Advanced Transesophageal Echocardiography

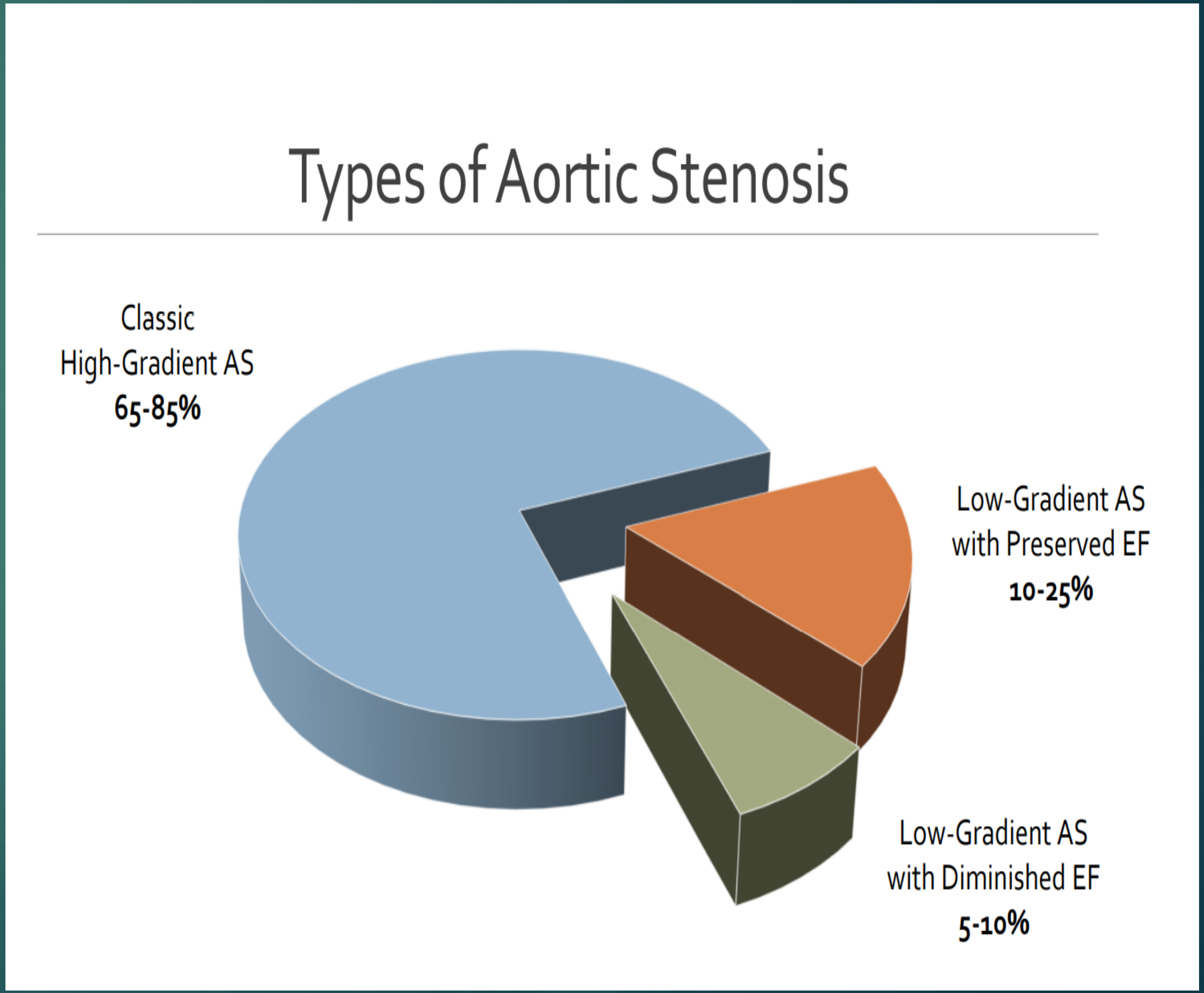
INTERVENTIONAL TEE

Objectives

- Discuss anesthesia considerations for transcatheter aortic valve replacement (TAVR)
- Discuss anesthesia considerations for transcatheter mitral valve repair (Mitraclip)
- Discuss anesthesia considerations for atrial appendage closure devices (Watchman, Amulet, Lariat)
- Describe the use of transesophageal echocardiography (TEE) for electrophysiology procedures

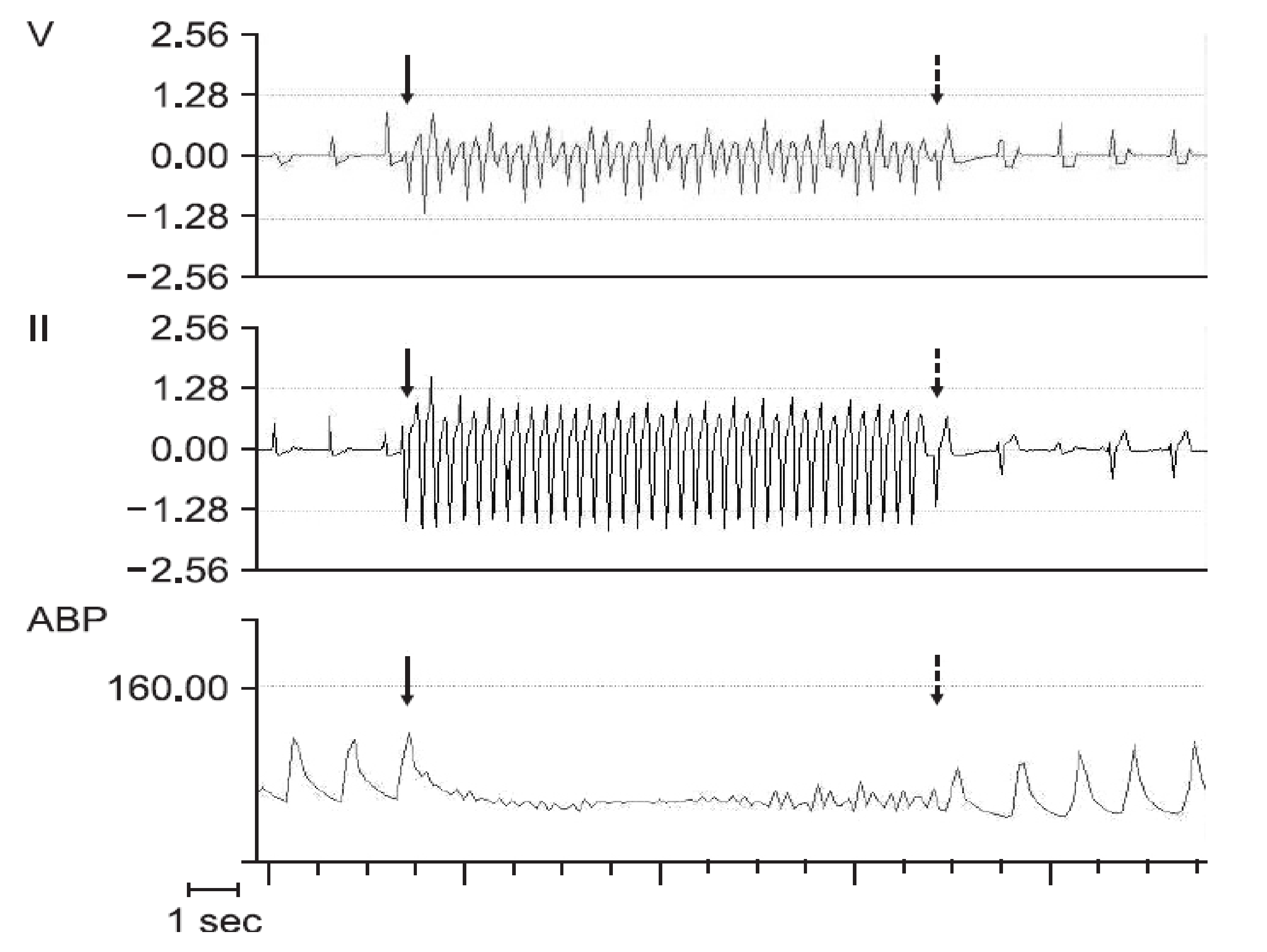
TAVR Overview

- Replacement valve is delivered via catheter using
  - Transfemoral
  - Transapical
  - Subclavian
  - Direct aortic
- Valve types
  - Core (Medtronic)
  - Sapien (Edwards)



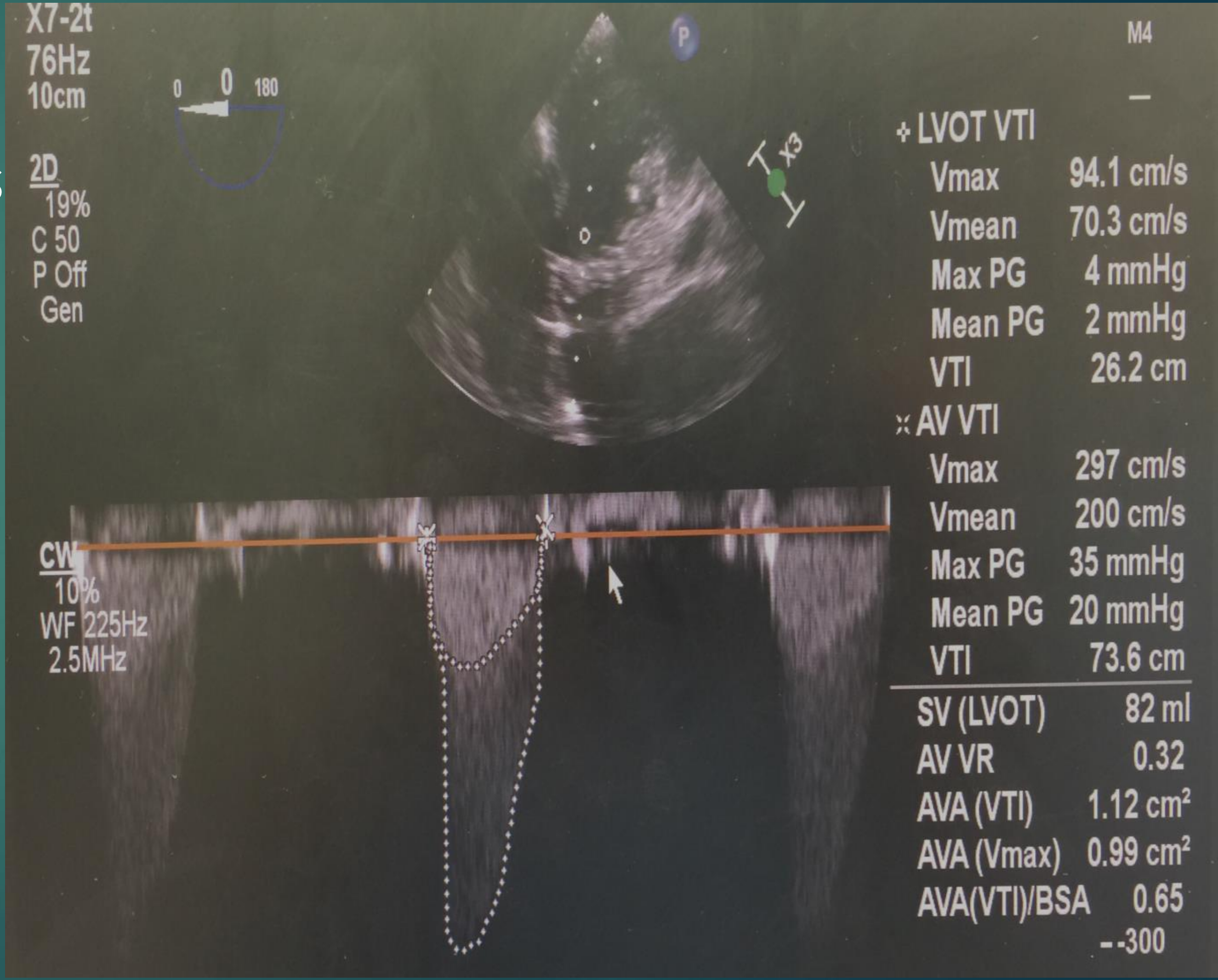
Hemodynamic Management

- Predeployment
  - Normal-high BP
  - Slow HR
  - Maintain contractility
- Deployment
  - Rapid ventricular pacing
  - Avoid hypercontractility
- Postdeployment
  - Normal-high BP
  - HR 70-80's
  - Aggressively treat dysrhythmias



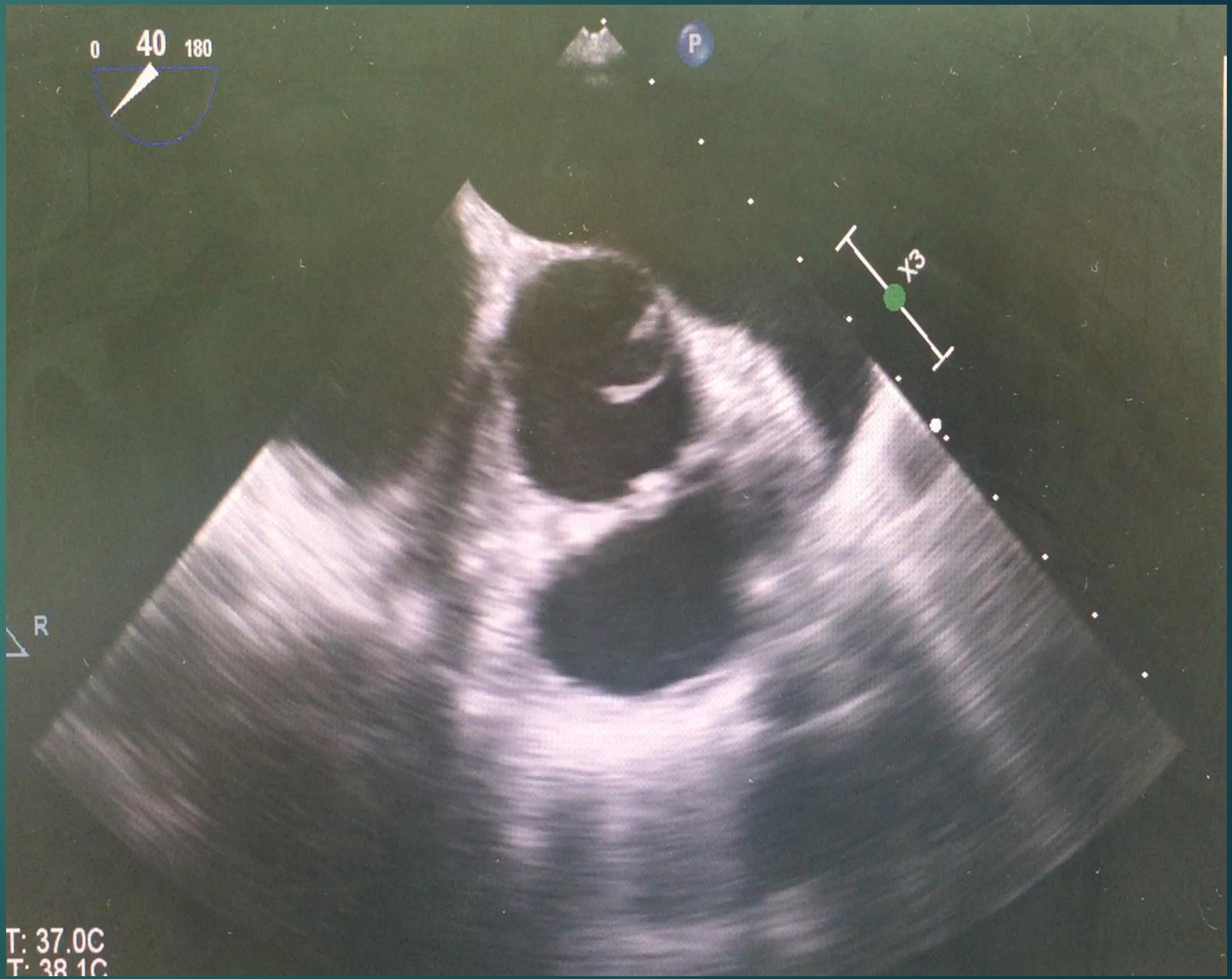
Role of TEE in TAVR

- Predeployment
  - LV function, aorta measurements
  - Transvalvular gradient, AVA
  - Other valve lesions
  - Measure aortic annulus
- Deployment/Postdeployment
  - Assist in assessing valve position and function
  - Assess for AI, paravalvular leak, gradient, complications
  - Hemodynamic management



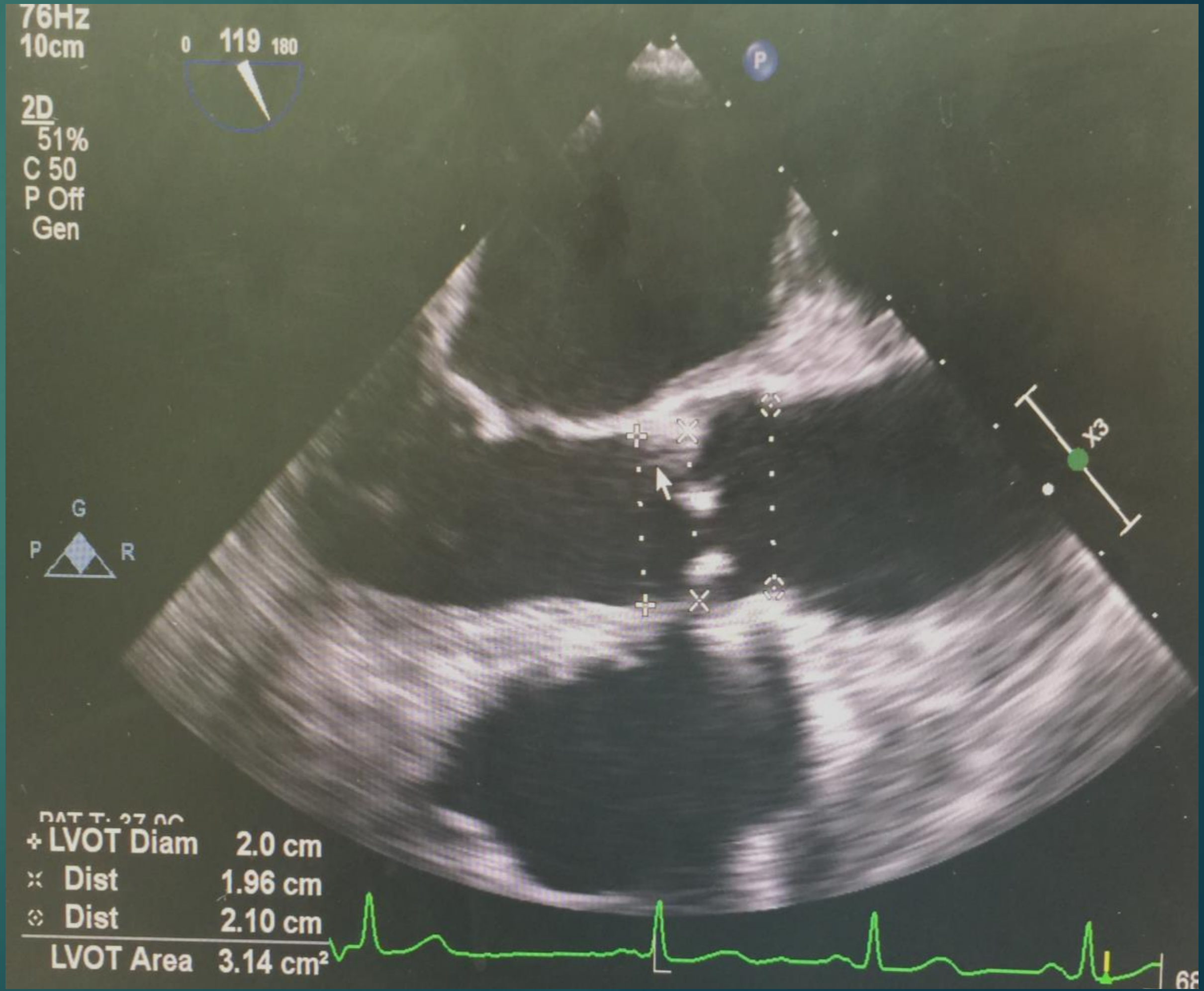
ME Short Axis Aortic Valve, ME RVIFOF and ME Bicaval Views

- Color flow mapping and planimetry of the aortic valve
- Color flow mapping of the tricuspid and mitral valve
- Assess right ventricular function (qualitative)
- Color flow mapping of the intra-atrial septum (Nyquist 30) to rule out PFO/ASD



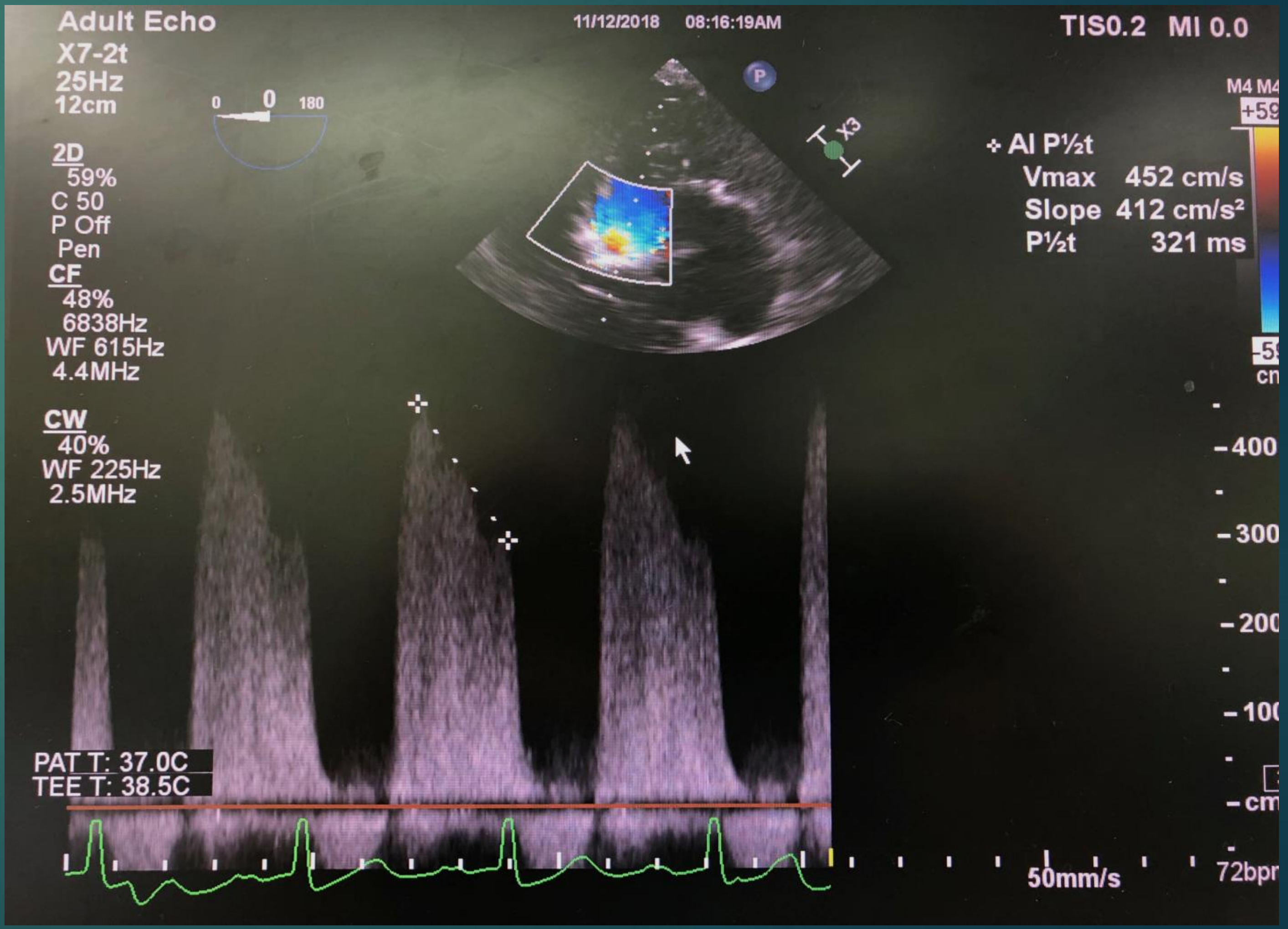
ME Long Axis and ME Aortic Valve

- Wall motion evaluation
- Color flow mapping of MV, AV
- Measure VC if MR, AI if present
- Measure PISA radius if significant mitral regurgitation or stenosis present
- Measure LVOT, annulus, sinuses of Valsalva, STJ, ascending aorta diameters



Transgastric and Deep Transgastric Views

- TG mid-papillary/basal and TG two chamber/long axis for wall motion and chamber dimensions
- Deep Transgastric View:
  - CFM and Doppler (CW)
  - PHT for AI (Normal >500 ms)
  - Mean and peak gradient for AS
  - Calculate aortic valve area using continuity equation

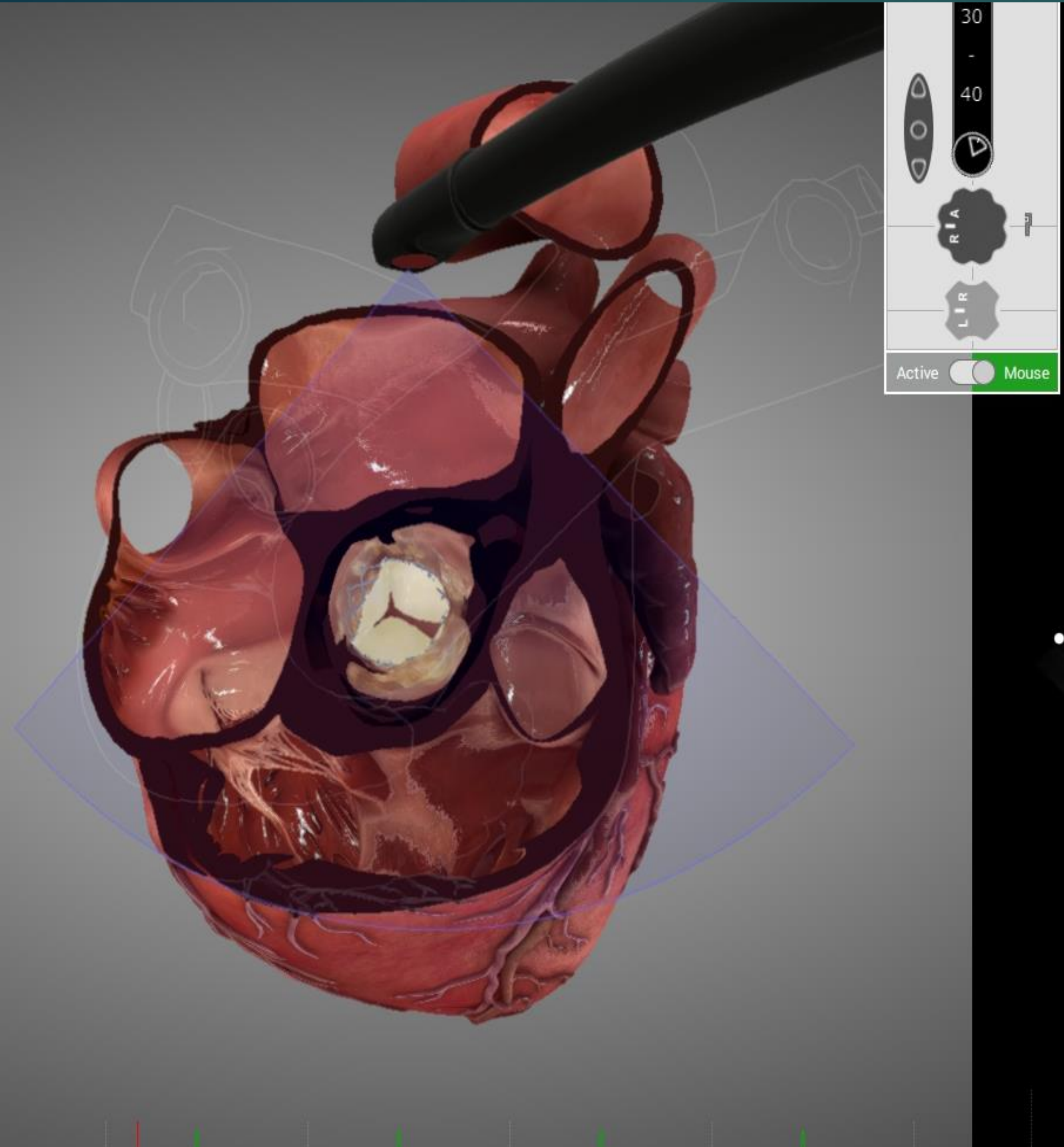


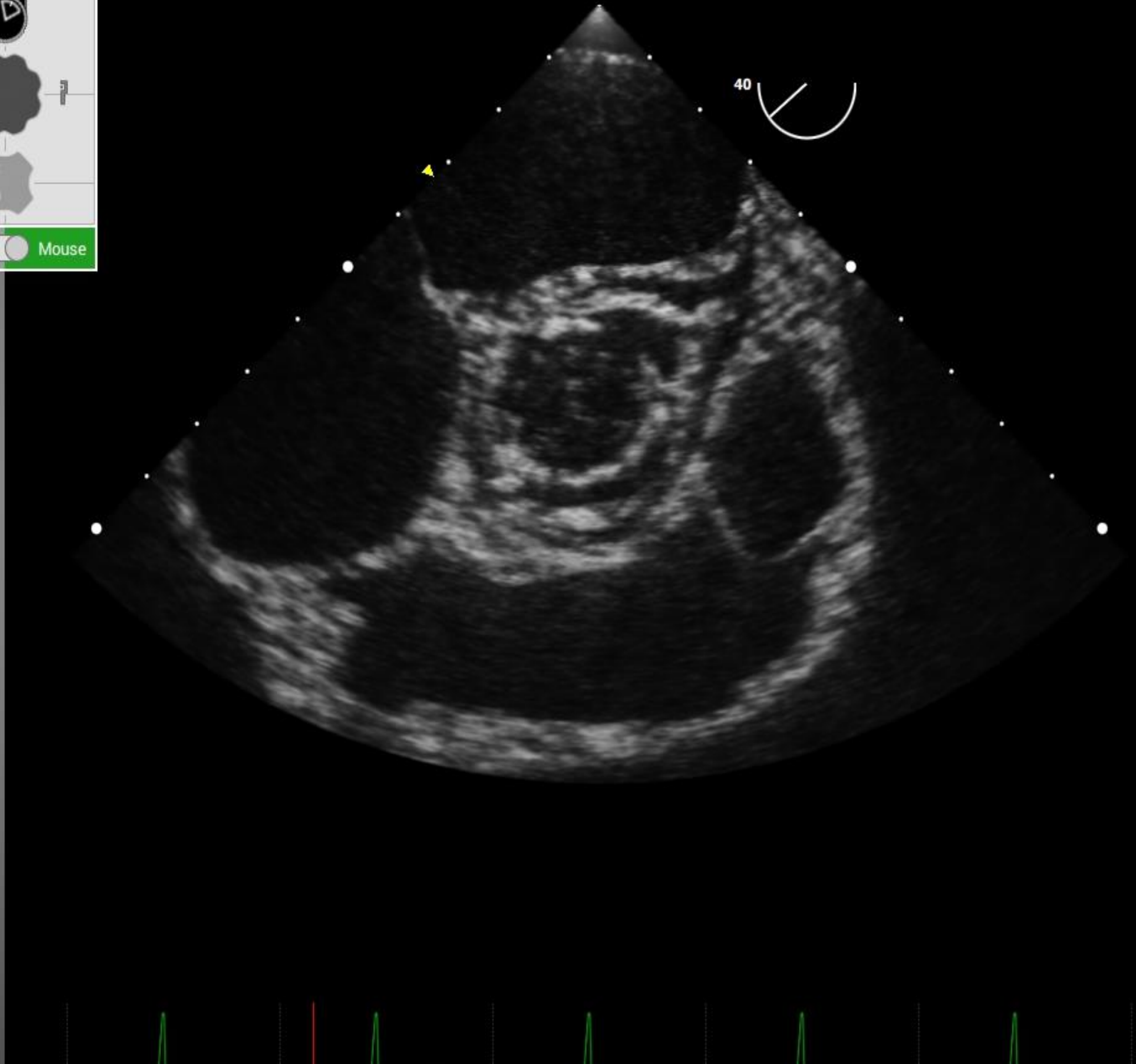
TAVR: Markers of Good Implantation

- Valve shape and location
  - Short axis: circular rather than ovoid
  - Long axis: proximal end 2-6 mm in LVOT
- Valve gradient (Vmax <2 m/s)
- Valve regurgitation
  - No significant paravalvuar or transvalvular AI
- If suboptimal consider:
  - Repositioning/Post-dilation
  - Reimplantation

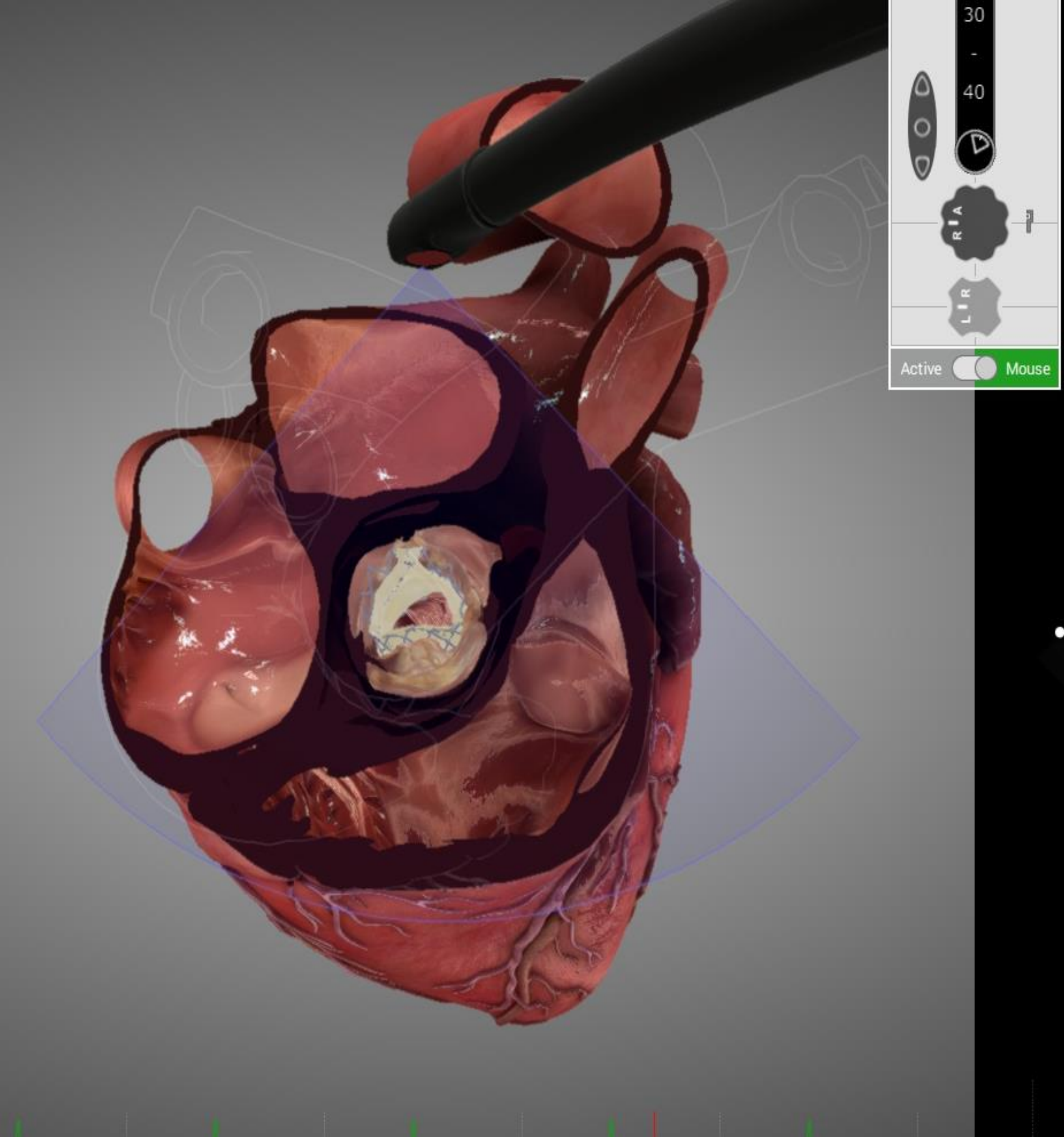
TAVR 80% Deployed

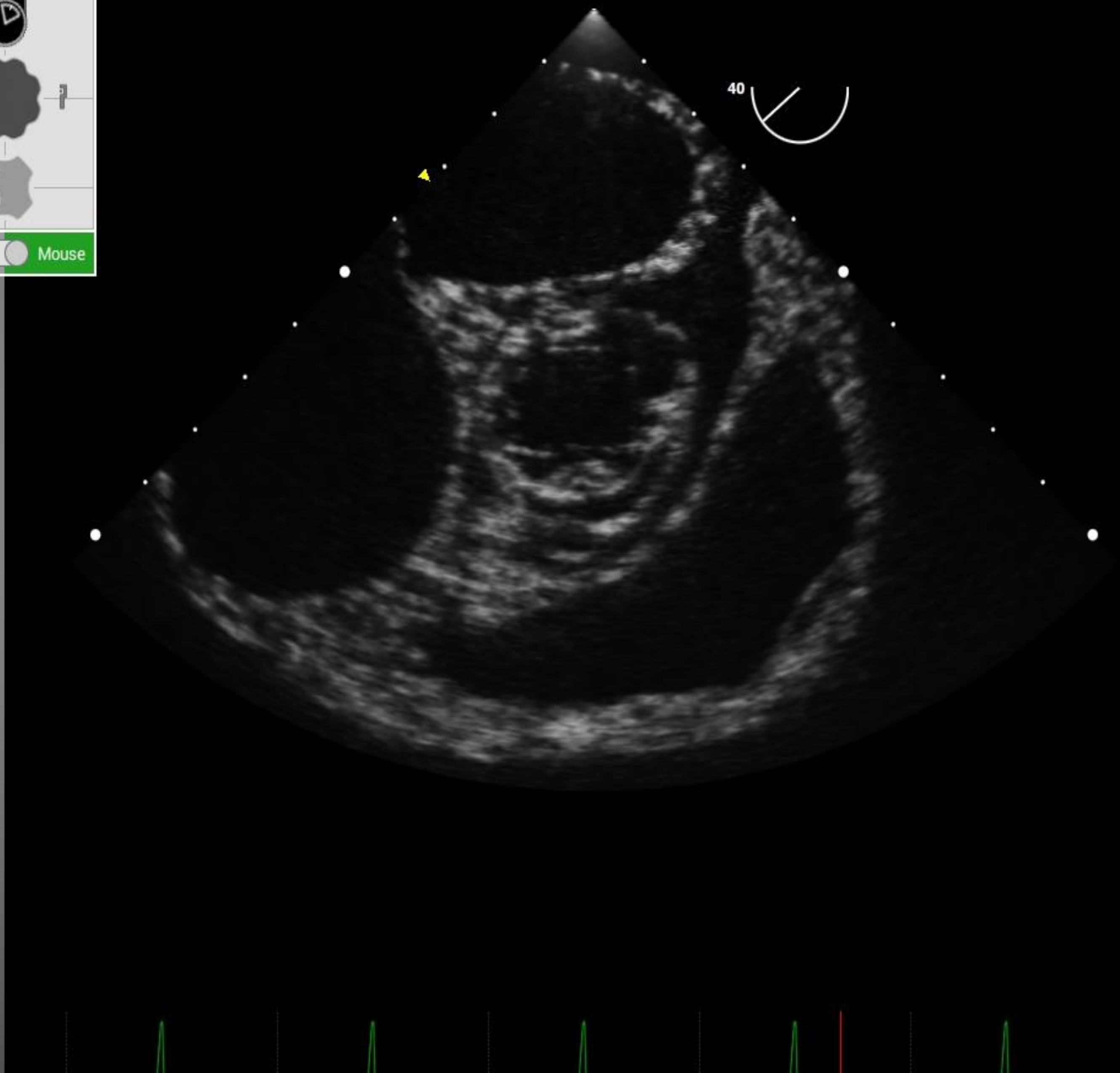
TAVR Valve Shape: Circular



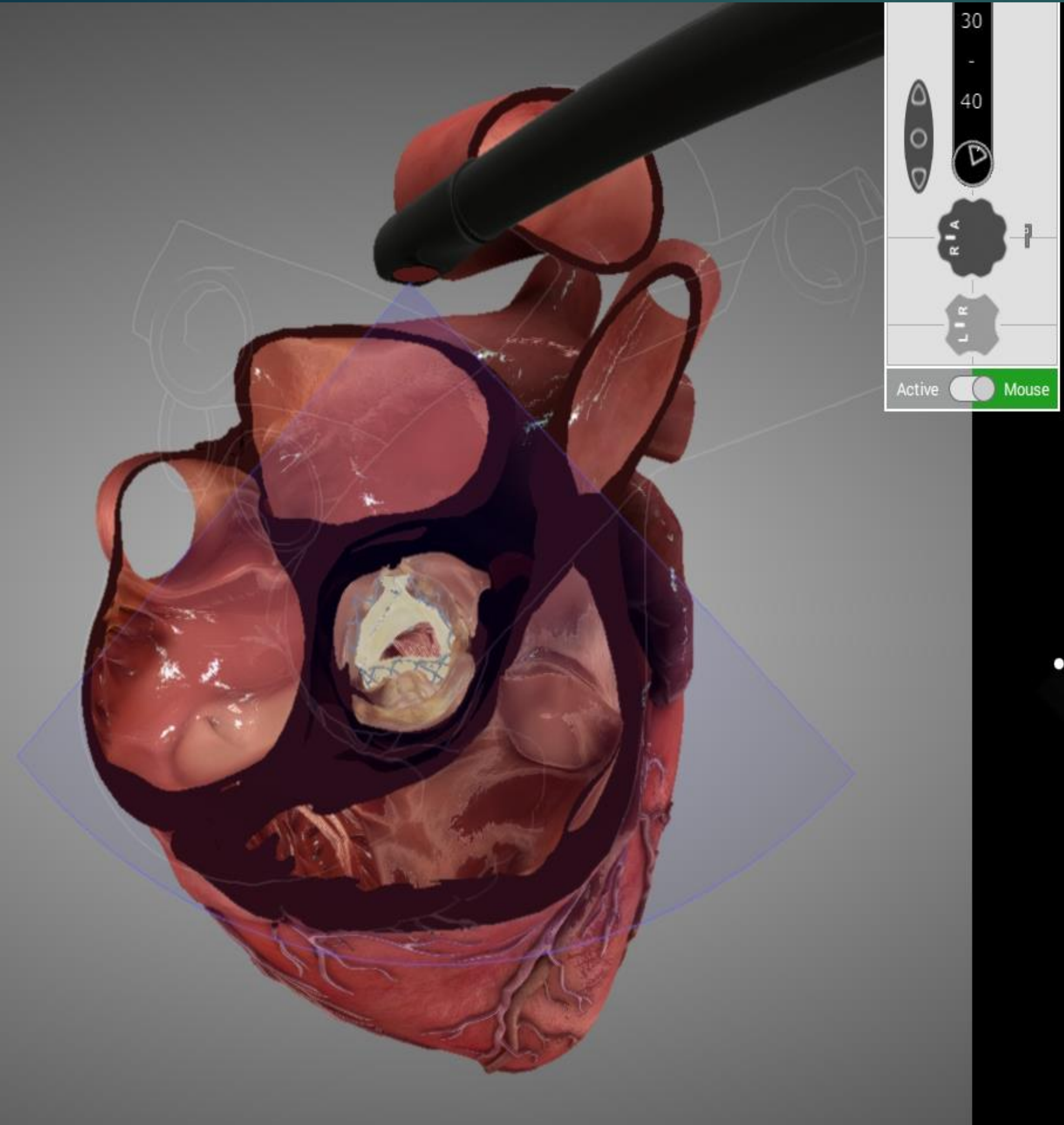


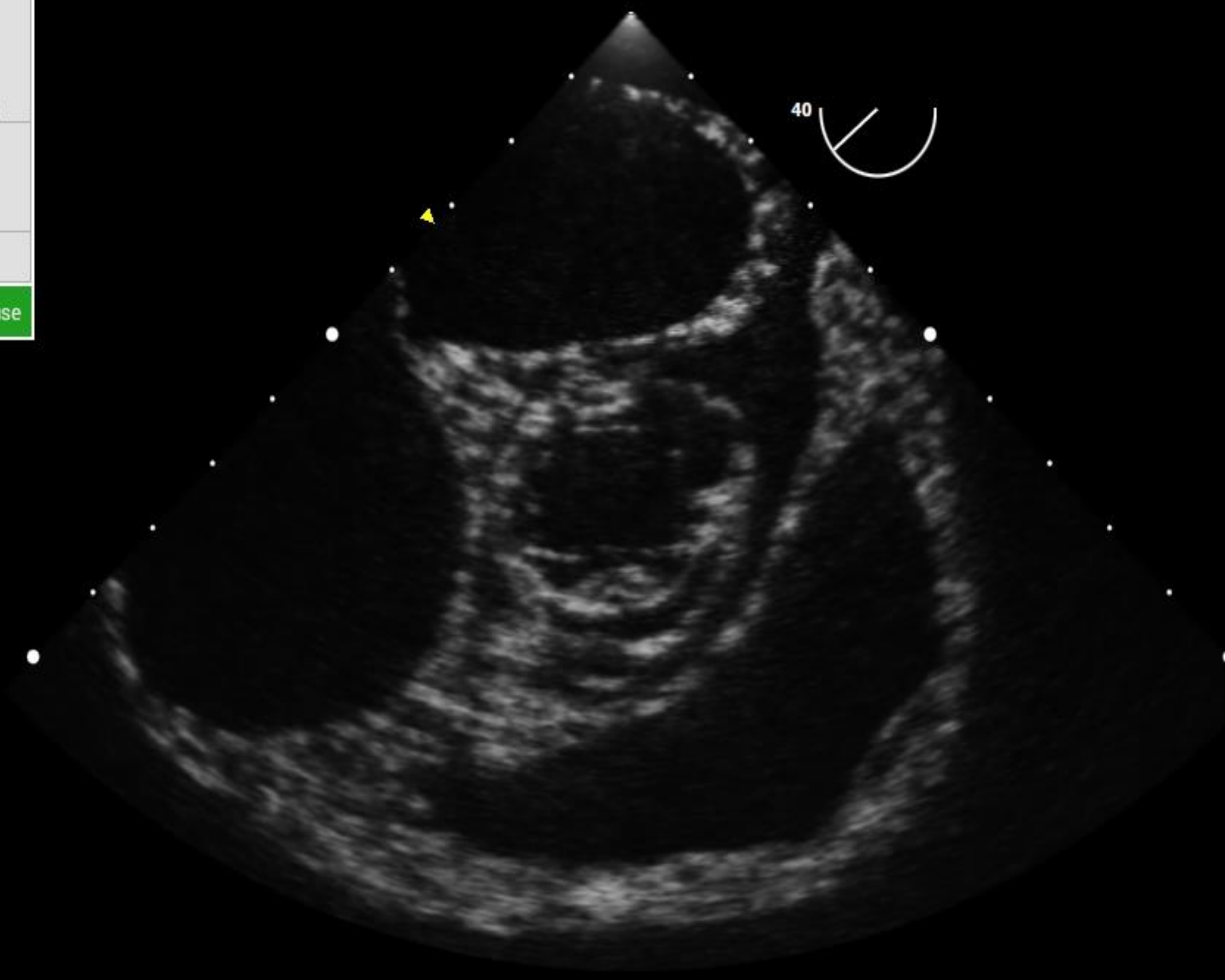
TAVR Valve Shape: Ovioid



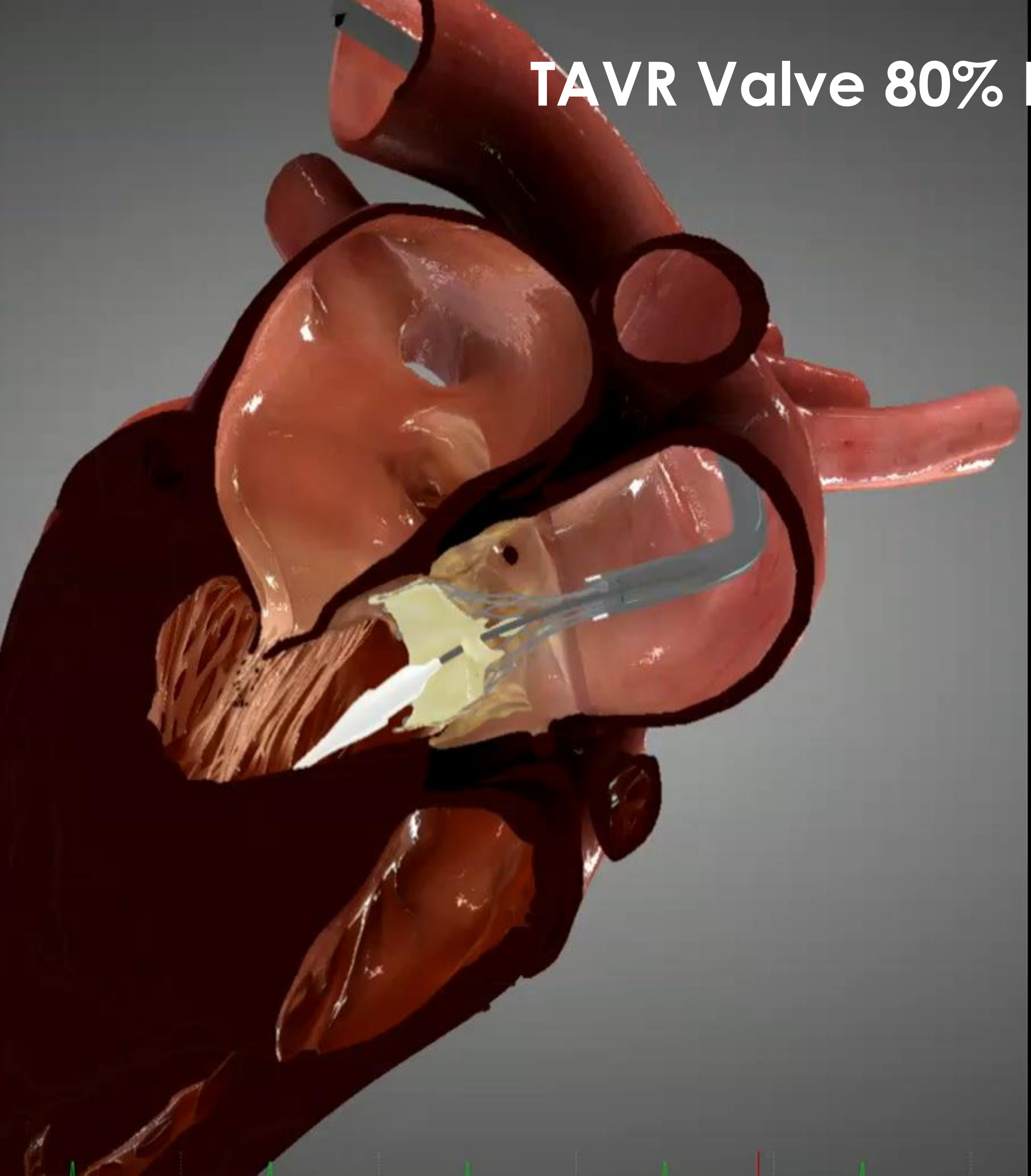


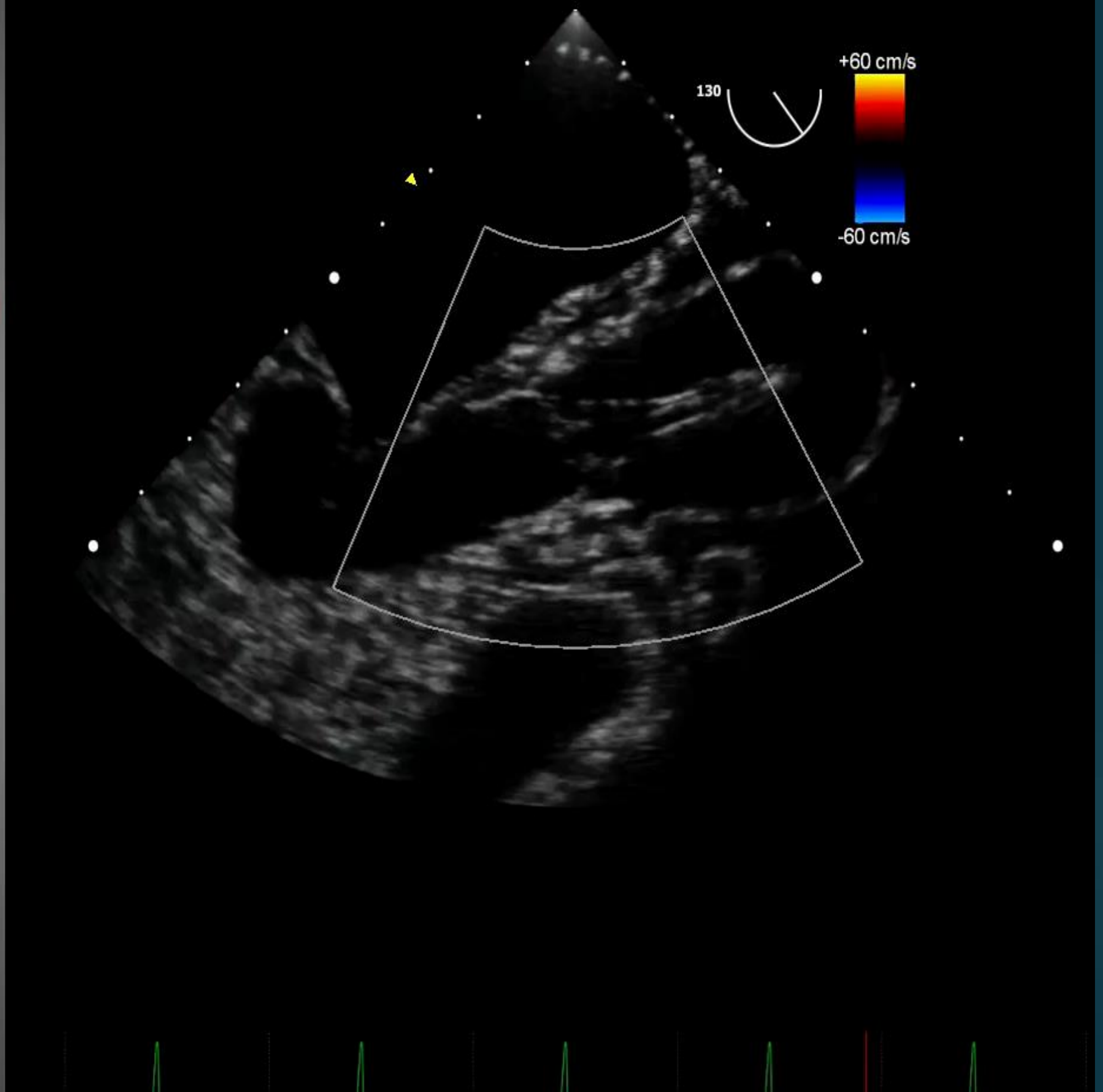
Constrained TAVR Valve



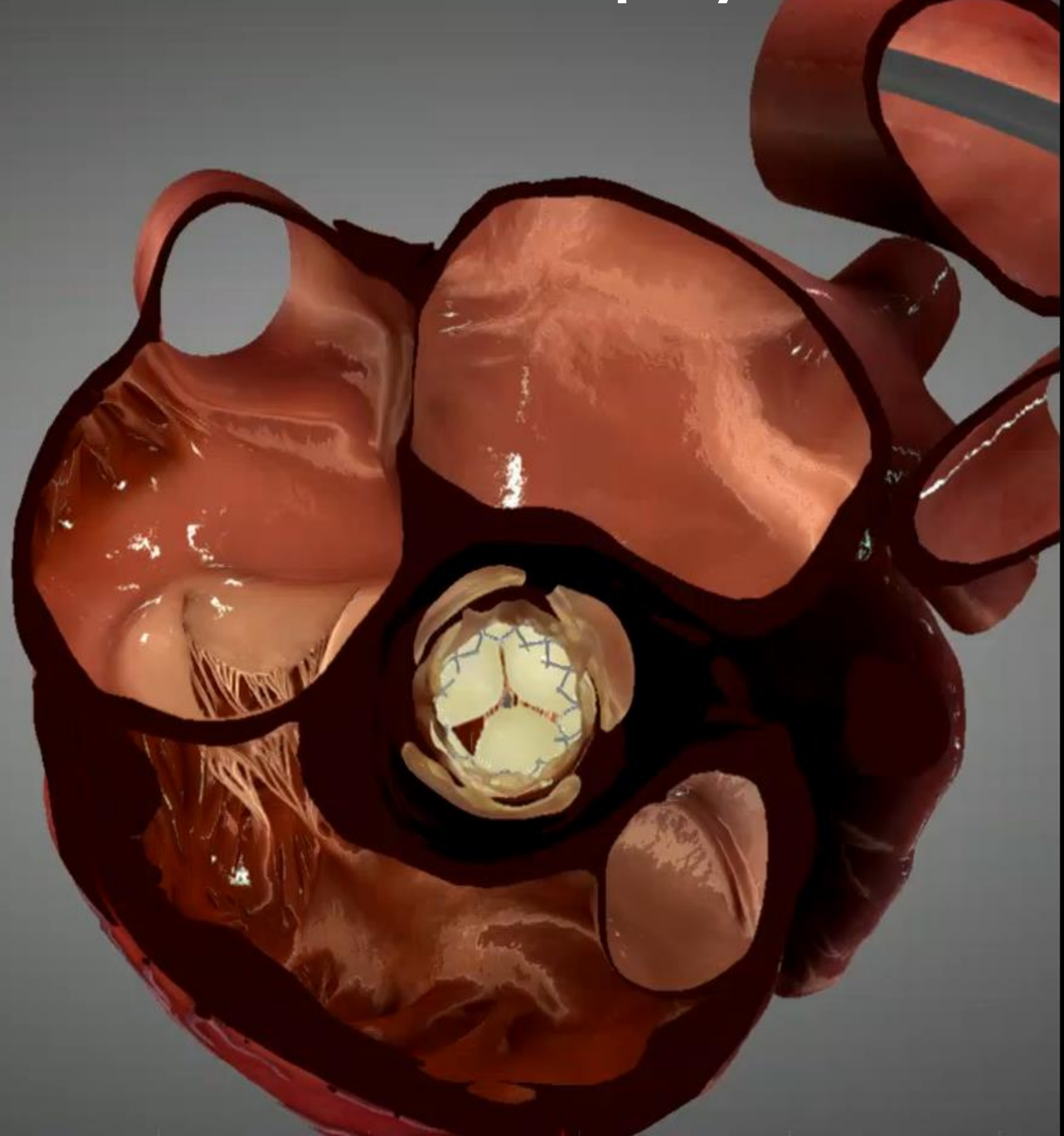


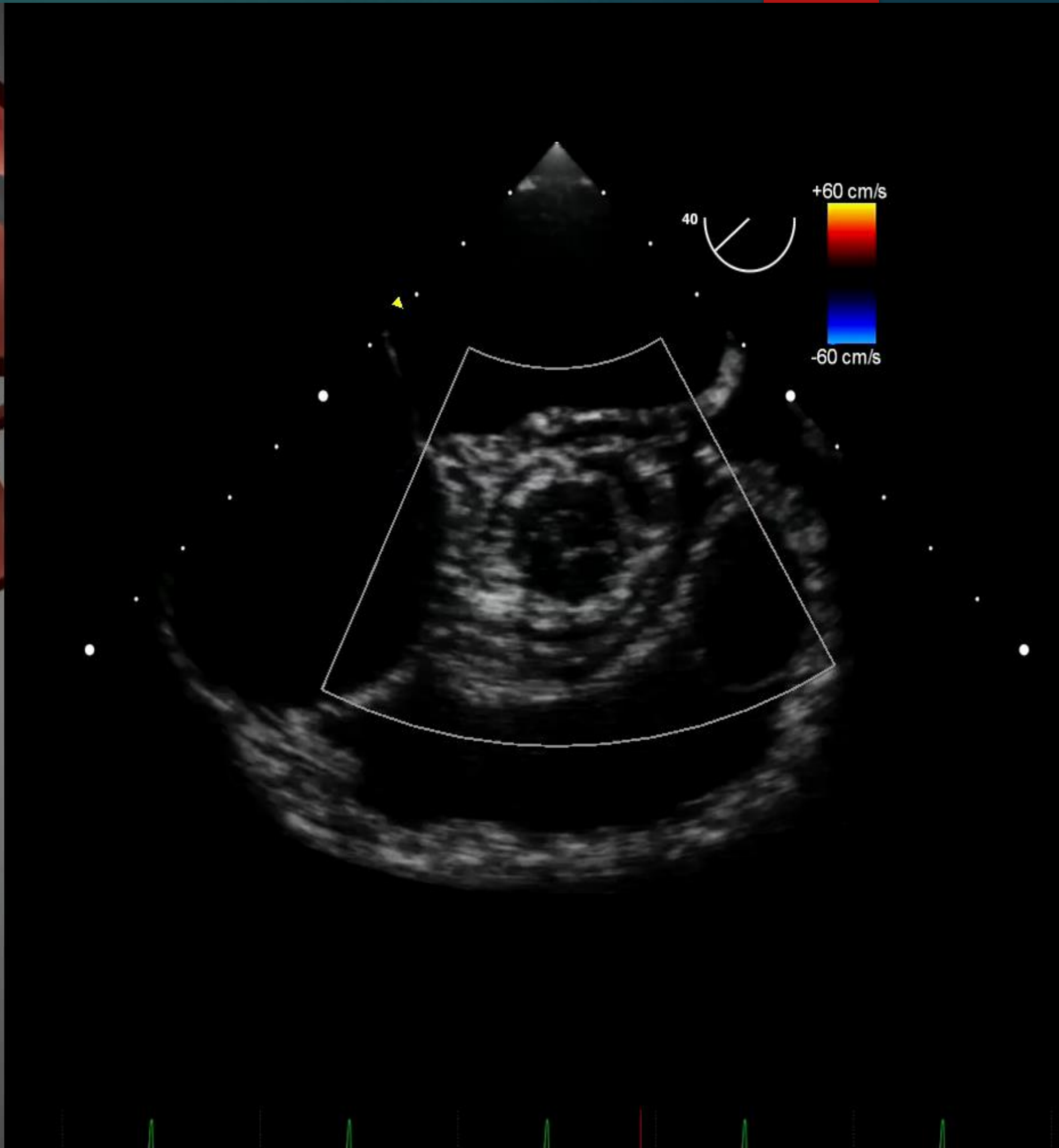
TAVR Valve 80% Deployed



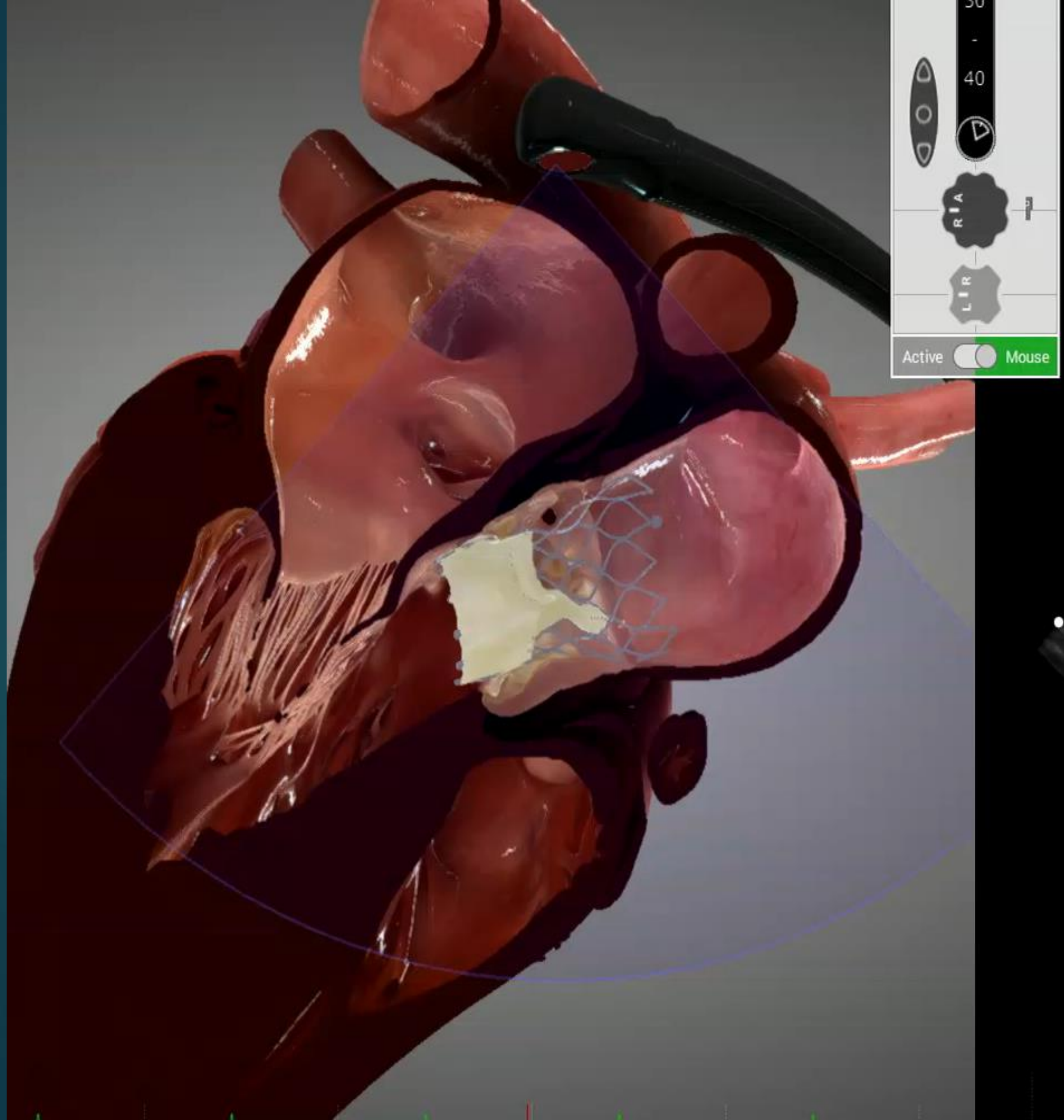


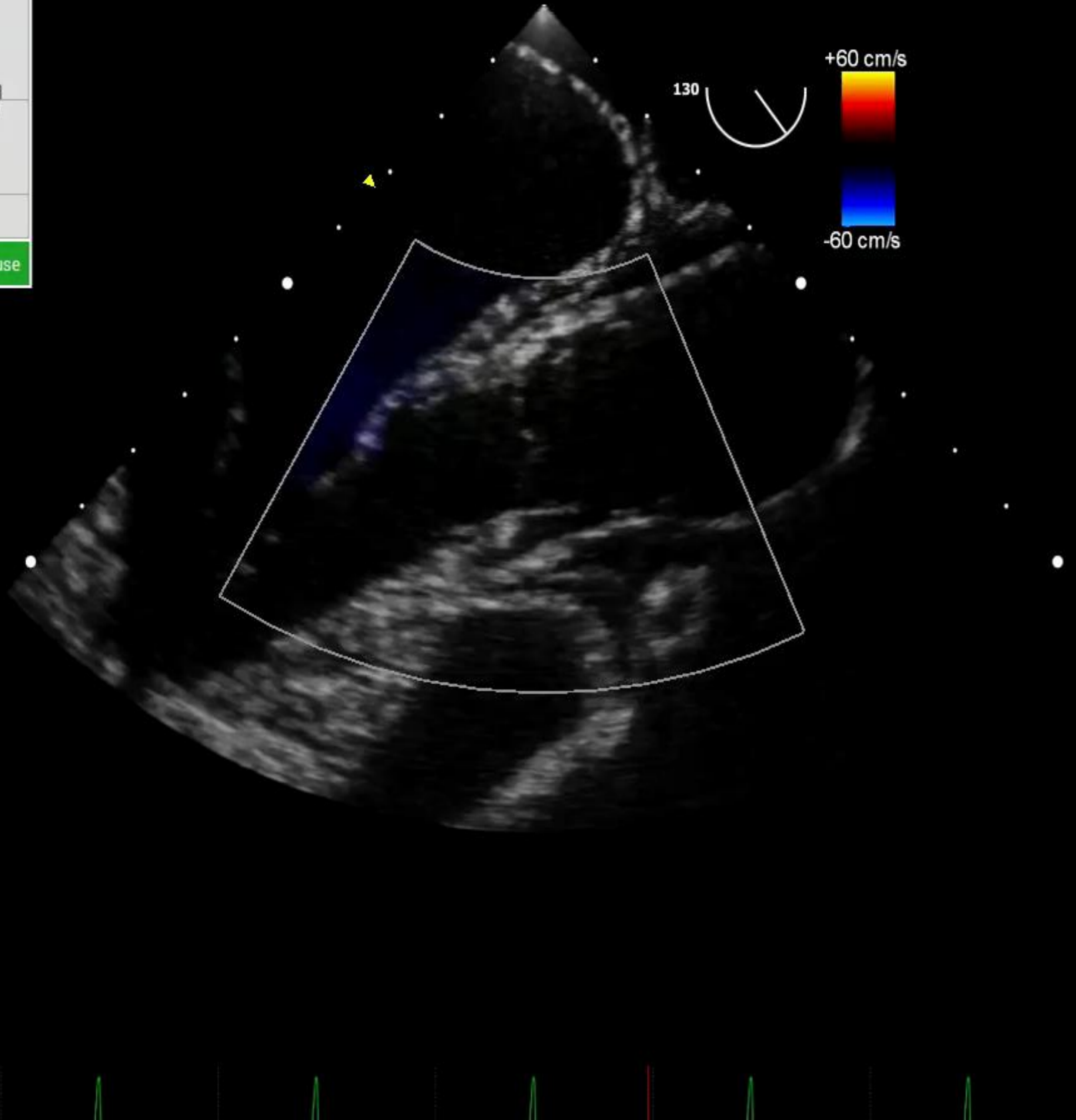
TAVR Valve 80% Deployed



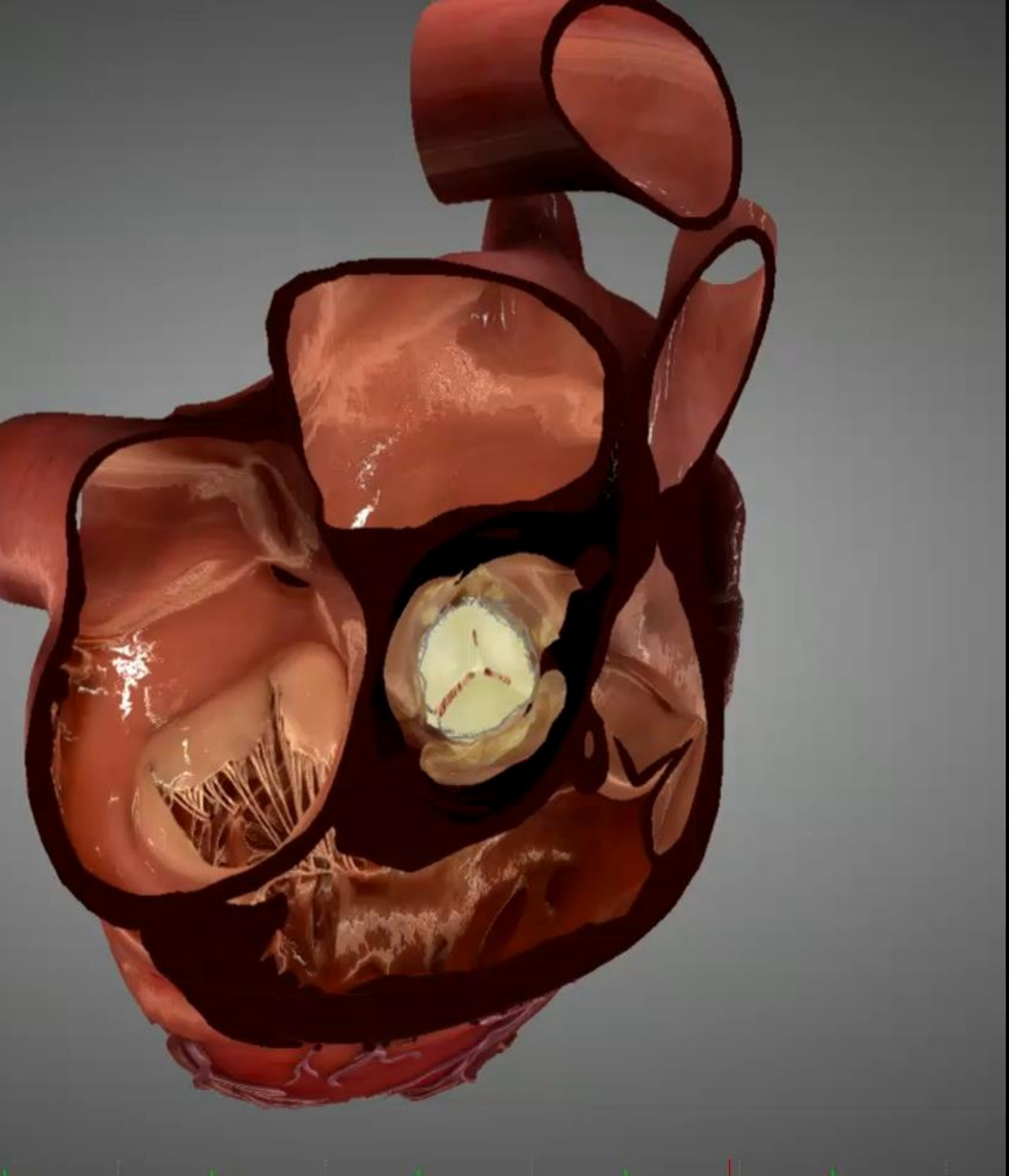


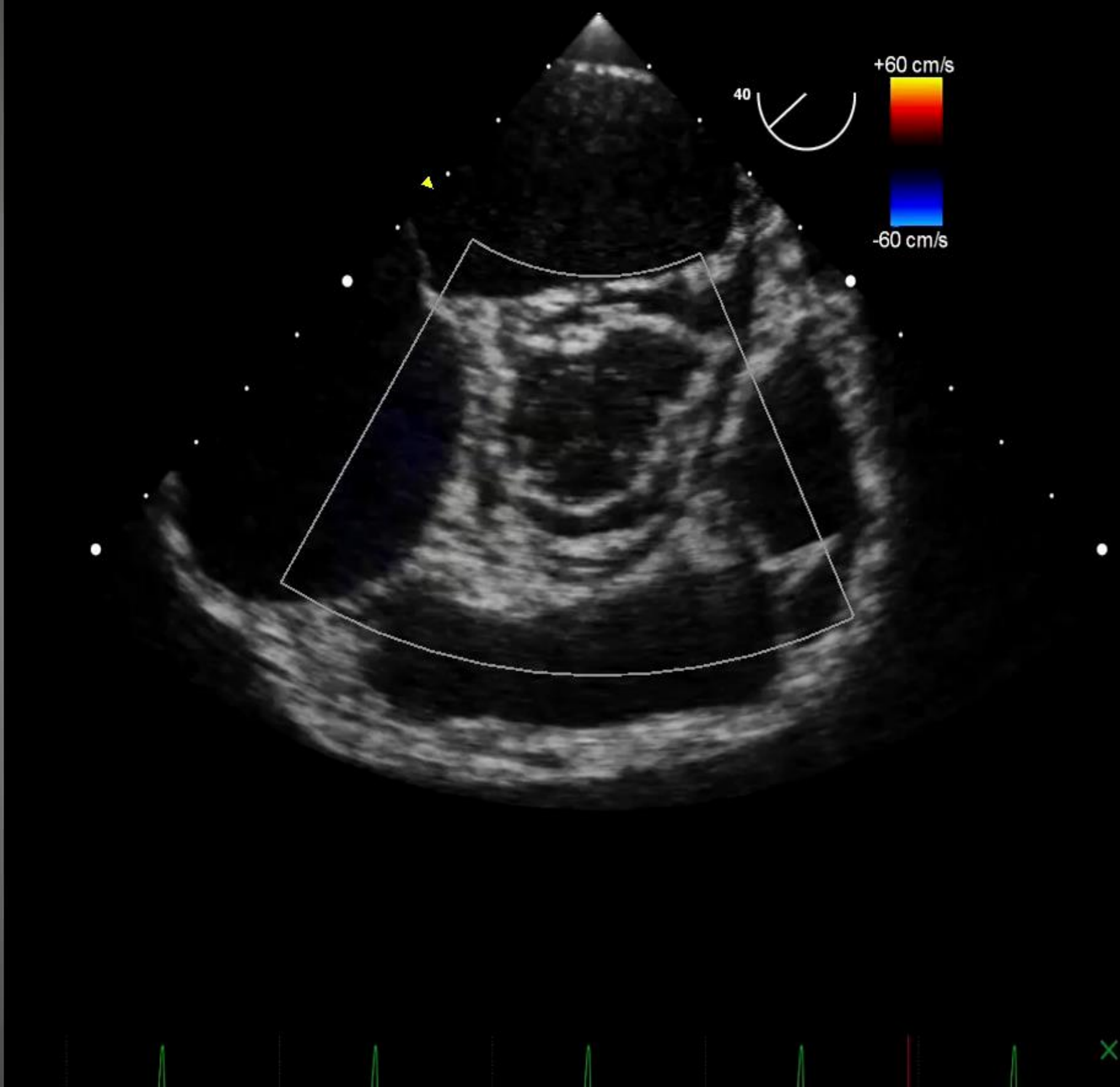
Normal TAVR Valve Location



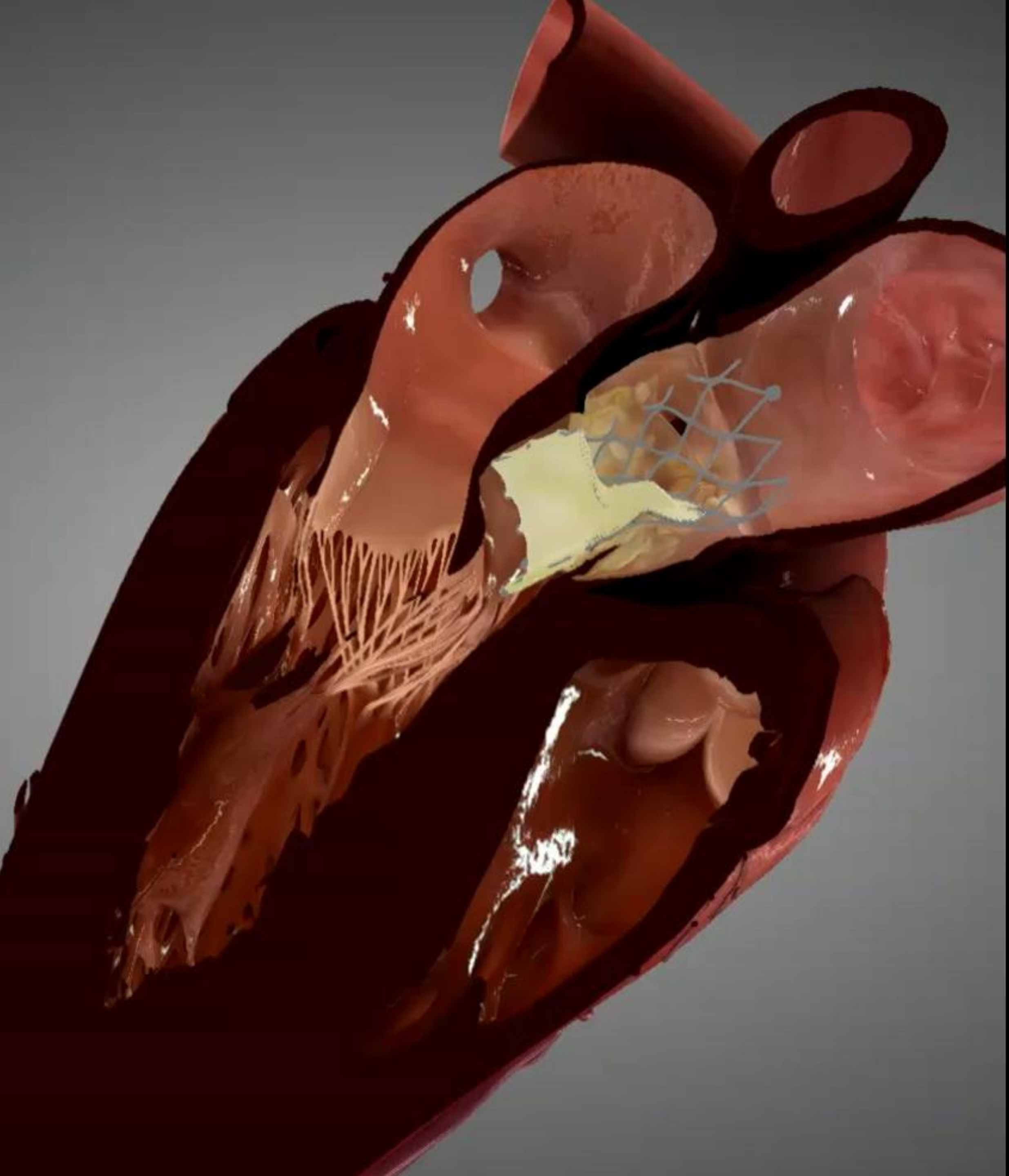


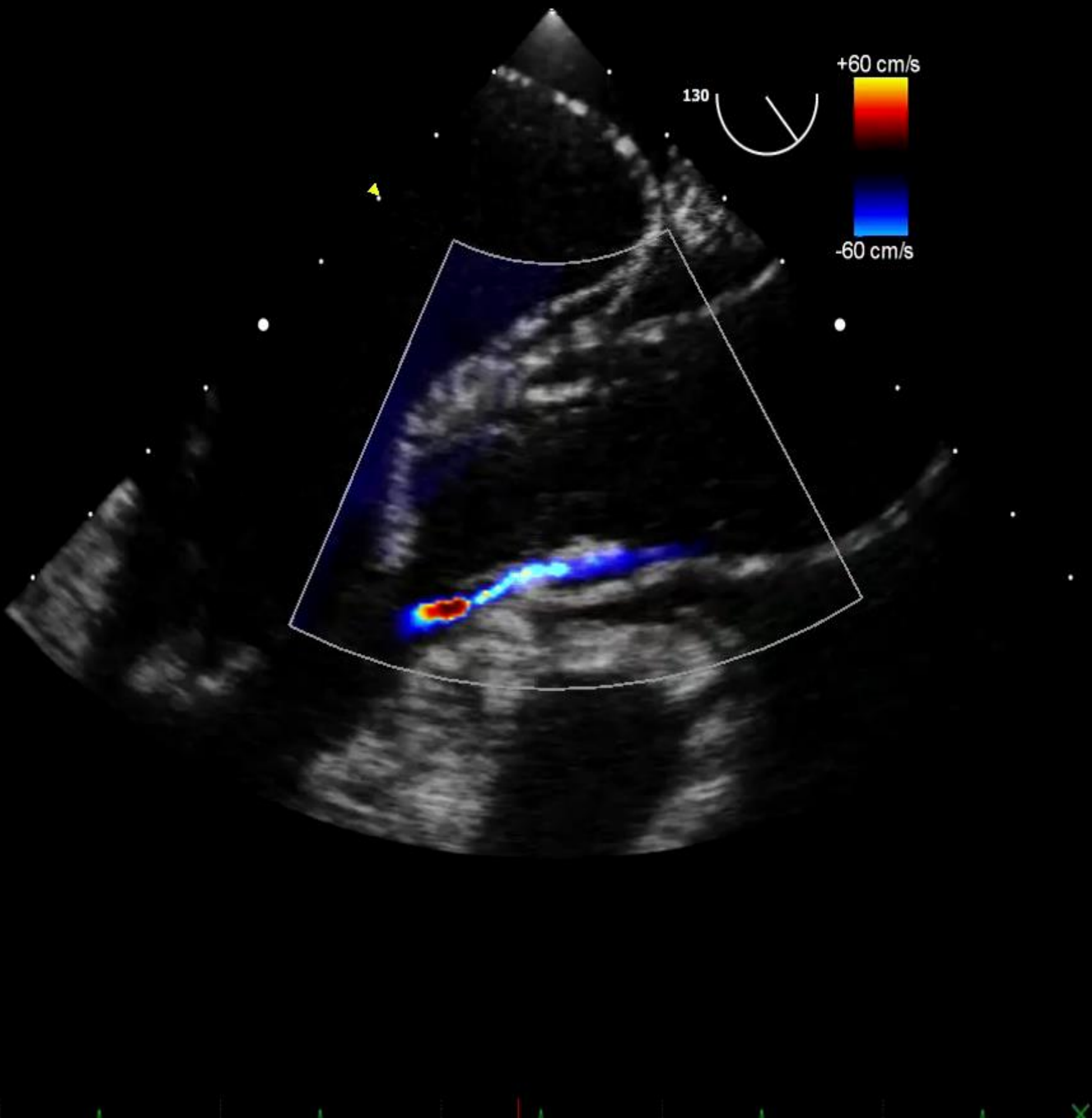
Normal TAVR Valve Location



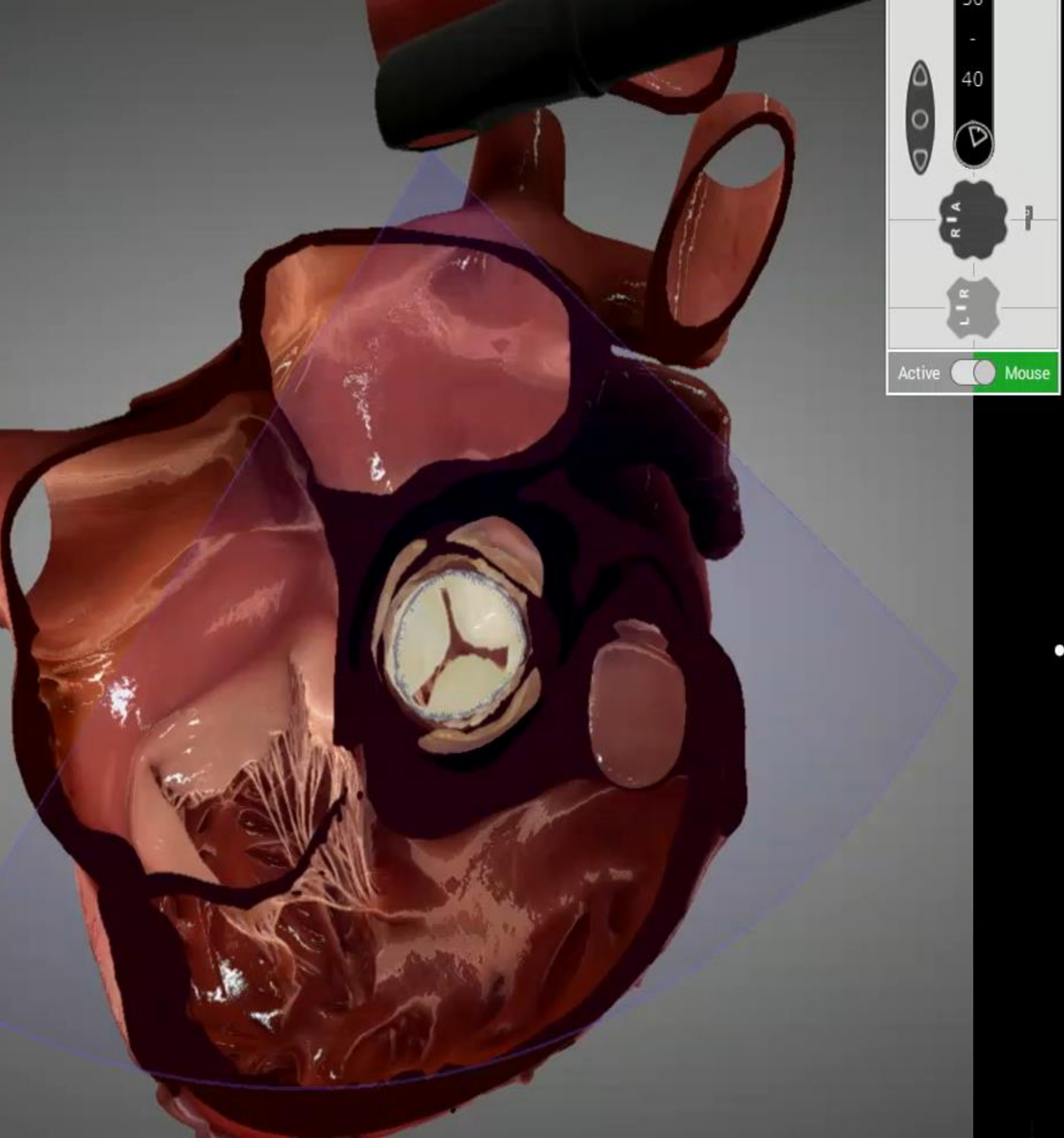


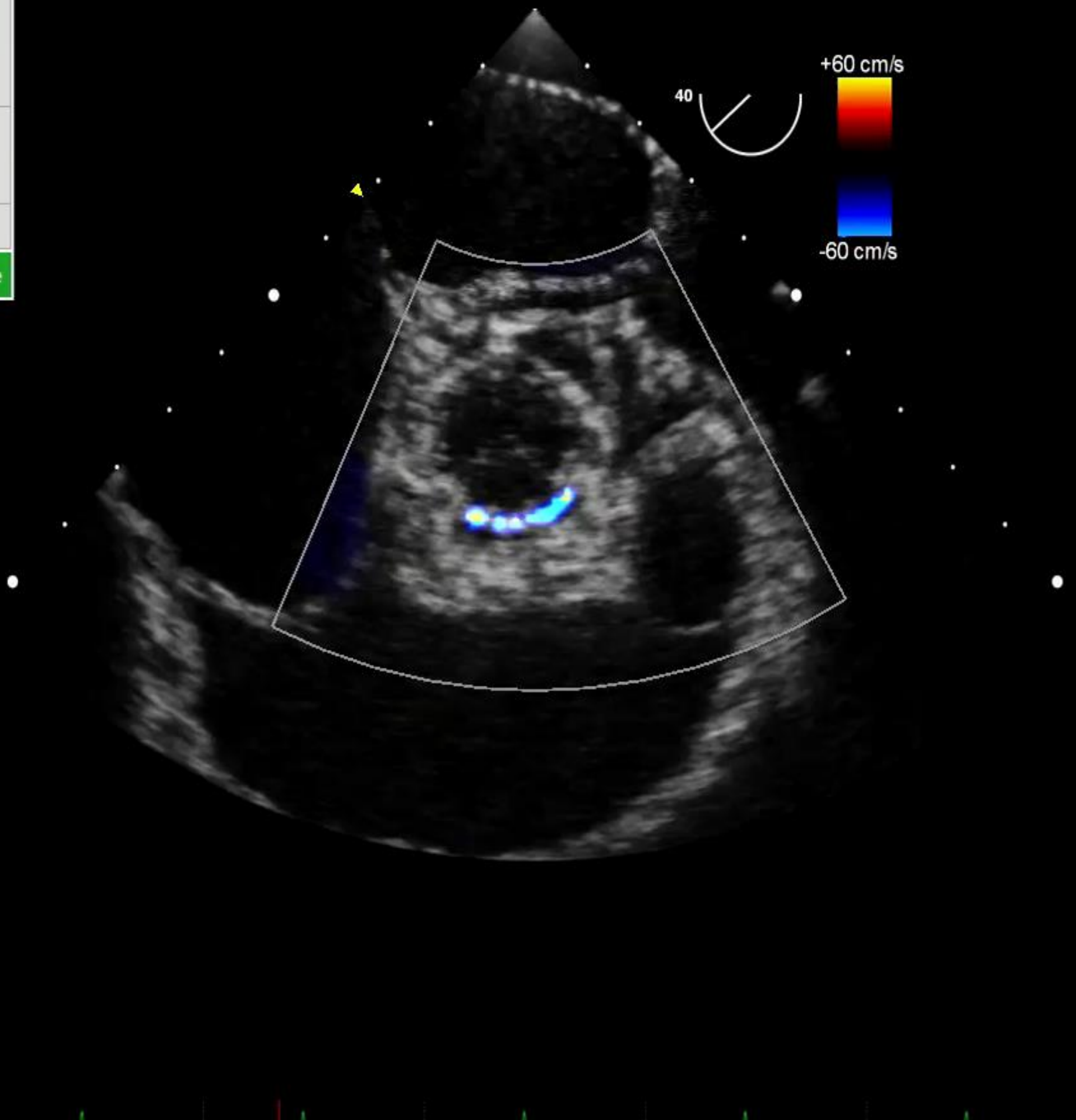
Low TAVR Valve Location



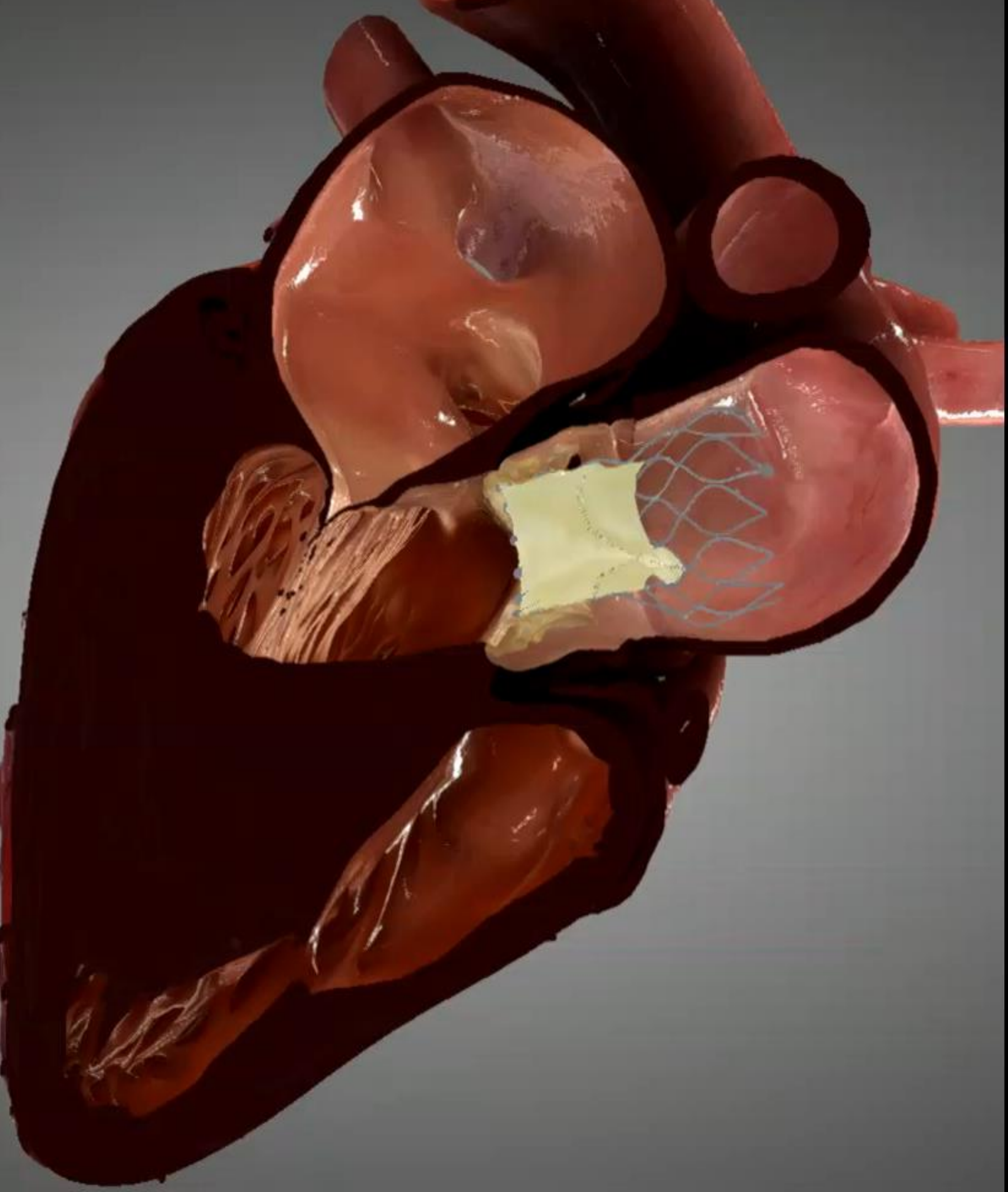


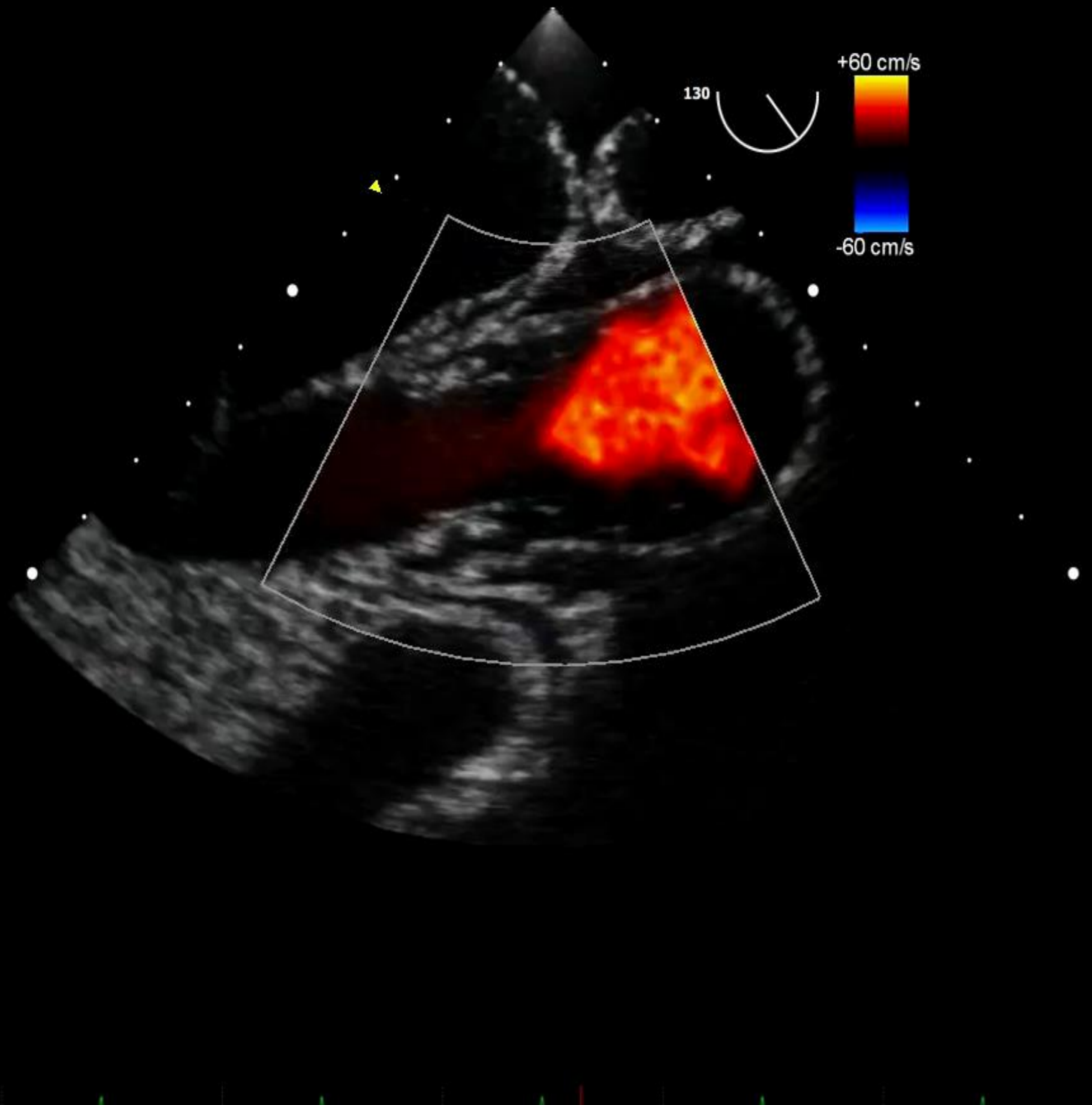
Low TAVR Valve Location

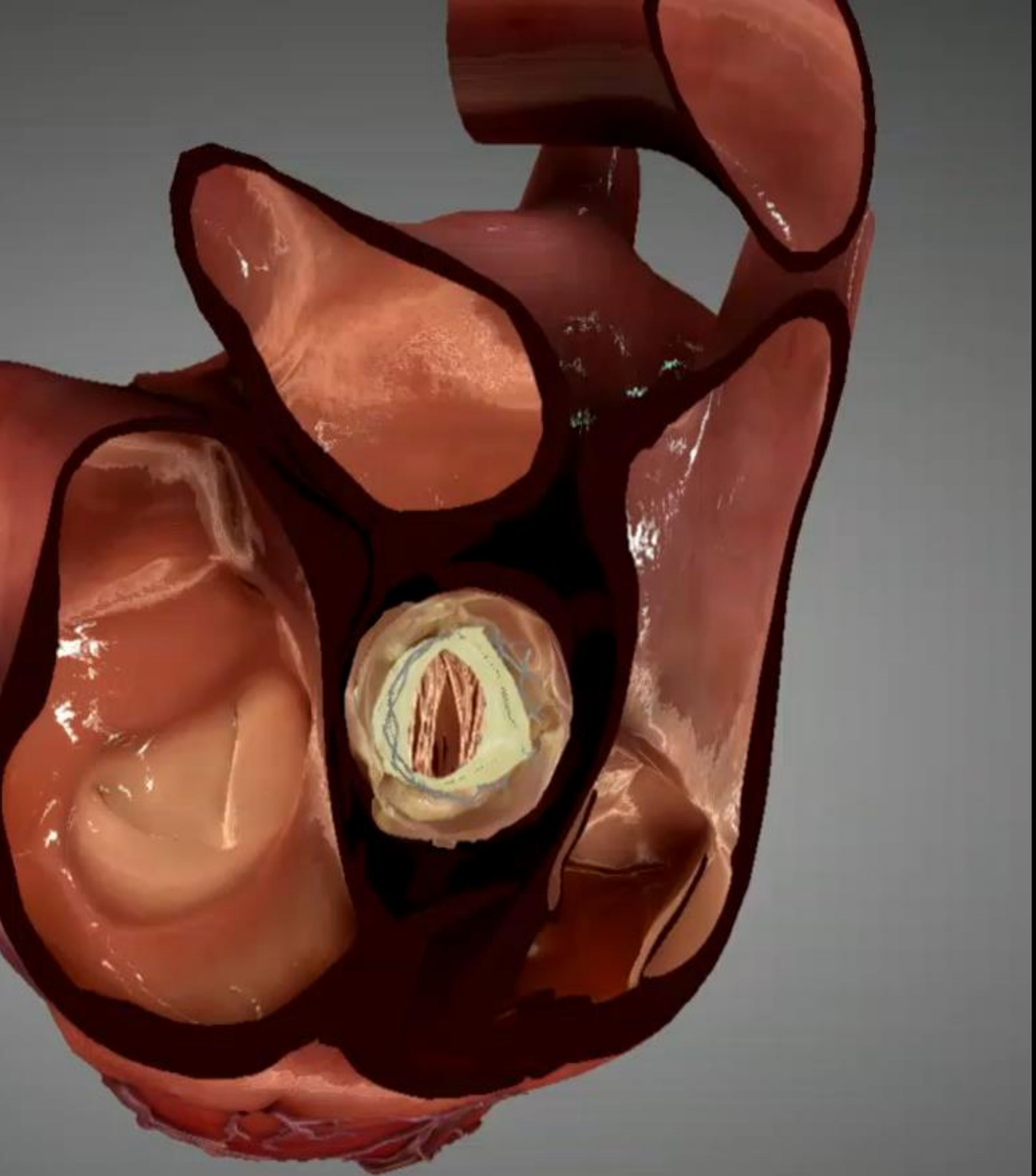




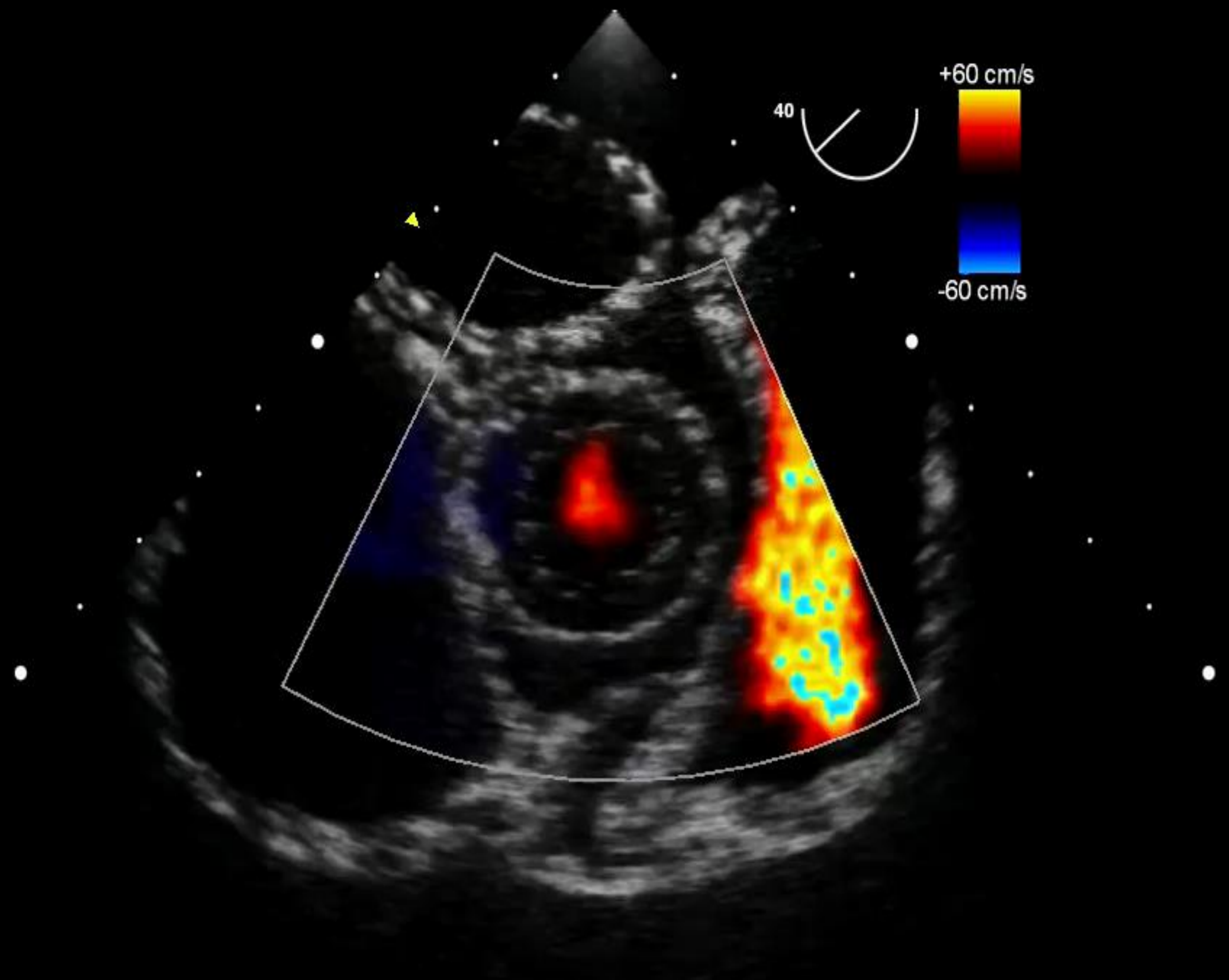
High TAVR Valve Location

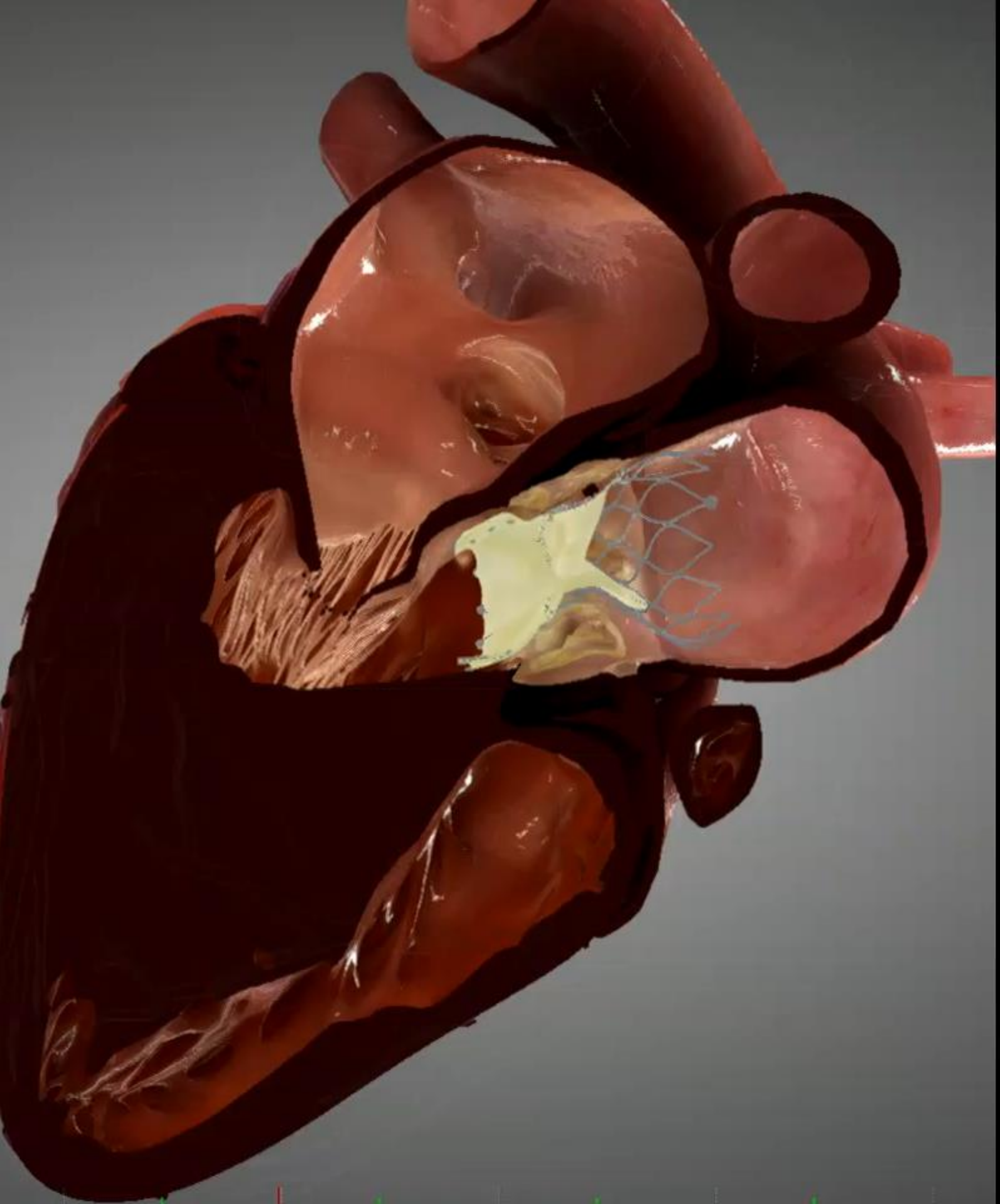




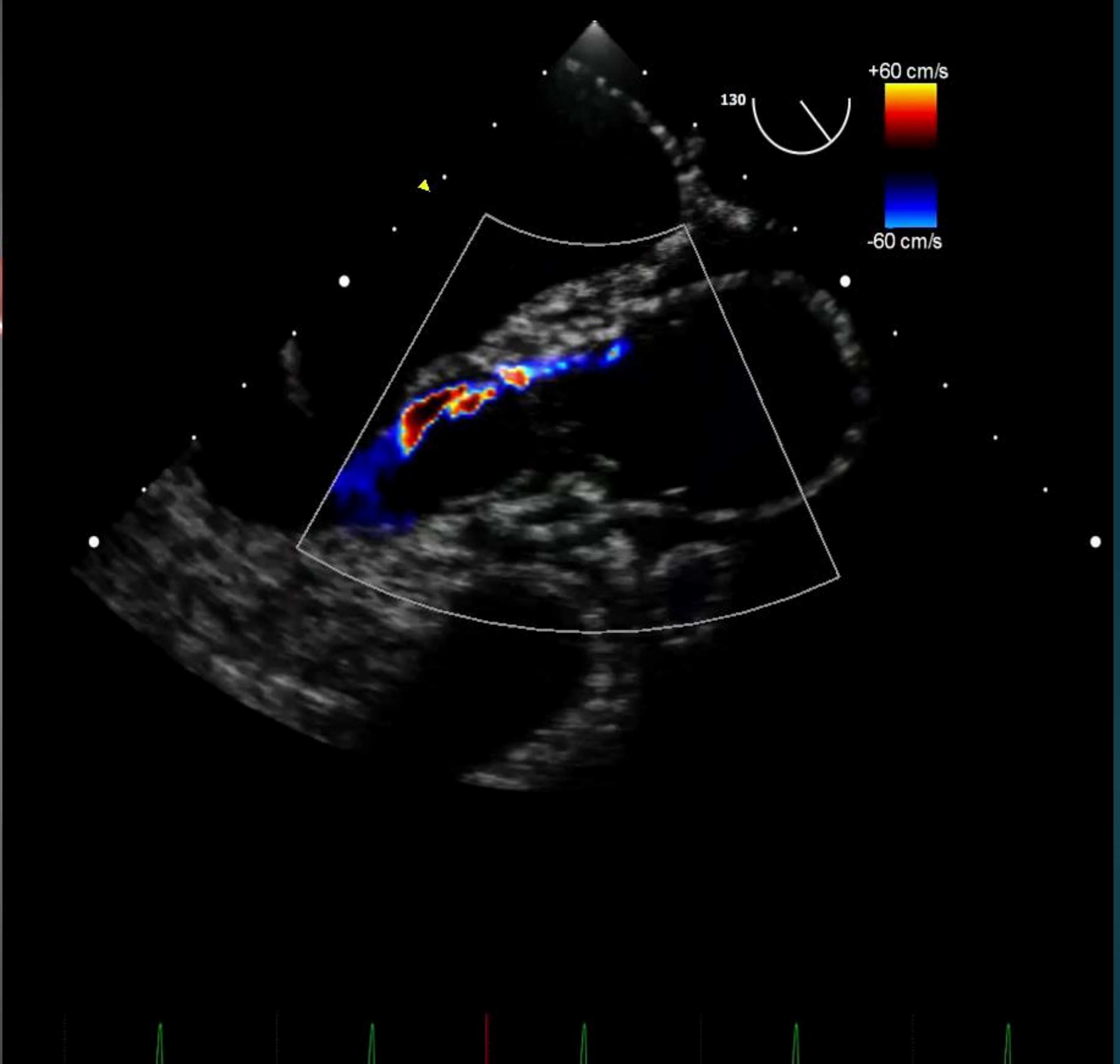


High TAVR Valve Location

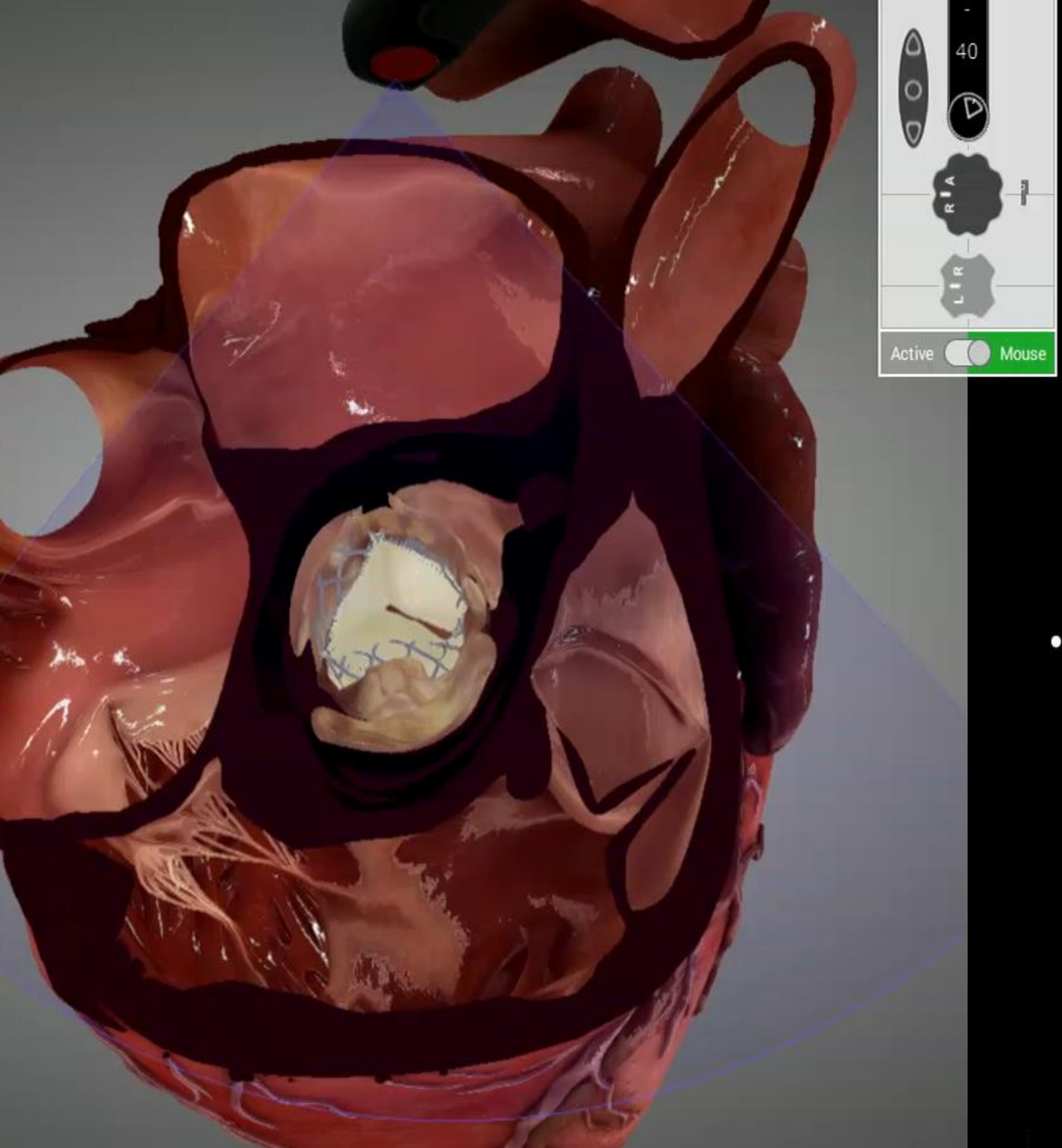


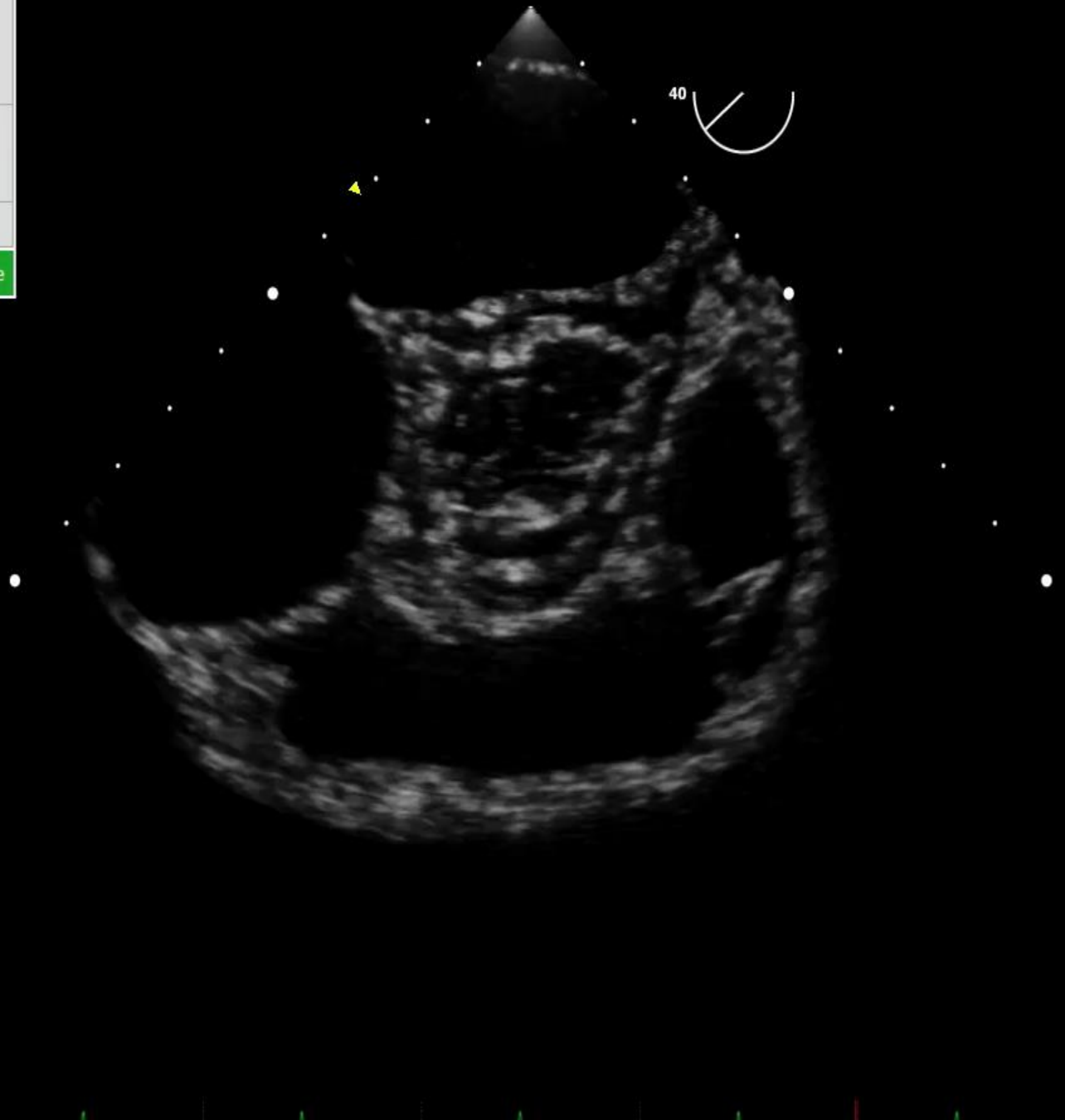


Constrained TAVR Valve

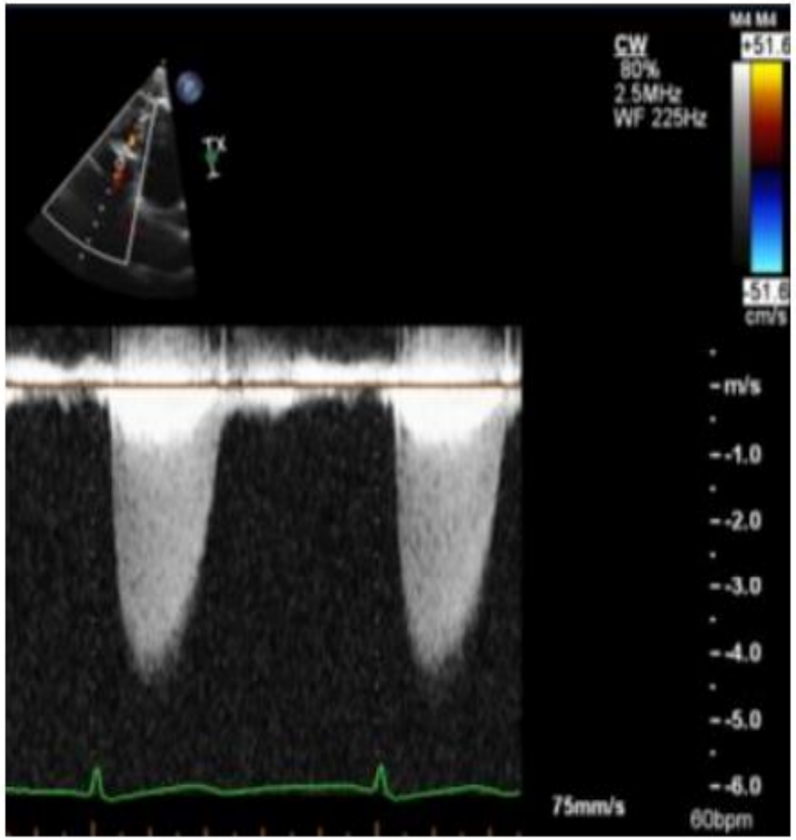


Constrained TAVR Valve

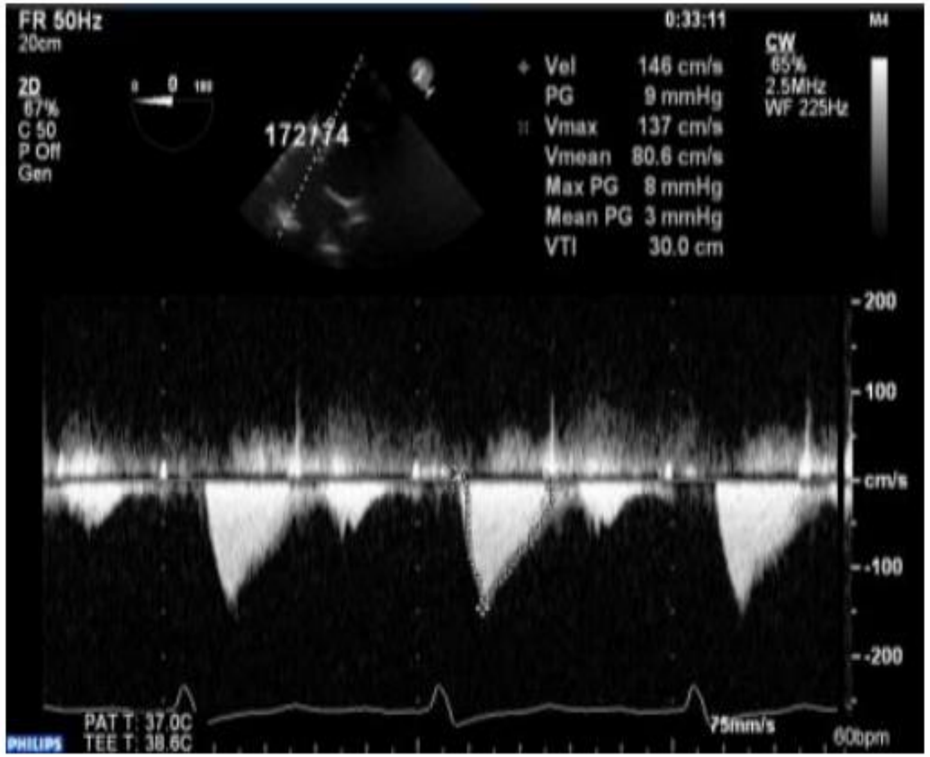




Aortic Valve Gradients | Pre & Post TAVR



Before TAVR
(Severe native valve stenosis)



After TAVR
(Minimal aortic valve gradients)

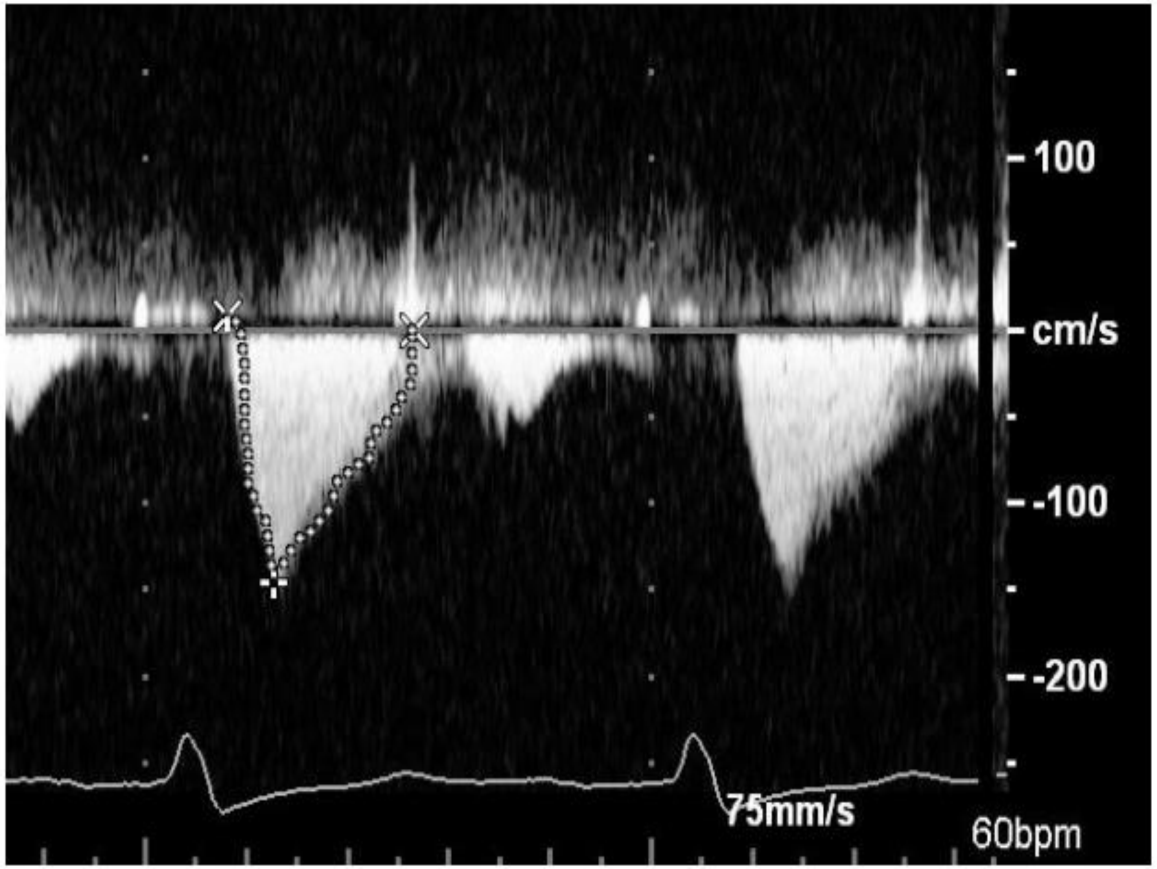
Vmax = **4.3** m/sec

Vmax = **1.4** m/sec

TAVR Valve Gradients

Optimal Gradient

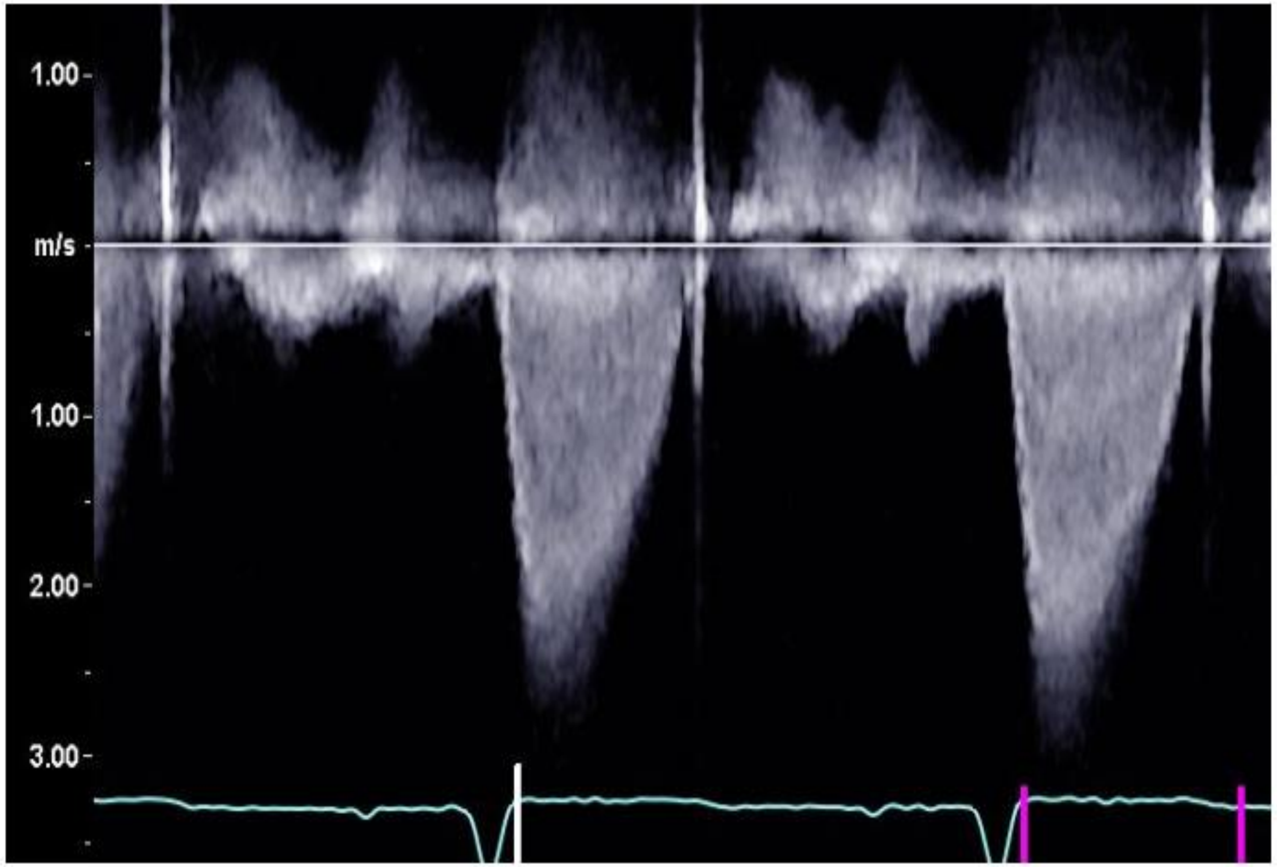
Vmax ≤ 2.0 m/sec



Vmax = **1.4** m/sec

Suboptimal Gradient

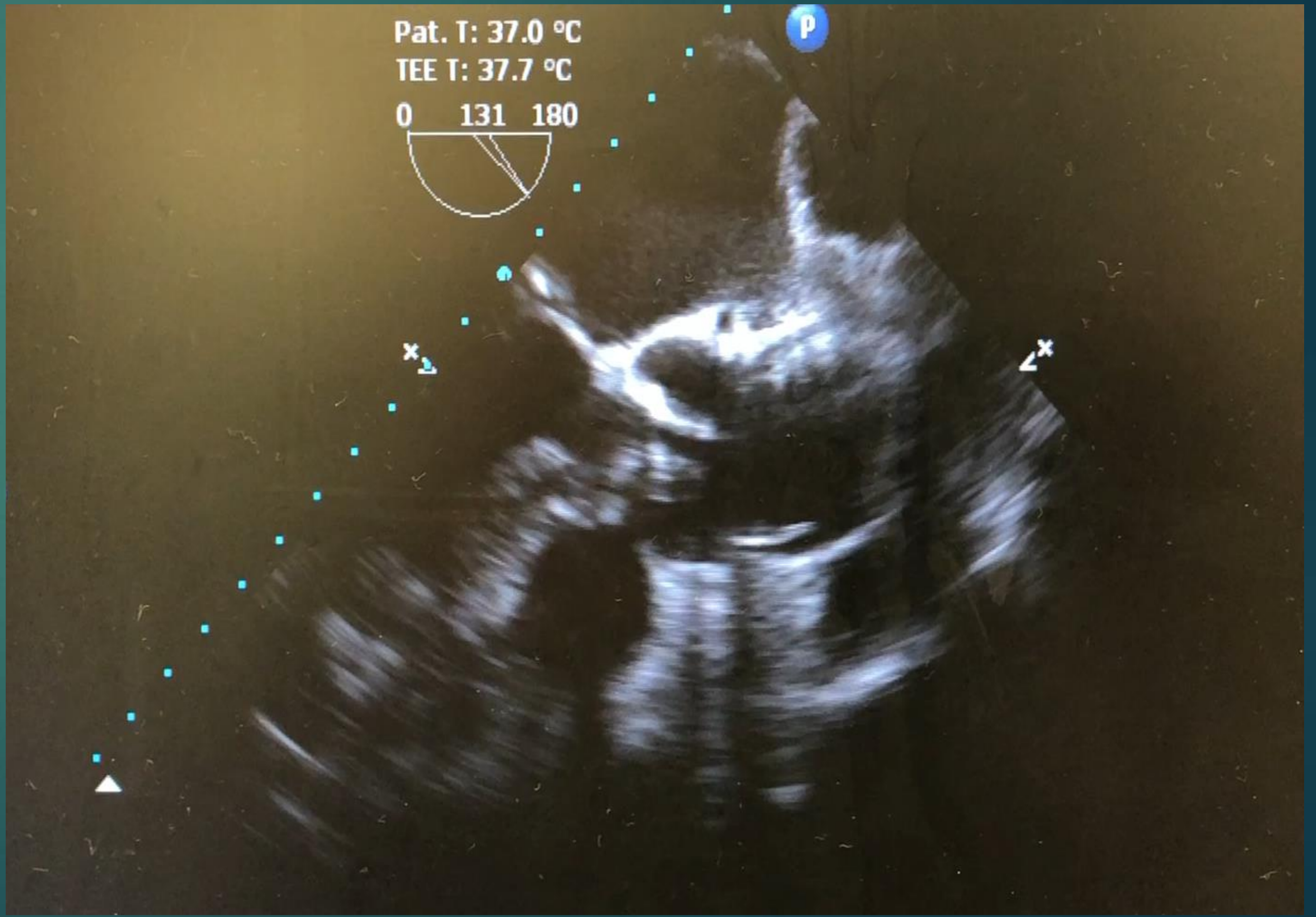
Vmax > 2.0 m/sec



Vmax = **2.6** m/sec

Post-Procedure Aorta Views

- **Descending aorta LAX and SAX** (use X-plane)
- **Aortic arch LAX and SAX**
- **Ascending aorta LAX and SAX**
- **ME AV and ME LAX**



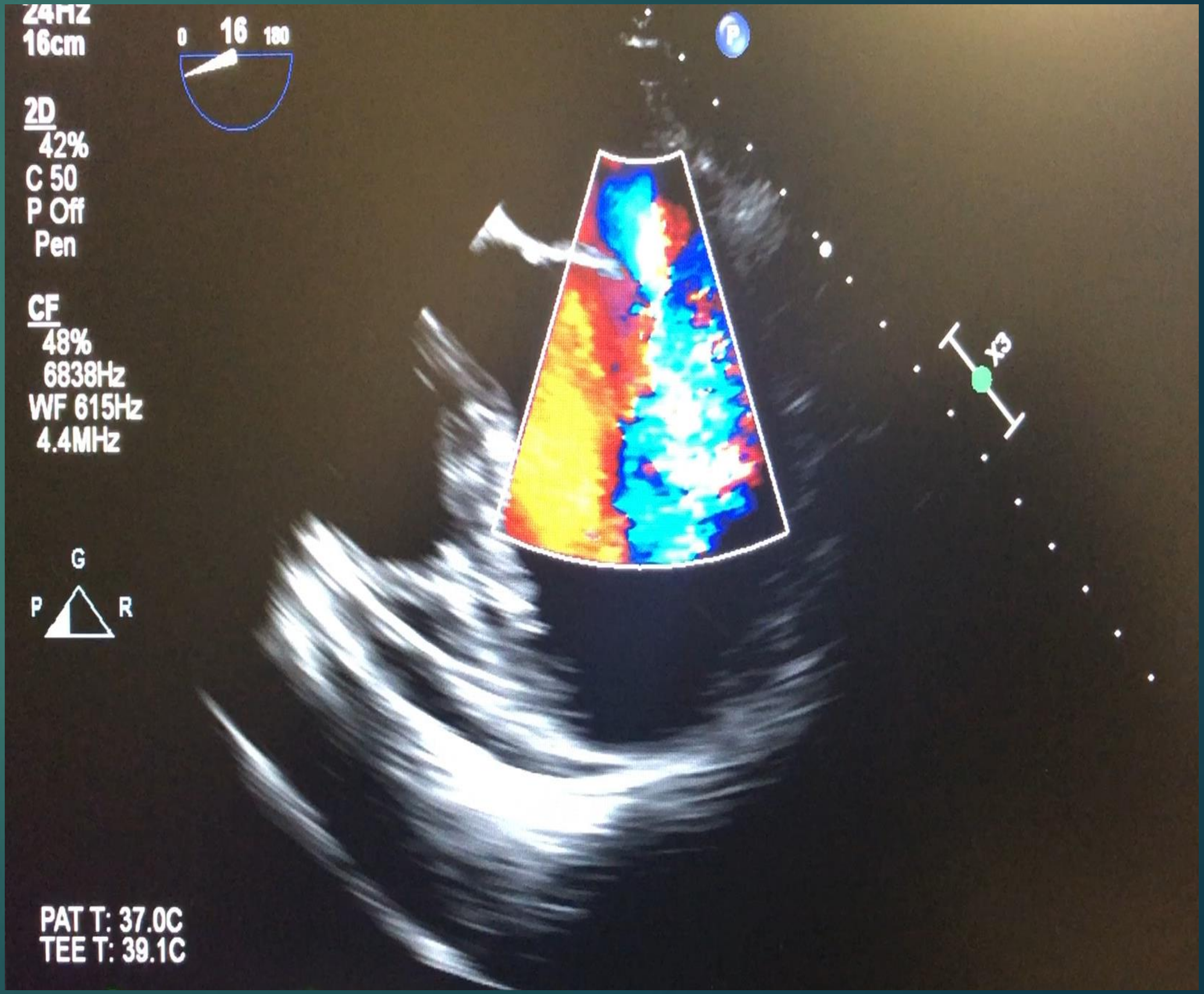
Anesthesia for MitraClip

- Percutaneous alternative to mitral valve replacement for mitral regurgitation
  - Used for high-risk patients only
  - Similar to Alfieri repair
- Mitral regurgitation and left ventricular volume is reduced and NYHA class is improved
- Repair is performed under fluoroscopy and 3-D echo

Kothandan et al-Anesthesia management for MitraClip device implantation. Ann Card Anaesth, 2014, 17:17-22

TEE Acquisition for Mitraclip

- Each view should be performed with and without color flow Doppler
- Ensure capture of the MR jet at the valve
  - Visualize the entire jet within the LA
  - Multiple cardiac cycles should be captured
- Implement 3D imaging when appropriate but not to the exclusion of traditional 2D image acquisition

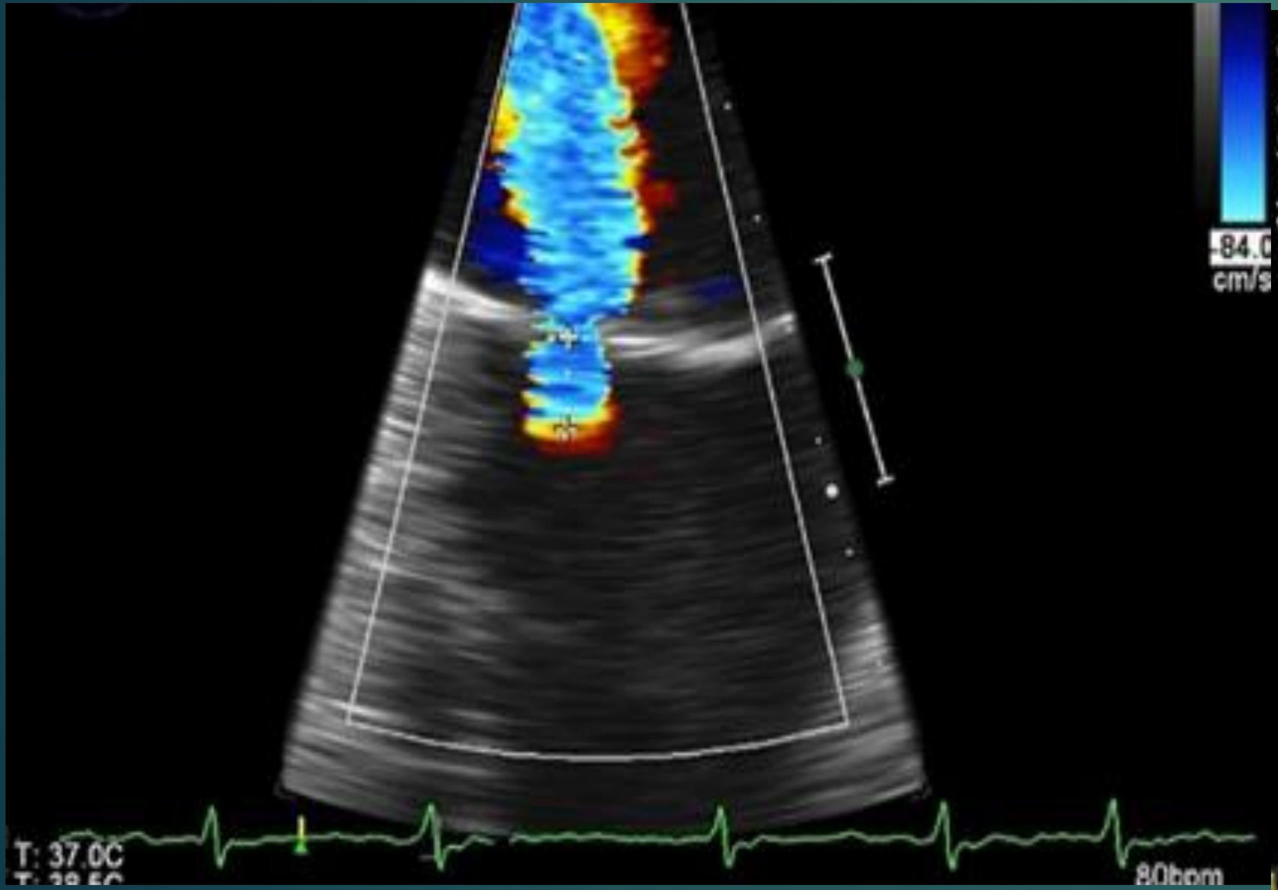


Role of TEE with Mitraclip

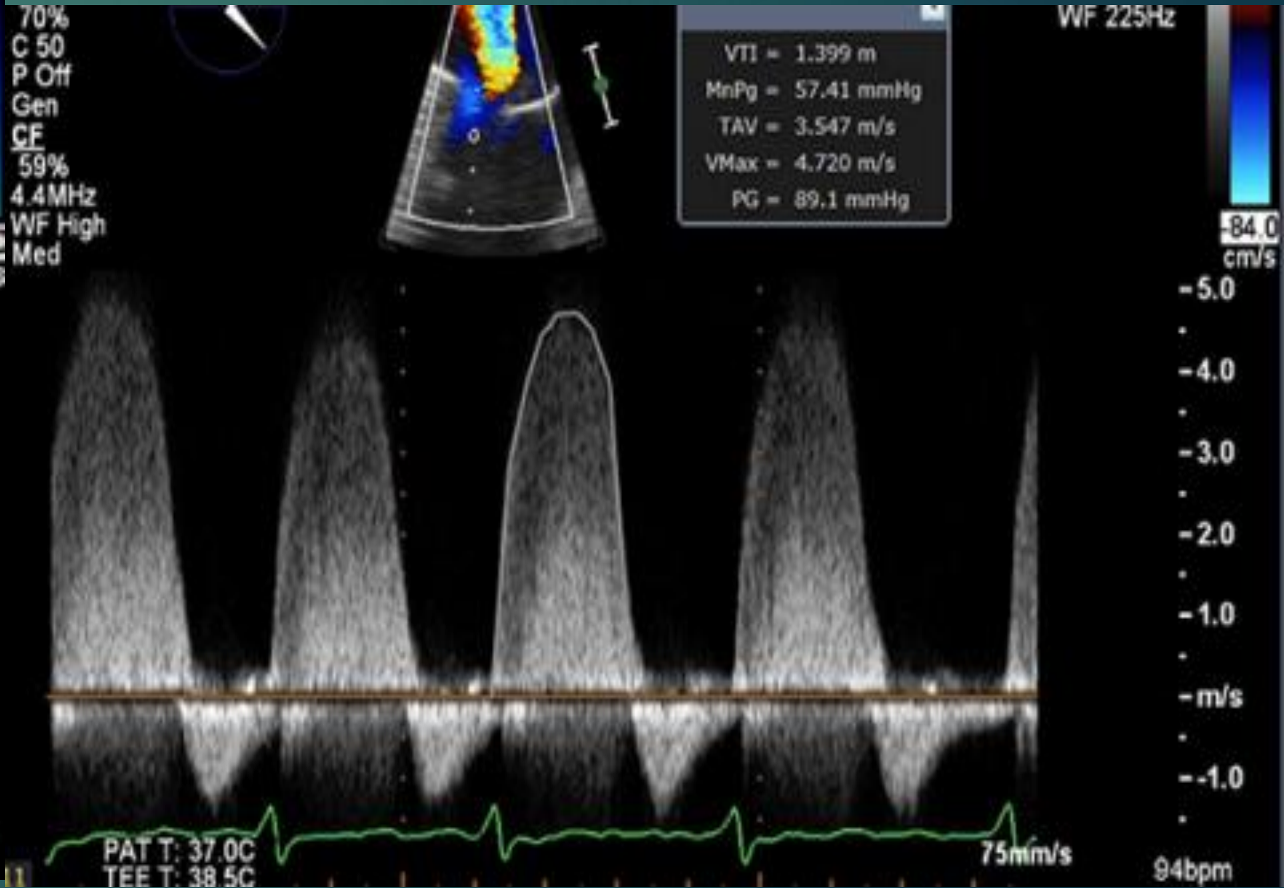
- Steerable guide catheter from femoral vein across atrial septum
- For degenerative MR flail gap should be measured in ME 4 chamber and ME LAX
- Left and right upper pulmonary veins should be assessed for flow reversal (PW Doppler 2 cm into vein)
- TG Basal SAX should assess mitral valve
- 3D images of MV should be used to supplement and confirm diagnosis and result

Mitraclip: 2D Proximal Isovelocity Surface Area (PISA) Calculation

PISA radius 0.78

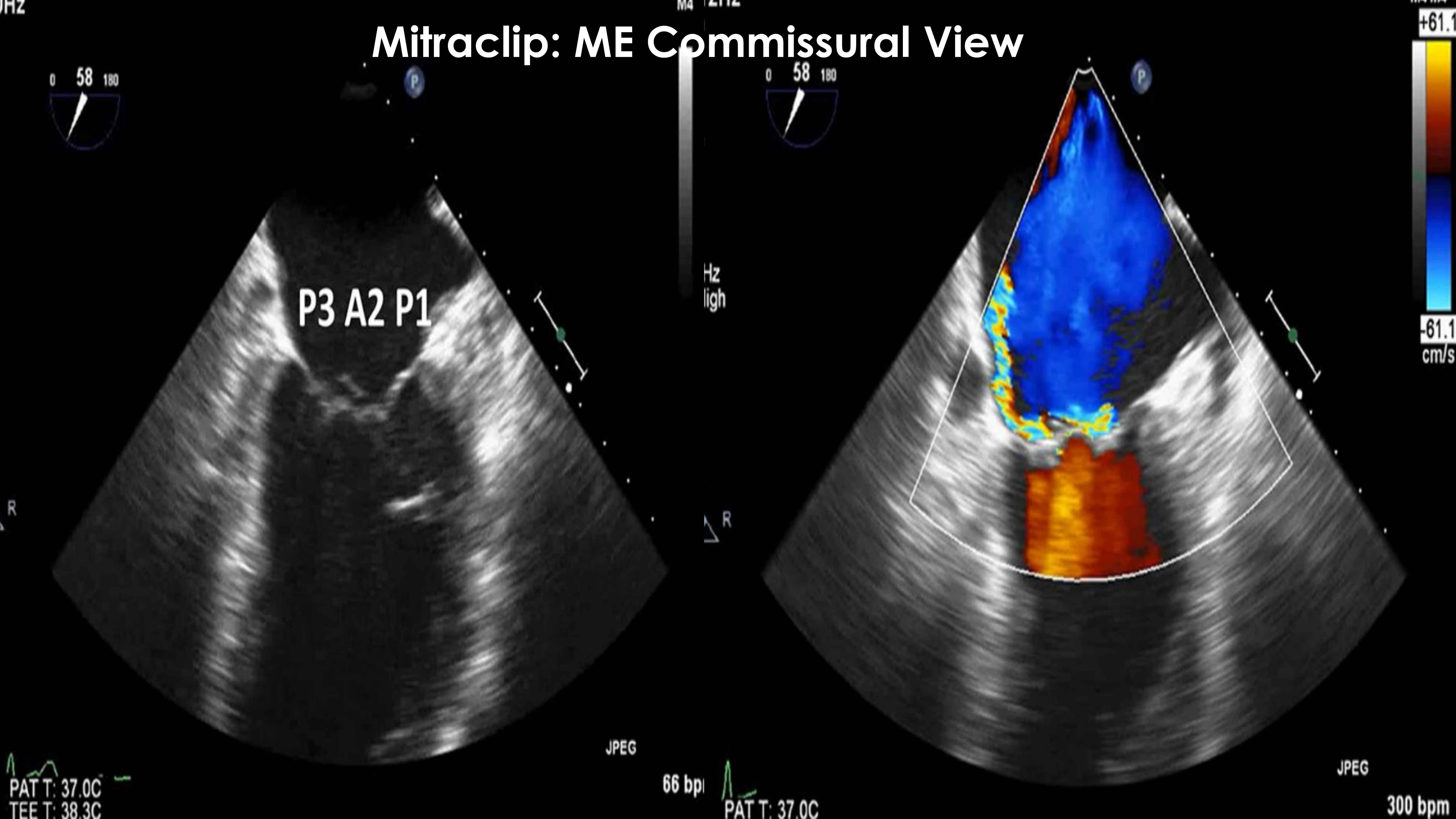


VTI 140 cm, Velocity 4.7 m/s

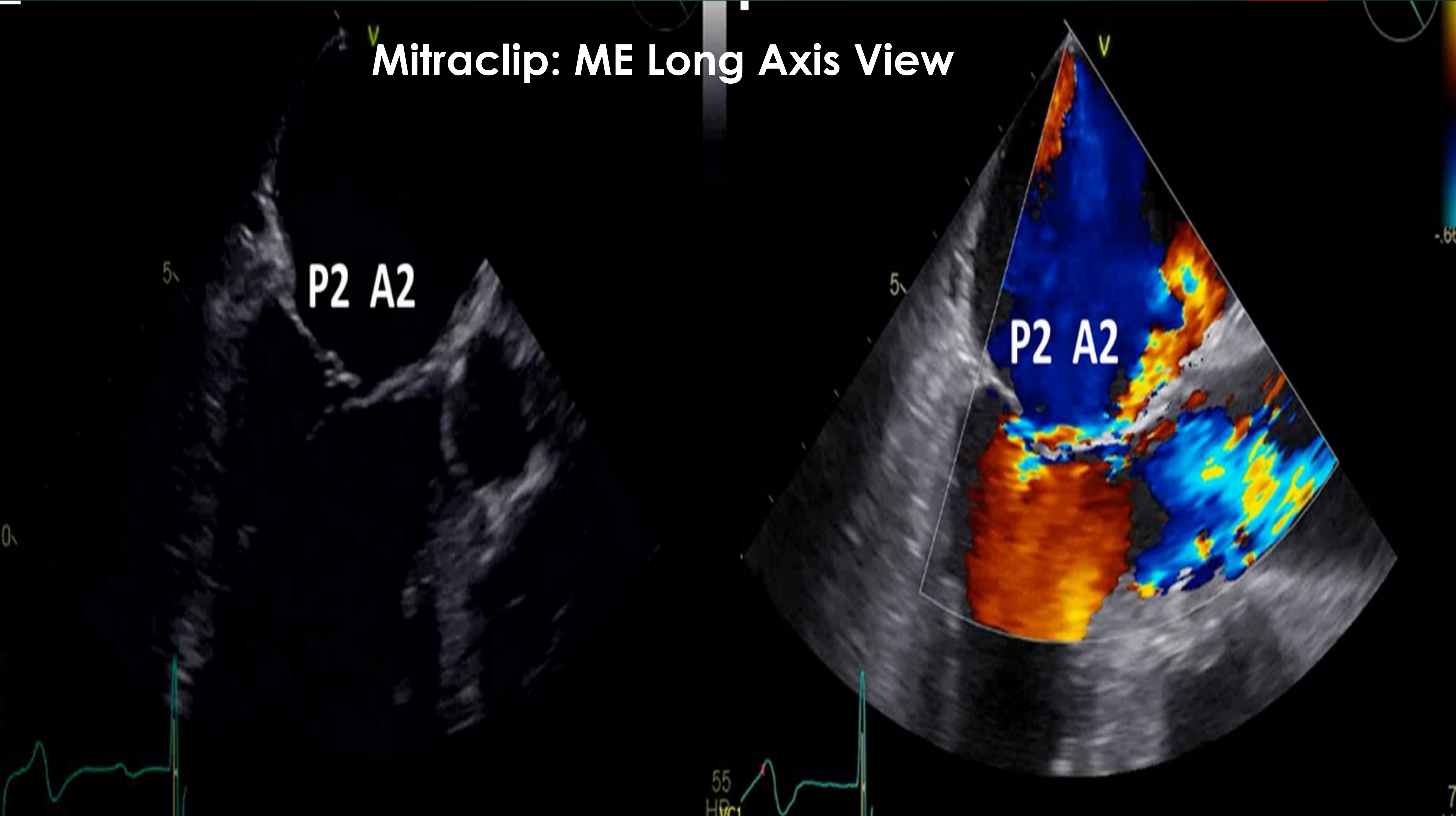


EROA=(2π*r²*aliasing velocity)/MR Vmax=[6.28 x $(0.79)^2$ x 38.2]/472=150/472=0.32 cm^2 (moderate MR)

Mitraclip: ME Commissural View

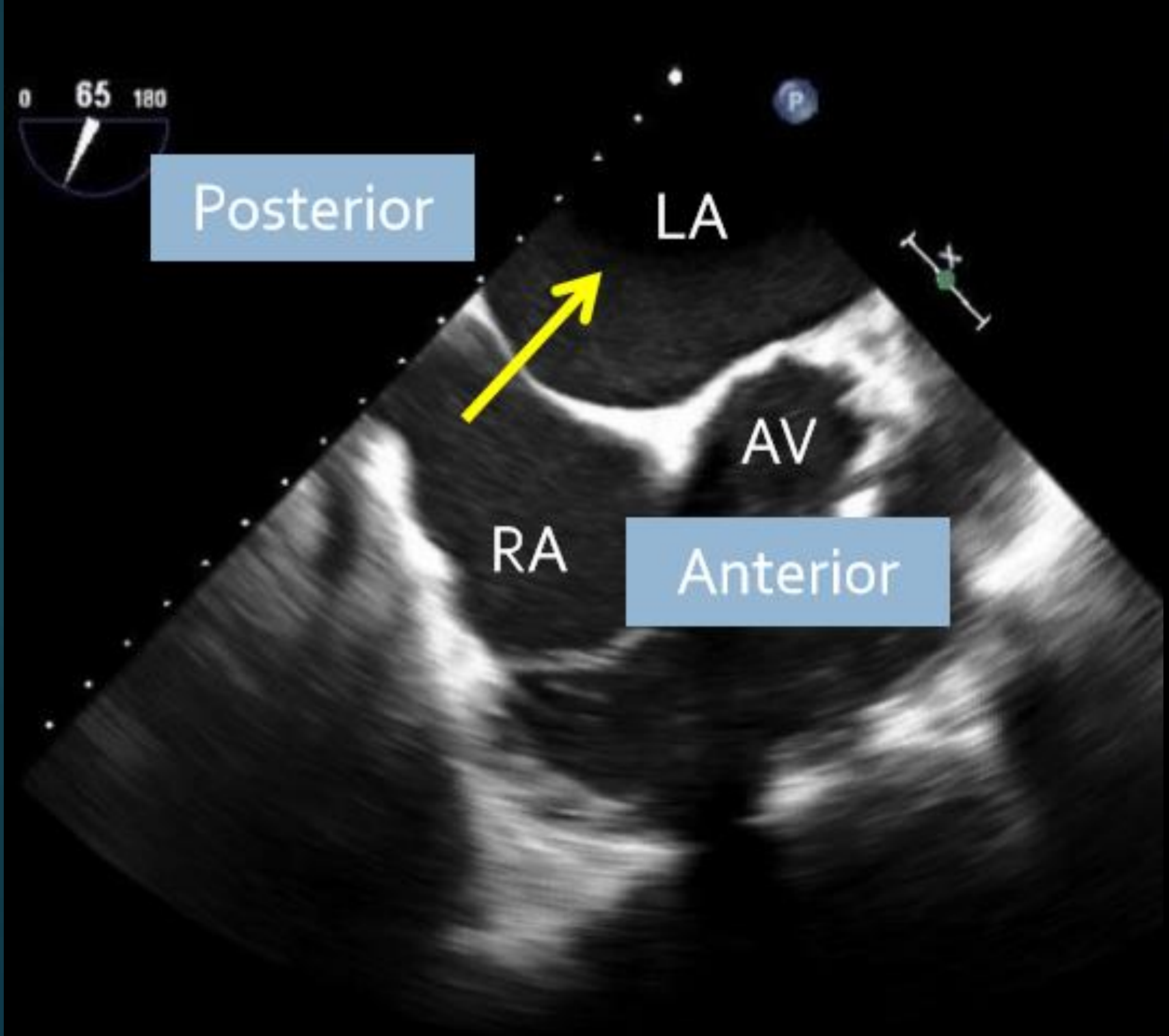


Mitraclip: ME Long Axis View

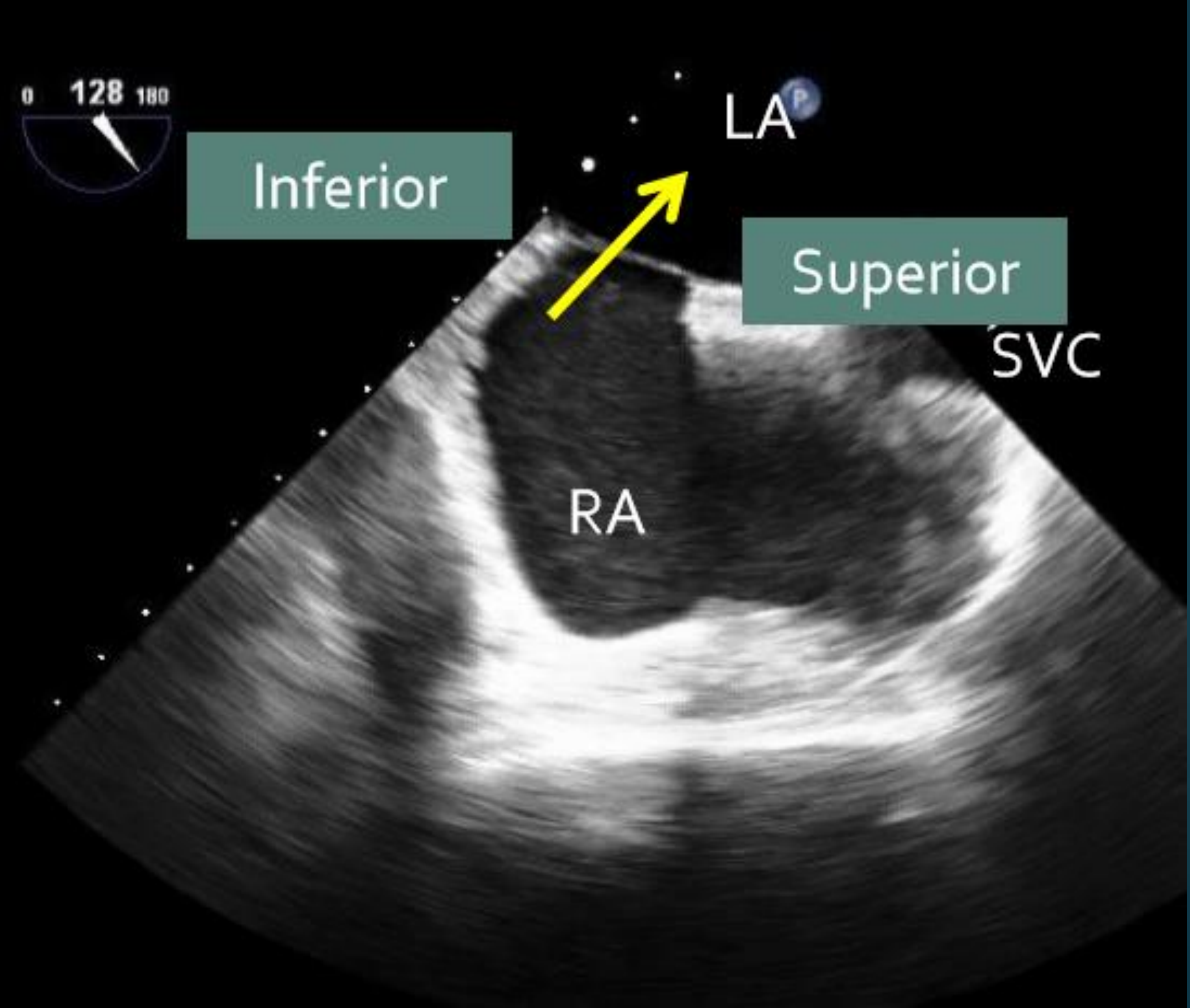


Use of TEE in Guiding Trans-Septal Puncture

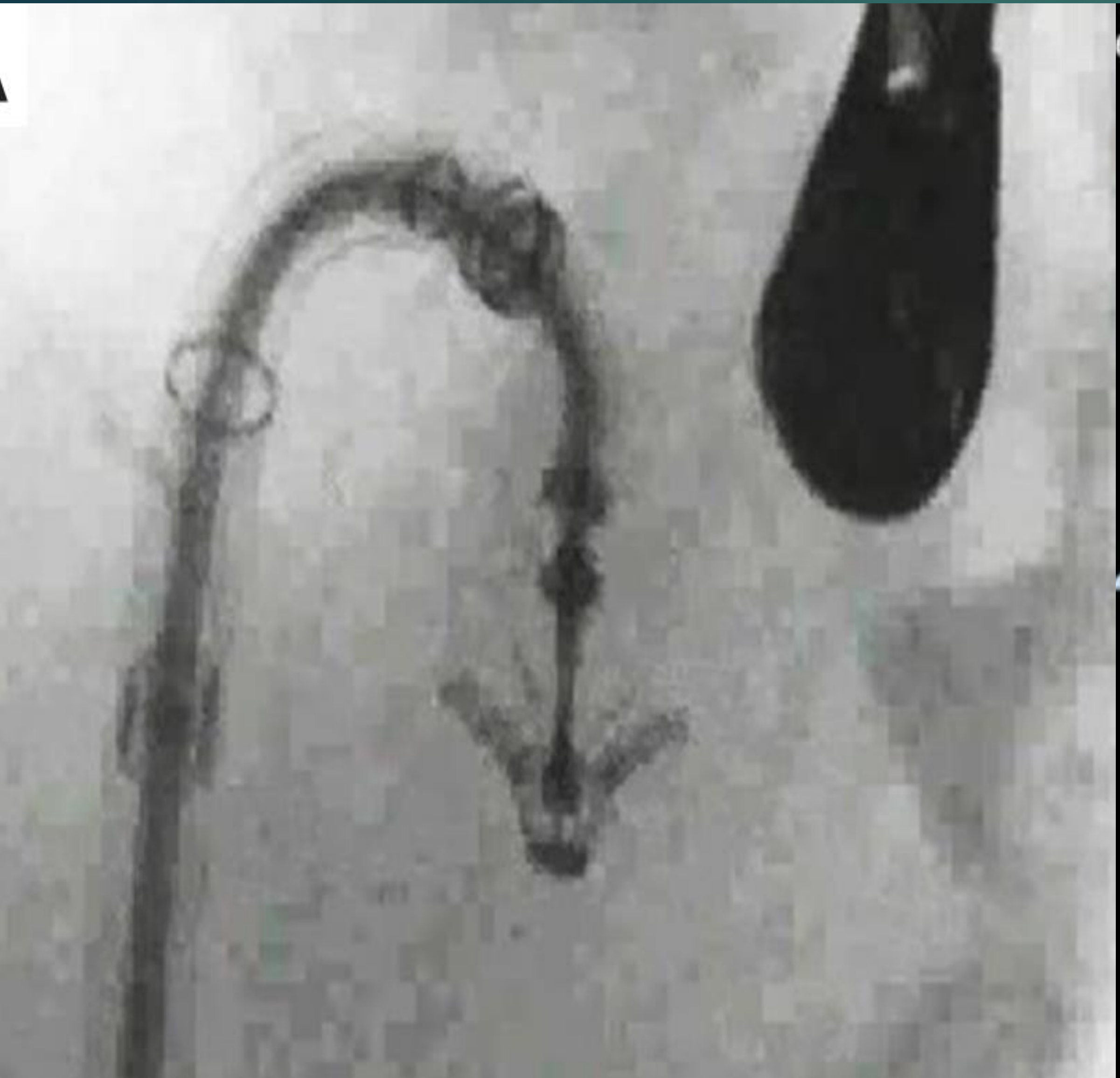
AV SAX



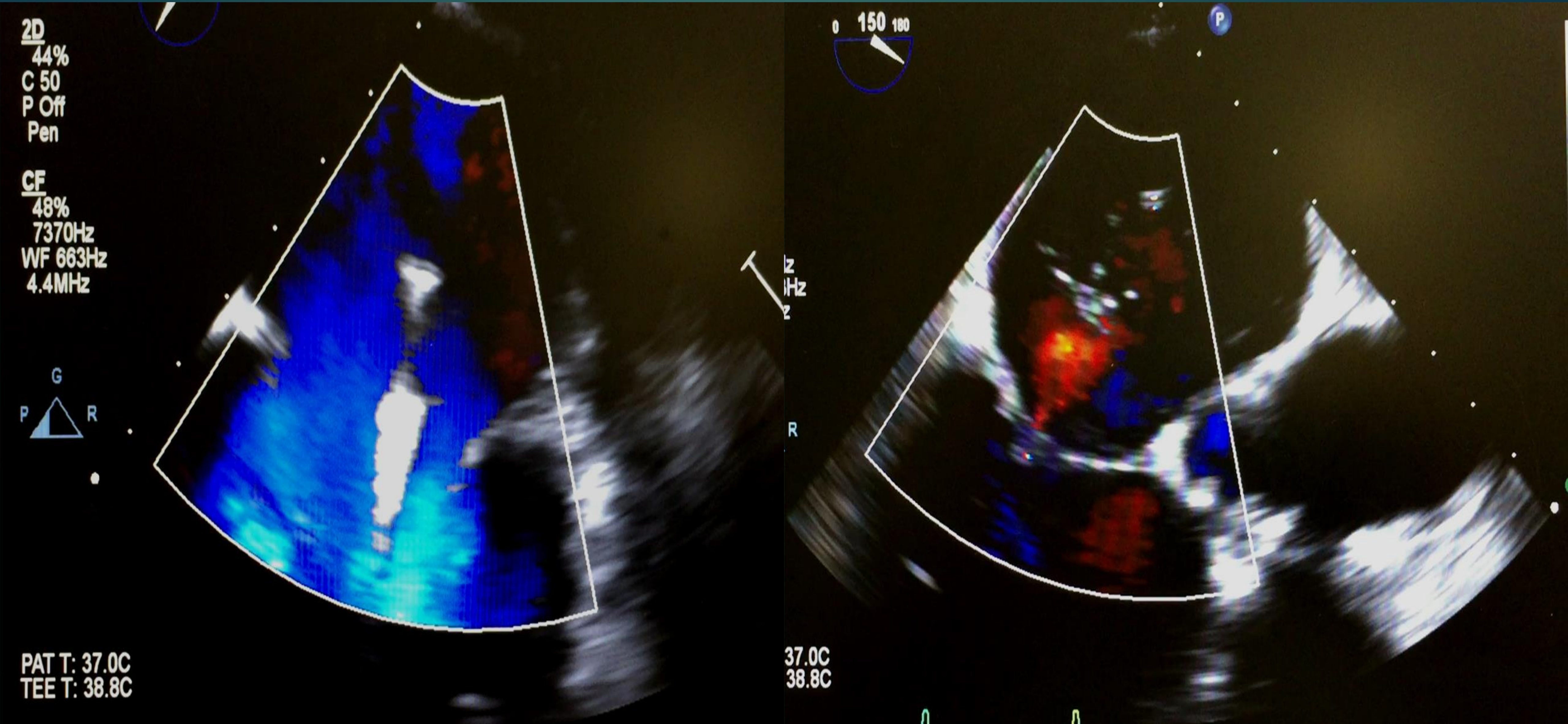
Bicaval View



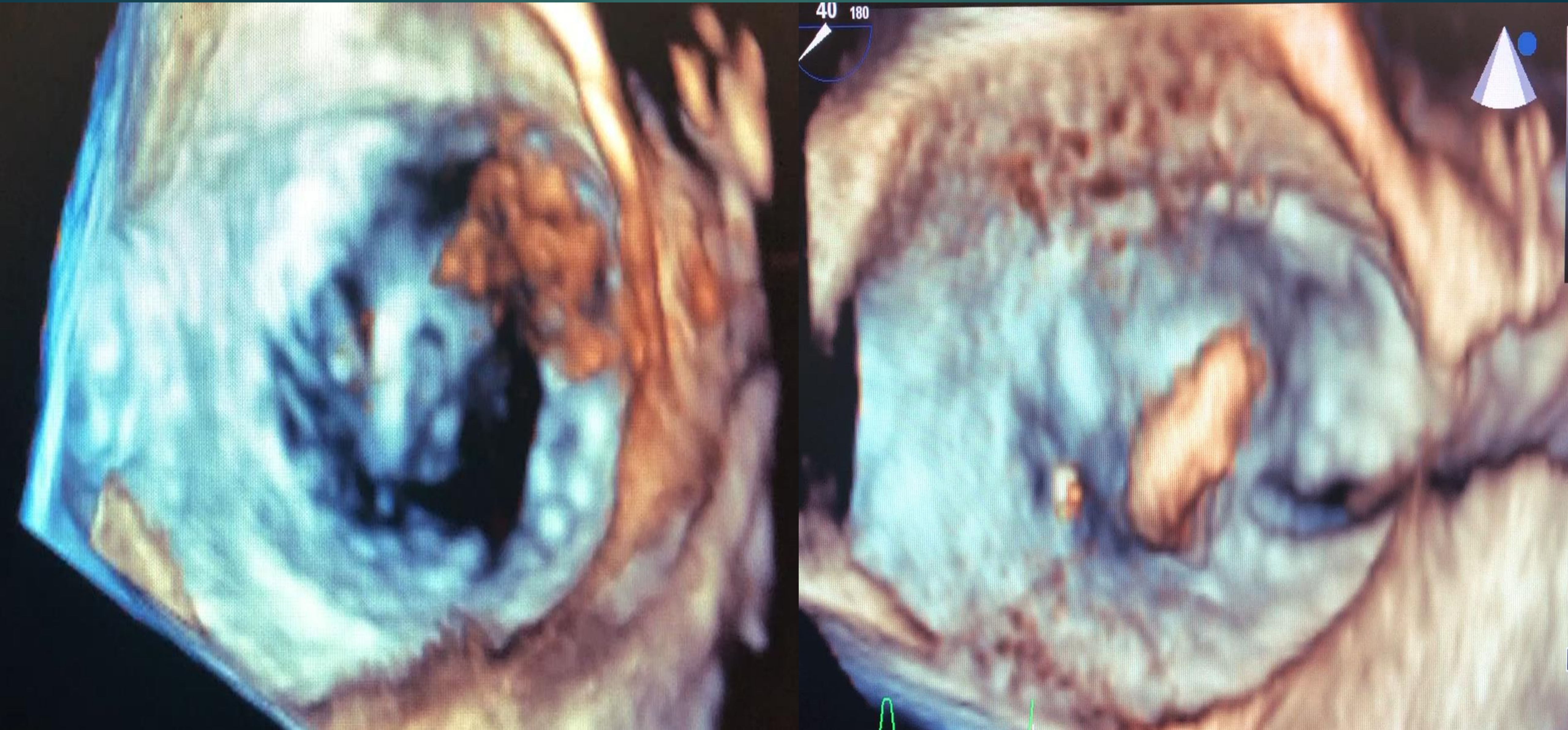
Mitraclip Positioning-Fluoro and 2D TEE



TEE Use with MitraClip: Before and After

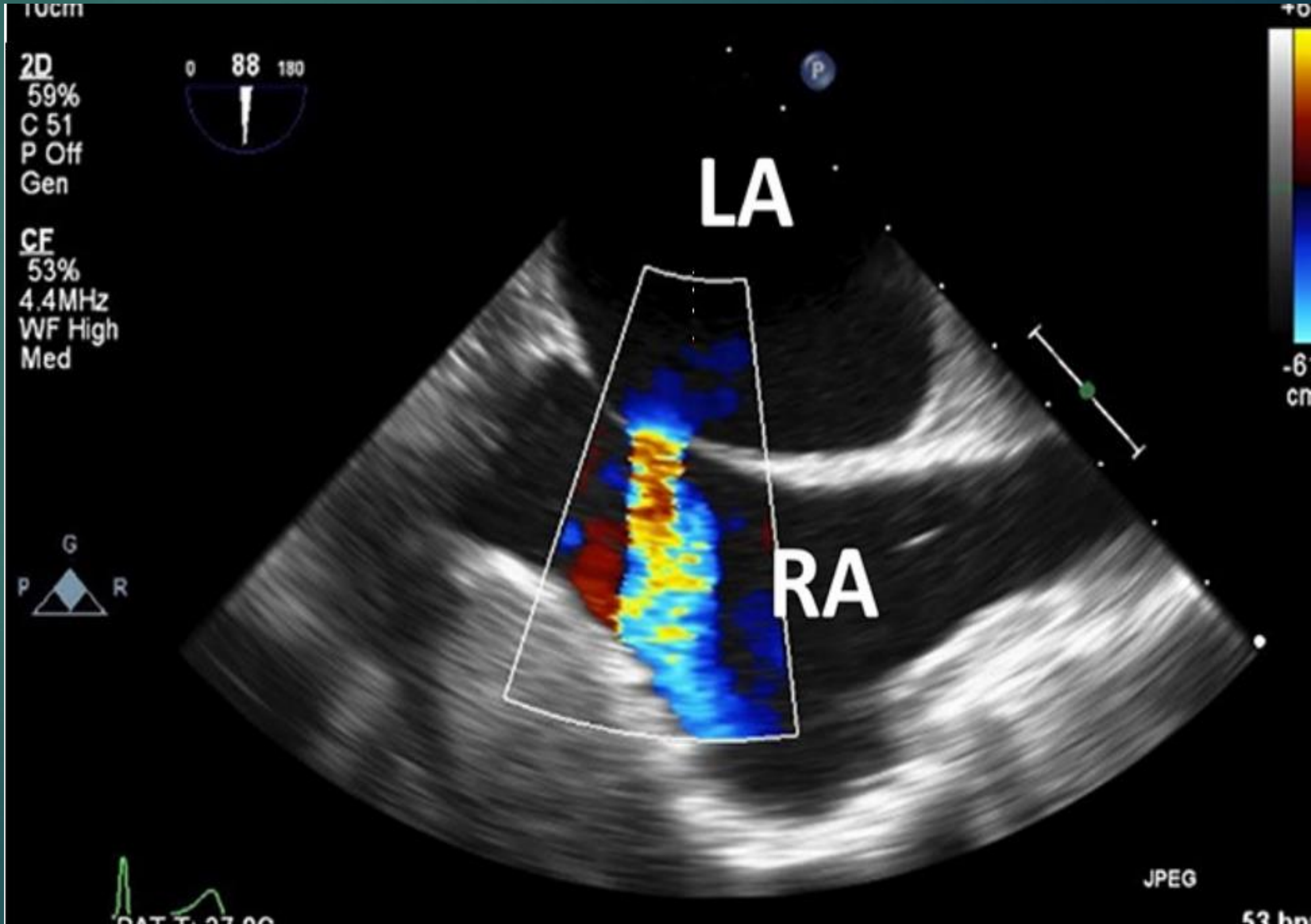


3D TEE with Mitraclip Before and After



Mitraclip Procedural Complications

- New intracardiac thrombus
- Ruptured chordae
- Atrial septal defect
- Leaflet perforation
- Mitral stenosis



Percutaneous Appendage Occlusion Devices

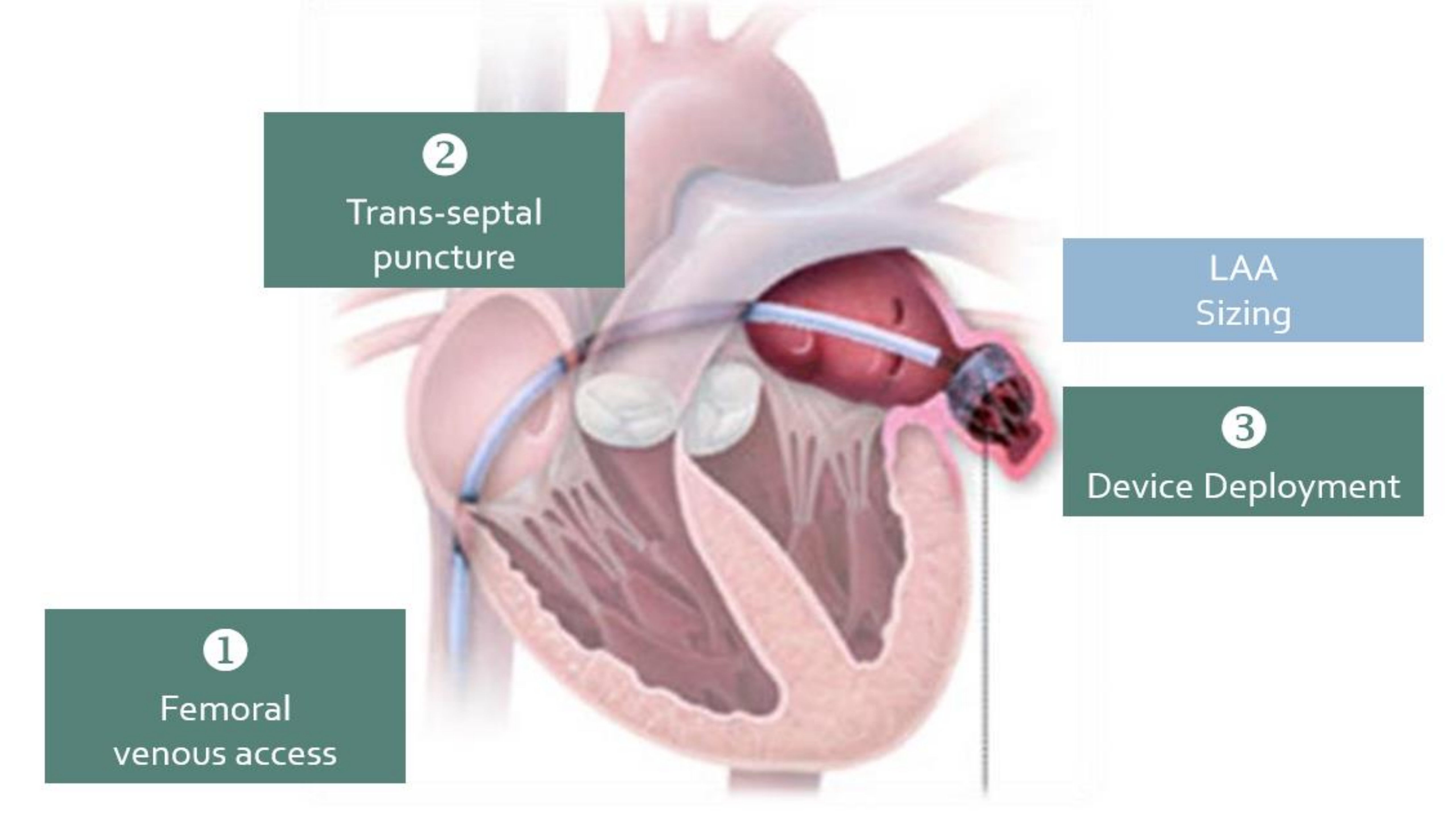
Endocardial

WATCHMAN

AMULET

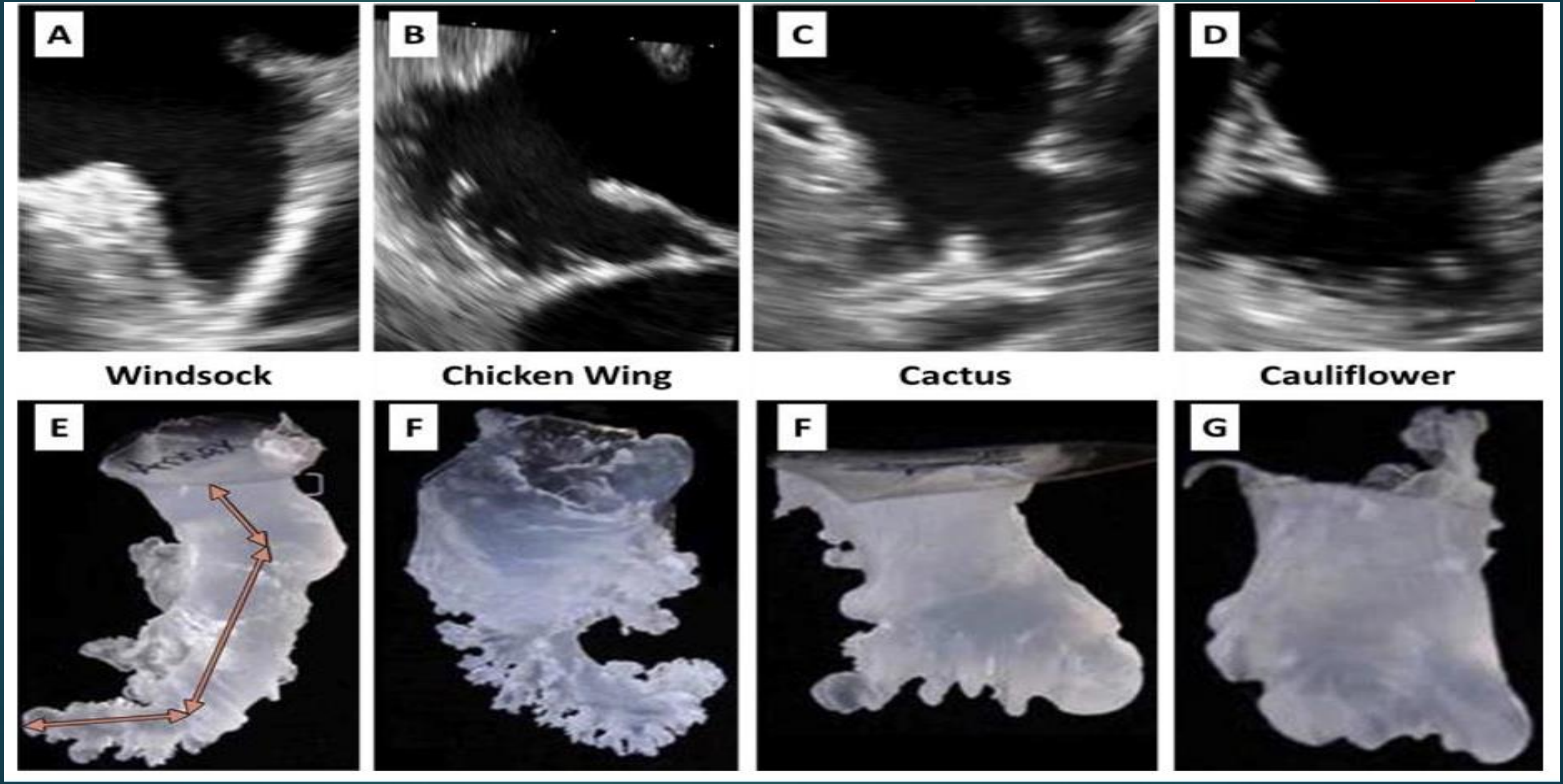
Epicardial

LARIAT



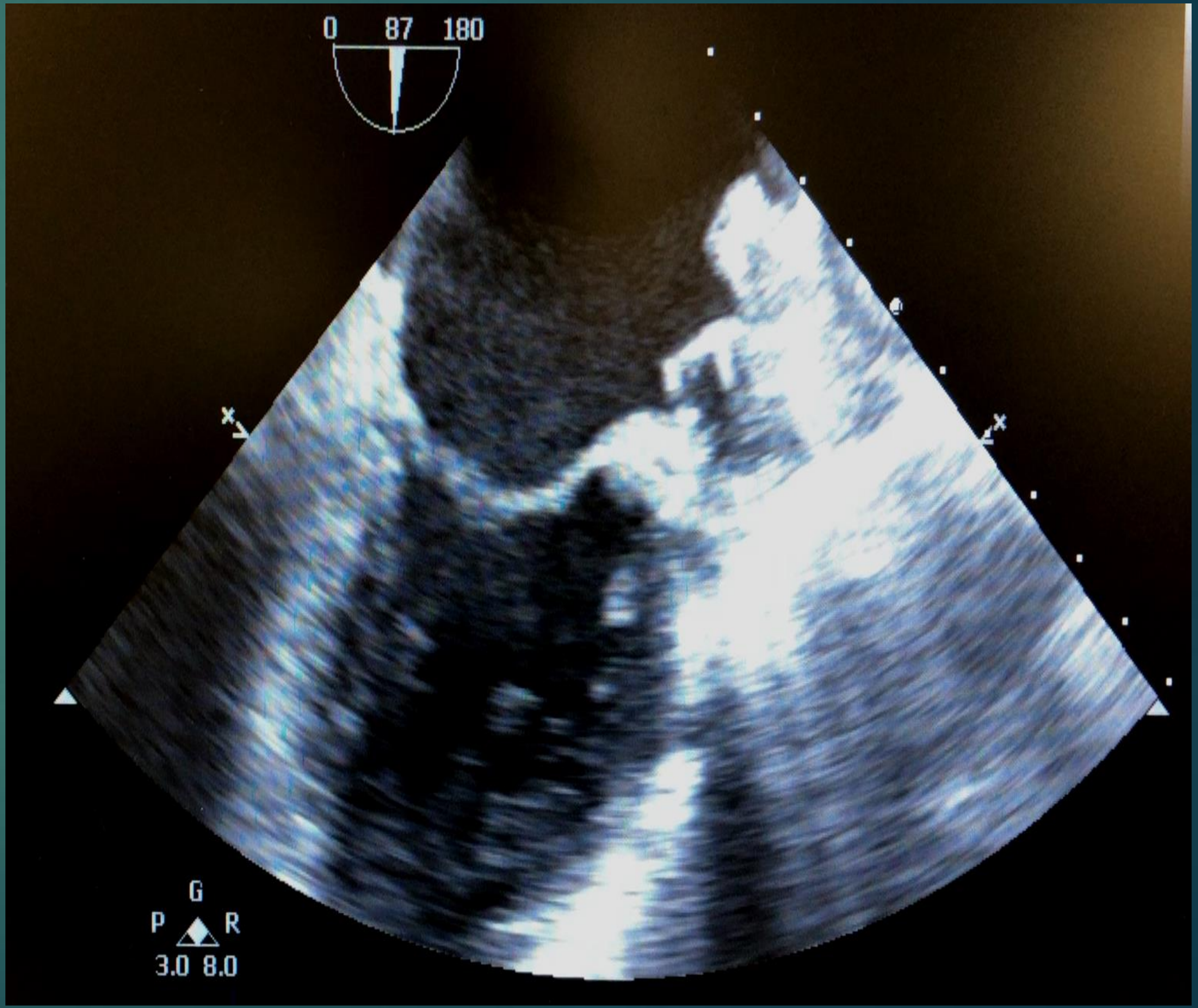
②
Trans-septal
puncture
LAA
Sizing
③
Device Deployment
①
Femoral
venous access

Left Atrial Appendage Morphologies



Use of TEE for Watchman and Other Atrial Occlusion Devices

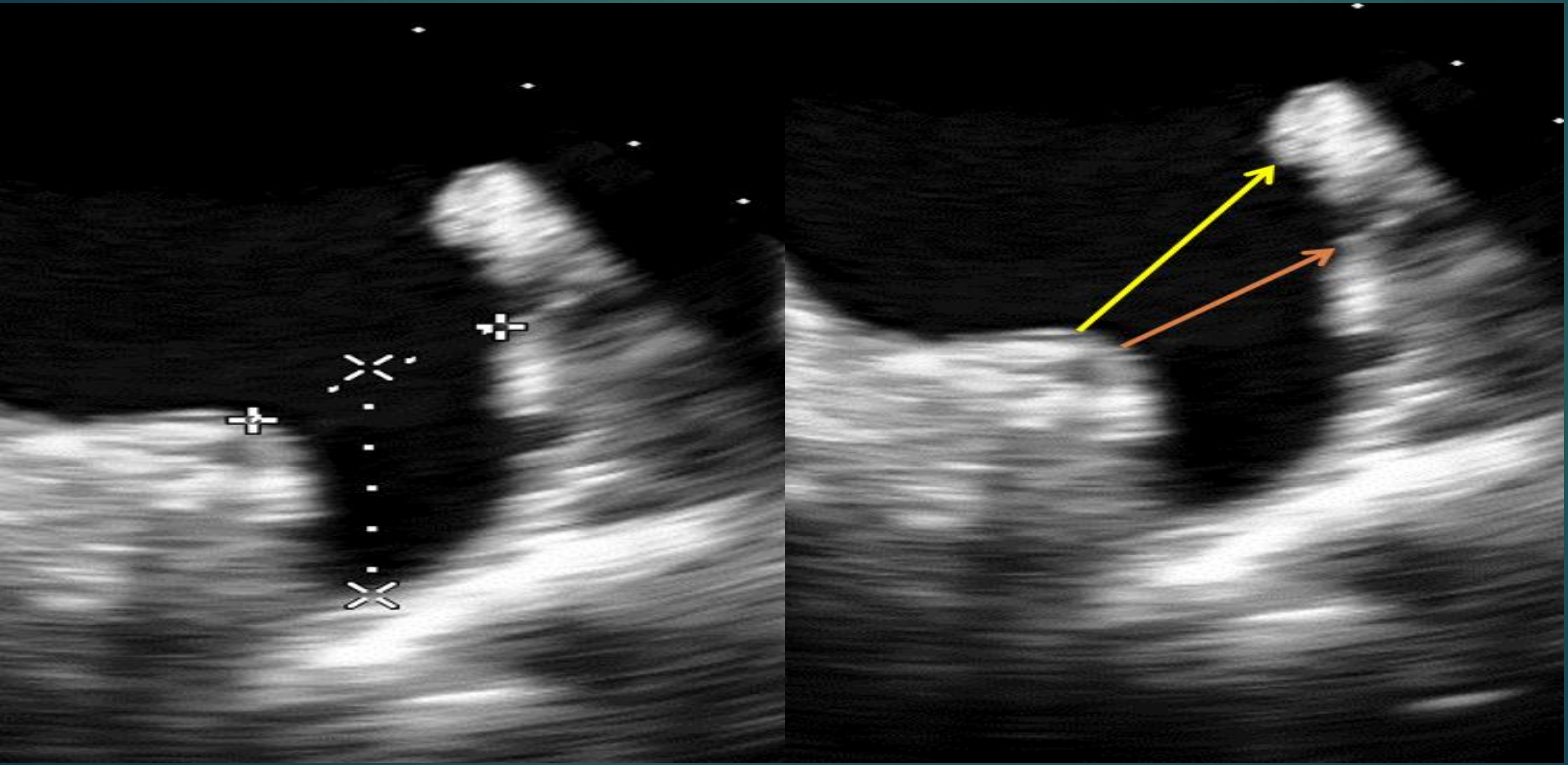
- Assess anatomy and sizing of left atrial appendage
- Map device landing site
- Trans-septal pucture
- Assess position along with fluoroscopy
- Verify occlusion by Doppler of flow



LAA Sizing for Endocardial Devices

Sizing Based on LAA Diameter and Depth

Diameter Measurements

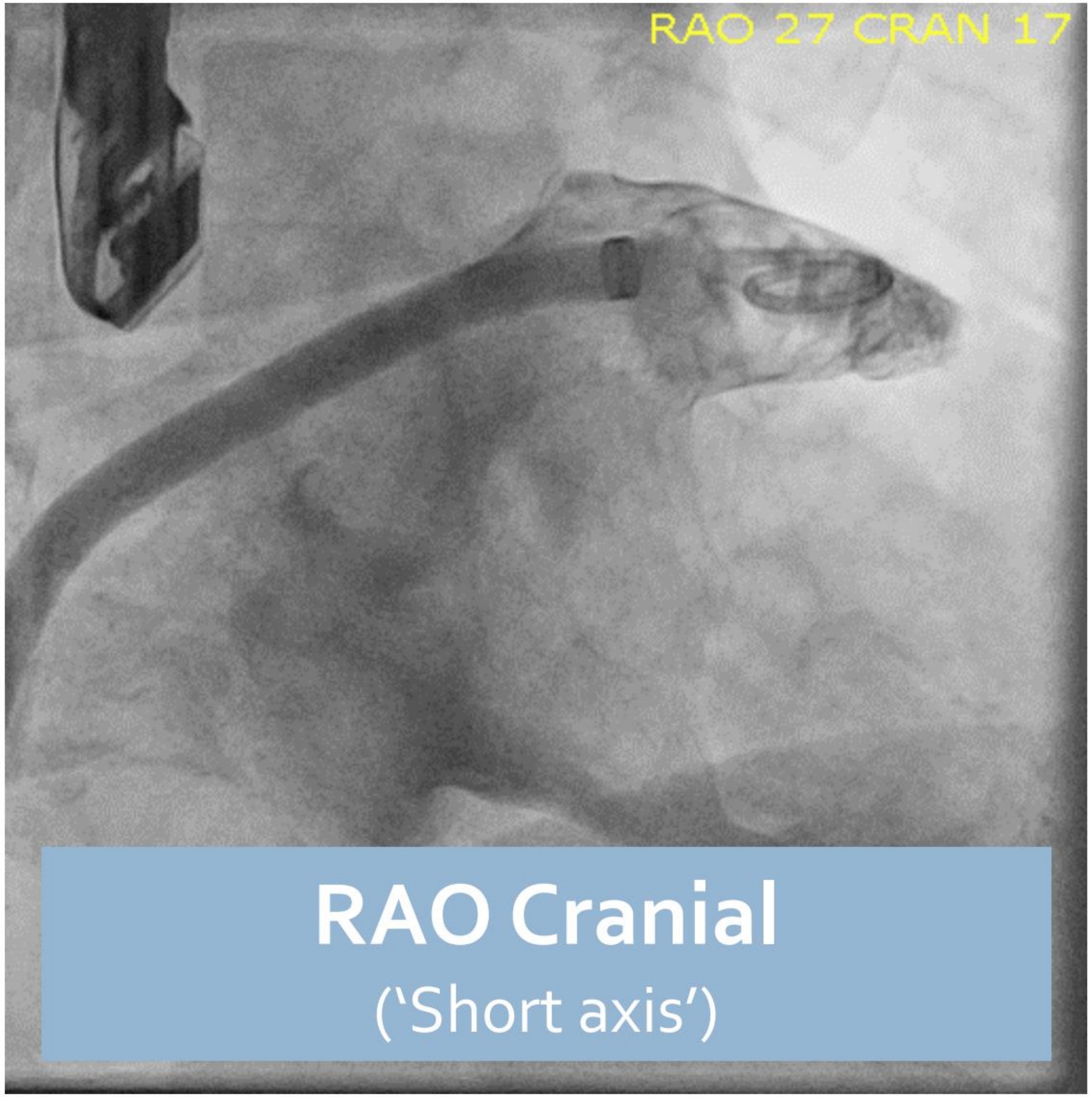


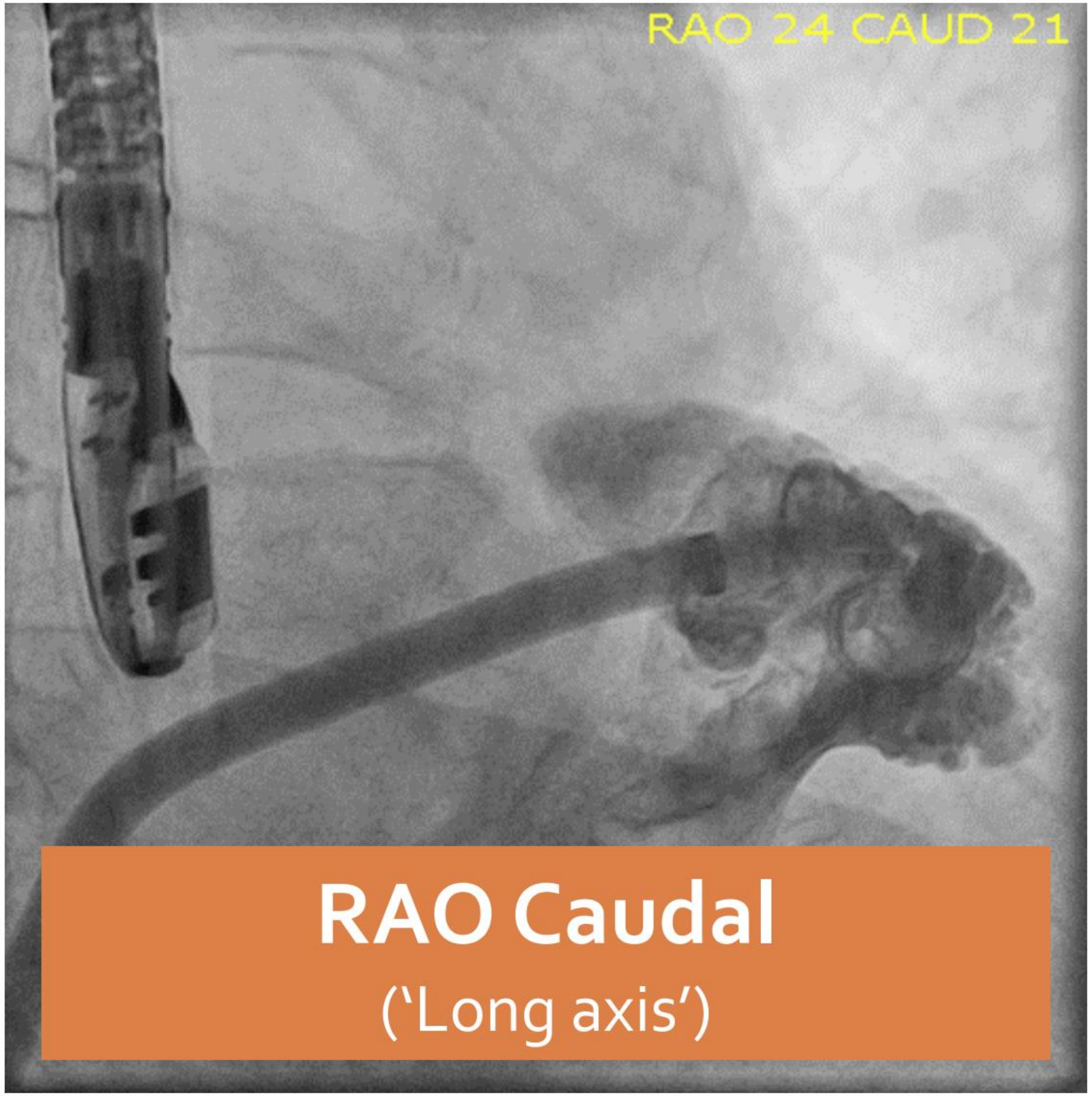
Anatomic Orifice Diameter

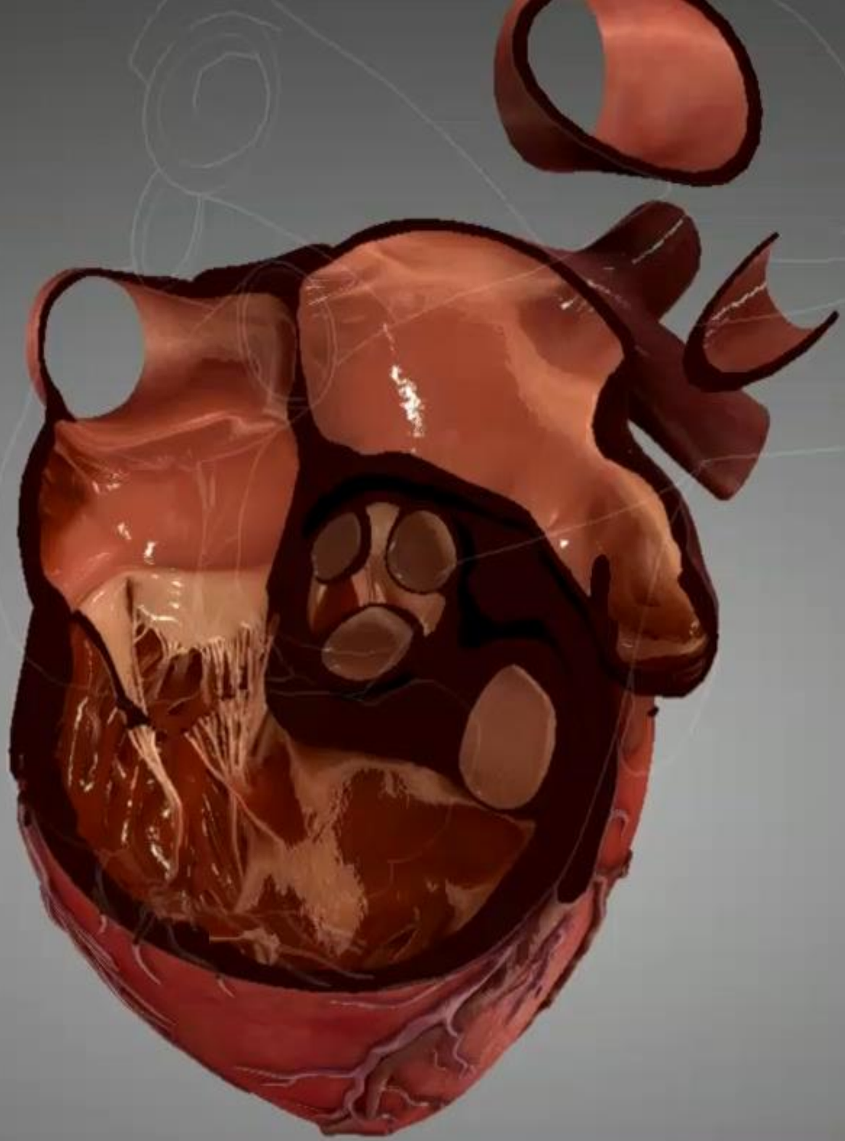
Sizing Orifice Diameter

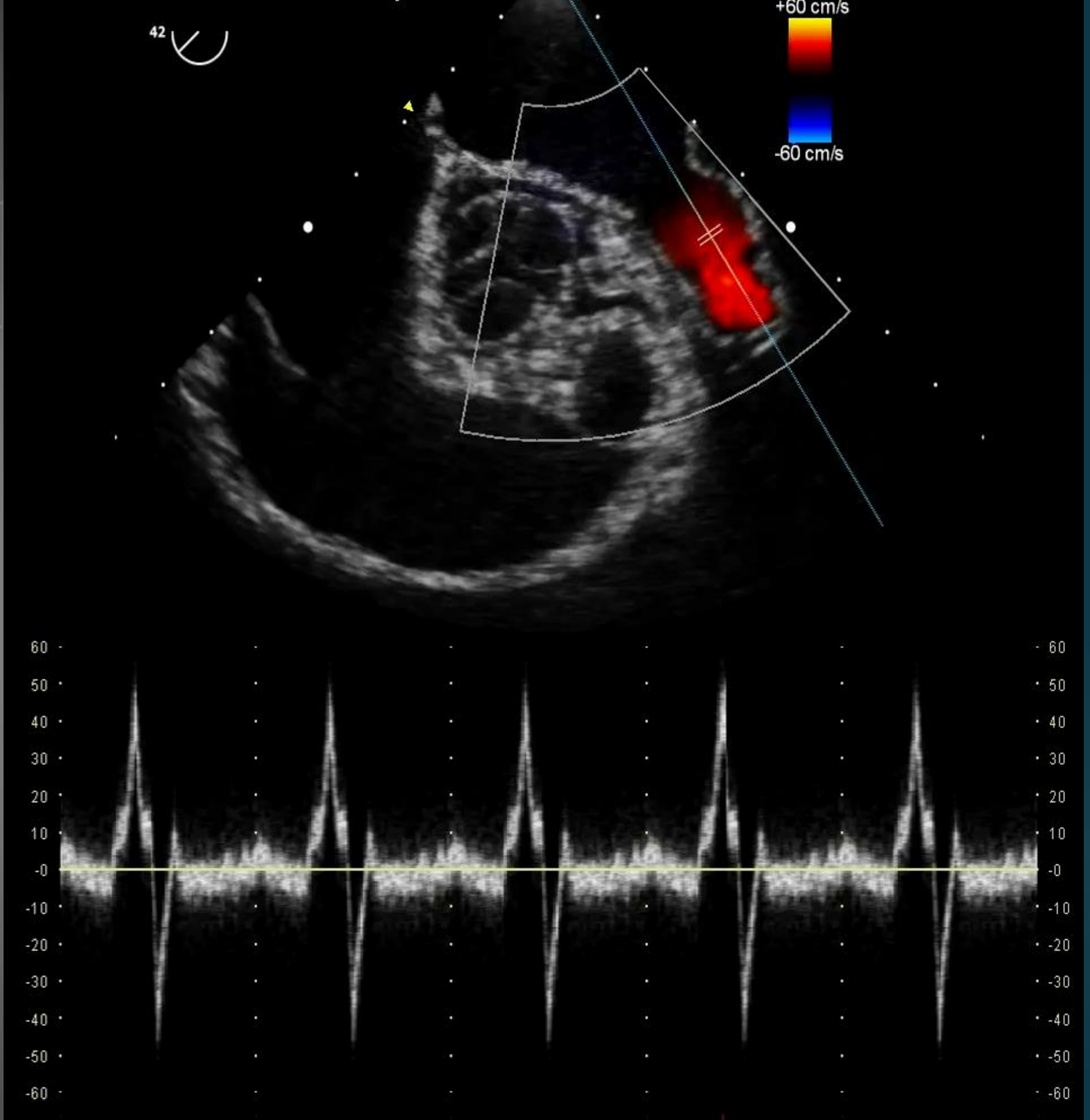
Trans-septal Puncture | Optimal Location

LAA Fluoroscopy View



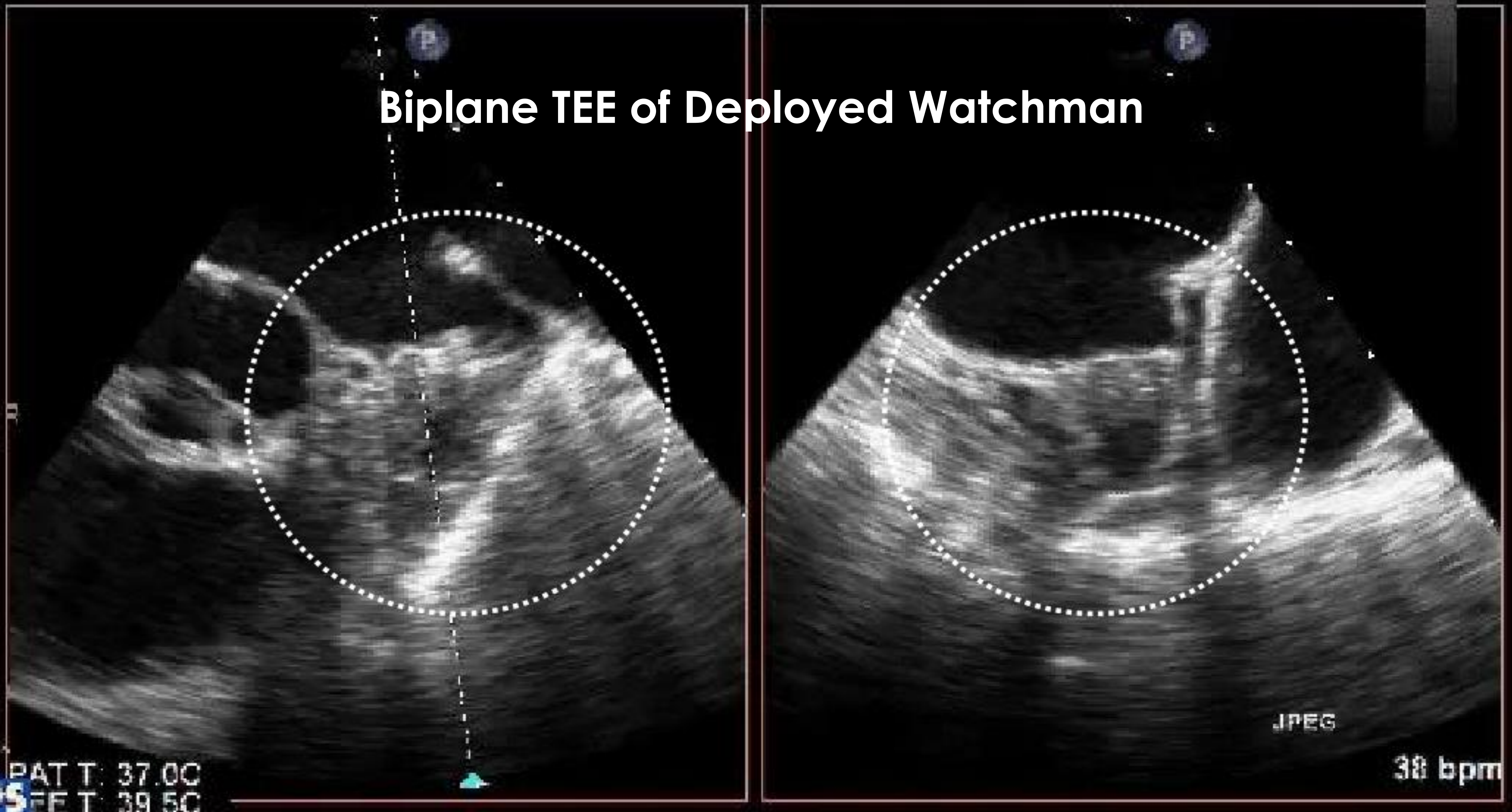






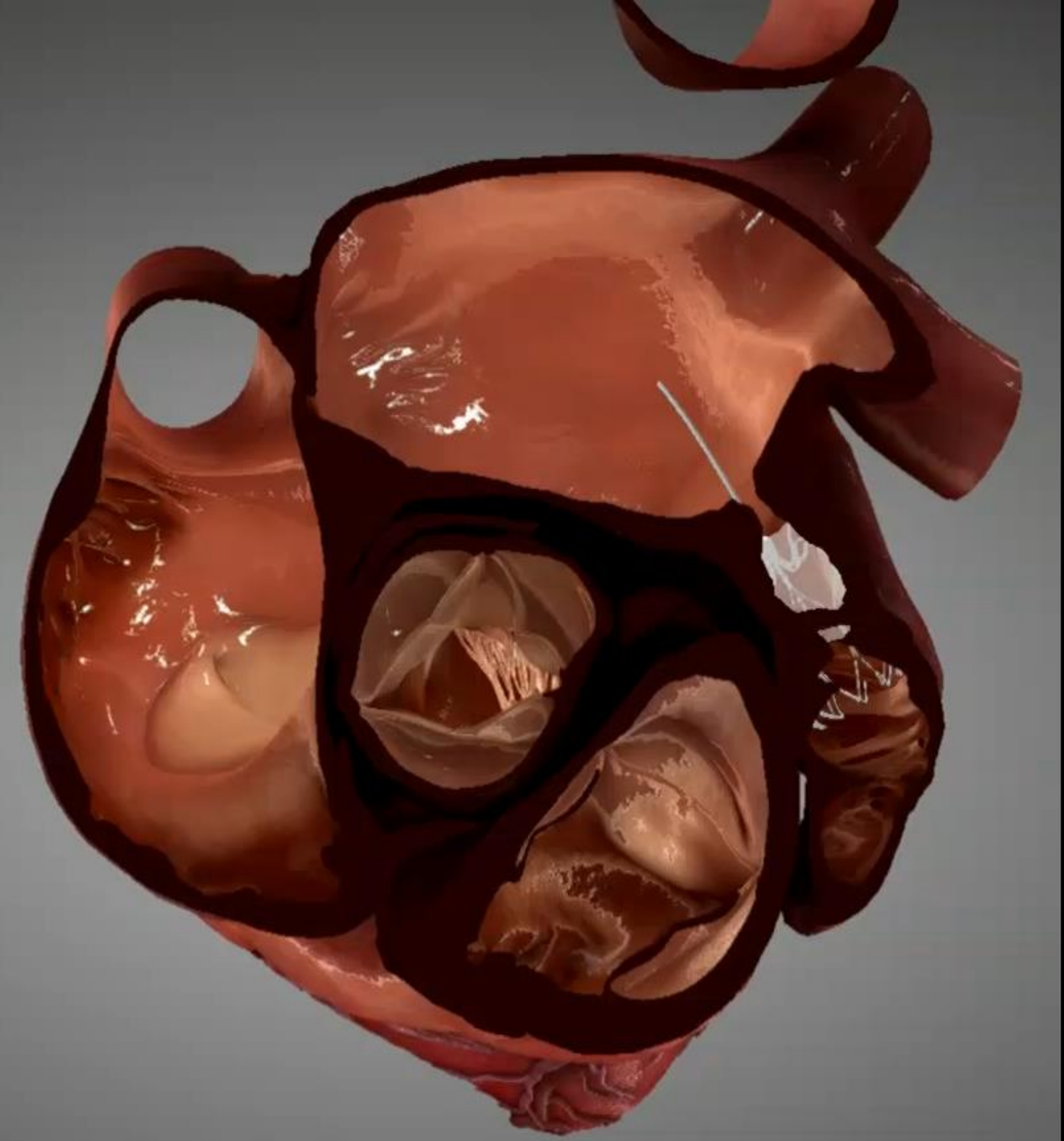
Hooked LAA with Doppler

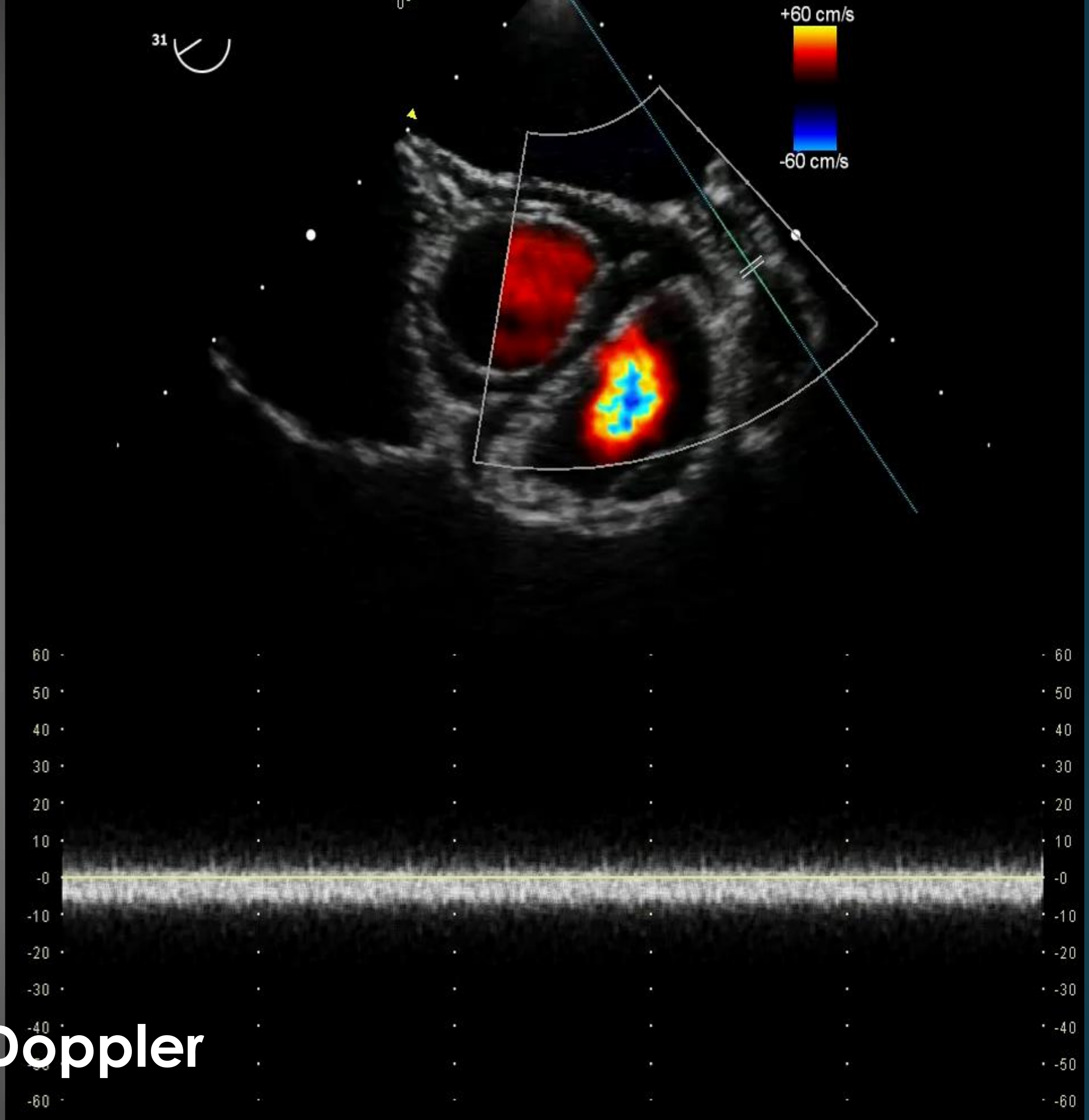
Biplane TEE of Deployed Watchman



Hooked LAA with Watchman

Hooked LAA/Watchman with Doppler





Summary

- TEE is not essential for TAVR deployment but is useful in assessing for paravalvular leak and gradients
- TEE is essential for mitraclips to gauge effect of clip deployment including reduction of mitral regurgitation and gradients across the mitral valve
- TEE is no longer essential for Watchman if intracardiac echo (ICE) is used and previous TEE study demonstrates LAA anatomy
- TEE continues to have evolving utility in surgical decision-making