Point of Care Ultrasound and Pericardial Effusions

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Focused Echo: What to look for?

4 E's

Effusion

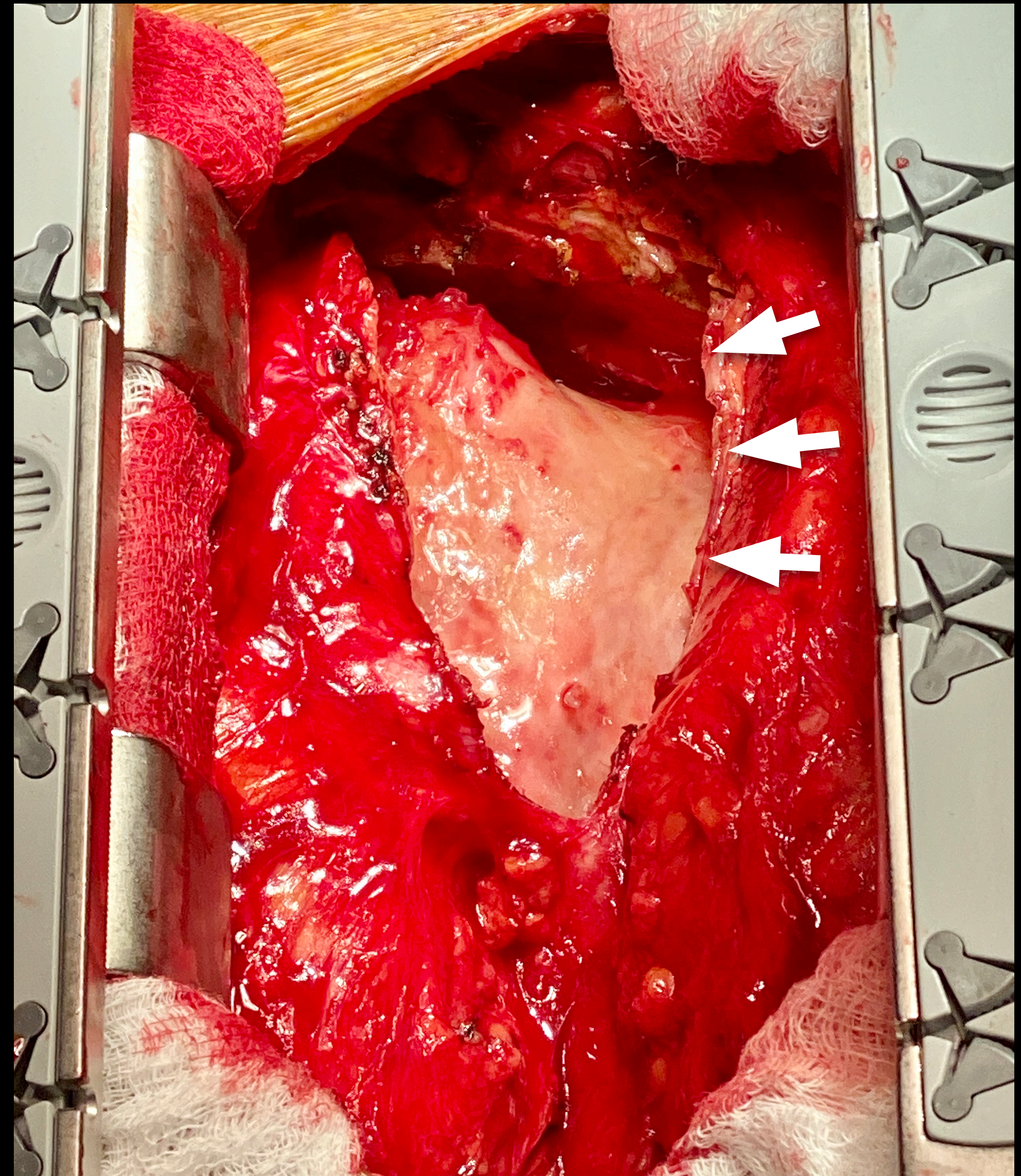
EF

Entrance

Equality

Anatomy

- Outer fibrous pericardium
- Inner visceral pericardium
- Functions to lubricate, limit cardiac displacement, limit volume-mediated cardiac distension
- Usually contains 5-15ml fluid
- First fluid usually in oblique sinus (behind LV)
- >100ml becomes circumferential

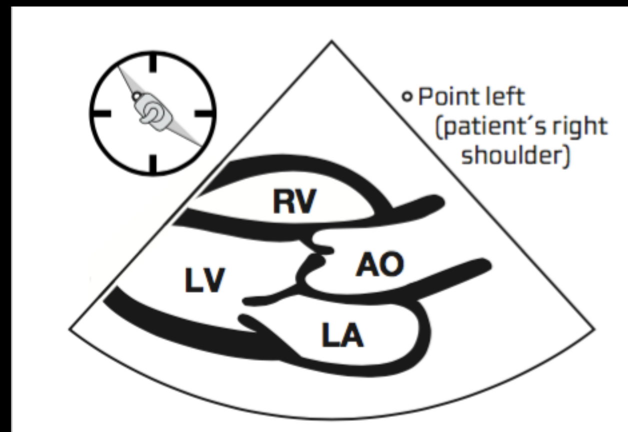


Etiology of Pericardial Effusions

- Increased fluid production/ decreased drainage
- Pericardial inflammation, post MI, post surgical, infectious, autoimmune, radiation
- Malignancy
- Fluid overload, cirrhosis, CHF
- Endocrine, uremia, myxedema
- Bleeding

How to quantify pericardial effusions

Parasternal long axis



Regionmidtjylland midt

Estimating Size of Pericardial Effusion (Measurements at end-diastole)	
Trivial	<10mm Only in systole
Small	<10mm (50-100ml)
Moderate	10-20mm (100-500ml)
Large	20mm (>500ml)

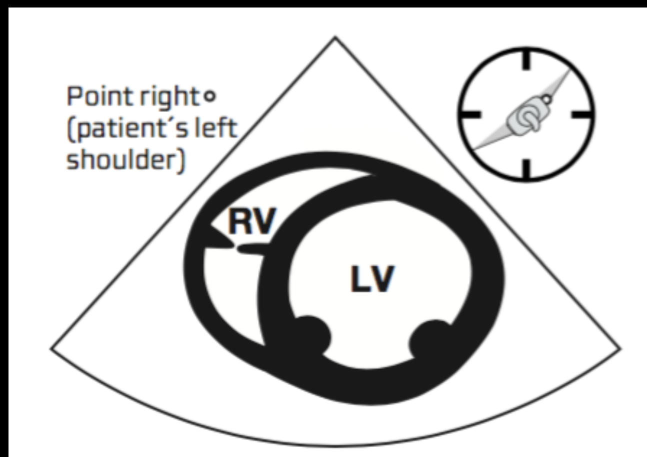
JASE 2013

DTA

106 bpm

How to quantify pericardial effusions

Parasternal short axis



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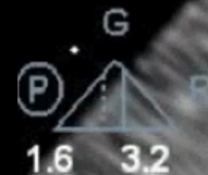

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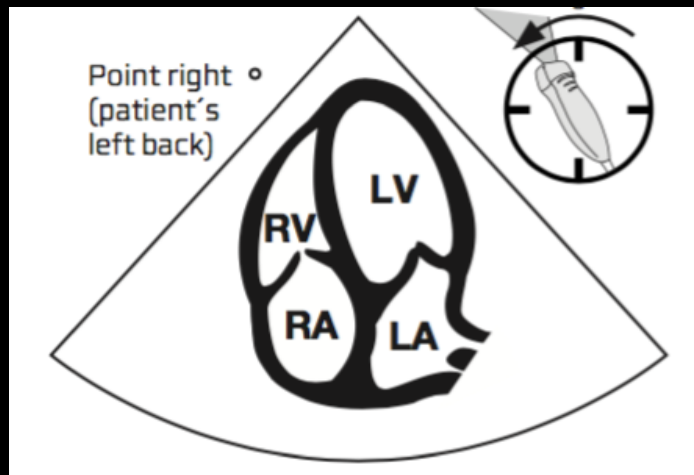
How to quantify pericardial effusions

Apical 4 chamber



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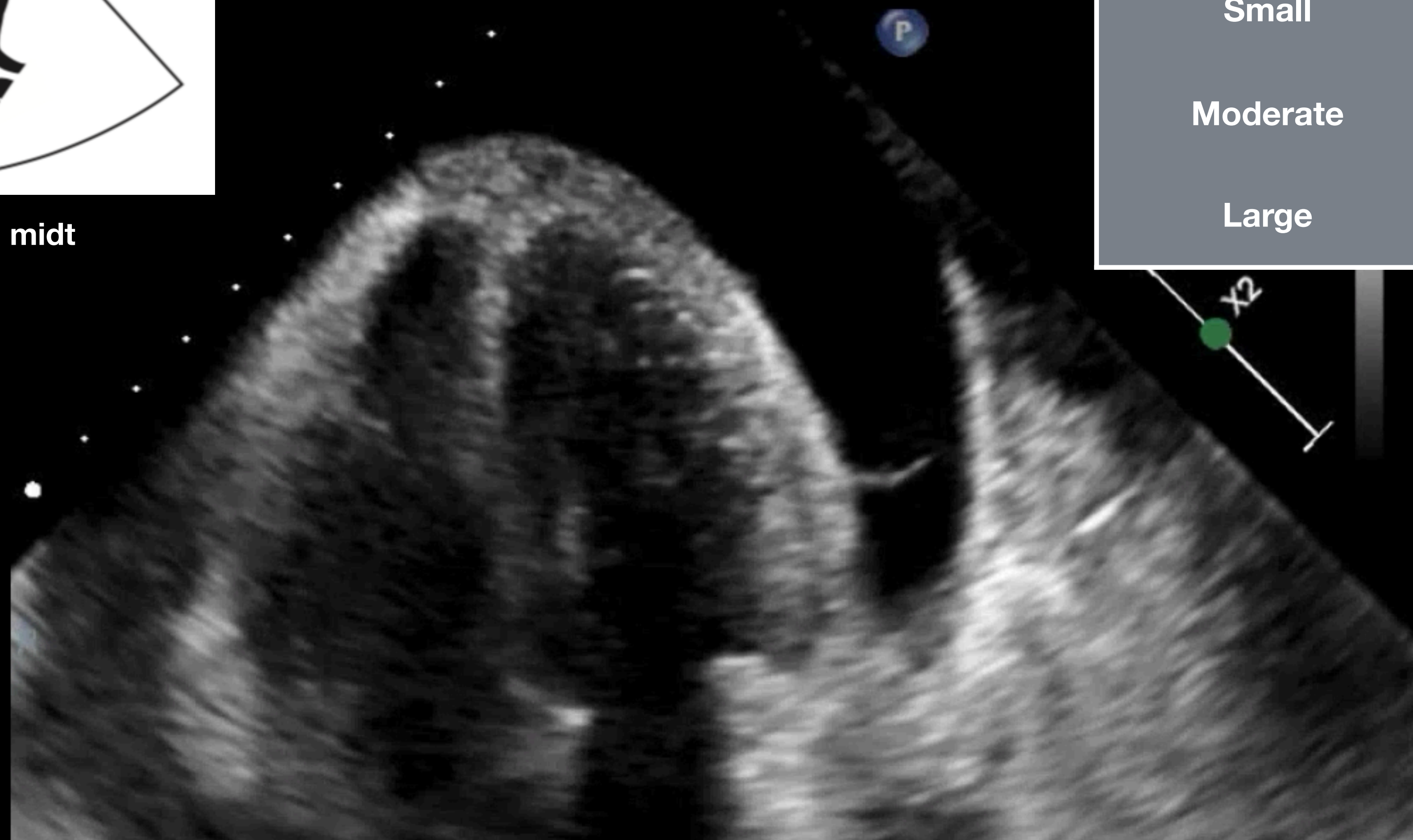
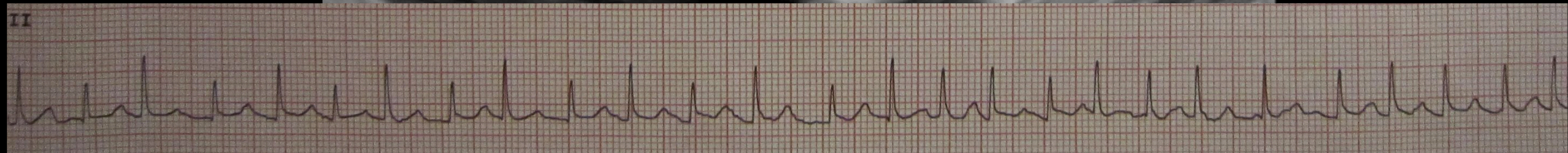
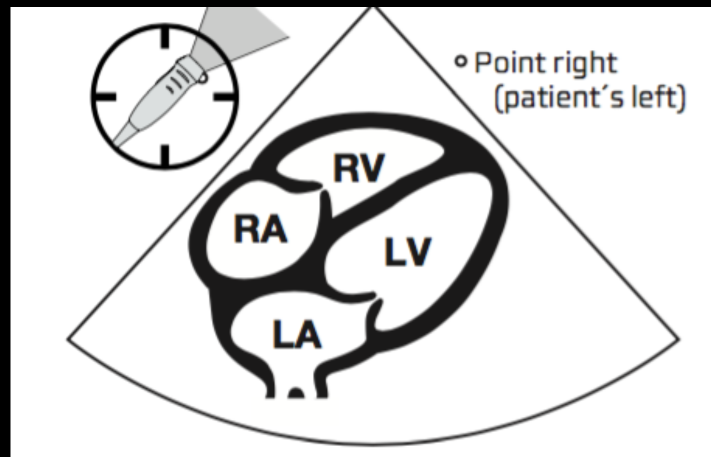




105 bpm

How to quantify pericardial effusions

Subcostal 4 chamber



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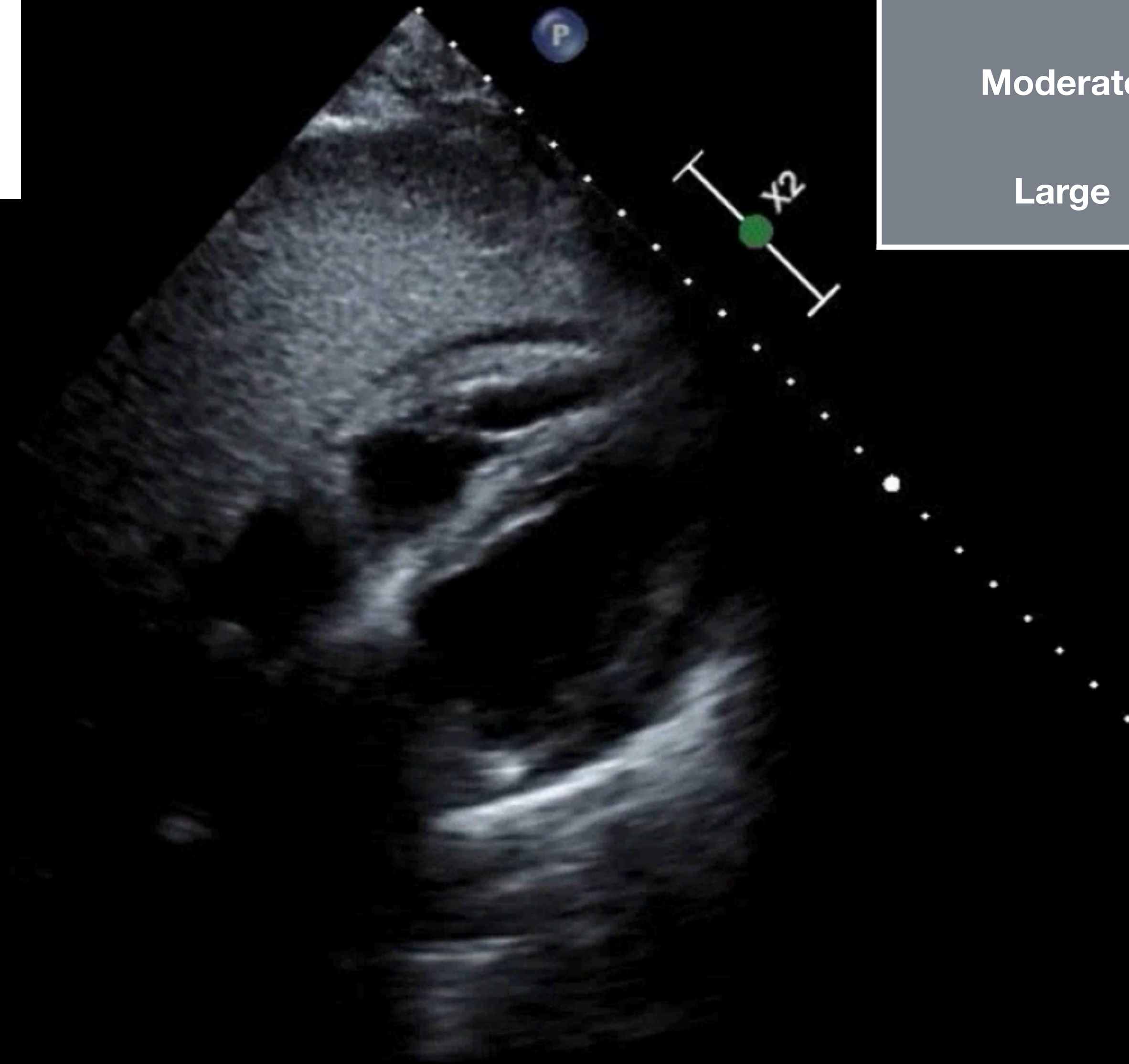
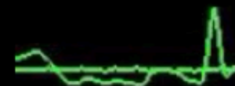
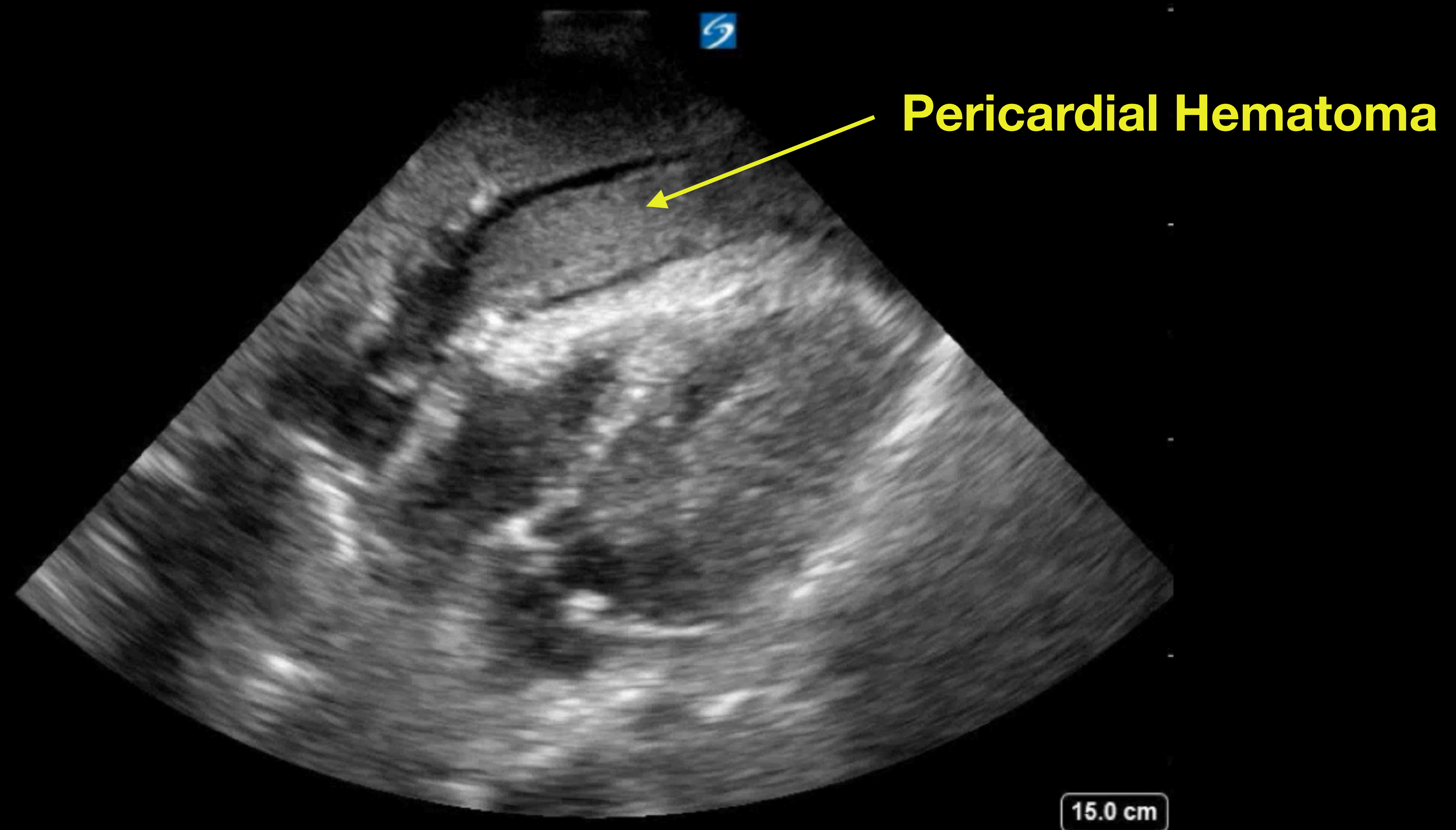
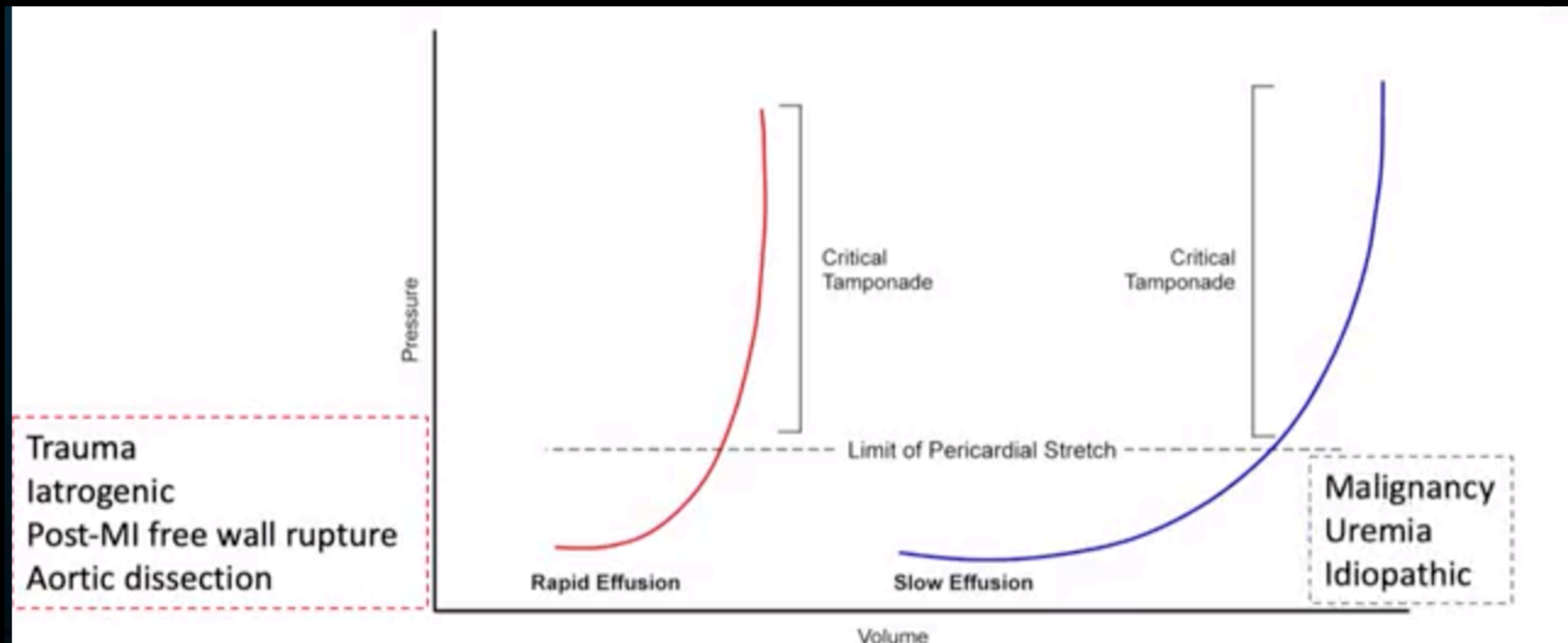




Other things found in the pericardial space



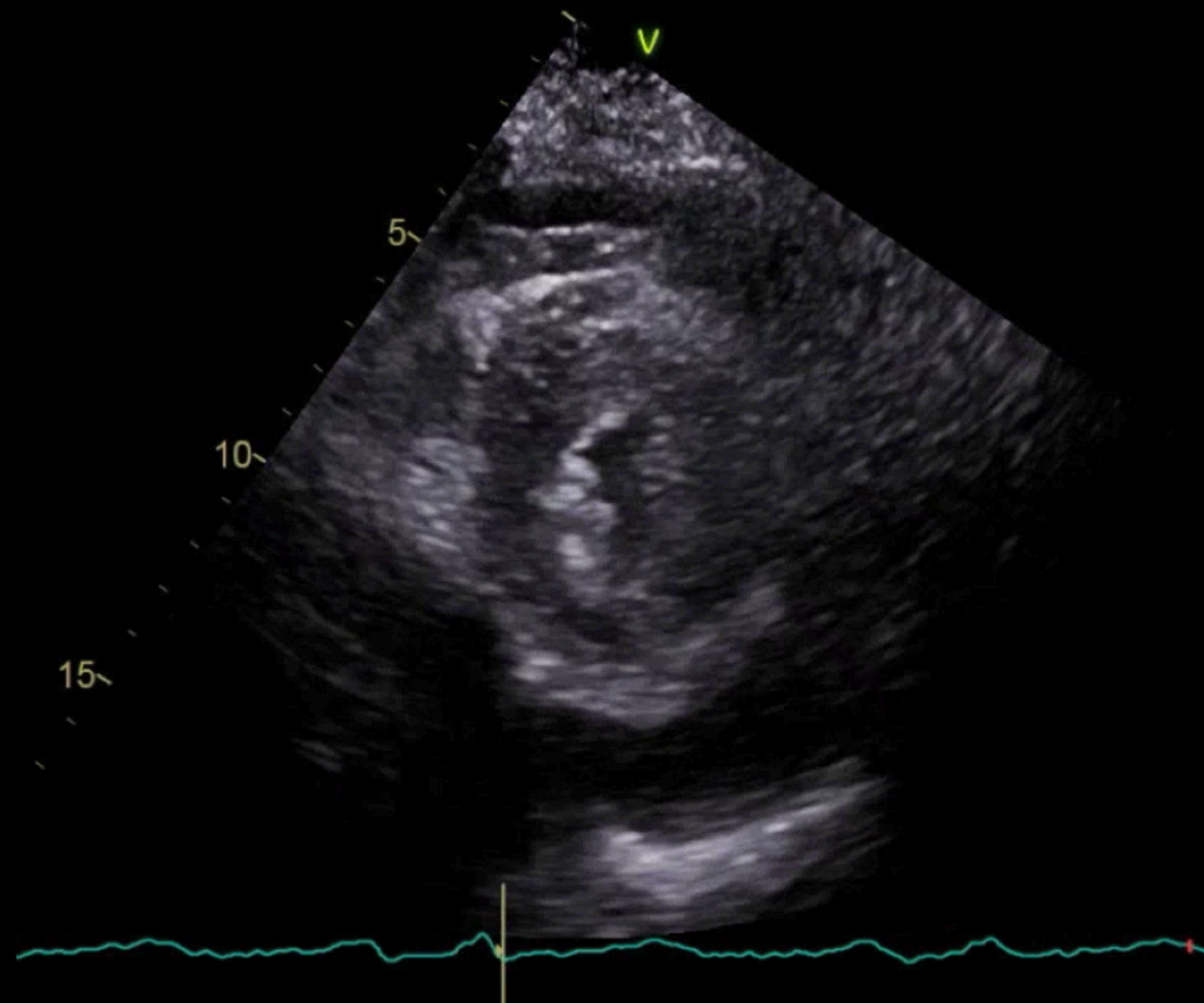
Does quantity equal quality?



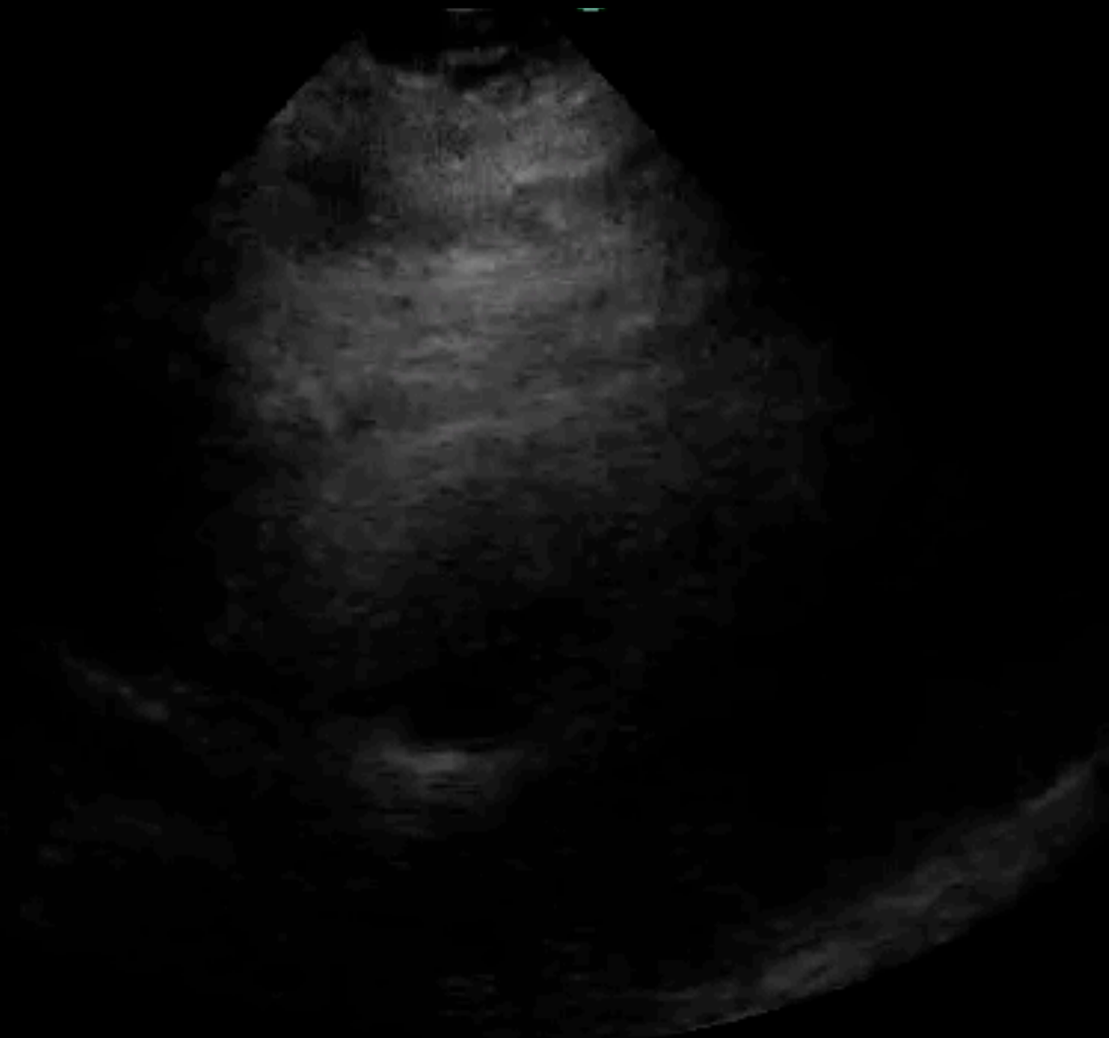
Spodick DH NEJM 2003

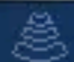
Hemodynamic effects depend on pressure not size

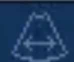
Moderate to large effusion not causing HD compromise



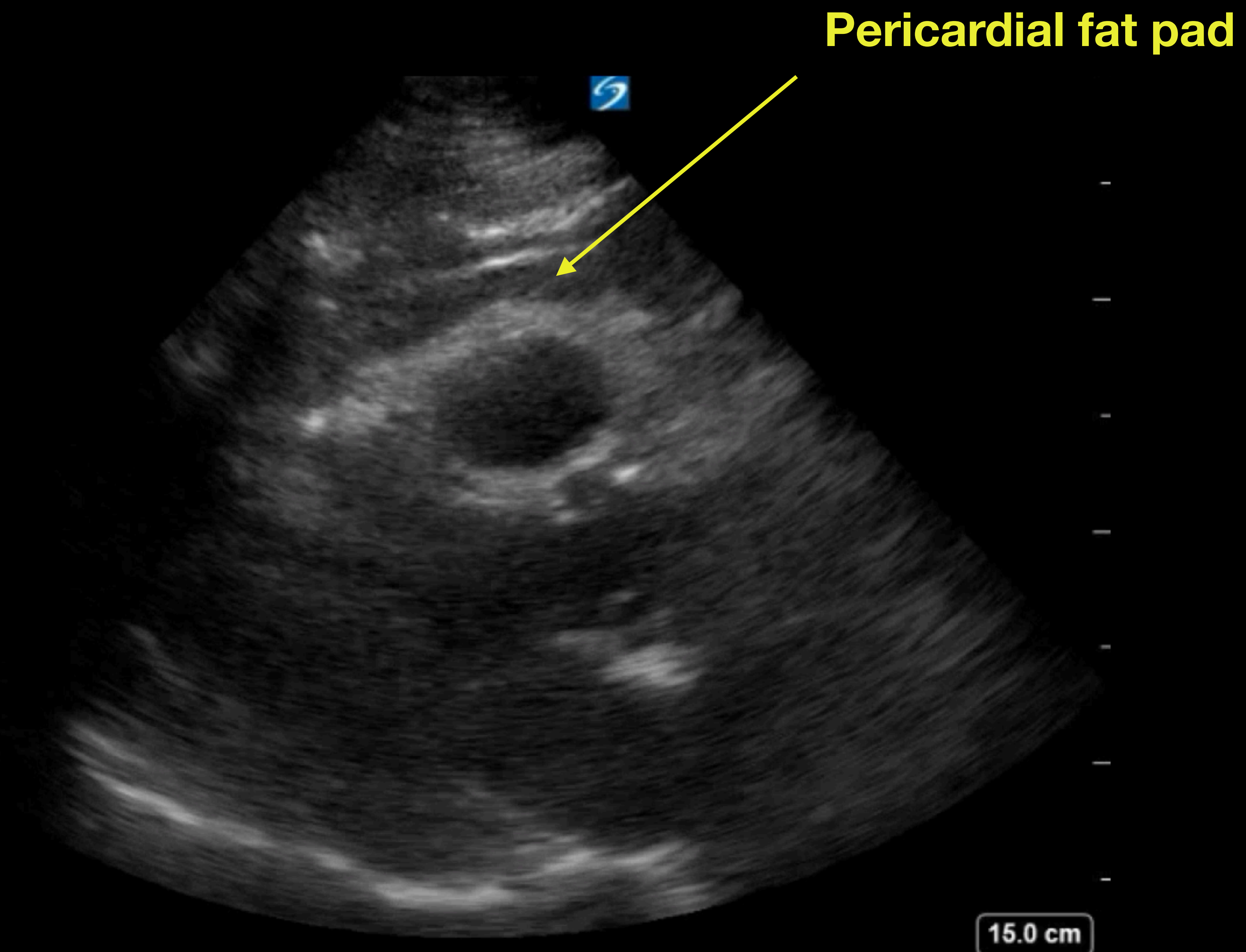
Small effusion causing HD compromise



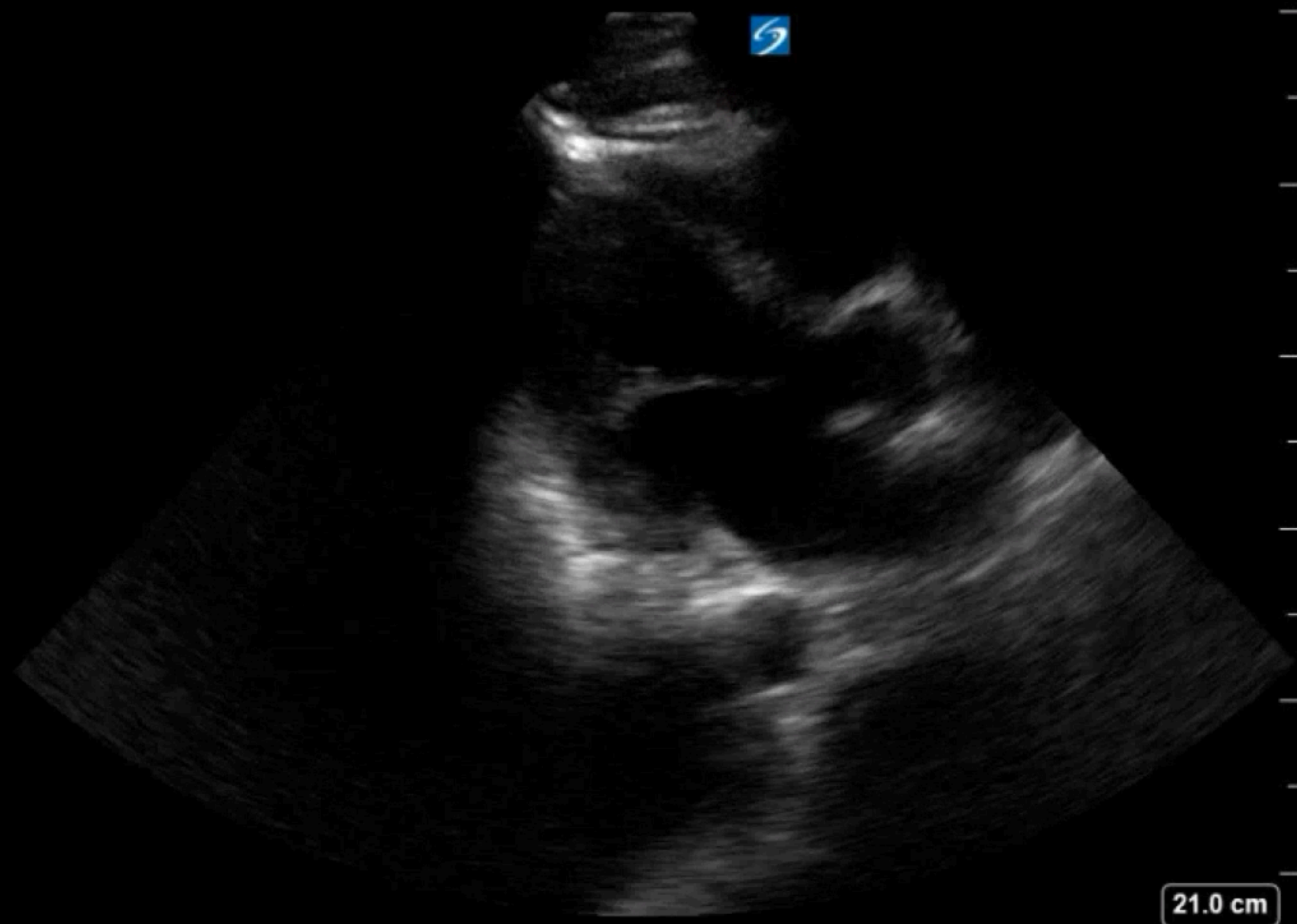




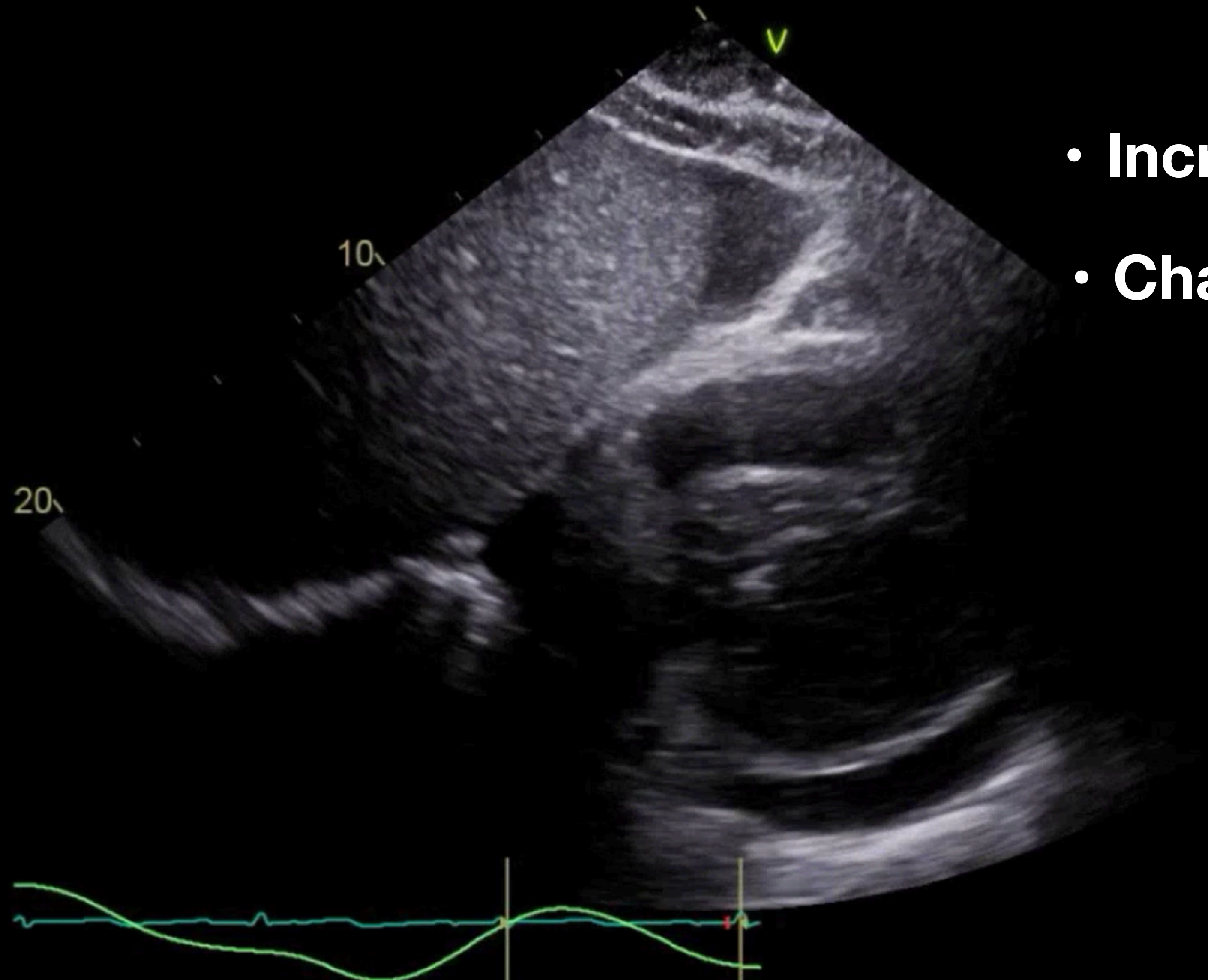
Pitfalls to avoid
Pericardial fat pad



Pitfalls to avoid
Pleural effusion



Pitfalls to avoid
Intra abdominal free fluid



- Increase depth
- Change view

Tamponade is a clinical diagnosis!

- Muffled heart sounds
- Raised JVP
- Tachypnea
- Tachycardia
- Pulsus paradoxus >10mmHg decrease in BP on inspiration
- Hypotension
- Electrical alternans

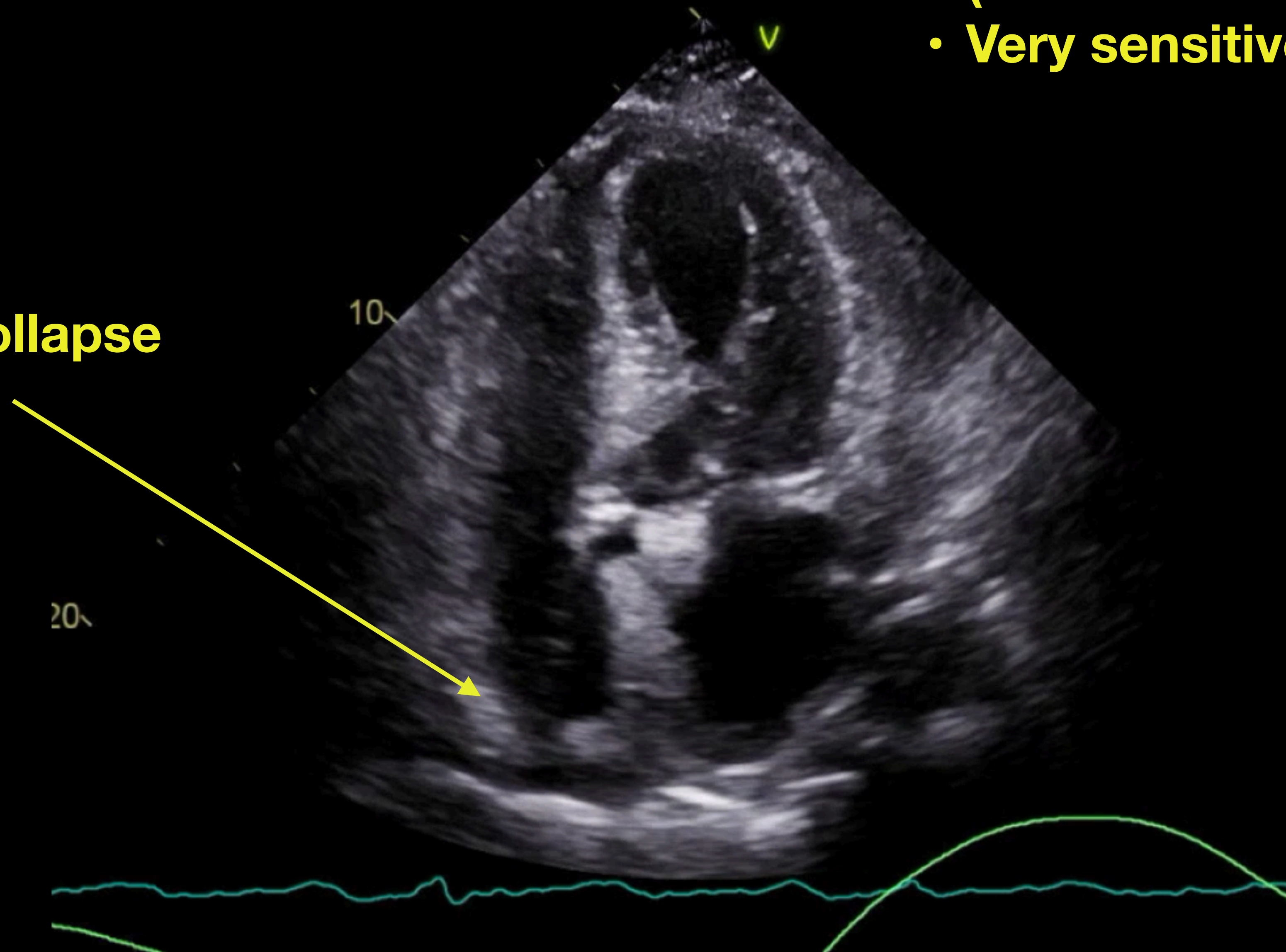
POCUS can detect presence of raised PP or early HD perturbations that May Not be clinically significant

- Raised pericardial pressure
  - Right atrial collapse
  - Right ventricular collapse
- Plethoric IVC - as diastolic/ filling pressures increase
- Increased ventricular interdependence - venous return diminished
  - Respirophasic septal shift/ competitive ventricular filling
  - Exaggerated respirophasic transvalvular doppler flow velocities

Right atrial collapse

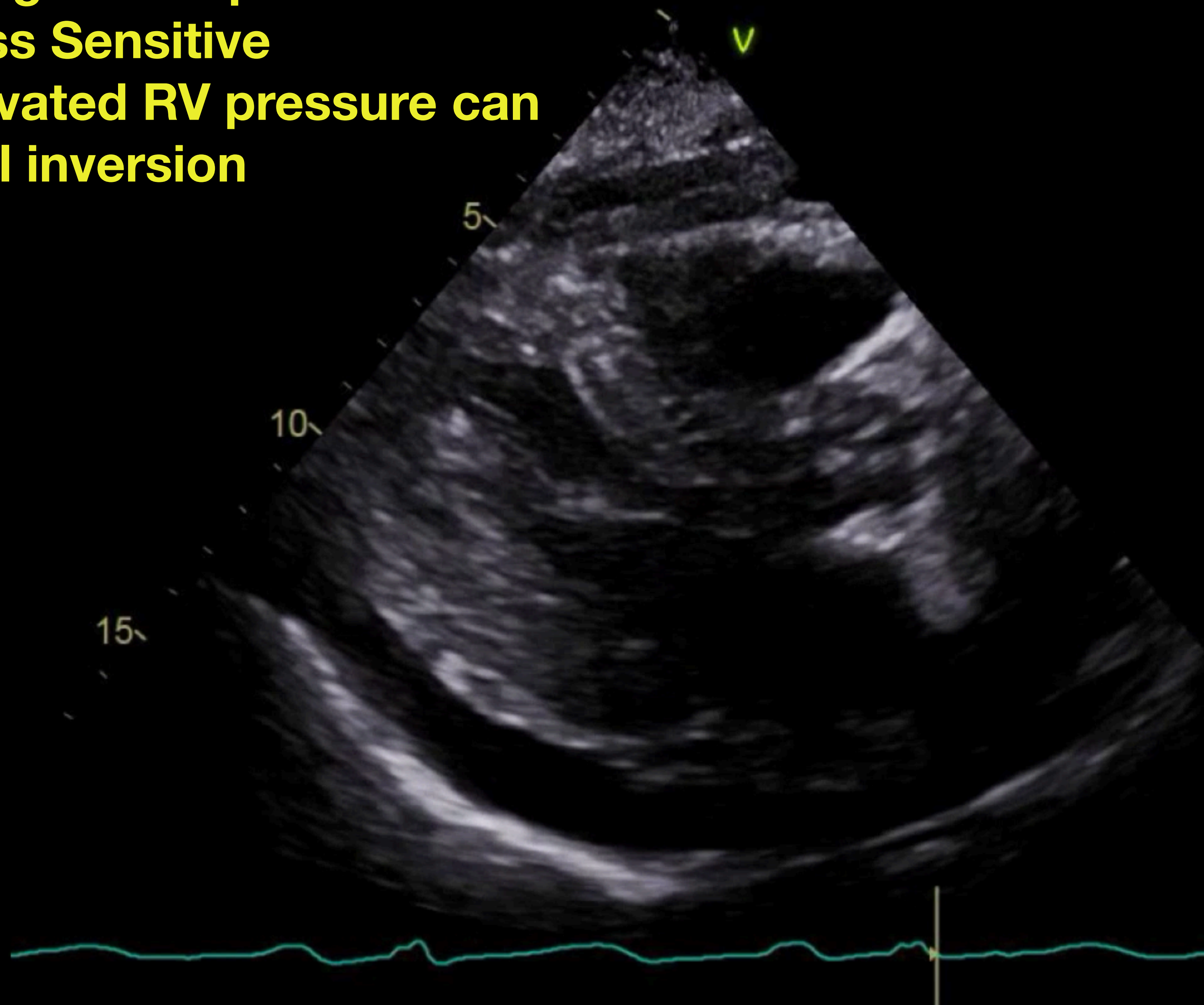
- Systolic inversion of RA
- (Atrial diastole)
- Very sensitive for raised PP

Right Atrial Collapse

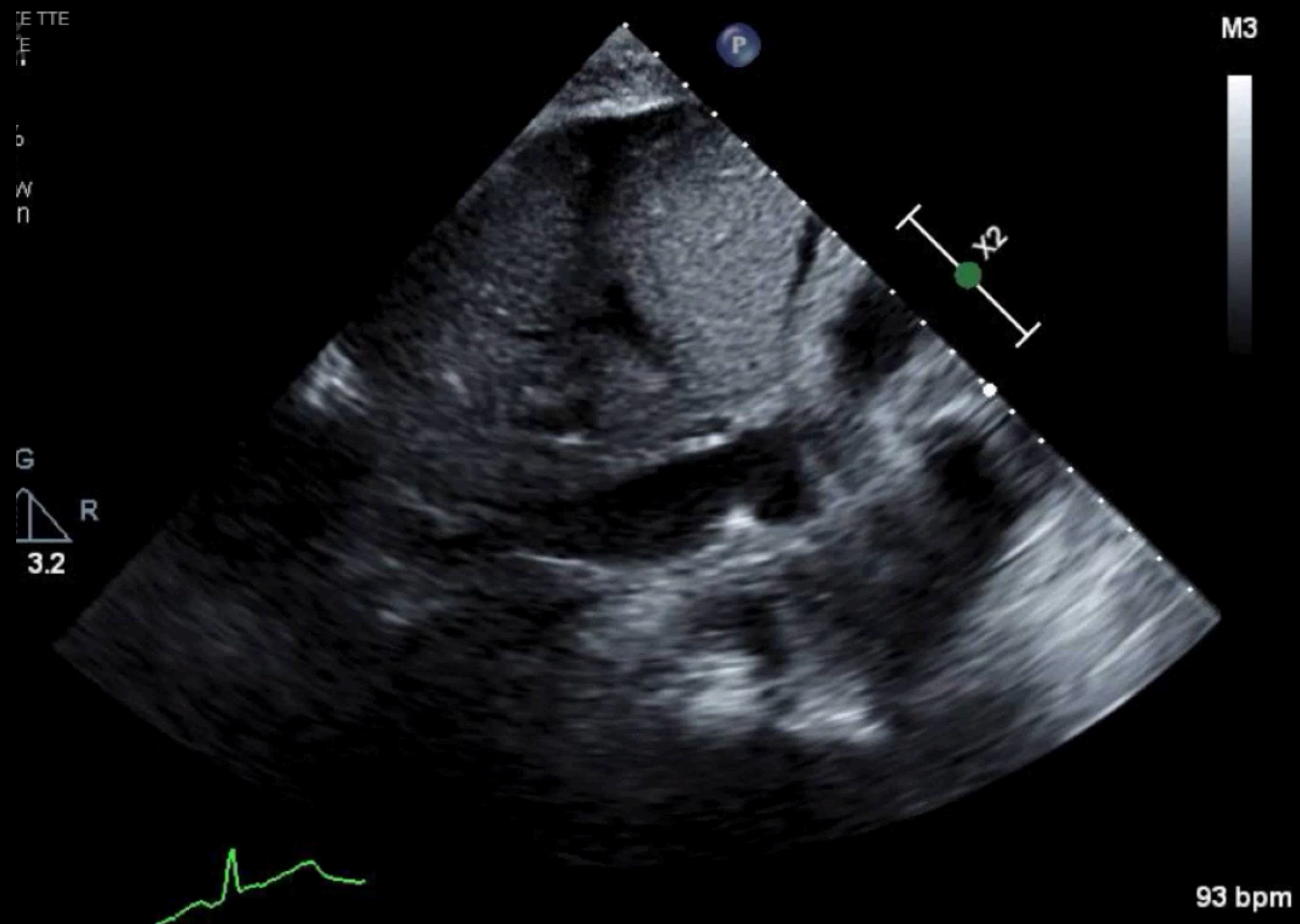


Right ventricular collapse

- Early diastolic inversion of free wall
- The longer the inversion extends into diastole - the higher the pressure
- Specific but less Sensitive
- Chronically elevated RV pressure can prevent RV wall inversion



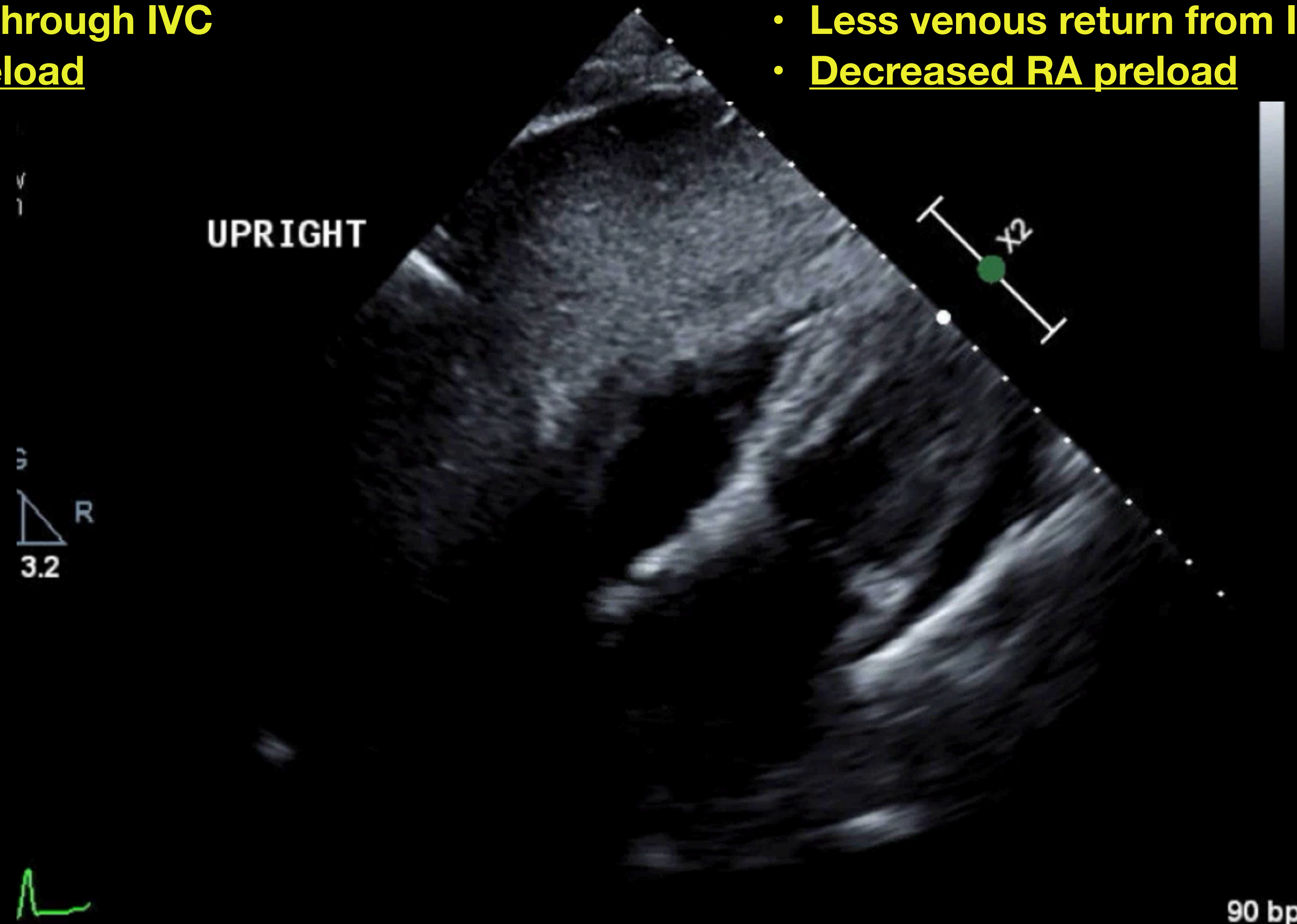
As pericardial pressure and diastolic/filling pressures increase, IVC become plethoric



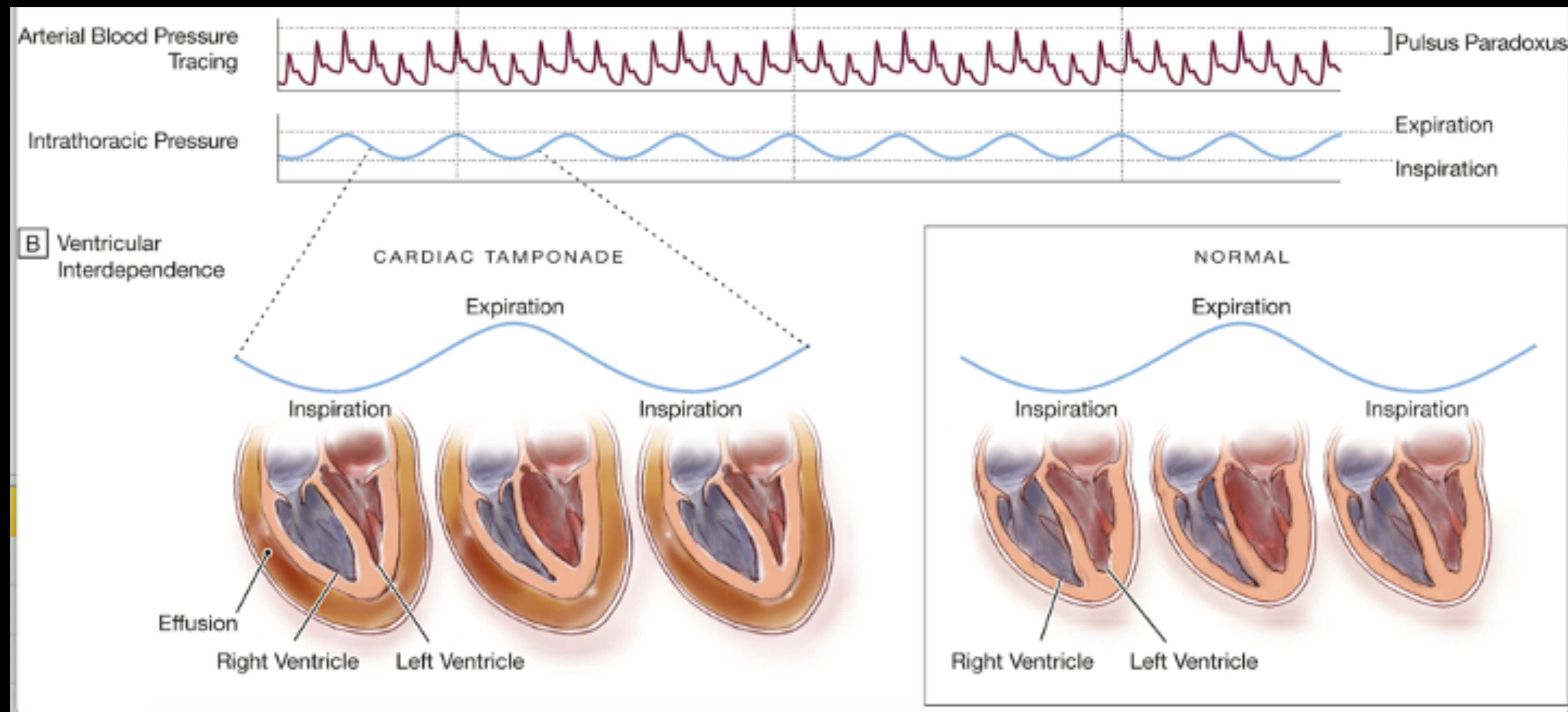
Respirophasic competitive filling of ventricles
Respirophasic Septal shift

- **Inhale**
  - **Decreased intra thoracic pressure**
  - **Blood sequestered in pulmonary vasculature**
  - **<u>Decreased LA preload</u>**
  - **Blood drawn up through IVC**
  - **<u>Increased RA preload</u>**

- **Exhale**
  - **Increased intra thoracic pressure**
  - **Blood 'squeezed' from pulmonary vasculature**
  - **<u>Increased LA preload</u>**
  - **Less venous return from IVC**
  - **<u>Decreased RA preload</u>**



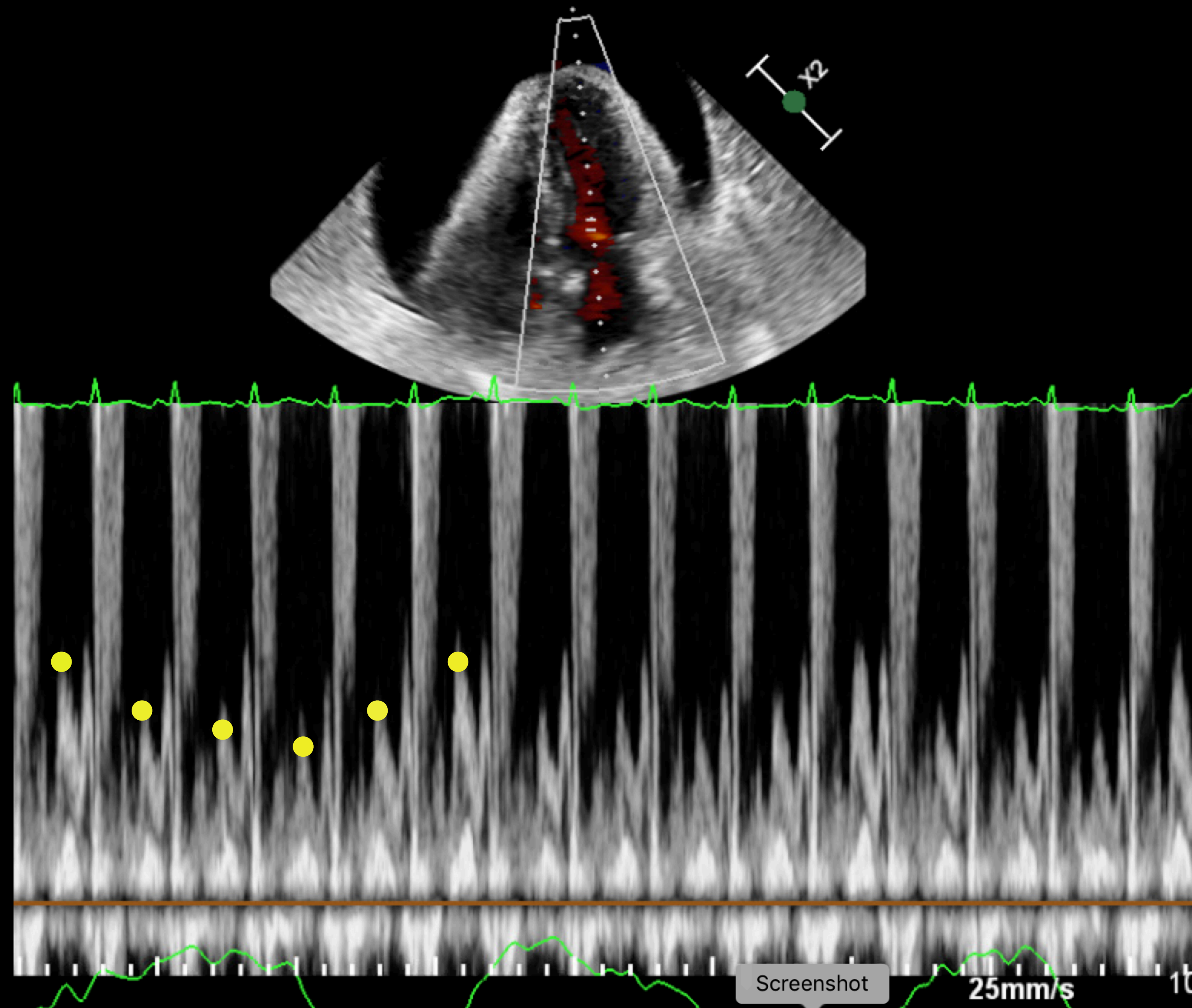
Ventricular interdependence/ Pulsus paradoxus



Respirophasic competitive filling of ventricles

Increased respirophasic variation in transvalvular doppler flow velocities

- Reciprocal variation in transvalvular flow velocities
- Mitral E wave >30%
- Tricuspid E wave >60%
- Opposite pattern if mechanical ventilation
- May be seen in other conditions such as respiratory disease



Key Points

- Use multiple different views and change depth to evaluate pericardial effusion
- Size of pericardial effusion does not relate to hemodynamic significance
- Tamponade is a clinical diagnosis
- Signs of increased pericardial pressure include R atrial and R ventricular collapse
- A plethoric IVC indicates high filling pressures
- Increased venticular inter-dependence (competitive filling, respirophasic septal shift, exaggerated respirophasic changes in trans valvular flow velocities) suggestive of tamponade physiology
- Caution! - Localized pericardial hematoma post cardiac surgery may lead to tamponade in the absence of US evidence

Question

- 64 yo M with history of CAD and severe aortic stenosis admitted to the ICU post CABG/ AVR. After initial brisk chest tube output overnight his chest tube output is minimal, however he becomes severely hypotensive with sinus tachycardia and notable respiratory variation on his arterial line. A point of care ultrasound is performed. The LV function is low normal, normal RV function, plethoric IVC and no large pericardial effusion identified. Focal pericardial hematoma by the right atrium is seen. The following is true:

- A) Tamponade physiology could be caused by the focal hematoma

- B) Only large pericardial effusions can lead to tamponade physiology

- C) Right ventricular collapse would be a sensitive indicator of raised intrapericardial pressure

- D) The IVC is unlikely to be plethoric in the setting of raised intrapericardial pressure and tamponade physiology