3D Immersive
Step-by-Step M – TEER Experience

Mastering TEER: Imaging to Intervention

Imrankhan Lohani
Meril

Burden of MR and Evolving Guidelines

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#15 Mn

Mitral Regurgitation[2]

~5000

TEER treatable population

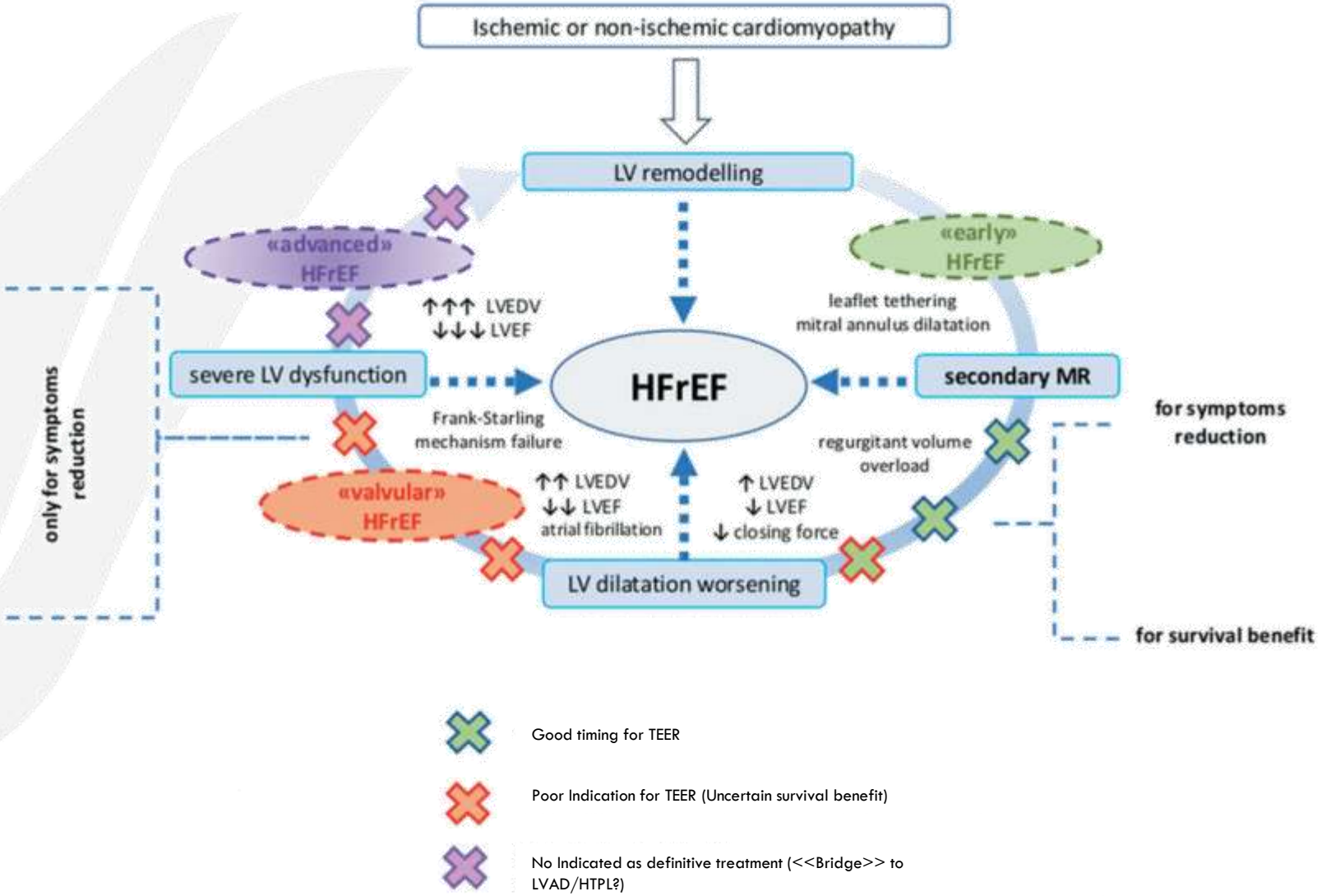
ESC EACTS

2025 ESC/EACTS Guidelines Strengthen Role of TEER in FMR[3]

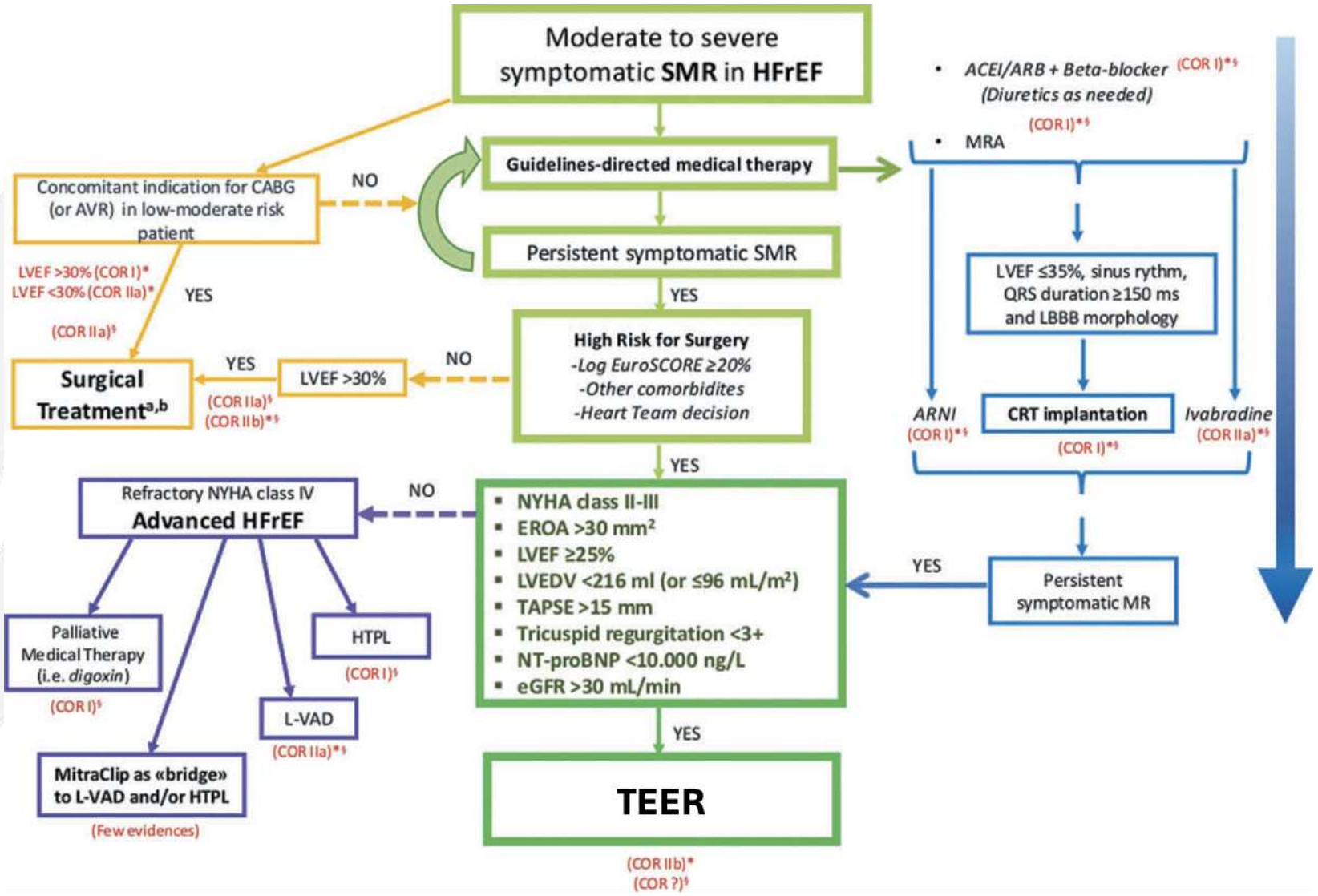
TEER is now Class I, Level A Recommended in Ventricular FMR

1. Douedi S, Douedi H. Mitral Regurgitation. [Updated 2024 Apr 30]. | 2. *J Am Heart Assoc.* 2024;13(24):e037991. | 3. European Heart Journal (2025) 00, 1–102

The vicious circle of FMR in HFrEF patients



When to Intervene?



Criteria for M-TEER

M-TEER in FMR patients

COAPT- eligible characteristics

- Severe SMR
- Optimized HF treatments according to the 2021 ESC guidelines
- New York Heart Association class II, III, or ambulatory class IV
- LV ejection fraction 20-50%
- LV end-systolic diameter ≤70 mm
- At least one HF hospitalization within the previous year or elevated natriuretic peptide values
- MV anatomy judged suitable for M-TEER.

COAPT- ineligible characteristics

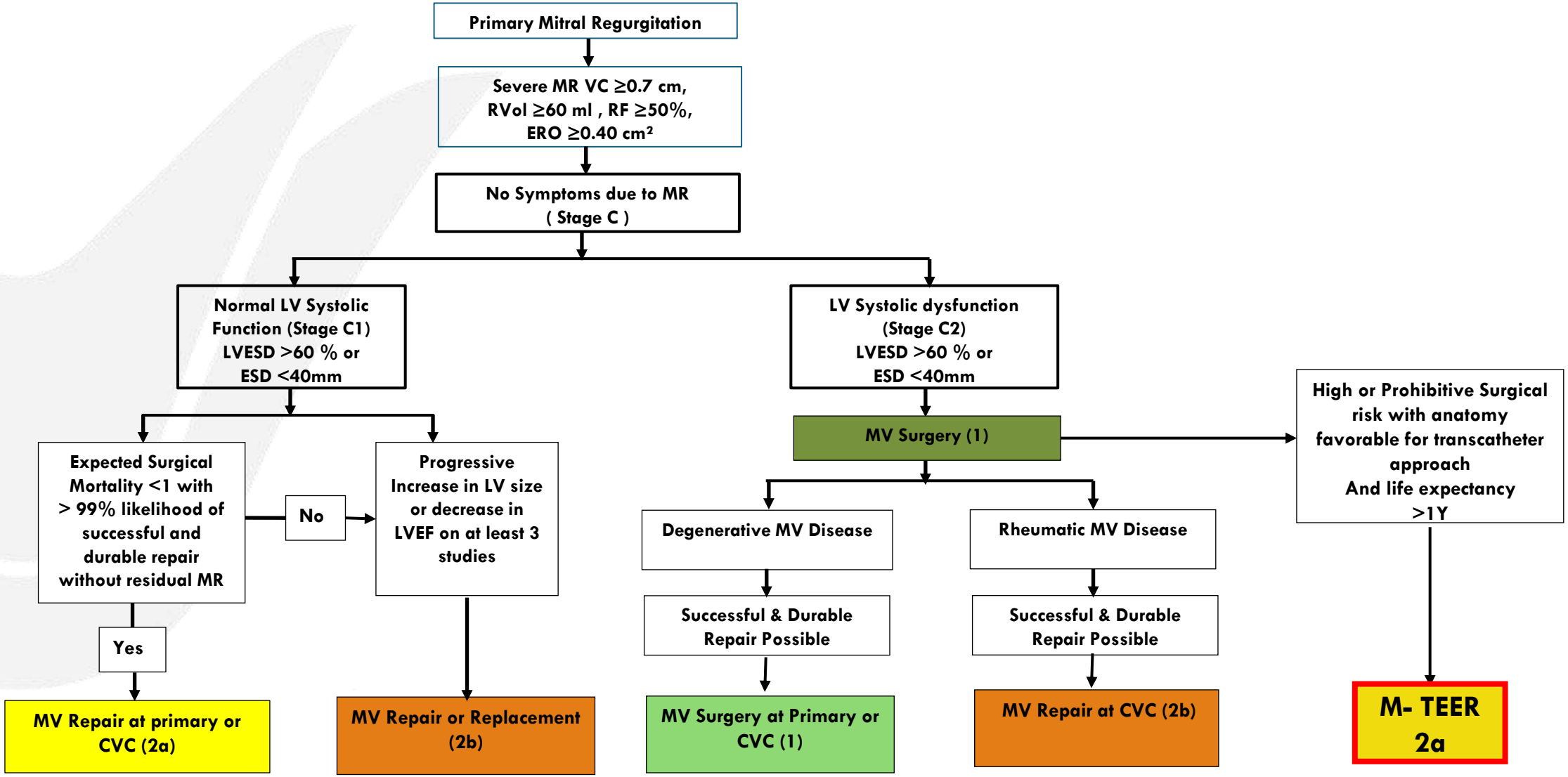
- Hemodynamic instability
- HF stage D
- Moderate or severe right ventricular dysfunction
- Systolic pulmonary pressure >70 mmHg
- Chronic obstructive pulmonary disease (COPD) requiring oxygen or steroids
- Coronary, aortic, or tricuspid valve disease requiring surgery
- Hypertrophic, restrictive, or infiltrative cardiomyopathy.

Current Percutaneous Approaches to Treat Mitral Valve Regurgitation. Curr Treat Options Cardio Med 25, 793–817 (2023)

Degenerative Mitral Regurgitation

Guideline Recommendation and Inclusion-Exclusion Criteria

Management Of Patients With Chronic Degenerative (Primary) MR



American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2021 Feb 2;143(5):e35-e71.

Recommendations for Intervention for Degenerative (Primary) MR

Recommendations for Intervention for Chronic Primary MR

COR	LOE	Recommendation
2a	B-NR	• In severely symptomatic patients (NYHA class III or IV) with primary severe MR • High or prohibitive surgical risk • M-TEER is reasonable • If mitral valve anatomy is favourable & patient life expectancy is at least 1 year

American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2021 Feb 2;143(5):e35-e71.

Anatomical Eligibility as per EVEREST II Trial

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Anatomical Eligibility
Leaflet mal-coaptation resulting in MR

Sufficient leaflet tissue for mechanical coaptation

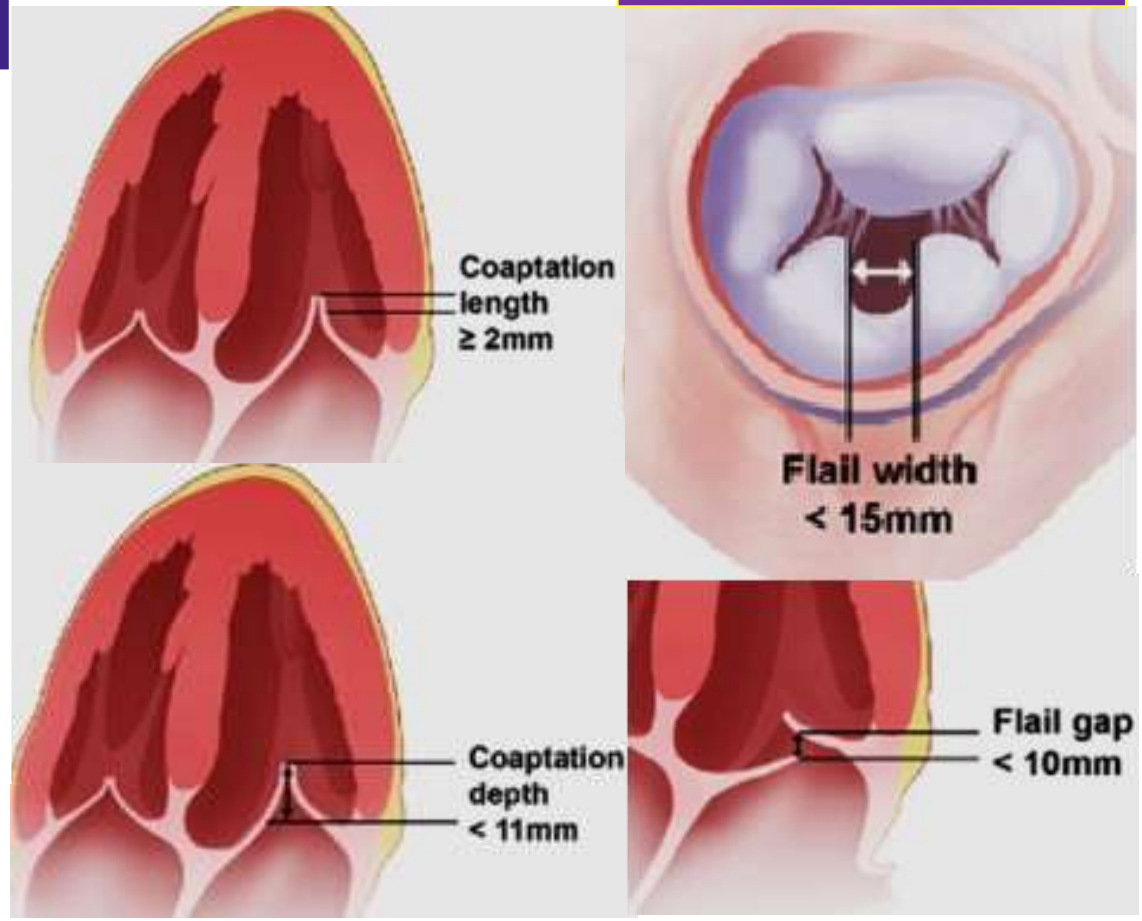
Non-rheumatic/endocarditic valve morphology

Protocol anatomic exclusions

- Flail gap >10mm
- Flail width >15mm
- Coaptation depth >11mm
- Coaptation length < 2mm
- LVIDs > 55mm
- MV Area < 4.0 cm^2

Functional MR

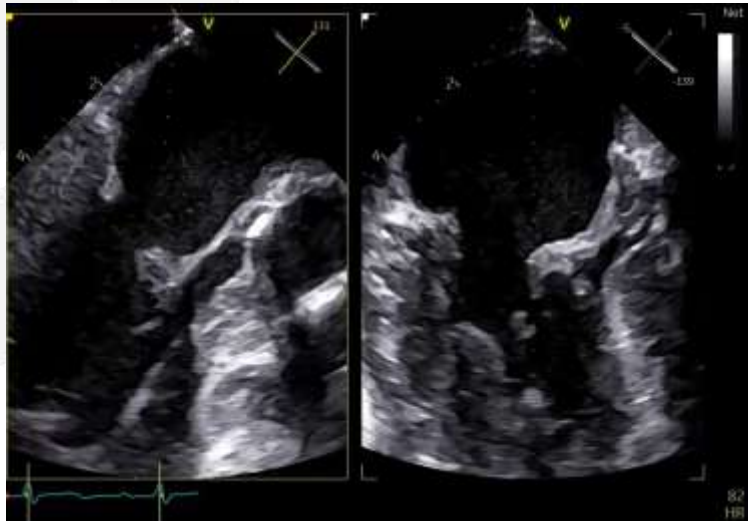
Primary MR

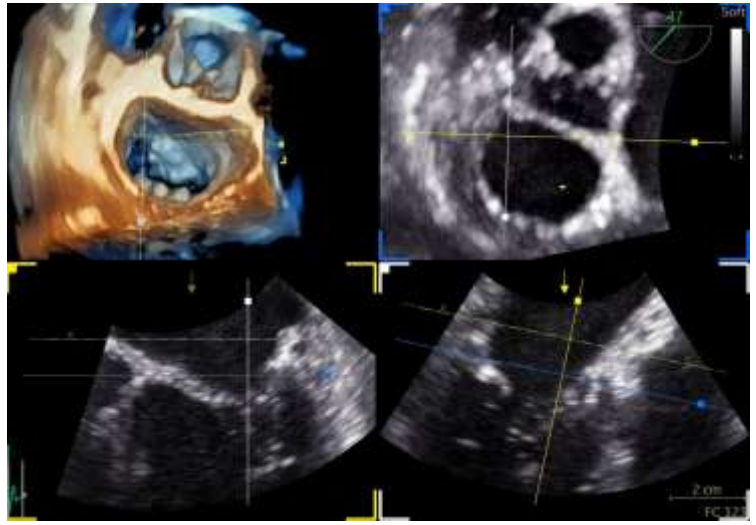


Current Problems in Cardiology Volume 37, Issue 2, February 2012, Pages 42-68

Suitability for TEER in DMR based on EVEREST Criteria

Optimal morphology	Challenging morphology	Unsuitable morphology
Central A2/P2	Peripheral A1/P1 or A3/P3	Cleft or perforation
No calcification	Calcification present but not in grasping zone	Calcification in grasping zone
MVA > 4 cm^2	MVA > 3 cm^2	MVA < 3 cm^2 or MG > 5 mm Hg
Posterior leaflet > 10 mm	Posterior leaflet 7-10 mm	Posterior leaflet < 7 mm
Tenting height < 11 mm Coaptation reserve > 2 mm	Tenting height ≥ 11 mm	
Normal leaflets and mobility	Carpentier IIIB	Carpentier IIIA
Flail gap < 10 mm flail width < 15 mm	Flail width > 15 mm (with sufficient valve area to tolerate multiple clips)	Multiple segments, Barlows





Valve Morphology Complexity vs Center Experience

REPAIR — **Anatomical Suitability for M-TEER** — **Centre Experience** — **REPLACEMENT**

Non-Complex Ideal for M-TEER	Complex Suitable for M-TEER	Very Complex Challenging for M-TEER	Criteria Favoring Replacement M-TEER Hard or Impossible
• Central pathology • No calcification • MVA >4.0 cm^2 • Posterior leaflet > 10 mm • Tenting height < 10 mm • Flail gap < 10 mm • Flail width < 15 mm	• Isolated commissural lesion (A1/P1 or A3/P3) • Annular calcification without leaflet involvement • MVA 3.5-4.0 cm^2 • Posterior leaflet length 7-10 mm • Tenting height > 10 mm • Asymmetric tethering • Coaptation reserve < 3 mm • Leaflet-to-anulus index < 1.2 • Flail width > 15 mm • Flail gap > 10 mm • Two jets from leaflet indentations	• Commissural lesion with multiple jets • Annular calcification with leaflet involvement • Fibrotic leaflets • Wide jet involving the whole coaptation • MVA 3.0-3.5 cm^2 • Posterior leaflet length 5-7 mm • Barlow's disease • Cleft • Failed surgical annuloplasty	• Concentric MAC with stenosis • MVA <3.0 cm^2 • Relevant mitral valve stenosis (mean gradient > 5 mmHg) • Posterior leaflet < 5 mm • Calcification in the grasping zone • Deep regurgitant cleft regurgitant • Leaflet perforation • Multiple/wide jets • Rheumatic mitral stenosis

A1/P1: lateral segments of anterior (A1) and posterior (P3) mitral valve leaflet; A3/P3: medial segments of anterior (A3) and posterior (P3) mitral valve leaflet; MAC: mitral annular calcification; MVA: mitral valve area

EuroIntervention 2023;18:957-976

M-TEER Procedural Steps

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Sympli 5-TEER

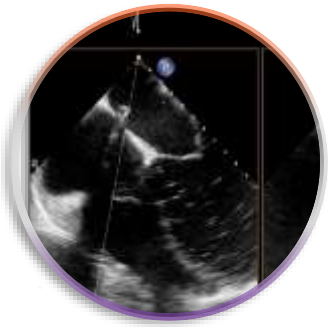
Five Stages for Predictive and Successful TEER Procedure and Outcomes

1

Vascular access & Transseptal puncture (TSP)

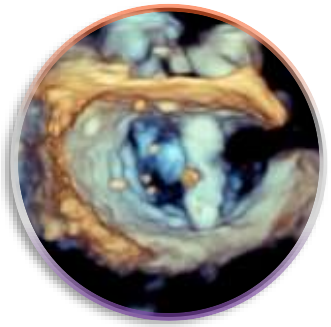
2

Advancement of MyClip Guide Catheter in LA



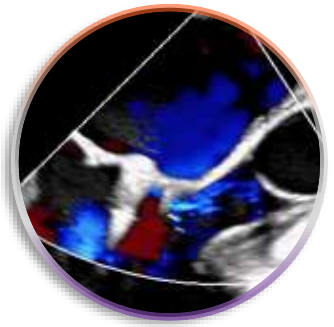
3

Advancement of Clip in LA & orientation over MV



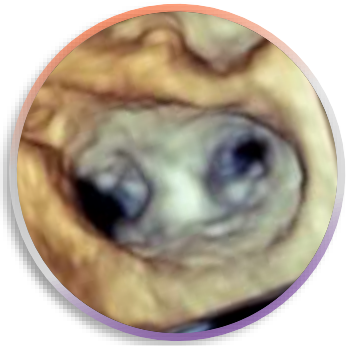
4

Advancement of Clip in LV, Leaflet Grasping, post grasp evaluation



5

Release of MyClip, post release assessment, additional clip planning & Vascular closure



TEE Working Views for Procedure

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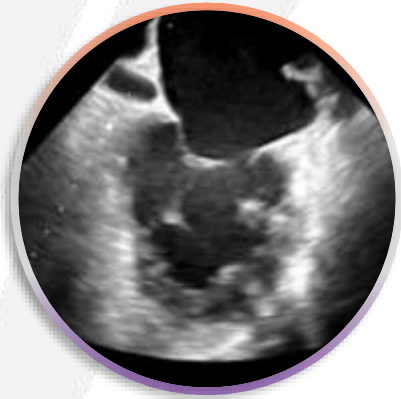
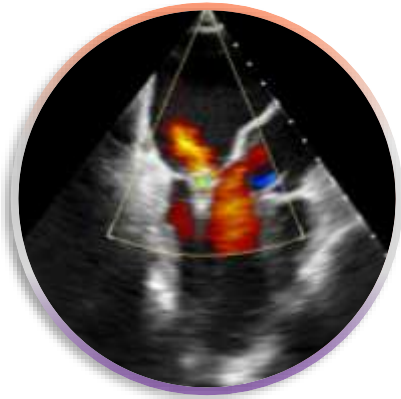
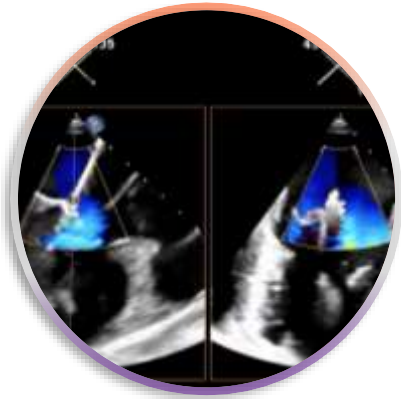
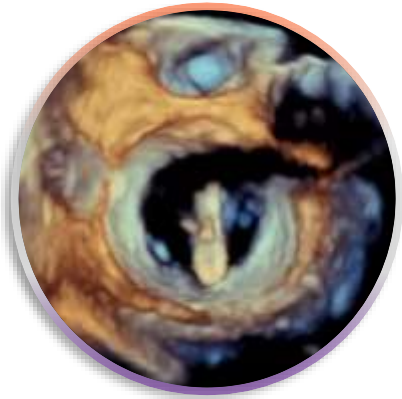
Transseptal puncture	Working views for procedure				
					
Bi-caval Short axis at base 4 chamber	Short axis at base	Inter-commissural or bi-commissural	Left ventricular outflow tract (LVOT)	X-plane	3D Enface

M-TEER Procedural Steps

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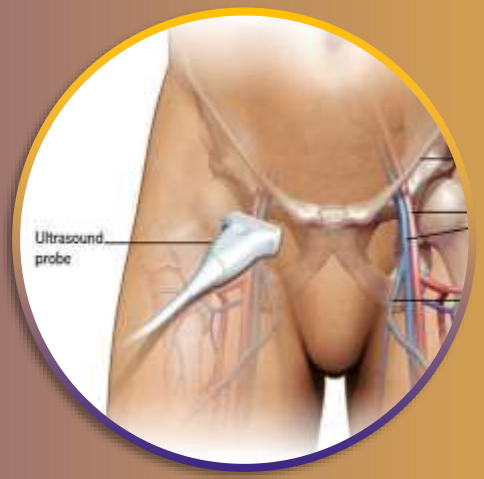
Sympli 5-TEER

Five Stages for Predictive and Successful TEER Procedure and Outcomes

Stage 1

Vascular access



Transseptal puncture (TSP)

Goals for Transseptal Puncture for M – TEER

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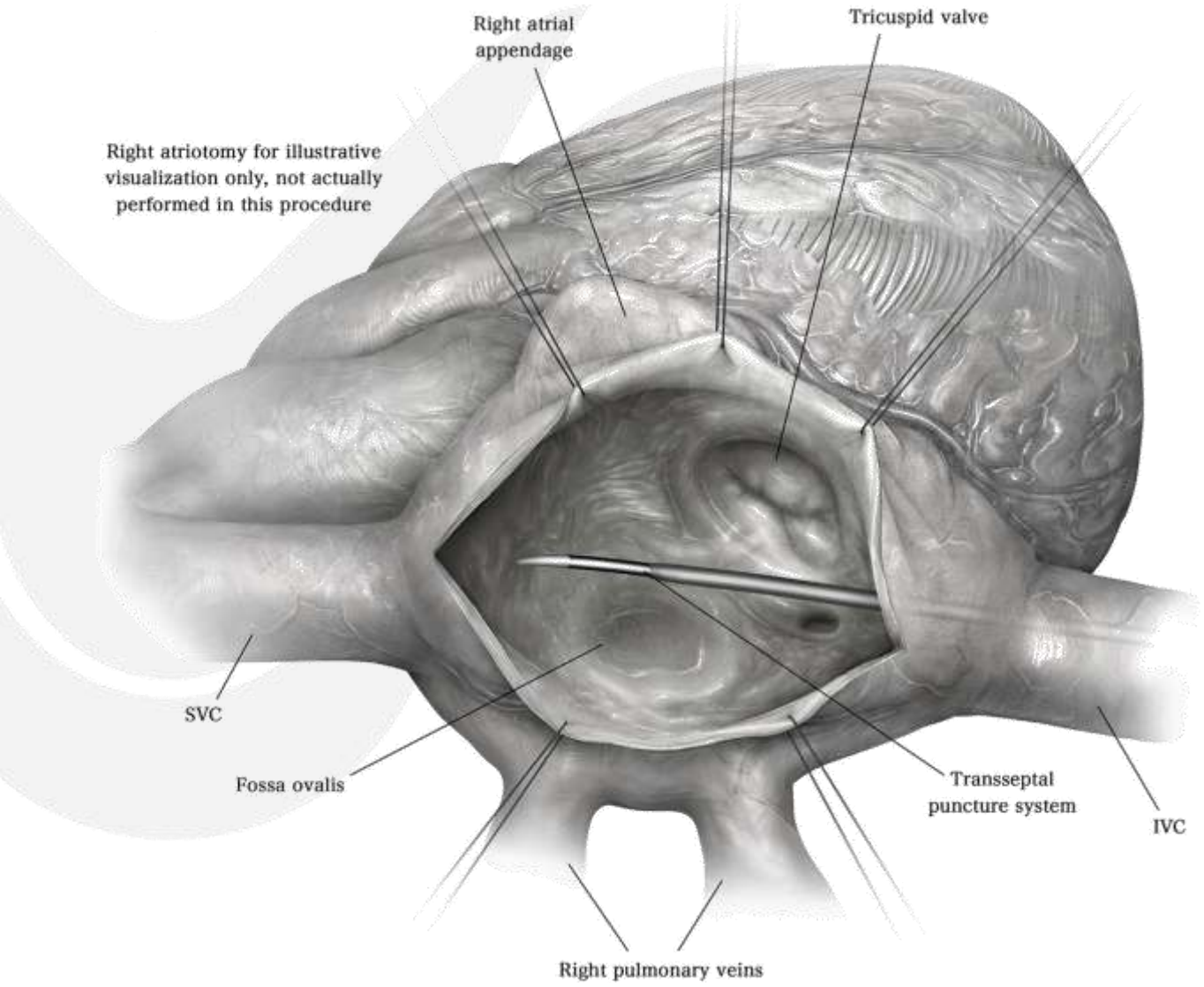
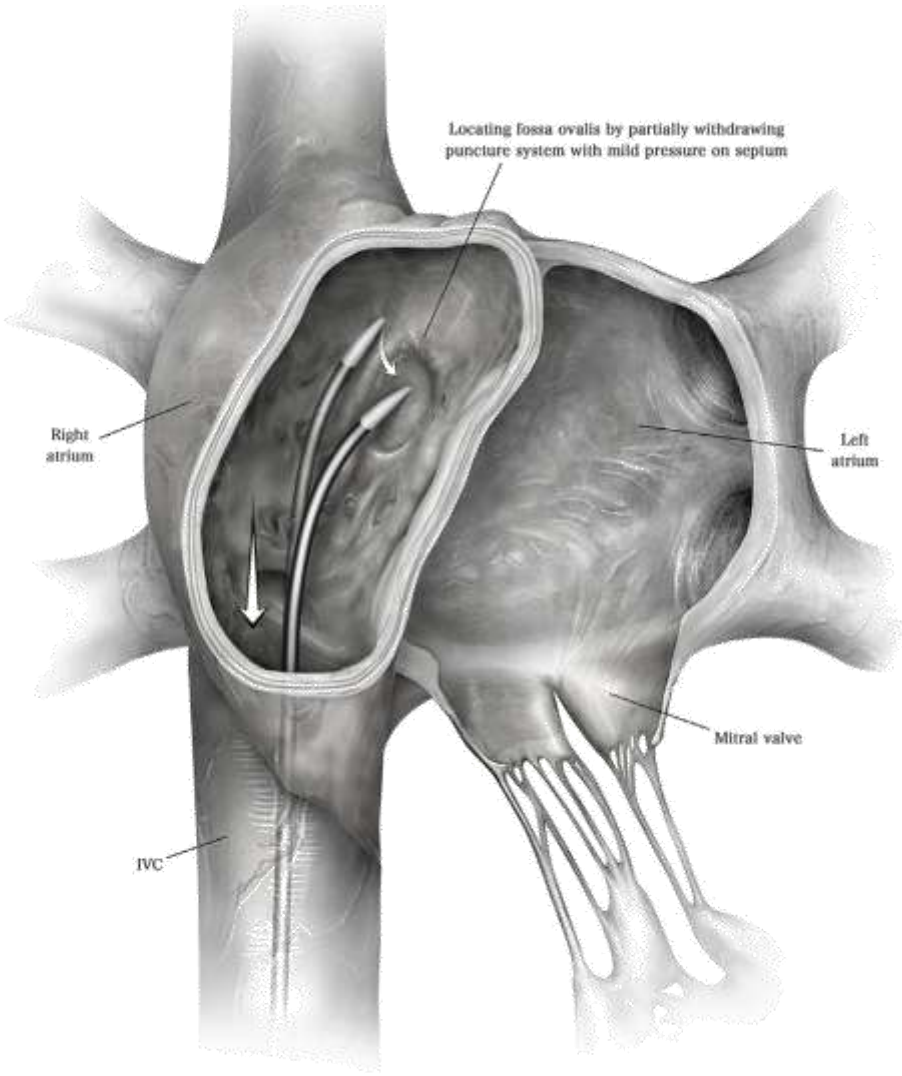
Mid Posterior

- Safe access from RA to LA **(Mid Fossa)**
- Adequate height ≥ 4.0 cm for safe maneuvering of M-TEER device **(Posterior Fossa)**
- To achieve ideal trajectory of delivery system from fossa ovalis to MV

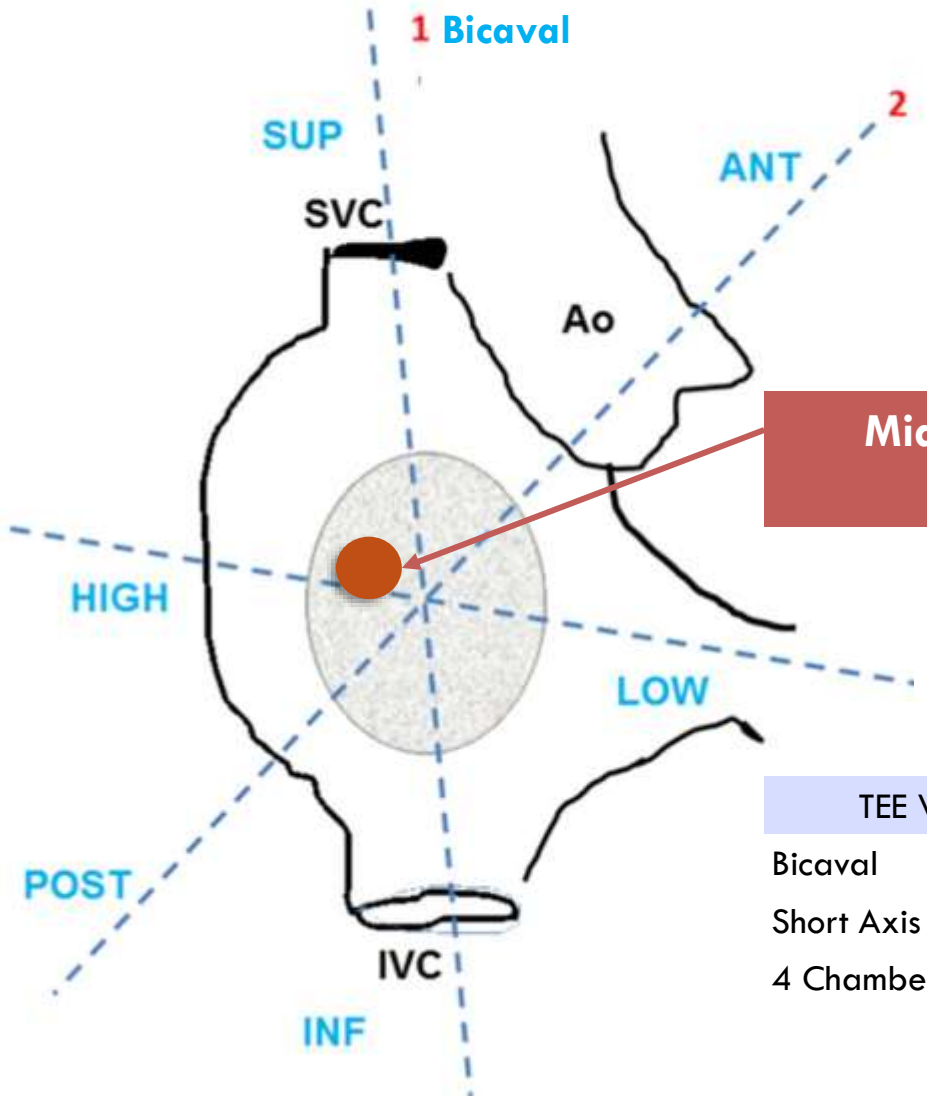
Transseptal Puncture for M – TEER

Meril



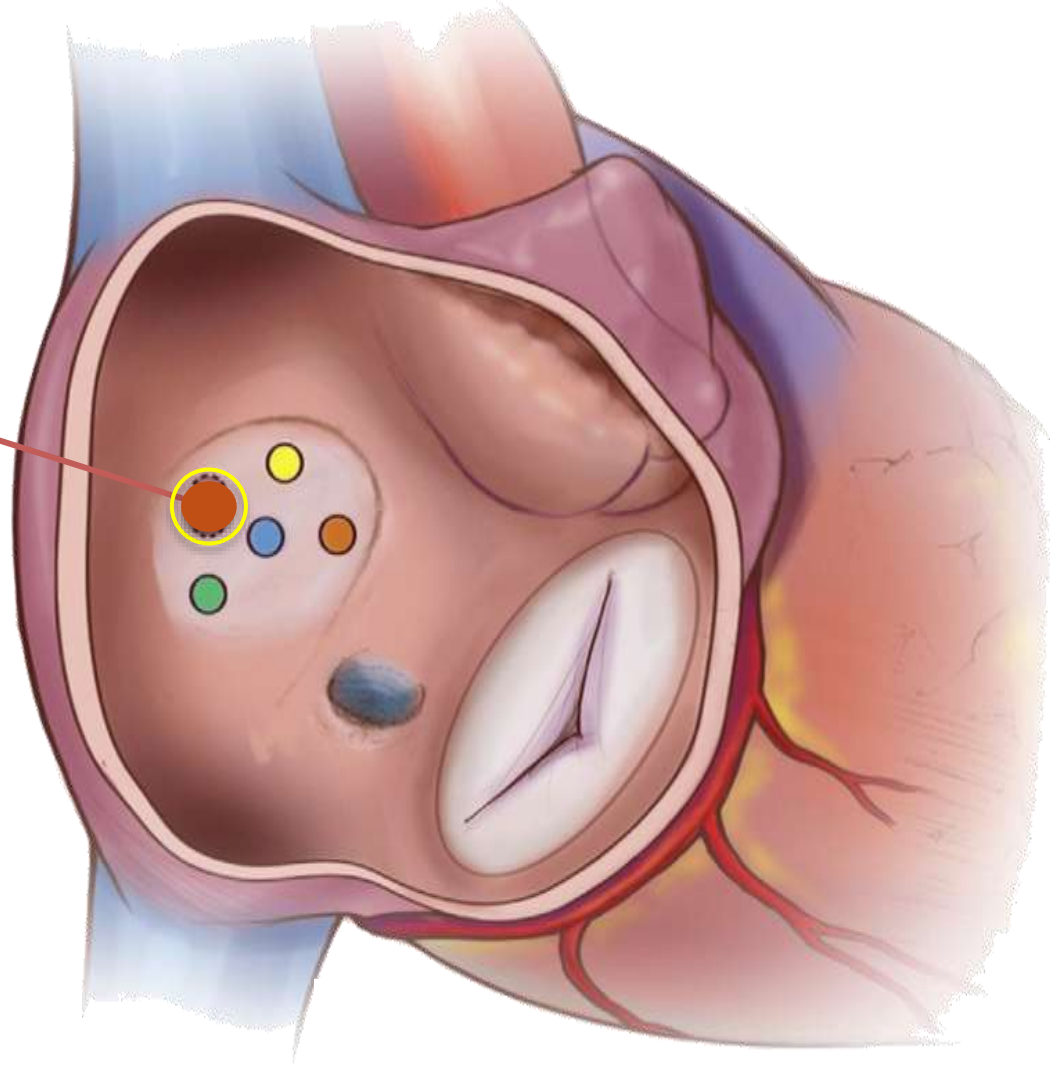


Transseptal Puncture for M – TEER

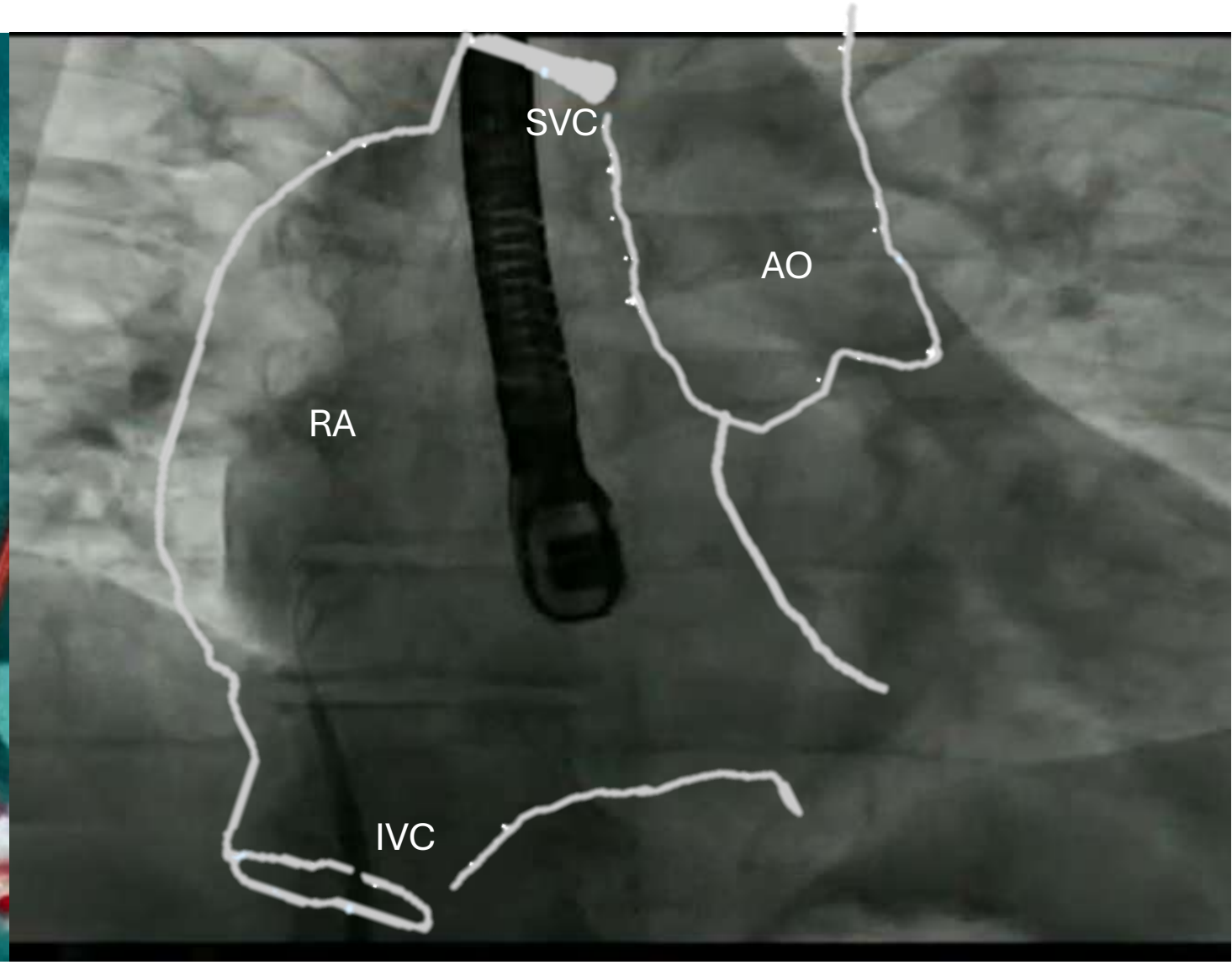


Mid Posterior puncture for M - TEER

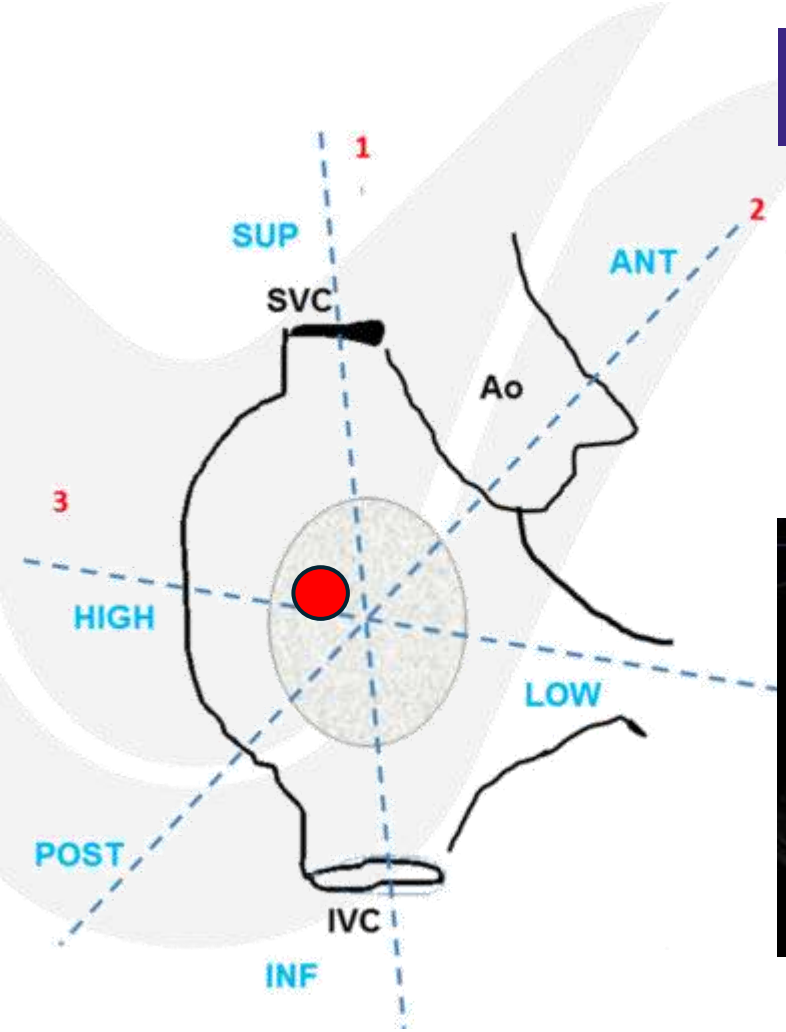
TEE View	Position
Bicaval	Mid
Short Axis	Posterior
4 Chamber	High

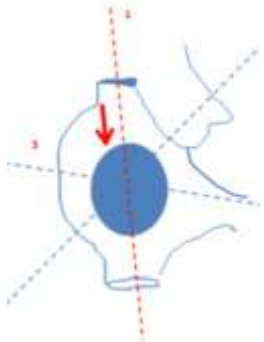
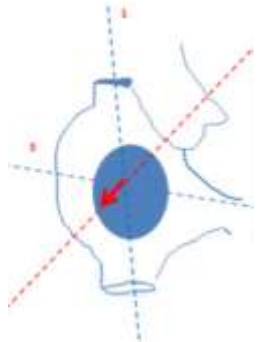
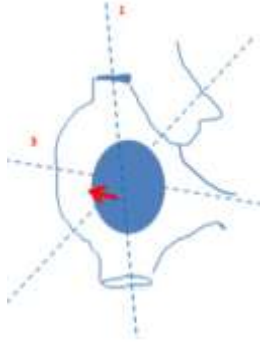
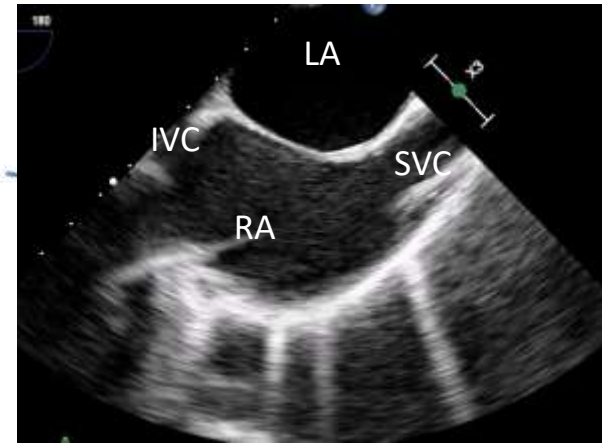
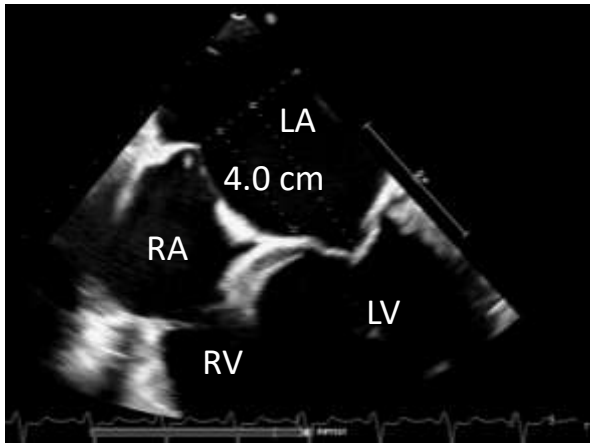


Introduce & advance TSP sheath over 0.032" guidewire into the SVC



TEE Views for Transseptal Puncture

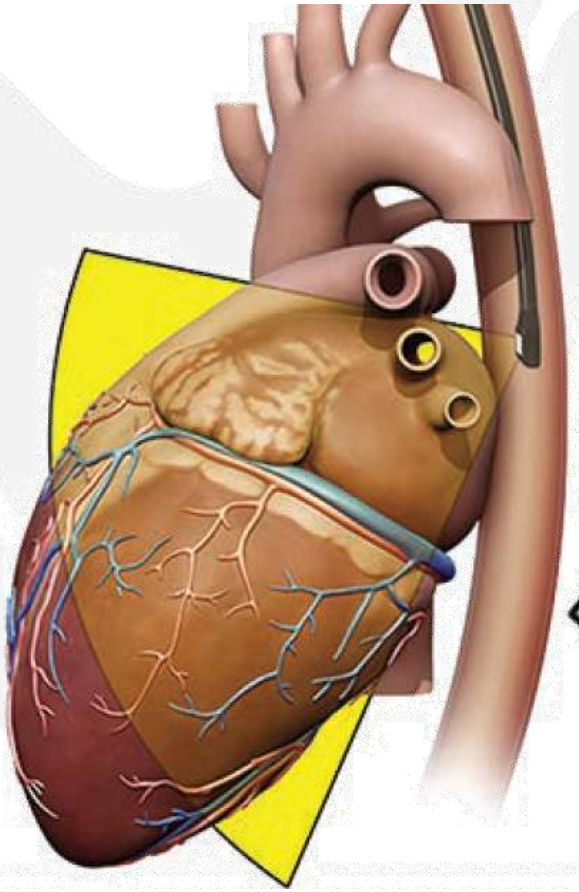


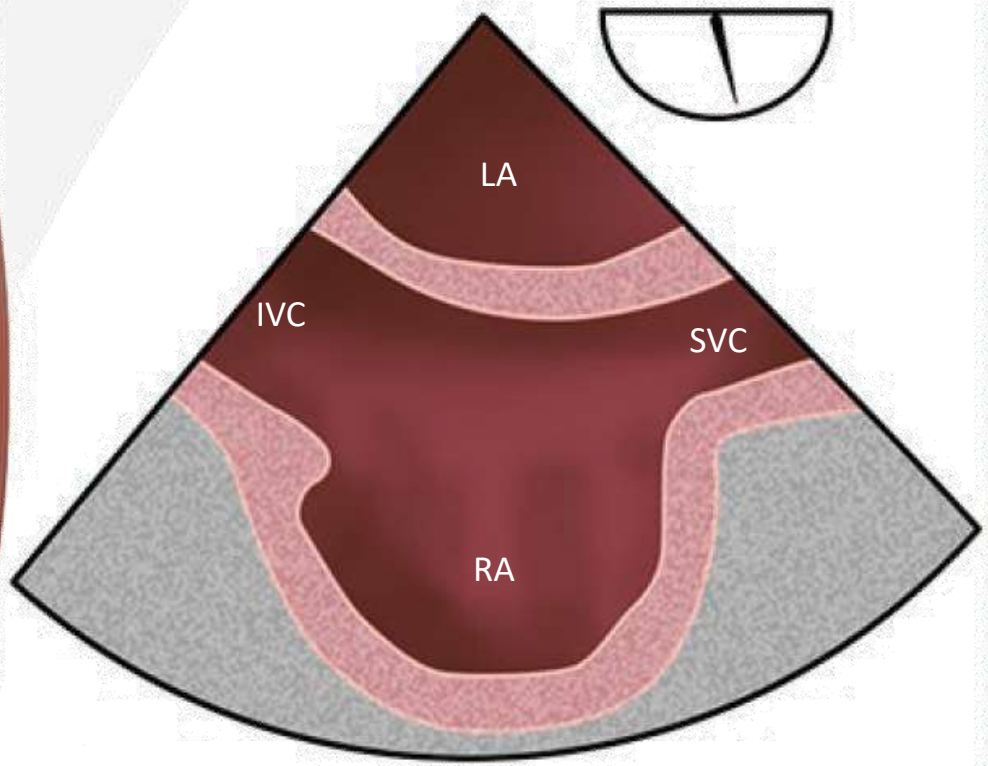
Bicaval View	Short Axis View	4 Chamber View
TEE 90° 	TEE 45° 	TEE 0° 
		
Visualise the fossa ovalis	Assess the anterior/ posterior position of the needle	Assess height of the needle from MV annulus

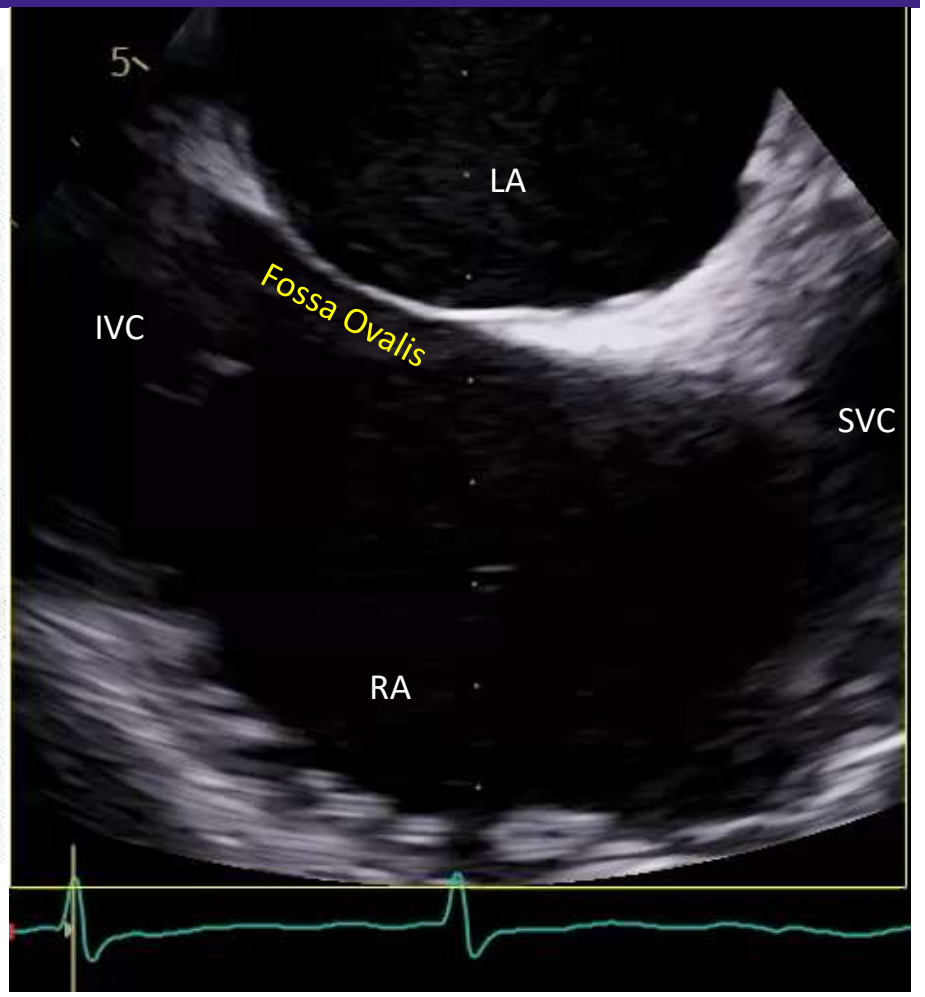
Visualise the fossa ovalis in Bicaval View

Meril

TEE Bicaval View | Transducer Angle: ~90 - 110° Level: Mid-esophageal



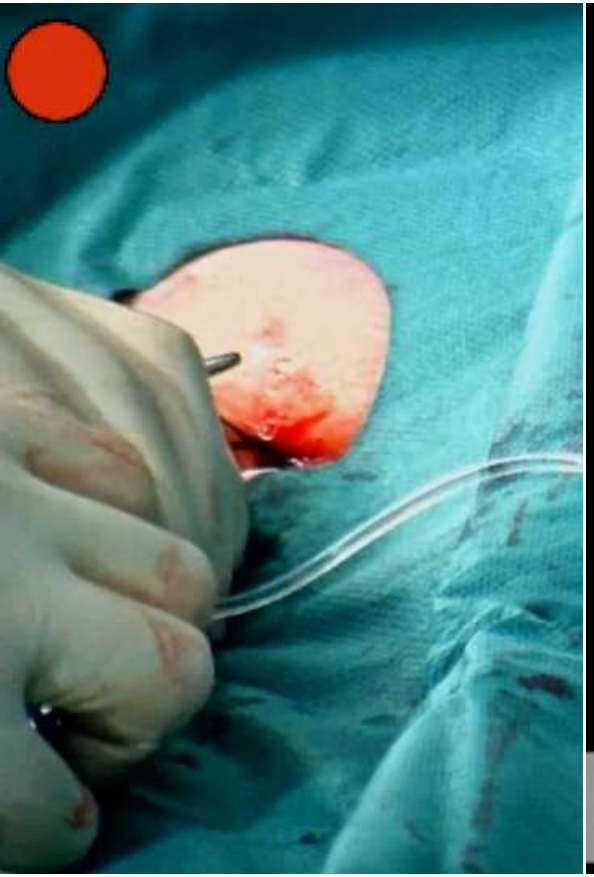


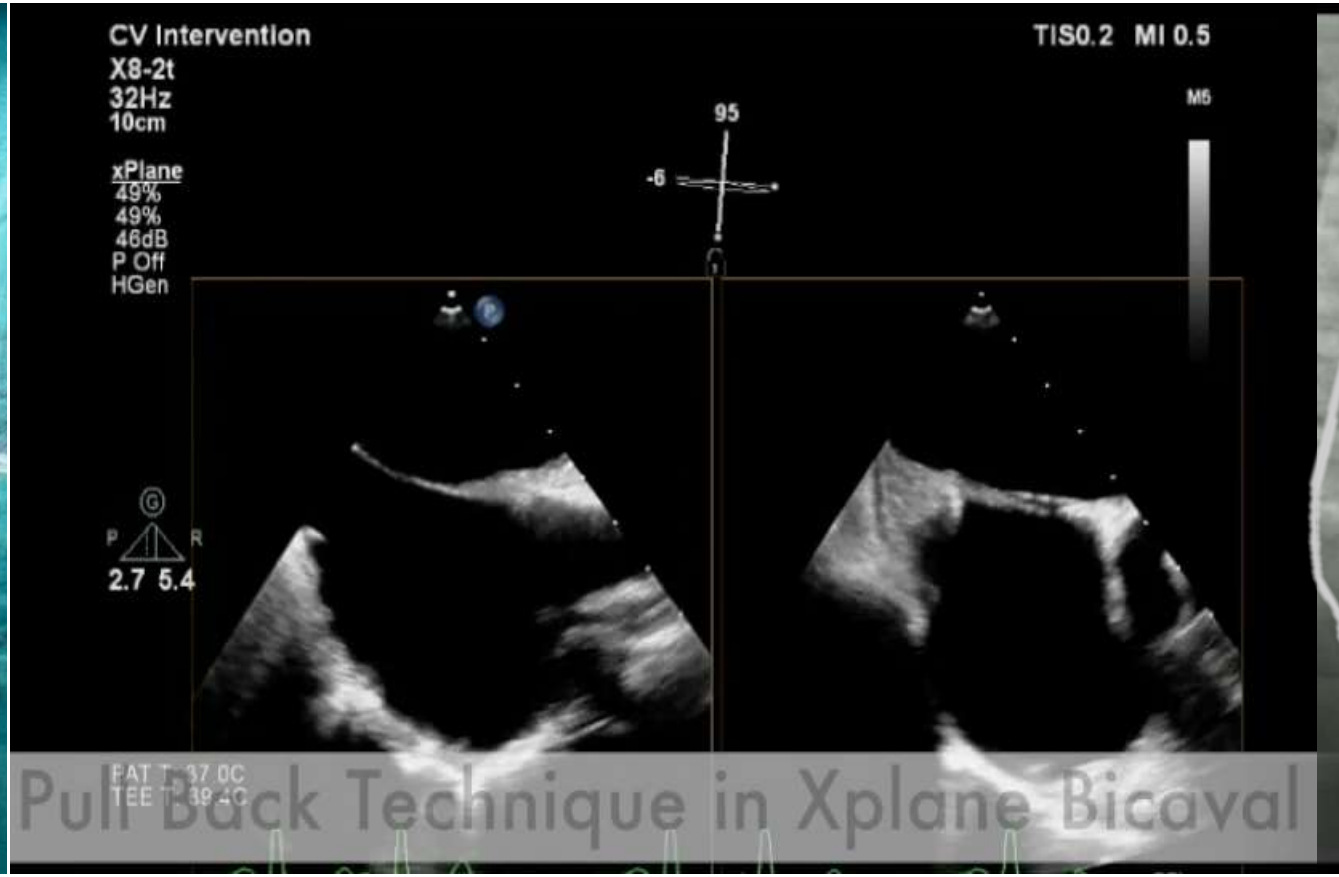


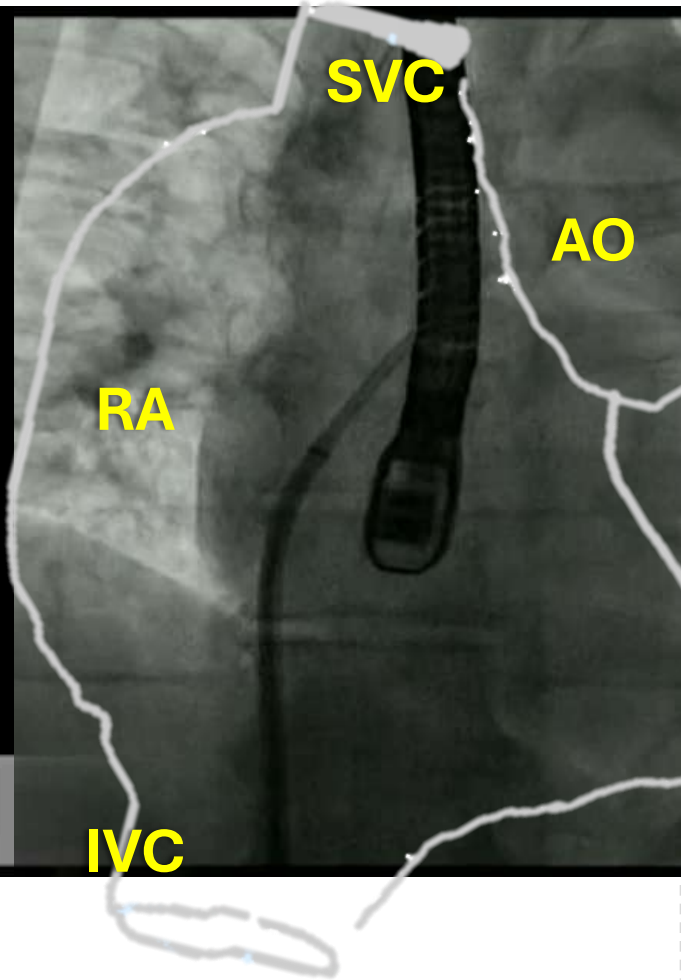
Rotate the needle to get the desired curve & pull back

Meril

Procedure	TEE Bicaval – X plane view	Fluoroscopy



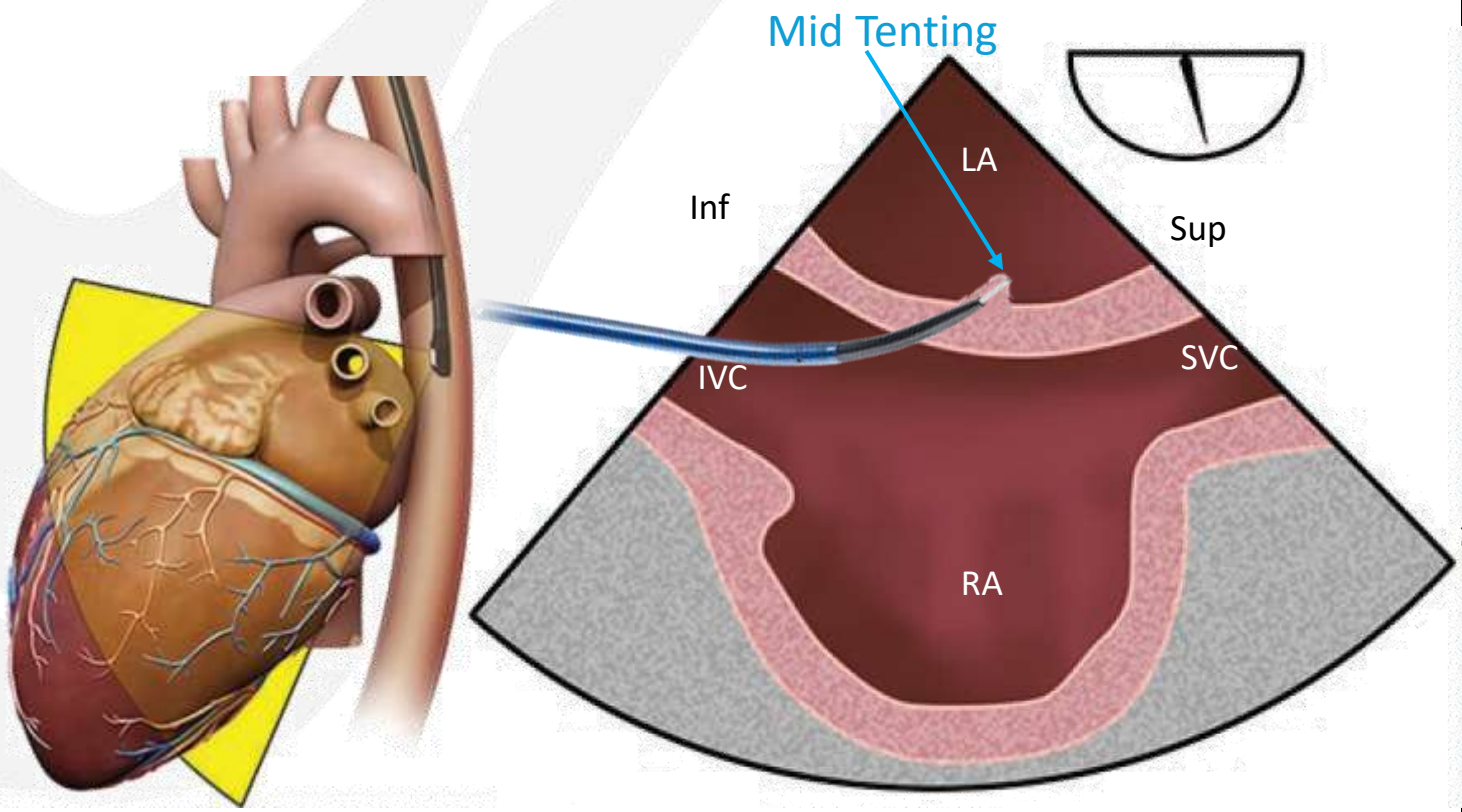


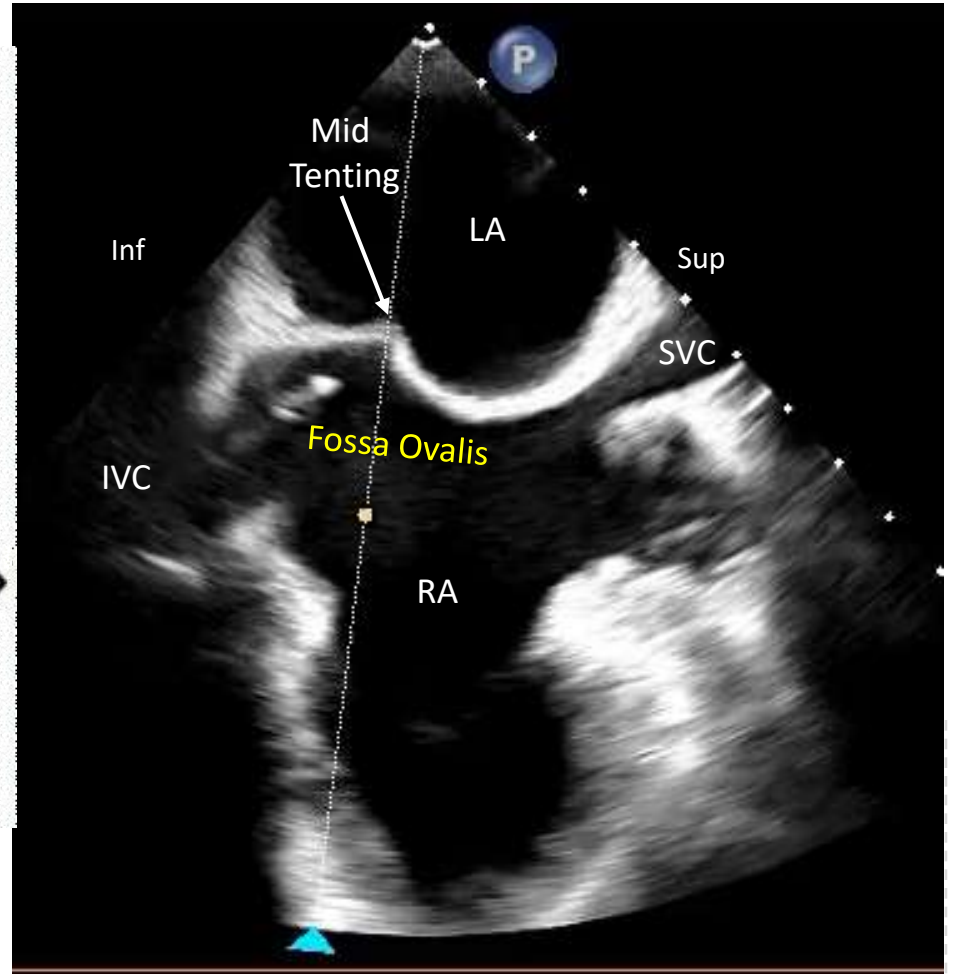


Visualise tenting at Mid Fossa in Bicaval View

Meril

Mid Fossa Tenting in TEE Bicaval View





- Transducer Angle: ~90 - 110°
- Level: Mid-esophageal

Anterior/Posterior part of Fossa in SAX view

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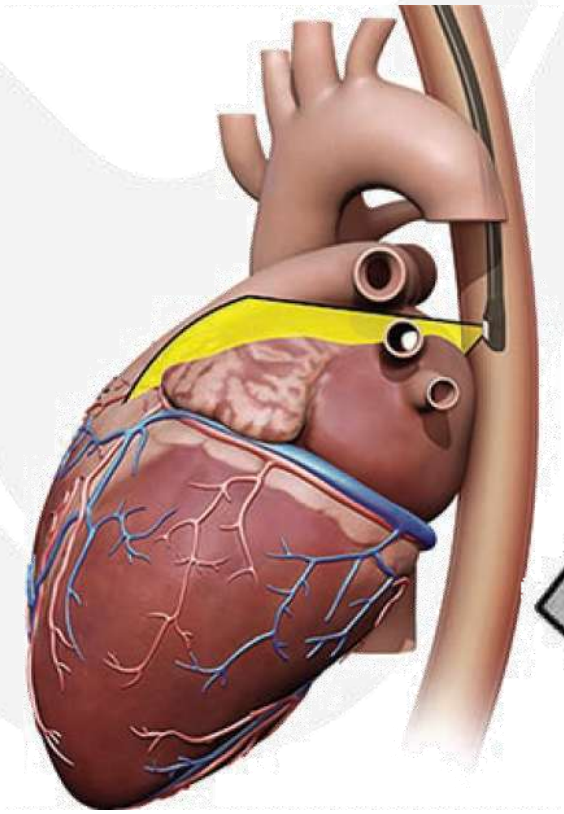
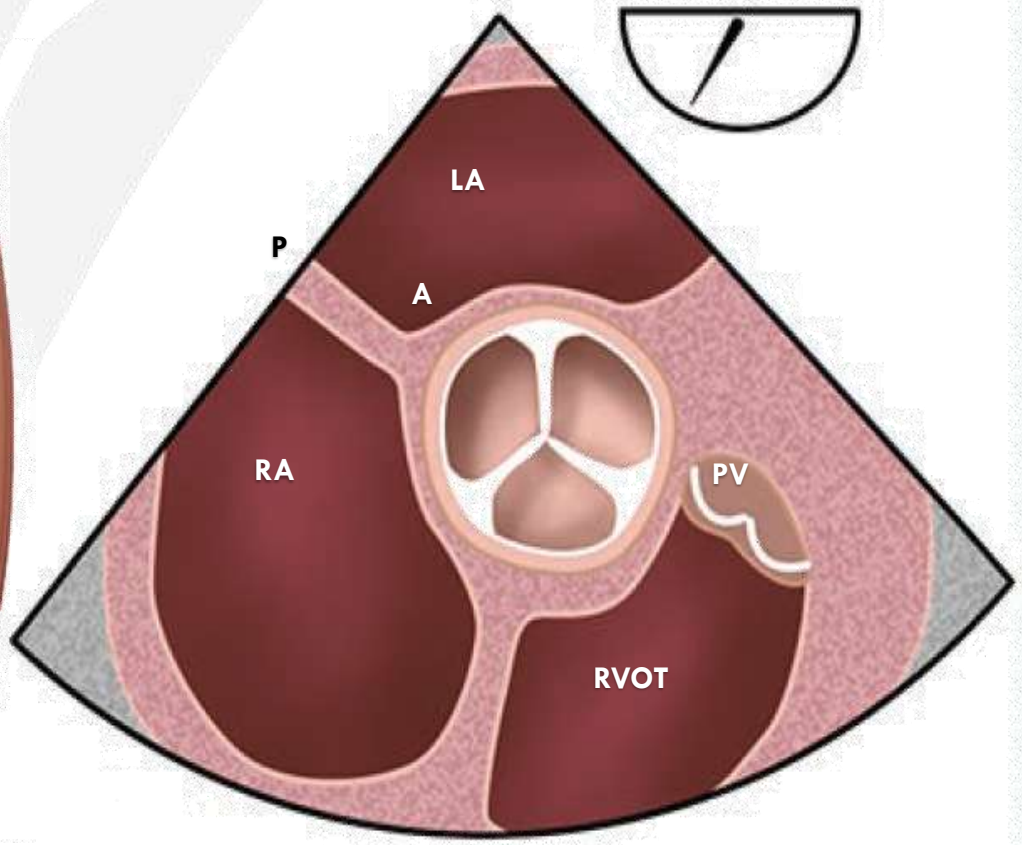
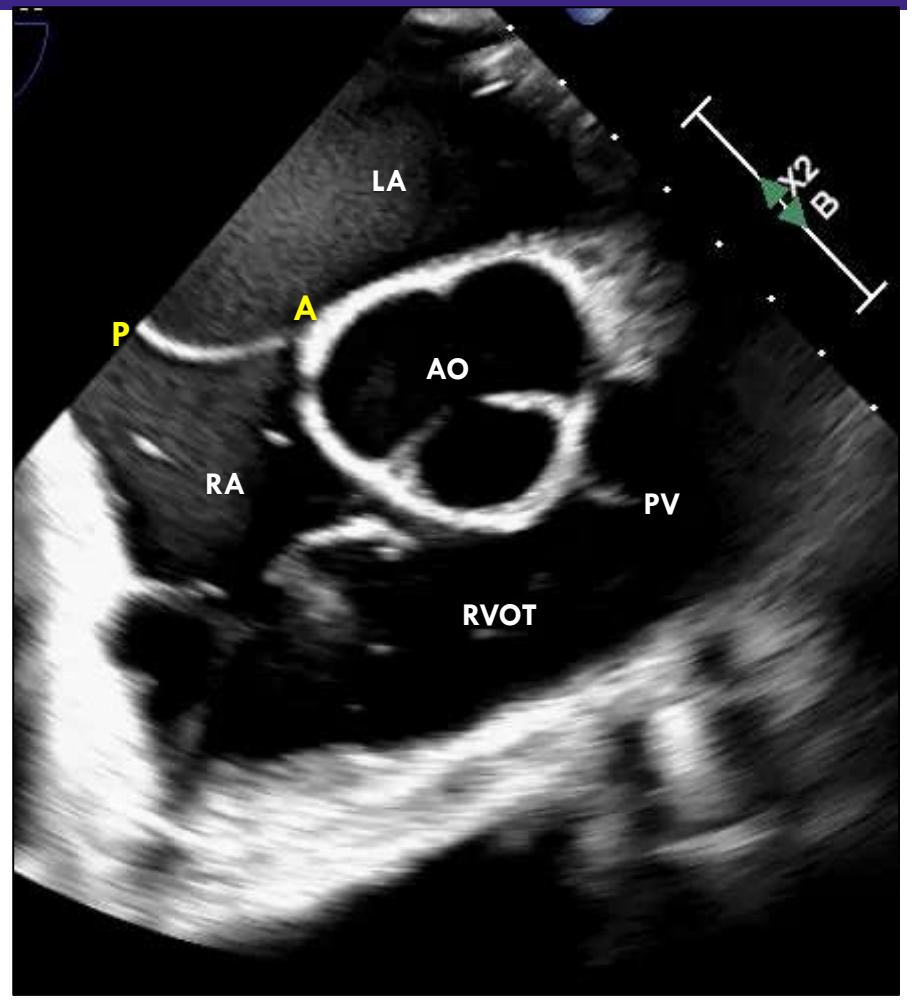
TEE Short Axis at Base | Transducer Angle: ~25 – 45° | Level: Mid-esophageal



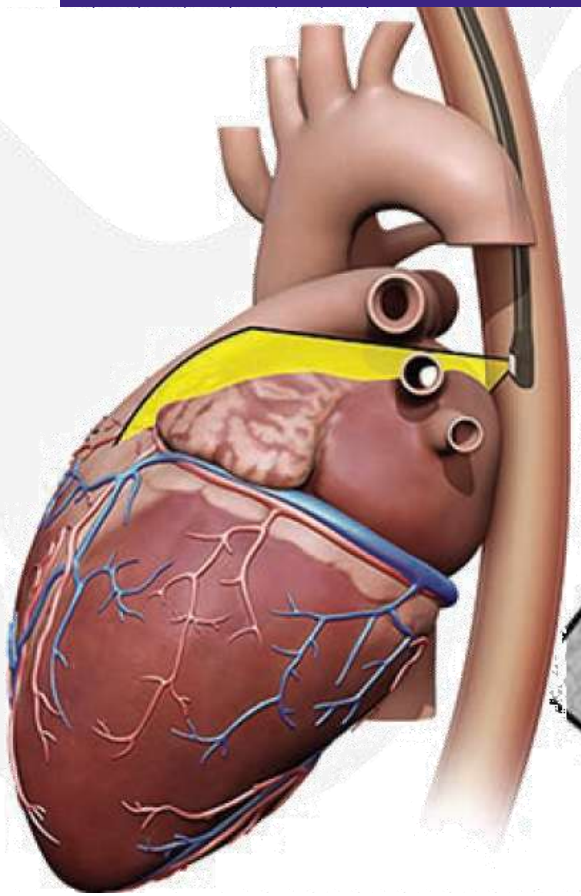


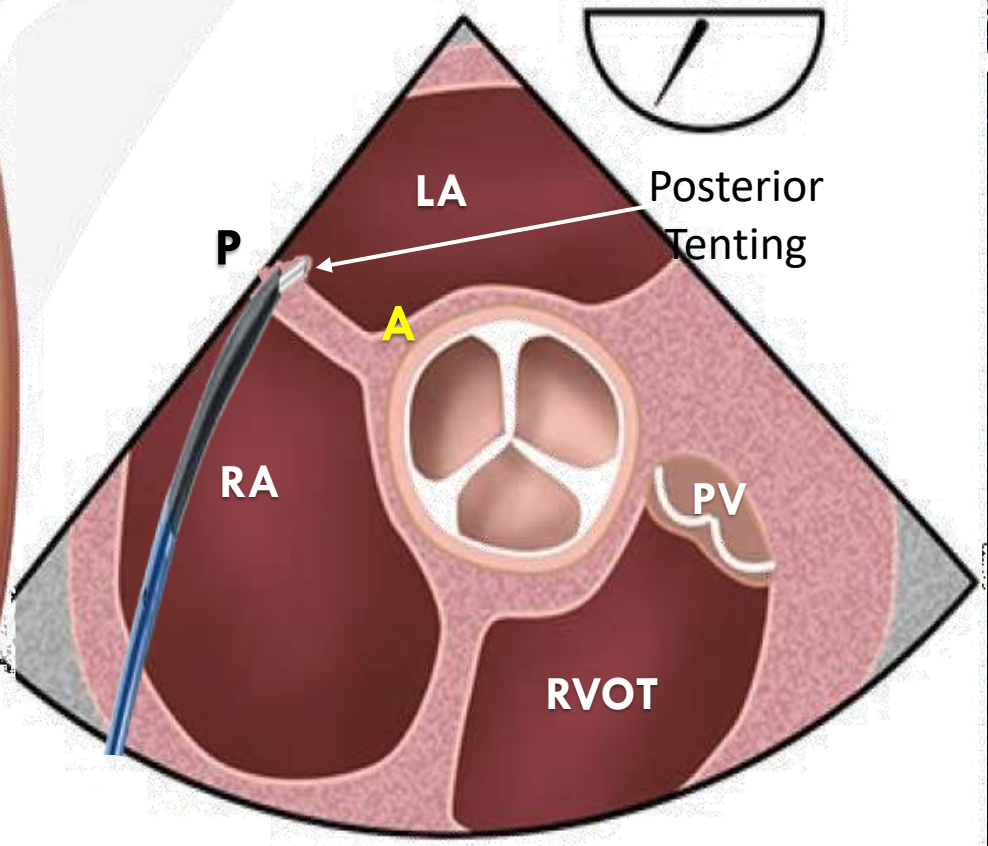


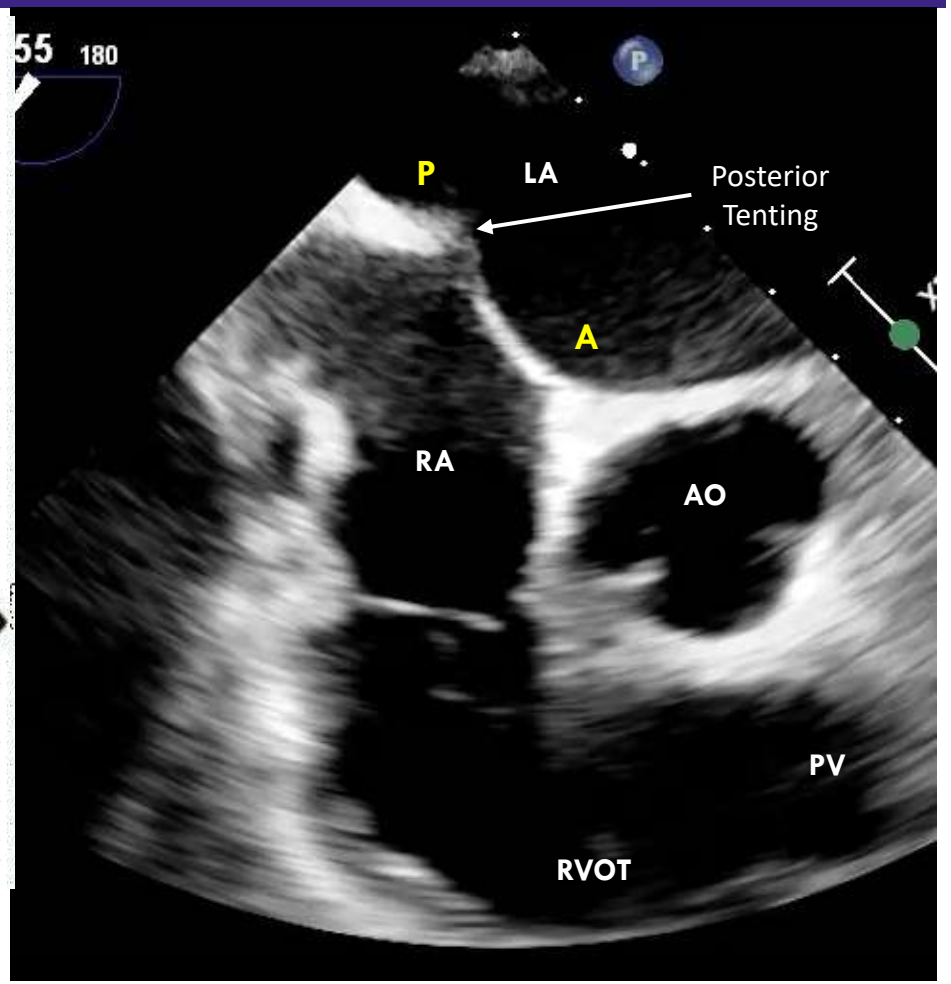
Visualize tenting at Posterior part of Fossa in SAX

Meril

Posterior Fossa Tenting in TEE Short Axis View (SAX)







Assess Tenting height from MV annulus in 4C View

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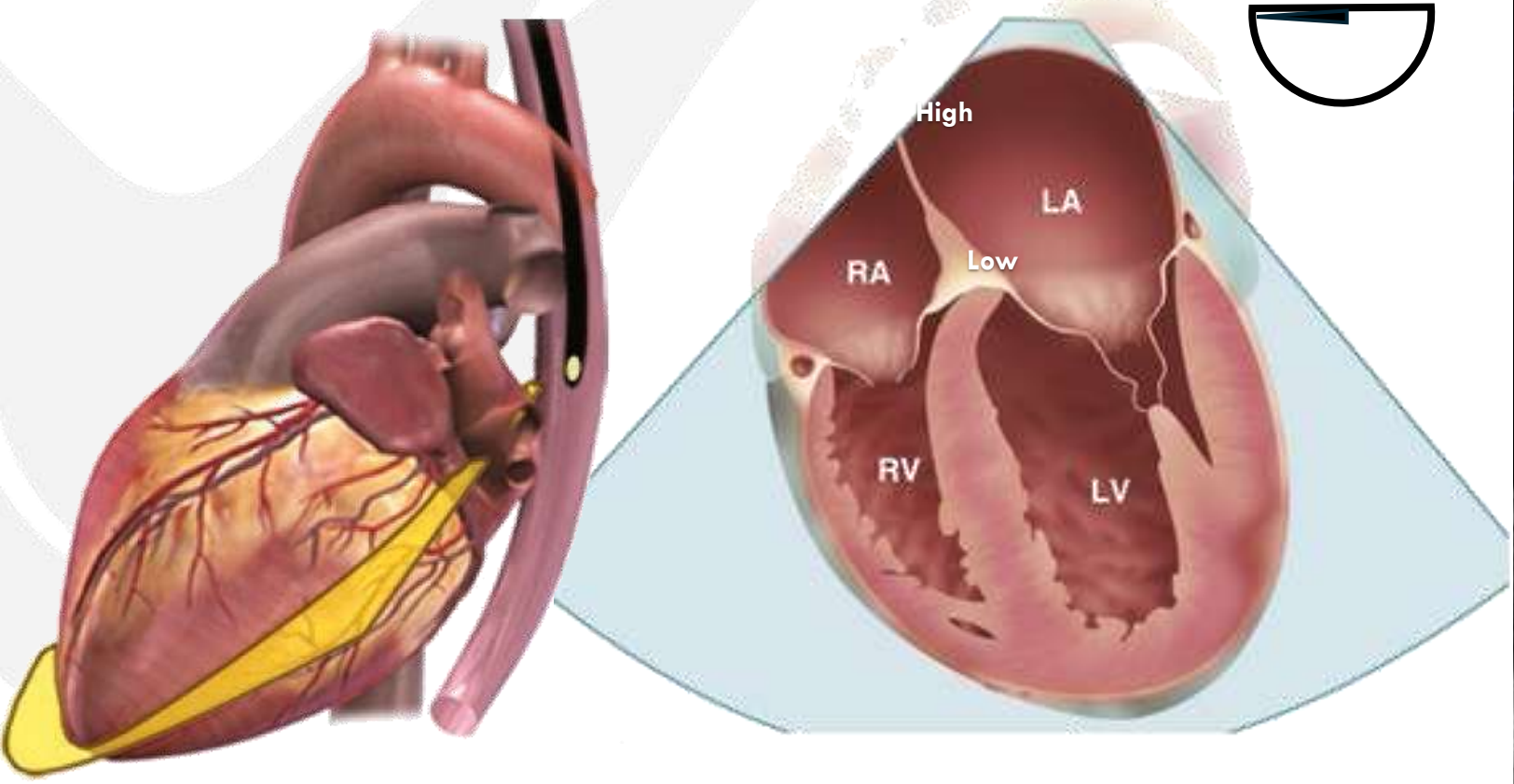
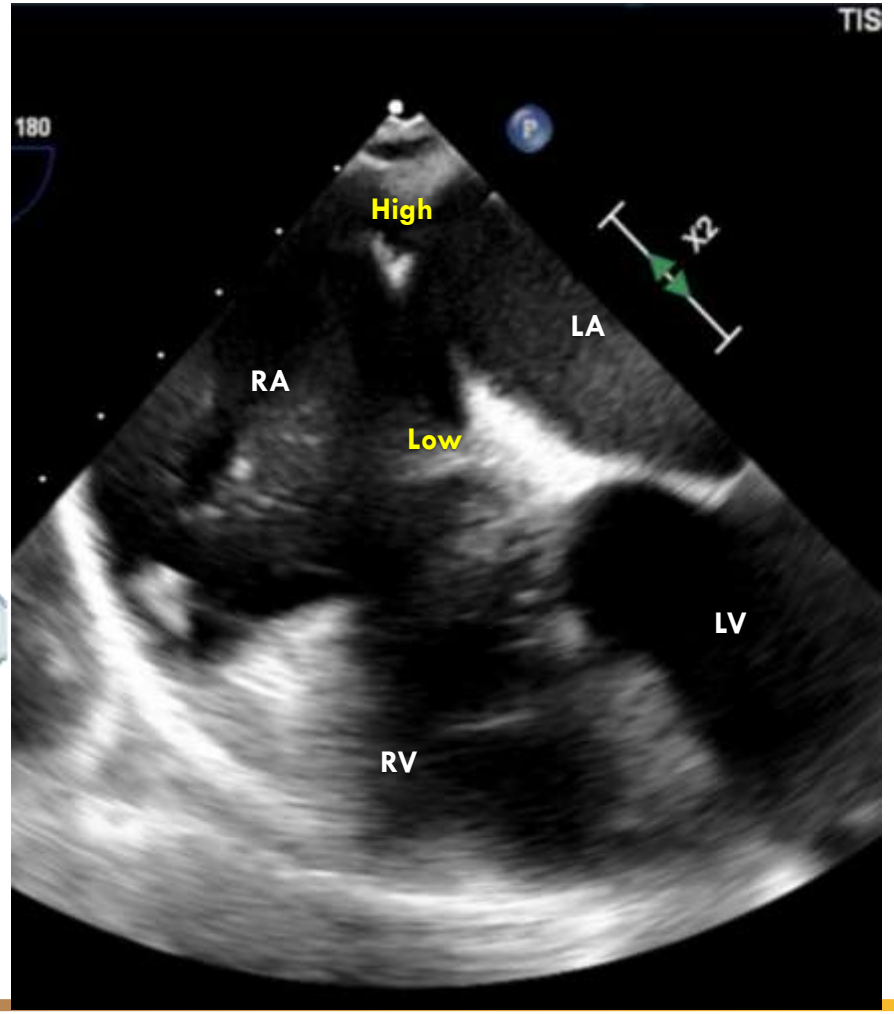
TEE 4 Chamber View | Transducer Angle: ~0 – 10° | Level: Mid-esophageal

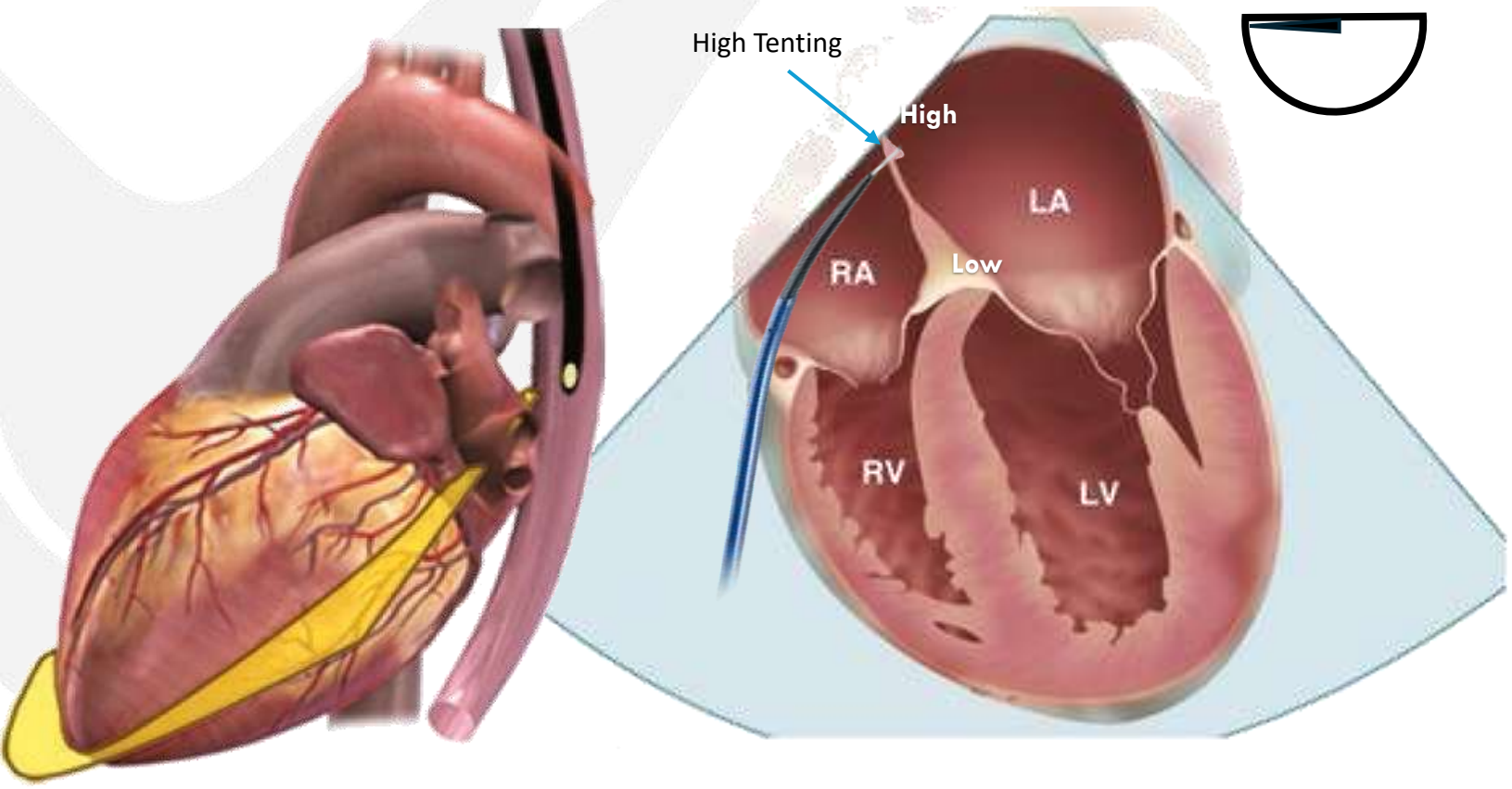


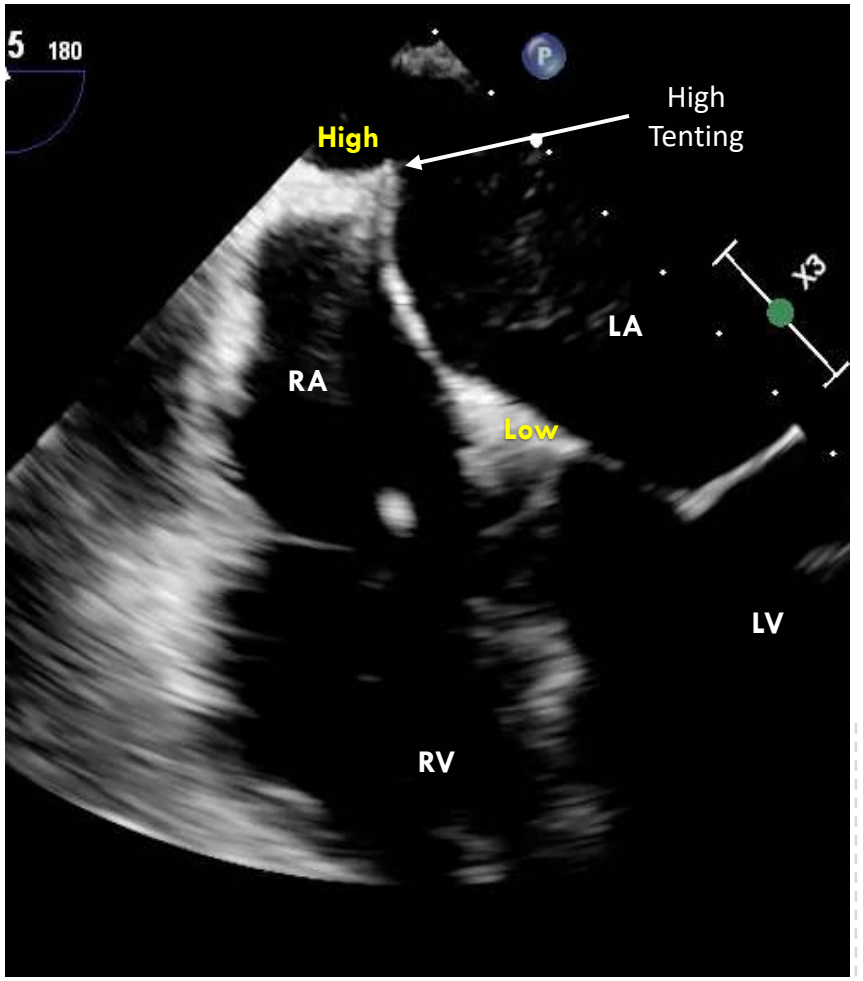


Visualize tenting at higher part of Fossa in 4C View

Meril

High Tenting in TTE 4 Chamber View





- Transducer Angle: ~0 – 10°
- Level: Mid-esophageal

Transseptal Puncture Imaging for TEER

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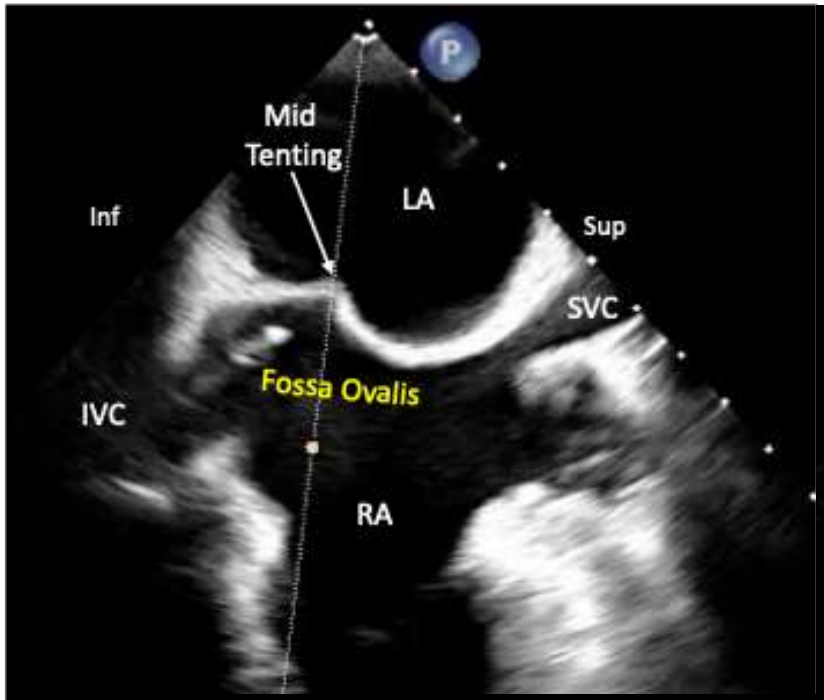
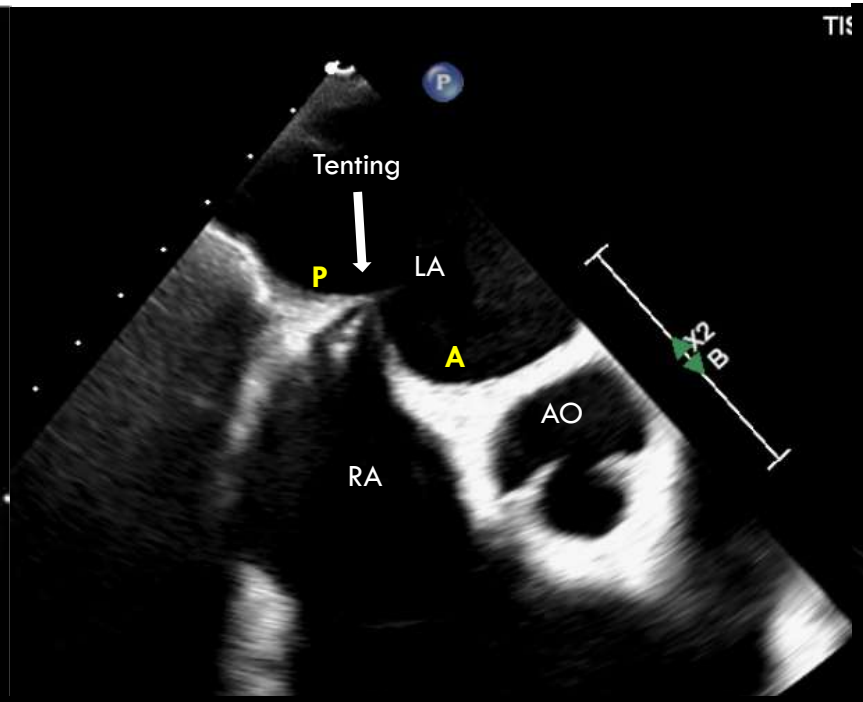
Draw parallel lines across the MV annular plane & transseptal tent plane to measure the height

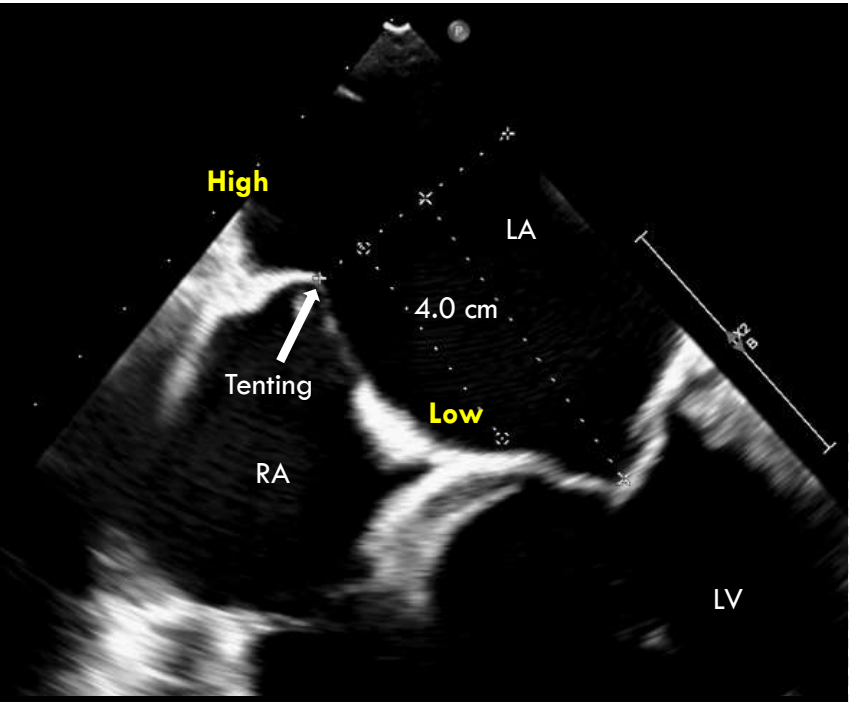
Bicaval view (90°)



Short Axis View



4 Chamber View



Puncture Height from Mitral Valve – For **DMR 4.0 to 4.5 cm** | For **FMR 3.5 to 4.0 cm**

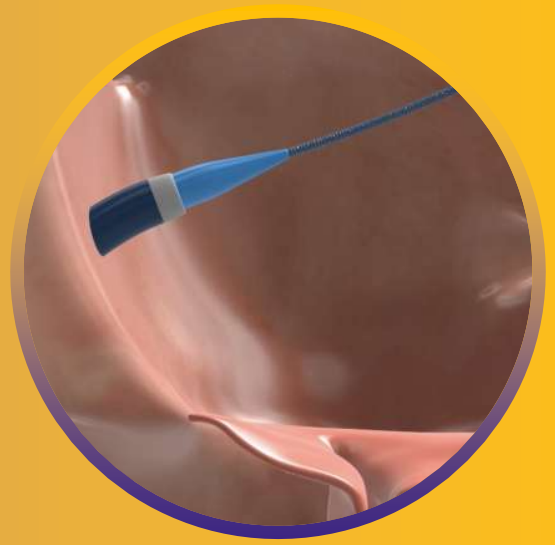
Meril

Sympli 5-TEER

Five Stages for Predictive and Successful TEER Procedure and Outcomes

Stage 2

Advancement of MyClip Guide Catheter (MGC) in Left Atrium (LA)



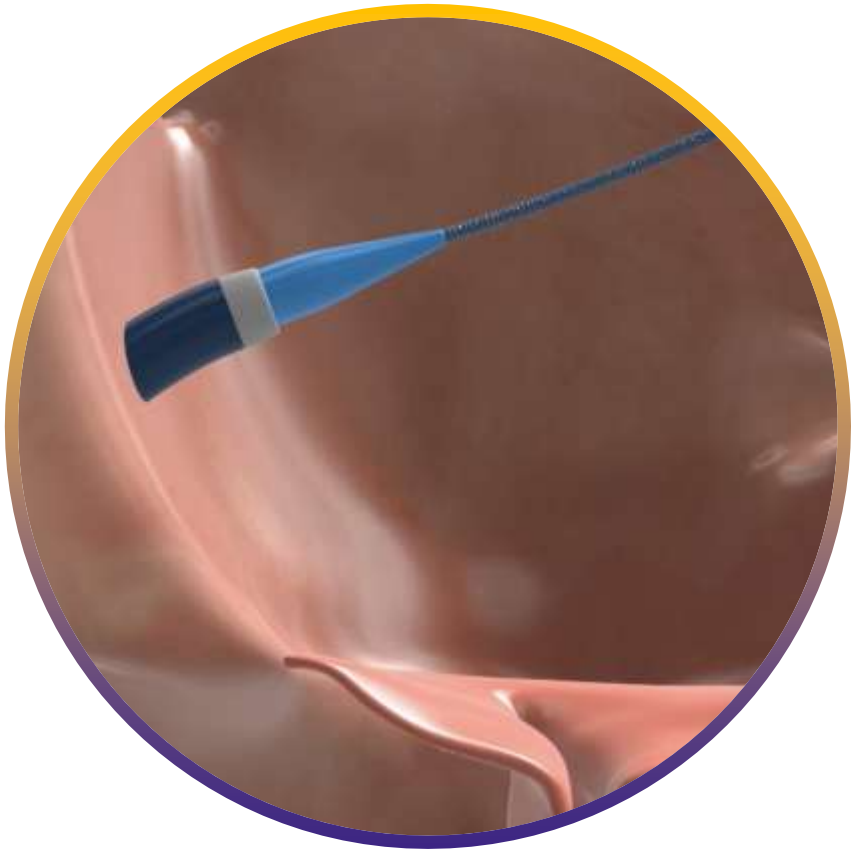
Goals for Advancement of MGC in LA

Meril

Safe insertion of MGC in LA
(Short axis and Fluoroscopy)

Adequate length (2 cm) of MGC in LA **(Short axis)**

Avoid air embolization

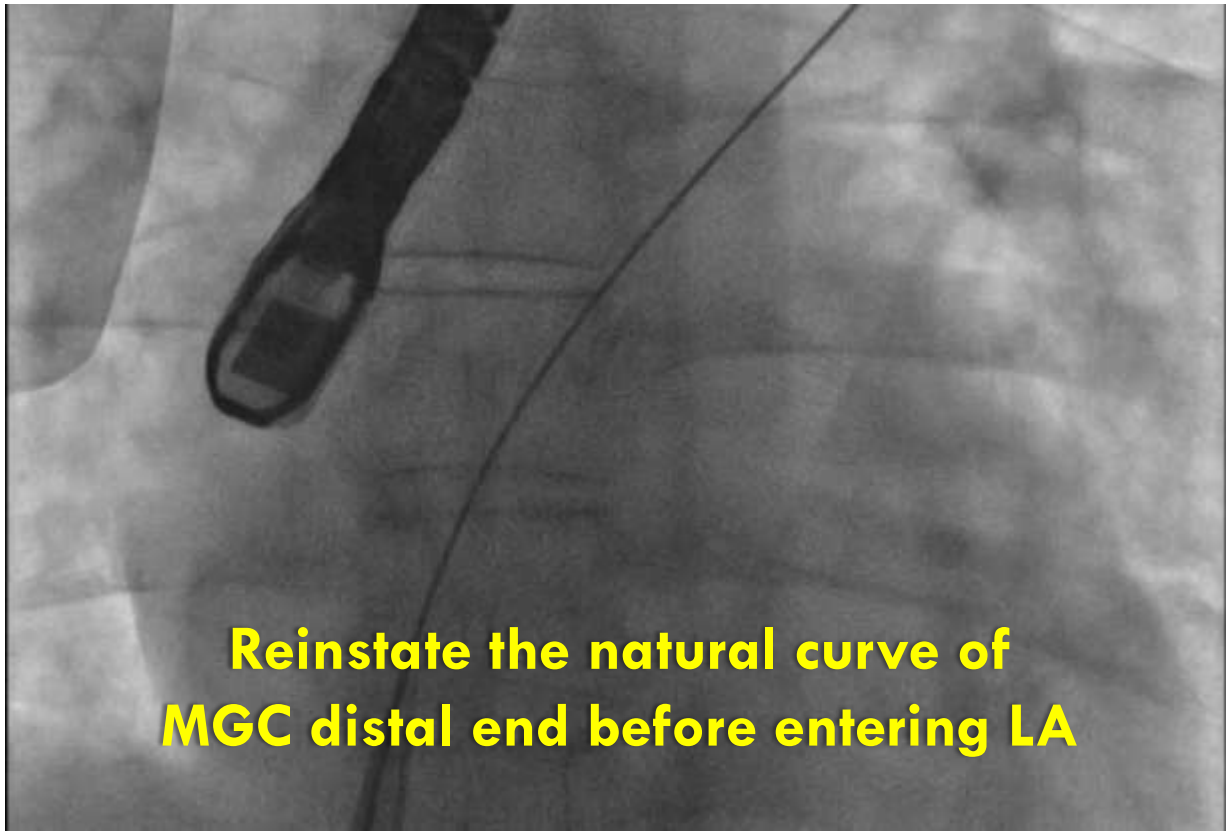


Insertion of Myclip Guide Catheter (MGC) into LA

- Load the MGC-Dilator and advance the MGC system on the exchange length super stiff 0.035” guidewire previously parked in the left upper pulmonary vein.

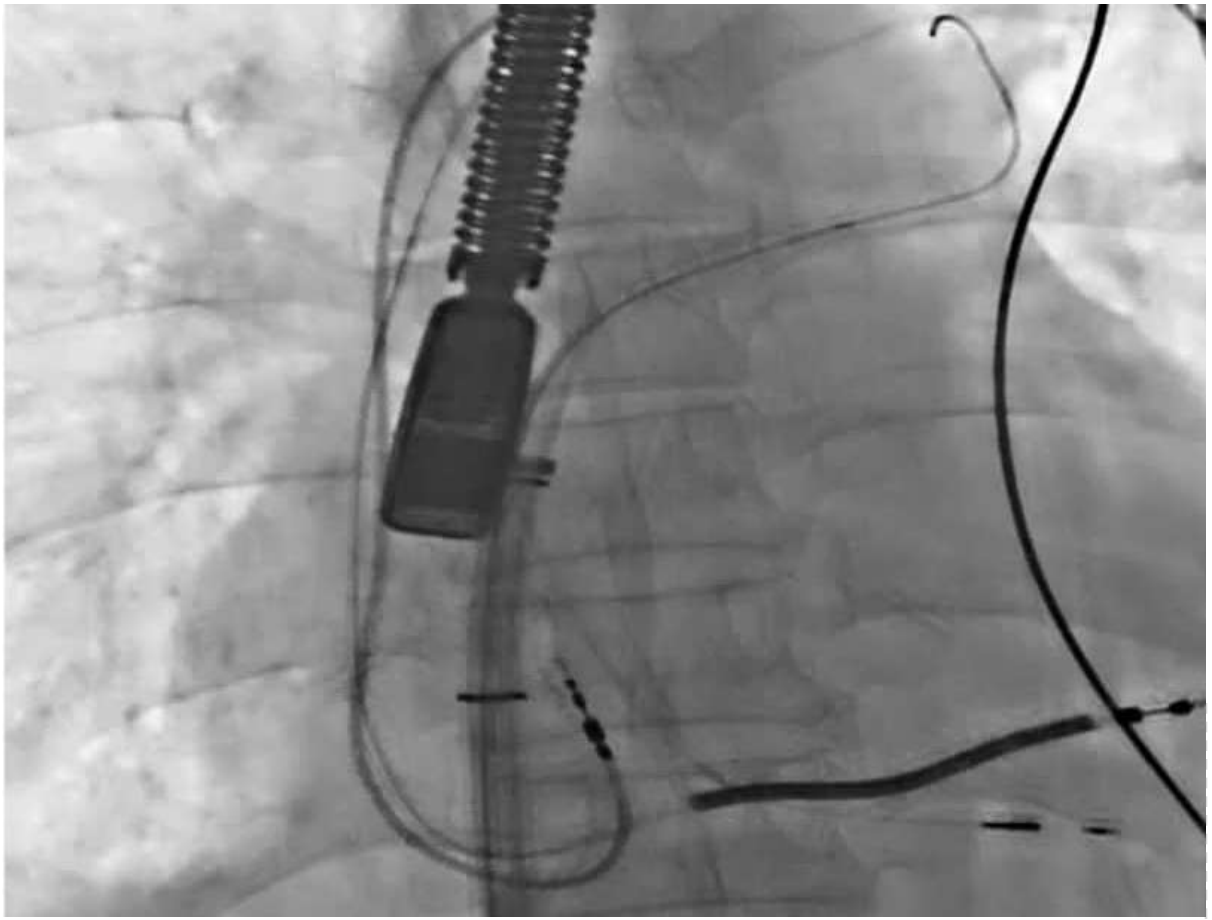
TEE Short Axis view

Fluoroscopy



Retrieve the dilator into MGC

Meril

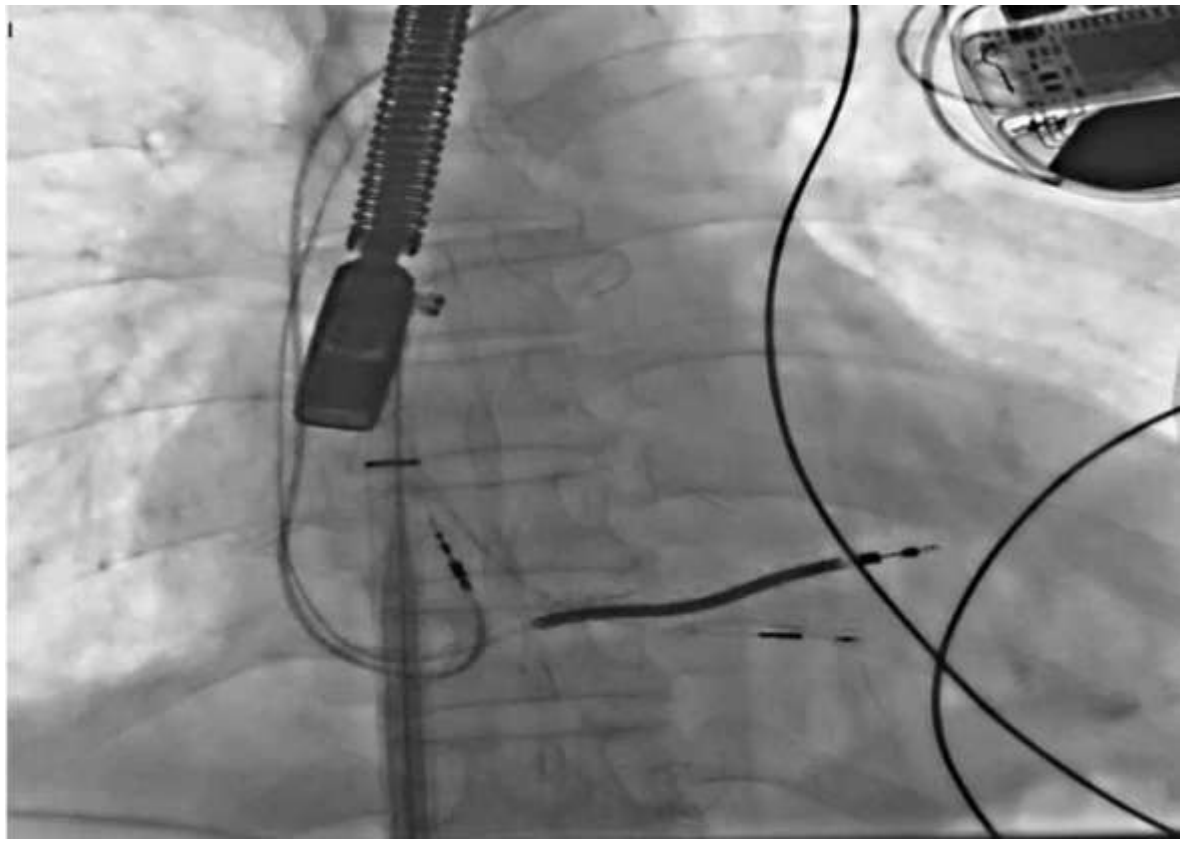
TEE Short Axis view	Fluoroscopy
	

Retrieve the dilator and wire

- Withdraw the exchange length super stiff 0.035” guidewire into the Dilator.
- Simultaneously retrieve the Dilator & Guidewire out of the MGC
- Perform this step under continuous aspiration to prevent air embolization

TEE Multi Plane View

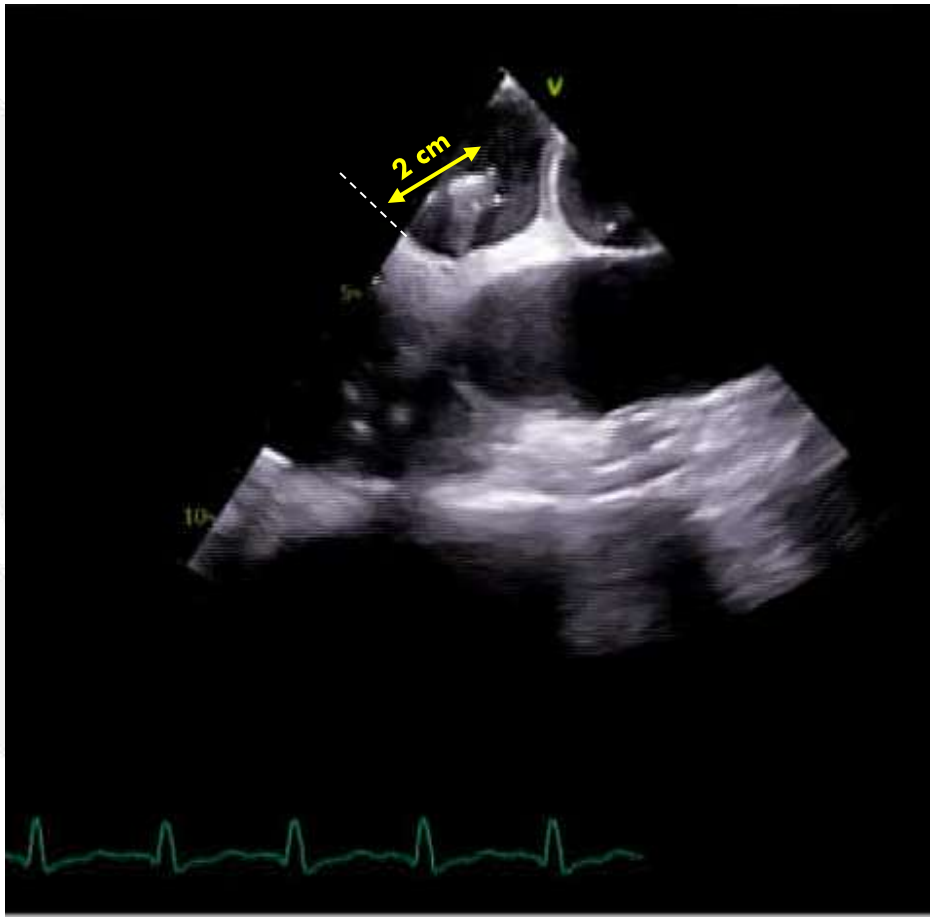
Fluoroscopy

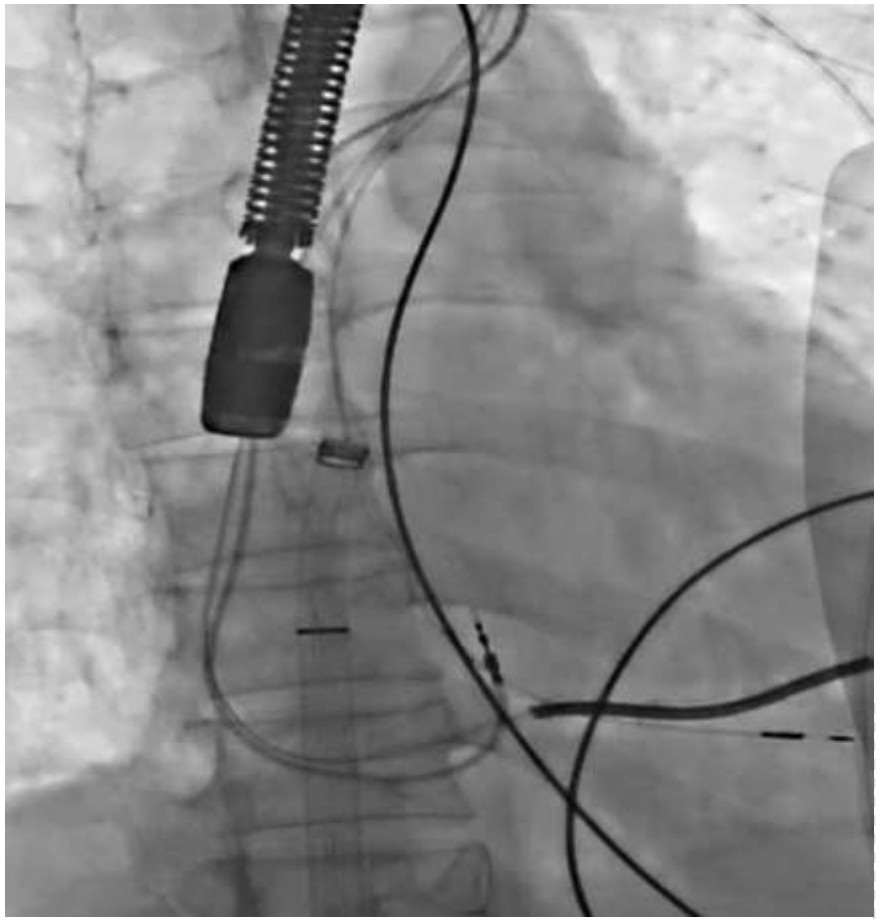


Placement of MGC 2 cm in LA

Meril

TEE Short Axis view	3D Enface	Fluoroscopy





Meril

Sympli 5-TEER

Five Stages for Predictive and Successful TEER Procedure and Outcomes

Stage 3

Advancement of Clip in LA & orientation over MV

Goals for Advancement of MyClip in LA & orientation over MV

- Establish optimal trajectory (minimal manipulation on MGC & MDS) to **reduce risk of complications**
- **Avoid interaction with the cardiac structures** (Coumadin Ridge, LA Appendage)
- Achieve optimal orientation & trajectory in LA over MV to **maximize procedural success**

Myclip Size Selection

Meril

Short or restricted PML (6–9 mm)

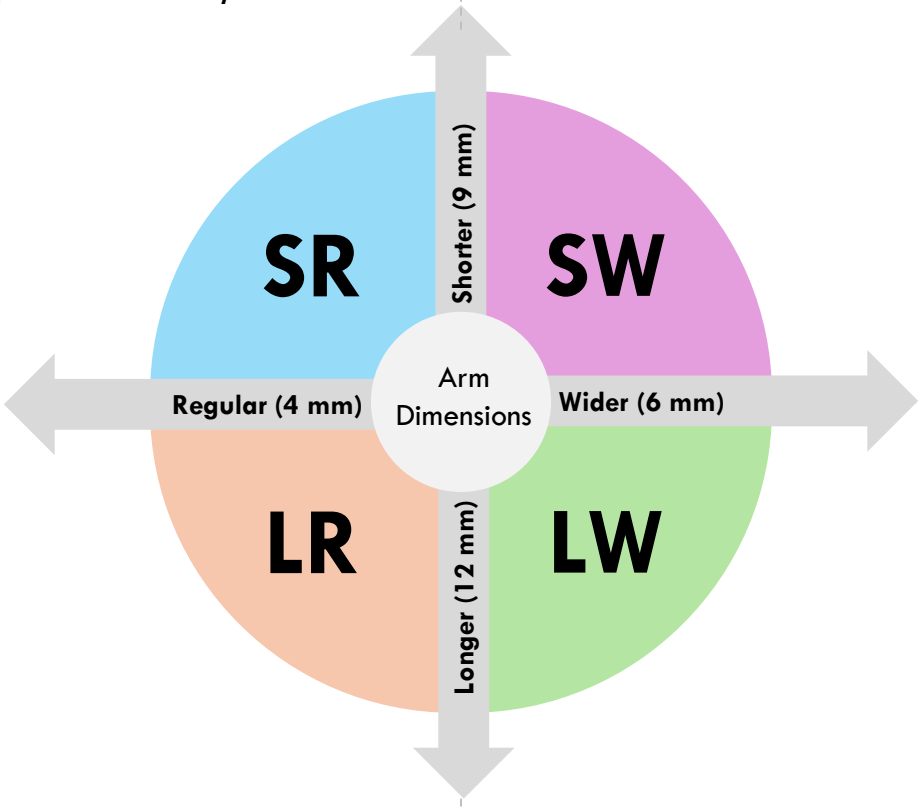
Pathology outside of A2/P2

Mitral annular calcification

Coaptation/flail gap <10 mm

Narrow/focused jet

Flail width < 15 mm



Wide/elongated jet

Flail width > 15 mm

Central (A2–P2) pathology

Long or redundant PML > 10 mm

No mitral annular calcification

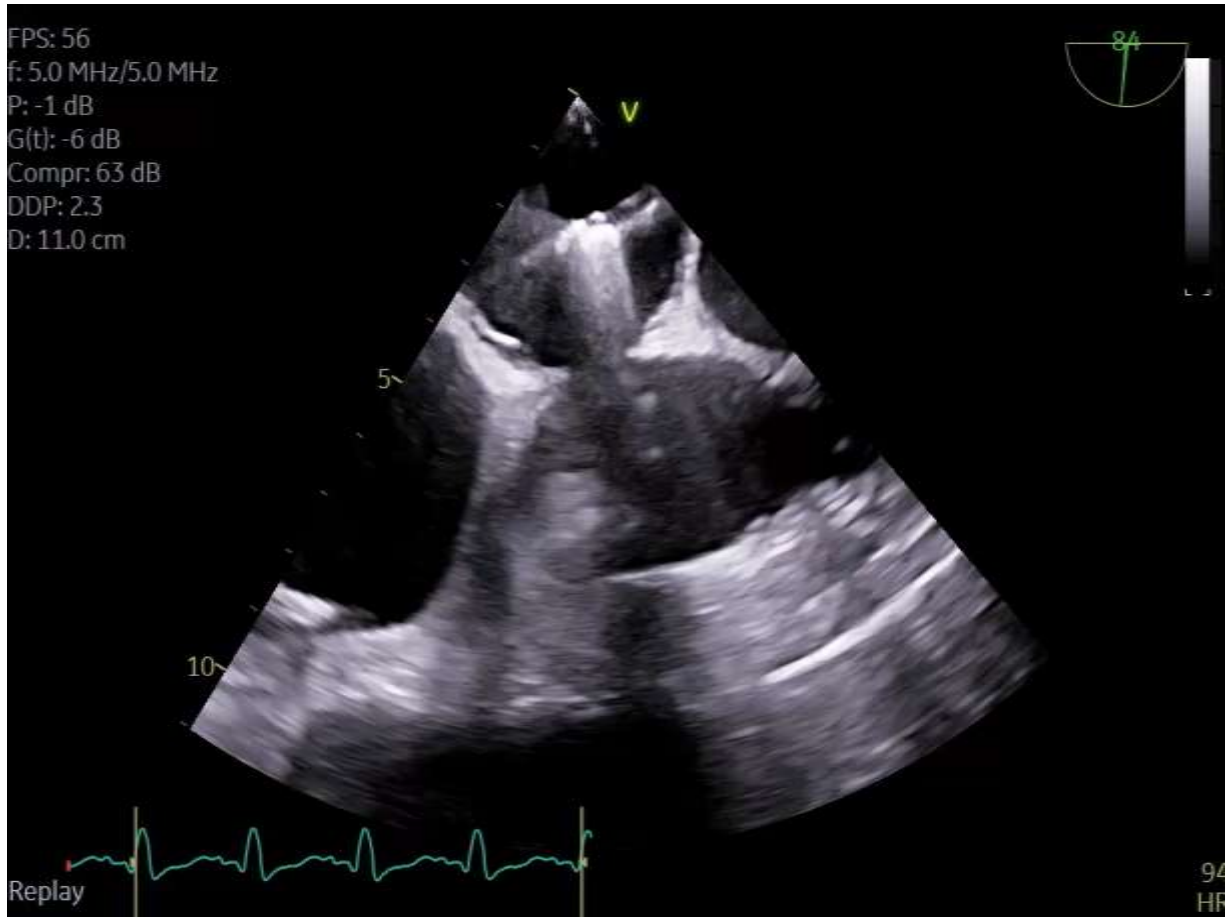
Large coaptation gap or height

Anita W. Asgar, et al, Transcatheter Edge-to-Edge Repair Ebook, 2022 Society for Cardiovascular Angiography and Interventions (SCAI)

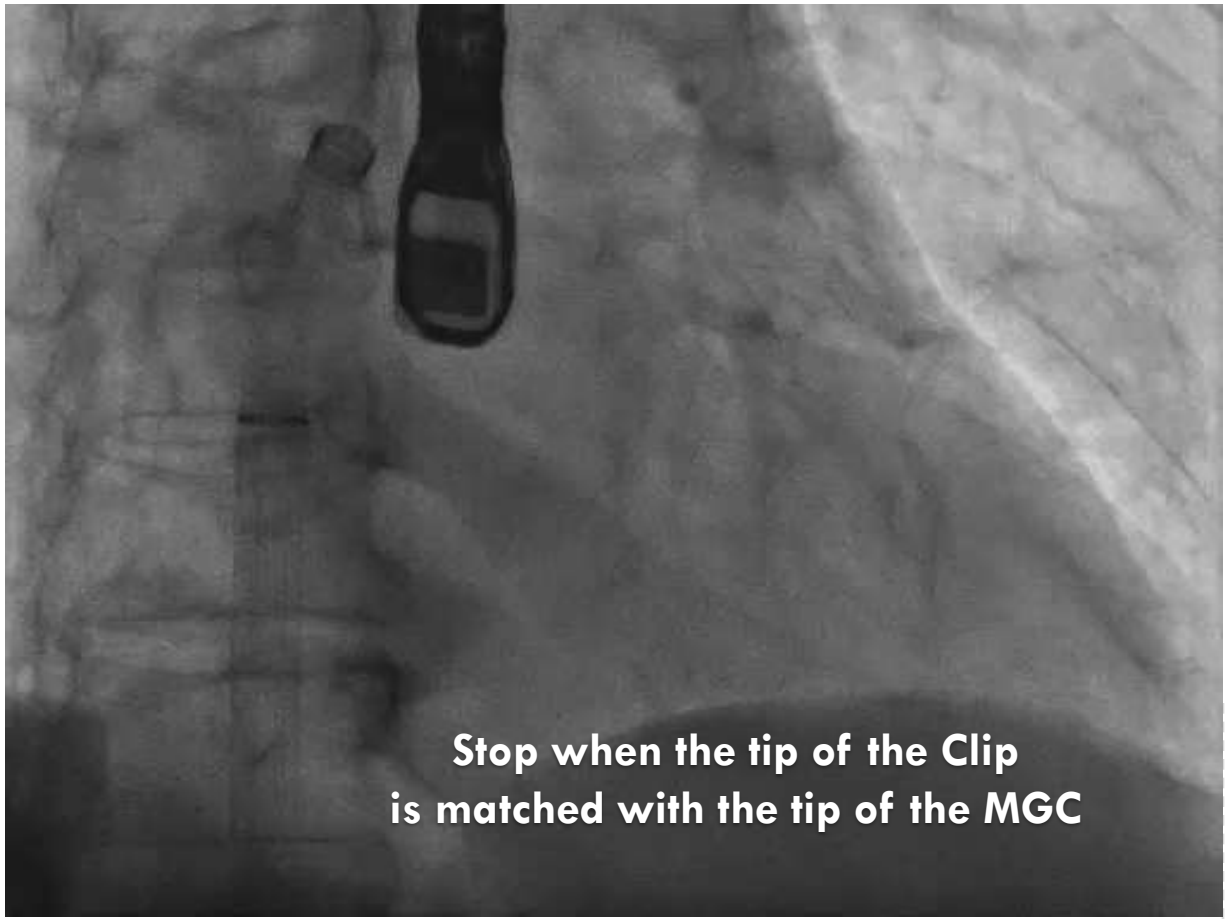
Insert the MDS through MGC under fluoroscopic guidance

Meril

TEE Short Axis View



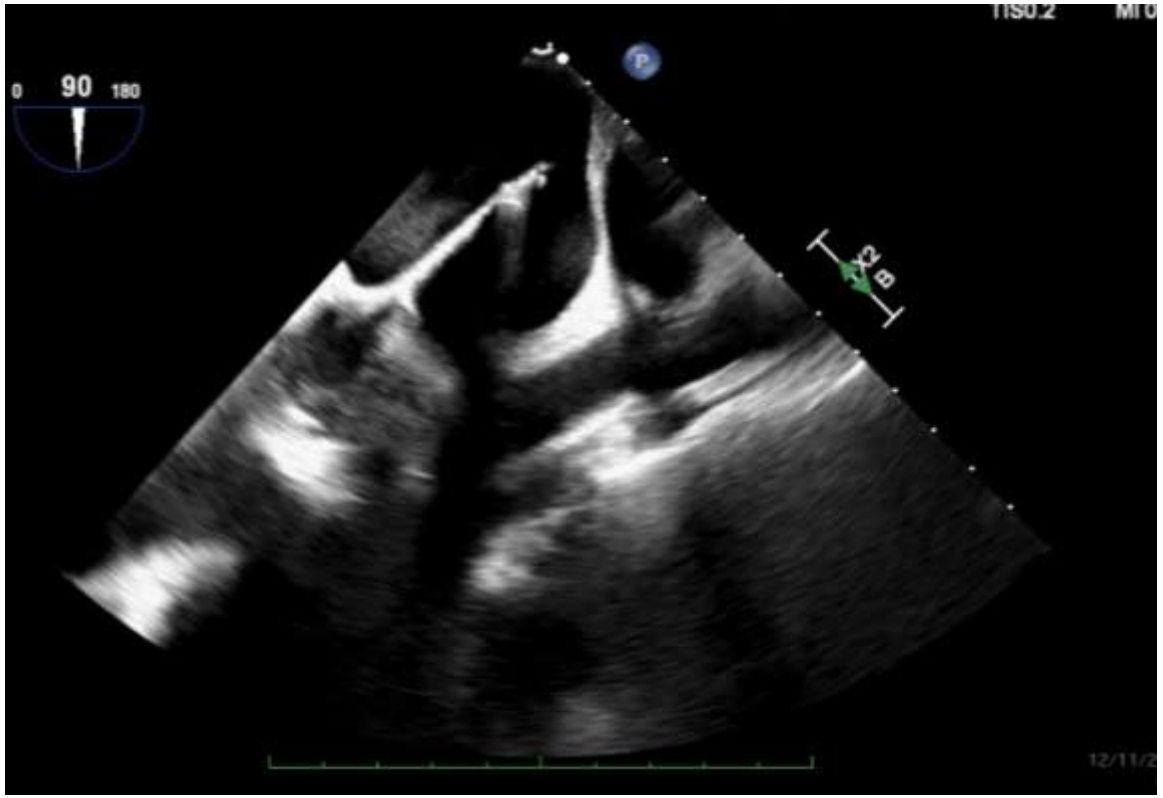
Fluoroscopy



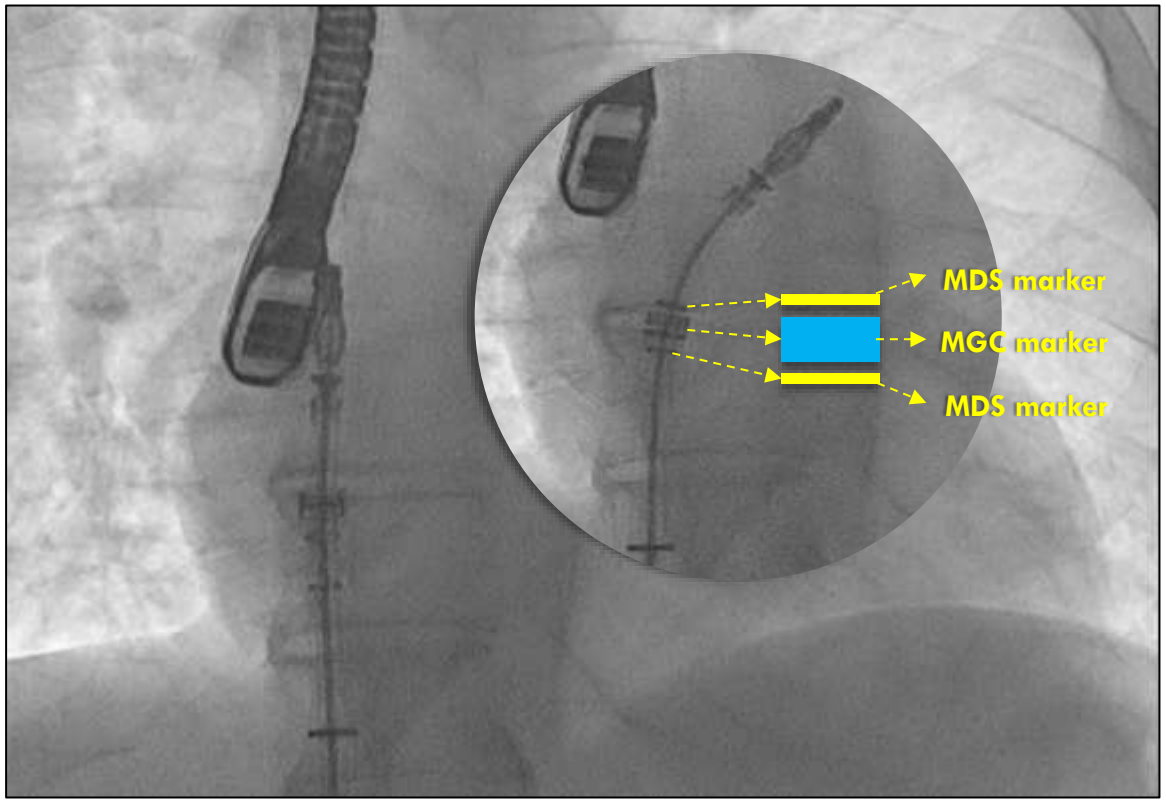
Myclip Delivery System (MDS) Sandwiching

Meril

TEE Short Axis View



Fluoroscopy

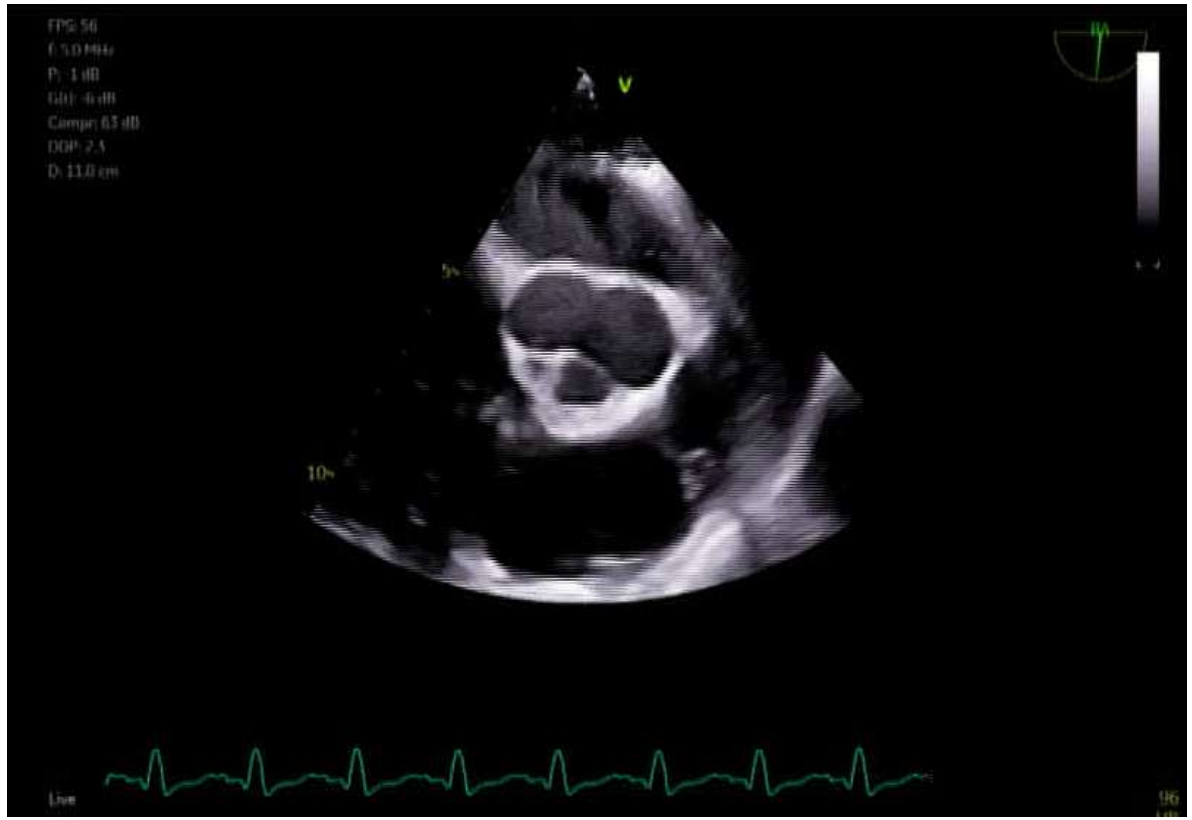


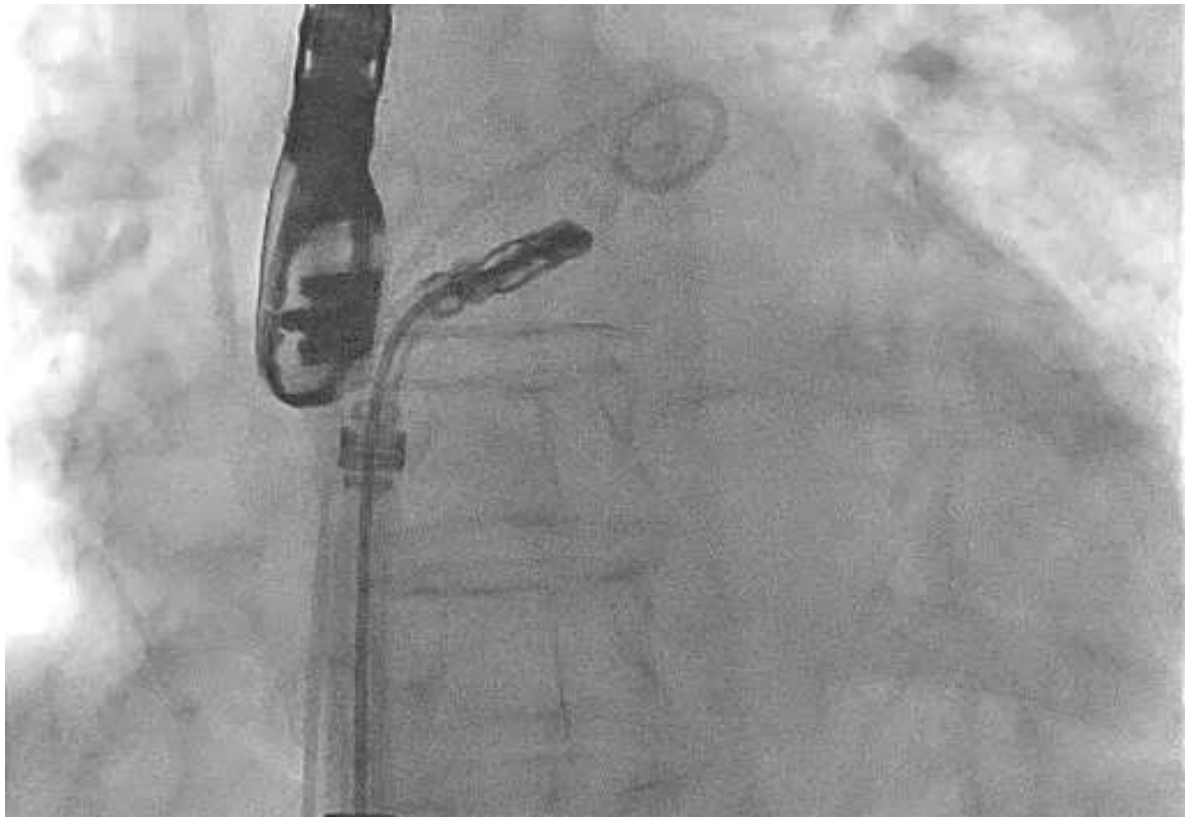
Sandwiching ensures optimal maneuvering and flexion of MDS within the LA

Positioning the MDS over Mitral valve with M - Knob

Meril

Transition from TEE SAX to Bicom View	Fluoroscopy



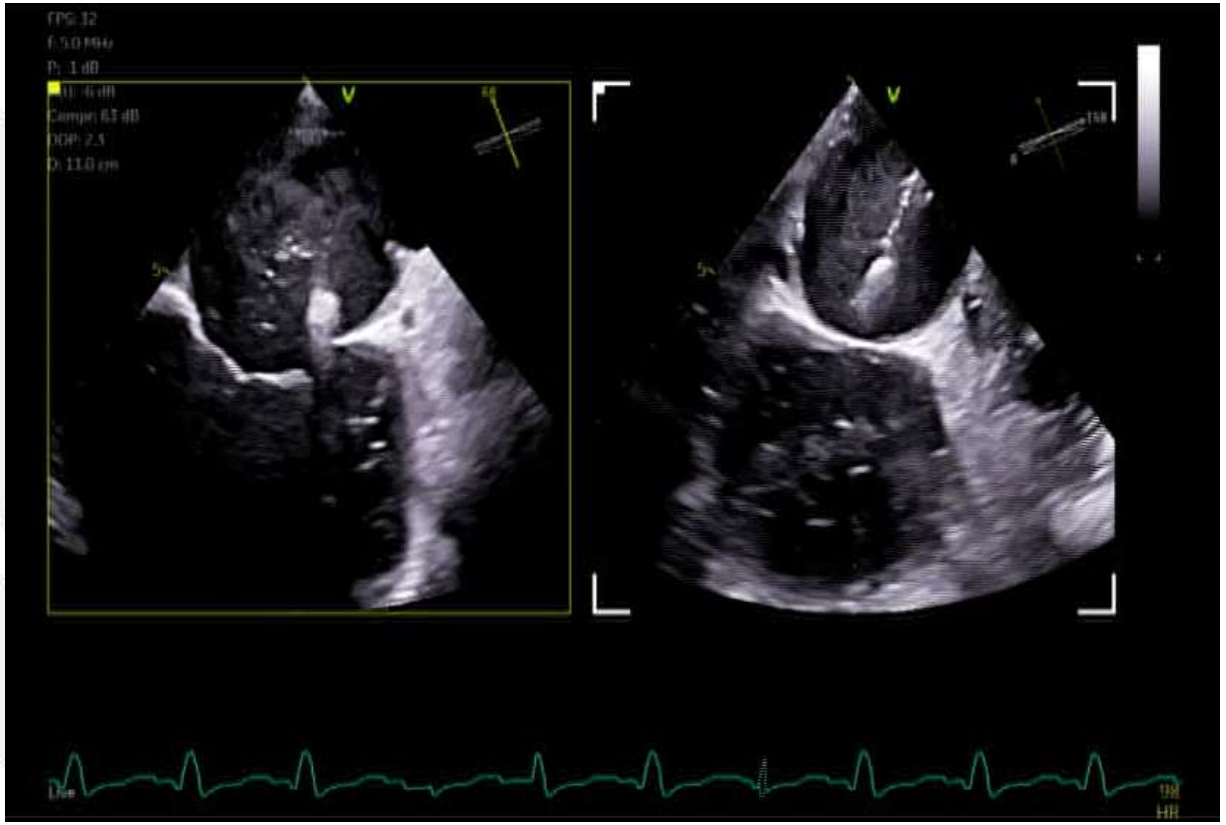


Make iterative adjustments to **avoid interaction with cardiac structures**
(Coumadin Ridge, LA Appendage)

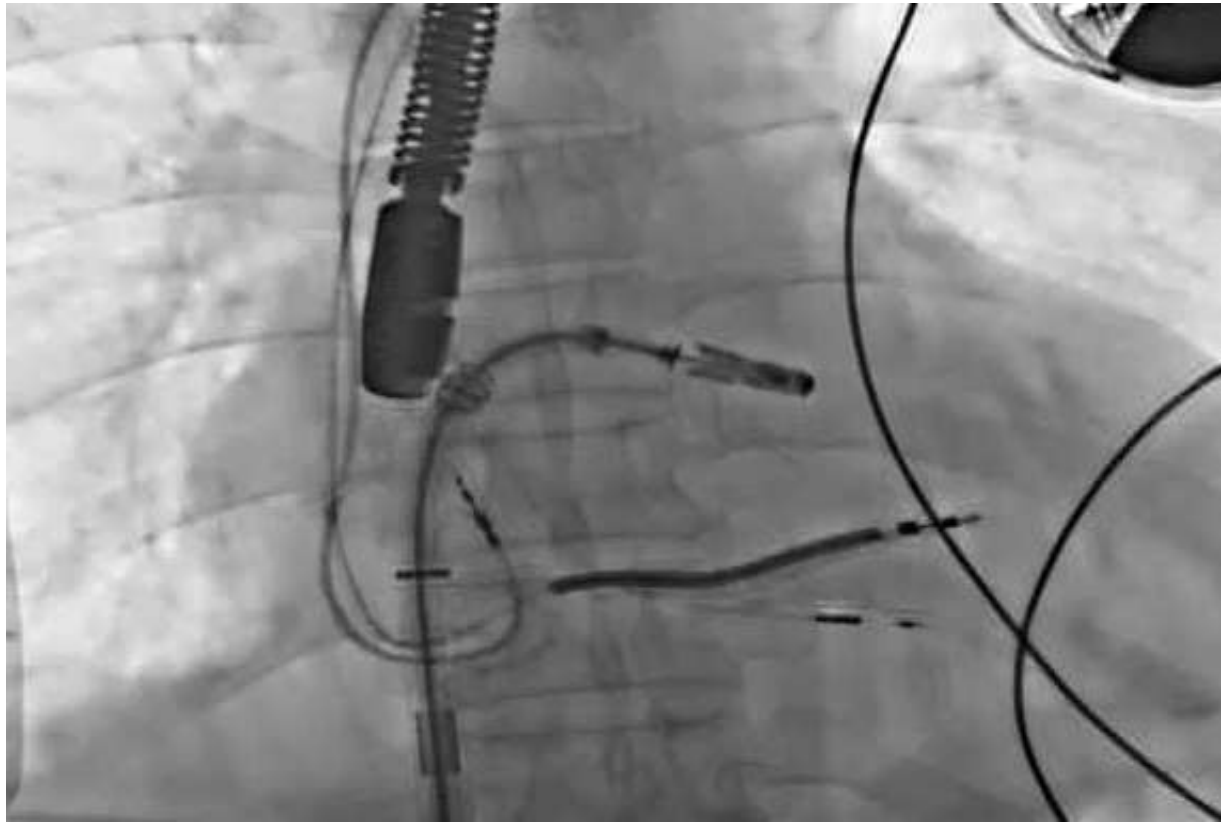
Positioning the MDS over Mitral valve with M - Knob

Meril

TEE Bicom X – Plane to LVOT View



Fluoroscopy

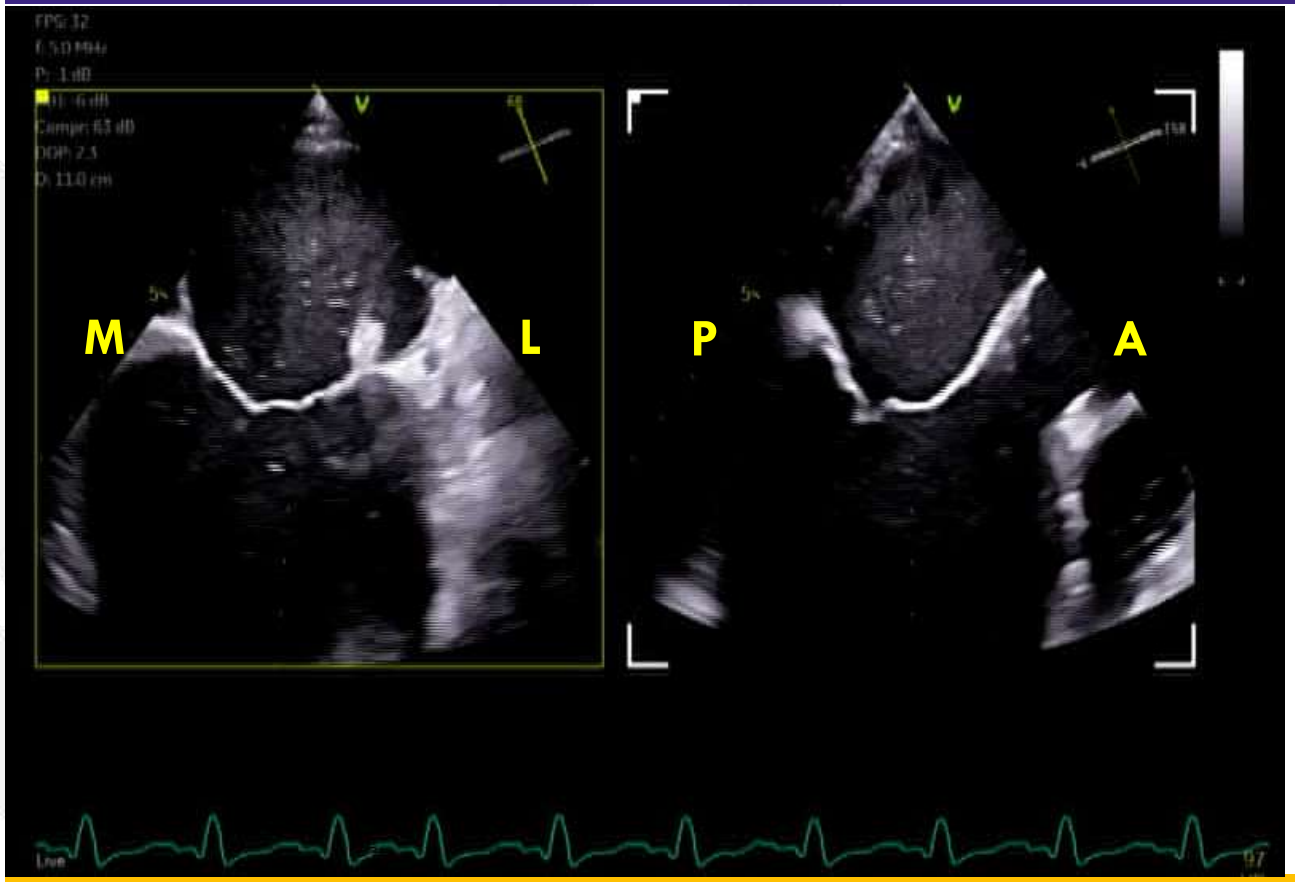


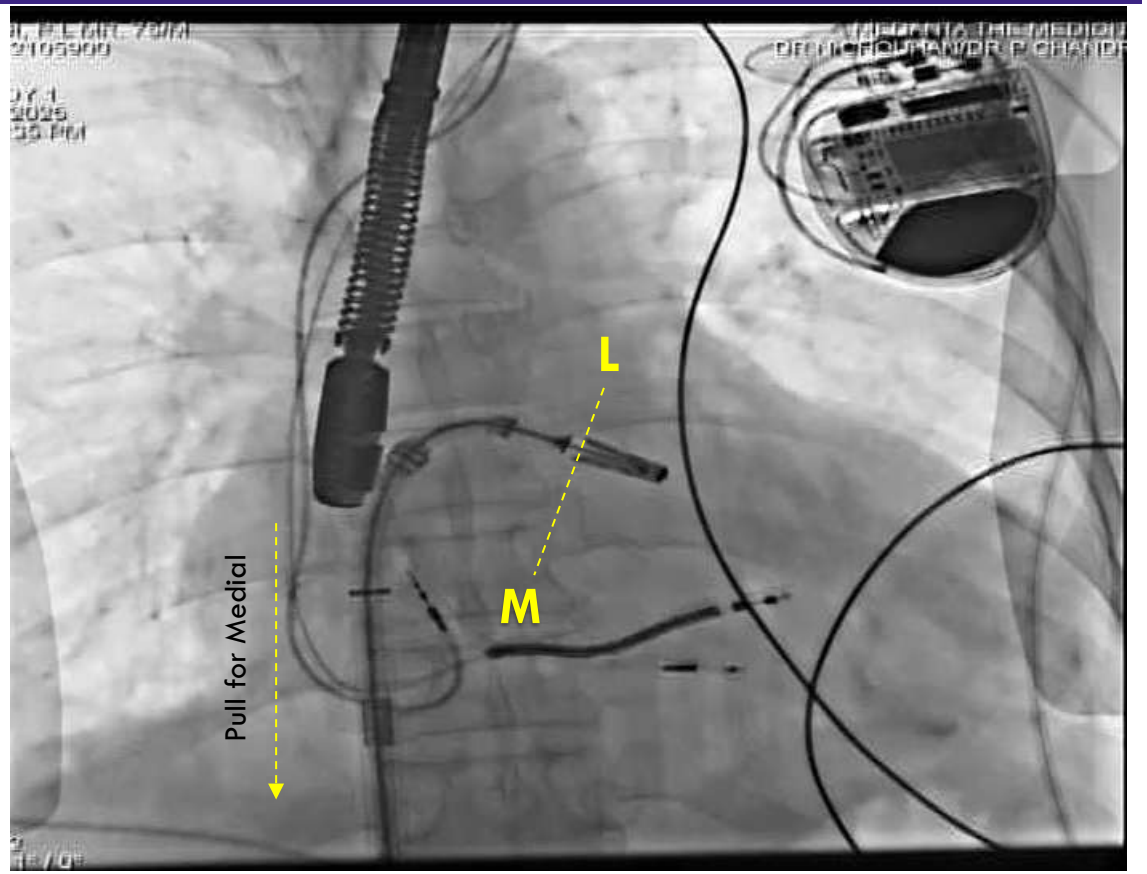
Note : The MDS Catheter tends to ride up by application of the Medial (M) knob to expose the inner Clip shaft. Correct this phenomenon by releasing the MDS Console-Bolt and retracting the MDS-Console handle completely. Once done, re-secure the MDS Console-Bolt.

Aligning & Orienting the clip over Mitral valve

Meril

TEE Bicom X – Plane to LVOT View	Fluoroscopy

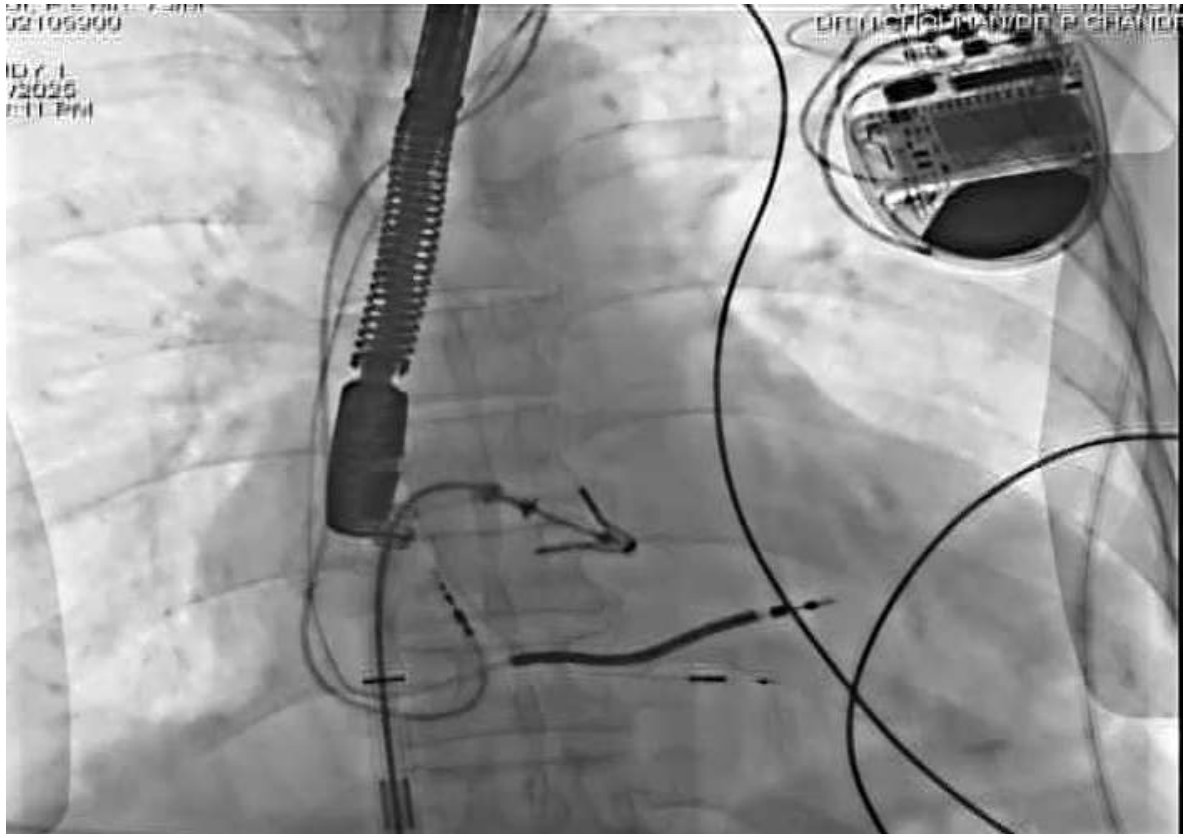




Hold the Bracket base firmly and advance the entire system to shift the Clip laterally or retract to shift medially across the mitral valve. Continue fine-tuning the Clip position in this manner until the MR jet is clearly bisected on colour Doppler.

Aligning & Orienting the clip over Mitral valve with clip arms opened

Meril

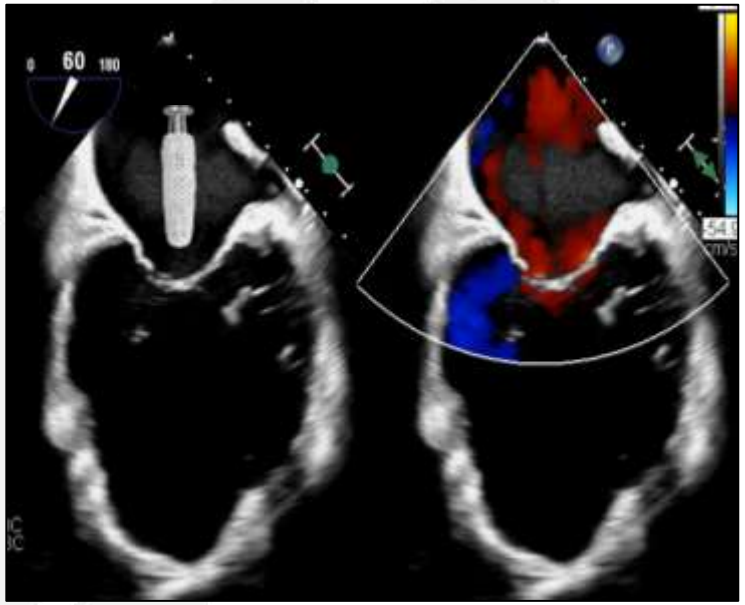
TEE Bicom X – Plane to LVOT View	Fluoroscopy
	

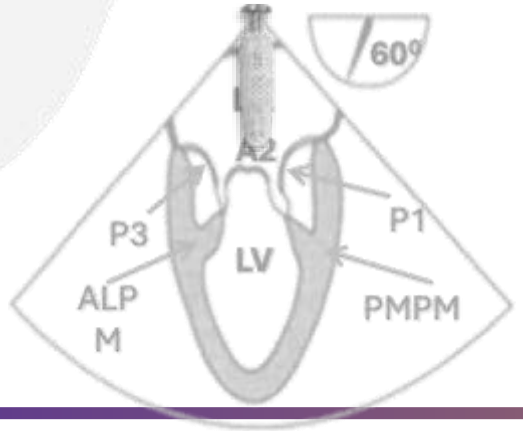
Open Clip-Arms at 120° in LA to check orientation of the clip

Correct Aligning & Orienting the clip over MV

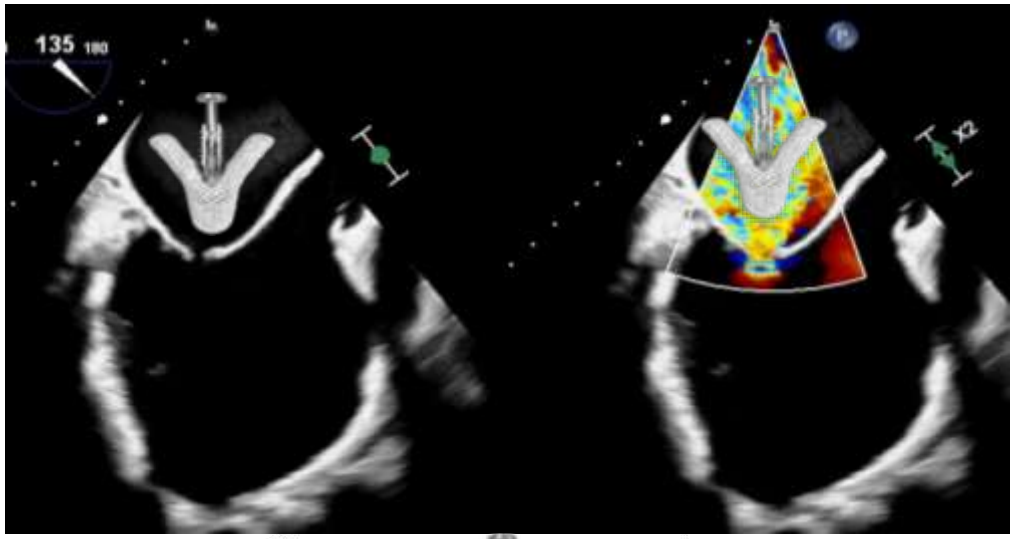
Meril

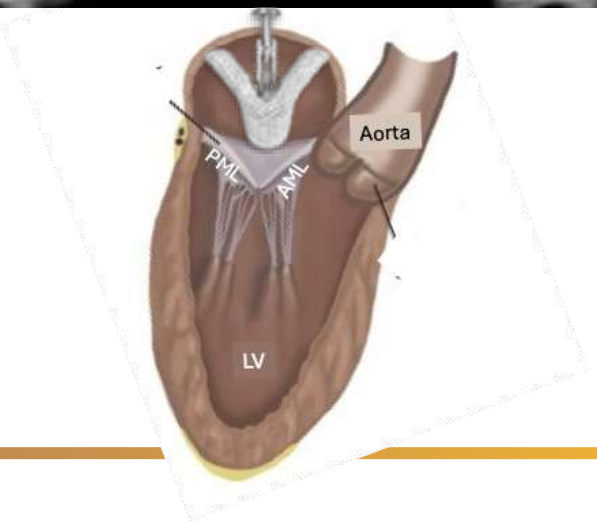
Perpendicular to Coaptation line - correct





Perpendicular to Coaptation line can see the Clip Arms - correct

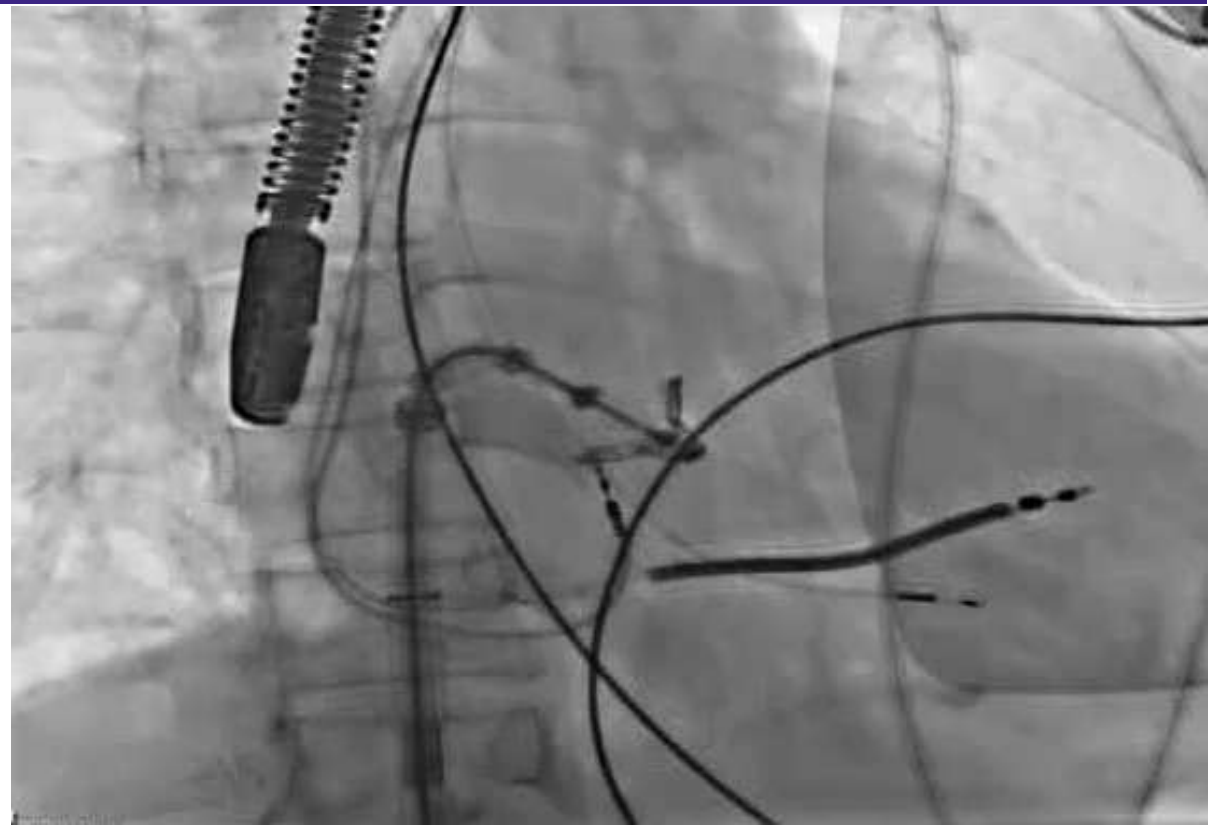




Aligning & Orienting the clip over Mitral valve with clip arms opened

Meril

TEE Multi Plane View with 3D Enface	Fluoroscopy

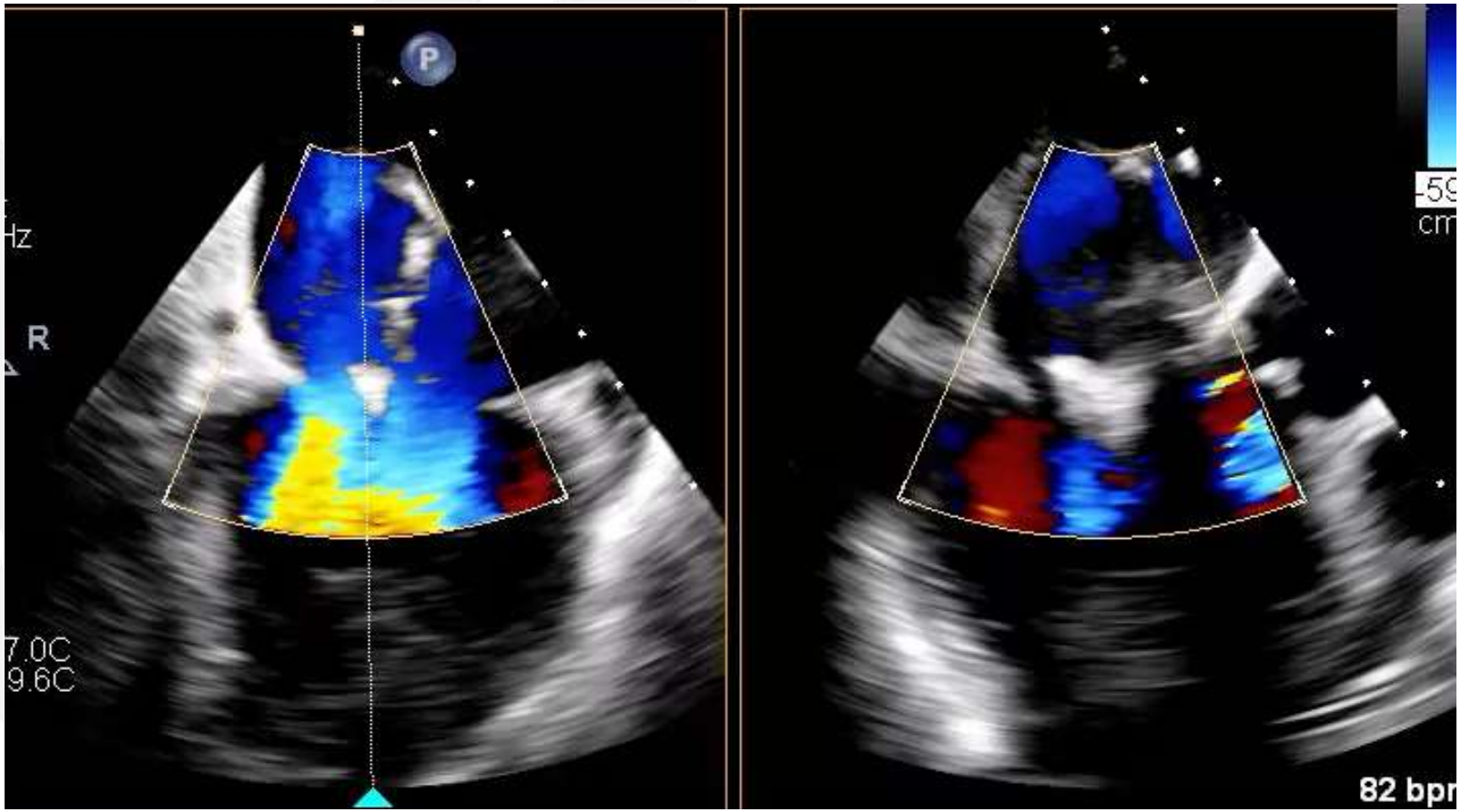


Rotate MDS Handle clock/anti-clock and transmit torque and orient the Clip-Arms perpendicular to the MV coaptation line (typically 12-6 o'Clock when the Aorta is positioned at 12-o'Clock)

Aligning & Orienting the clip over Mitral valve with clip arms opened – Check the trajectory

Meril

Bi-commissural View (X-Plane)



3D Enface View

Meril

Sympli 5-TEER

Five Stages for Predictive and Successful TEER Procedure and Outcomes

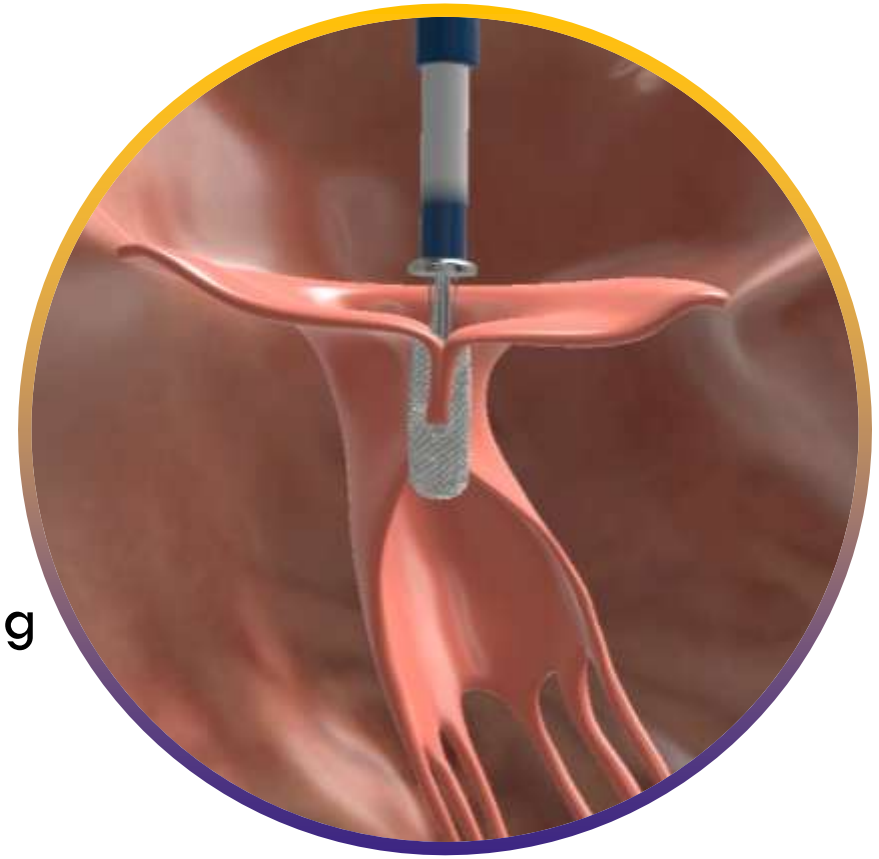
Stage 4

Advancement of Clip in LV, Leaflet Grasping, MR evaluation

Goals for Advancement of Clip in LV, Leaflet Grasping, MR evaluation

Meril

- Safe implantation of Clip
- **Reduction in MR at least by 2 grades**
- Reduction in LA pressure and V – wave
- Change in Pulmonary Vein Flow (reversal/blunting to forward systolic flow)

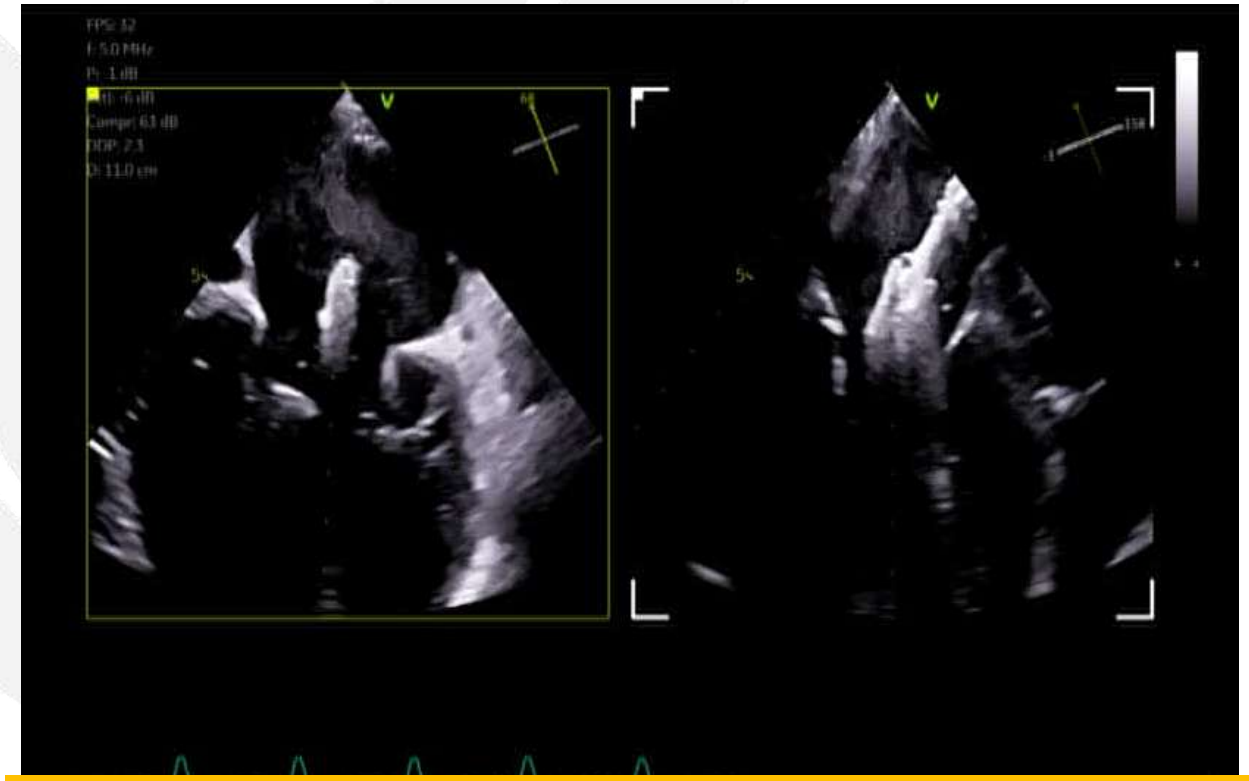


Advance Clip into the LV without altering the Clip orientation

Meril

Close Clip at 60° and gradually push the Console Slider to enter the LV

TEE Bicom X Plane to LVOT



Fluoroscopy

Stop further advancement as soon as the MyClip RO (radiopaque) ring is seen just below the free edge of the mitral valve leaflets and open the Clip to 120°

Reassess Clip orientation

Meril

Under TEE guidance (3D En Face view) reassess if the Clip orientation is perpendicular to the mitral valve coaptation line and still bisecting the MR jet

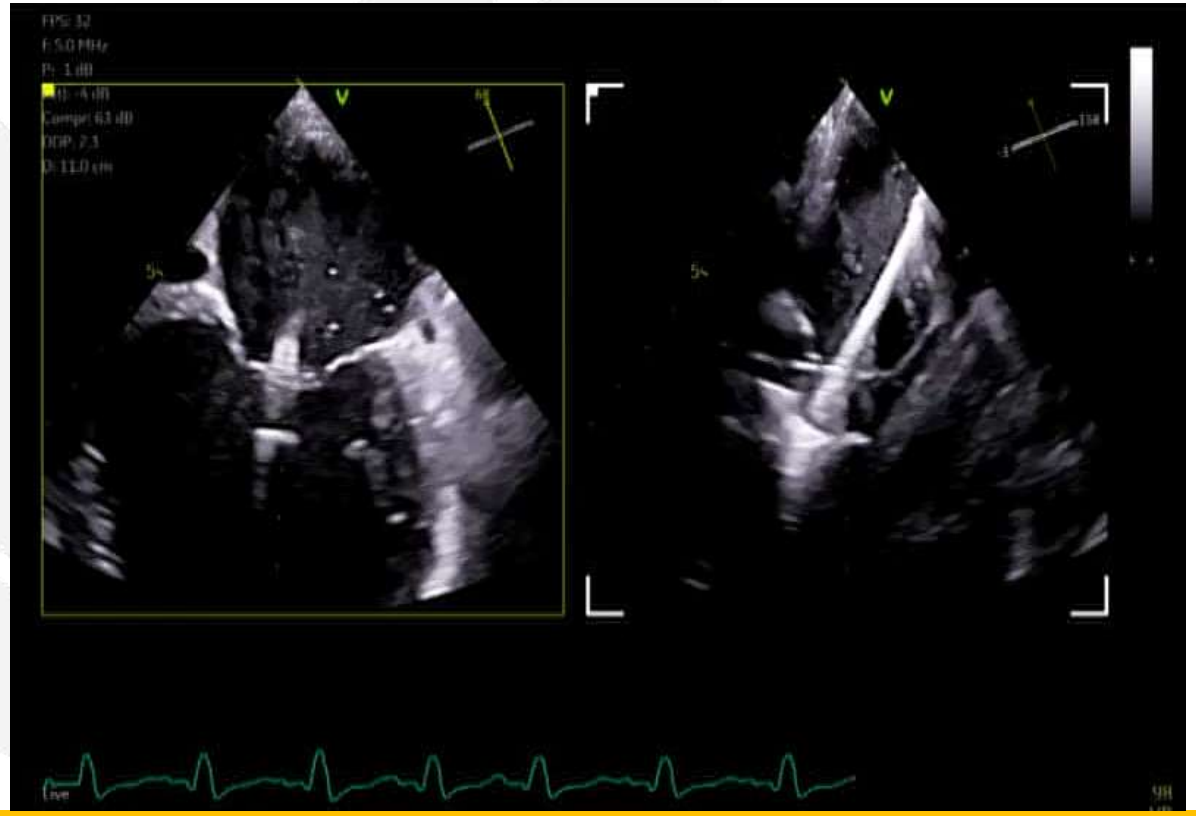
3D Enface View

3D Enface View Color

Myclip Grasping

Meril

TEE Bicom X Plane to LVOT	Fluoroscopy



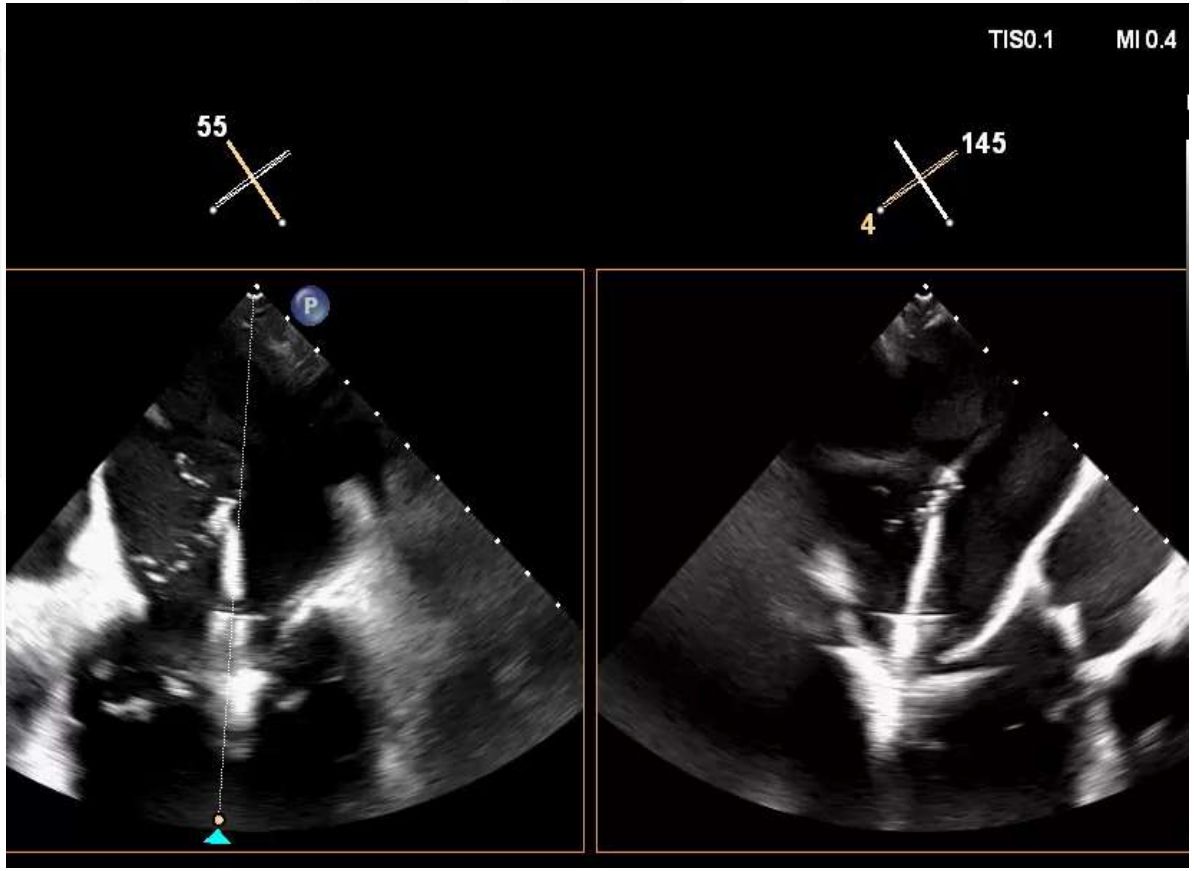
Ensure both the leaflets are adequately resting on the Clip arms

Retracting the Clip till the leaflets are resting on the Clip-Arms

Meril

Bicommissural View (X-Plane)	3D Enface View

In Bicommissural –LVOT view Pull gently till both the leaflets are adequately rest on clip arms
Confirm orientation on 3D *EnFace* View

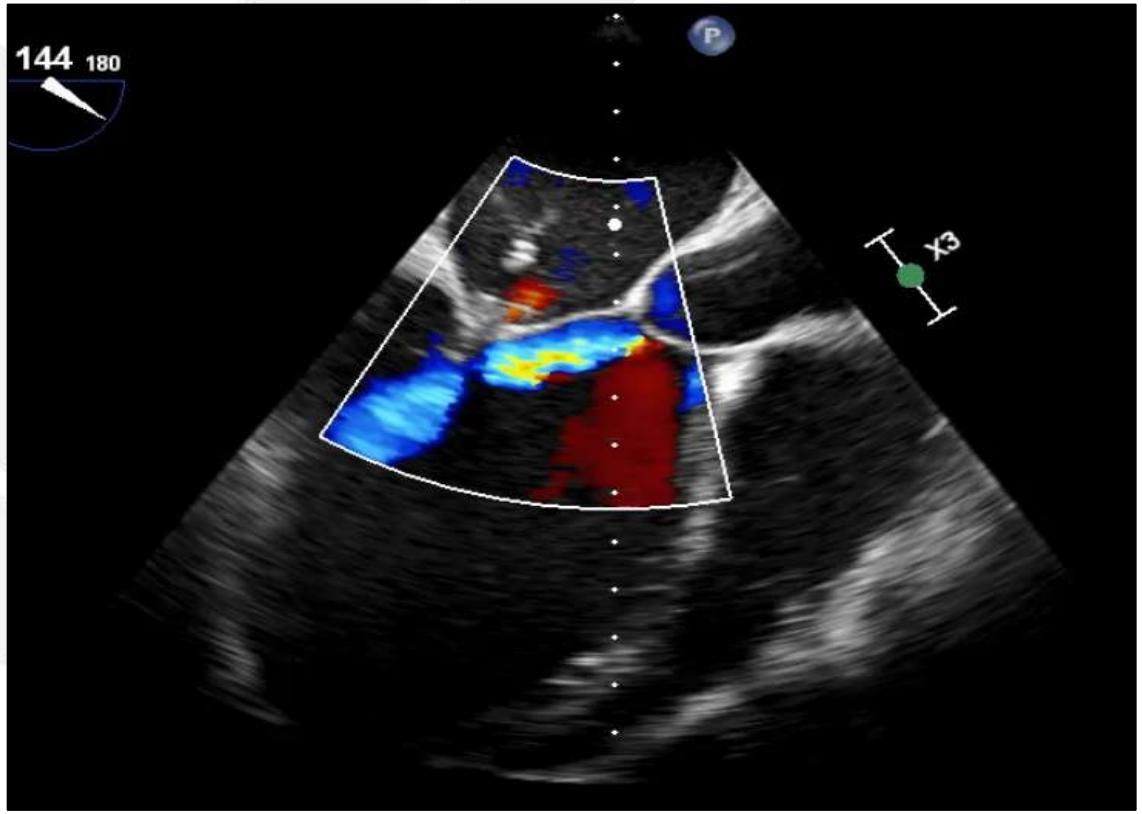


Post Grasping Assessment- Grasp, Stability, MR

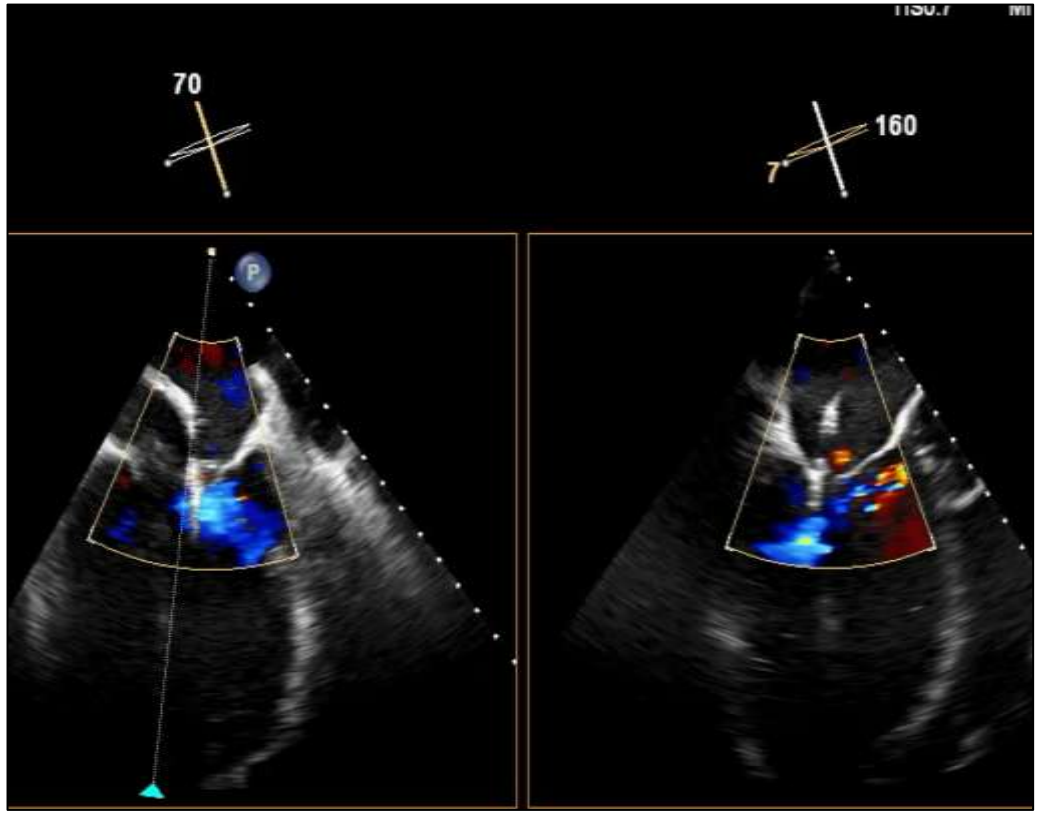
Meril

Ensure the adequate leaflet grasping under TEE guidance in 4C, LVOT, Bi-com and 3D-En Face views.
Add colour doppler in Bi-Commissural view to assess reduction in MR.

LVOT View MR Assessment

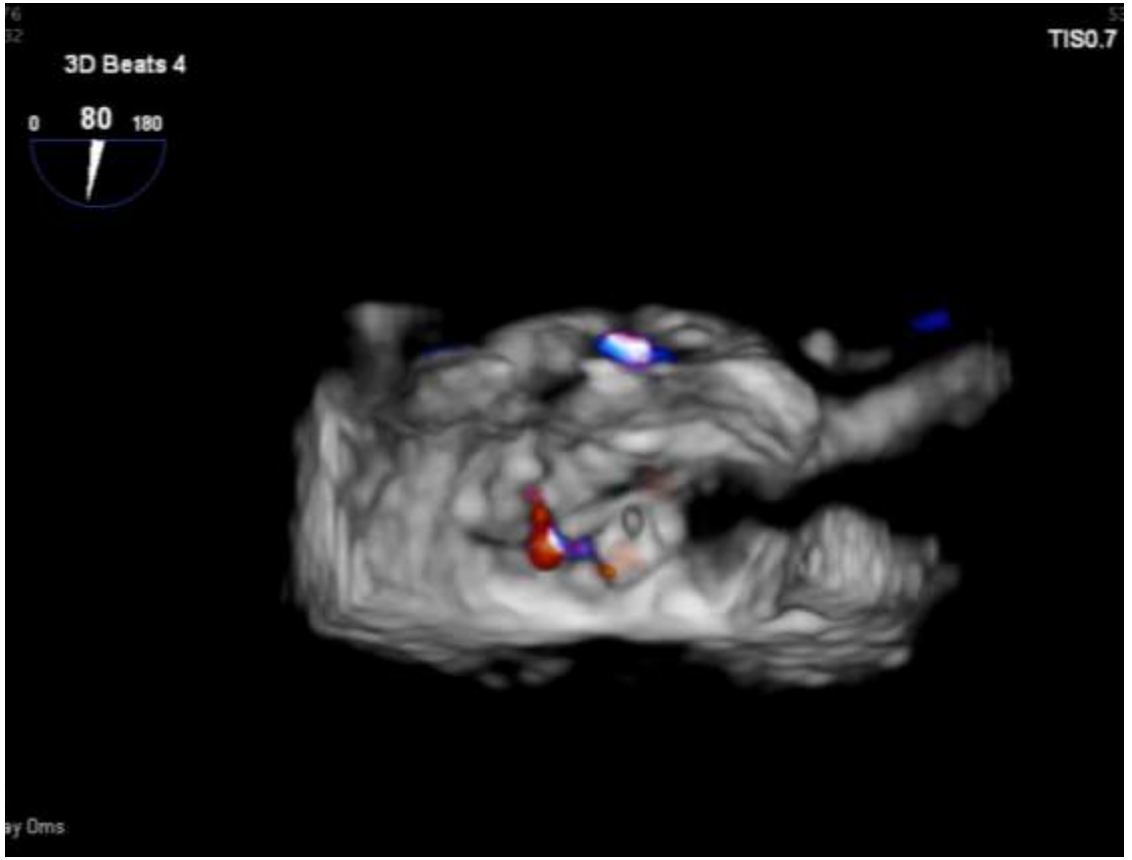


Bi-commissural View (X-plane)



Post Grasping Assessment- Grasp, Stability, MR

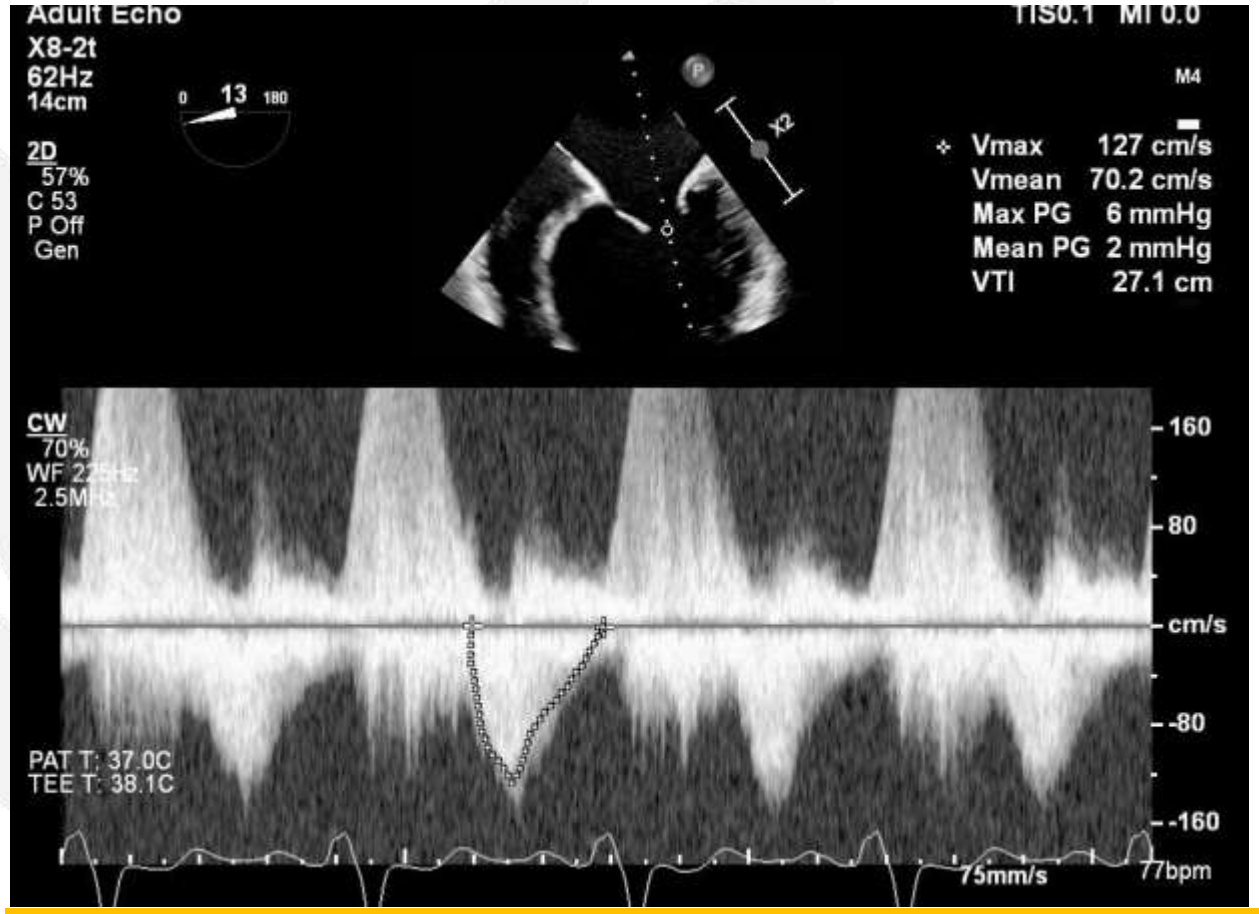
Meril

3D Enface	3D Enface (Color)
	

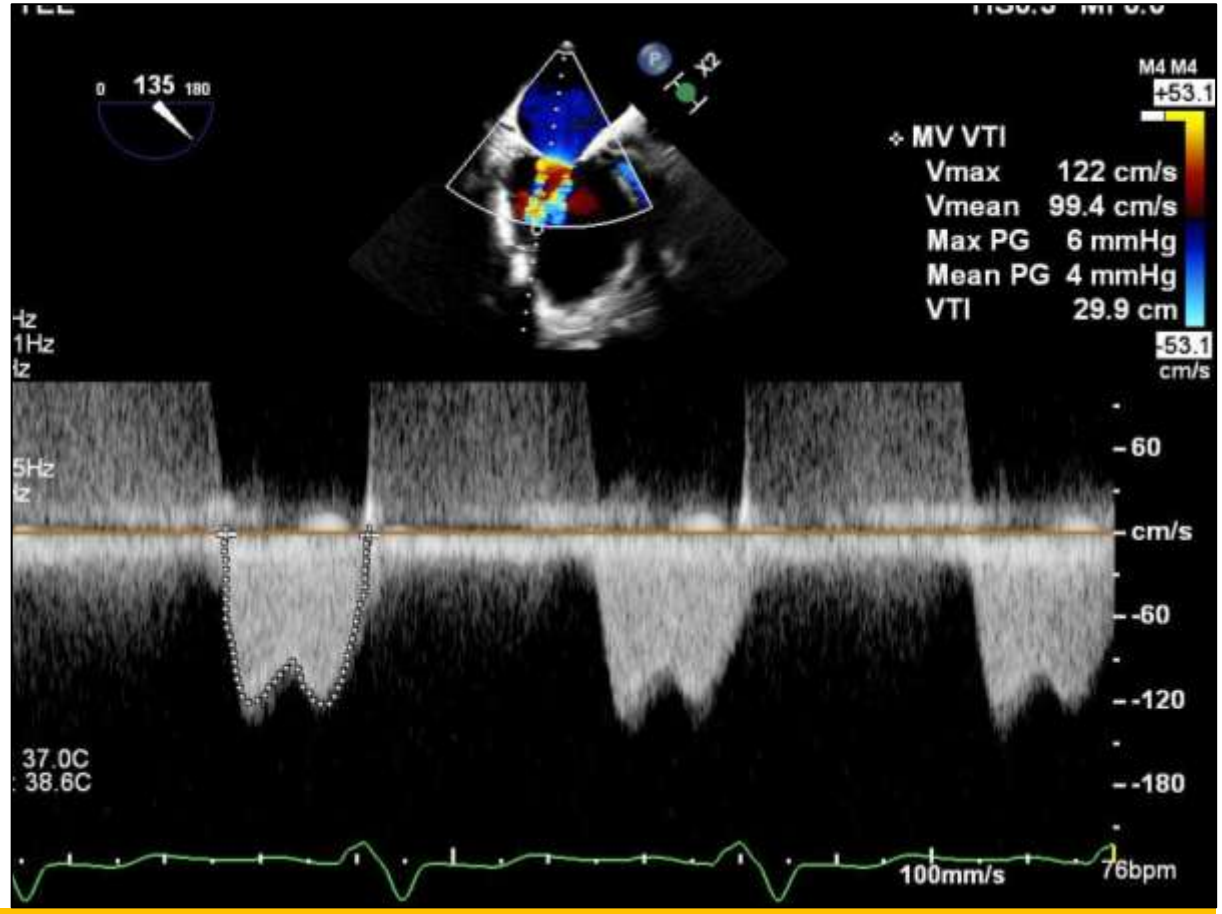
Post Grasping Assessment- Mitral Valve Gradient

Meril

Pre Procedure MV Gradient



Post TX MV Gradient

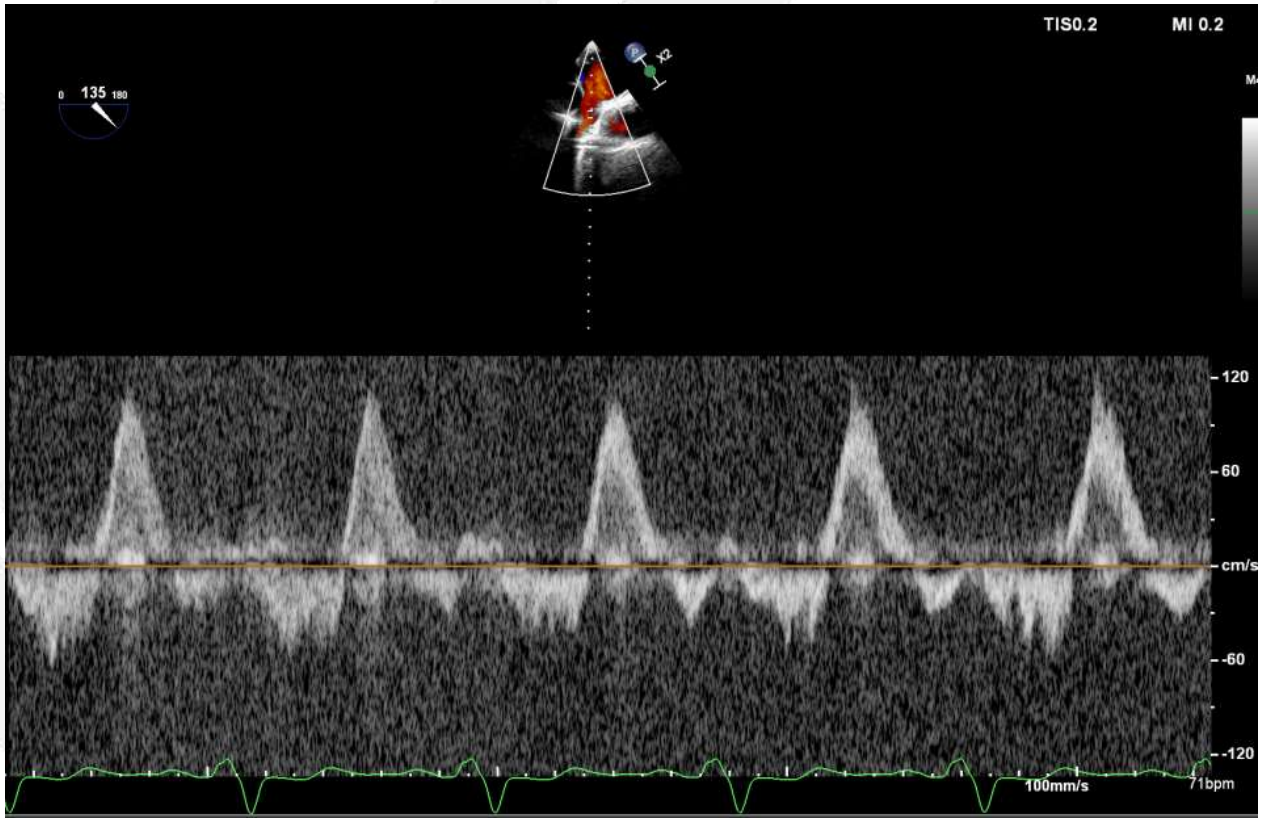


Assess the Final Clip Position and proceed for Clip release

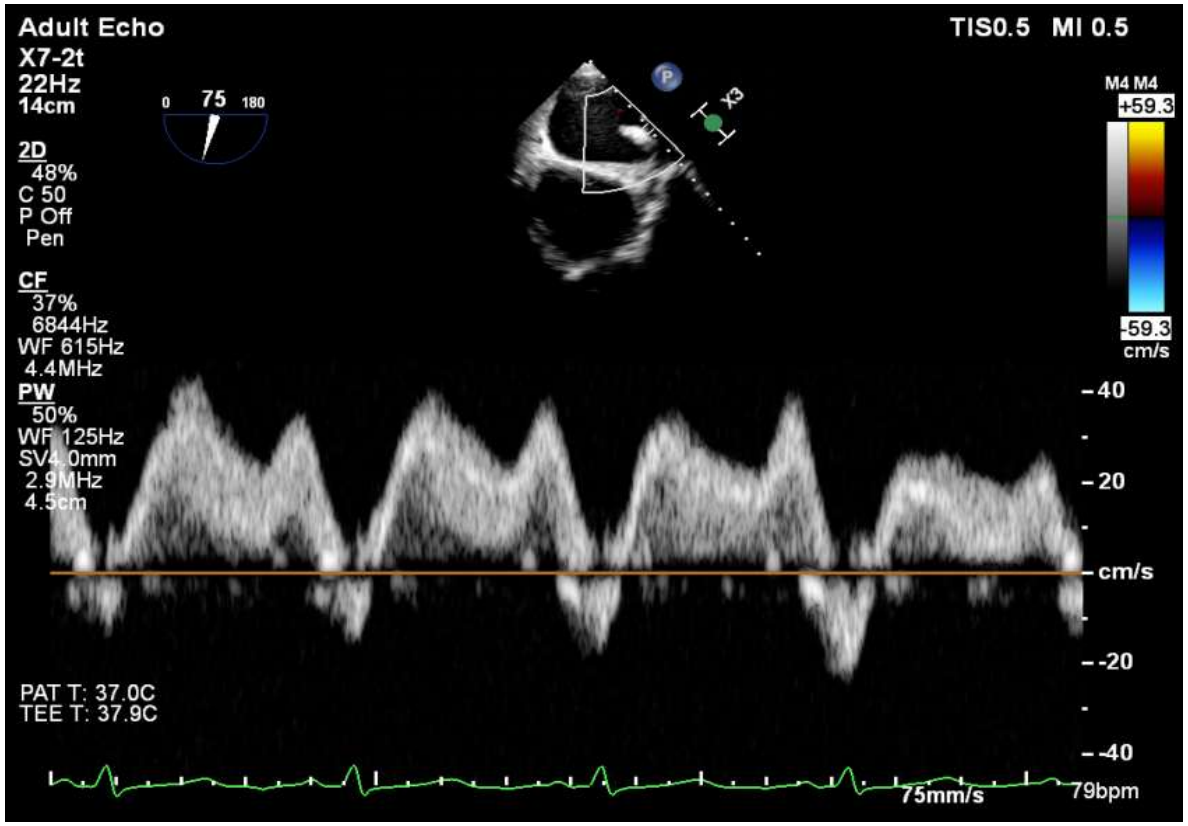
Post Grasping Assessment- Pulmonary vein flow

Meril

Pre Procedure Pulmonary Vein flow



Post TX Pulmonary Vein flow



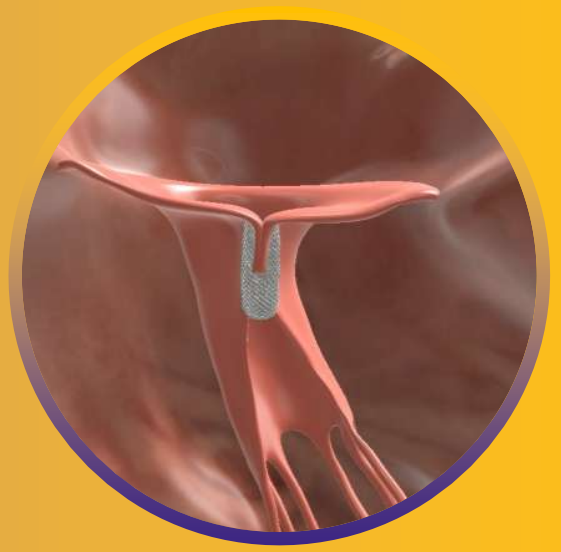
Meril

Sympli 5-TEER

Five Stages for Predictive and Successful TEER Procedure and Outcomes

Stage 5

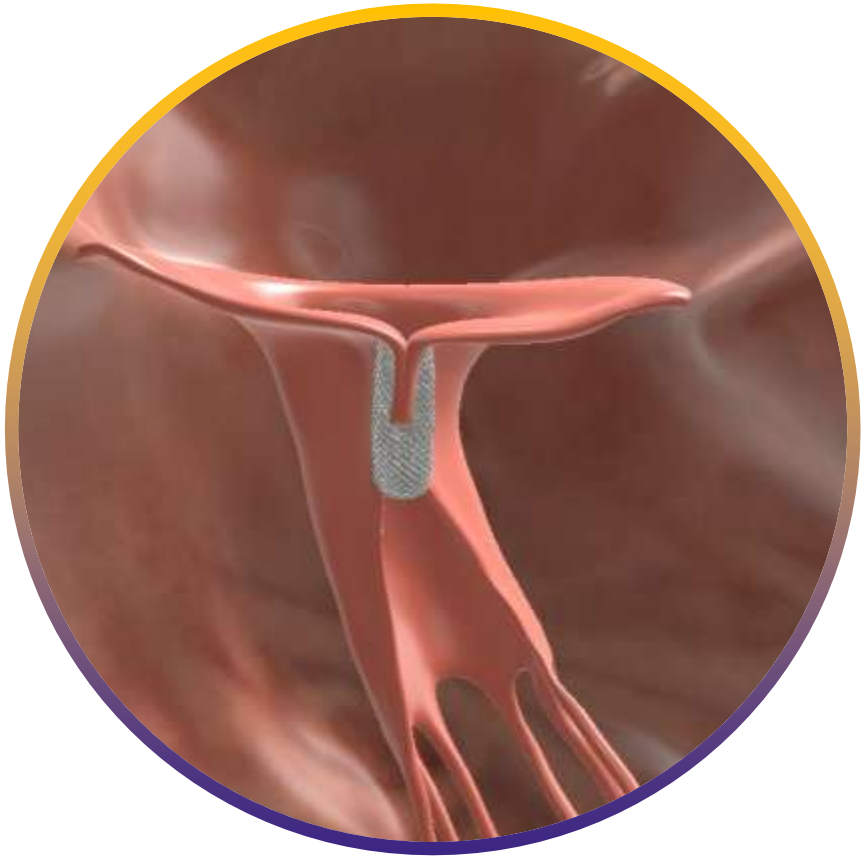
Release of MyClip, MR assessment, additional clip planning & Vascular closure



Goals for Release of MyClip, MR assessment, additional clip planning & Vascular closure

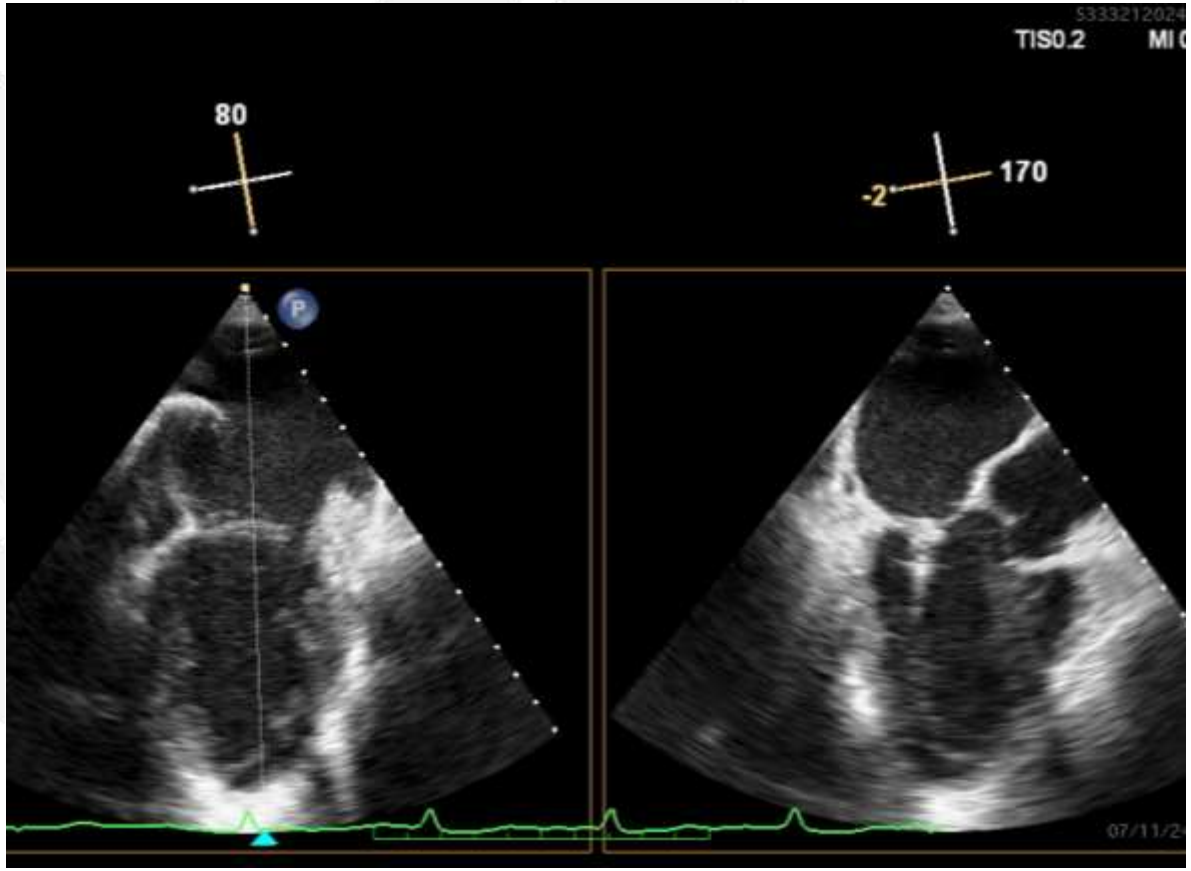
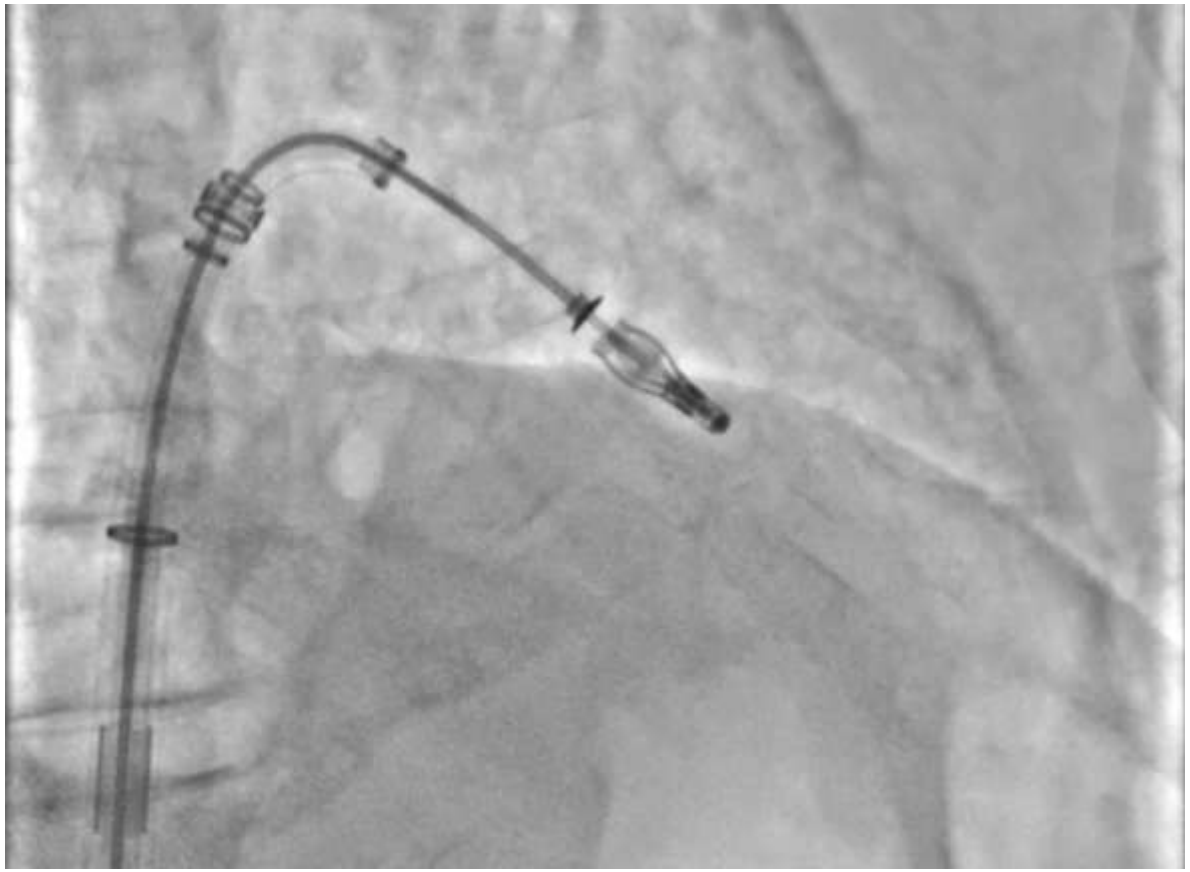
Meril

- **Reduction in MR at least by 2 grades**
- **Improvement in pulmonary vein flow hemodynamics**
- **Decrease in LA pressures**
- Adequate grasp of the leaflets
- Stable clip
- No significant increase in MDG



Myclip Deployment

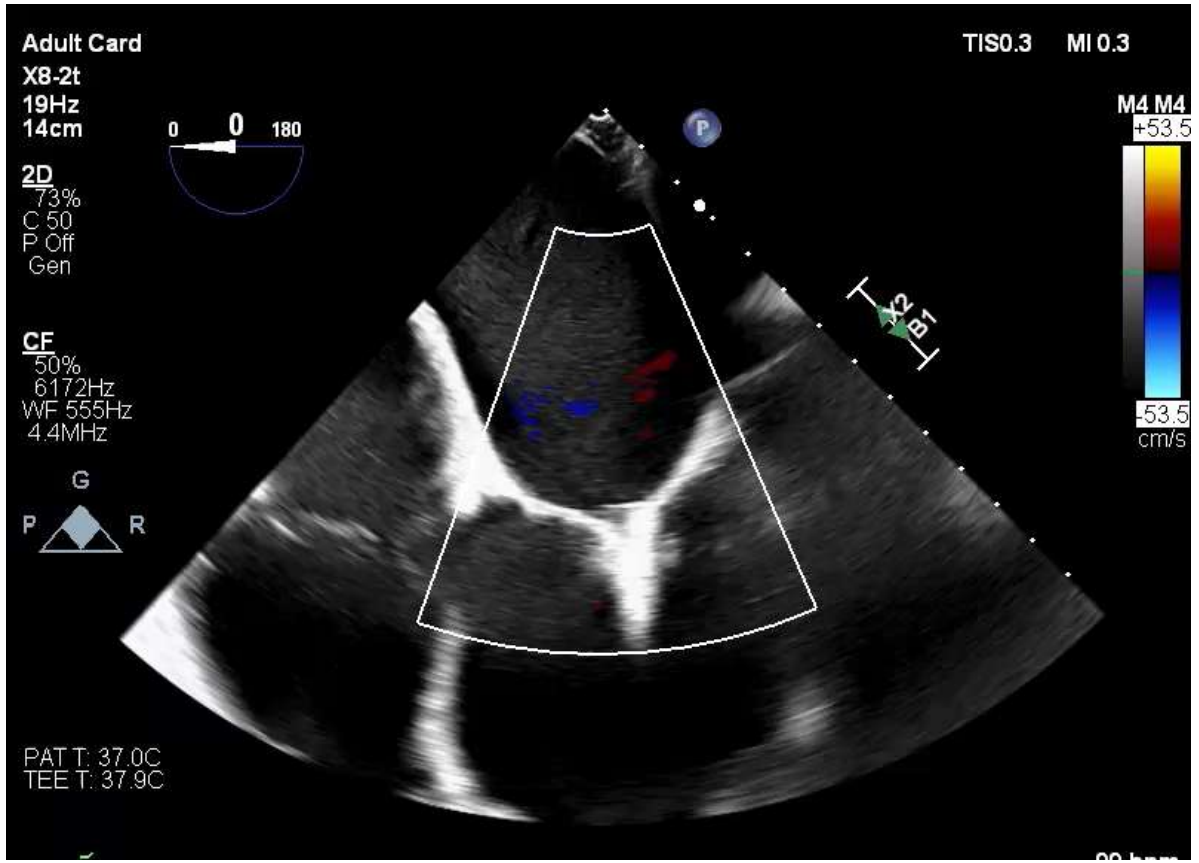
Meril

Clip deployment Bi-commissural View	Clip deployment – Fluoroscopy View
	

Post Deployment Assessment

Meril

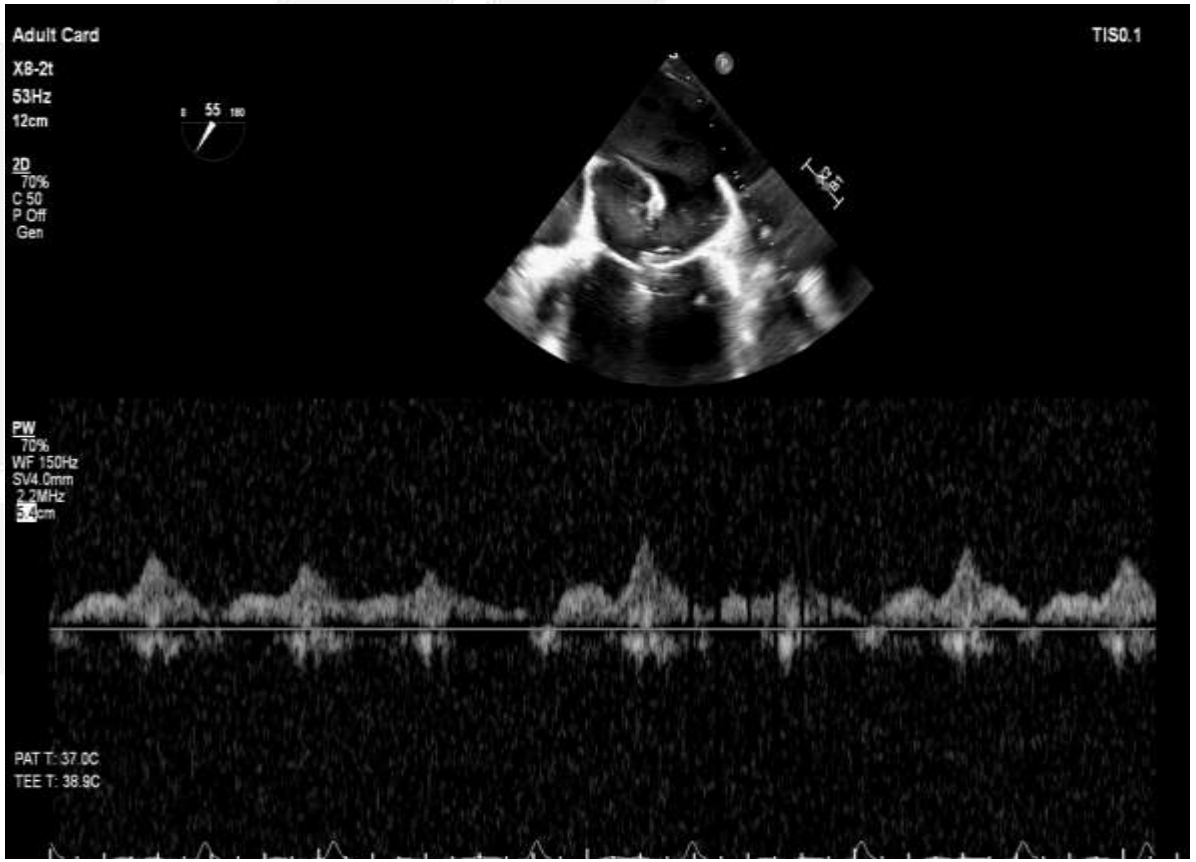
3D *EnFace*	4 Chamber with Colour
To ensure sufficient tissue bridge	Assessment of Residual MR

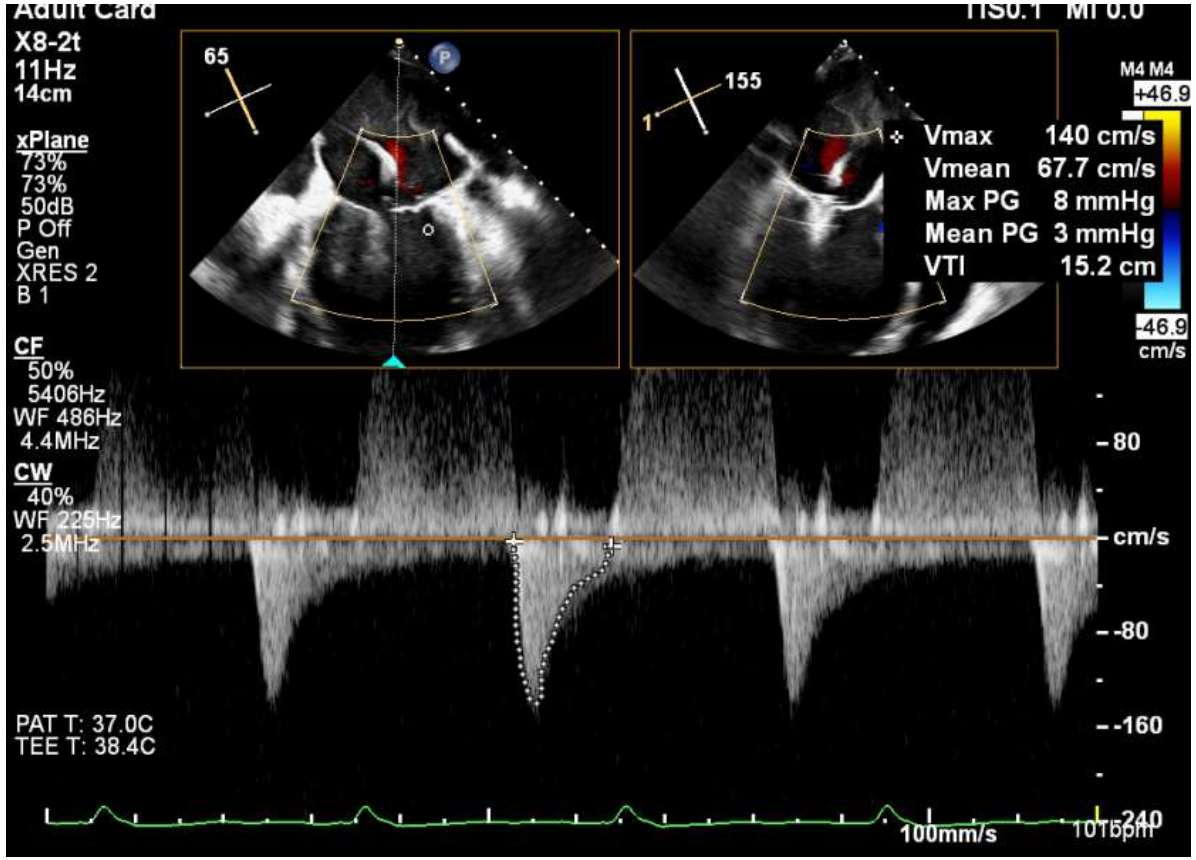


Post Deployment Assessment

Meril

Pulmonary Vein Flow	Mitral Valve Gradient
Pulmonary Vein Flow changed from Reversal to Blunted	MV Gradient - 3 mmHg post 1st Clip





Need for Additional Clip

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Parameters	Indicators
MR	• Residual Regurgitation • Pulmonary vein flow assessment • LA pressures assessment
Grasp	• Tissue Bridge • Stability of the clip device without excessive motion
Mitral valve narrowing	• Mean Diastolic Gradient

Better is the enemy of good

Meril

MyClip™

Transcatheter Edge To Edge Repair System