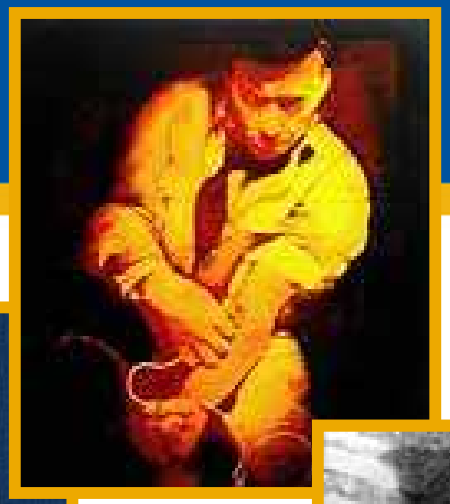
Principles of Cardiac Catheterization

Stephen Kaine, MD, FAAP, FACC, FSCAI
Ward Family Heart Center
Children's Mercy – Kansas City

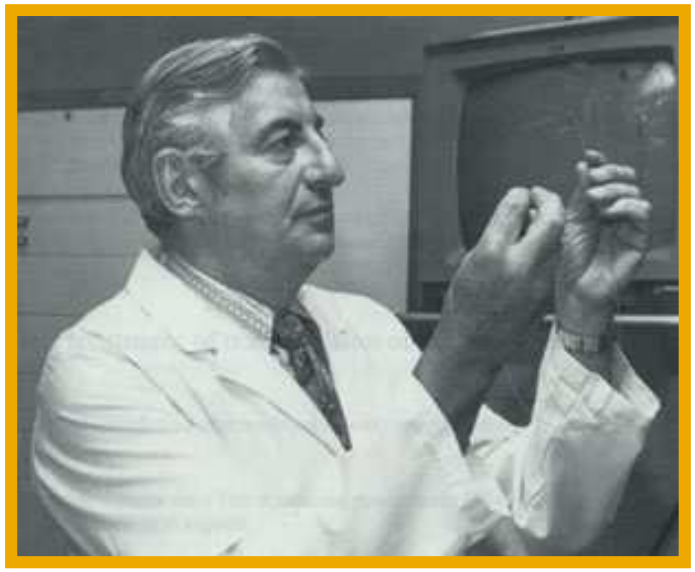
No Disclosures

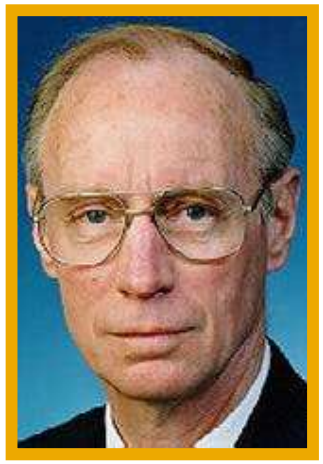


Children's Mercy
KANSAS CITY

Children's Mercy
KANSAS CITY

Children's Mercy
KANSAS CITY





Children's Mercy KANSAS CITY

Principles of Cardiac Catheterization

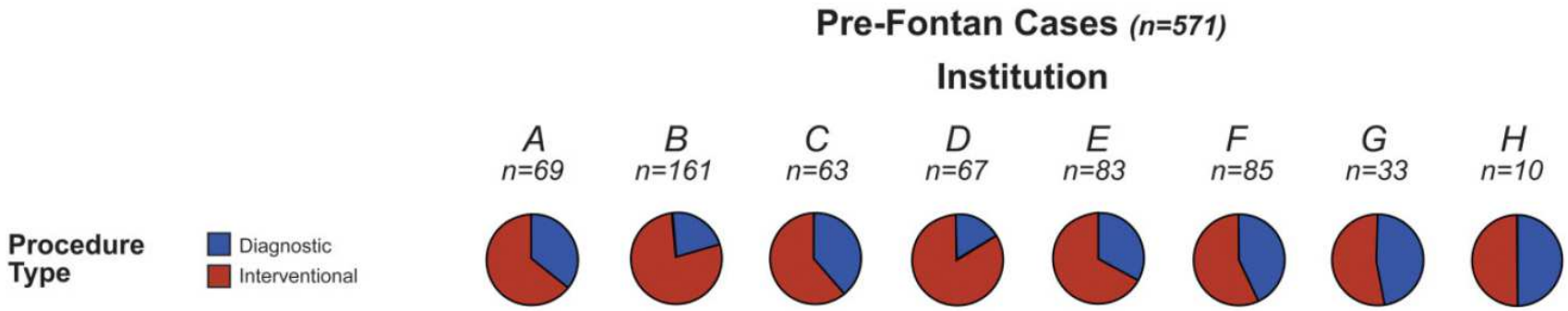
- "Diagnostic" Assessment
  - Pre-Fontan evaluation
- Interventional – Right Ventricular Rehab
  - Pulmonary Atresia/IVS with RV Hypoplasia

Children's Mercy KANSAS CITY

Principles of Cardiac Catheterization

- Pre-Fontan Evaluation
  - Hemodynamic assessment: Qp/Qs, PVR, ventricular end-diastolic, arch obstruction, atrial septum
  - Angiographic assessment: valvar regurgitation, PA anatomy/AVMs, DKS, distal arch
  - Opportunity for intervention: PA rehab, Coarctation, systemic-pulmonary collateral burden

Pre-Fontan Evaluation



Goldstein et al., Practice Variation in Single-Ventricle Patients Undergoing Elective Cardiac Catheterization: A Report from the Congenital Cardiac Catheterization Project on Outcomes (C3PO). *Congenit Heart Dis* 2016;11:122.

Children's Mercy KANSAS CITY

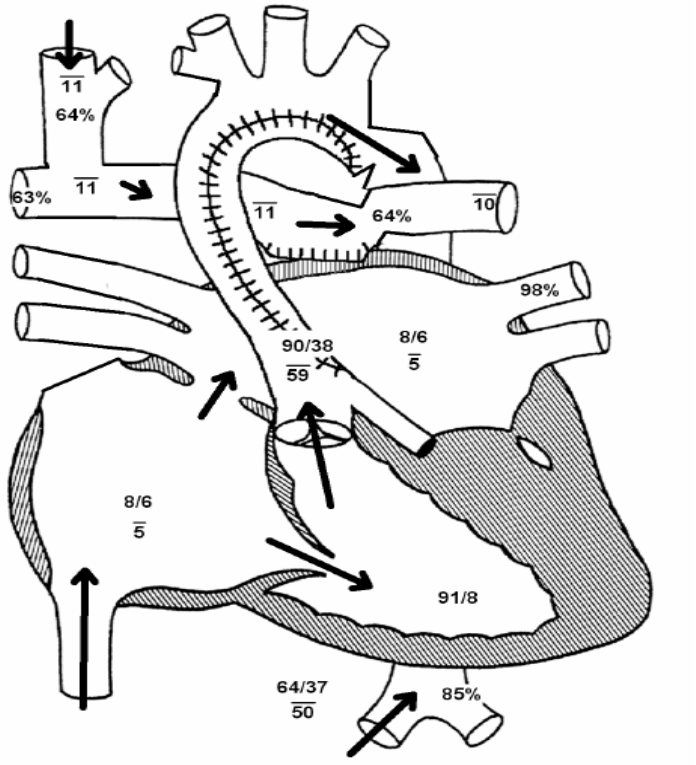
Pre-Fontan Evaluation

3yo HLHS s/p Mod Norwood/RMBTS and BDG

- Room Air, Sinus Rhythm
- VO2: 169 ml/min/m2 ???
- Hemoglobin: 15.9 gm/dL
- Qp = 1.38 L/min (2.30 L/min/m2) ???
- Qs = 2.23 L/min (3.72 L/min/m2)
- Rp = 4.35 units (2.61 units x m2) ???
- Rs = 20.15 units (12.09 units x m2)
- Qp/Qs = 0.62 : 1 | Rp/Rs = 0.22

Children's Mercy HOSPITAL

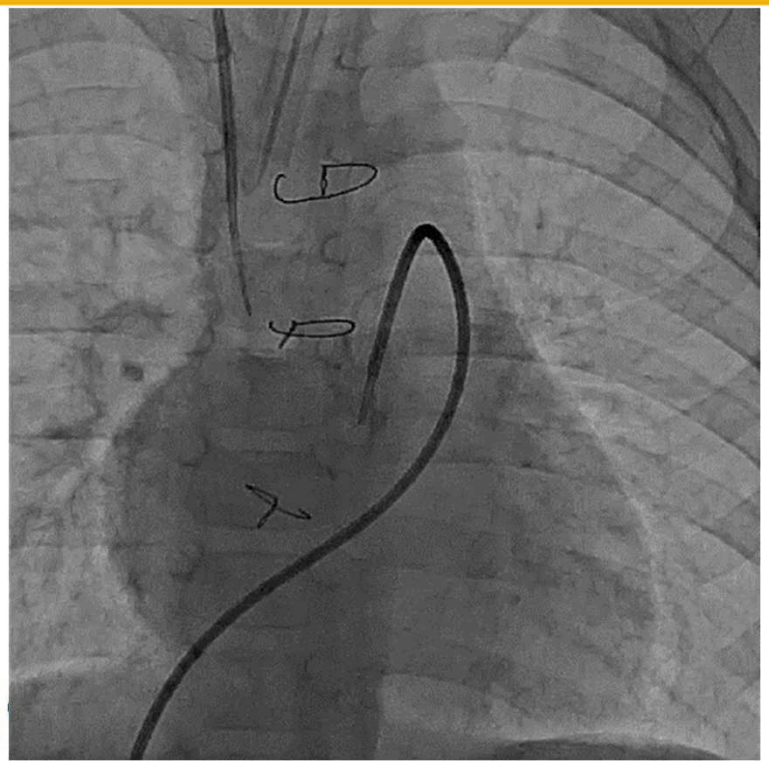
Children's Mercy Hospital
Kansas City, Missouri
Pediatric Cardiology
Cardiac Catheterization Laboratory

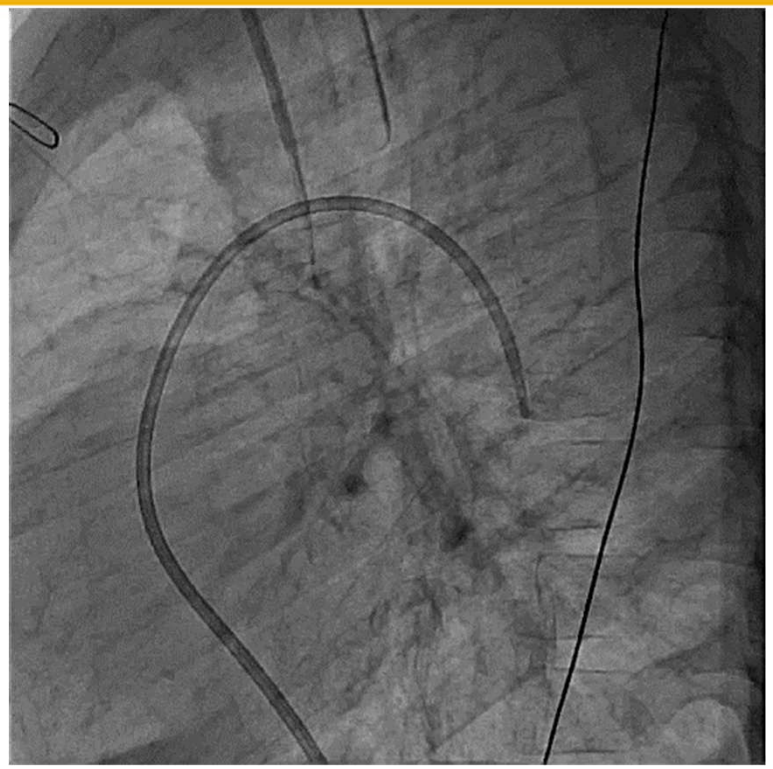


Arrows indicate catheter course.

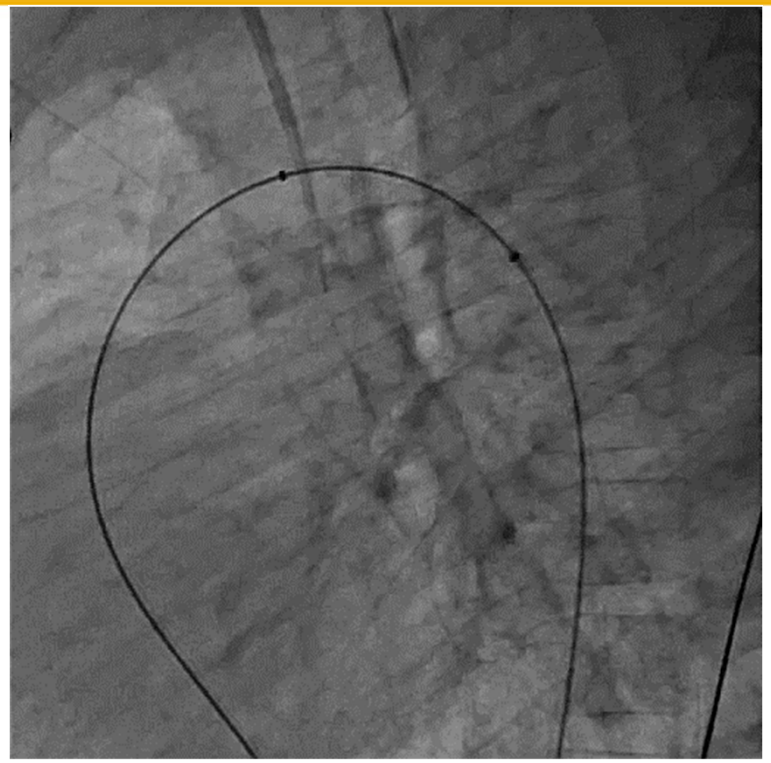
Children's Mercy KANSAS CITY

Pre-Fontan Arch Obstruction



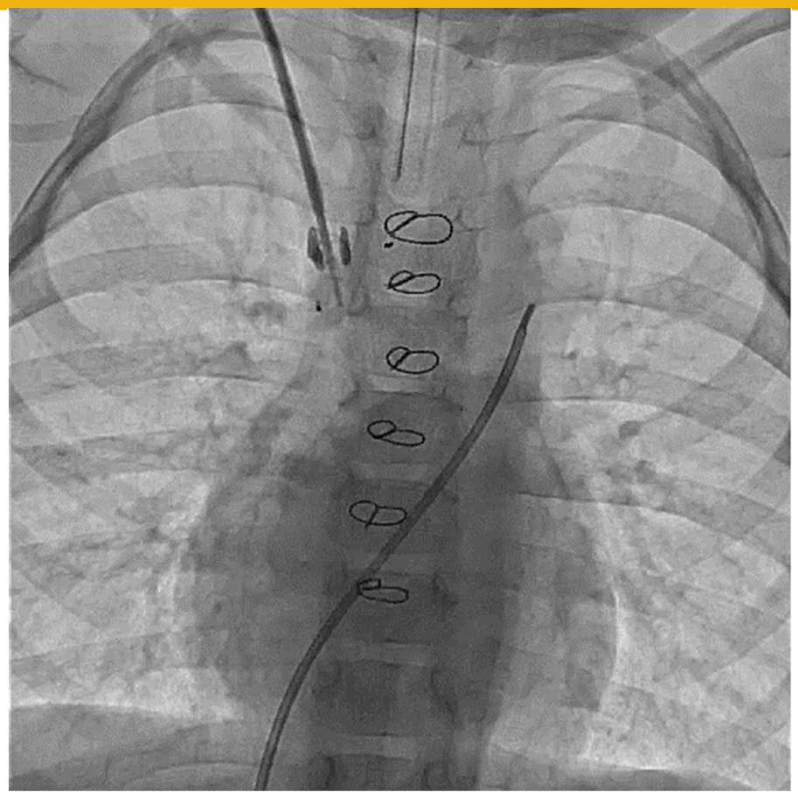


Pre-Fontan Arch Obstruction



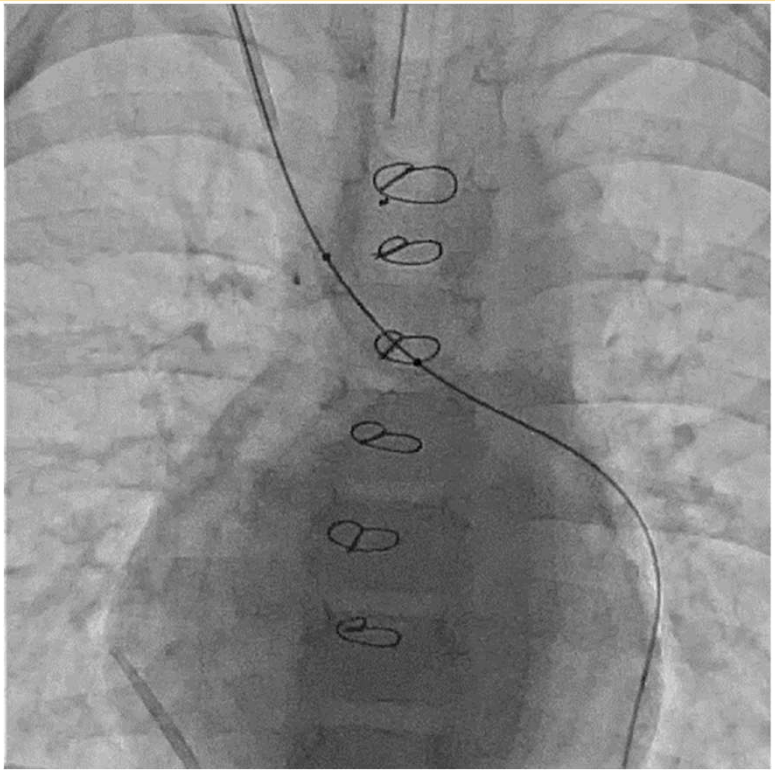
Children's Mercy KANSAS CITY

Pre-Fontan Glenn Obstruction



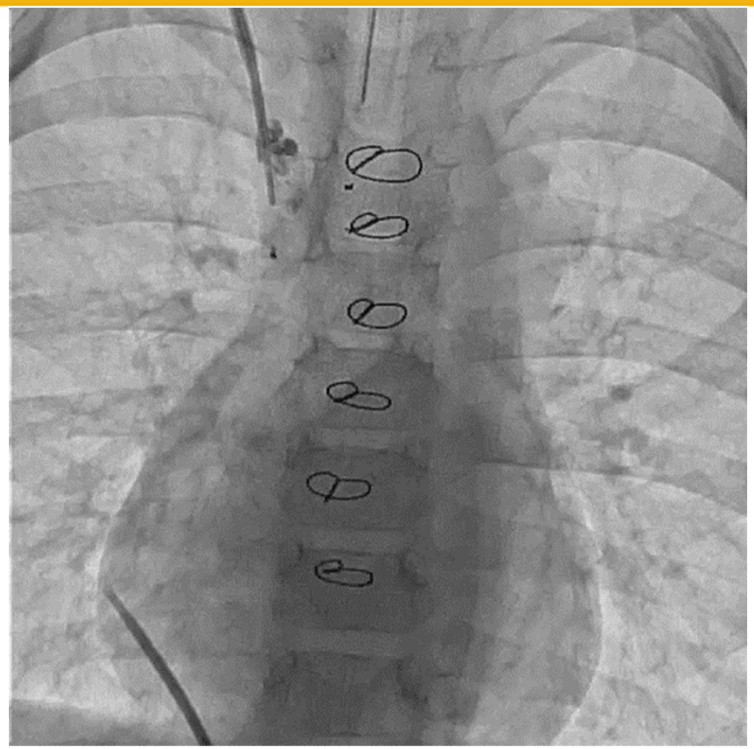
Children's Mercy KANSAS CITY

Pre-Fontan Glenn Obstruction



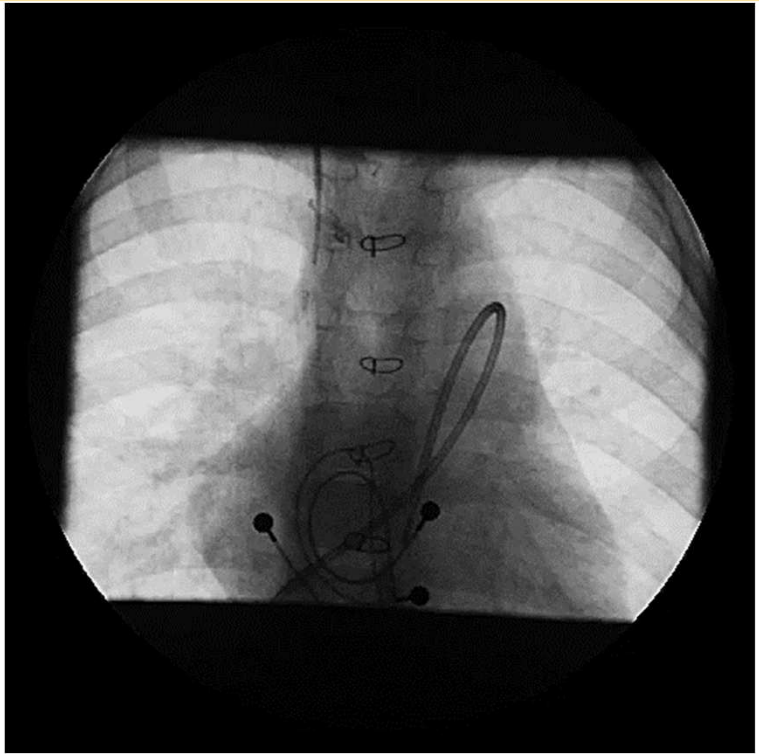
Children's Mercy KANSAS CITY

Pre-Fontan Glenn Obstruction



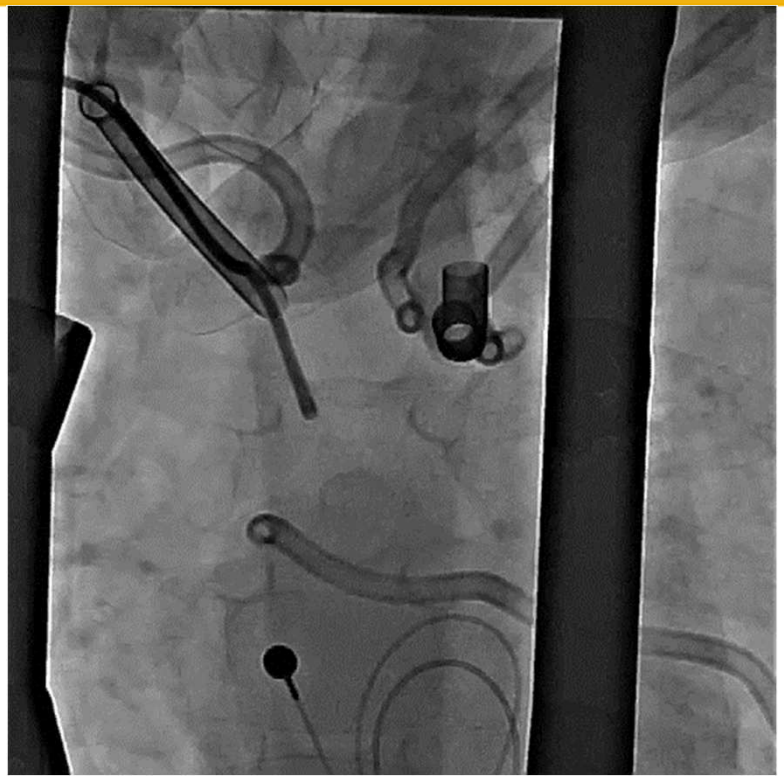
Children's Mercy KANSAS CITY

Pre-Fontan – LPA stenosis



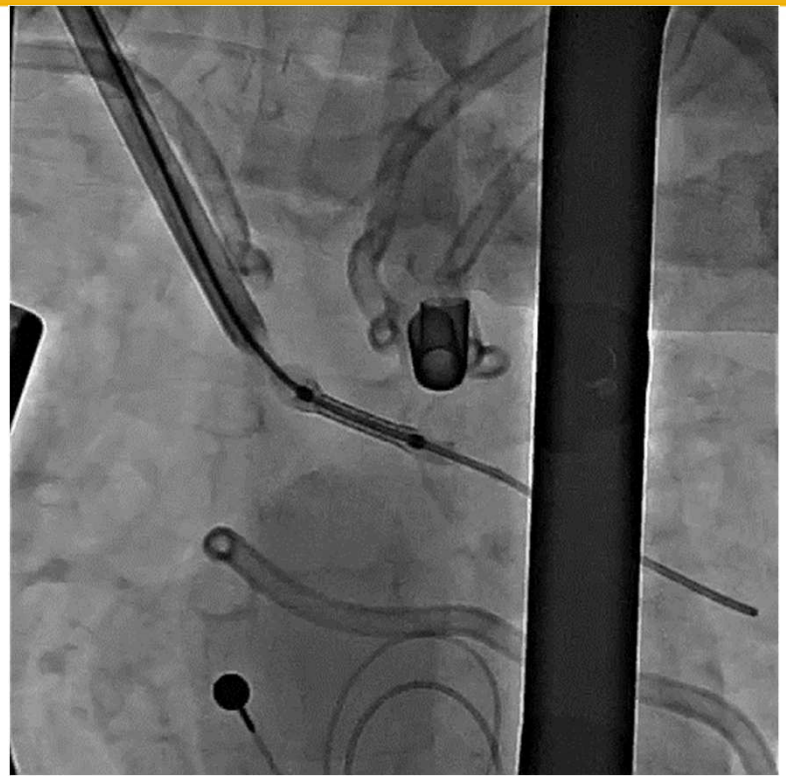
Children's Mercy KANSAS CITY

Hybrid Fontan – LPA stenosis



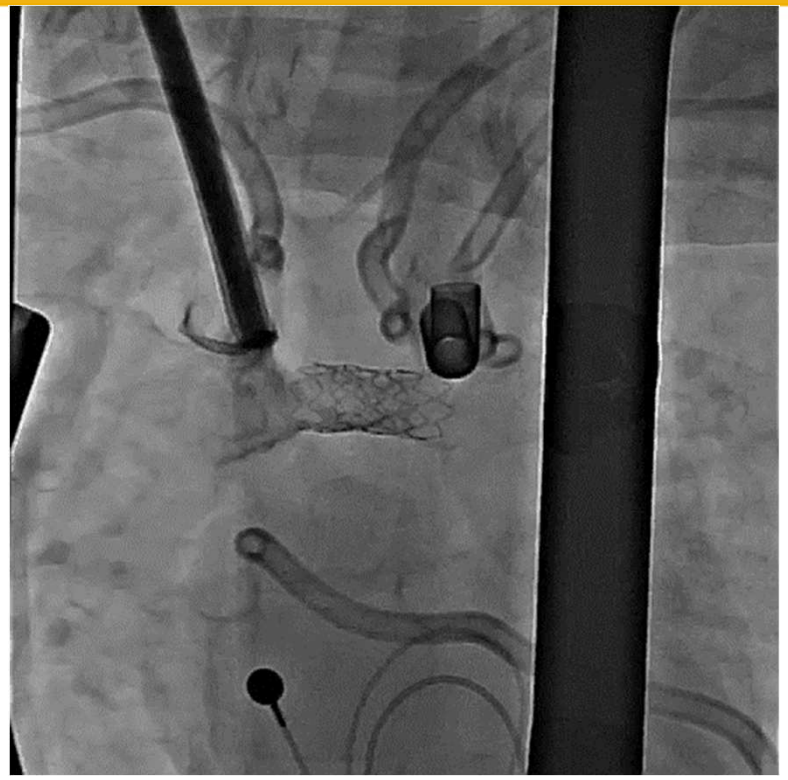
Children's Mercy KANSAS CITY

Hybrid Fontan – LPA stenosis



Children's Mercy KANSAS CITY

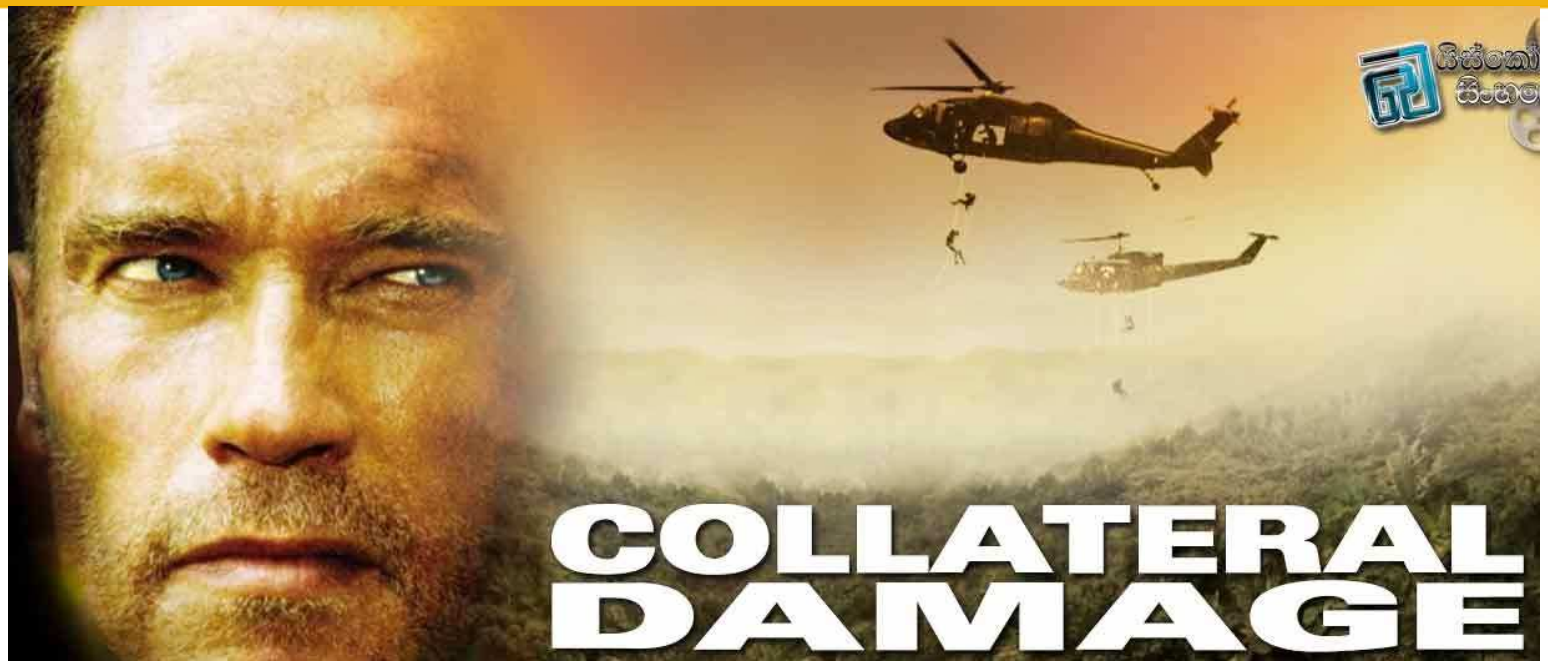
Hybrid Fontan – LPA stenosis



Children's Mercy KANSAS CITY

Children's Mercy KANSAS CITY

Systemic to Pulmonary Collaterals

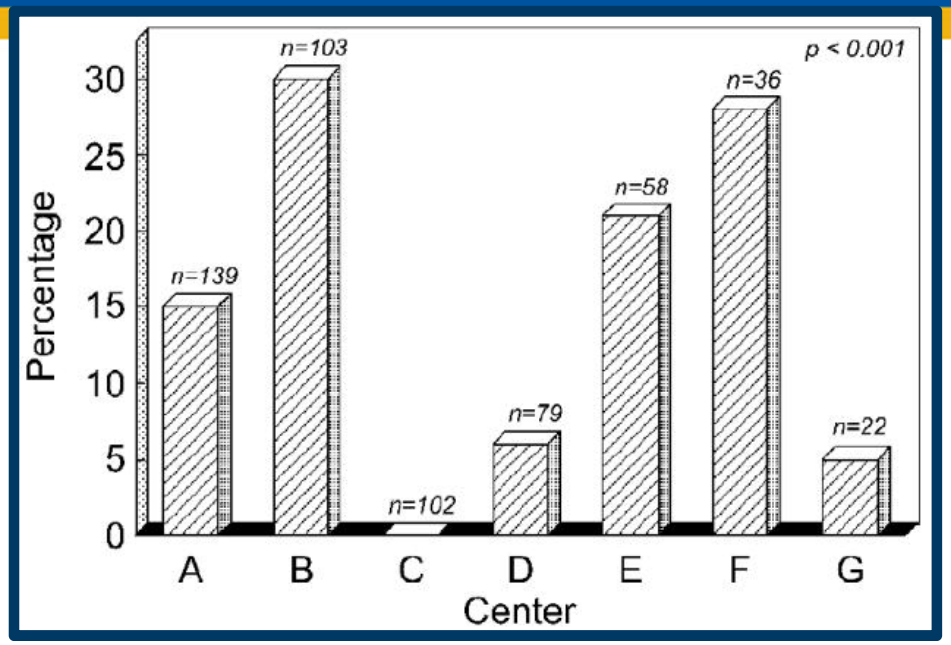


Children's Mercy KANSAS CITY

Systemic to Pulmonary Collaterals

- What: communications from brachiocephalic, bronchial and intercostal arteries to pulmonary circulation
- Why: hypoxemia?
- Good: support SaO2; diminish pulmonary AVMs risk
- Bad: Increase PBF and SV volume, diminish efficiency

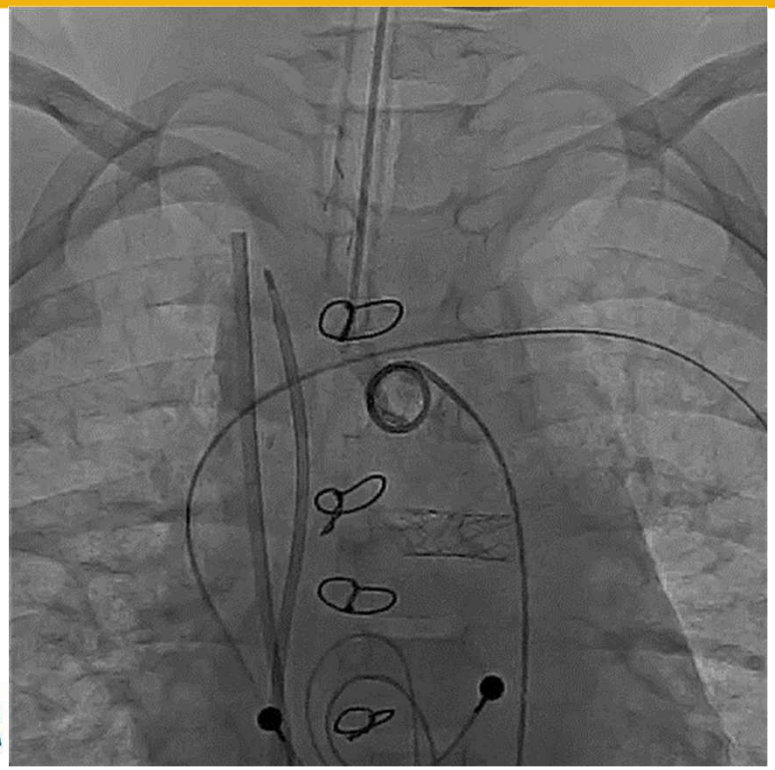
Pre-Fontan SPC Intervention

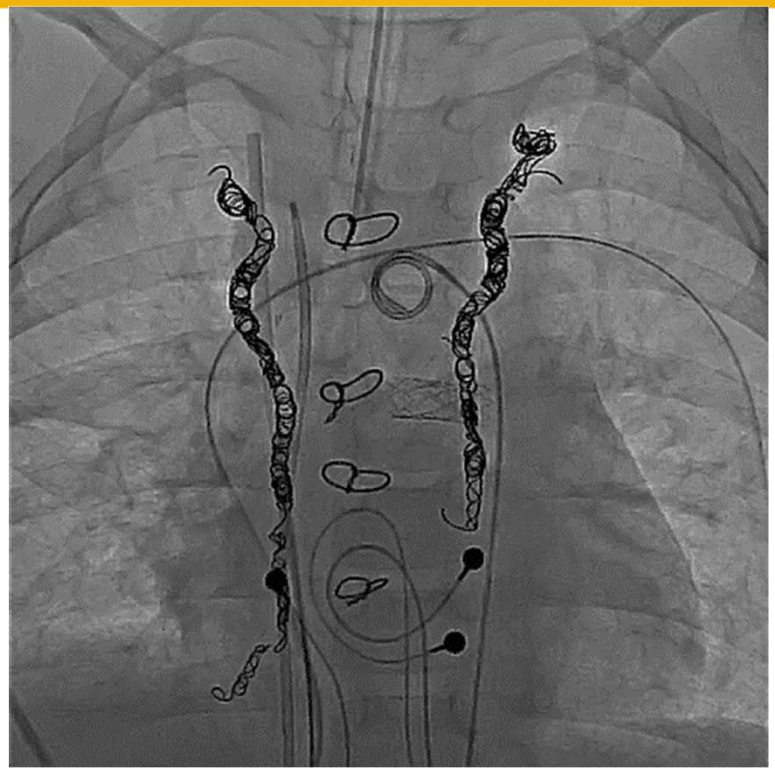


Banka et al., Practice Variability and Outcomes of Coil Embolization of Aortopulmonary Collaterals Prior to Fontan Completion: A Report from the Pediatric Heart Network Fontan Cross-Sectional Study. *Am Heart J* 2011;162:125.

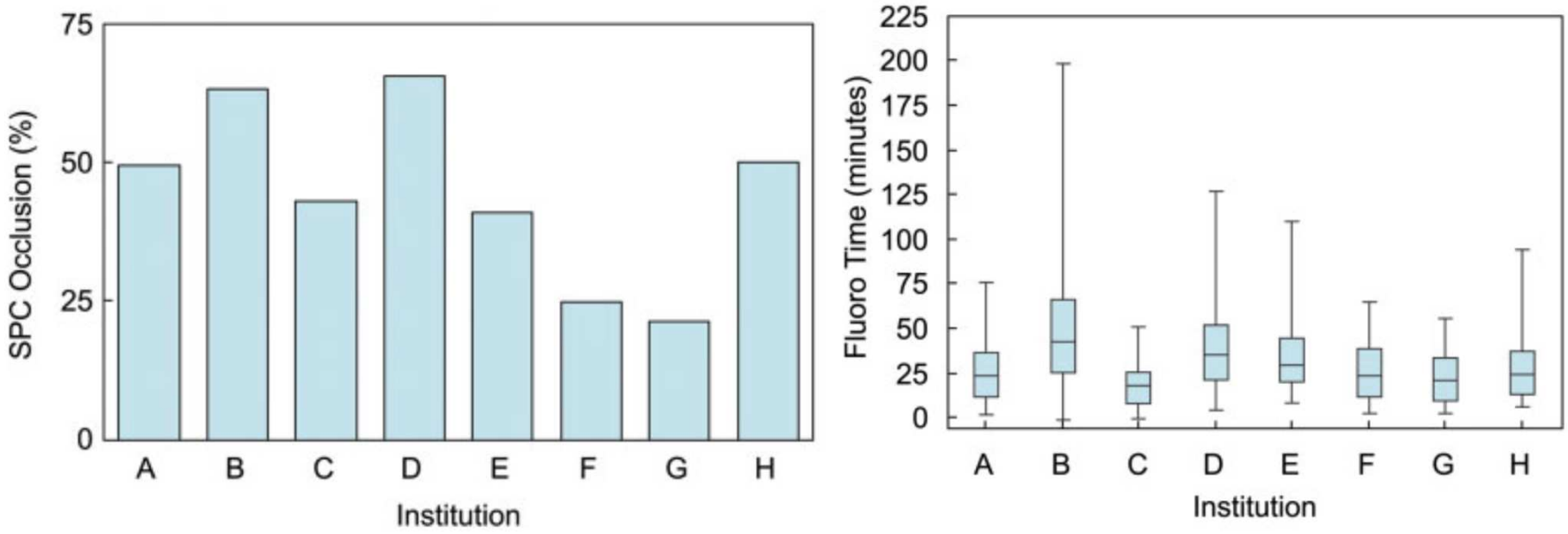
Children's Mercy KANSAS CITY

Systemic to Pulmonary Collaterals





Pre-Fontan SPC Intervention

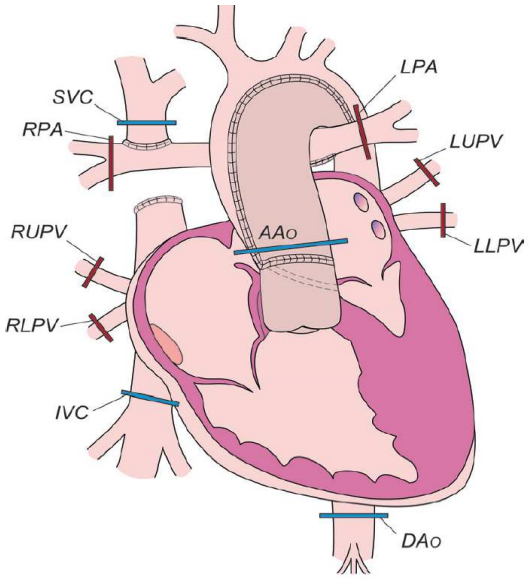


Children's Mercy KANSAS CITY

Goldstein et al., Practice Variation in Single-Ventricle Patients Undergoing Elective Cardiac Catheterization: A Report from the Congenital Cardiac Catheterization Project on Outcomes (C3PO). *Congenit Heart Dis* 2016;11:122.

MRI Quantification of SPC Flow

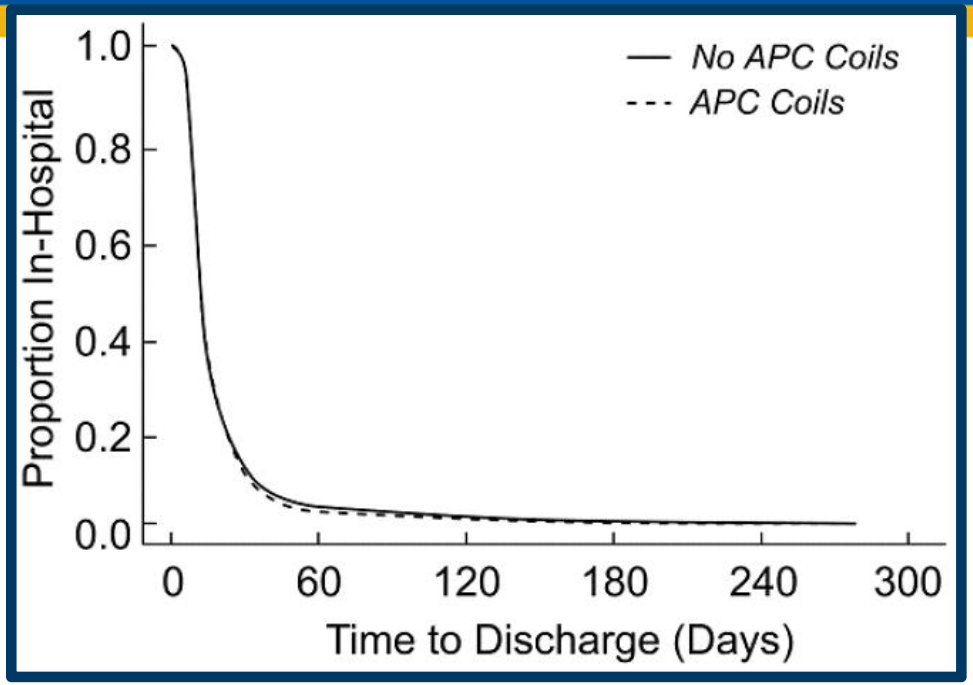
- Whitehead et al., *Circ Cardiovasc Imaging* 2009;2:405.
- Glatz et al., *Circ Cardiovasc Imaging* 2012;5:218.
- Dori et al., *Circ Cardiovasc Interv* 2013;6:101.



$SPC\ Flow_1 = (RPV_S + LPV_S) - (RPA + LPA)$
$SPC\ Flow_2 = AAo - (SVC + IVC)$

Children's Mercy KANSAS CITY

Pre-Fontan SPC Intervention



Children's Mercy KANSAS CITY

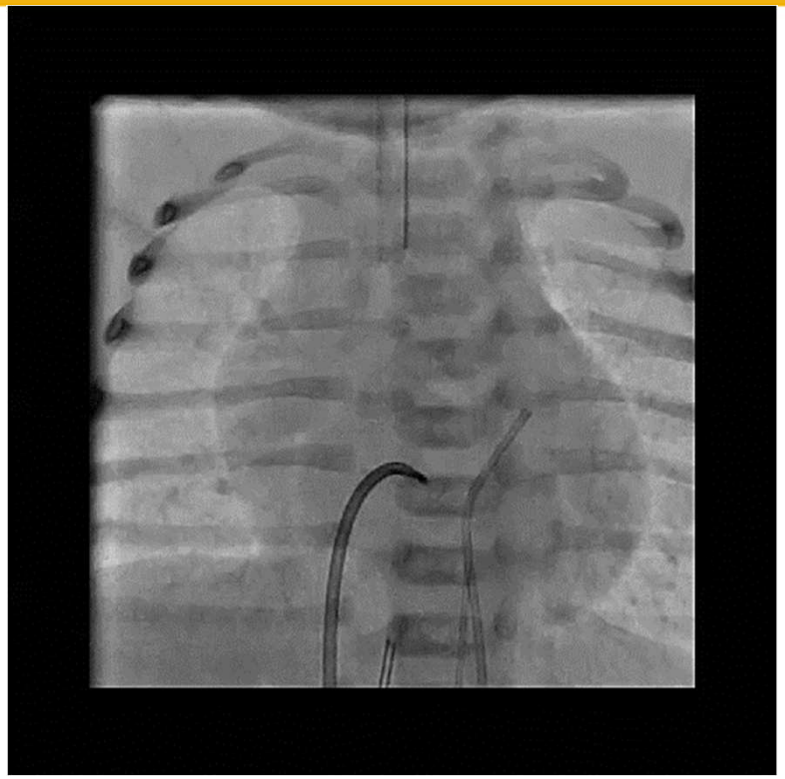
Banka et al., Practice Variability and Outcomes of Coil Embolization of Aortopulmonary Collaterals Prior to Fontan Completion: A Report from the Pediatric Heart Network Fontan Cross-Sectional Study. *Am Heart J* 2011;162:125.

Pre-Fontan SPC Intervention

Where does that leave us?

Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum



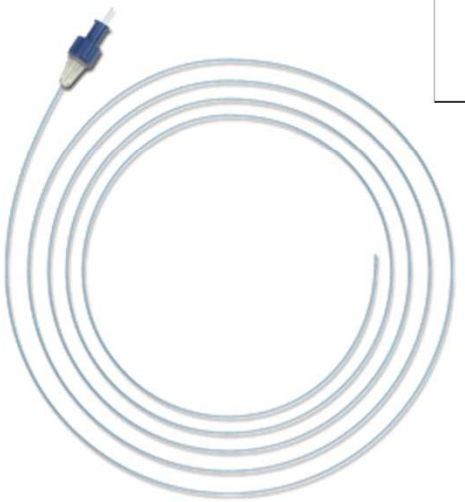
Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum

- PA/IVS with bipartite ventricle with pulmonary valve plate-like atresia and trivial RV-coronary communications
- RF wire perforation with Nykanen wire/coaxial catheter system (Baylis Medical)

Children's Mercy KANSAS CITY

Baylis RF System

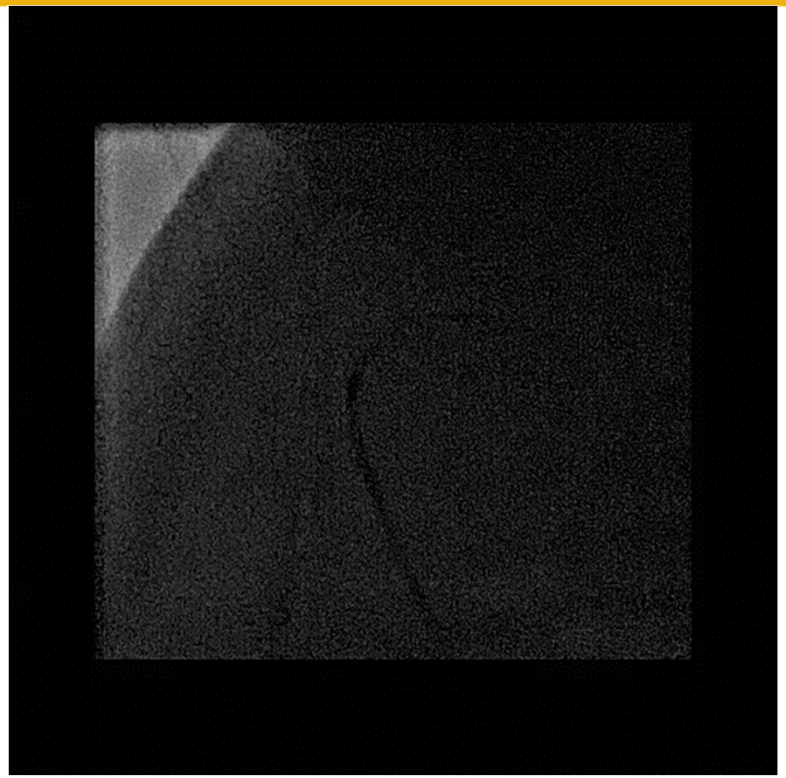


Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum

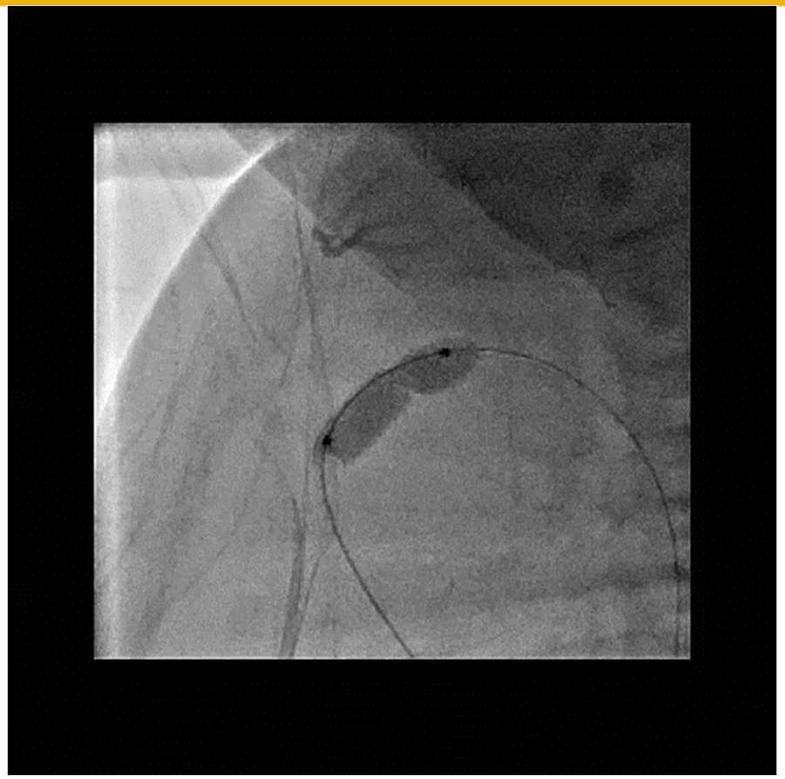
Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum



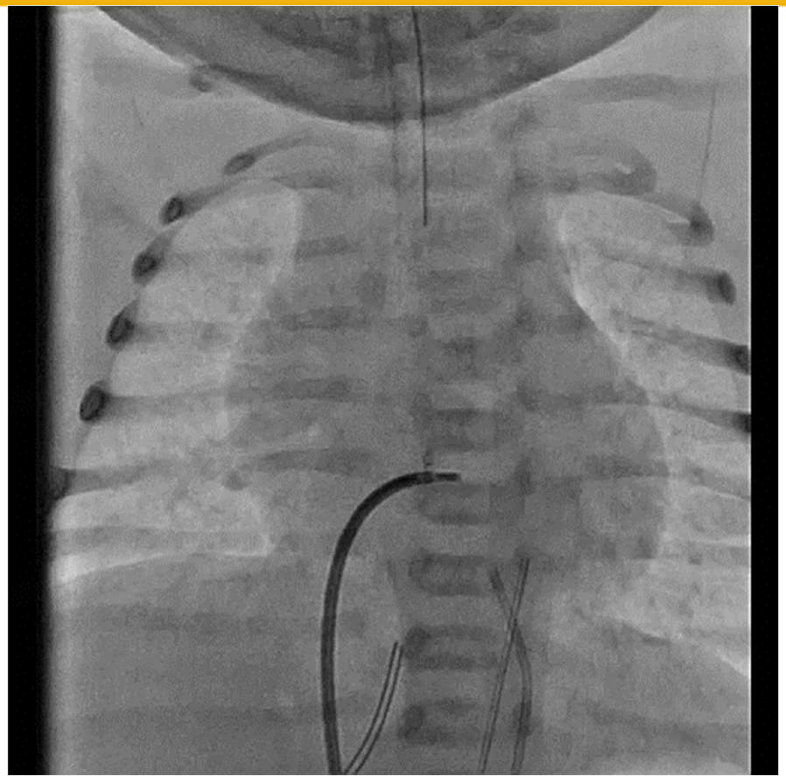
Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum



Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum

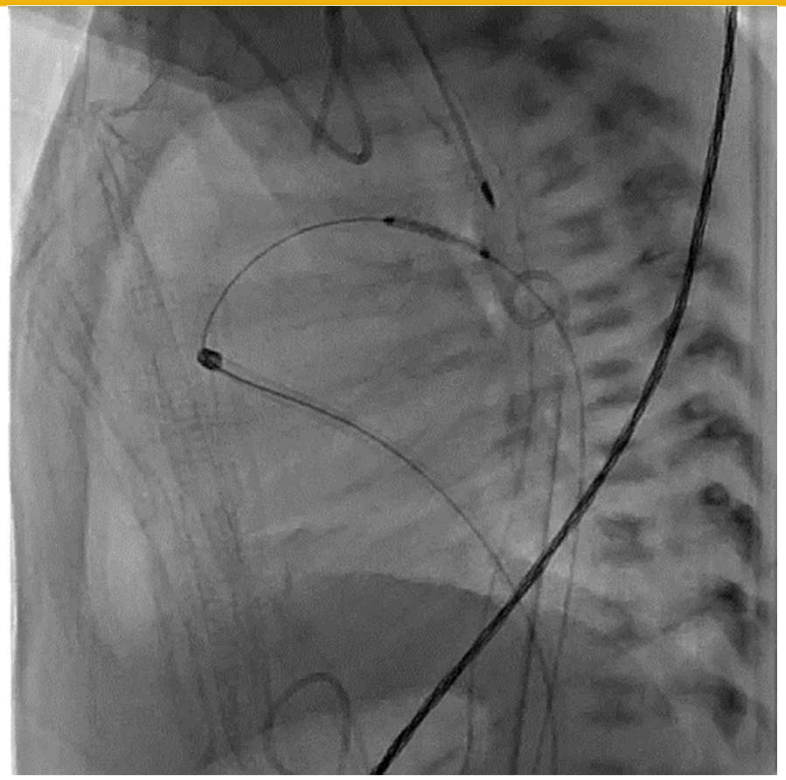


Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum

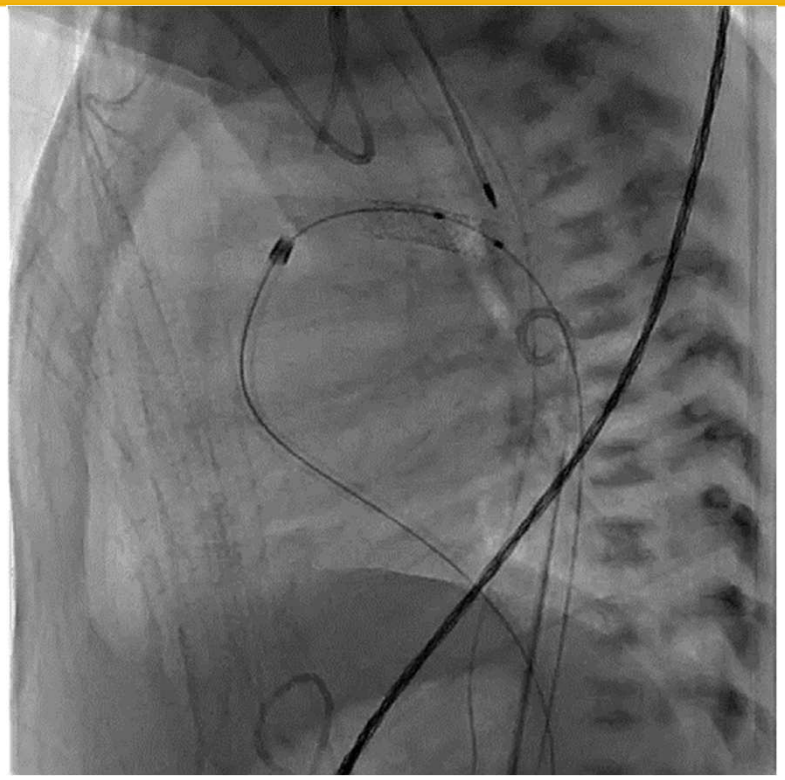
- **CMH experience (1999-2011): 20 underwent RFP/BDV**
  - Mean FU 4.2 years; survival 95%; FU SaO2 96 +/- 4%
  - 13 required augmentation of PBF (BTS or PDA stent)
  - APBF tricuspid z-score -1.26 +/- 0.98 vs. 0.40 +/- 0.57 no APBF (p=0.001)
  - 9 required surgical RVOT reconstruction during FU
  - 15 two-ventricle physiology; 4 required BDG/1.5 ventricle repair

Pulmonary Atresia/Intact Ventricular Septum



Children's Mercy KANSAS CITY

Pulmonary Atresia/Intact Ventricular Septum



Children's Mercy KANSAS CITY