

重症超音波工作坊

台灣急救加護醫學會

Essential Echocardiography **in ICU**



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萬芳醫院急診醫學科

課程學習目標

- ◆ **SonoAnatomy / Views** 心臟掃描，基本觀念
- ◆ **Critical Heart Disease** 急重症單位，不得不知
- ◆ **Point of Care Ultrasound** 照護問題導向超音波

SonoAntomy / Views

關鍵要點

了解
機器
極限

實用
Mode
功能

探頭
病人
擺位

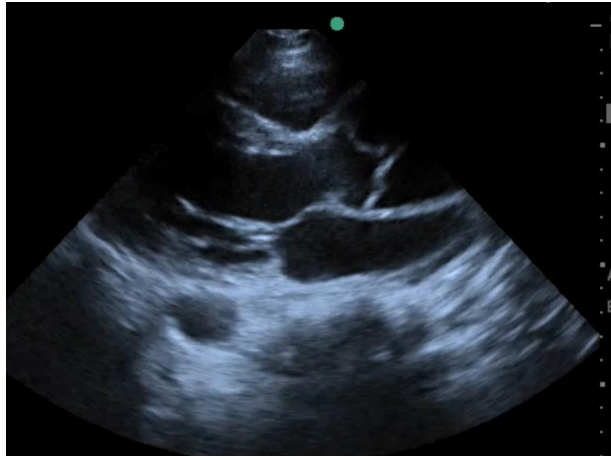
大小價位正相關影像?



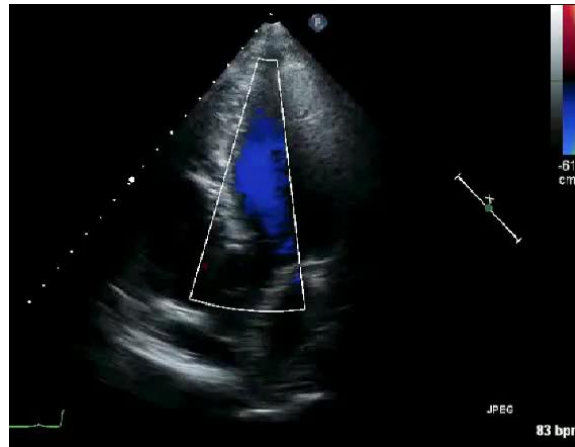


關鍵還是Operator

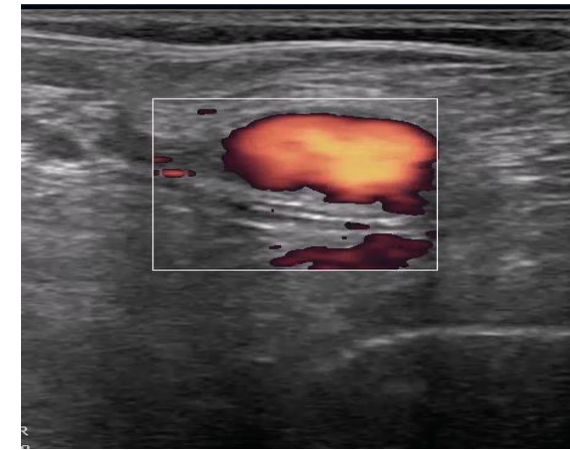
Modes/Functions



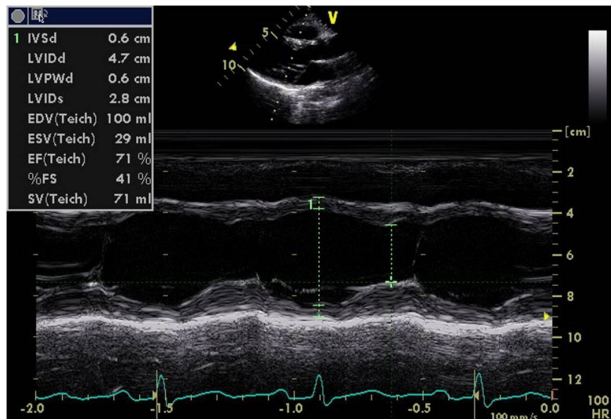
B-Mode



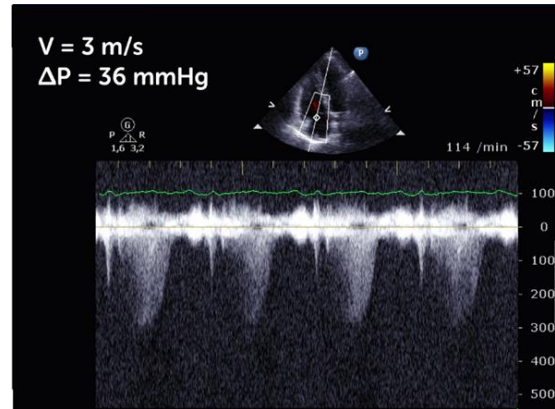
Color Doppler



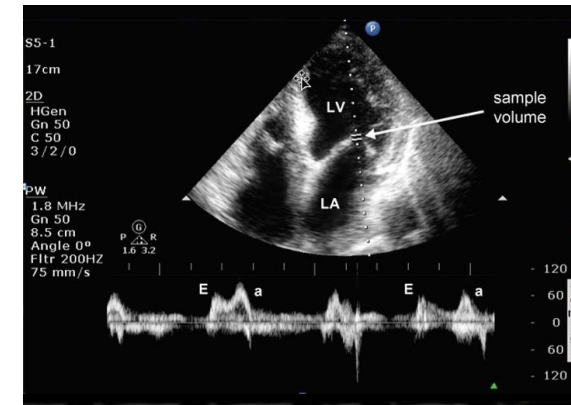
Power Doppler



M-Mode

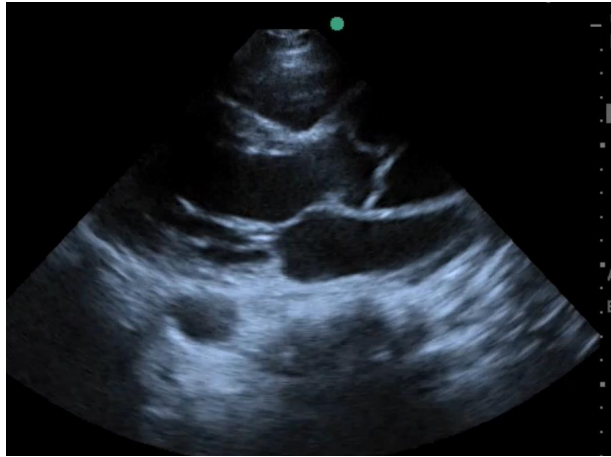


Continuous Wave Doppler

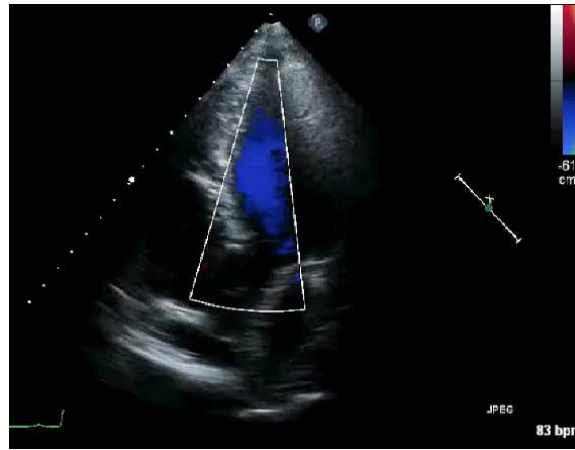


Pulsed Wave Doppler

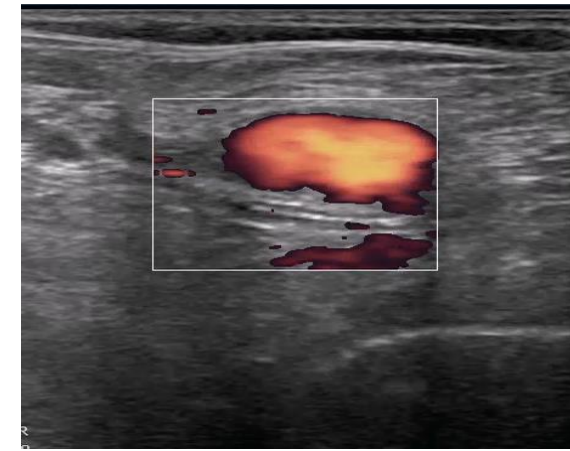
Modes/**Functions**



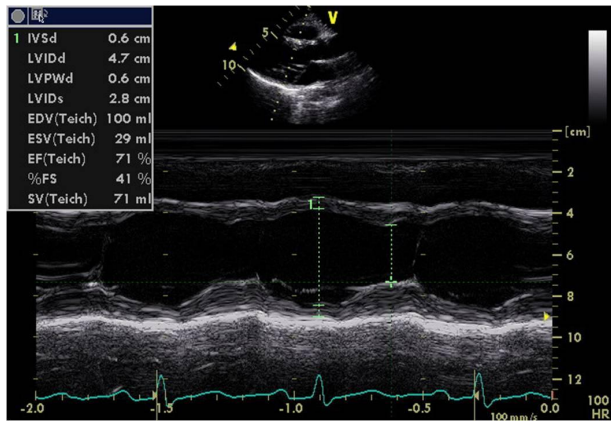
B-Mode



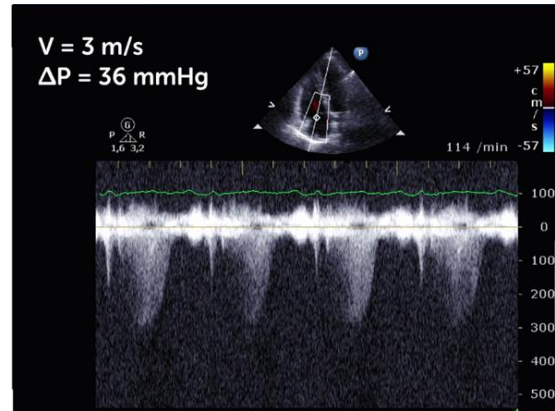
Color Doppler



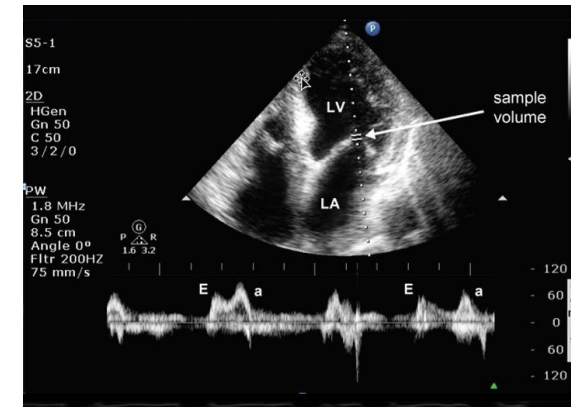
Power Doppler



M-Mode

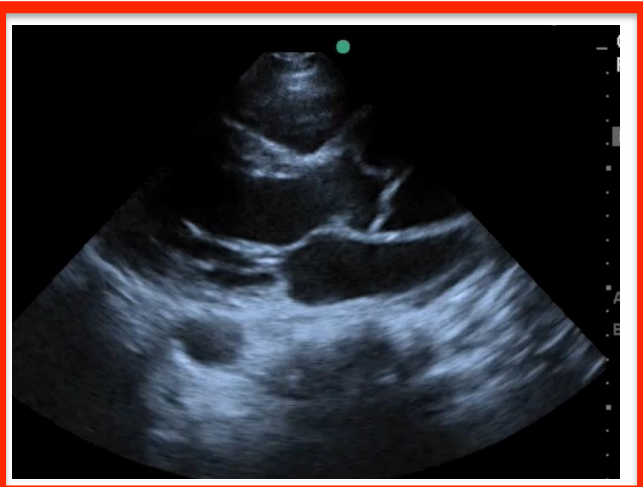


Continuous Wave Doppler

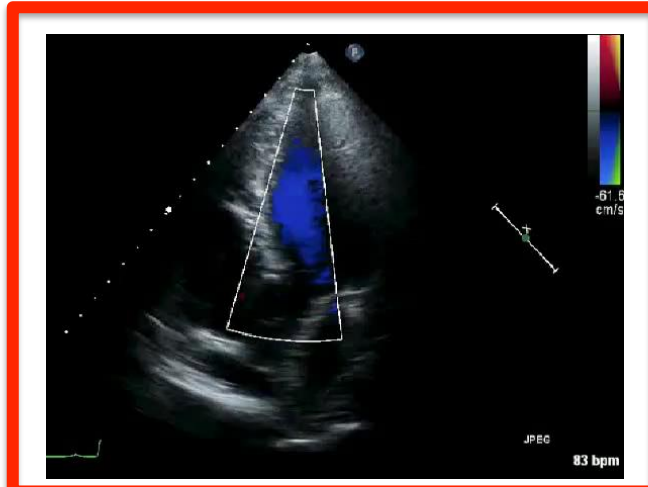


Pulsed Wave Doppler

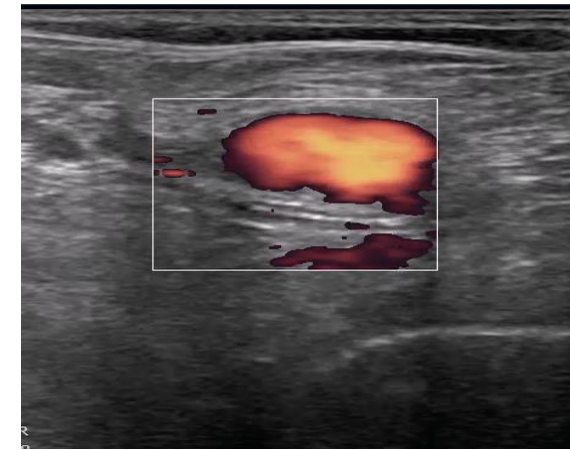
Basic Modes



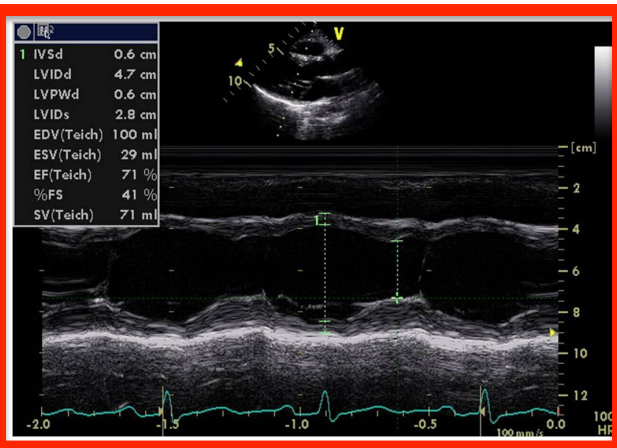
B-Mode



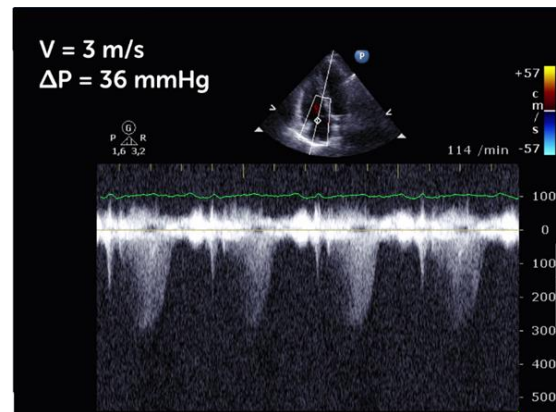
Color Doppler



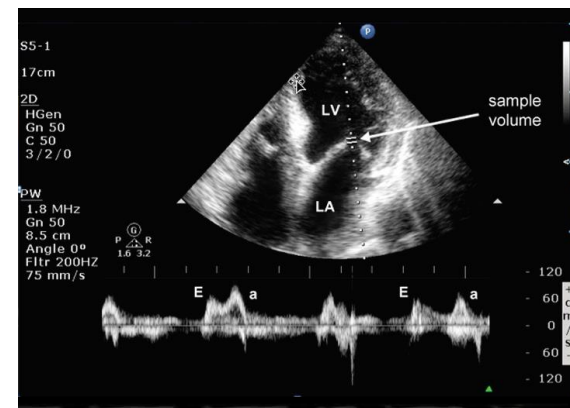
Power Doppler



M-Mode

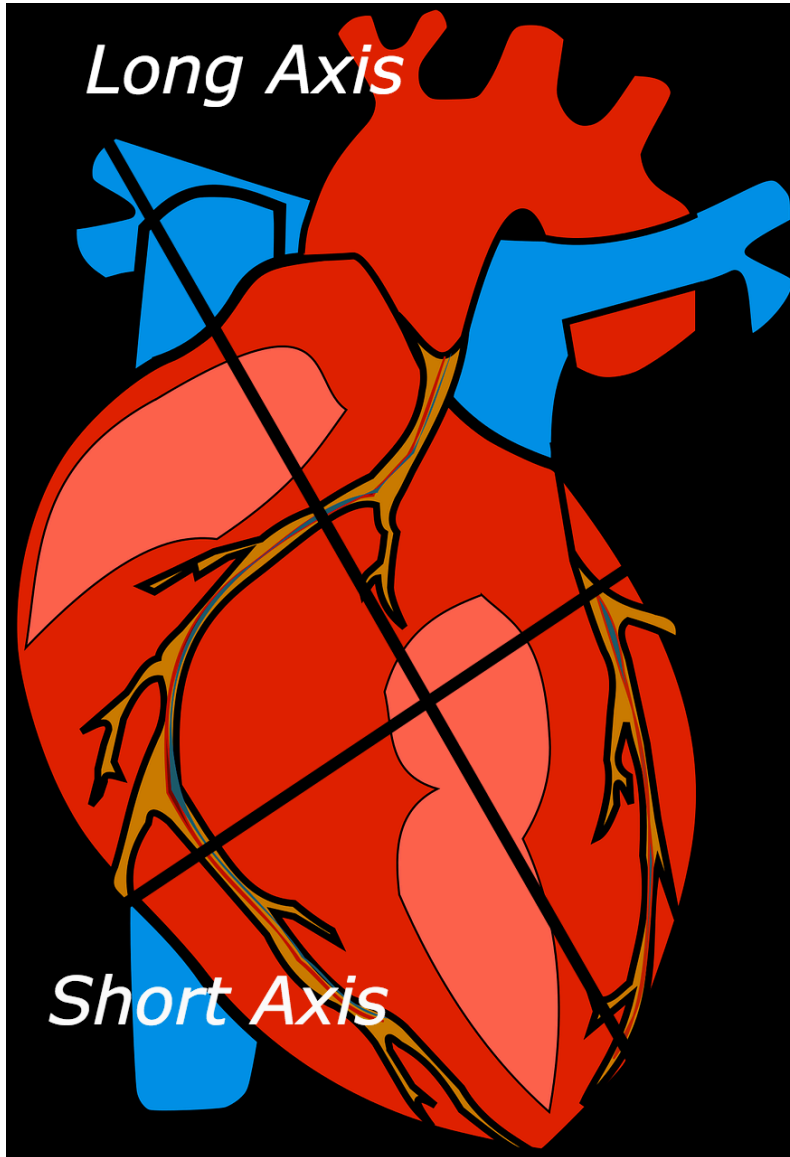


Continuous Wave Doppler



Pulsed Wave Doppler

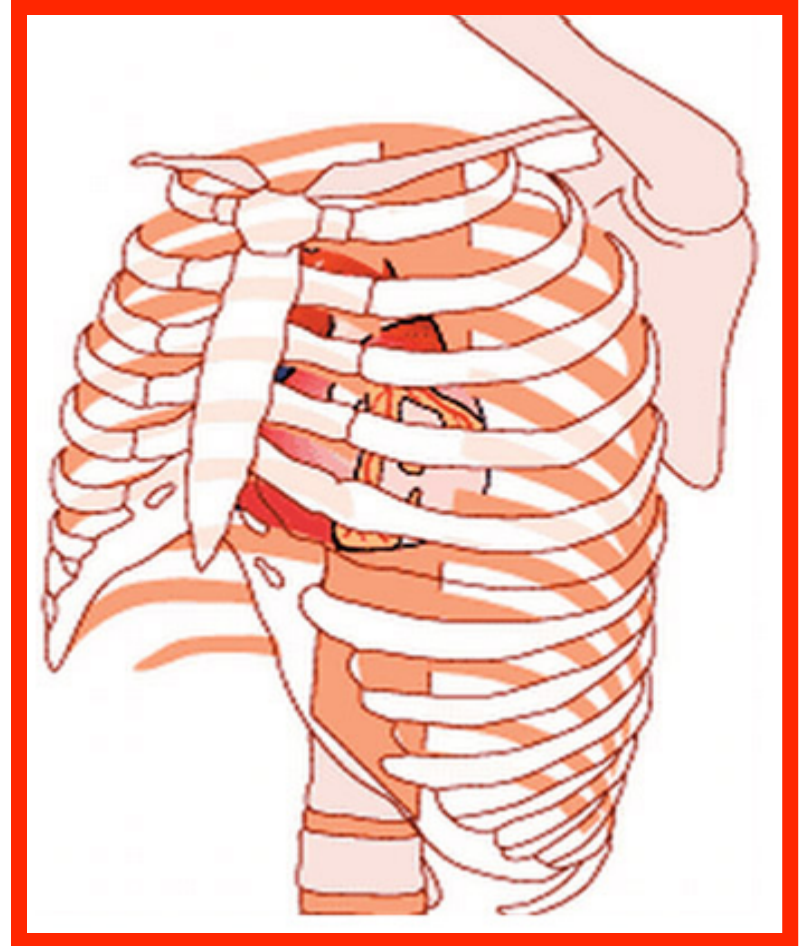
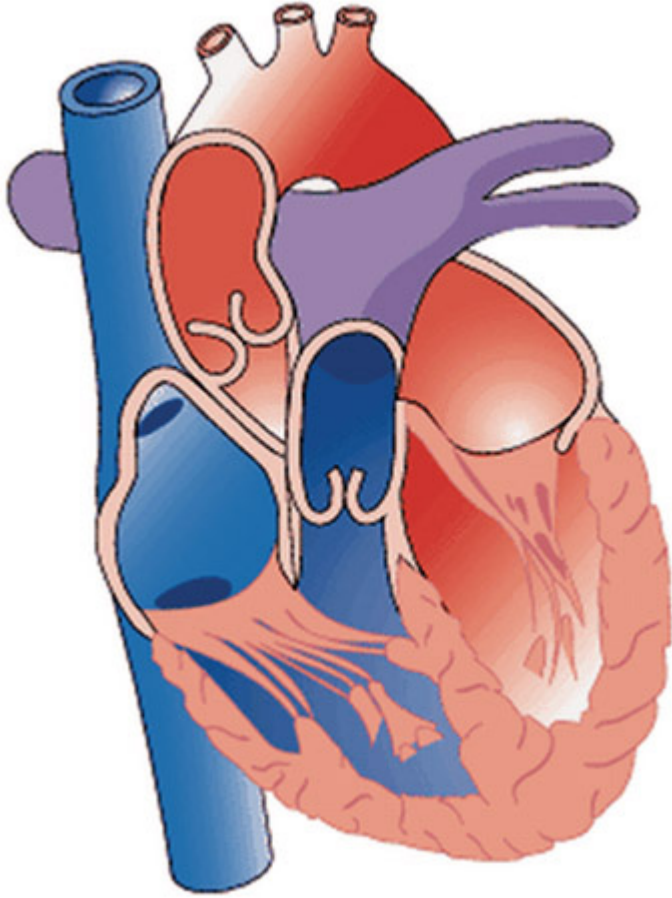
SonoAnatomy / Views



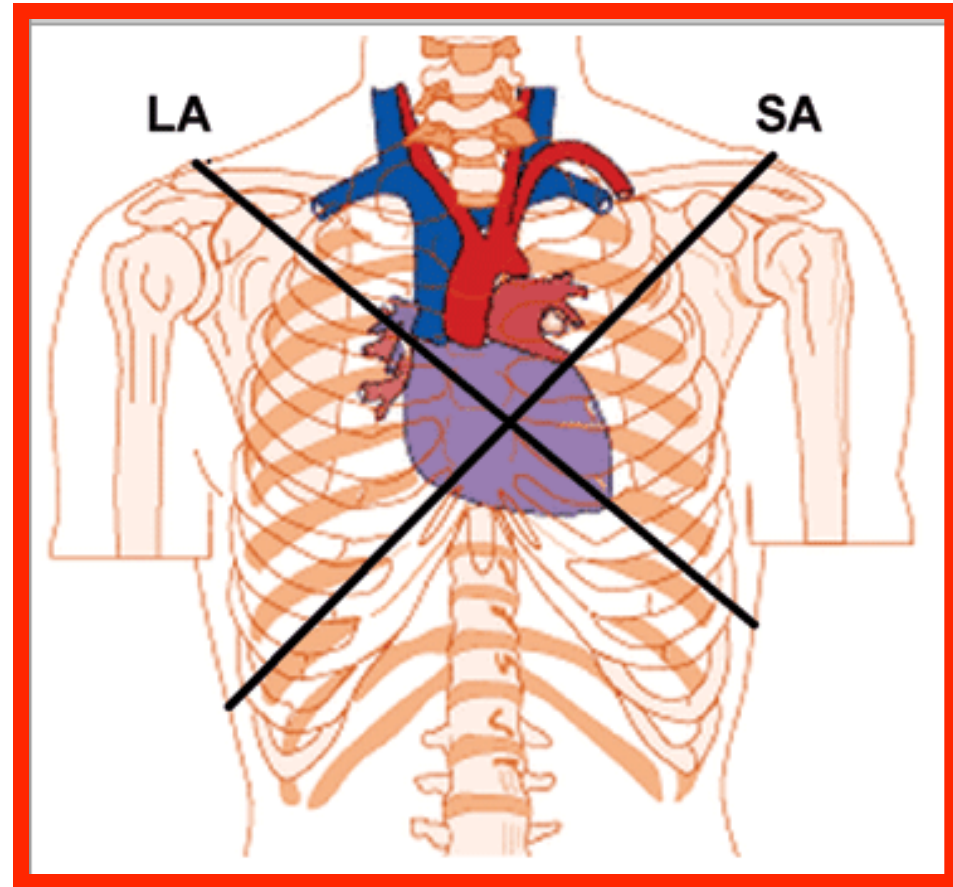
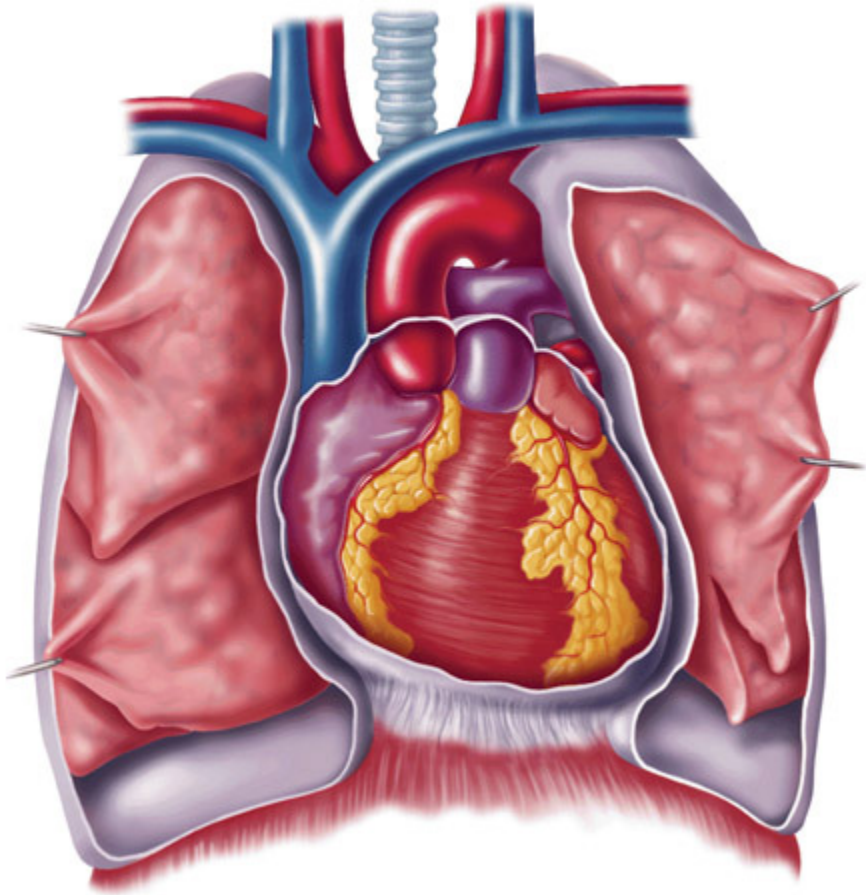
3D → **2Ds**



Anatomical Considerations



Anatomical Considerations



Scanning/ Technique

Best views by position

- Subxiphoid views =>supine

(hold a deep breath)

- Parasternal views=>supine /left lateral decubitus

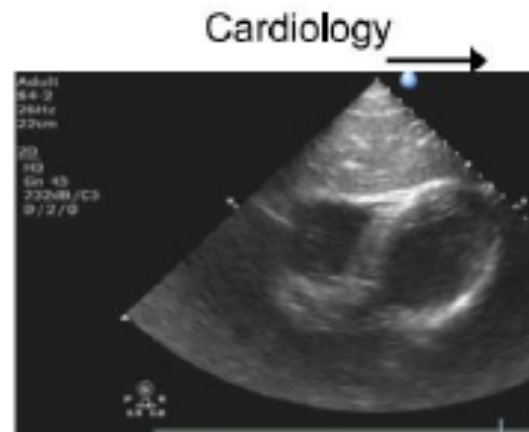
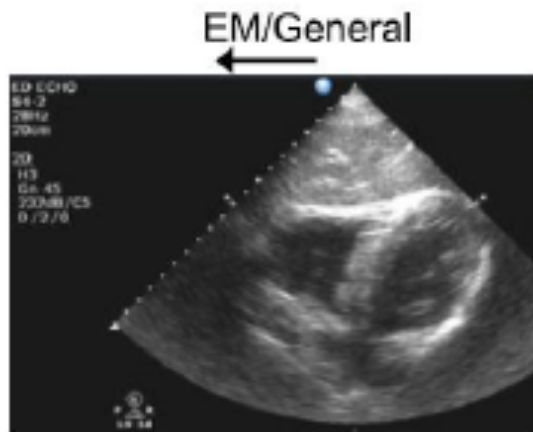
(expiratory hold)

- Apical views => left lateral decubitus

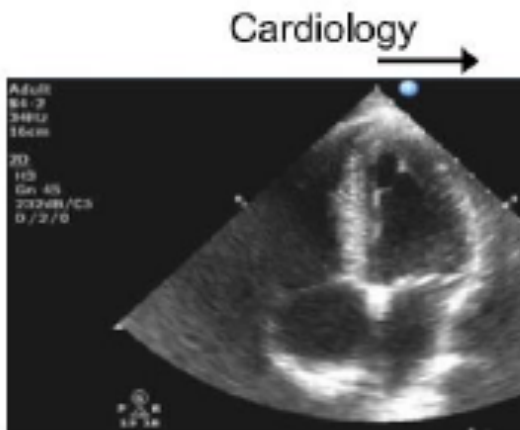
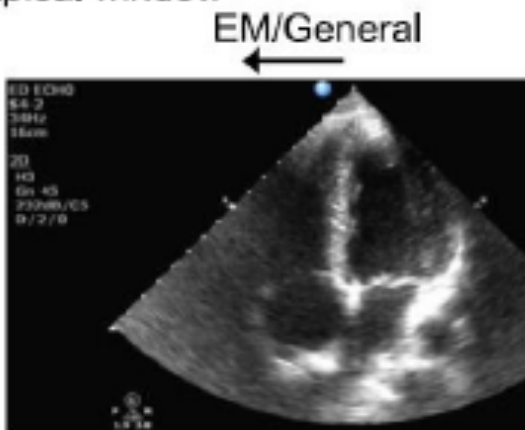
(left hand behind their head)

Orientation

1. Subcostal window



2. Apical window



Net
result:
same
image on
screen

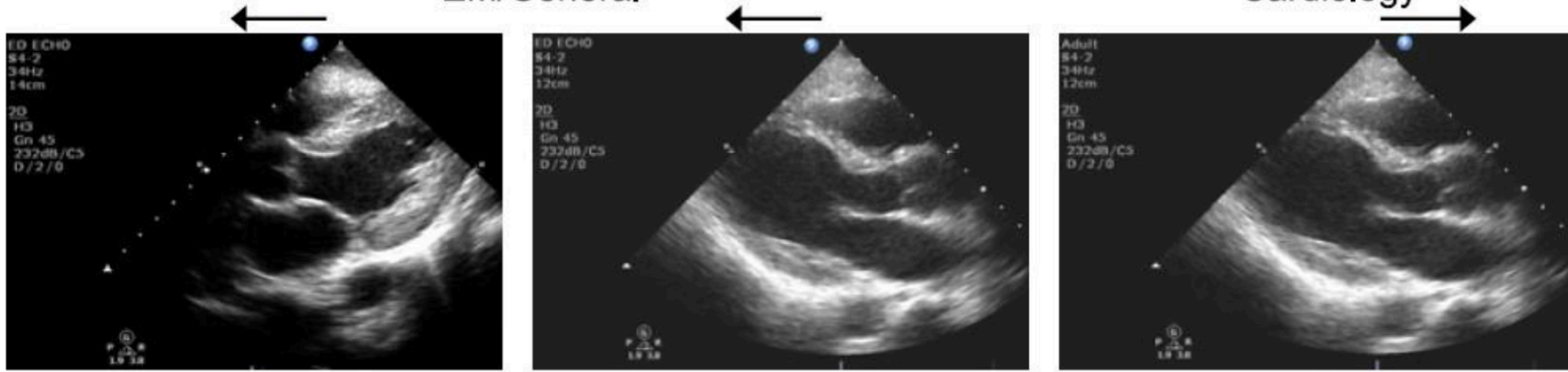
Orientation

Probe/Monitor Marker 方向

3. Parasternal window

EM/General

Cardiology

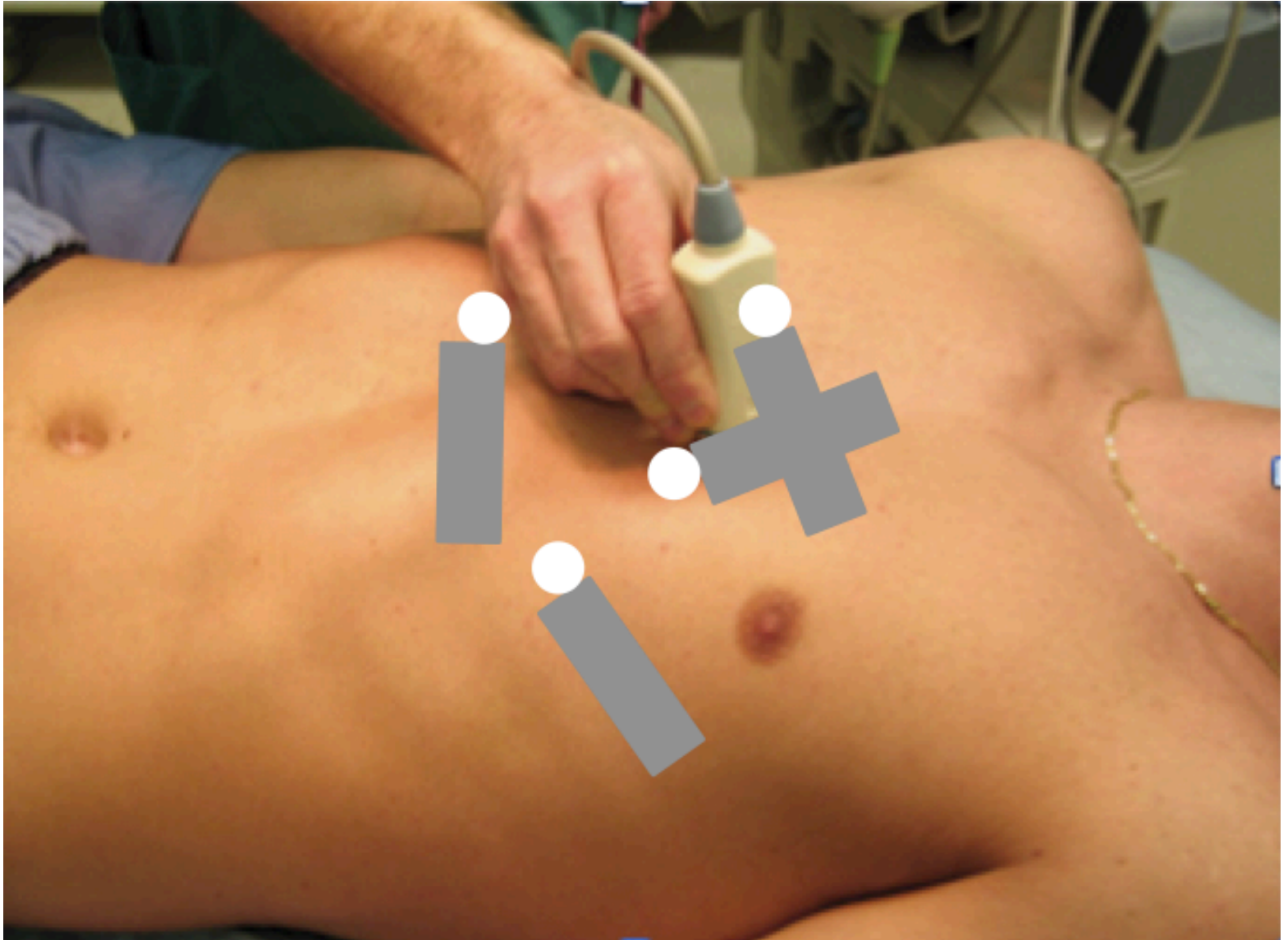


Consistent screen and probe orientation

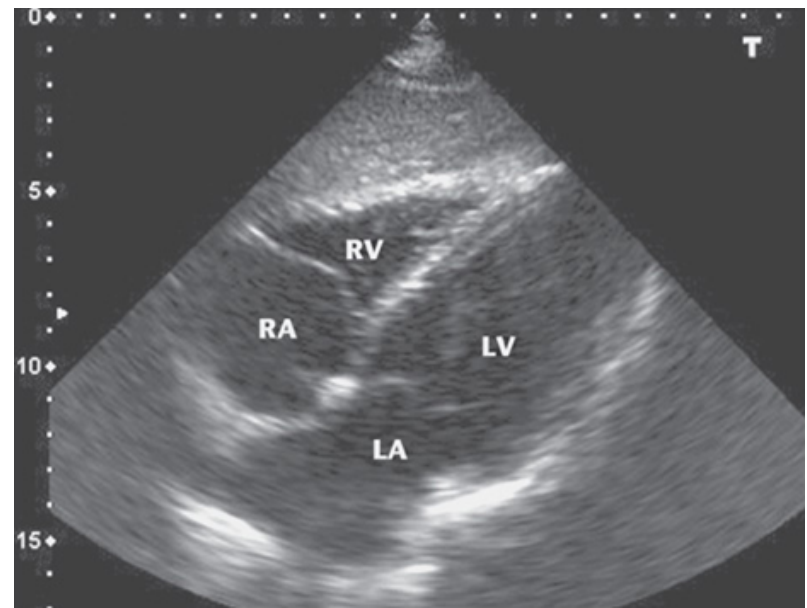
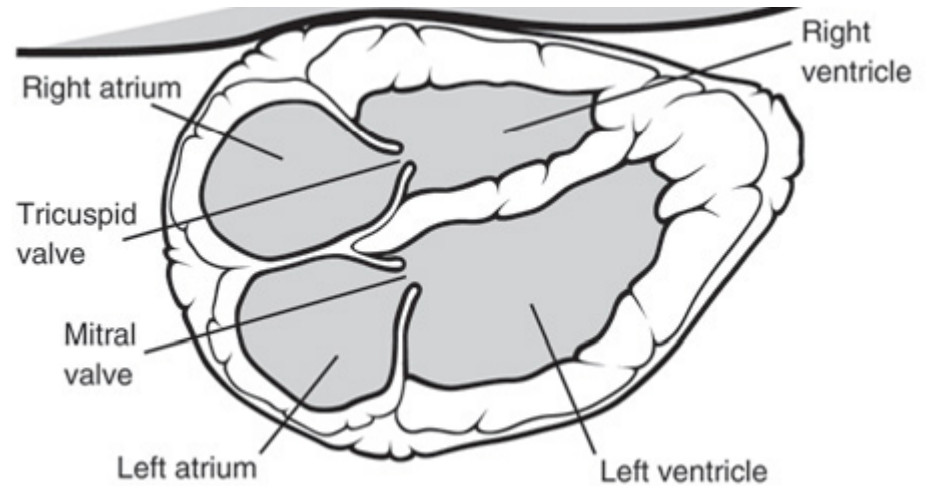
OR

Probe reversed but image consistent with cardiology

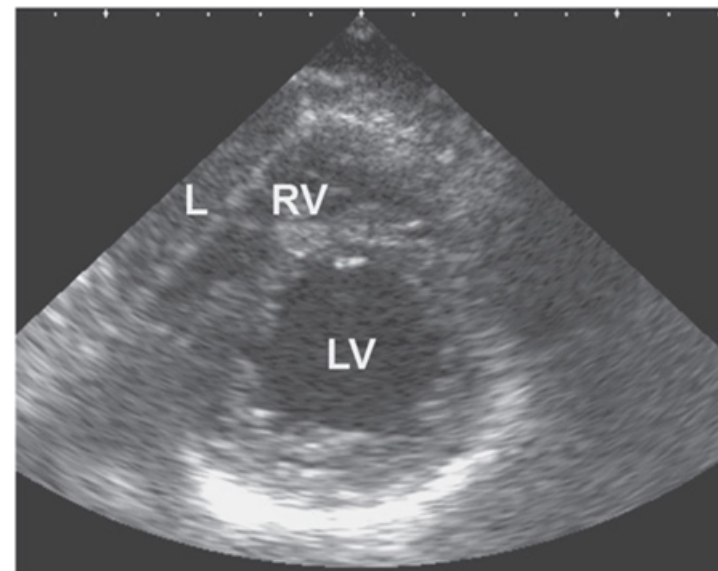
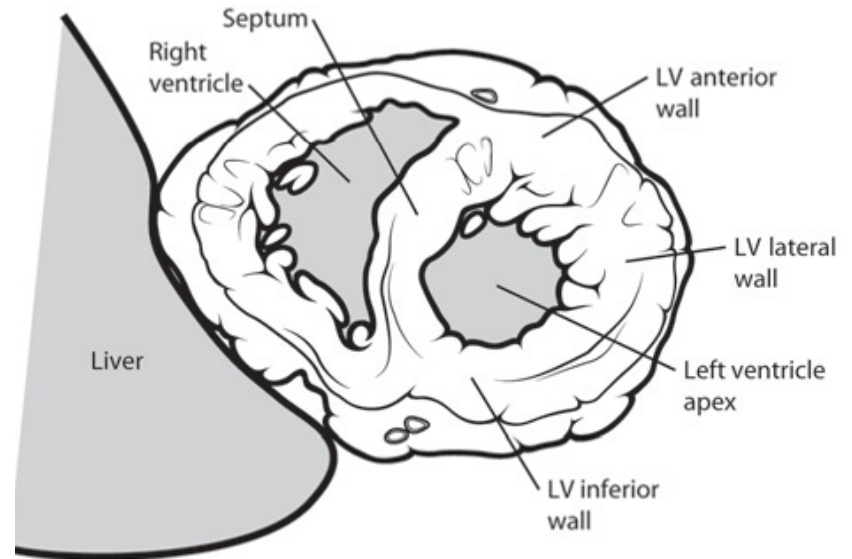
探頭擺放位置



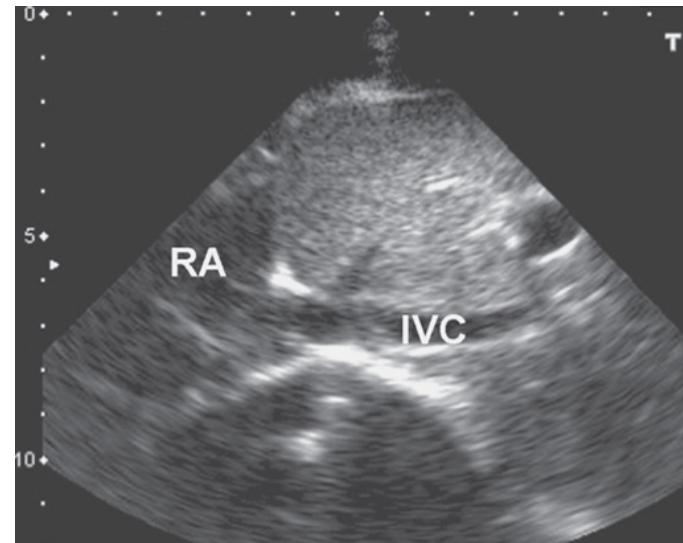
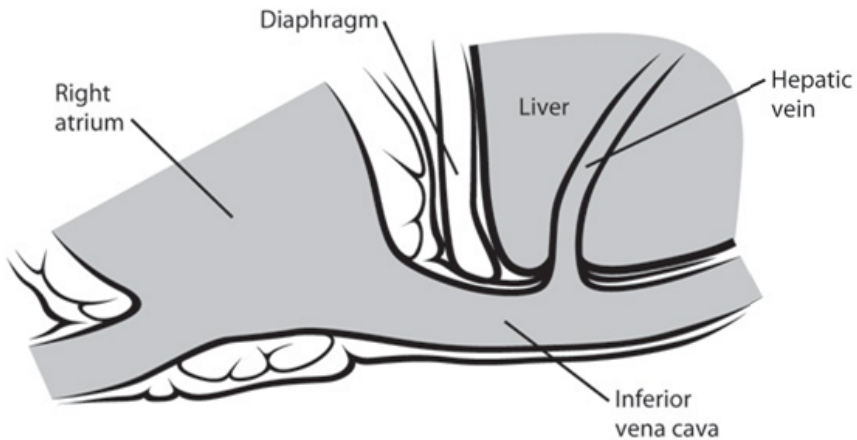
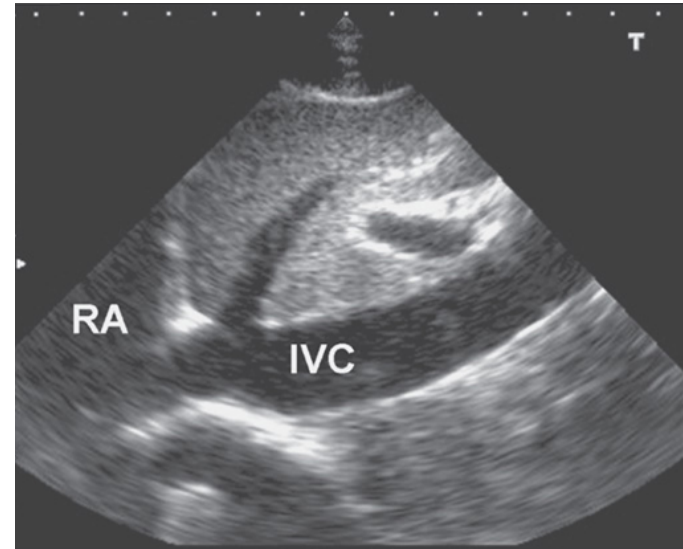
Subxiphoid Four-Chamber View



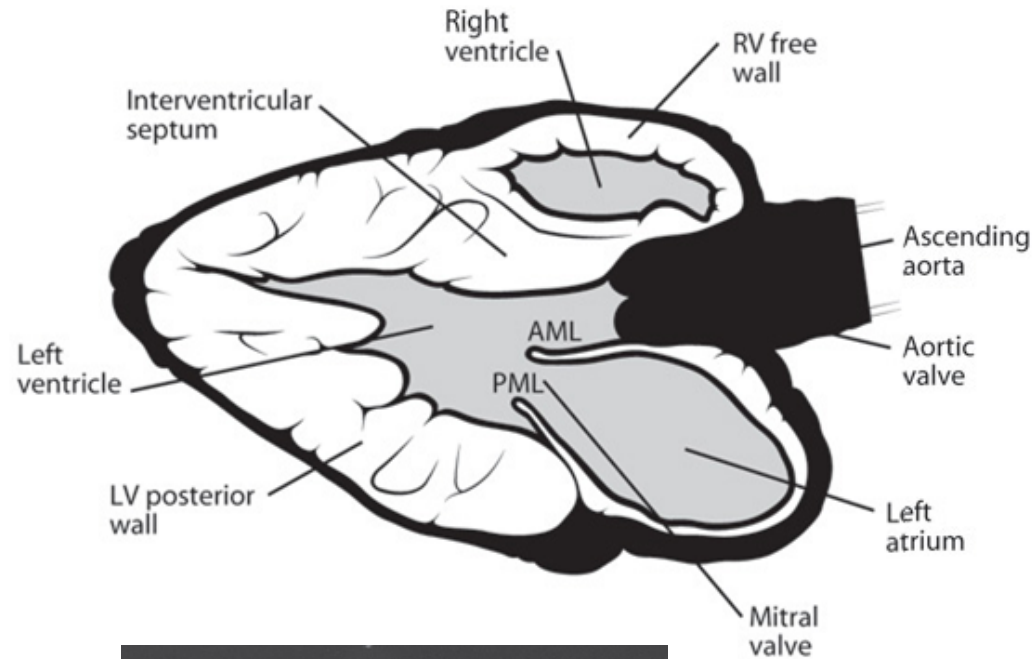
Subxiphoid Short-Axis View



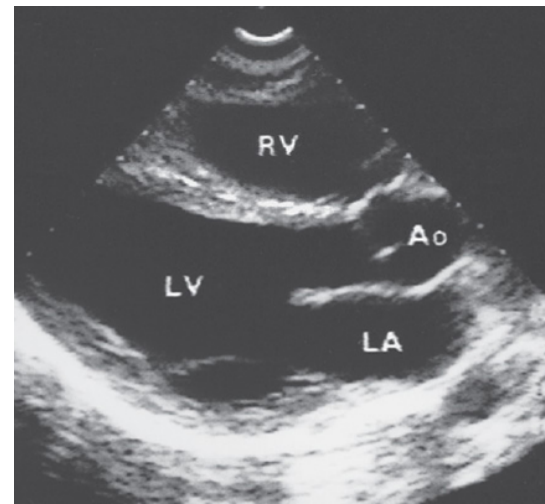
Subxiphoid Long-Axis View



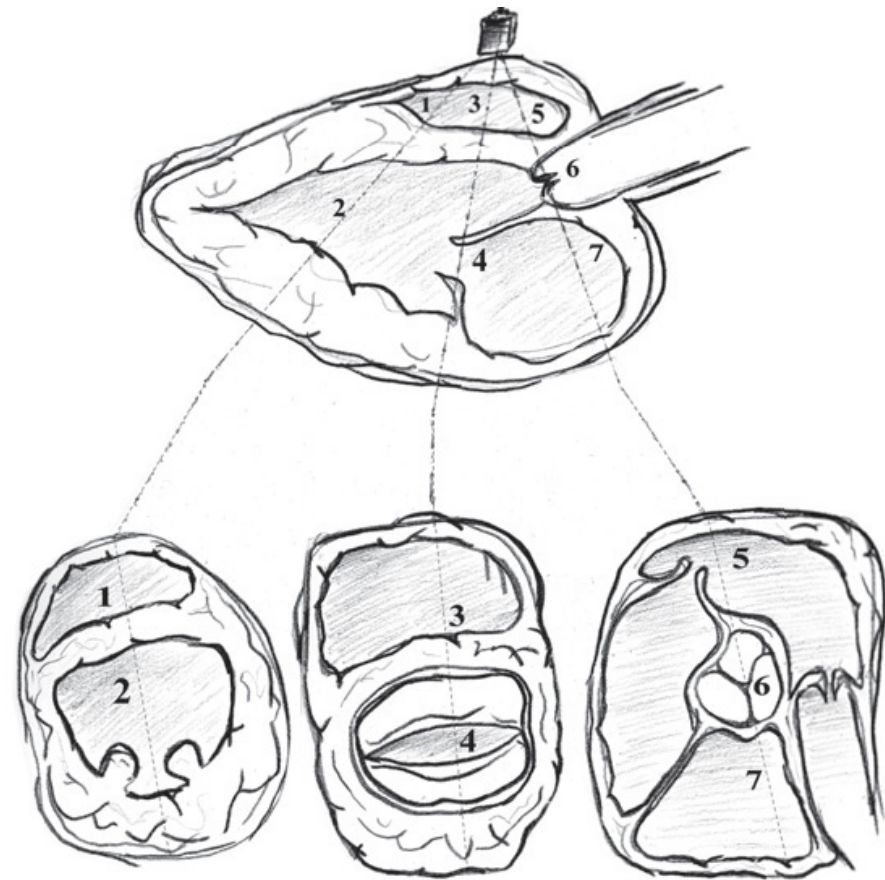
Parasternal Long-Axis View



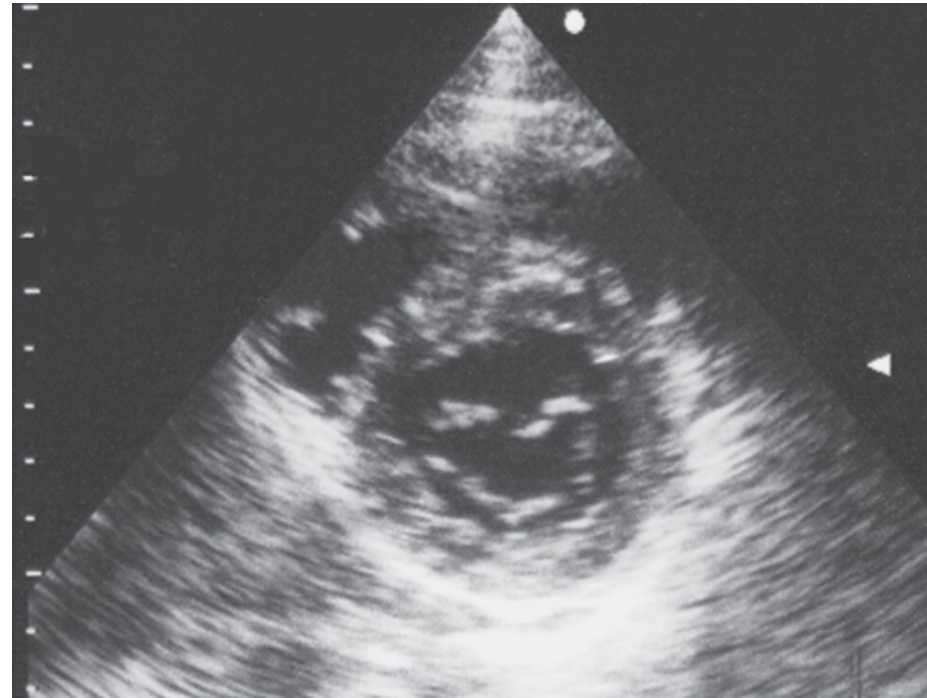
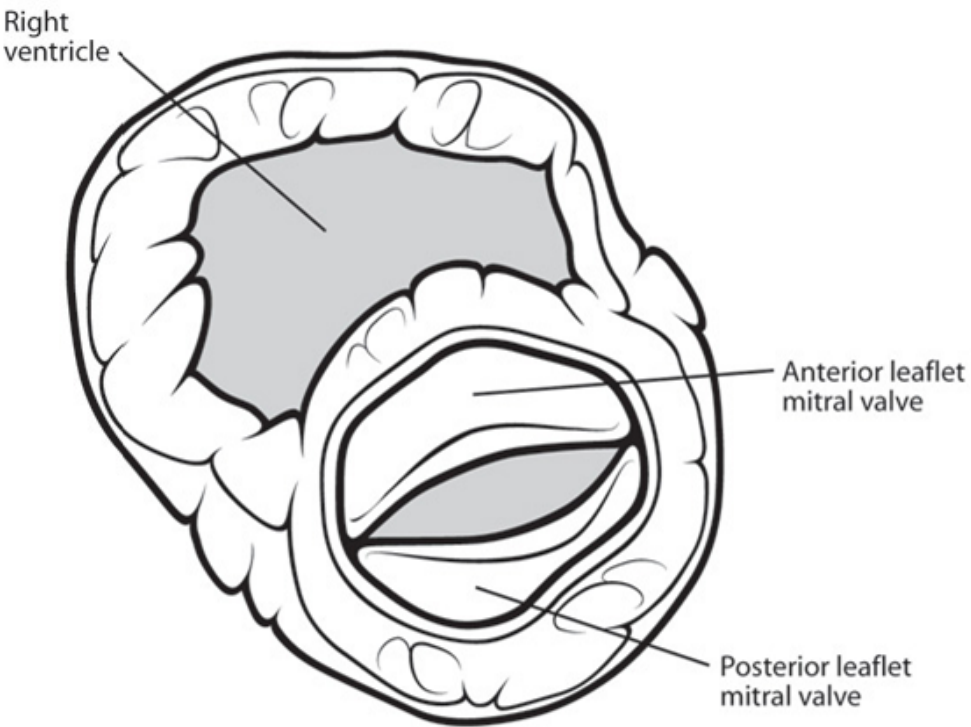
3rd or 4th intercostal space



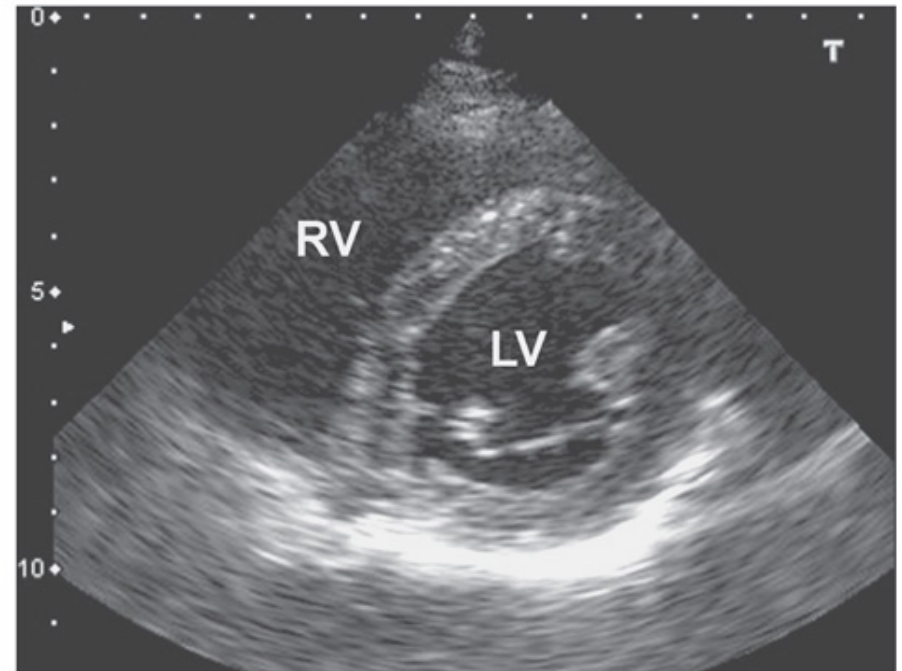
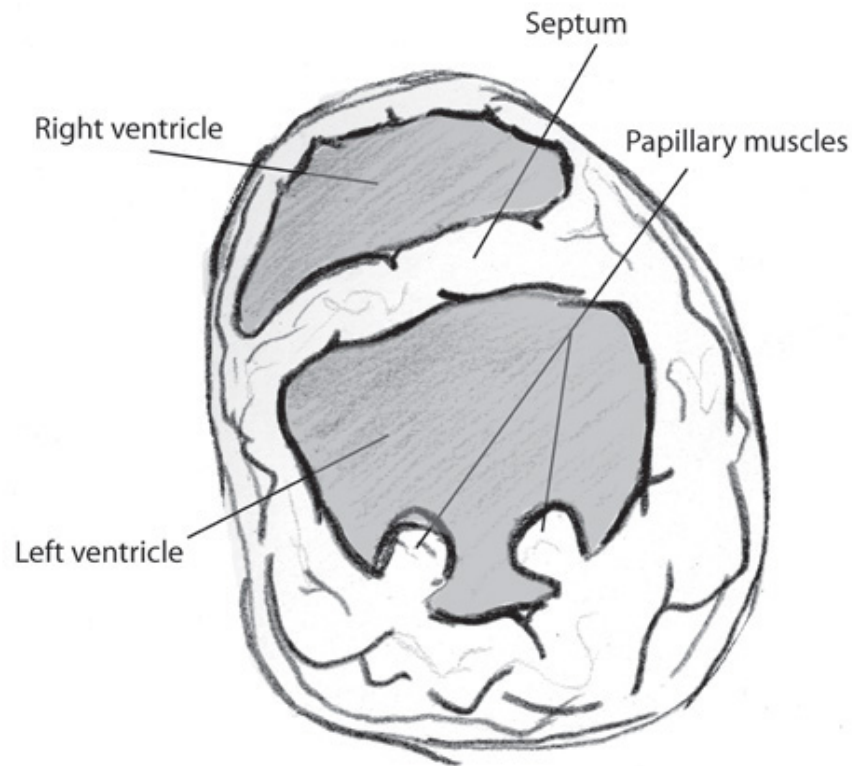
Parasternal Short-Axis View



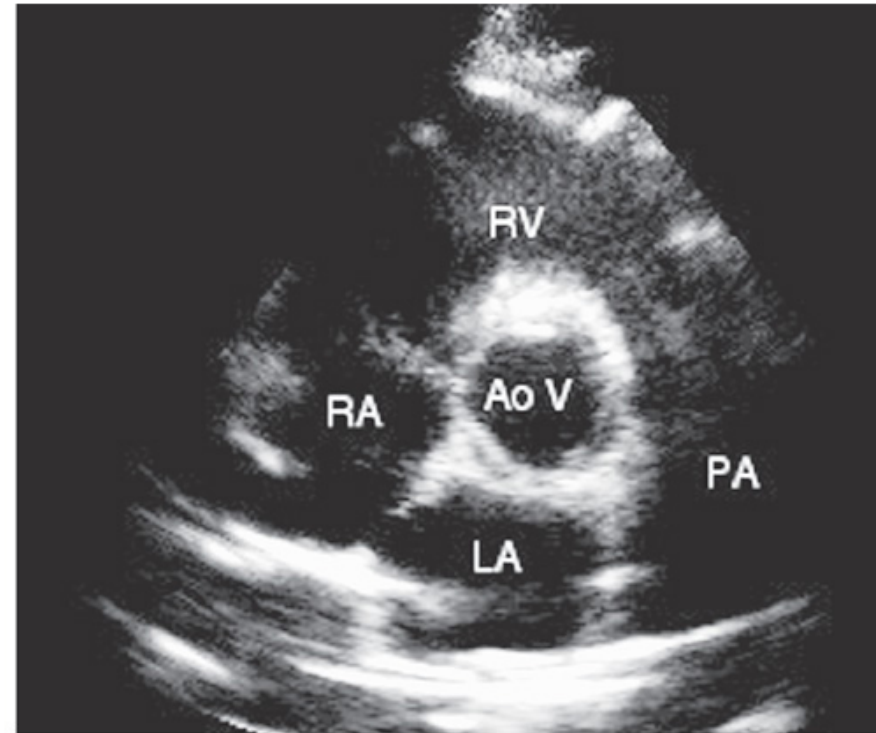
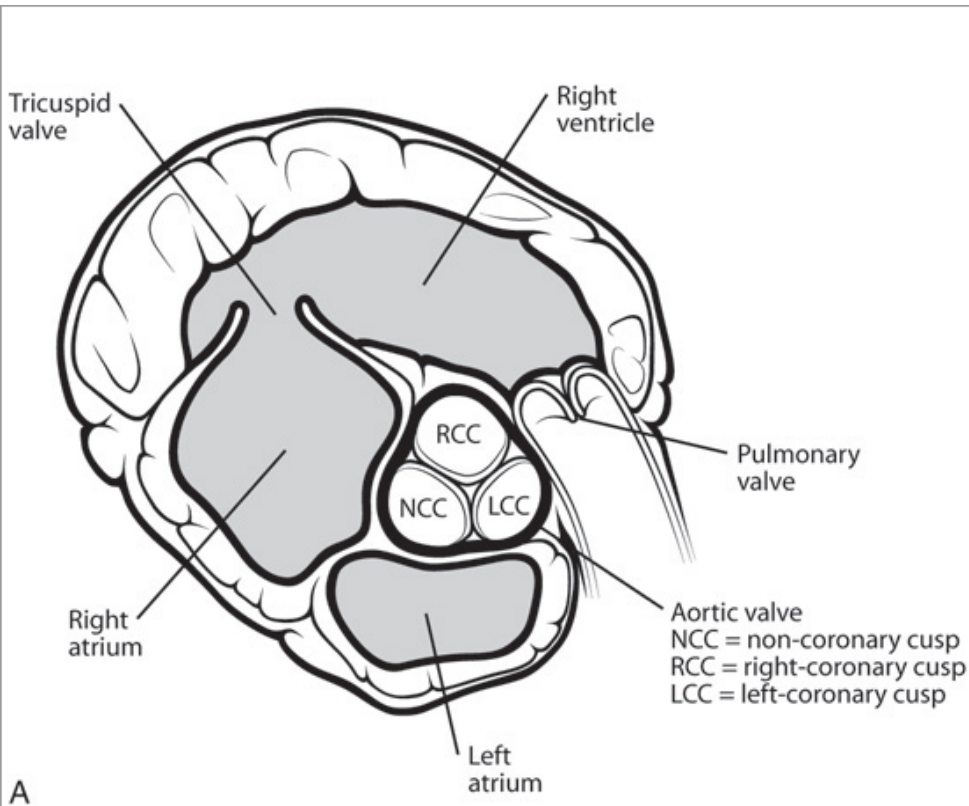
Parasternal Short-Axis View



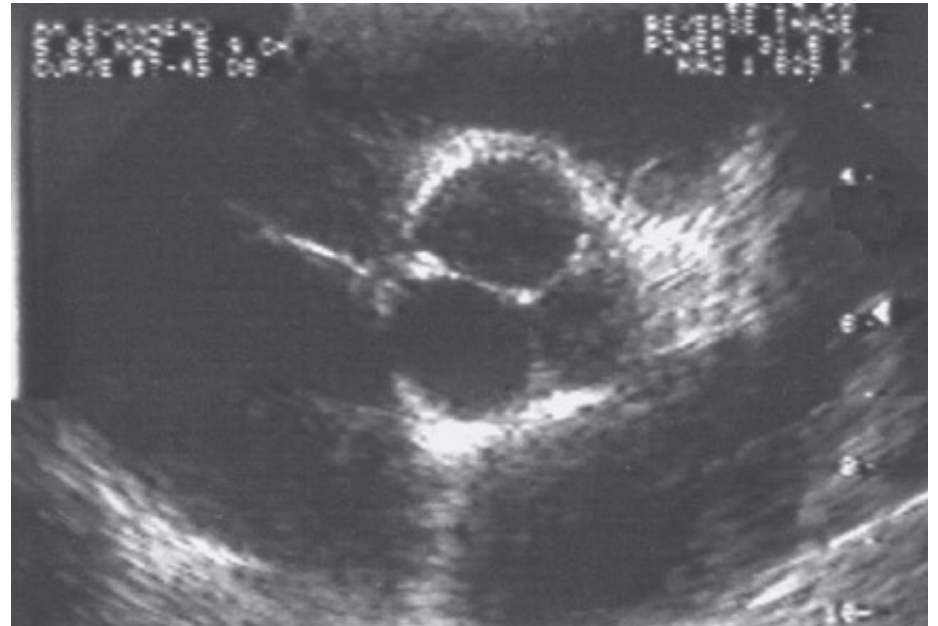
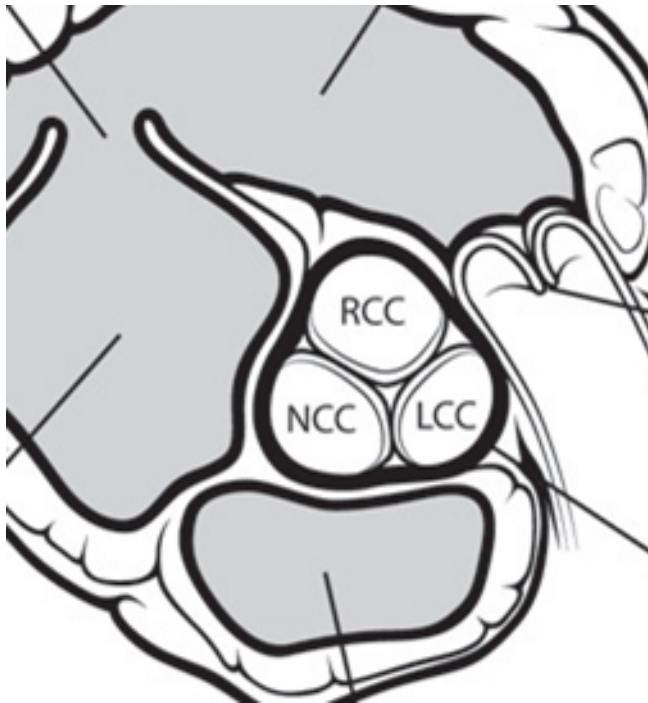
Parasternal Short-Axis View



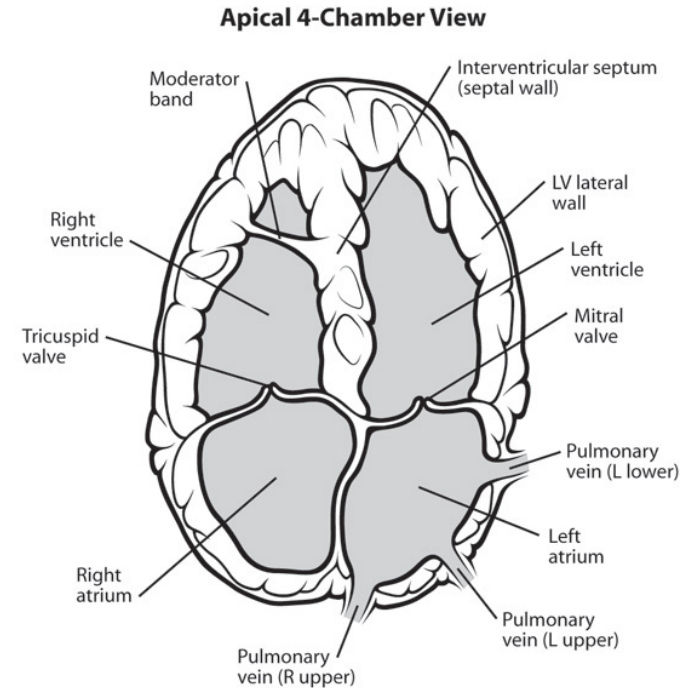
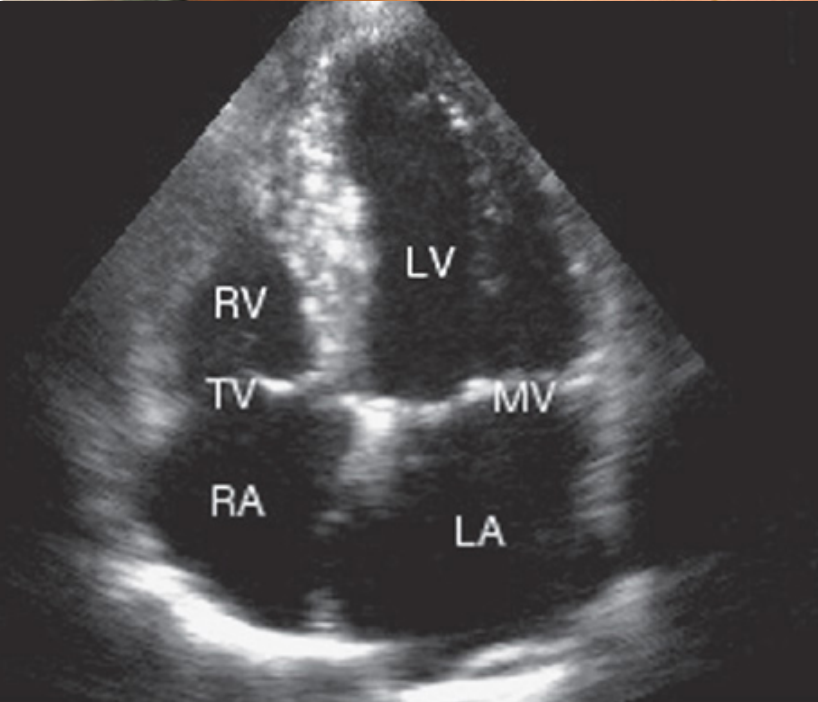
Parasternal Short-Axis View



Parasternal Short-Axis View



Apical Four-Chamber View



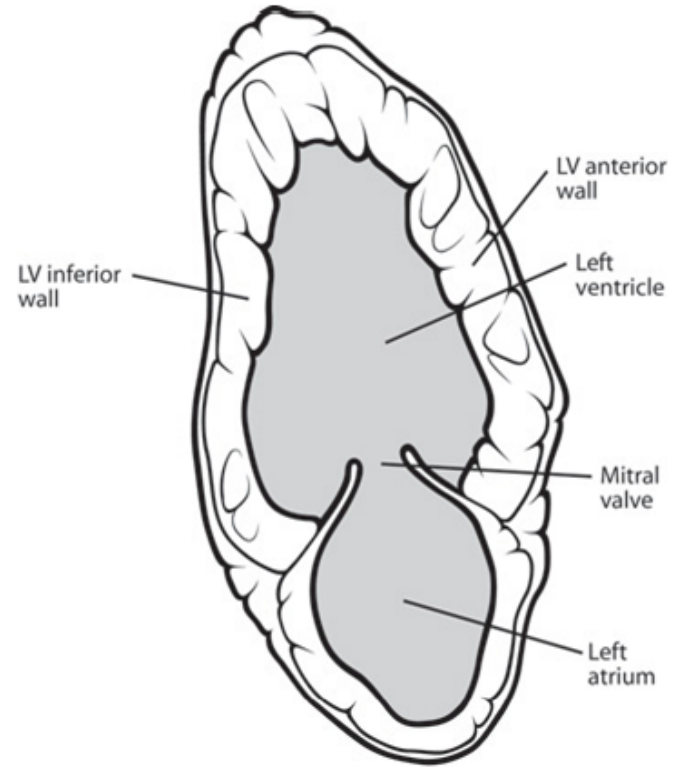
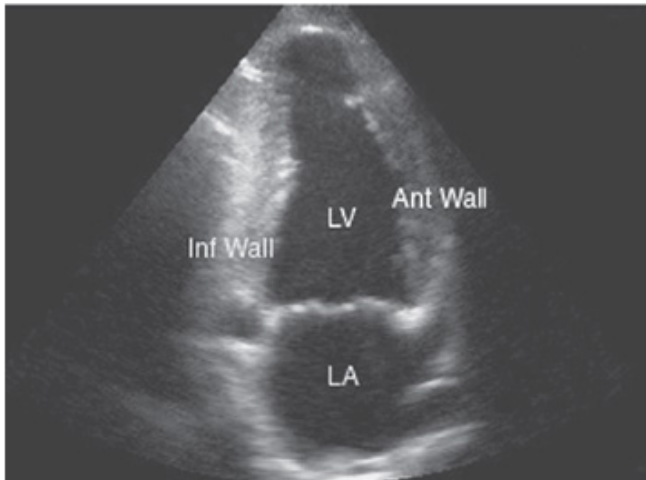
PMI

5th intercostal space

Apical Two-Chamber View

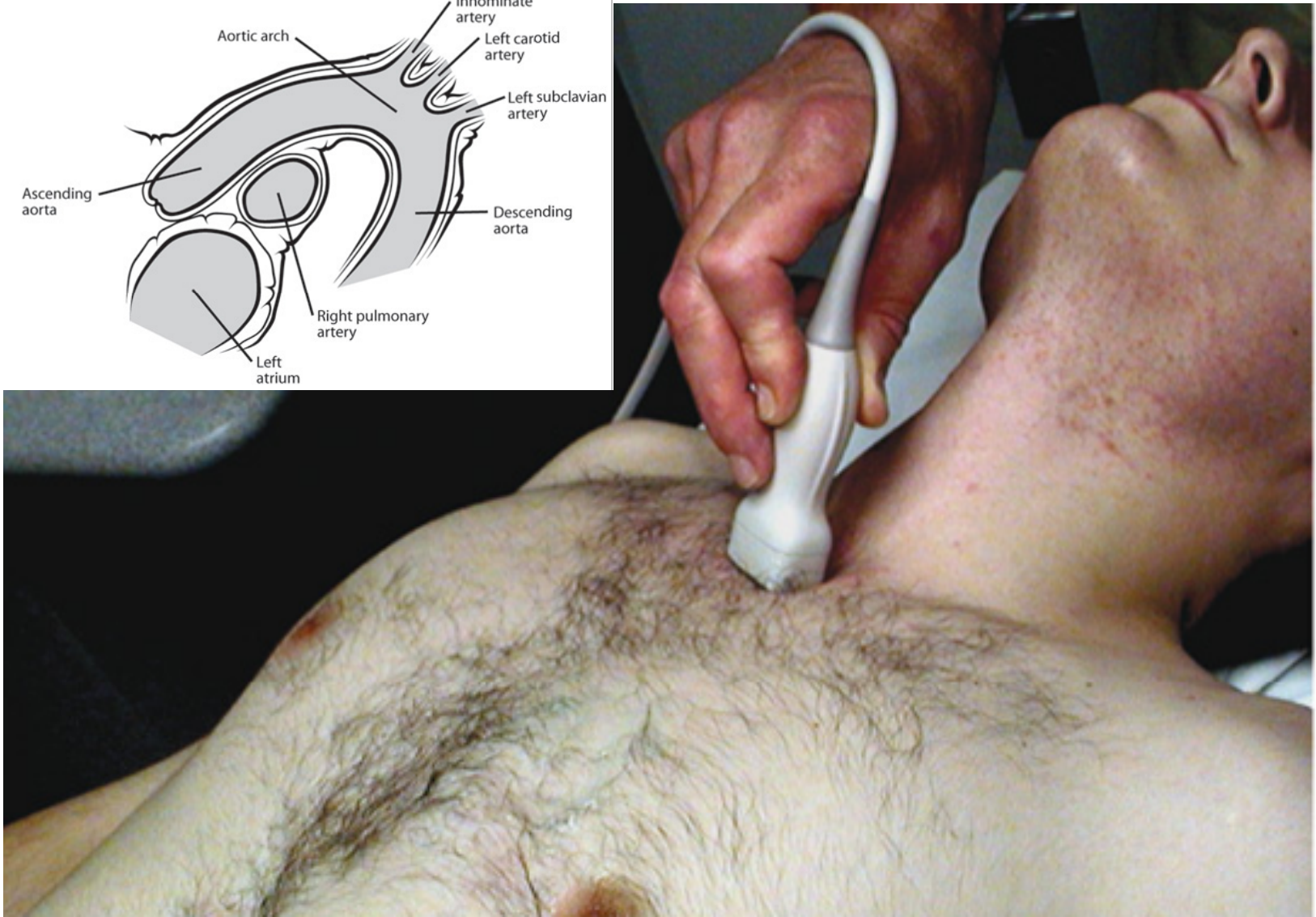
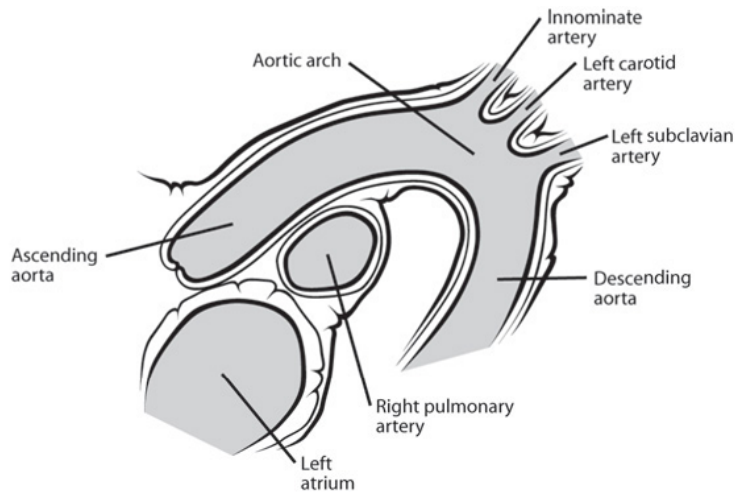


A



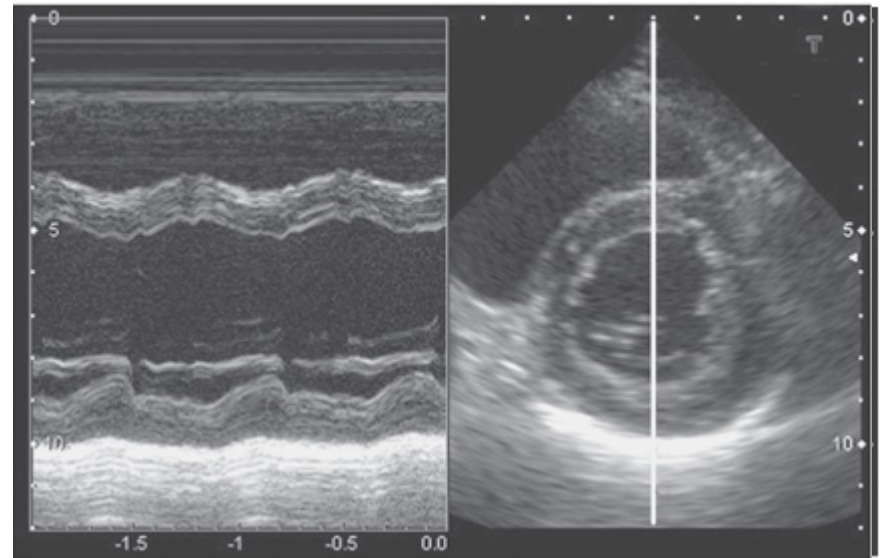
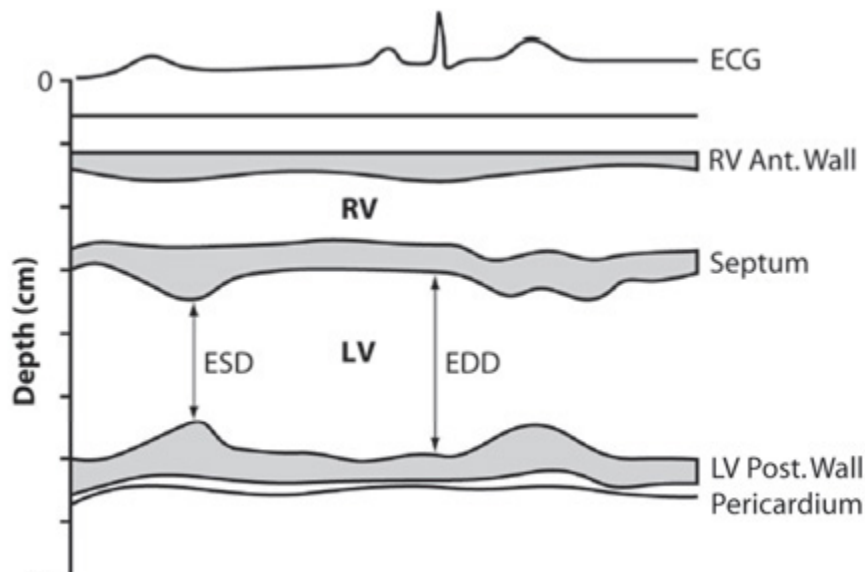
B

Suprasternal View



M-mode ?

Measurements of valve, chambers diameters, wall motion, wall thickness, and stroke volume



ESD = end systolic diameter, EDD = end diastolic diameter

$$EF: [(EDD^3 - ESD^3) / EDD^3] \times 100\% \approx FS \times 2$$

Fraction Shortening (FS) = $(EDD - ESD) / EDD$ (>25% in normal)

Critical Heart Disease

- Pericardial effusion
- Cardiac Tamponade
- Myocardial ischemia
- Pulmonary embolism
- Aortic Dissection

Check原則

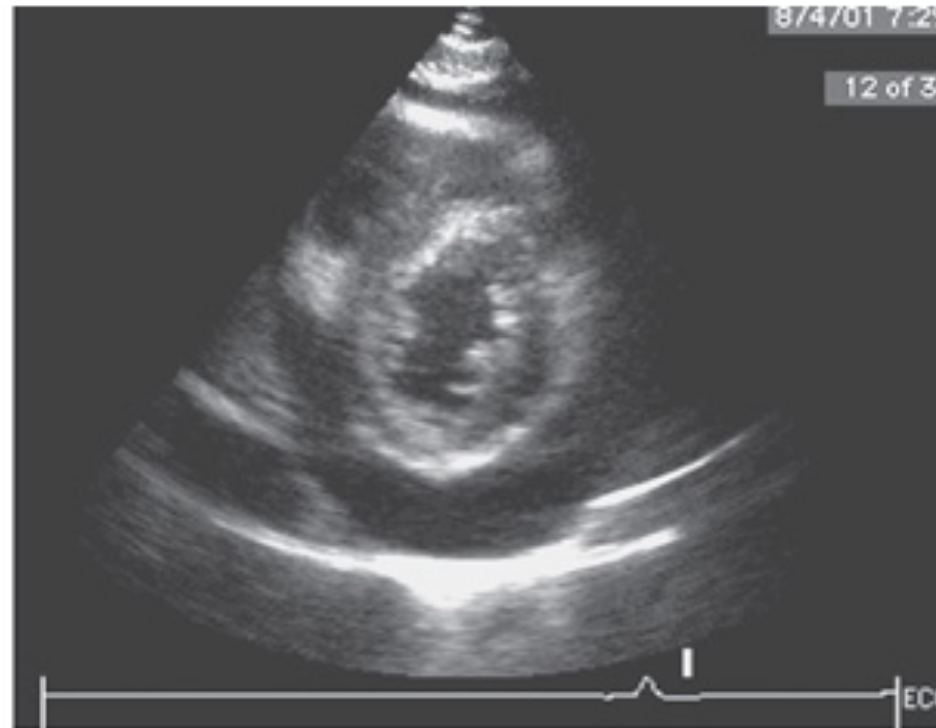
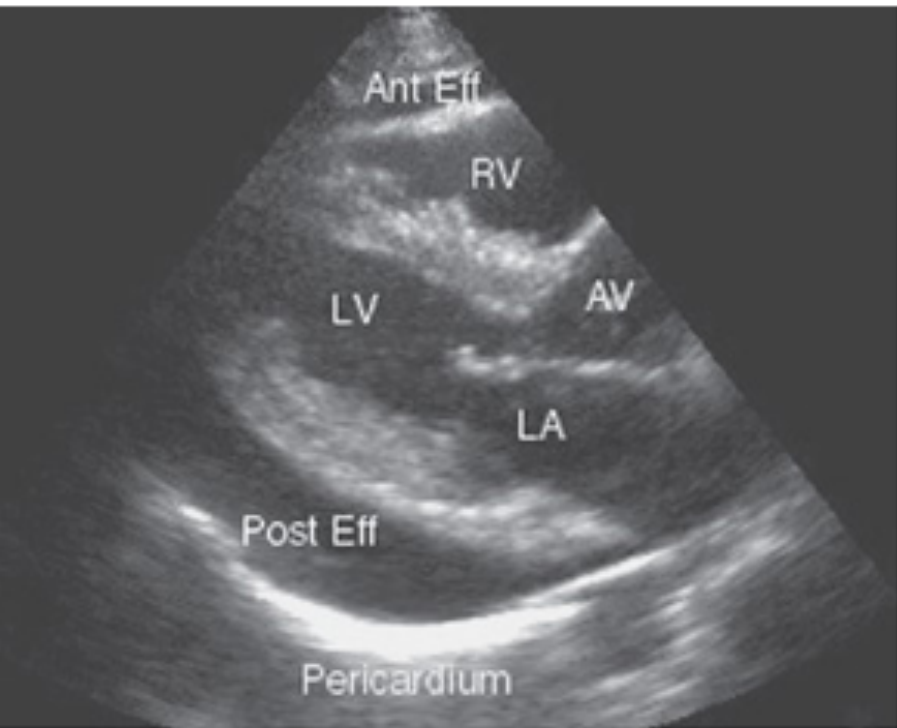
心包膜

右心

左心

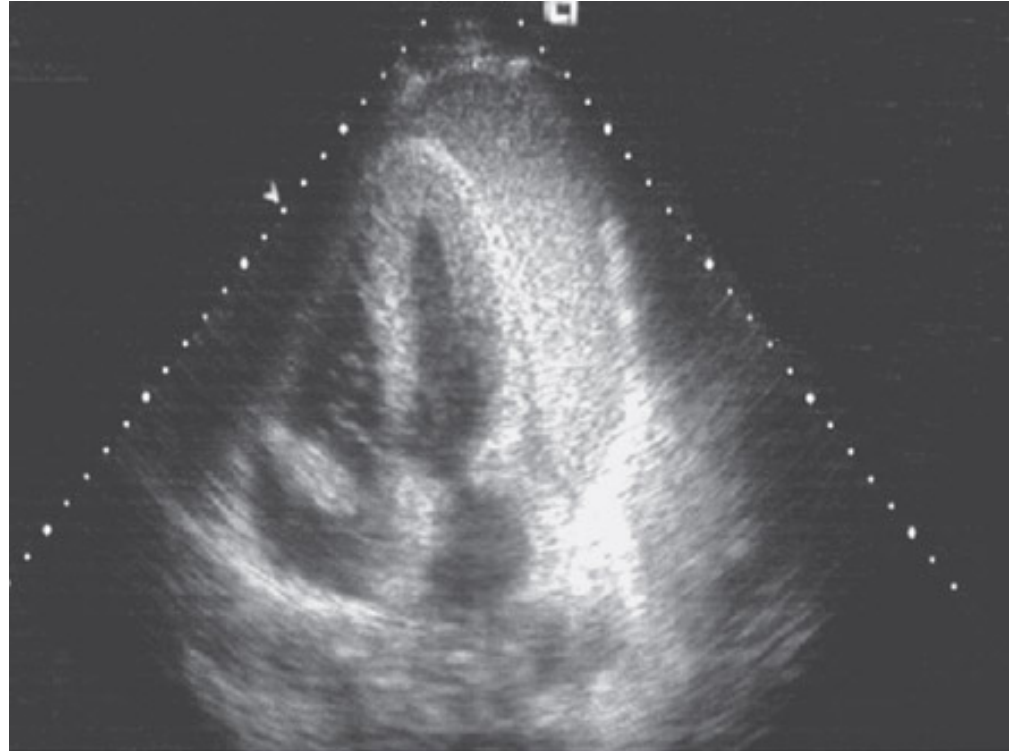
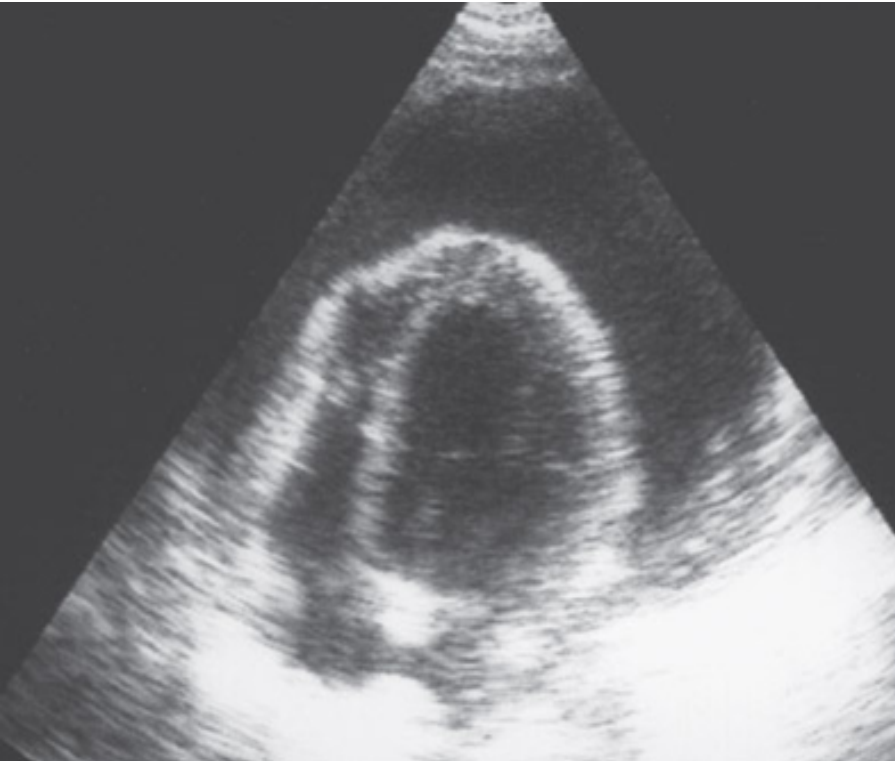
主動根

Pericardial Effusion



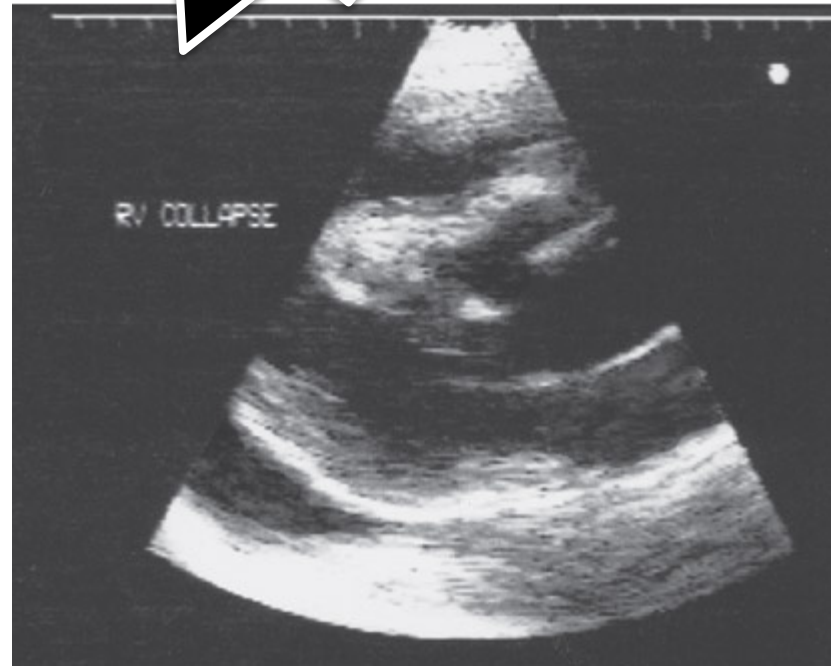
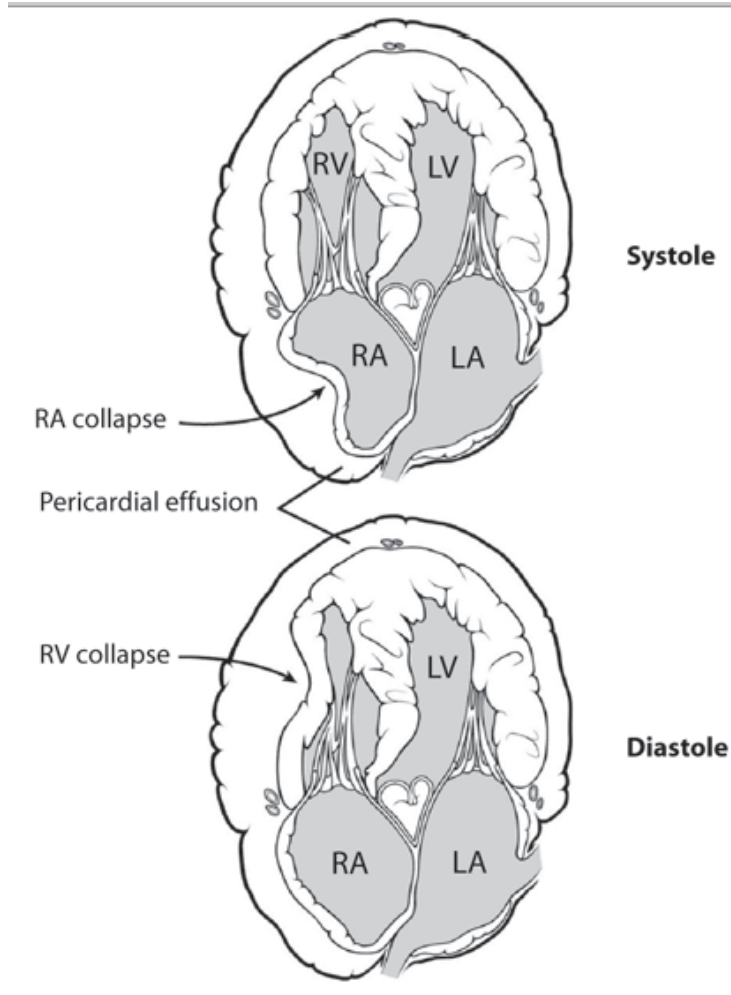
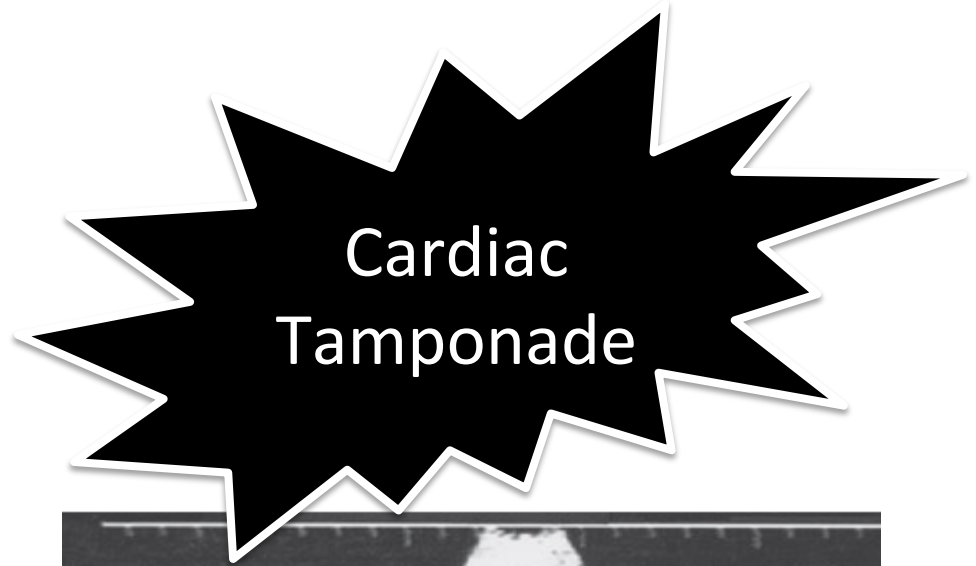
1. Small pericardial effusions: $<1\text{cm}$
2. Large effusions: $>1\text{cm}$

Pericardial Effusion



- ◆ Exudative effusions: as pus, malignant effusions, and blood mixed with fibrin material=> echogenic
- ◆ Gas-forming infections or by gas-causing tamponade (pneumopericardium)

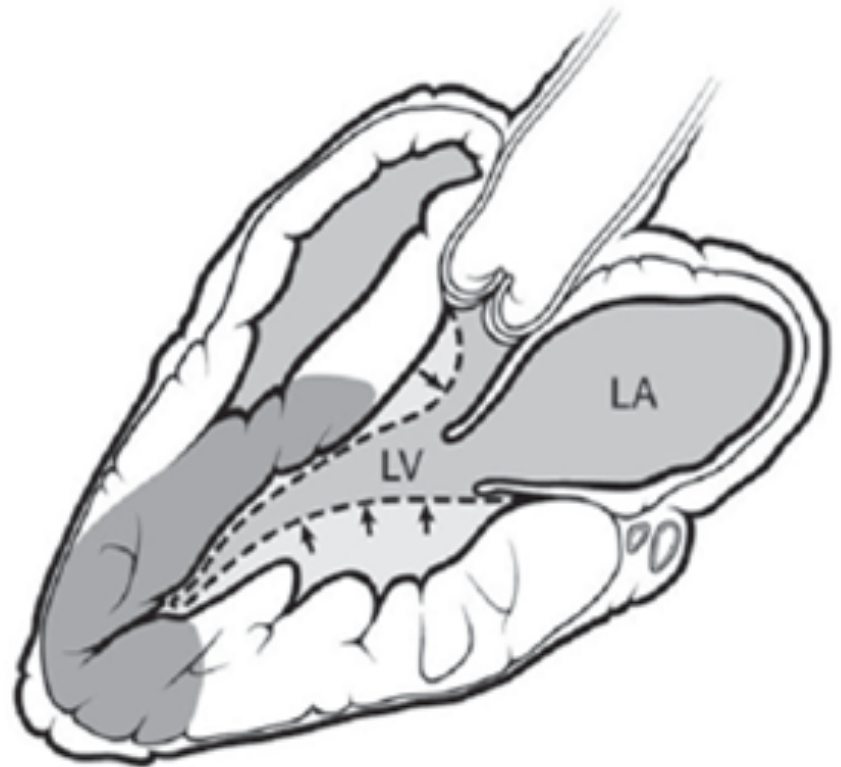
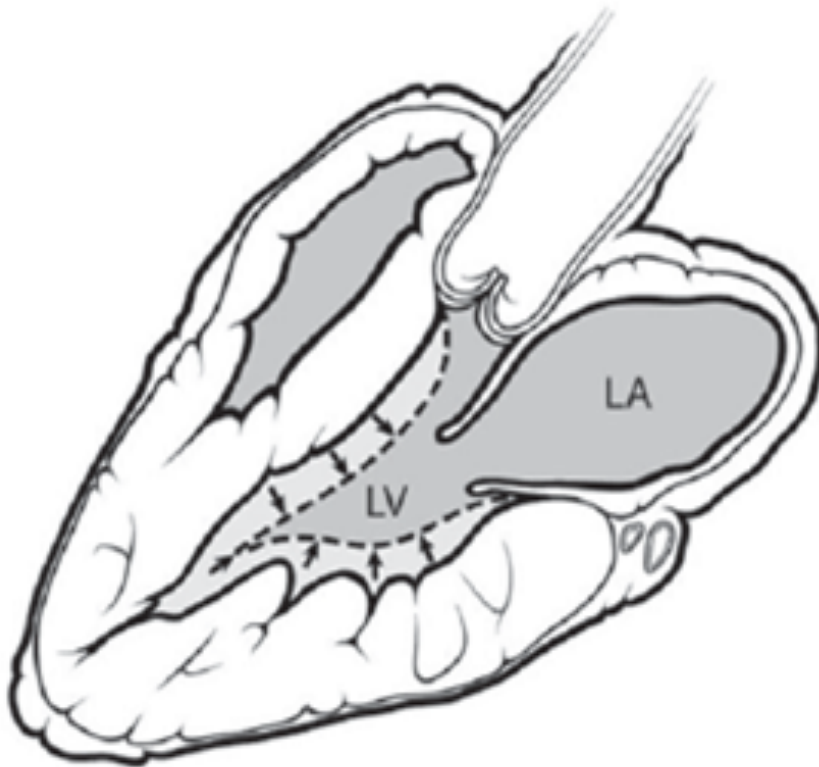
Cardiac Tamponade



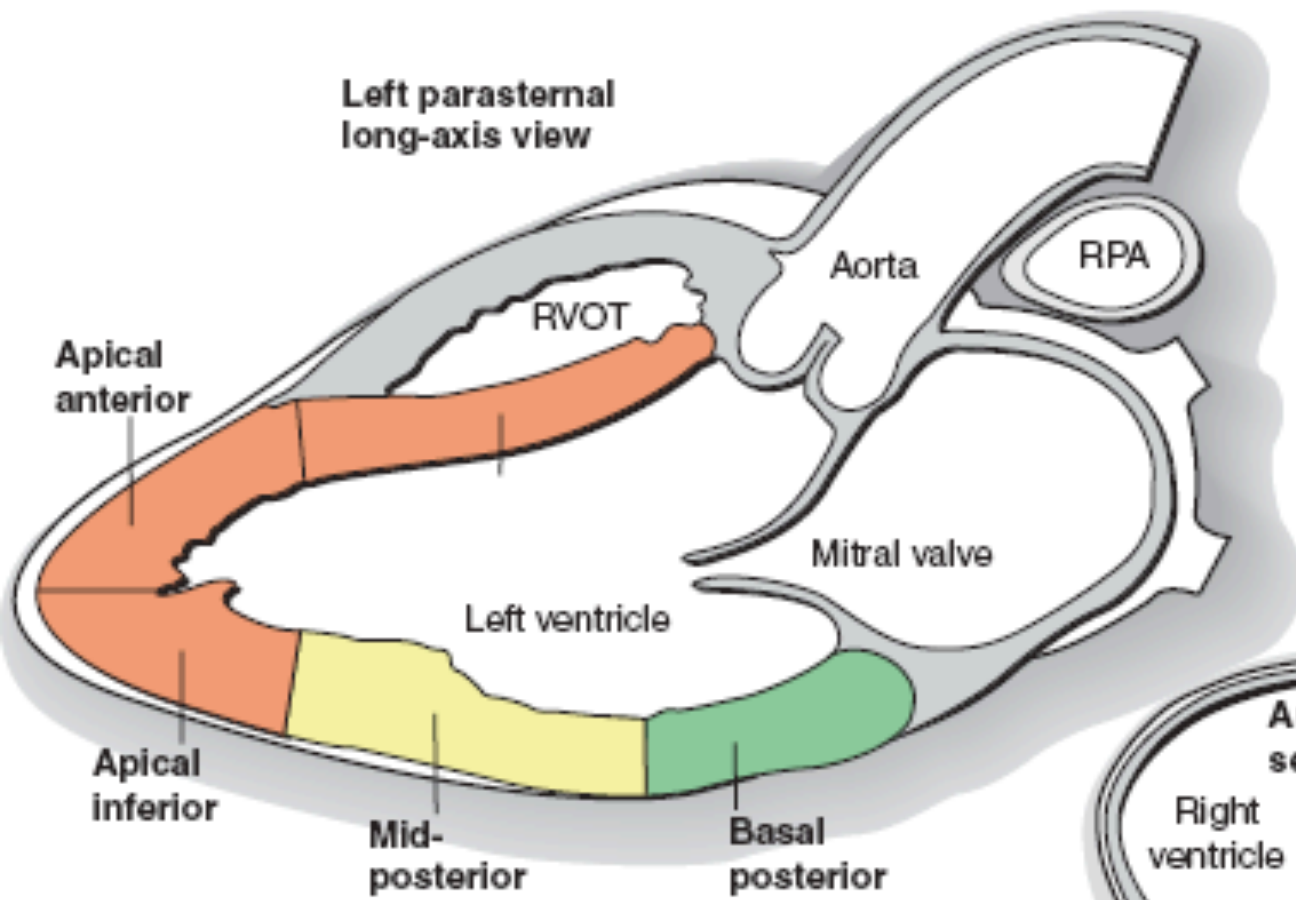
Myocardial Ischemia

Normal

Ischemic

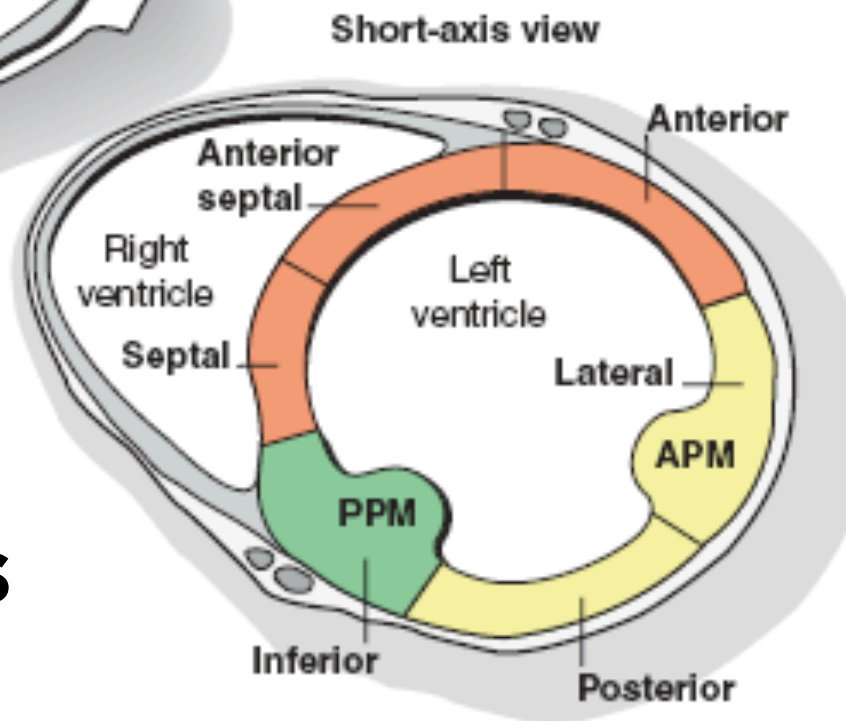


注意Wall motion /kinetic change

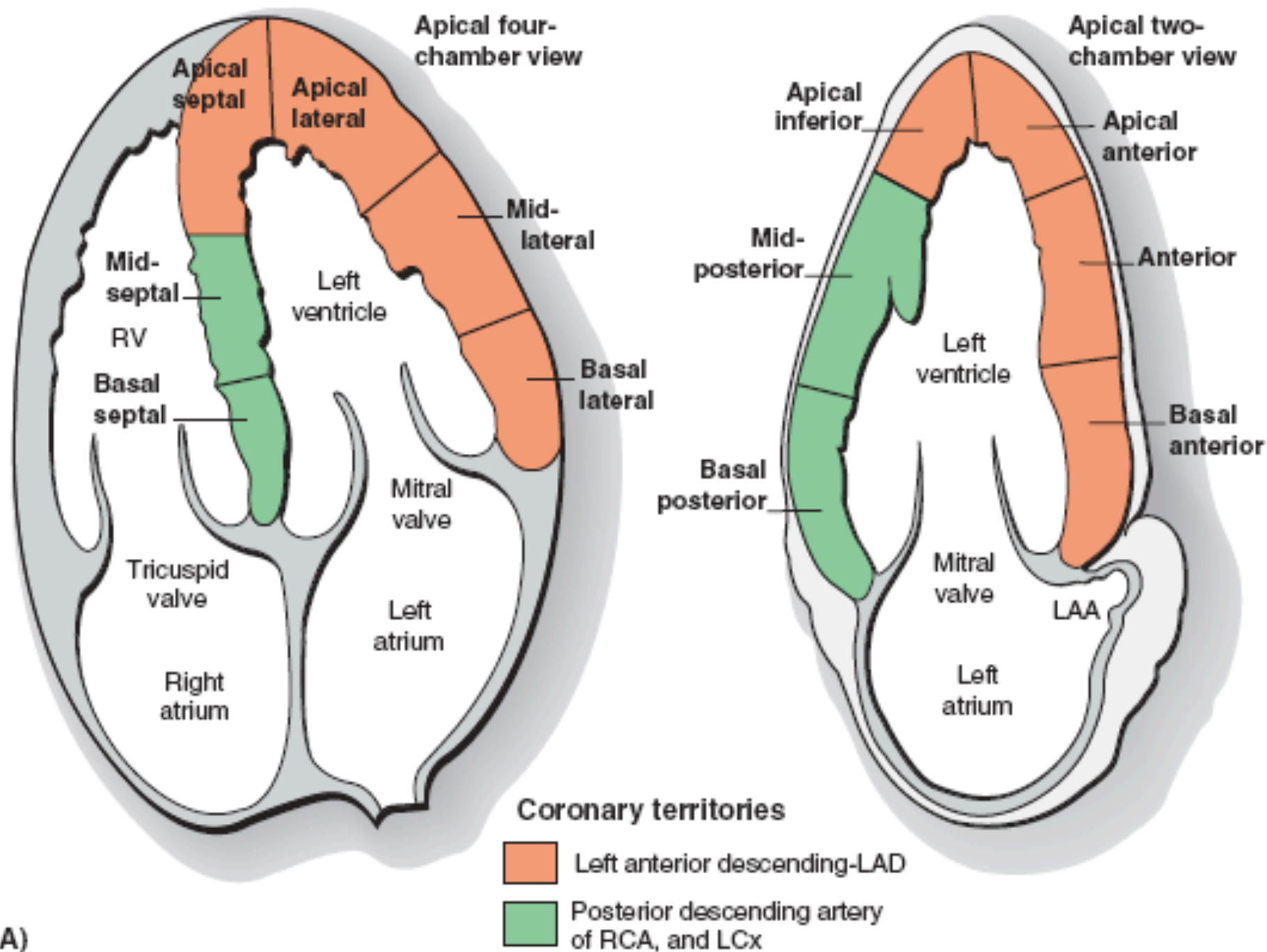


Coronary territories

- Left anterior descending-LAD
- Left circumflex artery-LCx
- Posterior descending artery of RCA, and LCx

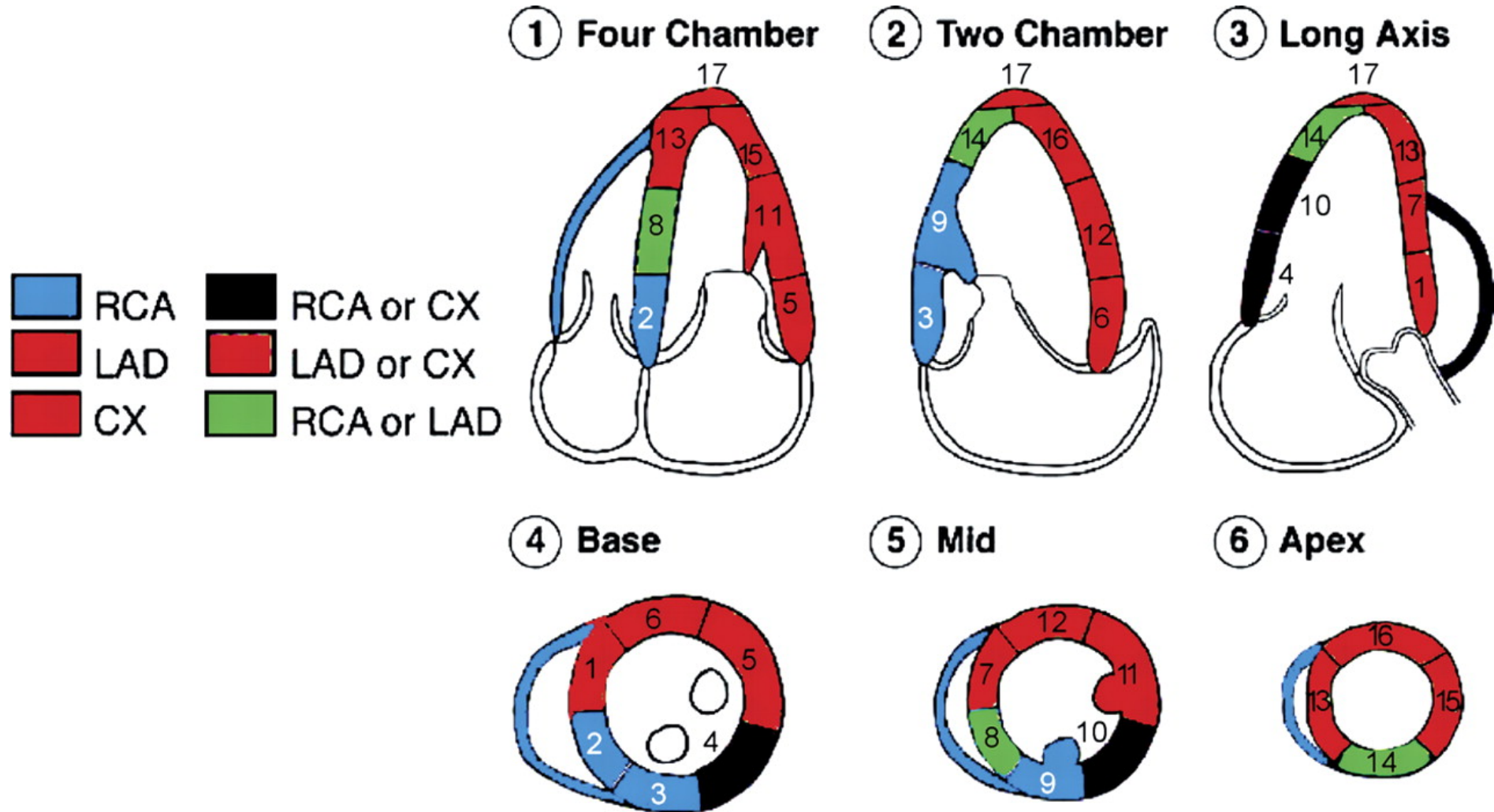


Coronary Territories

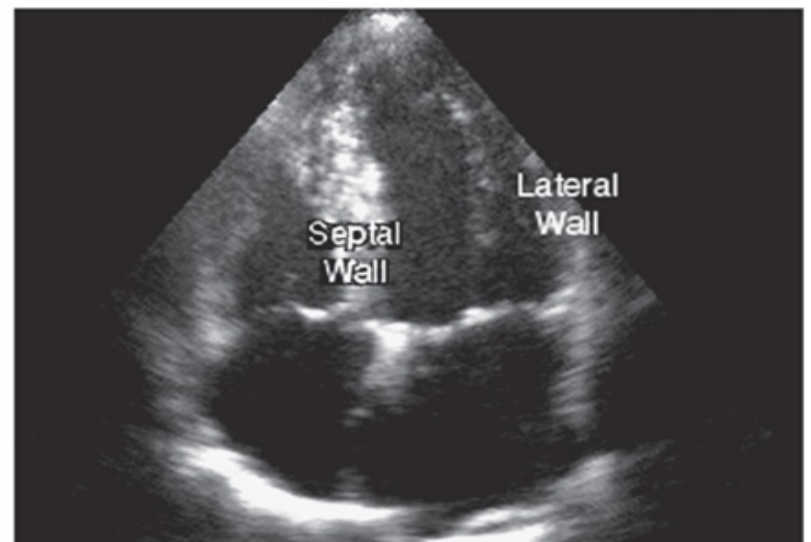
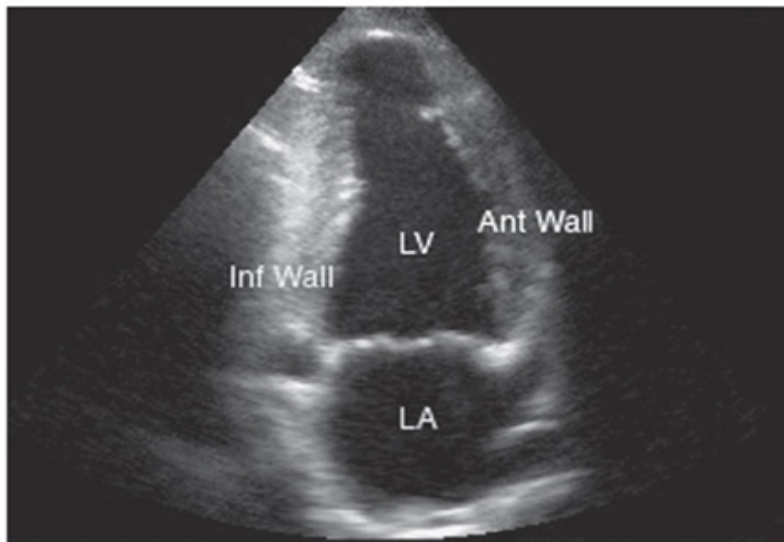
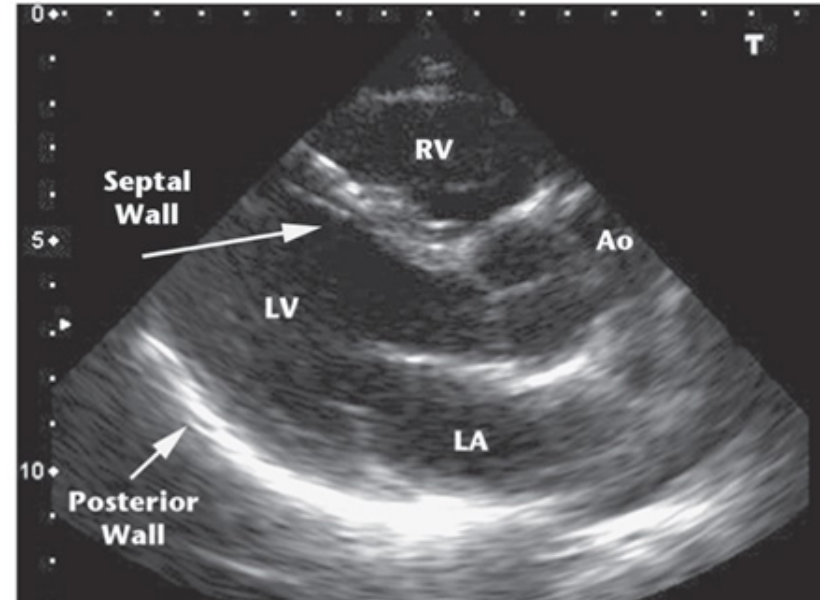
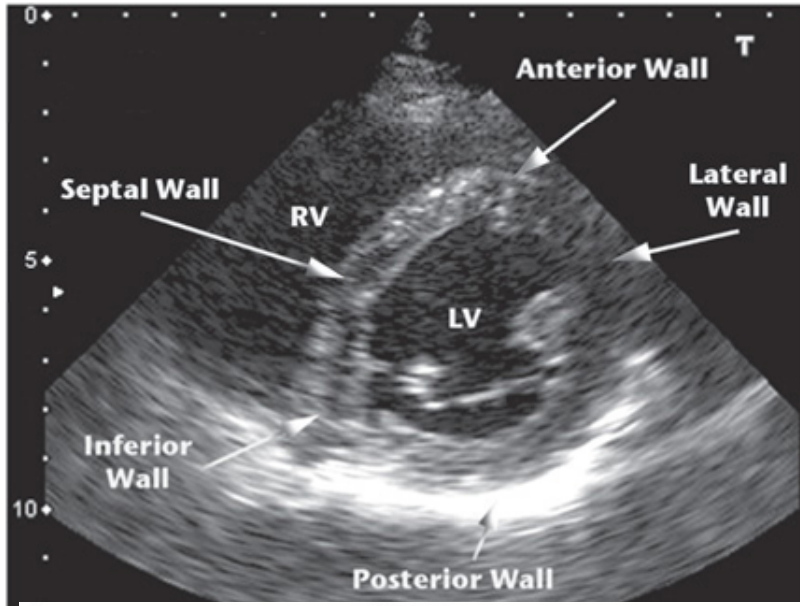


A)

Myocardial Ischemia

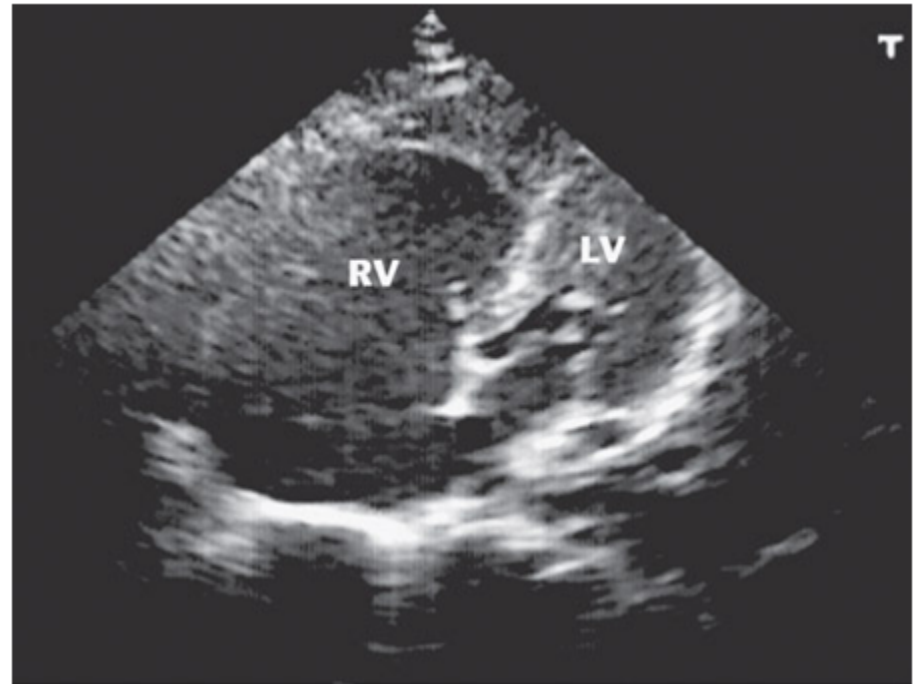
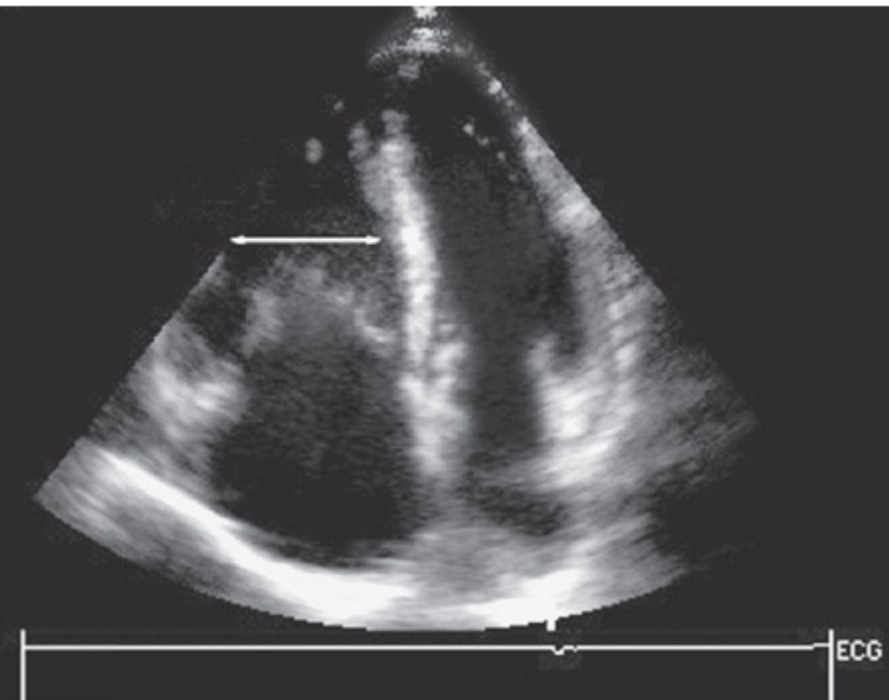


Myocardial Ischemia



Massive Pulmonary Embolism

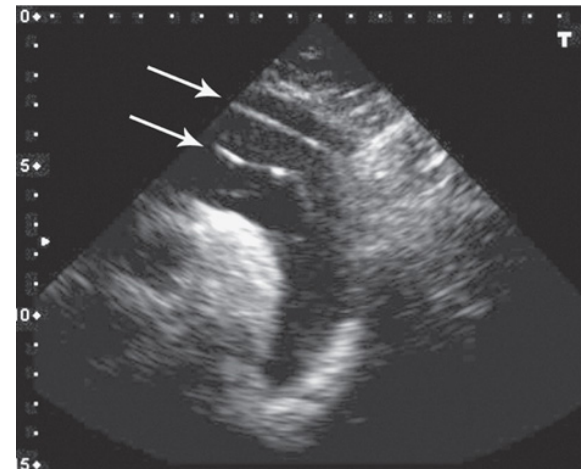
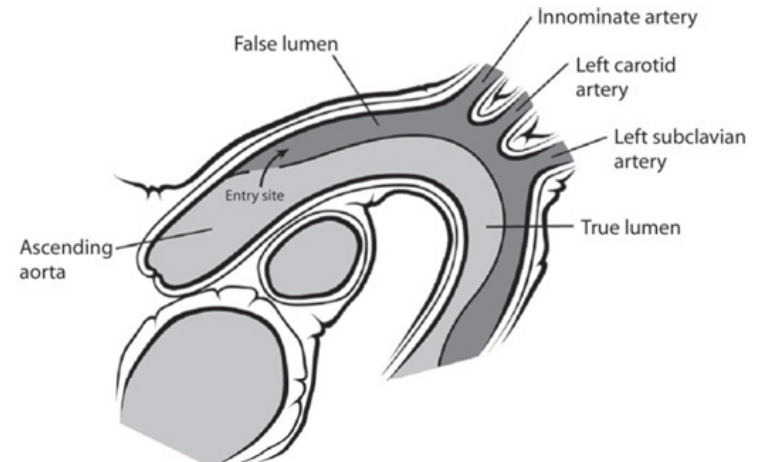
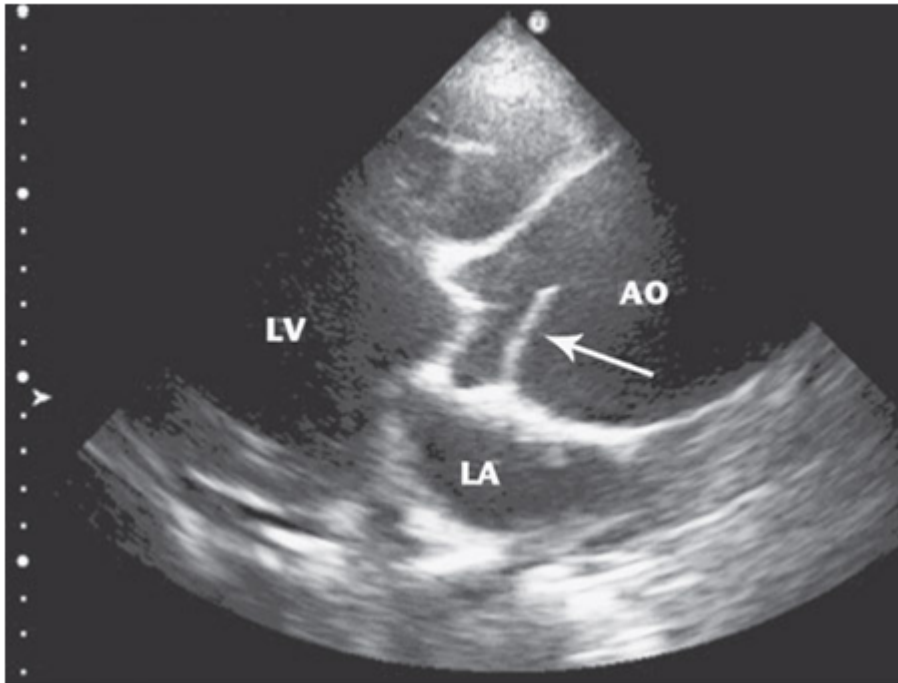
- ◆ normal right ventricular end diastolic diameter is 21 ± 1 mm in parasternal long axis view
- ◆ normal right to left ventricle ratio, obtained in the apical four-chamber view, is less than 0.5



Proximal Aortic Dissection

proximal thoracic aortic dissection :

1. a dilated aortic root (>3.8 cm)
2. easily visualized on the parasternal long axis view



Point Of Care UltraSound (POCUS)

急重症 A-B-C 處置

POCUS Shock

Integrate ultrasound early into the critically ill patient



RUSH

Rapid **U**ltrasound in **S**Hock

P. Perera, T. Mailhot, D. Riley, and D. Mandavia, “[The RUSH exam](#): rapid Ultrasound in SHock in the evaluation of the critically ill patient,” *Ultrasound Clinics*, vol. 7, no. 2, pp. 255– 278, 2012.

RUSH Protocol

三個最重要元素

Pump

Tank

Pipes



Step 1



Step 2

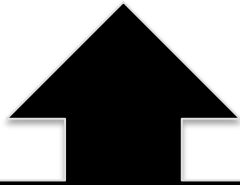


Step 3

RUSH Protocol

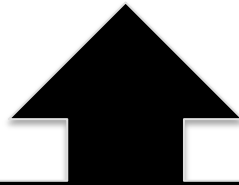
三個最重要元素及掃描重點

Pump



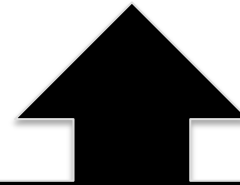
Pericardial effusion
LV contractility
RV dilation

Tank



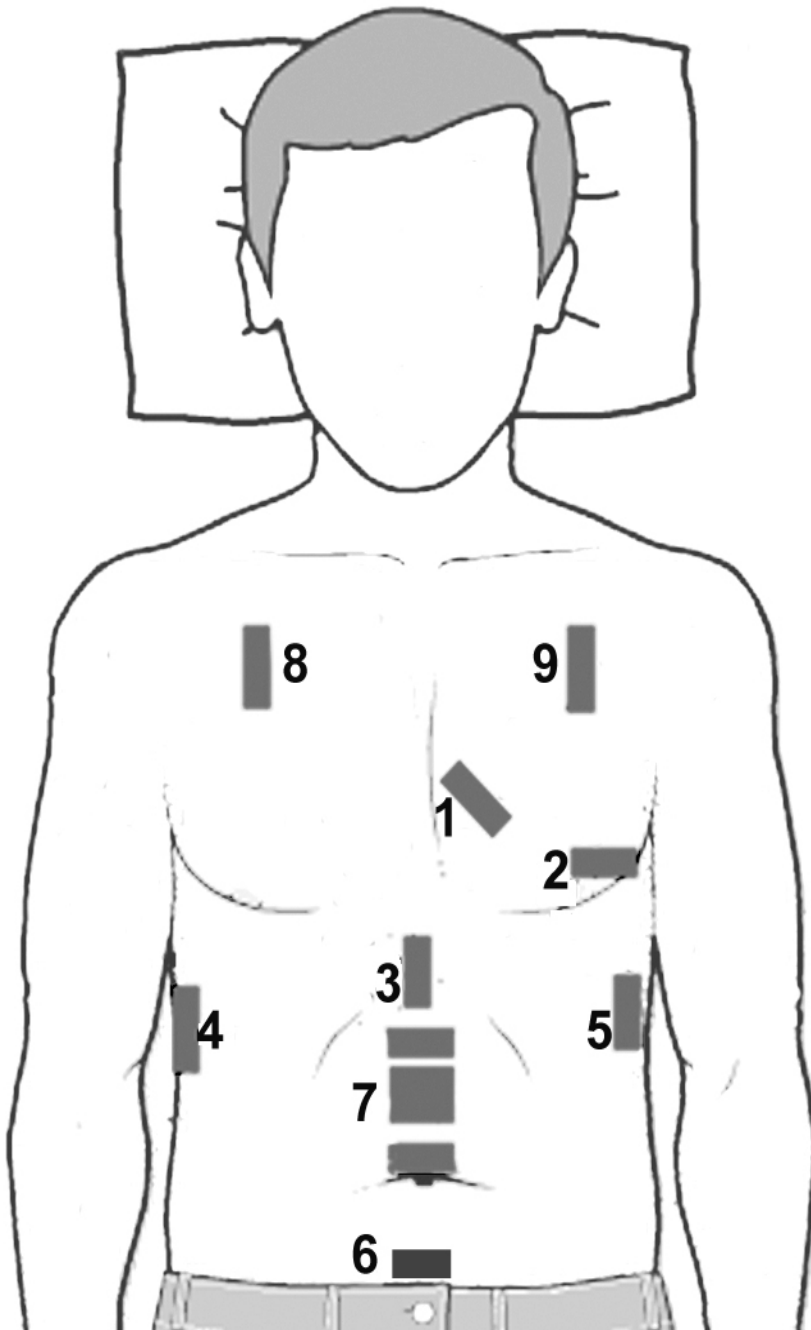
Fullness
Leakiness
Compromise

Pipes



Rupture
Obstruction

RUSH Exam Sequencing



1. Parasternal Long Cardiac View
2. Apical Four-Chamber Cardiac View
3. Inferior Vena Cava View
4. Morison's with Hemothorax View
5. Splenorenal with Hemothorax View
6. Bladder View
7. Aortic Slide Views
8. Pneumothorax View
9. Pneumothorax View

Use Curvilinear Array for 1-7

Use High-Frequency Array for 8 & 9

RUSH in shock

Table 1

Rapid Ultrasound in SHock (RUSH) protocol: ultrasonographic findings seen with classic shock states

RUSH Evaluation	Hypovolemic Shock	Cardiogenic Shock	Obstructive Shock	Distributive Shock
Pump	Hypercontractile heart Small chamber size	Hypocontractile heart Dilated heart	Hypercontractile heart Pericardial effusion Cardiac tamponade RV Strain Cardiac thrombus	Hypercontractile heart (early sepsis) Hypocontractile heart (late sepsis)
Tank	Flat IVC Flat jugular veins Peritoneal fluid (fluid loss) Pleural fluid (fluid loss)	Distended IVC Distended jugular veins Lung rockets (pulmonary edema) Pleural fluid (effusions) Peritoneal fluid (ascites)	Distended IVC Distended jugular veins Absent lung sliding (pneumothorax)	Normal or small IVC (early sepsis) Peritoneal fluid (peritonitis) Pleural fluid (empyema)
Pipes	Abdominal aneurysm Aortic dissection	Normal	DVT	Normal

Abbreviations: DVT, deep venous thrombosis; IVC, inferior vena cava; RV, right ventricle.

RUSH in SHOCK

TABLE 2: Using the RUSH protocol to diagnose the type of shock.

	Step no. 1	Step no. 2	Step no. 3
Pump	Pericardial effusion: (a) Effusion present? (b) Signs of tamponade? Diastolic collapse of R Vent +/- R Atrium?	Left ventricular contractility: (a) Hyperdynamic? (b) Normal? (c) Decreased?	Right ventricular strain: (a) Increased size of RV? (b) Septal displacement from right to left?
Tank	Tank volume: (1) Inferior vena cava: (a) Large size/small Insp collapse? —CVP high— (b) Small size/large Insp collapse? —CVP Low— (2) Internal jugular veins: (a) Small or large?	Tank leakiness: (1) E-FAST exam: (a) Free fluid Abd/Pelvis? (b) Free fluid thoracic cavity? (2) Pulm edema: Lung rockets?	Tank compromise: Tension pneumothorax? (a) Absent lung sliding? (b) Absent comet tails?
Pipes	Abdominal aorta aneurysm: Abd aorta > 3 cm?	Thoracic aorta aneurysm/dissection: (a) Aortic root > 3.8 cm? (b) Intimal flap? (c) Thor aorta > 5 cm?	(1) Femoral vein DVT? Noncompressible vessel? (2) Popliteal vein DVT? Noncompressible vessel?



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Practice Makes Perfect