Hybrid Stage I Palliation / Bilateral PAB

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CASE

- 1 week old neonate with HLHS
  - GA 38 weeks
  - Birth weight 3.0Kg
  - No definite risk factor

HLHS

- Norwood op.
  - Selective cerebral perfusion vs DHCA
  - Arch repair: patch vs direct anastomosis
  - BT shunt vs RV-PA conduit
  - Modification of RV-conduit anastomosis
- Hybrid procedure
  - Bilat. PAB + ductal stent
- Hybrid procedure : bridge to TPL
- Rapid 2 stage Norwood op
  - Norwood after bilat. PAB 2~4wks
- Bilat. PAB with continuous infusion of PGE1
  - Norwood + BCS
- TPL

Risk factors of Norwood operation

- Operative mortality: 30~40% → approaching 10%
- Low birth wt
- Prematurity
- Significant TR / Restrictive IAS / Poor ventricular function
- Preoperative shock
- Renal failure
- Small asc. Aorta
- Extracardiac abnormalities
- Chromosomal abnormalities

Norwood operation

- Unstable in-parallel circulation of Norwood physiology (BT shunt)
- Surgical stress driven by CPB and systemic inflammatory response

Hybrid palliation / Rapid 2 stage Norwood operation

- For high risk patients
- Shifting the major surgical stage to later in life

Hybrid approach for HLHS: intermediate results after learning curve

Table 5. Comparative Data from Published Series

	NCH-Hybrid Approach n = 40	CHB-BTS n = 46	CHB-RVPA n = 34	CHOP-BTS n = 95	CHOP-RVPA n = 54
Mortality stage 1	2%	11%	15%	14%	17%
Mortality interstage	5%	14%	0%	17%	5%
Interstage reintervention	36%	33%	27%	18%	37%
Rate of weight gain (gm/day)	16 (9–33)	16.5 (10–60)	20.6 (10–40)		
Gastrostomy tube	6 pts	6 pts	1 pt		
Moderate or severe RV dysfunction pre-2	0%	4%	10%		
Moderate or severe TV regurgitation pre-2	3%	26%	16%		
Moderate or severe RV dysfunction post-2	3%				
Moderate or severe TV regurgitation post-2	3%				
Mortality stage 2	8%				
Open sternum 1 or 2	0%	92%	79%	23%	33%
ECMO 1 or 2	0%	19%	7%	14%	13%
Combined hospital LOS, 1+2	21	33	22	18	18.5
Overall survival ("usual risk")	82.5%	76%	79%	68% ("86%")	74% ("86%")

BTS = Blalock-Taussig shunt; CHB = Children's Hospital Boston; CHOP = Children's Hospital of Philadelphia; Data = median (range); ECMO = extracorporeal membrane oxygenation; LOS = length of stay in days; NCH = Nationwide Children's Hospital; pt = patient; RV = right ventricle; RVPA = right ventricle to pulmonary artery conduit; TV = tricuspid valve.

Galantowicz et al Ann Thorac Surg 2008;85:2063-2071

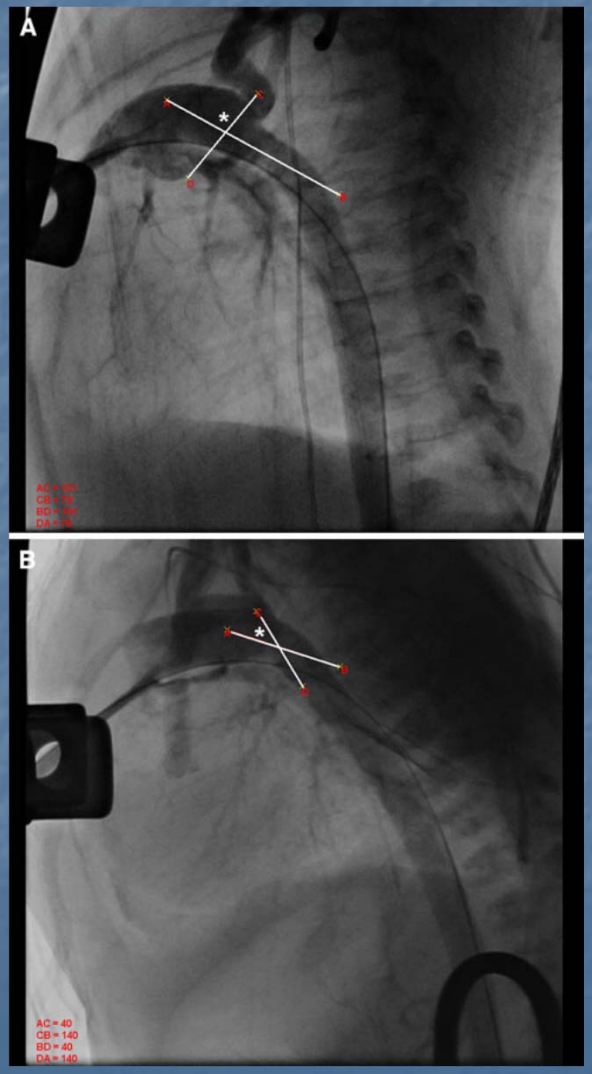
Hybrid vs Norwood operation

- Equivalent but not superior stage 1 palliation survival
- Comparable 1 year survival to conventional Norwood palliation
- Comparable pre-stage II hemodynamics and pulmonary artery growth
- Preserved ventricular function in stage II palliation

not randomized trial, different population, recently introduced

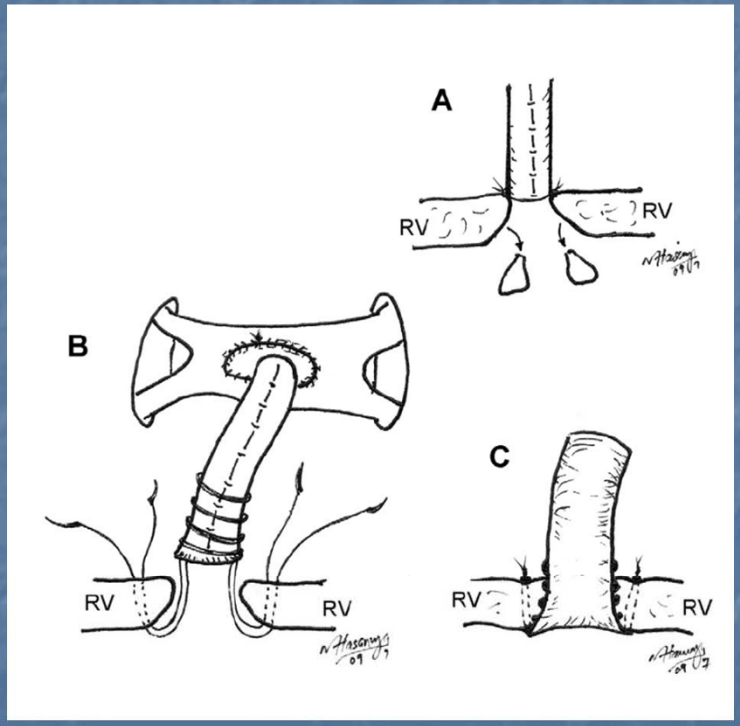
Predictors of RAAO after Hybrid palliation

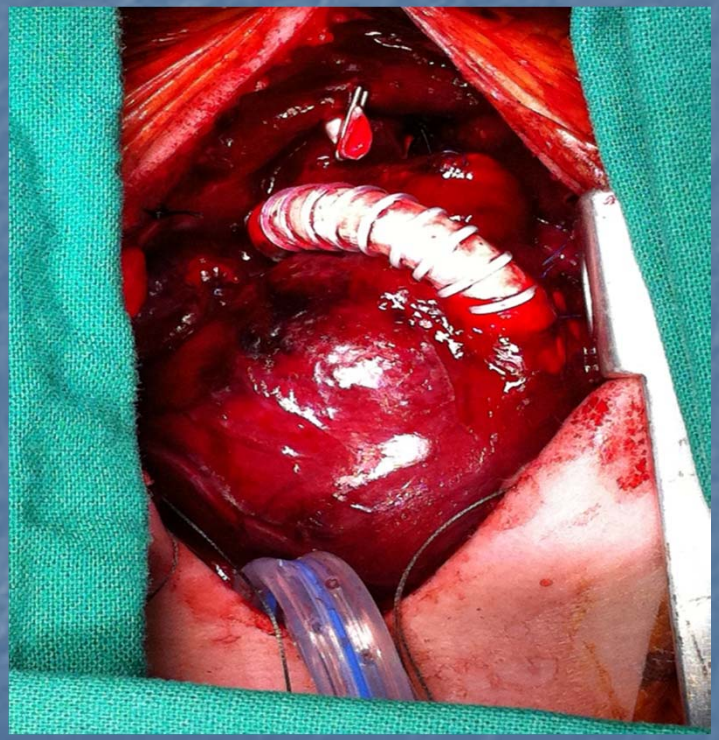
- 29% of pts
- Aortic atresia
- Small aortic root size
- Larger angiographic angle btw PDA and isthmus
- Higher retrograde aortic arch velocities



Nationwide Children's Hosp, Ohio, Pediatr Cardiol 2011

Rapid 2 stage Norwood operation
: Modification of conduit anastomosis





Rapid 2 stage Norwood operation
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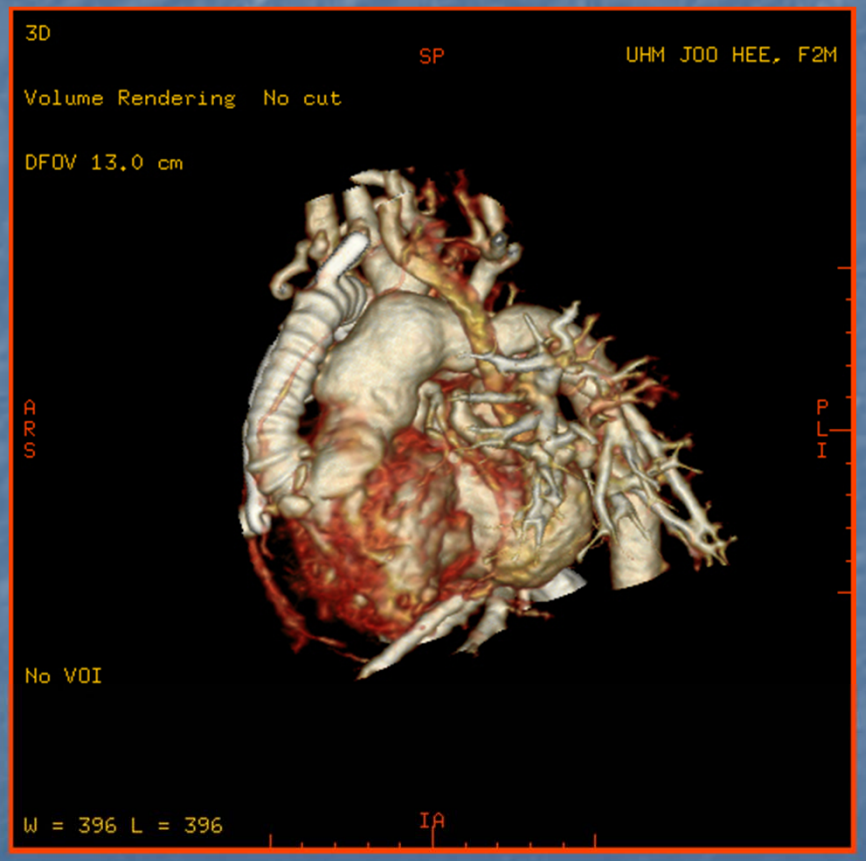


HLHS

- Increasing surgical and interventional options.
- Remarkable improvements in results, with ongoing evolution
- Case by case
- Consideration of hospital's experiences and results

Department of
Cardiovascular Surgery

Rapid Stage bilateral PA banding

Progress of Fetal echocardiogram
Progress of Maternal transfer
Progress of Hybrid strategy

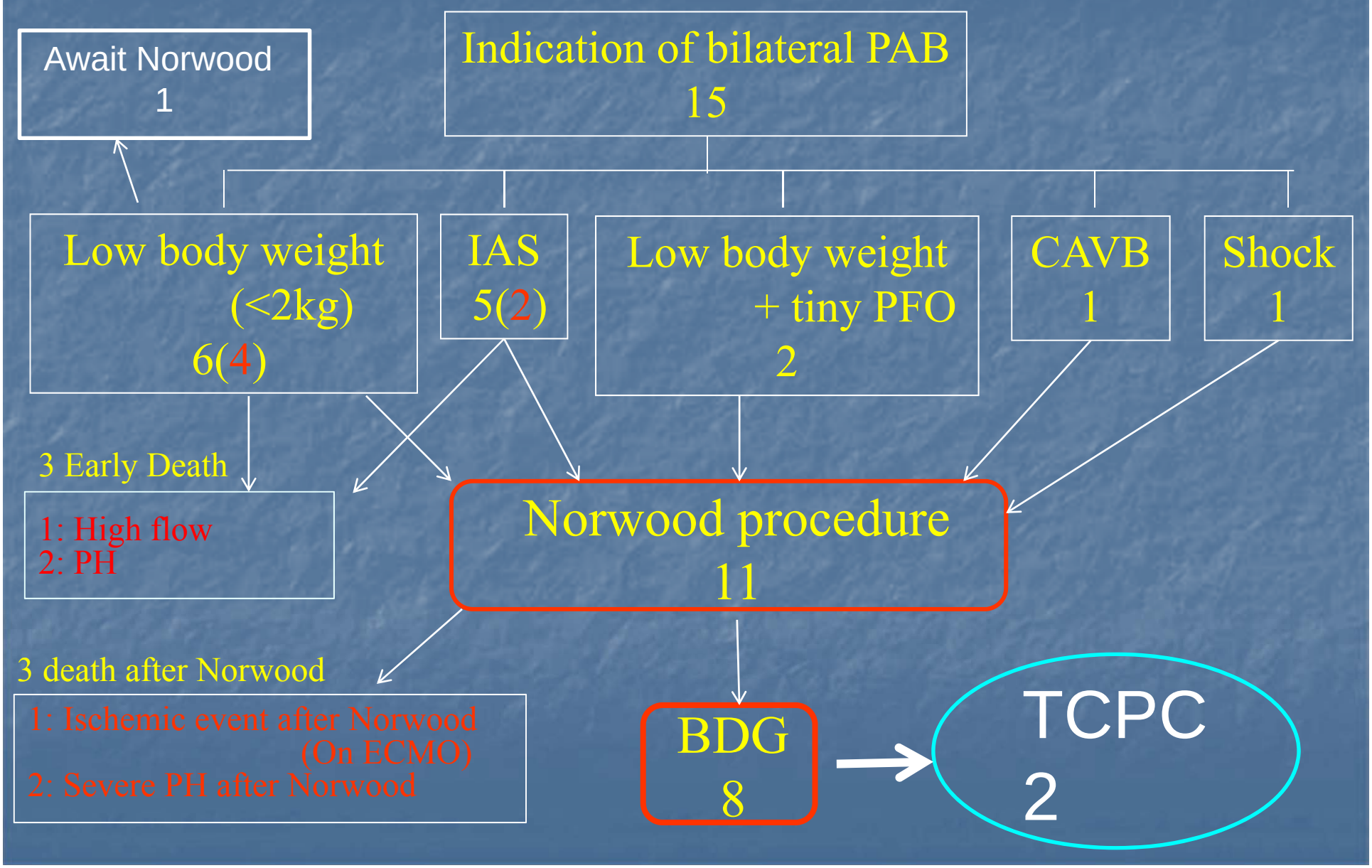
Intact atrial septum
Preoperative shock
Low birth weight

Bilateral PAB
Norwood procedure : 2-4 weeks time

Disadvantage of prolonged use of PGE1
Interstage high mortality after bil.PAB
Acceptable outcome of 1st stage palliation

Bilateral PA banding in high risk patients with HLHS

Result



Management of CHD

- Conventional therapy
  - Surgery
  - Catheter intervention
- Hybrid procedure
  - combination of surgical & interventional techniques
  - less invasive, less trauma to patient

Objectives of Stage 1 palliation for neonates with SV physiology

- Control PBF
- Unobstructed systemic output
- Unobstructed coronary flow
- Unrestricted atrial septum

avoiding CPB, cardioplegic arrest
circulatory arrest in neonatal period

Reverse BT shunt?

- Arch obstruction by ductal stent
  10%(4/40 cases) Galantowicz 2008 data
- Potential of coronary steal
- More complicated postop course

No longer use of reverse BT shunt

HLHS

- Marked hypoplasia or absence of the LV
  + Severe hypoplasia of the Asc. Aorta
- Ductus dependent systemic circulation
- Fatal lesion: without surgical intervention, 25% of cardiac death during the 1st wk of life
- Still high surgical and interstage mortality
- Anatomic subtype
  - AA + MS 45%
  - AA+ MA 41%
  - AS + MS 13%
  - AS + MA
- Significant TR 8~10%
- Dx: echo

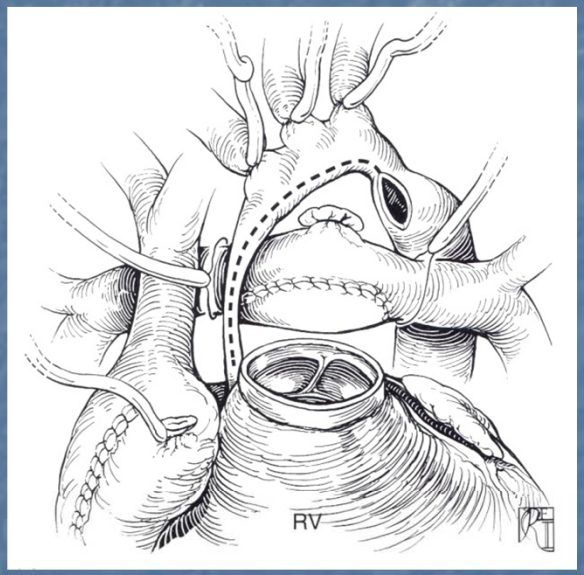
HLHS

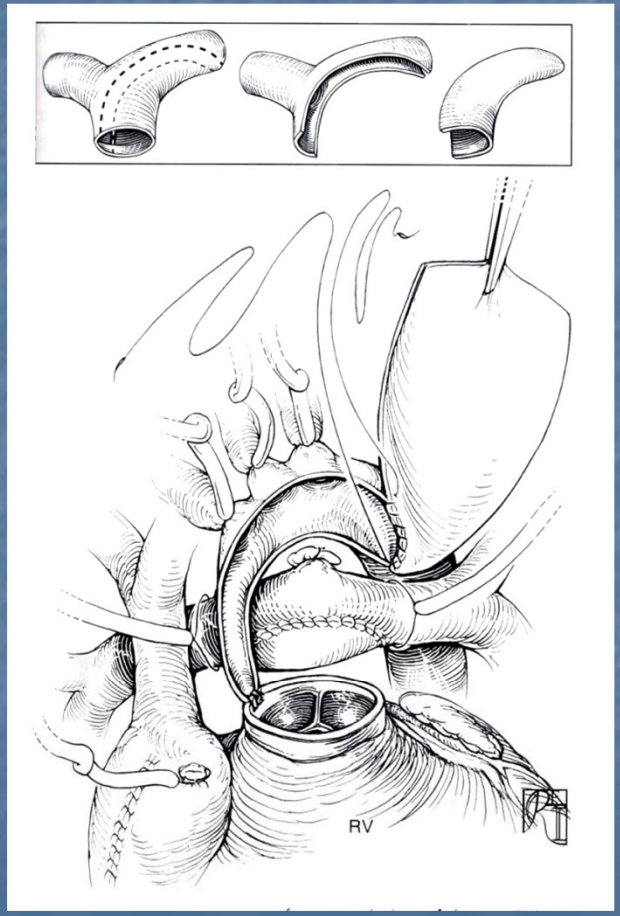
- Initial support
  - Maintenance of ductal patency: PGE1
  - Qp/Qs balance
  - Correction of metabolic acidosis

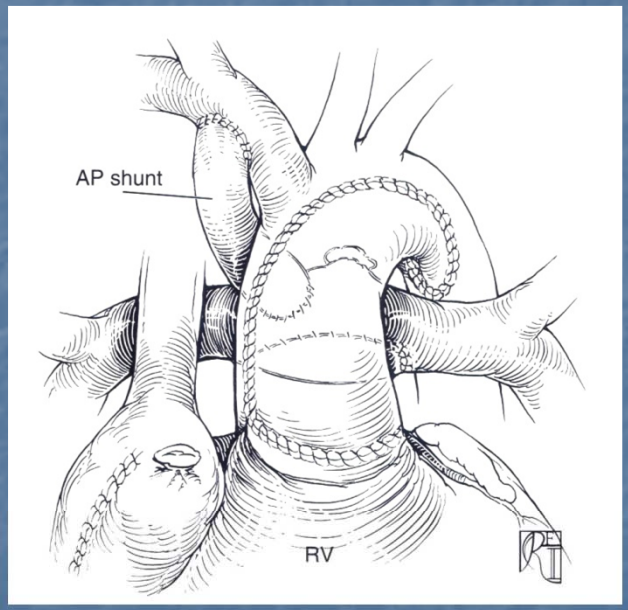
HLHS

- Priciples of 1st stage palliation
  - Unobstructed systemic flow
  - Unrestrictive ASD: Adequate mixing
  - Reliable PBF
- General aims
  - Preserve ventricular fxn by avoiding pressure and vol. overload
  - Minimize PVR by avoiding excessive PBF or PVO
  - Maintain optimal PA growth: adequate size and freedom from distortion

HLHS – Classic Norwood







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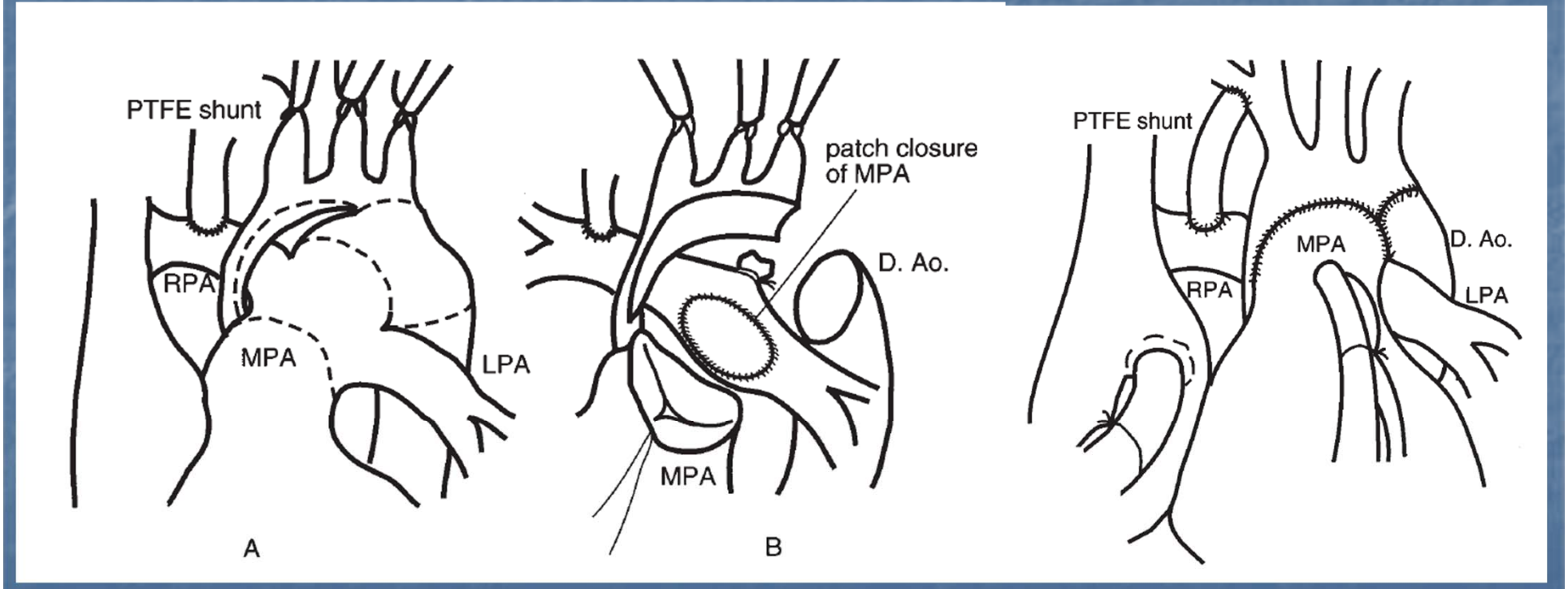

Hybrid procedure

- Beating heart/ short term CBP
- Extensive use of intraoperative imaging techniques (Fluoroscope/TEE/ICE)
- Devices

cath. Lab equipments

- Hybrid procedure
  - ➢ combination of surgical & interventional techniques
  - ➢ less invasive, less trauma to patient

Hybrid Procedure

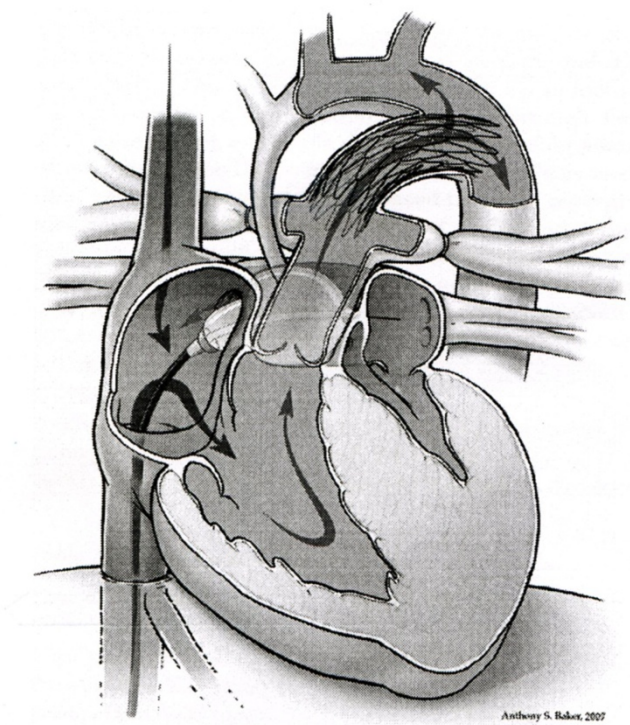

Fig 2. The hybrid stage 1 palliation. Branch pulmonary artery bands and a stent across the patent ductus arteriosus are placed at one procedure, while the balloon atrial septostomy is performed as a separate procedure.

- GA/median sternotomy/ off CPB
- Bilateral PAB
  - 3.5 mm GTVG(3.0 mm for <2.5 kg)
  - RT: SVC-AAo, Lt: LPA origin
- Ductal stenting
  - MPA sheath with pursestring
  - C-arm fluoroscoic guide
  - complete cover PDA
- BAS at cath Lab
  - just prior to discharge
  - mPG≥ 8 mmHg by Echo
- Reverse BT shunt

PAB size

- PTFE graft
  - cut into 5mm wide and opened, then this was re-sutured around through the pulmonary artery
- BWT
  - less than 2.5kg : 3.0mm PTFE graft
  - more than 2.5kg : 3.5mm PTFE graft
- PAB flow velocity : 3.5-4.0m/sec
- SaO2 : 80-85% on room air