The Normal Echocardiogram

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Acknowledgments

Dr. Susan Wiegers

Dr. Martin Keane

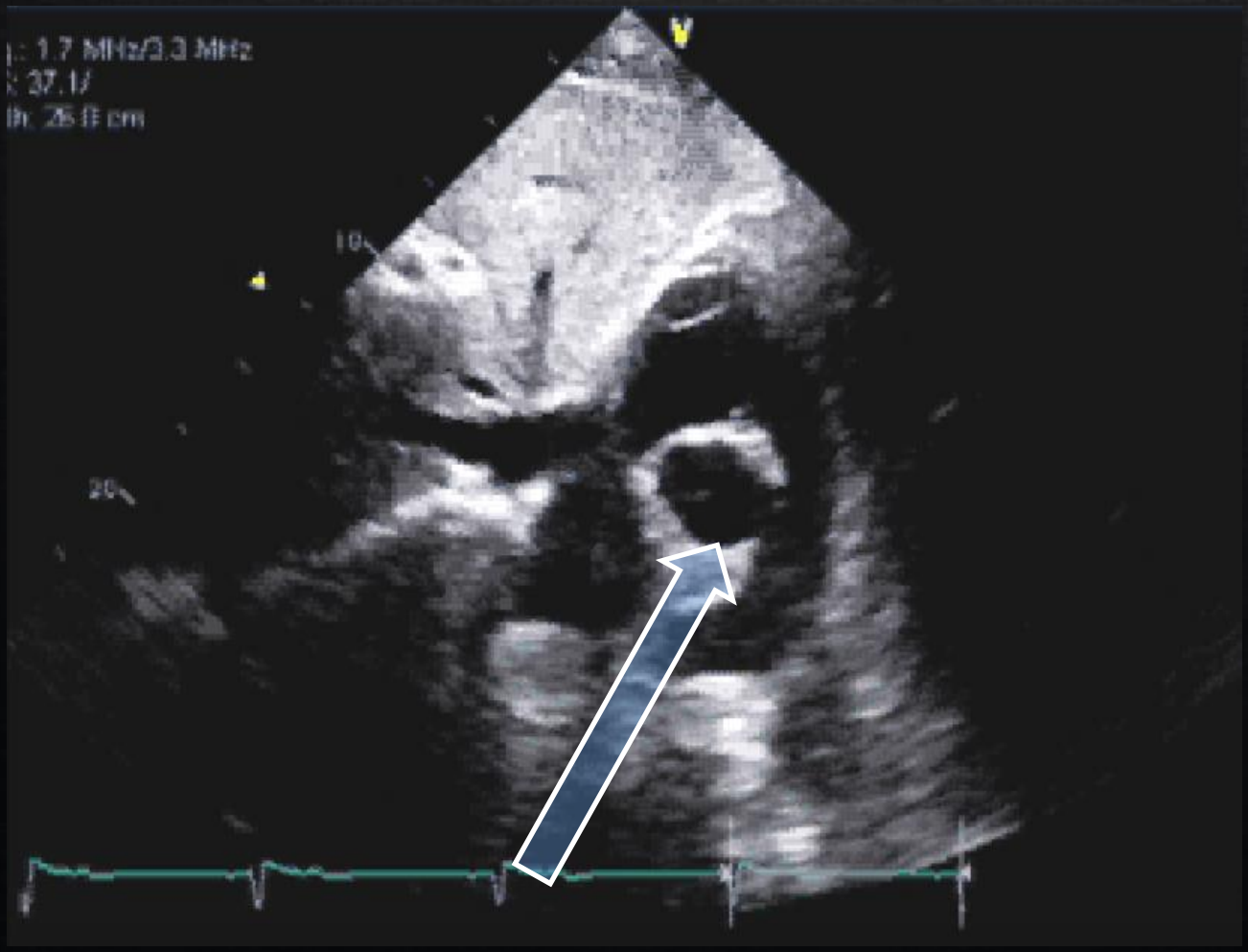
Temple Cardiac Sonographers

Disclosures

- ✓ No relevant financial disclosures

Question 1

Which aortic cusp is noted by the arrow?



A. Right

B. Left

C. Non-Coronary

D. Can't tell

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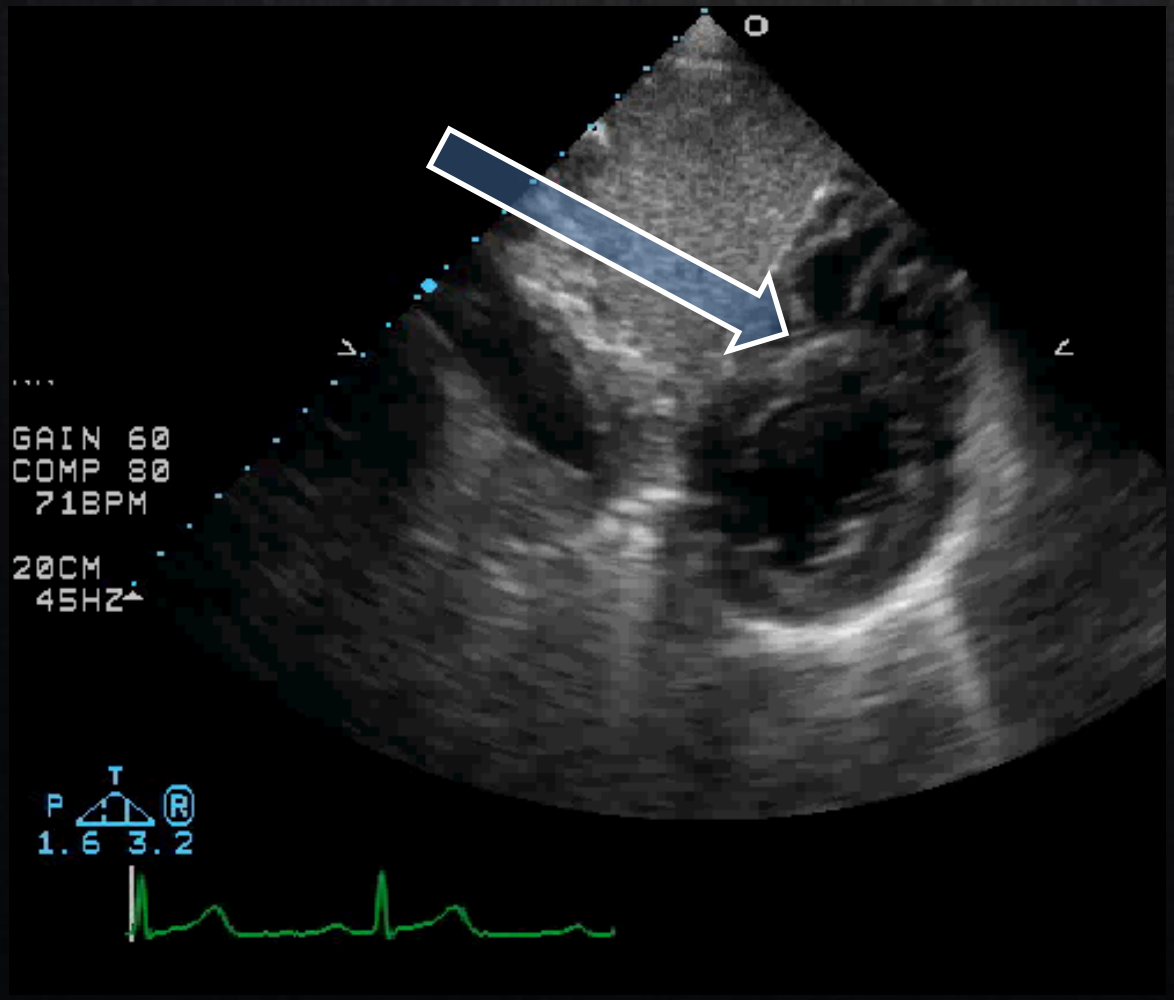
Question 2

- ✓Which myocardial segment is denoted by the arrow?



A. Mid Anterior

B. Mid Anteroseptum

C. Mid Inferoseptum

D. Basal Anteroseptum

E. Mid Inferolateral

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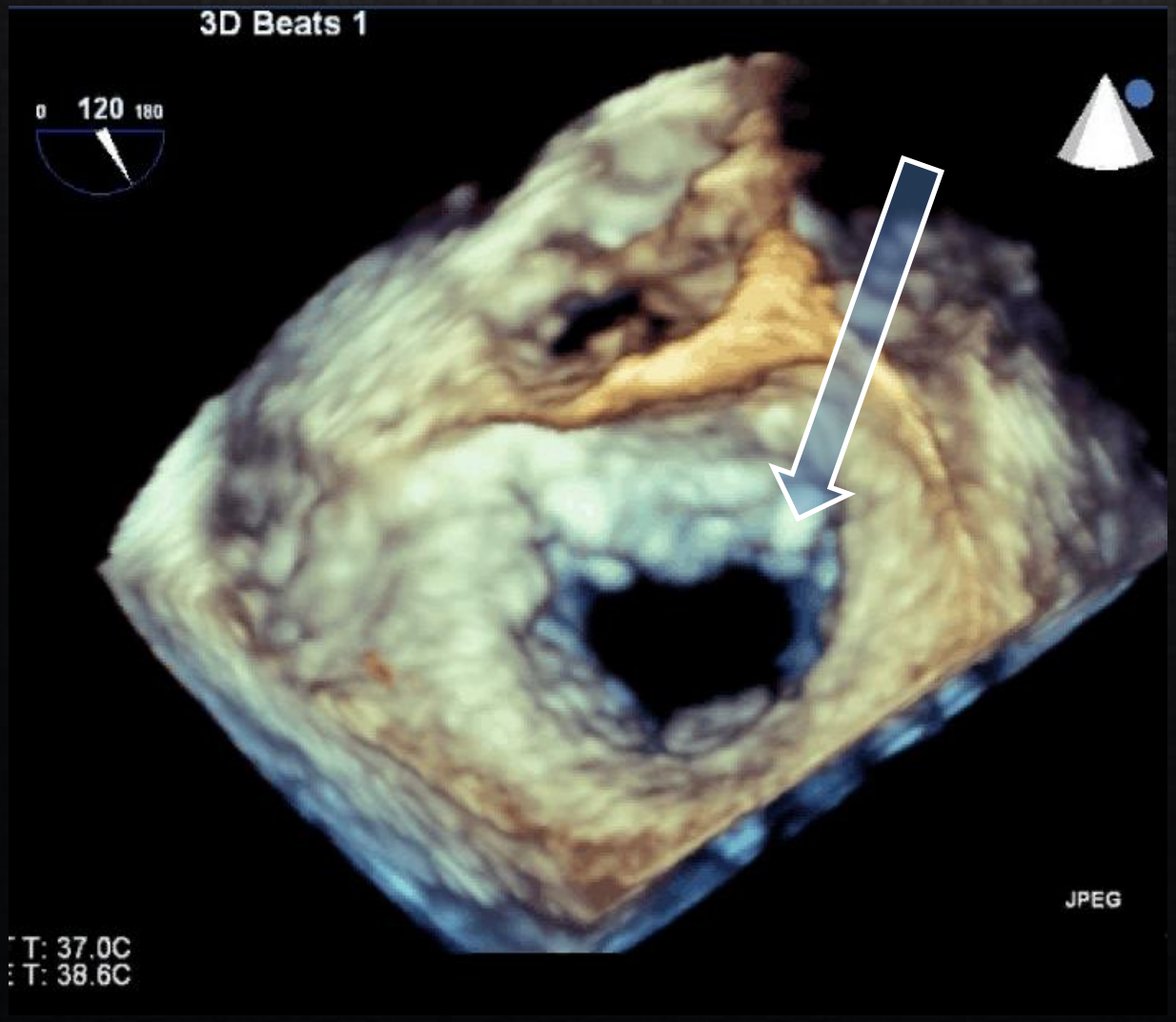
Question 3

Which scallop is noted by the arrow?



A. Non-coronary

B. A2

C. P1

D. A1

E. A3

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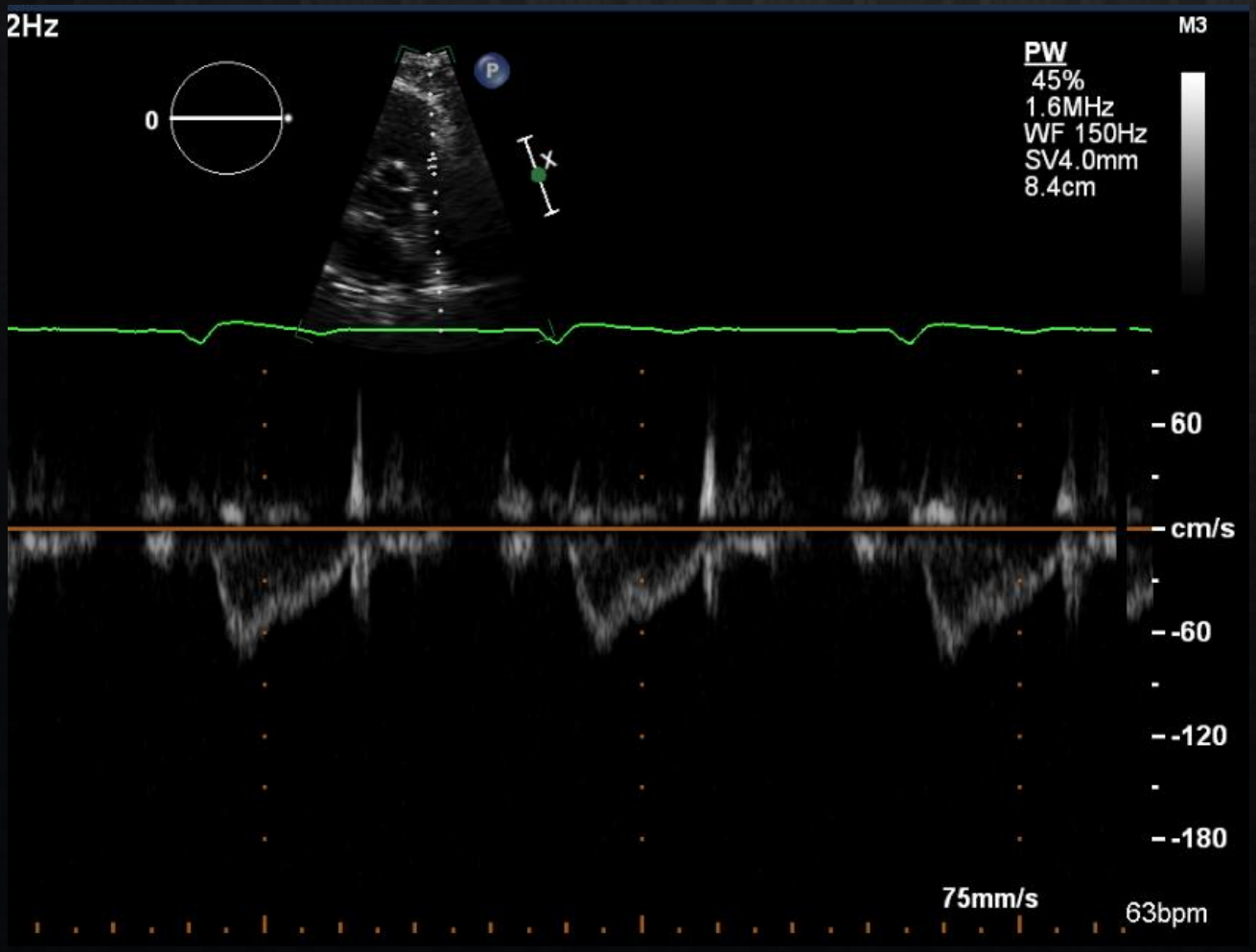
Question 4

How do you optimize this acquisition?



A. Raise baseline

B. Lower baseline

C. Increase scale

D. Decrease scale

E. Pedoff transducer

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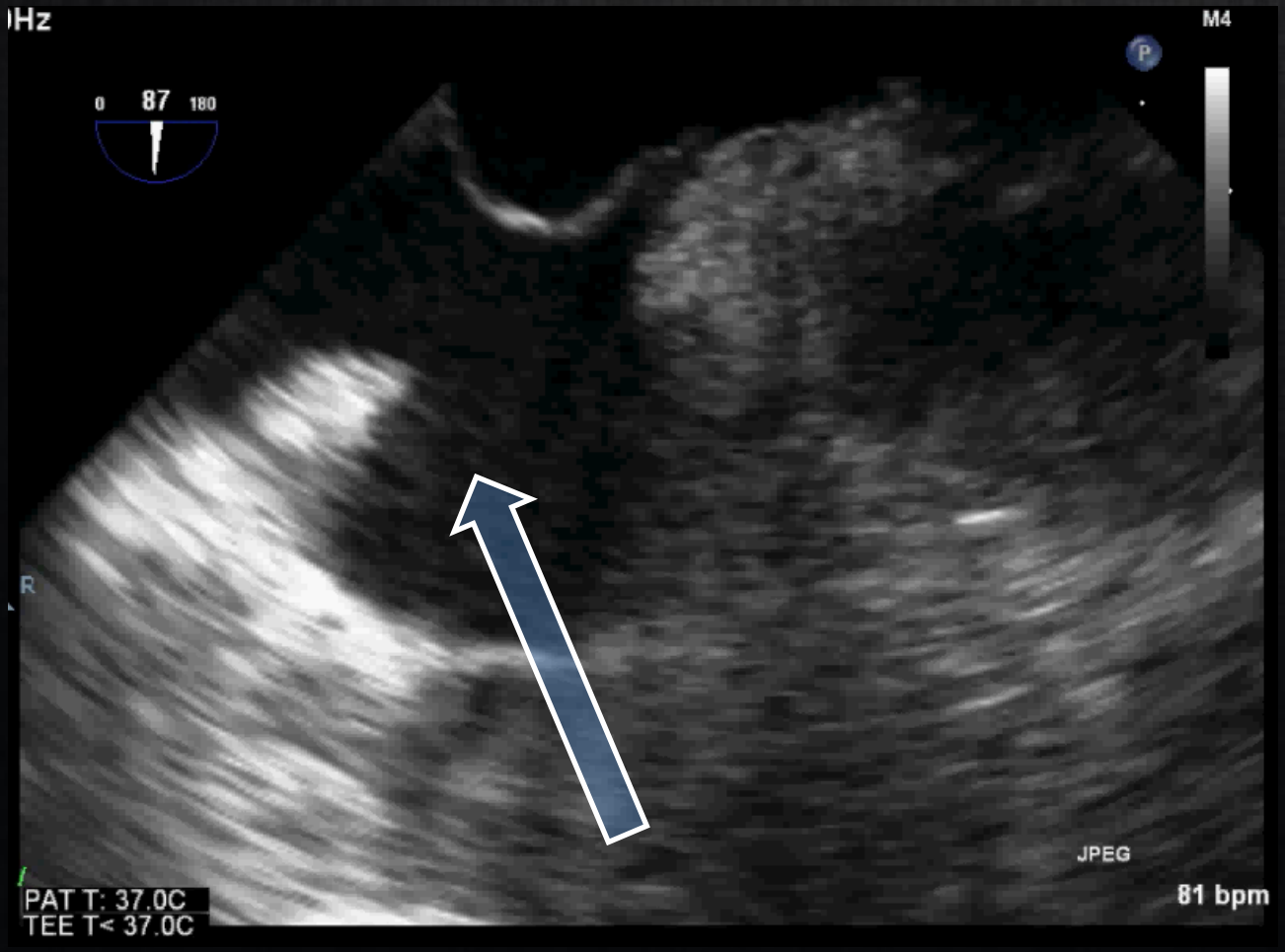
Question 5

What does the arrow indicate?



A. Eustachian Valve

B. RA thrombus

C. Chiari Network

D. Catheter in RA

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Transthoracic Echocardiography

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Normal Echocardiography

Why do we need to review this?

- ✓ Recognize pathology when it exists
- ✓ ASCeXAM
  - Standardized image acquisition
  - Image optimization
  - Anatomic identification
  - Chamber quantification
  - "Less known" normal structures
  - AUC/Indications/Contraindications

Appropriate Use Criteria

- ✓ Appropriate Use Criteria for Echocardiography
  - J Am Soc Echocardiogr 2011;24:229-267

	Indication	Appropriate use score (1–9)
	Murmur or Click With TTE	
34.	• Initial evaluation when there is a reasonable suspicion of valvular or structural heart disease	A (9)
35.	• Initial evaluation when there are no other symptoms or signs of valvular or structural heart disease	I (2)
36.	• Re-evaluation in a patient without valvular disease on prior echocardiogram and no change in clinical status or cardiac exam	I (1)
37.	• Re-evaluation of known valvular heart disease with a change in clinical status or cardiac exam or to guide therapy	A (9)
	Native Valvular Stenosis With TTE	
38.	• Routine surveillance (<3 y) of mild valvular stenosis without a change in clinical status or cardiac exam	I (3)
39.	• Routine surveillance (≥3 y) of mild valvular stenosis without a change in clinical status or cardiac exam	A (7)
40.	• Routine surveillance (<1 y) of moderate or severe valvular stenosis without a change in clinical status or cardiac exam	I (3)
41.	• Routine surveillance (≥1 y) of moderate or severe valvular stenosis without a change in clinical status or cardiac exam	A (8)

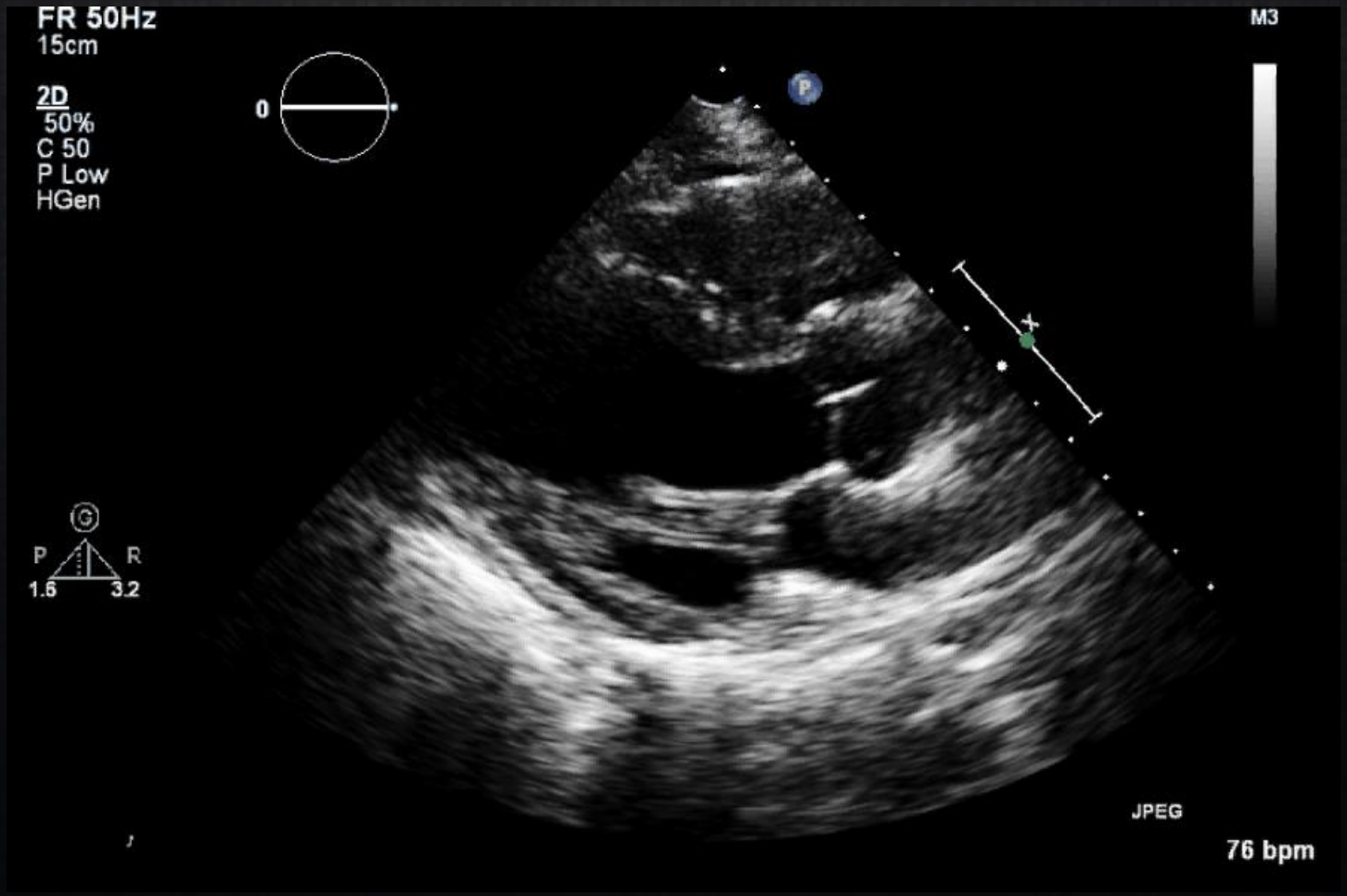
TEE Guidelines

- ✓ TEE Indications & Contraindications
  - J Am Soc Echocardiogr 2013;26:921-964

Table 6 List of absolute and relative contraindications to transesophageal echocardiography

Absolute contraindications	Relative contraindications
• Perforated viscus • Esophageal stricture • Esophageal tumor • Esophageal perforation, laceration • Esophageal diverticulum • Active upper GI bleed	• History of radiation to neck and mediastinum • History of GI surgery • Recent upper GI bleed • Barrett's esophagus • History of dysphagia • Restriction of neck mobility (severe cervical arthritis, atlantoaxial joint disease) • Symptomatic hiatal hernia • Esophageal varices • Coagulopathy, thrombocytopenia • Active esophagitis • Active peptic ulcer disease

Parasternal Long Axis



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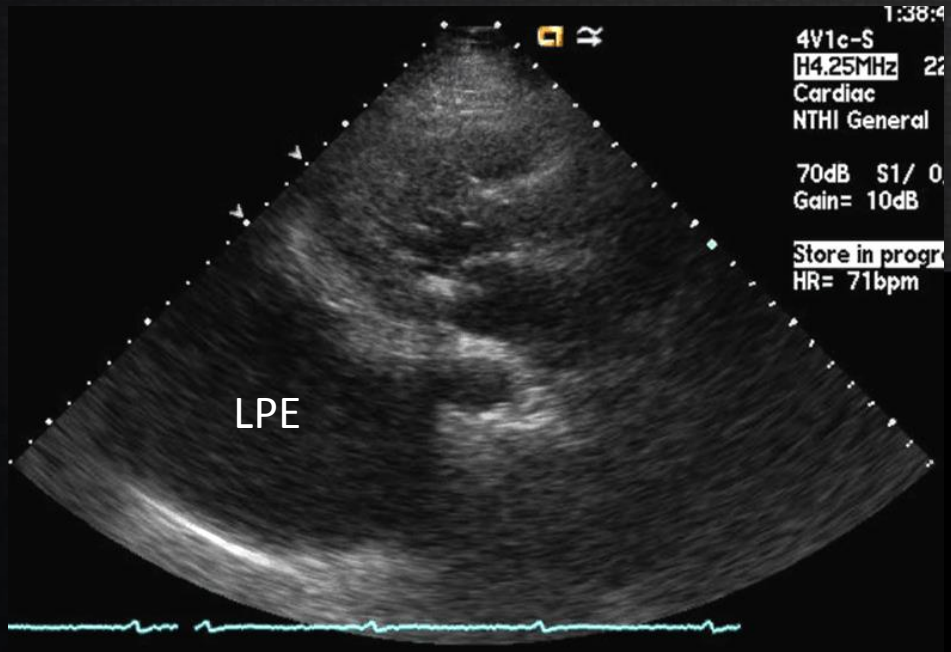
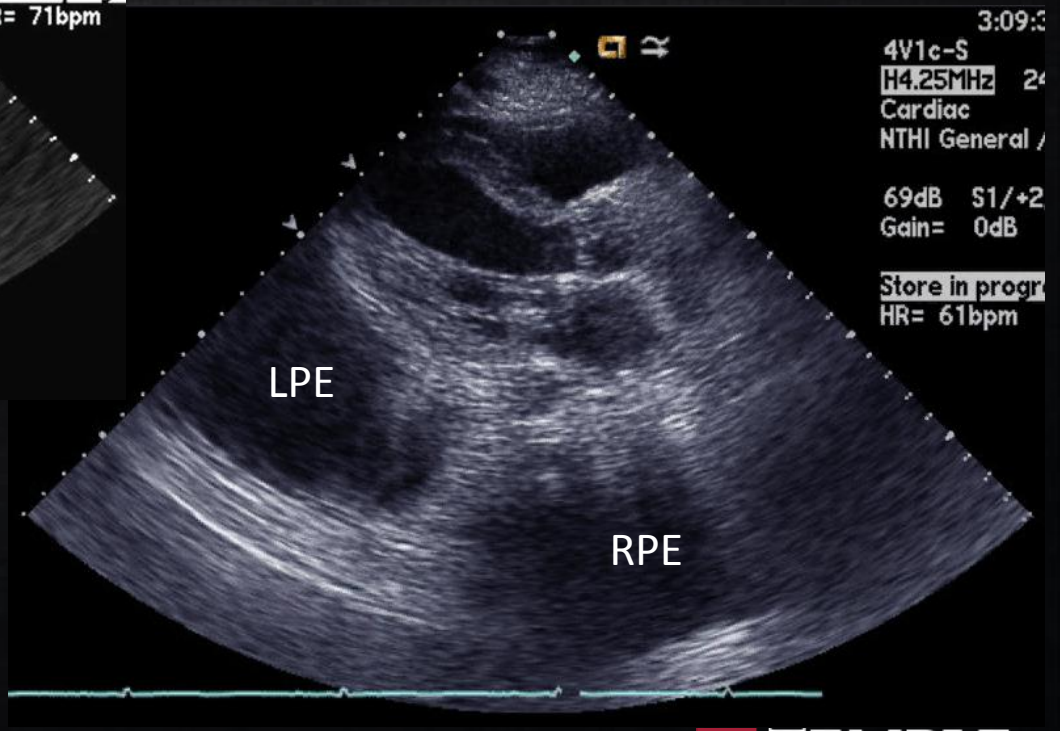
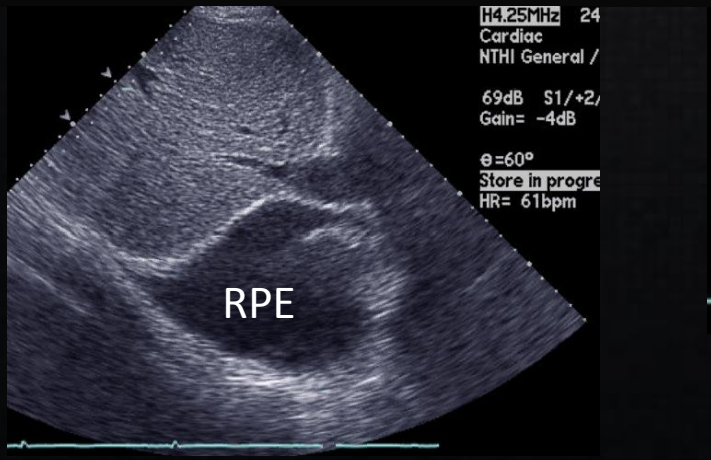
Depth Matters…







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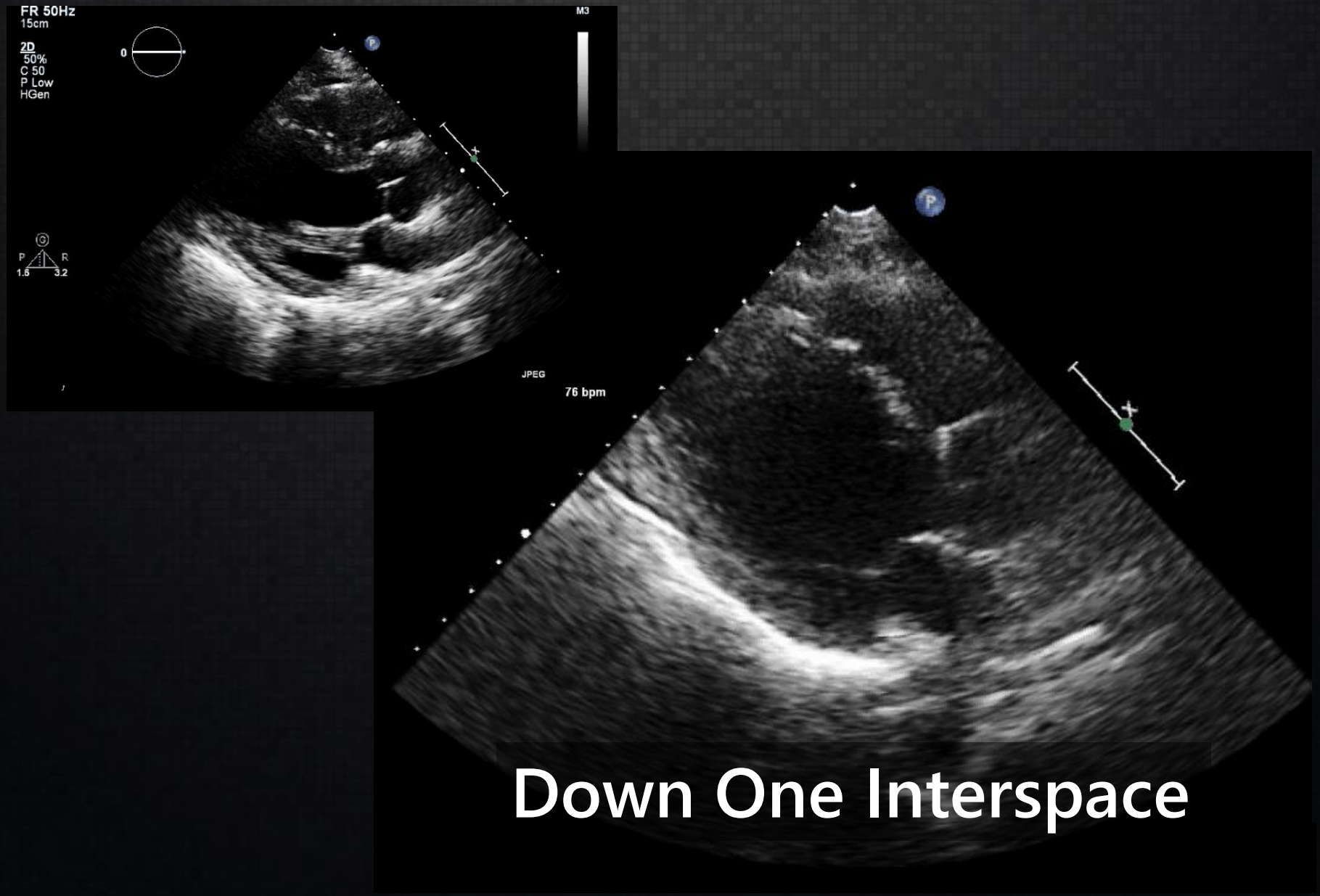
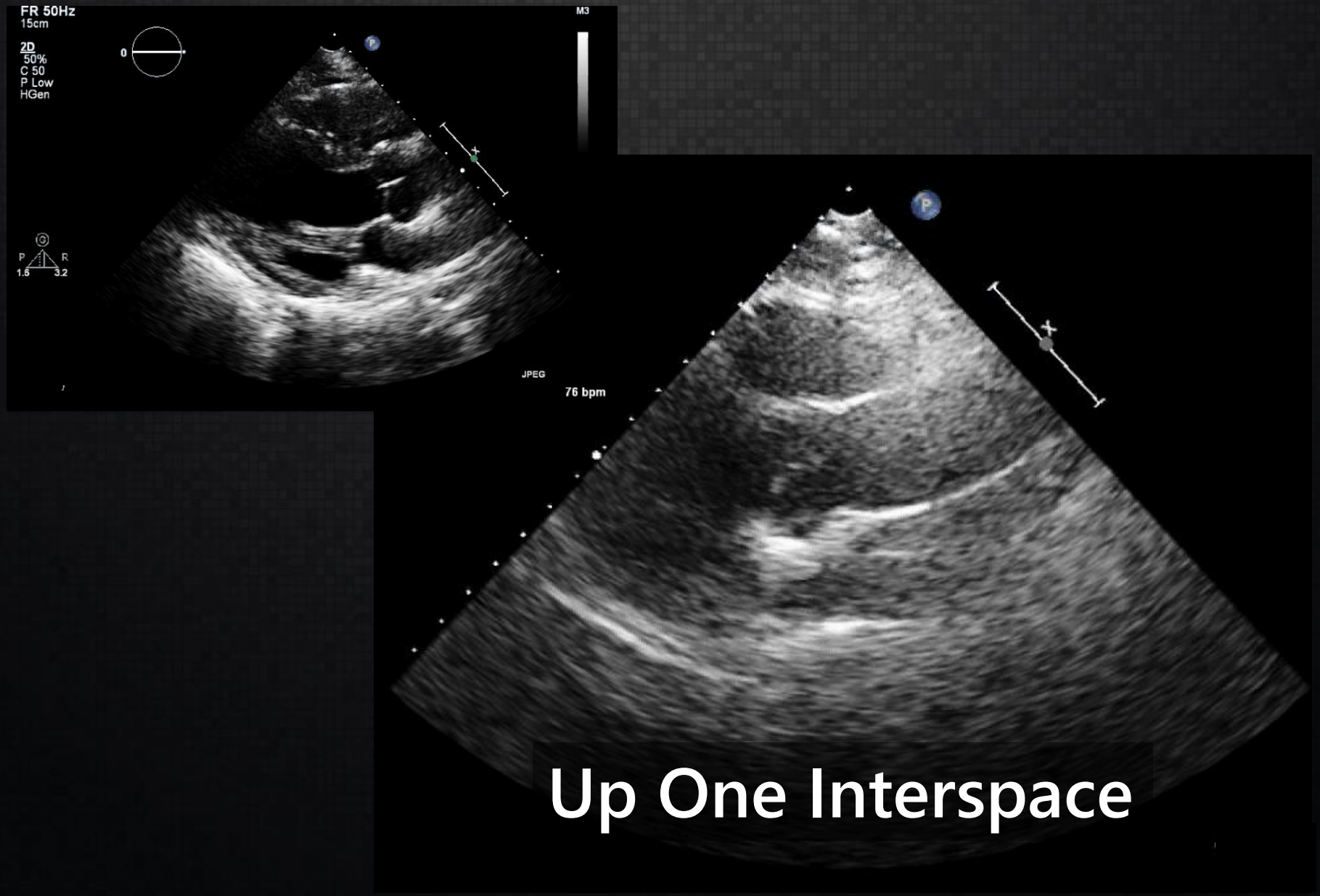


Down One Interspace



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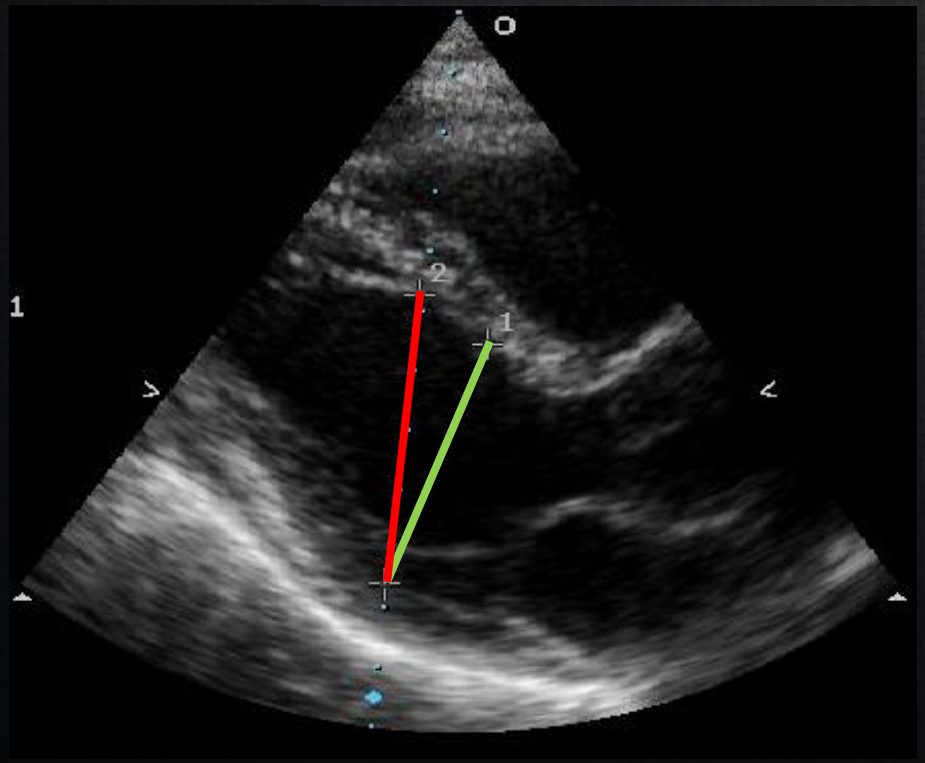
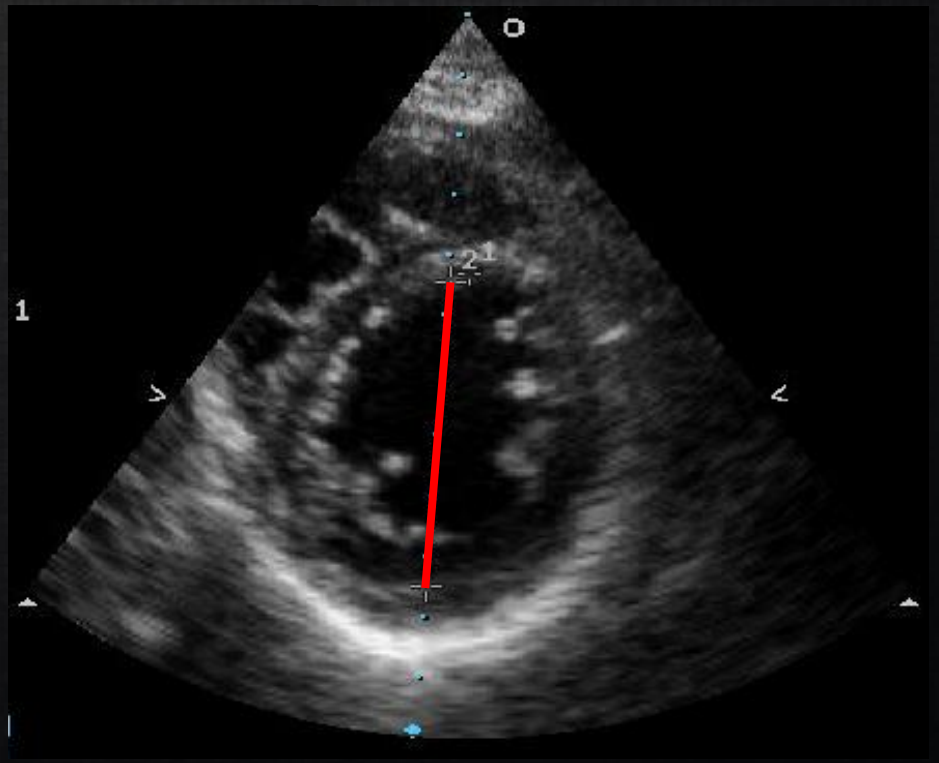
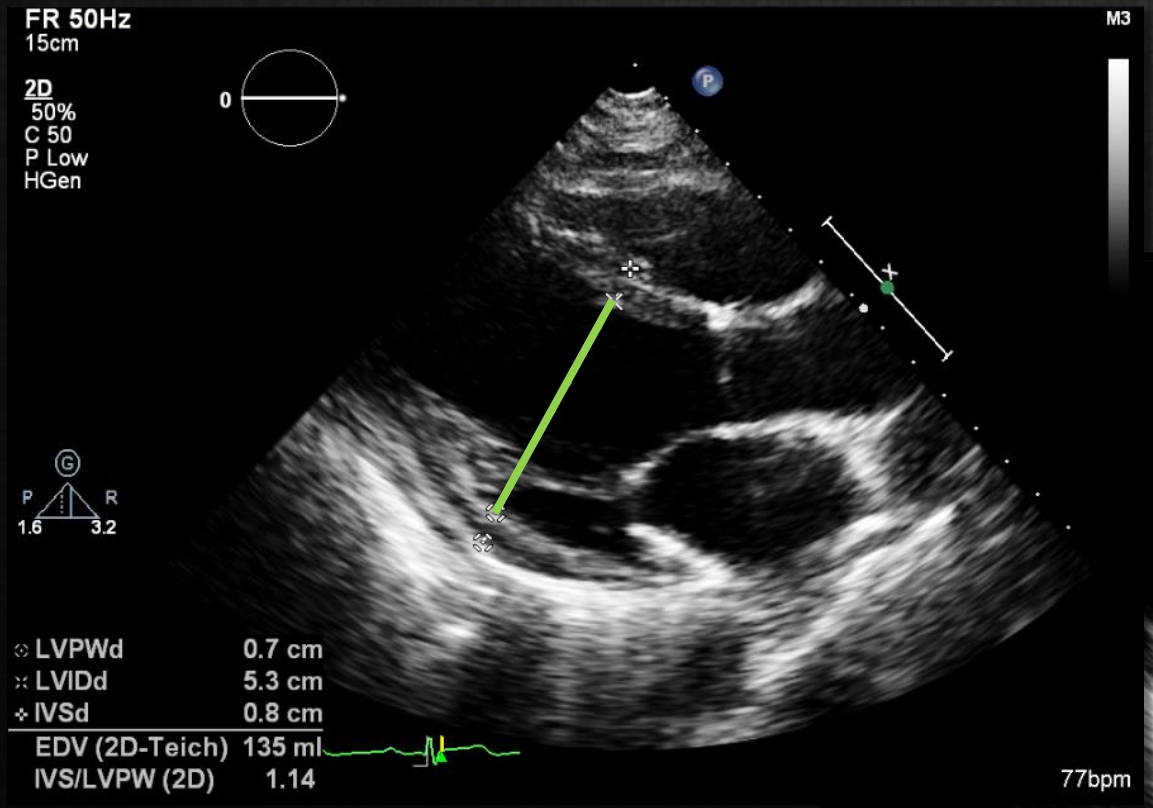
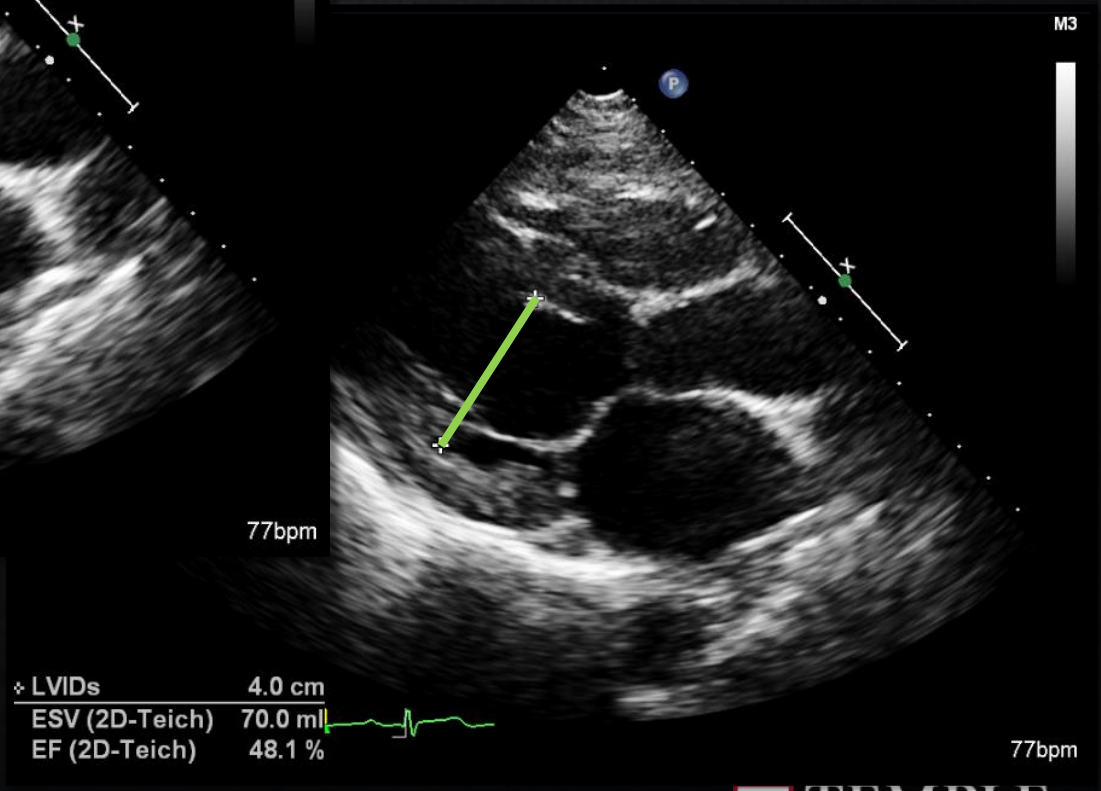
Off-Axis Measurements





On-Axis Measurements





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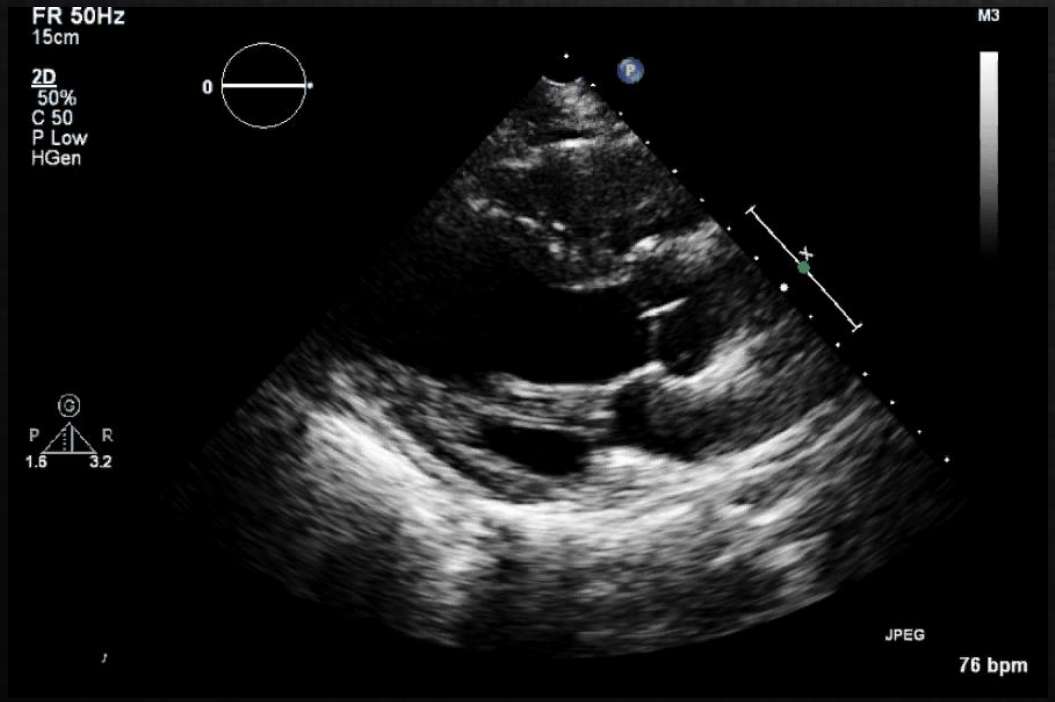
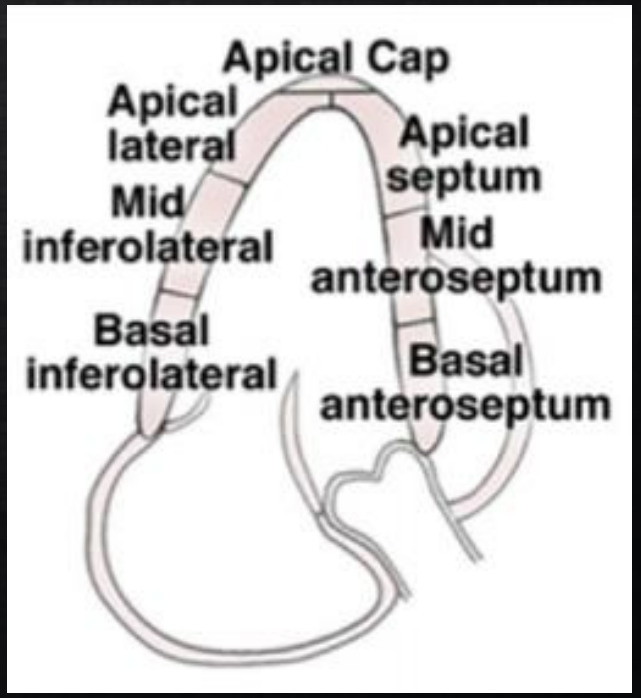
ASE/AHA 17 Segment Model





ASE Chamber Quant Guidelines, JASE 2015

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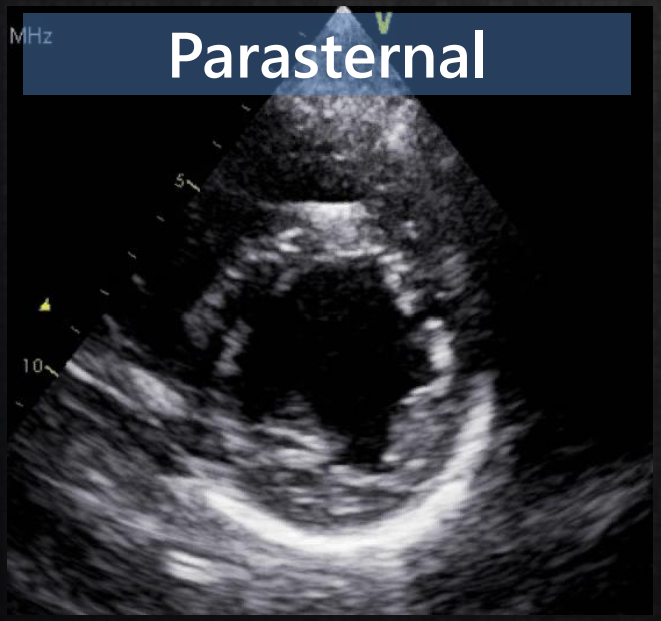
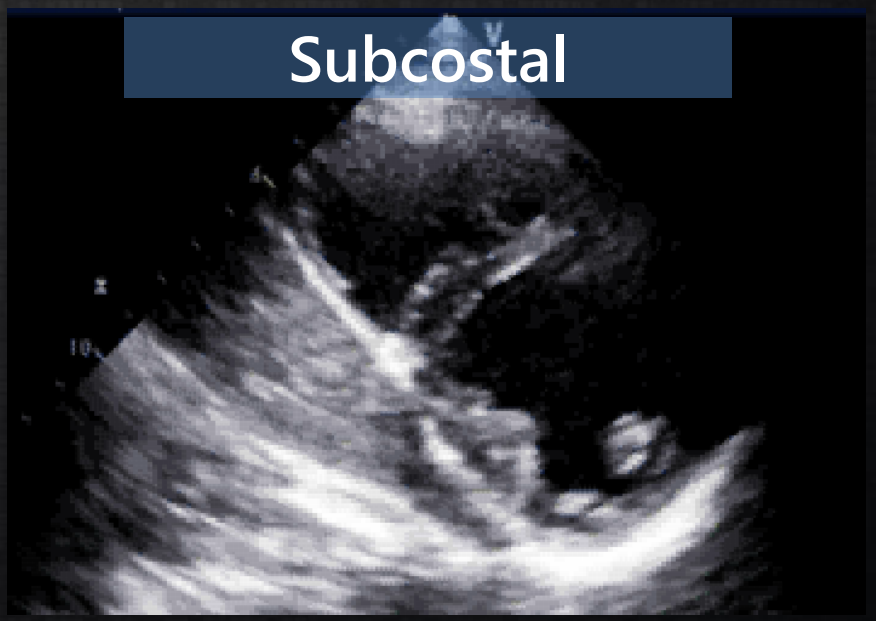
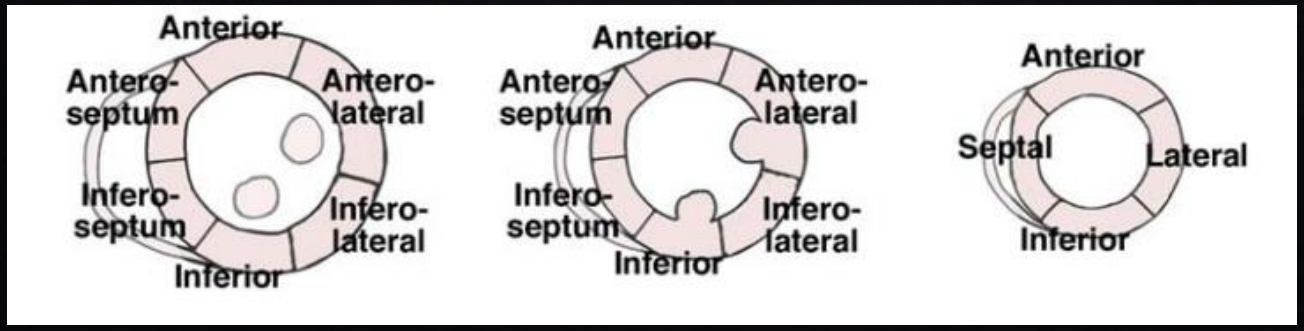
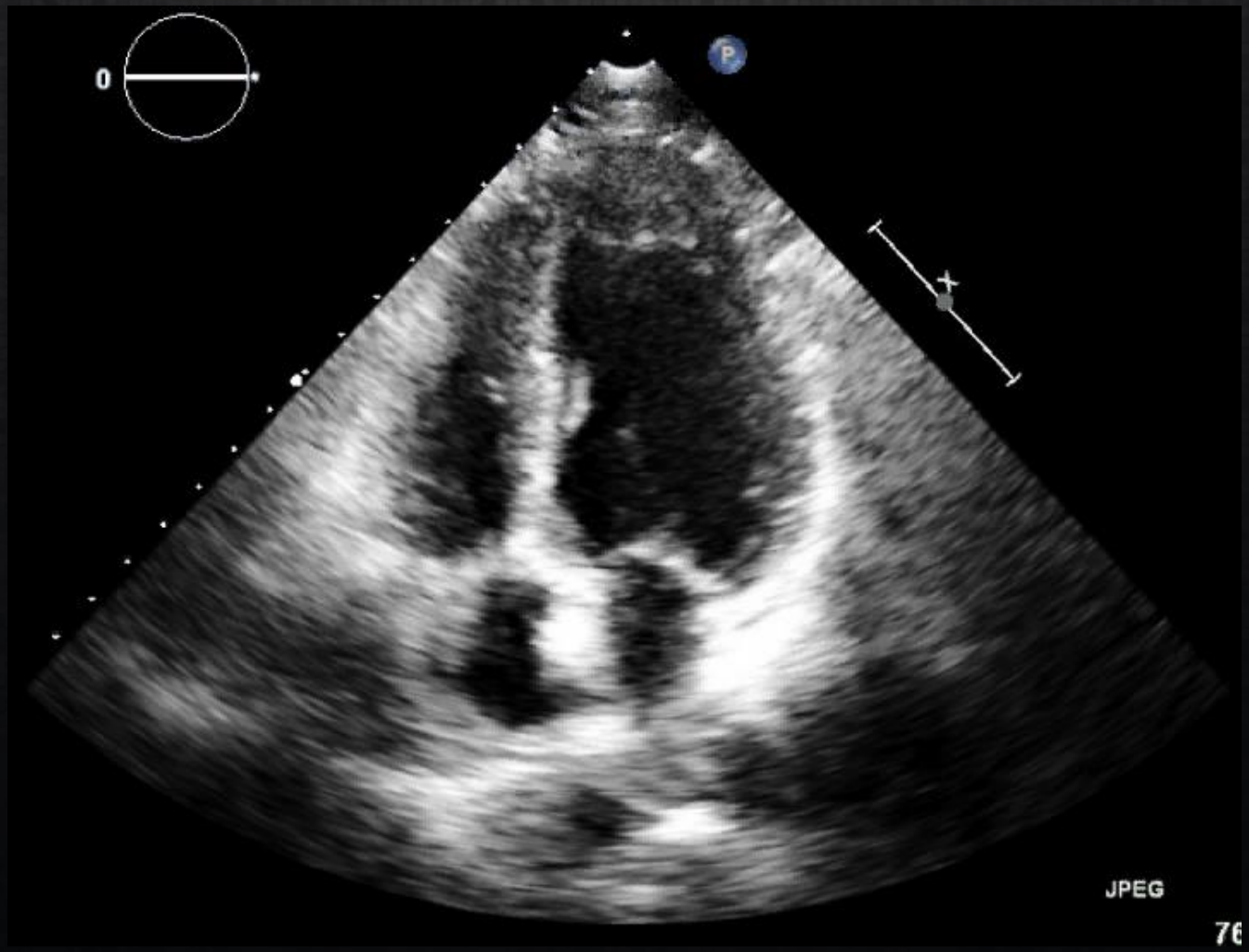
Short Axis LV







Apical Four Chamber



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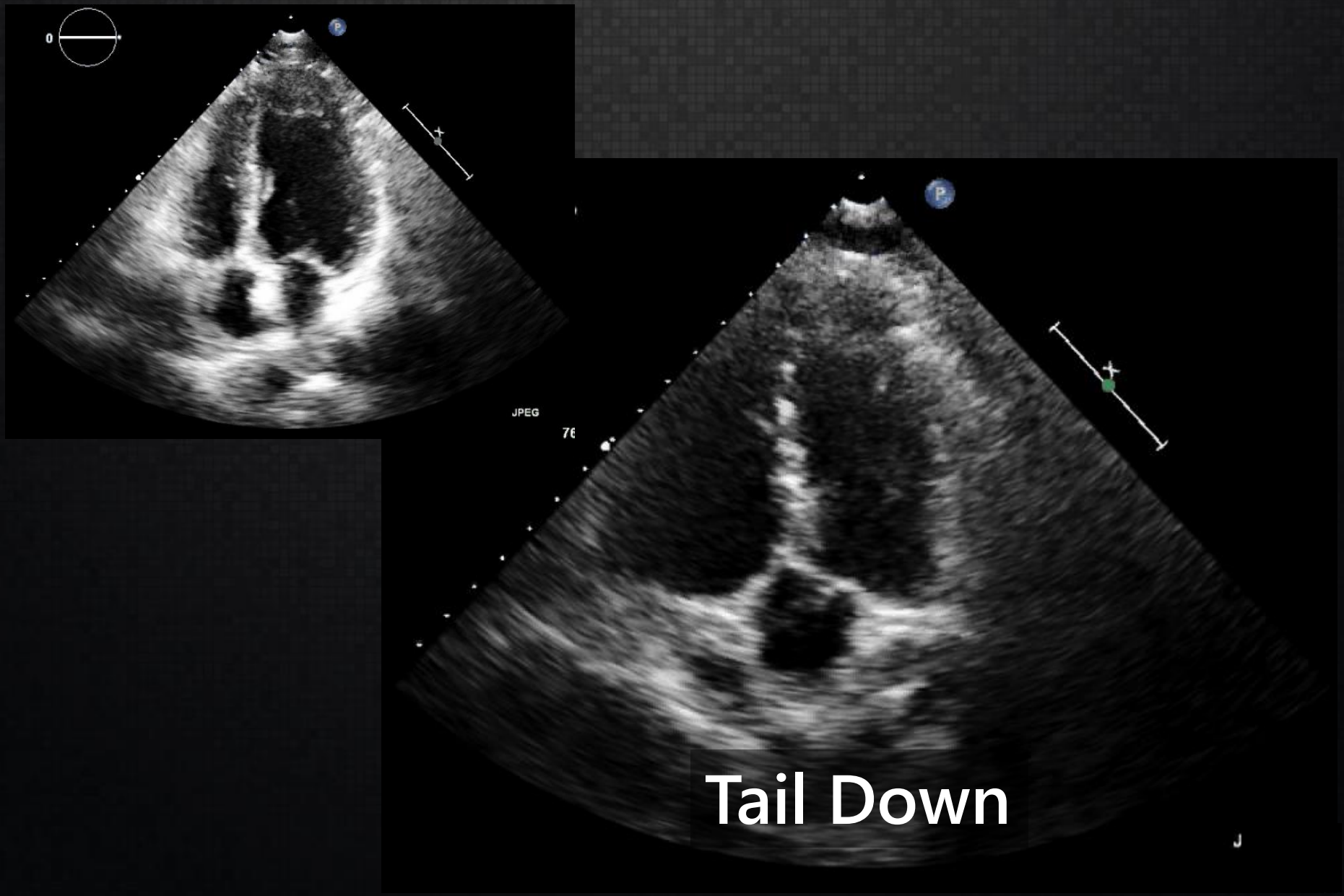

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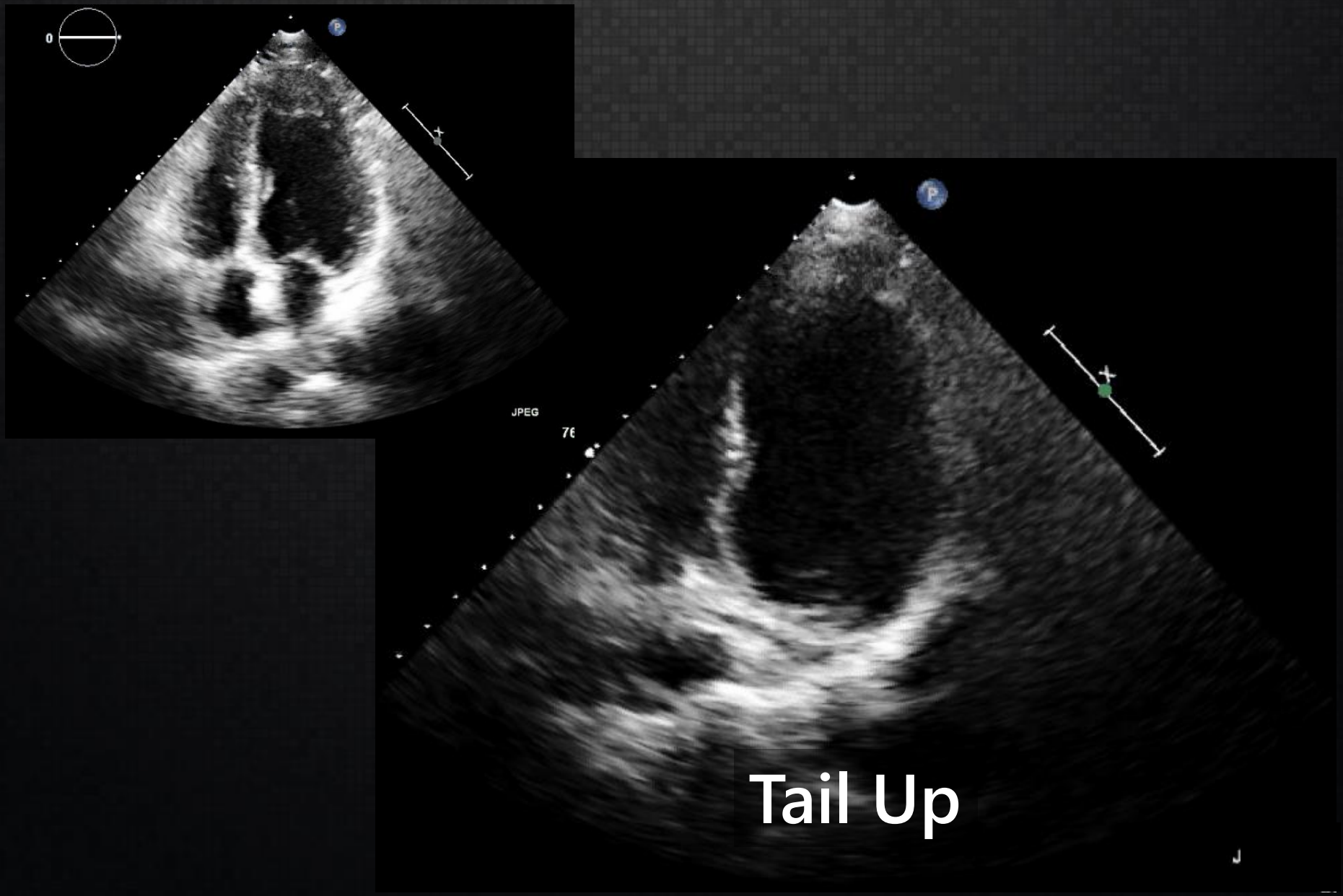

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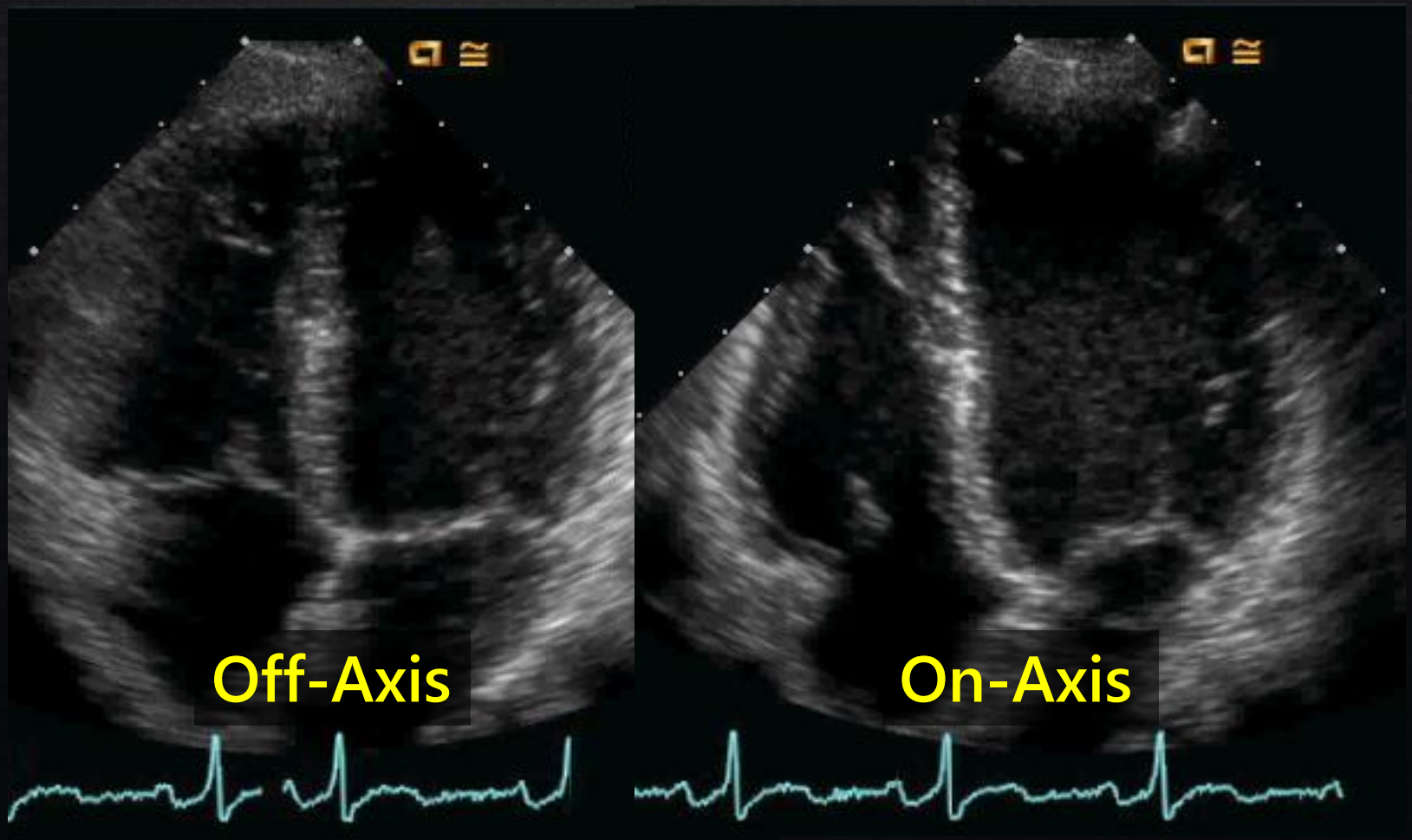
Apical 4 Chamber



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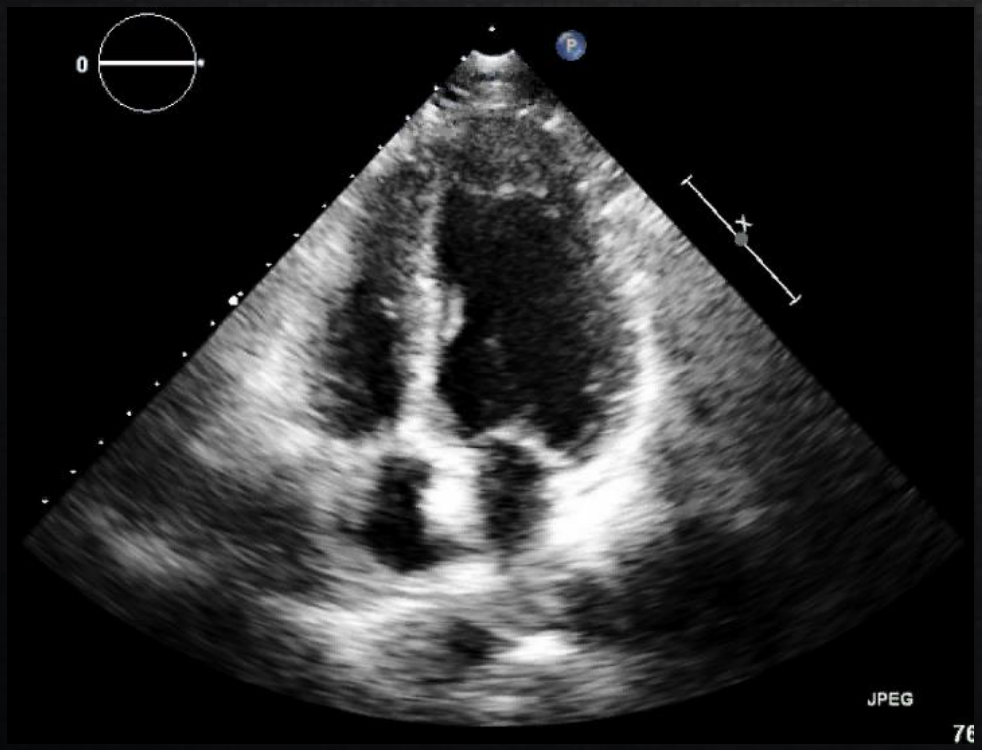

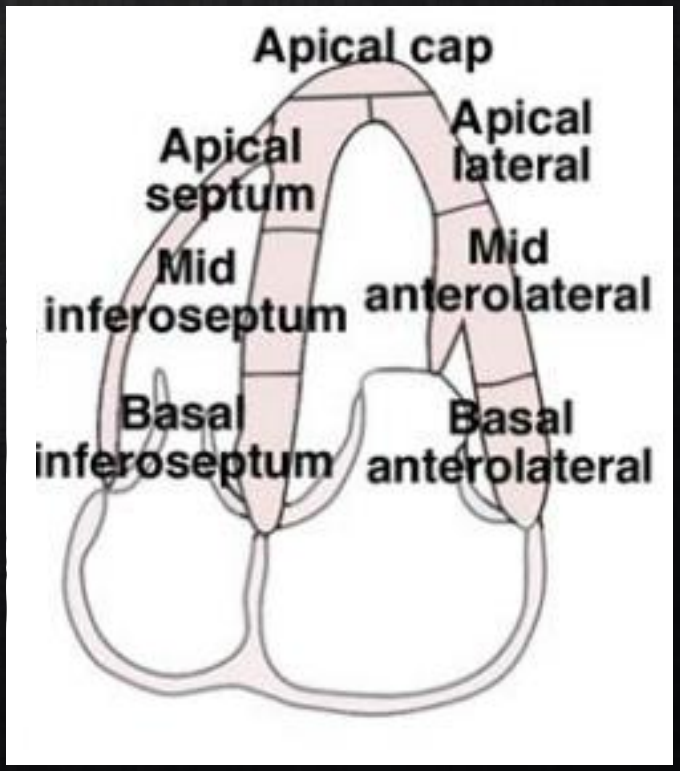

ASE Chamber Quant Guidelines, JASE 2015

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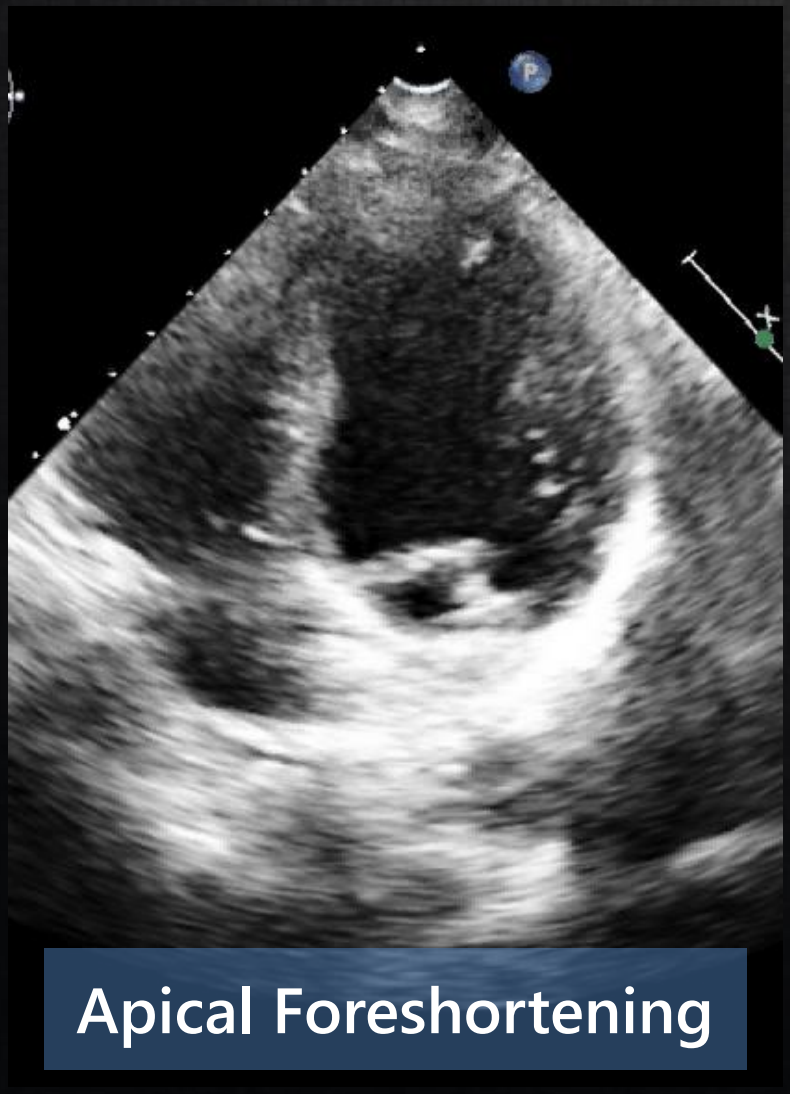
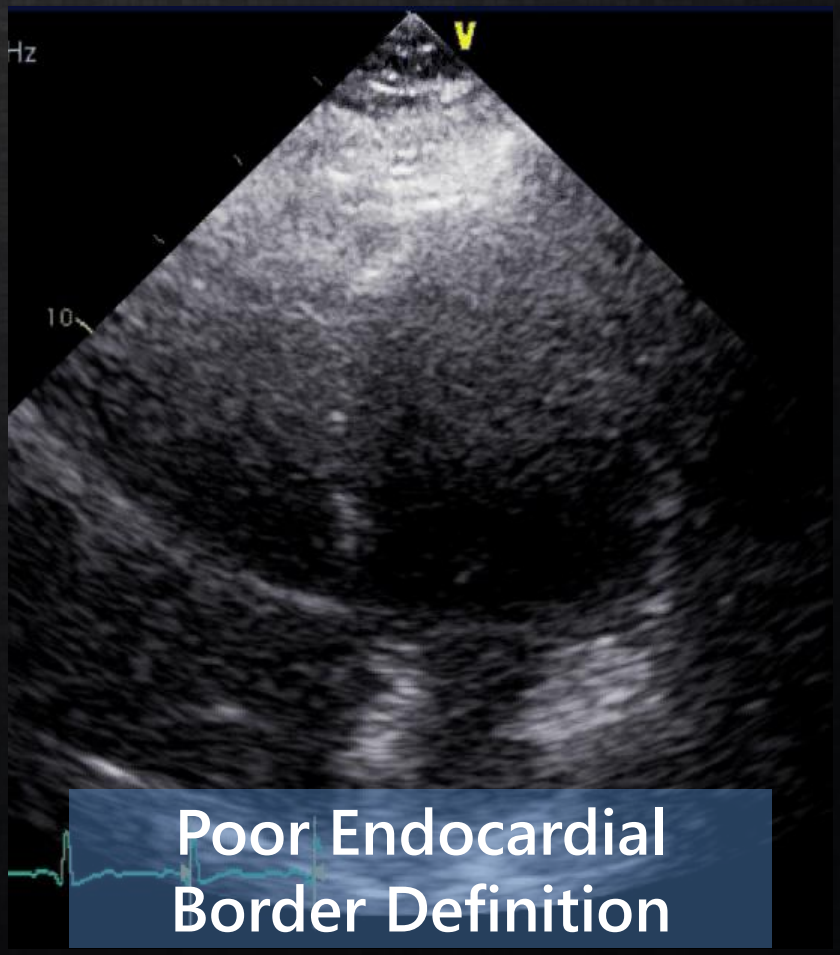
Normal?



Apical Foreshortening



Poor Endocardial Border Definition

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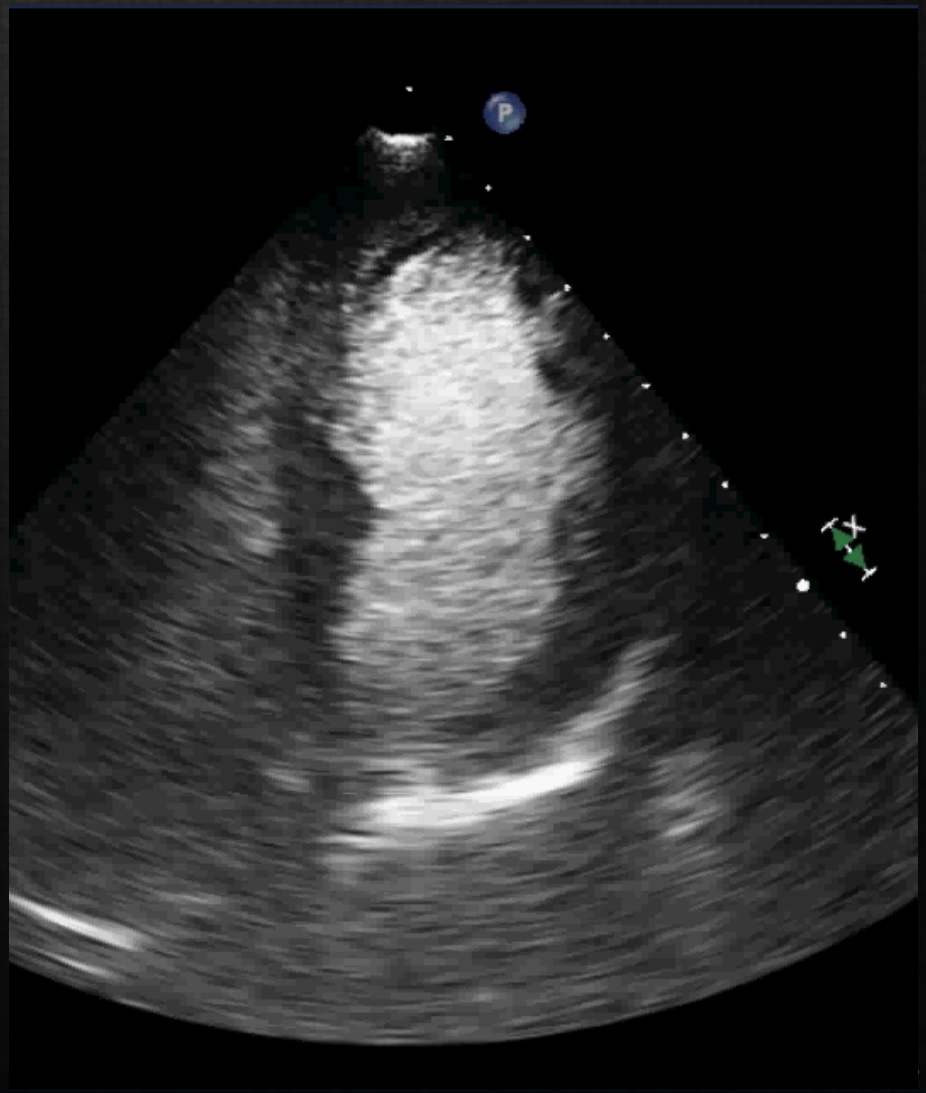
Contrast for LV Opacification

- ✓ Commercial Contrast
  - Improve endocardial border definition
  - Eliminate foreshortening
  - Evaluate for mural thrombi
  - Restore diagnostic quality

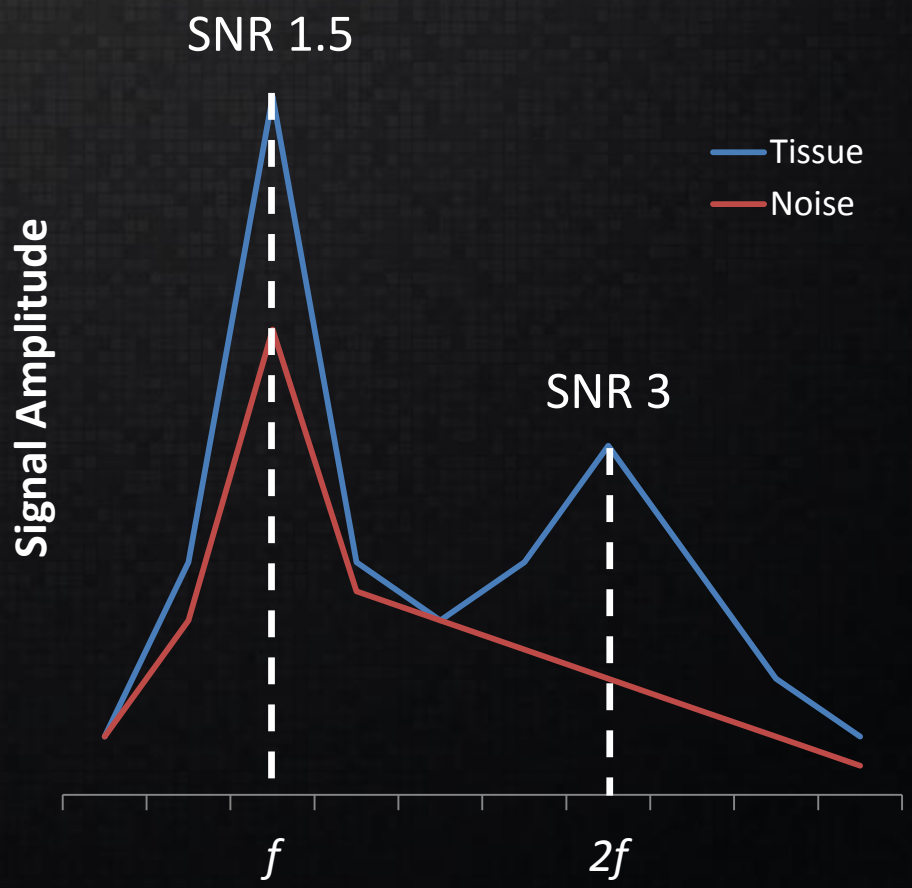


ASCeXAM Focus

- ✓ How do you fix this image?
  - Recognize off-axis views
  - Imaging from wrong interspace
  - Foreshorten cardiac structure
  - Contrast use and optimization
- ✓ Anatomical identification
- ✓ Myocardial segment identification
- ✓ Extracardiac findings recognition
- ✓ Common Artifacts

Tissue Harmonic Imaging

- ✓ Non-linear distortion of acoustic signal in tissue generates harmonics
- ✓ Noise/artifacts generate no significant harmonic
- ✓ Tissue Harmonic Imaging takes advantage of increased SNR



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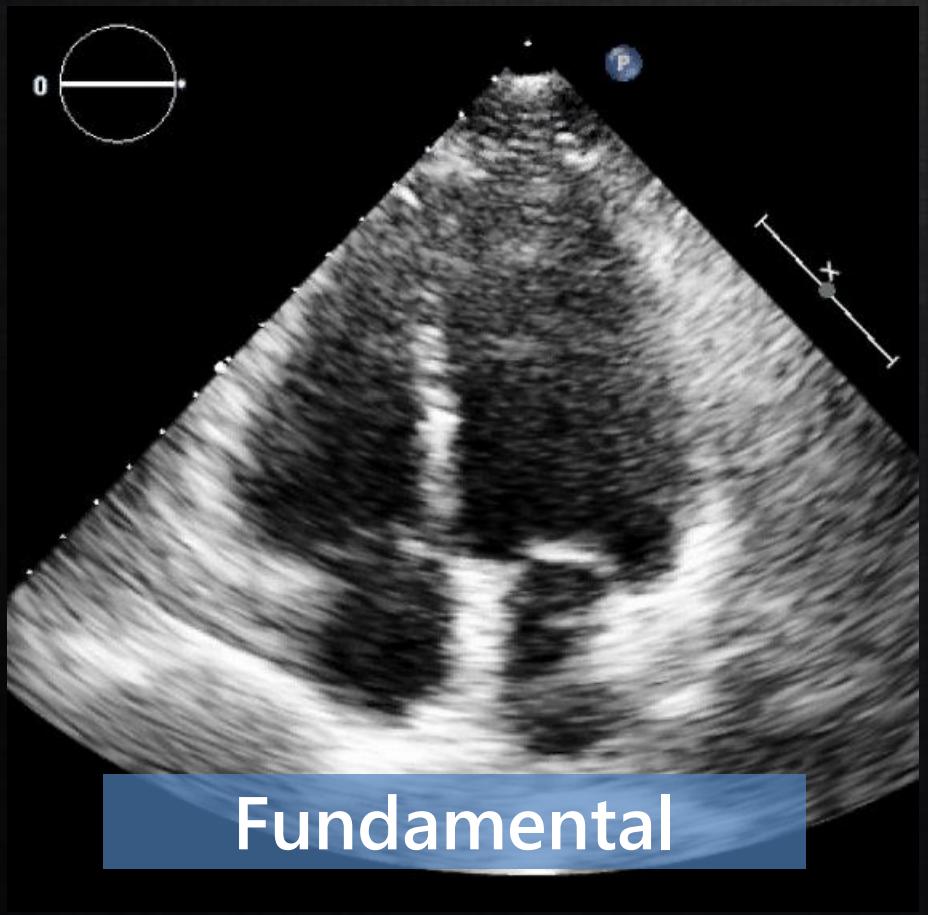
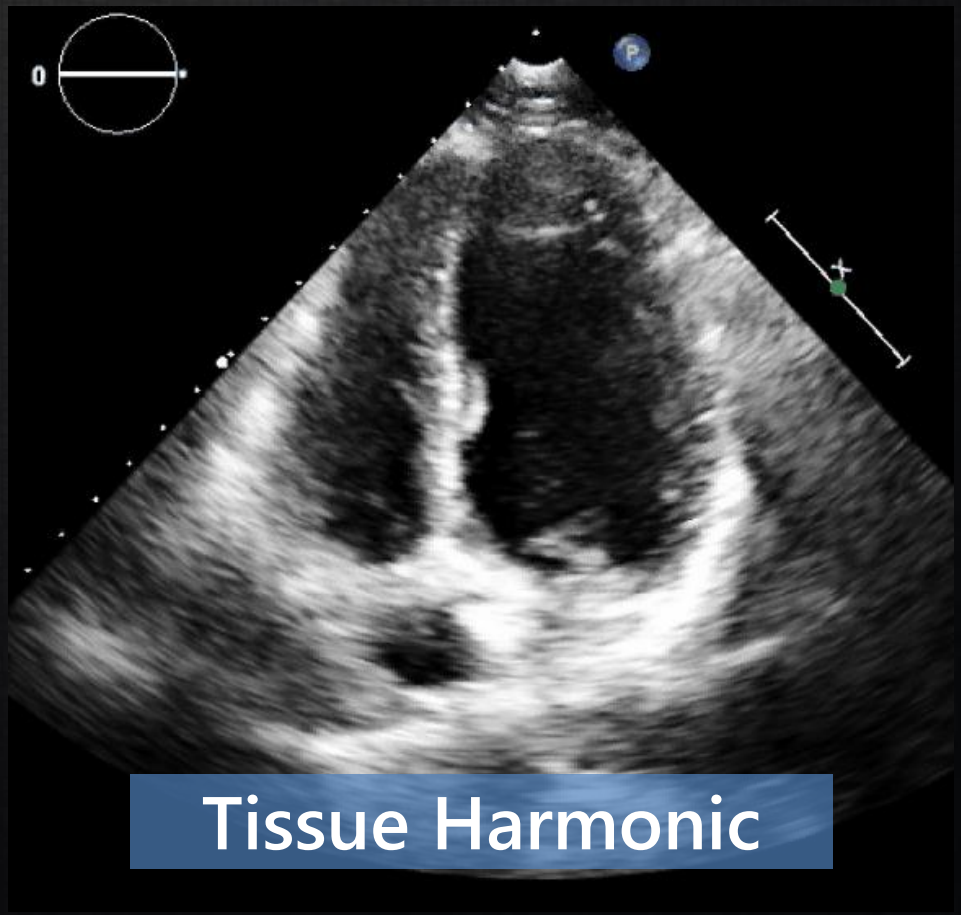
Tissue Harmonic Imaging





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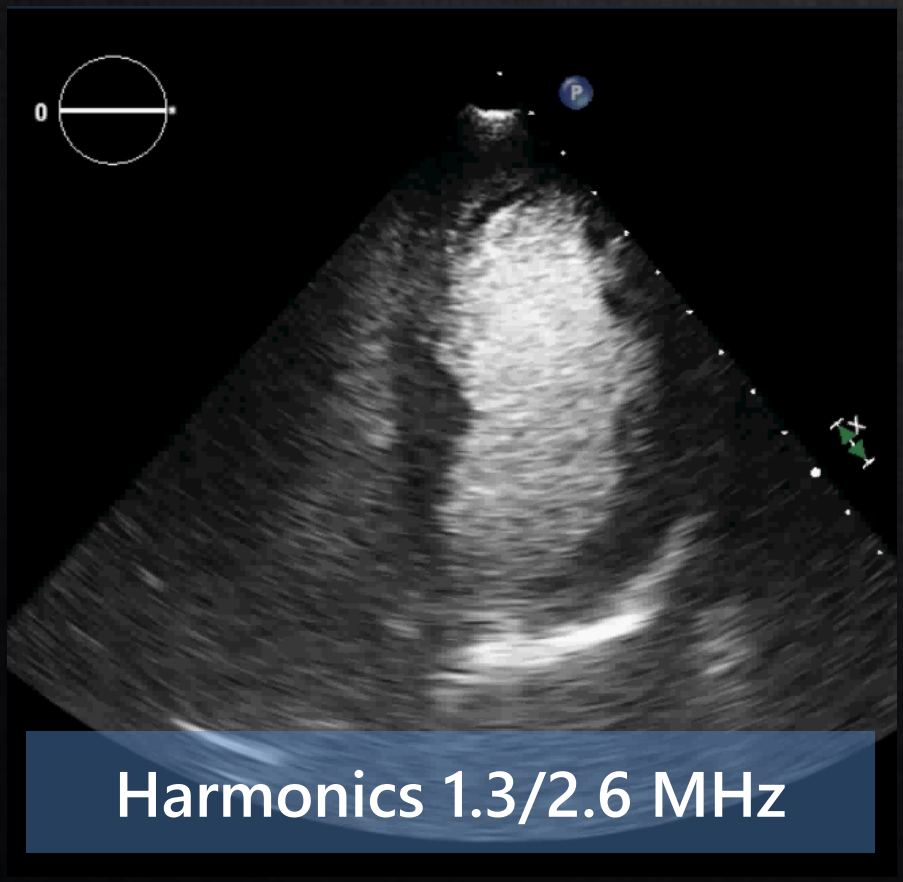
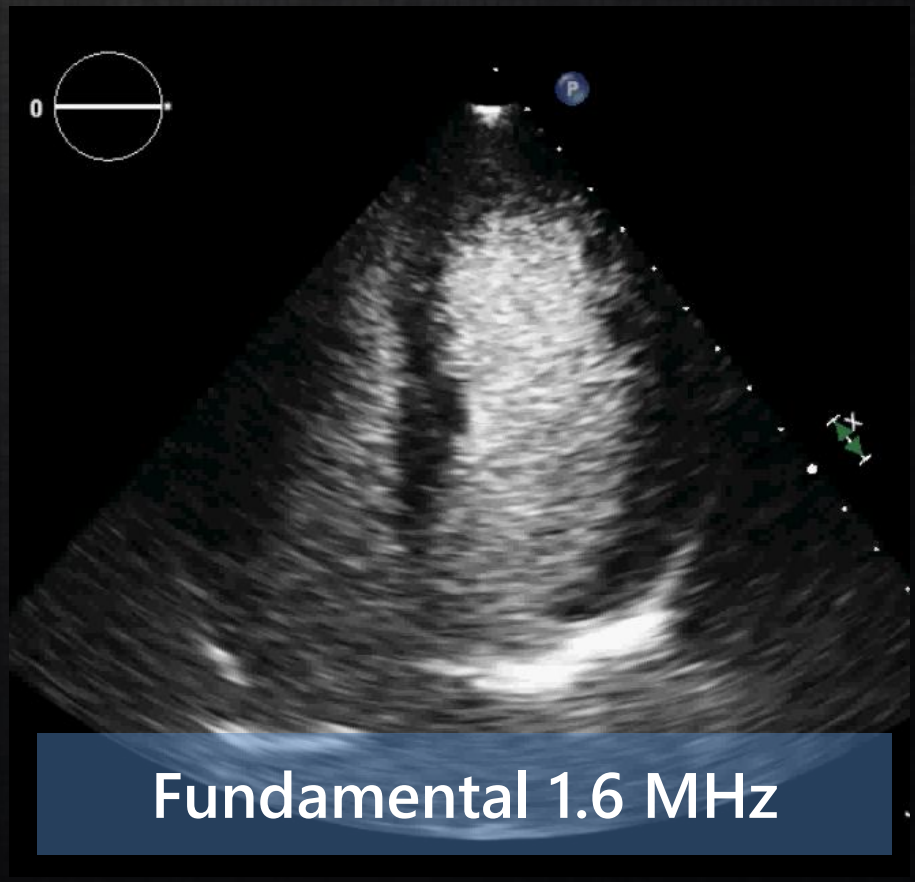
Bubbles Have Harmonics too..



Harmonics 1.3/2.6 MHz



Fundamental 1.6 MHz

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Doppler Echocardiography

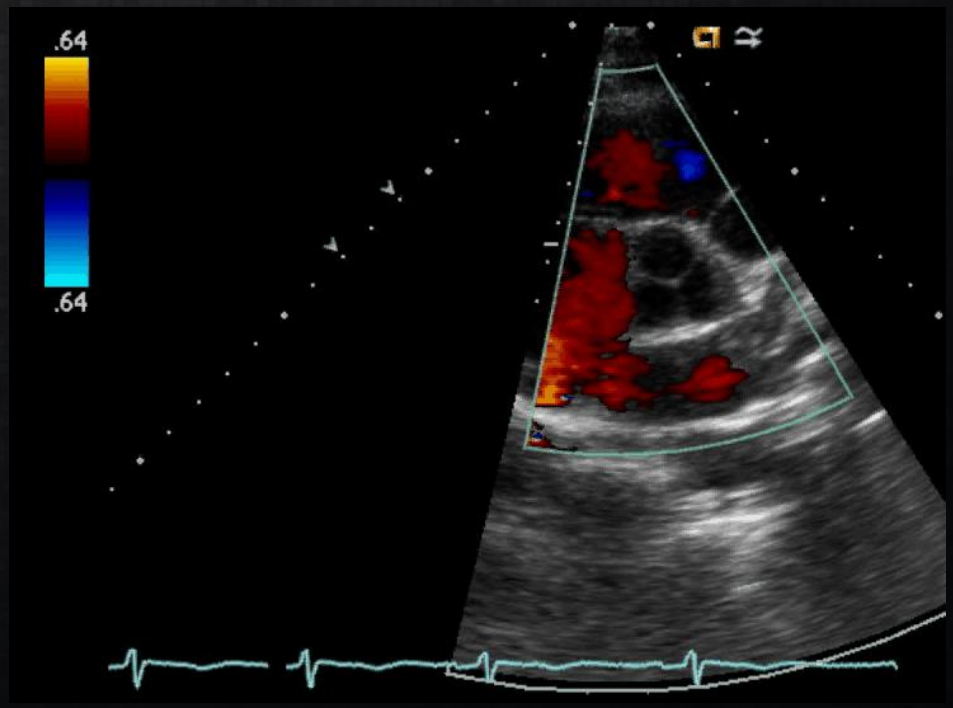
- ✓ Optimal 2D images when ultrasound beam is perpendicular to structures
- ✓ Optimal Doppler imaging when ultrasound beam is parallel to flow
- ✓ Apical views allow alignment with most cardiac flows (i.e. aortic, mitral and tricuspid valves)

Doppler Echocardiography

- ✓ Color Doppler
  - Pulse wave modality that cannot resolve high velocities
  - Turbulence/variance maps can help define jet, direction and turbulence
- ✓ Pulse Wave Spectral Doppler
  - Range specific
  - Subject to aliasing at high velocities like CFD
- ✓ Continuous Wave Spectral Doppler
  - Able to resolve high velocities
  - Range ambiguous

Color Flow Doppler

- ✓ Pay attention to the baseline
- ✓ Make note of the Nyquist limit
- ✓ Color scales vary
- ✓ Variance maps
- ✓ Optimize size and sector for frame rate



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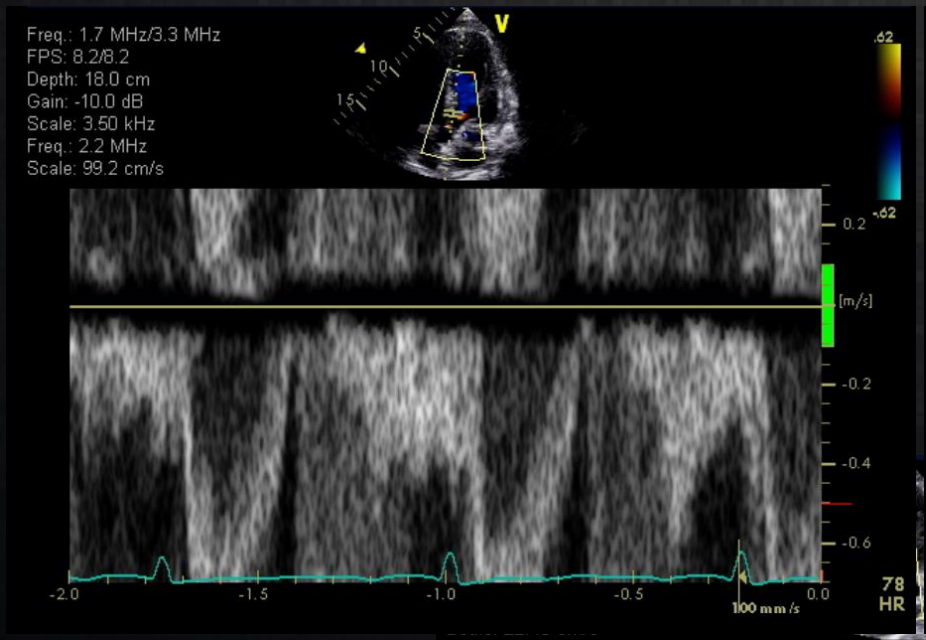
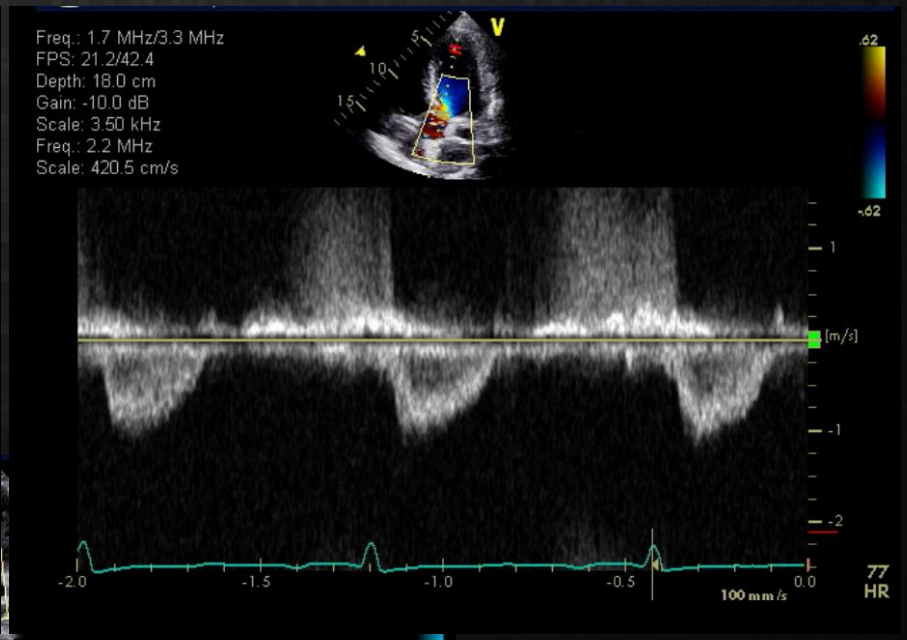
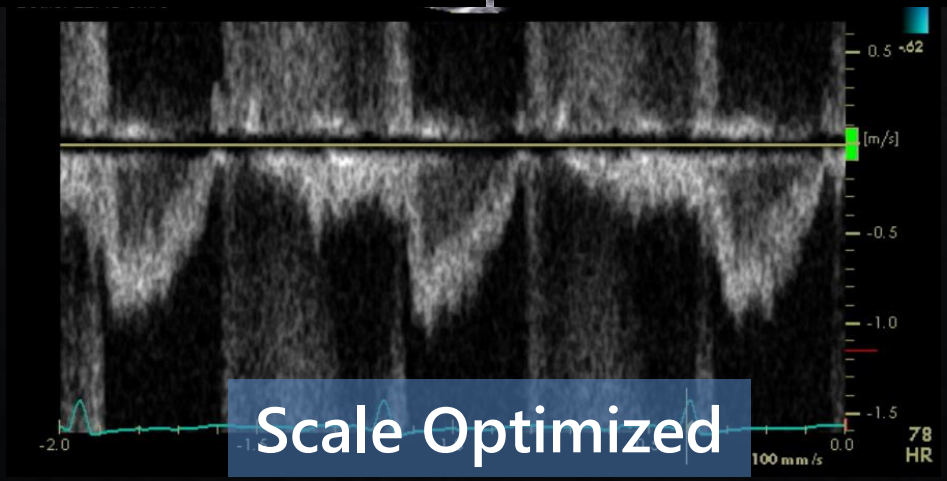
Doppler Optimization







Scale Optimized

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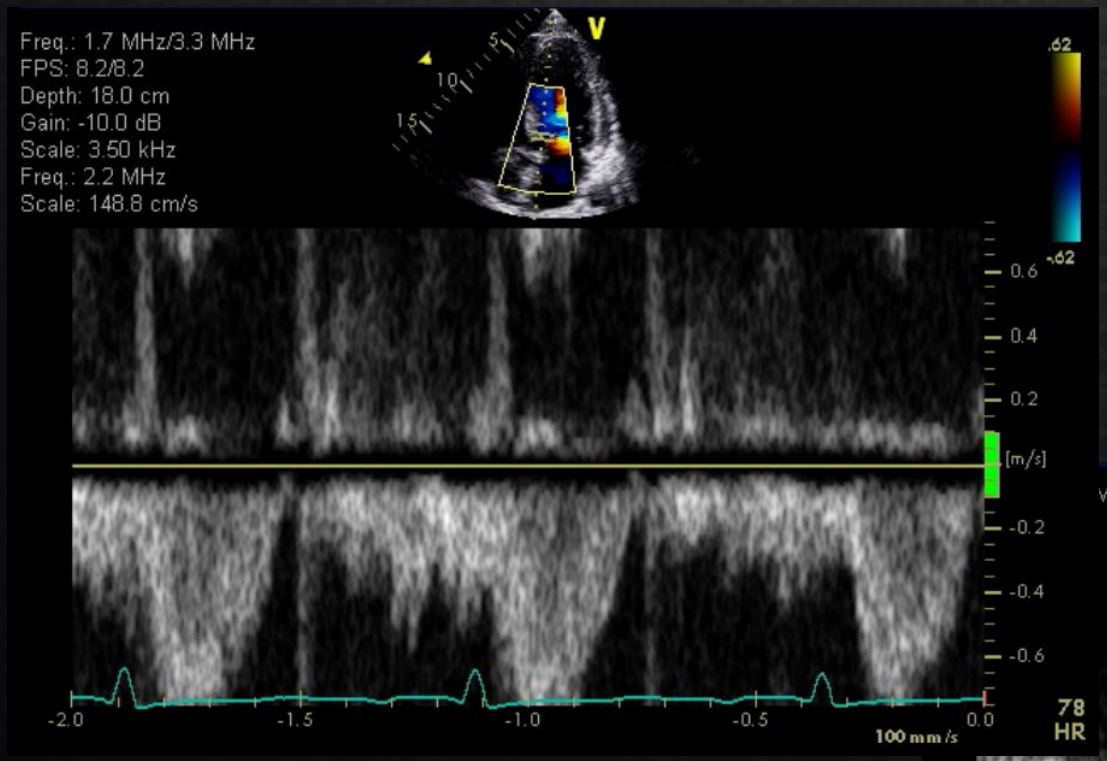
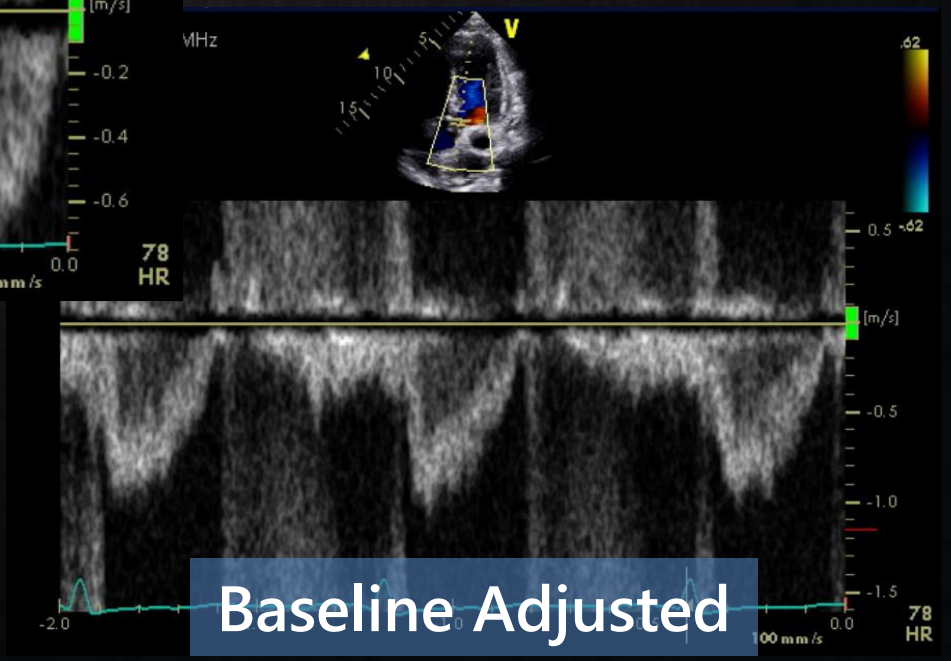
Doppler Optimization





Baseline Adjusted

ASCeXAM Focus

- ✓ Effects of harmonic imaging
- ✓ Appropriate indications for contrast
- ✓ Contrast Physics and optimization
- ✓ Types of Doppler and technique limitations
- ✓ Spectral Doppler signal optimization
- ✓ Color Flow Doppler optimization

Transesophageal Echocardiography

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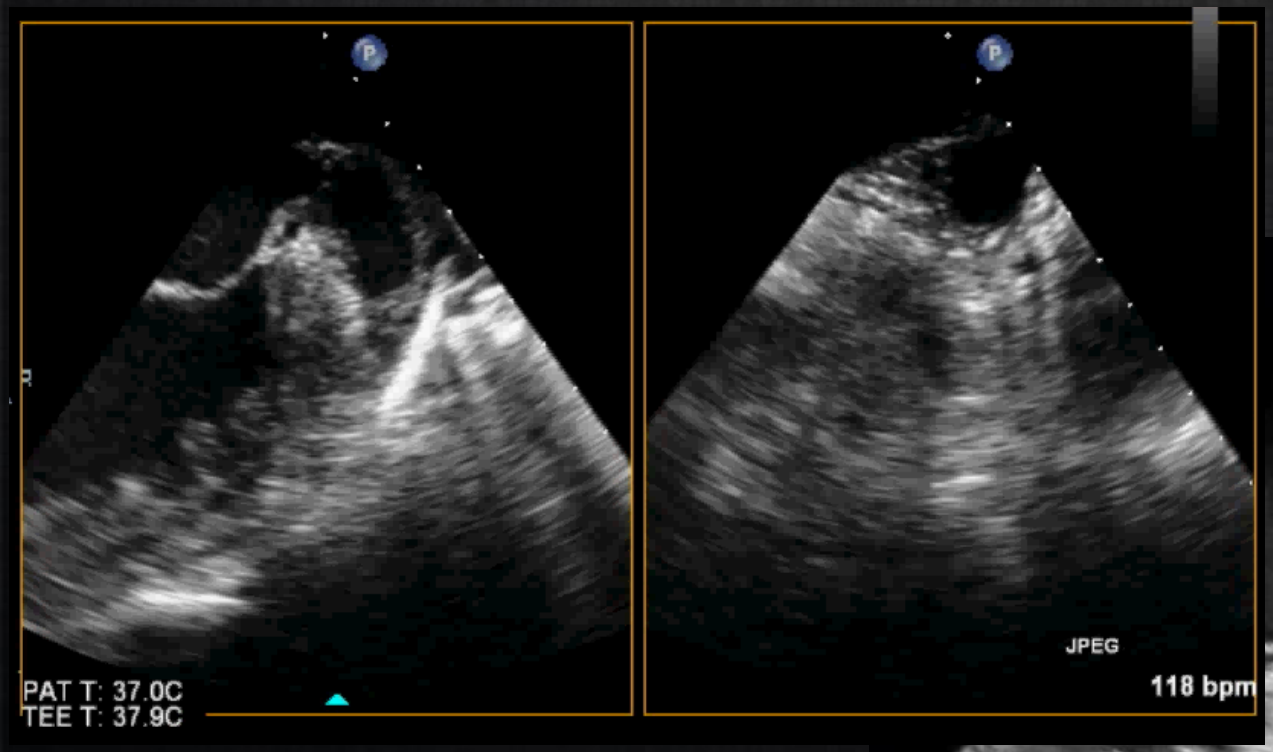
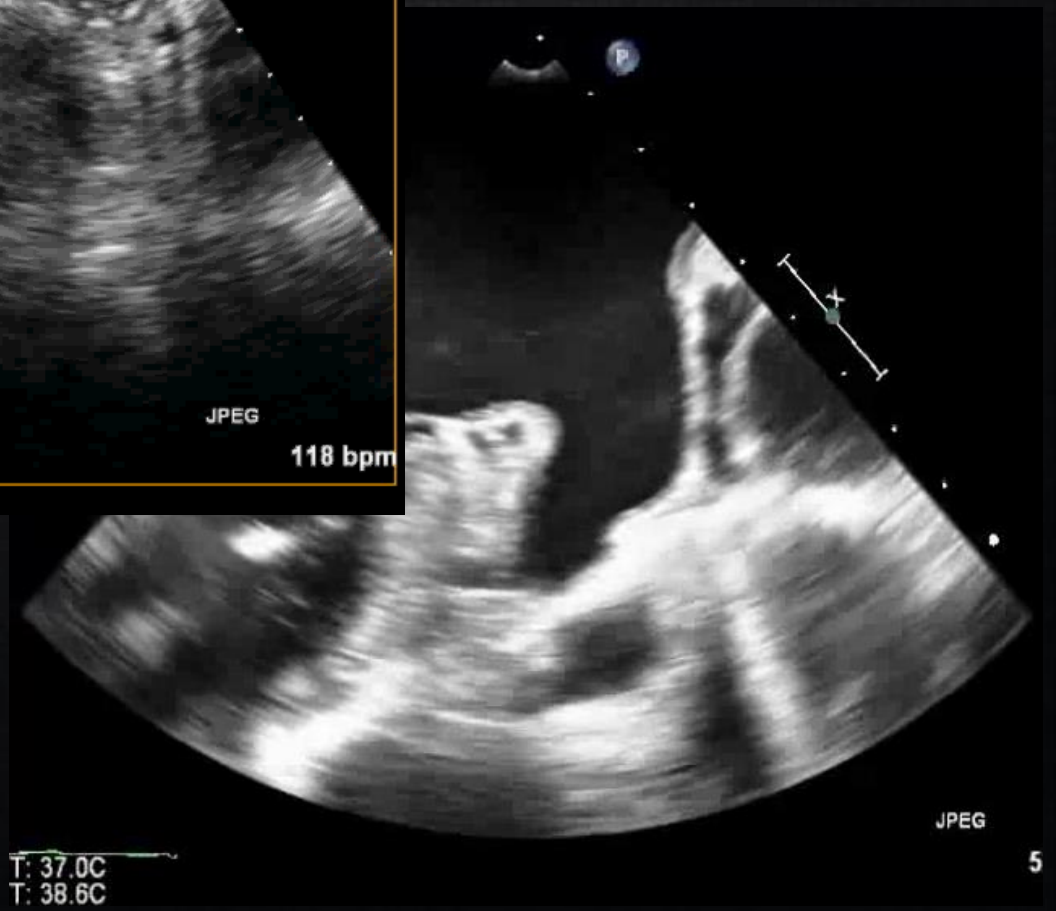
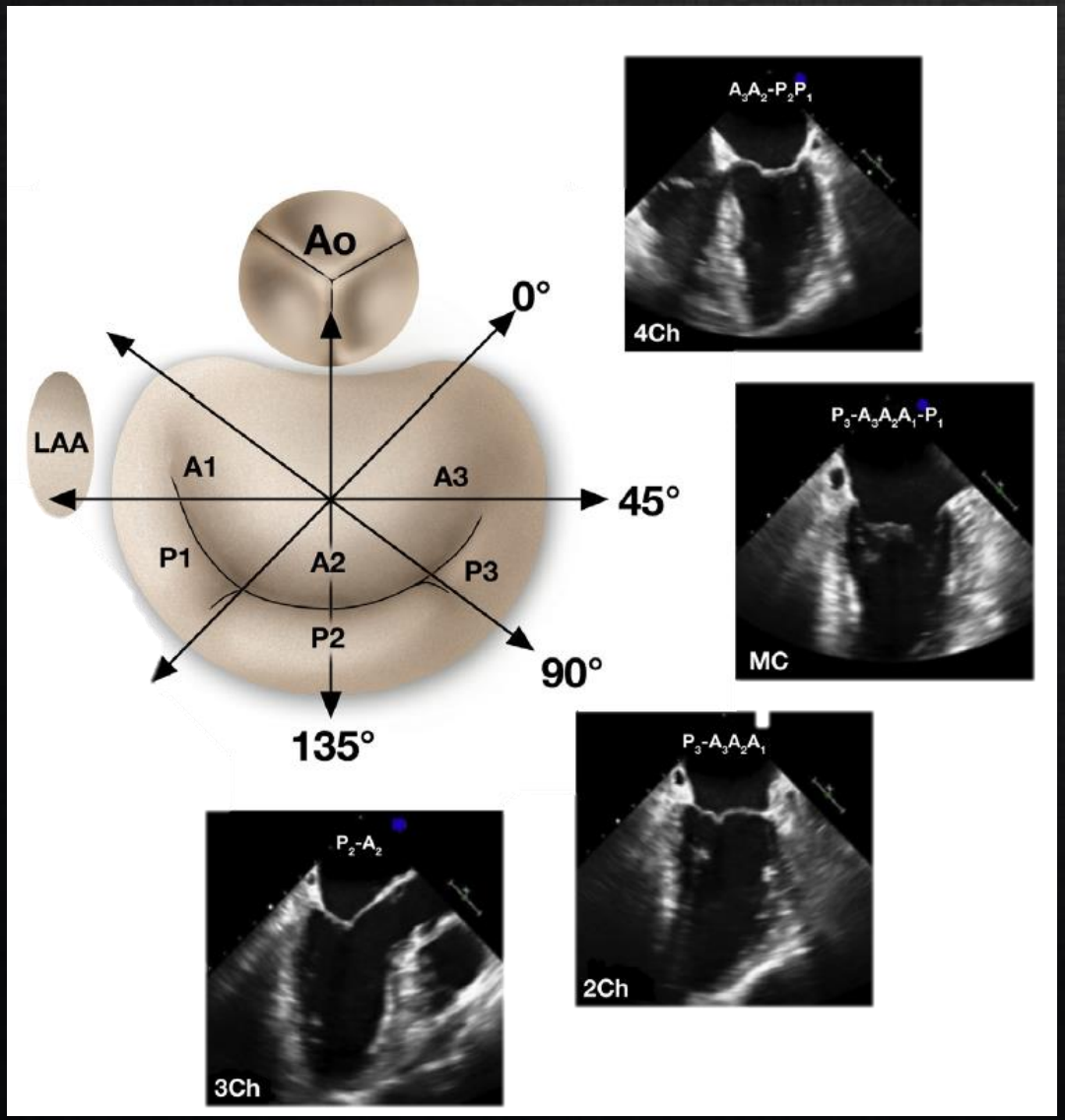
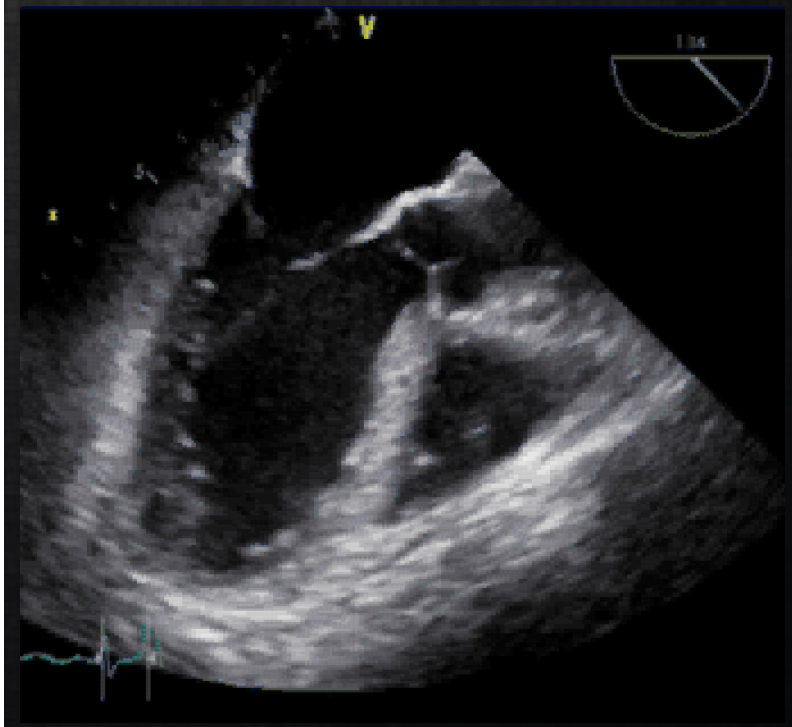
Left Atrial Appendage





Mitral Valve





Hahn et al. TEE Guidelines. JASE 2013;26:921-64

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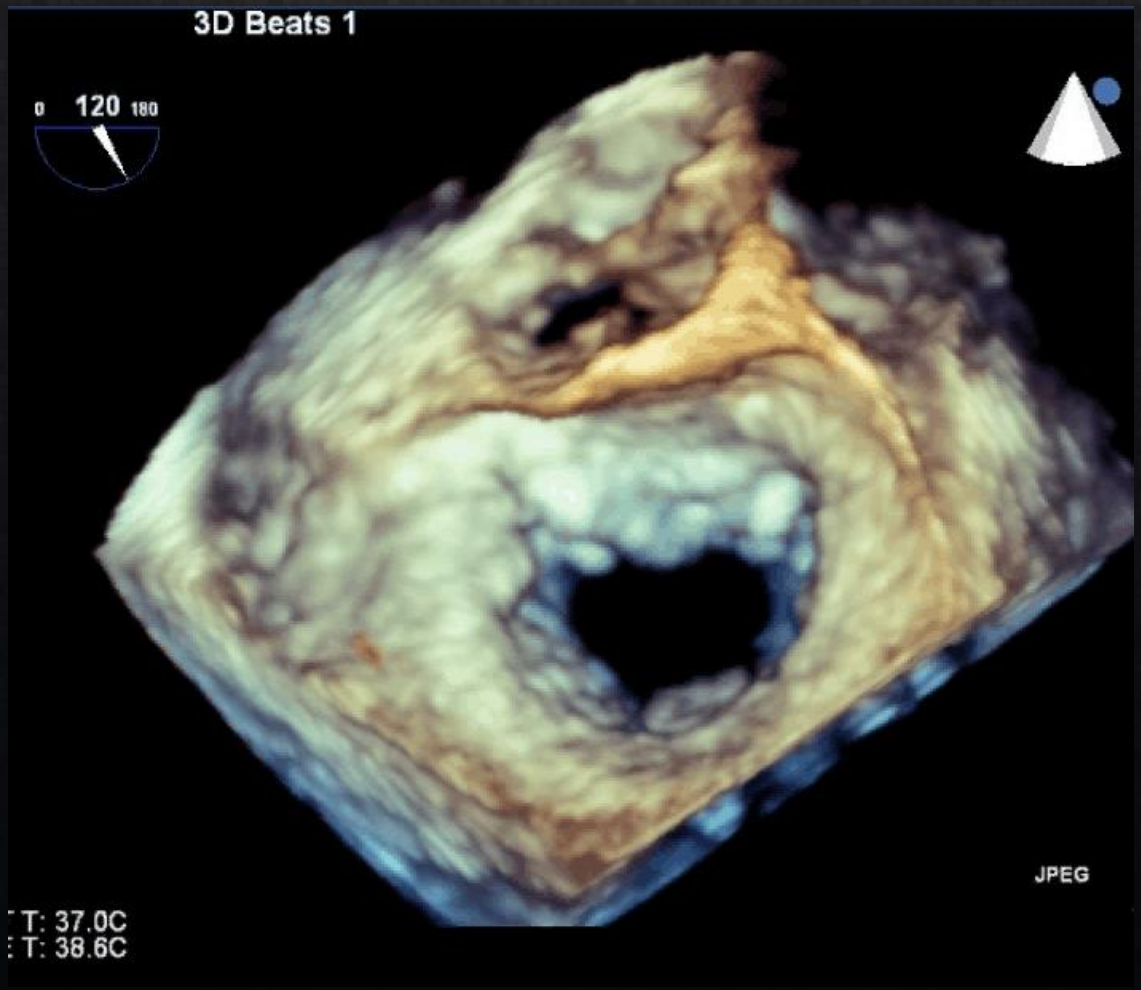
3D Mitral Valve



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Aortic Valve

SAX

LAX

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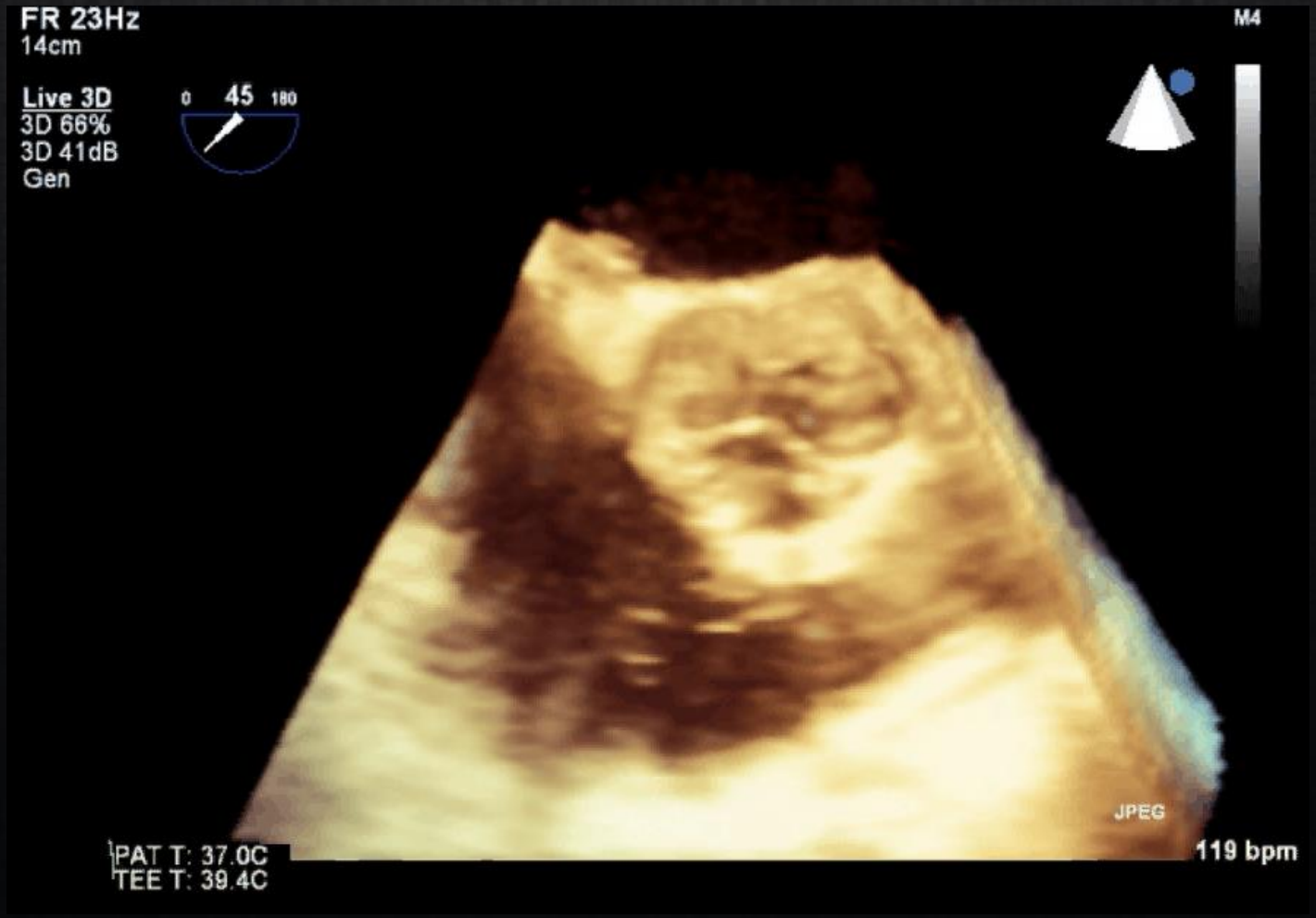
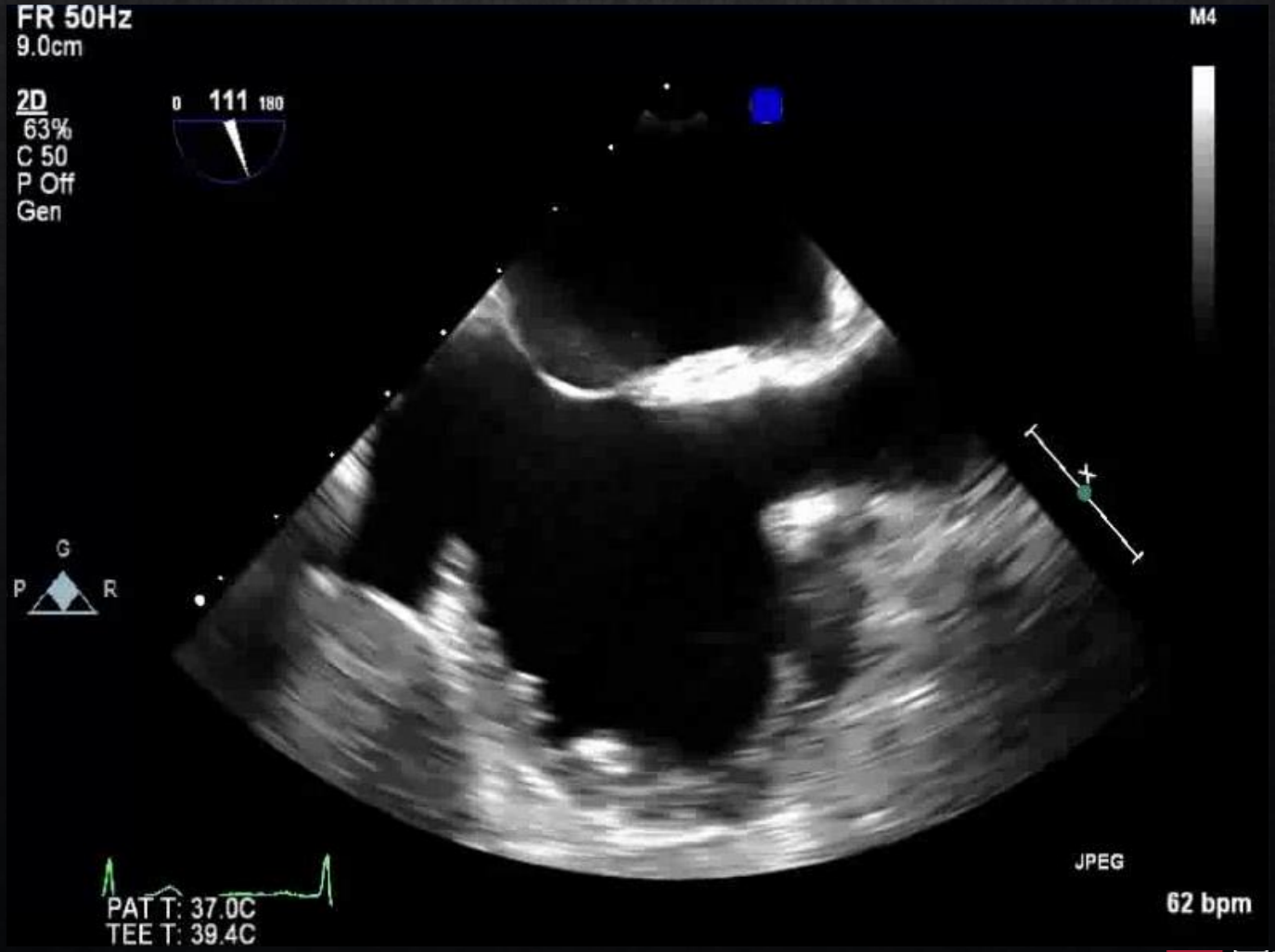
3D Aortic Valve



Bi-Caval View



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Transgastric LV

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ASCeXAM Focus

- ✓ TEE not heavily tested
- ✓ AUC, Indications and Contraindications for TEE
- ✓ Anatomical identification
- ✓ Standard 3D views of Mitral and Aortic valves
- ✓ Correlative anatomic imaging with TTE

Normal Anatomic Structures

Transthoracic and Transesophageal Echocardiography

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Persistent Venous Valves

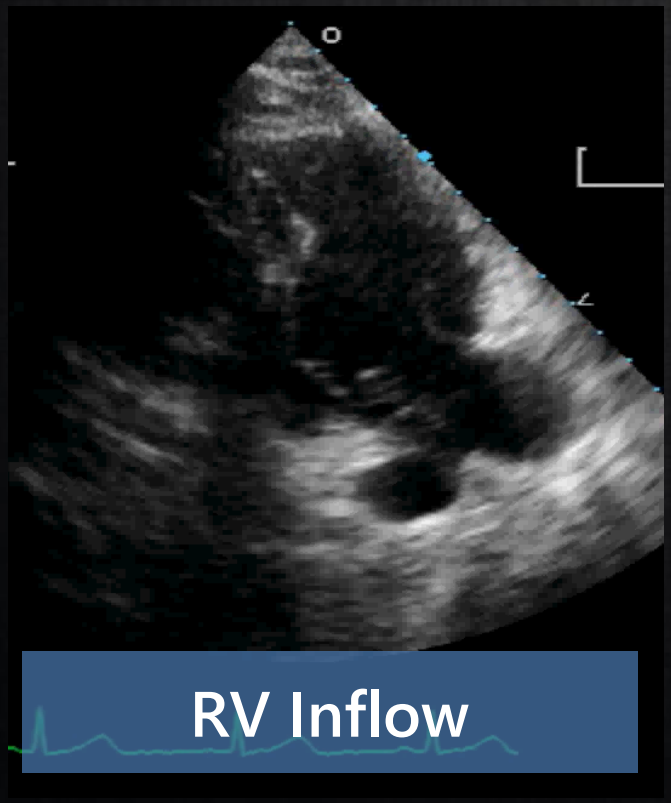
Chiari Network

- ✓ No known function
- ✓ Not present in every patient
- ✓ Netlike structure that is highly mobile
- ✓ Usually arises from the vicinity of the IVC not attached to the septum

Eustachian Valve

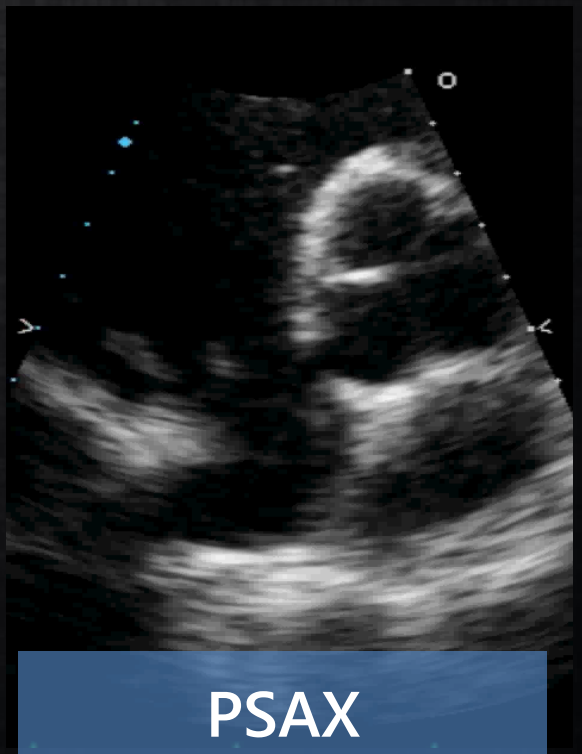
- ✓ Directs IVC flow across fossa in fetus
- ✓ Present in every fetus
- ✓ Ridge of tissue - rarely mobile at all
- ✓ Arises from the IVC and runs to the fossa

Chiari Network



RV Inflow

Apical Four



PSAX

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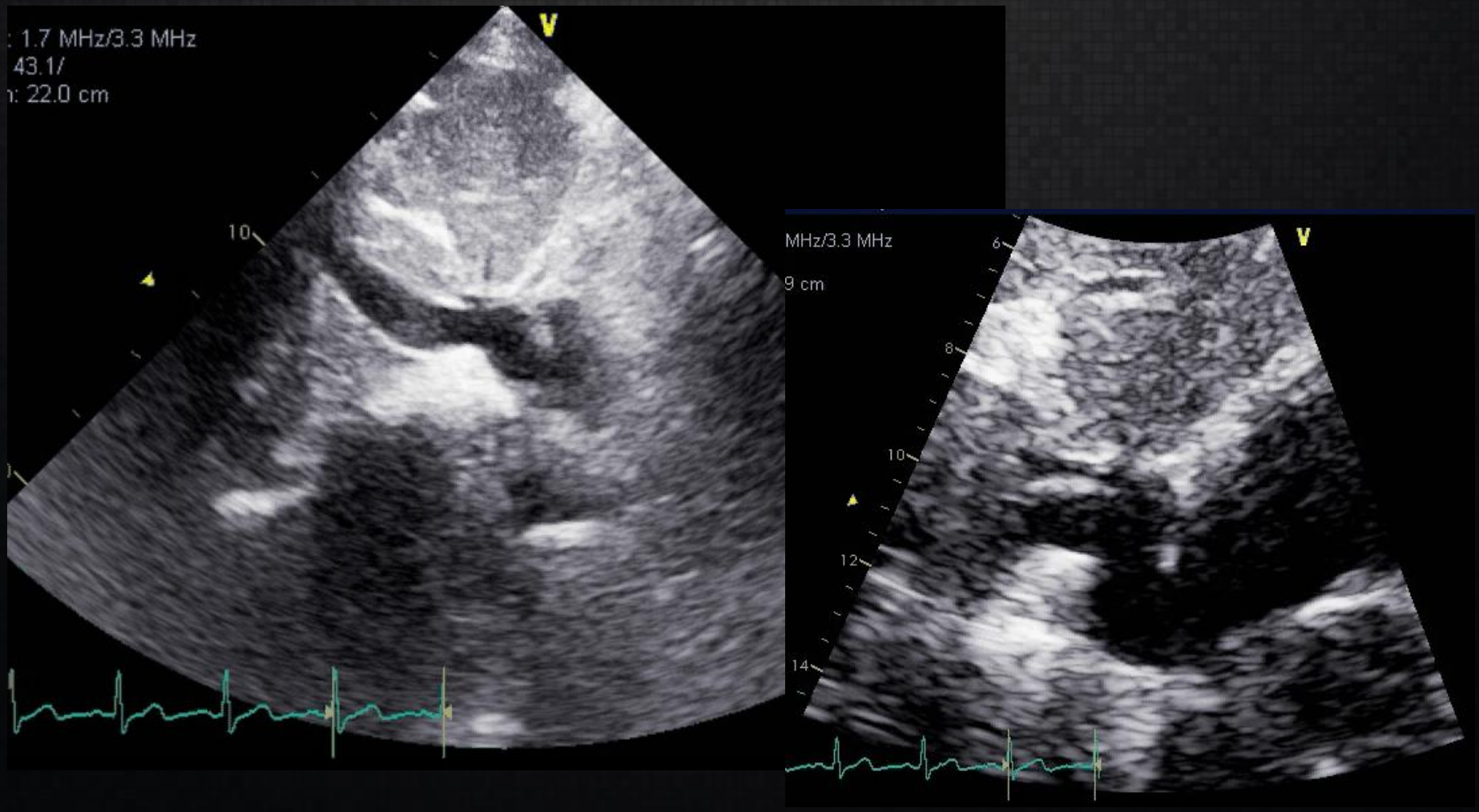
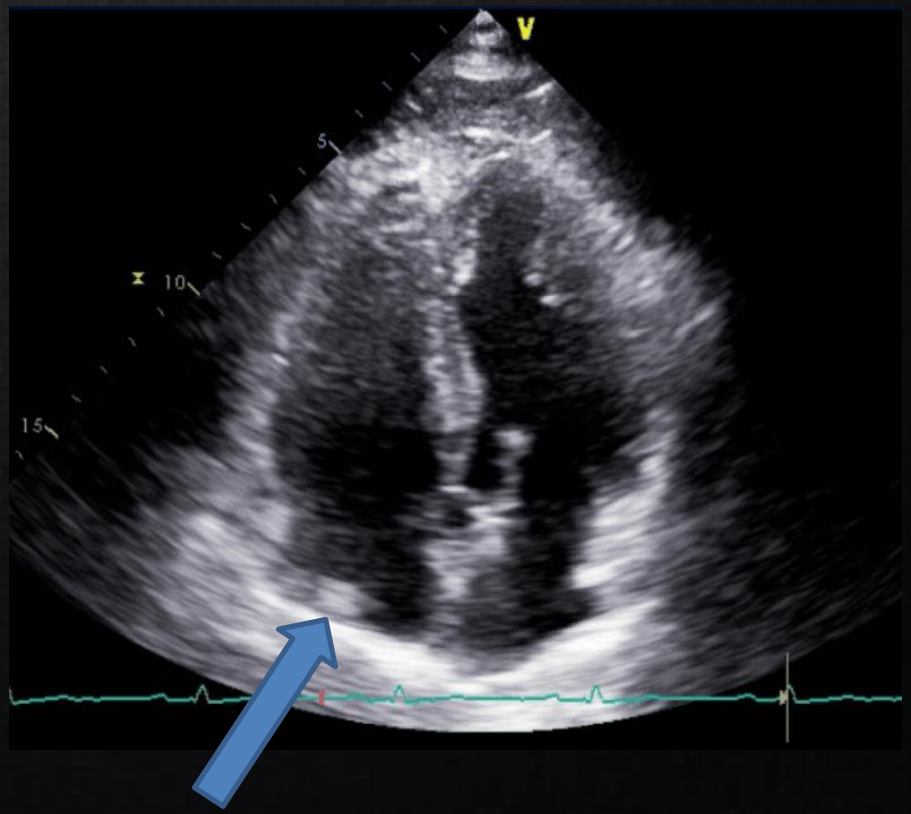
Eustachian Valve



Crista Terminalis

- ✓ Normal structure
- ✓ Often confused for a right atrial mass
- ✓ Smooth myocardial ridge from RA-SVC junction along posterolateral RA wall



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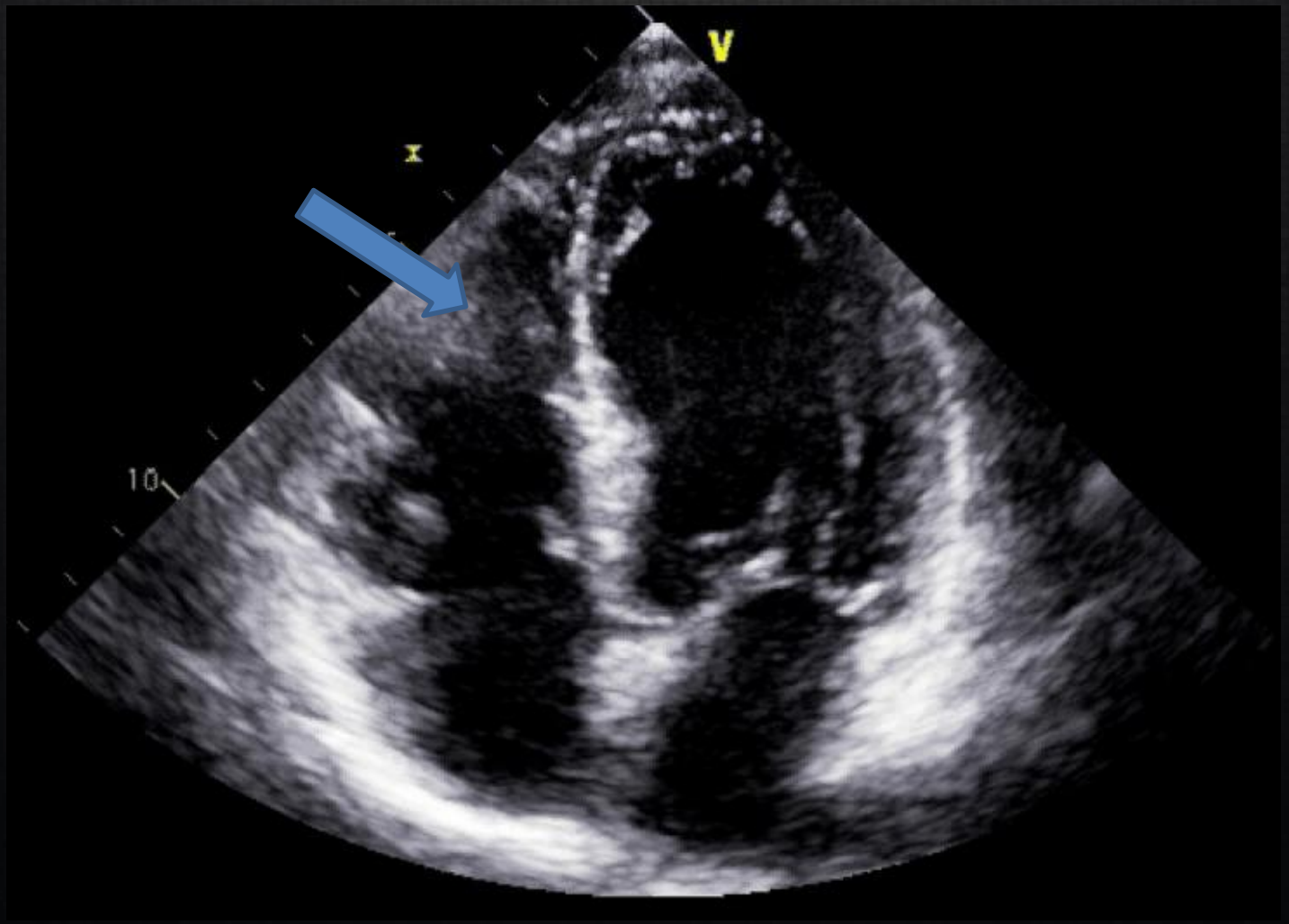
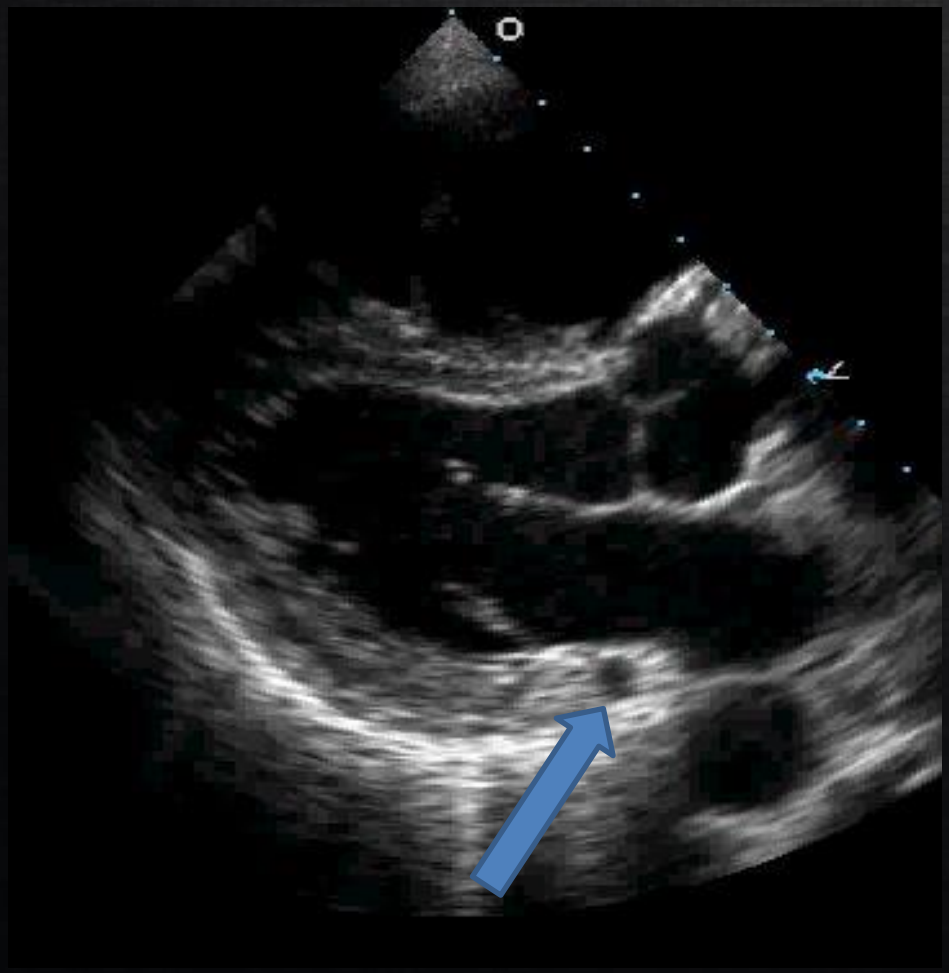
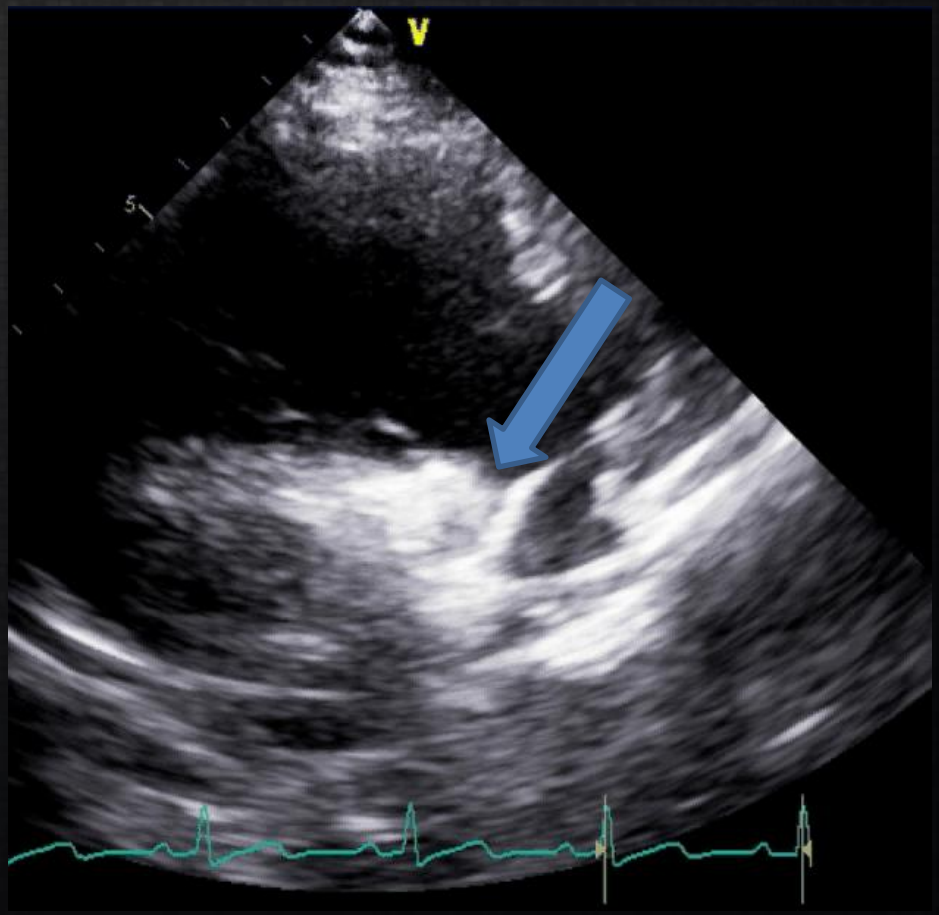
Moderator Band



Coronary Sinus





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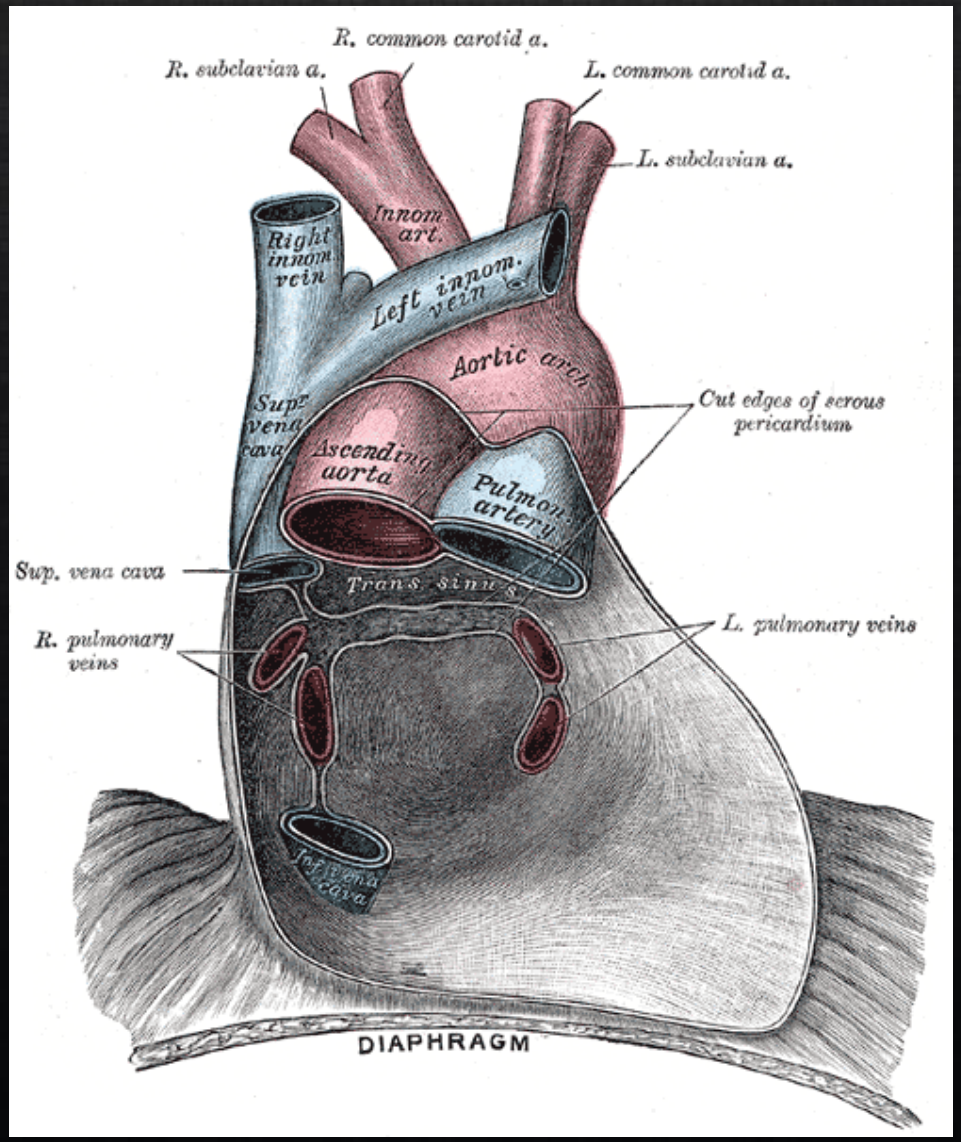
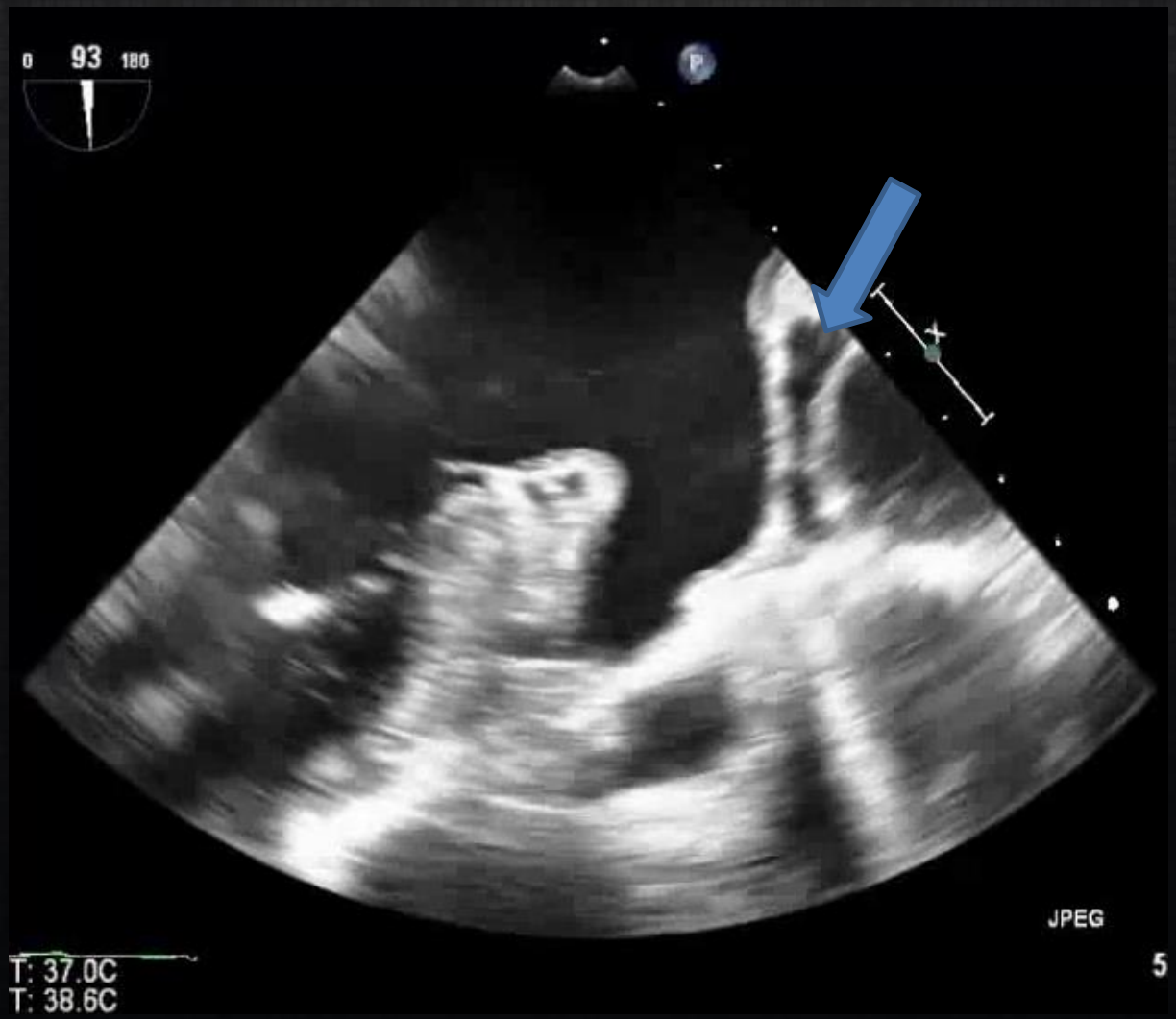
Pericardial Sinuses



Transverse Sinus



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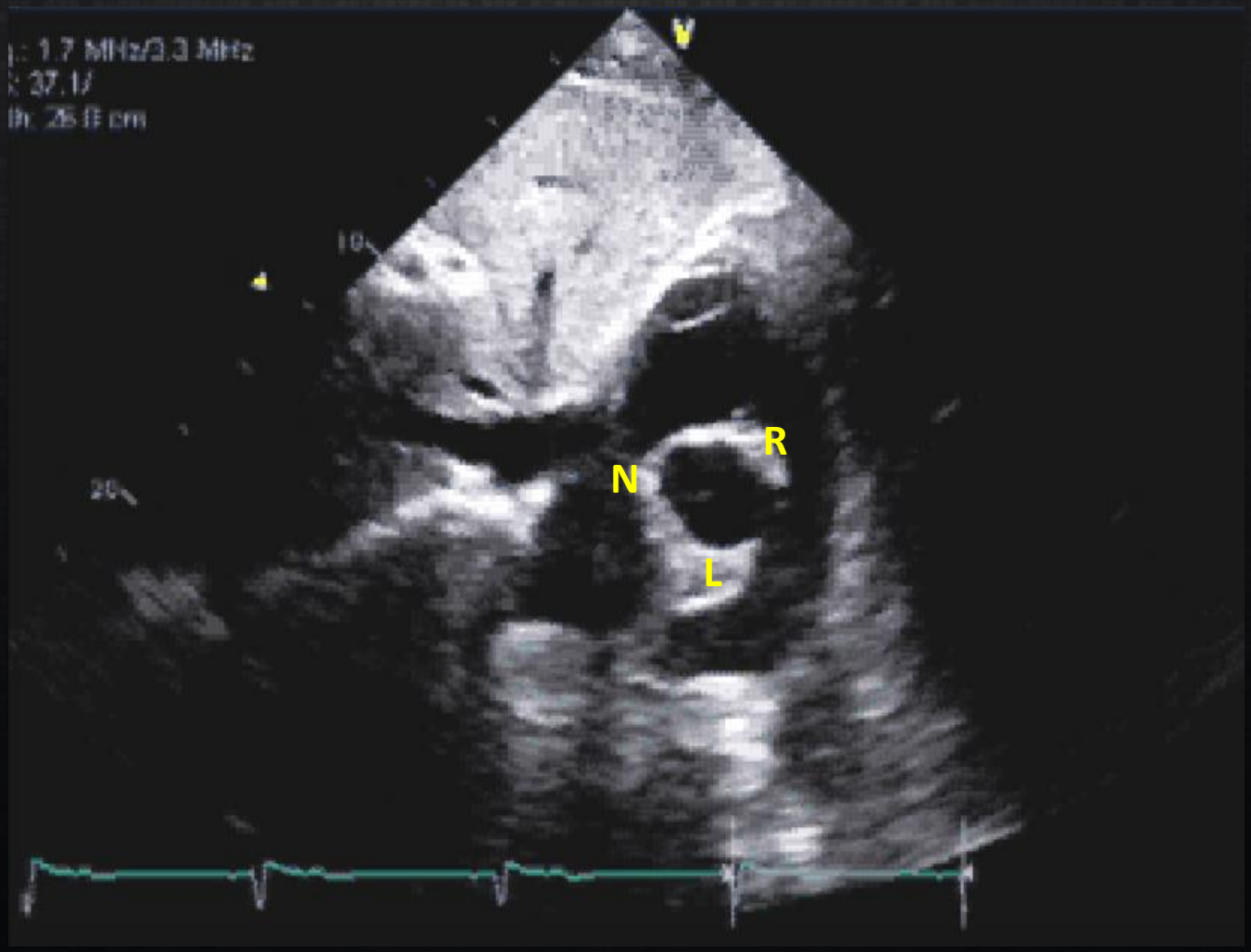
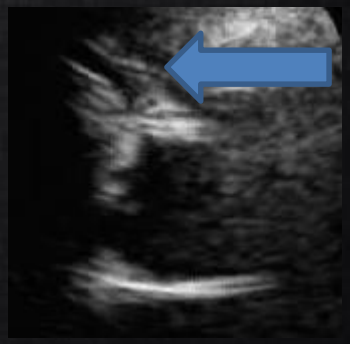
Subcostal SAX Aortic Valve

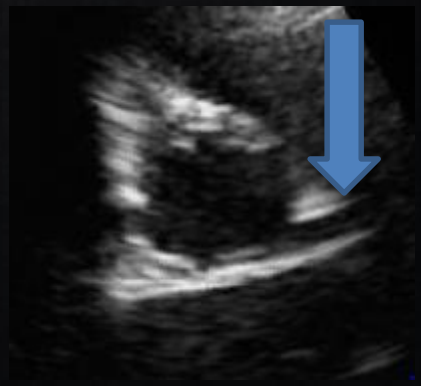


Coronary Arteries

RCA



LMCA



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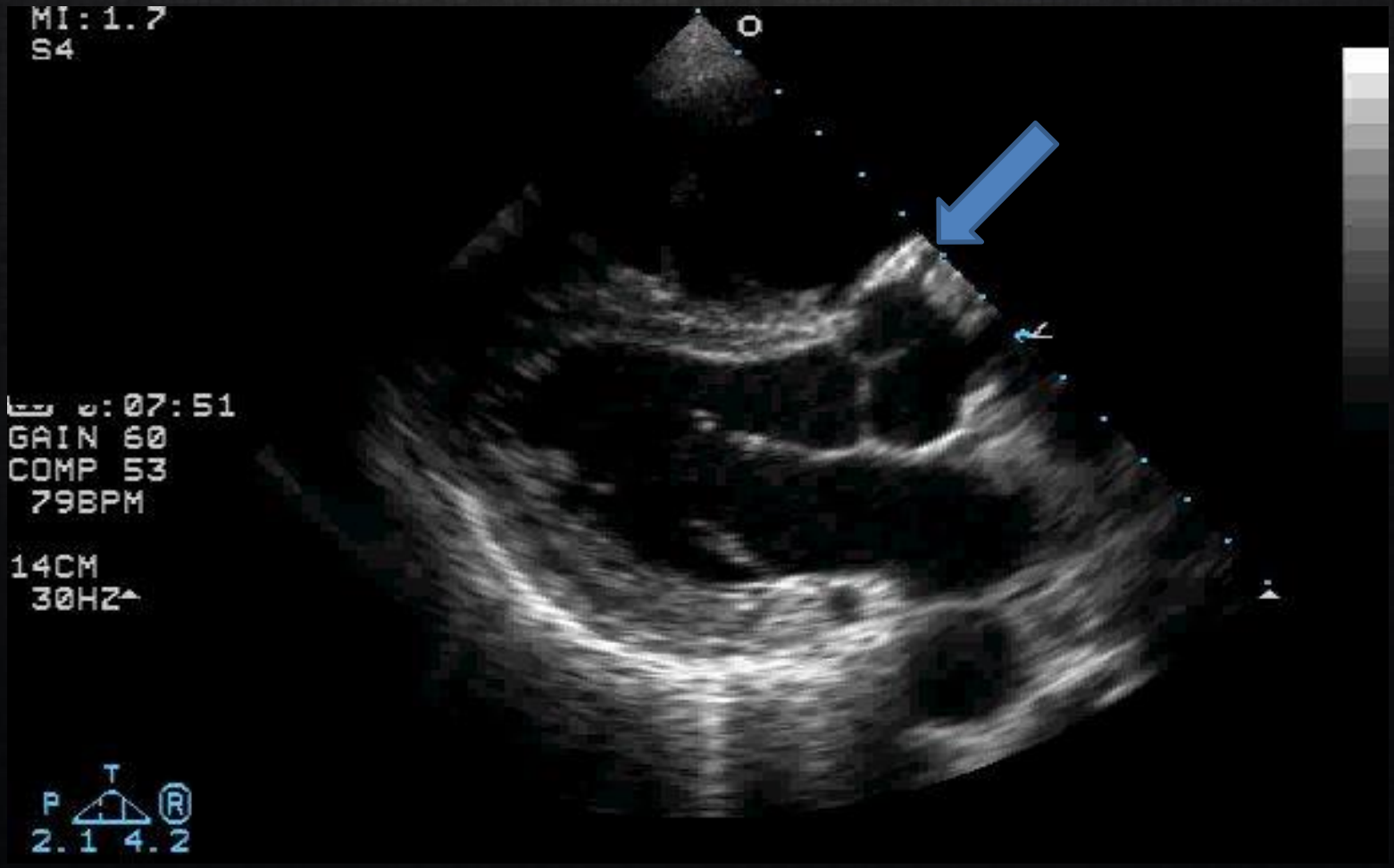
Coronary Arteries



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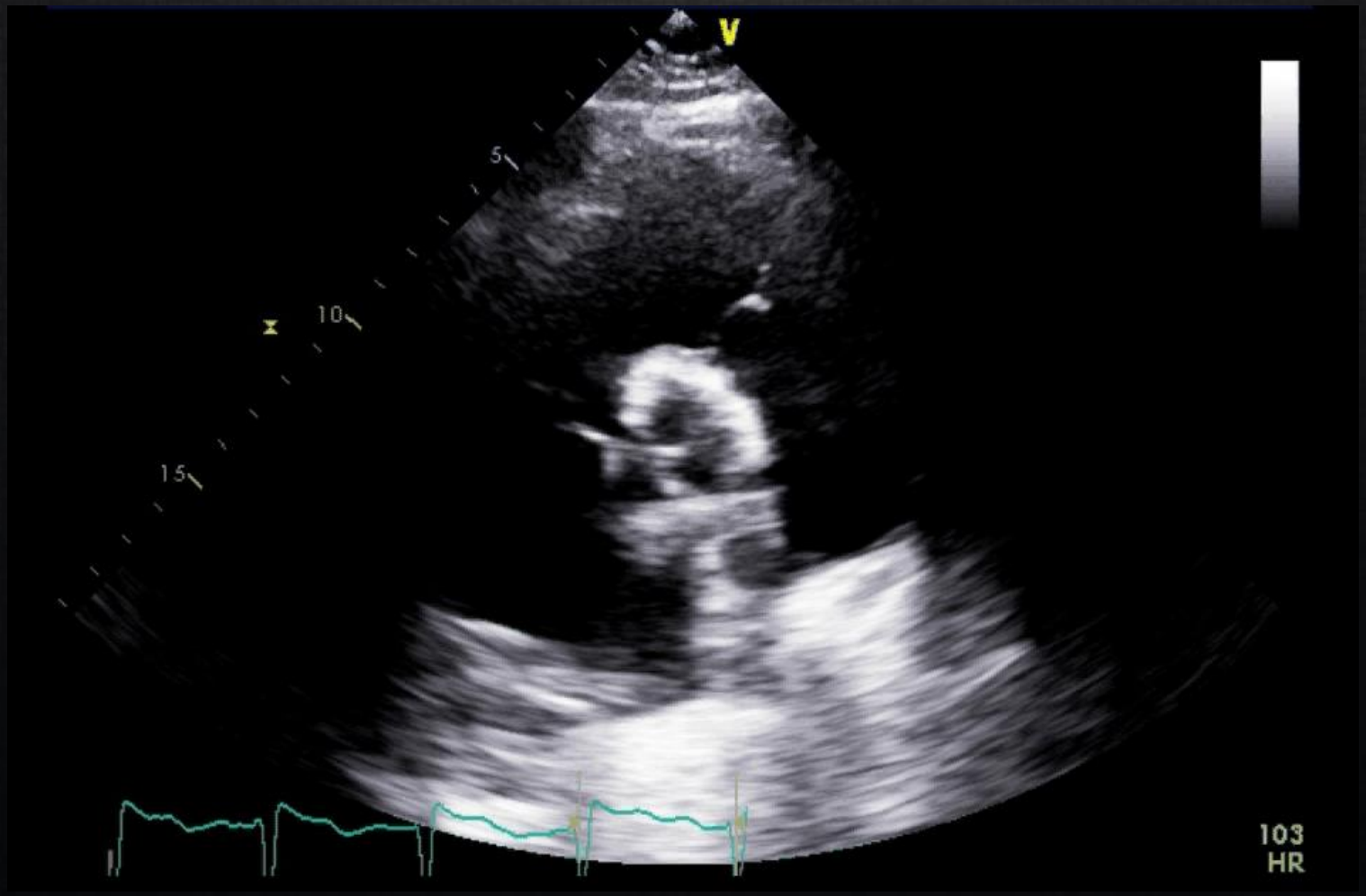
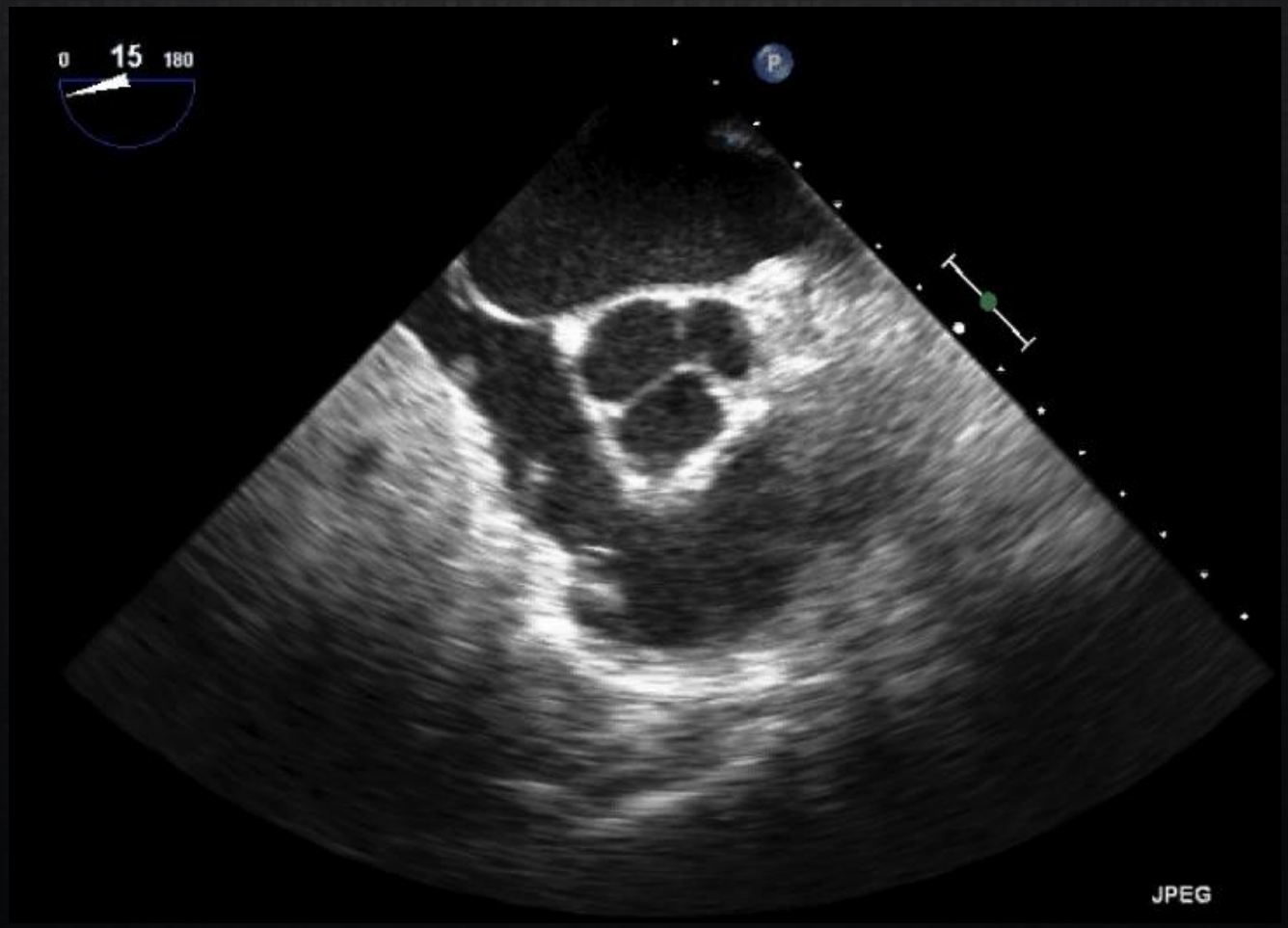
Coronary Arteries



TEE Aortic Valve



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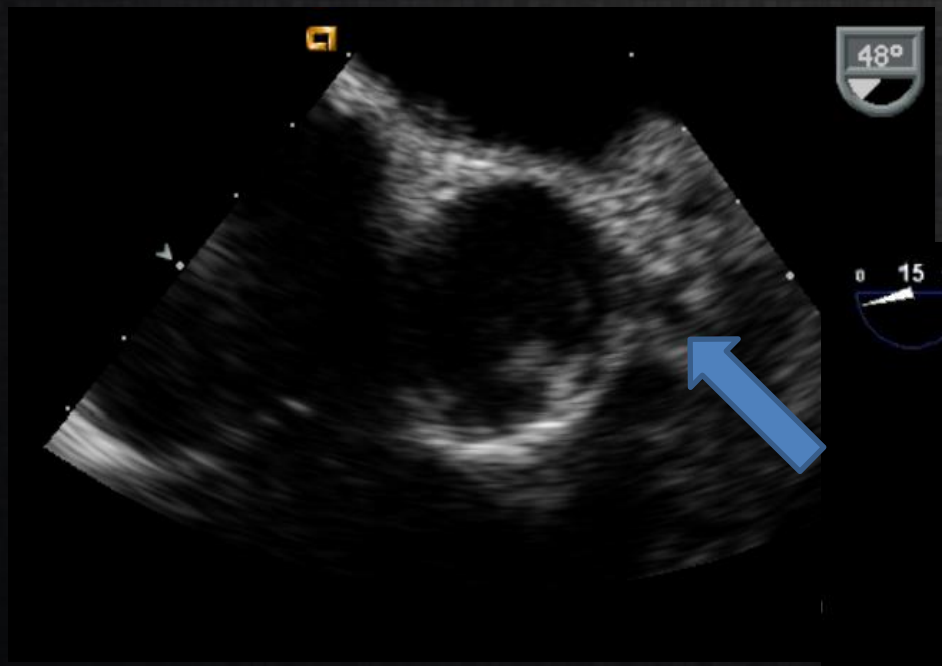
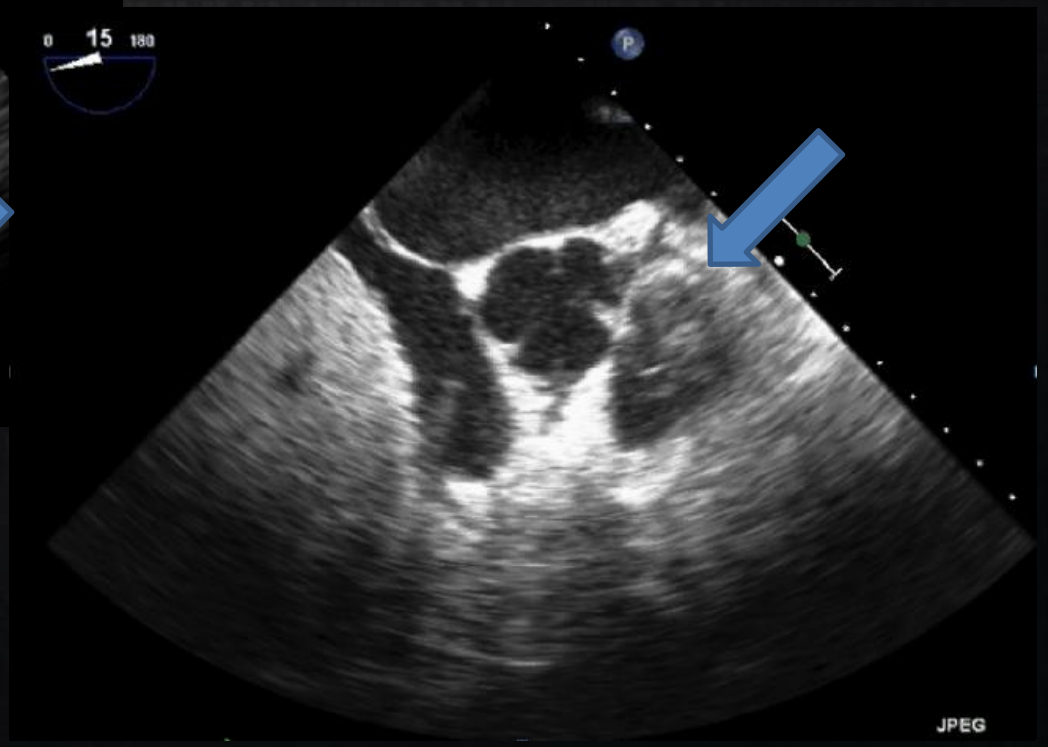
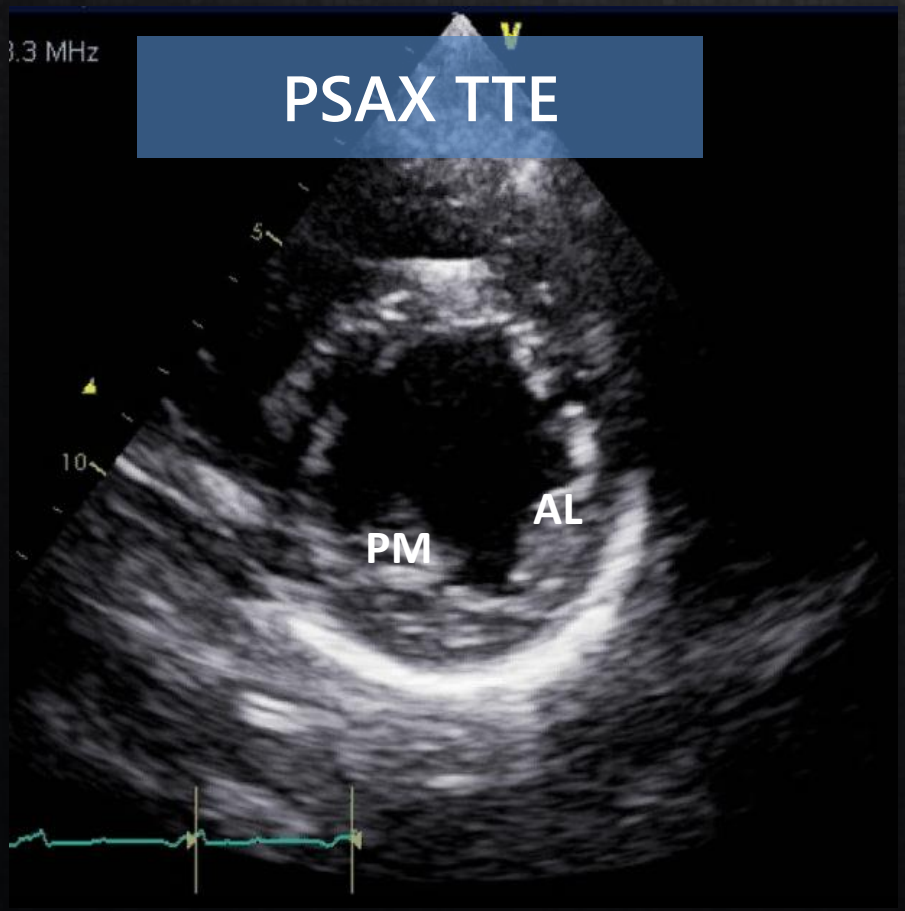
TEE Aortic Valve

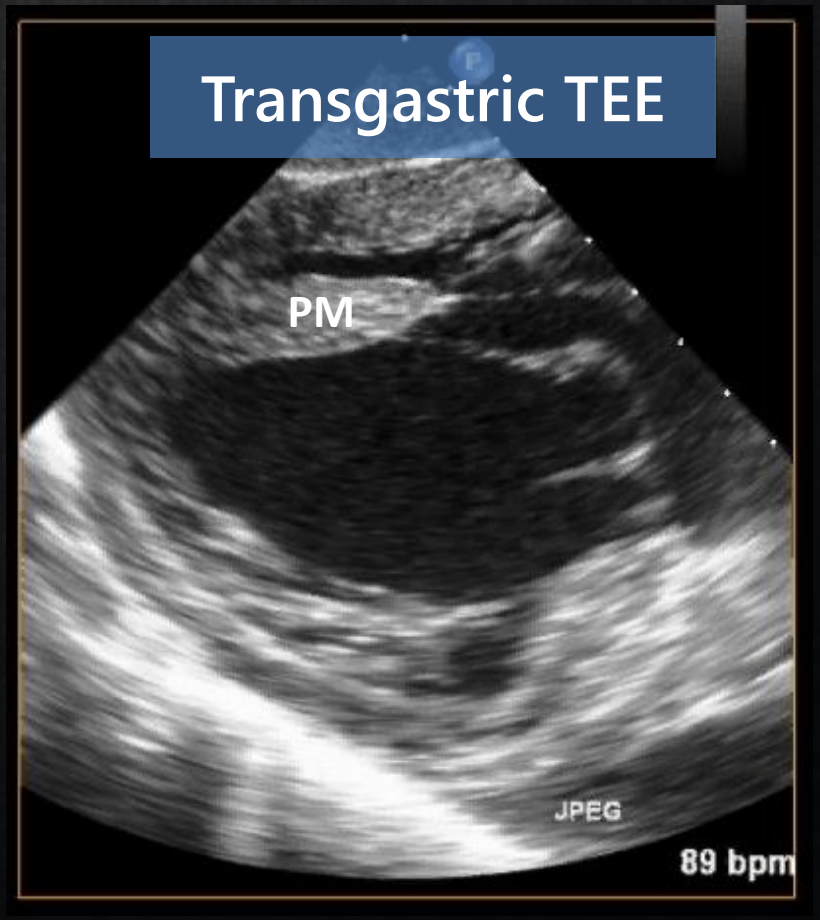




LAD or Circumflex?

Papillary Muscles





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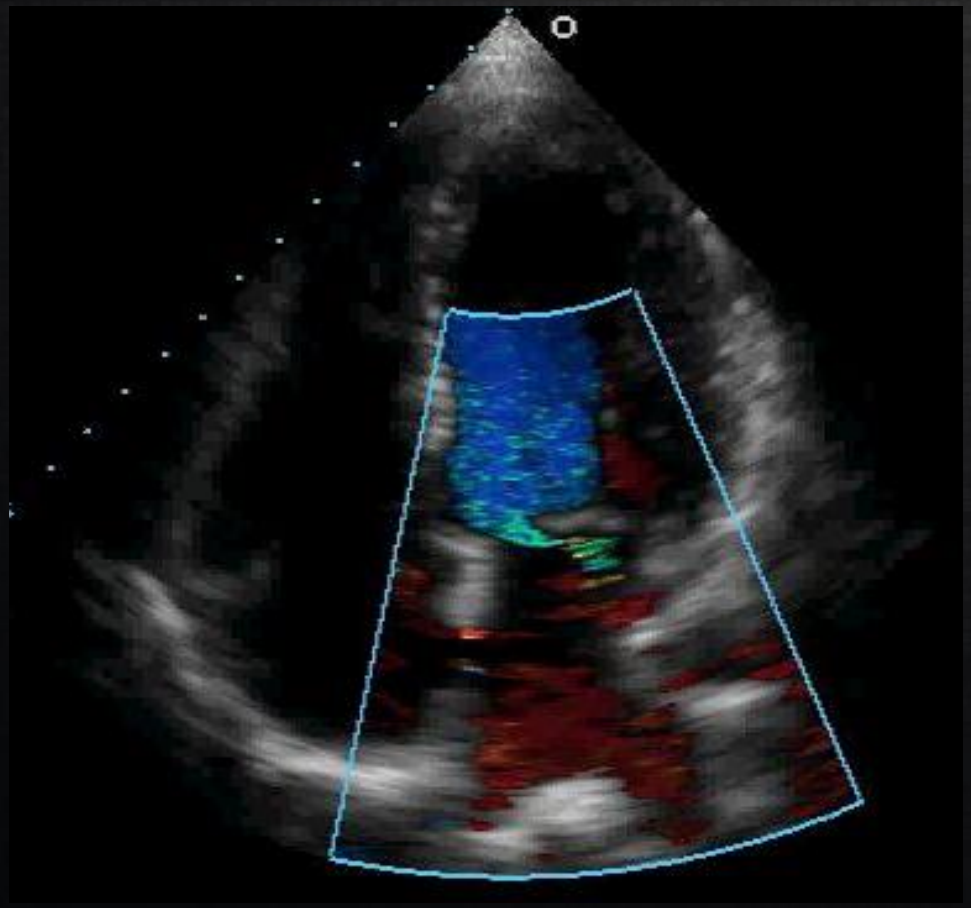
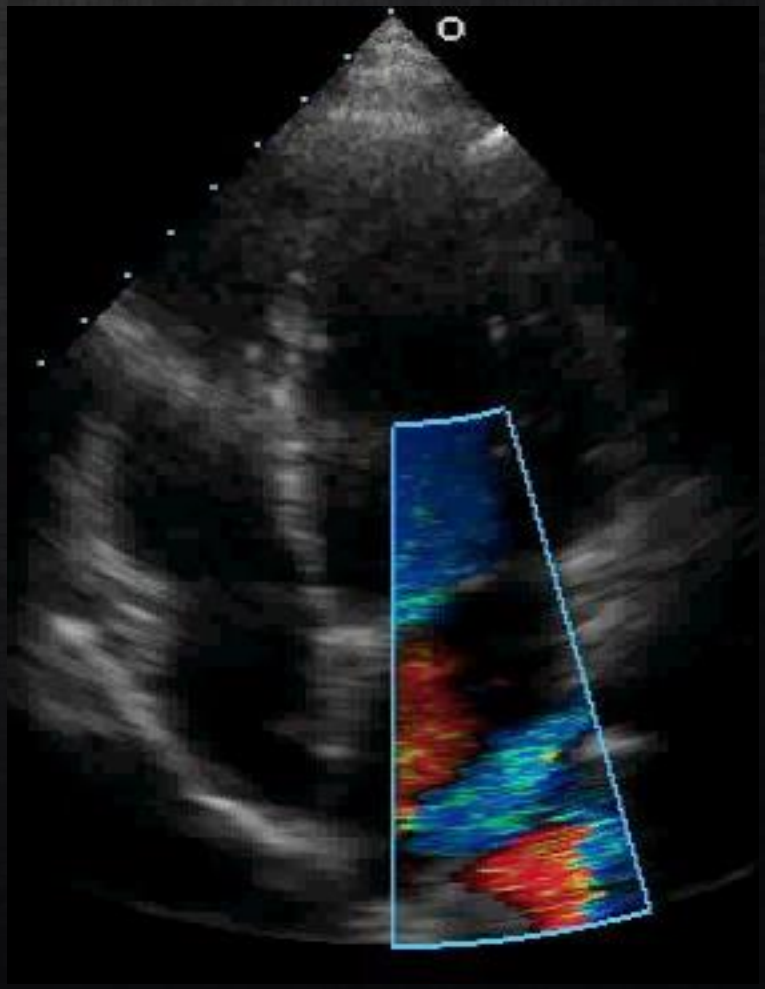
Pulmonary Veins





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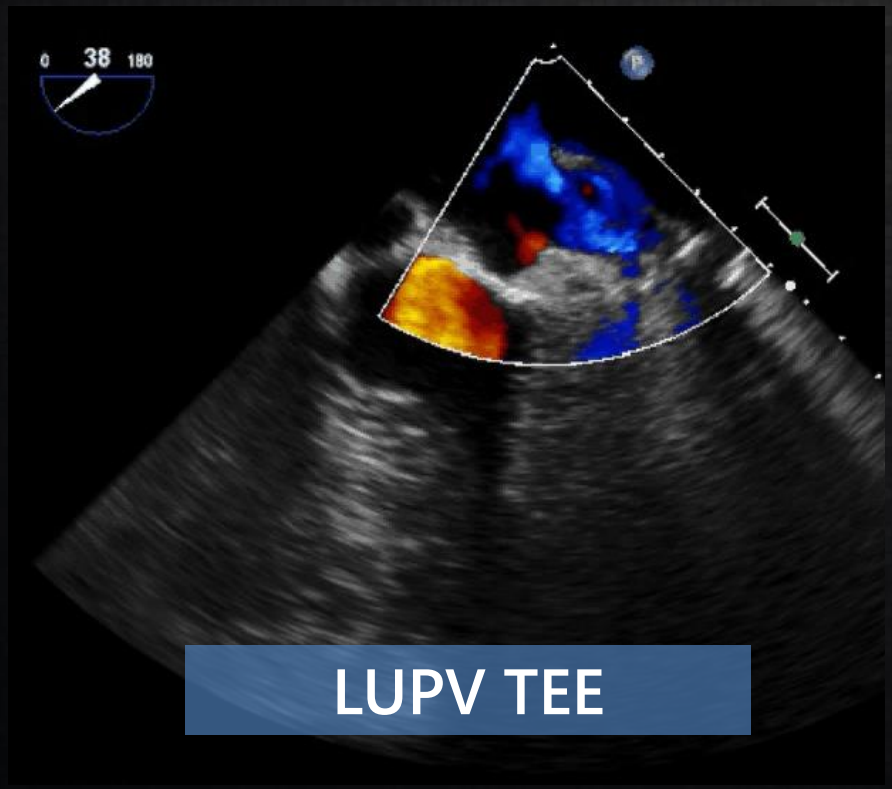
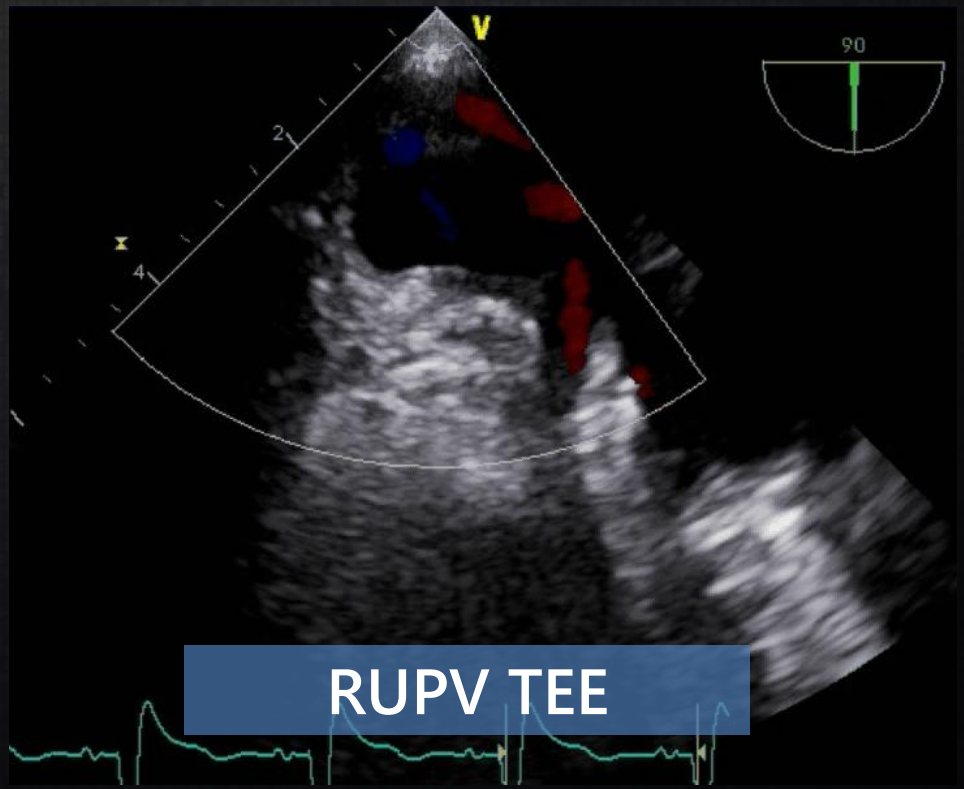
Pulmonary Veins

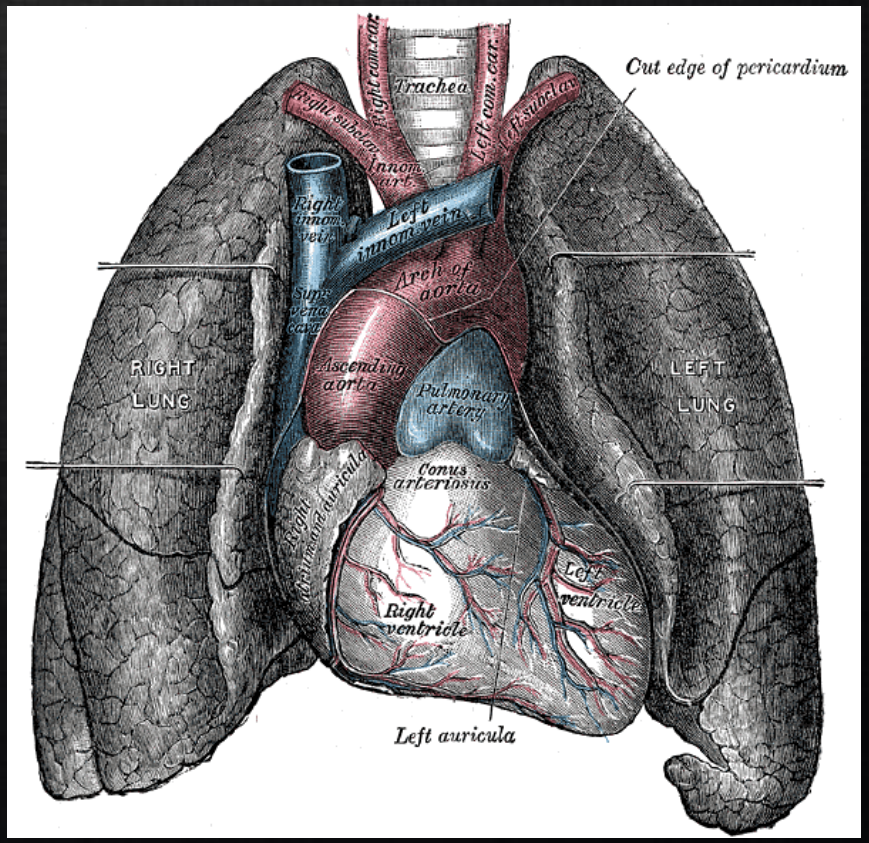


LUPV TEE



RUPV TEE

Suprasternal Notch



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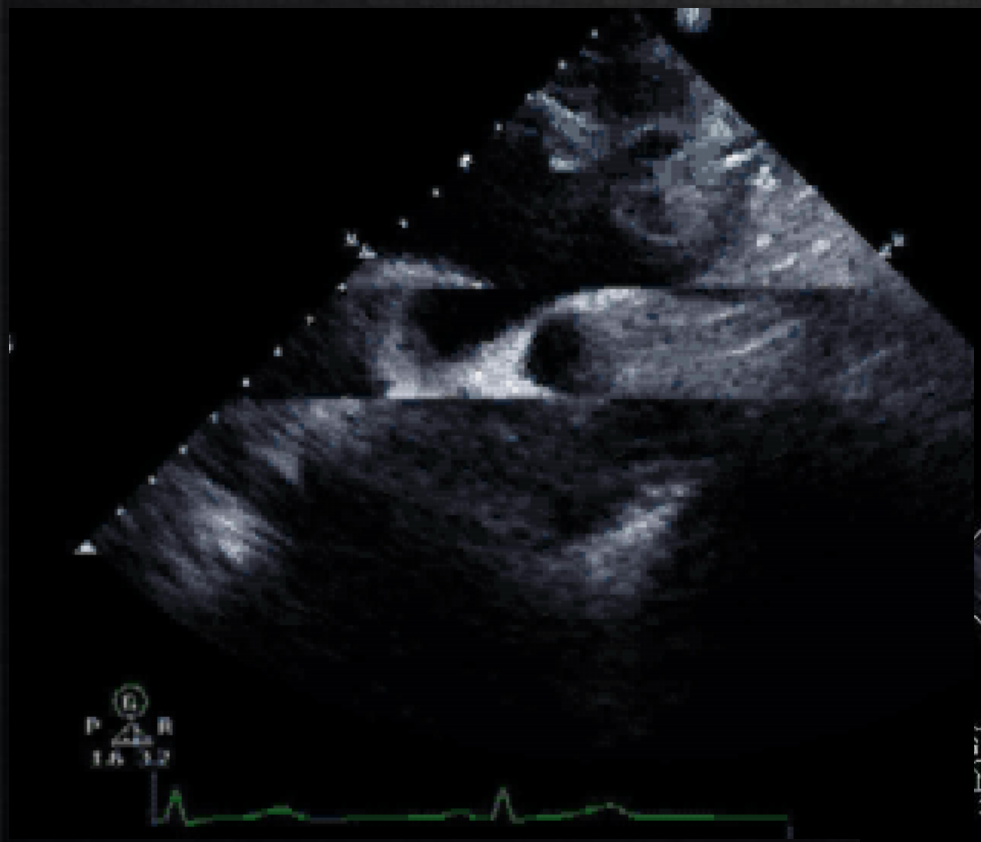
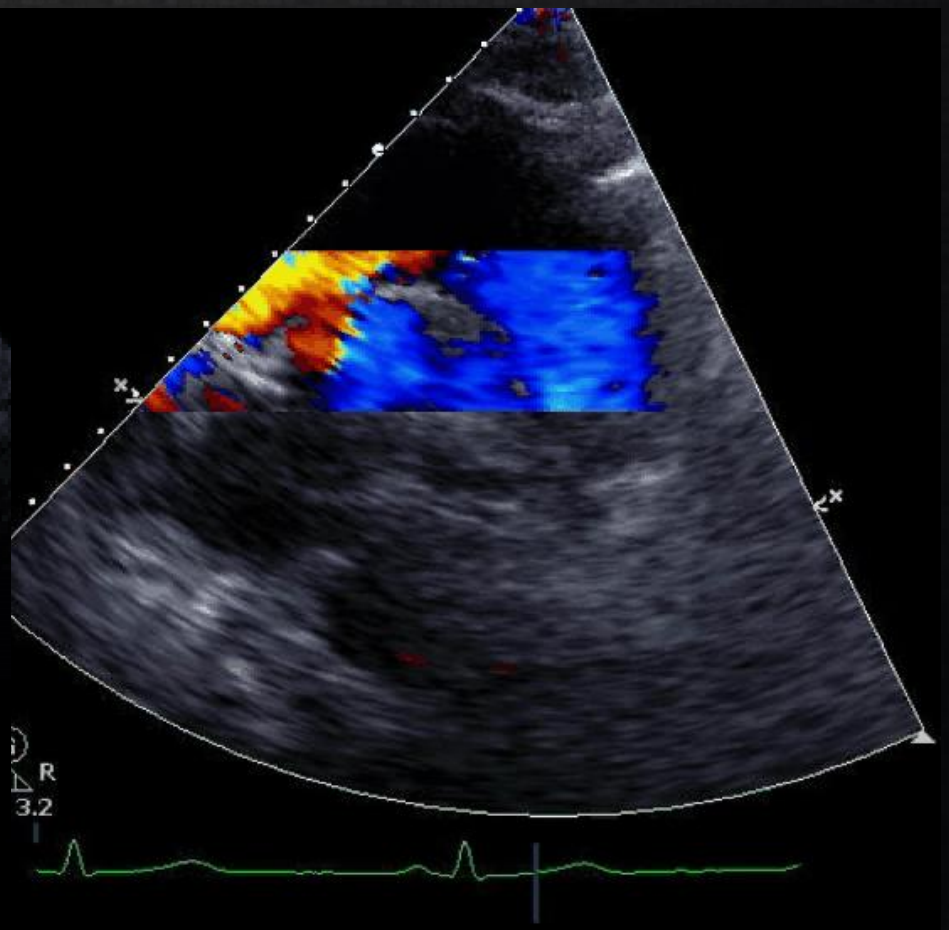
Suprasternal Notch



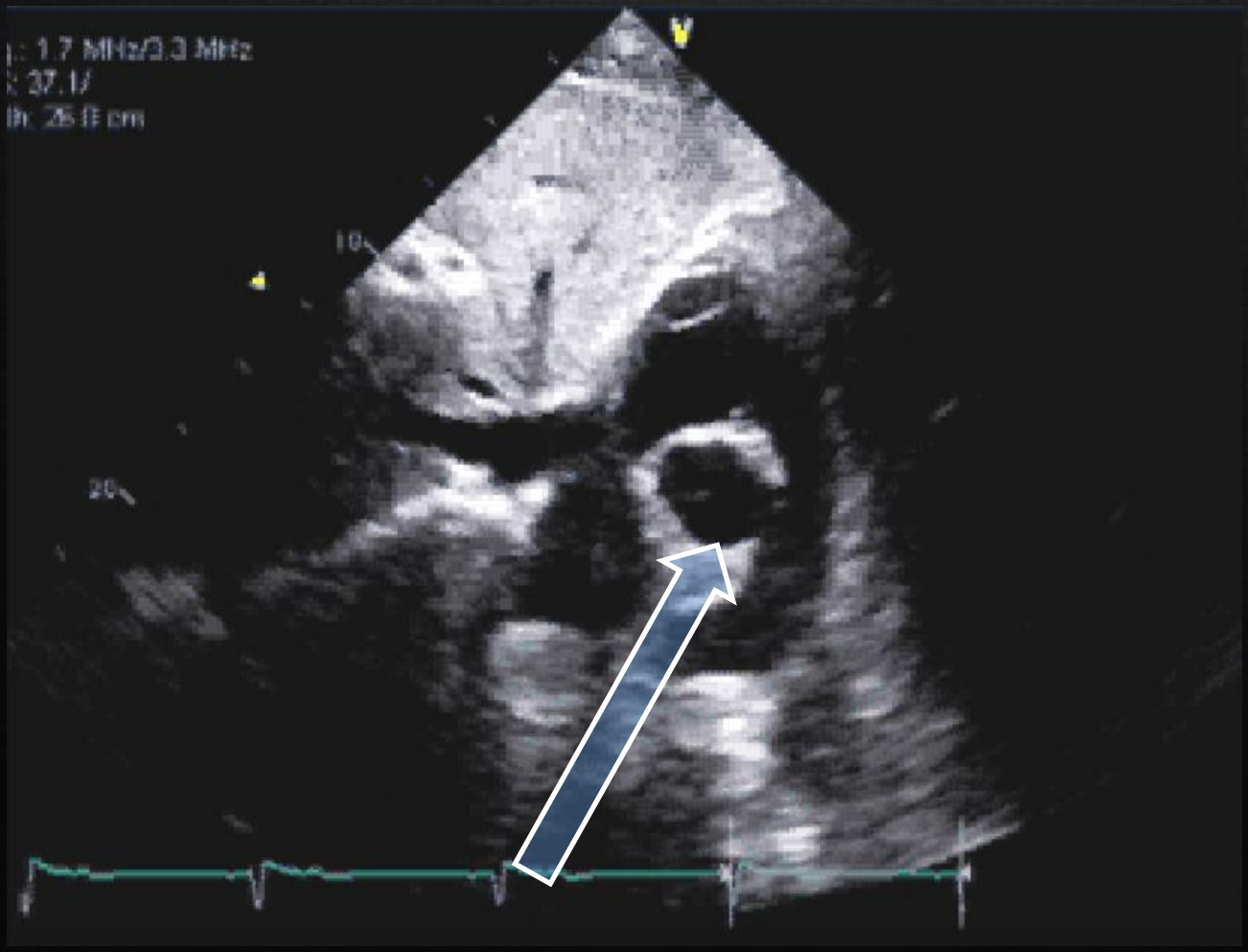


ASCeXAM Focus

- ✓ Normal Anatomic Structures
  - Right Heart
    - Persistent Venous Valve
    - Crista Terminalis
    - Coronary Sinus
    - Moderator Band
  - Left Heart
    - Pericardial Sinuses
    - Pulmonary Veins
    - Coronary Arteries
    - Papillary Muscles
    - Suprasternal Notch

Question 1

Which aortic cusp is noted by the arrow?



A. Right

B. Left

C. Non-Coronary

D. Can't tell

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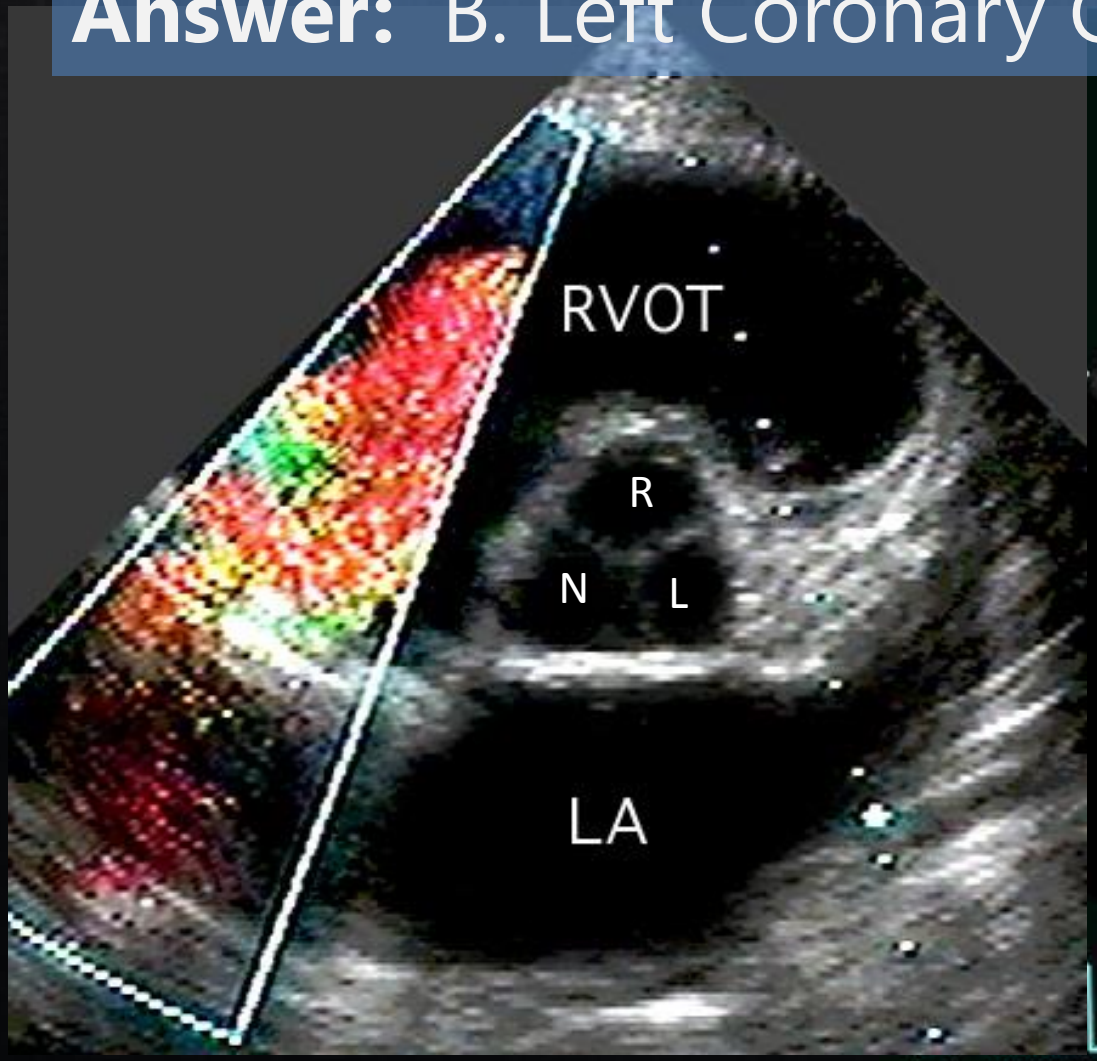
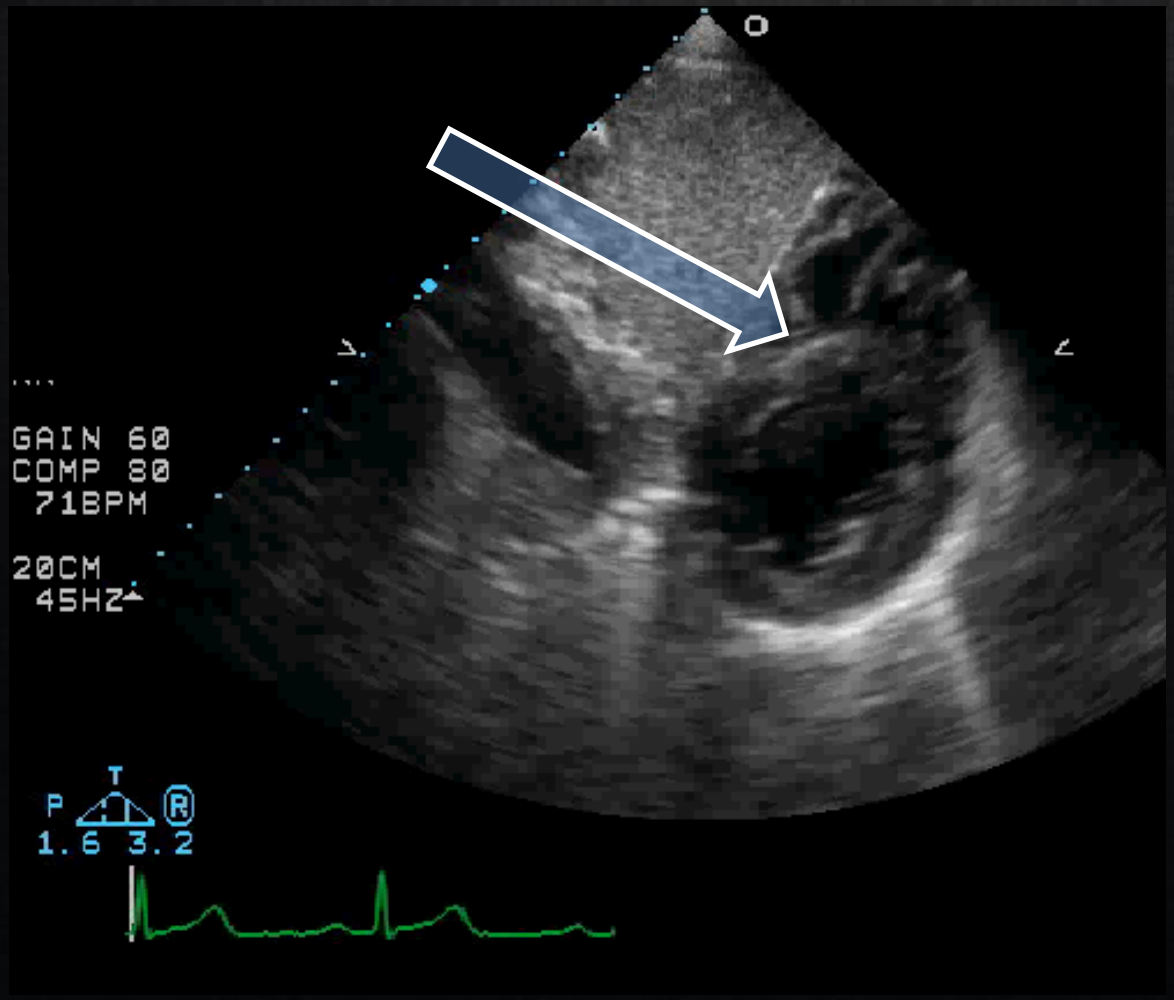
Question 1 - Followup

Answer: B. Left Coronary Cusp



Question 2

- ✓Which myocardial segment is denoted by the arrow?



A. Mid Anterior

B. Mid Anteroseptum

C. Mid Inferoseptum

D. Basal Anteroseptum

E. Mid Inferolateral

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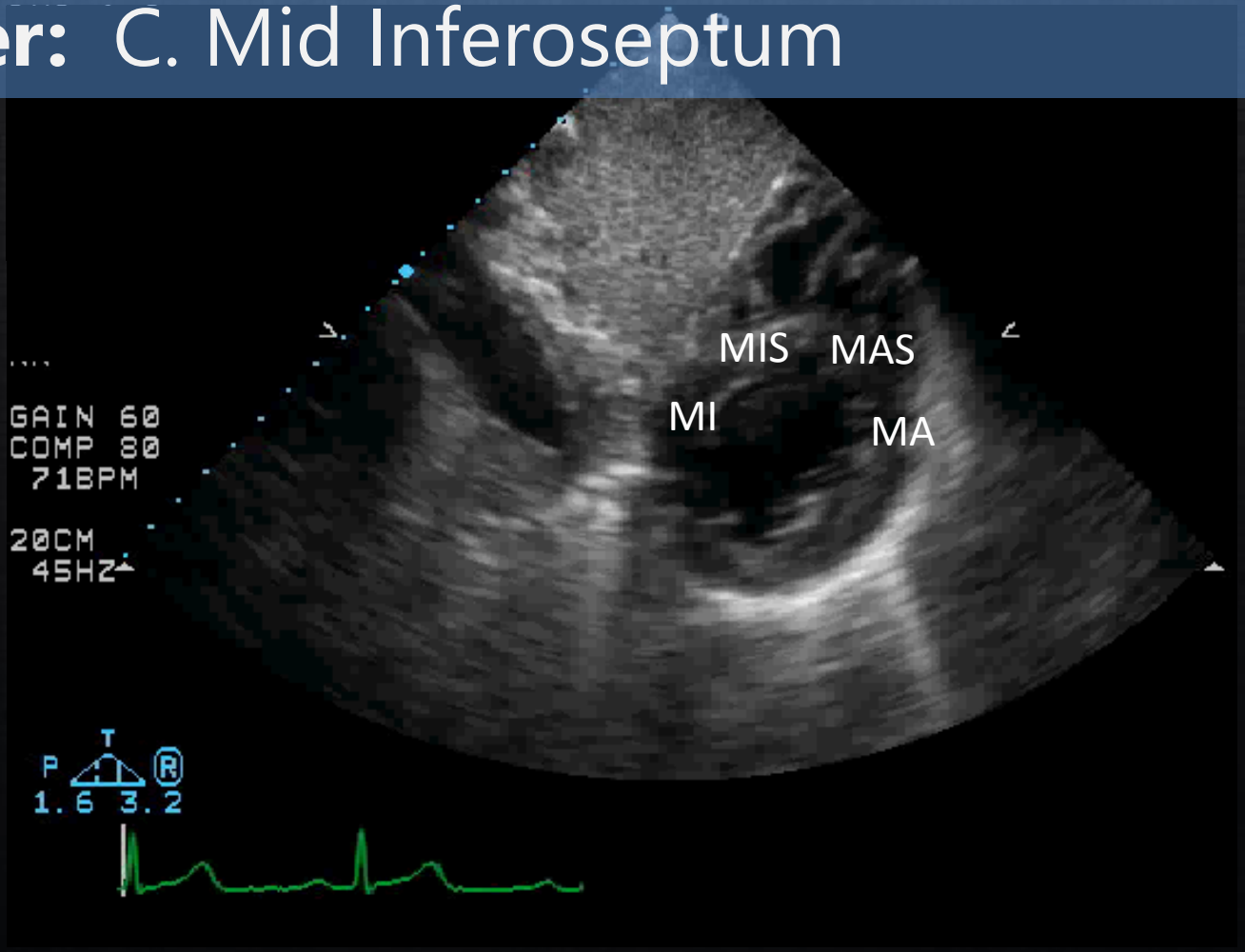
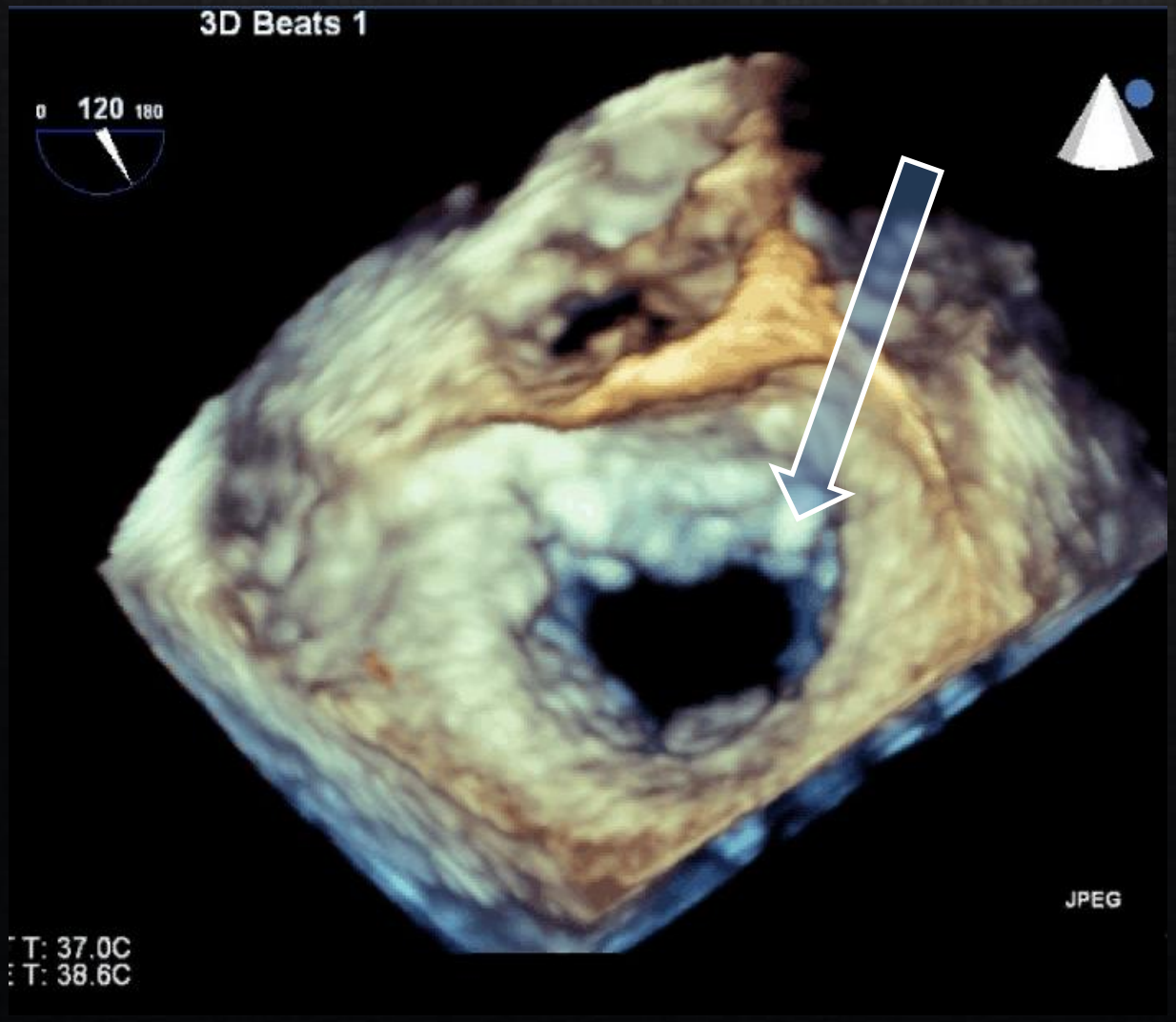
Question 2 - Followup

Answer: C. Mid Inferoseptum



Question 3

Which scallop is noted by the arrow?



A. Non-coronary

B. A2

C. P1

D. A1

E. A3

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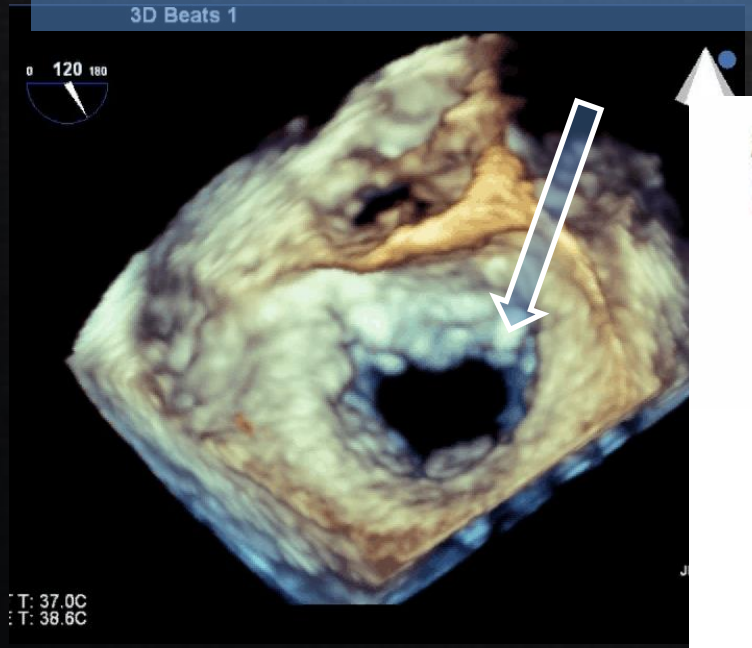
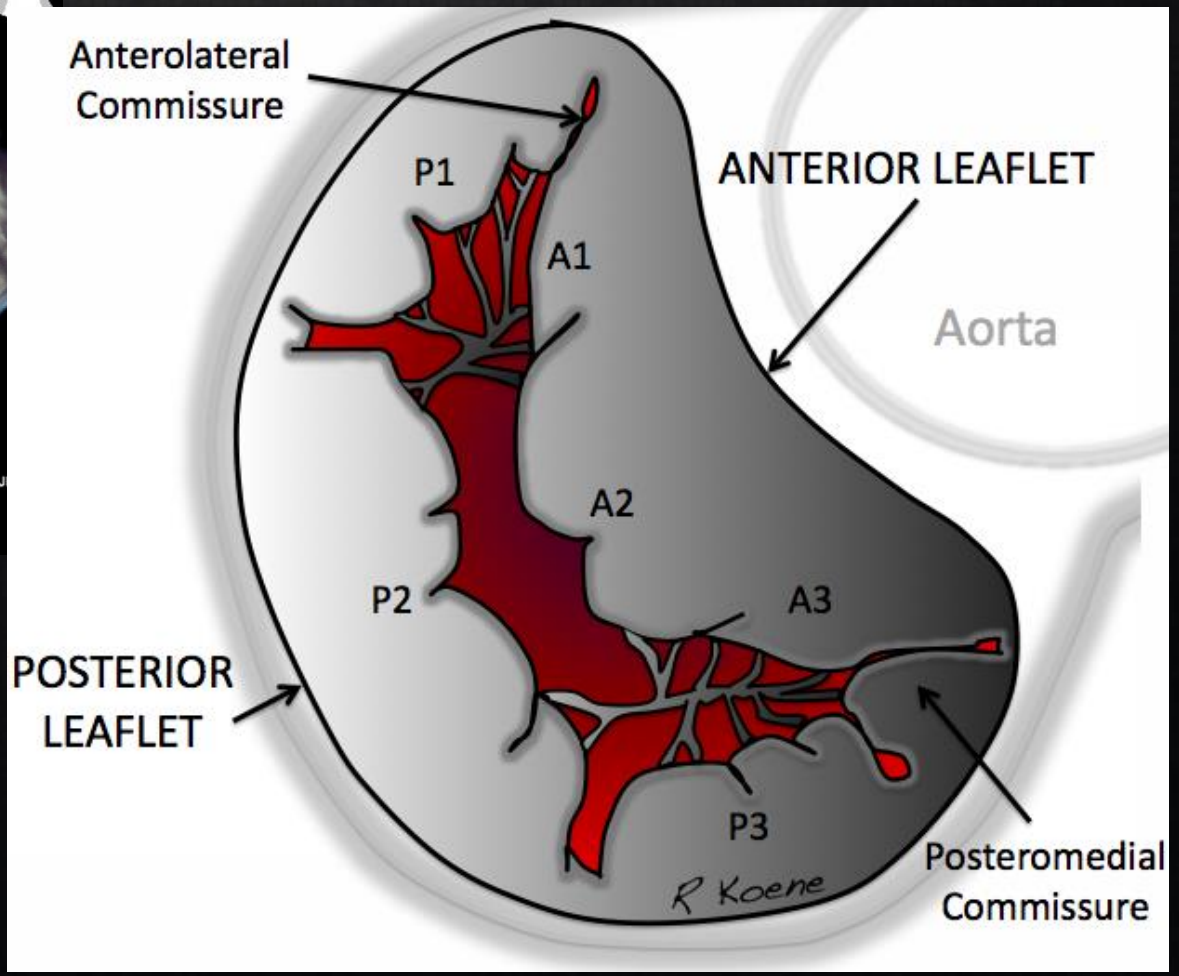
Question 3 - Followup

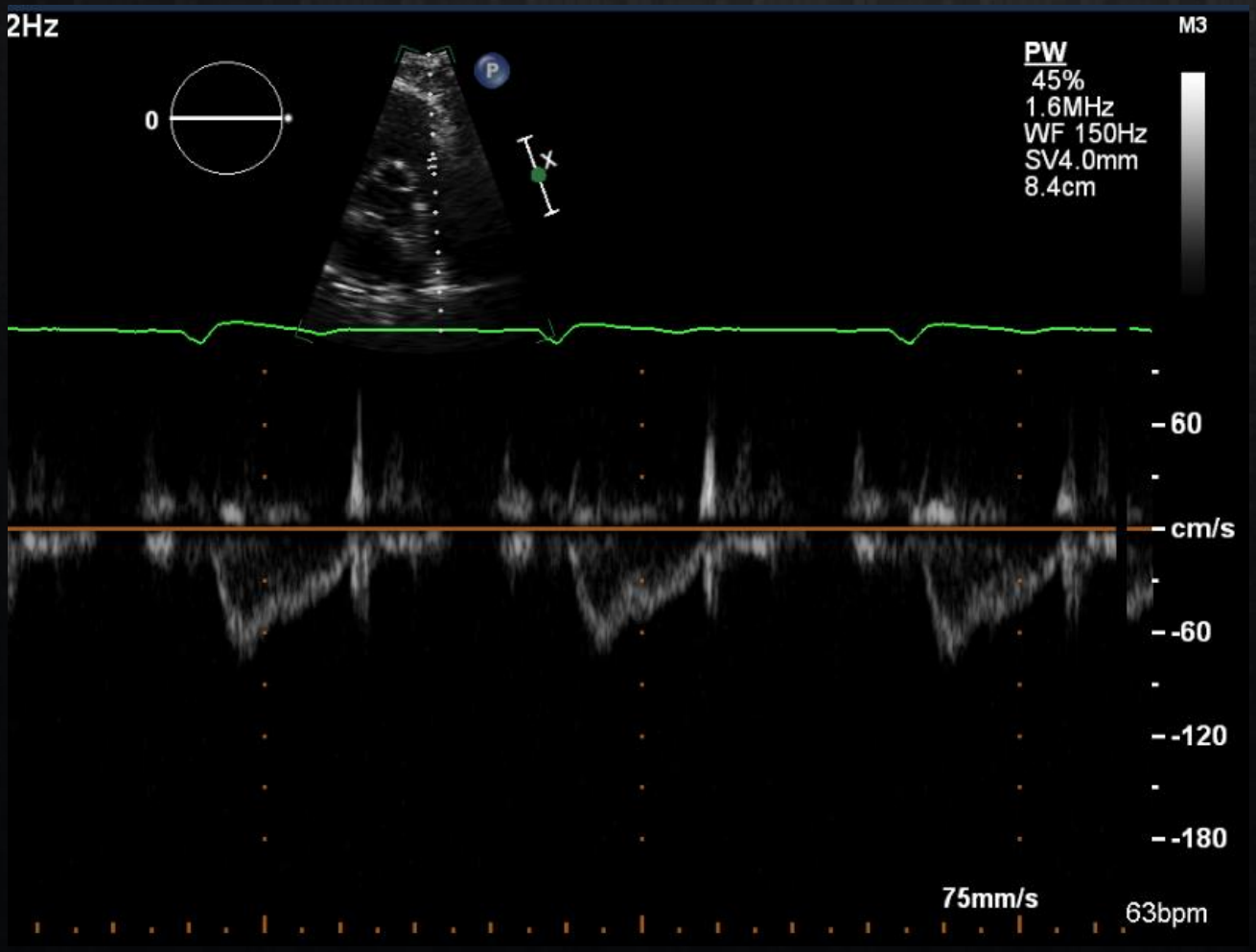
Answer: E. A3 Scallop





Question 4

How do you optimize this acquisition?



A. Raise baseline

B. Lower baseline

C. Increase scale

D. Decrease scale

E. Pedoff transducer

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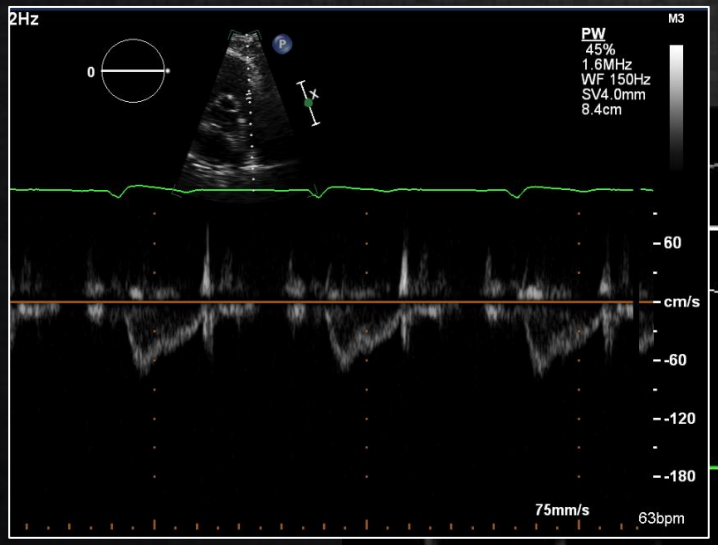
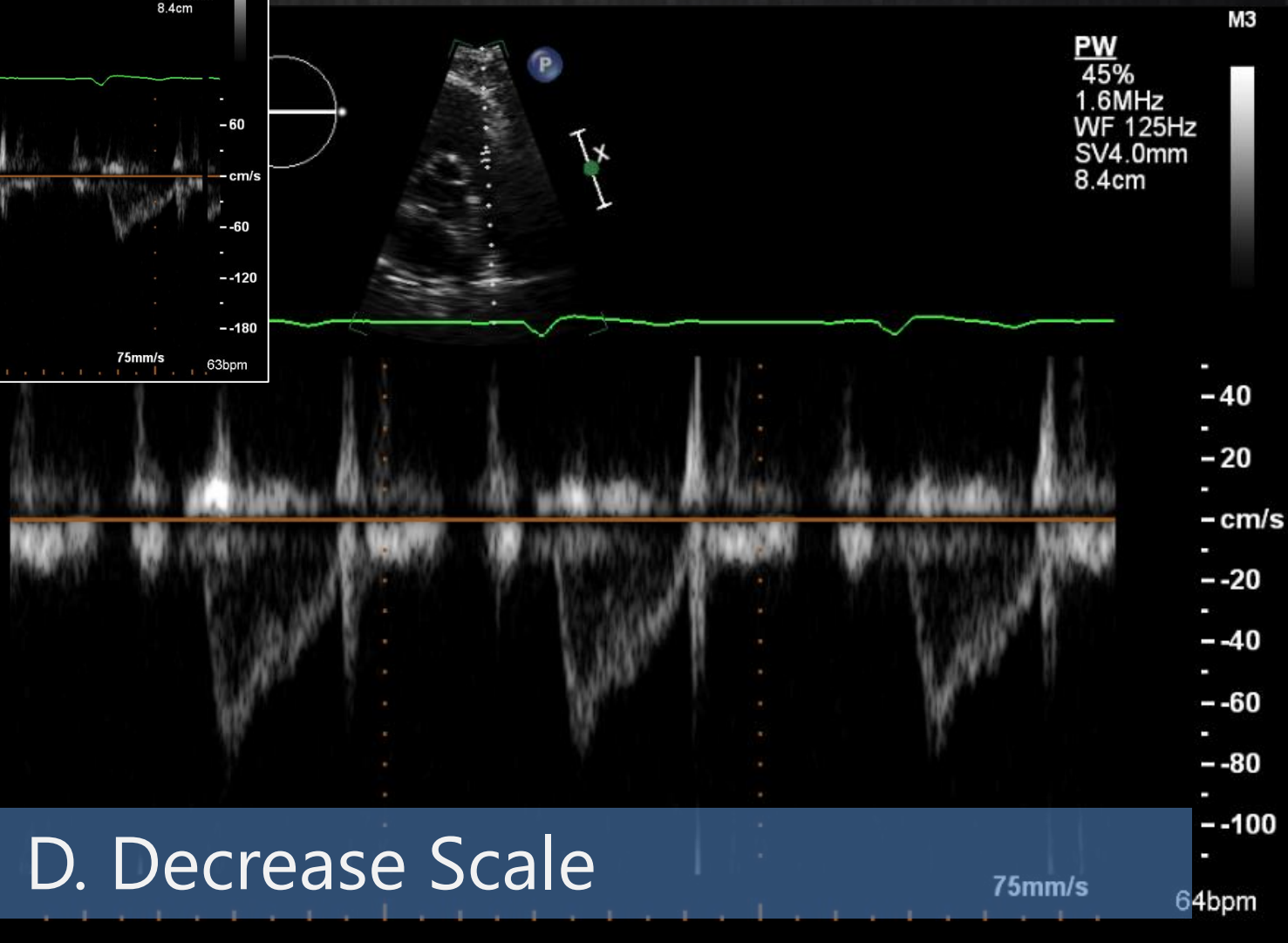
Question 4 - Followup

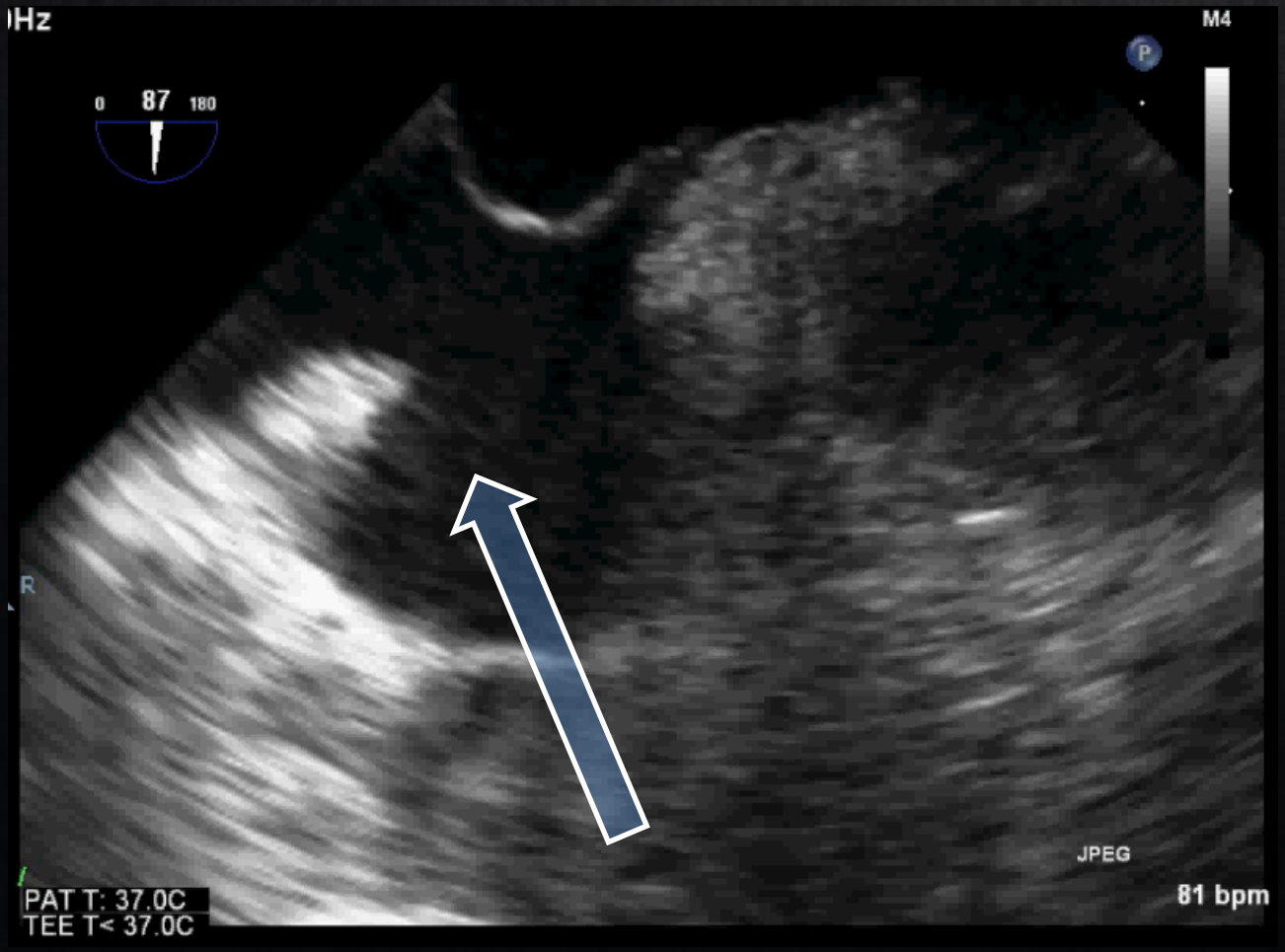




Answer: D. Decrease Scale

Question 5

What does the arrow indicate?



A. Eustachian Valve

B. RA thrombus

C. Chiari Network

D. Catheter in RA

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Question 5 - Followup

Answer: C. Chiari Network

Chiari Network

- ✓ **No known function**
- ✓ **Not present in every patient**
- ✓ **Netlike structure that is highly mobile**
- ✓ **Usually arises from the vicinity of the IVC not attached to the septum**

Eustachian Valve

- ✓ Directs IVC flow across fossa in fetus
- ✓ Present in every fetus
- ✓ Ridge of tissue - rarely mobile at all
- ✓ Arises from the IVC and runs to the fossa

Thank You!

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