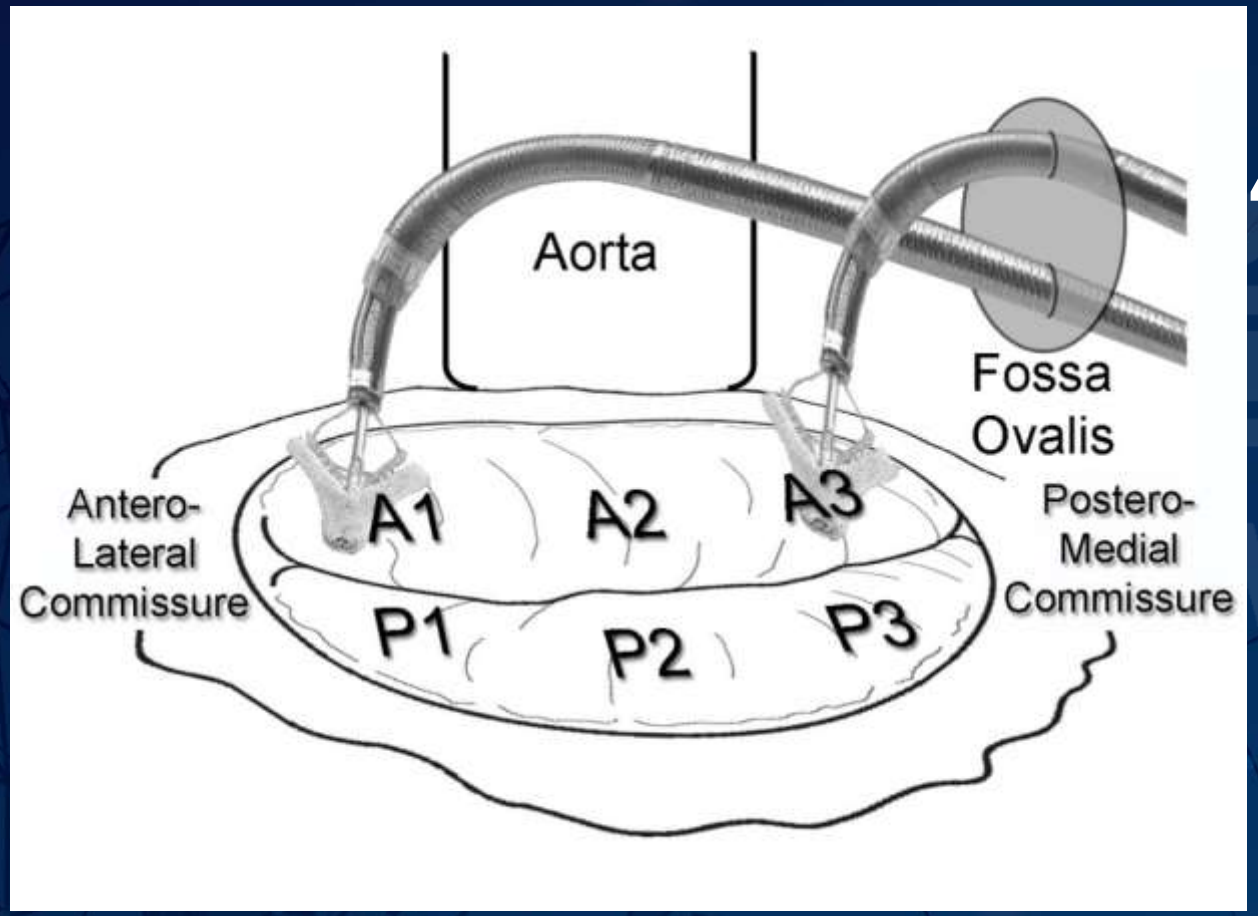
시술 중 TEE 평가 노하우

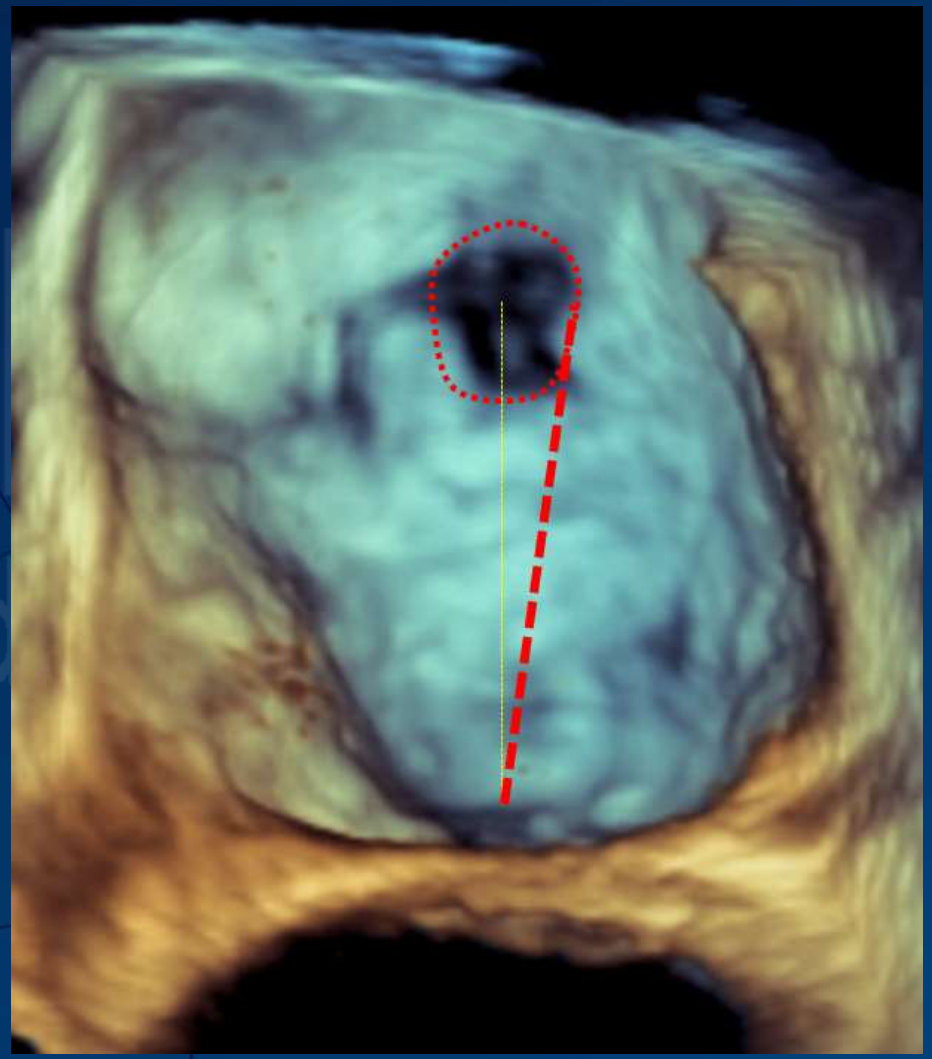
Dae-Hee Kim
Asan Medical Center
Ulsan College of Medicine

Transseptal puncture- modification



4.5cm

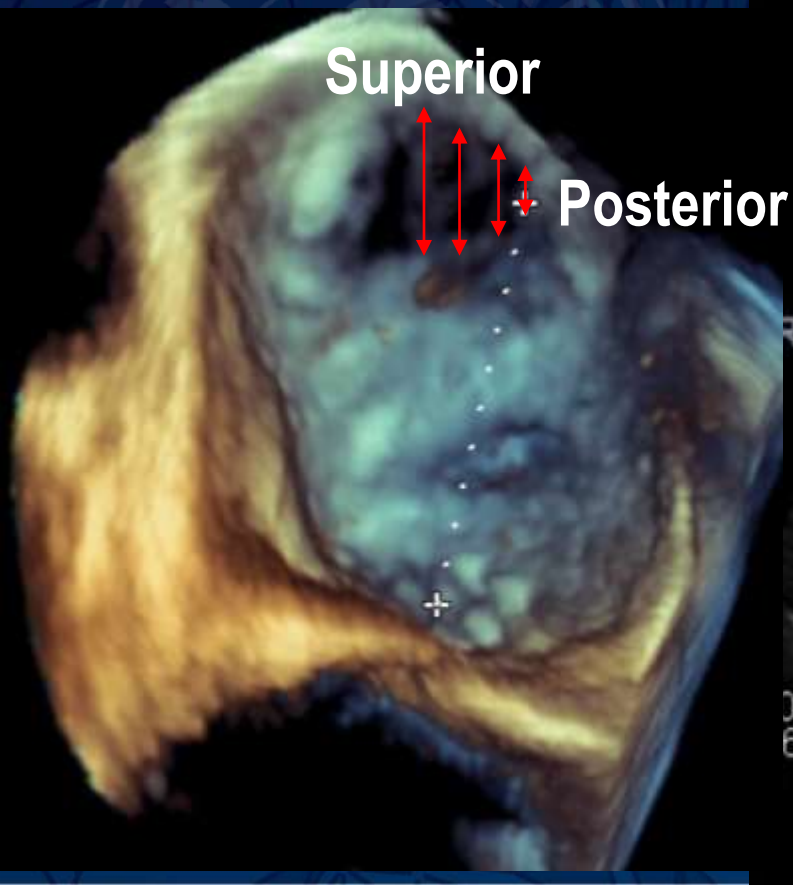
4.0cm

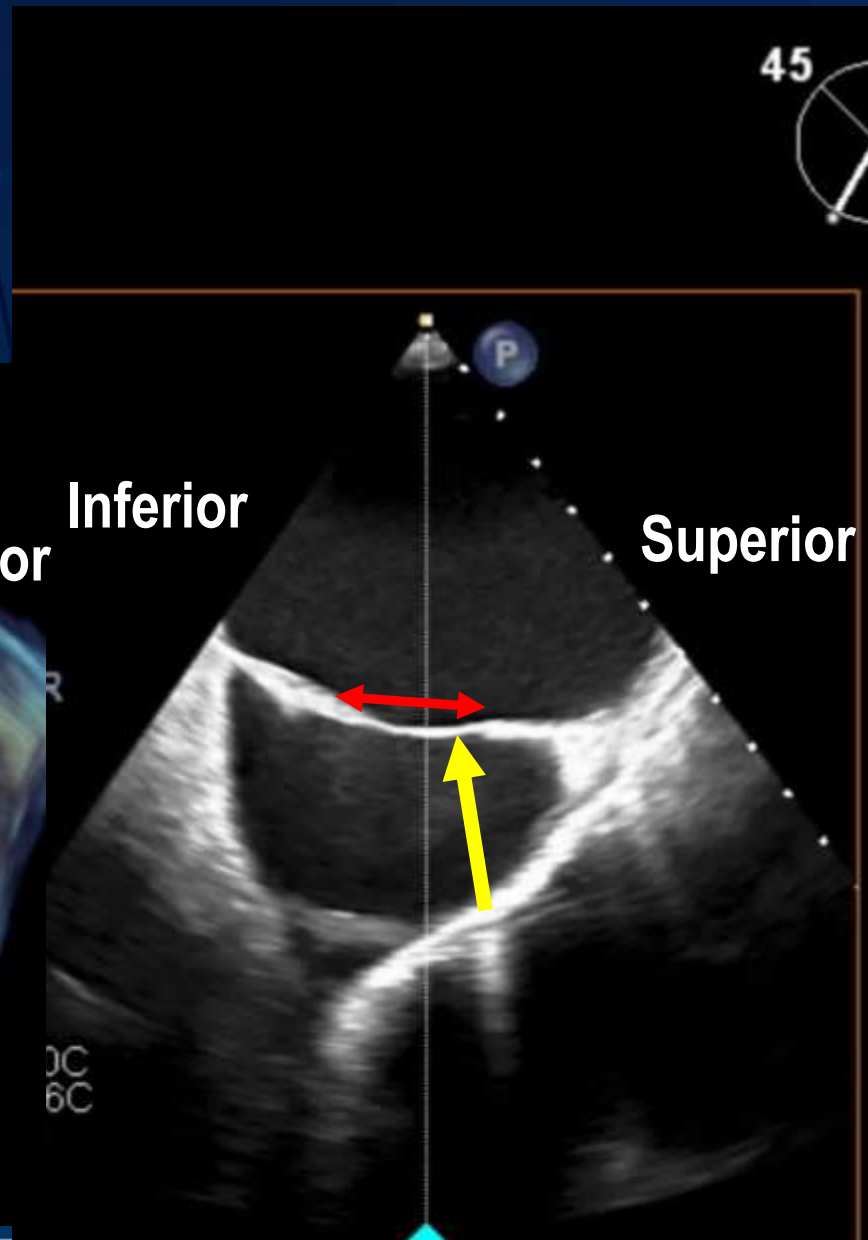


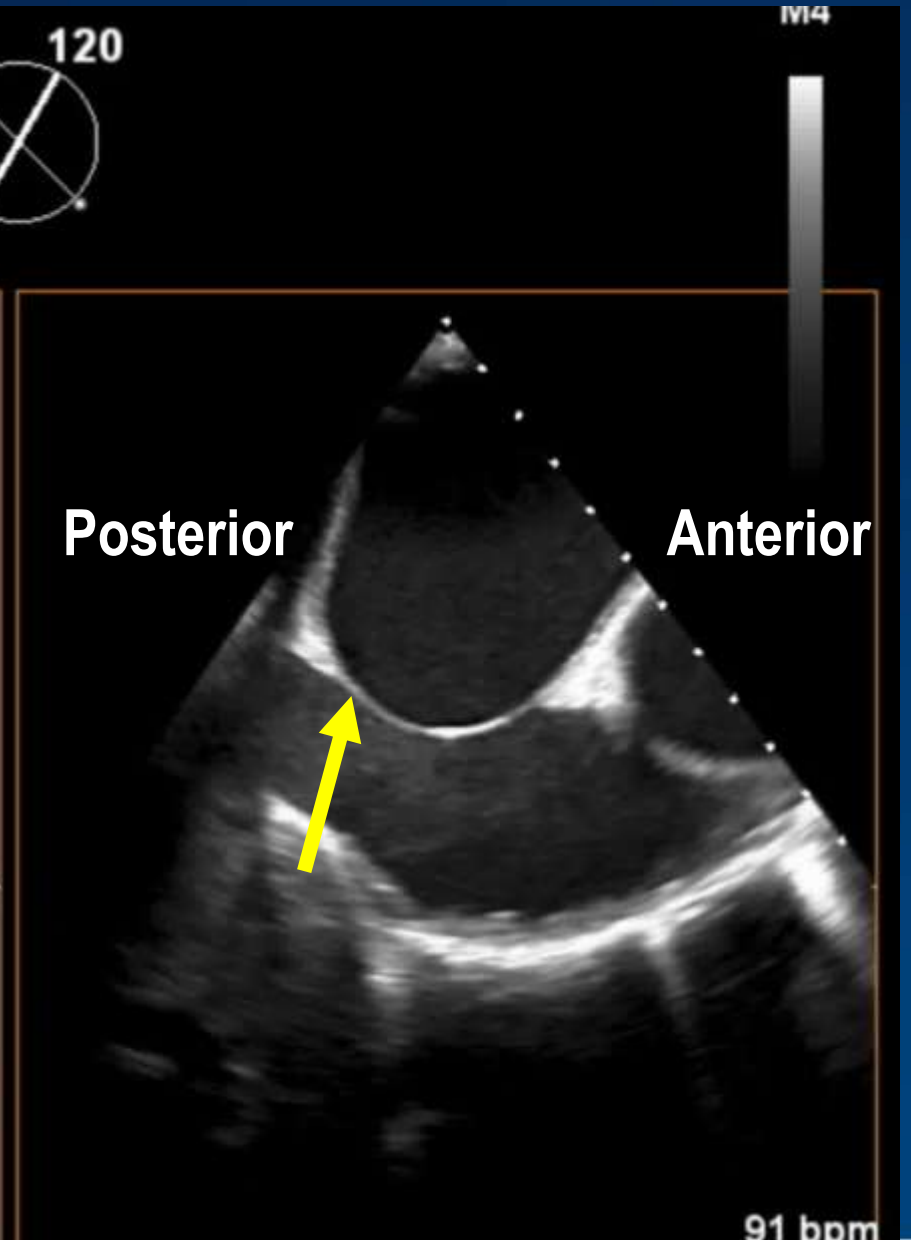
Singh, et al. *Interventional Cardiology Clinics* 2016

Trans septal puncture

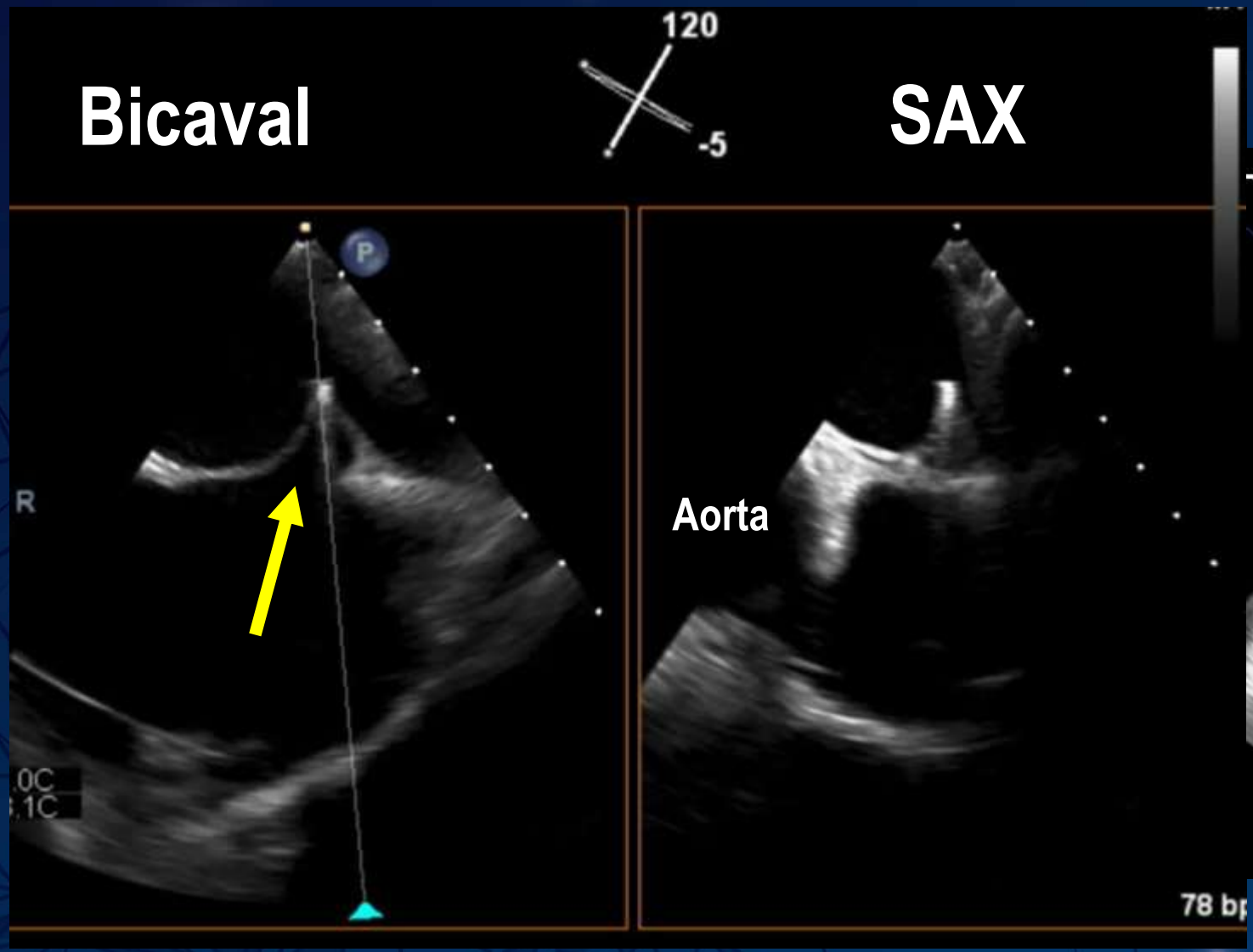
To posterior

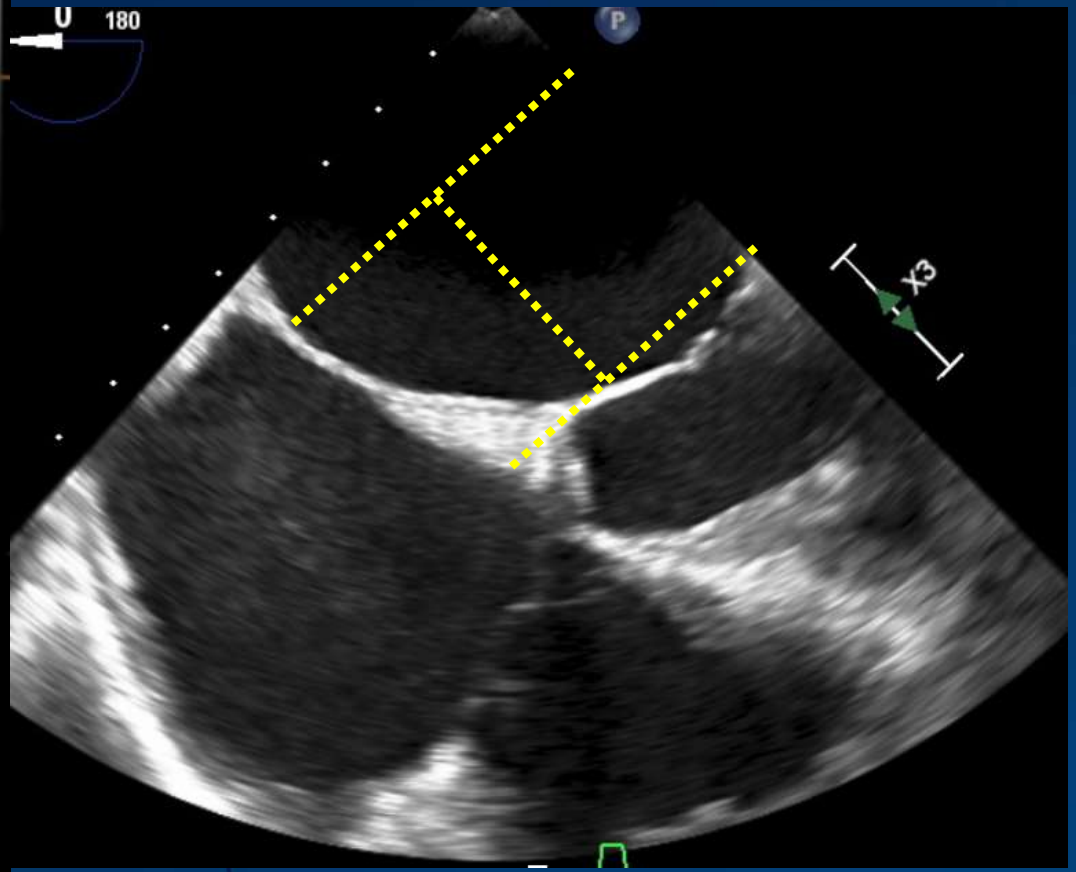






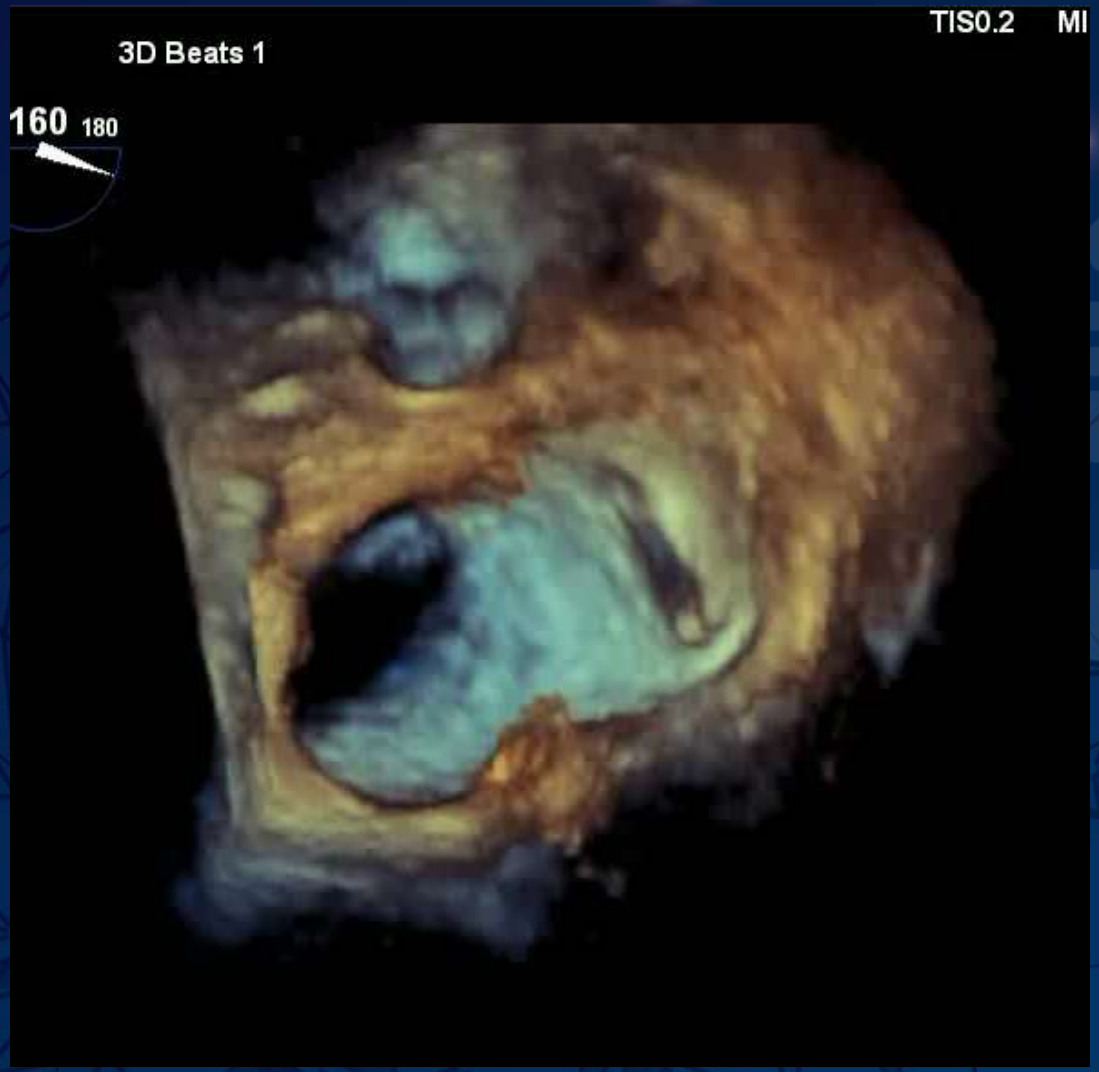
Transseptal puncture – Mid-Posterior

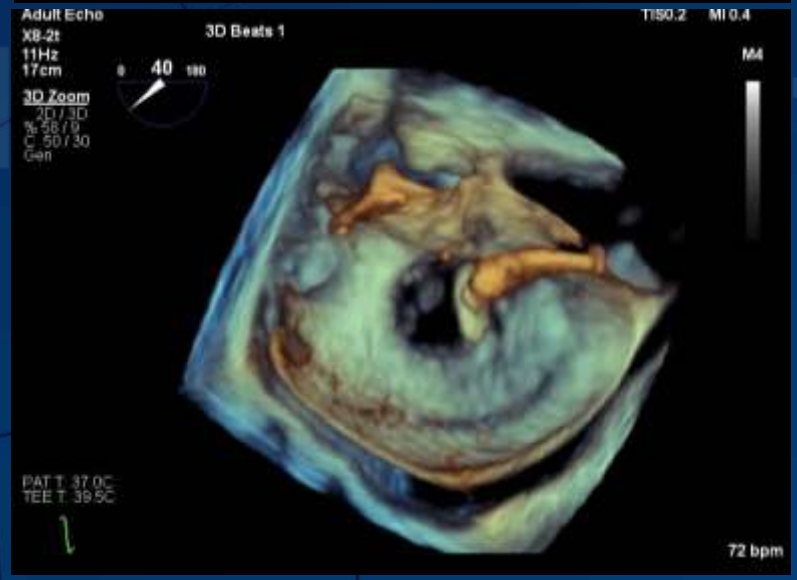




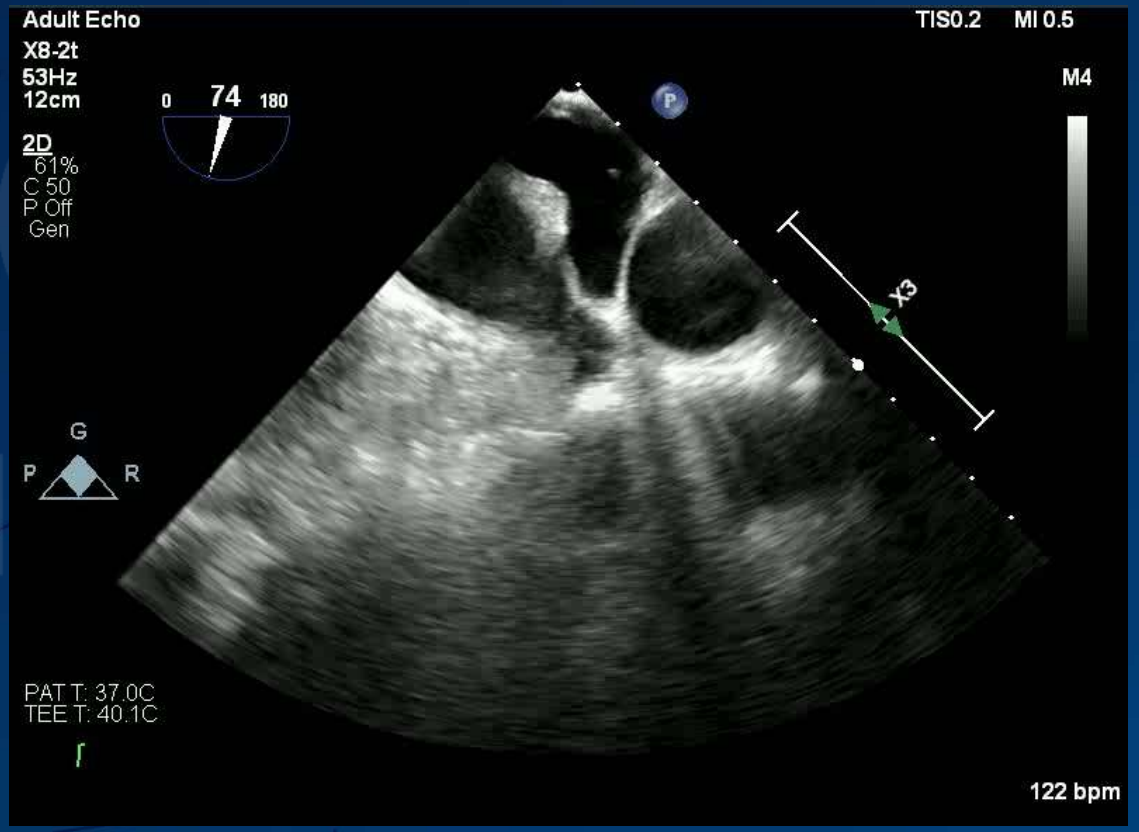
Suitable TSP height is 4.0-4.5 cm

3D location of puncture site

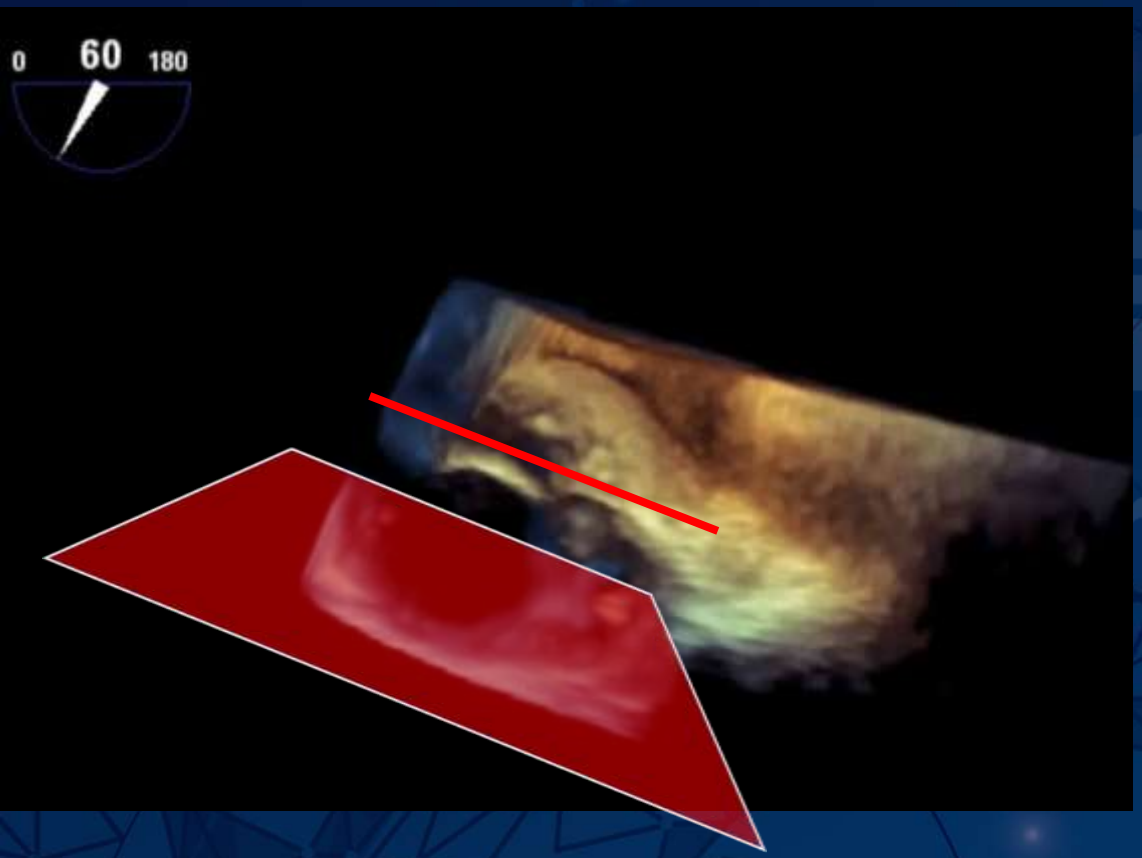


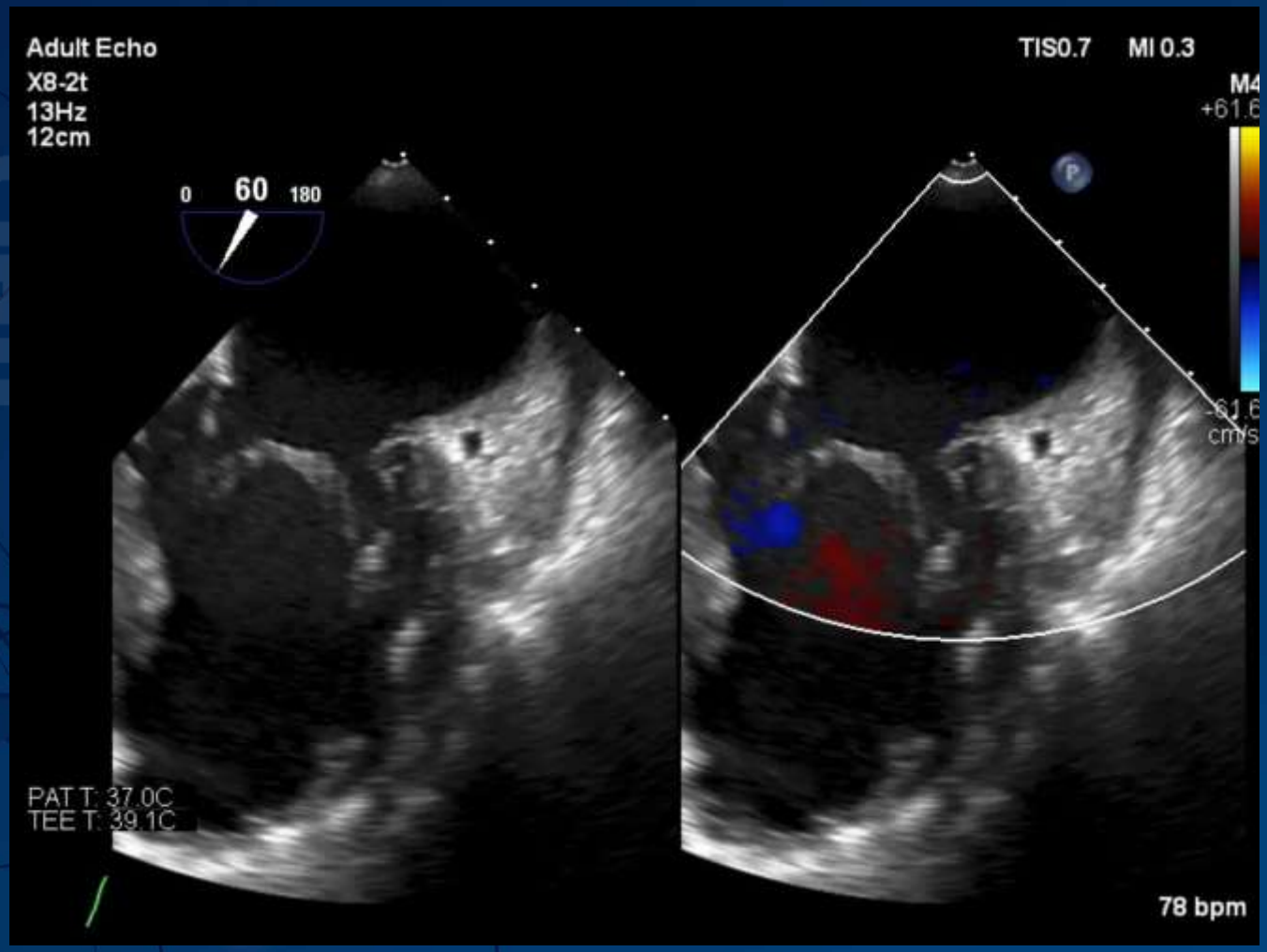


Guidewire location

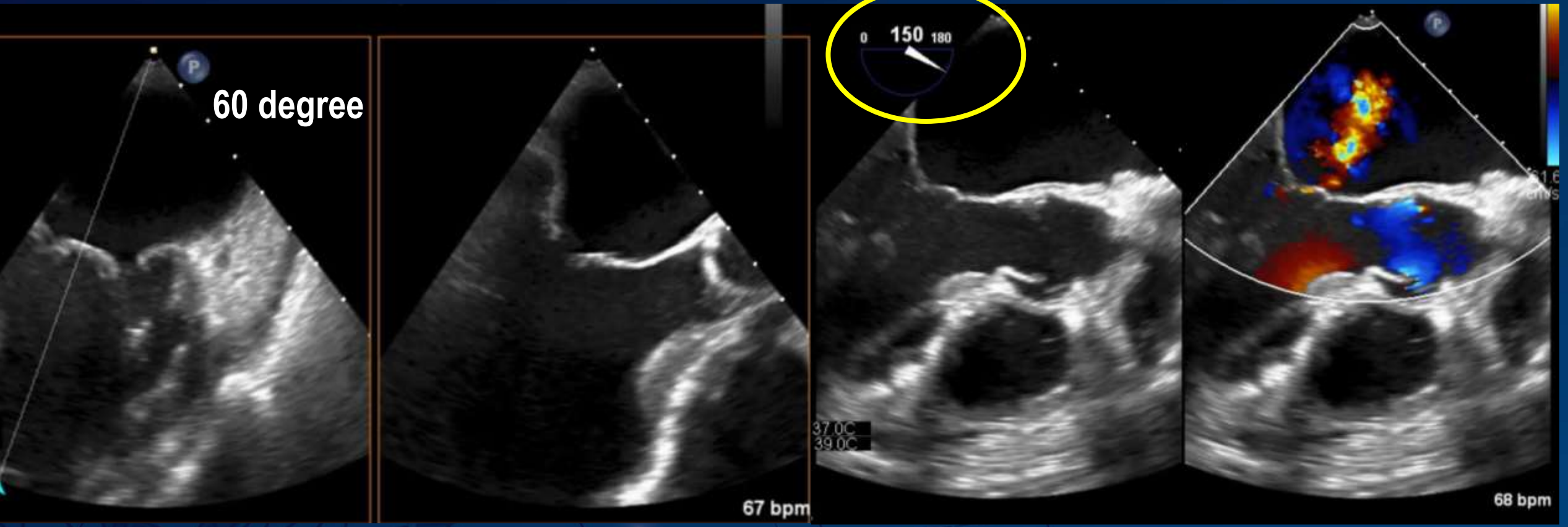


True bi-commissural (BC) view





LVOT view (BC + 90 degrees)



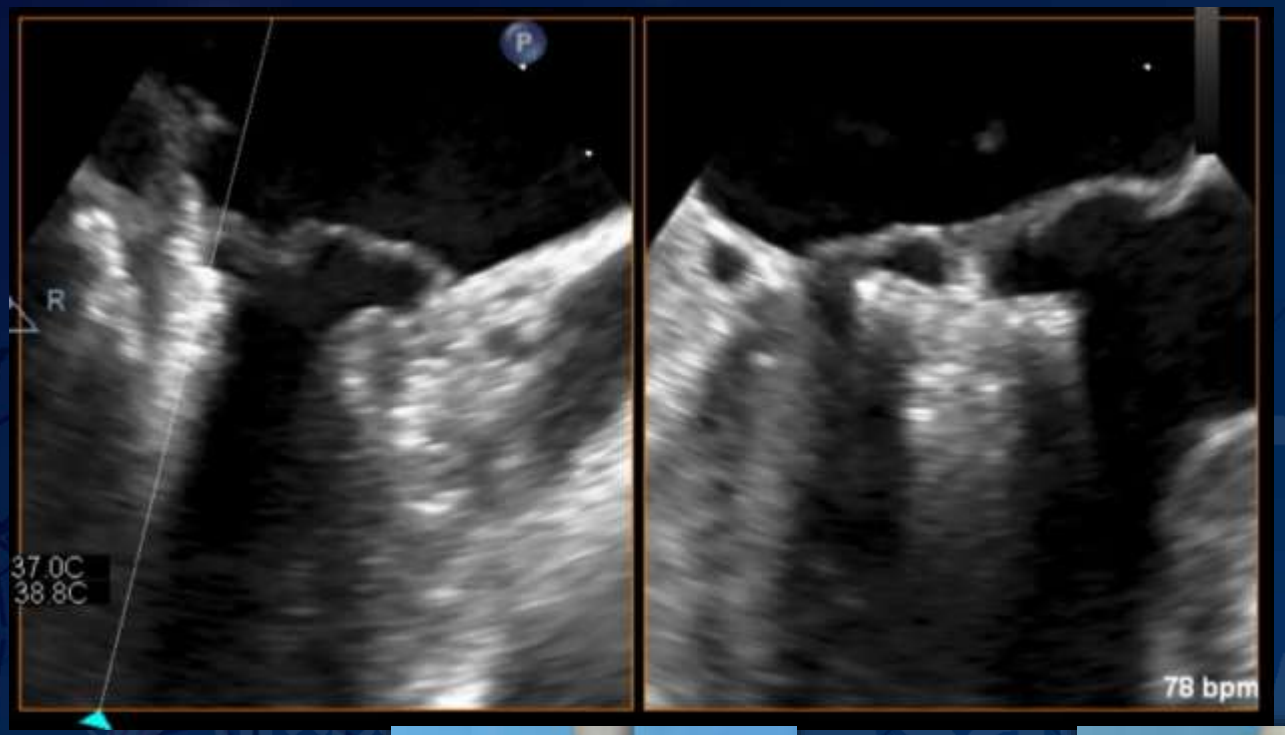
Clip maneuver in LA

3D en face

Anterior

Lateral

Leaflet insertion



At least 6 mm is necessary

J Am Soc Echocardiogr. 2019;32:431-475

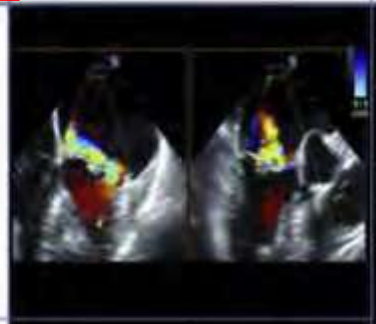
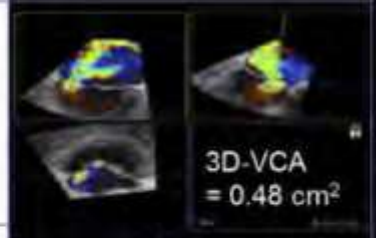
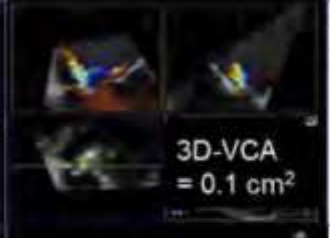
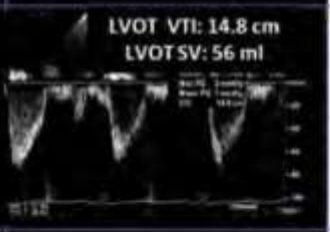
GUIDELINES AND STANDARDS

Guidelines for the Evaluation of Valvular Regurgitation After Percutaneous Valve Repair or Replacement

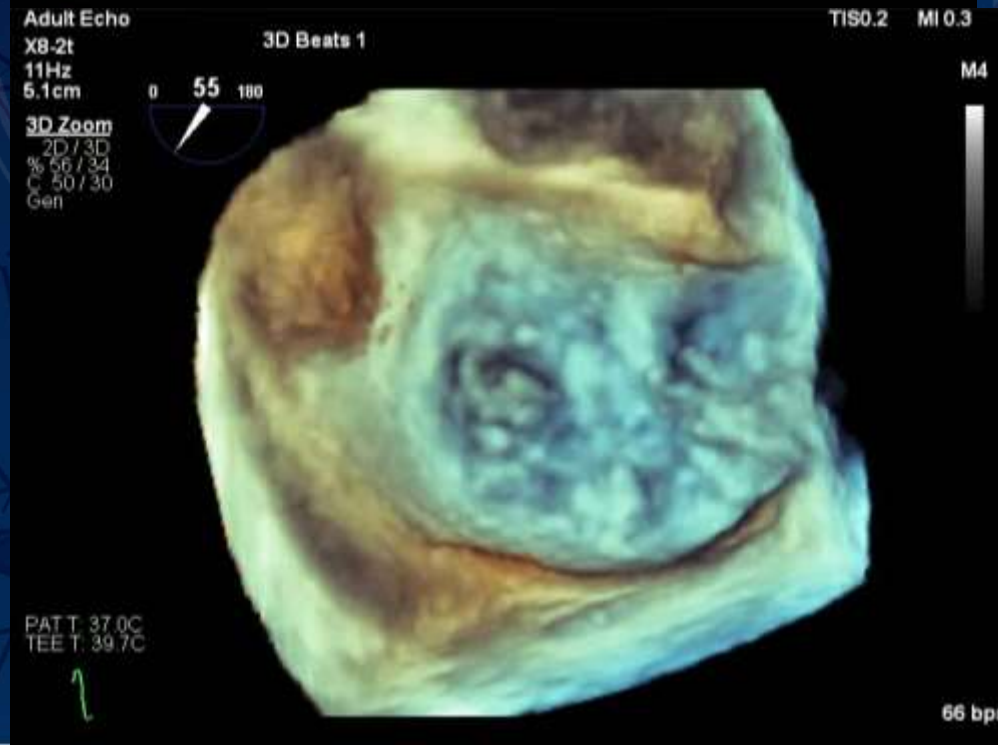
A Report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Angiography and Interventions, Japanese Society of Echocardiography, and Society for Cardiovascular Magnetic Resonance

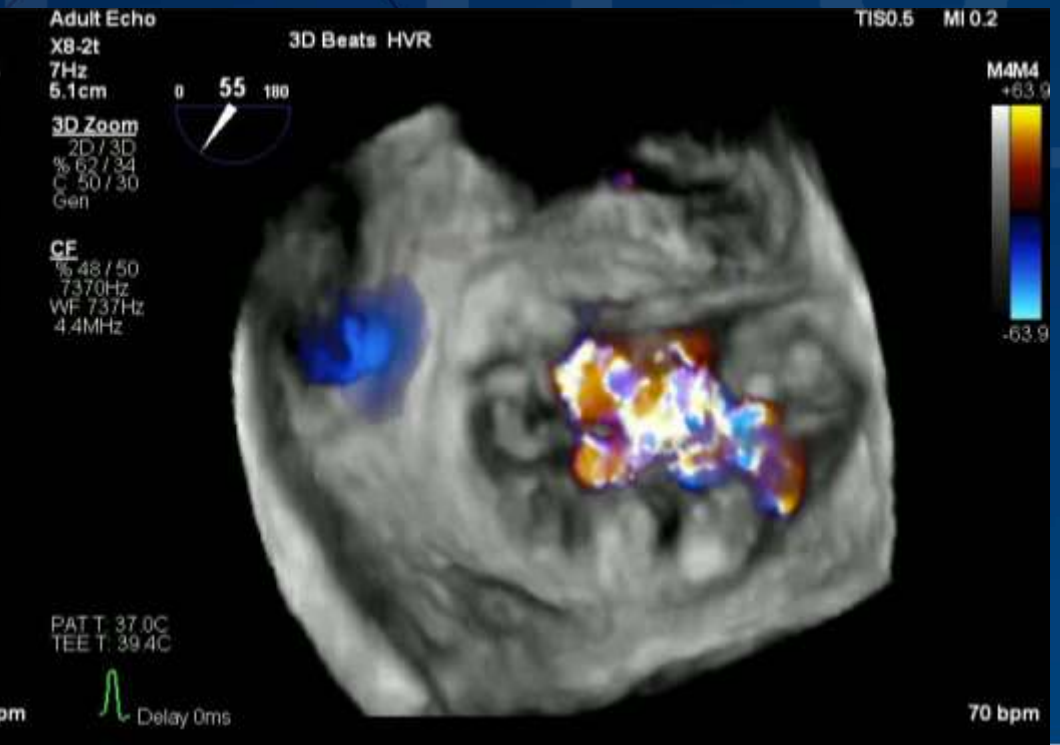
William A. Zoghbi, MD, FASE, (Chair), Federico M. Asch, MD, FASE, Charles Bruce, MBChB, FASE, Linda D. Gillam, MD, MPH, FASE, Paul A. Grayburn, MD, FASE, Rebecca T. Hahn, MD, FASE, Ignacio Inglessis, MD, Ashequl M. Islam, MD, MPH, FSCAI, Stamatios Lerakis, MD, FASE, Stephen H. Little, MD, FASE, Robert J. Siegel, MD, FASE, Nikolaos Skubas, MD, DSc, FASE, Timothy C. Slesnick, MD, FASE, William J. Stewart, MD, FASE, Paaladinesh Thavendiranathan, MD, MSc, FASE, Neil J. Weissman, MD, FASE, Satoshi Yasukochi, MD, JCC, SJSUM, and Karen G. Zimmerman, BS, ACS, RDCS, RVT, FASE, *Houston and Dallas, Texas; Washington, District of Columbia; Rochester, Minnesota; Morristown, New Jersey; New York, New York; Boston and Springfield, Massachusetts; Los Angeles, California; Cleveland, Ohio; Atlanta, Georgia; Toronto, Ontario, Canada; Nagano, Japan; and Morgantown, West Virginia*

Keywords: Doppler echocardiography, Valve disease, Transaortic valve replacement, Magnetic resonance imaging, Aortic regurgitation, Mitral regurgitation

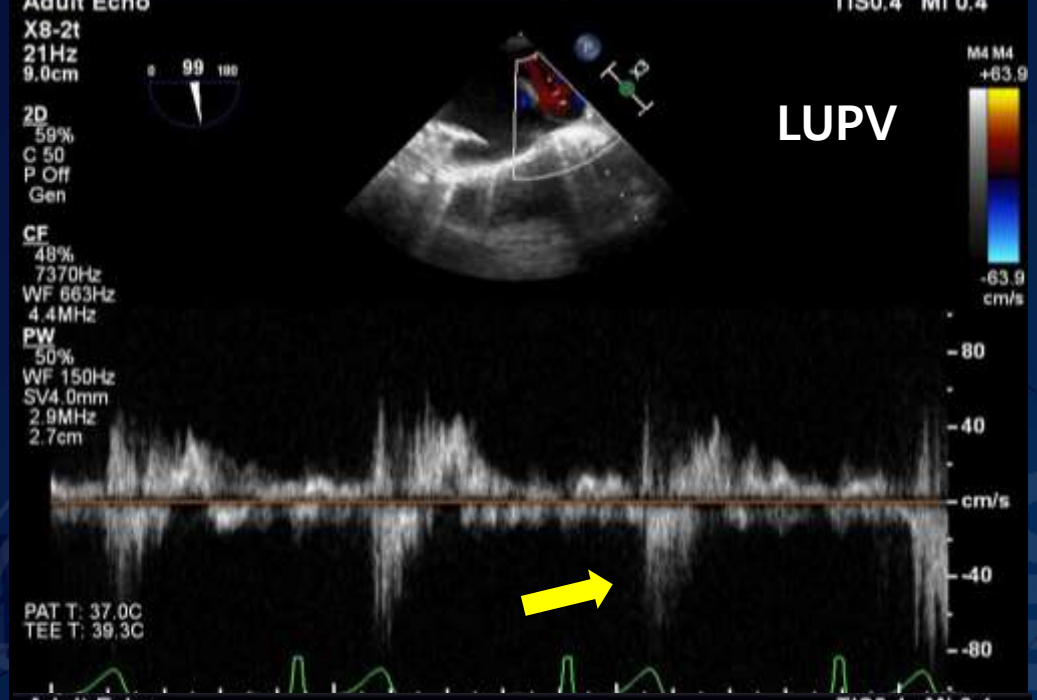
Findings of ≤ Mild Residual MR	Baseline	After Edge-to-edge Repair	Specific Features
Significant reduction in color Doppler jet features			• Small vena contracta width (< 0.3 cm) of individual MR jets • Small flow convergence radius (≤ 0.3 cm) • Central MR jet with limited penetration into LA
Significant reduction in VCA by 3D color Doppler			• More tedious to perform • VCA < 0.2 cm²
Improvement or normalization of pulmonary vein flow			• Change from S-wave reversal or blunting to antegrade flow • Marked reduction in D-wave velocity
Improvement of forward stroke volume (Deep trans-gastric LVOT VTI); often with decrease in LVEF			• Marked increase in PWD VTI in LVOT and derived systemic stroke volume • "paradoxical" decrease in LVEF by 5-10%
New onset spontaneous contrast within LA or LA appendage			• Associated with low flow conditions including atrial fibrillation, and/or severe LV systolic dysfunction • Mean diastolic MV gradient may not be markedly elevated (e.g. < 7mmHg)

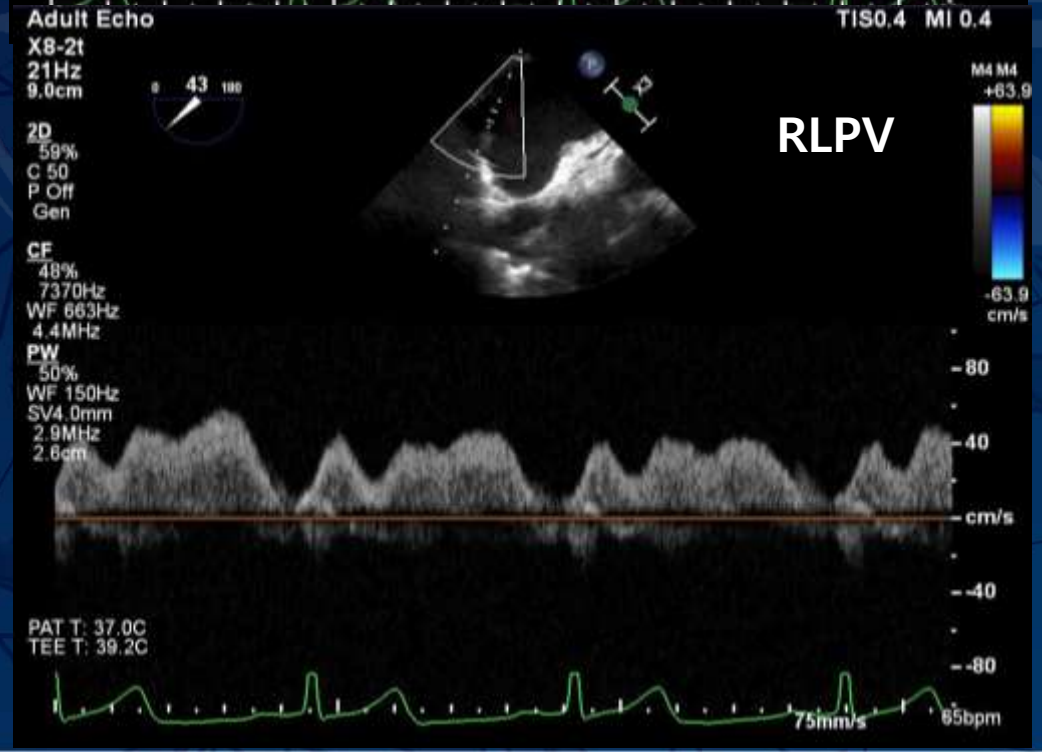
80/M KJM

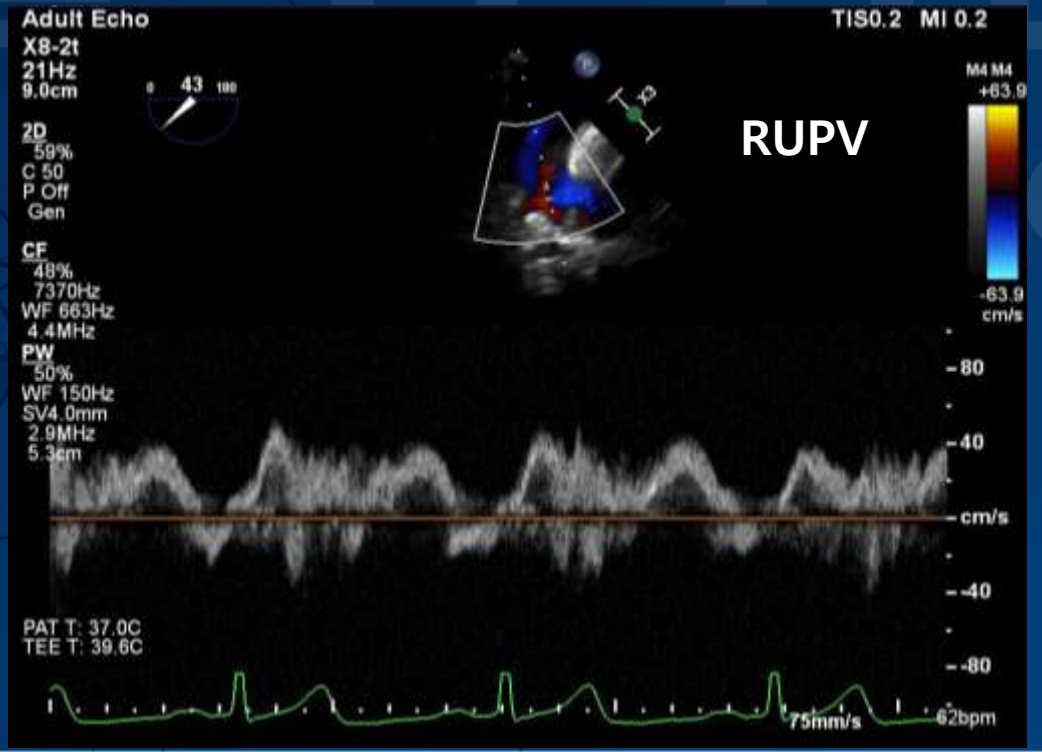




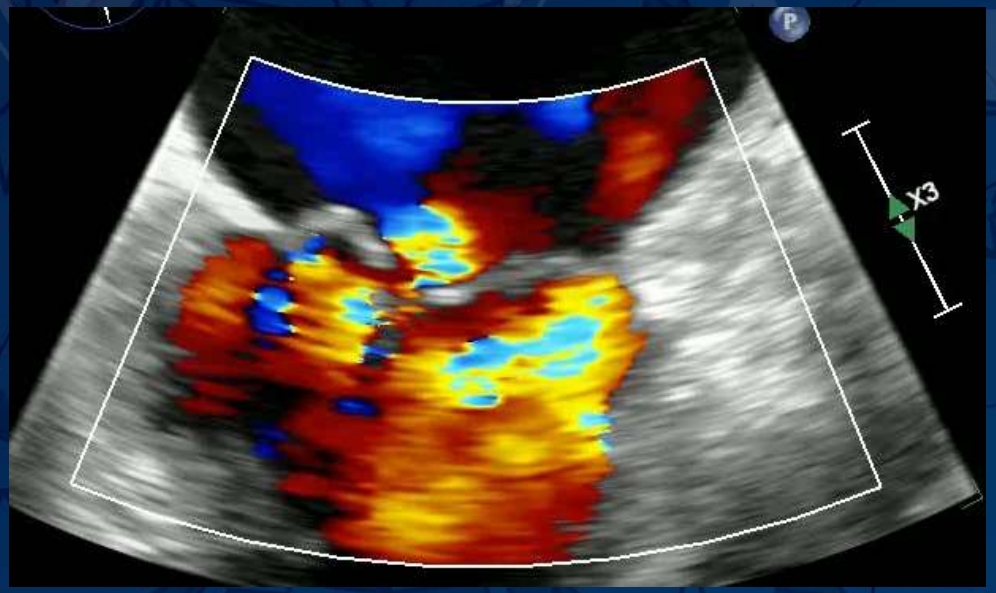
80/M KJM

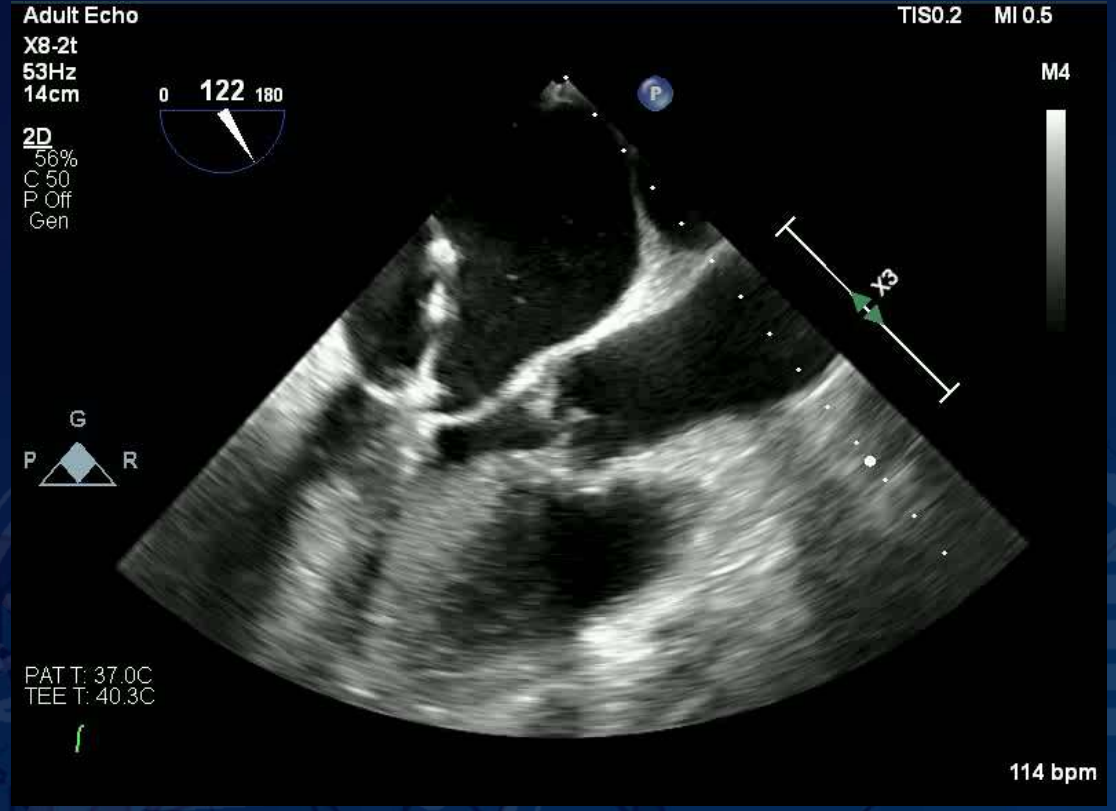


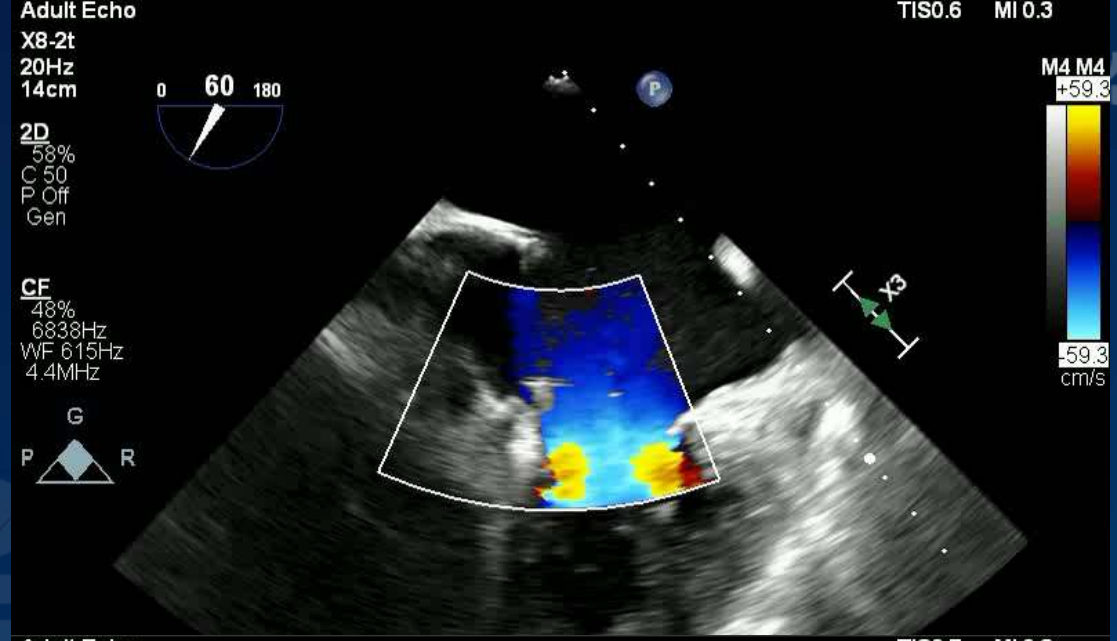


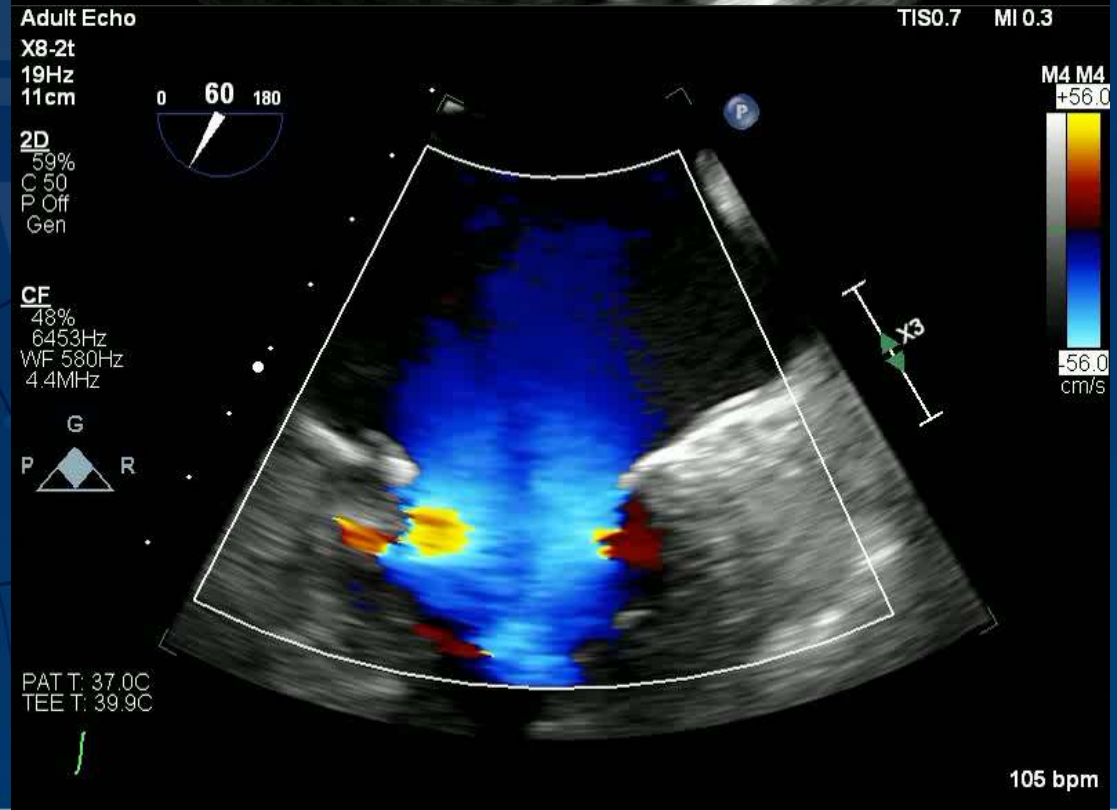


83YO Female, P3 chordae rupture

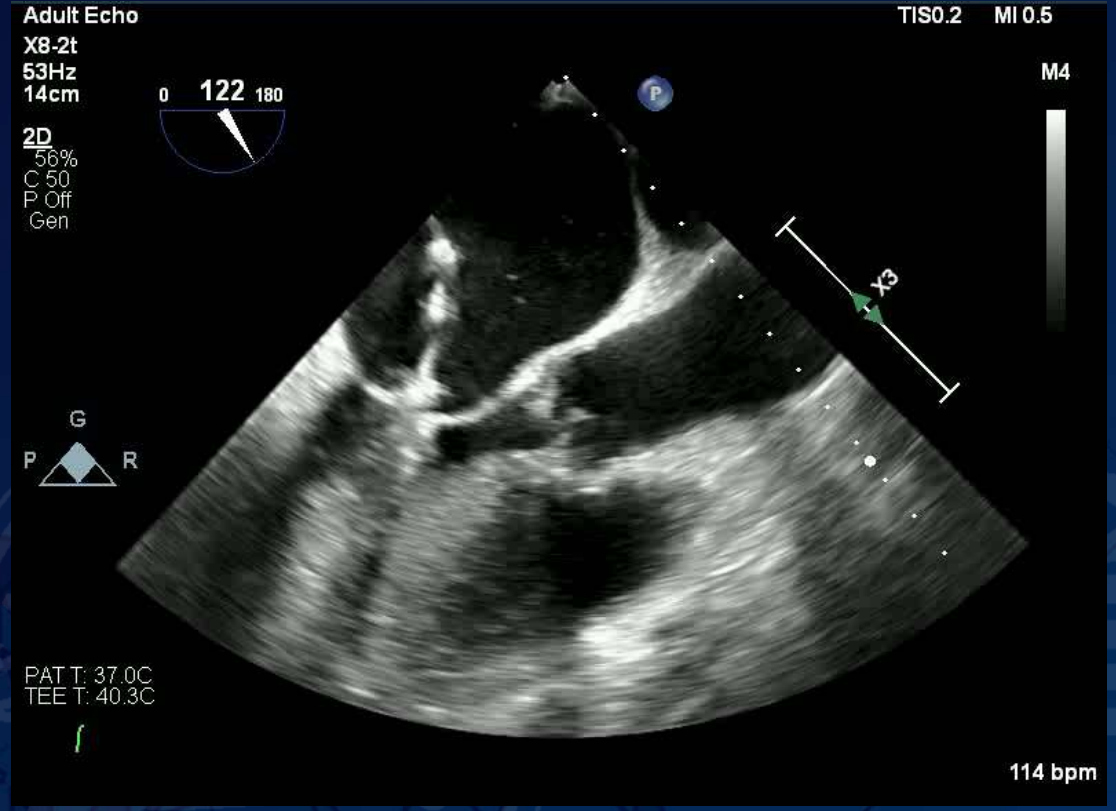


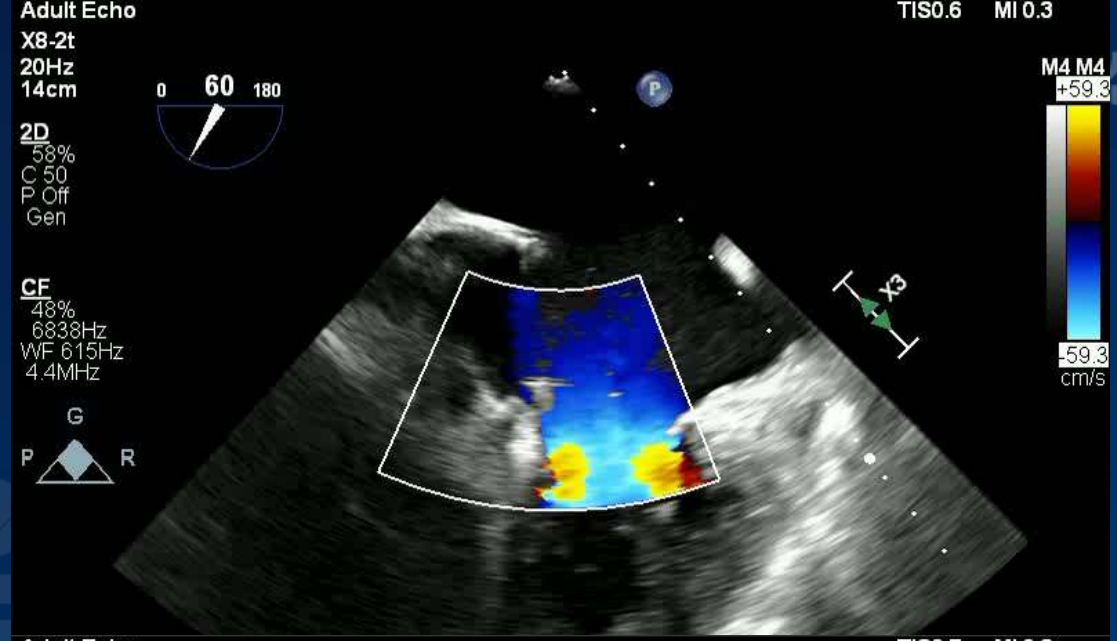


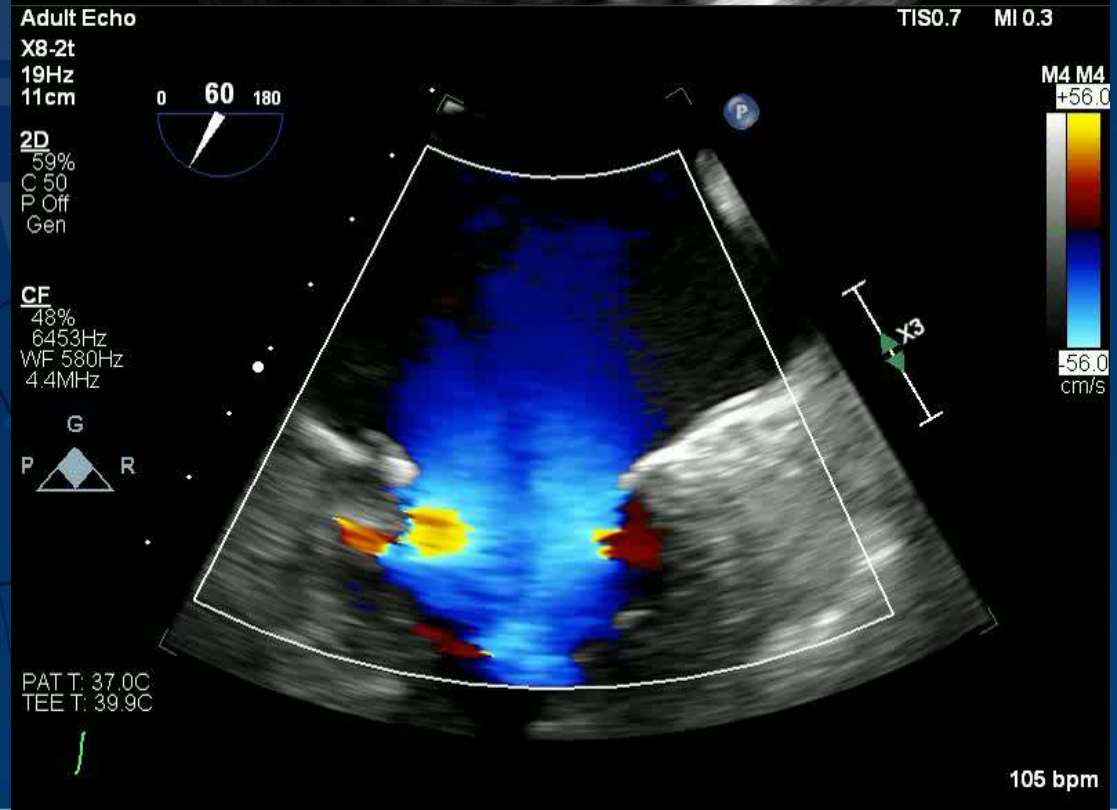




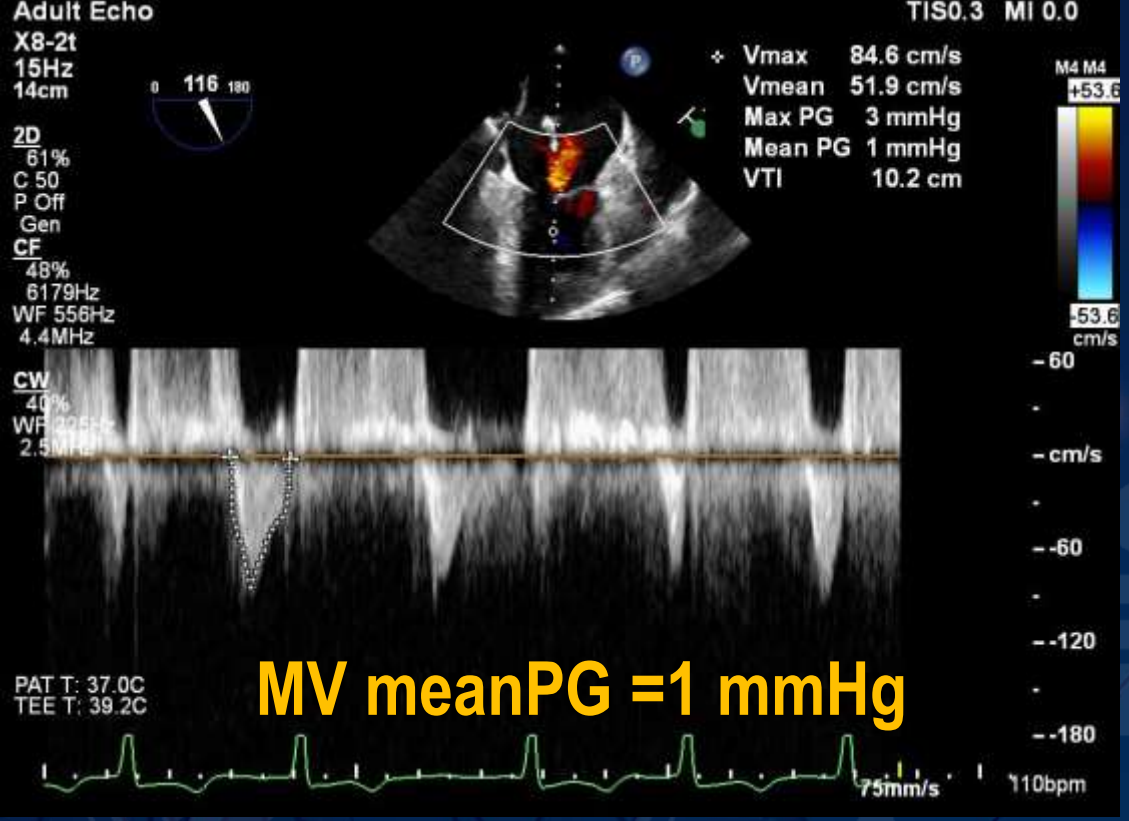
First clip implantation





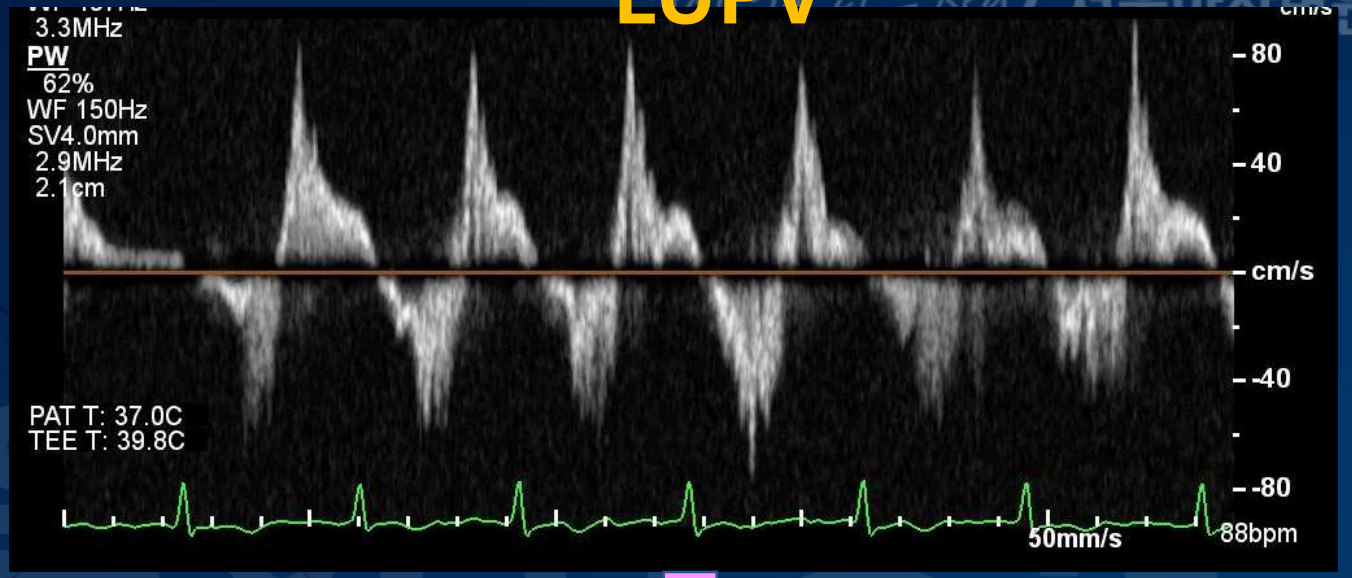


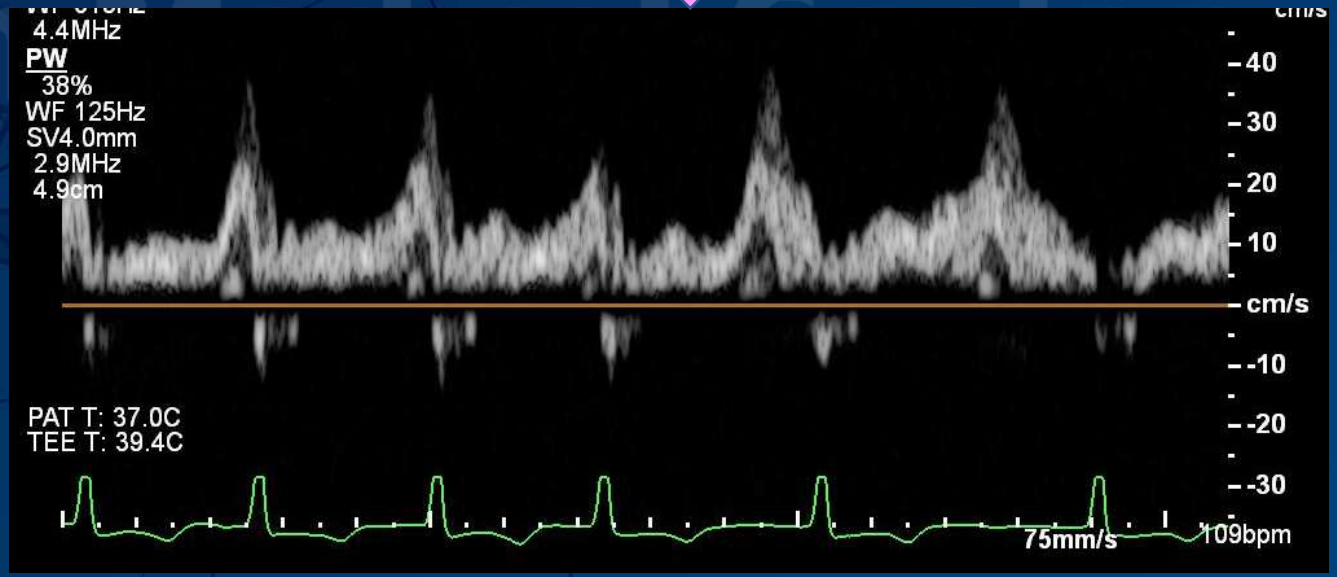
First clip implantation



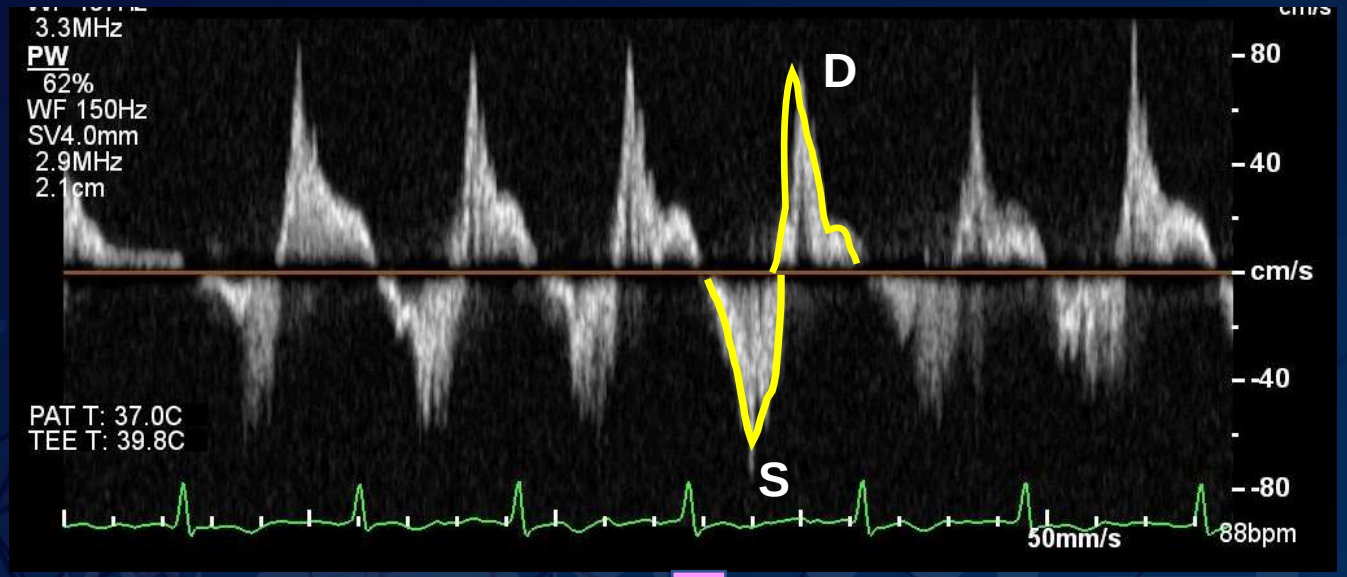
MV meanPG =1 mmHg

LUPV



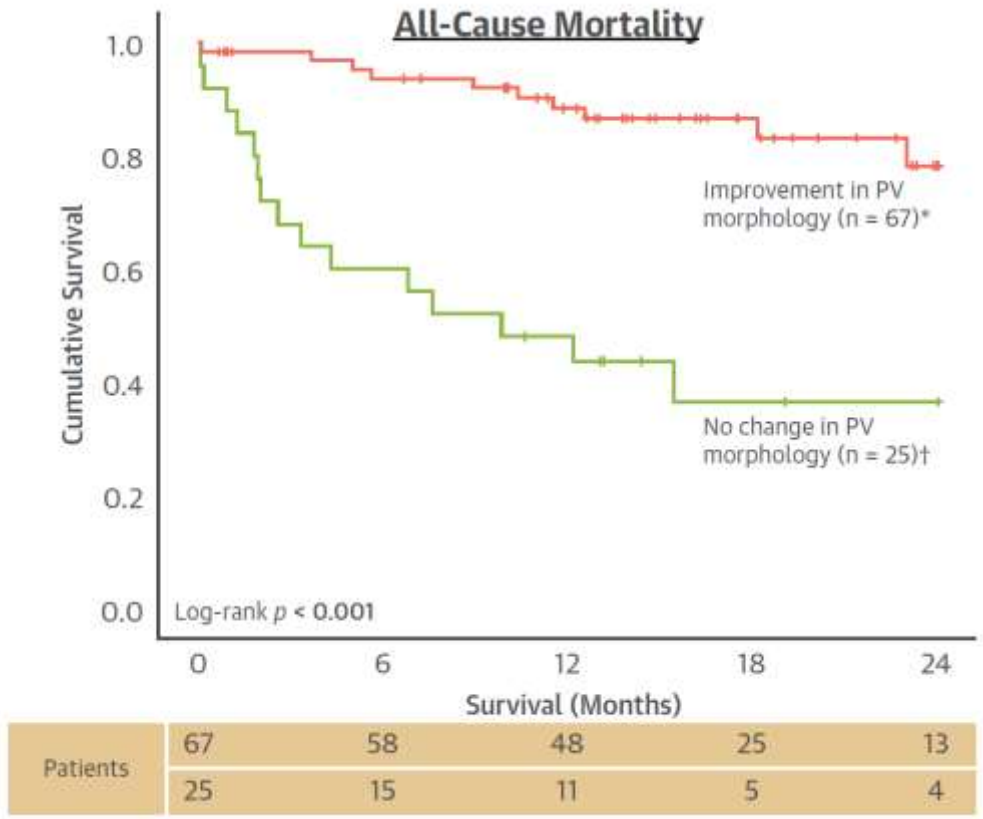


First clip implantation



Improvement in PV waveform
Change in S-wave velocity
Change in S/D velocity ratio
Change in S/D TVI ratio

Improvement in PV morphology



Intraprocedural predictor of two-year survival	Area Under Curve (95% CI)	*p*
Invasive:		
Final LA pressure	0.39 (0.25-0.53)	0.136
Change in LA pressure	0.46 (0.32-0.61)	0.607
Change in V-wave	0.46 (0.32-0.67)	0.619
Echocardiographic:		
Final MR grade	0.52 (0.37-0.67)	0.837
Change in MR grade	0.46 (0.31-0.61)	0.615
Final transmitral gradient ≥5	0.44 (0.29-0.59)	0.447
PV assessment:		
Change in S-wave velocity	0.80 (0.69-0.92)	**< 0.001**
Change in S/D velocity ratio	0.78 (0.66-0.91)	**< 0.001**
Improvement in PV waveform	0.74 (0.60-0.87)	**0.001**

J Am Coll Cardiol Img 2019;12:1905–13

PV Wave form change

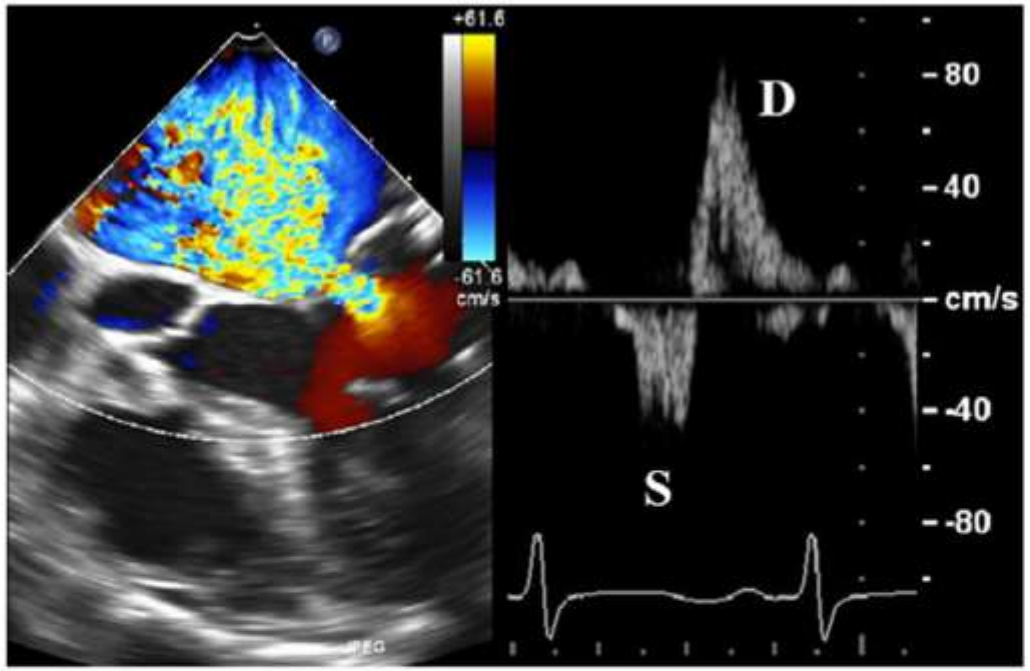
TABLE 2 Adjusted Proportional Hazards Models of the Primary Endpoints by Intraprocedural Predictors of Outcomes

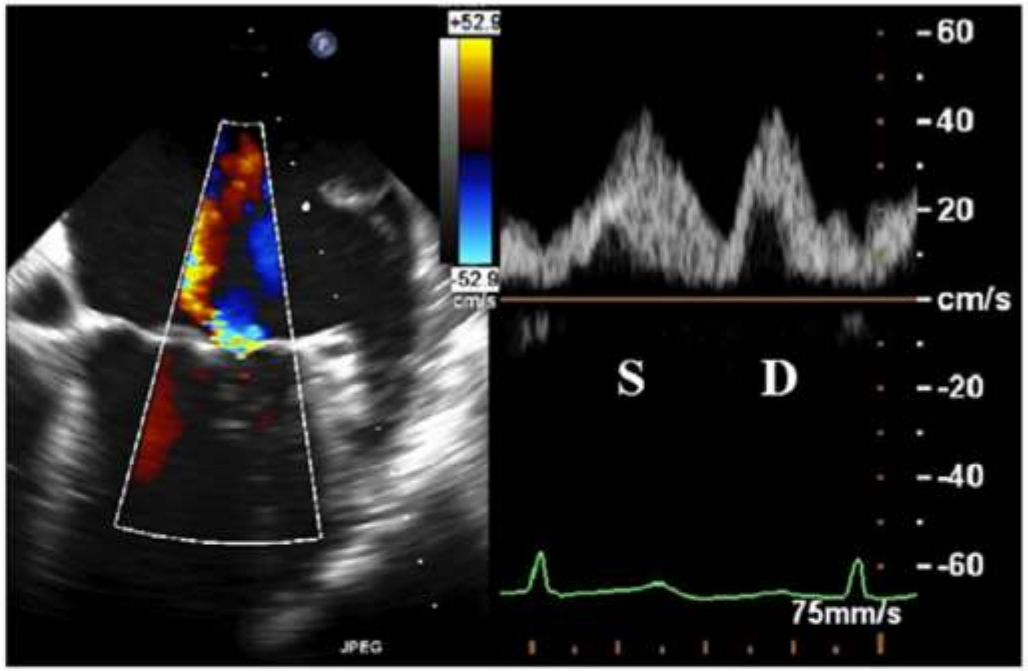
	All-Cause Mortality		Composite Endpoint*	
	HR (95% CI)	p Value	HR (95% CI)	p Value
Invasive				
Final left atrial pressure	1.05 (0.99-1.11)	0.138	1.04 (0.98-1.09)	0.197
Change in left atrial pressure	1.05 (0.98-1.13)	0.181	1.02 (0.95-1.09)	0.609
Change in V-wave	1.05 (1.01-1.10)	**0.013**	1.04 (1.00-1.08)	**0.028**
Echocardiographic				
Final MR grade	1.28 (0.79-2.08)	0.323	1.42 (0.90-2.24)	0.131
Change in MR grade	1.54 (0.94-2.54)	0.088	1.71 (1.06-2.76)	**0.029**
Final transmitral gradient ≥5 mm Hg	2.19 (1.05-4.55)	**0.037**	1.92 (0.94-3.96)	0.075
PV assessment				
Change in S-wave velocity	0.28 (0.07-1.12)	0.072	0.30 (0.09-1.05)	0.059
Change in S/D velocity ratio	0.36 (0.15-0.84)	**0.019**	0.36 (0.16-0.79)	**0.011**
Improvement in PV waveform	0.28 (0.08-0.93)	**0.038**	0.30 (0.10-0.90)	**0.032**

Composite endpoint: all-cause mortality, LVAD implantation, MV surgery, and repeat TEER in prolonged follow-up

J Am Coll Cardiol Img 2019;12:1905–13

Pre-MitraClip → Post-MitraClip





Peak Sv = - 46 cm/s, Peak Dv = 83 cm/s

Svti = -5.7 cm, Dvti = 11.5 cm

Peak Sv/Dv ratio = -0.56

Svti/Dvti ratio = -0.50

Mean LA pressure = 37 mm Hg

LA pressure V-wave = 73 mm Hg

Peak Sv = 44 cm/s, Peak Dv = 43 cm/s

Svti = 11.2 cm, Dvti = 8.1 cm

Peak Sv/Dv ratio = 1.02

Svti/Dvti ratio = 1.38

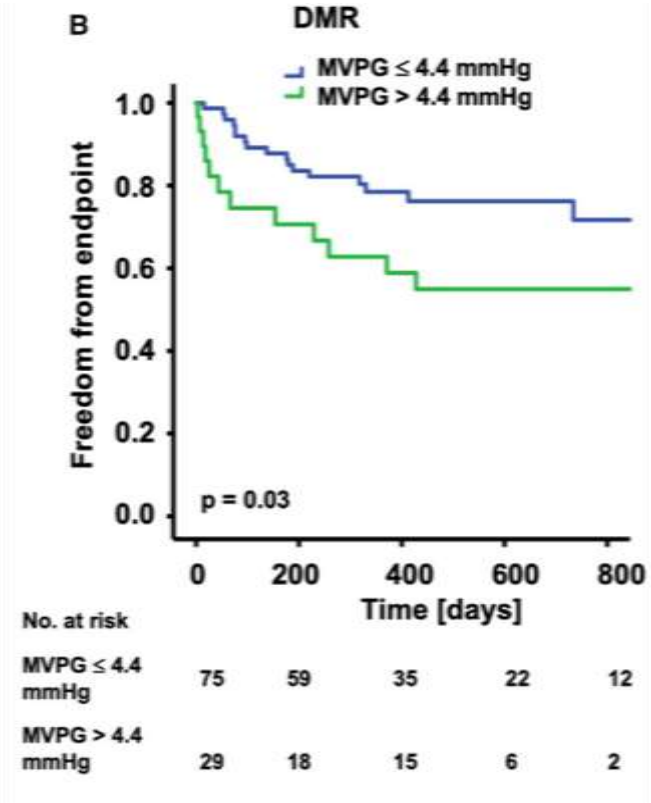
Mean LA pressure = 16 mm Hg

LA pressure V-wave = 25 mm Hg

Am J Cardiol. 2018;122:13791386

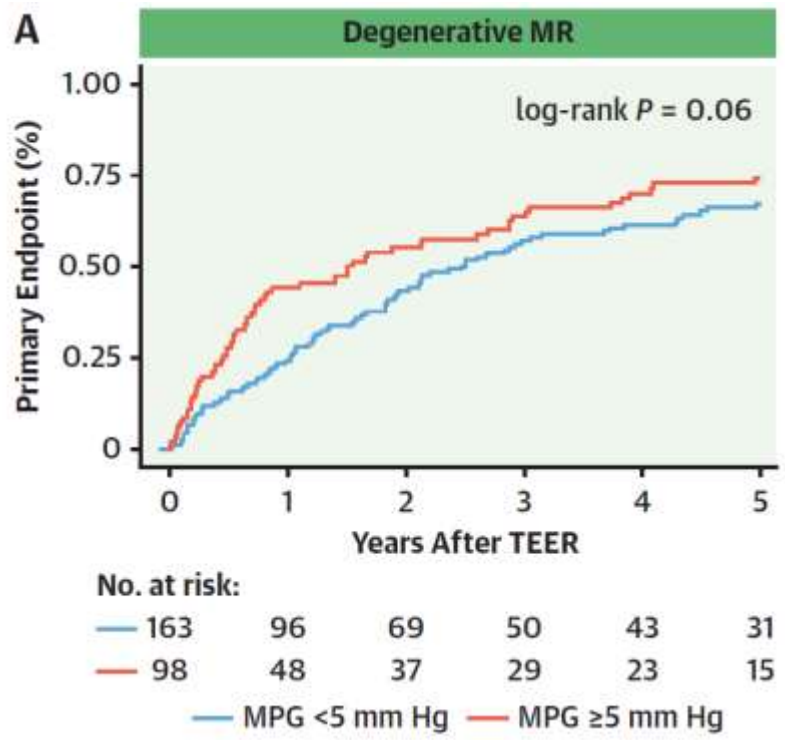
Contrasting Results of Impact of High Transmitral Gradient after TEER for Primary MR

255 from German Single Center
Mortality, MV Surgery, Redo, LVAD



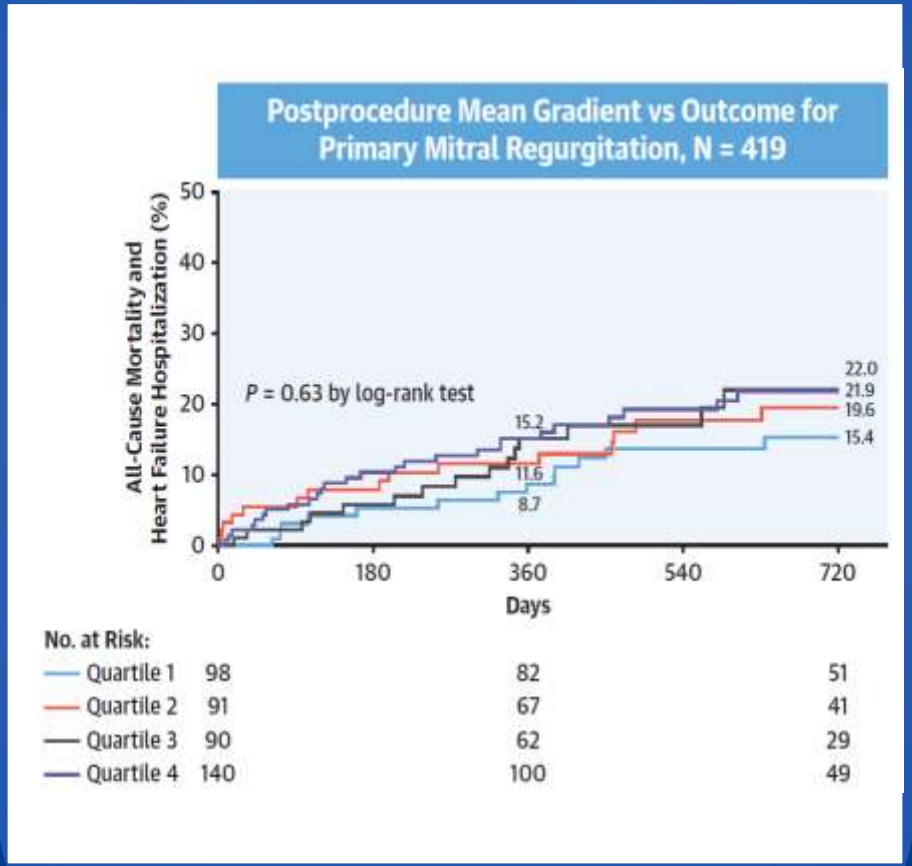
Patzelt J et al. JAHA. 2019;8:e011366.

265 from German Single Center
Mortality, HF Hospitalization



Koell B et al. JACC Interv. 2022;15:922-34.

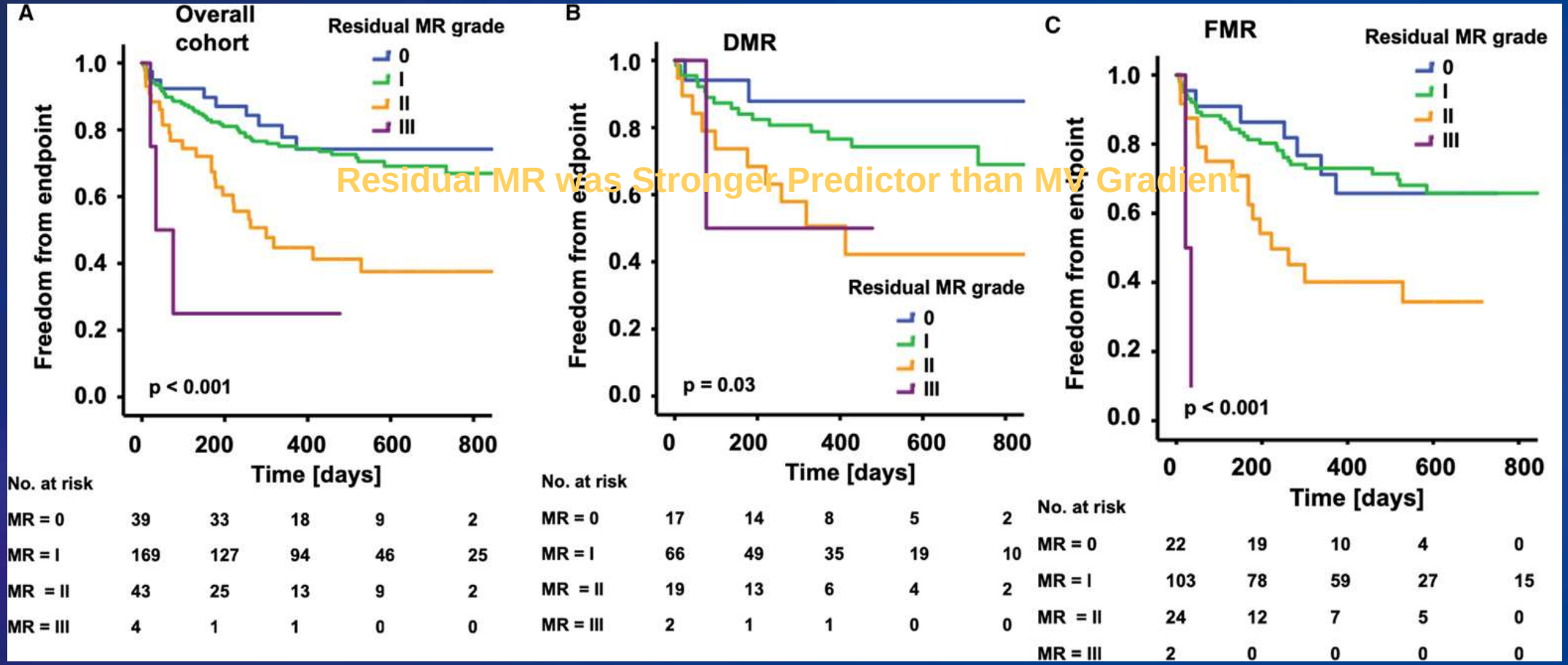
419 from US Single Center
Mortality



Yoon S et al. JACC Interv. 2022;15:935-45.

Residual MR was Stronger Predictor than MV Gradient

255 Patients from German Single Center from 2014 to 2017, Primary 41%, Secondary 59%
Clinical Outcome: All-cause mortality, MV Surgery, LVAD, or Redo TEER



Residual MR was Stronger Predictor than MV Gradient

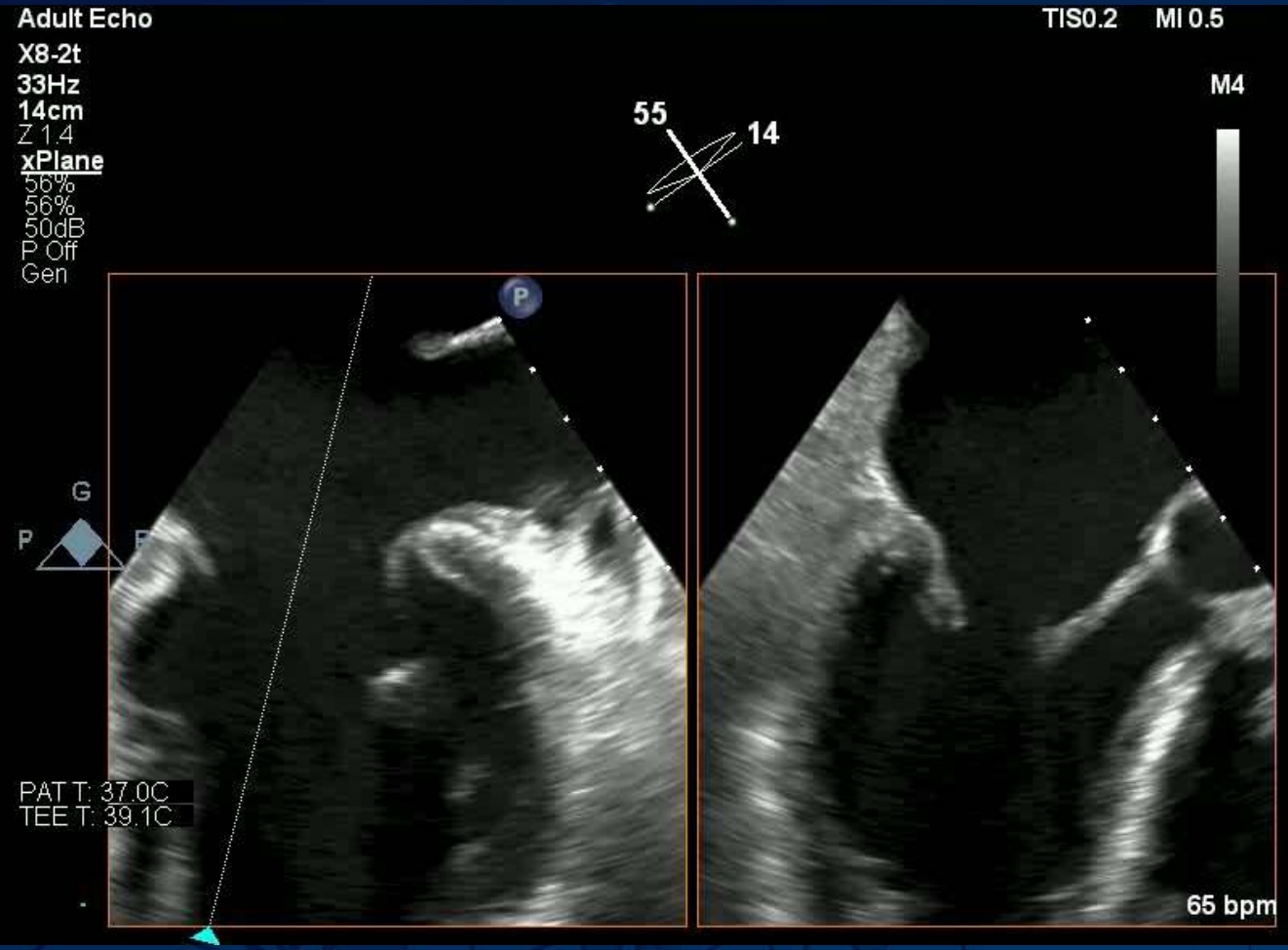
Patzelt J et al. J Am Heart Assoc. 2019;8:e011366.

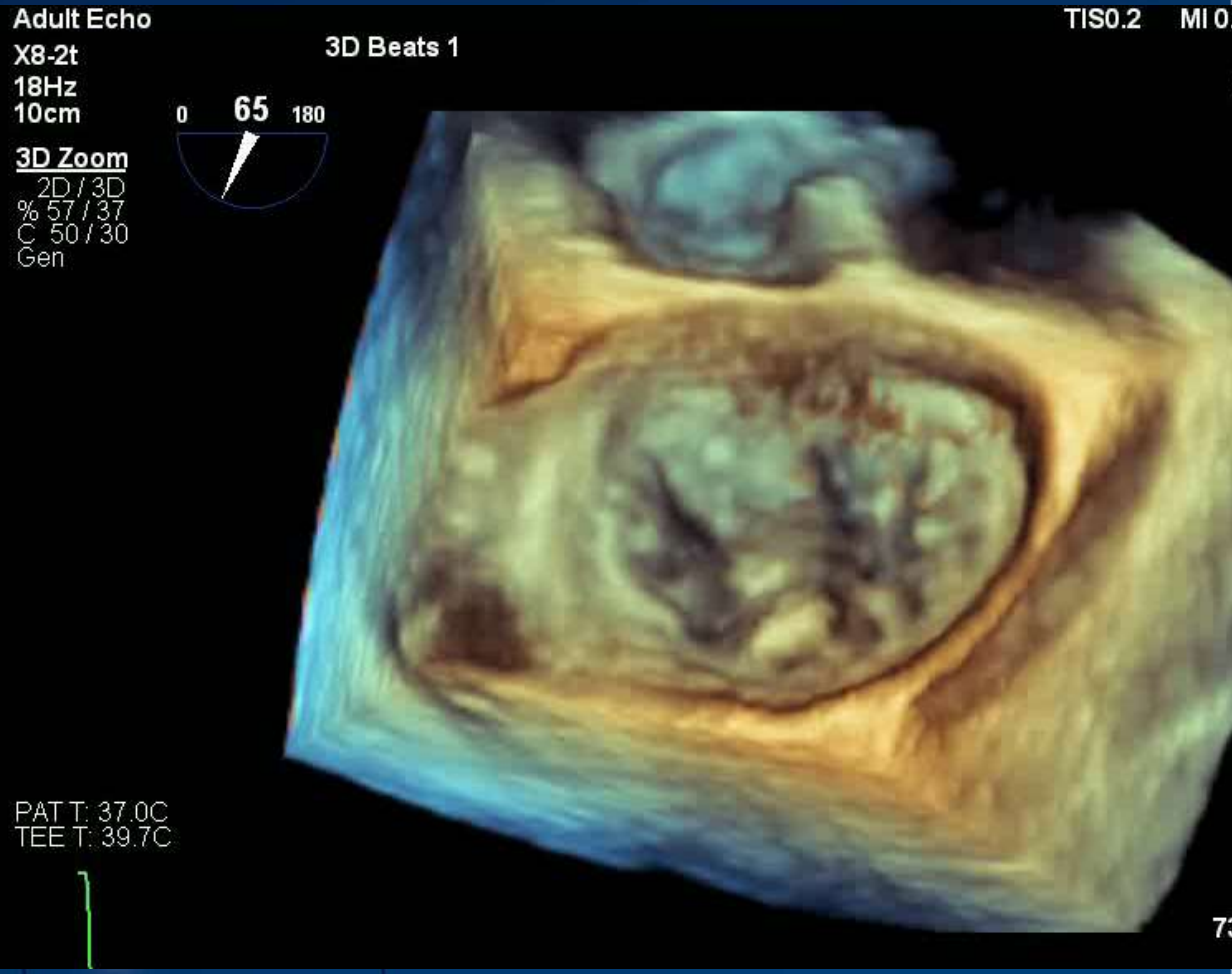
Table 4 Intraprocedural Assessment of MV Immediately after Device Deployment (before Release)

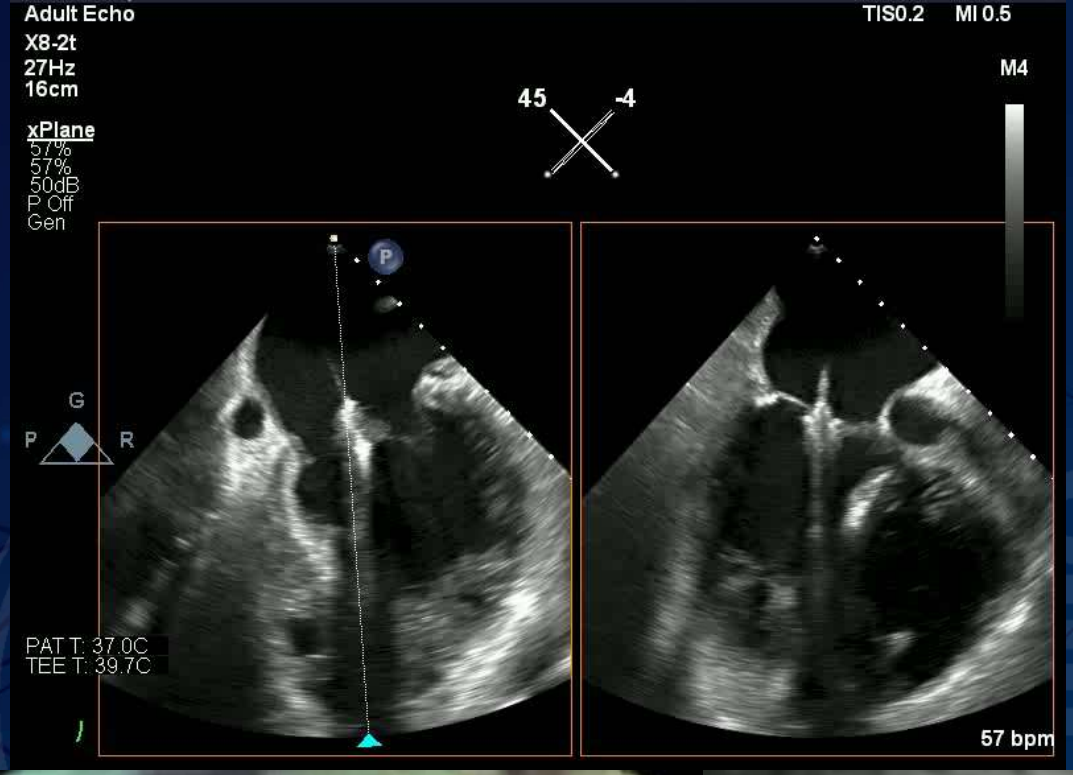
- Ensure adequate leaflet insertion and a stable tissue bridge
- Ensure that the valve geometry is not distorted
- Measure diastolic transmitral gradients (see Supplemental Figure 3)
- Measure residual MV area, preferably by 3D planimetry (see Supplemental Figure 4)
- Assess for residual MR: number and localizations of jets, quantification with 3D vena contracta area if possible
- Look for complications: pericardial effusion, clip detachment
- If residual grade MR > 2+ (and first device cannot be optimized), may consider another device if MV area > 3 cm^2 and mean gradient (at normal blood pressure and heart rate) < 4 mm Hg

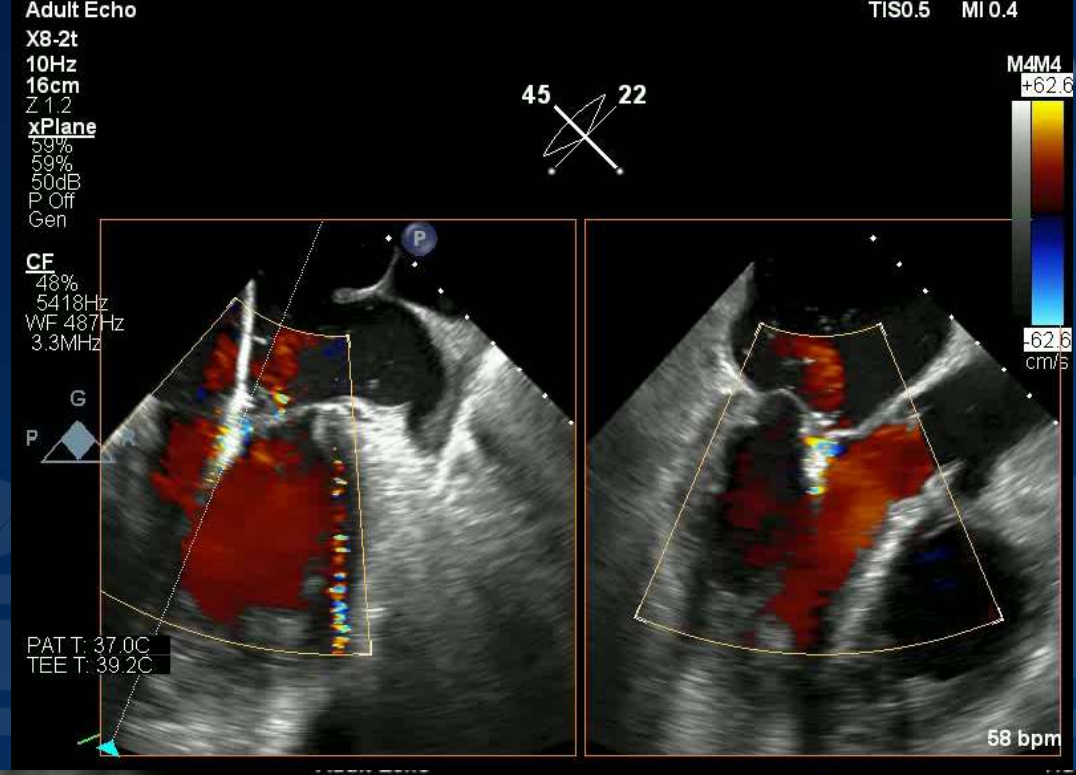
J Am Soc Echocardiogr. 2019;32:431-475

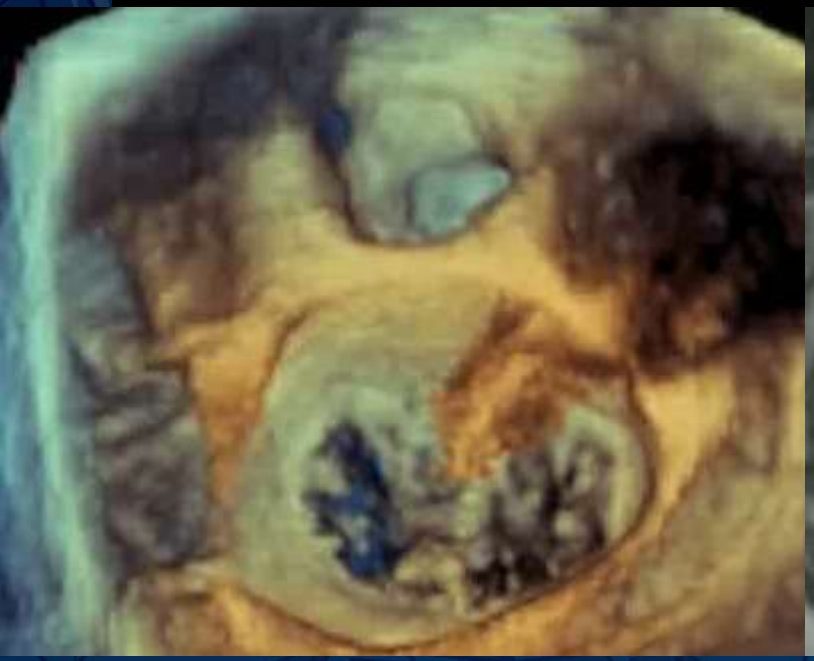
78/F KKJ

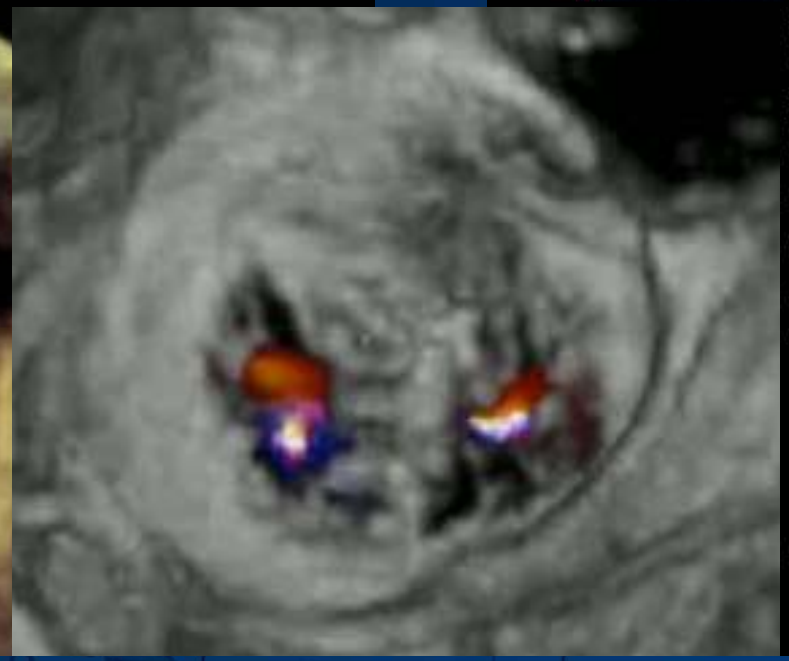


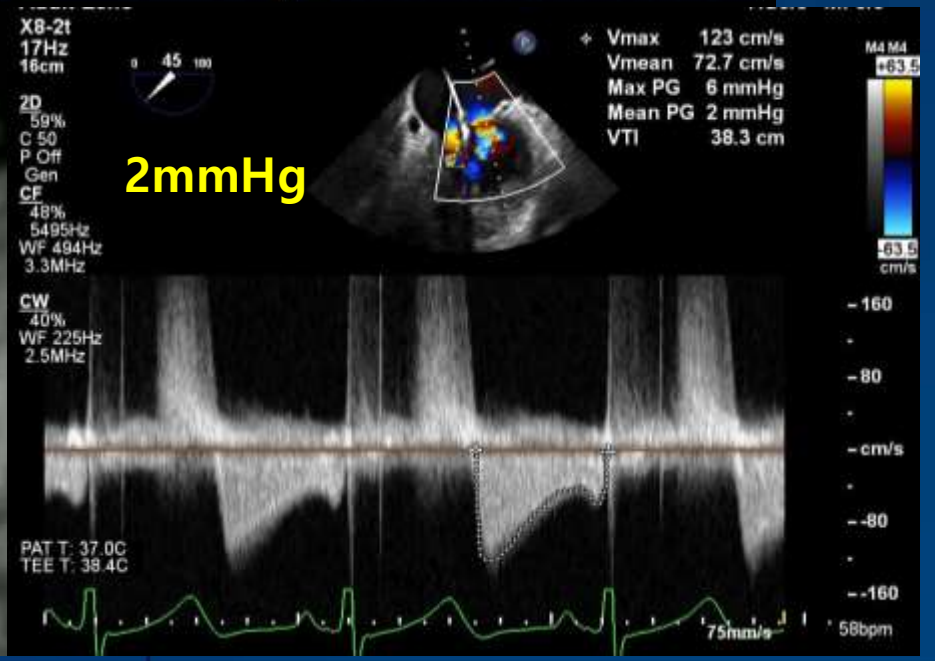



Adult Echo
X8-2t
27Hz
16cm
xPlane
57%
57%
50dB
P Off
Gen
TIS0.2 MI 0.5
M4
45 -4
PAT T: 37.0C
TEE T: 39.7C
57 bpm


Adult Echo
X8-2t
10Hz
16cm
Z 1.2
xPlane
59%
59%
50dB
P Off
Gen
CF
48%
5418Hz
WF 487Hz
3.3MHz
TIS0.5 MI 0.4
M4M4
+62.6
-62.6
cm/s
45 22
PAT T: 37.0C
TEE T: 39.2C
58 bpm






X8-2t
17Hz
16cm
2D
59%
C 50
P Off
Gen
CF
48%
5495Hz
WF 494Hz
3.3MHz
CW
40%
WF 225Hz
2.5MHz
2mmHg
Vmax 123 cm/s
Vmean 72.7 cm/s
Max PG 6 mmHg
Mean PG 2 mmHg
VTI 38.3 cm
M4 M4
+63.5
-63.5
cm/s
160
80
cm/s
-80
-160
PAT T: 37.0C
TEE T: 38.4C
75mm/s
58bpm

When We Stop?
Echo-Guided Decision-Making

- Balance between less MR and more residual transmitral PG after MitraClip
- Visual assessment of residual prolapse and coaptation gap
- Doppler assessment
- PV improvement and change in waveform
- Surgical conversion

Summary
시술 중 TEE 평가 노하우

- TEE training !!!!
- Septal puncture
- Guidance
- Residual MR, mitral PG 평가
- When to stop