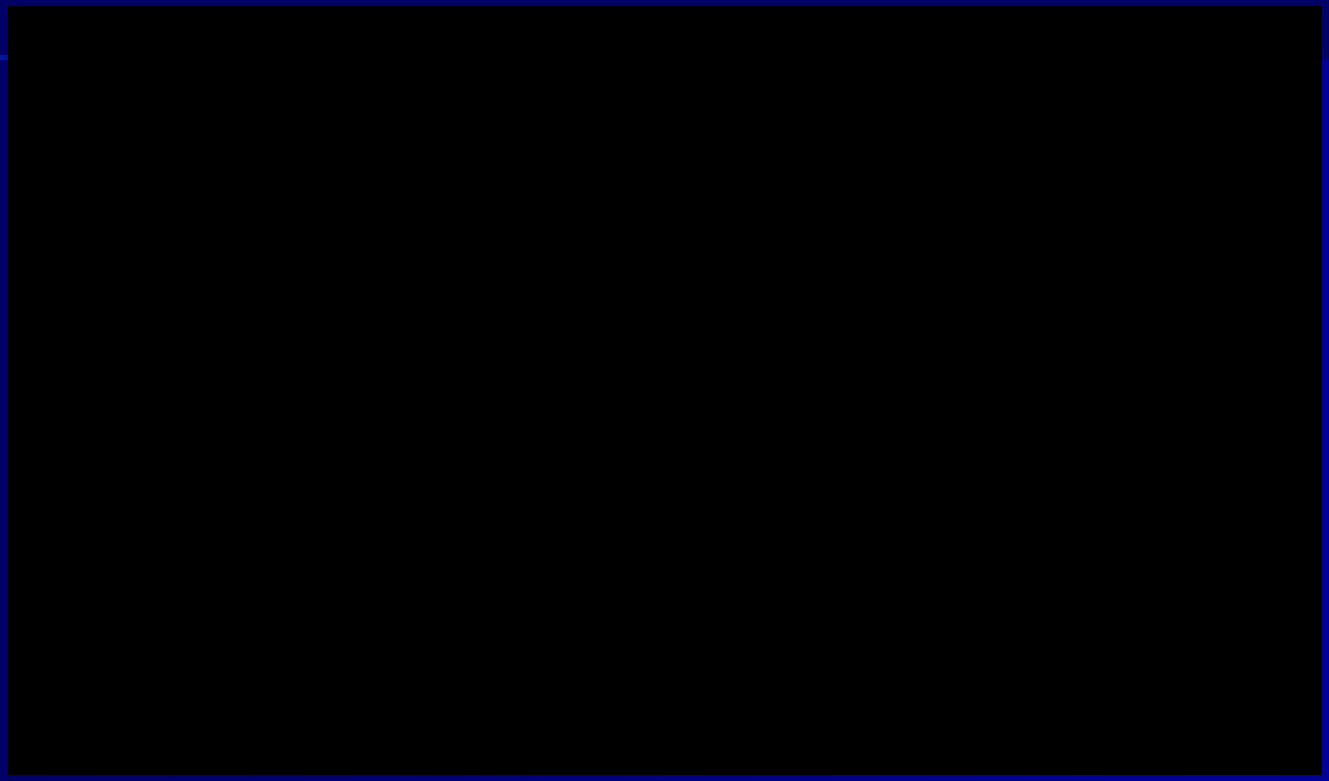
Tampa Bay

Fishing

Gulf of Mexico

Innovation in Pediatric Cardiac Interventions: Laser Technology



Elsa Suh, MD

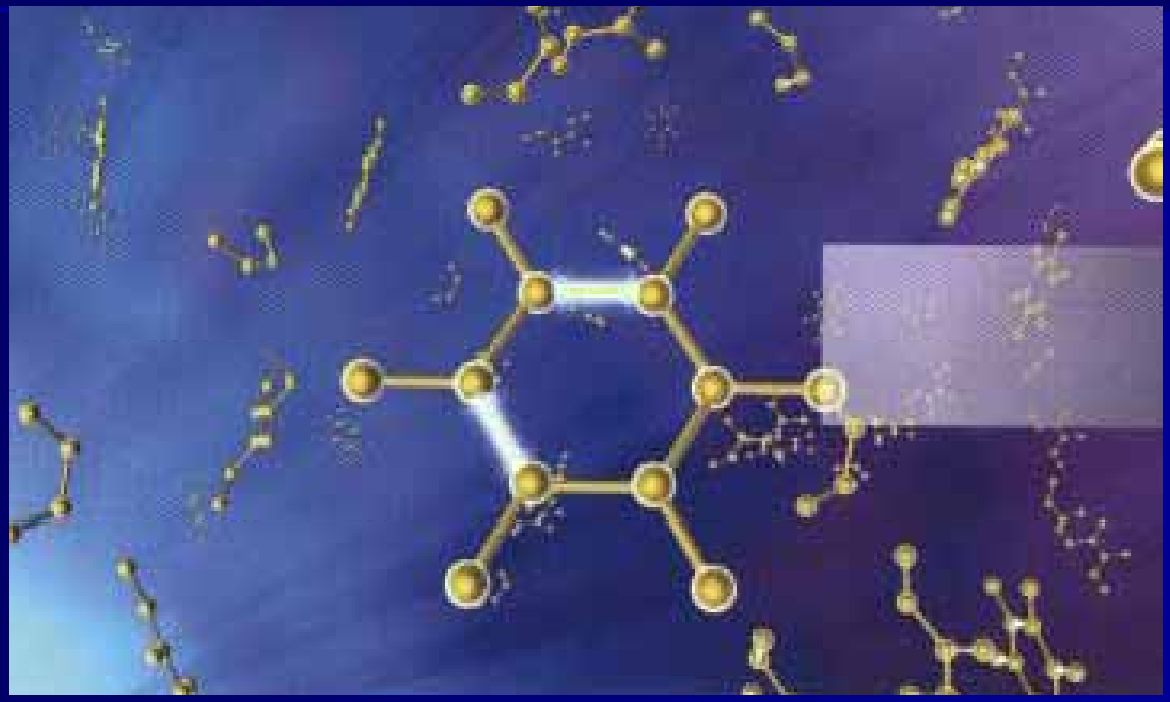
Florida Heart Insitute of Florida

Tampa Children's Heart Center

Principle of Laser Photoablation:

- **Photoablation** is the use of light to vaporize and remove tissues.

Photochemical Reaction: Breaking Molecular Bonds

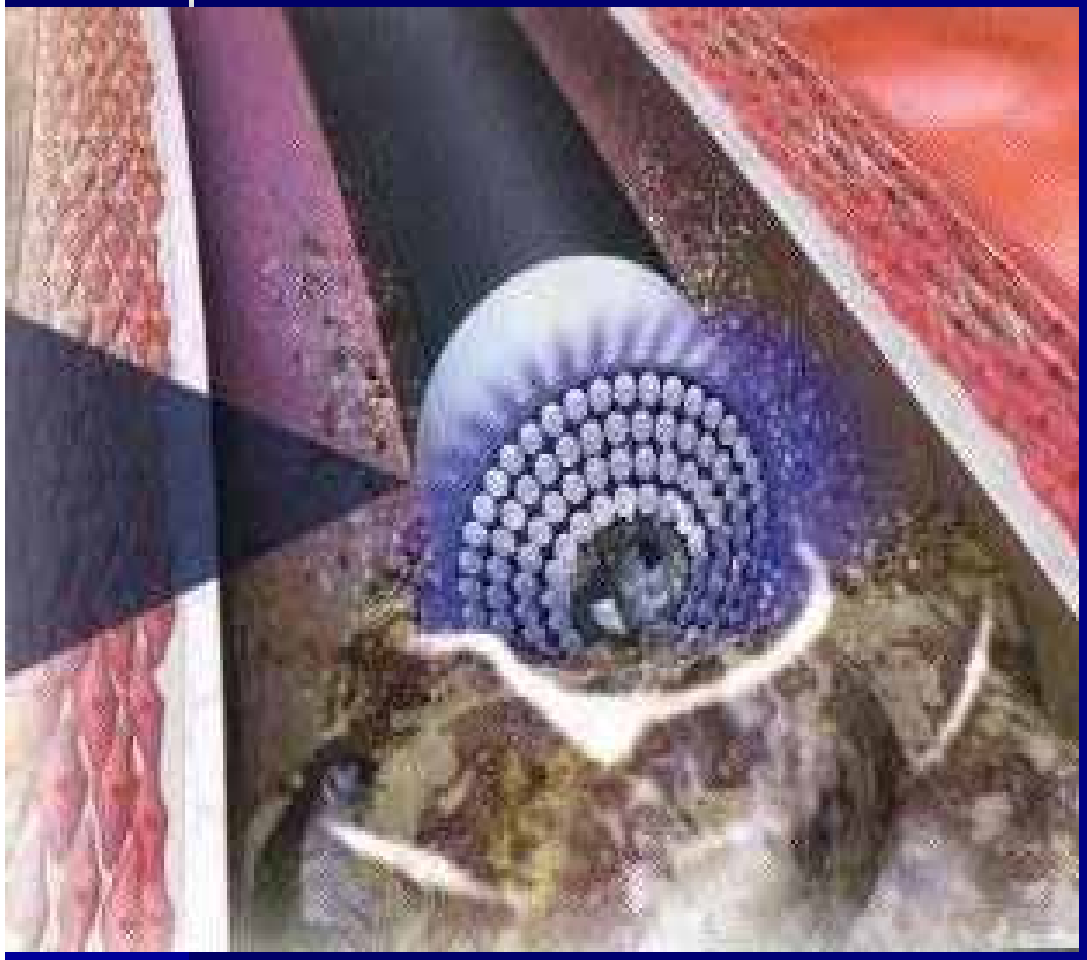


- UV light pulse hits tissue for 125 billionth/sec
- 50 microns penetration

Photothermal: Producing Thermal Energy

- Tissue experiences molecular vibration
- Intracellular water temperature becomes elevated
- Intracellular H_2O vaporizes and ruptures cells (cell lysis)

Photomechanical Reaction: Creating Kinetic Energy



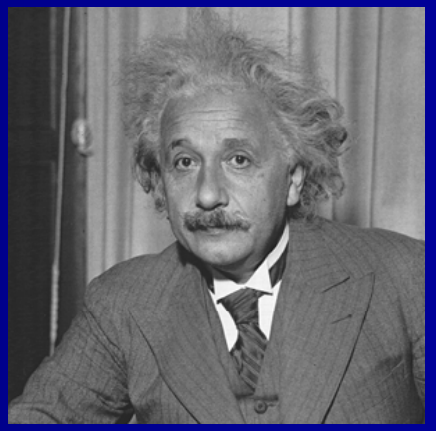
- By-products of ablation are **H_2O**, **gas**, **small particles** (<10 microns)

*RBC=6-8 microns

History of Laser

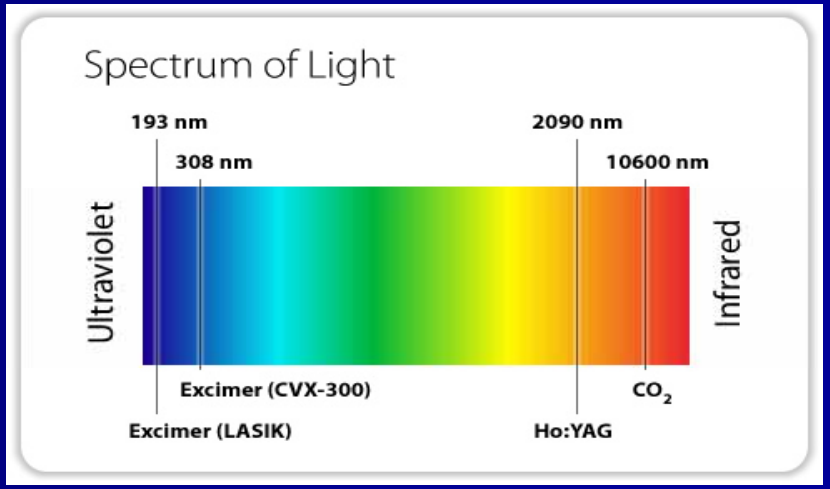
- **1917: Einstein first postulates energy is generated from stimulated photons**

  E= mc2



- **1960: Optical laser technology testing**

- **1987: first Laser Eye Surgery (NY, USA)**



***Uses a wavelength of 308 nm**

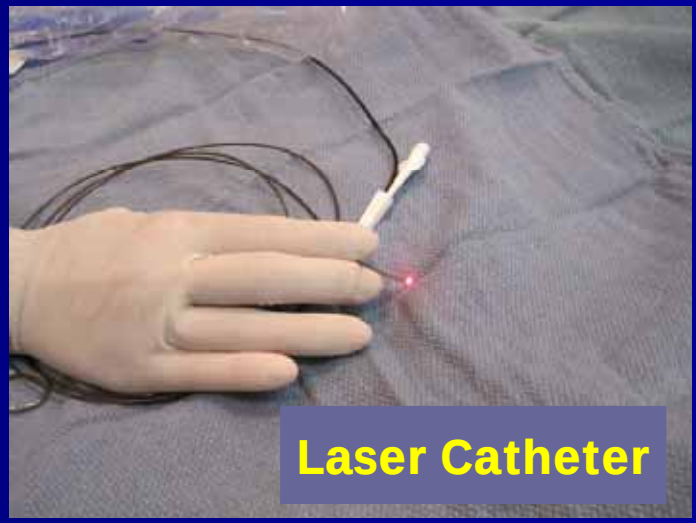
Basis of Excimer Laser

- **EXCIMER: Excited & diMER**
- **LASER: Light Amplification by Stimulated Emission of Radiation**
- **Excimer Laser:** 2 atoms from a pulsed gas (XeCl) form a temporary "excited molecule", creating energy

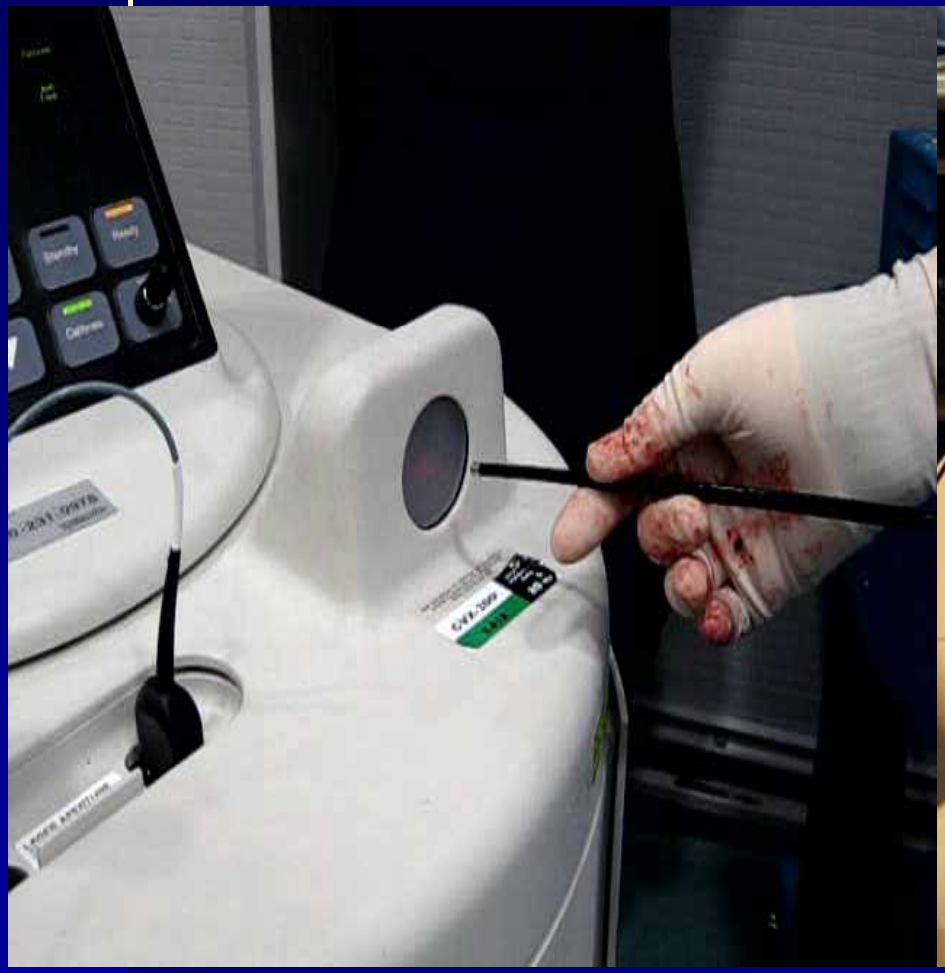
Equipments: Spectronetics Laser & catheters

CVX-300
Excimer Laser System

Catheter Size: 0.9-2.5 mm



Laser Catheter Caliberation (0.9mm-2.5mm)



Laser Setting

- **Fluence(30-80):** output energy density in millijoules/mm2
- **Frequency (25-80Hz):** repetition rate in cycle/second

Pediatric Clinical Applications

- **Fetal Intervention:** Twin-twin Transfusion, HLHS with IAS, PA/IVS
- **Creation of PFO/ASD**
- **Perforation of Valve Tissues:** Pulmonary Atresia/ IVS
- **Creation of Fenestration** in Extracardiac (Goretex) and Lateral Tunnel Fontan

First Use of Laser in Fetal Cardiac Intervention: In Utero PFO Creation in HLHS/IAS

Elsa Suh, Ruben Quintero, James Huhta

- 2005: a 28 week gestational age fetus with HLHS and intact atrial septum
- Transatrial delivery of Laser beam x 7 against the atrial septum (fenestrated PFO)
- Result: FT 3.2 Kg infant with HLHS and restrictive PFO but patent, who underwent a Stage I Norwood.

Creation of PFO/ASD

L-R Shunting

(Decompression of LA Hypertension)

- Mitral Stenosis/ HLHS+IAS
- Mitral Regurgitation/ PHTN, etc.

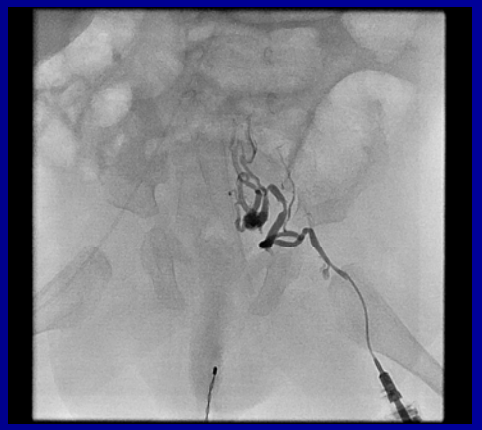
R-L Shunting

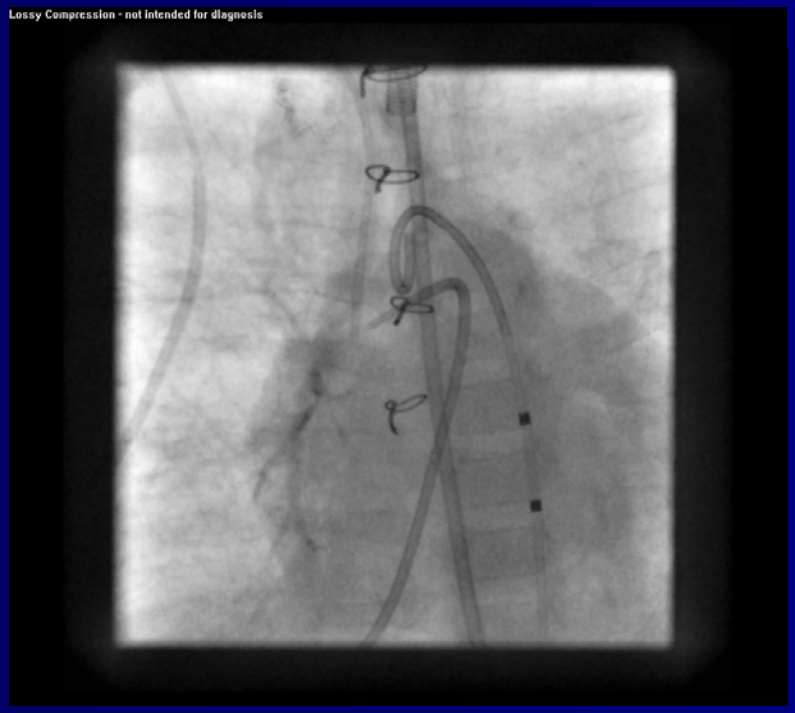
(Decompression of RA Hypertension)

- RV Hypertension (from PHTN, postop TAPVC, TOF/PA/MAPCA'S, etc.)

PFO Creation for R-L shunting

- 1 month old 3.9 Kg male
- S/P TAPVC Repair
- Severe PHTN with frequent pulmonary hypertensive crisis
- Obstructed bilateral iliac veins and upper compartment veins
- Create atrial level R-L decompression via transhepatic approach

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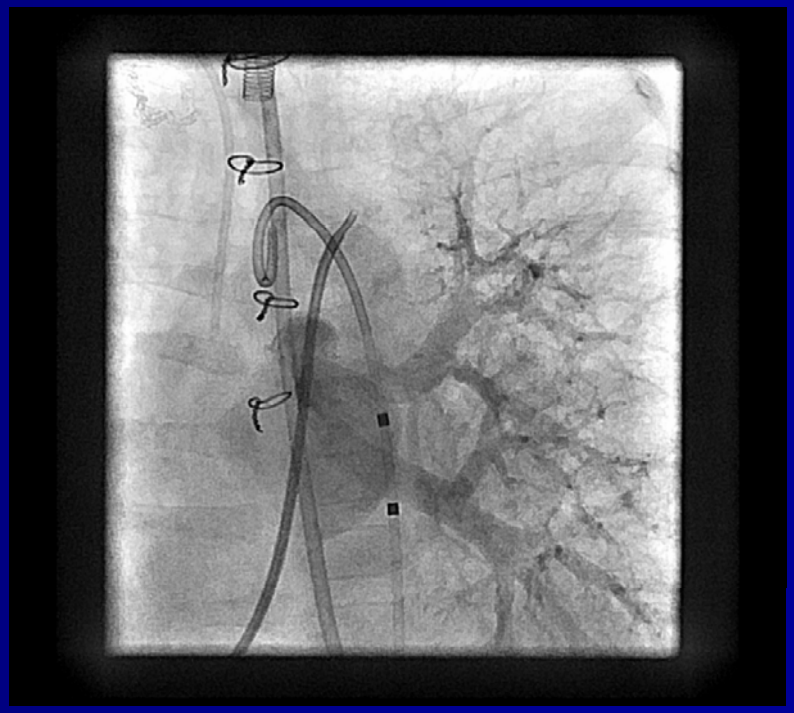

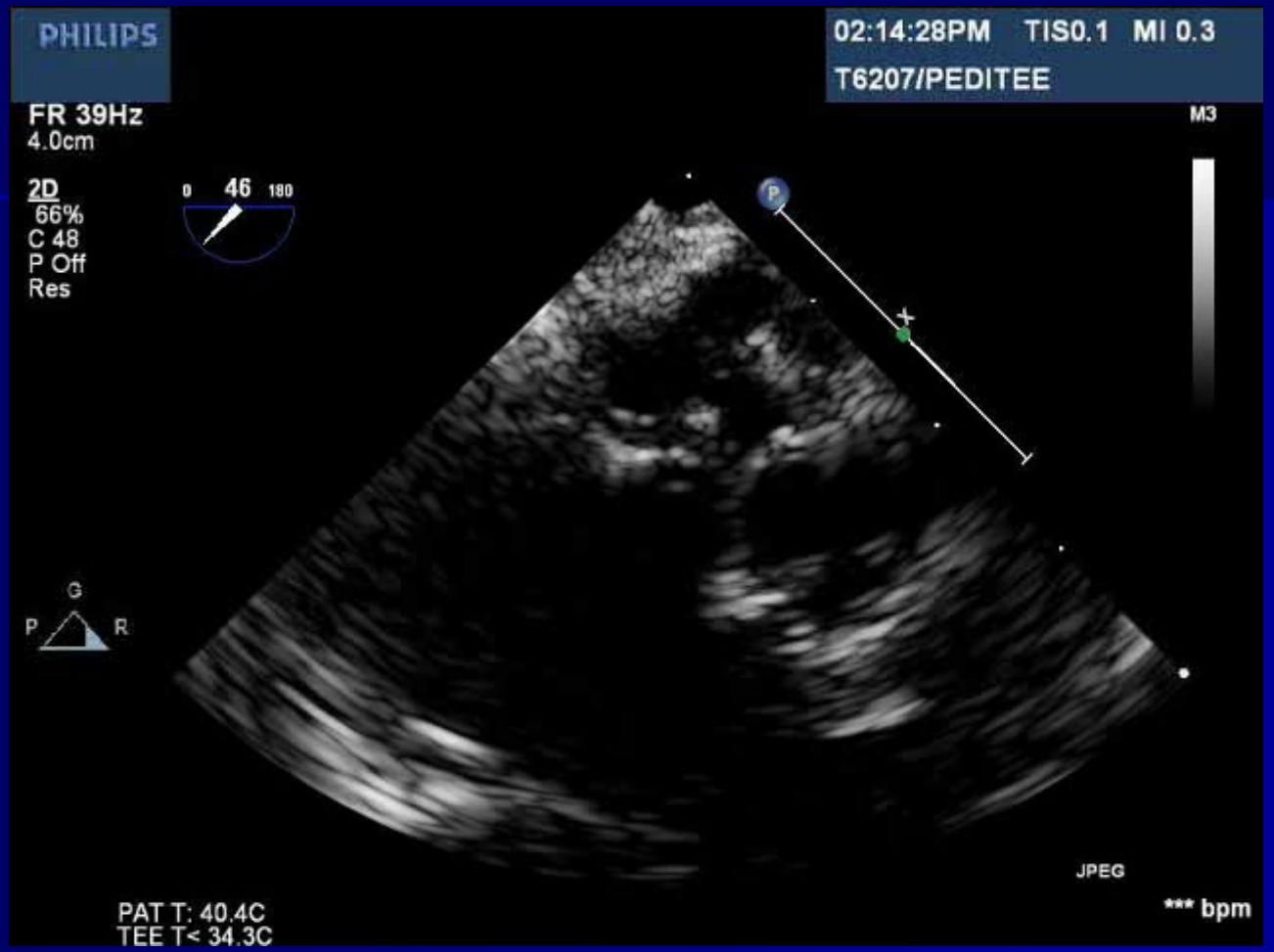
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C 48
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Res
0 46 180
G
P
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JPEG
*** bpm
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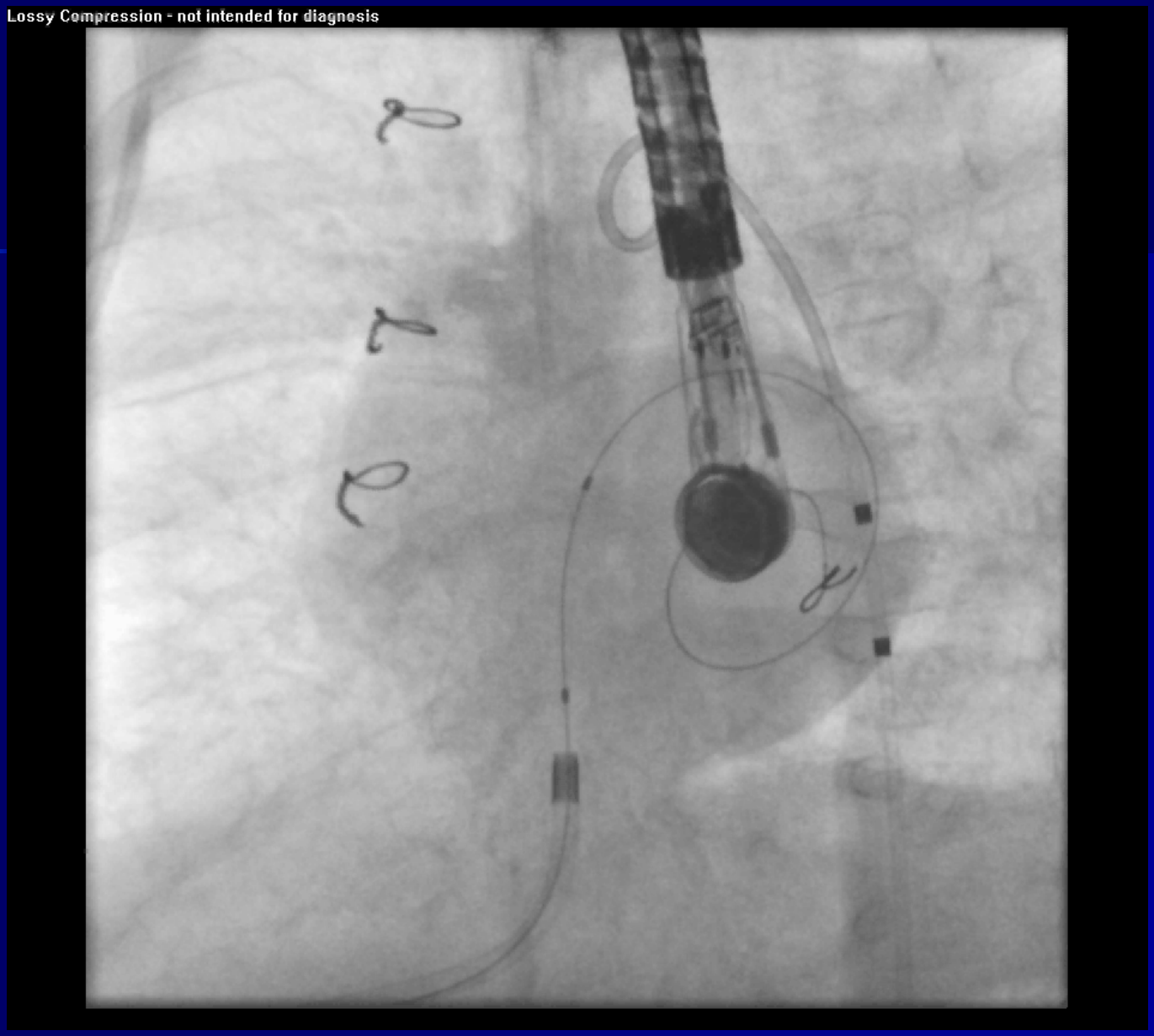
TEE T< 34.3C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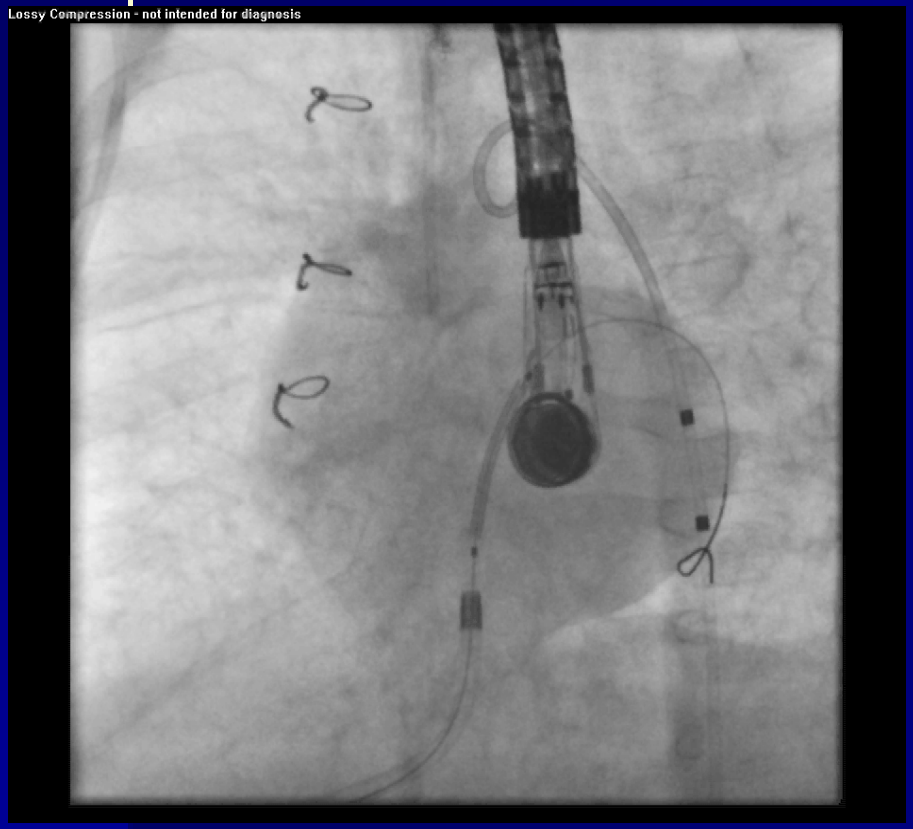
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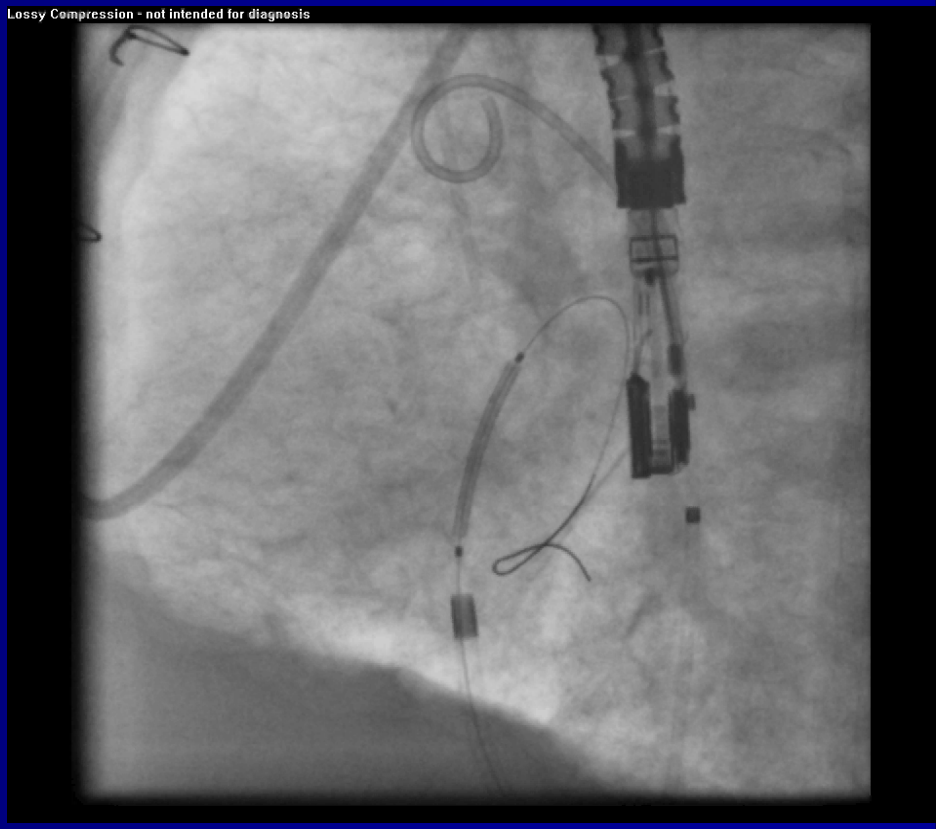
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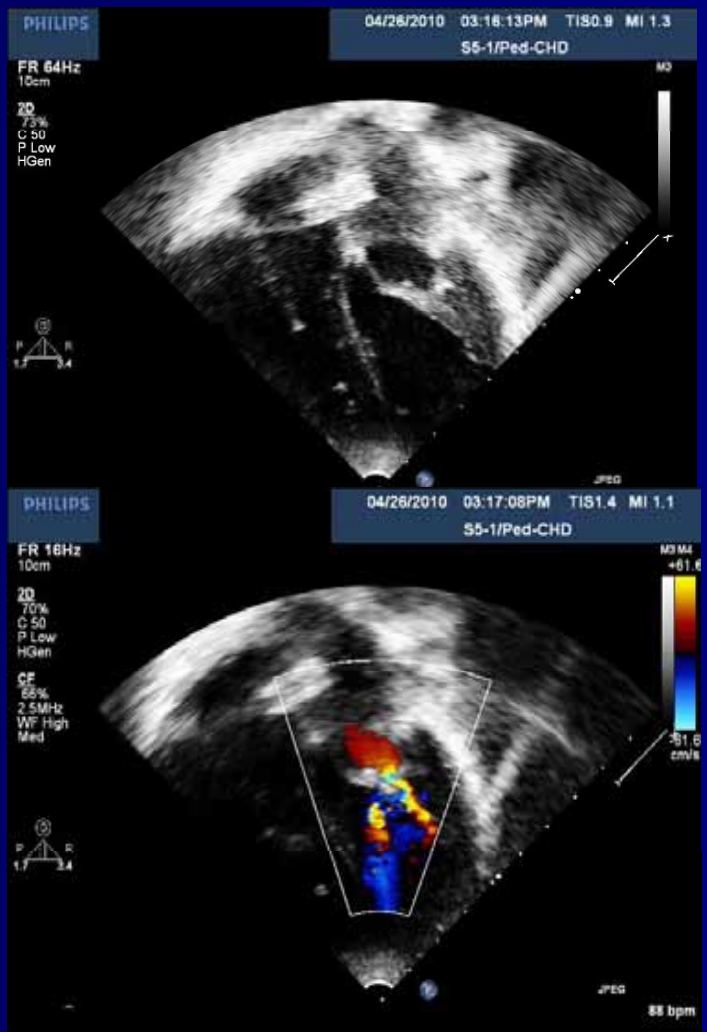
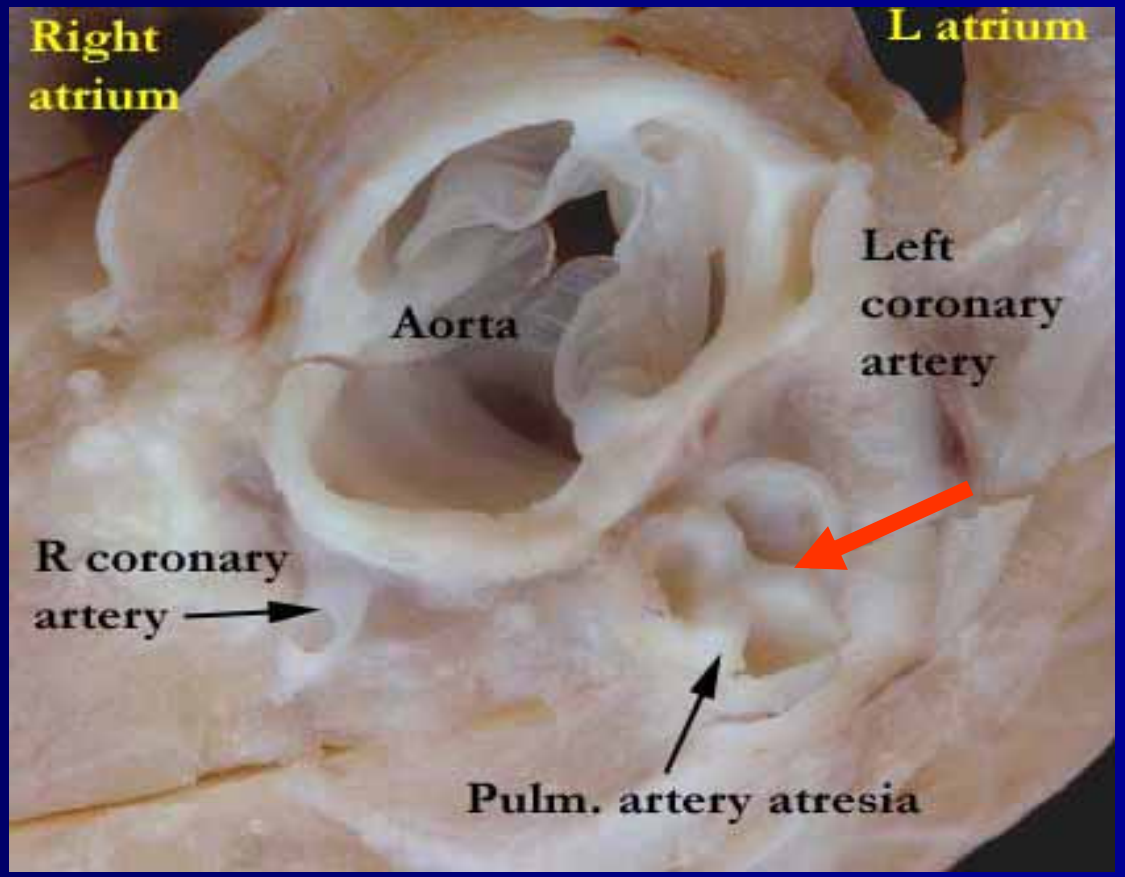
Creation of PFO for L-R Shunting: Mitral Stenosis

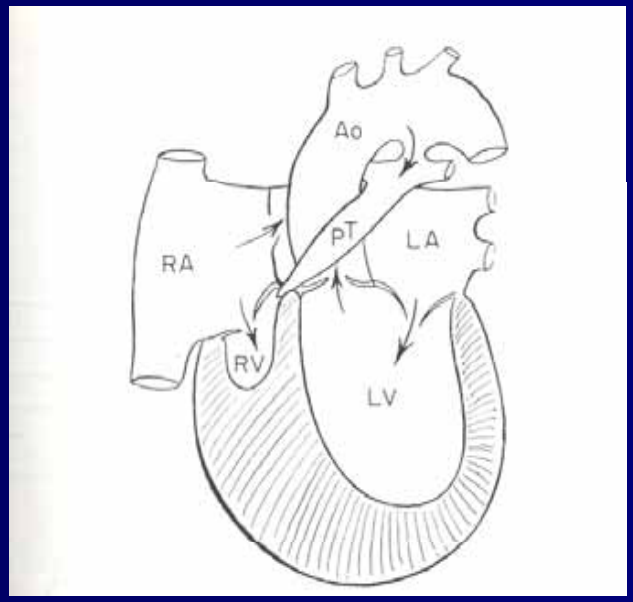


- A 5 YO male with Shone's Complex with Mitral Arcade & MS
- S/P 6 mm Genesis PM stent at 8 mo of age for LA HTN causing secondary PHTN
- Underwent MVR surgery at age 5 YO

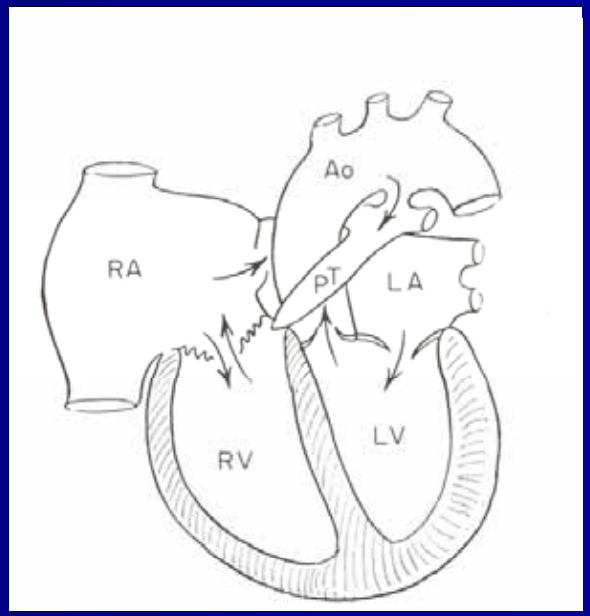
Perforation of Pulmonic Valve: Pulmonary Atresia / IVS



2 Major Types of PA/IVS



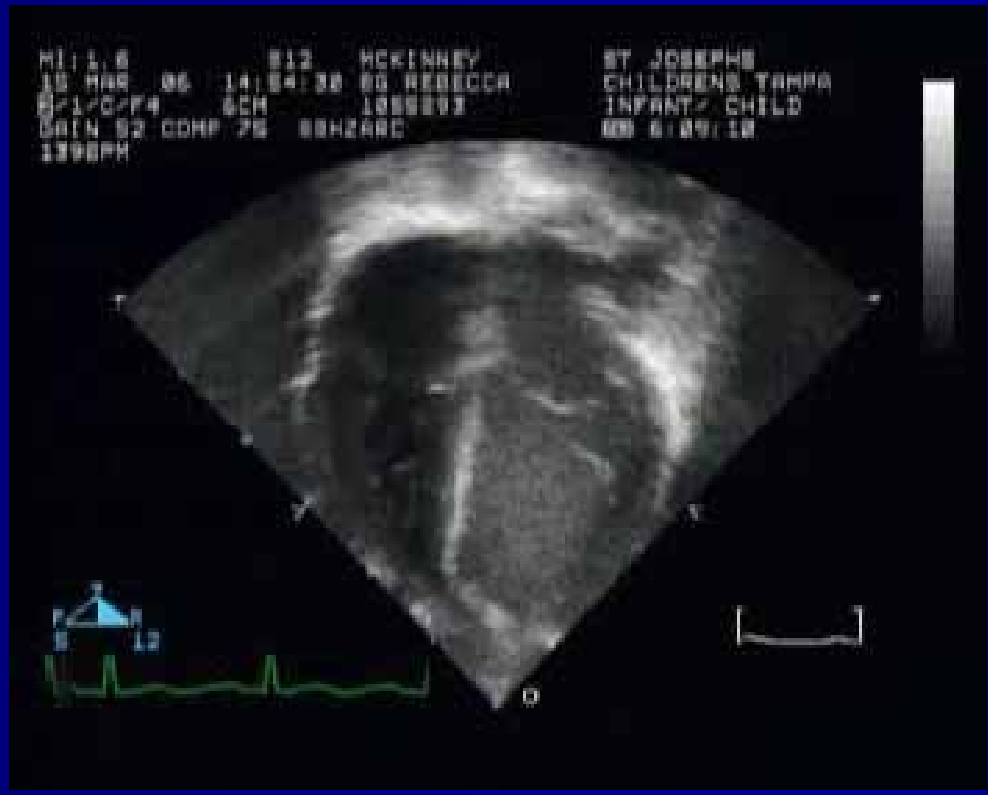
Hypoplastic RV
> 80%

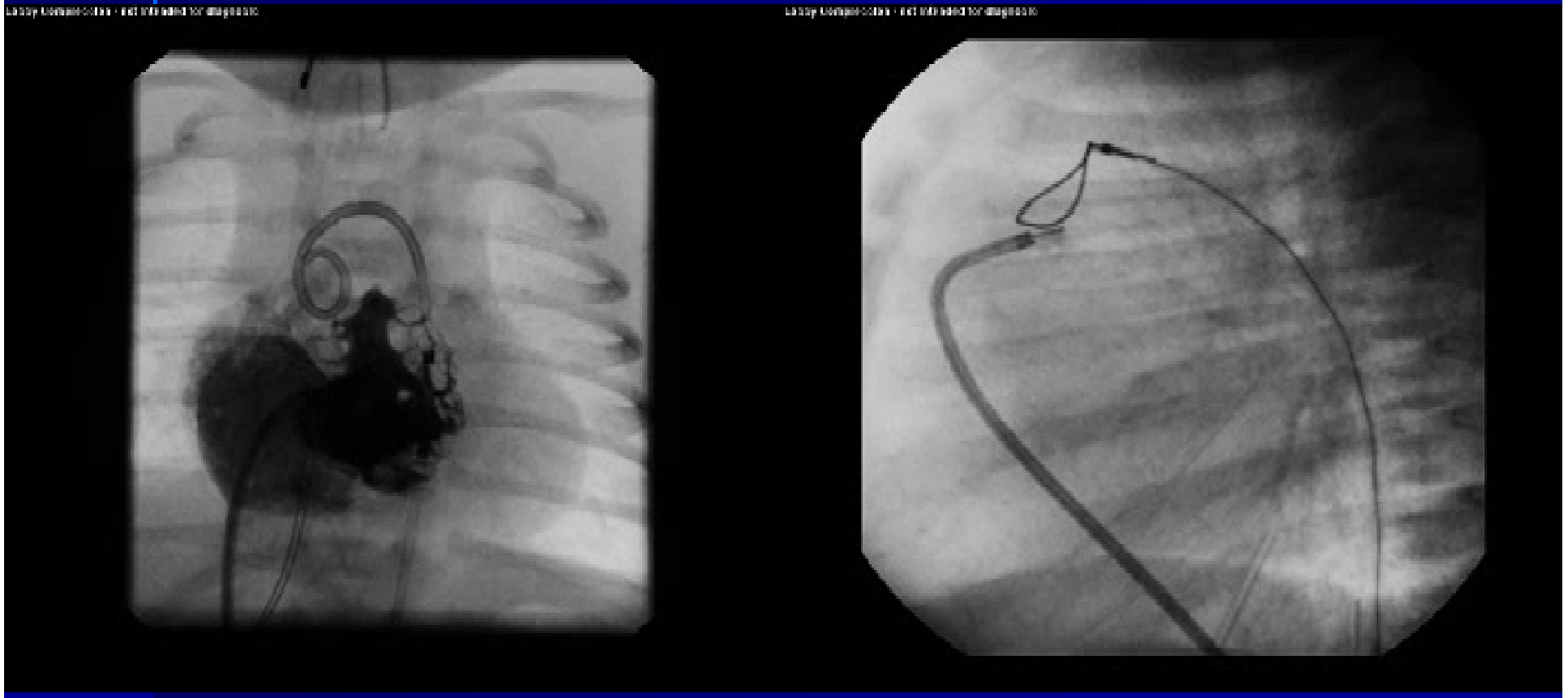


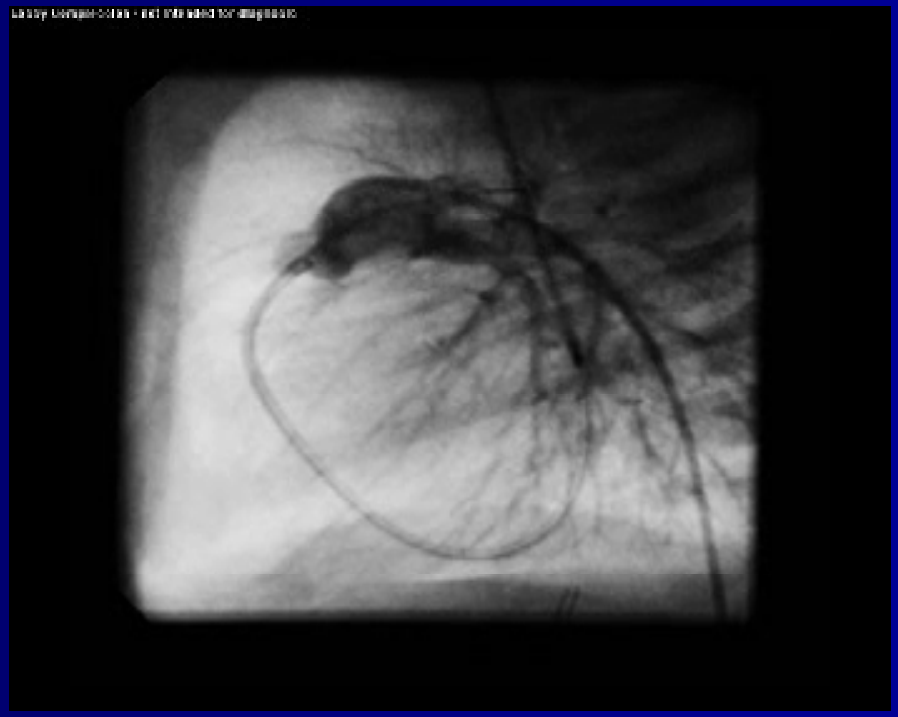
Normal-Dilated RV
< 20%

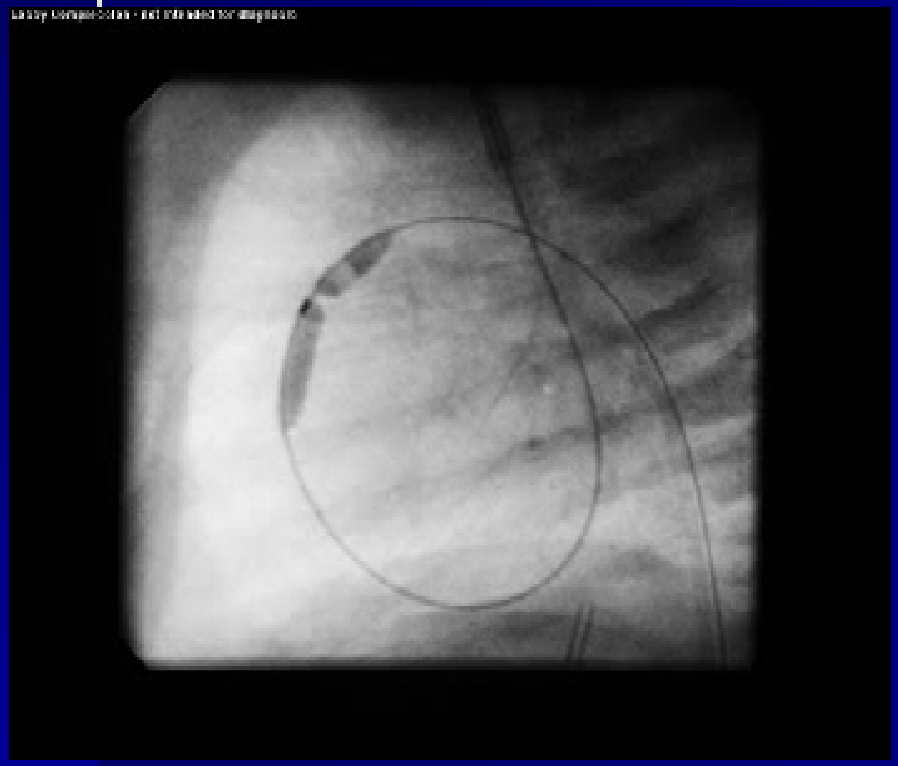
Postnatal Echocardiogram: PA/IVS s/p fetal valvotomy

- Fetal Dx of PA/IVS
- S/P fetal pulmonic valvotomy at 29 weeks gestation
- FT female delivery BW = 2.9 Kg





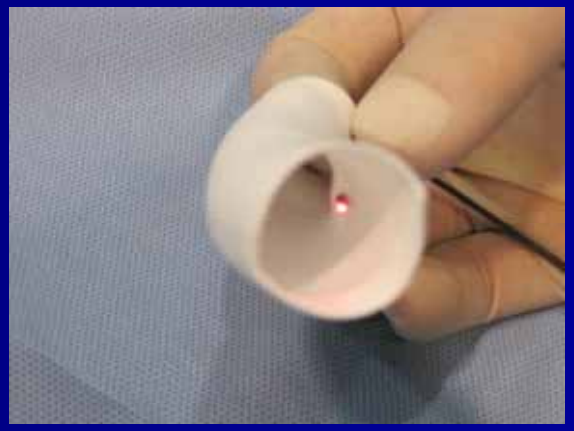




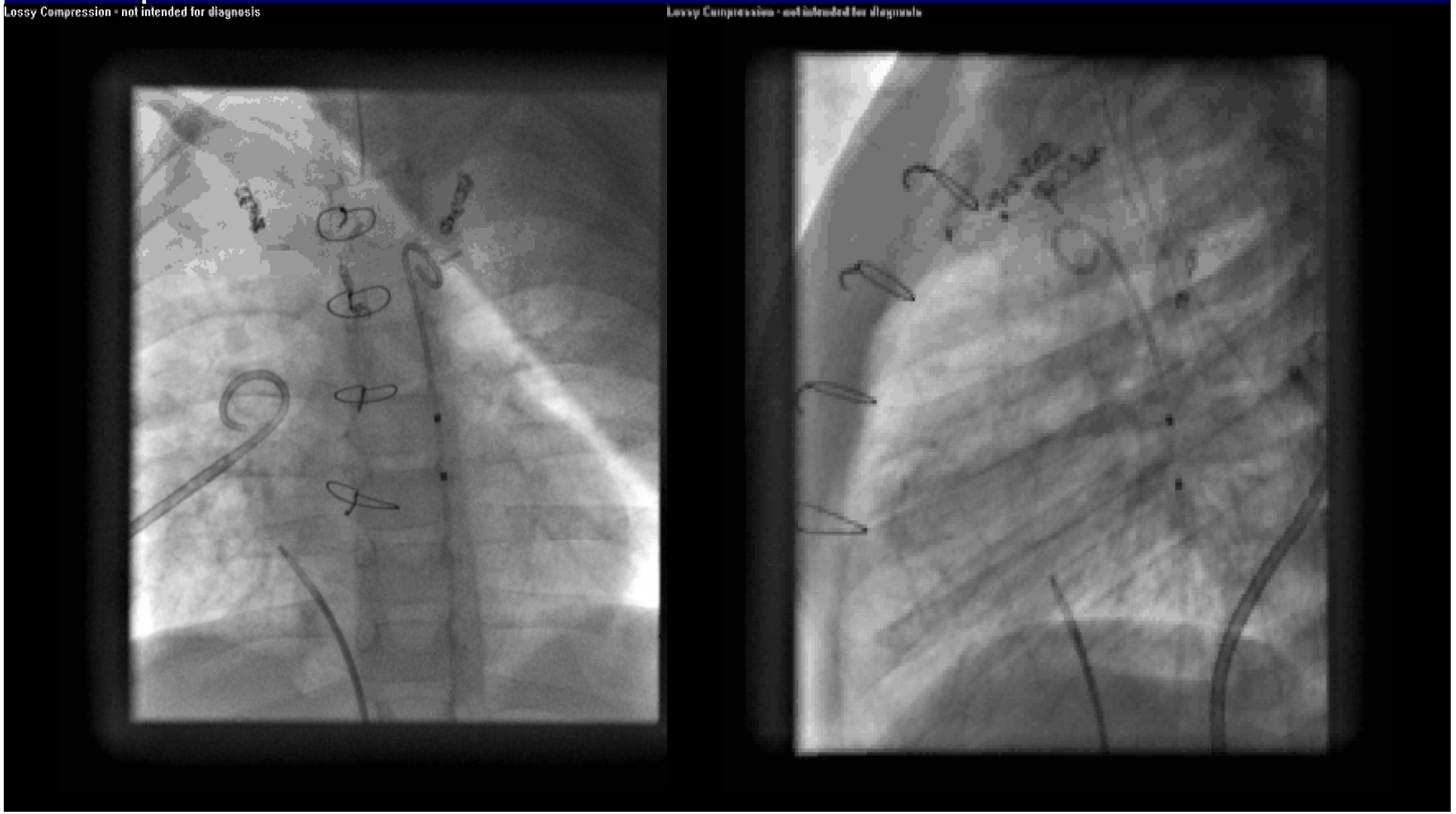
Fontan Conduit: Creation of Fenestration

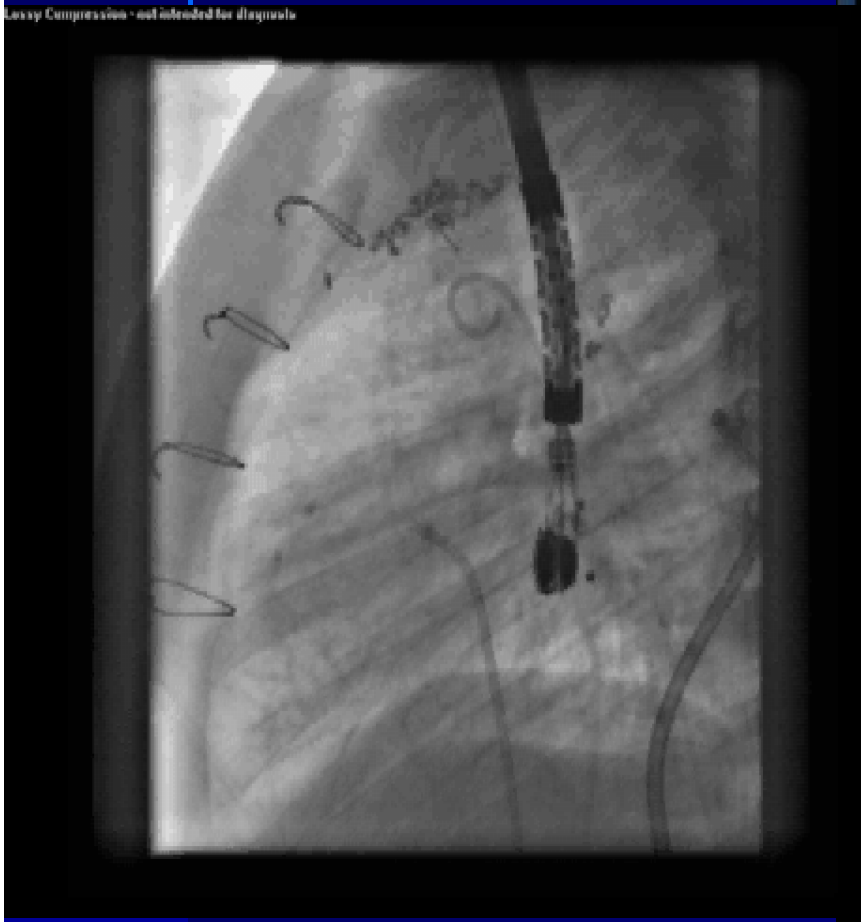
- Useful technology for perforating Goretex (PTFE) conduit in Extracardiac Fontan

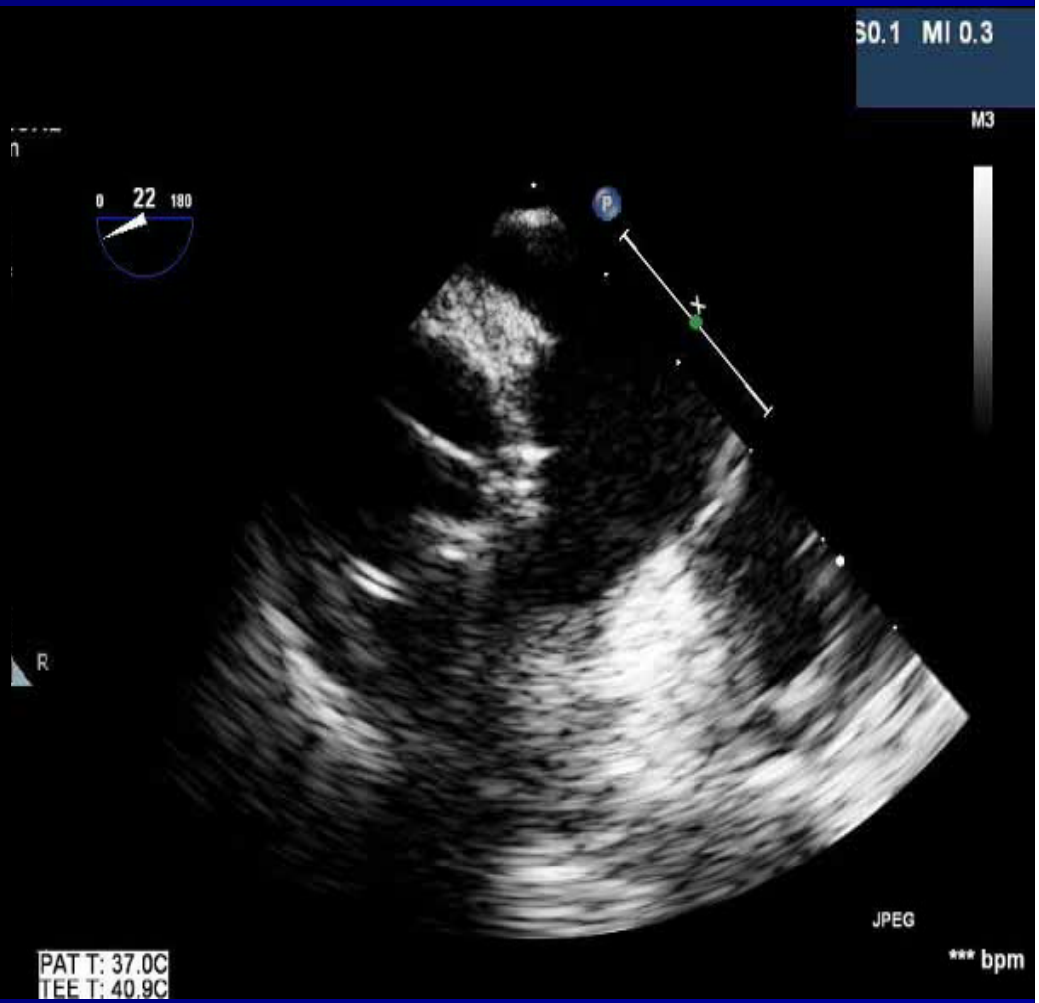
- **Melting Point of** PTFE = 400 Celsius (752 F)



Extracardiac Fontan Angiogram



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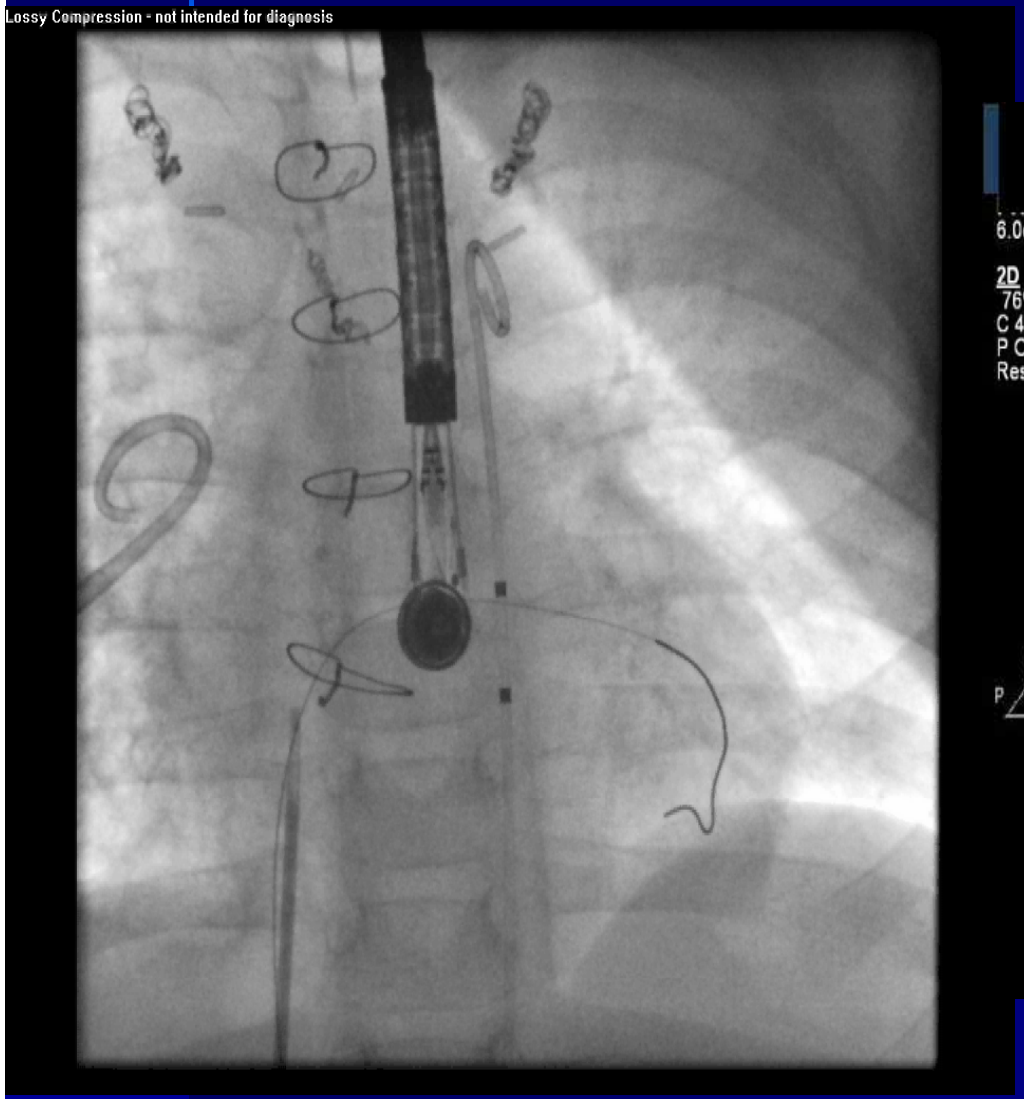
M3
0 22 180
R
JPEG
*** bpm
PAT T: 37.0C
TEE T: 40.9C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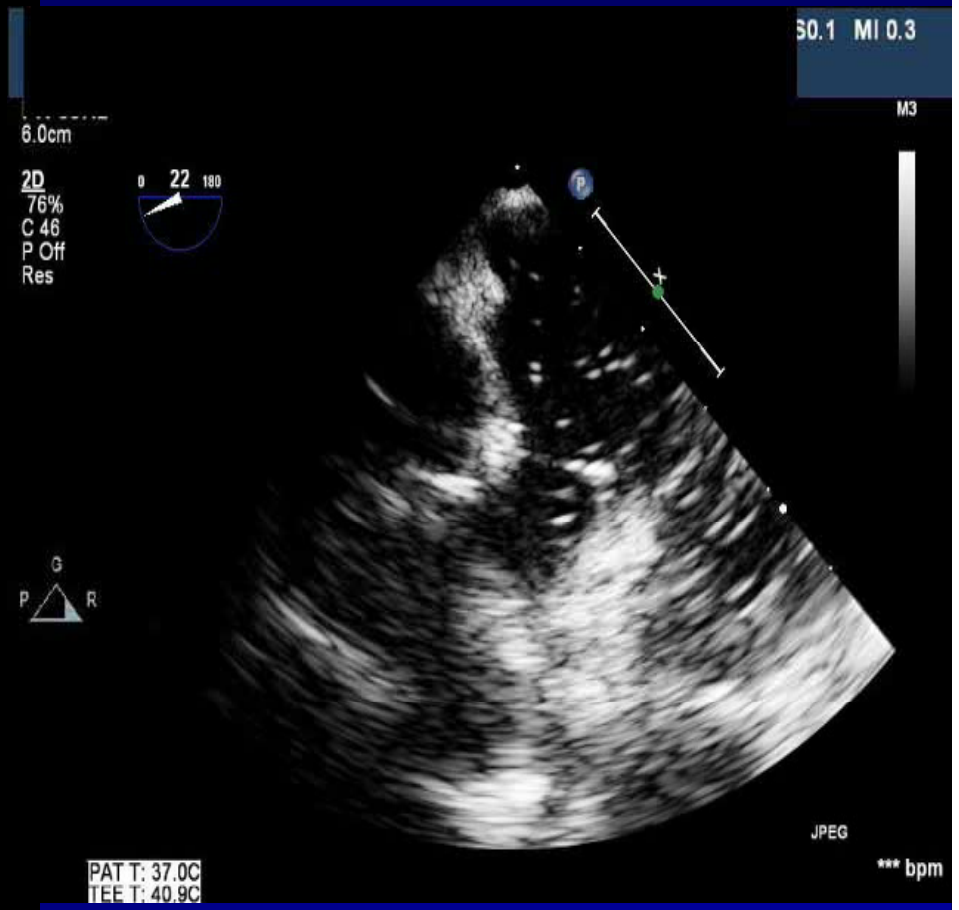
S0.1 MI 0.3
M3
6.0cm
2D
76%
C 46
P Off
Res
0 22 180
G
P R
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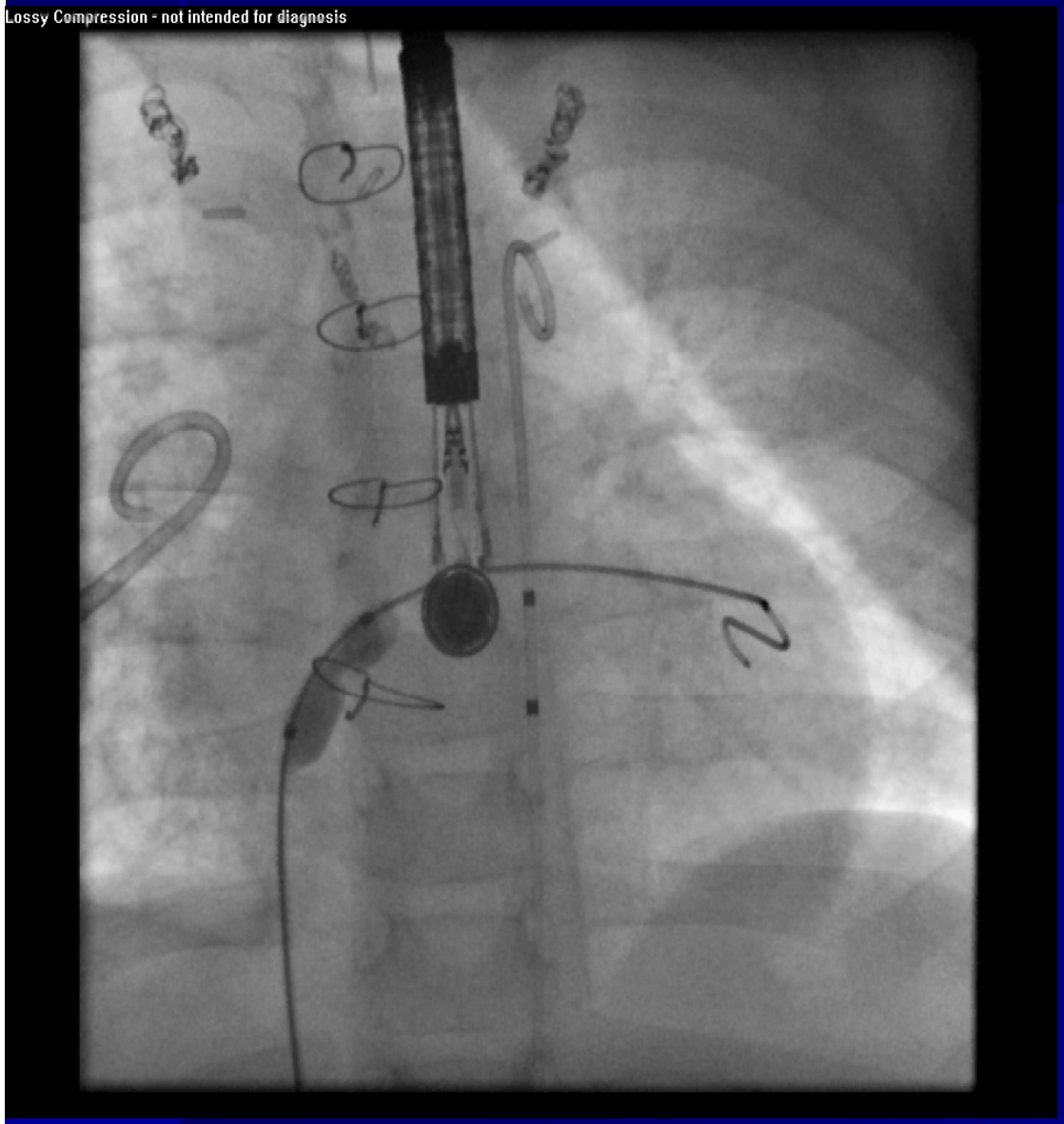
*** bpm
PAT T: 37.0C
TEE T: 40.9C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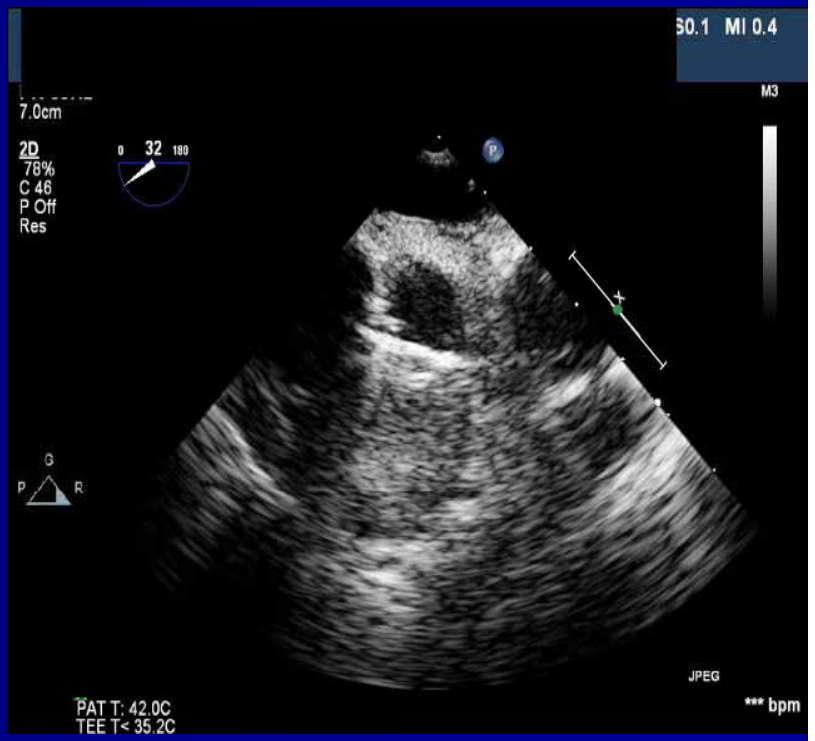
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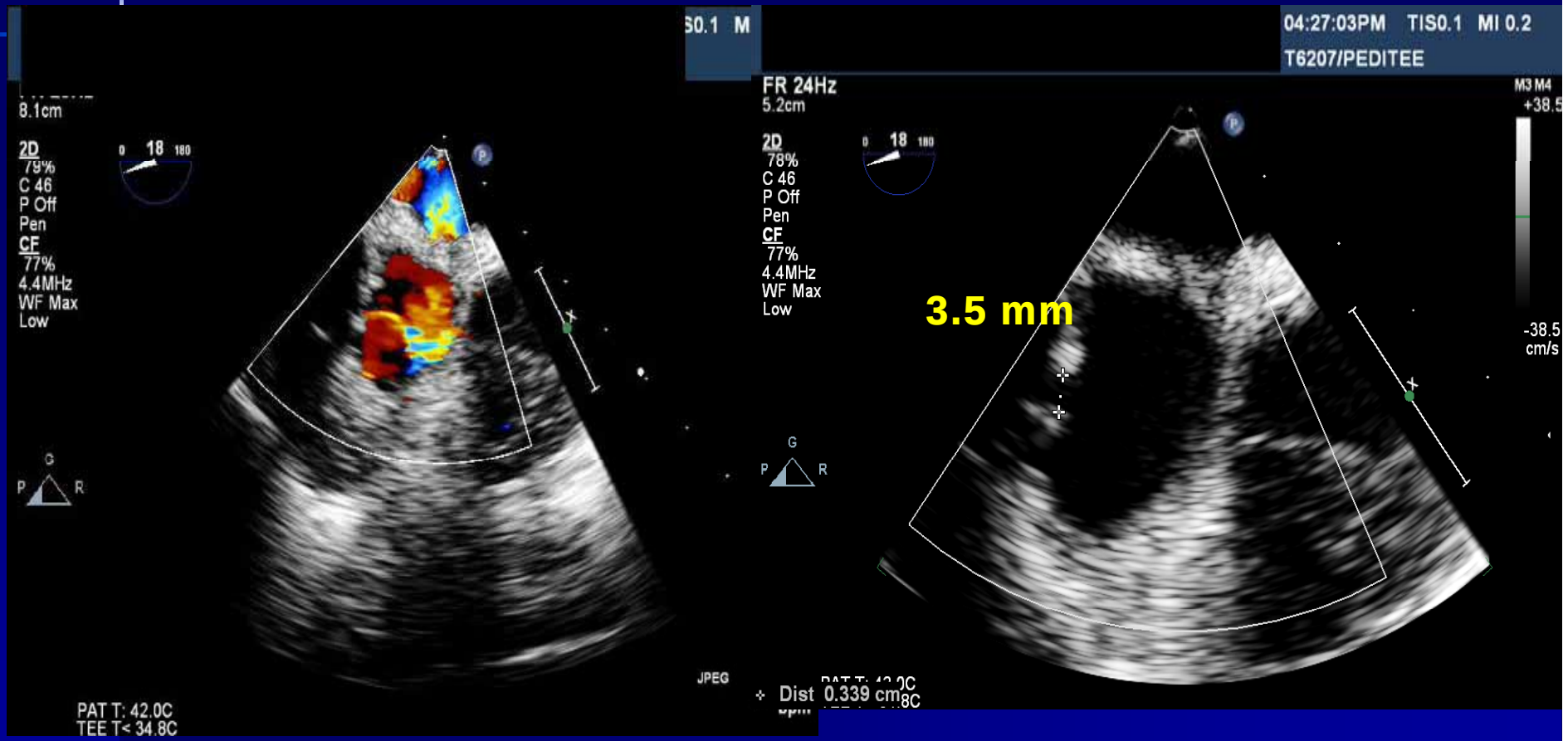
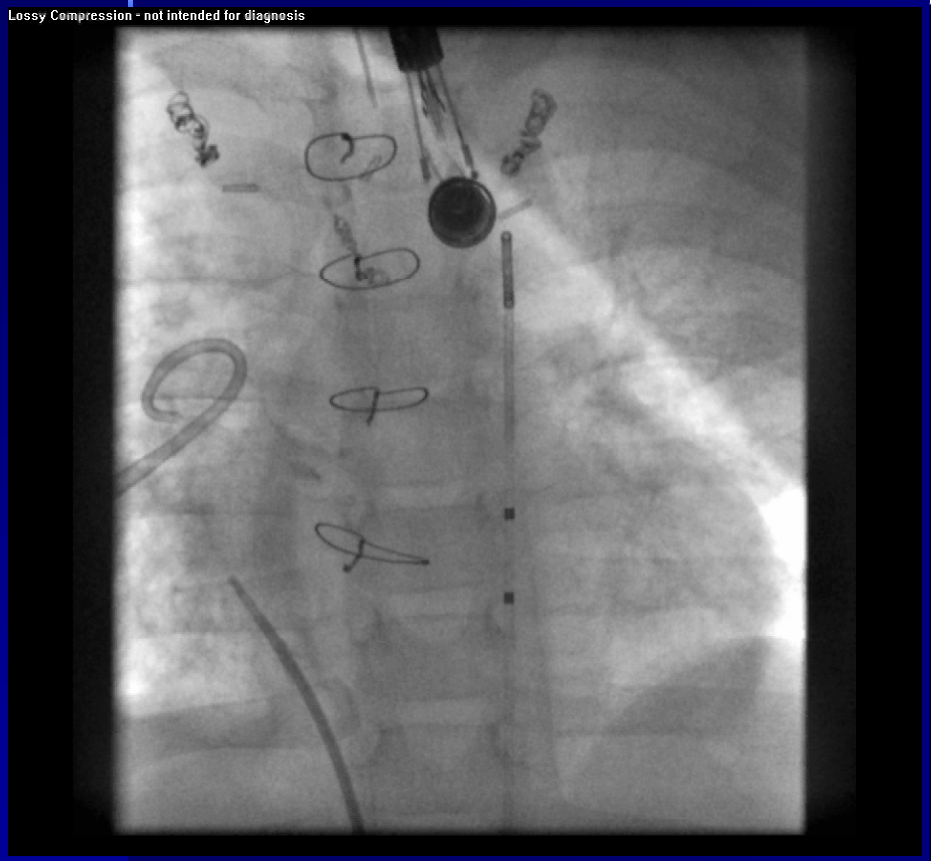
*** bpm

New Fenestration with R-L Shunting




Lossy Compression - not intended for diagnosis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Conclusion: Advantage of Laser Technique

1. The smallest laser catheter could be inserted through a 4f delivery : useful in small infants

2. Perforates all tissue types, including synthetic materials i.e. PTFE (Goretex)

3. Vascular access does not limit its feasibility: the only requirement is a physical contact of the laser catheter

Disadvantage of Laser Technique

1. Old calcified (>12 years) PTFE graft did not respond to Laser (also did not respond to Brockenbrau needle)
2. It is quite **EXPENSIVE $$$:**

Laser System: $ 250,000

Laser Catheter: $1915

Clinical Summary

Total: 10 patients

Fetal: PFO creation (n=1)

PFO/ASD Creation (n=3)

Pumonary valve perforation (n=1)

Fontan: (n=5 with 2 failure)