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GUVERNUL ROMÂNIEI
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POSDRU 2007-2013
Instrumente Structurale
2007-2013
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ȘI PERSOANELOR VÂRSTNICE
OIRPOSDRU REGIUNEA CENTRU
UNIVERSITATEA DE MEDICINĂ ȘI
FARMACIE "CAROL DAVILA"
BUCUREȘTI

AD-COR Program inovativ de formare in domeniul cardiologiei pediatrice
POSDRU/179/3.2/S/152012

Data: 23-11-2015

MODUL TEORETIC

RVOT OBSTRUCTION: Pulmonic Stenosis, ToF, Pulmonary Atresia

Imputernicit: Prof. Dr. Tammam Youssef

Activitate prestata de I.R.C.C.S. POLICLINICO SAN DONATO – MILANO, ITALIA in baza contractului nr. 18/22144/29.07.2015

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Acest material a fost documentat/ validat/ prezentat la sesiunile de formare în cadrul proiectului *„AD-COR Program inovativ de formare în domeniul cardiologiei pediatrice”* - POSDRU/179/3.2/S/152012, proiect cofinanțat din Fondul Social Operațional Sectorial Dezvoltarea Resurselor Umane 2007-2013.

Beneficiar: Universitatea de Medicină și Farmacie „Carol Davila” București

RVOT OBSTRUCTION: PULMONIC STENOSIS, TOF, PULMONARY ATRESIA

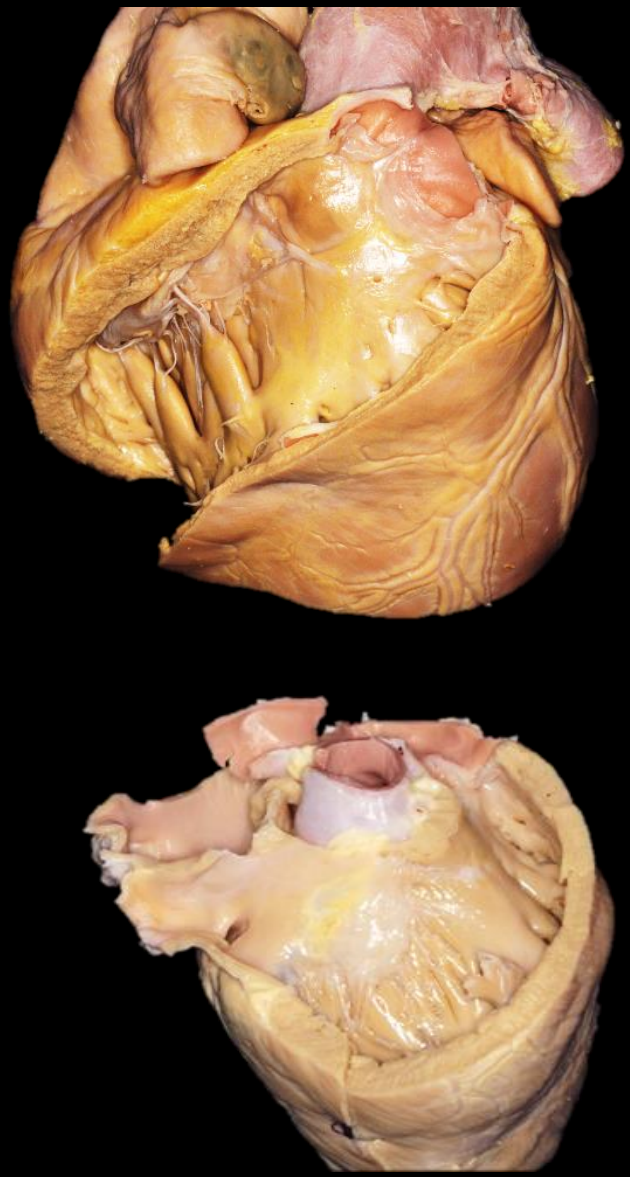
Claudio Bussadori

Department of Pediatric Cardiology and Adult with Congenital Heart Disease

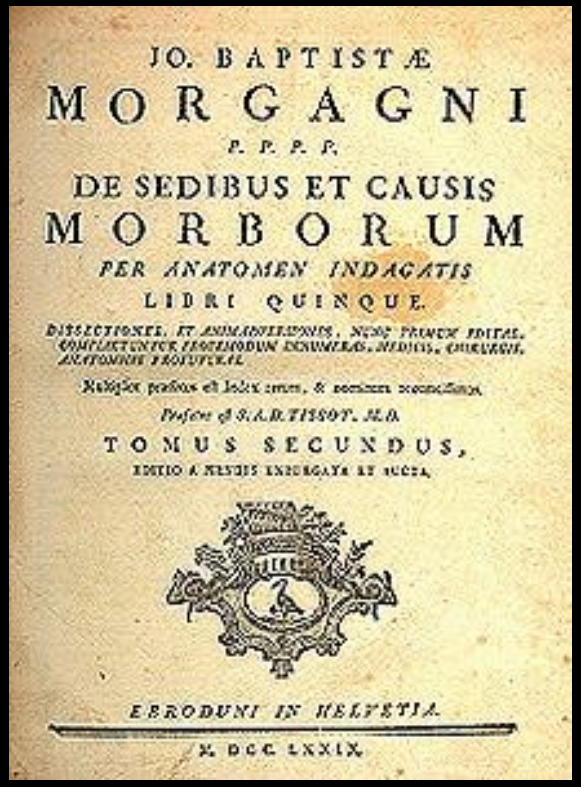
San Donato Hospital Milano Italy

By Convention The RV is divided in:

1. Inflow
2. Apex
3. Outflow Infundibulum

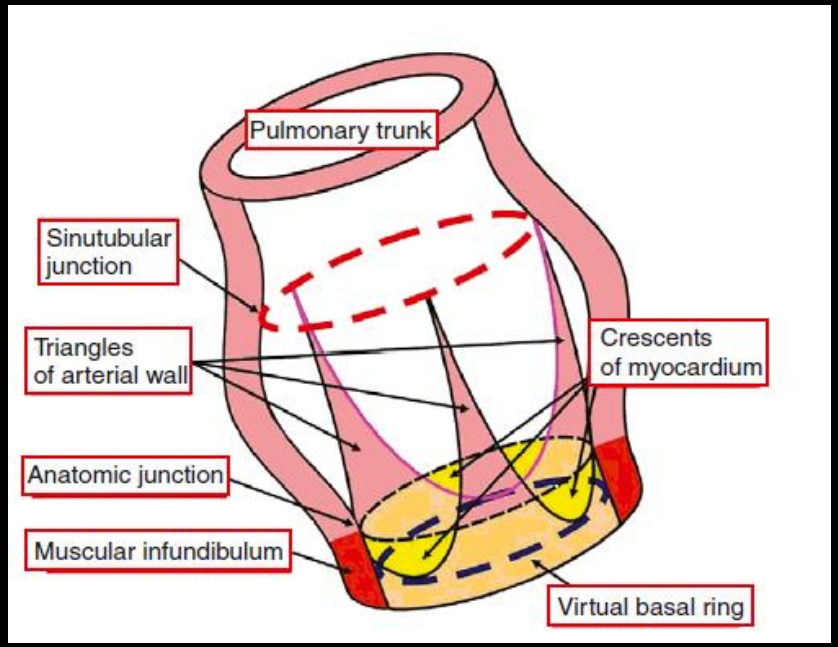


PULMONIC STENOSIS


JO. BAPTISTÆ
MORGAGNI
P. P. P. P.
DE SEDIBUS ET CAUSIS
MORBORUM
PER ANATOMEN INDAGATIS
LIBRI QUINQUE.
TOMUS SECUNDUS,
EBRODUNI IN HELVETIA.
M. DCC. LXXIX.

FIBERS ORIENTATION

PULMONARY VALVE ANATOMY



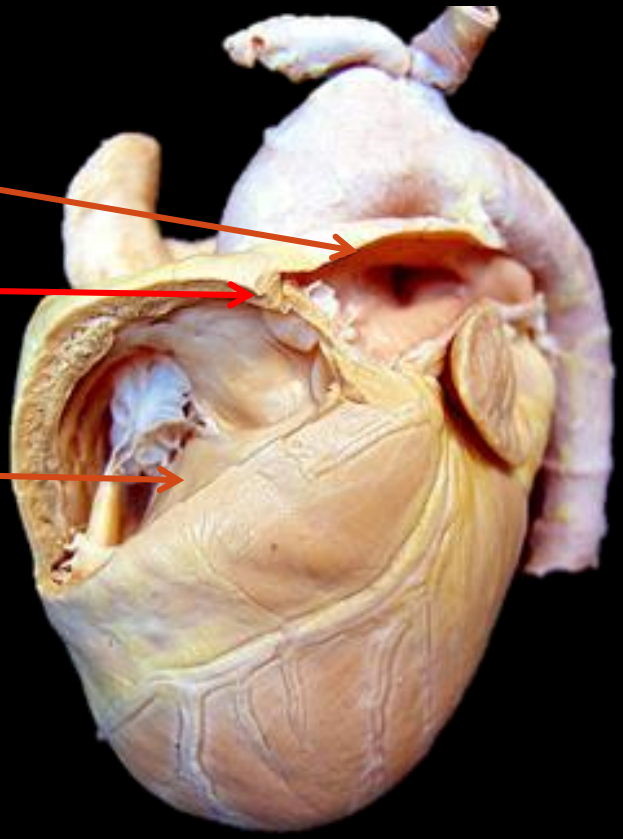
Pulmonary Valvular Movement

LOCATION OF PS

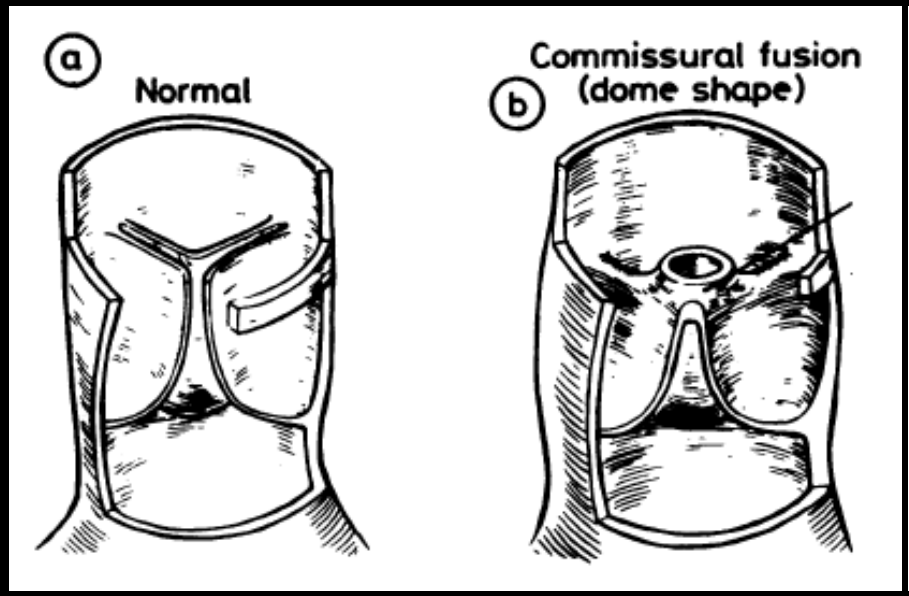
Supravalvular

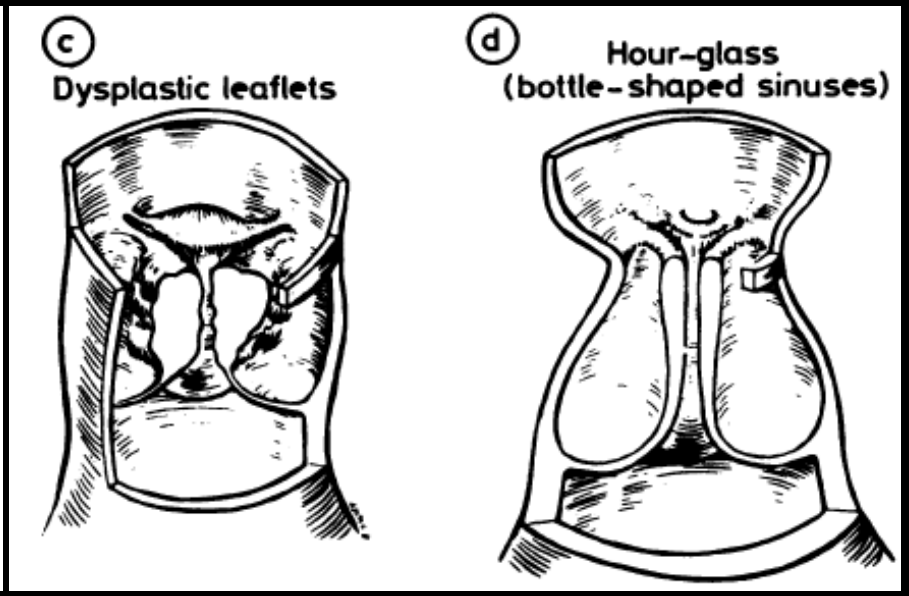
Valvular

Subvalvular

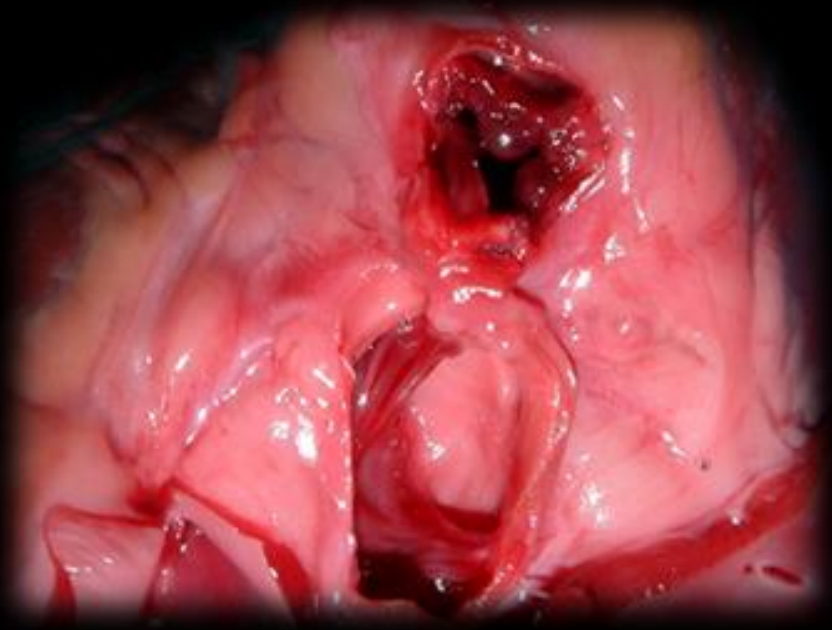


MORPHOLOGY OF THE STENOSIS





VALVULAR PATHOLOGY



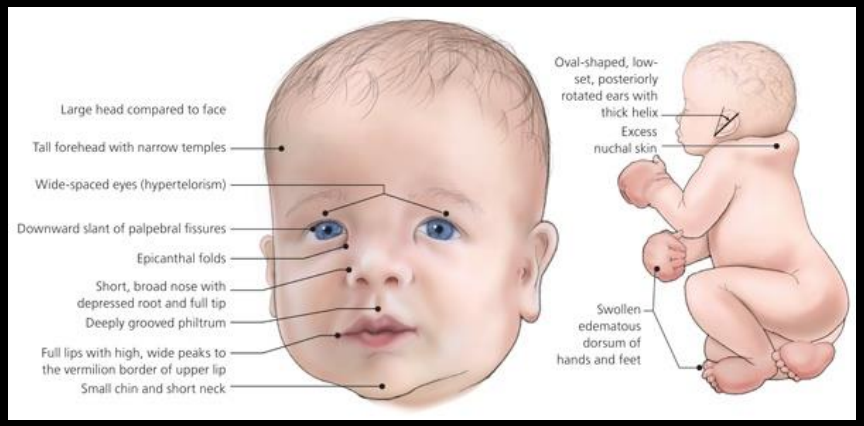
PULMONIC STENOSIS

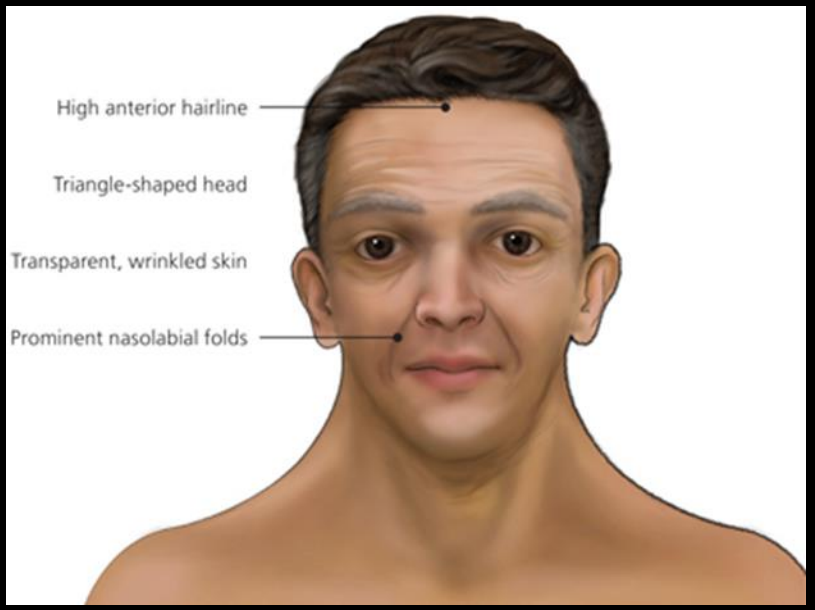
- 8% of all CHD
- Present in 30-50% of CHD
- More Frequent in Female

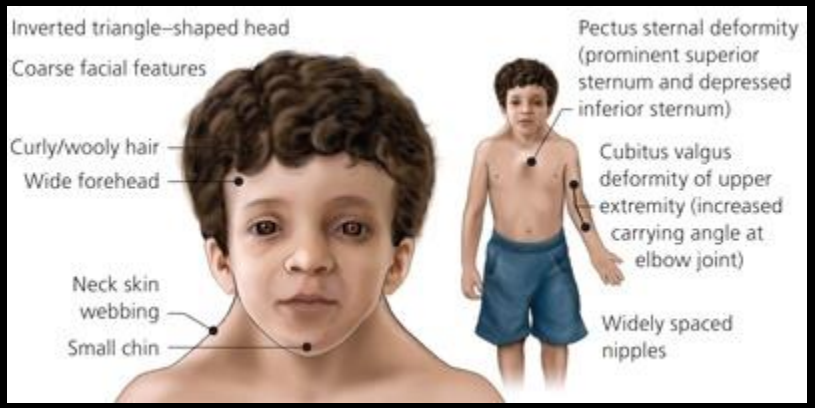
- **Genetic Sindrome** :
- Noonan: present in 39% of the syndromic patients, sometimes associated with periferial PS
- Williams: 41%. of the syndromic patients, Mostly Supravalvular and/or associated with periferial PS
- Alagille: 53% of the syndromic patients, mostly with periferial PS
- Rubella Infection may cause supravalvular PS

NOONAN

THE MOST COMMON ASSOCIATION







ECHOCARDIOGRAPHIC PROTOCOL
ANATOMY

What to Study

- Valvular Morfology and Motion
- Annulus Diameter
- Post Stenotic Dilatation
- Infundibulum Morphology and Motion

Sections

✓Short Axis at the base

✓Subcostal

ECHOCARDIOGRAPHIC PROTOCOL
ECHO EVALUATION OF THE RV

What to Study

- Kinetics
- Longitudinal Strain
- Miocardial Doppler
- RV Measure
- TAPSE
- RV Hypertrophy
- Fibroelastosis
- Tricuspid morphology

Sections

✓Apical 4CH
✓Subcostal 4CH
✓Parasternal SAX
✓Subcostal SAX

ECHOCARDIOGRAPHIC PROTOCOL
DOPPLER

What to Study

- Peack and Mean PV Gradient
- Dynamic Subvalvular Gradient
- ASD/PFO
- Trycuspid Gradient

Sections

✓Subcostal

✓Apical

✓Parasternal

ECHOCARDIOGRAPHIC PROTOCOL
TO COMPLETE THE MINIMAL DATA SETTING

What to Study

- Tricuspid Valve
- RA
- ASD/ PFO
- Inferior VC
- Ductus Arteriosus

Sections

✓Subcoastal

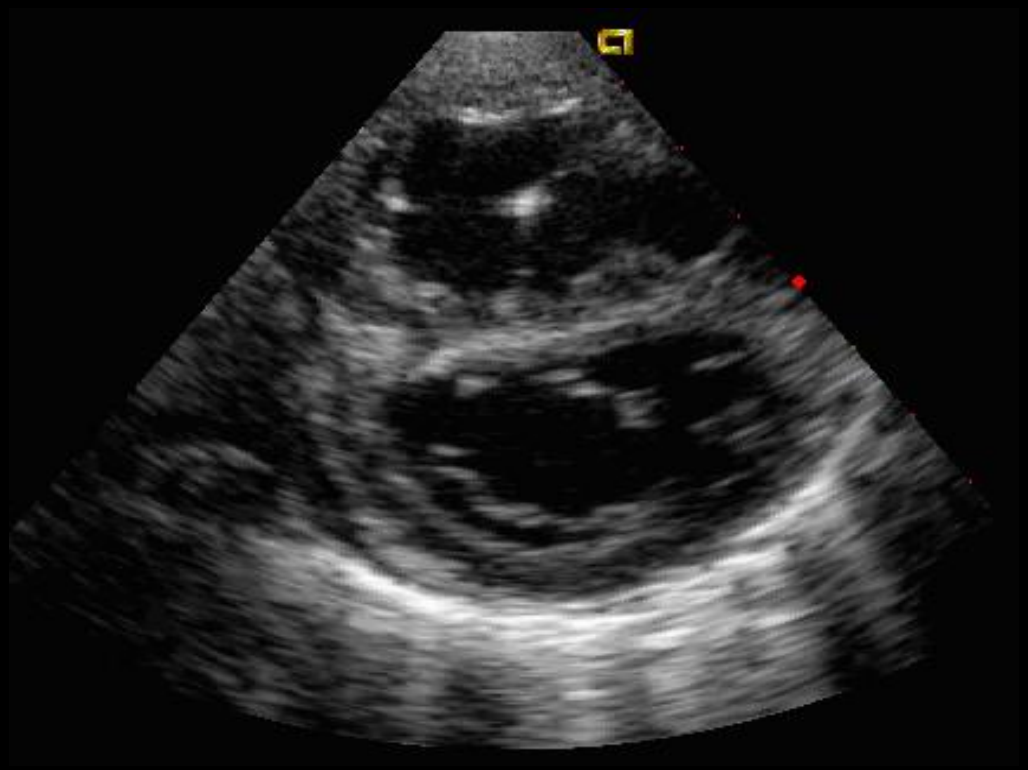
✓Apical

✓Parasternal SAX

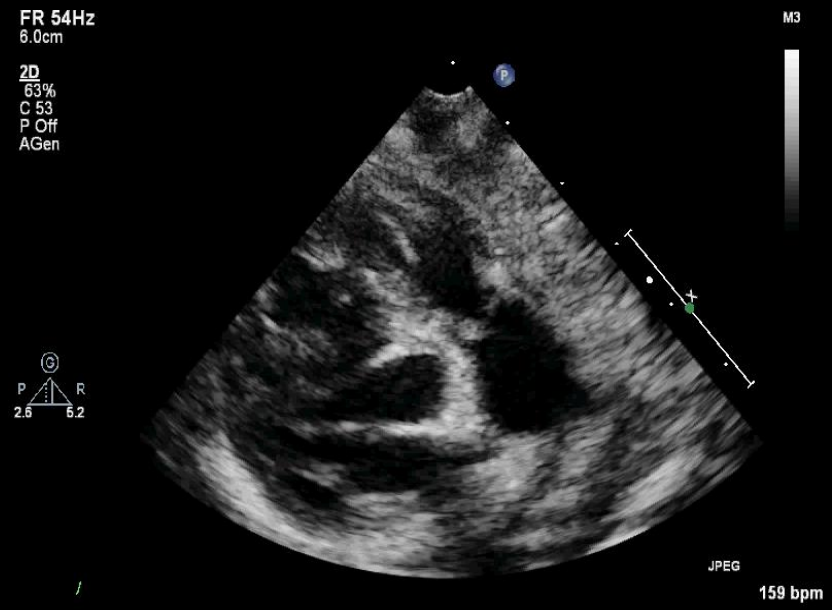
ECHOCARDIOGRAPHIC PROTOCOL
STAGING OF SEVERITY

- Mean an Peack Gradient
- Valve and RV Morphology
- RV Function
- Estimated RV Pressure
- Variability of IVC
- Shunt on ASD /PFO

PS WATCH THE PA



PS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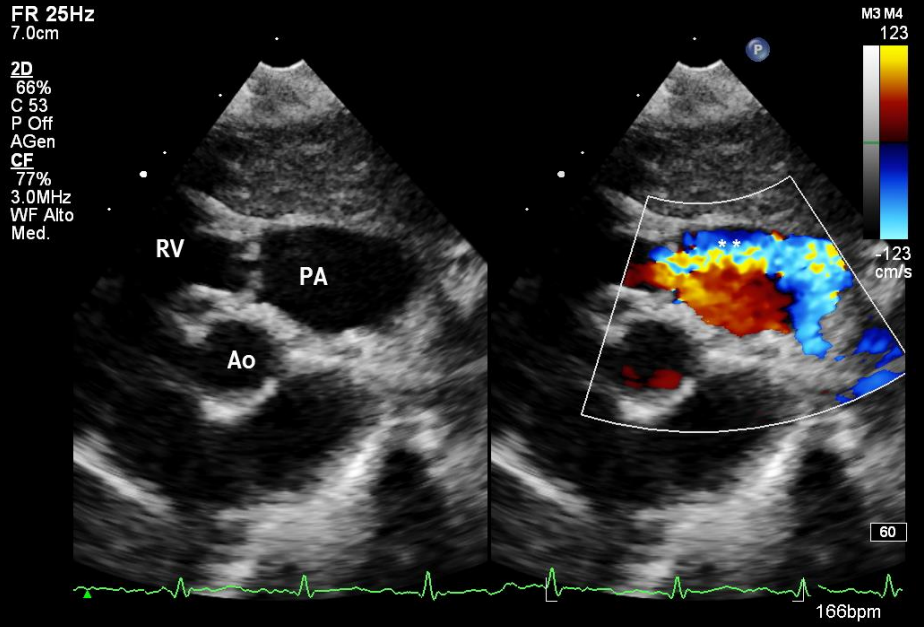
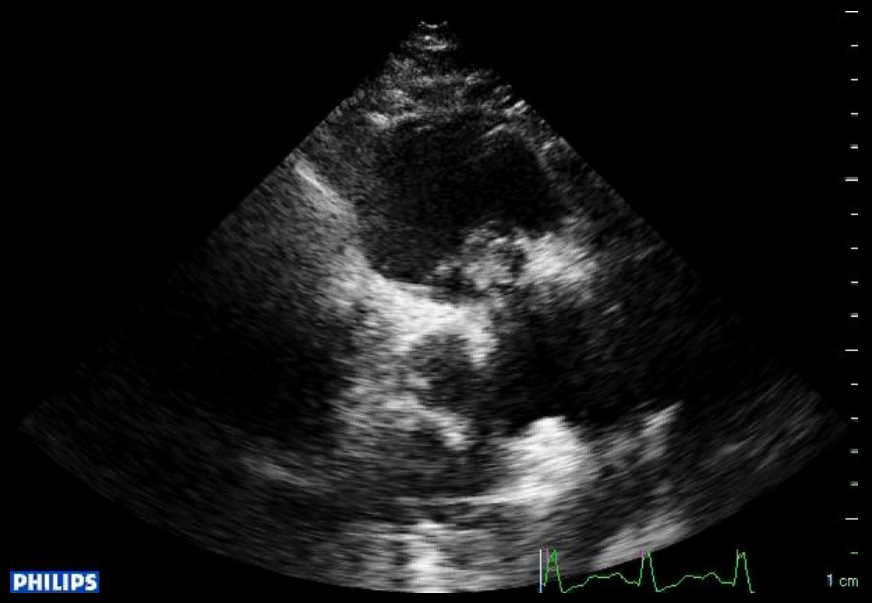
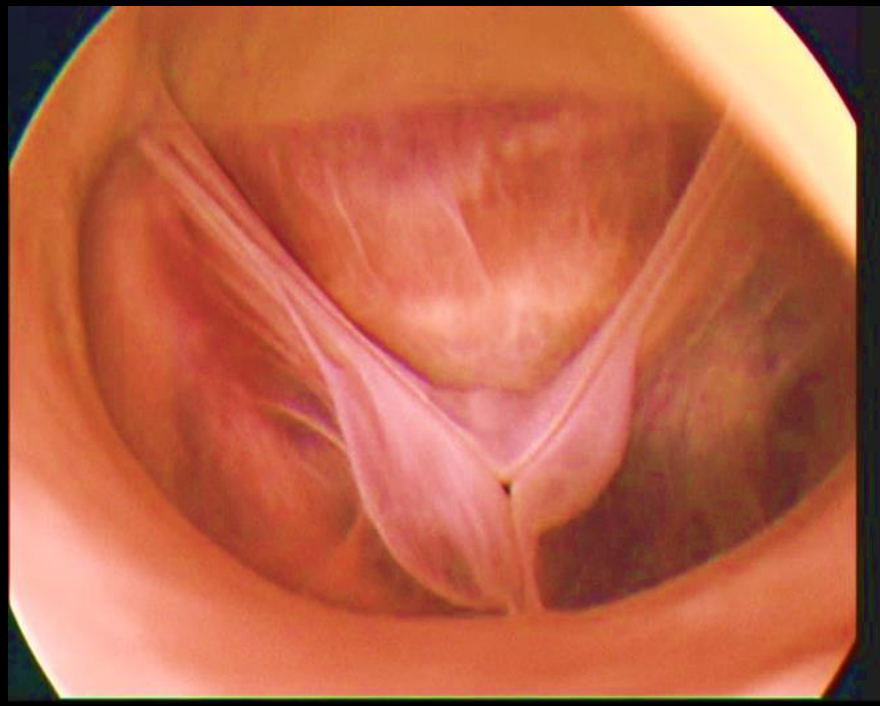
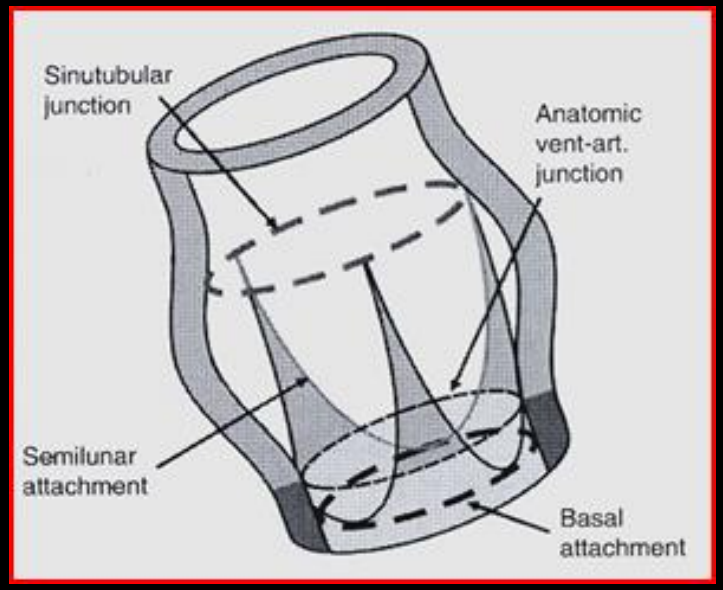
6.0cm
2D
63%
C 53
P Off
AGen
M3
JPEG
159 bpm


FR 25Hz
7.0cm
2D
66%
C 53
P Off
AGen
CF
77%
3.0MHz
WF Alto
Med.
M3 M4
123
-123
cm/s
RV
PA
Ao
60
166bpm

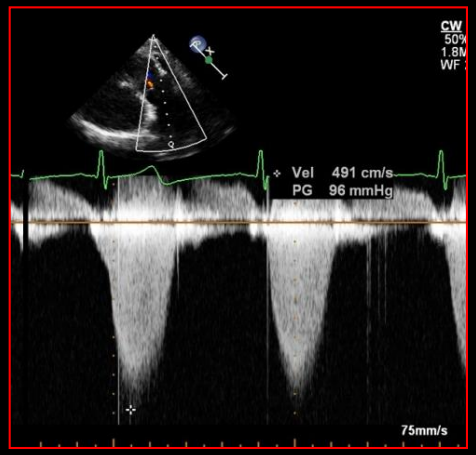
SP IN AN ADULT

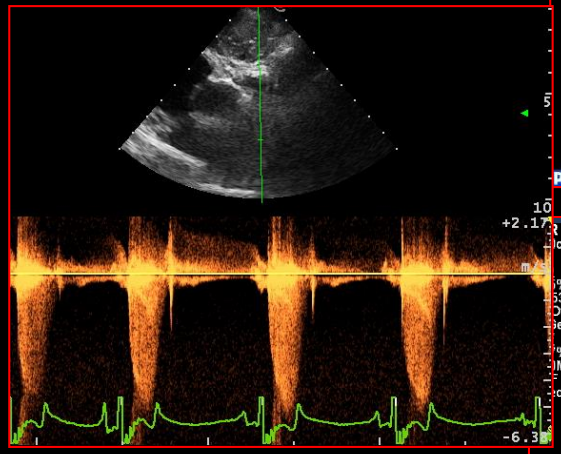


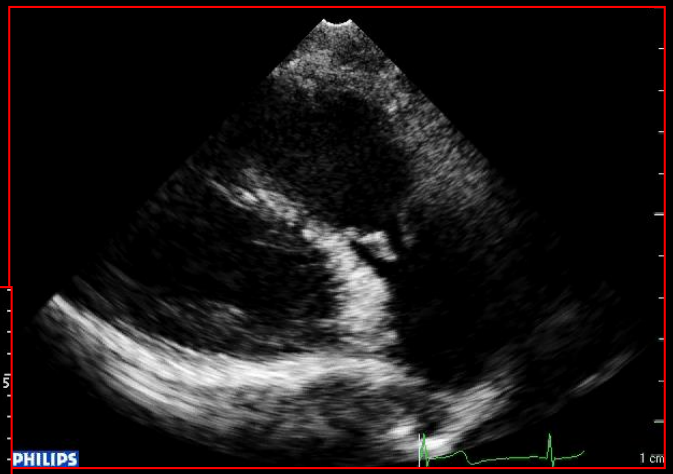


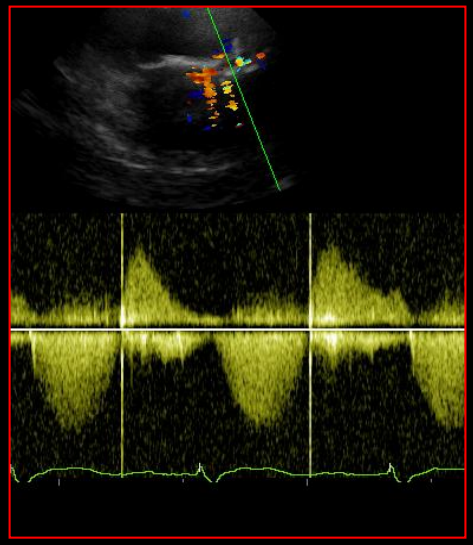


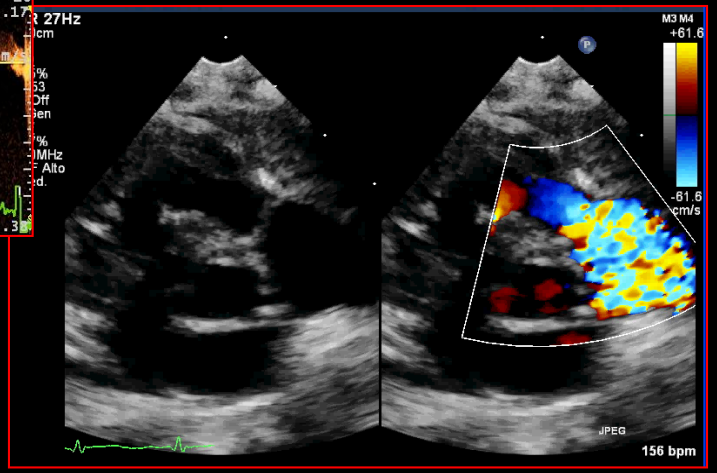
PS


CW
Vel 491 cm/s
PG 96 mmHg
75mm/s



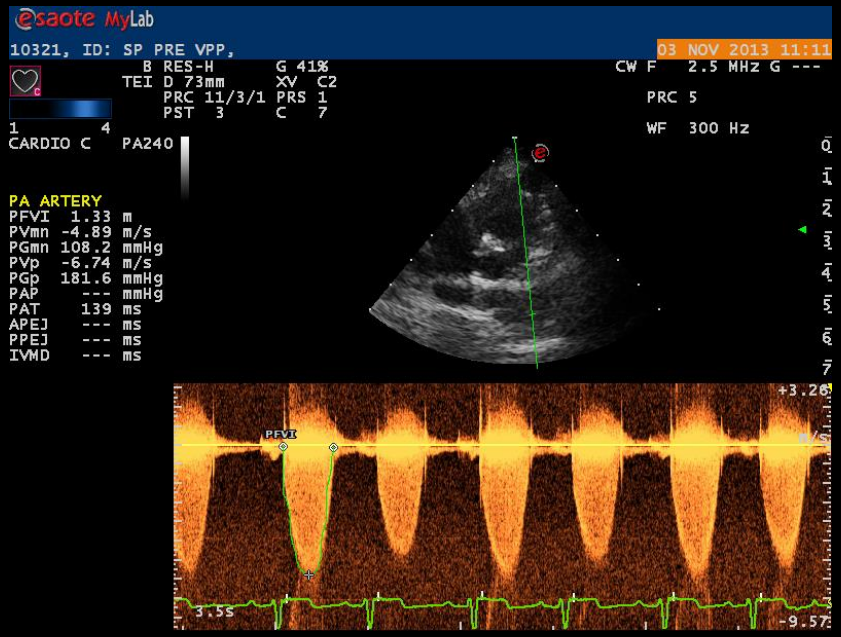

PHILIPS
1 cm



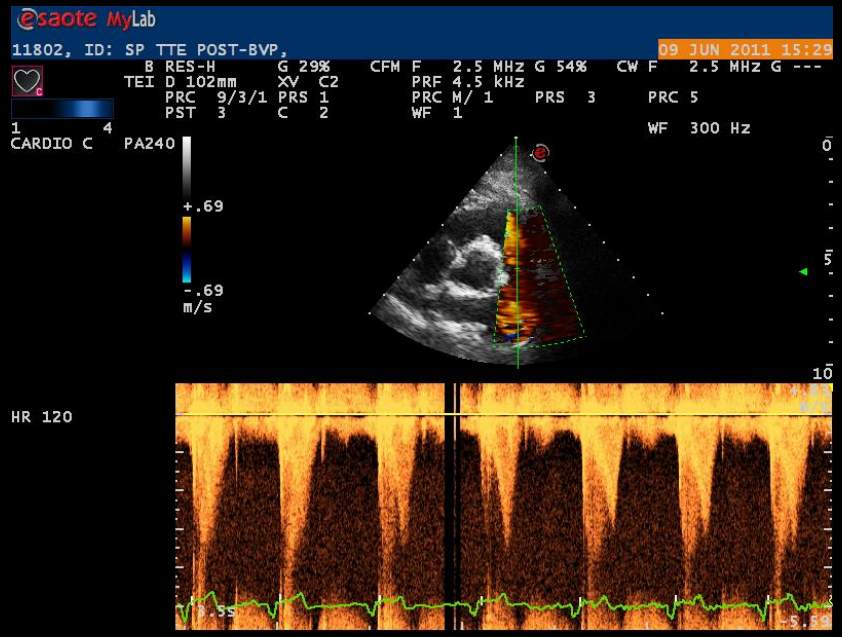

M3 M4
+61.6
-61.6
cm/s
JPEG
156 bpm

ANTEROGRADE PULMONARY FLOW

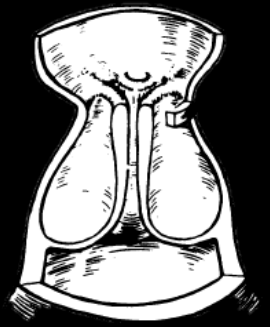
Severe Stenosis

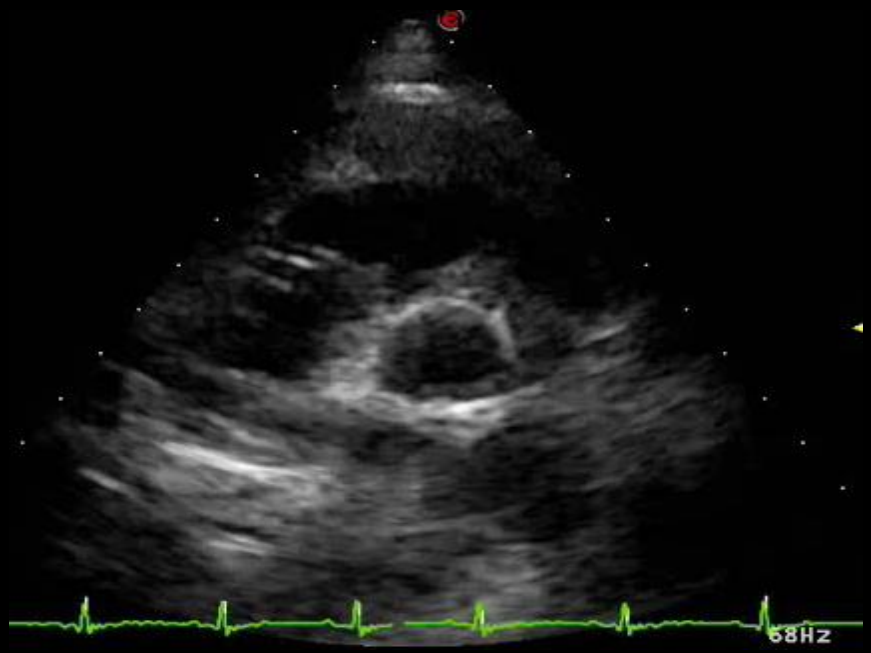


Dynamic Stenosis



PULMONIC STENOSIS: HOURGLASS SHAPE

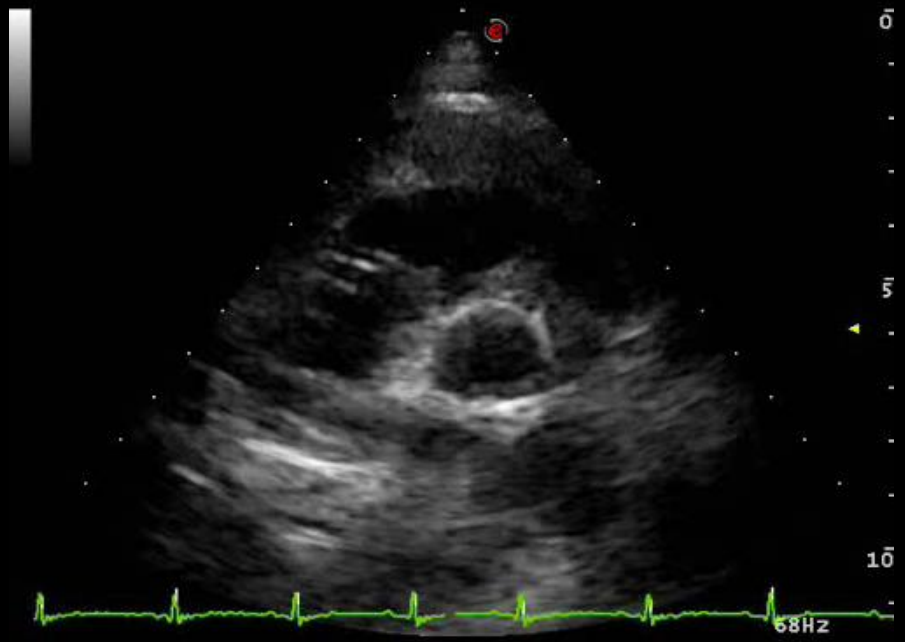


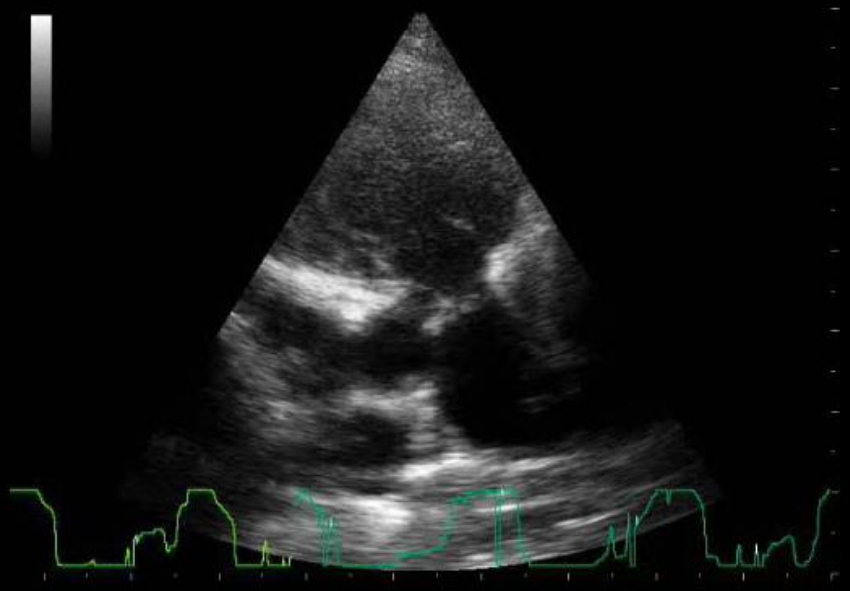


Milo S, Fiegel A, Shem-Tov A, Neufeld HN, Goor DA. Hour-glass deformity of the pulmonary valve: A third type of pulmonary valve stenosis. *Br Heart J*. 1988;60:128-133

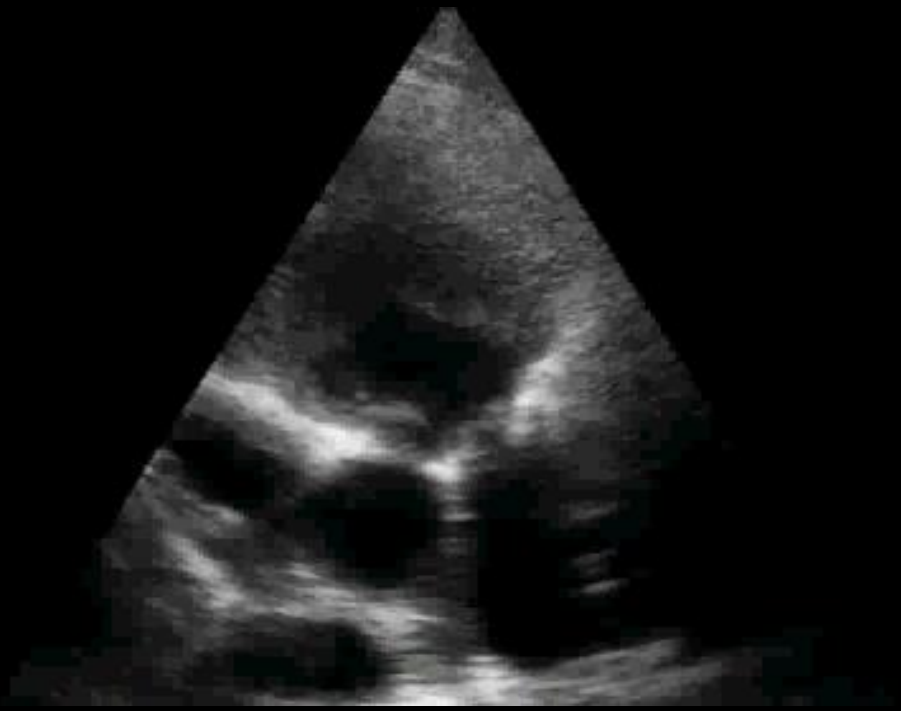
PULMONIC STENOSIS

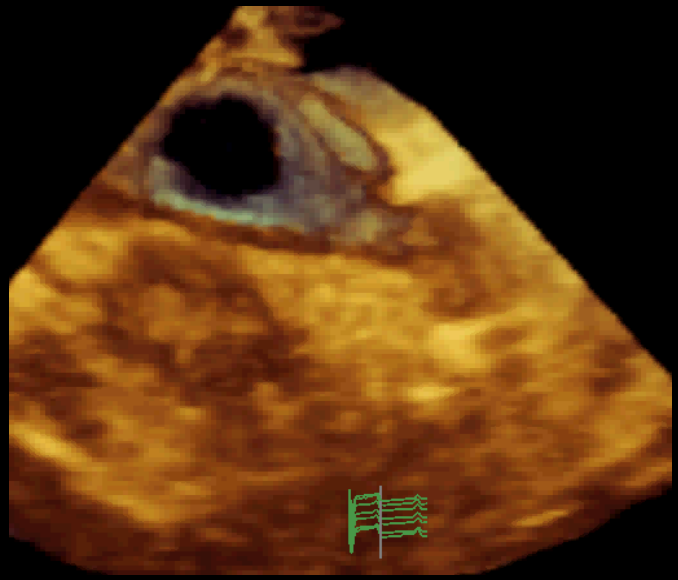
Hourglass Shape

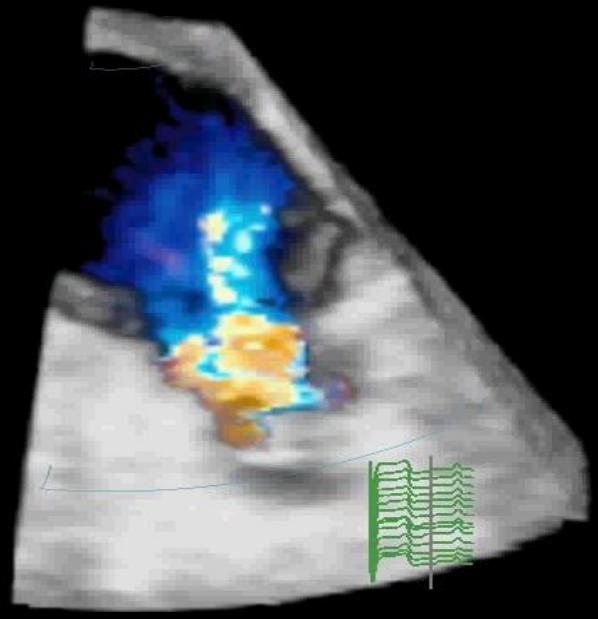




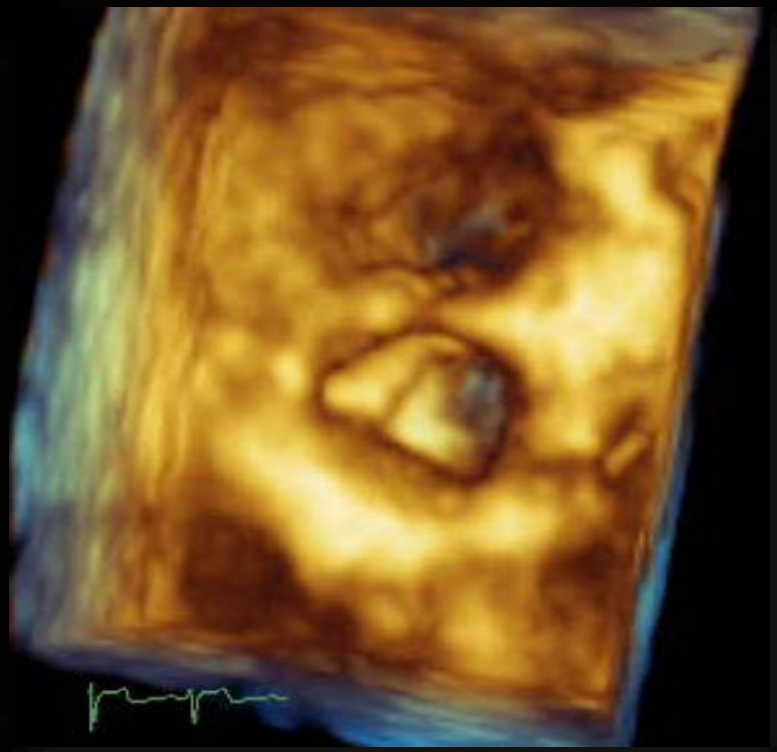
HOURGLASS



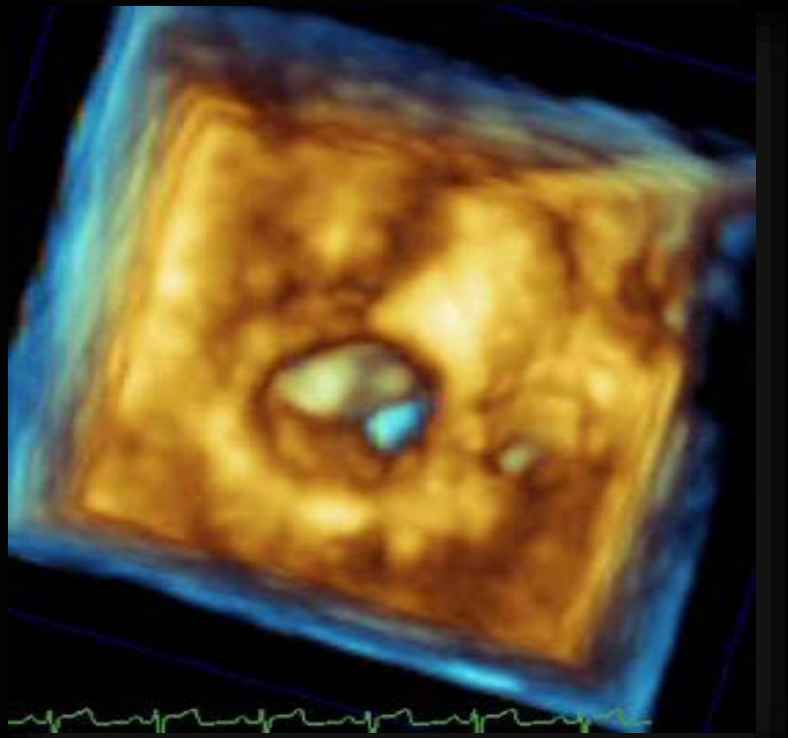




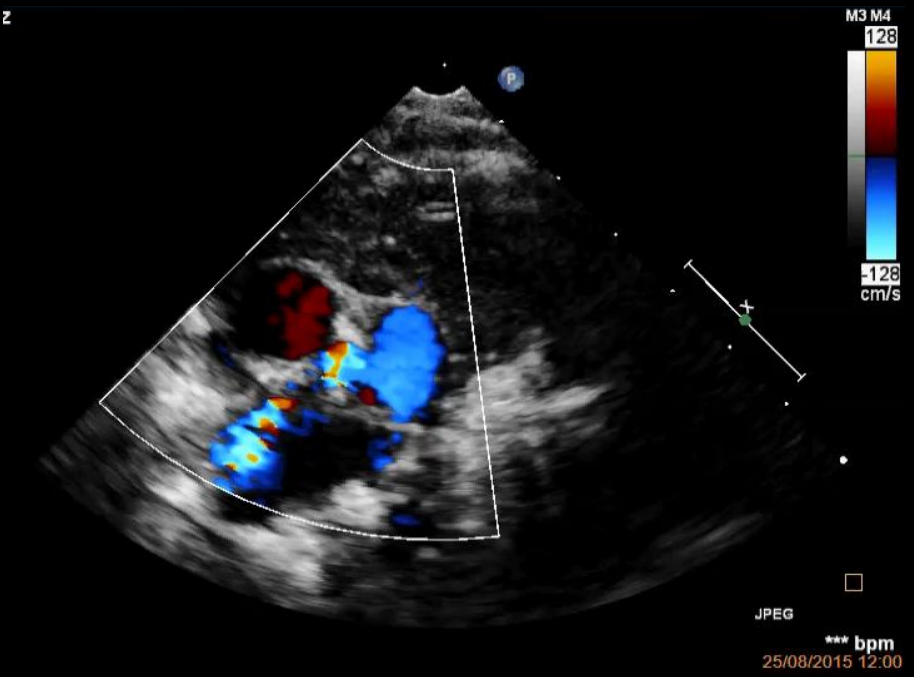
«En face» pre PBV

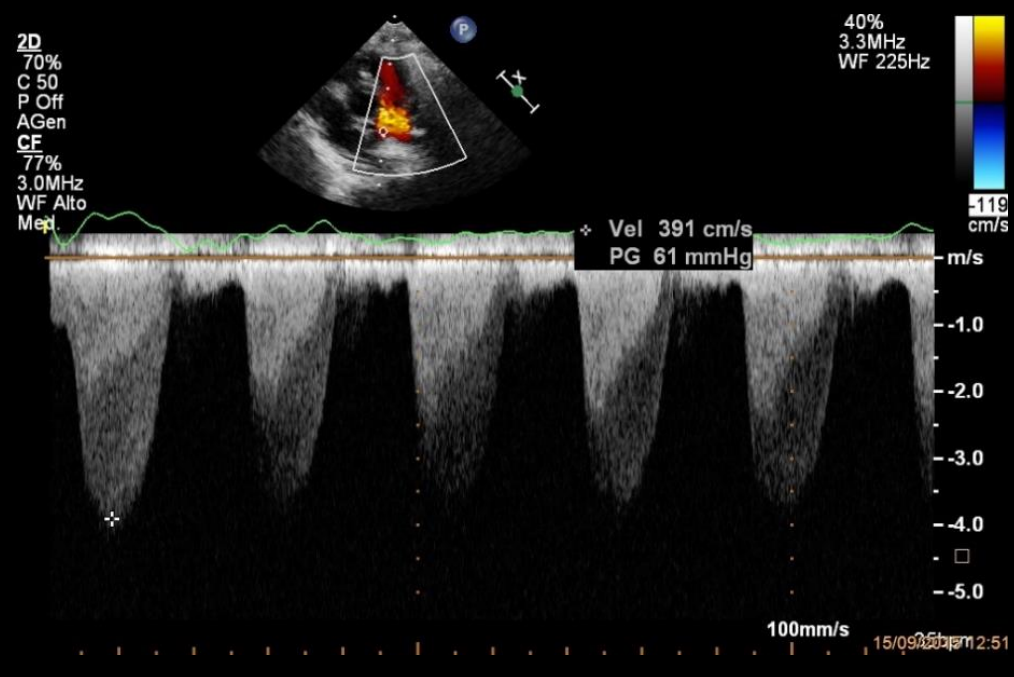


«En face» post PBV



PERIFERIAL PS





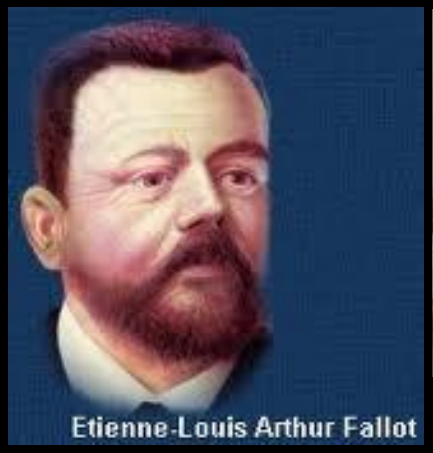
TETRALOGY OF FALLOT

"Blue baby syndrome"

1° anthomical description Niels Stensen 1671

1° pathophyisiological description Étienne L. A. Fallot 1888

1° Blalock-Taussig-Thomas shunt 1946



Alfred Blalock Vivien Thomas

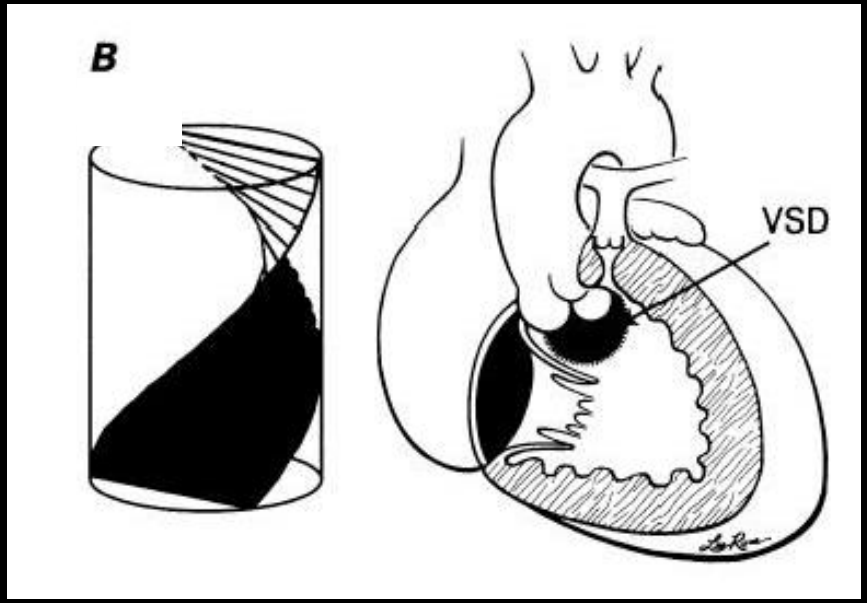
Helen Taussig

E. L. A. Fallot. Contribution à l'anatomie pathologique de la maladie bleue (cyanose cardiaque). Marseille médical, 1888,
Sommer et al. Circulation 2008 ; 117 (10) 1340

TETRALOGY OF FALLOT

Cono-truncal Malformation

- Incomplete leftward displacement of the conal derivatives
- Anterior displacement of the complete conal septum that does not align with the interventricular septum which causes a large DIV below an ectasic aorta



Patterson DF, Pexieder T, Schnarr WR, Navratil T, Alaili R. A single major-gene defect underlying cardiac conotruncal malformations interferes with myocardial growth during embryonic development: Studies in the ctd line of keeshond dogs. *American journal of human genetics*. 1993;52:388-397

TETRALOGY OF FALLOT

The physiologic consequences and the prognosis of ToF depend on:

- Degree of pulmonic stenosis
- RVOT morphology
- Systemic vascular resistance
- Pulmonary vasculature
- Associated anomalies

Different phenotype presentation

Overriding aorta is not hemodinamically important

Symptomatic patients presents severe PS and large VSD

TETRALOGY OF FALLOT (SEVERE PS, LARGE VSD)

Systolic pressures in RV, LV, and aorta are identical

↓

The resistance to flow through the VSD and systemic circulation are less than resistance across the pulmonic valve

↓

Deoxygenated blood shunts from RV into LV

↓

Systemic hypoxemia

TETRALOGY OF FALLOT (SEVERE PS, LARGE VSD)

⇓ Pulmonary blood flow (because of PS)

⇓

⇓ Venous return to LV

⇓

⇓ LV size and Stroke volume

⇓

⇓ oxygenated blood that reaches the circulation

CLINICAL FINDINGS

- Cyanosis (from absent to severe):
  - Symmetrically distributed
  - Absent at rest: may be produced by exercise
  - Present at rest: exercise makes it worse
- Ejection murmure, loudest at left heart base
- Murmure intensity varies inversely with the severity of stenosis
- Polycithemia (⇑ blood viscosity)

TETRALOGY OF FALLOT
ASSOCIATED ANOMALIES

Atrail Septal Defect (15-20%)

Left SVC in CS(10%)

Aortic Arch Anomaly

- Right Aortic Arch 25-35%
- Aberrant Succlavia

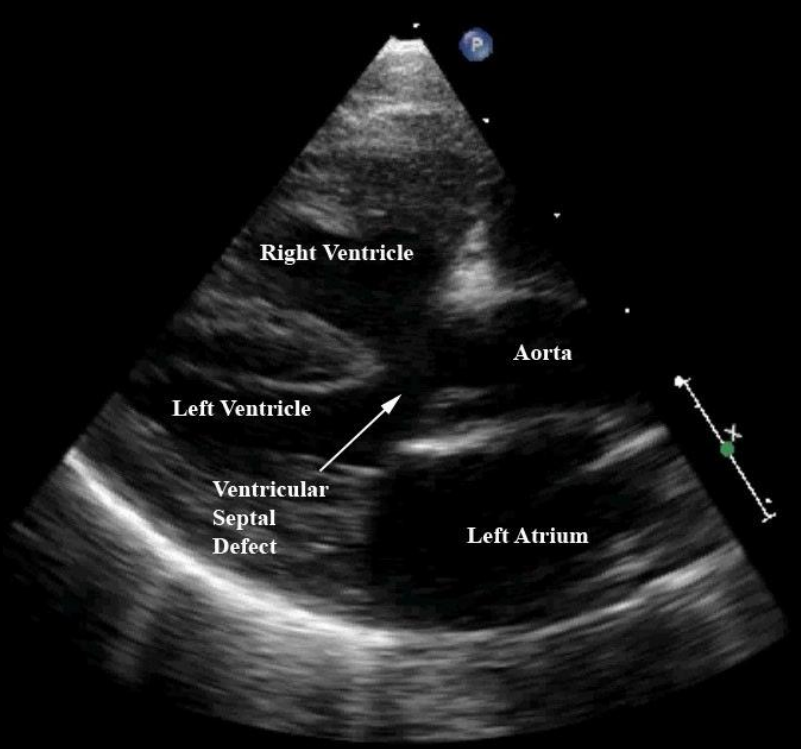
Coronary Anomalies (20-30%)

- LAD arising from RCA (5%)

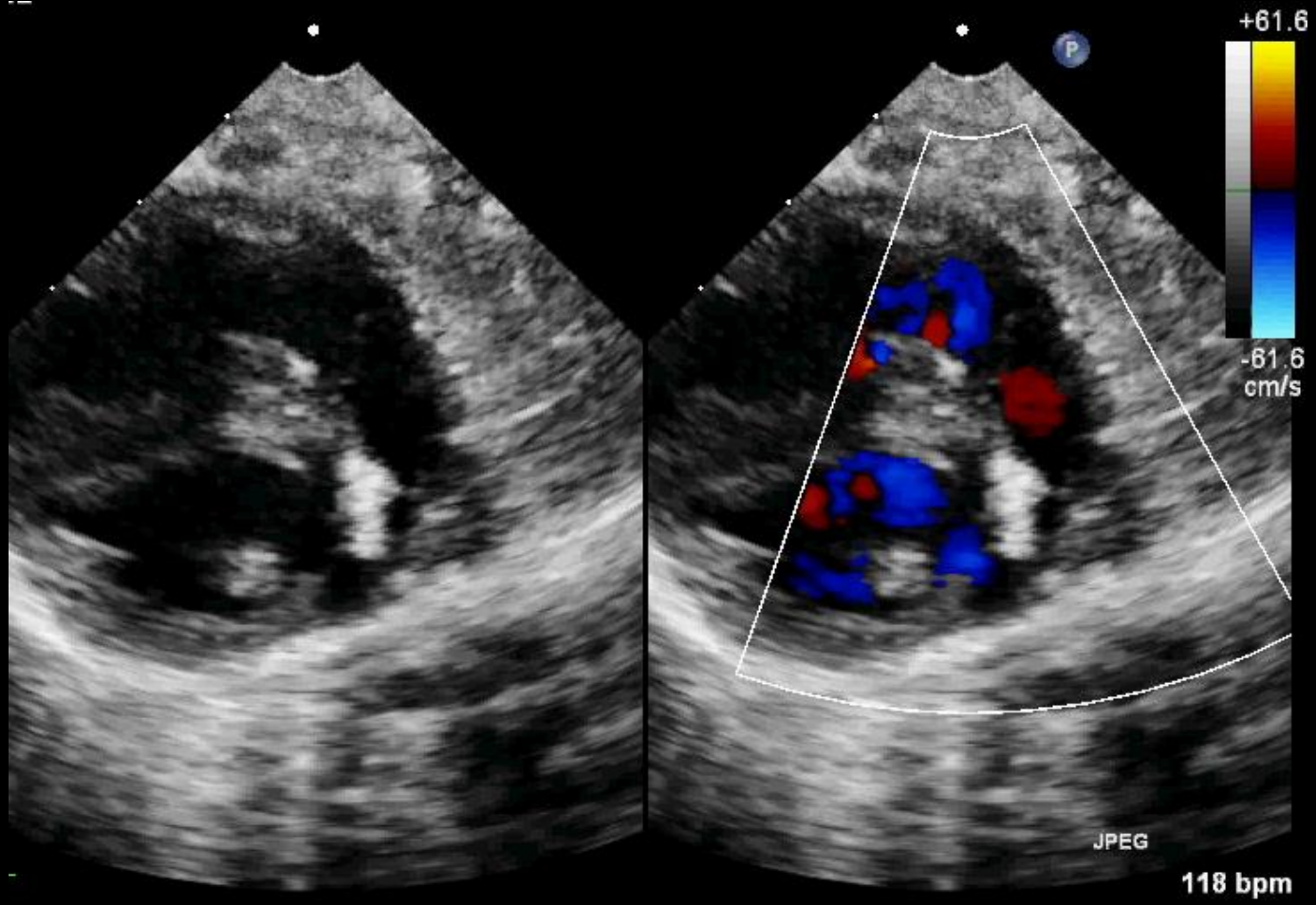
Atrioventricular Septal Defect

PV Absence → Dilatation of RVOT and MPA and Bronchial Compression

PARASTERNAL



PARASTERNAL



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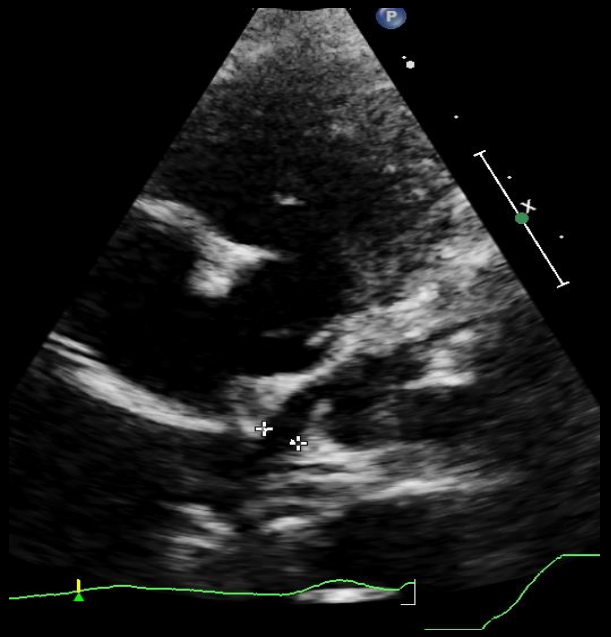
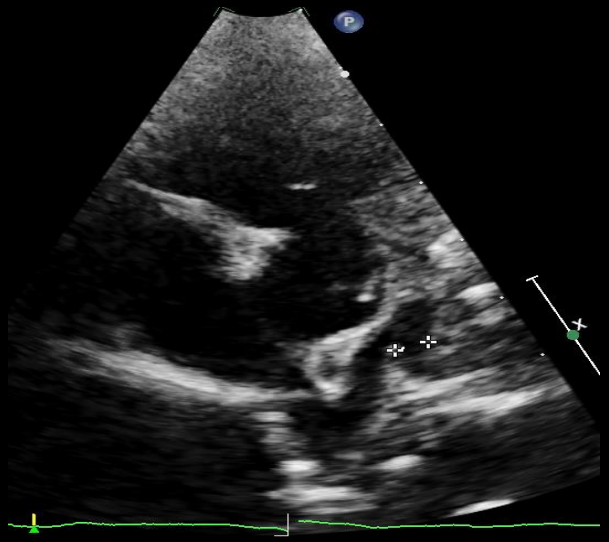
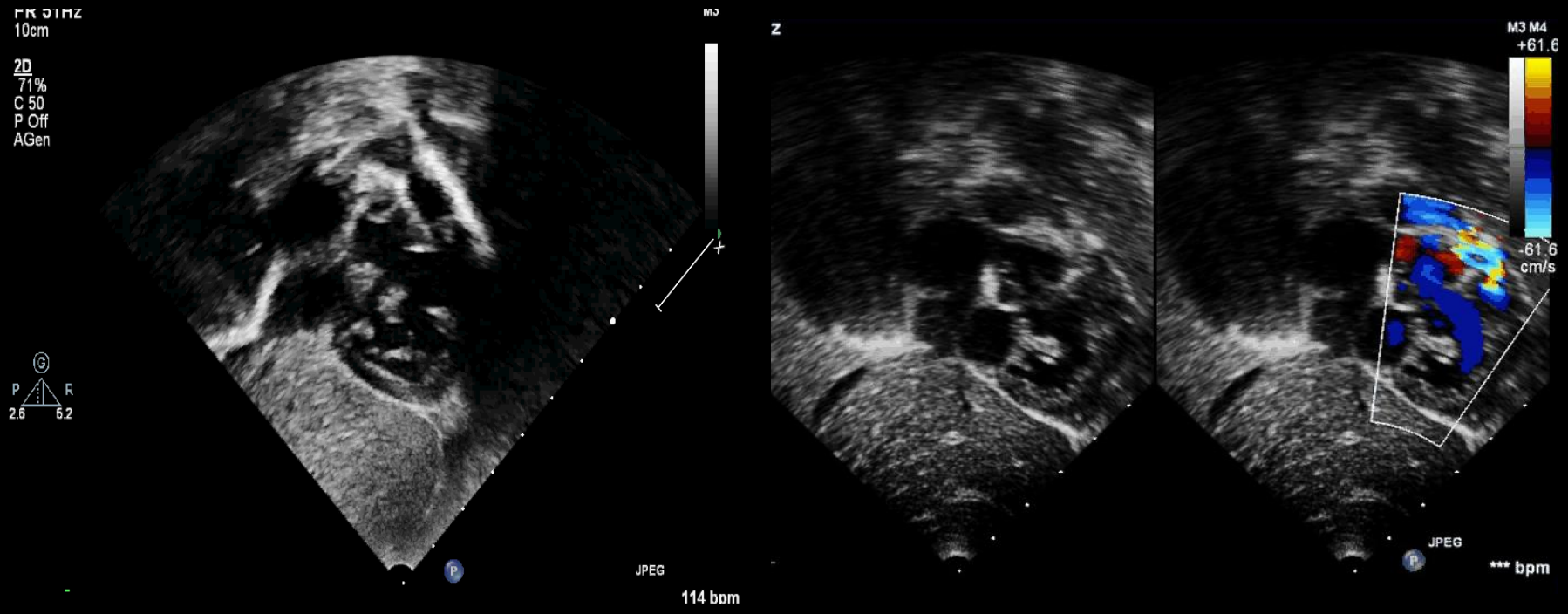
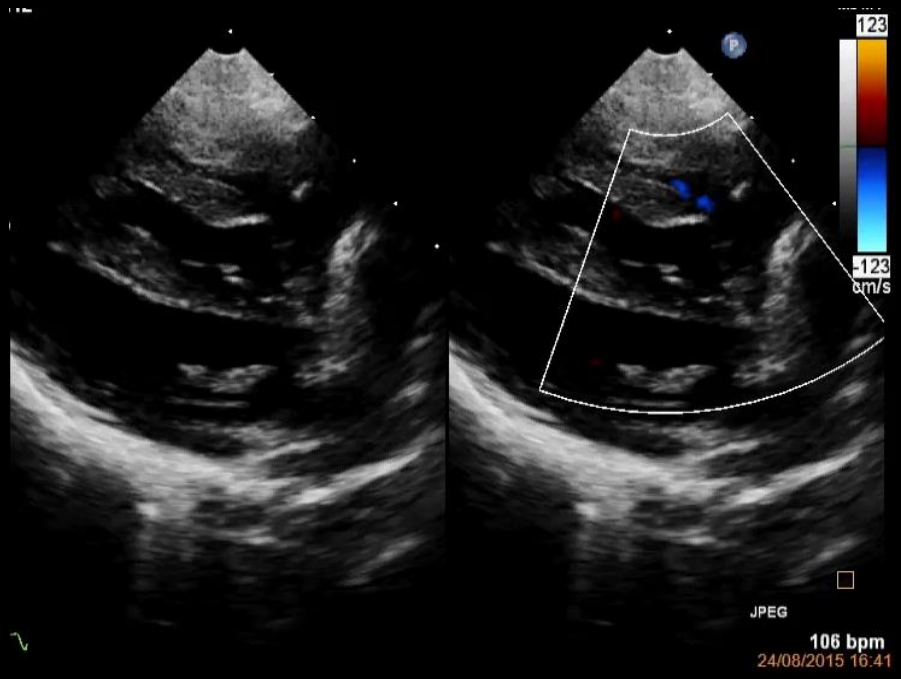


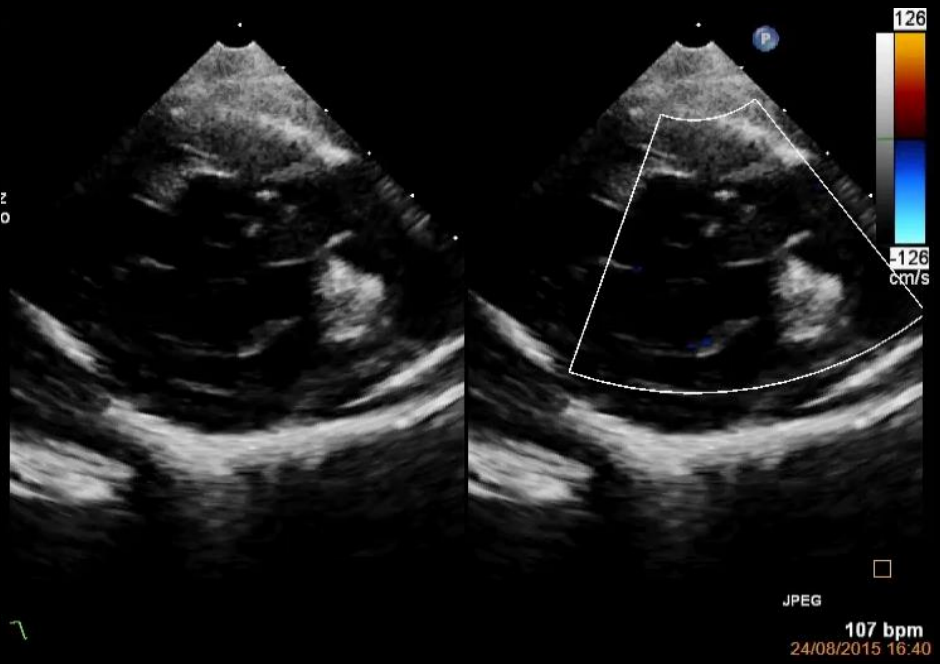


SUBCOSTAL

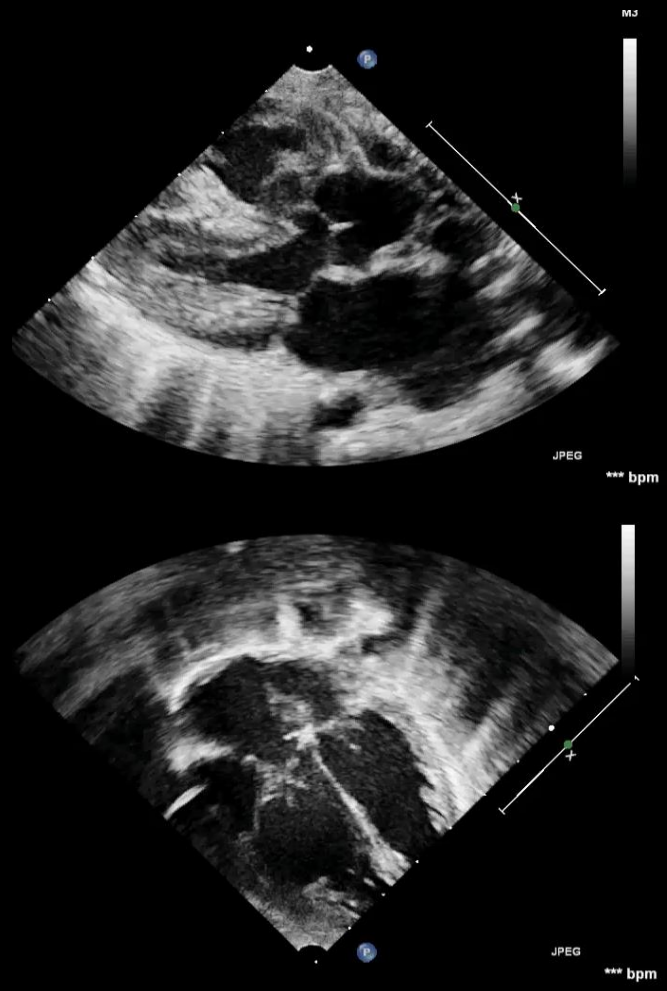

10cm
2D
71%
C 50
P Off
AGen
P
R
2.6
6.2
JPEG
114 bpm
M3 M4
+61.6
-61.6
cm/s
JPEG
*** bpm

SMALL VSD HYPERTENSIVE RV

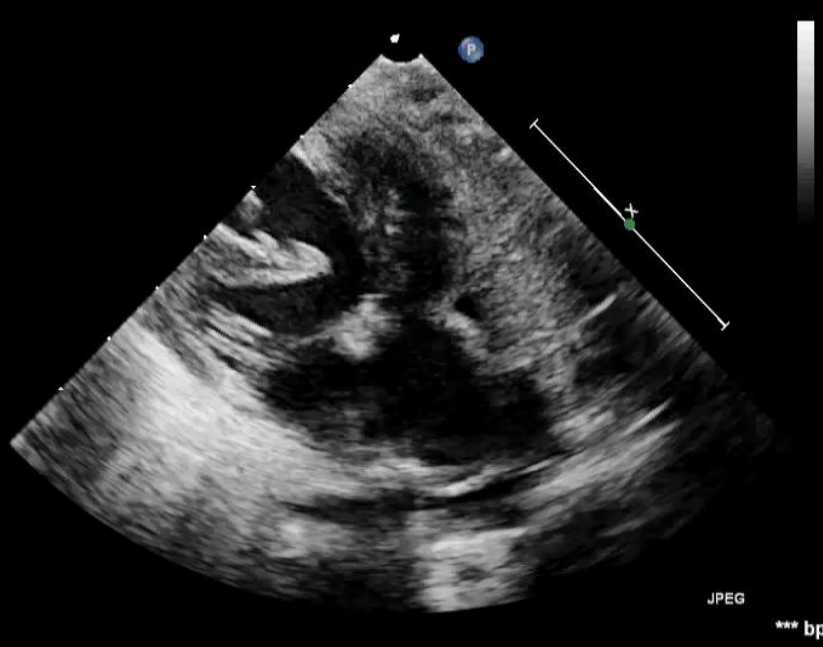


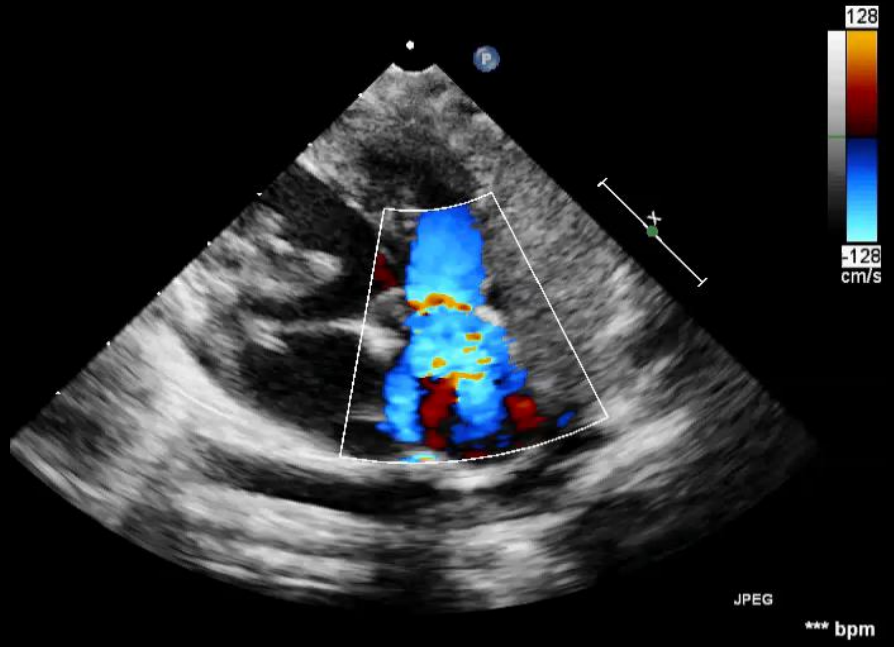


TOF AND PV ABSENCE

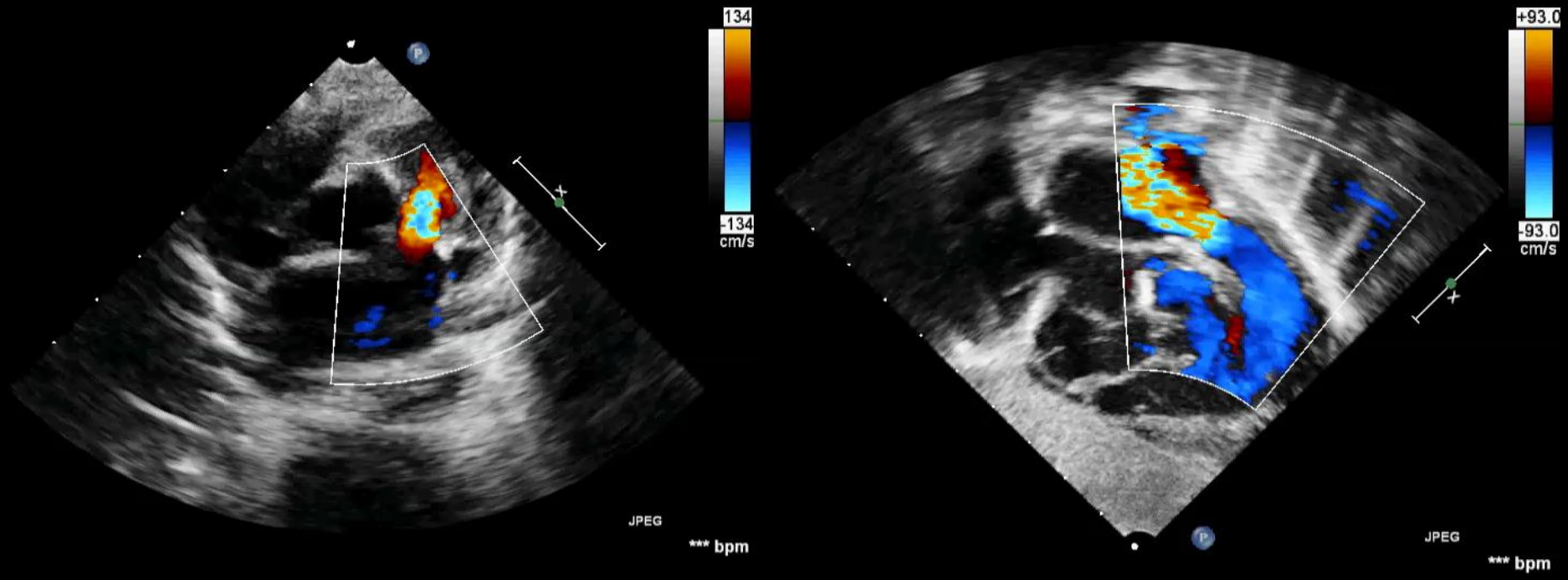


TOF AND PV ABSENCE

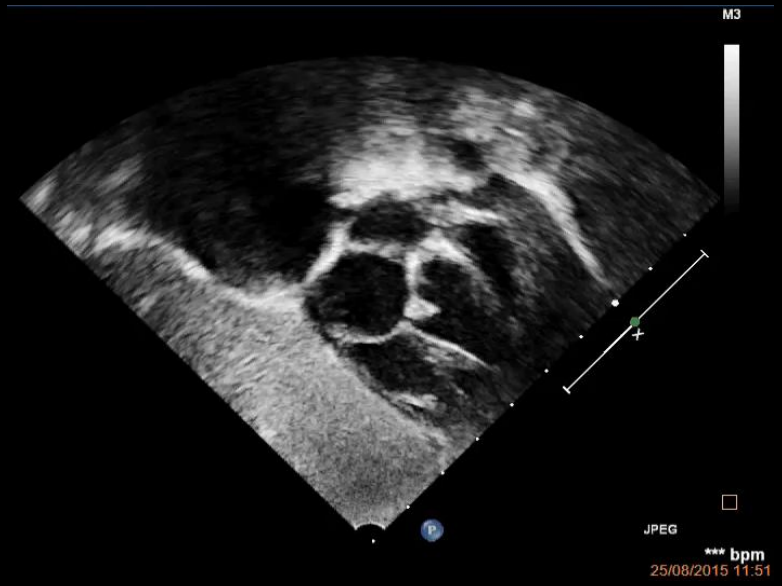




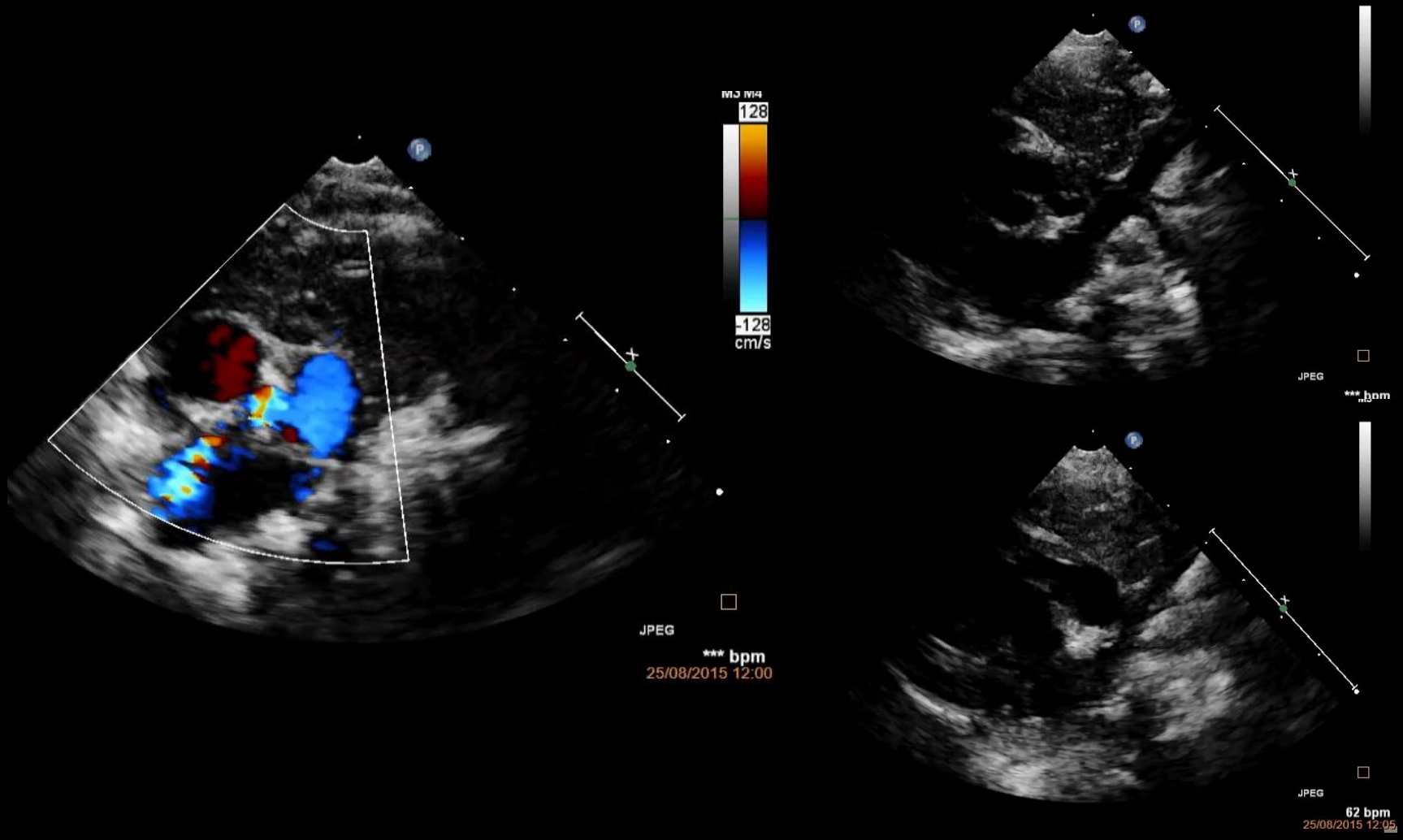
TOF AND PV ABSENCE



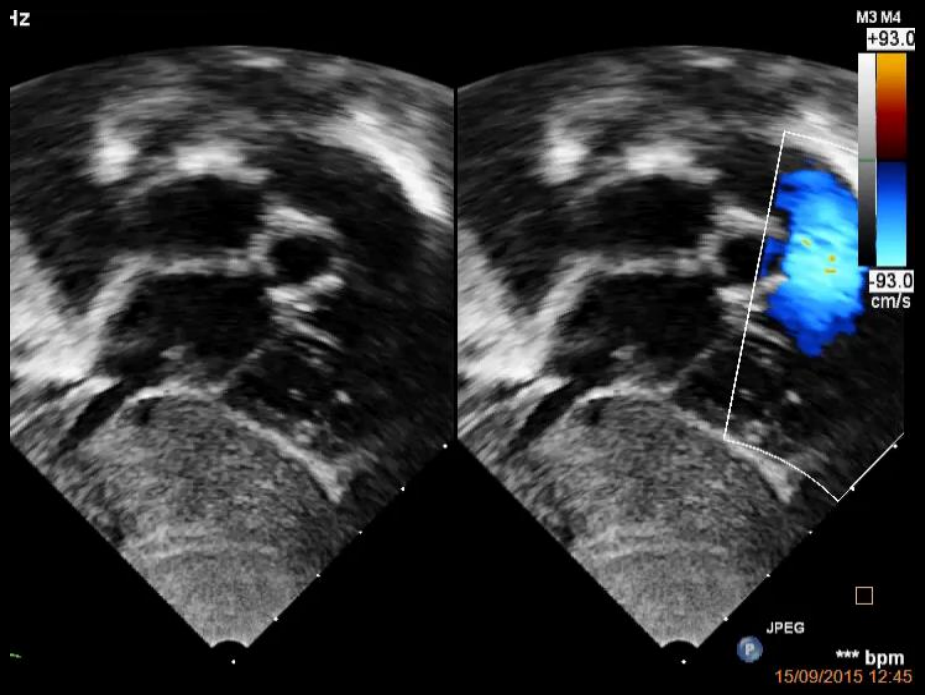
VA..LEO... PRE OP

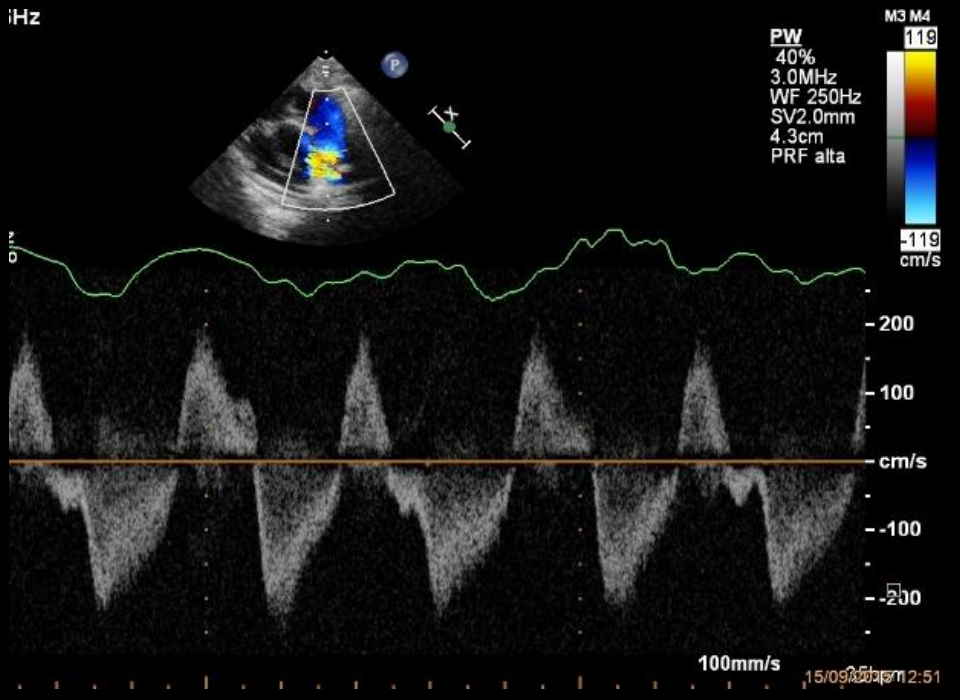


PERIPHERIAL STENOSIS AND LSVC

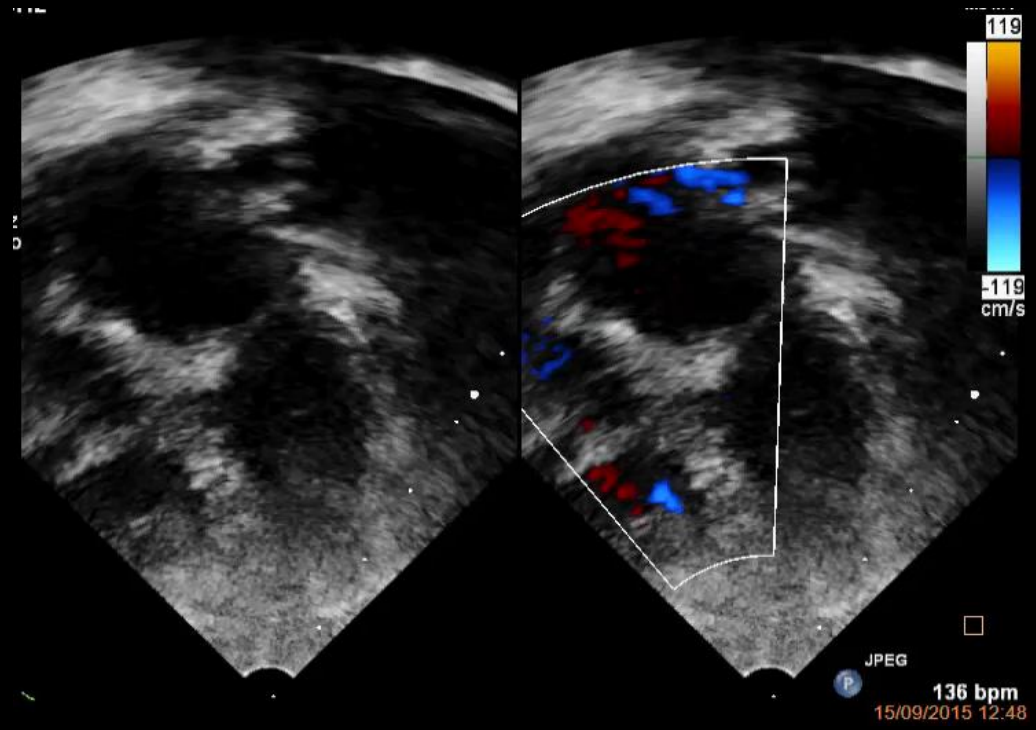


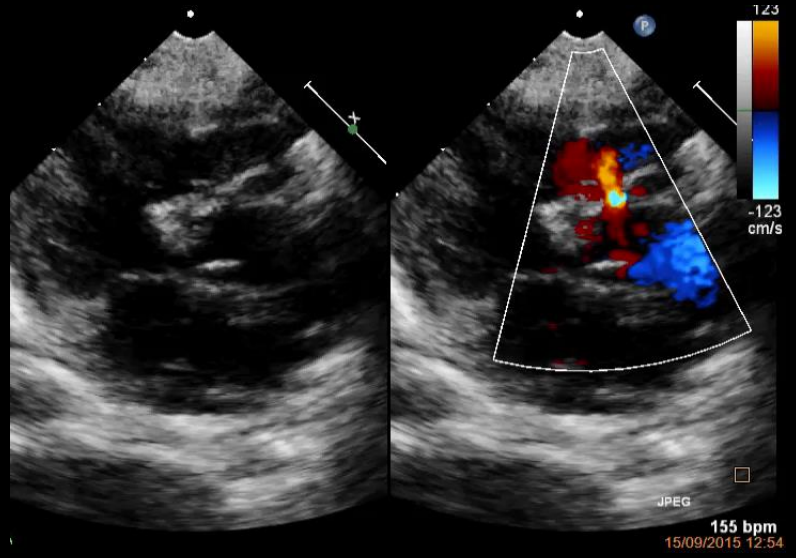
POST OP PR

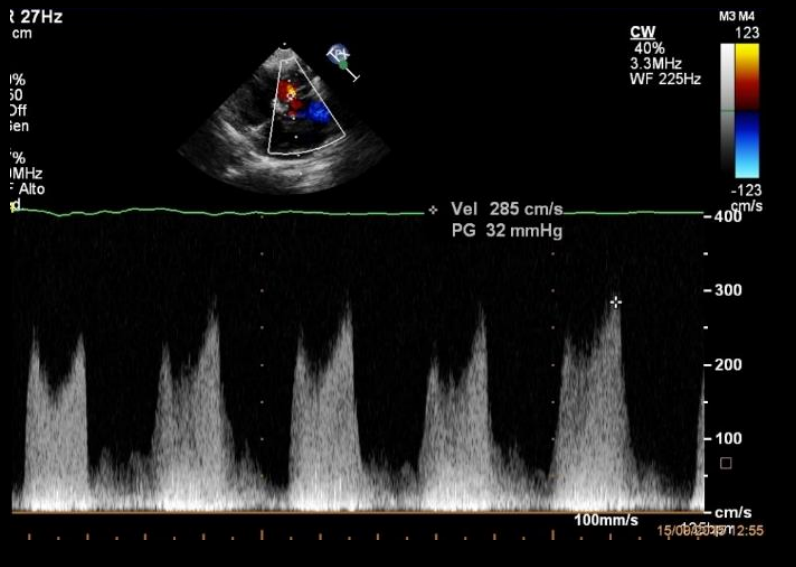

M3 M4
+93.0
-93.0
cm/s
JPEG
*** bpm
15/09/2015 12:45

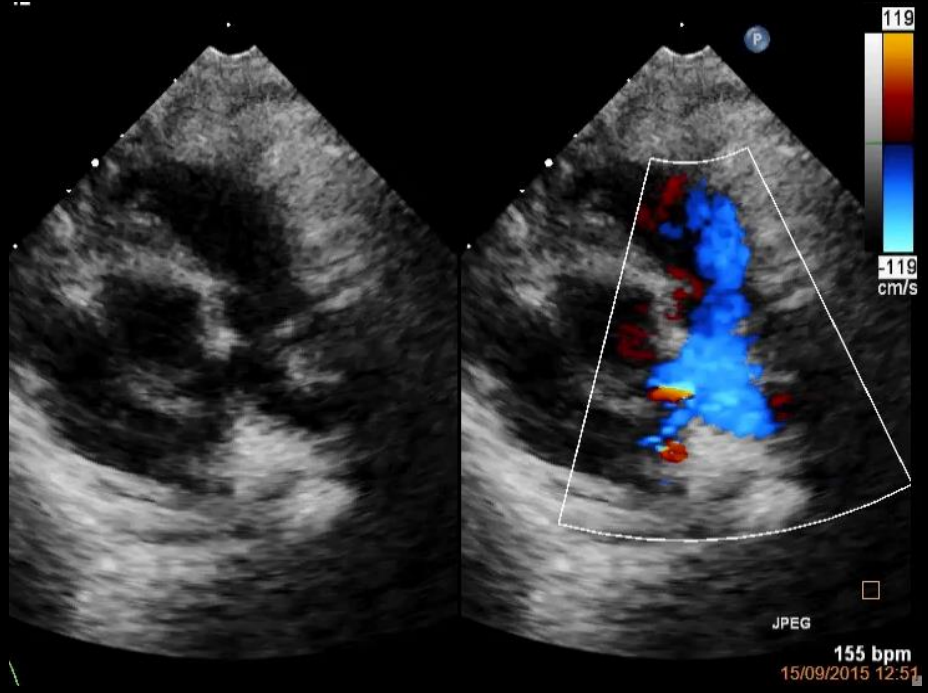

PW
40%
3.0MHz
WF 250Hz
SV2.0mm
4.3cm
PRF alta
M3 M4
119
-119
cm/s
200
100
cm/s
-100
-200
100mm/s

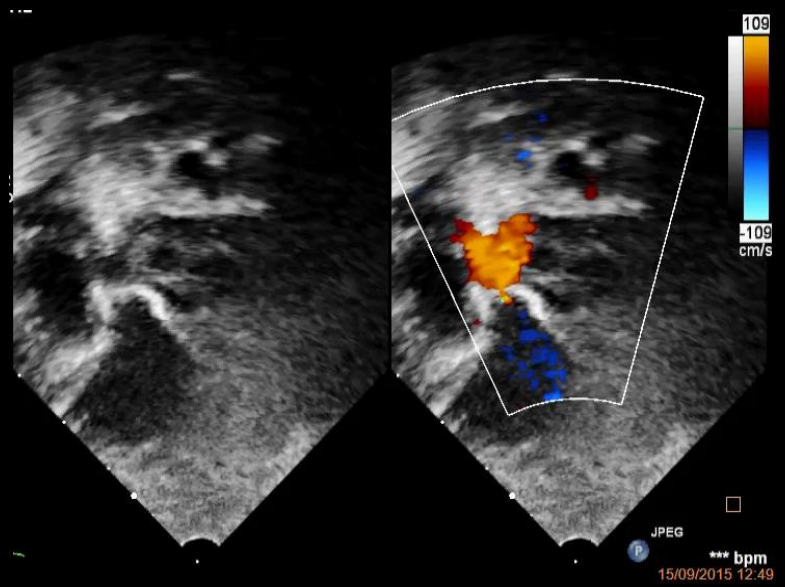
RESIDUAL VSD

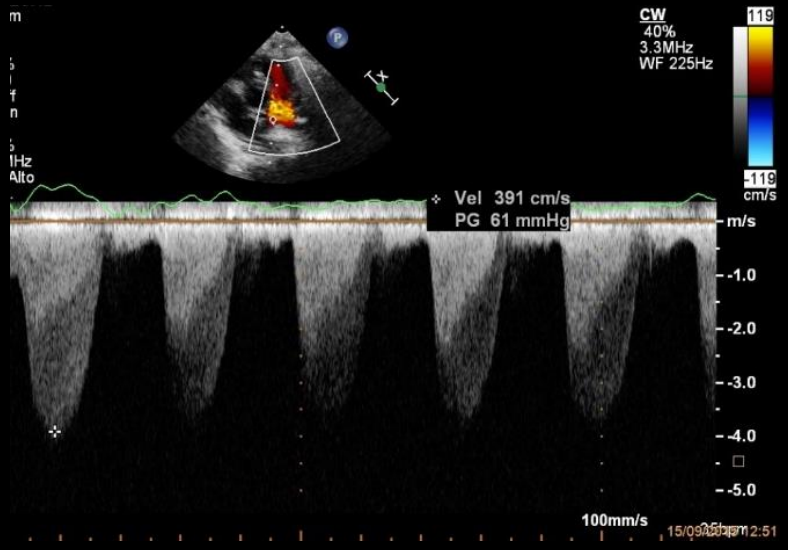







119
-119
cm/s
JPEG
155 bpm
15/09/2015 12:51


109
-109
cm/s
JPEG
*** bpm
15/09/2015 12:49


CW
40%
3.3MHz
WF 225Hz
119
-119
cm/s
Vel 391 cm/s
PG 61 mmHg
m/s
-1.0
-2.0
-3.0
-4.0
-5.0
100mm/s

ADULT POST TOF A NEW PATHOLOGY

DOI: 10.1111/echo.12566

Echocardiography

REVIEW ARTICLE

Evaluation of Right Ventricular Function in Adults with Congenital Heart Defects

Claudio Bussadori, M.D., Ph.D.,* Giovanni Di Salvo, M.D., Ph.D.,† Francesca R. Pluchinotta, M.D.,* Luciane Piazza, M.D.,* Giampiero Gaio, M.D.,‡ Maria Giovanna Russo, M.D.,‡ and Mario Carminati, M.D., F.E.S.C., F.S.C.A.I.*

*Pediatric Cardiology and Adult with Congenital Heart Disease Department, IRCCS San Donato Hospital, Milan, Italy; †Heart Institute, Pediatric Cardiology, King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia; and ‡Department of Cardiology, Division of Pediatric Cardiology, Second University of Naples–Monaldi Hospital, Naples, Italy

The Right Ventricle in Adults with Tetralogy of Fallot

Bussadori C. Imaging evaluation, *in: Chessa, M. Giamberti, A. The Right Ventricle in Adults with Tetralogy of Fallot Springer, Milan 2012, pp. 91-112*. 2012

frontiers in PEDIATRICS

REVIEW ARTICLE
published: 02 February 2015
doi: 10.3389/fped.2015.00003

Echocardiographic assessment after surgical repair of tetralogy of Fallot

Mario Carminati, Francesca R. Pluchinotta, Luciane Piazza, Angelo Micheletti, Diana Negura, Massimo Chessa, Gianfranco Butera, Carmelo Arcidiacono, Antonio Saracino and Claudio Bussadori*

EXPERT REVIEWS

Timing of pulmonary valve replacement after tetralogy of Fallot repair

Expert Rev. Cardiovasc. Ther. 10(7), 917–923 (2012)

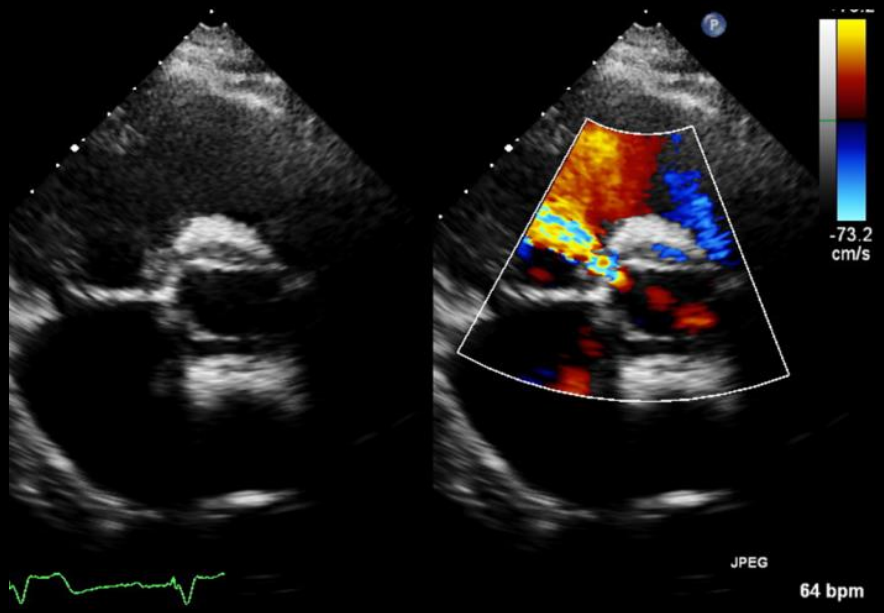
Luciane Piazza, Massimo Chessa*, Alessandro Giamberti, Claudio Maria Bussadori, Gianfranco Butera, Diana Gabriela Negura, Angelo Micheletti, Edward Callus and Mario Carminati

Tetralogy of Fallot (TOF) is the most common form of cyanotic congenital heart disease. If untreated, it carries a 33% mortality in the first year of life and a 50% mortality in the 3 years of life. Since the introduction of the first open-heart repair by Lillehei and Varco in 19 surgical management of TOF has evolved to be the primary repair during infancy in the majo of patients. Surgical management of TOF results in anatomic and functional abnormalities in majority of patients, such as chronic pulmonary valve regurgitation and right ventricular dysfunction. Long-standing chronic pulmonary valve regurgitation can result in RV dilatation failure, increasing tricuspid regurgitation, impaired exercise performance and supraventricula ventricular arrhythmias. A timely reoperation may prevent these consequences, with a comp RV-function recovery. This article provides insight into the questions of when to perfor pulmonary valve implantation and in whom.

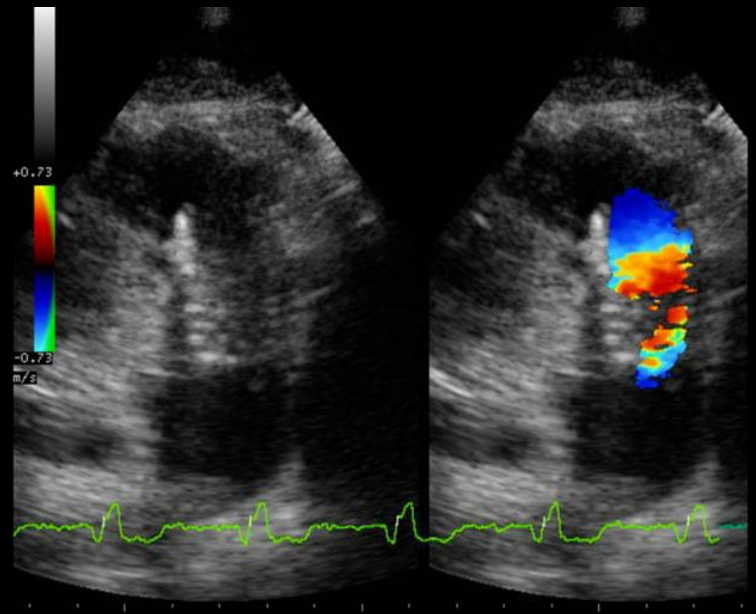
Keywords: adult with congenital heart disease • pulmonary regurgitation • tetralogy of Fallot • timing

POST FALLOT

Residual VSD



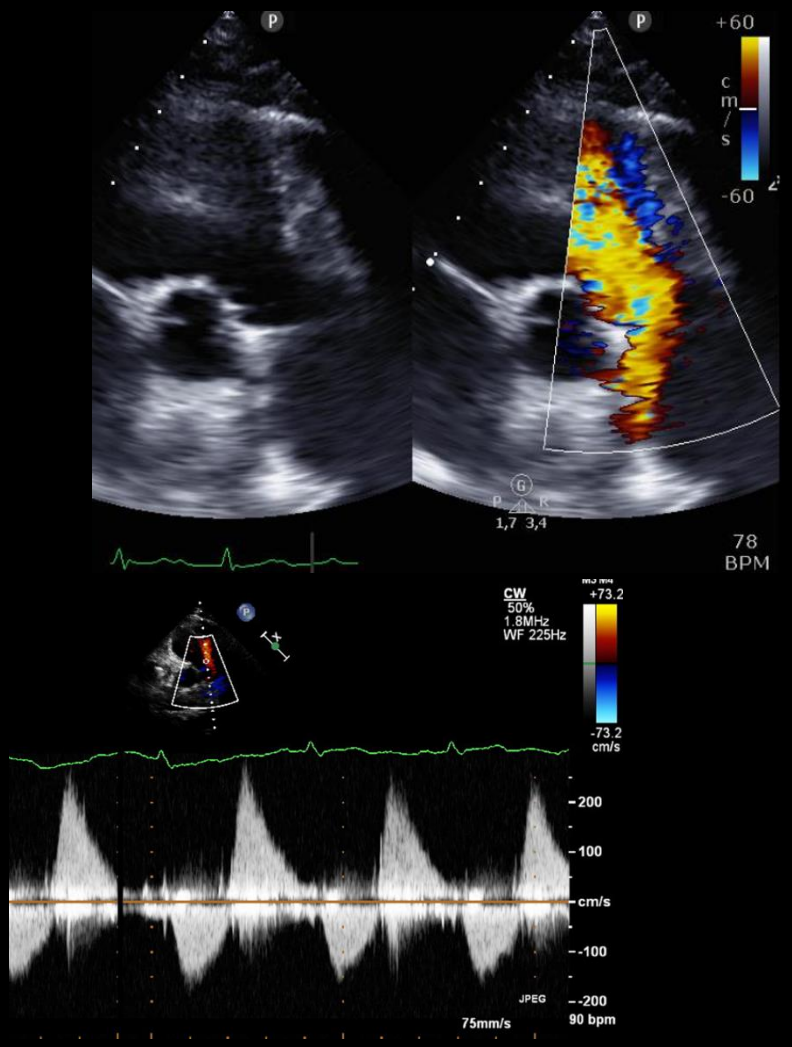
Percutaneous Valve



POST FALLOT

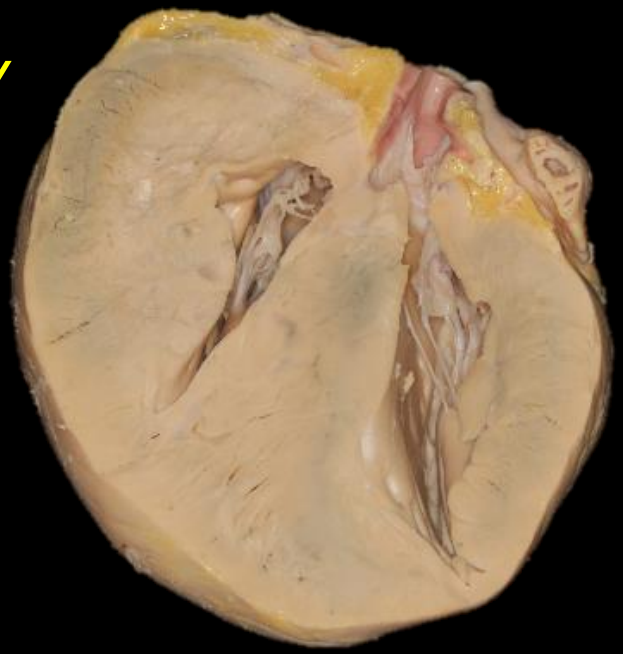
- Pulmonary Insufficiency
- Conduit Stenosis
- Restrictive RV

- lindex Based on CFM
  - Variability, Setting dependent
- PHT< 100 msec
  - indicative of Severity



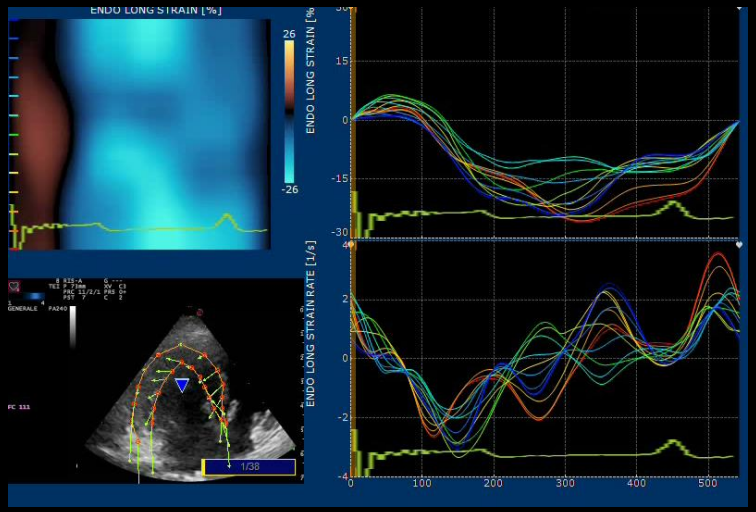
Silversides CK, Veldtman GR, Crossin J, Merchant N, Webb GD, McCrindle BW, Siu SC, Therrien J: Pressure half-time predicts hemodynamically significant pulmonary regurgitation in adult patients with repaired tetralogy of fallot. *J Am Soc Echocardiogr* 2003, 16(10):1057-1062.

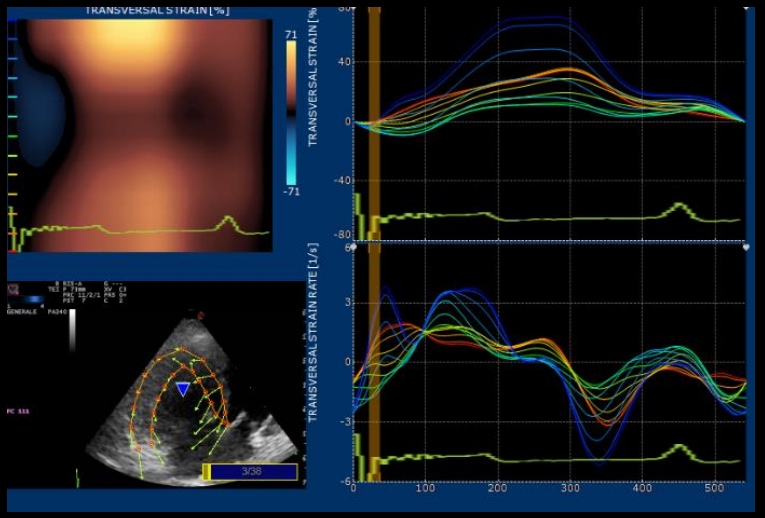
RV RESTRICTIVE PHYSIOLOGY



Gross right ventricular hypertrophy, small RV cavity volumes, and fibrosis.

Systolic function become much more radial than longitudinal.





Bussadori C. Imaging evaluation, . *in: Chessa, M. Giamberti, A. The Right Ventricle in Adults with Tetralogy of Fallot Springer, Milan 2012, pp. 91-112*. 2012

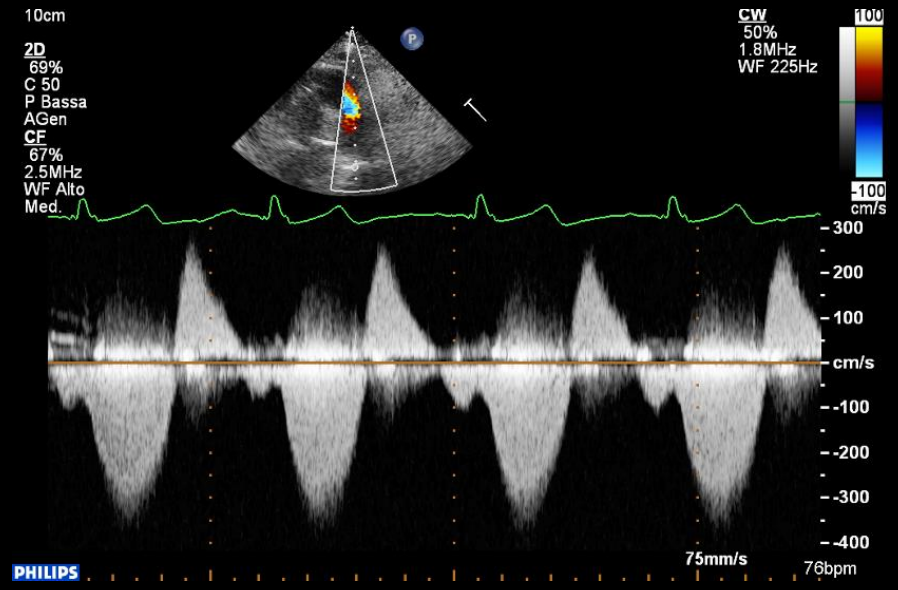
RV RESTRICTIVE PHYSIOLOGY

RAP > of PADP

- Transtricuspid flow will be transmitted to the pulmonary artery rather than translating to right ventricular filling.

End Diastolic Forward Flow (EDFF)

- Persistence of antegrade diastolic flow in the pulmonary artery.

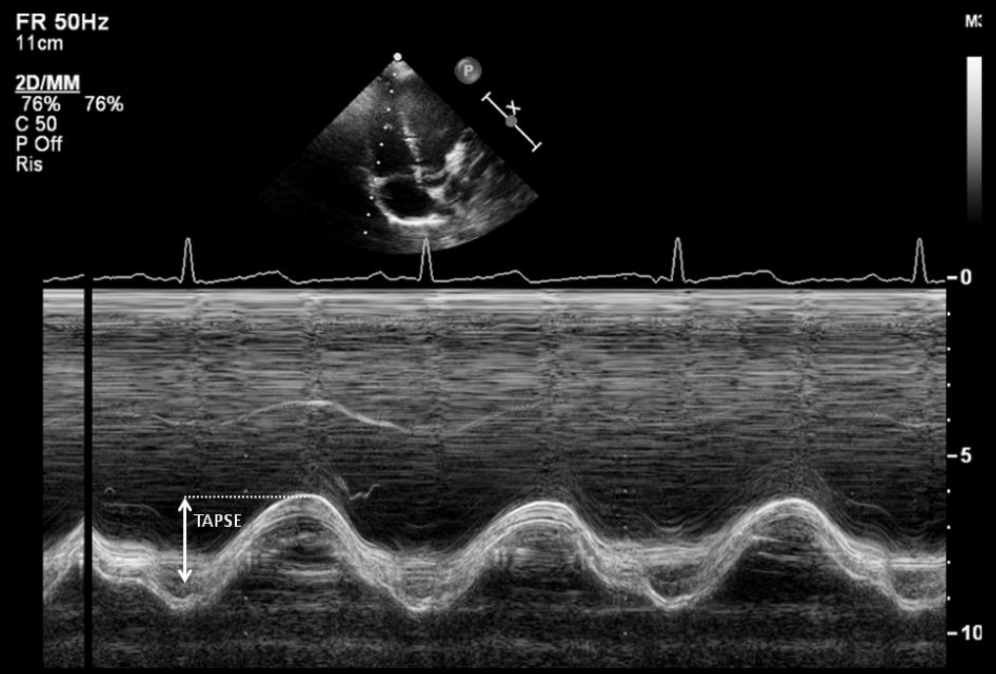


Bussadori C et al Evaluation of right ventricular function in adults with congenital heart defects. *Echocardiography*. 2014

TAPSE

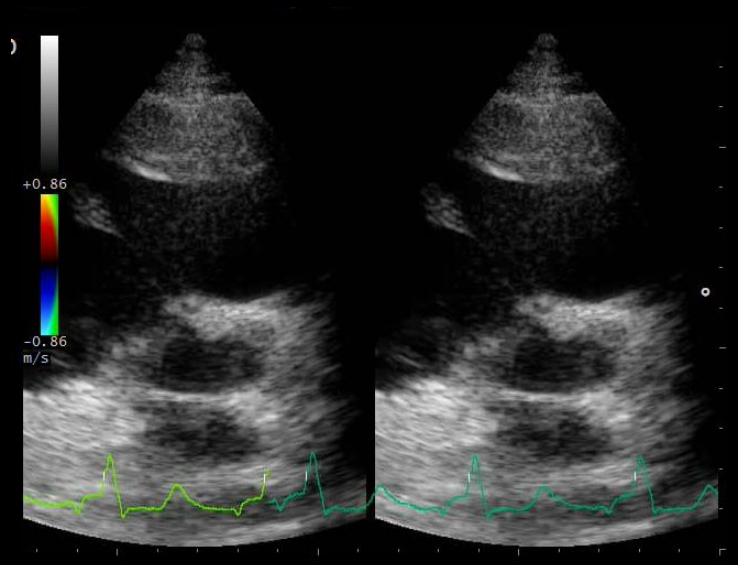
TRICUSPID ANNULUS PEAK SYSTOLIC EXCURSION

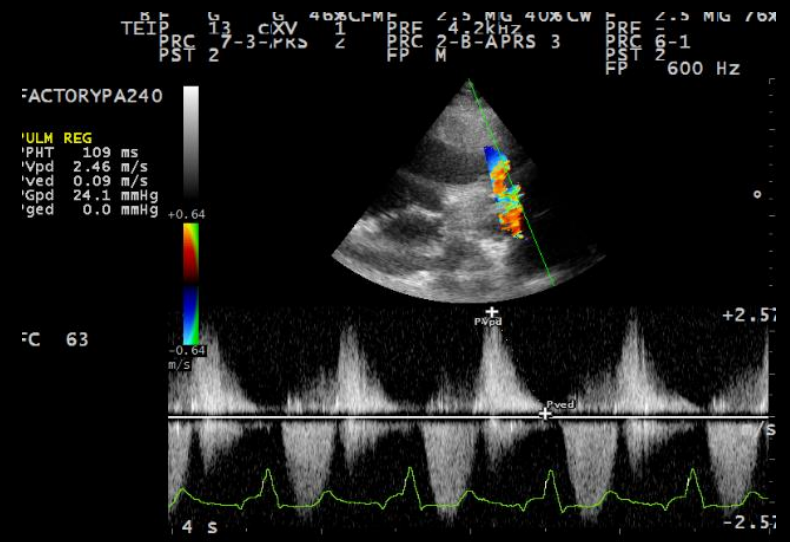
- Widely used to study RV systolic function
- BASED on the ASSUMPTION that displacement of basal and adjacent segments in apical 4-chamber view is representative of the function of the entire RV
- Not valid in the regional RV wall motion abnormalities

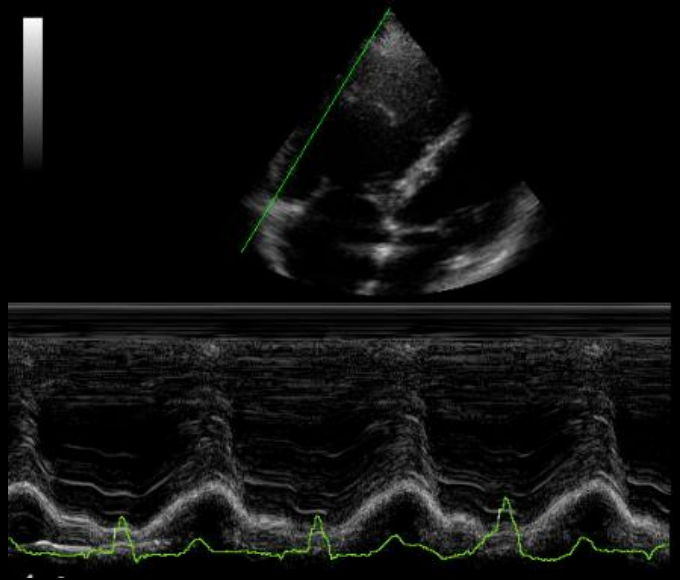


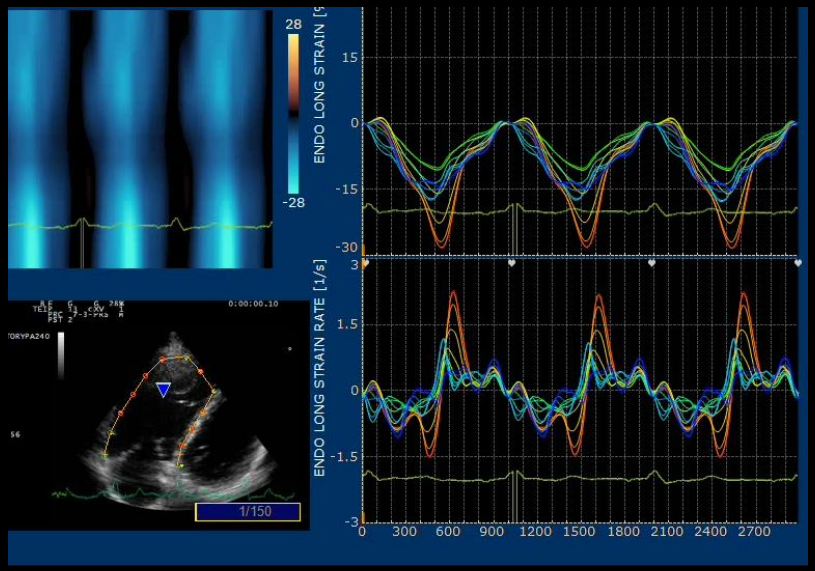
Tricuspid annular motion
Hammarstrom E, Wranne B, Pinto FJ, Puryear J, Popp RL.
J Am Soc Echocardiogr 1991 Mar-Apr4(2):131-9

SEVERE PR POST TOF REPAIR

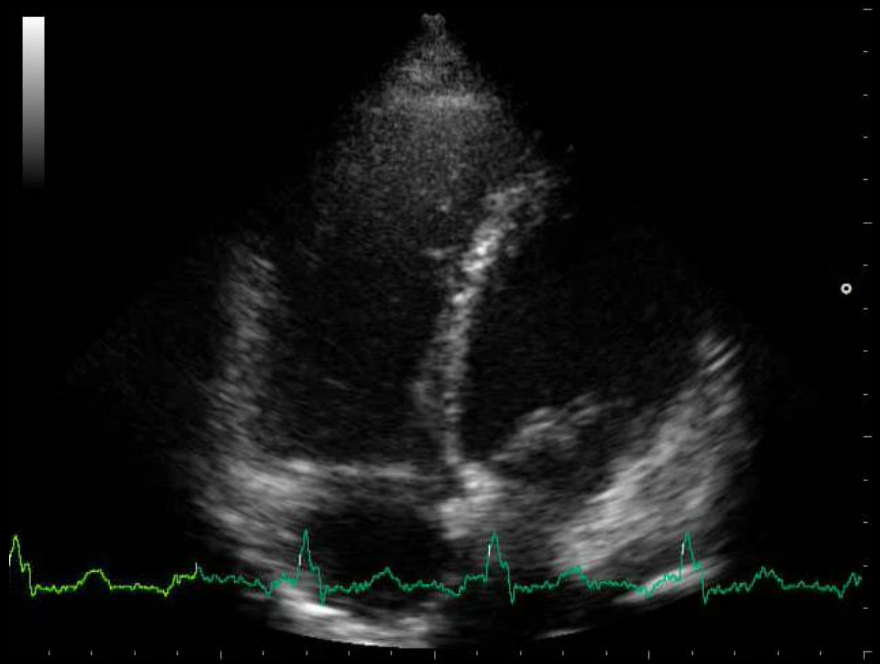


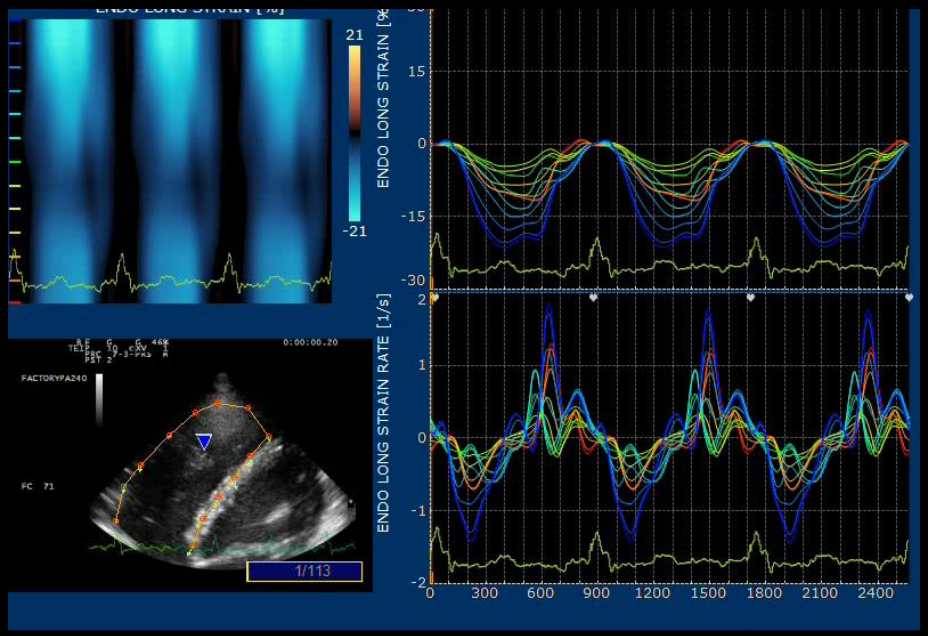






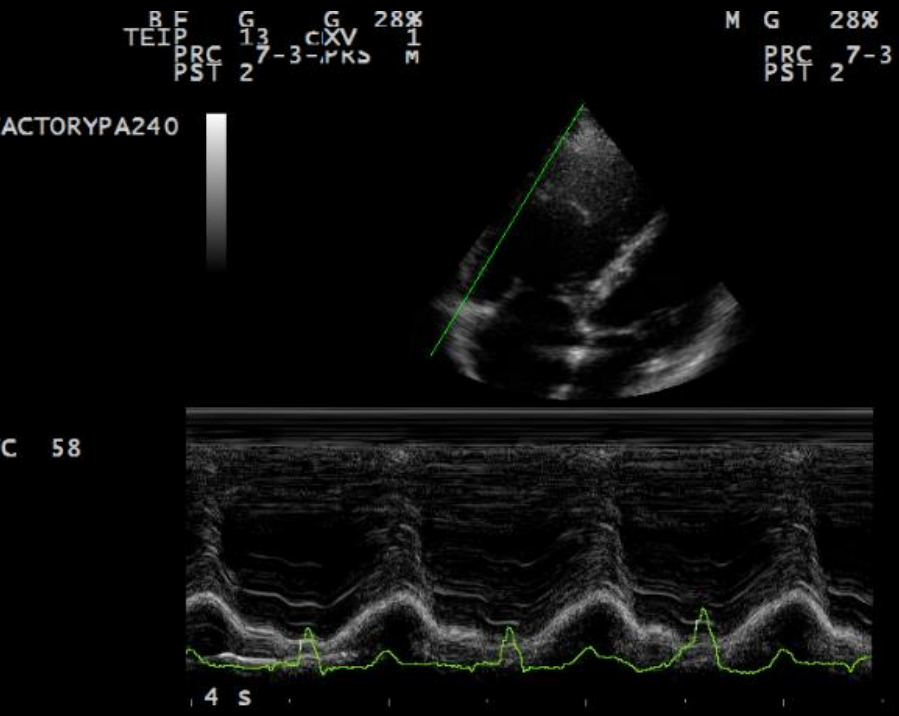
HYPERKINESIS VOLUME OVERLOAD PULMONARY REGURGITATION



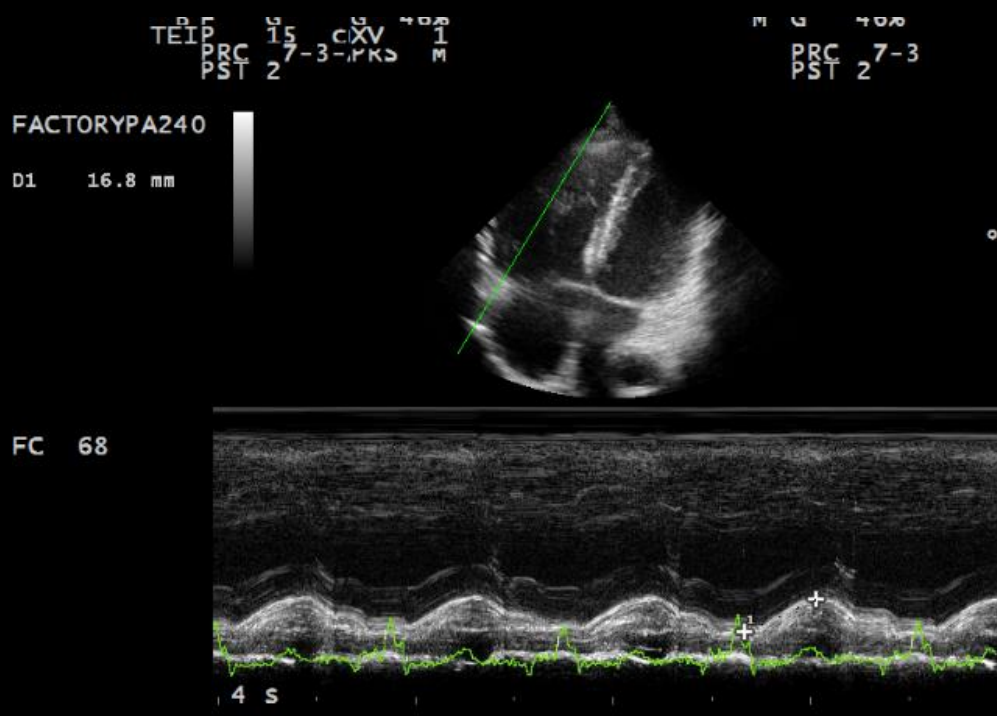


PERCUTANEOUS PULMONARY VALVE IMPLANTATION

PRE

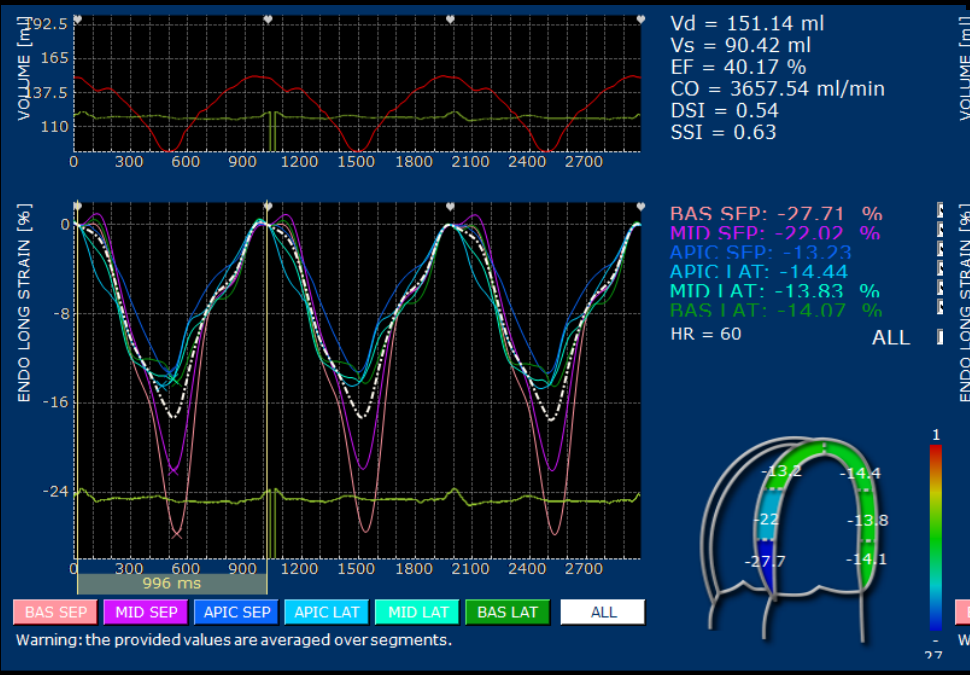


POST



PERCUTANEOUS PULMONARY VALVE

Pre



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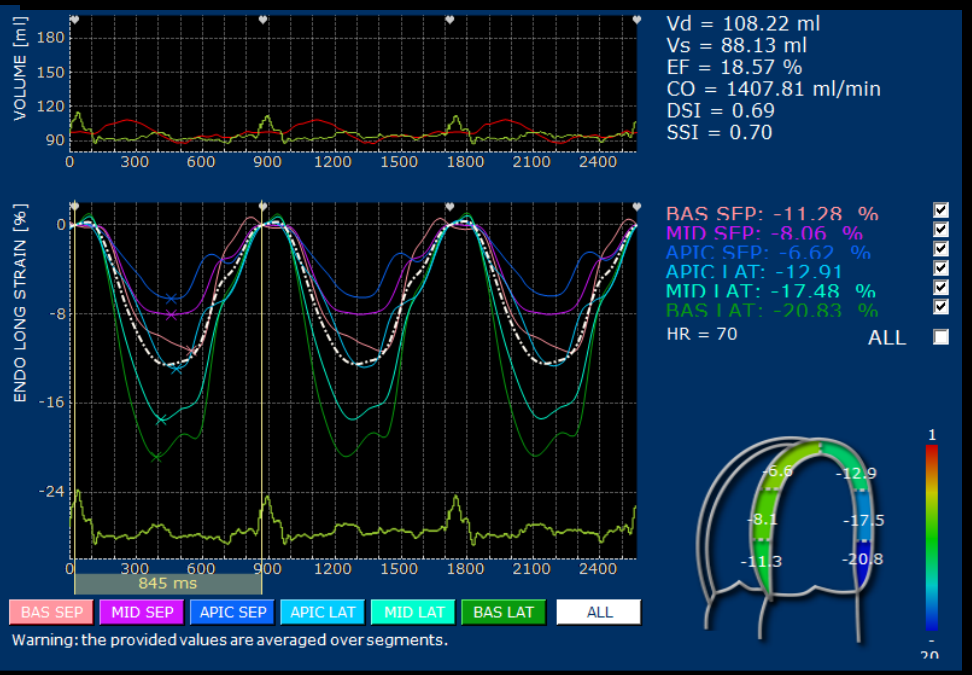
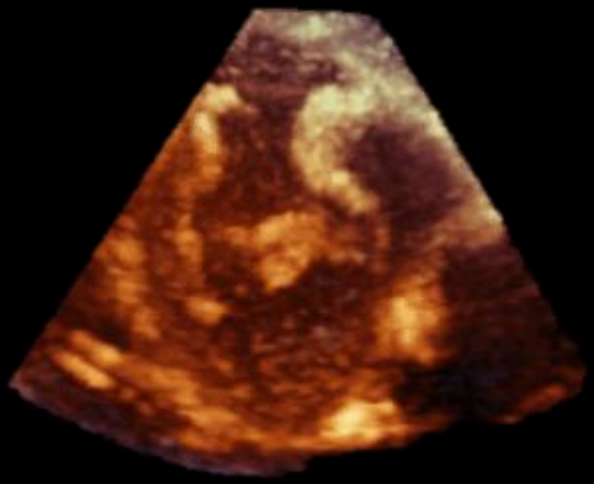
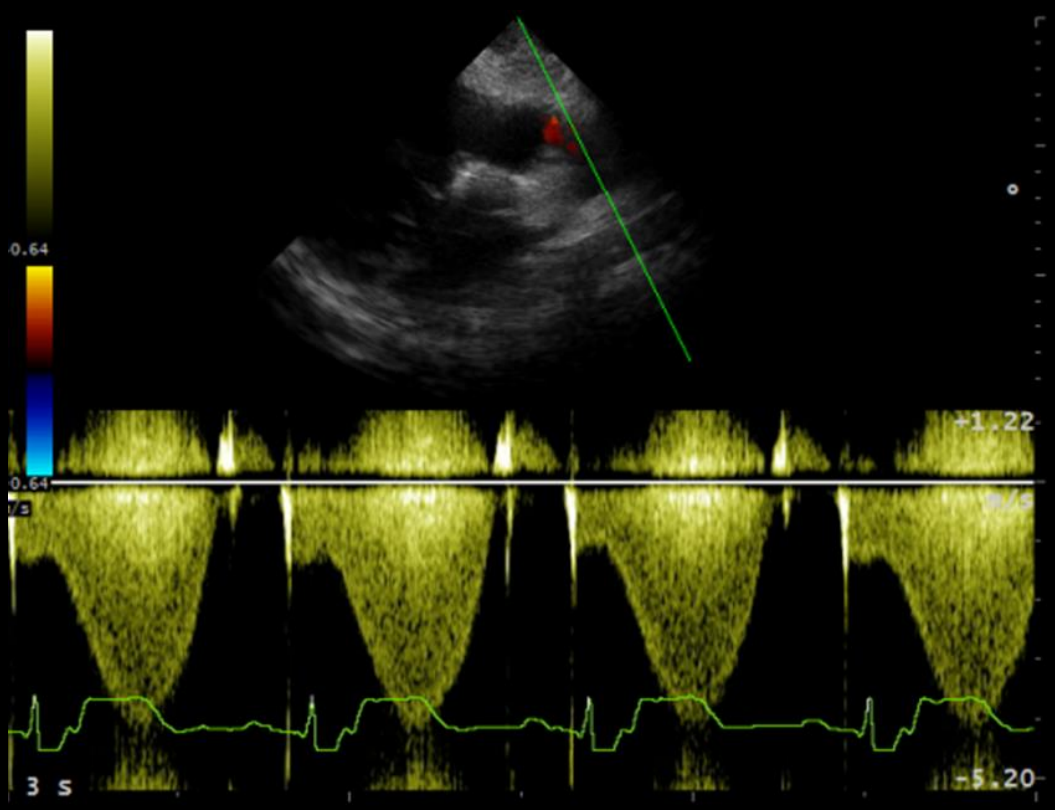
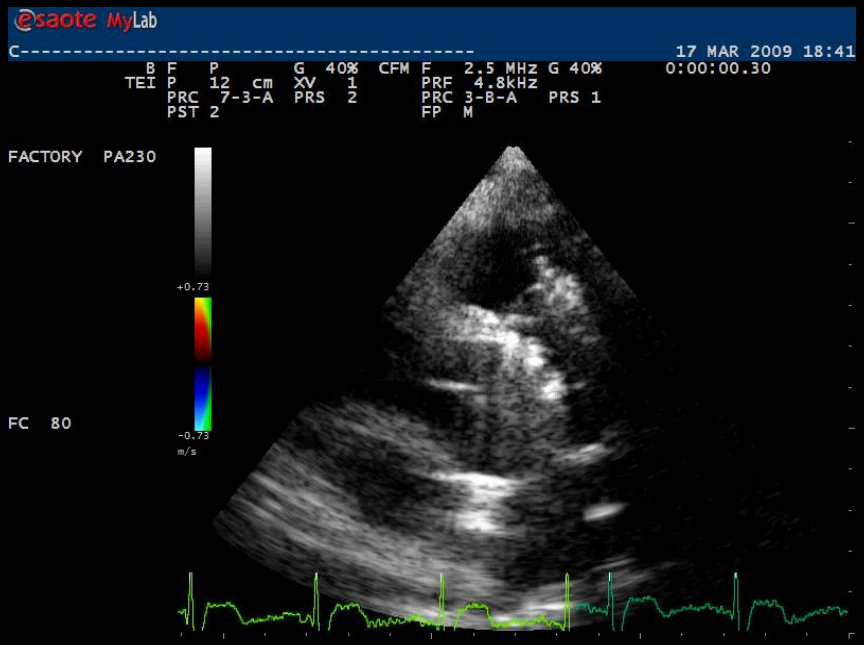


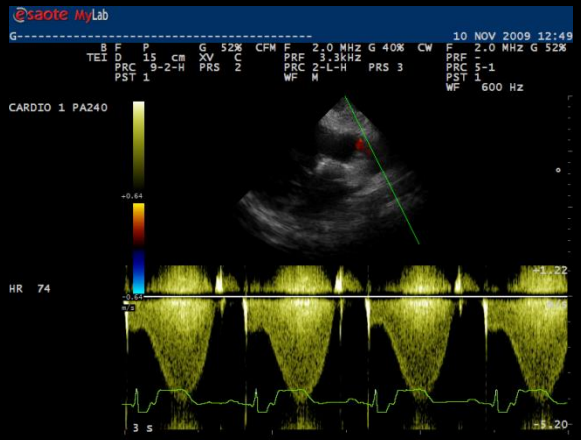
PULMONARY CONDUIT STENOSIS

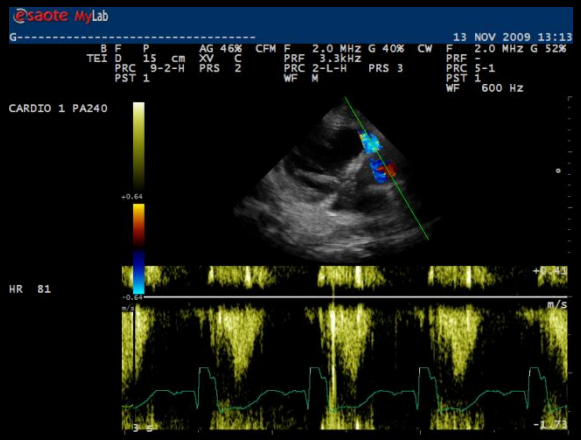




PERCUTANEOUS PULMONARY VALVE







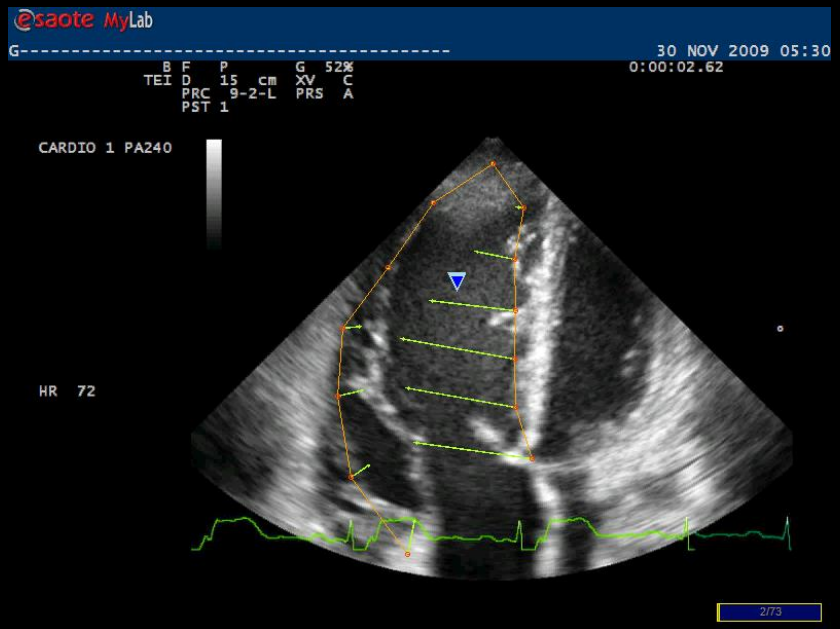
Reduction of Pulmonary gradient result in increase of RV and right septal Strain 24 h after procedure

Moiduddin et al. **Am J Cardiol 2009**

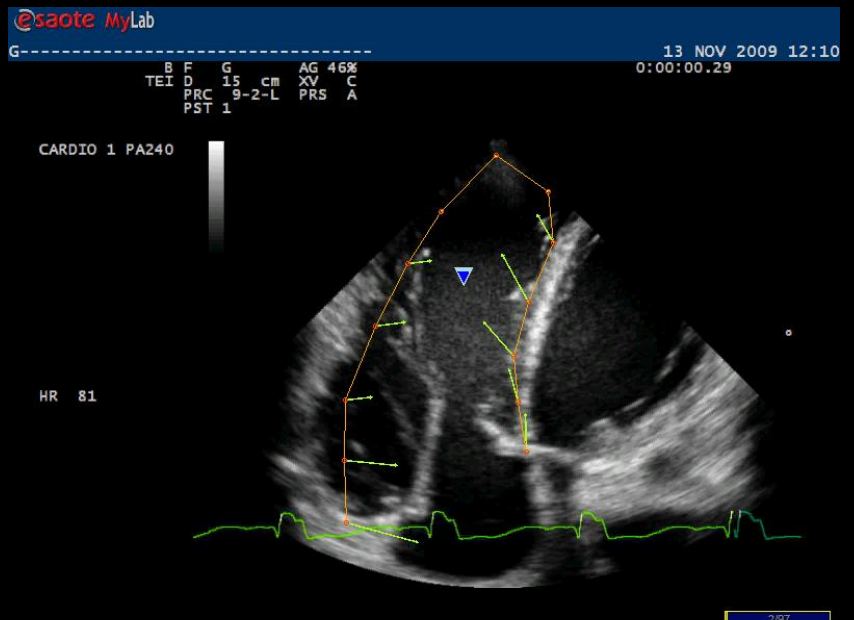
Bussadori C, et al: *Echocardiography* 2014

PERCUTANEOUS PULMONARY VALVE RV STRAIN AND VOLUMES 3 DAYS POST

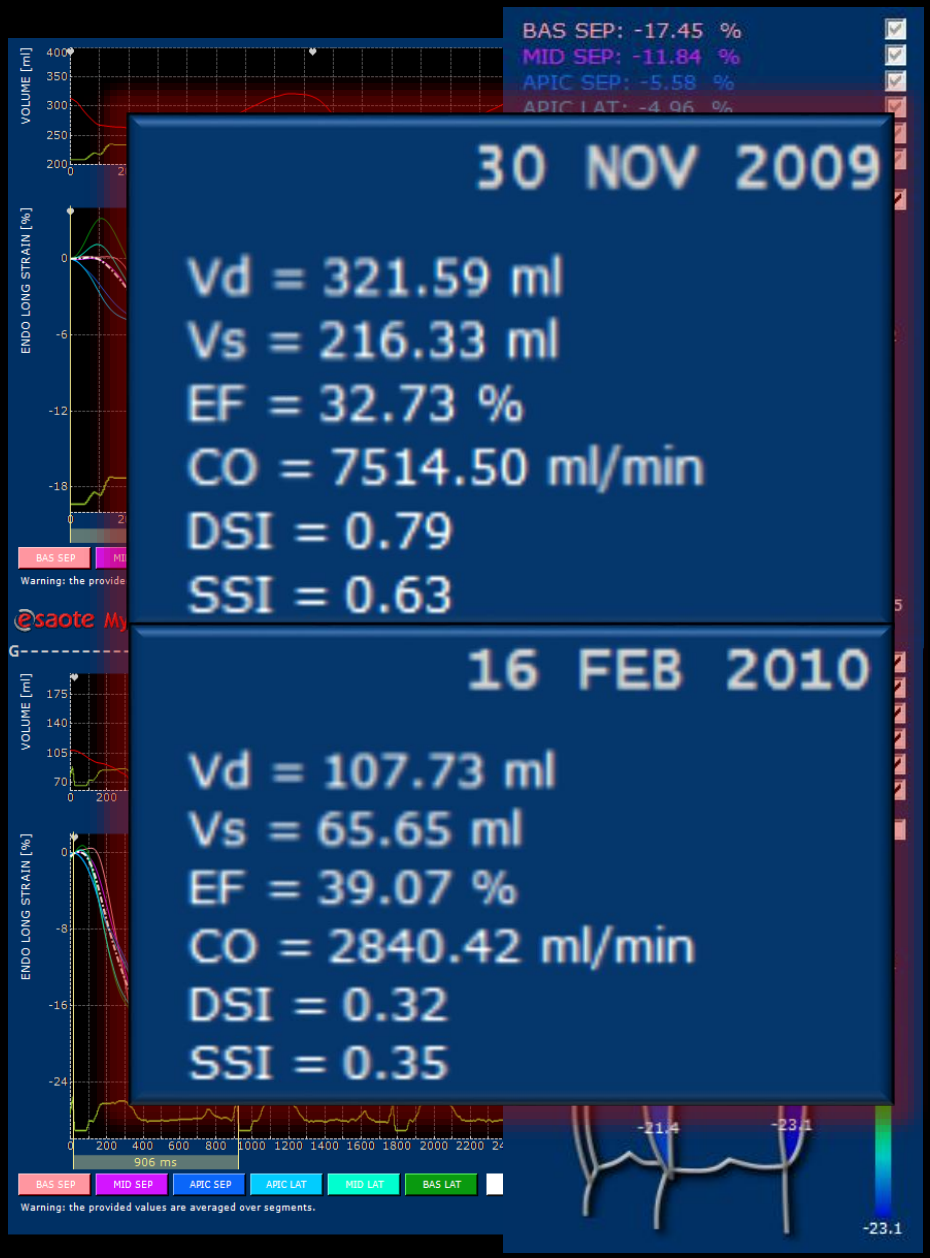
Vd = 321.59 ml
Vs = 216.33 ml
EF = 32.73 %
CO = 7514.50 ml/min
DSI = 0.79
SSI = 0.63

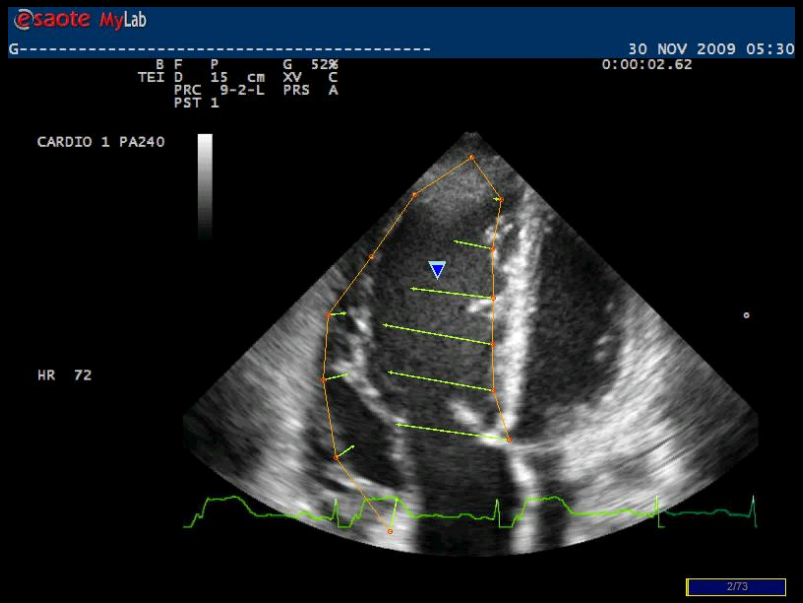


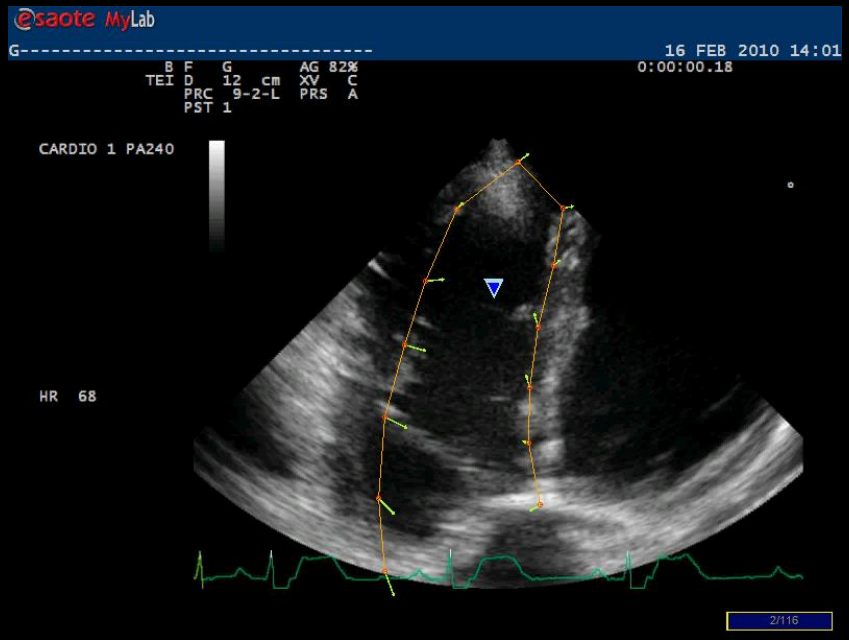
Vd = 202.95 ml
Vs = 148.58 ml
EF = 26.79 %
CO = 4426.56 ml/min
DSI = 0.54
SSI = 0.43



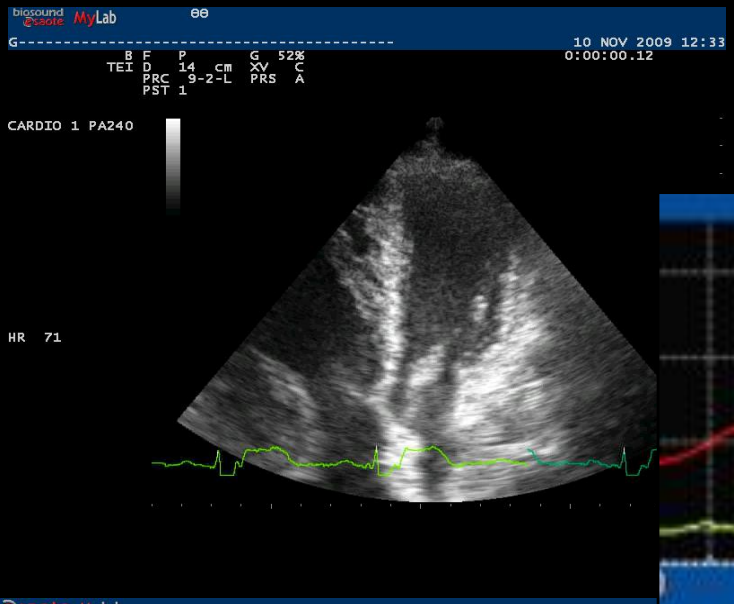
PERCUTANEOUS PULMONARY VALVE RV STRAIN AND VOLUMES 3 M POST

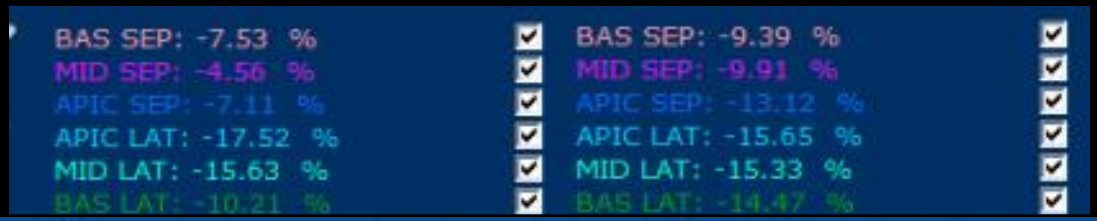


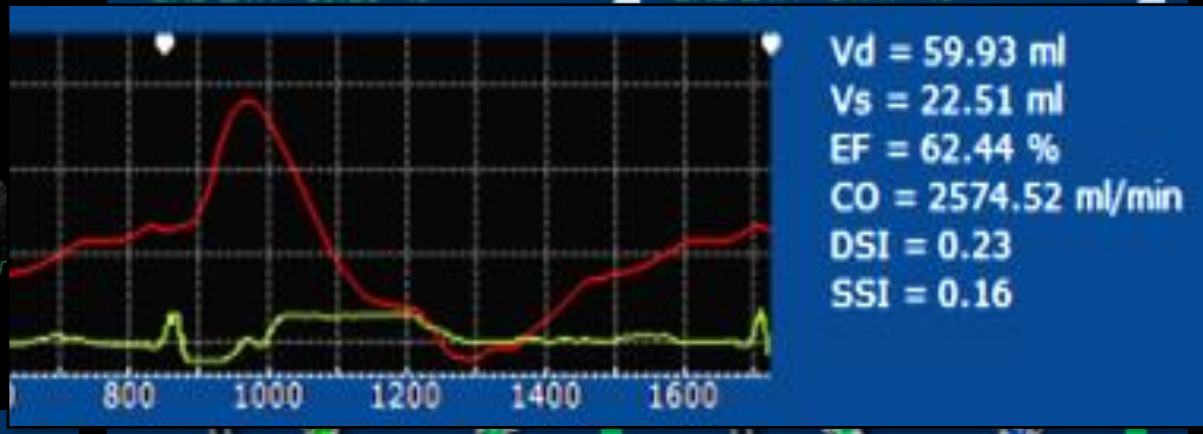


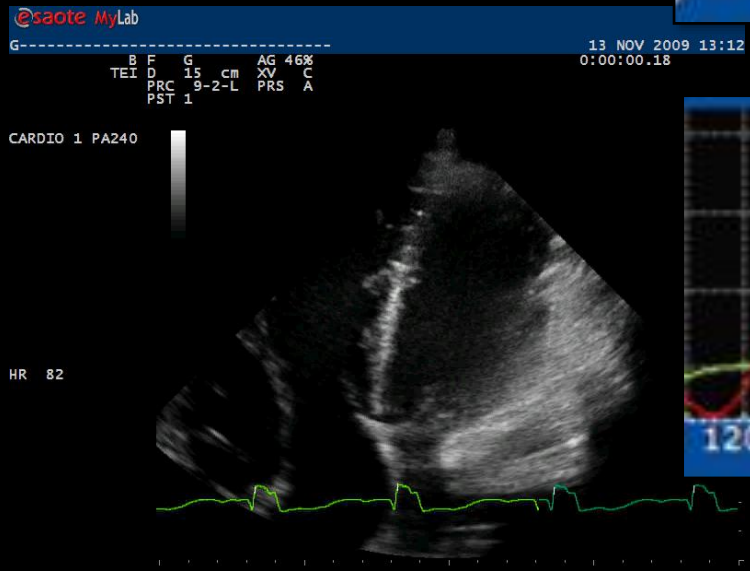


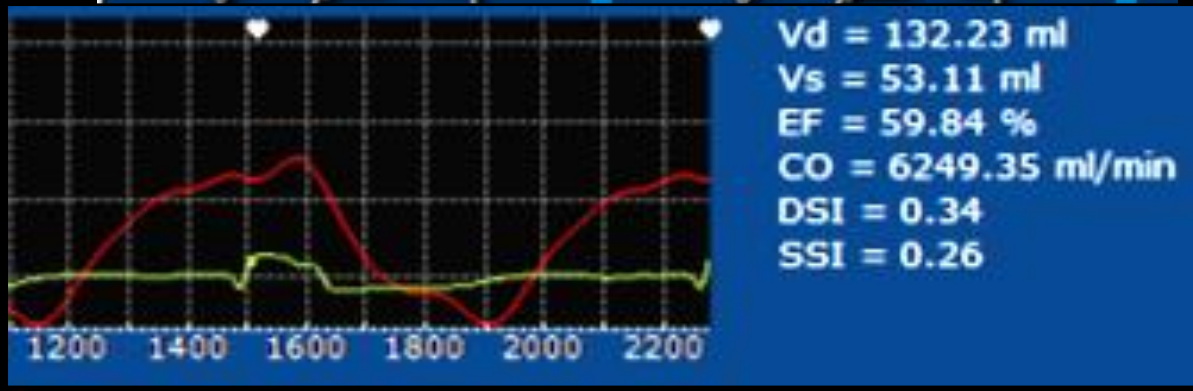
PERCUTANEOUS PULMONARY VALVE
LV STRAIN AND VOLUMES 3 DAYS POST











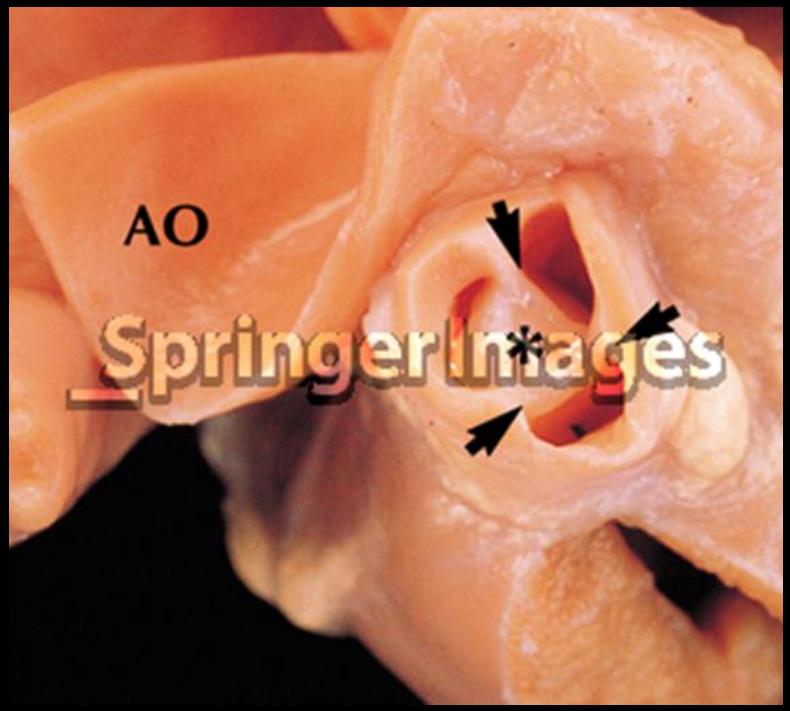
Pulmonary Atresia

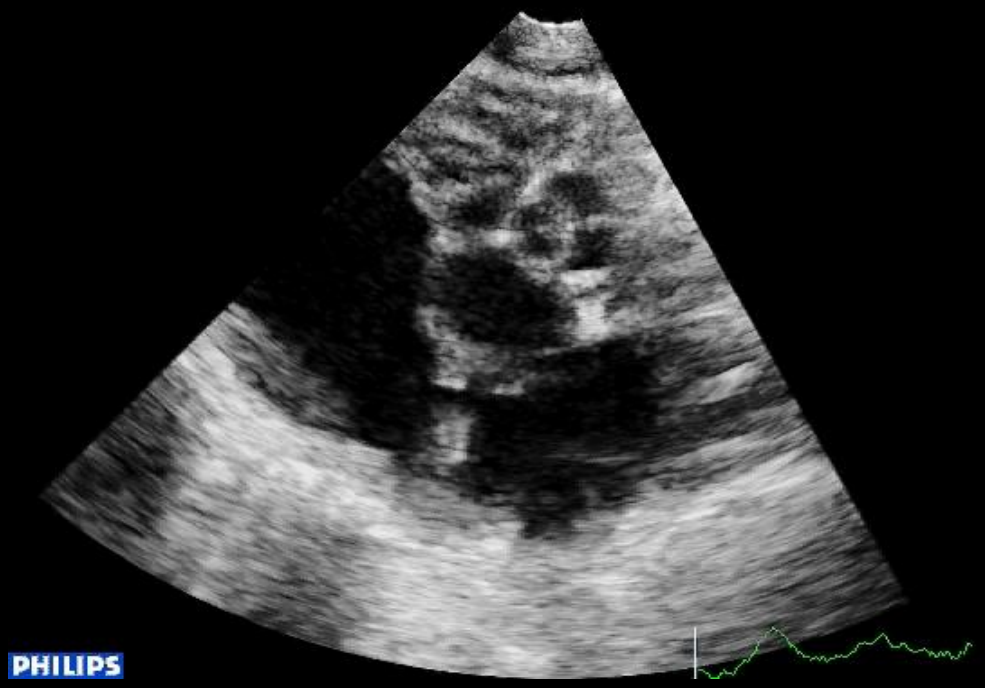
PULMONARY ATRESIA

- PA – IVS is a rare disease with considerable anatomic diversity
- Incidence estimated 4.5 / 100000 live births
- Atretic pulmonary valve in the absence of a significant VSD is the constant feature
- Other right heart structures are commonly abnormal

Pulmonary valve morphology

Pulmonary valve is inperforated and often appears as a smooth central dome with three raphes



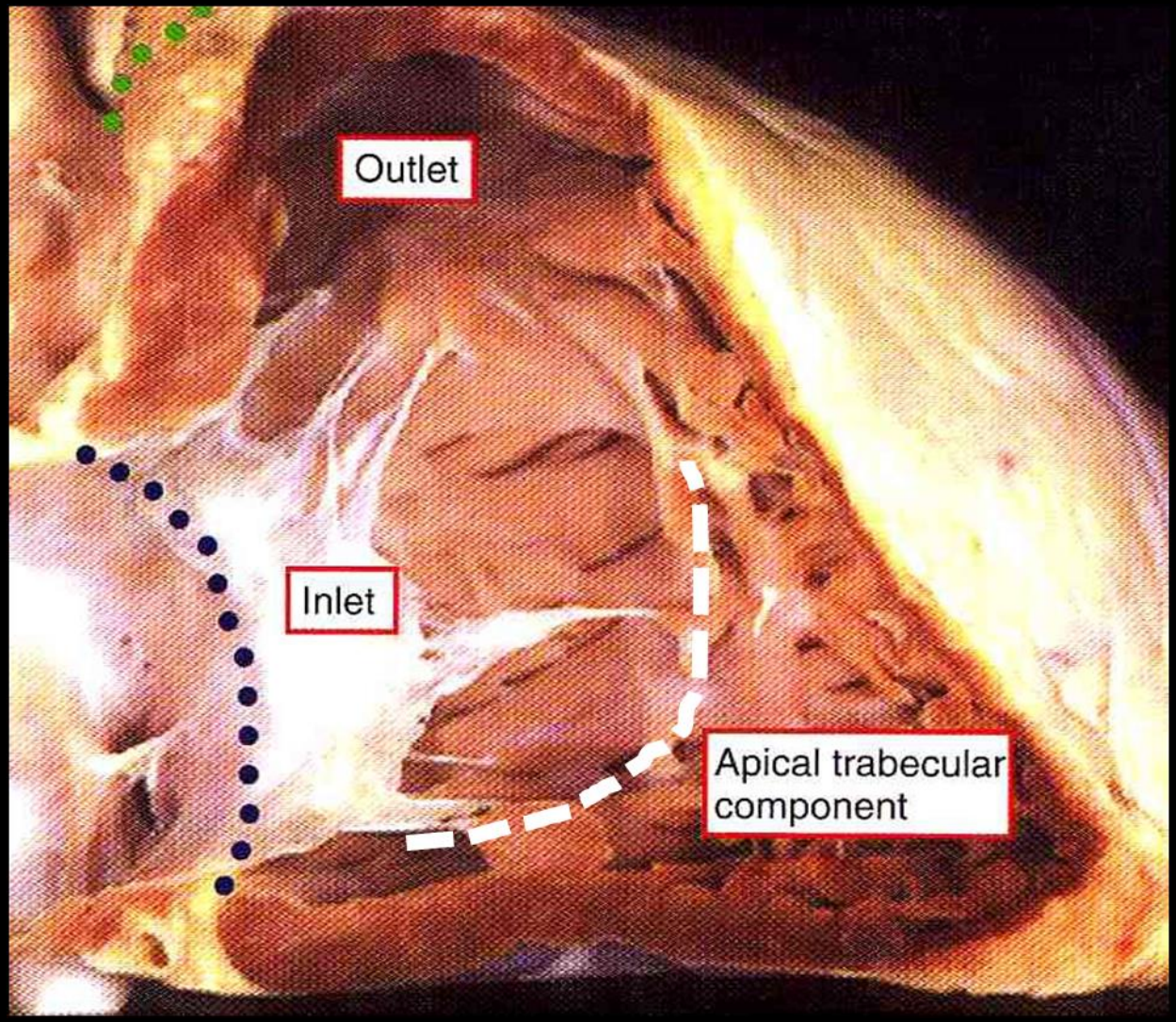


PULMONARY VALVE MORPHOLOGY

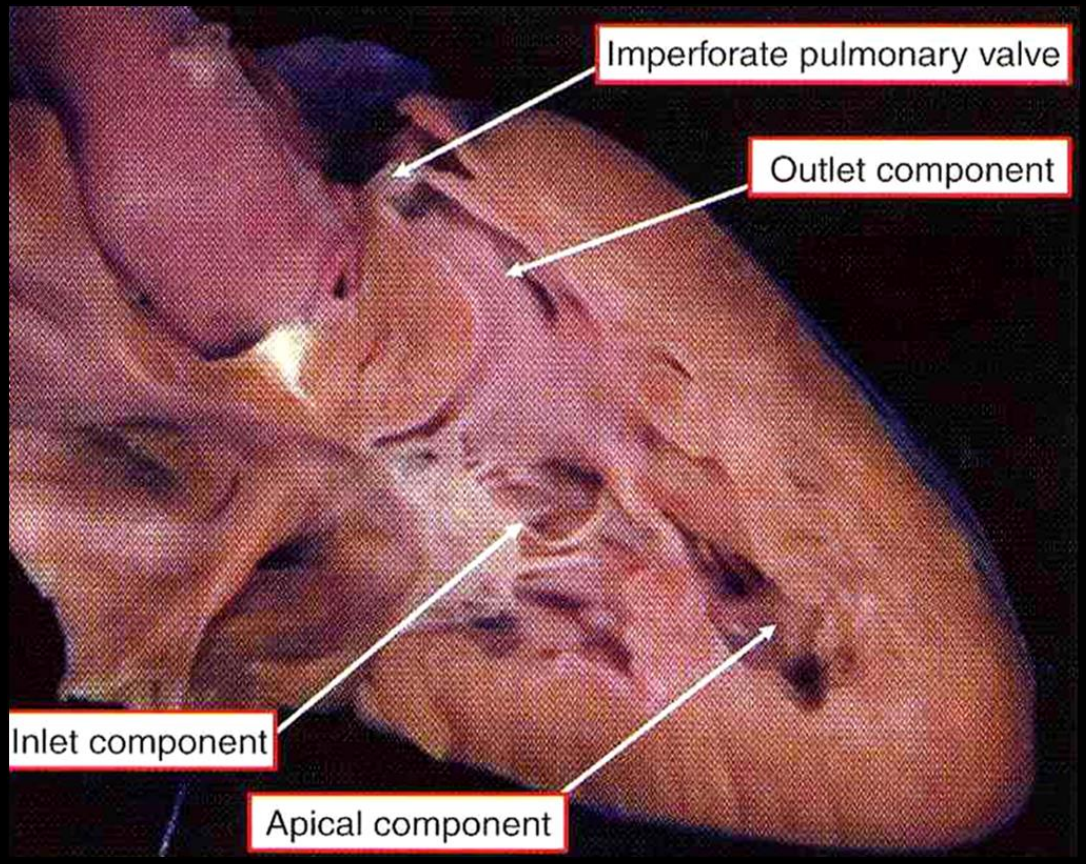
- In a more rare variant, prominent commissural ridges meet at the centre of the pulmonary root.
- This variant is associated with hypoplastic pulmonary annulus and severe infundibular hypoplasia or atresia.
- The pulmonary trunk is usually of normal size (rarely small), and pulmonary arteries are almost always confluent.

- Hypoplasia of the right ventricle is usual, but there is a spectrum of RV cavity size.
- Due to the marked RV wall hypertrophy, complete obliteration of one or two of the normal RV cavity portions can occur:
- Tripartite→ Bipartite→ Monopartite RV

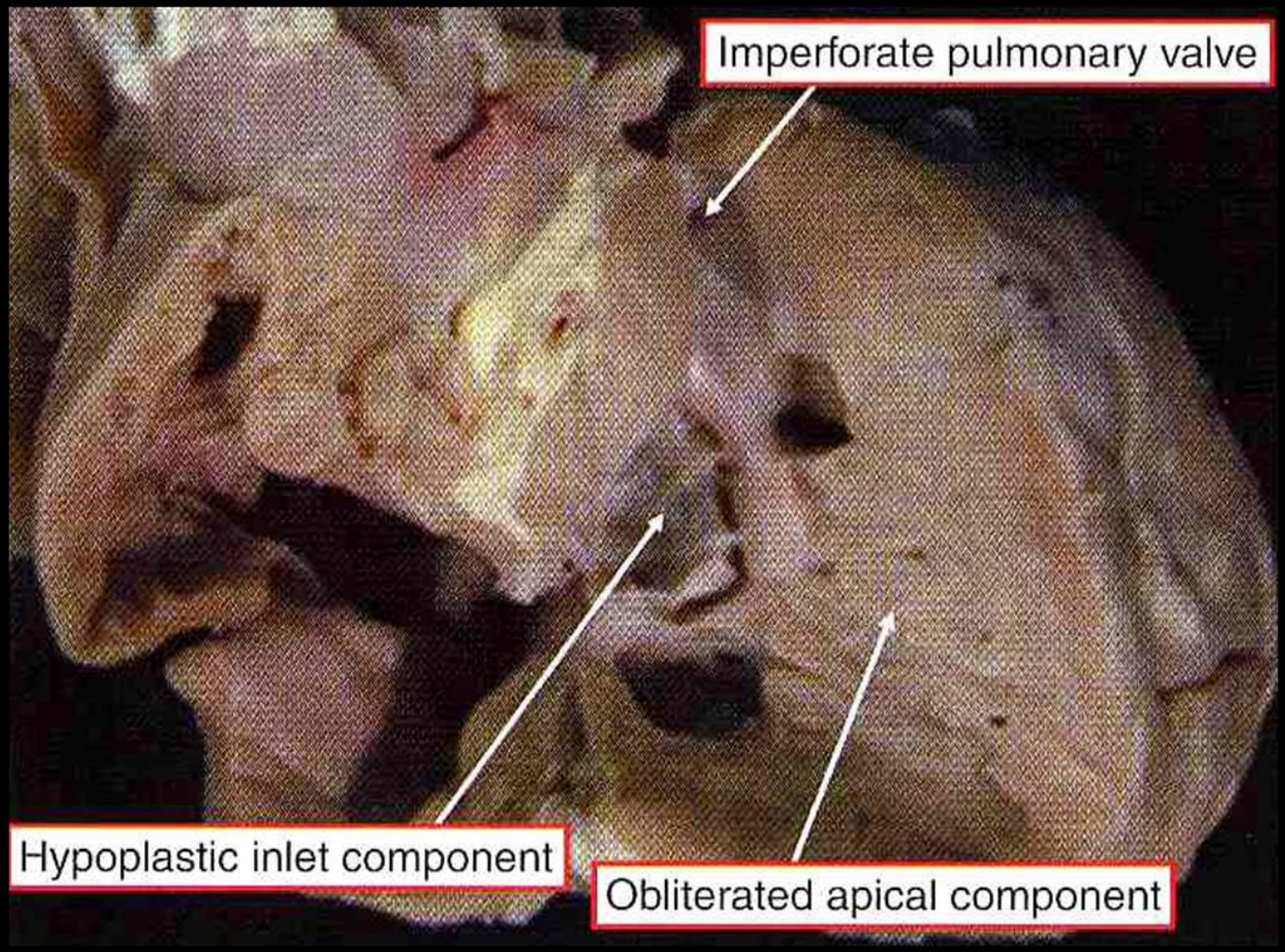
RIGHT VENTRICLE COMPONENTS



PULMONARY ATRESIA WITH THREE VENTRICULAR COMPONENTS



PULMONARY ATRESIA WITH BIPARTITE RIGHT VENTRICLE



PULMONARY ATRESIA WITH MONOPARTITE RV

RIGHT VENTRICULAR MORPHOLOGY

Other important parameters to assess degree of RV hypoplasia:

1. Tricuspid annulus size and Z – Score
2. Base – to – apex length of RV and RV/LV length ratio
3. RV transverse width and RV/LV width ratio

VENTRICULAR DIAMETERS

Echocardiographic determinants of successful balloon dilation in pulmonary atresia with intact ventricular septum

European Journal of Echocardiography (2010) **11**, 172–175
doi:10.1093/ejechocard/jep193

Abdenasser Drighil[1,2]*, Mansour Aljufan[2], Amal Slimi[2], Samira Yamani[2], James Mathewson[3], and Fadl AlFadly[2]

[1]Department of Cardiology, Ibn Rochd University Hospital, Quartier des hopitaux, Casablanca, Morocco; [2]King Faisal Specialist Hospital and Research Center, Heart Institute Riyadh, Saudi Arabia; and [3]Rady Children's Hospital in Association with the University of California, San Diego, CA, USA

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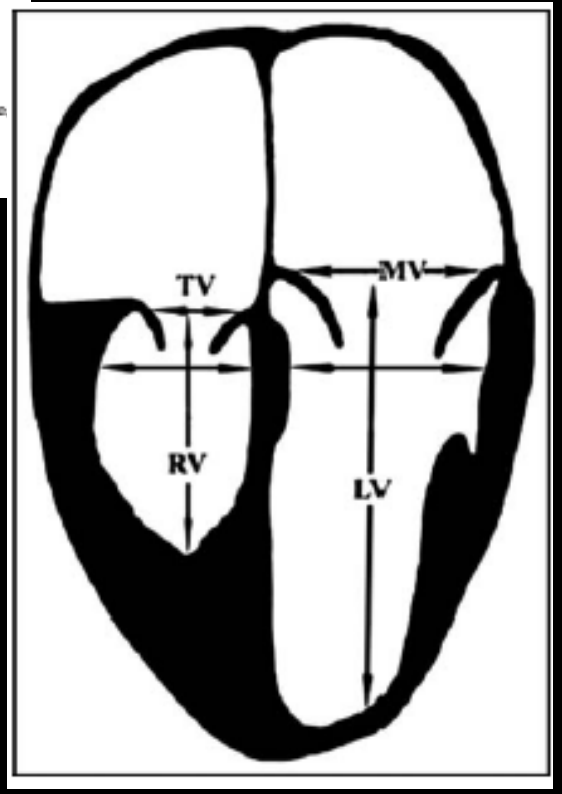
Rule 1: If RV/LV diameter ratio is >0.76, the probability of successful balloon angioplasty is 92.3%.

Rule 2: If RV/LV diameter ratio is ≤0.76 and RV/LV length ratio ≤0.70, then the probability of an unsuccessful balloon angioplasty is 100%.

Rule 3: If RV/LV diameter ratio is ≤0.76 and RV/LV length ratio >0.70, then the probability of successful balloon angioplasty is 75%.



TRICUSPID VALVE MORPHOLOGY

- Size of TV annulus correlates with RV cavity size;
- Tricuspid valve dysplasia is common but does not correlate with RV size
- Ebstein's malformation is common
- (10-40%), sometimes associated with
- dilated RV
- Suspension apparatus is often abnormal

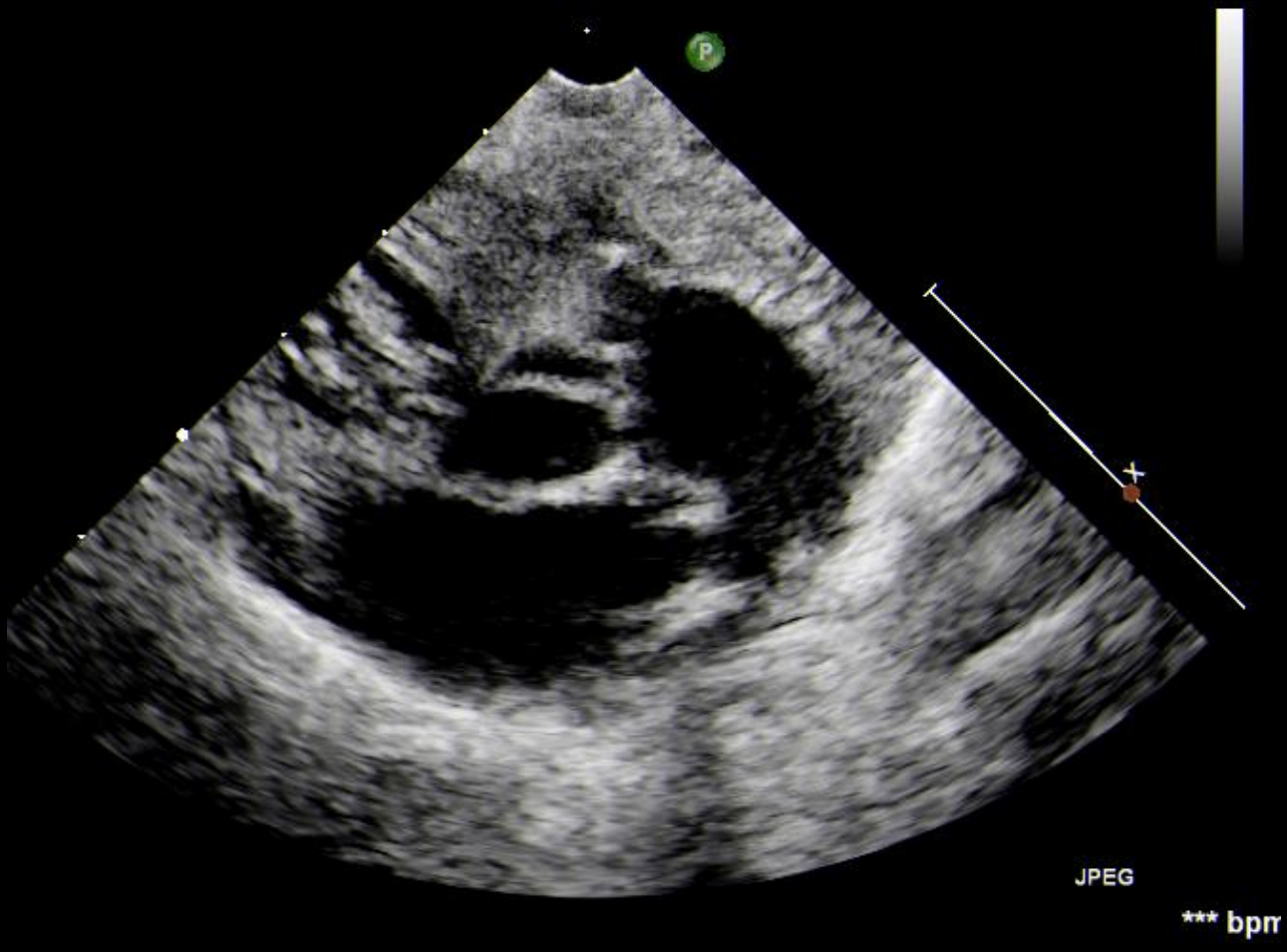
TRIPARTITE RV, EBSTEIN – LIKE TV

TRIPARTITE RV, DYSPLASTIC TV, DILATED RA

TRIPARTITE HYPOPLASTIC RV

BIPARTITE RV

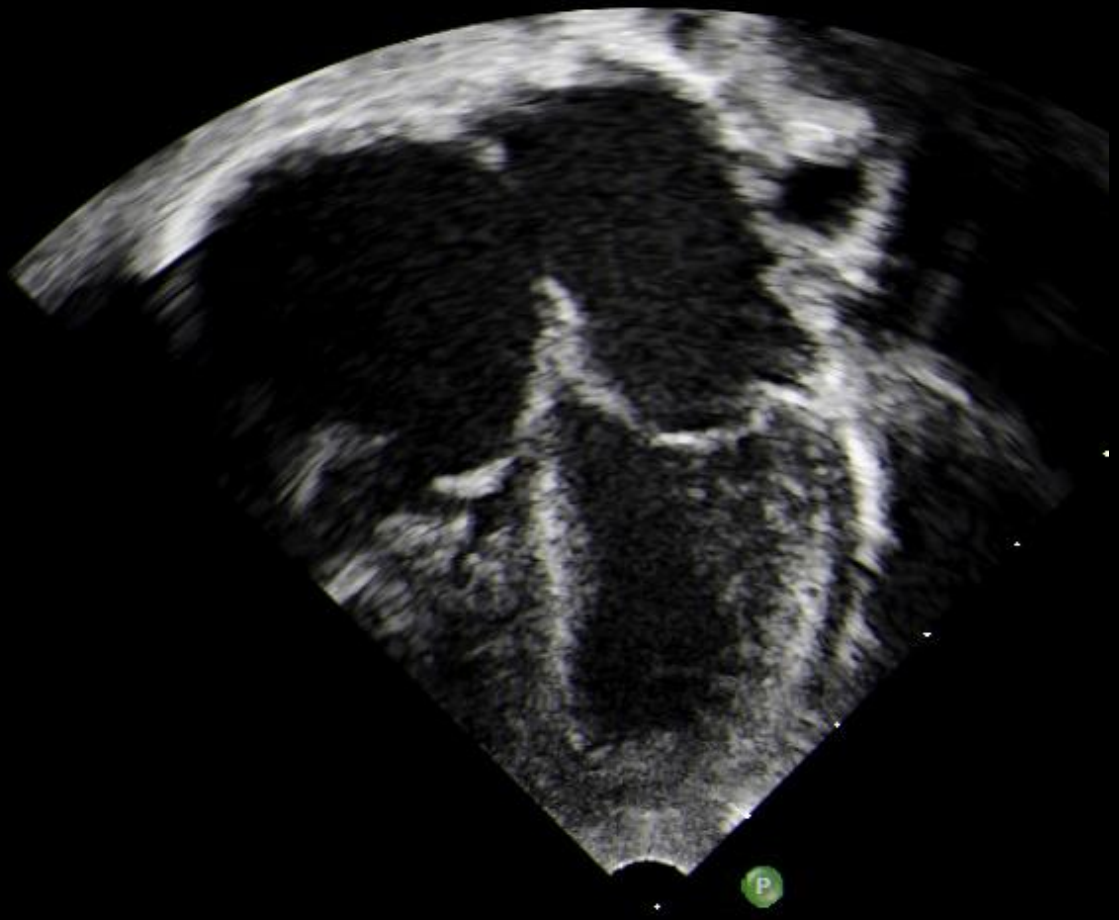
BIPARTITE RV



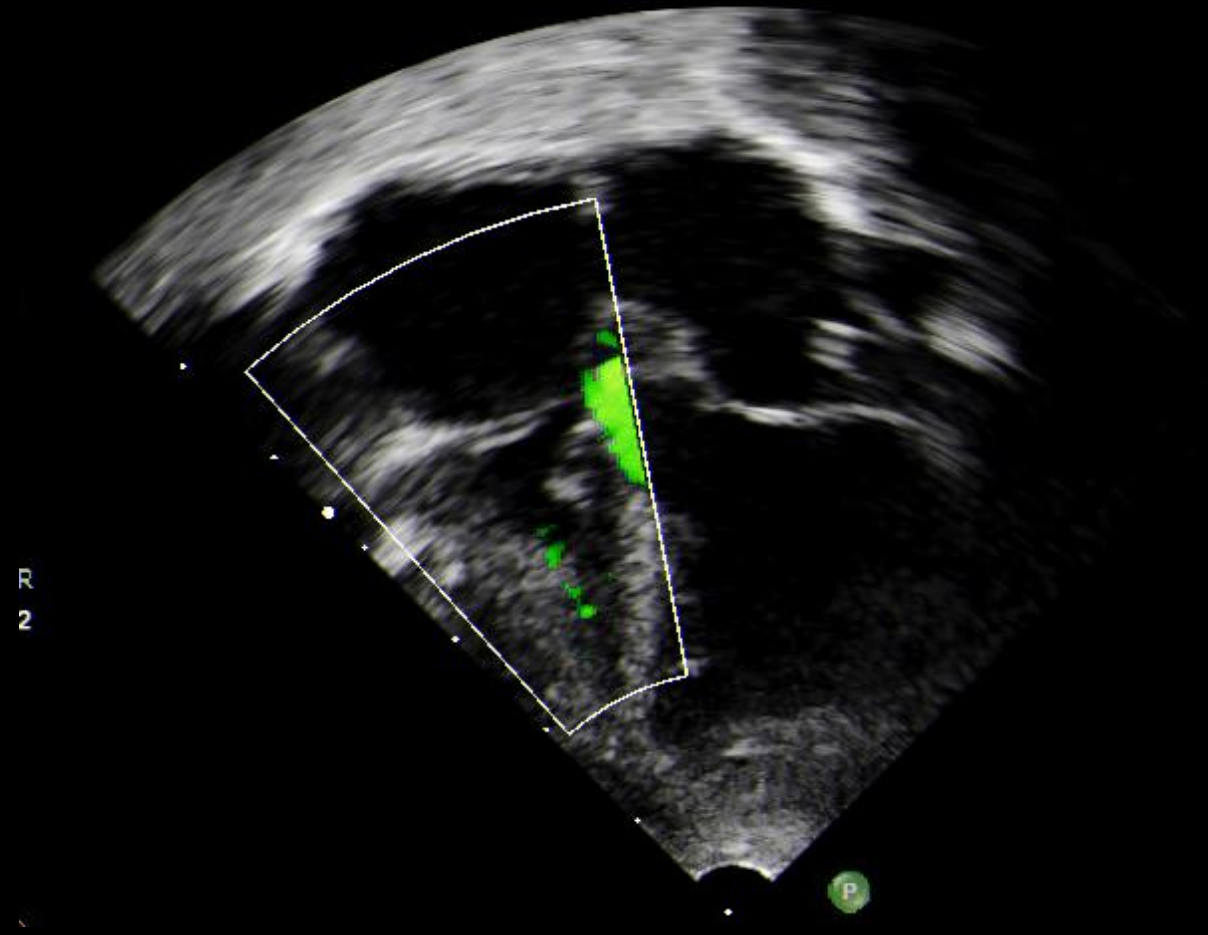
BIPARTITE RV

NORMAL PULMONARY TRUNK AND BRANCHES

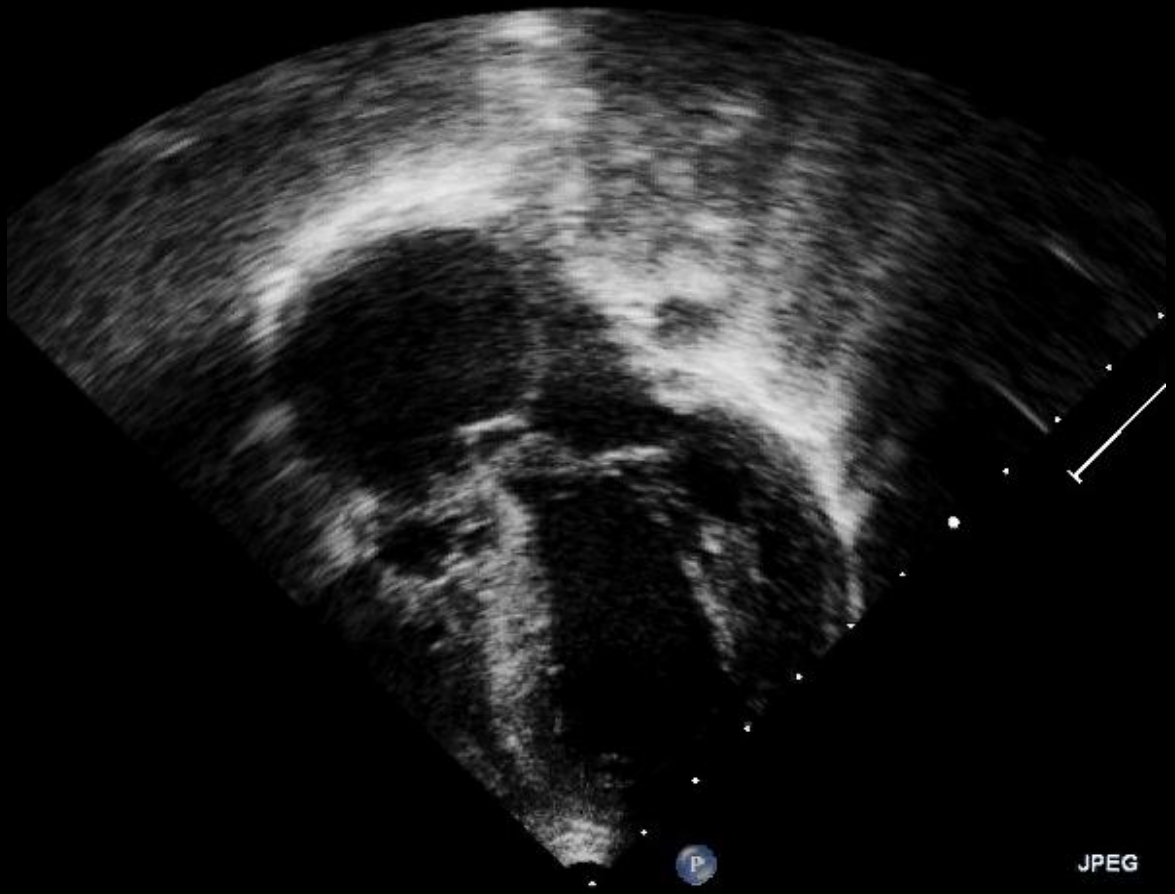
MONOPARTITE RV



MONOPARTITE RV



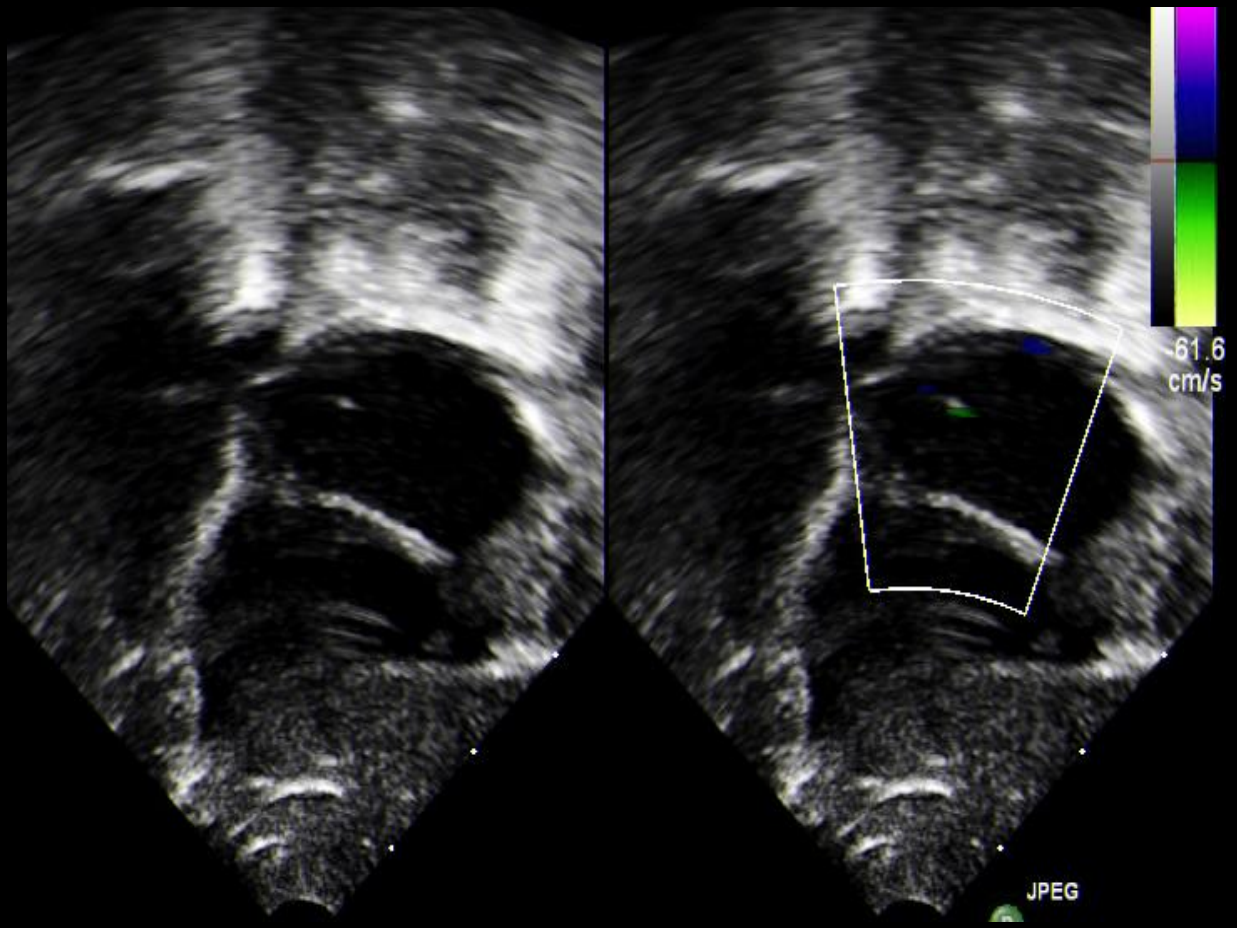
MONOPARTITE RV, SEVERE TV HYPOPLASIA



RIGHT ATRIAL MORPHOLOGY

- The right atrium is often dilated
- An interatrial communication (ASD, PFO) with R-L shunt allows drainage of the systemic venous flow
- If the PFO becomes restrictive, signs of R heart failure can occur

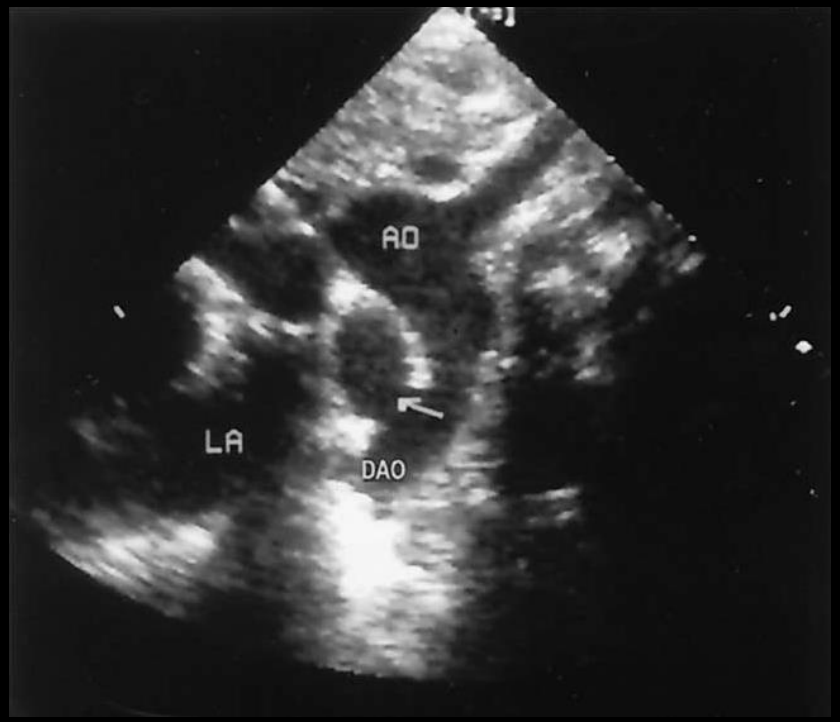
RIGHT ATRIAL MORPHOLOGY



ARTERIAL DUCT MORPHOLOGY

- PA – IVS is a duct – dependent lesion;
- The angle that the PDA subtends with descending aorta can be acute or obtuse (normal);
- PDAs with acute angle tend to occur in cases with more hypoplastic RV.

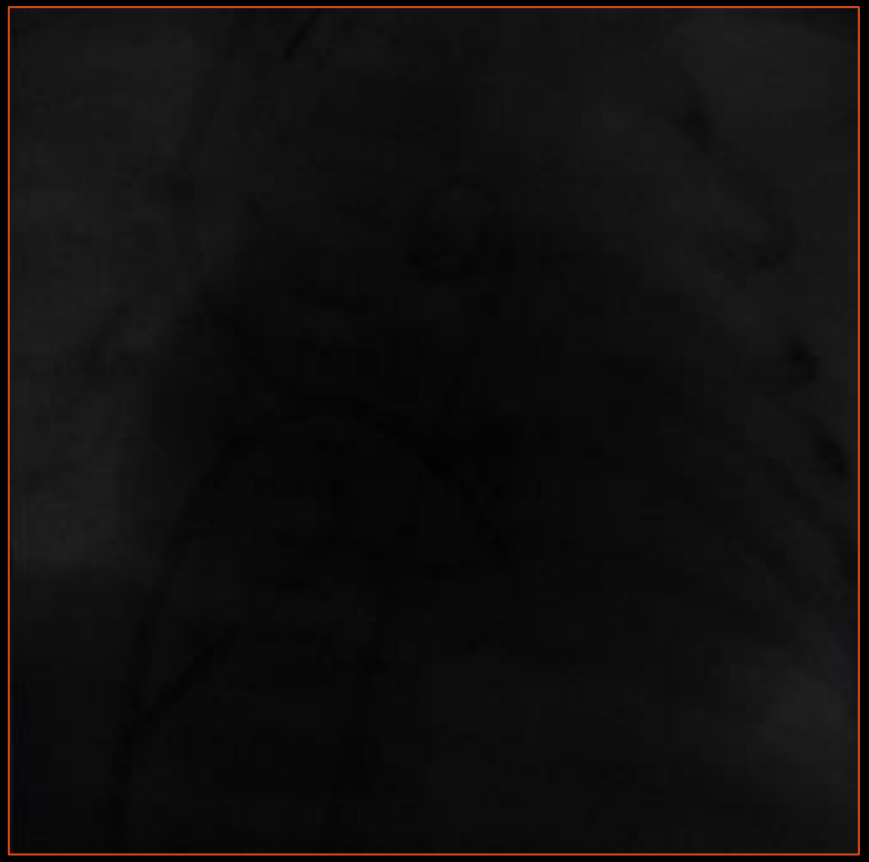
ARTERIAL DUCT MORPHOLOGY

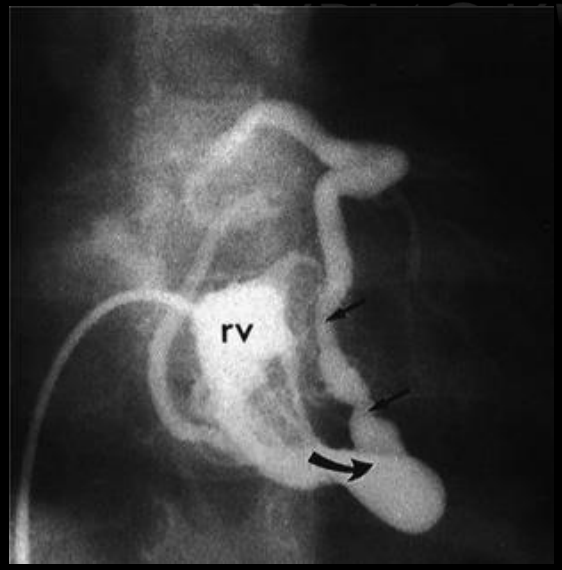


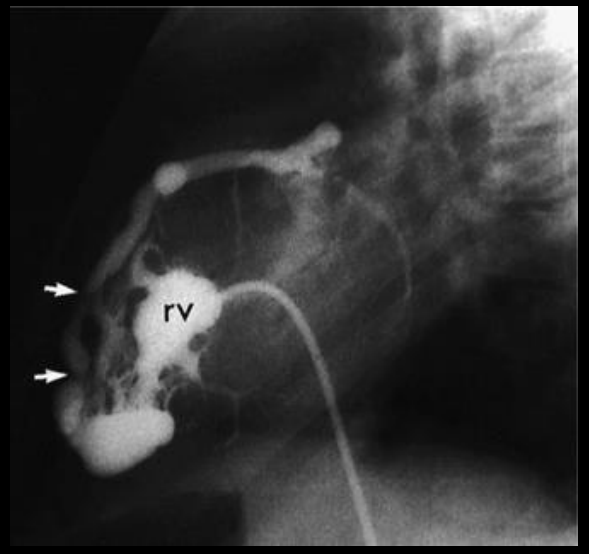
MONOPARTITE RV, SEVERE TV HYPOPLASIA

- RV – dependent coronary circulation
- Association of RV – coronary fistulas with:
- Absent aorto – coronary connection, or
- Coronary interruption, or
- Significant stenosis of two main coronary arteries (RCA, LCA, LAD, PD, or Cx)

CORONARY ARTERY ABNORMALITIES







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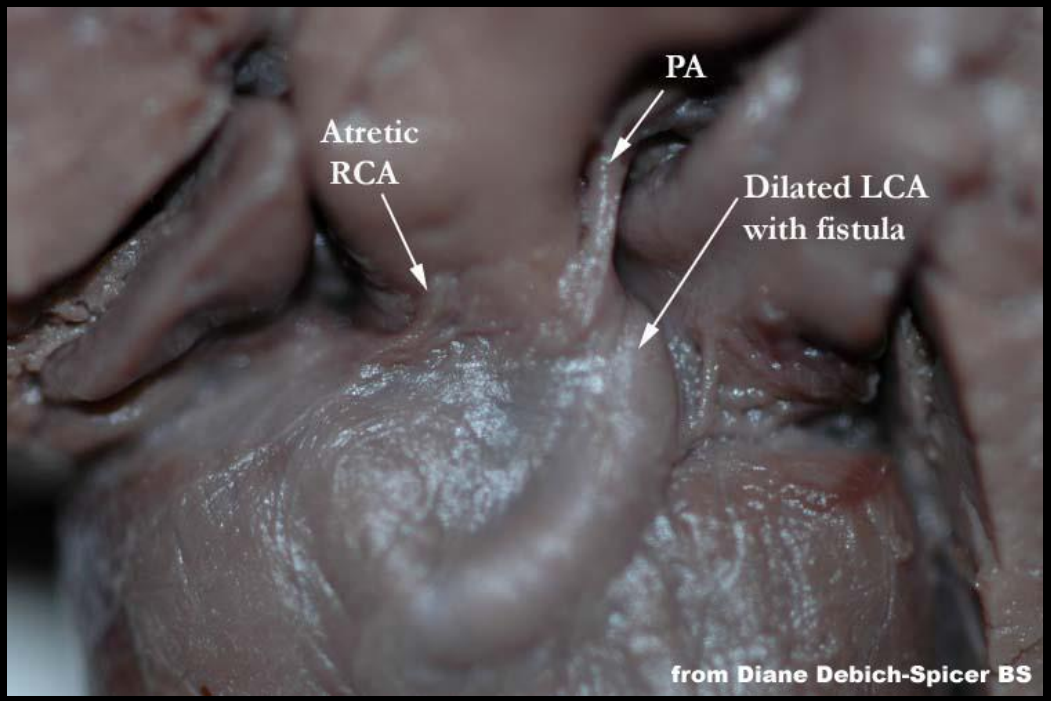

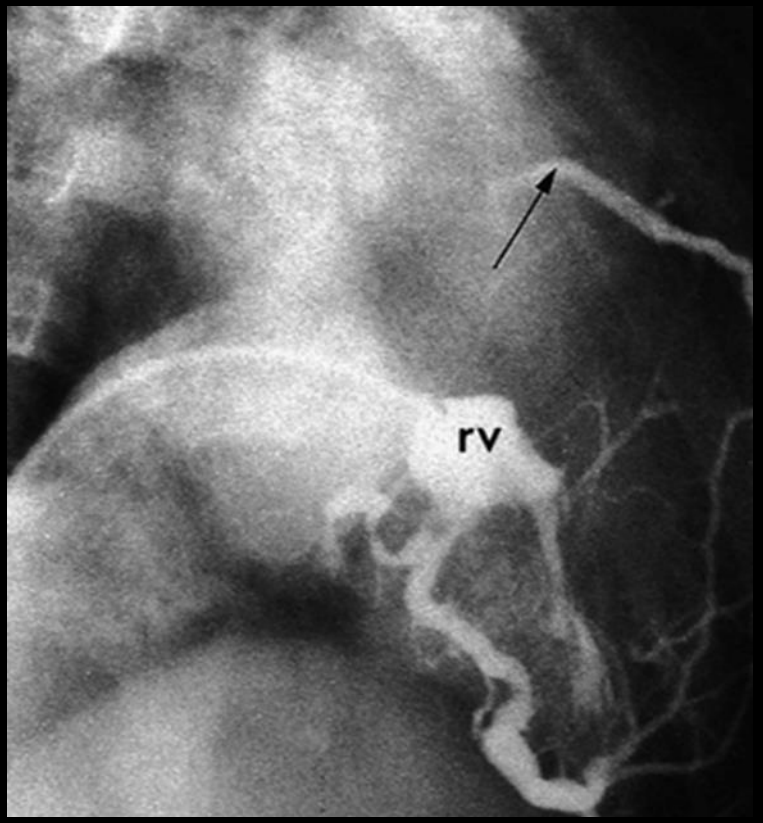

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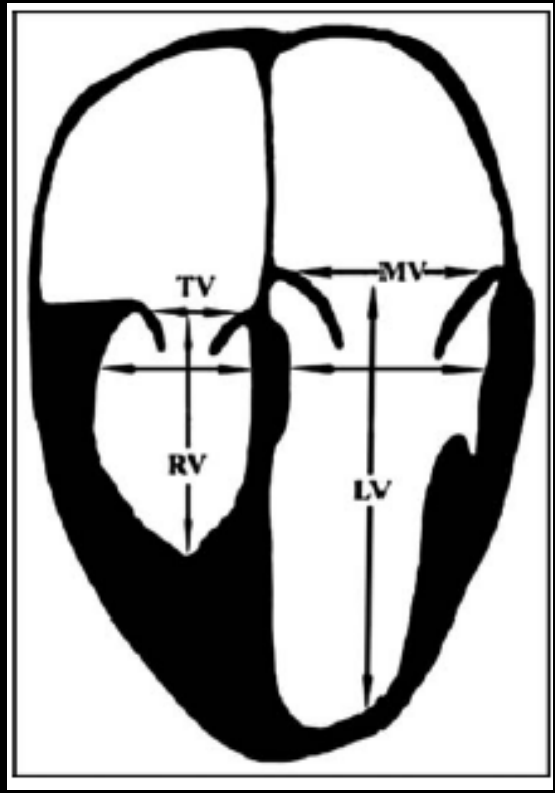

CLINICAL ASSESSMENT

- Weight, height, gestational age;
- Basal Oxygen saturation;
- Dose of prostaglandin infusion (usually 5-20 ng/kg/min)
- Physical examination, BP
- CXR
- ECG

ECHO ASSESSMENT

- RV length Z-score
- TV annulus (mm)
- TV Z-score
- PV annulus (mm)
- PV Z-score
- TV/MV ratio
- RV/LV length ratio
- RV/LV diameter ratio
- RV morphology (Tripartite, Bipartite, Monopartite)

- PFO/ASD (Restrictive, Unrestrictive)
- TV morphology (Ebstein's, Dysplasia, Normal)
- TR (Absent, Mild, Moderate, Severe)
- Estimated RV pressure (mmHg)
- Pulmonary trunk (diameter, mm)
- Pulmonary arteries (confluent?) Diameter (mm)
- PDA size (small, moderate, large), pattern of shunting, flow – velocity.
- Coronary fistulas (detected?)
- LV size and function (M-Mode)

FOLLOW - UP ASSESSMENT

- Weight, height, level of activity;
- Basal SpO2, SpO2 on exertion
- Physical examination, BP
- ECG

ECHO ASSESSMENT

- Right atrial transverse diameter, end- systolic area.
- ASD/PFO: size, pattern of shunting
- RV length, RV diameter,(mm)
- RV function (good, mild, moderate, severe reduction).
- Tricuspid valve: diameter, transvalvar gradient.
- TR: mild, moderate, severe
- Estimated RV systolic pressures
- Pulmonary valve: gradient
- Pulmonary incompetence: mild, moderate, severe.
- Pulmonary trunk and branches: diameter
- PDA (or shunt), size, pattern of shunting, flow velocity (gradient)
- LV size and function (M-Mode)

FOLLOW - UP ASSESSMENT

- After RFP and ballooning alone, continue prostaglandin infusion until unsatisfactory SpO2 levels, monitoring the gradient across PDA (PVR) and pulmonary valve gradient (restenosis?).
- If still unsatisfactory after 2 weeks, consider stenting PDA, surgical BTS.
- If ballooning fails to relieve pulmonary/subpolmonary stenosis, consider surgical RVOT enlargement.