Basic Anatomy (Standard Echocardiographic Views) and Physiology

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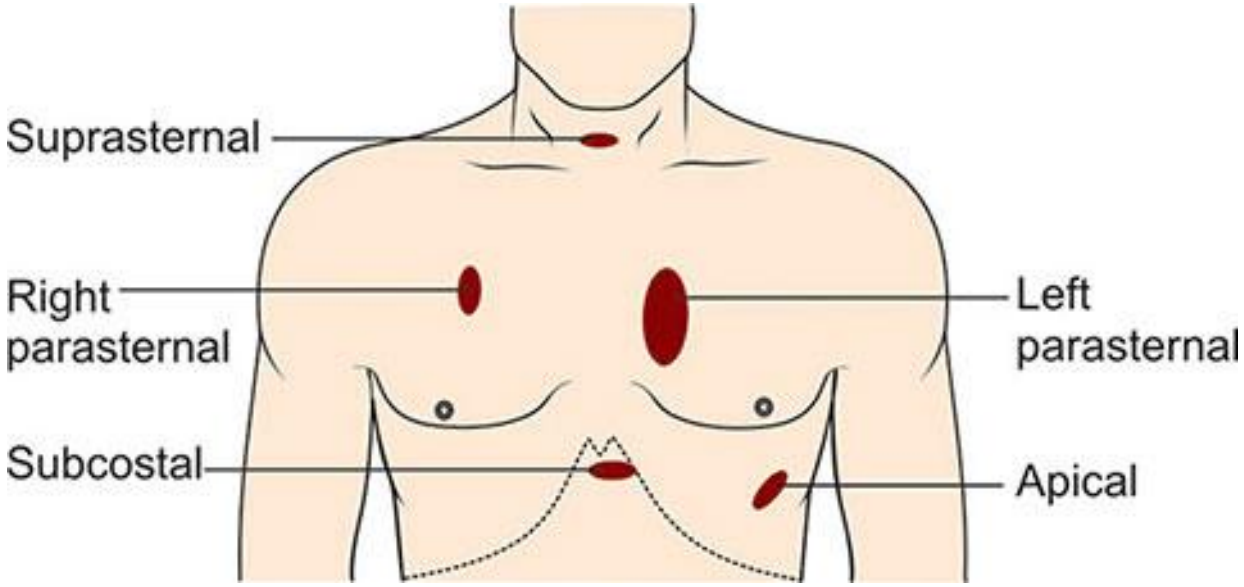
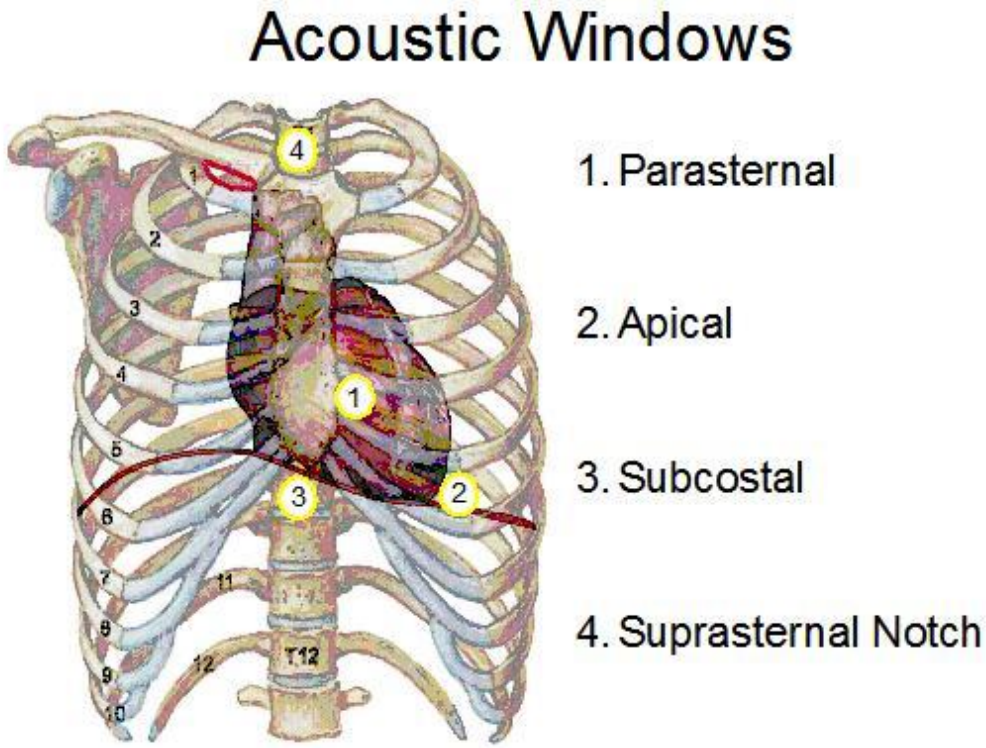
Content

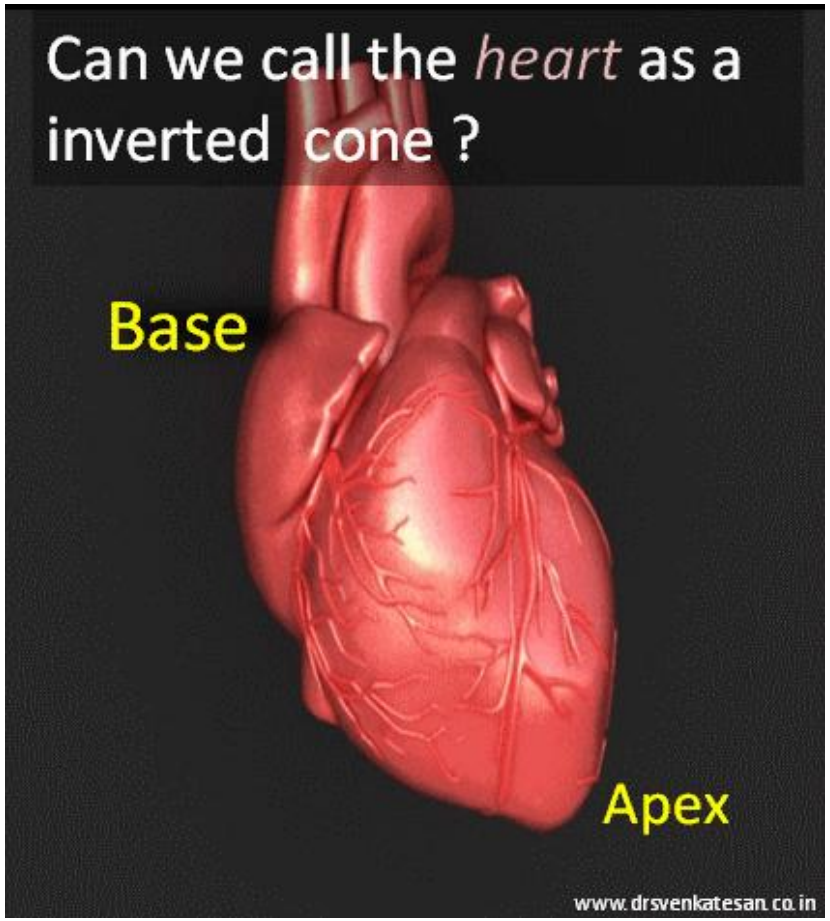
- Location of the heart in thoracic cavity
- Orientation of the heart
- Basic anatomy of the heart
- Standard Echocardiographic Views
- Standard Echocardiographic Windows
- Basic physiology of the heart
- Cardiac cycle of the heart

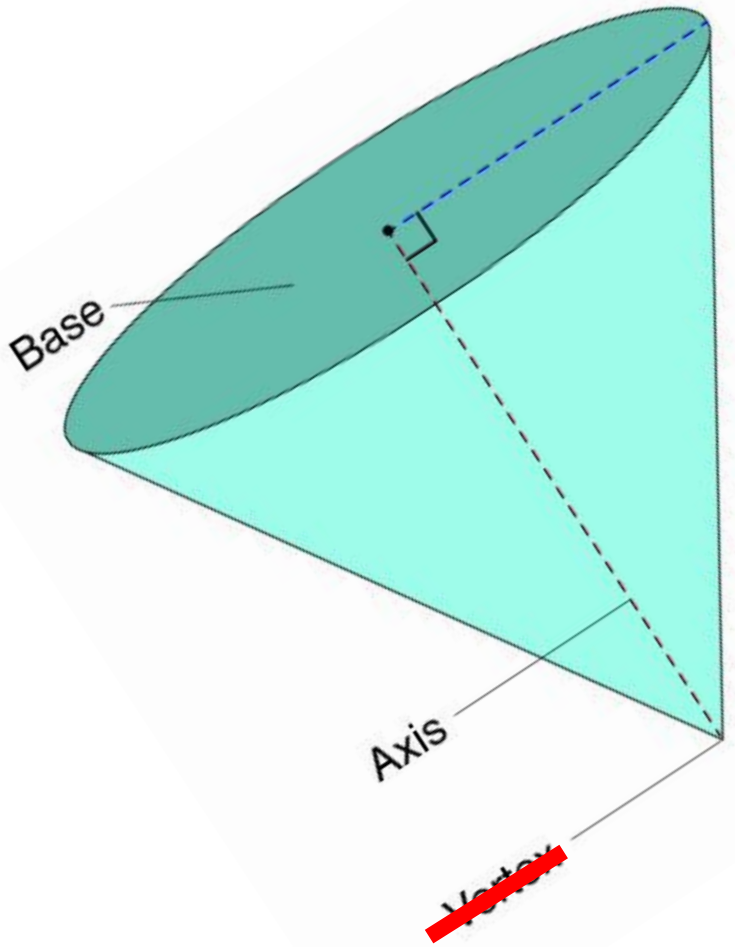
Standard Echocardiographic Windows





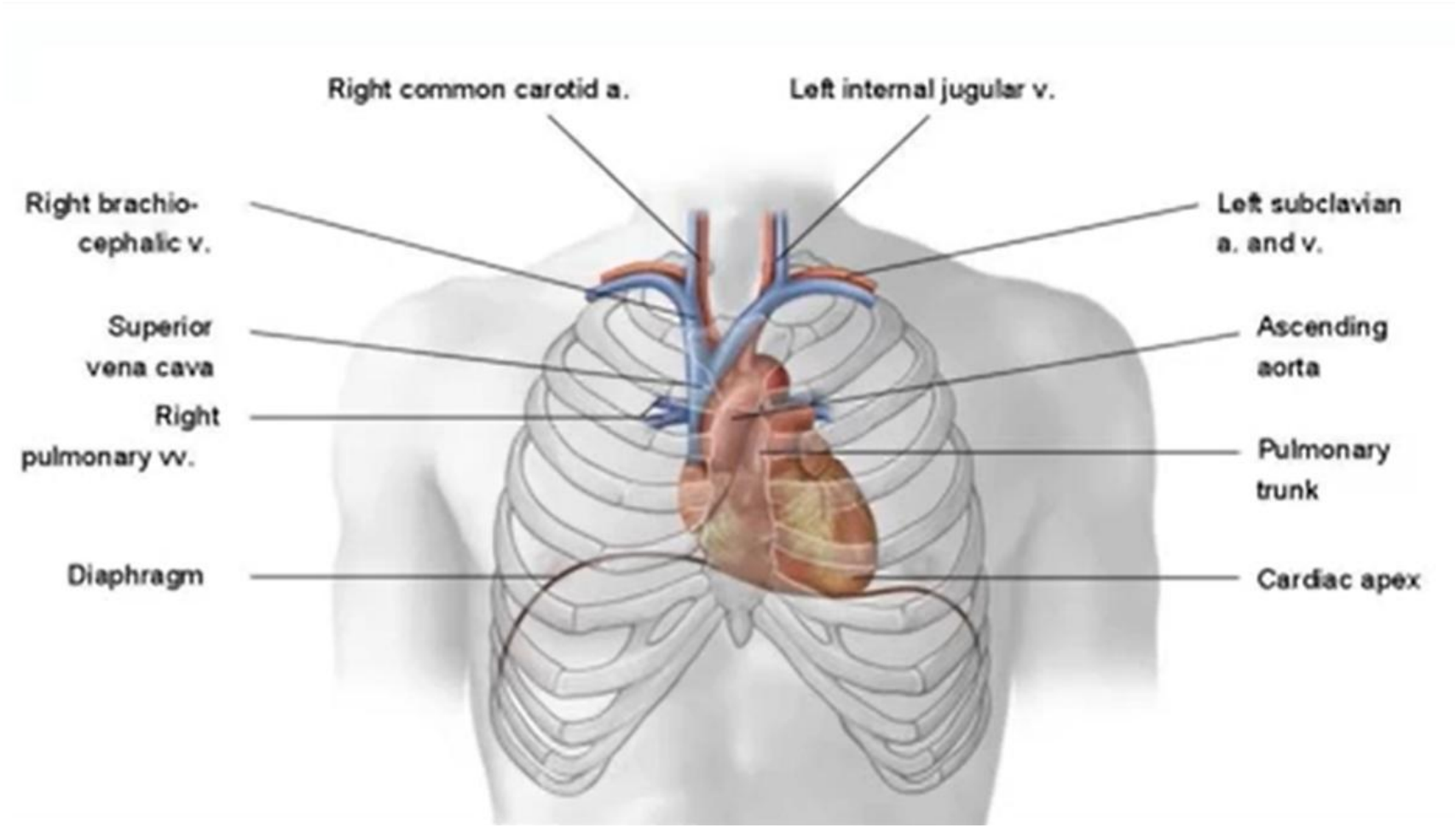
Heart – cone shaped



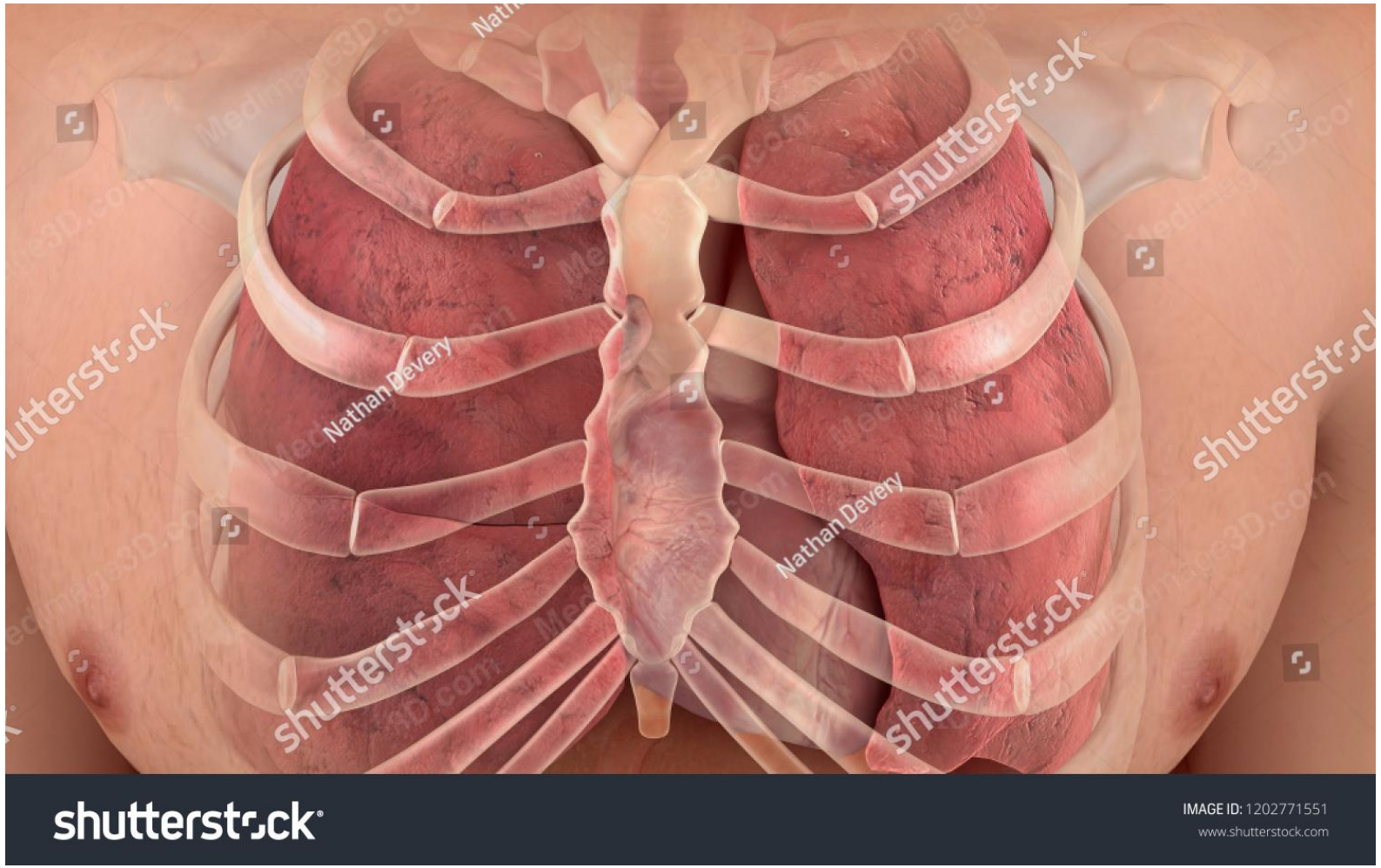


Apex

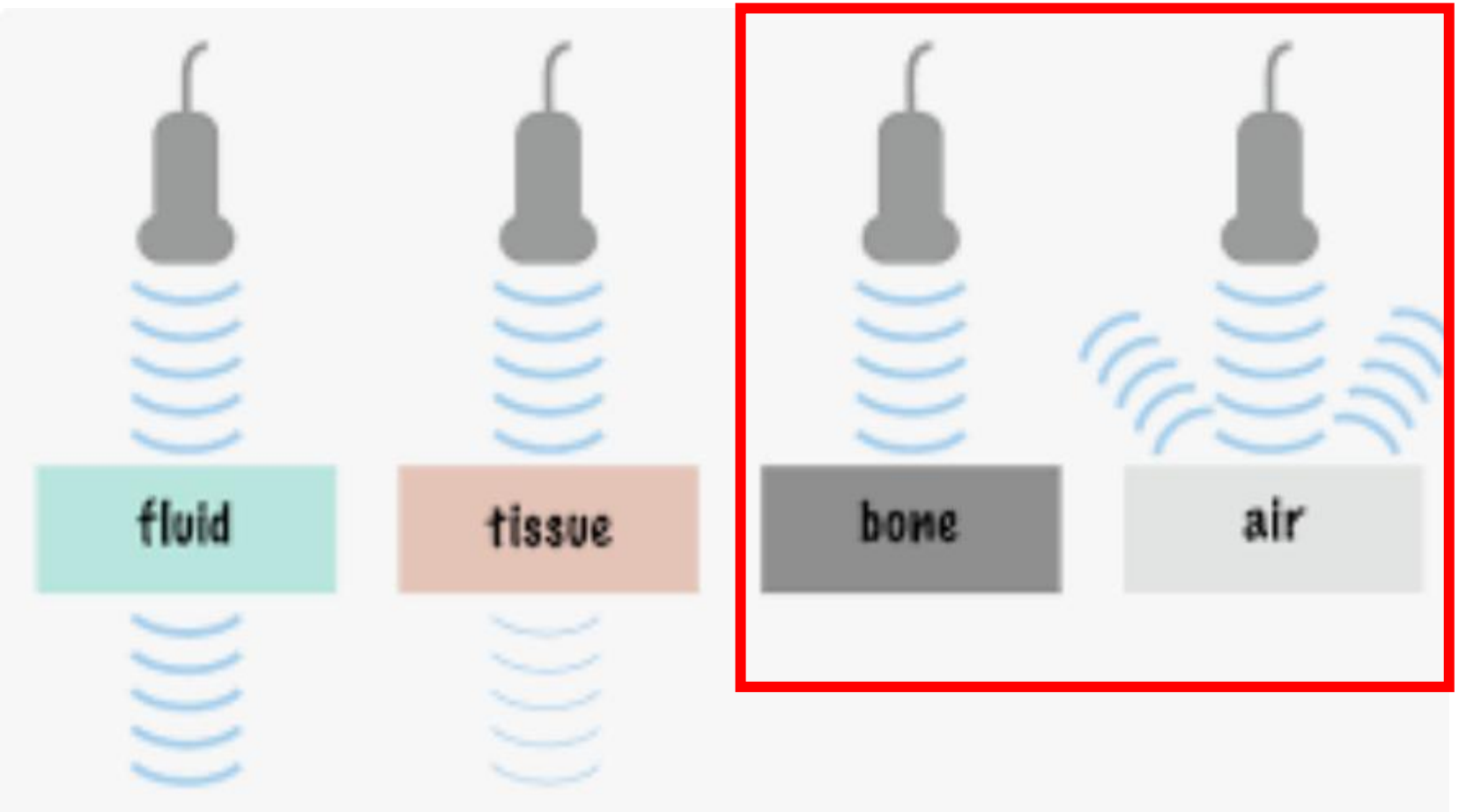
It is not exposed…



Hidden behind bones and lung tissues



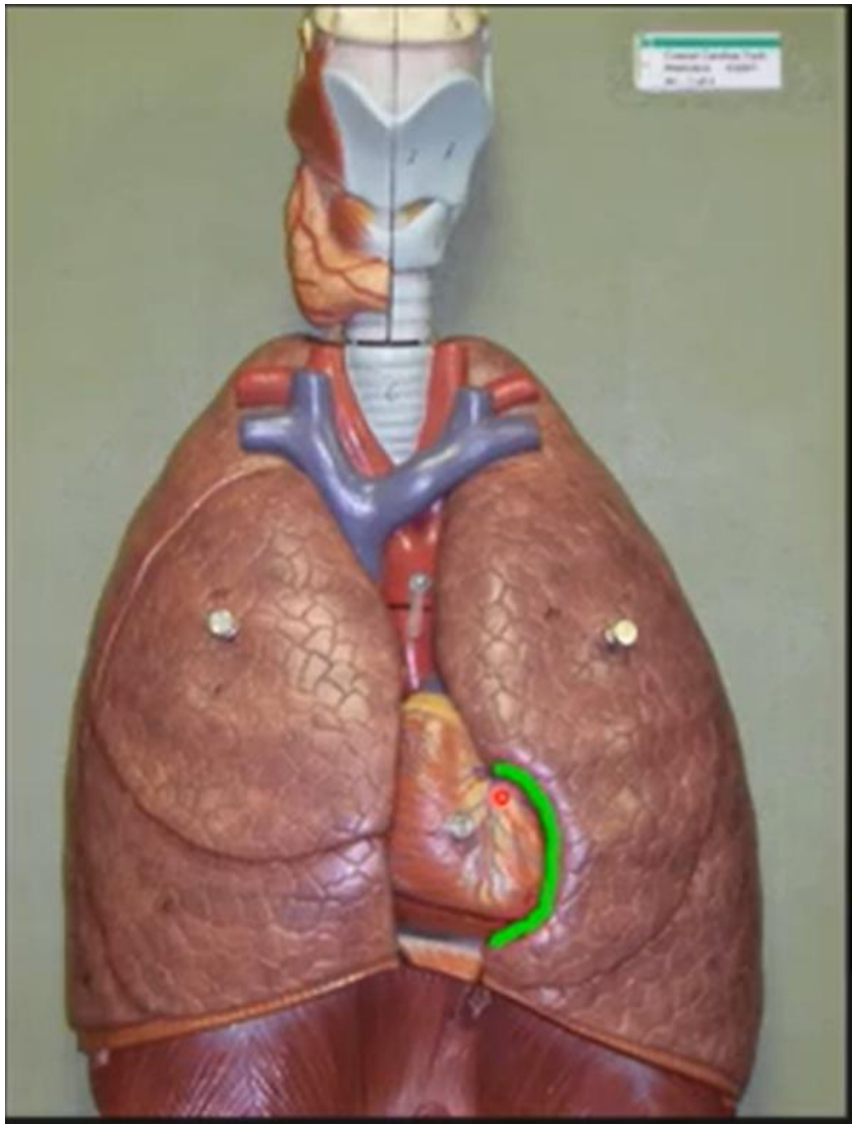
Ultrasound conduction through different medium.

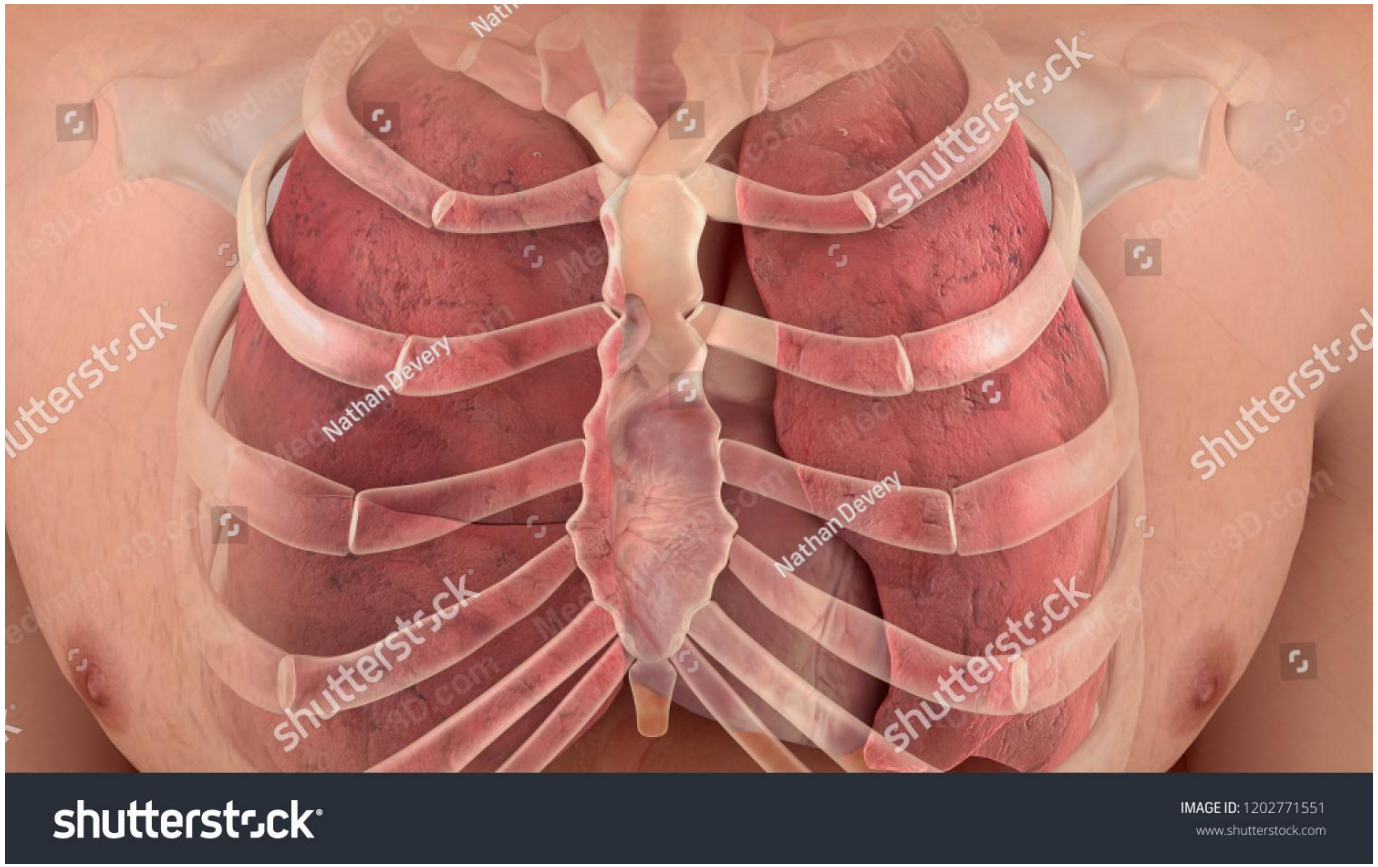


Ultrasound through air and bone

- Bone will result in
  - almost complete reflection
  - making it impossible to image structures under it.
- Air
  - poor conductor of sound
  - will result in artifacts and failure to obtain a quality image.

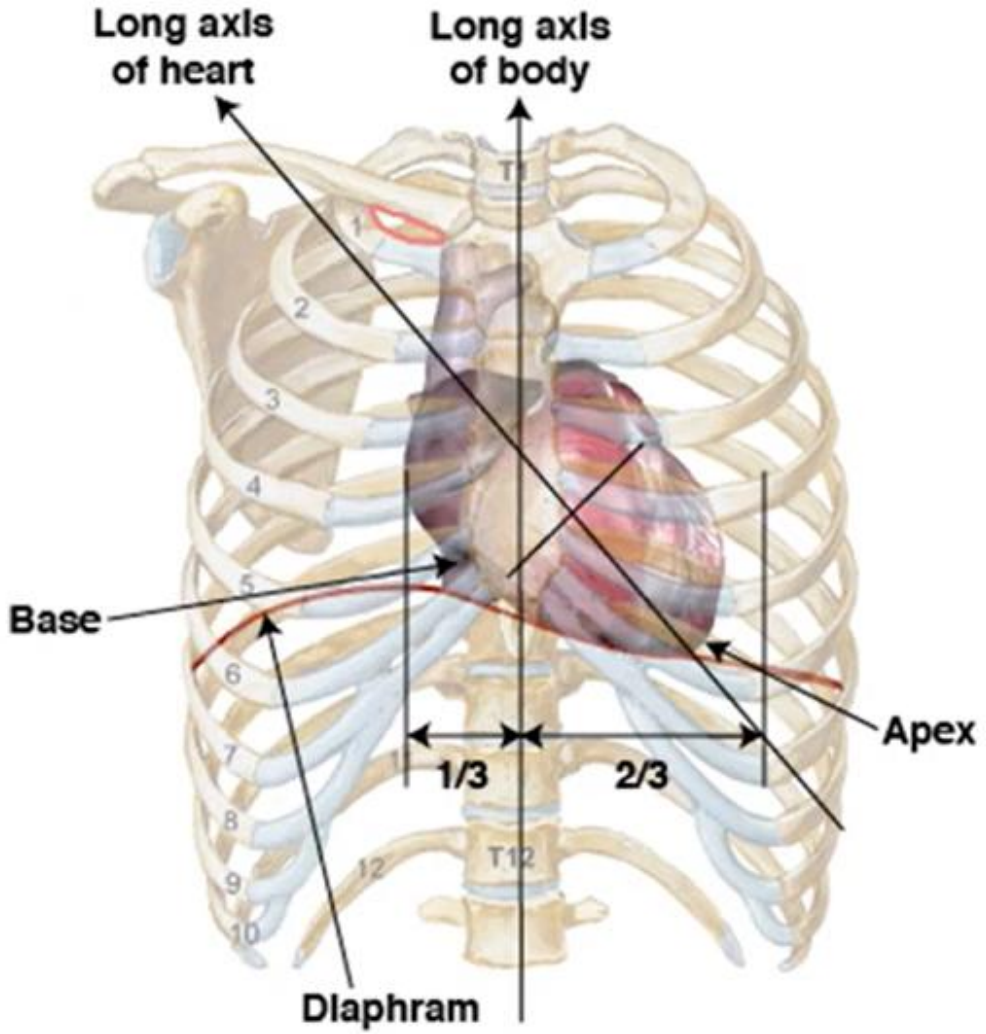
Cardiac Notch



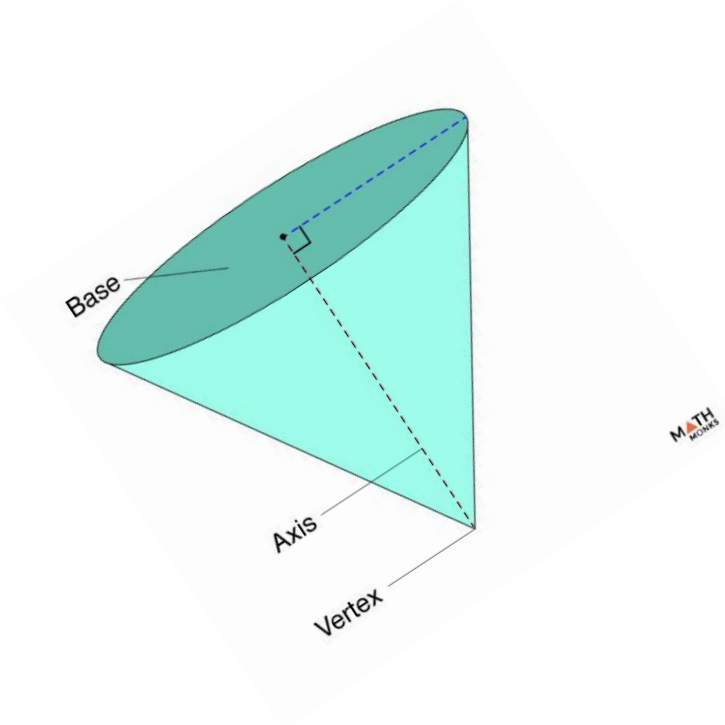


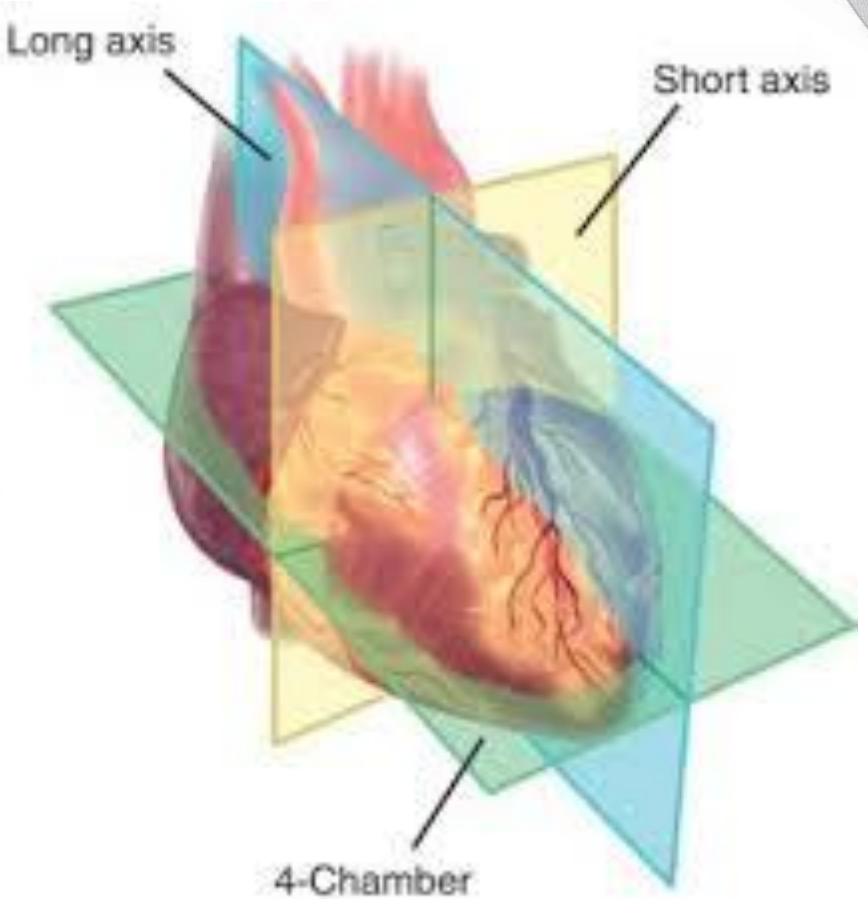
- There is still some window for us to see the heart

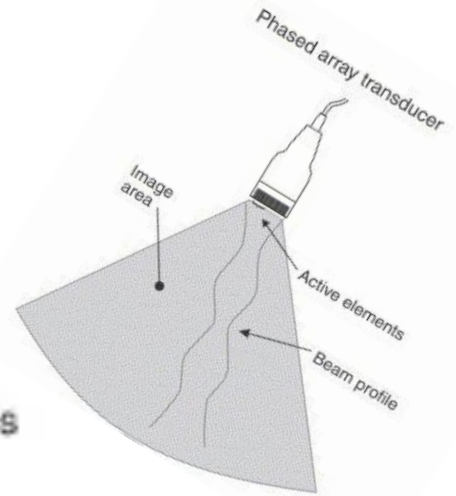
Location of the heart in the thoracic cavity.



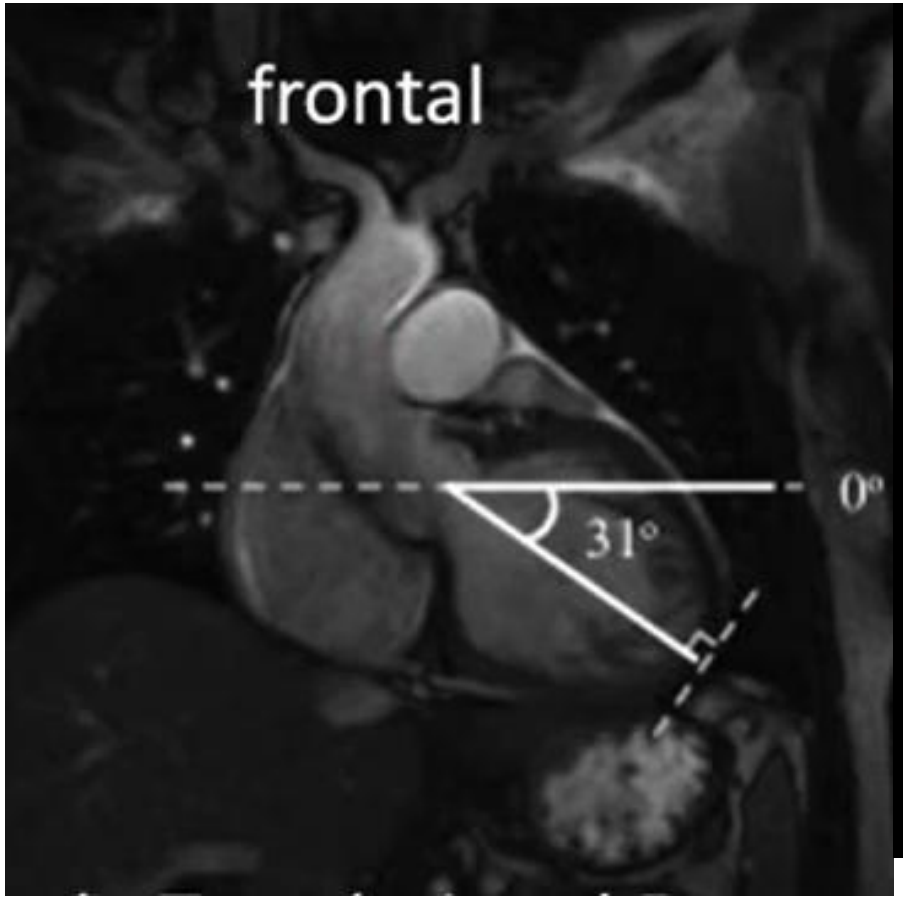
Axis of the heart
– Orientation of the heart..

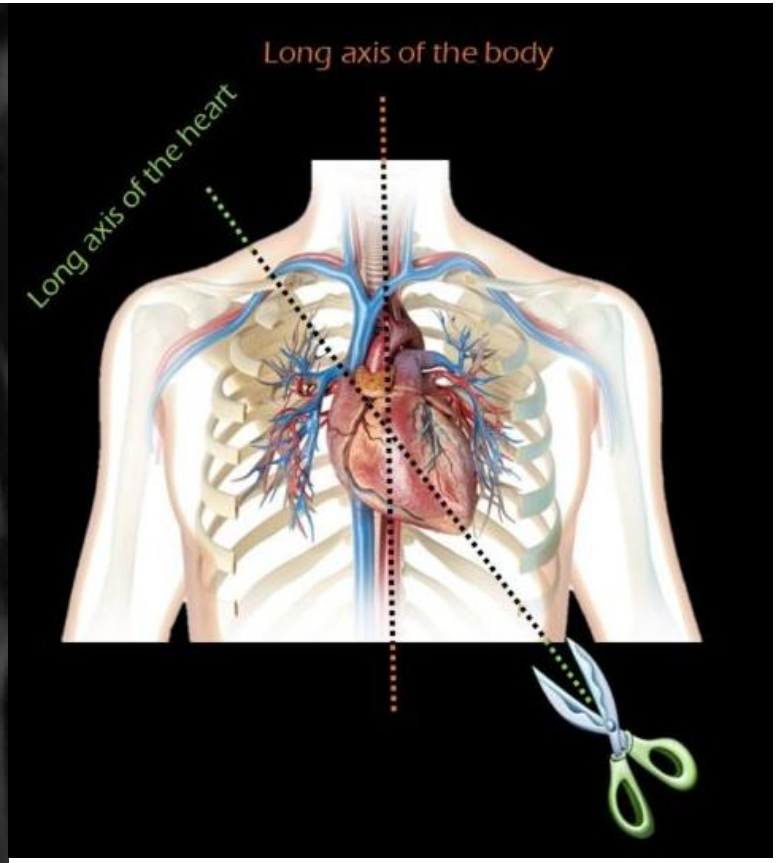


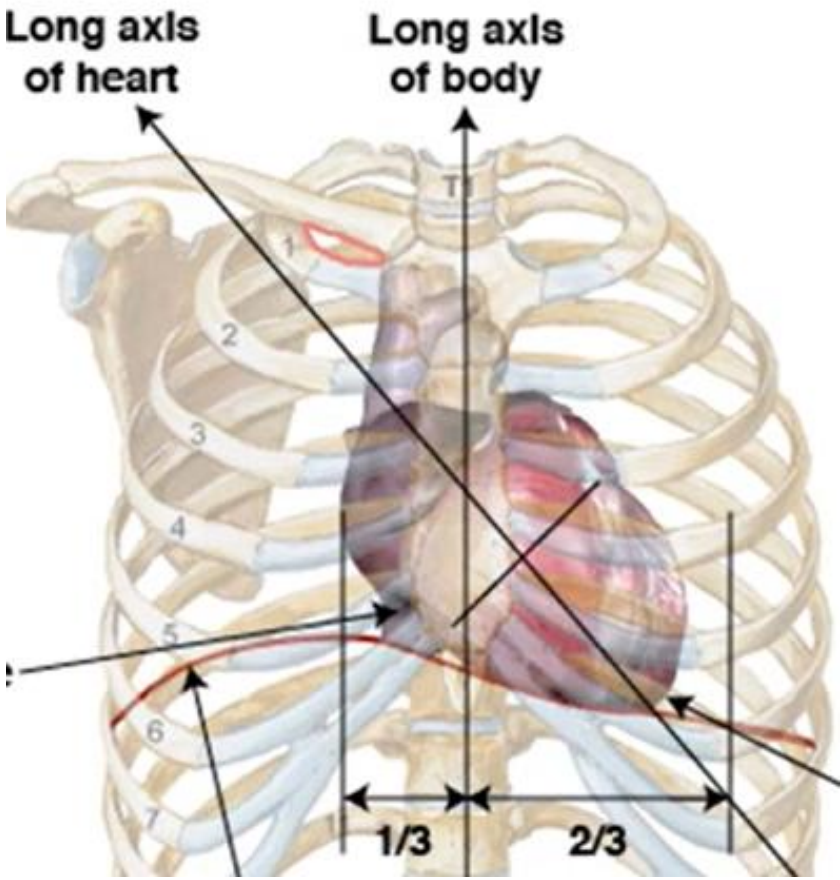




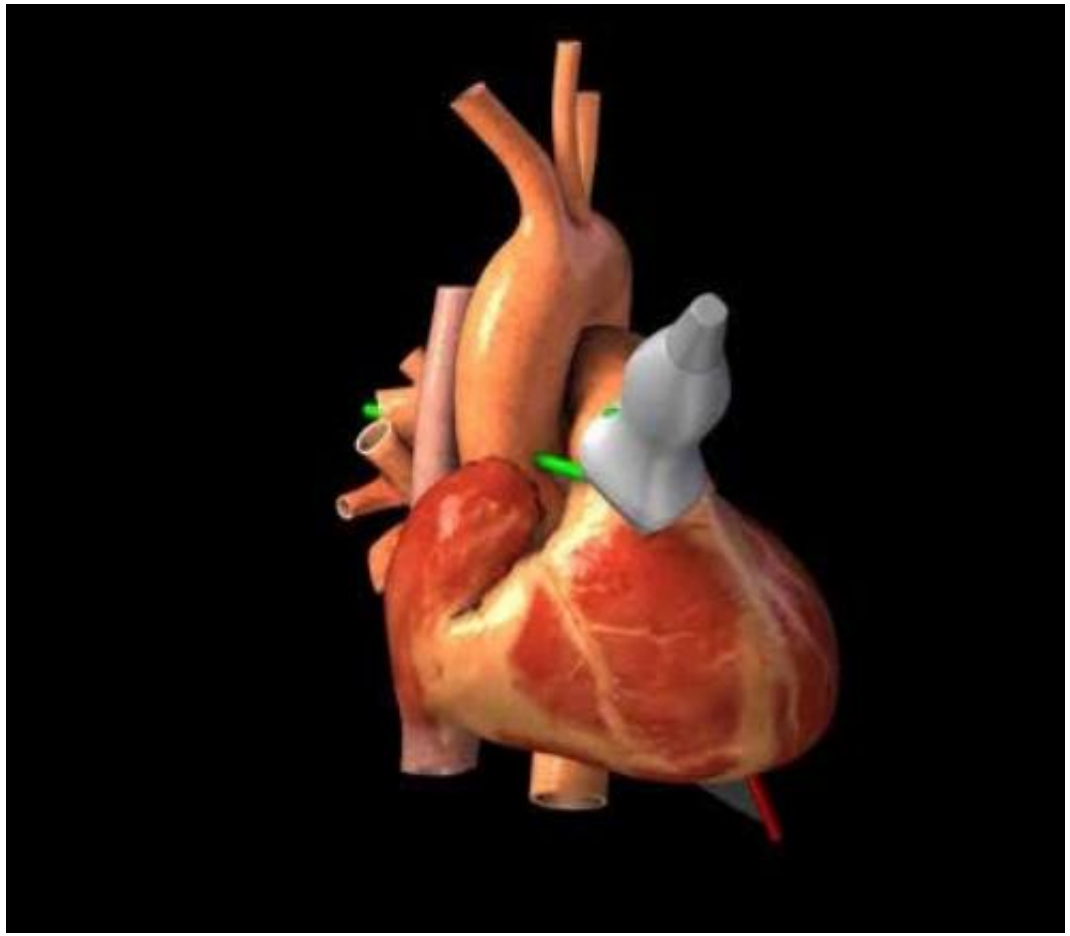
Anatomical axis (Long axis) of the heart – 30 - 35° (10 – 4 o'clock)



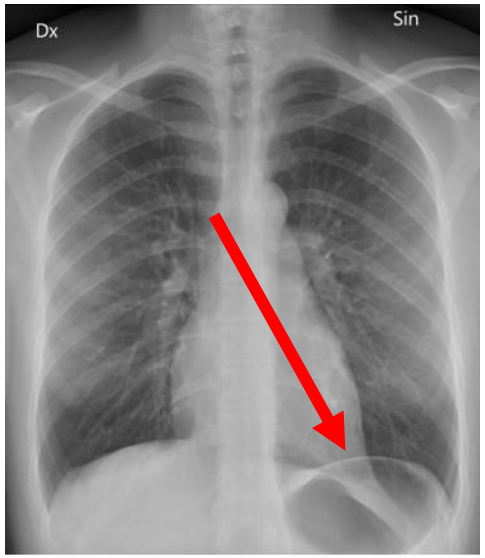




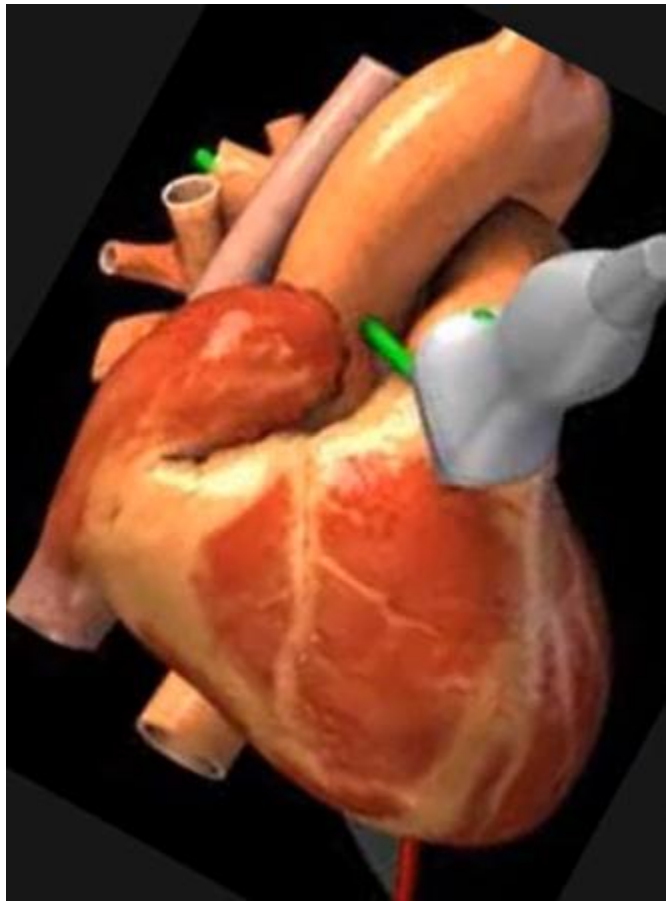
Why is this information relevant in echocardiography?

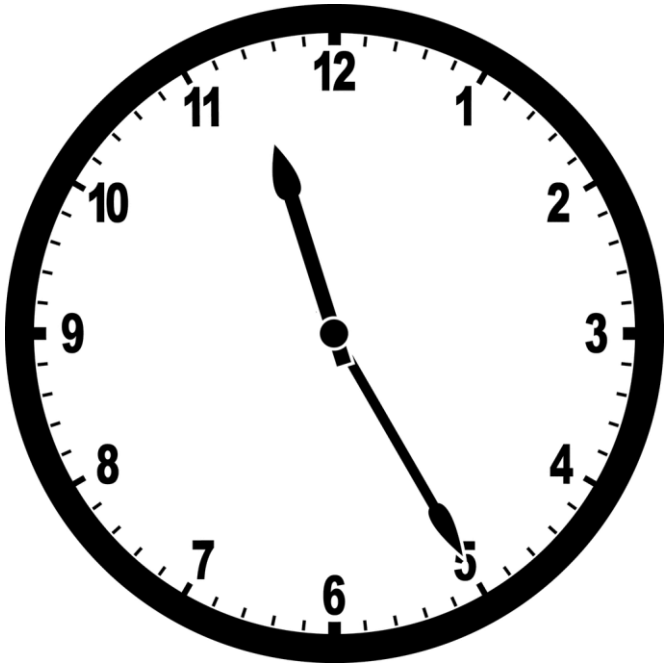


Tall and skinny… More vertical heart

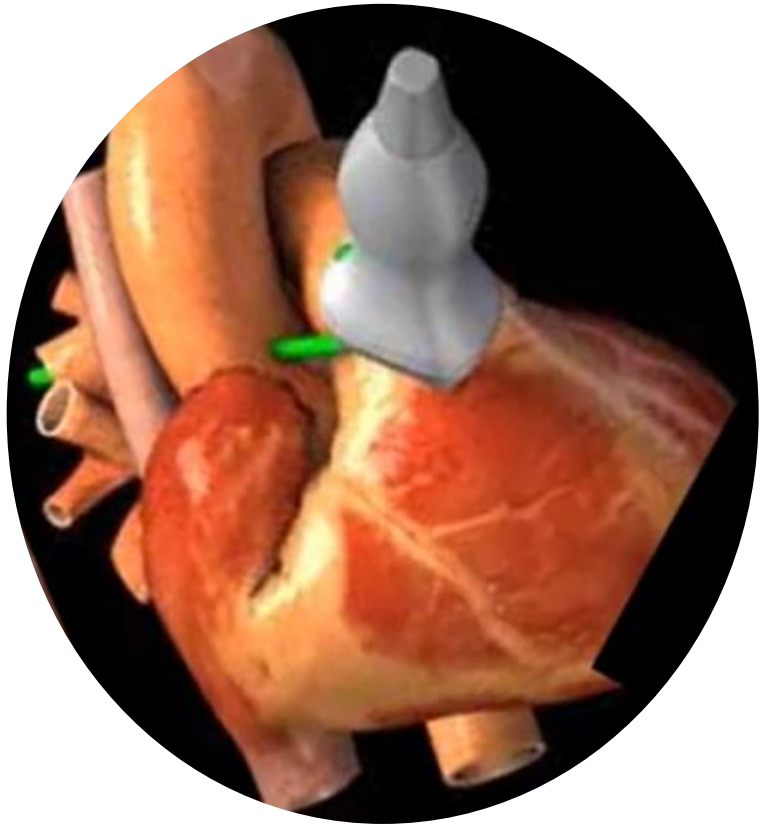


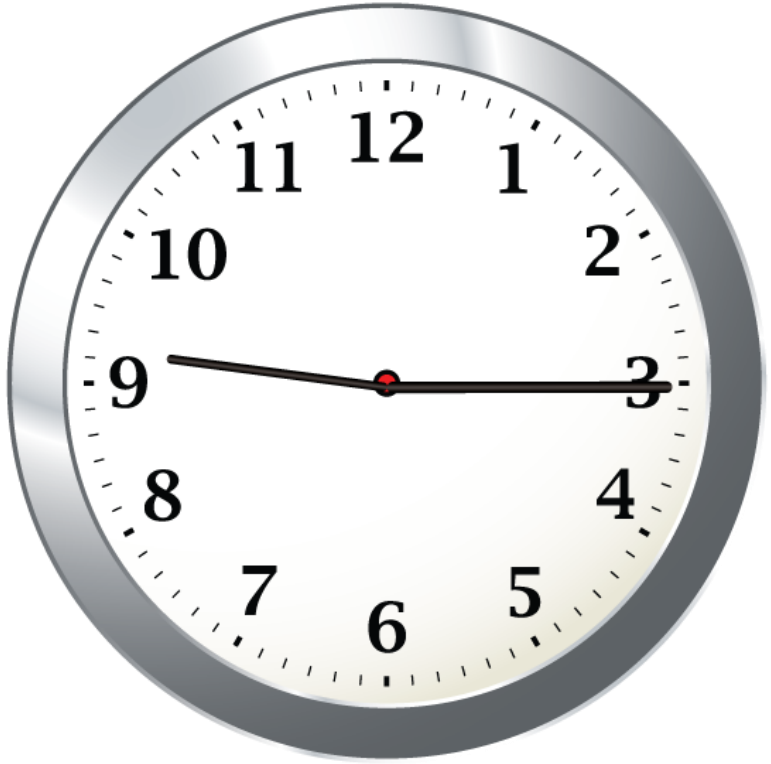
Normal Size Heart on Chest X-ray





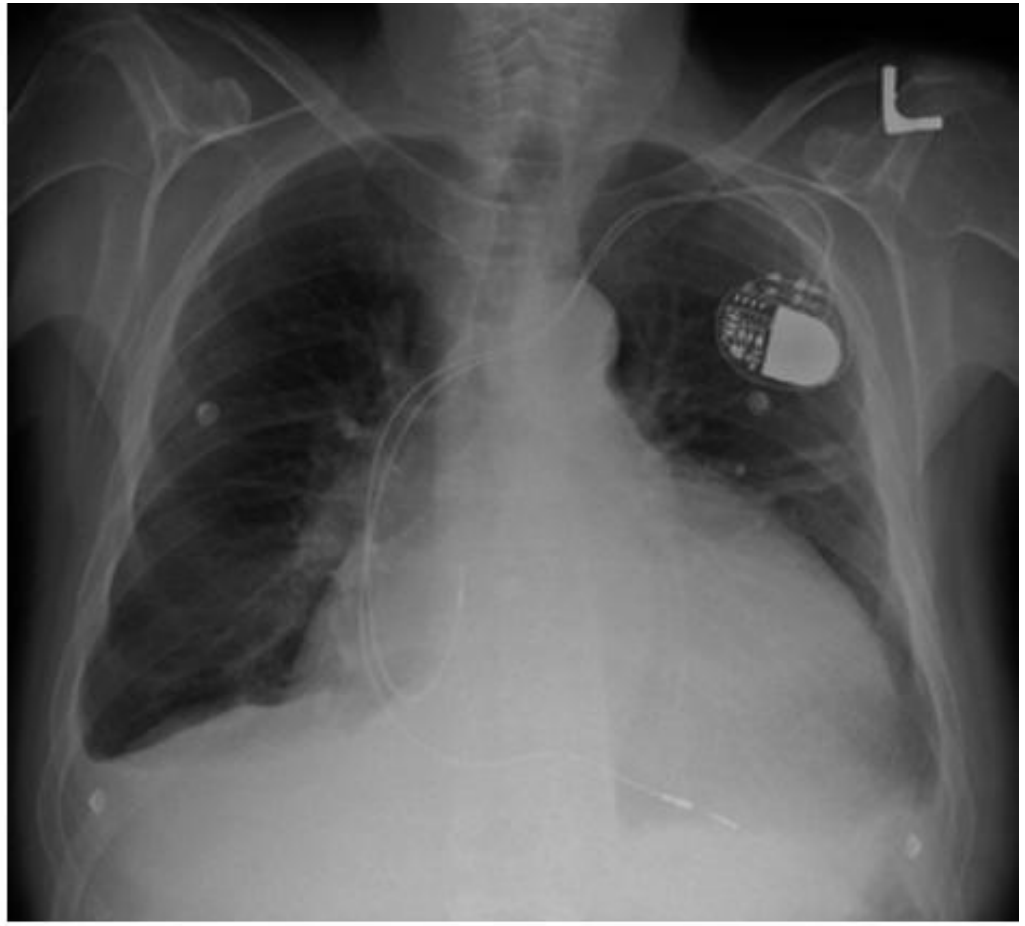
Short and overweight... More horizontal heart



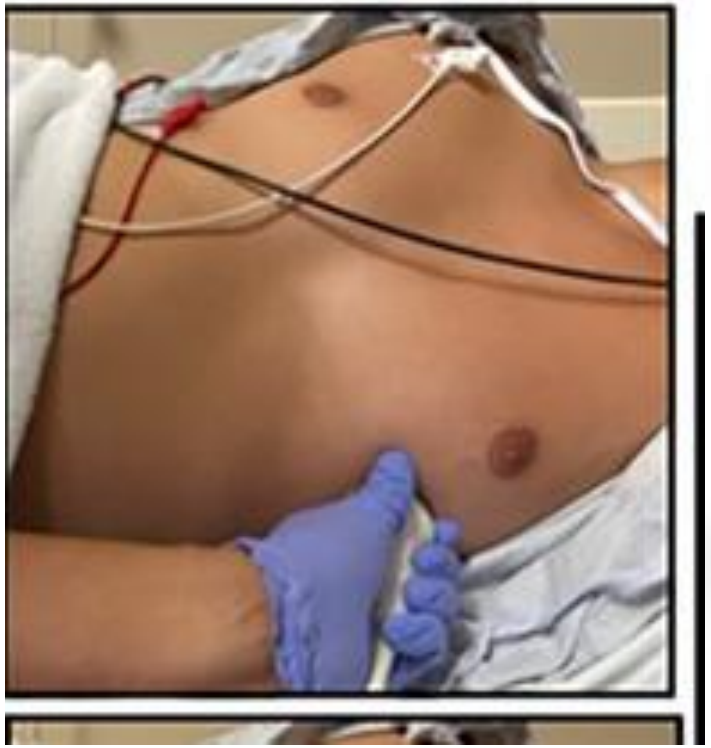


COPD..

Cardiomegaly..



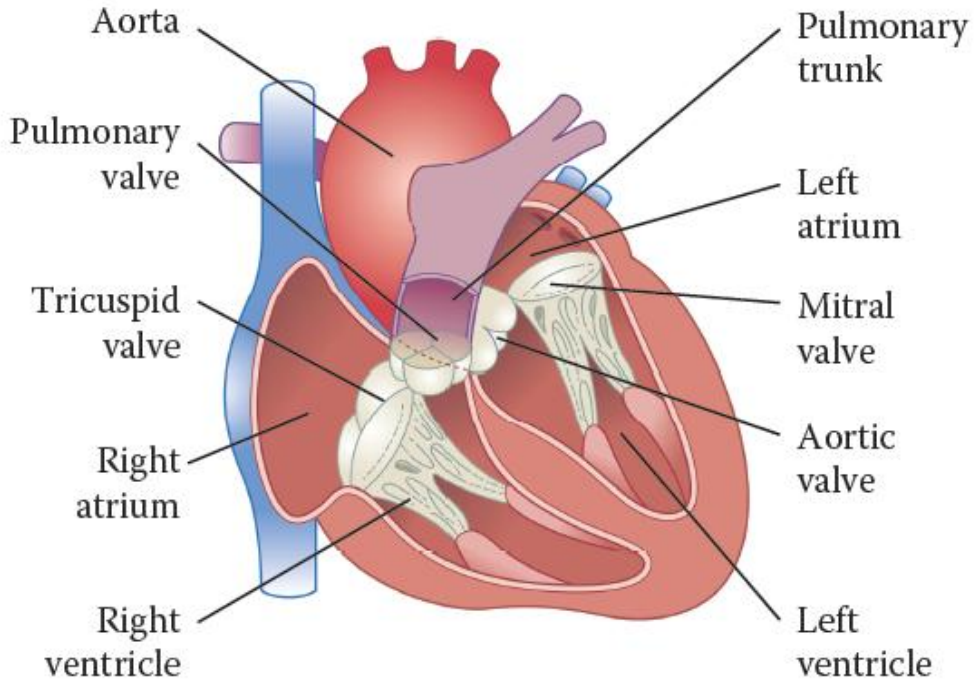
Cardiomegaly on Chest x-ray



Why we put the probe on the

- Left
- Parasternal 2^{nd} – 5^{th} intercoastal space
- Pointer at 10 – 4 o'clock (usually) for long axis
- Pointer at 2 – 8 o'clock (usually) for short axis
- For apical views, the location of the apex can vary as well

Heart valves and chambers



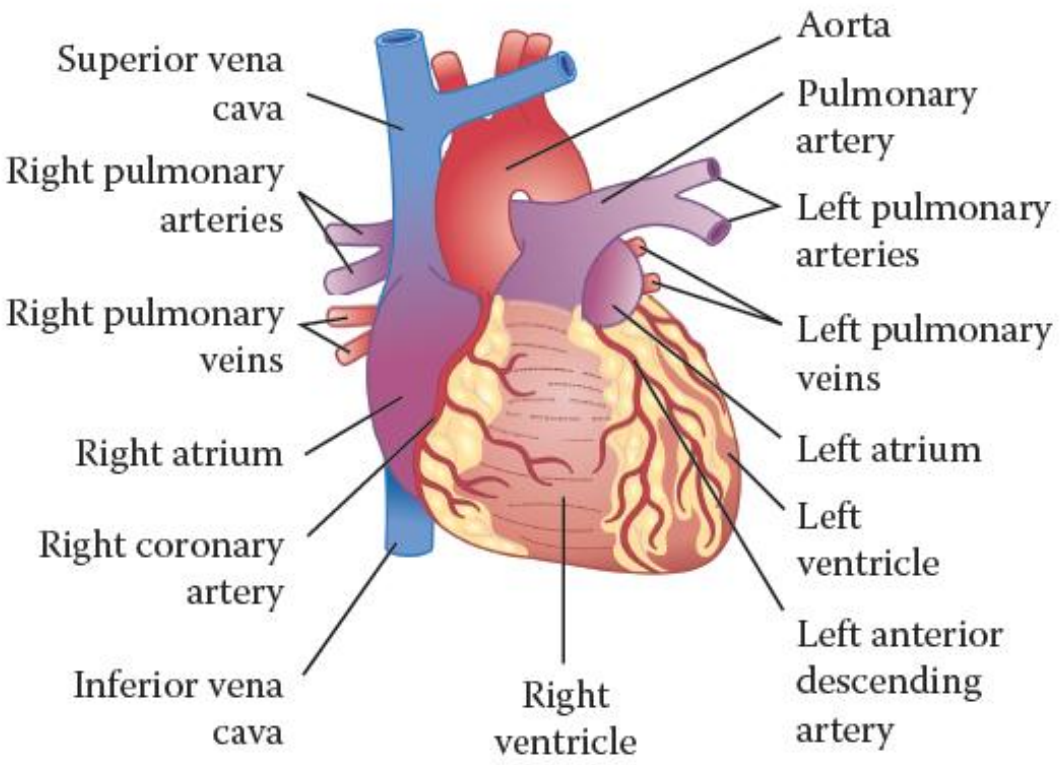
<u>Atrioventricular Valves (AV Valves)</u>

- Tricuspid valve
- Mitral valve

<u>Semilunar valves</u>

- Aortic valve
- Pulmonic valve

Basic Anatomy – Major vessels and Chambers



- Superior Vena Cava
- Inferior Vena Cava
- Pulmonary artery
- Pulmonary vein
- Aorta

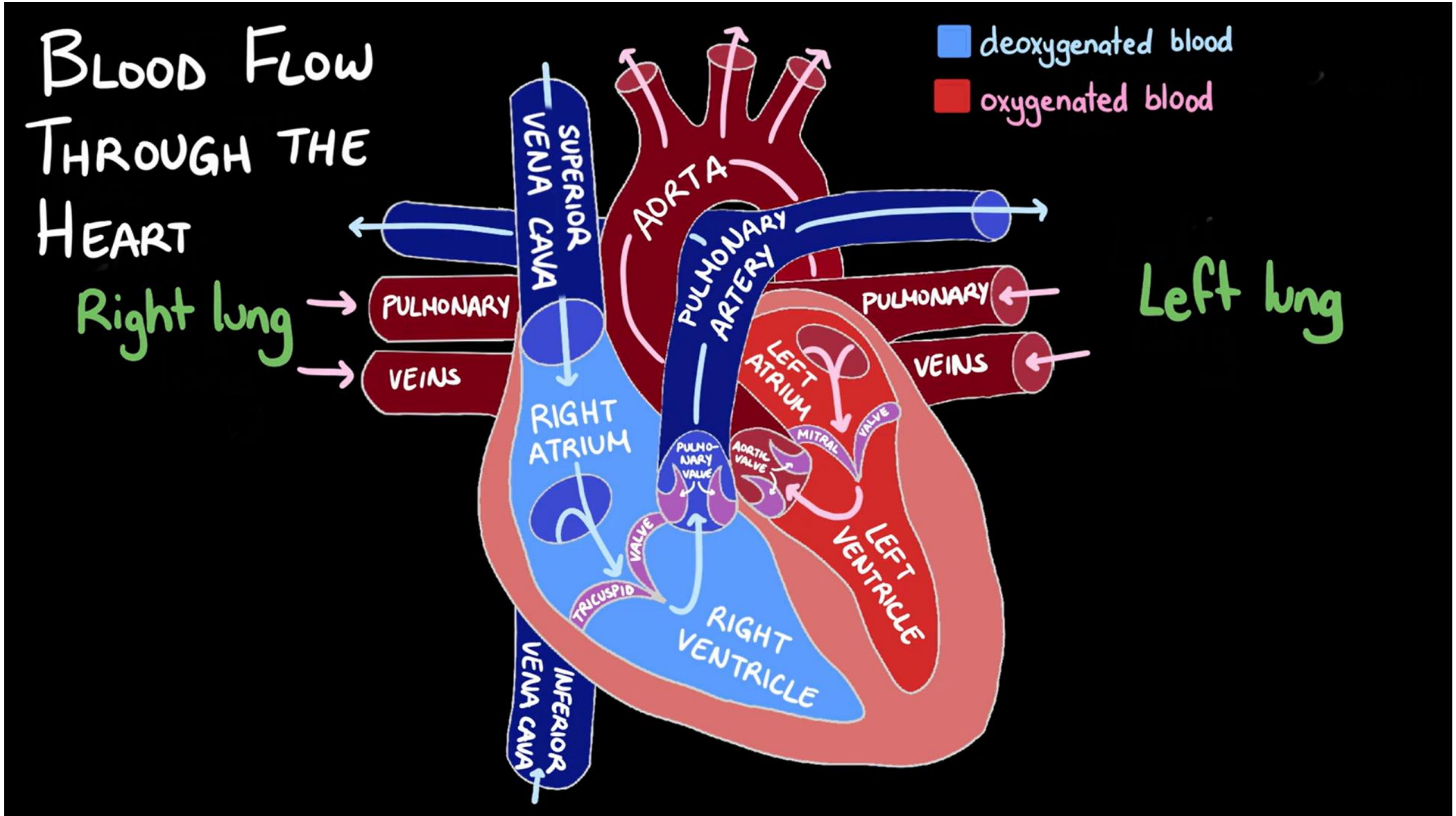
Basic concept:

Artery :

- Carries blood away from the heart
- Usually carry oxygenated blood, except, pulmonary artery

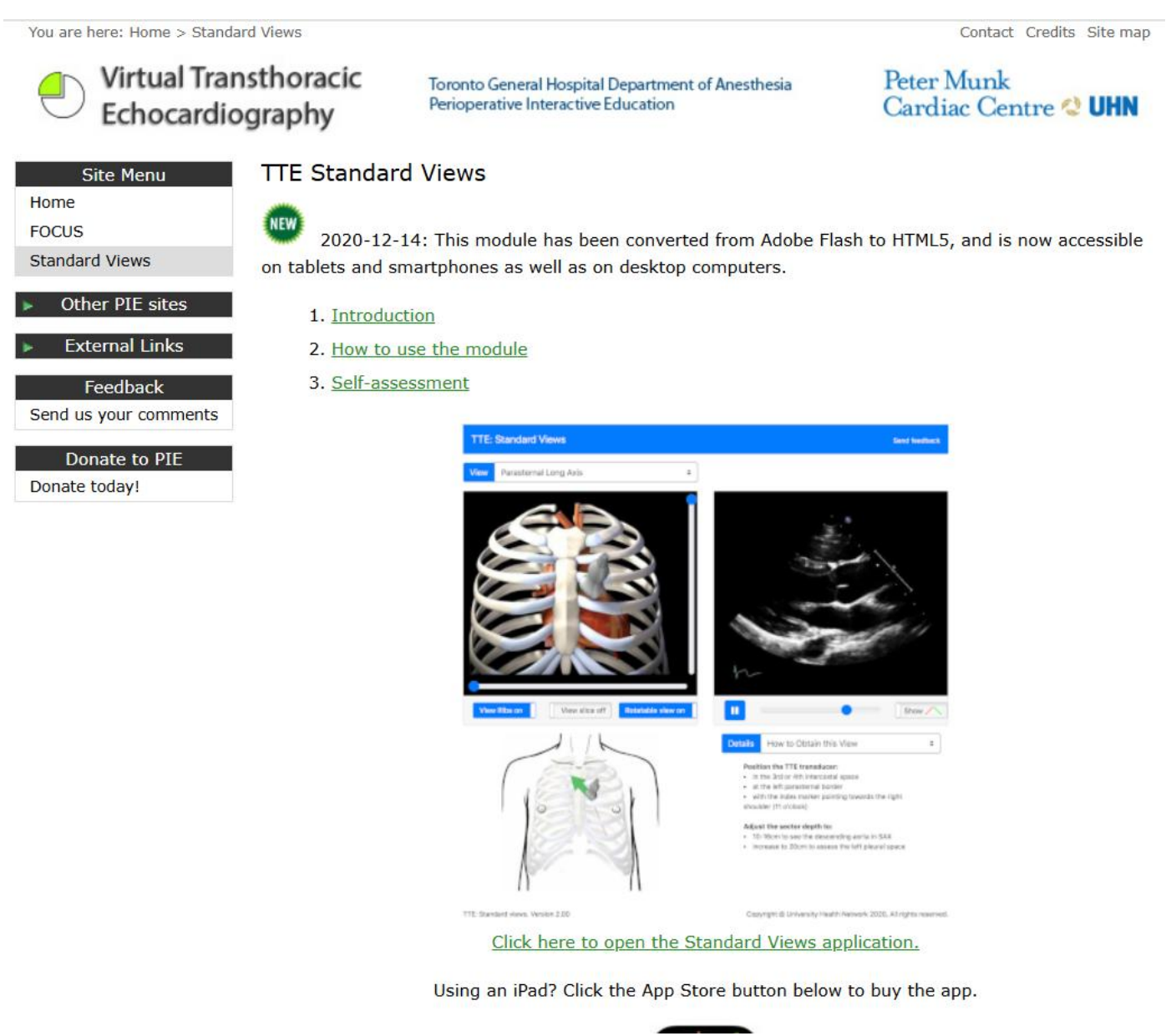
Vein:

- Carries blood towards the heart
- Usually carry deoxygenated blood, except pulmonary vein

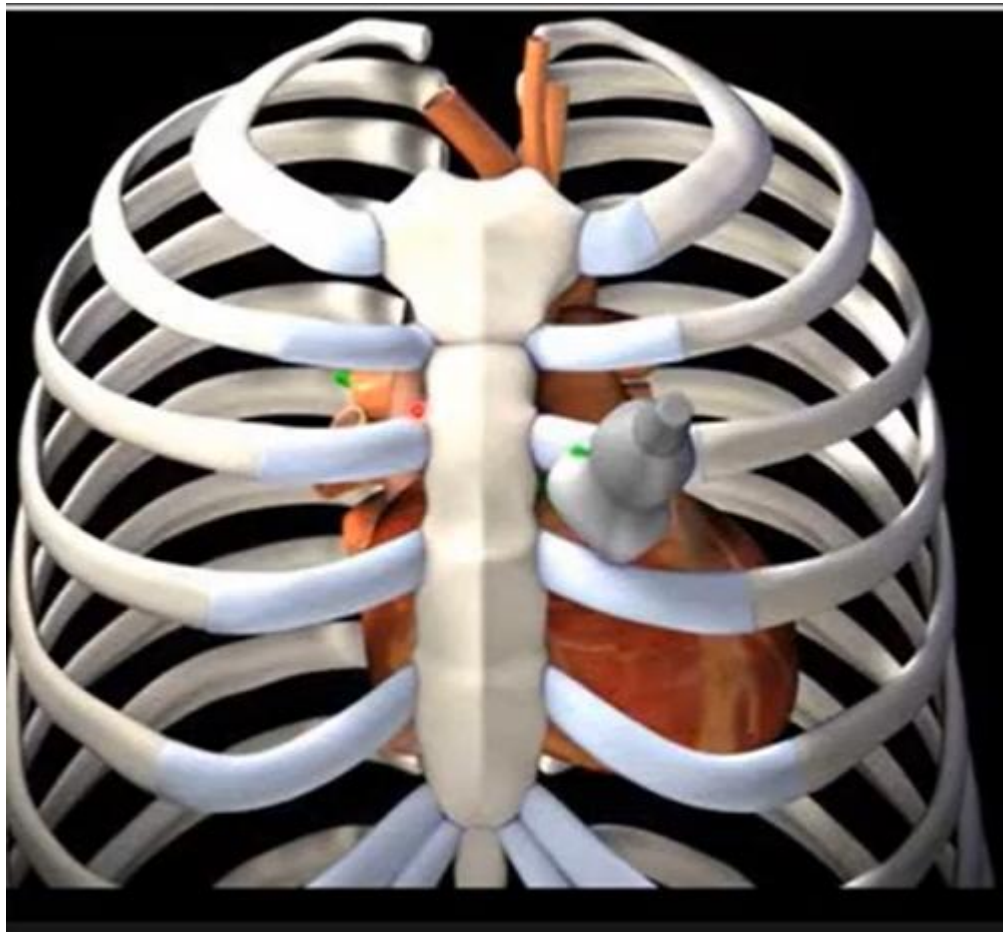

Blood Flow Through the Heart
deoxygenated blood
oxygenated blood
Right lung
Left lung
PULMONARY
VEINS
PULMONARY
VEINS
SUPERIOR VENA CAVA
AORTA
PULMONARY ARTERY
RIGHT ATRIUM
LEFT ATRIUM
MITRAL VALVE
PULMONARY VALVE
AORTIC VALVE
TRICUSPID VALVE
RIGHT VENTRICLE
LEFT VENTRICLE
INFERIOR VENA CAVA

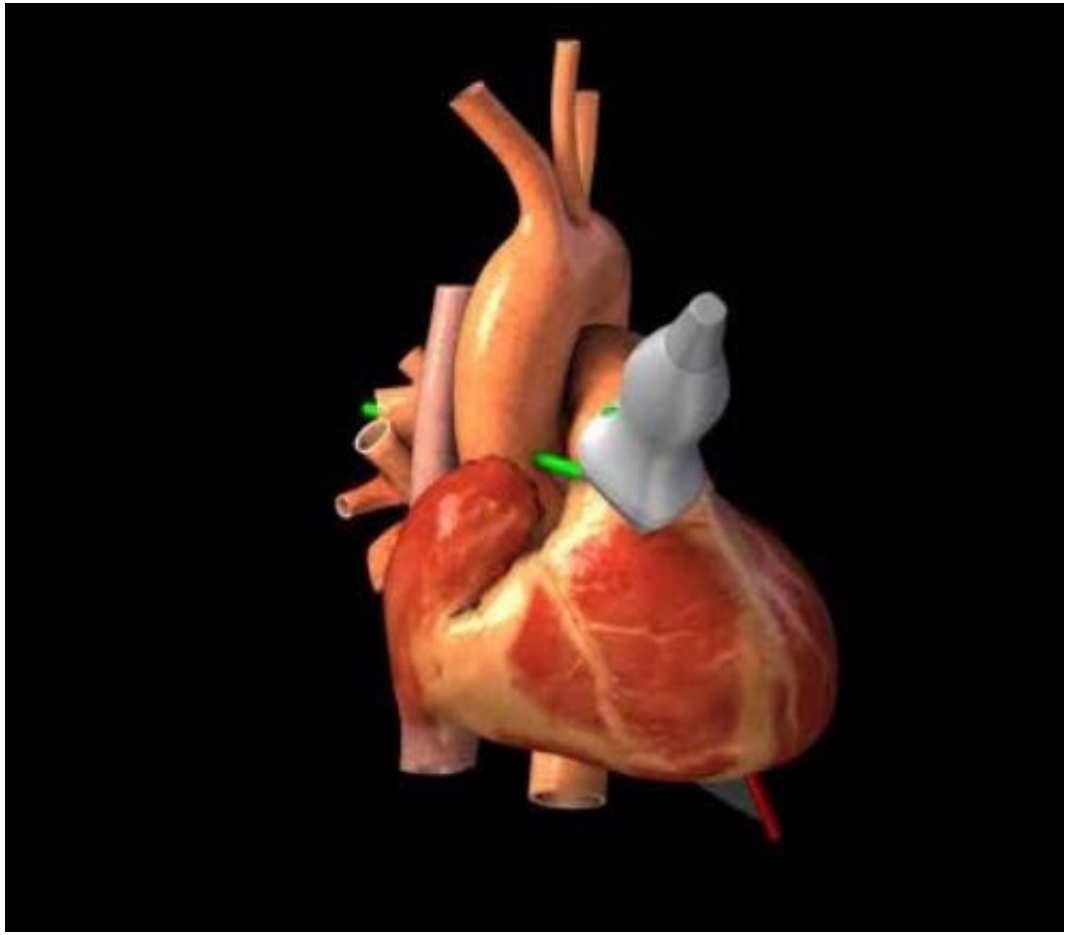
TORONTO TTE

- Free, public, everyone can access
- Strongly recommended



Parasternal Long Axis View





PARASTERNAL WINDOW

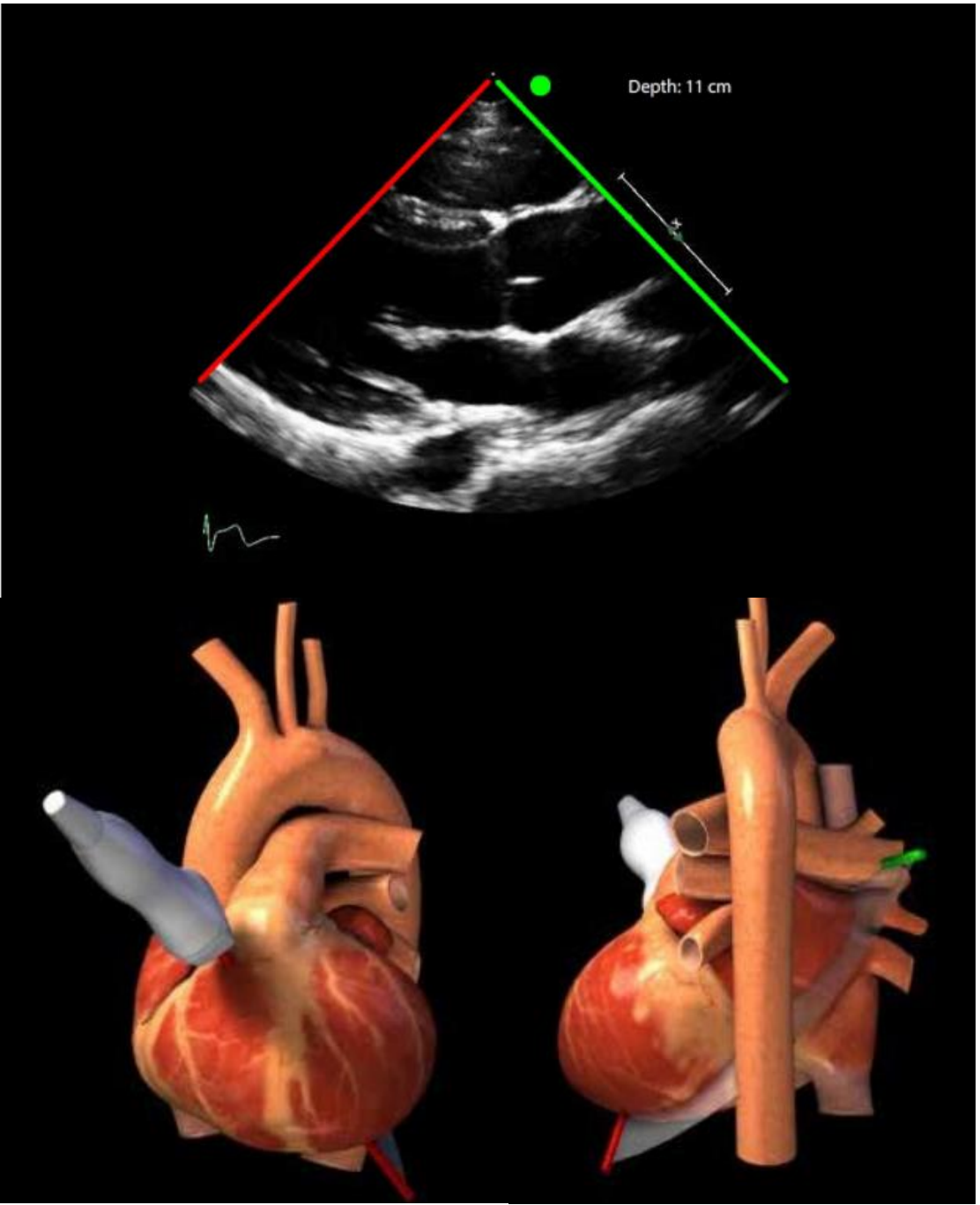
PARASTERNAL VIEWS

PARASTERNAL LONG AXIS VIEWS

PARASTERNAL LONG AXIS

RIGHT VENTRICULAR INFLOW

RIGHT VENTRICULAR OUTFLOW



Parasternal Long Axis View

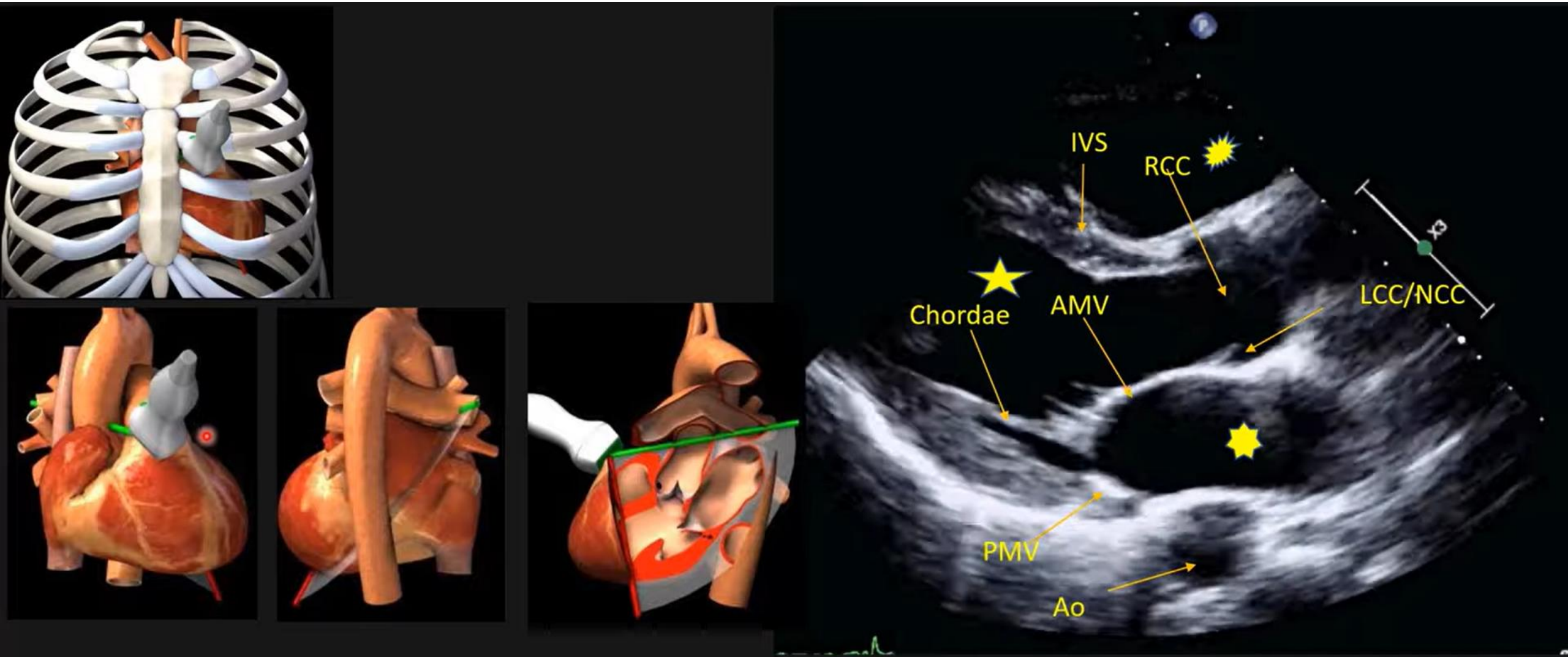
Position the TTE transducer:

- in the 3rd or 4th intercostal space
- at the left parasternal border
- with the index marker pointing towards the right shoulder (11 o'clock)

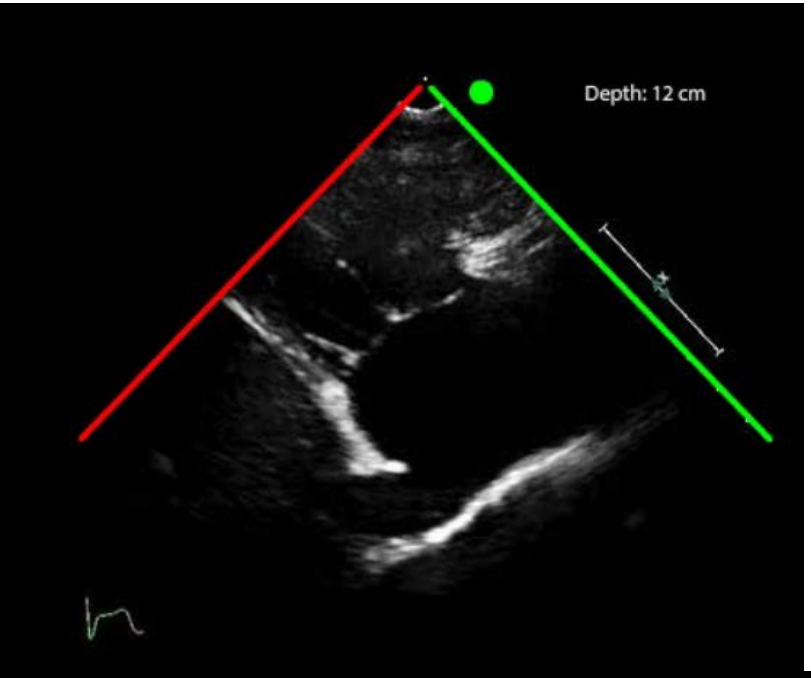
Adjust the sector depth to:

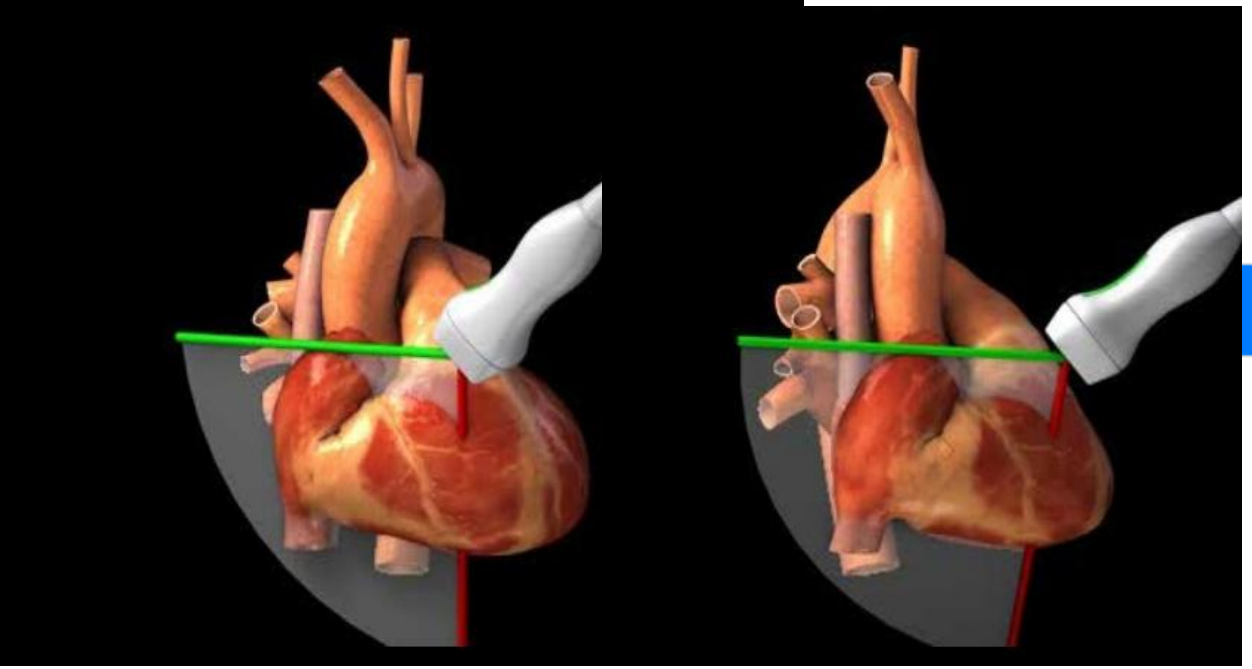
- 10-16cm to see the descending aorta in SAX
- increase to 20cm to assess the left pleural space

Parasternal Long Axis View



PLAX – RV Inflow View





Details How to Obtain this View

Position the TTE transducer:

- modification of the Parasternal LAX view
- in the 3rd or 4th intercostal space
- at the left parasternal border
- with the index marker pointing towards the right shoulder (11 o'clock)
- tilted inferiorly and medially (towards R hip)

Adjust the sector depth to:

- 10-16cm to see the IVC

Details How to Optimize this View

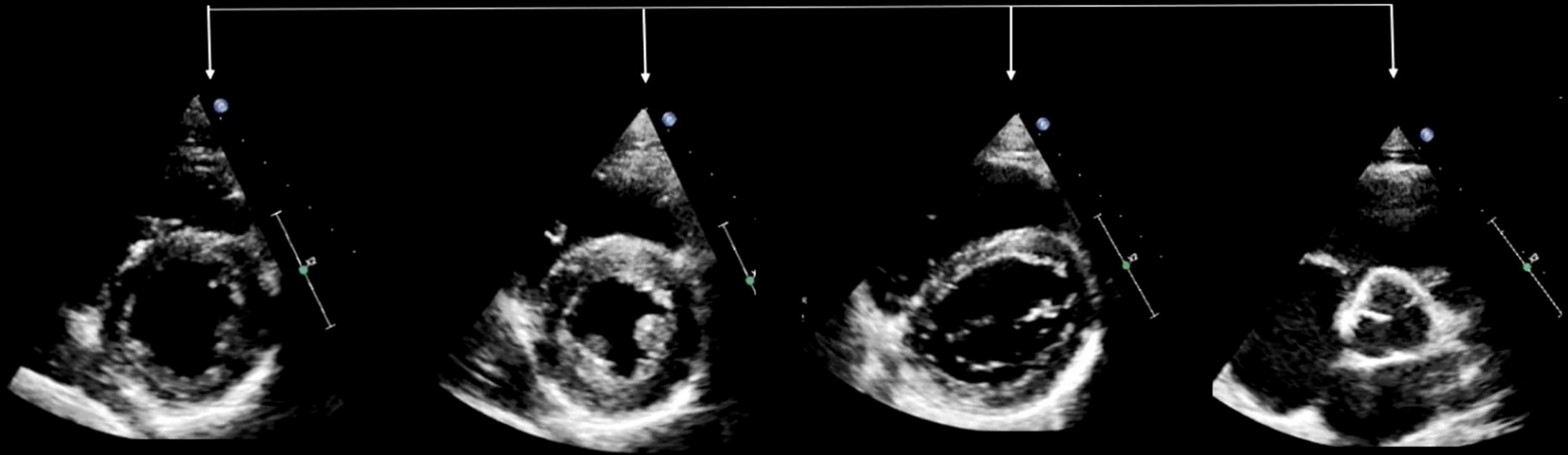
Adjust the TTE probe position to:

- visualize only the RV and not the LV
- center the image (slide probe away from sternum)
- make the TV cusps appear symmetric (rotate probe clockwise)
- visualize the RV apex (change one interspace lower)

PARASTERNAL WINDOW

PARASTERNAL VIEWS

PARASTERNAL SHORT AXIS VIEWS

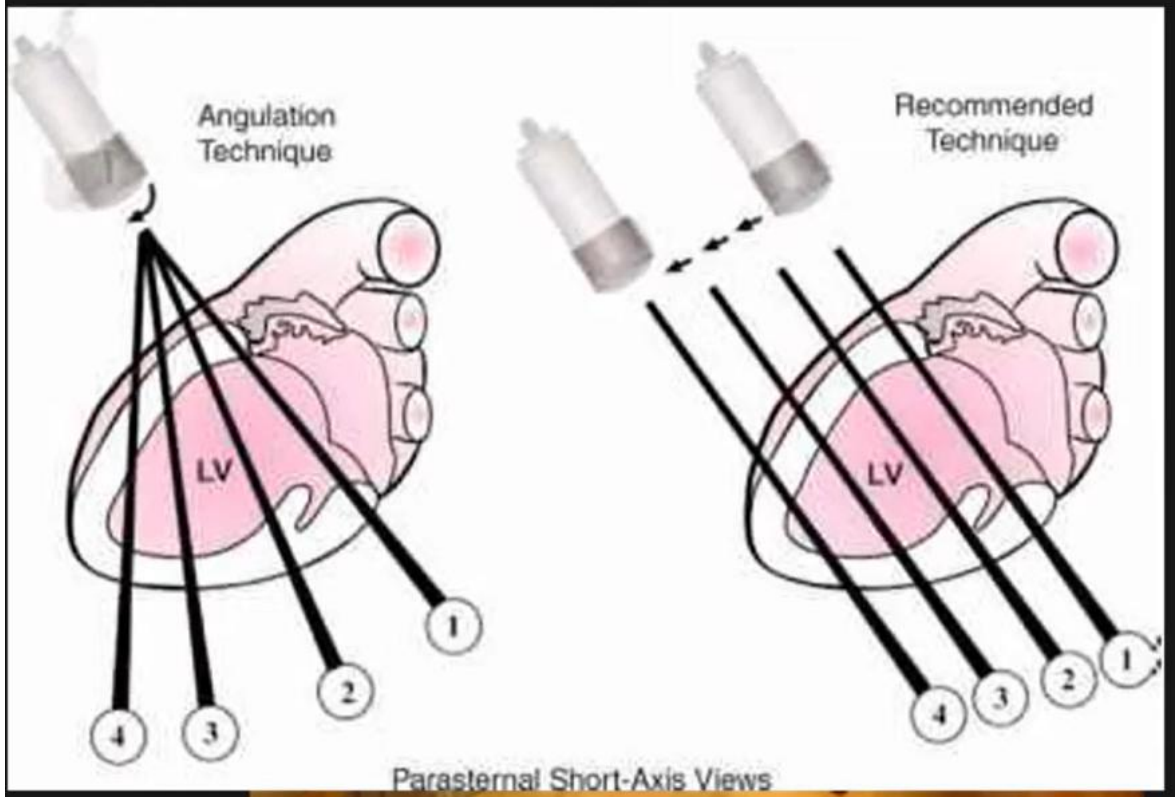


AT LEFT VENTRICULAR APEX LEVEL

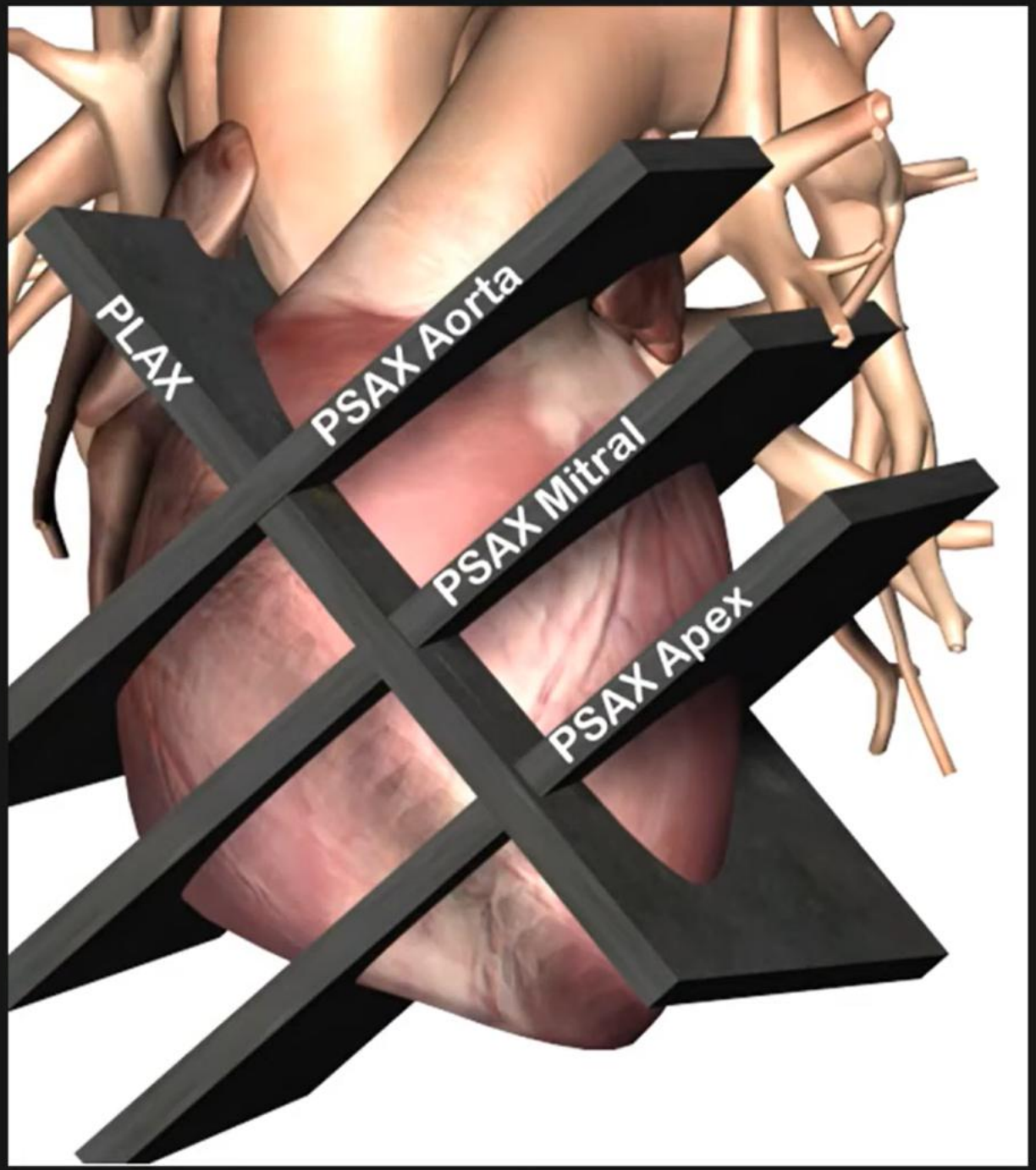
AT PAPILLARY MUSCLE LEVEL

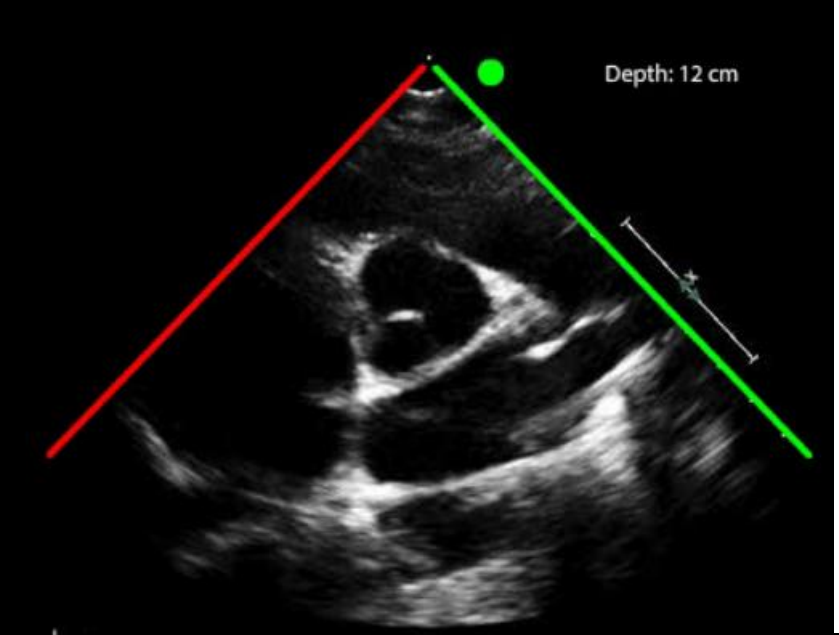
AT MITRAL VALVE LEVEL

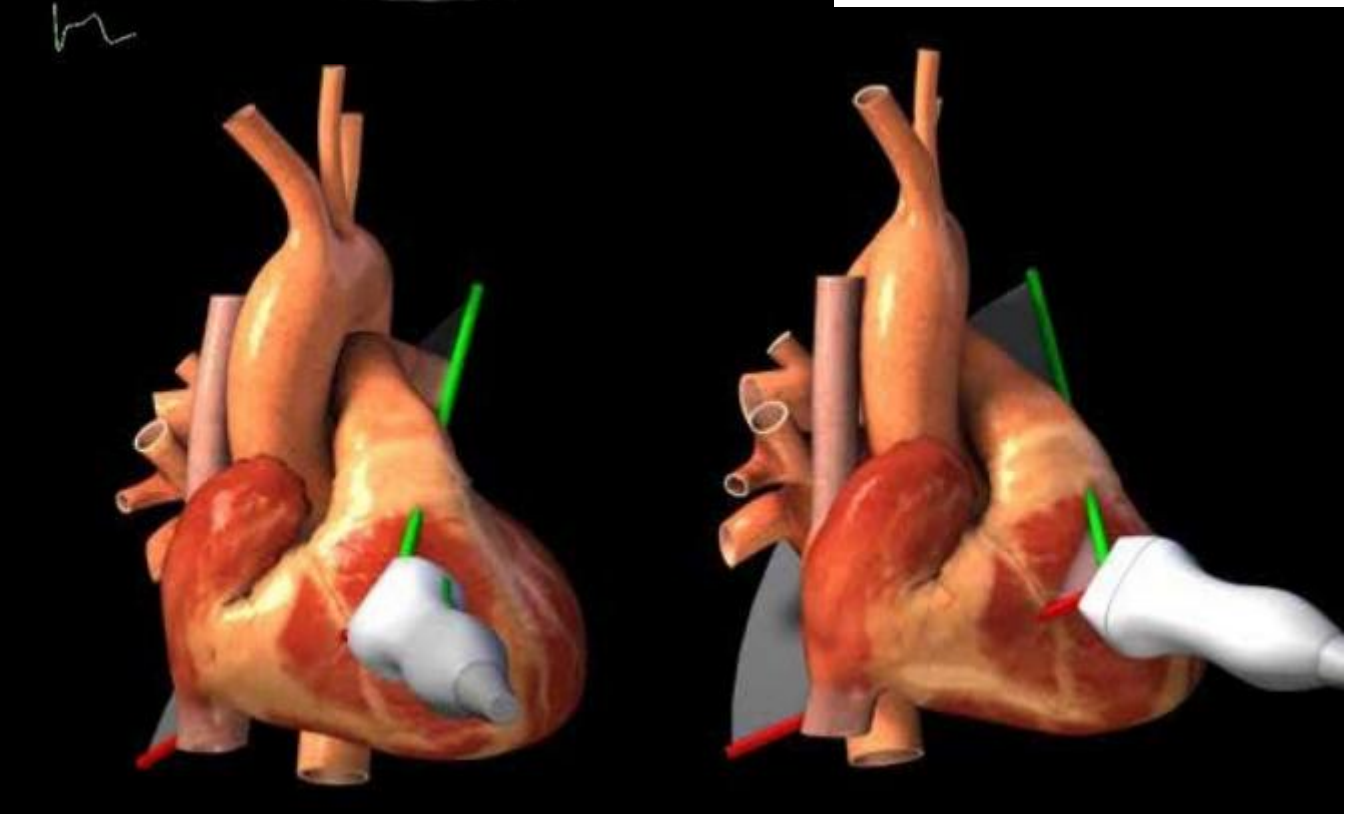
AT GREAT VESSELS LEVEL



Parasternal Short-Axis Views







PSAX – Ao View

Details How to Obtain this View

Position the TTE transducer:

- modification of the Parasternal LAX view in which the AV is in the center of the screen
- in the 3rd or 4th intercostal space
- at the left parasternal border
- rotate the probe 90° clockwise from the right shoulder (marker at 11 o'clock) so the index marker now points towards the left shoulder (2 o'clock)

Adjust the sector depth to:

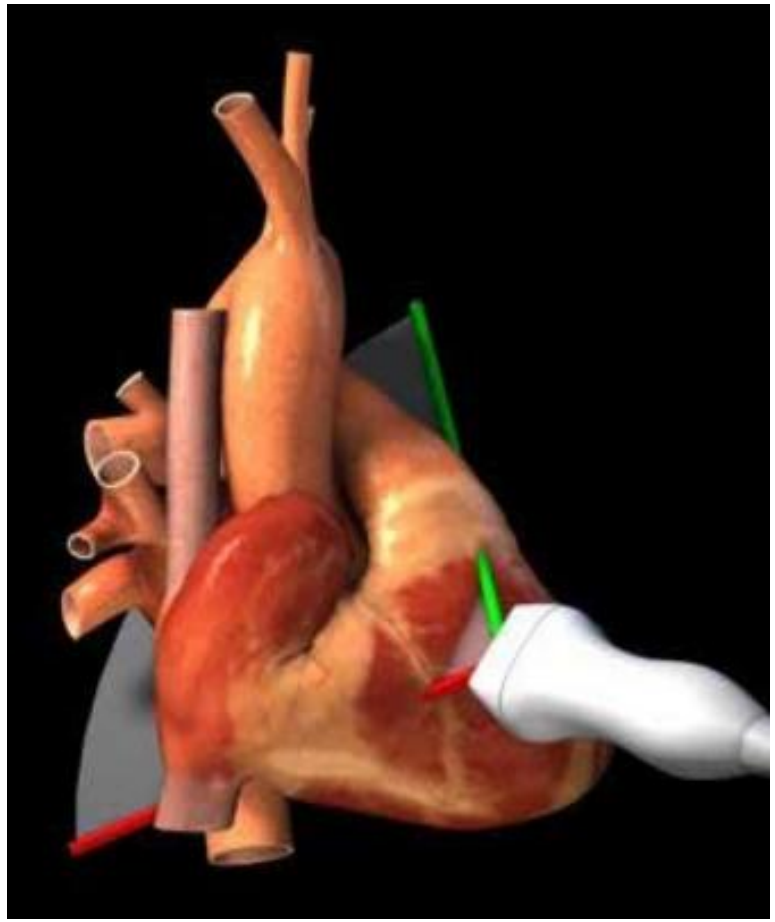
- 10-16cm to see the descending aorta

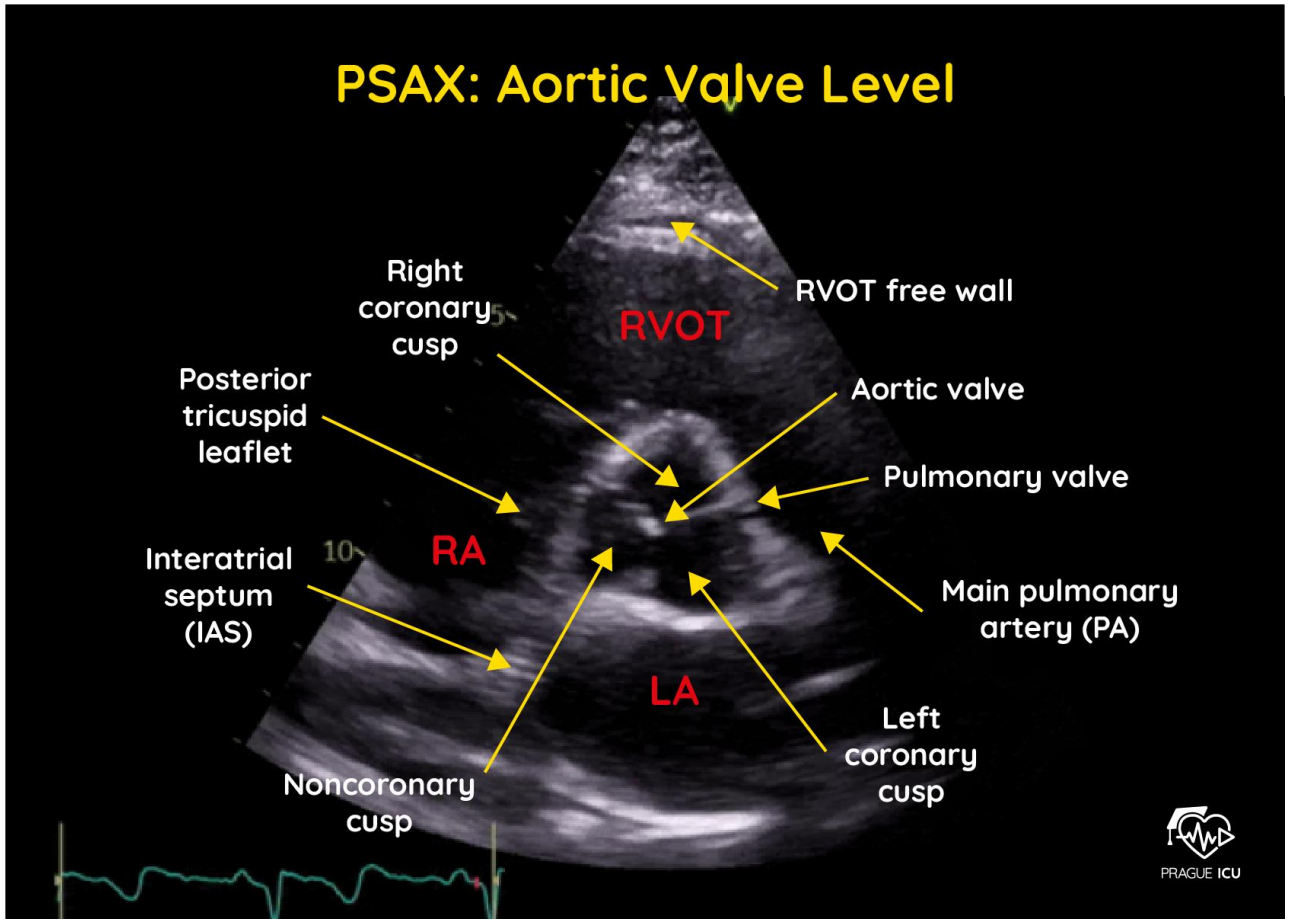
Details How to Optimize this View

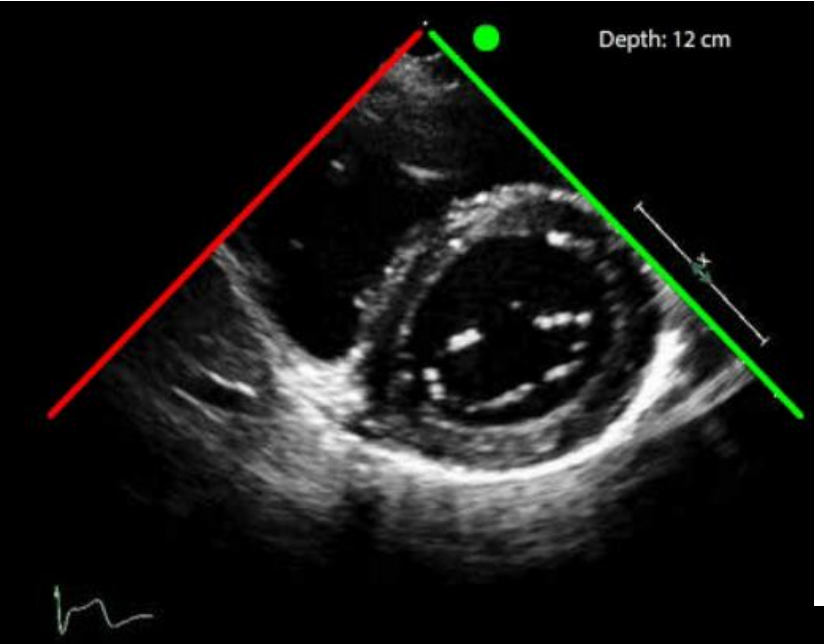
Adjust the TTE probe position to:

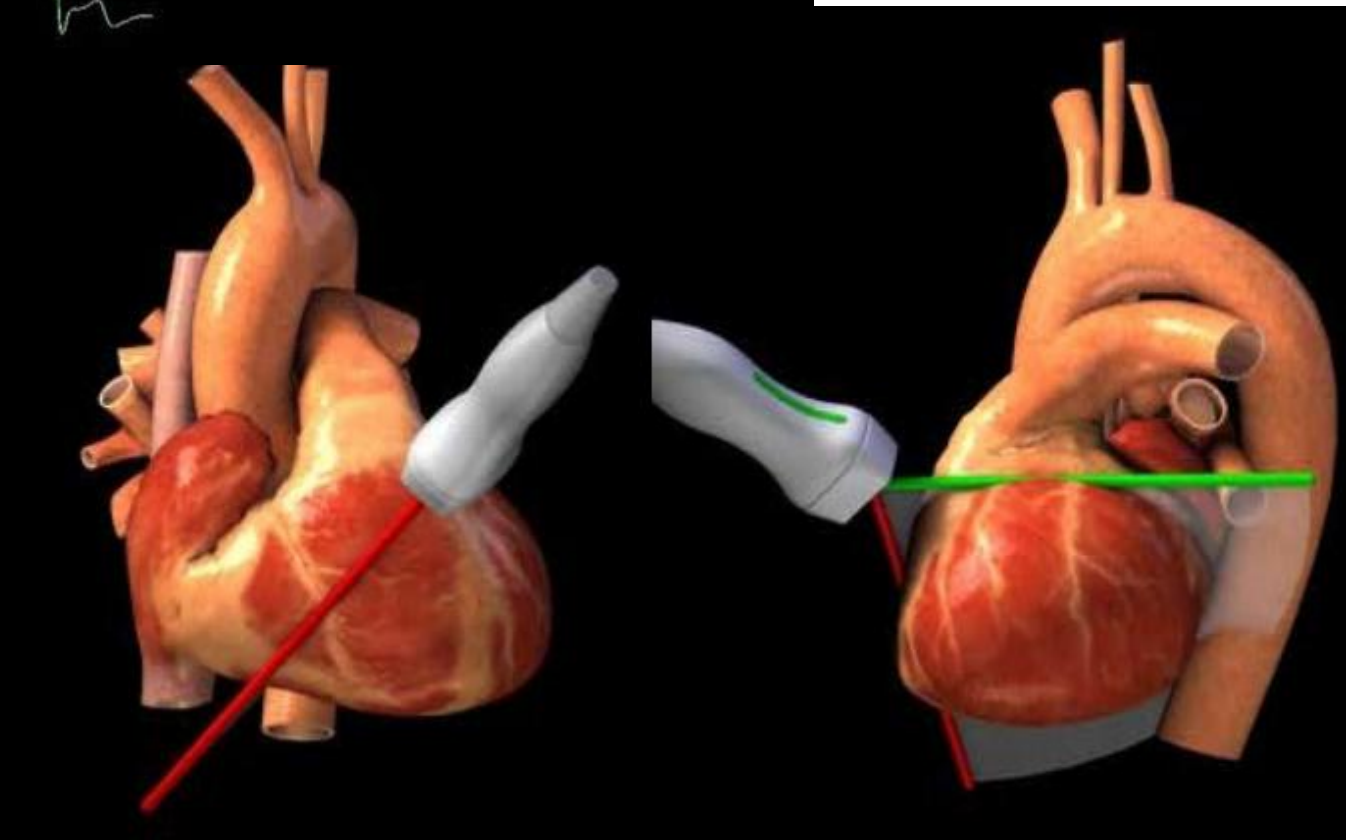
- center the image (slide probe away from sternum)
- make the AV cusps appear symmetric (rotate probe)
- visualize the RV outflow tract (change one interspace higher)

PSAX – Ao View




PSAX: Aortic Valve Level
Right coronary cusp
RVOT
RVOT free wall
Posterior tricuspid leaflet
Aortic valve
Pulmonary valve
RA
Interatrial septum (IAS)
Main pulmonary artery (PA)
LA
Left coronary cusp
Noncoronary cusp
PRAGUE ICU





PSAX – Mitral valve (Basal) level

Details | How to Obtain this View

Position the TTE transducer:

- modification of the Parasternal SAX AV and RVOT Level view
- in the 3rd or 4th intercostal space
- at the left parasternal border
- with the index marker pointing towards the left shoulder (2 o'clock)
- slightly tilted inferiorly towards LV apex

Adjust the sector depth to:

- 10-16cm to see the entire LV

Details | How to Optimize this View

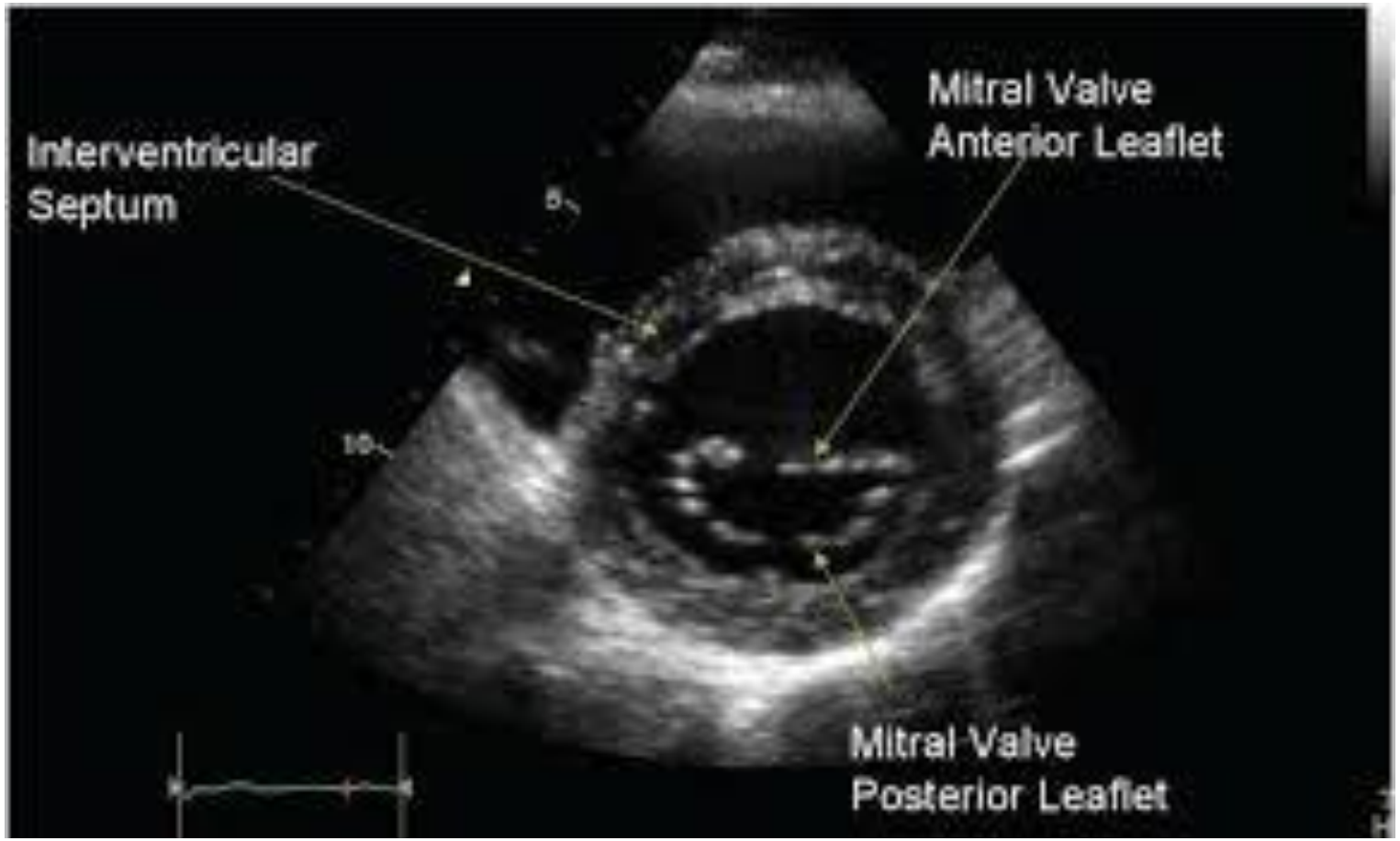
Adjust the TTE probe position to:

- place the LV in the center of the image (rotate probe)
- make the LV appear round in shape and the RV crescent shaped (change interspace)
- visualize both mitral valve leaflets (tilt or slide probe inferior)

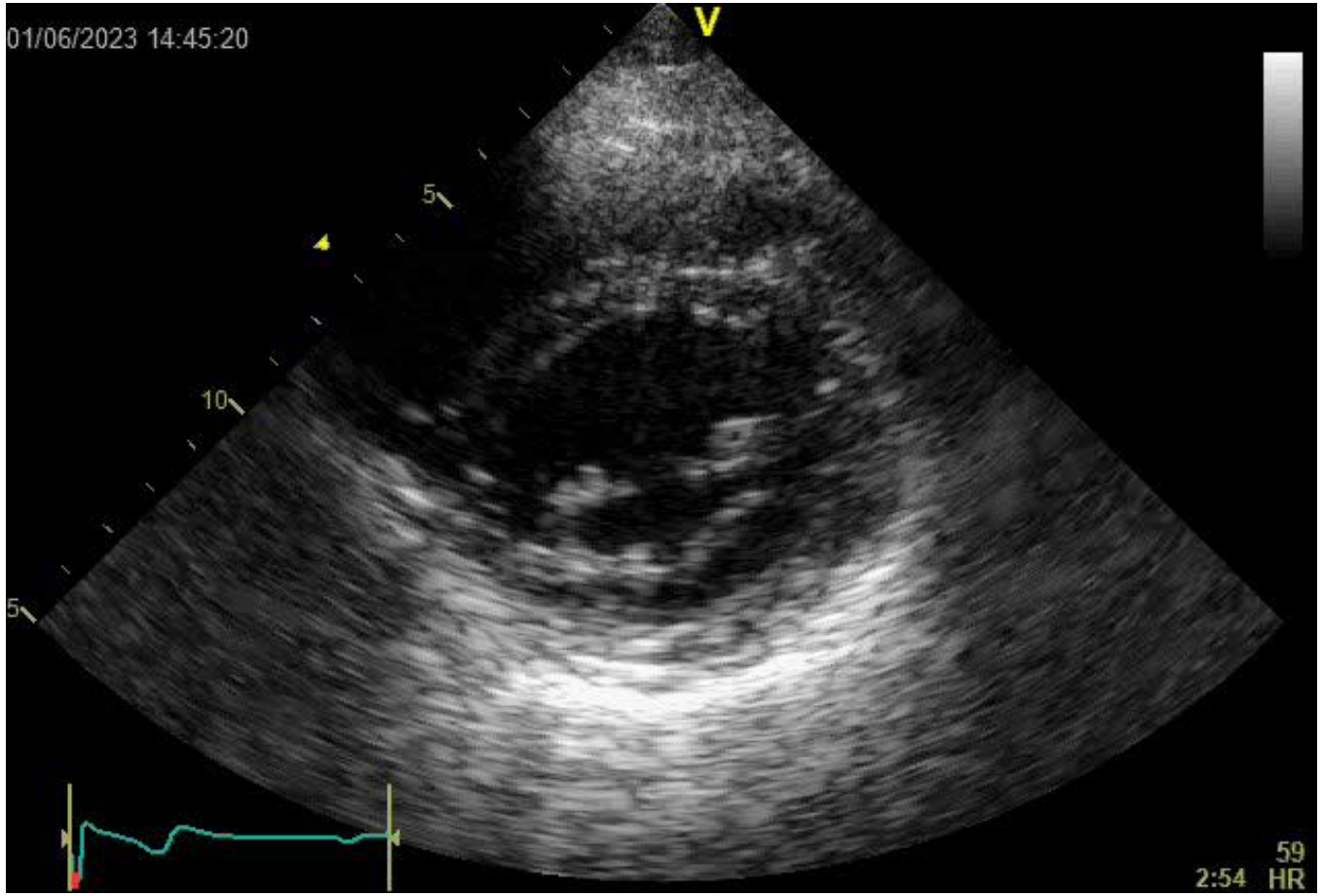
Adjust the image gain to:

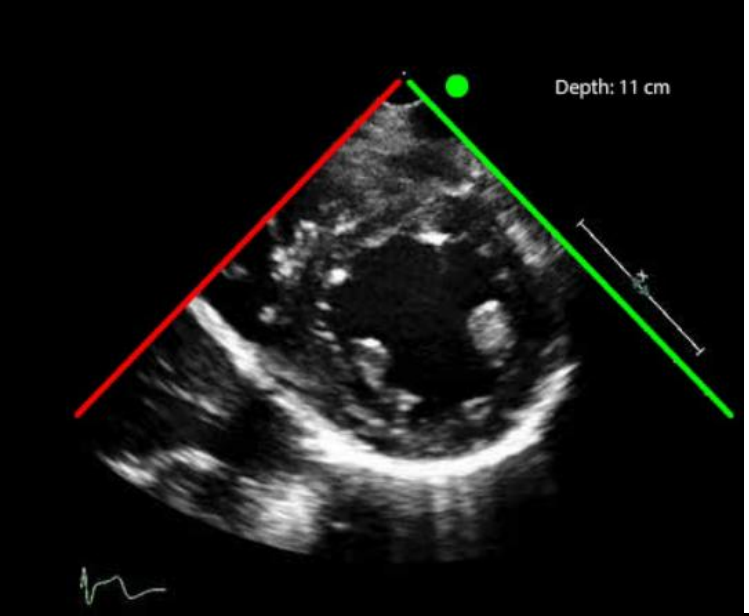
- visualize the endocardium

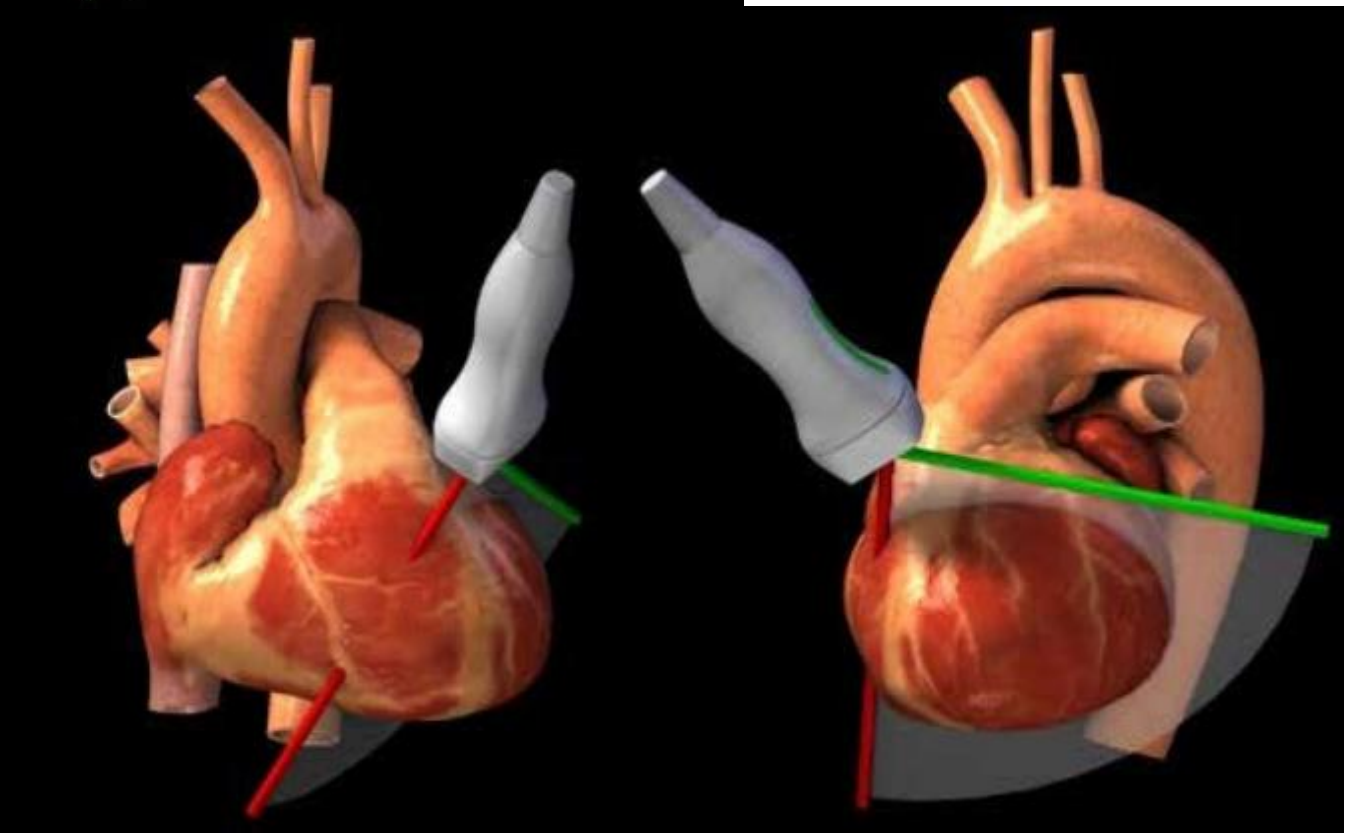
PSAX – Mitral valve (Basal) level



Fish mouth in Rheumatic mitral stenosis







PSAX – Mid Papillary level

Details | How to Obtain this View

Position the TTE transducer:

- modification of the Parasternal SAX AV and RVOT Level view
- in the 3rd or 4th intercostal space
- at the left parasternal border
- with the index marker pointing towards the left shoulder (2 o'clock)
- tilt or slide inferiorly towards LV apex

Adjust the sector depth to:

- 10-16cm to see the entire LV

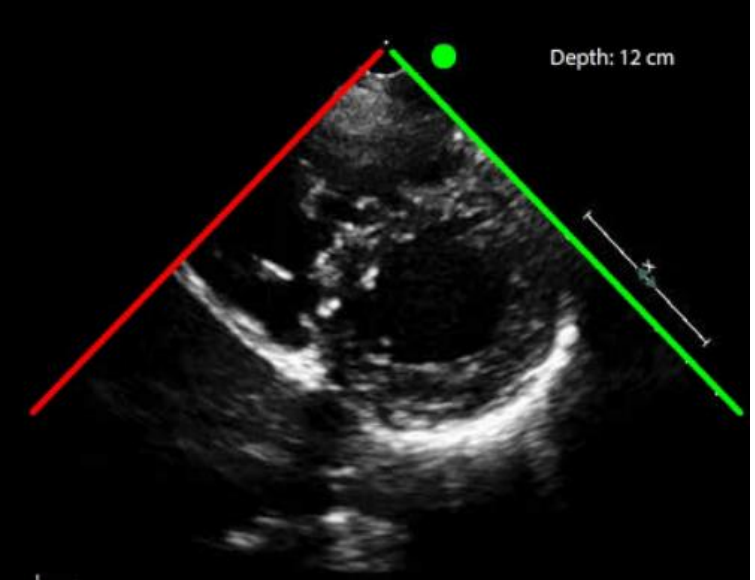
Details | How to Optimize this View

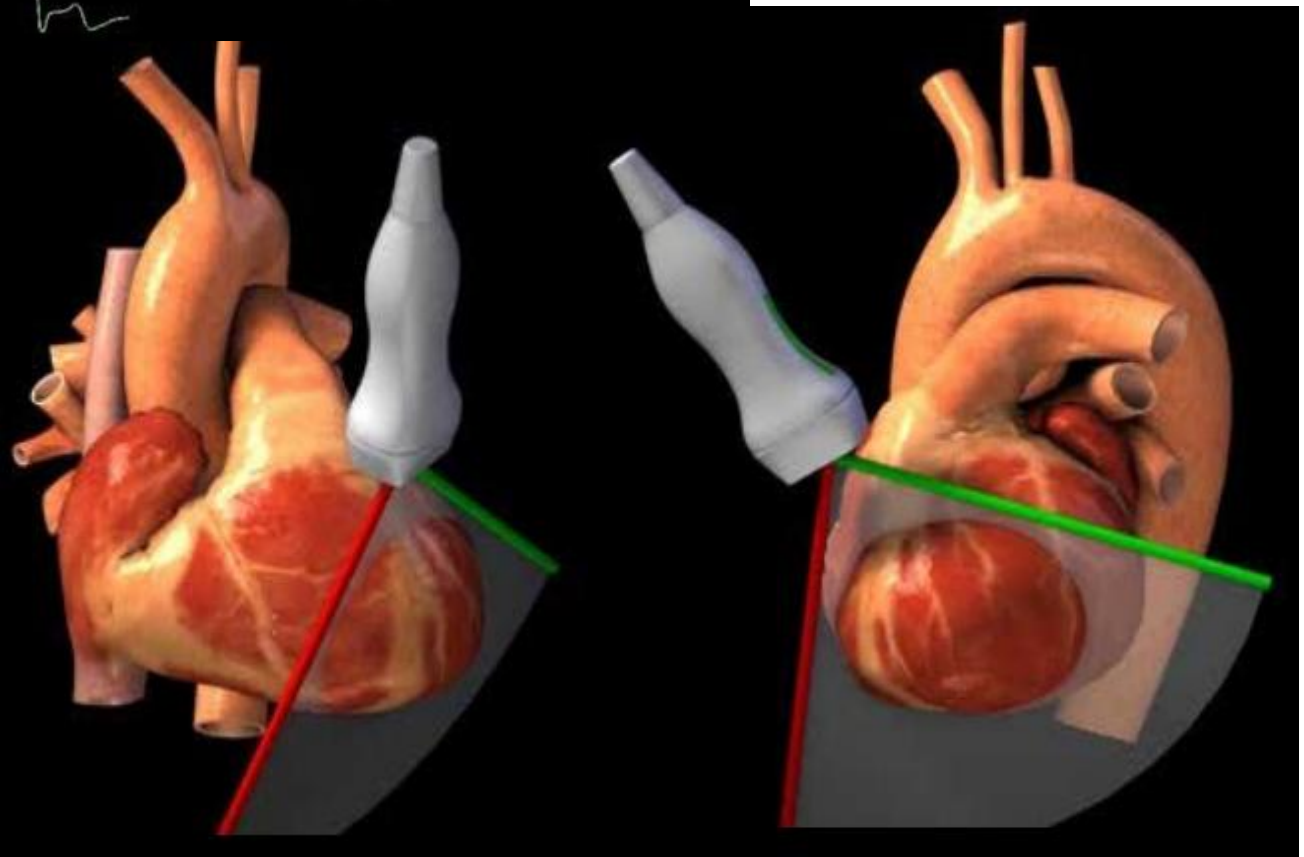
Adjust the TTE probe position to:

- place the LV in the center of the image (rotate probe)
- make the LV appear round in shape and the RV crescent shaped (change one interspace lower)
- visualize both papillary muscles attached to the LV wall (change one interspace lower)
- not visualize the mitral valve (tilt more inferior or change one interspace lower)

Adjust the image gain to:

- visualize the endocardium





PSAX – Apical level

Details | How to Obtain this View

Position the TTE transducer:

- modification of the Parasternal SAX AV and RVOT Level view
- in the 3rd or 4th intercostal space
- at the left parasternal border
- with the index marker pointing towards the left shoulder (2 o'clock)
- tilt or slide inferiorly towards LV apex

Adjust the sector depth to:

- 10-14cm to see the entire LV and pericardium

Details | How to Optimize this View

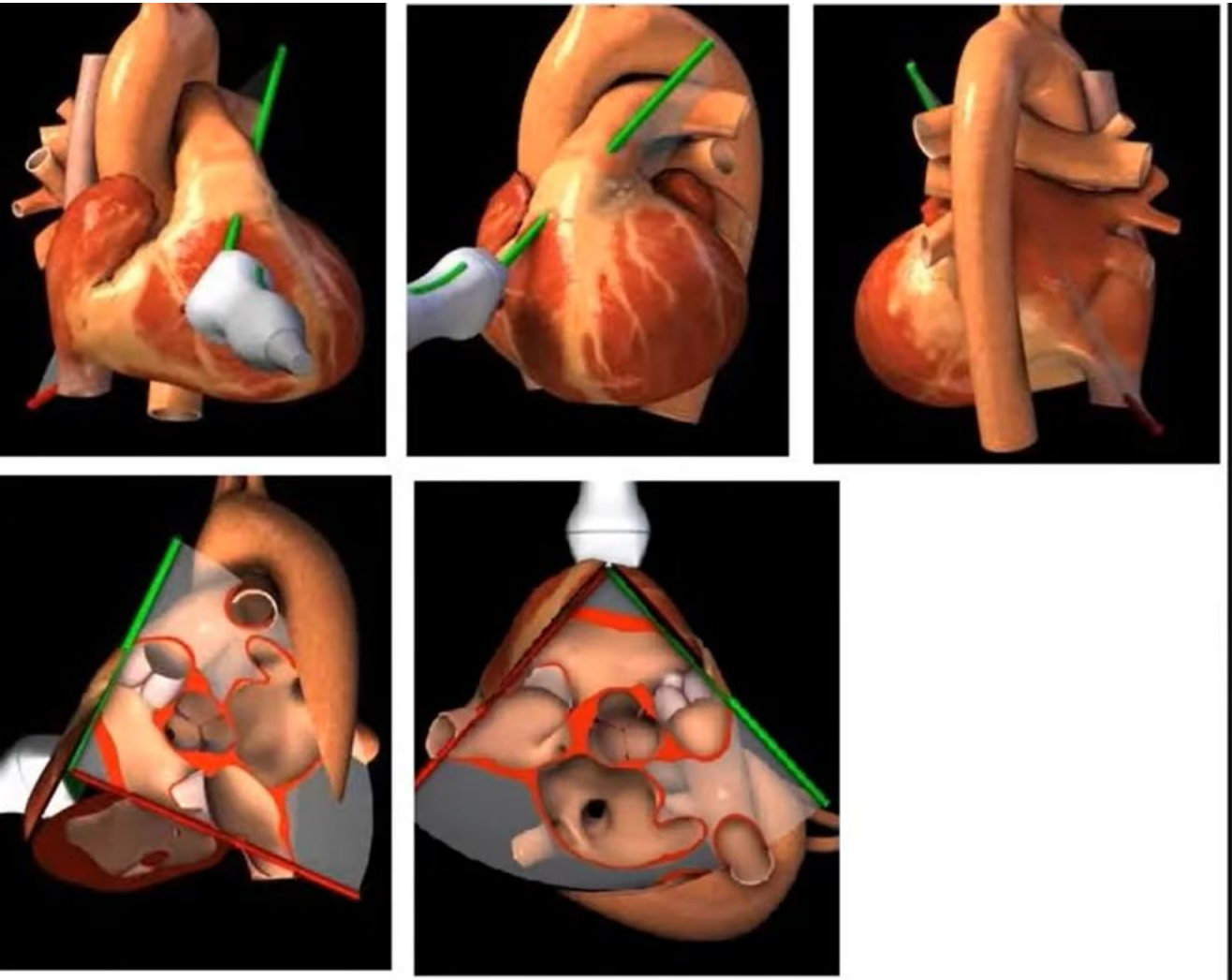
Adjust the TTE probe position to:

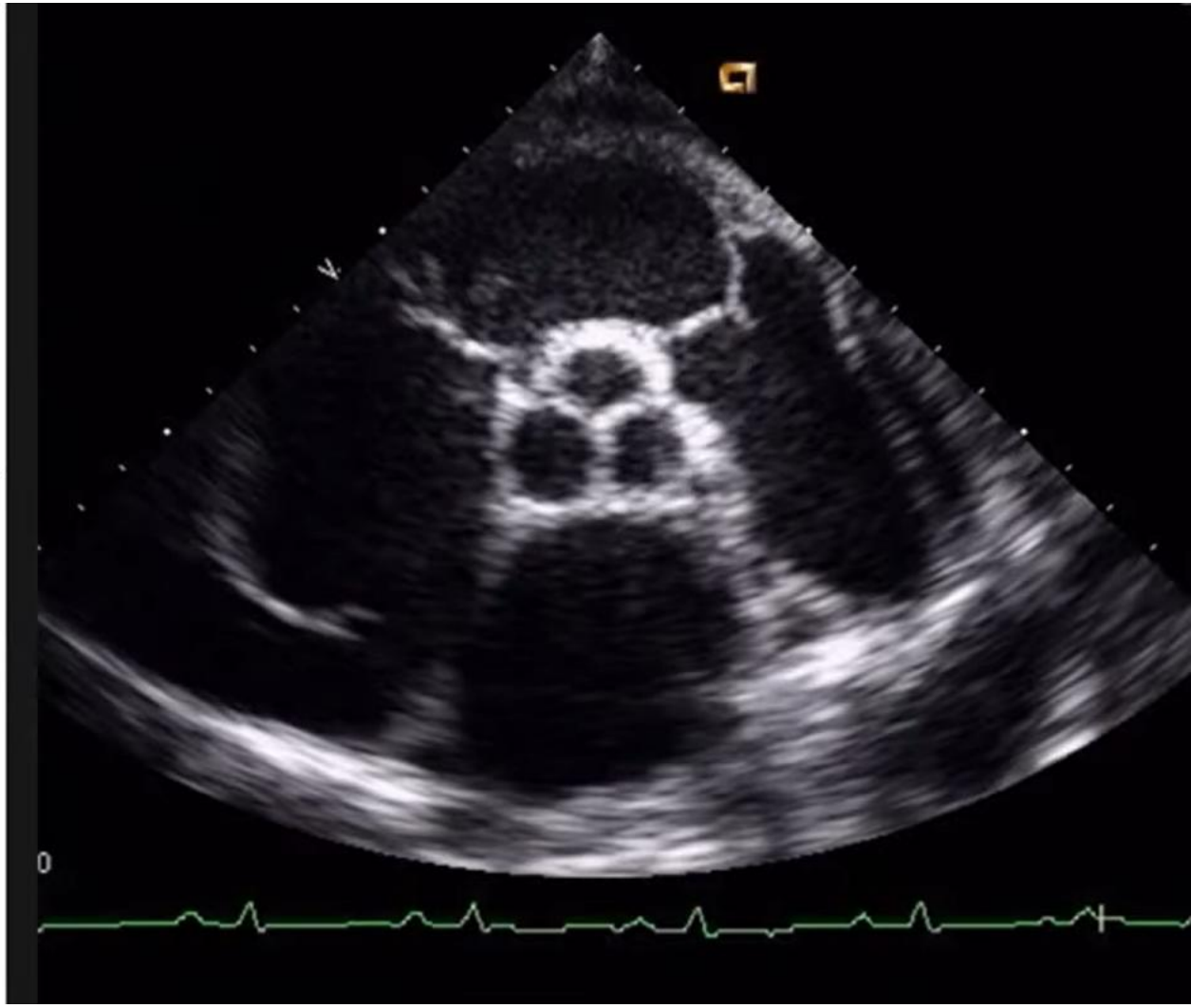
- place the LV in the center of the image (slide probe)
- make the LV appear round in shape (change one interspace lower)
- no papillary muscles should be seen (tilt or slide inferior)
- a small portion of the RV apex may be seen

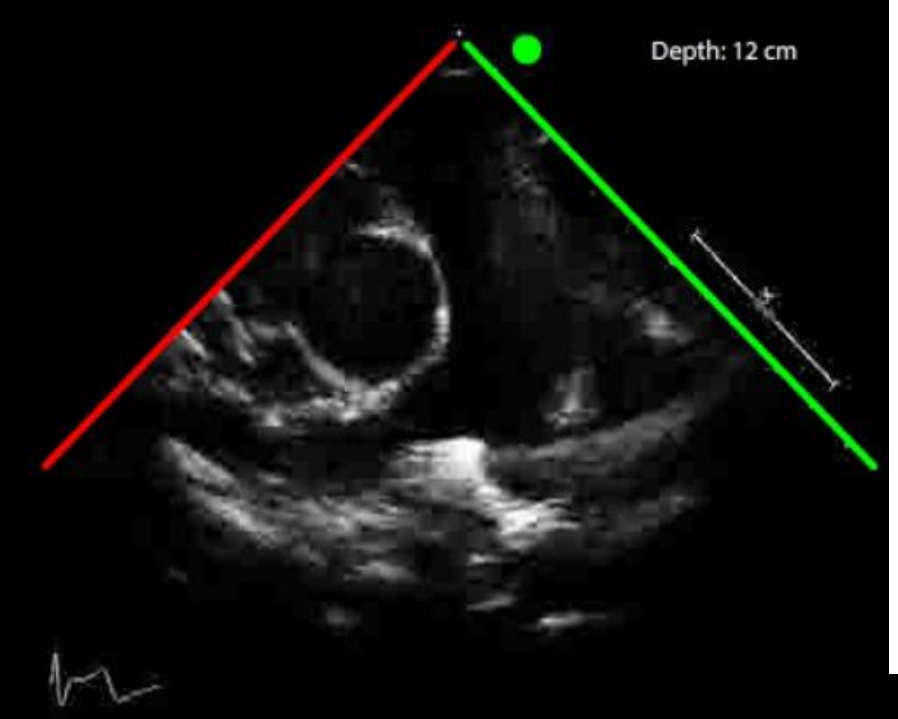
Adjust the image gain to:

- visualize the endocardium

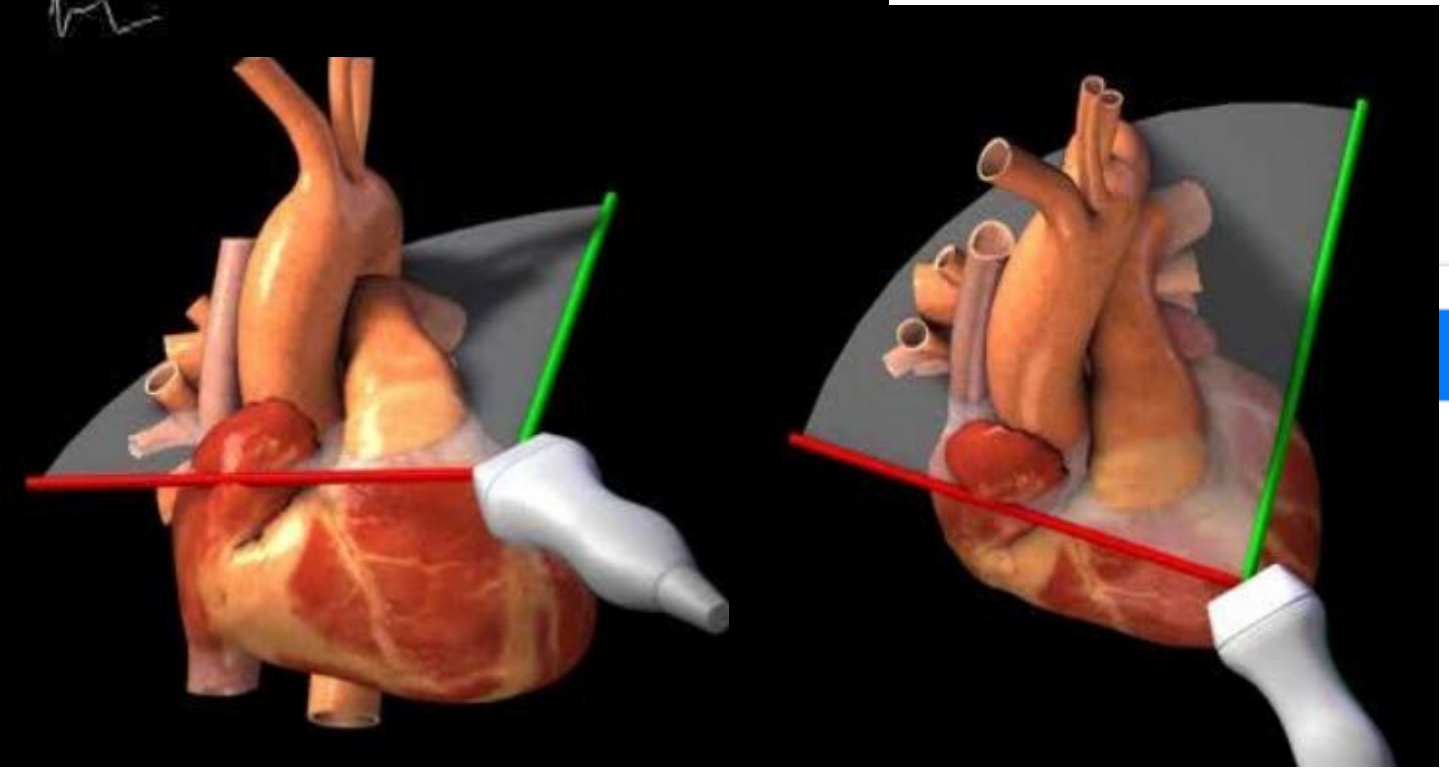
PSAX – Ao PA view







PSAX – Ao PA View



Details | How to Obtain this View

Position the TTE transducer:

- modification of the Parasternal SAX AV and RVOT Level view
- in the 3rd or 4th intercostal space
- at the left parasternal border
- with the index marker pointing towards the left shoulder (1-2 o'clock)
- tilted superiorly and medially

Adjust the sector depth to:

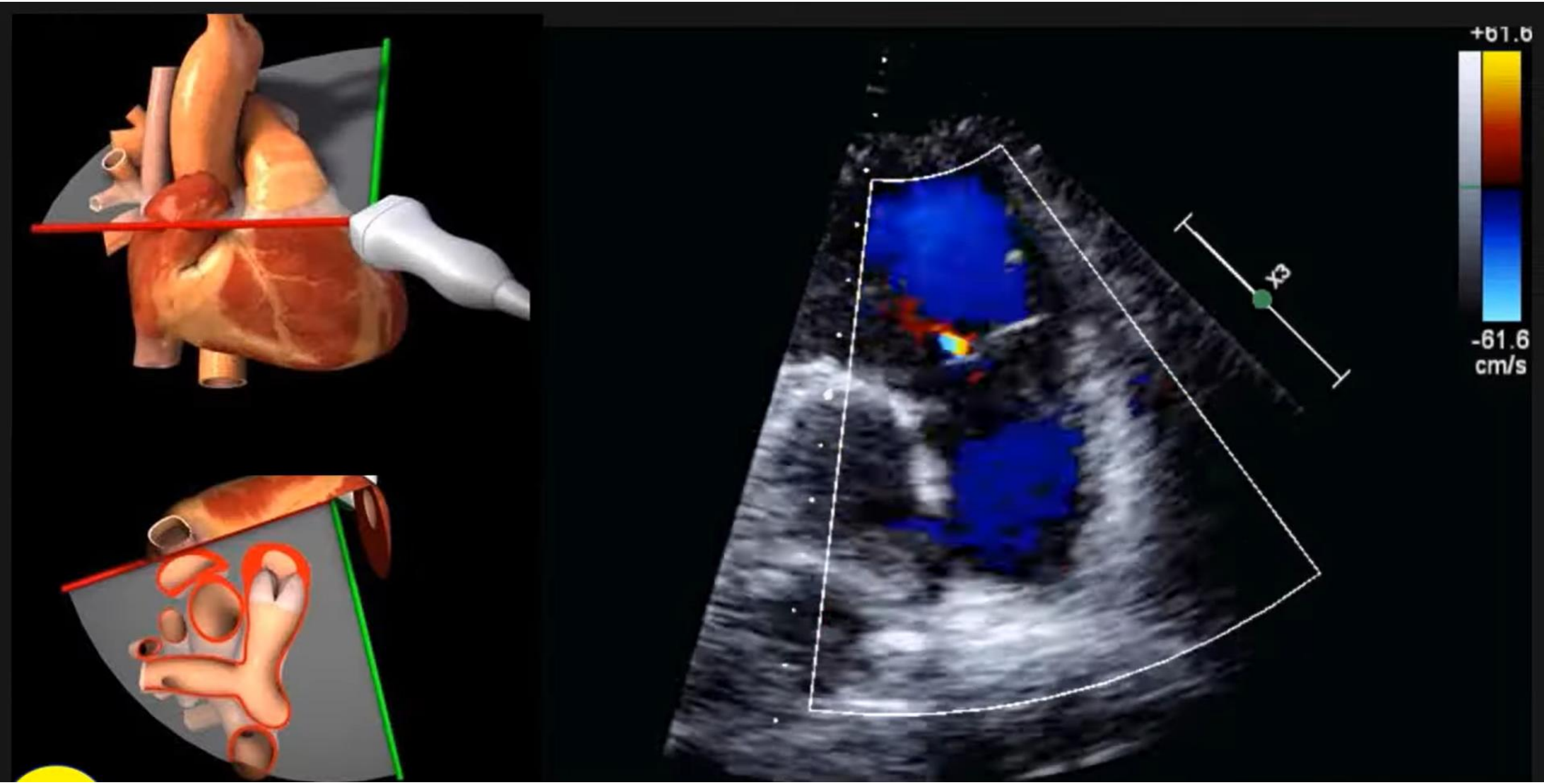
- 10-16cm to see the PA bifurcation

Details | How to Optimize this View

Adjust the TTE probe position to:

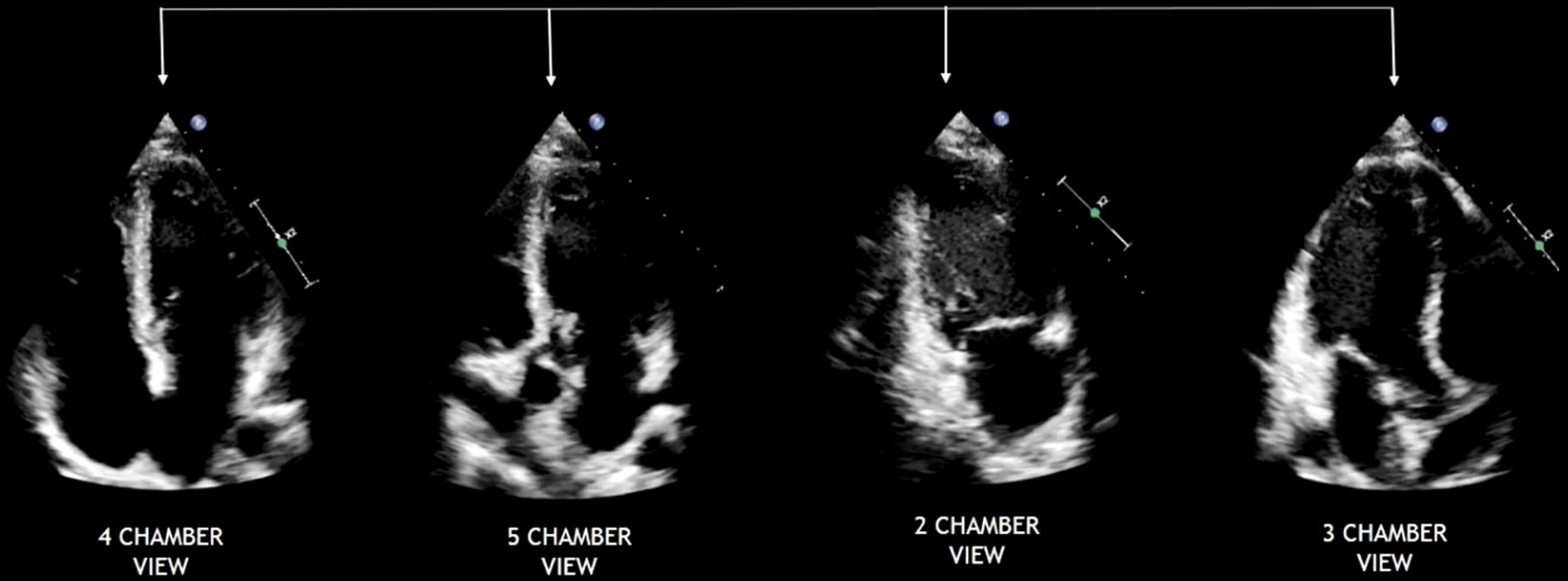
- center the image (slide probe away from sternum)
- make the main pulmonary artery walls appear symmetric (rotate probe)
- visualize the RV outflow tract (change one interspace higher)
- AV should not be seen only aorta (tilt probe superior)

PSAX – Ao PA View


+61.6
-61.6
cm/s

APICAL WINDOW

APICAL VIEWS

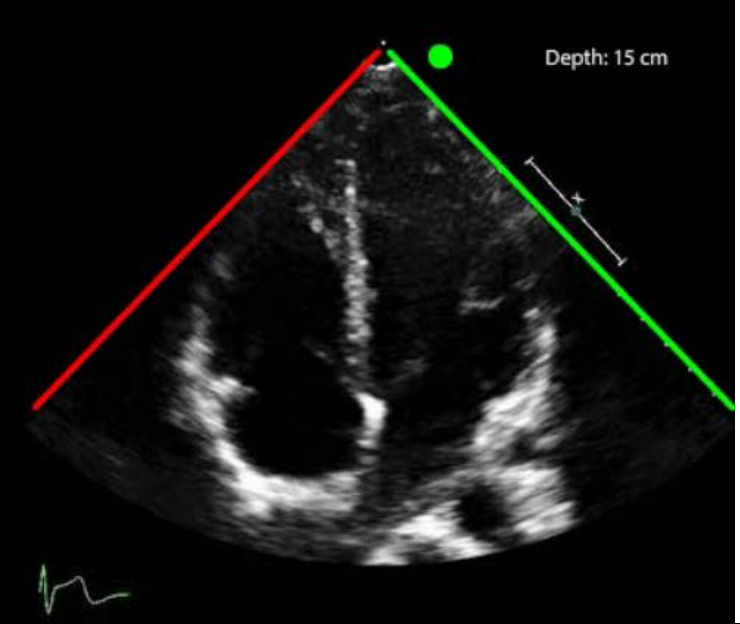


4 CHAMBER VIEW

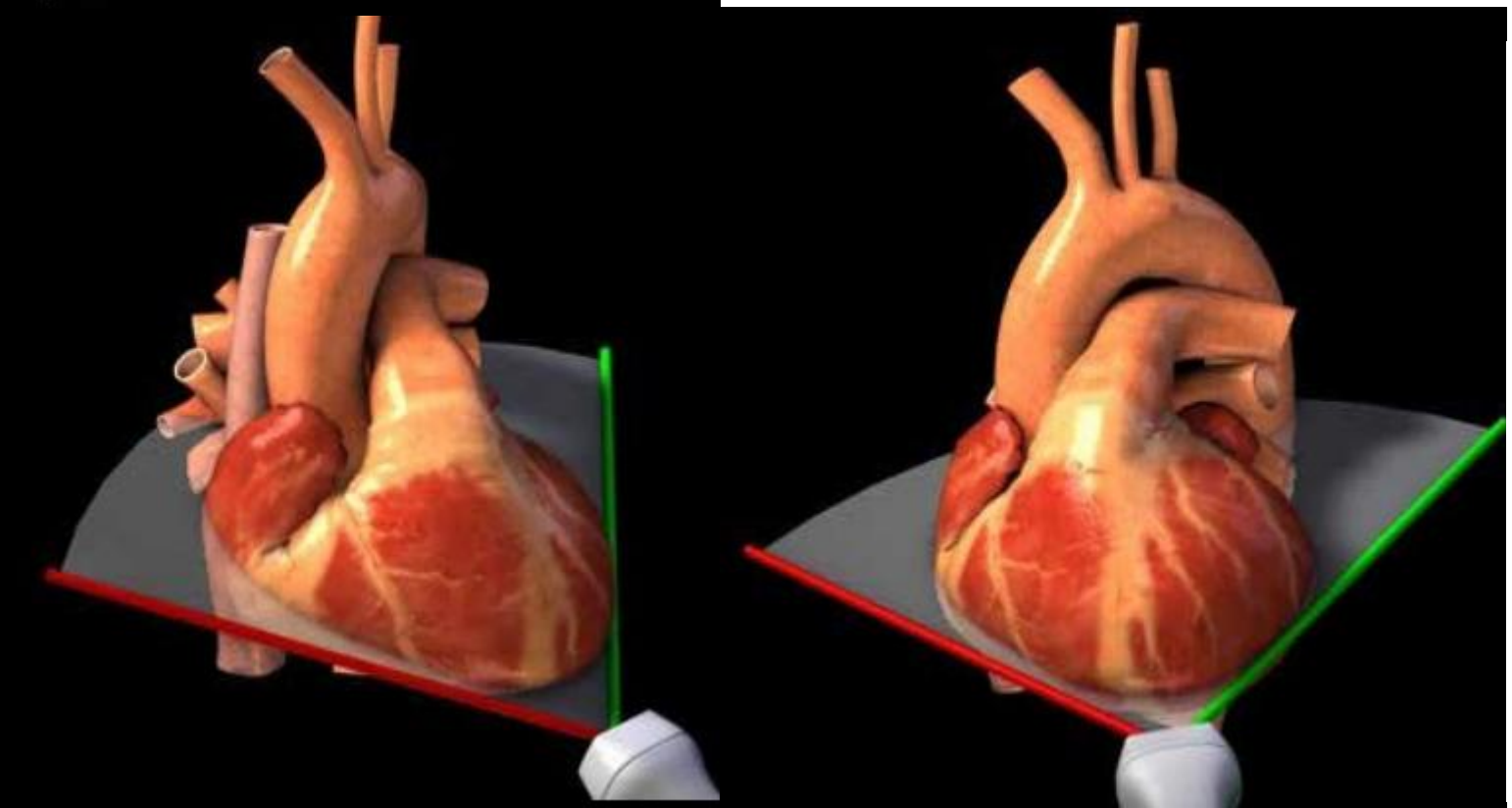
5 CHAMBER VIEW

2 CHAMBER VIEW

3 CHAMBER VIEW



Apical 4 Chamber



Details | How to Obtain this View

Position the TTE transducer:

- in the 4th or 5th intercostal space
- in the midclavicular line or at the point of apical pulsation
- with the index marker pointing towards the left (3 o'clock)

Adjust the sector depth to:

- 14-18cm to image the atria
- 6-10cm to assess the LV apex

Details | How to Optimize this View

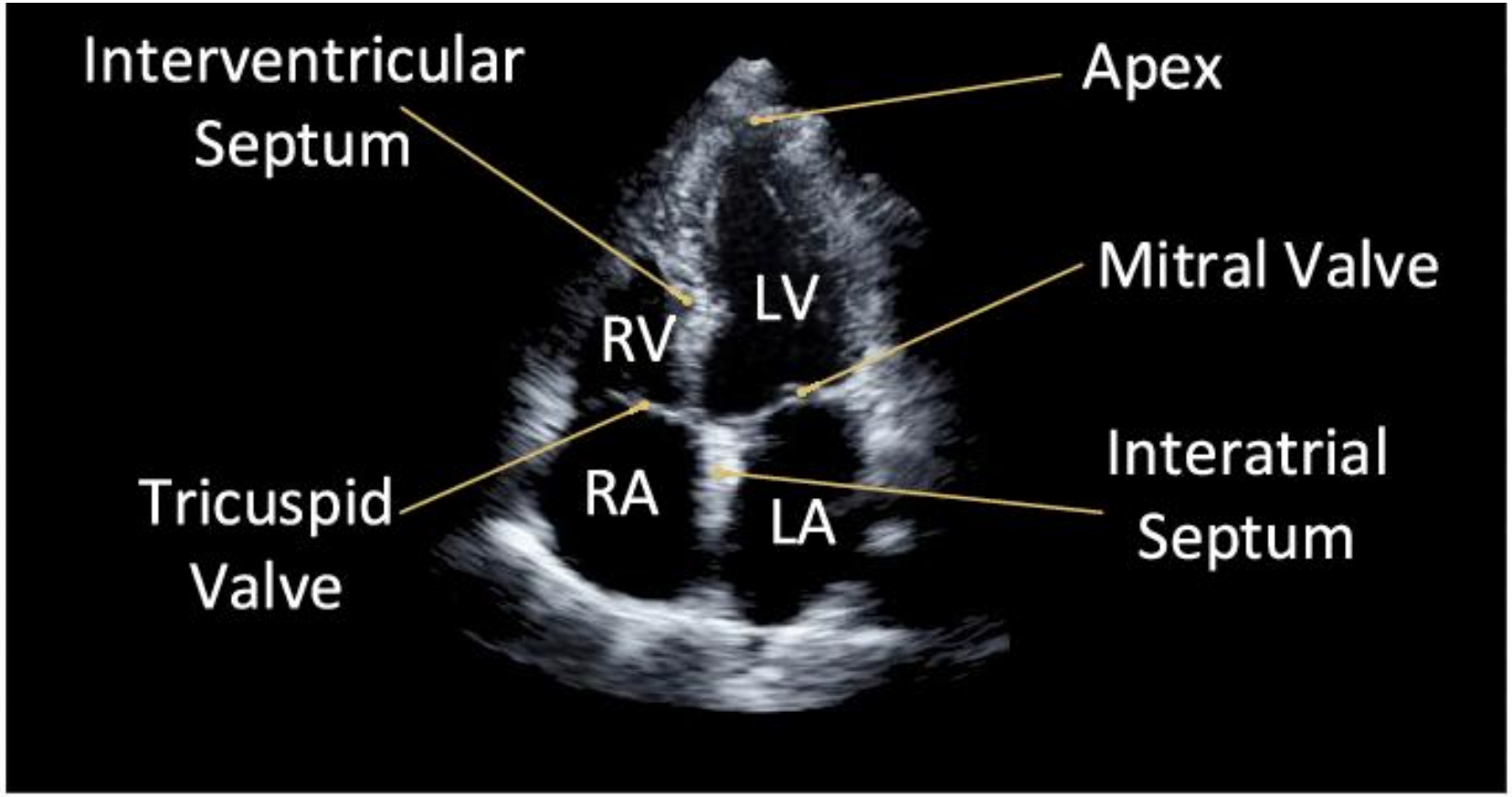
Adjust the TTE probe position to:

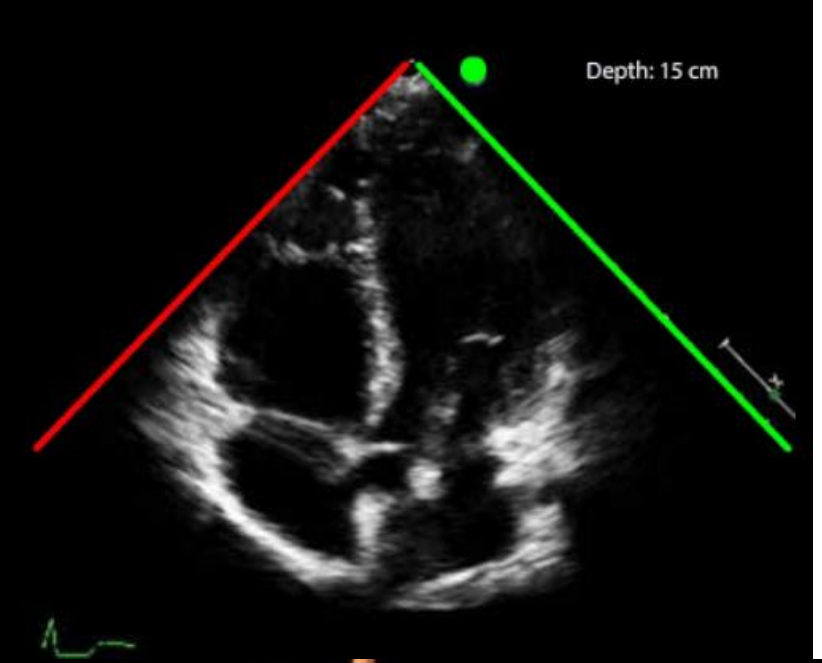
- ensure all four cardiac chambers are seen
- if the atria are not seen, tilt the probe anterior
- if the ventricles are too spherical, move probe down one interspace
- make the IVS appear vertical and in the center of the image (move probe laterally)
- if LV tilted to right (move probe laterally)
- if LV tilted to the left (move probe medially)
- not visulaize the AV (if AV is seen the probe is too anterior, tilt probe posterior)
- not foreshorten the LV apex (slide probe to apex)
- LV apex is thinner then the other LV walls and does not contract

Adjust the image gain to:

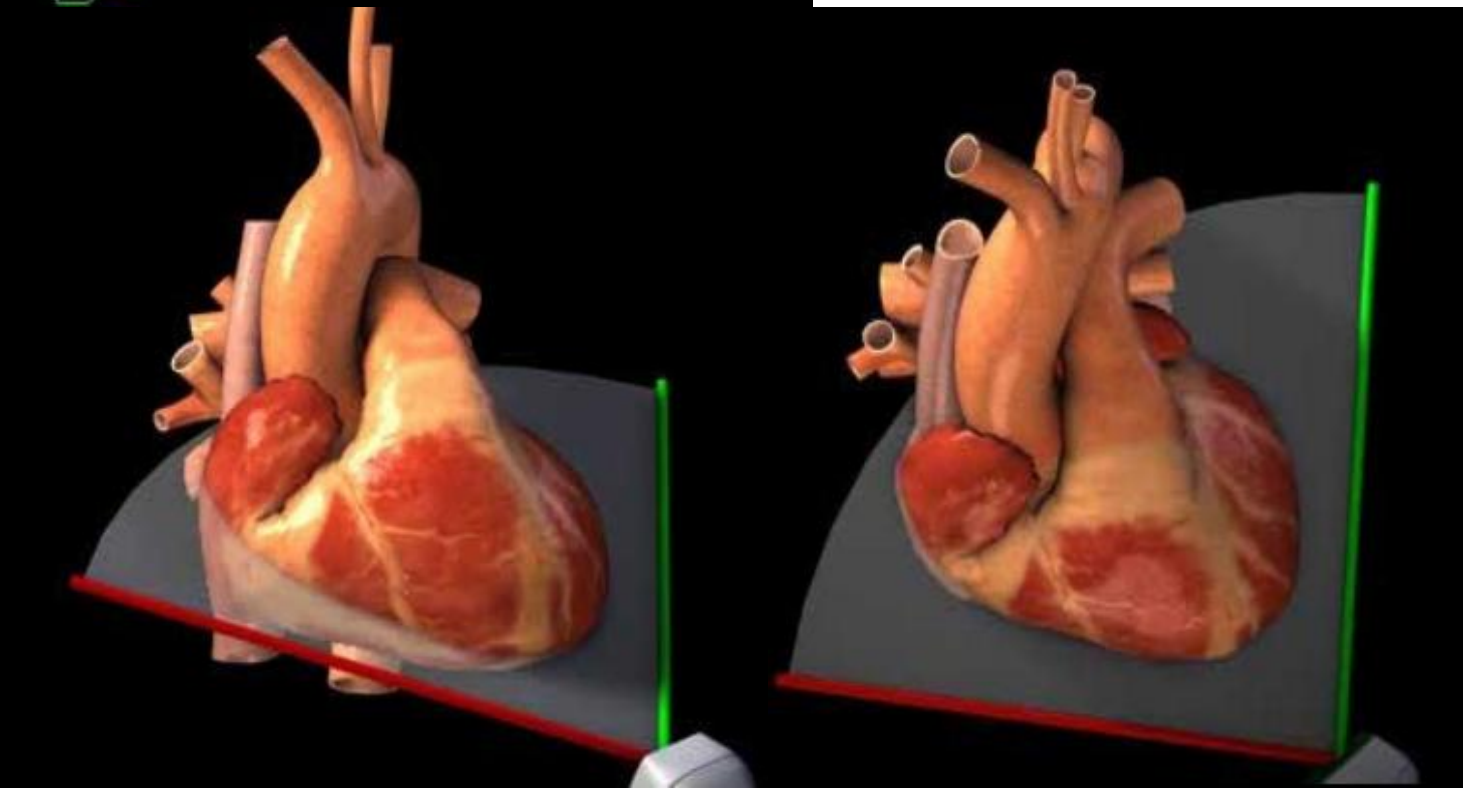
- visualize the endocardium
- visualize valvular leaflets

Apical 4 Chamber View





Apical 5 Chamber



Details | How to Obtain this View

Position the TTE transducer:

- modification of the Apical 4 Chamber view
- in the 4th or 5th intercostal space
- in the midclavicular line or at the point of apical pulsation
- with the index marker pointing towards the left (3 o'clock)
- tilt anterior to see the aortic valve

Adjust the sector depth to:

- 14-18cm to image both atria

Details | How to Optimize this View

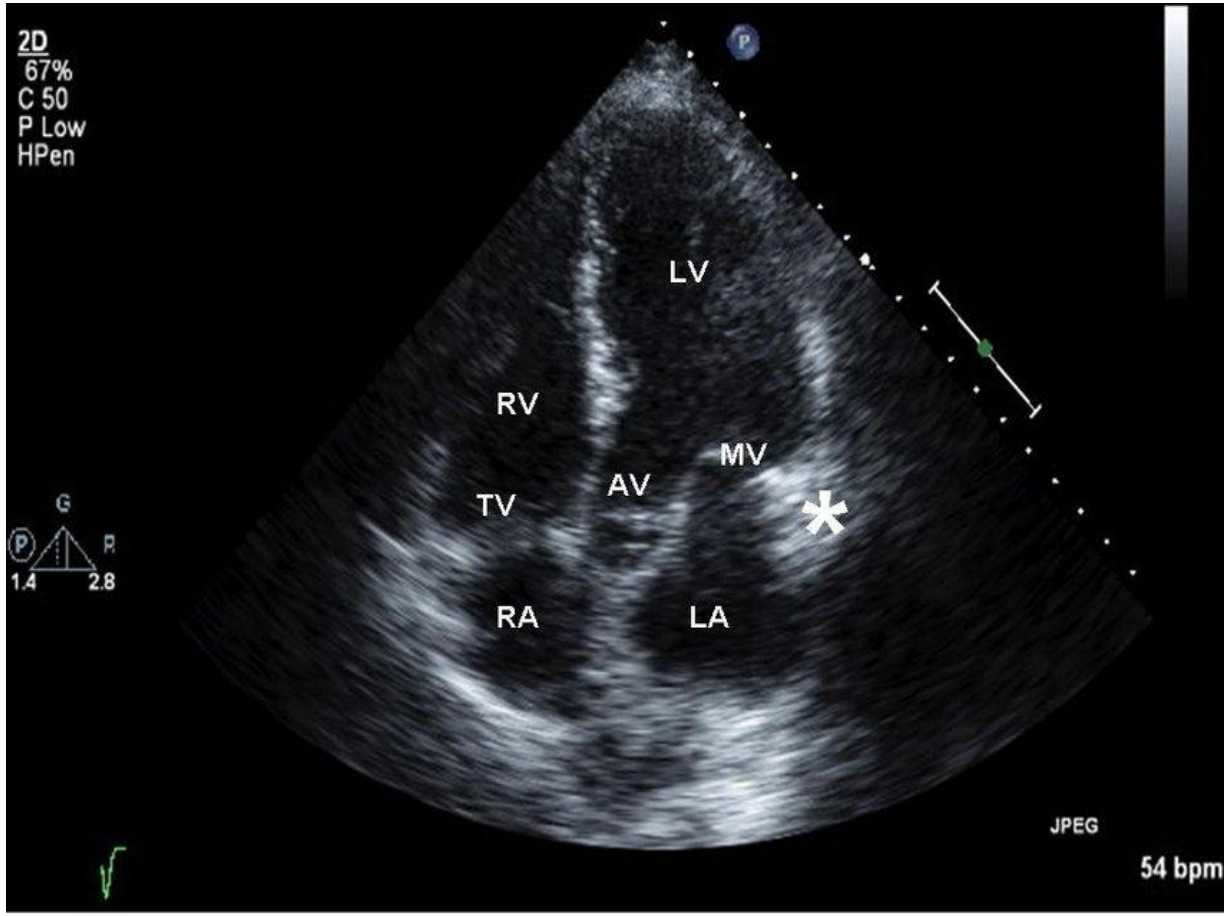
Adjust the TTE probe position to:

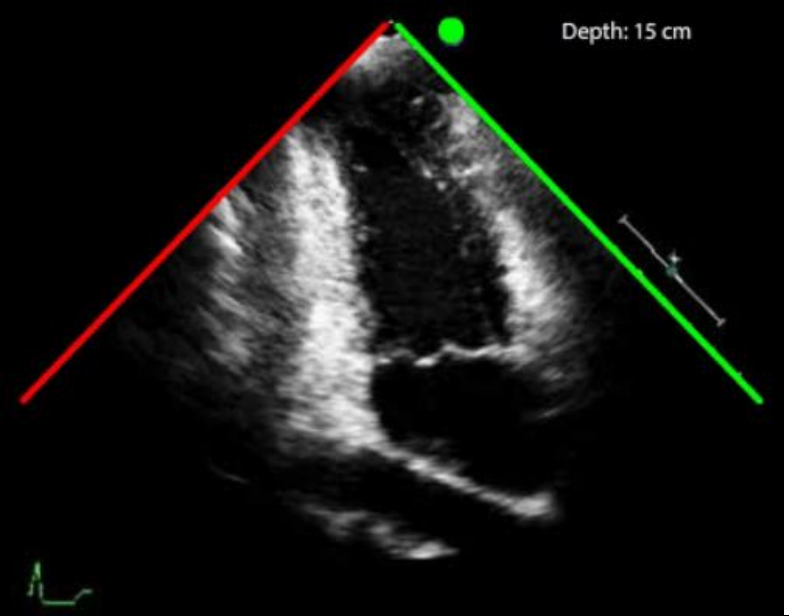
- visualize the AV and LVOT (tilt probe anterior)
- LVOT alignment (higher interspace and slide probe lateral)
- make the IVS appear vertical and in the center of the image
- if LV tilted to right (slide probe lateral)
- if LV tilted to the left (slide probe medial)
- atria and IAS should be incompletely seen

Adjust the image gain to:

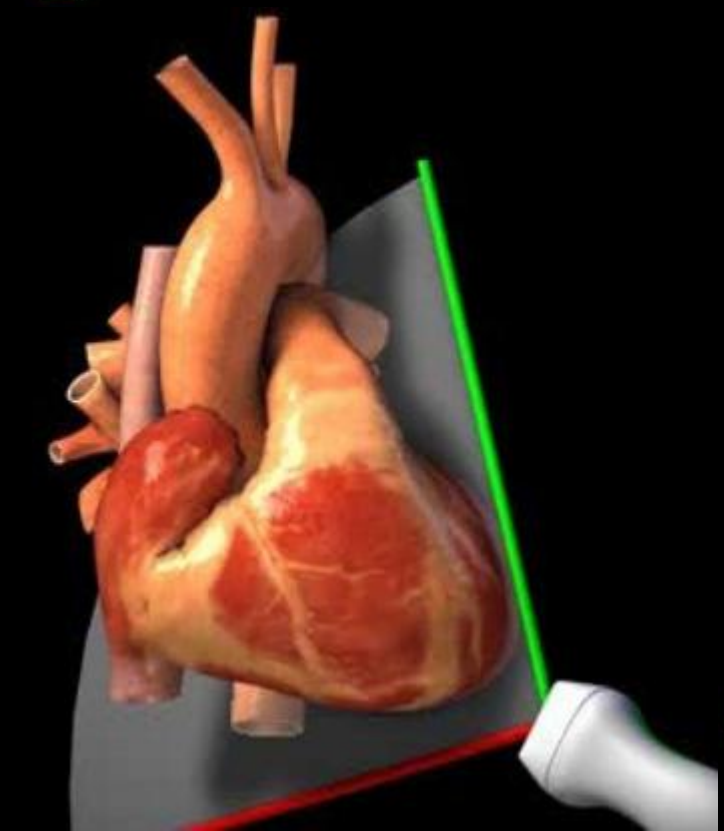
- visualize the endocardium
- visualize aortic valve cusps

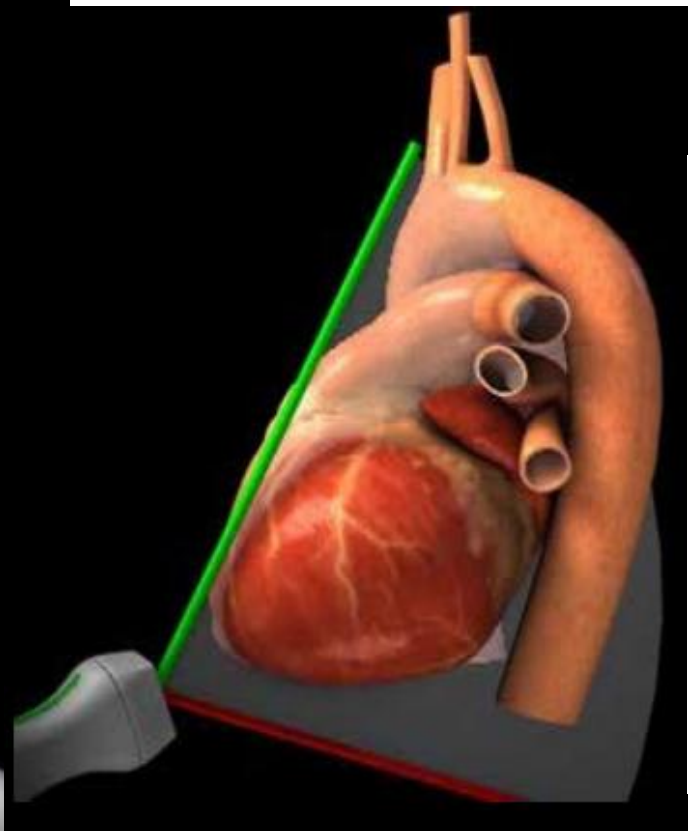
Apical 5 chamber view





Apical 2 Chamber





Details | How to Obtain this View

Position the TTE transducer:

- modification of the Apical 4 Chamber view
- in the 4th or 5th intercostal space
- in the midclavicular line or at the point of apical pulsation
- from the Apical 4 Chamber view, rotate the probe 60-90 degrees counterclockwise
- with the index marker now pointing towards the left axilla (1 o'clock)

Adjust the sector depth to:

- 14-18cm to image the LA

Details | How to Optimize this View

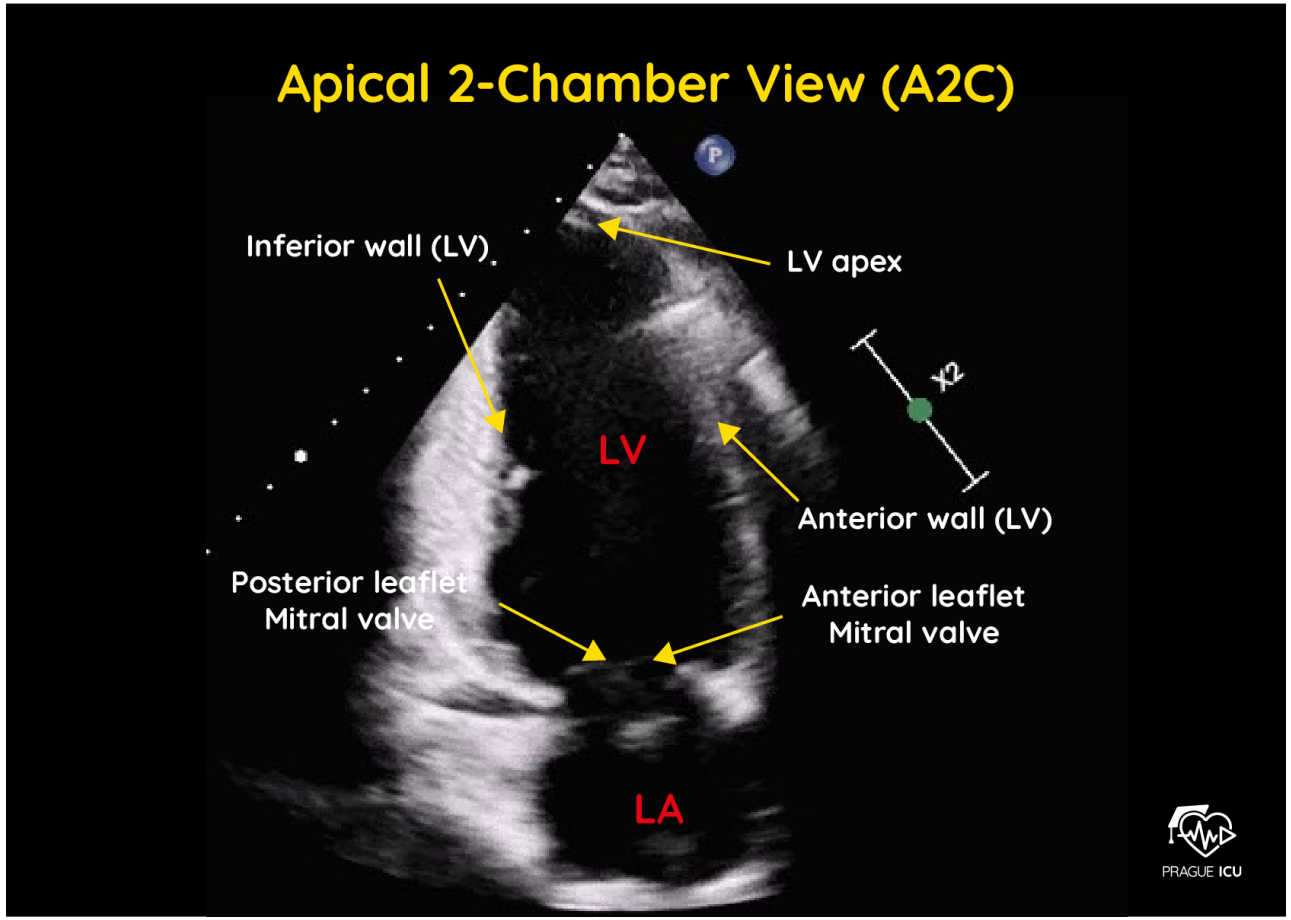
Adjust the TTE probe position to:

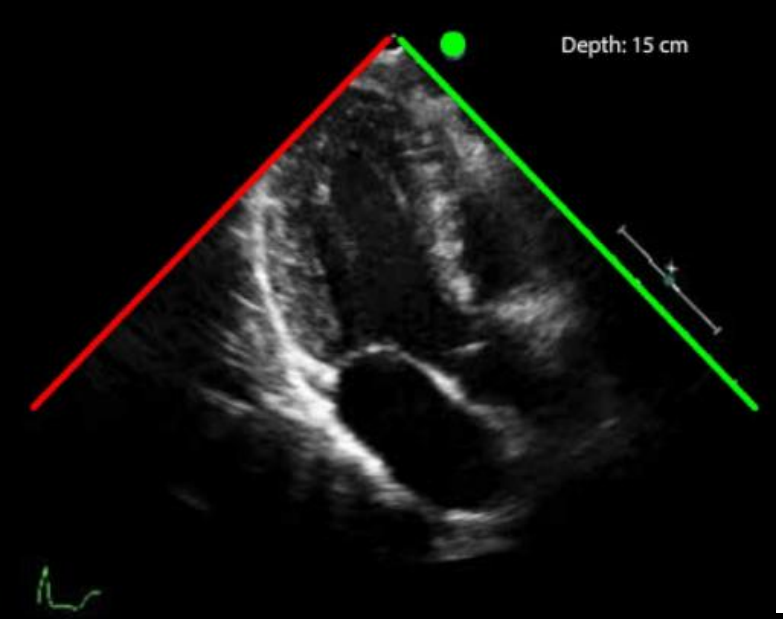
- ensure the LV, LA and MV are seen
- LV apex at the top of the display (slide probe)
- Right heart should not be seen (not enough probe rotation)
- AV and LVOT should not be seen (too much probe rotation)
- Descending aorta can be seen by tilting probe posterior and medial
- Descending aorta in LAX rotate probe clockwise

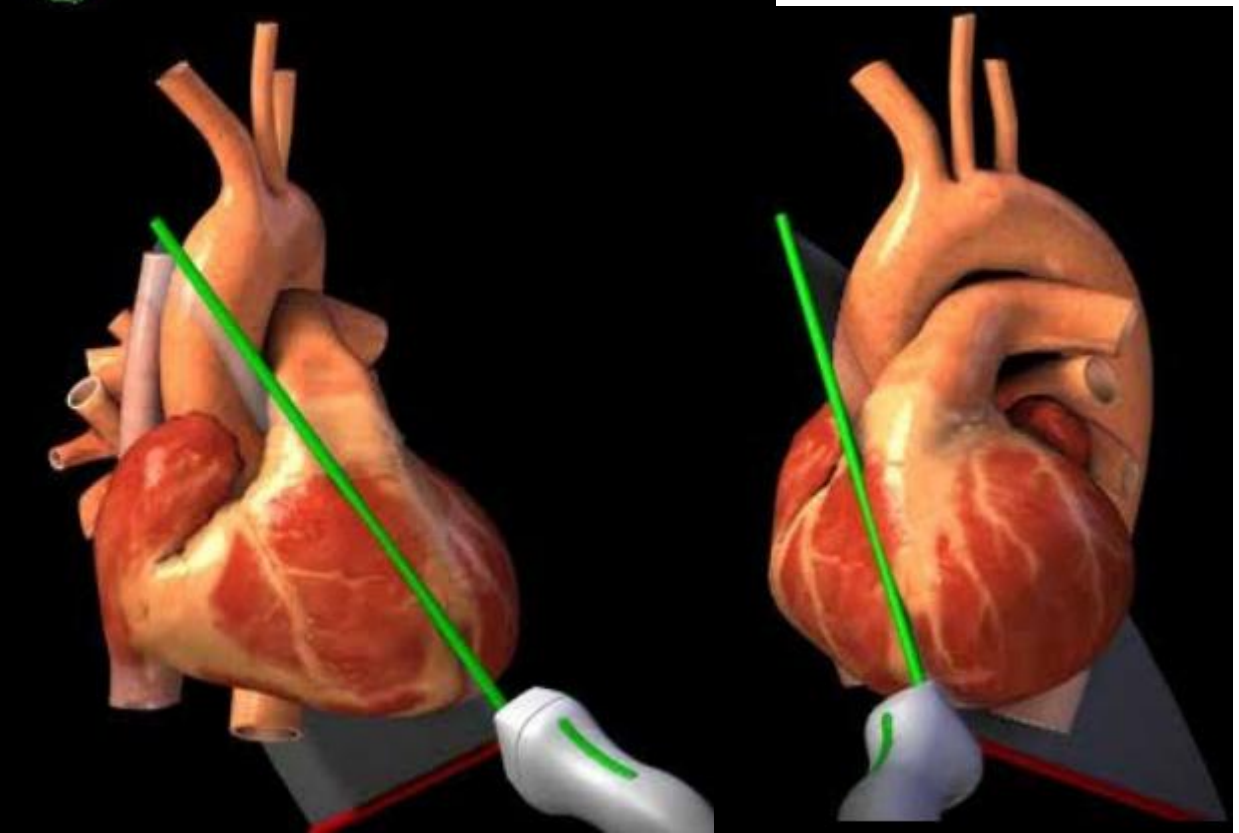
Adjust the image gain to:

- visualize the endocardium

Apical 2 Chamber View







Apical 3 Chamber view

Details How to Obtain this View

Position the TTE transducer:

- modification of the Apical 2 Chamber view
- in the 4th or 5th intercostal space
- in the midclavicular line or at the point of apical pulsation
- from the Apical 2 Chamber view, rotate 45 degrees counterclockwise and tilt anterior
- with the index marker now pointing towards the right shoulder (11 o'clock)

Adjust the sector depth to:

- 14-18cm to image the LA

Details How to Optimize this View

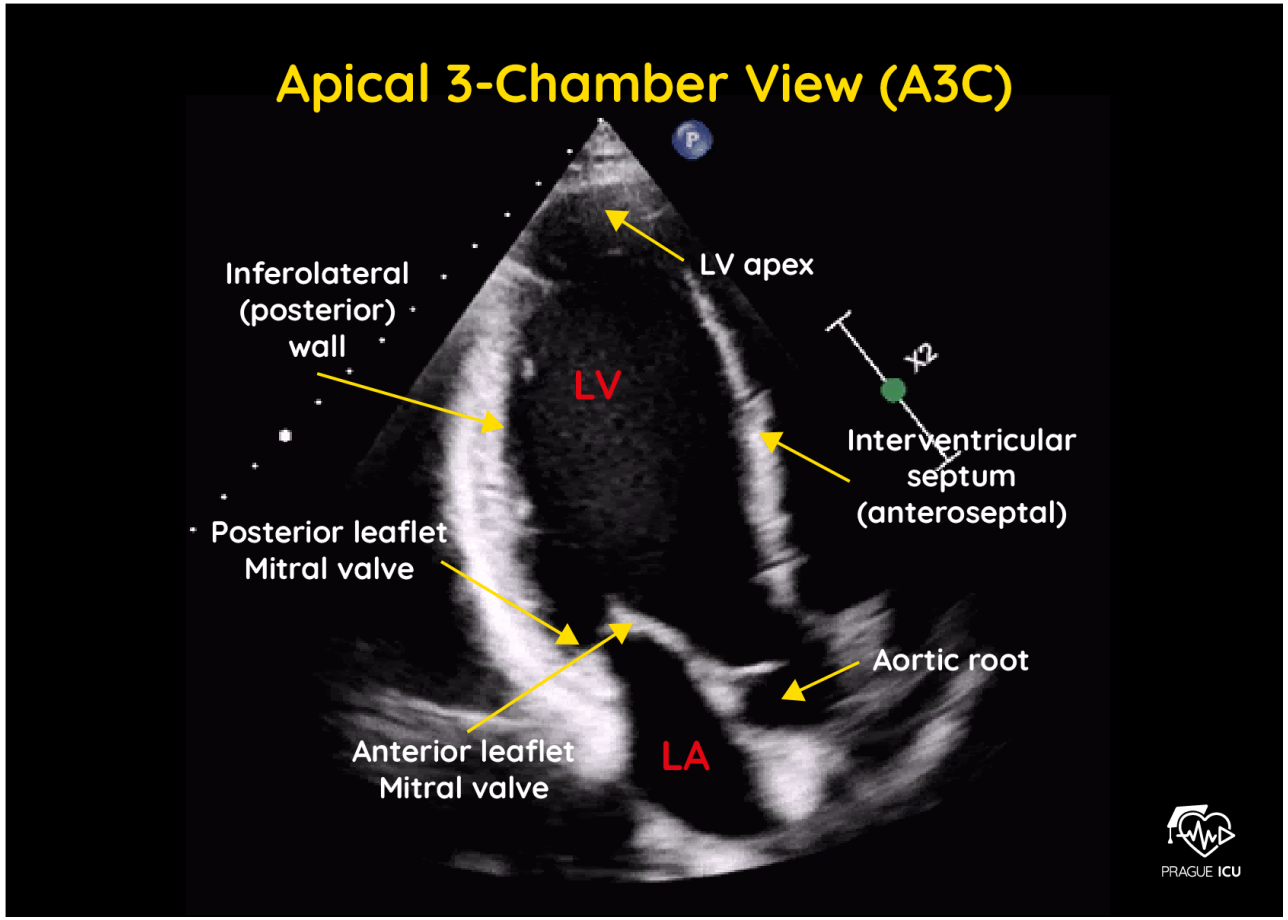
Adjust the TTE probe position to:

- ensure cardiac chambers are centered (slide probe lateral)
- make the IVS appear vertical
- visualize the AV and LVOT (rotate probe)

Adjust the image gain to:

- visualize the endocardium

Apical 3 Chamber View



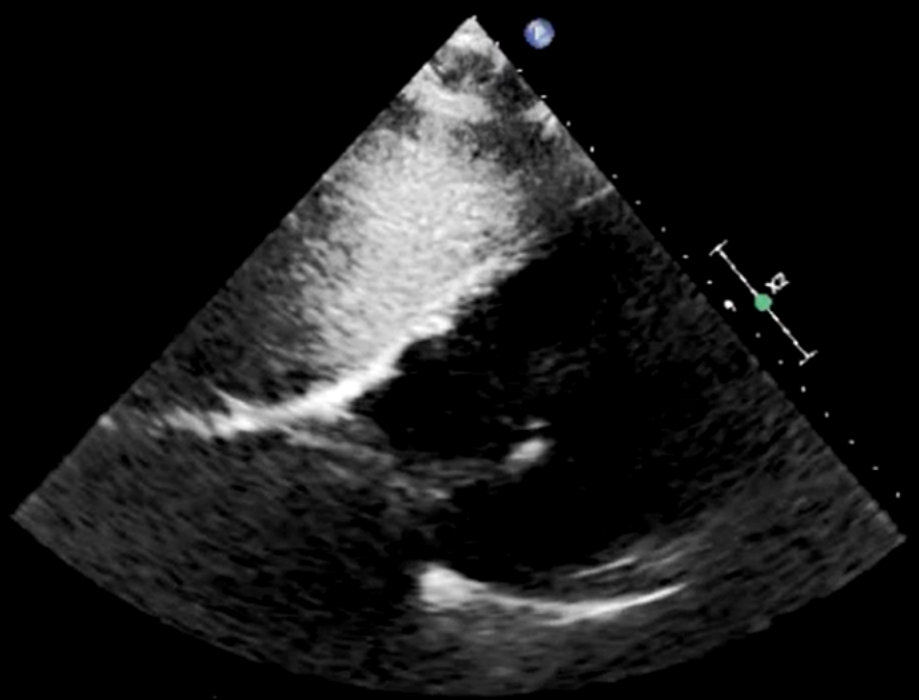
SUB-COSTAL WINDOW

↓

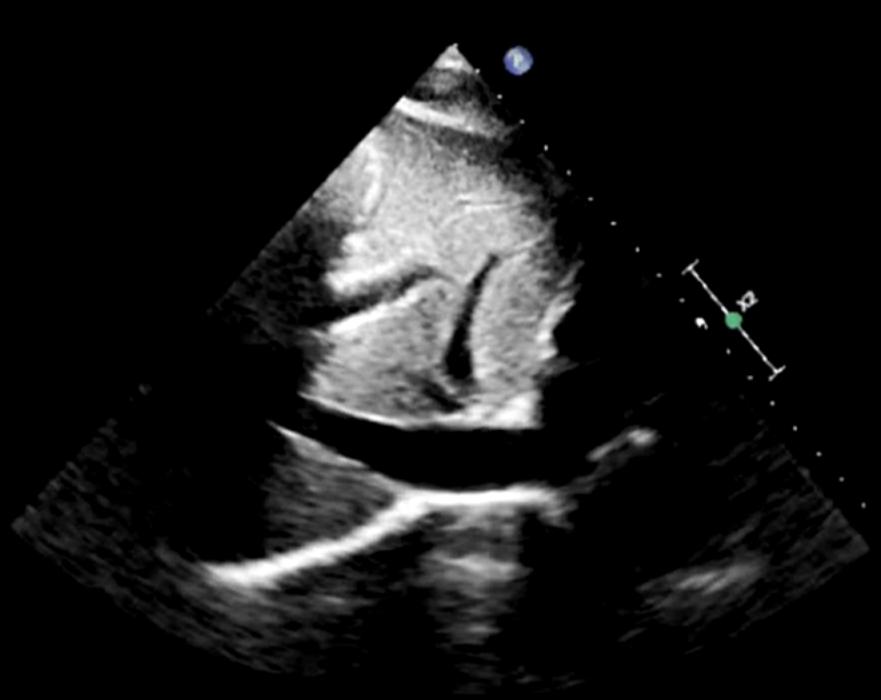
SUB-COSTAL VIEWS

↓

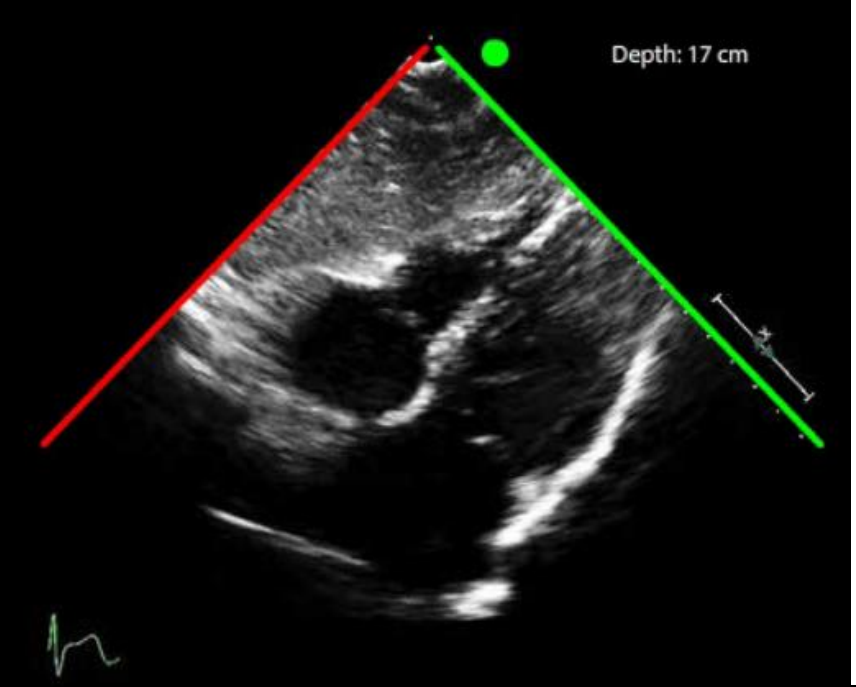
CLASSIC SUB-COSTAL VIEW

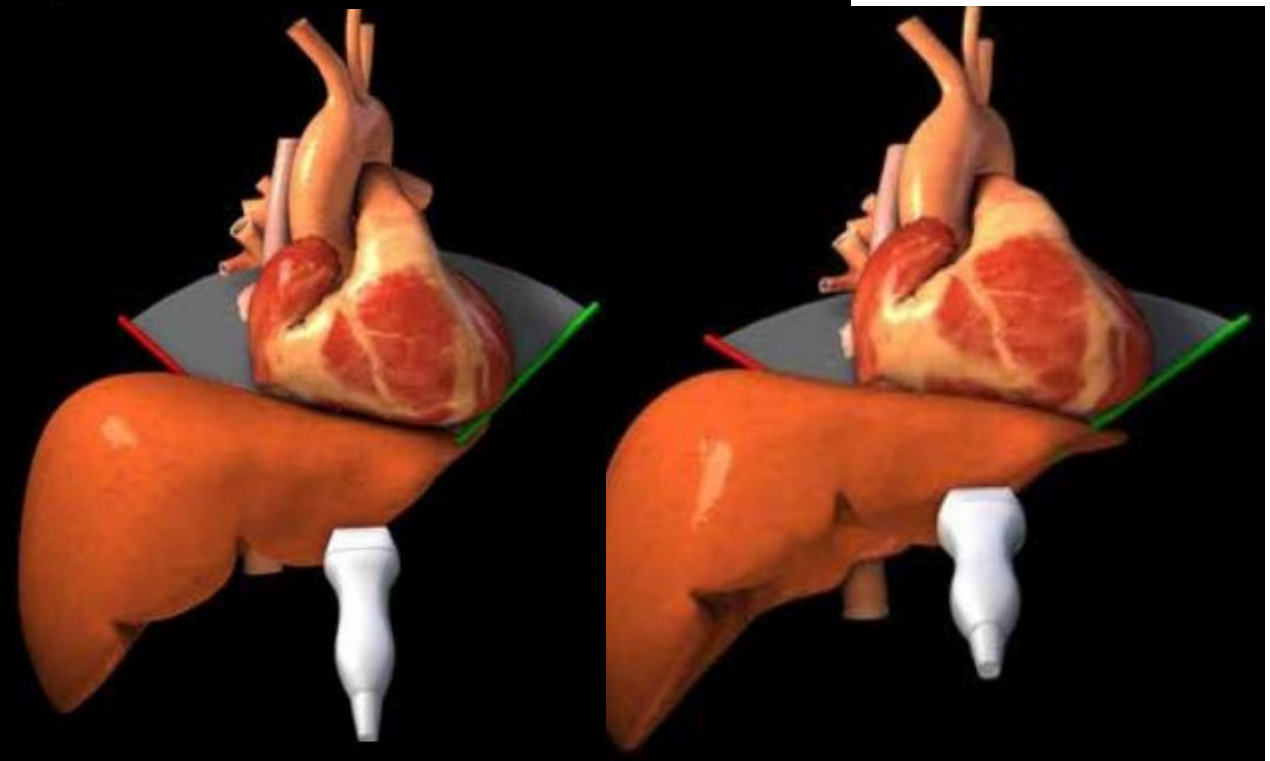


PERICARDIAL VIEW



INFERIOR VENA CAVA VIEW





Subcoastal 4 chamber view

Details How to Obtain this View

Position the TTE transducer:

- in the subxiphoid region of the abdomen
- flat and push down with a slight tilt to the patient's right
- with the index marker pointing towards the left (3 o'clock)

Adjust the sector depth to:

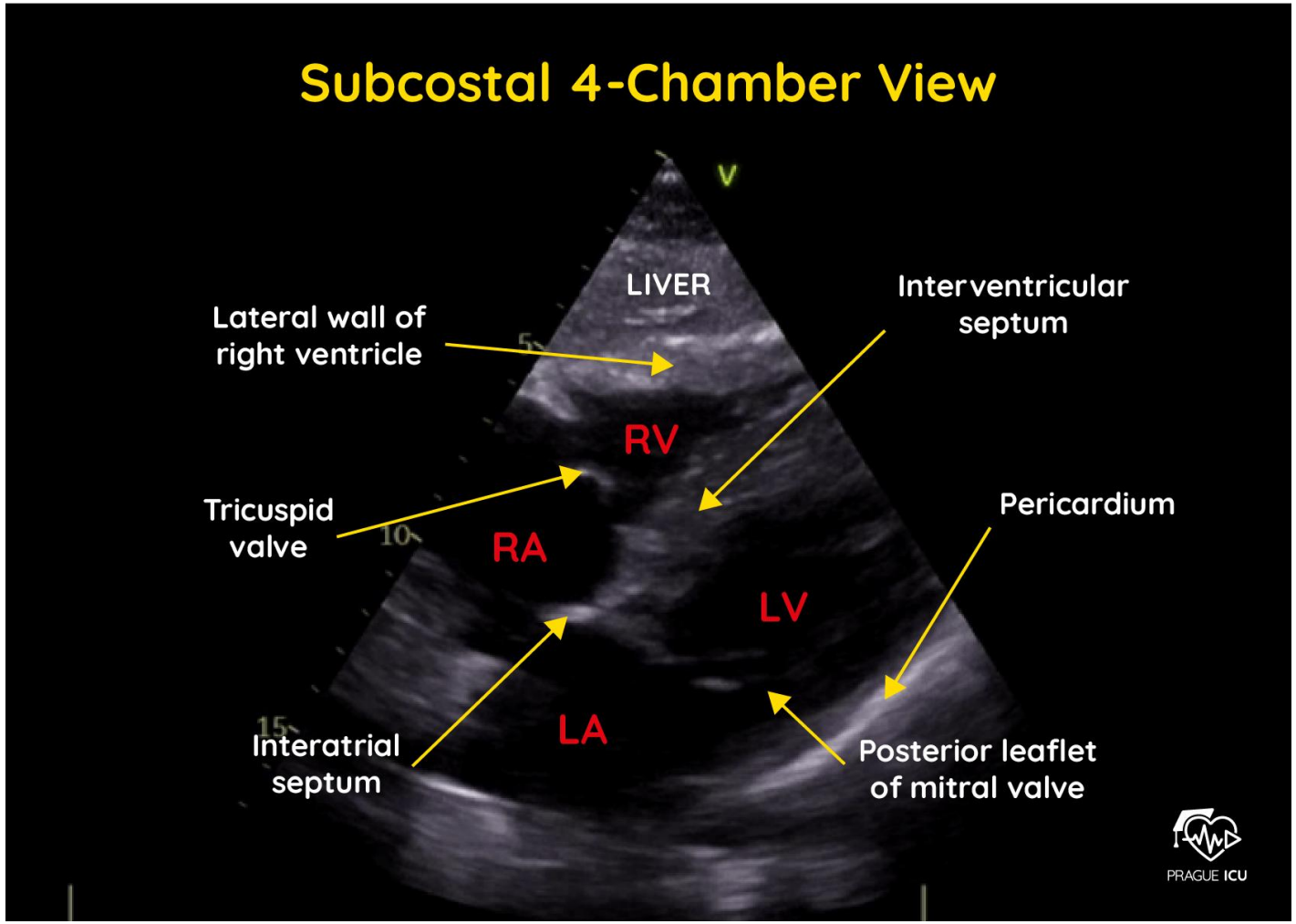
- 16-24cm to image the entire LA and LV

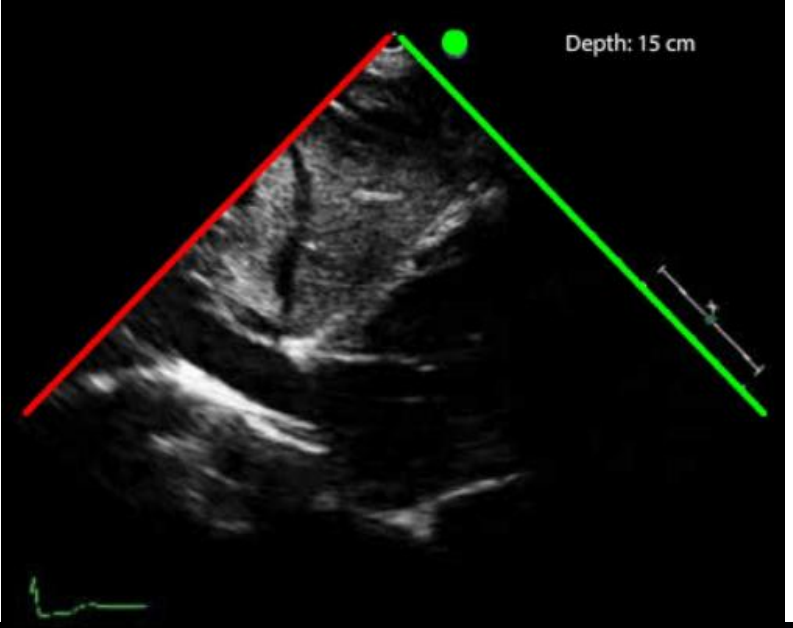
Details How to Optimize this View

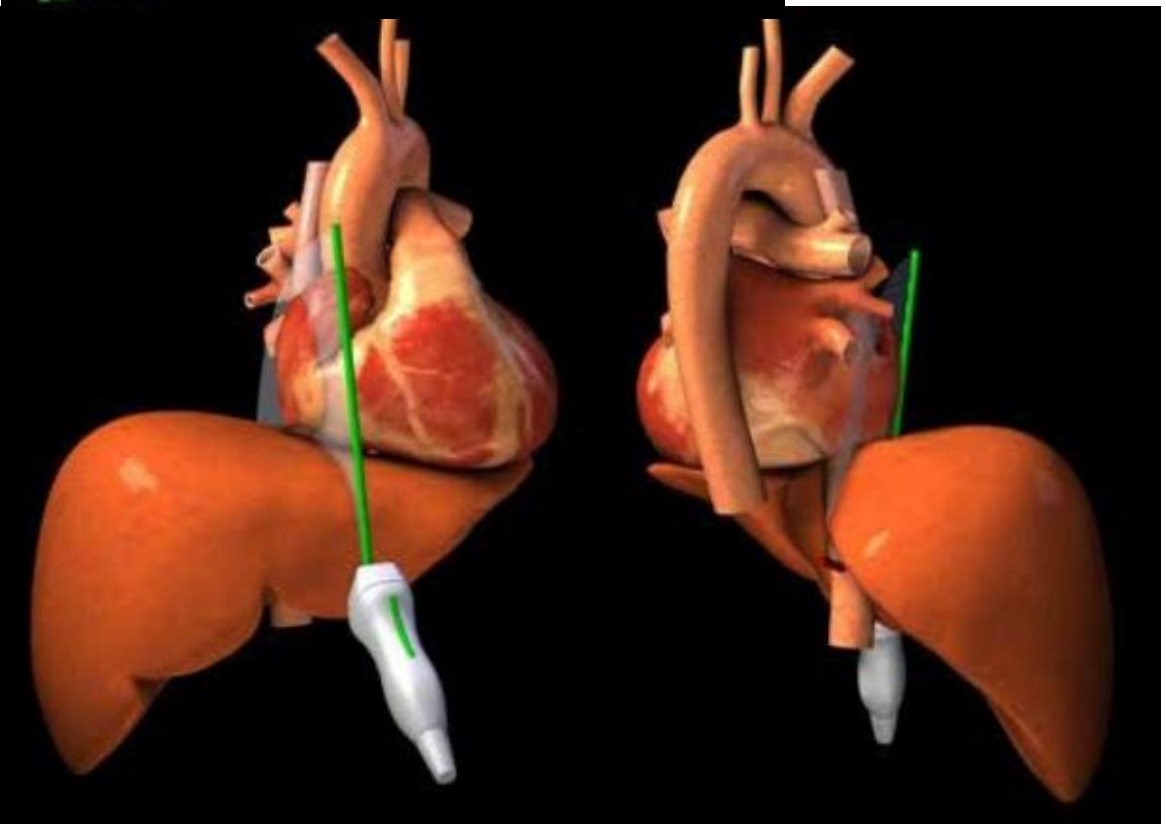
Adjust the TTE probe position to:

- view all four cardiac chambers
- see entire LV including apex (slide probe)
- not visualize the AV (if AV seen then tilt probe posterior or rotate the probe)
- lengthen the IVS (rotate probe so marker at 2-3 o'clock)

Subcoastal 4 chamber view







Subcoastal - IVC

Details | How to Obtain this View

Position the TTE transducer:

- modification of the subcostal 4C view
- in the subxiphoid region of the abdomen
- tilt to the patient's left
- from the subcostal 4C view , rotate the probe 90° counterclockwise while keeping the RA in view
- with the index marker pointing towards the head (12 o'clock)

Adjust the sector depth to:

- 16-24cm to image the entire IVC

Details | How to Optimize this View

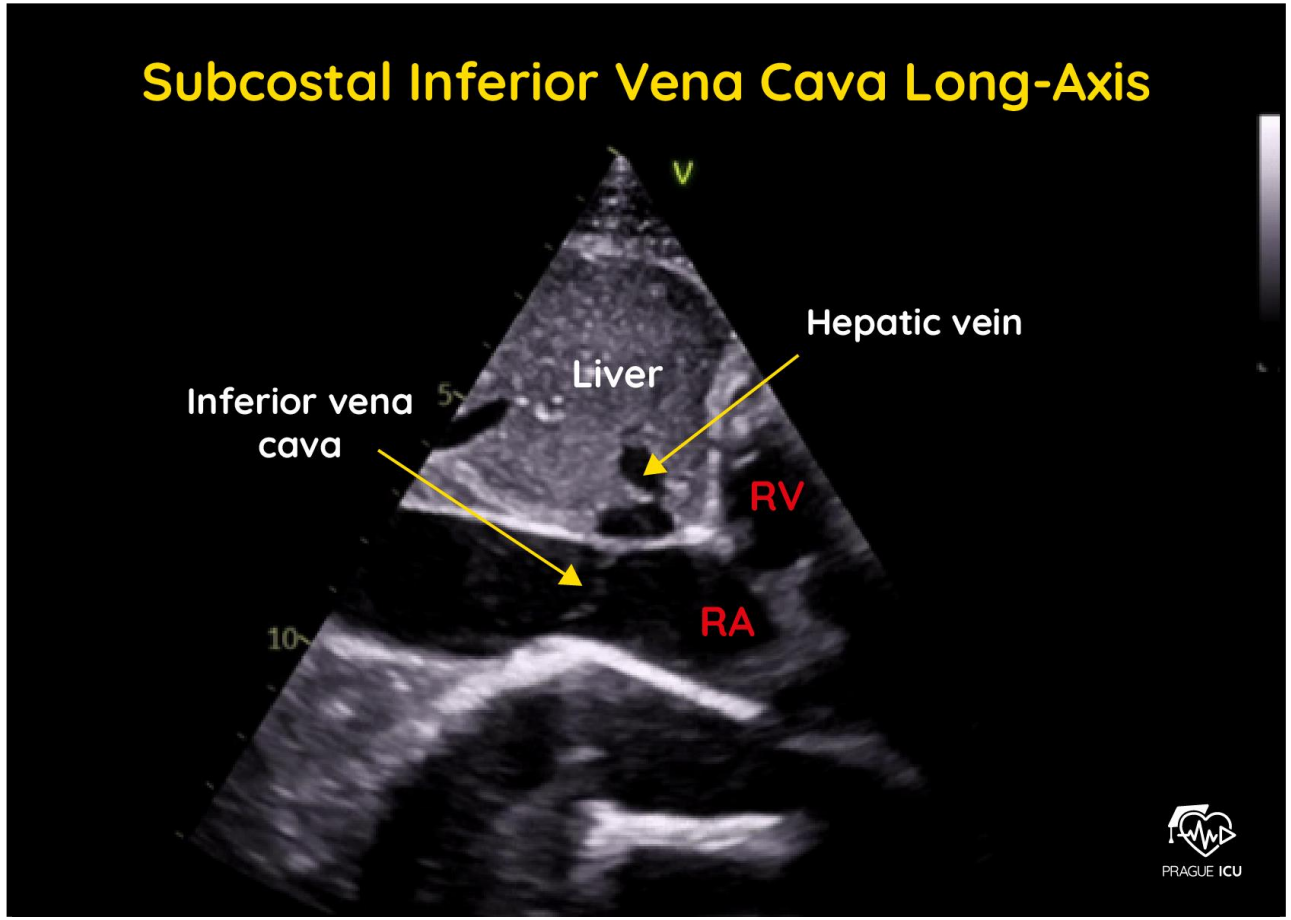
Adjust the TTE probe position to:

- view the junction of the IVC and RA (IVC must be shown to enter the RA)
- make the IVC appear horizontal
- image an hepatic vein

Differentiate the IVC from the aorta by:

- look for liver surrounding both sides of IVC
- non-pulsatile IVC, pulsatility of aorta
- IVC goes into RA
- no change in aorta size with respiration
- hepatic vein entering IVC

Subcoastal - IVC



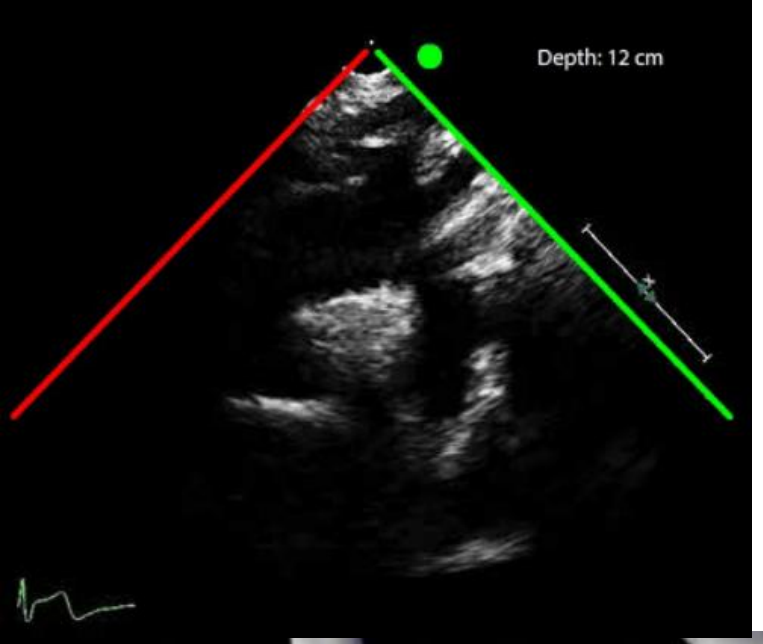
SUPRASTERNAL WINDOW

↓

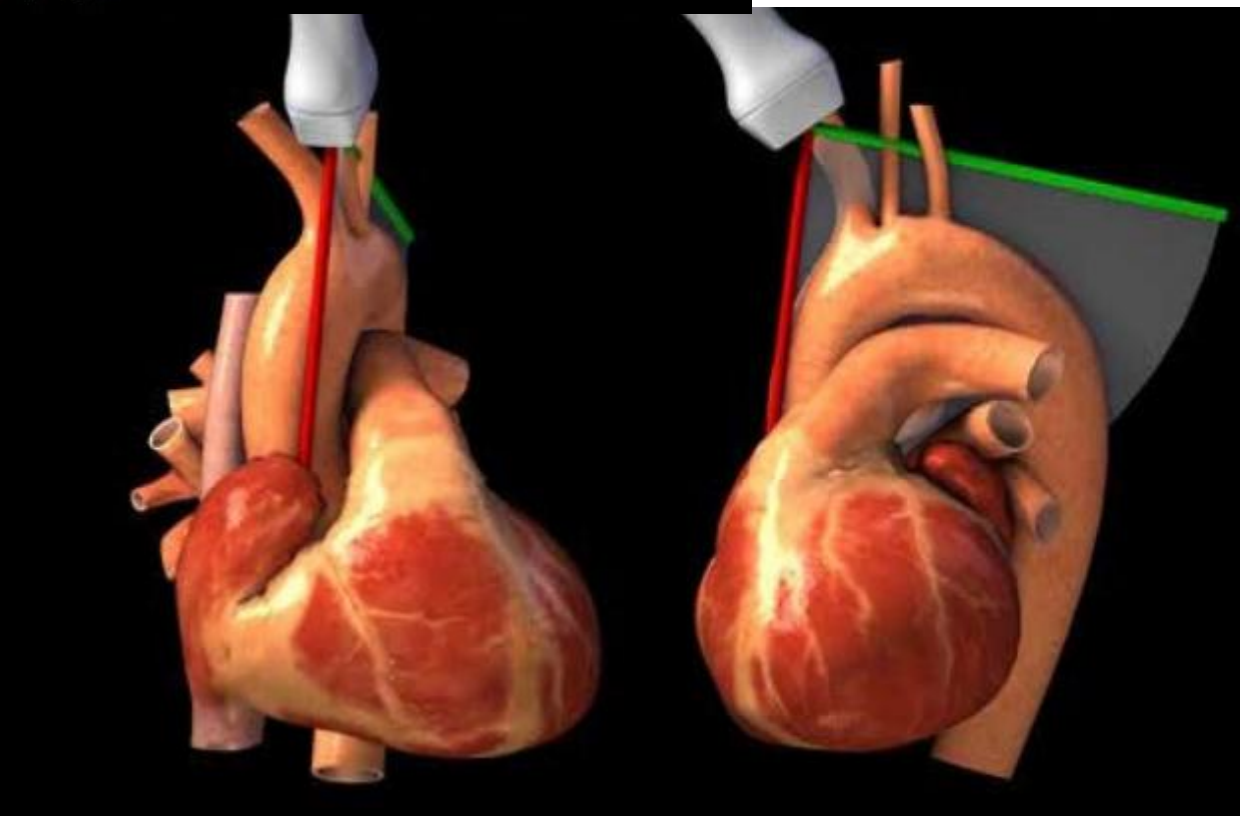
SUPRASTERNAL VIEW

↓

AORTIC ARCH VIEW



Suprasternal view



Details | How to Obtain this View

Position the TTE transducer:

- in the suprasternal notch
- with the index marker pointing towards the left supraclavicular notch (1 o'clock)
- tilt inferior and anterior

Adjust the sector depth to:

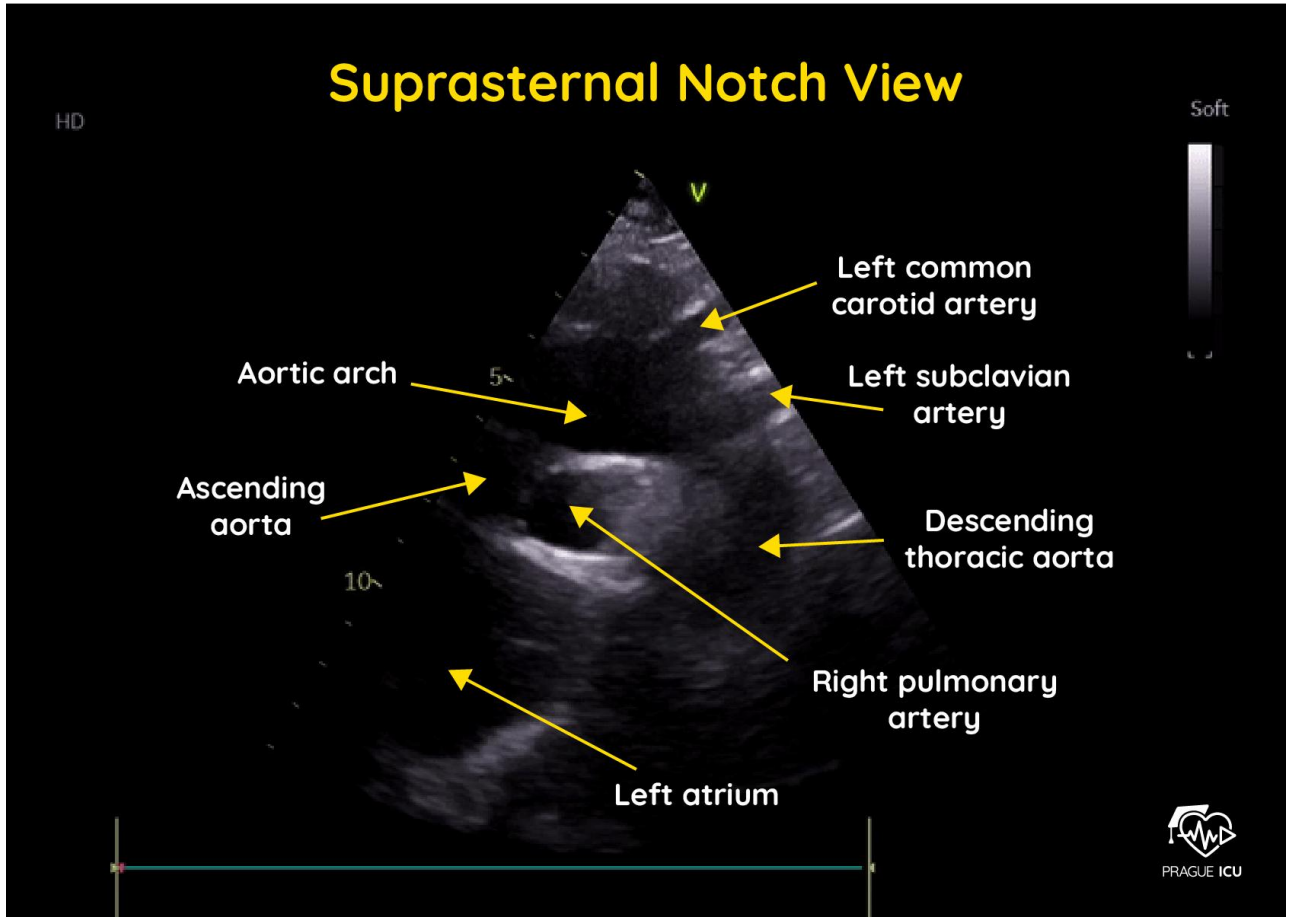
- 10-12cm to image the descending aorta

Details | How to Optimize this View

Adjust the TTE probe position to:

- view the descending aorta (tilt more anterior)
- view the head vessels (tilt more posterior)
- open the lumen of the aorta and see arch (rotate probe)

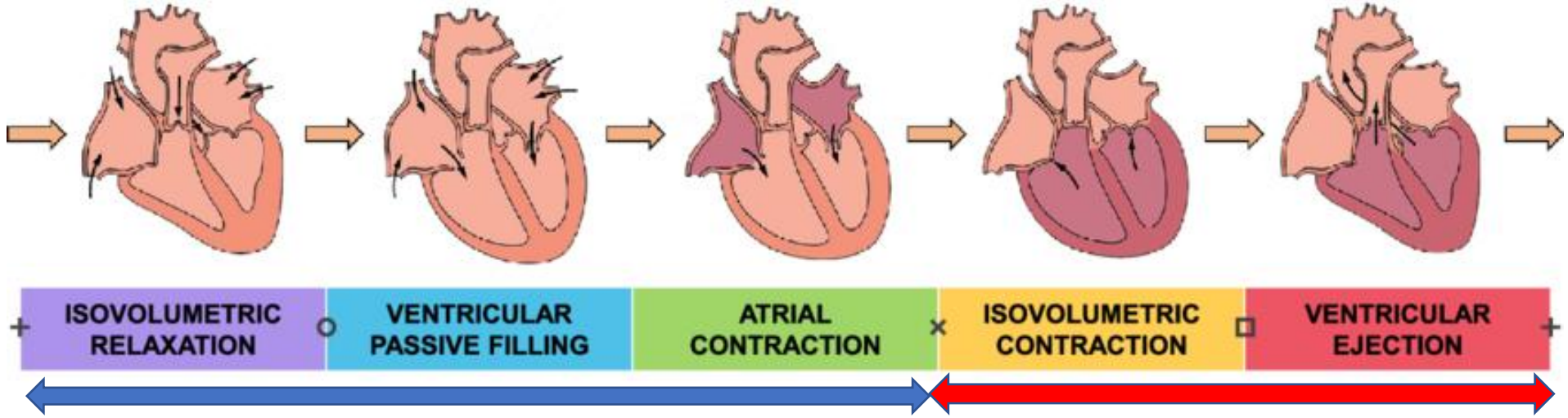
Suprasternal view



Physiology of the Heart

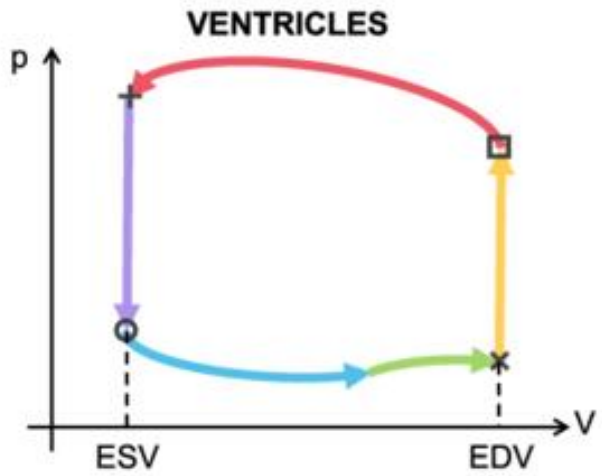
Phases of the cardiac cycle.

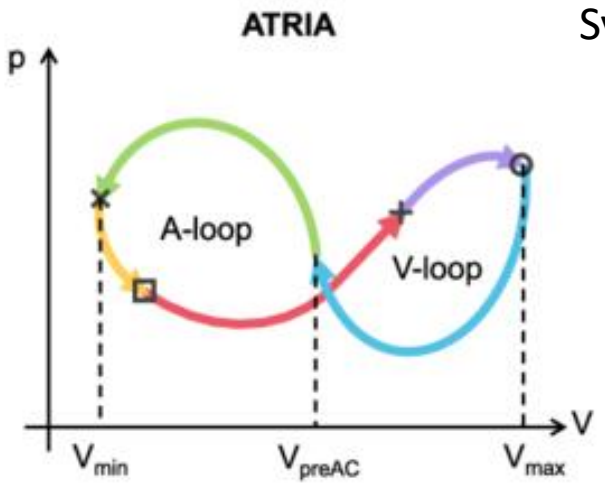
- Systole = Ventricular contraction
- Diastole = Ventricular relaxation

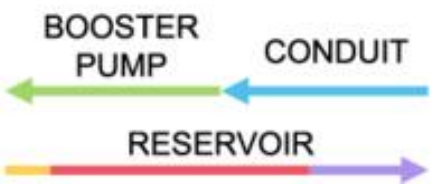


Diastolic phase

Systolic phase



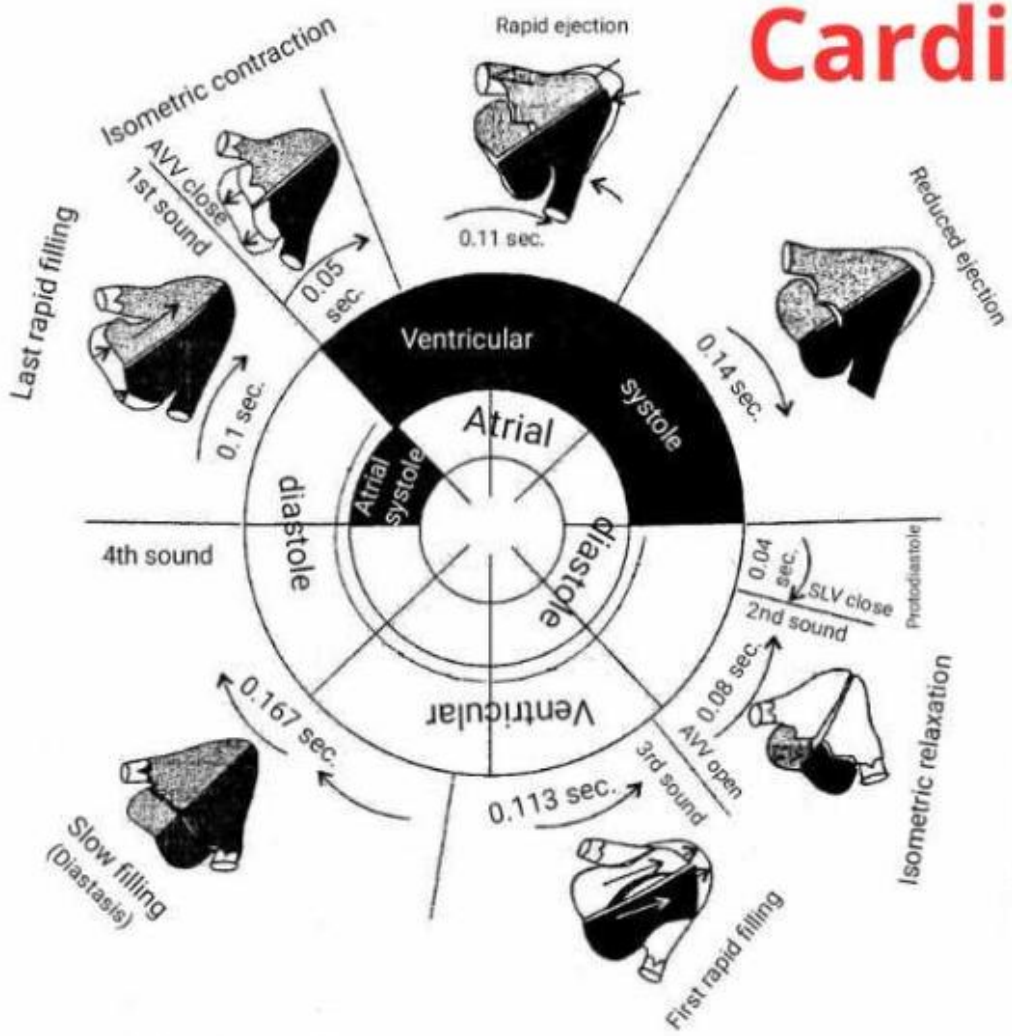


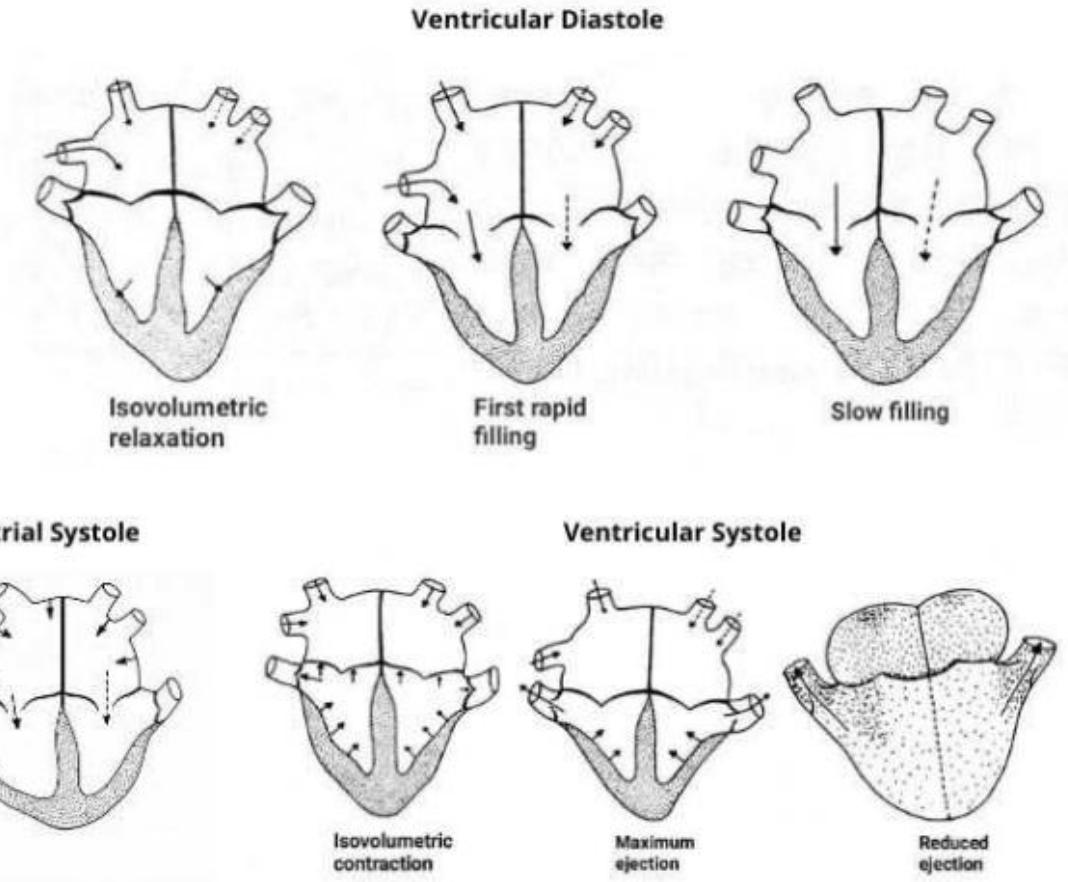


5 phases of the cardiac cycle

- Isovolumetric relaxation
- Passive filling
- Atrial contraction
- Isovolumetric contraction
- Ejection phase

Cardiac Cycle and its Phases





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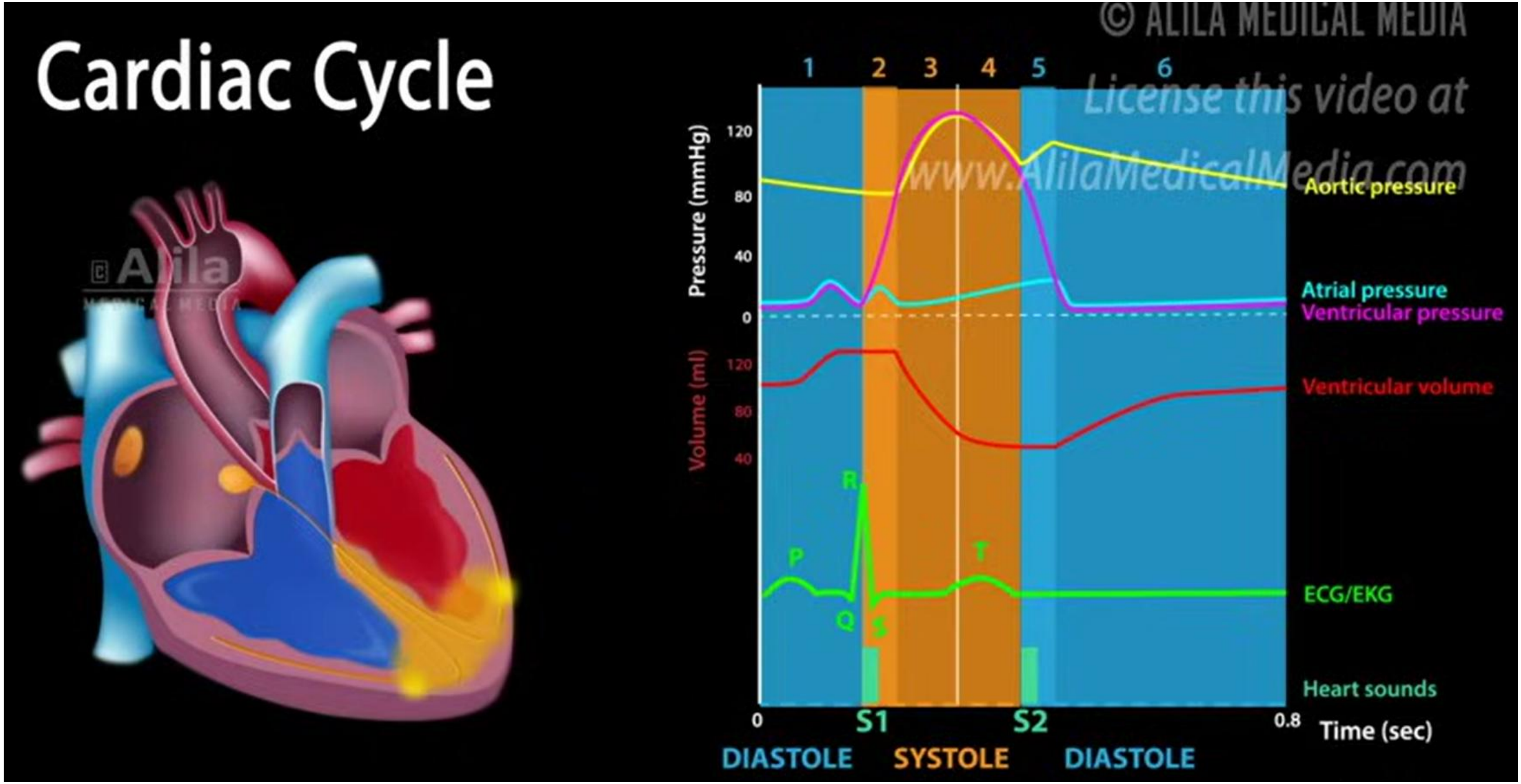
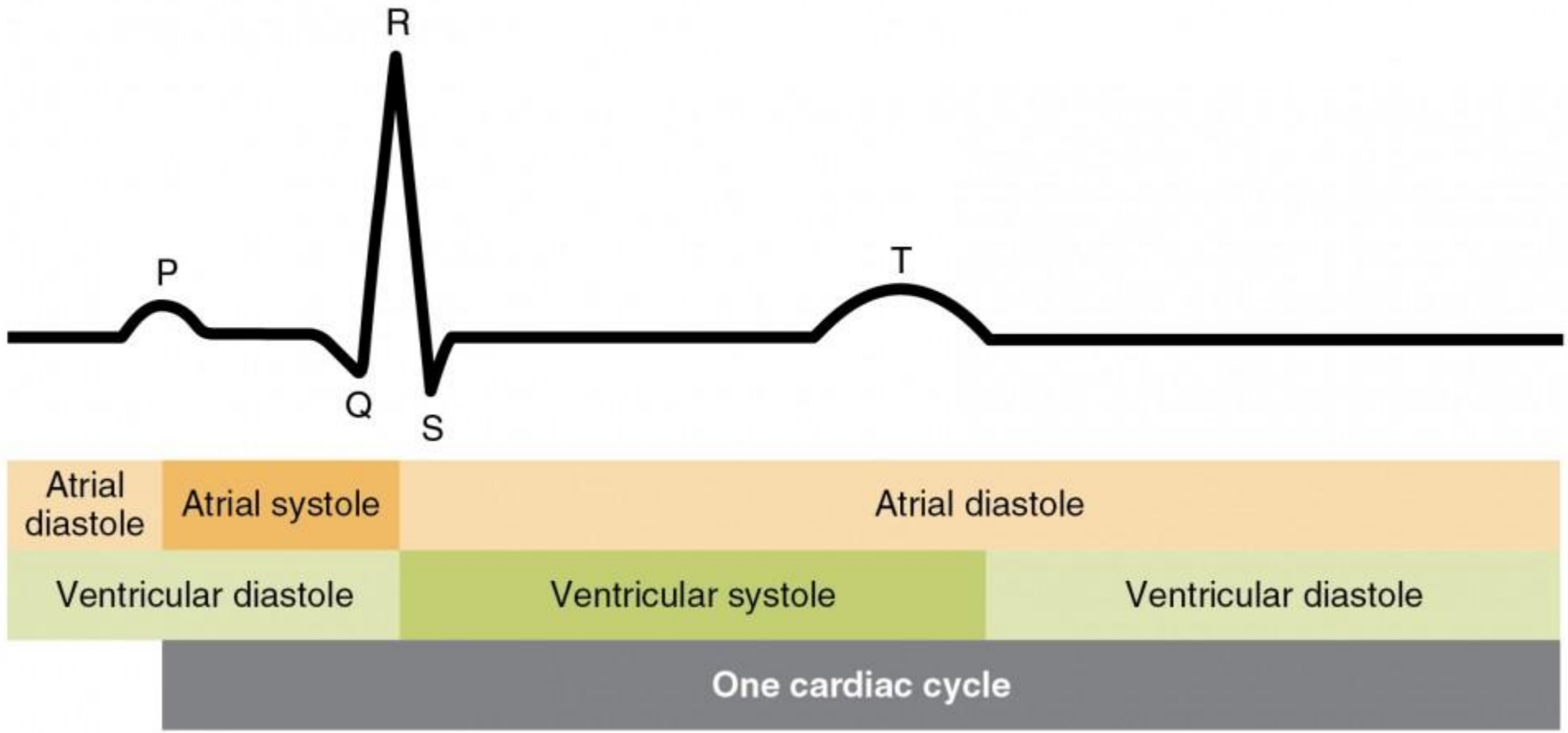
Systole and Diastole




R
P
T
Q
S
Atrial diastole
Atrial systole
Atrial diastole
Ventricular diastole
Ventricular systole
Ventricular diastole
One cardiac cycle

The End..