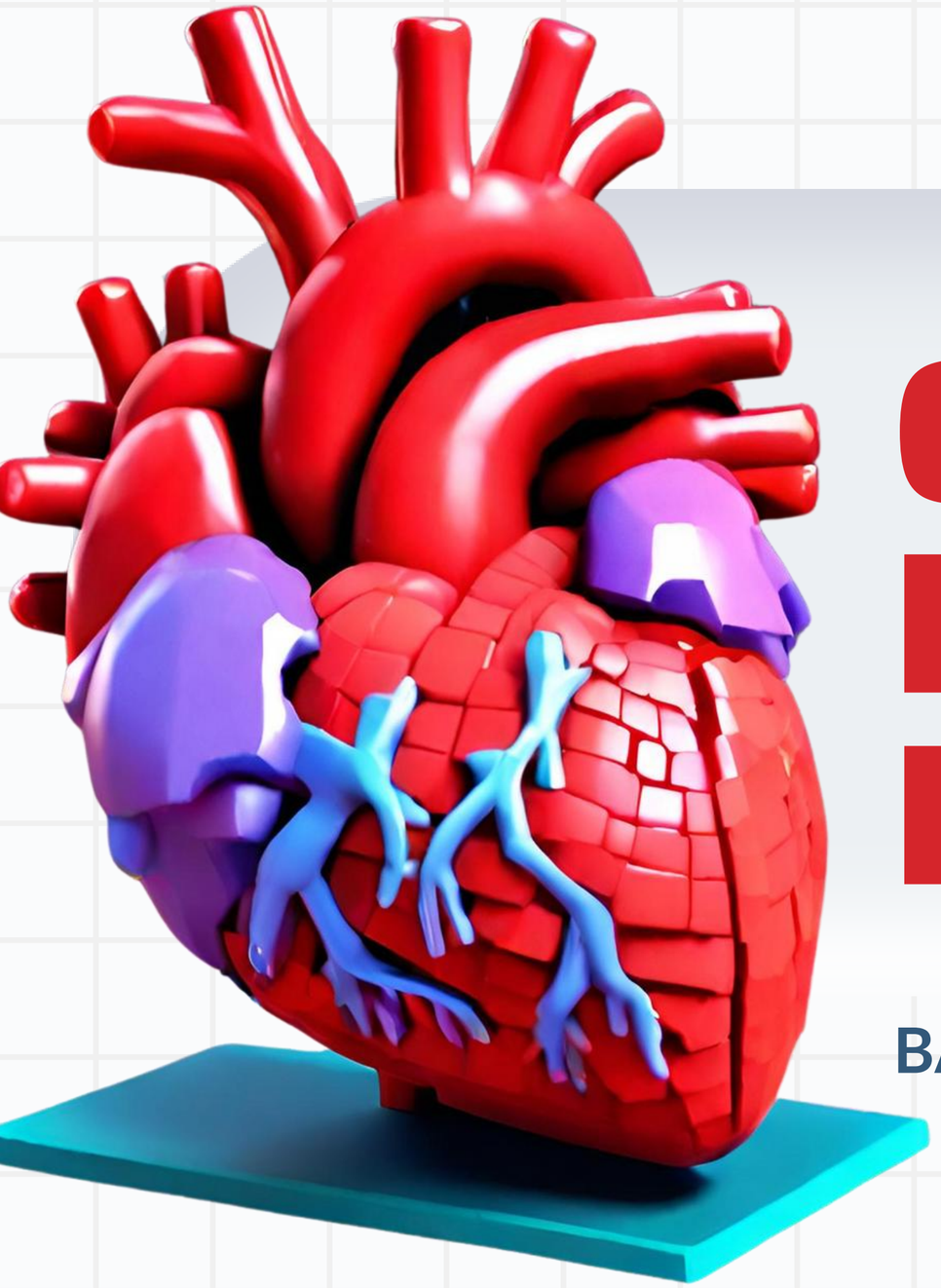
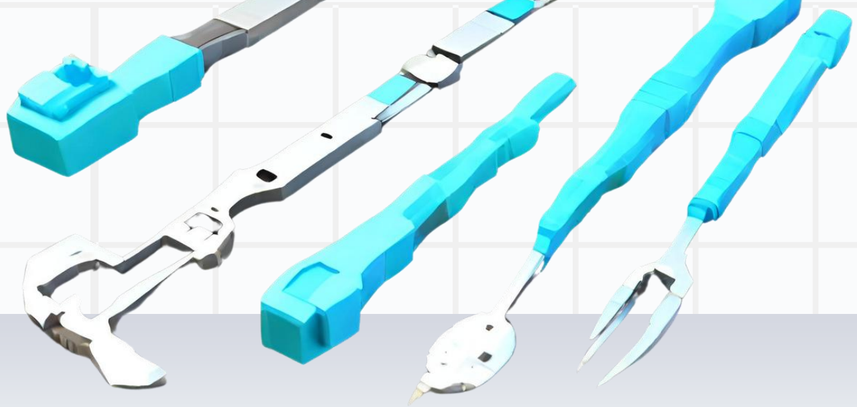
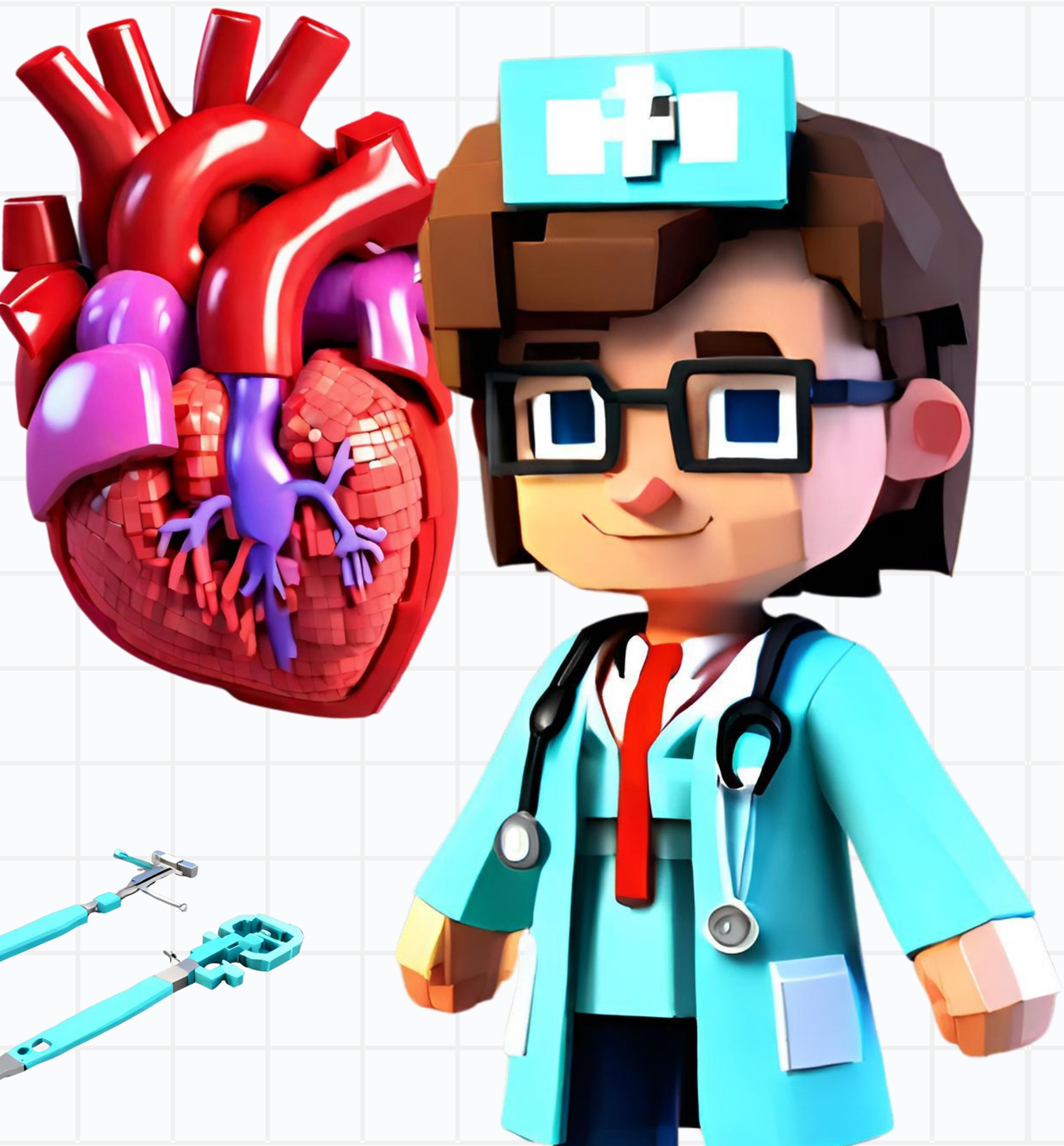




CONGENITAL HEART DISEASE

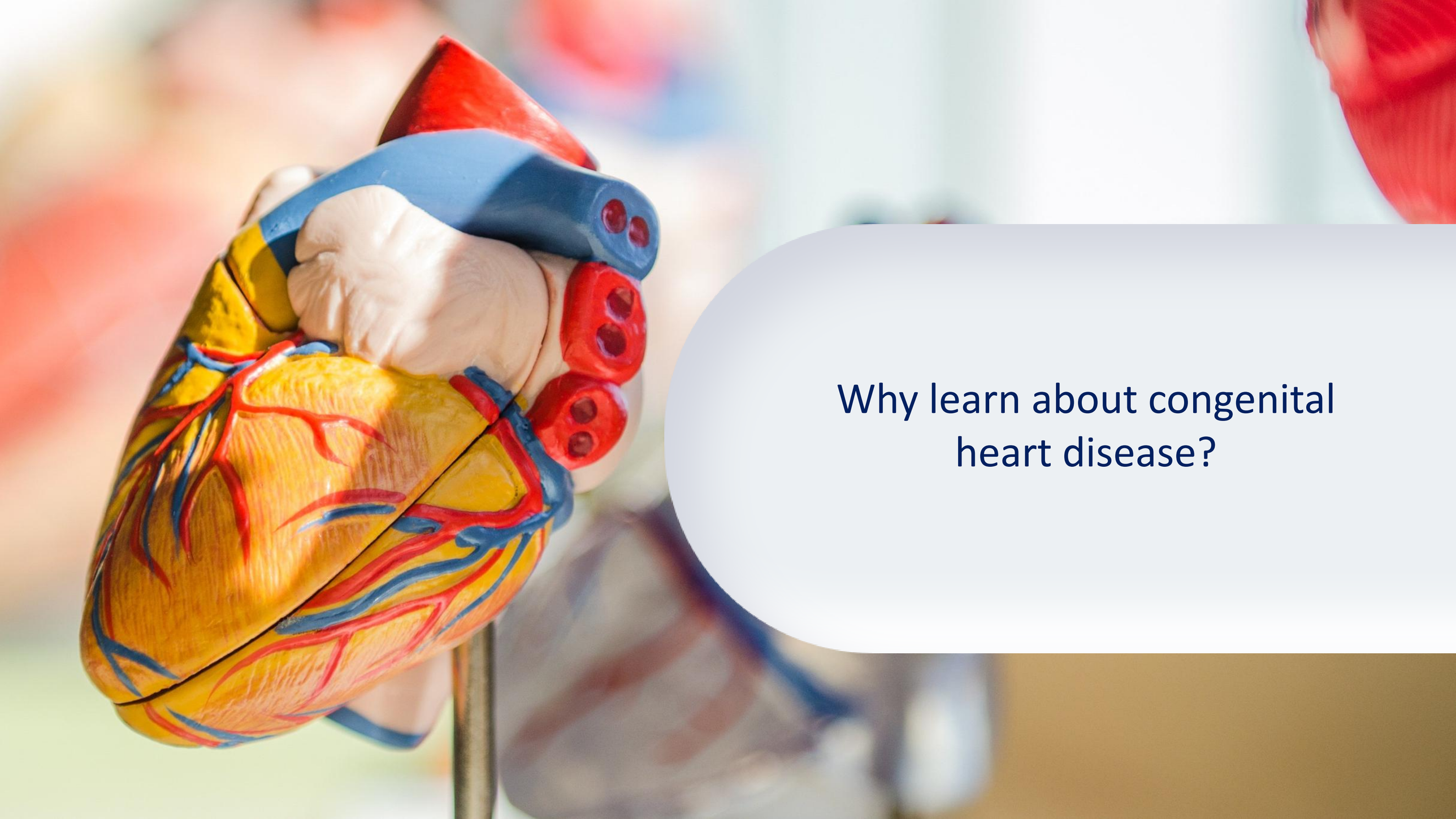
BASIC ECHOCARDIOGRAPHY

Dr Jason Tan
Paediatric Cardiologist , HSIS



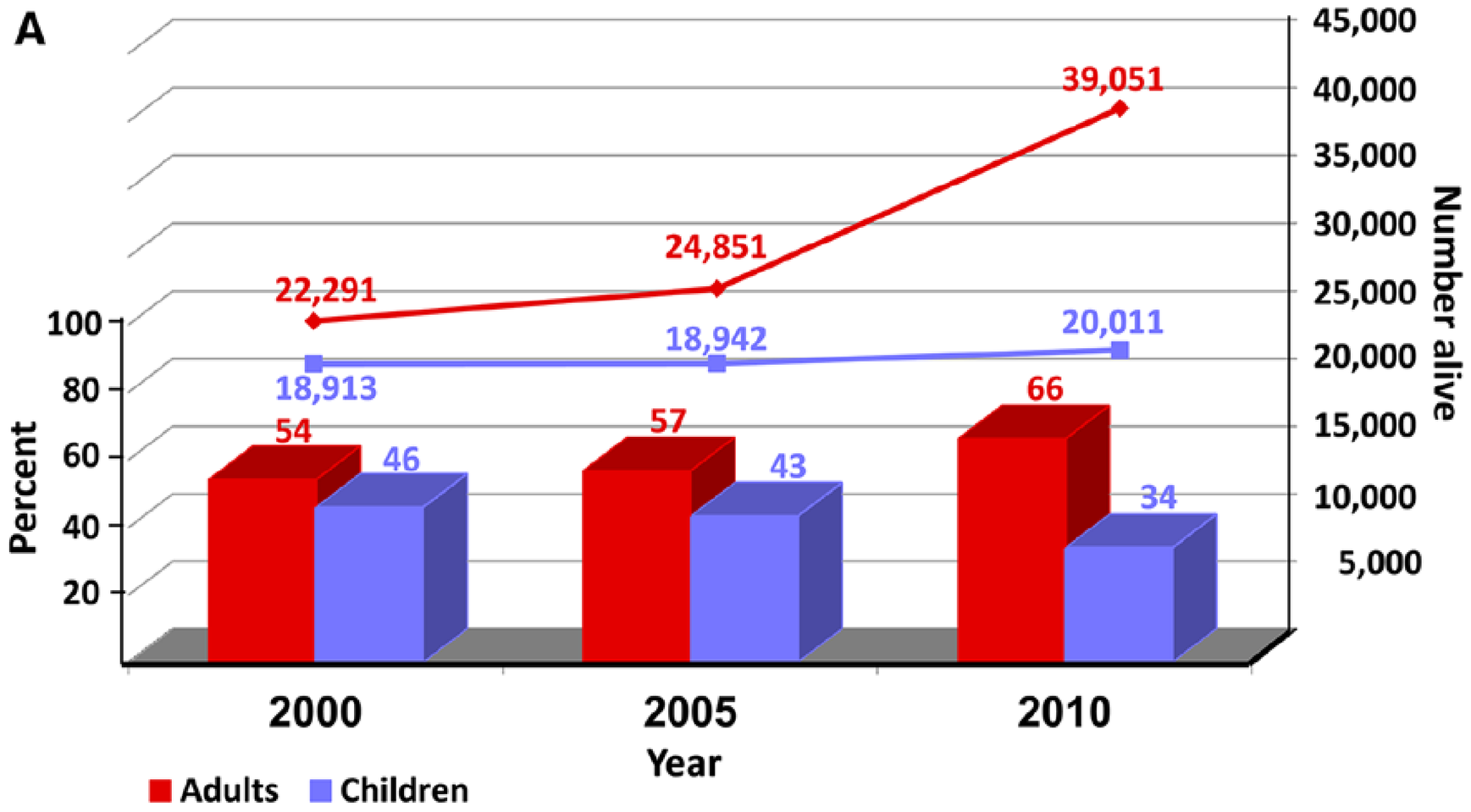
OVERVIEW

- The burden of adult with CHD
- Differences of ECHO in children and adults
- Knowing what is normal
- Selected scope of lesions to be discussed

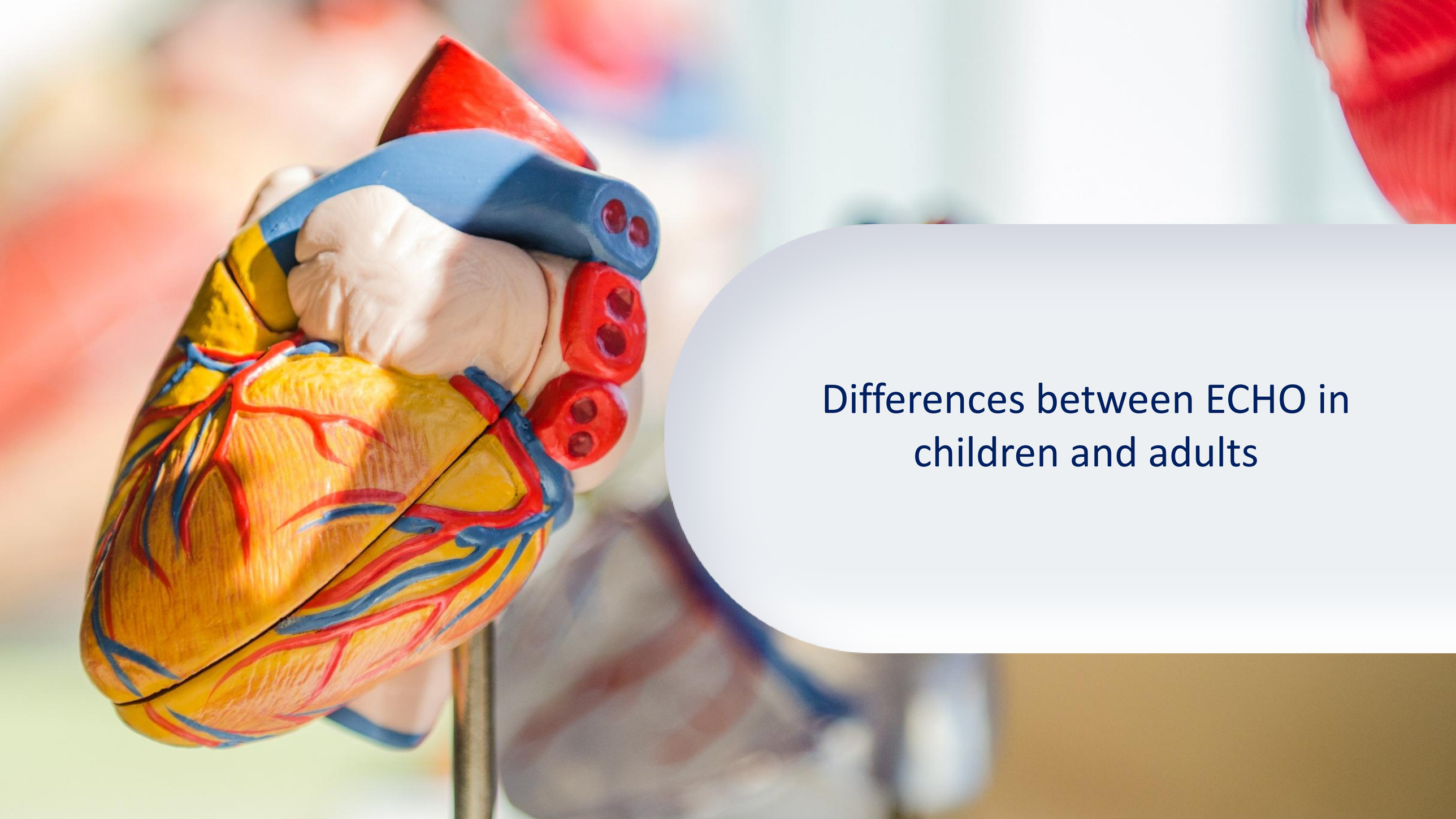


Why learn about congenital heart disease?

Prevalence of adult CHD – more children are *surviving* into adulthood



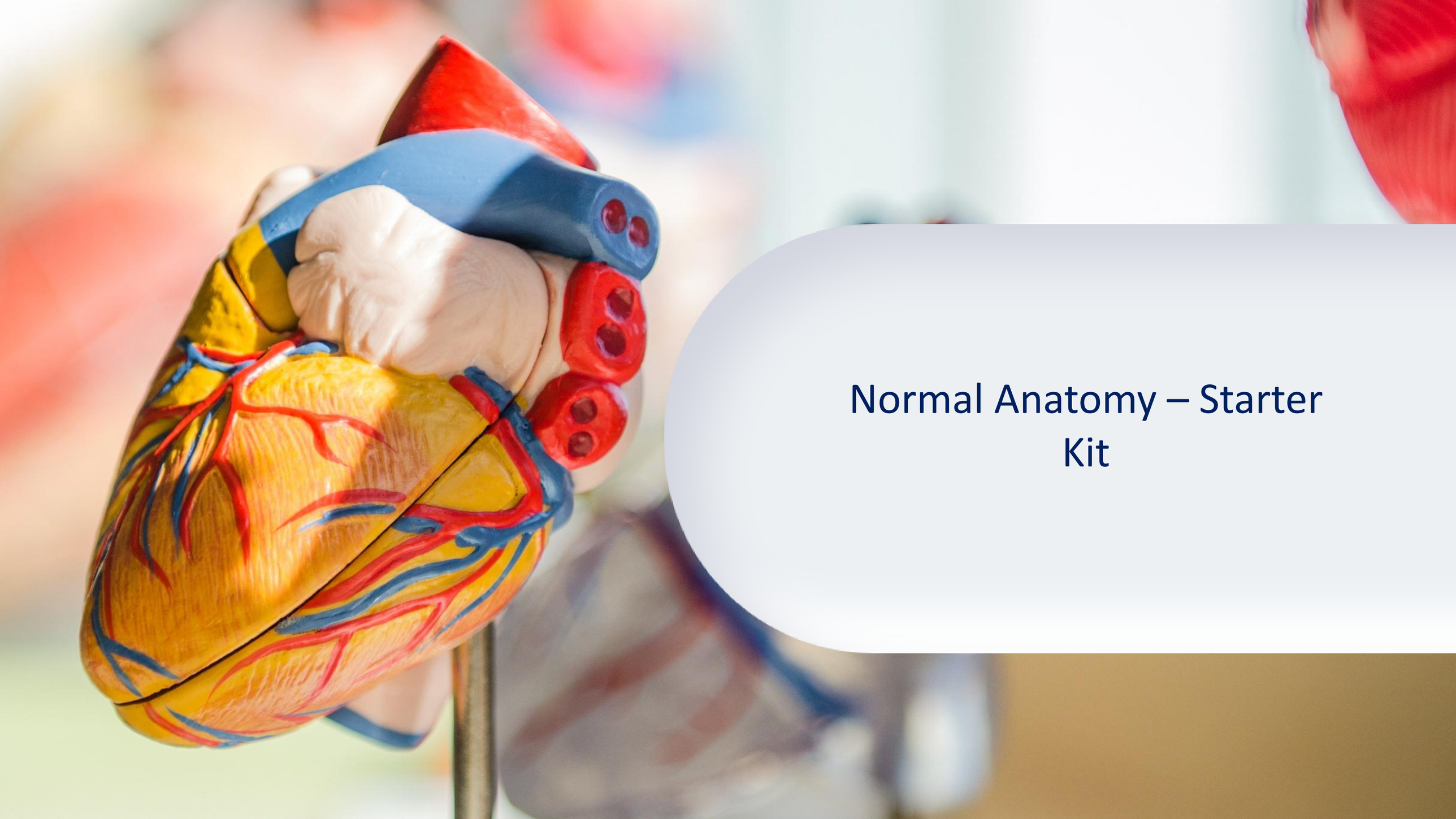
Marelli AJ, Ionescu-Ittu R, Mackie AS, Guo L, Dendukuri N, Kaouache M. Lifetime prevalence of congenital heart disease in the general population from 2000 to 2010. Circulation. 2014 Aug 26;130(9):749-56



Differences between ECHO in children and adults

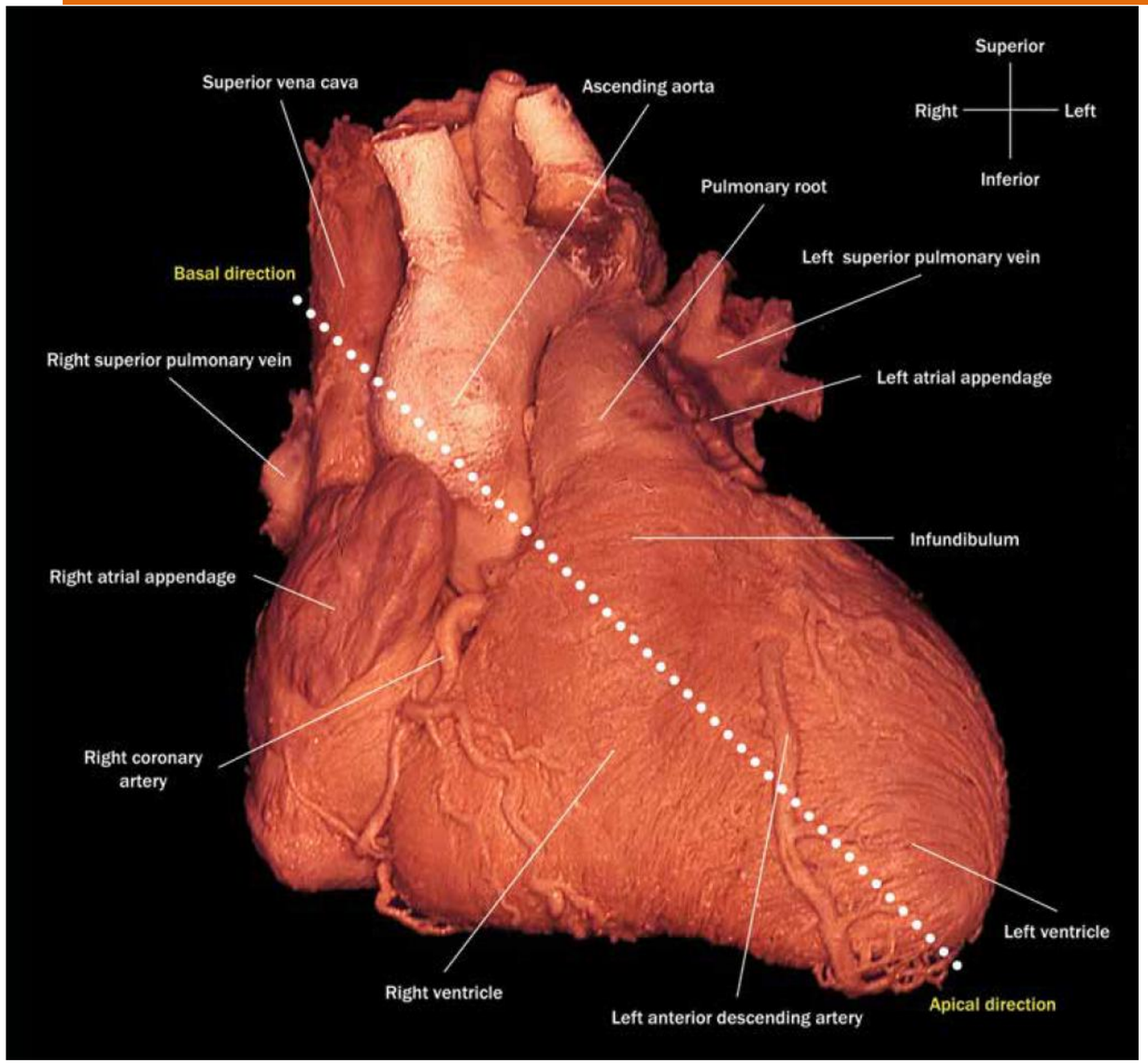
Adult vs Children

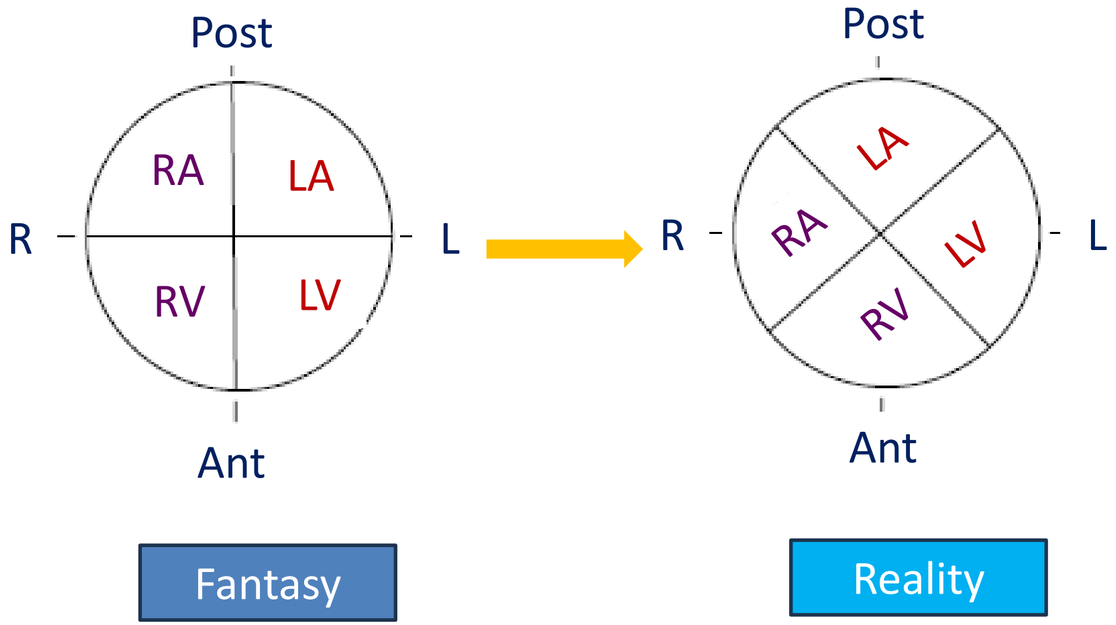
	Adults	Children
Body size	Large	Small
Transducer	Lower frequency • More penetration, less resolution	Higher frequency • Less penetration, higher resolution
Views	Standard views, ECHO window may be poor	May need additional modified views, ECHO window usually good
Surgery	Most post surgical repair Some not repaired	Many awaiting repair Older ones mostly repaired
Reference ranges	Fairly fixed value of reference numbers	Rely a lot on z scores depending on age, height, weight
Focus of ECHO	More functional assessment (for diagnosed cases)	More structural / morphological assessment
Need for other imaging	Higher • Lower heart rates in adults allow ECG gating in CT and MRI	Less • ECHO mostly adequate • Higher heart rates in children make ECG gated imaging more difficult



Normal Anatomy – Starter Kit

Understanding the heart position in the body

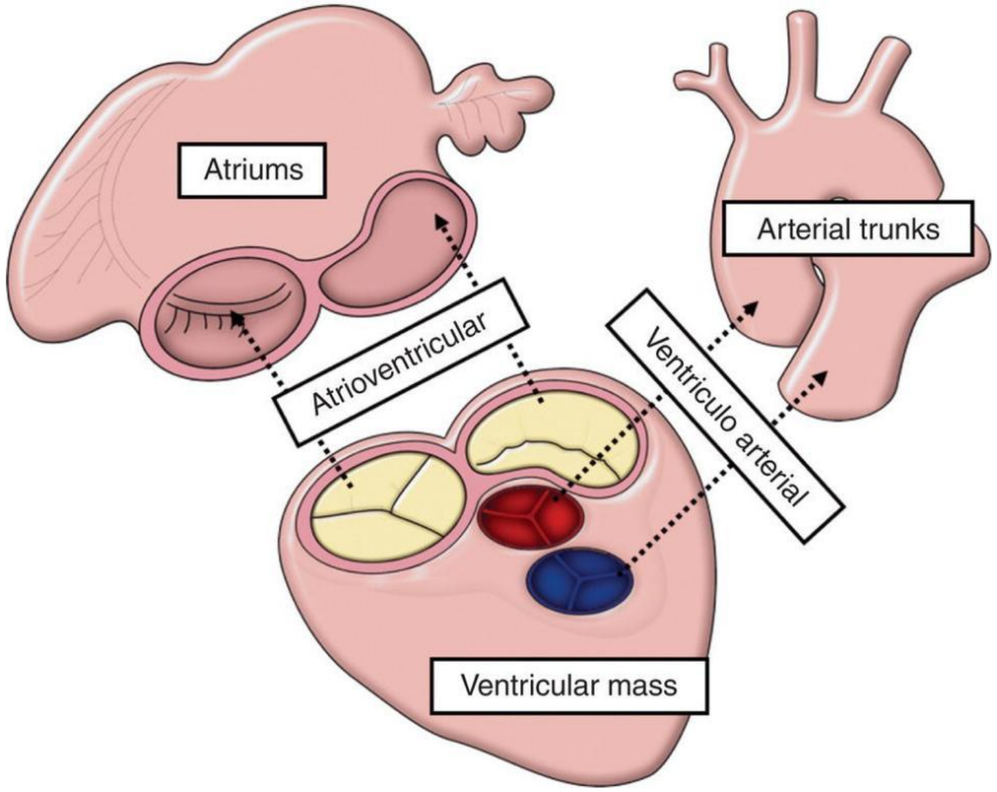


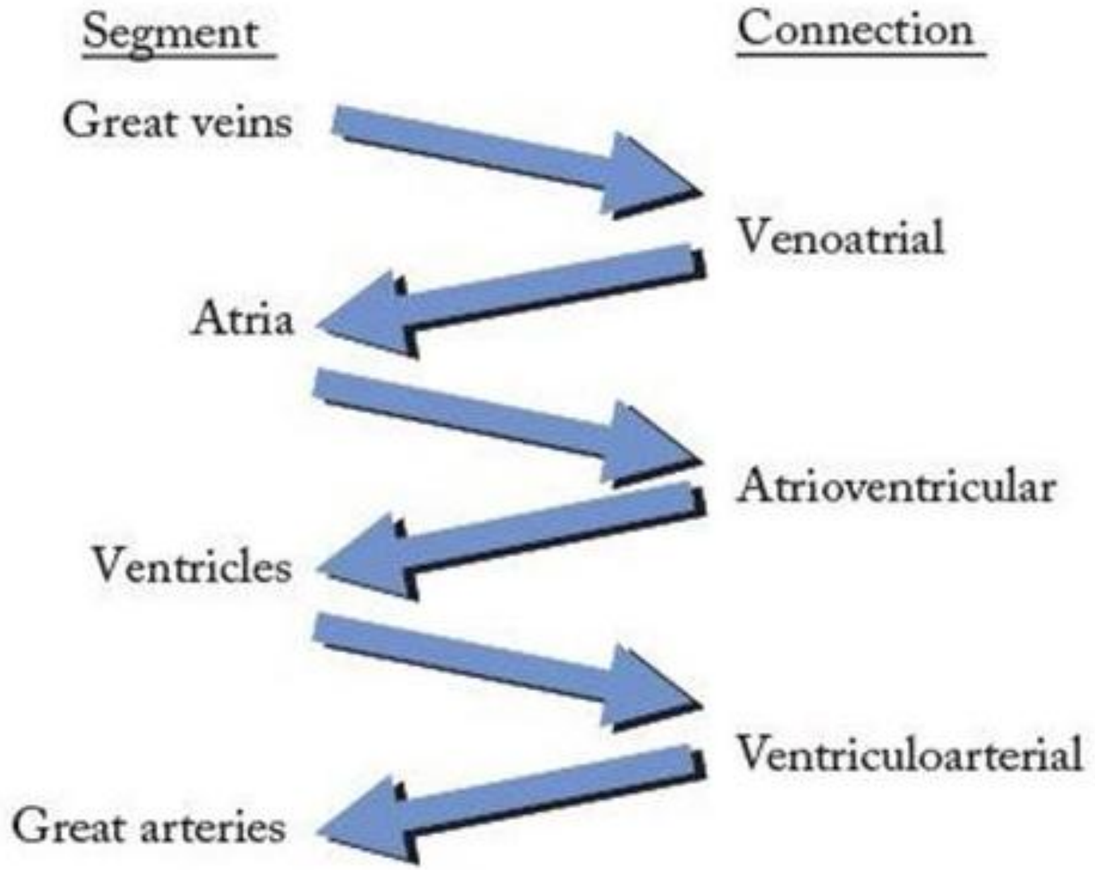


Fantasy

Reality

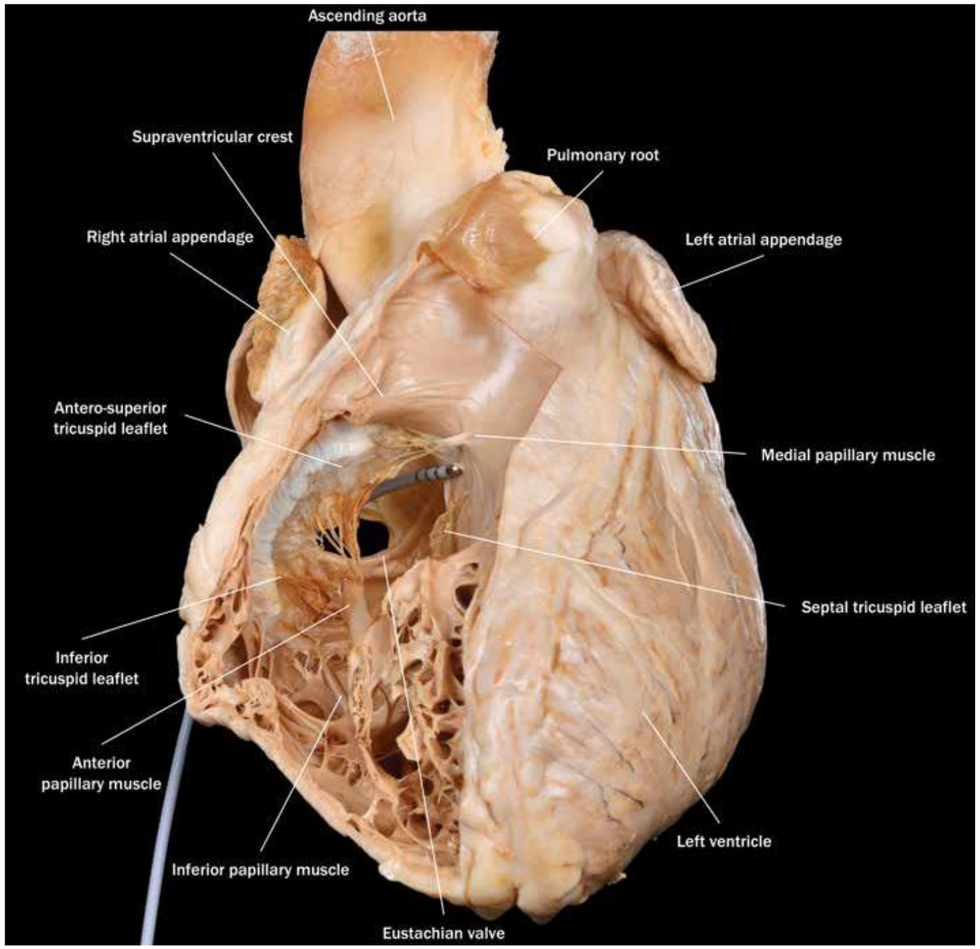
Sequential, segmental approach

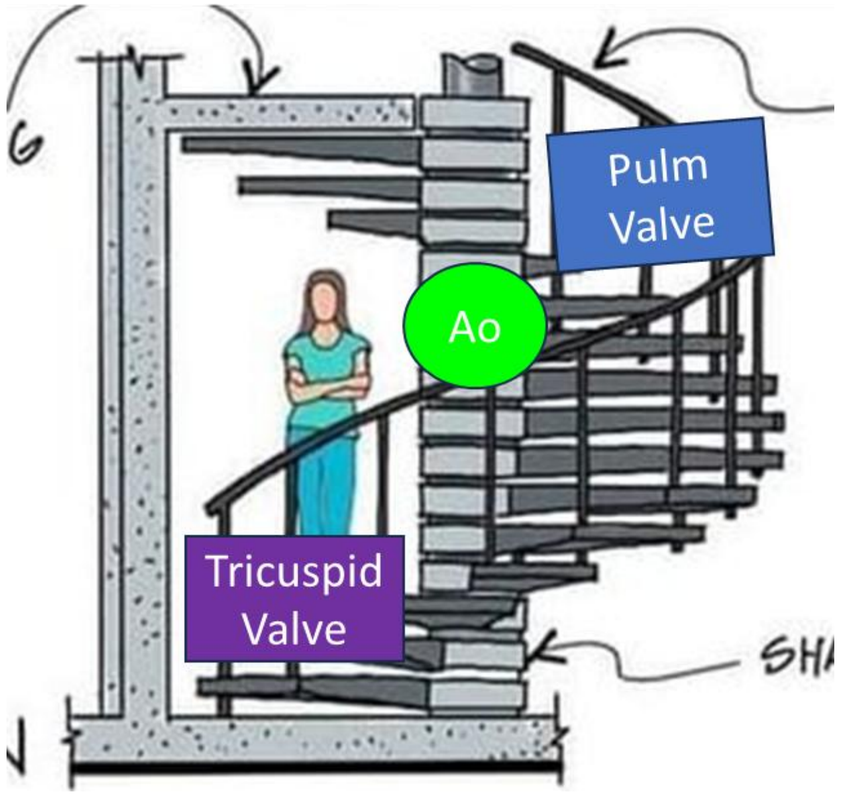


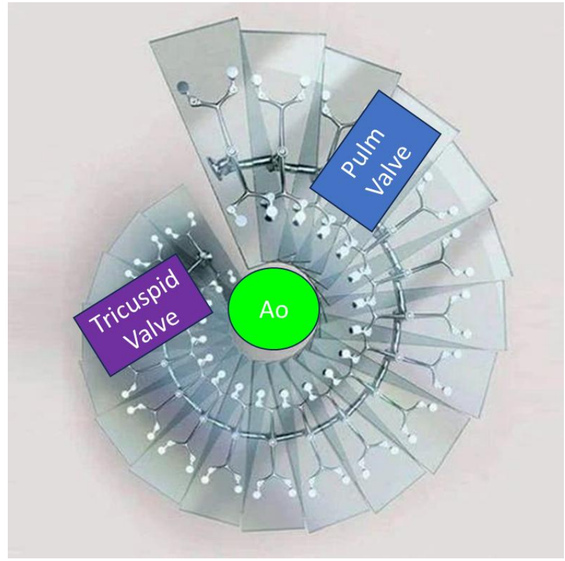


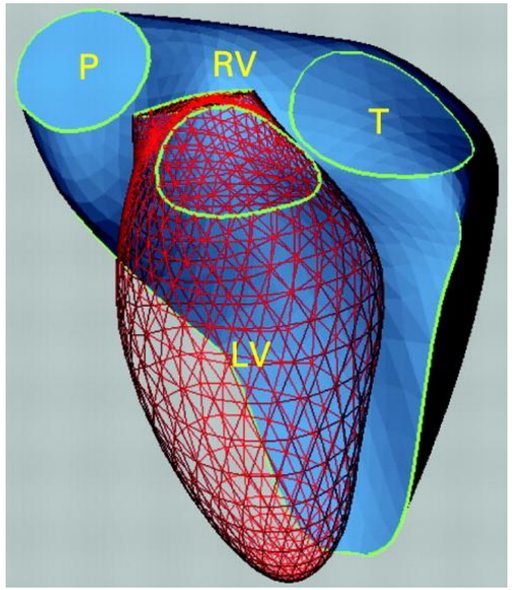
The wrapping of the aorta by the right ventricle

The interventricular septum is NOT an entirely flat structure







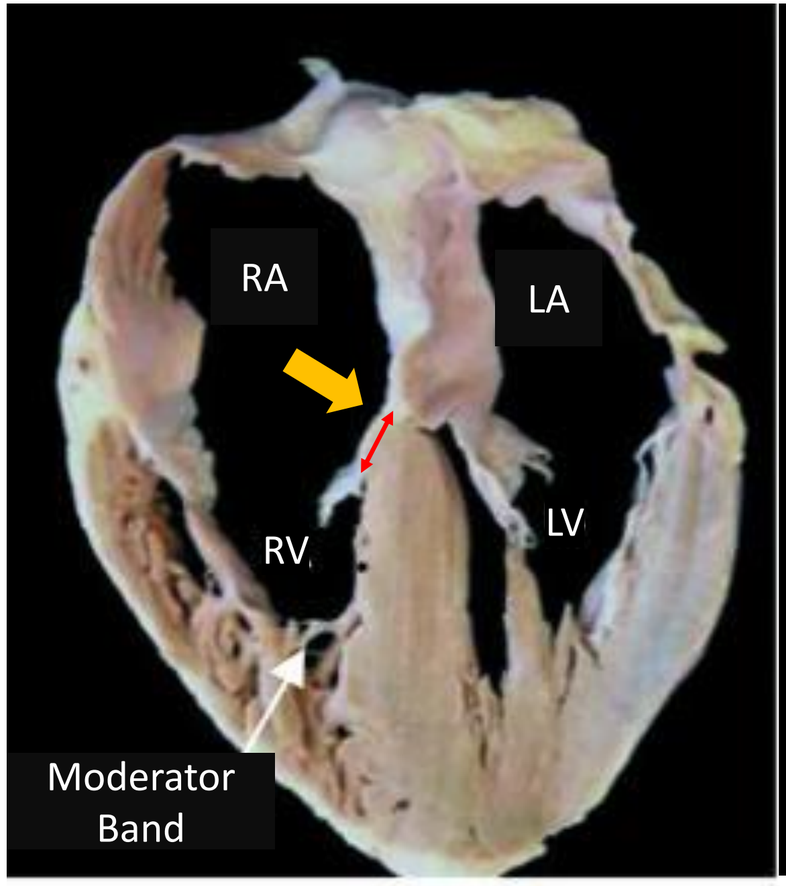


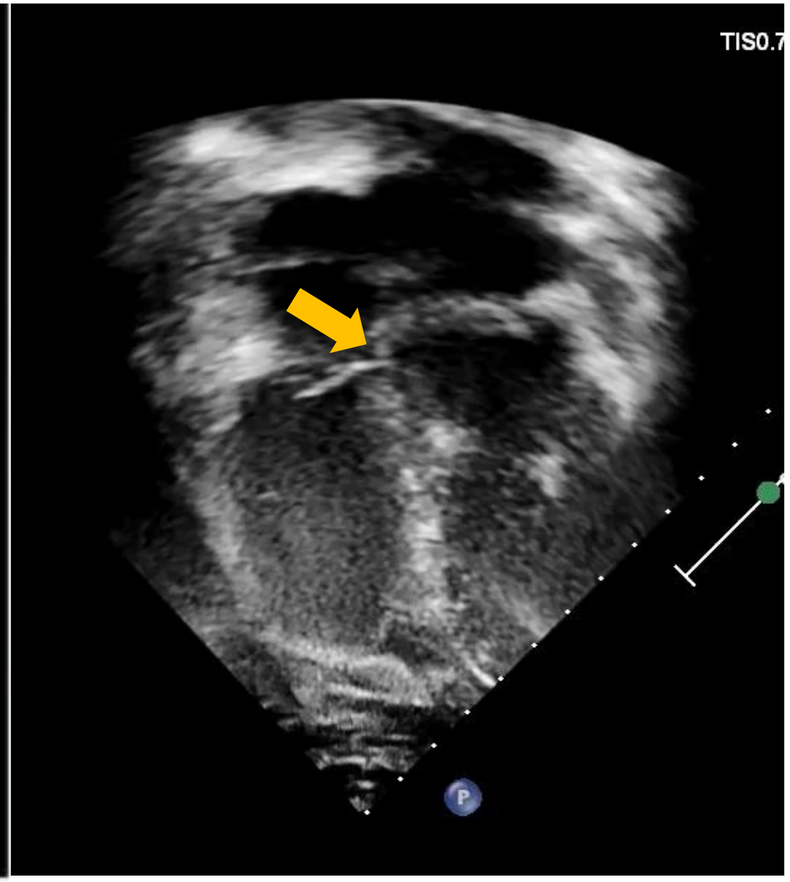
The pulmonary artery is *ANTERIOR* to the aorta in normal hearts

In other words, the *SPACE BEHIND the chest wall* should be filled by the *PULMONARY ARTERY* and not the AORTA

Left ventricle vs Right ventricle

Tricuspid valve, septal attachment

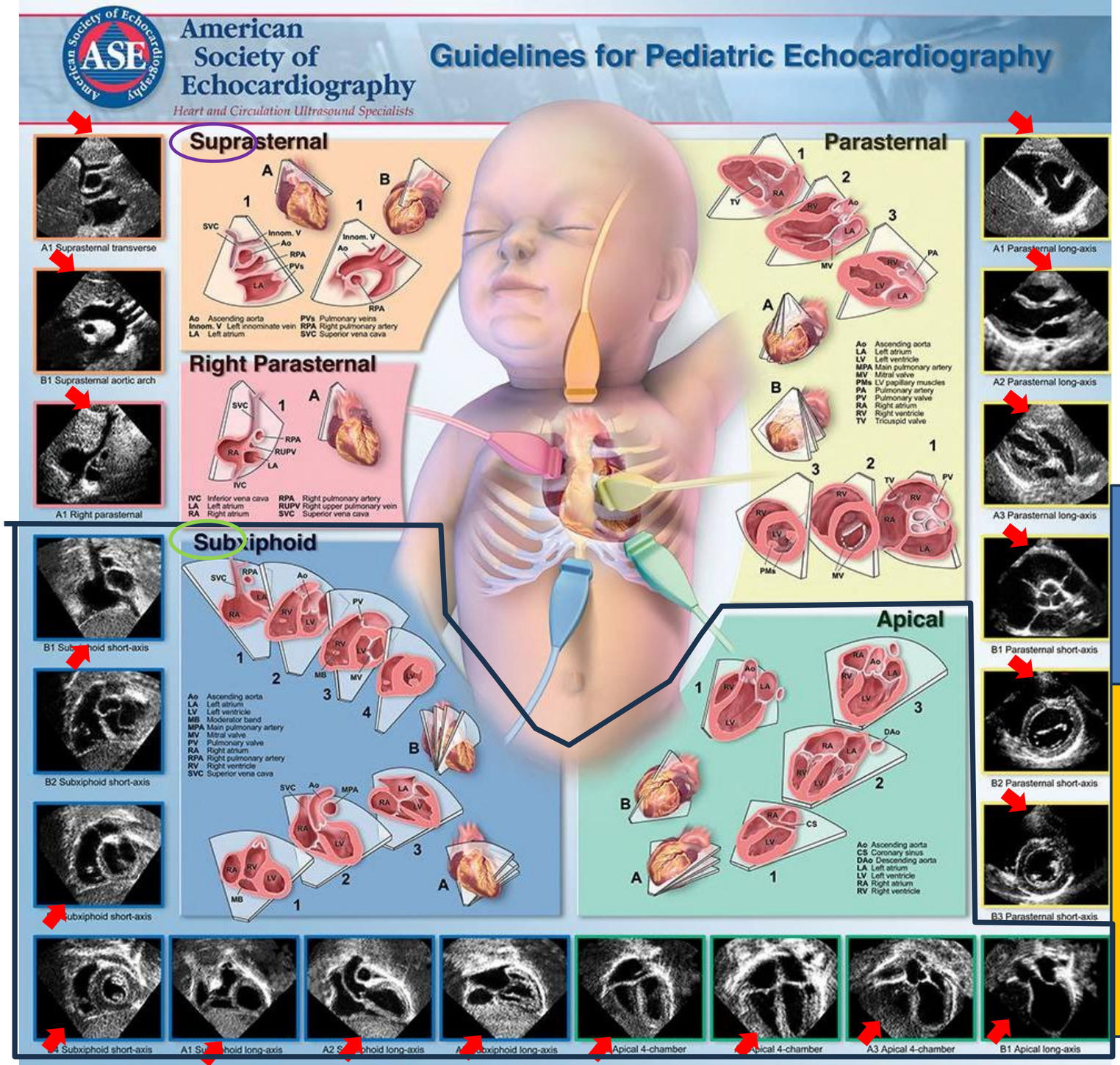




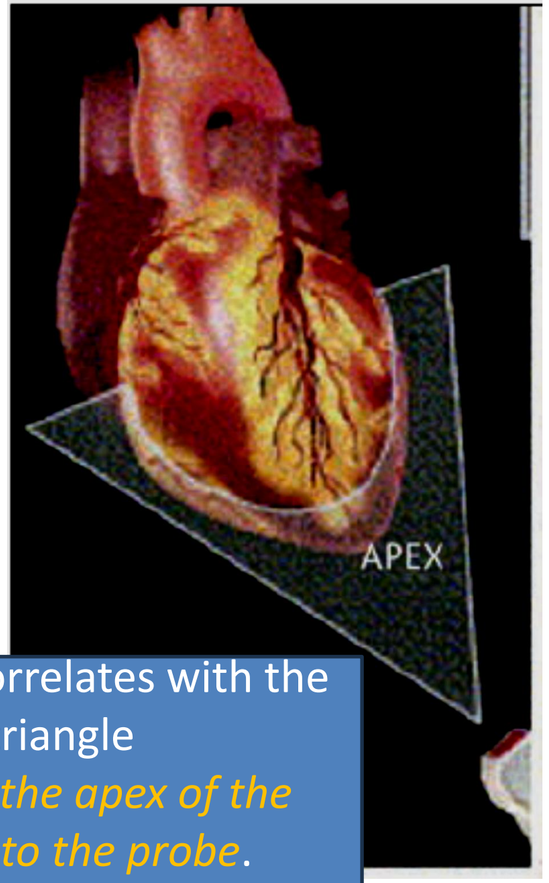
Mitral valve, NO septal attachment

Offset between tricuspid and mitral
Tricuspid attaches more apically

ECHO in CHD



Apply to Adult CHD

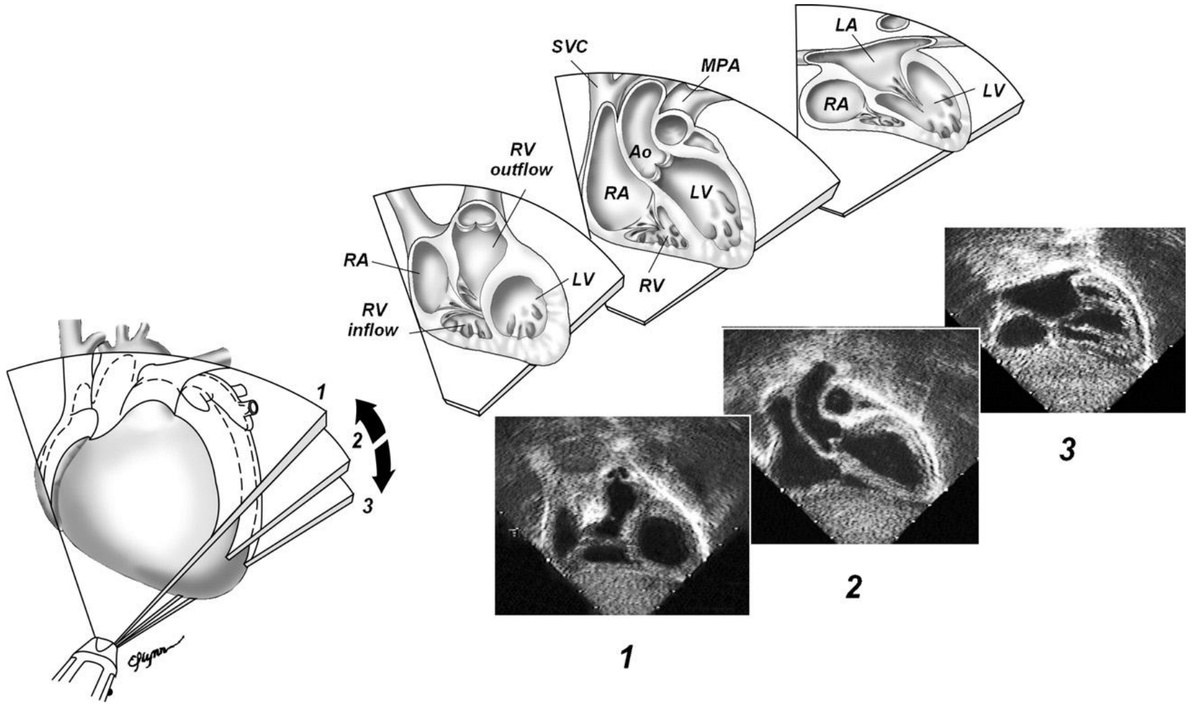


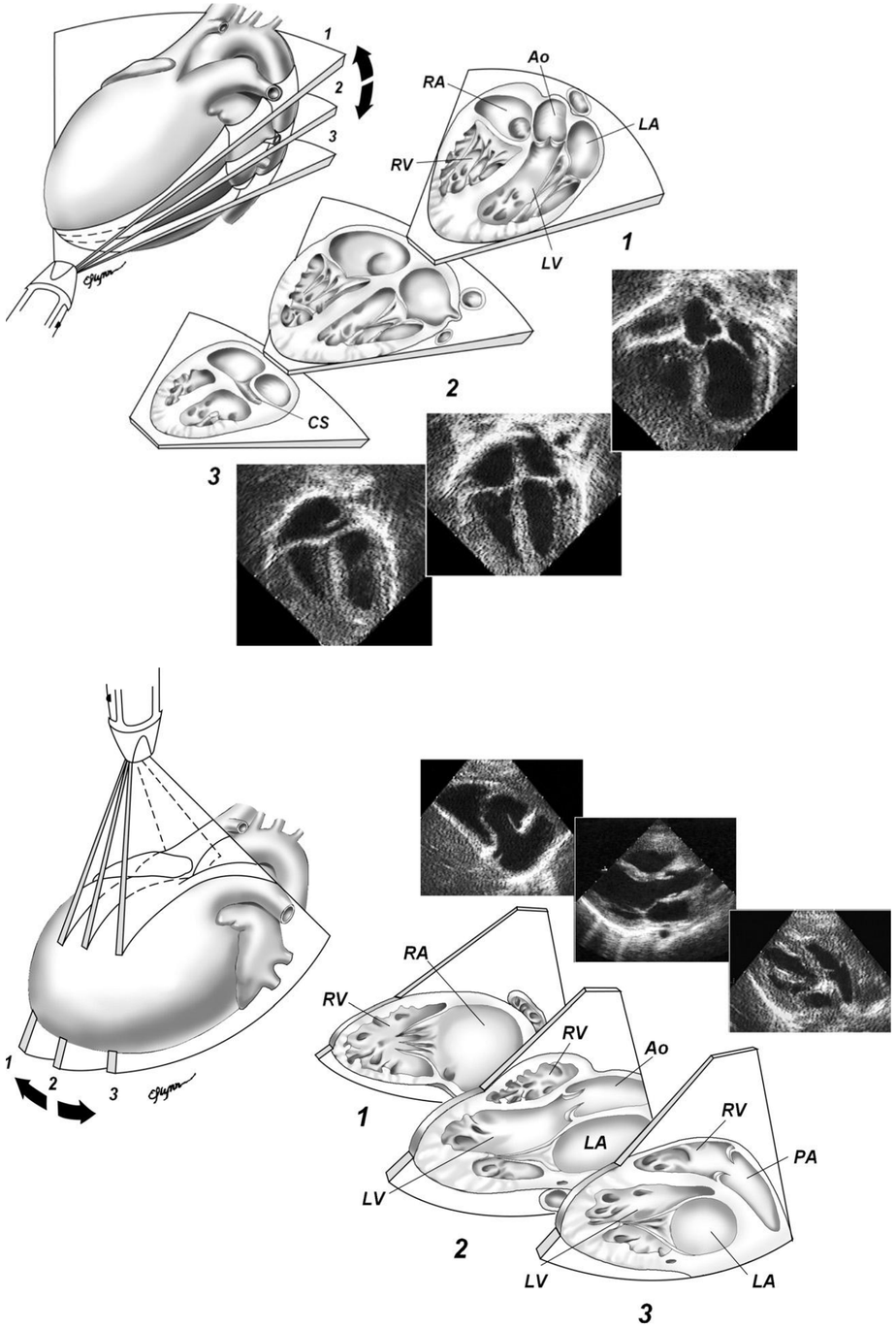
The tip of the probe correlates with the apex of the triangle

Structures nearer to the apex of the triangle are closer to the probe.

- If probe on anterior chest : apex structures are anterior in the thorax
- If probe is SUPRAsternal : apex structures are superior in the thorax
- If probe is SUBcostal : apex structures are inferior in the thorax

Sweeps

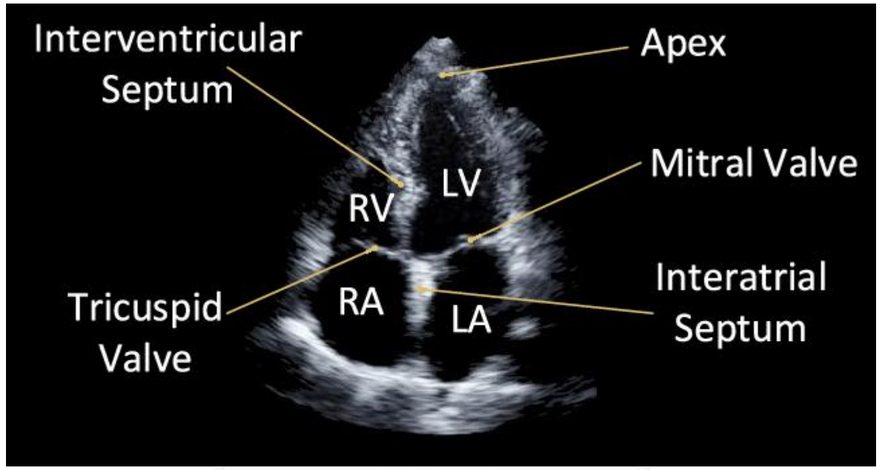




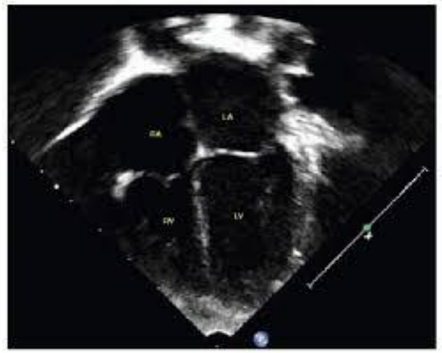
- Sweeping – taking as thin slices as possible of the entire 3D structure
- Establish continuity of structures
- Assessing entire septal structure and can give idea of extent of a defect

Inverting the image

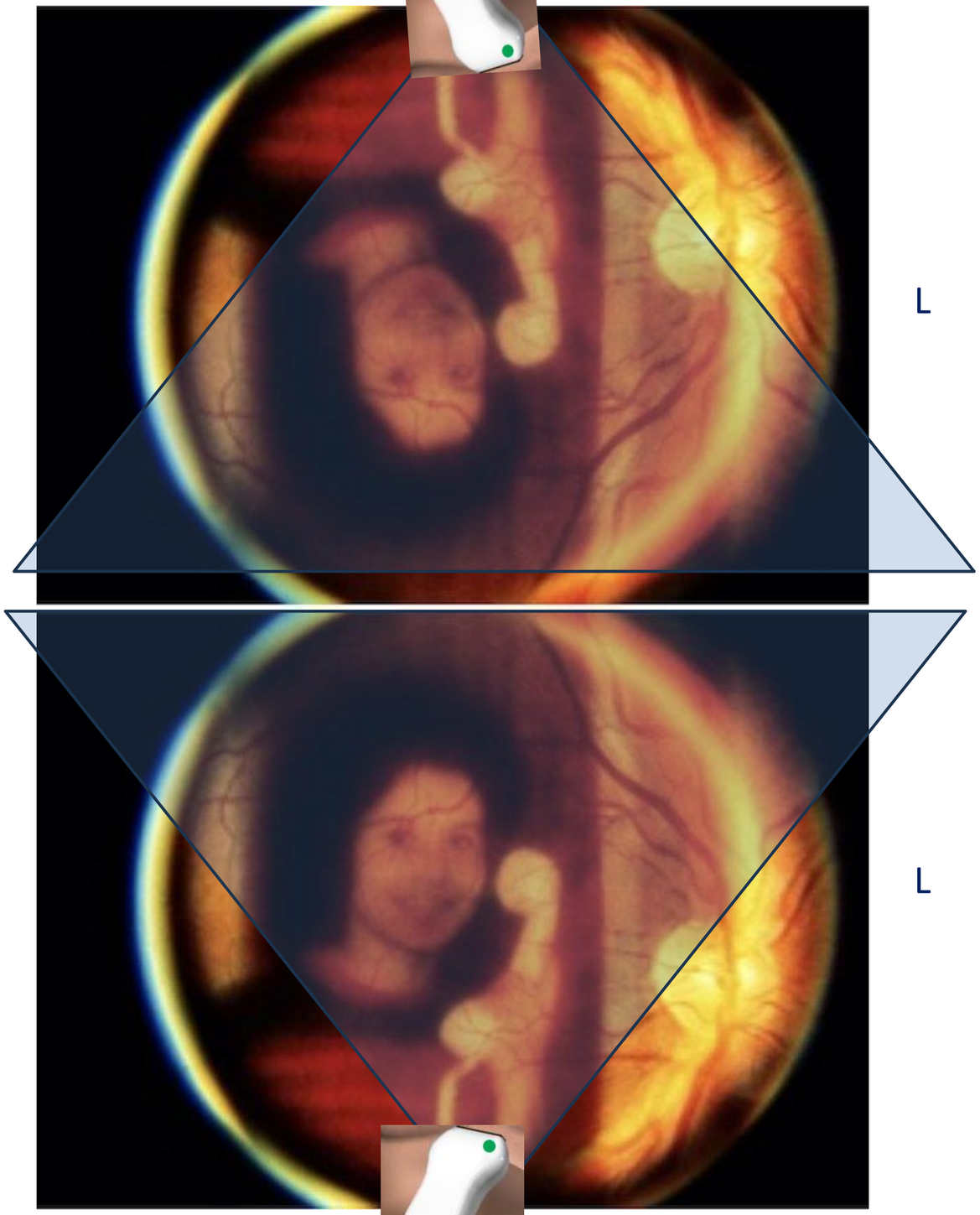
- If you approach from the subcostal (subxiphoid), you are looking from below. The structures nearest to the probe are inferior.
- The reason to invert the image is for the purpose of displaying superior and inferior in attitudinally correct fashion on the screen.
- However, remember that the image is only flipped upside down but left and right remain the same.



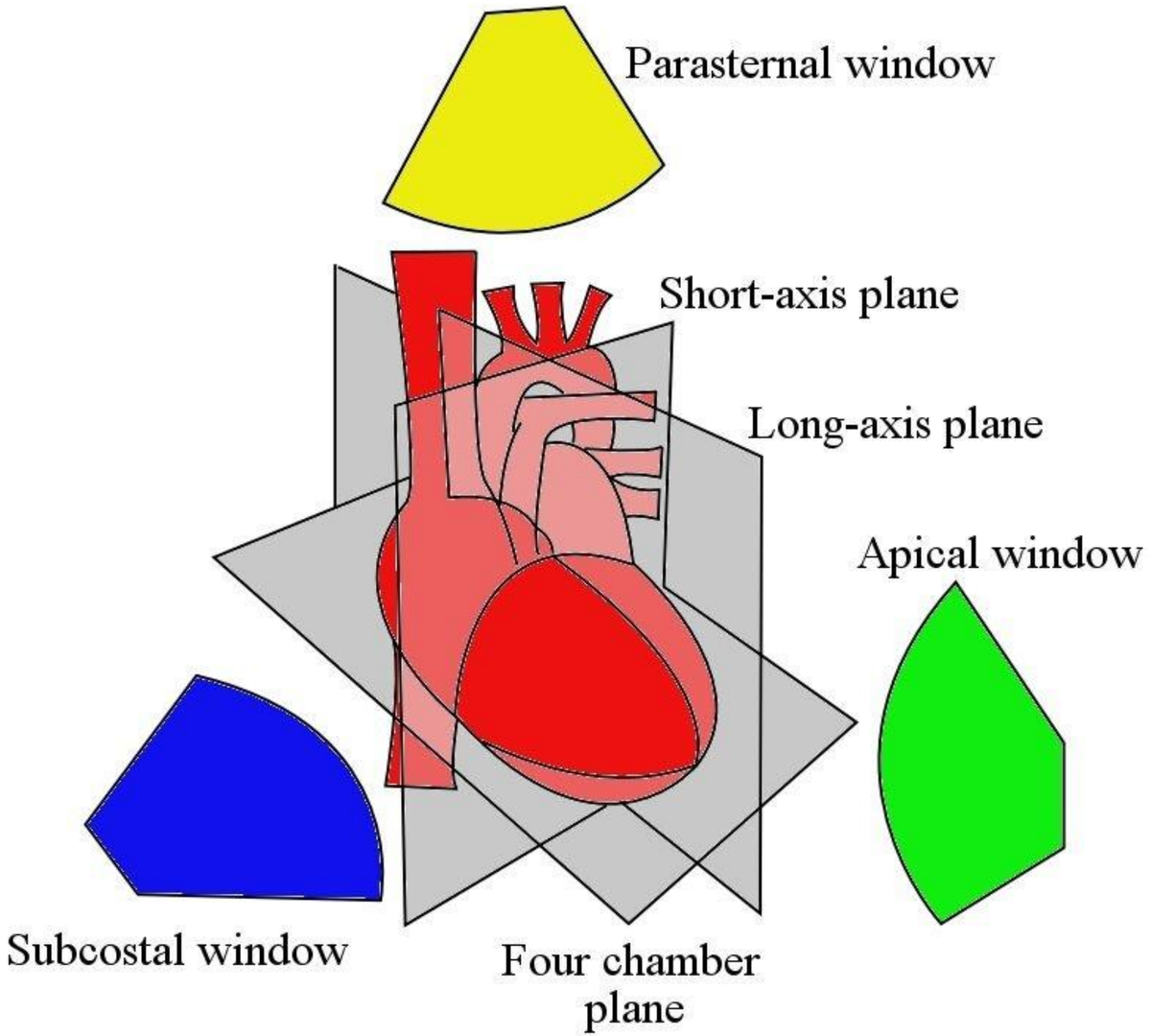
Adult functional

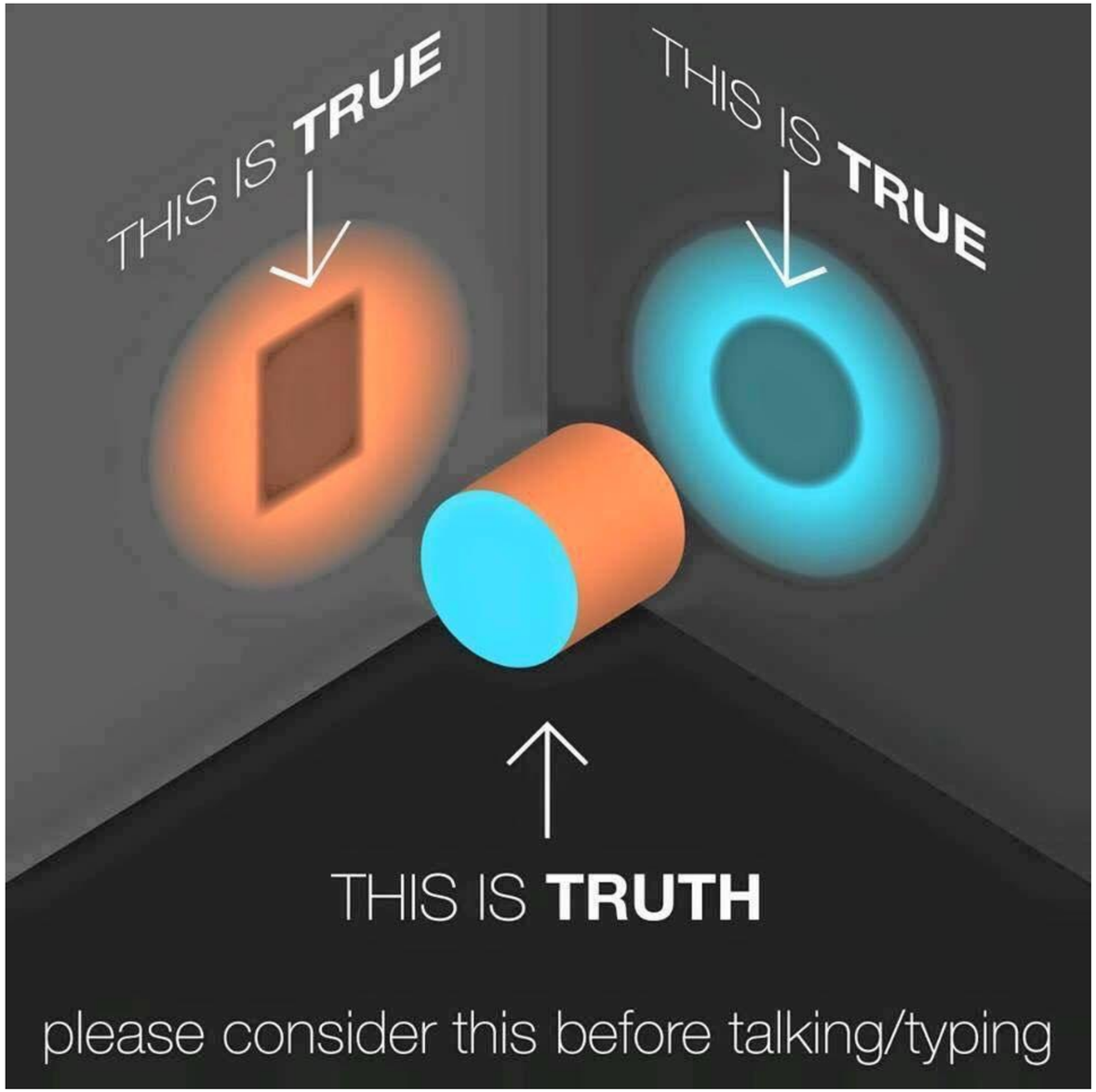


Adult Congenital



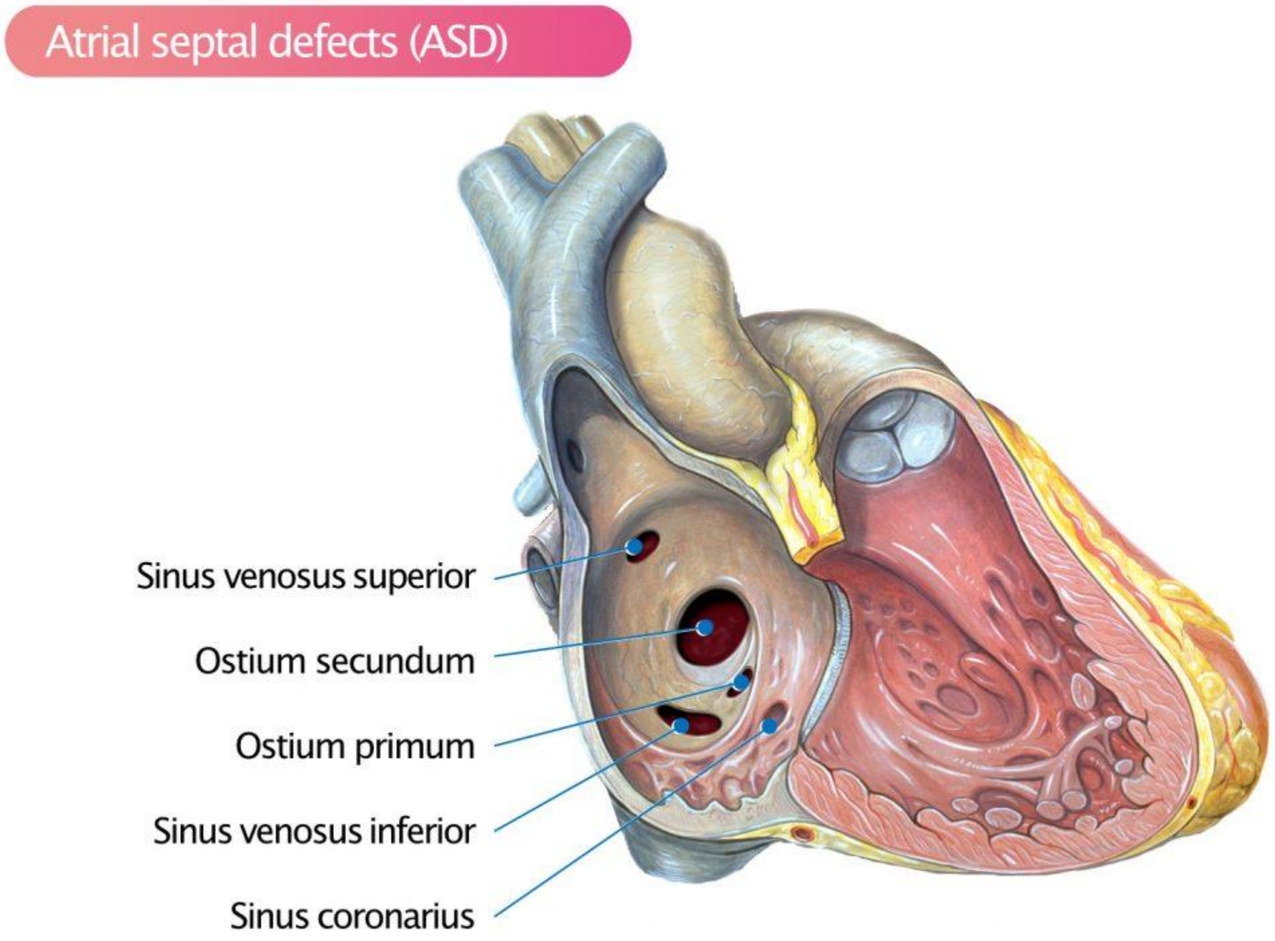
Look from different angles in 2D …to *see* in 3D





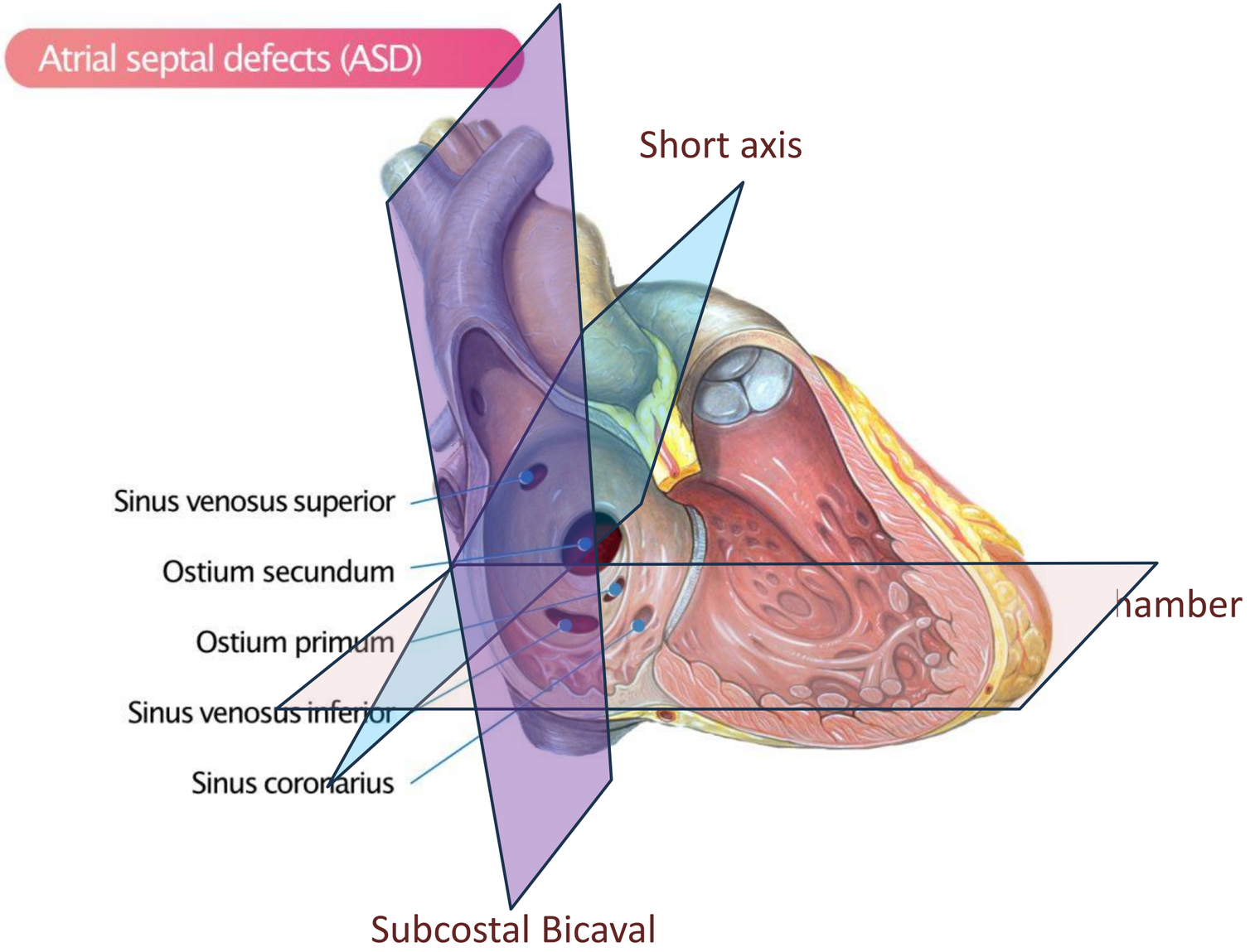
Lesions commonly encountered in adult population

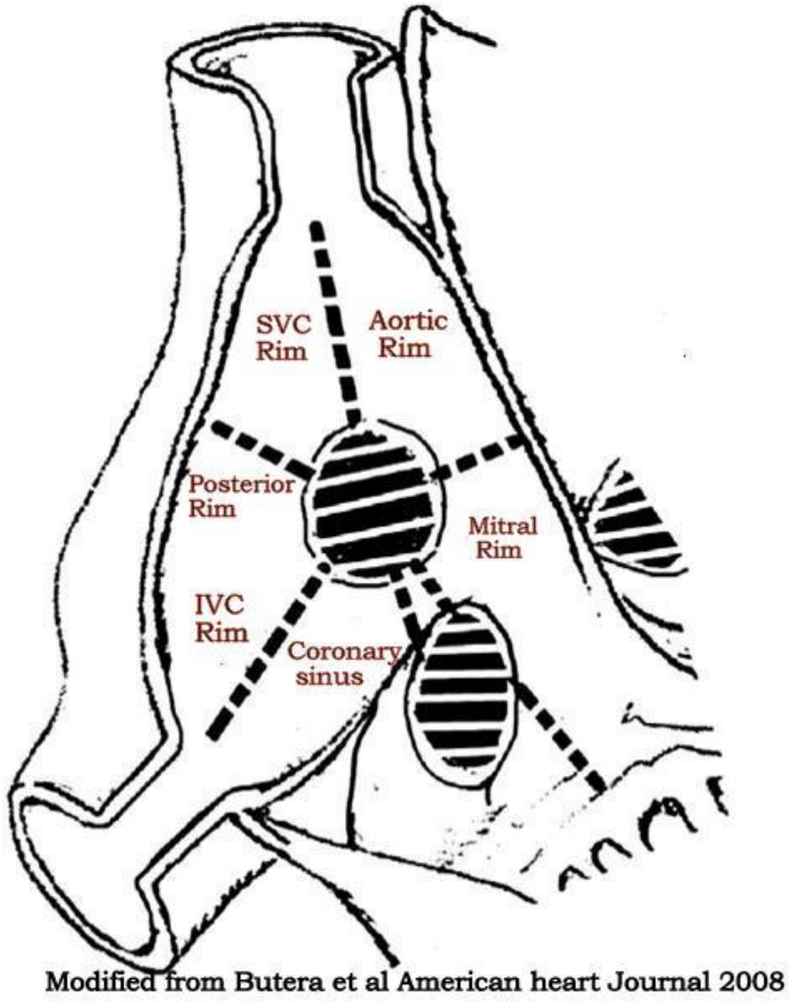
ASD – many types



- Interatrial communication
- Commonest is secundum type ASD
- May remain asymptomatic for many years, especially if small.
- Mixing is diastole, leading to gradual right heart volume overload
- After many years, may lead to pulmonary hypertension
- Important to assess Right heart function

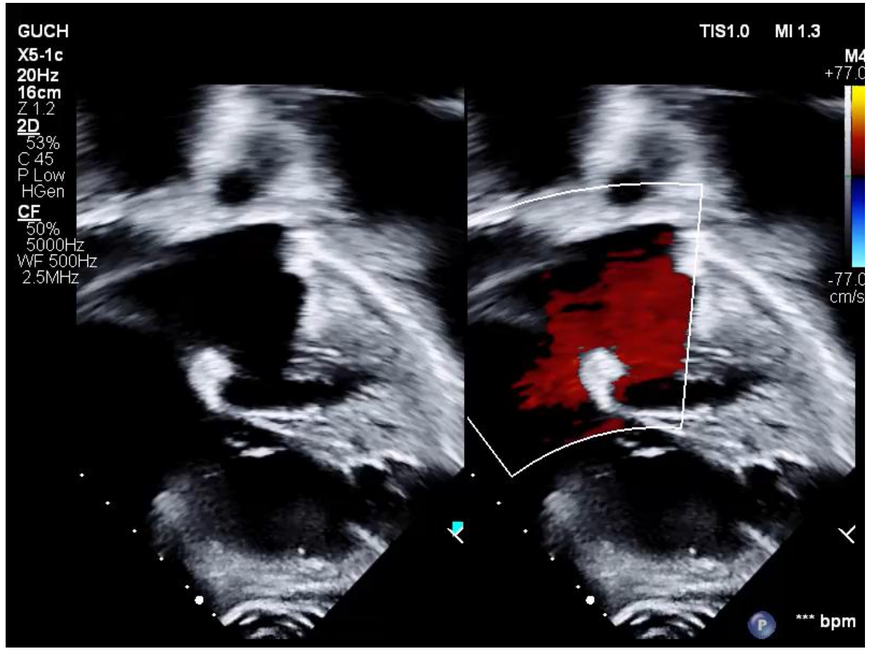
ASD – why multiple views are used

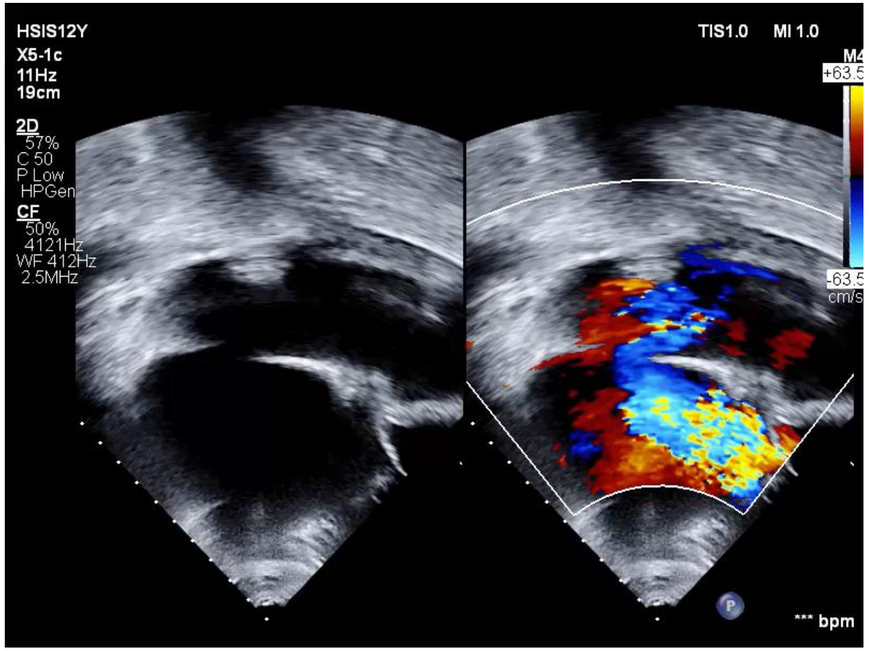




Modified from Butera et al American heart Journal 2008

Atrial septal defect (ASD)

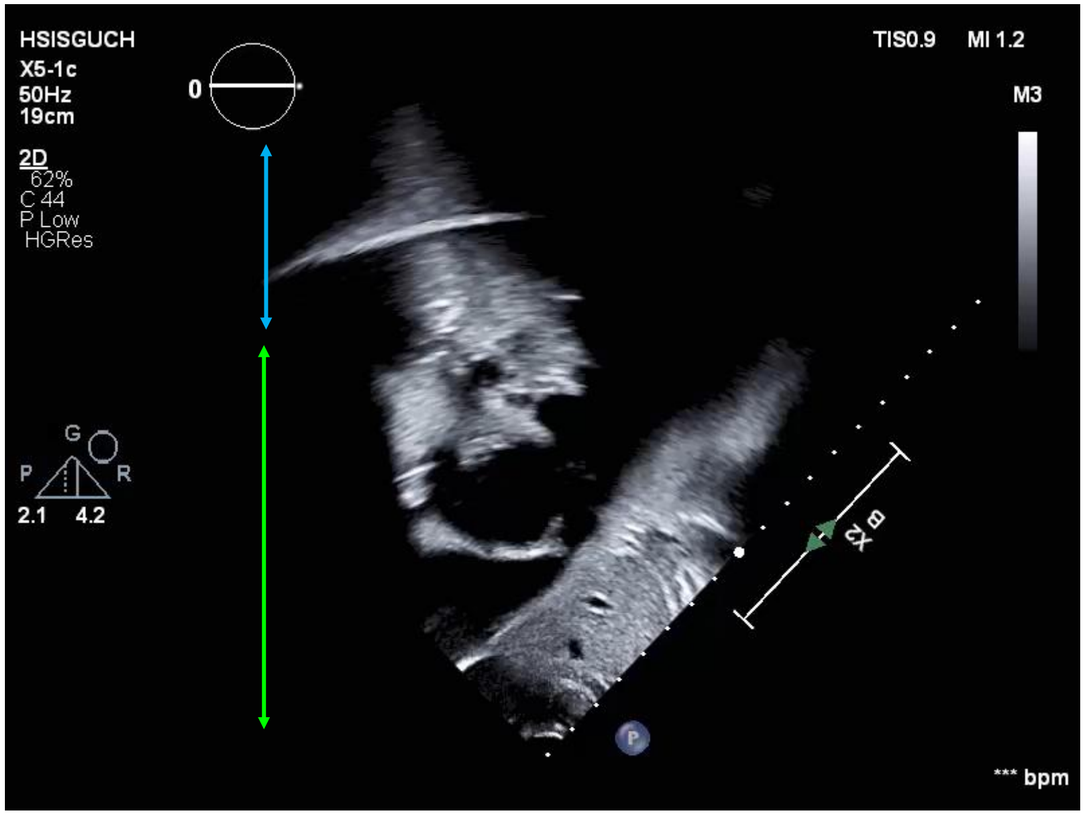




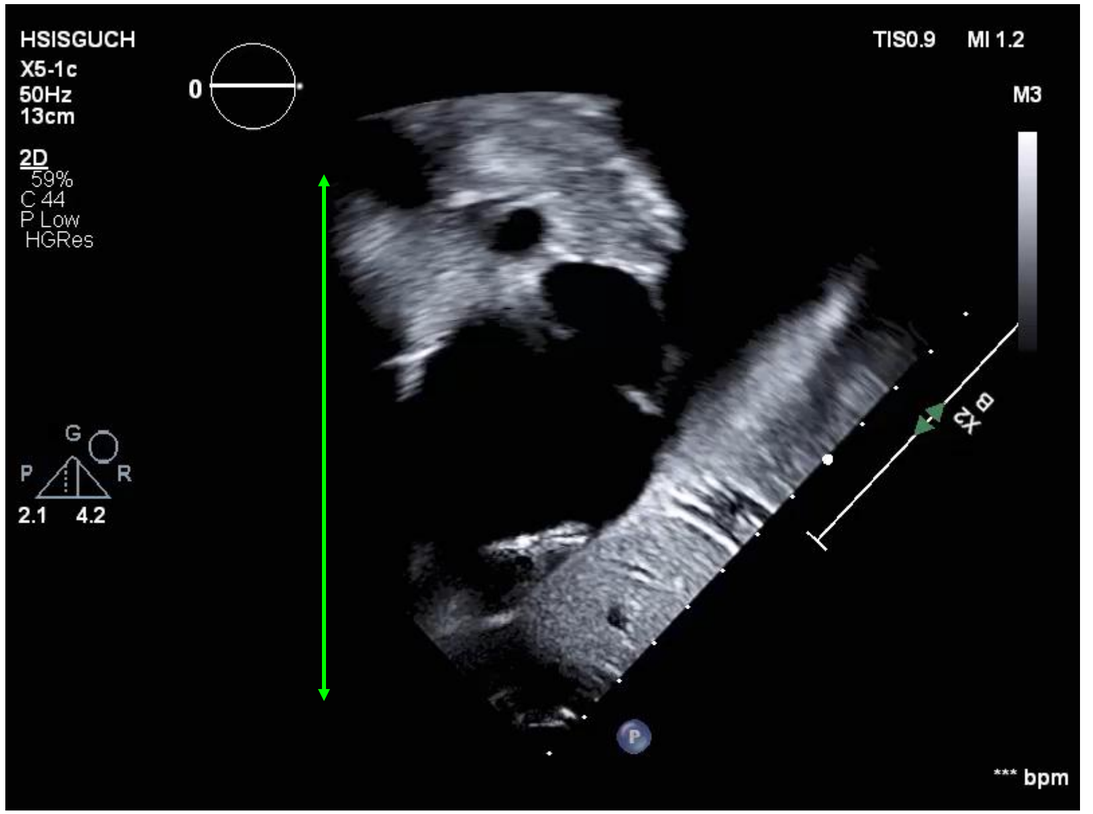
The more perpendicular to septum, the clearer the borders of defect are defined

Subcostal views offer the best perpendicular signal but in adults, can be challenging

ASD - Optimising Depth

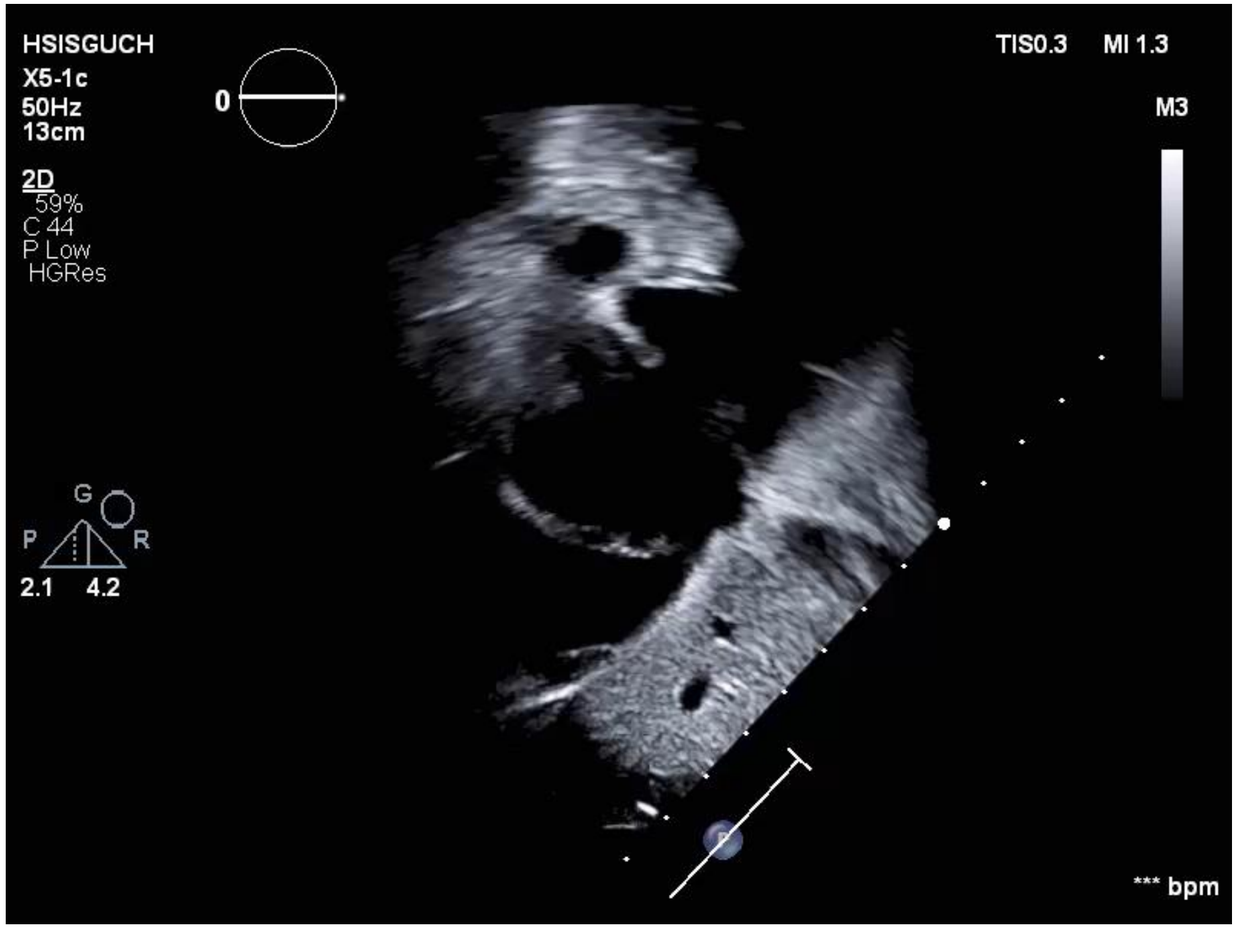


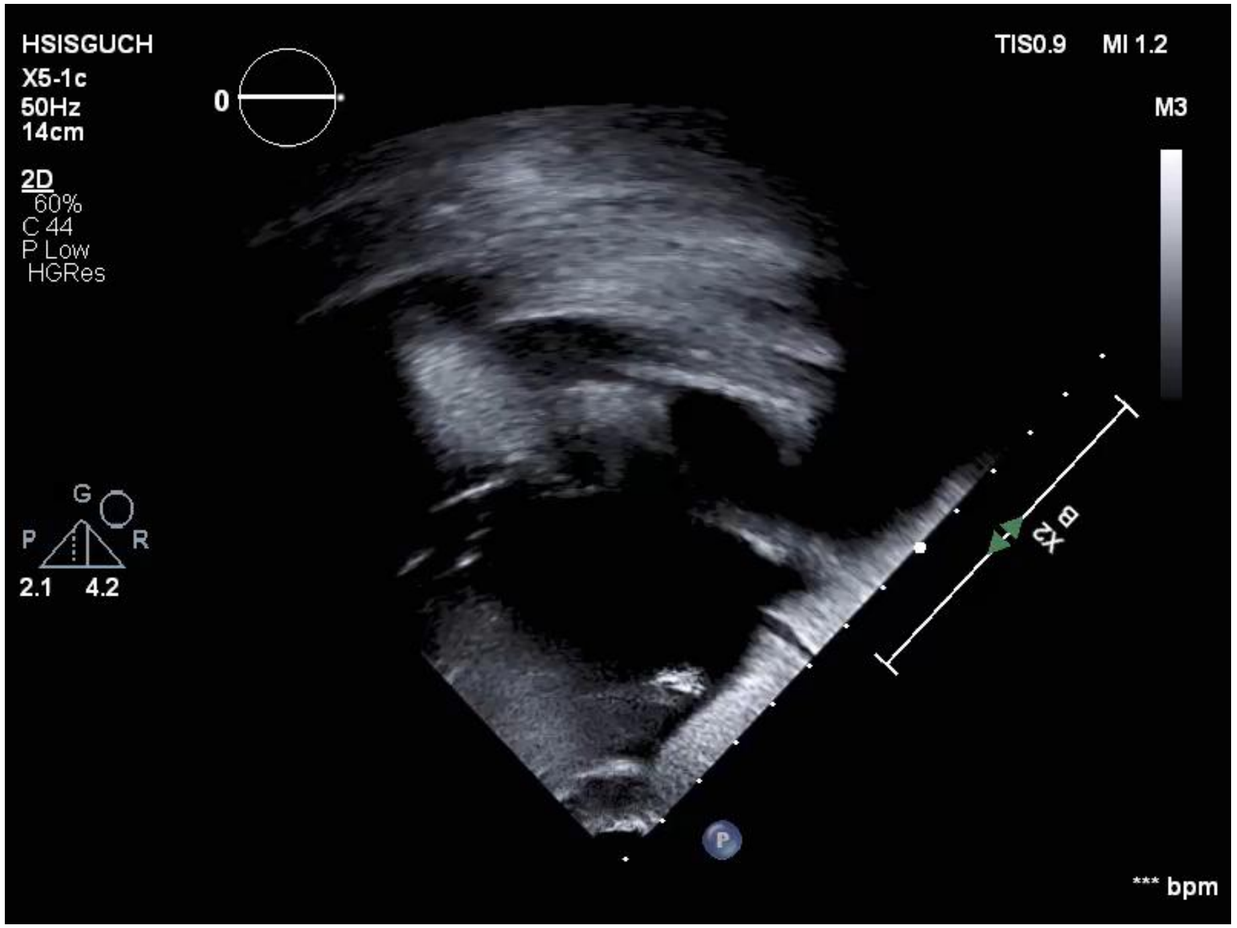
Depth 19 cm



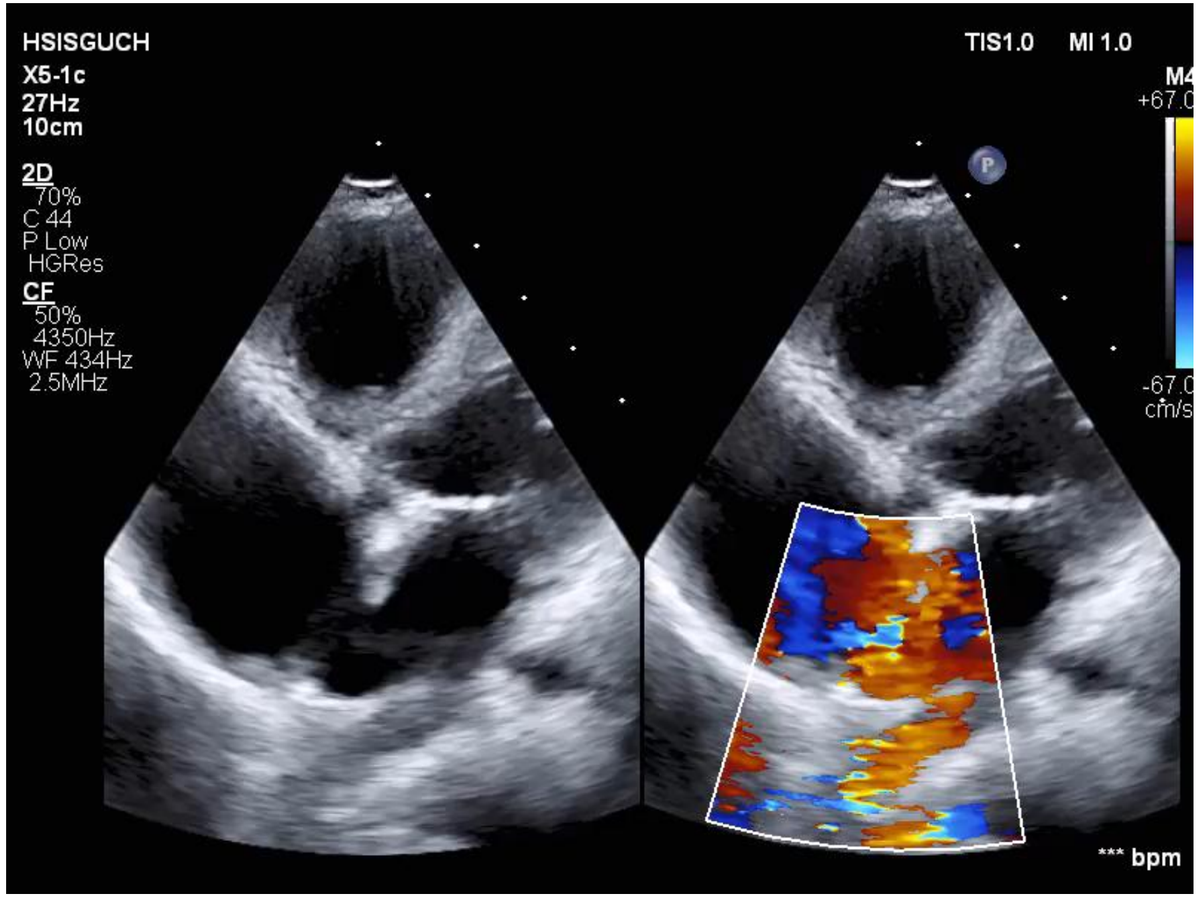
Depth 13 cm

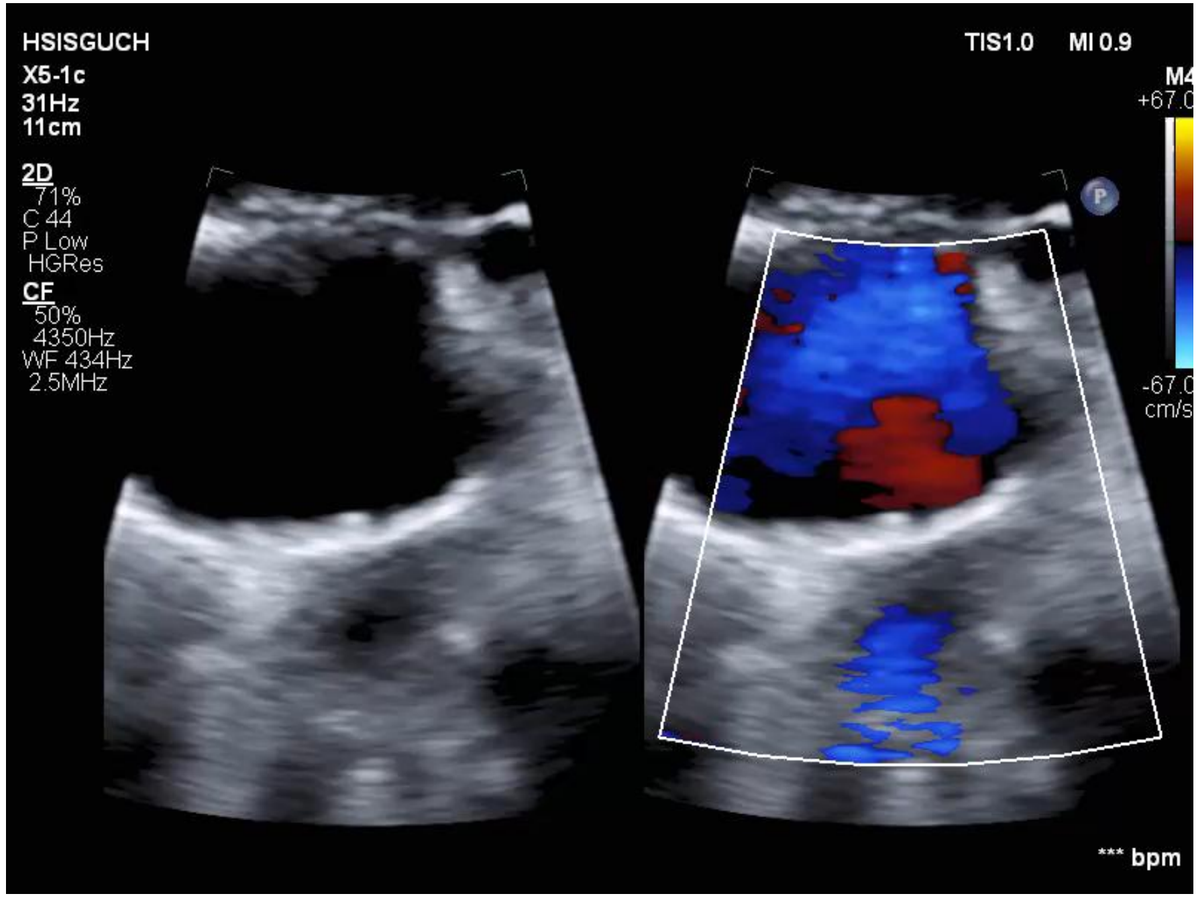
ASD - Optimising focus



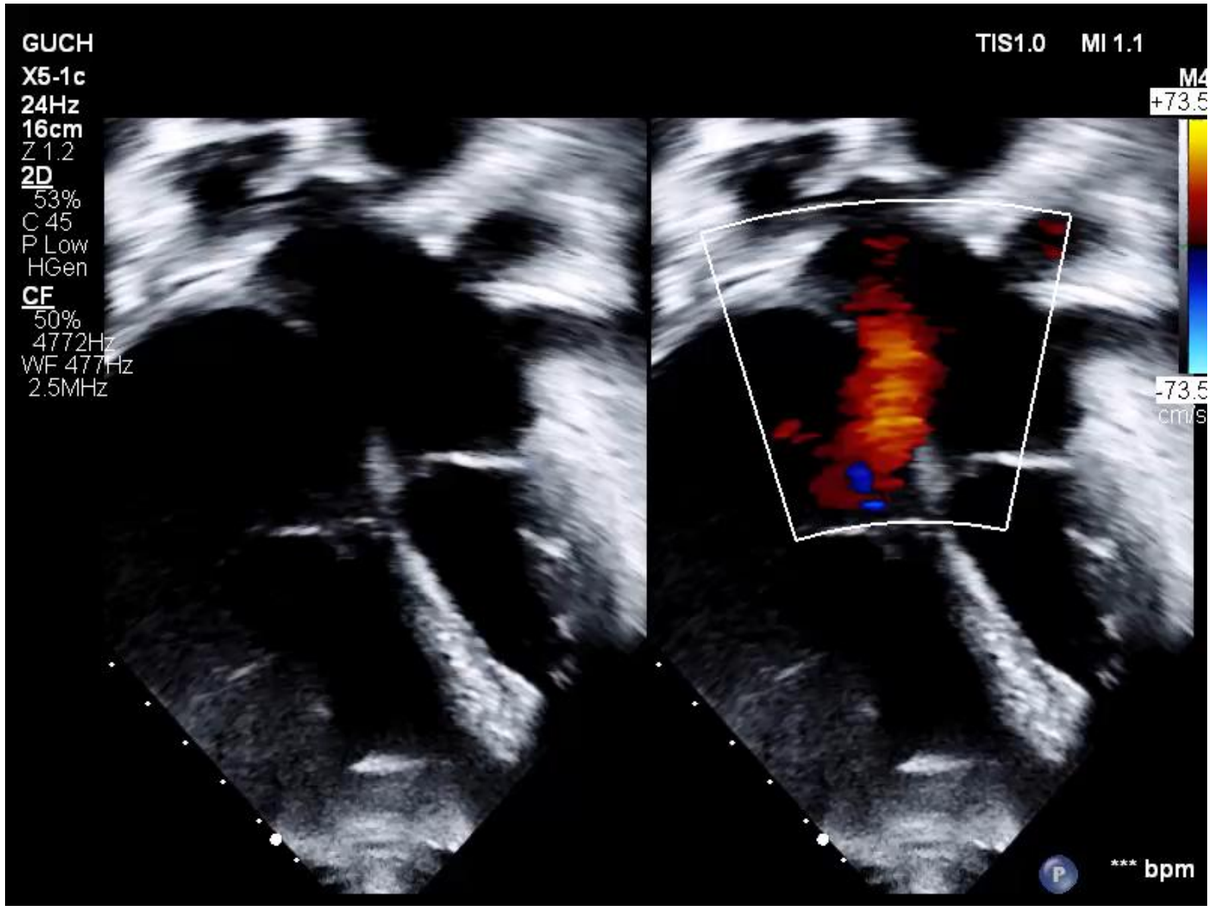


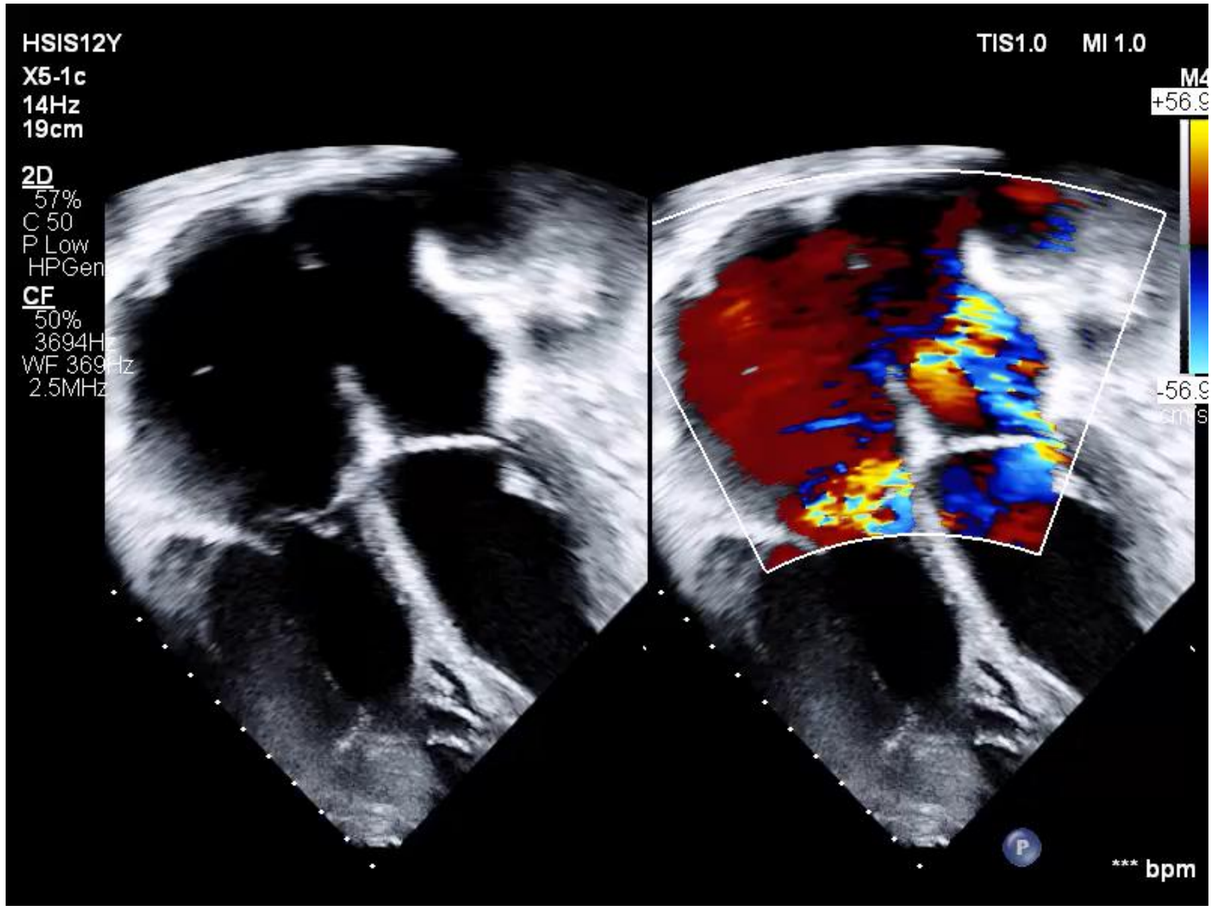
ASD - Optimising Zoom



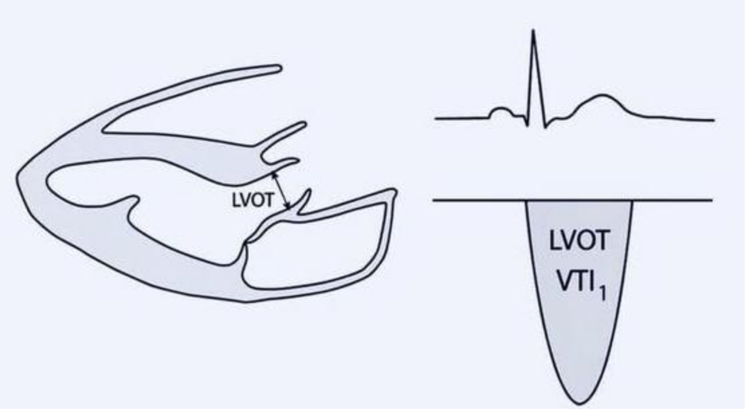


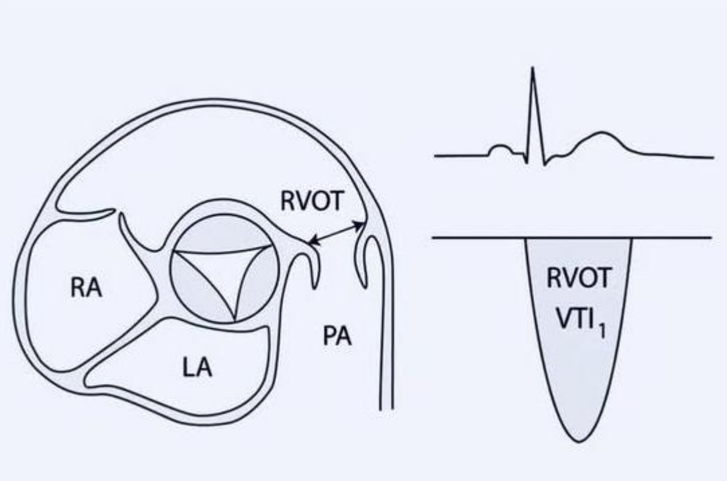
RV dilatation – volume or pressure overload

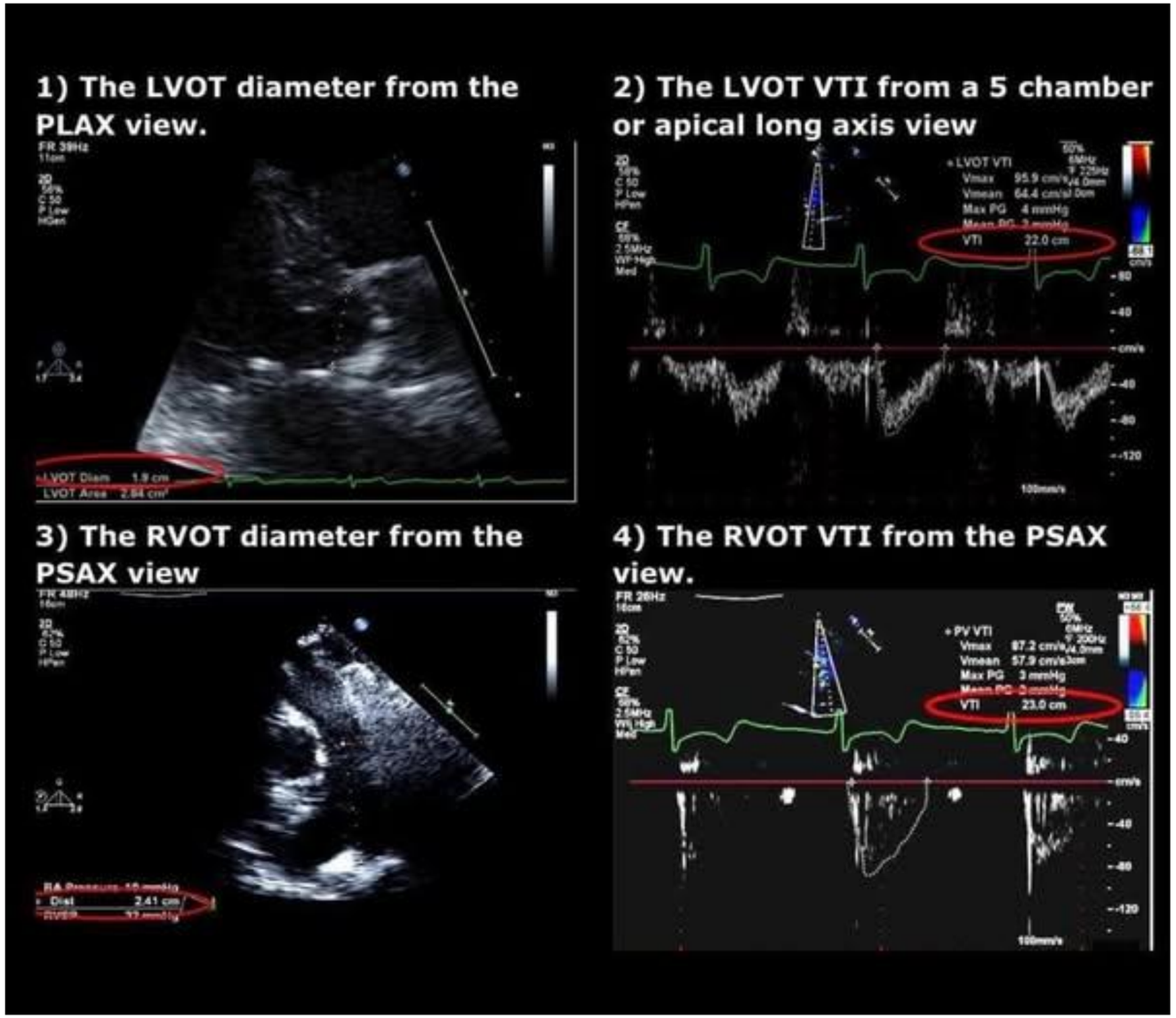




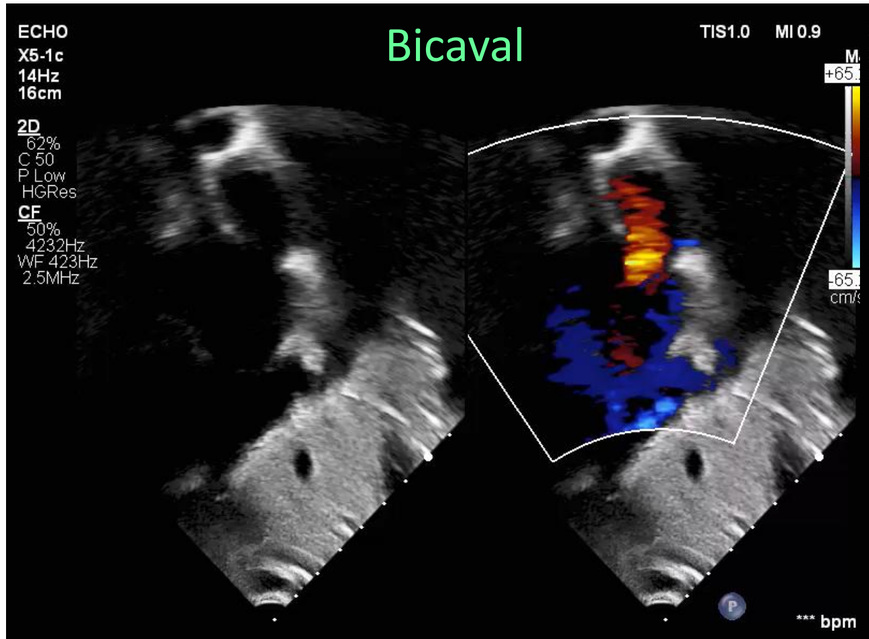
QP:Qs

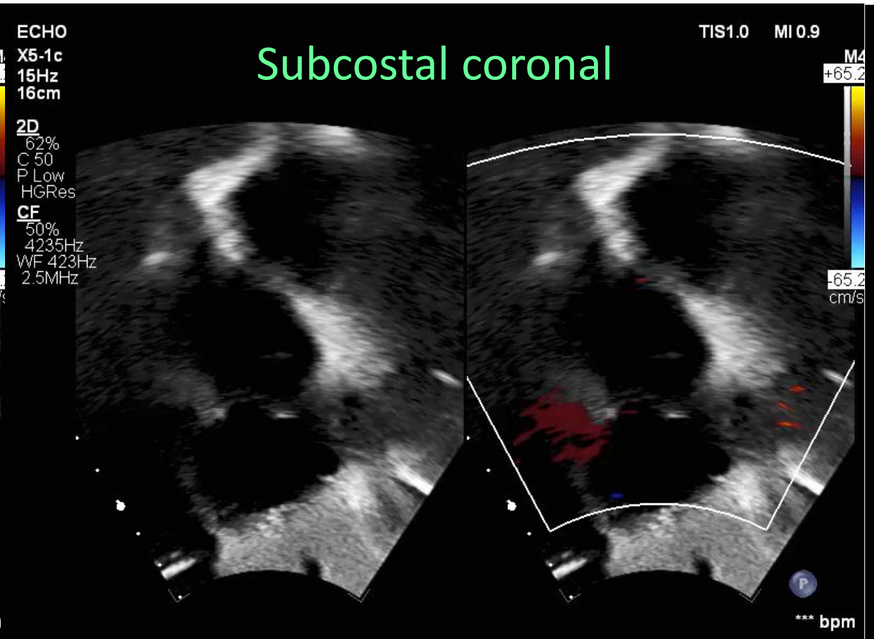

LVOT
LVOT
VTI1

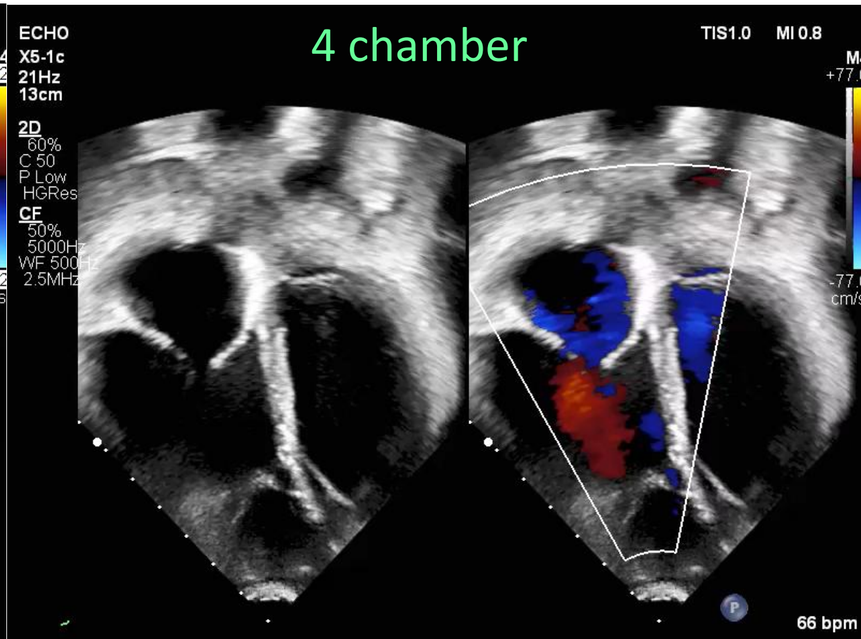

RVOT
RA
LA
PA
RVOT
VTI1

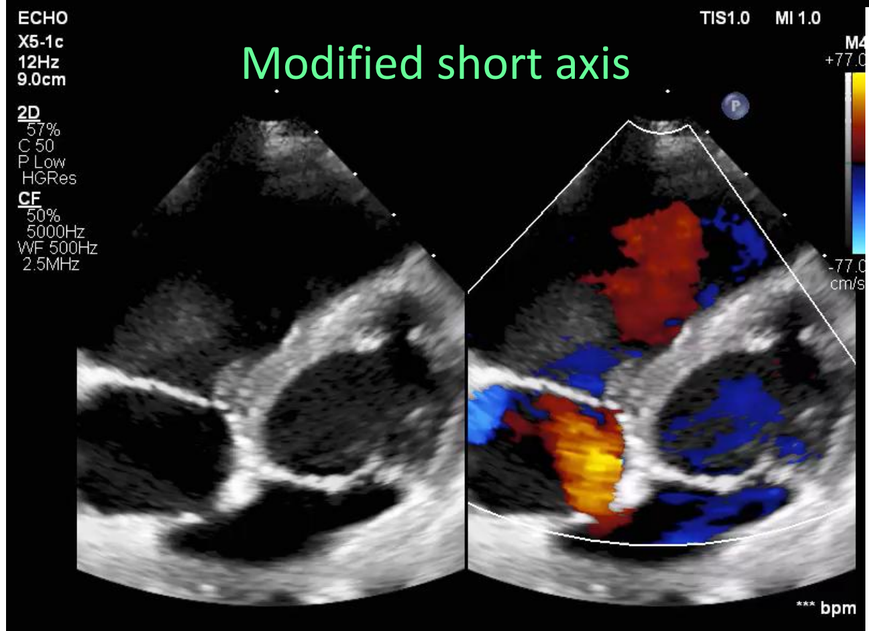

1) The LVOT diameter from the PLAX view.
2) The LVOT VTI from a 5 chamber or apical long axis view
LVOT VTI
Vmax 95.9 cm/s
Vmean 64.4 cm/s
Max PG 4 mmHg
VTI 22.0 cm
3) The RVOT diameter from the PSAX view
4) The RVOT VTI from the PSAX view.
PV VTI
Vmax 87.2 cm/s
Vmean 57.9 cm/s
Max PG 3 mmHg
VTI 23.0 cm

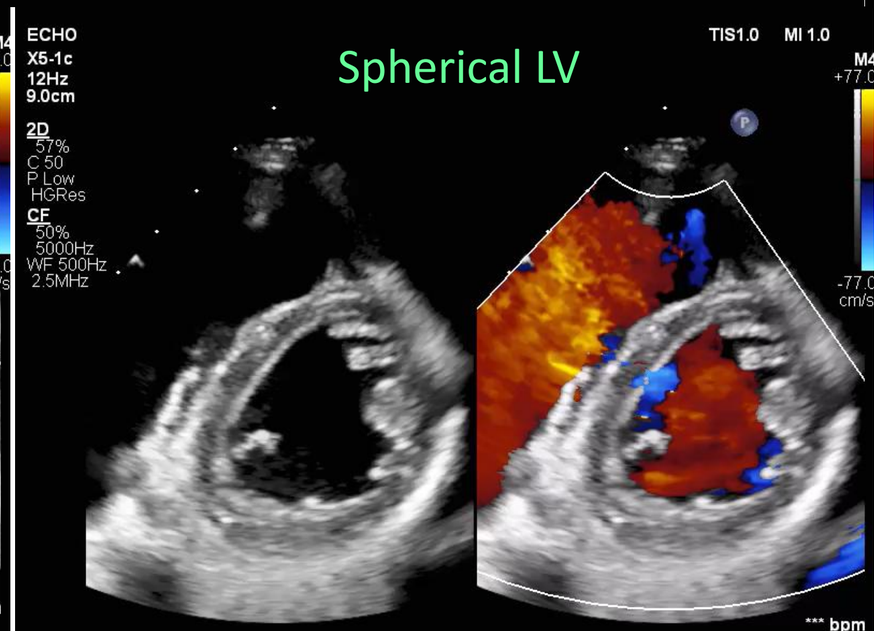
25 years old Small ASD – multiple views

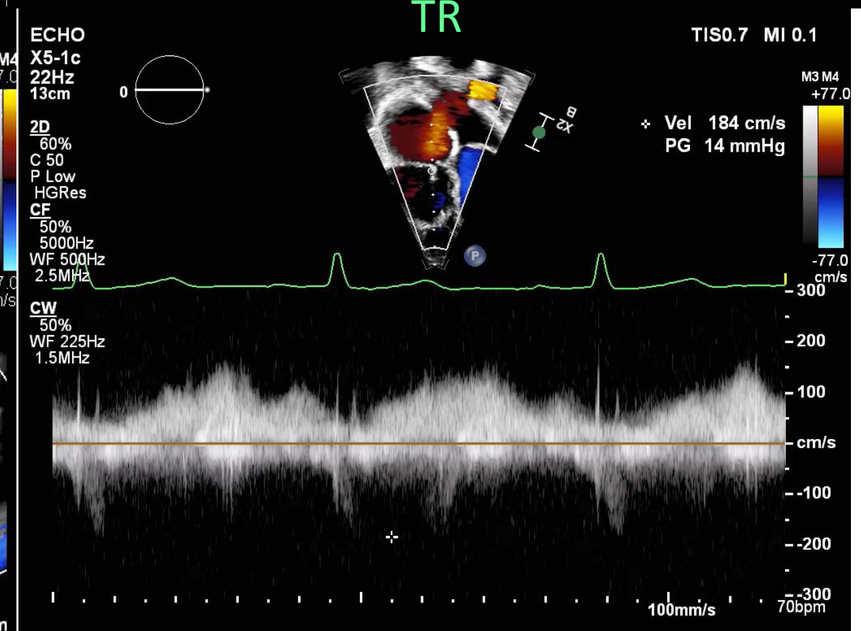




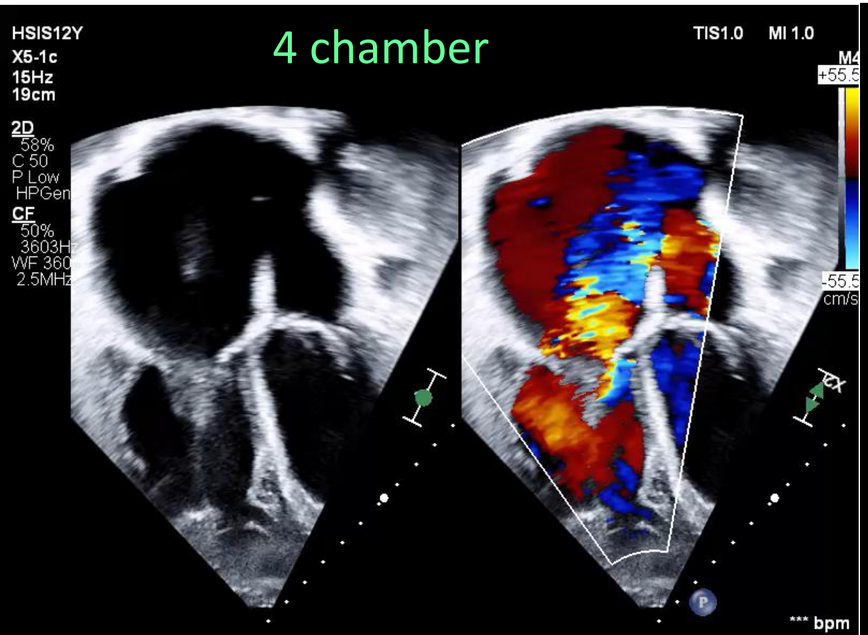


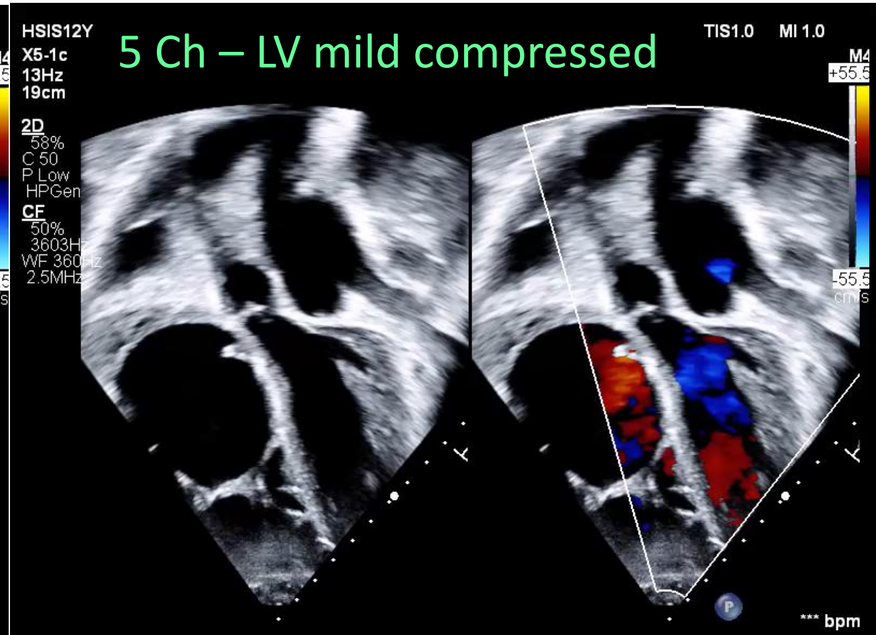


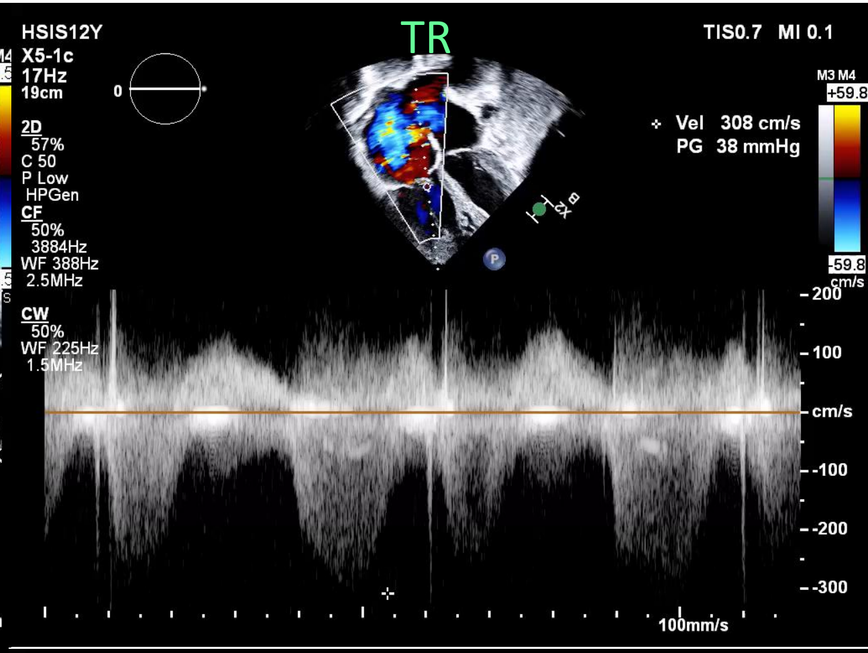


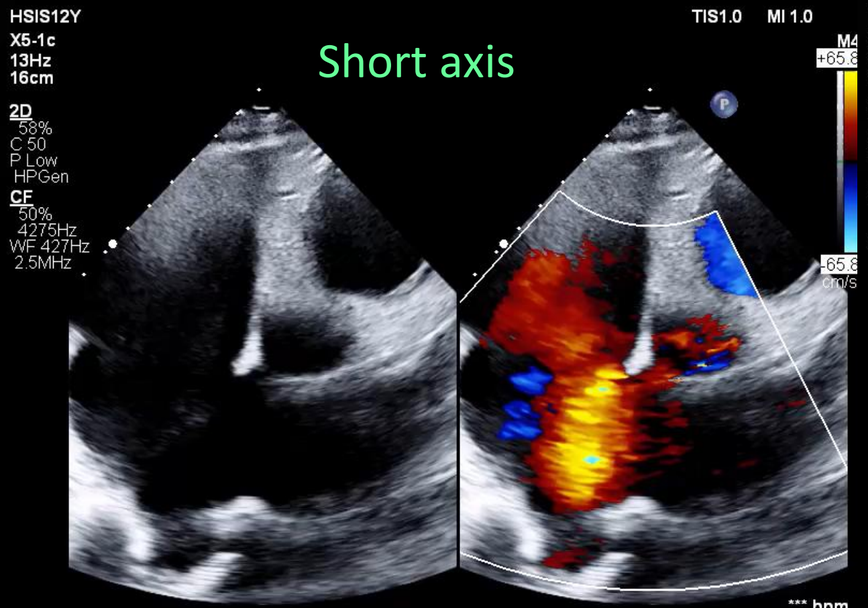


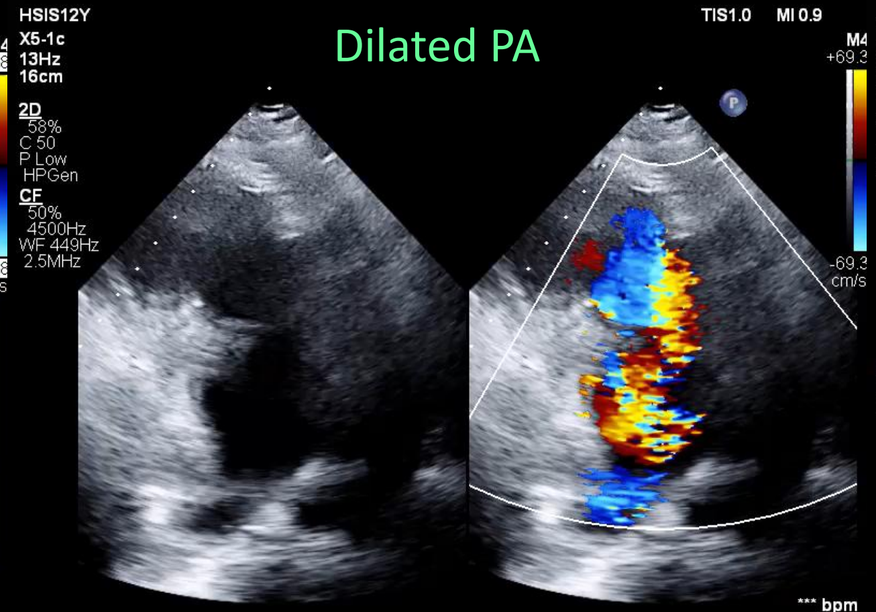
26 years old ASD secundum – retroaortic deficiency – mild PH

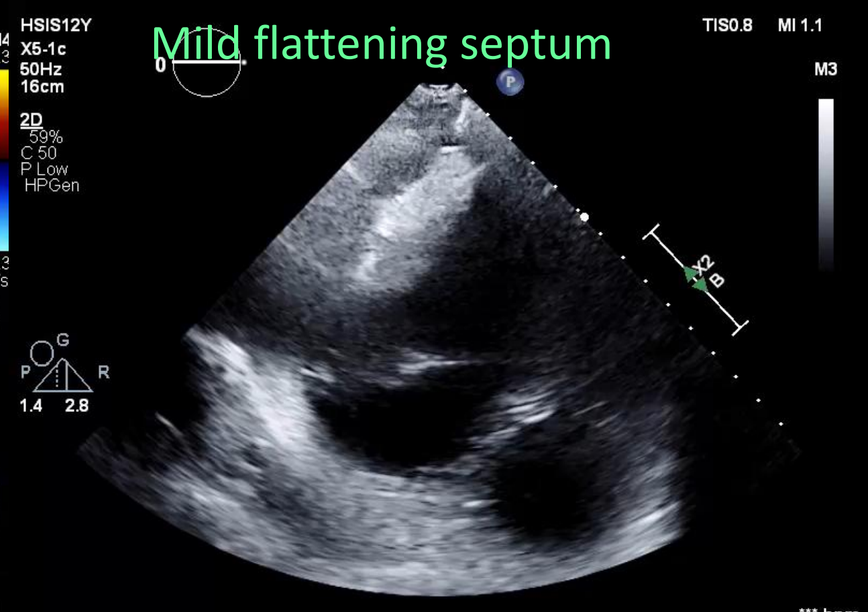




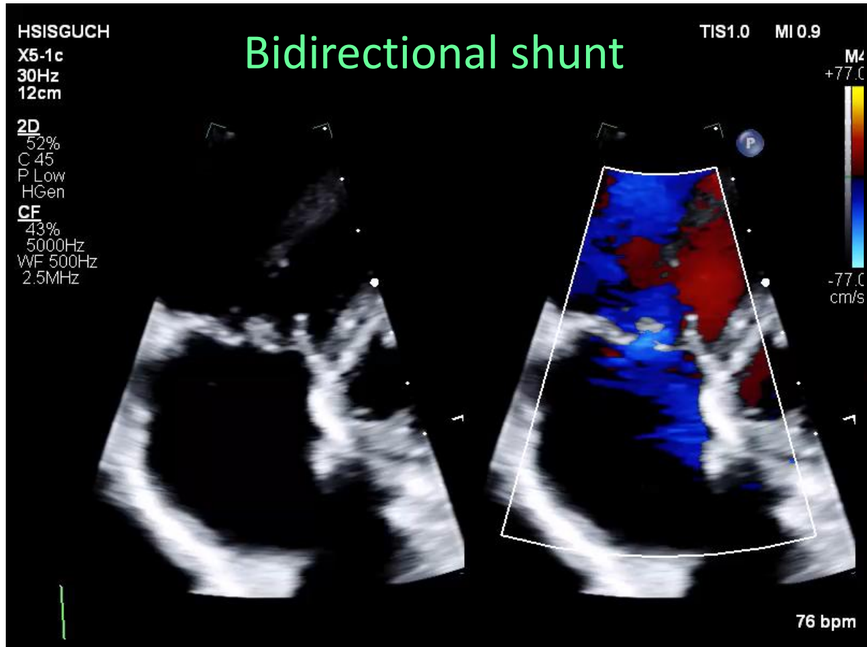


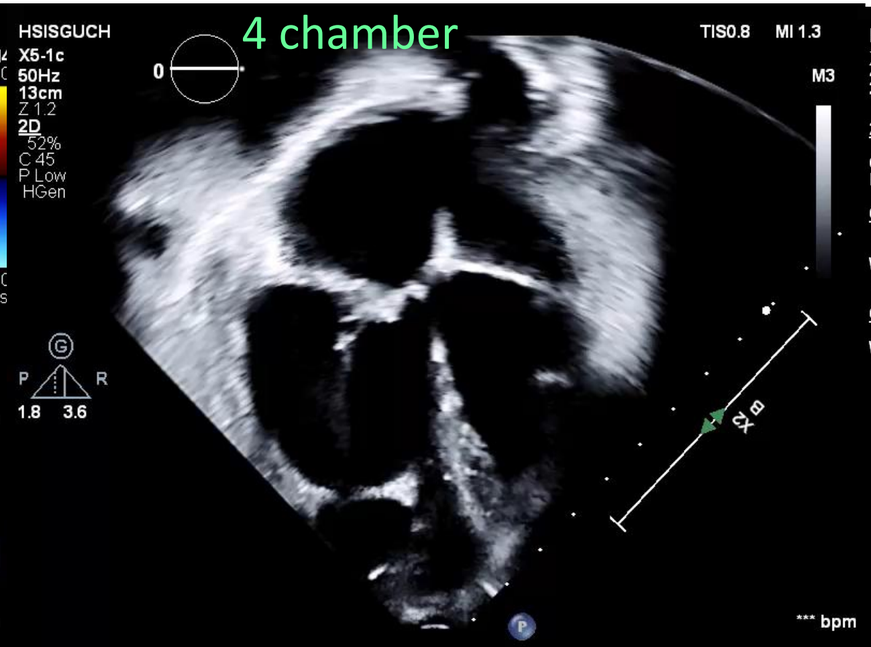


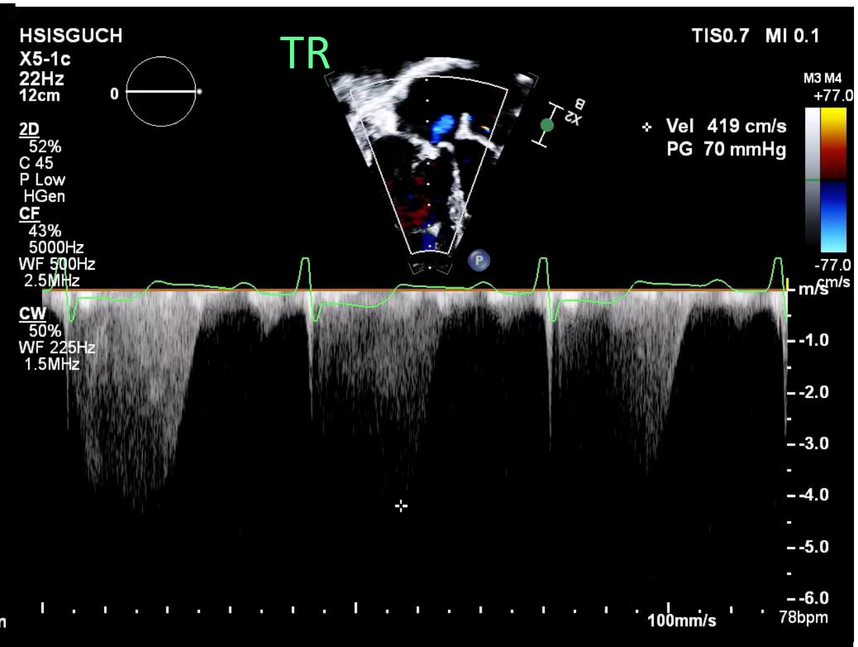


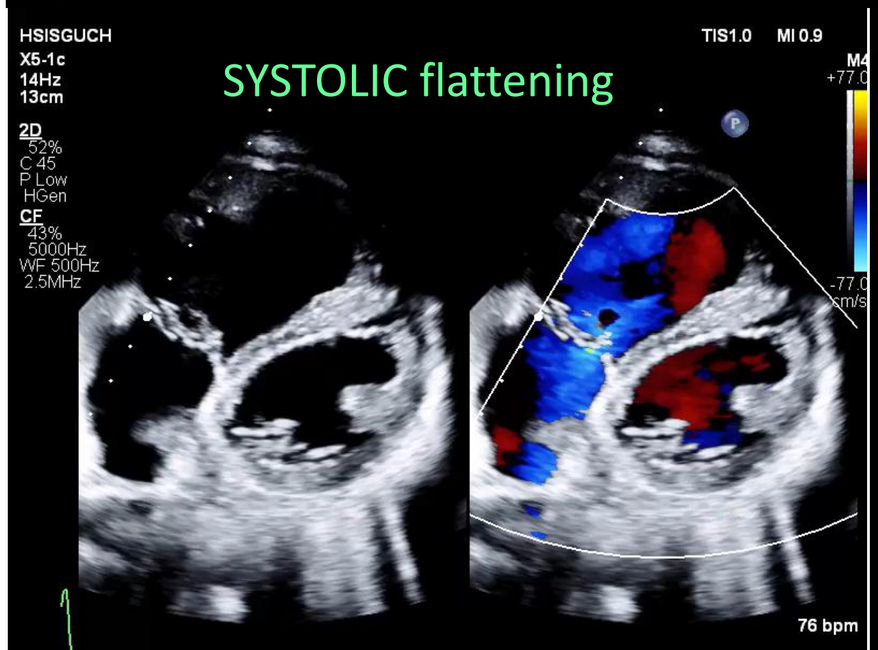


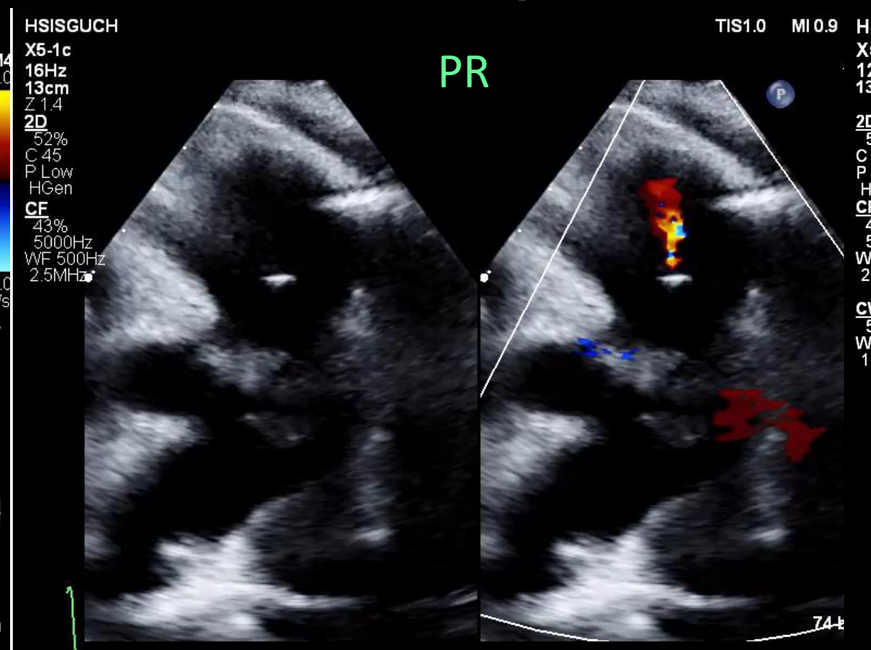
31 years lady – ASD with severe PAH

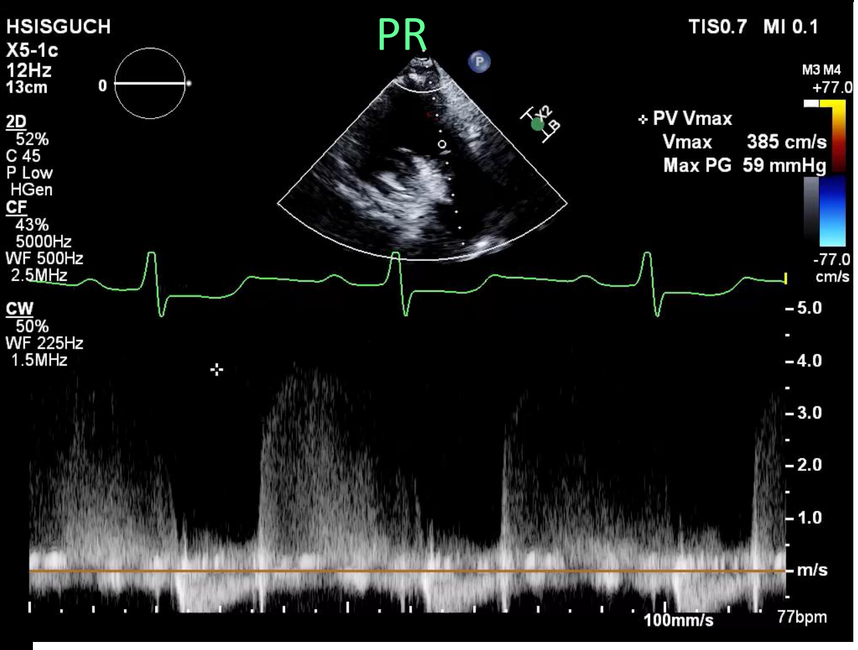




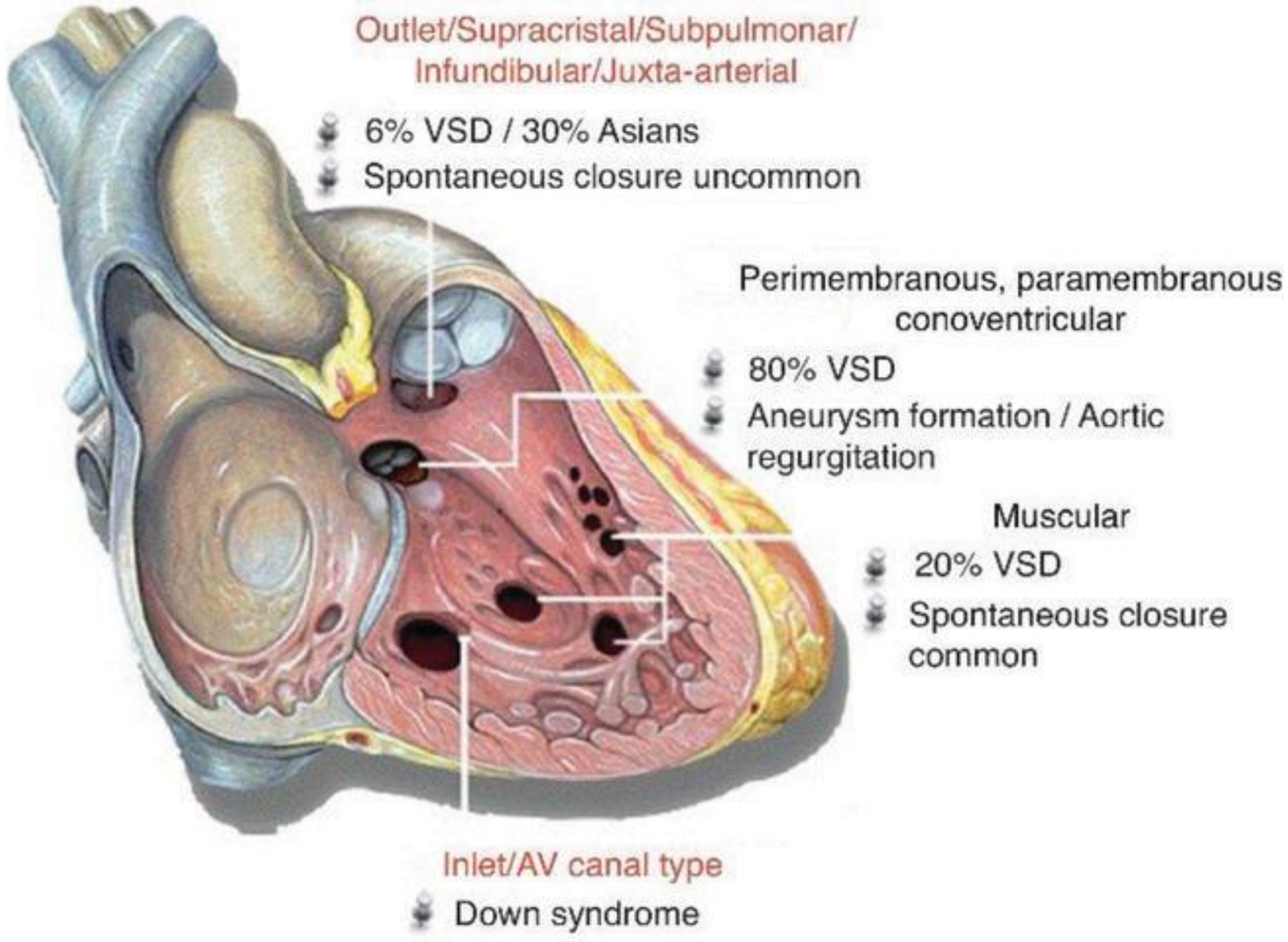






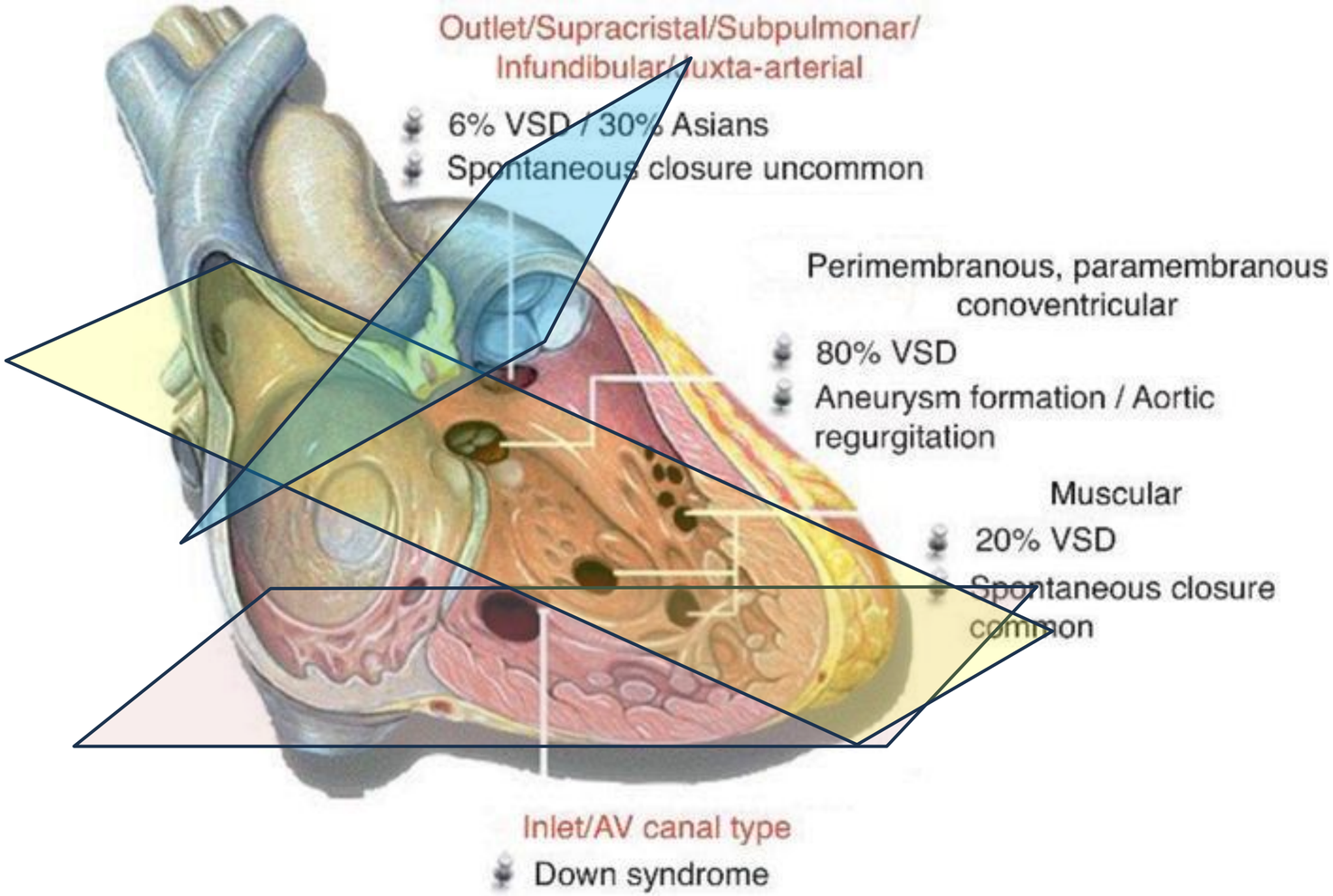


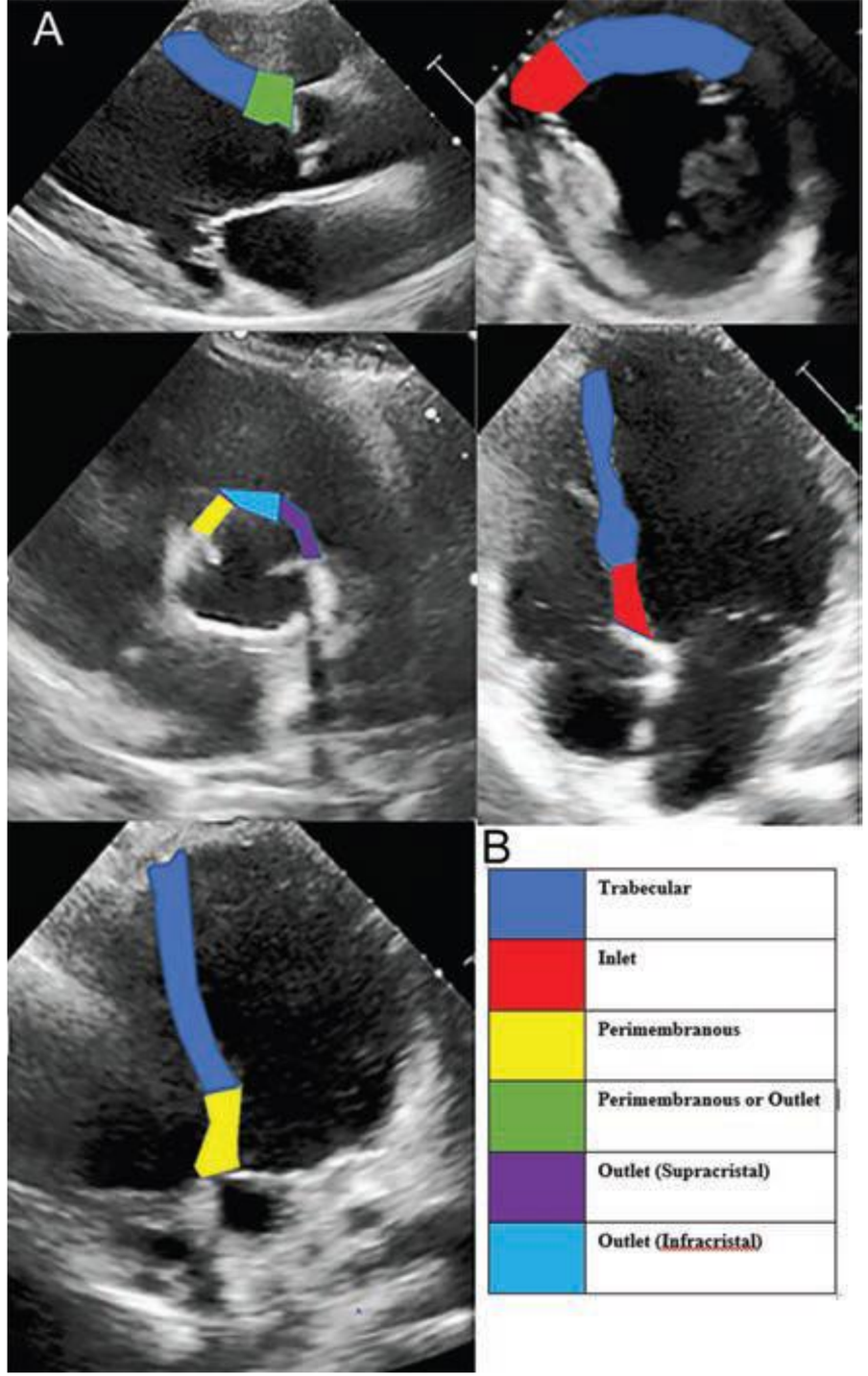
Ventricular Septal Defects (VSD)



- Connection between both ventricles.
- Septum is a broad area. VSDs are defined based on location and nearest structures
- Hemodynamics of VSDs occur due to pressure gradient between LV and RV
- During sytole, both ventricles pump together and blood doesn’t spend much time in RV but goes to lungs.
- The increased return to left heart then results in dilatation.
- However, in long term, the lungs can also develop pulmonay hypertension.

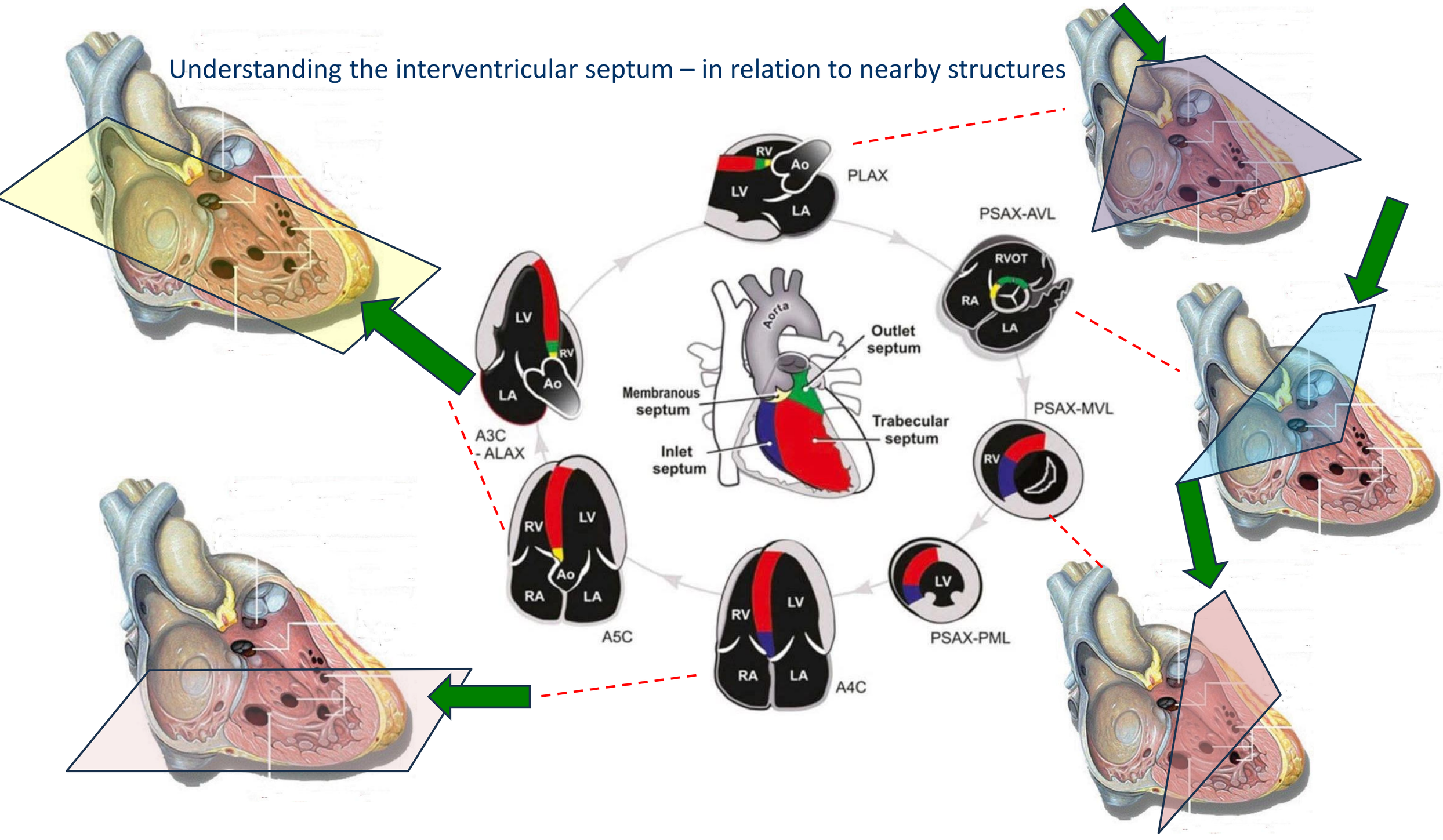
Ventricular Septal Defects (VSD)



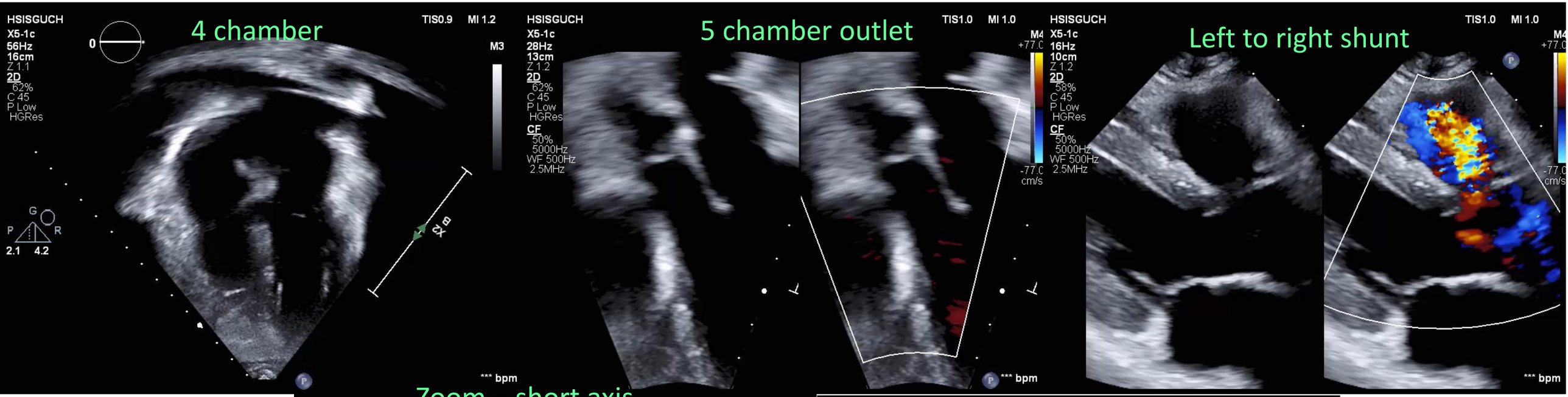


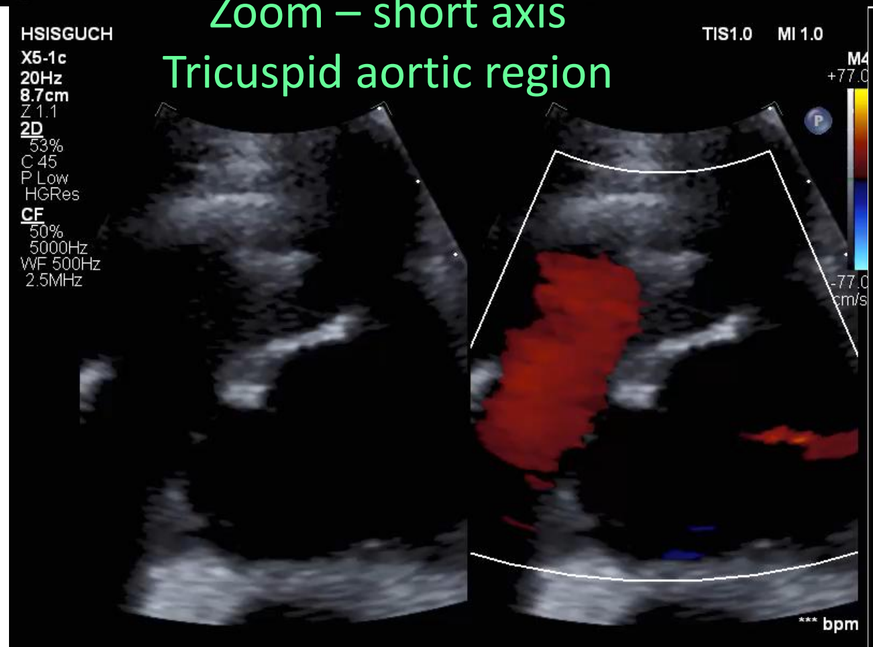
Septum is a broad area. VSDs are defined based on location and nearest structures

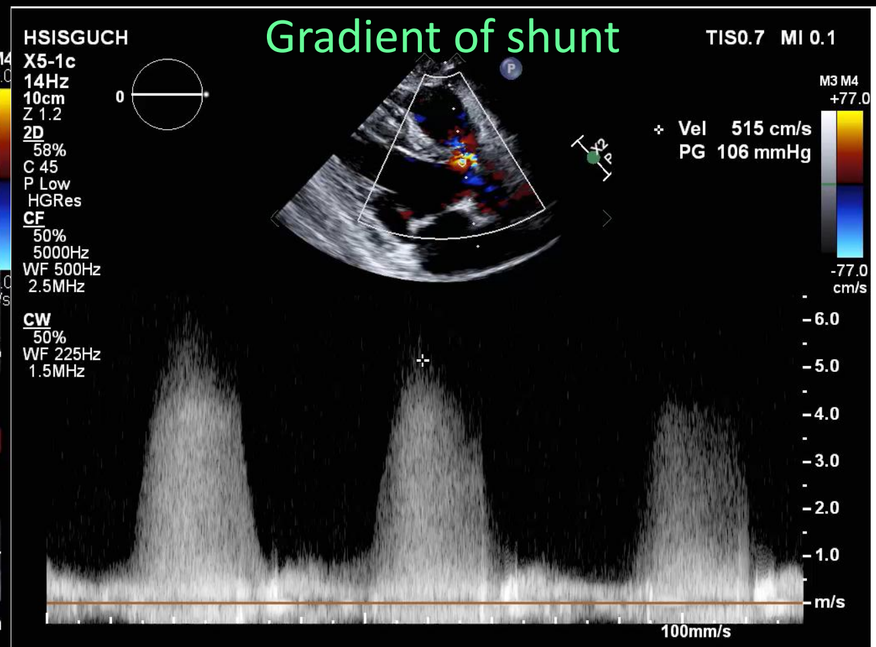
Understanding the interventricular septum – in relation to nearby structures



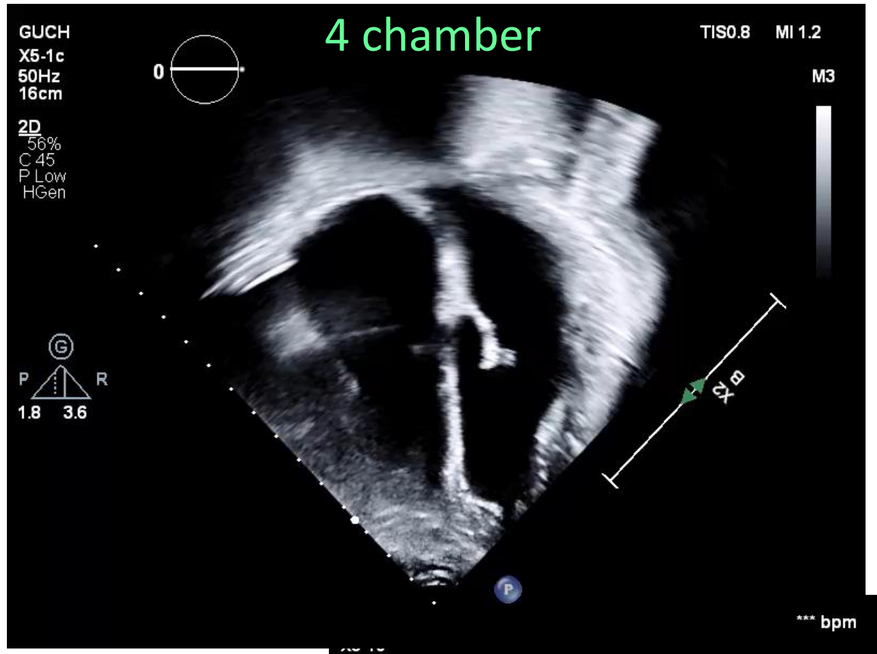
Ventricular Septal Defects – perimembranous, small

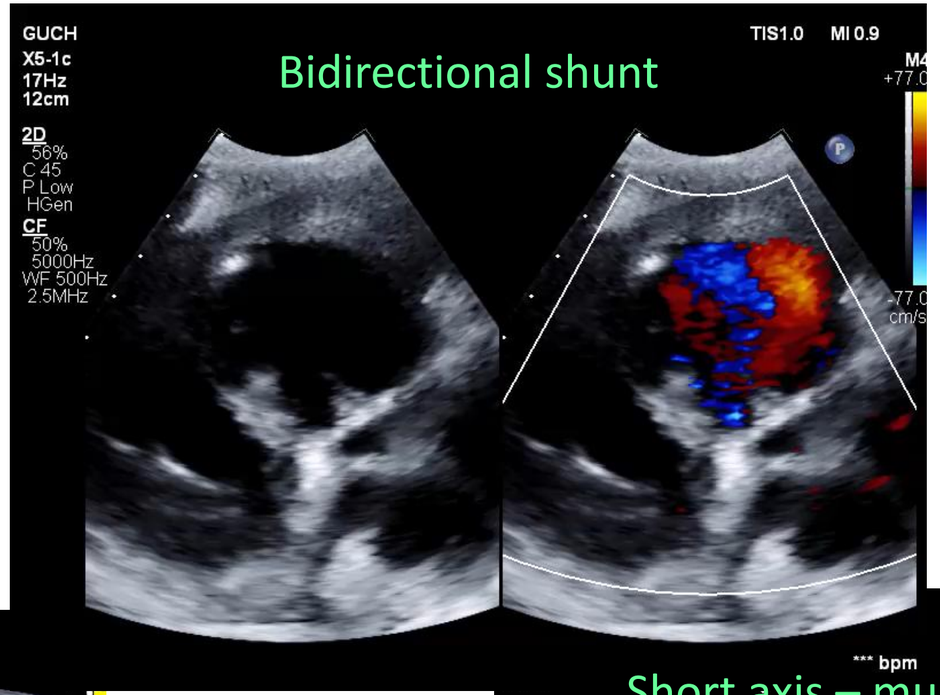


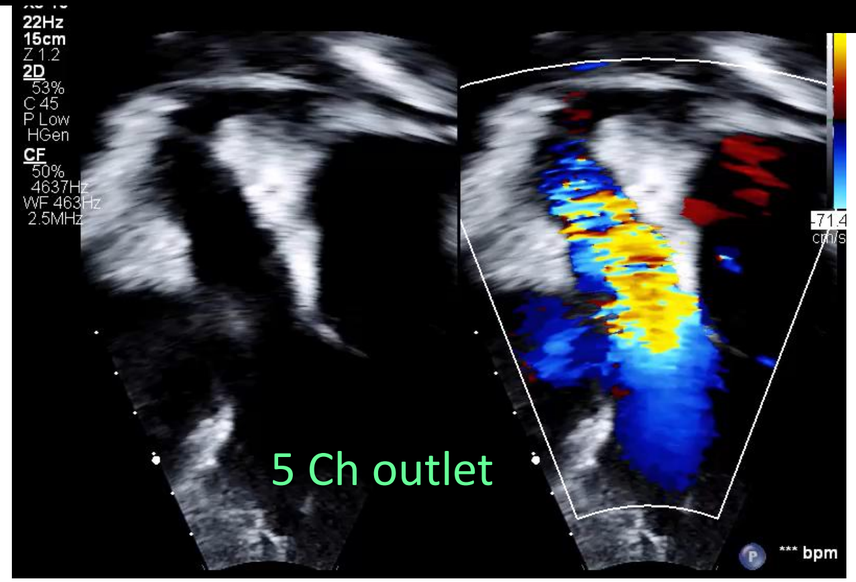


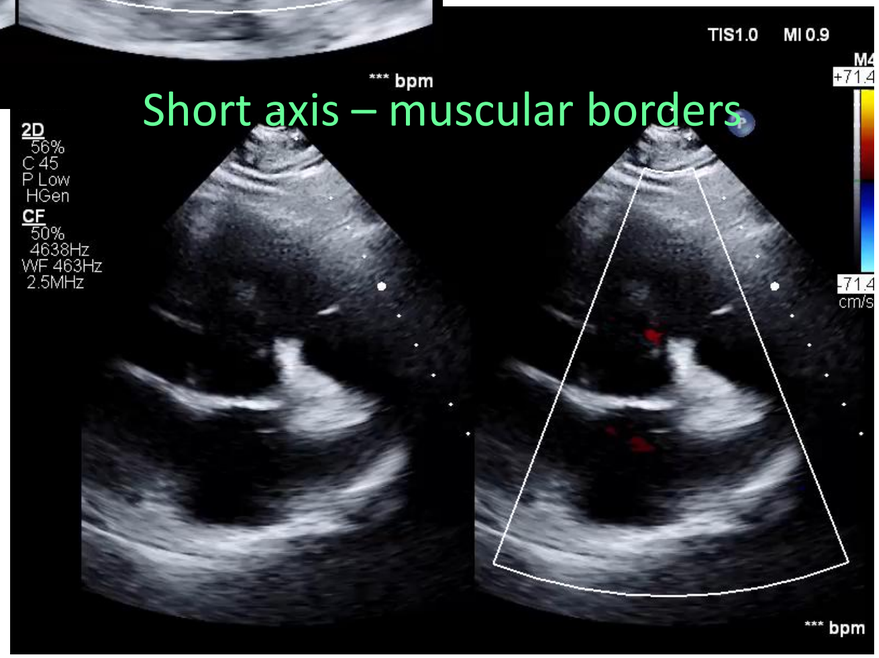


Muscular outlet VSD - Eisenmenger

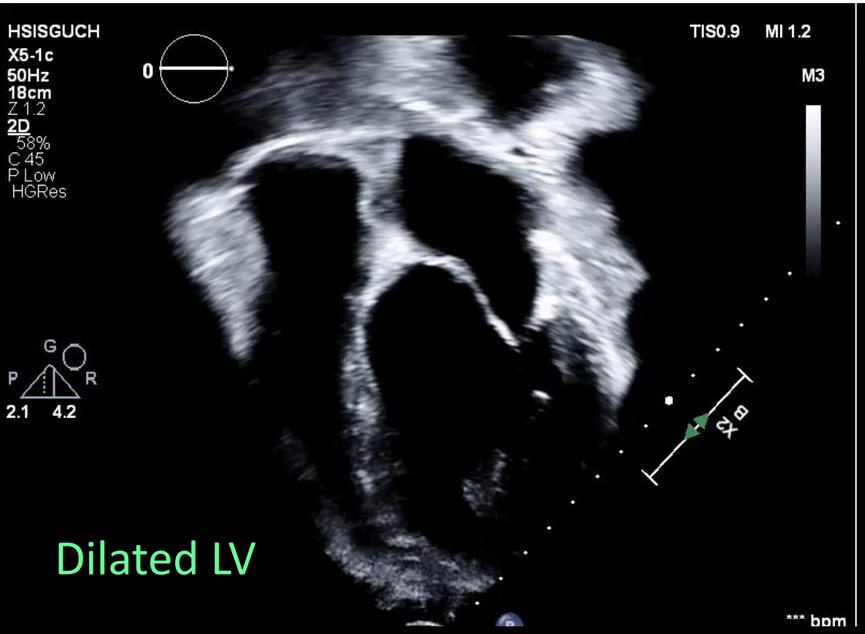




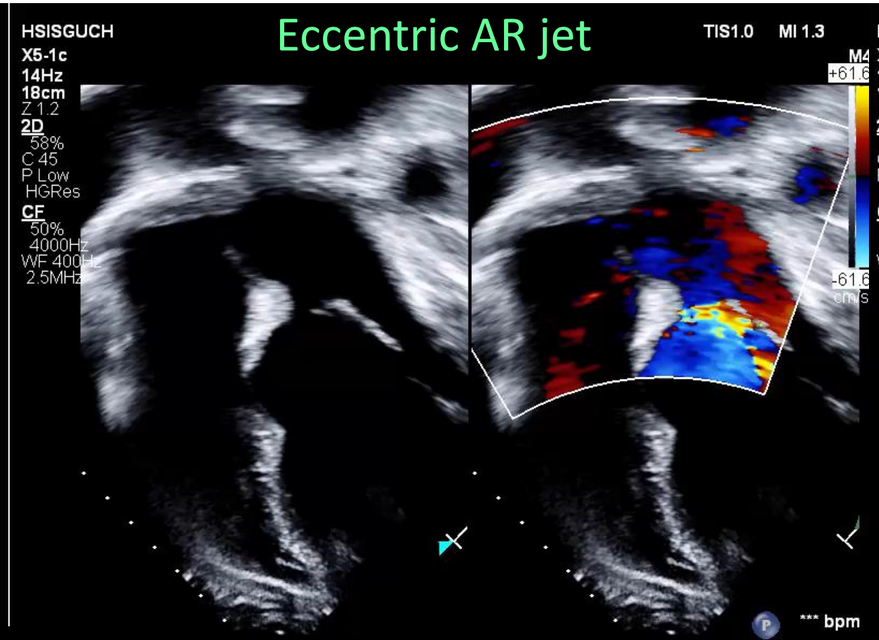




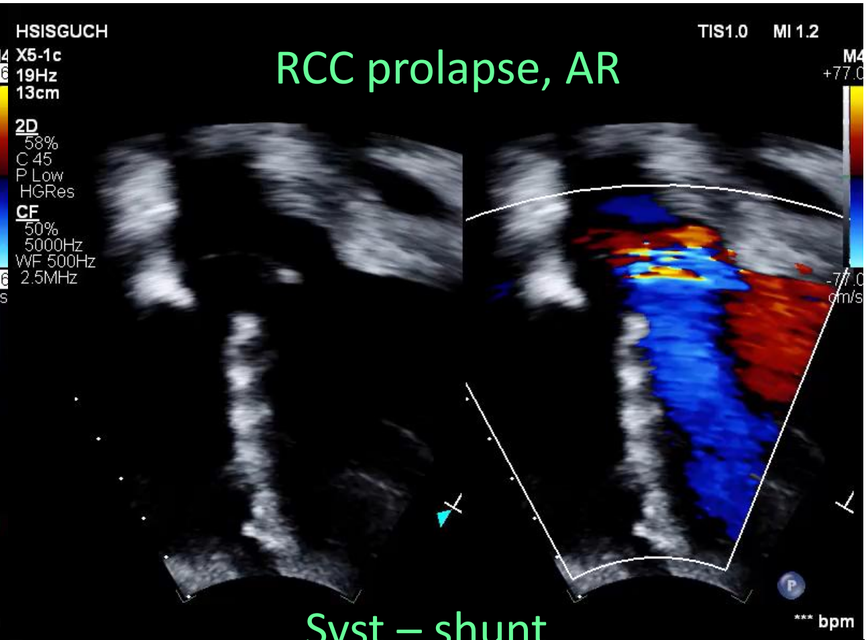
Doubly committed Subarterial VSD (DCSA)



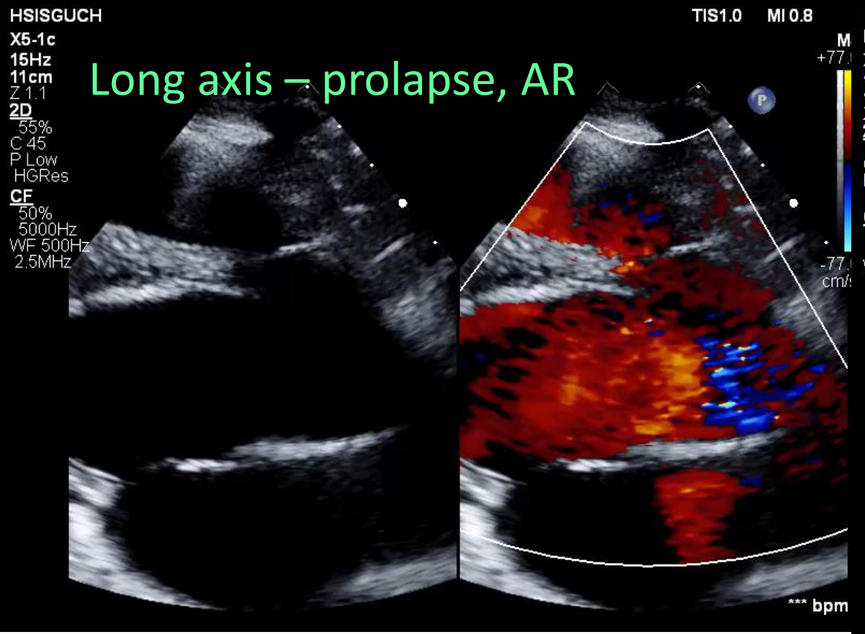
Dilated LV



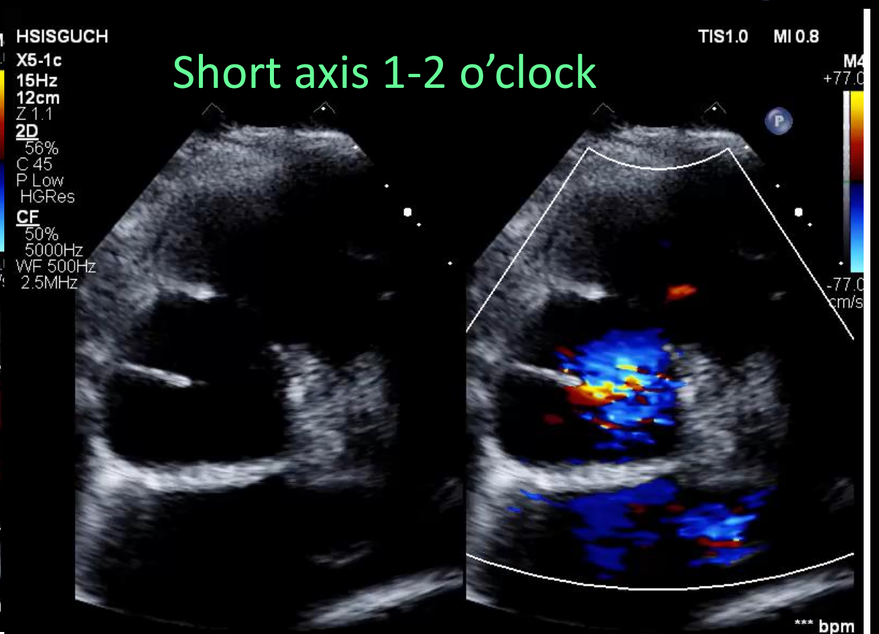
Eccentric AR jet



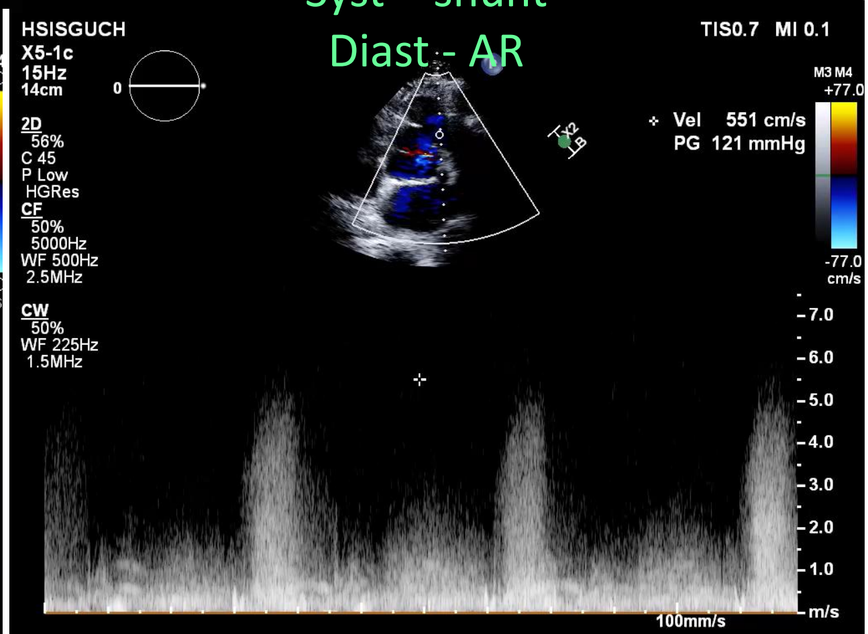
RCC prolapse, AR



Long axis – prolapse, AR



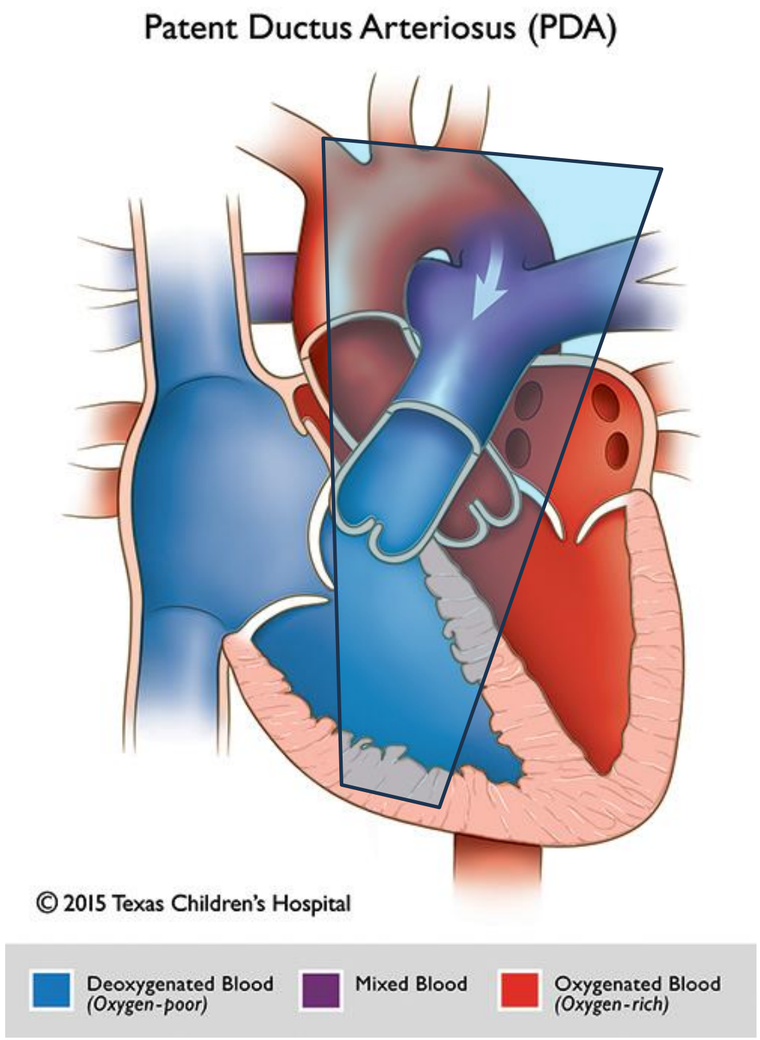
Short axis 1-2 o’clock

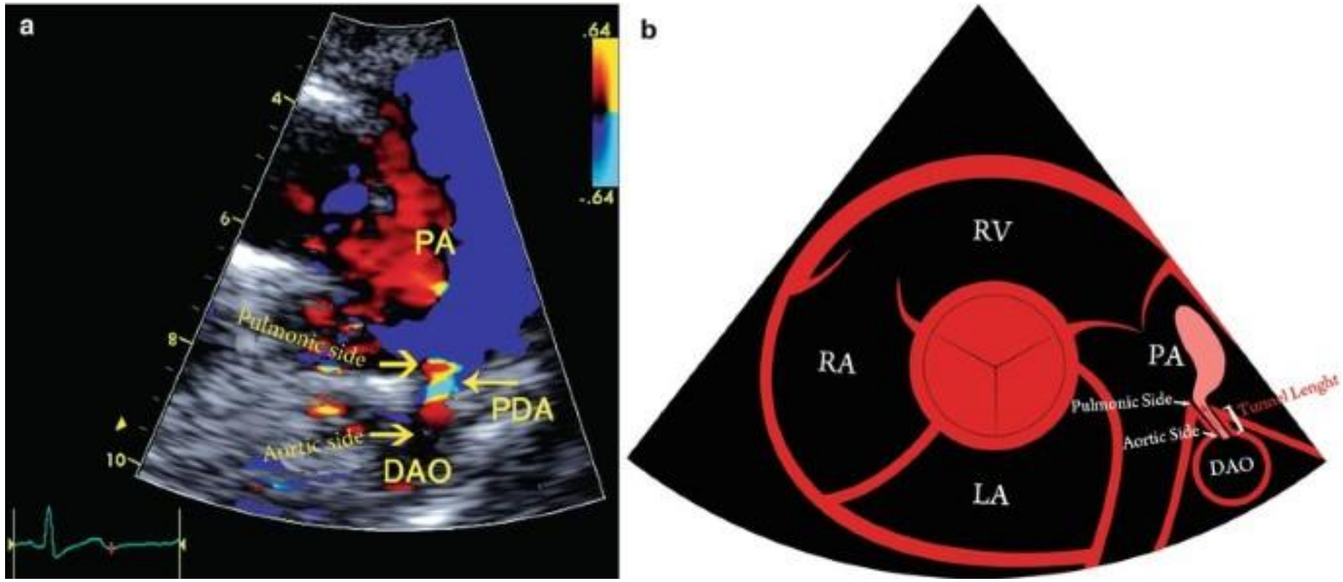


Syst – shunt

Diast – AR

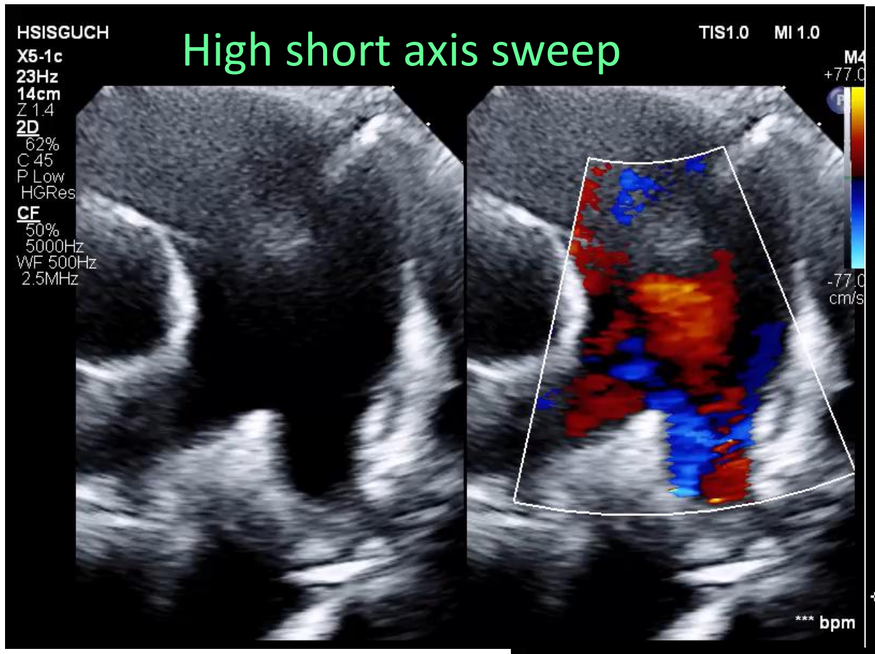
Patent Ductus Arteriosus - PDA

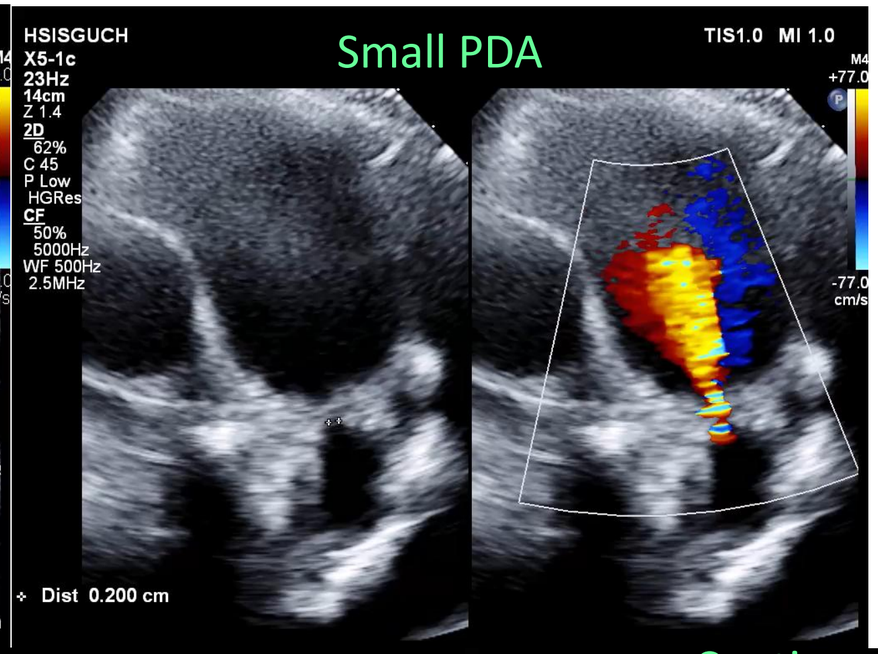


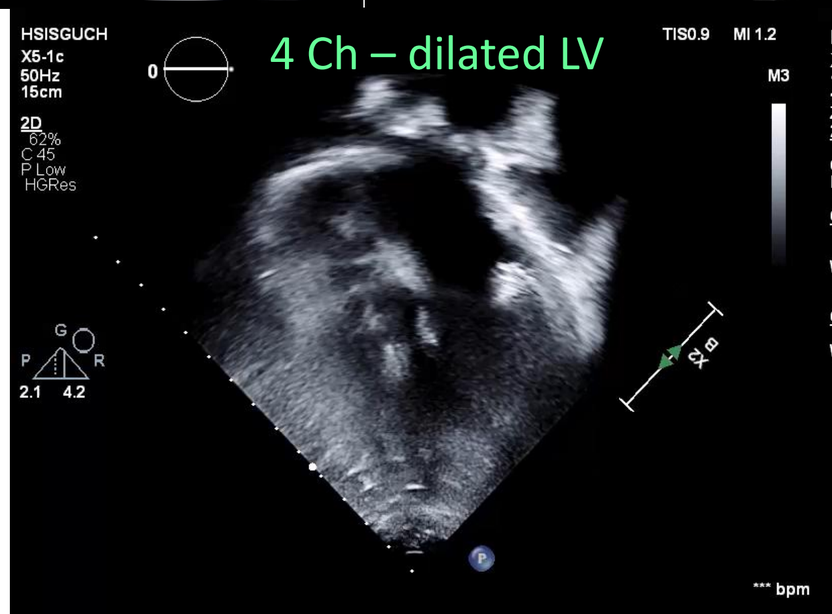


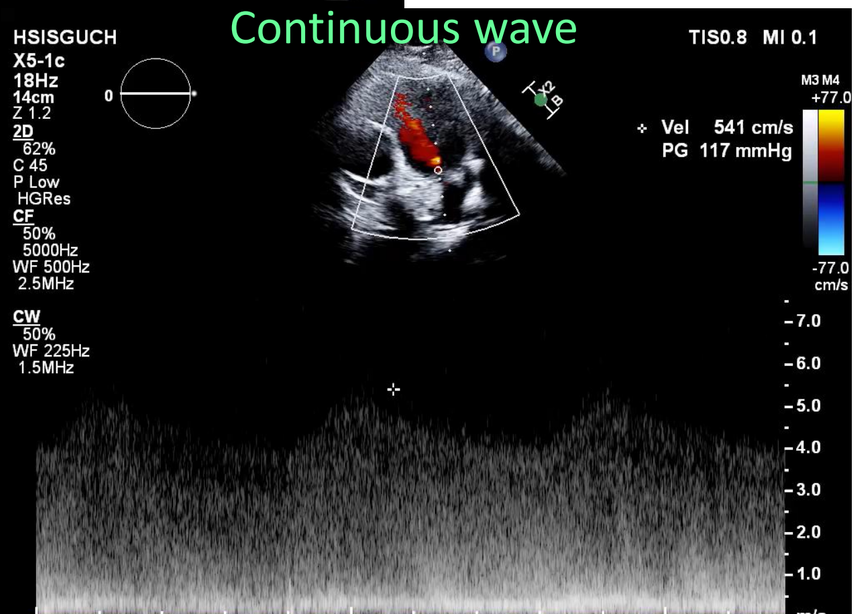
- Ductus arteriosus – communication between the Aorta and pulmonary artery
- In adults, may present with shortness of breath, fatigue, or rarely infective endocarditis
- It is extracardiac structure SUPERIOR to the heart
- From the short axis, modify slightly by sweeping up to see
- In children, suprasternal view may see the PDA but can be challenging in adults

PDA – left heart volume loading

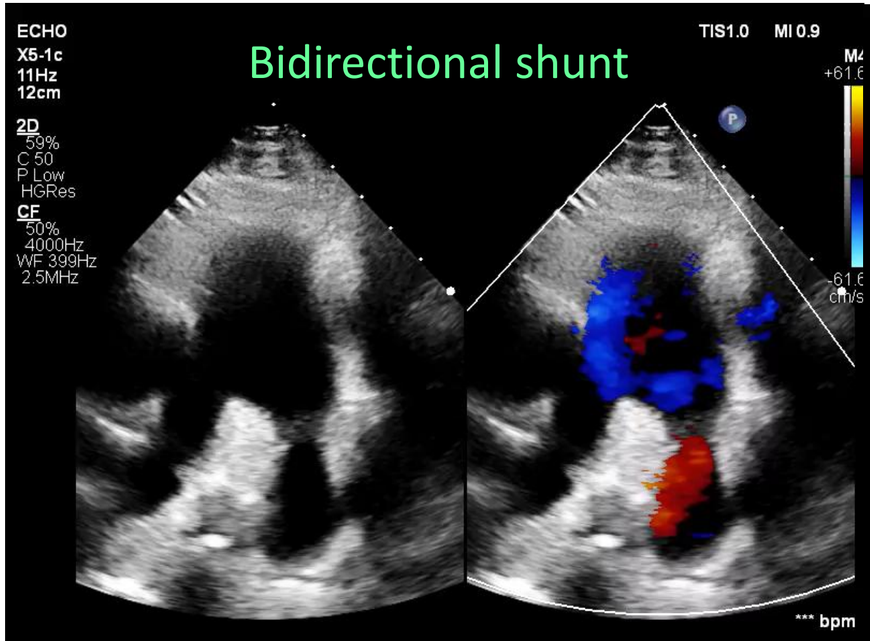


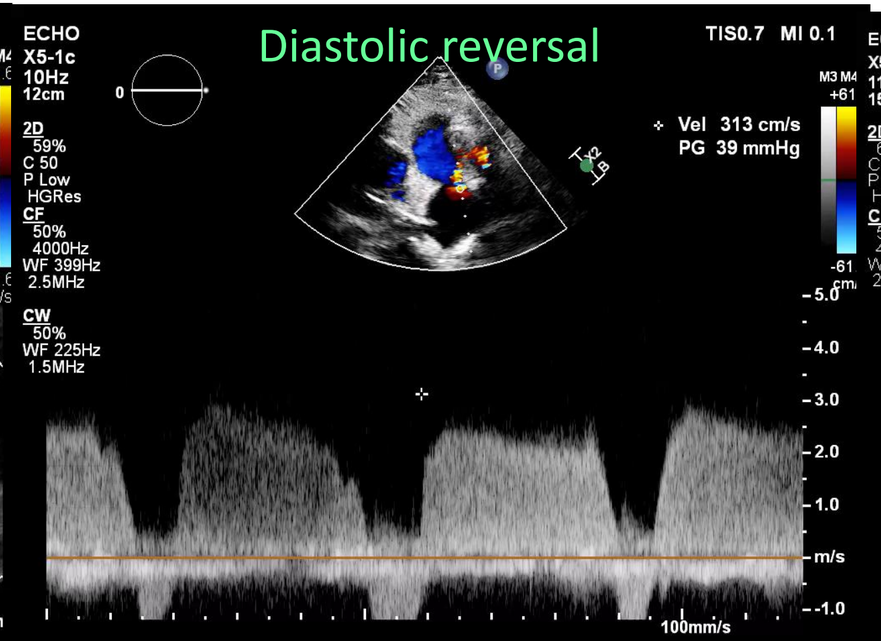


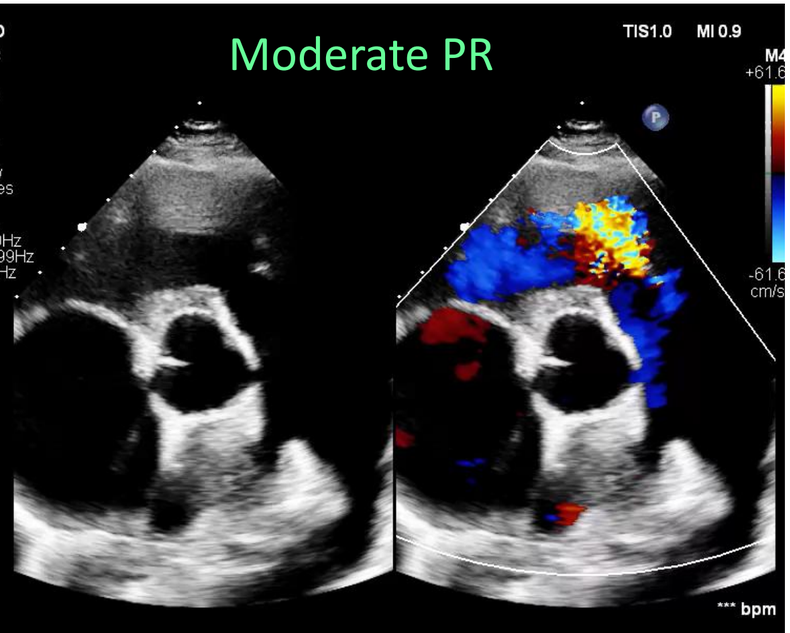


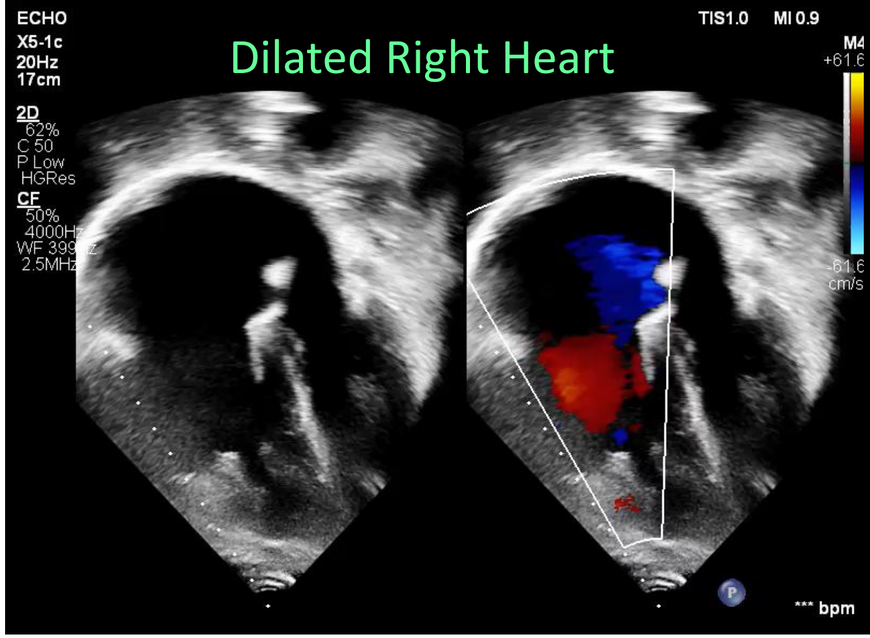


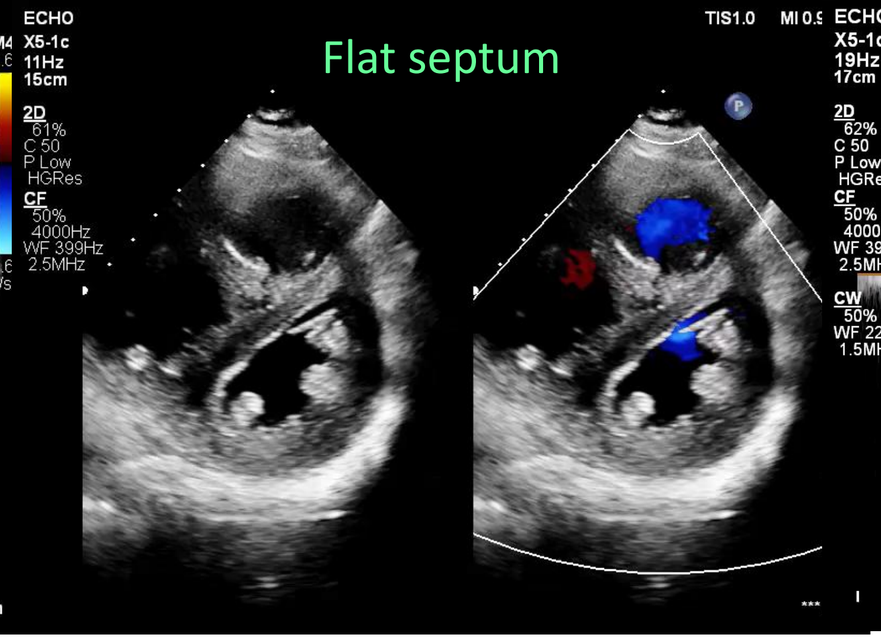
PDA - Eisenmenger

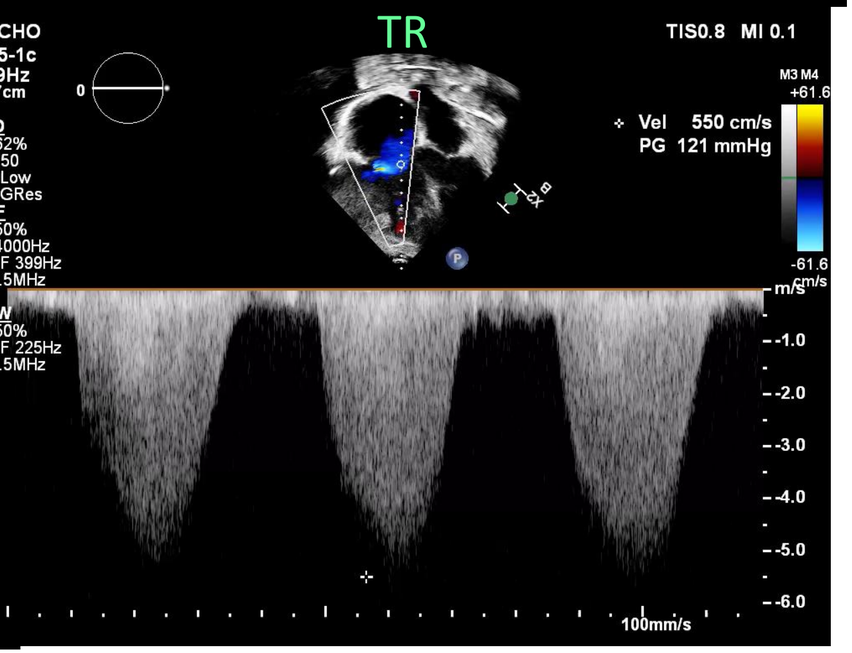






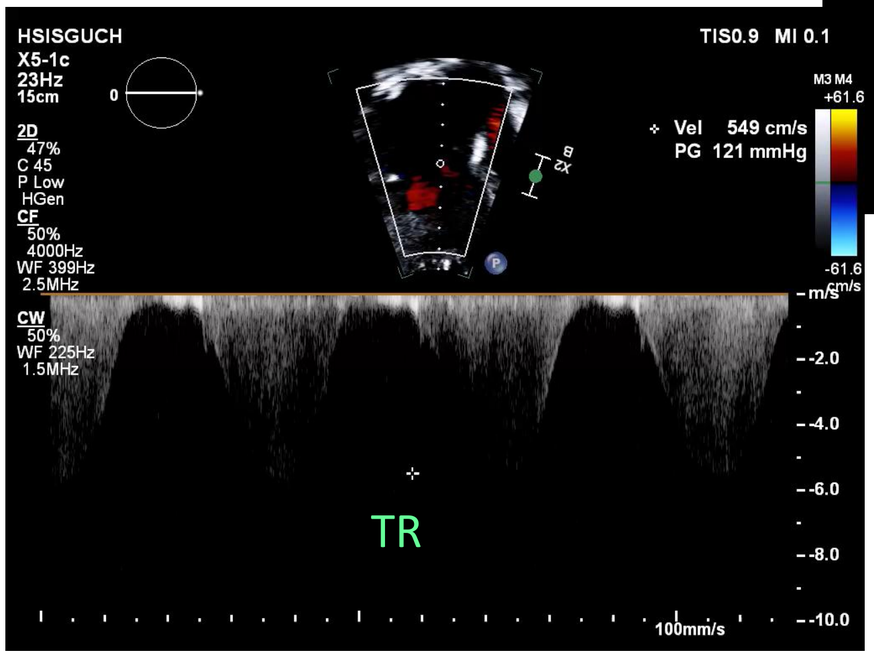


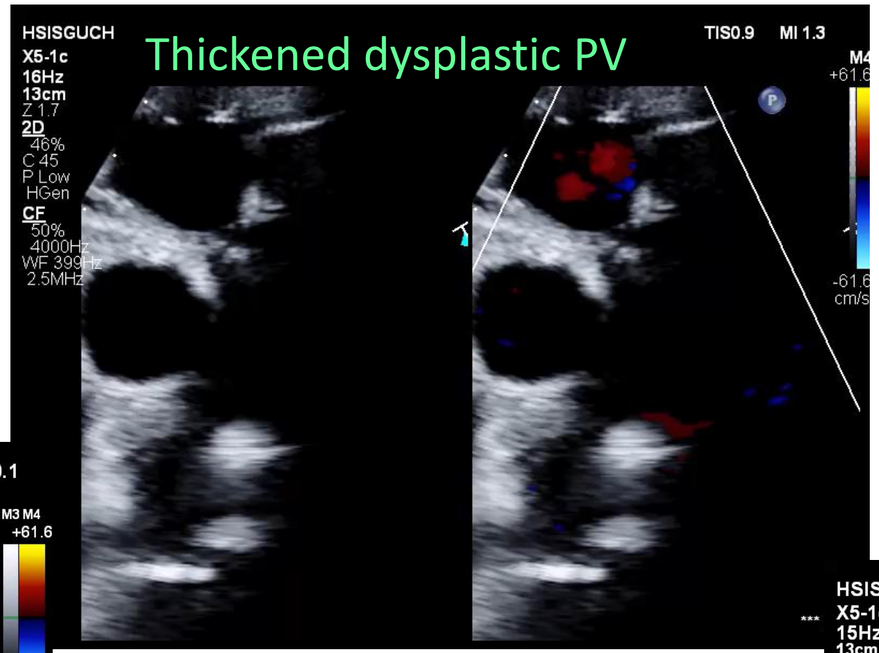




Pulmonary Stenosis

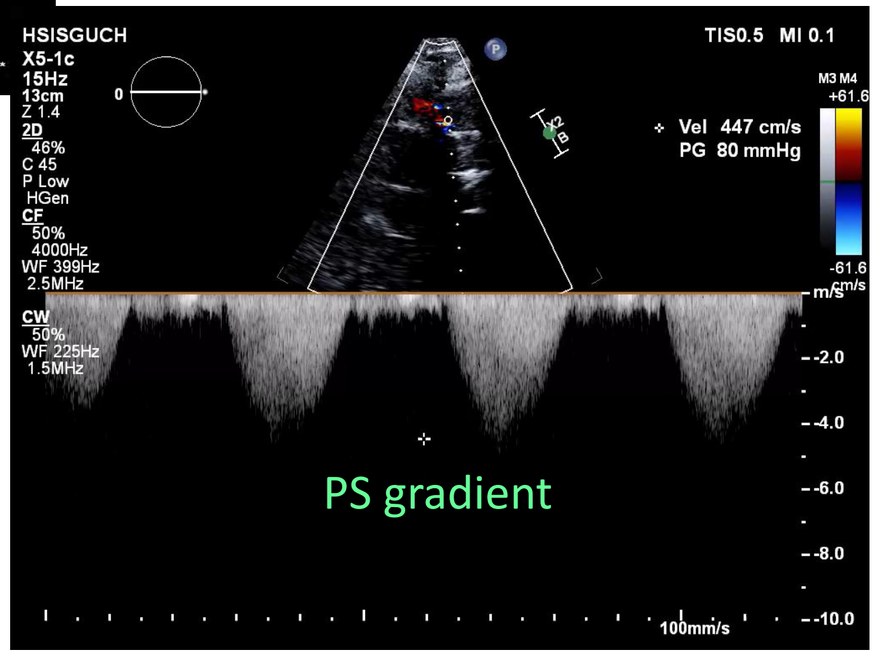
Very high TR gradient –
DON'T Jump to conclude Pulm Hypertension !!!





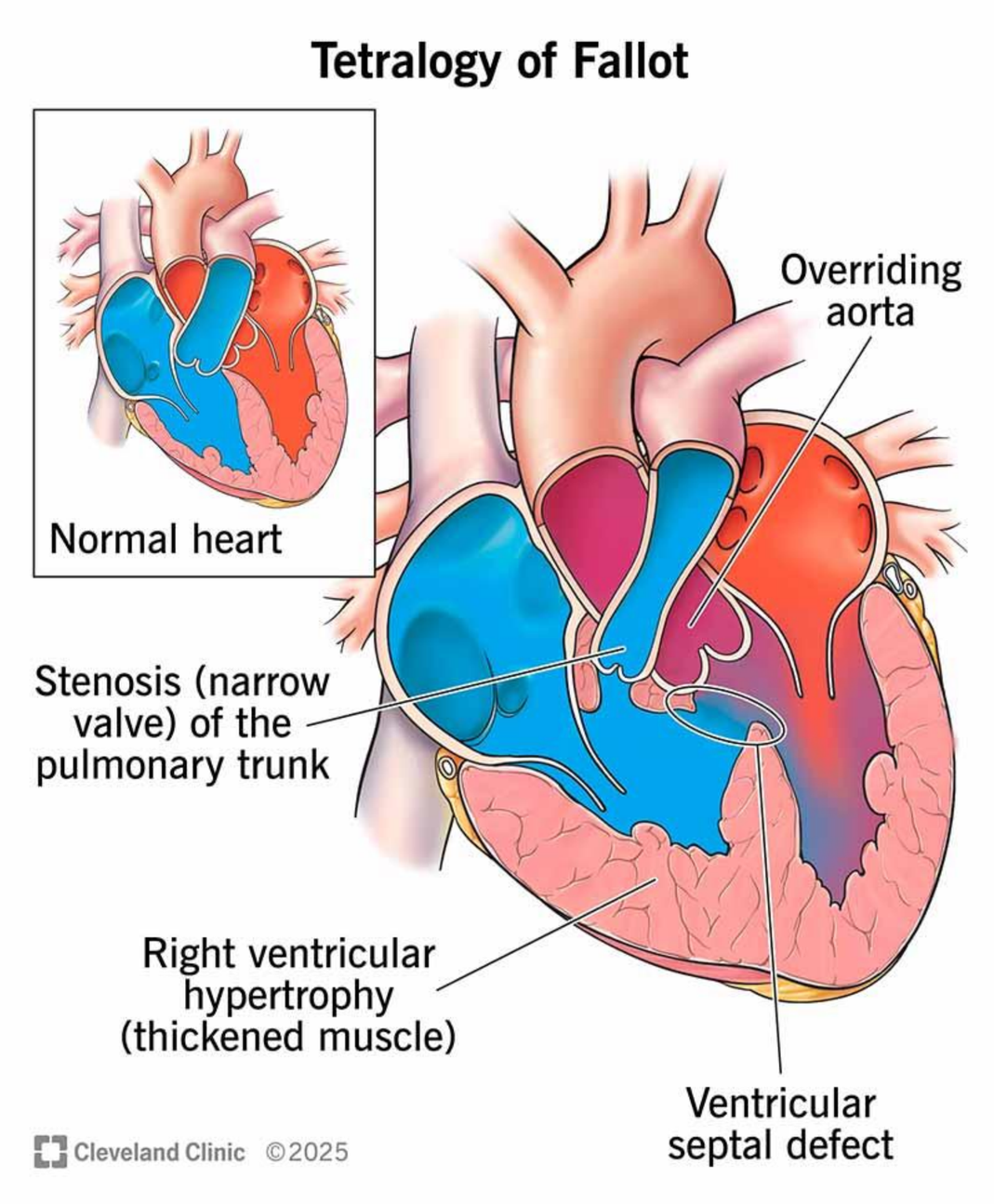
Check pulmonary valve

Severe pulmonary stenosis
- CURABLE condition

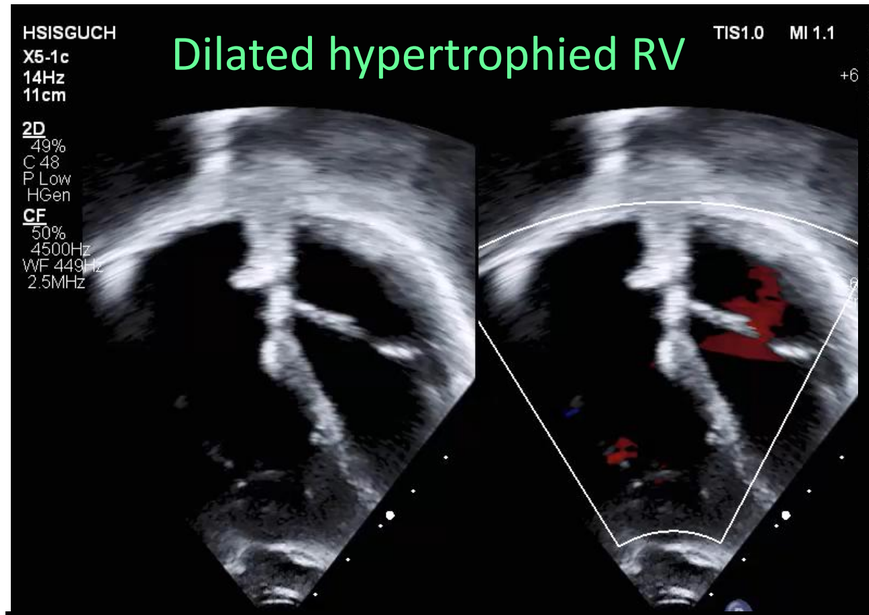


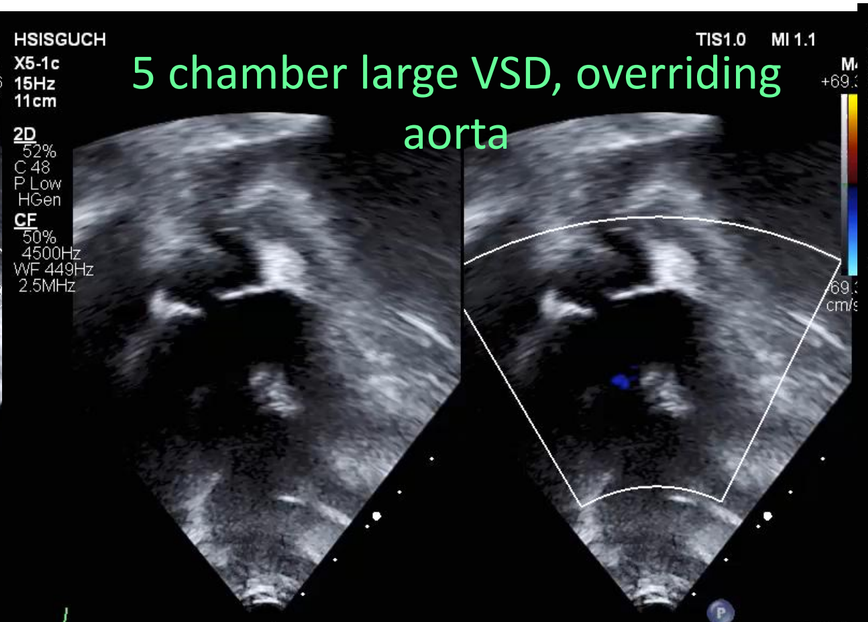
Tetralogy of Fallot

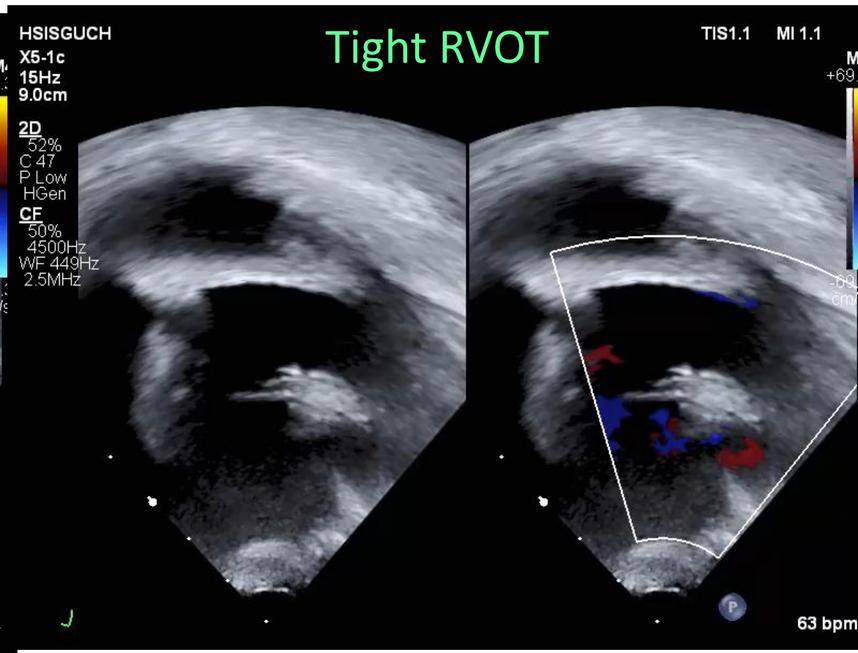
- VSD
- Overriding of aorta
- Pulmonary stenosis
- RVH

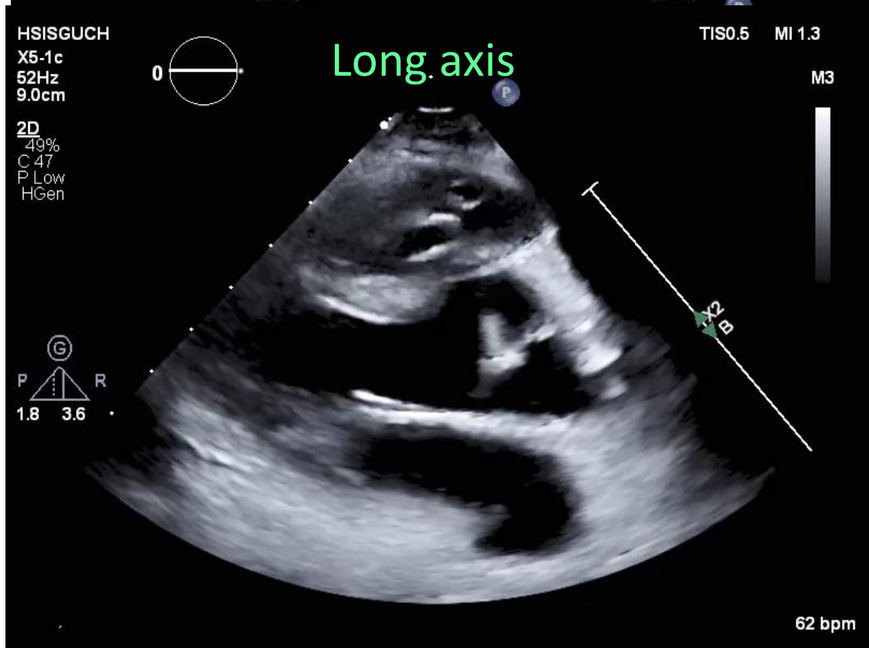


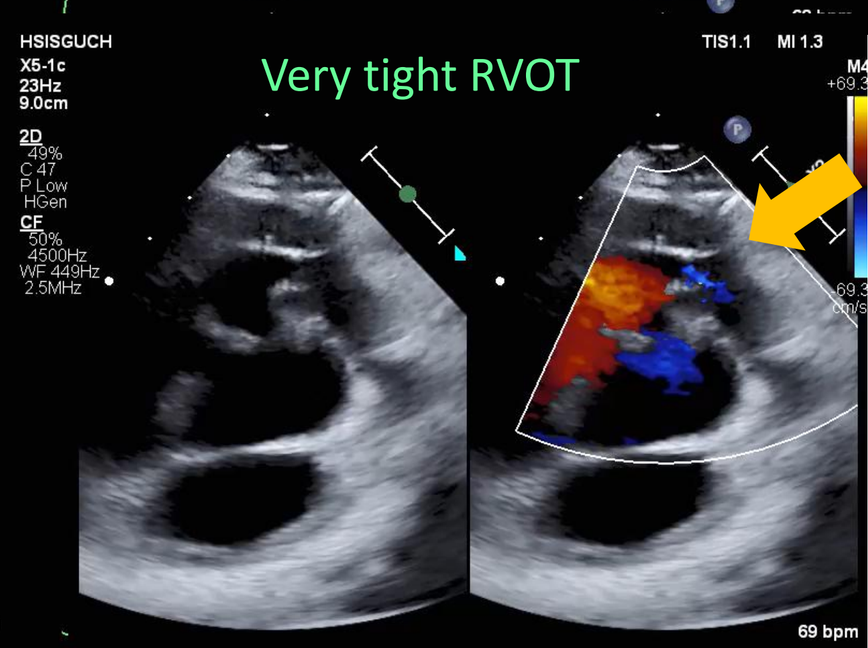
Tetralogy of Fallot – severe subvalvular (infundibular) pulmonary stenosis





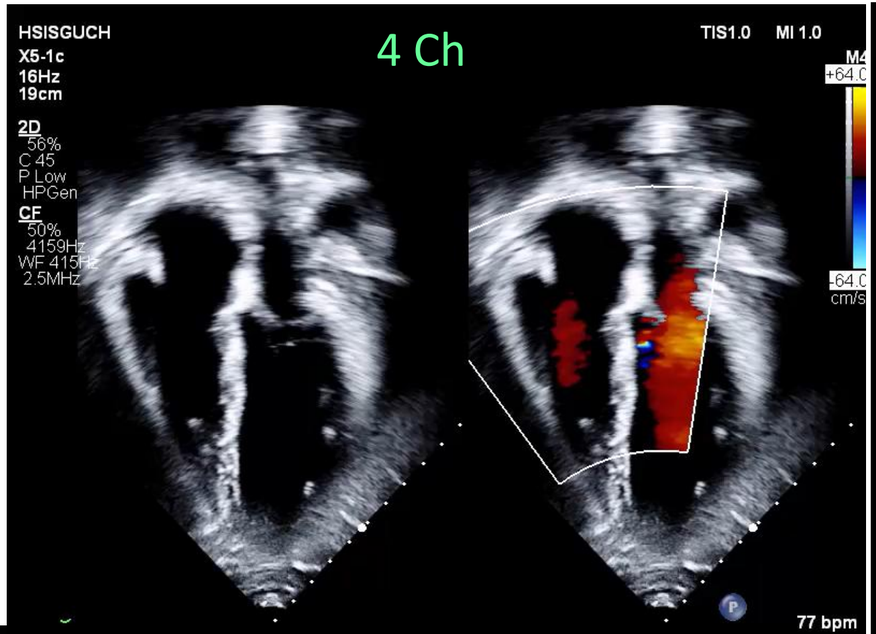


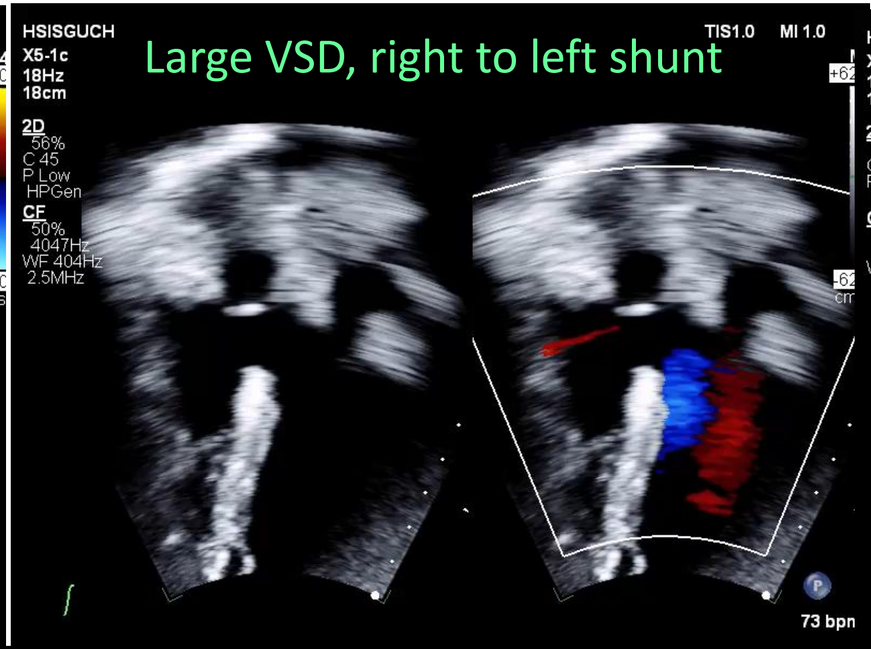


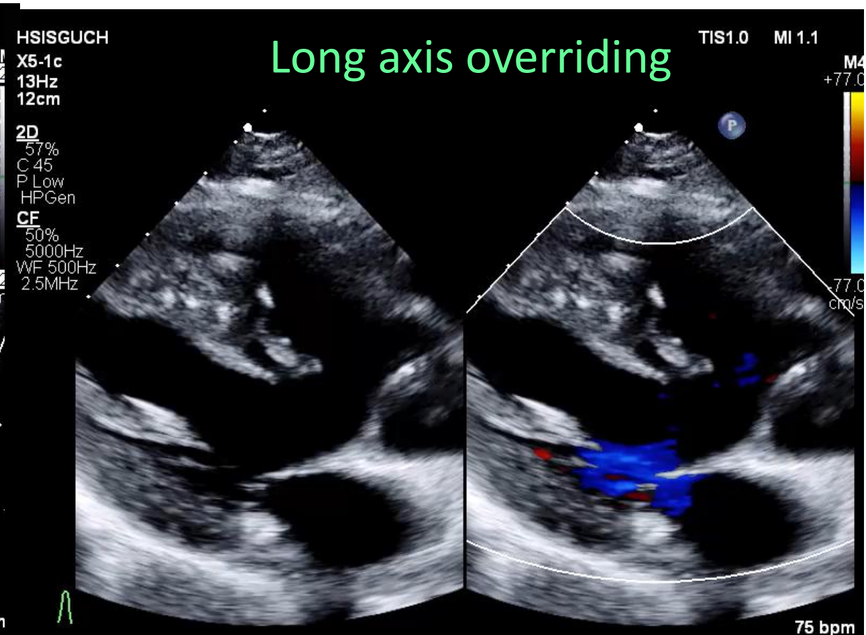


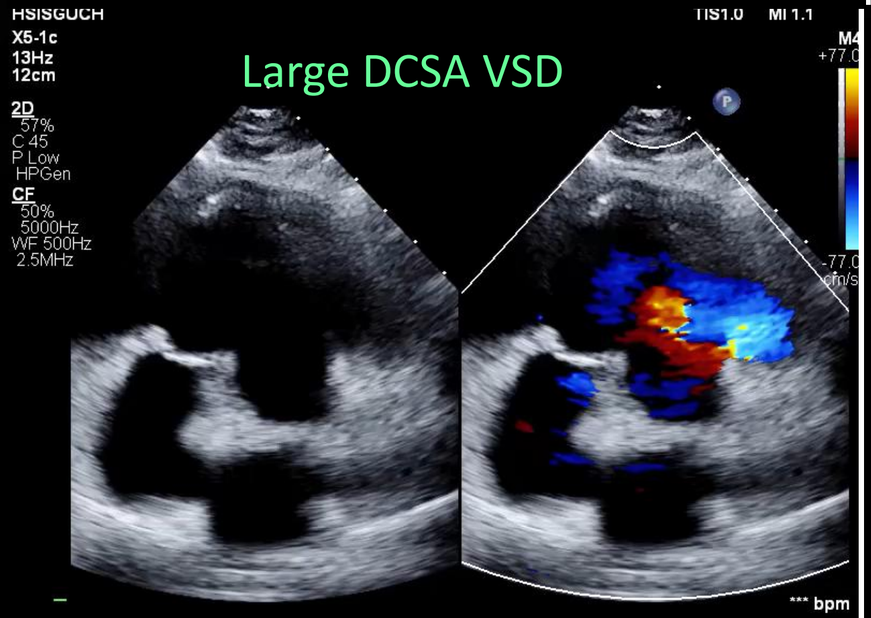
RVOT – (most anterior structure)
tightly stenosed
Anterocephalad deviation of outlet septum

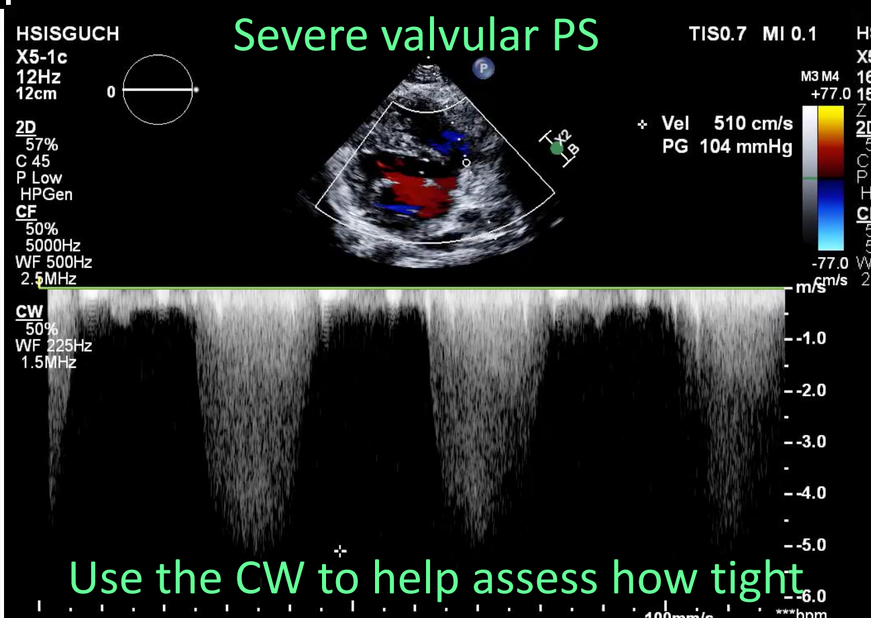
TOF –PS example 2 – DCSA VSD, severe valvular, supravalvular stenosis

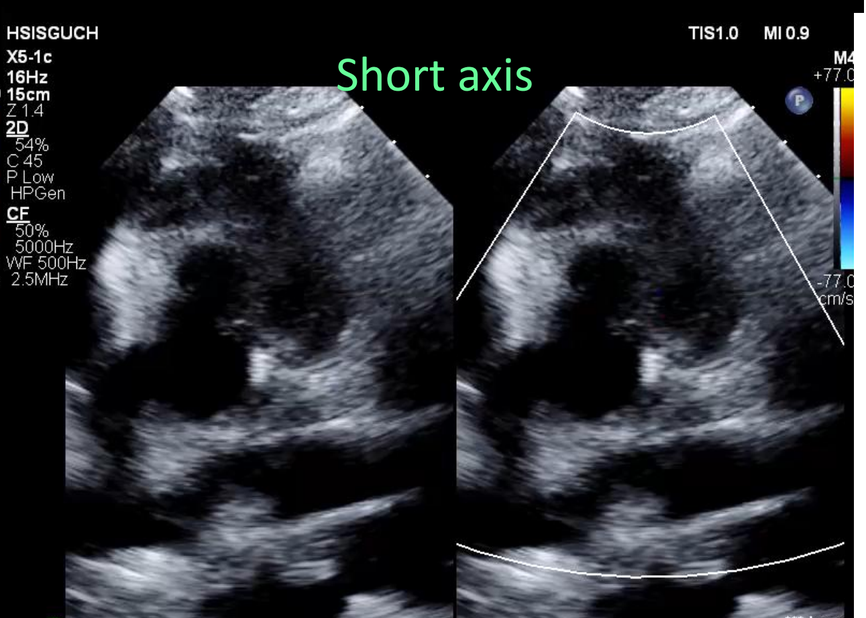




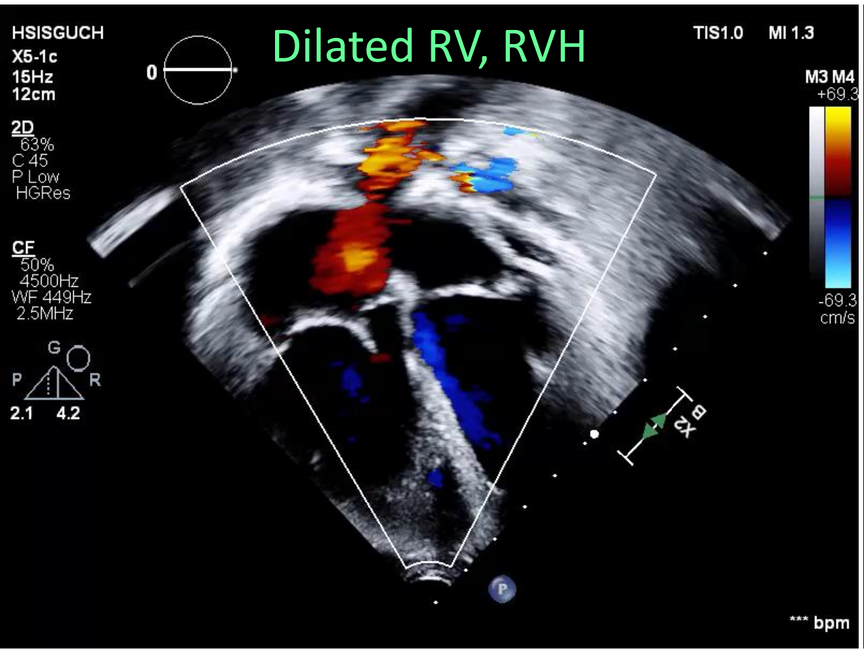


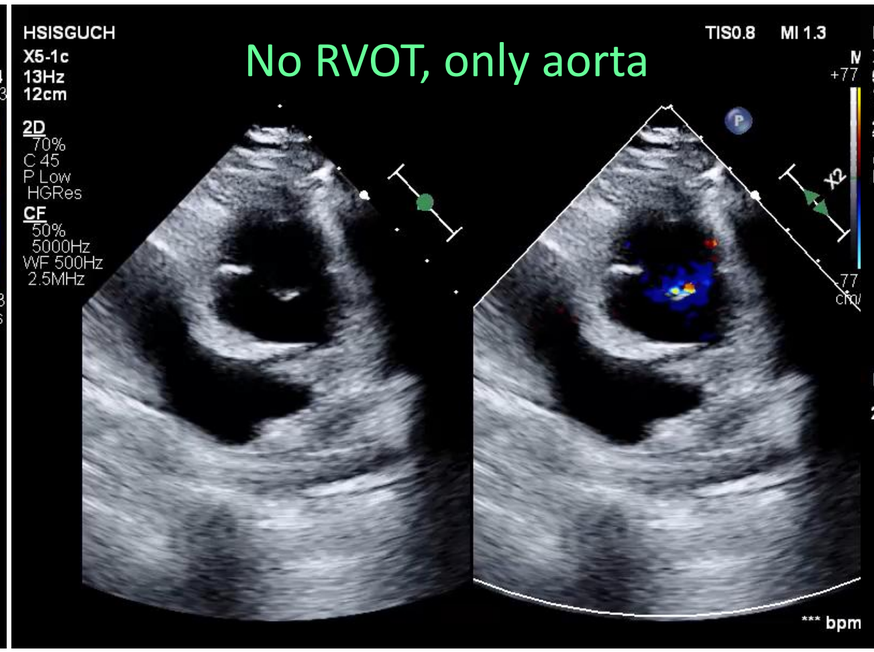


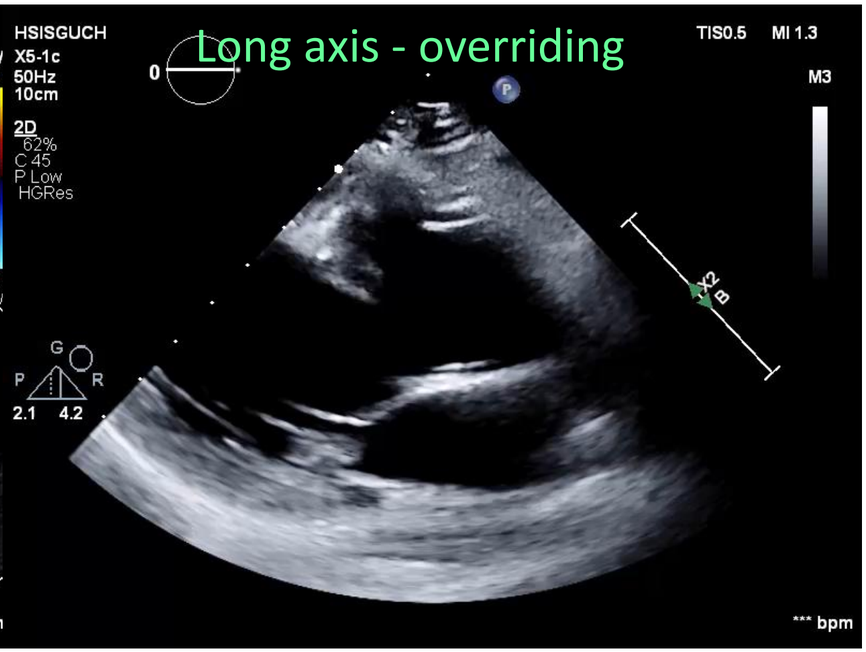




TOF – Pulmonary atresia (absent RV to pulmonary connection)







Extreme squeeze. No RVOT.

Behind the chest wall is directly aorta

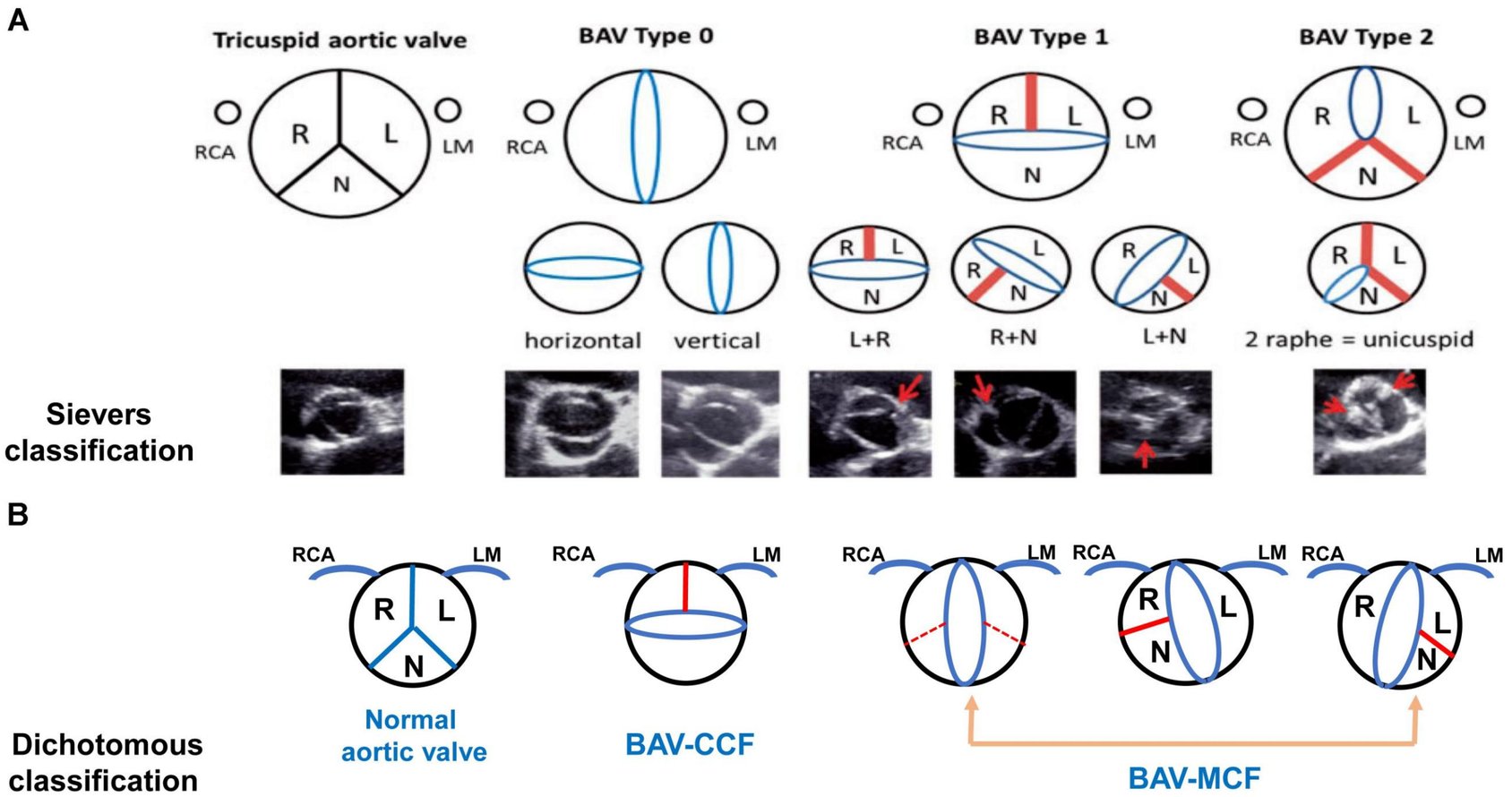
Important :

Study entire ECHO before deciding cause of the RV dilatation or right to left shunting

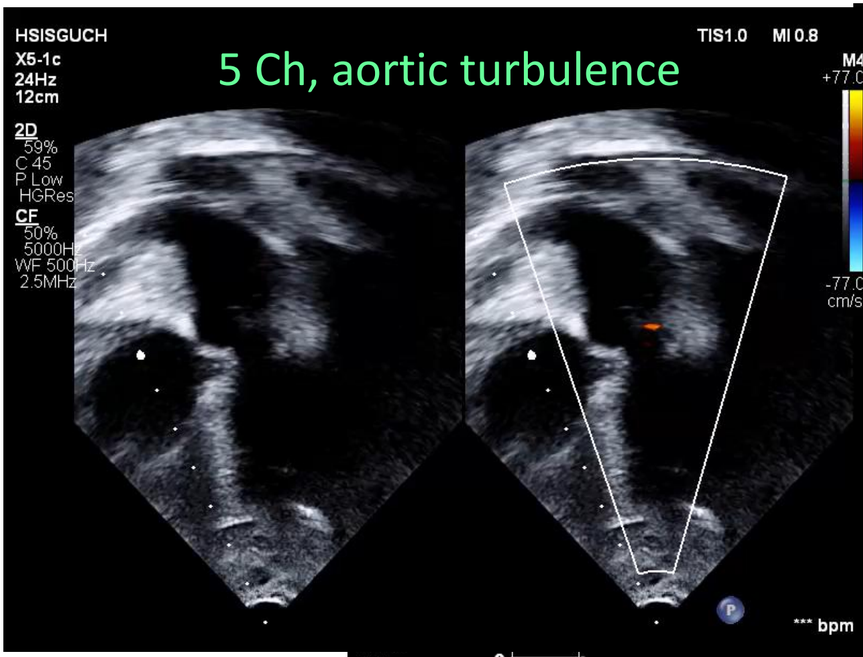
High TR gradient ≠ pulmonary hypertension if there is obstruction

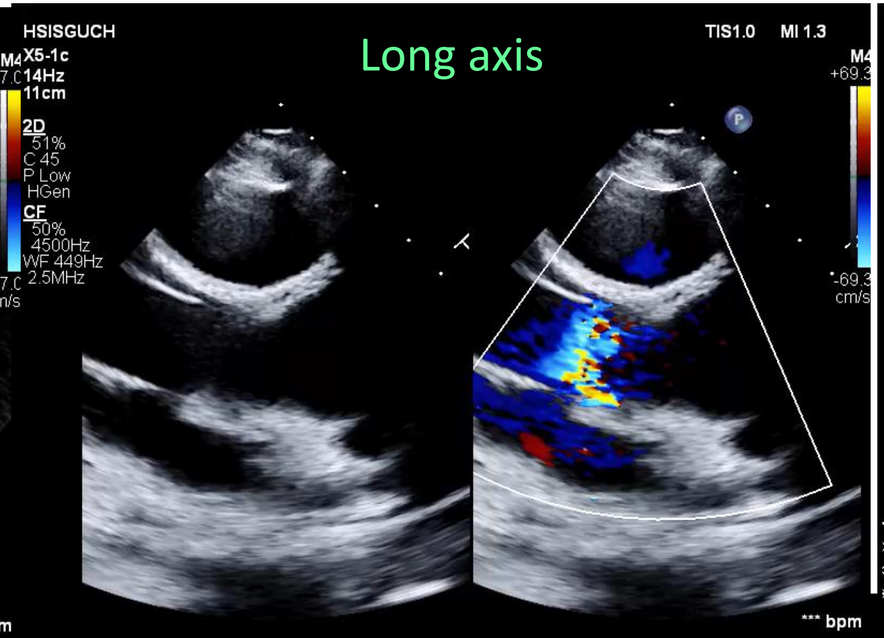
Bicuspid aortic valve

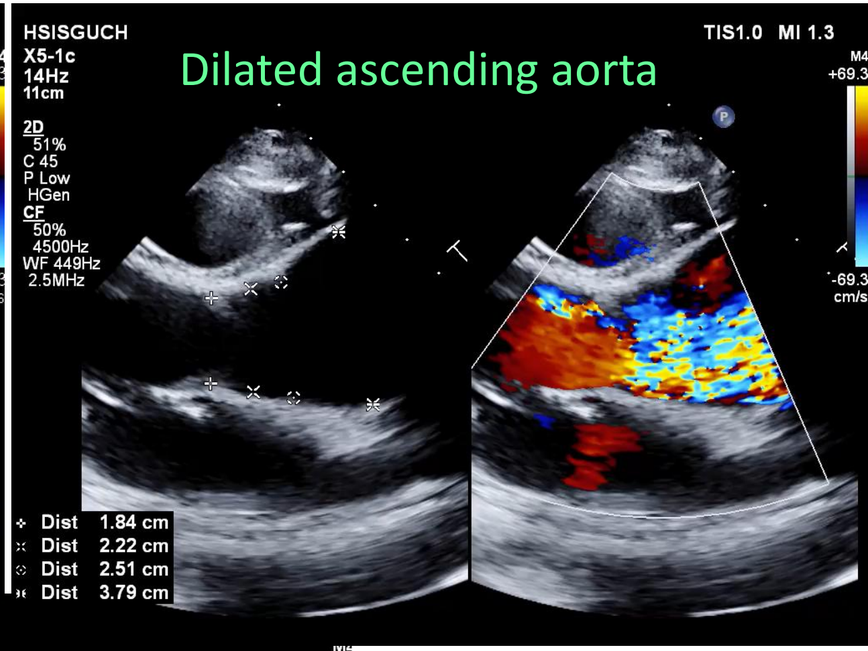
- Suspect when :
  - Doming / thickened valve
  - Stenosis/ regurgitation
  - Dilated ascending aorta

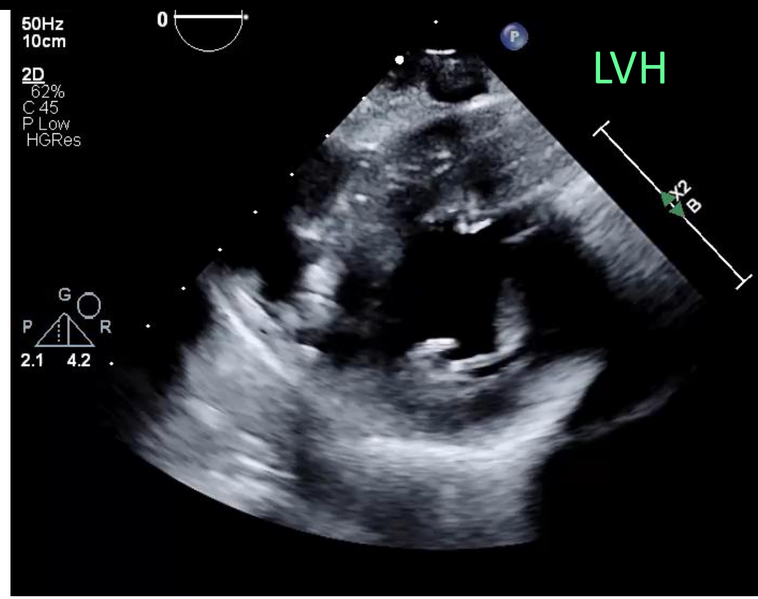


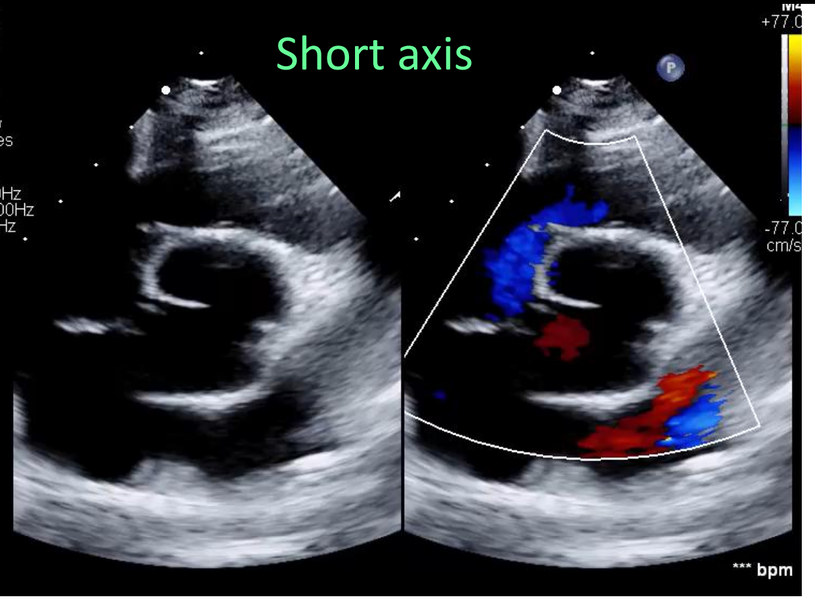
Bicuspid aortic valve – horizontal type



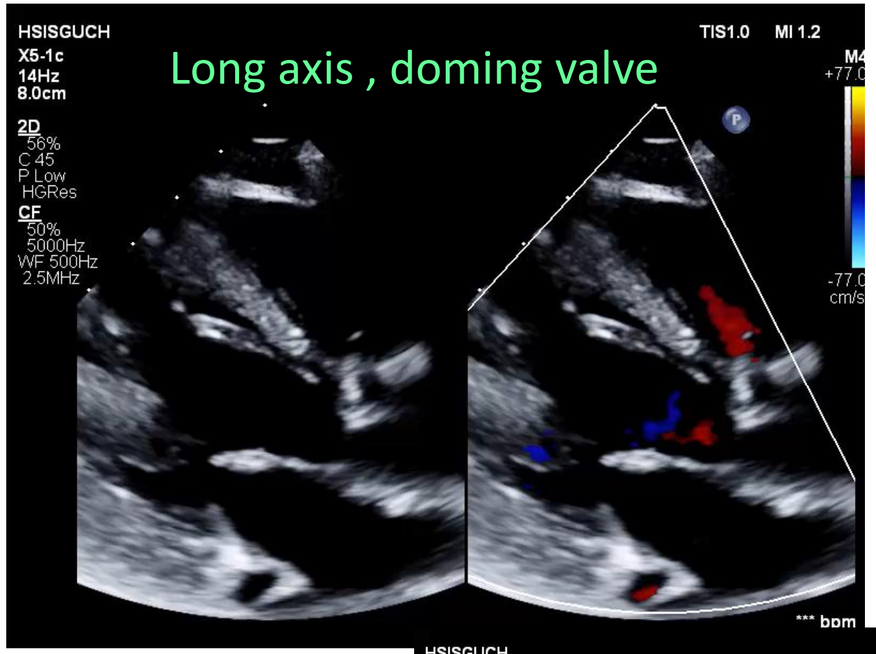


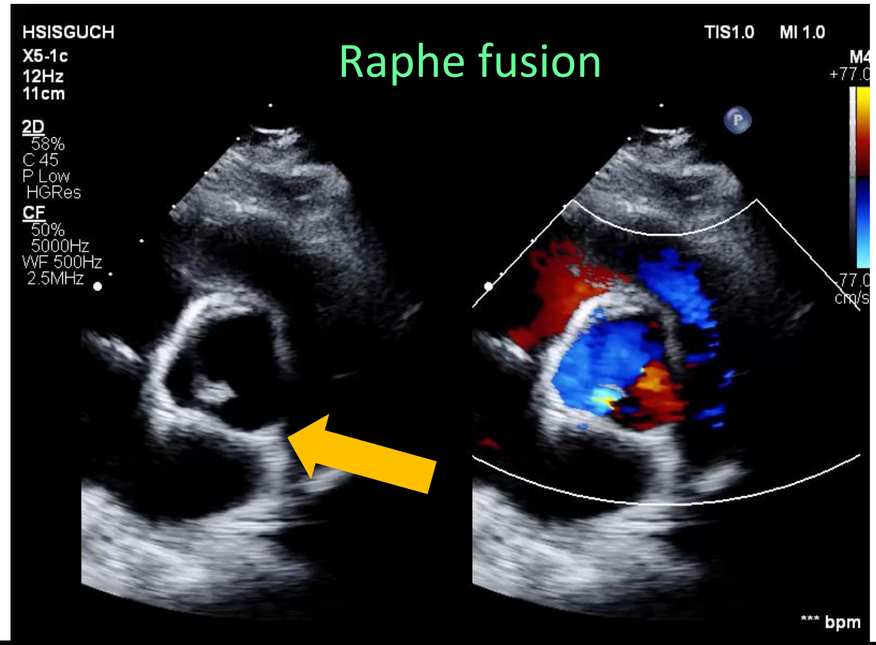


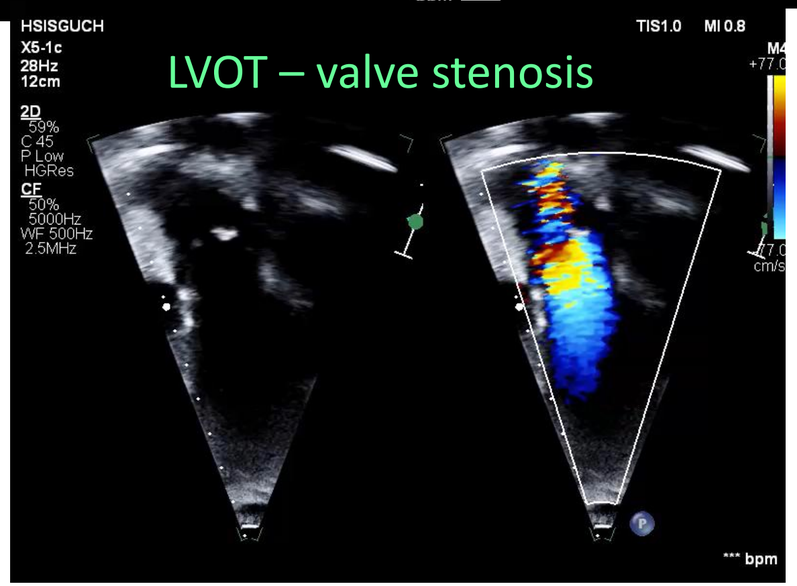


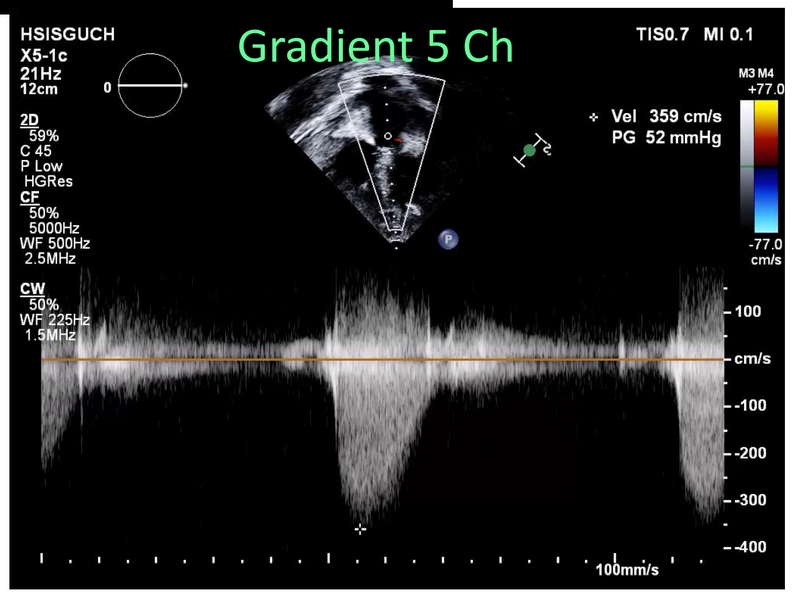


BAV – fusion of raphe

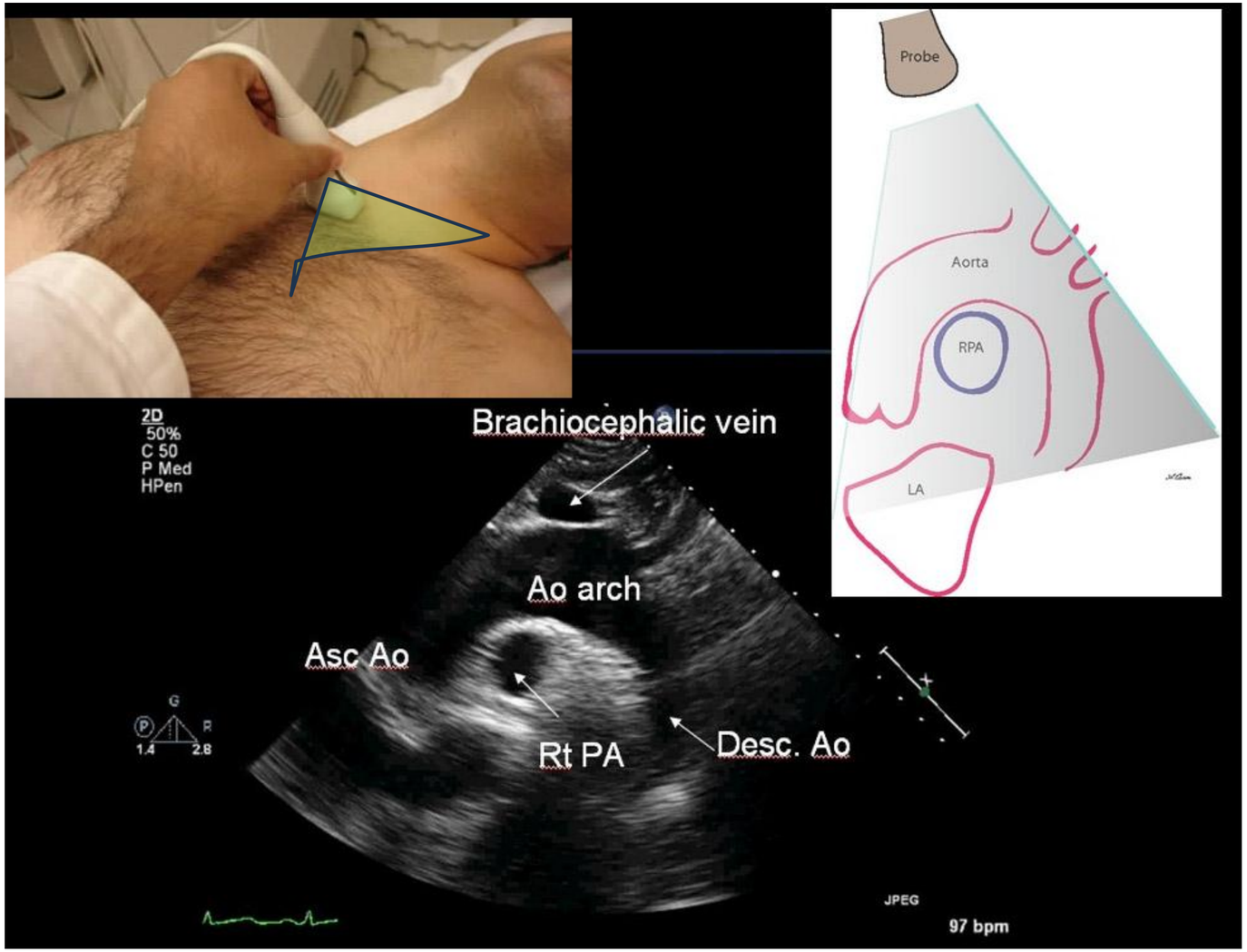


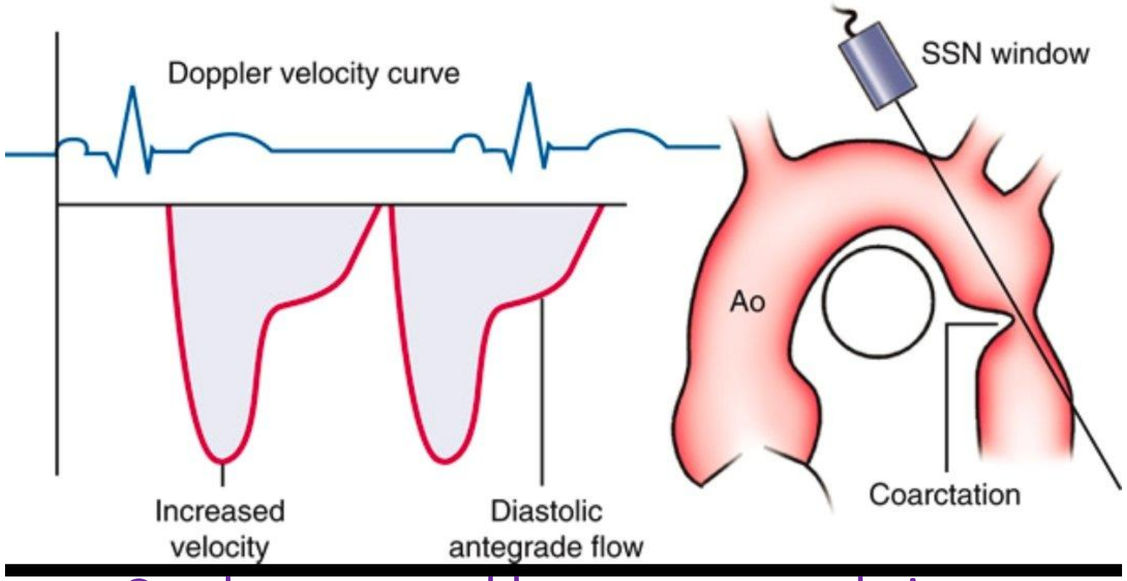






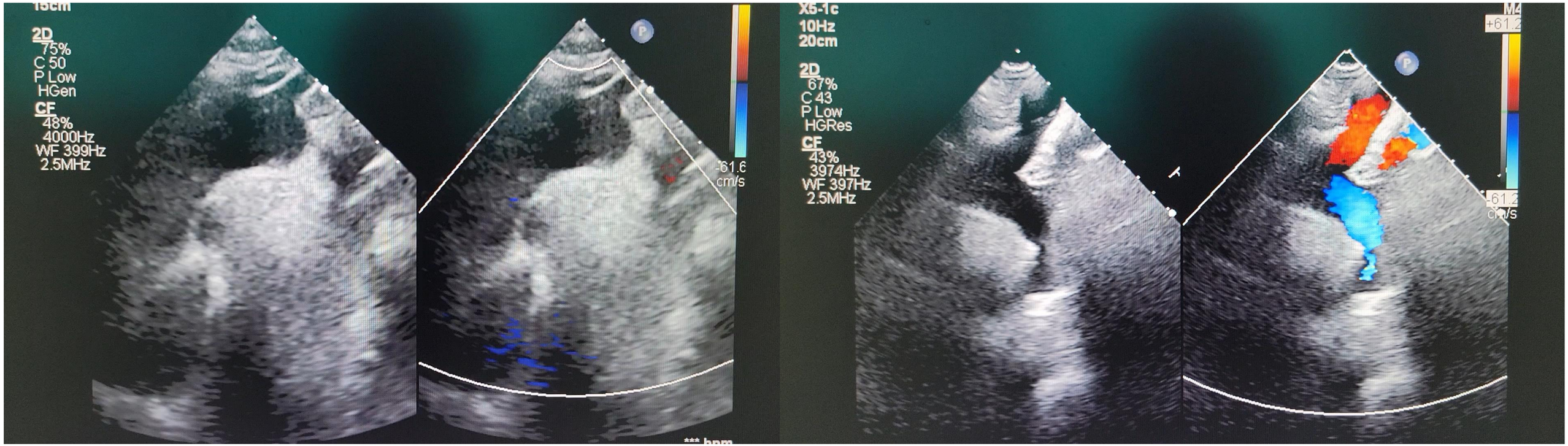
Coarctation





- Can be assessed by suprasternal view
- Need to put probe in the suprasternal notch
- The angle of probe with respect to midline differs between individuals
- Gentle rotation and tilting of probe to get best image

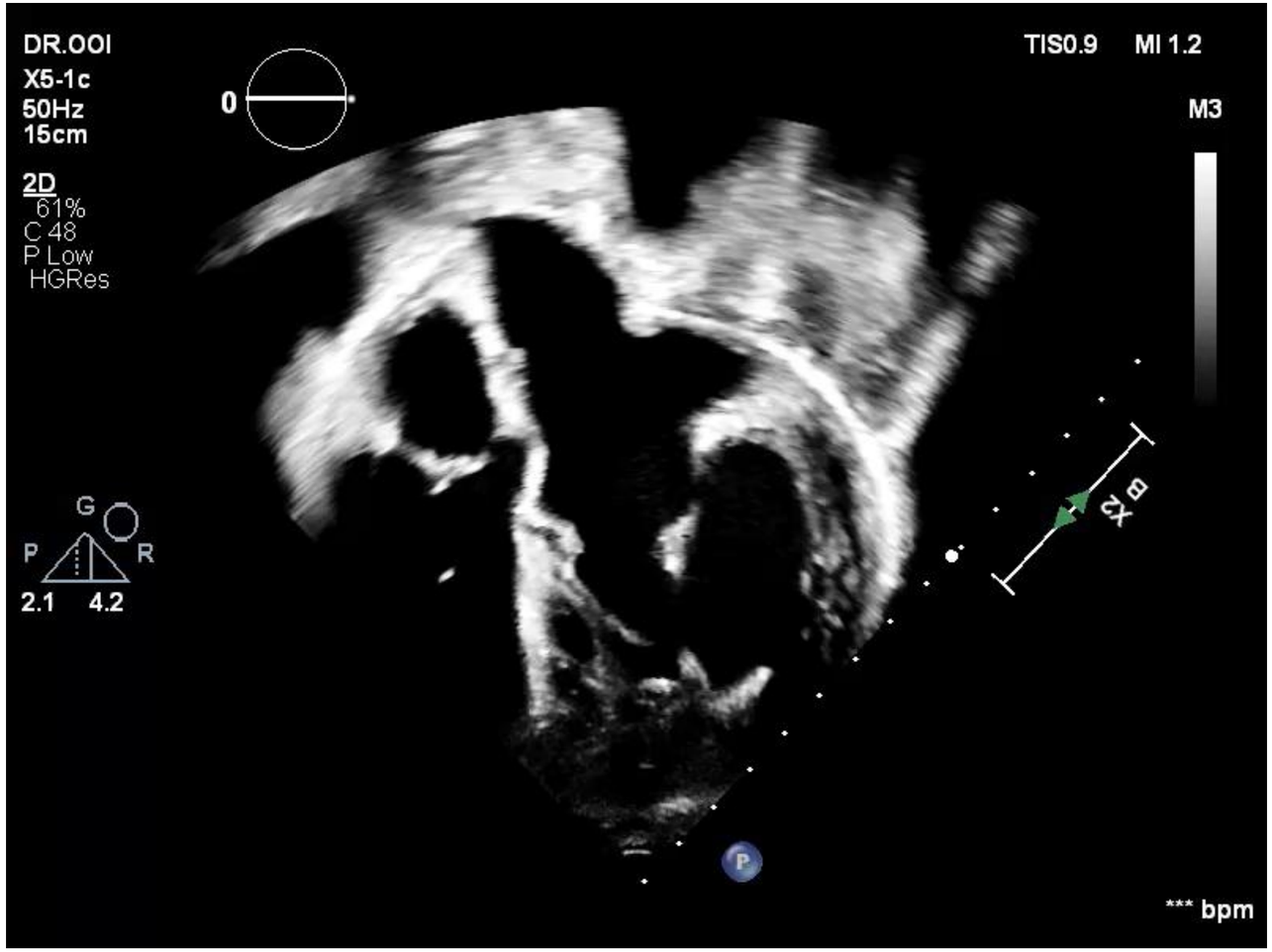
Coarctation



- Can be assessed by suprasternal view
- However, sometimes in adults, can be difficult and other imaging eg CT scan would help
- Gradient >20mmHg generally regarded as significant
- Can measure difference between upper and lower limb BP

1 last thing…

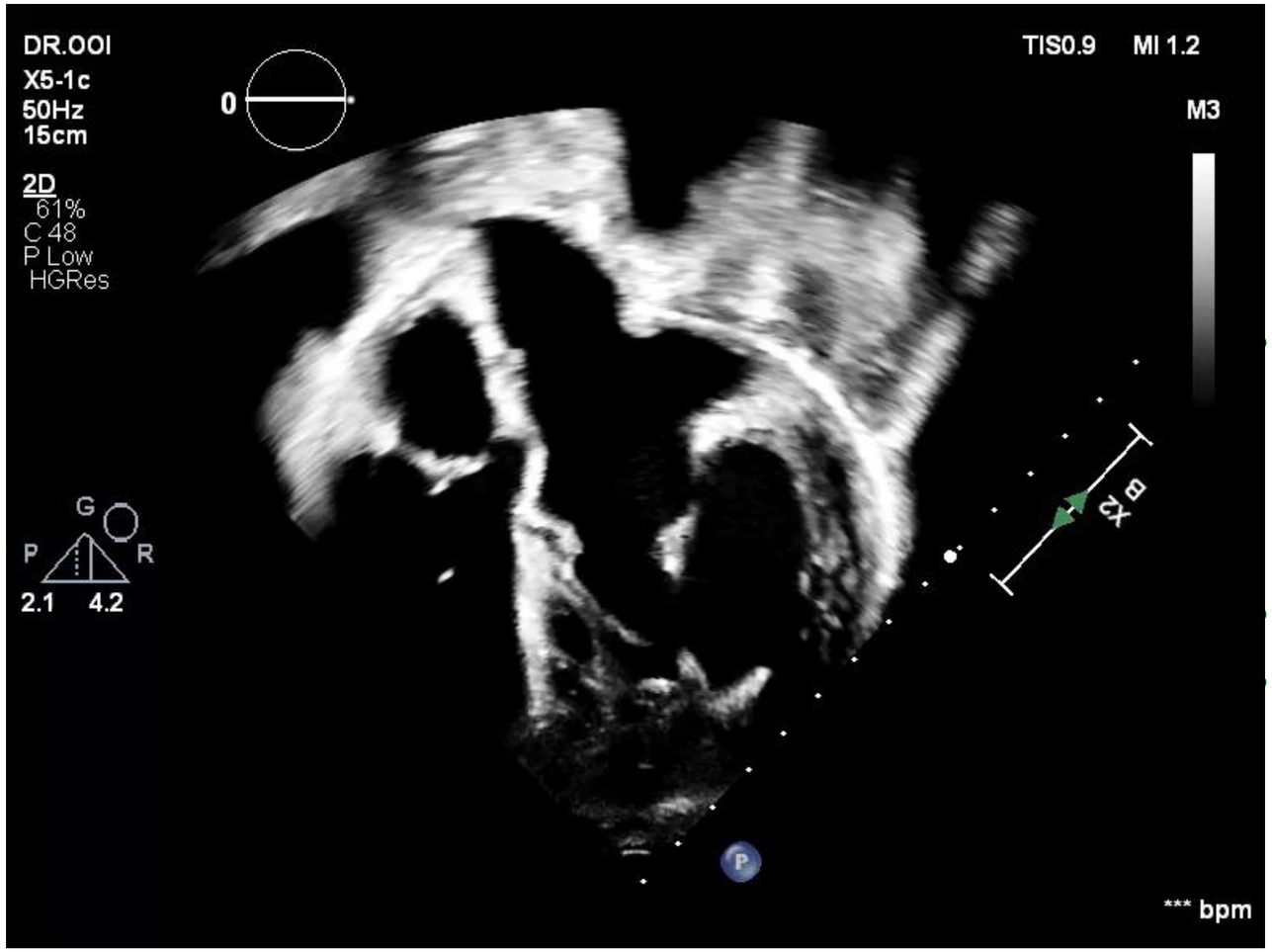
What’s wrong with the picture?



What’s wrong with the picture?

LV

- Mitral valve higher than tricuspid valve insertion
- Smooth wall



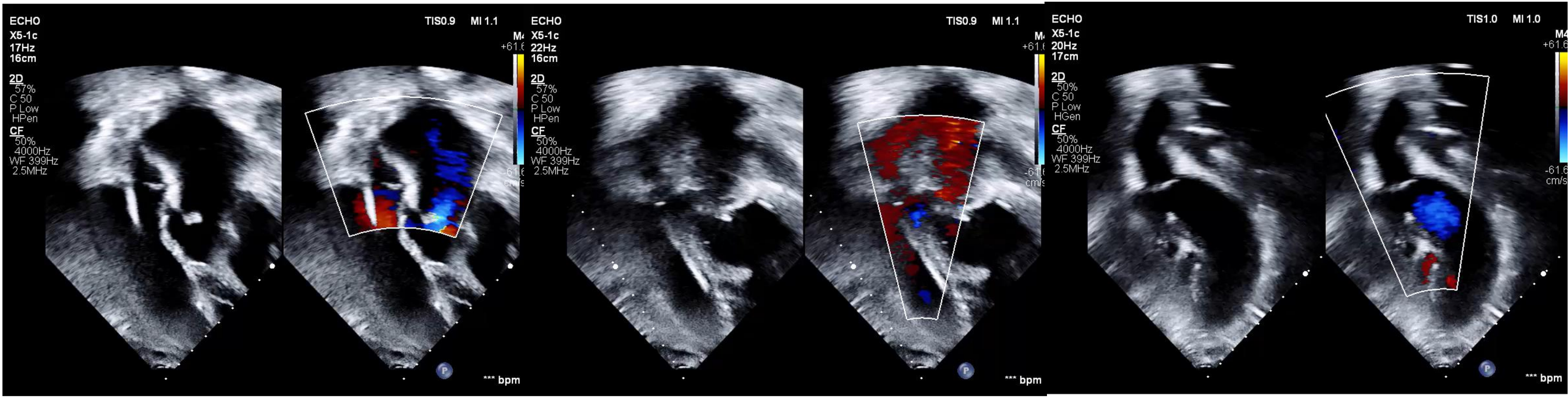
RV

Tricuspid valve more apically displaced (offset)

Moderator band

Septal leaflet attachment

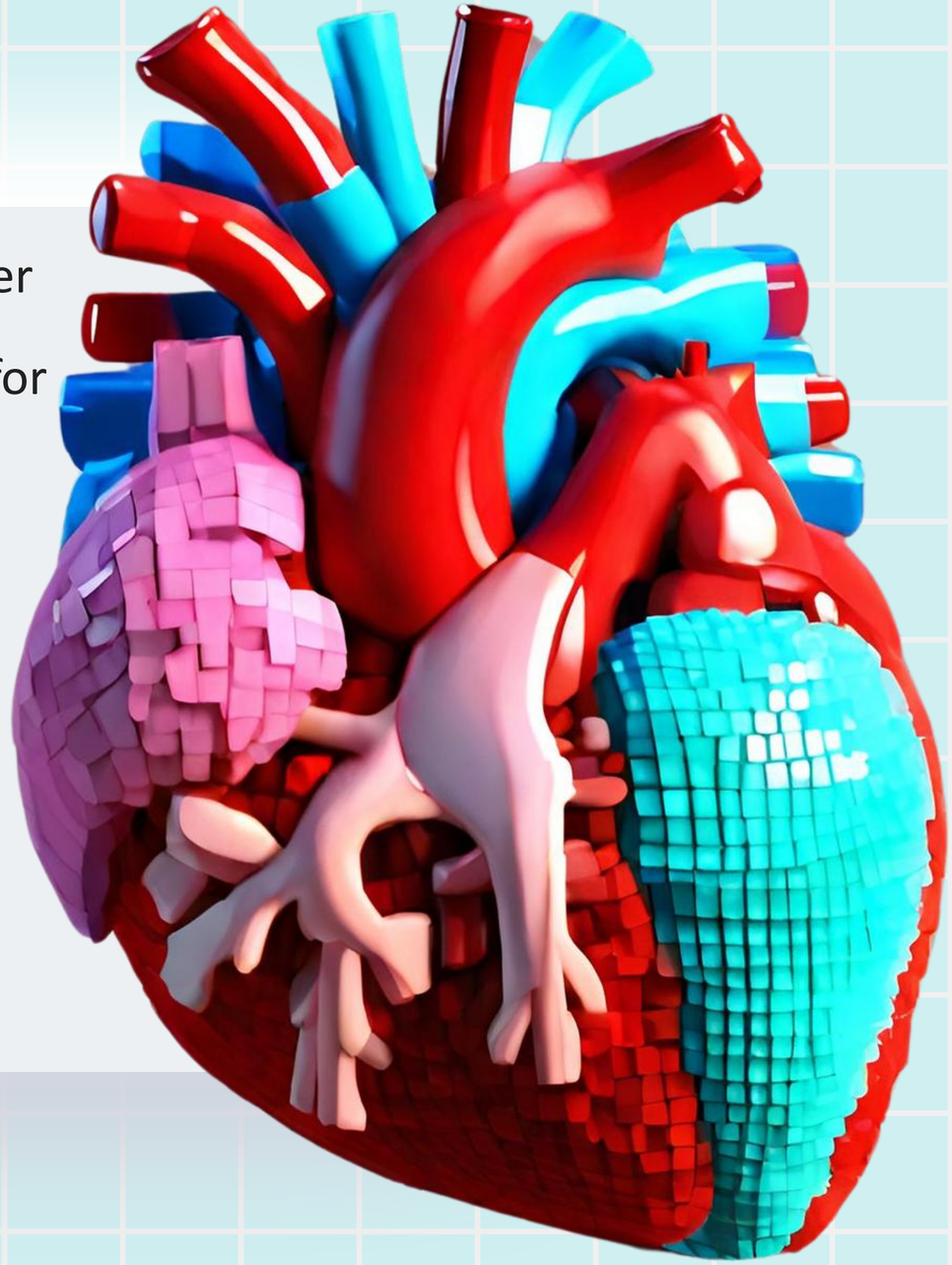
ccTGA



- Common association VSD, PS
- Tricuspid regurgitation (Left sided valve) is common because RV is working hard as systemic ventricle and frequently dilated and will fail
- Heart block is common hence the pacing lead seen
- Recognizing the *REVERSE OFFSET* of the valves is the KEY feature to spot this condition

Reading :

- Lopez L, Saurers DL, Barker PCA, Cohen MS, Colan SD, Dwyer J, Forsha D, Friedberg MK, Lai WW, Printz BF, Sachdeva R, Soni-Patel NR, Truong DT, Young LT, Altman CA. Guidelines for Performing a Comprehensive Pediatric Transthoracic Echocardiogram: Recommendations From the American Society of Echocardiography. J Am Soc Echocardiogr. 2024 Feb;37(2):119-170.
- Park's Pediatric Cardiology for Practitioners
- Galzerano D, Pergola V, Eltayeb A, Ludovica F, Arbili L, Tashkandi L, Michele SD, Barchitta A, Parato MV, Salvo GD. Echocardiography in Simple Congenital Heart Diseases: Guiding Adult Patient Management. J Cardiovasc Echogr. 2023 Oct-Dec;33(4):171-182



THANK YOU!