

@MJGriksaitis

# Point of Care Cardiac Ultrasound

**Dr Michael Griksaitis**

*Consultant Paediatric Intensivist*

# Overview

- Role of POCUS: Cardiac Assessment
- How do you scan the heart?
- Approach the child with three questions:
  - 1. Does the child need volume?*
  - 2. Does the child need an inotrope or vasopressor?*
  - 3. Is there a pericardial effusion/tamponade?*
- Questions & Discussions

# **Role of POCUS: Cardiac Assessment**

# Indications of POCCUS

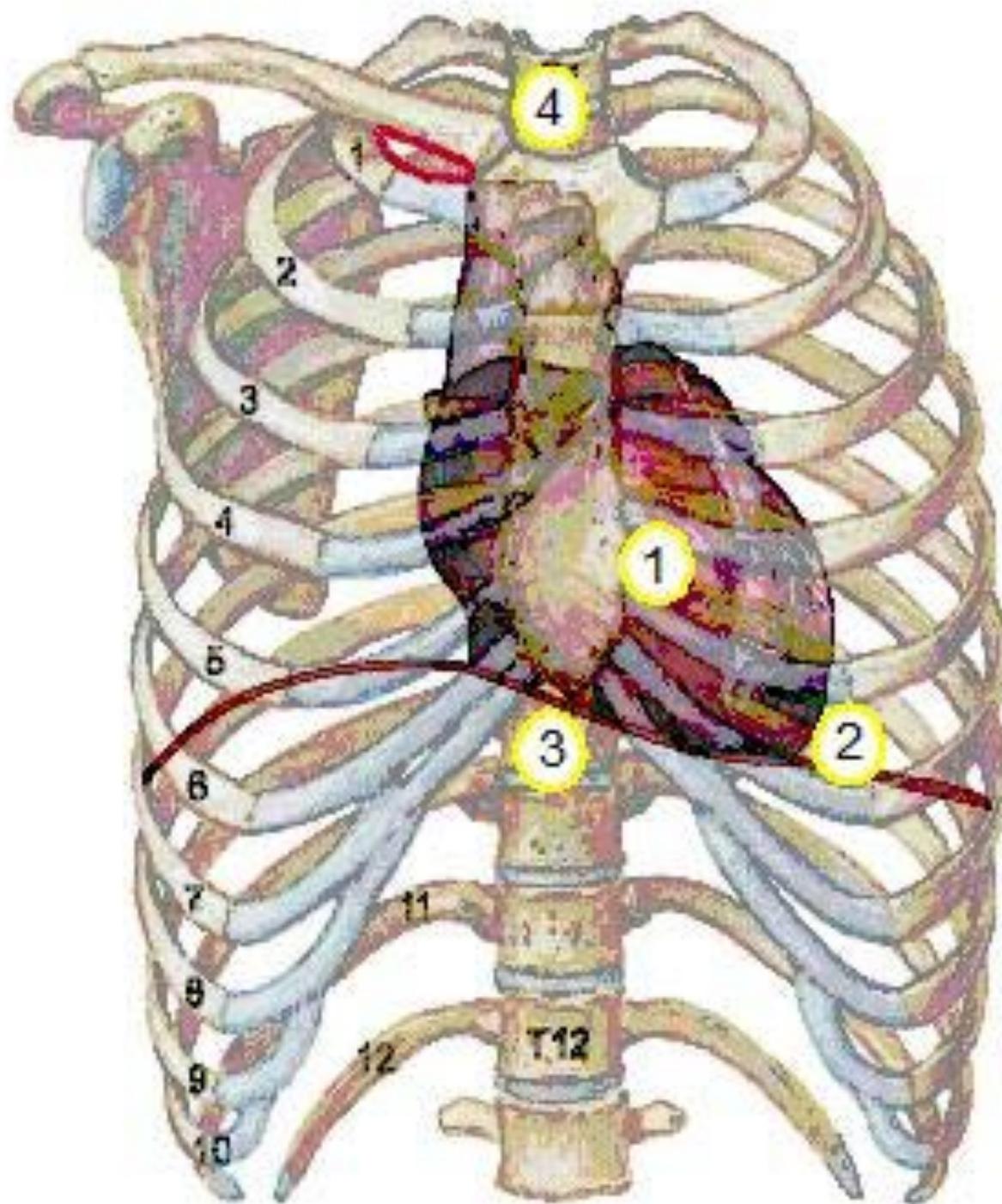
- Assess volume status
- Assess cardiac contractility
- Assess cardiac output
- Assess pulmonary pressures
- Assess for pericardial effusions
- Guide pericardiocentesis
- Monitor treatment strategies

***Critical care cardiac US is very different to echocardiography; structural heart disease is out of the remit of POCUS***

**How do I Scan the Heart?**



# Echo Windows



1. Parasternal

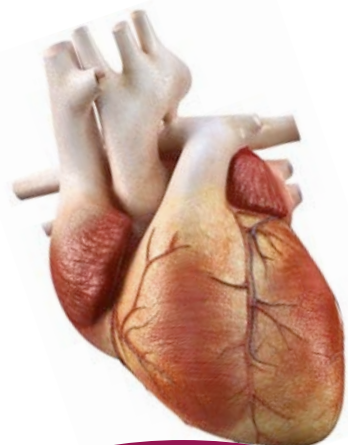
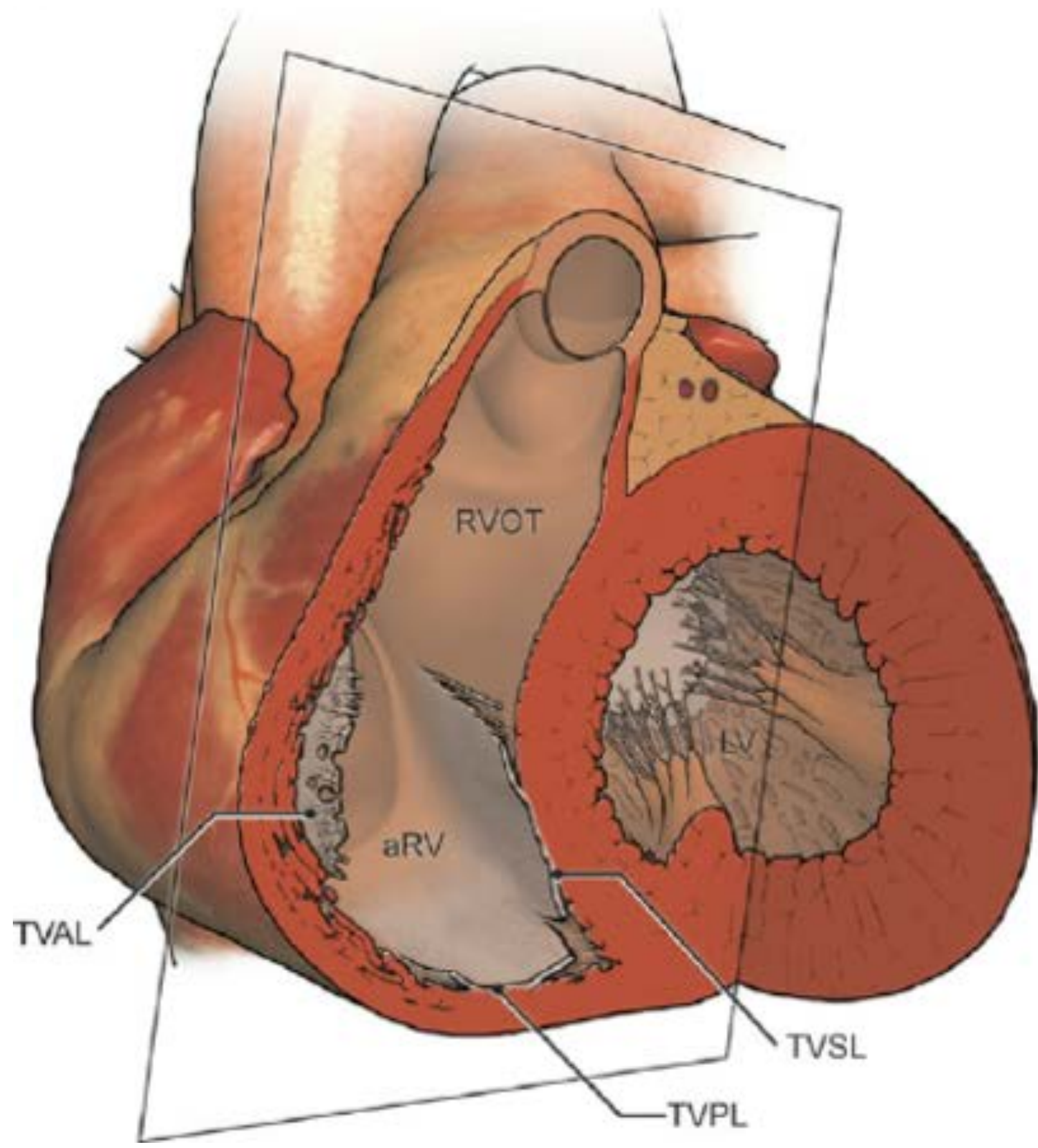
2. Apical

3. Subcostal

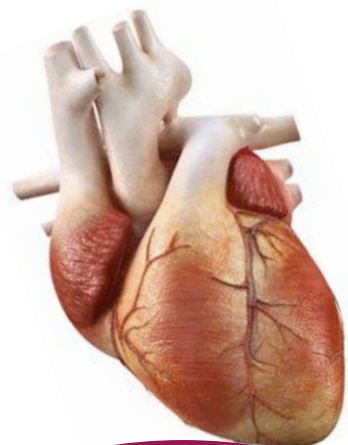
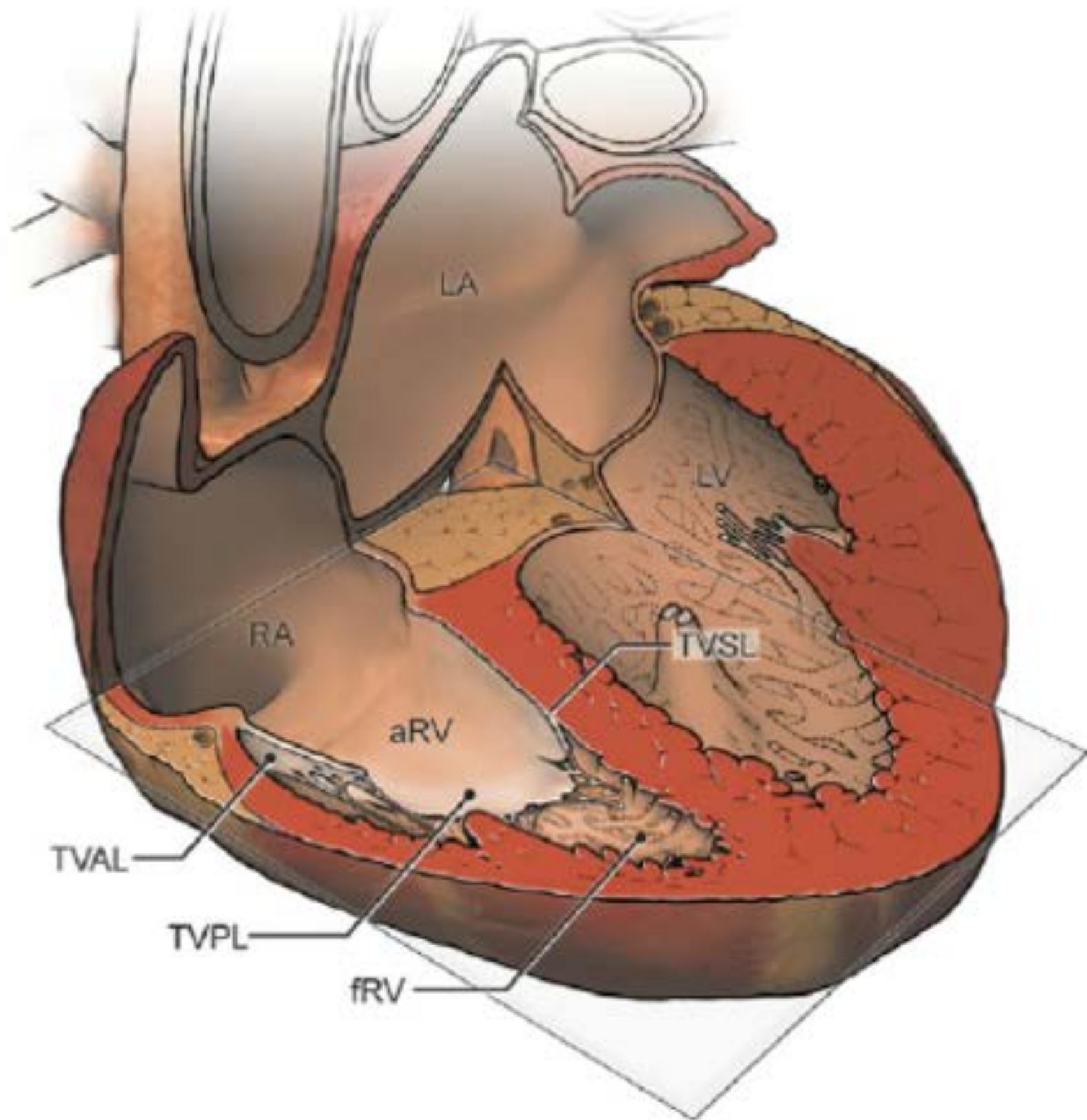
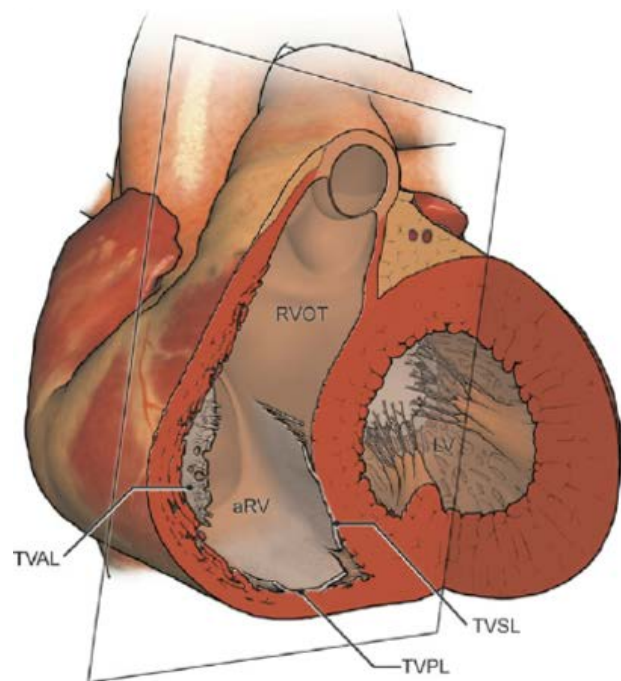
4. Suprasternal Notch



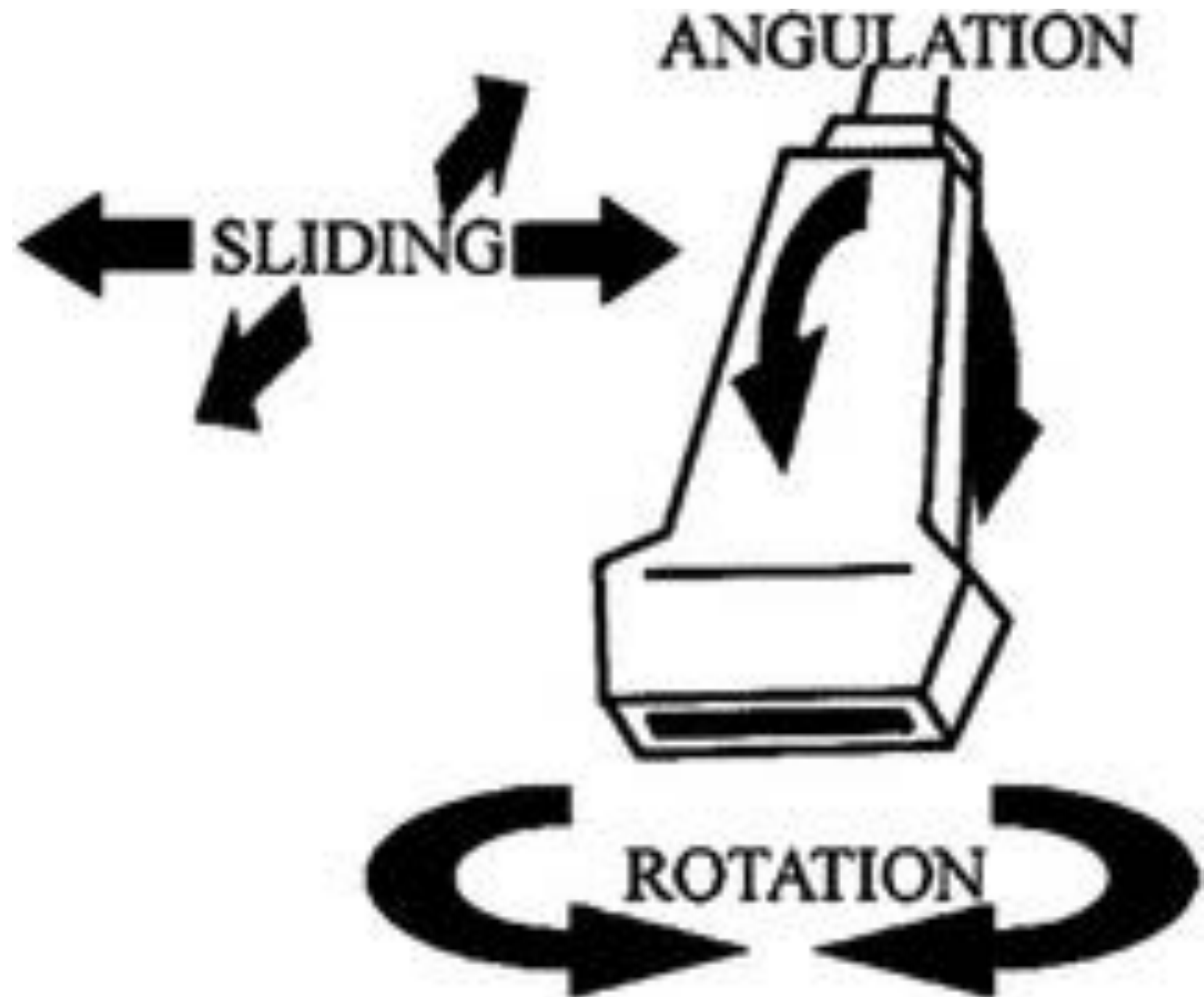




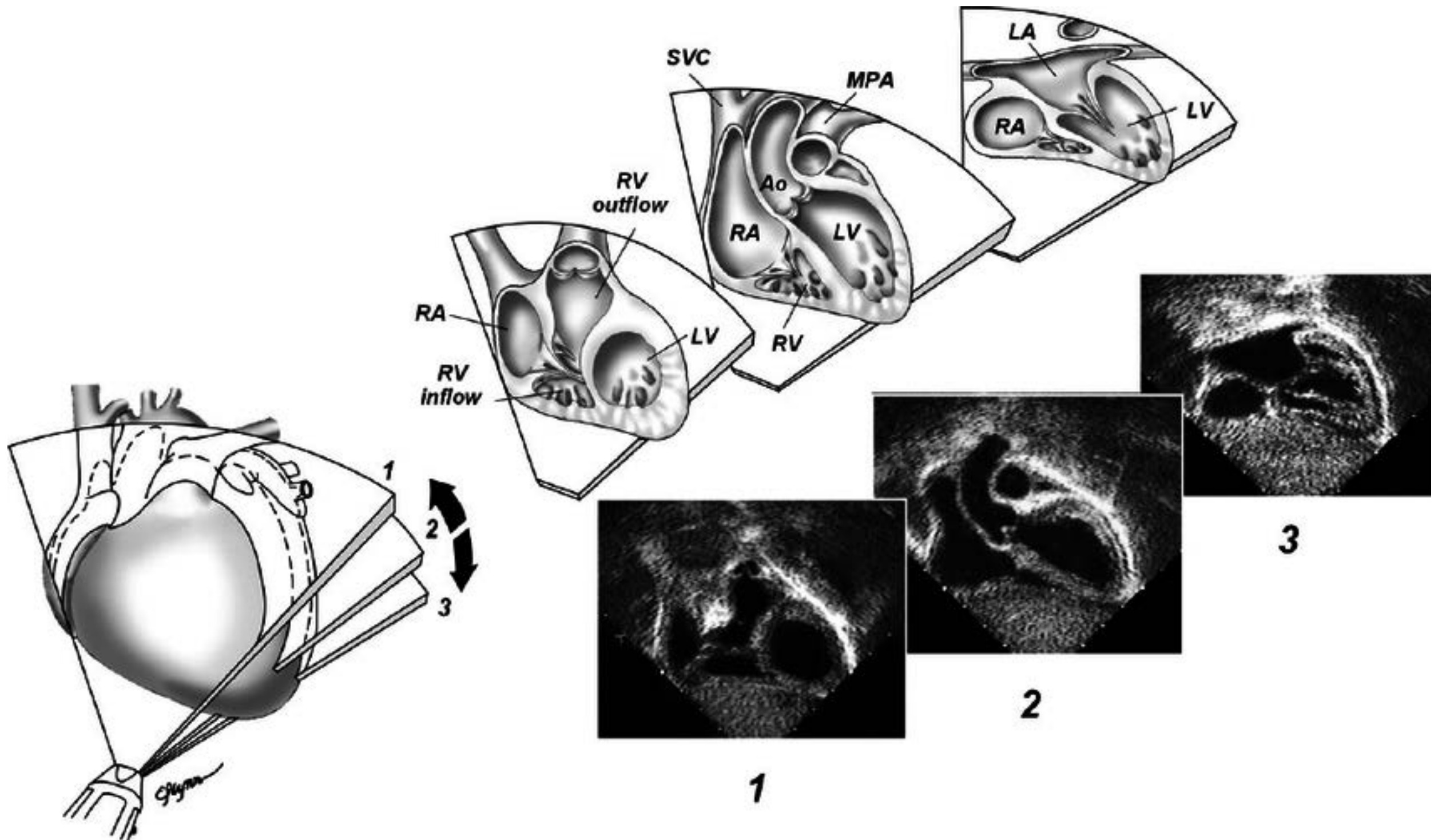




# Key Terminology



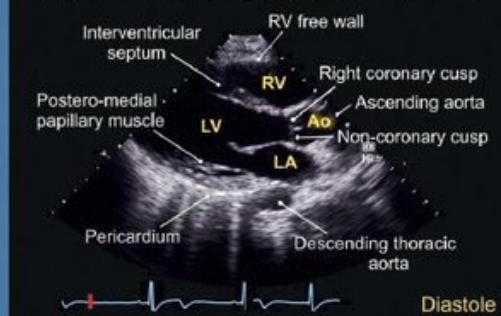
# Key Terminology: Sweep



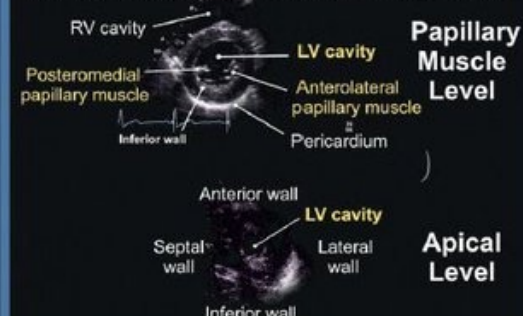


# Echo Anatomy

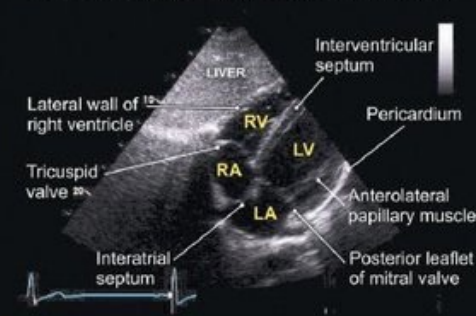
**Parasternal Long-Axis View (PLAX)**



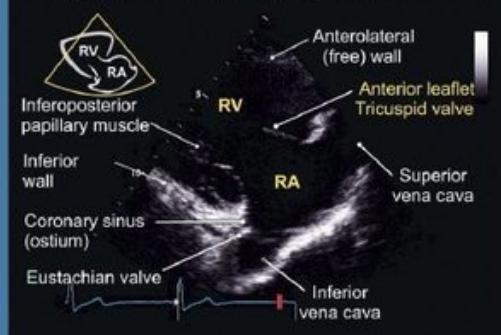
**Parasternal Short-Axis (PSAX) Views**



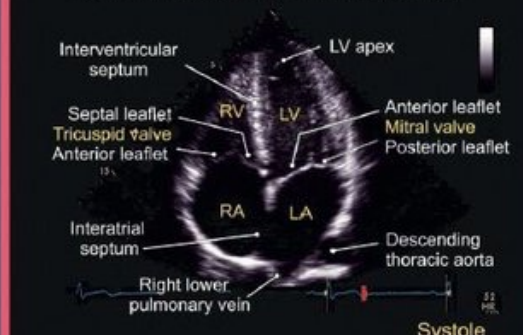
**Subcostal (SC) 4-Chamber View**



**Right Ventricular (RV) Inflow View**



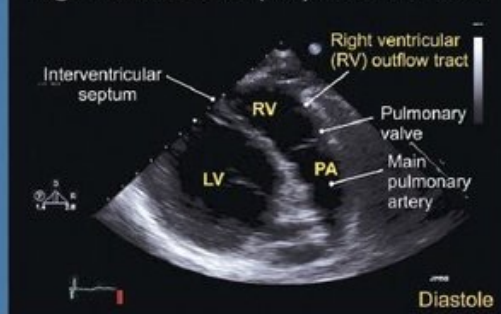
**Apical 4-Chamber View (A4C)**



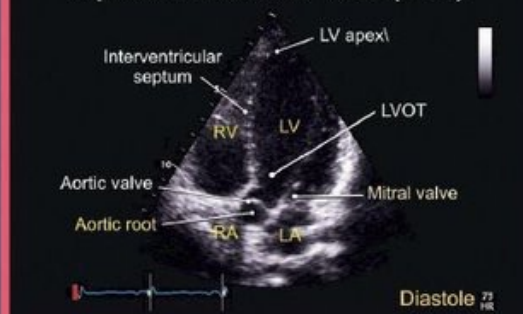
**Inferior Vena Cava (SC) Long Axis**



**Right Ventricular (RV) Outflow View**



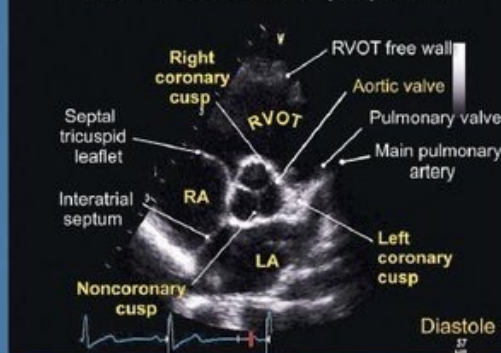
**Apical 5-Chamber View (A5C)**



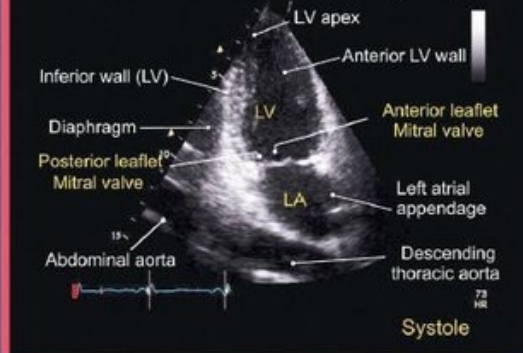
**SC Abdominal Aorta Long Axis**



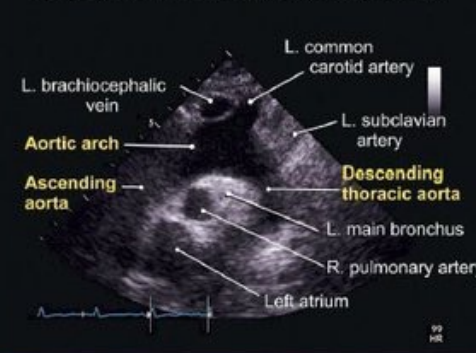
**PSAX: Aortic Valve (AV) Level**



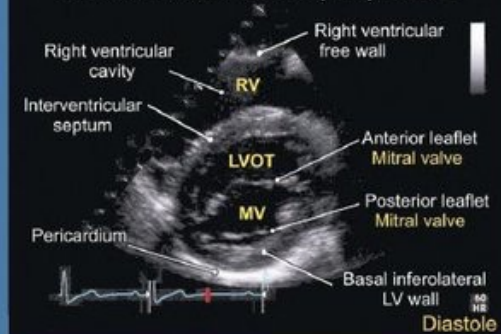
**Apical 2-Chamber View (A2C)**



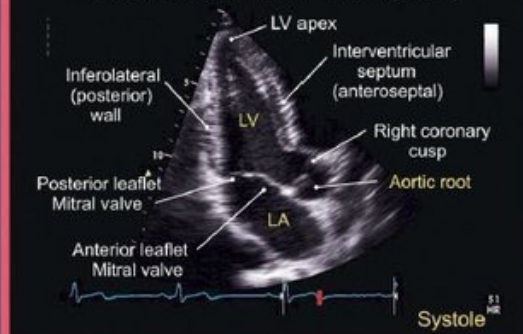
**Suprasternal Notch (SSN) View**



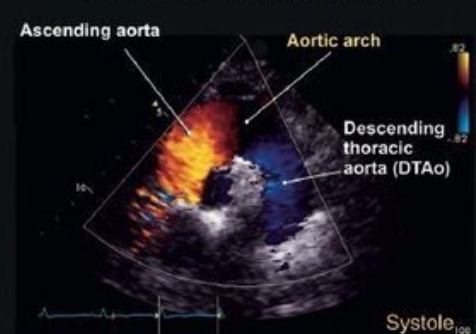
**PSAX: Mitral Valve (MV) Level**



**Apical 3-Chamber View (A3C)**

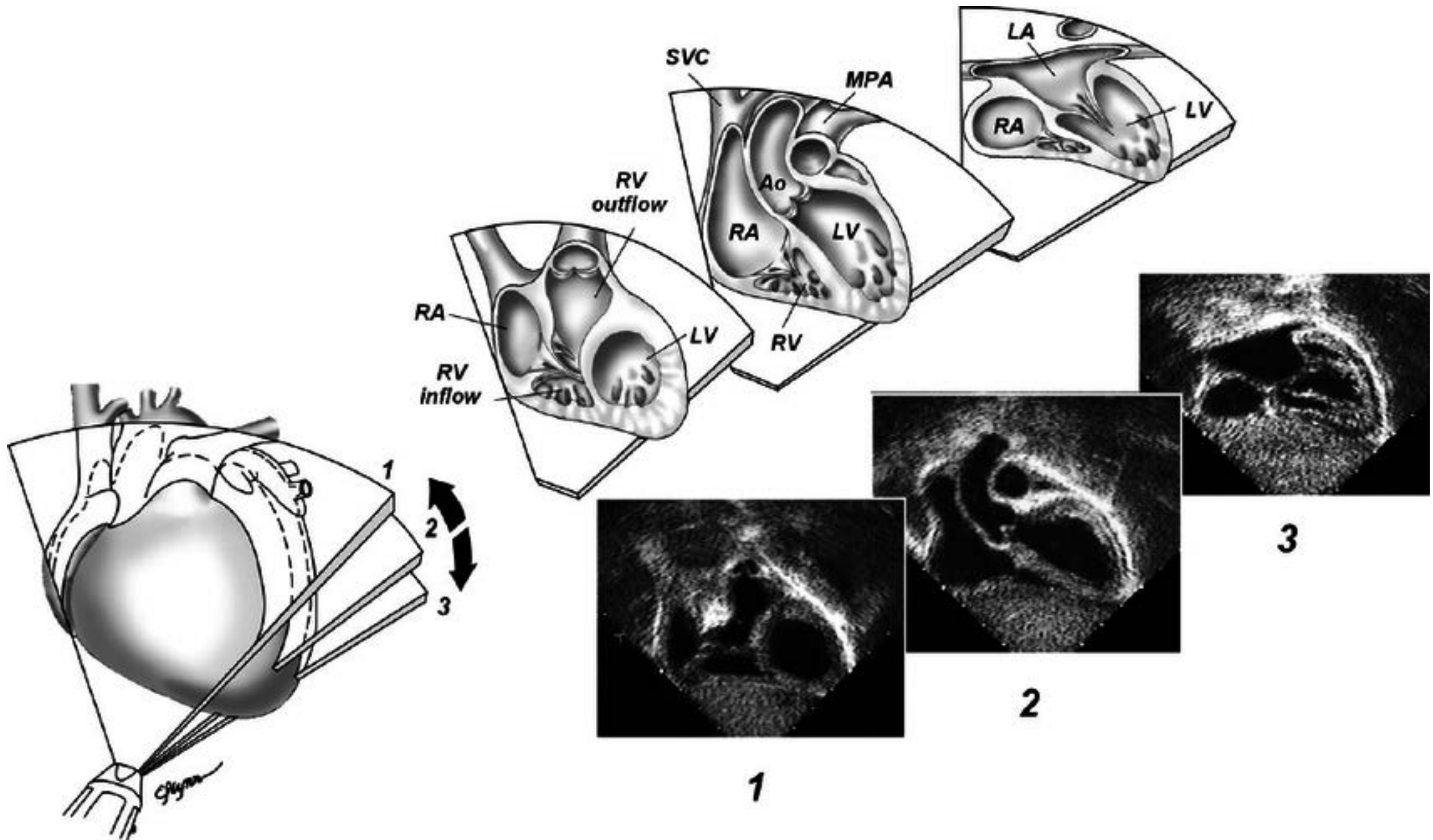


**SSN: Color Flow Doppler**

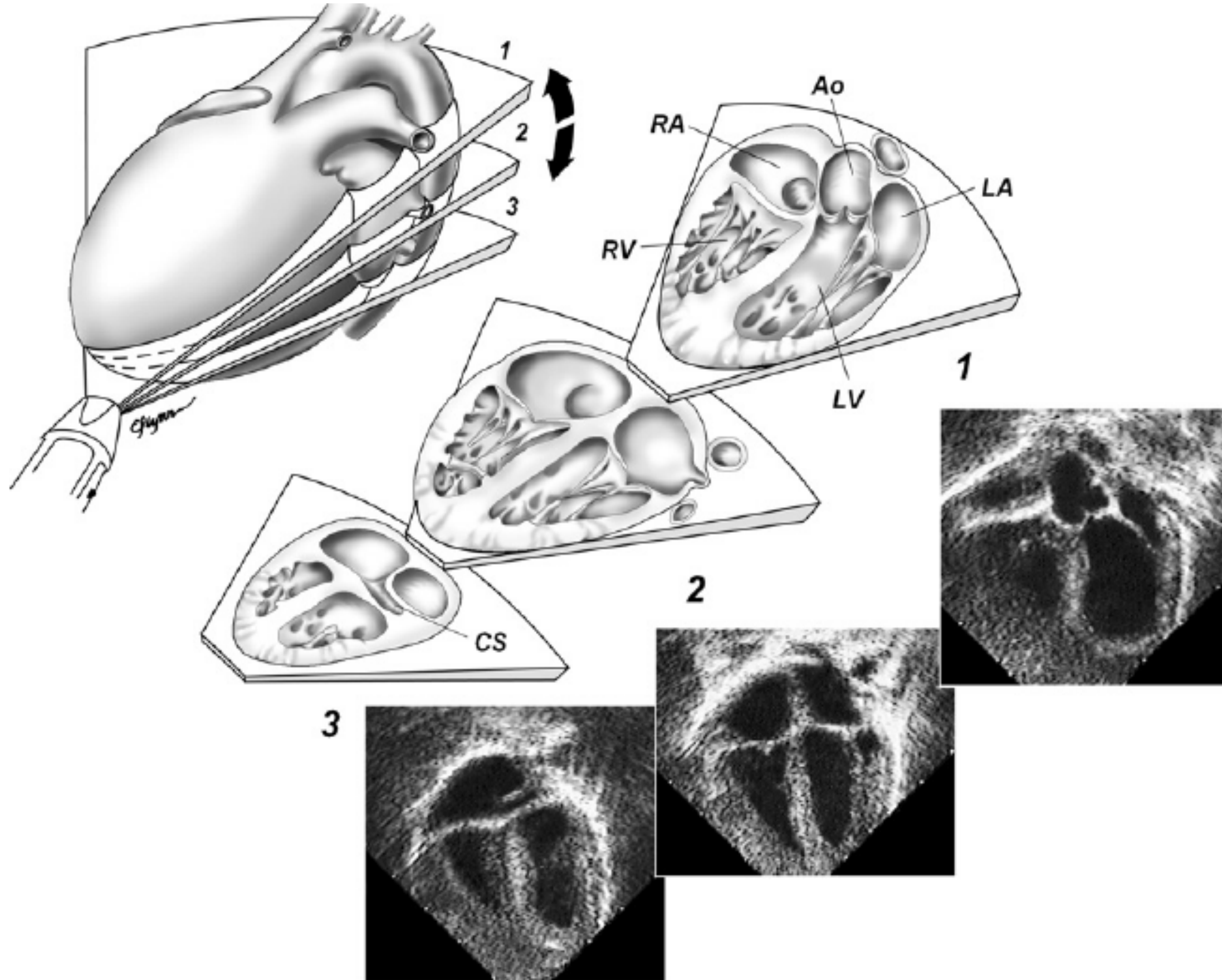




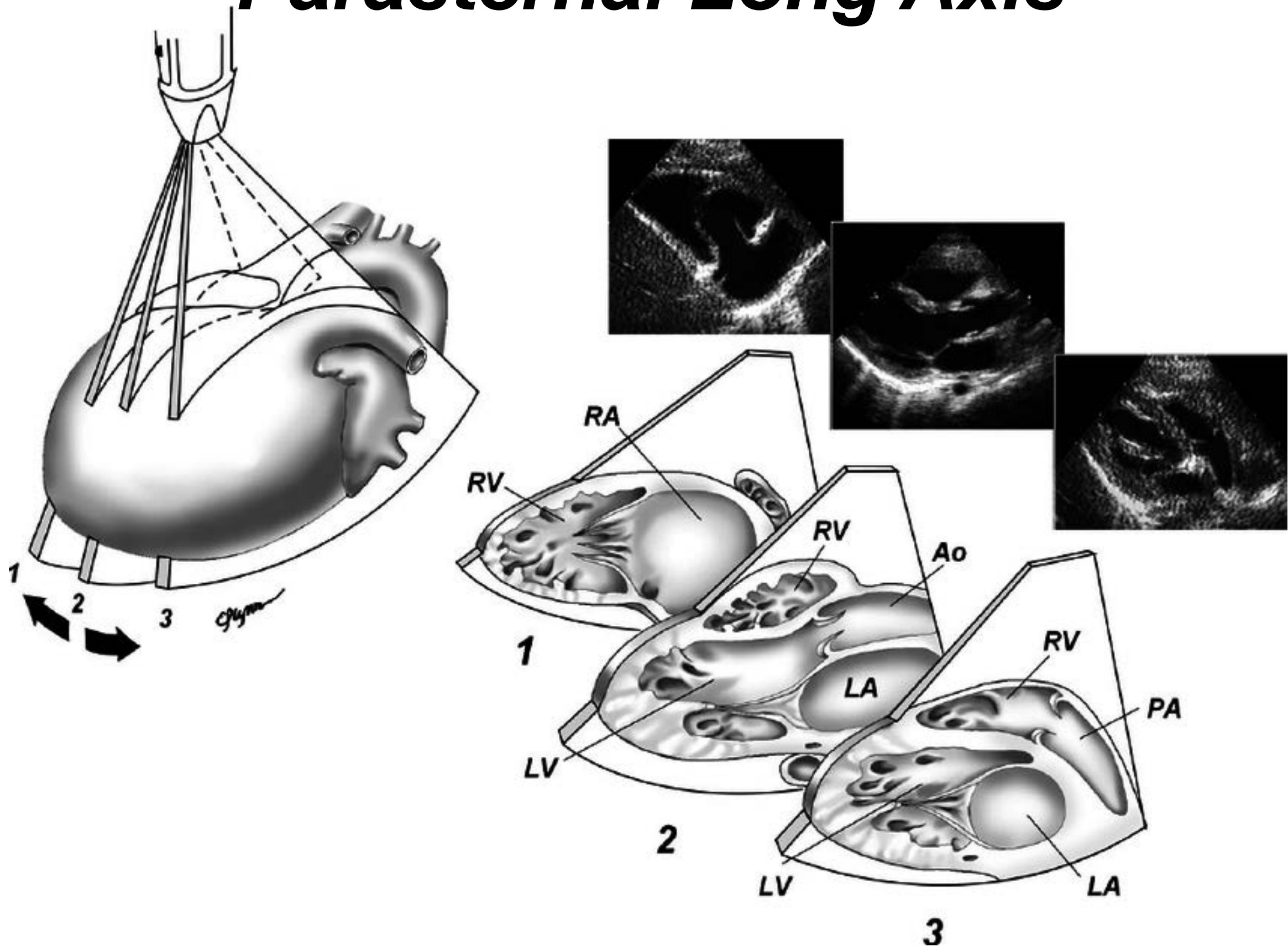
# Echo Anatomy: *Subcostal*



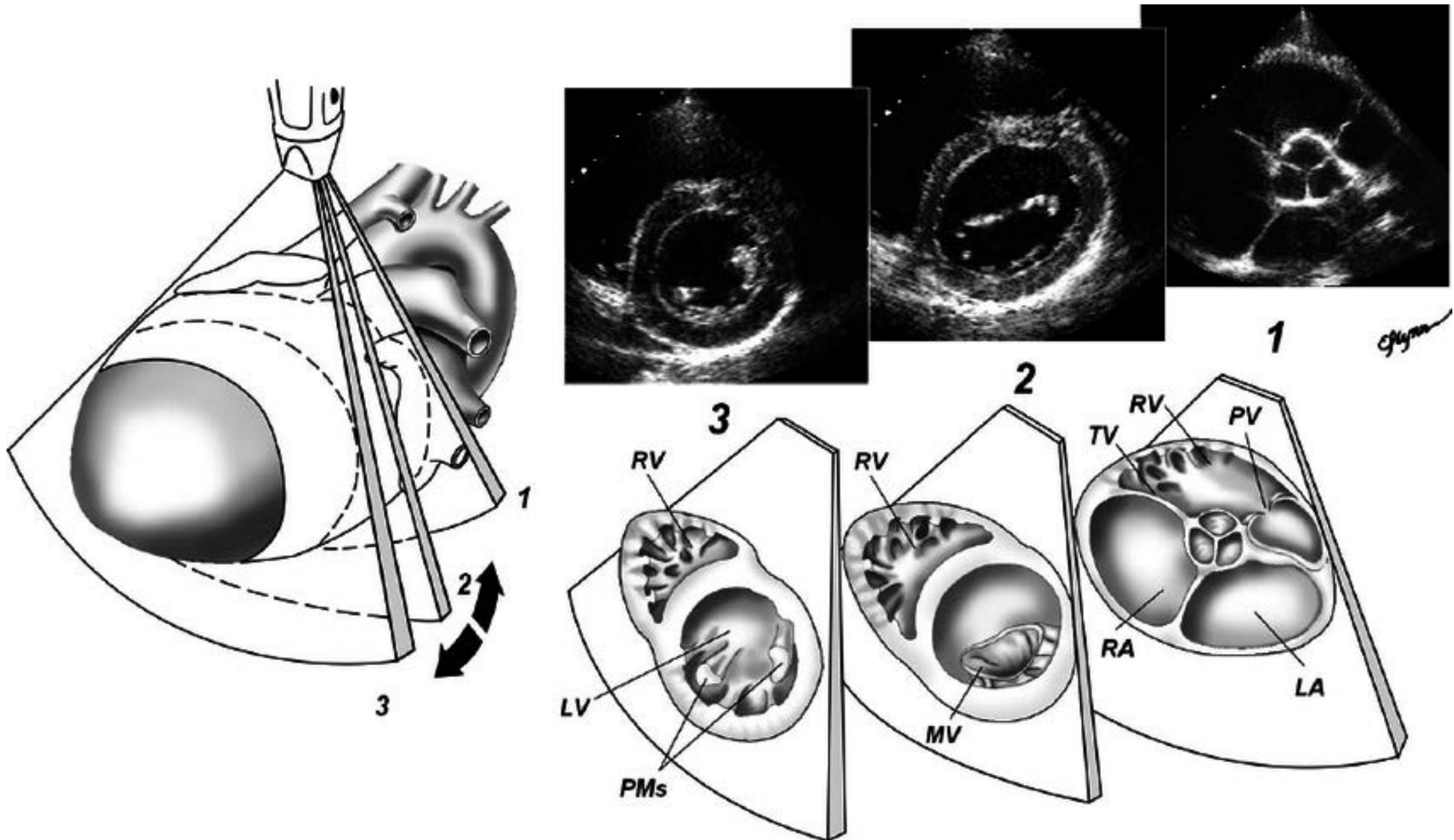
# Echo Anatomy: *Apical*



# Echo Anatomy: *Parasternal Long Axis*



# Echo Anatomy: *Parasternal Short Axis*



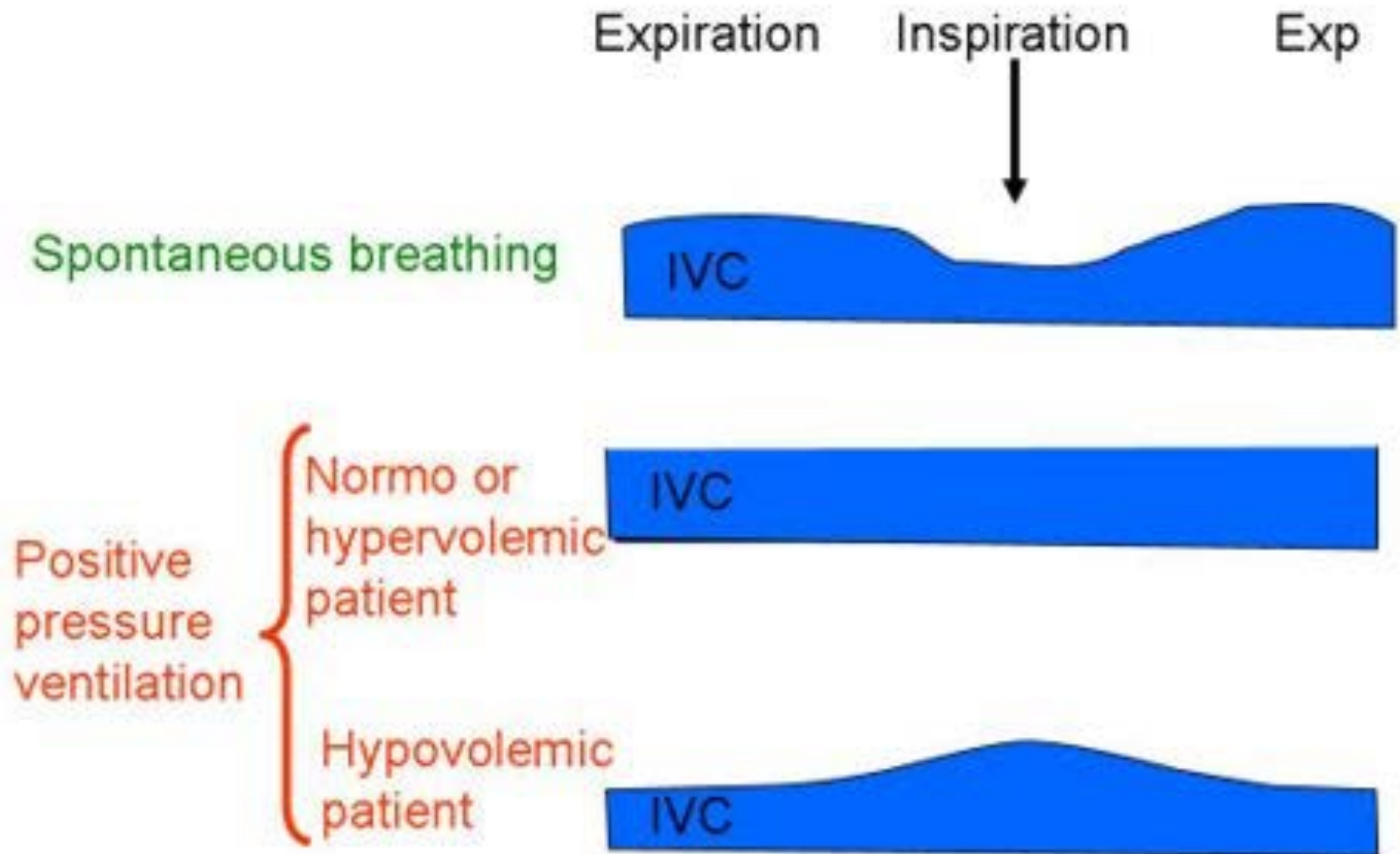


**Does the Child Need  
Volume?**

# Hypovolaemia

- Ultrasound evidence of intravascular hypovolaemia include:
  - Under filling of the ventricles
  - Meeting of the papillary muscles
  - Variation in IVC size with respiratory effort
    - ✦ IVC collapsibility -> Spontaneous breathing
    - ✦ IVC Distention common in mechanically ventilated

# Hypovolaemia & IVC



Pediatric

S8-3

55Hz

7.0cm

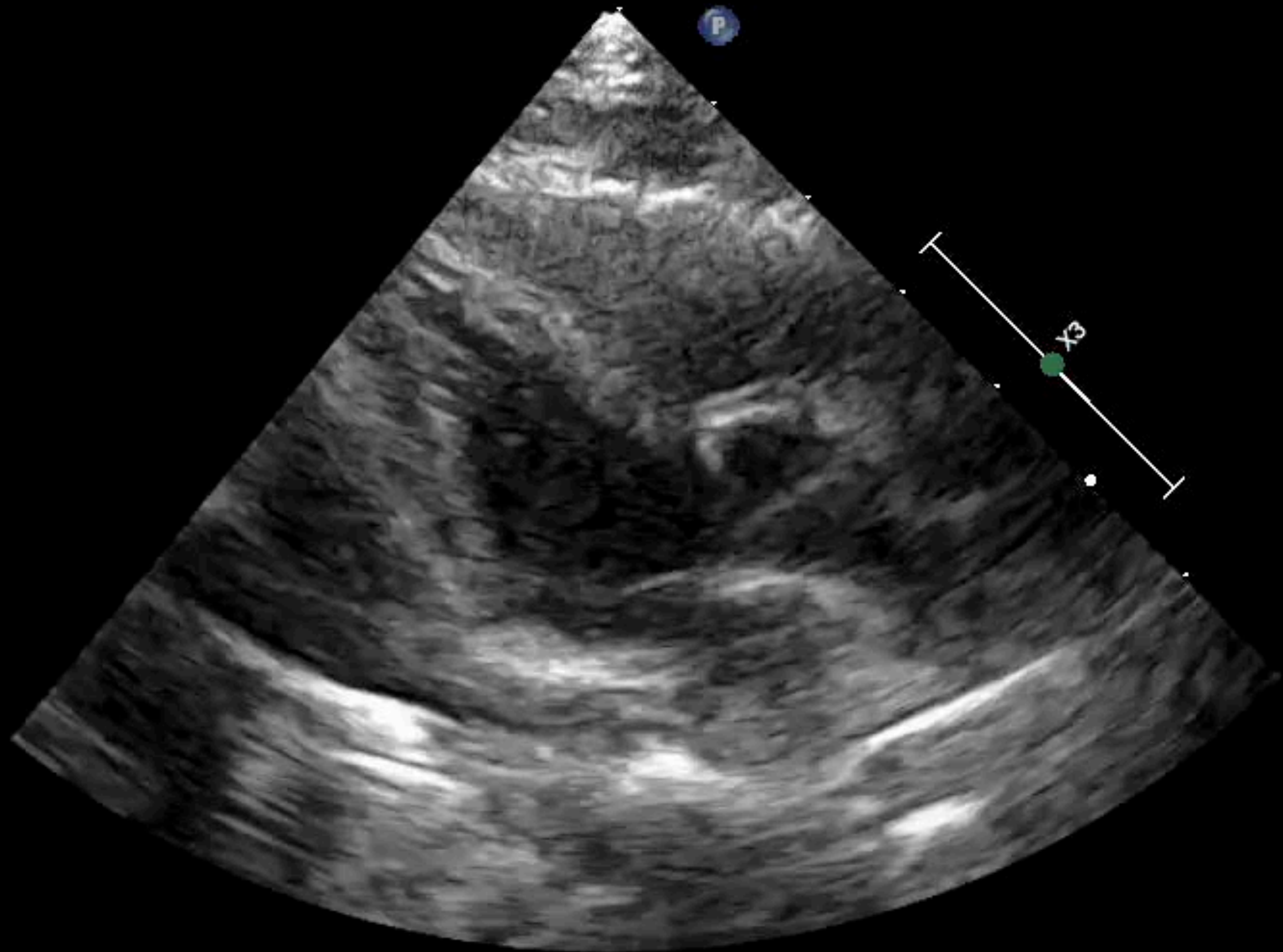
2D

76%

C 50

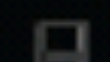
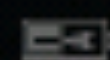
P Off

Gen



176 bpm





99%

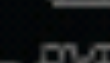
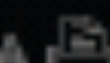
MI

1.2

TIS

0.3

<|||>

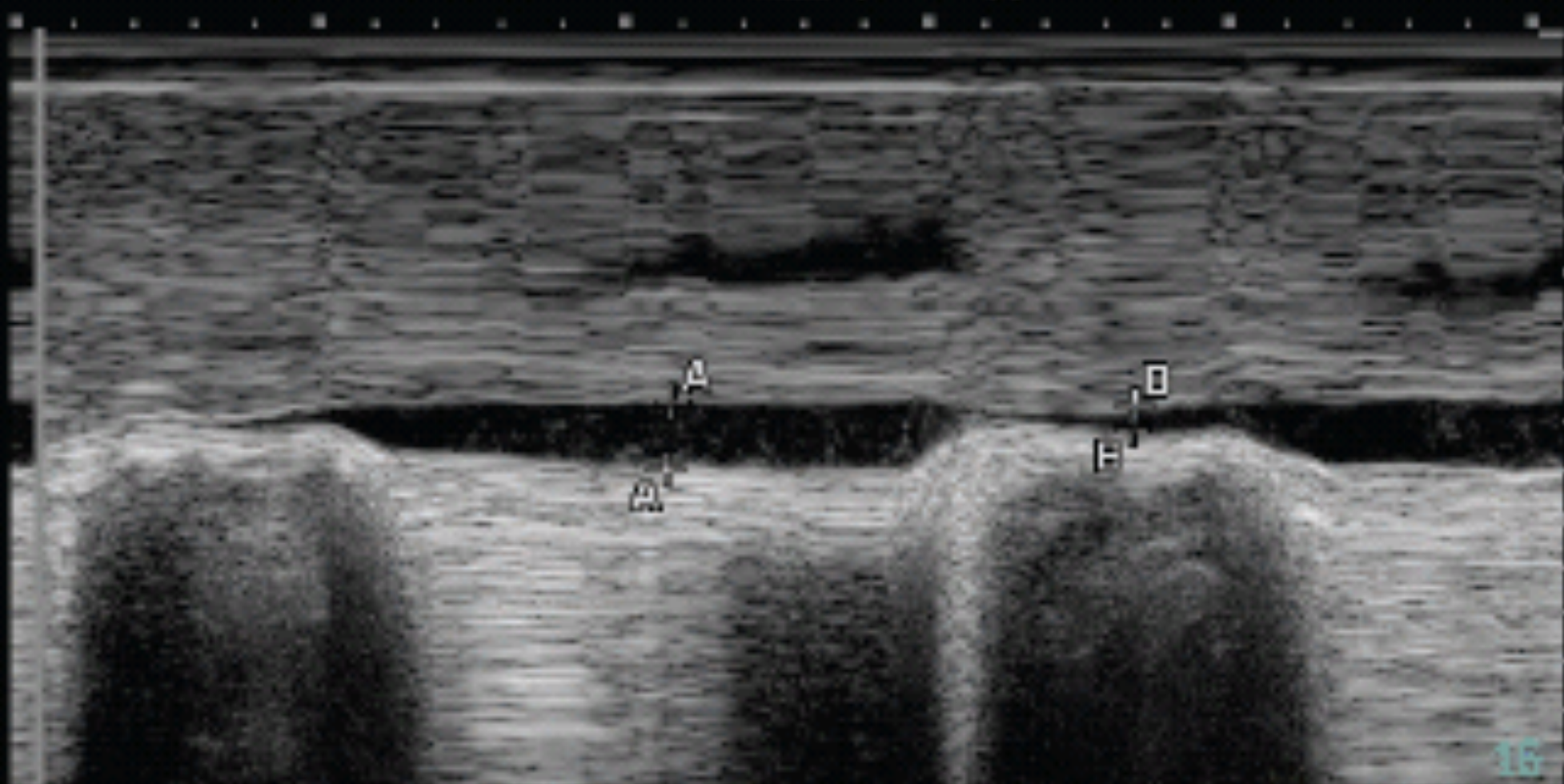


A

B



Cine



A 1.39cm 0.02s

B 0.50cm 0.01s

Home

Home/Set

Label...

Symbols...

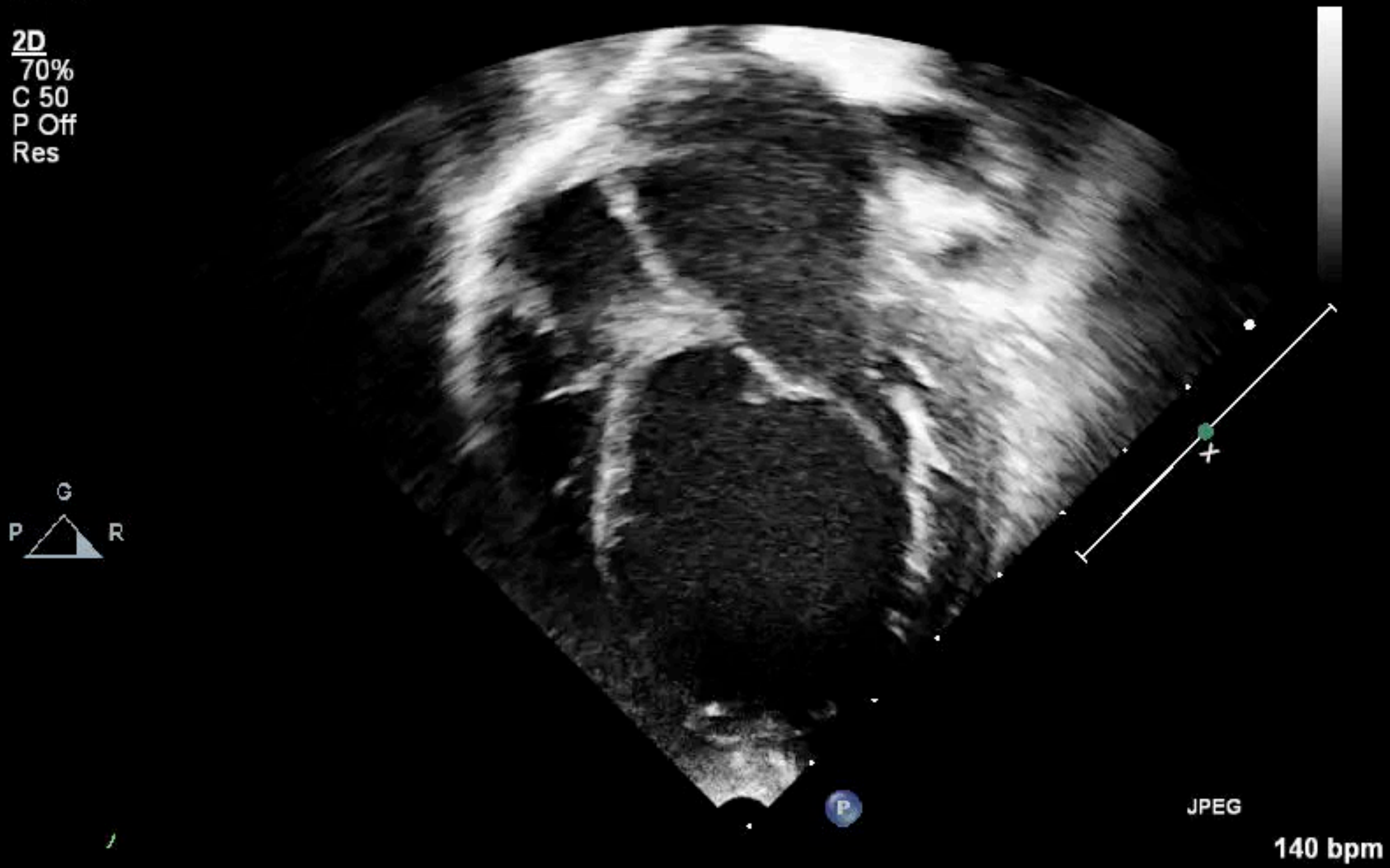
X Word

Done

**Recognition of a  
volume loaded  
heart is easier  
than an under  
filled heart**

9.0cm

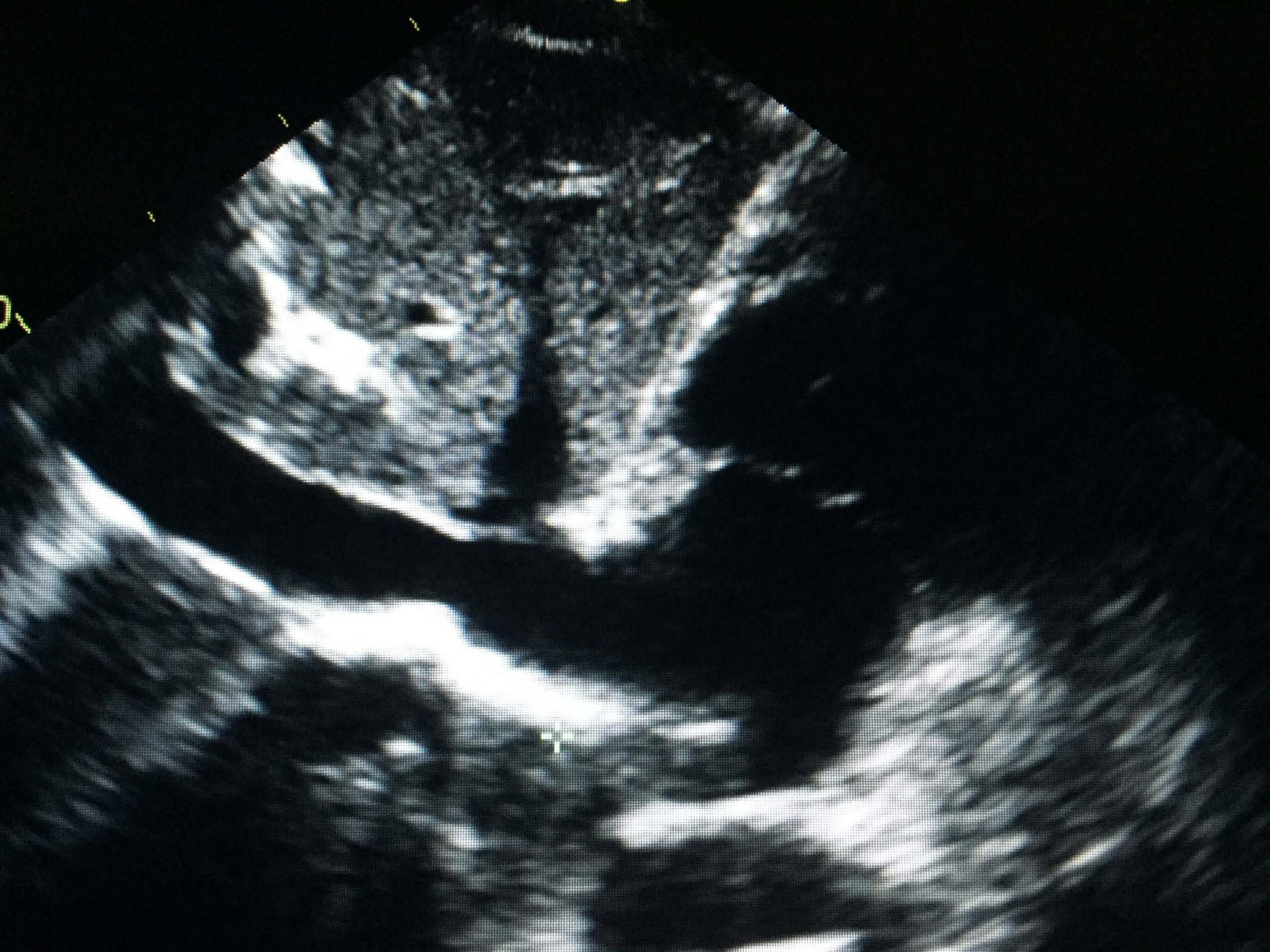
2D  
70%  
C 50  
P Off  
Res



JPEG

140 bpm

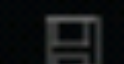








19



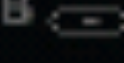
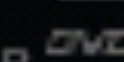
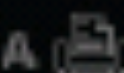
97%

MI

1.2

TIS

0.3



A  
A

B  
B

19

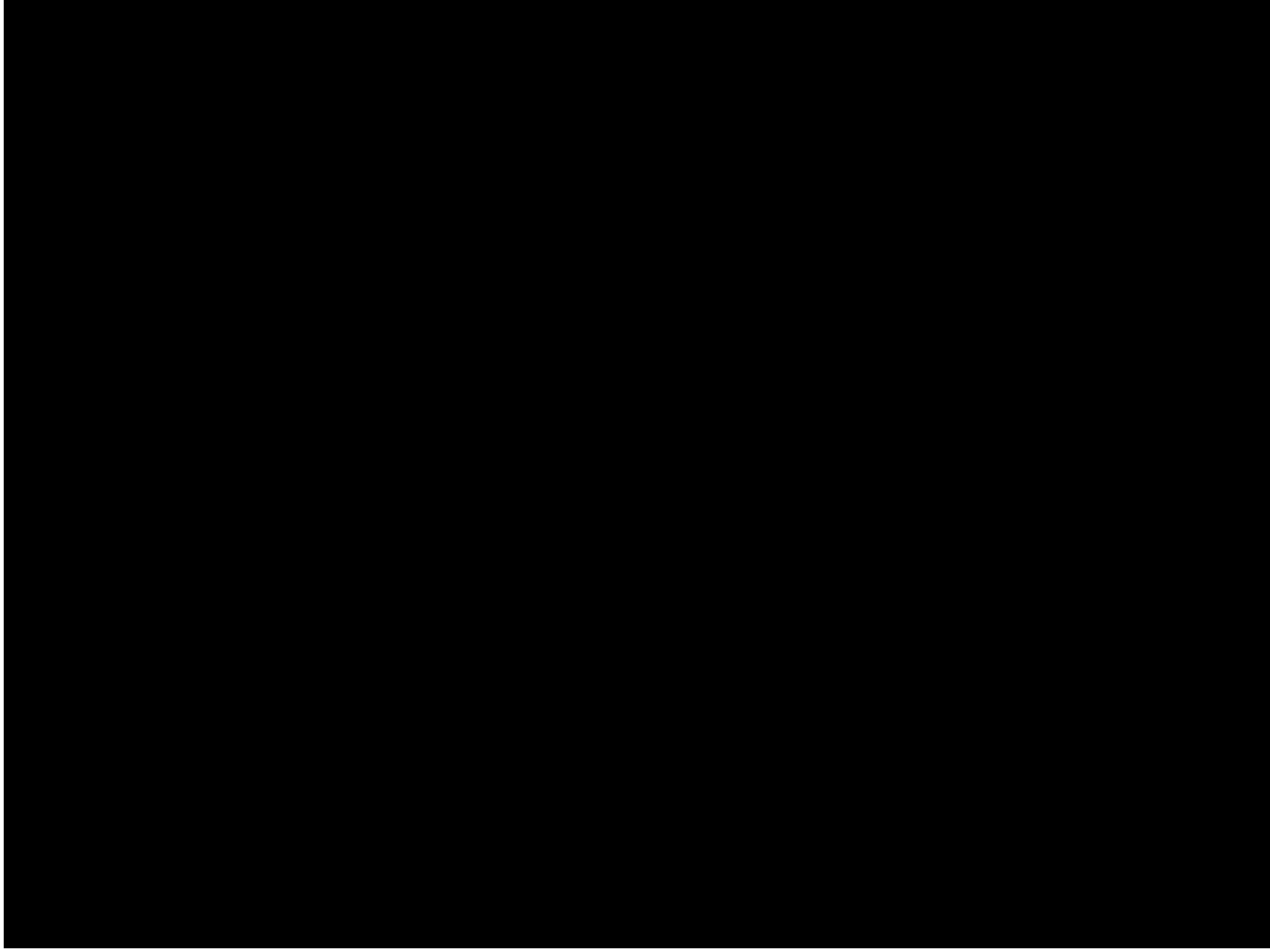
Cine

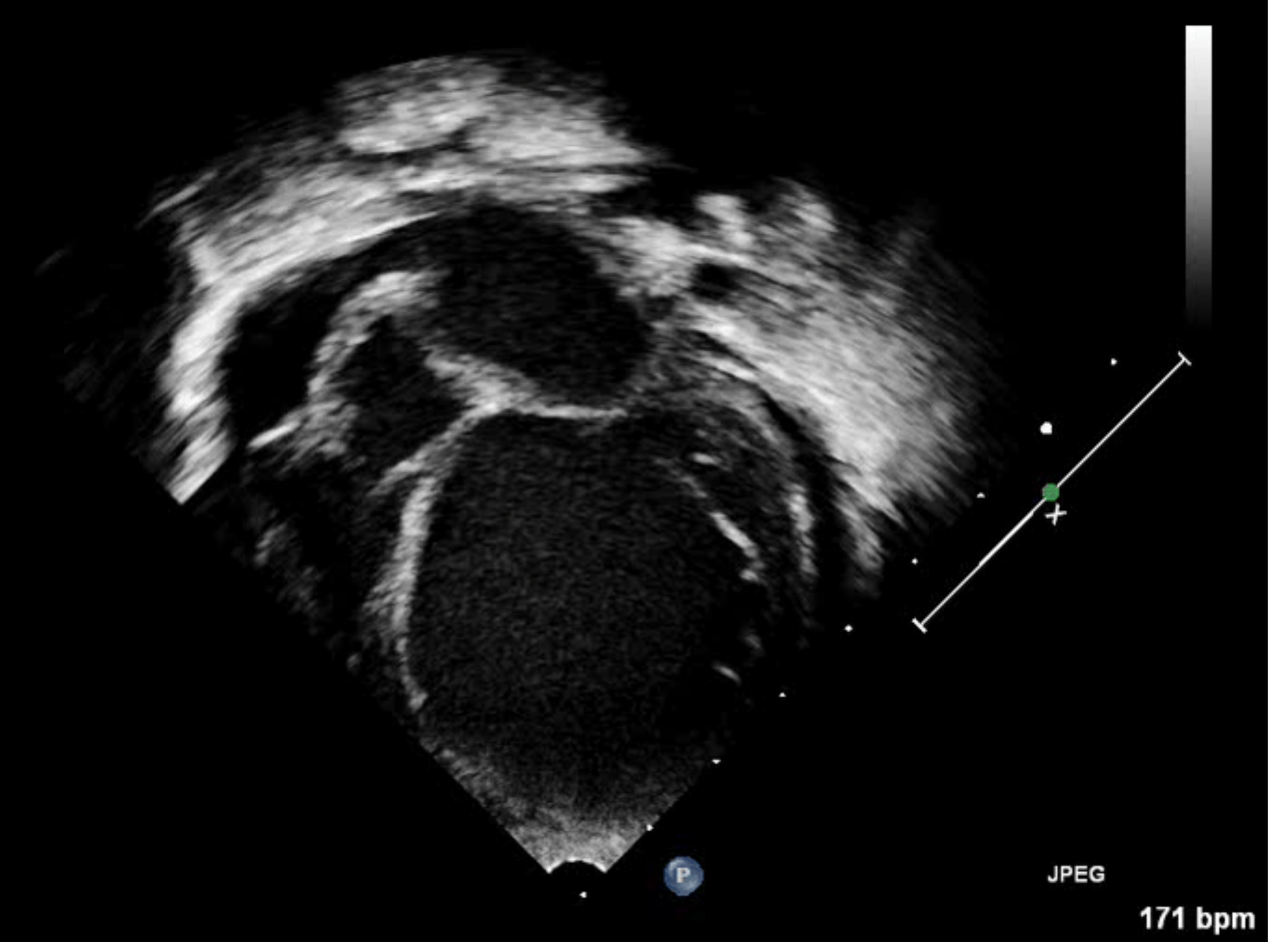
A 2.15cm

B 2.37cm 0.01s

# Re-Assess After Volume

- Can be used in real time to assess impact
- Aim to prevent excessive volume therapy
- Adult data supports 'Passive Leg Raise' as a technique to assess likelihood of fluid responsiveness
- Need to apply to clinical features as well
- Include pulmonary ultrasound - ?B lines







**Does the Child Need an  
Inotrope or Vasopressor?**

**Assessment of Heart on POCUS**

```
graph TD; A[Assessment of Heart on POCUS] --> B[Ensure the heart is well filled]; B --> C[Assess the Ventricular Function]; C --> D[Normal or Hyperdynamic Ventricular Function]; C --> E[Reduced LV Function]; D --> F[Vasopressor]; E --> G[Inotrope];
```

The flowchart illustrates the process of assessing heart function using POCUS. It begins with a green box 'Assessment of Heart on POCUS', followed by a blue box 'Ensure the heart is well filled', and then a red box 'Assess the Ventricular Function'. From the red box, the path splits into two: a purple box 'Normal or Hyperdynamic Ventricular Function' leading to a purple box 'Vasopressor', and an orange box 'Reduced LV Function' leading to an orange box 'Inotrope'. Arrows indicate the flow between these steps.

**Ensure the heart is well filled**

**Assess the Ventricular Function**

**Normal or  
Hyperdynamic  
Ventricular Function**

**Vasopressor**

**Reduced LV Function**

**Inotrope**

# Assessment of LV Function

- Can be carried out in any view
- 'Visual assessment'
  - ❖ Do the ventricular walls move together during systole? (Also, radius change in short axis view)
  - ❖ Does the LV cavity empty during systole?
  - ❖ Does the myocardium thicken during systole?
  - ❖ What is the LV shape?
- Measurements
  - 🌟 FS, EF, Simpsons

13cm

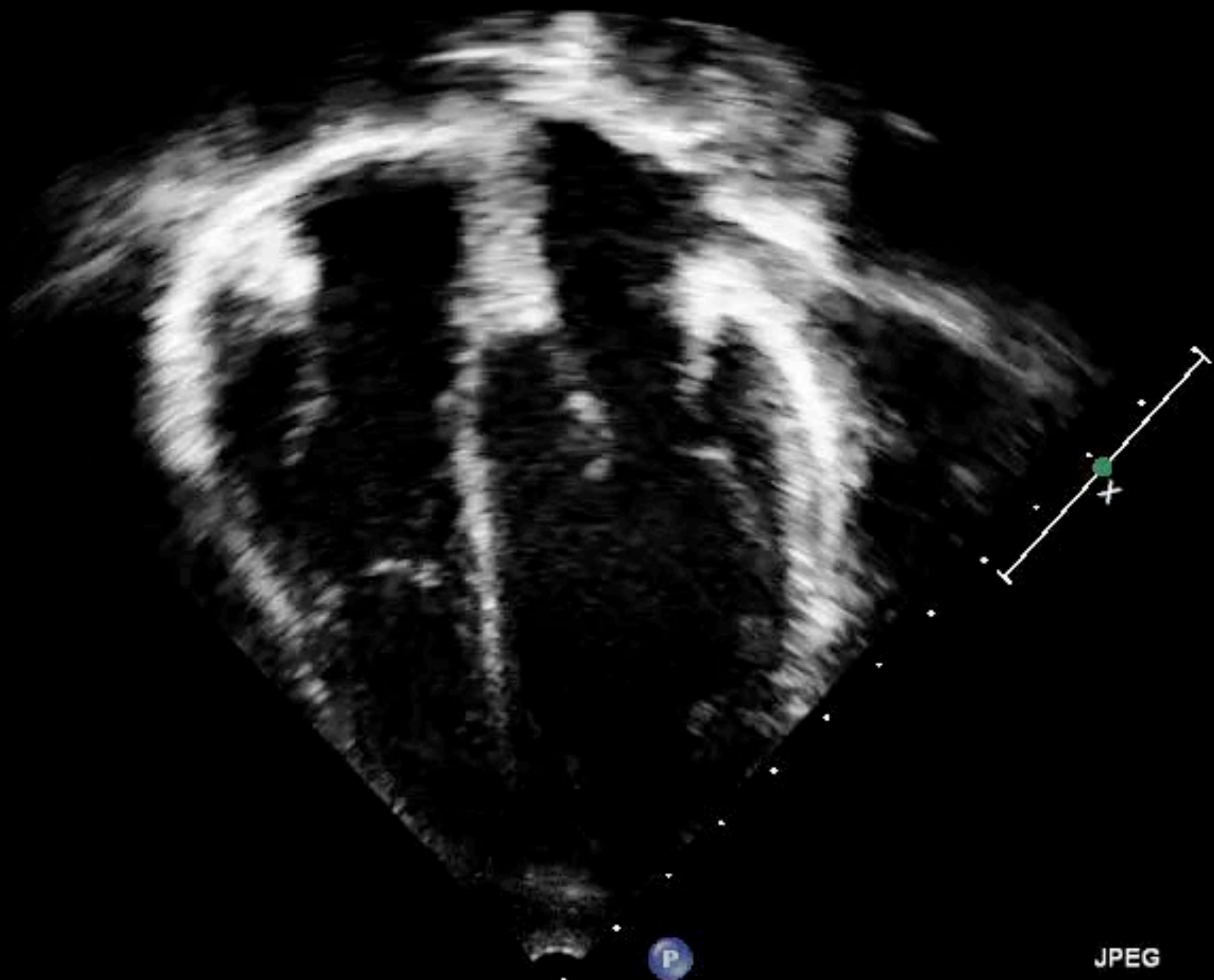
2D

55%

C 50

P Low

HGen



P

JPEG

88 bpm



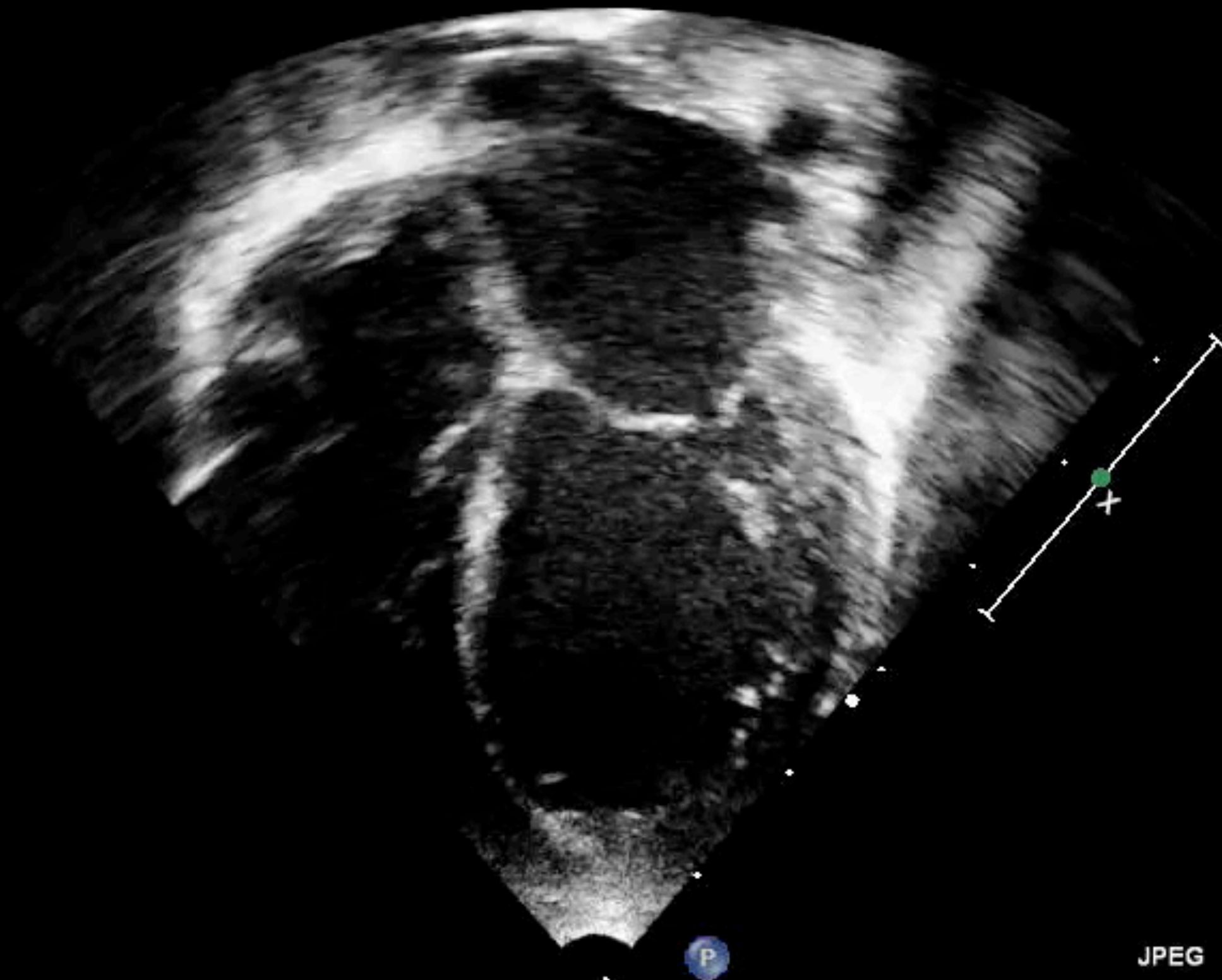
2D  
67%  
C 50  
P Low  
HGen

Ⓒ  
P R  
1.6 3.2

62 bpm

7.0cm

**2D**  
58%  
C 50  
P Off  
Res



P

JPEG

114 bpm

6.0cm

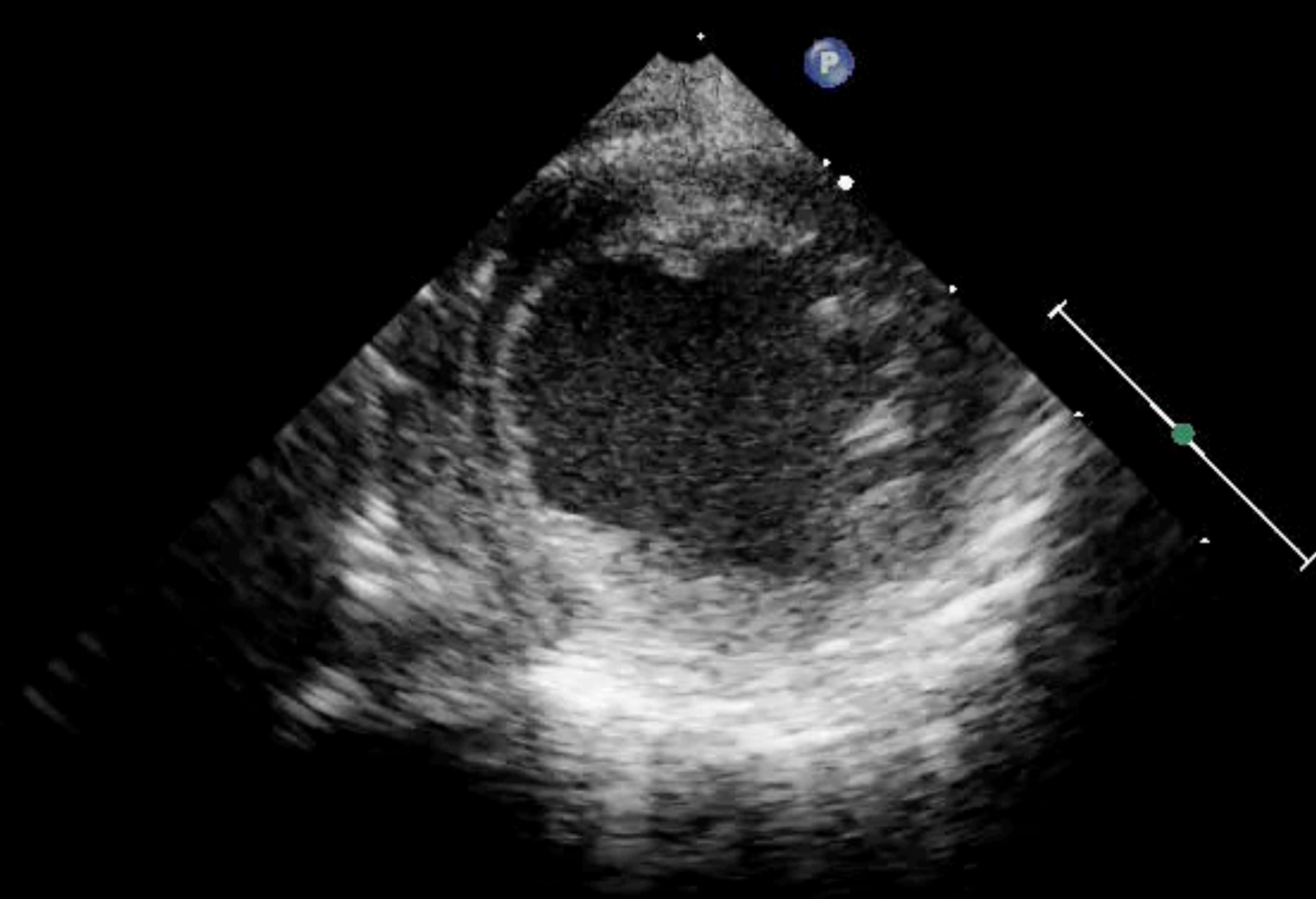
**2D**

76%

C 50

P Off

Gen

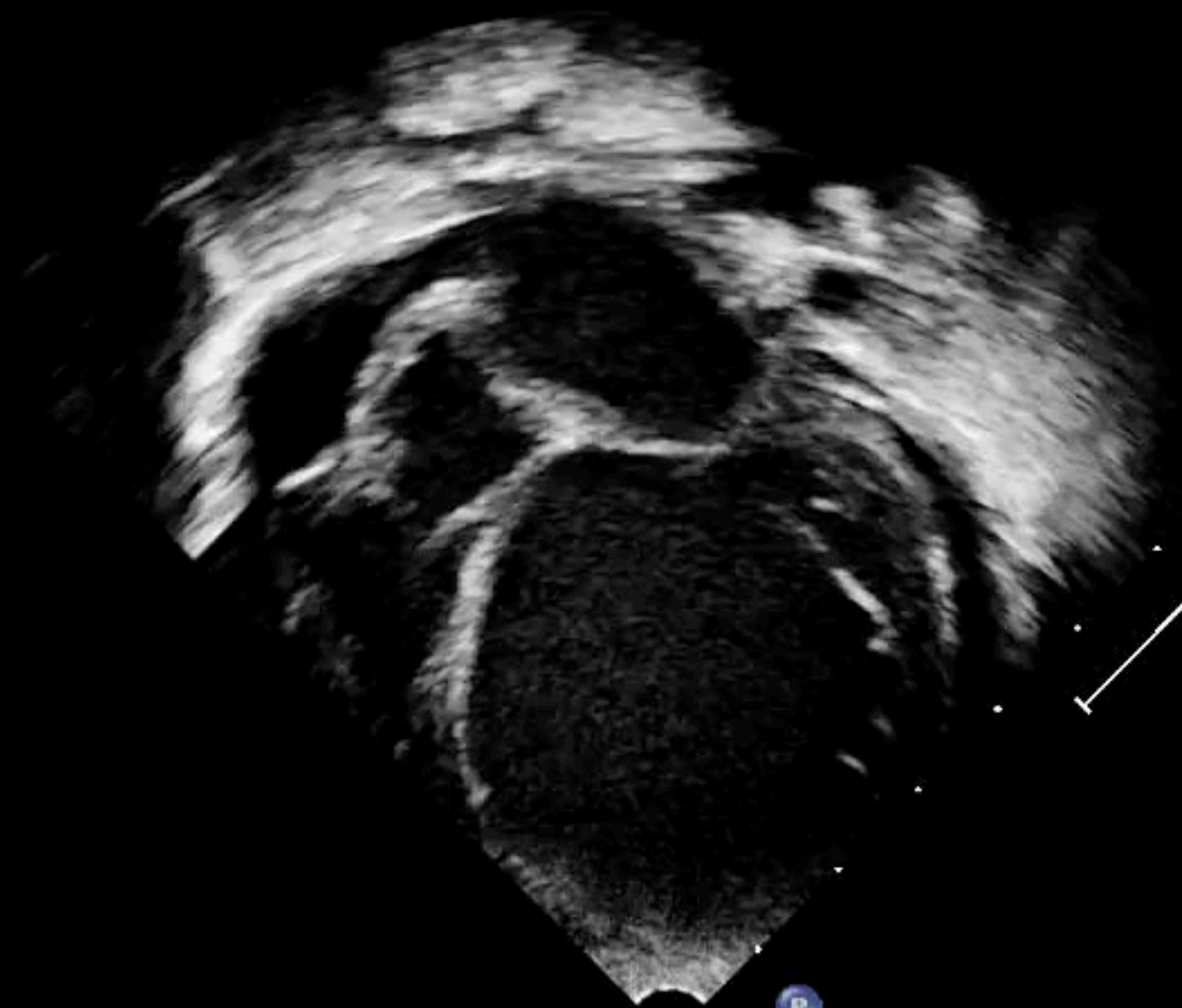


JPEG

115 bpm

9.0cm

**2D**  
61%  
C 50  
P Off  
HGen

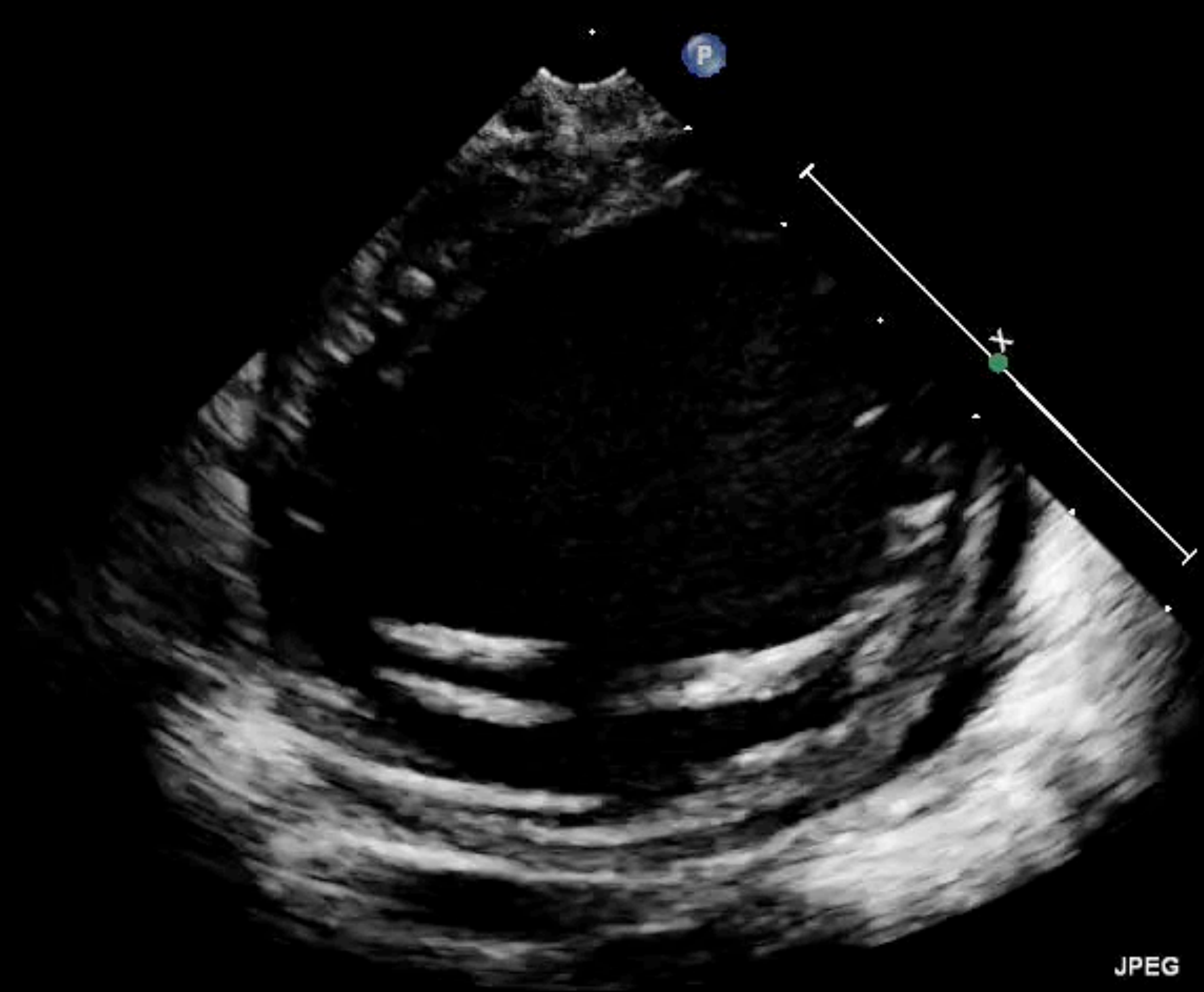


JPEG

171 bpm



2D  
60%  
C 50  
P Off  
HGen

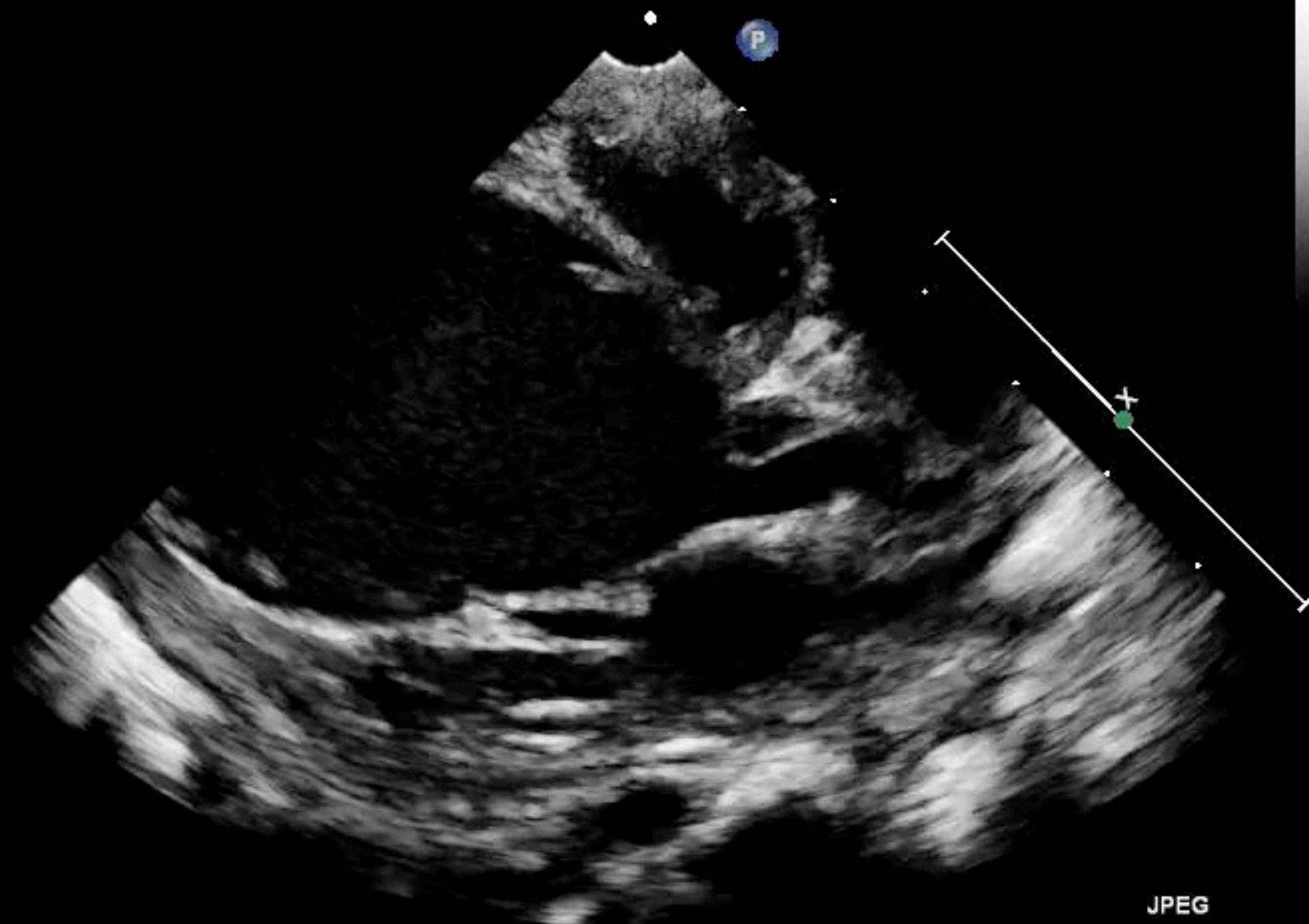


JPEG

157 bpm

7.0cm

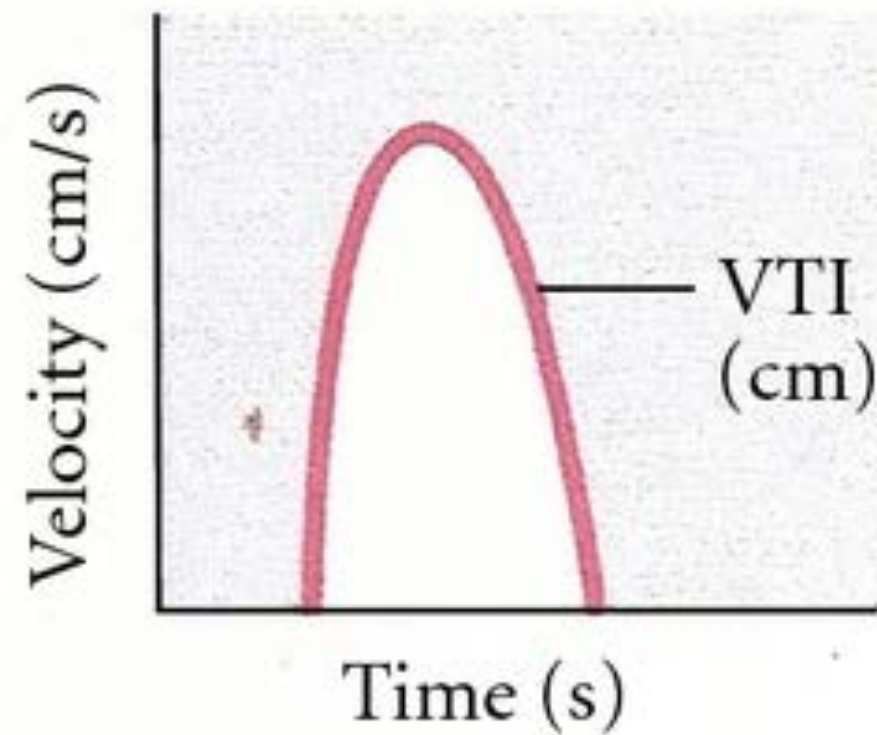
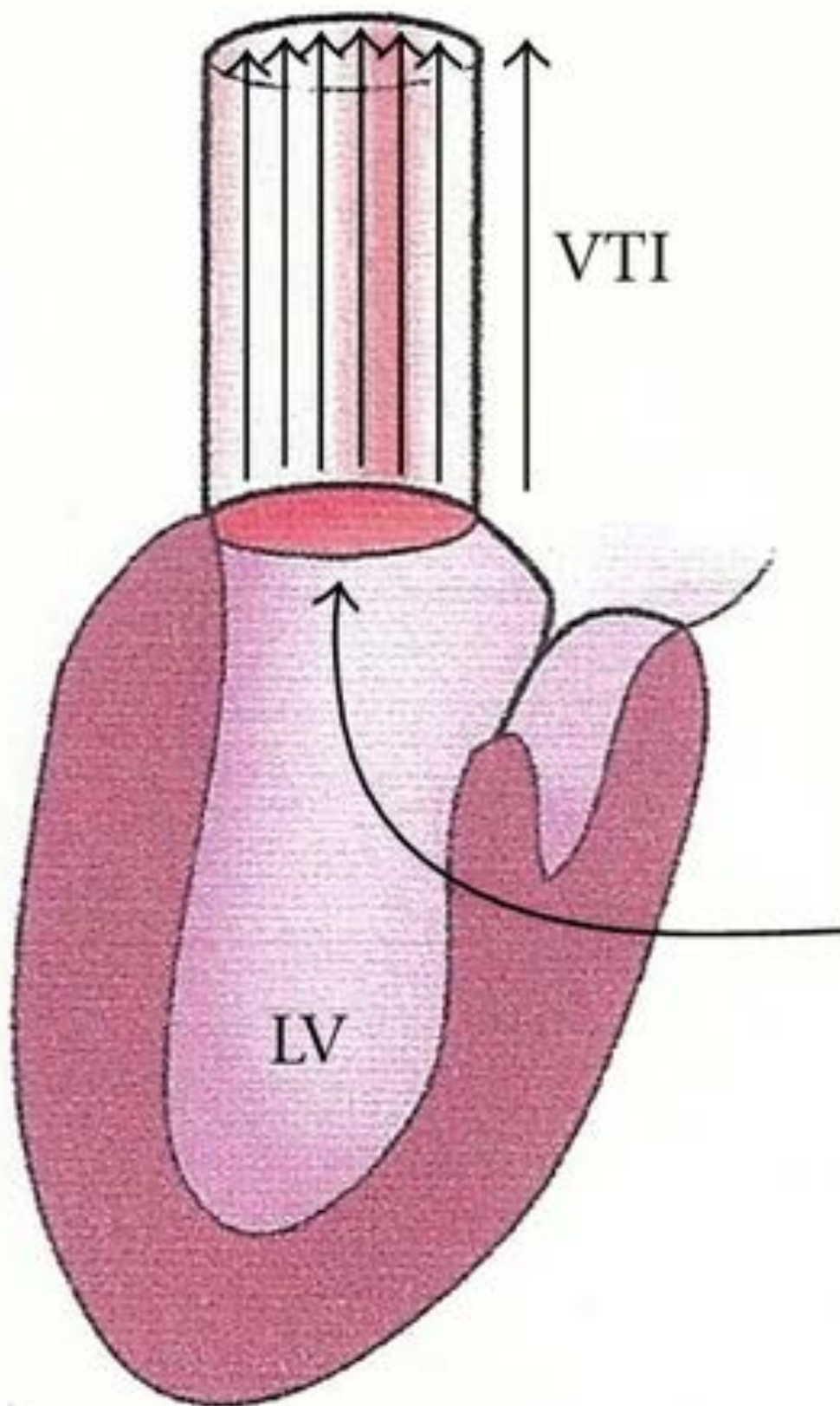
**2D**  
63%  
C 50  
P Off  
HGen



JPEG

164 bpm

# Assessment of LV Output

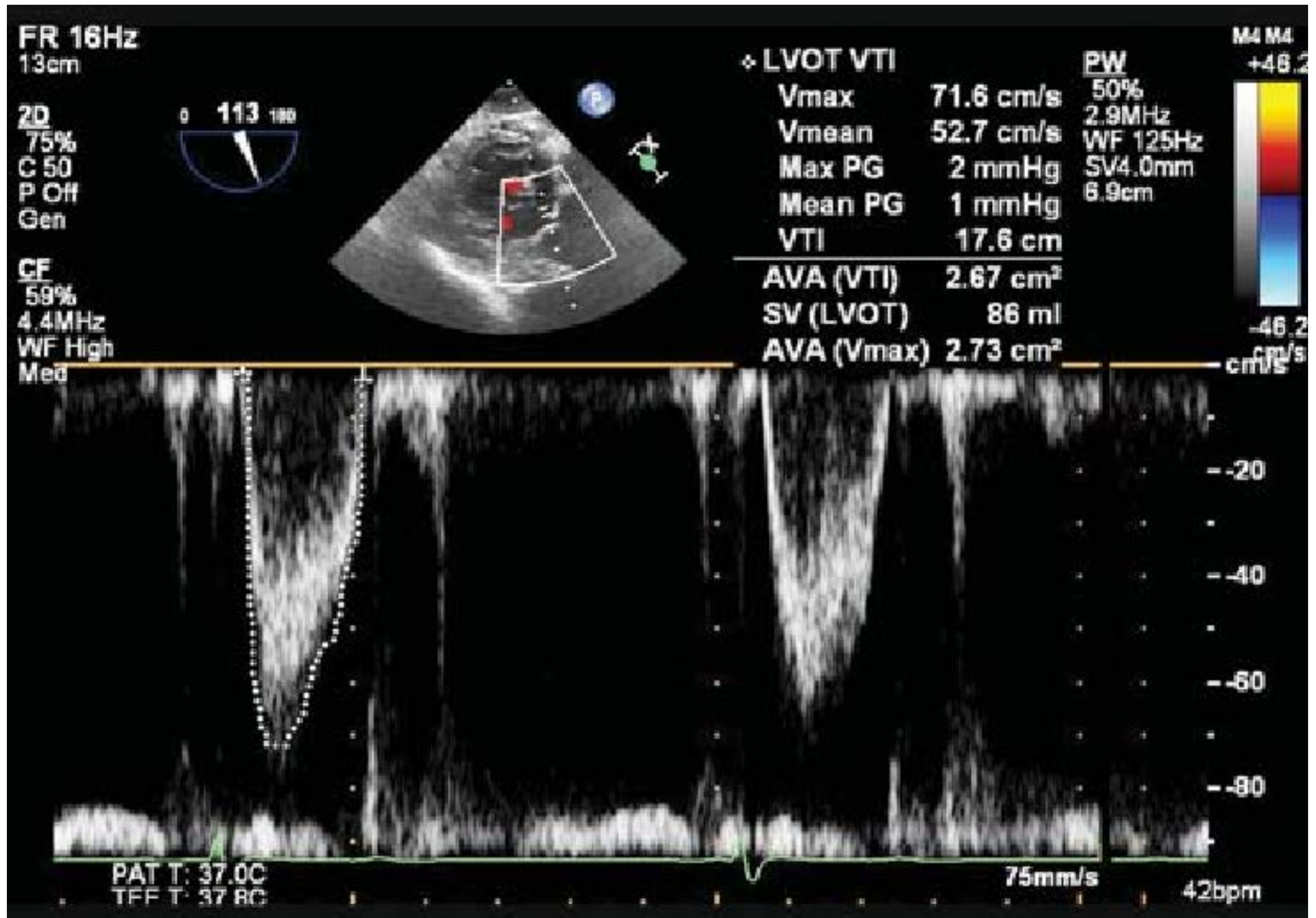


$$\text{CSA (cm}^2\text{)} = 3.14 (D/2)^2$$

$$\text{SV} = \text{CSA} \times \text{VTI}$$



# Assessment of LV Output



# Assessment of RV Function

- Much harder to assess
- Consider:
  - ✴ Size, shape, contractility
  - ✴ RA > LA
  - ✴ Flattened inter-ventricular septum
- Can use tricuspid regurgitation jet to estimate PA pressures

10cm

2D  
77%  
C 50  
P Off  
HGen



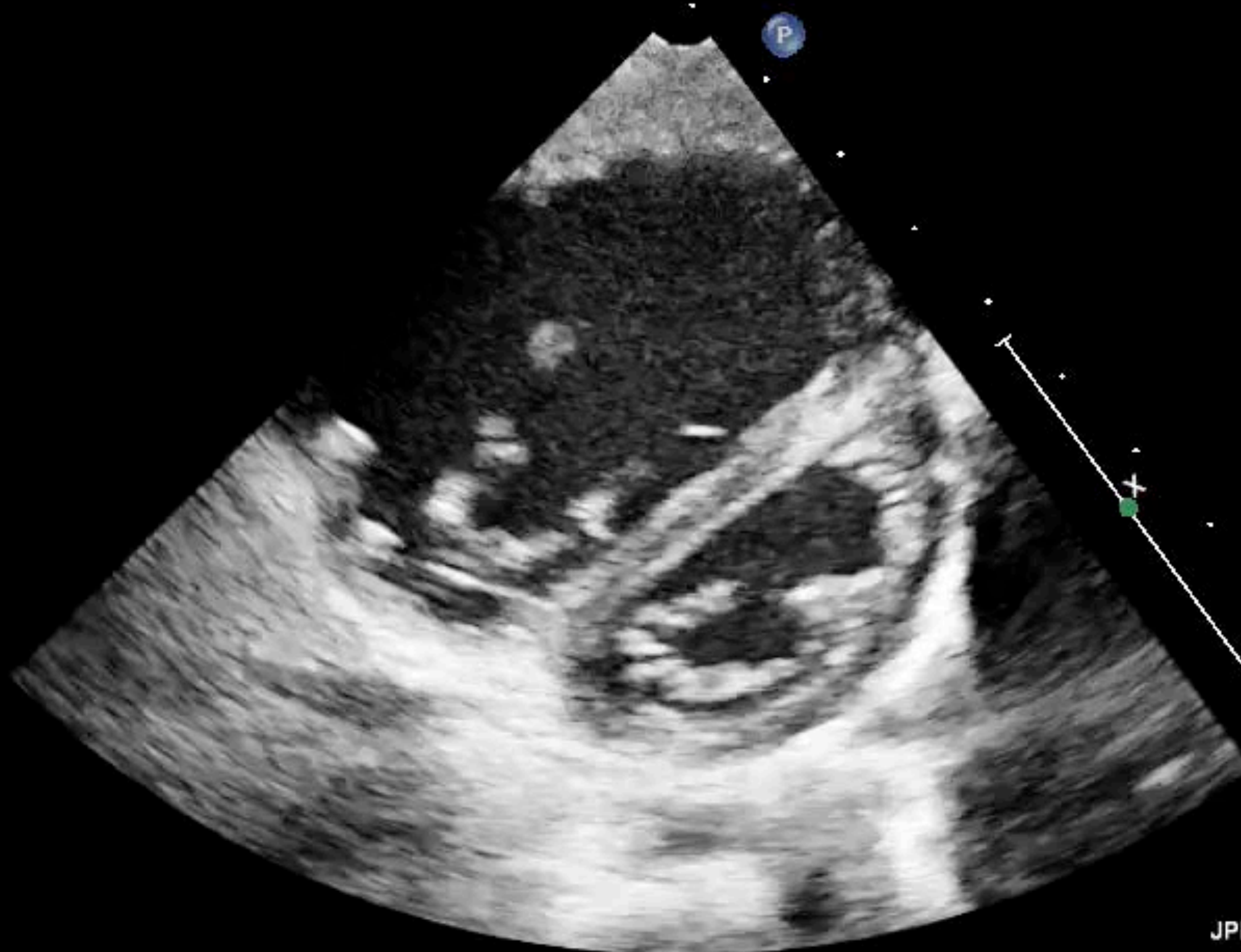
JPEG

138 bpm



9.0cm

**2D**  
77%  
C 50  
P Off  
HGen



JPEG

138 bpm

# Estimating PA Pressures

- PA Peak Systolic Pressures can be estimated by using the peak velocity of the Tricuspid Regurgitation jet

$$\Rightarrow \text{PA Pressure} = 4[\text{TR peak vel}]^2 + \text{RA Pressure}$$

10cm

**2D**

80%

C 50

P Off

HGen

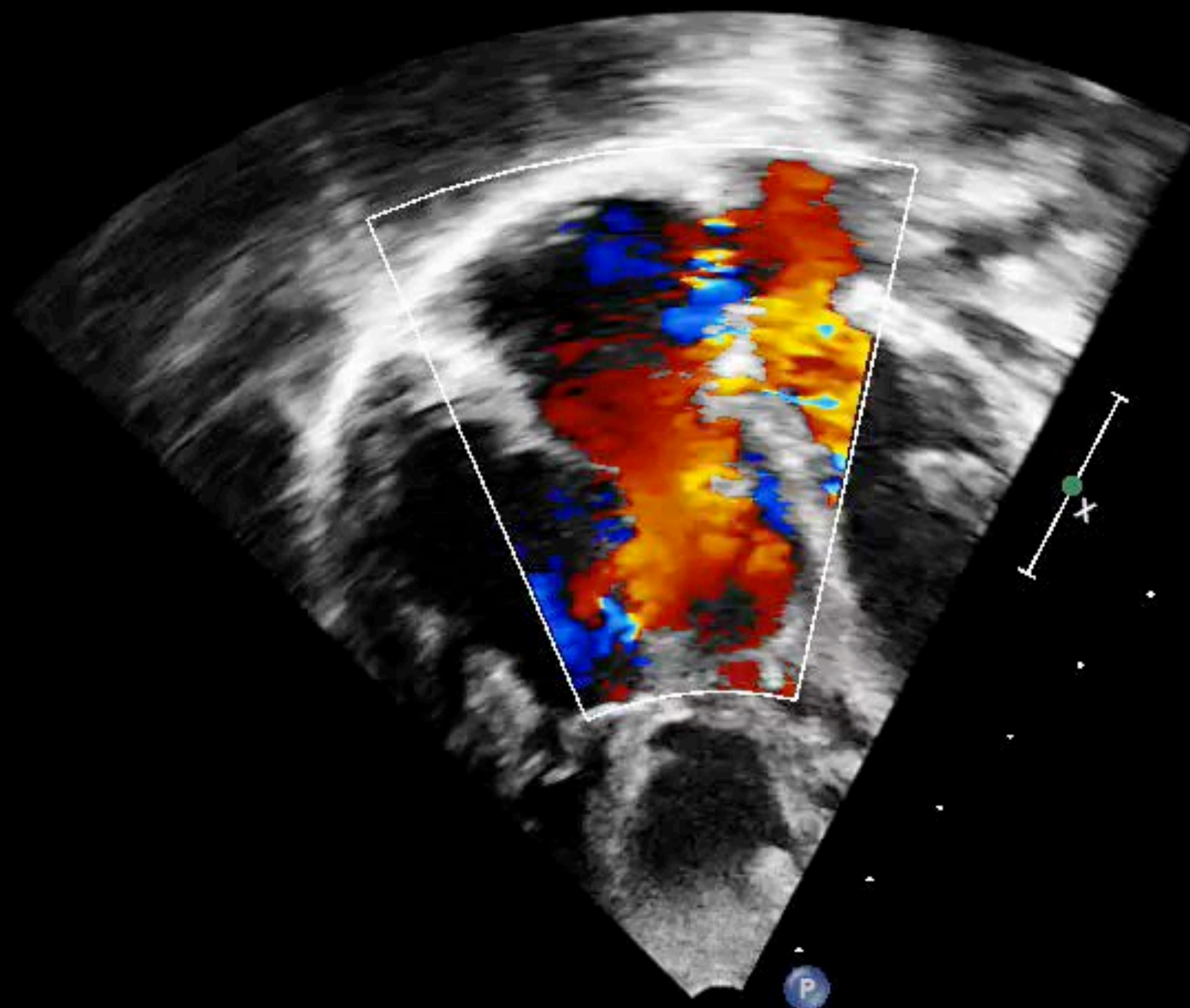
**CF**

77%

3.0MHz

WF High

Med



+63.9

-63.9  
cm/s

JPEG

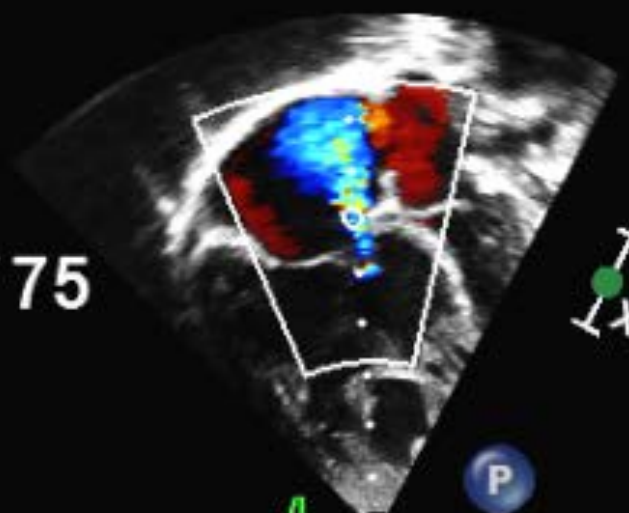
128 bpm



FR 19Hz  
10cm

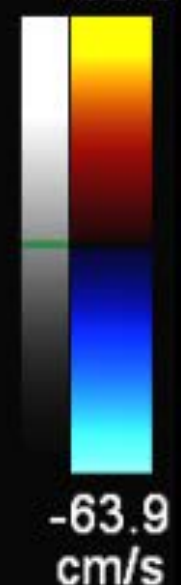
2D  
80%  
C 50  
P Off  
HGen  
CF  
77%  
3.0MHz  
WF High  
Med

BP 111/75

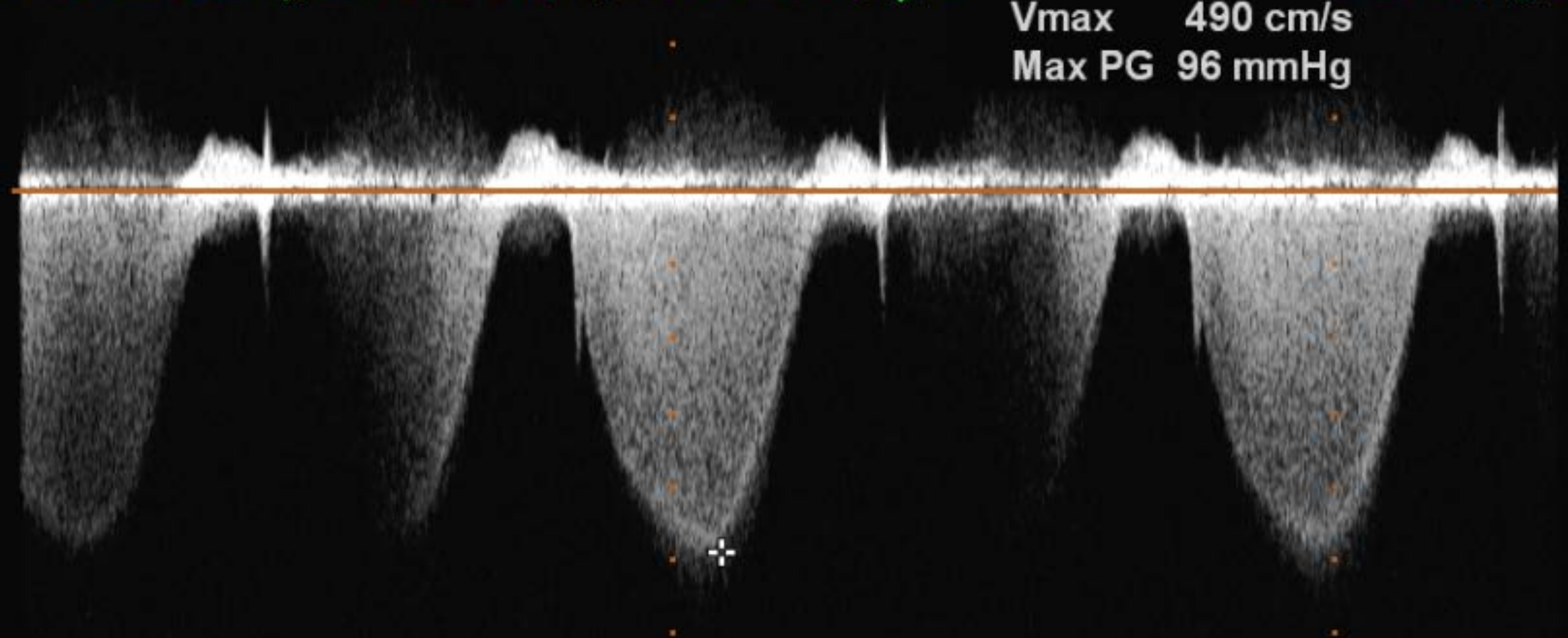


CW  
40%  
3.3MHz  
WF 225Hz

M3 M4  
+63.9



÷ TR Vmax  
Vmax 490 cm/s  
Max PG 96 mmHg



-2.0  
-  
-m/s  
-  
-2.0  
-  
-4.0  
-  
-6.0

100mm/s

129bpm

**Is there a Pericardial  
Effusion or Tamponade?**

# Pericardial Effusion

- Sub-costal view is key position; then apical 4 chamber
- Need to sweep posterior to anterior
- High sensitivity (96% in one study)
- Caution...

➡ *Anterior fat pads*

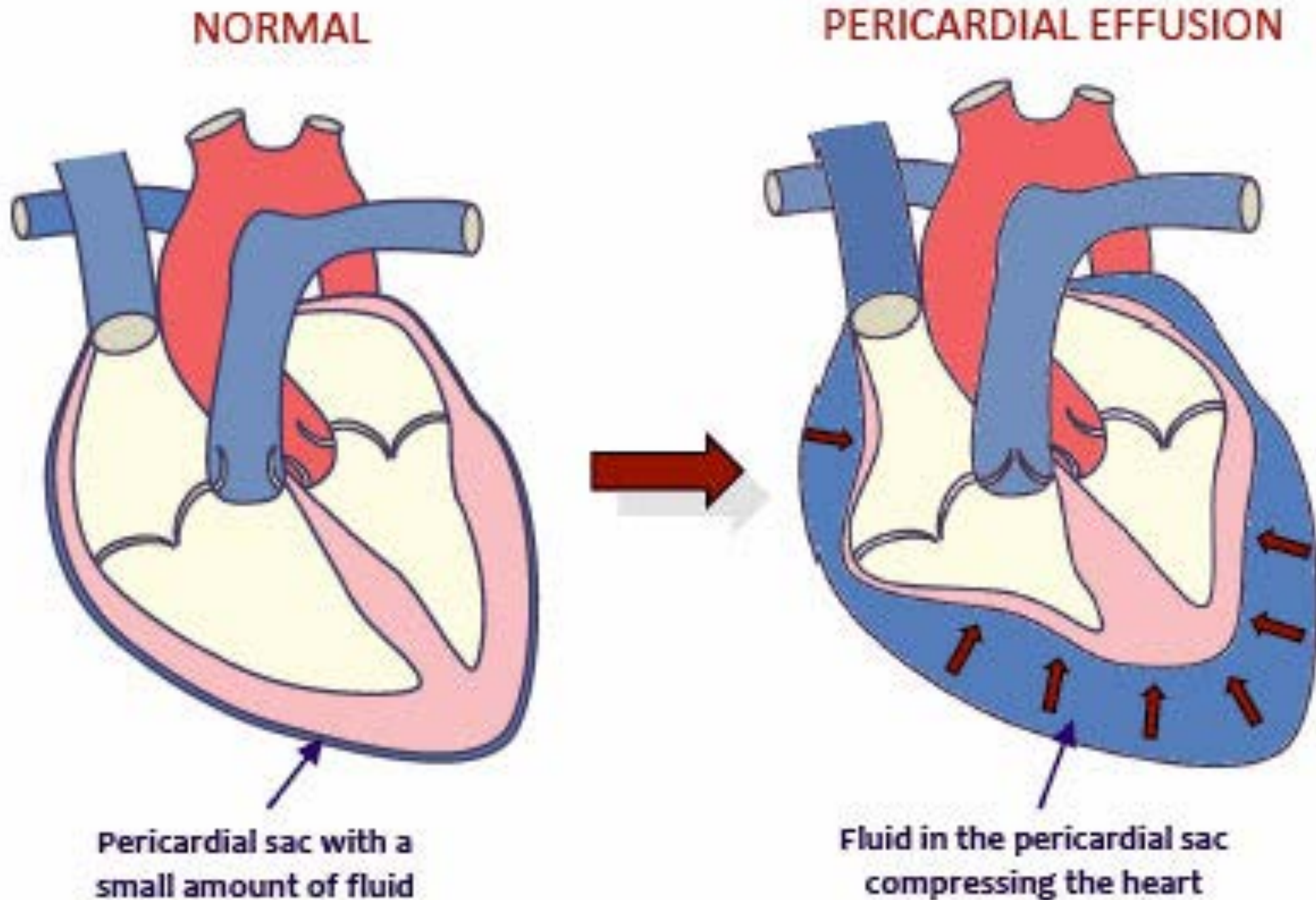
➡ *Clotted blood*

➡ *Tamponade with small or no effusion...*

➡ *Pleural effusions*



# Pericardial Effusion



100mm

**2D**  
69%  
C 50  
P Low  
HGen



P

JPEG

107 bpm

22cm

2D

69%

C 50

P Low

HGen



P

JPEG

110 bpm



7.0cm

**2D**

66%

C 50

P Off

Res



P

JPEG

181 bpm

# Cardiac Tamponade

- Ultrasound features include:
  - ✓ *Right atria & ventricular collapse*
  - ✓ *Reduced chamber filling/size*
  - ✓ *Reduced ventricular function*
  - ✓ *Distended IVC (reduced variability on respiration)*
- Can occur in the absence of pericardial effusion

# Take Home Messages

- Use cardiac POCUS to answer three questions:
  - ✓ *Is the pre-load adequate/well filled heart?*
  - ✓ *Is the heart contracting?*
  - ✓ *Is the heart surrounded by a pericardial effusion?*
- Consider this an alternative stethoscope; use in all shocked children



# ***Any Questions?***



***Thank you!***

michael.griksaitis@uhs.nhs.uk



**@MJGriksaitis**