Imaging for Guidance in Tricuspid & Mitral Interventions: What's New; Role of ICE & 4D

Stamatios Lerakis, MD

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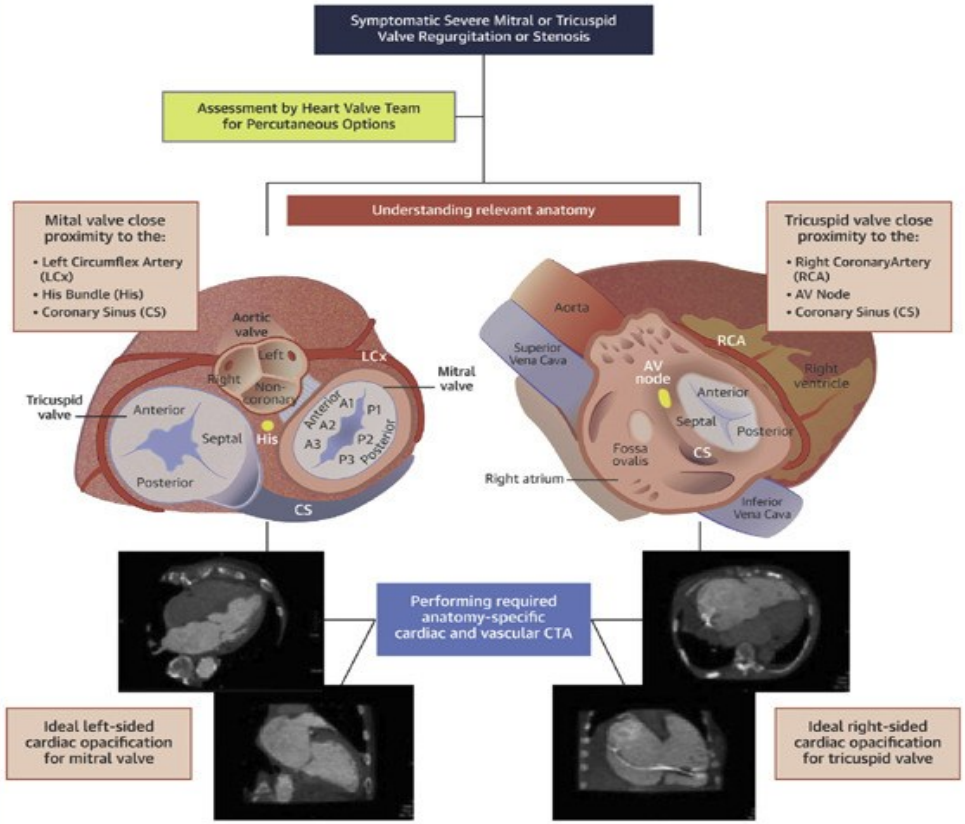
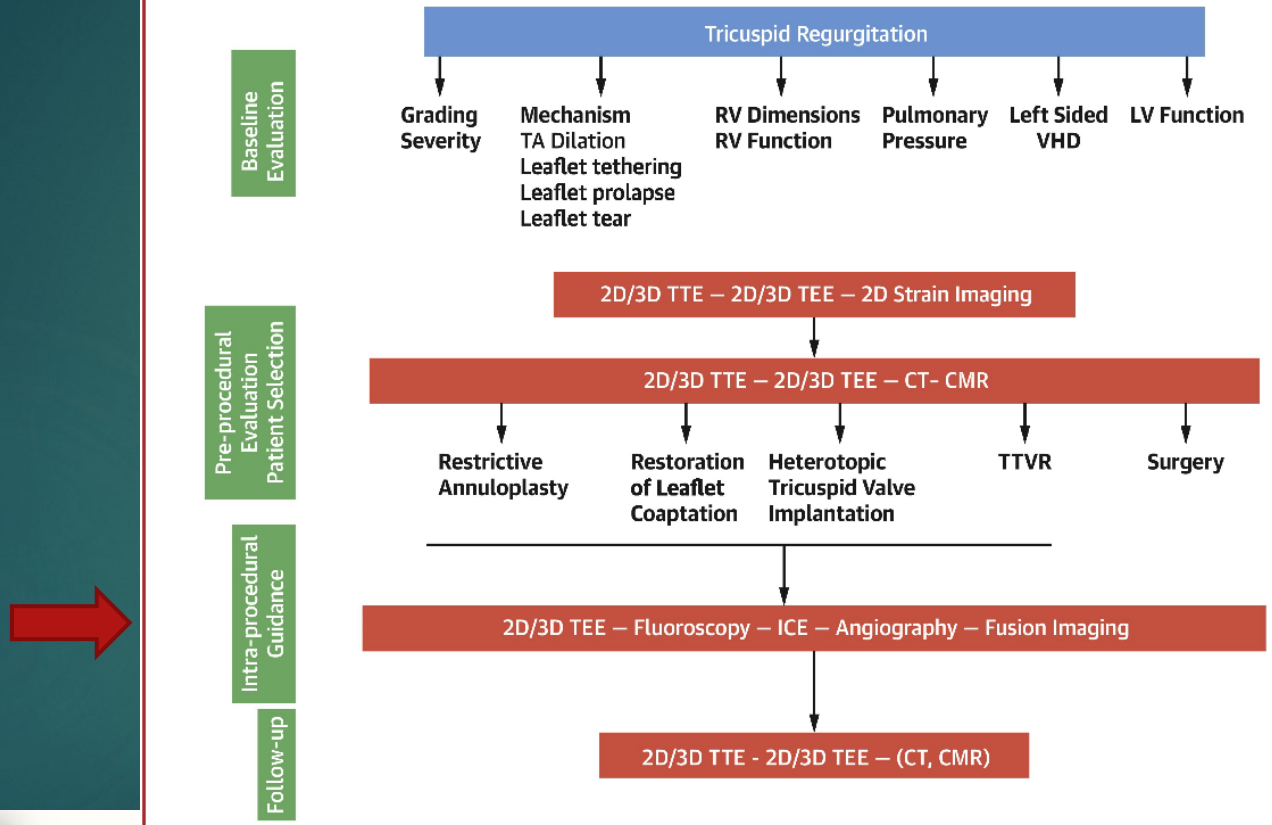
No Disclosures

CENTRAL ILLUSTRATION: Clinical Approach to Imaging Evaluation of Patients With Severe, Symptomatic Mitral and Tricuspid Valve Disease Under Consideration for Percutaneous Therapies



Pulerwitz, T.C. et al. J Am Coll Cardiol Img. 2020;13(3):836-50.

CENTRAL ILLUSTRATION: Multimodality Imaging for Assessing Eligibility and Guiding Procedure for Transcatheter Tricuspid Valve Intervention



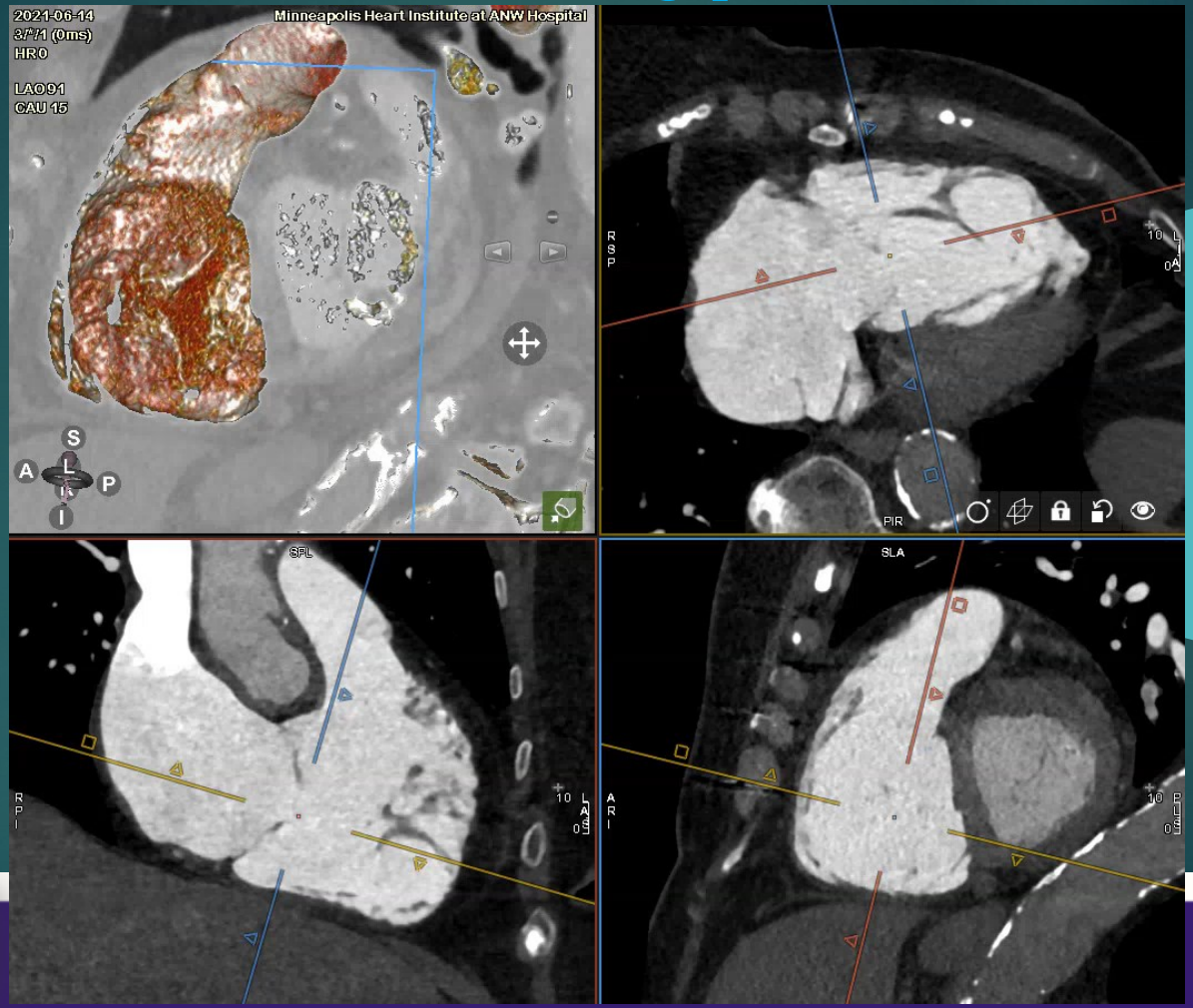
Agricola, E. et al. J Am Coll Cardiol Img. 2021;14(1):61-111.

1. Dynamic CCT and CMR Imaging

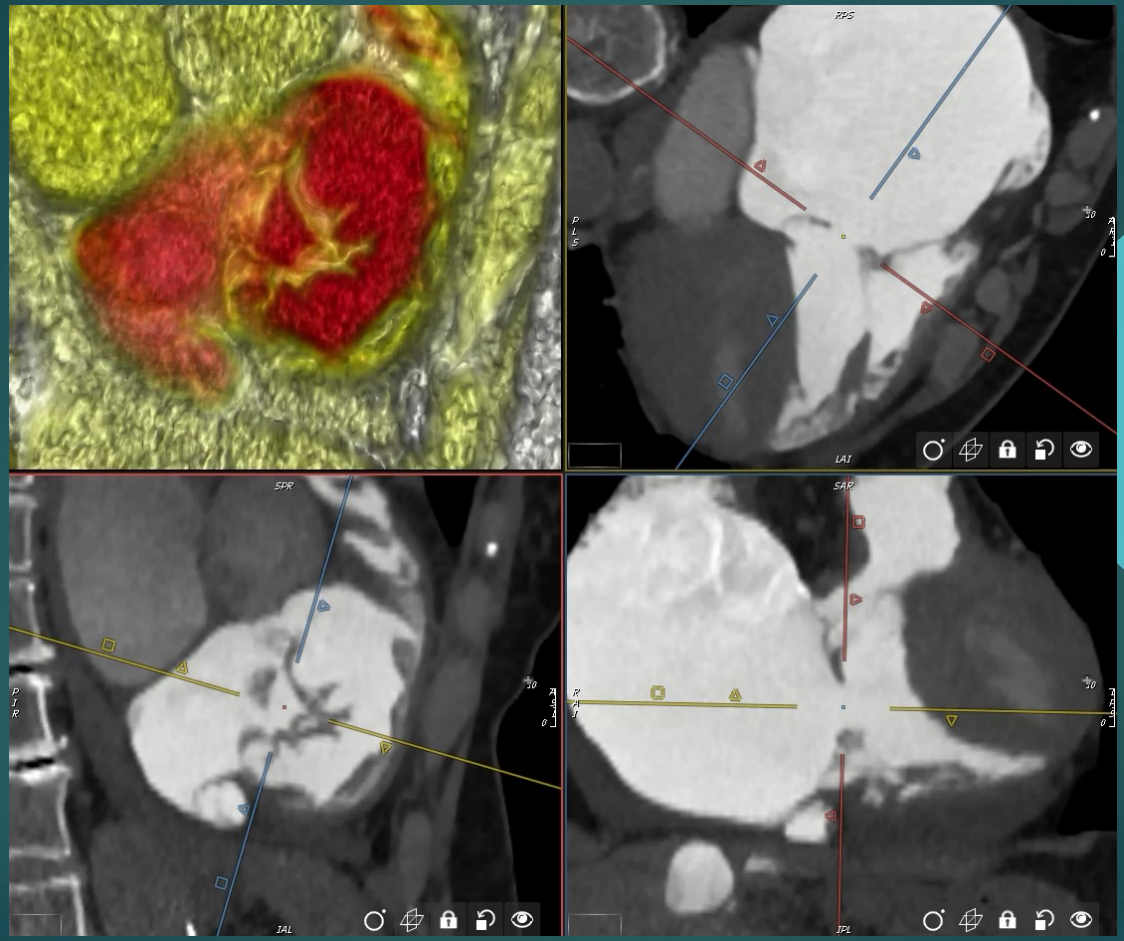
2. Fusion Imaging

3. ICE, 4D ICE

Evaluation of gaps

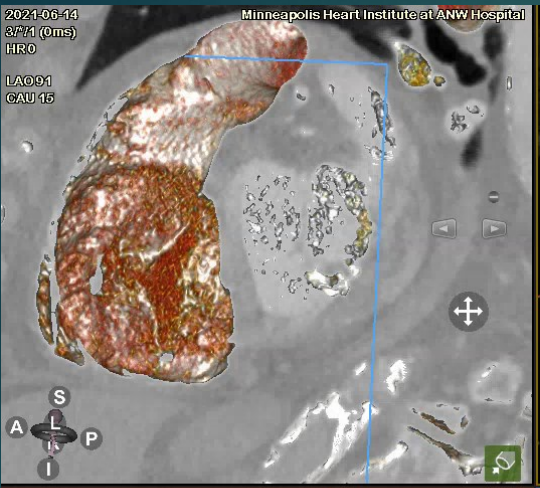


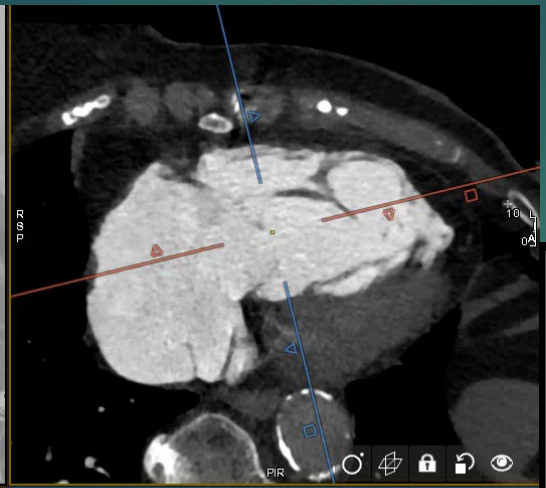
Anatomical ROA – Assessment by CTA

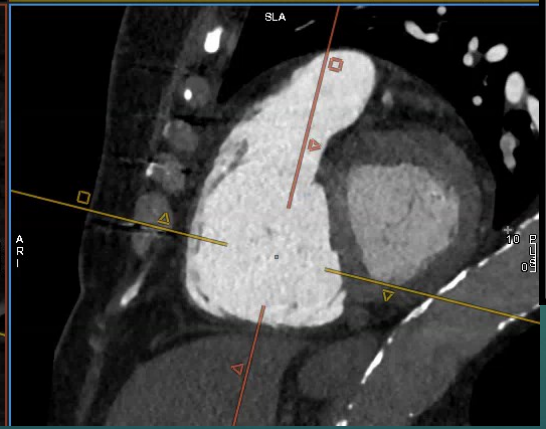


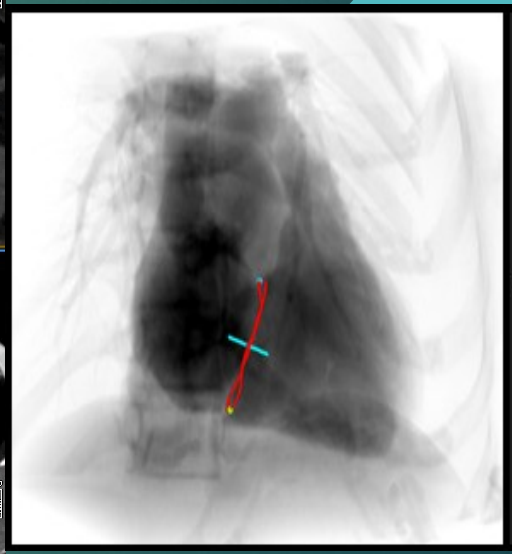
Lopes BBC et al. JACC Cardiovasc Imaging 2021;14(8):1669-72

Fluroscopic Angles

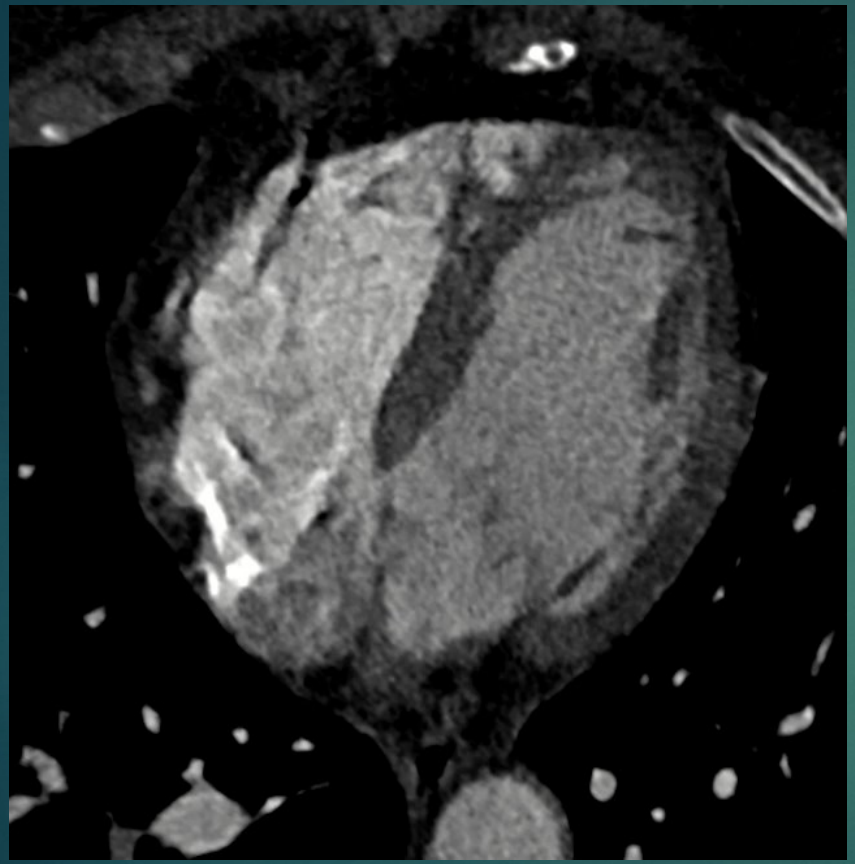




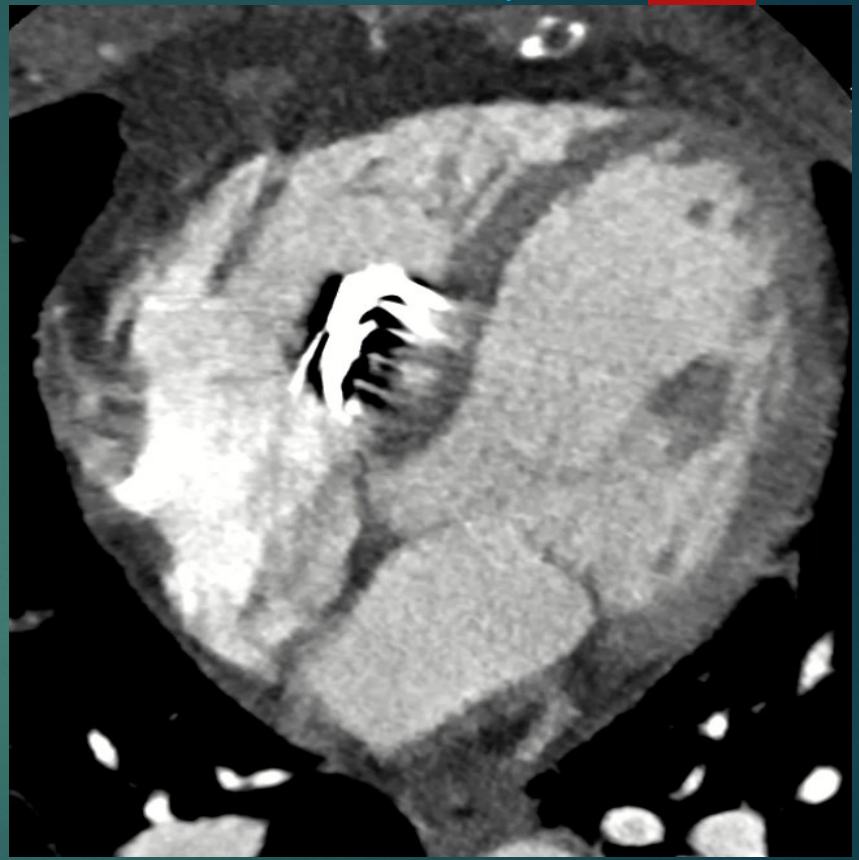




Pre- TriClip



Post- TriClip



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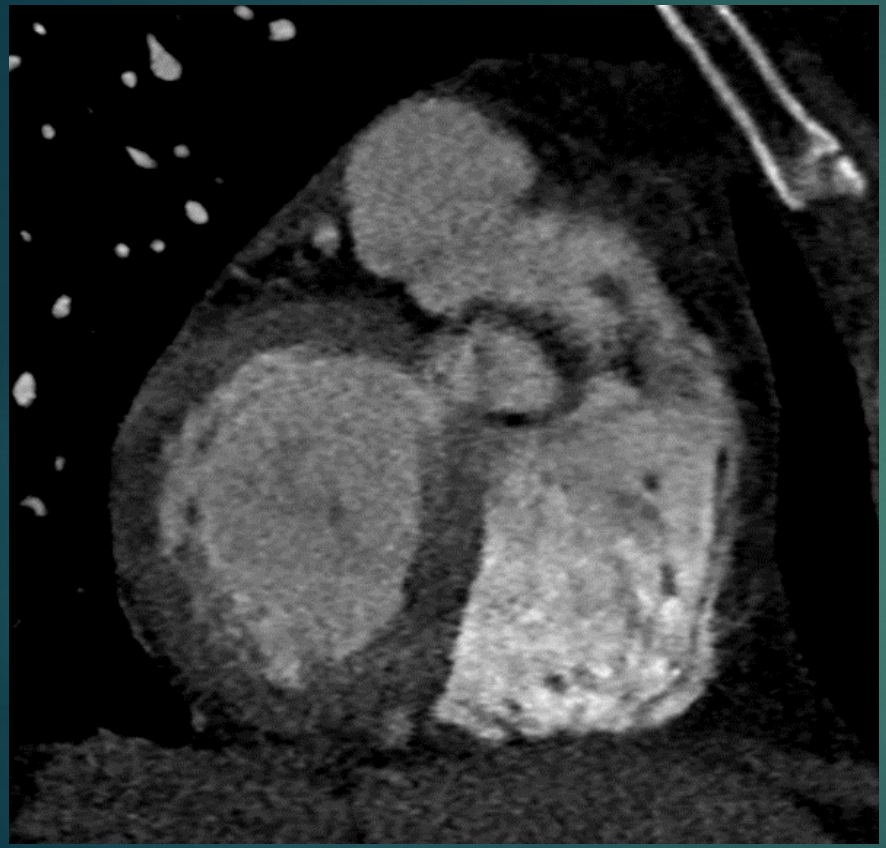
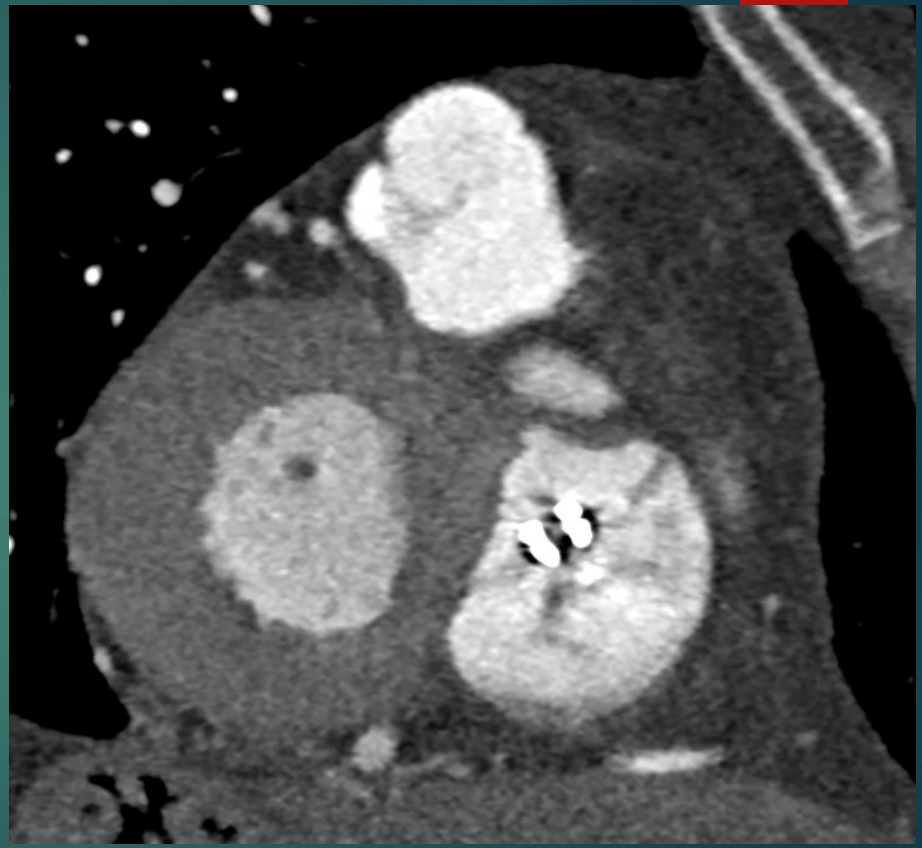
Pre- TriClip

Post- TriClip





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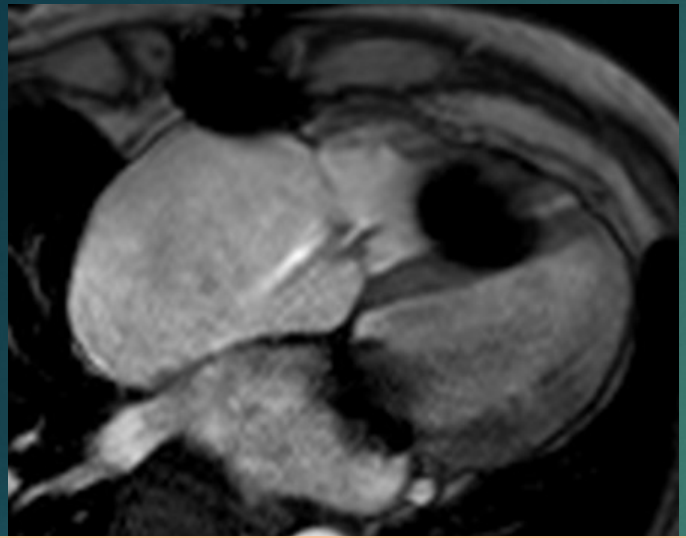


Mechanical MV replacement and Micra PPM

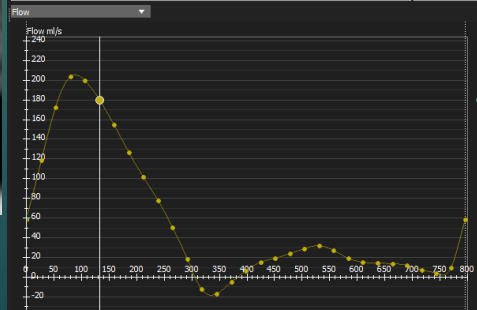
SAX3D Stack RV Function

number of slices used to calculate syst. (pha

RVEDV:	177.2 ml
RVESV:	74.0 ml
RVSV:	103.2 ml
RVEF:	58.2 %
RVCO:	7789.0 ml/min
RVCI:	4.5 l/min/m²
HR:	75.5/min
Phase Diastole:	1
Phase Systole:	11
RVEDV/H:	105.8 ml/m
RVEDV/BSA:	103.5 ml/m²

TR Volume=103-45=58 ml/beat
TR Fraction=58/103 = 56%

RV and LV infarct seen on delayed enhancement imaging



Flow Report

No Background Correction Applied
Through Plane Encoding

Flow Analysis Pulmonary Artery

Measurement	*Total*
Total Forward Volume:	45.3 ml
Total backward Volume:	-0.8 ml
Total Volume:	44.5 ml
Regurgitation Fraction:	1.7 %
Vol/min:	3418.8 ml/min
Vol/min (effective):	3361.2 ml/min
Heart Rate:	75.5 /min
Max Pressure Gradient:	1.0 mmHg
Mean Pressure Gradient:	0.2 mmHg
Maximum Velocity (1x1 px):	50.7 cm/s
Minimum Velocity (1x1 px):	-15.5 cm/s
Maximum Acceleration:	0.4 cm/s/s
Minimum Acceleration:	-0.3 cm/s/s

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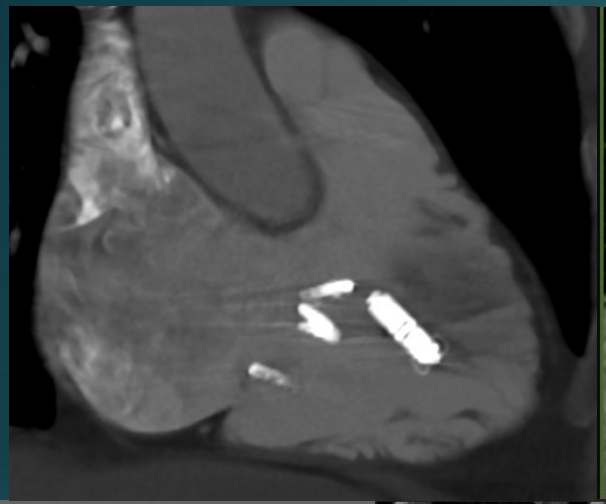
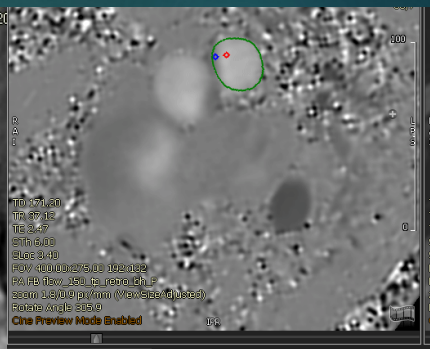
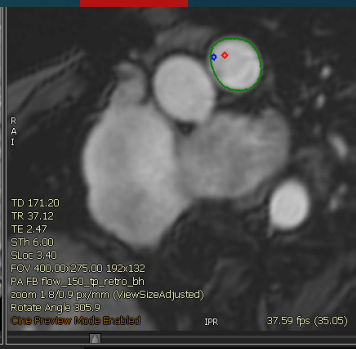
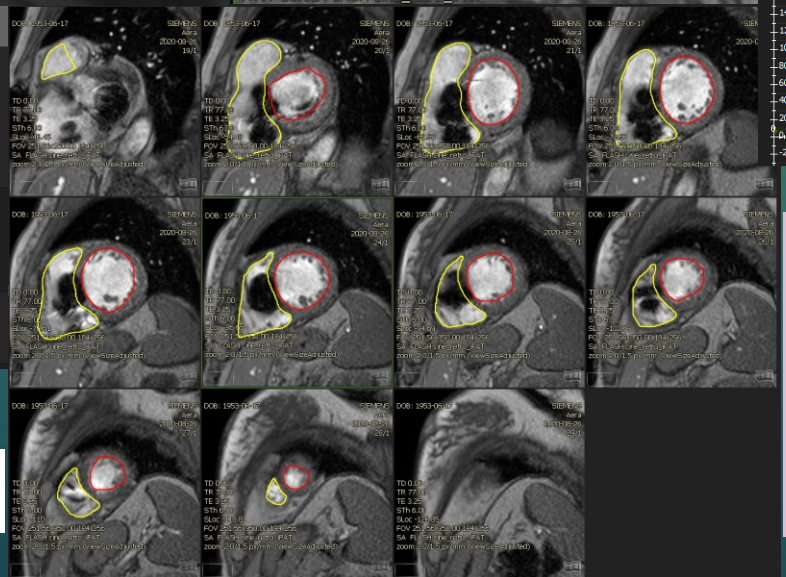
TRILUMINATE PIVOTAL TRIAL

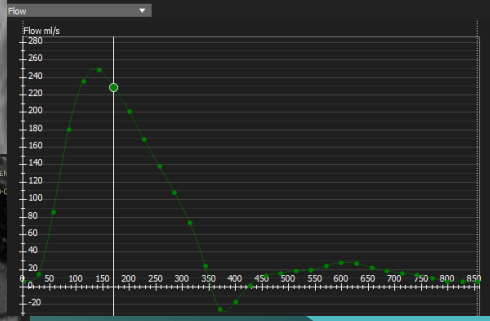






SAX3D Stack RV Function	
RVEDV:	150.6 ml
RVESV:	79.3 ml
RVSV:	71.3 ml
RVEF:	47.3 %
RVCO:	4975.0 ml/min
RVCI:	3.0 l/min/m²
HR:	69.8/min
Phase Diastole:	1
Phase Systole:	10





Flow Report

No Background Correction Applied

Through Plane Encoding

Flow Analysis Pulmonary Artery

Measurement	*Total*
Total Forward Volume:	55.7 ml
Total Backward Volume:	-1.0 ml
Total Volume:	54.7 ml
Regurgitation Fraction:	1.8 %
Vol/min:	3907.8 ml/min
Vol/min (effective):	3837.1 ml/min
Heart Rate:	70.2 /min
Max Pressure Gradient:	1.7 mmHg
Mean Pressure Gradient:	0.3 mmHg
Maximum Velocity (1x1 px):	64.5 cm/s
Minimum Velocity (1x1 px):	-18.7 cm/s
Maximum Acceleration:	0.5 cm/s/s

TR Volume=71-56=15 ml/beat

TR Fraction=15/71 = 21%

Within 1 month after 3 TriClips

RV Forward Flow increased by 25%

TR Fraction decreased from 56% to 21%

TRILUMINATE

PIVOTAL TRIAL

1. Dynamic CCT and CMR Imaging
2. Fusion Imaging
3. ICE, 4D ICE

Tricuspid Valve Challenges

1. Very large annulus
2. Lack of fluoroscopic anatomic landmarks due to the absence of calcification
3. Steep angulation between the vena cava tricuspid annulus, making coaxial alignment difficult
4. Small and trabeculated RV
5. Proximity to His bundle and RCA

Fusion Imaging

1. Fusion of Live Echo with Live Fluro

2. Brings together Fluro, critical for devices visualization, and High Resolution echo imaging showing tissue information of cardiac structures

3. Simplifies navigation of devices

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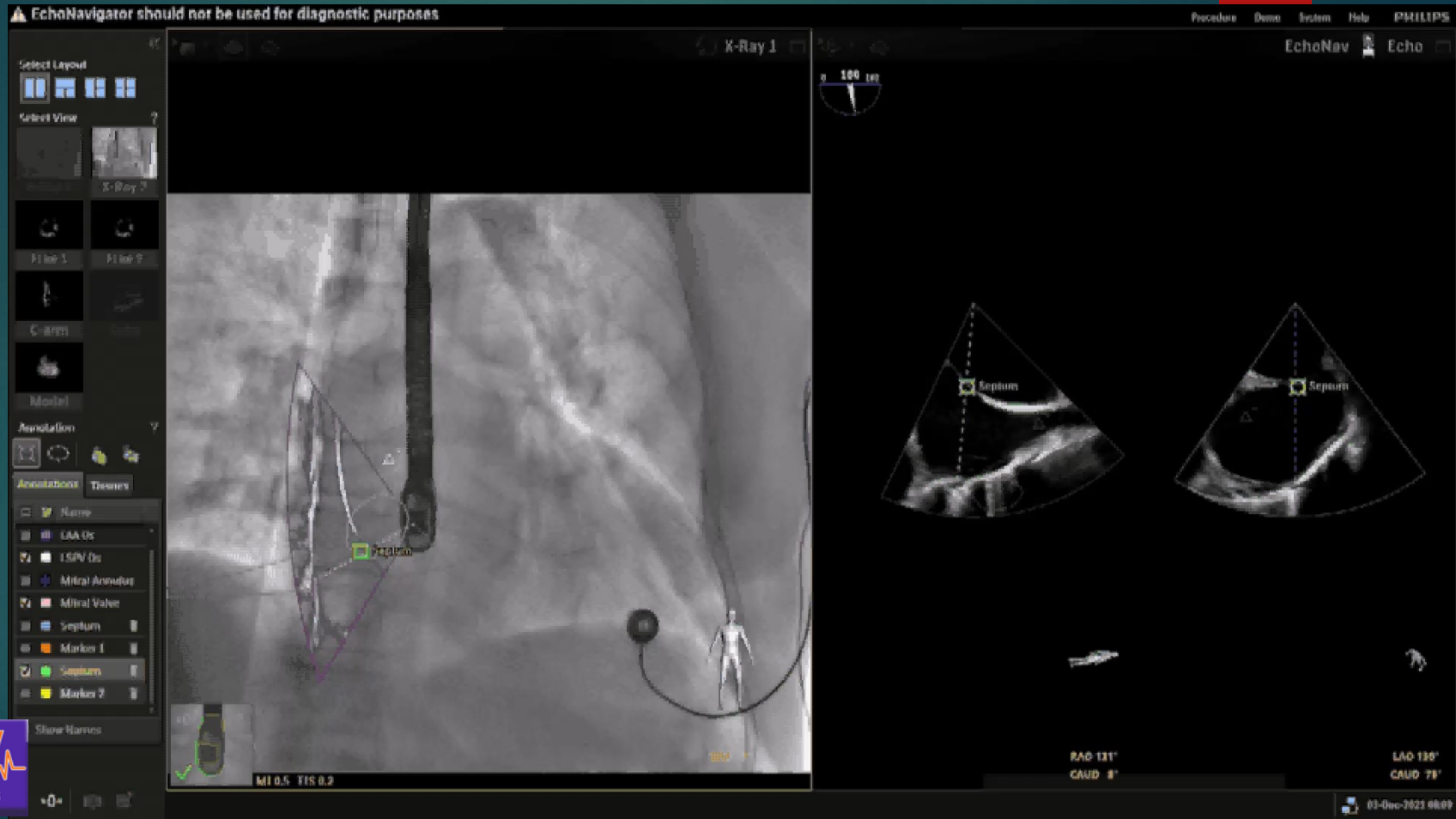
Fusion Imaging

4. Guides device placement
5. Evaluate results of the procedure
6. Improves communication
7. Improves efficiency

Transeptal Puncture




EchoNavigator should not be used for diagnostic purposes
PHILIPS
X-Ray 1
EchoNav
Echo
Aortic Valve
LAA Os
LSPV Os
Mitral Annulus
Mitral Valve
RAO 143°
CRAN 2°
LAO 128°
CAUD 42°

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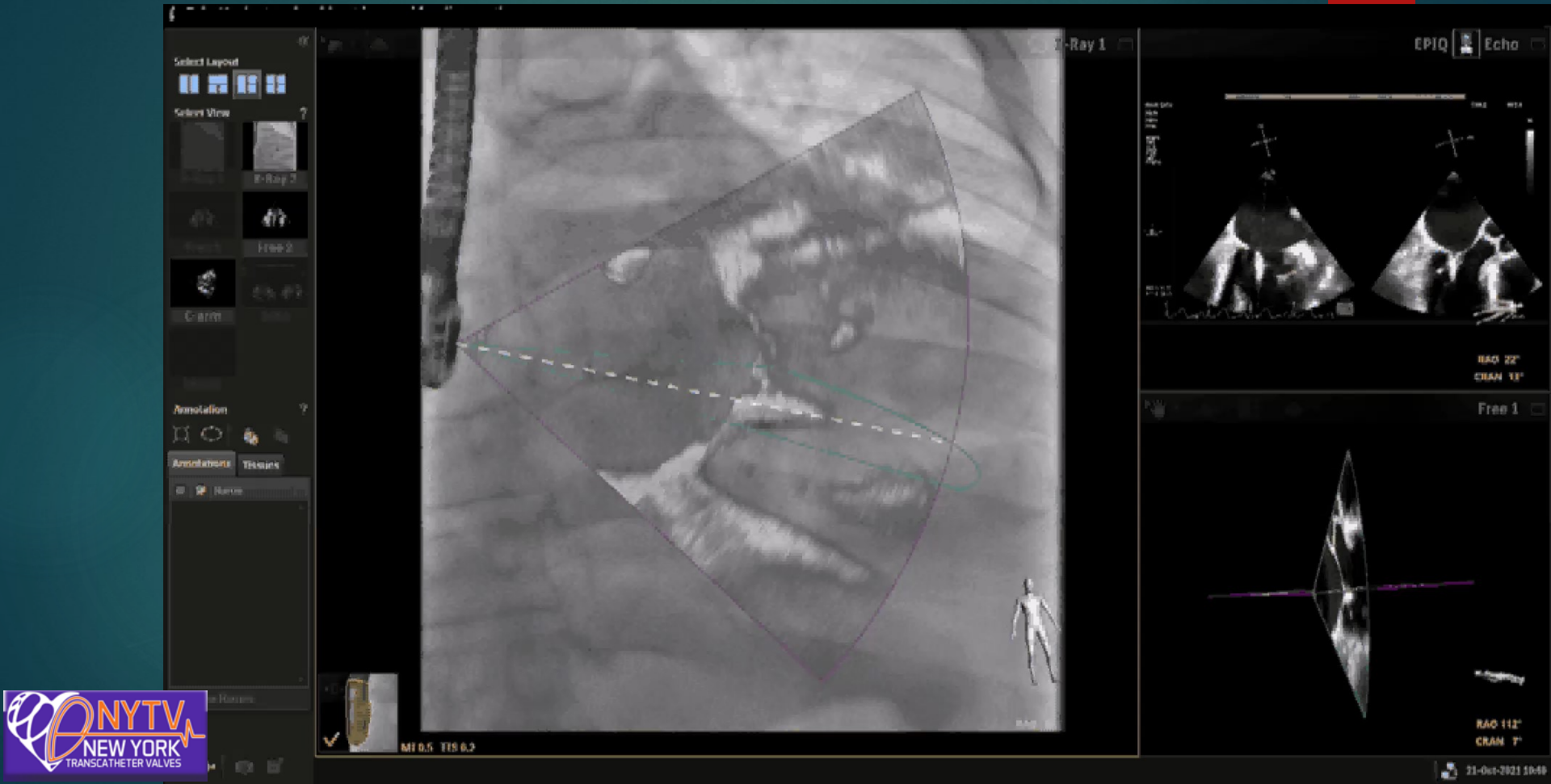
Select Layout
Select View
C-arm
Annotation
Annotations
Tissues
X-Ray 1
EPIQ
Echo
RAO 22°
CRAN 11°
Free 1
RAO 112°
CRAN 7°
MI 0.5 TIS 0.3
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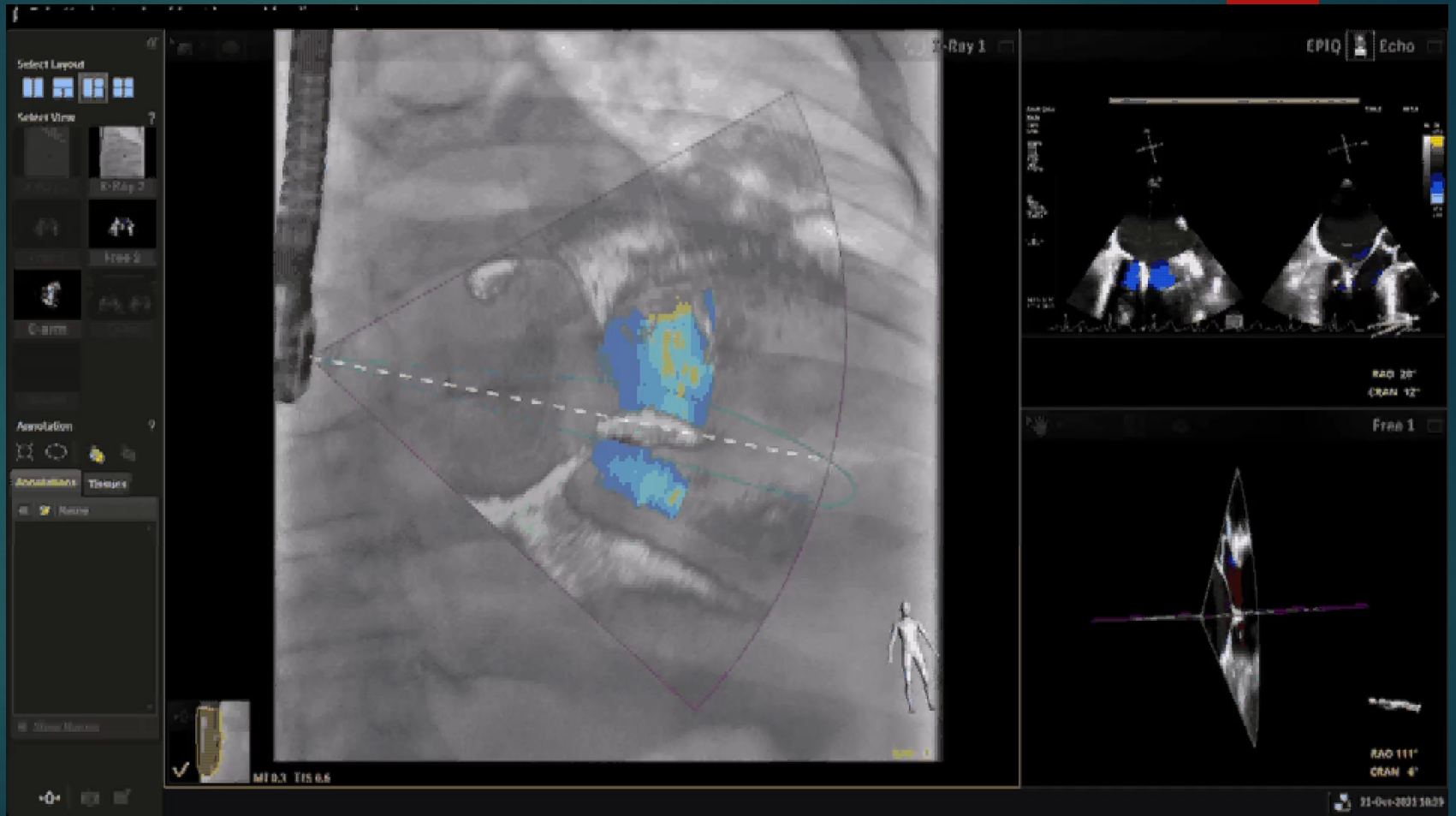
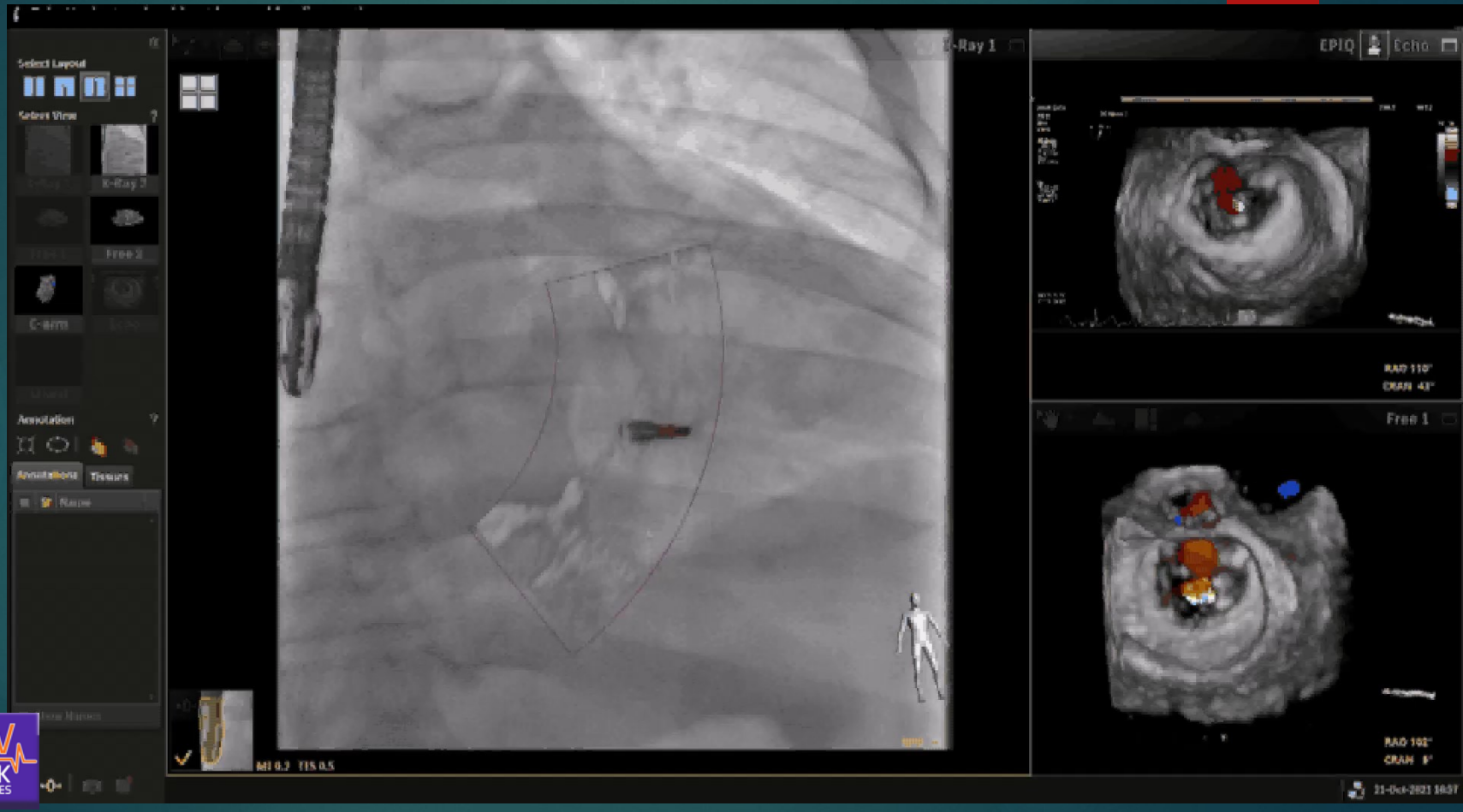
Color on Fluro



Mount Sinai Heart

Color on Fluro



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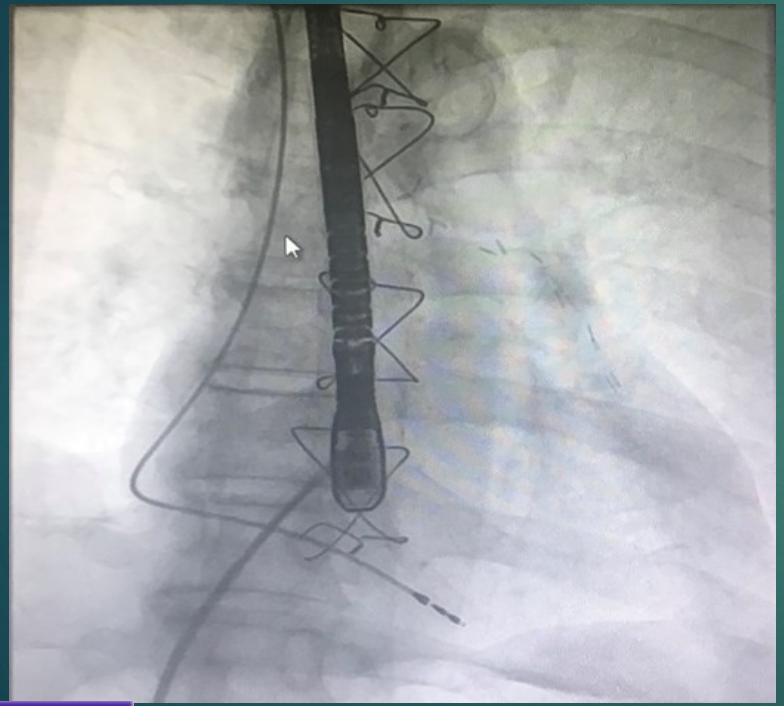
1. Dynamic CCT and CMR Imaging

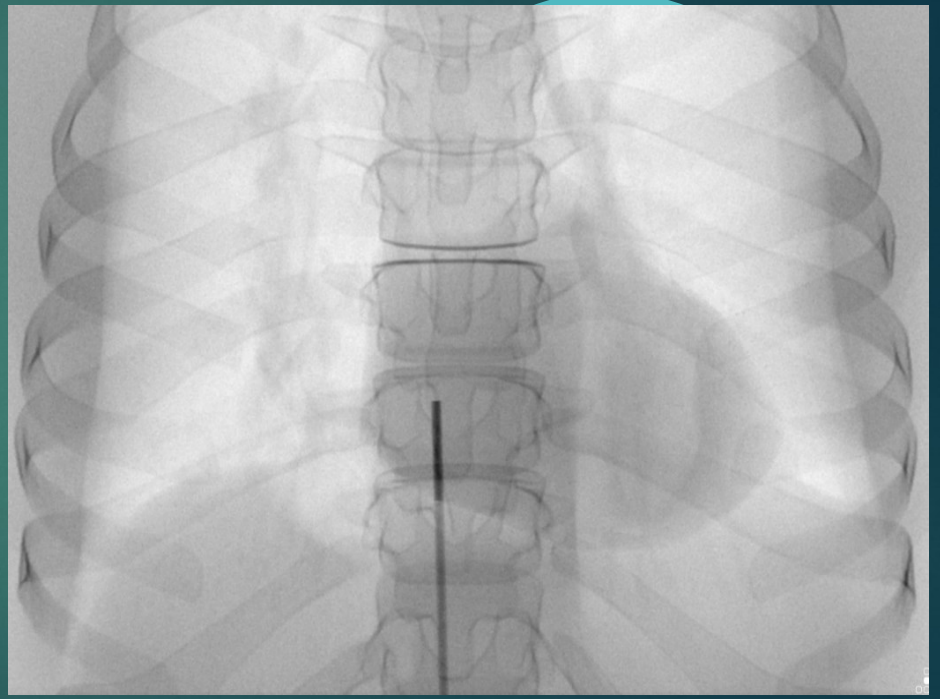
2. Fusion Imaging

3. ICE, 4D ICE

TEE probe behind the left atrium



4D ICE Catheter in the mid-right atrium



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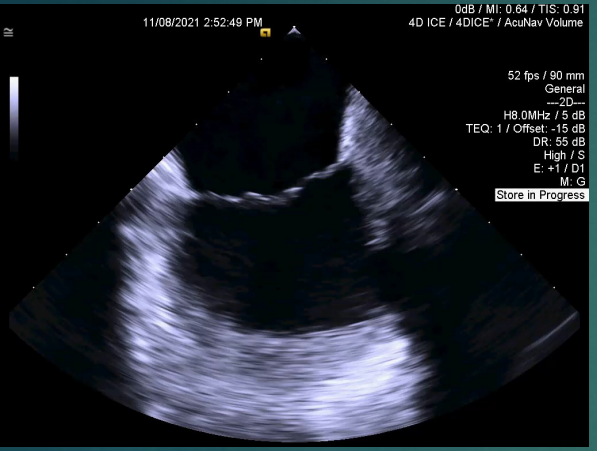
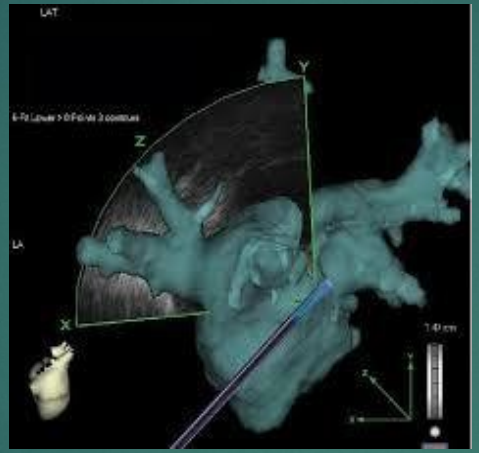
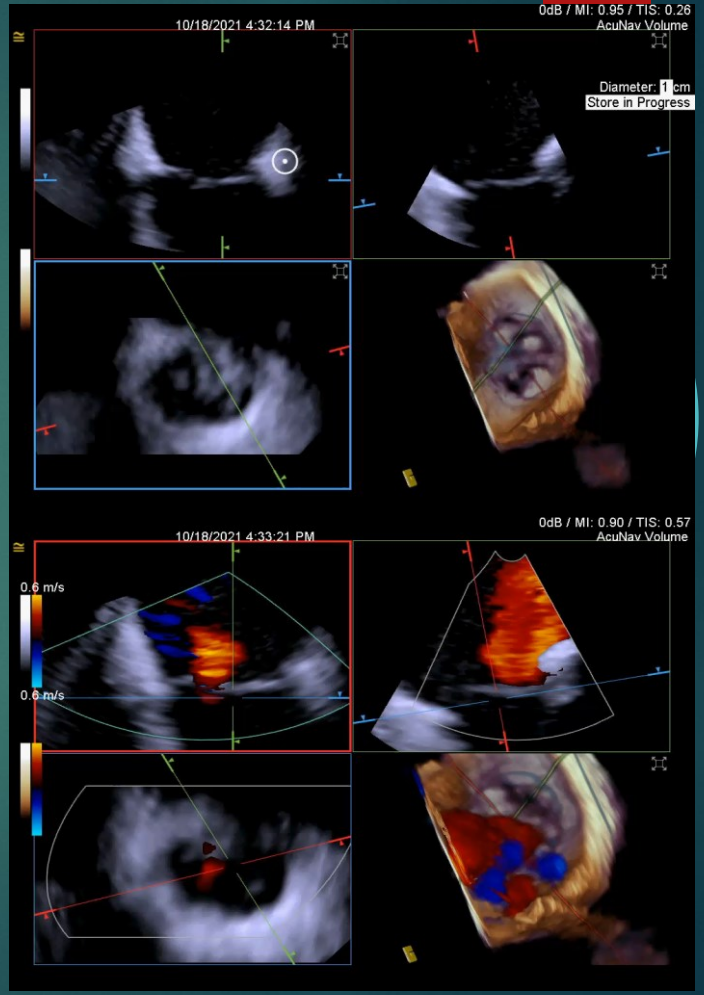
2D ICE



3D ICE



4D ICE



4D = Live 3D in motion

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Structural Imaging

TEE	4D ICE
Matrix of 2500 elements	Matrix of 840 elements
Gold Standard with standard views Larger Field of View	No standard views, No Landmarks Smaller Field of View (depending on tip of catheter position)
Requires Anesthesia	Conscious Sedation
Less Cost	More cost
Great for imaging posterior structures	Great for imaging anterior structures May be helpful when there is shadowing from prosthetic valves, pacer wires, etc
Esophageal Complications	Vascular Complications
Echocardiographer	Interventionalist Alone? Will need assistance with the manipulation of the images

CASE #1
Novel Hybrid Imaging approach using 2D&3D TTE and 2D ICE for TEER

- 85 yo woman with refractory right heart failure
- Absolute contraindication to TEE due to a bleeding esophageal polyp

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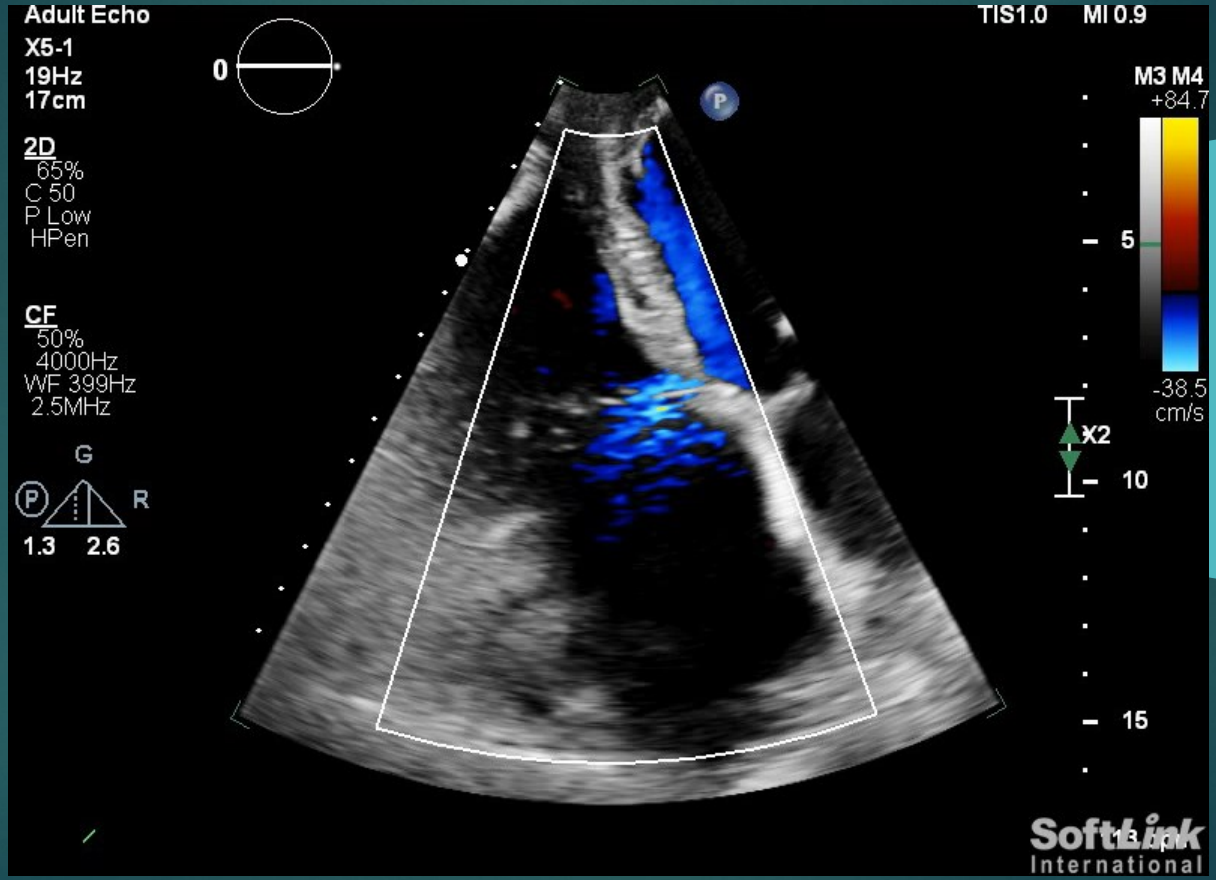
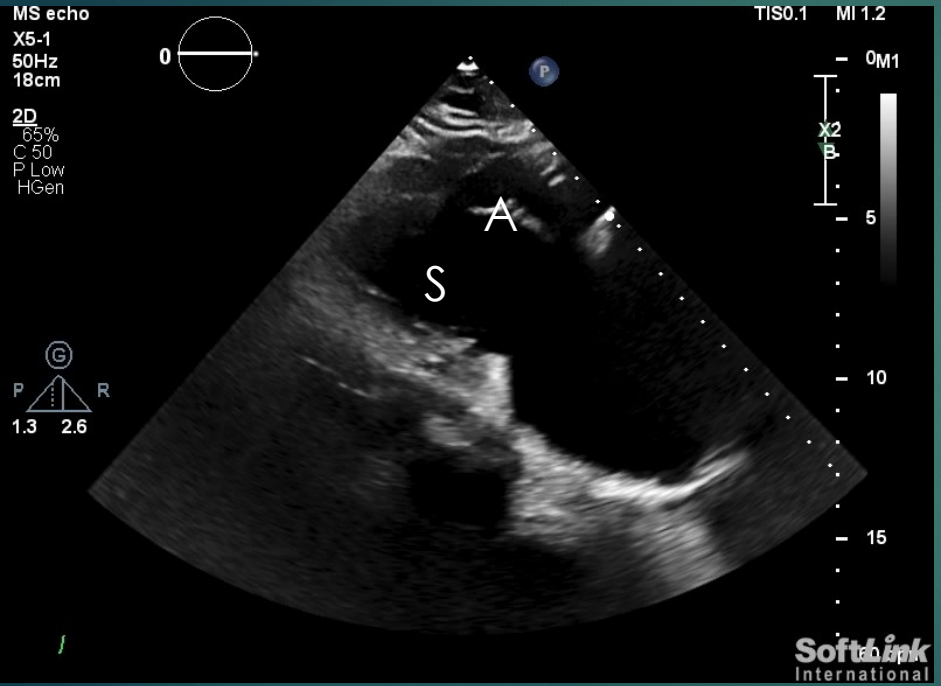
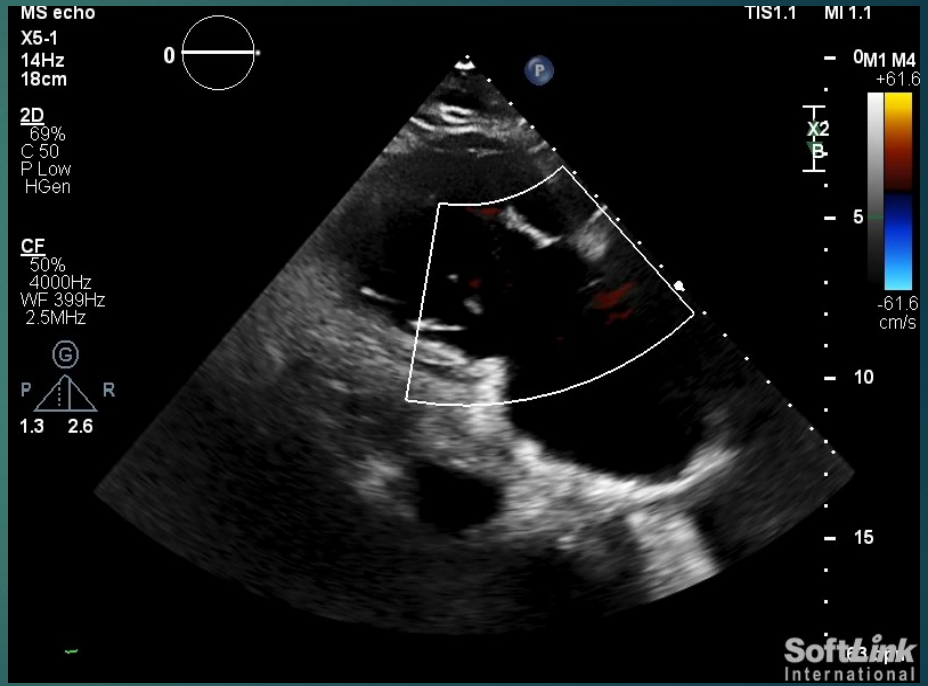
Anastasius M et al, JASE 2021; 34(5):567-568

Torrential TR

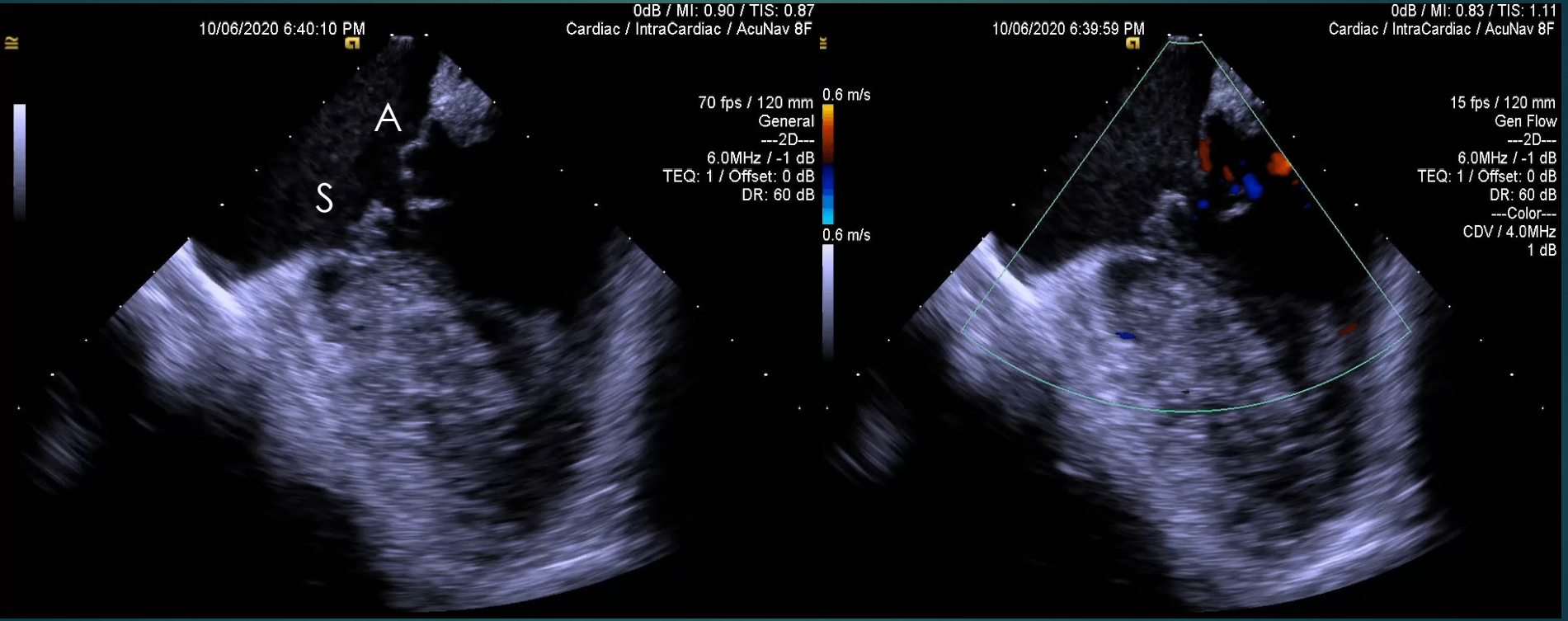


RV inflow view

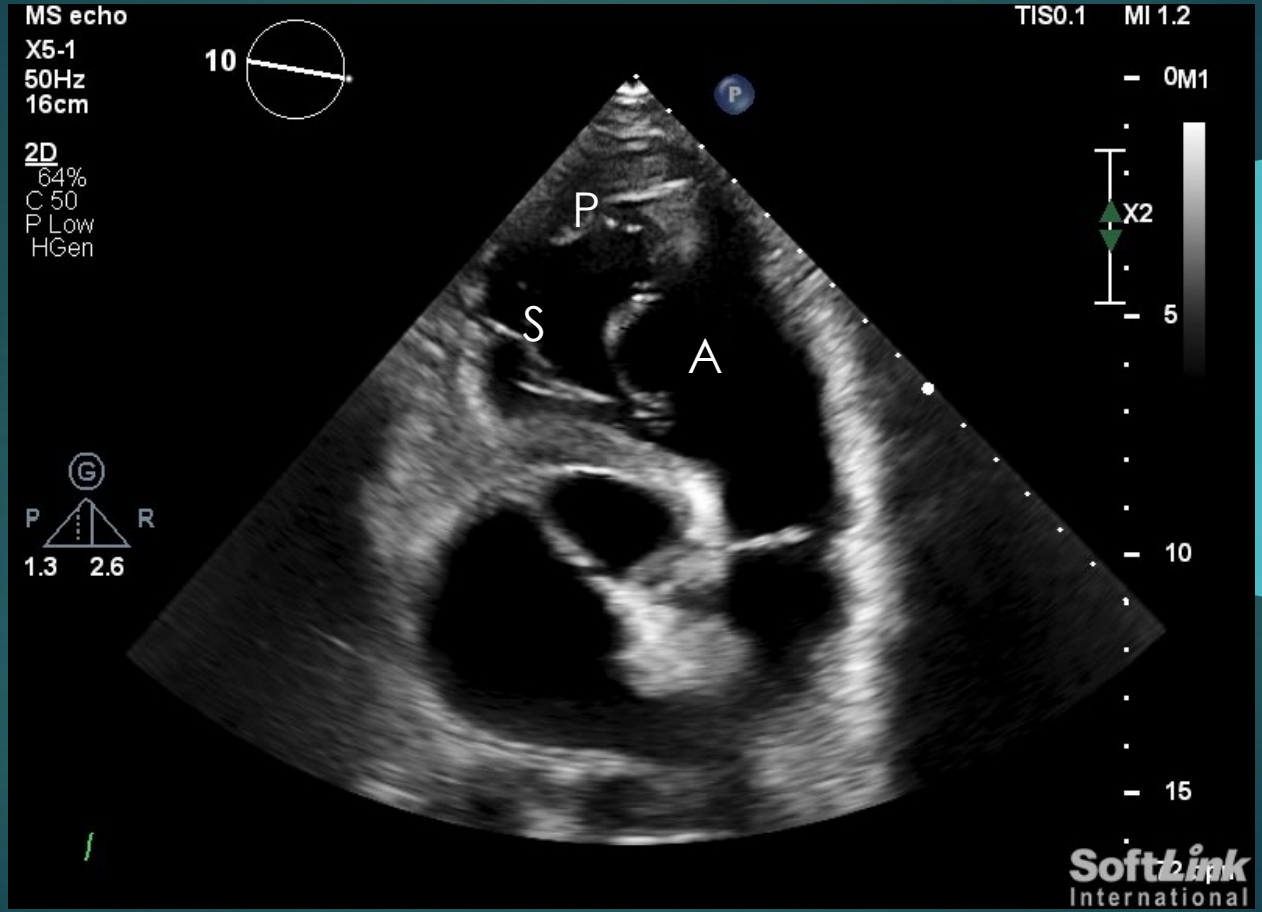




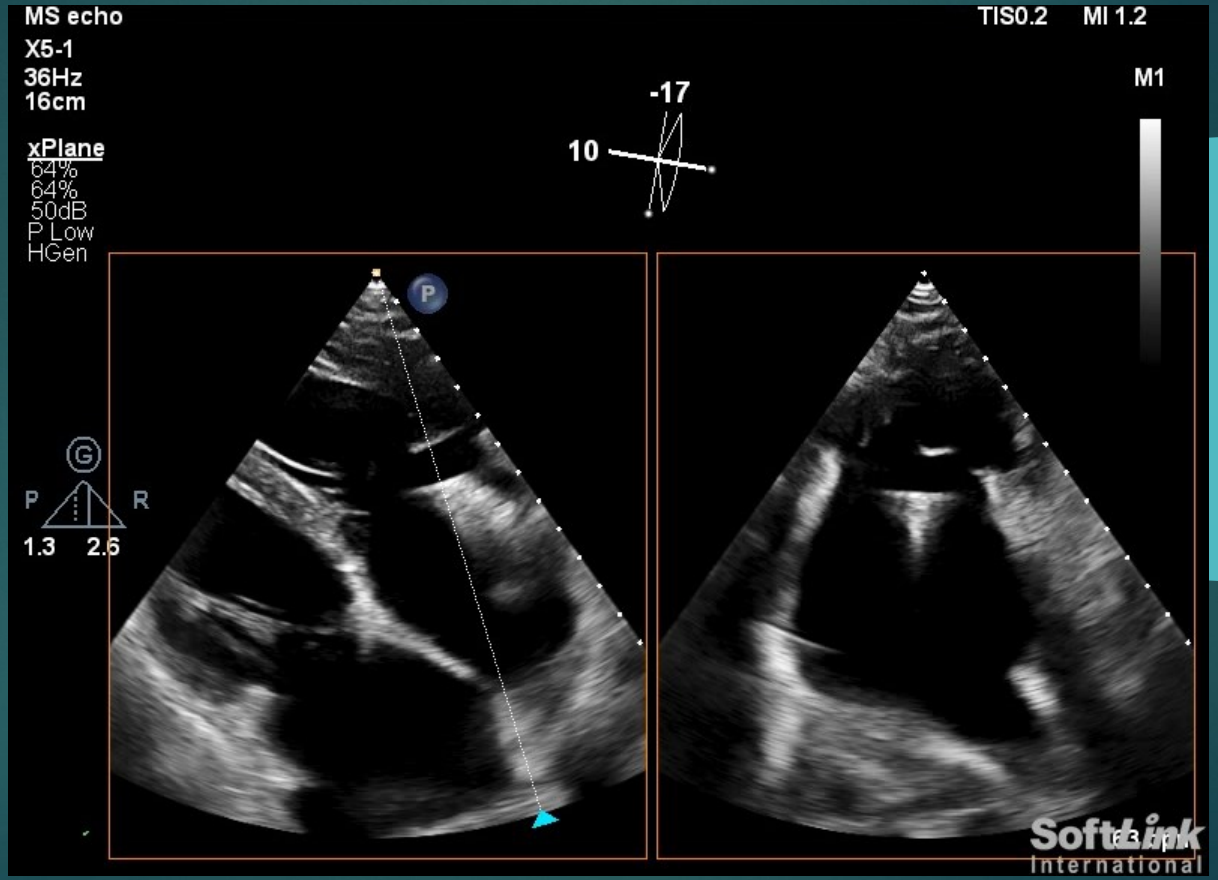
2D ICE of the Tricuspid Valve



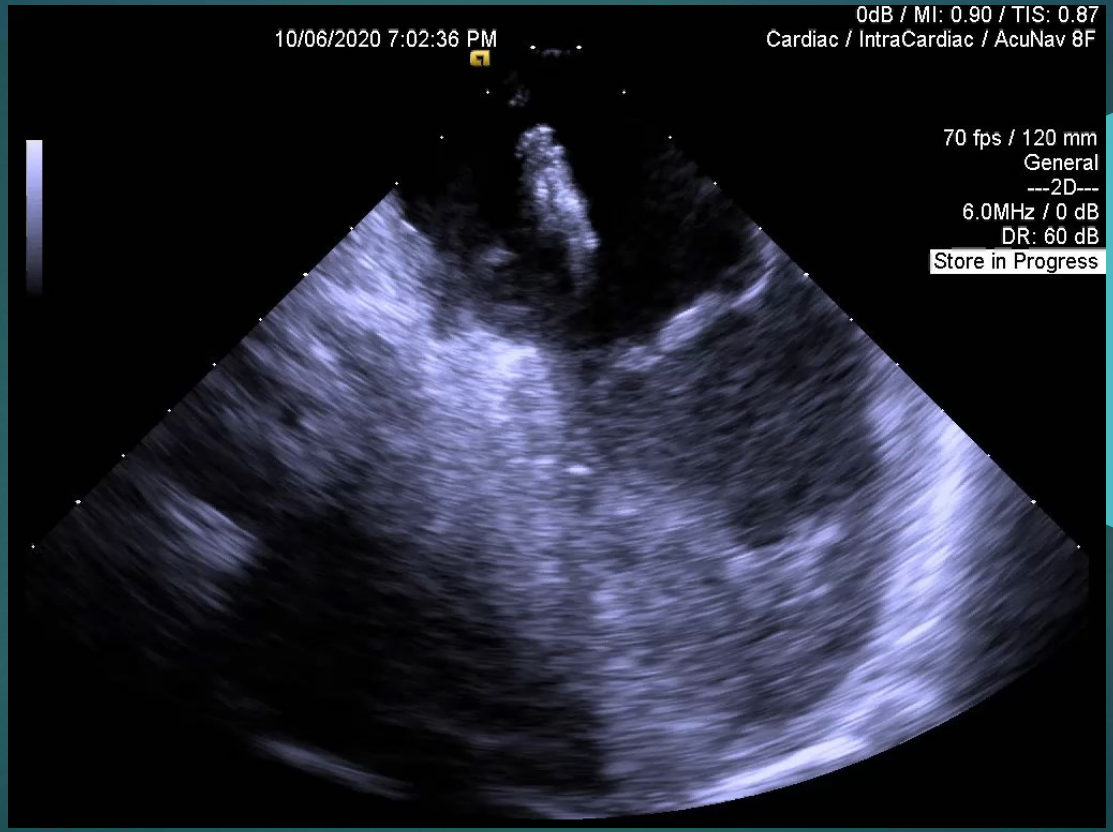
Subcostal off- axis view



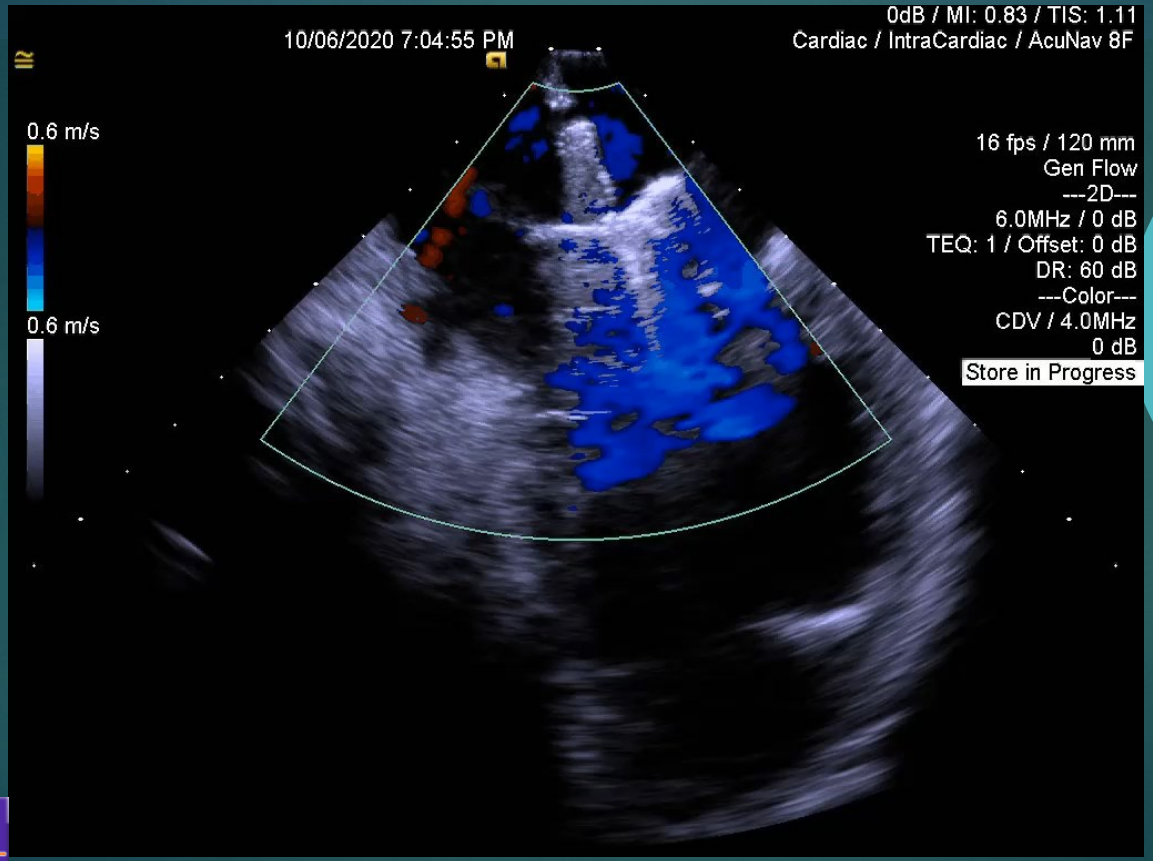
xplane of a Subcostal off- axis view



Steering MitralClip towards the TV



Clip on top of the TR jet



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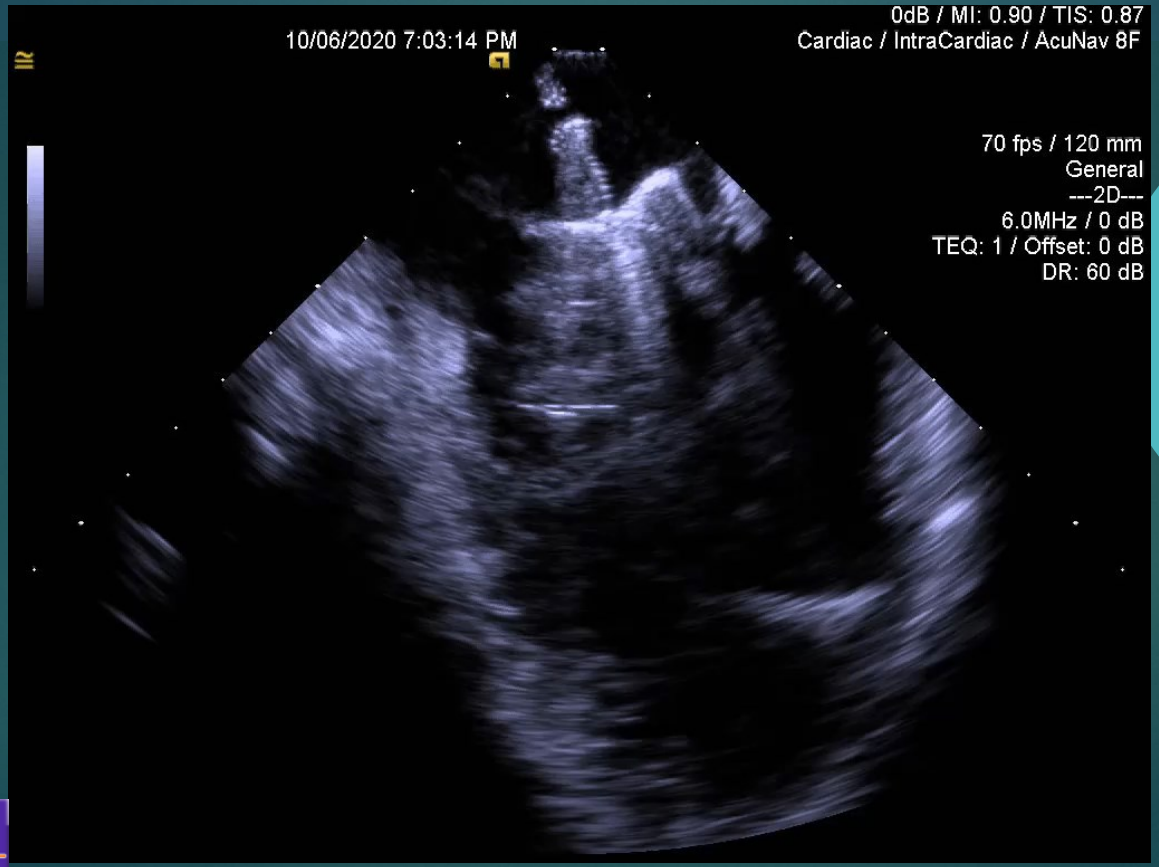
Checking the Grippers



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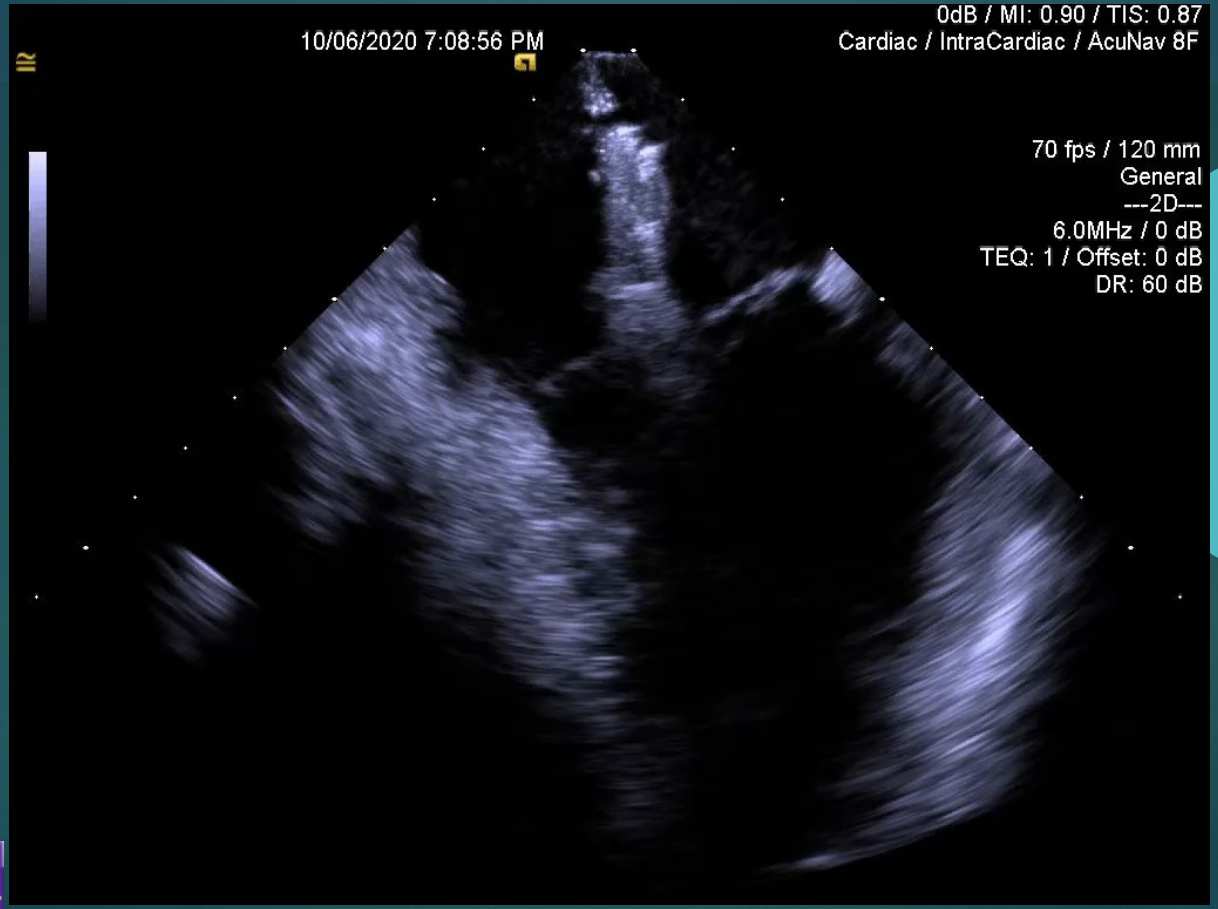
Closing the Clip



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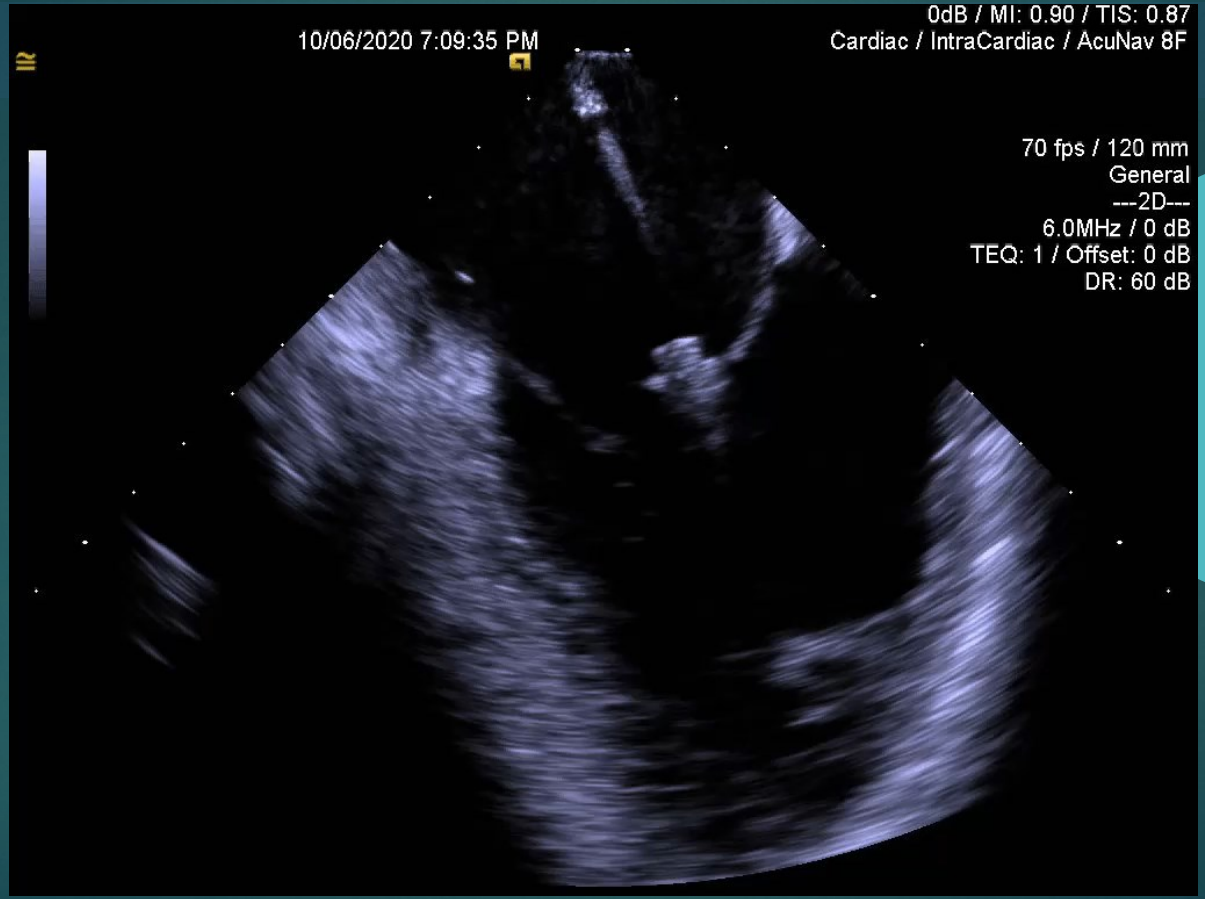
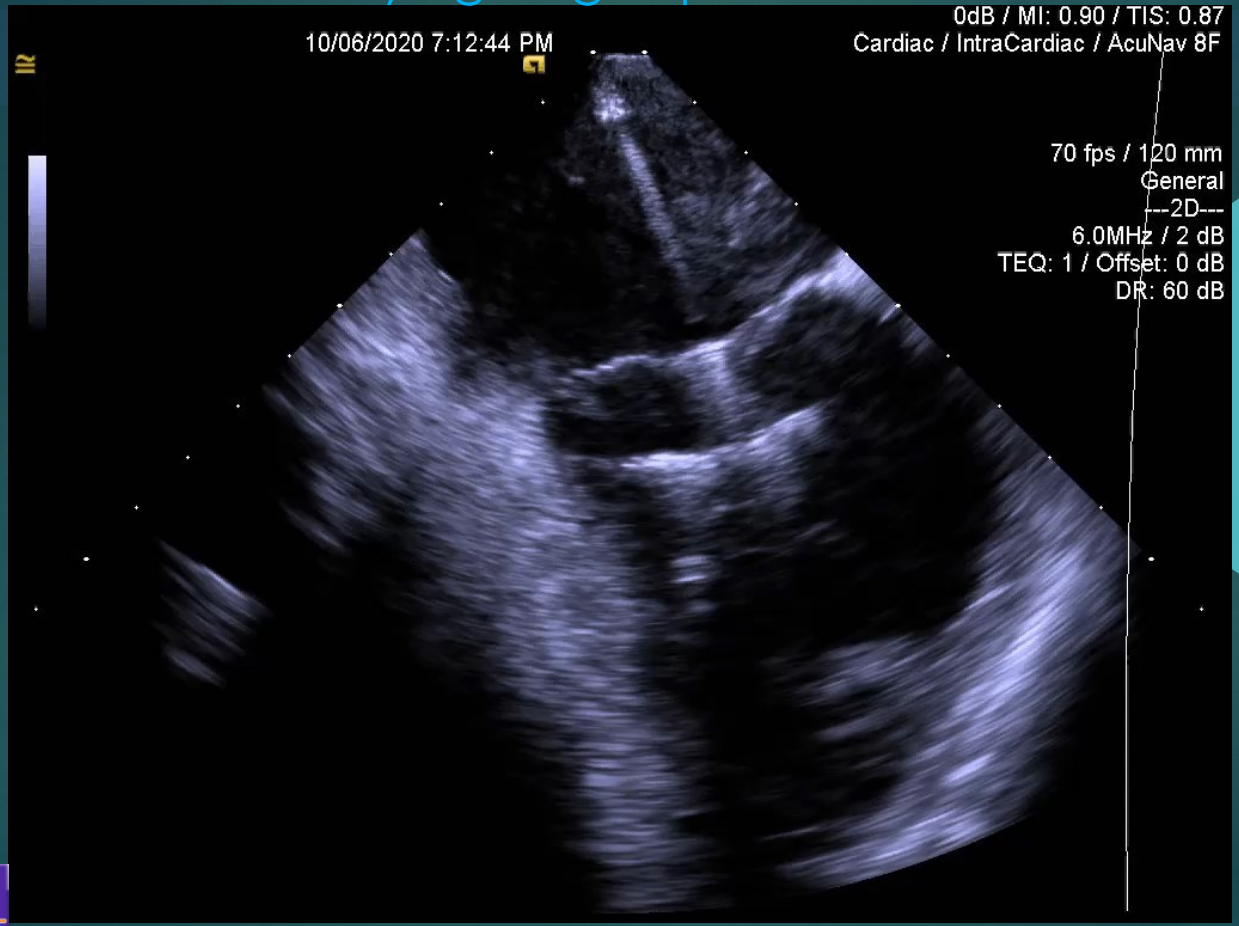
Opening the Clip in the RV



Trying to grasp



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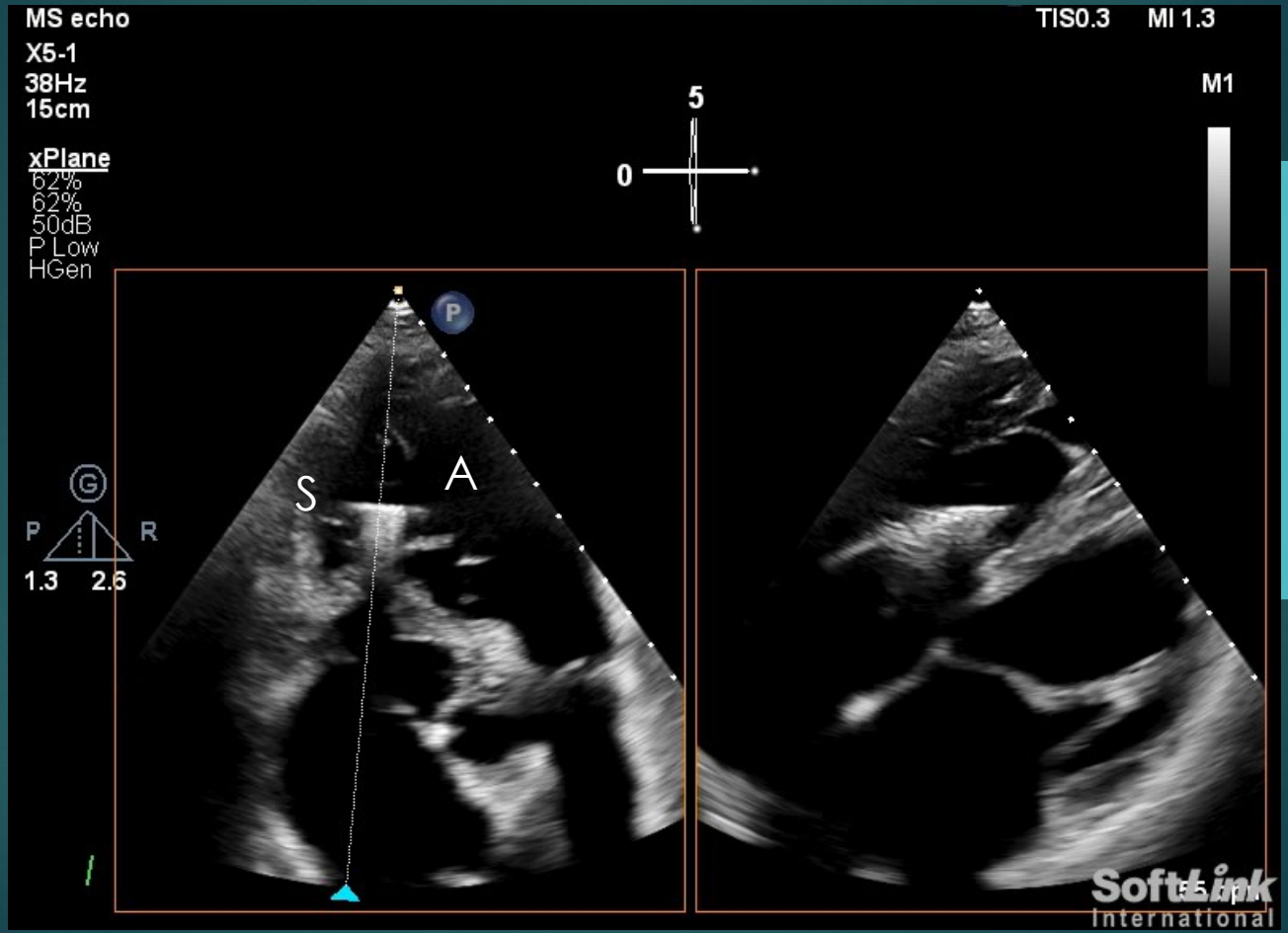
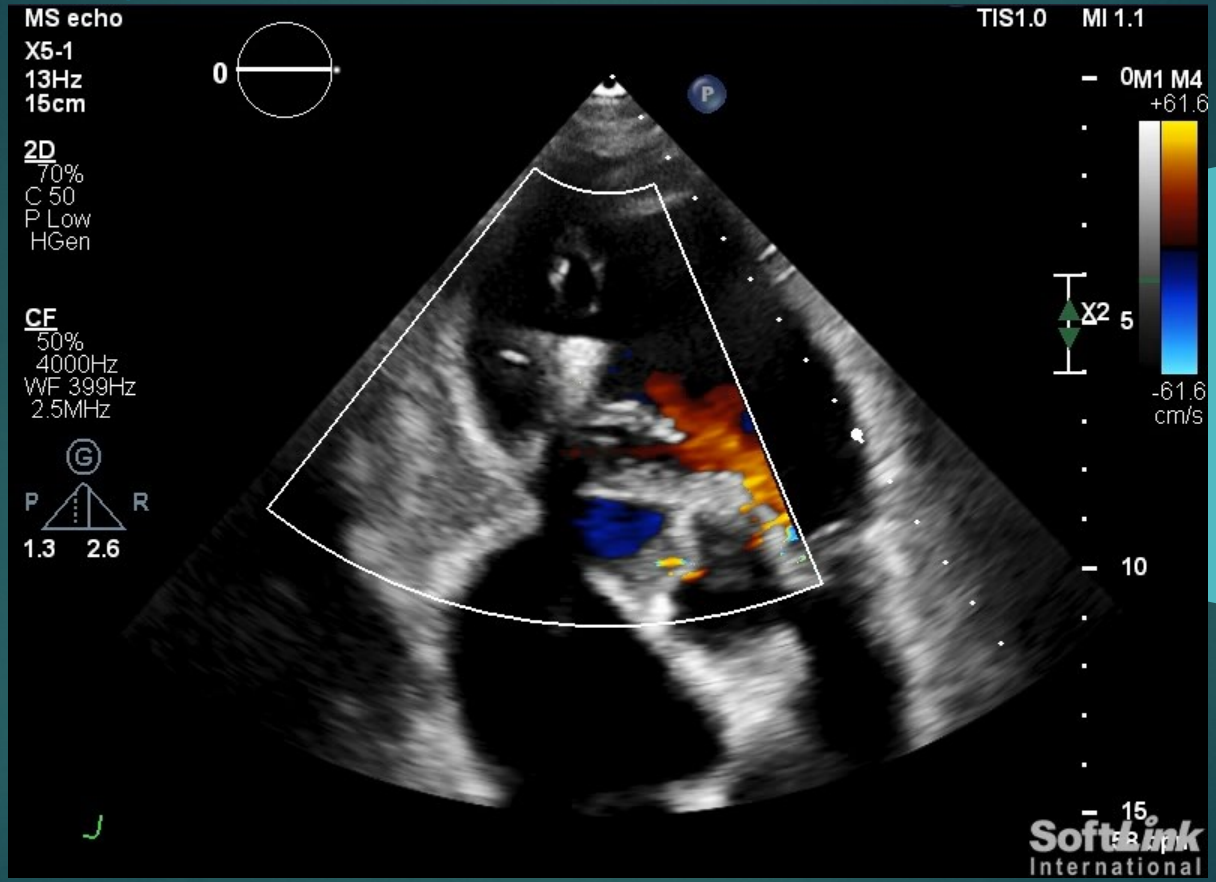
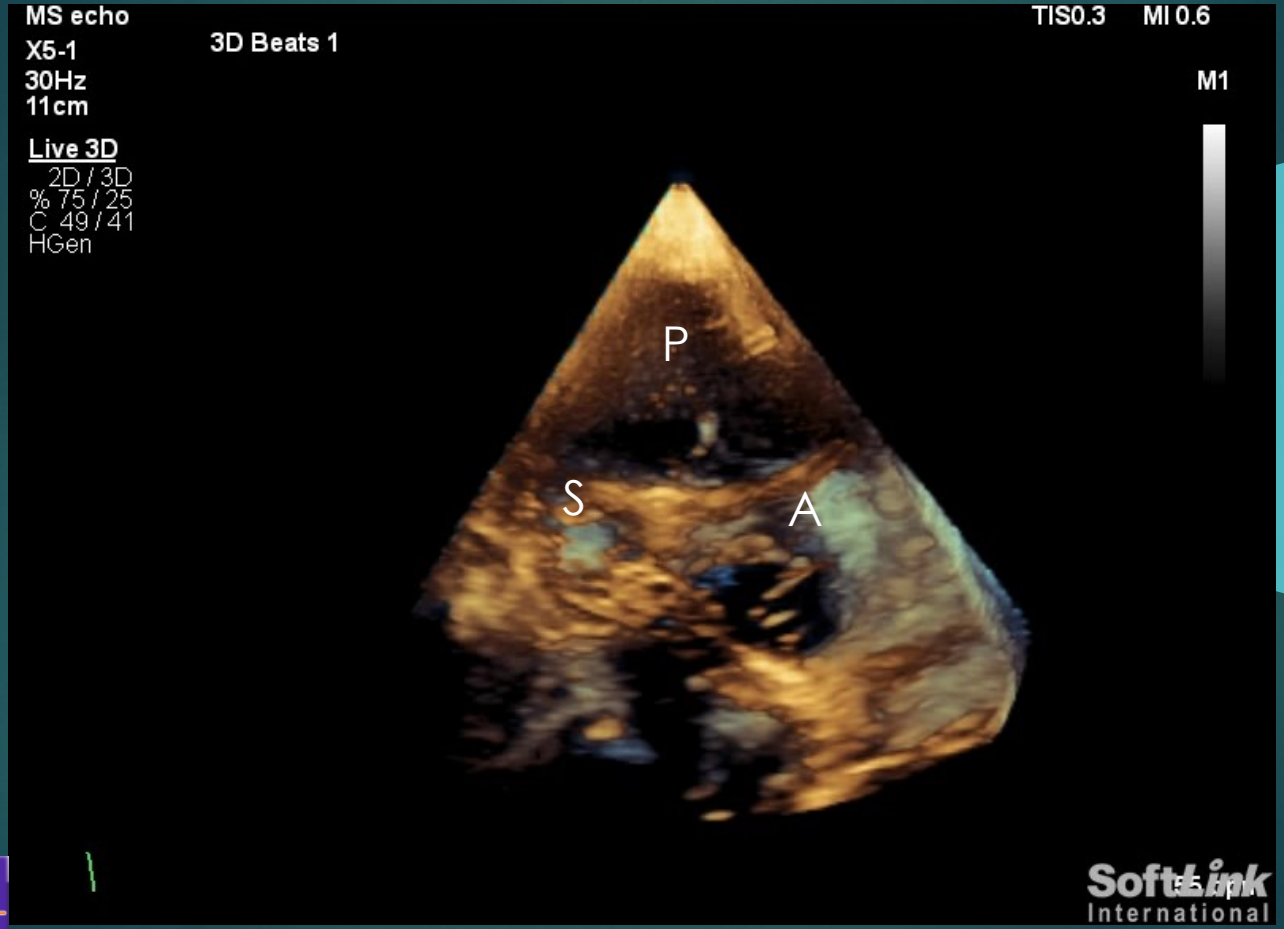
xplane off axis subcostal view



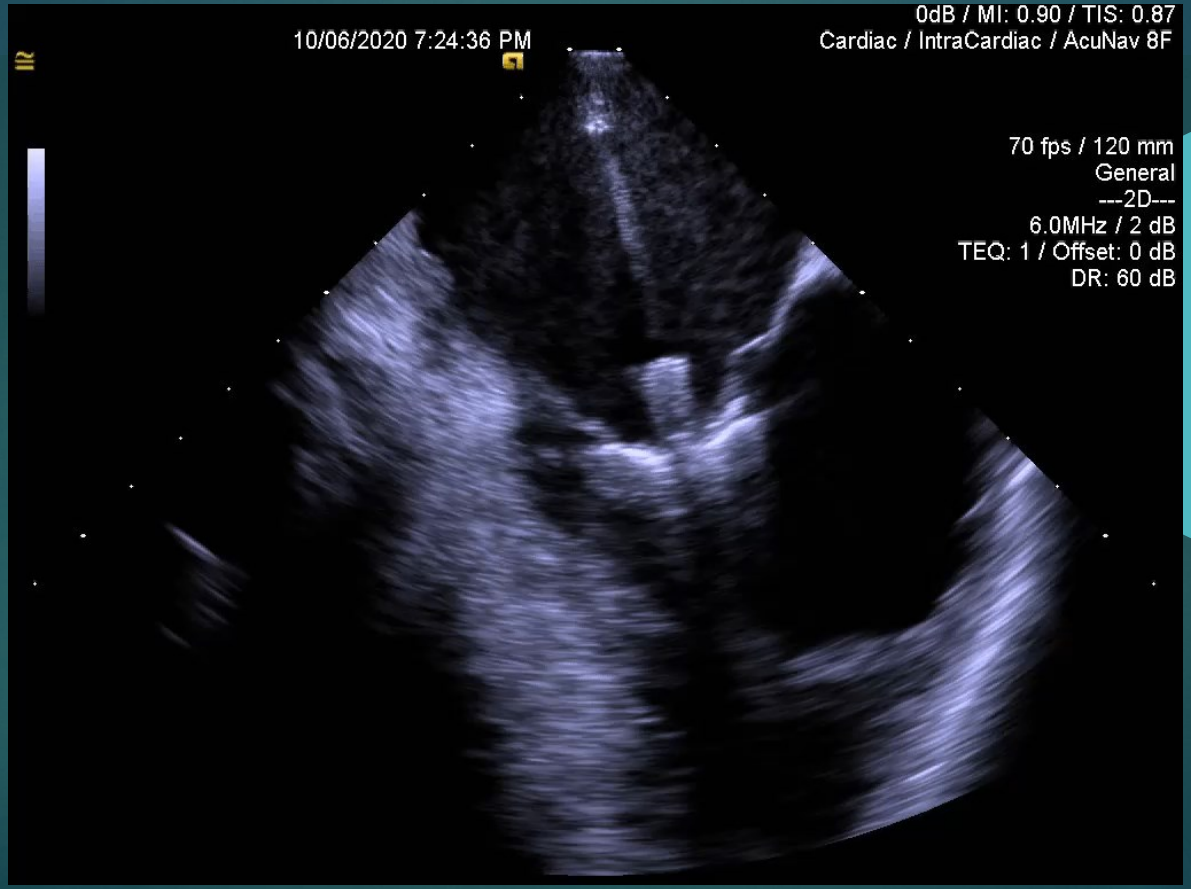
xplane off axis subcostal view with color



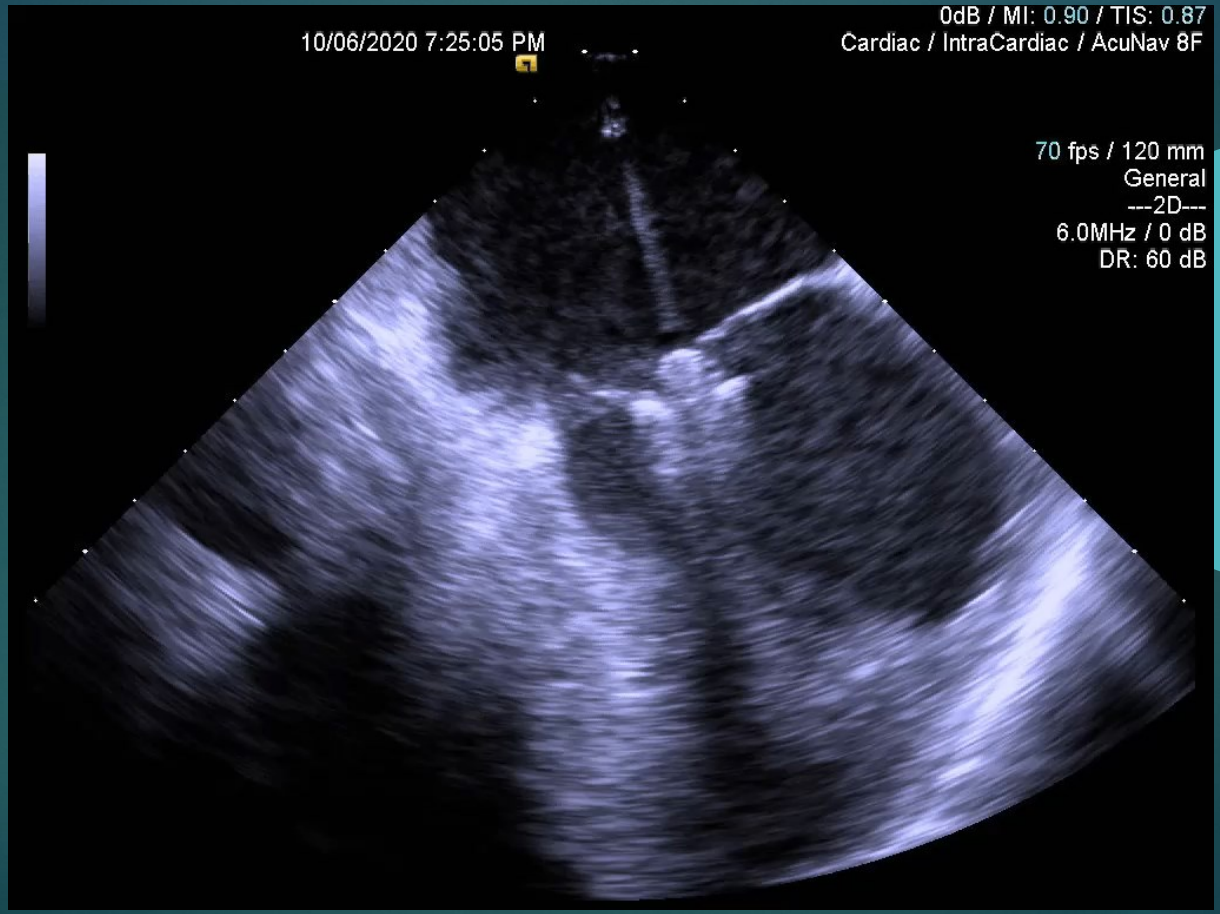
3D TTE confirming the orientation of the clip



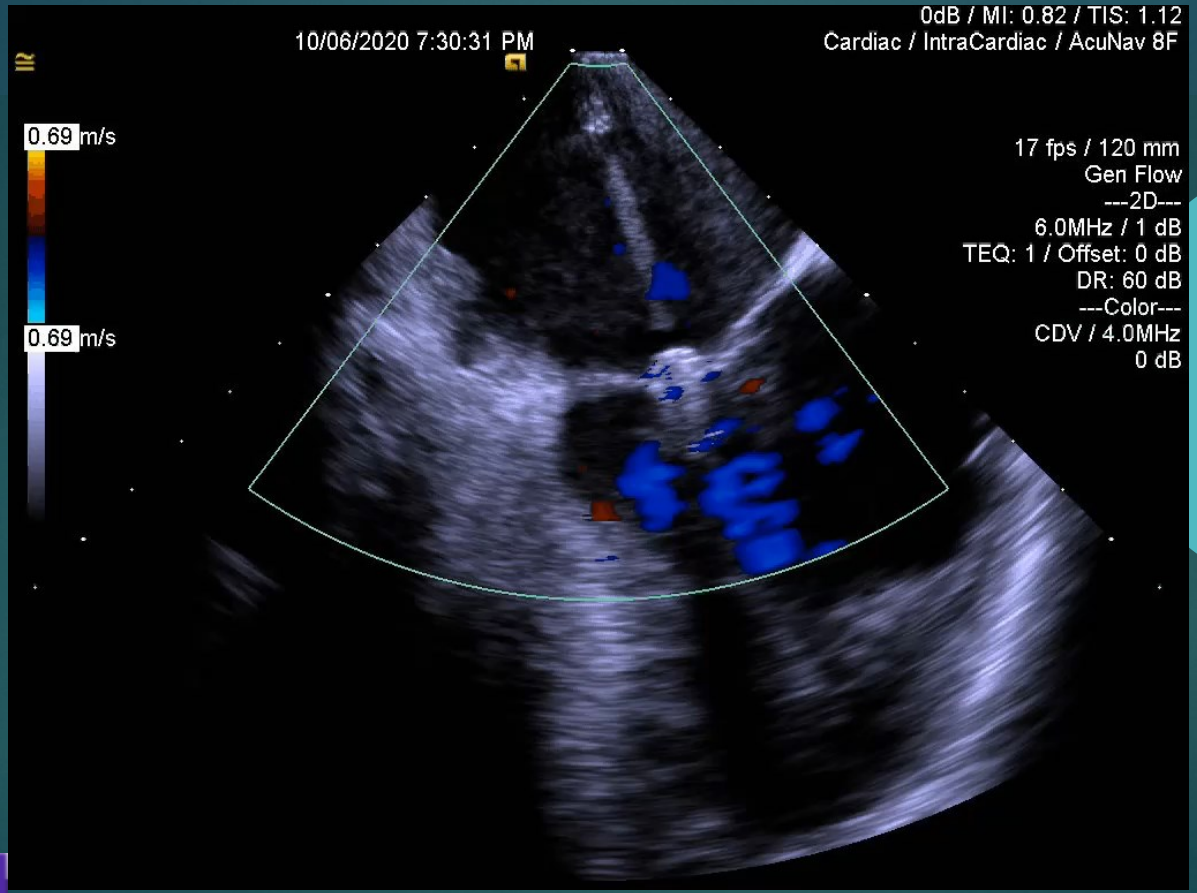
Both leaflets are grasped



Closing the clip

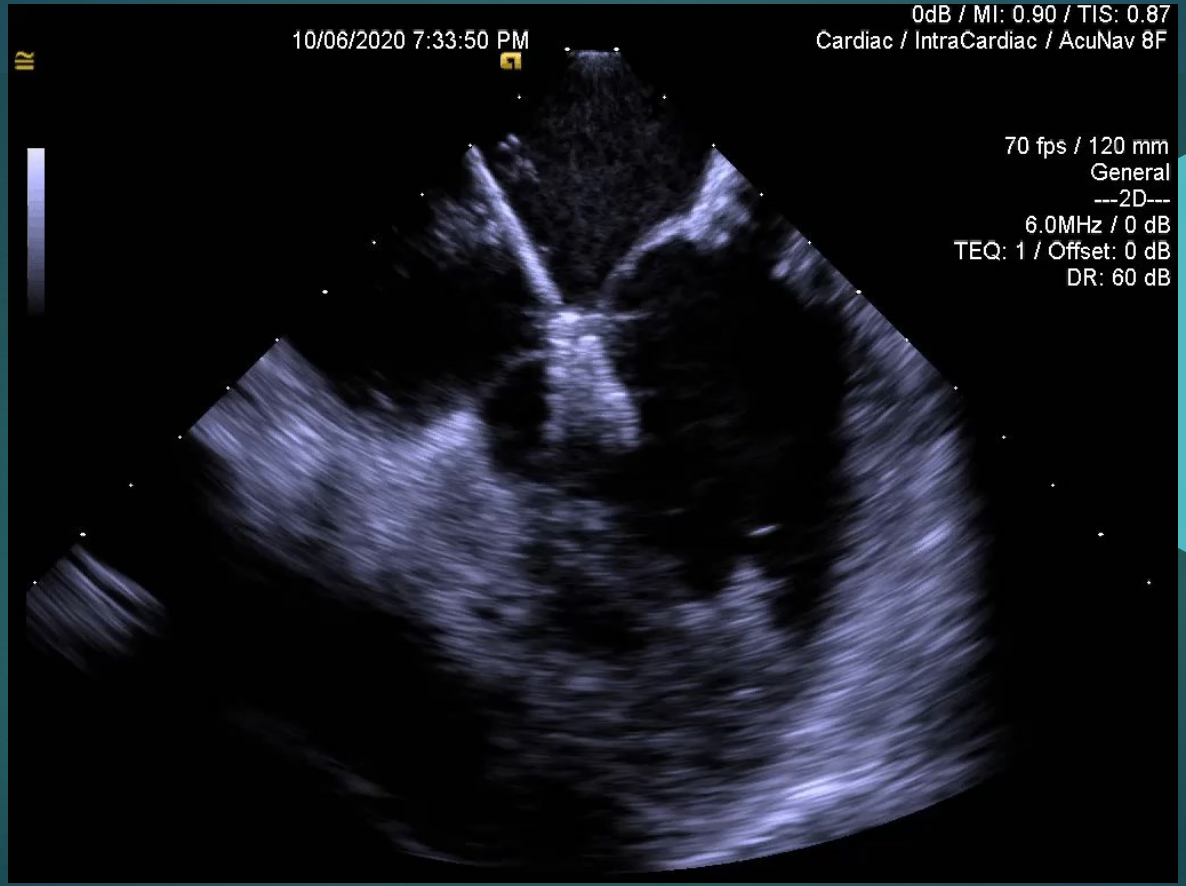


Closing clip with color

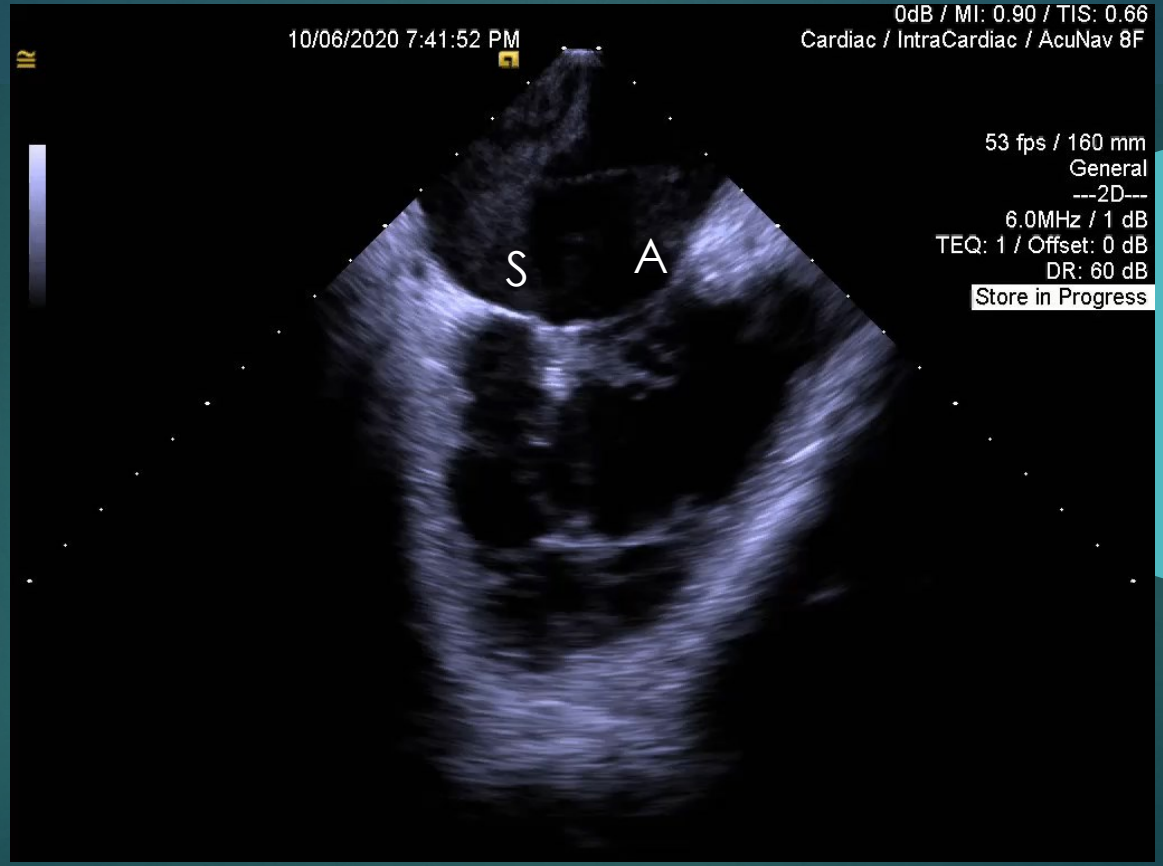


NYTV NEW YORK TRANSCATHETER VALVES

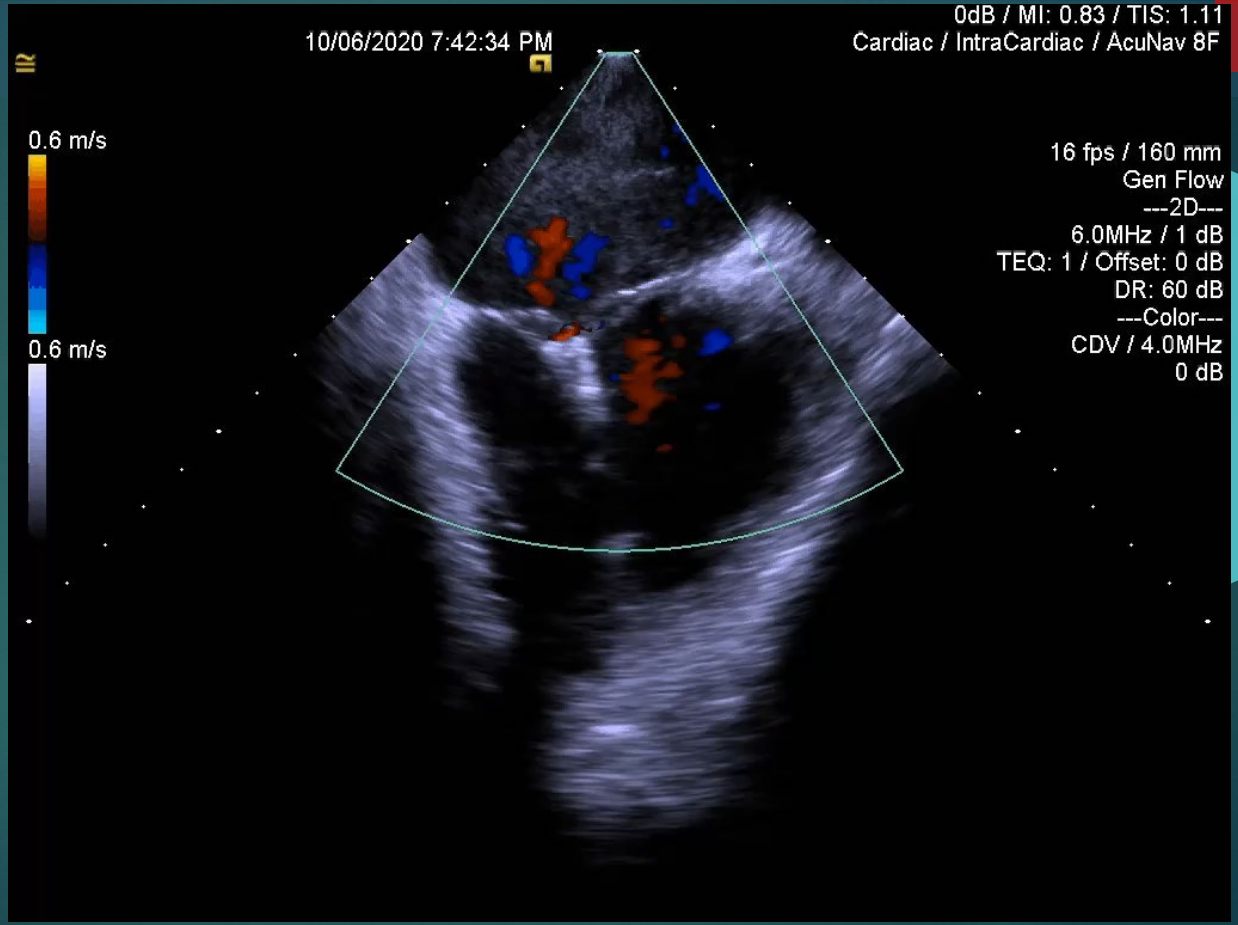
Clip deployment



Clip is stable



Deployed clip with color



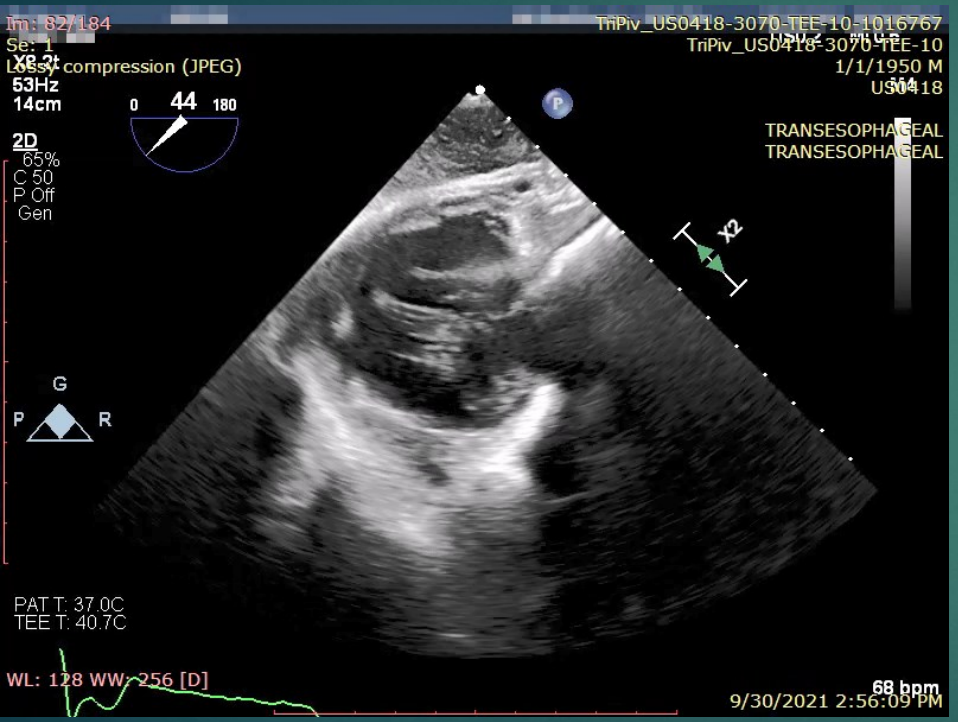
NYTV NEW YORK TRANSCATHETER VALVES

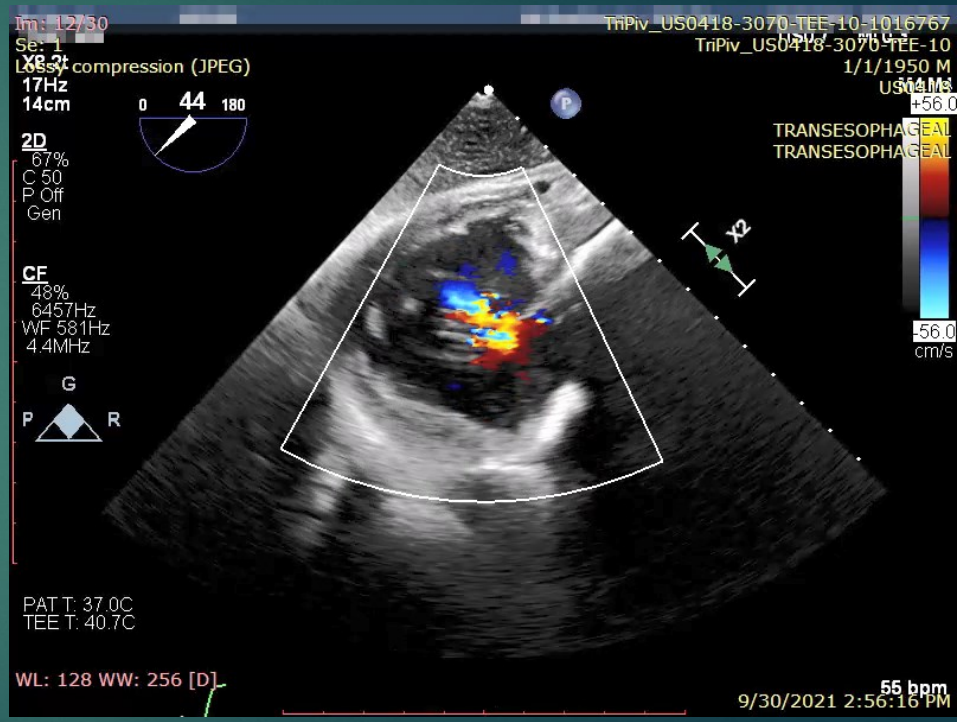
Case #2

- 75 year-old male; severe TR, LVEF 65%, NYHA-III
- Prior AVR + CABG, frail
- Deemed high risk for reop tricuspid surgery
- Symptomatic despite maximally optimal GDMT
- TEE: Severe TR due to leaflet restriction, annular dilatation

NYTV NEW YORK TRANSCATHETER VALVES

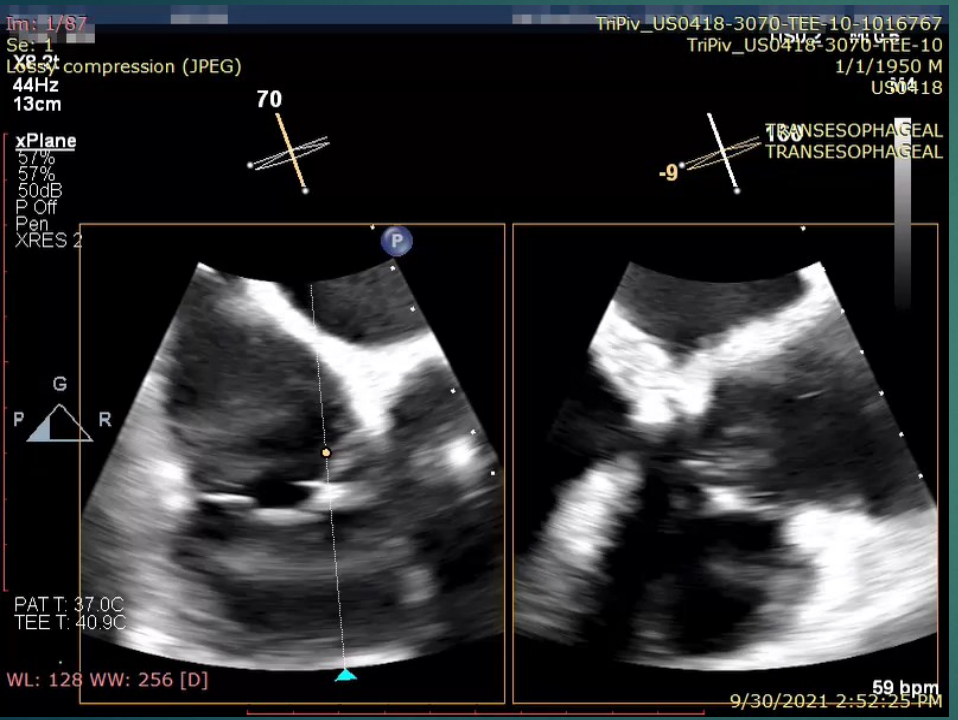
Pre-Clip Screening: TG SAX

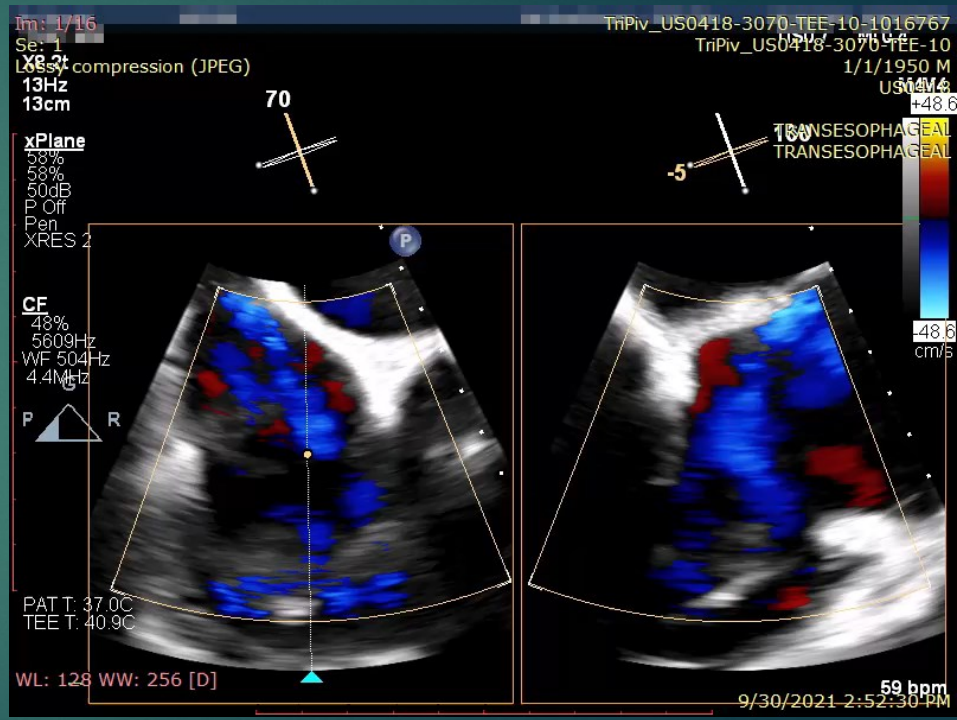




NYTV NEW YORK TRANSCATHETER VALVES

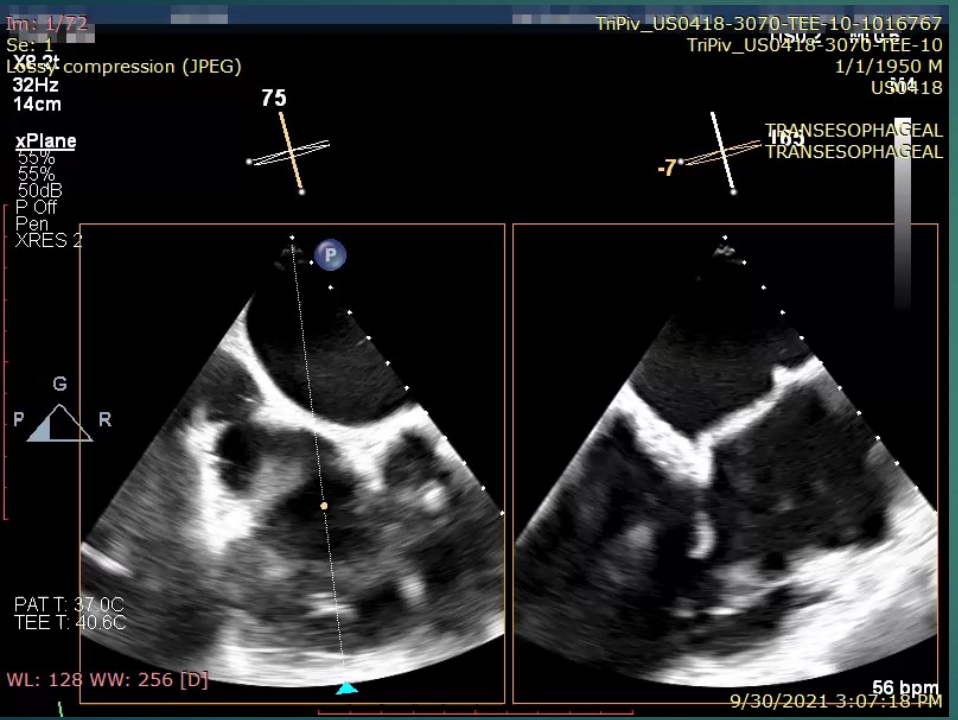
RV Inflow X-plane: Mid A-S

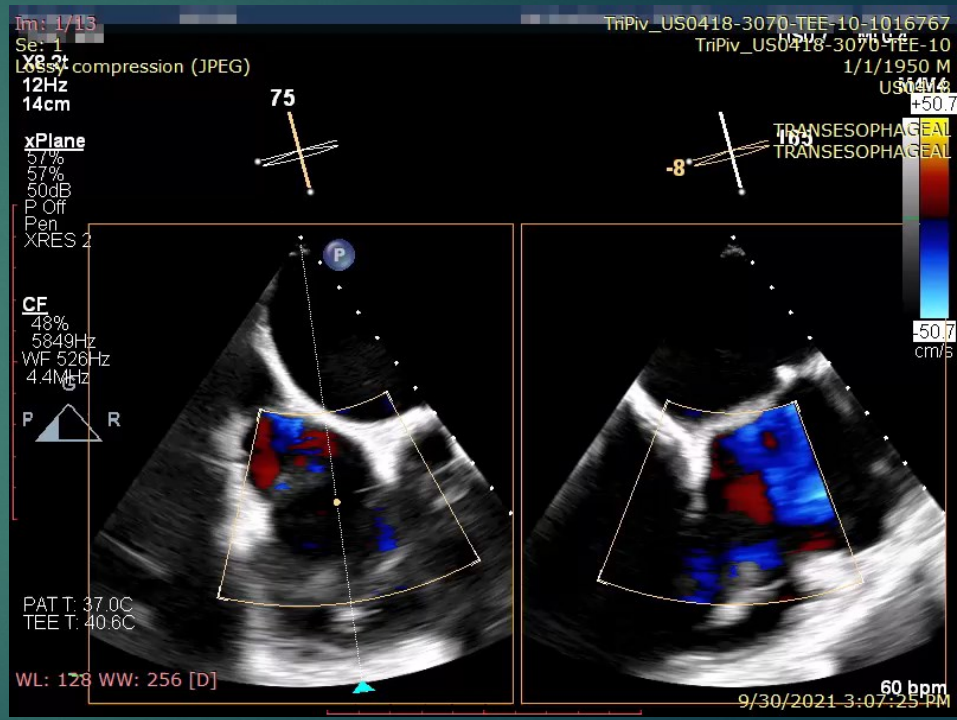




NYTV NEW YORK TRANSCATHETER VALVES

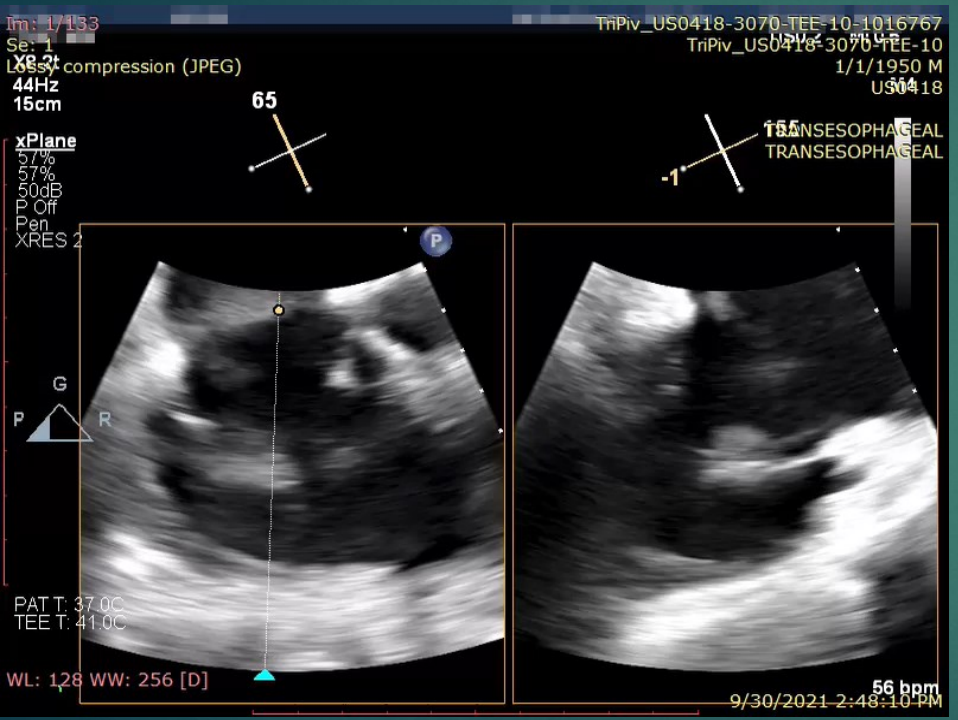
RV Inflow X-plane: Mid to Central A-S

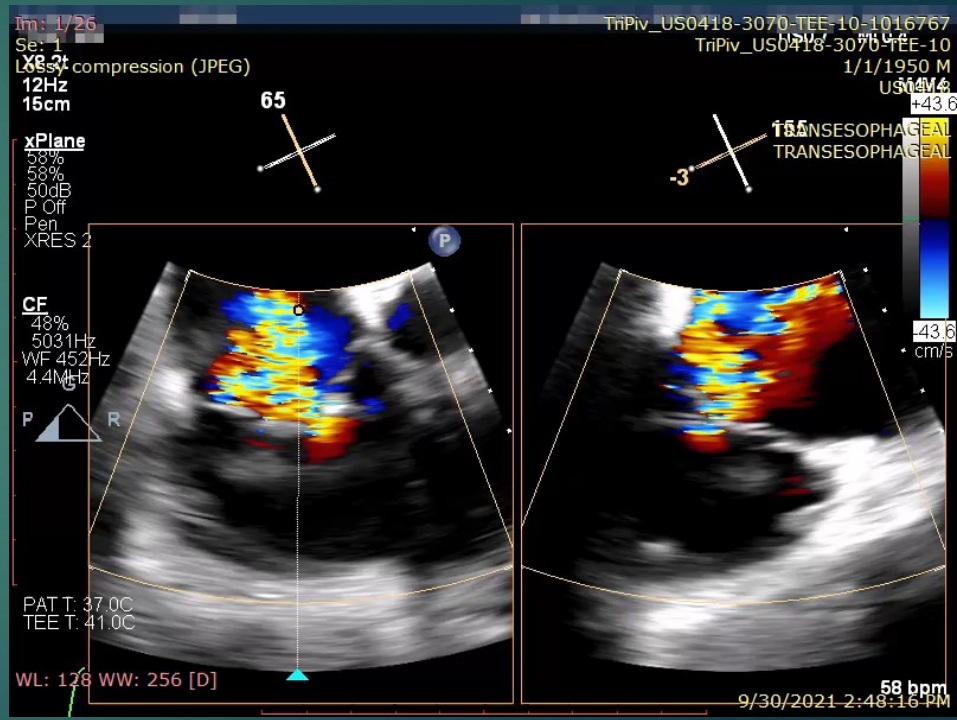




NYTV NEW YORK TRANSCATHETER VALVES

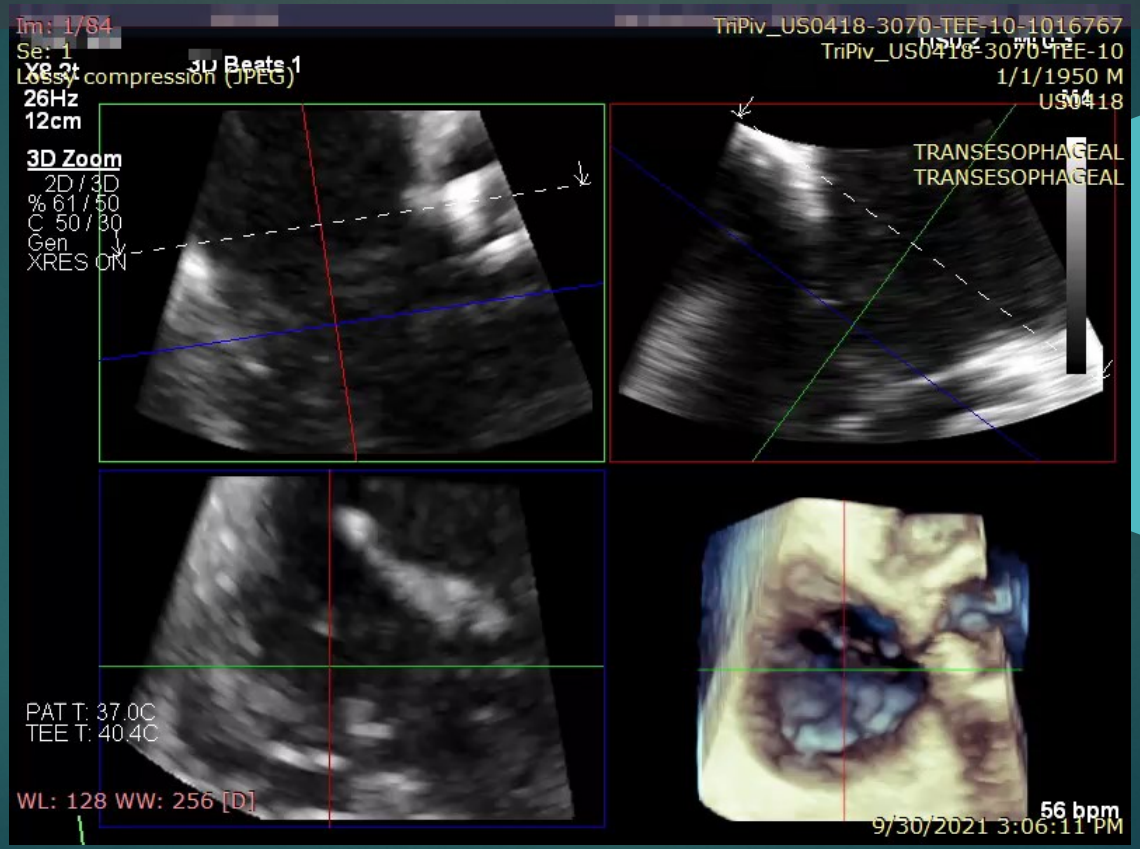
RV Inflow X-plane: Central A-S





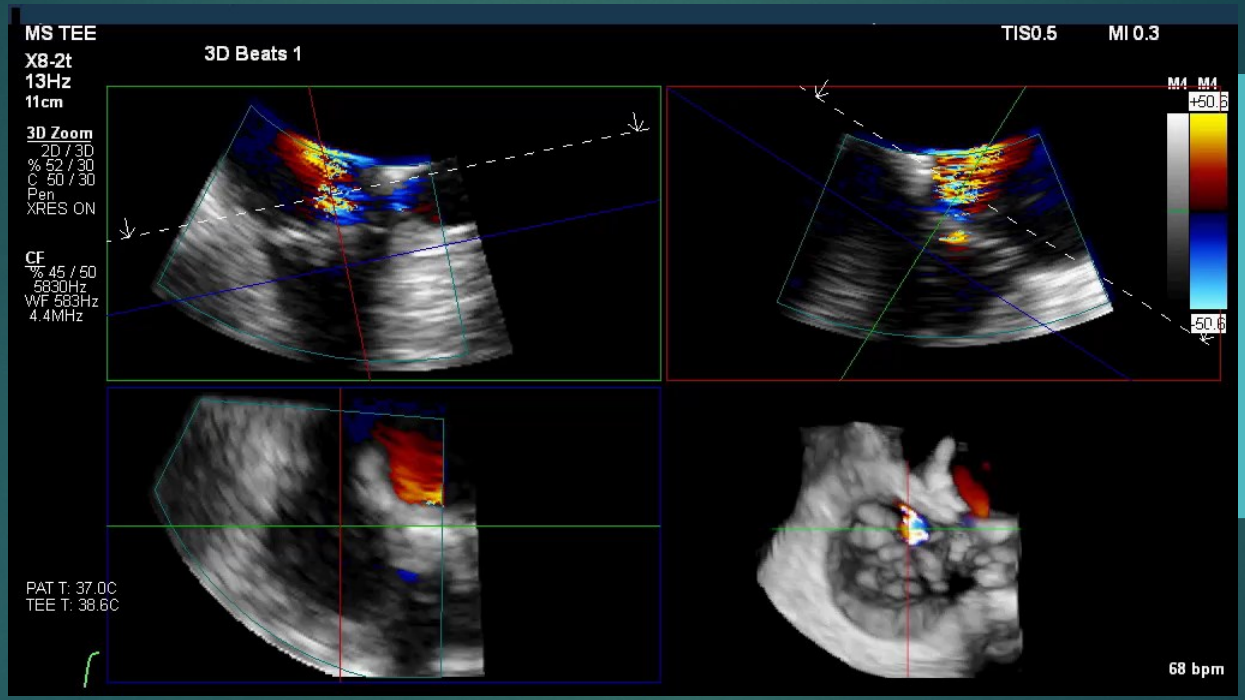
NYTV NEW YORK TRANSCATHETER VALVES

3D MPR

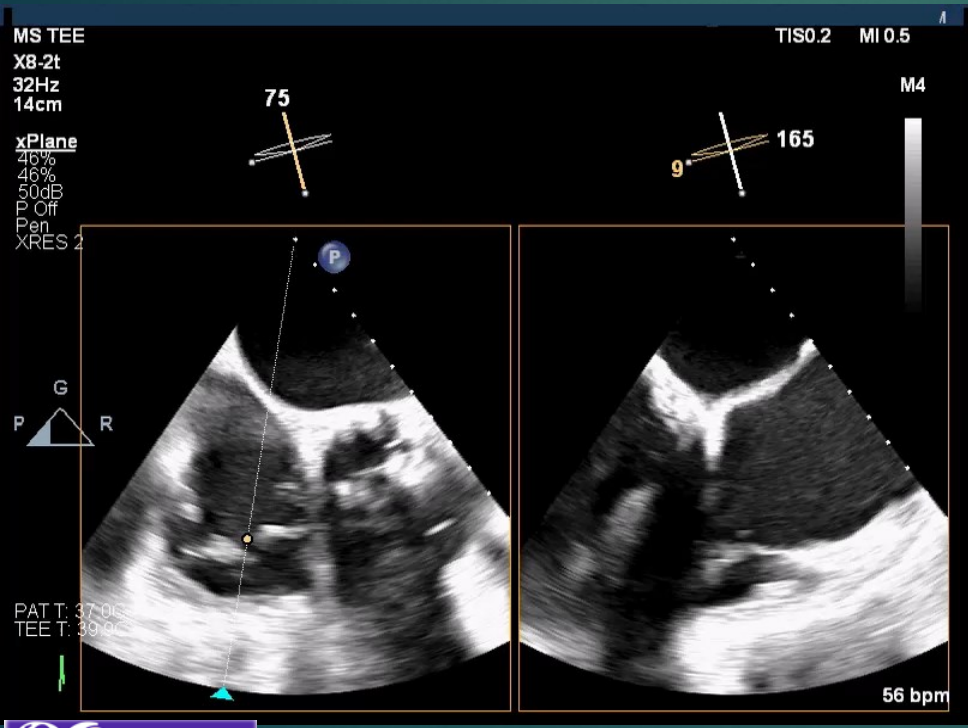


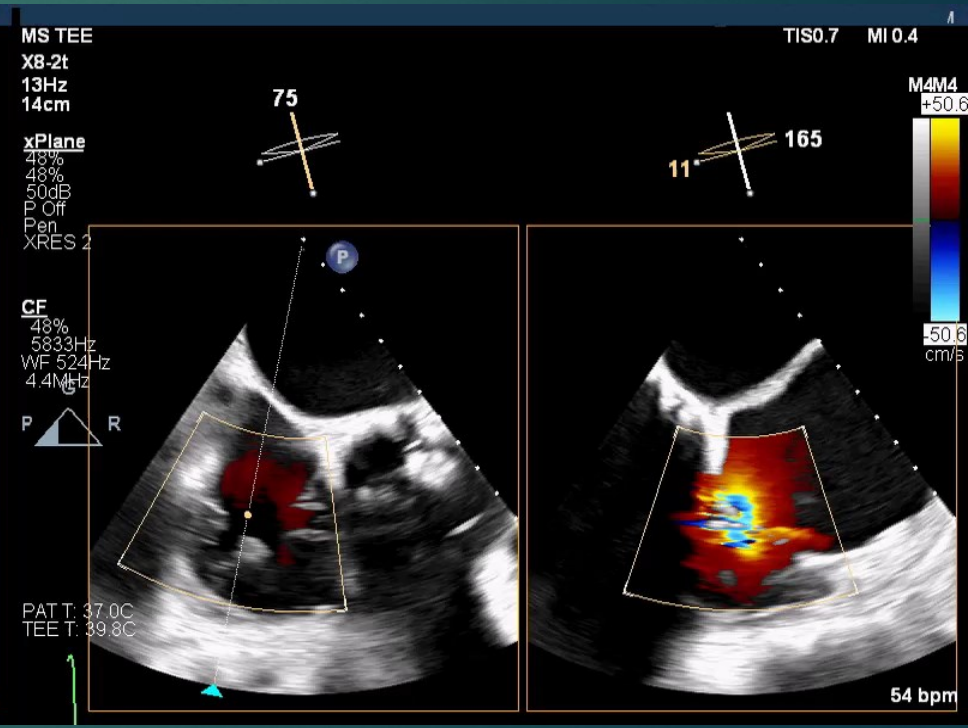
NYTV NEW YORK TRANSCATHETER VALVES

3D MPR with Color

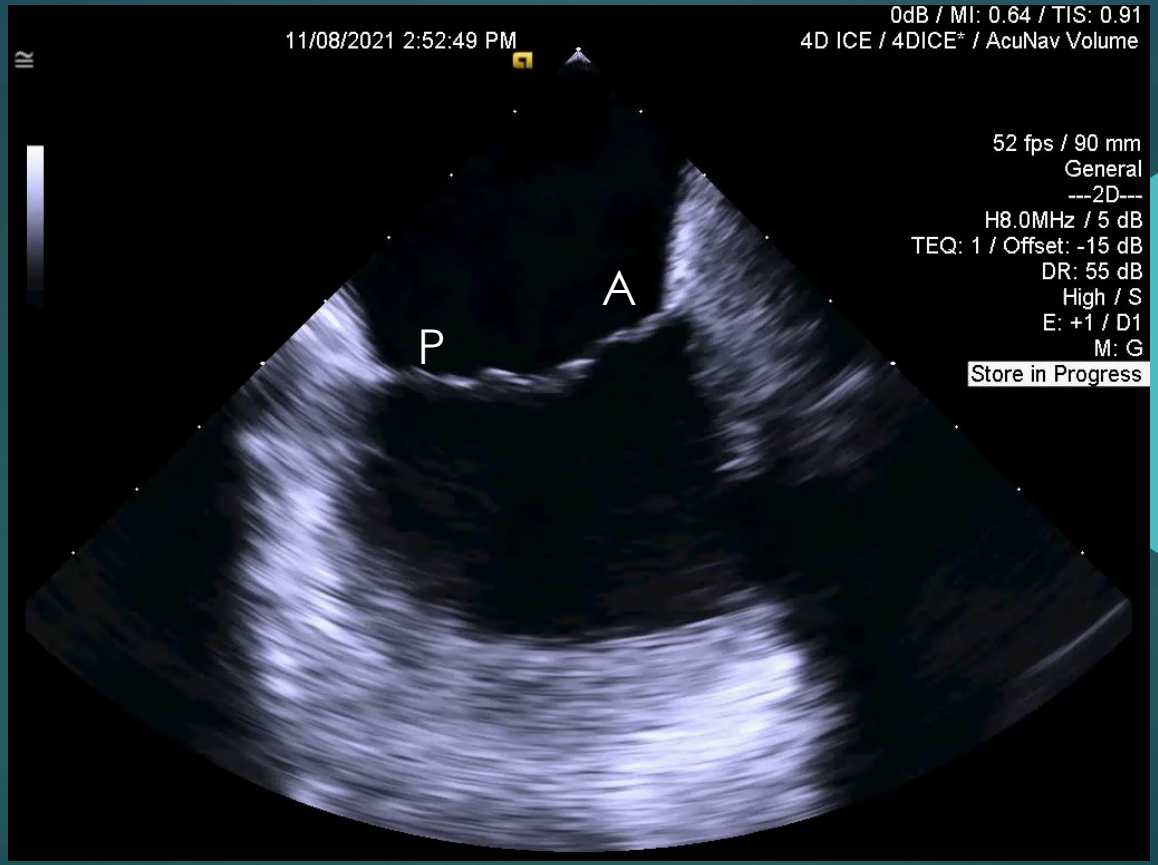


Intraprocedural TEE: Septal Leaflet Shadowed





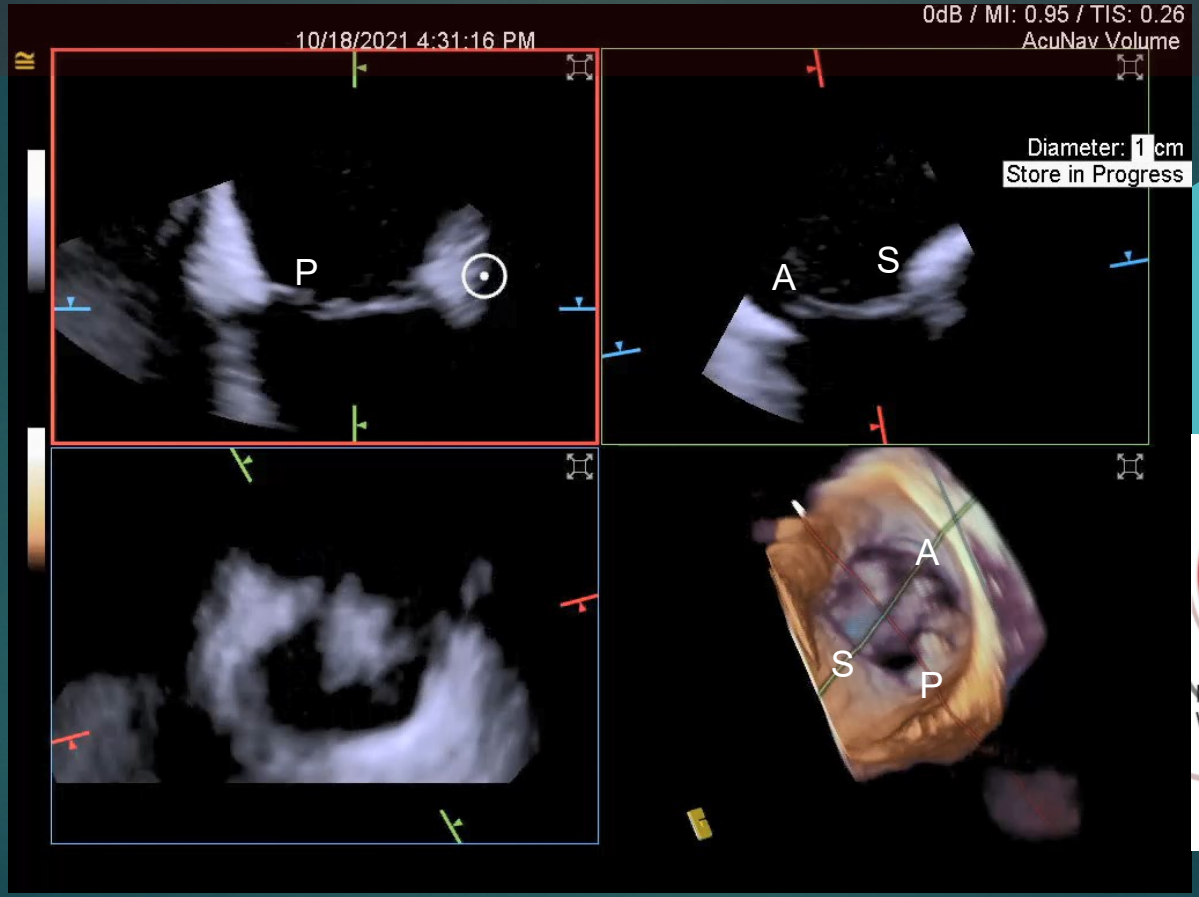
Home View

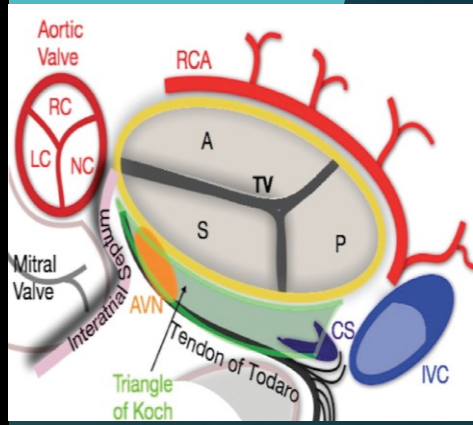

11/08/2021 2:52:49 PM
0dB / MI: 0.64 / TIS: 0.91
4D ICE / 4DICE* / AcuNav Volume
52 fps / 90 mm
General
---2D---
H8.0MHz / 5 dB
TEQ: 1 / Offset: -15 dB
DR: 55 dB
High / S
E: +1 / D1
M: G
Store in Progress
A
P

4D botton push

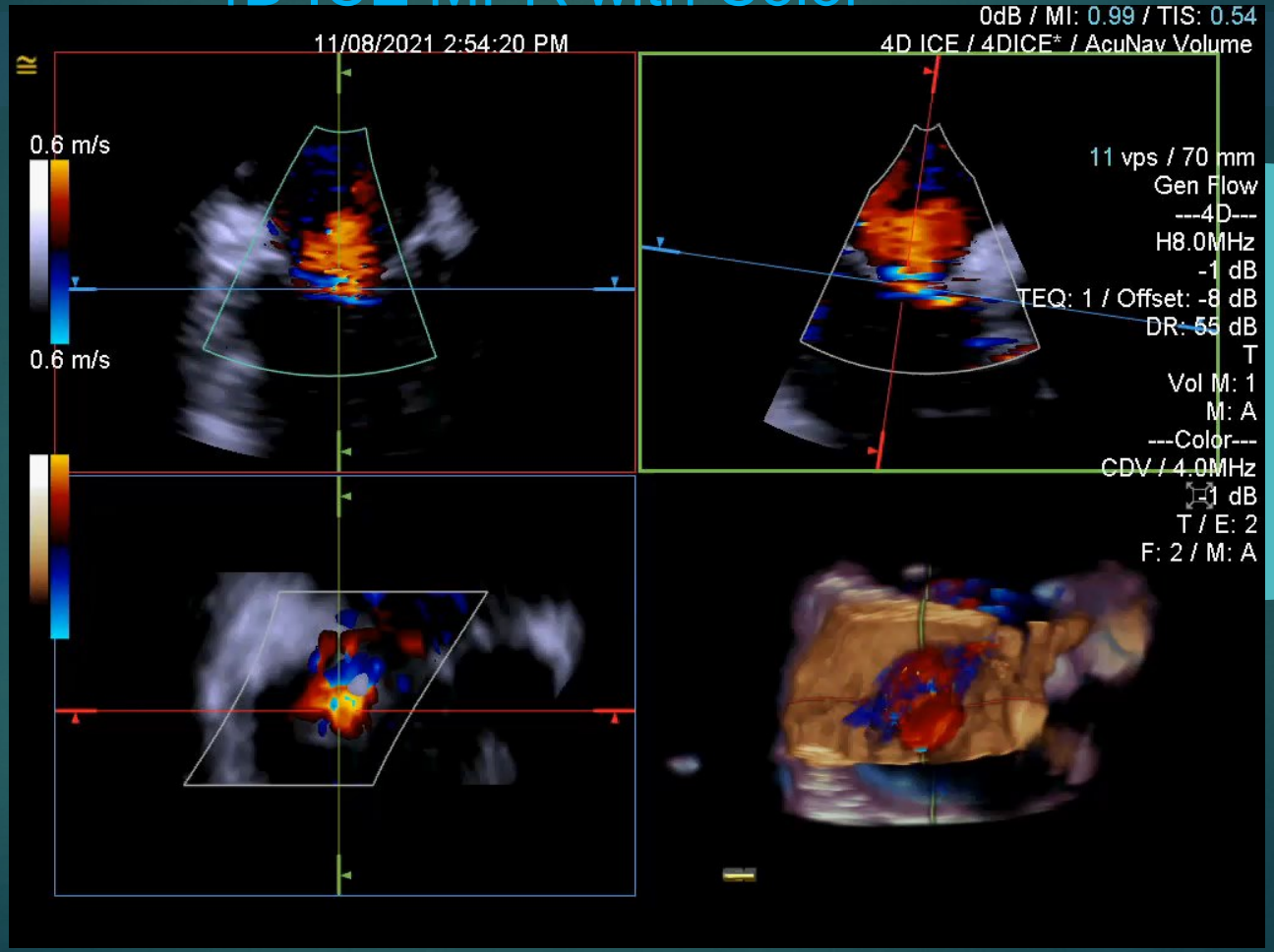
- Circle tool on the aorta; anatomic intedyfying tool

4D ICE MPR


0dB / MI: 0.95 / TIS: 0.26
10/18/2021 4:31:16 PM
AcuNav Volume
Diameter: 1 cm
Store in Progress
P
A
S
A
S
P

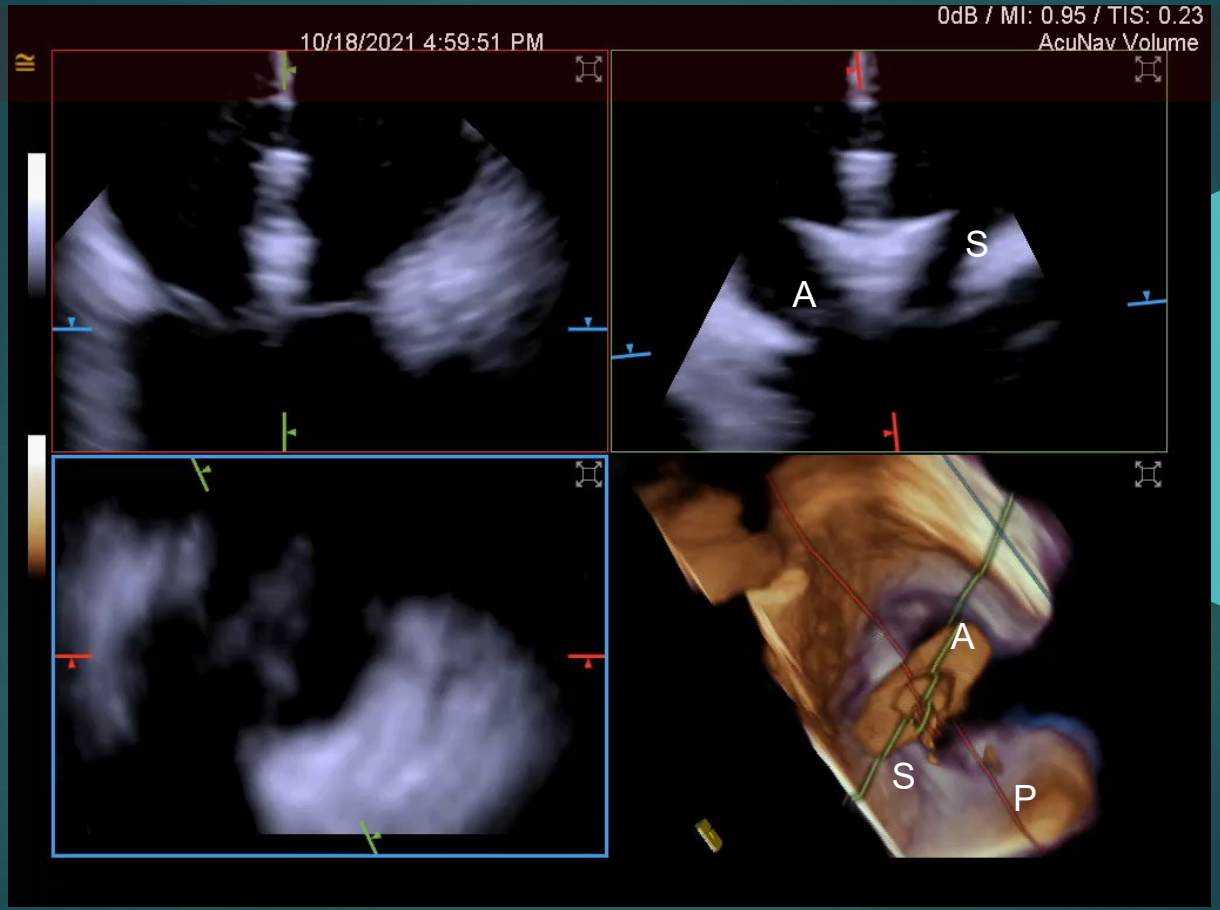

Aortic Valve
RCA
RC
LC
NC
A
TV
S
P
Mitral Valve
Interatrial Septum
AVN
Tendon of Todaro
CS
IVC
Triangle of Koch

4D ICE MPR with Color

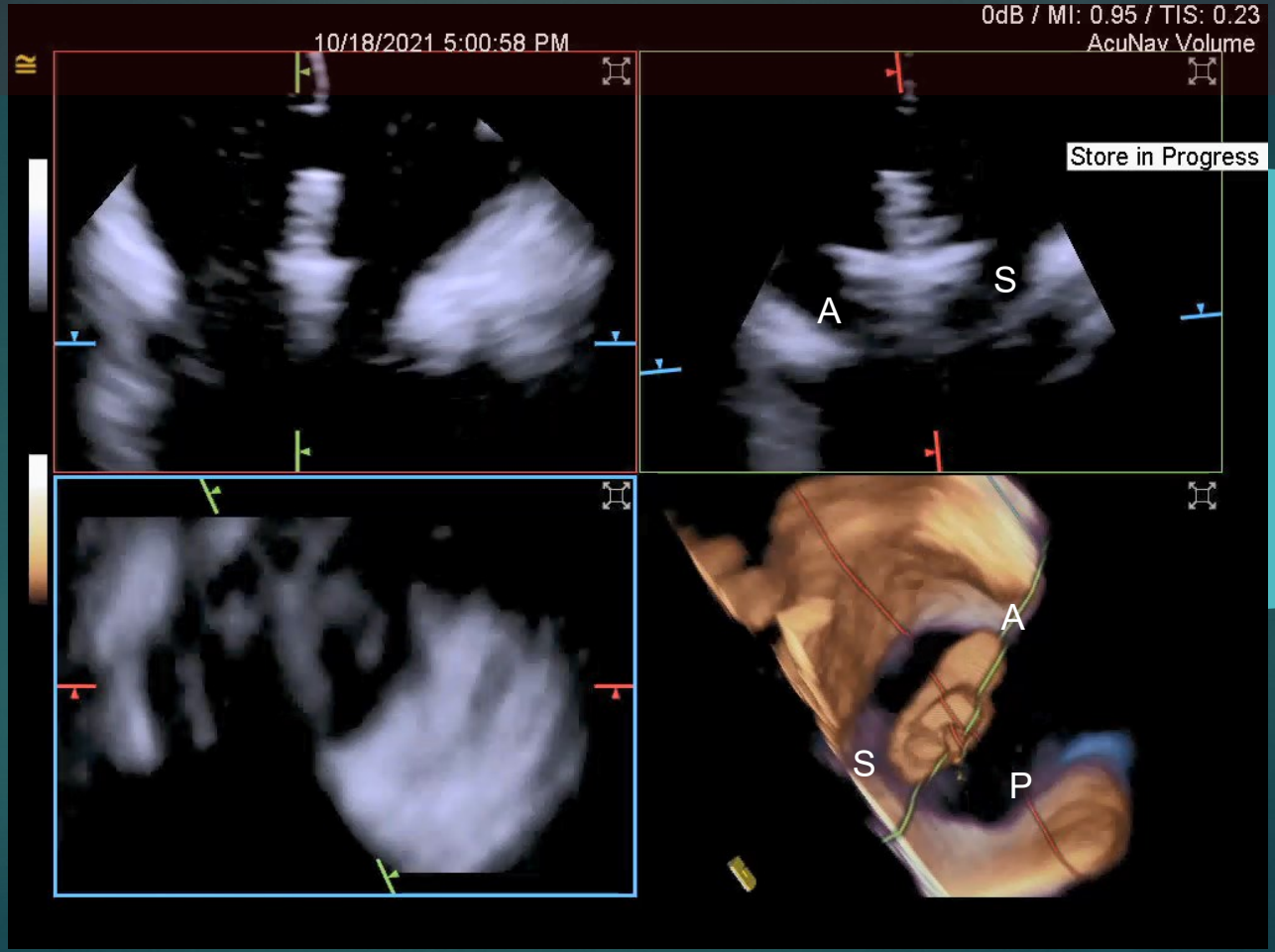


NYTV NEW YORK TRANSCATHETER VALVES

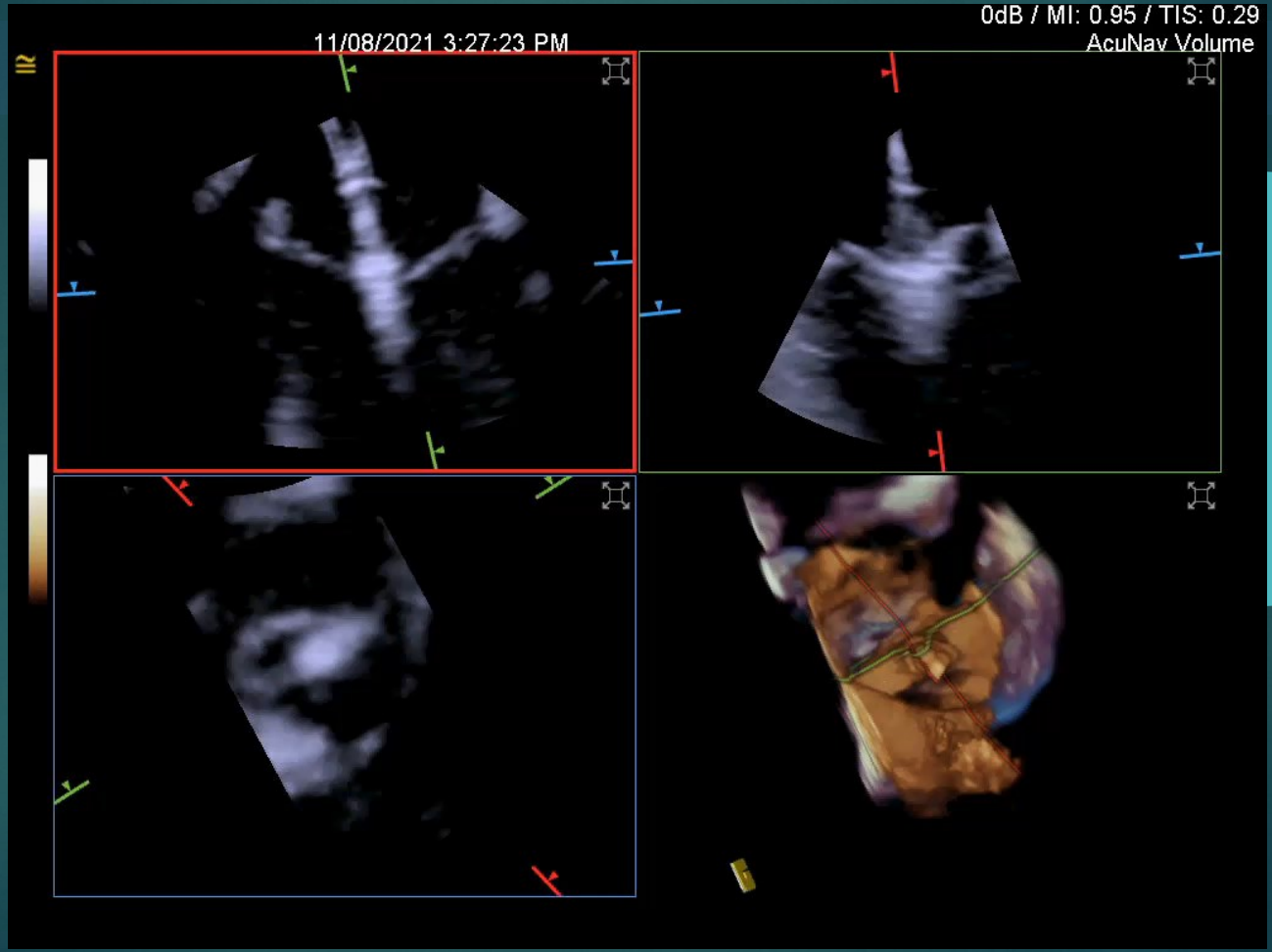
4D ICE to Optimize Clip Trajectory



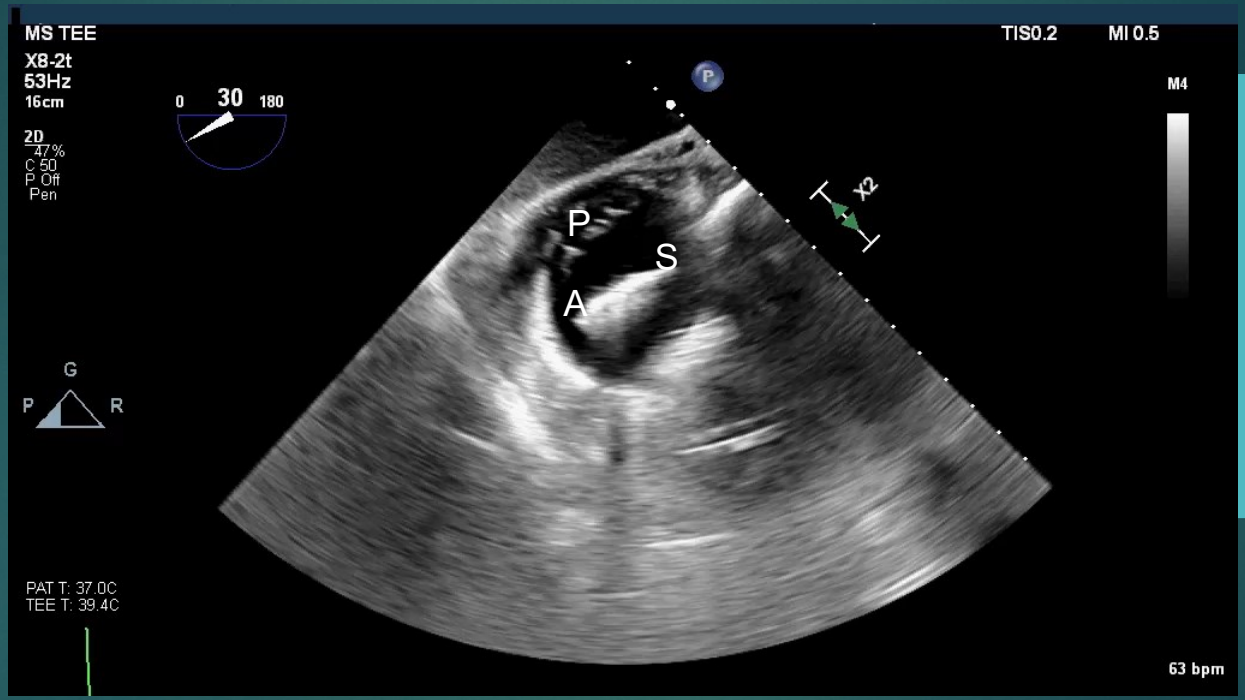
4D ICE to do Gripper Check



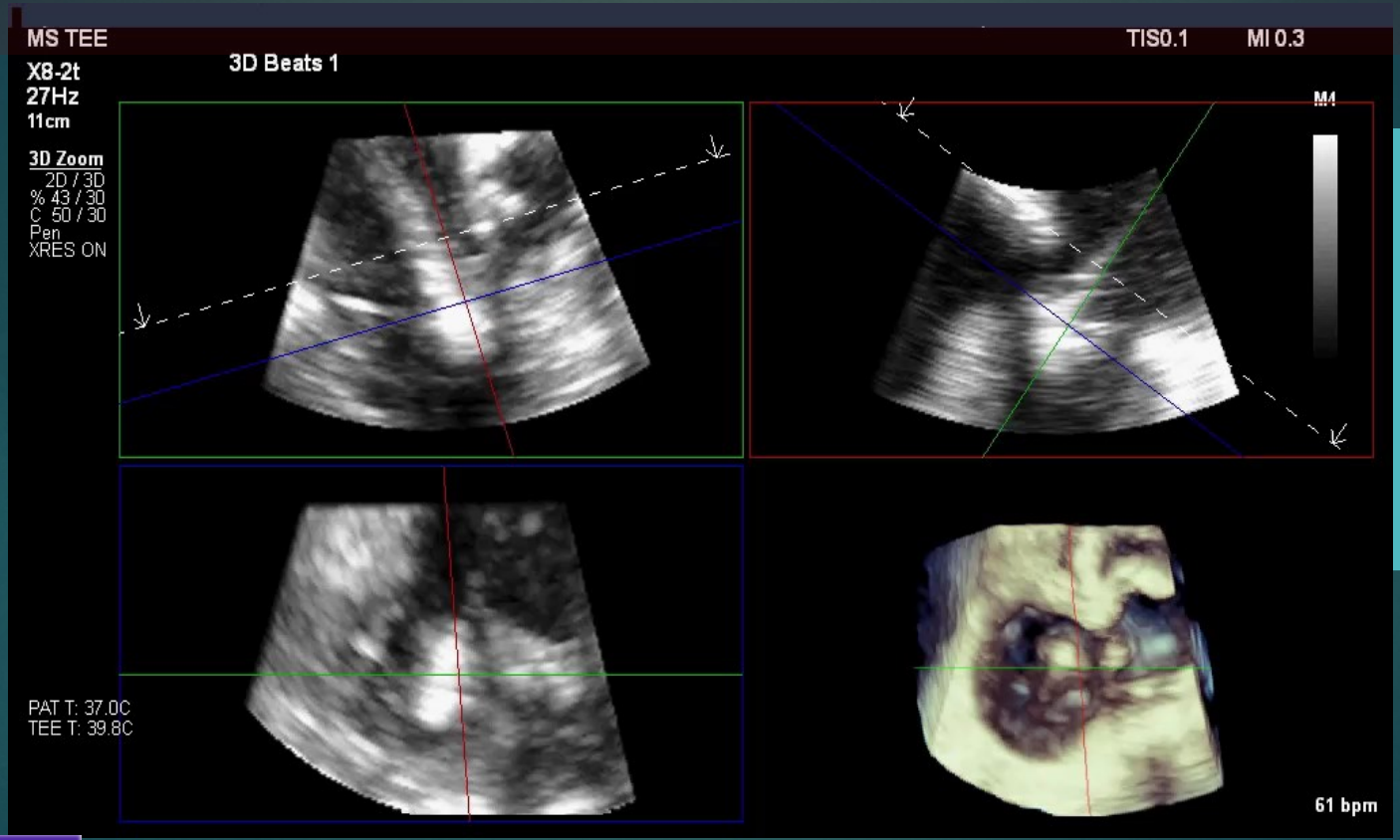
3D closing clip to cross the valve



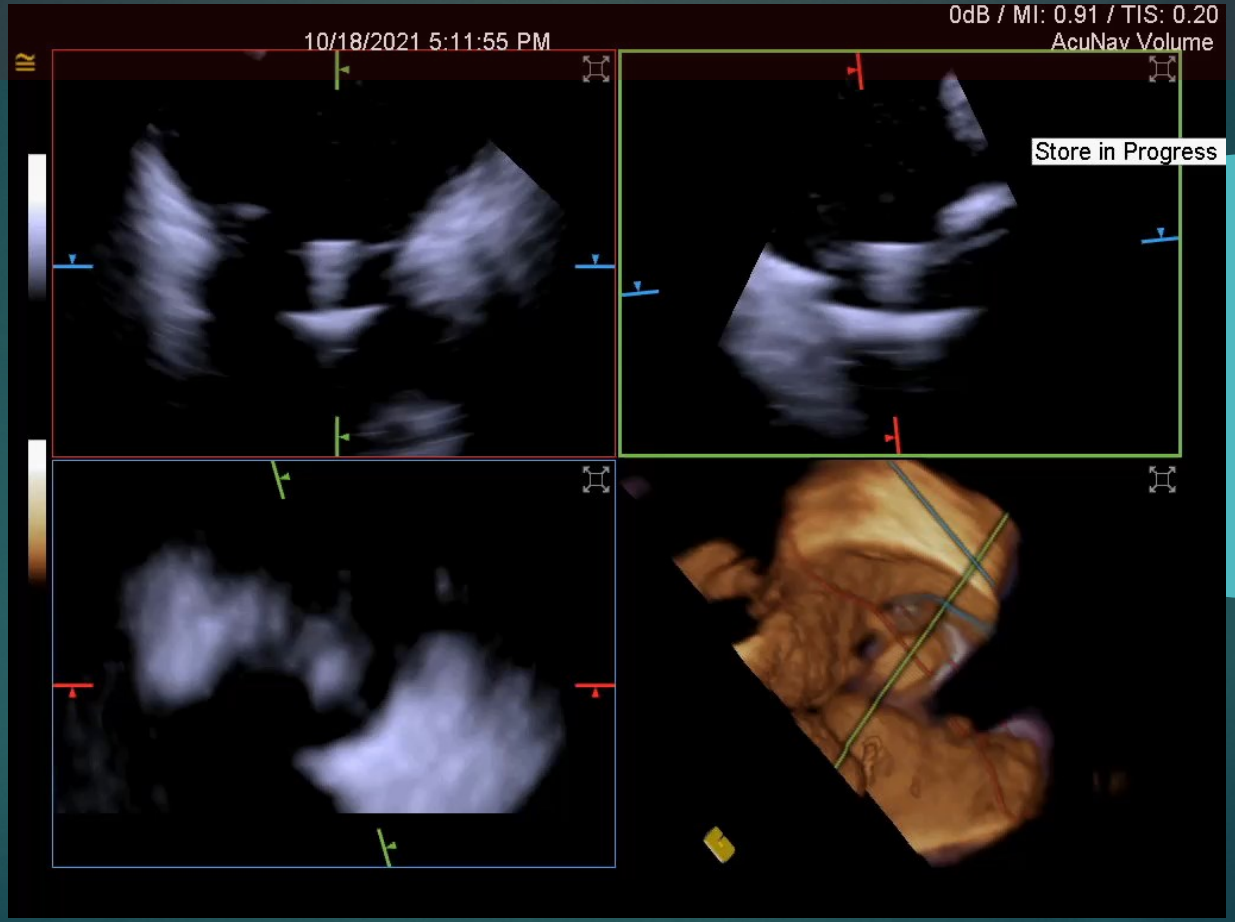
Optimize Clip Orientation in TG SAX View



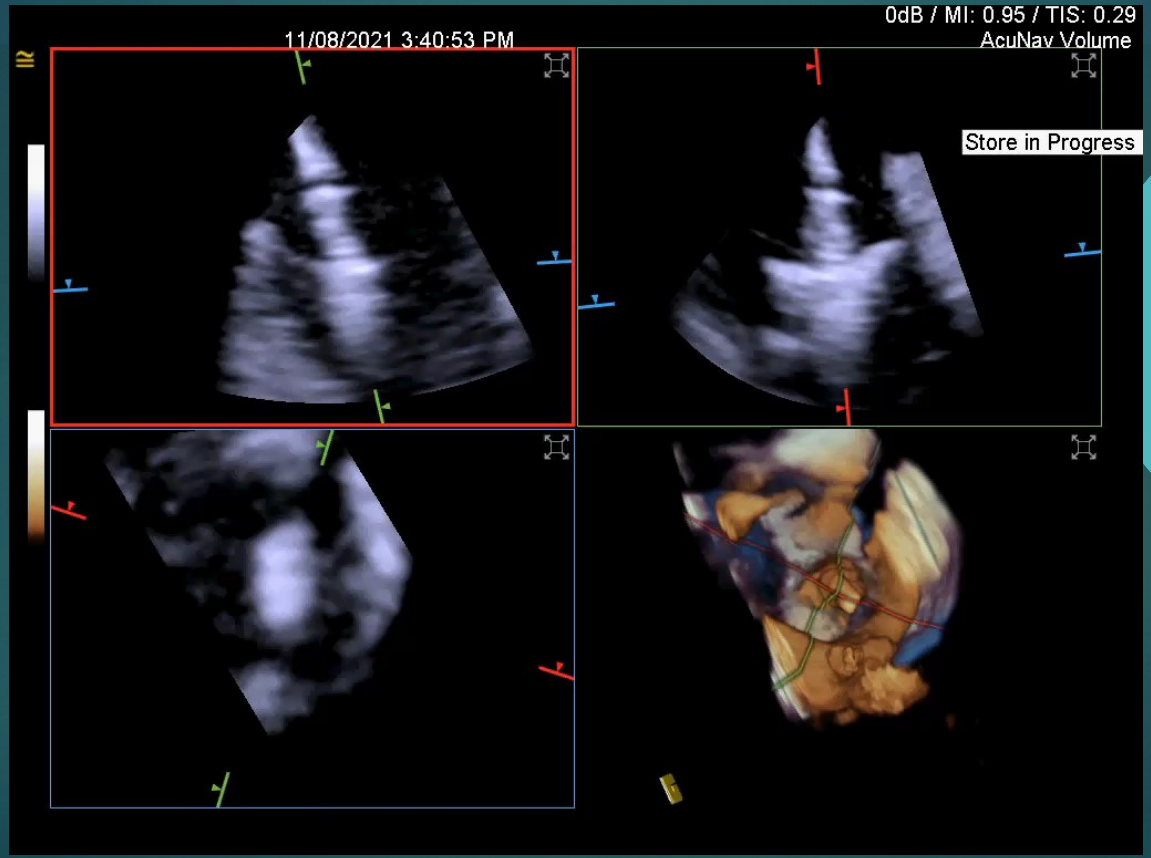
Optimize Clip Orientation and Grasping on 3D MPR View



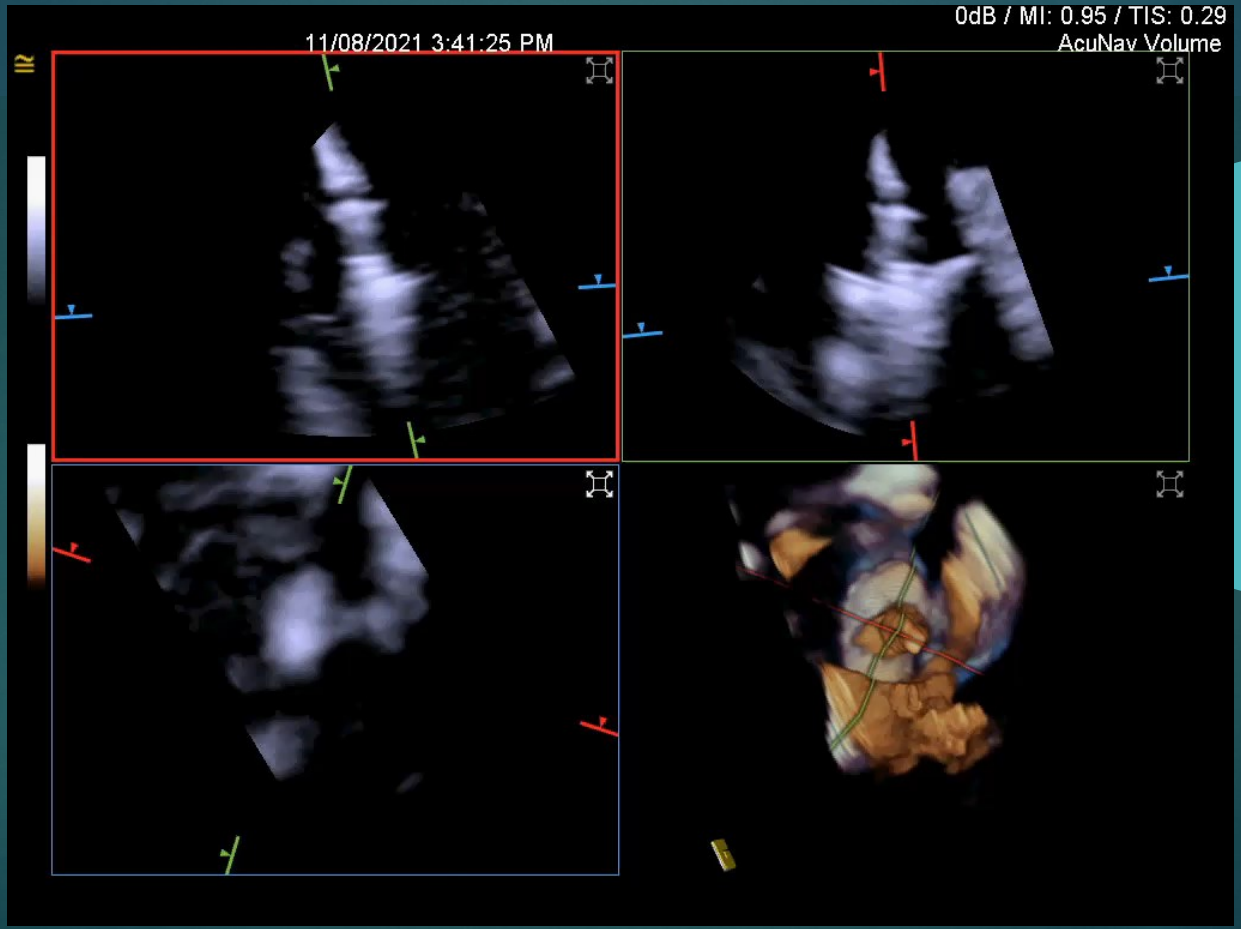
Leaflet Grasping on 4D ICE



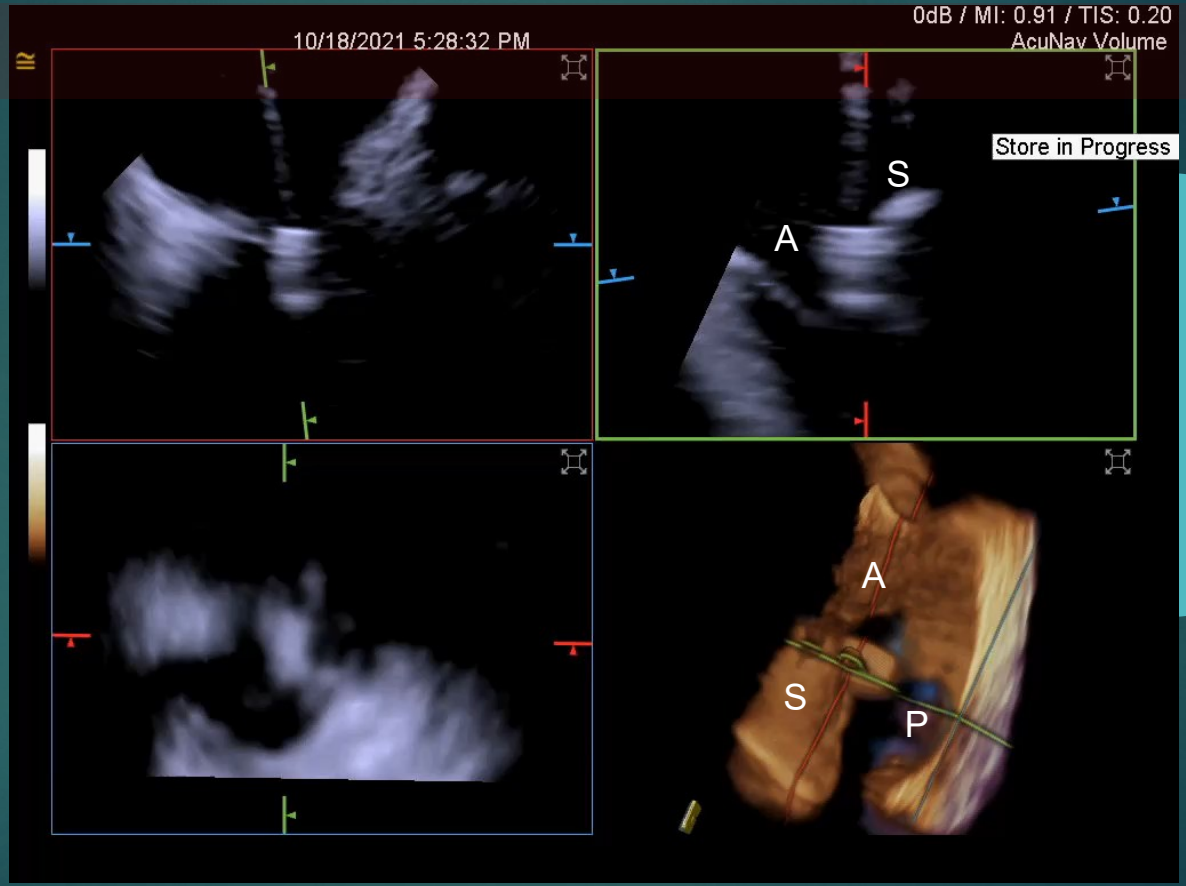
3D dropping grippers on the both leaflets



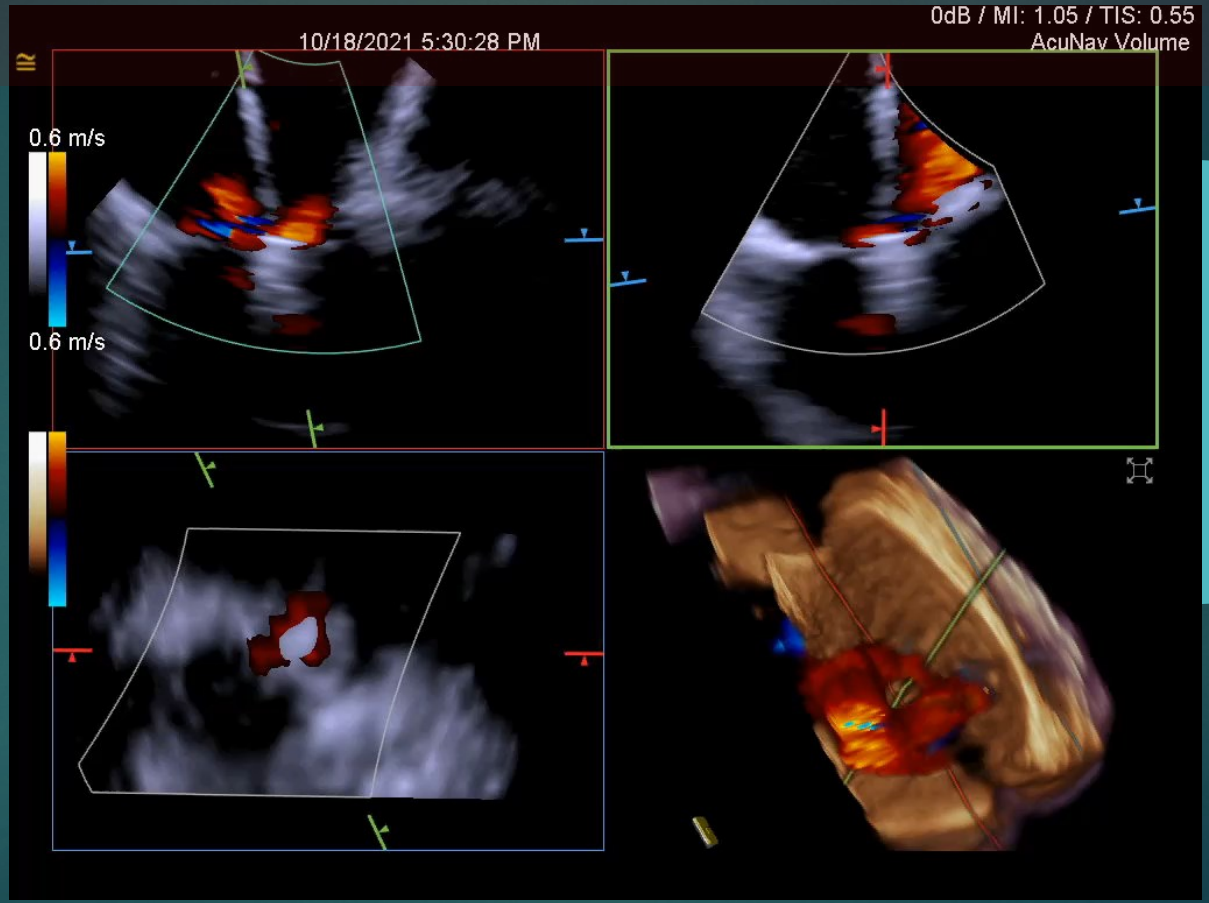
3D gripper bouncing



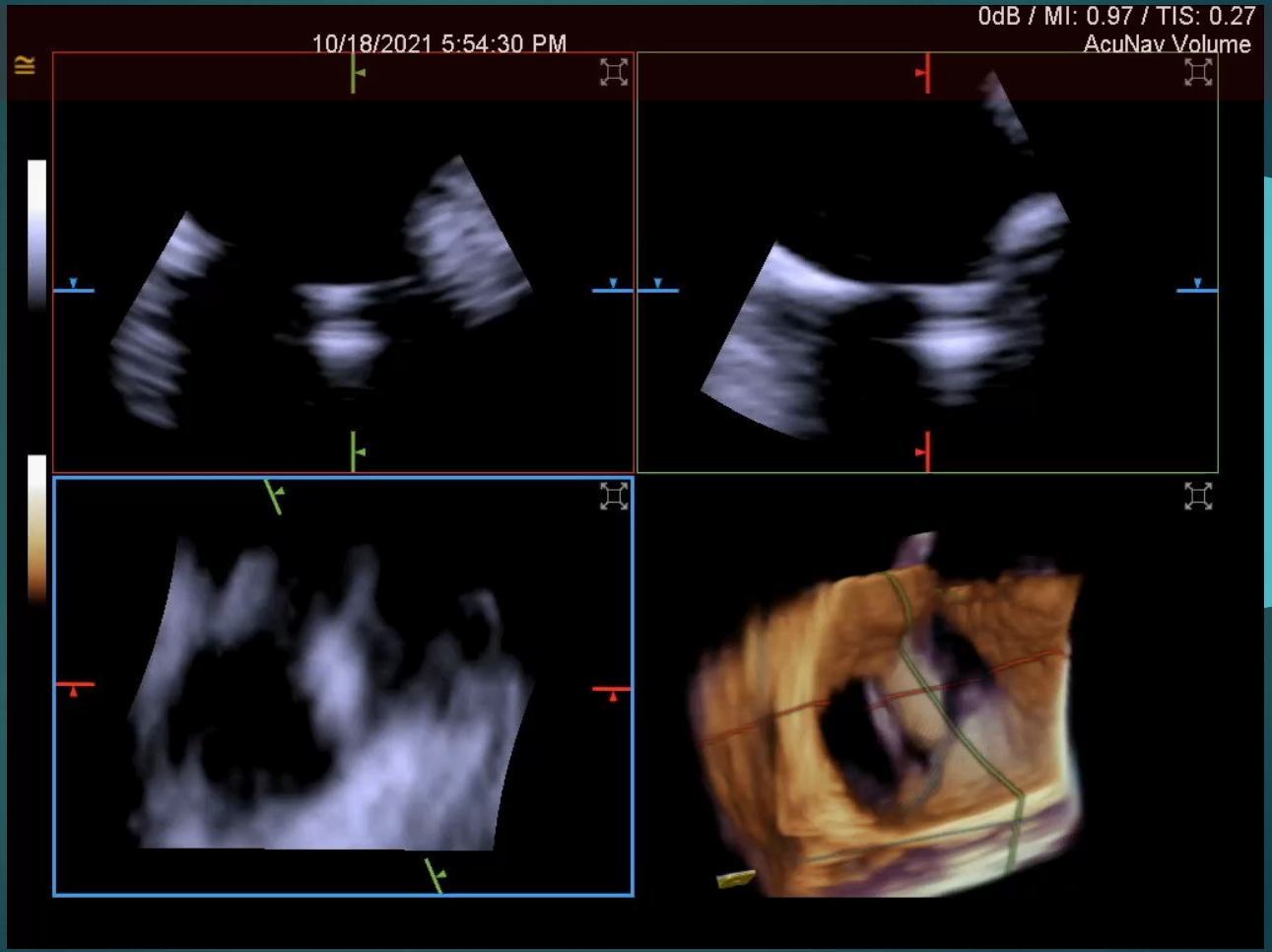
Confirm Leaflet Insertion on 4D ICE



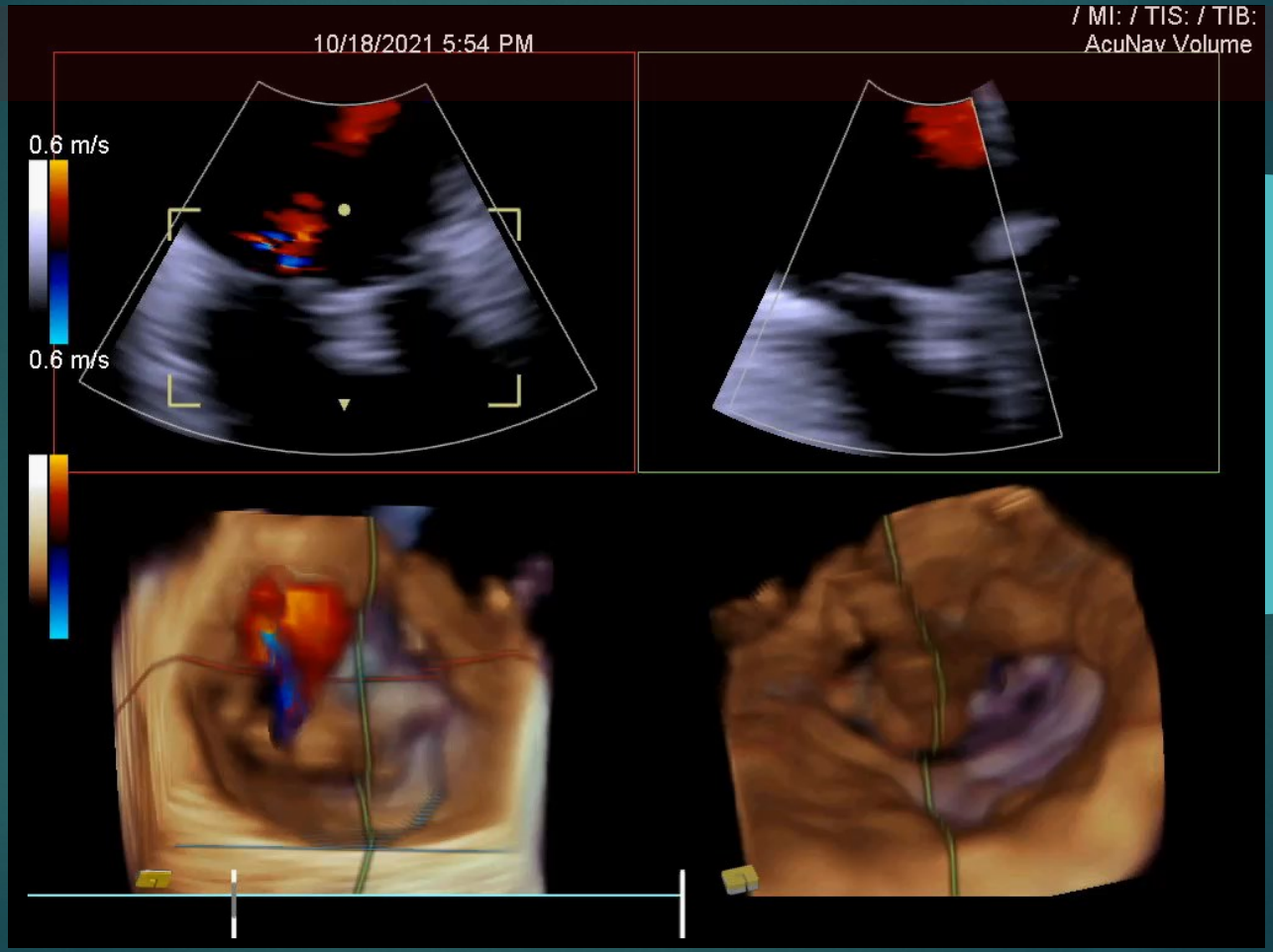
Confirm TR Reduction on 4D ICE



Final Clip Position on 4D ICE



Final TR Assessment on 4D ICE



Structural Imaging; TEE vs 4D ICE

- Complimentary
- 4D ICE when TEE is contraindicated or TEE windows are poor or there is shadowing
- Learning curve
- Reimbursement
- Driven by imagers or interventionalists or both?

THANK YOU!!!!!

Take Home Messages

- TriClip G4 system is a game changer in tricuspid TEER in more complex anatomies
- Smaller gap with better coaptation reserve more straightforward than larger gap / poorer coaptation reserve
- L femoral access: gain height from TV and may avoid septal hugger
- Anterior-septal leaflets are the most common target
- 4D ICE complementary to TEE in confirming leaflet insertion, especially in challenging imaging or anatomic situations

CASE #1
Novel Hybrid Imaging approach using 2D&3D TTE and 2D ICE for TEER

- 85 yo woman with refractory right heart failure
- Absolute contraindication to TEE due to a bleeding esophageal polyp

Mount Sinai Heart

Anastasius M et al, JASE 2021; 34(5):567-568