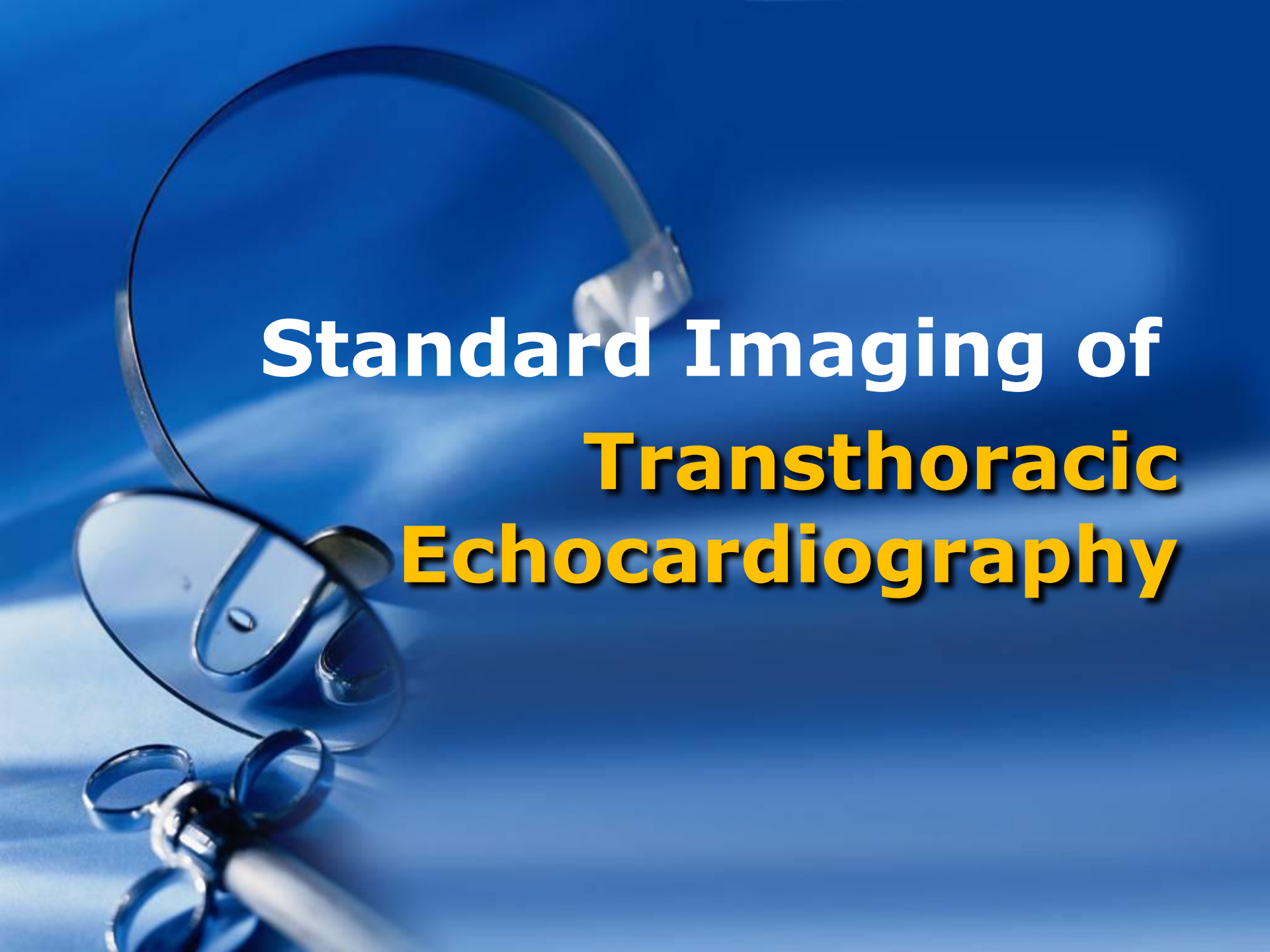
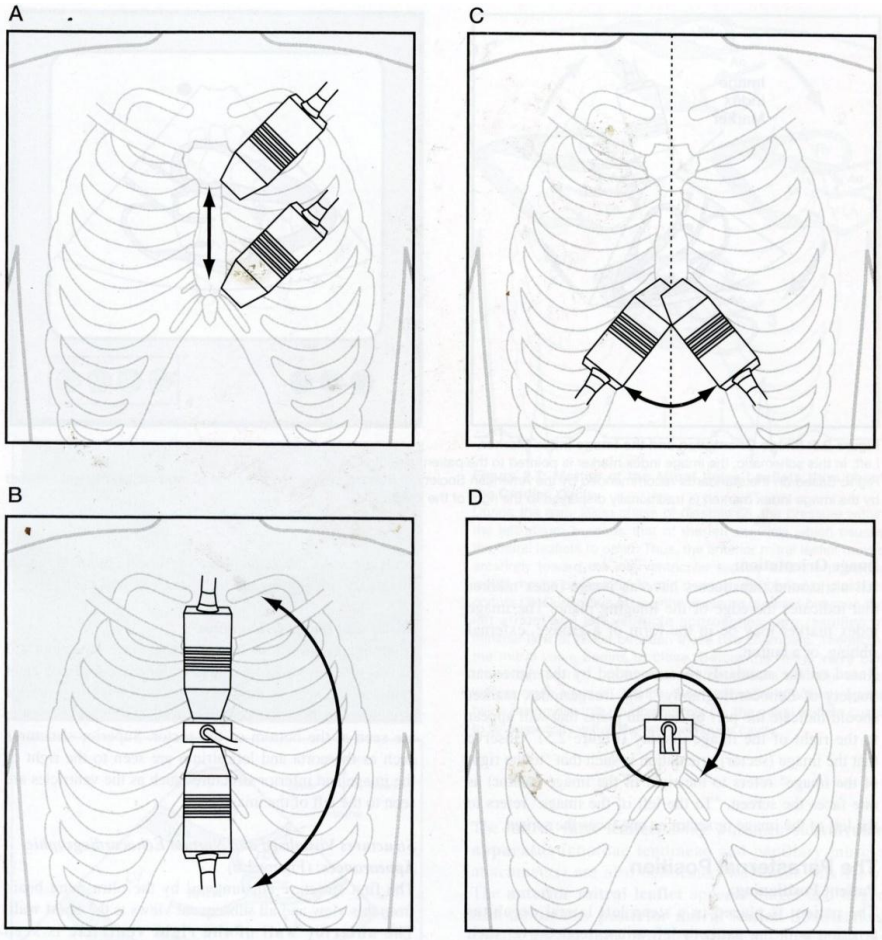

Standard Imaging of
Transthoracic
Echocardiography

Terminology

(movement)



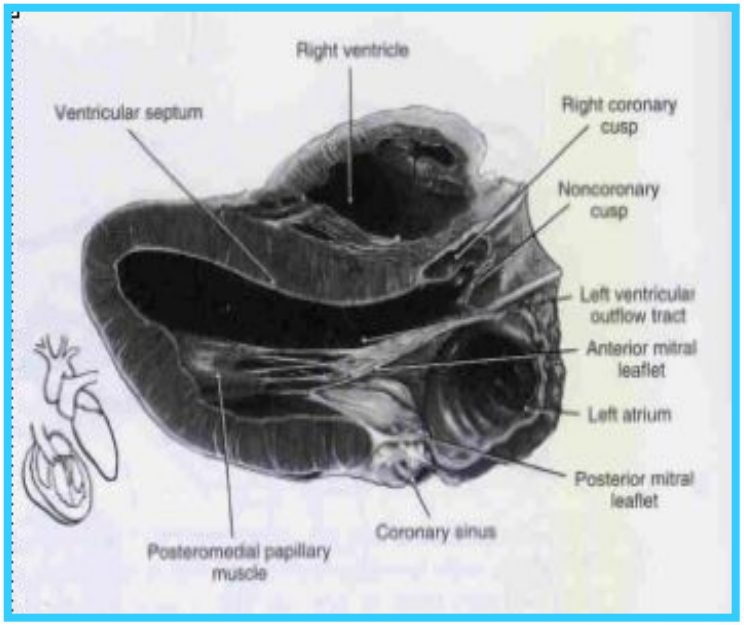
(angulation)

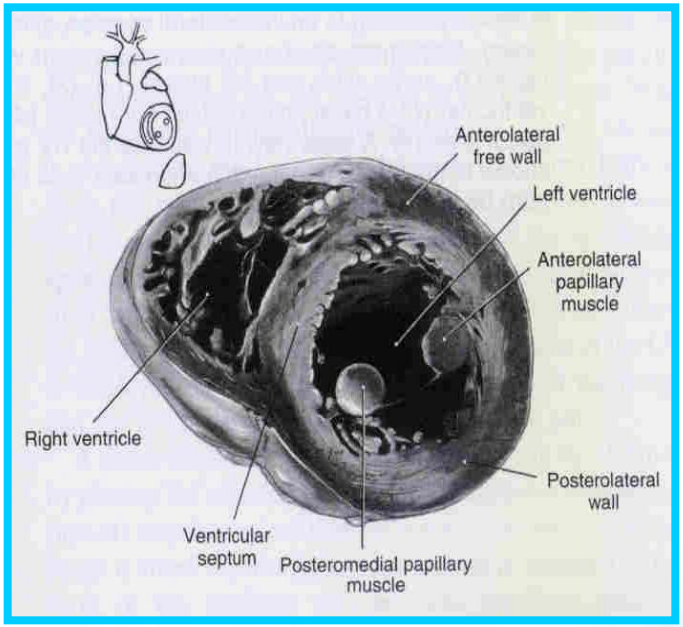
(tilting)

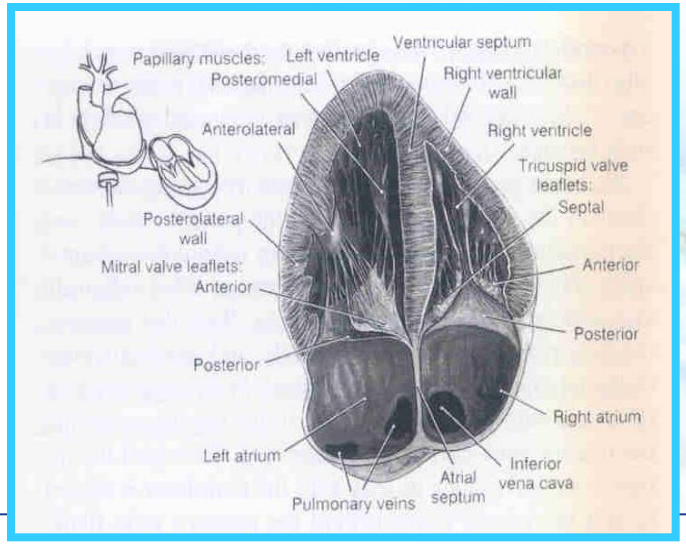
D. 회전

(rotation)

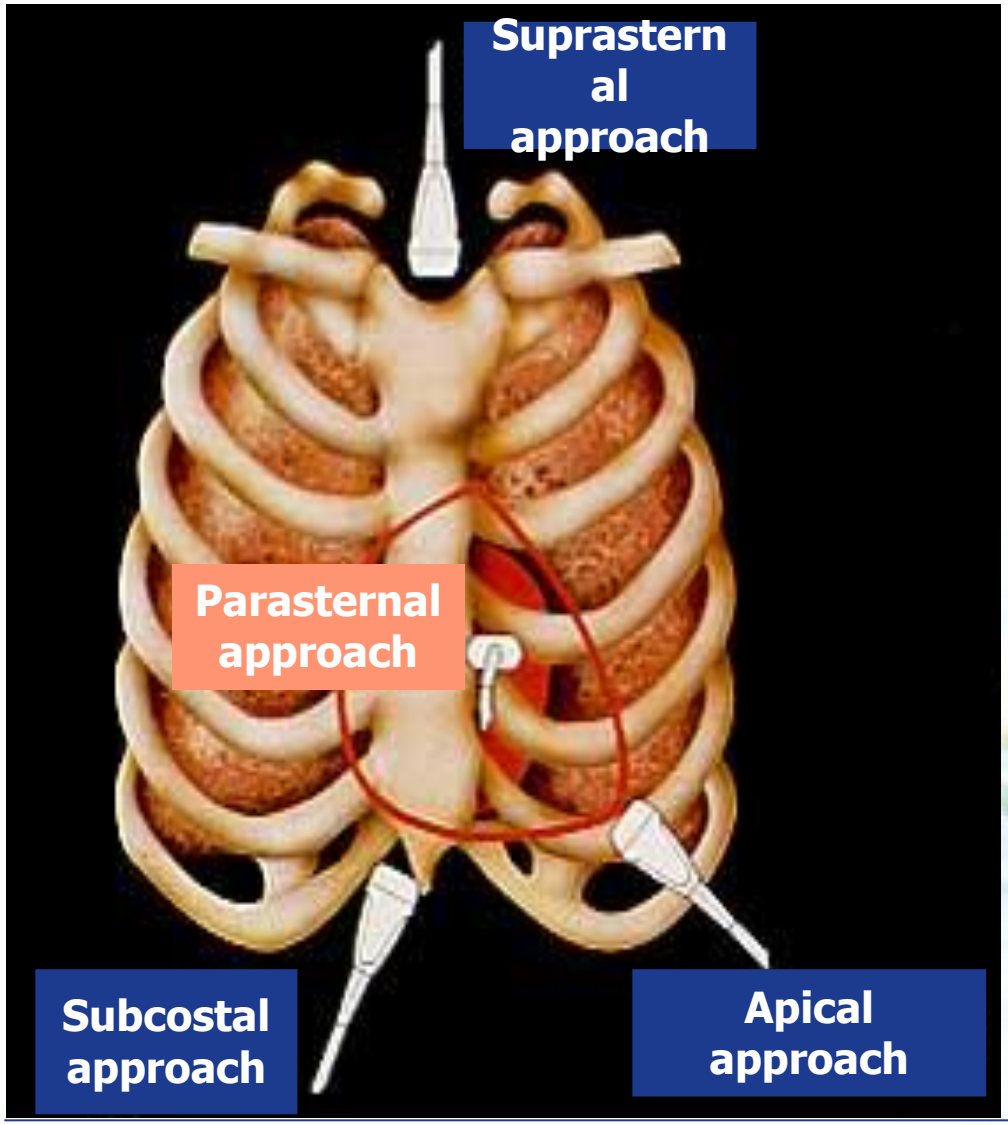
Anatomy of Echo





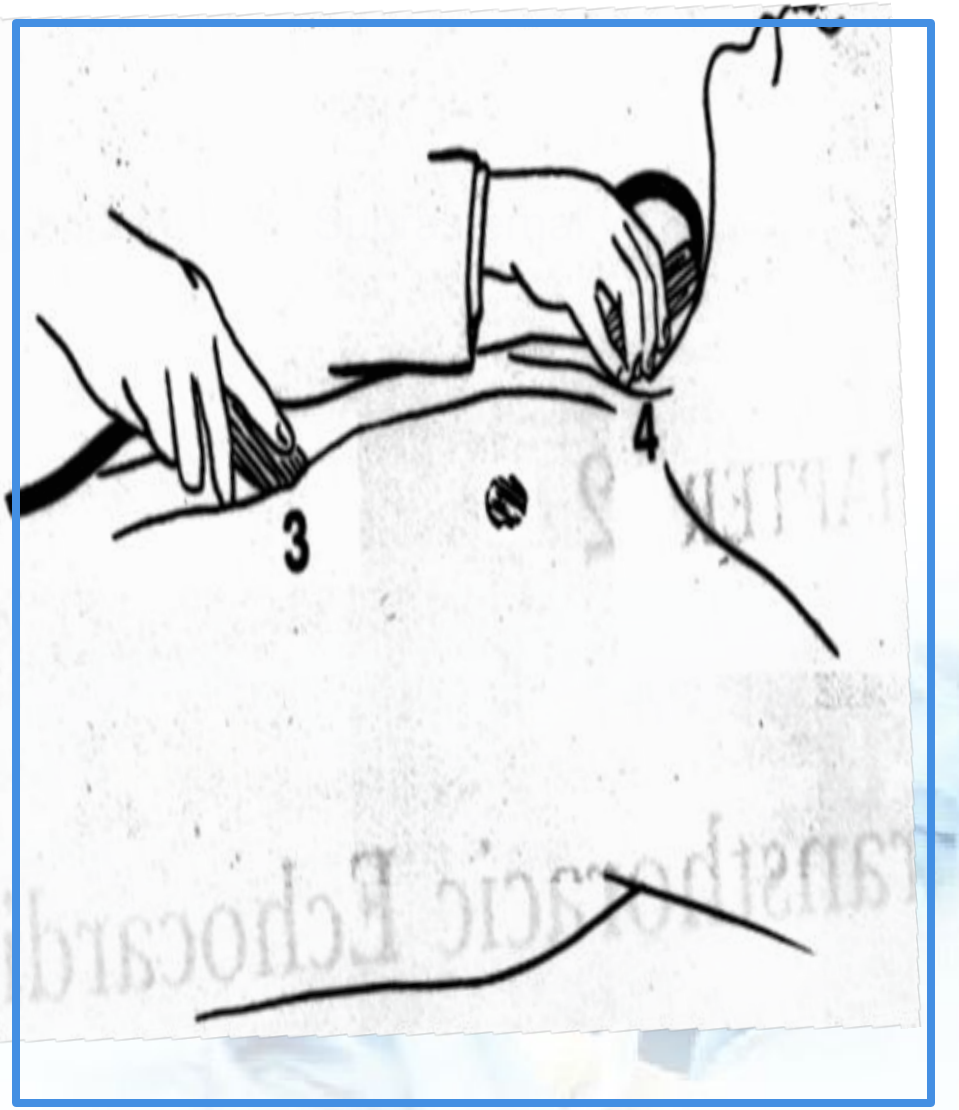


Echo Window

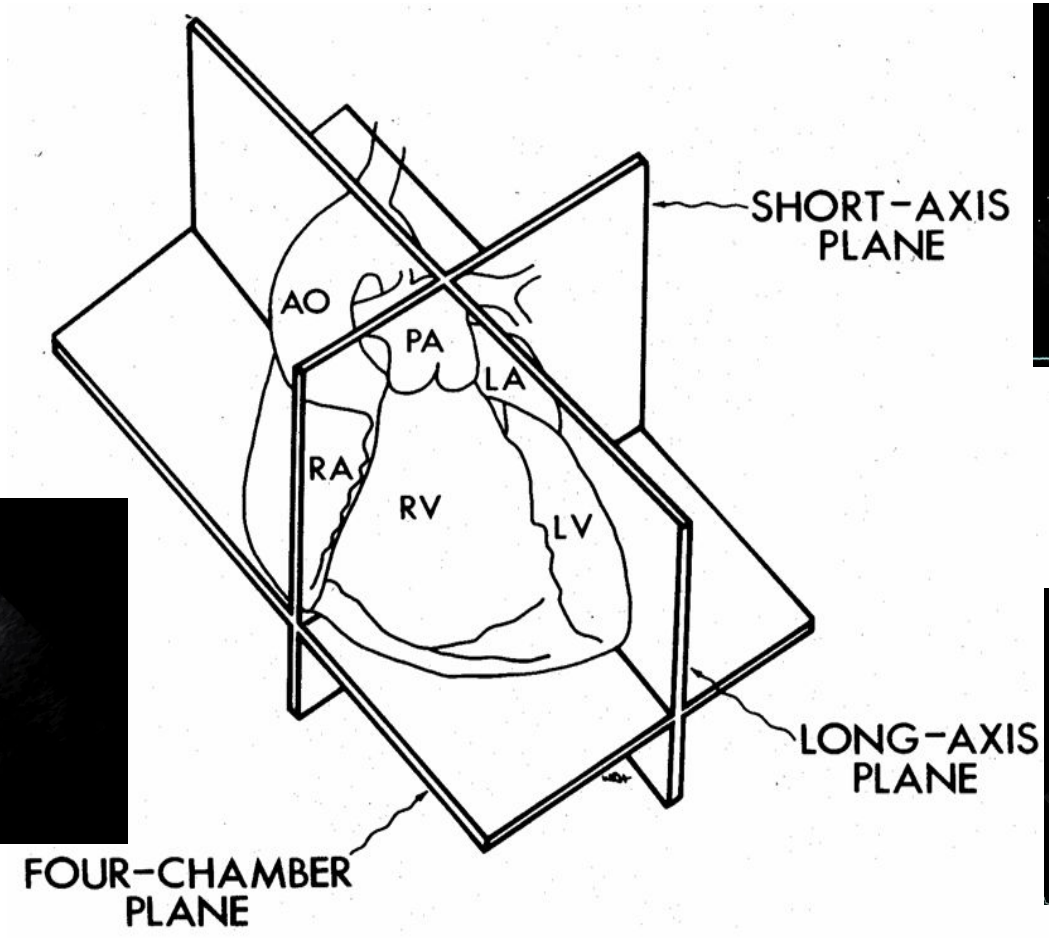


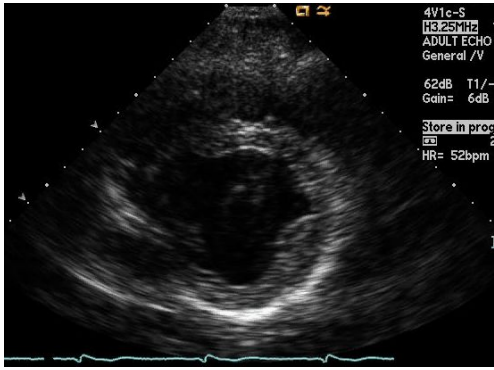
1. Parasternal
2. Apical
3. Subcostal
4. Suprasternal notch

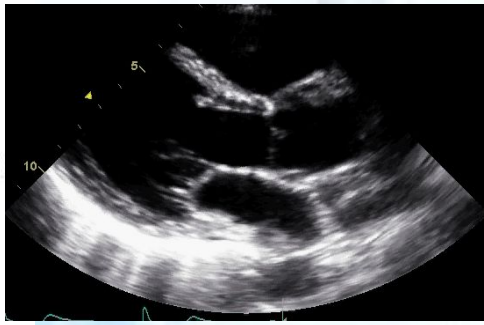
Basic views of Echocardiography



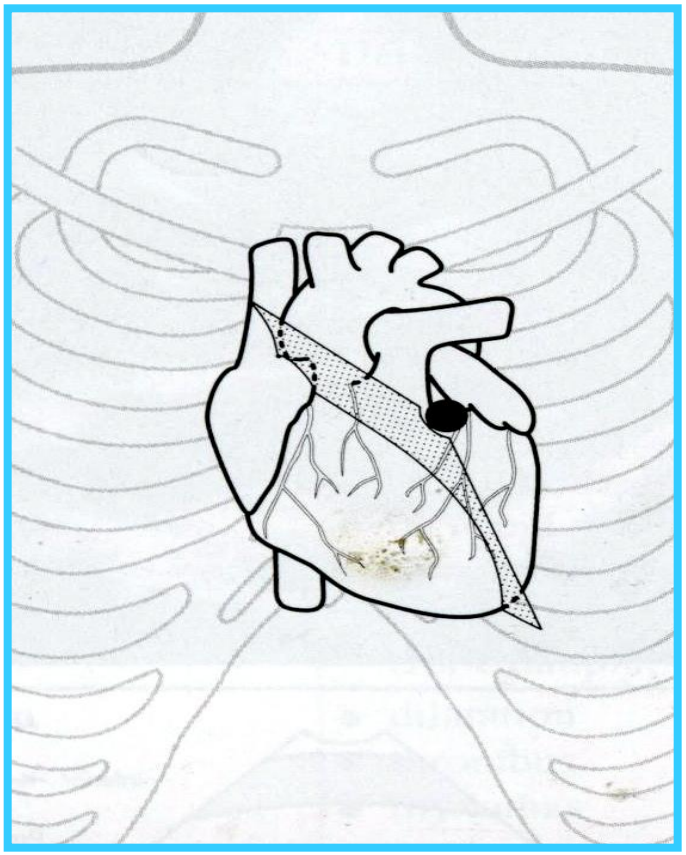
Basic views of Echocardiography

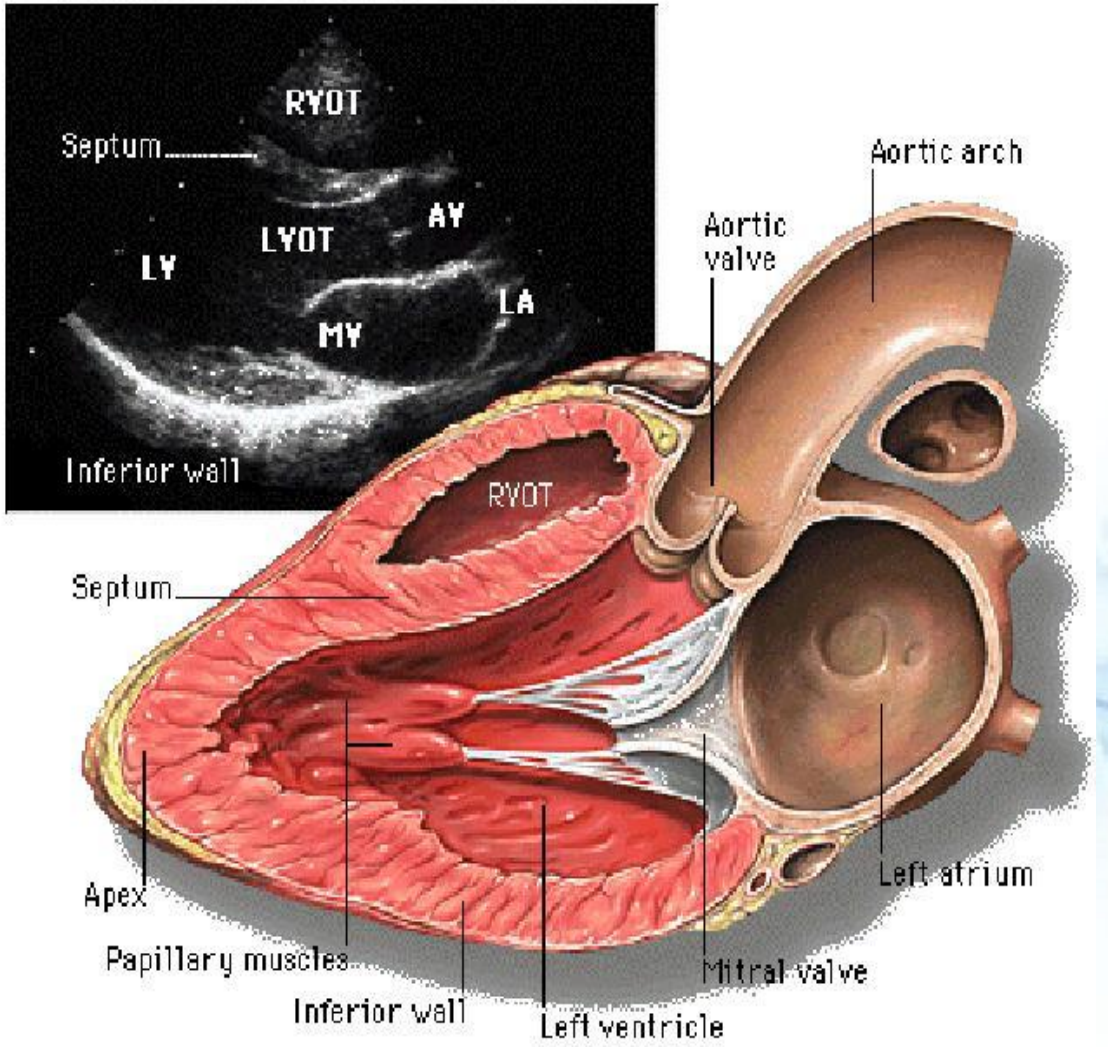




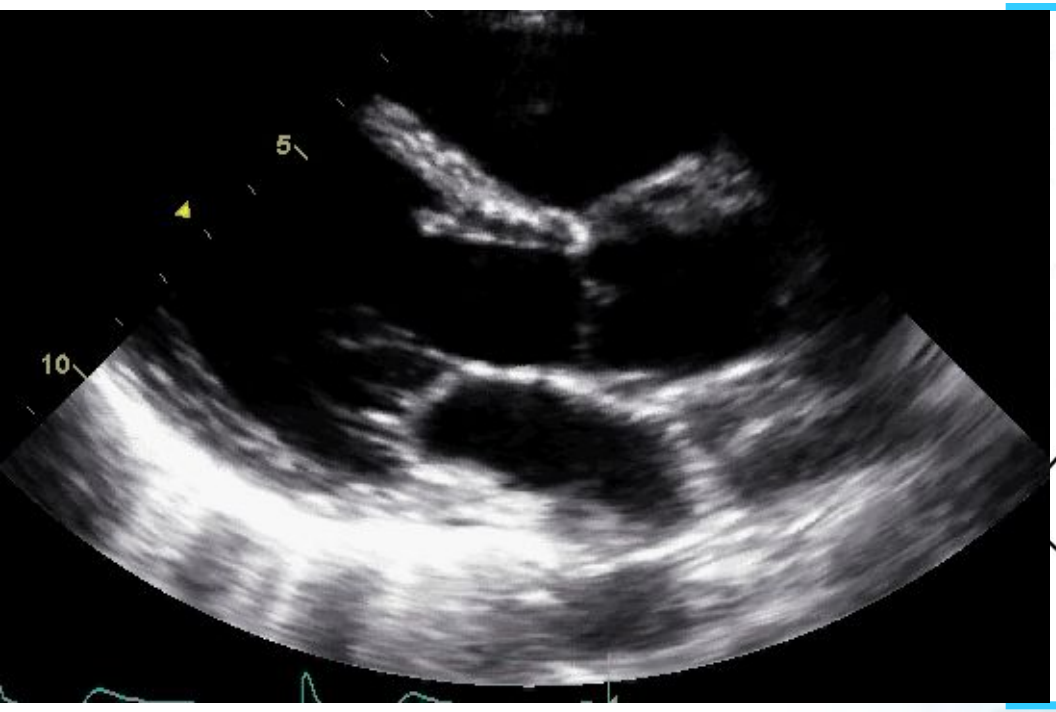


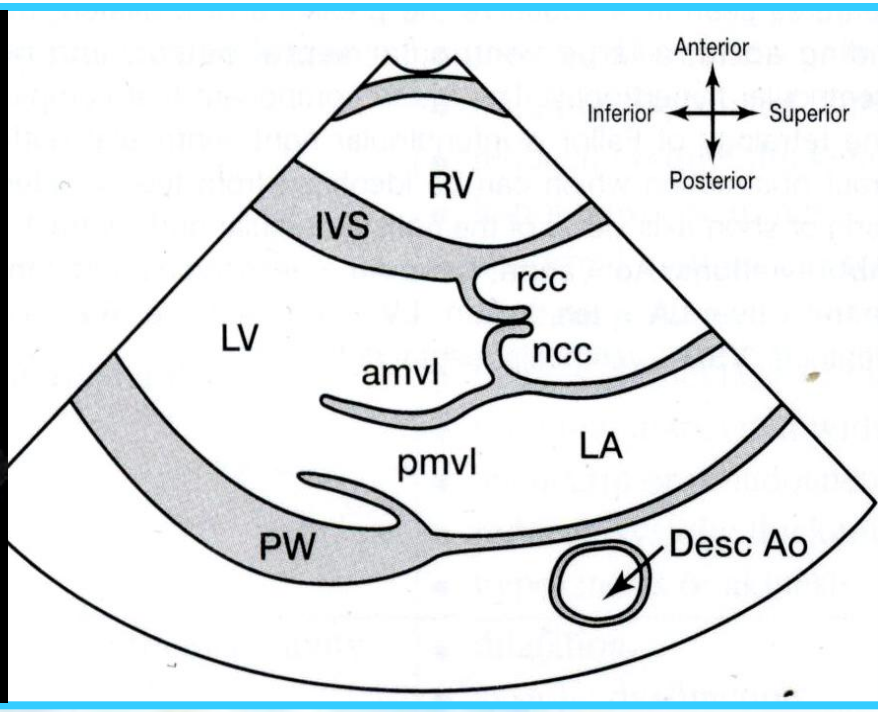
Parasternal long axis view



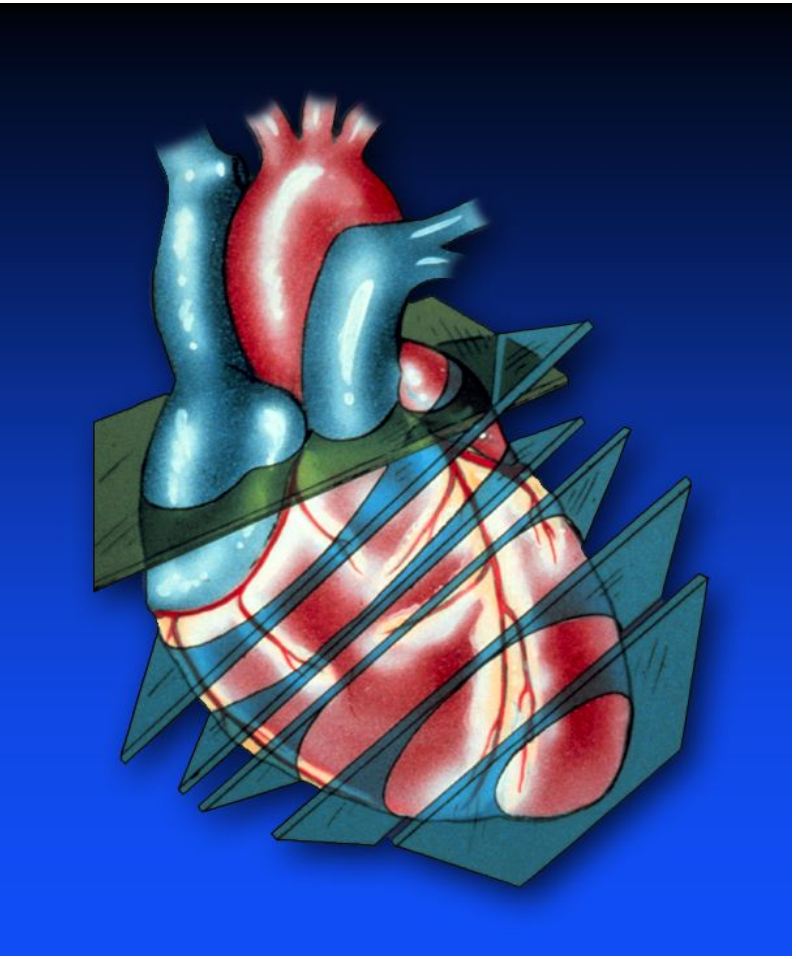


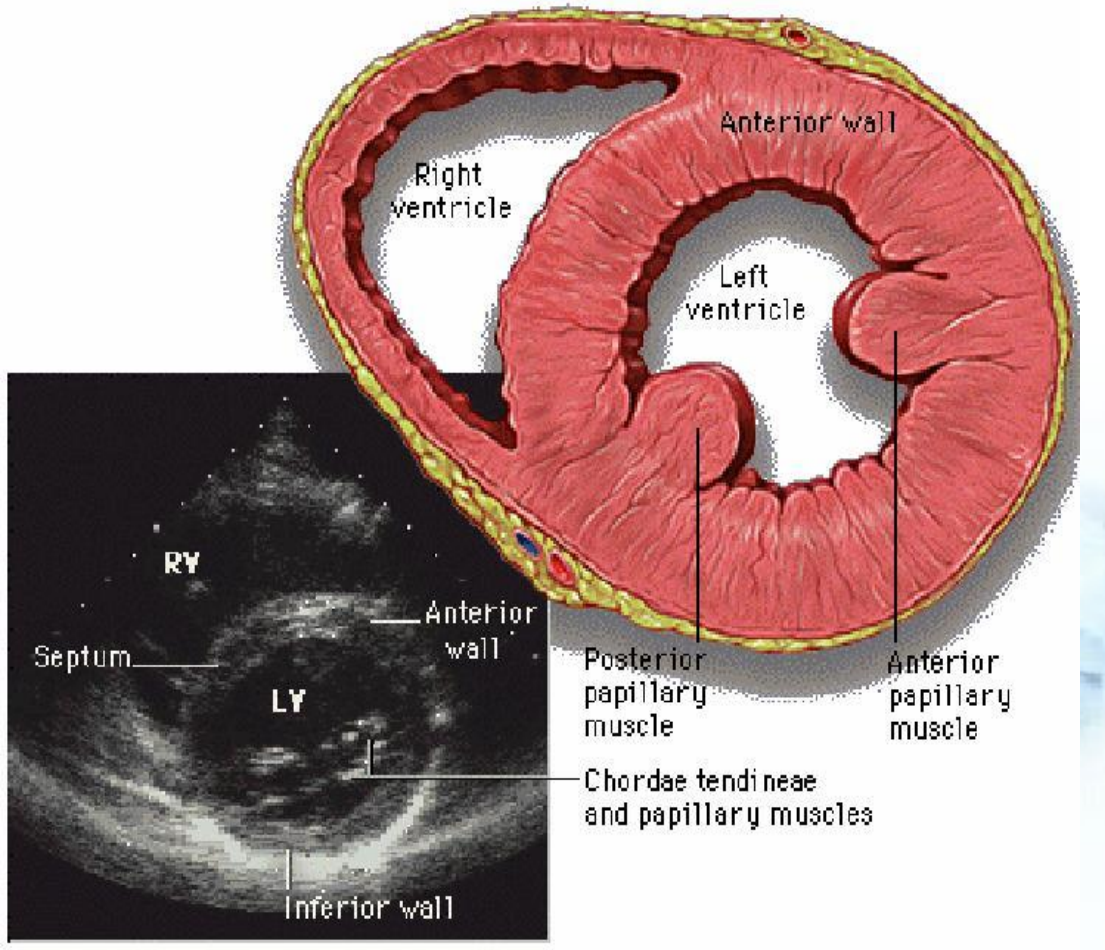
Parasternal long axis view



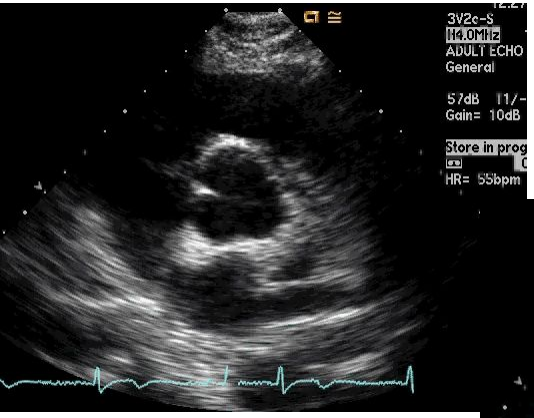


Parasternal short axis view

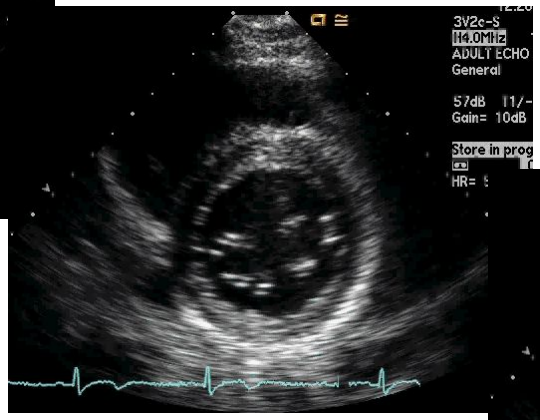




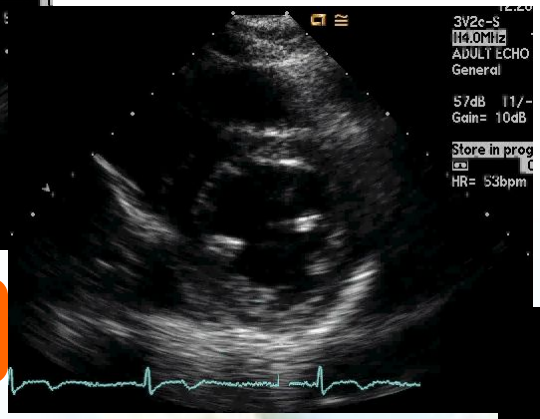
Parasternal Short Axis view



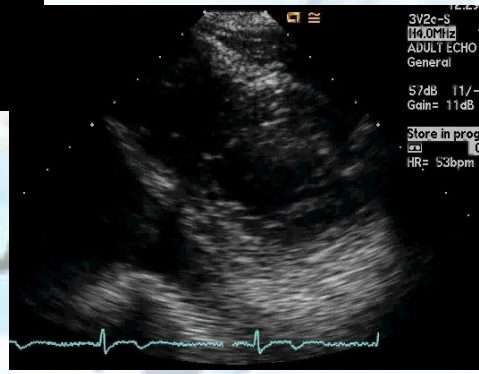
PSAX- AV level



PSAX- MV base

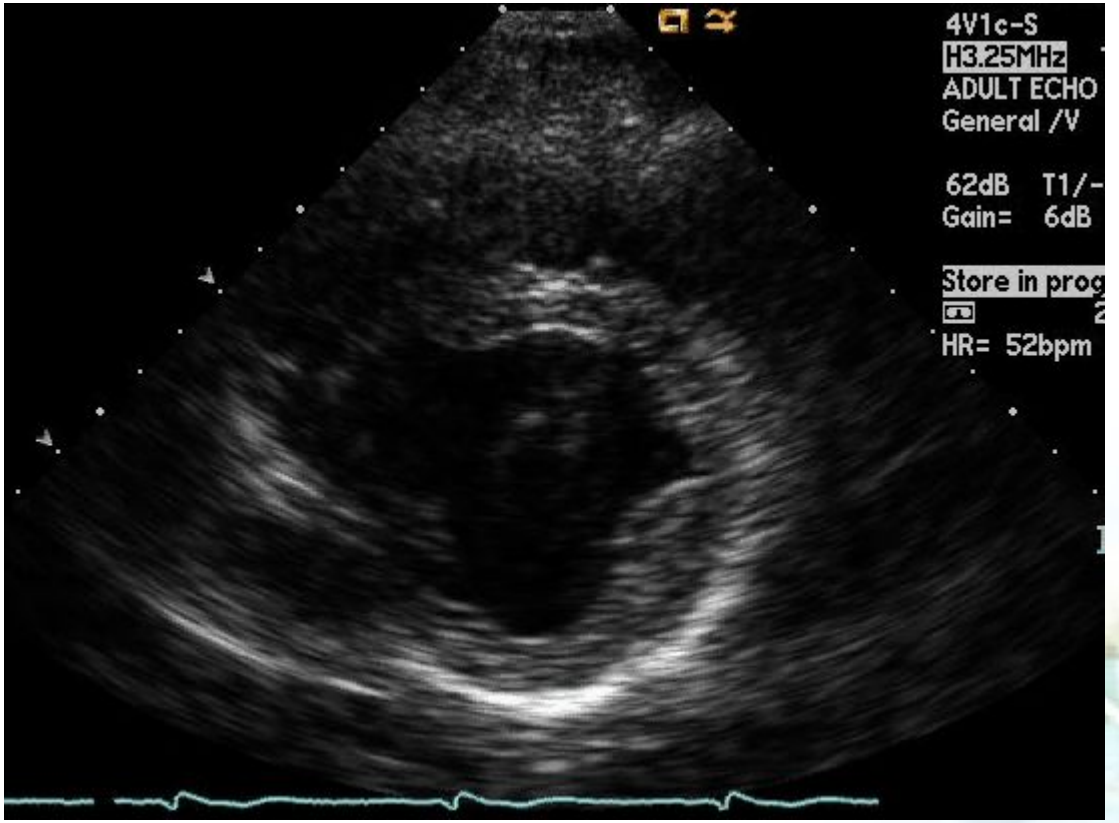


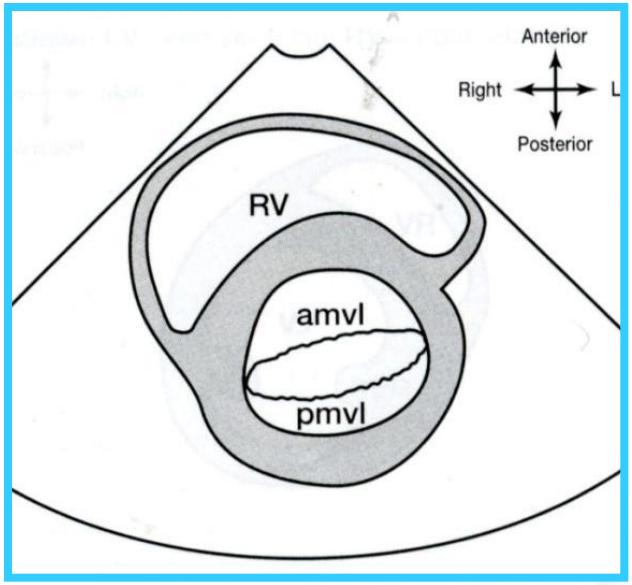
PSAX- Mid

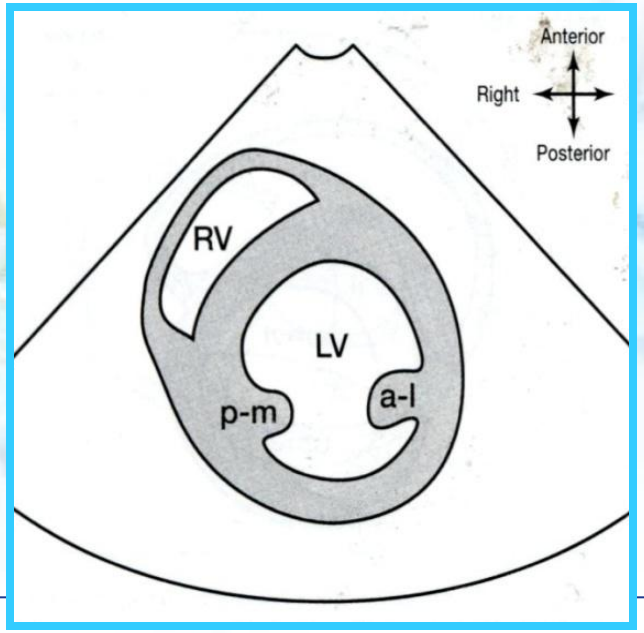


PSAX- Apex

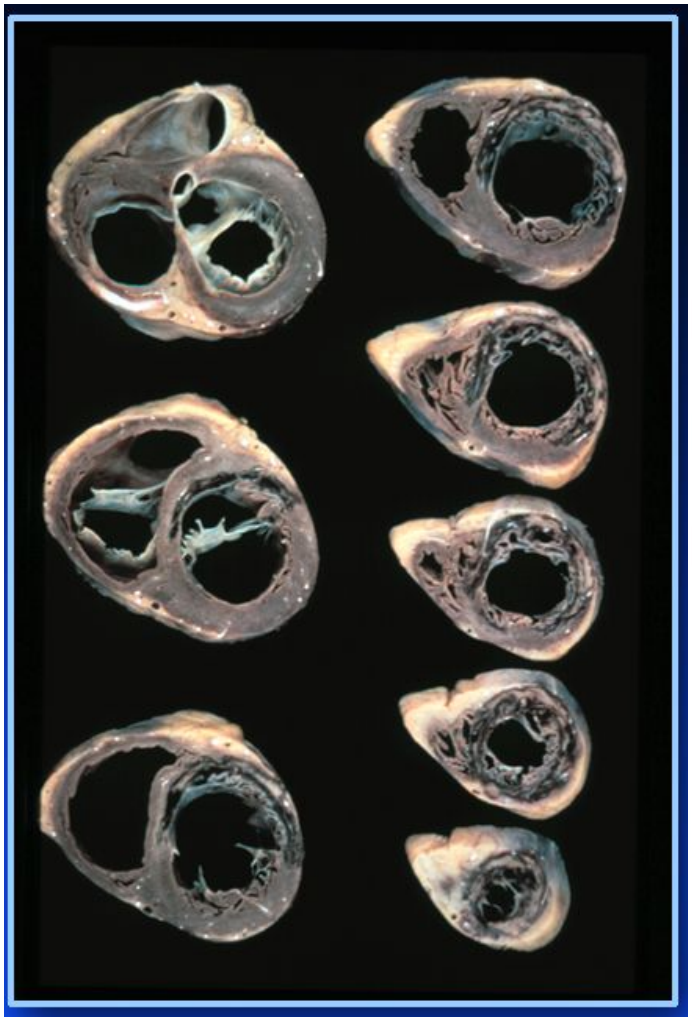
Parasternal short axis view

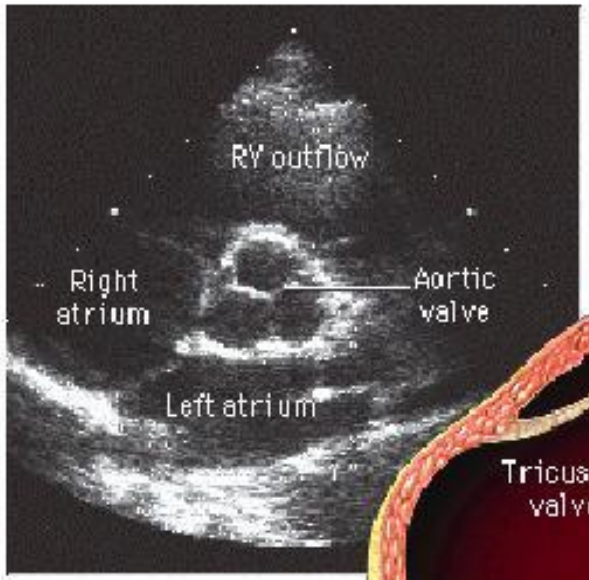


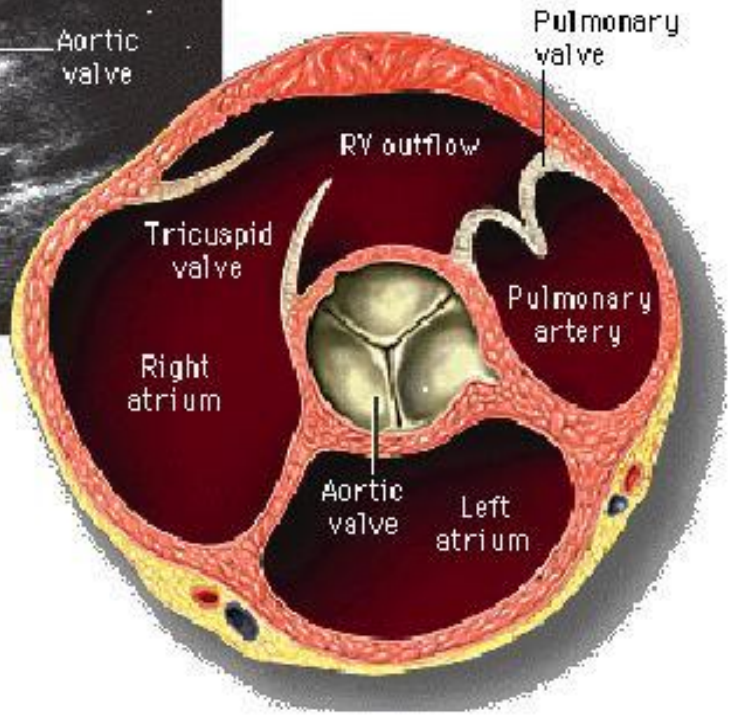




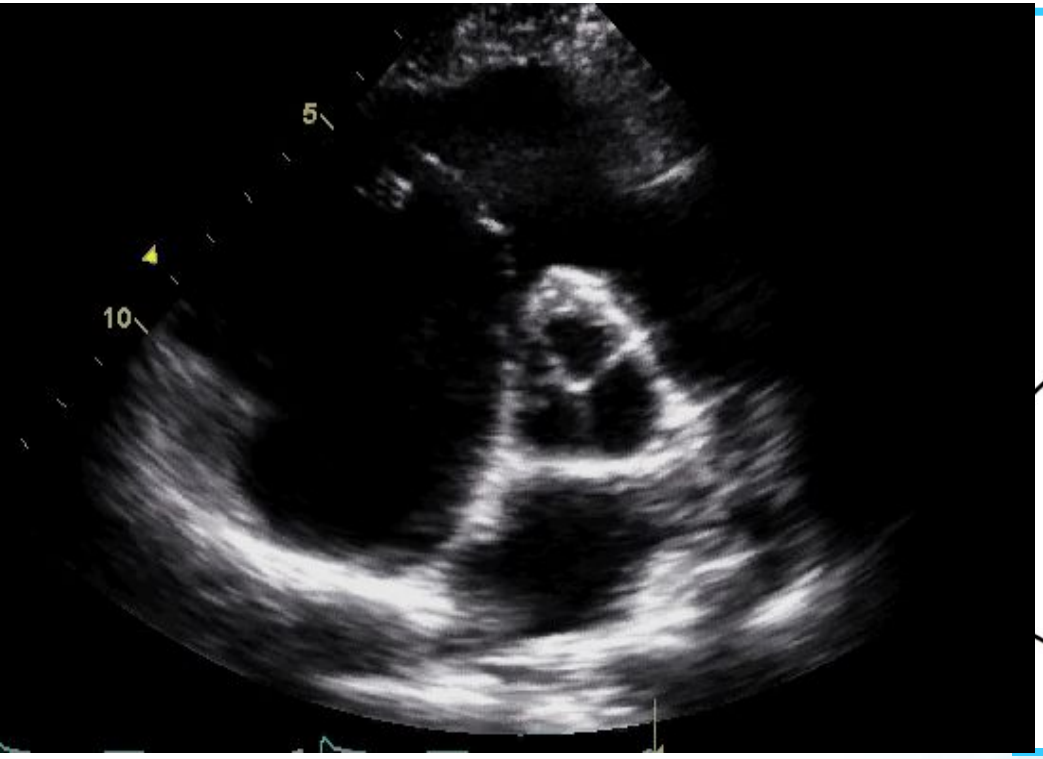
Short axis view of aorta

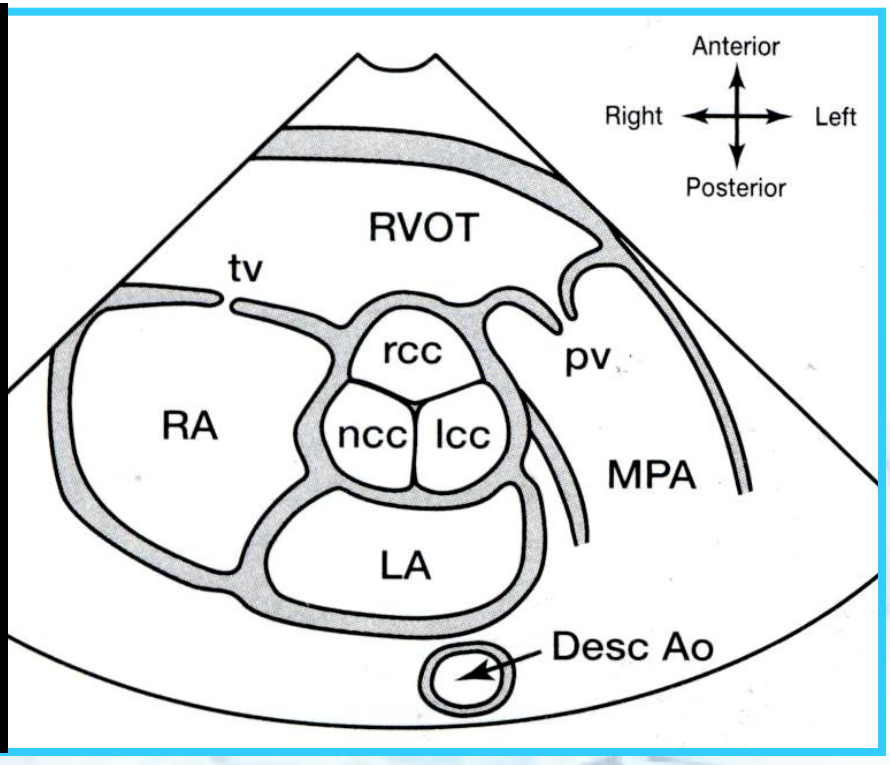




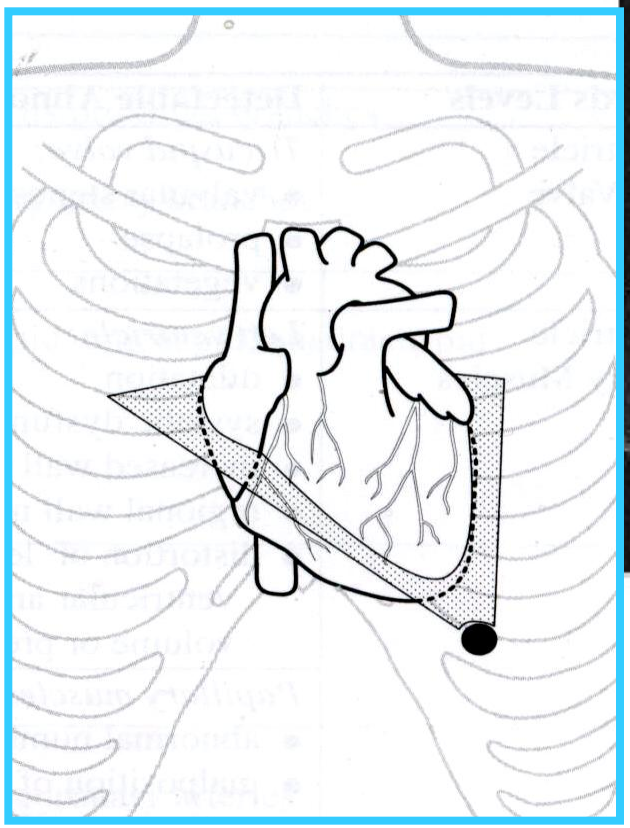


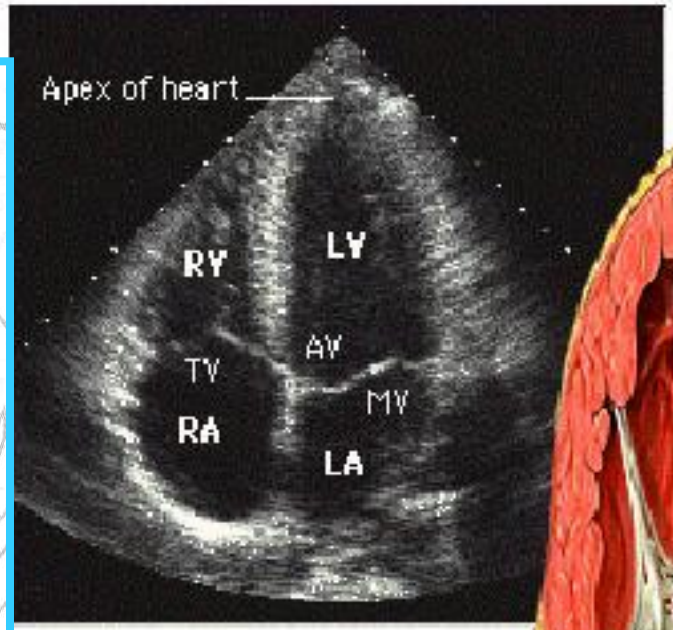
Short axis view of aorta



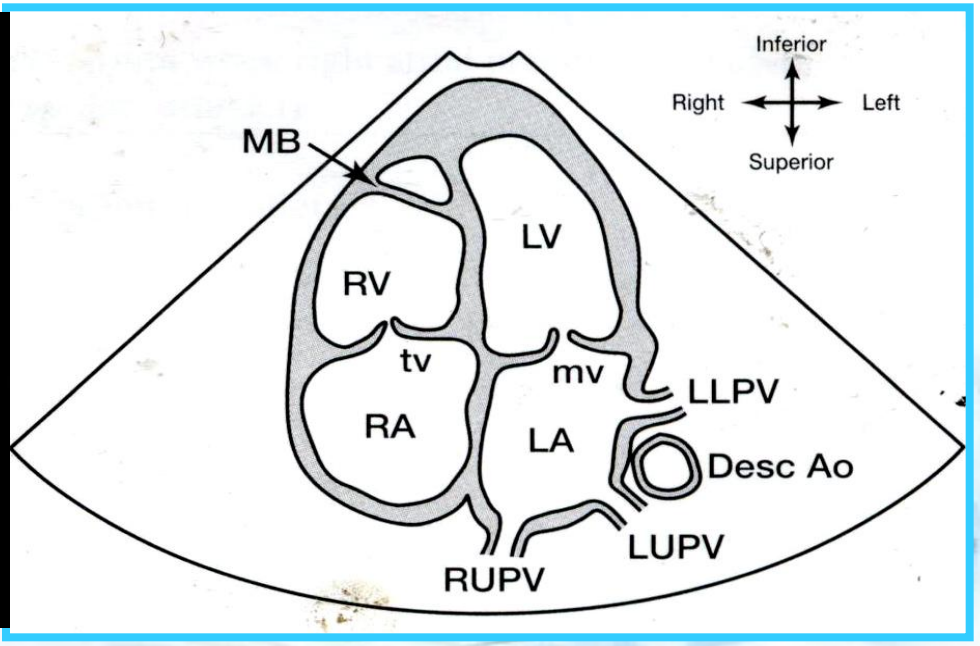


Apical 4 chamber view

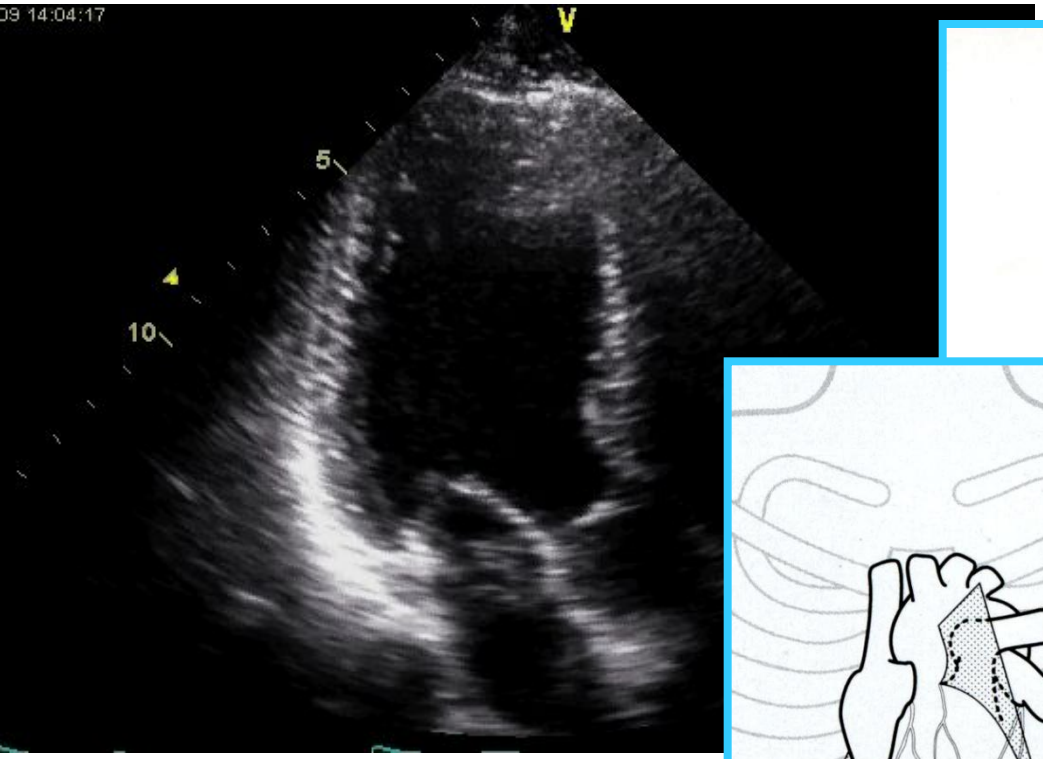


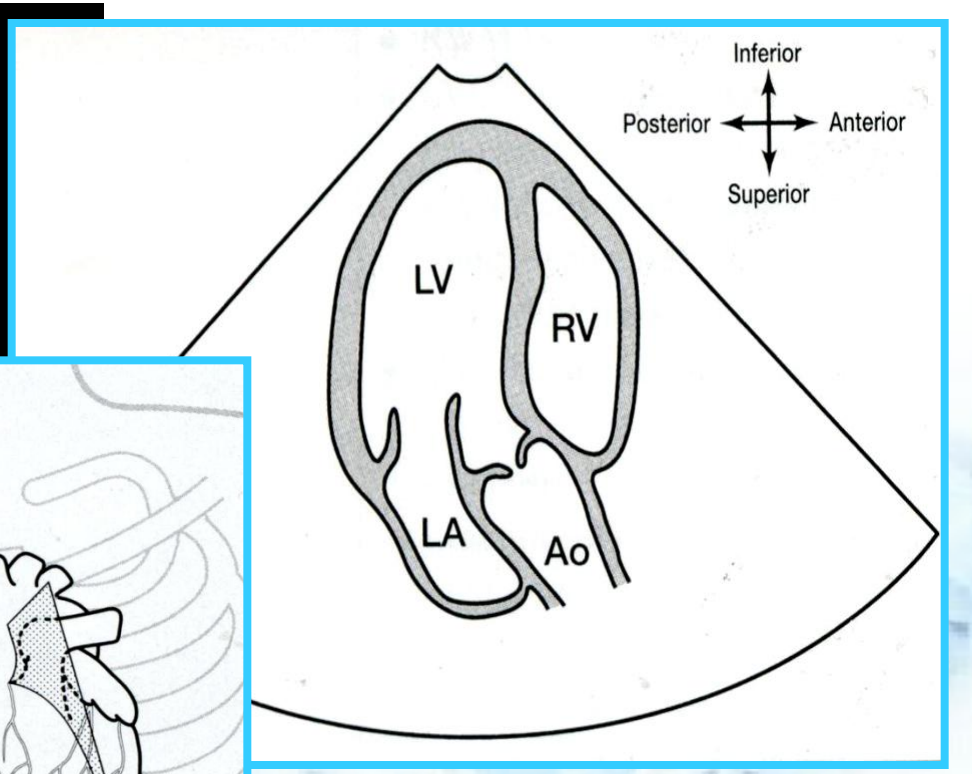


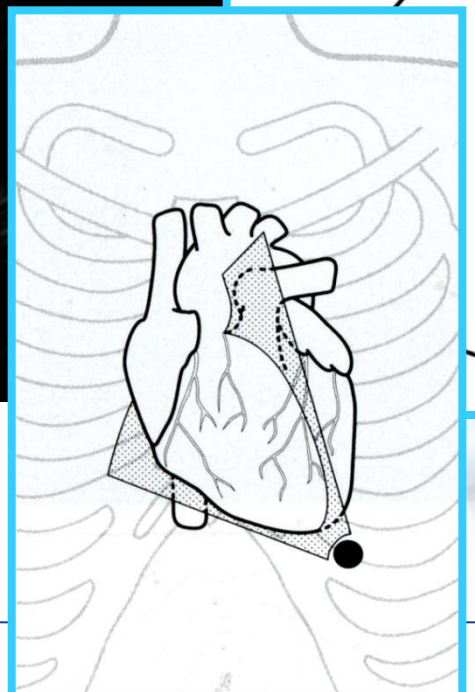
Apical 4 chamber view



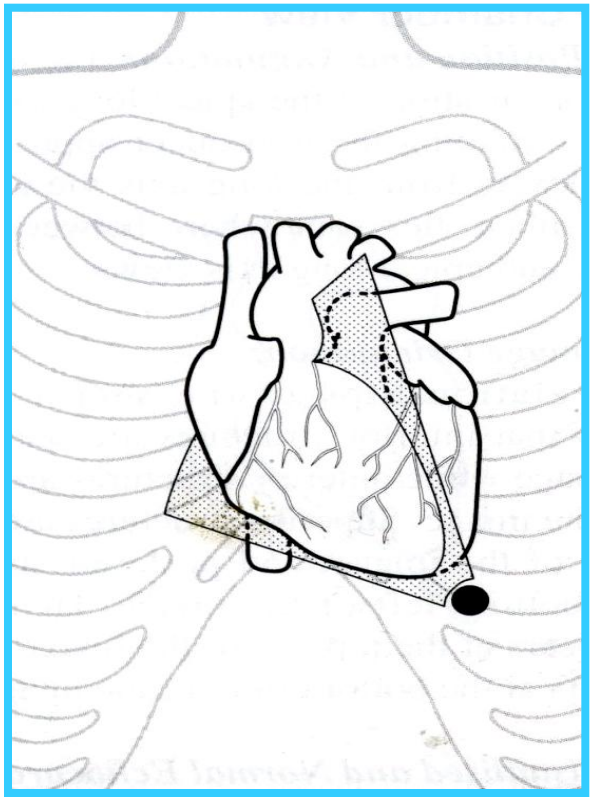
Apical long axis view

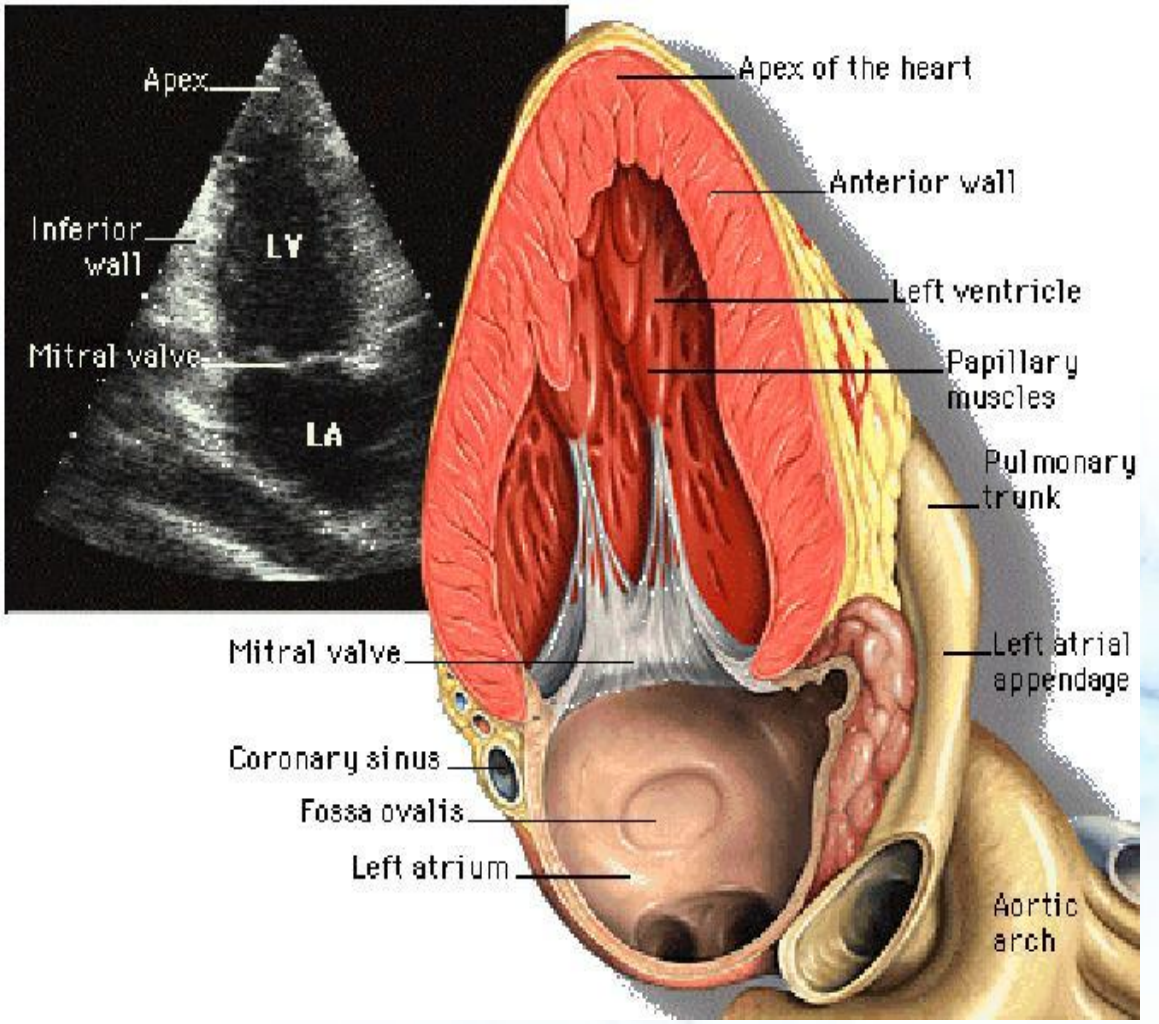




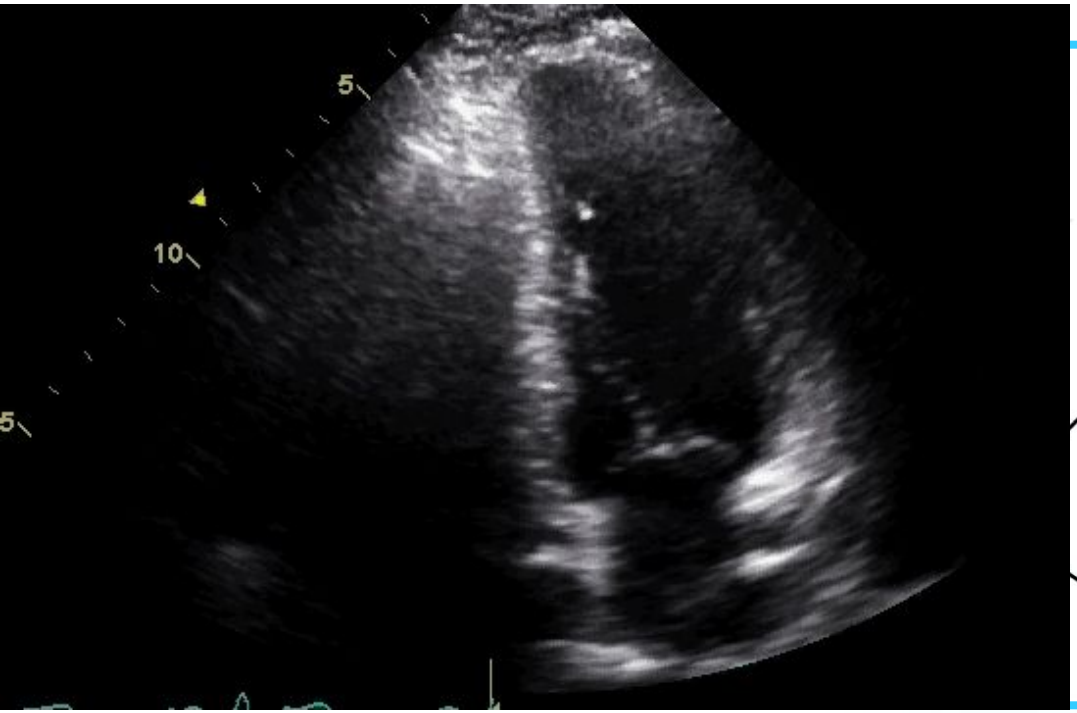


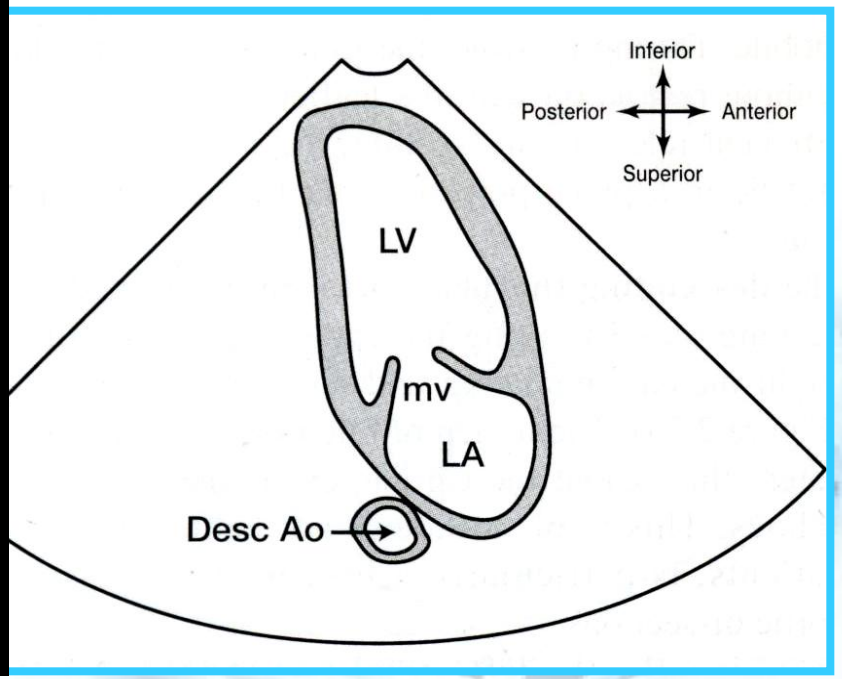
Apical 2 chamber view



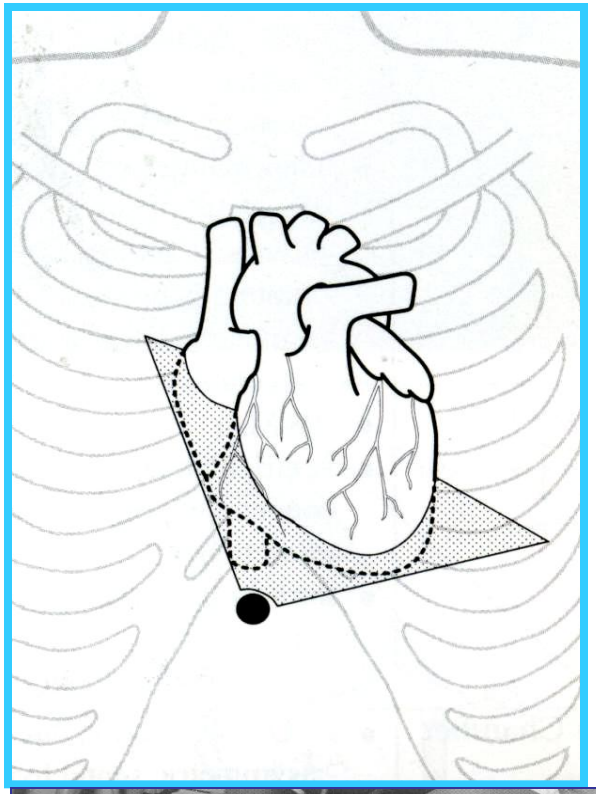


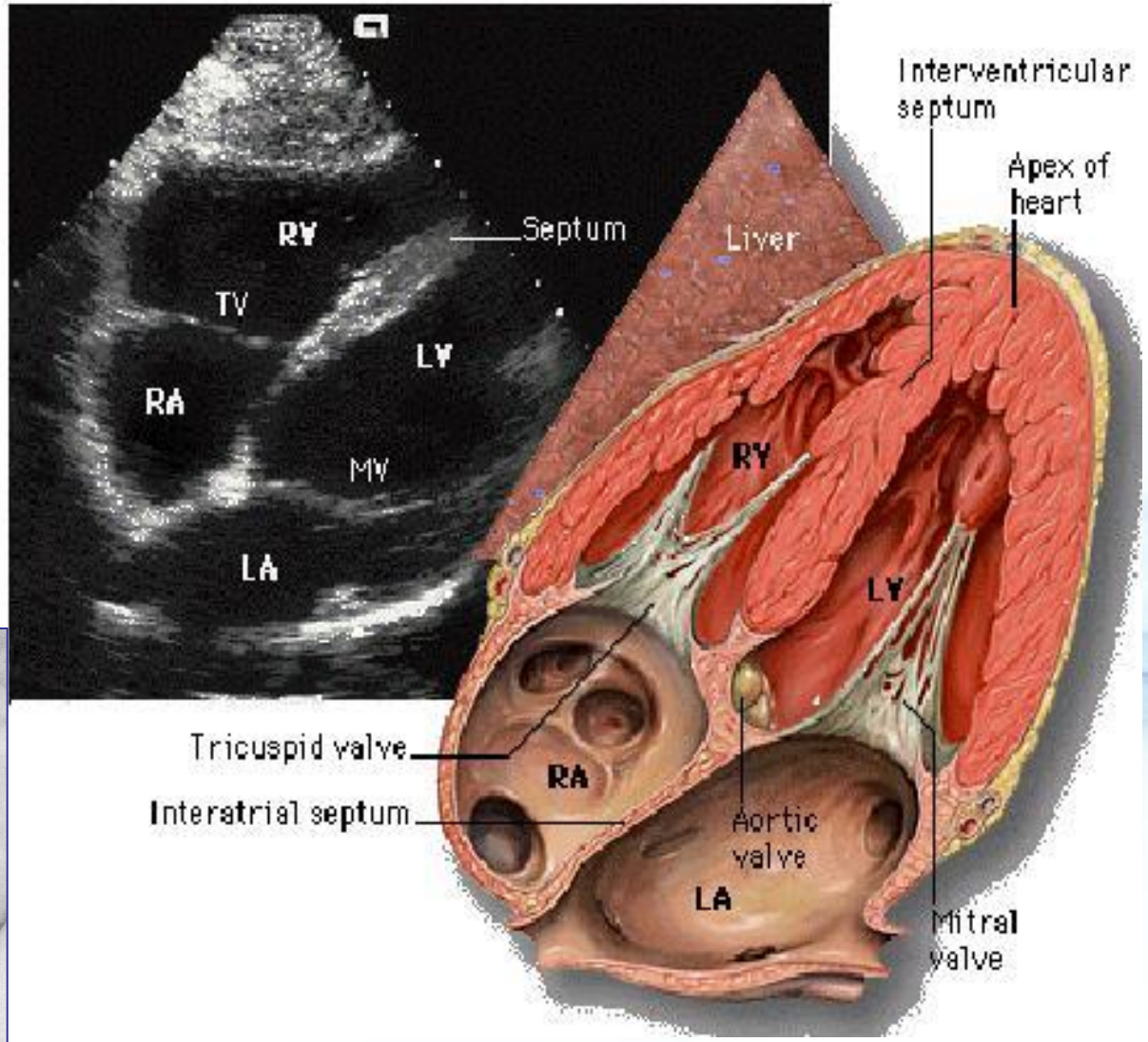
Apical 2 chamber view



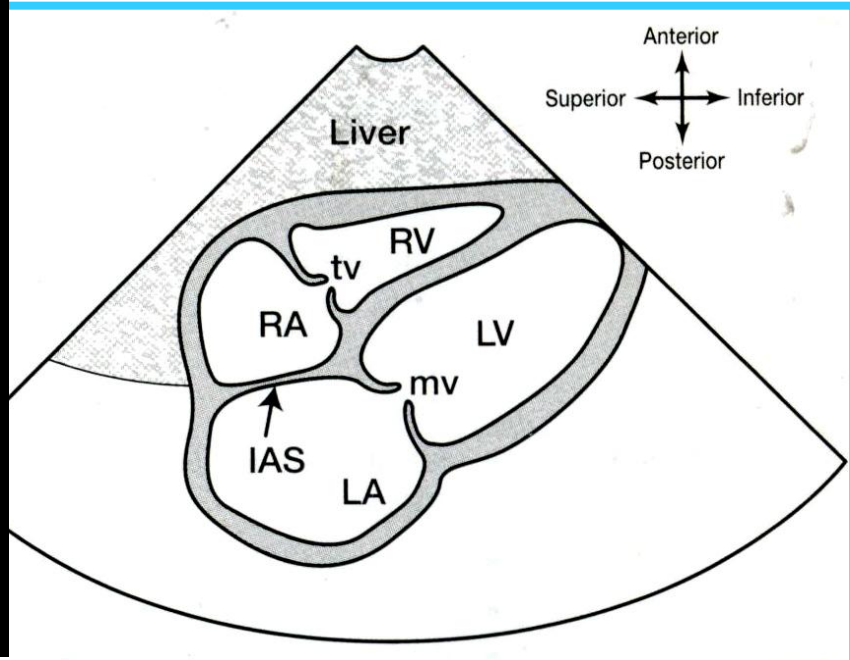


Subcostal view

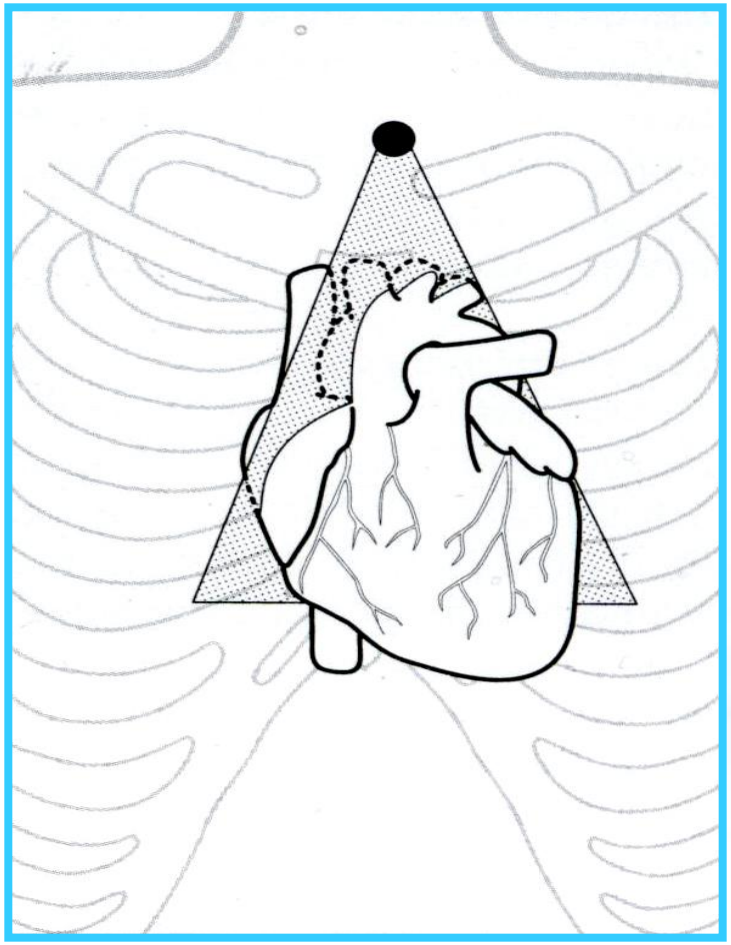


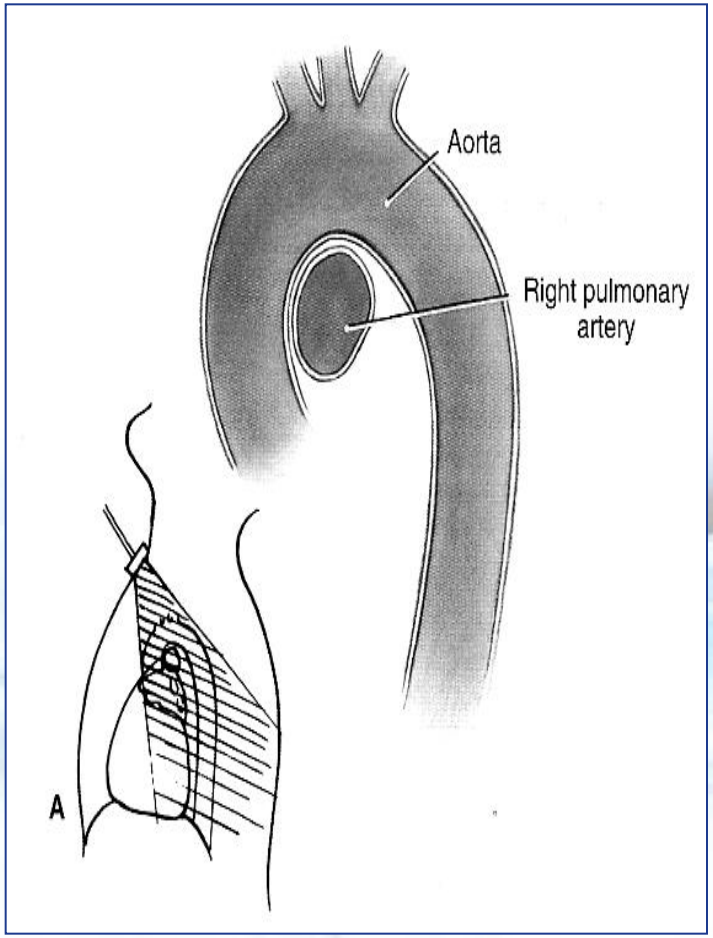


Subcostal view

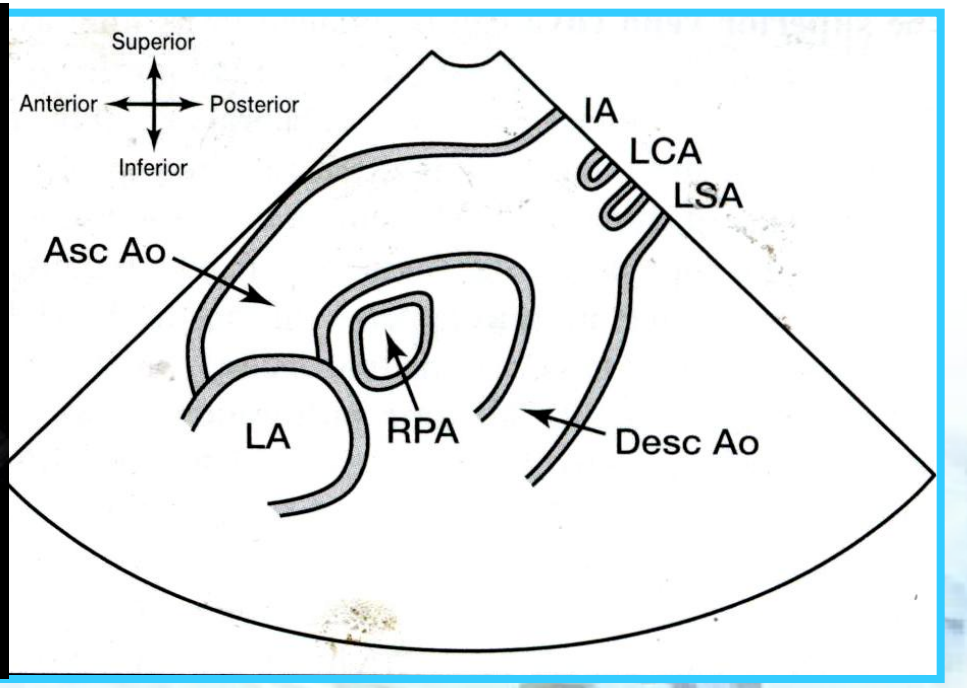


Suprasternal notch view

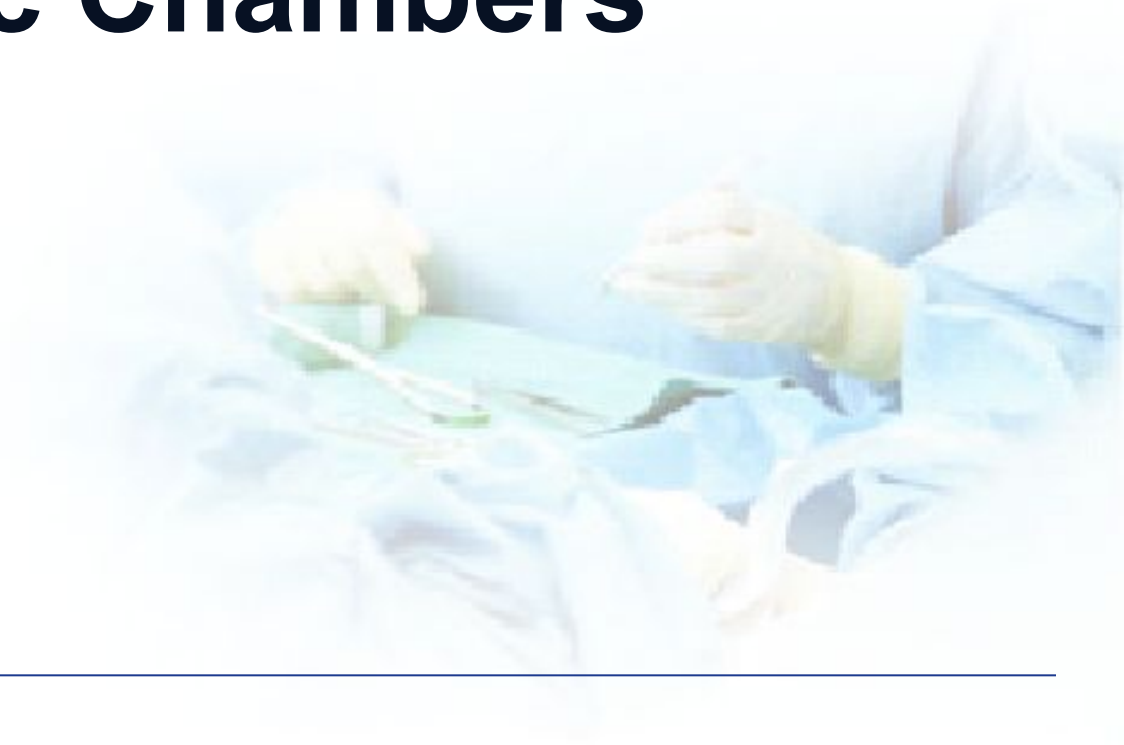




Suprasternal notch view



Measurement of Cardiac Chambers



General principles

- Considering cardiac cycle
  - : sinus rhythm
  - : Multiple beats should be used in AF
  - : Avoid PVC or PAC

    (avoided in the post-ectopic beat in PACs or PVCs)
- Quantification
  - : Mildly or moderately or severely abnormal

General principles

- Respiration (at end-expiration)
- Image at minimum depth necessary
- Highest possible transducer frequency
- Adjust gains, dynamic range, transmit
- Frame rate ≥ 30/s
- Harmonic imaging
- B-color imaging

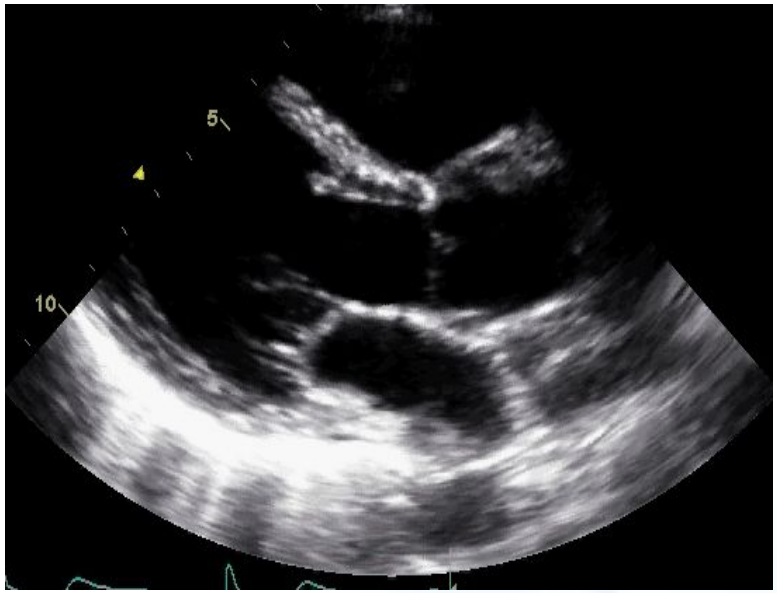
Factors affecting image quality

Tester factors

technique

knowledge

experience



Machine factor
Depth
Gain
Frame rate
Resolution
Power
Compression
Dynamic range
Persistence
Focusing
Artifacts, etc

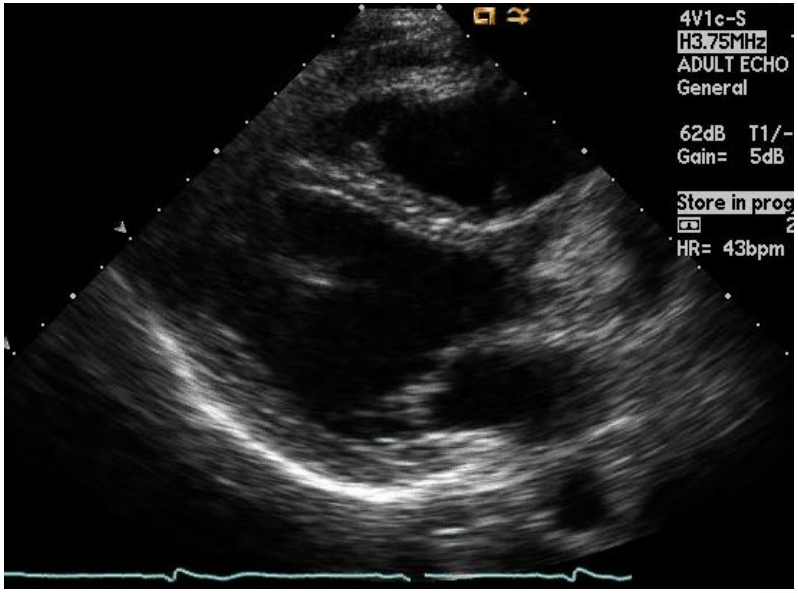
Patient factors

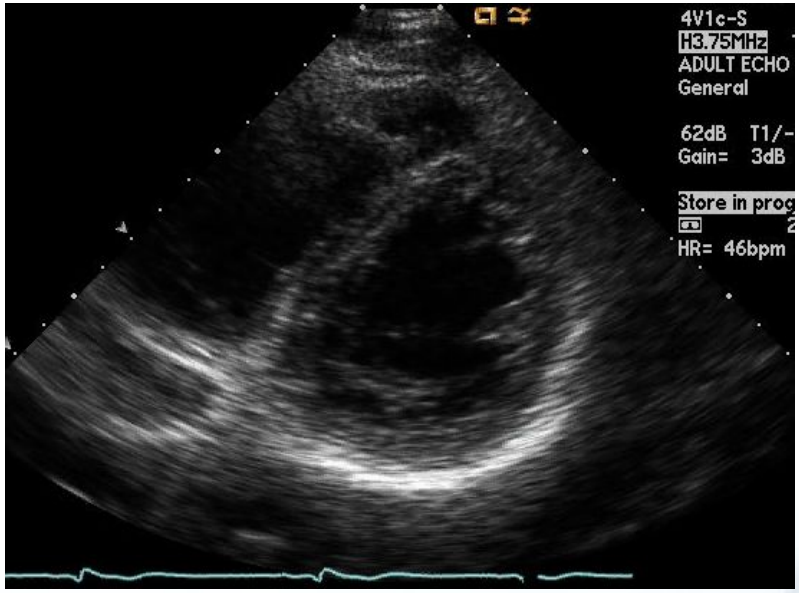
Hemodynamic stability

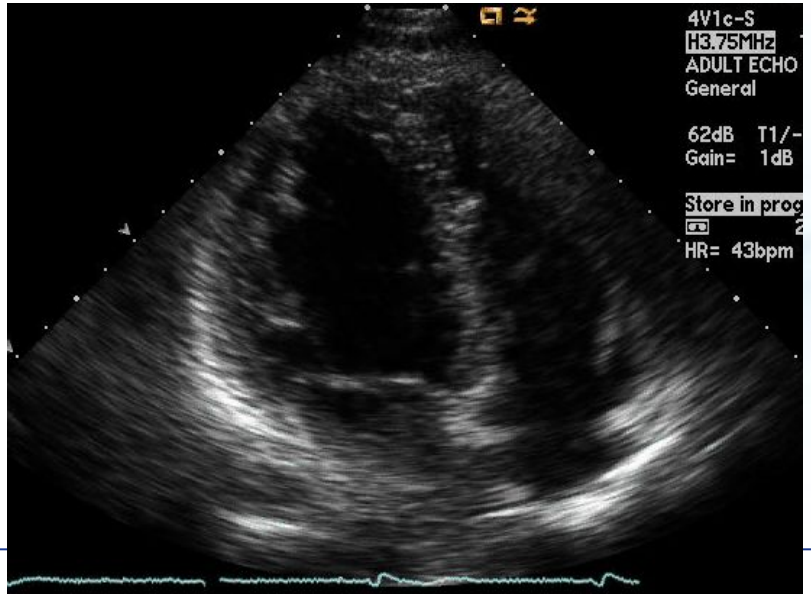
Body shape

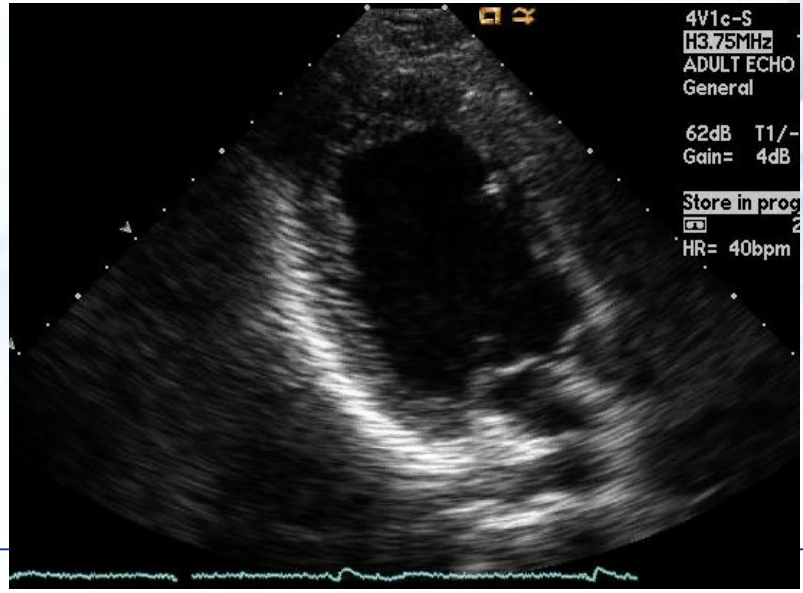
Combined disease

2D Image Optimization

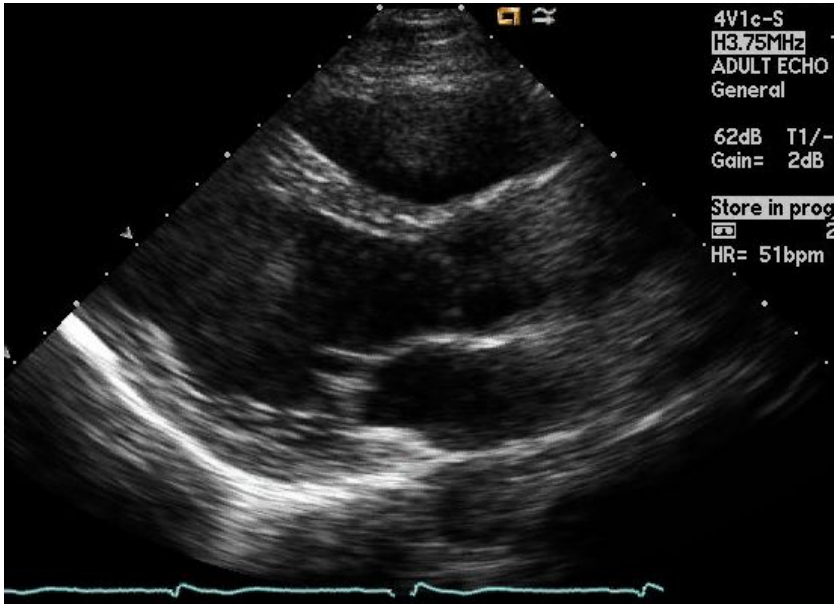


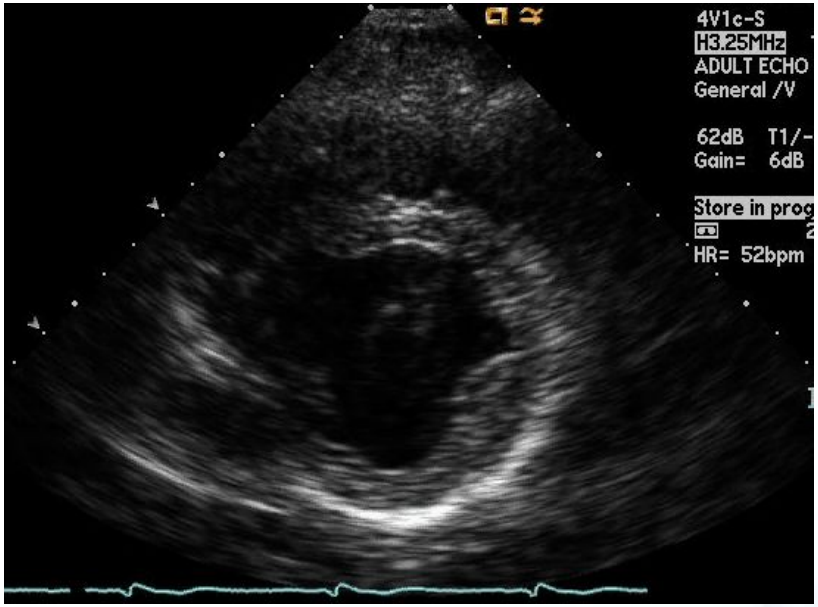


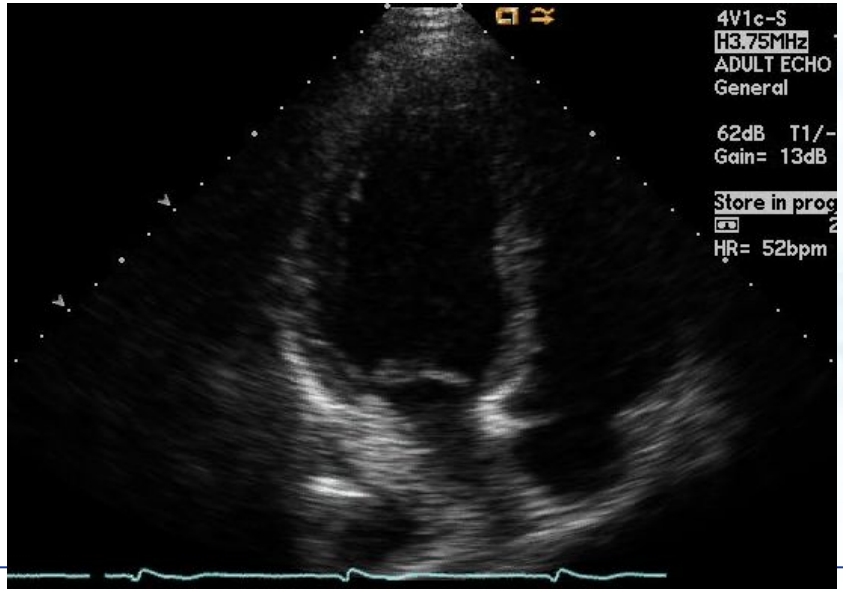


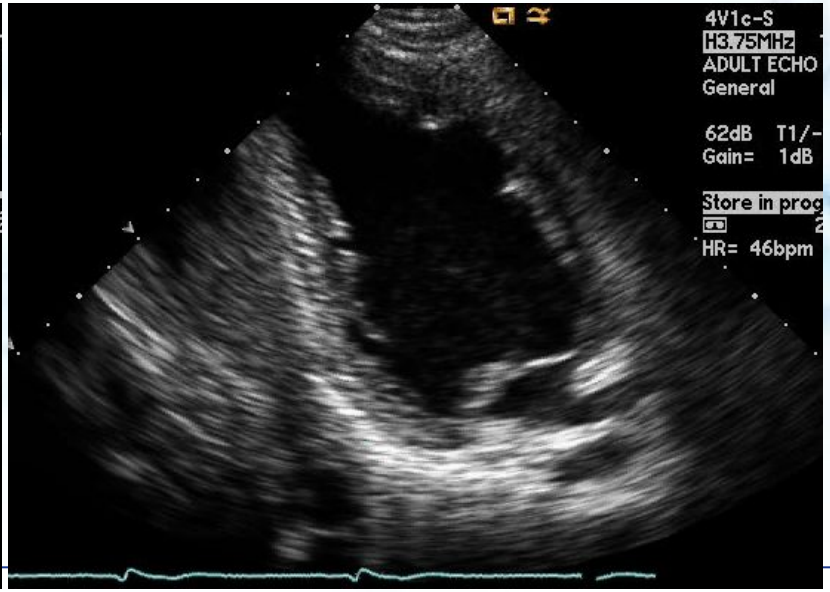


2D Image Optimization









Measure LV dimension

	Advantage	Limitation
Linear		
M-mode	Reproducible - High frame rates - Most representative in normally shaped ventricles	Beam frequently off axis Single dimension may not be representative in distorted ventricle
2D	- perpendicular to ventricular long axis	- Lower frame rates - Single dimension only

Measure LV volume

	Advantage	Limitation
Volumetric		
Simpsons'	- Correct for shape distortions - Minimize mathematic assumptions	- Apex frequently foreshortened - Endocardial dropout - Relies on only two planes - Few accumulated data
Area length	- Partial correction for shape distortion	- Based on mathematic assumptions - Few accumulated data

Measure LV mass

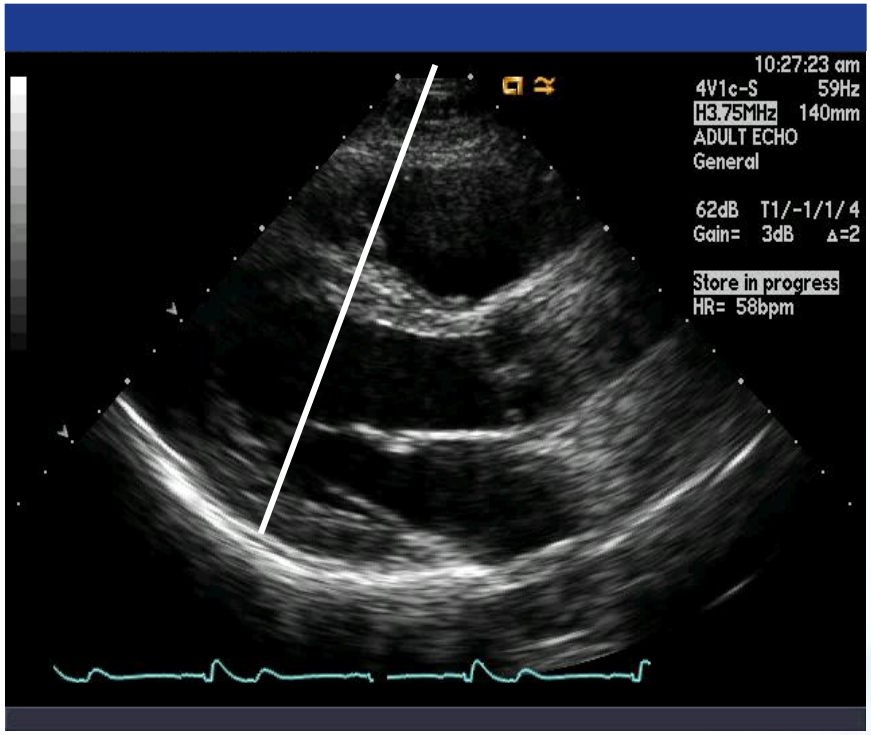
	Advantage	Limitation
Mass		
M-mode 2D	Wealth of accumulated data	- Inaccurate with RWMA - Beam orientation (M-mode) - Small errors magnified - Overestimates LV mass
Area length	- Allows for contribution of papillary muscle	- Insensitive to distortion
Truncated ellipsoid	- More sensitive to distortions	- Based on mathematic assumptions - Minimal normal data

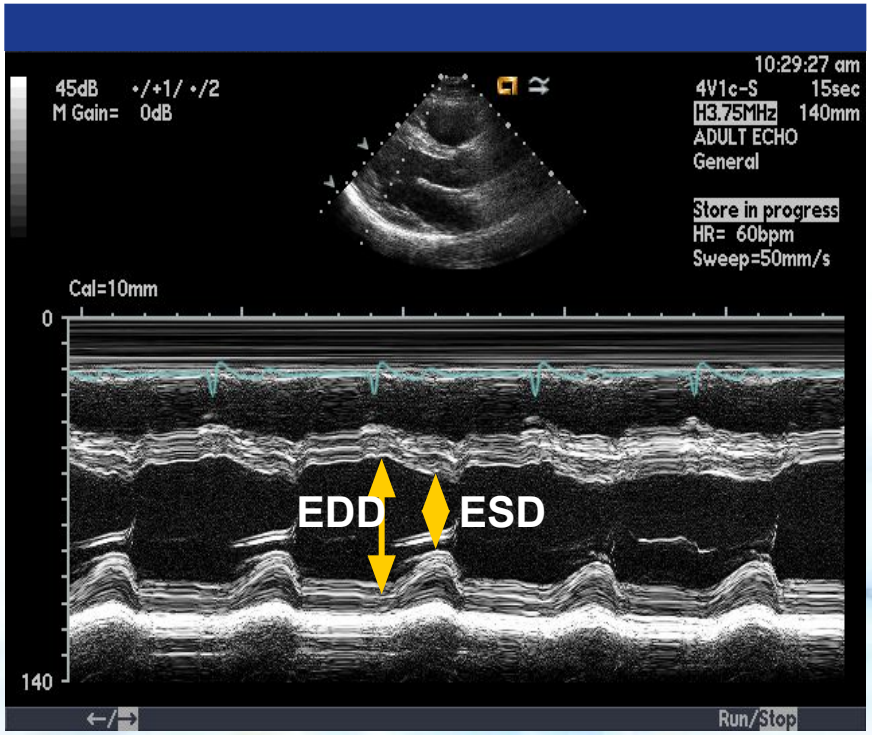
Measure LV dimension & thickness

- PLAX, PSAX view
- End of mitral leaflet
- 2D or M-mode
- End diastole, systole

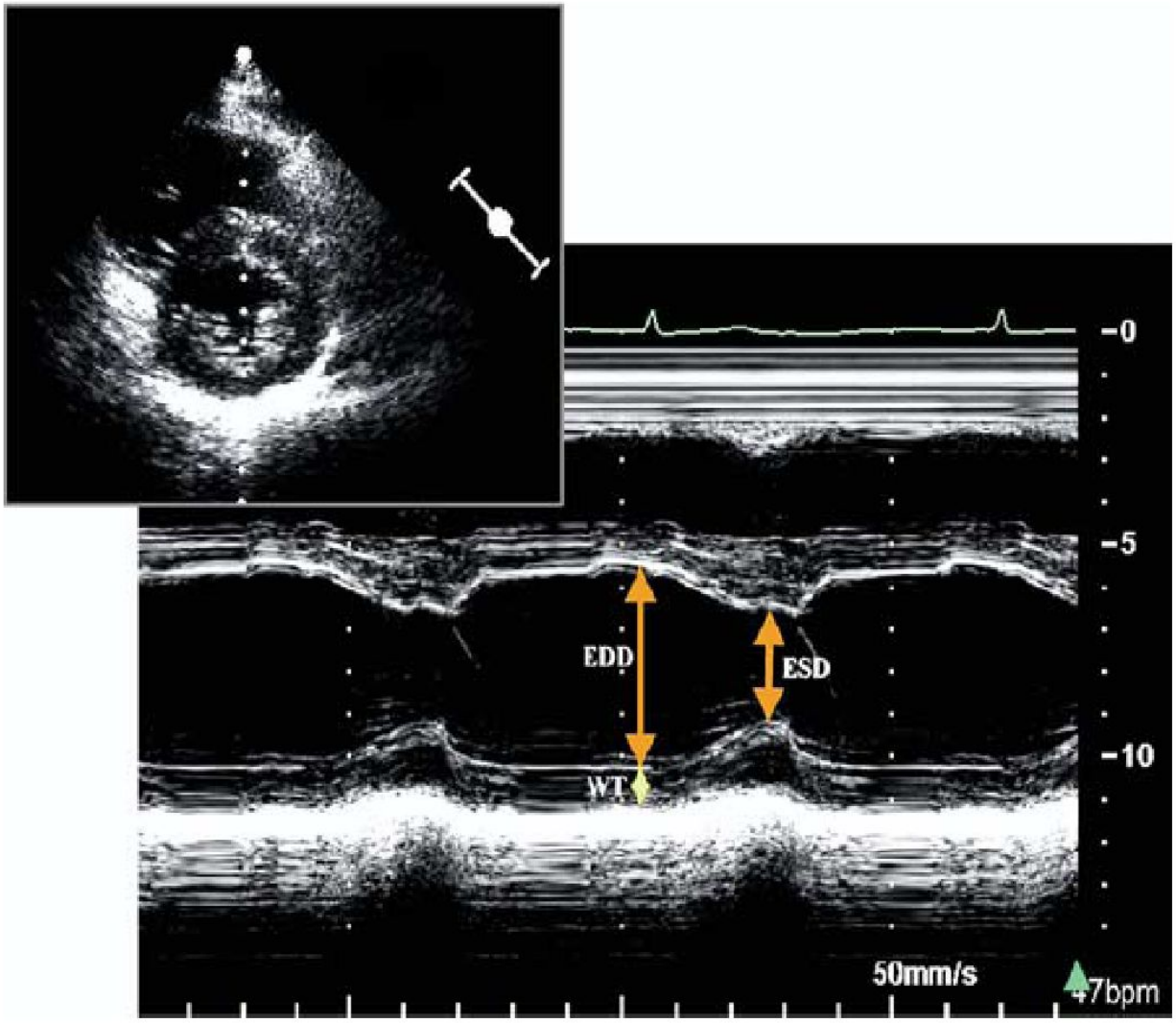
  - multiple beat

LV M-mode

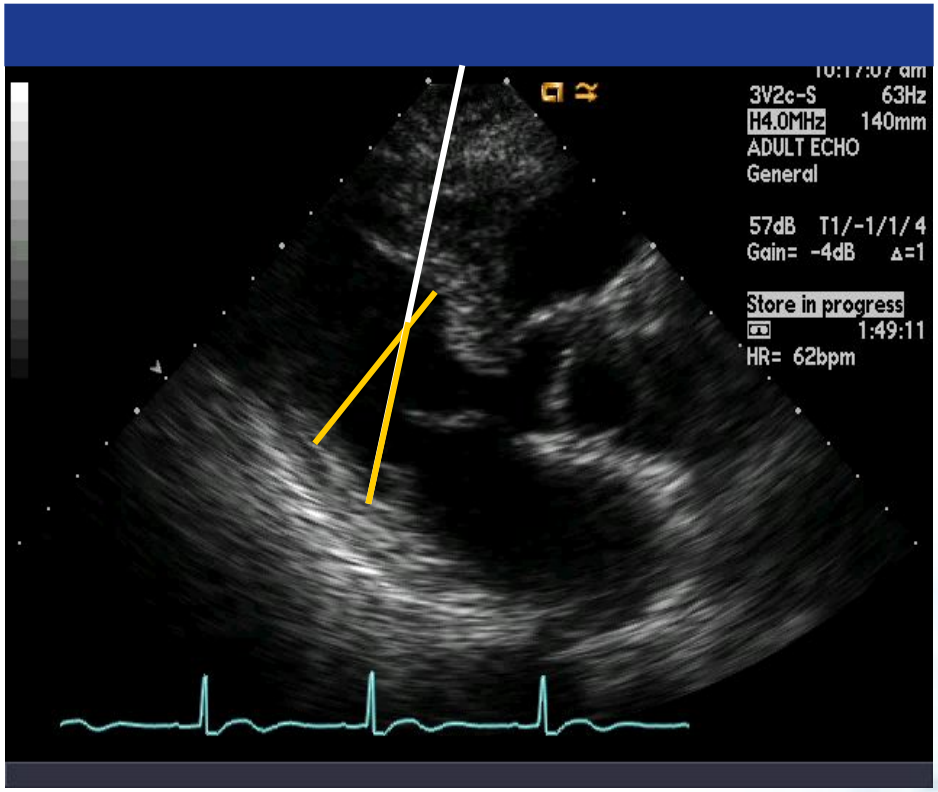

10:27:23 am
4V1c-S 59Hz
H3.75MHz 140mm
ADULT ECHO
General
62dB T1/-1/1/4
Gain= 3dB Δ=2
Store in progress
HR= 58bpm

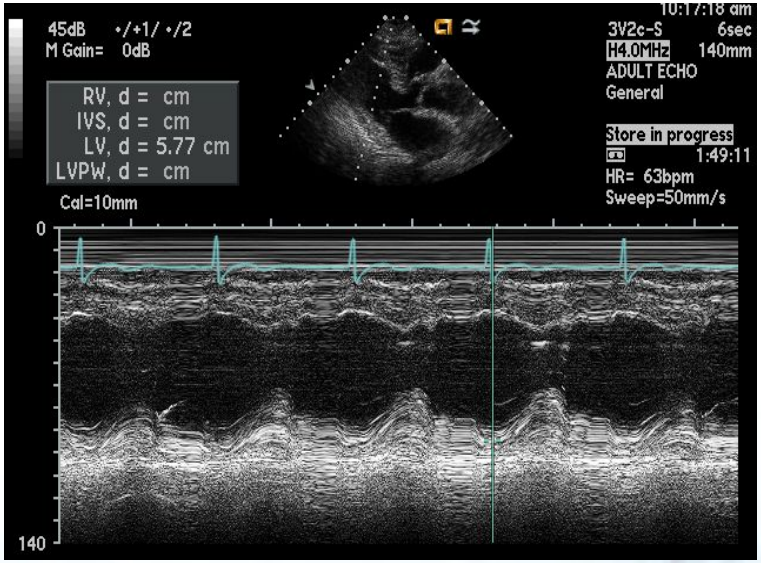

45dB •/+1/ •/2
M Gain= 0dB
10:29:27 am
4V1c-S 15sec
H3.75MHz 140mm
ADULT ECHO
General
Store in progress
HR= 60bpm
Sweep=50mm/s
Cal=10mm
0
EDD
ESD
140
Run/Stop

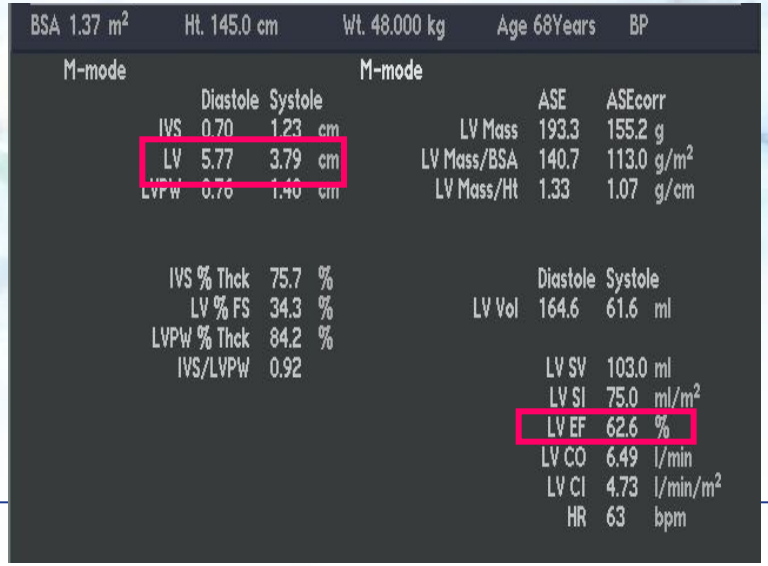
LV M-mode



LV 2D


3V2c-S 63Hz
H4.0MHz 140mm
ADULT ECHO
General
57dB T1/-1/1/4
Gain= -4dB Δ=1
Store in progress
1:49:11
HR= 62bpm


45dB
M Gain= 0dB
RV, d = cm
IVS, d = cm
LV, d = 5.77 cm
LVPW, d = cm
Cal=10mm
3V2c-S 6sec
H4.0MHz 140mm
ADULT ECHO
General
Store in progress
1:49:11
HR= 63bpm
Sweep=50mm/s
0
140


BSA 1.37 m²
Ht. 145.0 cm
Wt. 48.000 kg
Age 68Years
BP
M-mode
Diastole Systole
IVS 0.70 1.23 cm
LV 5.77 3.79 cm
LVPW 0.76 1.40 cm
M-mode
ASE ASEcorr
LV Mass 193.3 155.2 g
LV Mass/BSA 140.7 113.0 g/m²
LV Mass/Ht 1.33 1.07 g/cm
IVS % Thck 75.7 %
LV % FS 34.3 %
LVPW % Thck 84.2 %
IVS/LVPW 0.92
Diastole Systole
LV Vol 164.6 61.6 ml
LV SV 103.0 ml
LV SI 75.0 ml/m²
LV EF 62.6 %
LV CO 6.49 l/min
LV CI 4.73 l/min/m²
HR 63 bpm

Normal LV size

	Women				Men			
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
LV dimension								
LV diastolic diameter	3.9–5.3	5.4–5.7	5.8–6.1	≥6.2	4.2–5.9	6.0–6.3	6.4–6.8	≥6.9
LV diastolic diameter/BSA, cm/m^2	2.4–3.2	3.3–3.4	3.5–3.7	≥3.8	2.2–3.1	3.2–3.4	3.5–3.6	≥3.7
LV diastolic diameter/height, cm/m	2.5–3.2	3.3–3.4	3.5–3.6	≥3.7	2.4–3.3	3.4–3.5	3.6–3.7	≥3.8
LV volume								
LV diastolic volume, mL	56–104	105–117	118–130	≥131	67–155	156–178	179–201	≥201
LV diastolic volume/BSA, mL/m^2	*35–75*	*76–86*	*87–96*	**≥***97*	*35–75*	*76–86*	*87–96*	**≥***97*
LV systolic volume, mL	19–49	50–59	60–69	≥70	22–58	59–70	71–82	≥83
LV systolic volume/BSA, mL/m^2	*12–30*	*31–36*	*37–42*	**≥***43*	*12–30*	*31–36*	*37–42*	**≥***43*

LV volume

- Manual measurements

  : Mid-papillary short axis view , A4C, and A2C view

  : Trace endocardial border

- End diastole

  : QRS starting point, pre-MV closure, or biggest dimension during cardiac cycle

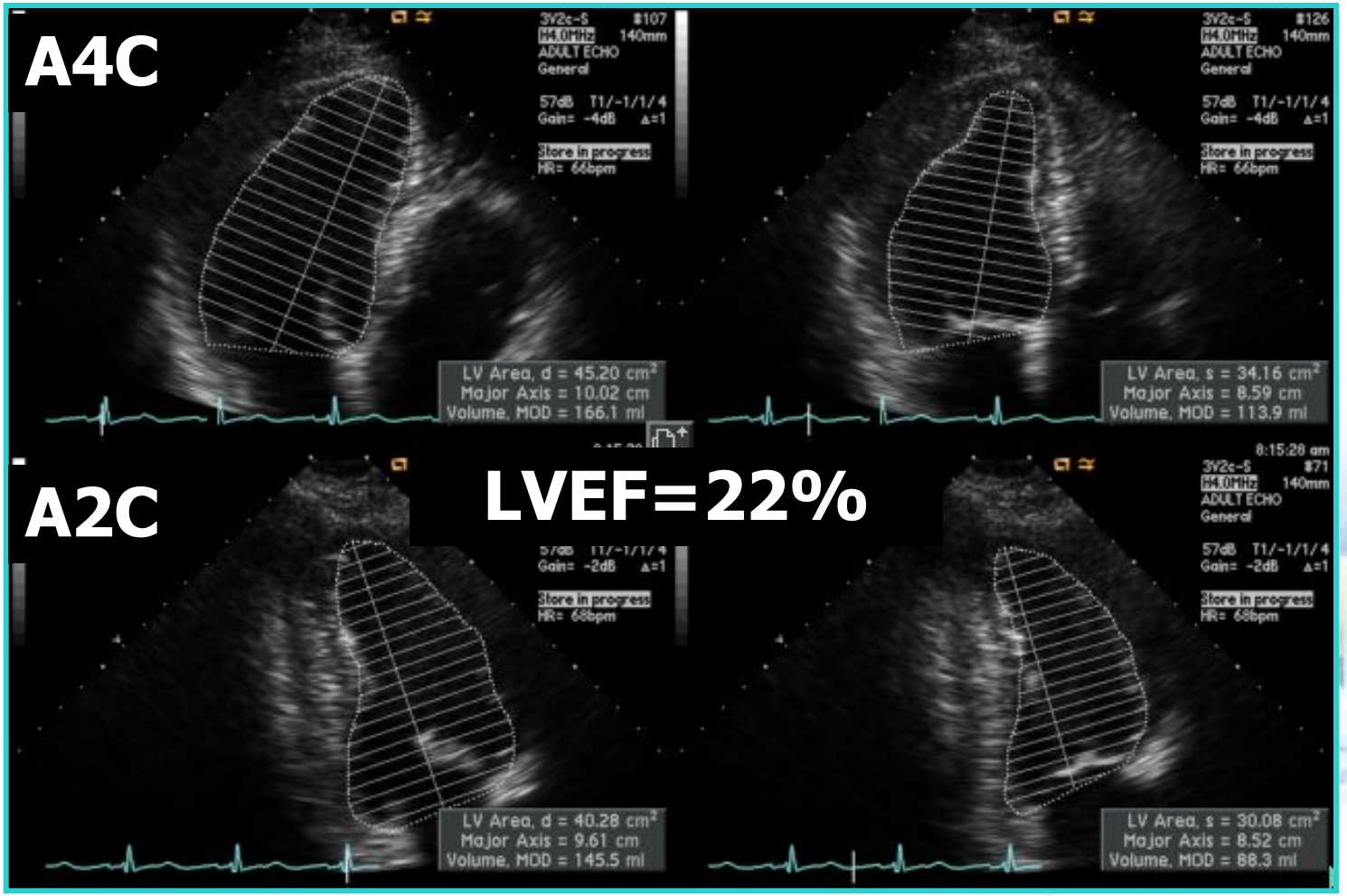
- End systole

  : Pre-MV opening, or smallest dimension during cardiac cycle

LV volume measure

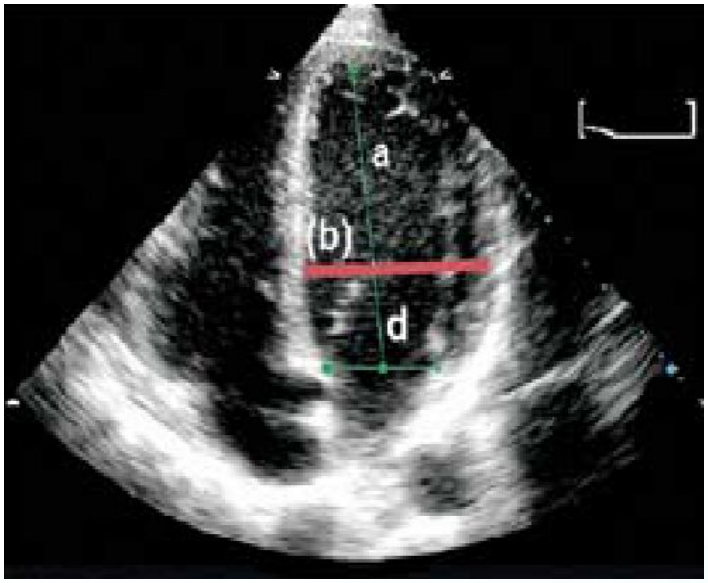
End diastole

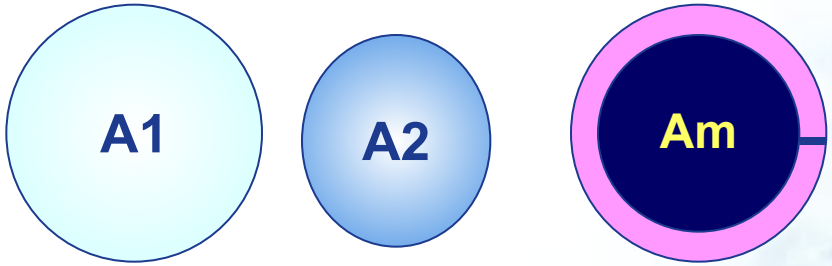
End systole



LV mass calculation

Am = A1 – A2





$$b = \sqrt{\frac{A_2}{\pi}} \qquad t = \sqrt{\frac{A_1}{\pi}} - b$$

$$\text{LV Mass (AL)} = 1.05 \left\{ \left[{}^{5}/_{6}\, A_1\, (a+d+t) \right] - \left[{}^{5}/_{6}\, A_2\, (a+d) \right] \right\}$$

$$\text{LV Mass (TE)} = 1.05 \times \left\{ (b+t)^2 \left[{}^{2}/_{3}\, (a+1) + d - \frac{d^3}{3(a+t)^2} \right] - b^2 \left[{}^{2}/_{3}\, a + d - \frac{d^3}{3a^2} \right] \right\}$$

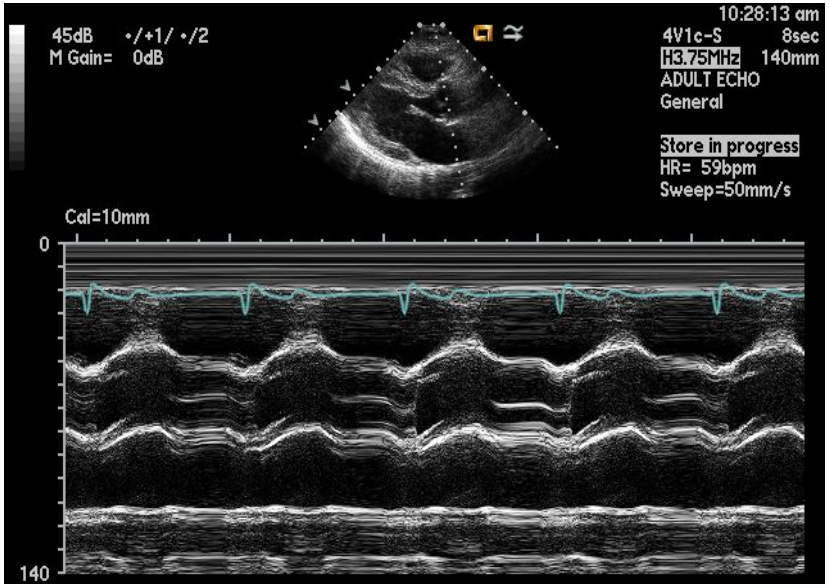
Normal LV mass

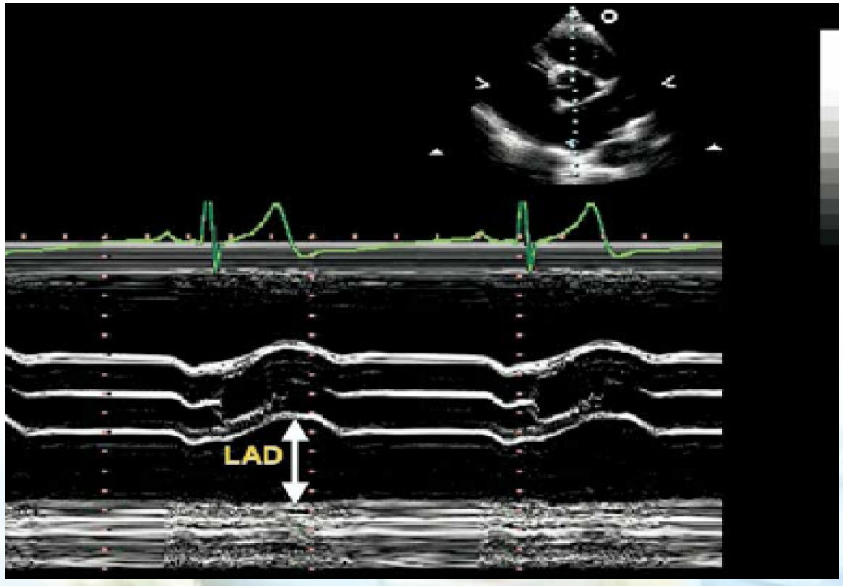
	Women				Men			
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
Linear Method								
LV mass, g	67–162	163–186	187–210	≥211	88–224	225–258	259–292	≥293
LV mass/BSA, g/m²	*43–95*	*96–108*	*109–121*	***≥122***	*49–115*	*116–131*	*132–148*	***≥149***
LV mass/height, g/m	41–99	100–115	116–128	≥129	52–126	127–144	145–162	≥163
LV mass/height^{2,7}, g/m^{2,7}	18–44	45–51	52–58	≥59	20–48	49–55	56–63	≥64
Relative wall thickness, cm	0.22–0.42	0.43–0.47	0.48–0.52	≥0.53	0.24–0.42	0.43–0.46	0.47–0.51	≥0.52
Septal thickness, cm	*0.6–0.9*	*1.0–1.2*	*1.3–1.5*	***≥1.6***	*0.6–1.0*	*1.1–1.3*	*1.4–1.6*	***≥1.7***
Posterior wall thickness, cm	*0.6–0.9*	*1.0–1.2*	*1.3–1.5*	***≥1.6***	*0.6–1.0*	*1.1–1.3*	*1.4–1.6*	***≥1.7***
2D Method								
LV mass, g	66–150	151–171	172–182	>193	96–200	201–227	228–254	>255
LV mass/BSA, g/m²	*44–88*	*89–100*	*101–112*	***≥113***	*50–102*	*103–116*	*117–130*	***≥131***

Measure LA size

- LV end systole, maximal LA size
- Avoid foreshortening of LA
- LA length in true long axis of the LA
- Excluded pulmonary veins and LAA

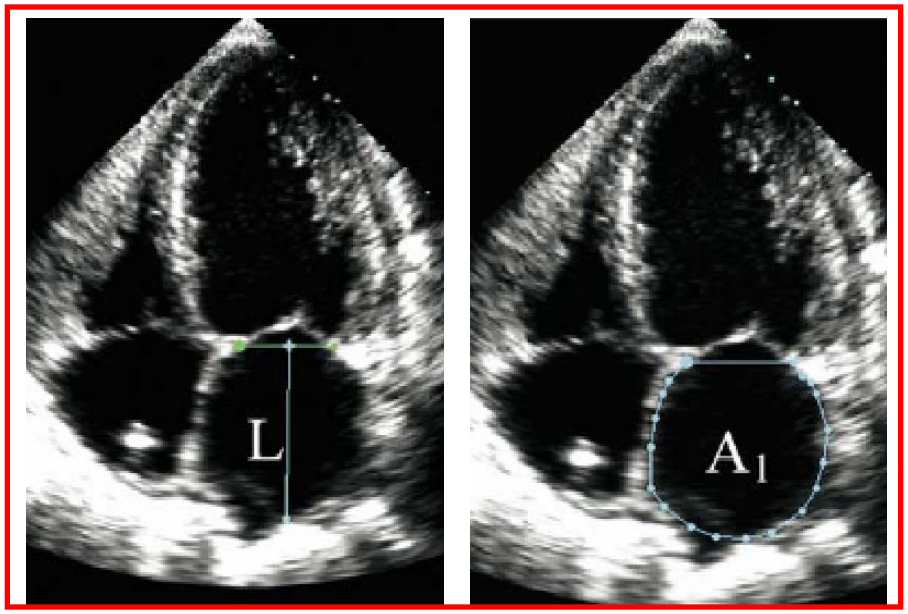
Measure LA size

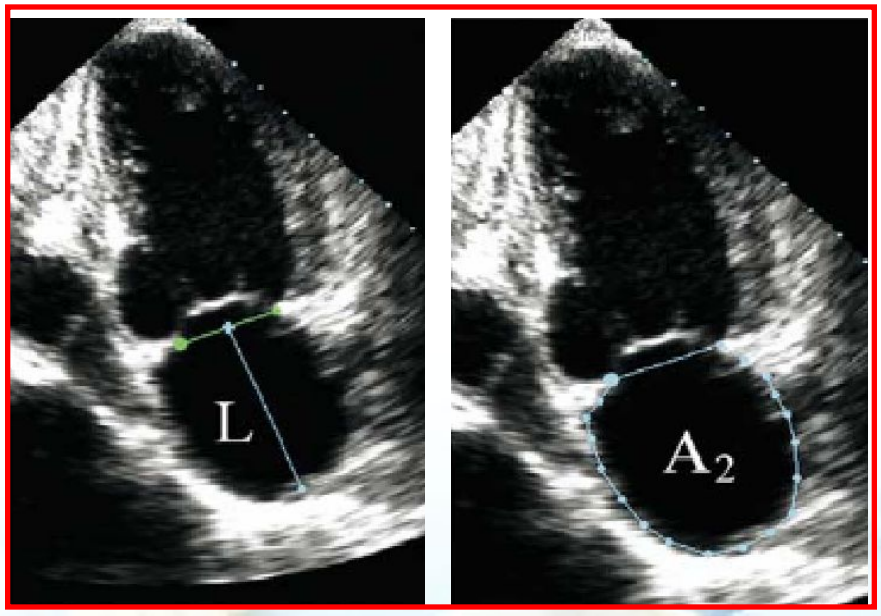




- Measured from the leading edge of the posterior aortic wall to the leading edge of the posterior LA wall
  - measure end systole

LA size measure: Area-Length Method



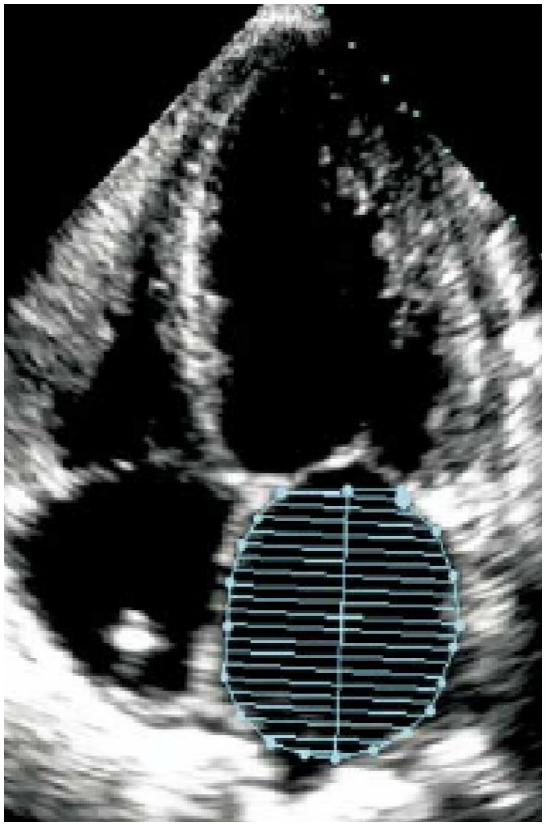


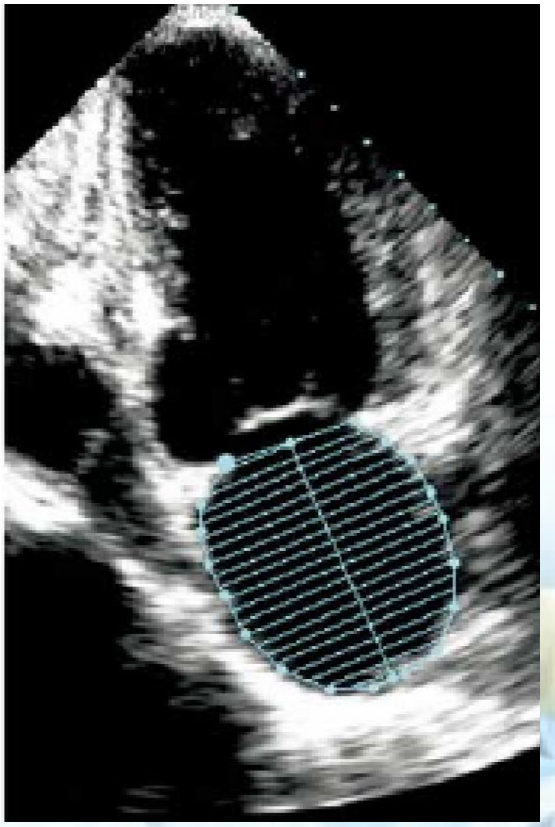
A2C

LA volume = 8/3 π [(A1) (A2) / (L)]

※(L) is the shortest of either the A4C or A2C length

LA size measure
: Modified Simpson's Method



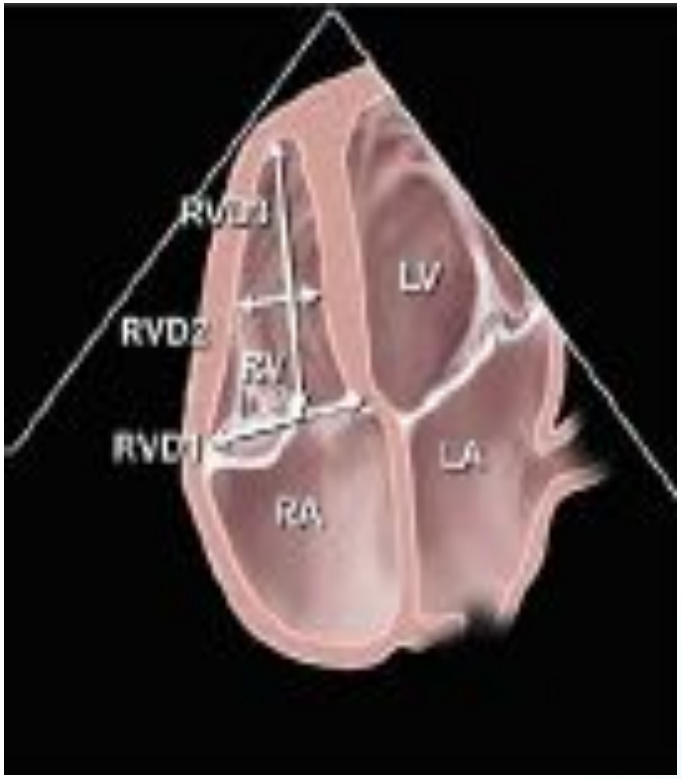


A2C

Normal LA size

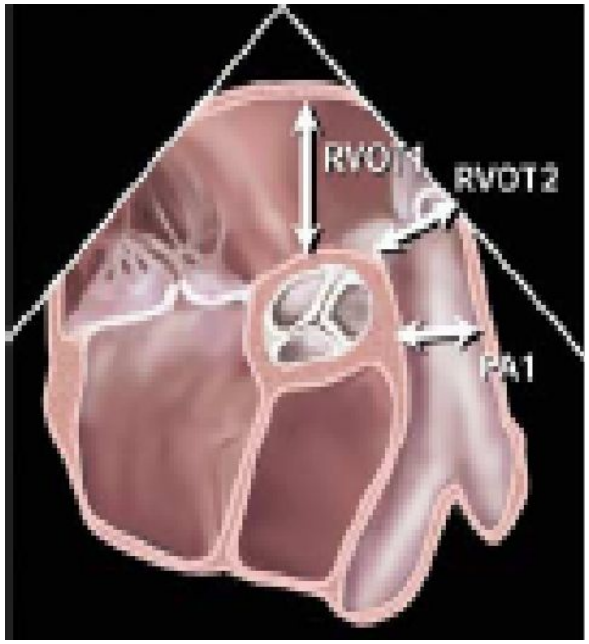
	Women				Men			
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
Atrial dimensions								
LA diameter, cm	2.7–3.8	3.9–4.2	4.3–4.6	≥4.7	3.0–4.0	4.1–4.6	4.7–5.2	≥5.2
LA diameter/BSA, cm/m^2	1.5–2.3	2.4–2.6	2.7–2.9	≥3.0	1.5–2.3	2.4–2.6	2.7–2.9	≥3.0
RA minor-axis dimension, cm	2.9–4.5	4.6–4.9	5.0–5.4	≥5.5	2.9–4.5	4.6–4.9	5.0–5.4	≥5.5
RA minor-axis dimension/BSA, cm/m^2	1.7–2.5	2.6–2.8	2.9–3.1	≥3.2	1.7–2.5	2.6–2.8	2.9–3.1	≥3.2
Atrial area								
LA area, cm^2	≤20	20–30	30–40	>40	≤20	20–30	30–40	>40
Atrial volumes								
LA volume, mL	22–52	53–62	63–72	≥73	18–58	59–68	69–78	≥79
LA volume/BSA, mL/m^2	*22 ± 6*	*29–33*	*34–39*	***≥40***	*22 ± 6*	*29–33*	*34–39*	***≥40***

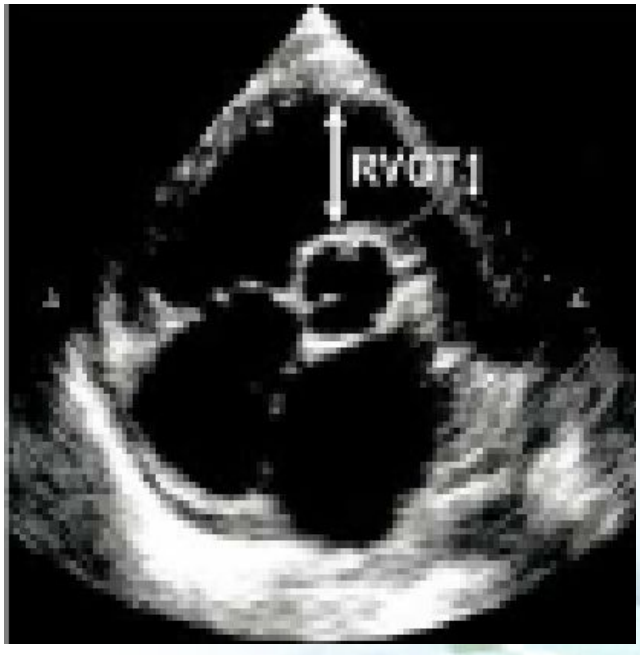
RV size measure

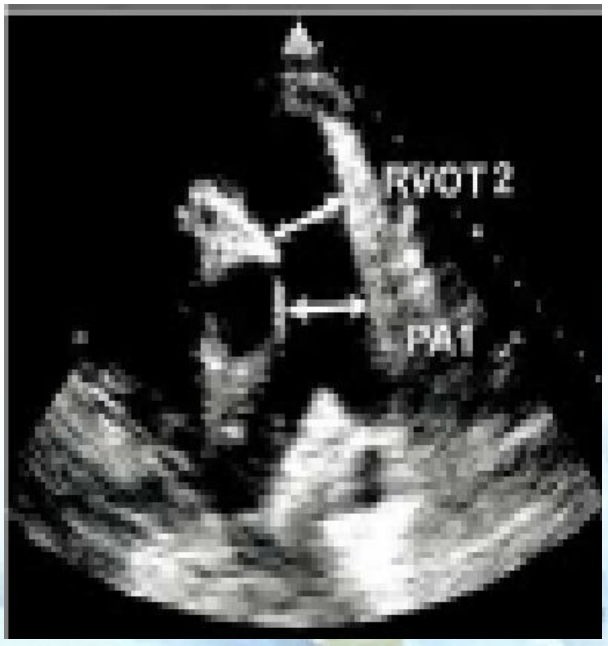


- Apical 4-chamber view, at end diastole
- RV diameter < LV diameter

Measure RVOT, PA diameter







- At end diastole, PSAX

Normal RV, RVOT, PA diameter

	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
RV dimensions (Figure 12)				
Basal RV diameter (RVD 1), cm	2.0–2.8	2.9–3.3	3.4–3.8	≥3.9
Mid-RV diameter (RVD 2), cm	2.7–3.3	3.4–3.7	3.8–4.1	≥4.2
Base-to-apex length (RVD 3), cm	7.1–7.9	8.0–8.5	8.6–9.1	≥9.2
RVOT diameters (Figure 13, 14)				
Above aortic valve (RVOT 1), cm	2.5–2.9	3.0–3.2	3.3–3.5	≥3.6
Above pulmonic valve (RVOT 2), cm	1.7–2.3	2.4–2.7	2.8–3.1	≥3.2
PA diameter				
Below pulmonic valve (PA 1), cm	1.5–2.1	2.2–2.5	2.6–2.9	≥3.0


Thank You !