonary Valvuloplasty

- Very effective means of improving pulmonary blood flow in cases where obstruction is at the pulmonary valve
- Increased forward flow to PA’s promotes pulmonary artery growth
Tetralogy of Fallot: Stent in RV Outflow Tract

- In settings where there is muscular subvalvar or supravalvar pulmonic obstruction
- Must have hypoplastic pulmonary valve annulus
- Results in pulmonary insufficiency which is well tolerated
Tetralogy of Fallot: Ductus Arteriosus Stent

- The “natural” systemic to pulmonary artery shunt
- Independent of site of obstruction to pulmonary blood flow
- Does not result in pulmonary valve insufficiency
Hypoplastic Left Heart: Physiology

- Must have a patent foramen ovale (PFO) for obligatory L to R shunt
- Systemic circulation is dependent on the ductus arteriosus
- The pulmonary vs systemic blood flow is dependent on pulmonary vascular resistance
The Norwood Procedure: A Five Step Program

- Use pulmonary trunk to reconstruct aortic arch
- Resect coarctation
- Atrial septectomy
- Establish systemic to pulmonary shunt
- Keep baby alive!
Drawbacks of the Norwood Procedure

- Bypass
- Delicate balance between pulmonary and systemic circulation post-op
- Low diastolic pressures
- Operative mortality of 10-20%
  Risk factors: BW < 2.5 Kg, prematurity < 34 wks, restrictive atrial septum, other associated anomalies
- Risk of re-coarctation
- Left PA relative hypoplasia
- Effect on neurologic development
Hybrid Approach

- Combination of surgery and catheter-based intervention
- Consists of 3 separate stages
- Does not require cardiopulmonary bypass
Hybrid Management of HLHS and its Variants: The Nevada Experience

- Initial banding of branch PA’s in the OR
  - Performed prior to PDA stent placement
  - 1.5mm rings from Gore-Tex graft are cut open
    - 3.0 mm Gore-Tex for BW < 2.7 kg
    - 3.5 mm Gore-Tex for BW >2.7 kg
  - Gore-Tex bands are placed around each branch PA and closed using 5-0 polypropolene mattress suture
Hybrid Management of HLHS and its Variants: The Nevada Experience

- PDA stent diameter 1 mm > PDA and 20 mm long
- If there is PDA stenosis use balloon-expandable or BW < 2.0 kg
  - Genesis or Omnilink premounted stents
- If no PDA stenosis can use self-expanding stent
  - eV3 Protégé or Abbott Absolute
- Balloon atrial septostomy / atrial stent
Balloon-expandable PDA stent in 1 Kg patient
Self-expanding PDA stent
Hybrid Management of HLHS and its Variants: The Nevada Experience

- Program began in August 2007
- Initially directed at management of high-risk Norwood candidates
  - Birth weight < 2.2 kg
  - Restrictive atrial septum
- Due to initial success program expanded to include all patients with HLHS and very low birth weight patients with arch anomalies and +/- VSD’s
Hybrid Management of HLHS and its Variants: The Nevada Experience

Total 14 patients from 8/07 to 7/09

- 11 HLHS
- 3 Aortic arch anomalies
  - IAA type B (BW 1.4 kg)
  - Hypoplastic Ao arch/ large apical VSD (BW 1.3 Kg)
  - Hypoplastic Ao arch/ multiple VSD’s (BW 2.2 Kg)

6 with BW < 2.2 kg (1.1 – 2.2 kg)

4 restrictive atrial septum at birth
  - 2 taken directly to cath lab from delivery room
HLHS - Intact Atrial Septum
Hybrid Management of HLHS
The Nevada Experience: Results to Date

HLHS (n=11)

- 1 died due to LV-coronary communications
- 1 died due to severe bronchomalacia
- 7 patients have undergone Norwood
  - 4 with Glenn shunts now awaiting Fontan
  - 3 required BT shunt due to ↑ PVR
- 2 awaiting Norwood/Glenn
Hybrid Management of Arch Hypoplasia/Low BW
The Nevada Experience: Results to Date

- 2 have undergone successful biventricular repair with arch reconstruction
- 1 converted to Damus-Kaye-Stansel procedure
Summary and Conclusions

- Several important interventions in neonates with congenital heart disease
- In general, very good success rate with low complication rate
- Future:
  - Stents delivered through small sheaths
  - Biodegradable stents
  - PDA devices for smaller infants
  - Advances in other hybrid procedures