

# **Challenging Anatomy and Advanced Techniques**

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**15 min**

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# Disclosure Information

## Jung-Sun Kim, MD, PhD

- Grants/Research Support: None
- Support/Consultant: None
- Speaker's Bureau: Abbott Vascular

# MITRACLIP™ G4 DESIGN

## CLIP ARMS OVERVIEW

Clip Length

Coaptation Length

Clip Arms at 120°

Clip Arms at 180°

G4 NT & G4 NTW

G4 XT & G4 XTW

~ 6 mm\*

~ 9 mm\*\*

G4 NT & G4 NTW

~ 9 mm\*

~ 12 mm\*\*

G4 XT & G4 XTW

\* Leaflet insertion needed to engage all frictional elements

\*\* Clip Arm length

4 mm

6 mm

50% wider in the grasping area

4 mm

6 mm

50% wider in the grasping area

NT/XT

NTW/XTW

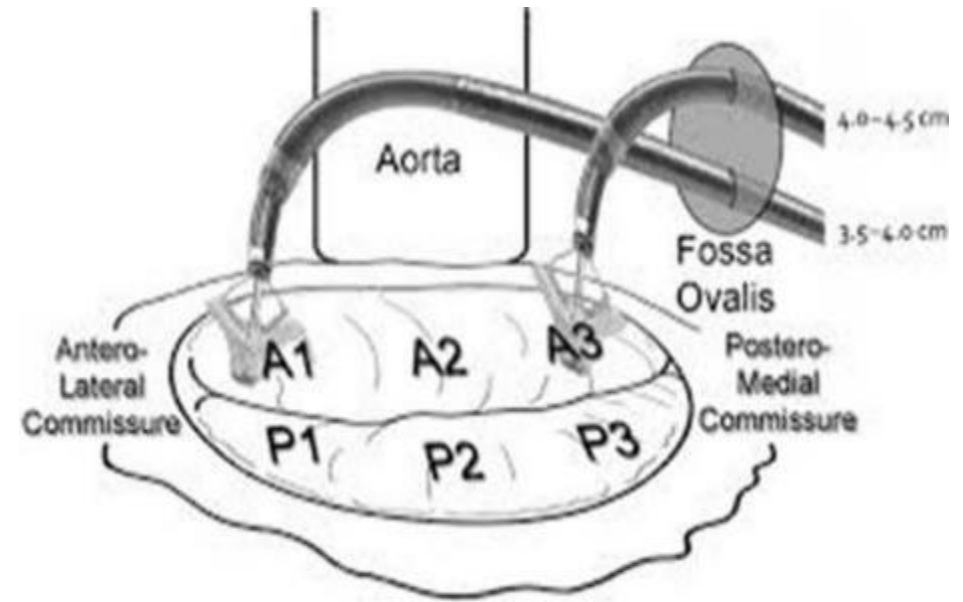
# Issues of Septal Puncture

# Optimal Puncture Site

Consideration: *Etiology and site of MR*

- TSP must be performed in the **mid-posterior part** of the fossa ovalis and at a sufficient distance (height) from the mitral valve
- **Primary MR**, the TSP height should be **4.5–5 cm above the mitral annulus** to allow the capture of prolapsed valves.
- **Secondary MR**, the puncture site must be lower, approximately **4.0-4.5 cm above the annular plane** in order to be able to advance the catheter more deeply into the LA because of valve tethering.

Better to **have more rather than less height**, and thus a transseptal puncture height of **≥4 cm** is usually favorable.



Atrial MR - **4.5–5 cm above the mitral annulus**

Medial site needs a greater height than lateral site.

Sharma V, et al. US Cardiology Review 2022;16:e24

# MitraClip Device Component Movement

	ANTERIOR	POSTERIOR	MEDIAL	LATERAL	LOSE HEIGHT ABOVE VALVE	GAIN HEIGHT ABOVE VALVE
<b>Steerable Guide Catheter (SGC)</b>						
Plus (+)		++	+		+	
Minus (-)	++			+		+
Clockwise rotation		++				+
Counter-clockwise rotation	++				+	
<b>Clip Delivery system (CDS)</b>						
Medial (M)			+++		+	
Lateral (L)				+++		+
Posterior (P)		+	+		+	
Anterior (A)	+			+		+
<b>Stabilizer</b>						
Push In (L)				+		
Pull out (M)			+			

It is important to note that the movements of the steerble sleeve are only predominant in their direction, and are not pure in any single path.

Transcatheter Edge-to-Edge Repair. Textbook of SCAI

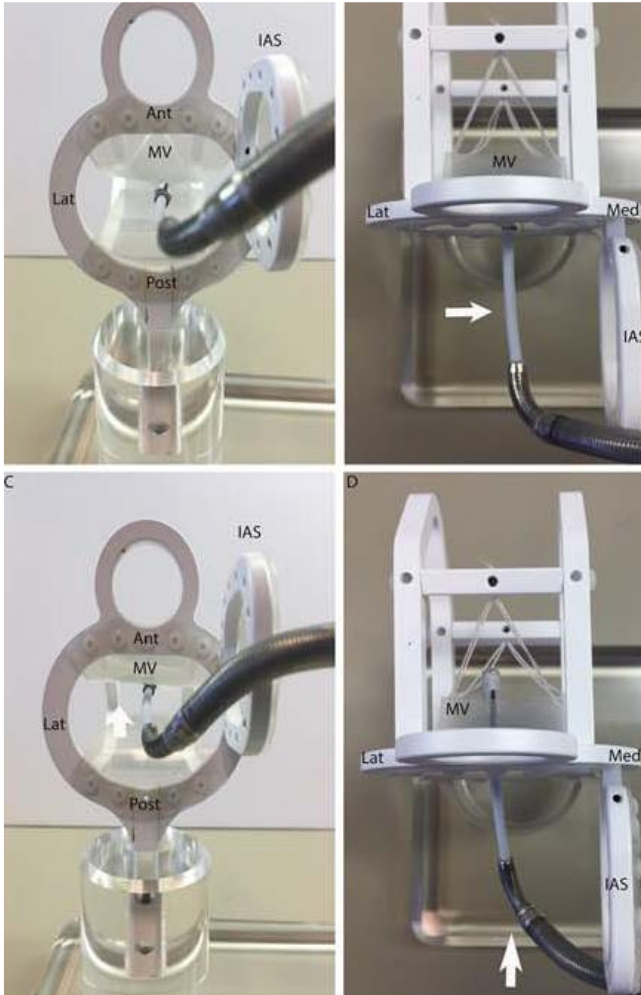
## Anterior Transseptal Puncture or “Aorta Hugger



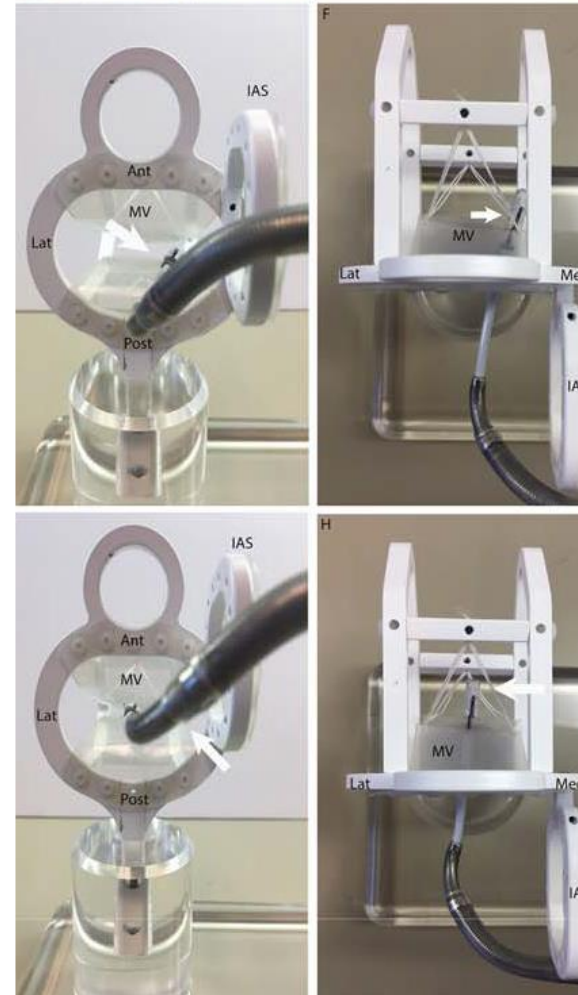
**Transcatheter Edge-to-Edge Repair. Textbook of SCAI**  
**Sharma V, et al. US Cardiology Review 2022;16:e24**

# Clinical Situations

## Transseptal height is too High



SGC is rotated  
counter-clockwise  
(anteriorly)



application of “**P**” on the  
“A/P” knob to steer the  
CDS posterior to the  
mitral valve.

releasing the “**M**” knob or  
advancing the SGC  
superiorly may be required  
to move laterally

Sorajja P, et al. CCI 2017

# Clinical Situations

## Transseptal height is too Low

SGC is rotated **clockwise (posteriorly)**, with anterior correction of the SS by applying **“A” on the “A/P” knob**. As the turning toward “A” also moves the system laterally, application of the **“M” or withdrawal of the SGC** to move medial may be required.

## Chordal Entrapment

Aiming for an *adequate height during the transseptal puncture, avoidance of sleeve deflections of more than 90 degrees* (careful use of the M knob), and maintaining the MitraClip in the LA, above the leaflets until ready to grasp. Once the operator has advanced the MitraClip into the LV, past the mitral valve leaflets, only minimal device manipulations should be performed in **LV**

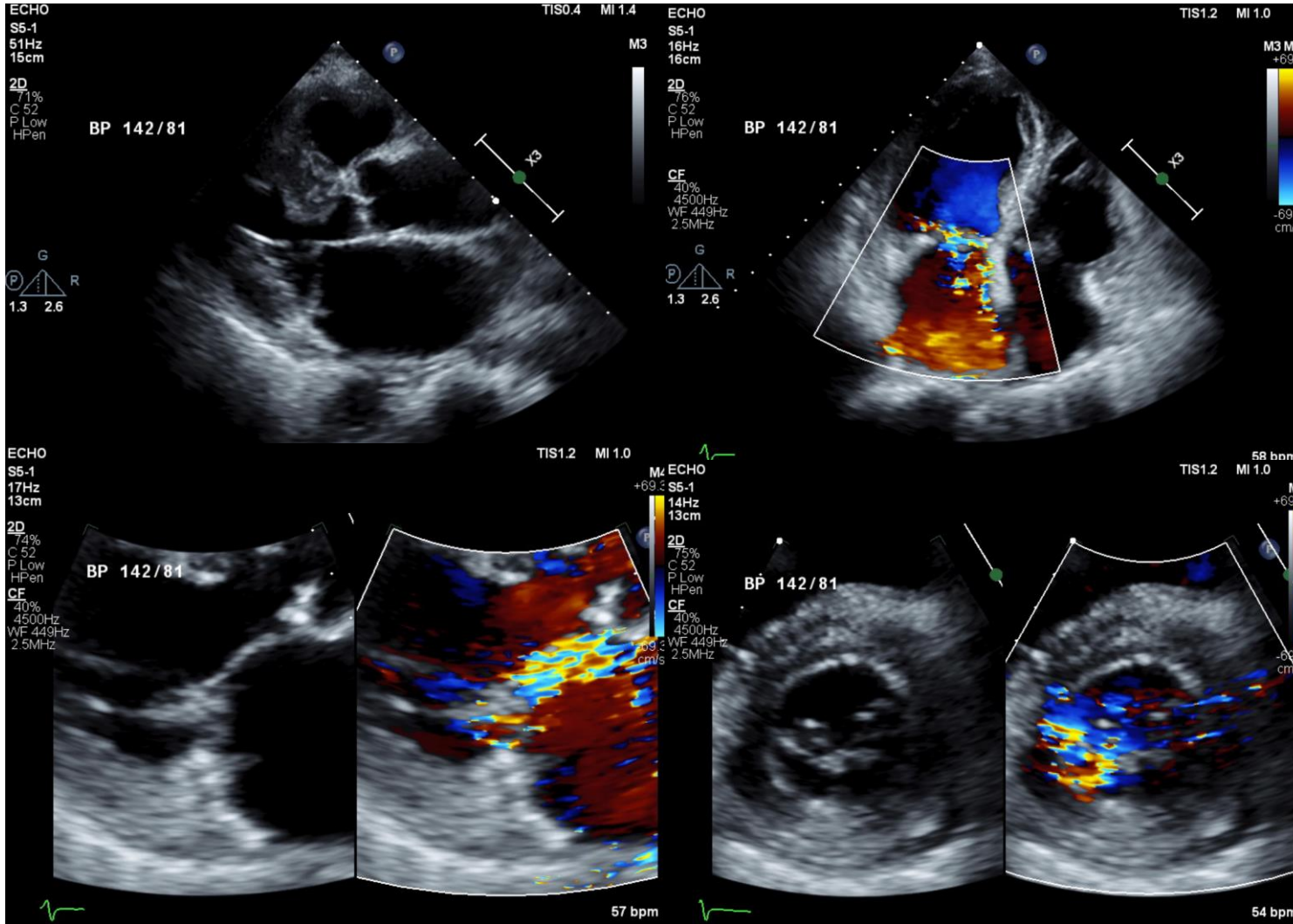
1. Invert a Clip
2. Rising and/or lowering of the grippers
3. Reverse ordered maneuvers
4. Converted to a surgical procedure
5. If not surgical candidate, may need to be placed within the chordal apparatus

Sorajja P, et al. CCI 2017

# Brief history

- F/86
- Height: 145.5 cm / Weight: 44.4 kg / BSA: 1.34 m<sup>2</sup>
- Chief complaint
  - Dyspnea on exertion, orthopnea (Onset : 3 months ago )
- Comorbidities
  - Hypertension, dyslipidemia
  - Ovarian tumor
  - Alzheimer dementia
- STS score : 5.44% for MV repair, 6.94% for MV replacement

# Transthoracic echocardiography

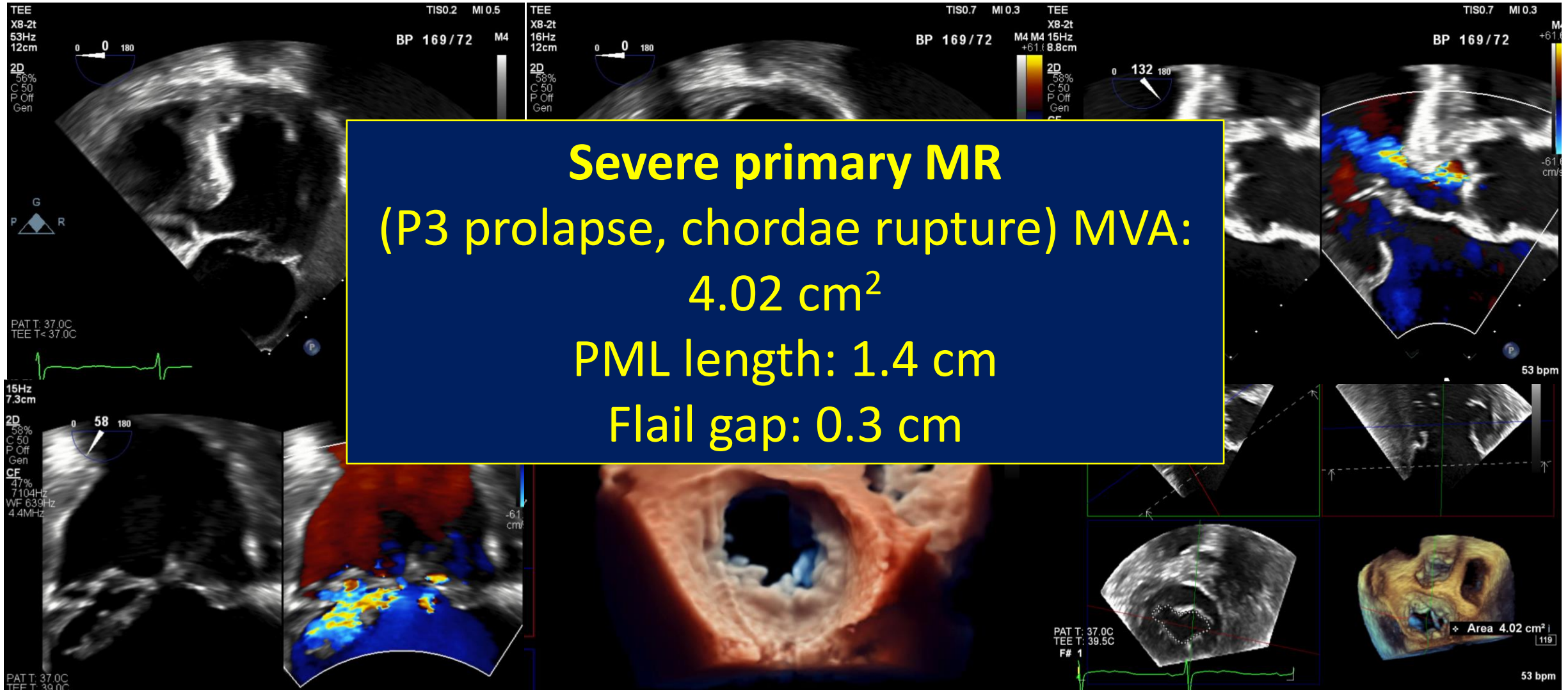


**Severe MR, PML prolapse**  
(GIV, ERO: 32 mm<sup>2</sup>, RV: 57 ml)  
Mild TR

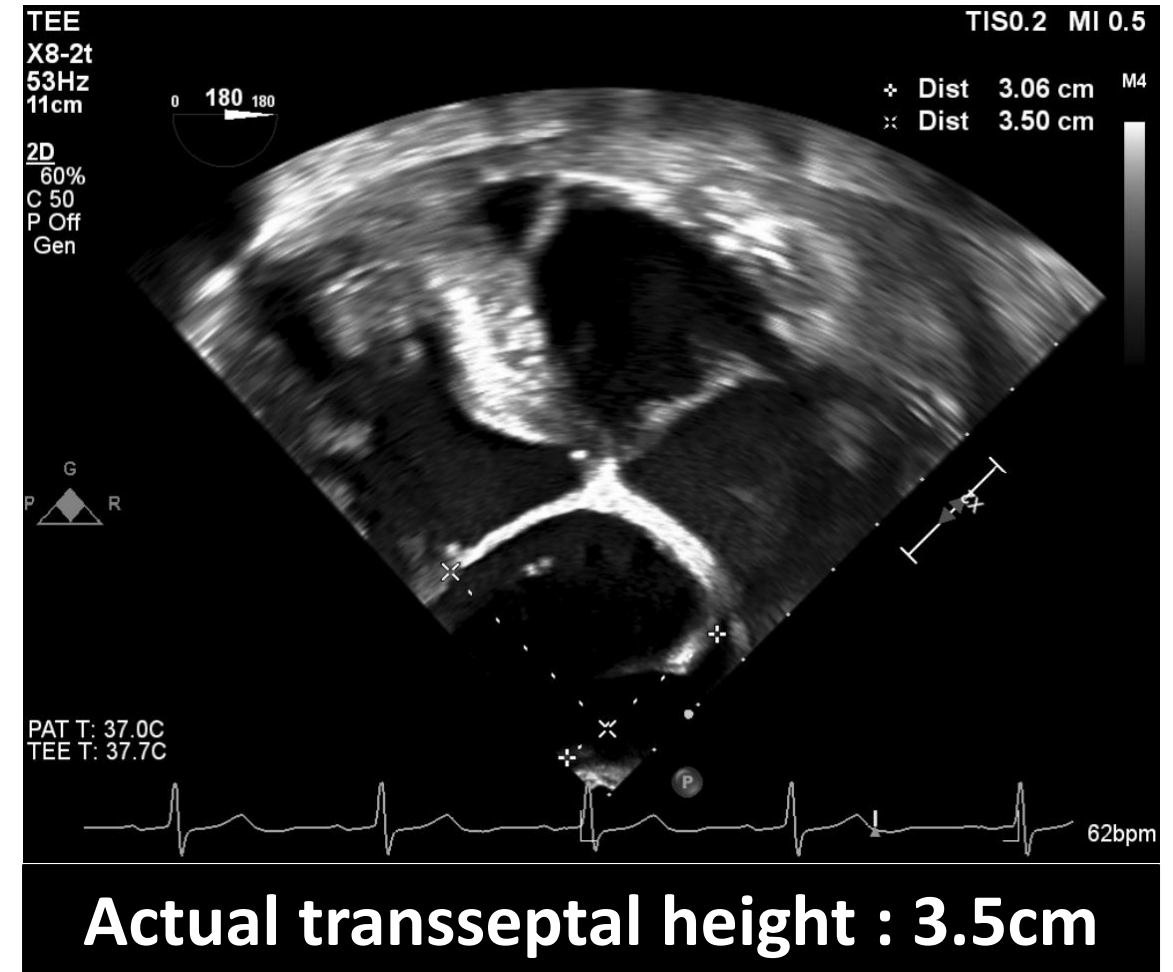
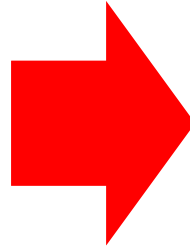
EF: 74%, LVEDD/ESD: 50/30 mm,  
E/e' : 27

LAVi: 66.1 ml/m<sup>2</sup>,  
RVSP: 49 mmHg

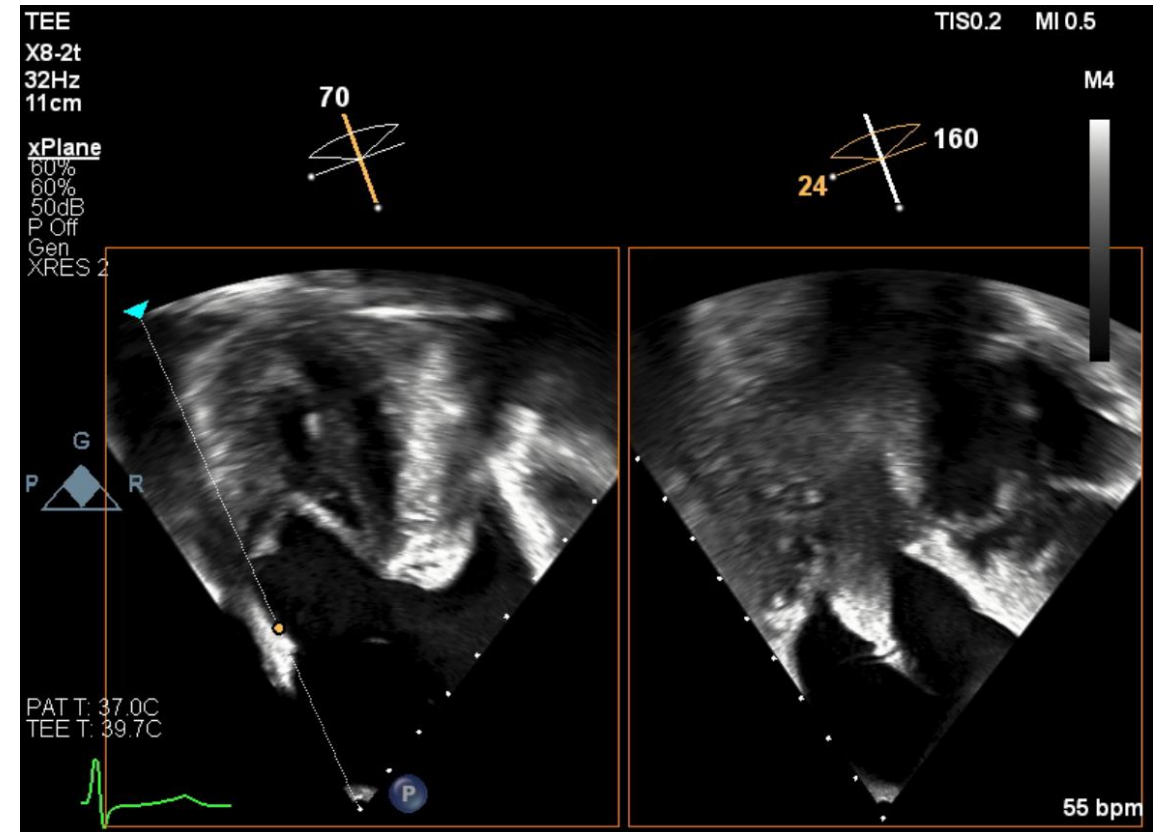
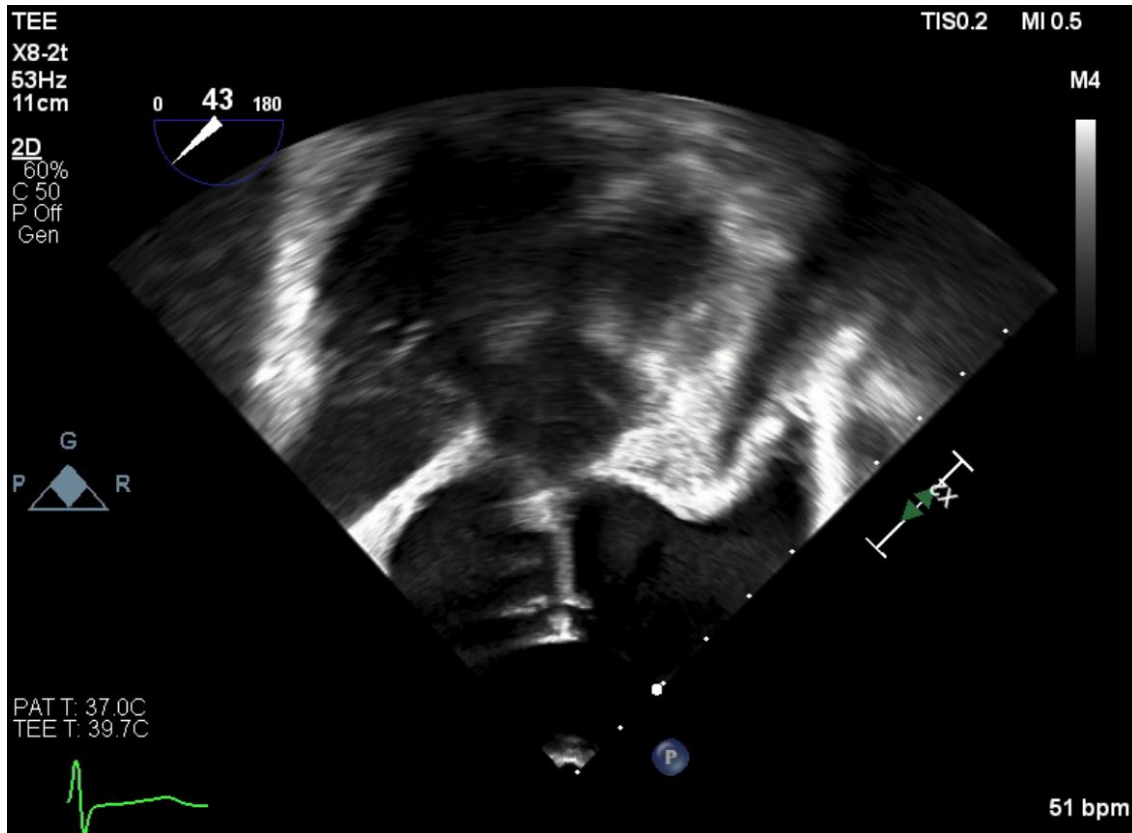
# Transesophageal echocardiography



# TEER : Transseptal puncture

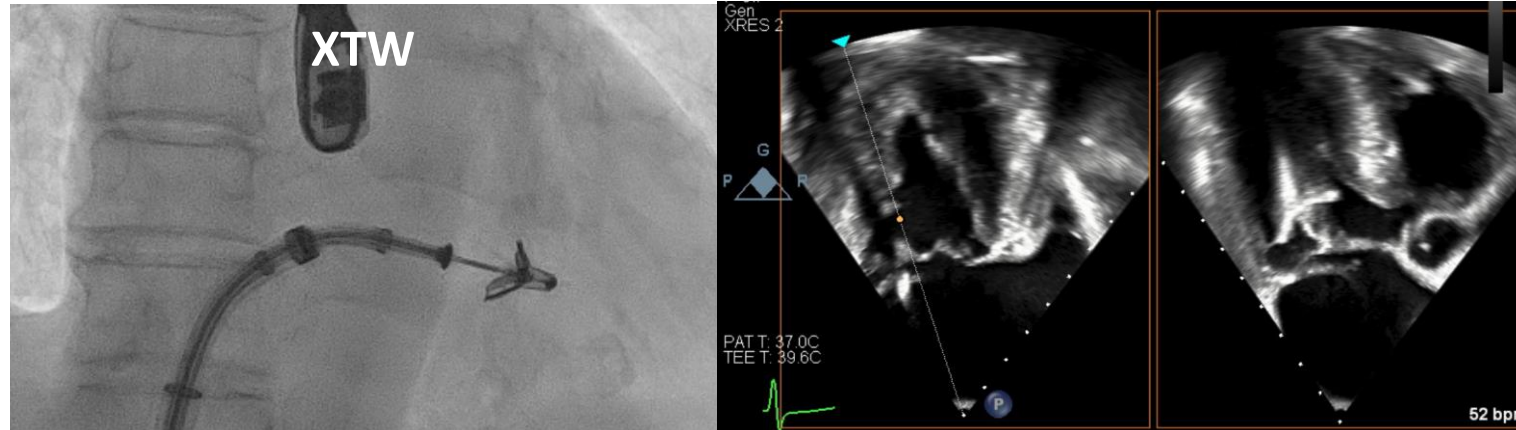


# Low height clip maneuver

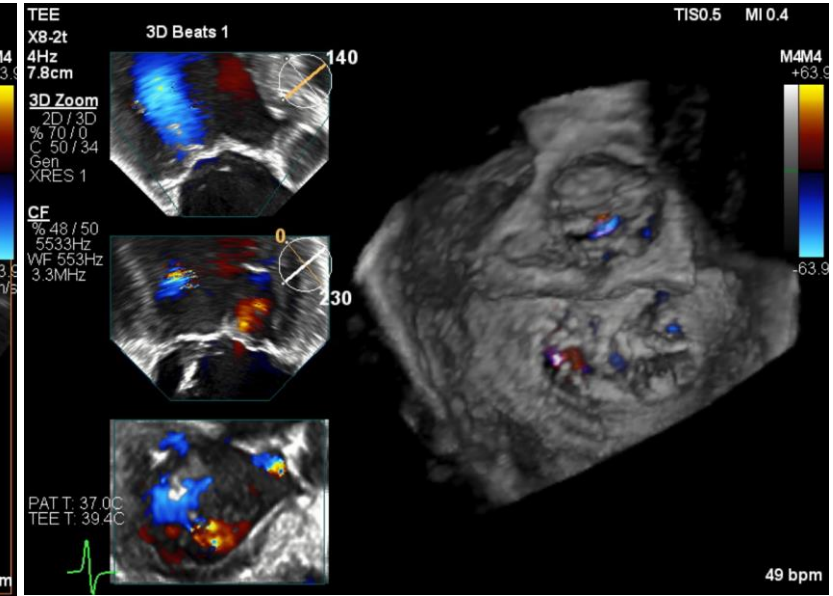
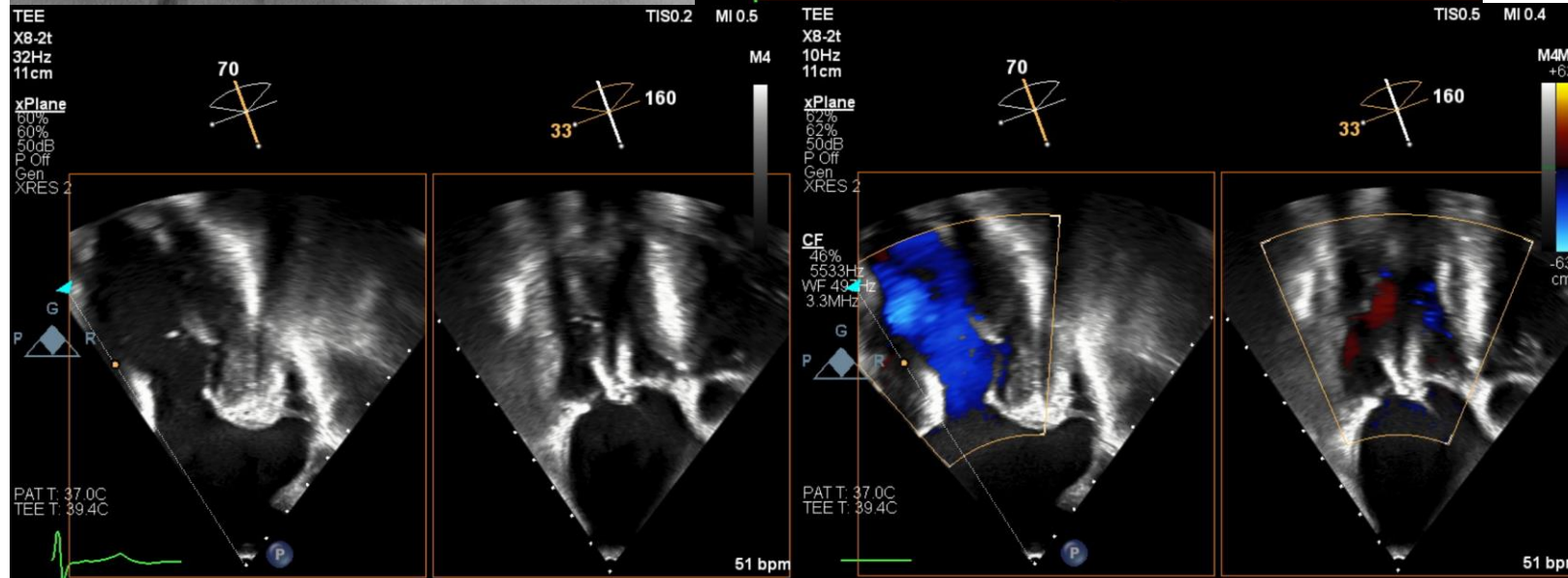


1. Posterior movement
2. A knob
3. Medial movement

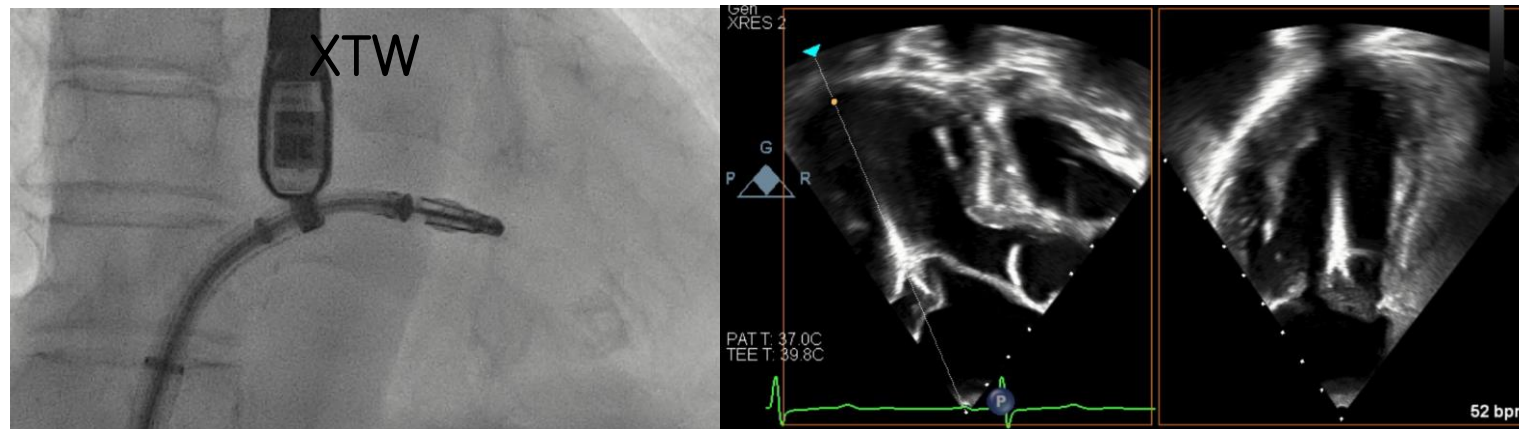
# TEER – 1<sup>st</sup> clip 1<sup>st</sup> attempt



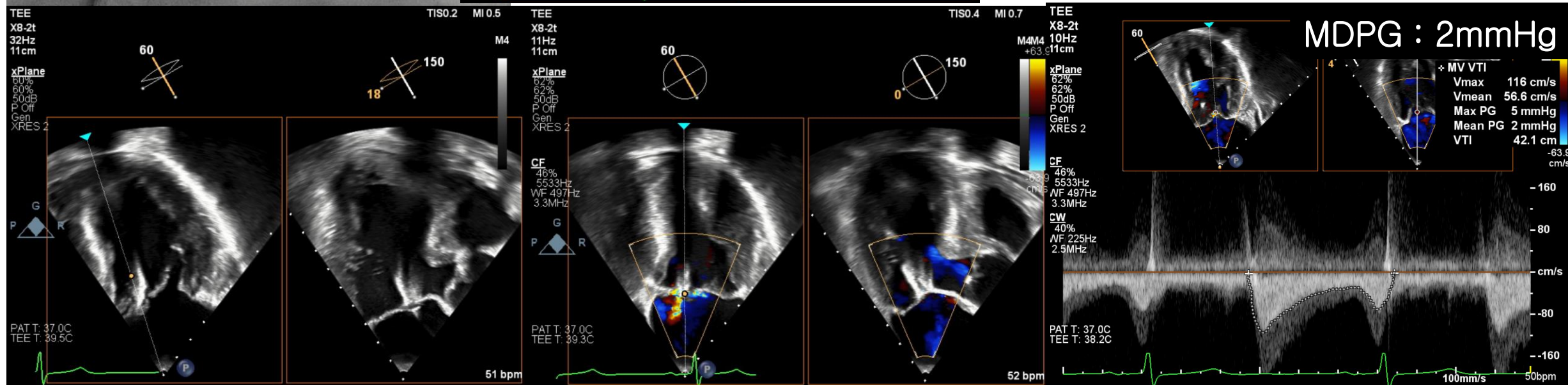
- ✓ Trajectory check
- ✓ Perpendicularity check
- ✓ Grasping the leaflets



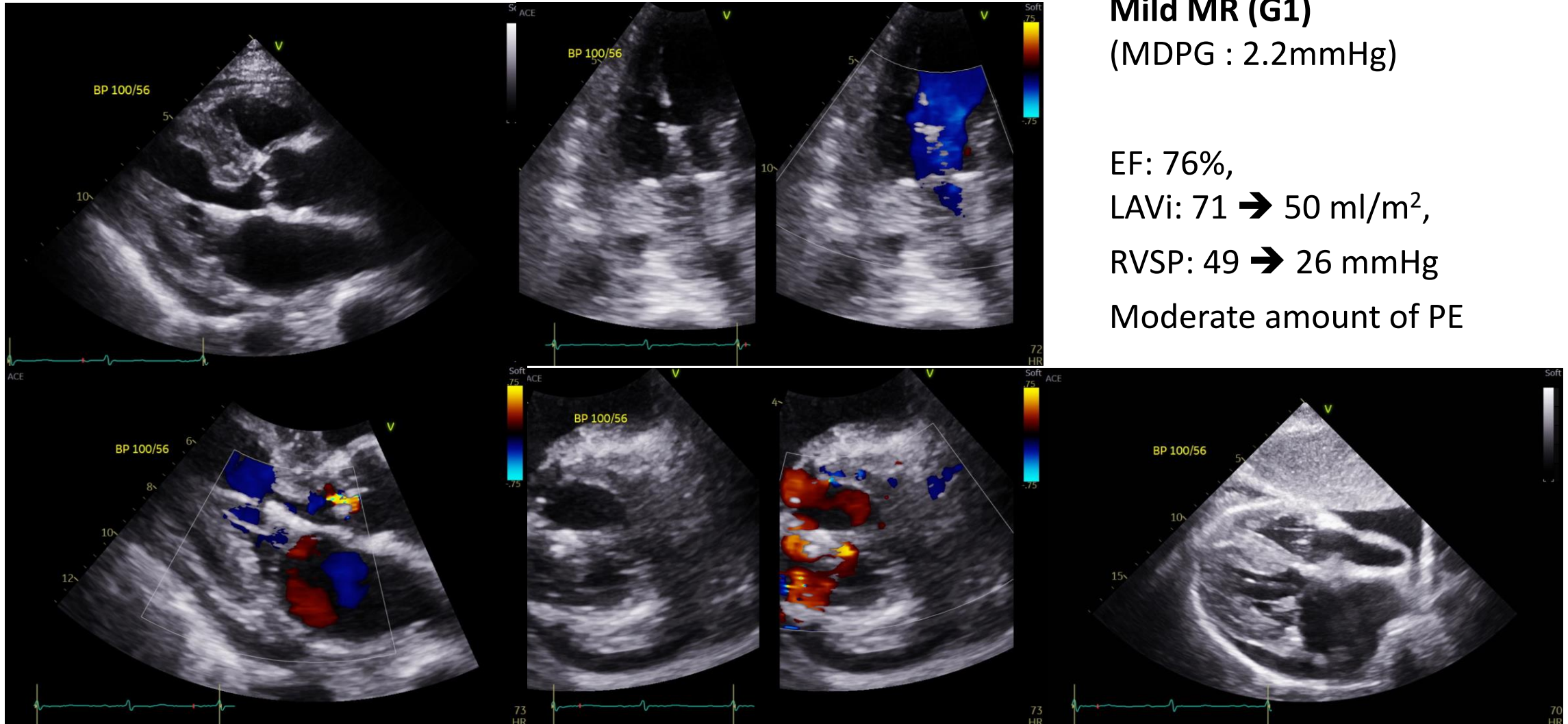
# TEER – 1<sup>st</sup> clip 2<sup>nd</sup> attempt



- ✓ More stable clip position
- ✓ More reduced MR



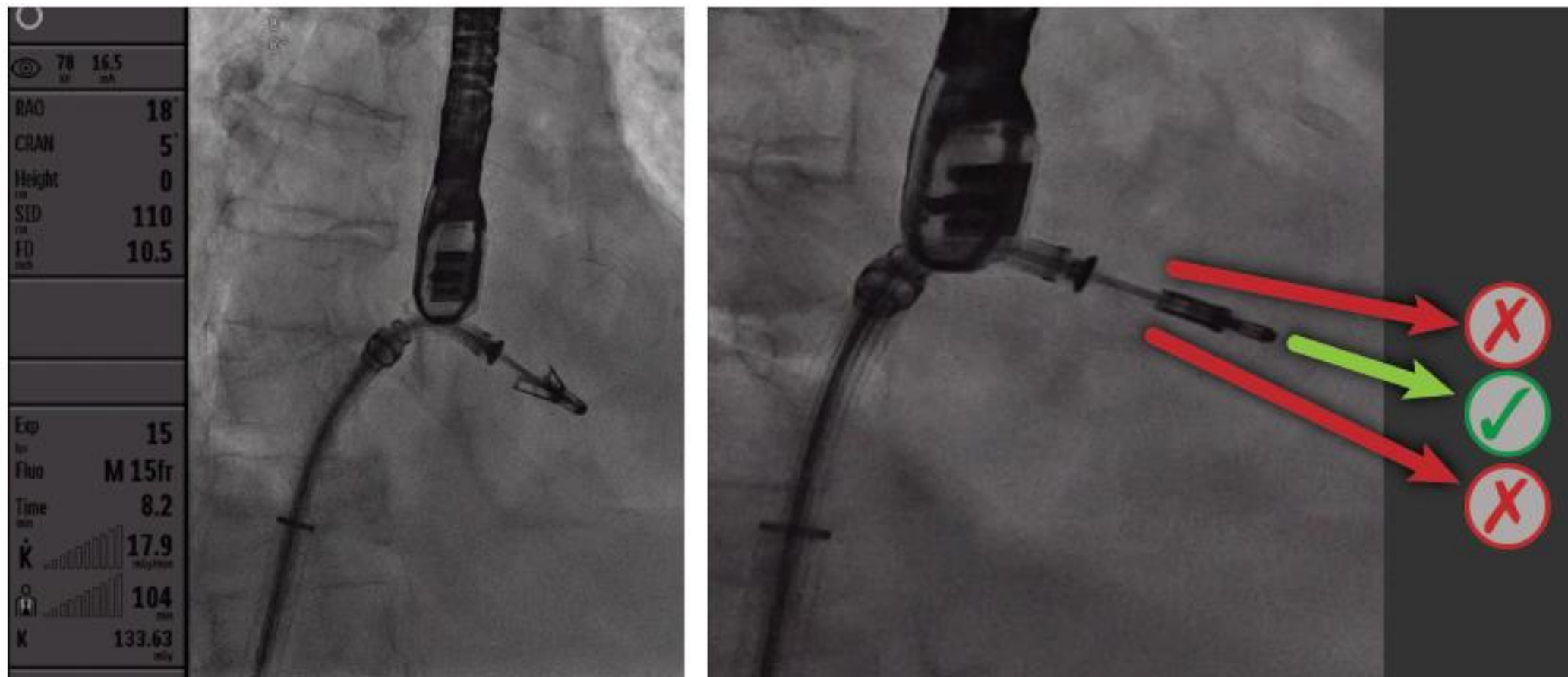
# Post TEER TTE



**Mild MR (G1)**  
(MDPG : 2.2mmHg)

EF: 76%,  
LAVi: 71 → 50 ml/m<sup>2</sup>,  
RVSP: 49 → 26 mmHg  
Moderate amount of PE

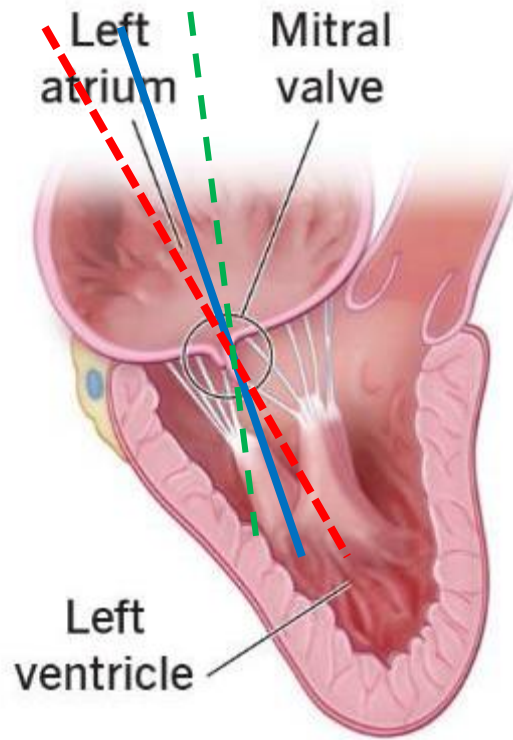
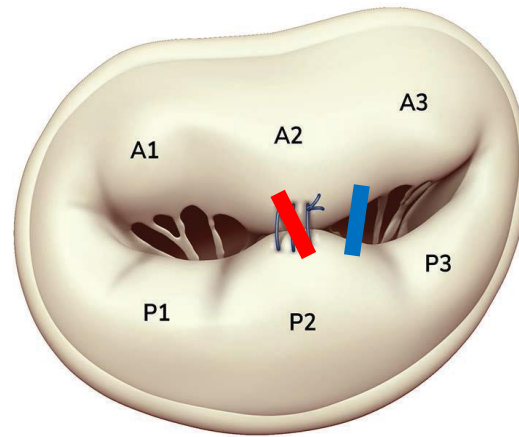
# Issues of Clip Trajectory and Clip Orientation



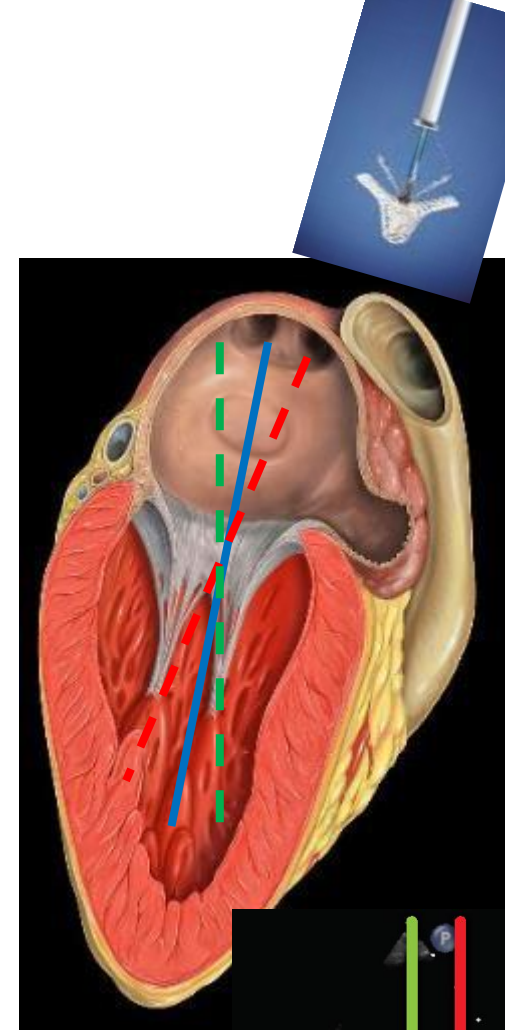
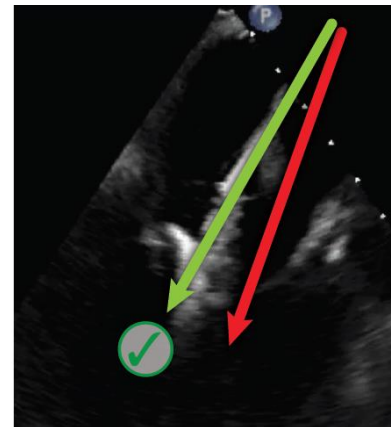
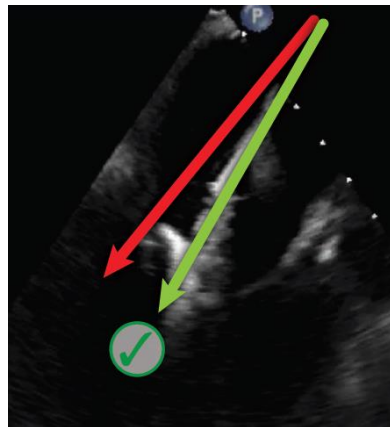
**Figure 10. Removing Parallax and Using M Knob for Optimal Entry Trajectory**

(Left image) Clip with arms open but parallax not removed. The fluoroscopic angle is changed to superimpose the clip arms (removing parallax) and then the clip is advanced under TEE and fluoroscopy into the LV. (Right image) Correcting from the red arrow trajectories to an optimal fluoroscopic entry trajectory (green arrow) can be achieved by adding or removing M knob.<sup>1</sup>

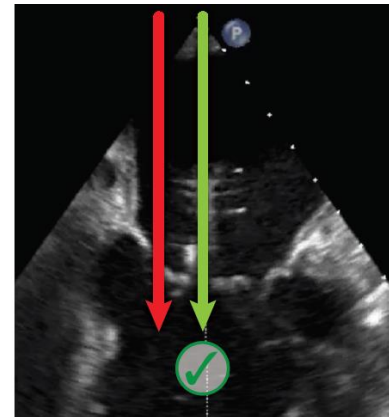
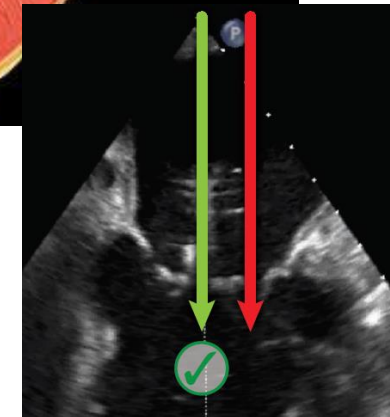
# Trajectory



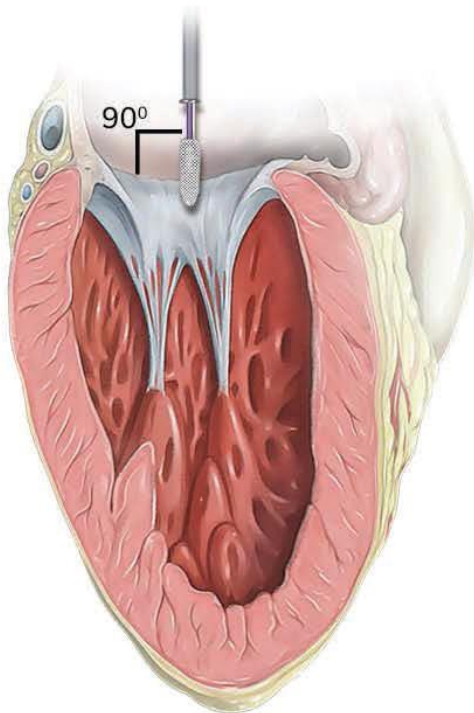
**Anterior and Posterior Trajectory**



**Medial and Lateral Trajectory**

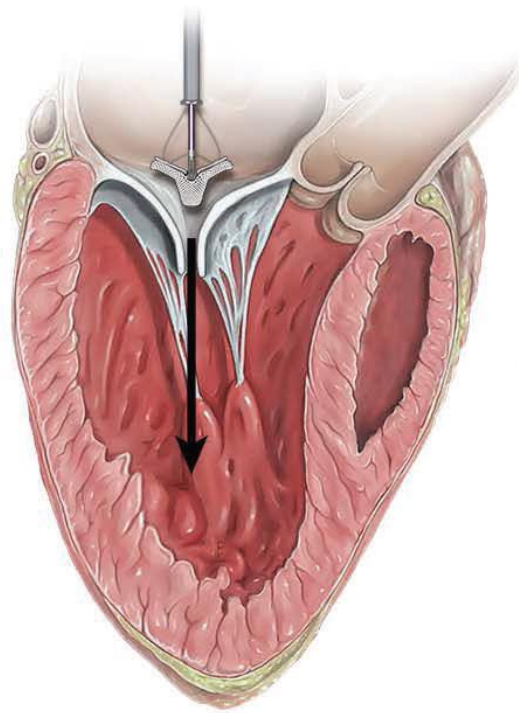


## BICOMM VIEW

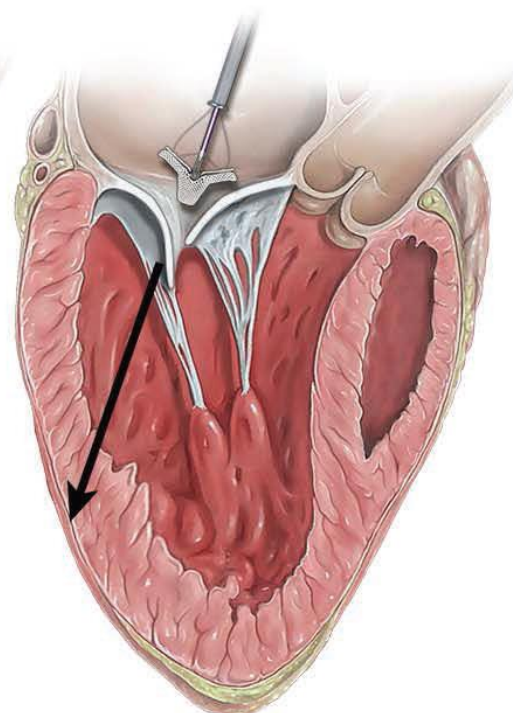


Clips should be orthogonal to mitral annular plane

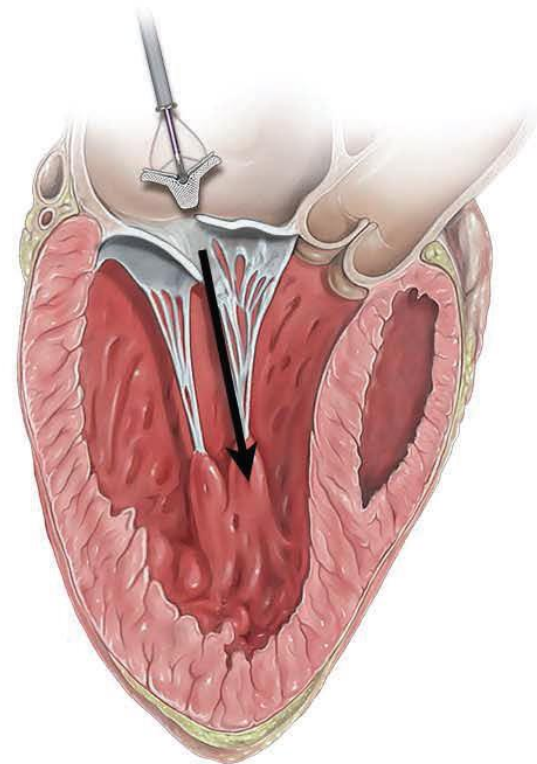
## LVOT VIEW



Symmetric tethering



Asymmetric tethering

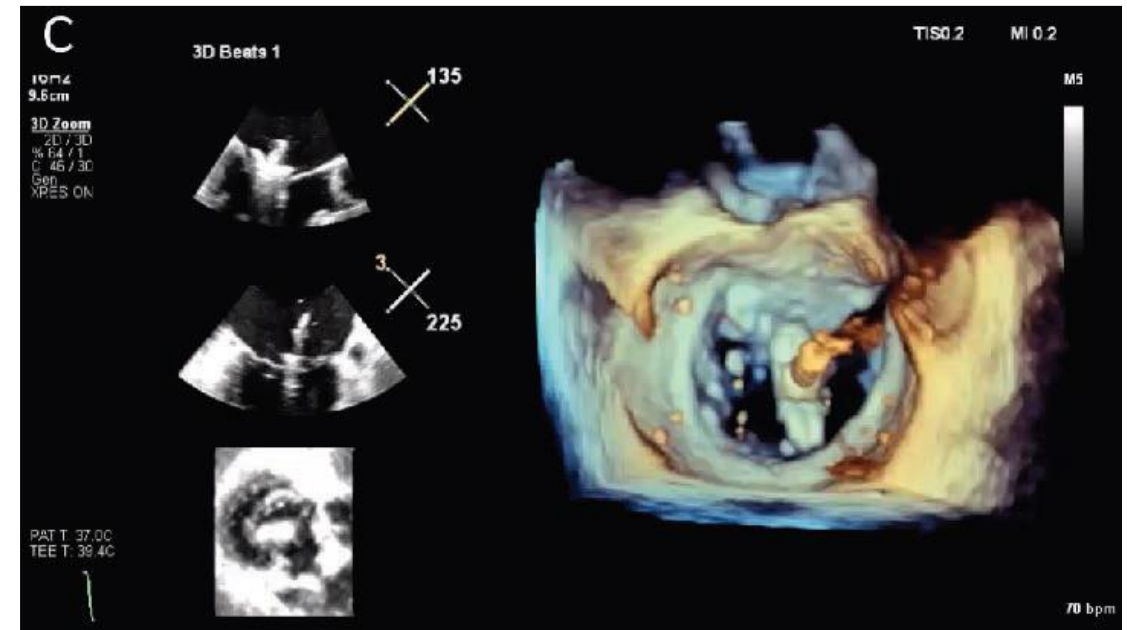
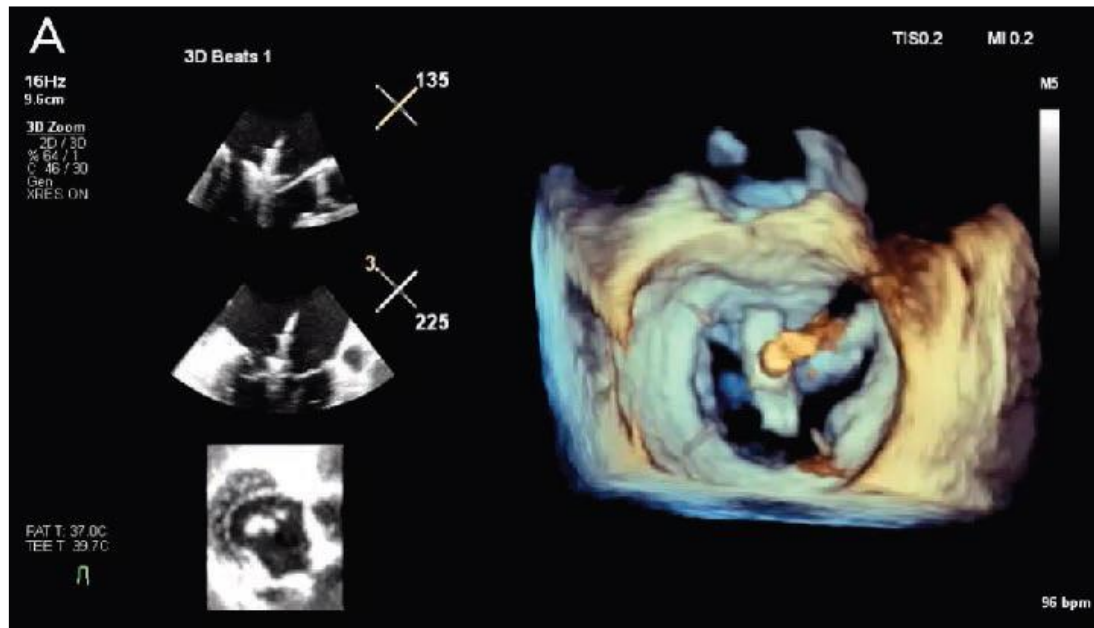
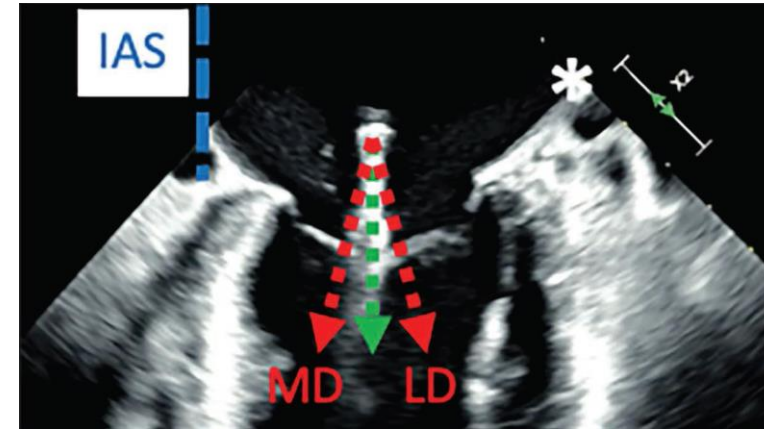
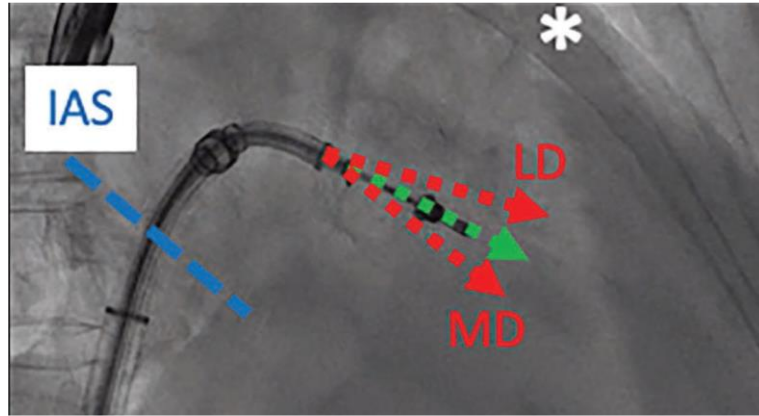


Anterior leaflet prolapse



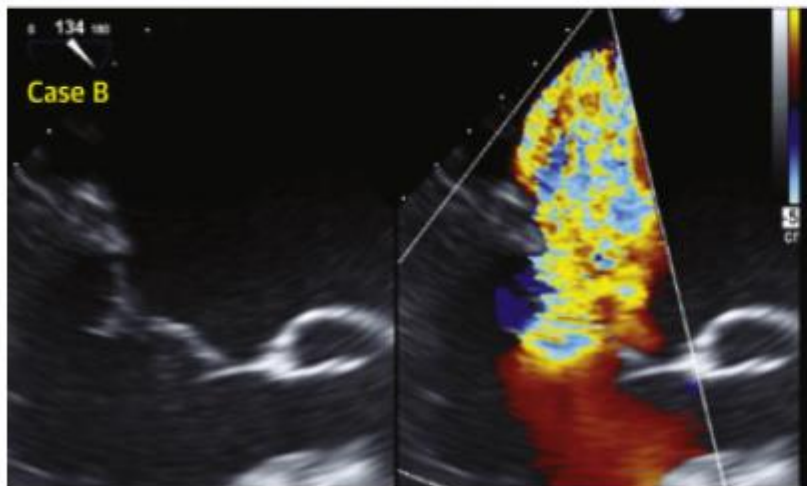
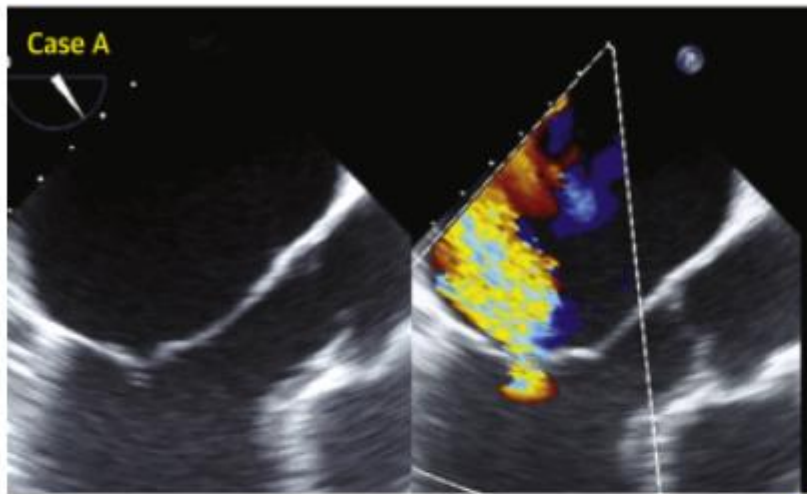
Transcatheter Edge-to-Edge Repair. Textbook of SCAI

# Trajectory and Perpendicularity – Clip orientation

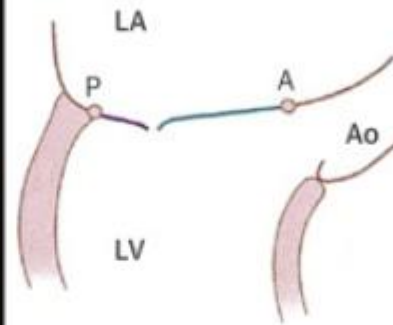


Transcatheter Edge-to-Edge Repair. Textbook of SCAI

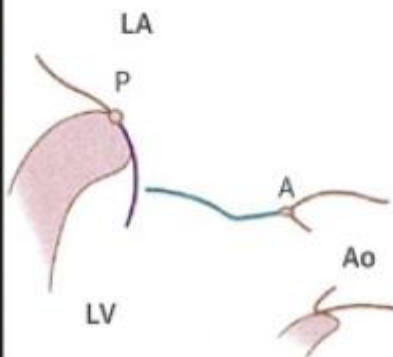
Transesophageal echocardiography



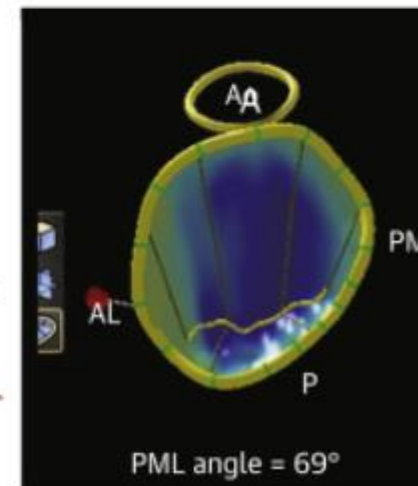
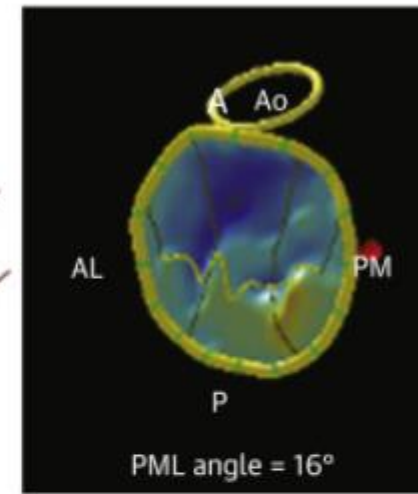
Schema



XT or XTW



3D modeling



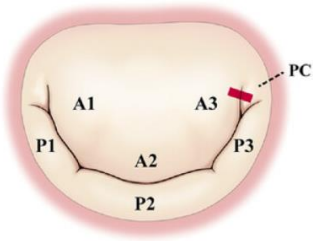
2 cases with different anatomical characteristics of the mitral valve.  
An annuloplasty alone may not always be effective.

Short PML -> NT or NTW

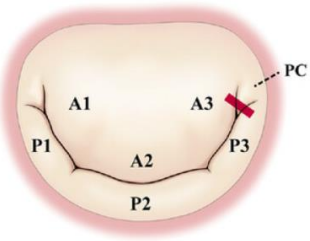
Kagiyama N, et al. J Am Coll Cardiol Img. 2020;13:820–835

## A) Posterior commissure case

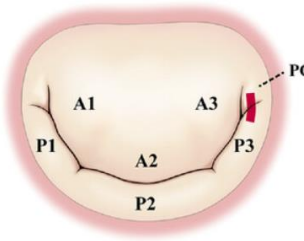
(a) A3-PC grasping



(b) Medial A3-P3 grasping

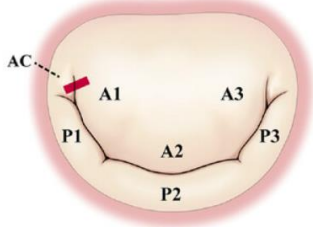


(c) PC-P3 grasping

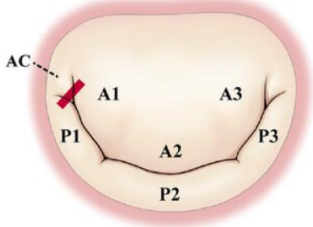


## B) Anterior commissure case

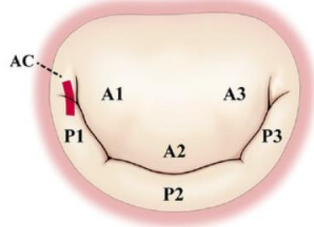
(a) A1-AC grasping



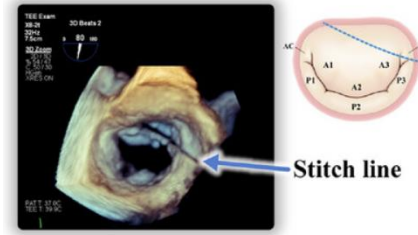
(b) Lateral A1-P1 grasping



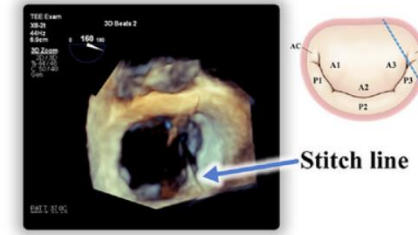
(c) AC-P1 grasping



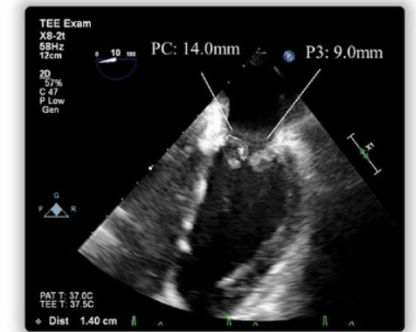
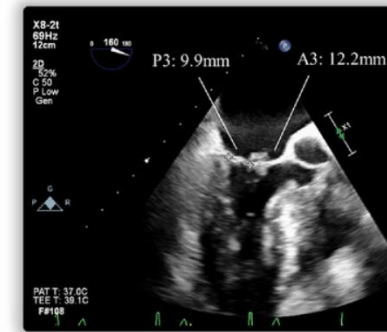
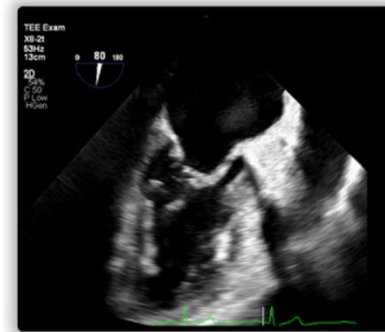
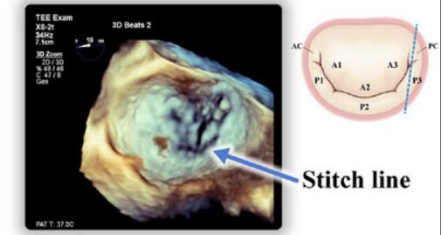
(A) A3-PC grasping



(B) Medial A3-P3 grasping



(C) PC-P3 grasping



Successful treatment of commissure TEER cases requires that the risk of clip-entanglement with subvalvular apparatus be minimized. Specifically, highly accurate clip-angle adjustment should be conducted at the LA. After the clip is inserted into the LV, clip manipulation should be restricted to “just open and pull up to stabilize leaflets to grasp”.

Seo M, et al. Echocardiography 2023

# Large Gap

Rapid ventricular pacing (140–180 BPM) to create ventricular standstill or the use of adenosine

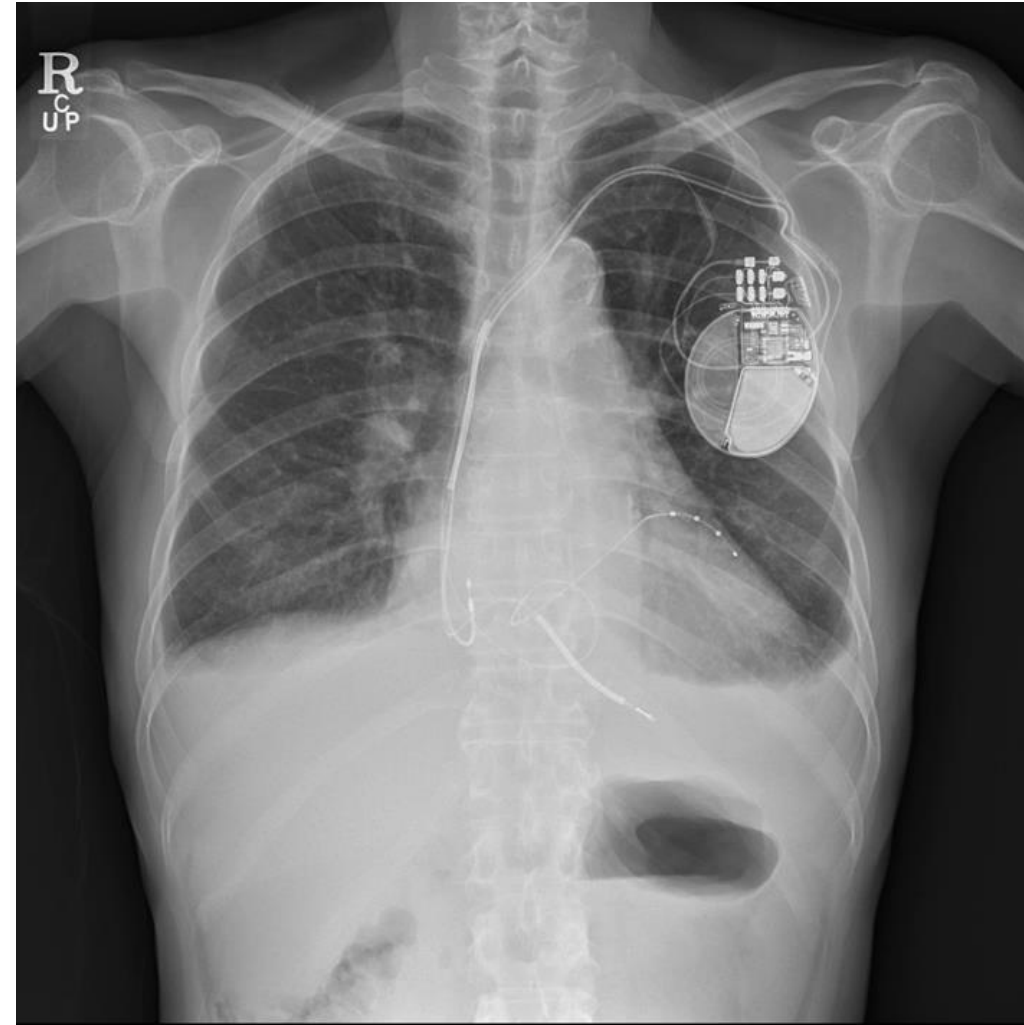
Easier to deploy *the second clip lateral to the initial clip* as the maneuvering is more straightforward. It is also easier to deploy the second clip near the central A2-P2 segments rather than in the commissures.

Sharma V, et al. US Cardiology Review 2022;16:e24

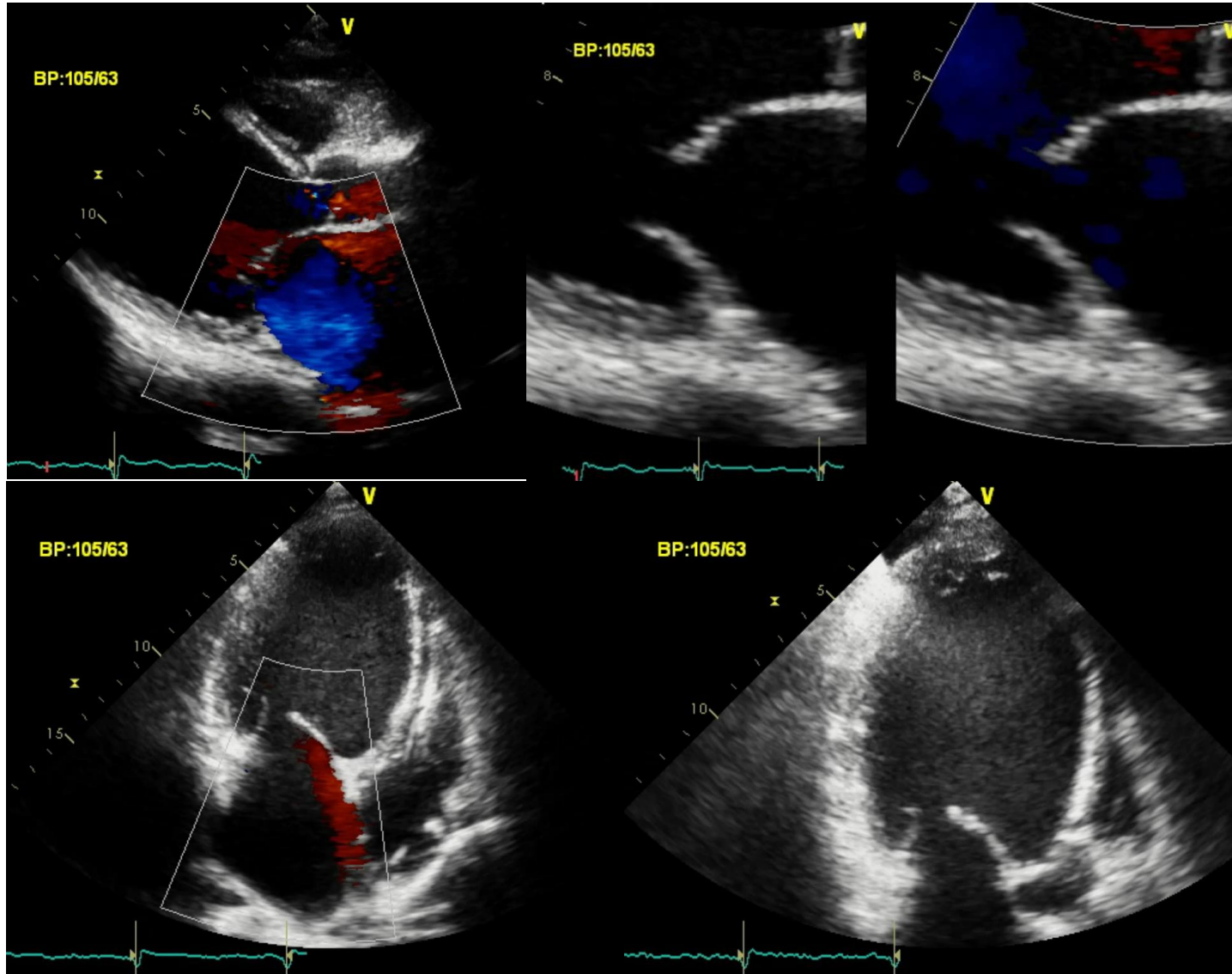
# Case 1

- M/66
  - DCMP HFrEF (EF 16%)
  - s/p ICD implantation s/p CRT-D upgrade
  - Persistent AF, DCMP
  - HTN
  - CKD

STS score : 3.201% for MV repair, 4.701% for MVR



# Echocardiography



## TTE

**Severe MR due to tethering and incomplete coaptation**

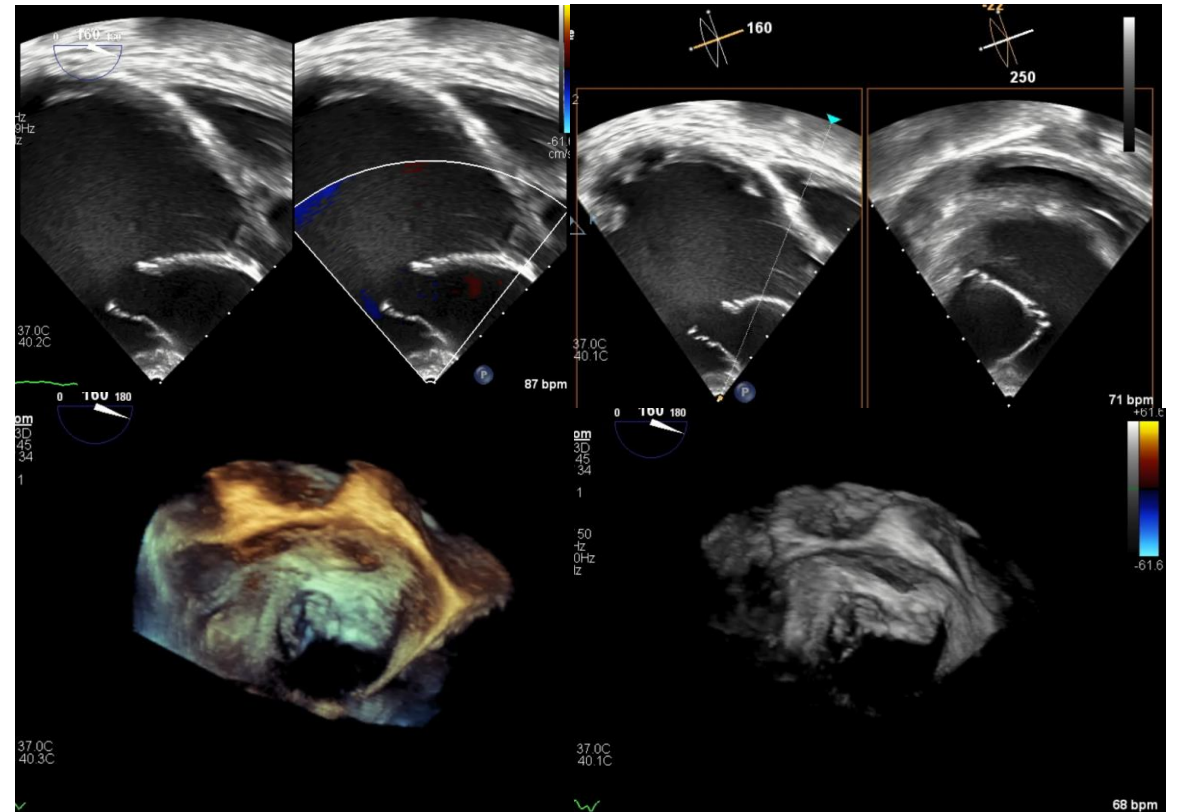
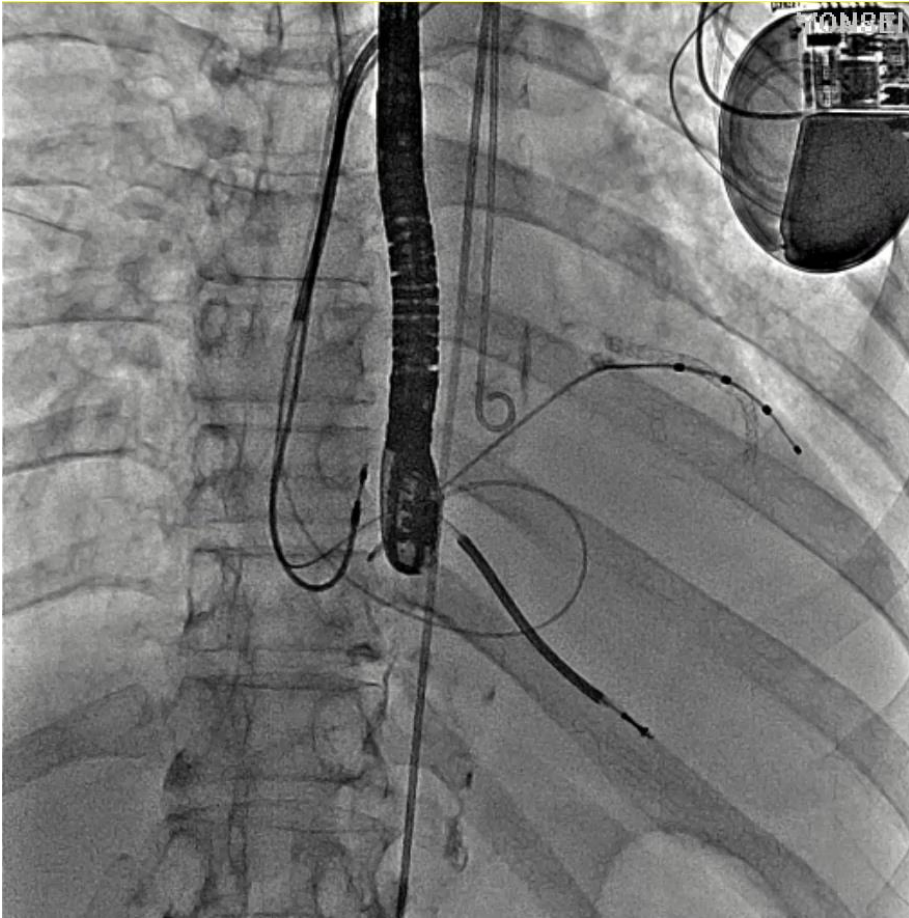
ERO 46 mm<sup>2</sup>, RV 72 cc by PISA method

RWMA: multivessel territories

Enlarged LA (LAVI 99 ml/m<sup>2</sup>) and LV (LVEDD/LVESD 73/64 mm)

Reduced LV systolic function (EF 16% by biplane method)

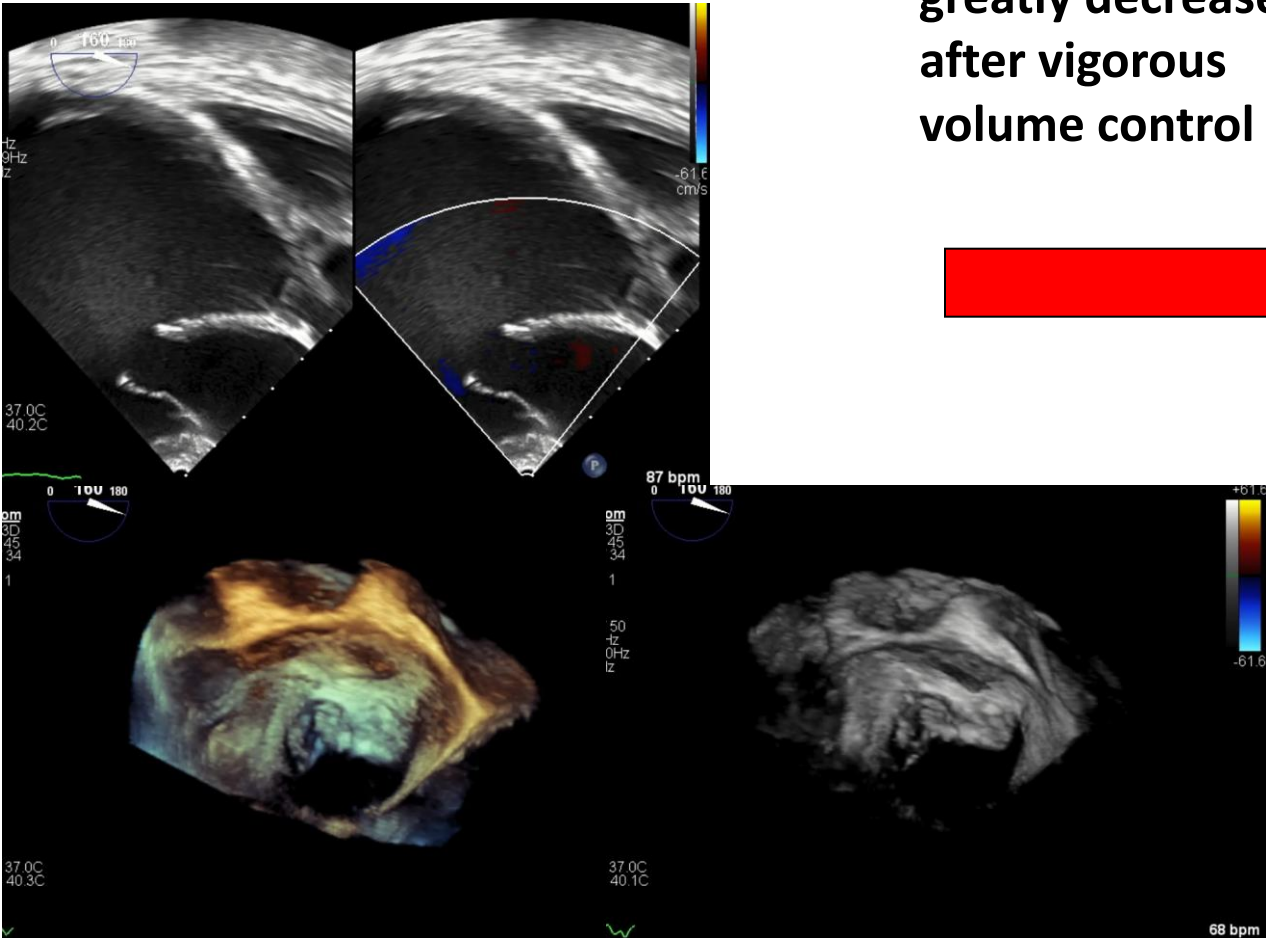
# TEER (1<sup>st</sup> trial, 2023-04-11)



**Large MV gap → TEER was postponed.  
After vigorous volume control, retry of TEER was planned.**

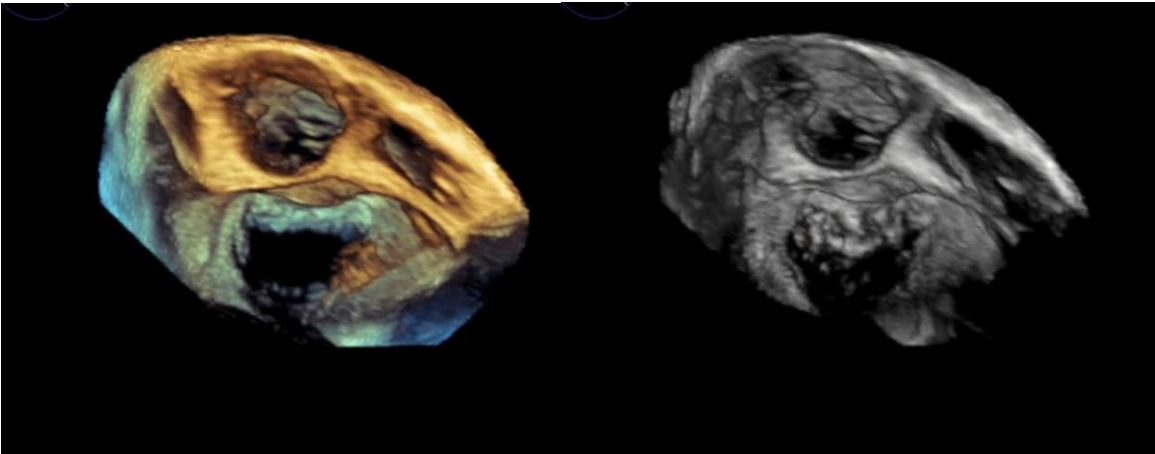
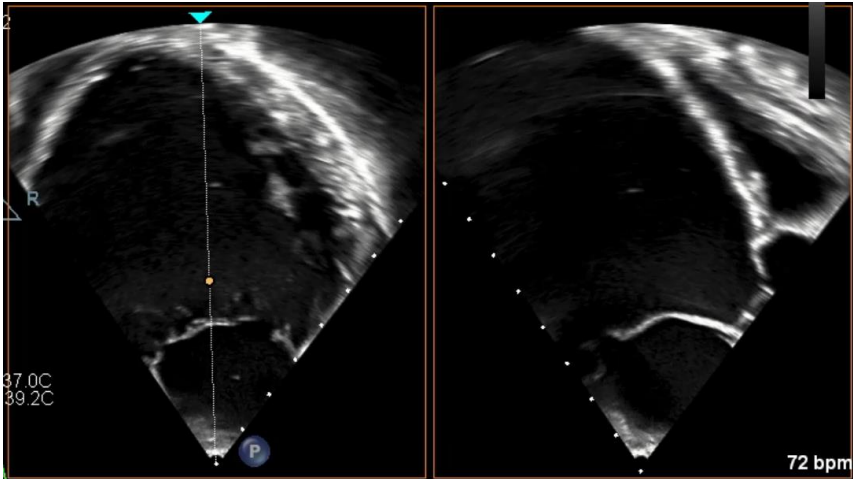
# TEER 3 days later

2023-04-11

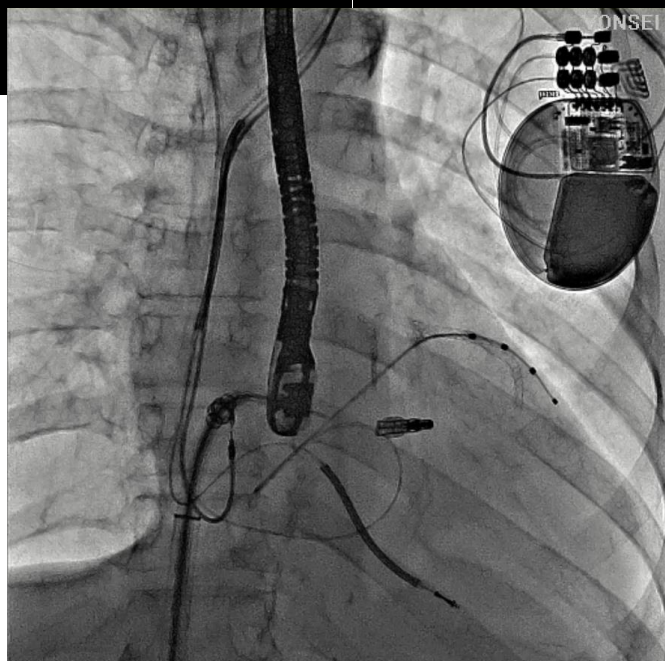
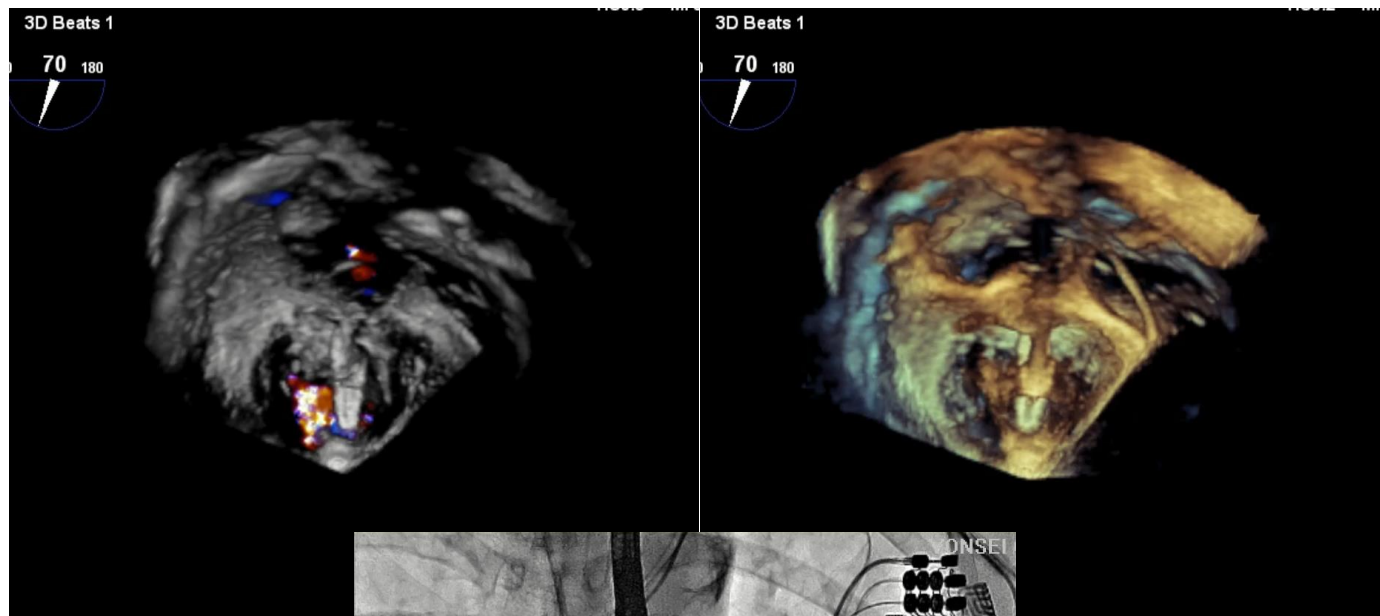


Coaptation gap  
greatly decreased  
after vigorous  
volume control

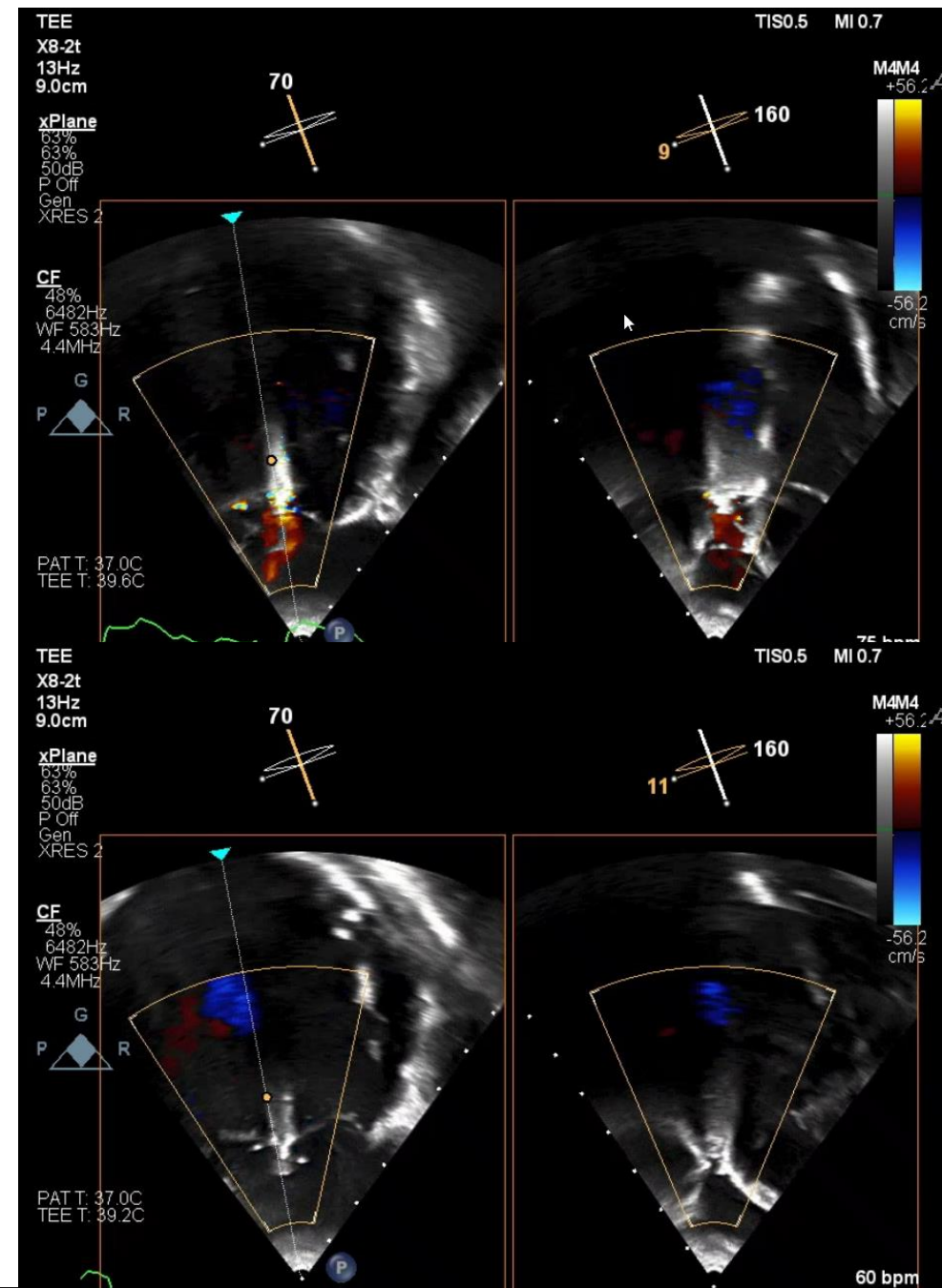
2023-04-14



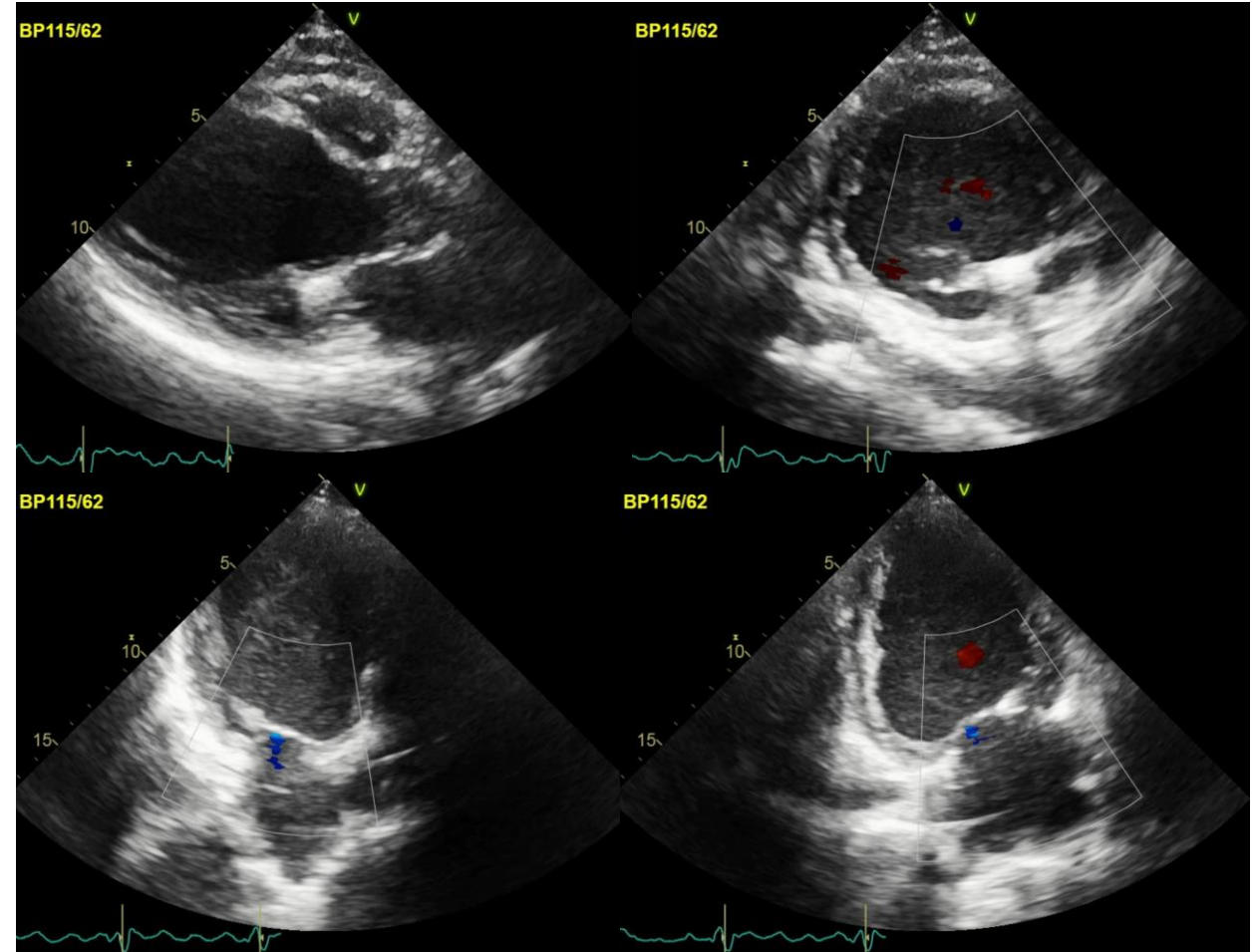
# TEER 3 days later



XT



# Post-procedural CXR



**S/P Mitraclip (MDPG 1.0 mmHg) with trivial MR**

# Case 2

- **M/78**

- **Chief complaint**

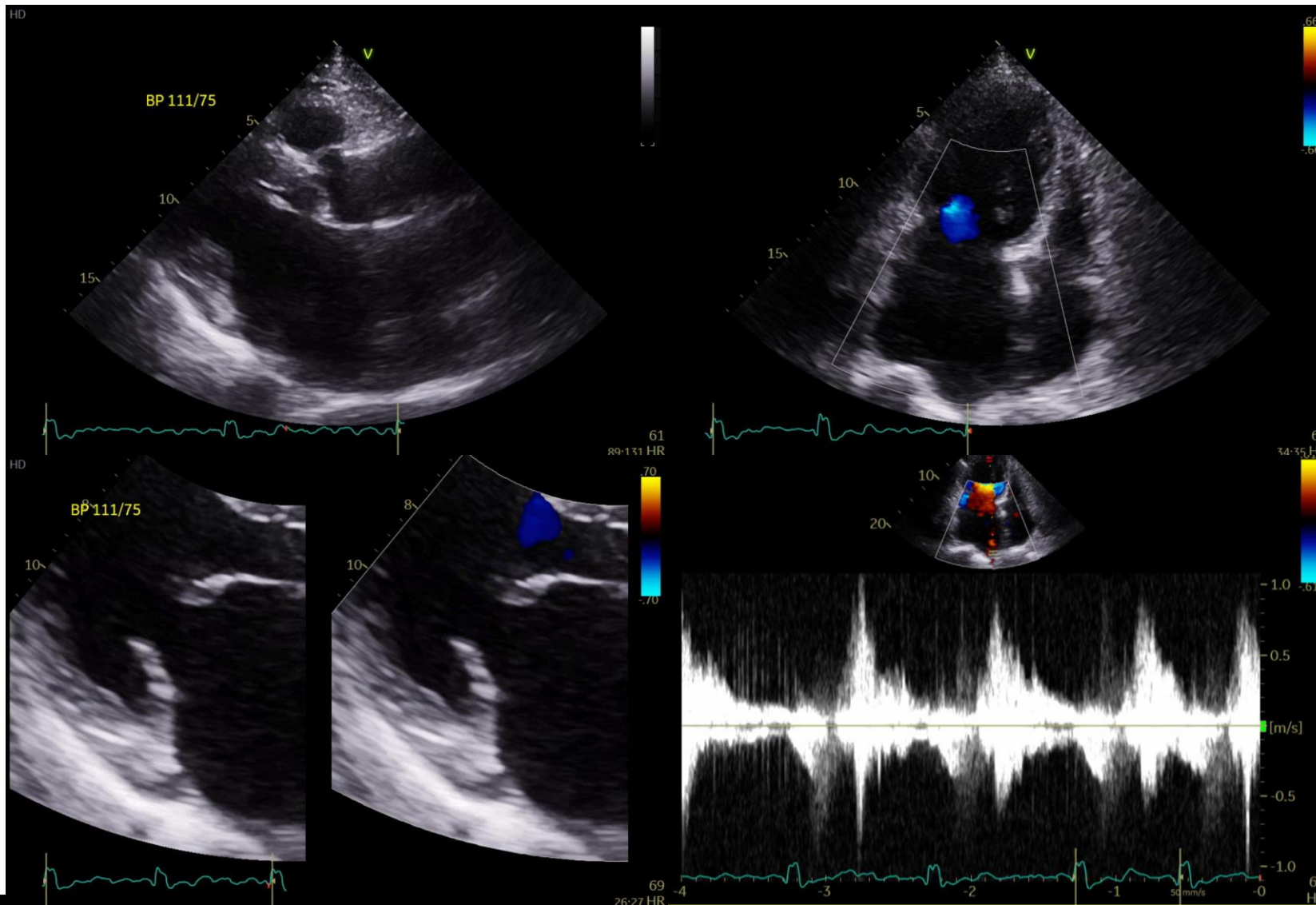
- **Dyspnea (Duration : 2wks) → Emergency department**

- **Comorbidity**

- **Persistent AF**
- **Atrial functional MR**
- **Hypertension, Diabetes mellitus taking oral hypoglycemic medication**
- **Chronic obstructive pulmonary disease**
- **Prostate cancer s/p prostatectomy (7-year-ago)**



# Transthoracic echocardiography



Severe MR

ERO : 93mm<sup>2</sup>, RV 97mL (by flow convergence)

Incomplete coaptation

Dilated MV annulus

PV systolic reversal

LVEF : 75%

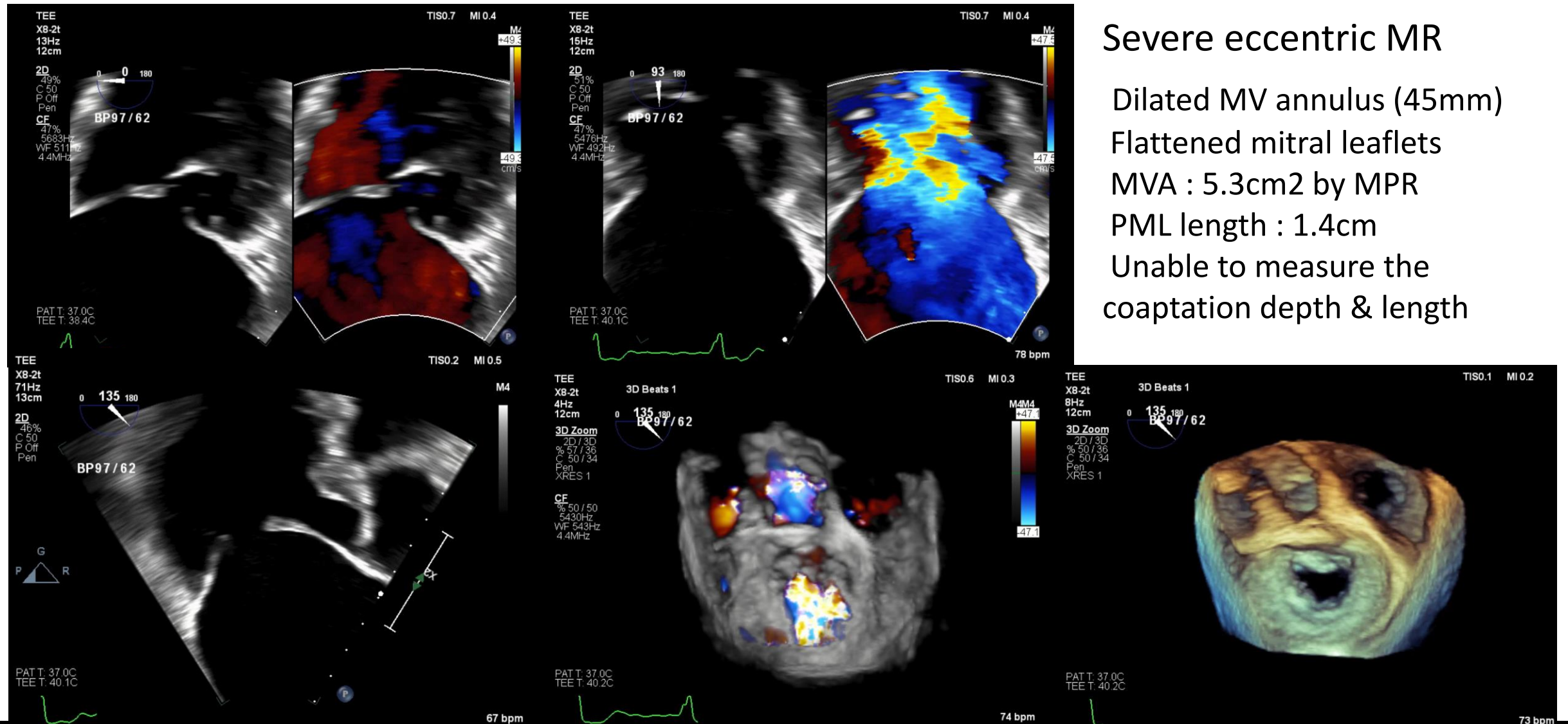
LVEDD/ESD : 60/35mm

LAVI : 151mL/m<sup>2</sup>

E/E' : 21

RVSP : 65mmHg

# Transesophageal echocardiography



Severe eccentric MR

Dilated MV annulus (45mm)

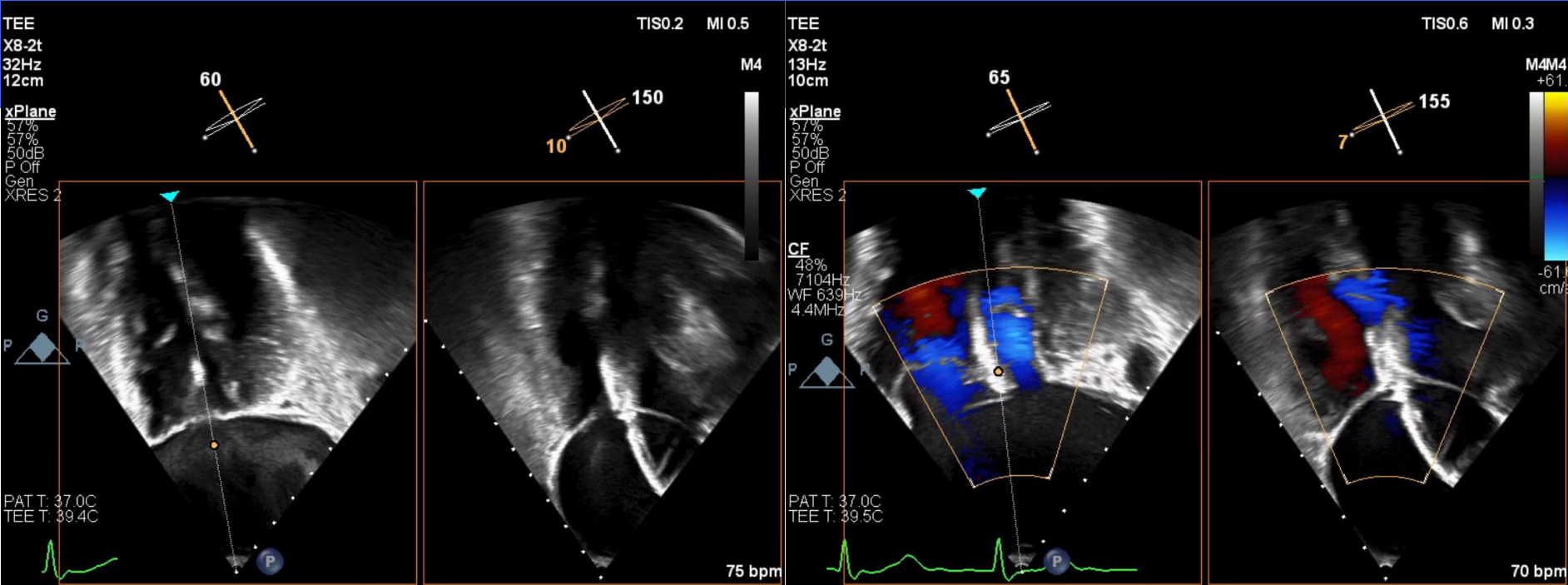
Flattened mitral leaflets

MVA : 5.3cm<sup>2</sup> by MPR

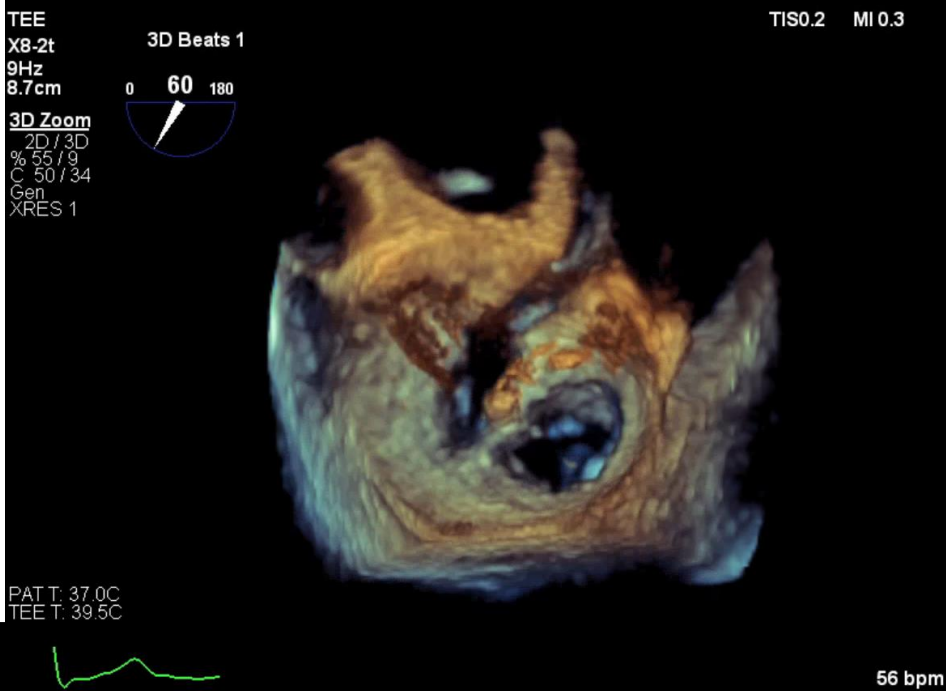
PML length : 1.4cm

Unable to measure the  
coaptation depth & length

TEER –  
1<sup>st</sup> attempt

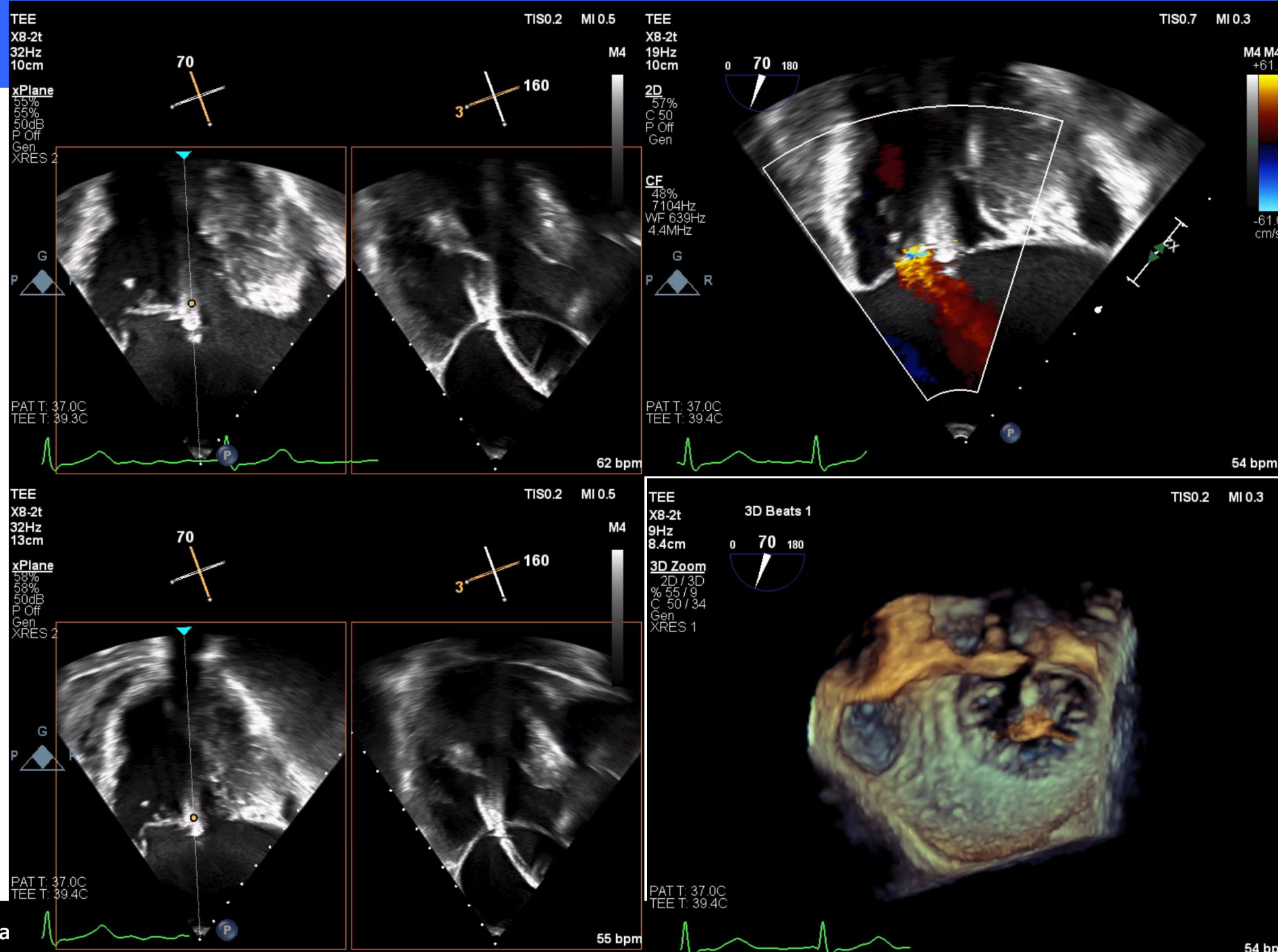


MitraClip XTW

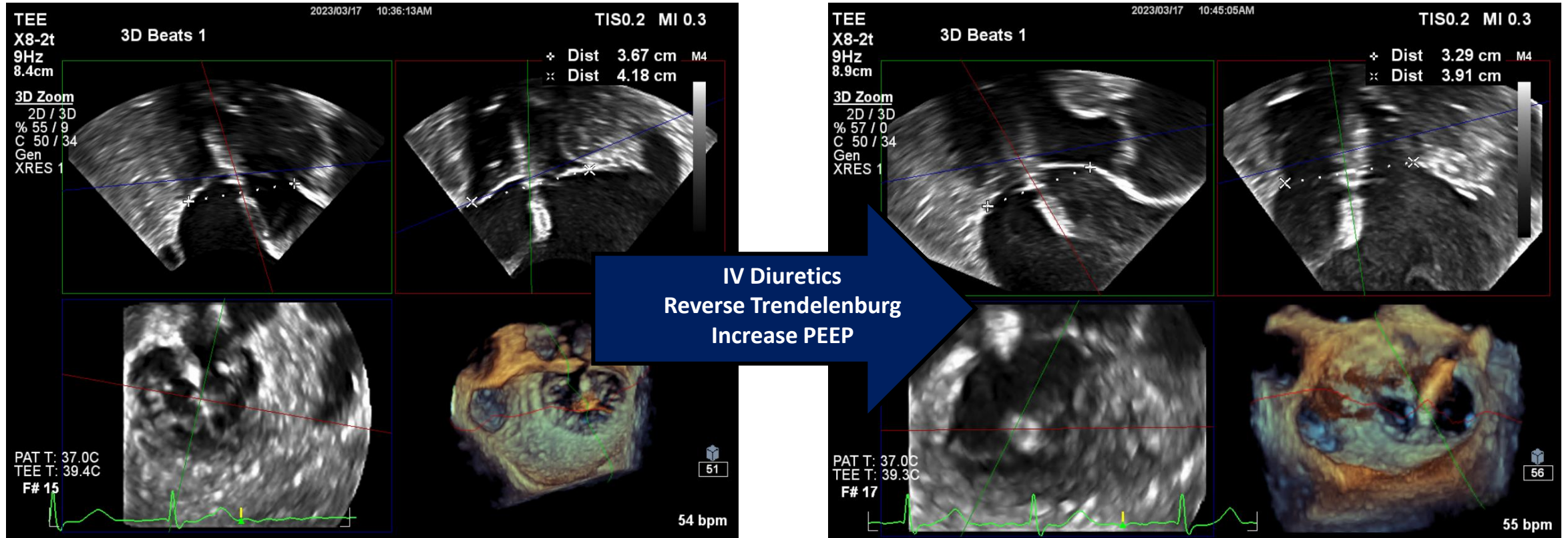


TEER –  
2<sup>nd</sup> attempt

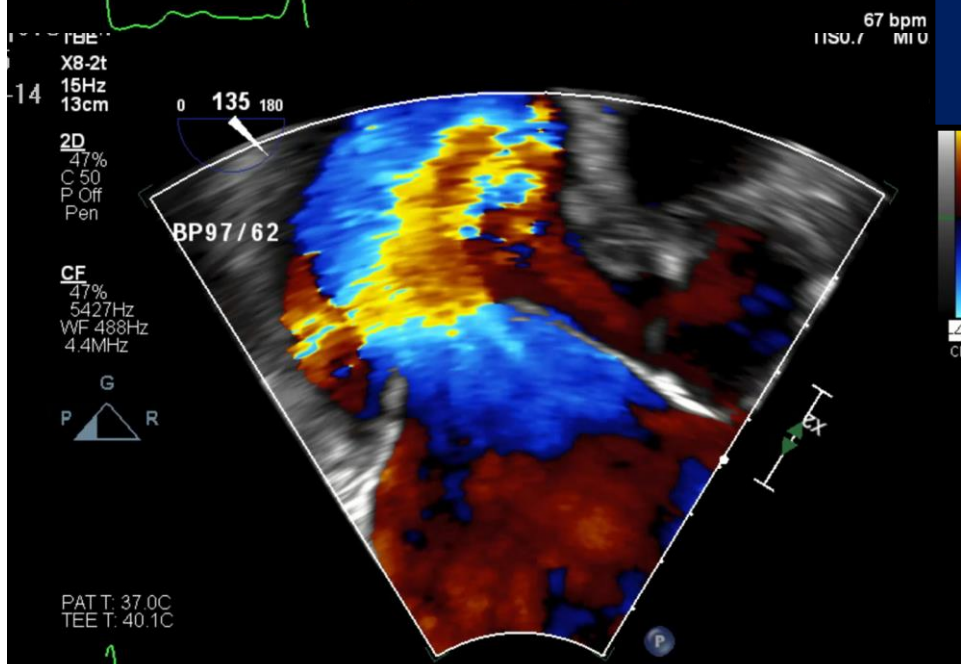
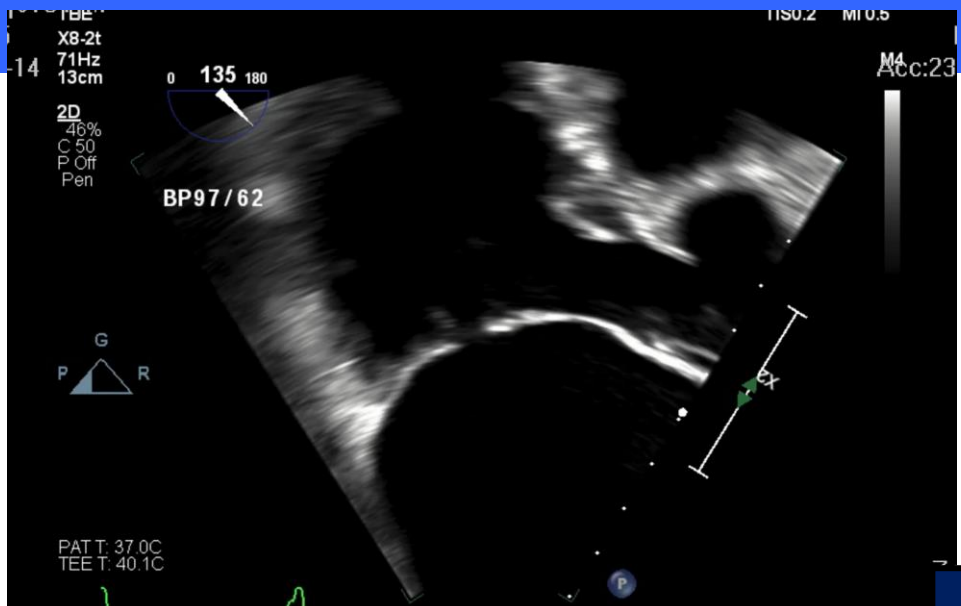
3<sup>rd</sup> attempt



# TEER – overcoming large gap

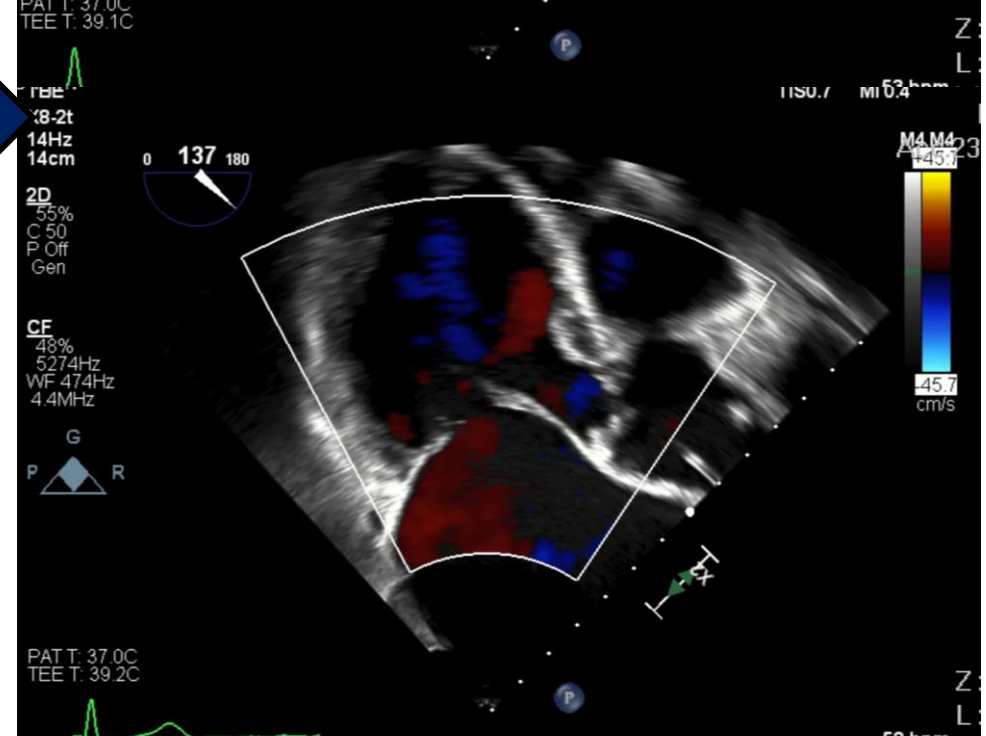
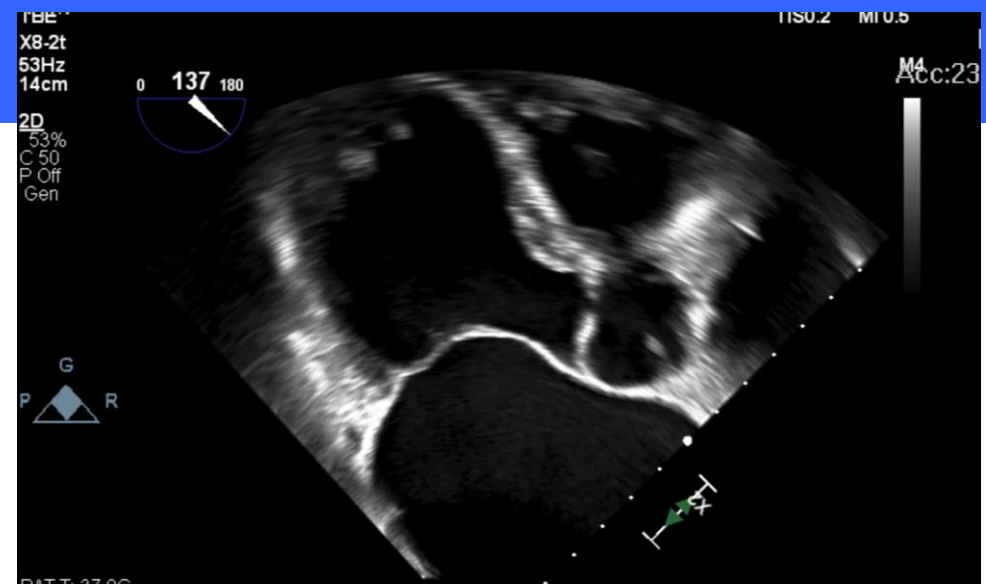


Inter-commissural diameter : 4.2cm → 3.9cm  
Antero-posterior diameter : 3.7cm → 3.3cm



Severance Cardiovascular Hospital

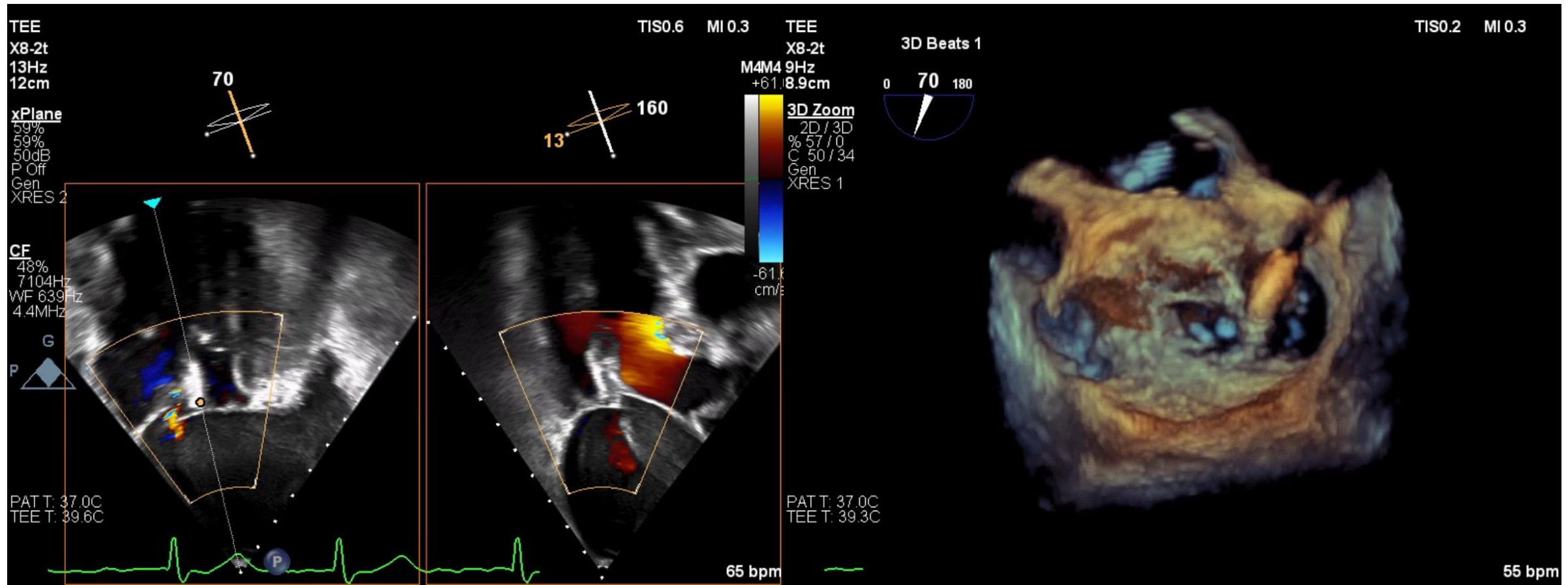
IV Diuretics  
Reverse Trendelenburg  
Increase PEEP



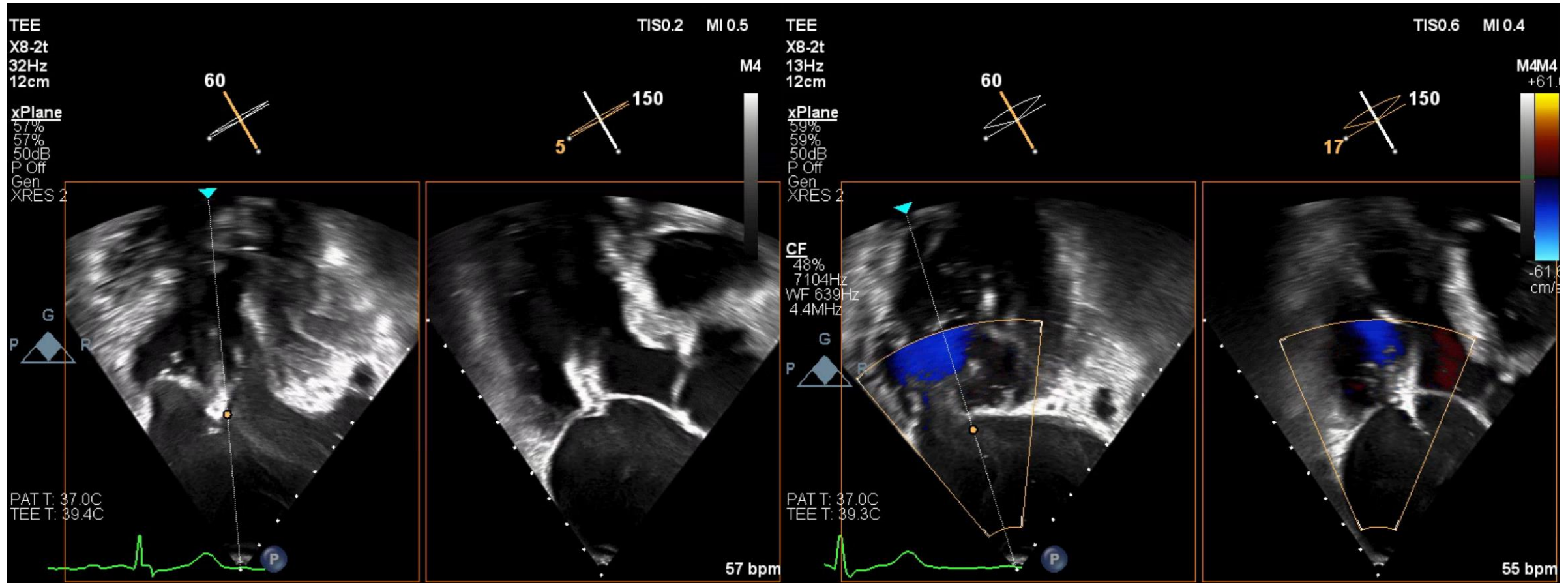
Yonsei University College of Medicine



# TEER – after PEEP & maneuver

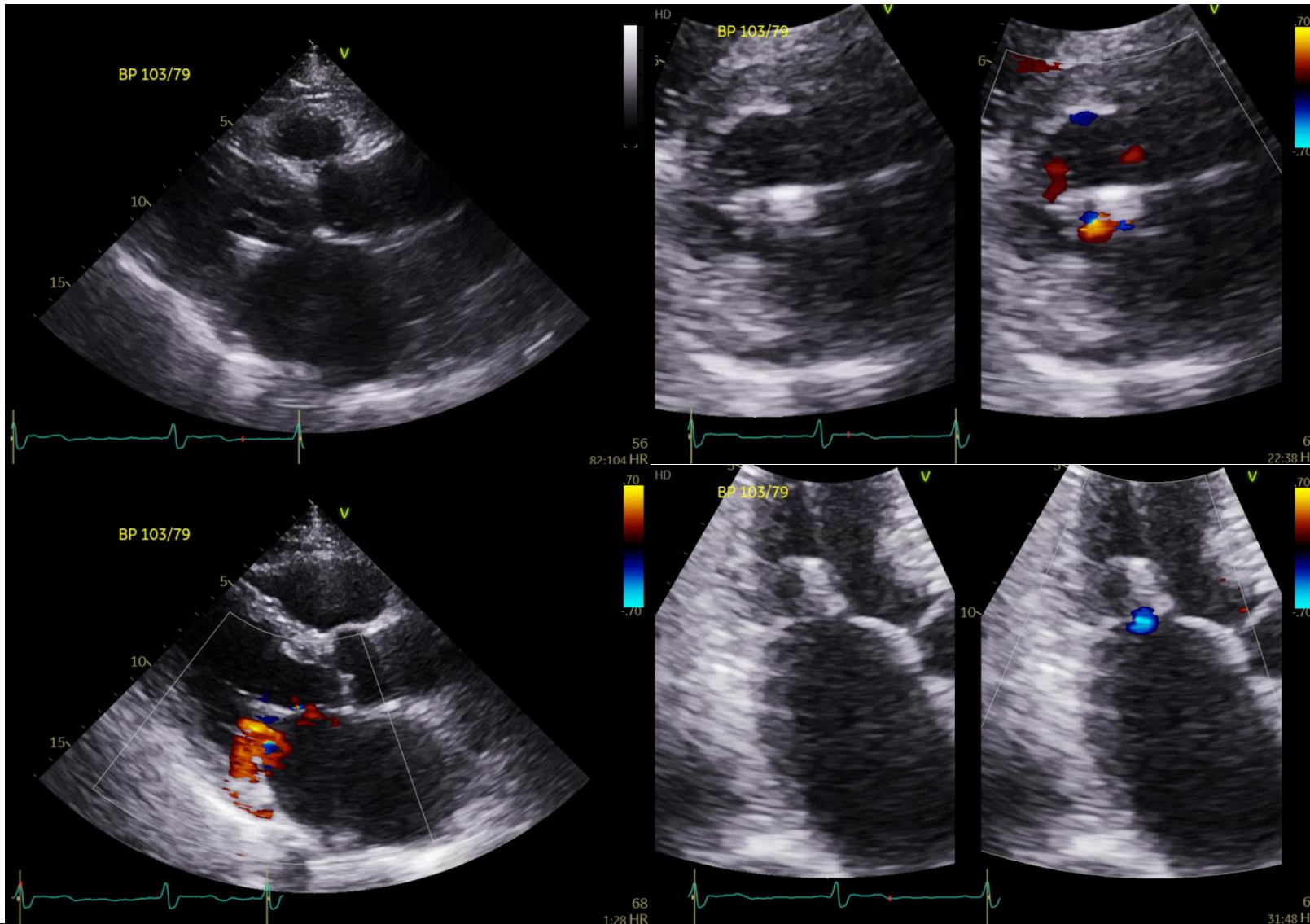


# TEER – after clipping



MDPG = 1.8mmHg

# Post procedural TTE



**Well-positioned Mitra Clip**

**Decreased to mild MR**

**MDPG : 1.6mmHg**

**Decreased LV&LA chamber**

**LAVI :**

**89ml/m<sup>2</sup> (← 151ml/m<sup>2</sup>)**

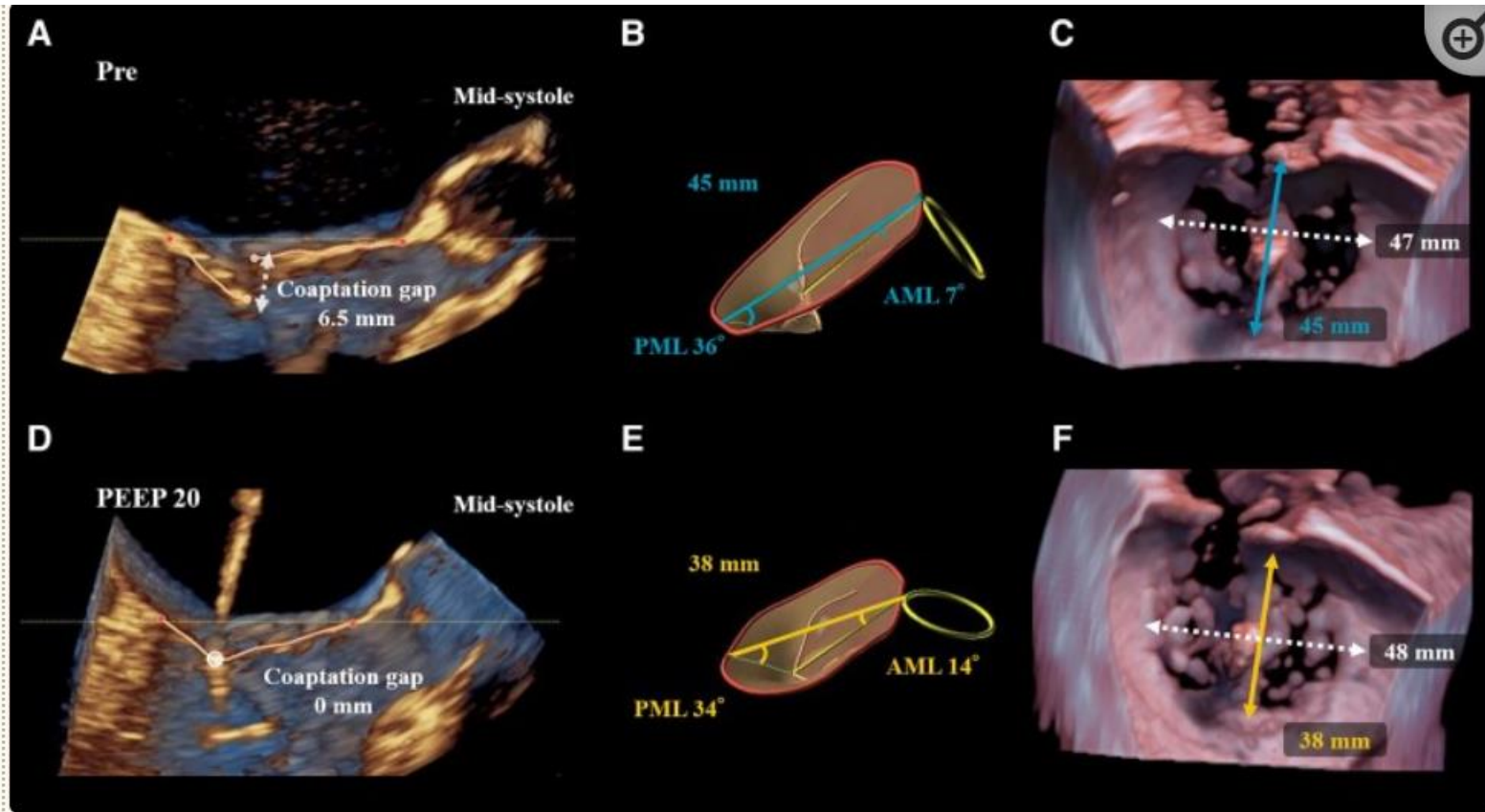
**LVEDD/ESD :**

**60/35mm (← 54/33mm)**

**Decreased RVSP :**

**31mmHg ← 54mmHg**

The application of 20 cm H<sub>2</sub>O of PEEP was shown to shorten the anterior–posterior diameter of the MA and increase coaptation length



Masumoto A, et al. Eur Heart J  
Case Rep 2023

# Summary

- 1. The optimal location of septal puncture is important.**
- 2. Understanding the function of knob and SGC torque is crucial to overcome special situations.**
- 3. Appropriate plans and target goals are needed for difficult cases.**
- 4. Close cooperation with imaging specialists and anesthesiologist is essential to get over difficult issues.**