THE HYBRID PROCEDURE FOR TWO VENTRICLE REPAIRS

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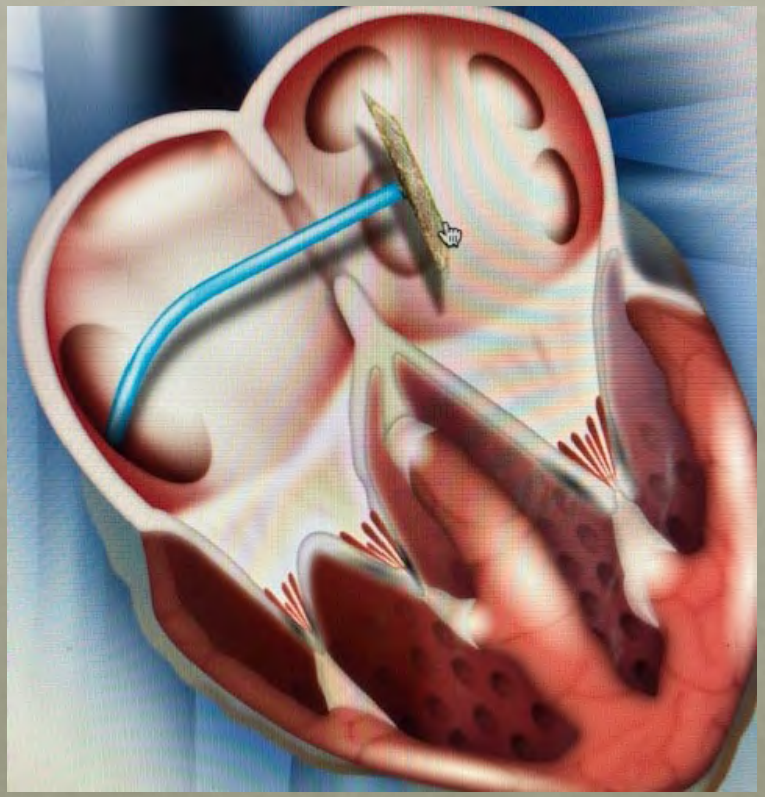
HYBRID PROCEDURE ORIGINS

Surgery

Intervention



HYBRID CARDIAC SURGICAL PROCEDURE

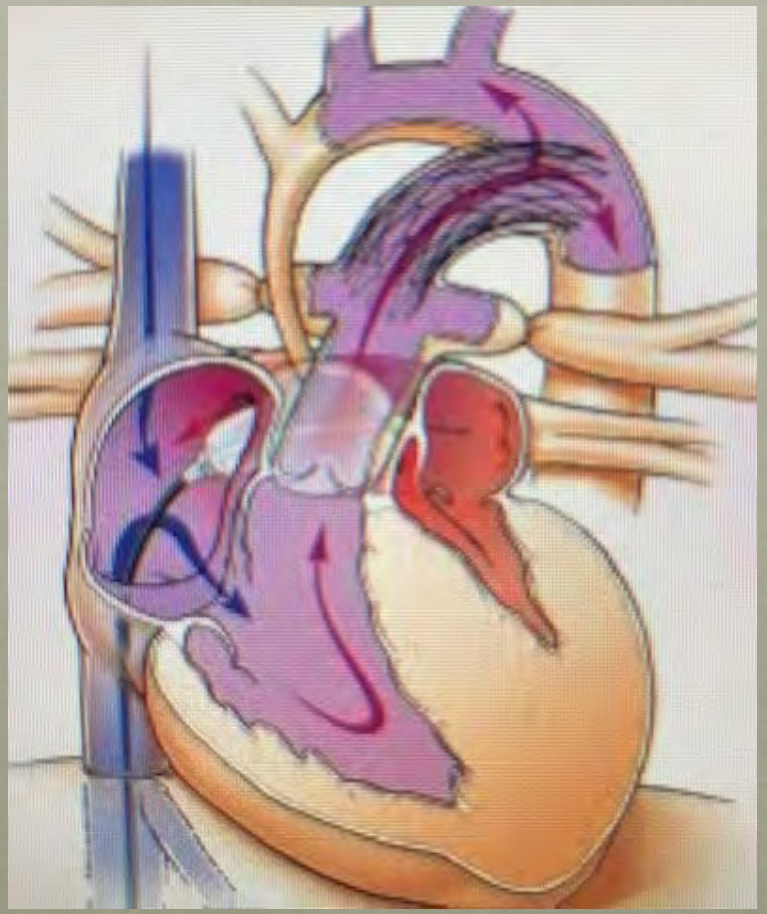
- In a narrow sense is defined as a procedure that combines a conventional surgical part (including a skin incision) with an interventional part, using some sort of catheter-based procedure guided by fluoroscopy (or other, e.g. CT or MRI) imaging in a hybrid OR without interruption.
- A wider definition includes a clinically connected succession of a catheter intervention and a surgical procedure with a time gap.

WikipediA

HYBRID CARDIAC SURGICAL PROCEDURE

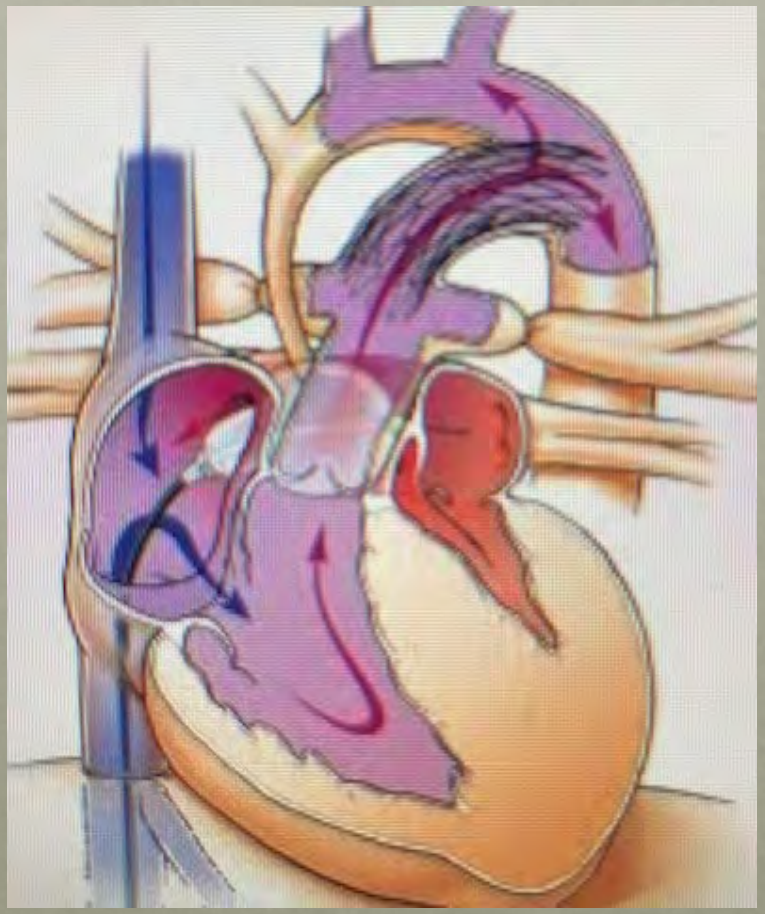
- Hypoplastic Left Heart Syndrome
- Muscular VSD by device closure via a median sternotomy
- Carotid cutdown for ductal stent
- LIMA plus OM stent
- TAVR, TEVAR
- Future TMVR

THE HYBRID PROCEDURE FOR HLHS



HYBRID FOR HLHS

- Median sternotomy
- Bilateral branch PA bands
- Ductal stent via PA sheath
- Atrial septostomy
- Hybrid OR



HISTORY OF HYBRID FOR HLHS

- In 1993 Gibbs et al reported the first stenting of the arterial duct (PDA) combined with bilateral branch PA bands and atrial septostomy as an alternative to the Norwood procedure.
- However, based on the initial eight patients, the same group from Leeds, England did not further recommend ductal stenting as a palliation of newborns with ductal-dependent systemic blood flow.

Circulation. 2016 Oct 25: 134(17): 1265-1279

HISTORY OF HYBRID FOR HLHS

- In Giessen, Germany a second highly collaborative group achieved success by surgically performed bPAB via a brief open chest procedure followed by a second elective percutaneous transcatheter PDA stenting which was combined with atrial septostomy.
- This patient was admitted in cardiogenic shock and was sucessfully palliated.
- Five months later, in 1998 Hakan Akintuerk performed the first comprehensive stage 2.
- Fontan completion also successful and publication in 2002.

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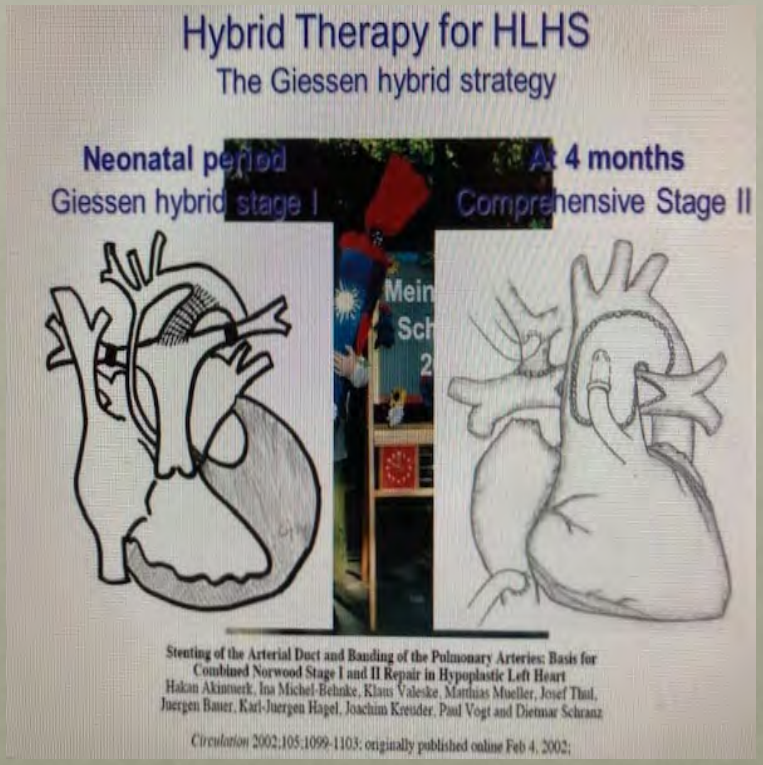
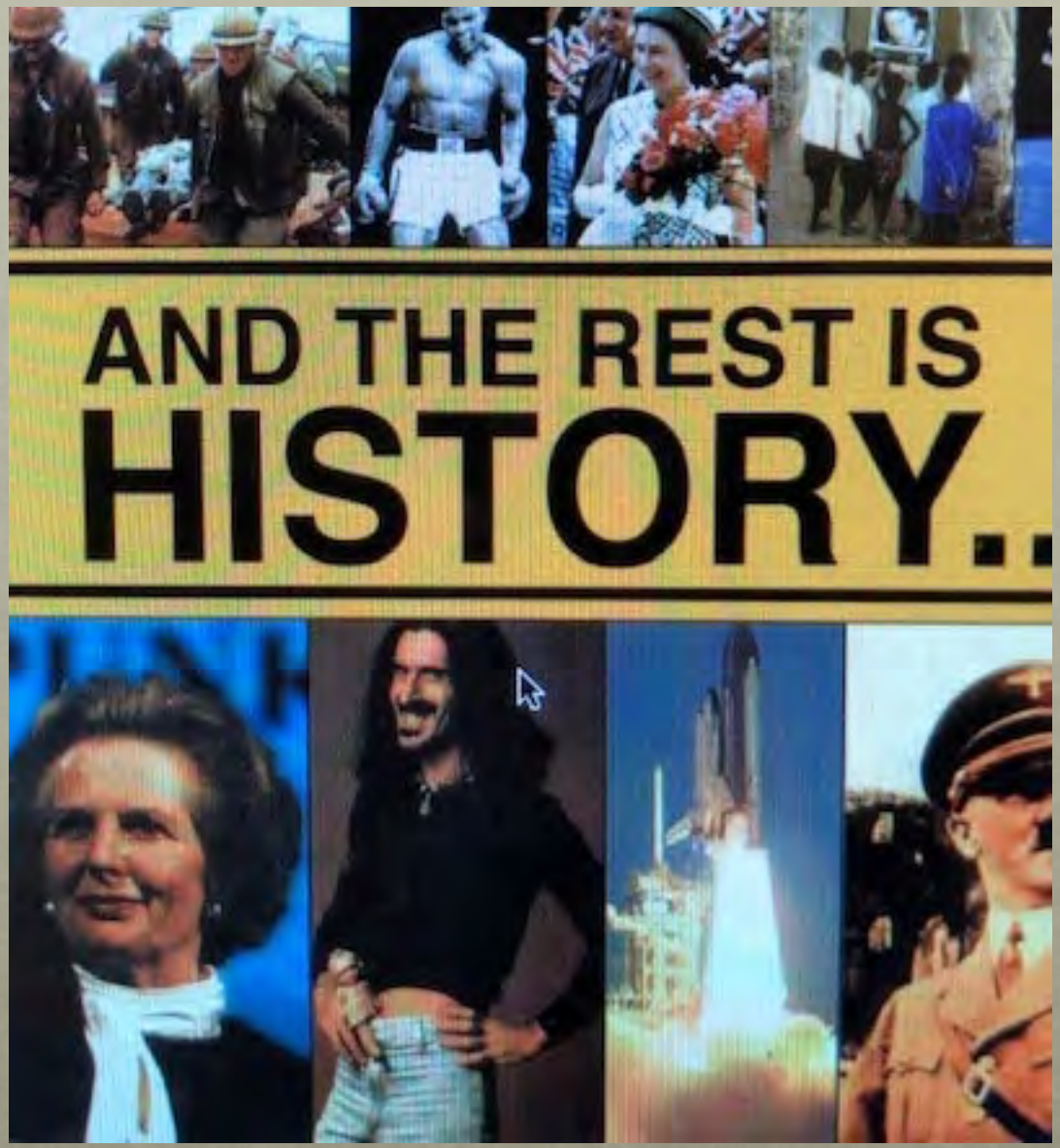
HISTORY OF HYBRID FOR HLHS



HISTORY OF HYBRID FOR HLHS

- Independent from the Giessen group, early in the new millennium a second group of collaboratively minded interventionists and surgeons in Columbus, Ohio focused on a one-step Hybrid procedure, which entailed placing a stent within the duct by transpulmonary access immediately after bPAB during the same open chest approach.
- Percutaneous manipulation of the interatrial septum was delayed until just before the palliated patient was discharged home.
- In both Giessen and Columbus the hybrid procedure replaced the Norwood procedure as the preferred first stage of palliation.

Circulation. 2016 Oct 25: 134(17): 1265-1279


AND THE REST IS
HISTORY..

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ORIGINAL ARTICLE

Hybrid Palliation for Ductal-Dependent Systemic Circulation

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Abstract We reviewed our hybrid palliation experience for 91 neonates, with ductal-dependent systemic circulation, born between August 2007 and October 2015. For analysis, we stratified the 91 patients by a risk factor (RF) score and divided them into three groups: (1) high-risk two-functional ventricles (2V) median RF score of 3 ($N = 20$); (2) low-risk one-functional ventricle (1V) RF score 0–1 ($N = 32$); and (3) high-risk 1V RF score ≥ 2 ($N = 39$). Midterm survival (median 4 years) by group was: (1) 95 %, (2) 91 %, and (3) 15 %, ($p = 0.001$). In conclusion, hybrid palliation was associated with excellent midterm results for high-risk 2V and low-risk 1V patients with ductal-dependent systemic circulation. In contrast, high-risk 1V patients had significantly worse outcomes.

Keywords Hybrid procedure · Ductal-dependent systemic circulation · Hypoplastic left heart syndrome · Hypoplastic aortic arch

Introduction

Cardiac malformations with ductal-dependent systemic circulation occur in about 0.04 % (4/10,000) of live births [43]. Conditions principally include hypoplastic left heart syndrome (HLHS), hypoplastic aortic arch and coarctation, interrupted aortic arch, critical aortic stenosis, and severe Shone complex. Most often, management includes prostaglandin and neonatal open-heart procedures. Described in the 1990s [16], hybrid stage 1 palliation avoids neonatal open-heart surgery, delaying a comprehensive, open-heart stage 2 procedure to approximately 6 months of age. Hybrid palliation has become a management alternative, especially at some centers for high-risk, premature, or low-birth newborns with 1V ductal-dependent systemic circulation [1, 3, 8, 15, 23, 24, 26–28]. Commencing in 2007, our center elected to employ hybrid palliation for low-risk 1V, high-risk 1V, and high-risk 2V patients. This report reviews our experience.

Methods

This study received approval from the local institutional review board. We obtained data for this observational, nonrandomized, retrospective report by inquiring our research database (Epi-InfoTM) and electronic health records. We analyzed data from all neonates, born between August 2007 and October 2015, with ductal-dependent systemic circulation referred to our center that underwent hybrid palliation. We excluded those that did not undergo hybrid palliation and those that parents elected comfort care before any intervention. The Children's Heart Center Nevada is the sole provider of congenital heart care in the state, and our database and EHR contain information on all

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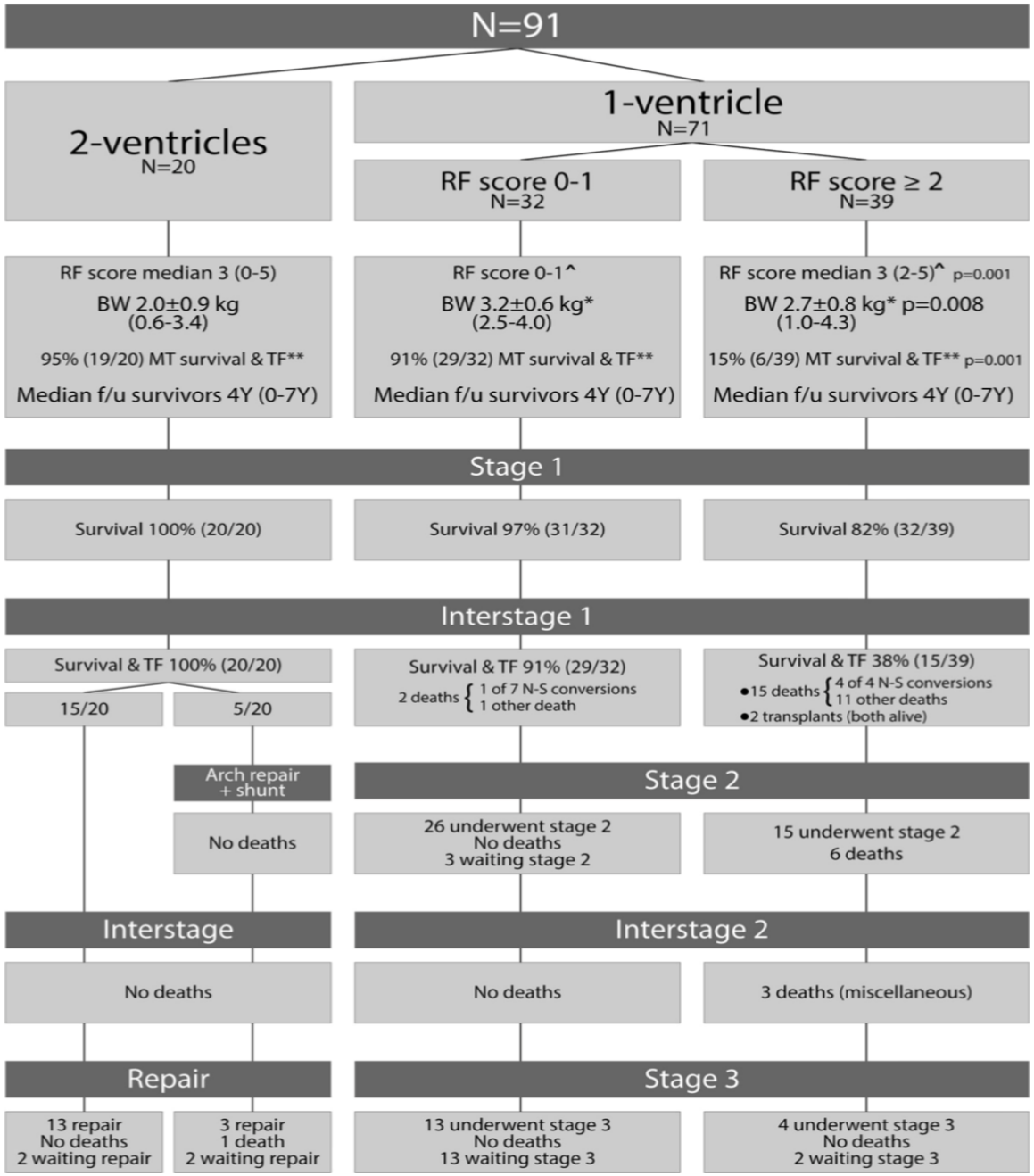


ig. 1 Patient outcome summary. *Arch repair + shunt* arch repair with a Glenn or systemic-to-pulmonary artery shunt, *BW* birth weight, *F* follow-up, *MT* midterm, *N-S* Norwood Blalock–Taussig shunt, *RF* risk factor, *TF* transplant free

2V HYBRID DATA.xlsx

LN	FN	DOB	BW	GA	HEMO UNSTABL OR EXT OR RESP	HYP Ao Ann	PN	DX
Simpkins/ALDRICH	KAYDEN 'B'	1/12/11	0.6	29	Y		N-LV	2V Coarct VSDS
DAGGETT	WILLIAM	10/10/12	0.8	29	Y		Y-R	2V TRUNCUS
Rodriquez/Cleveland	Rick	9/8/14	1	29	Y		Y-LV	2V VSD HYPOAo
MALONE	BBA/IAN	11/10/15	1.2	30	Y		Y-LV	2V IAA
PEREZ-Limones	YISEL	3/12/10	1.2	31			N-LV	2V VSD-HAoA
GOMEZ	ARI	9/15/08	1.3	26	Y		N-LV	2 V VSD-HAoA
Heczko/Ramirez	Uriel	9/12/14	1.3	27	Y		X-NPC	2V MULT VSDS HYPAA
REICH	LINCOLN	7/28/10	1.3	30			N-LV	2V COA
LAND - TWIN	EMMA	5/2/08	1.4	30	Y		Y-LV	2V IAA-B
KNITTEL	IVY	3/20/12	1.5	31	Y		Y-LV	2V TRUNCUS
ROTHSTEIN/VARGAS	SIVAN	4/20/16	1.5	35	Y		Y-LV	2V ARCH
Linochun/LINO	KEVIN	10/2/09	1.7	32	Y		N-LV	2V IAA B
Ang	TANNER	11/23/10	1.8	36	Y		N-LV	2V VSD HYPOAo
DelHureta/SOTO	DANIEL	10/9/08	2.2	33			Y-LV	2V VSD-HAoA
GONZALEZ/Arias	ANGELICA	12/28/14	2.2	36	Y		Y-LV	2V VSD HYPOAo SUB AS
ENGLUND	MIA	2/9/11	2.4	29			Y-ID	2V DORV
ABEITA	TYLER	12/26/16	2.5	37	Y		Y-LV	2V TRUNCUS
ELIZALDE	JESUS	10/4/15	3	40		Y	Y-R	2V IAA
HENDERSON	IVY	5/28/14	3	38			Y-LV	2V TRUNCUS IAA RV HYPOPL
MAJENTY	FORREST	1/7/19	3	40	Y	Y	X-OOA	2V IAA B
MORALES	BG	1/24/19	3	38		Y	Y-LV	2V IAA C
RODRIGUEZ-PALMAS-CABALLERO	JOSUE	11/24/11	3	38	Y	Y	N-LV	2V IAA-B, VSD
VANDERPOOL/WARD	Alexander	3/10/14	3	38		Y	Y-LV	2V COARCT
SALAZAR/DOSS	KINGSTON	9/17/15	3.1	38		Y	N-R	2V AO ATRESIA
Echols	MARTHA	9/17/14	3.2	40			Y-LV	2V DORV HAo IAA-B
ORR	RUTHE	7/11/13	3.4	38		Y	Y-LV	2V IAA-B

COHORT 2V HYBRIDS

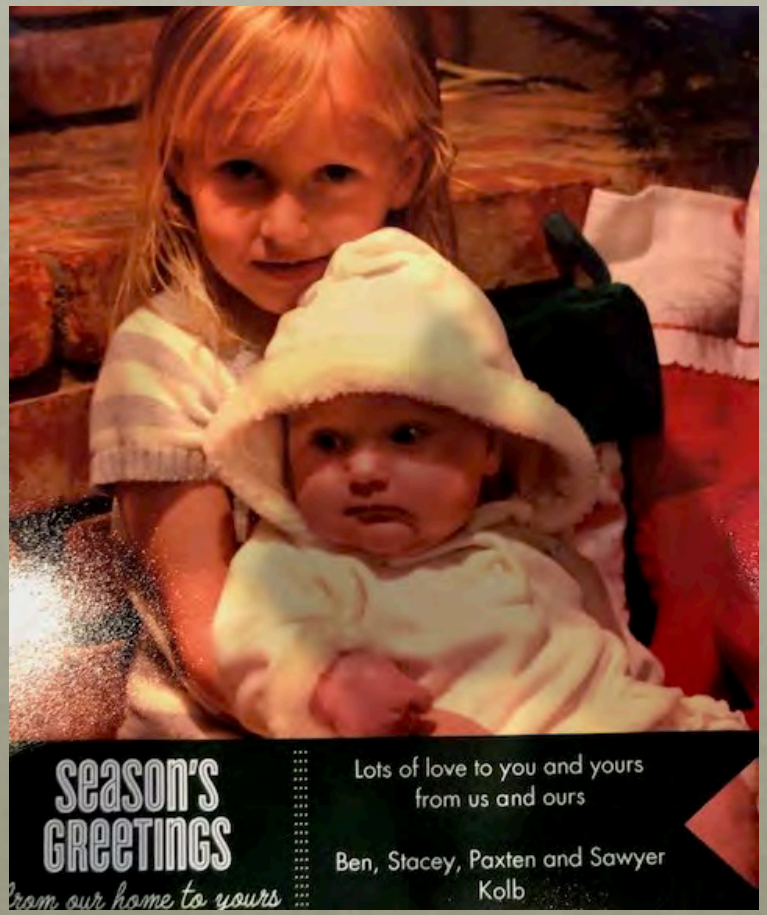
- Total cohort 26
- 5/2/2008-1/24/2019
- Birth weight 600g-3400g
- Average birth weight 2060g
- Average gestational age 33.9 wks
- Majority of diagnoses arch hypolasia, arch interruption and truncus arteriosus

CASE STUDY #1

- WD male birth gestational age 29 wks, wt 810 g 10/10/12 DOB
- Type 1 truncus arteriosus
- Occluded hepatic portion of IVC
- Born in northern Nevada but lived Southern Nevada
- Transferred down for treatment
- "Truncito"

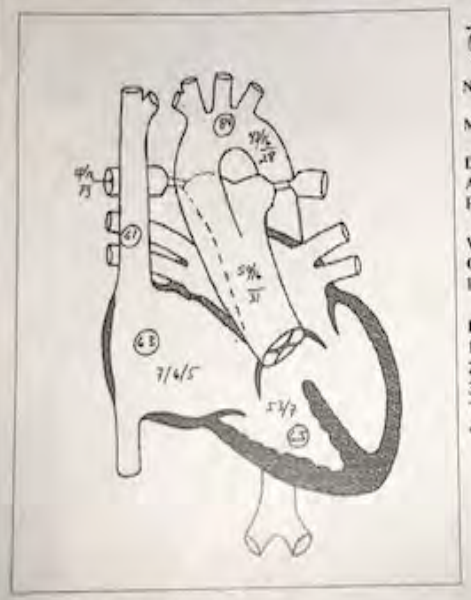
CASE STUDY #1

- 810 g truncus 1 DOB 10/10/12
- Underwent bilateral branch pulmonary artery bands at 8 days of age
- Underwent complete repair at 4 months weighing 3.14 Kg
- Interstage the baby was off the ventilator and was primarily gavage fed



CASE STUDY #1

SUNRISE HOSPITAL PEDIATRIC CATH LAB



Name:

Med Rec: 207-48-97

DOB: 10/10/12 Cath Date: 12/17/12
Age: 9 wks
Referring Physician: Dr. Kip

Weight: 1.8 kg Hb: 13.3
Qs: 4.97 Qp: 6.64 Qp/Qs: 1.3
PVR: 0.9 SVR: 5.2

DIAGNOSIS:
1) 860 gm former 29 wk premie
2) Truncus arteriosus type I
3) s/p banding branch PA's (3mm Gore-Tex) 10/18/12
4) Occluded hepatic portion of IVC

PROCEDURE/FINDINGS:
1) Preserved distal pulmonary artery anatomy
2) No additional VSD's
3) Occluded hepatic portion of IVC with flow through collaterals to the azygous circulation and to hepatic veins

DISPOSITION:

Conference date: 12/17/12

Alvaro Galindo MD

CASE STUDY #2

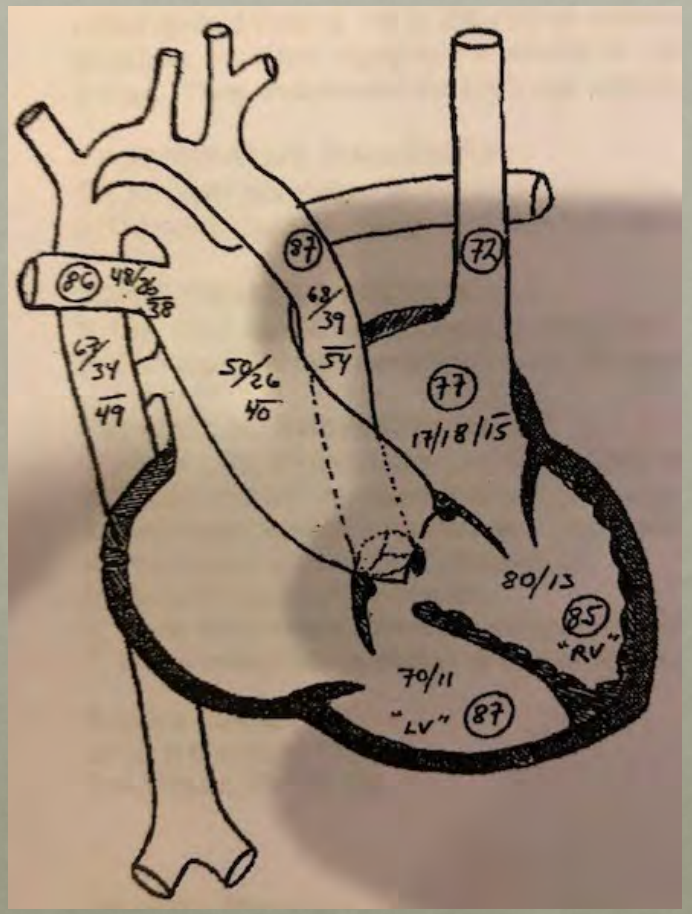
- KA 600 g 30 week twin gestation male
- DOB 1/12/2011
- Intrauterine hydrops from twin-to-twin transfusion
- Possible genetic syndrome
- Ductal dependant hypoplastic aortic arch and apical VSD

CASE STUDY #2

- DOB 1/12/2011
- Bilateral PA bands and PGE1
- Prehybrid OR SRCH
- Complete repair at 2 months of age; wt,2.2 Kg
- Gtube/fundo 5/4/11
- Discharge home 6/24/2011

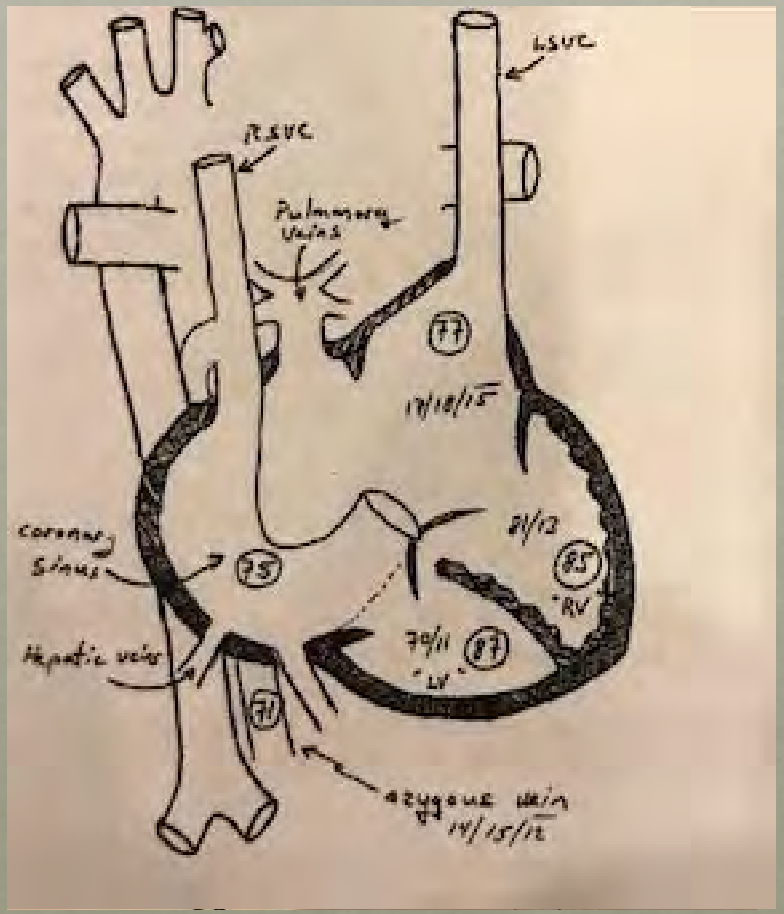
CASE STUDY #3

- BG E DOB 2/9/11
- Wt. 2200 g
- Heterotaxy syndrome, transverse liver, probable asplenia
- Atrial situs inversus, L-vent. Loop, interrupted IVC, bilateral SVC, RSVC to CS
- DORV, subaortic VSD
- Valvar PS 30-35 mm Hg
- Mild-moderate AI, dysplastic aortic valve 5-6 mm annulus



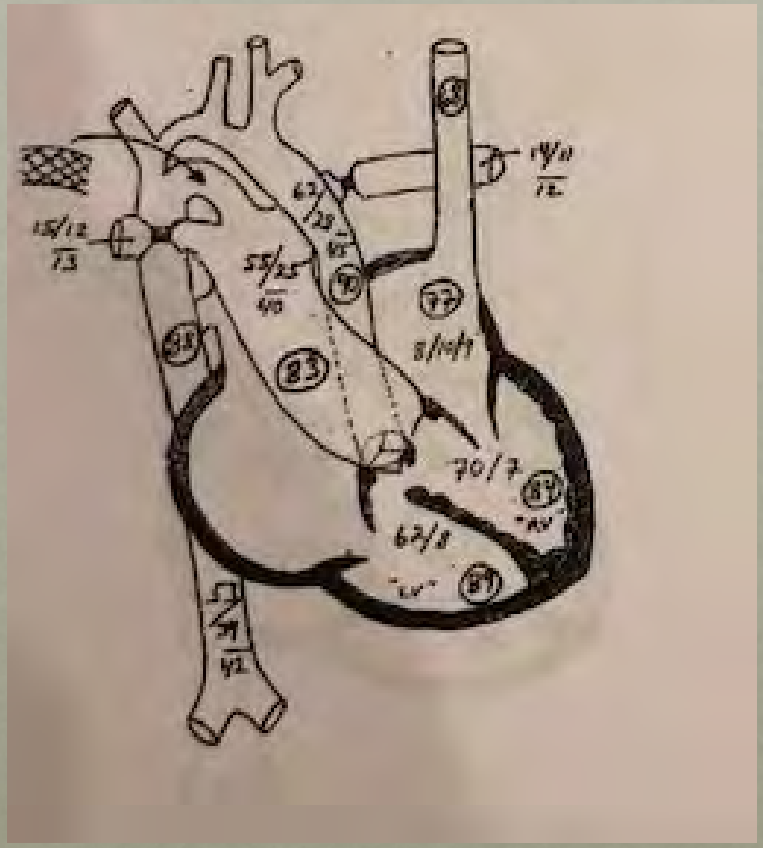
CASE STUDY #3

- Hypoplastic transverse arch, right arch
- PDA on PGE1
- Sinus node dysfunction with rate support on isoproterenol
- Systemic atrium posterior on CTA heart



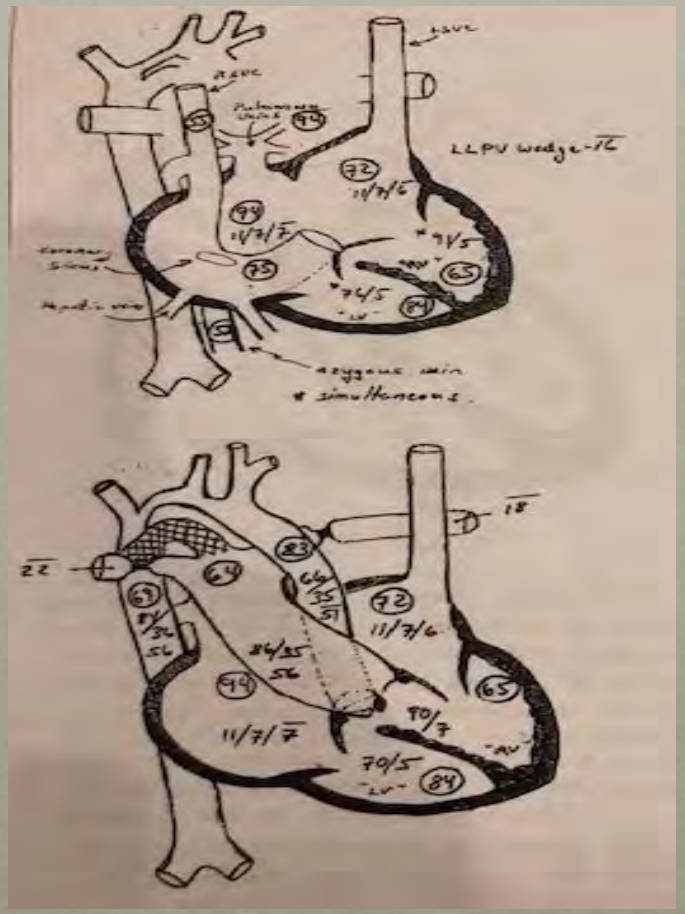
CASE STUDY #3

- 3.5 mm gortex band RPA
- 3.0 mm gortex band LPA
- Dual chambered epicardial pacemaker
- RA SL broviac catheter
- Ductal stent



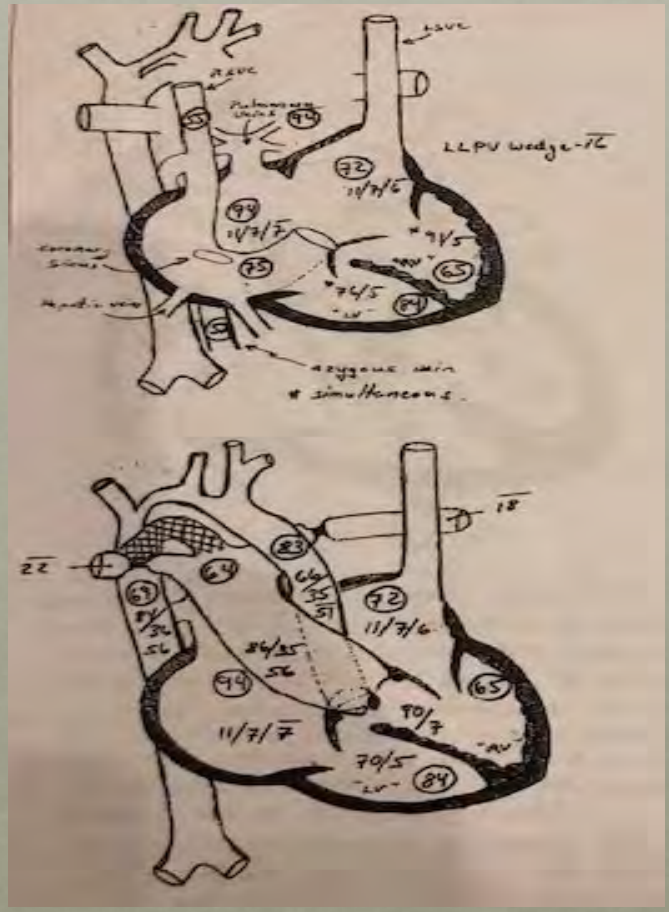
CASE STUDY #3

- Preop complete repair cath
- Unroofed coronary sinus
- Minimal PS and AS
- Left pulmonary veins committed to LA and right pulmonary veins committed to RA by contrast flow



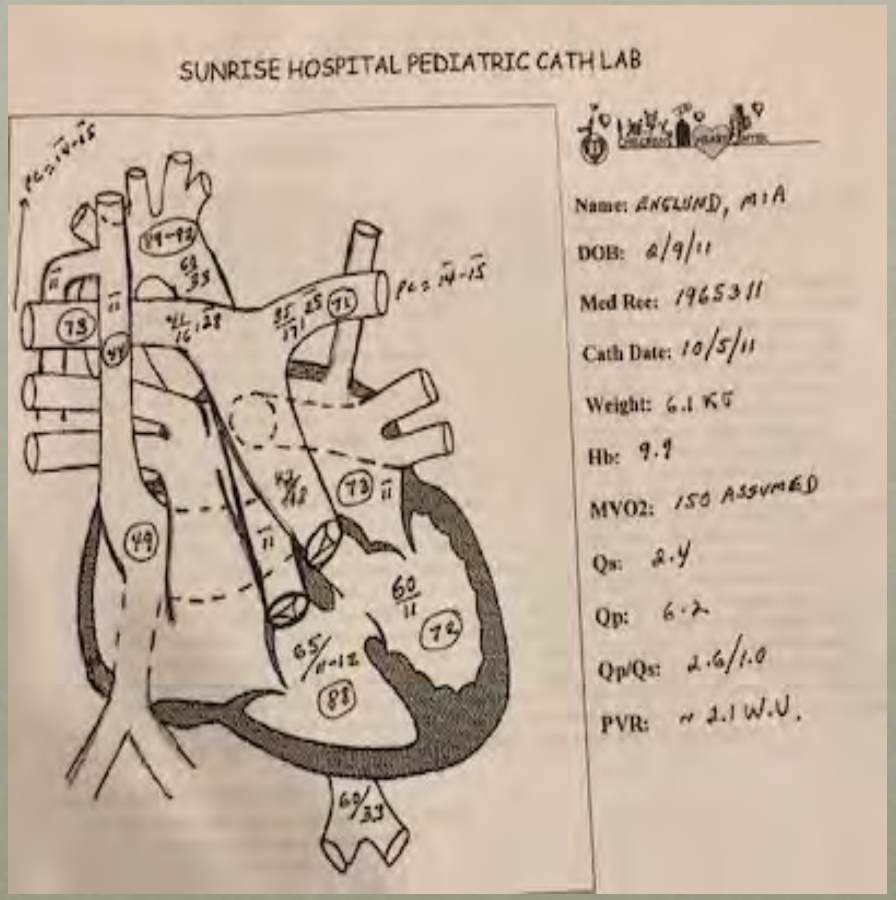
CASE STUDY #3

- Aortic arch reconstruction
- Removal PDA stent and PA bands
- Division PDA
- Bilateral PA plasty
- VSD could not be exposed through either atrium and Qp:Qs postop calculated at 1.4:1
- Closure of CS ASD
- Intraop postop bubble studies revealed no atrial shunting only ventricular



CASE STUDY #3

- Repair PAPVR
- Atrial septectomy
- Closure VSD through the aortic valve
- Closure ASD (to correct PAPVR)
- Debridemnet of sternal wound infection



CASE STUDY #3

2V HYBRID COHORT

- Total cohort 26 patients
- One late death during complete repair
- Initial palliation no deaths
- No surgically induced pacemakers
- Hybrid approach allows either 2 V or single V pathway to be determined at time of second procedure

2 V HYBRID

- Works best on patients with arch abnormalities or truncus arteriosus
- Very good for small birth weitht neonates or premies
- Low death rate
- Low incidence of surgical heart block
- A variation involves no ductal stent and PGE1
- Excellent feeding protocols and RA central access facilitate success


CHILDRENS
HEART CENTER
NEVADA