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Guidance of Mitral and Tricuspid Interventions: *Role of 3D Echo*

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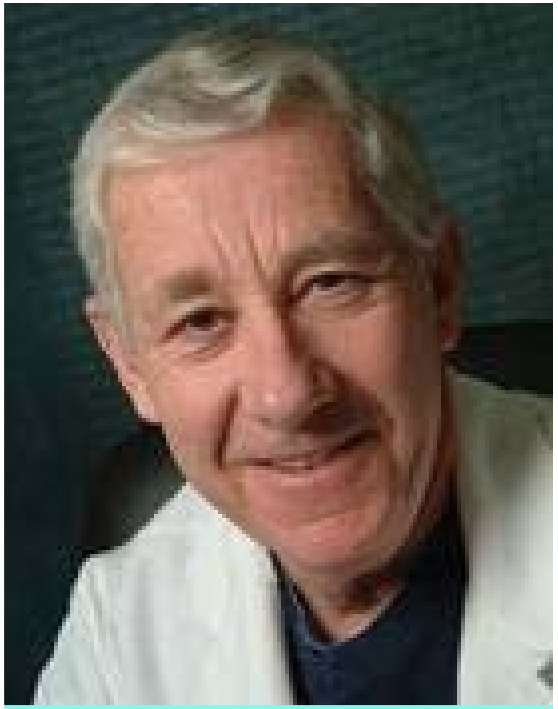
Conflicts of interest: GE, Abbott, Edwards (honoraria)
Spouse employment: Bay Labs

Percutaneous balloon valvotomy for patients with severe mitral stenosis

IGOR PALACIOS, M.D., PETER C. BLOCK, M.D., SERGIO BRANDI, M.D., PABLO BLANCO, M.D., HUMBERTO CASAL, M.D., JOSE I. PULIDO, M.D., SIMON MUNOZ, M.D., GABRIEL D'EMPAIRE, M.D., MIGUEL A. ORTEGA, M.D., MARSHALL JACOBS, M.D., AND GUS VLAHAKES, M.D.

ABSTRACT Thirty-five patients with severe mitral stenosis underwent percutaneous mitral valvotomy (PMV). There were 29 female and six male patients (mean age 49 ± 3 years, range 13 to 87). After transseptal left heart catheterization, PMV was performed with either a single- (20 patients) or double- (14 patients) balloon dilating catheter. Hemodynamic and left ventriculographic findings were evaluated before and after PMV. There was one death. Mitral regurgitation developed or increased in severity in 15 patients (43%). One patient developed complete heart block requiring a permanent pacemaker. PMV resulted in a significant decrease in mitral gradient from 18 ± 1 to 7 ± 1 mm Hg ($p < .0001$) and a significant increase in both cardiac output from 3.9 ± 0.2 to 4.6 ± 0.2 liters/min ($p < .001$) and in mitral valve area from 0.8 ± 0.1 to 1.7 ± 0.2 cm^2 ($p < .0001$) Effective balloon dilating diameter per square meter of body surface area correlated significantly with the decrease in mitral gradient but did not correlate with the degree of mitral regurgitation. There was no correlation of age, prior mitral commissurotomy or mitral calcification with hemodynamic results. PMV is an effective nonsurgical procedure for patients with mitral stenosis, including those with pliable valves, those with previous commissurotomy, and even those with mitral calcification.

Circulation 75, No. 4, 0-0, 1987.

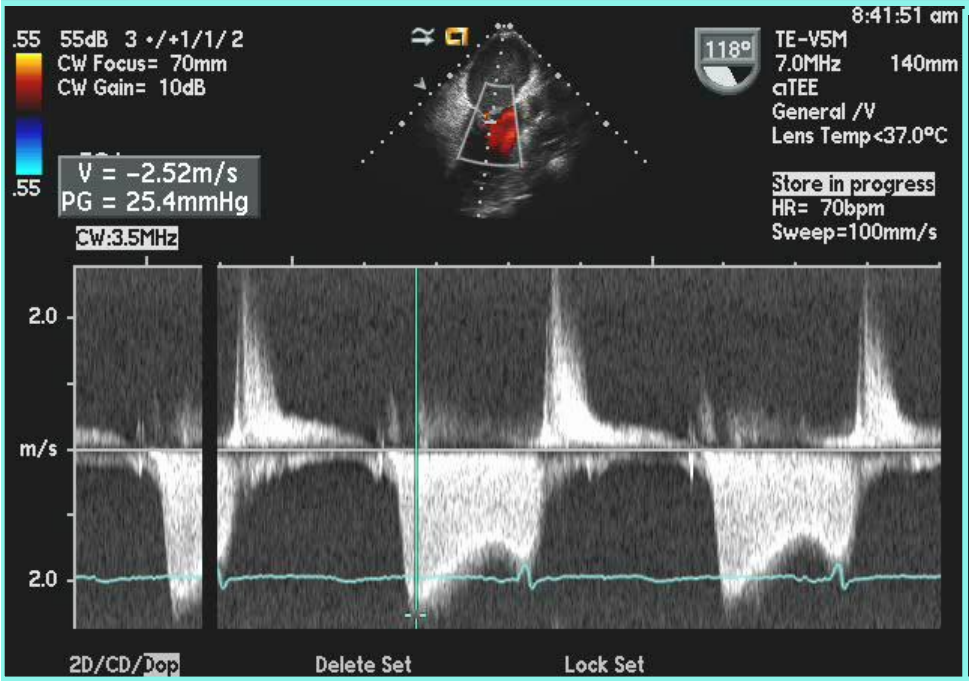


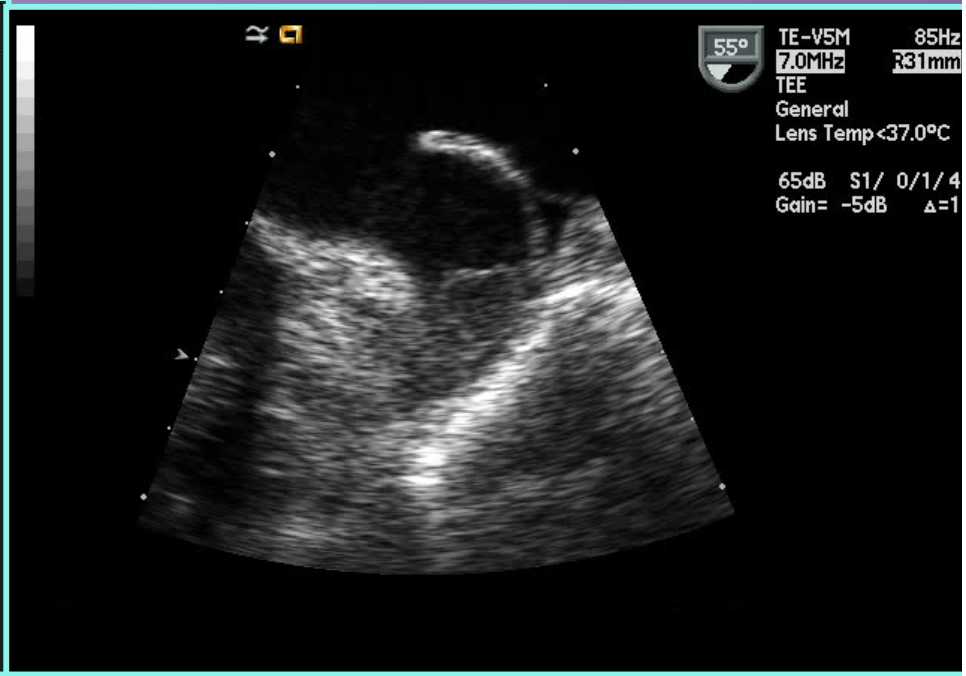
Peter C. Block, MD

- *1988: 1st live course for PMV (Beth Israel, then MGH)*
- *Day 1 at Beth Israel went "poorly"*
- *Peter Block calls at 10 PM:*
  - **"I want you and an echo machine in the cath lab for both cases tomorrow"**

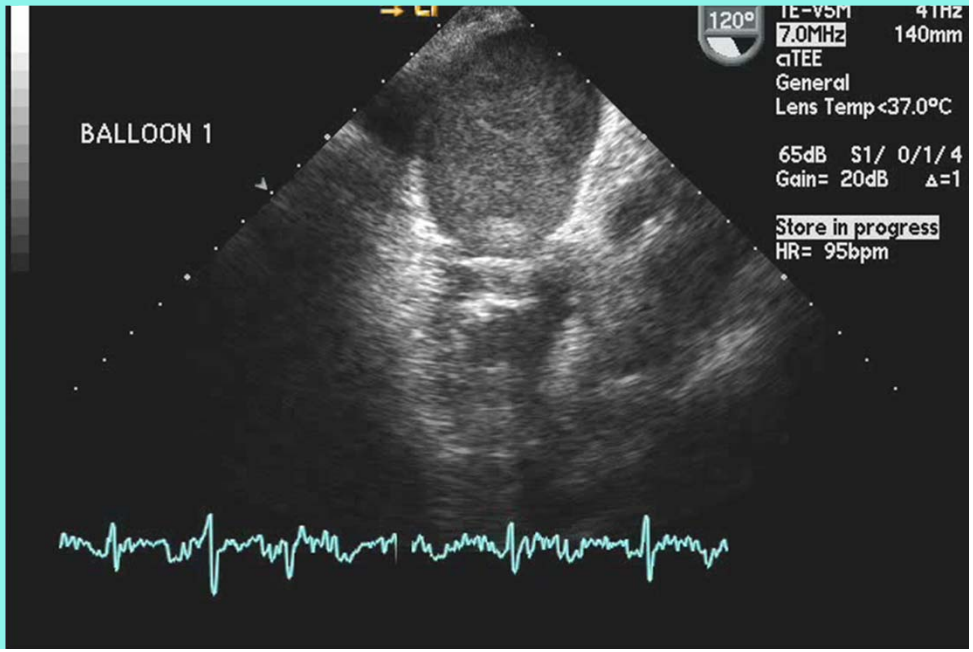
Palacios et al. Circ 1987; 75: 778-84

You Don’t Need 3D for BMV Guidance

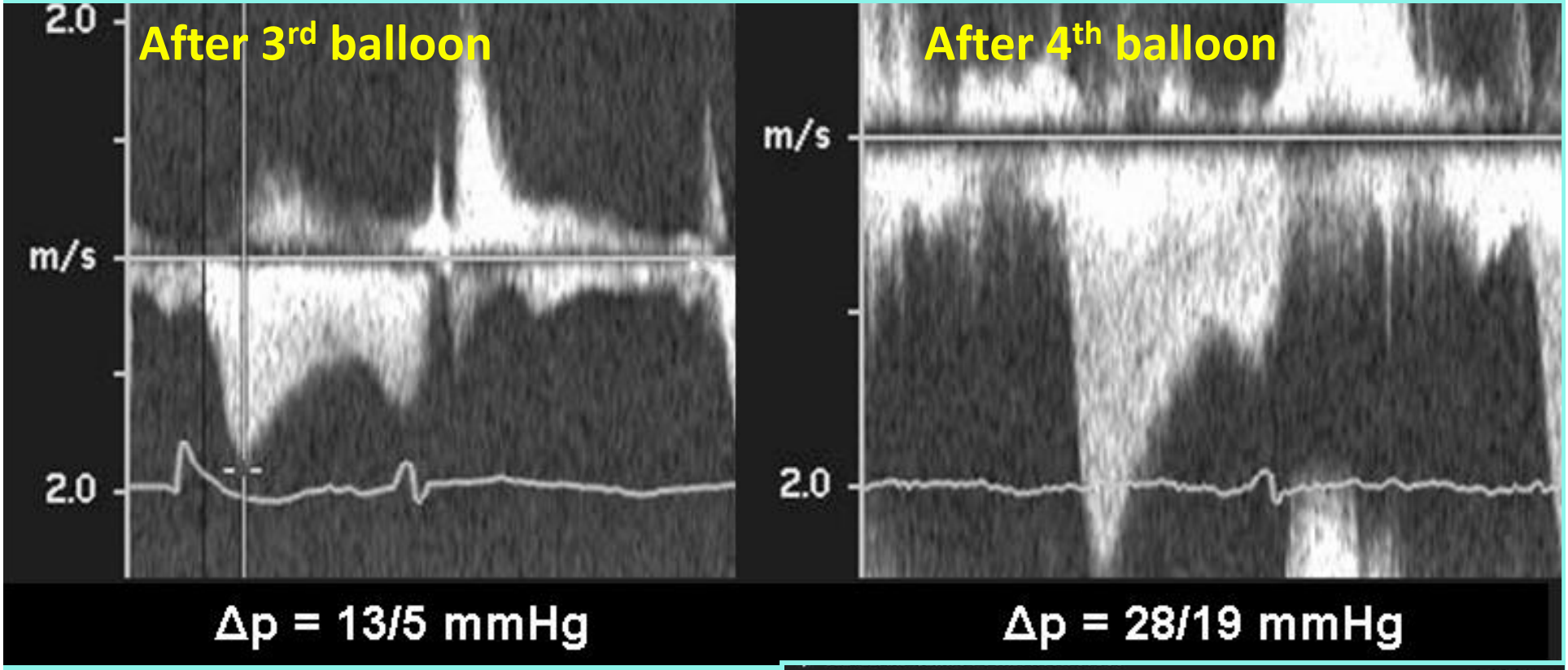




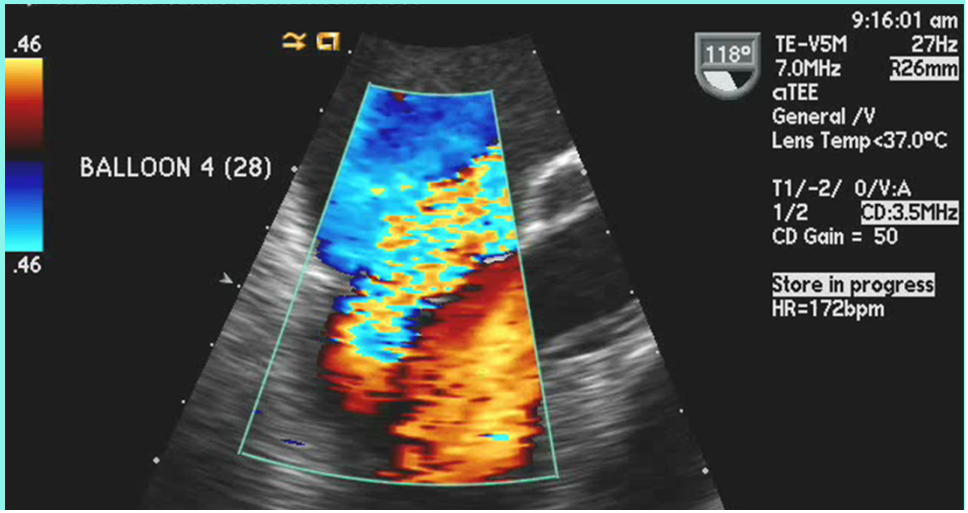
- **Baseline hemodynamics**
- **Rule out LAA thrombus**
- **Assure balloon placement**



One Balloon Dilation Too Many



- MV torn by 4th balloon
- Severe MR
- OR necessary



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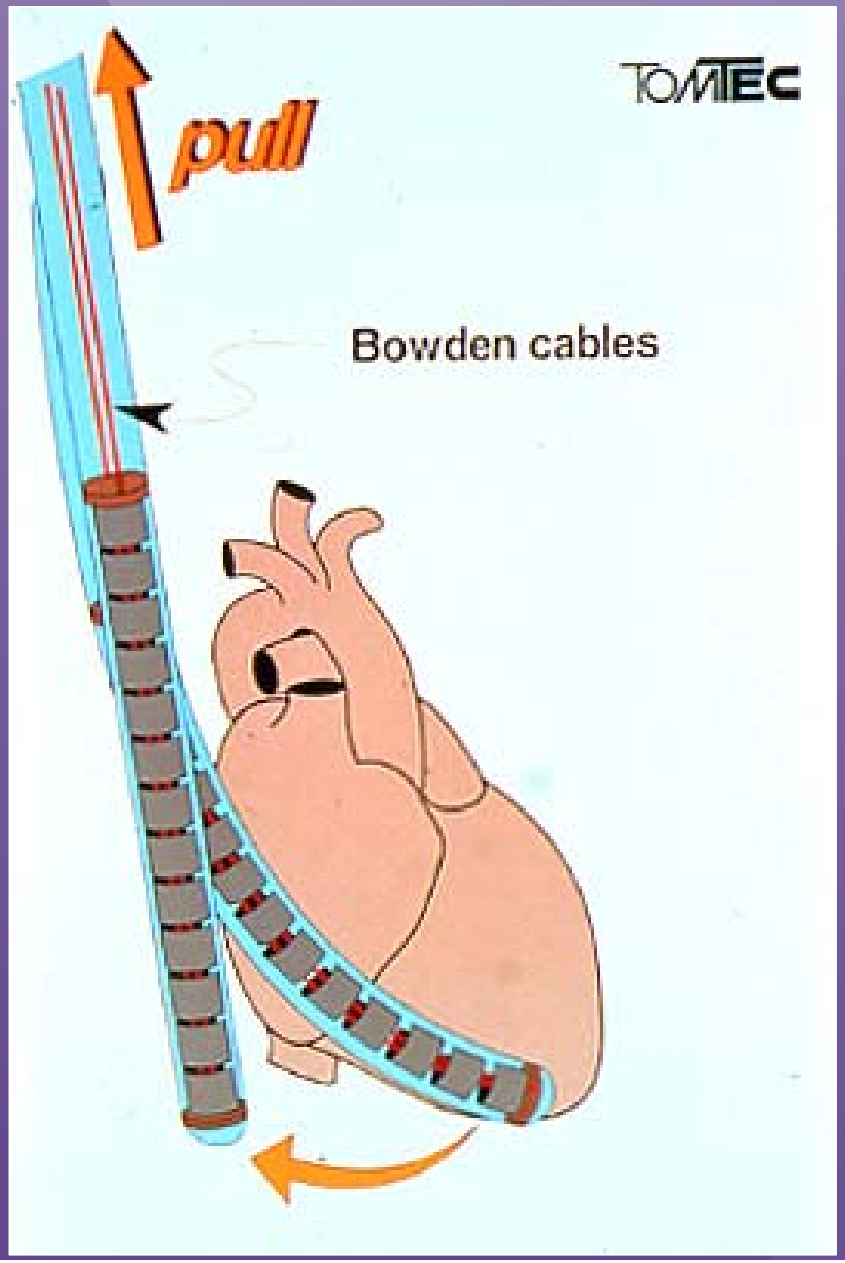
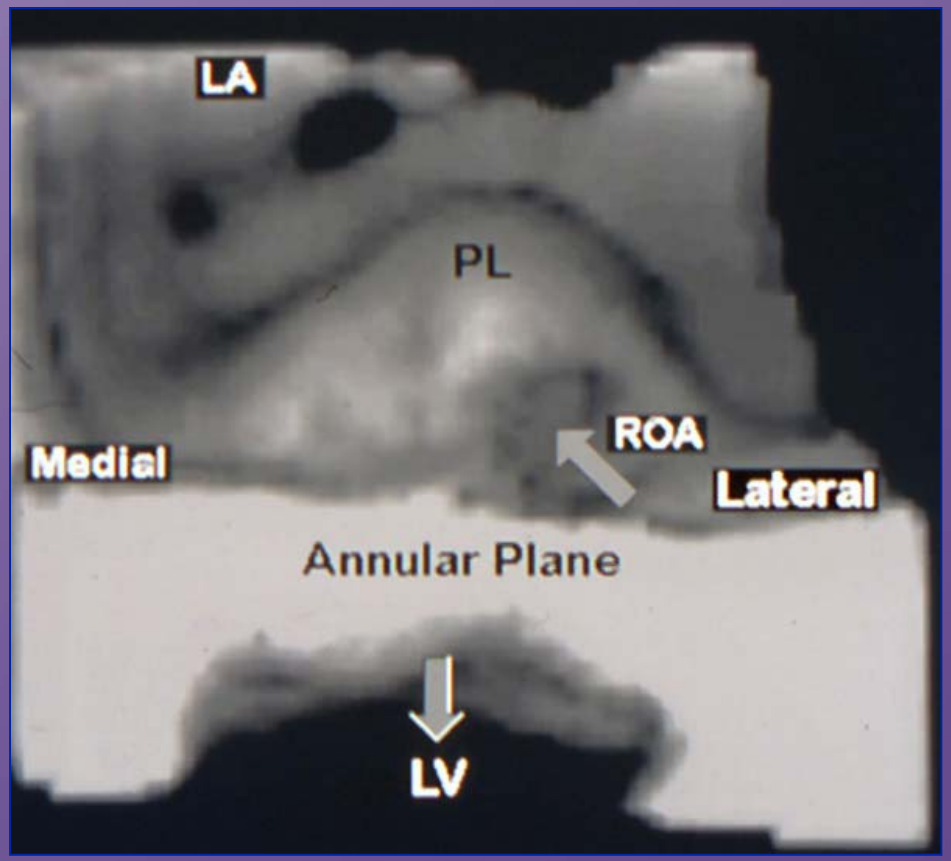
3D TEE was Tough in the Early Days…



TomTec approach ~1992



Breburda et al., JACC 1998;32:432-7

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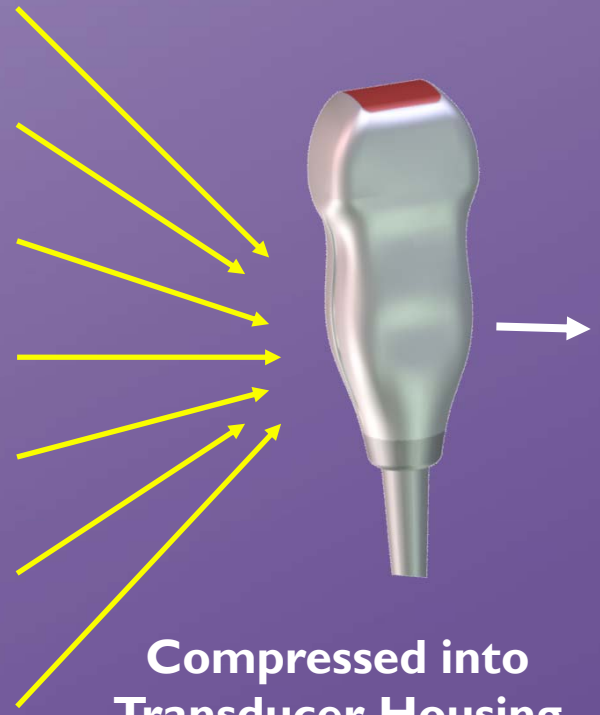
And Now It's in a TEE
Shrinking Beamforming Electronics

>150 Front End Boards

Electronics needed for 2500 Elements



Compressed into Transducer Housing

Further compressed into TEE Tip

Higher density electronics
New micro-beamforming architecture
Novel interconnect scheme

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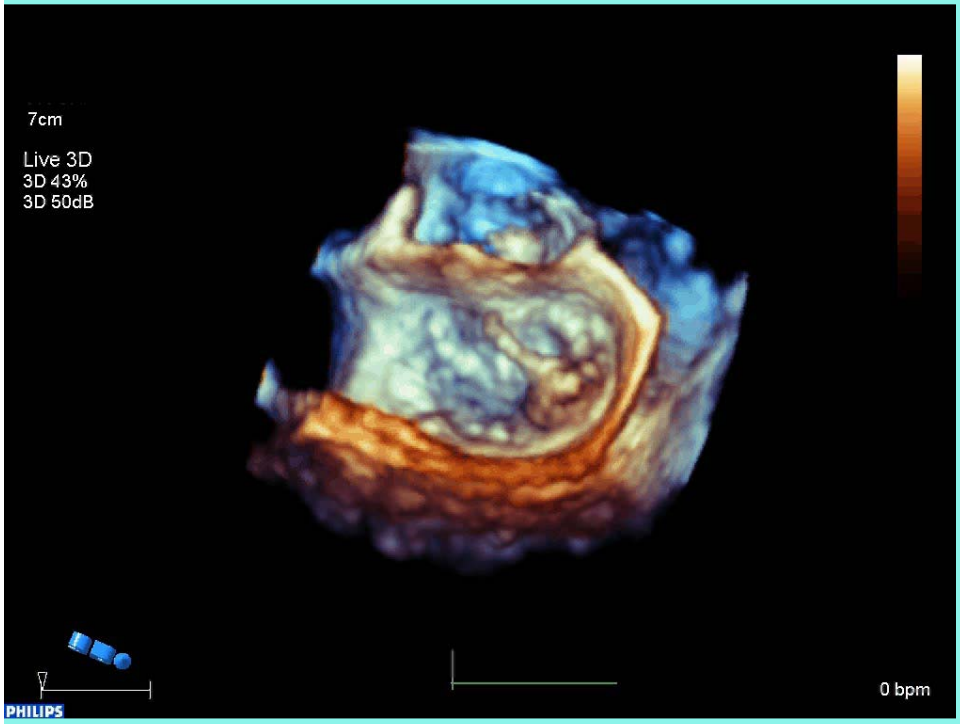
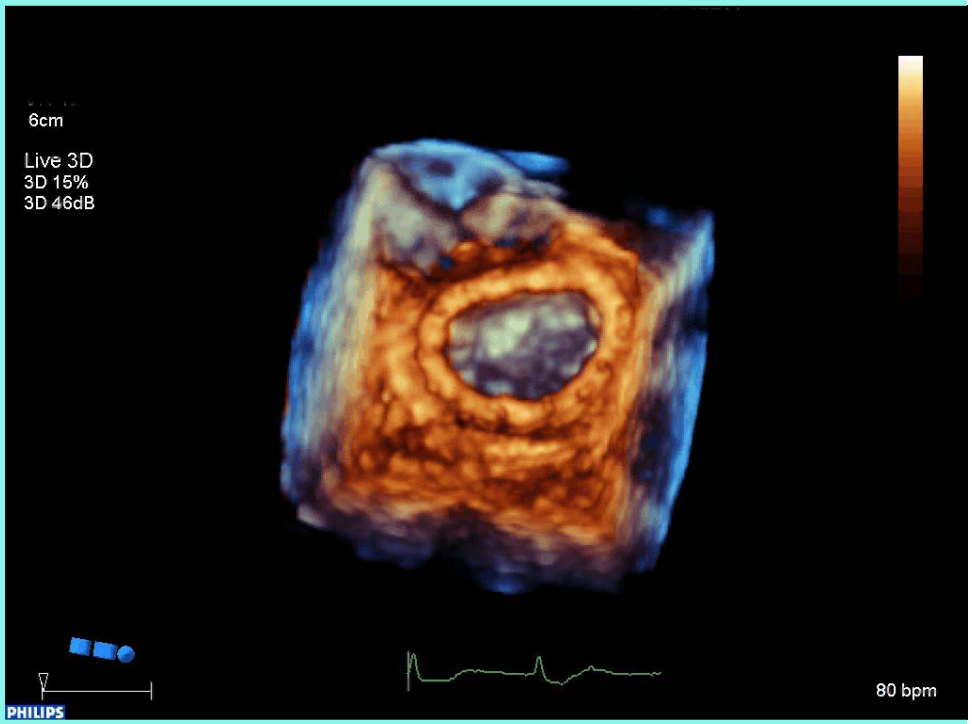
3DTEE in Intraoperative Echo





Mitral valve with P3 flail, repaired with resection and annuloplasty

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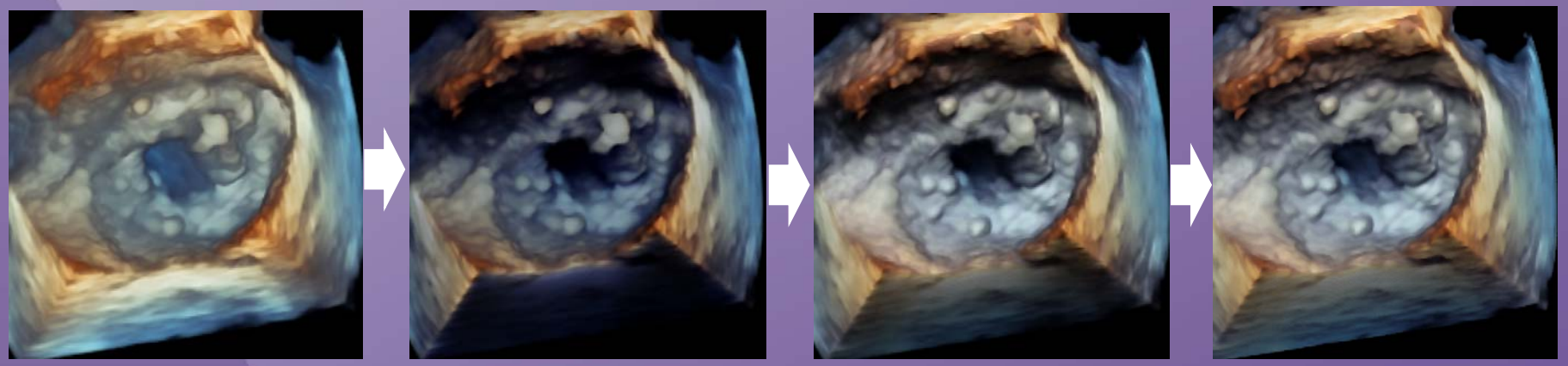
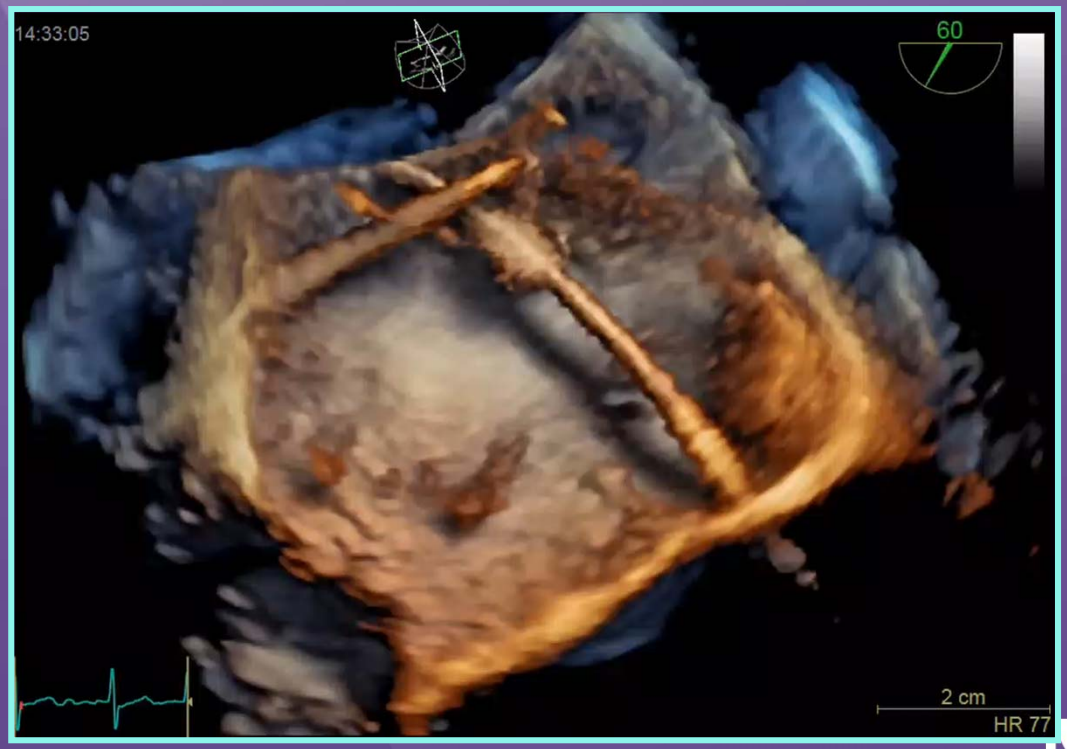
Next generation real time rendering



Depth coloring | Shadows | Reflections | HDR
High Dynamic Range



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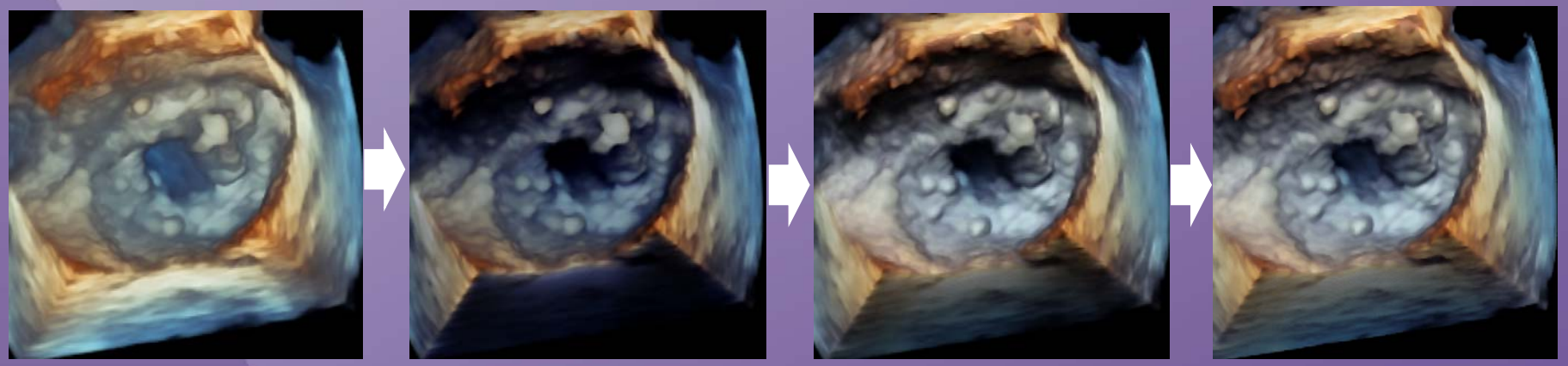
Next generation real time rendering



Depth coloring | Shadows | Reflections | HDR
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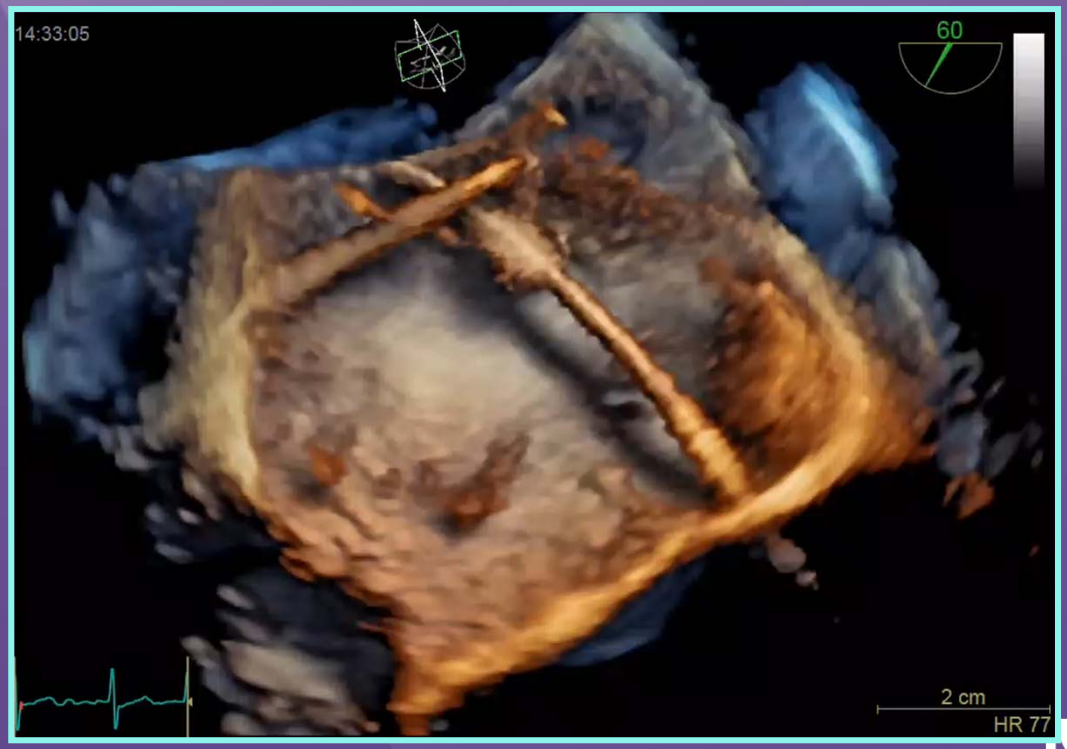

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It looks even better in stereo…

…even if we don't!

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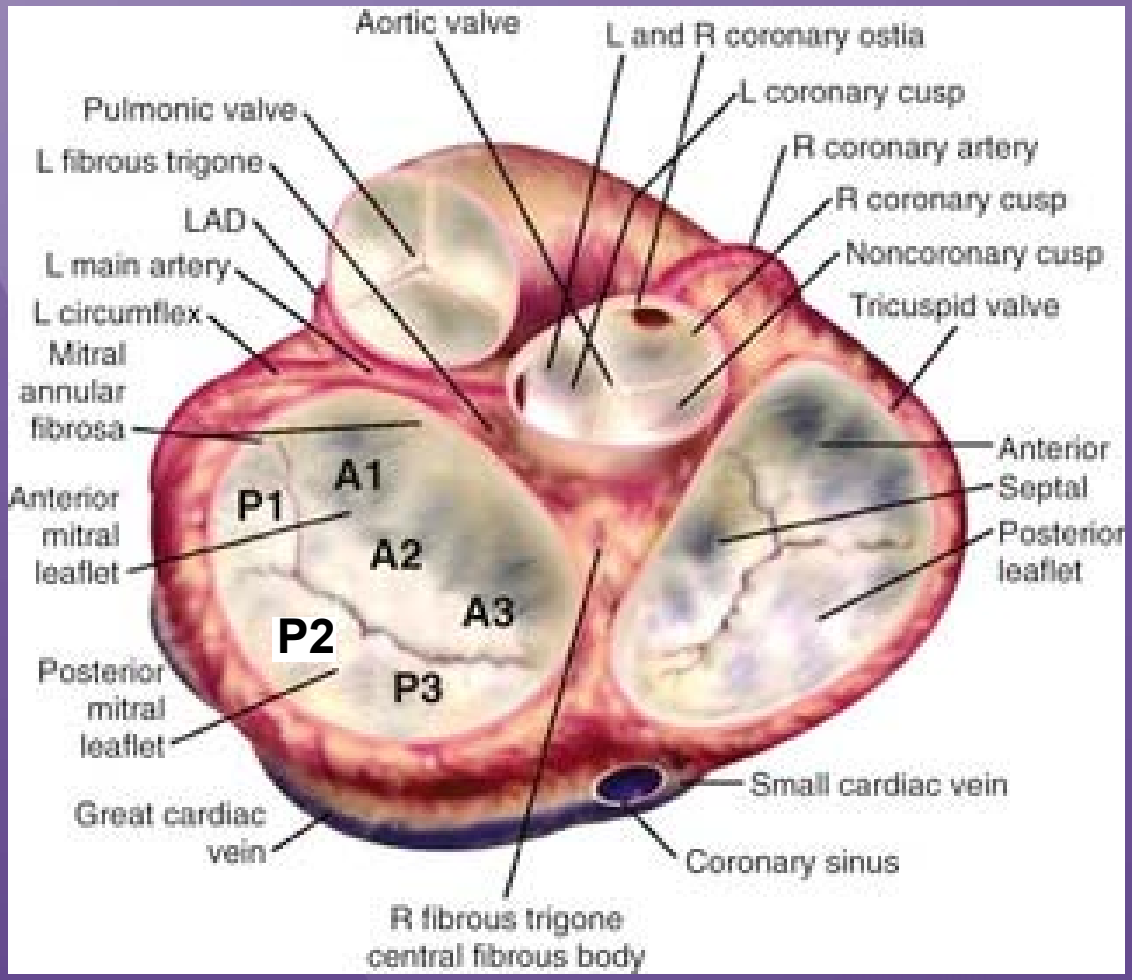
For optimal interventions, you need optimal imaging



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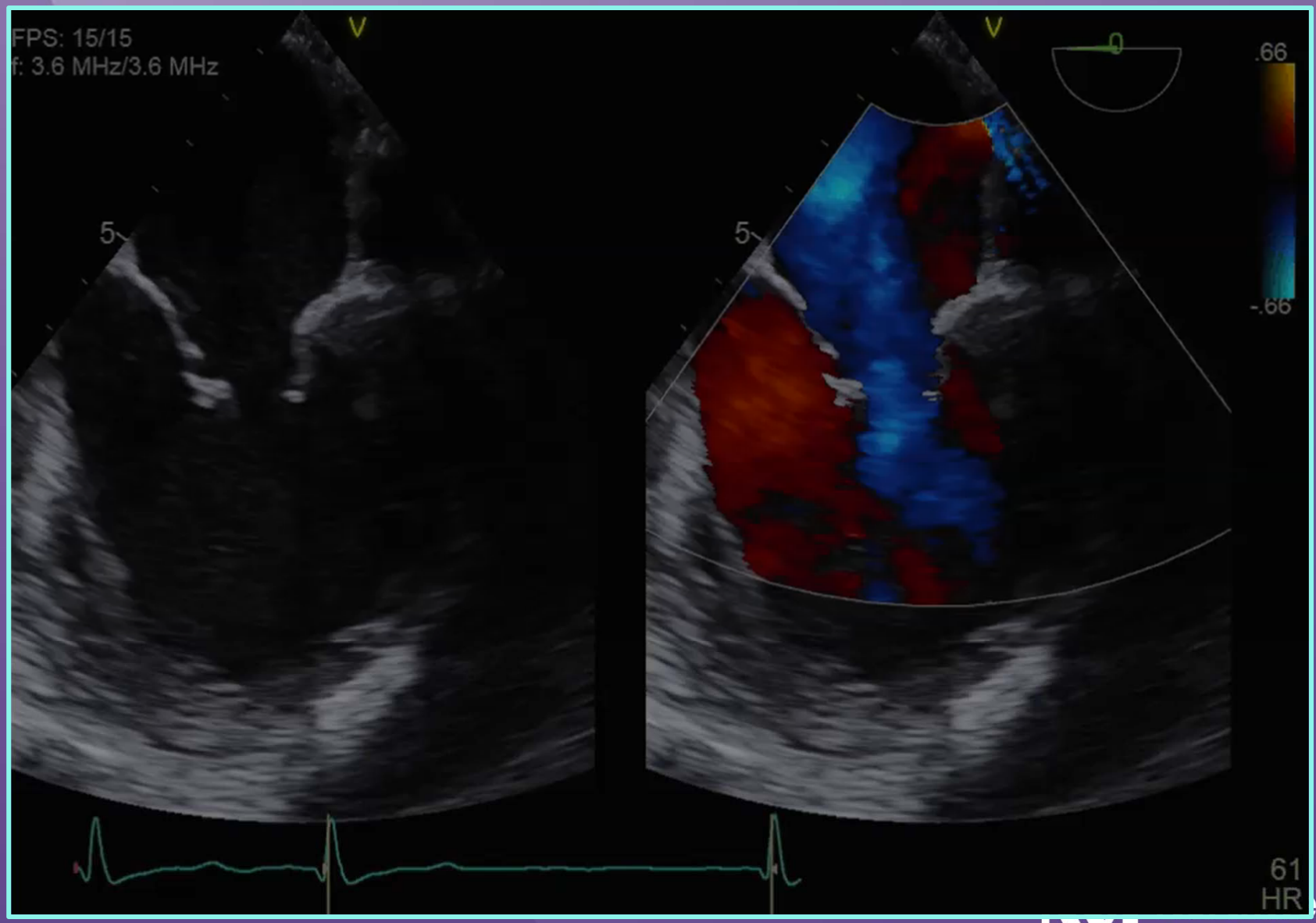
84 yo Man with Class III DOE
Mixed Organic and Functional MR



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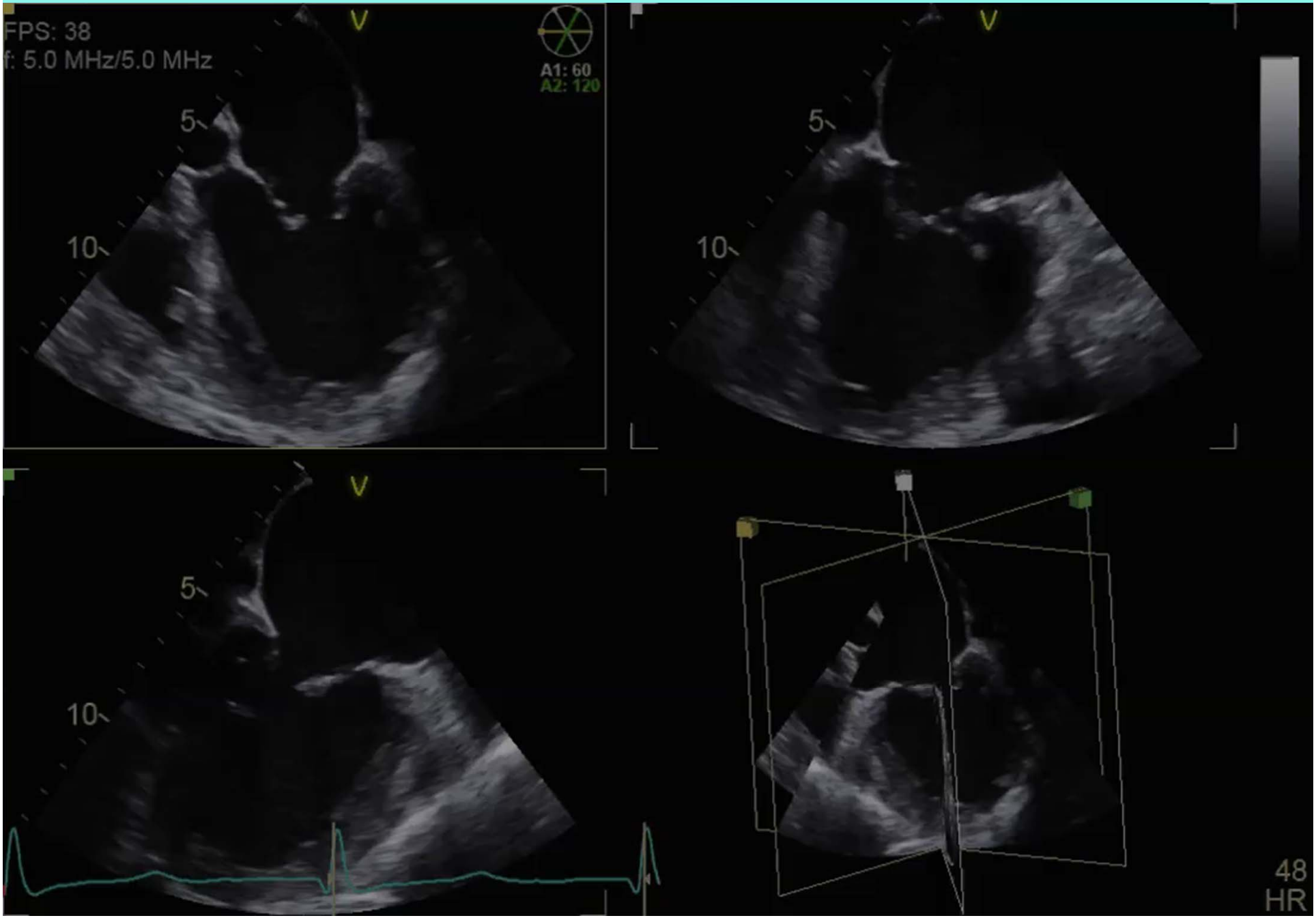
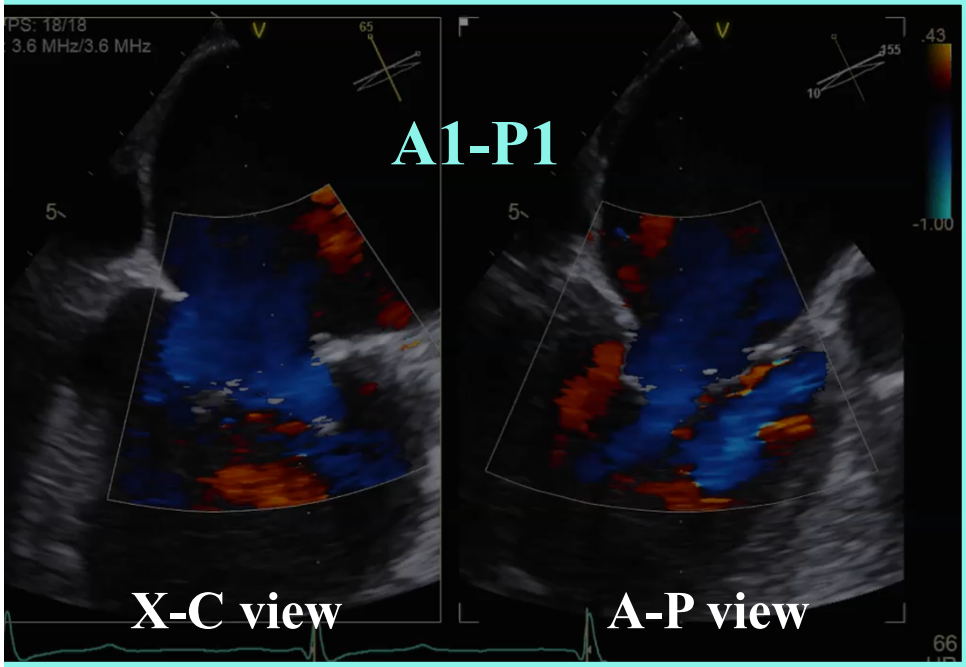
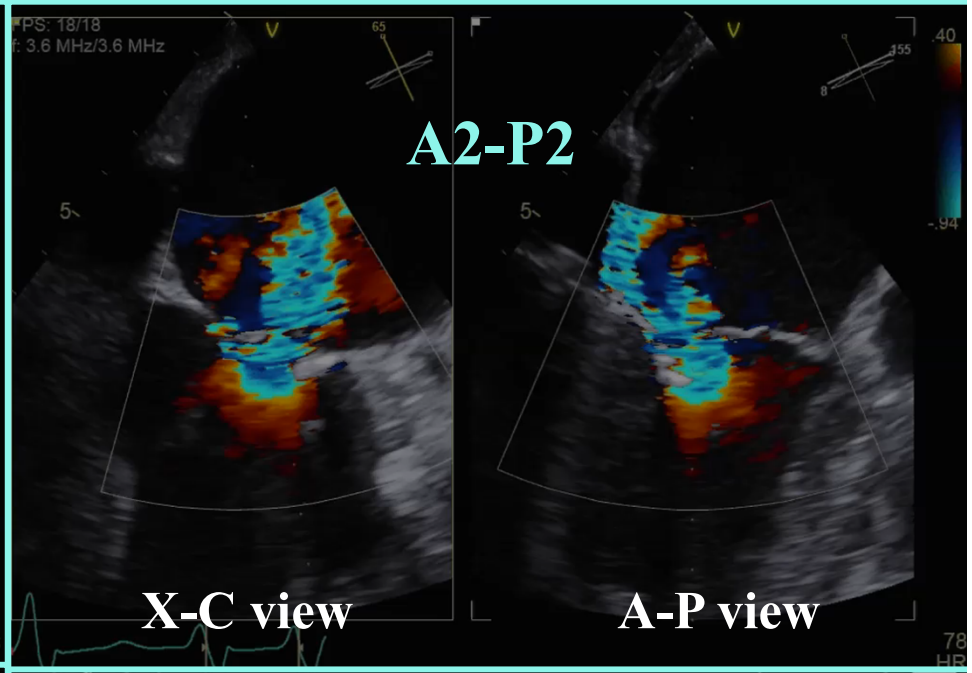
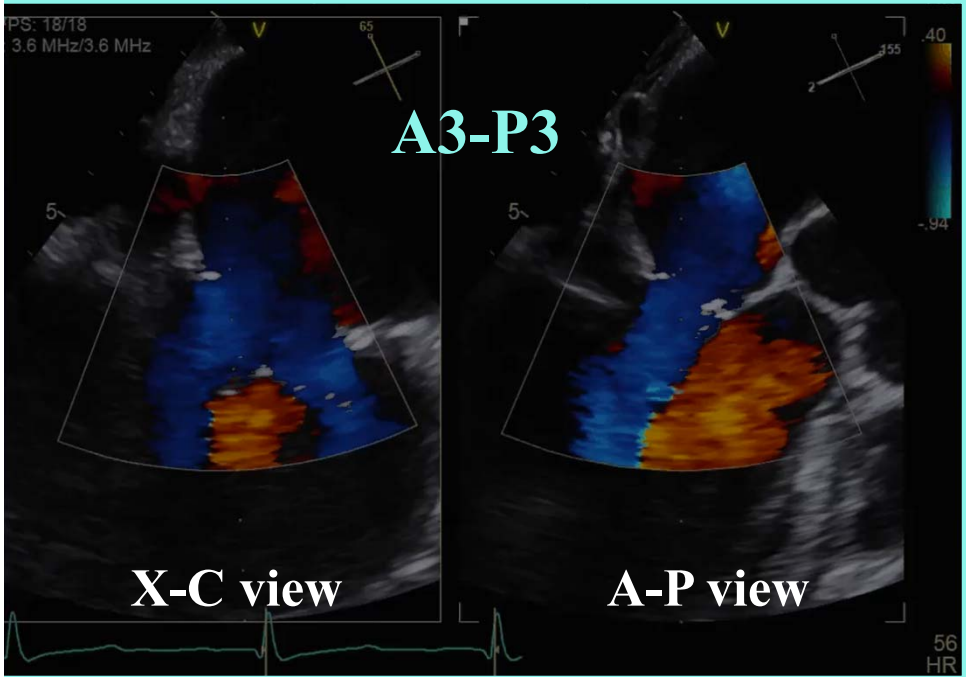
Moderately Severe LV with LAD and LCx Scars



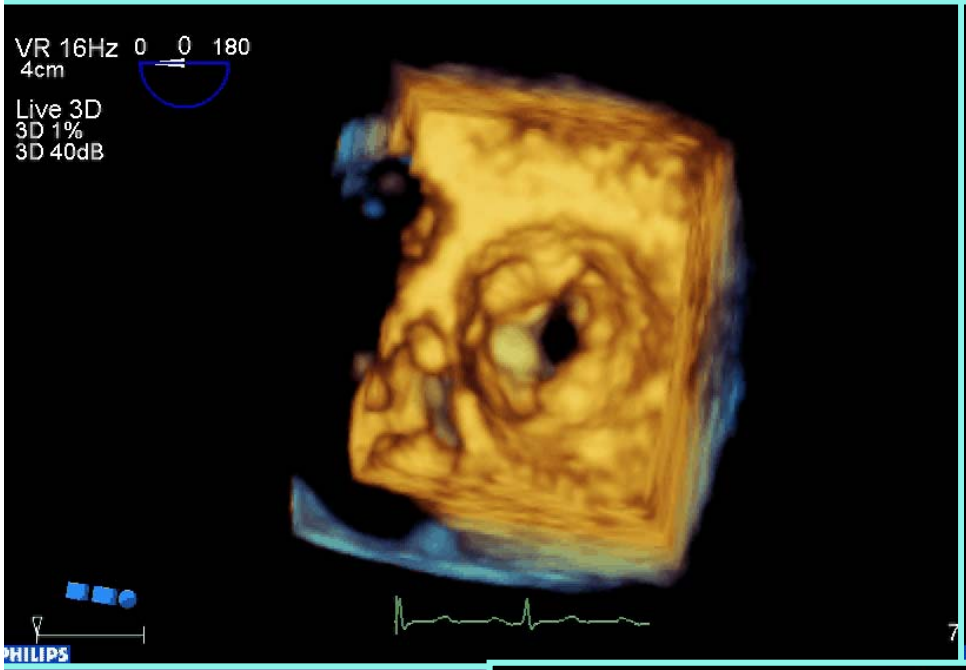
Localizing the Etiology

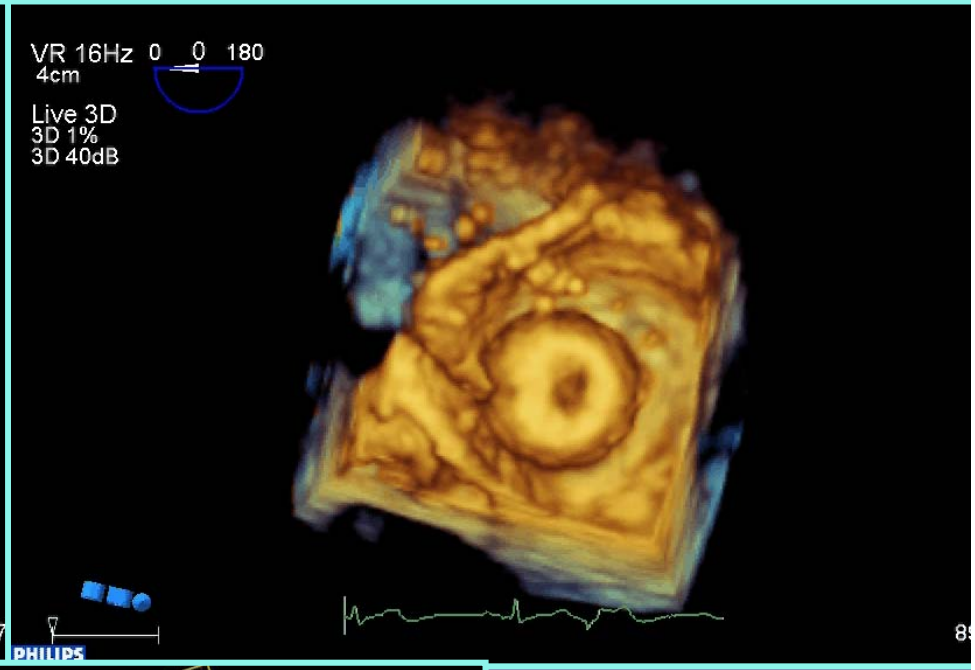




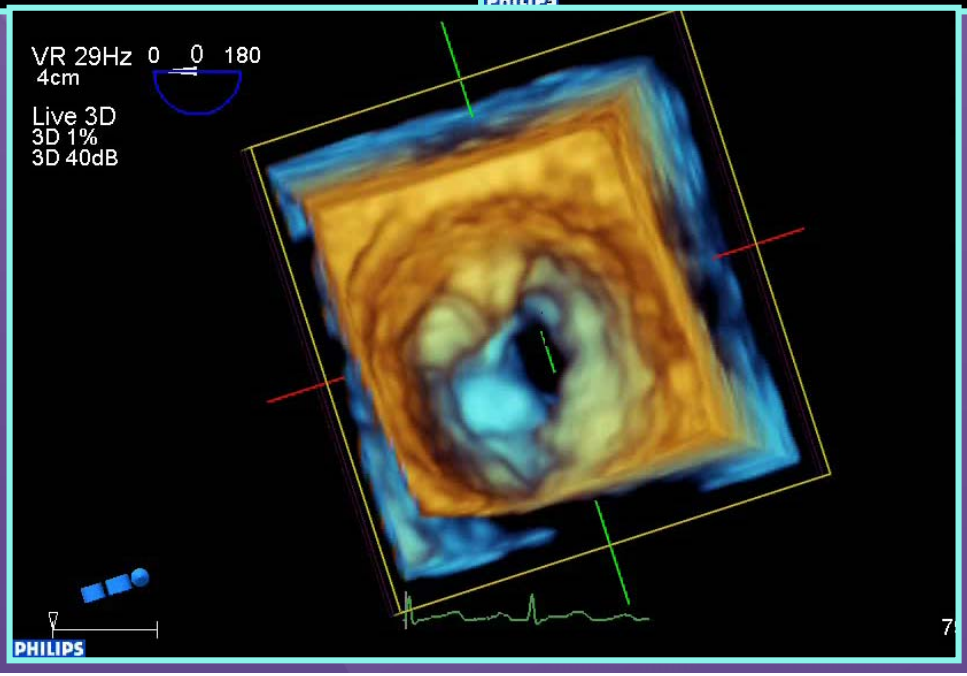


Mitral Balloon Valvuloplasty





Before



During

After

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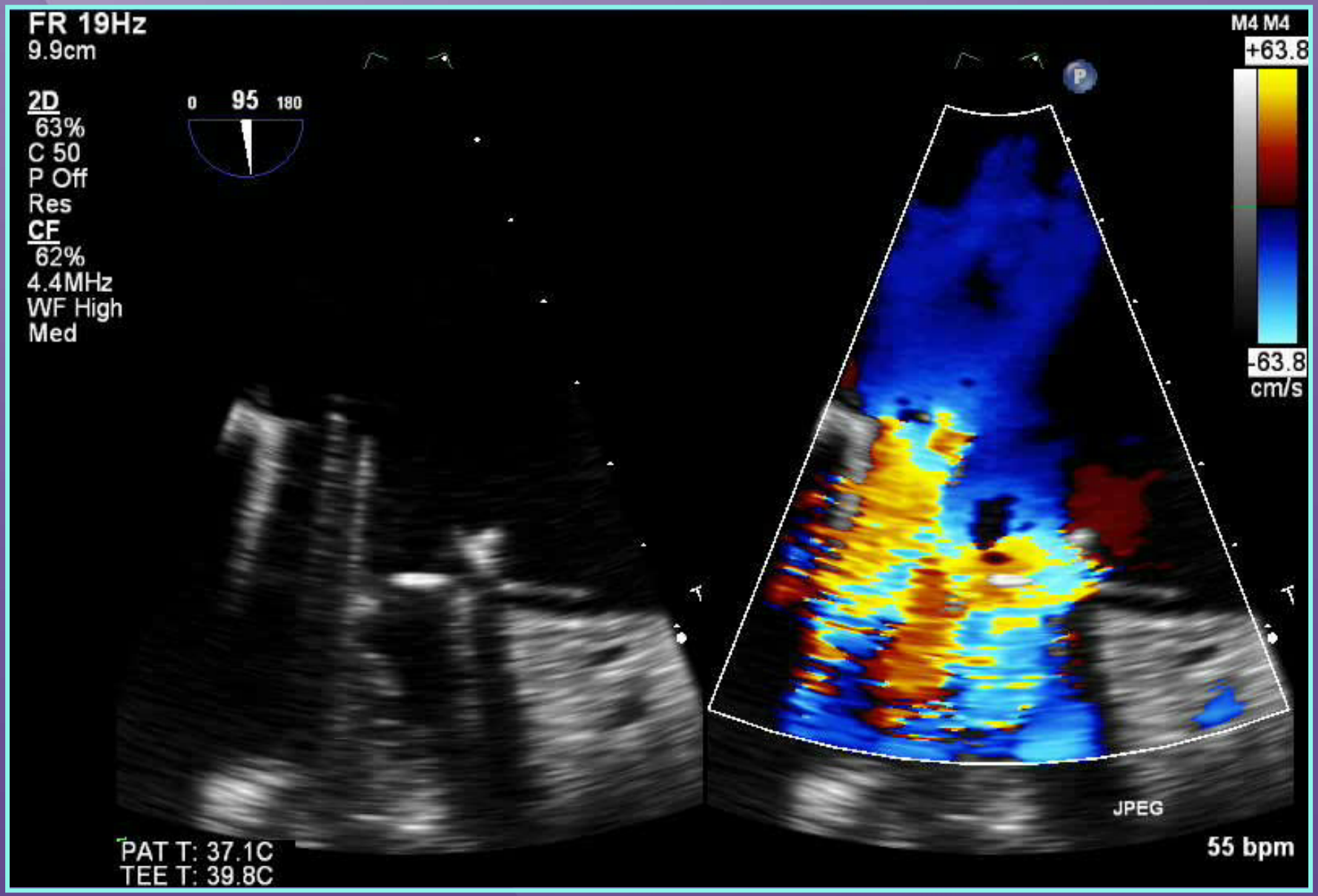
Closure of Paravalvular Leaks



Anterior and inferior holes

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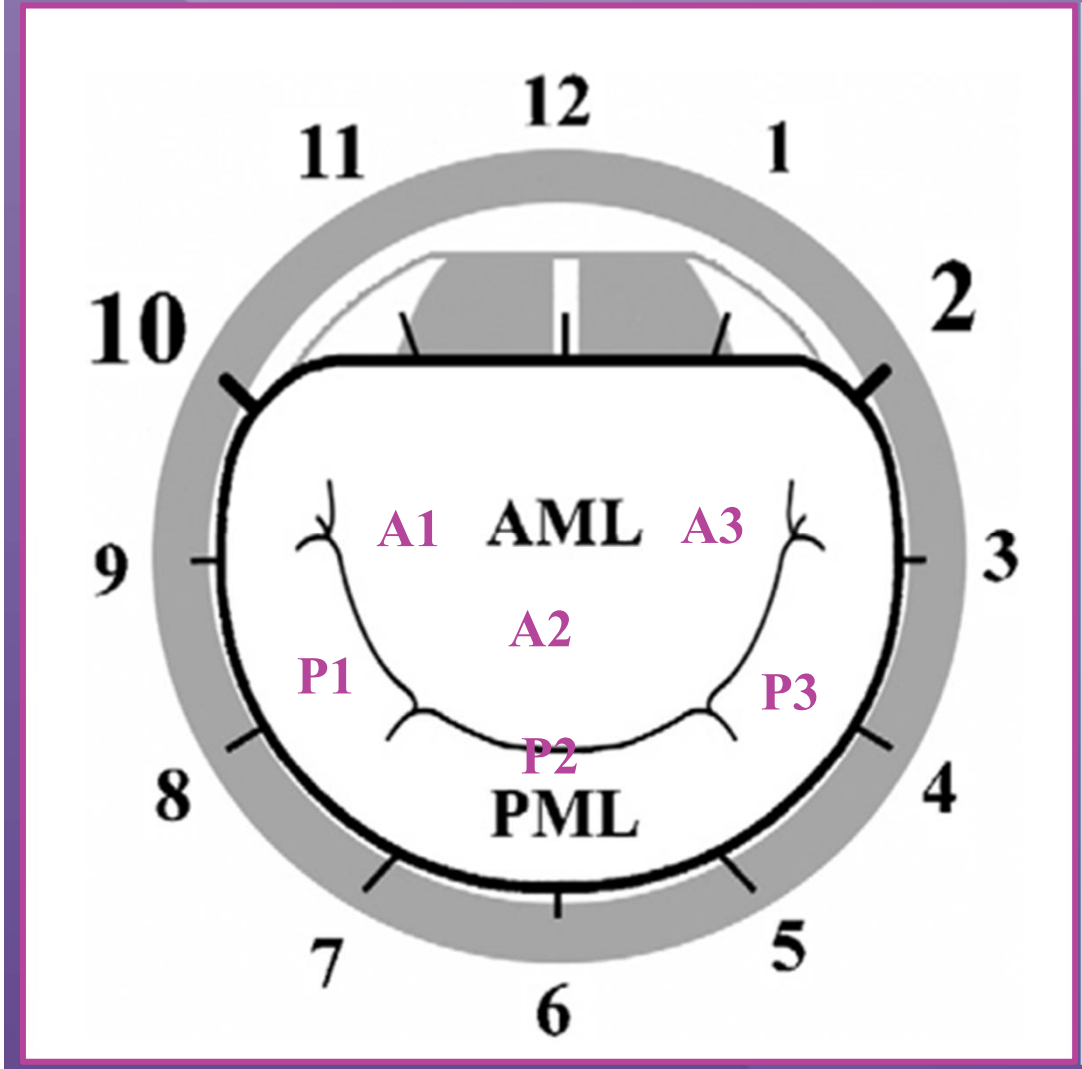
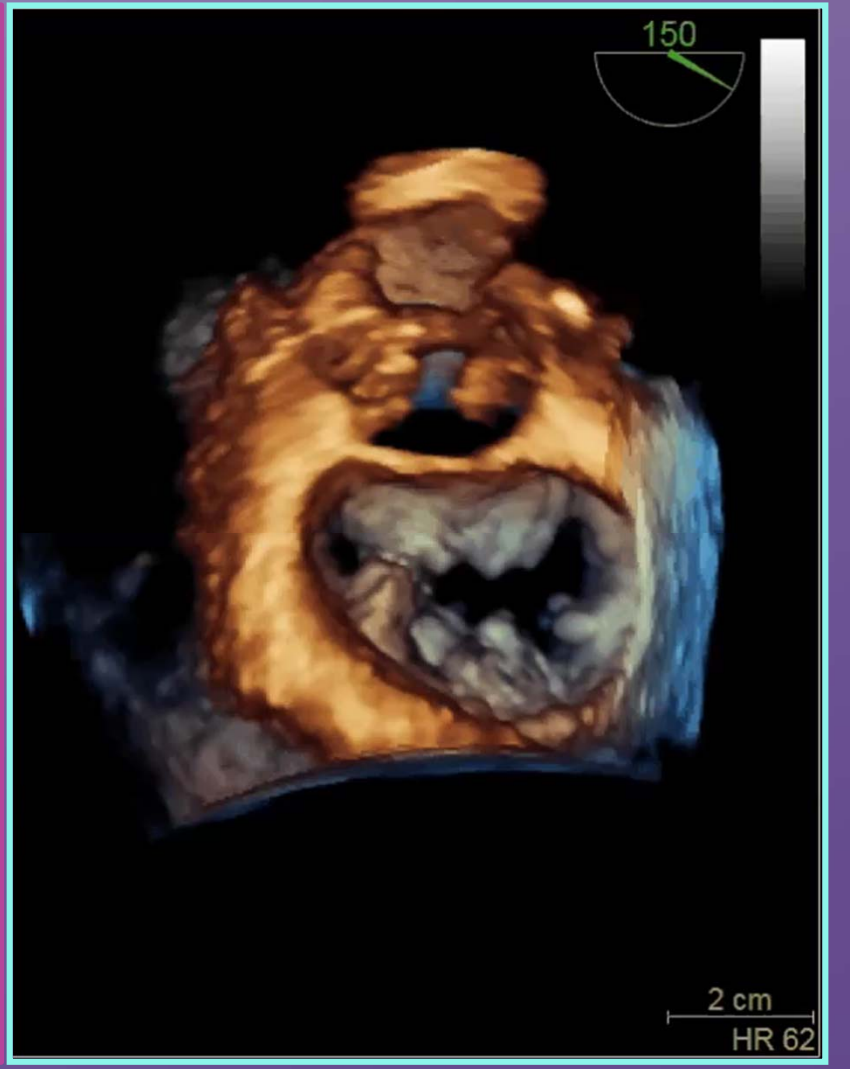
Relationship of Native & Prosthetic MV

Clock vs Scallops





DeCicio et al. EJCTS 2006; 30 887-891

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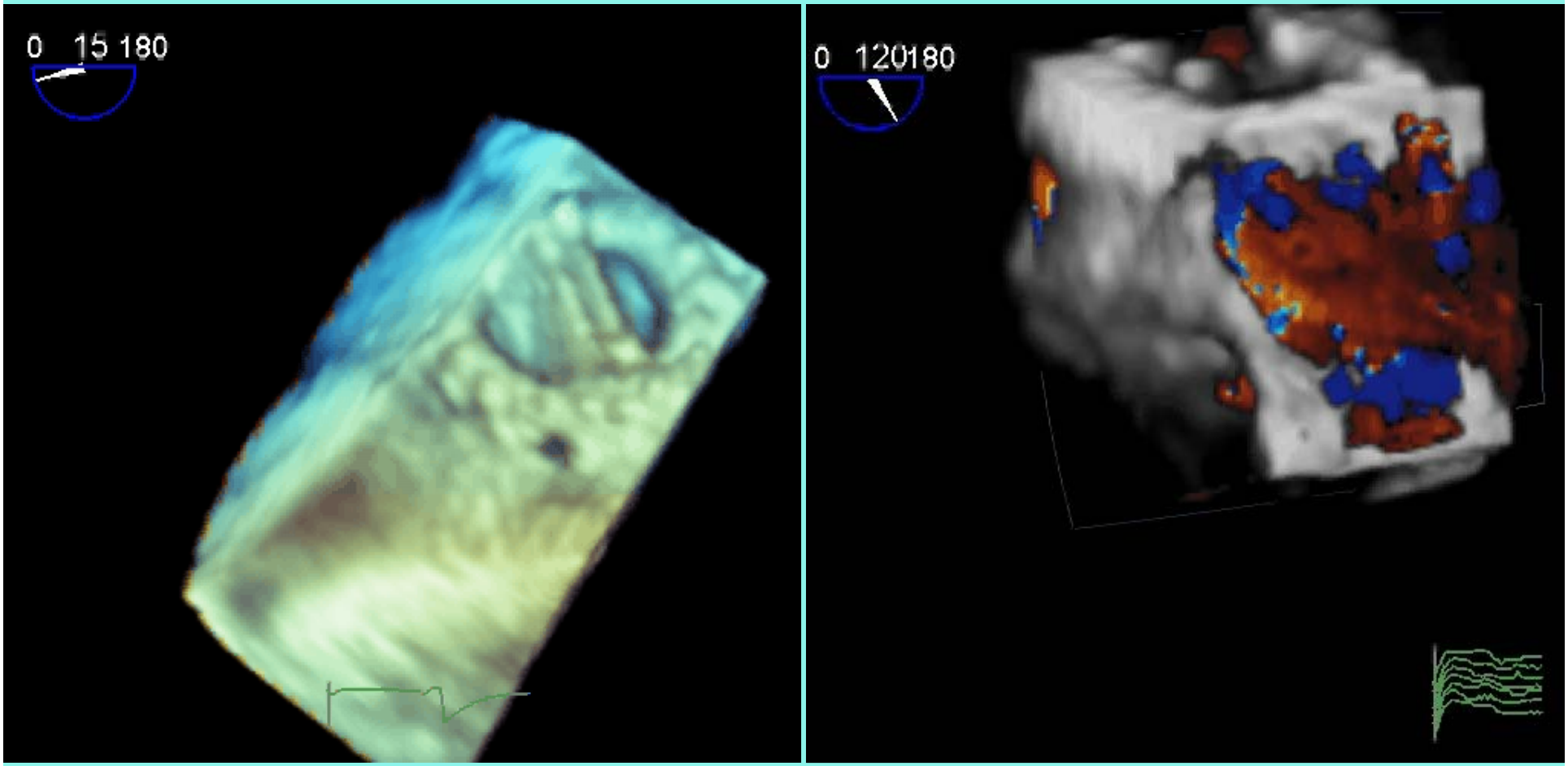
Direct visualization of paravalular leak



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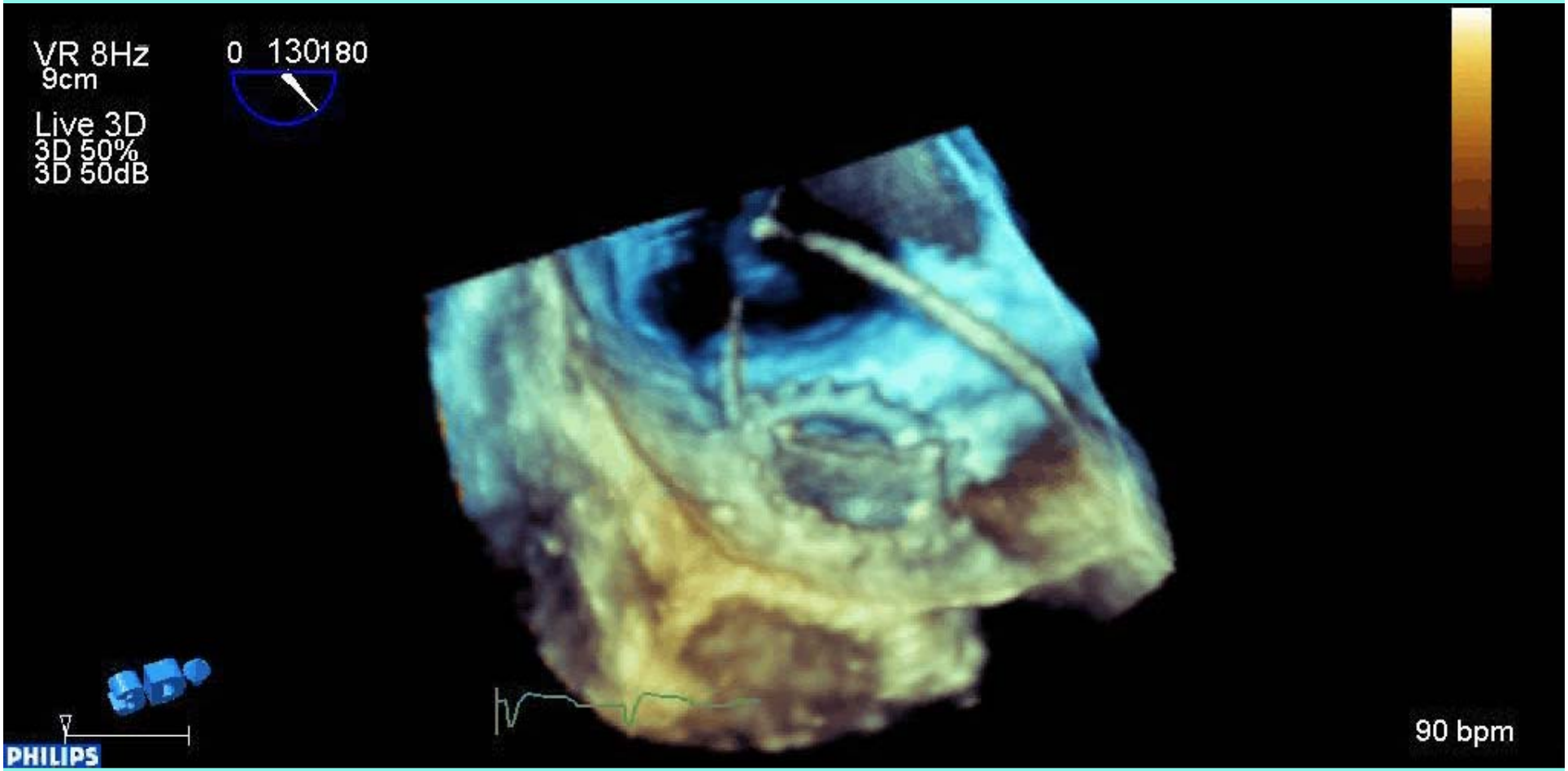

Transseptal lasso catheter capturing retrograde wire through leak

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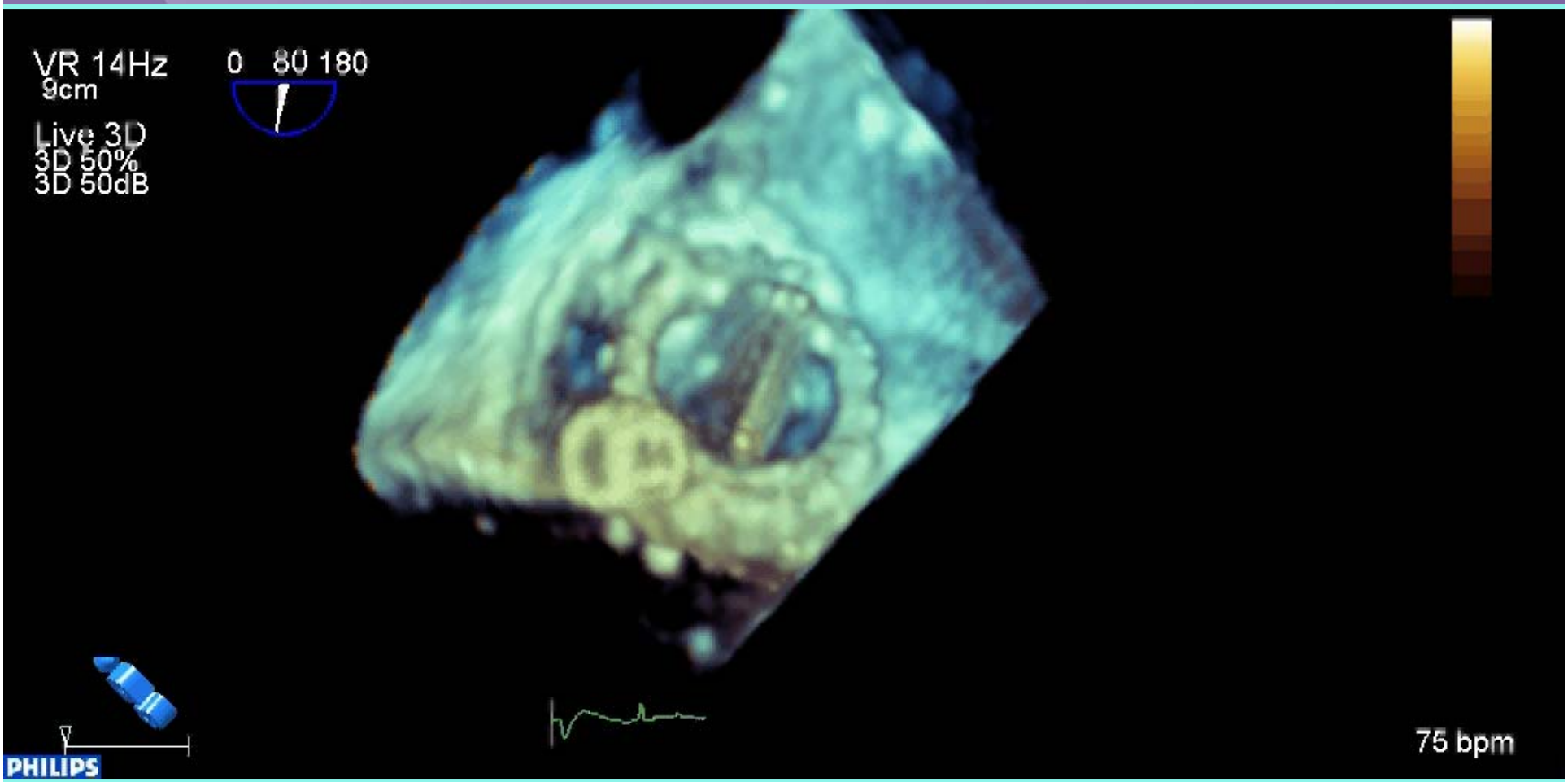

Two closure plugs in place

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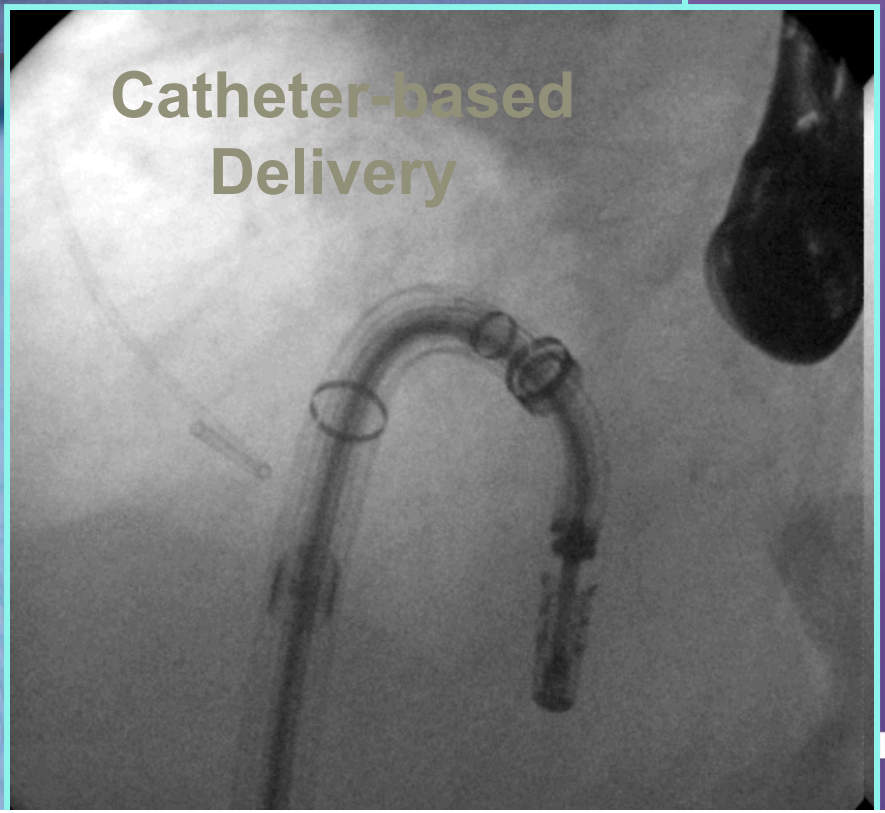
Percutaneous Mitral Repair (PMR)

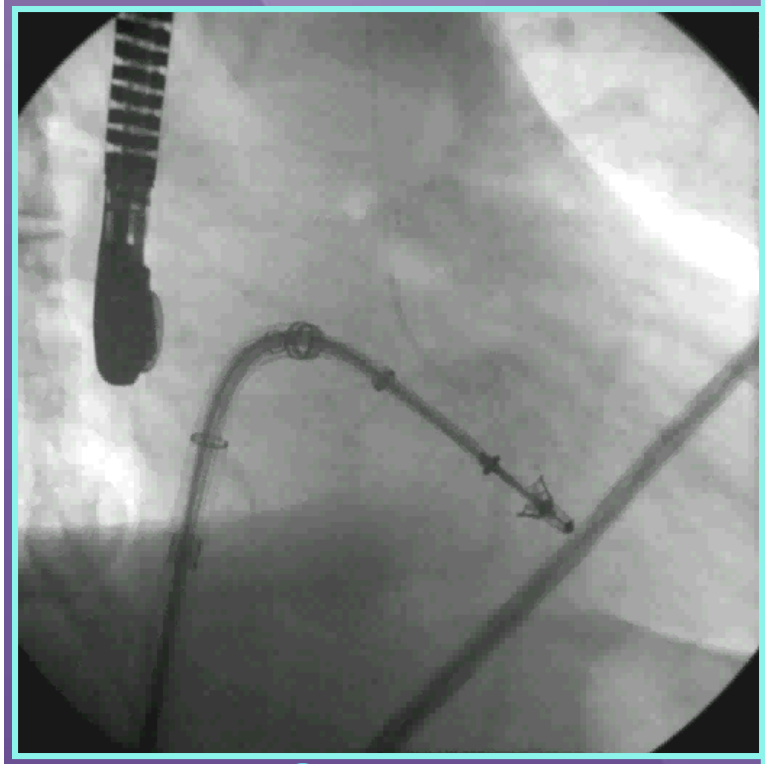
Evalve Clip

The Delivery System

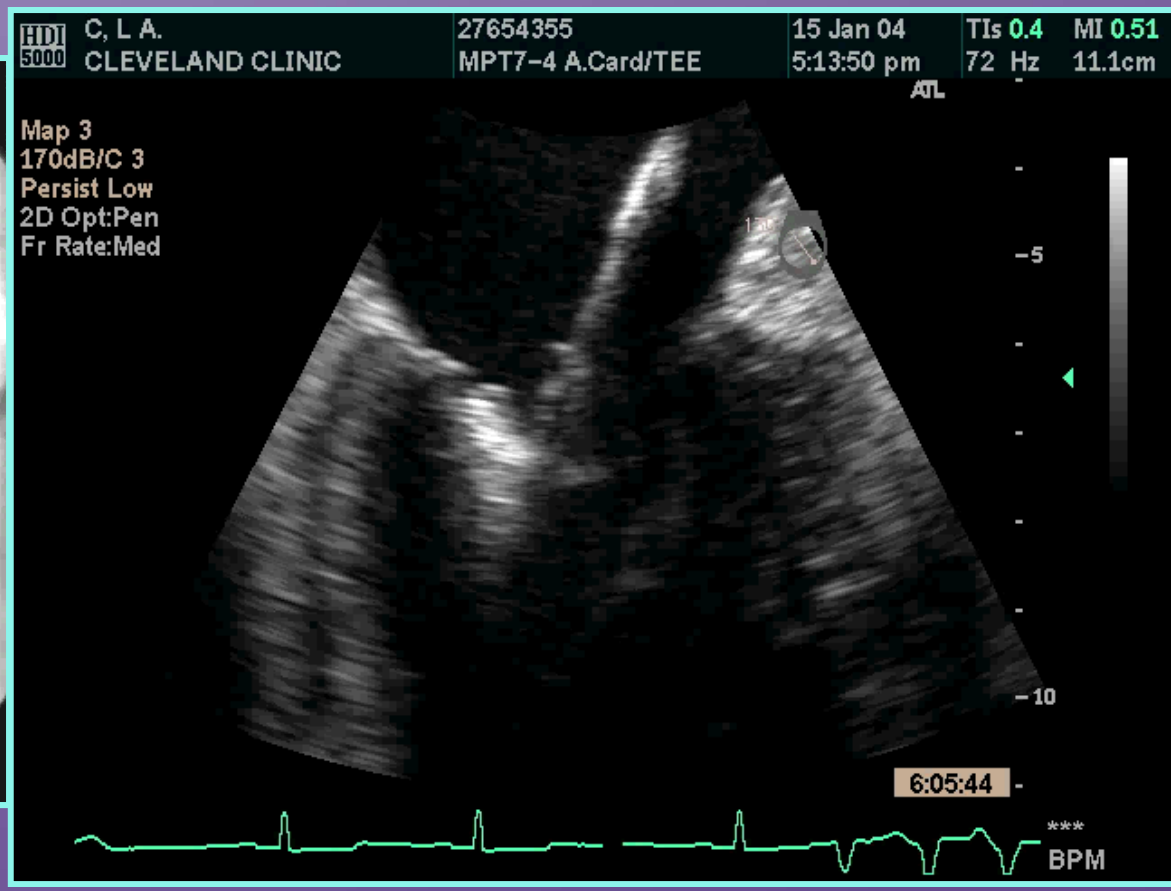


Catheter-based Delivery

In the early days, we didn't know much about interventional guidance



RAO



Repeat x 5 hours

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Further Refinement of Criteria

German Echo Suitability by Echo Criteria

Optimal	Limited suitable	inappropriate
Pathology in segment 2	Pathology in segment 1 or 3	Leaflet perforation or cleft
No calcification	- Slight calcification outside the grasping area - Ring calcification - Anuloplasty with ring	Severe calcification
Valve area >4cm^2	Valve area >3 cm^2 & good leaflet mobility	Mitral stenosis (< 3cm^2, gradient >5mmHg)
Length of the posterior leaflet > 10mm	Length of the posterior leaflet 7-10mm	Length of the posterior leaflet < 7mm
Coaptation depth < 11mm	Coaptation depth >11mm	
Normal thickness and mobility of the leaflets	Restriction (Carpentier IIIB)	Rheumatic thickening and restriction (Carpentier IIIA)
MR with prolaps Flail size < 15mm Flail gap < 10mm	Flail size > 15mm only with large mitral aulus and option for more than 1 clip	Barlows desease

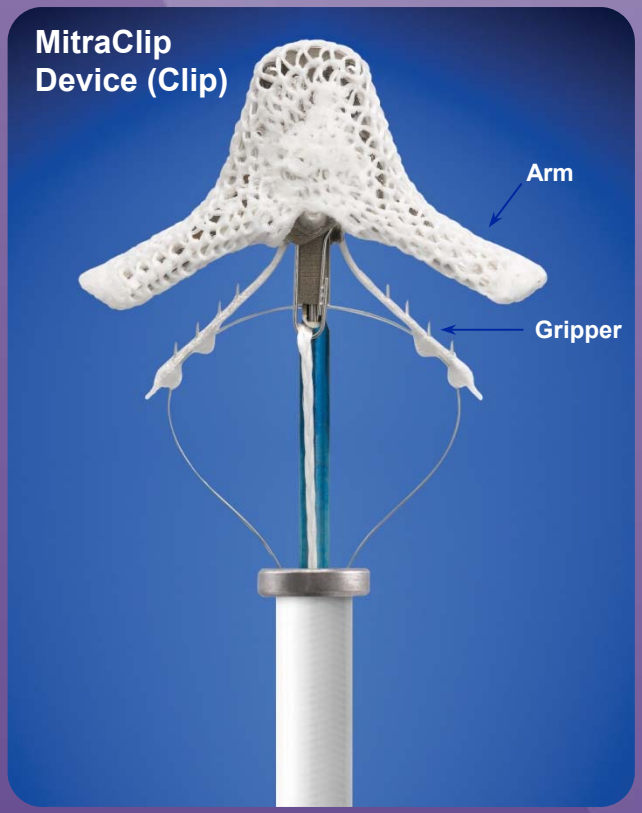
Easy

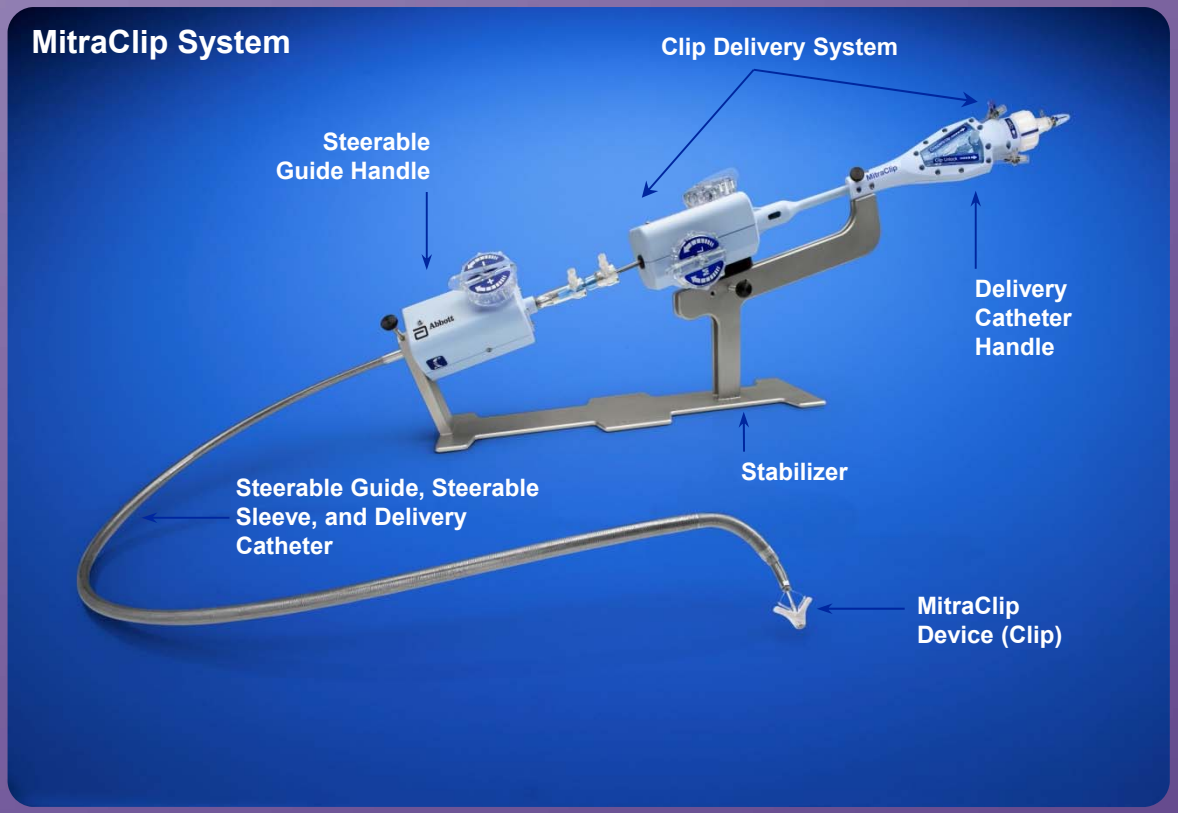
Hard

Boekstegers P; Hausleiter J , Baldus S, von Bardeleben RS, et al. Clin Res Cardiol 2013

The MitraClip System

Learning the System is the Crucial First Step!





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Steerable Guide Catheter – Overview

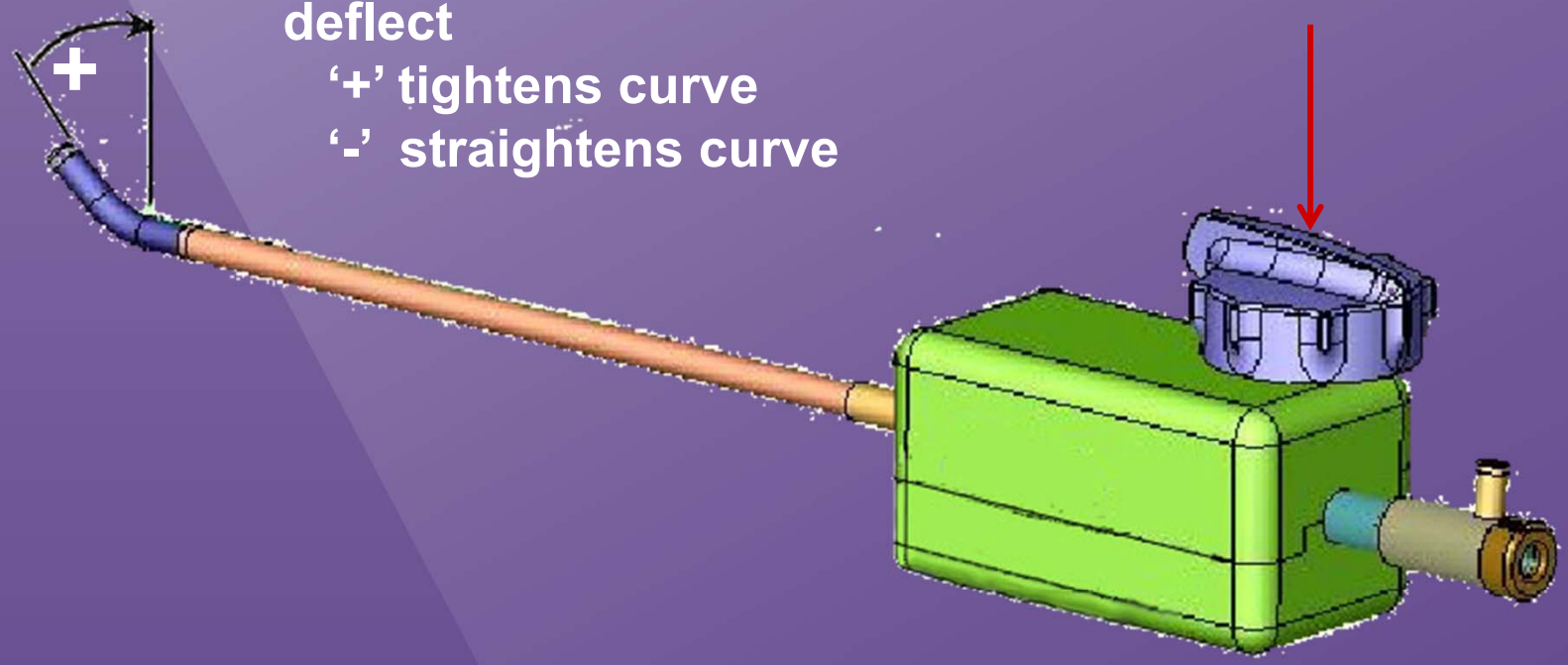
Guide Deflection

+/- Knob causes the tip to deflect

‘+’ tightens curve

‘-’ straightens curve

+/- Knob



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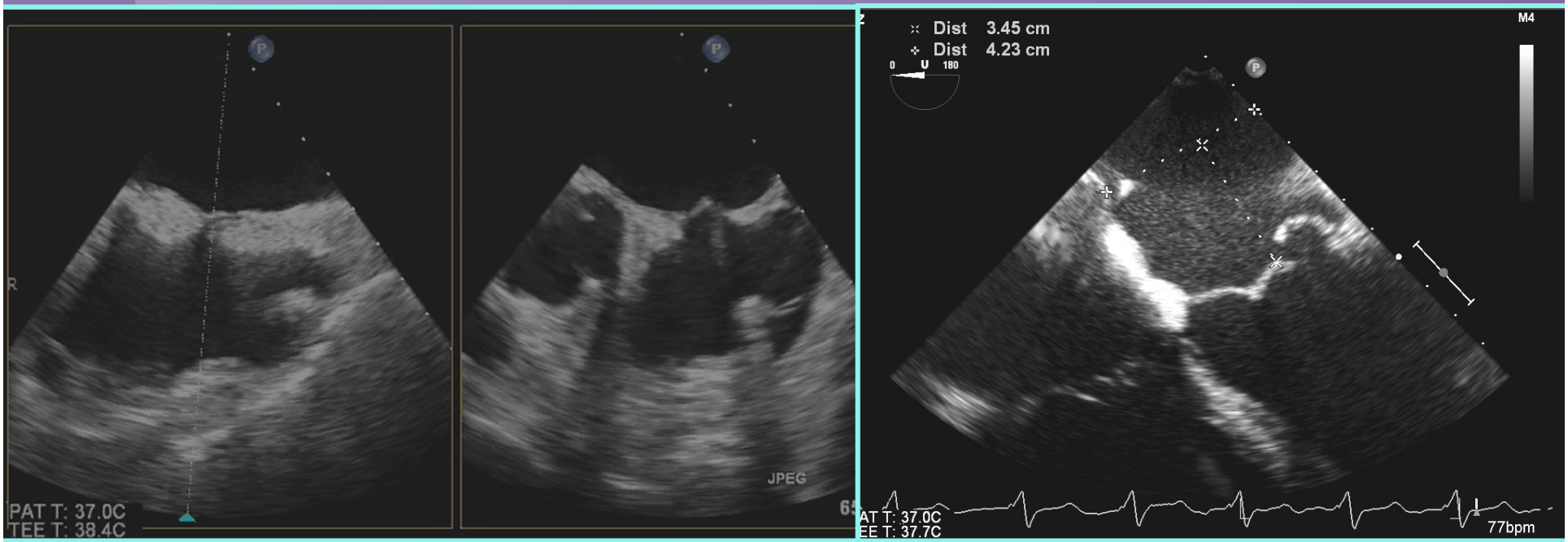
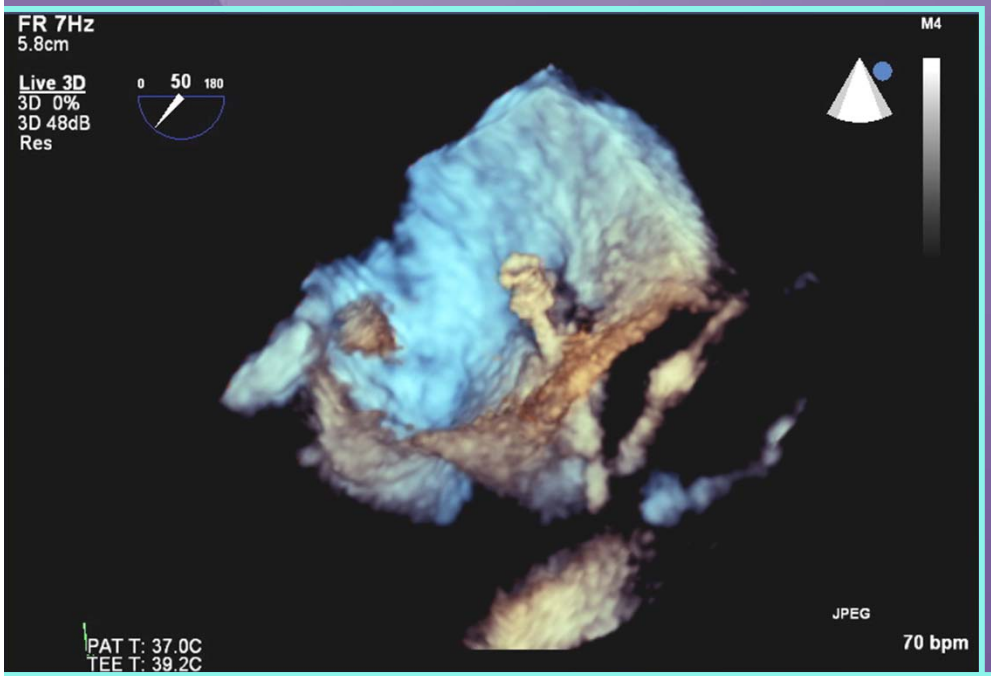
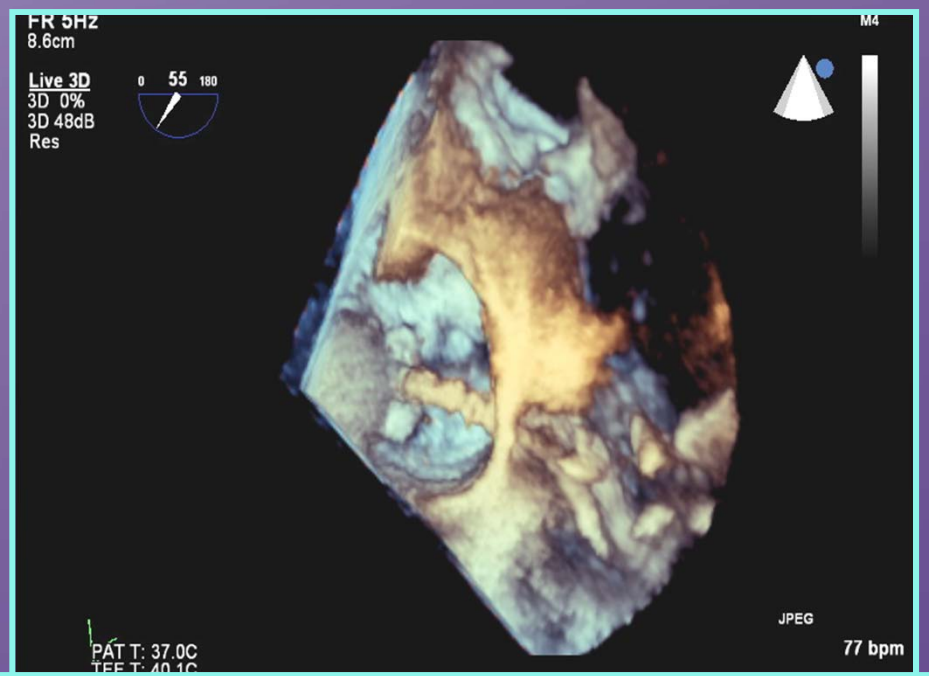
TEE: MitraClip Septal Puncture

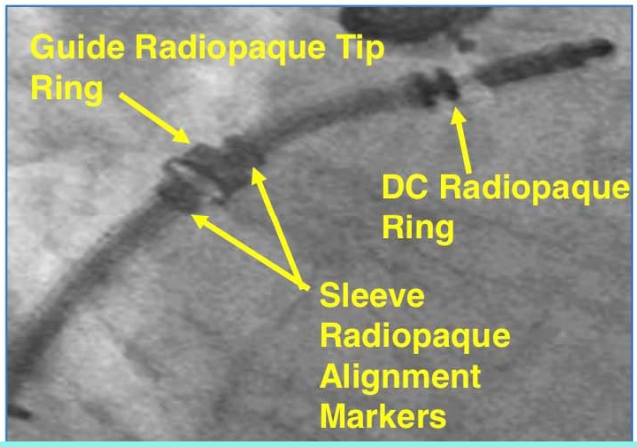


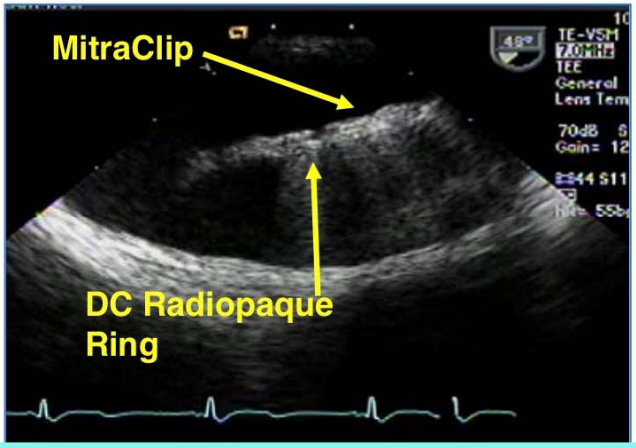
- Aim for the thin portion, fossa ovalis
- X-plane very helpful
- Puncture should be ~4 cm above annular plane
- Up to 5 cm for prolapse, 3.5 cm for functional

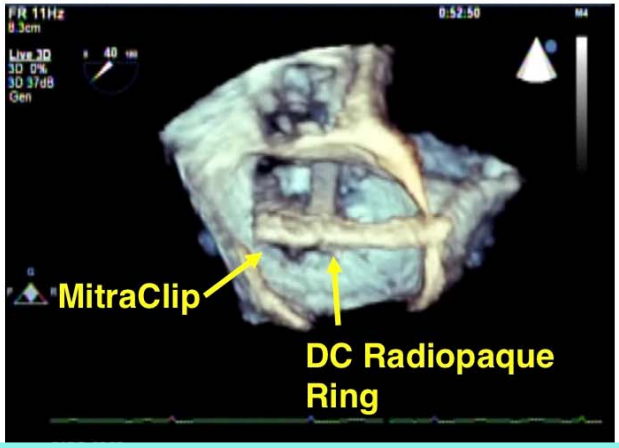
Advancing MitraClip Catheter Through Guide





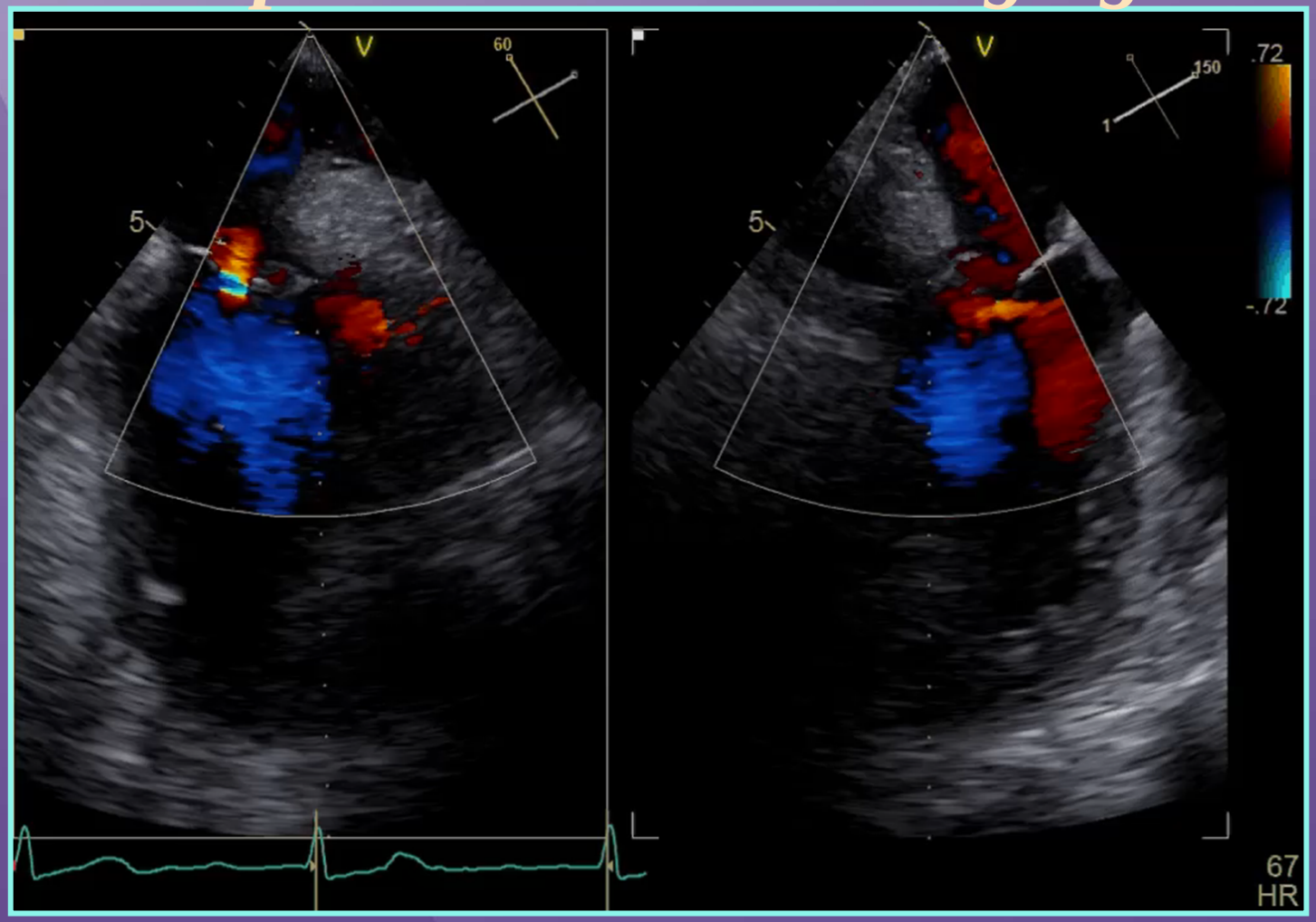






80 yo Man with Severe MR

Biplane Anatomic Imaging



Flail posterior, P1 ± P2

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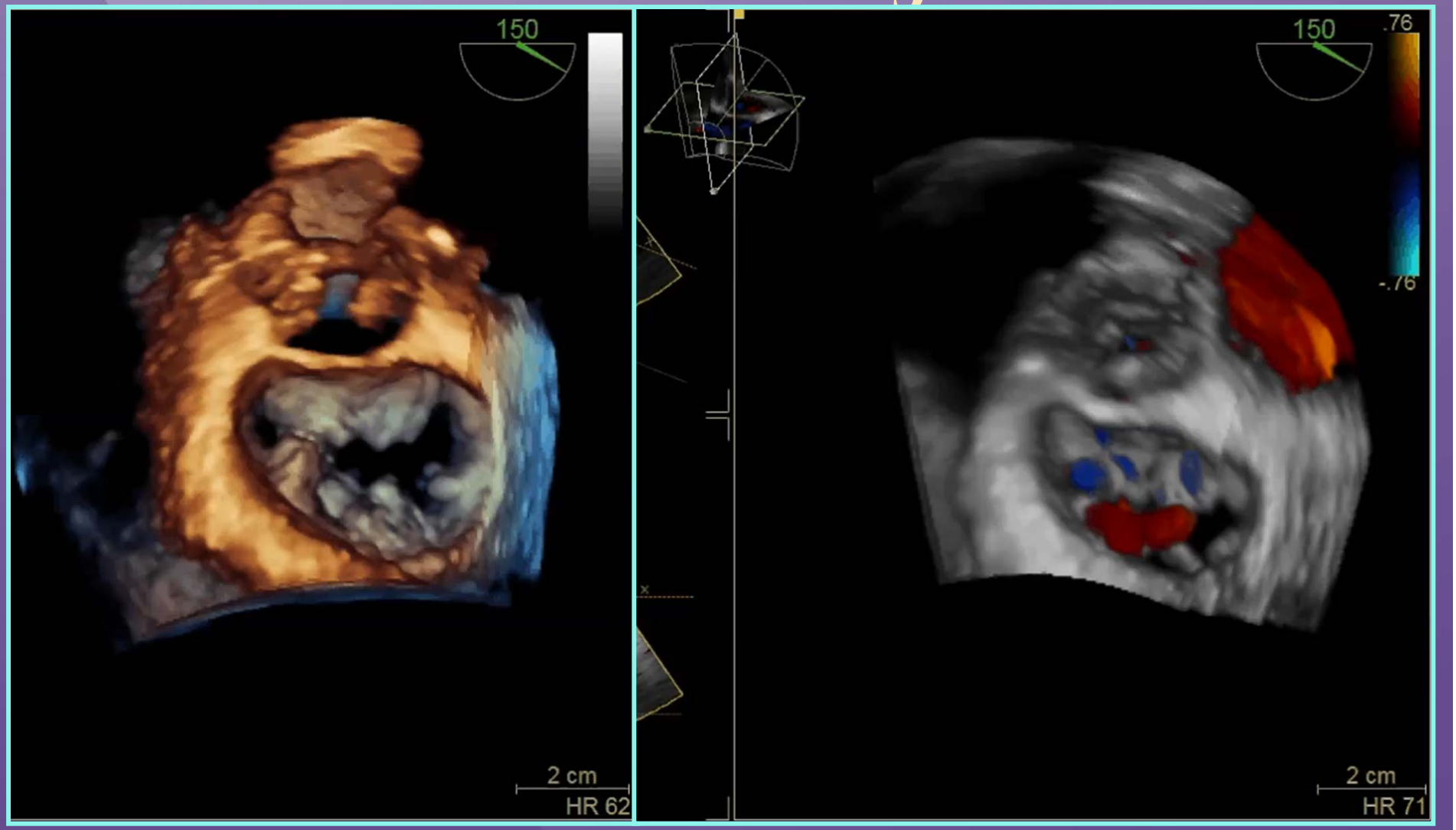
Transesophageal Echo

3D Rendering



Flail posterior, P1 ± P2

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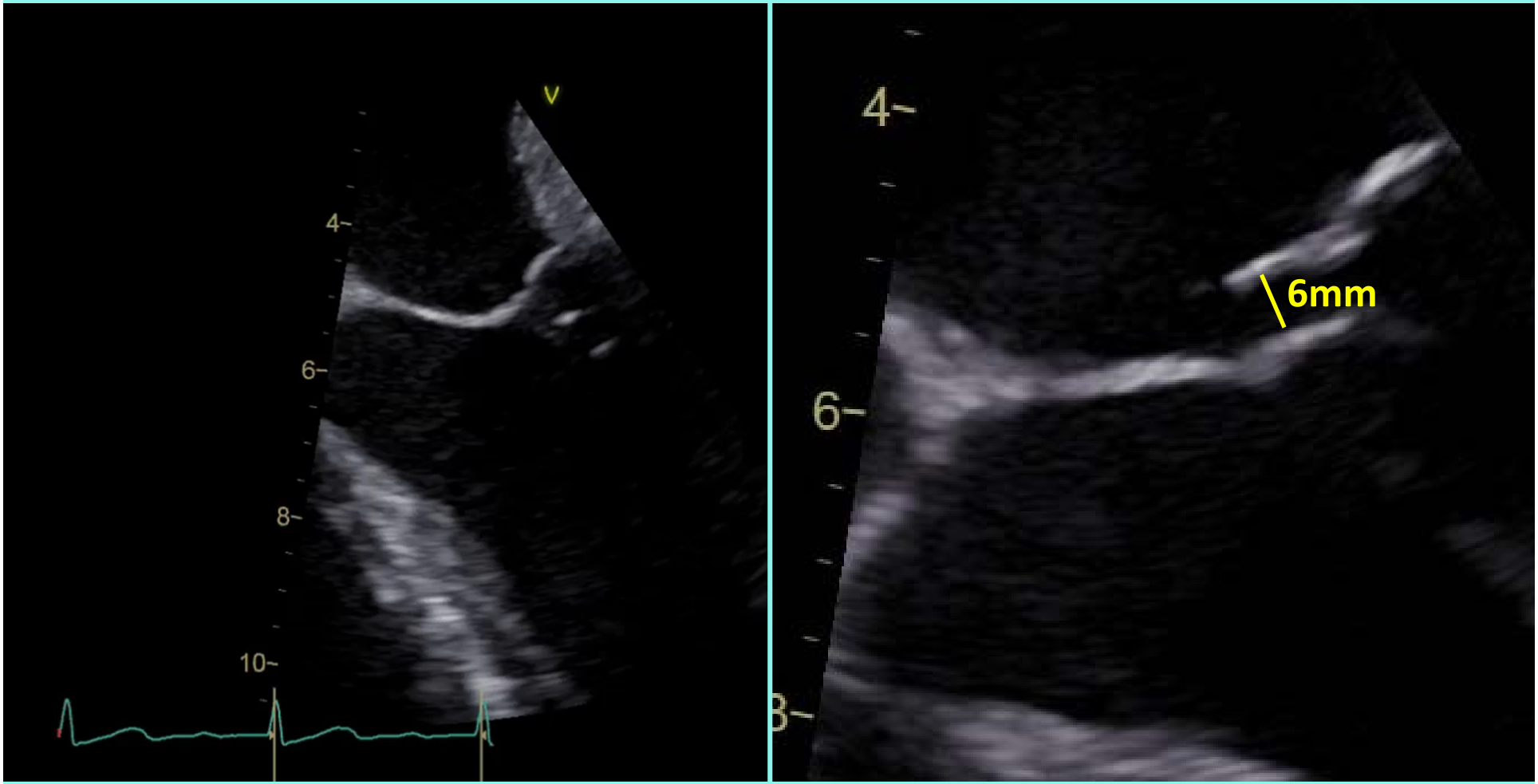
Transesophageal Echo
Assessing Flail Gap



Acceptable gap for clipping

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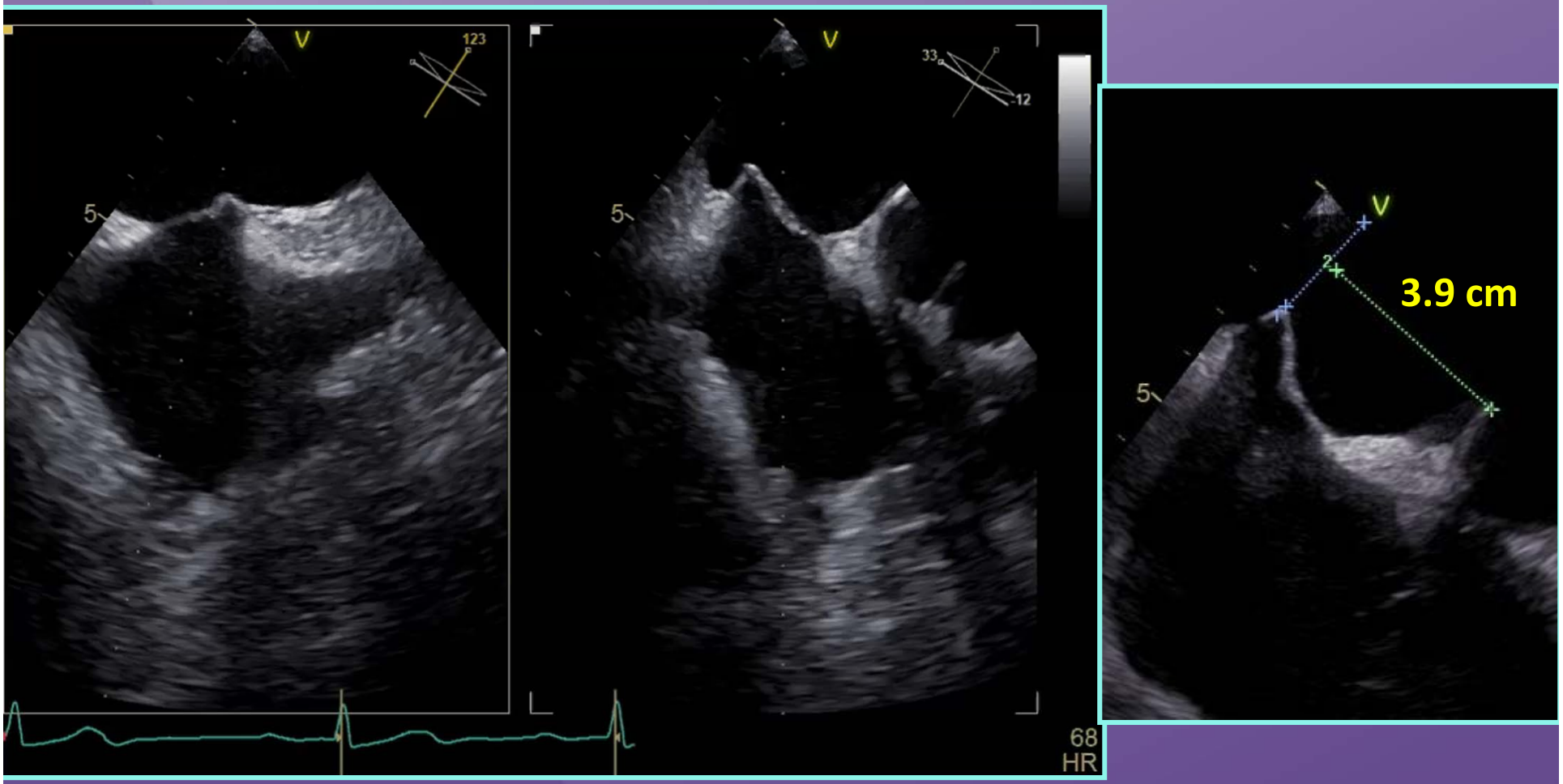

Precision puncture to reach P1

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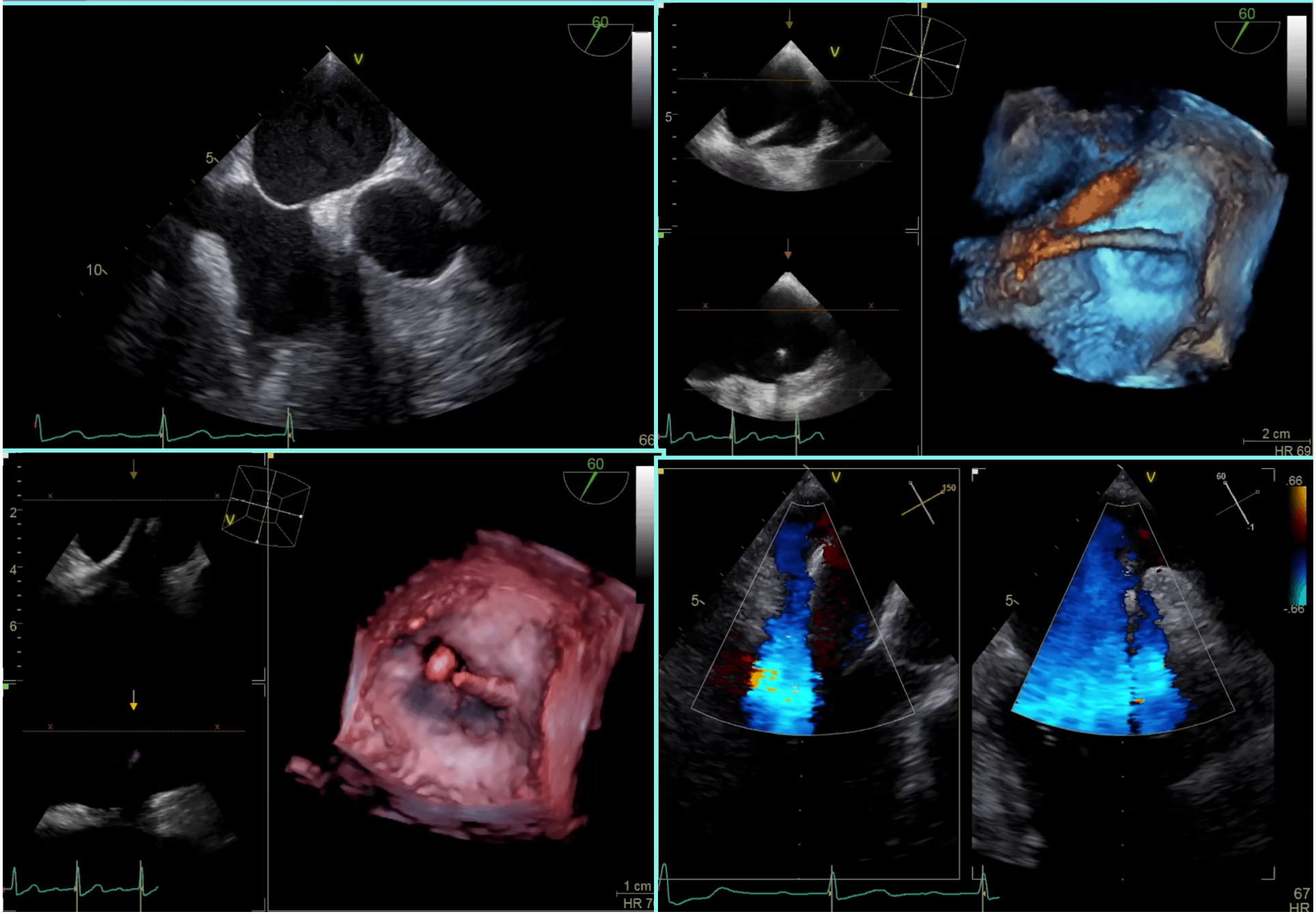
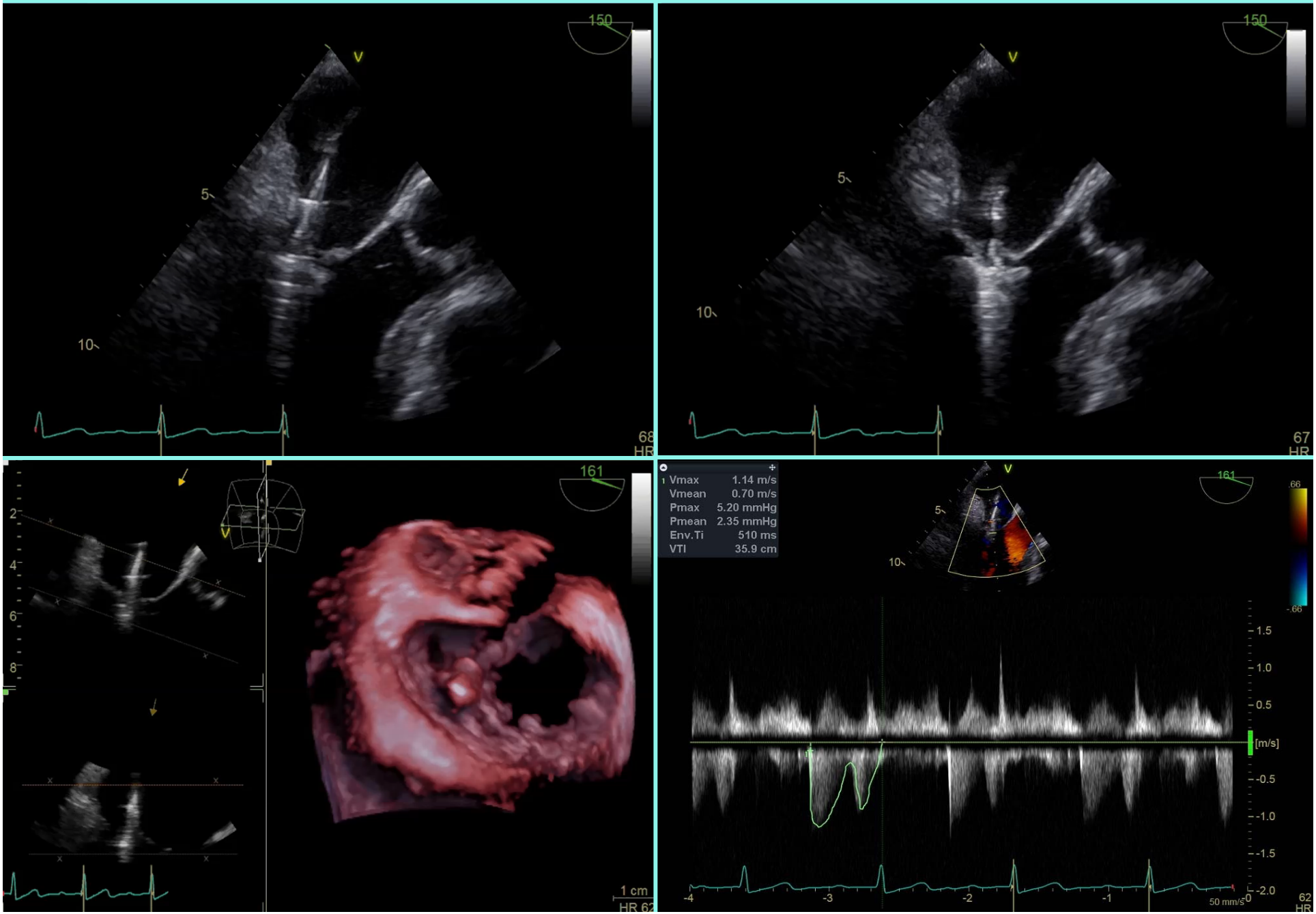
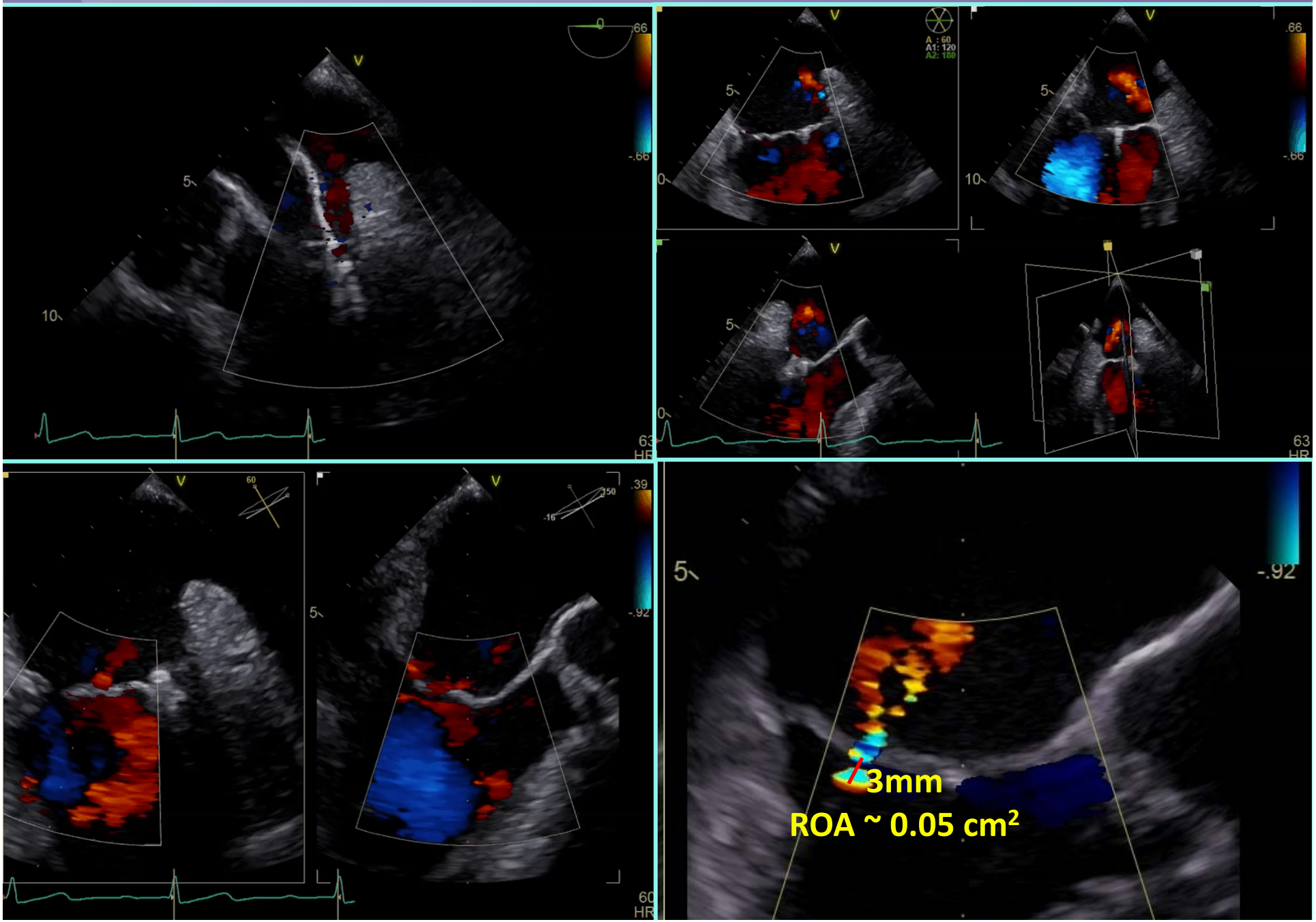
Steering Clip into Position



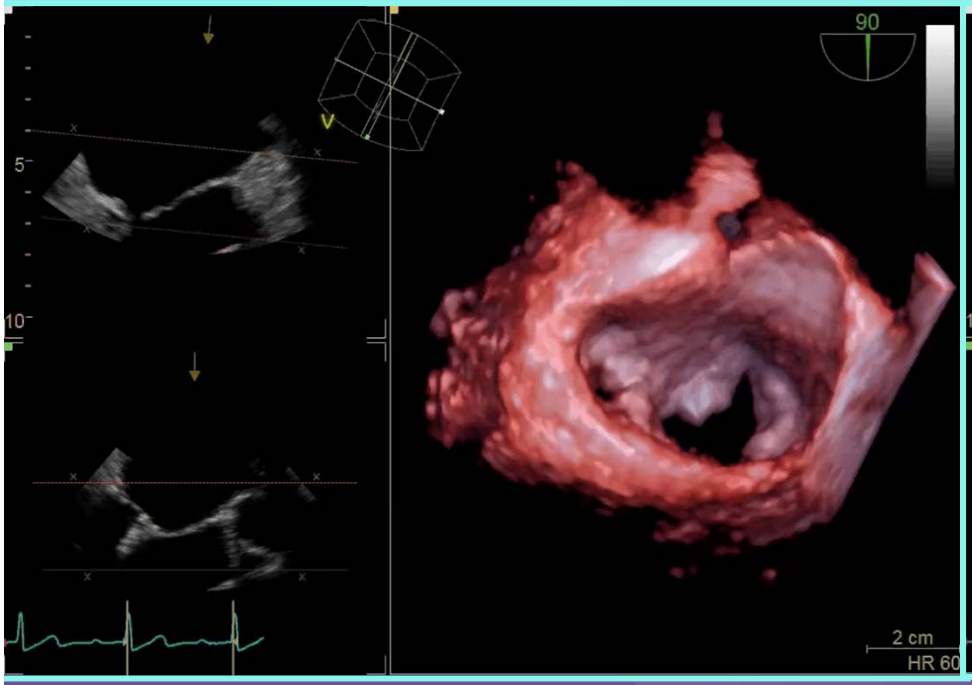
Grabbing Leaflets, Testing Gradient

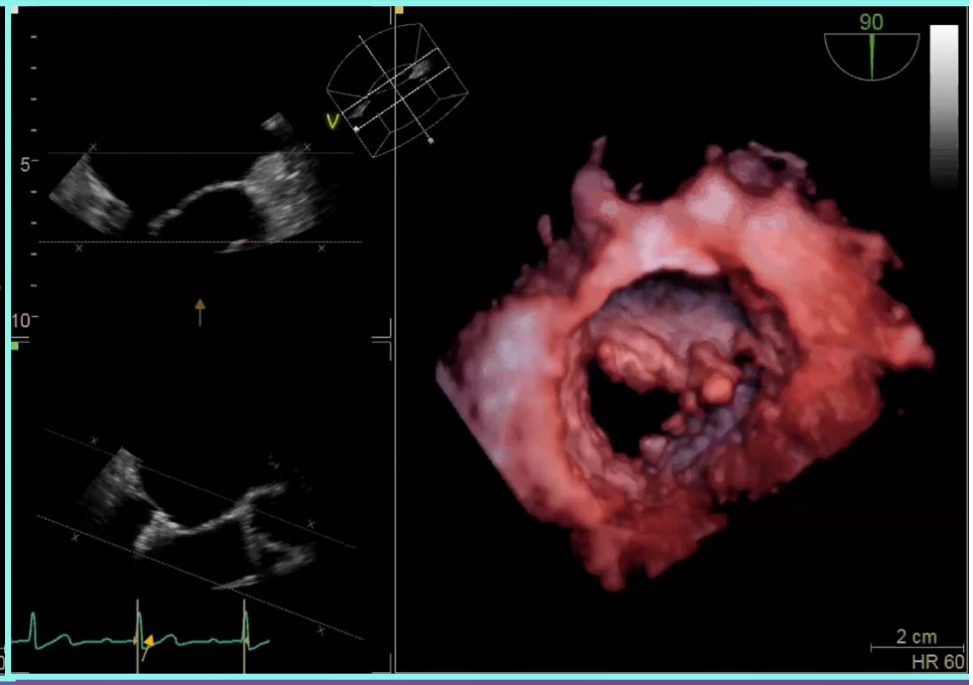


Final Color Check, then Release



Final Look
Assessing Clip Location





LA view

LV view

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Delighted To Be In Manila

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Future Directions

Percutaneous Mitral Replacement

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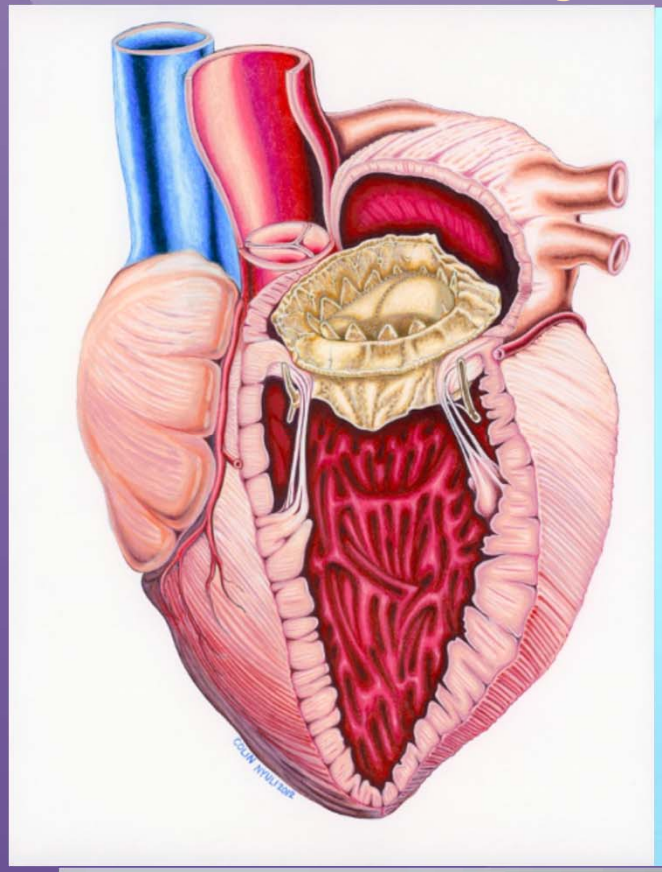
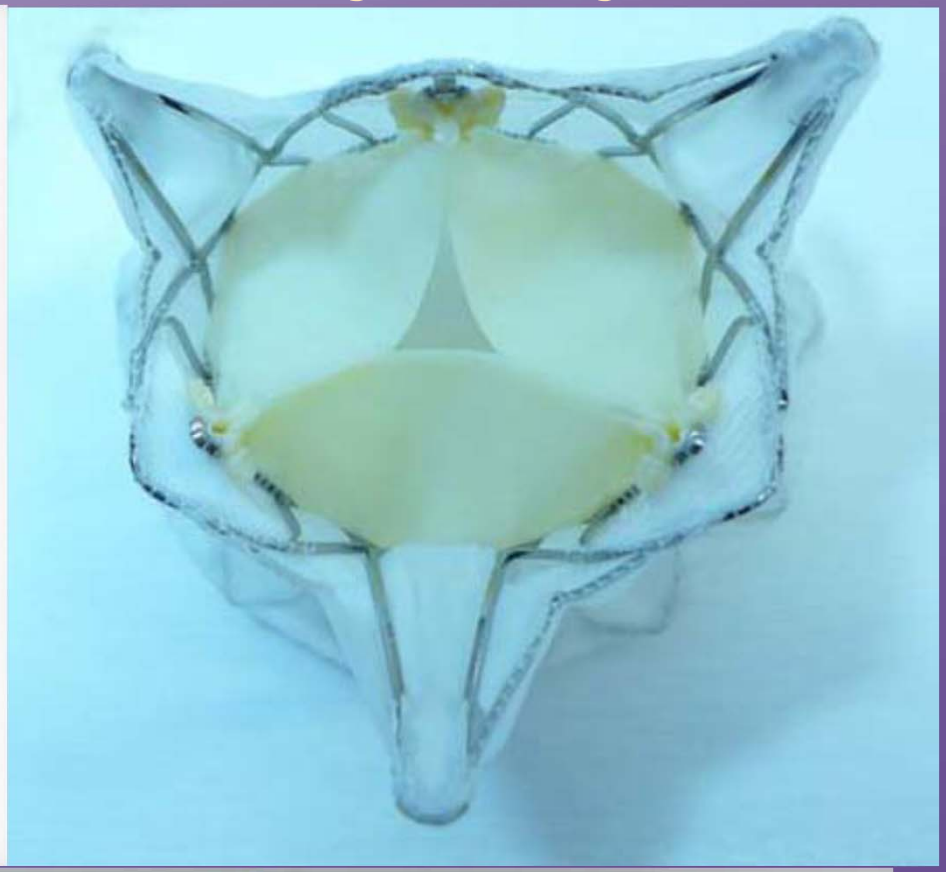
Neovasc TIARA Mitral Valve

Early Feasibility Study





Tiara Delivery System – 32 Fr

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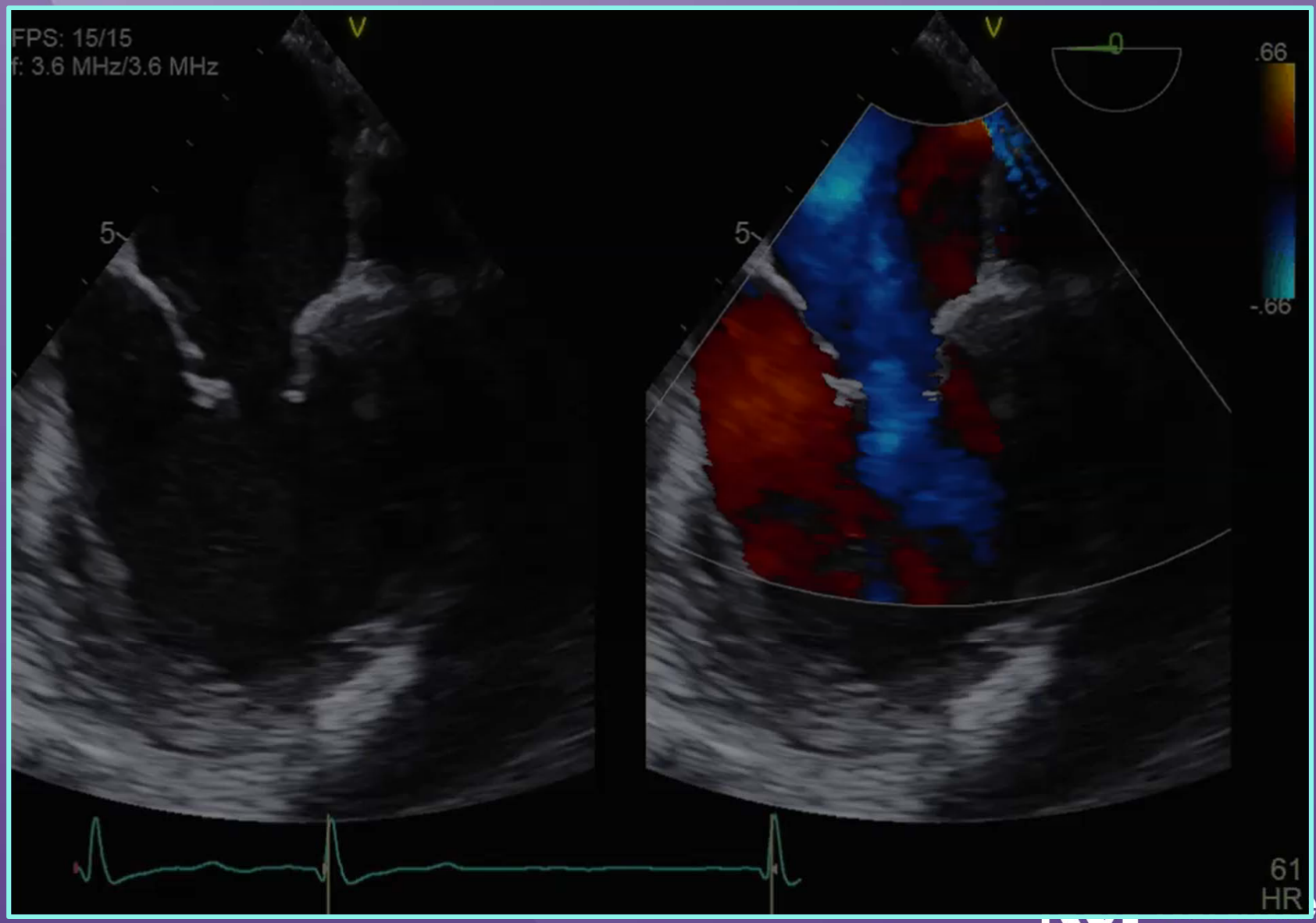
84 yo Man with Class III DOE
Mixed Organic and Functional MR



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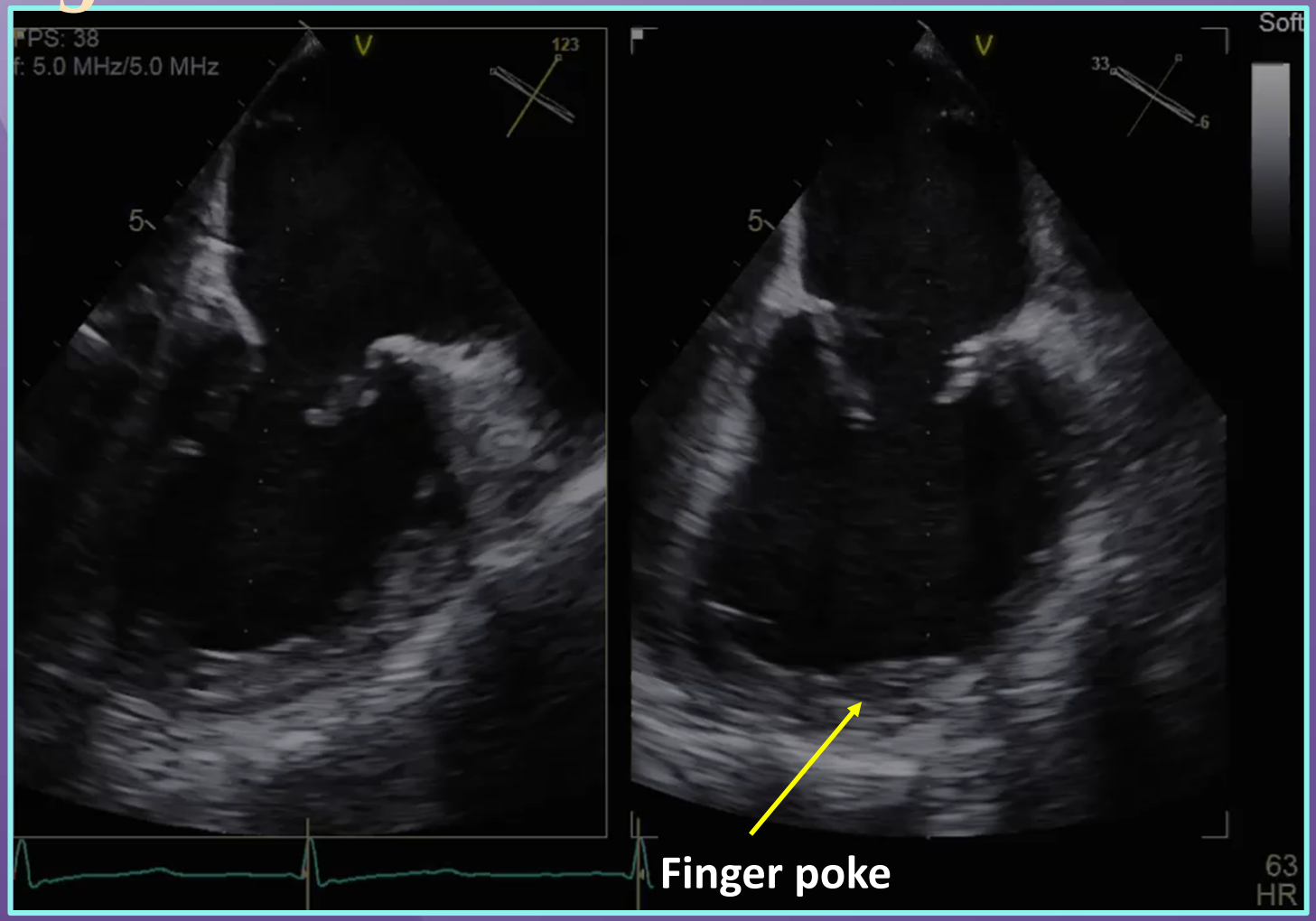
Initiating the Procedure

Finger Poke to Localize the Needle Stick



Assures deployment is coaxial with the MV

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Centering the Device

Must be Free of Chordal Entanglements

Both X-plane and 3D are helpful

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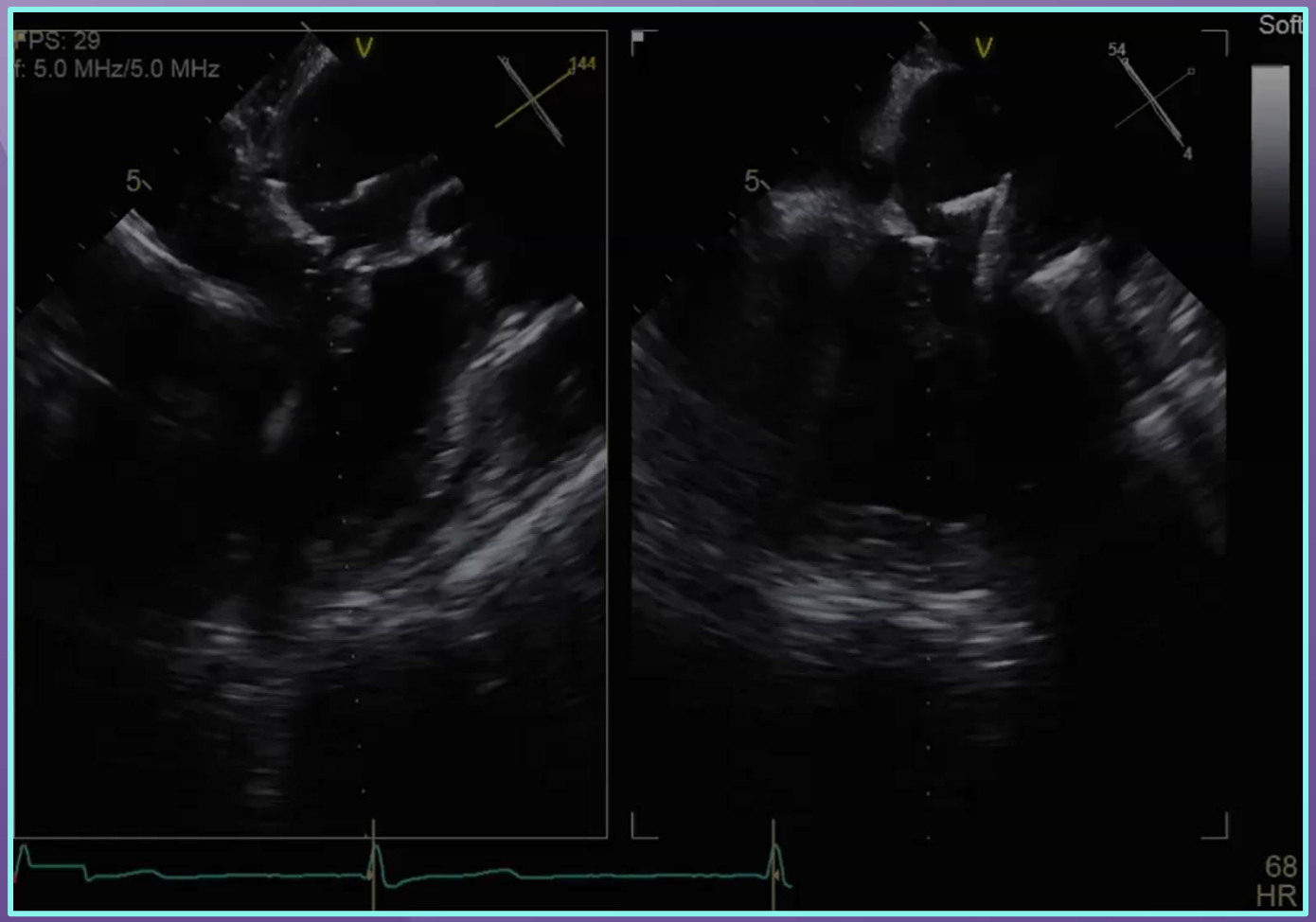
Opening the Atrial Portion

Assure it Remains Above the Valve and Centered



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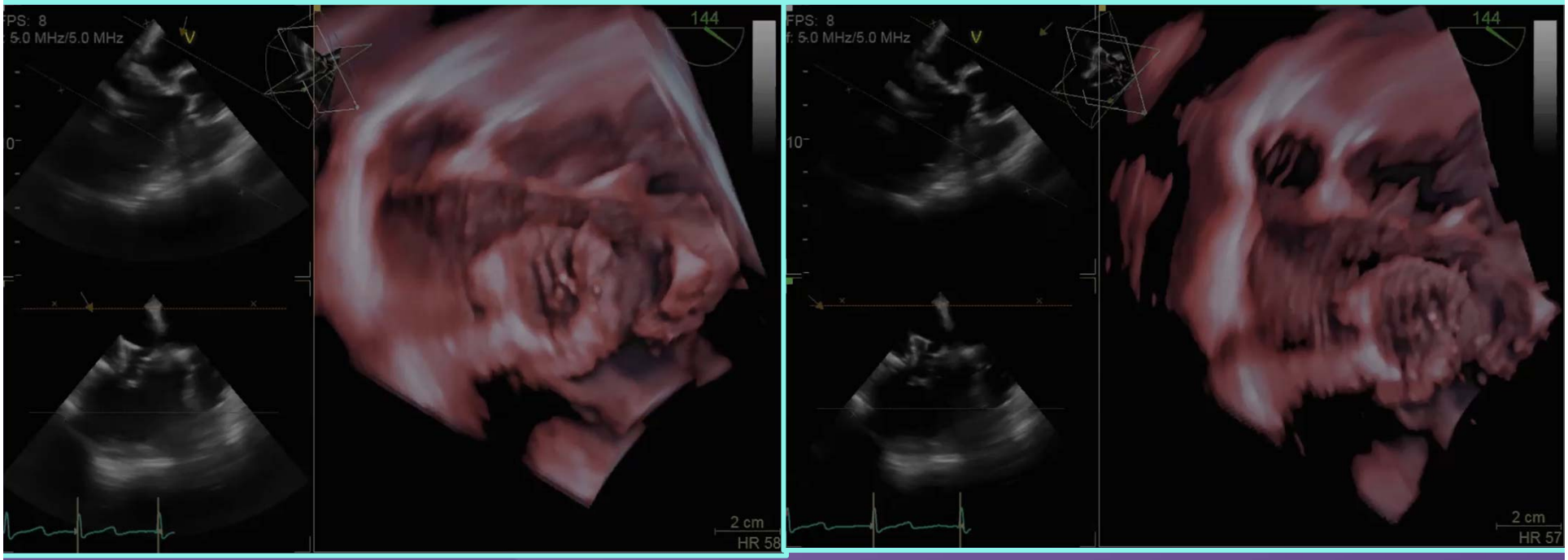
Orienting the Device

Assure Flat Portion Goes Trigone-Trigone



Typically lies under the aortic valve

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Seating the Device

Leave No Space Between Valve and LA Wall

Then deploy LV portion and release three tabs while holding constant 8 Newton tension on the device

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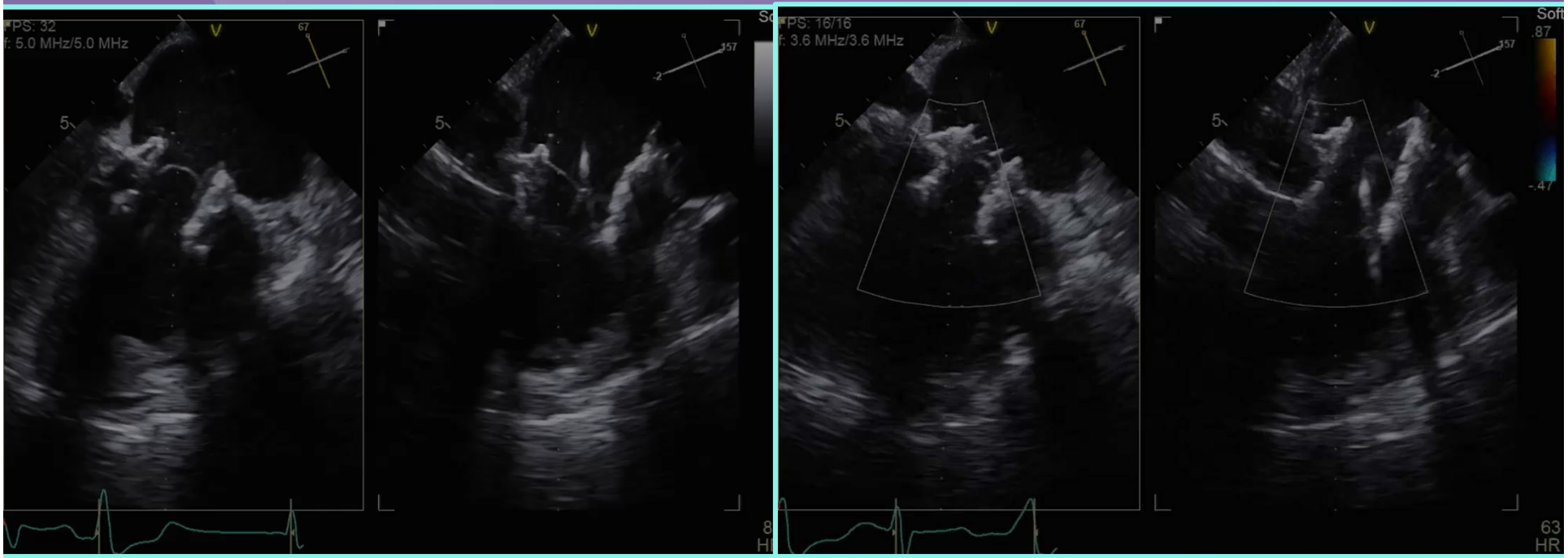
Checking the Deployment
Well-Seated without Paravalvular Regurgitation



Some central MR may be seen from the wire

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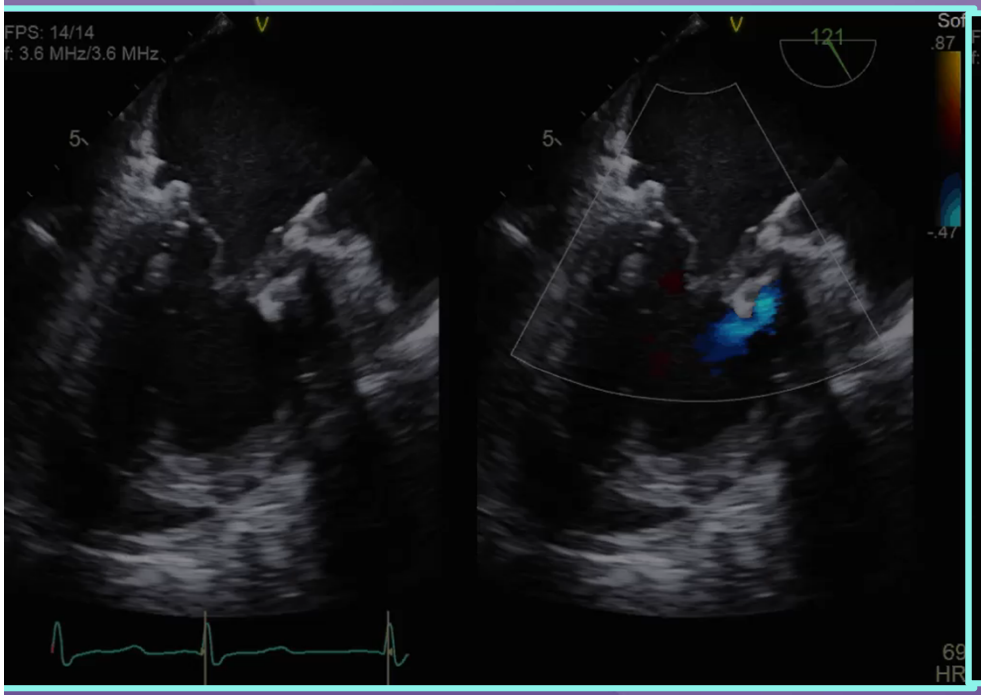
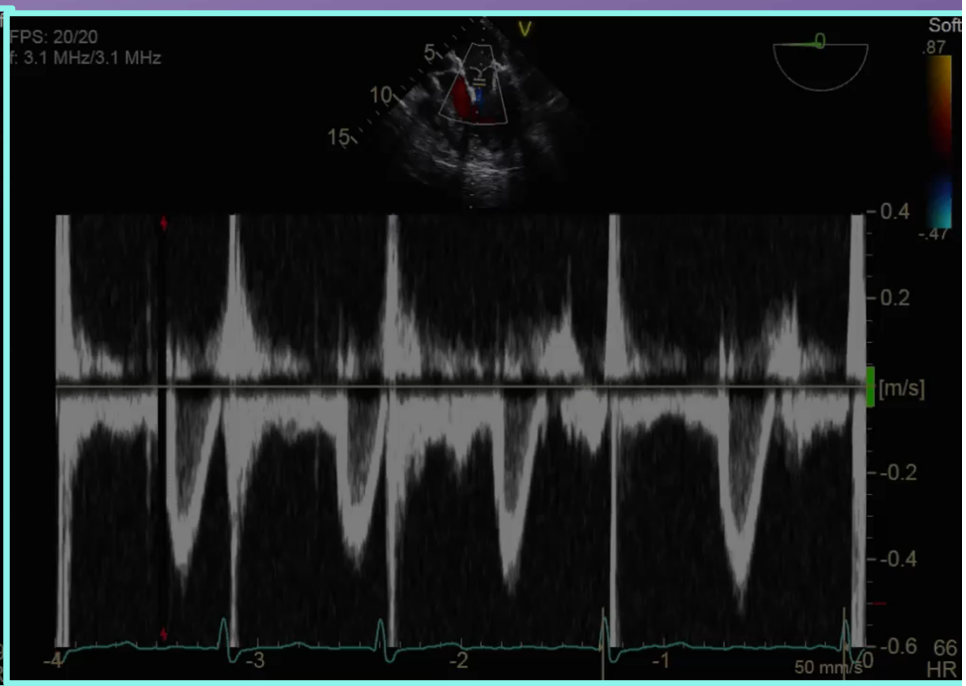
Final Check





No MR, mean gradient 1 mmHg

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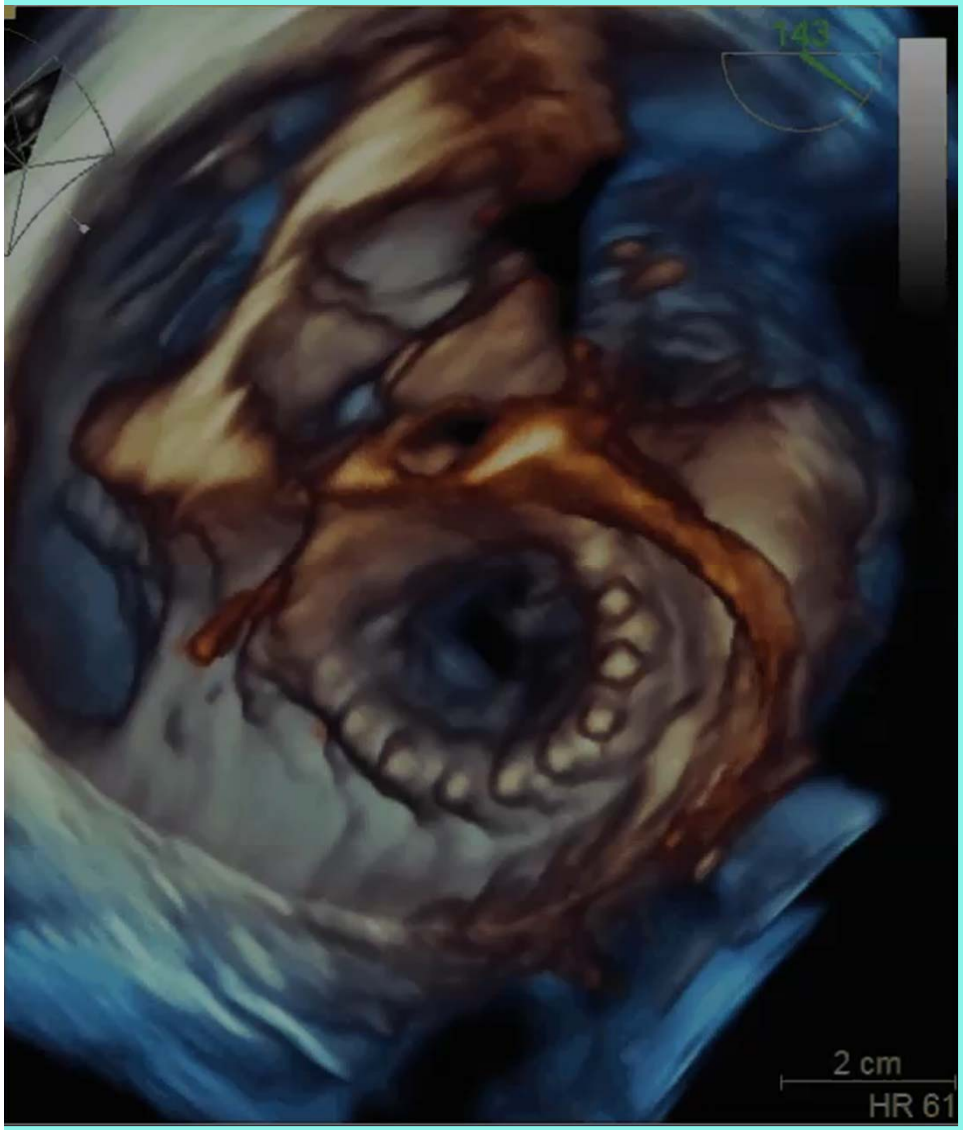
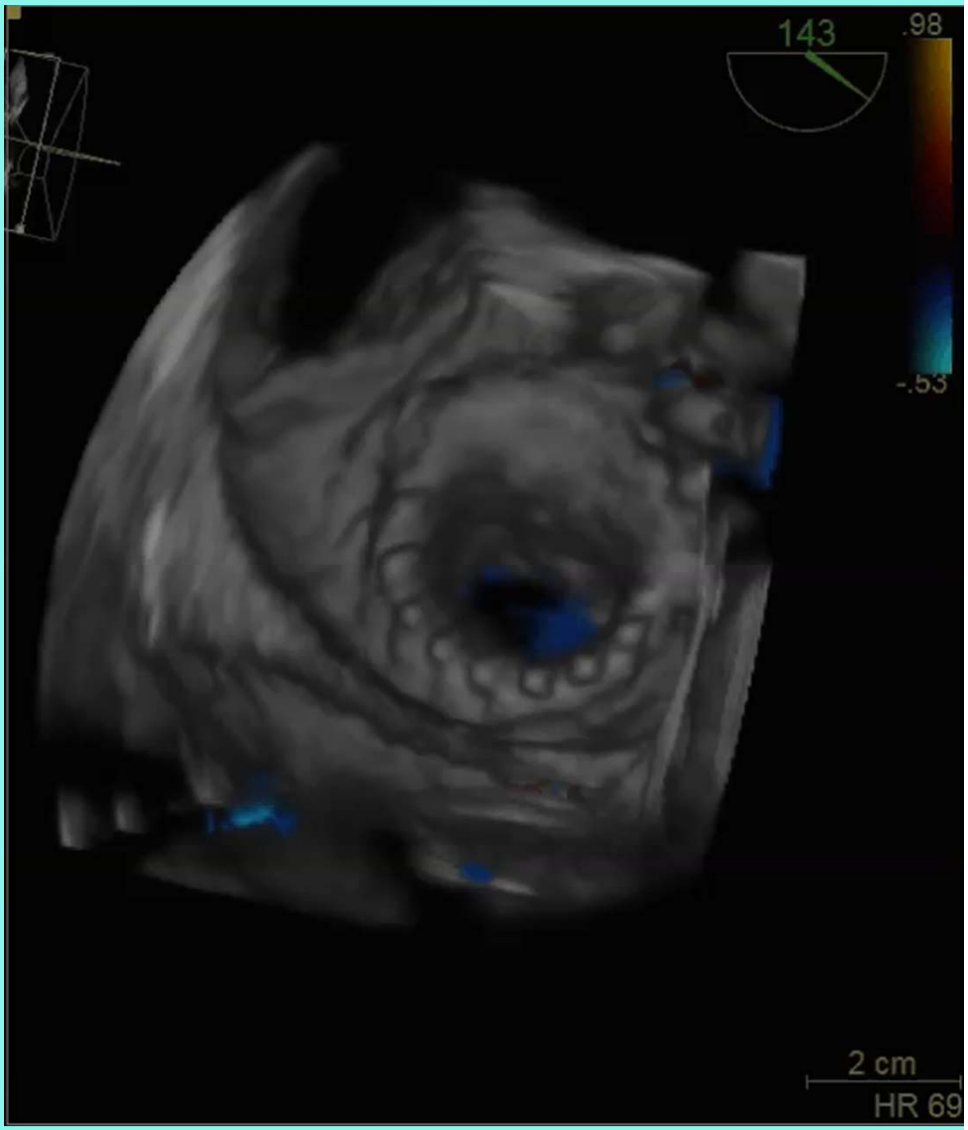
Final Check





Flat portion aligned with trigones, no MR

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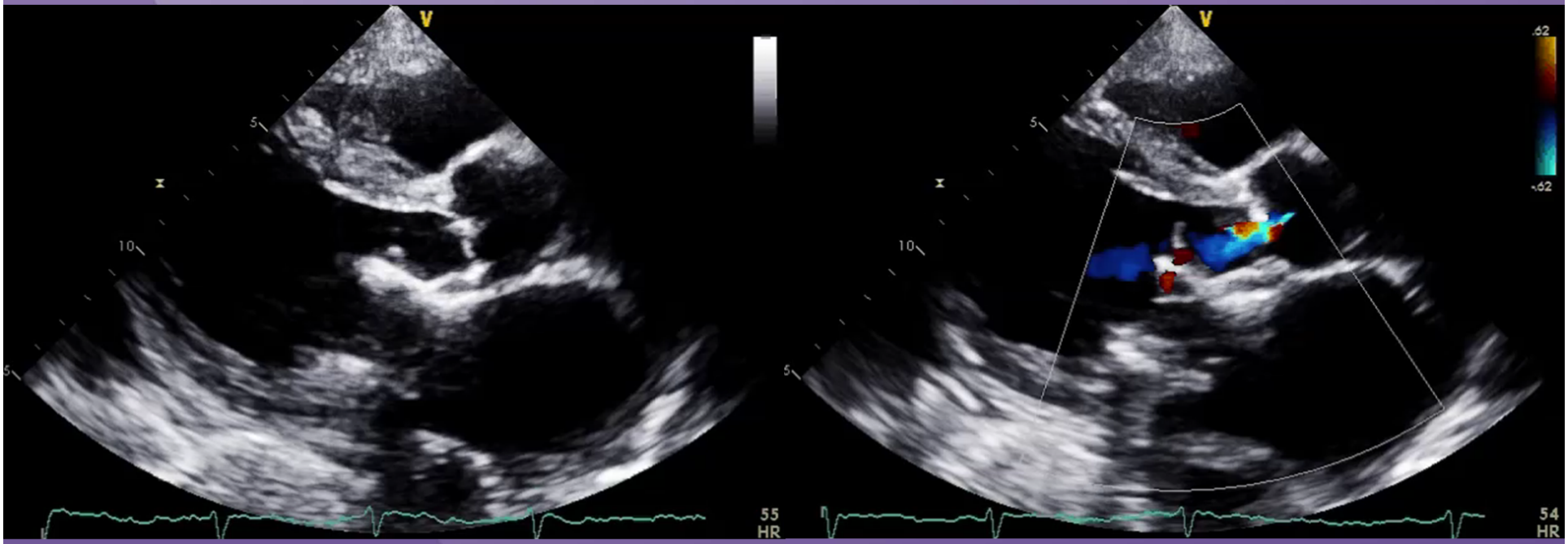
One Month Post-Procedure

Class I Symptoms, Toured Europe that Summer



Moderate LV dysfunction, no MR

Mean gradient 3 mmHg

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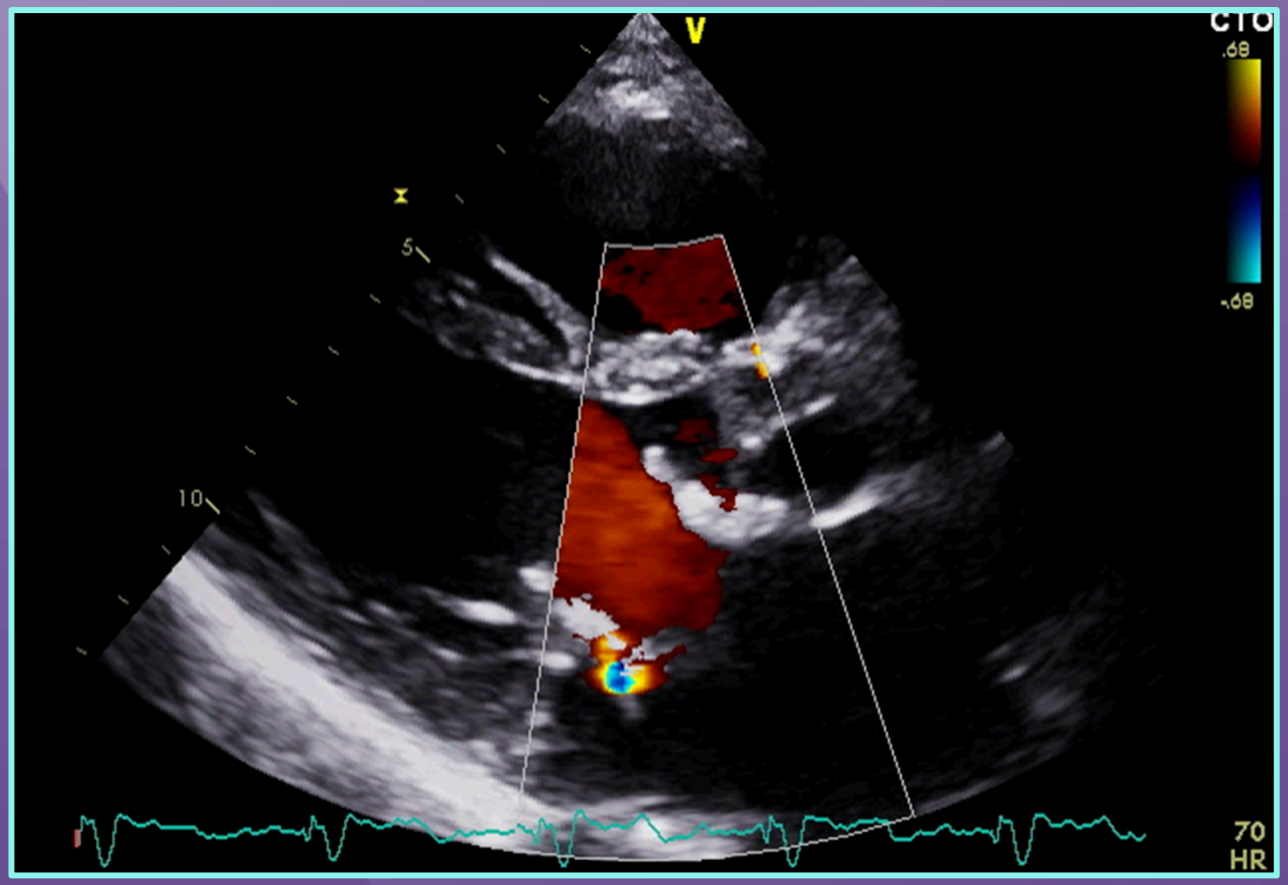
S/P Mitral VIV
Trivial MR



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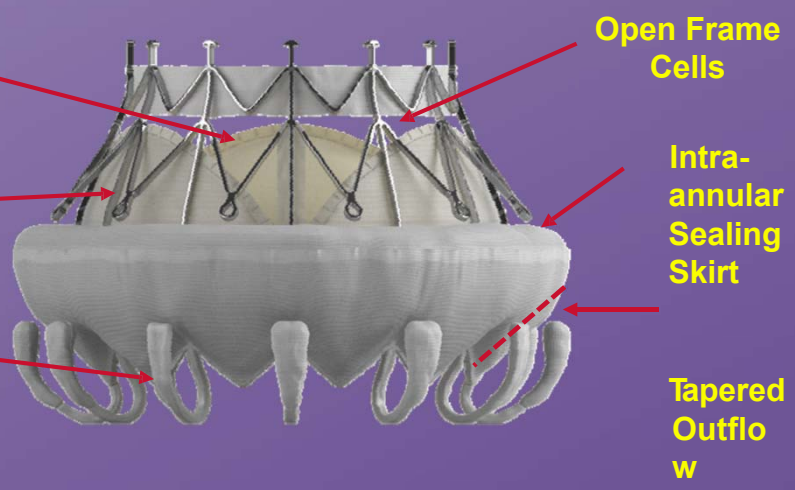
Transcatheter Mitral Valve Replacement

CardiAQ



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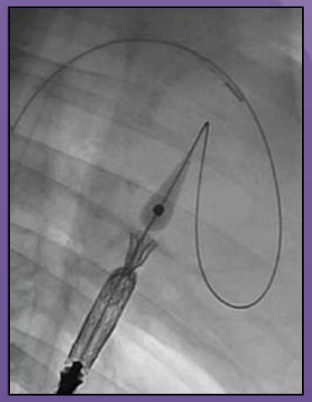
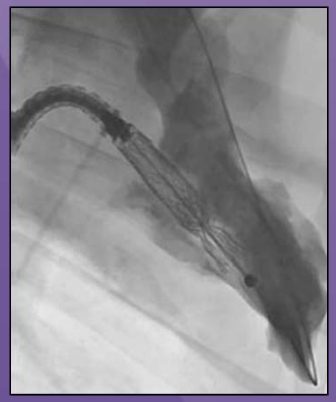
TMVR Transseptal Procedure

CardiAQ

Advance DS into LV	Position for Depth and Axial Alignment	Release Anchors, then Adjust Depth to Initiate Leaflet Capture	Expand Valve and Finalize Leaflet Capture	Confirm Position and Release Valve
				

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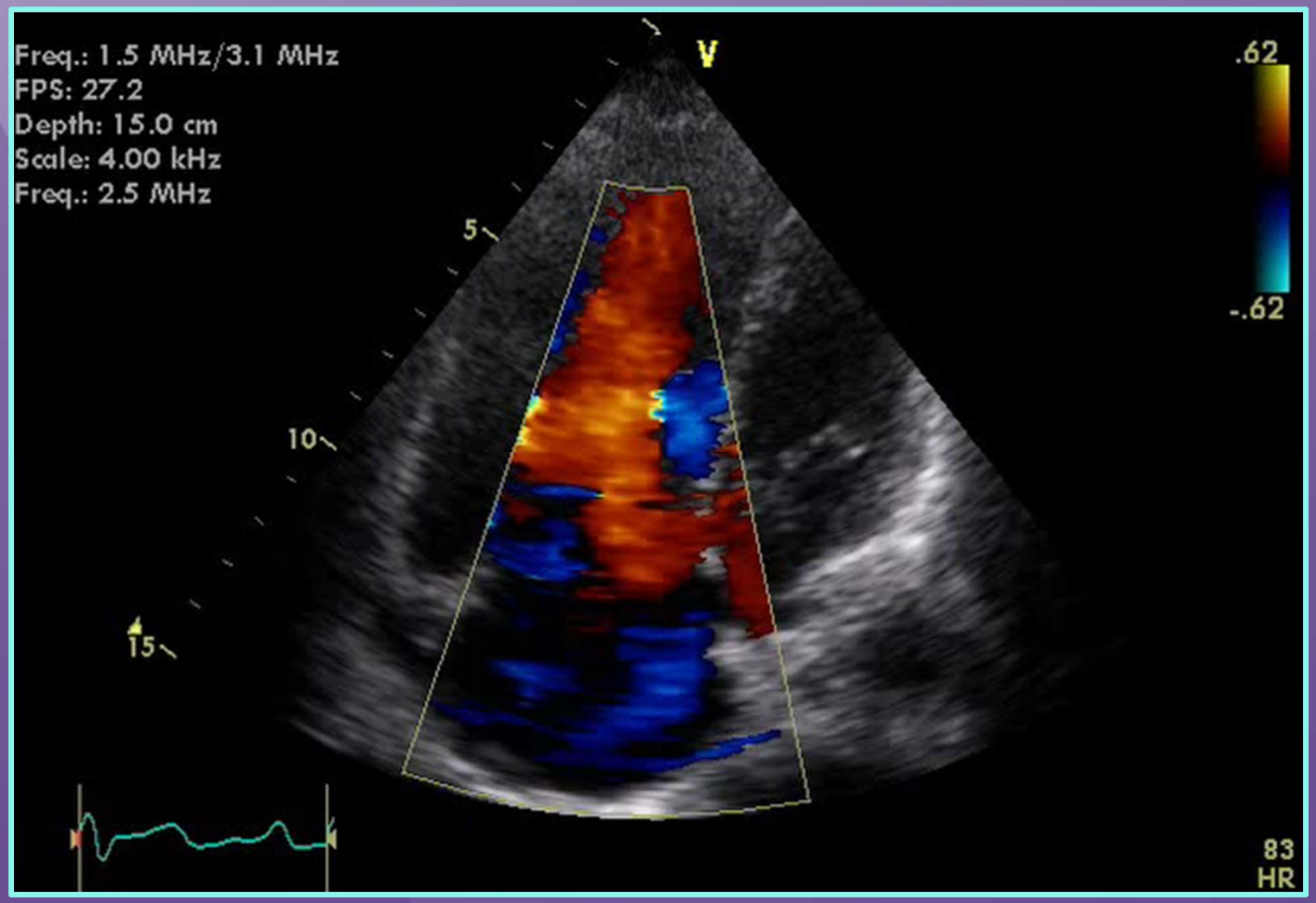
What About Tricuspid Regurgitation?

Frequent Complication of Mitral Regurgitation



Exciting new trial of percutaneous TV repair

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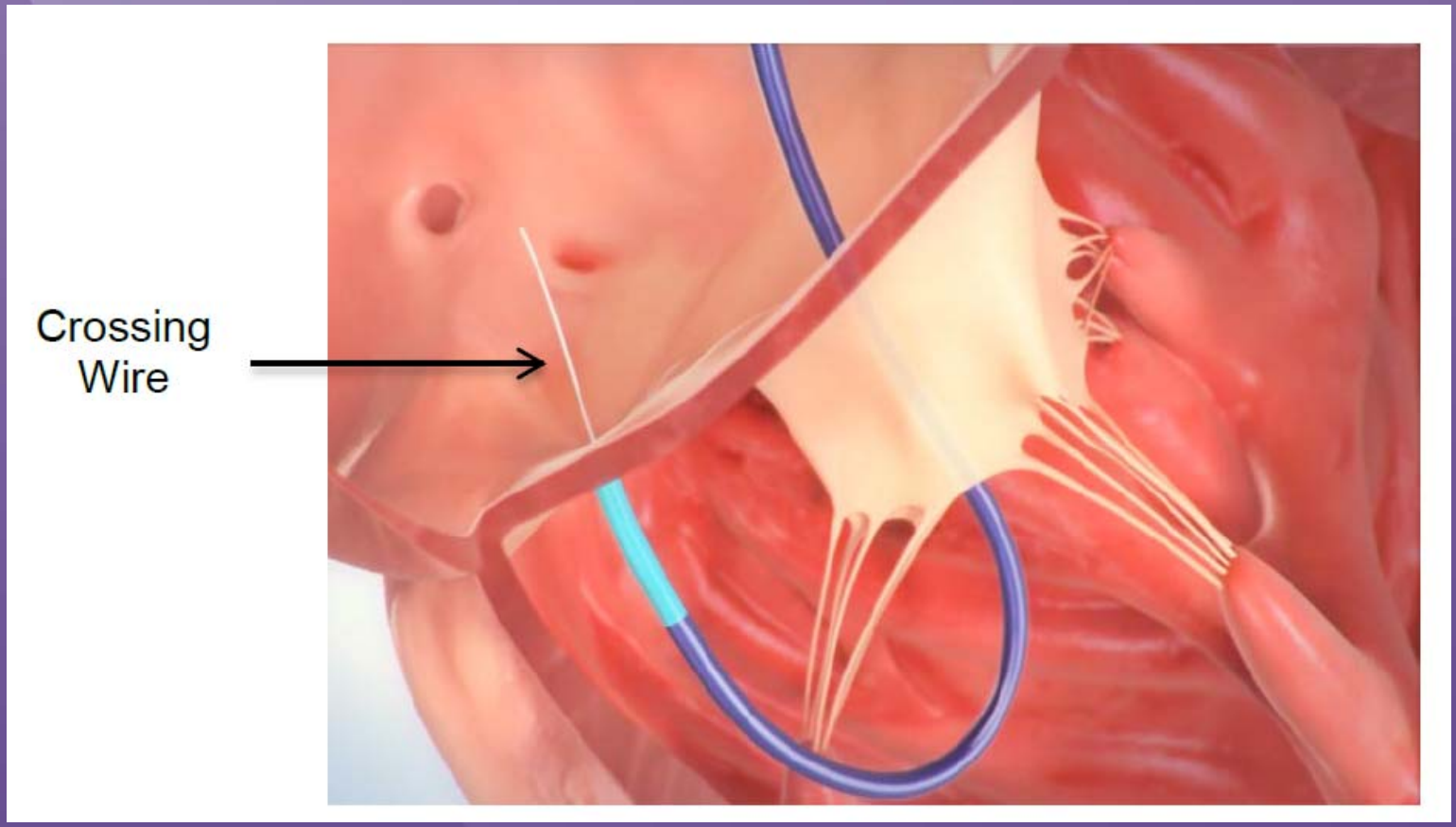
SCOUT Trial: Percutaneous TV Annuloplasty System



Requires precise catheter guidance

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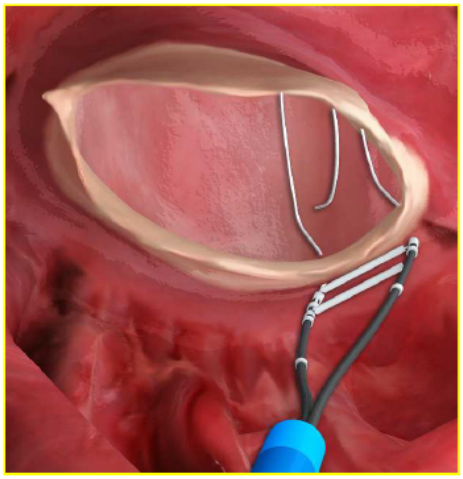
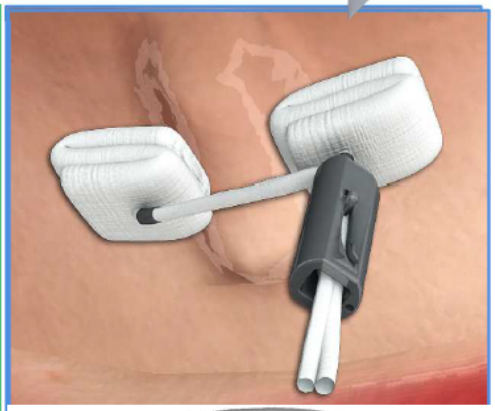
Mitralign Procedure:
3 Main Steps

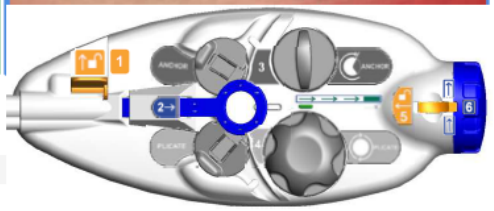
Wire Delivery

Pledget Delivery

Plication & Lock







mitralign

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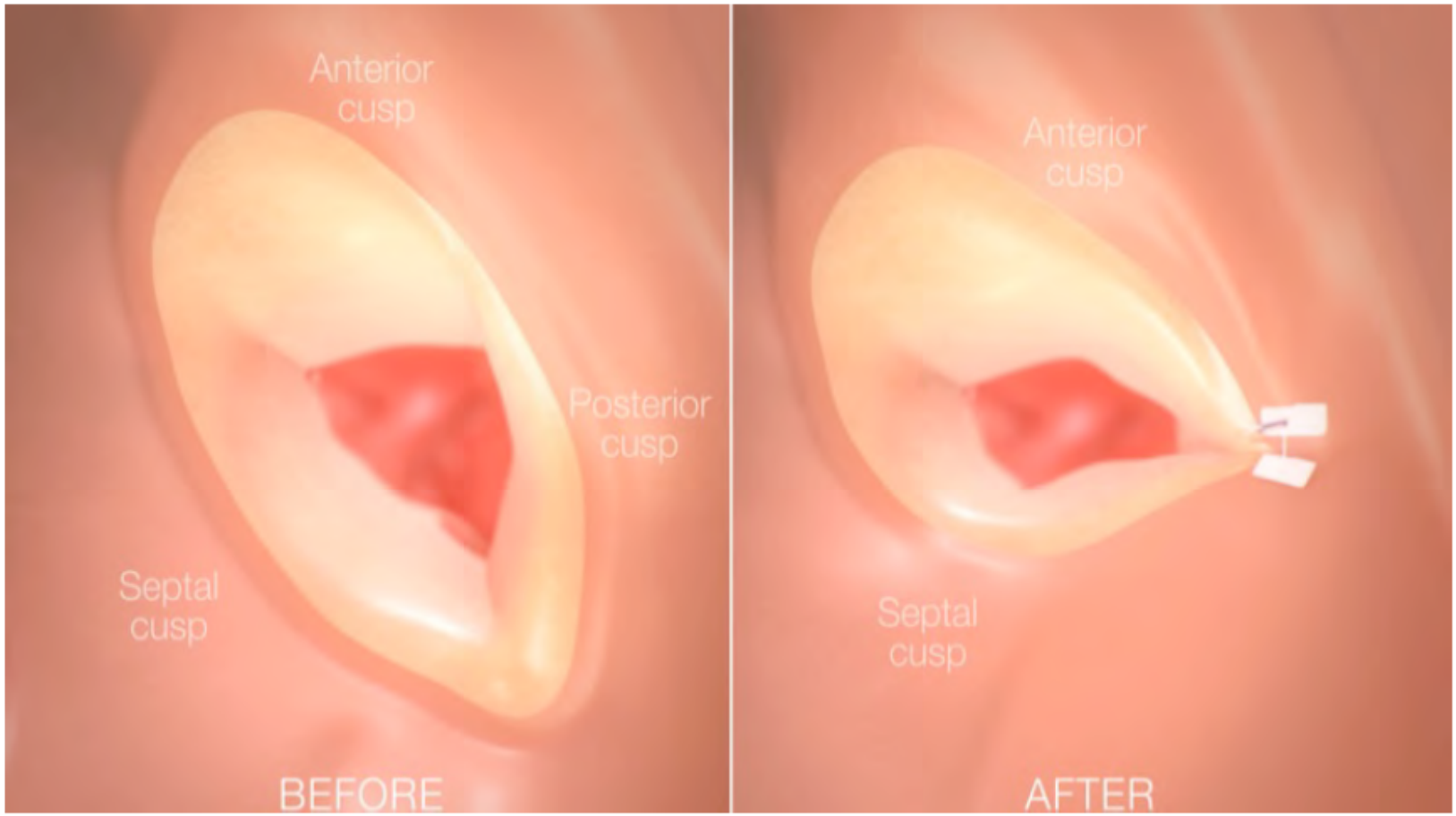
Turns the Tricuspid Valve into a Bicuspid Valve



Mimics the Kay annuloplasty

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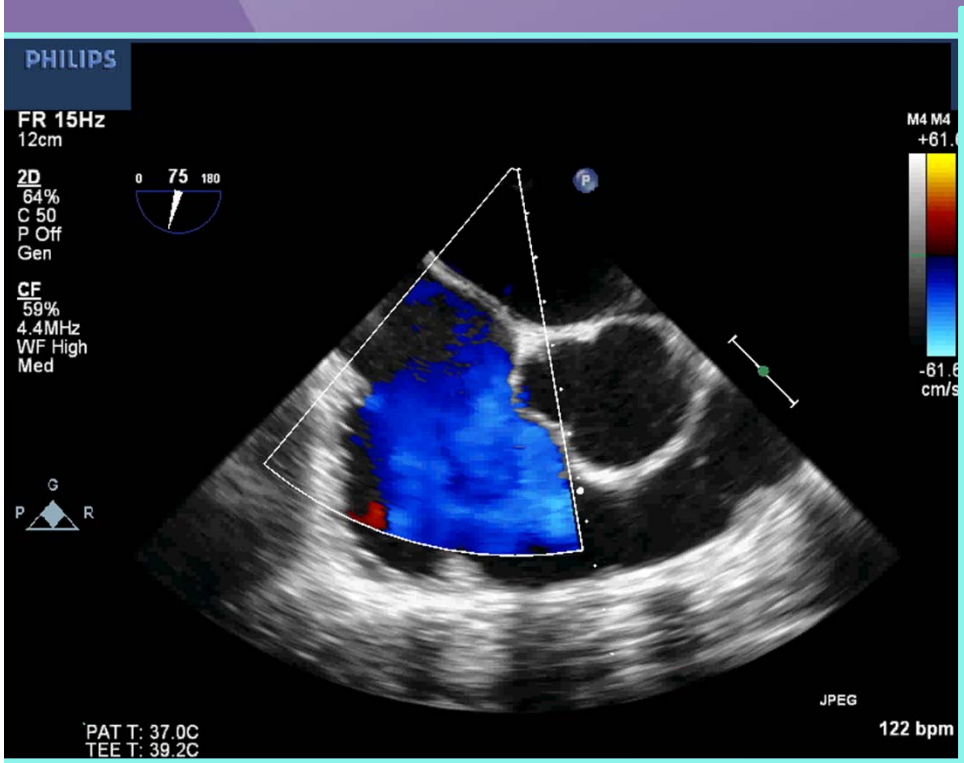
75 yo Woman with Severe TR
s/p MV Repair 1988, AF s/p CVA



Severe functional TR, annulus 5.0 cm

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Procedure Steps Overview

Guide Delivery

- LAO for deflection relative to valve
- RAO for working view
- 3D/2D ECHO

Wire Delivery

- Small – Septo-Posterior commissure
- Medium, – Posterior / Anterior commissure
- 3D/2D ECHO

Snaring

- Visualize **CW** in RA

Pledget Delivery

- Pledget Catheter crossing
- 3D/2D ECHO

Plication, Lock & Cut

- 3D/2D ECHO

Anatomical relationships

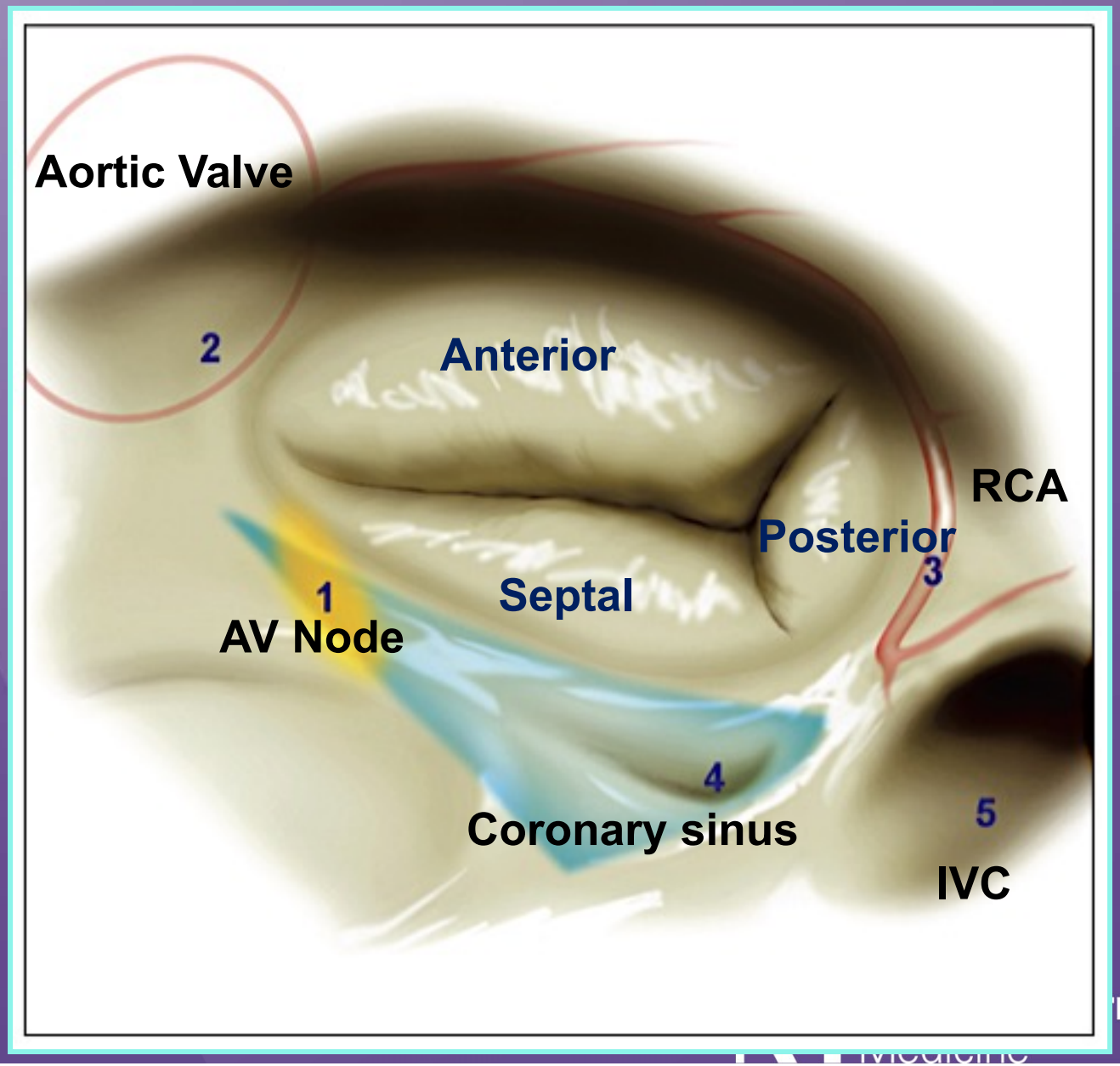
1 atrioventricular node

2 aortic valve

3 right coronary artery

4 coronary sinus

5 inferior vena cava



Anatomical Relationships

1 atrioventricular node

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3 right coronary artery

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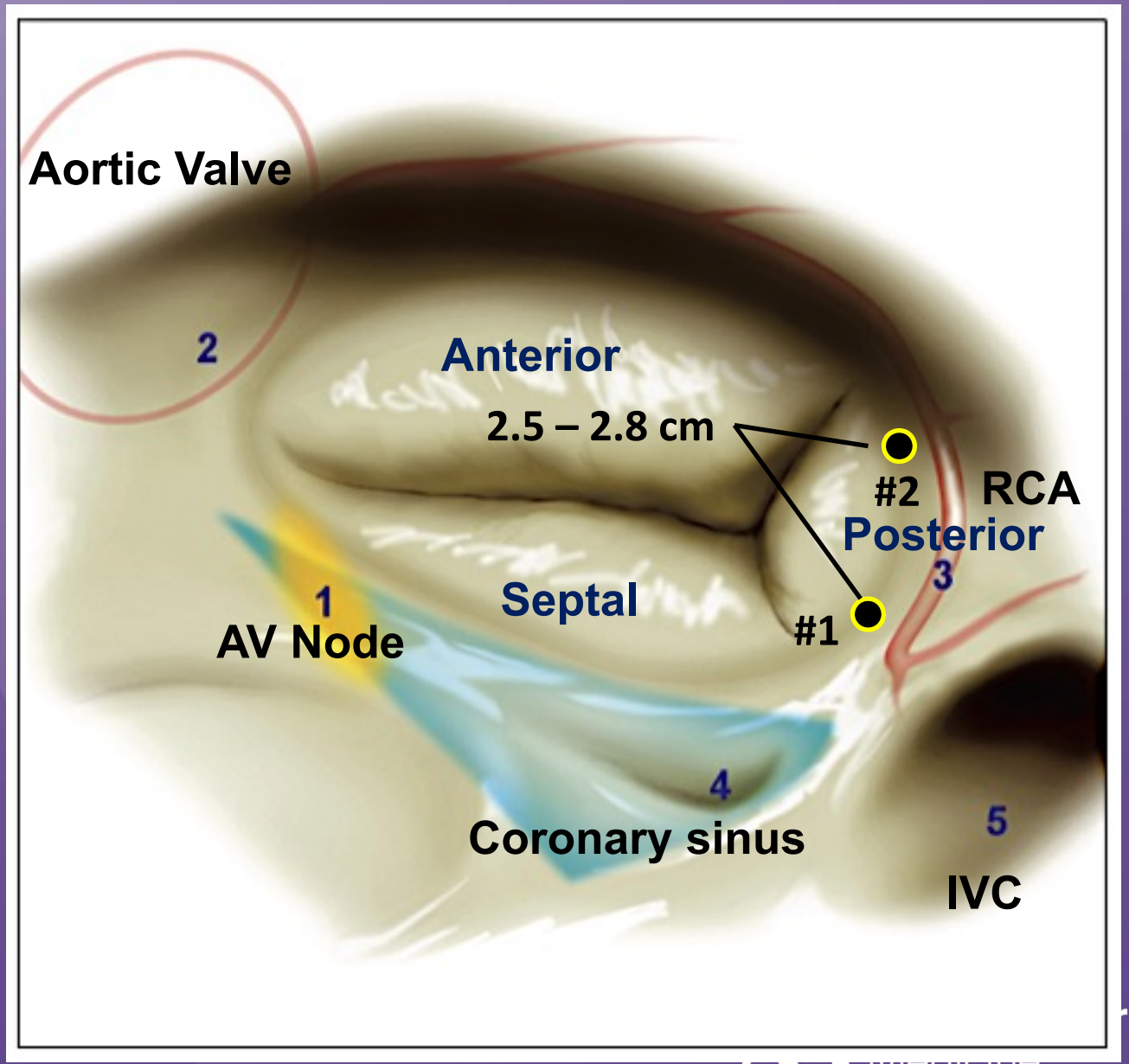
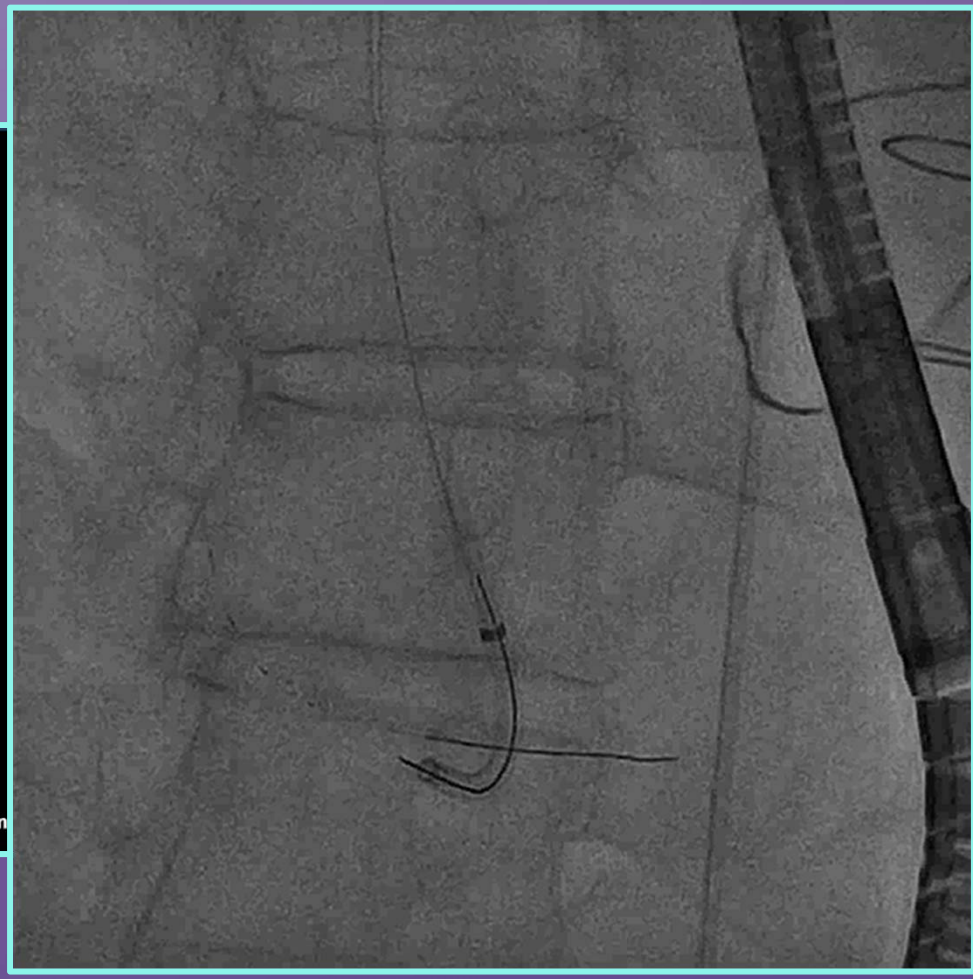
5 inferior vena cava



Placement of First Wire
Septal Commissure of Posterior Leaflet



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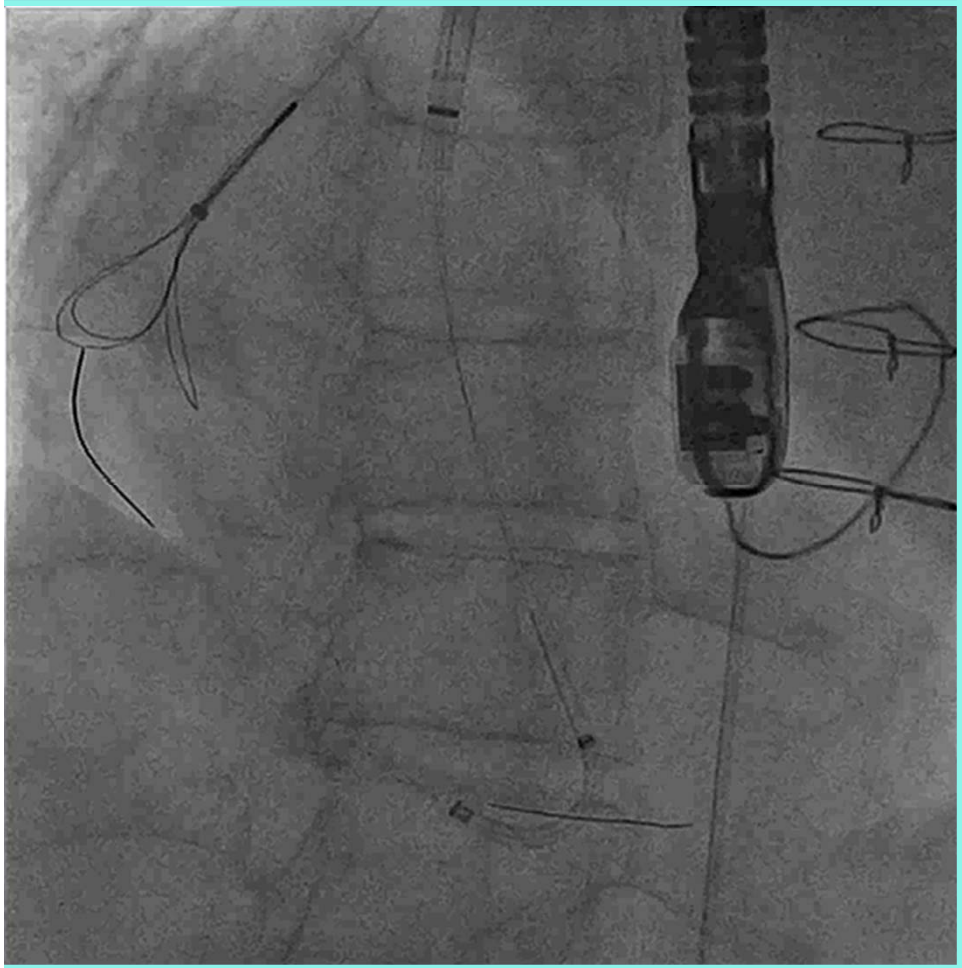
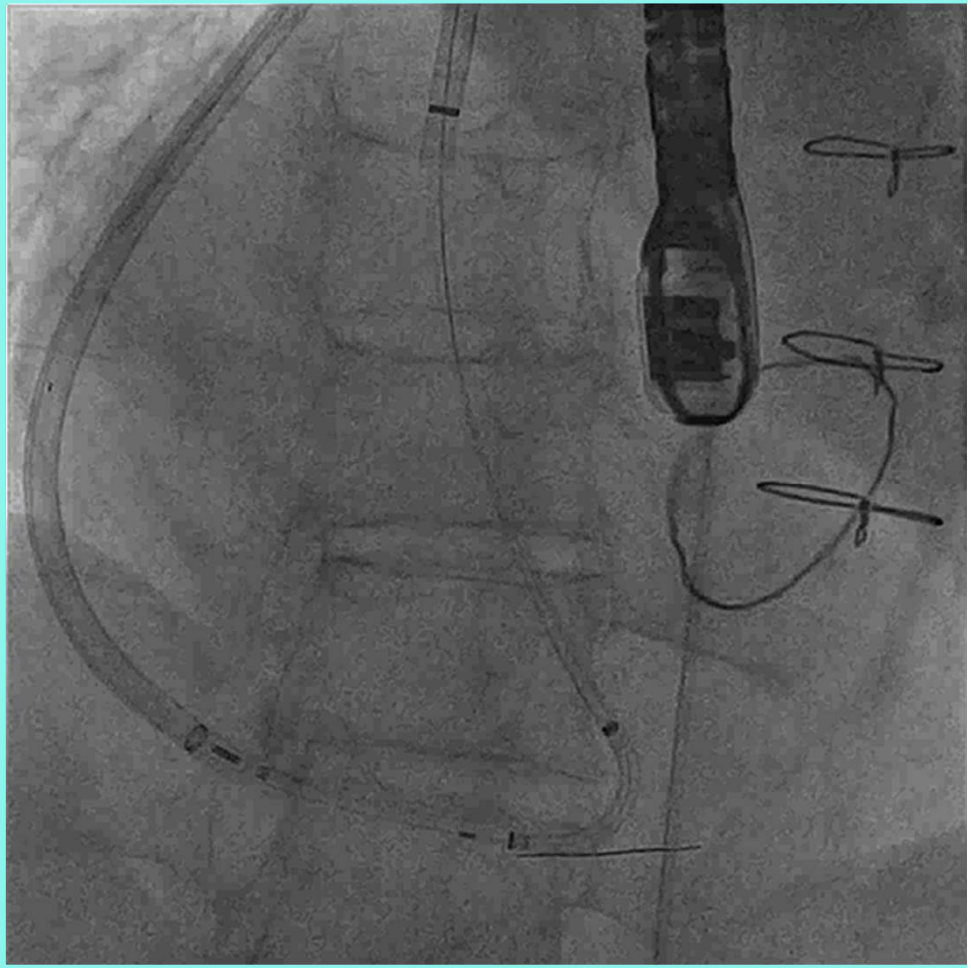
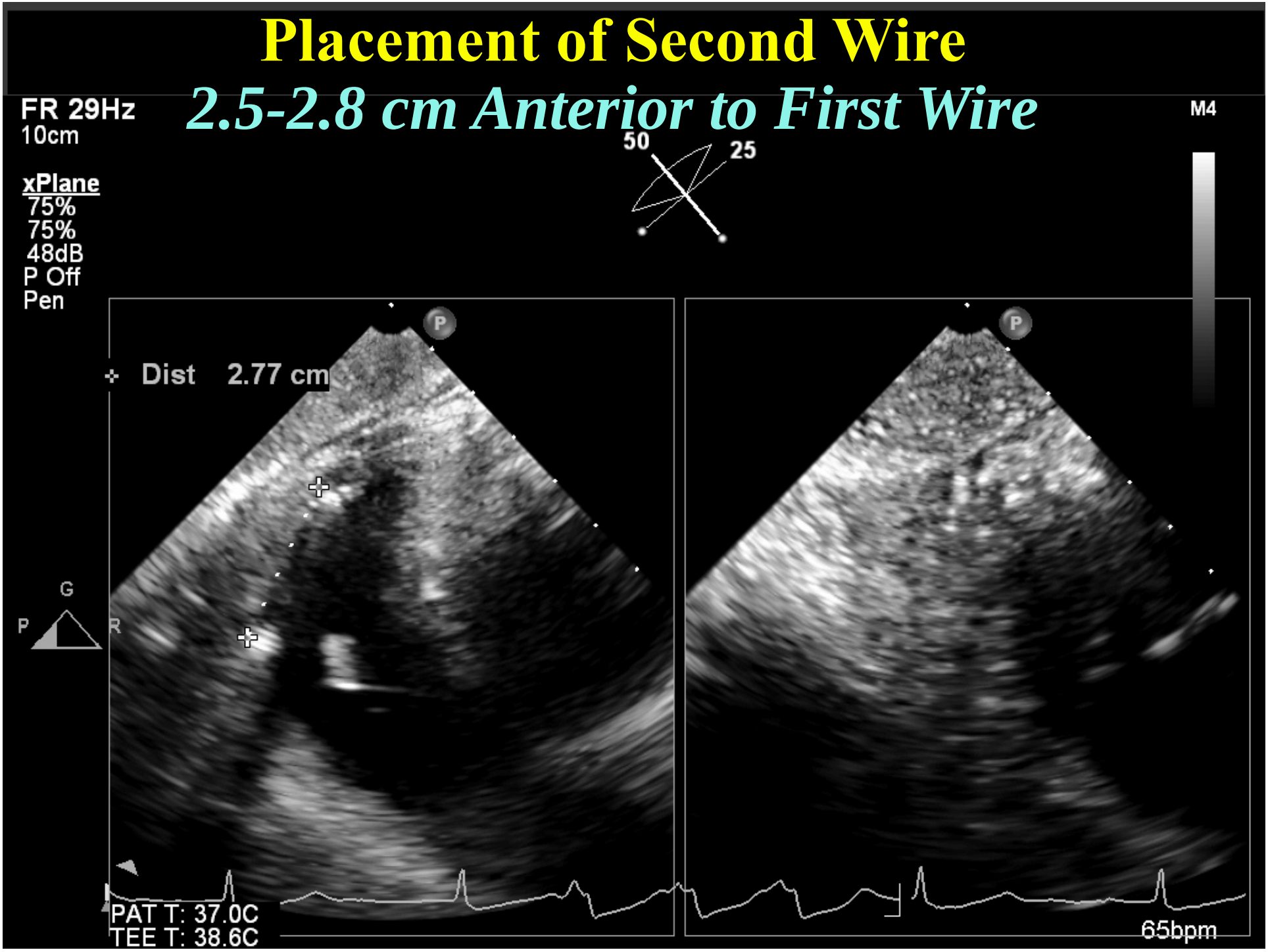
Snaring Wire, Placement of Pledget



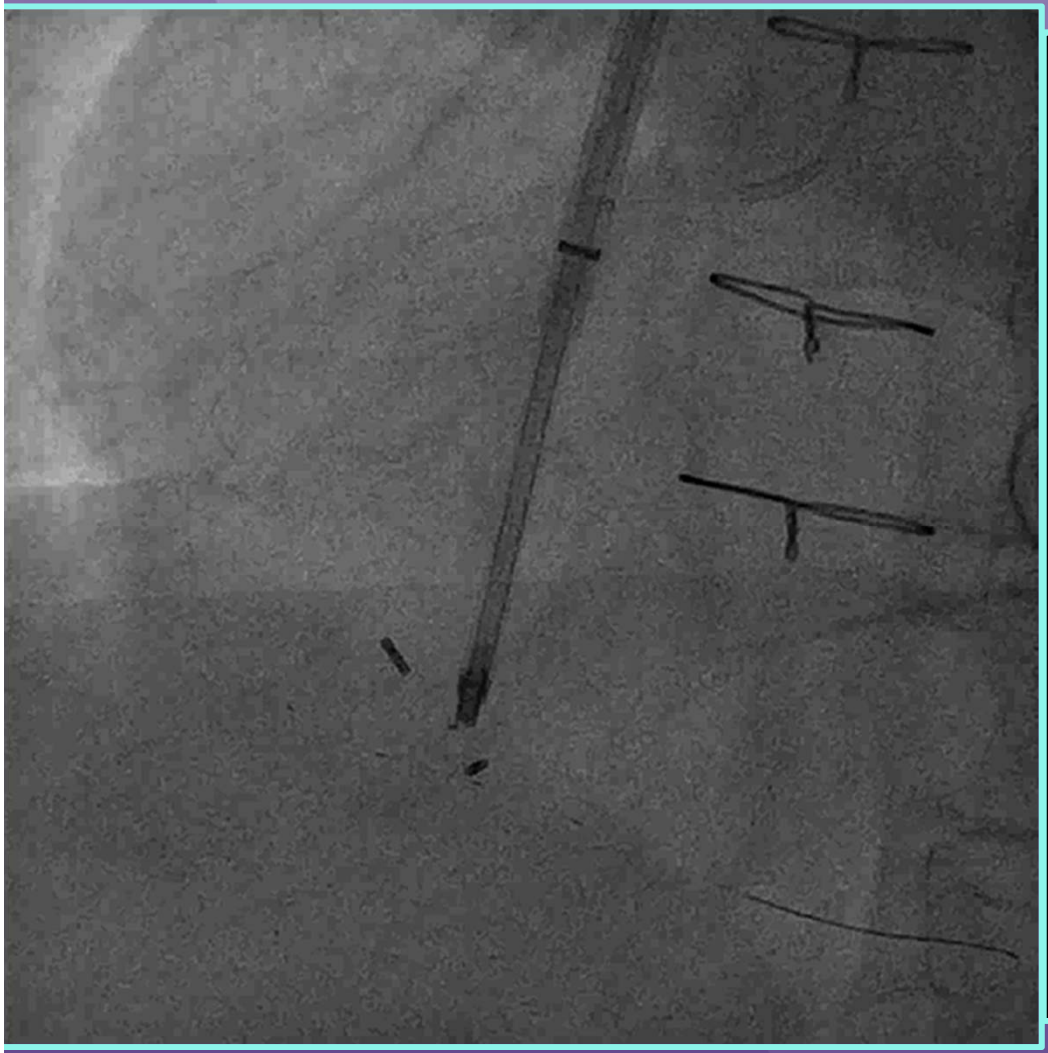


Placement of Second Wire

2.5-2.8 cm Anterior to First Wire



Plication of Posterior Leaflet



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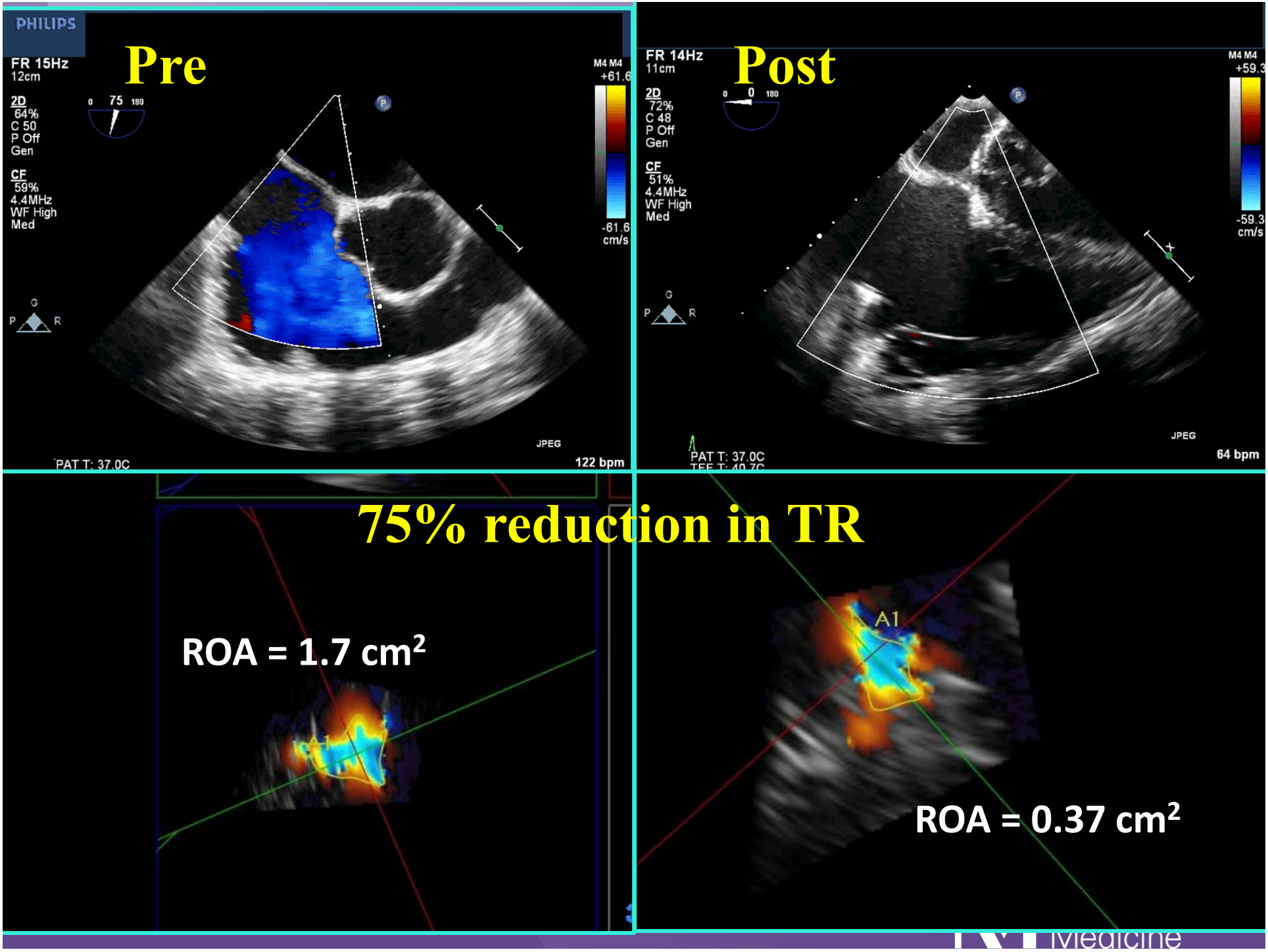
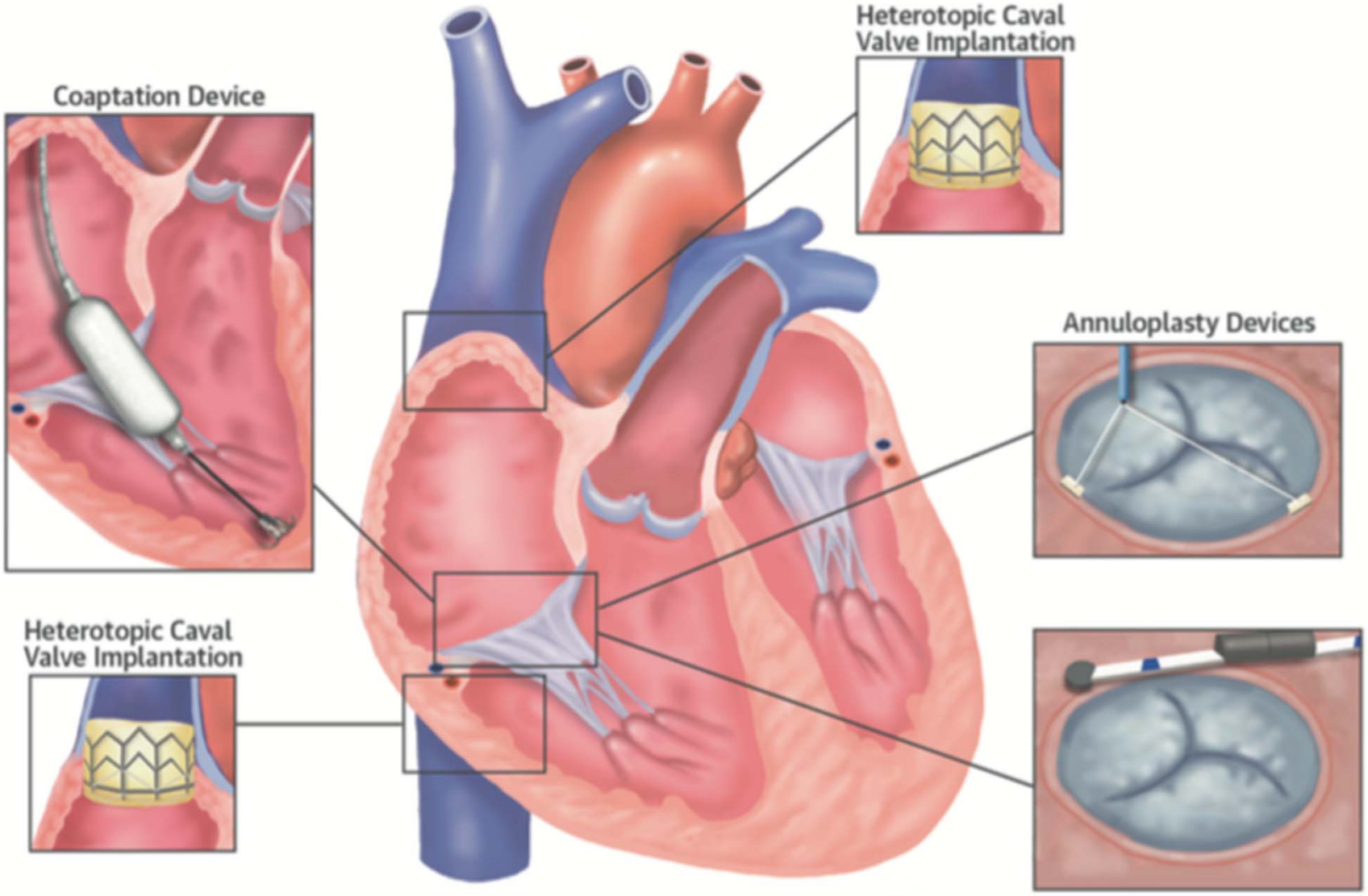

PHILIPS
Pre
FR 15Hz
12cm
2D
64%
C 50
P Off
Gen
CF
59%
4.4MHz
WF High
Med
M4 M4
+61.6
-61.6
cm/s
JPEG
PAT T: 37.0C
122 bpm
Post
FR 14Hz
11cm
2D
72%
C 48
P Off
Gen
CF
51%
4.4MHz
WF High
Med
M4 M4
+59.3
-59.3
cm/s
JPEG
PAT T: 37.0C
64 bpm
75% reduction in TR
ROA = 1.7 cm²
A1
ROA = 0.37 cm²

Transcatheter Therapies for Tricuspid Regurgitation

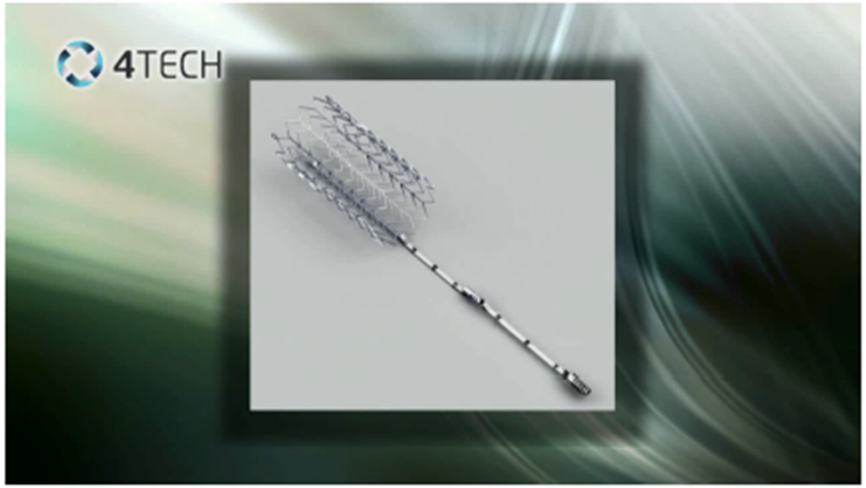


Rodes-Cabau J et al. JACC 2016;67:1829-45

4Tech TriCinch

Simple controlled procedure

With a percutaneous approach the Tricinch System is implanted under Fluoroscopic imaging, 3D and ICE Echo guidance in 4 simple steps



1 Corkscrew implant in APC

2 Coupling mechanism

3 Tension applied

4 Stent deployment in IVC

tct2016

Cardiovascular Research Foundation

Vahanian A, TCT 2016 Washington DC

Medicine

FORMA (Edwards)

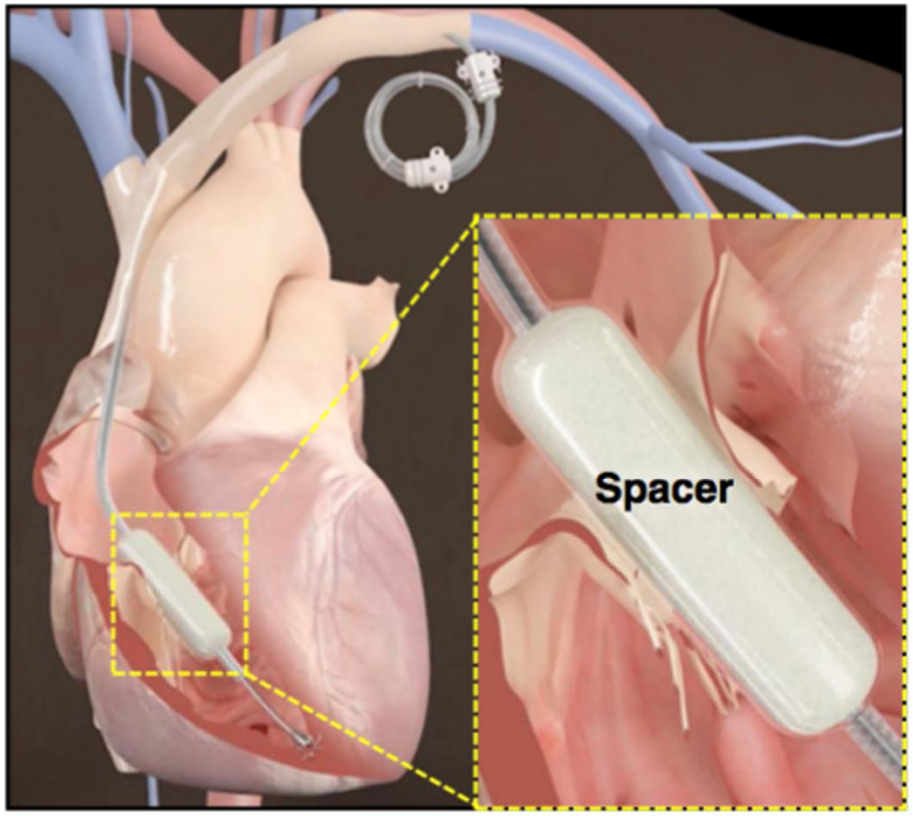
FORMA Repair System Overview

Spacer

- Positioned into the regurgitant orifice
- Creates a platform for native leaflet coaptation
- Preserves underlying structure

Rail

- Tracks Spacer into position
- Distally and proximally anchored



Northwestern Medicine

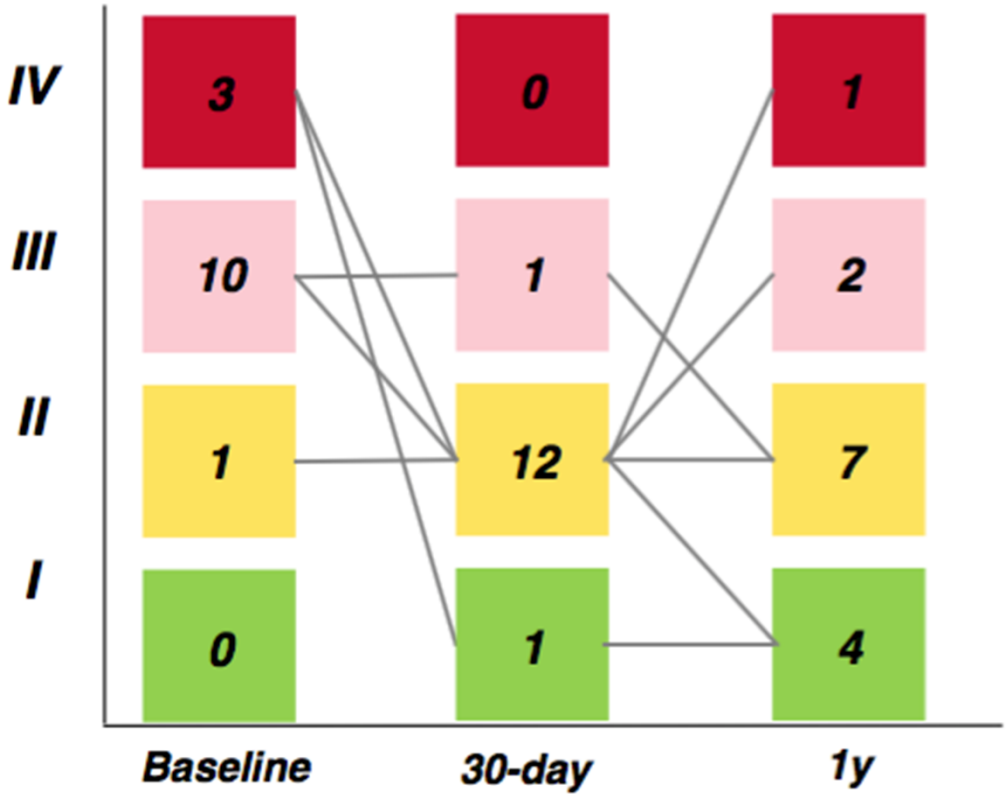
Rodes-Cabau J, TCT 2016, Washington, D

FORMA Compassionate Use

Paired Functional Outcomes at 1-Year Follow Up

NYHA Grade

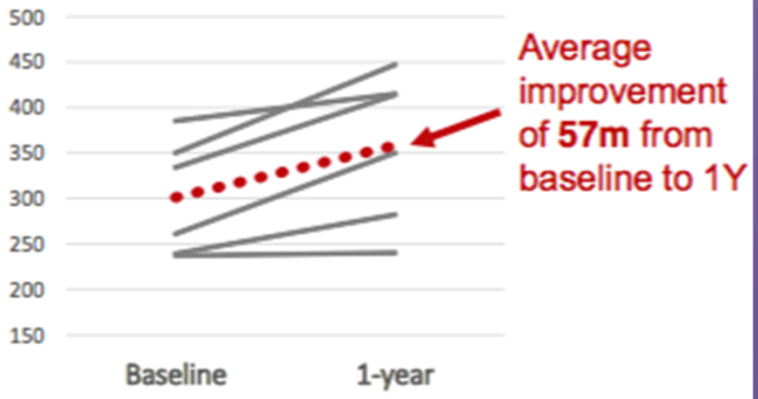
*N = 14**



**3 patients have not reached 1Y; patents with device dislodgment (1) or conversion to open heart surgery (1) not included*

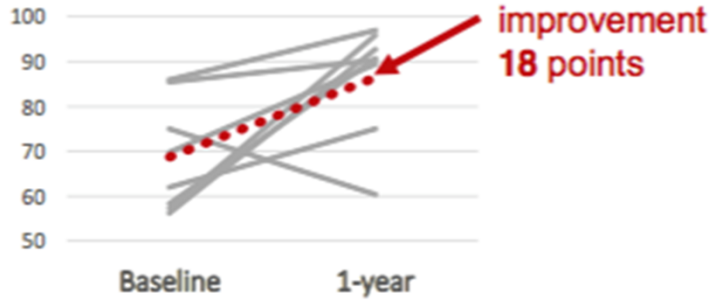
6MWT (m)

N = 6



KCCQ Score

N = 8



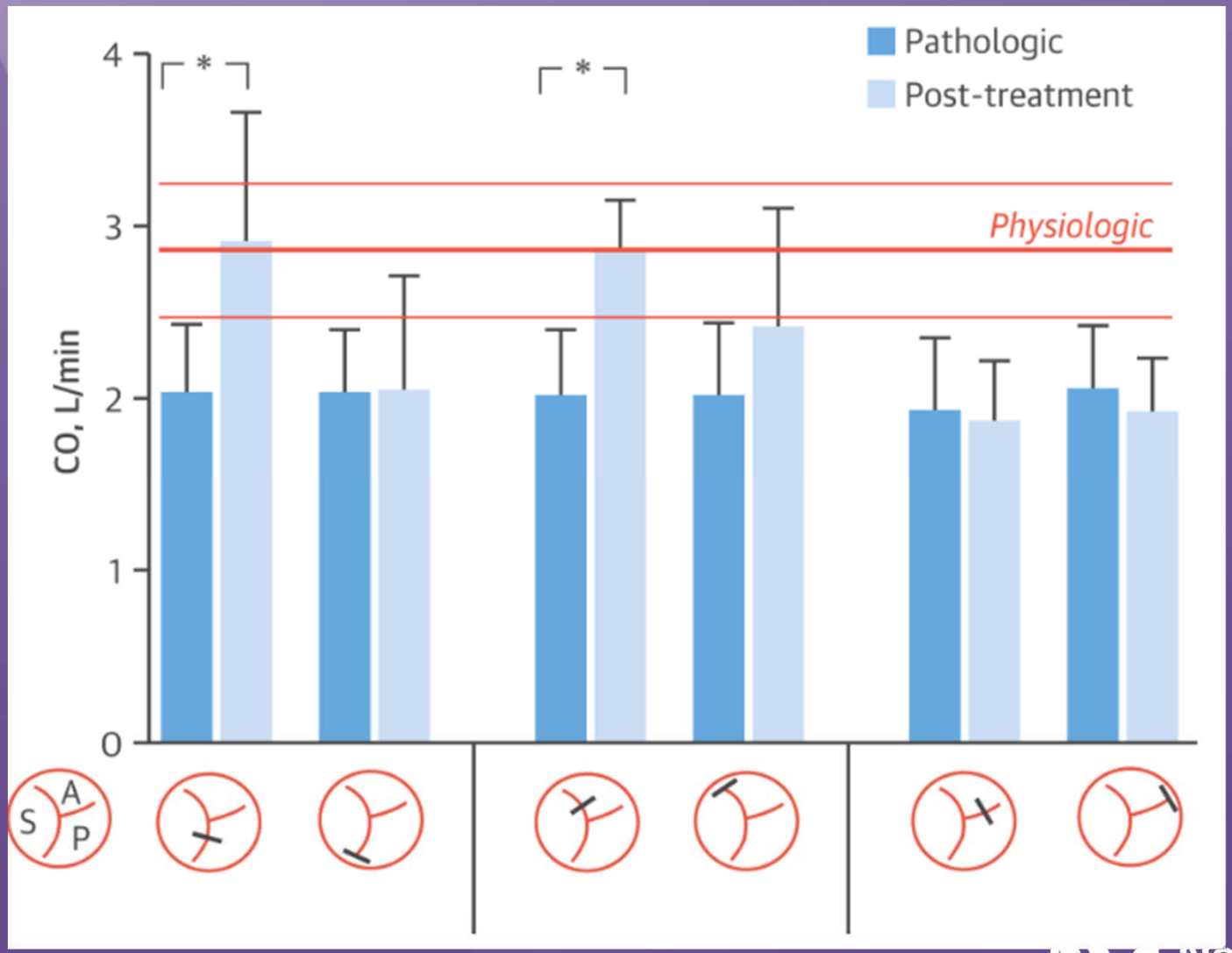
tct2016

Rodes-Cabau J, TCT 2016; Washington, D

Northwestern Medicine

Tricuspid MitraClip

Evaluated in an ex-vivo animal model



Vismara et al, *J Am Coll Cardiol.* 2016;68(10):1024-103

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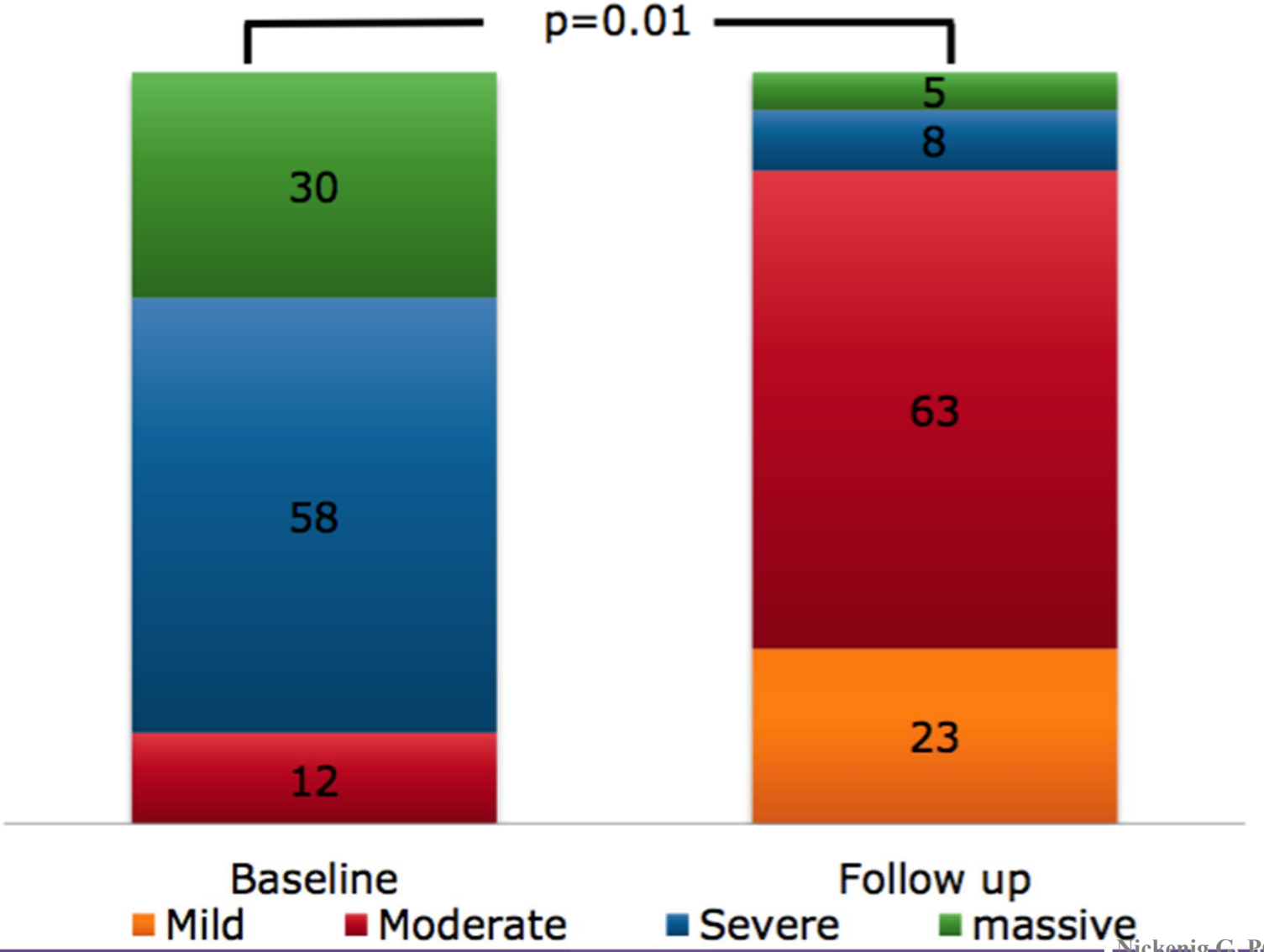
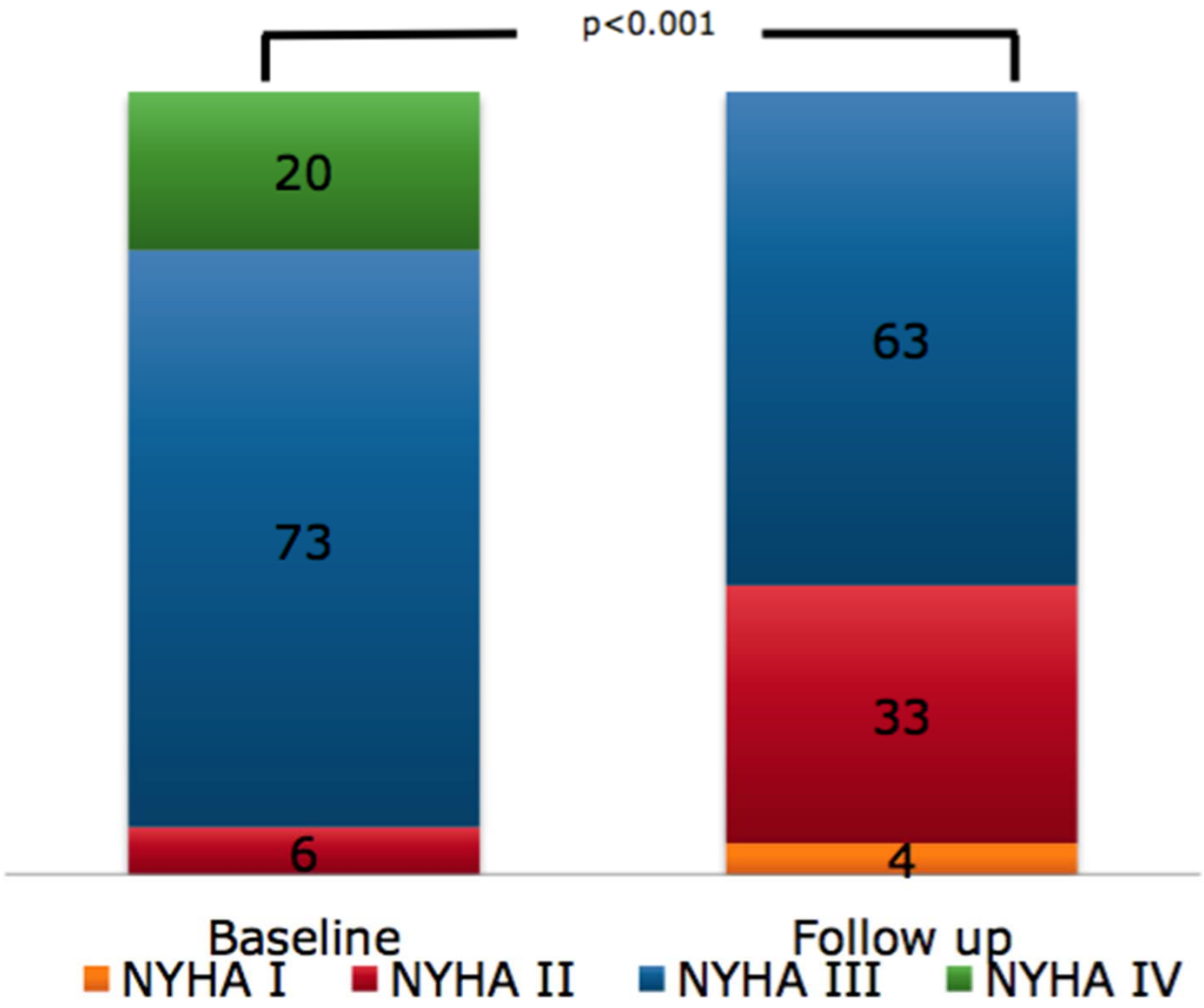
Mitraclip for Tricuspid

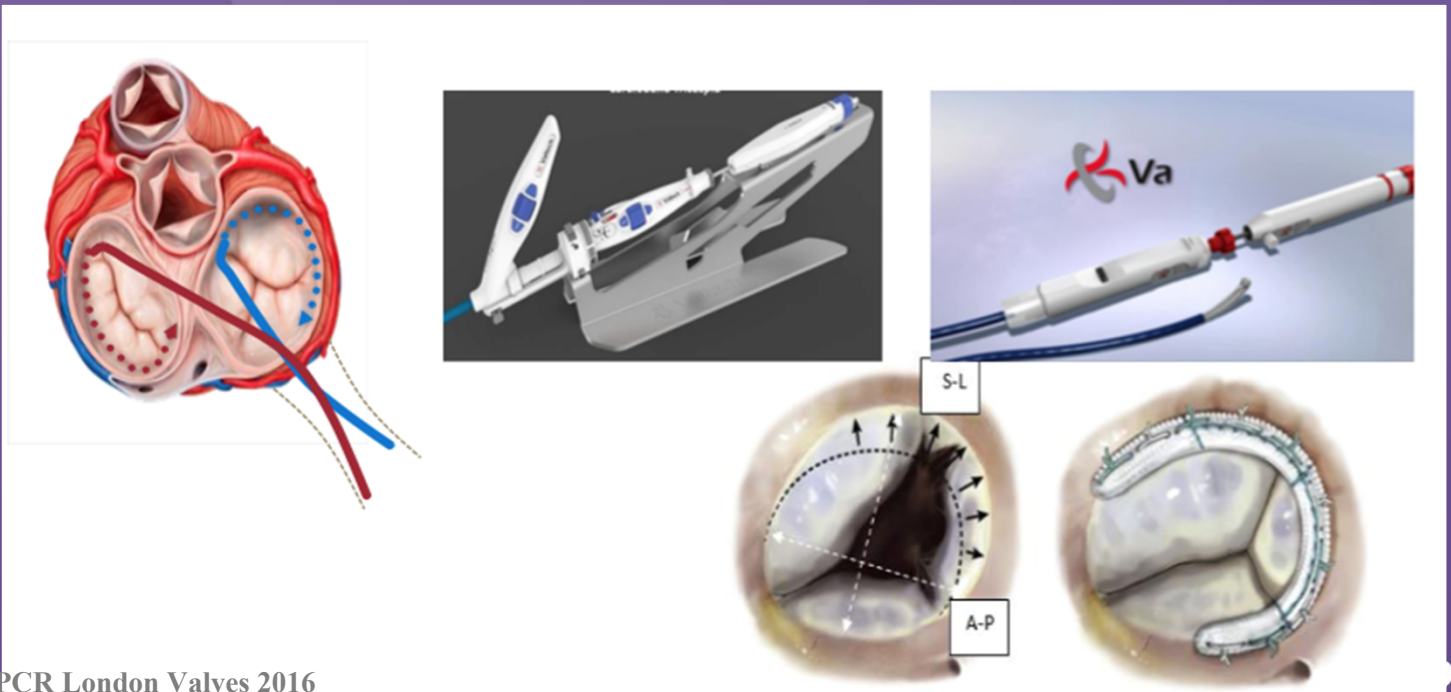


Mitraclip for Tricuspid



Cardioband (Valtech)

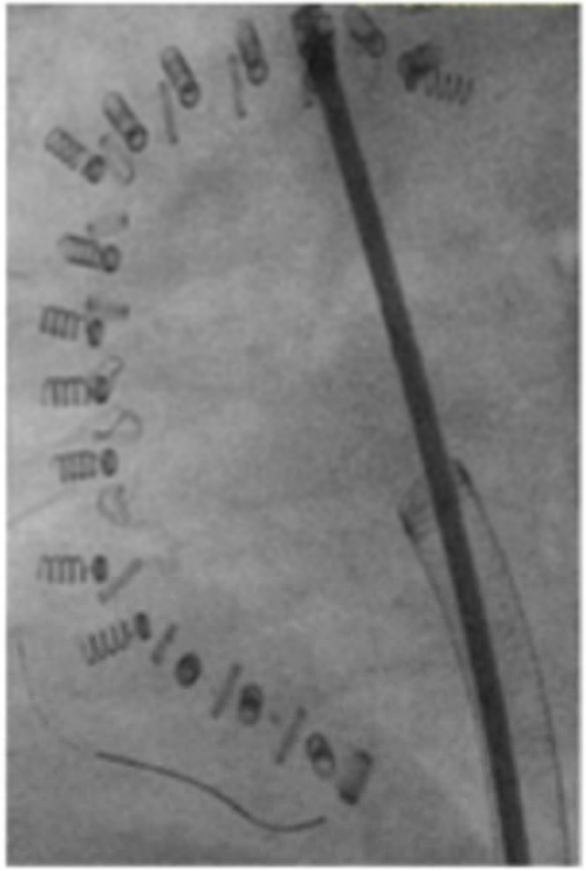
- *CE Approved Device for mitral regurgitation*
- *Transfemoral annuloplasty device with proven safety in the mitral position*
- *First in human performed in tricuspid position in June 2016, cases reported have been successful*
- *Currently undergoing safety trial in EU*



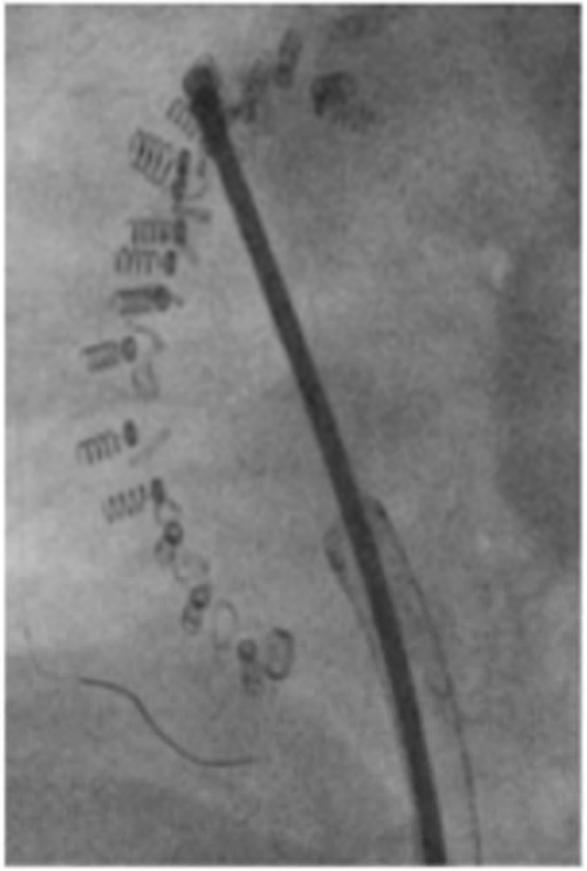
Pre and post cinching with size adjustment tool

Procedure #1 (CE Mark Study)

Baseline



Post procedure



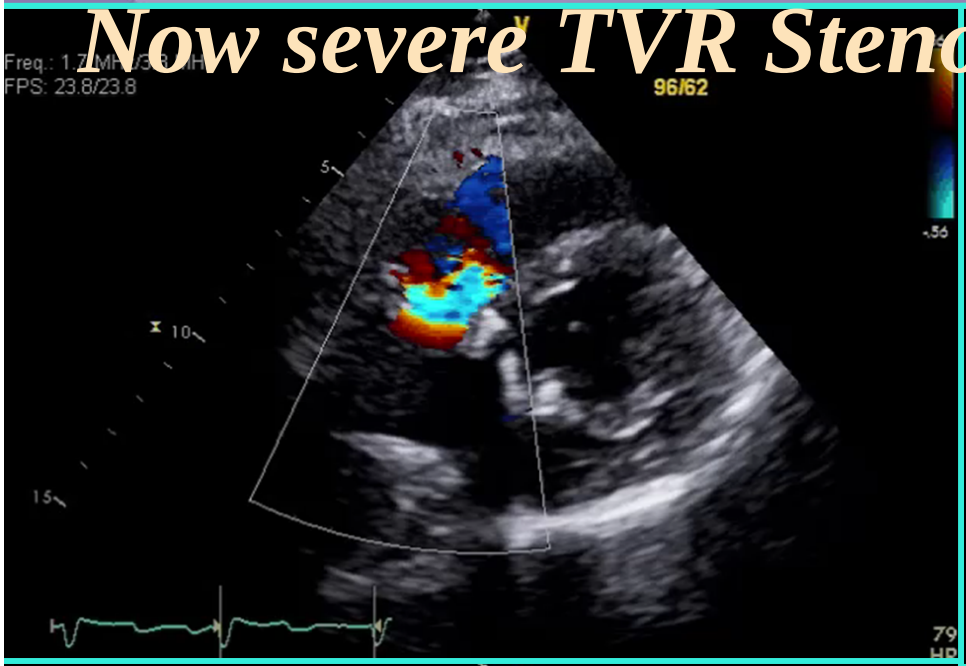
Taramasso M, TCT 2016 Washington DC

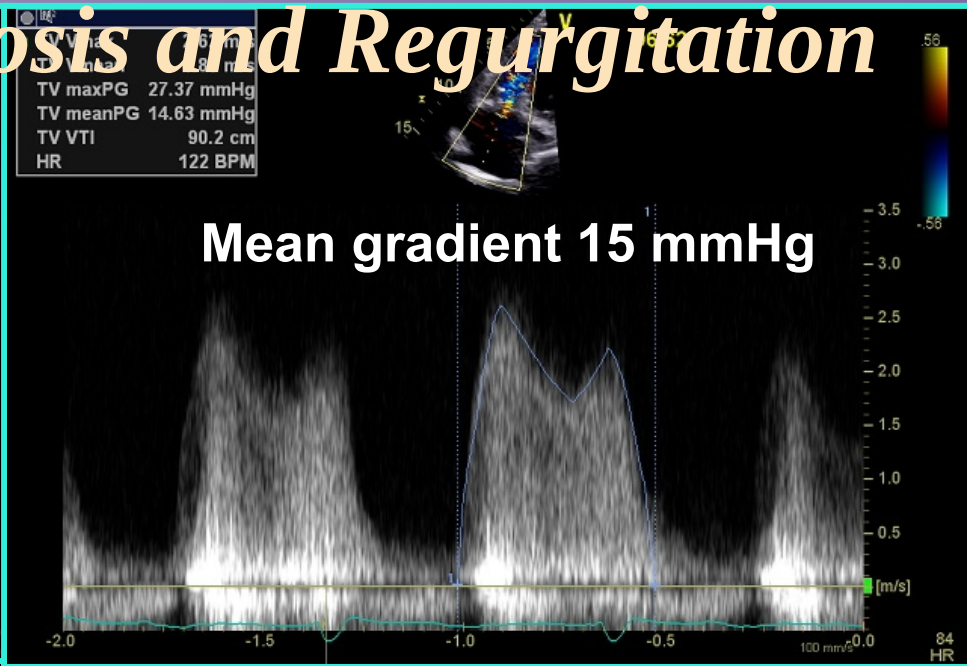
One last case…

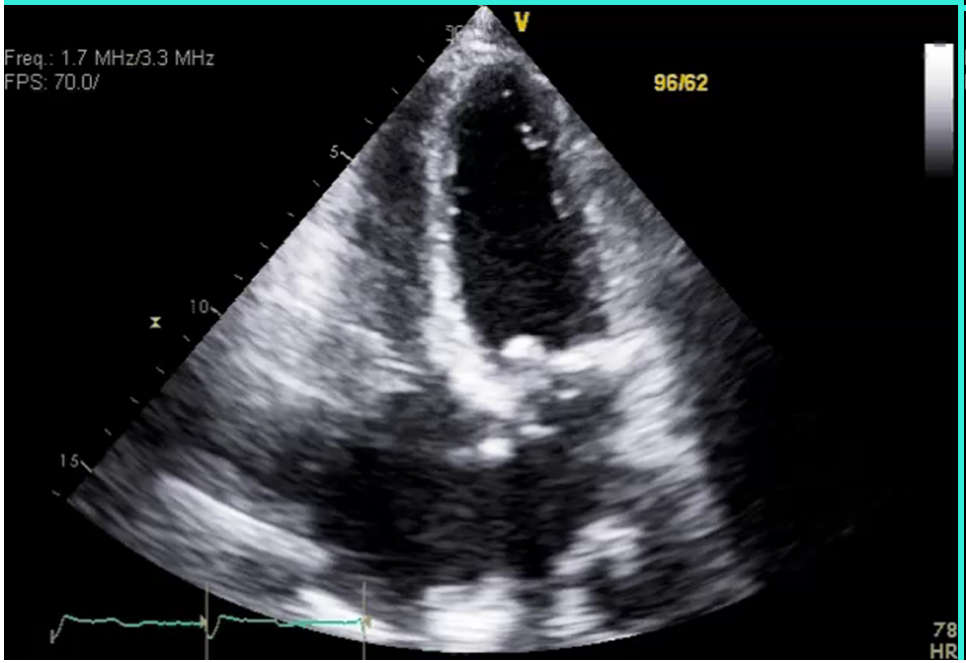
Northwestern Medicine®

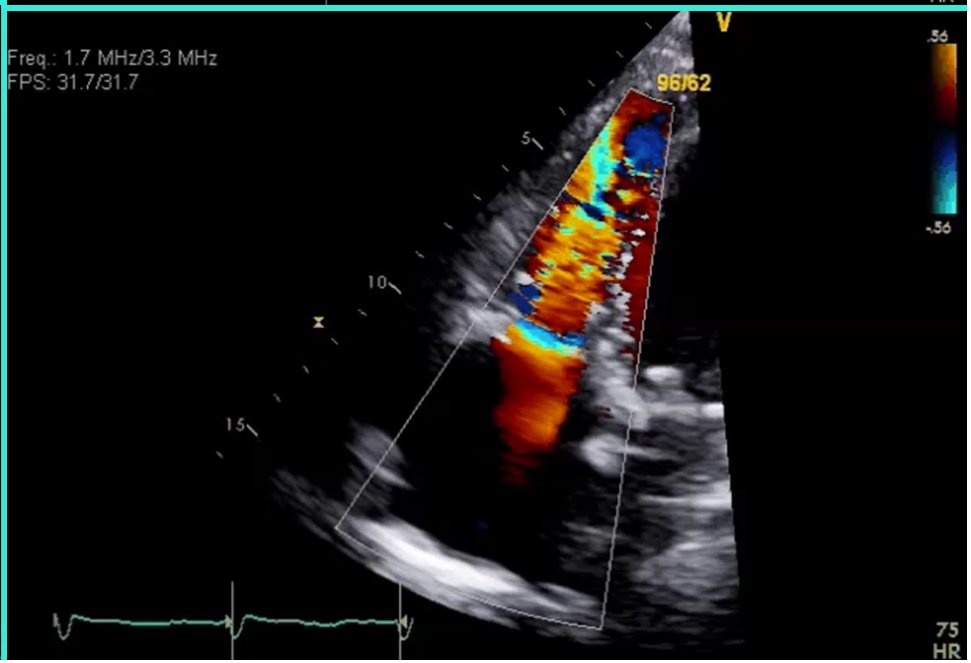
68yo Woman s/p TVR/MVR for Carcinoid

Now severe TVR Stenosis and Regurgitation



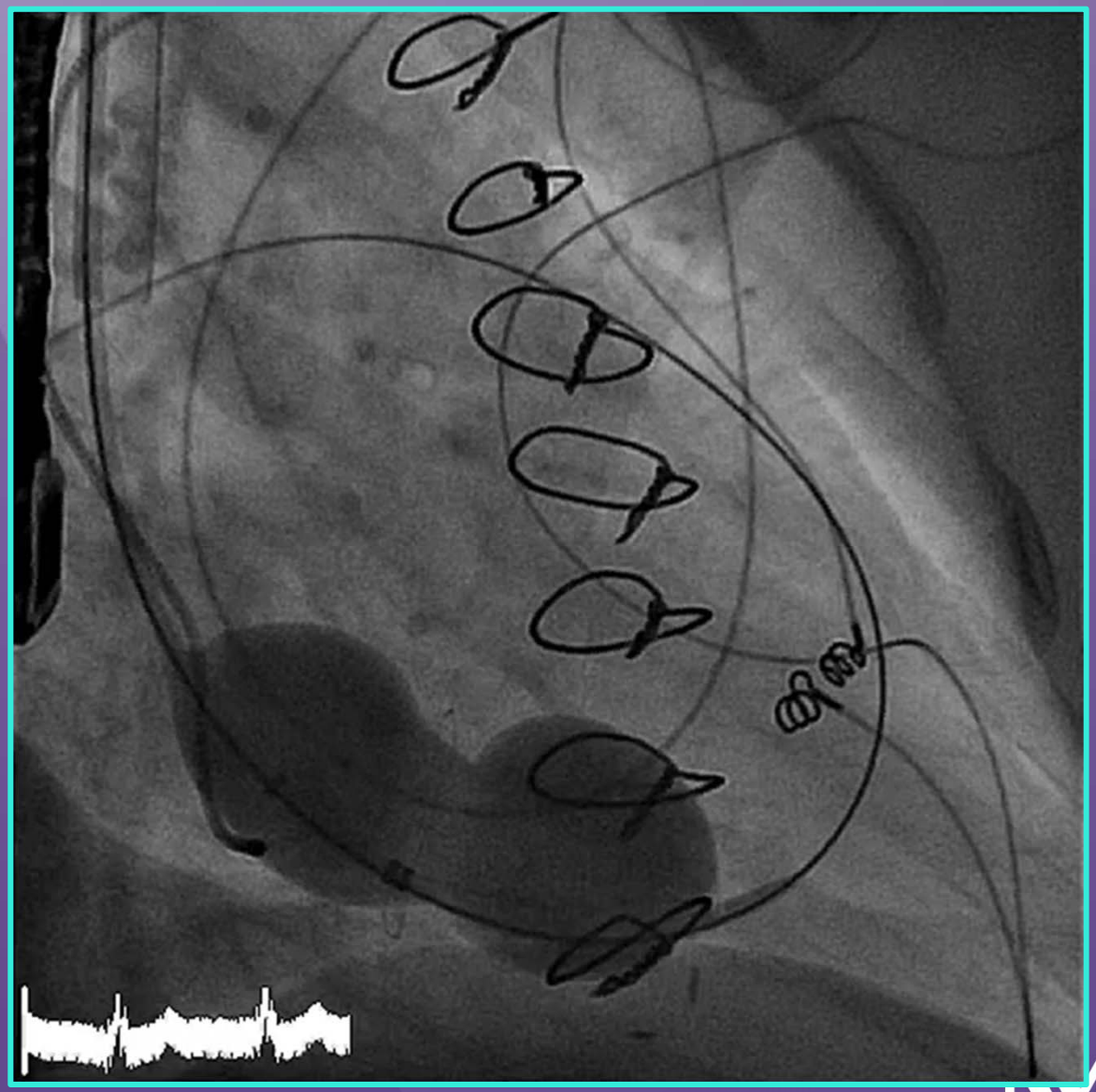






How to Treat?

Valve-in-Valve TTVR



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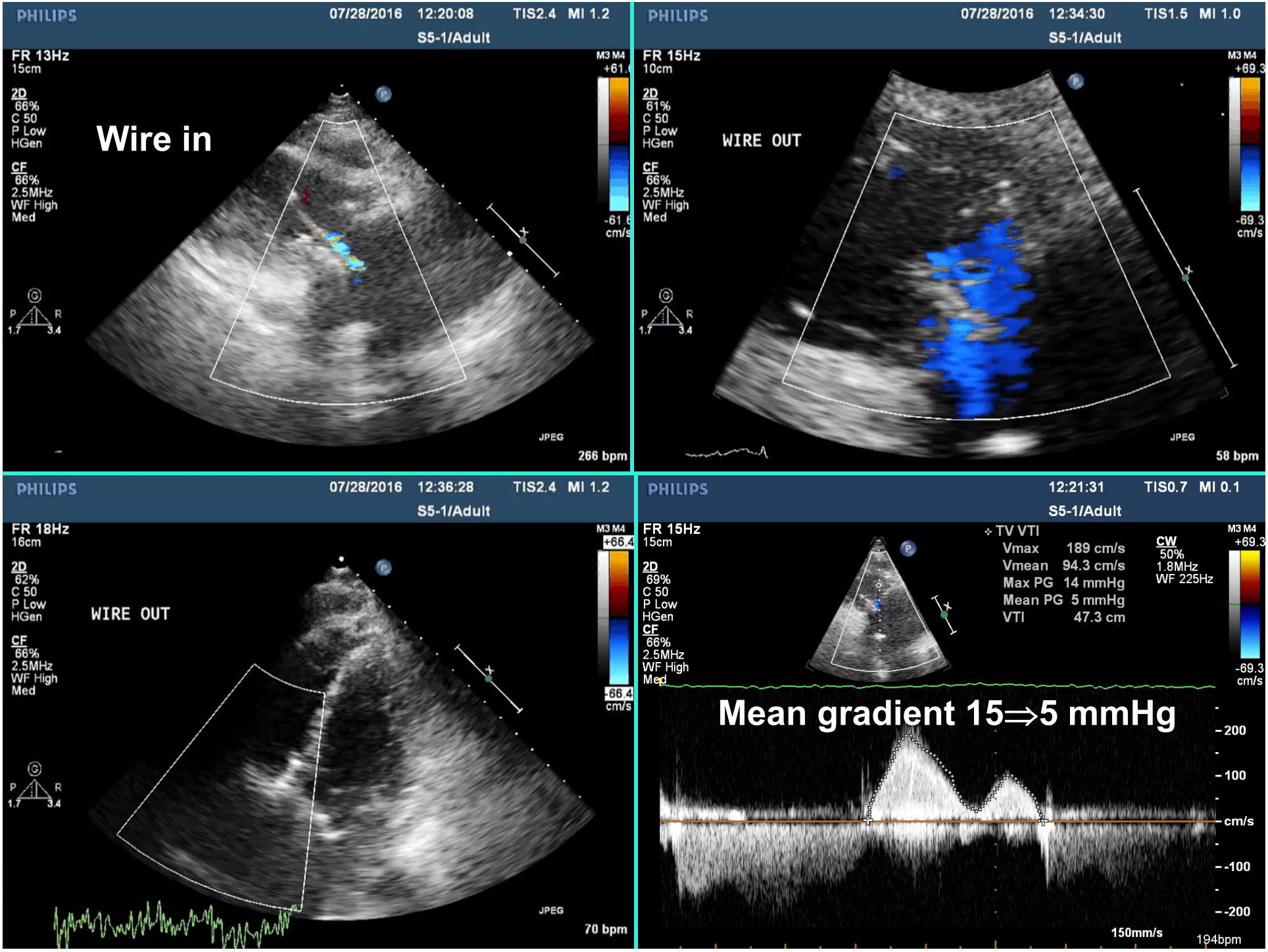
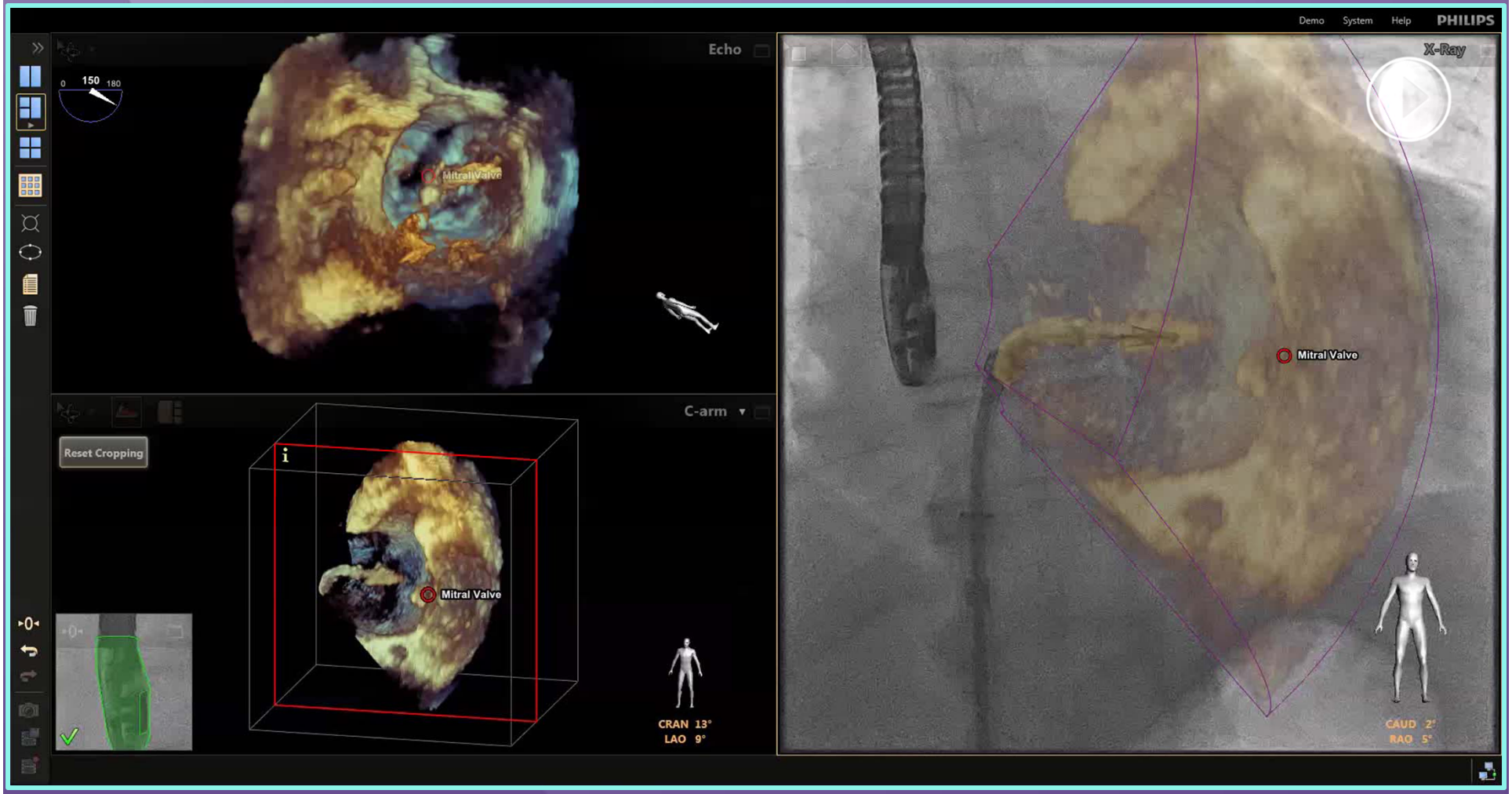
Post Deployment

Valve-in-Valve TTVR


PHILIPS
07/28/2016 12:20:08 TIS2.4 MI 1.2
S5-1/Adult
FR 13Hz
15cm
2D
66%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
Wire in
M3 M4
cm/s
JPEG
266 bpm
PHILIPS
07/28/2016 12:34:30 TIS1.5 MI 1.0
S5-1/Adult
FR 15Hz
10cm
2D
61%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
WIRE OUT
M3 M4
cm/s
JPEG
58 bpm
PHILIPS
07/28/2016 12:36:28 TIS2.4 MI 1.2
S5-1/Adult
FR 18Hz
16cm
2D
62%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
WIRE OUT
M3 M4
cm/s
JPEG
70 bpm
PHILIPS
12:21:31 TIS0.7 MI 0.1
S5-1/Adult
FR 15Hz
15cm
2D
69%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
TV VTI
Vmax 189 cm/s
Vmean 94.3 cm/s
Max PG 14 mmHg
Mean PG 5 mmHg
VTI 47.3 cm
CW
50%
1.8MHz
WF 225Hz
M3 M4
cm/s
Mean gradient 15⇒5 mmHg
200
100
cm/s
-100
-200
150mm/s
194bpm

What About Fusion Imaging?



Combining echo and fluoro for better guidance

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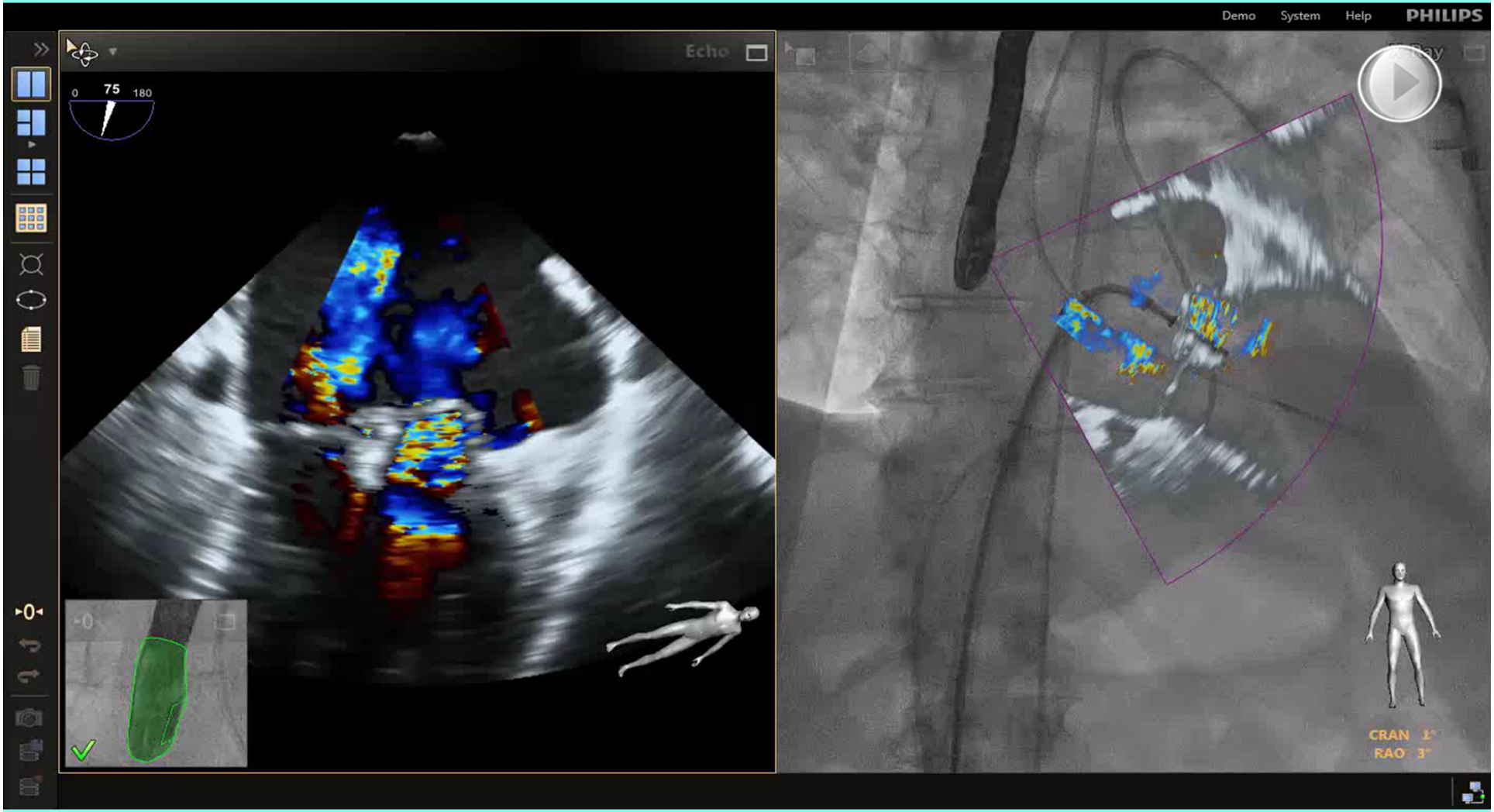
What About Fusion Imaging?



Some technical issues (frequent calibration)

Big issue: echo and angio eqpt must be same brand

Needed: "DICOM" standard for fusion imaging

The Echo Guy in the Cath Lab

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But Some Days We Feel Pretty Important!

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Special Feelings for Thailand

Mandarin Oriental, June 19, 2006