

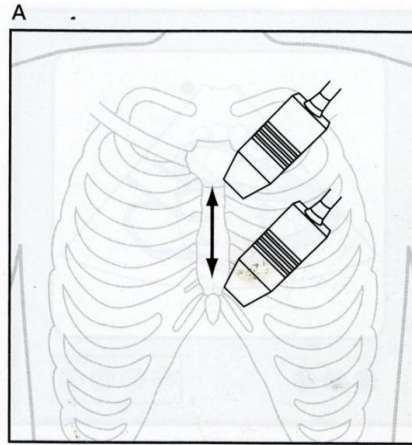
A blue-toned background featuring a stethoscope and a pair of glasses. The stethoscope is positioned in the lower-left corner, and the glasses are in the upper-left corner. The text is centered on the right side of the image.

**Standard Imaging of  
Transthoracic  
Echocardiography**

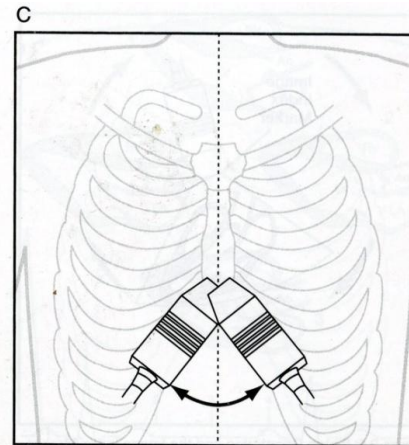
# Terminology



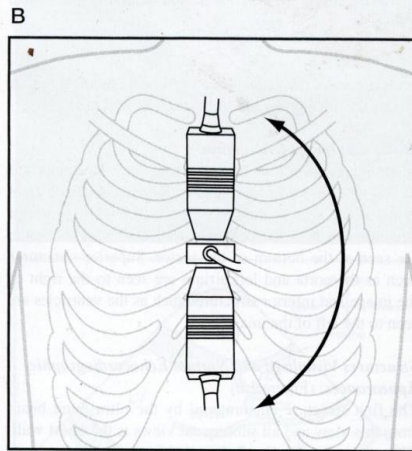
(movement)



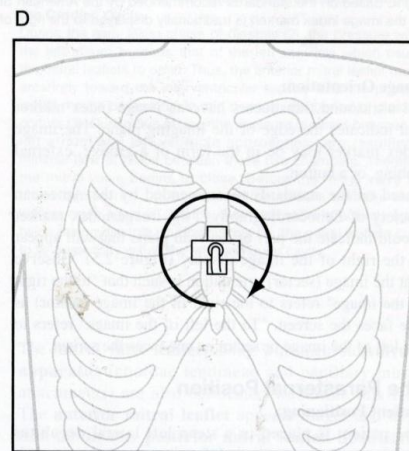
(angulation)



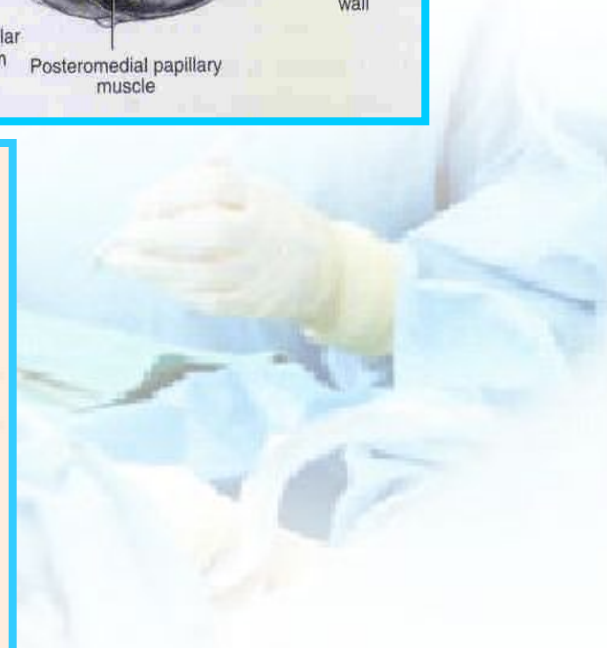
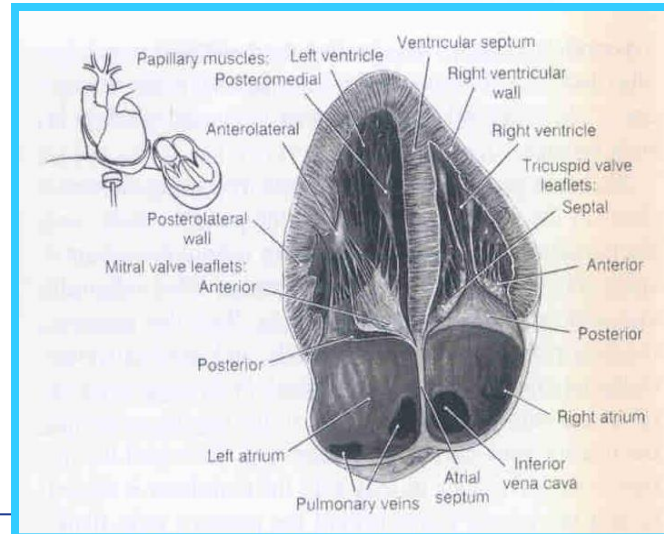
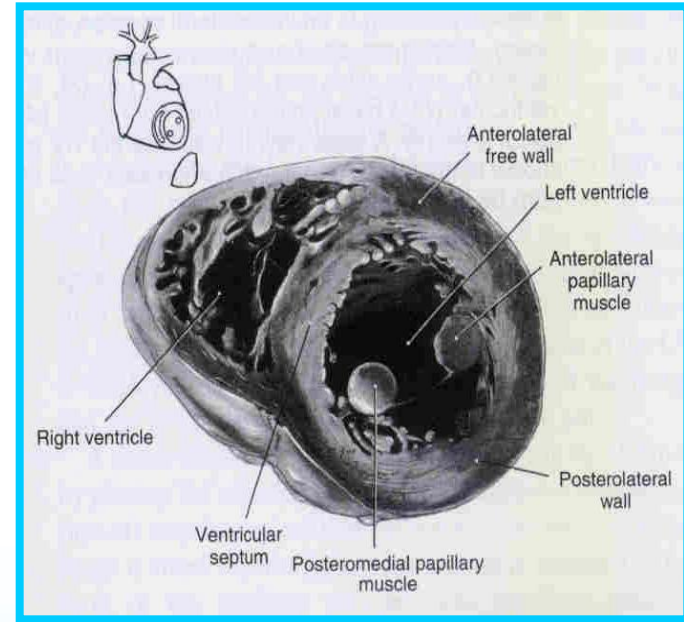
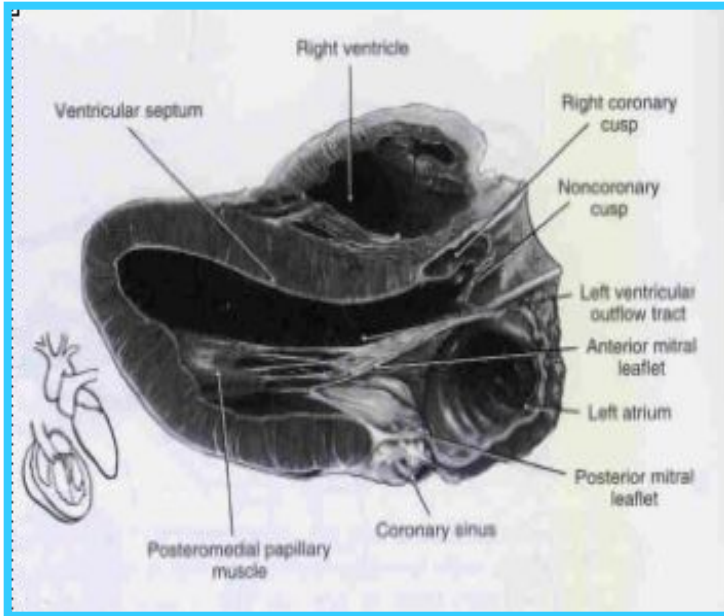
(tilting)



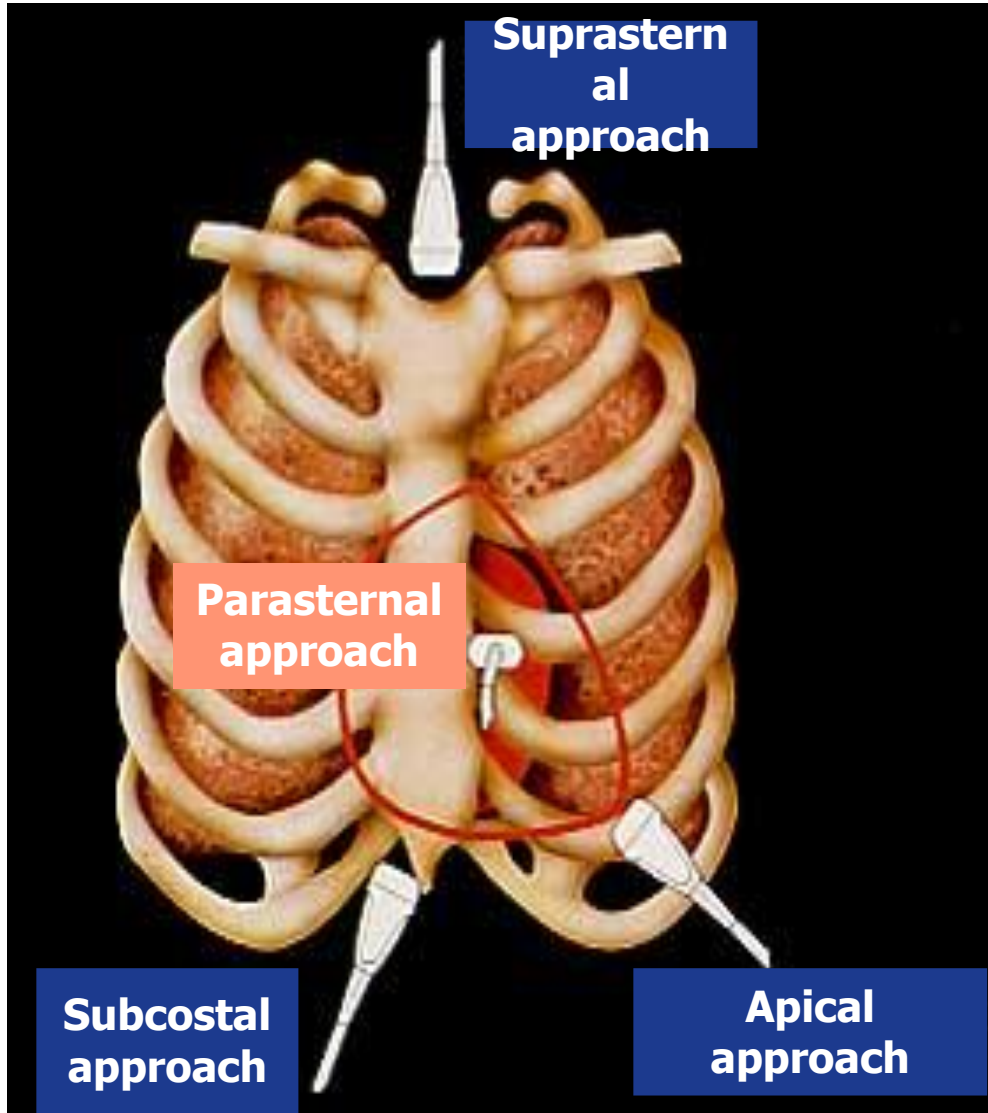
D 회전  
(rotation)



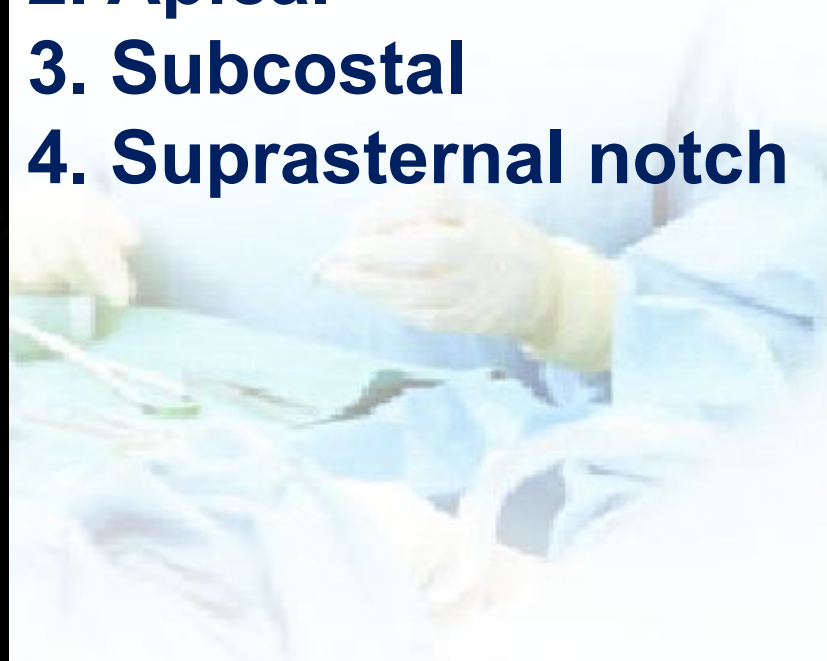
# Anatomy of Echo



# Echo Window

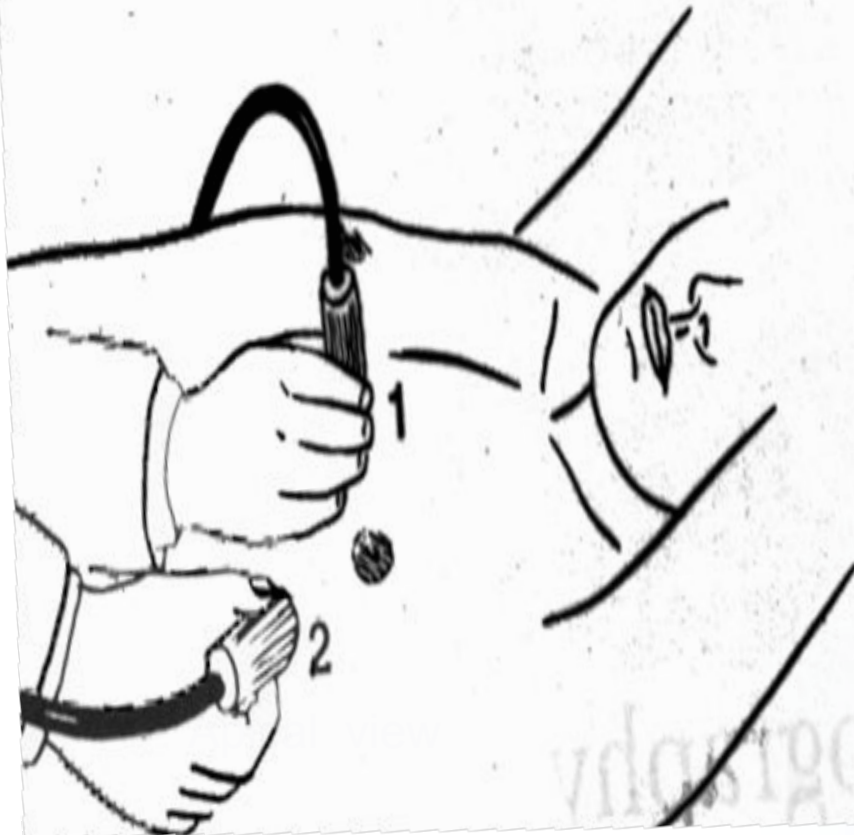


1. Parasternal
2. Apical
3. Subcostal
4. Suprasternal notch

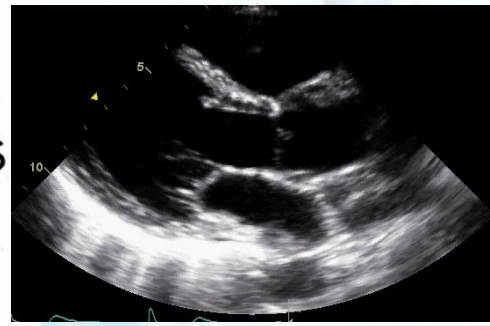
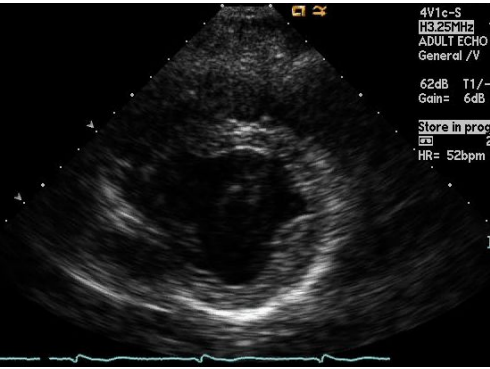
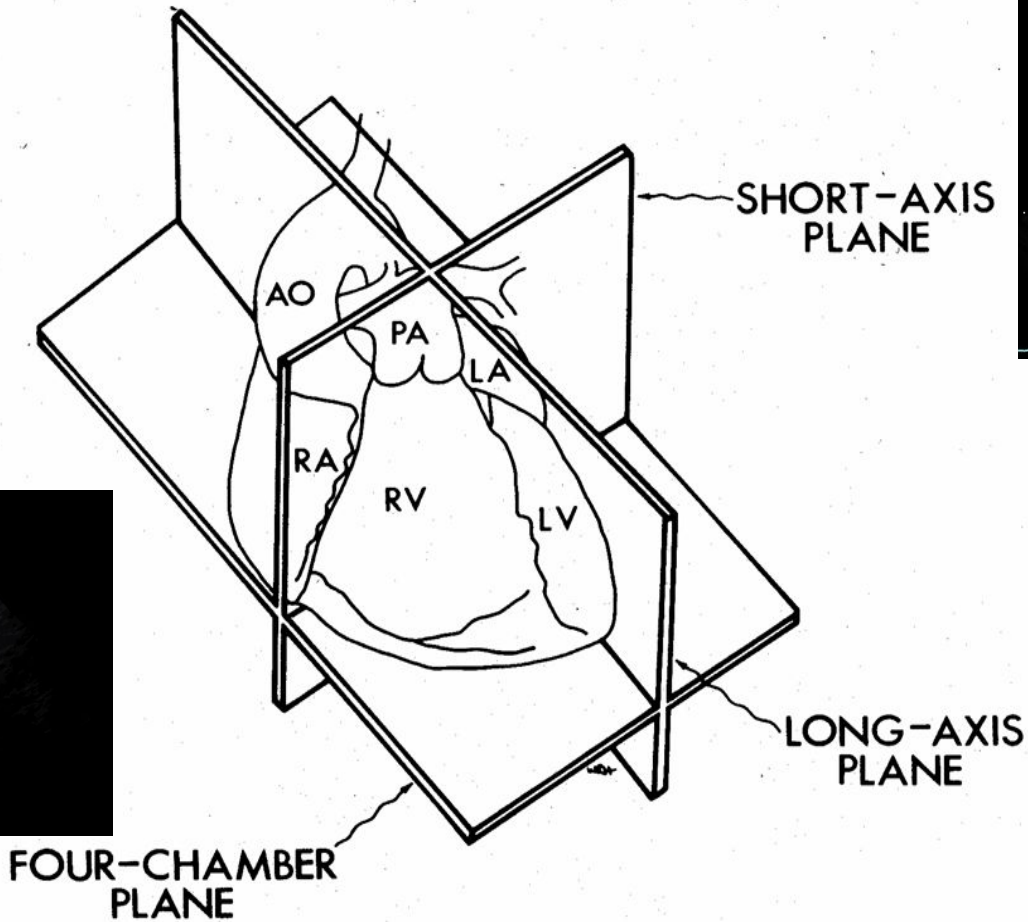




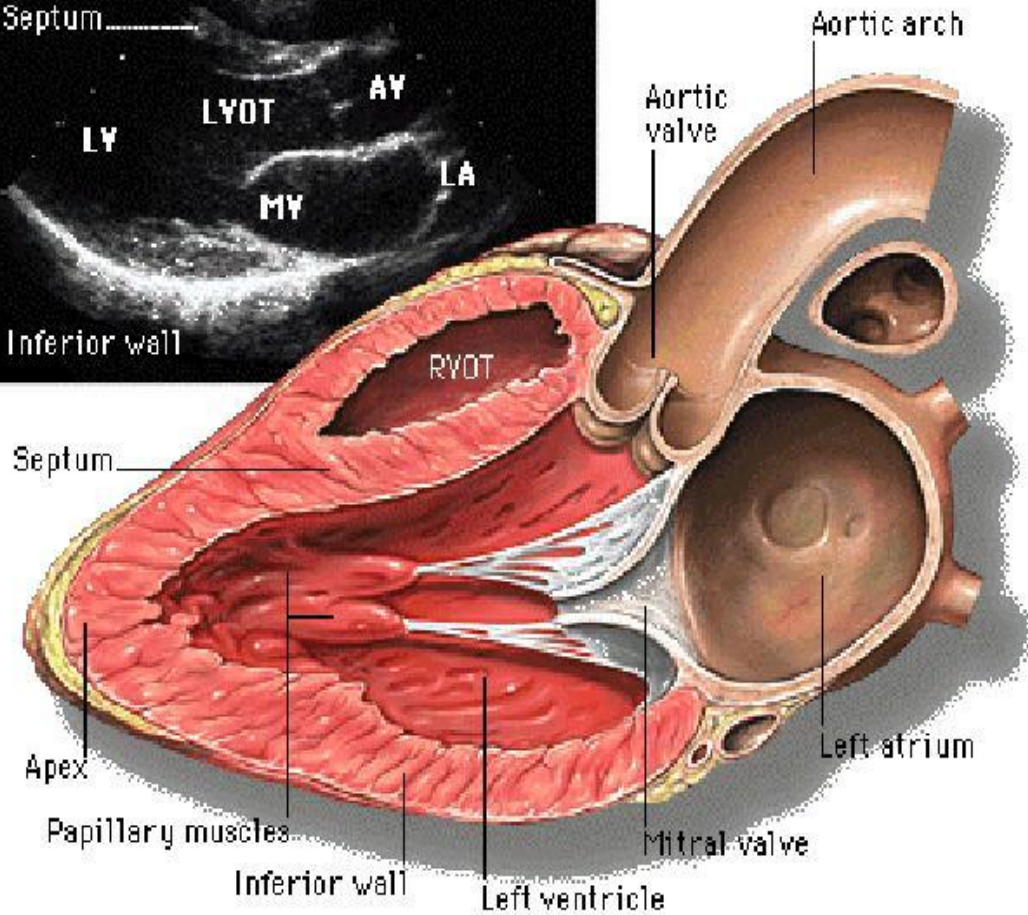
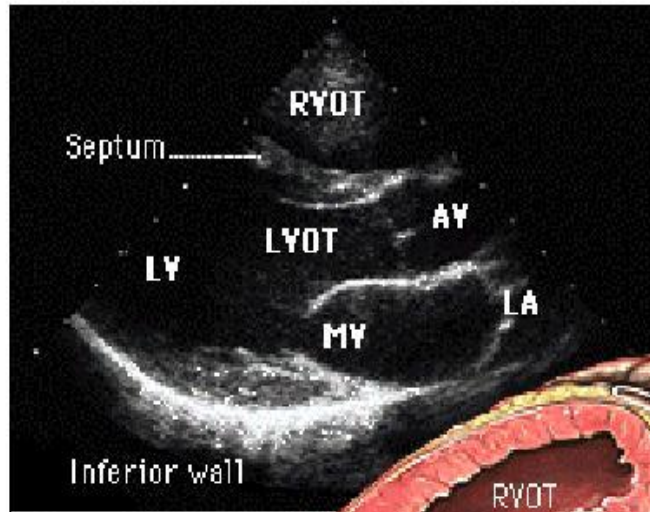
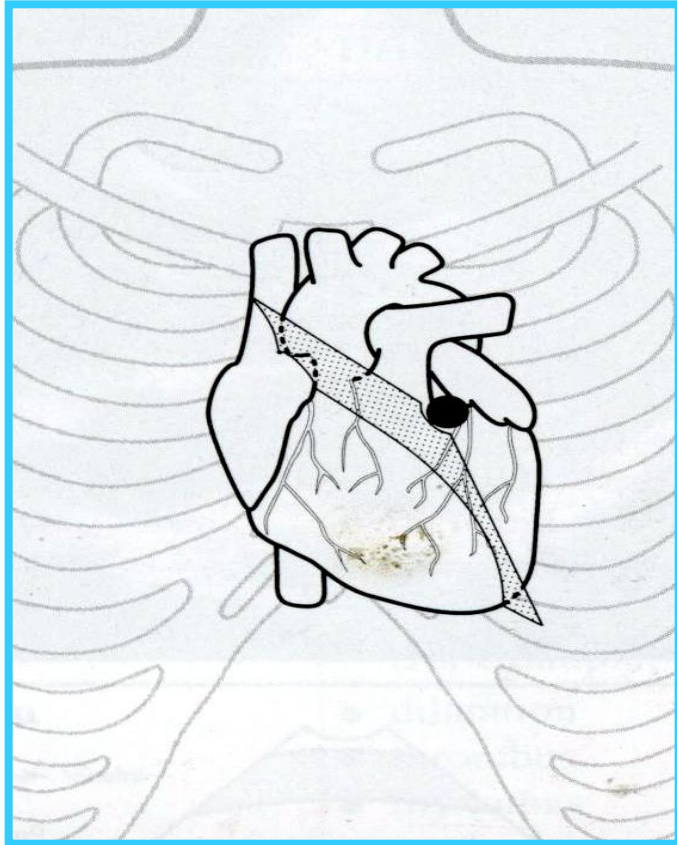
# Basic views of Echocardiography



# Basic views of Echocardiography

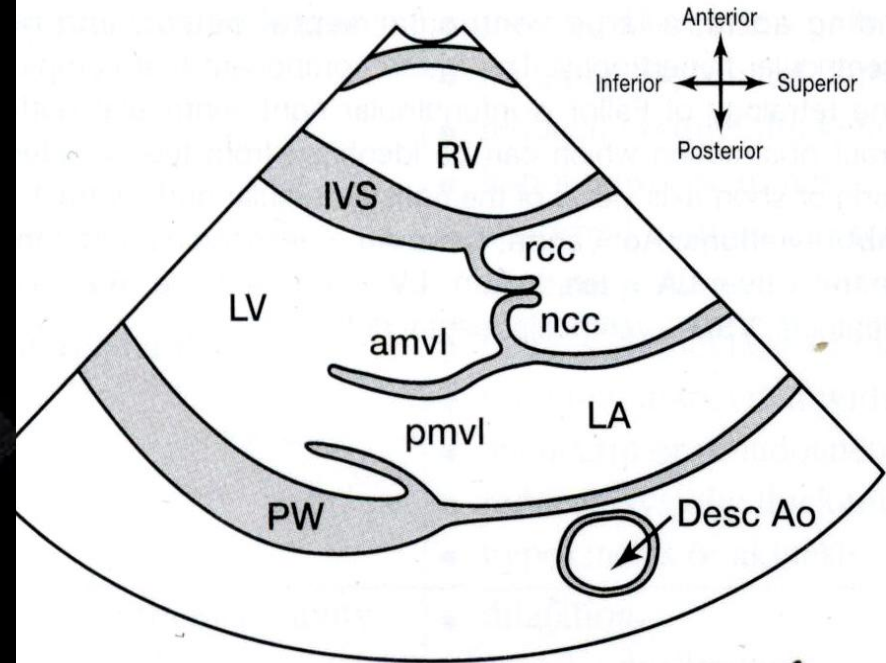


# Parasternal long axis view



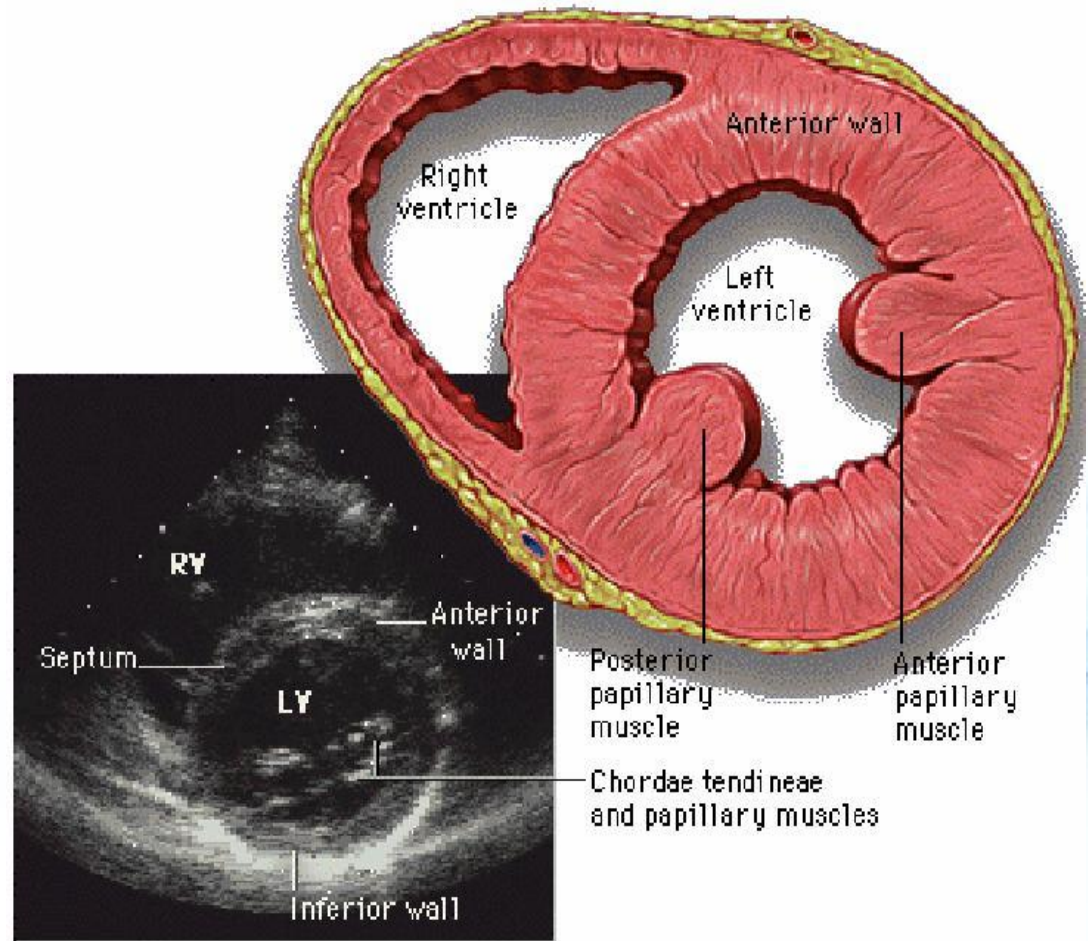
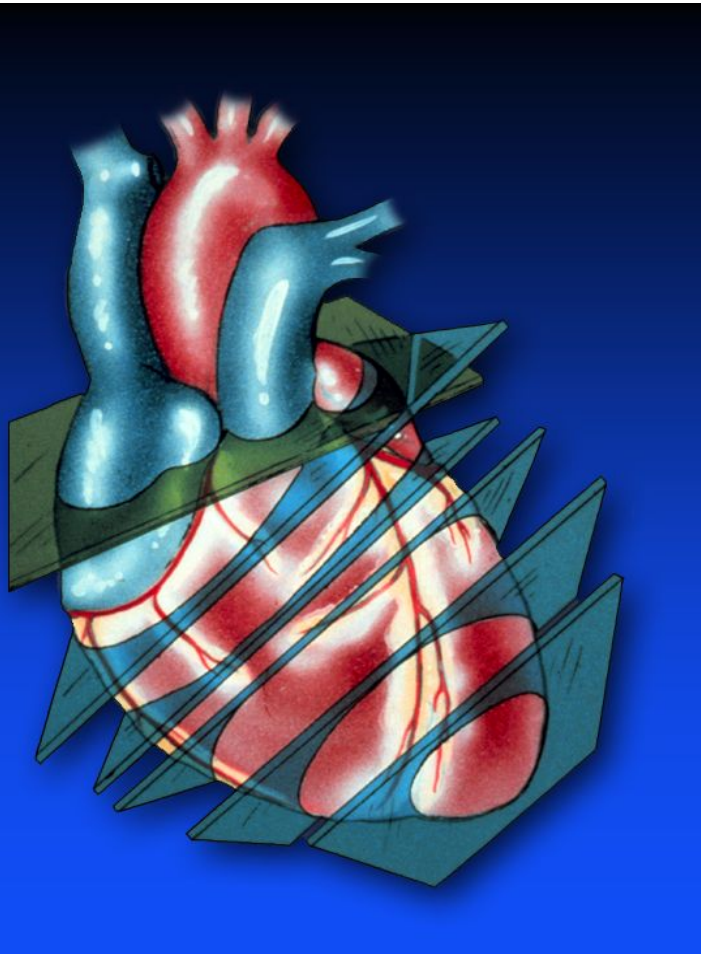


# Parasternal long axis view

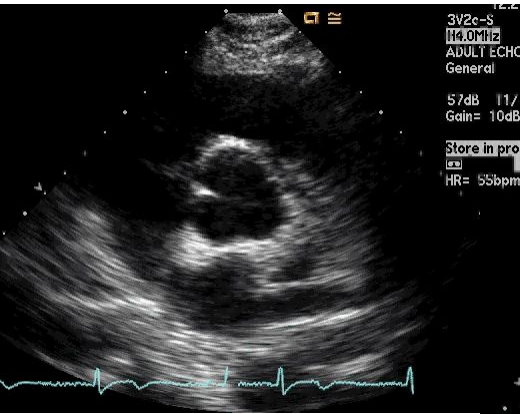




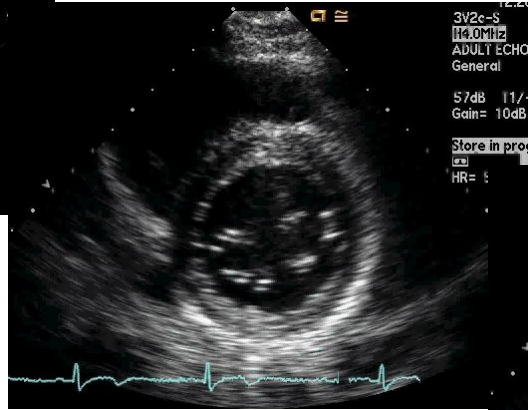
# Parasternal short axis view



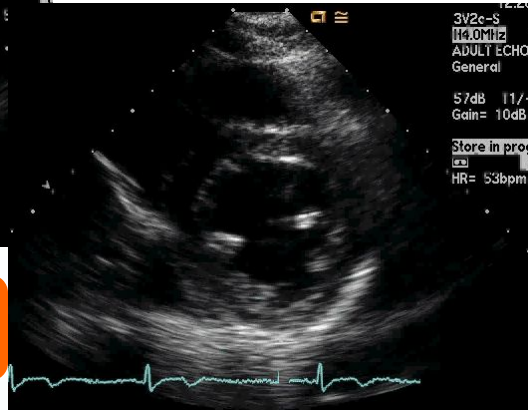
# Parasternal Short Axis view



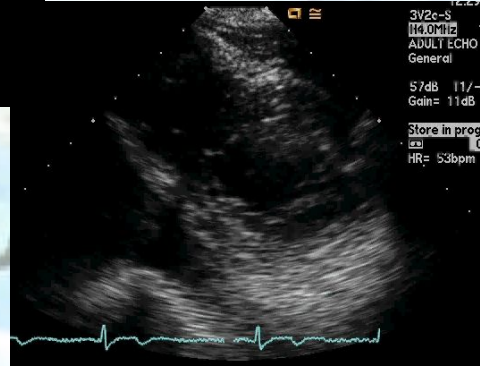
PSAX- AV level



PSAX- MV base

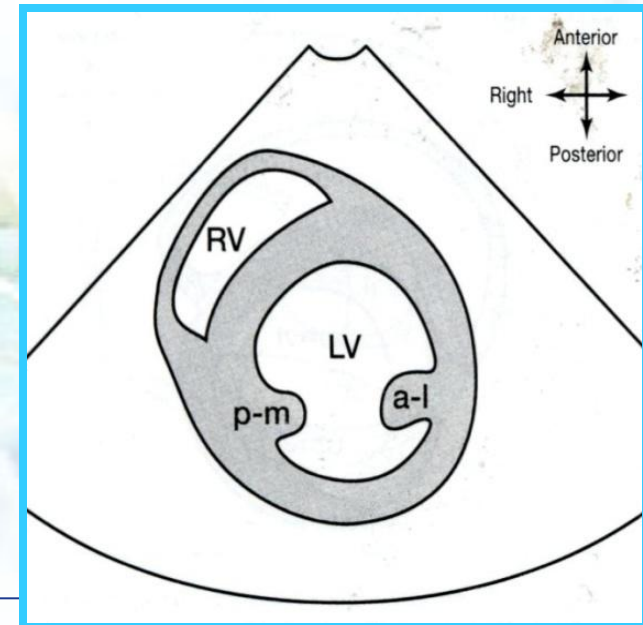
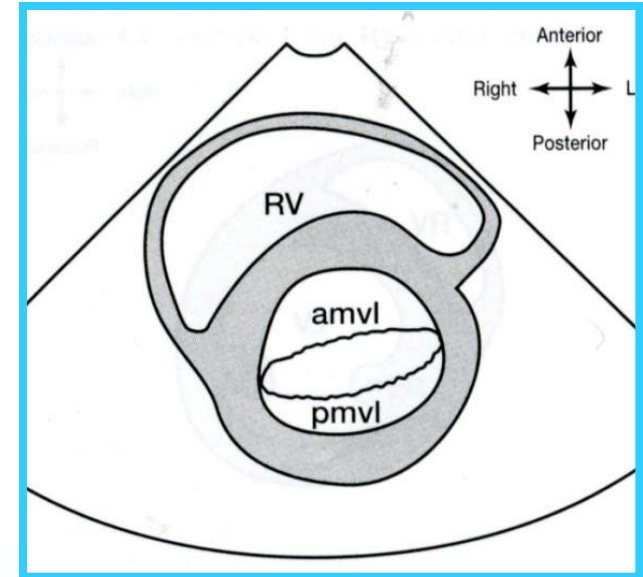
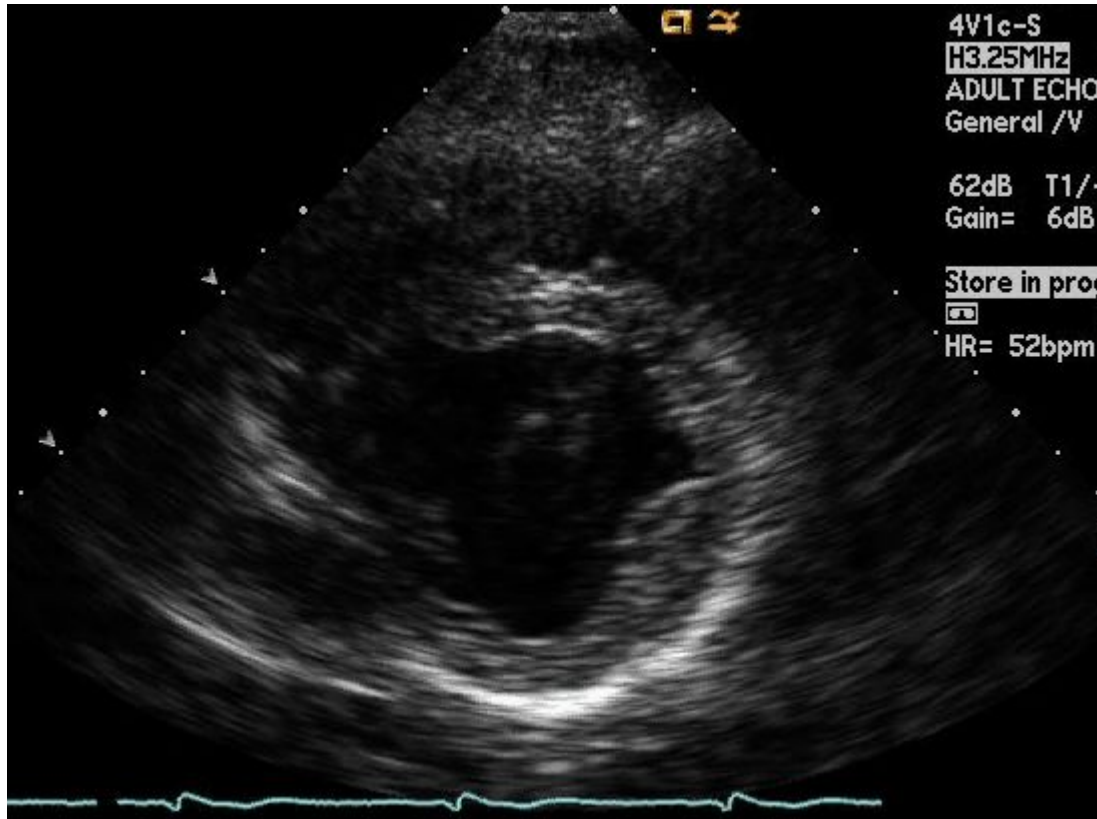


PSAX- Mid



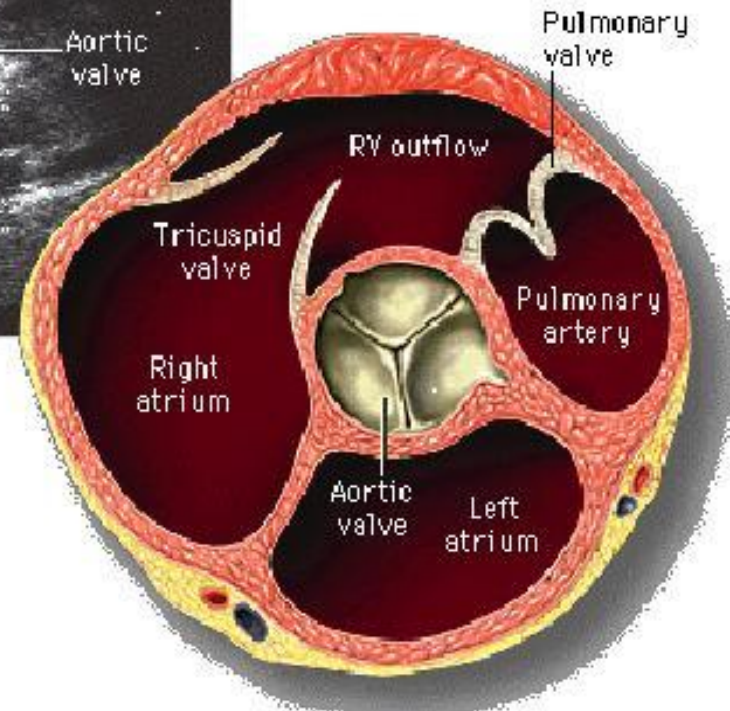
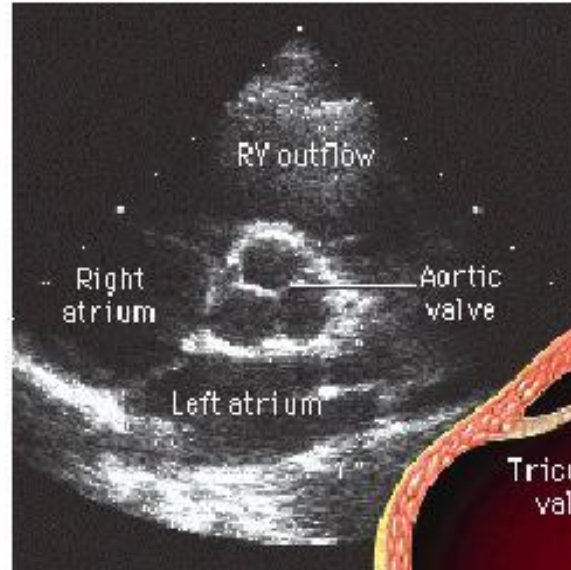
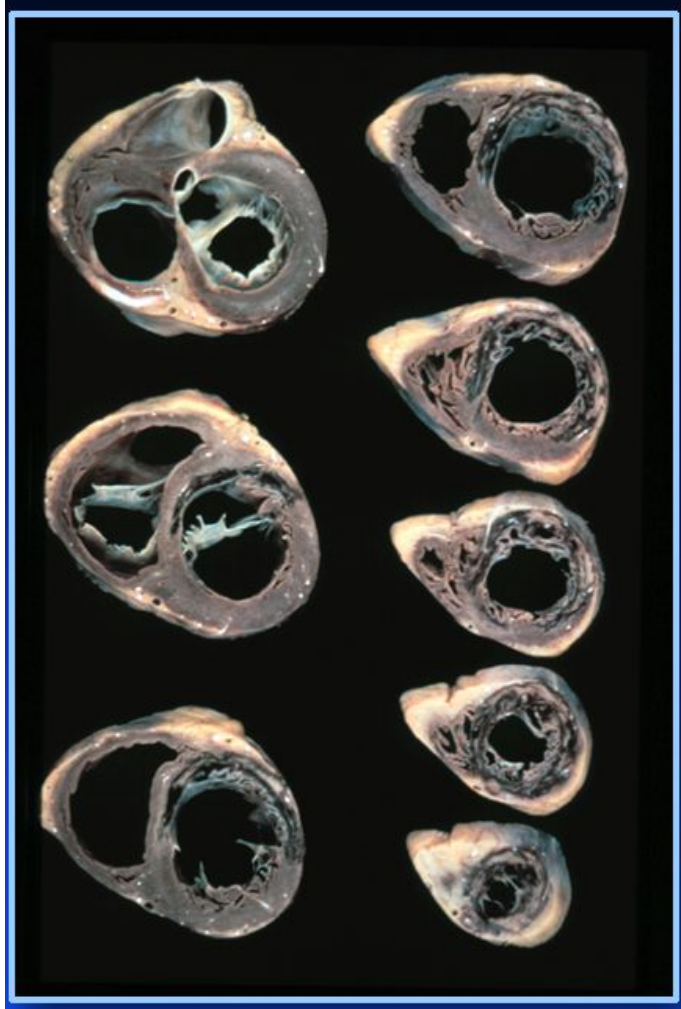
PSAX- Apex

# Parasternal short axis view

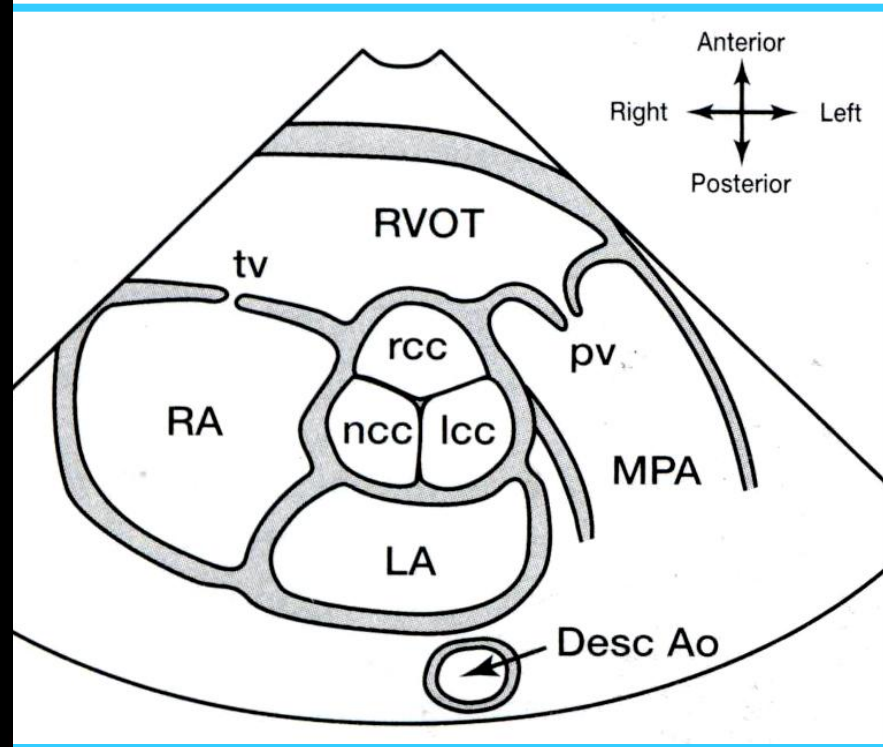
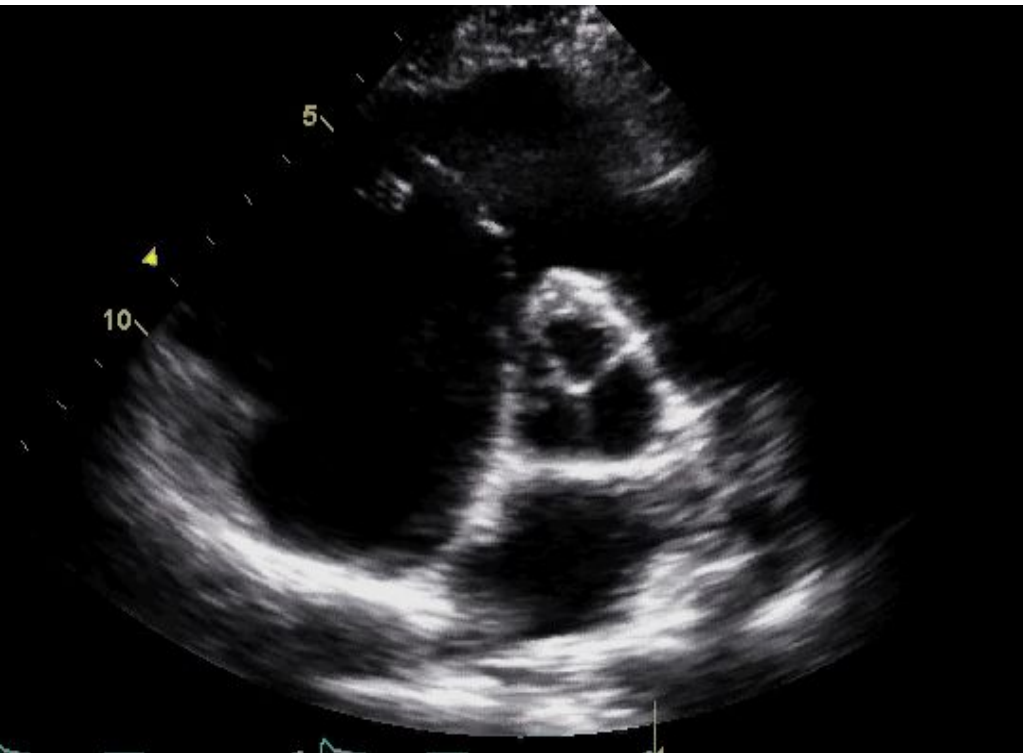




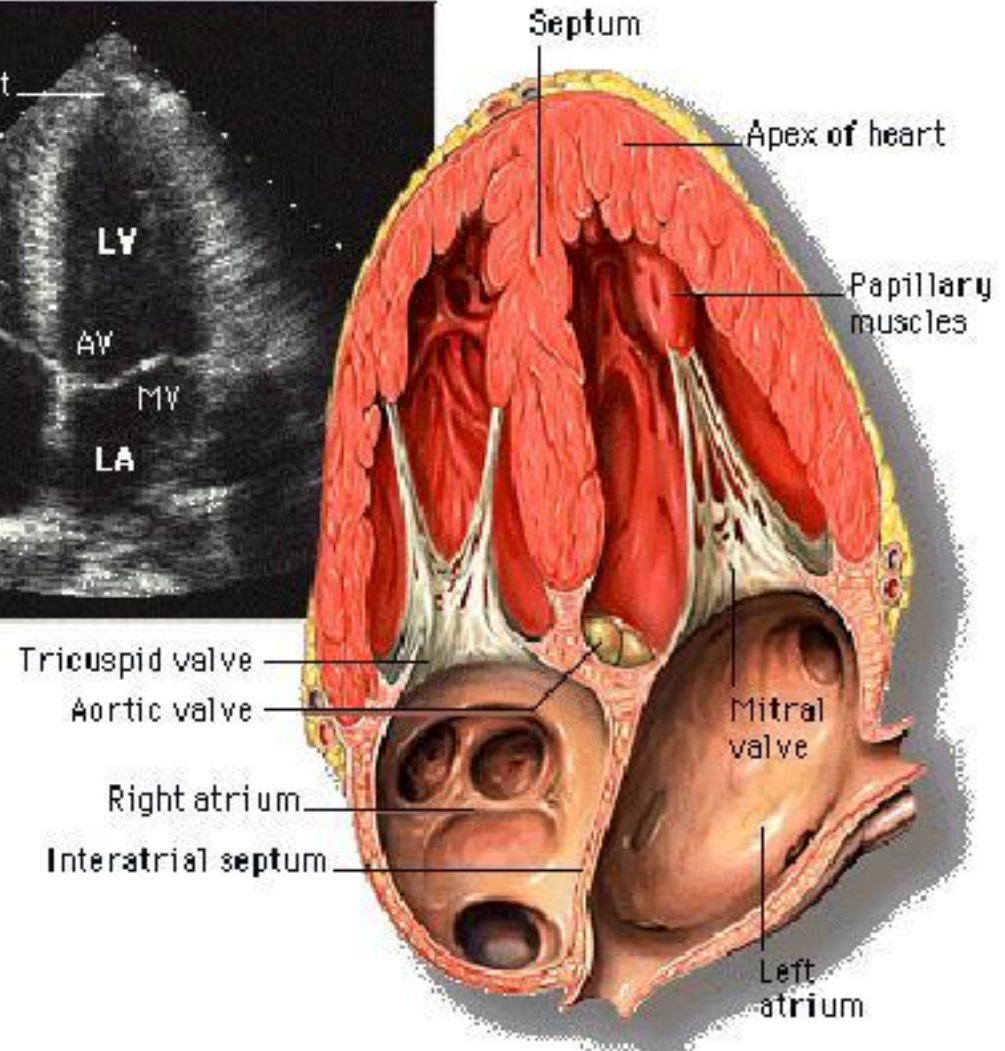
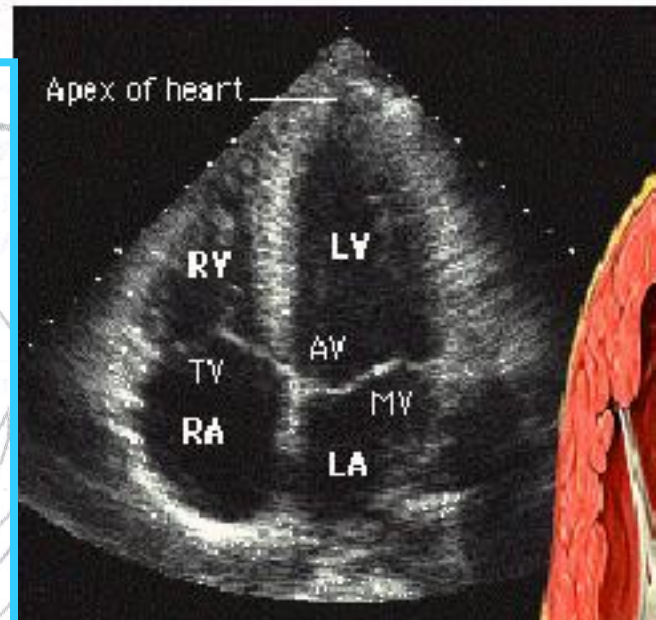
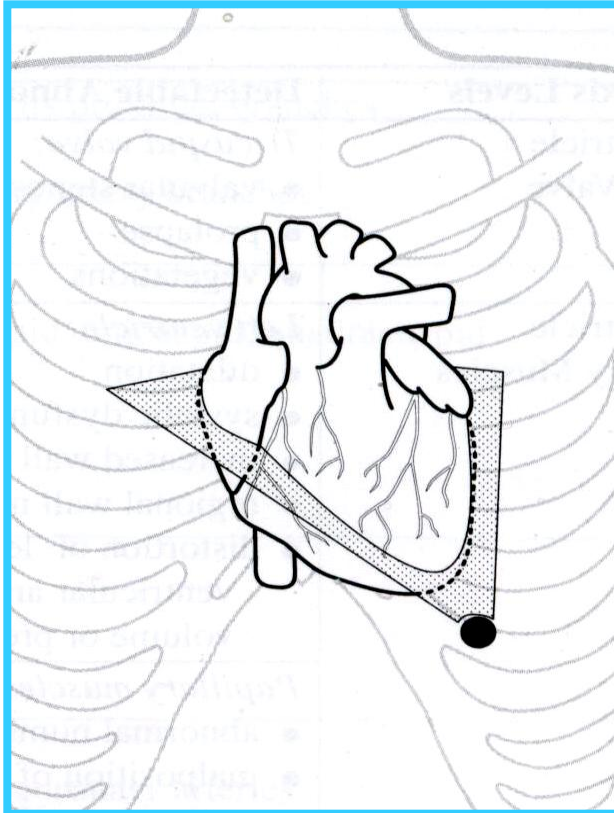
# Short axis view of aorta



# Short axis view of aorta

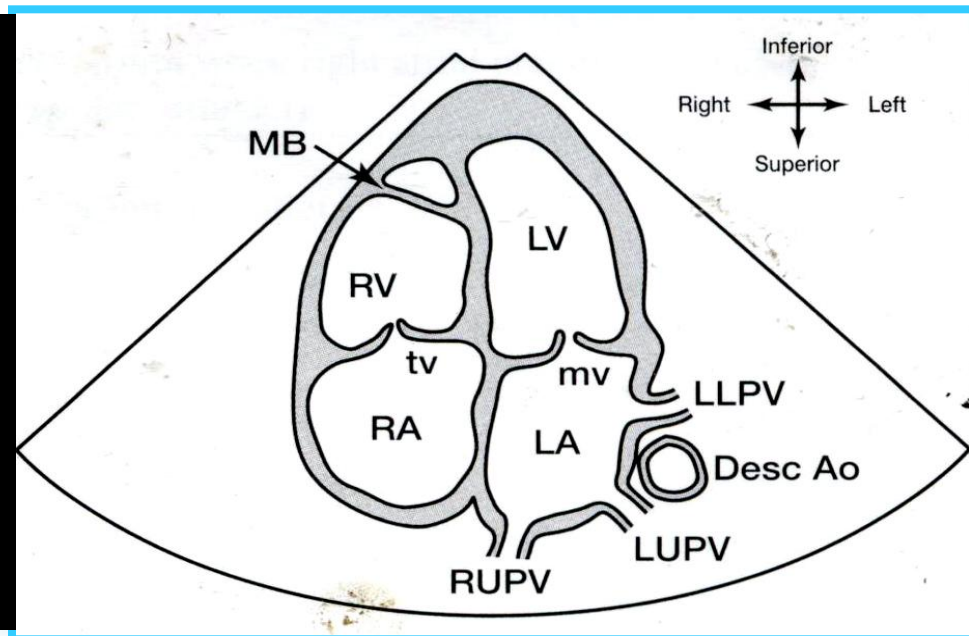


# Apical 4 chamber view

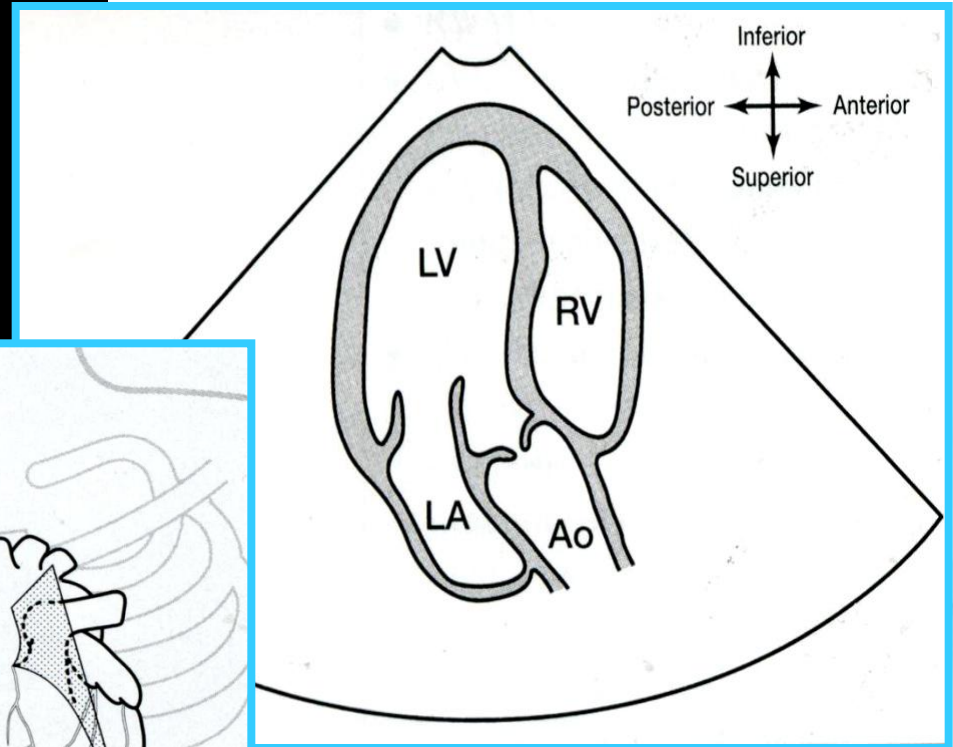
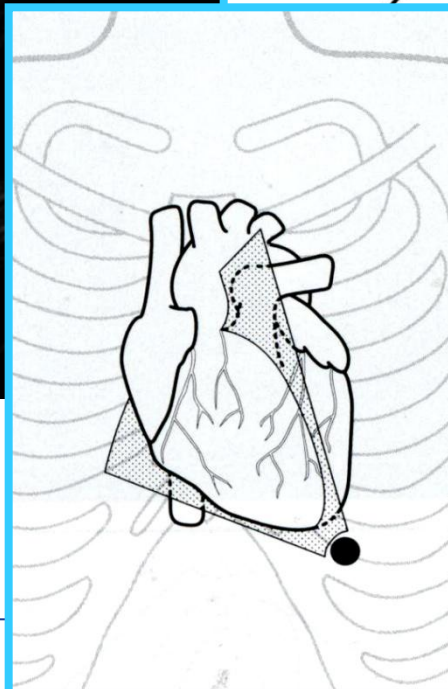
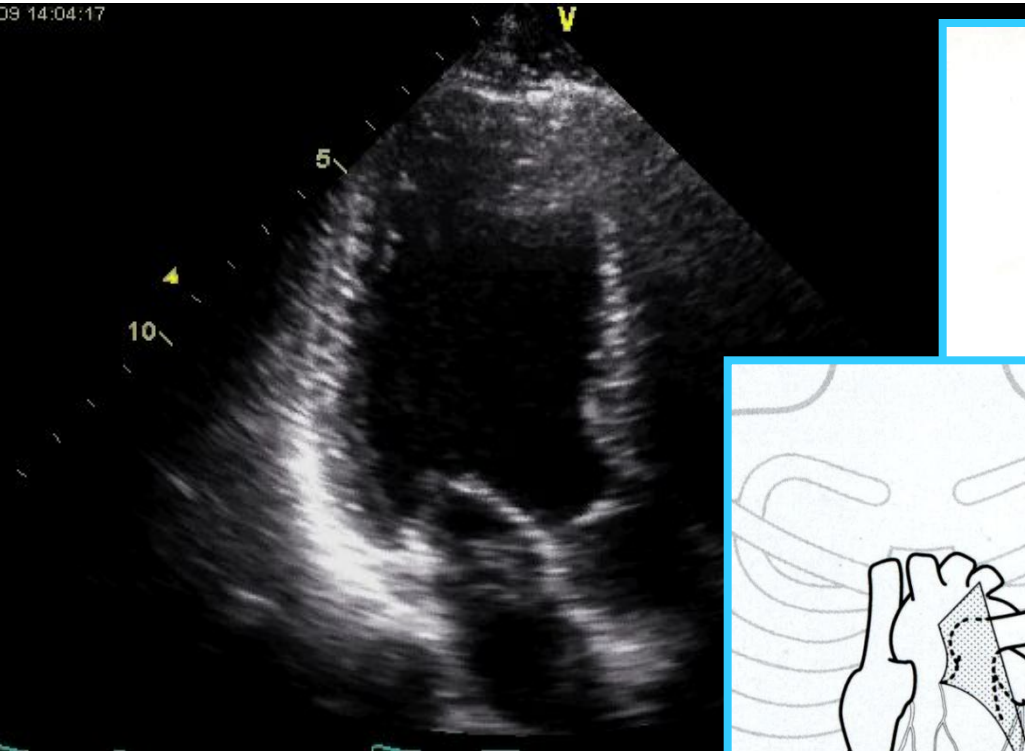




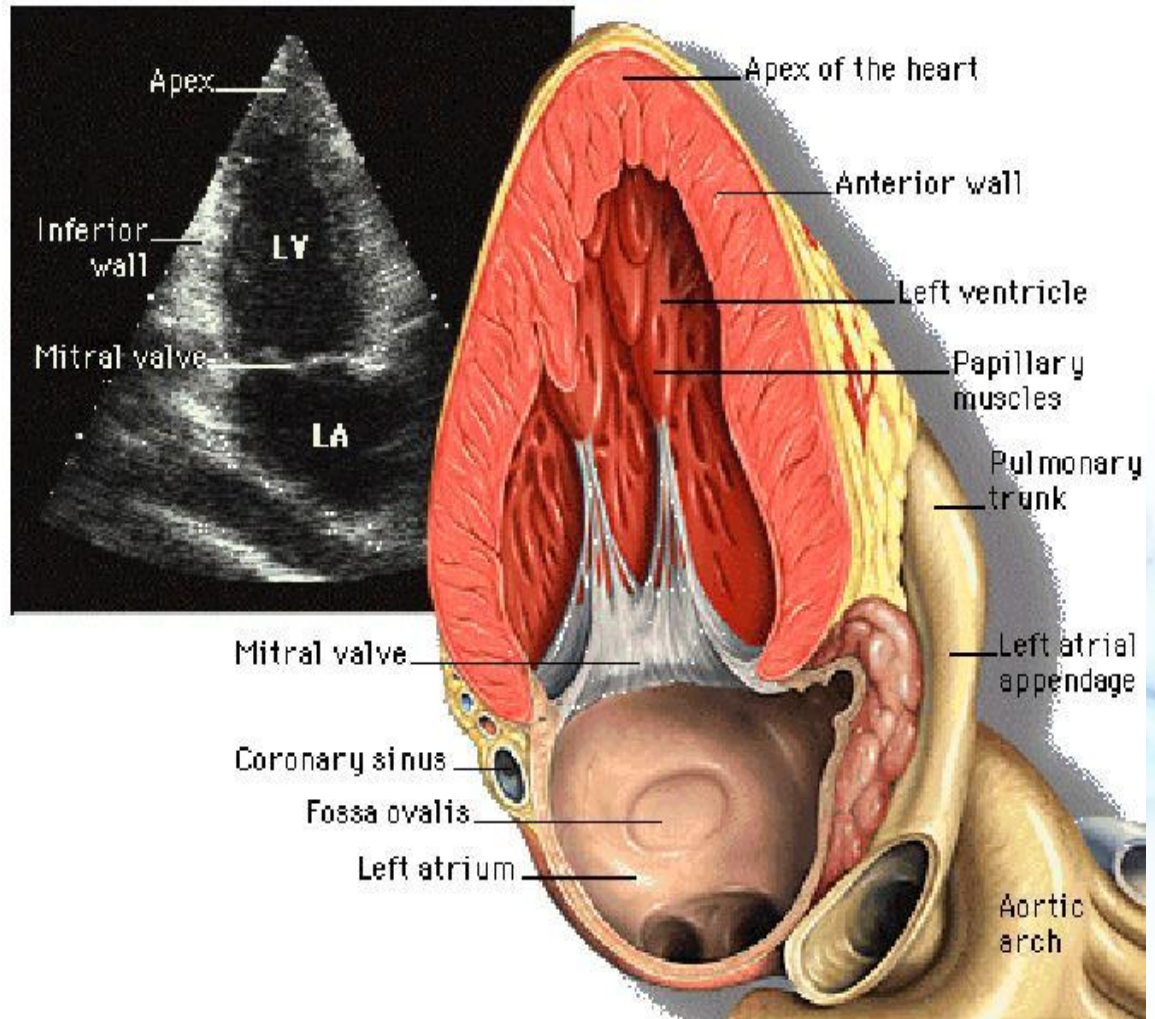
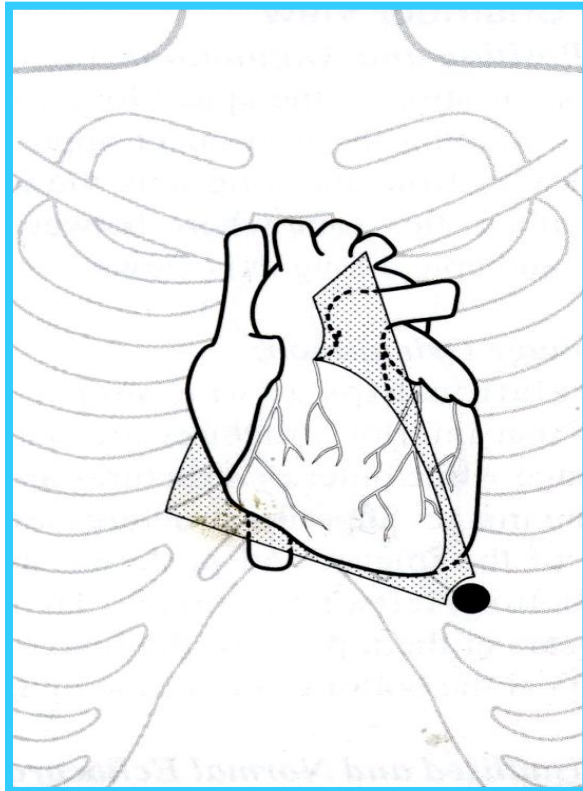
# Apical 4 chamber view



# Apical long axis view

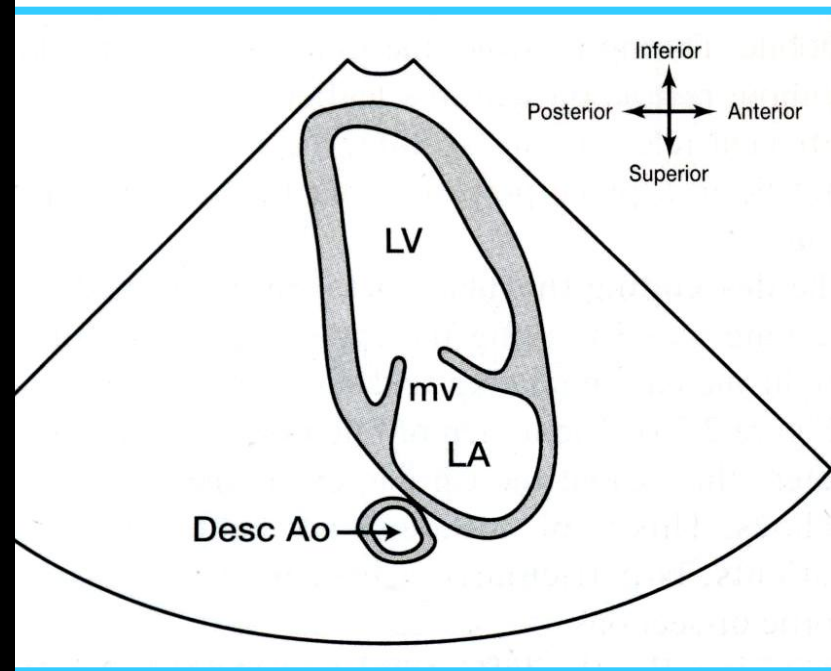


# Apical 2 chamber view

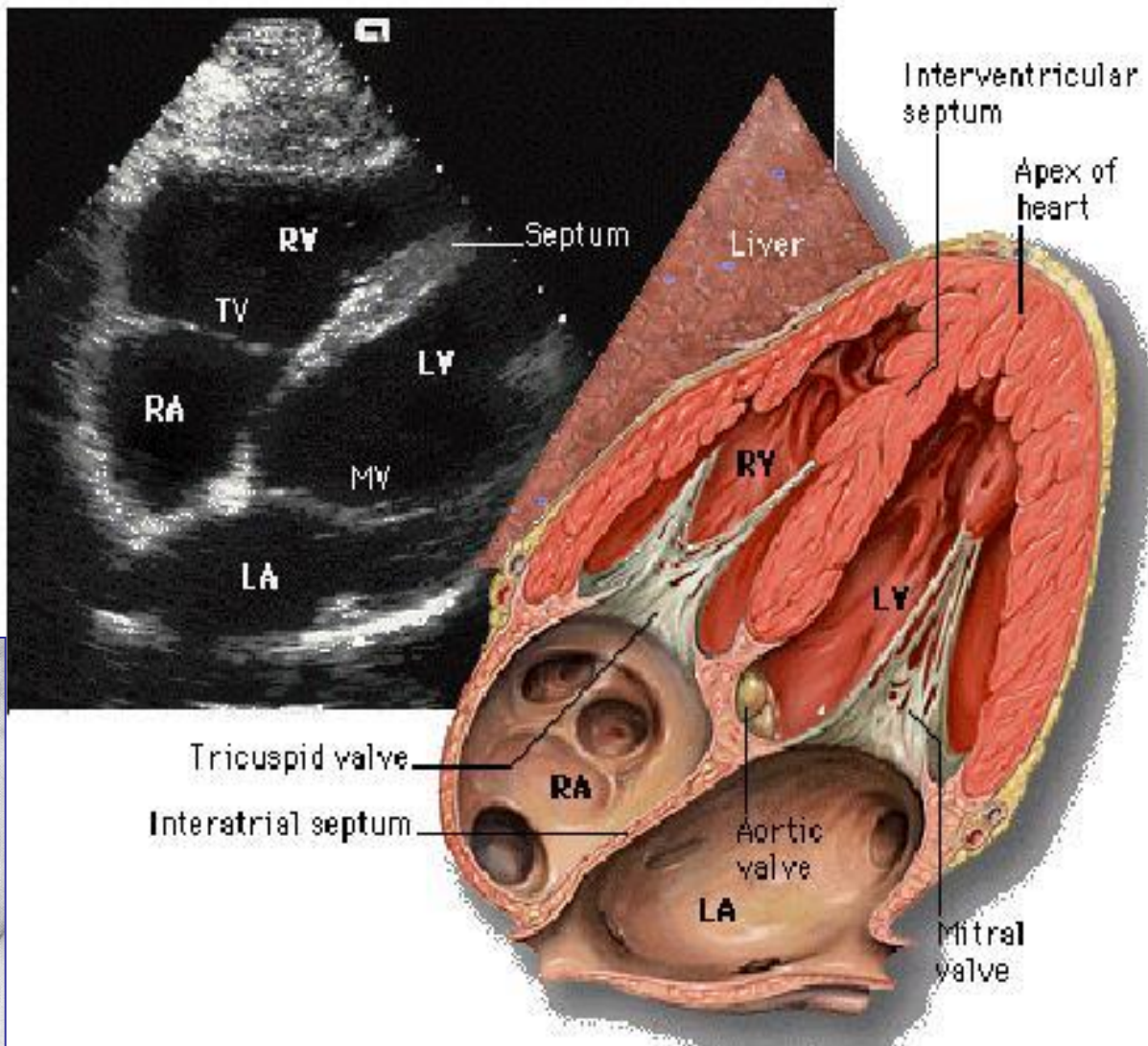
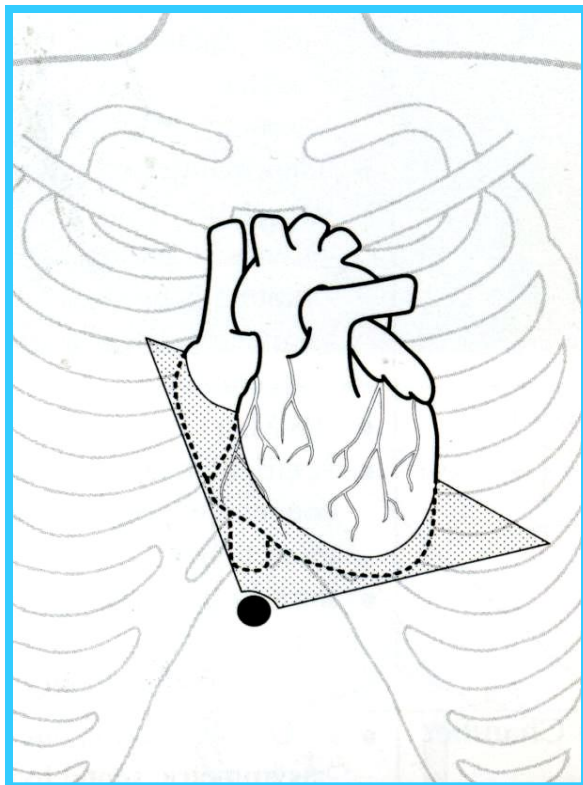




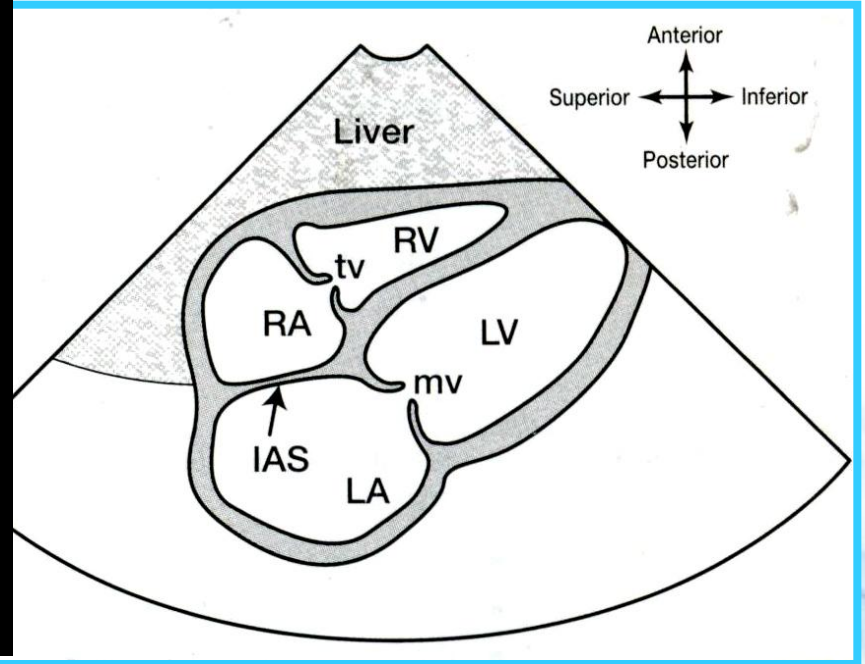
# Apical 2 chamber view



# Subcostal view

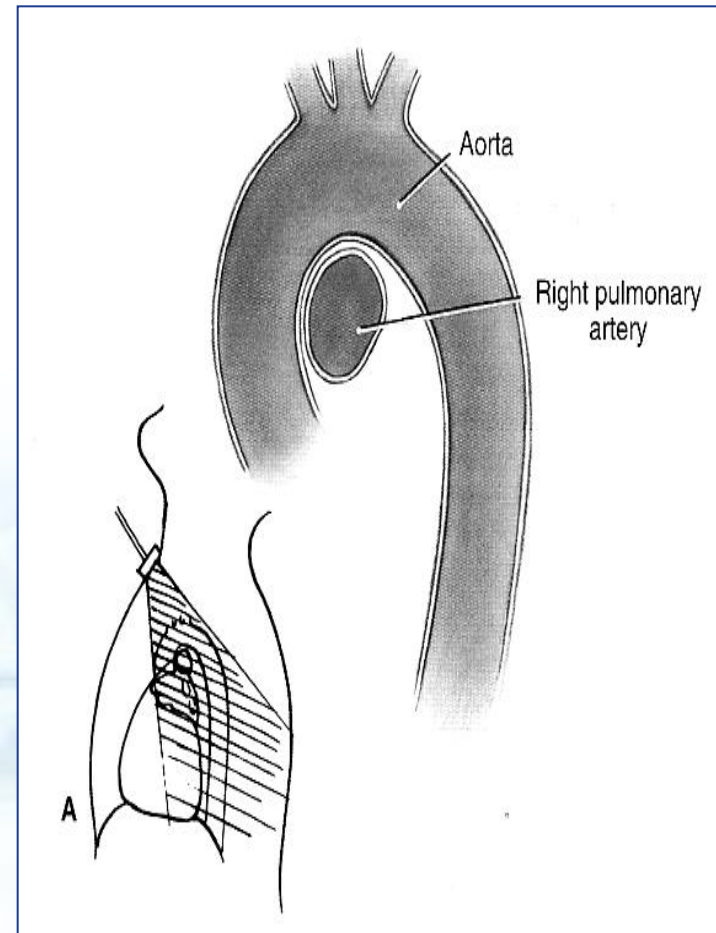
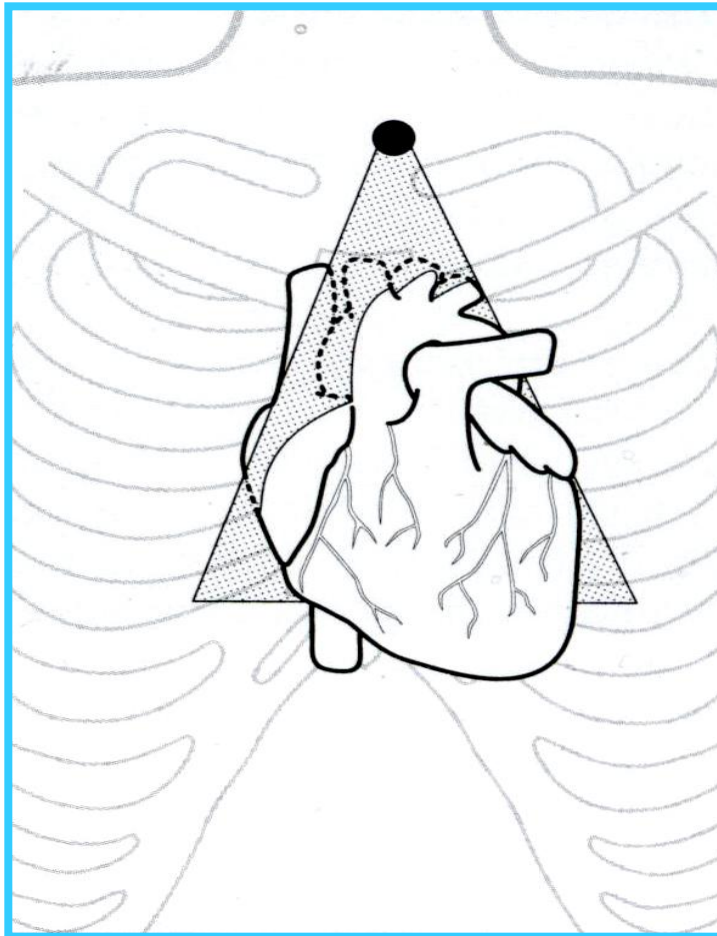


# Subcostal view

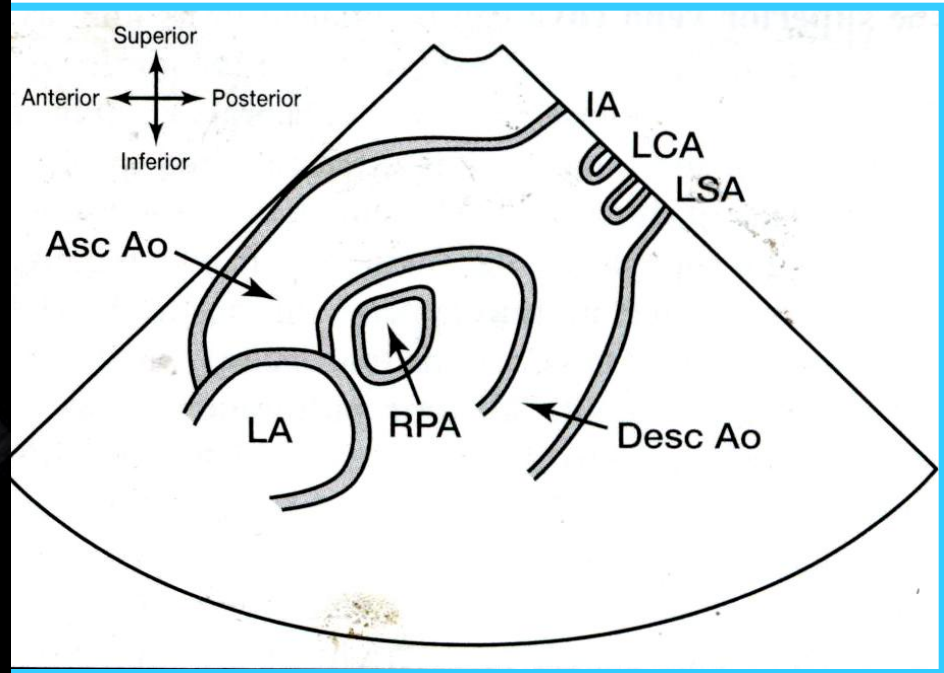




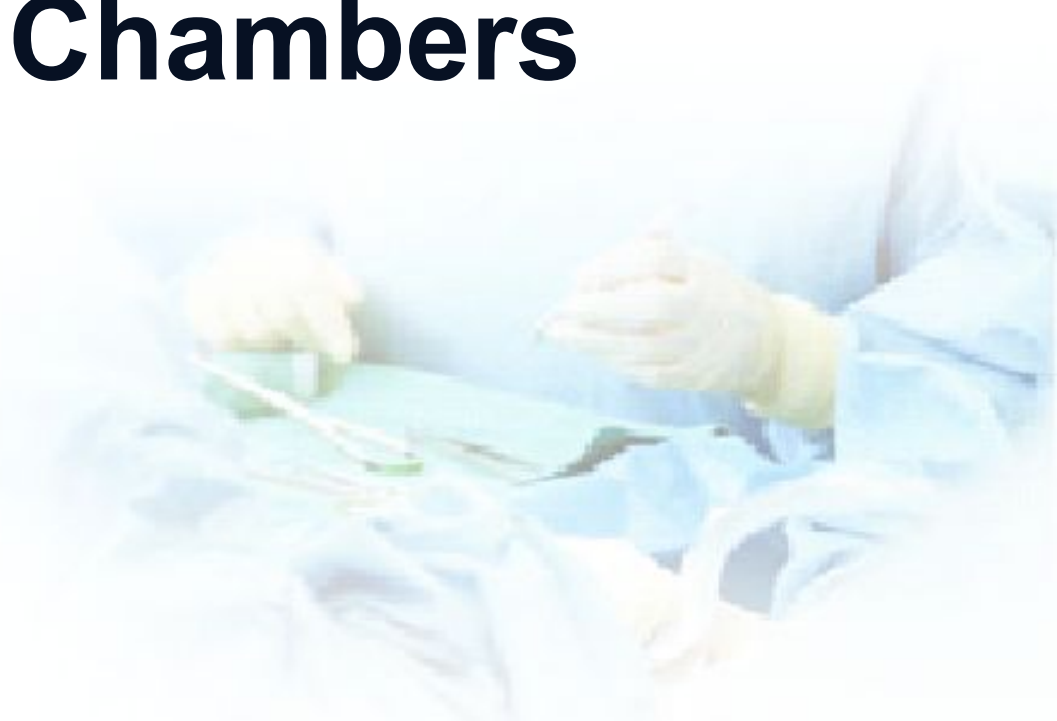
# Suprasternal notch view



# 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



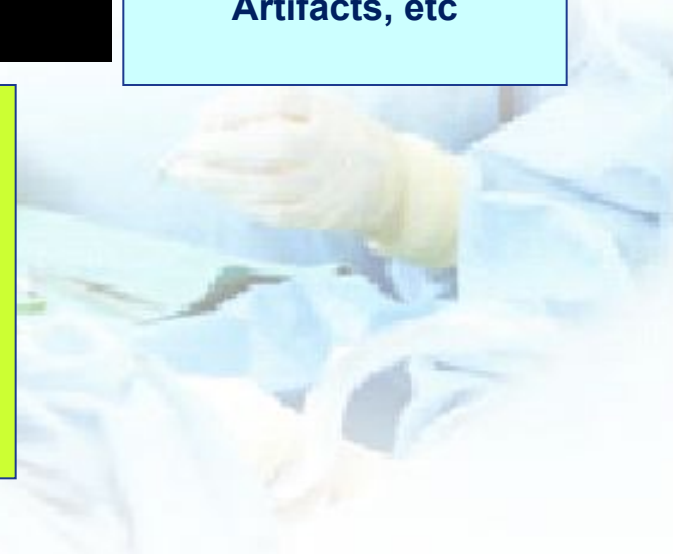
## Tester factors

technique  
knowledge  
experience



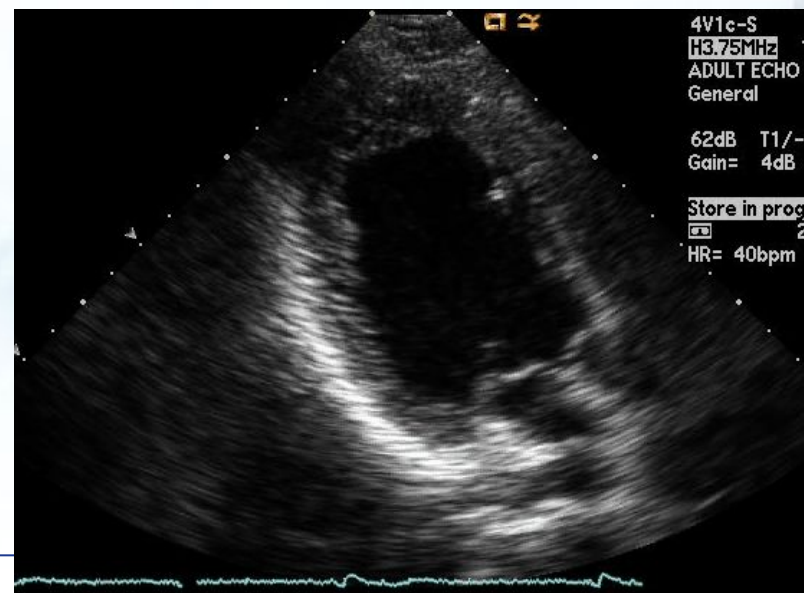
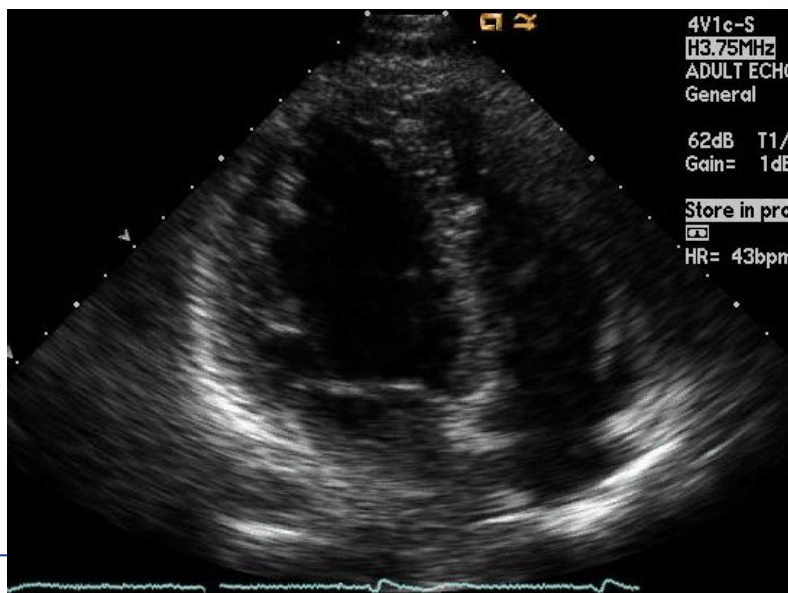
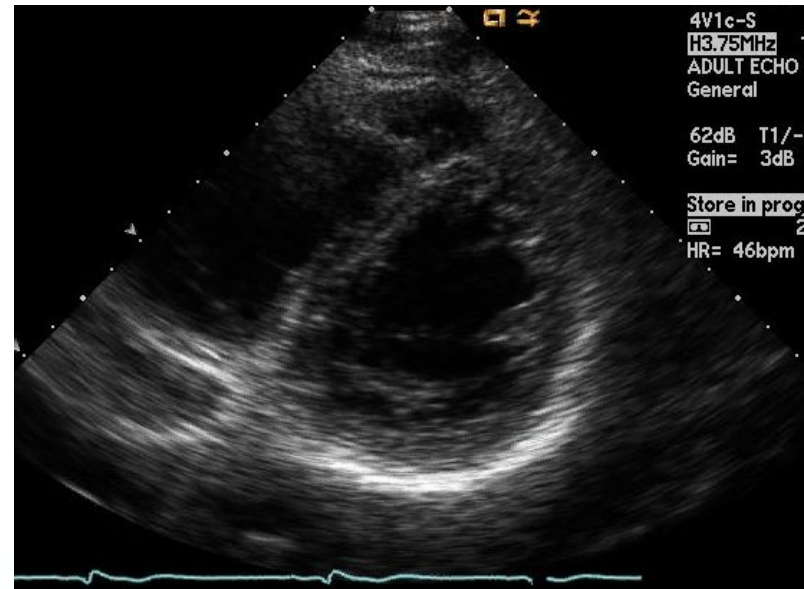
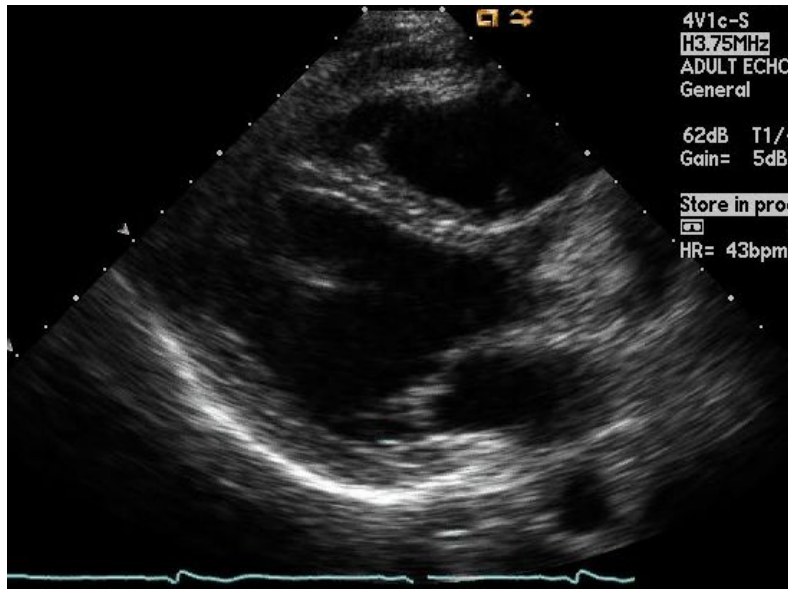
**Machine factor**  
Depth  
Gain  
Frame rate  
Resolution  
Power  
Compression  
Dynamic range  
Persistence  
Focusing  
Artifacts, etc

**Patient factors**  
Hemodynamic stability  
Body shape  
Combined disease

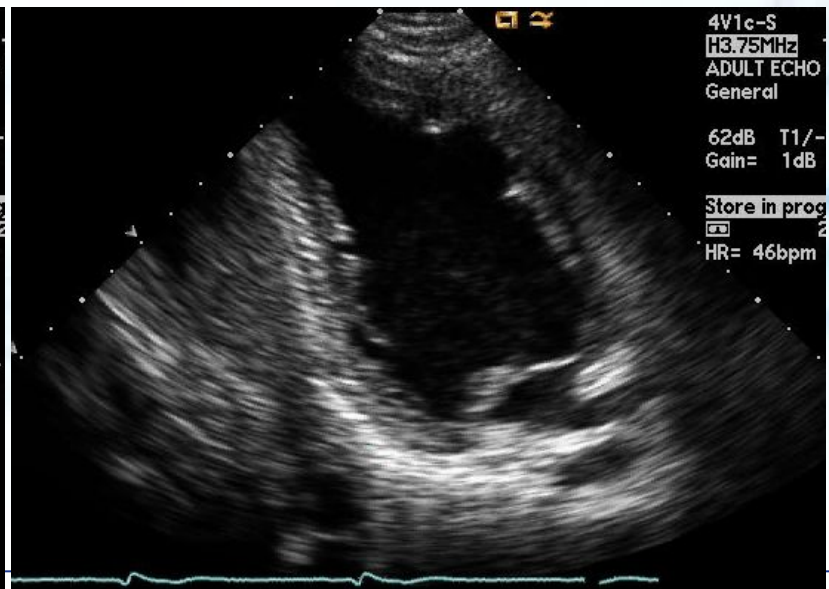
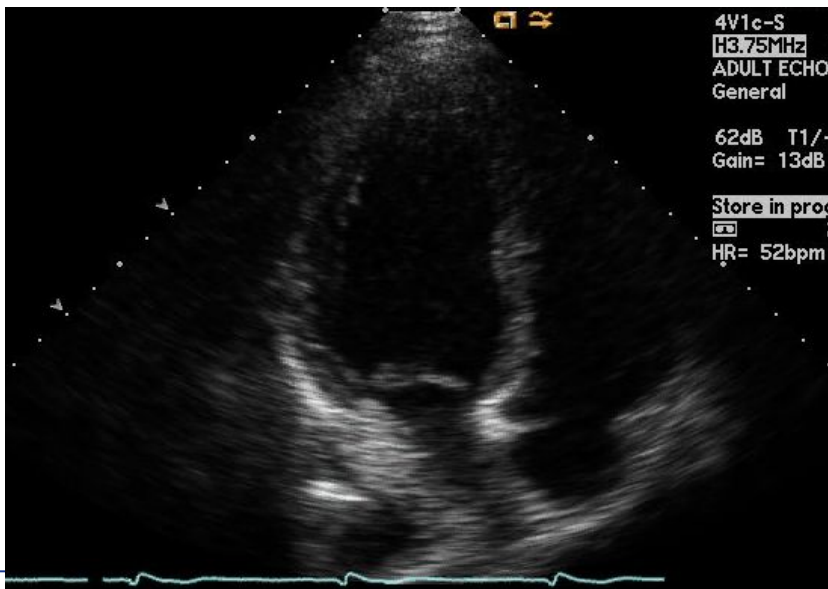
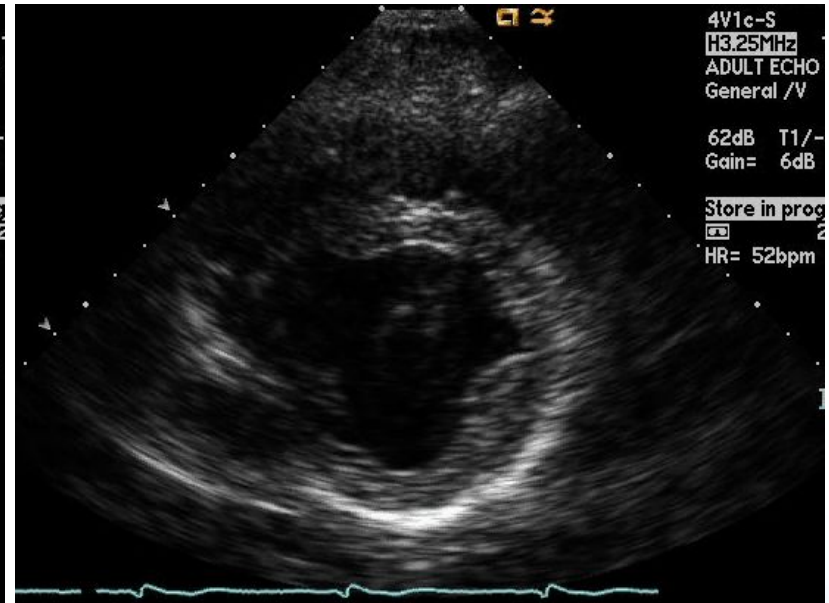
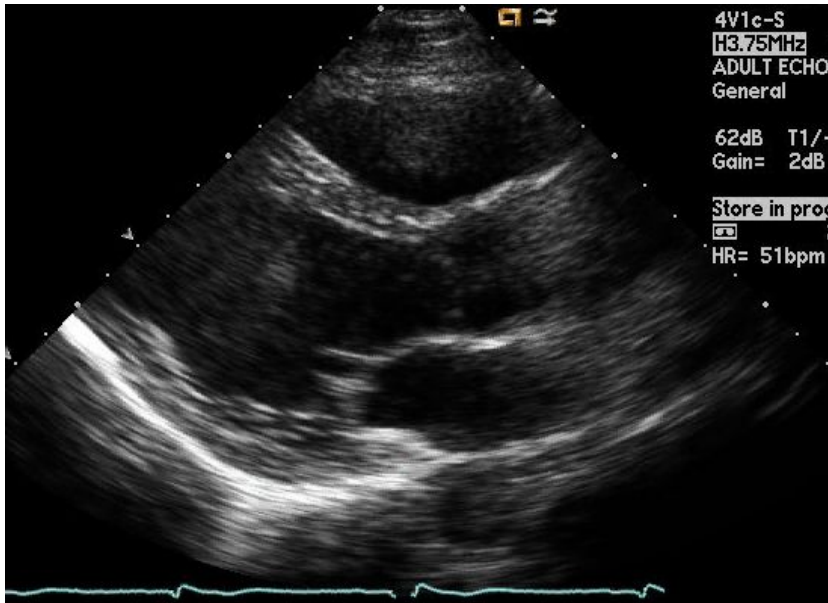




# 2D Image Optimization



# 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



	<b>Advantage</b>	<b>Limitation</b>
<b>Mass</b>		
<b>M-mode 2D</b>	<b>Wealth of accumulated data</b>	<ul style="list-style-type: none"><li>- Inaccurate with RWMA</li><li>- Beam orientation (M-mode)</li><li>- Small errors magnified</li><li>- Overestimates LV mass</li></ul>
<b>Area length</b>	<ul style="list-style-type: none"><li>- Allows for contribution of papillary muscle</li></ul>	<ul style="list-style-type: none"><li>- Insensitive to distortion</li></ul>
<b>Truncated ellipsoid</b>	<ul style="list-style-type: none"><li>- More sensitive to distortions</li></ul>	<ul style="list-style-type: none"><li>- Based on mathematic assumptions</li><li>- Minimal normal data</li></ul>

# Measure LV dimension & thickness

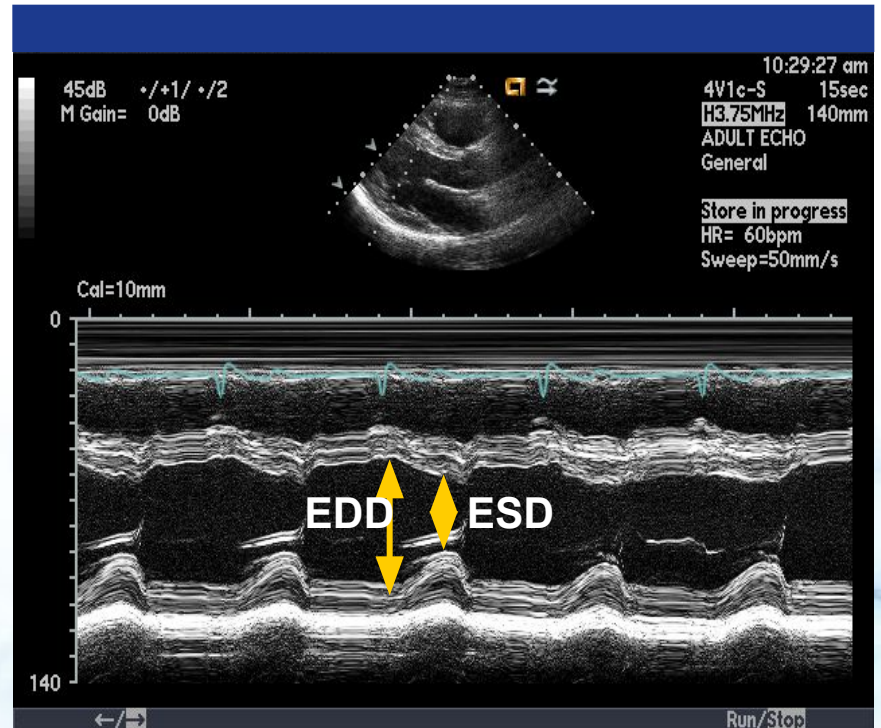
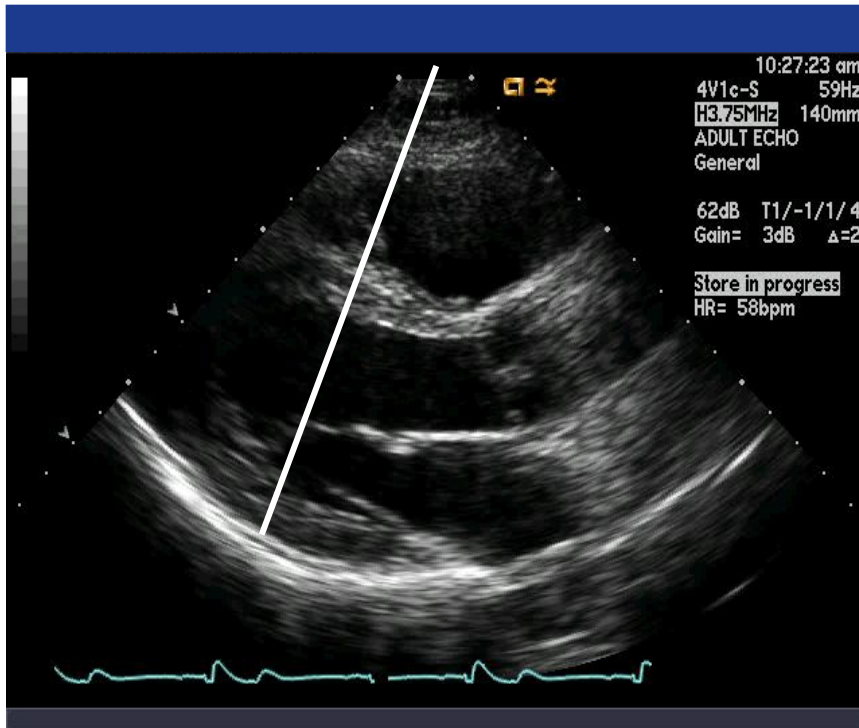


- **PLAX, PSAX view**
- **End of mitral leaflet**
- **2D or M-mode**
- **End diastole, systole**
  - **multiple beat**

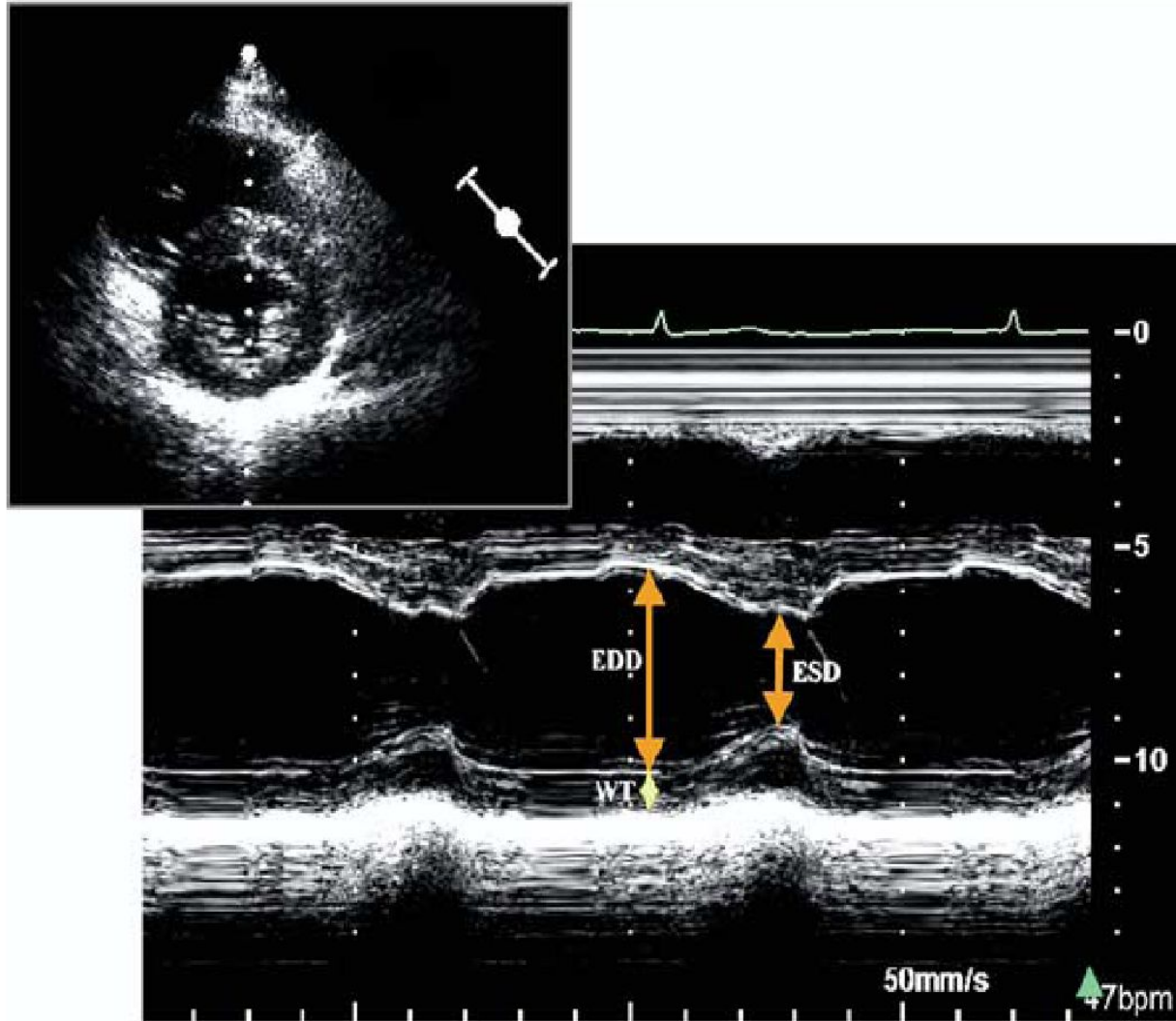




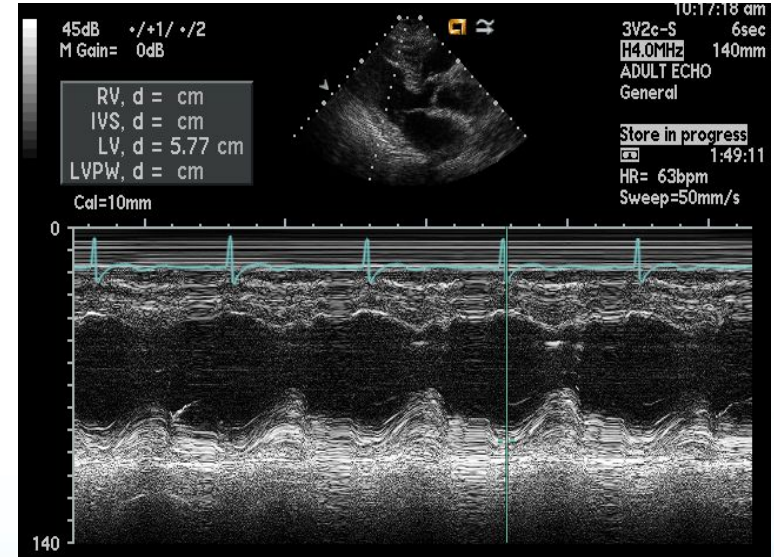
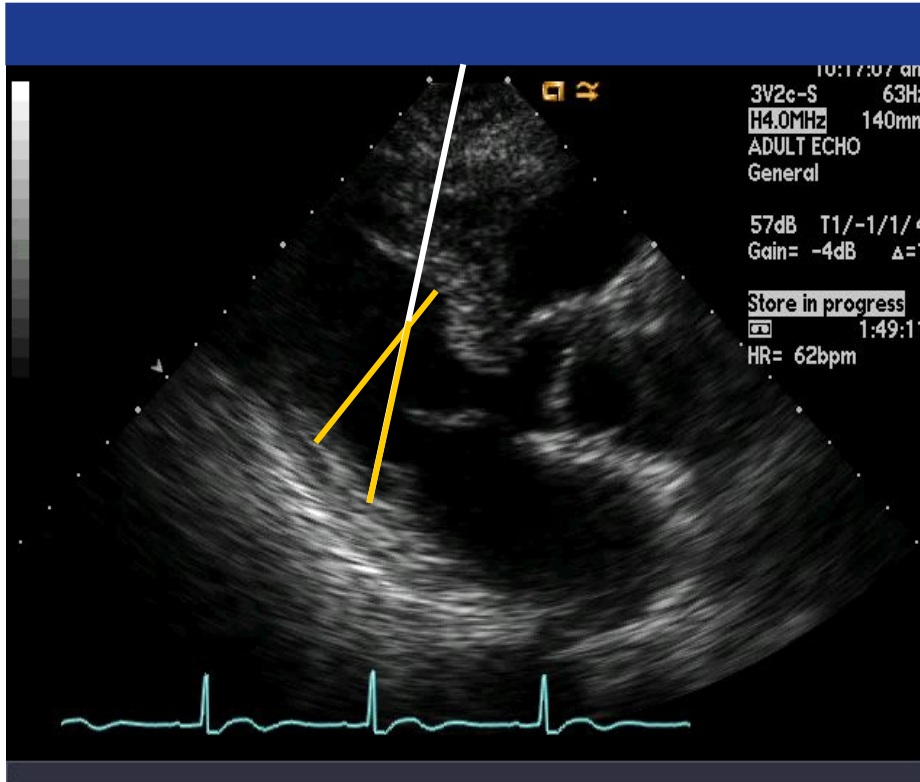
# LV M-mode



# LV M-mode



# LV 2D



BSA 1.37 m<sup>2</sup> 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 <sup>2</sup>
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 <sup>2</sup>
				LV EF	62.6 %
				LV CO	6.49 l/min
				LV CI	4.73 l/min/m <sup>2</sup>
				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 <sup>2</sup>	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/m<sup>2</sup></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/m<sup>2</sup></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**

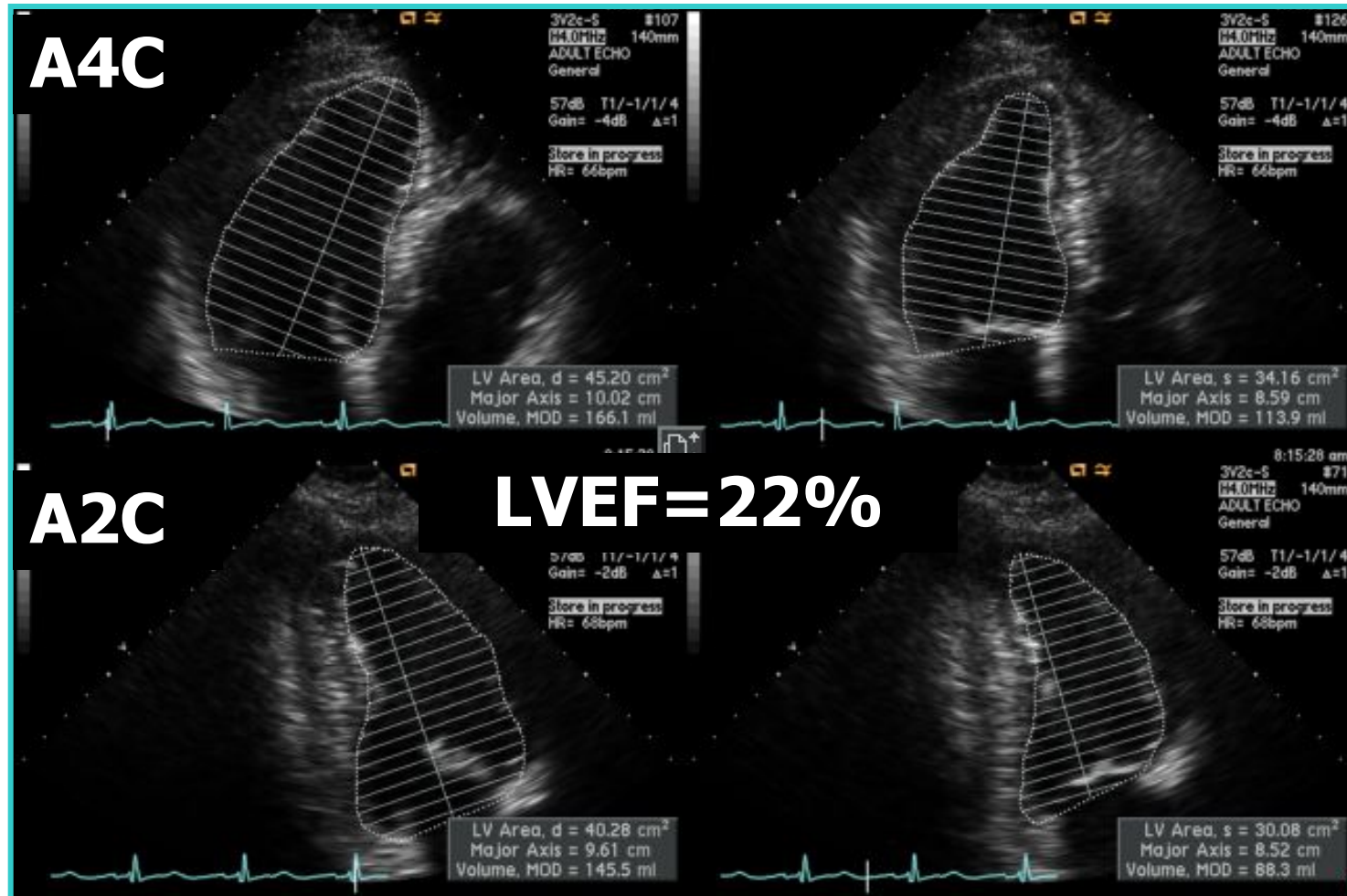


# LV volume measure

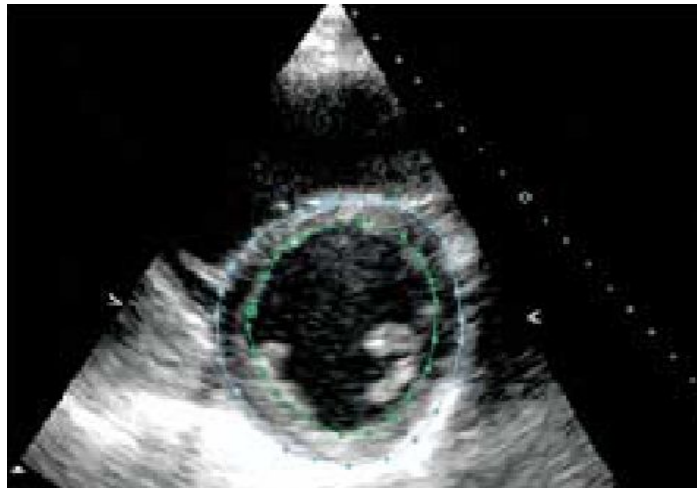


End diastole

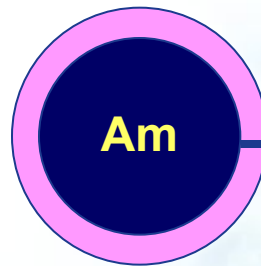
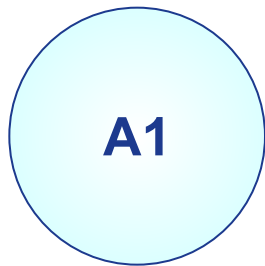
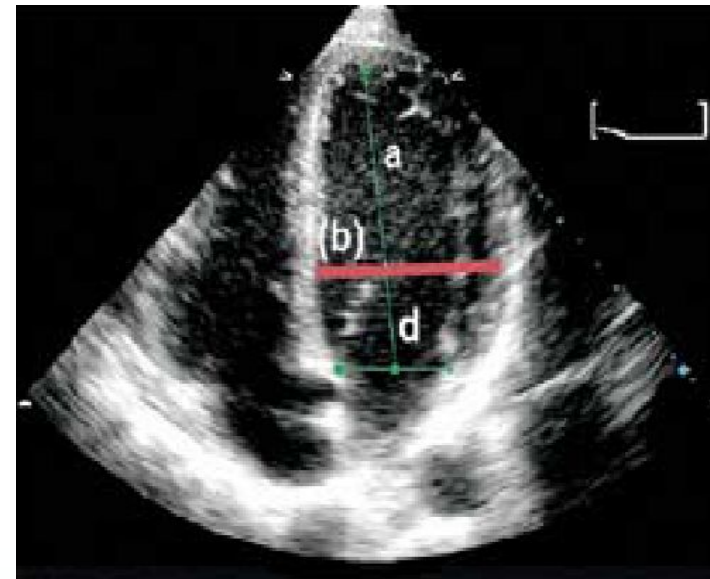
End systole



# 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/m<sup>2</sup></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 <sup>2,7</sup> , g/m <sup>2,7</sup>	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/m<sup>2</sup></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>



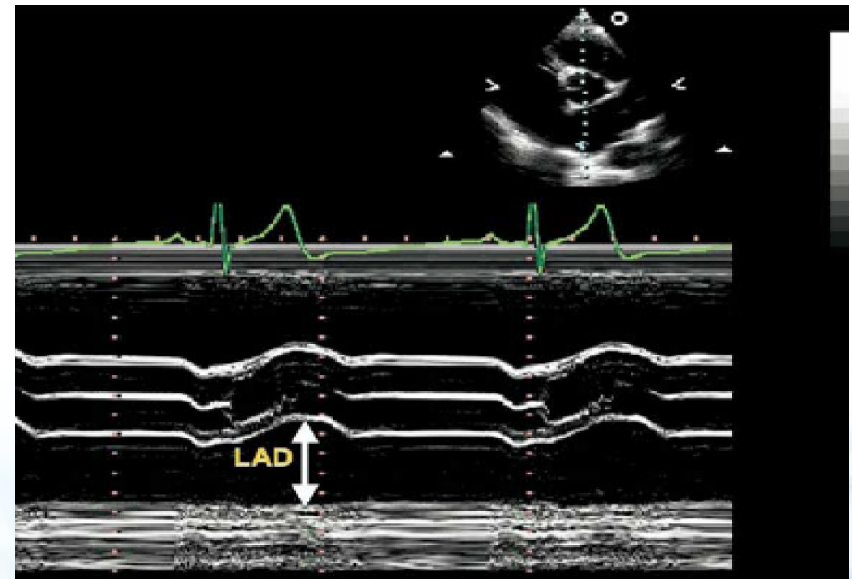
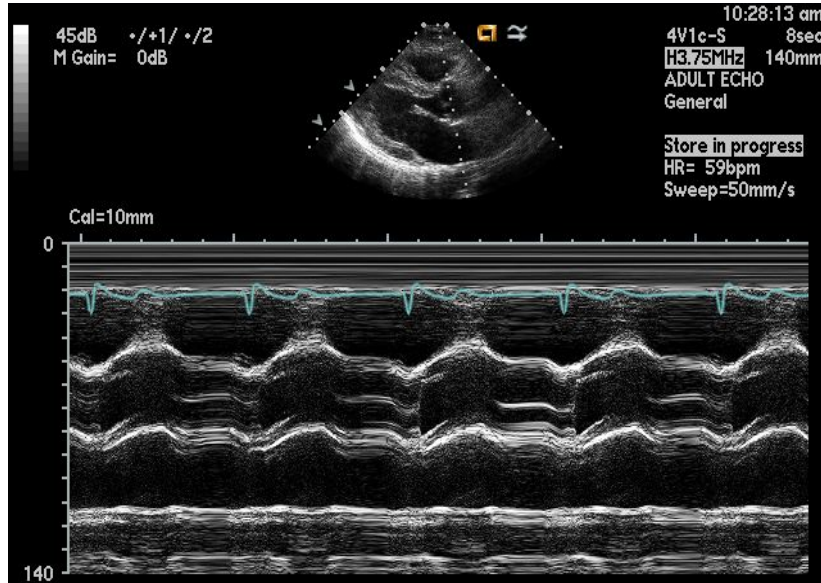
# Measure LA size



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

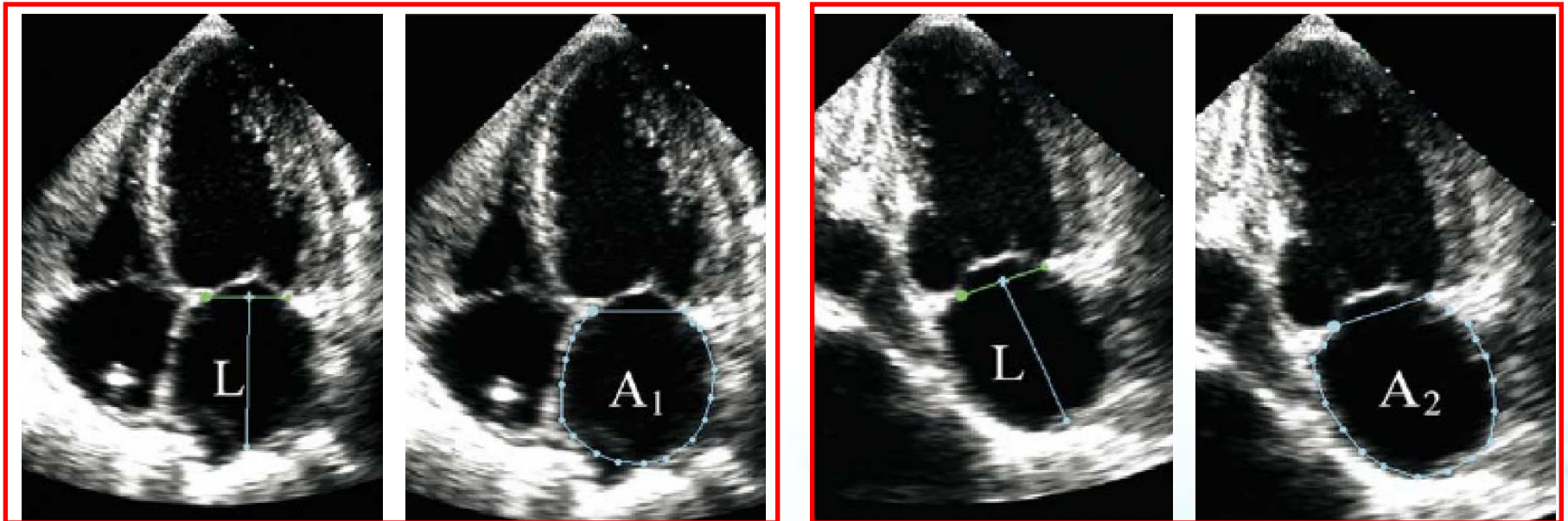


# Measure LA size



- ▶ 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

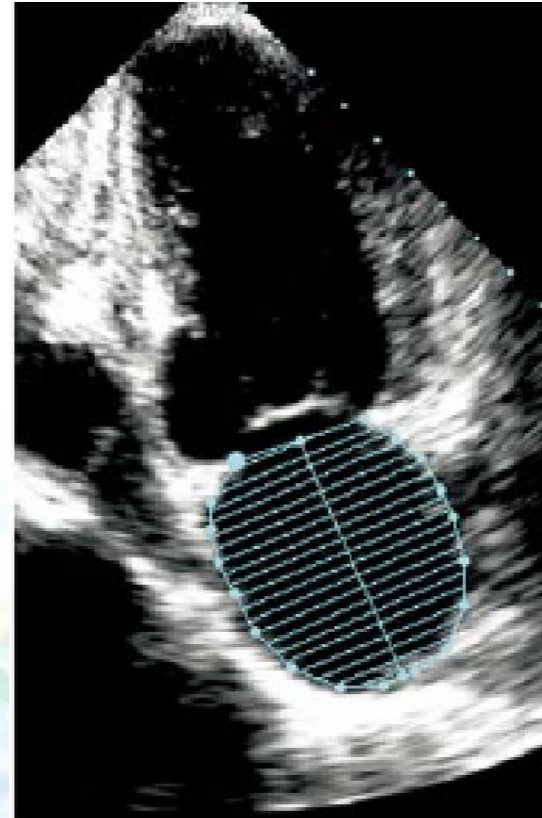
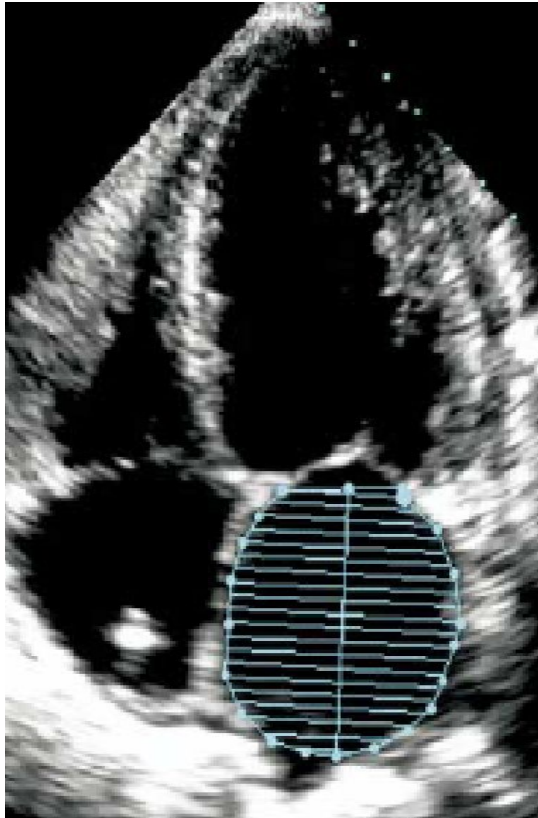


A2C

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

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

# LA size measure : Modified Simpson's Method



A2C

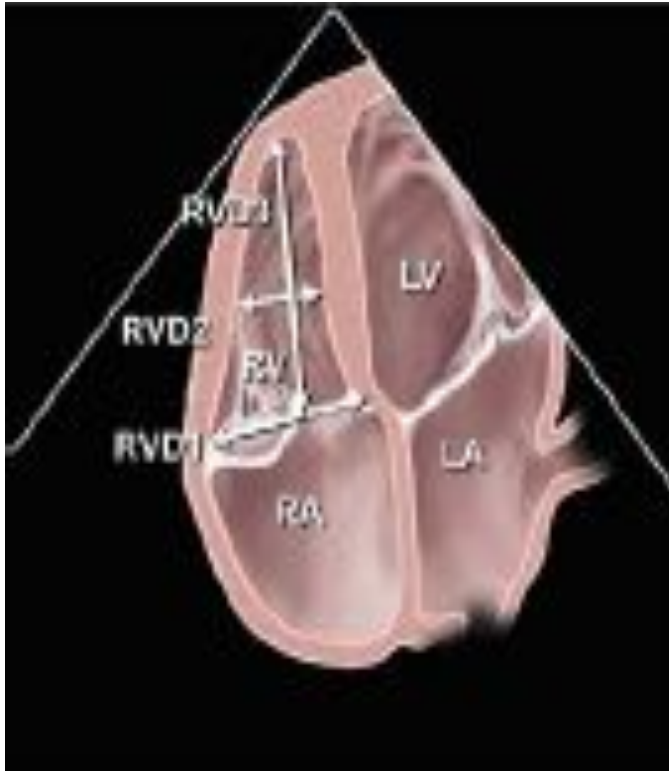


# Normal LA size



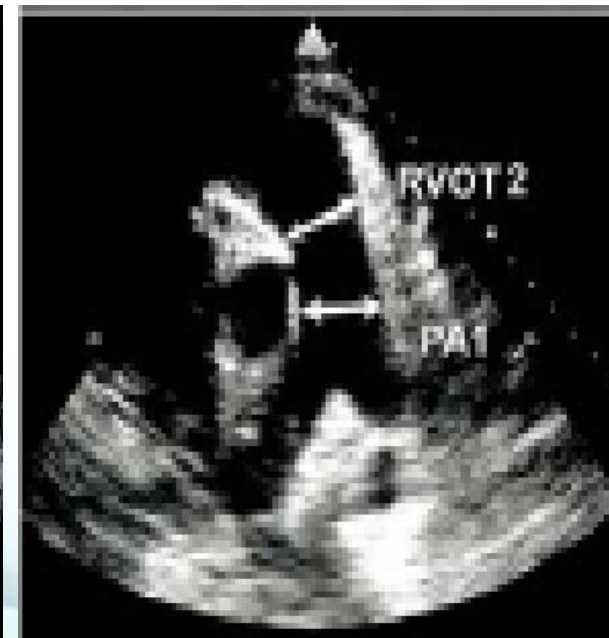
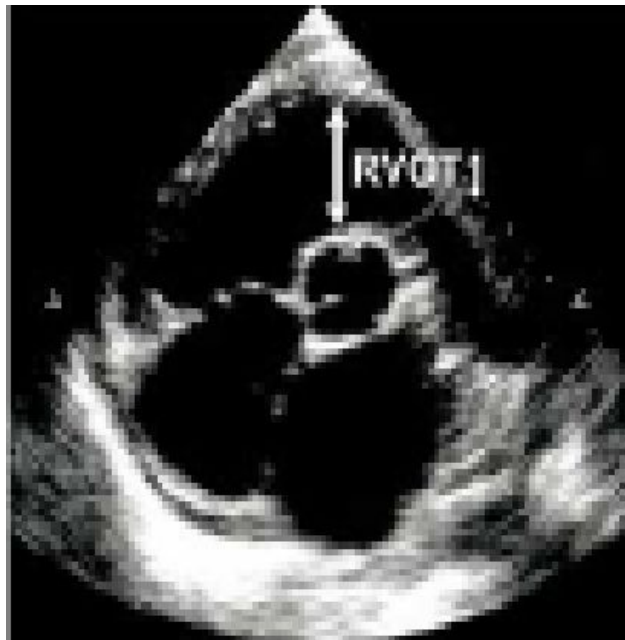
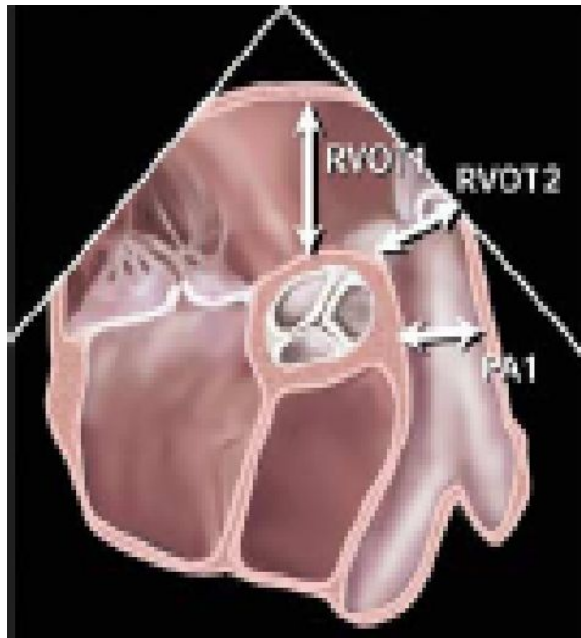
	Women				Men			
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
Atrial dimensions								
LA diameter, cm	2.7–3.8	3.9–4.2	4.3–4.6	≥4.7	3.0–4.0	4.1–4.6	4.7–5.2	≥5.2
LA diameter/BSA, cm/m <sup>2</sup>	1.5–2.3	2.4–2.6	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 <sup>2</sup>	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 <sup>2</sup>	≤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 <sup>2</sup>	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
<b>RV dimensions (Figure 12)</b>				
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
<b>RVOT diameters (Figure 13, 14)</b>				
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
<b>PA diameter</b>				
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 blue-tinted sunglasses 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 !*