Hybrid Procedures in Congenital Cardiac Surgery

Seoul

2005

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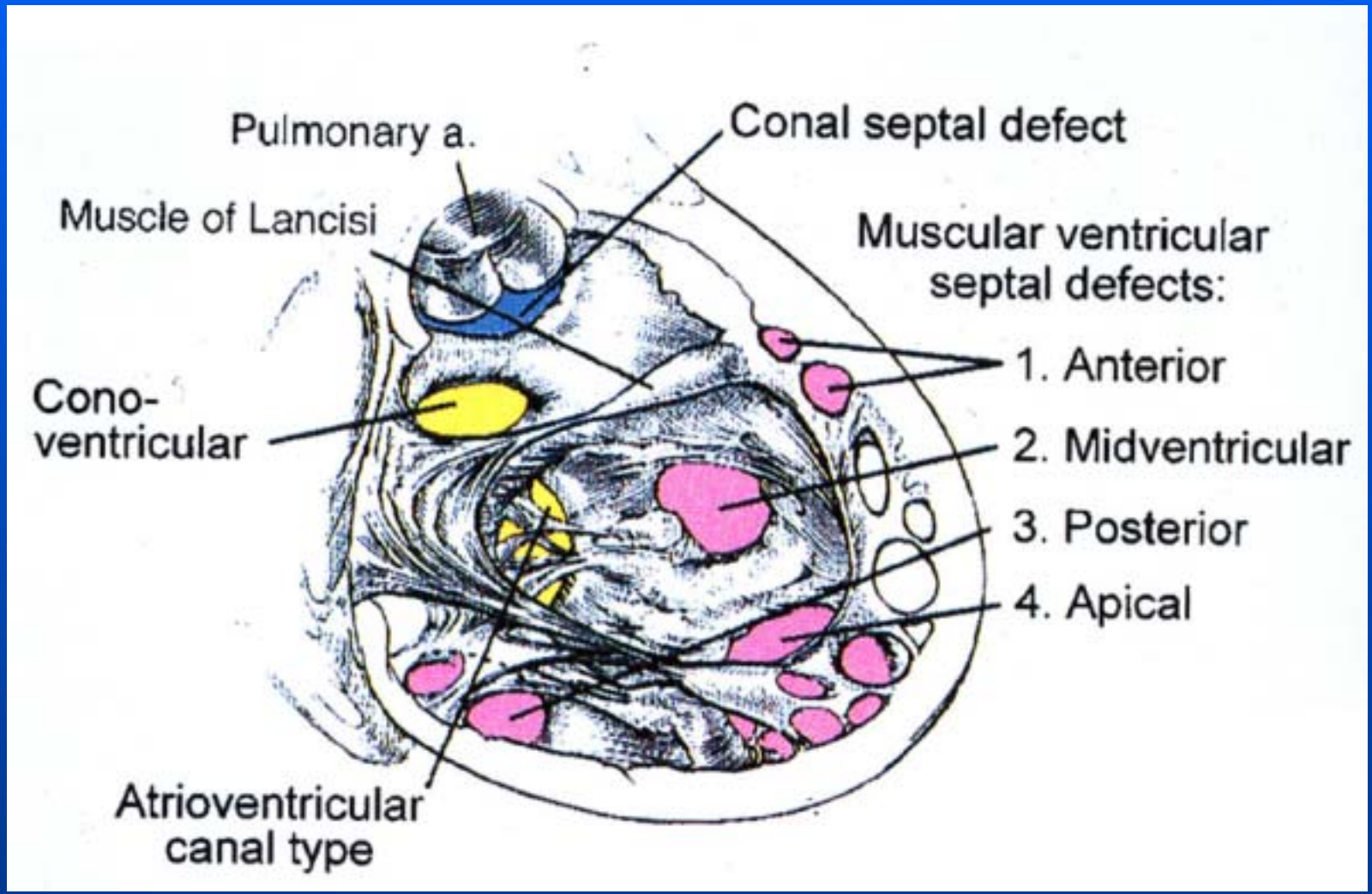
The Hospital for Sick Children

Toronto

Hybrid Procedures

- Multiple VSD’s
- Hybrid “Norwood Procedures”
- Cath Lab Fontan


Pulmonary a.
Conal septal defect
Muscle of Lancisi
Muscular ventricular septal defects:
1. Anterior
Cono-ventricular
2. Midventricular
3. Posterior
4. Apical
Atrioventricular canal type

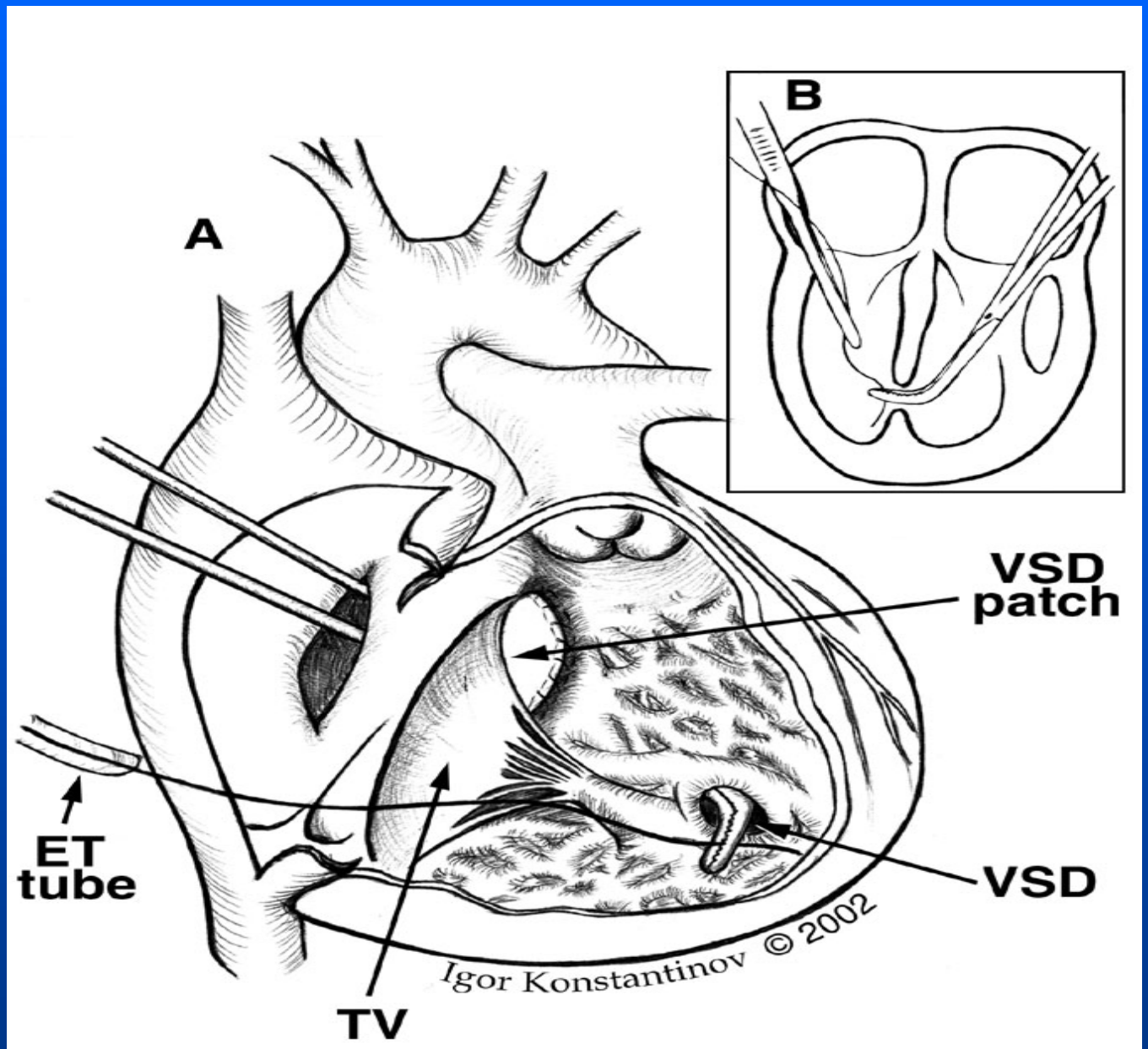
Intra-Operative Device Closure of mVSD

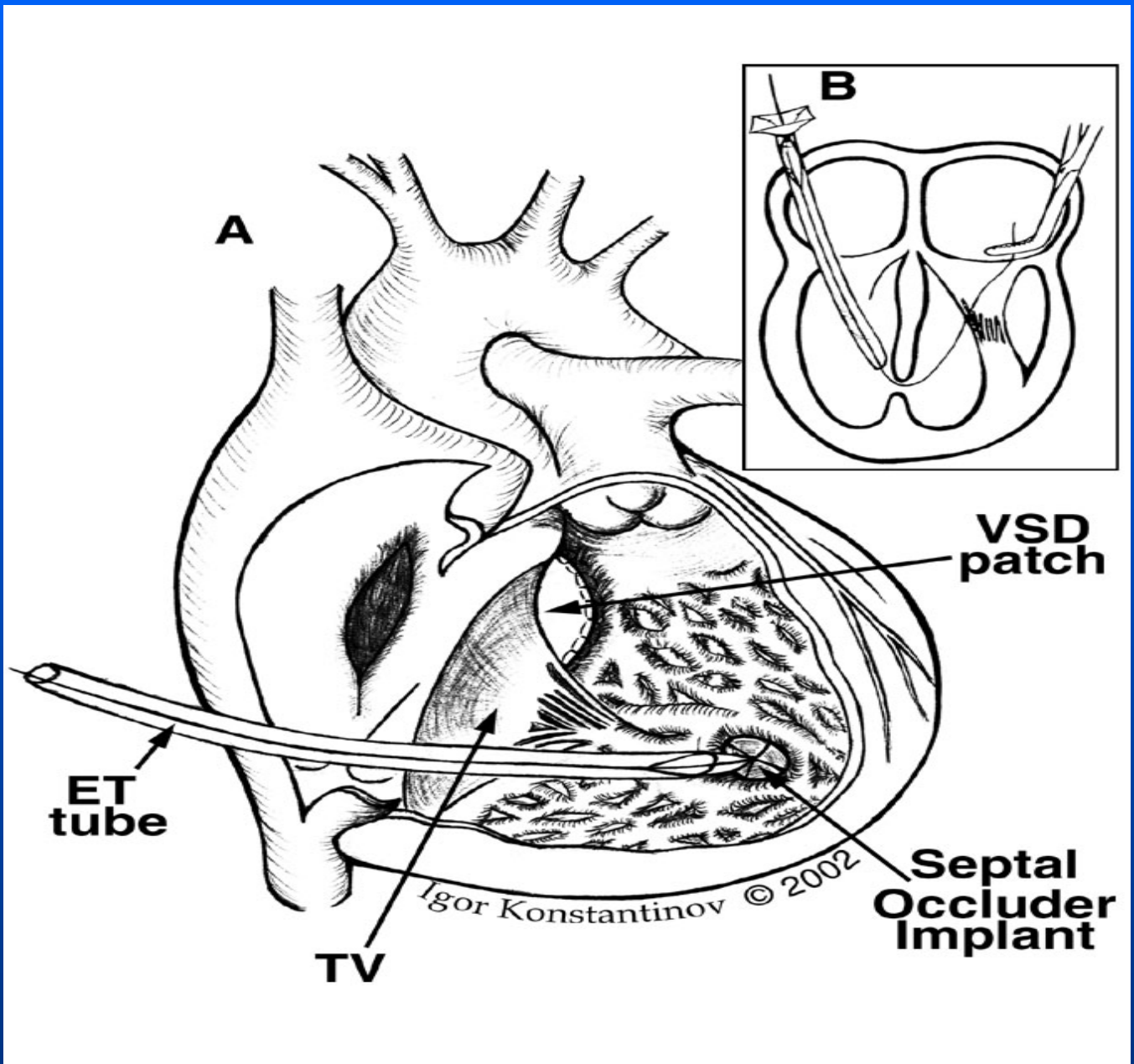
Pro

- Avoids venticulotomy/division of muscle bands
- Applicable to neonates {transcather problematic}

Cons:

- Suture closure may be easier
- Mitral Valve Chordae
- Limited data regarding function


A
B
VSD
patch
ET
tube
VSD
TV
Igor Konstantinov © 2002


B
A
VSD
patch
ET
tube
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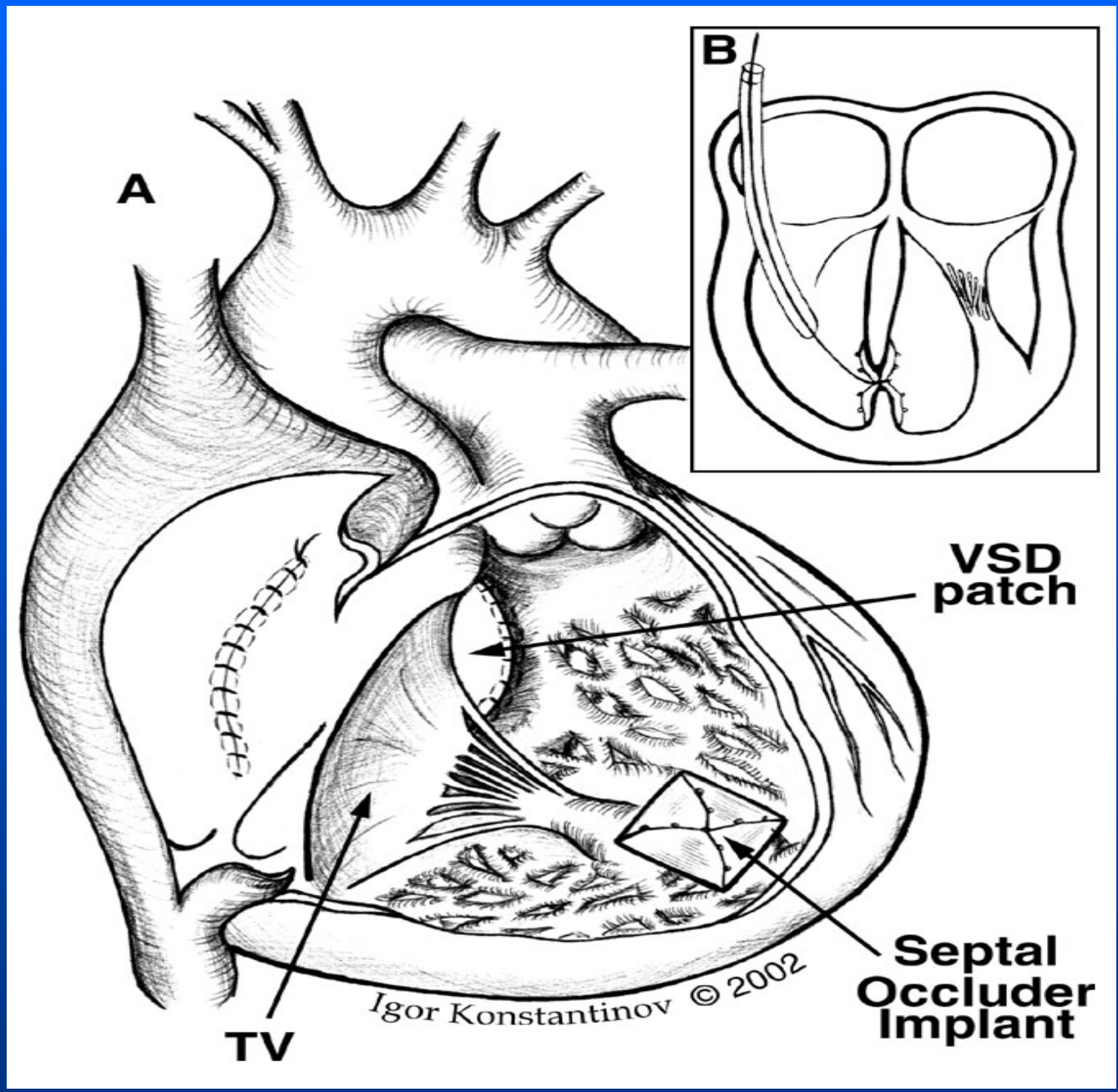
Septal
Occluder
Implant
TV


A
B
VSD
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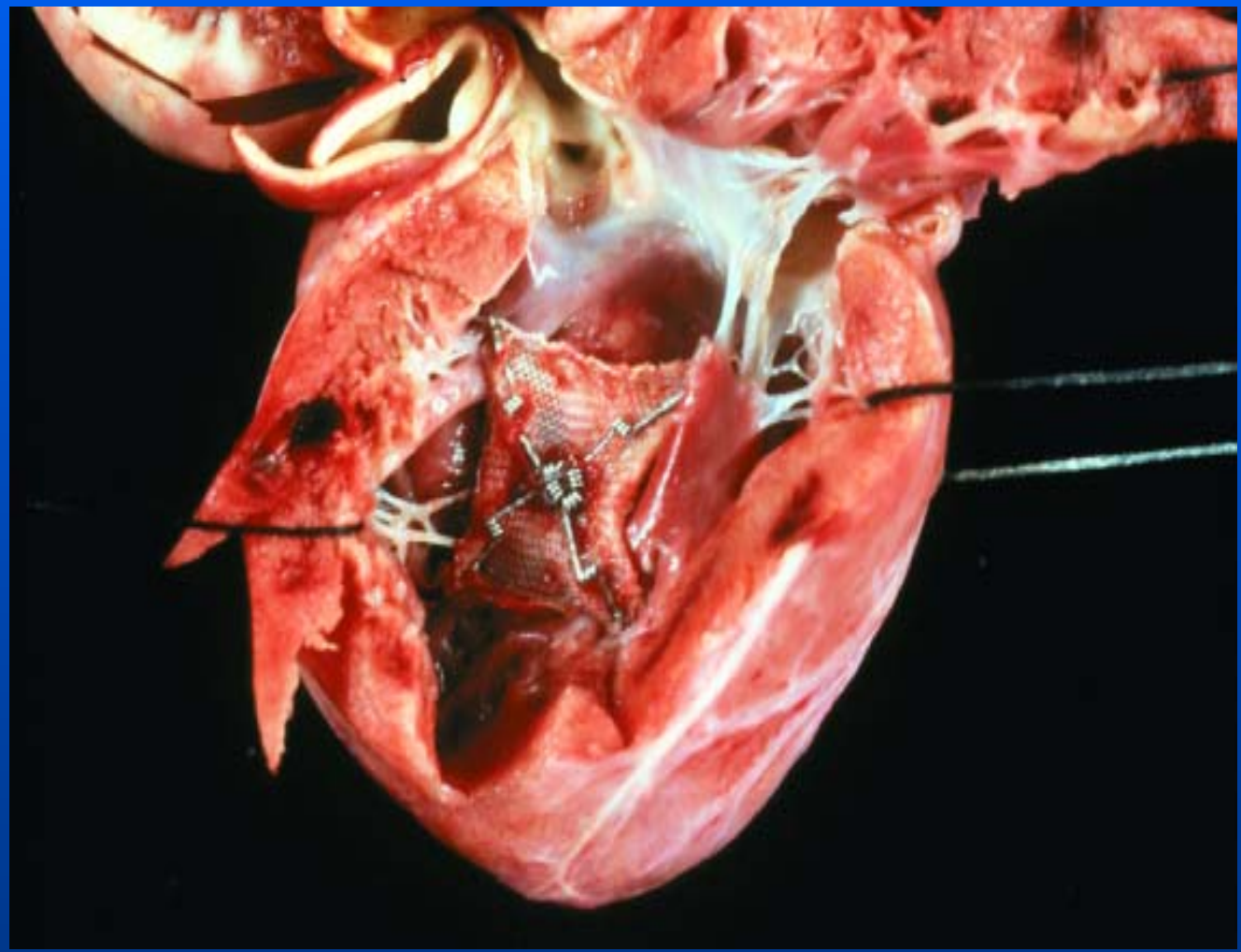


Device Closure of mVSD
{HSC; 1989-Dec 2001}

	No. Pts.
Single VSD	**4**
mVSDs	**12**
Totals	***16***

Device Closure mVSD

Table 3. Midterm Echocardiographic Functional Outcomes

Patient No.	LV Function	Qualitative RV Function	Wall Motion Abnormalities	Mitral Valve Regurgitation	Tricuspid Valve Regurgitation
2	Normal	Good	None	Mild	Mild
4	Normal	Good	None	None	Mild
5	Normal	Good	Septal	None	Mild
7	Normal	Good	None	None	Trace
9	Normal	Good	Septal	None	Mild
10	Normal	Good	None	None	Mild
11	Normal	Good	Septal	None	Mild
12	Normal	Good	None	Mild	Mild to moderate
13	Normal	Good	Septal	Trace	Trace.
14	Normal	Good	Septal	None	Mild

LV = left ventricle; RV = right ventricle.

Multiple VSDS: Recommendations

Smaller defects:

→ **Suture closure via RA or Mitral Valve**
Re-endocardialization

Large defects:

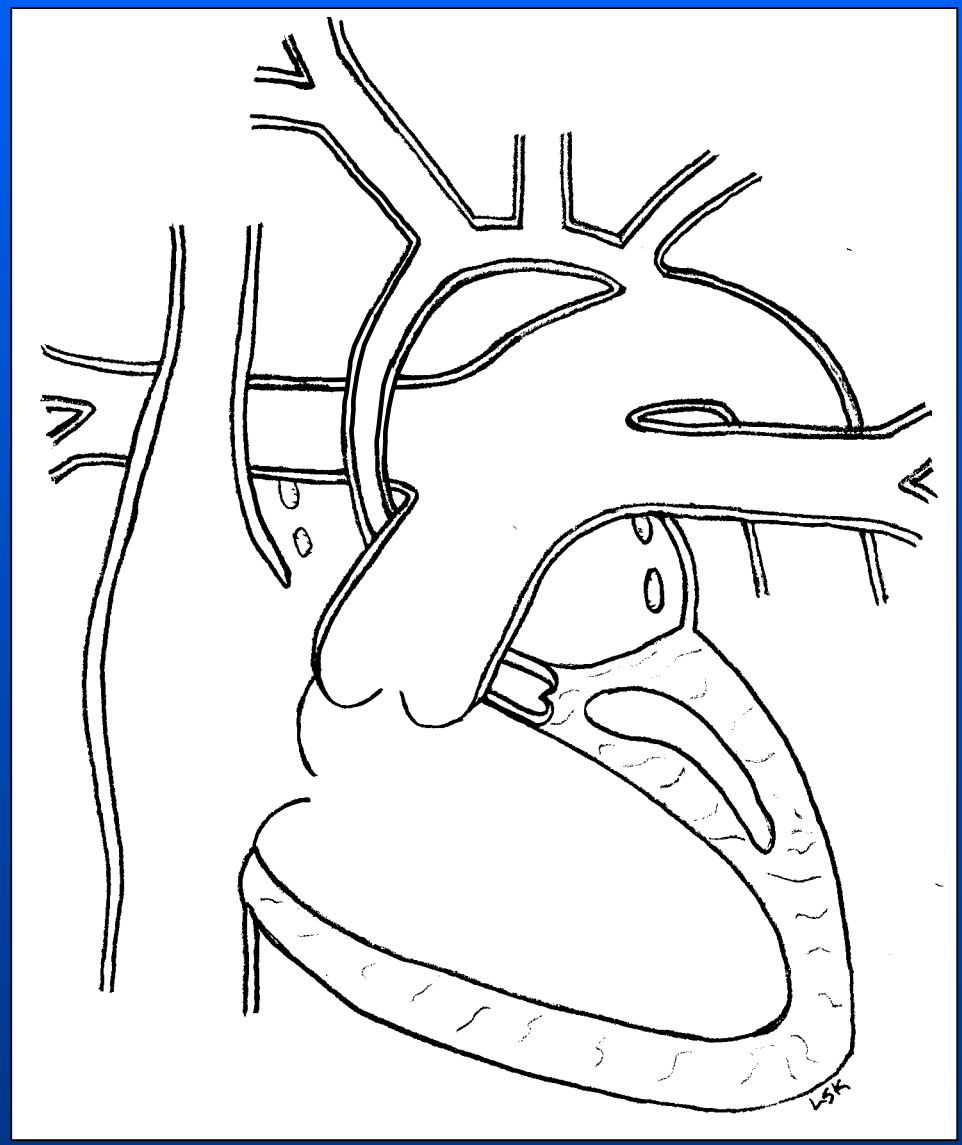
→ **Patch via RA, device closure multiple**
Apical defects

“Swiss cheese”:

→ **Patch PM and Inlet lesions**
Re-endocardialize anterior and posterior
Possible device - distal mid and apical

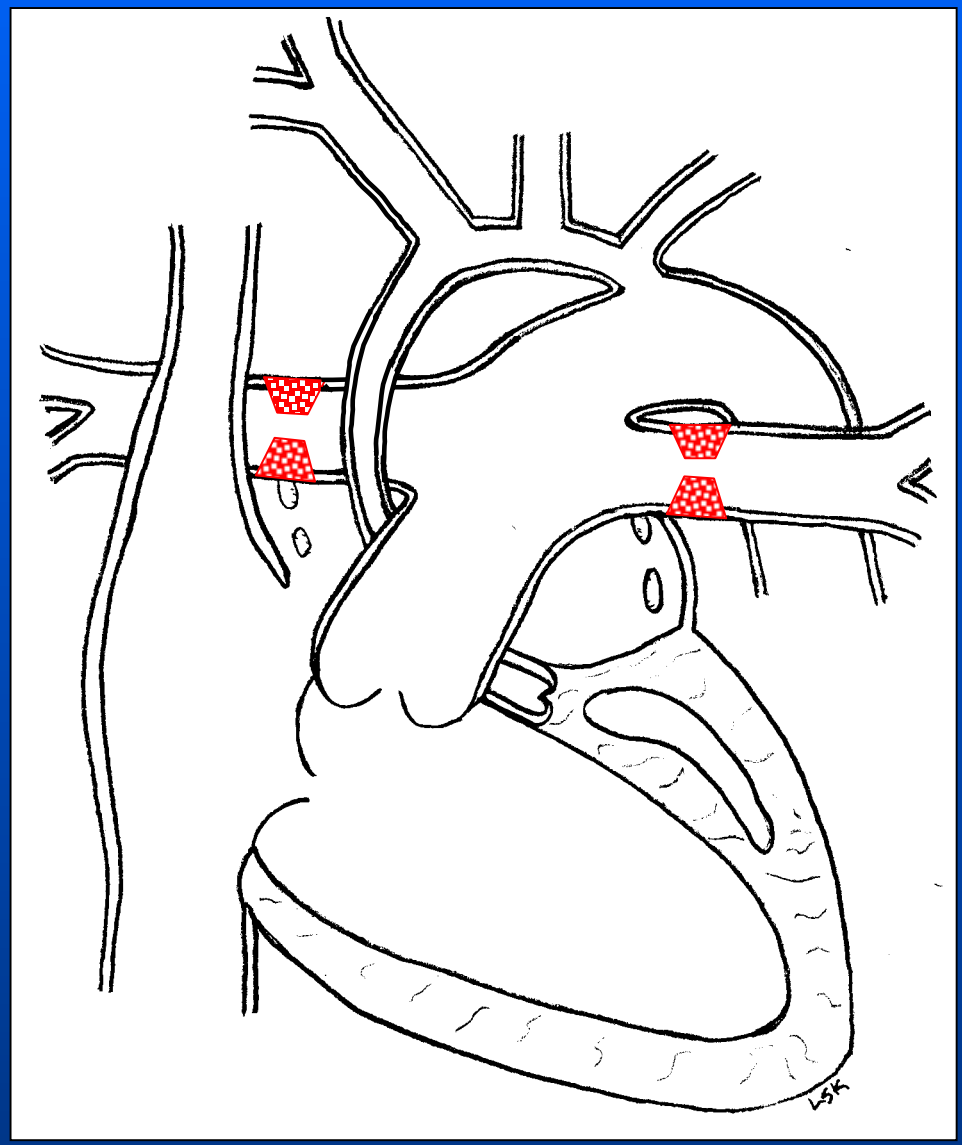
Hybrid “Norwood” Procedures

- Work in progress
- Hybrid program initiated (n=13)



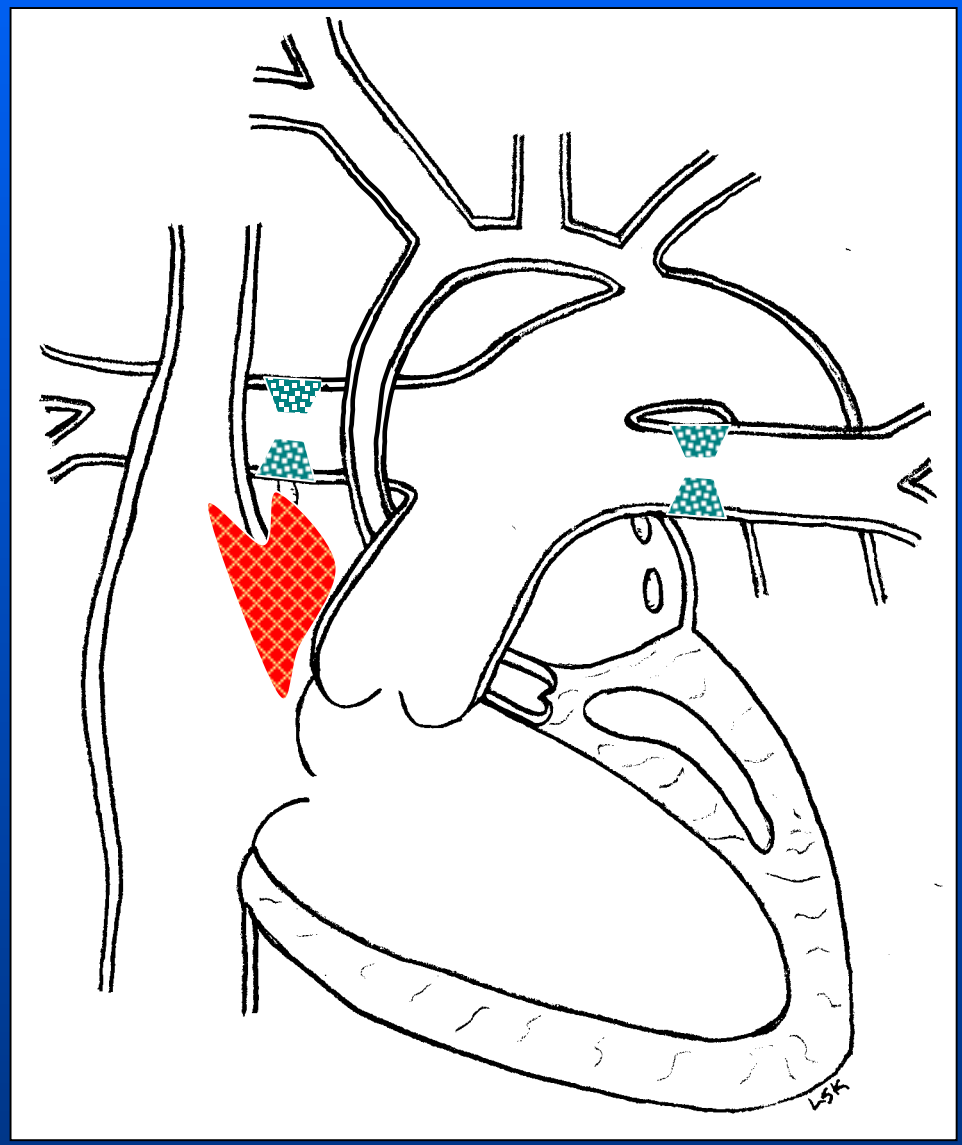
Control pulmonary flow

>*Bilateral PA bands*



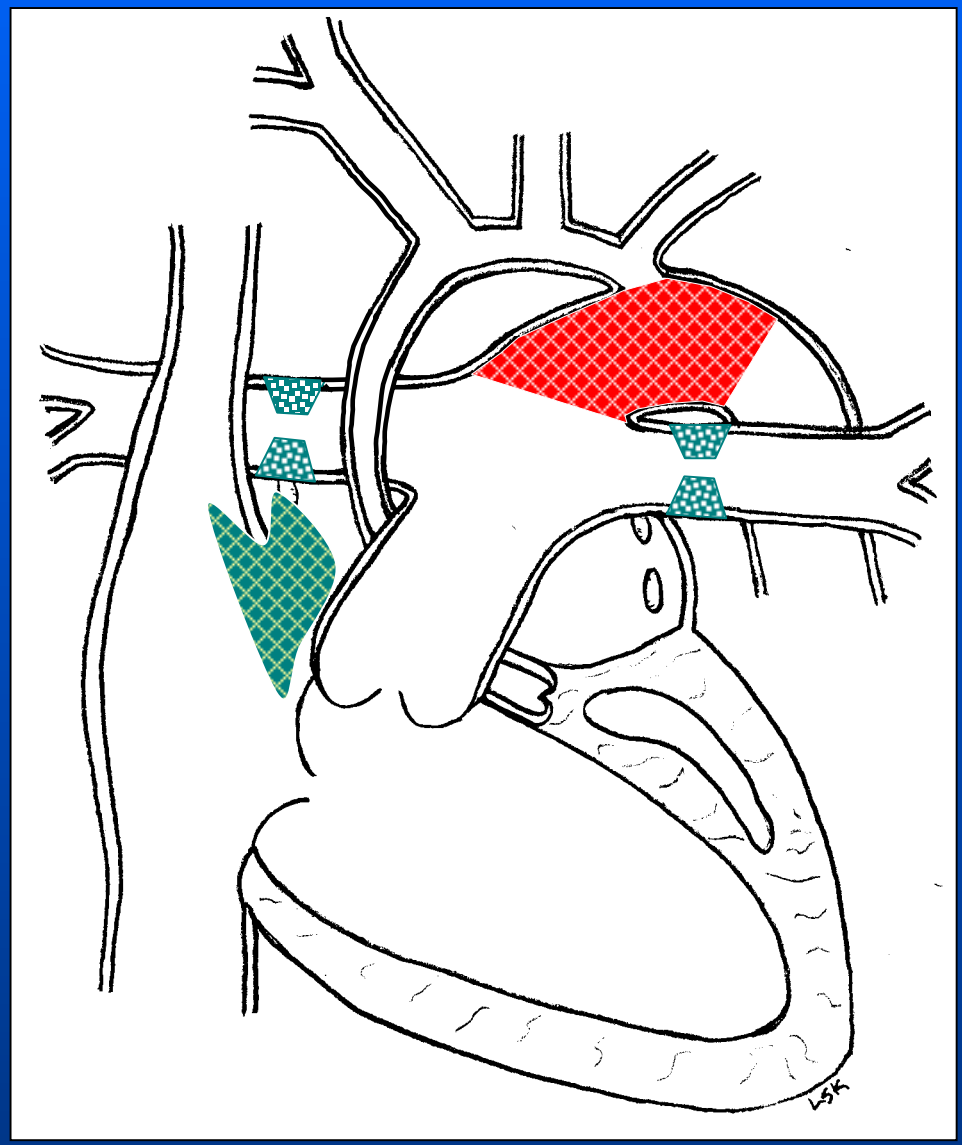
Unrestricted atrial septum

>*Atrial stent/balloon*



Systemic cardiac output

>*Ductal stent*



Coronary flow

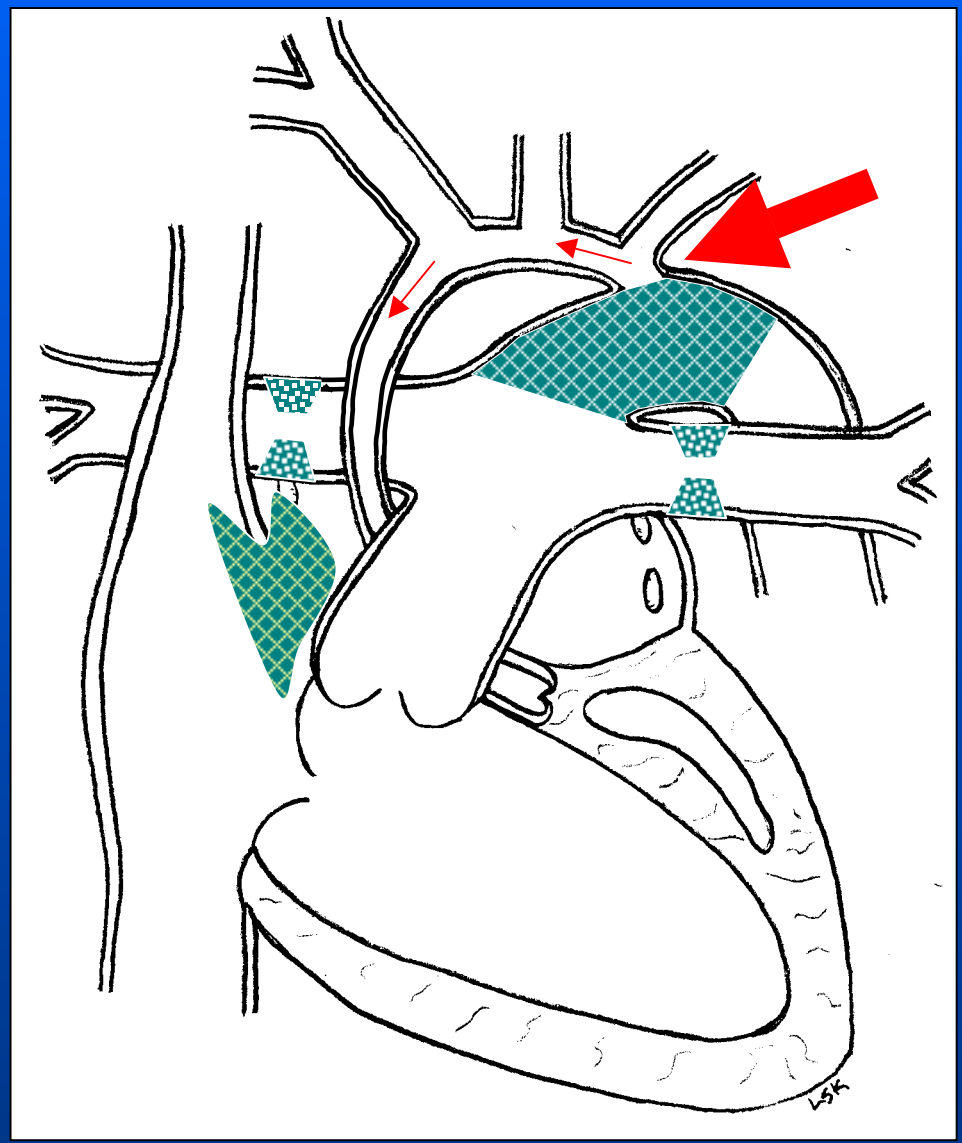
At risk in aortic atresia

Risk periods:

1. Stent deployment

2. D/C PGE's

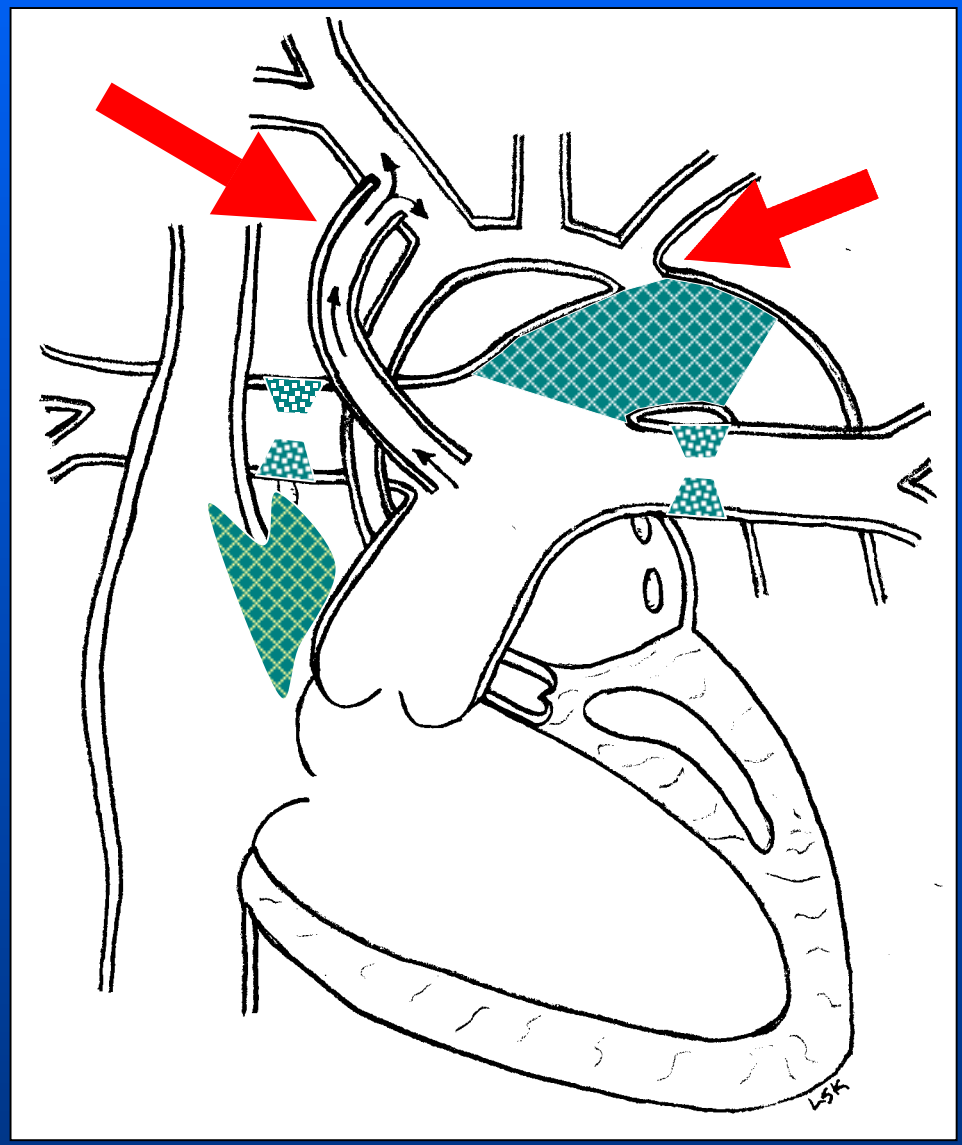
3. Late fibrosis

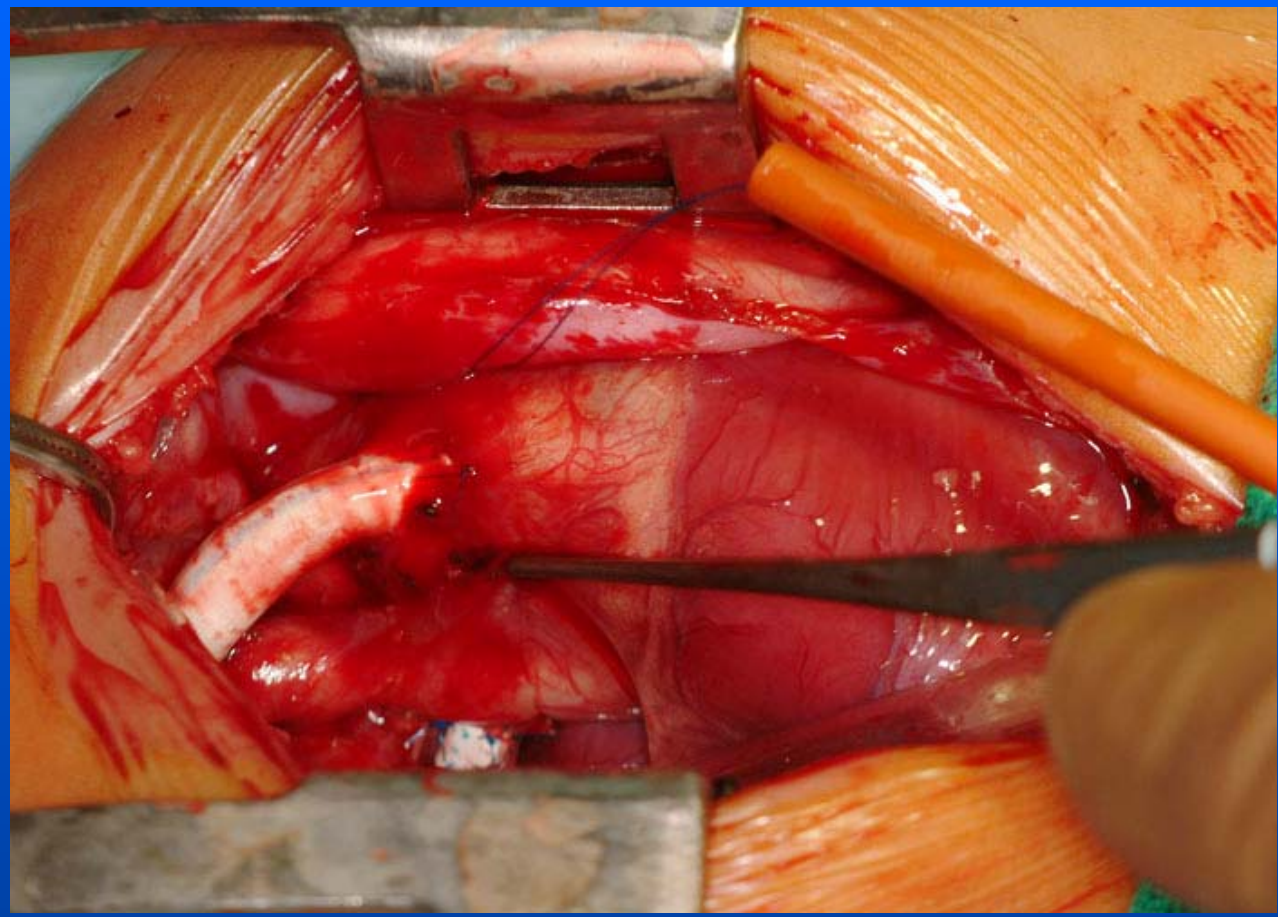


Prevention:

‘Reverse’ BT Shunt

(4 patients)





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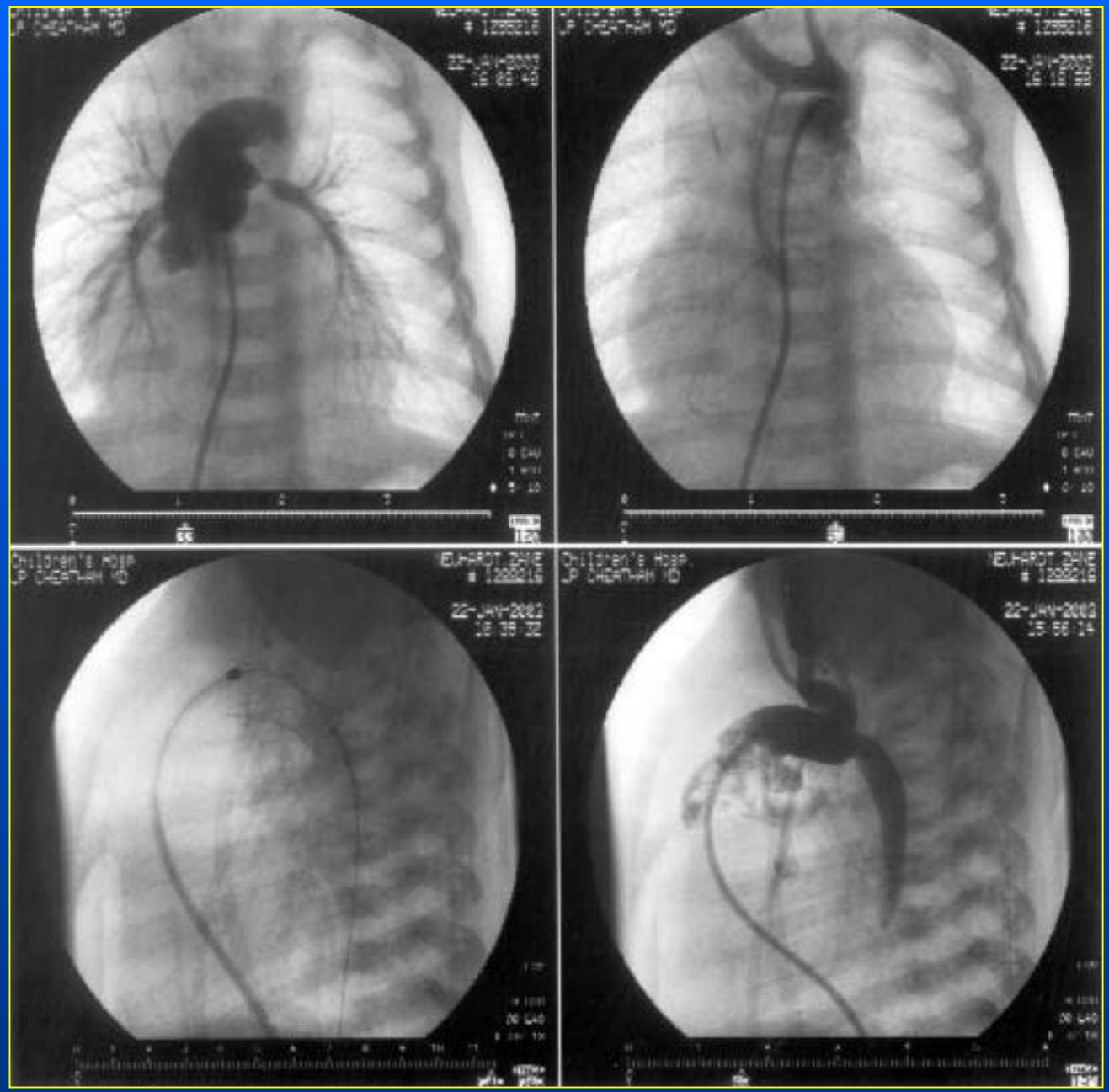
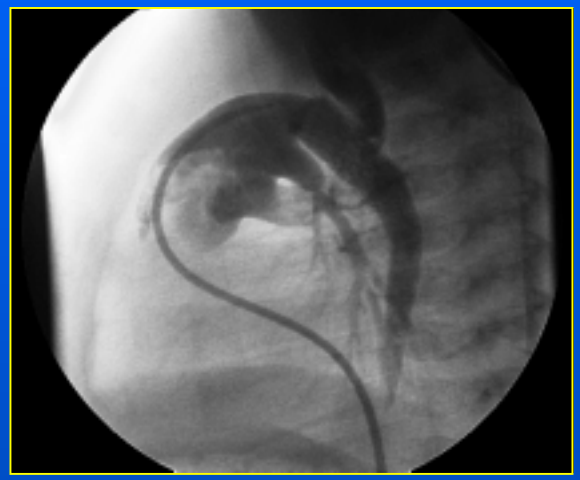
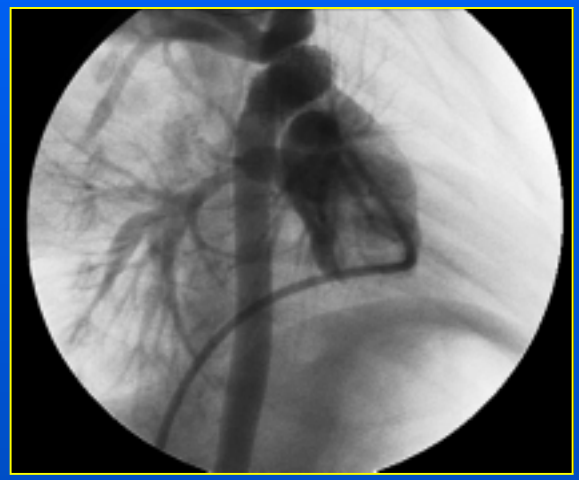
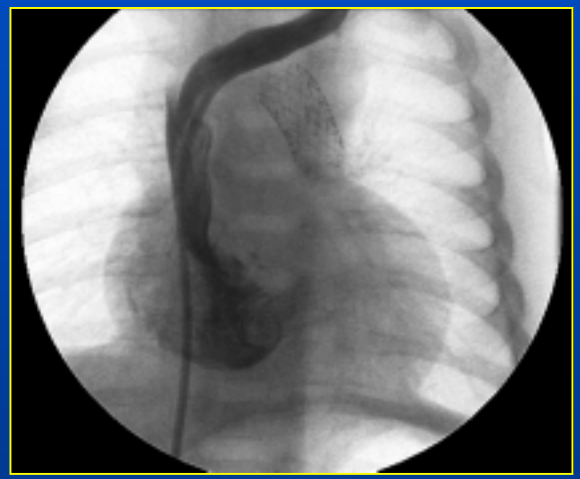


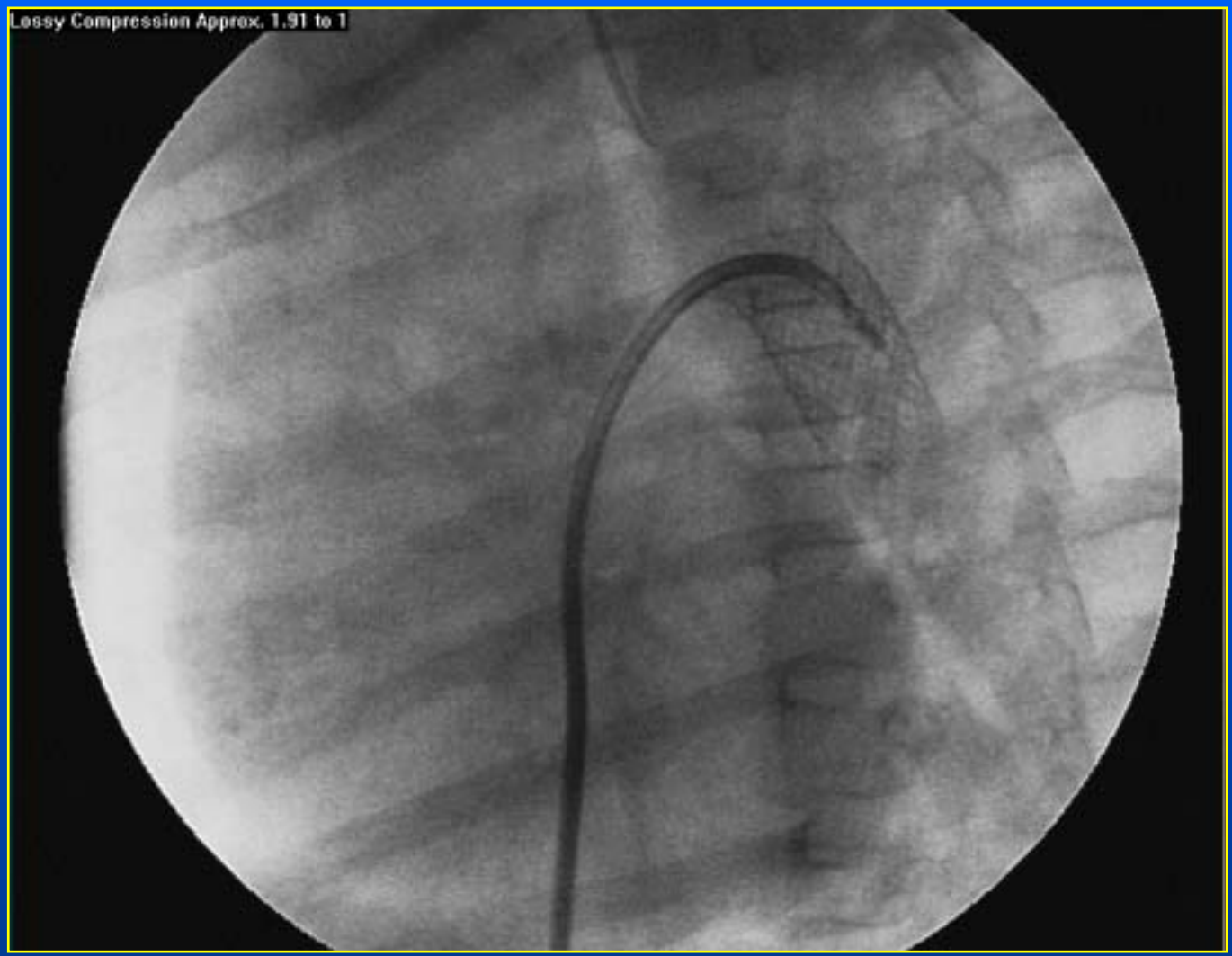
Later Follow up





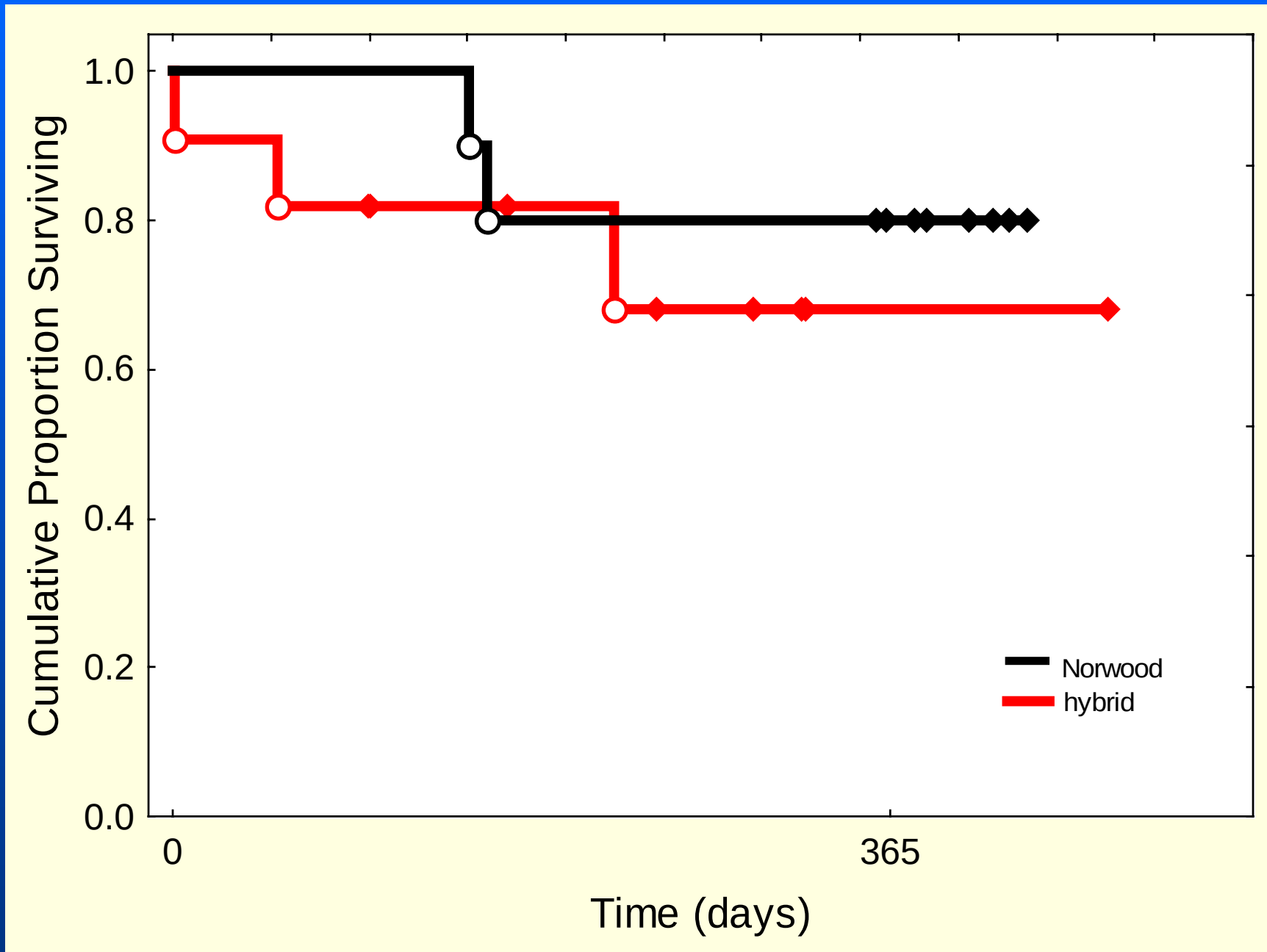


Stent can Migrate



Indications for hybrid procedures

Fontan track	8 *(4 second stage)*
Pre – transplant palliation	4 *(3 transplanted)*
Salvage	1


Cumulative Proportion Surviving
1.0
0.8
0.6
0.4
0.2
0.0
0
365
Time (days)
Norwood
hybrid

ICU data

Hybrids: Most no inotropes, chest closed
Norwoods: All on inotropes, chest open 50%

Intubation time

Hybrids (Fontan track)	3.1 +/- 2.1*
Norwood	14.8 +/- 15.0

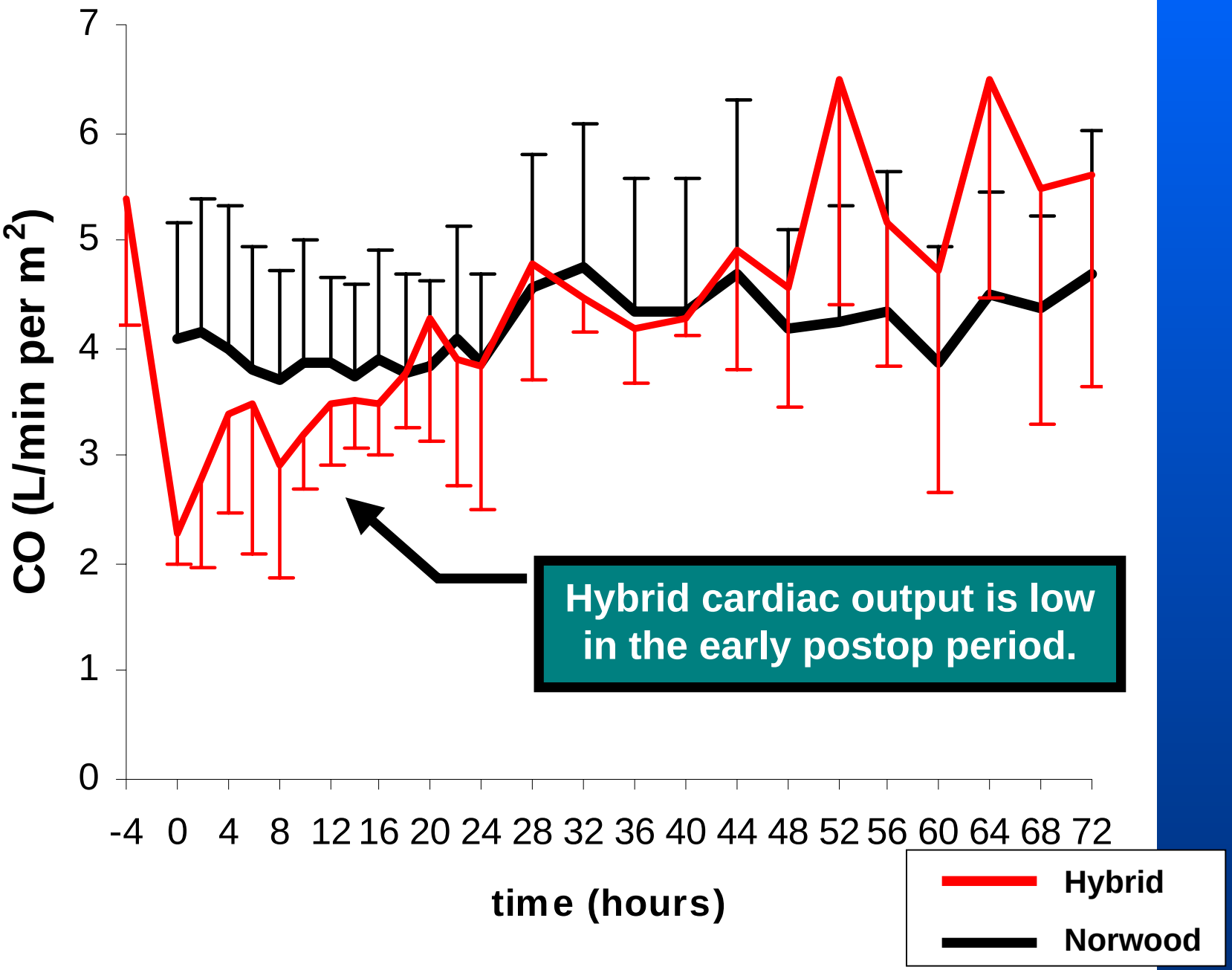
ICU time

Hybrids (Fontan track)	5.7 +/- 2.1*
Norwood	18.7 +/- 16.0

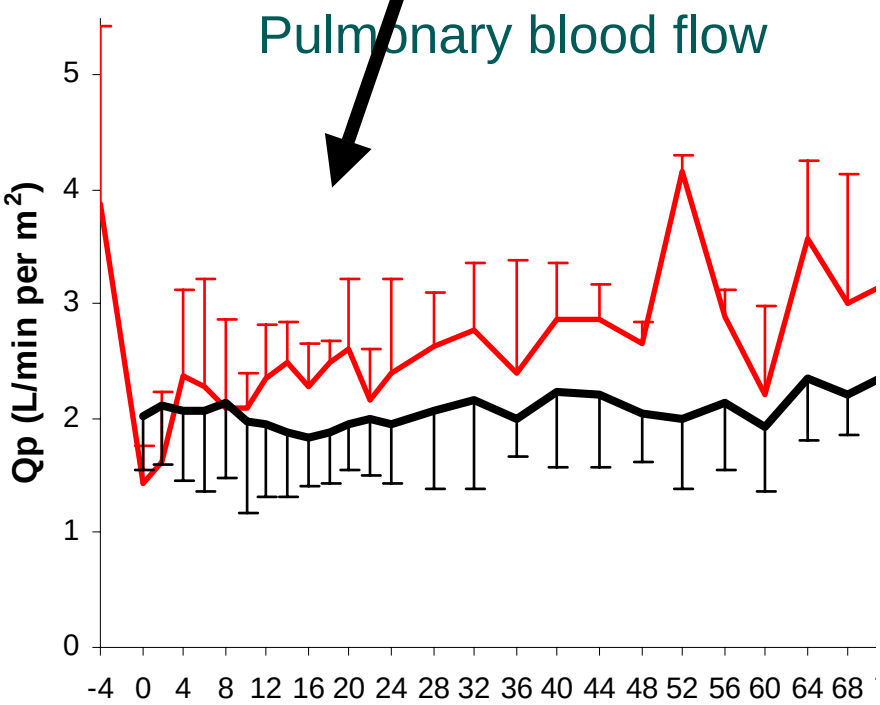
Methods

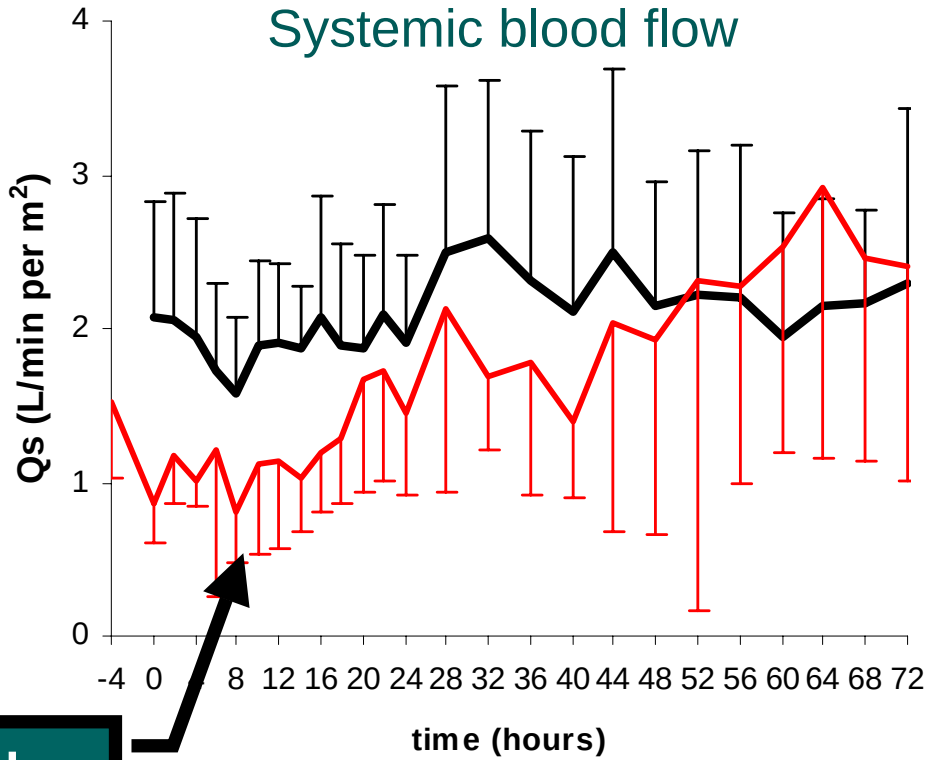
- Respiratory mass spectrometry

- Norwoods: all patients
- Hybrids: restricted to aortic atresia (n=4)


CO (L/min per m2)
7
6
5
4
3
2
1
0
-4 0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72
time (hours)
Hybrid cardiac output is low in the early postop period.
Hybrid
Norwood

Pulmonary blood flow is relatively flat in both groups

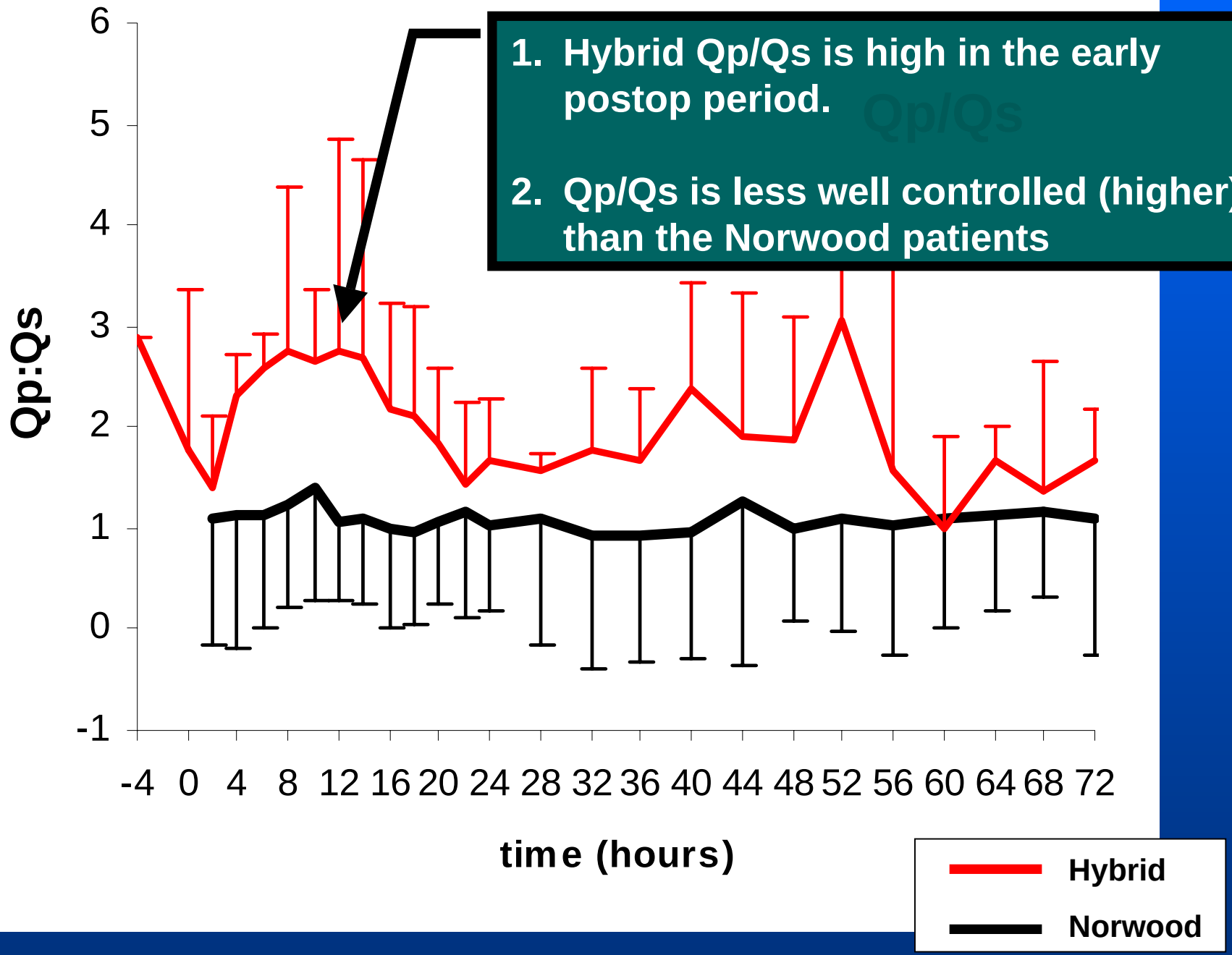




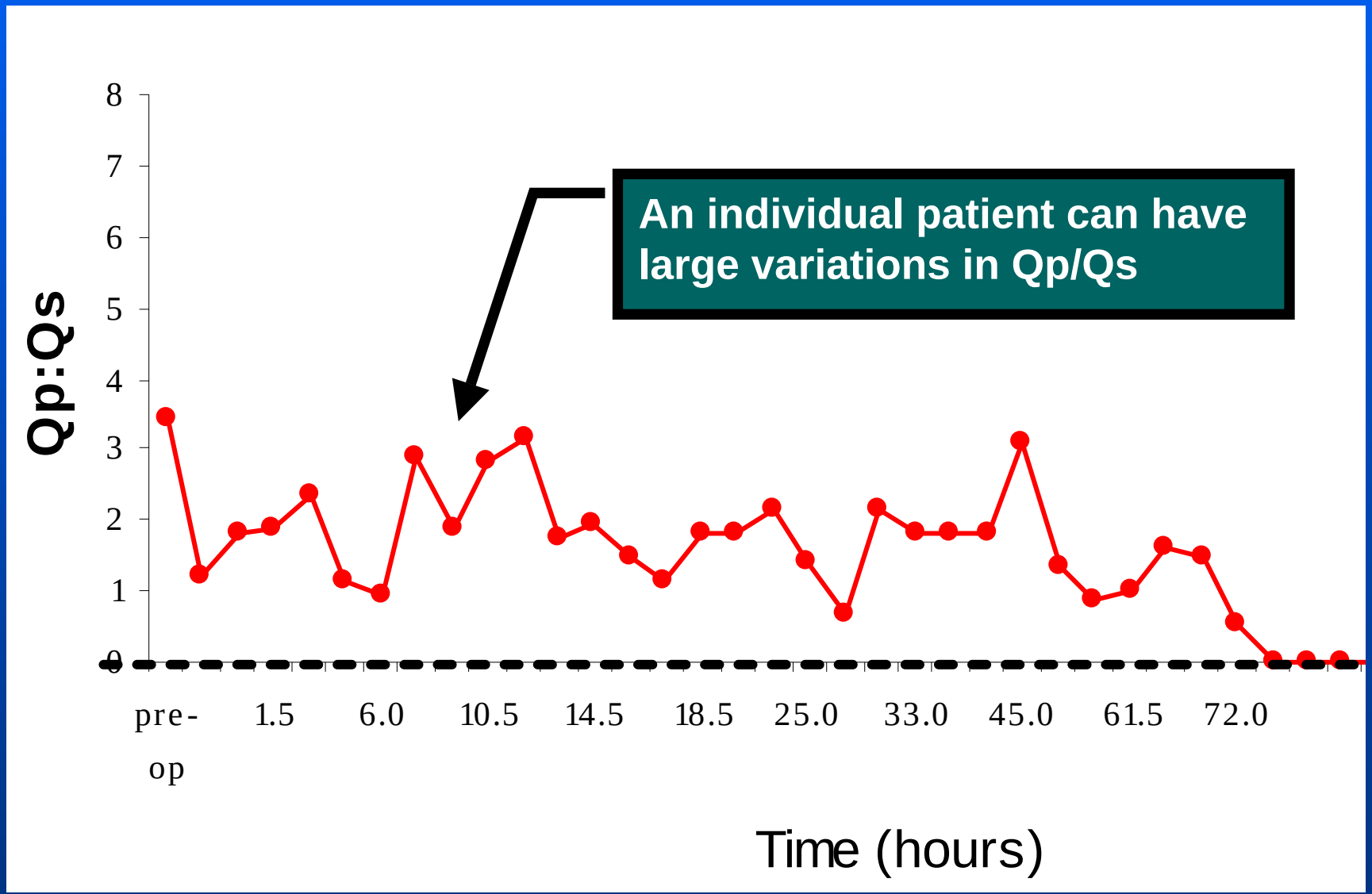
Early postoperative systemic blood flow is diminished in the hybrid patients

Hybrid

Norwood

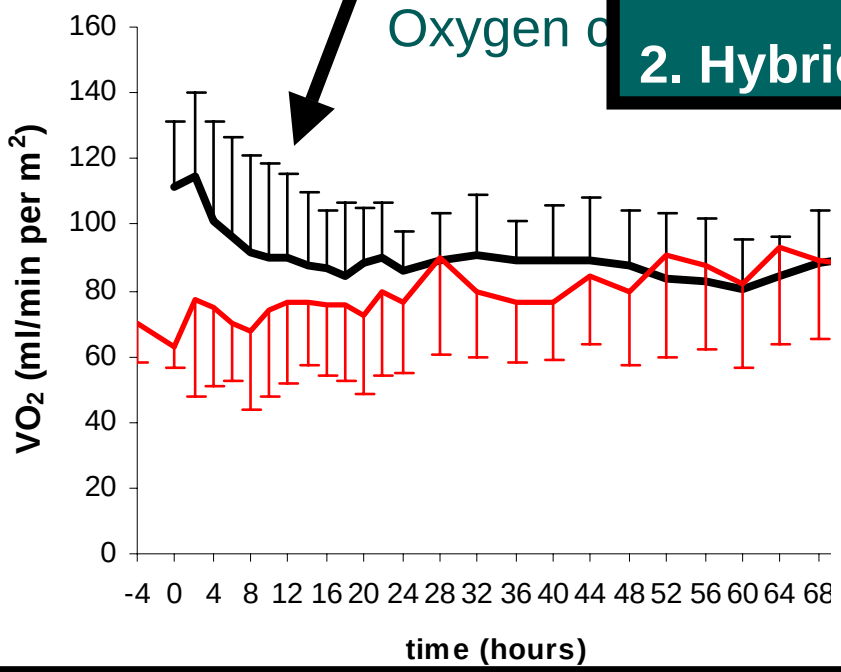

1. Hybrid Qp/Qs is high in the early postop period.
2. Qp/Qs is less well controlled (higher) than the Norwood patients
Qp/Qs
Qp:Qs
6
5
4
3
2
1
0
-1
-4 0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72
time (hours)
Hybrid
Norwood

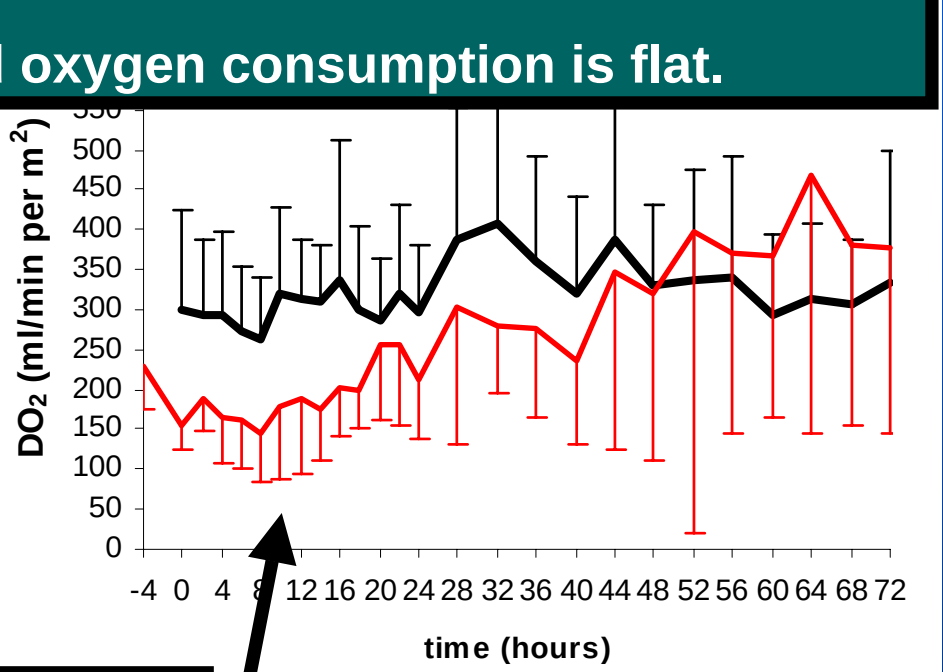
Qp/Qs for individual hybrid patient



1. Norwood patients have an early period of high oxygen consumption.
   1. Anesthetic
   2. Inotropes
   3. CPB-associated inflammation

2. Hybrid oxygen consumption is flat.

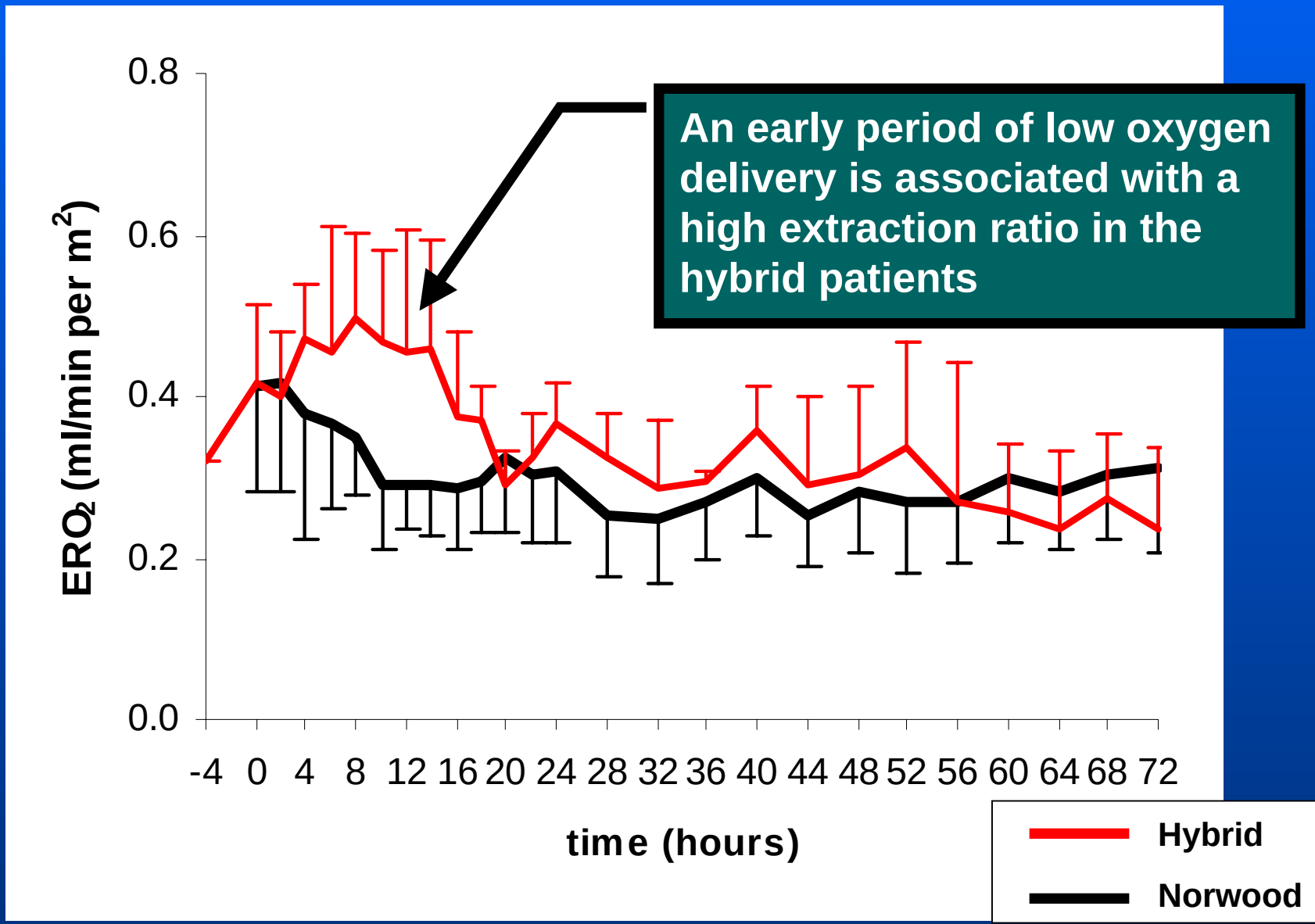




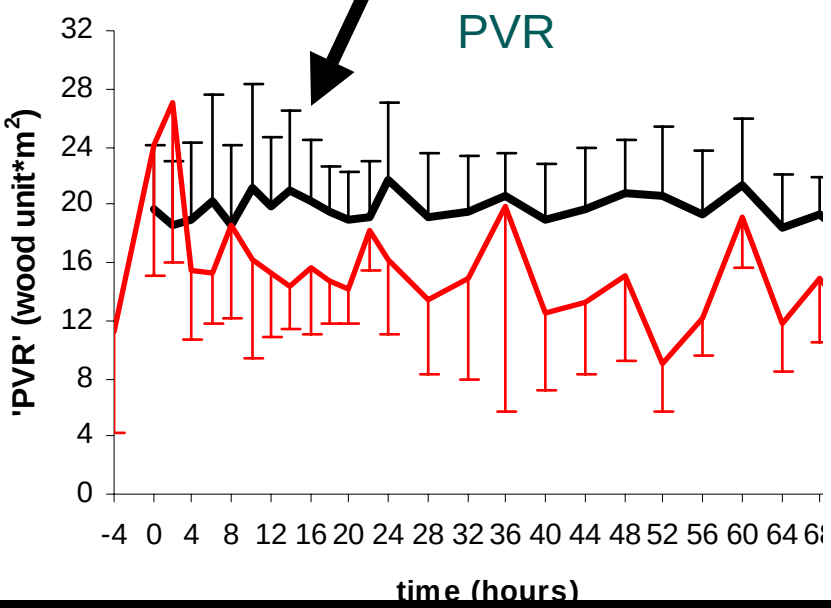
Hybrid oxygen delivery is low in the early postoperative period.
Increases with decreased sedation

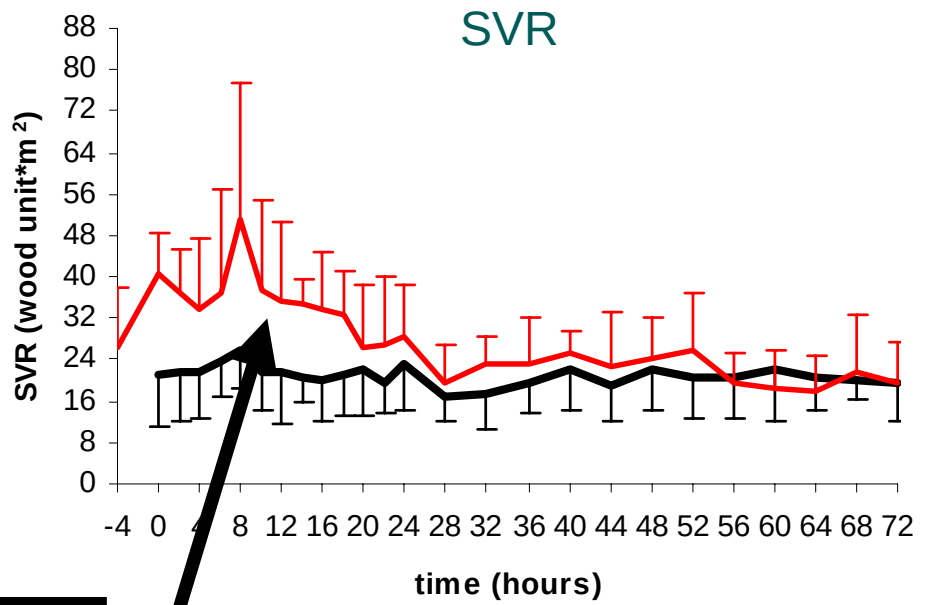
Hybrid
Norwood

Oxygen Extraction



No obvious trends in PVR



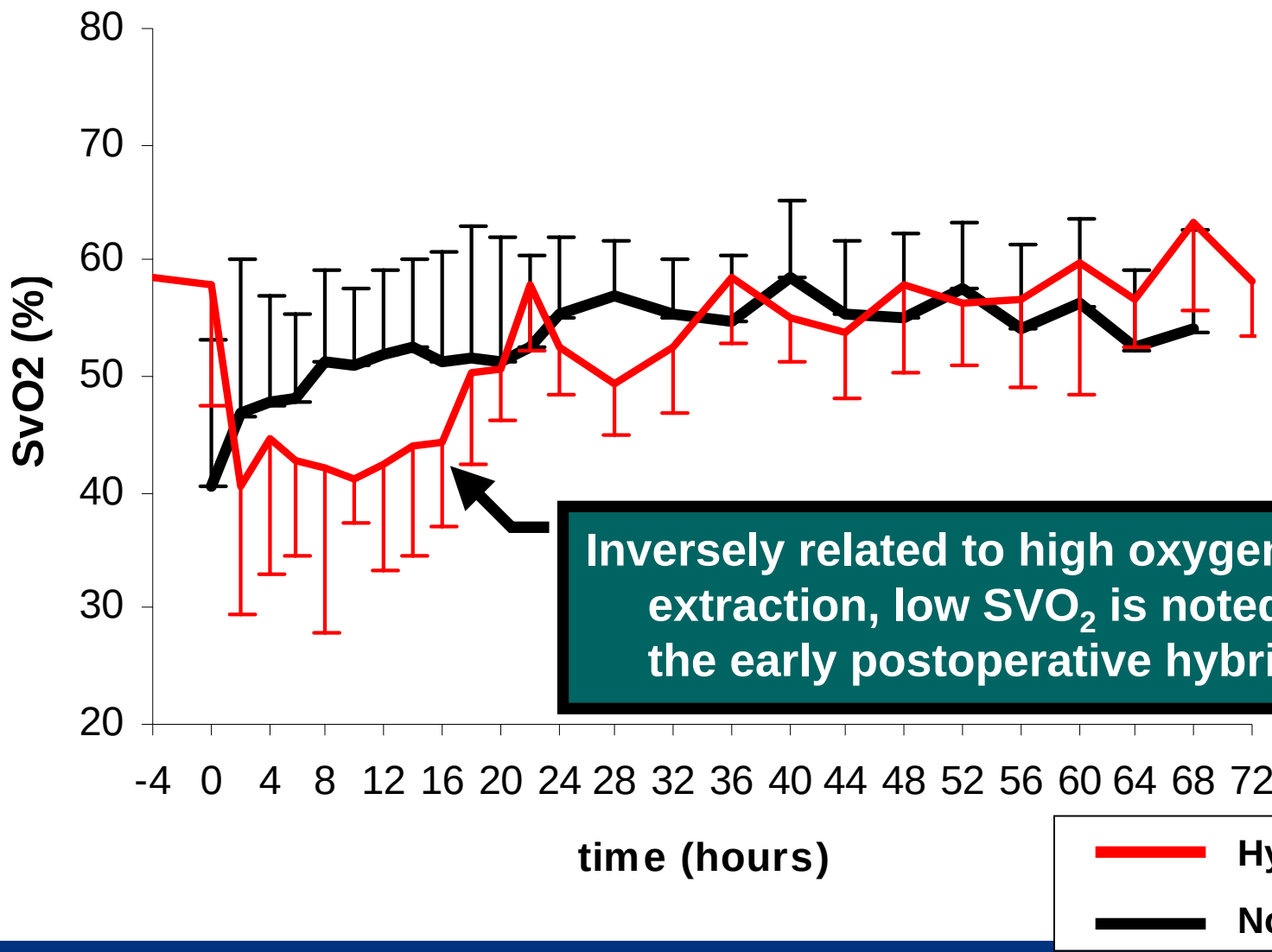


Early period of high SVR in hybrids
? Lifting sedation

Hybrid

Norwood

SvO_2


80
70
60
50
40
30
20
SvO2 (%)
-4 0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72
time (hours)
Inversely related to high oxygen extraction, low SVO2 is noted in the early postoperative hybrid
Hybrid
Norwood

Conclusion

- **Fontan track palliation with the hybrid procedure is encouraging**
  - **Impact of more difficult second stage procedure remains to be determined**

    Significant
  - **Refinements in technique at first and second stage can be anticipated**

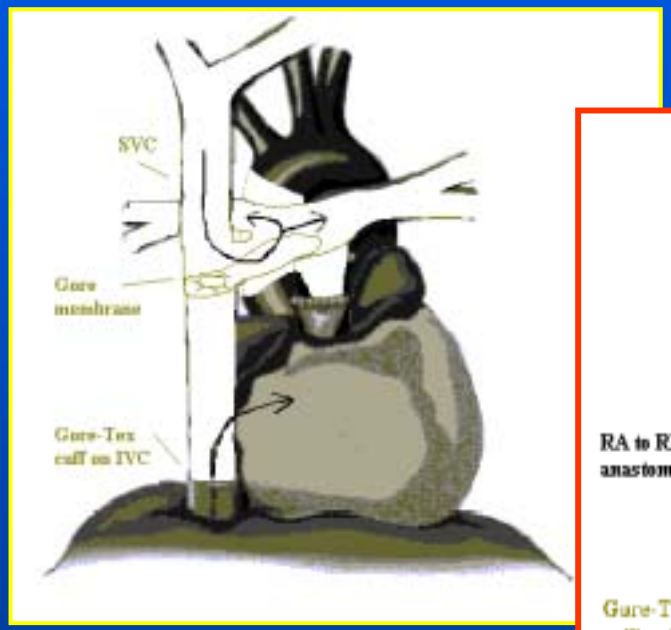
Hybrid “Norwood” Conclusion

- Postoperative hybrid patients avoid the period of high early postoperative oxygen consumption associated with the Norwood procedure
  - May contribute to the apparent hemodynamic stability in hybrids
  - Issues with aortic atresia can be resolved with reverse BT shunt

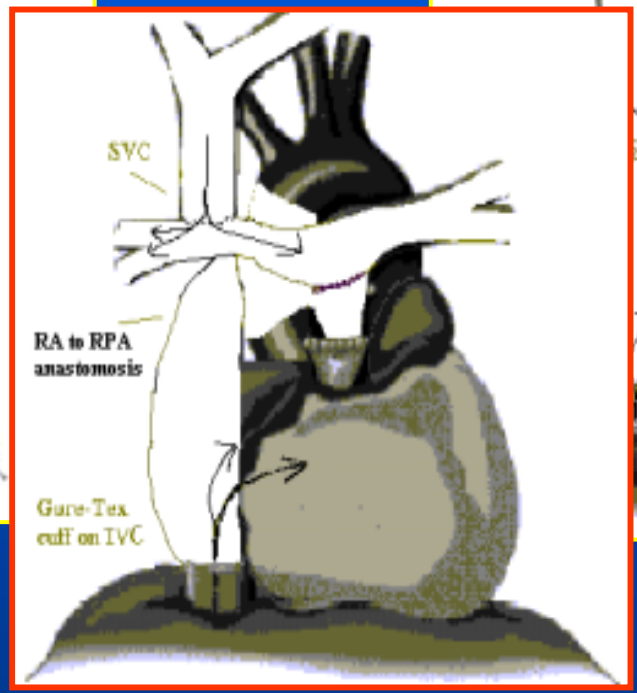
Catheter Completion of the Fontan Operation after Surgical Preconditioning
A Work in Progress

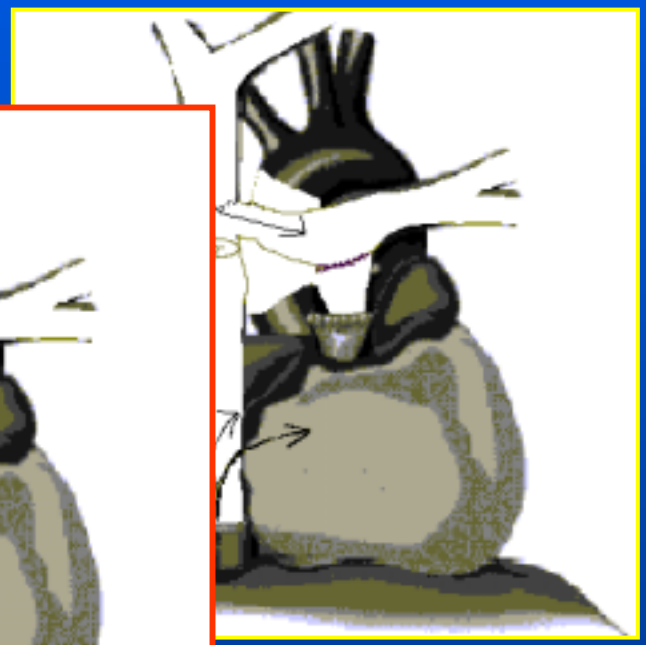
- Intra-atrial conduit (+/ fenestration)
- Possibly better tolerated.
- Avoid open chest and cardiopulmonary bypass

Surgical Preconditioning



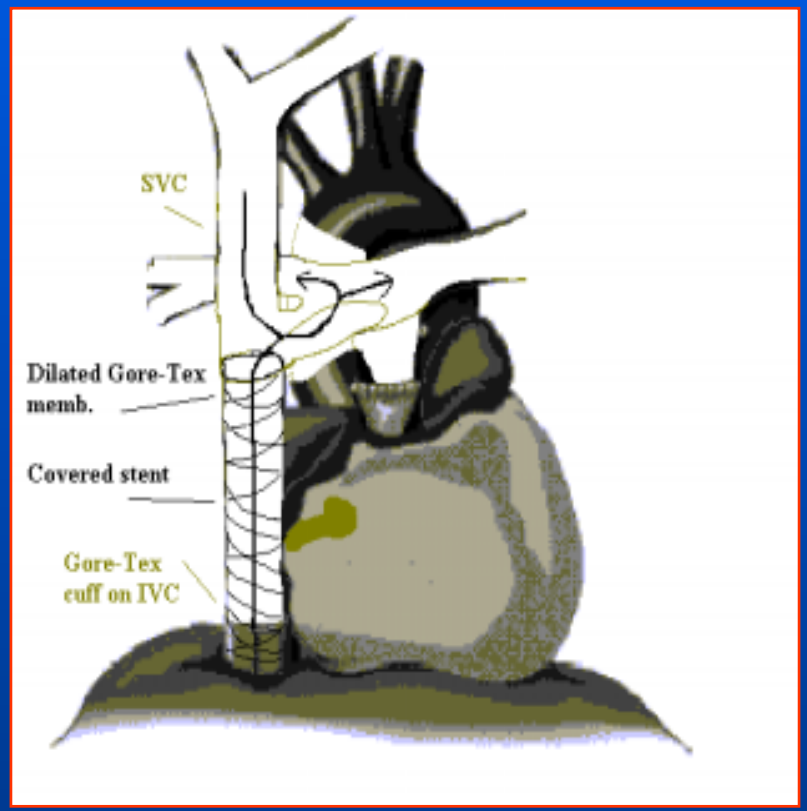
Hemi-Fontan

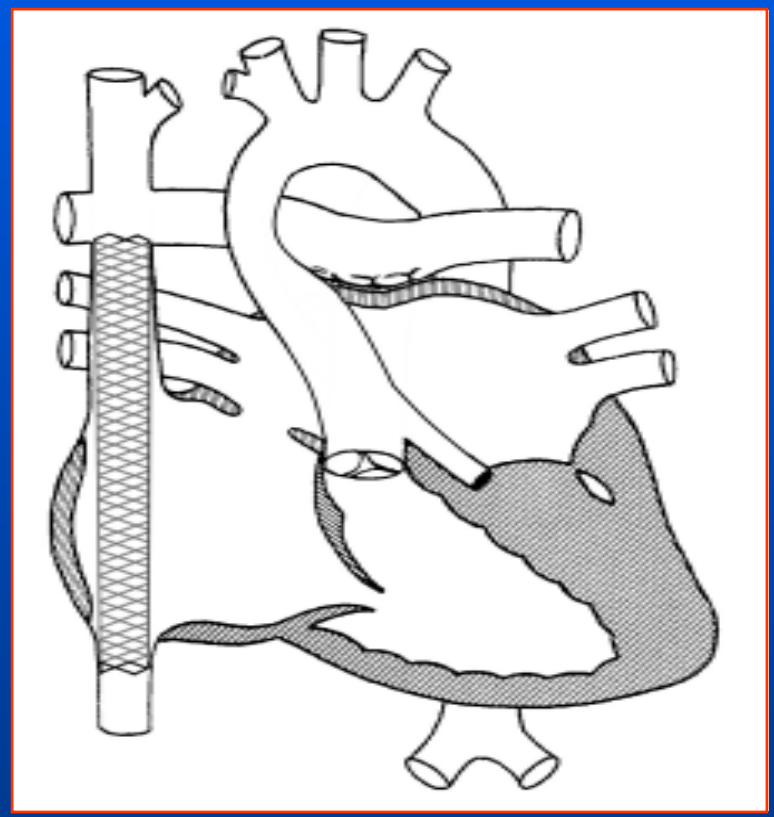


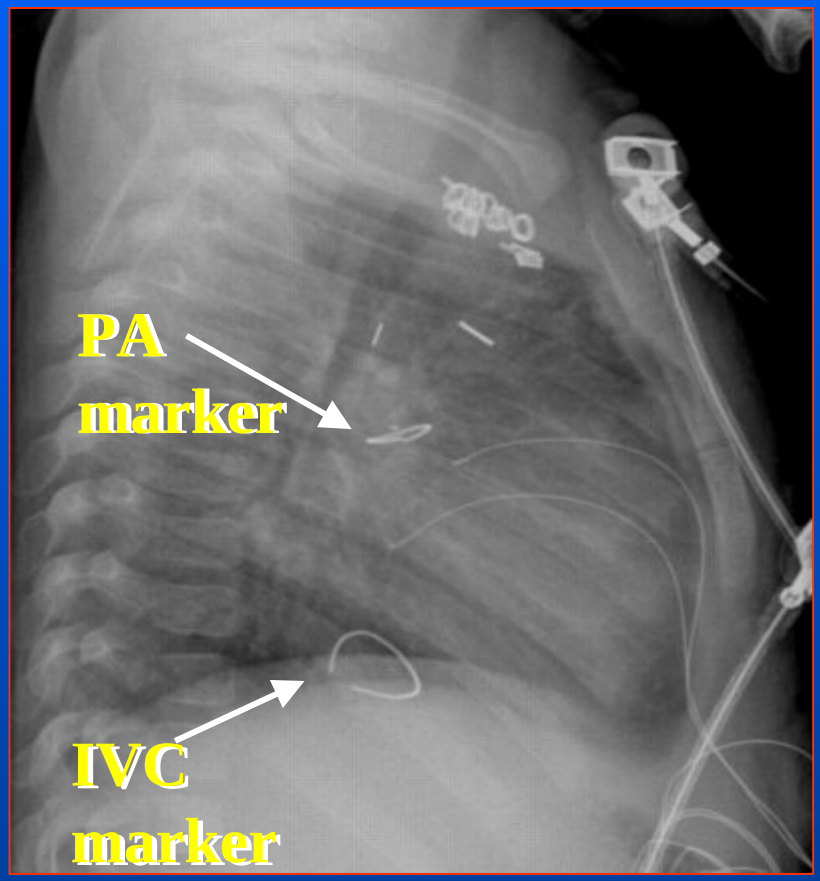


BCPC

Catheter Completion



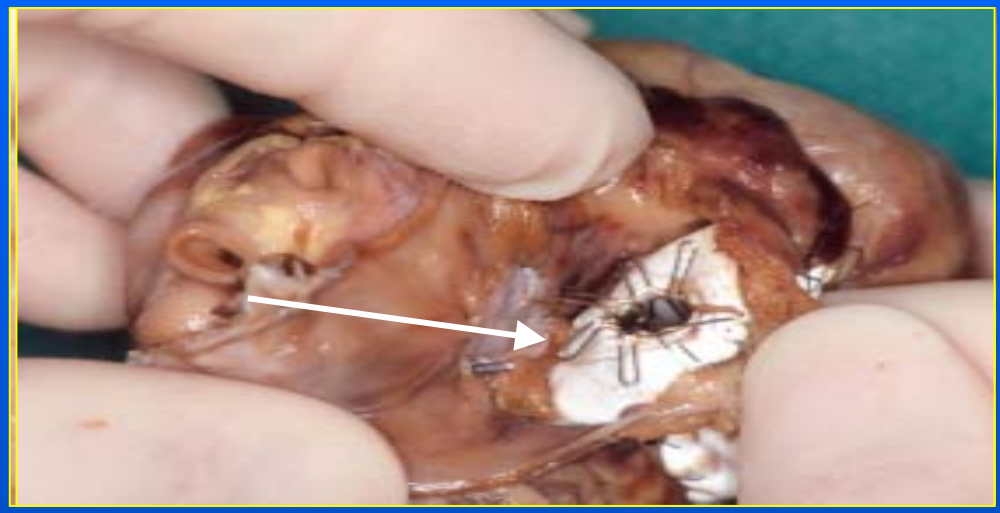




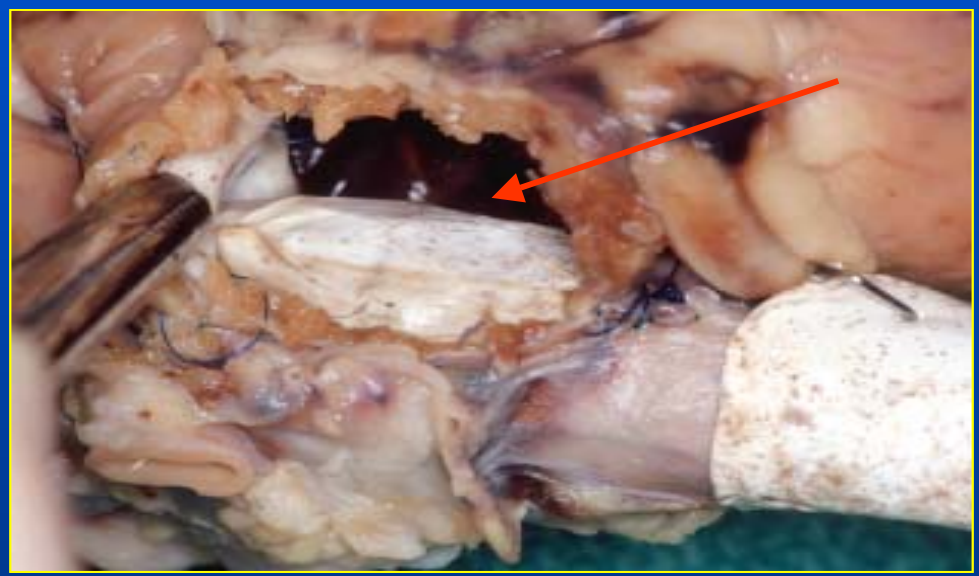
SVC and IVC markers

NuMed - Cheatham covered stent:

15mm diameter, 10 cm length - 12Fr.
20mm diameter, 10 cm length – 14 Fr. on BIB balloon



SVC end

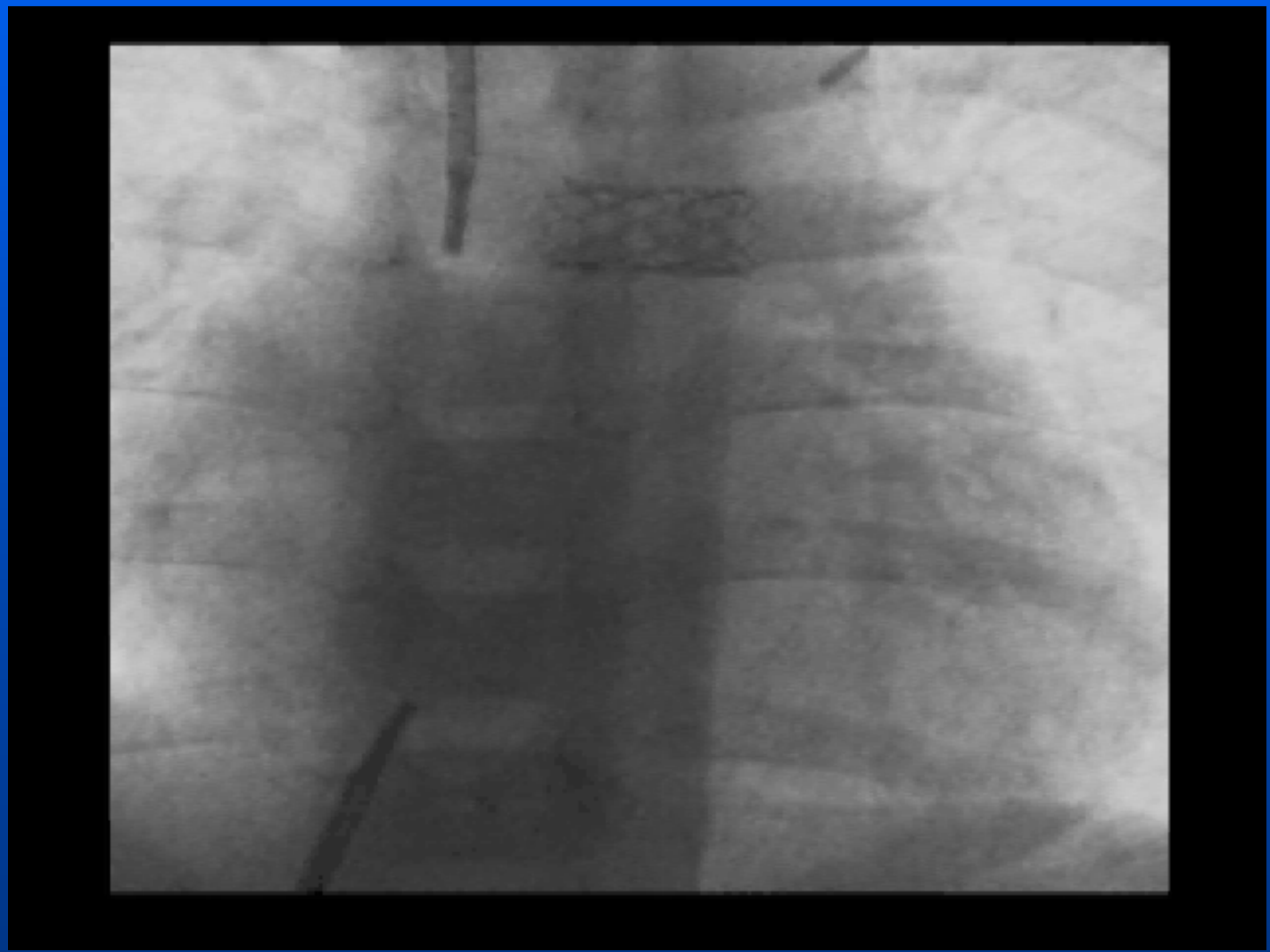


Interatrial baffle

Haemostatic seal

Animal study

Cath Lab Fontan



Hybrid Procedures

In Evolution and Revisions –

Not a Revolution

Rapid ECMO Standbuy

May decrease morbidity

Still Significant learning curve

Patient population

Anatomy (hybrid)

HLHS	9	
Unbalanced AVSD	2	
Transposition, single ventricle		2

Anatomy (Norwoods)

HLHS	8	
Univentricular hearts		2

- **Parameter Equations**

$Qp\ (L/min\ per\ m^2) = VO_2 / (CpvO_2 - CaO_2)$

$Qs\ (L/min\ per\ m^2) = VO_2 / (CaO2 - CvO_2)$

$DO2\ (ml/min\ per\ m^2) = Qs \times CaO_2$

$ERO_2 = VO_2/DO_2$