

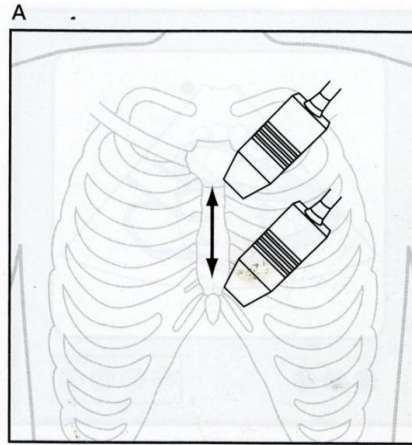
The background of the slide is a solid blue color. On the left side, there is a pair of glasses with a dark frame and clear lenses, resting on a surface. Below the glasses, a portion of a stethoscope is visible, showing its metal binaurals and tubing. The overall composition is clean and professional, typical of a medical or educational presentation.

Standard Imaging of Transthoracic Echocardiography

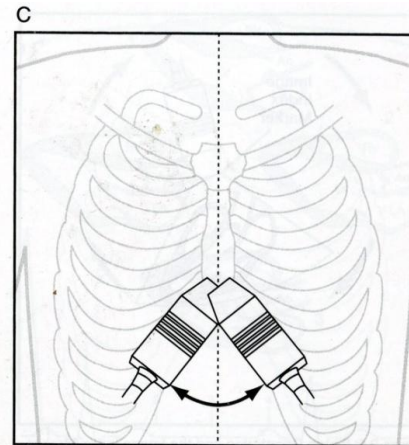
Terminology



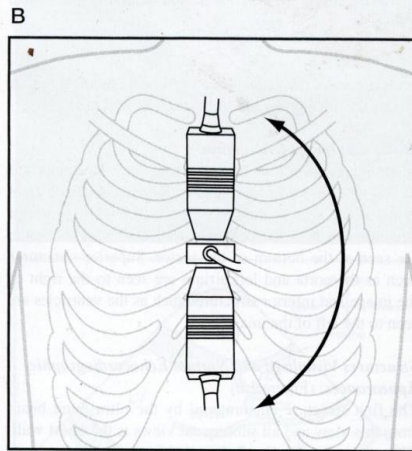
(movement)



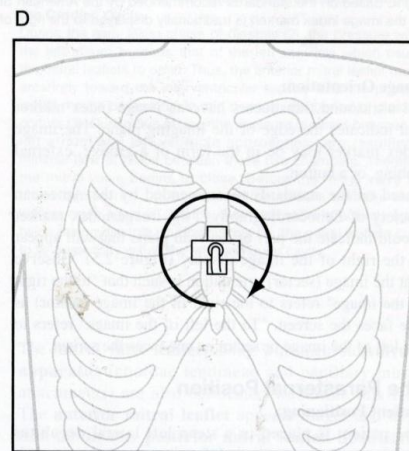
(angulation)



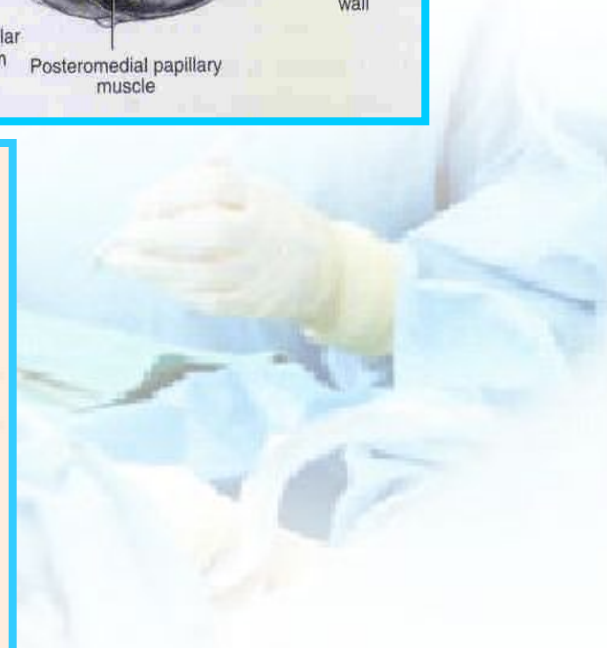
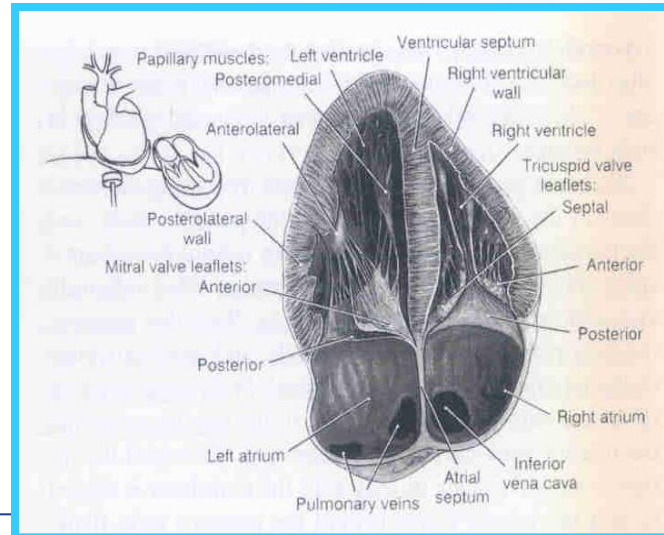
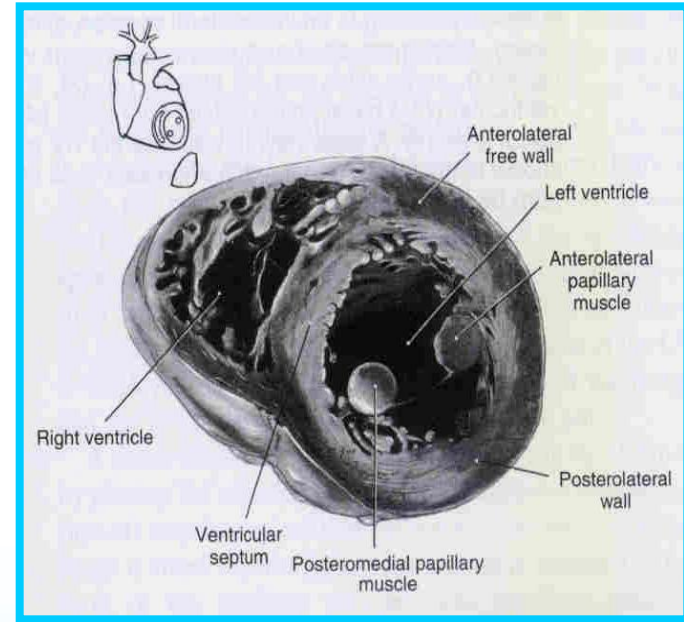
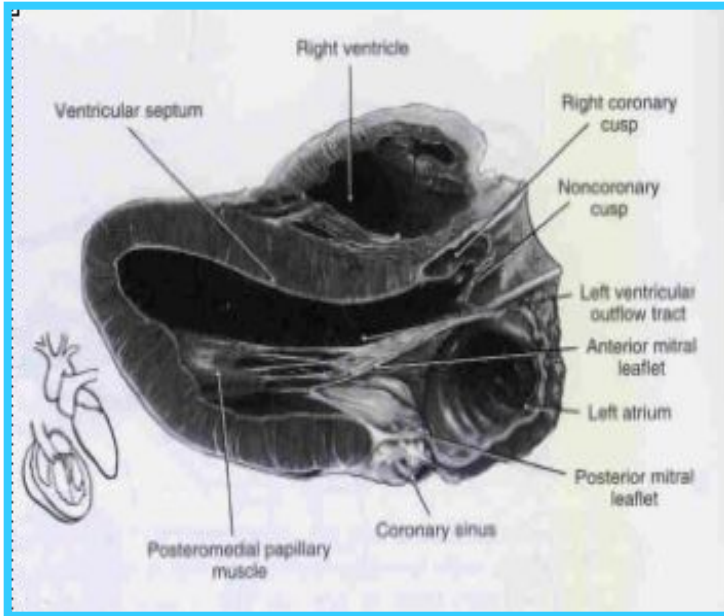
(tilting)



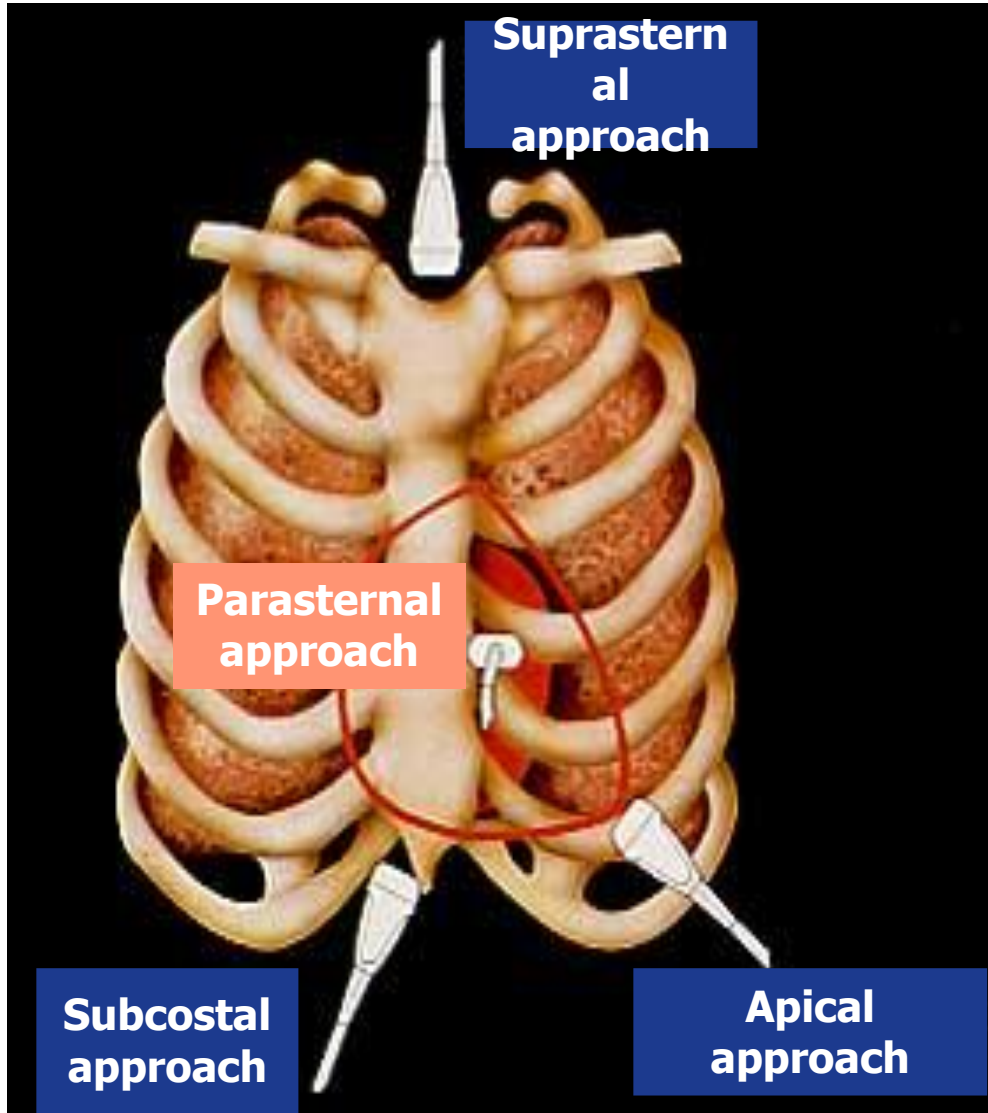
D 회전
(rotation)



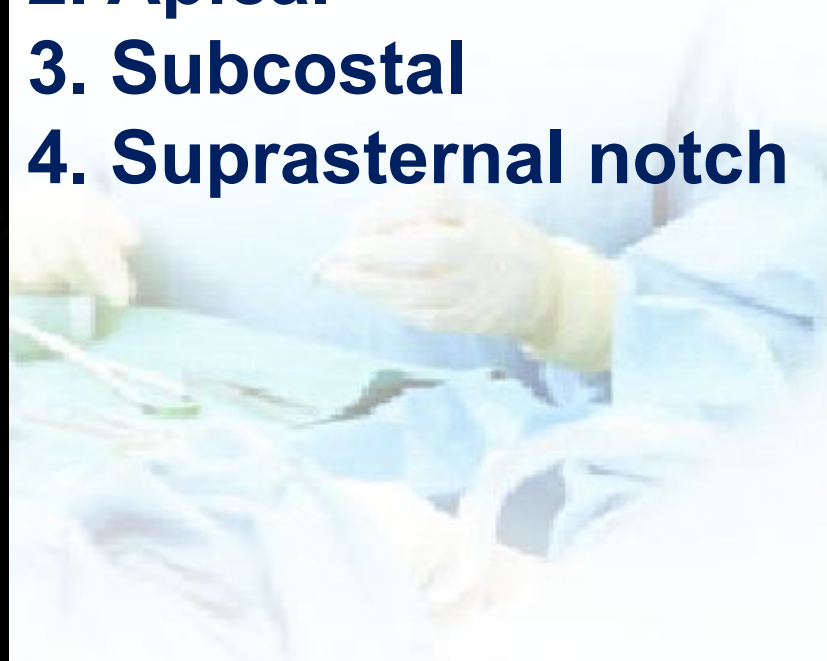
Anatomy of Echo



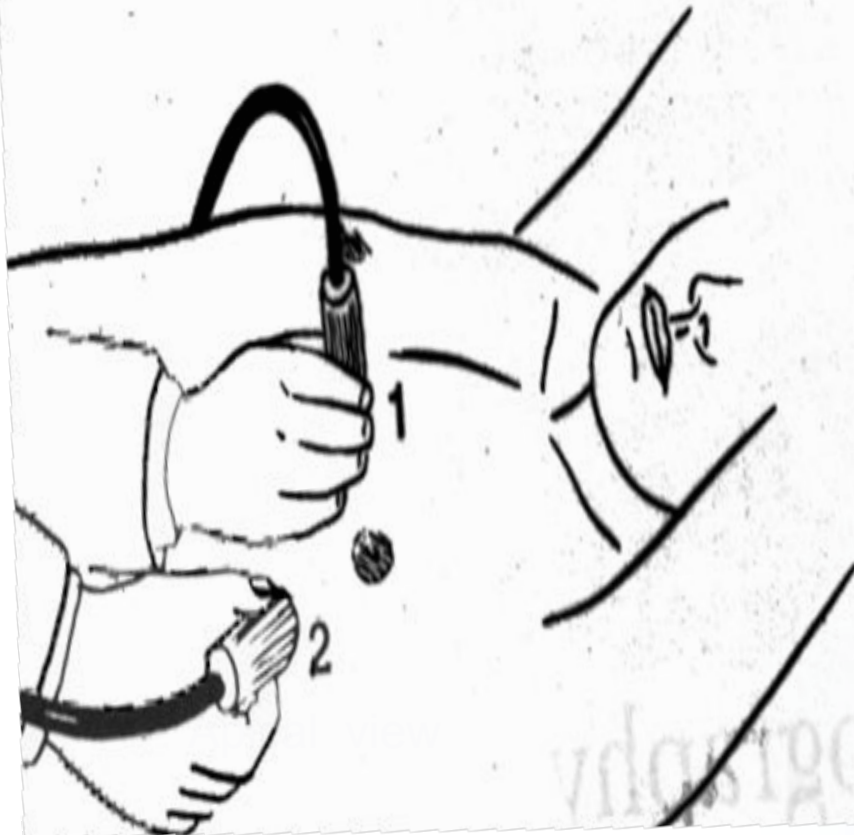
Echo Window



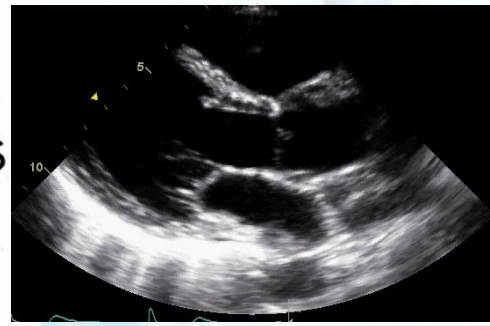
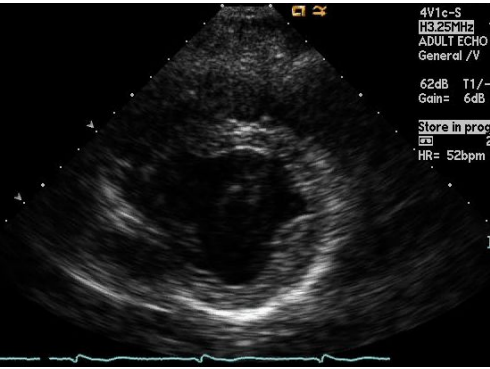
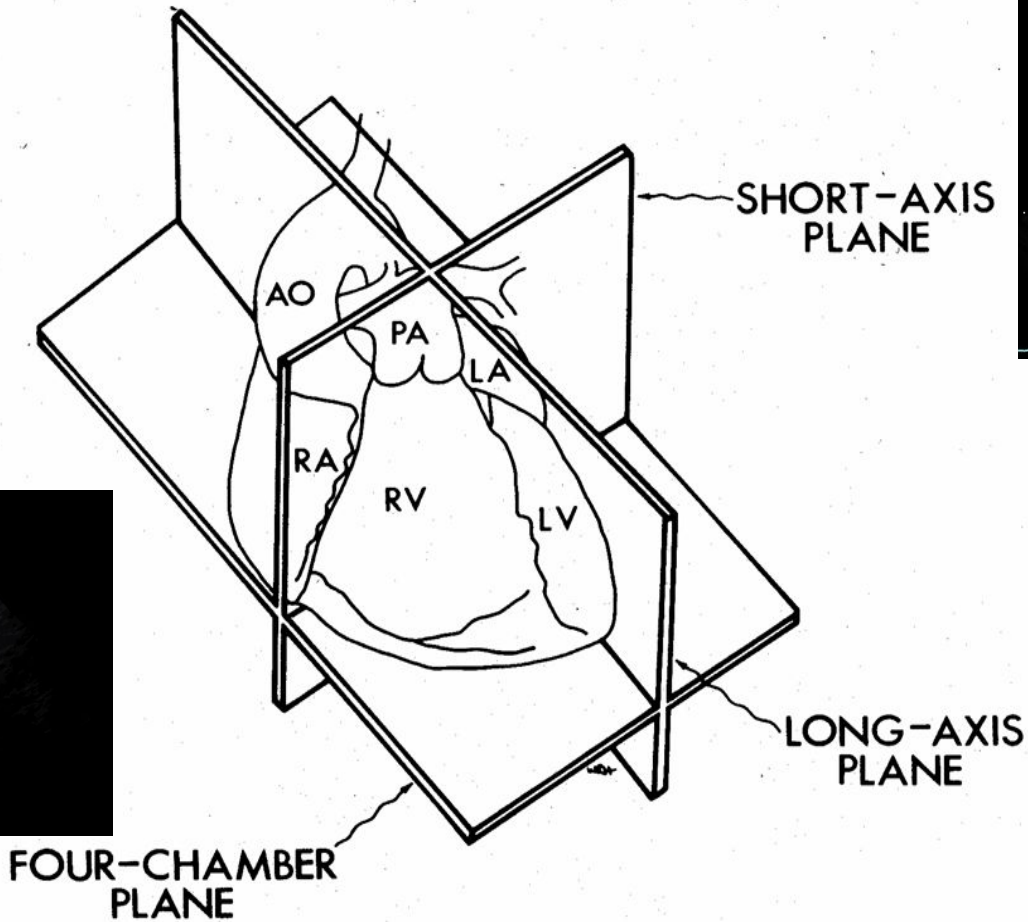
1. Parasternal
2. Apical
3. Subcostal
4. Suprasternal notch



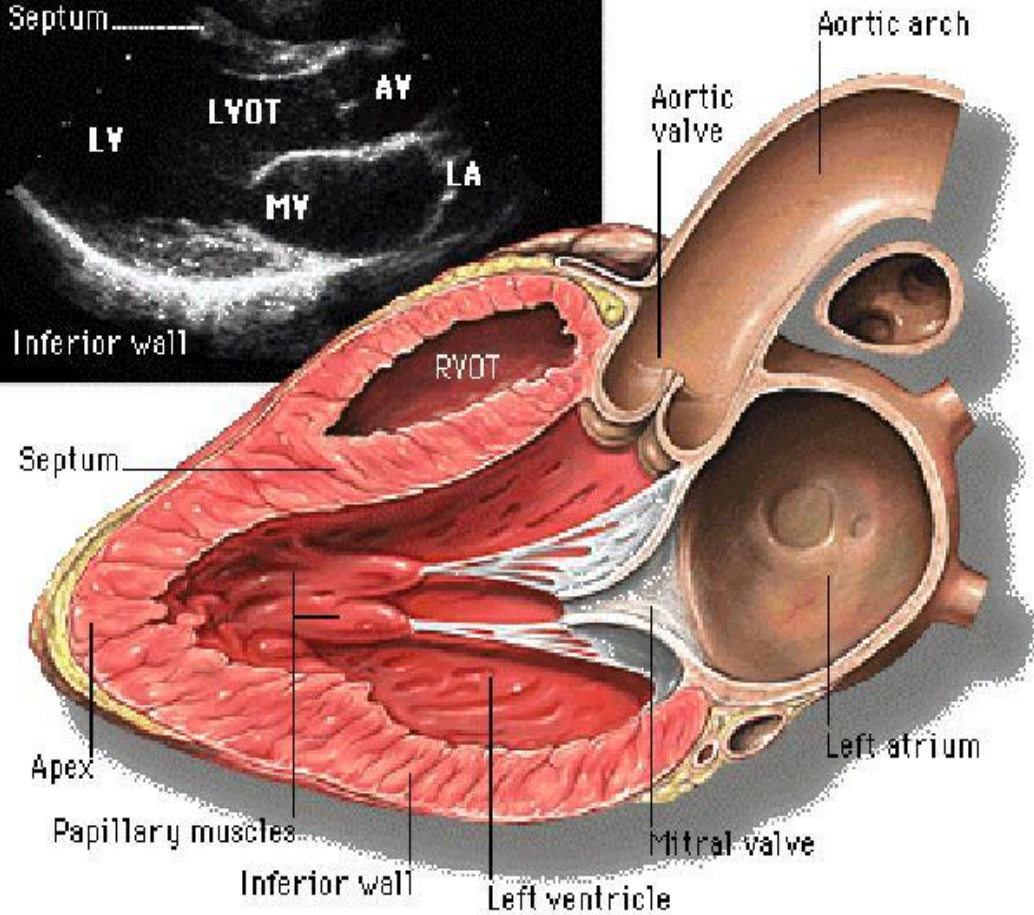
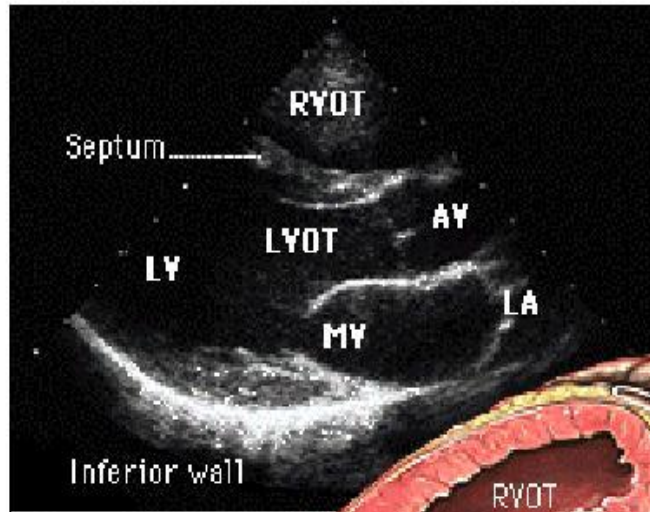
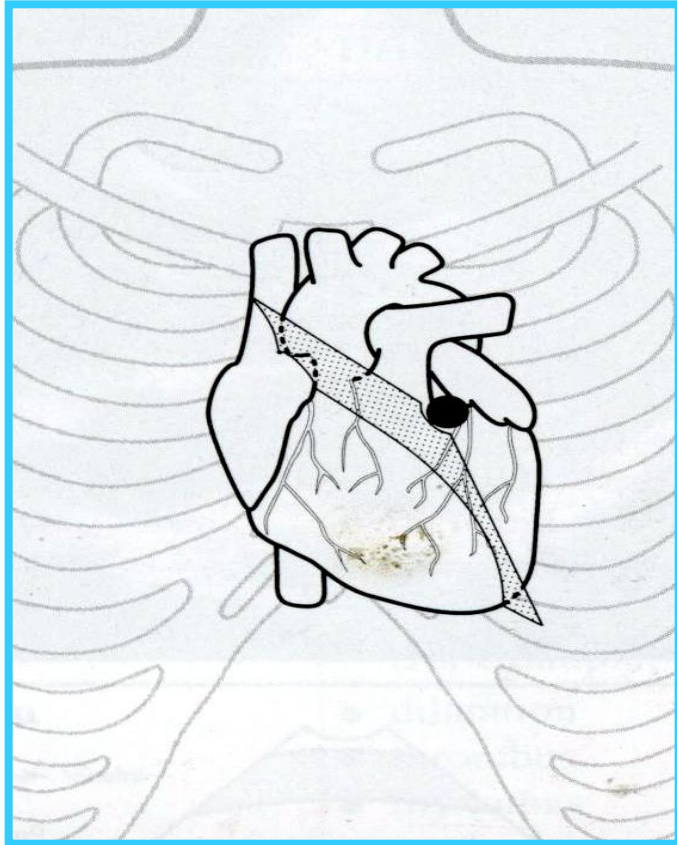
Basic views of Echocardiography



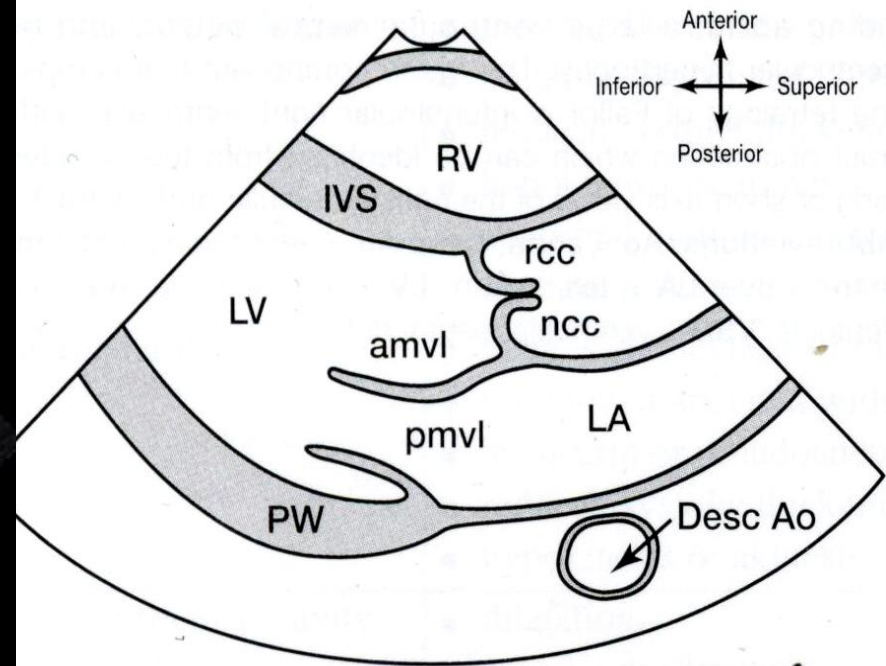
Basic views of Echocardiography



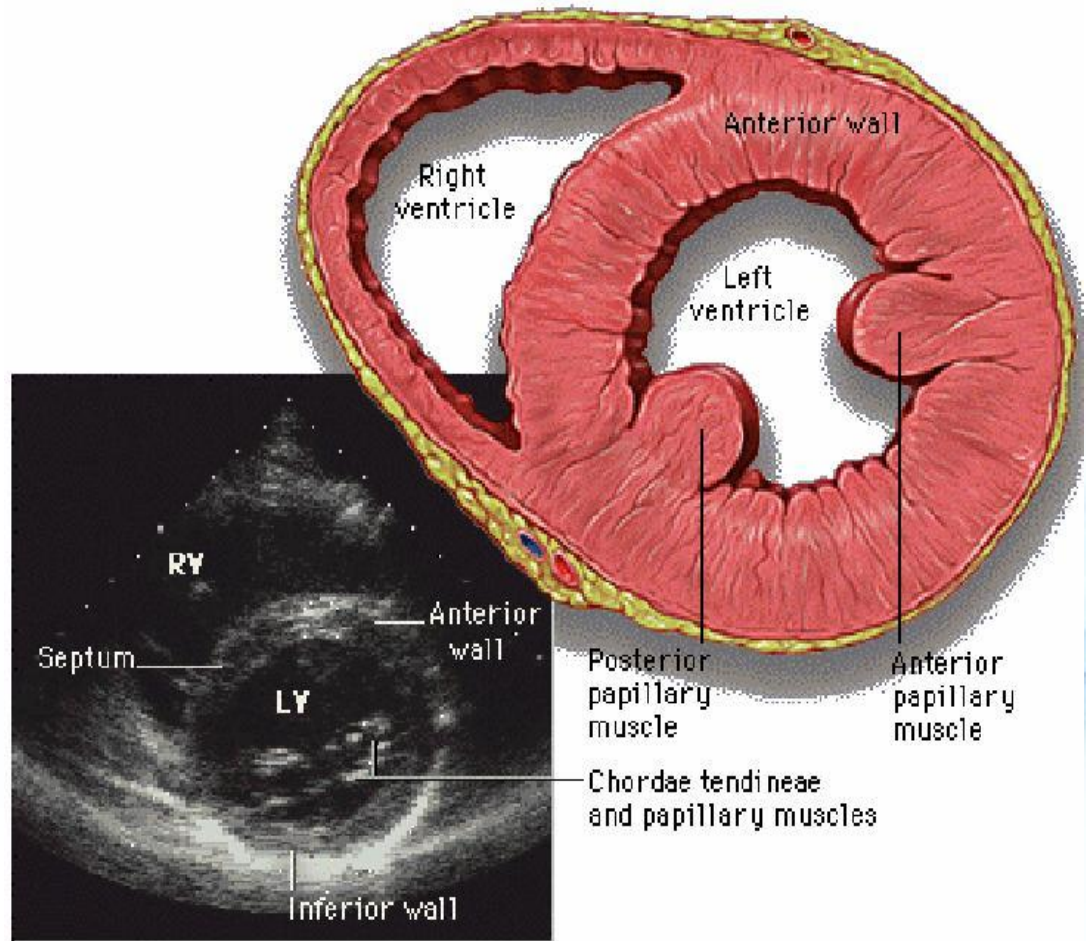
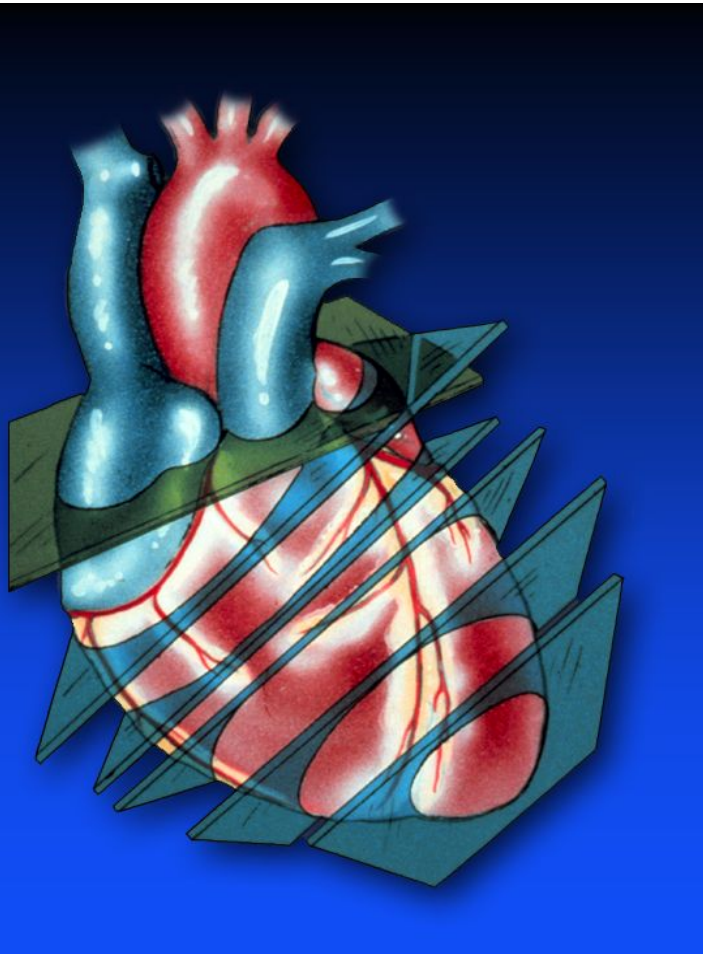
Parasternal long axis view



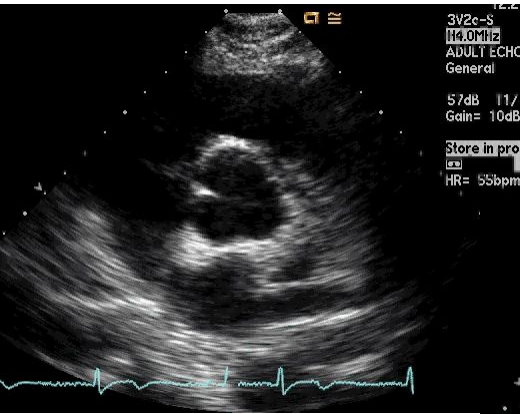
Parasternal long axis view



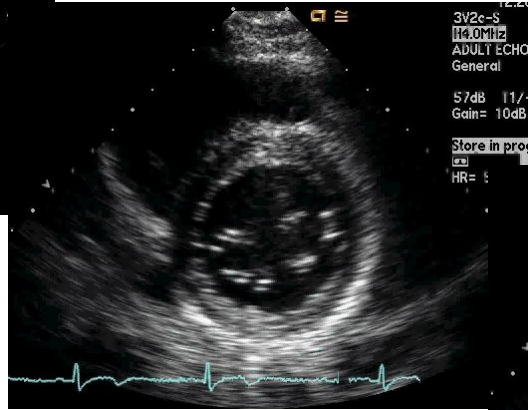
Parasternal short axis view



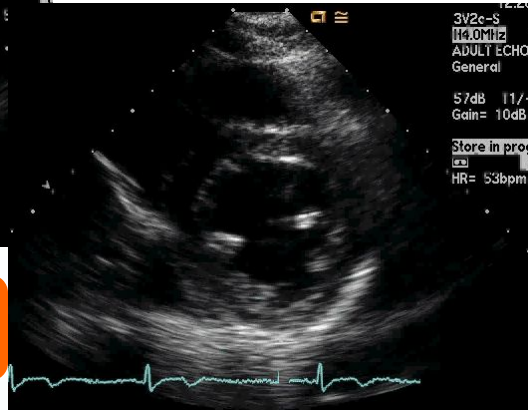
Parasternal Short Axis view



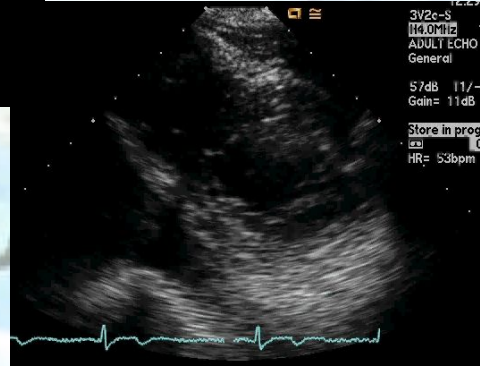
PSAX- AV level



PSAX- MV base

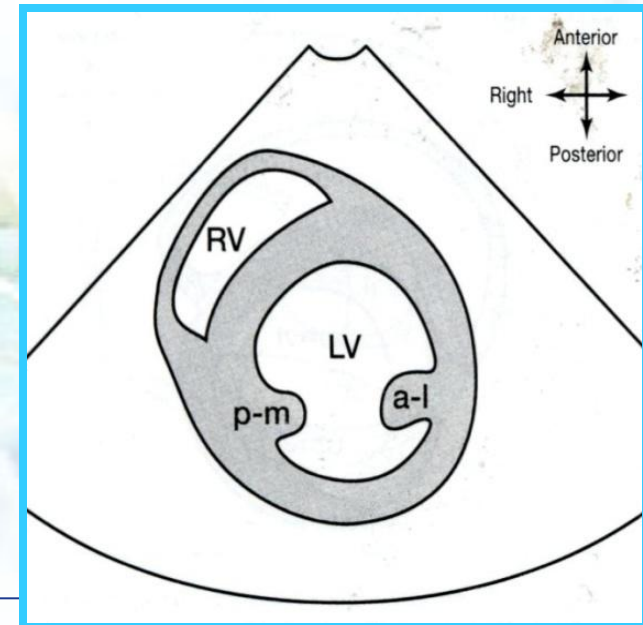
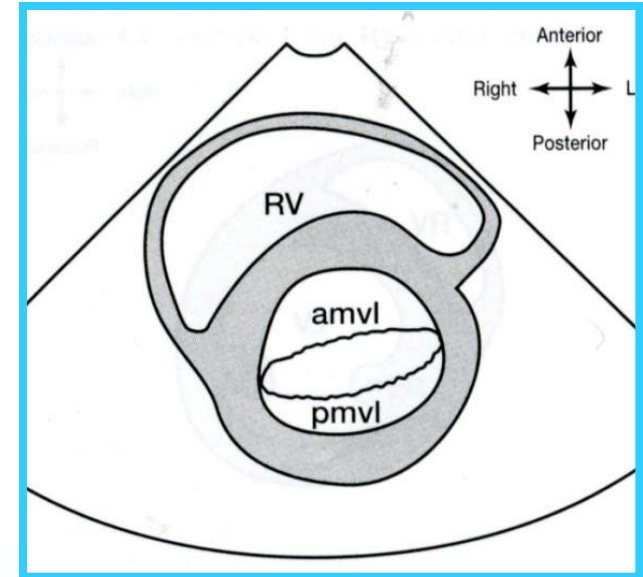
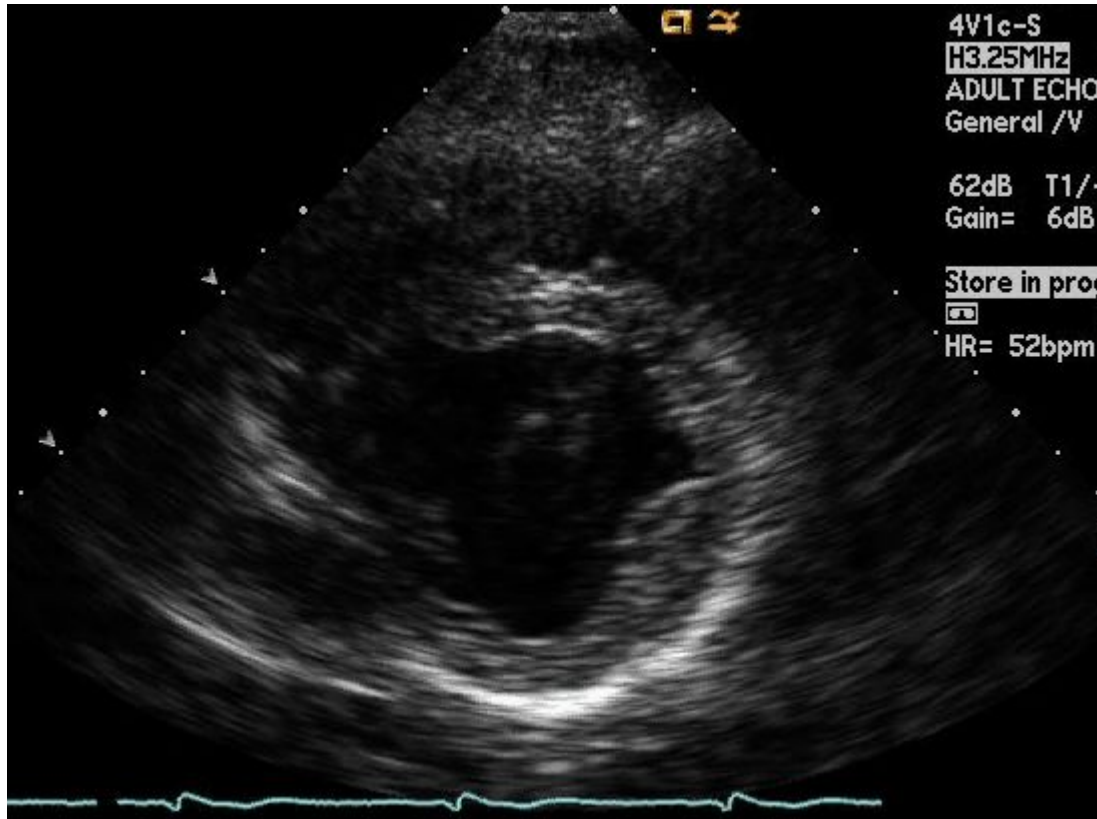


PSAX- Mid

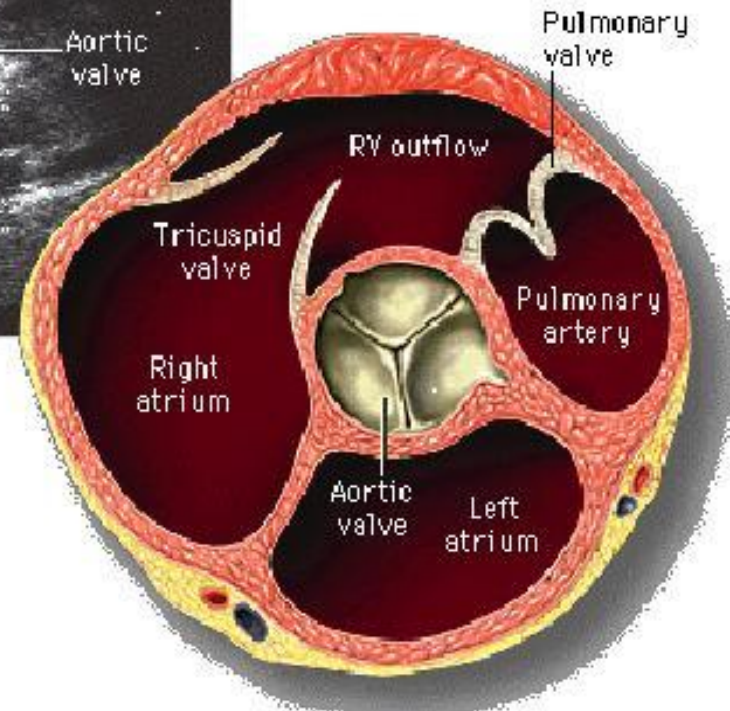
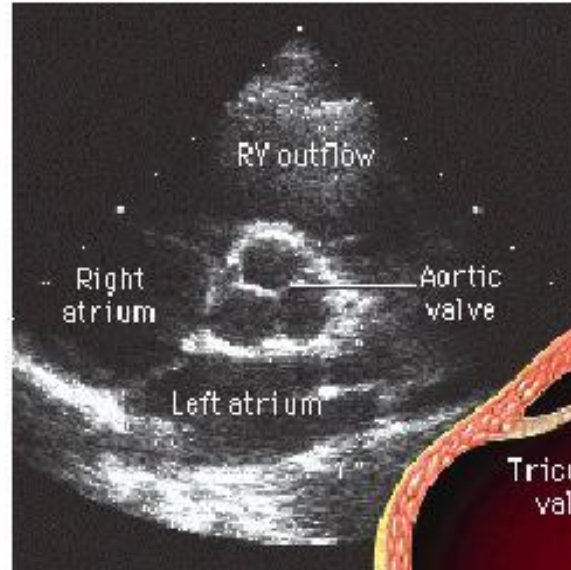
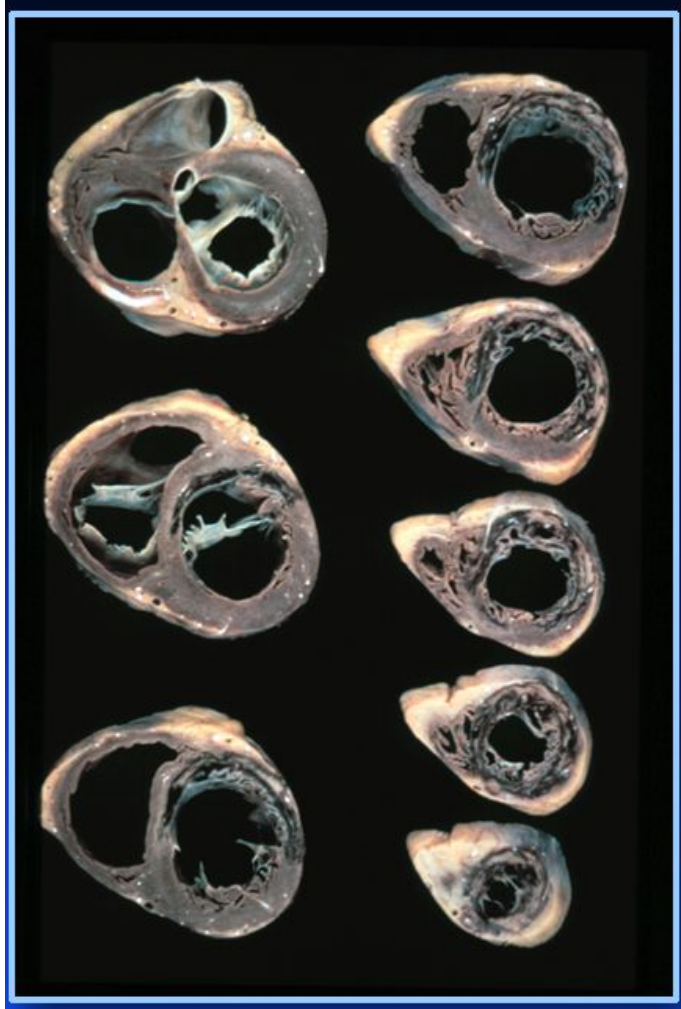


PSAX- Apex

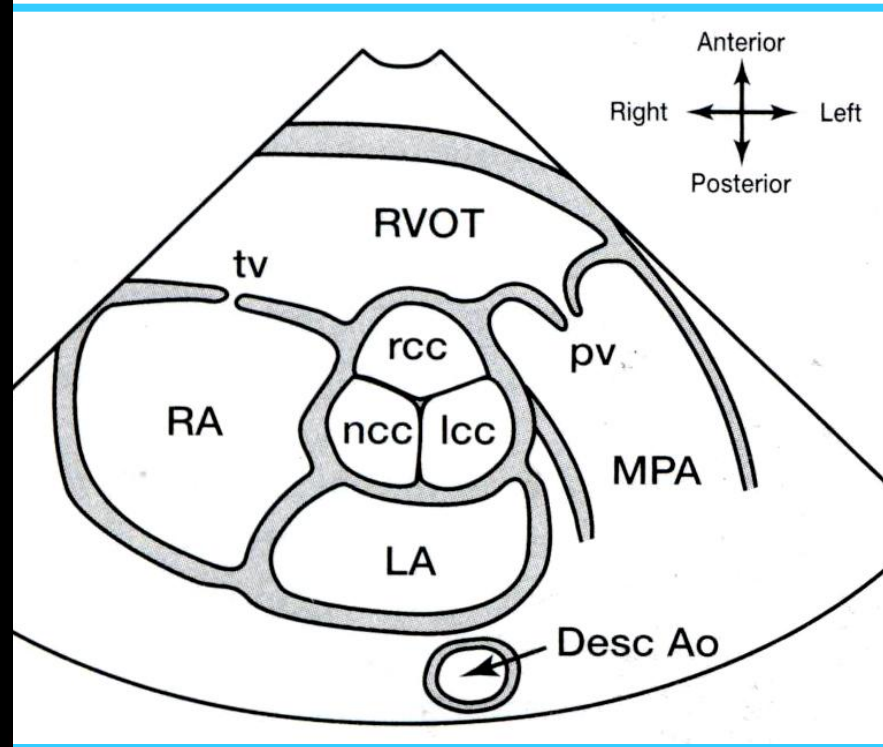
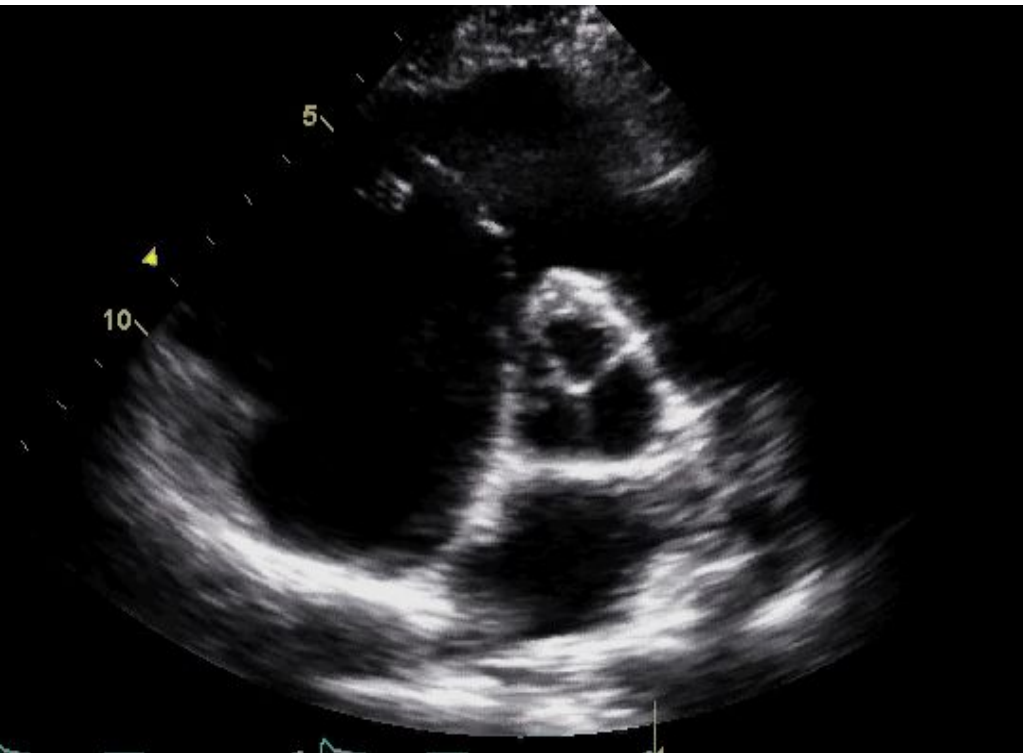
Parasternal short axis view



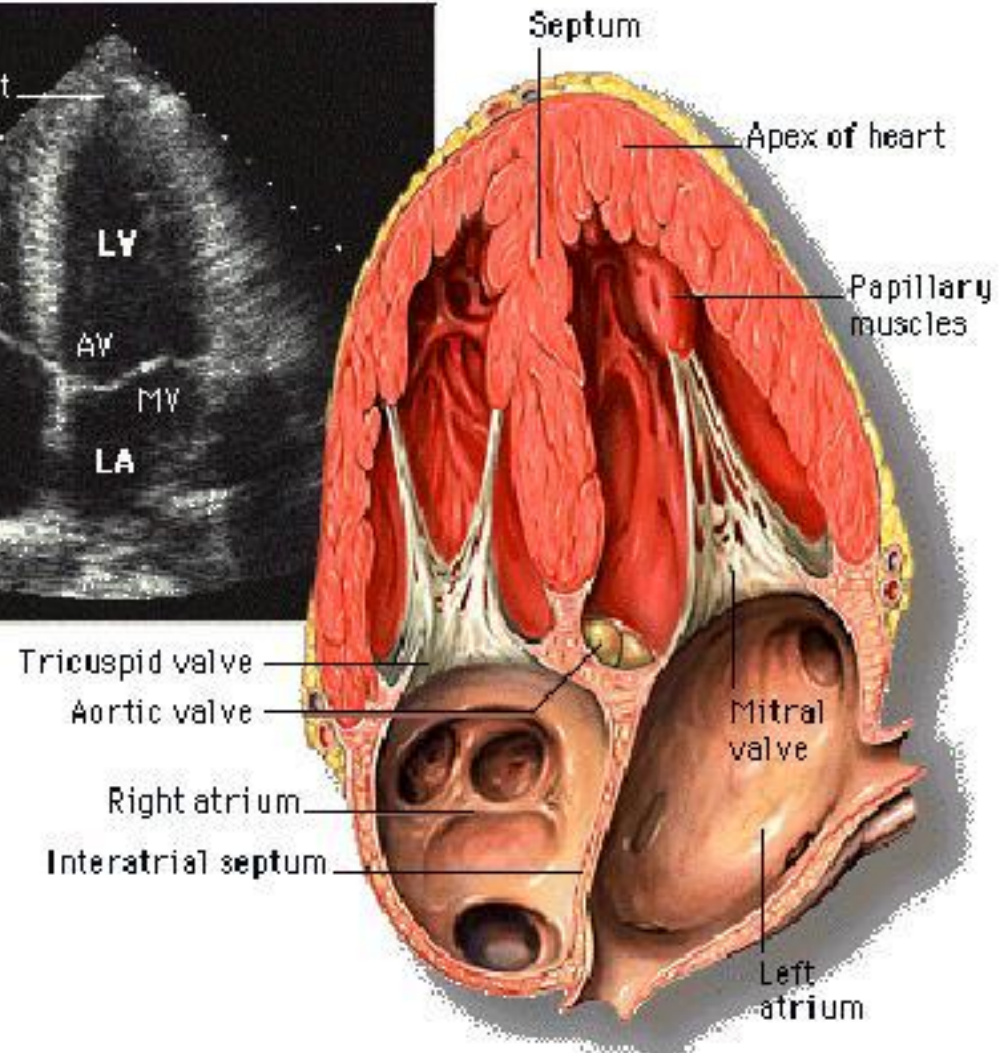
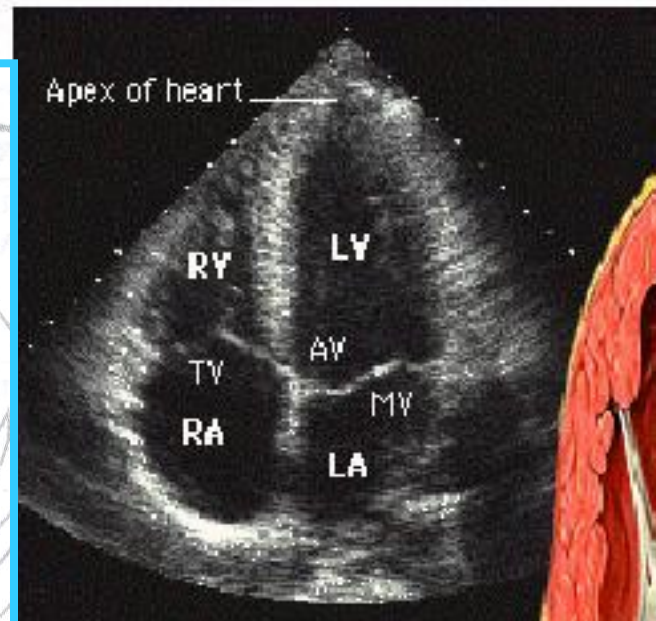
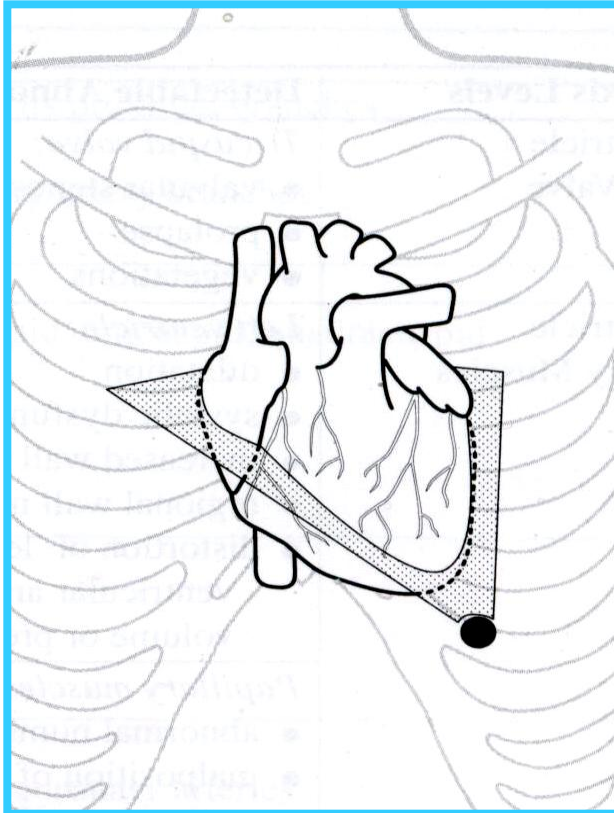
Short axis view of aorta



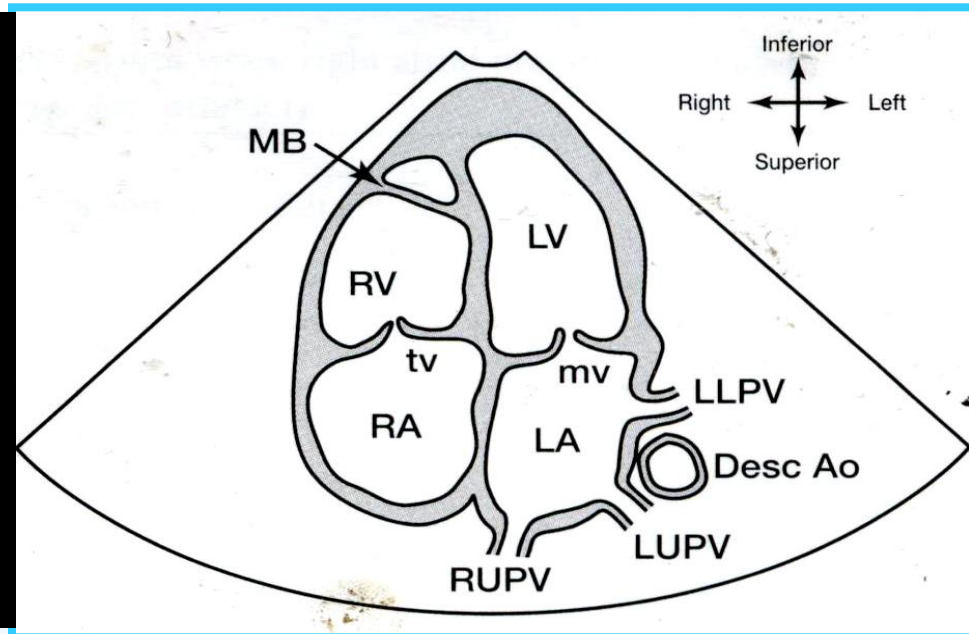
Short axis view of aorta



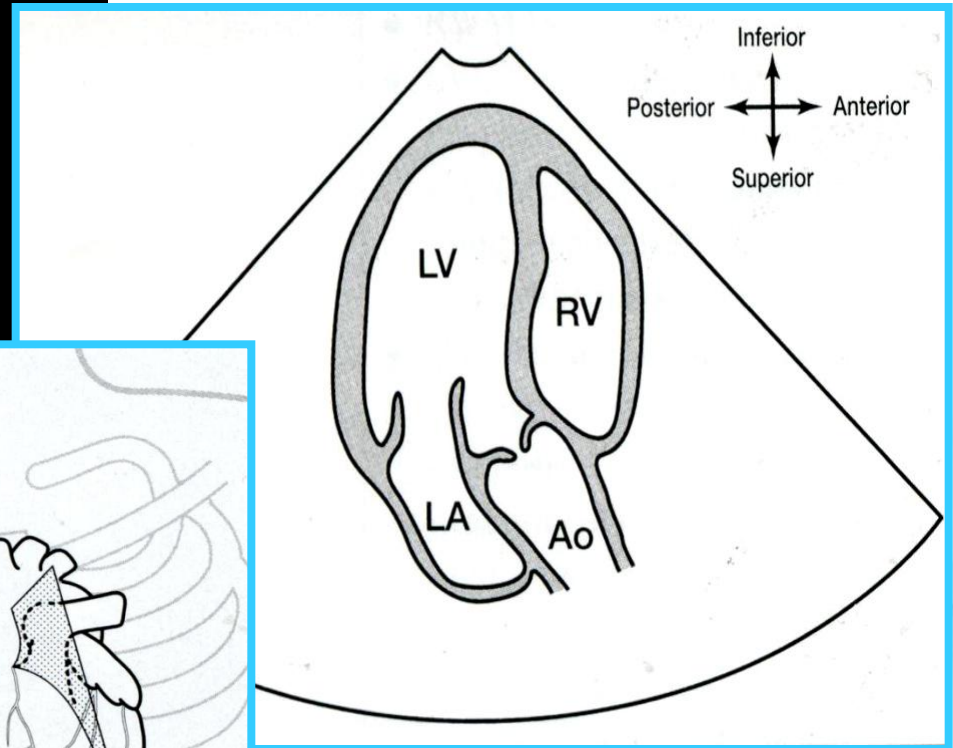
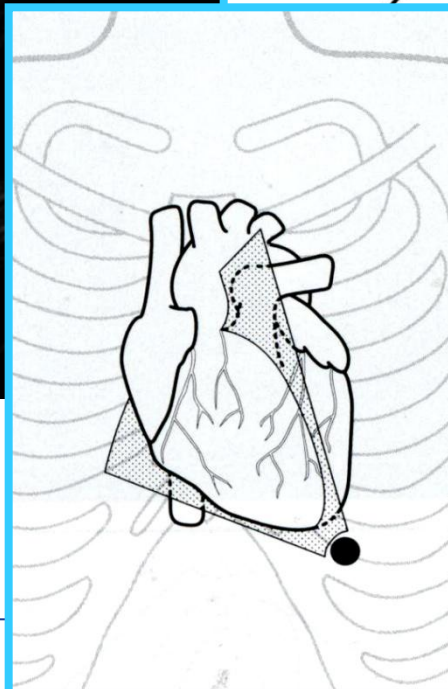
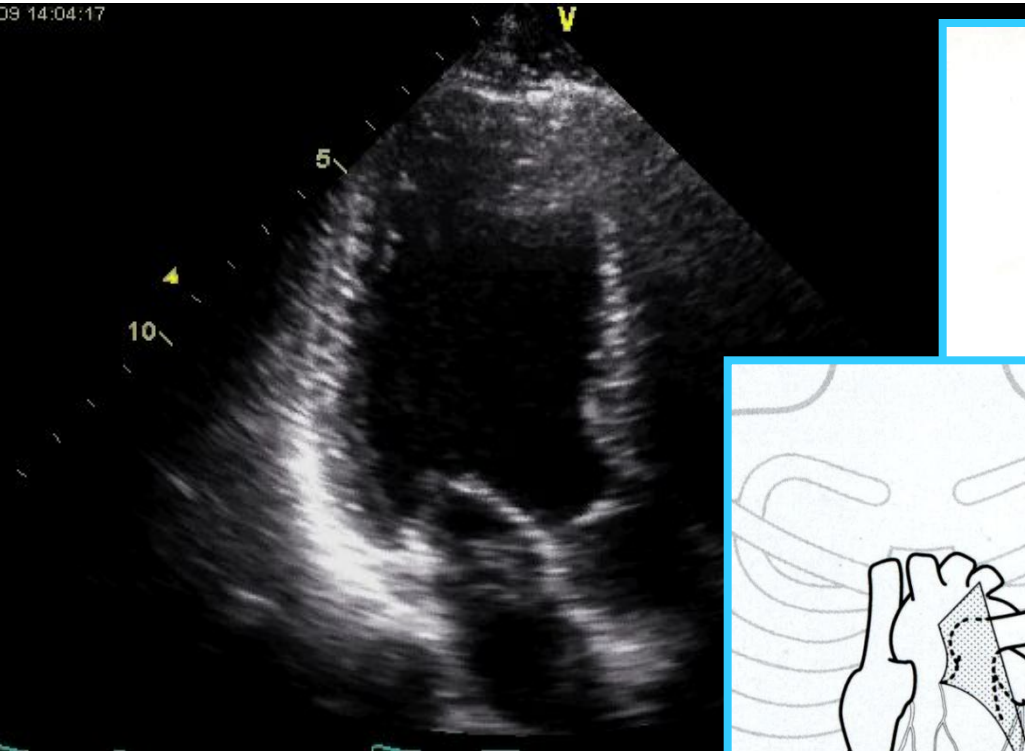
Apical 4 chamber view



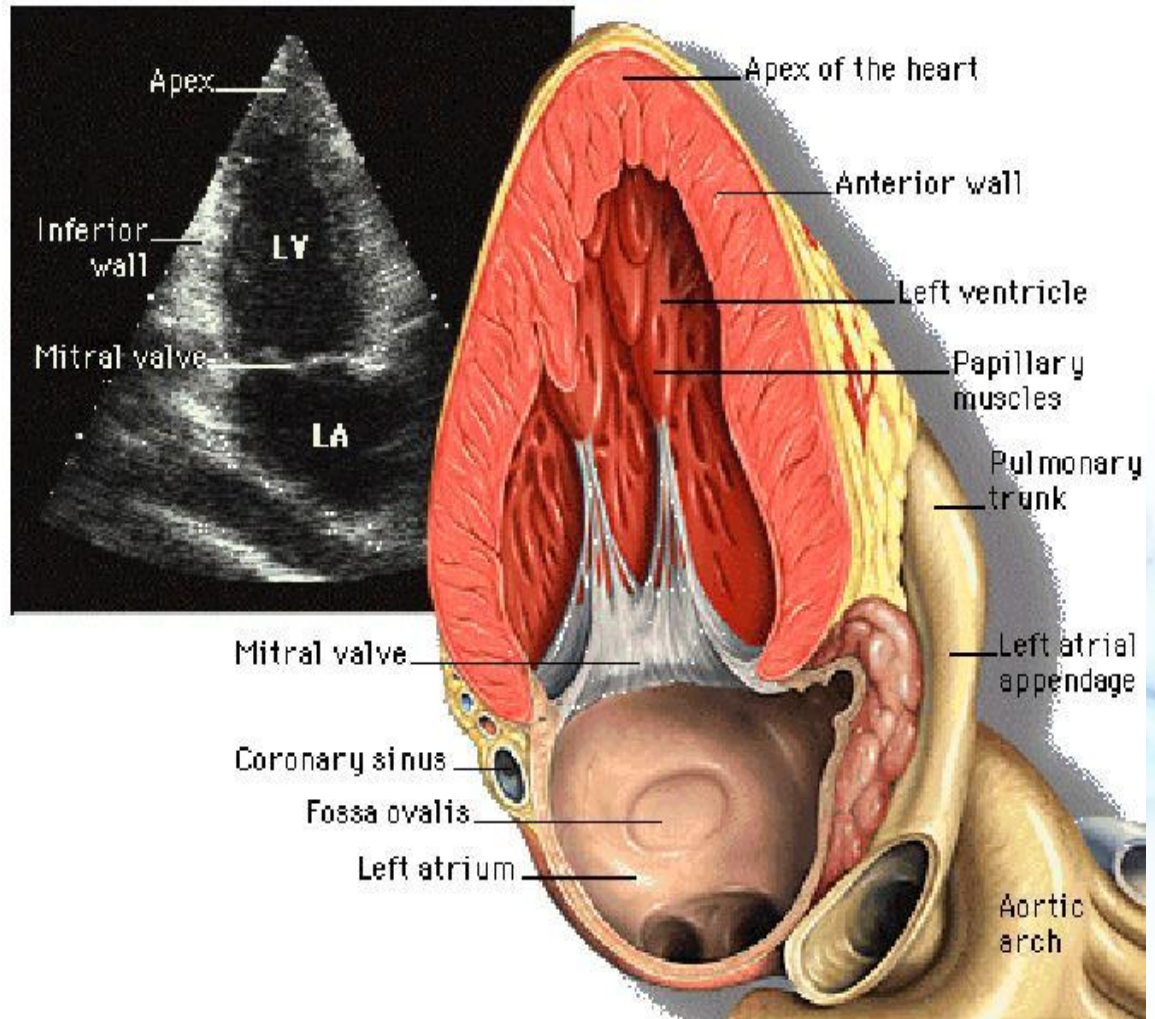
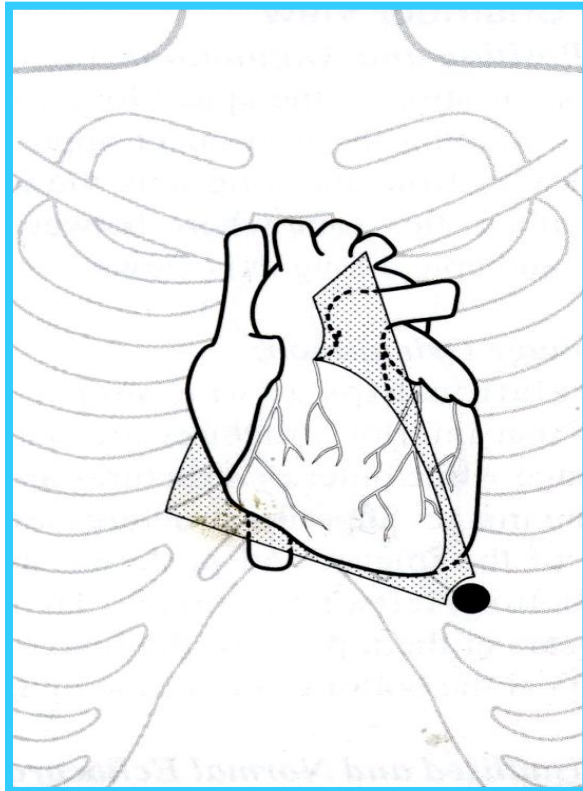
Apical 4 chamber view



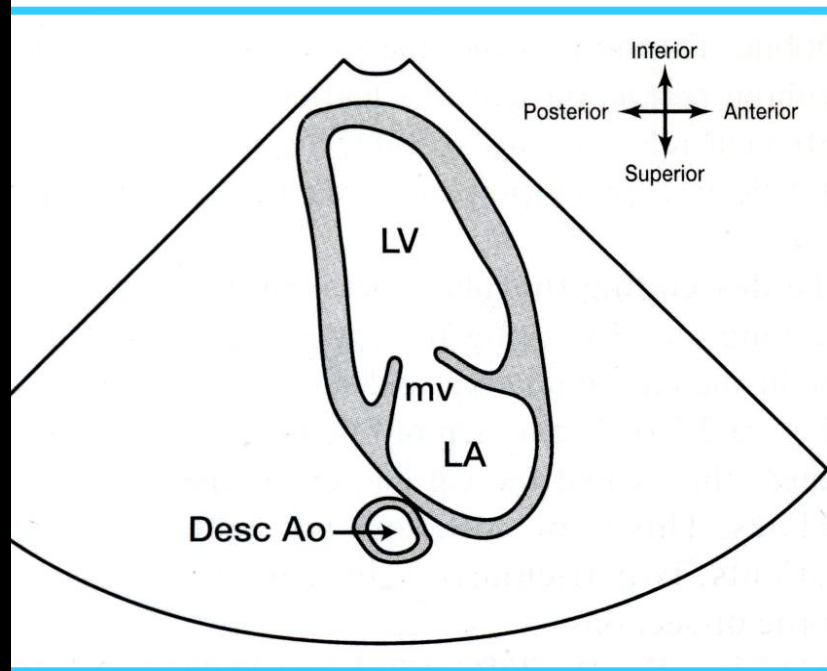
Apical long axis view



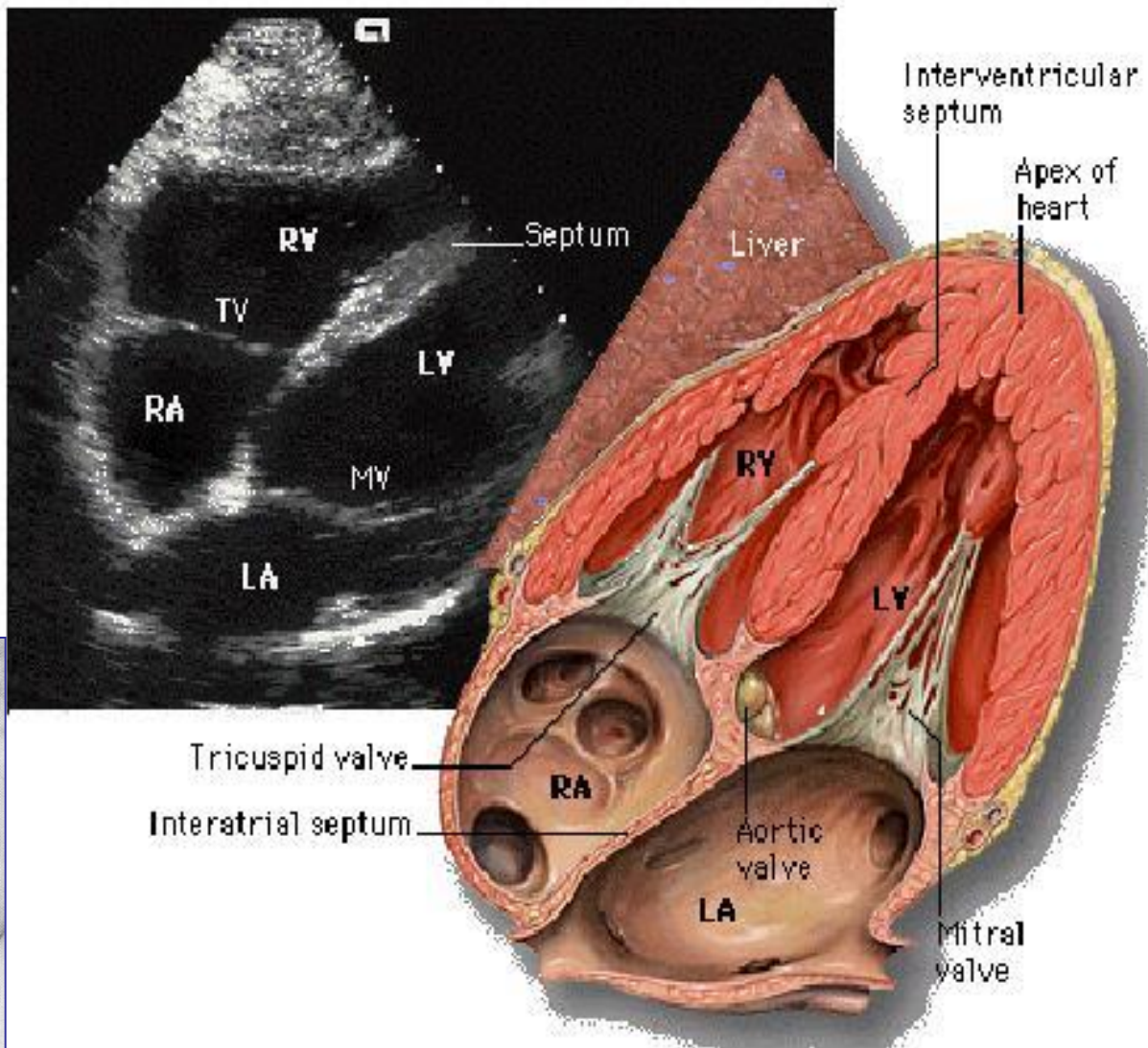
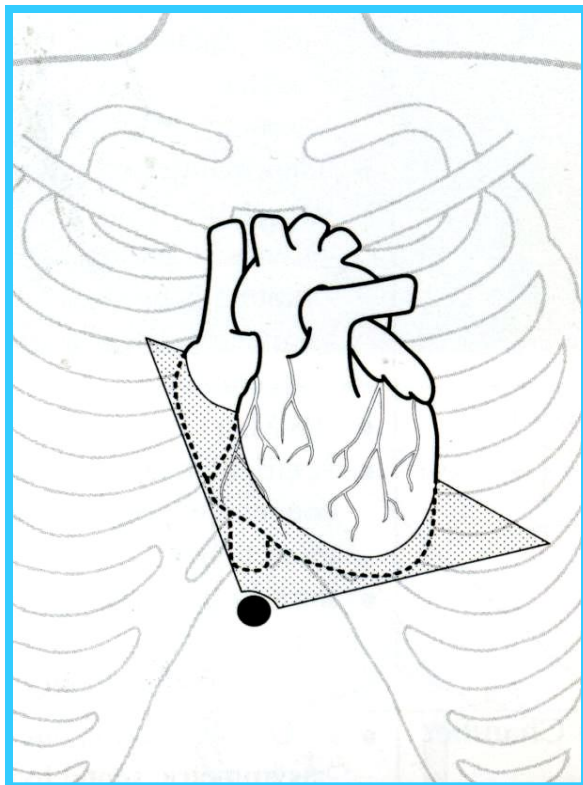
Apical 2 chamber view



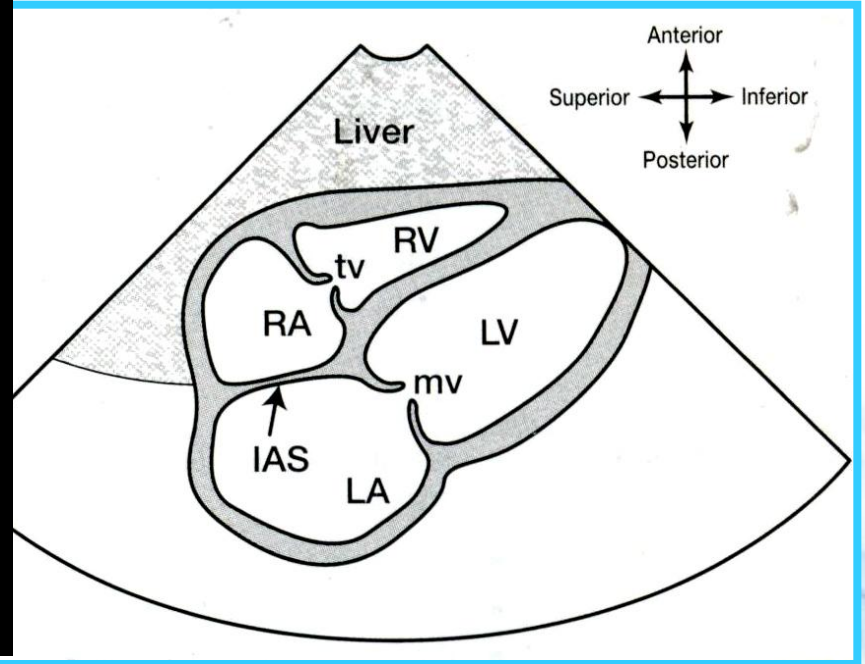
Apical 2 chamber view



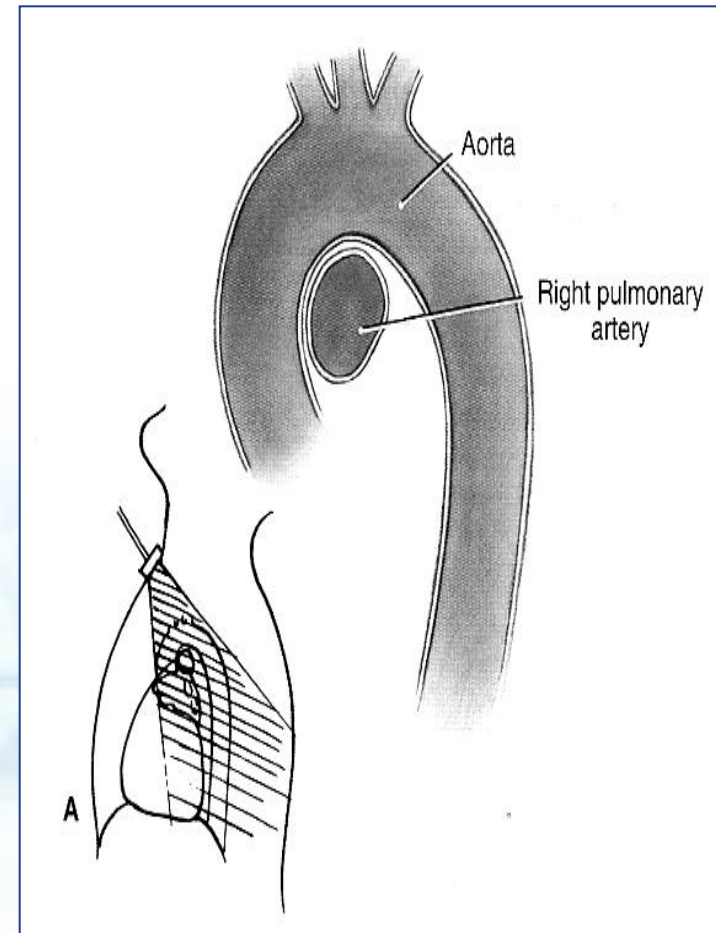
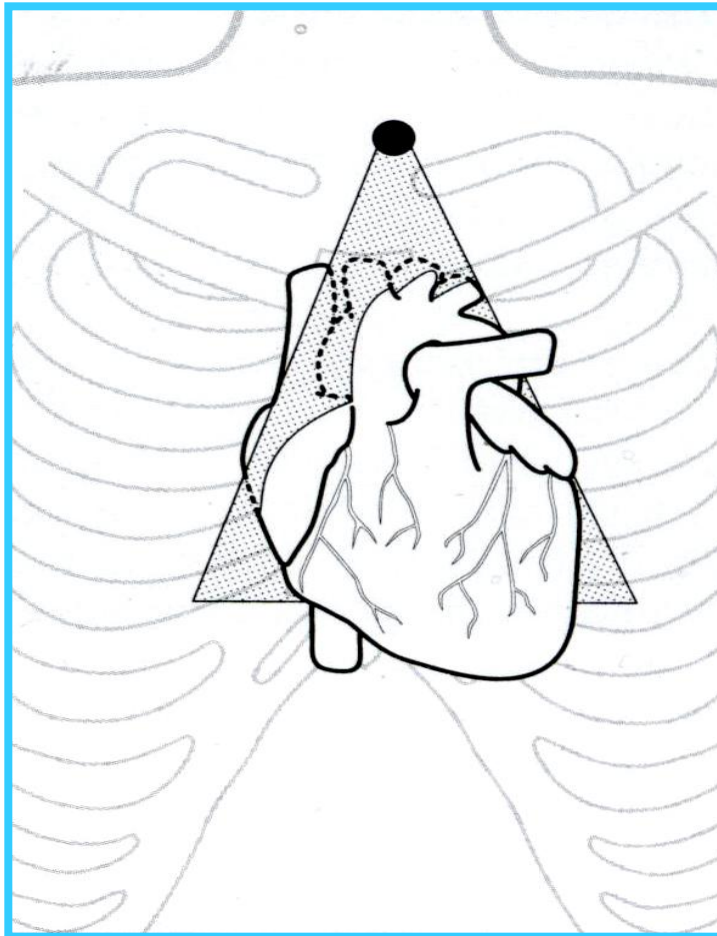
Subcostal view



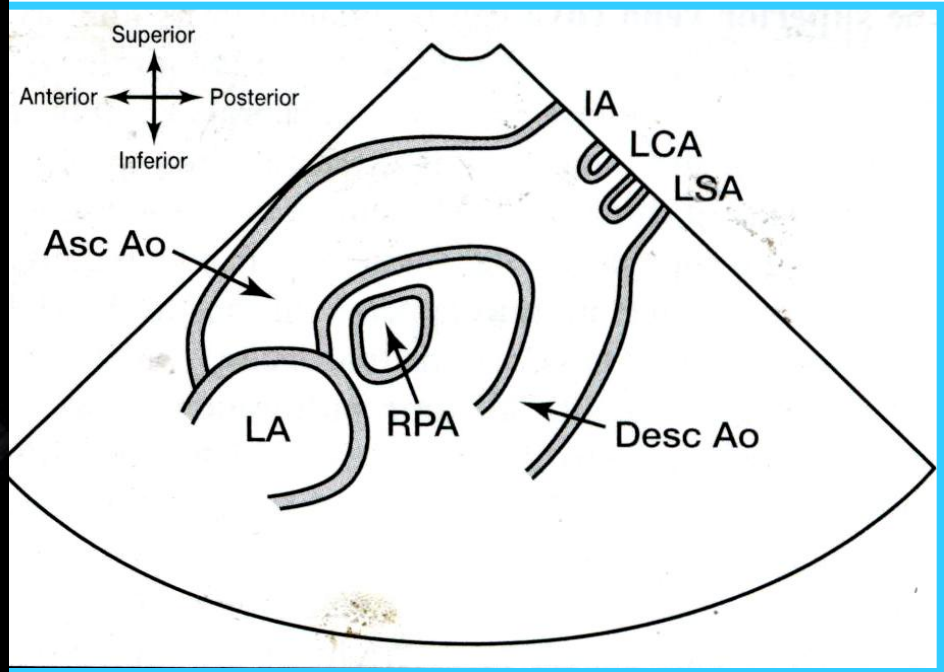
Subcostal view



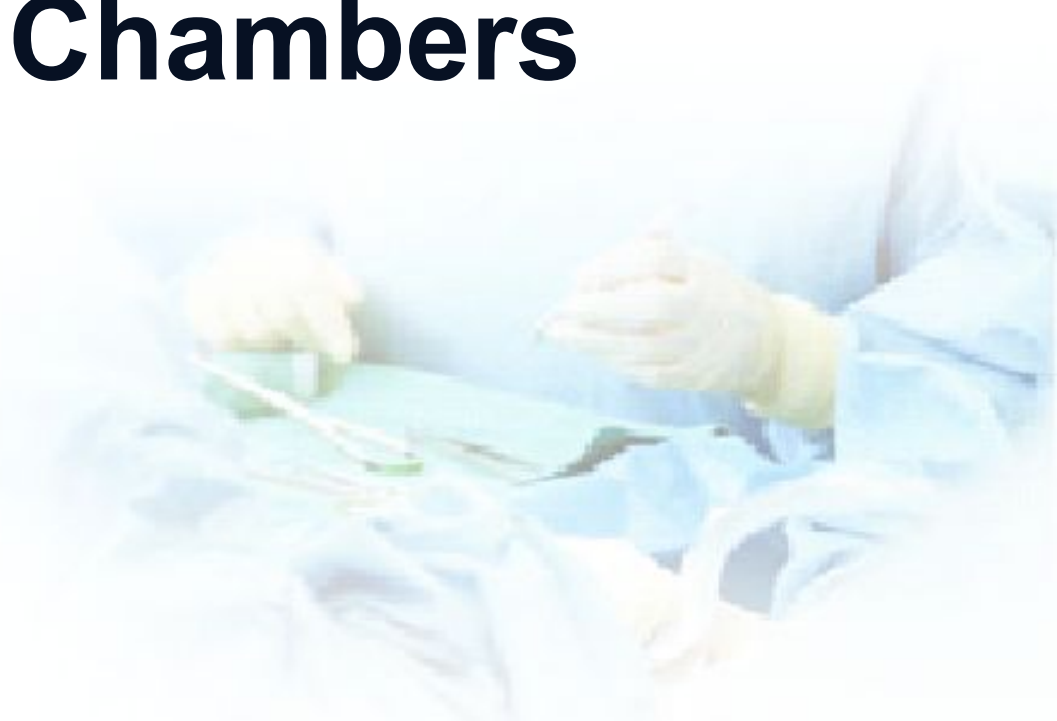
Suprasternal notch view



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 $\geq 30/s$**
- **Harmonic imaging**
- **B-color imaging**



Factors affecting image quality



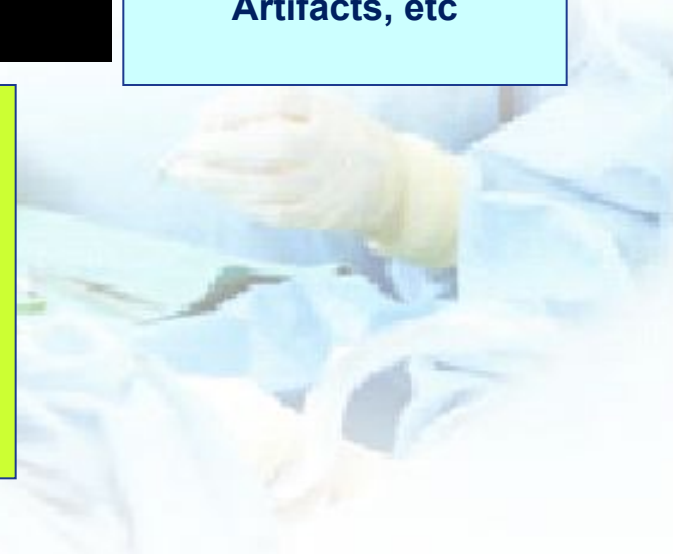
Tester factors

technique
knowledge
experience

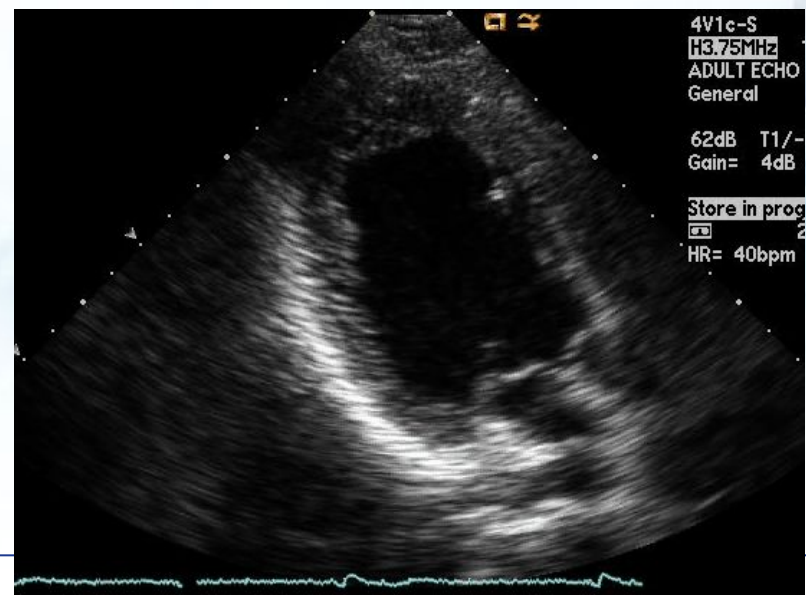
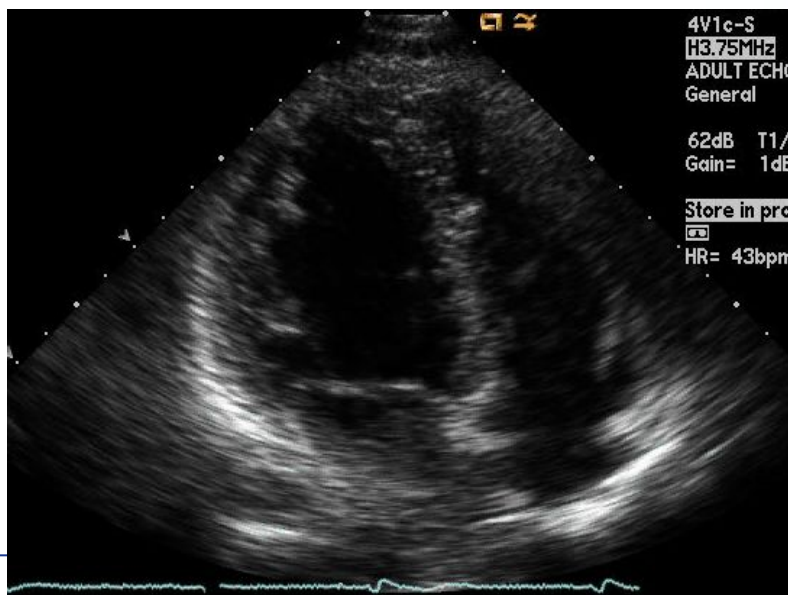
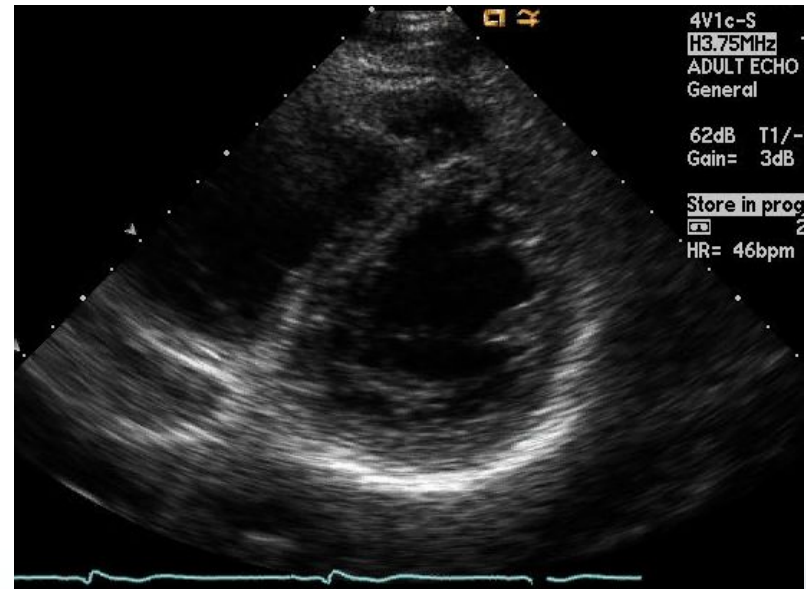
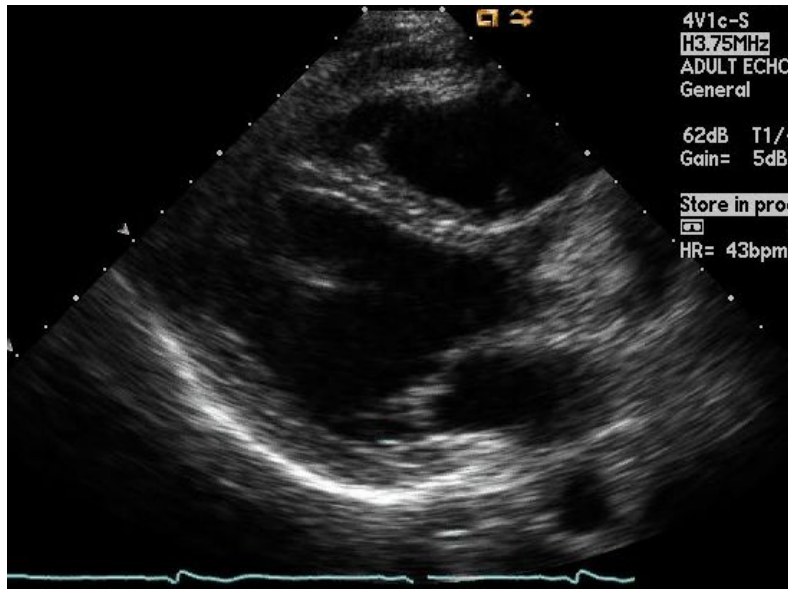


Machine factor
Depth
Gain
Frame rate
Resolution
Power
Compression
Dynamic range
Persistence
Focusing
Artifacts, etc

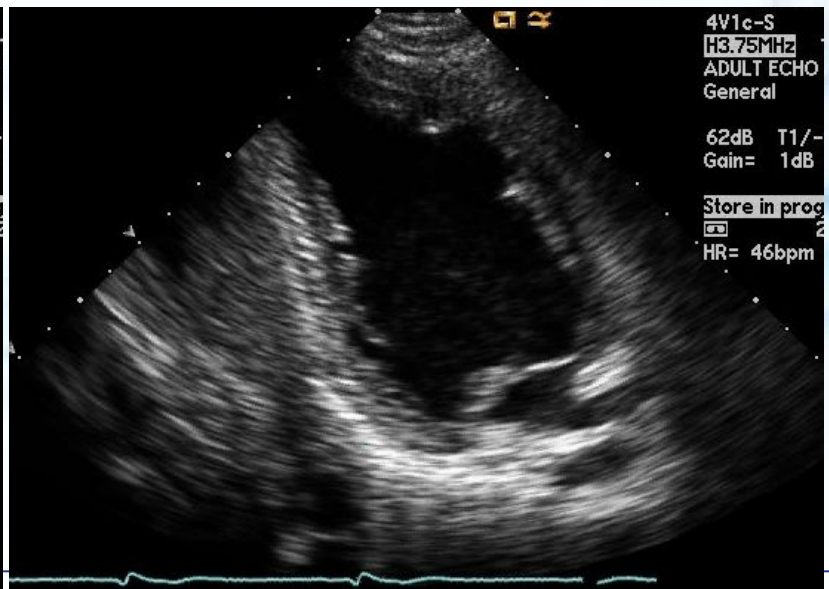
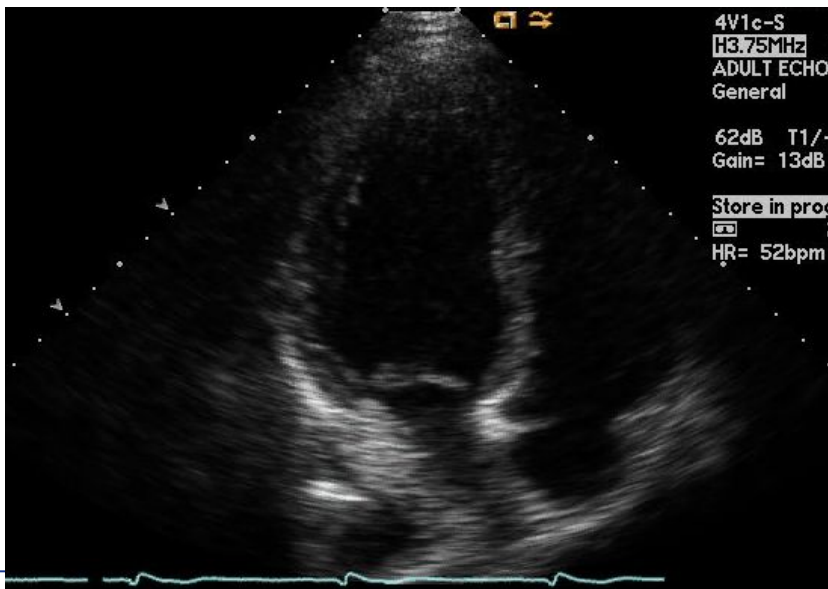
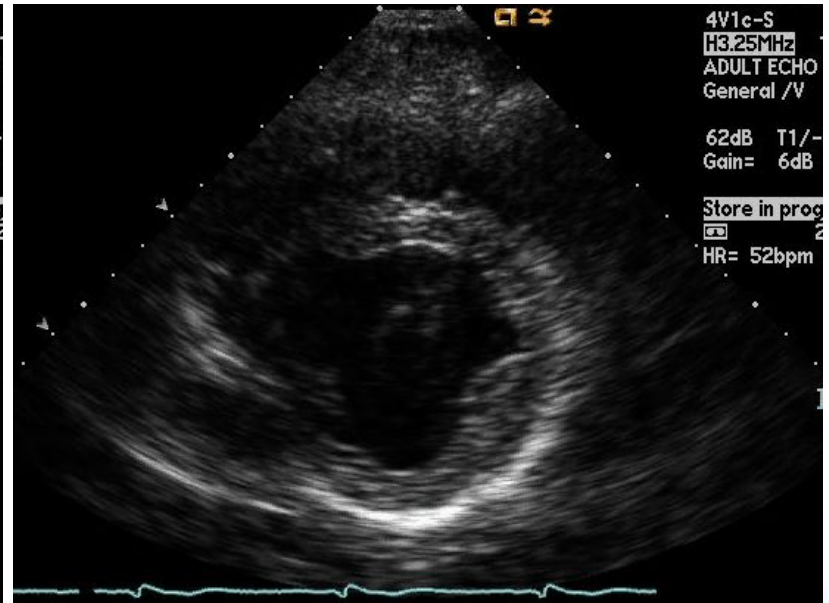
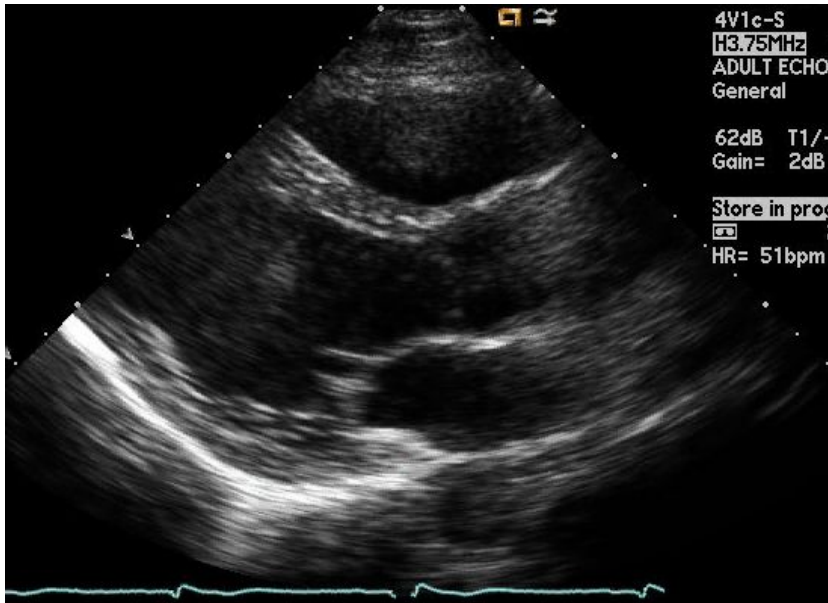
Patient factors
Hemodynamic stability
Body shape
Combined disease



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	<ul style="list-style-type: none">- Inaccurate with RWMA- Beam orientation (M-mode)- Small errors magnified- Overestimates LV mass
Area length	<ul style="list-style-type: none">- Allows for contribution of papillary muscle	<ul style="list-style-type: none">- Insensitive to distortion
Truncated ellipsoid	<ul style="list-style-type: none">- More sensitive to distortions	<ul style="list-style-type: none">- Based on mathematic assumptions- Minimal normal data

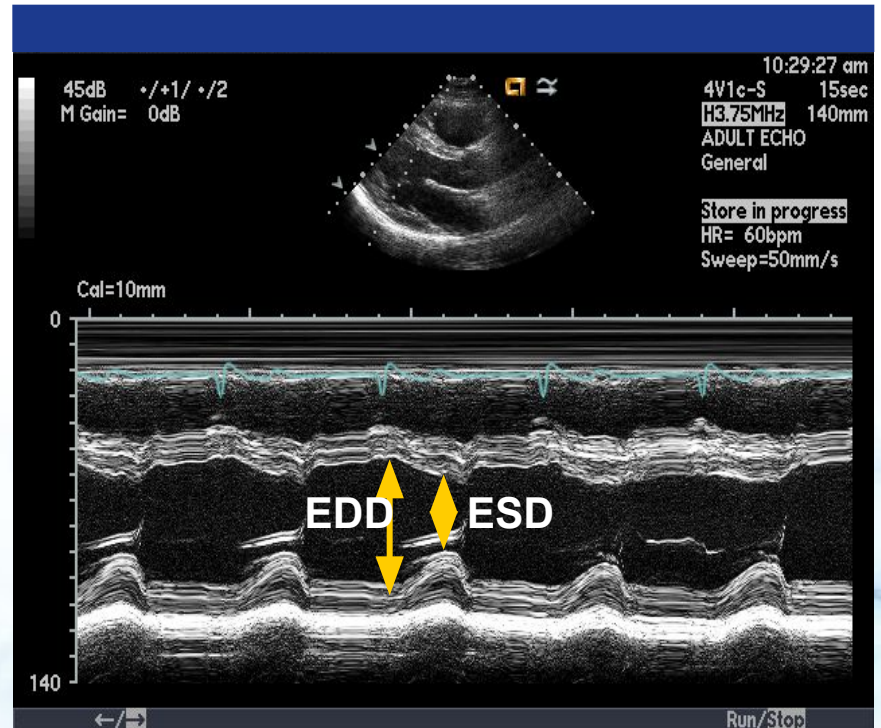
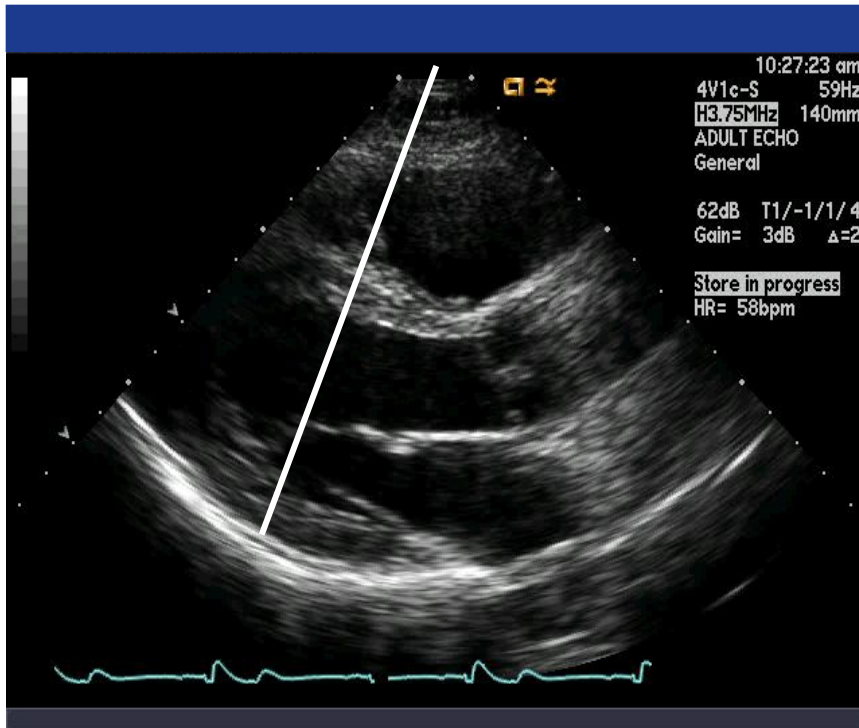
Measure LV dimension & thickness



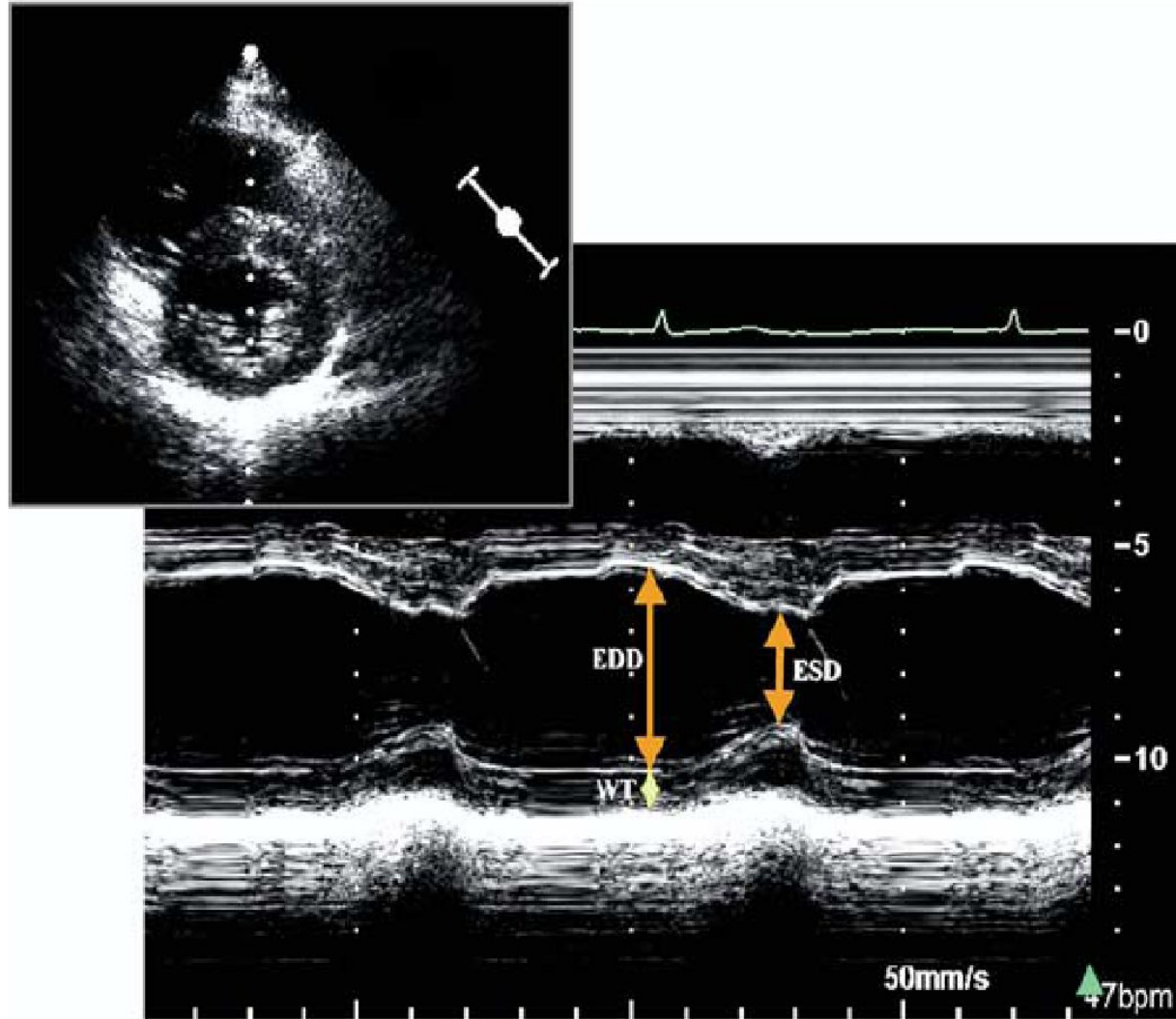
- **PLAX, PSAX view**
- **End of mitral leaflet**
- **2D or M-mode**
- **End diastole, systole**
 - **multiple beat**



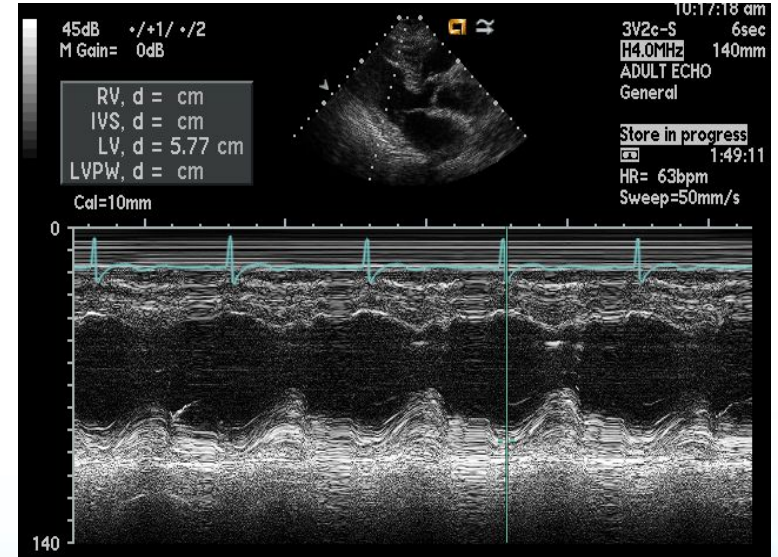
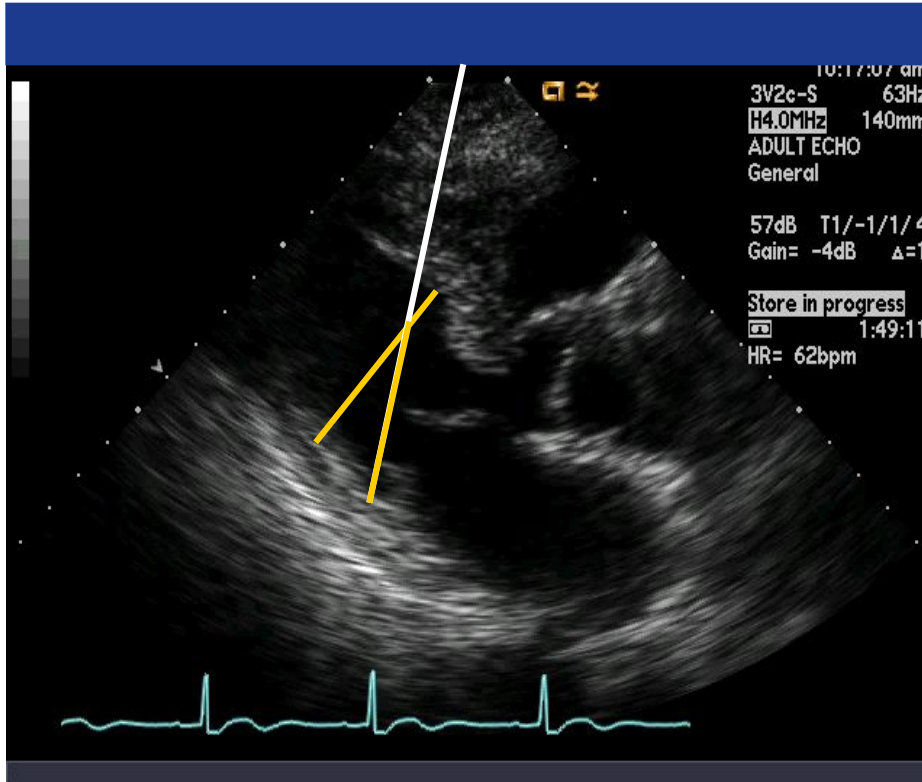
LV M-mode



LV M-mode



LV 2D



BSA 1.37 m² Ht. 145.0 cm Wt. 48.000 kg Age 68Years BP

M-mode		M-mode		ASE	ASEcorr
	Diastole	Systole			
IVS	0.70	1.23	cm	LV Mass	193.3 155.2 g
LV	5.77	3.79	cm	LV Mass/BSA	140.7 113.0 g/m ²
LVPW	0.76	1.40	cm	LV Mass/Ht	1.33 1.07 g/cm
IVS % Thck	75.7	%		Diastole	Systole
LV % FS	34.3	%		LV Vol	164.6 61.6 ml
LVPW % Thck	84.2	%		LV SV	103.0 ml
IVS/LVPW	0.92			LV SI	75.0 ml/m ²
				LV EF	62.6 %
				LV CO	6.49 l/min
				LV CI	4.73 l/min/m ²
				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
<i>LV diastolic volume/BSA, mL/m²</i>	<i>35–75</i>	<i>76–86</i>	<i>87–96</i>	<i>≥97</i>	<i>35–75</i>	<i>76–86</i>	<i>87–96</i>	<i>≥97</i>
LV systolic volume, mL	19–49	50–59	60–69	≥70	22–58	59–70	71–82	≥83
<i>LV systolic volume/BSA, mL/m²</i>	<i>12–30</i>	<i>31–36</i>	<i>37–42</i>	<i>≥43</i>	<i>12–30</i>	<i>31–36</i>	<i>37–42</i>	<i>≥43</i>

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**

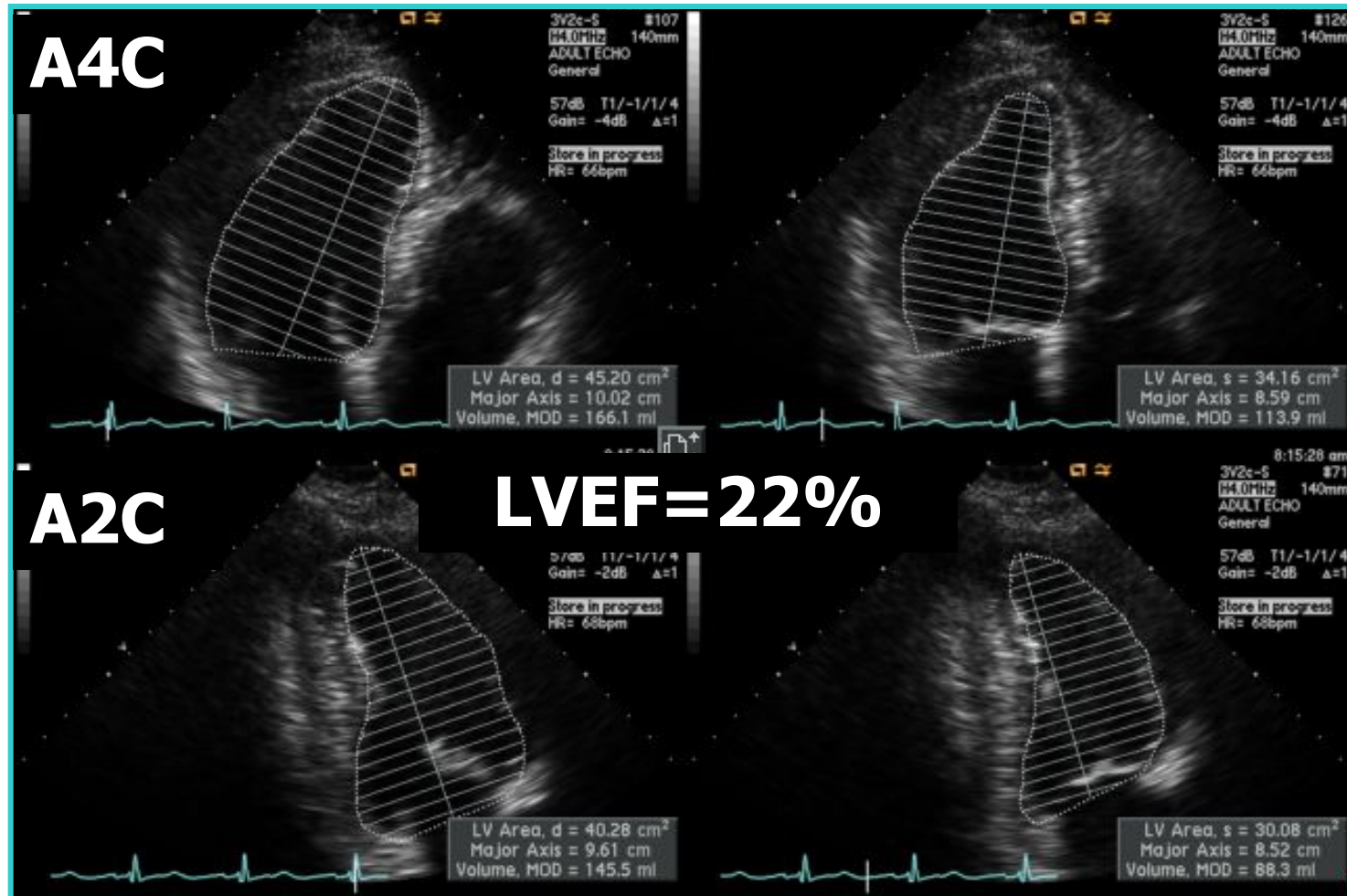


LV volume measure

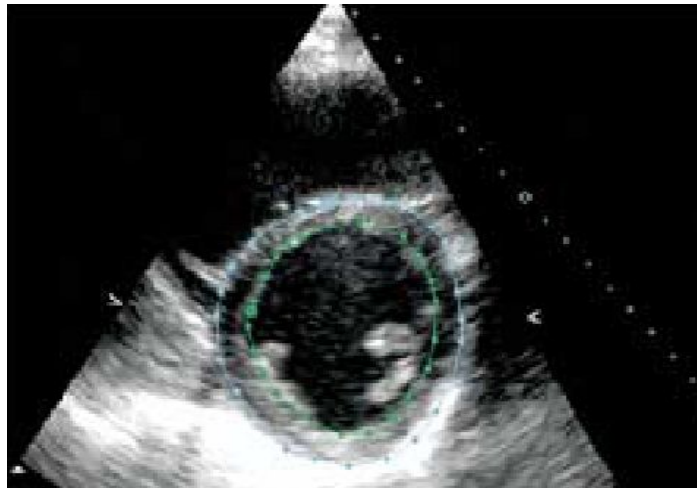


End diastole

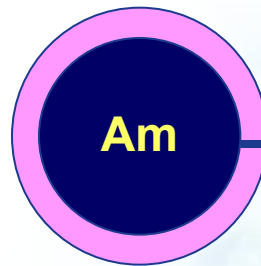
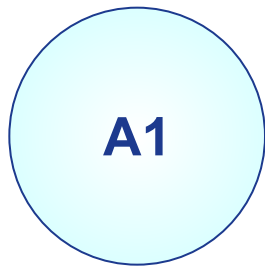
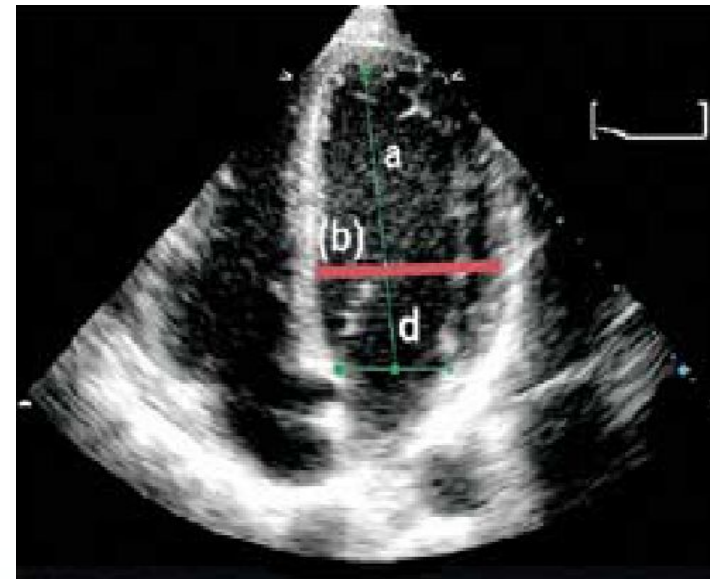
End systole



LV mass calculation



$$A_m = A_1 - A_2$$



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

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

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

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
<i>LV mass/BSA, g/m²</i>	<i>43-95</i>	<i>96-108</i>	<i>109-121</i>	<i>≥122</i>	<i>49-115</i>	<i>116-131</i>	<i>132-148</i>	<i>≥149</i>
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
<i>Septal thickness, cm</i>	<i>0.6-0.9</i>	<i>1.0-1.2</i>	<i>1.3-1.5</i>	<i>≥1.6</i>	<i>0.6-1.0</i>	<i>1.1-1.3</i>	<i>1.4-1.6</i>	<i>≥1.7</i>
<i>Posterior wall thickness, cm</i>	<i>0.6-0.9</i>	<i>1.0-1.2</i>	<i>1.3-1.5</i>	<i>≥1.6</i>	<i>0.6-1.0</i>	<i>1.1-1.3</i>	<i>1.4-1.6</i>	<i>≥1.7</i>
2D Method								
LV mass, g	66-150	151-171	172-182	>193	96-200	201-227	228-254	>255
<i>LV mass/BSA, g/m²</i>	<i>44-88</i>	<i>89-100</i>	<i>101-112</i>	<i>≥113</i>	<i>50-102</i>	<i>103-116</i>	<i>117-130</i>	<i>≥131</i>

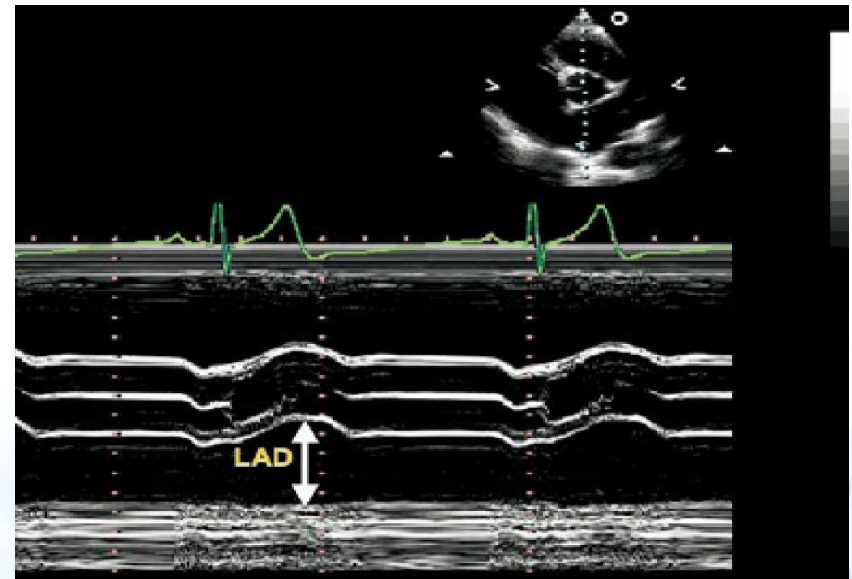
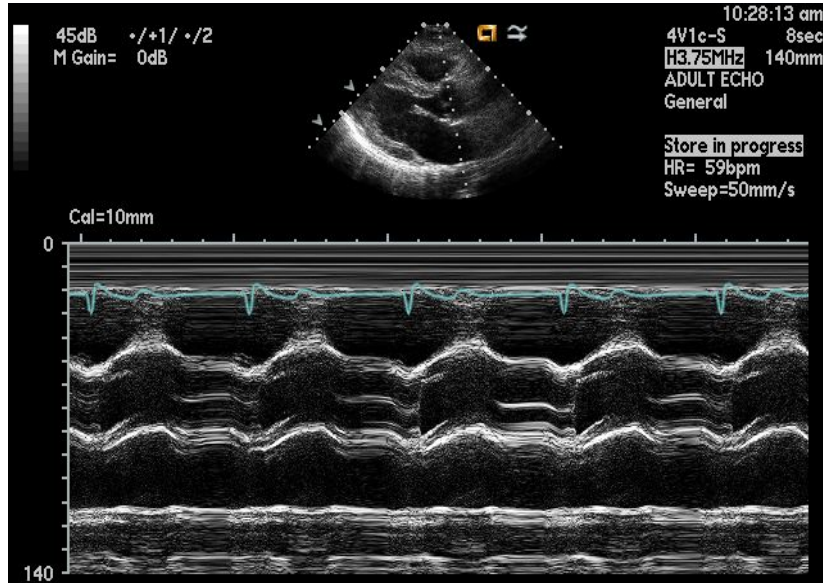
Measure LA size



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

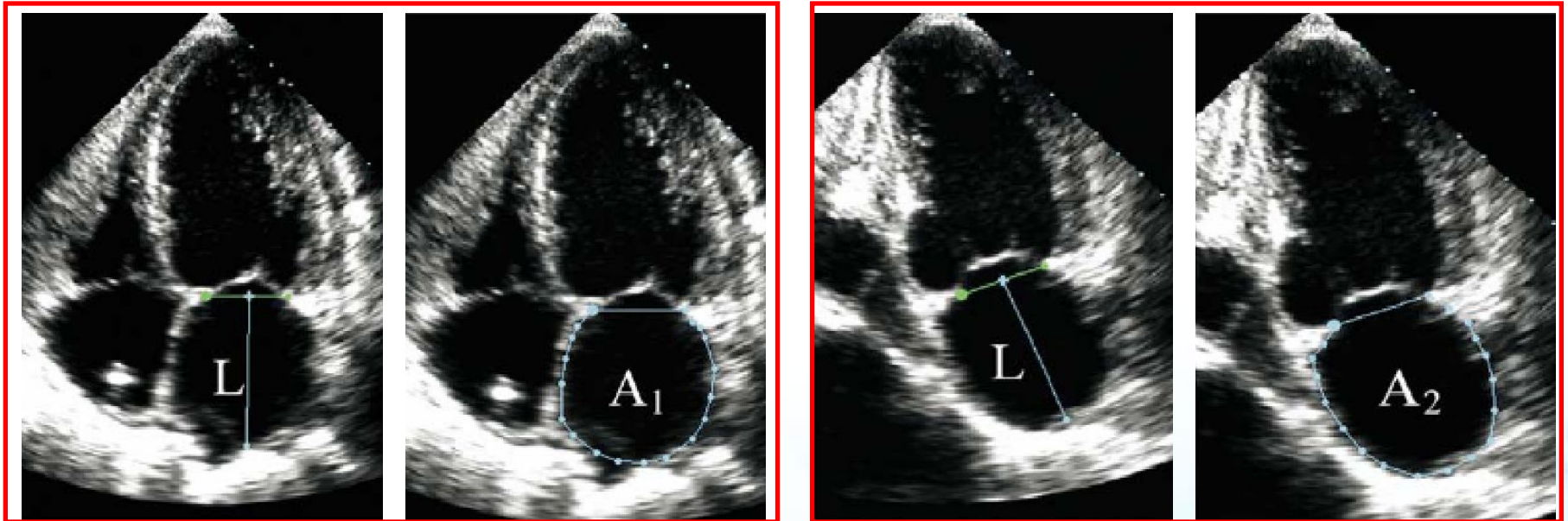


Measure LA size



- ▶ 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

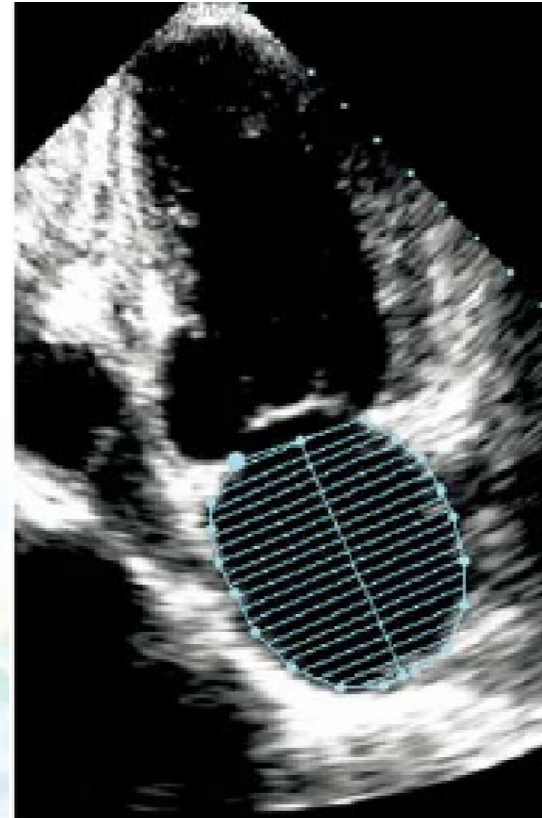
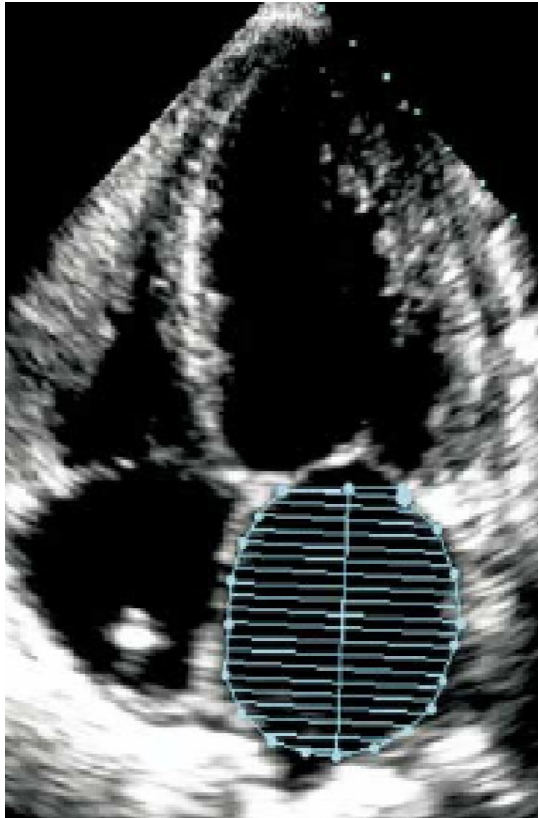


A2C

$$\text{LA volume} = \frac{8}{3} \pi [(A1) (A2) / (L)]$$

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

LA size measure : Modified Simpson's Method



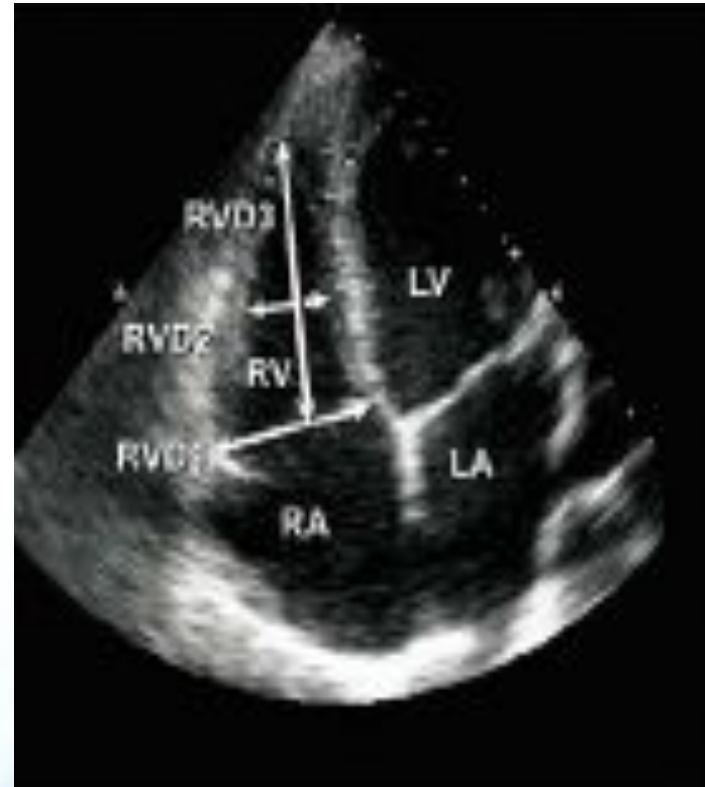
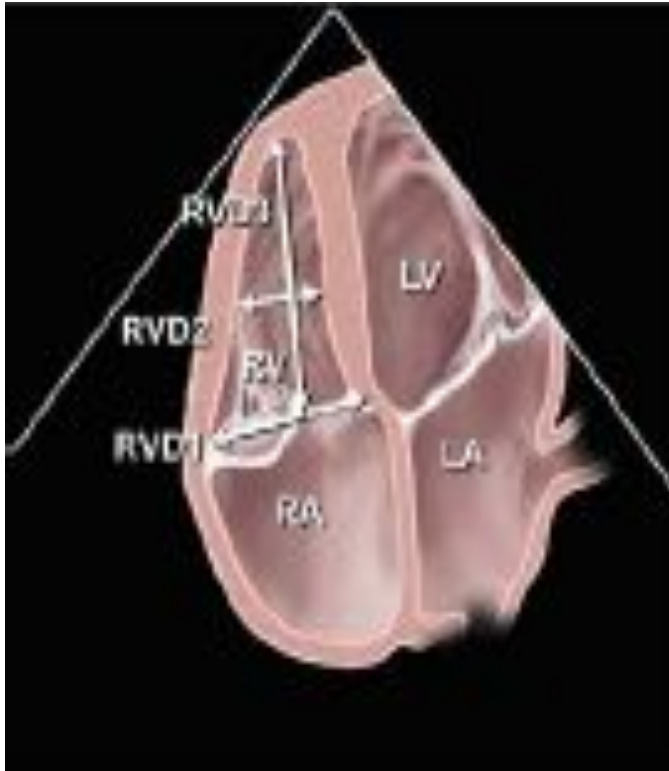
A2C

Normal LA size



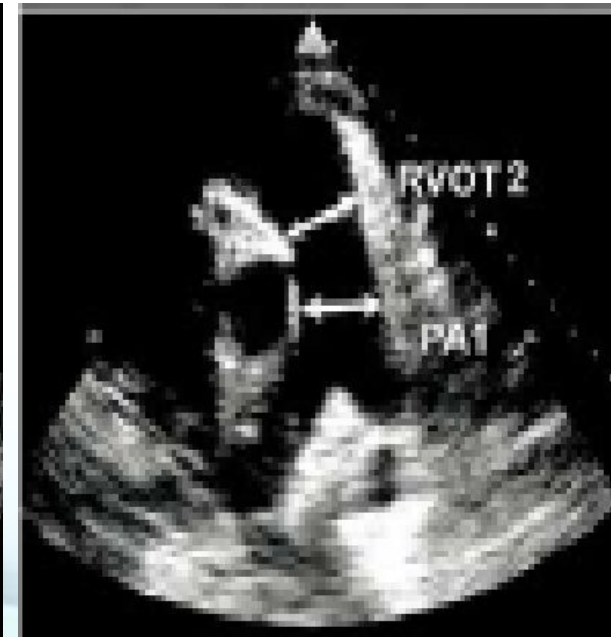
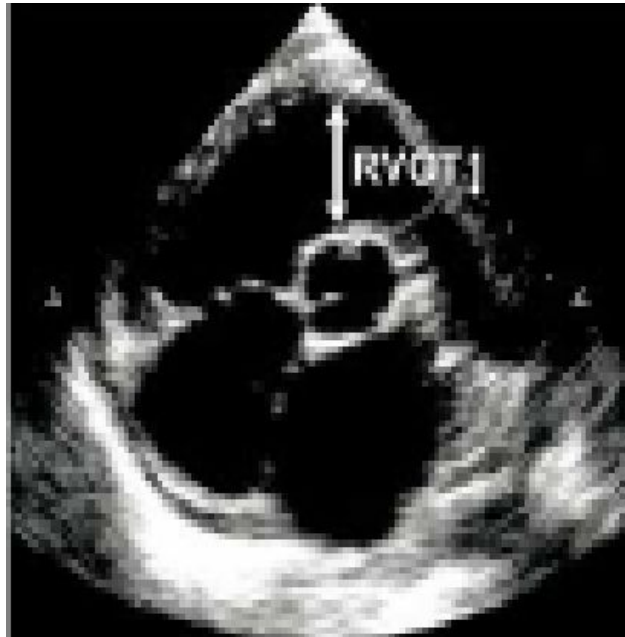
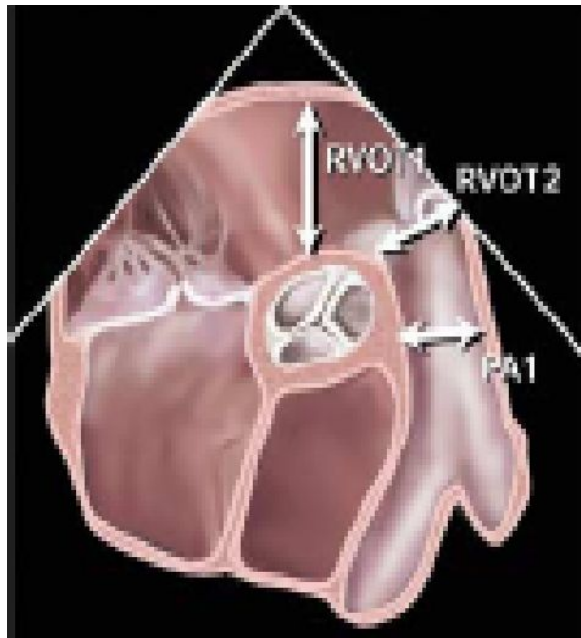
	Women				Men			
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
Atrial dimensions								
LA diameter, cm	2.7–3.8	3.9–4.2	4.3–4.6	≥4.7	3.0–4.0	4.1–4.6	4.7–5.2	≥5.2
LA diameter/BSA, cm/m ²	1.5–2.3	2.4–2.6	2.7–2.9	≥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

A pair of glasses with a thin frame and a white earpiece is positioned in the upper left. Below it, a pair of sunglasses with a dark frame is visible. In the lower left, a silver pen with a blue ring is partially shown. The background is a solid blue color with a subtle gradient and soft shadows.

Thank You !