



*Complimentary Educational Session
for Cardiology Fellows*

Sep 30, 2015

Echo in Emergency and Critical Care Settings

Common pitfalls and role of echo in decision making

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Outline

- Basic standard echo view
- Cases of echo in critical and emergency settings



IVC size



ASE American Society of
Echocardiography
Heart & Circulation Ultrasound Specialists

Guidelines for the Echocardiographic Assessment of the Right Heart in Adults

Adapted from: Rudski LG, Lai WW, Afilalo J, Hua L, Handschumacher MD, Chandrasekaran K, Solomon SD, Louie EK, Schiller NB. Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography. *J Am Soc Echocardiogr* 2010;23:685-713.



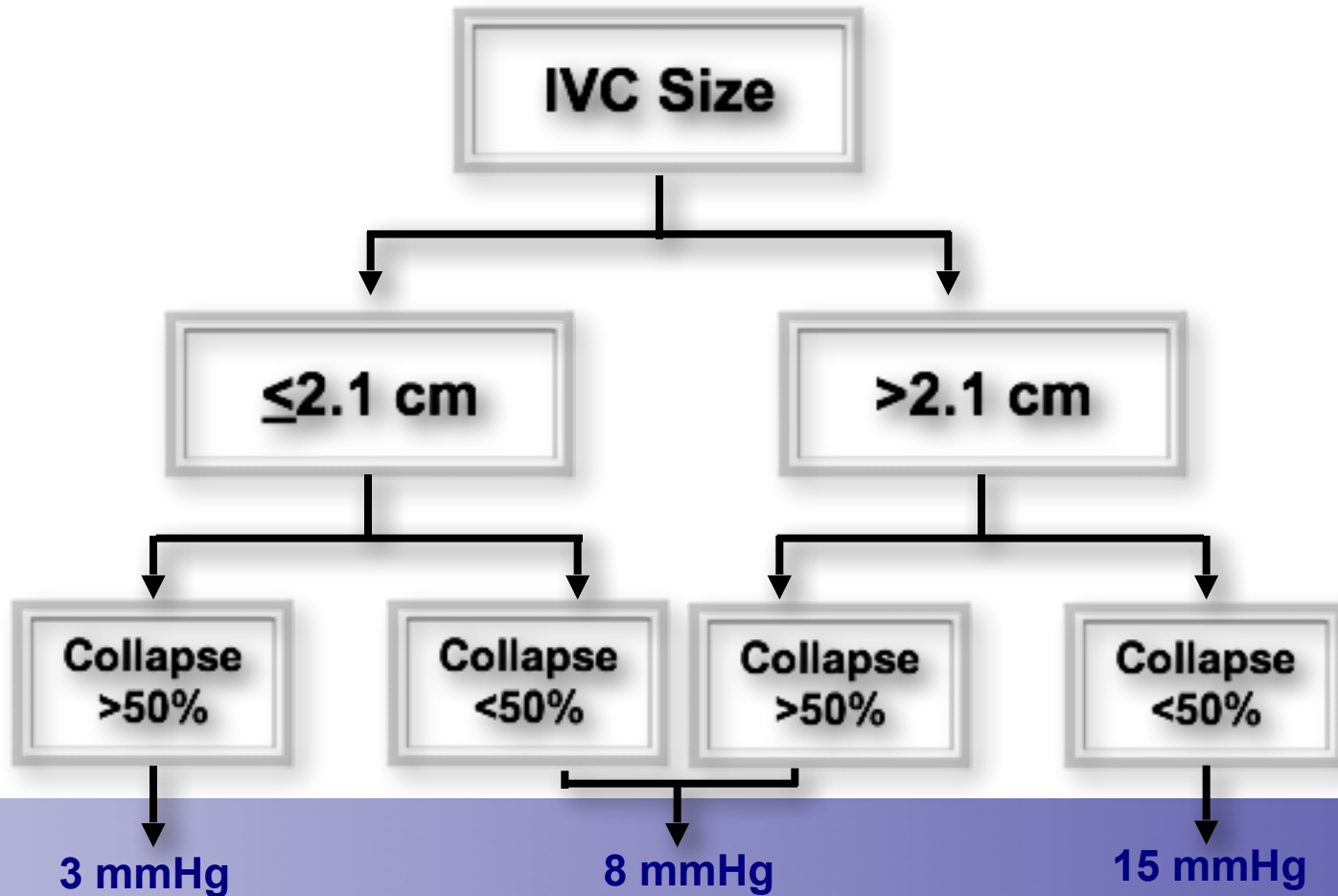
Right Atrial Pressure

Estimation of RA pressure on the basis of IVC diameter and collapse

| Variable | Normal (0-5 (3) mmHg) | Intermediate (5-10 (8) mmHg) | High (15 mmHg) |
|---|--------------------------|----------------------------------|---|
| IVC diameter | ≤2.1 cm | ≤ 2.1 cm >2.1 cm | > 2.1 cm |
| Collapse with sniff | >50% | <50% >50% | < 50% |
| Secondary indices of elevated RA pressure | | | - Restrictive filling - Tricuspid E/E' >6 - Diastolic flow predominance in HV |



IVC size and RA pressure

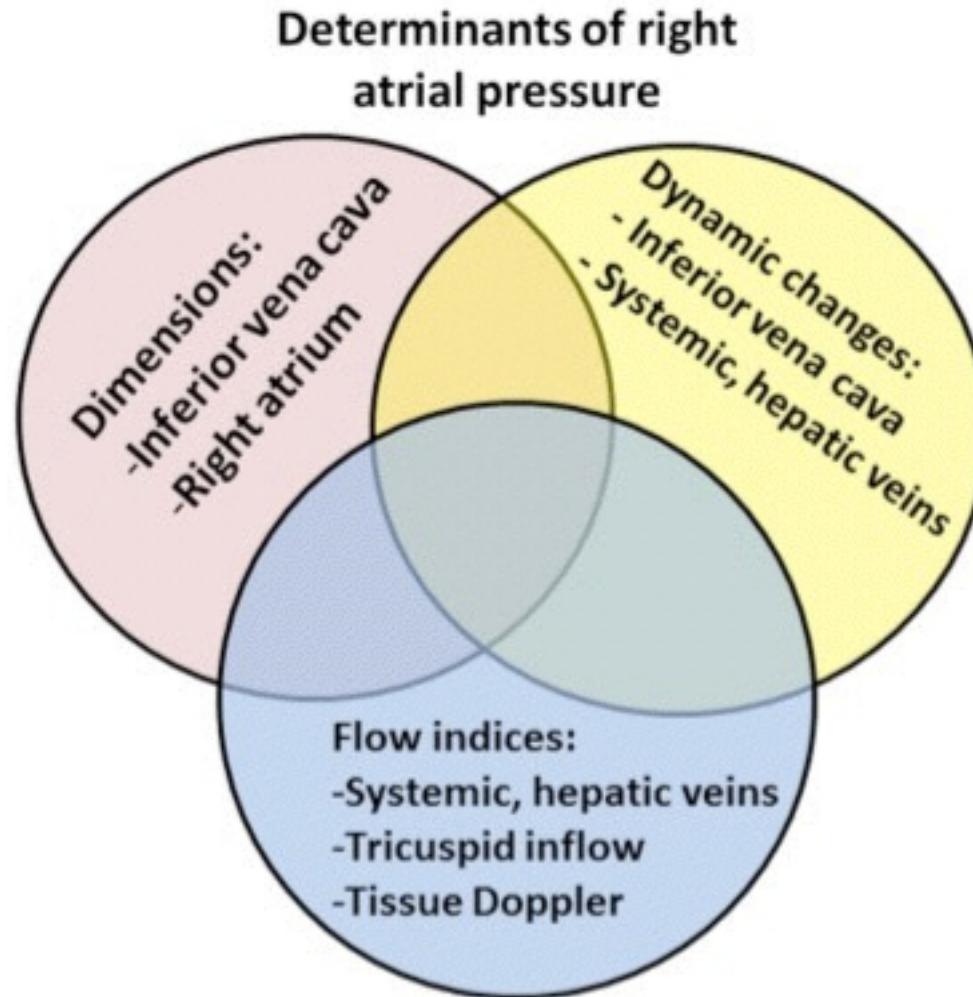


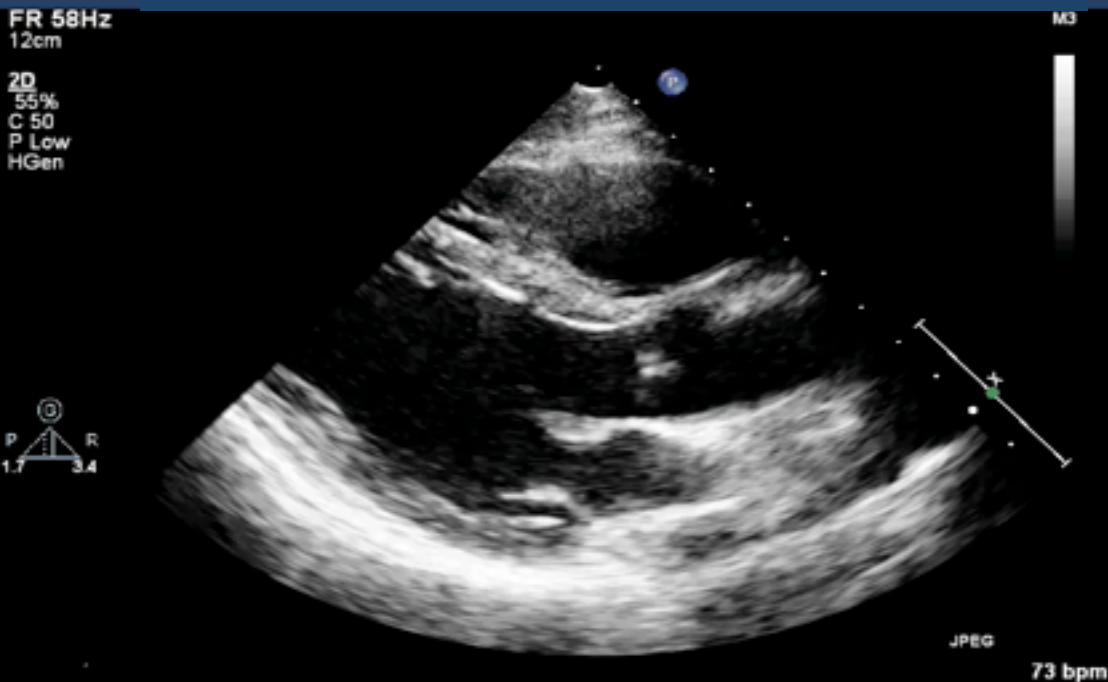
Causes for IVC enlargement in the presence of Normal RAP

| |
|----------------------------------|
| Prominent Eustachian valve |
| Athletic training |
| Large BSA |
| Mechanical ventilation |
| Narrowing of the IVC-RA junction |
| Web or tissue present in the IVC |



Non-invasive assessment of RAP

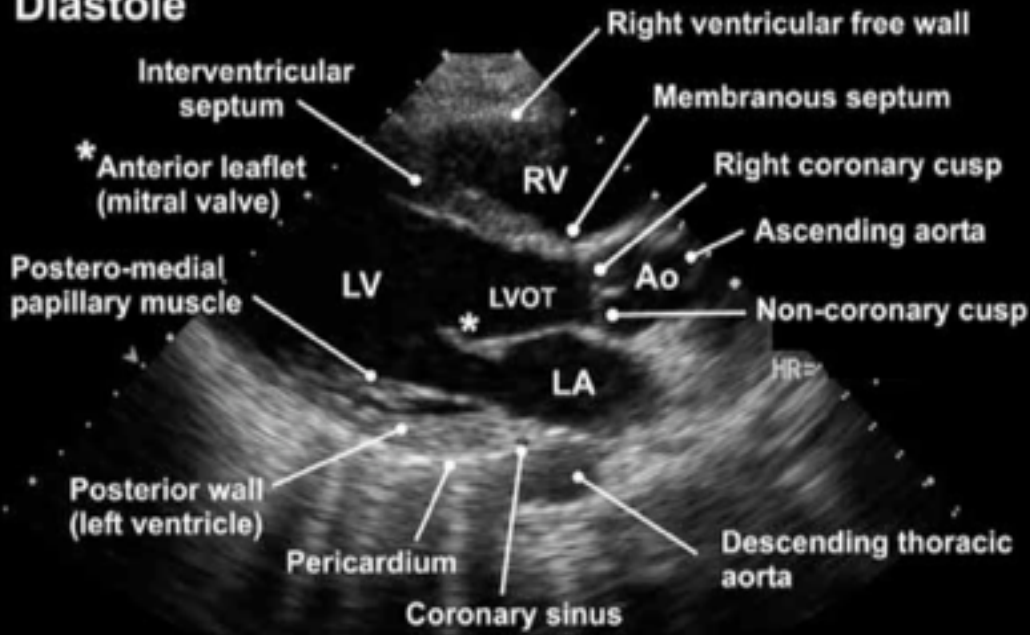




Structure

- Chamber size
- Wall thickness
- Valve structure, morphology integrity
- Mass (tumor, clot, vegetation)
- Pericardial effusion
- Congenital heart disease

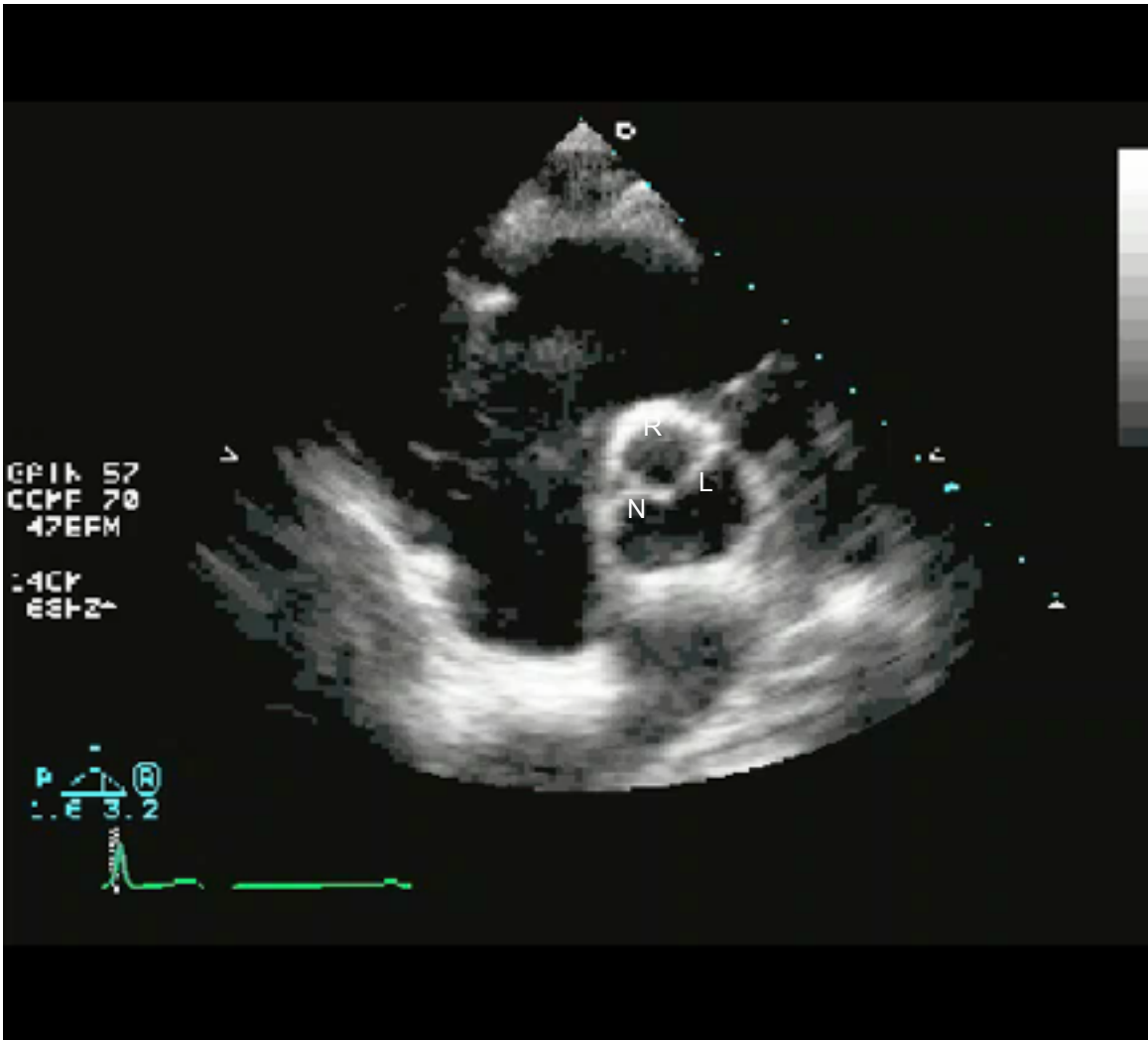
Diastole



Function

- Global systolic function
- Regional wall motion

PSAX : AV level

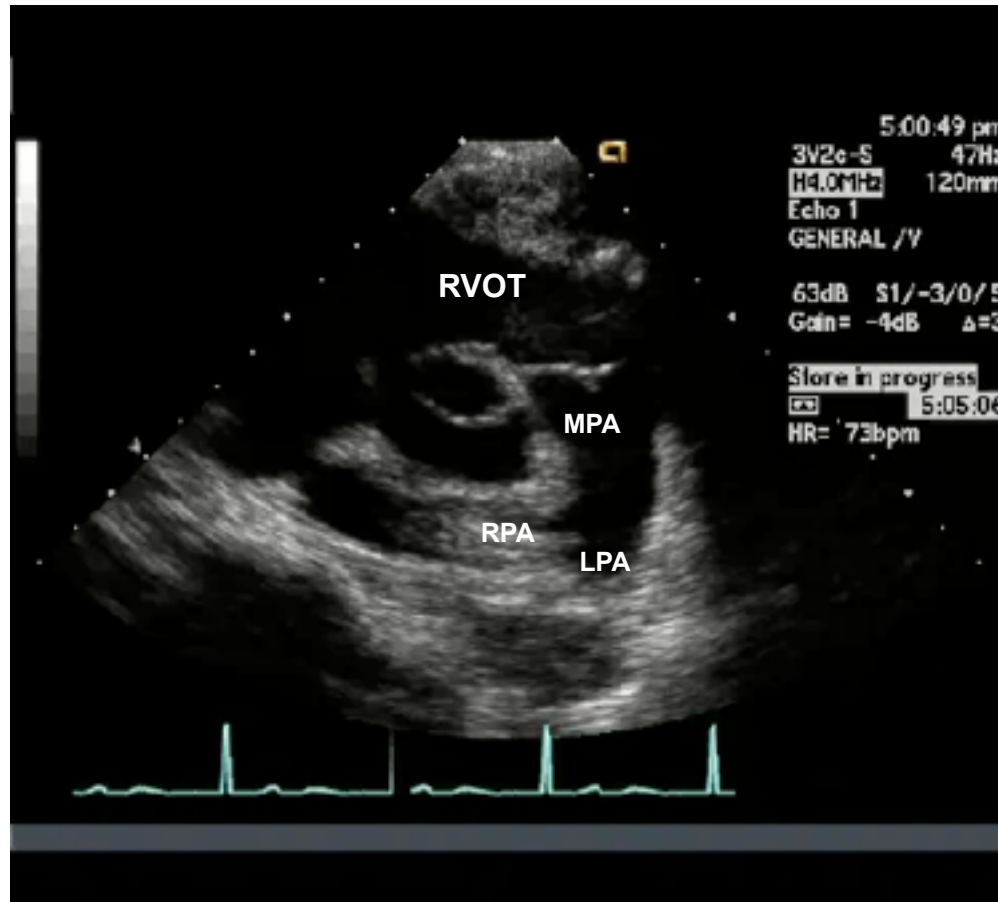


Observe:

- Aortic valve cusp (numbers, mass)
- LA, RA
- IAS ? ASD
- LAA thrombus
- TV, RVOT
- PV and proximal PA

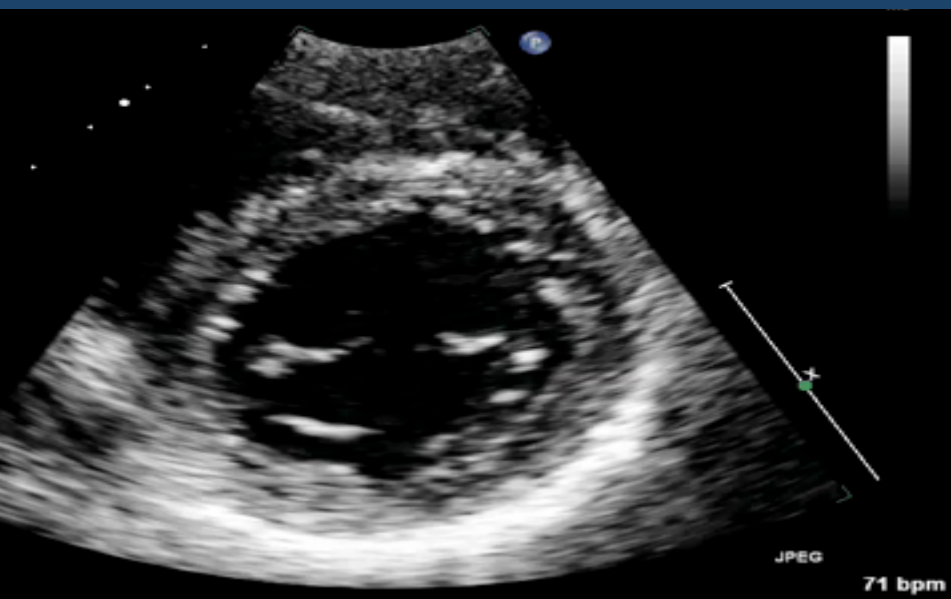


PSAX Pulmonary trunk bifurcation



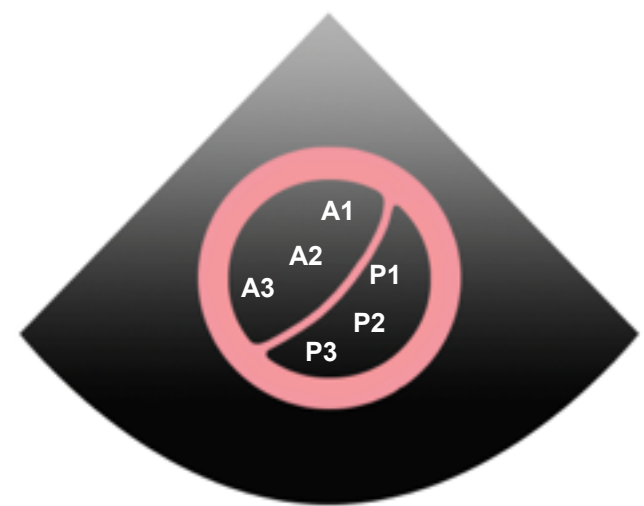
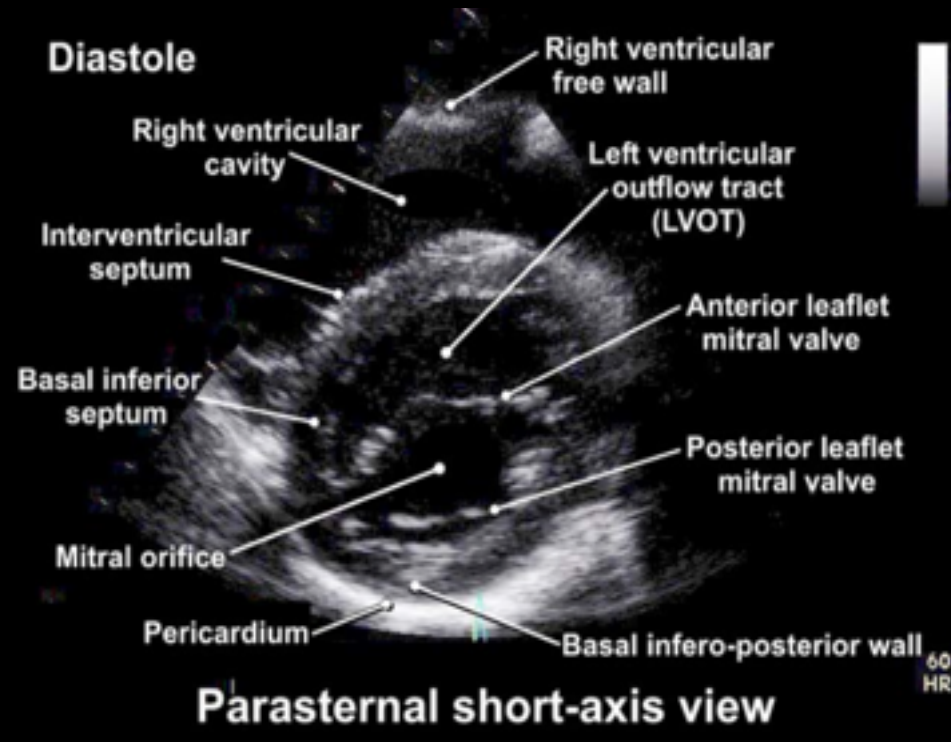
Look for : PDA, PV disease (PS/PR), RVOT obstruction, PE

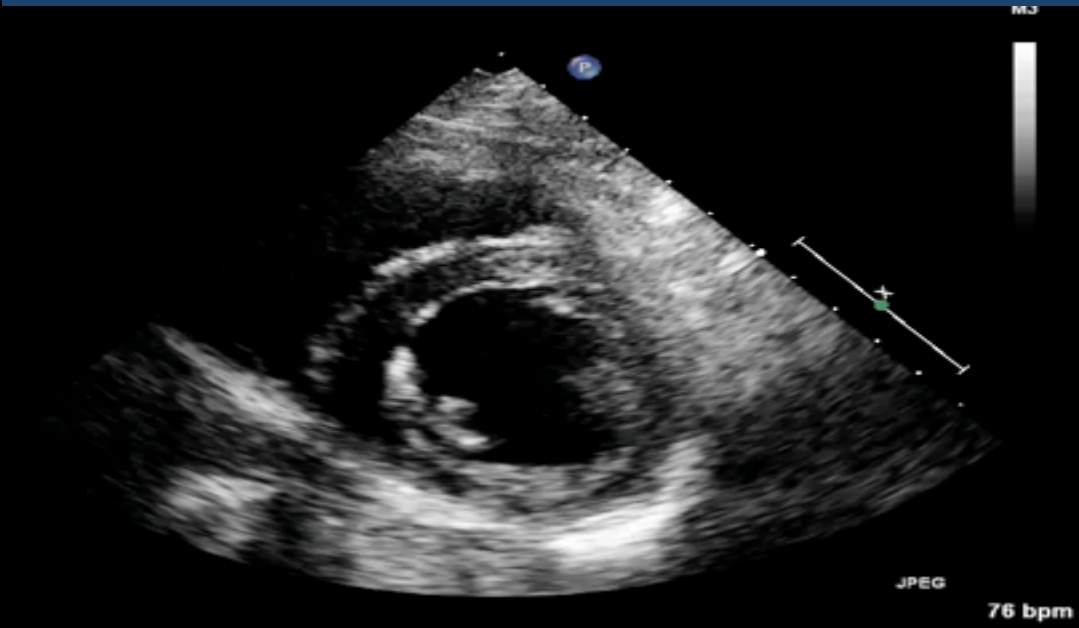




PSAX : MV Level

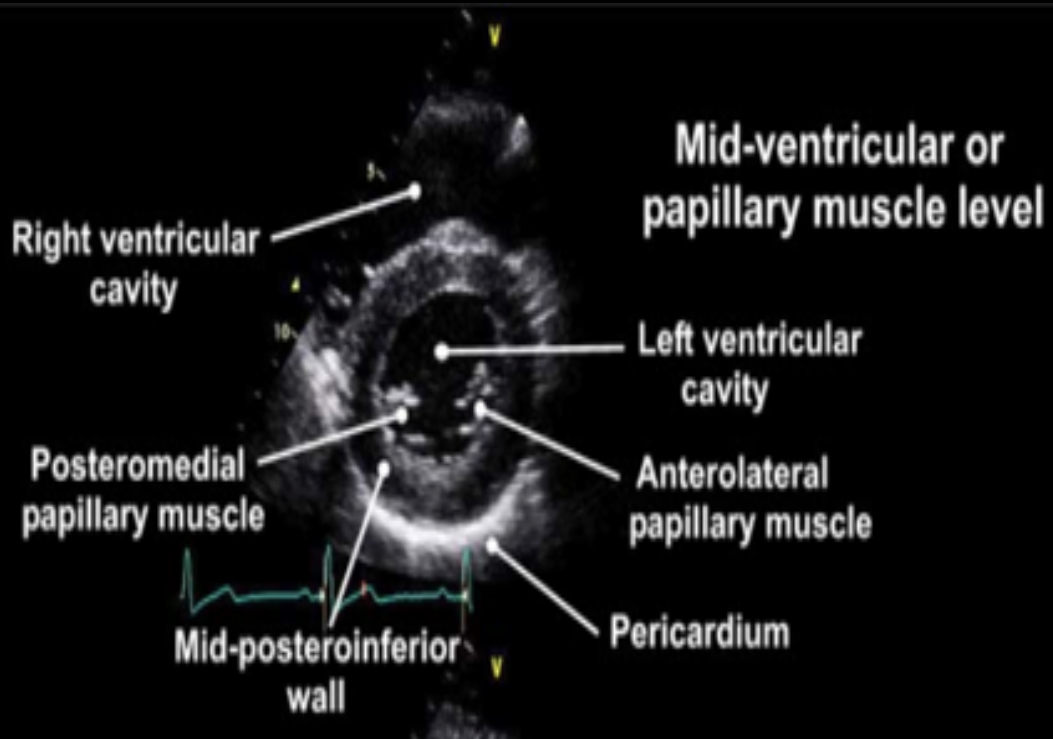
Mitral valve function and structure
MVA : Planimetry
Localize the MV lesion





PSAX : Mid LV Level

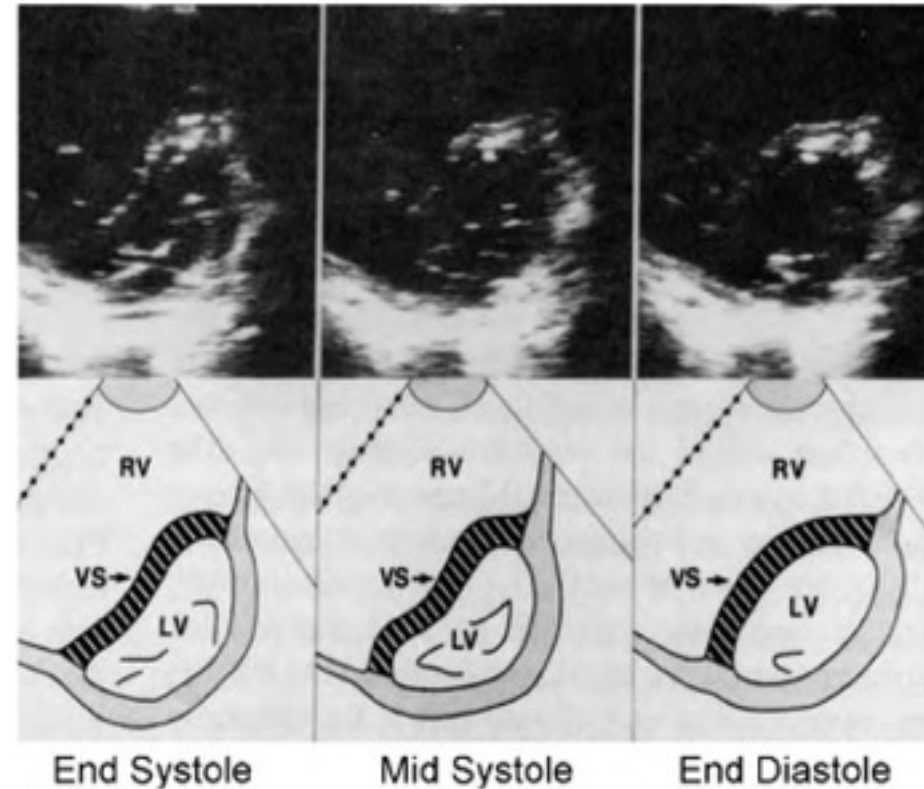
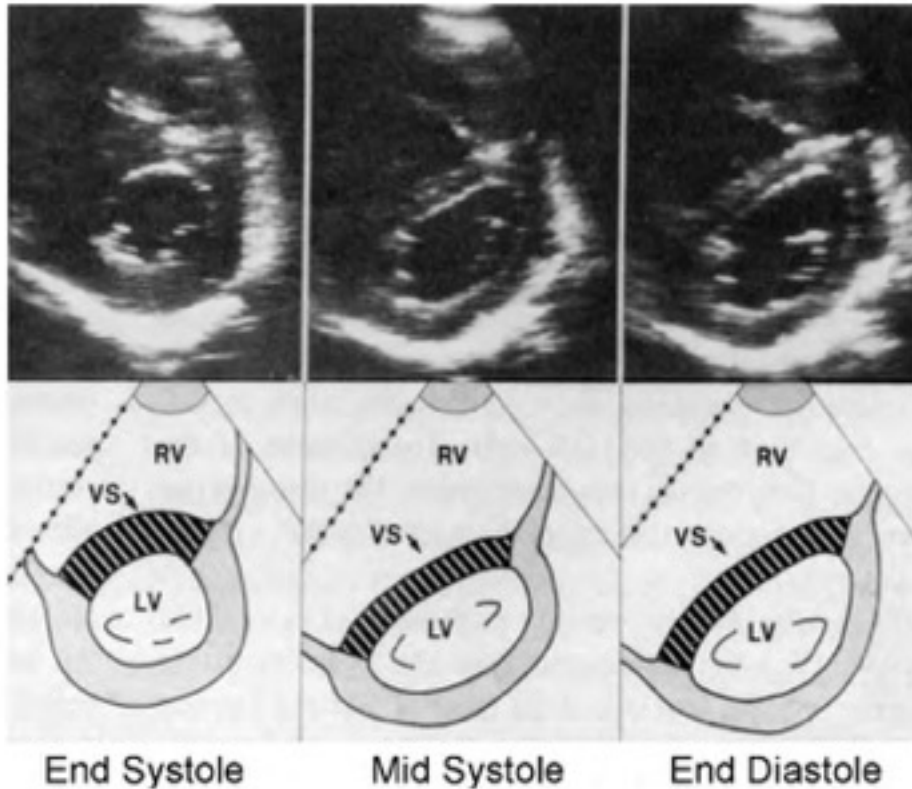
- LV function
- Septum thickness and motion
- RV size
- Pericardial effusion



RVVO Vs RVPO

ventricular septal flattening in *diastole only*

ventricular septal flattening in both *systole* and *diastole*



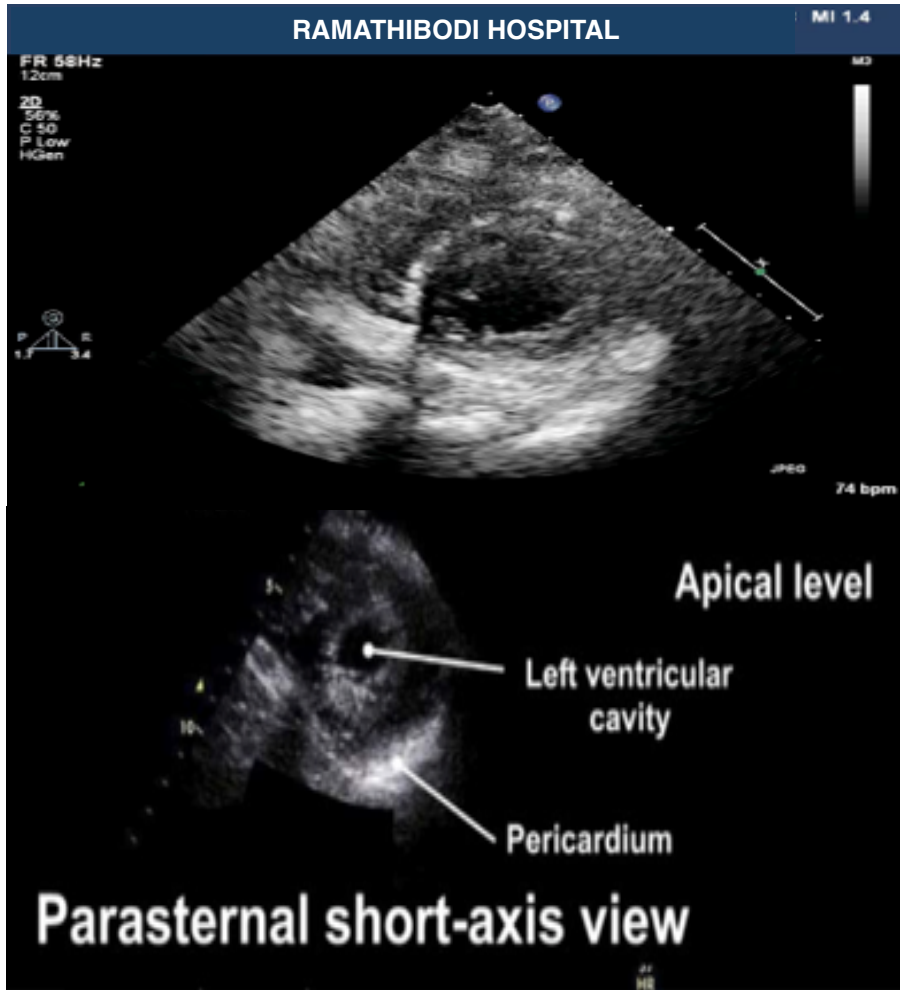
RVVO conditions

- a. ASD
- b. Anomalous pulmonary venous drainage
- c. TR
- d. Pulmonic regurgitation
- e. Ruptured sinus of Valsalva aneurysm

RVPO conditions

- a. Cor pulmonale (acute or chronic)
- b. Primary pulmonary hypertension
- c. Eisenwenger's syndrome
- d. Tetralogy of Fallot

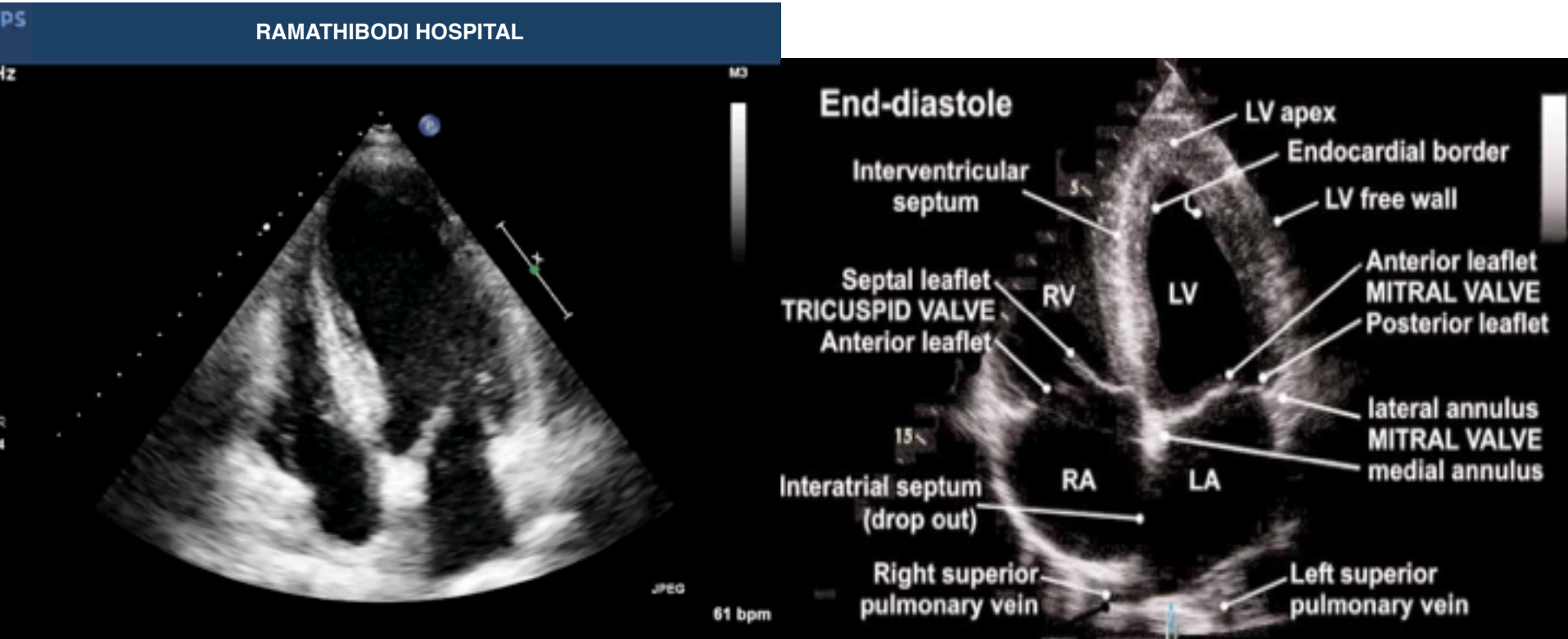
PSAX : Apex



LV apical motion
LV thumbs



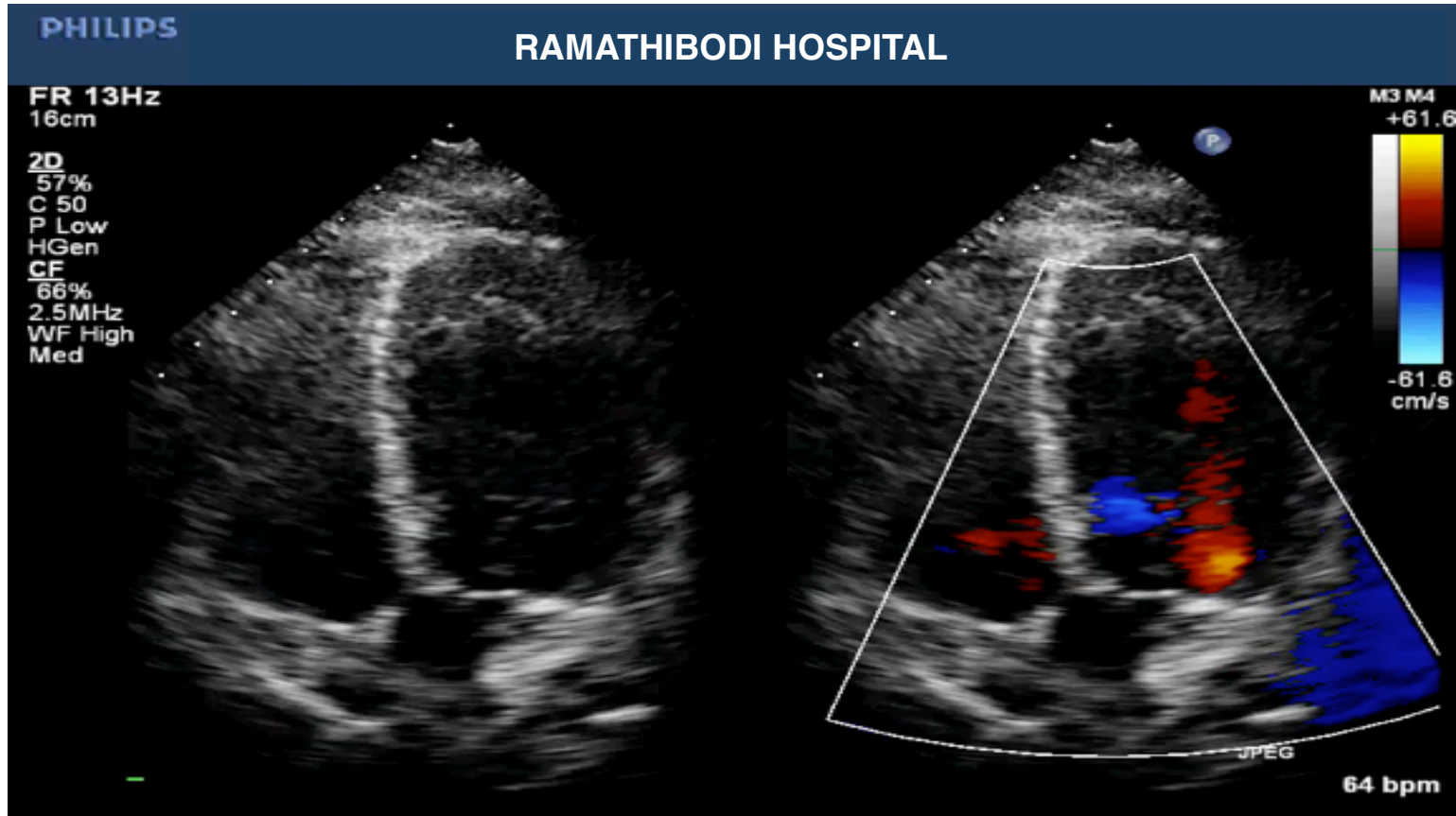
Apical 4 chamber



- Global function view
- Function of MV and AV
- LV size, LA / RA size



Apical 5 chamber



- Tilt the probe anteriorly
- Good Doppler alignment for LVOT and MV
- Color Doppler assessment for AR and MR
- Subvalvular vs. valvular aortic stenosis



Echo Estimation of SV and CO

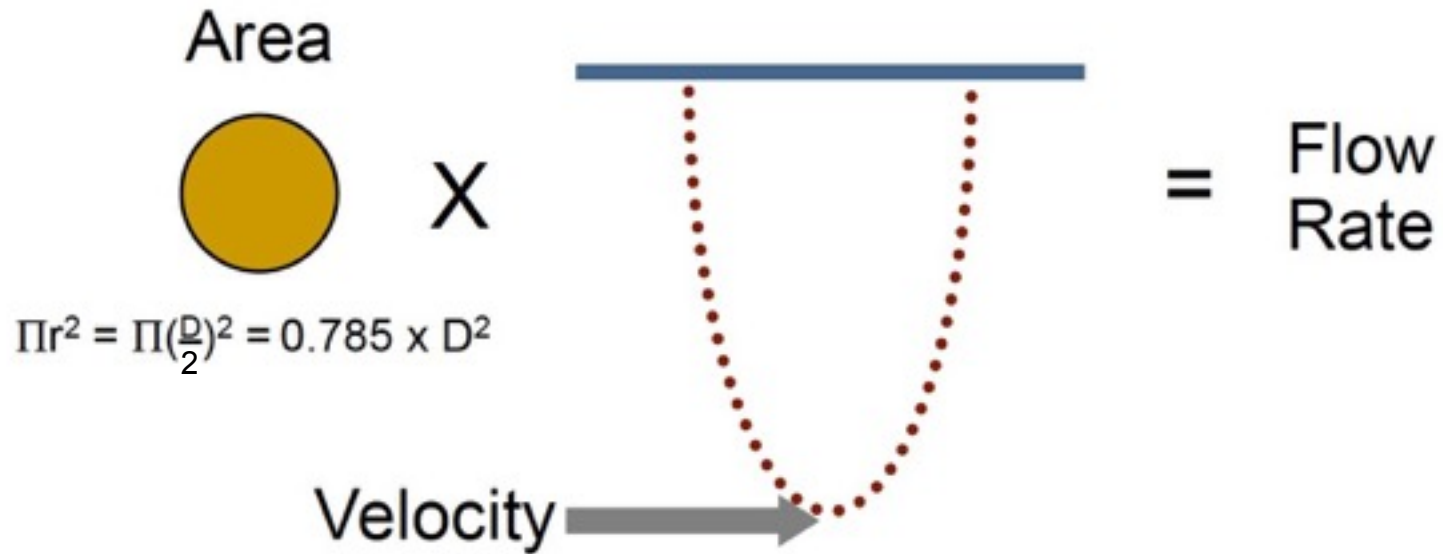
- Volumetric determination
 - $SV = EDV - ESV$
 - $CO = SV \times HR$
- Doppler determination
 - Hydraulic orifice formula
 - >> Using LVOT and TVI



Volumetric Flow



Flow Rate

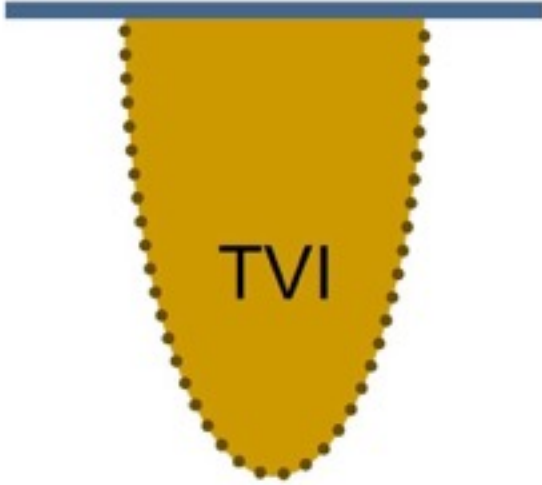


Volume

Area



X



=



Volume

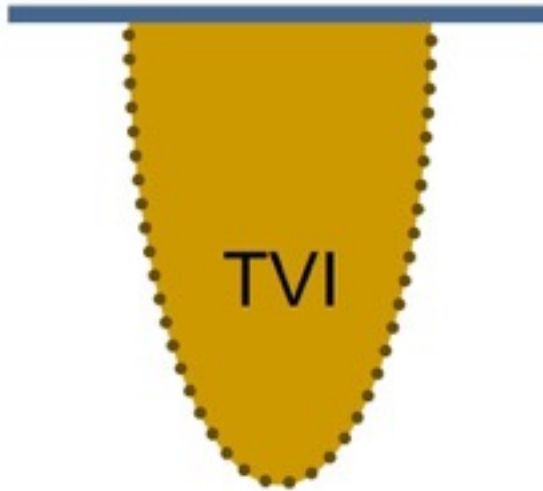


Volume

Area



X



=



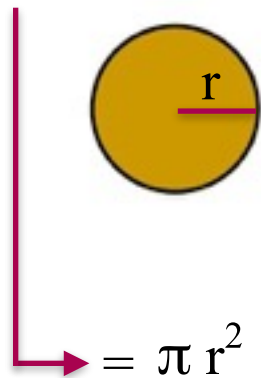
Volume

TVI (stroke distance) = distance (cm) blood travels with each stroke

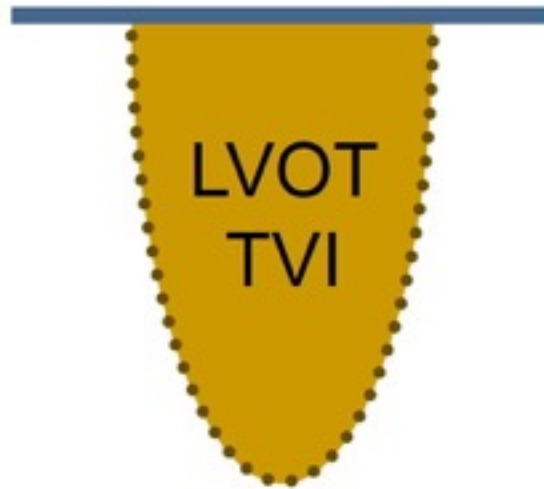


Volume

LVOT Area



X



=


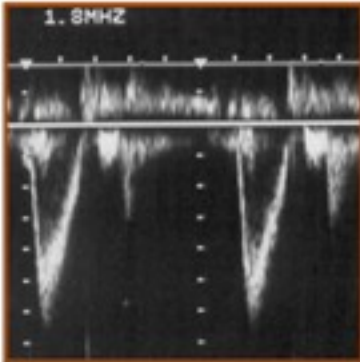


$$\begin{aligned} &= \pi r^2 \\ &= \pi (D/2)^2 \\ &= \frac{3.14 (D)^2}{4} = 0.785 (D)^2 \end{aligned}$$



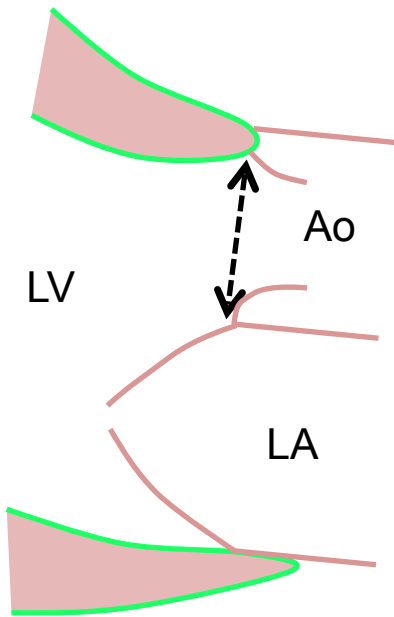
Calculation of Stroke Volume

$$SV = \text{LVOT diameter}^2 \times 0.785 \times \text{LVOT TVI}$$

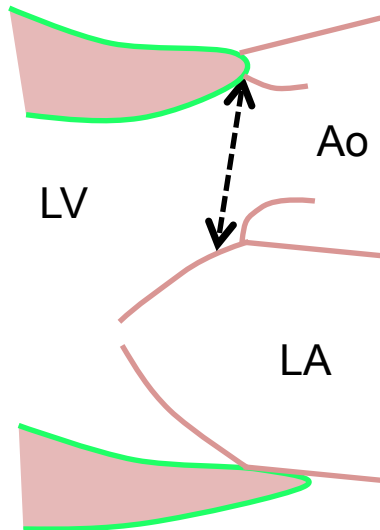
$$SV = \text{^2 \times 0.785 \times \text{$$



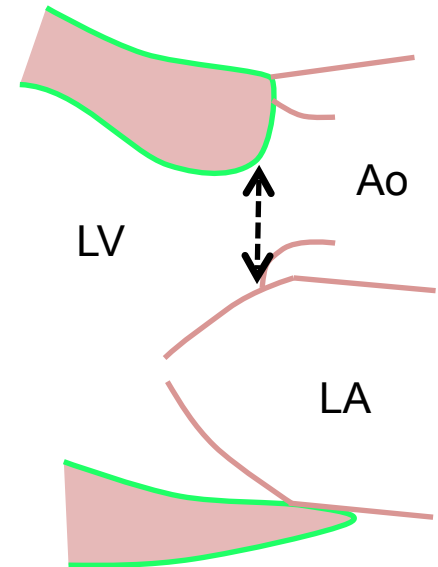
Pitfall : LVOT Measurement



Correct Angle



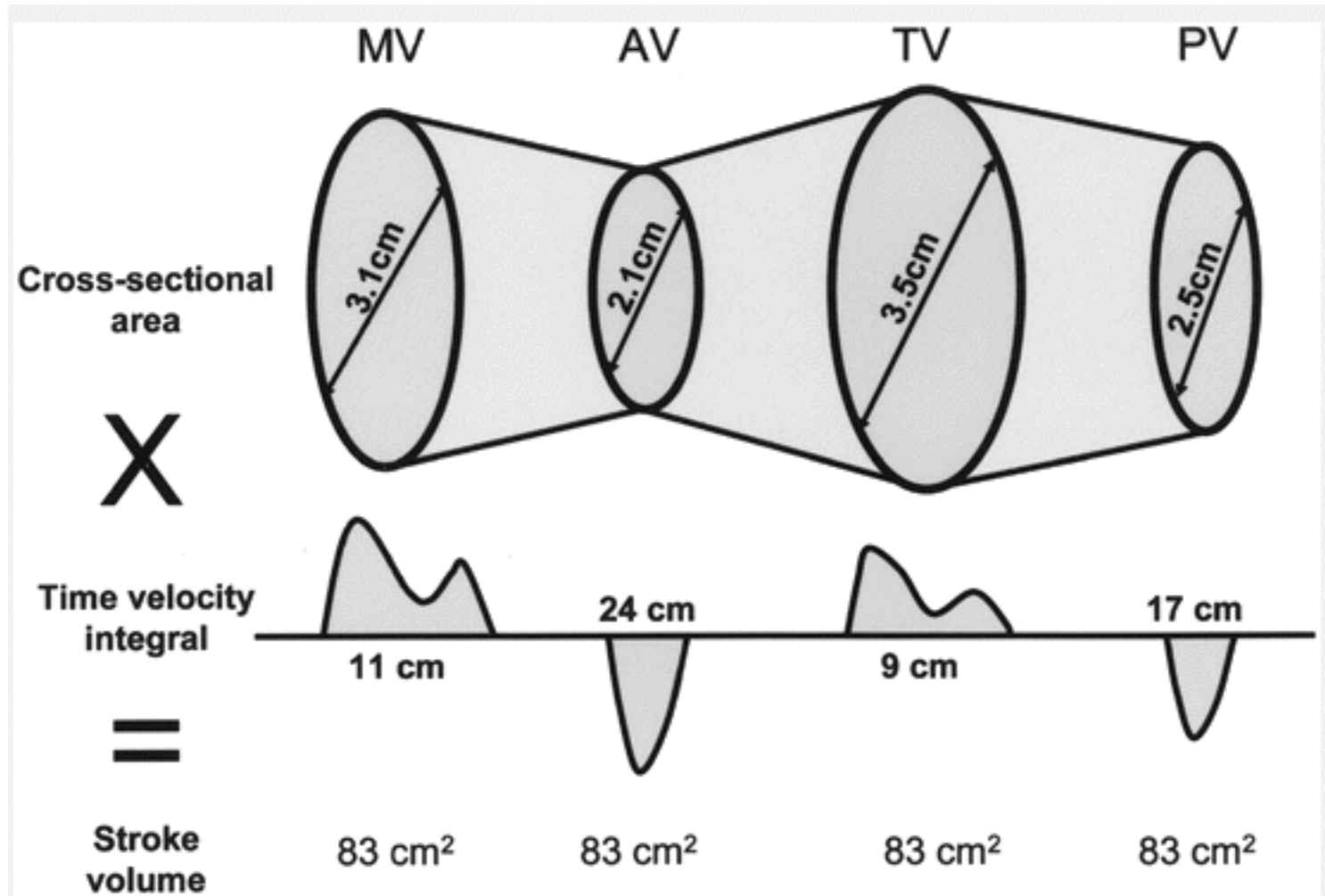
Oblique angle
(Overestimation)



Subaortic septal rim
(Underestimation)



Conservation of Mass Principle

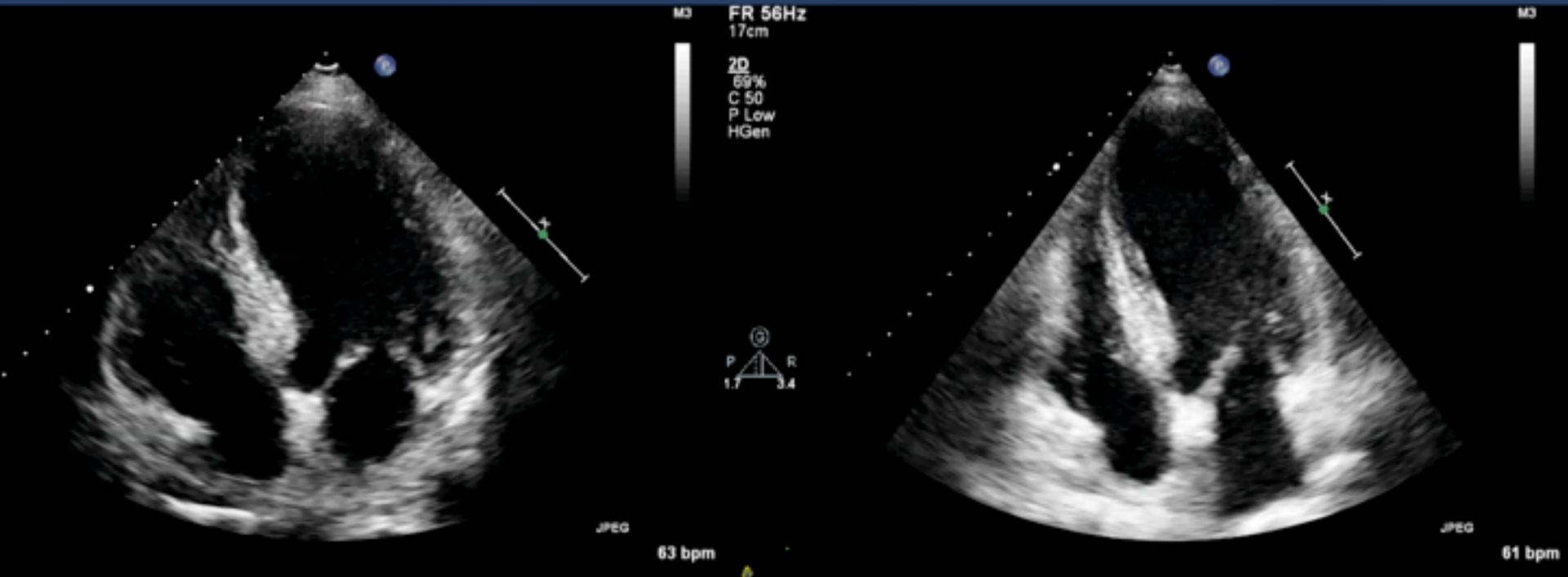


Foreshortening

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PHILIPS

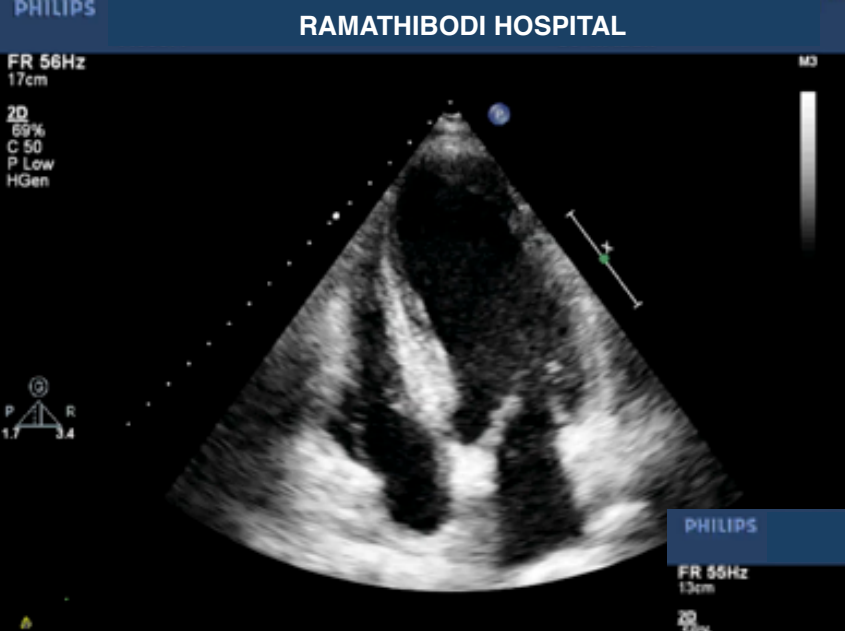
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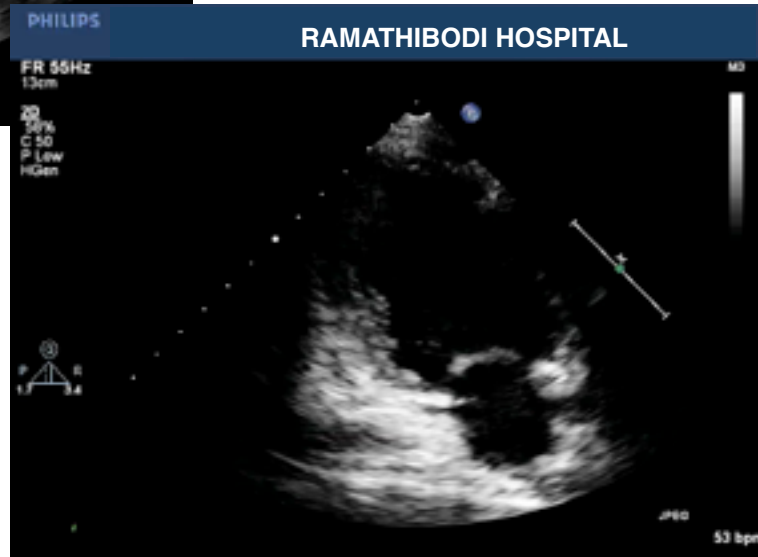
Foreshortening

- Inward motion of the apex
- True apex not visualized
- Volume underestimation

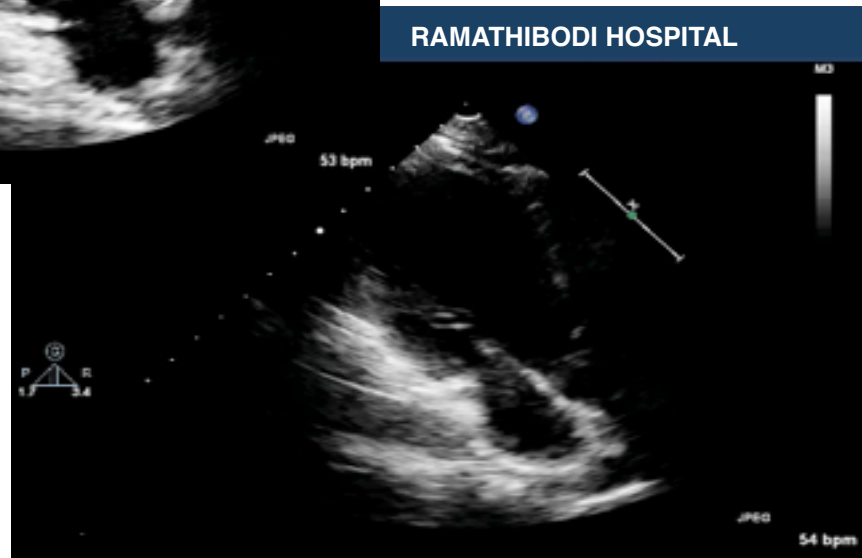




60 ° clockwise
Apical 2 chamber

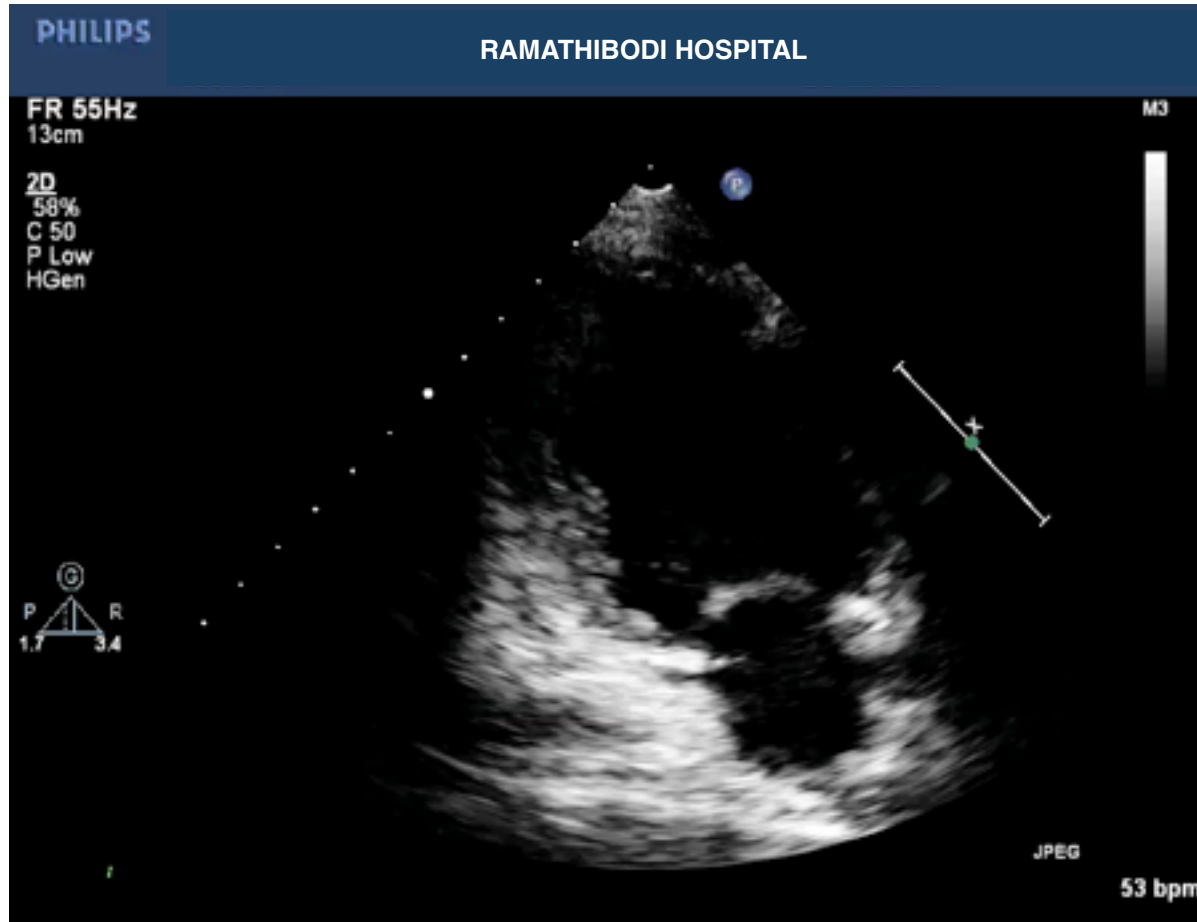


30 ° clockwise
Apical 3 chamber



JPEQ 54 bpm

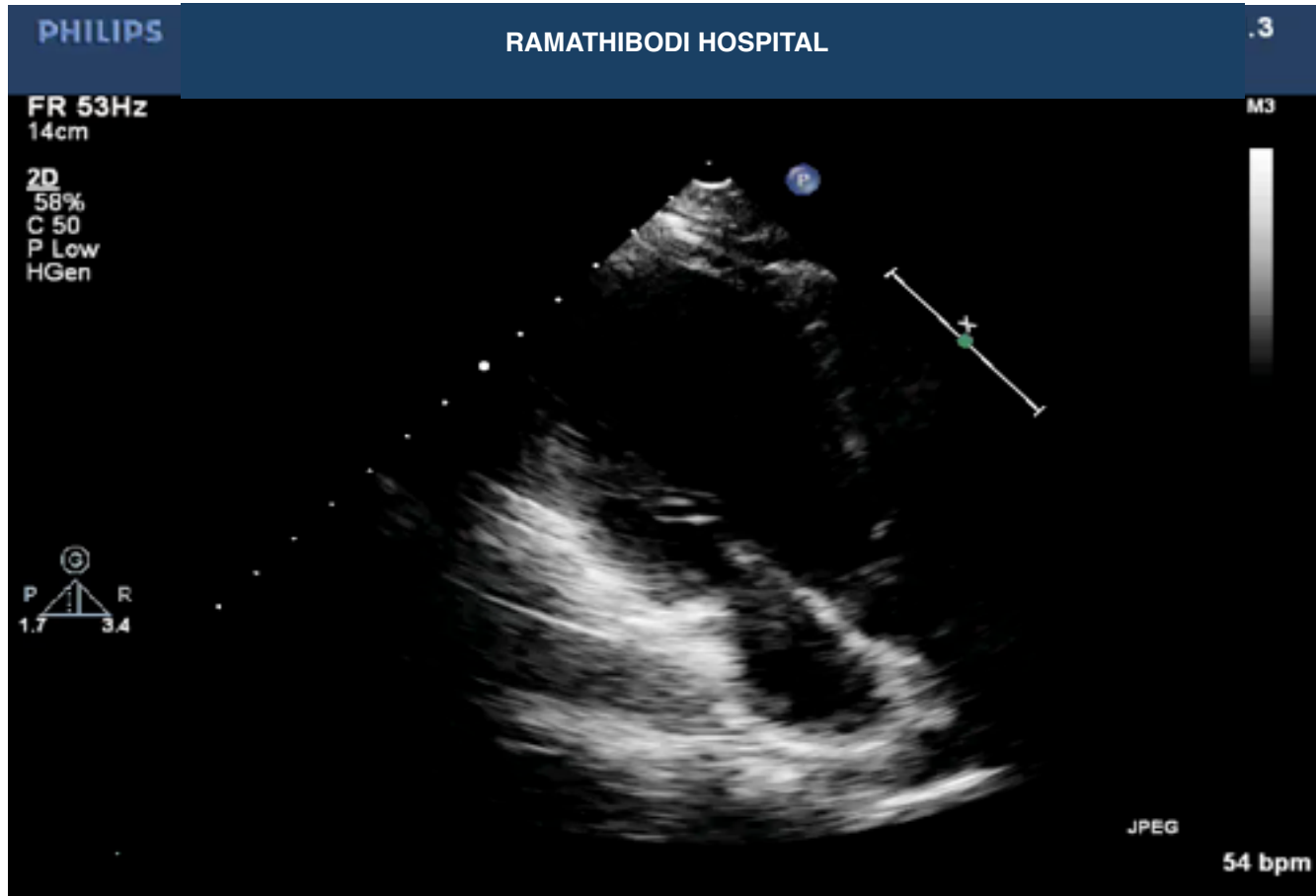
Apical 2 chamber



- Only LA & LV (+MV)
- Occasionally LAA
- Correspond to RAO



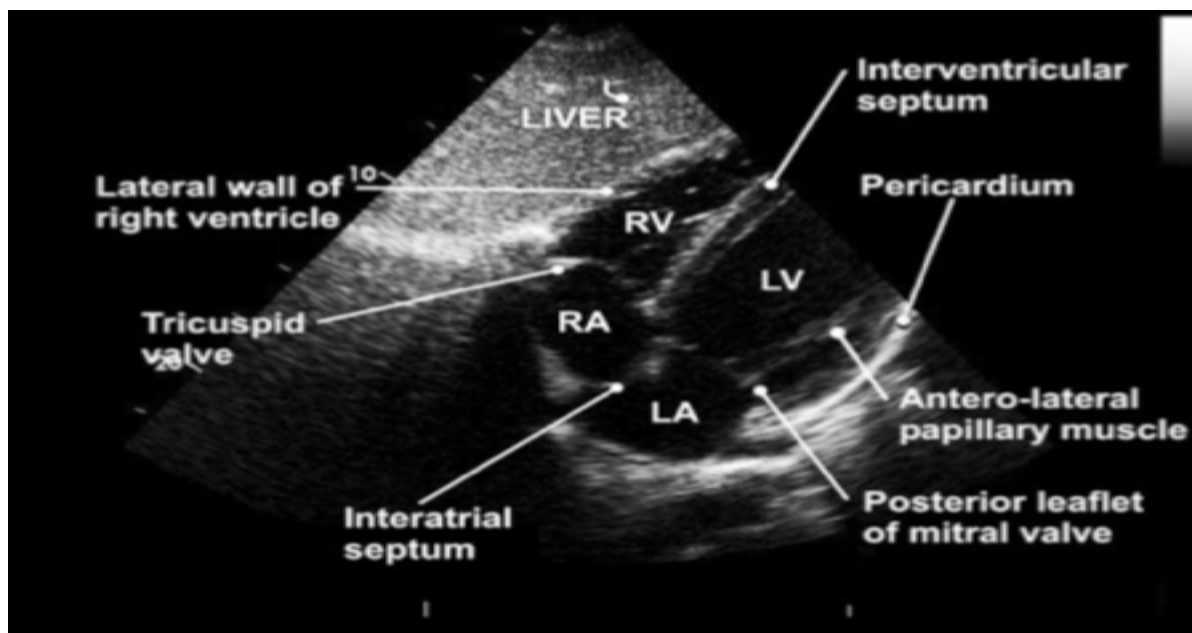
Apical 3 chamber



- LA, LV, aorta
- Correspond to PLAX
- (sub)valvular obstruction (HOVM)



Subcostal View



- ASD/VSD visualization
- RV wall thickness
- Pericardium
- Used in patients with limited echo windows



Hemodynamic Unstable Patients

IVC + CO

Small hyperdynamic LV
Small, collapse IVC
Low CO

Hypovolemic shock

IV fluid

Hyperdynamic LV/RV
Small/normal size IVC
High CO

Distributive shock

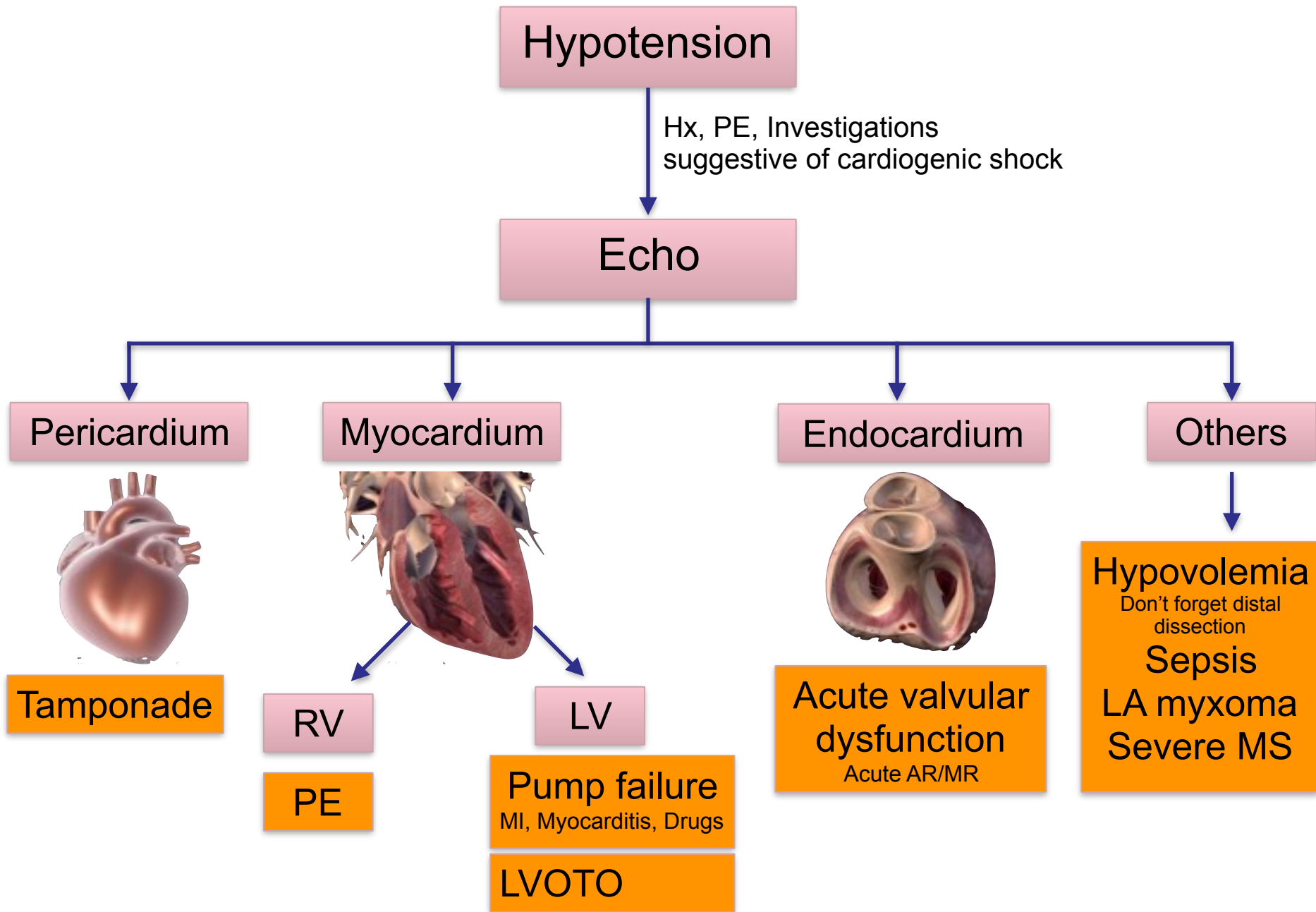
Consider sepsis
-ATB+IV fluid
-Vasopressors

Poor LV, abnormal echo
Normal/large IVC
Low CO

Cardiogenic shock

Further investigation
and treat according
to causes



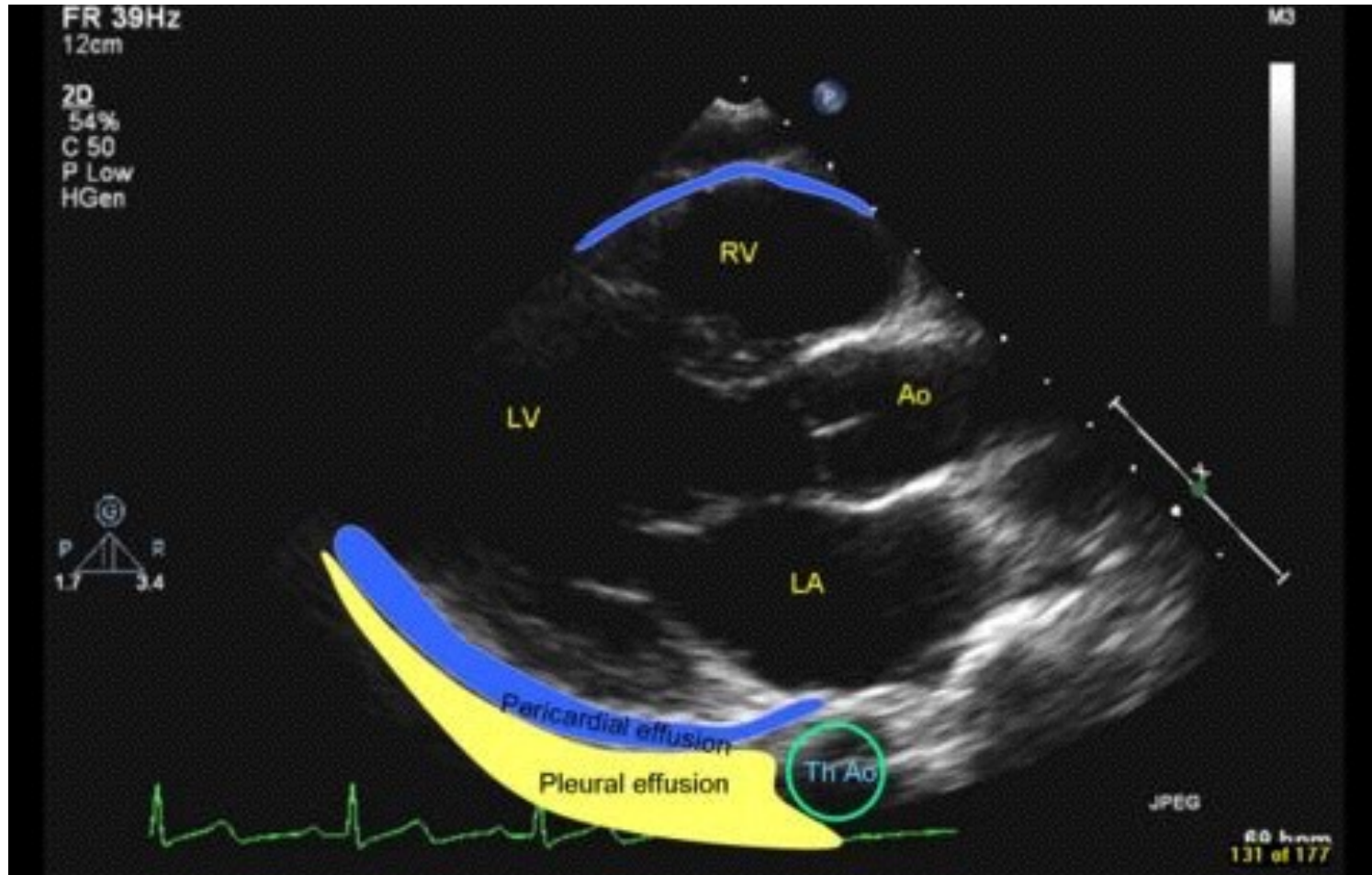


Echo Evaluation of pericardial effusion

- Size
- Location
- Consolidation or associated mass
- Loculation
- Hemodynamics
- Clearance for tap



Differentiating Pericardial Vs Pleural effusion



Quantification of pericardial effusion

Trivial

Seen only during systole

Small

< 1 cm

Moderate

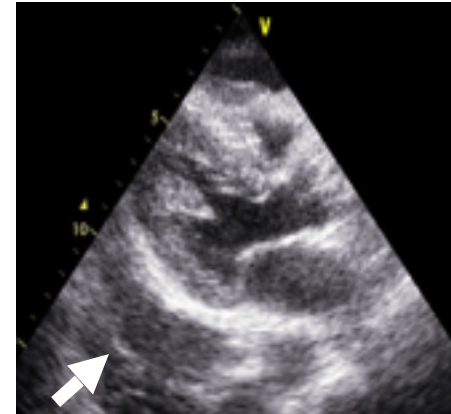
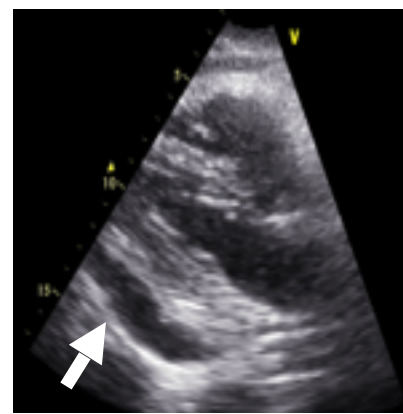
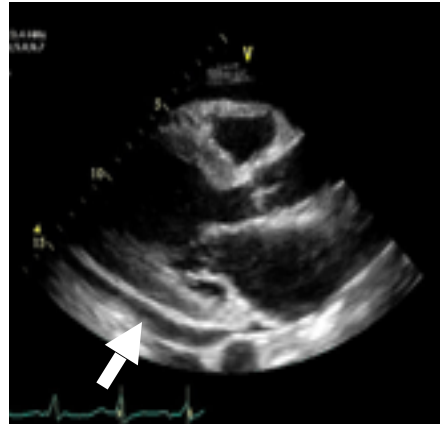
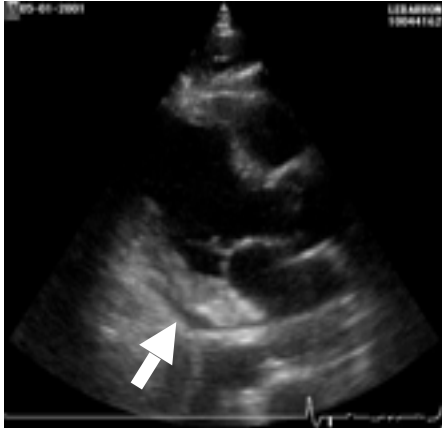
1-2 cm

Large

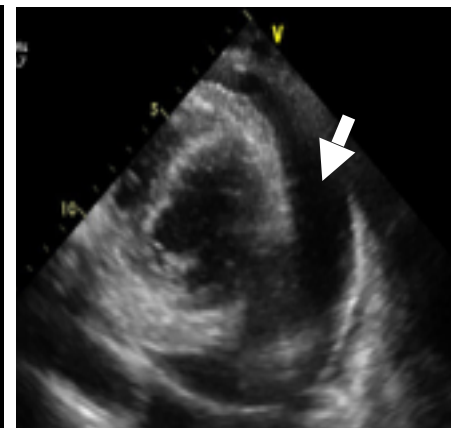
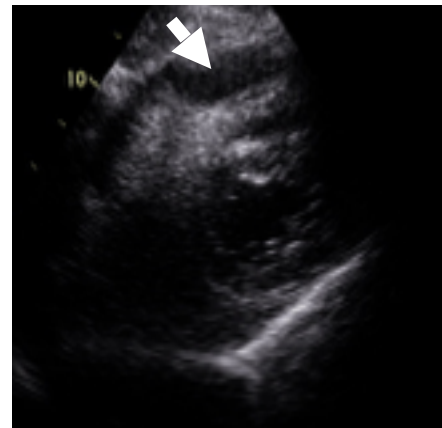
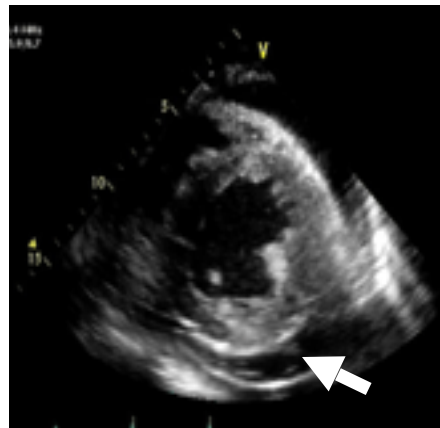
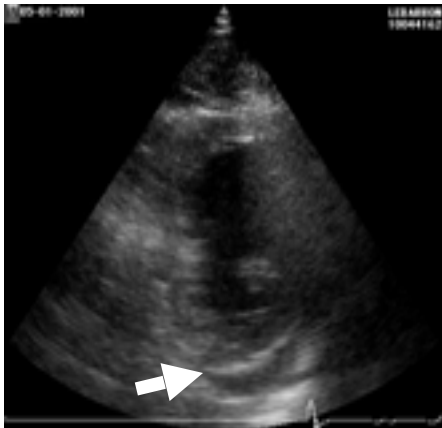
>2 cm

Measurement performed at end *diastole*

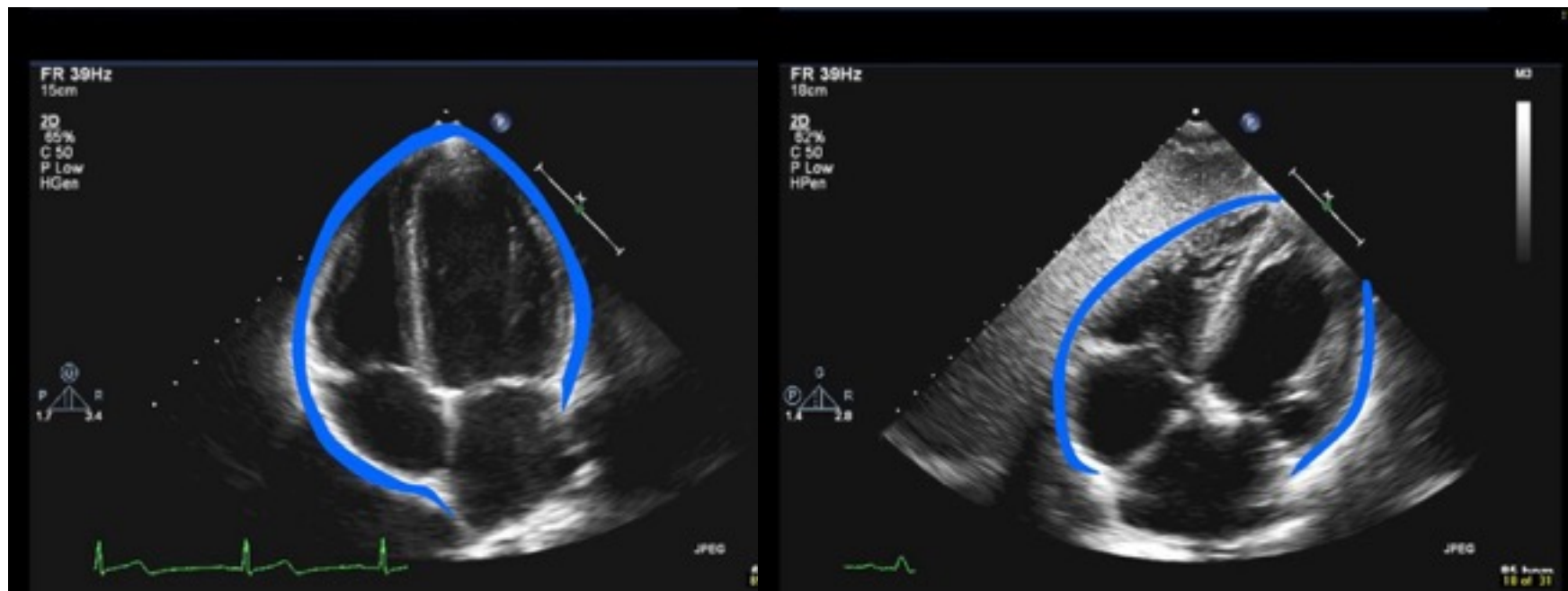
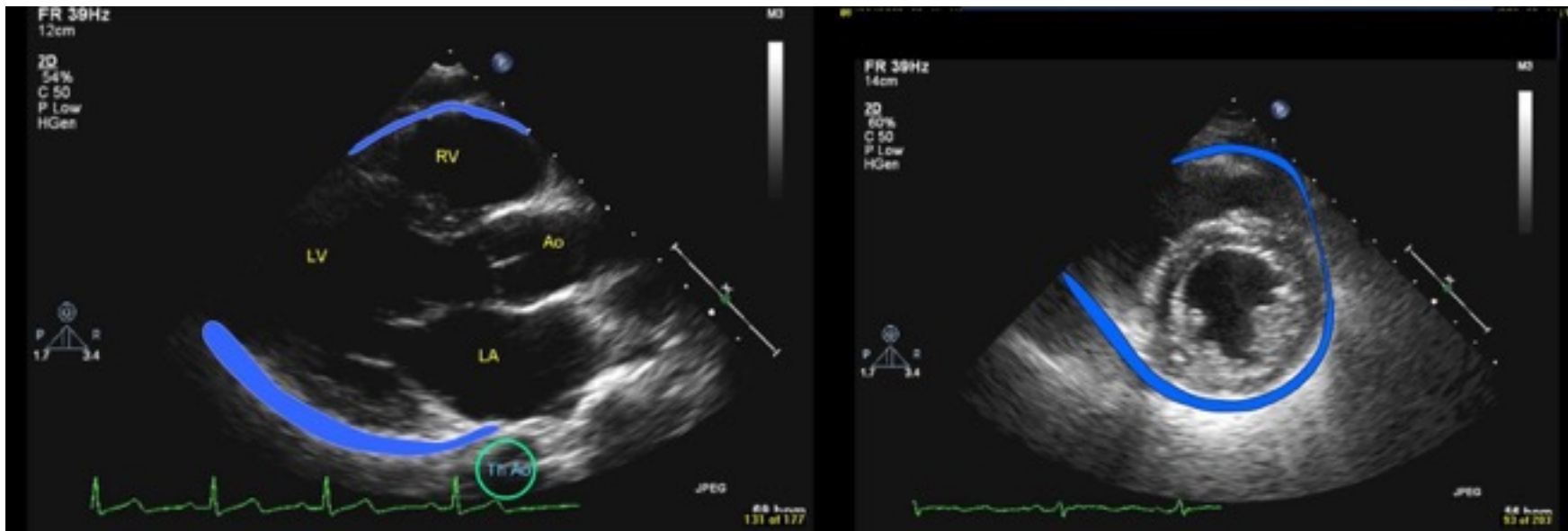
L
A
X



S
A
X



Location of pericardial effusion



The most sensitive sign of tamponade is “cyclic compression”

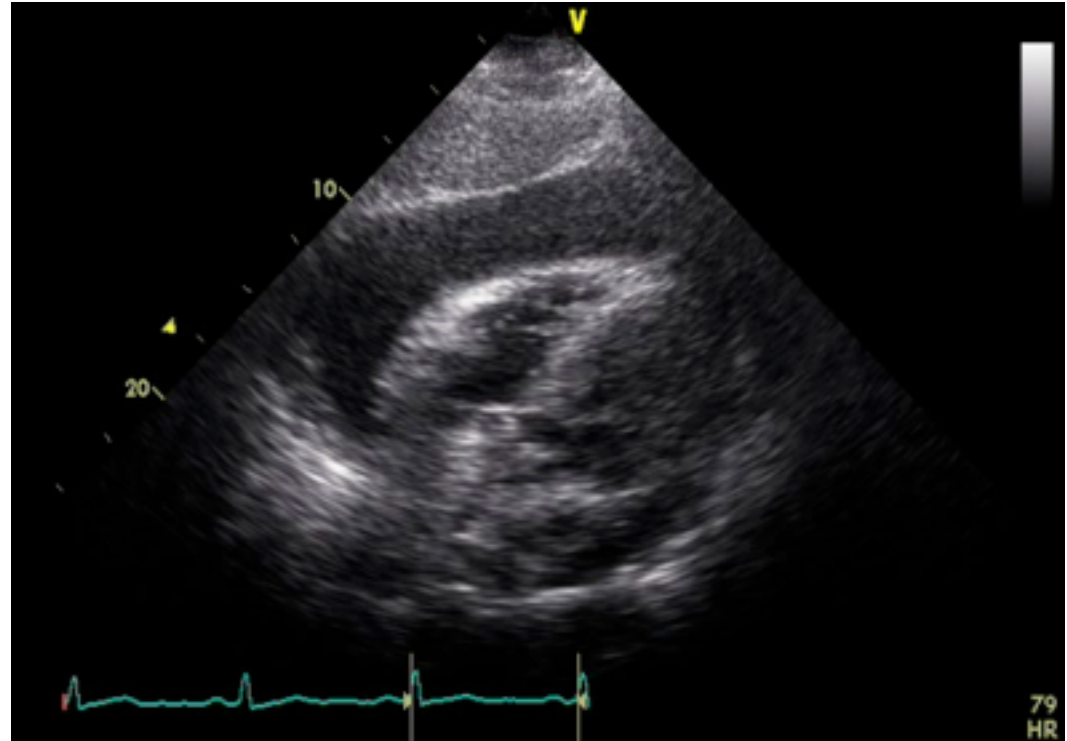
RA Collapse

Any RA collapse

100% sensitivity
88% specificity

RA Inversion Time Index (RAITI)
RA collapse >1/3 cardiac cycle

94% sensitivity
100% specificity



$$\frac{\text{Total \# frames with inversion}}{\text{Total \# frames in the cardiac cycle}}$$

RA collapse begins in end diastole and continues into systole. Considered an “earlier” sign of tamponade.



The most sensitive sign of tamponade is “cyclic compression”

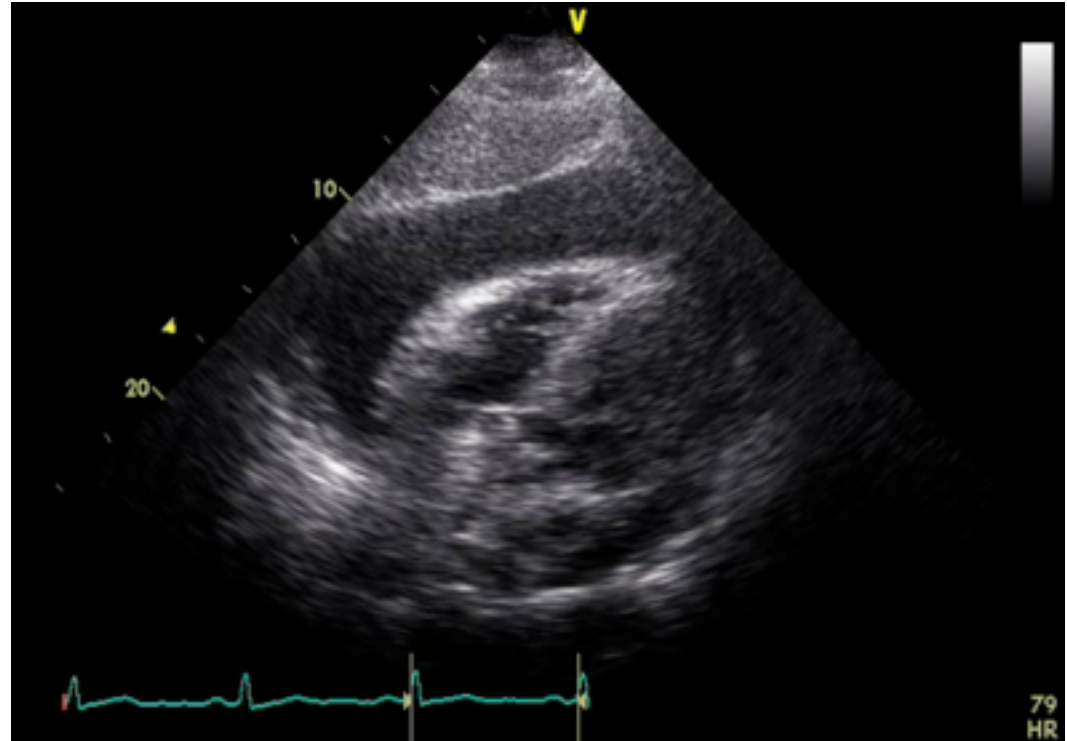
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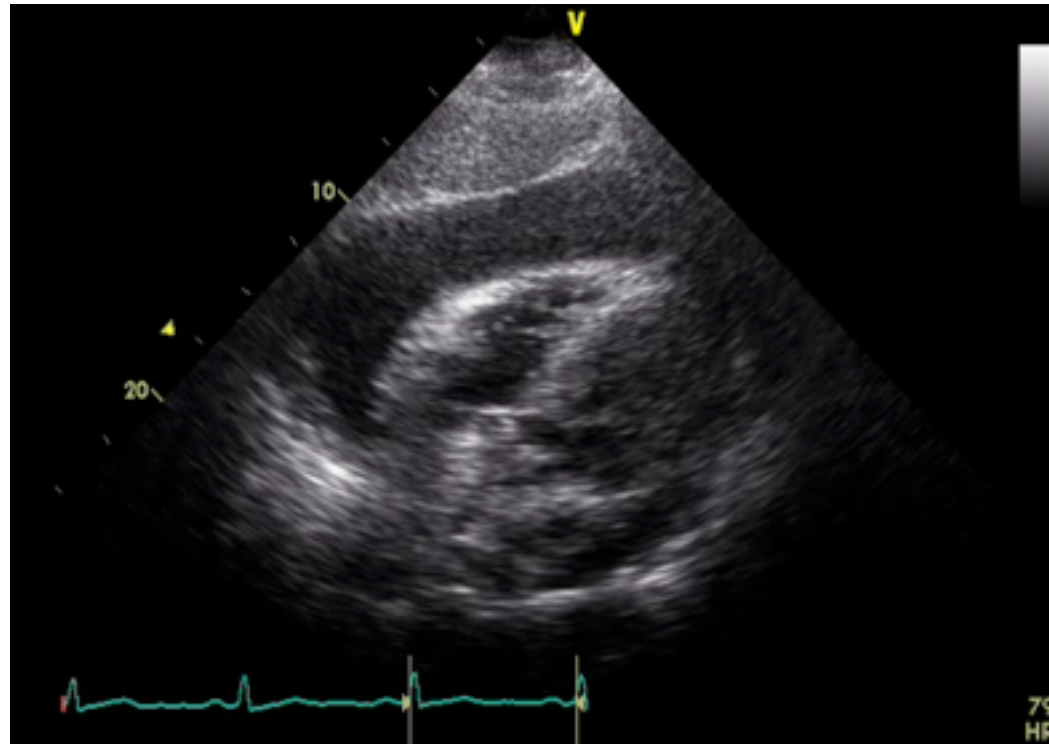
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The most sensitive sign of tamponade is “cyclic compression”

RV Collapse

- Most commonly involves the RV outflow tract (more compressible area of RV)
- When collapse extends from outflow tract to the body of the right ventricle, this is evidence that intrapericardial pressure is elevated more substantially
Considered a “later” sign of tamponade

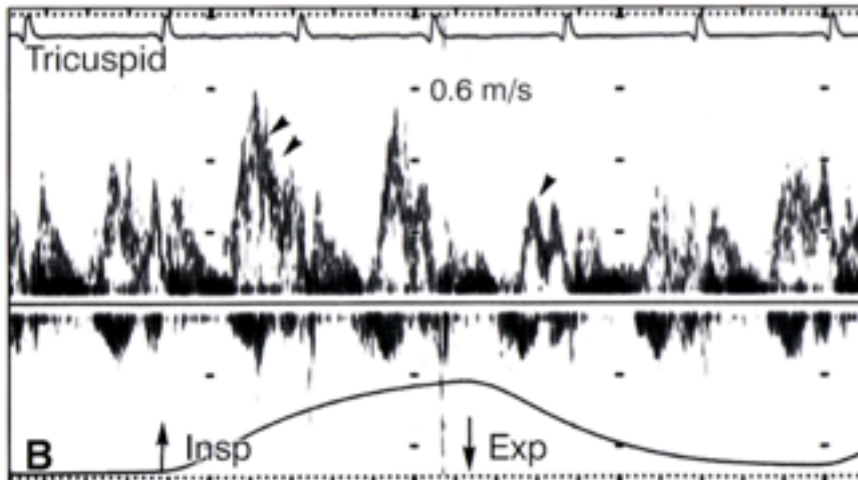
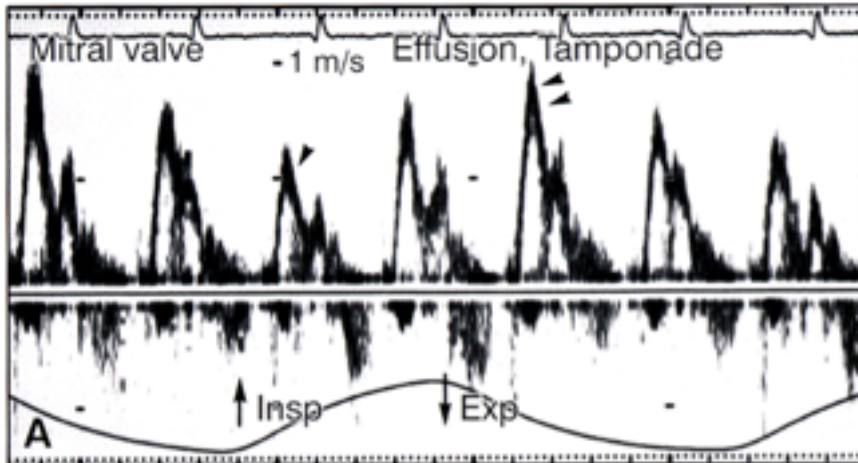


RV collapse occurs in early diastole

48-93% sensitivity
50-100% specificity



Doppler Respiratory Variation



- Normal
 - MV inflow variation <10%
 - TV inflow variation <25%
- In tamponade
 - MV inflow variation usually >30%
 - TV inflow variation usually >60%

Consensus Guideline : $E(\text{exp}) - E(\text{insp}) / E(\text{exp})$

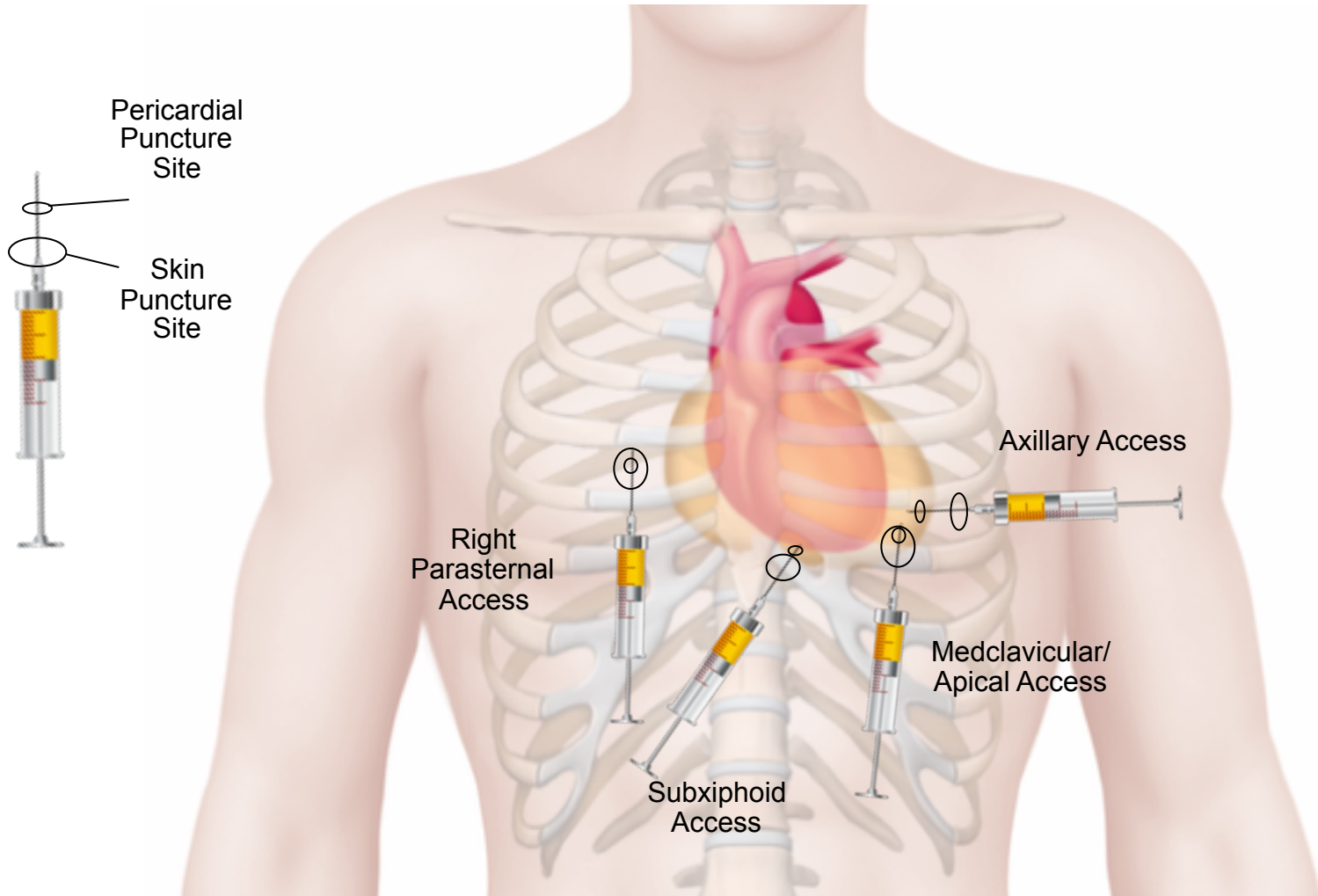


Tamponade : Echo and Doppler features

- RA collapse
- RV collapse
- Dilated IVC with lack of inspiratory collapse
- Abnormal respiratory variation in tricuspid and mitral flow velocities
- Abnormal hepatic vein flow (expiratory diastolic reversal)
- LA compression (severe)
- LV diastolic compression (severe)
- Swinging heart



Common access for pericardiocentesis



Clearance for the pericardiocentesis

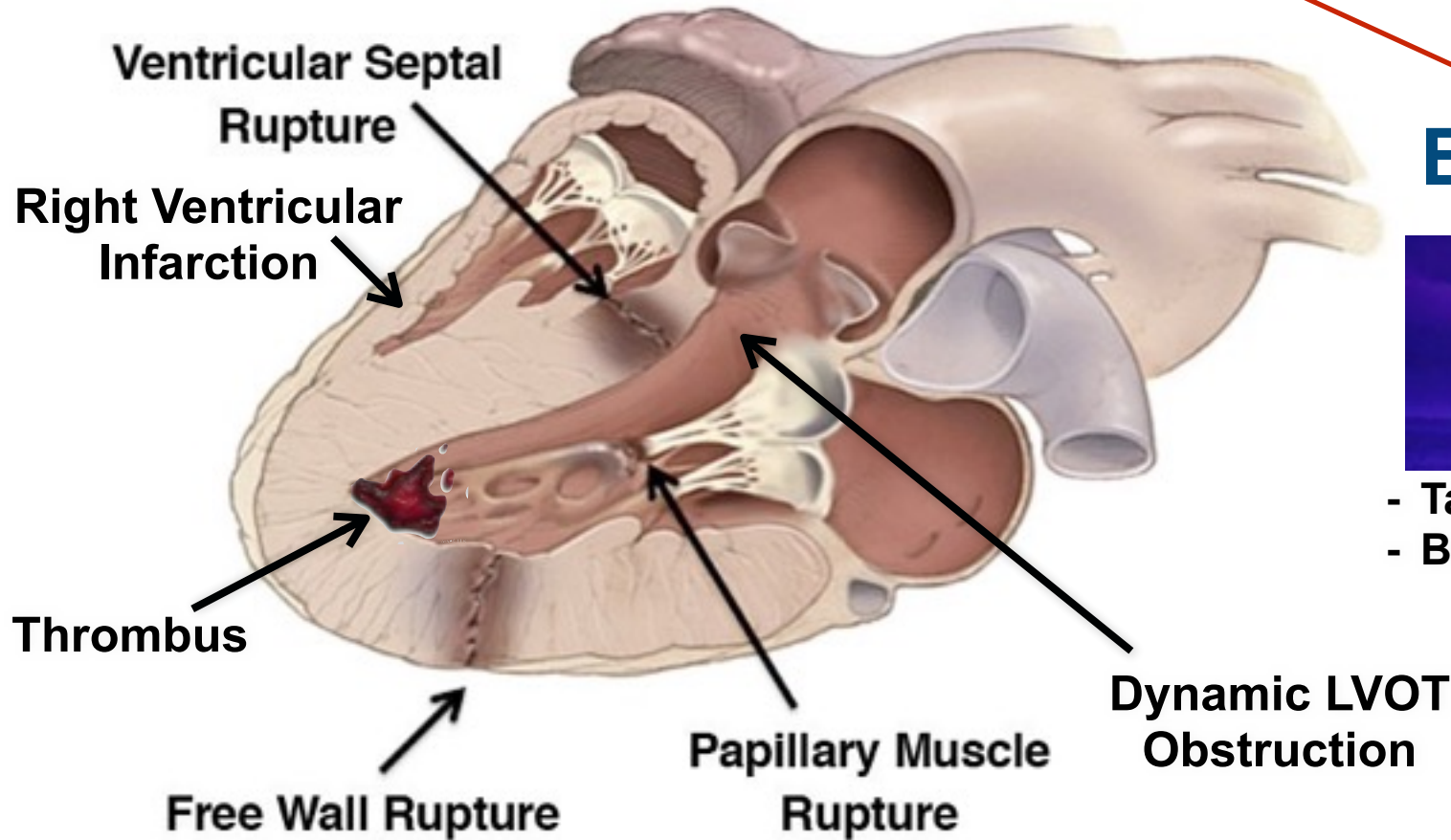
- ① Subcostal view
- ① At least 1 cm fluid between visceral and parietal pericardium
- ① No significant adhesions
- ① Effusions not consolidated
- ① Path to pericardium not THROUGH the liver



Complications of MI

Mechanical

Electrical



- Tachyarrhythmias
- Bradyarrhythmia



Echocardiographic Contraindications to ECMO

Absolute contraindications to VA ECMO/LVAD

- Aortic dissection (unrepaired)
- Severe aortic regurgitation
- Coarctation of the aorta (unrepaired)

Relative contraindications to VA ECMO/LVAD

- Severe aortic atheroma
- Abdominal/thoracic aortic aneurysm with intraluminal thrombus

Absolute contraindications to VV ECMO

- Severe ventricular dysfunction
- Cardiac arrest
- Severe pulmonary hypertension

Relative contraindications to VV ECMO

- Large PFO/ASD
- Significant TV pathology (TS/TR)



**THANK YOU
FOR YOUR ATTENTION**

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