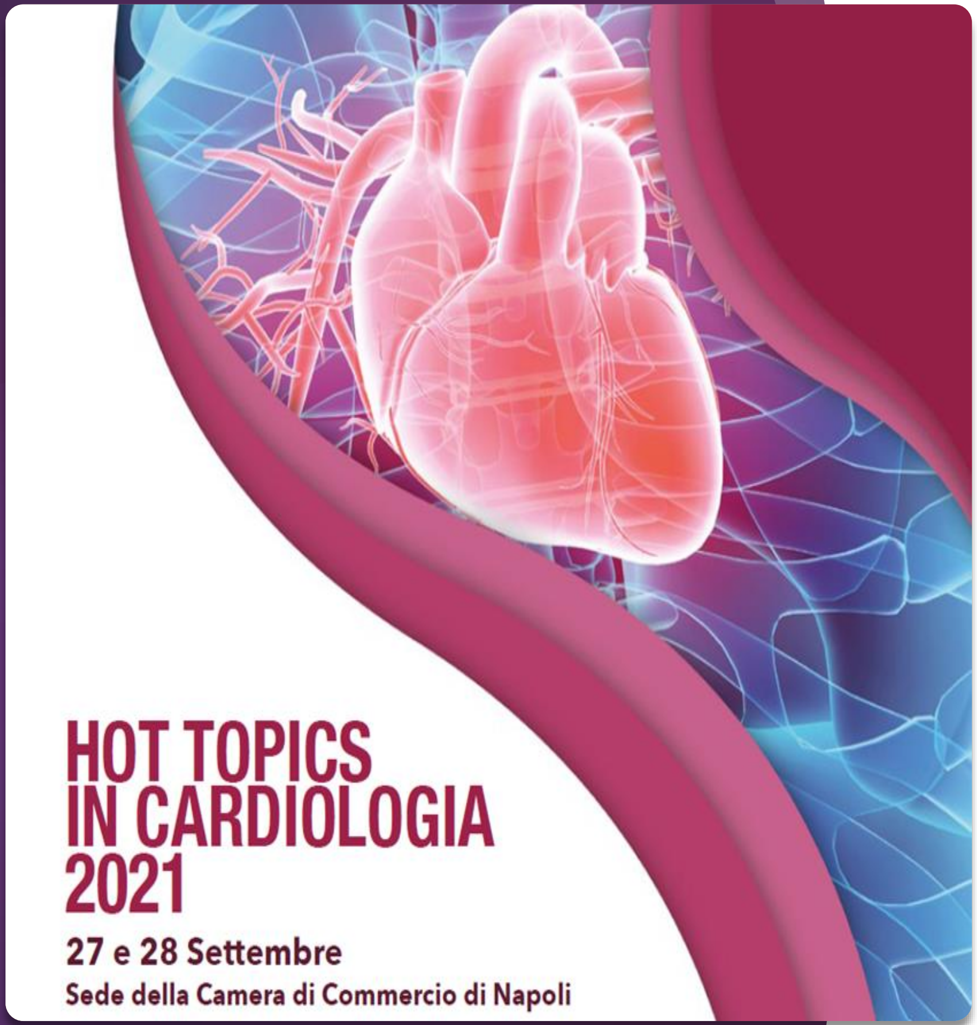

Valvulopatie ed imaging multimodale

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berti@ftgm.it

Heart Valve Disease:

ROLE OF IMAGING

Diagnosis

Follow Up

Heart Valve Disease:

ROLE OF IMAGING

Diagnosis

Preprocedural Planning

Procedural Guidance

Follow Up

Heart Valve Disease:

ROLE OF IMAGING

Diagnosis →

Preprocedural Planning →

Procedural Guidance →

Follow Up →

Multimodality imaging

Heart Valve Disease:

ROLE OF IMAGING

There is not one single imaging modality that by itself can provide all the necessary information needed to plan and perform a safe and effective intervention

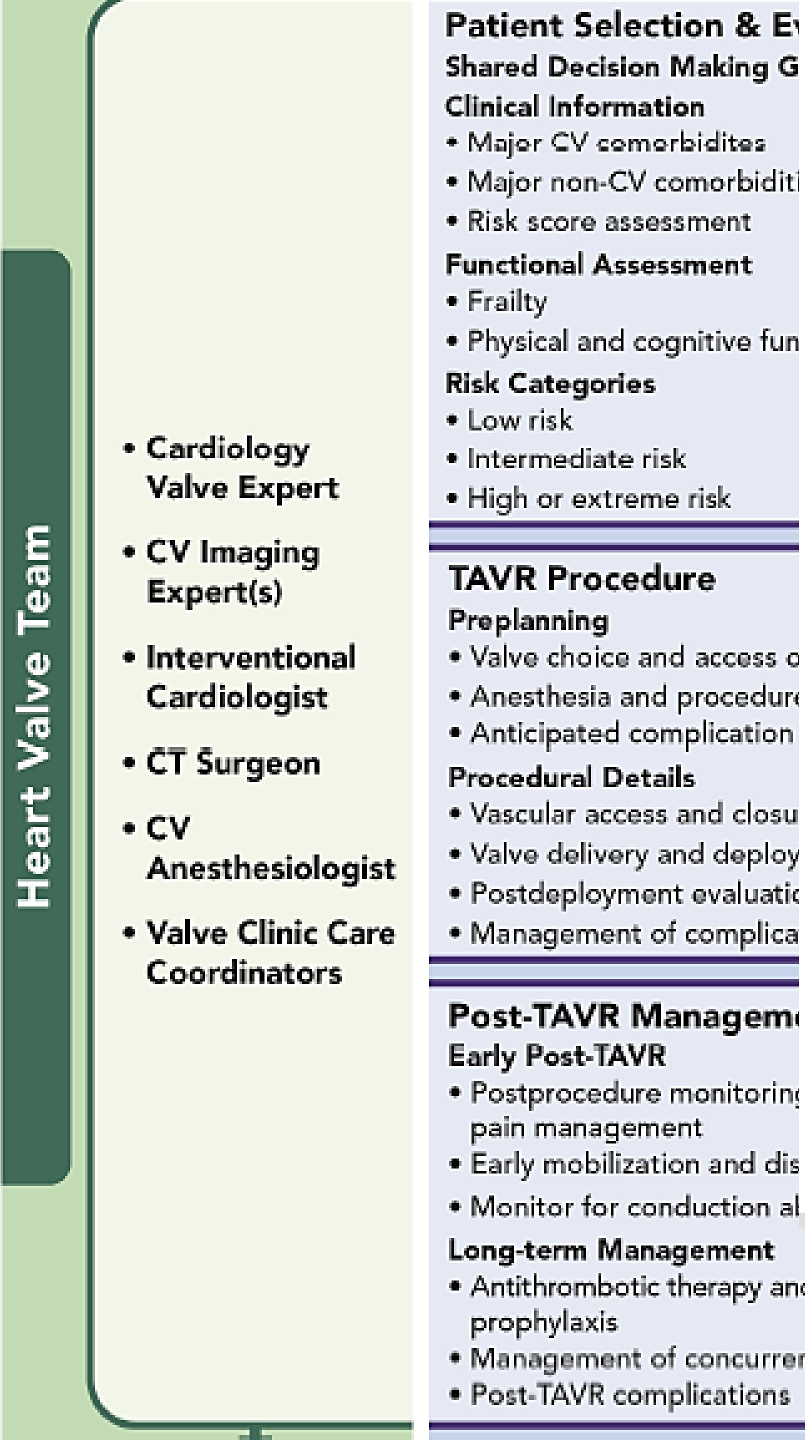
• TEE 2D/3D

Procedural Guidance

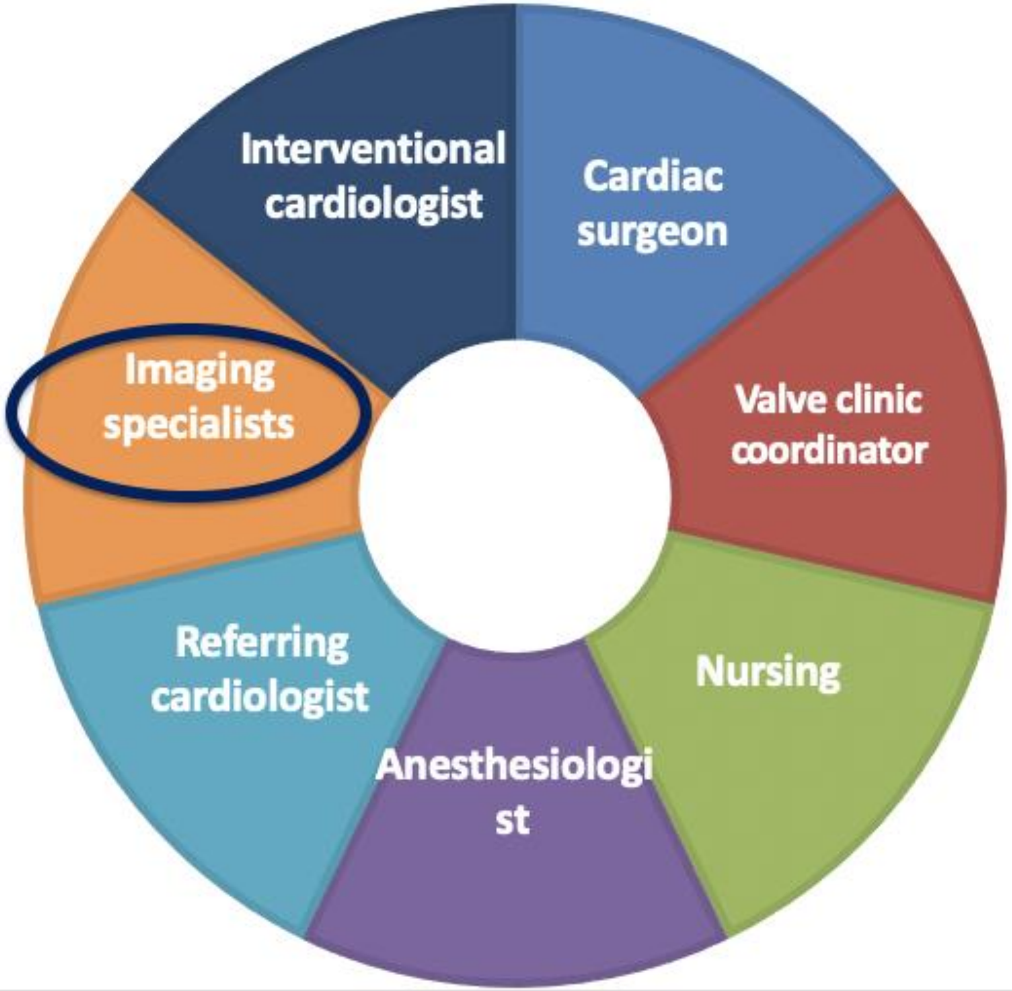
• CMR?

Follow Up

Imaging



Heart Team composition



Otto CM et al. ACC Expert Consensus TAVI 2017.

JACC 2017;69(10):1313-1346.

Aortic Stenosis:

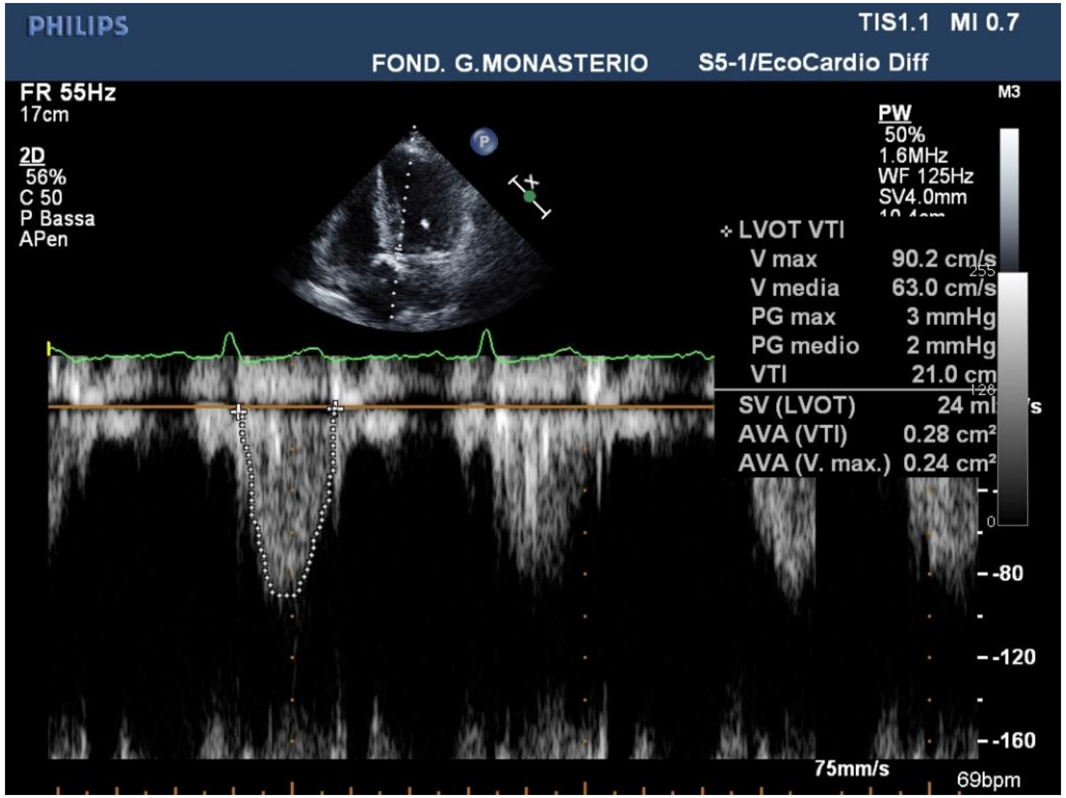
echocardiographic definition

- Mean and Peak Transvalvular gradients

$$P = 4v_{max}^2$$

If LVOT velocity is > 1.5 m/s or the aortic velocity is < 3.0 m/s, LVOT velocity should be considered in the Bernoulli Equation

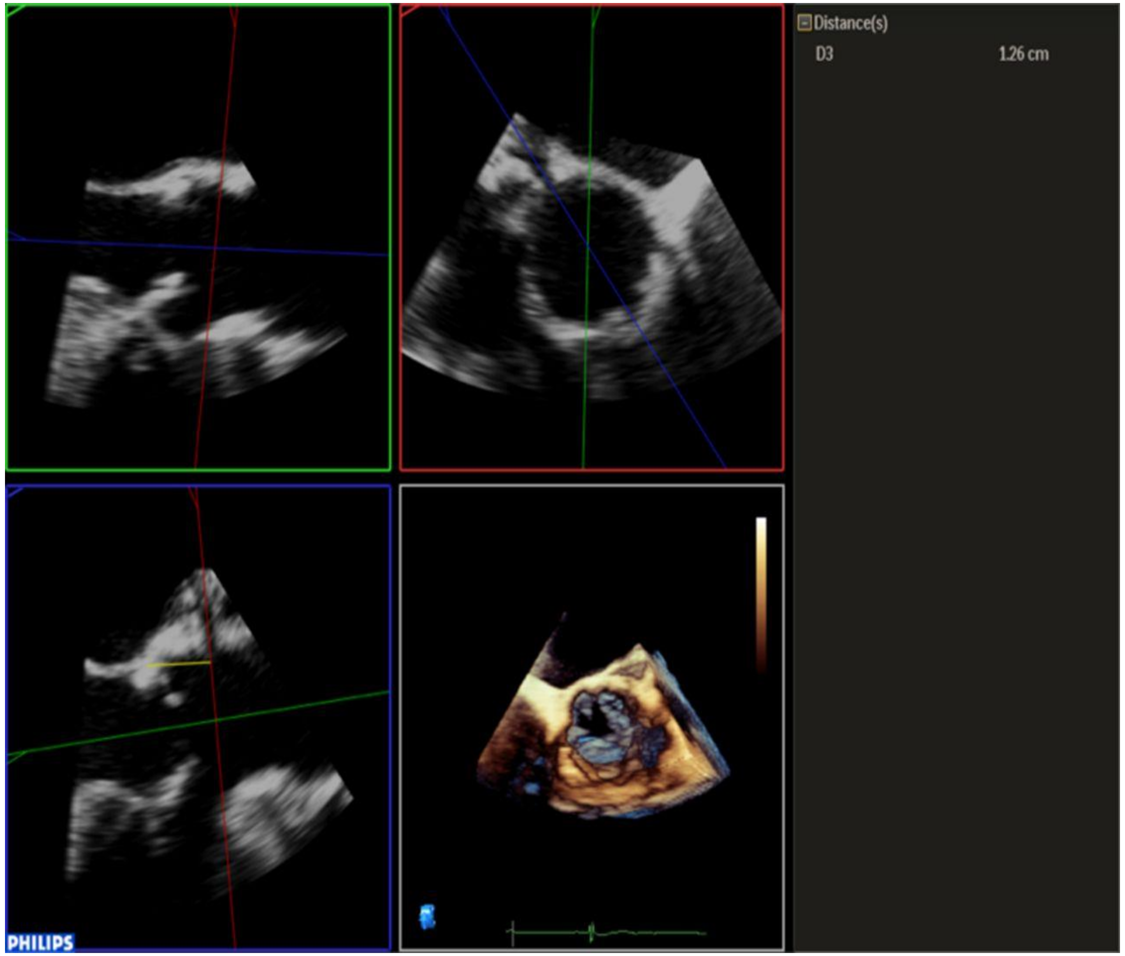
$$P = 4\,(v_{max}^2 - v_{LVOT}^2)$$

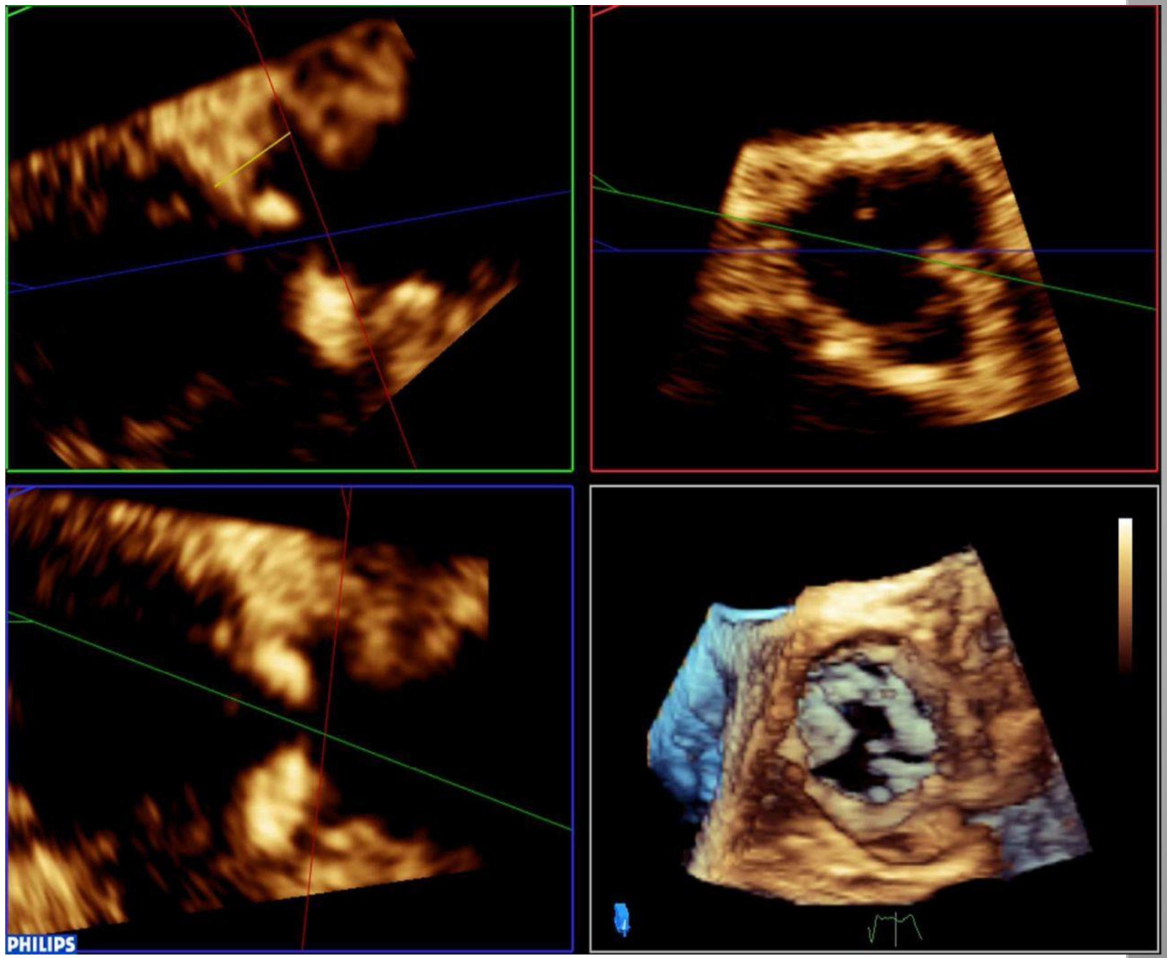


Aortic valve evaluation
the role of echocardiography

- Aortic Valve assessment:
  - AS severity (Valvular Area and Gradient)
  - Calcification distribution, mobility, AR grade
  - Spatial relationship of Calcium and coronary ostia
  - Valvular Morphology (Bicuspid valve)
  - LVOT morphology (septal hypertrophy, ...)
  - Any vegetations or mobile structures
- Measurement of Aortic root diameters
- Annulus, sub-aortic/LVOT, sino-tubular junction

Aortic valve evaluation:
the role of echocardiography





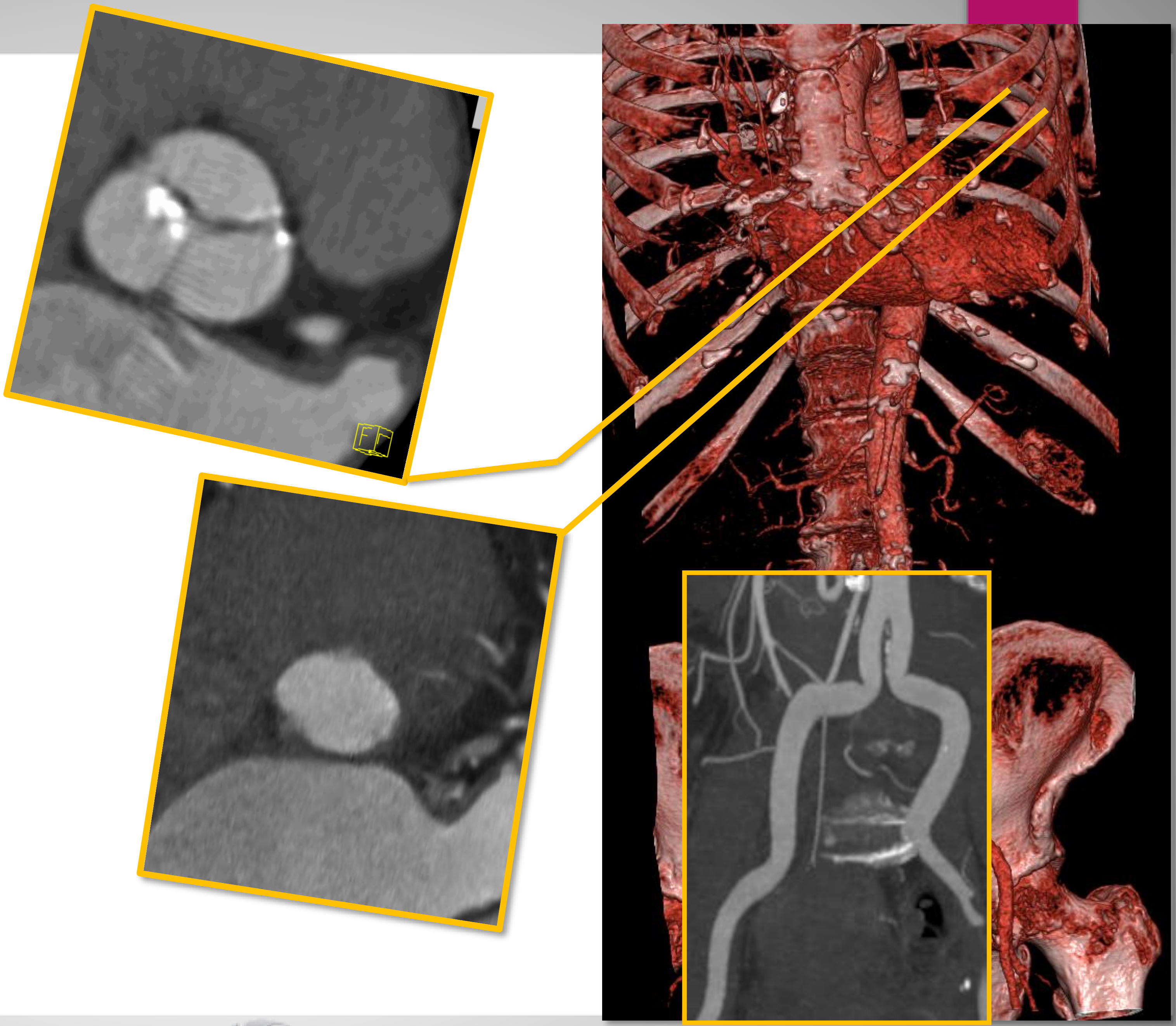
Bleakley C, Eskandari M, Monaghan M. 3D transoesophageal echocardiography in the TAVI sizing arena: should we do it and how do we do it?. *Echo Res Pract*. 2017;4(1):R21–R32. doi:10.1530/ERP-16-0041

CT for TAVI

→ Rapid volume coverage

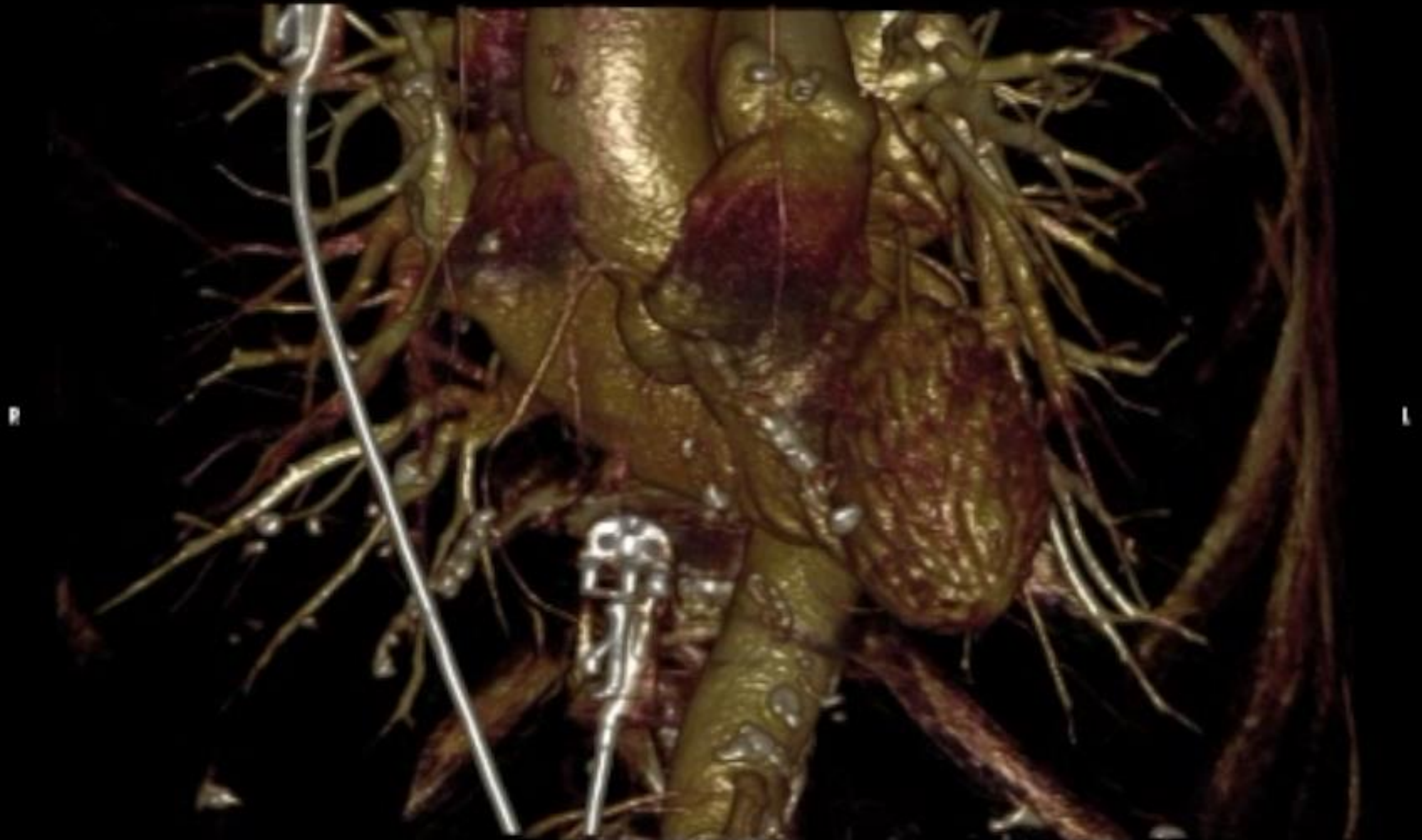
→ High and isotropic spatial resolution

→ Sensitive to calcium



CT PREPROCEDURAL EVALUATION

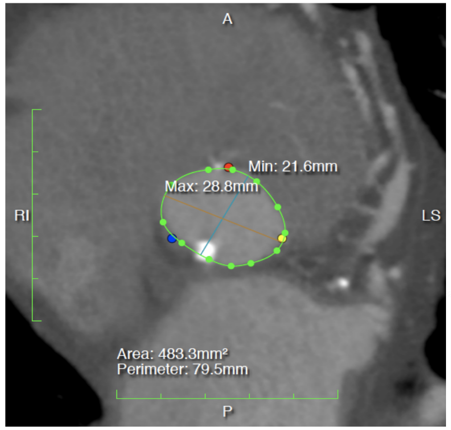
3D Volume Rendering



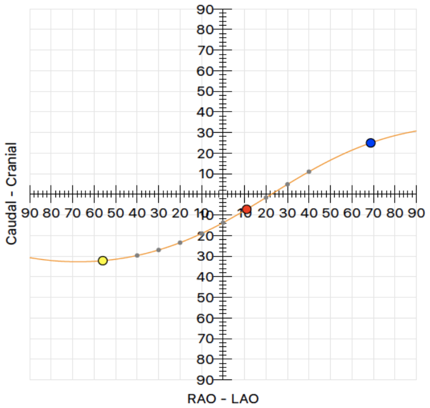
CT TAVI Planning

Date of Birth:	19 mar 1936 (83)	Study Date:	Jan 21, 2019
Patient ID:	550392	Report Date:	Mar 23, 2019

Aortic Annulus Measurements:	
Perimeter:	79.5 mm (⌀ 25.3 mm)
Area:	483.3 mm² (⌀ 24.8 mm)
Excentricity:	0.25 (21.6 x 28.8 mm)
Aortic Angulation:	32.8°
LCA Distance:	15.7 mm
RCA Distance:	21.5 mm
Cusp Calcification:	Mild (1)
LVOT Calcification:	Moderate (2)
Annulus Calcification:	Mild (1)



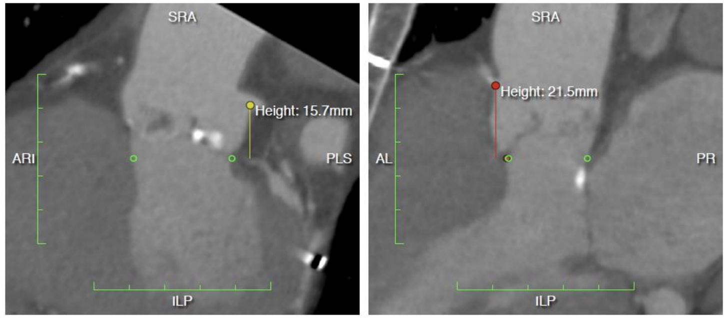
Implantation Plane:	
RCC Anterior:	LAO 11° Caudal 7°
LCC Posterior:	RAO 56° Caudal 32°
NCC Posterior:	LAO 69° Cranial 25°
LV View:	RAO 30° Caudal 27°



Access:	
Planned Access:	TF Left
Pigtail Access:	TF Right

Coronary Arteries:

LCA	RCA

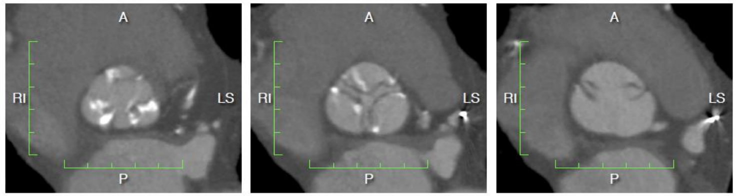


LVOT:

-15 mm	-10 mm	-5 mm

Aortic Valve:

+5 mm	+10 mm	+15 mm



Comments:

AFC sx 6 x 7 calcio posteriore. AFC dx 6 x 6,5 calcio posteriore AIC dx Stenosi placca molle 3,5 x 5,5 mm. AIC sx 7 x 7 mm un po di calcio

Calcio LVOT
SAPIEN 3 ULTRA 26 mm o ACURATE TF L o EVOLUT PRO 29 mm

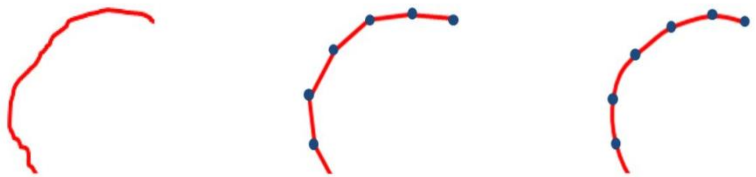
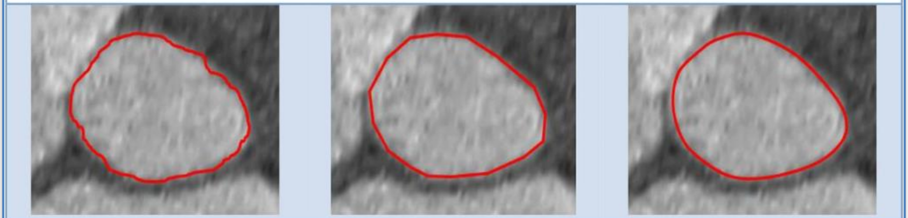
RAO Projection:		LAO Projection:	
40°	Caudal 30°	0°	Caudal 14°
30°	Caudal 27°	10°	Caudal 8°
20°	Caudal 23°	20°	Caudal 2°
10°	Caudal 19°	30°	Cranial 5°
0°	Caudal 14°	40°	Cranial 11°

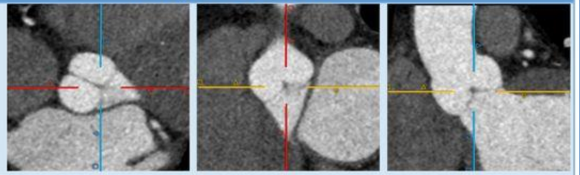
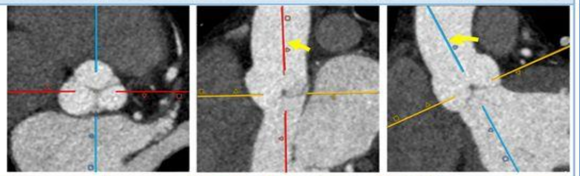
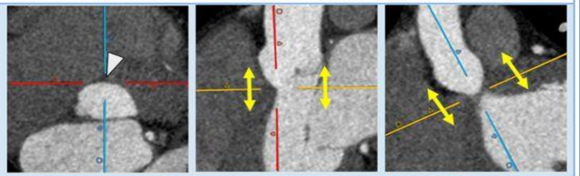
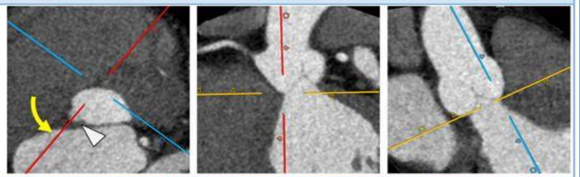
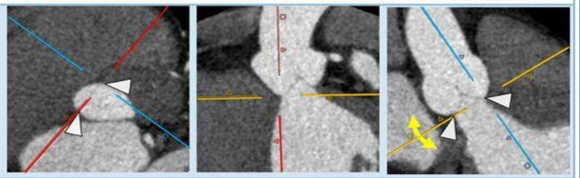
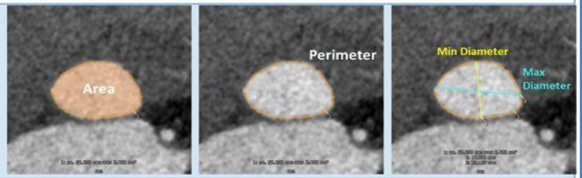
GUIDELINES

Computed Tomography Imaging in the Context of Transcatheter Aortic Valve Implantation (TAVI)/Transcatheter Aortic Valve Replacement (TAVR)

An Expert Consensus Document of the Society of Cardiovascular Computed Tomography

Philipp Blanke, Jonathan R. Weir-McCall, Stephan Achenbach, Victoria Delgado, Jörg Hausleiter, Hasan Jilaihawi, Mohamed Marwan, Bjarne L. Nørgaard, Niccolo Piazza, Paul Schoenhagen and Jonathon A. Leipsic

Freehand tool or Hounsfield-based Contour detection	Polygon	Spline
Non-smoothened, irregular line following path of cursor or detected attenuation threshold	Manual placed segmentation points connected by straight line without interpolation	Manual placed segmentation points connected by a cubic spline interpolation – 'elastic ruler'
		
		
Systematic overestimation of perimeter due to non-smoothened contour; Smoothing algorithms, can allow for more realistic perimeter assessment.	Depending on the number of dots, this may yield a closer estimate of perimeter than freehand contouring without smoothing	Accurate quantification of annular perimeter

Step & Description	Multiplanar reformats
Step 1: Start out with multi-planar images in default axial, sagittal, and coronal orientation; center cross-hairs onto the aortic valve	
Step 2: Align the cross-hairs in the sagittal and coronal views with the long axis of the aortic root; the resulting double oblique transverse view will depict the aortic valve en face.	
Step 3: Move the double oblique transverse plane up and down to identify the lowest insertion point of the right coronary cusp which is usually located at about 1 o´clock. Position the center of the cross-hairs exactly at the most basal insertion point of the right coronary cusp (white arrow head).	
Step 4: Rotate the cross-hairs counter-clock-wise without moving up and down while maintaining its center position so that the formerly coronal view (here red cross-hair) transects the lowest insertion point of the non-coronary cusp, which is located at approximately 8 o´clock (white arrow head).	
Step 5: The formerly coronal, now double-oblique view will show the lowest insertion point both of the right coronary cusp and the non-coronary cusp (white arrow heads). In this view, rotate the (here orange) cross-hair indicating the double-oblique transverse view to transect exactly through the most basal insertion point of the non-coronary cusps. Once this is achieved, the transverse double oblique plane will contain two of the three lowest cusp insertion points.	
Step 6: In the formerly sagittal view, rotate (without moving it) the cross-hair of the transverse double oblique plane (here orange) until the lowest insertion point of the left coronary cusp just barely appears in the double oblique transverse view (white arrow head). Now, the formerly axial plane is exactly aligned with the lowest cusp insertion points of all three aortic cusps and represents both the orientation as well as the level of the annular plane.	
Step 7: Measurements of aortic annulus dimensions should be performed in the annular plane by means of a contouring tool.	

CT for TAVI: DATA

1 Vascular Access

2 Coronary Ostia

3 Annulus Dimensions / Sizing

4 Fluroscopic Angulation

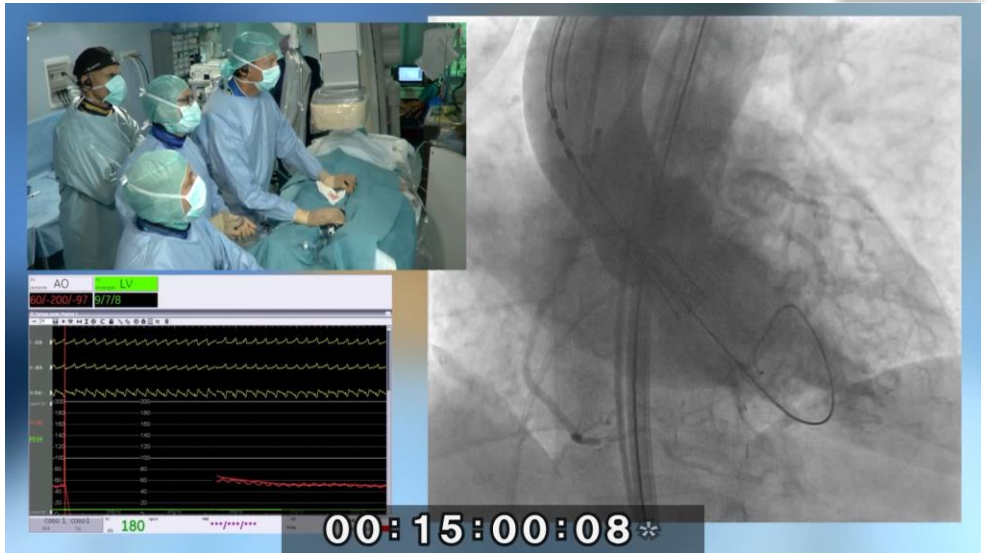
Table 4 Procedural Outcomes

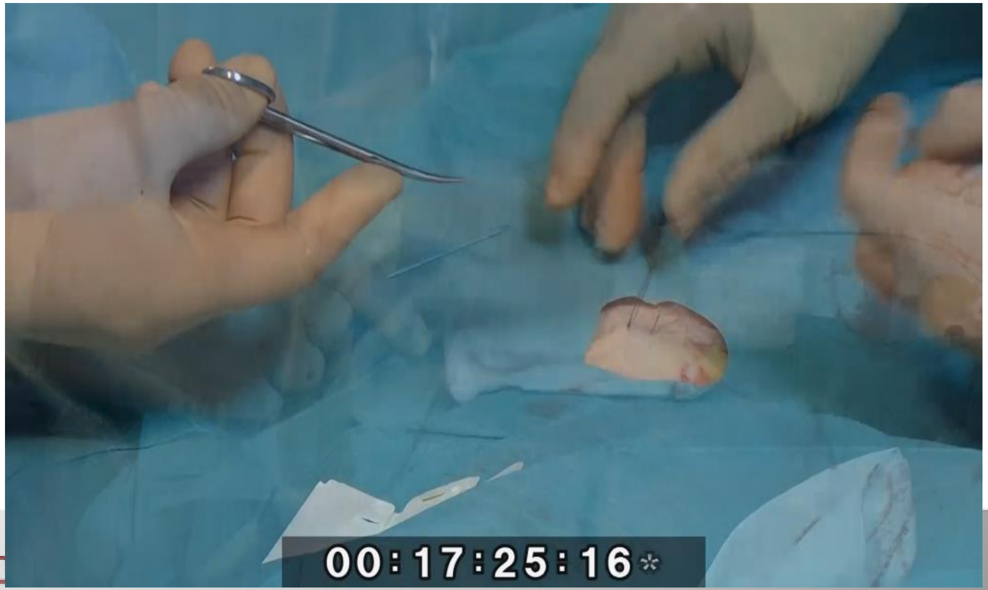
	MDCT Group (n = 133)	Control Group (n = 133)	p Value
Procedural mortality	0 (0)	0.8 (1)	0.316
In-hospital mortality	3.8 (5)	6.8 (9)	0.272
30-day mortality	5.3 (7)	6.8 (9)	0.606
Annular rupture	0.8 (1)	0.8 (1)	1.000
THV embolization	0 (0)	1.5 (2)	0.156
THV-in-THV implantation	0.8 (1)	2.3 (3)	0.314
Procedural myocardial infarction	0.8 (1)	0 (0)	0.316
Post-dilation	12.8 (17)	12.8 (17)	1.000
Permanent pacemaker implantation	8.3 (11)	9 (12)	0.827
Paravalvular regurgitation			
None	27.8 (37)	28.6 (38)	0.892
Mild	66.9 (89)	58.6 (78)	0.163
More than mild	5.3 (7)	12.8 (17)	0.032
Severe	0 (0)	4.5 (6)	0.013

Link
profitable solutions

Binder et al, J Am Coll Cardiol 2013

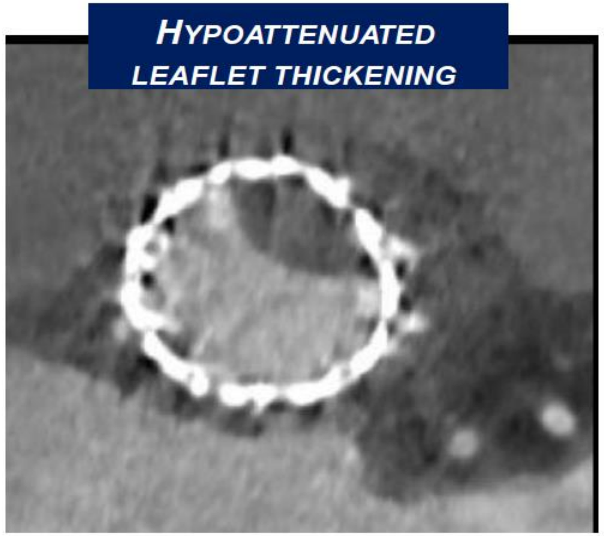
Fluoroscopic intraprocedural guidance

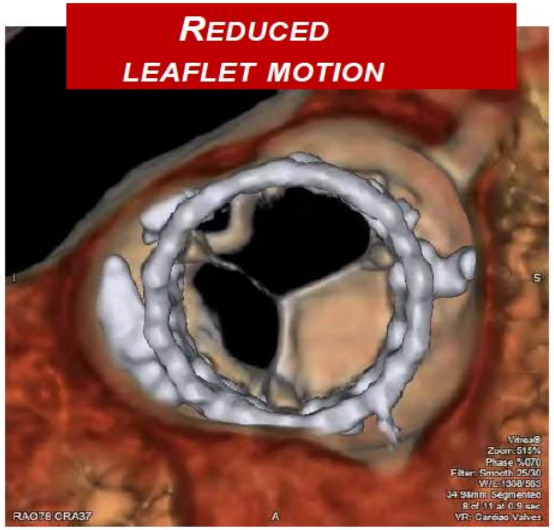




Subclinical leaflet thrombosis in TAVI and SAVR bioprostheses

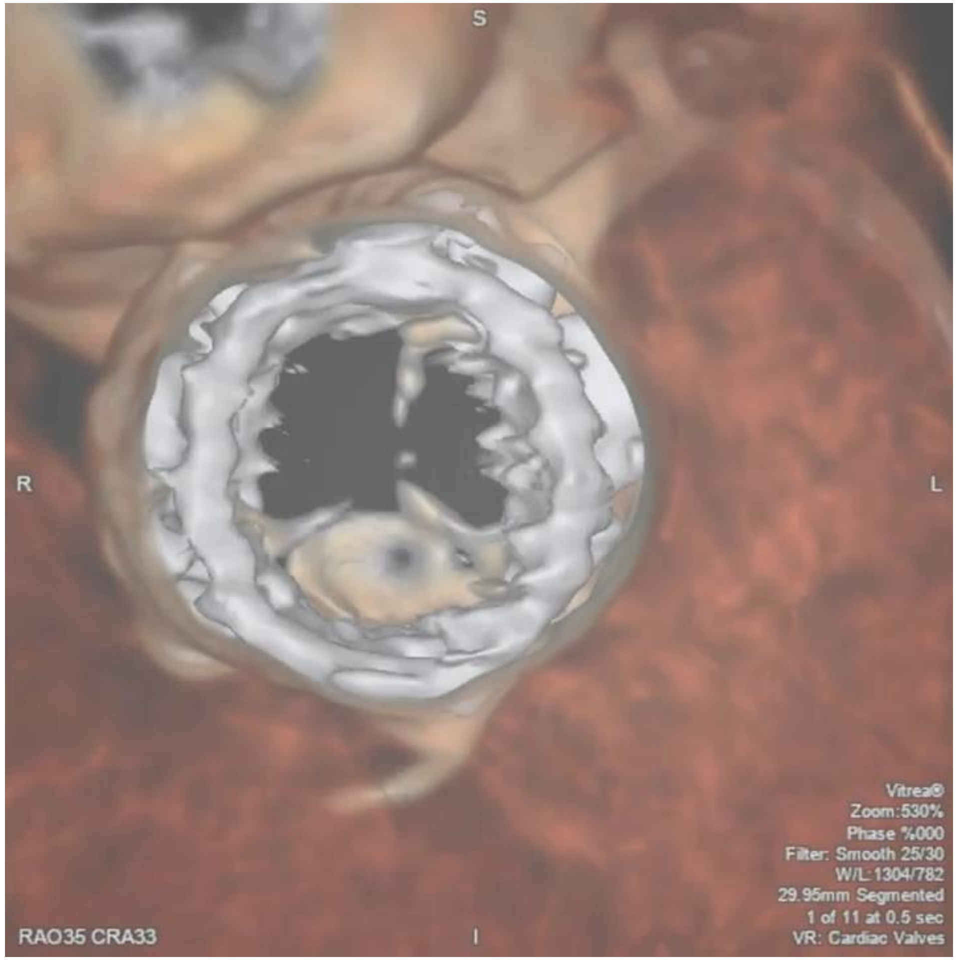
- Reduced leaflet motion (RELM) was found in 40% in the Portico trial and 13% in the registries
- OAC vs DAPT was associated with a lower RELM (0% vs. 55%, P=0.01, in the clinical trial; 0% vs. 29%, P=0.04, in the registries)
- Restoration of leaflet motion in all 11 patients who received OAC
- Higher stroke/TIA in patients with RELM (18% vs 1%, P=0.007, in the registries)

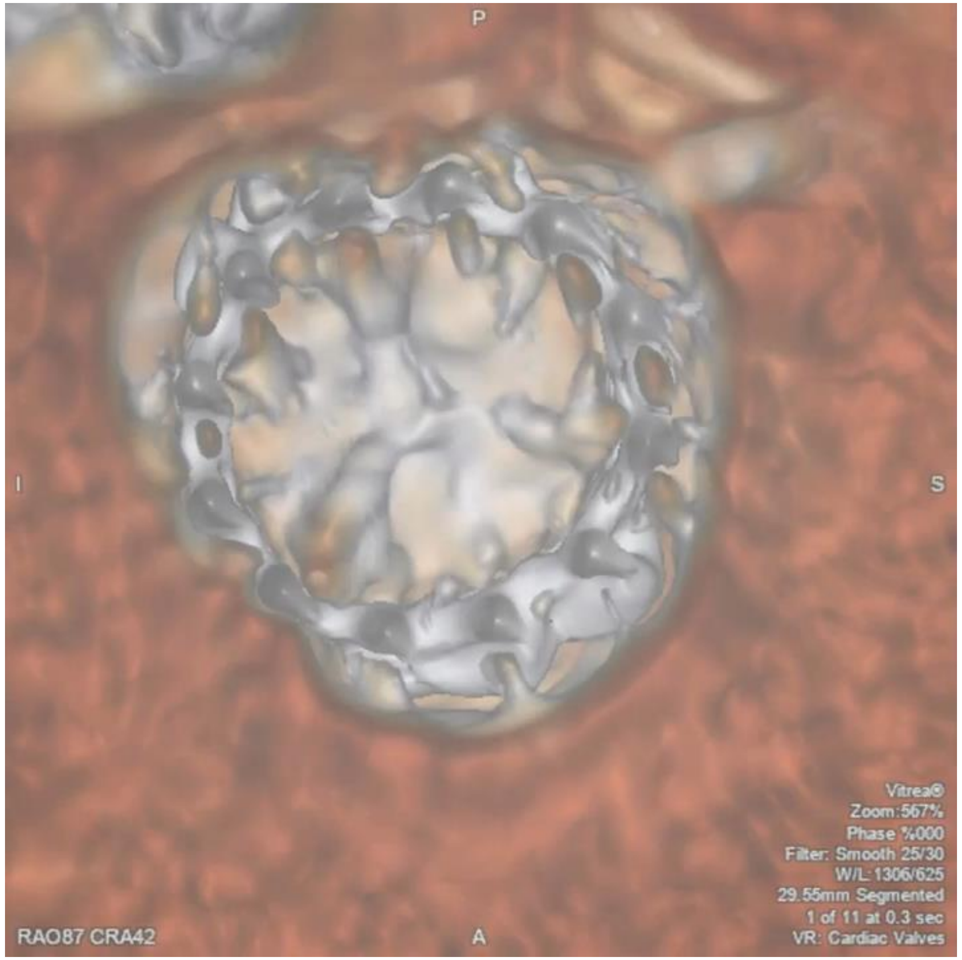




Makkar RR et al. *N Engl J Med* 2015

Moderate and severe RELM

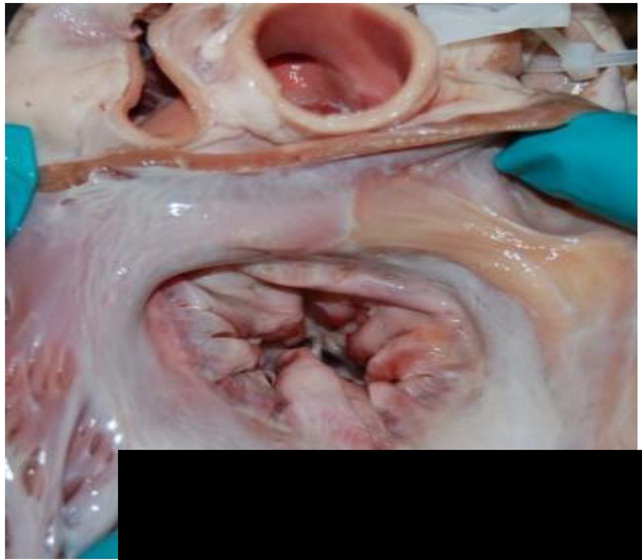


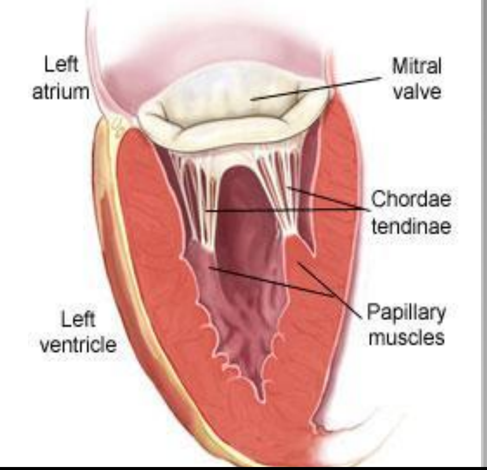


Chakravarty T. Lancet 2017; 389: 2383–92

The Mitral Valve Complex is Complex!

- It’s not round nor “D” shaped – it’s asymmetric
- It’s not flat – it’s saddle-shaped
- Its annulus is not rigid – it’s “dynamic”
- It’s not passive – it contracts, reducing valve area during systole
- It’s a high pressure closure valve, not a high pressure opening valve
- It’s got 24+ chords
- It’s relatively easy to block aortic outflow
- It’s easier to form thrombus on than the AV
- Its annulus changes size as the heart fails
- **MR is not one disease!**



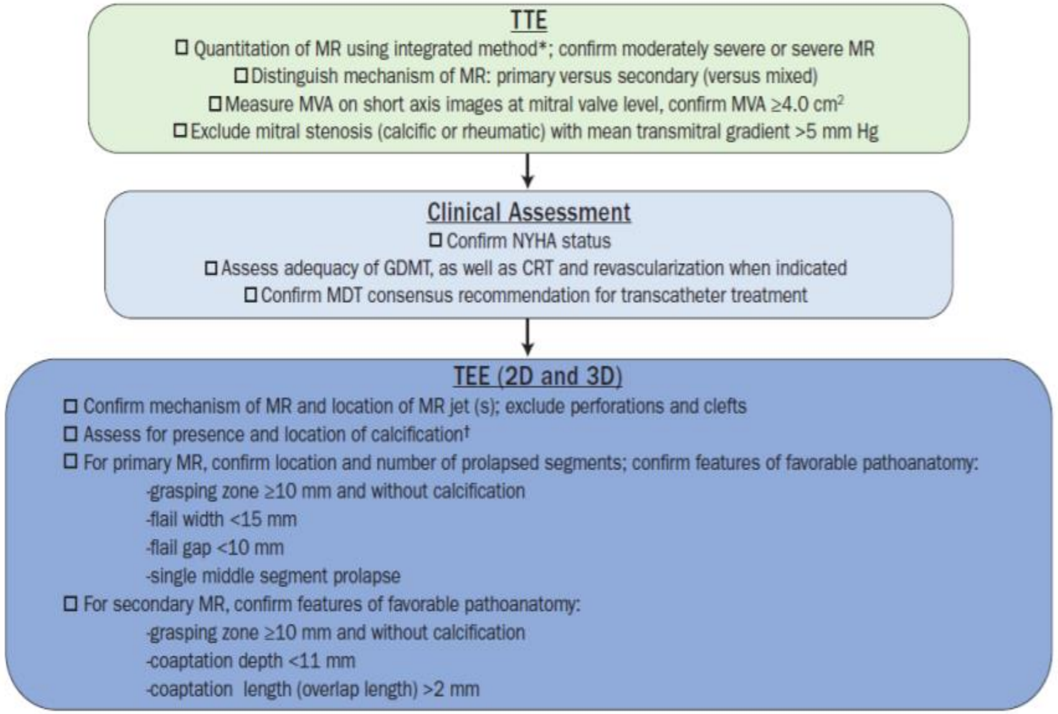


Just Accepted

2020 Focused Update of the 2017 ACC Expert Consensus Decision Pathway on the Management of Mitral Regurgitation

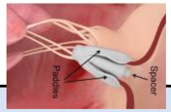
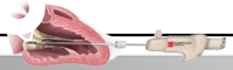
FOCUSED UPDATE WRITING COMMITTEE, Robert O. Bonow, Patrick T. O'Gara, David H. Adams, Vinay Badhwar, Joseph E. Bavaria, Sammy Elmariah, Judy W. Hung, JoAnn Lindenfeld, Alanna A. Morris, Ruby Satpathy, Brian Whisenant and Y. Joseph Woo

Figure 12. Algorithm for Determining Eligibility for Transcatheter MV Intervention

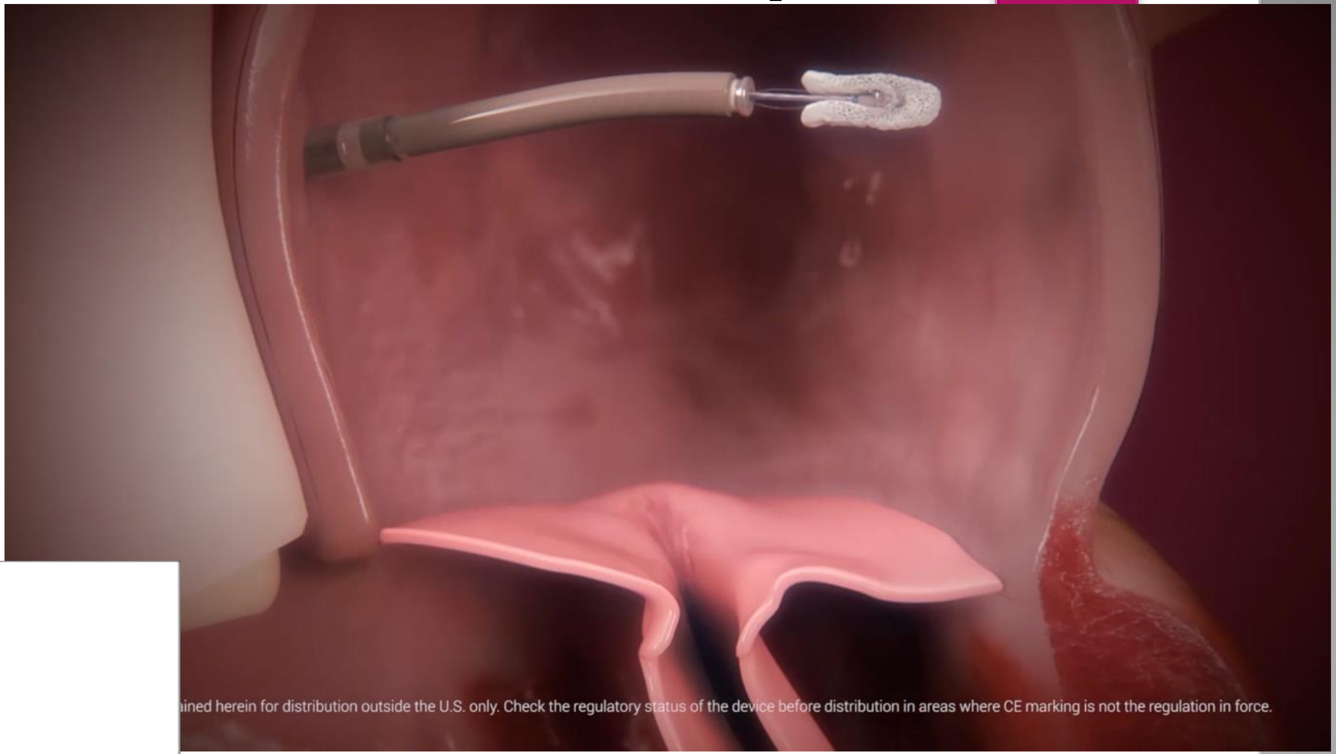


Transcatheter Repair Devices

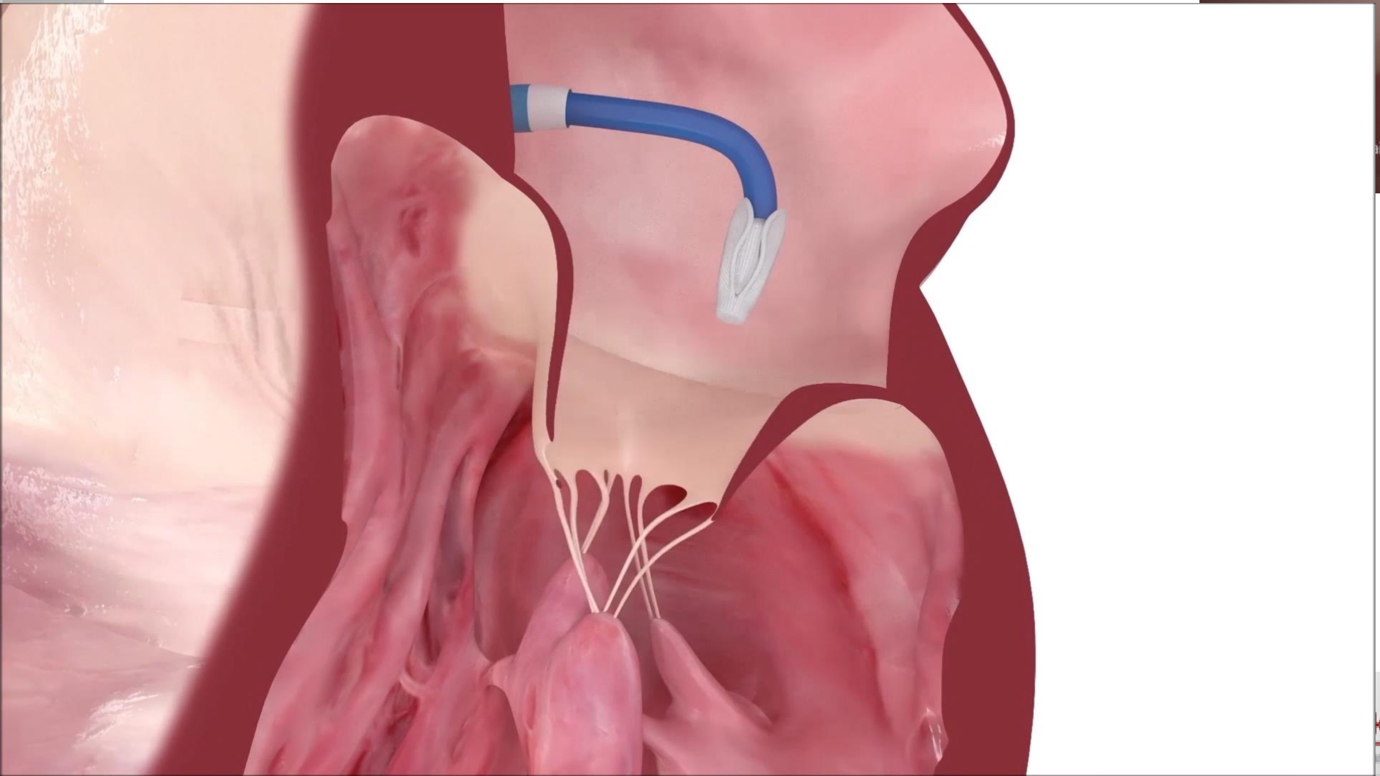
TMVr targets MV leaflets, chordal apparatus, and mitral annulus.
These devices show good safety outcomes, but improvements in ease of use and efficacy are required.

Anatomic Target	Device	Description	Main Indications	Status	Reported # of Treated Patients
Mitral Leaflets  	MitraClip	Edge-to-Edge	Primary and Secondary MR	FDA Approved CE Mark	>80,000
	Pascal	Edge-to-Edge	Primary and Secondary MR	CE Mark	2500
  	Carillon	Coronary Sinus cinching	Secondary MR	CE Mark	>1000
	Cardioband	Direct annuloplasty	Secondary MR	CE Mark	>500
	Millipede	Direct annuloplasty	Secondary MR	-	>65
Chordal A… s  	NeoChord	Artificial chordal implantation	Posterior leaflet flail/prolapse	CE Mark	>1100
	Harpoon	Artificial chordal implantation	Posterior leaflet flail/prolapse	-	>65

Mitraclip

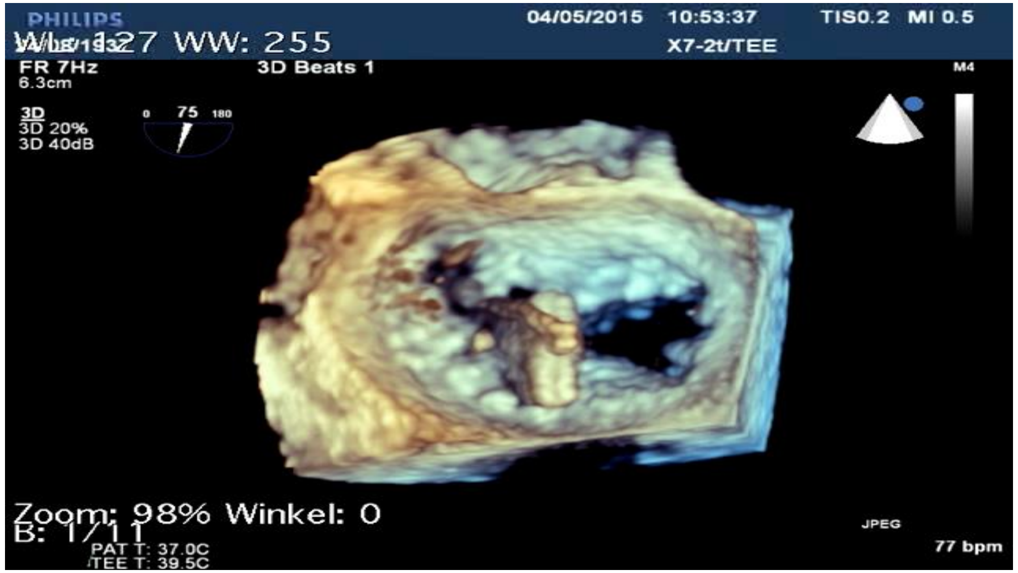


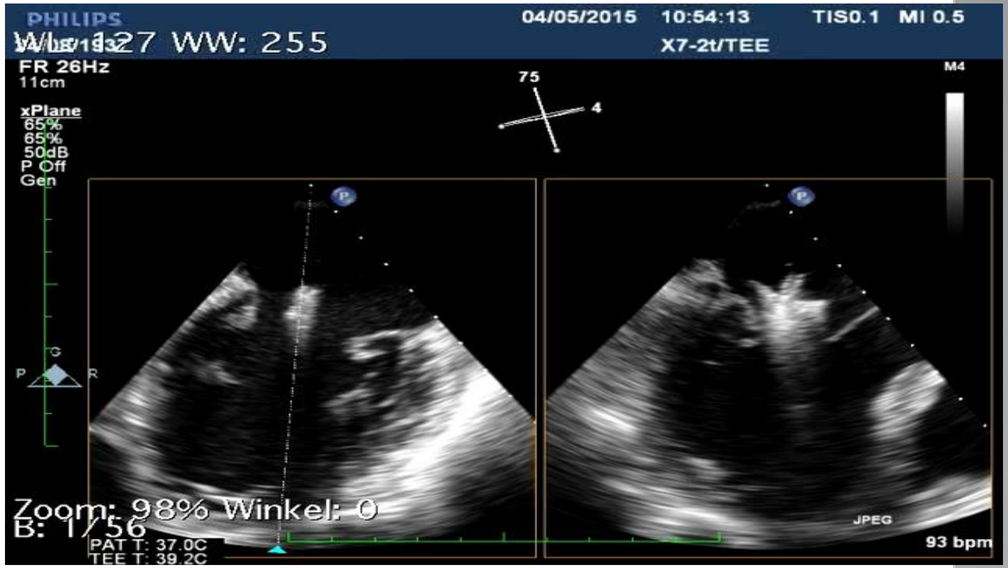
PASCAL



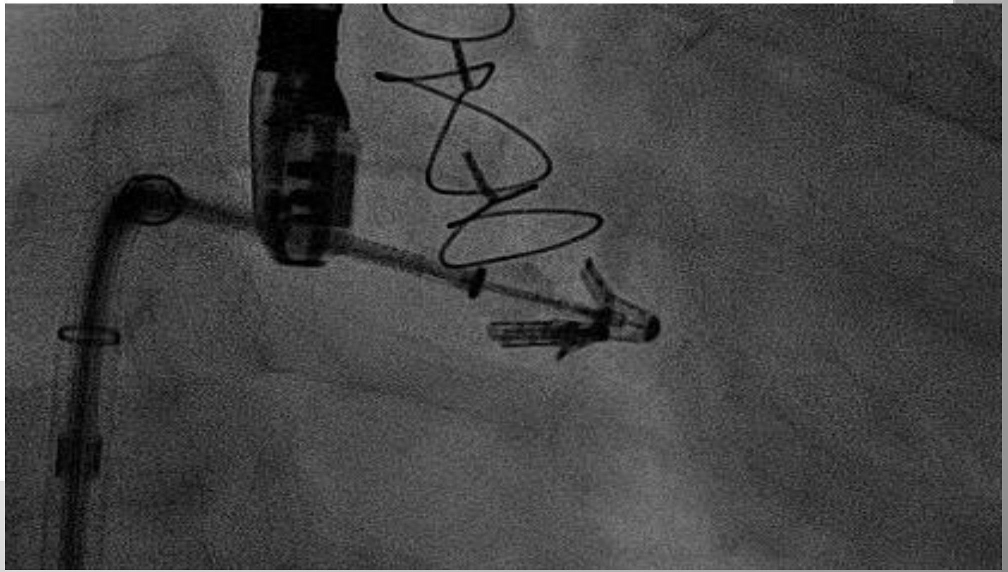
Mitraclip

- First

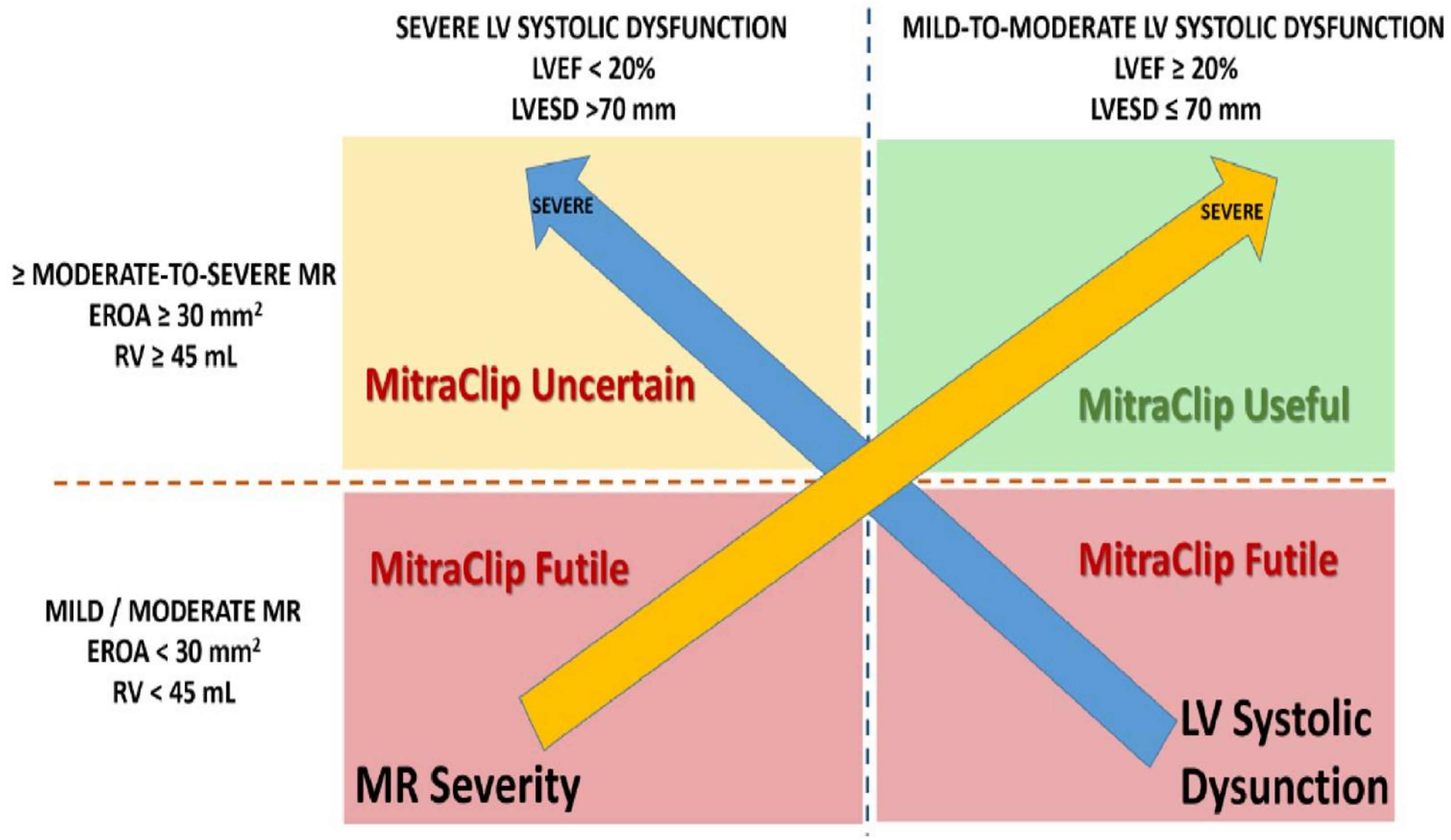




- Second



Utility vs. futility of MitraClip procedure according to severity of MR and LV systolic dysfunction

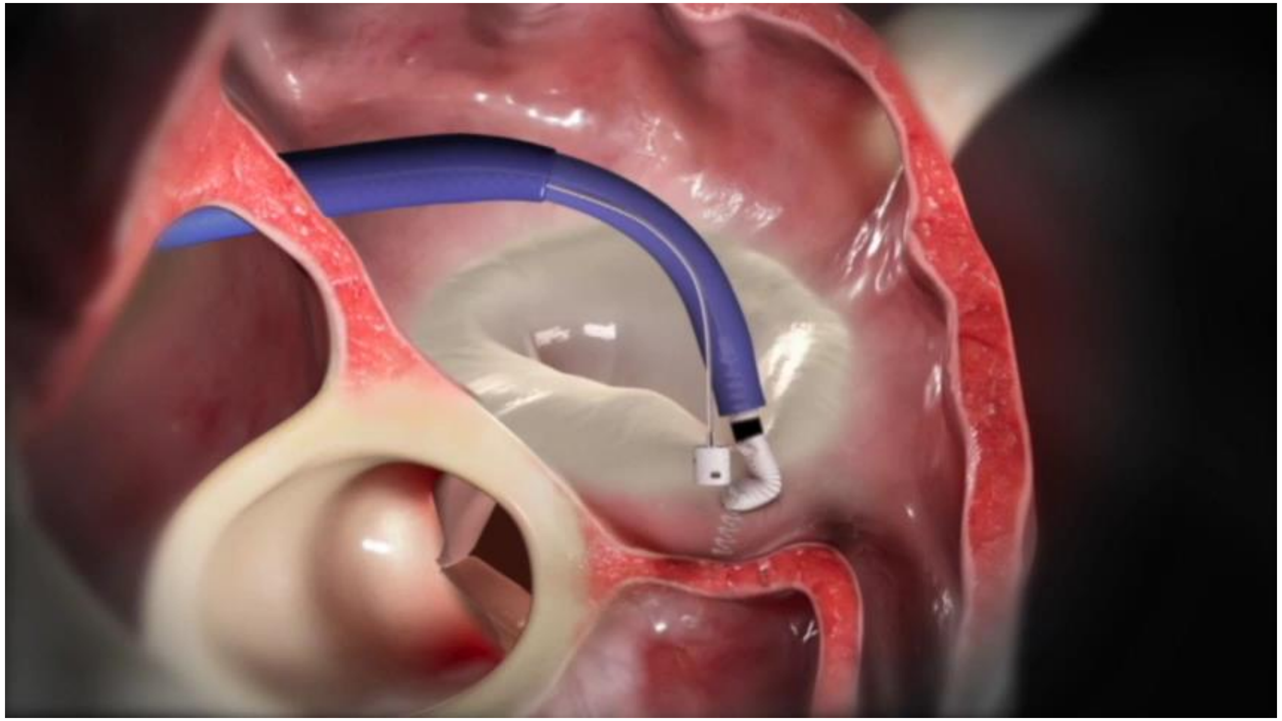


Pibarot, Philippe et al. "MITRA-FR vs. COAPT: lessons from two trials with diametrically opposed results." *European heart journal cardiovascular Imaging* (2019).

Direct Annuloplasty by Cardioband

500 patients treated

- **Trans-femoral venous access (transeptal)** – best for safety
- **Supraannular fixation** like in surgery
- **Significant Reduction of Annular dimensions –** device enables reduction of up to size 28 surgical ring
- Preserves the native anatomy – **keeps future options open**

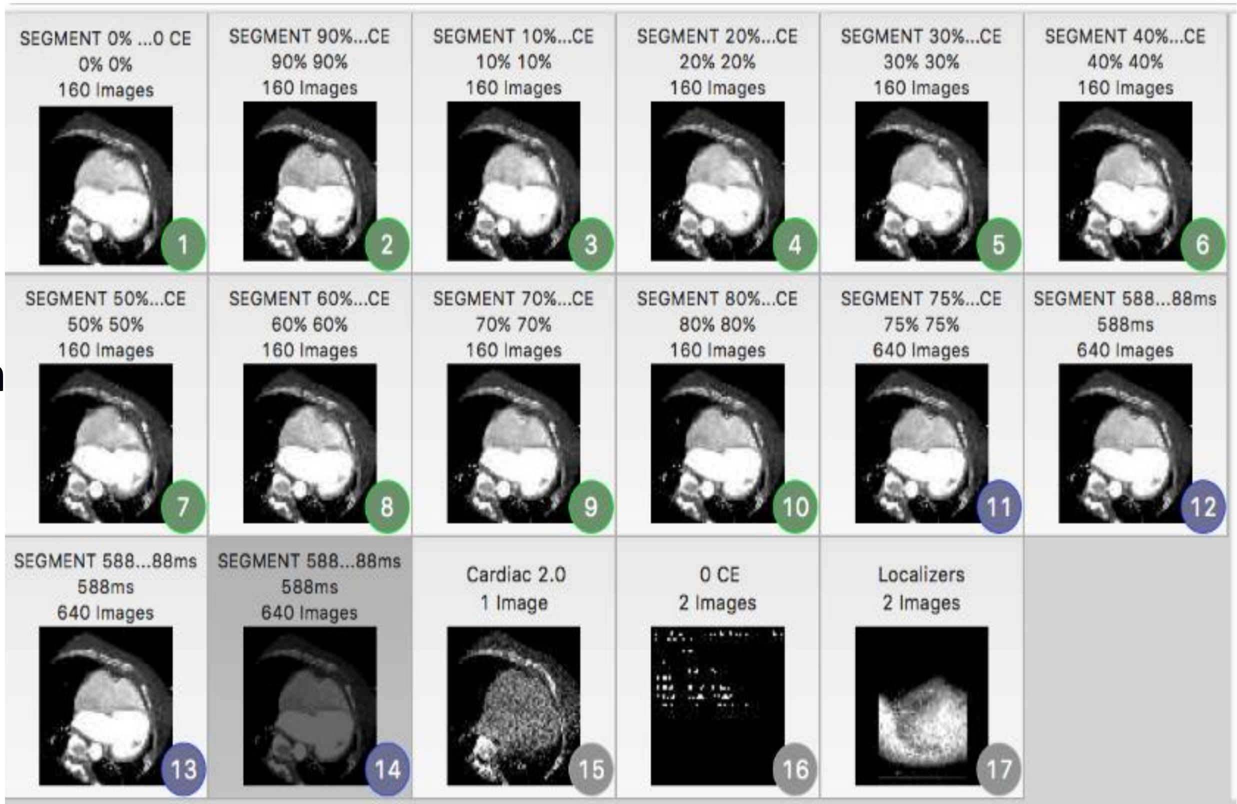


Direct Annuloplasty by Cardioband

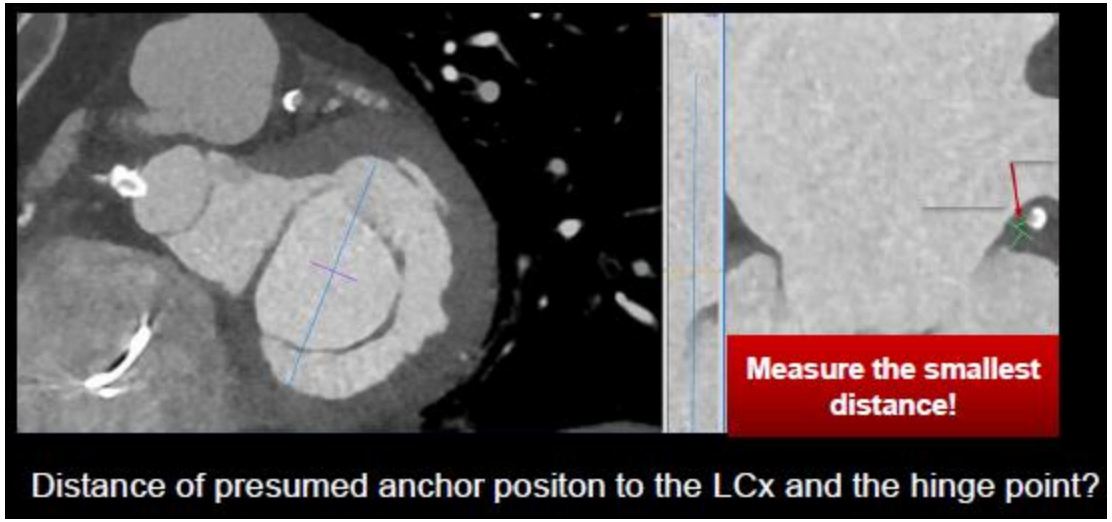
- **Trans-femoral venous access (transeptal)** – best for safety
- **Supraannular fixation** like in surgery
- **Significant Reduction of Annular dimensions –** device enables reduction of up to size 28 surgical ring
- Preserves the native anatomy – **keeps future options open**

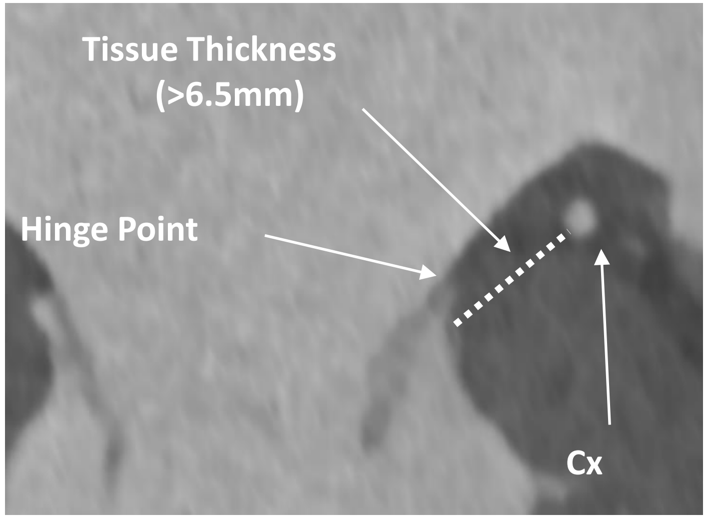
Cardioband Preprocedural imaging: CT

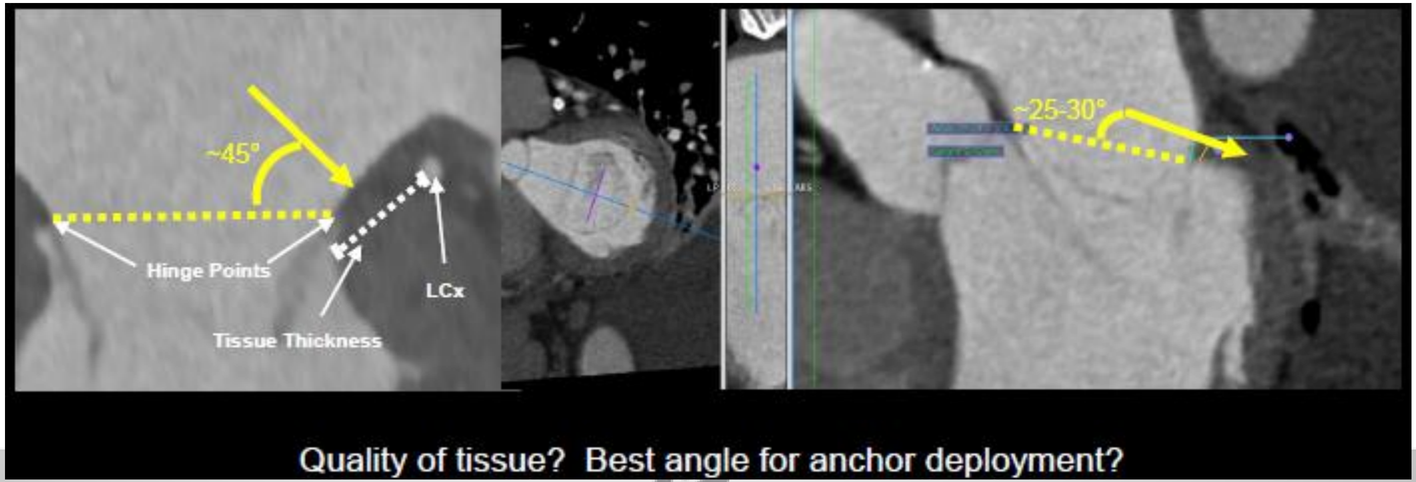
- Procedural Planning
- Mitral annulus measurement
- No significant mitral annulus calcification
- LCx and CS distance/hinge point/angle for anch deployment
- TS puncture (see beyond)
- Need for high CT quality



LCx distance/hinge point/angle for anchor deployment

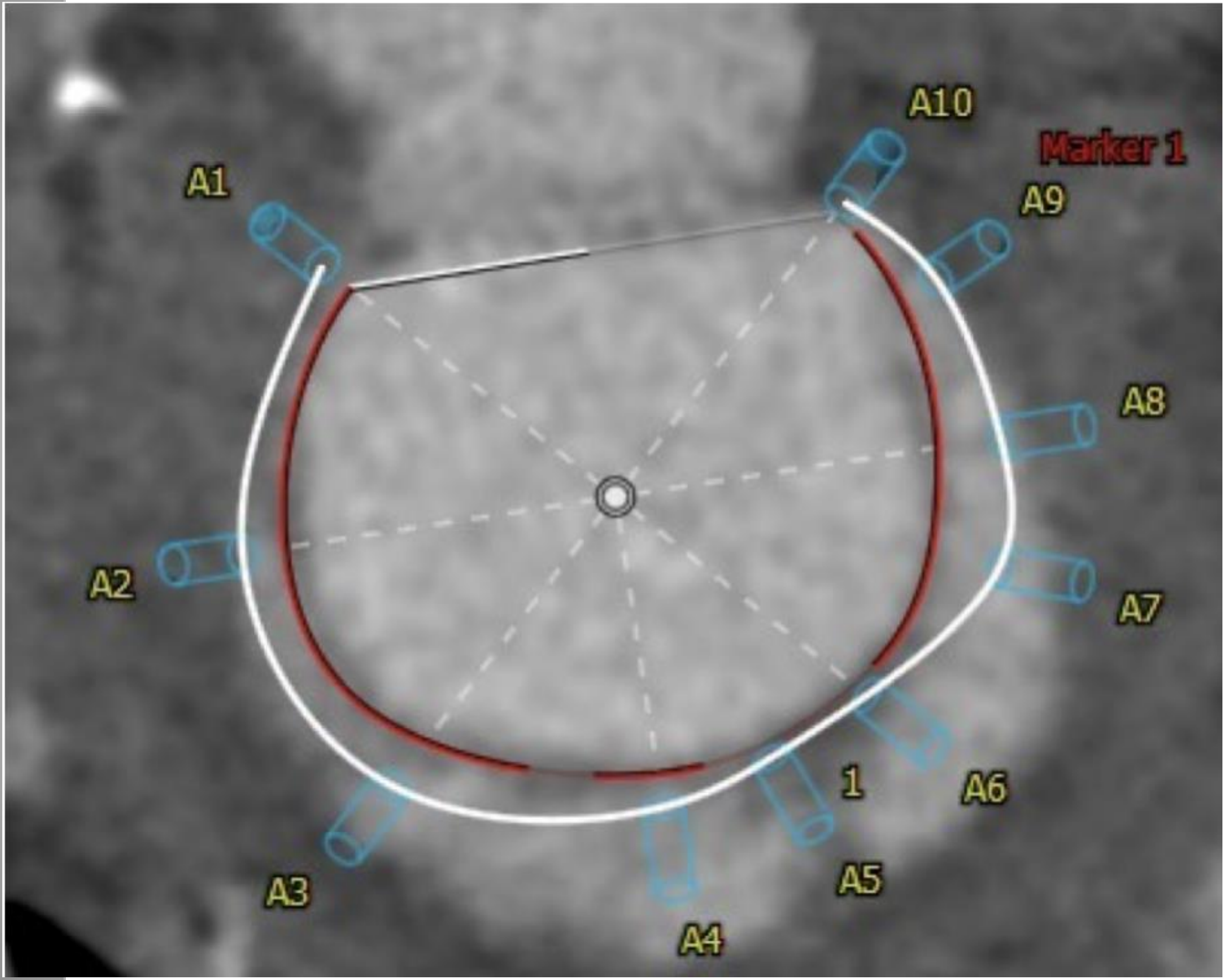


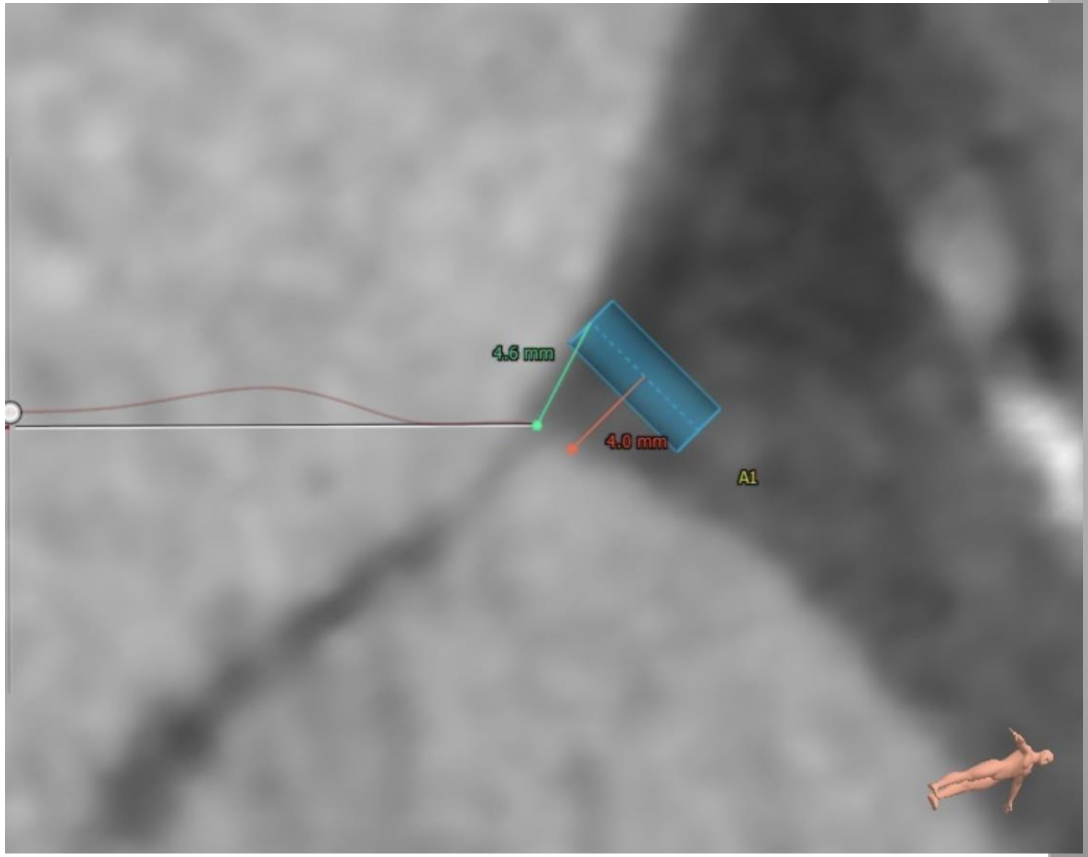




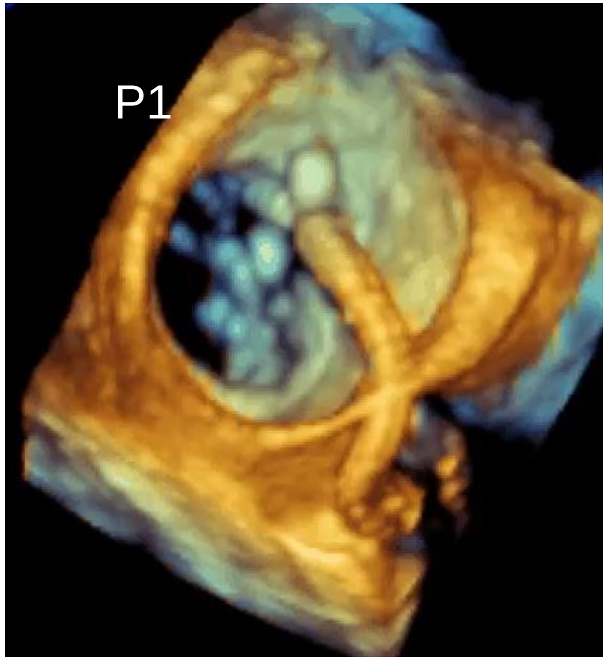
Link
profitable solutions

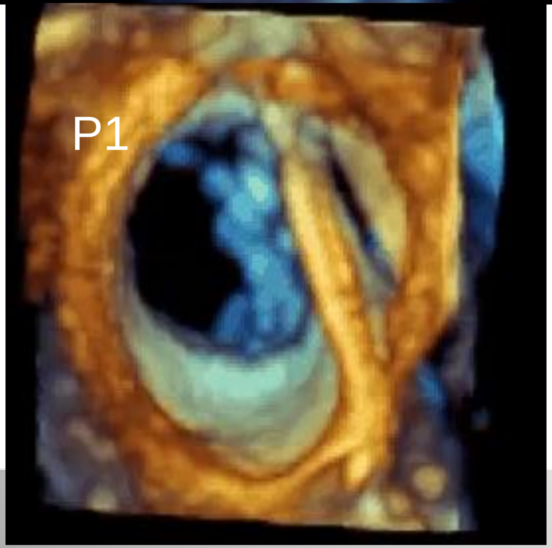
Cardioband Preprocedural imaging: CT





3D TEE views for different regions



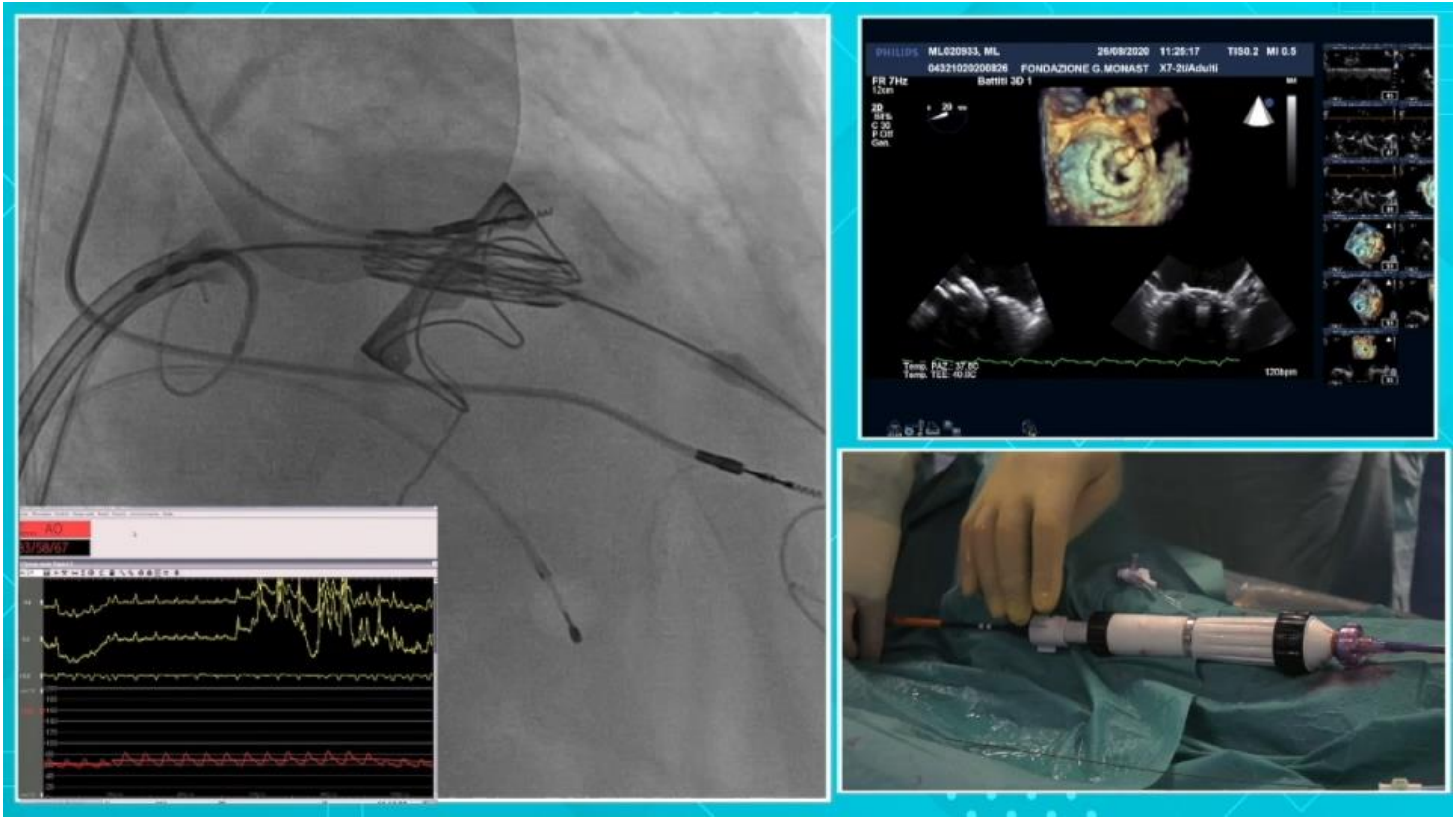


Cardioband-procedural steps

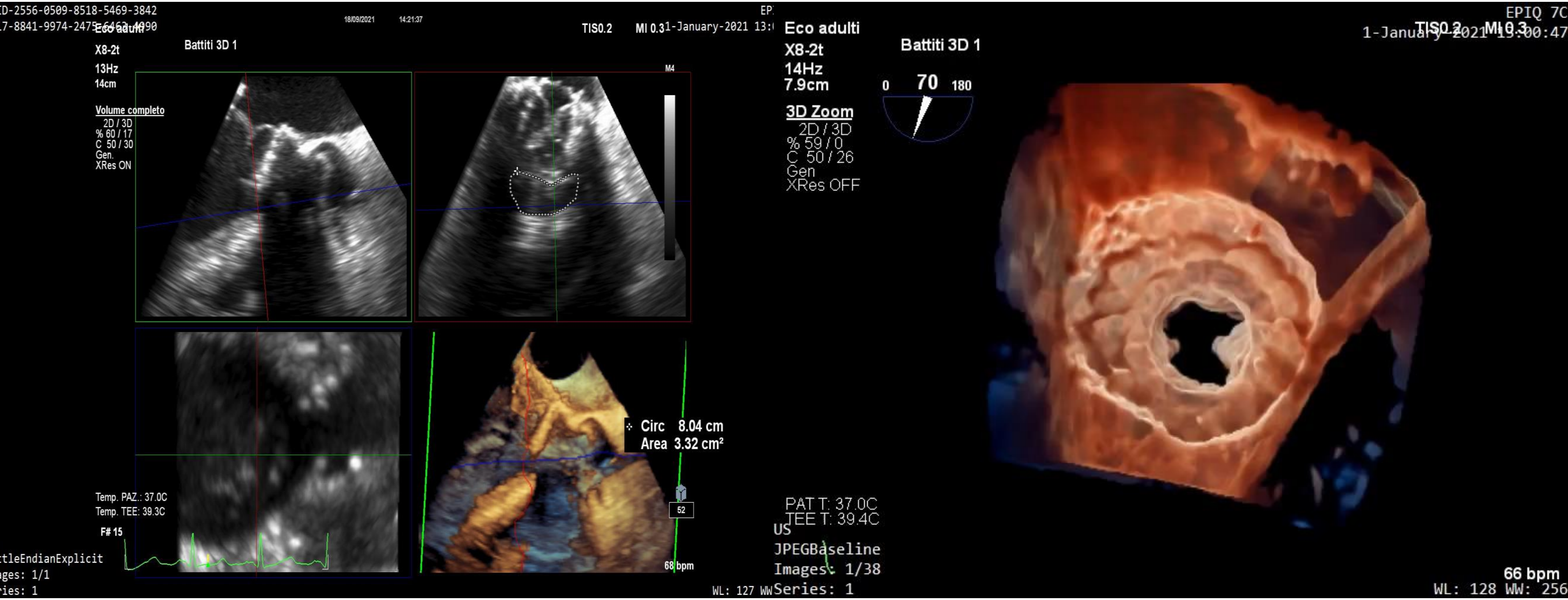
Imaging modalities used during different procedural steps

- Access
  - Femoral vein
  - Transseptal puncture — **Echo**/ Fluoro
- Transseptal sheath (TSS) positioning — Echo/ Flouro
- Guide catheter (GC) positioning at the landing zone for the 1st anchor — **Echo/ Fluoro**
- Navigation of the GC/device deployment — **Echo/ Fluoro**
- Size adjustment and evaluation of final result (Annular dimensions/ MR grade) — **Echo/ Flouro**

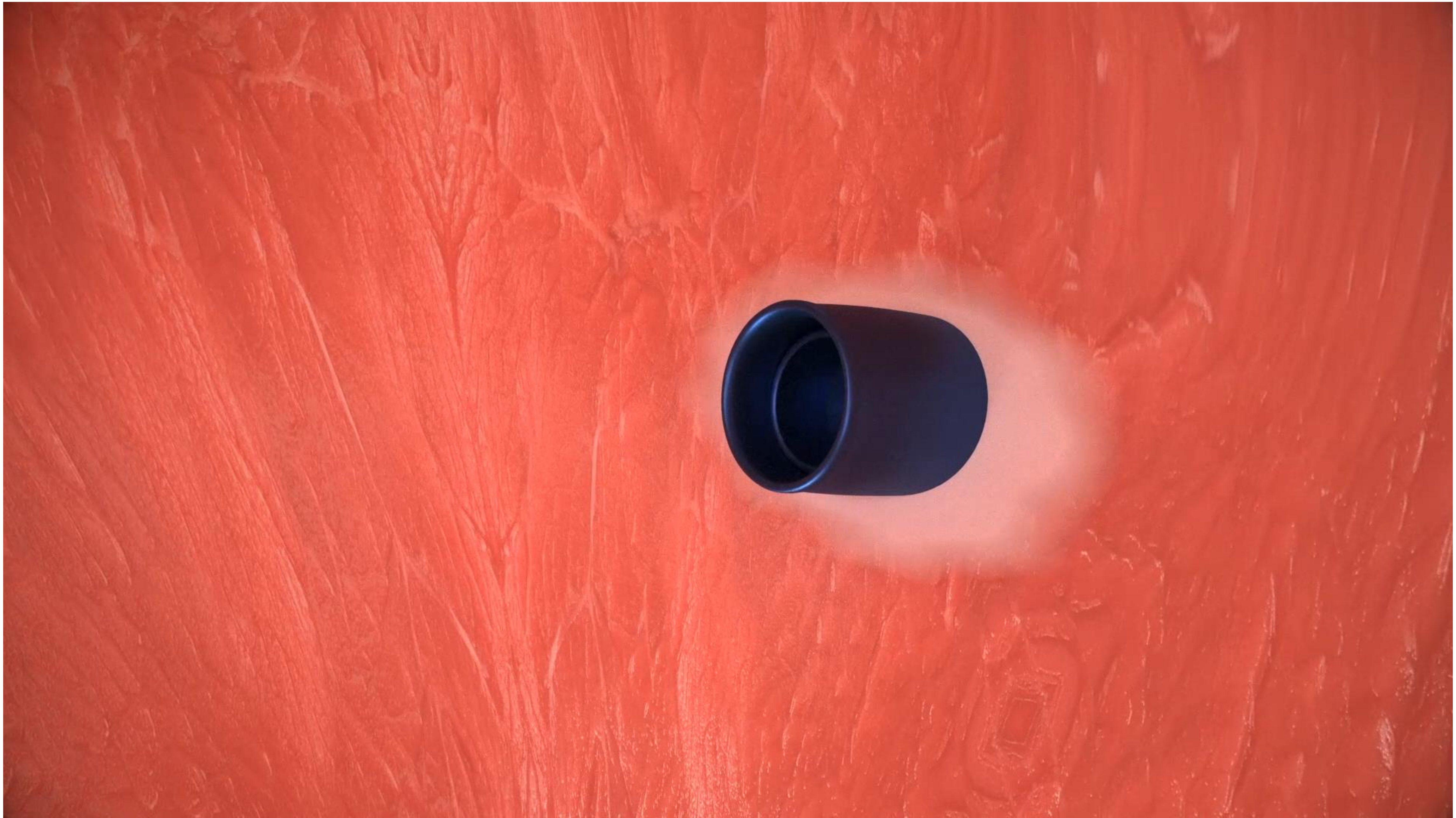
Transseptal Mitral Valve in Valve



Transseptal Mitral Valve in Valve

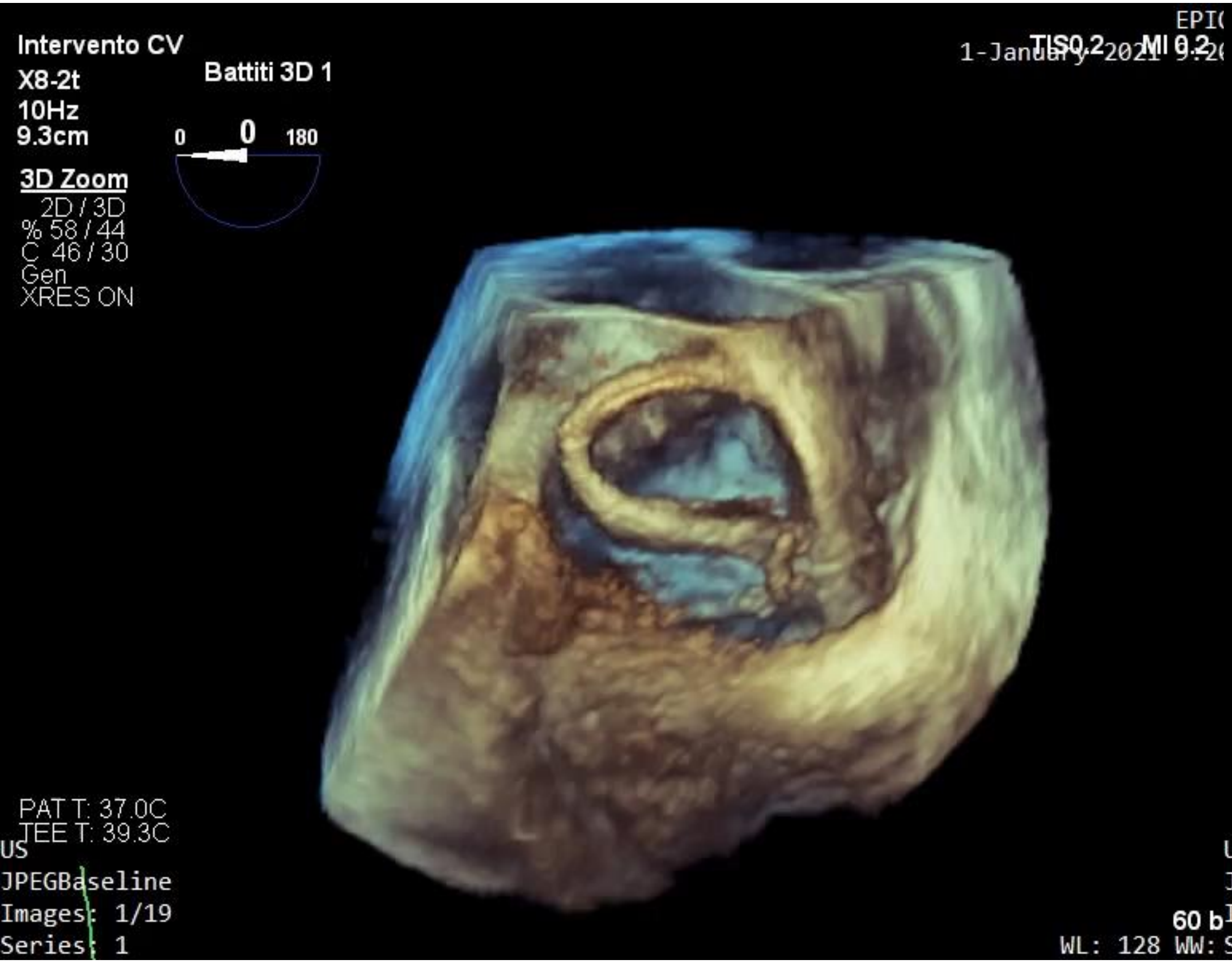


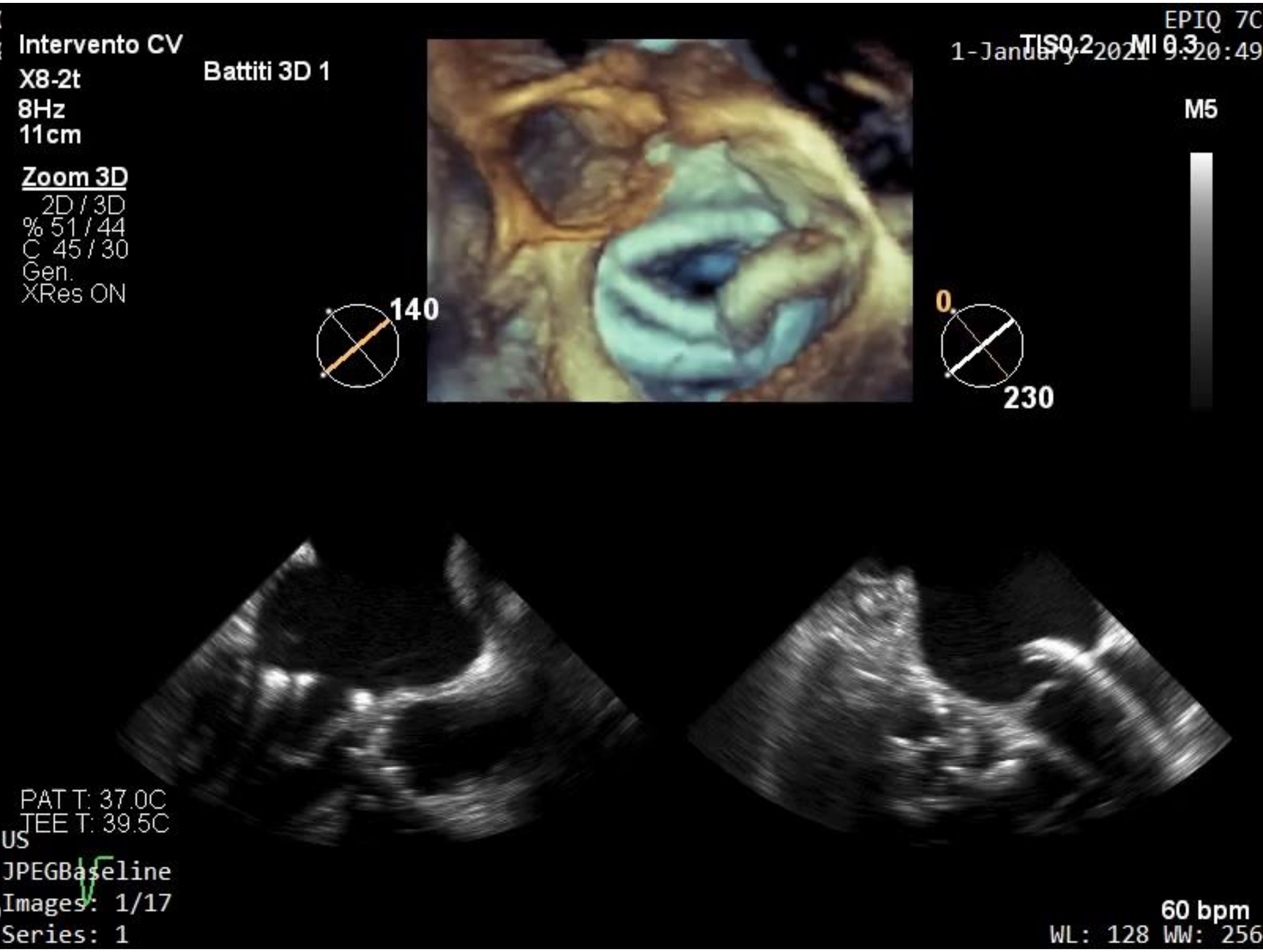
Valcare Amend direct Transseptal Mitral Anuloplasty



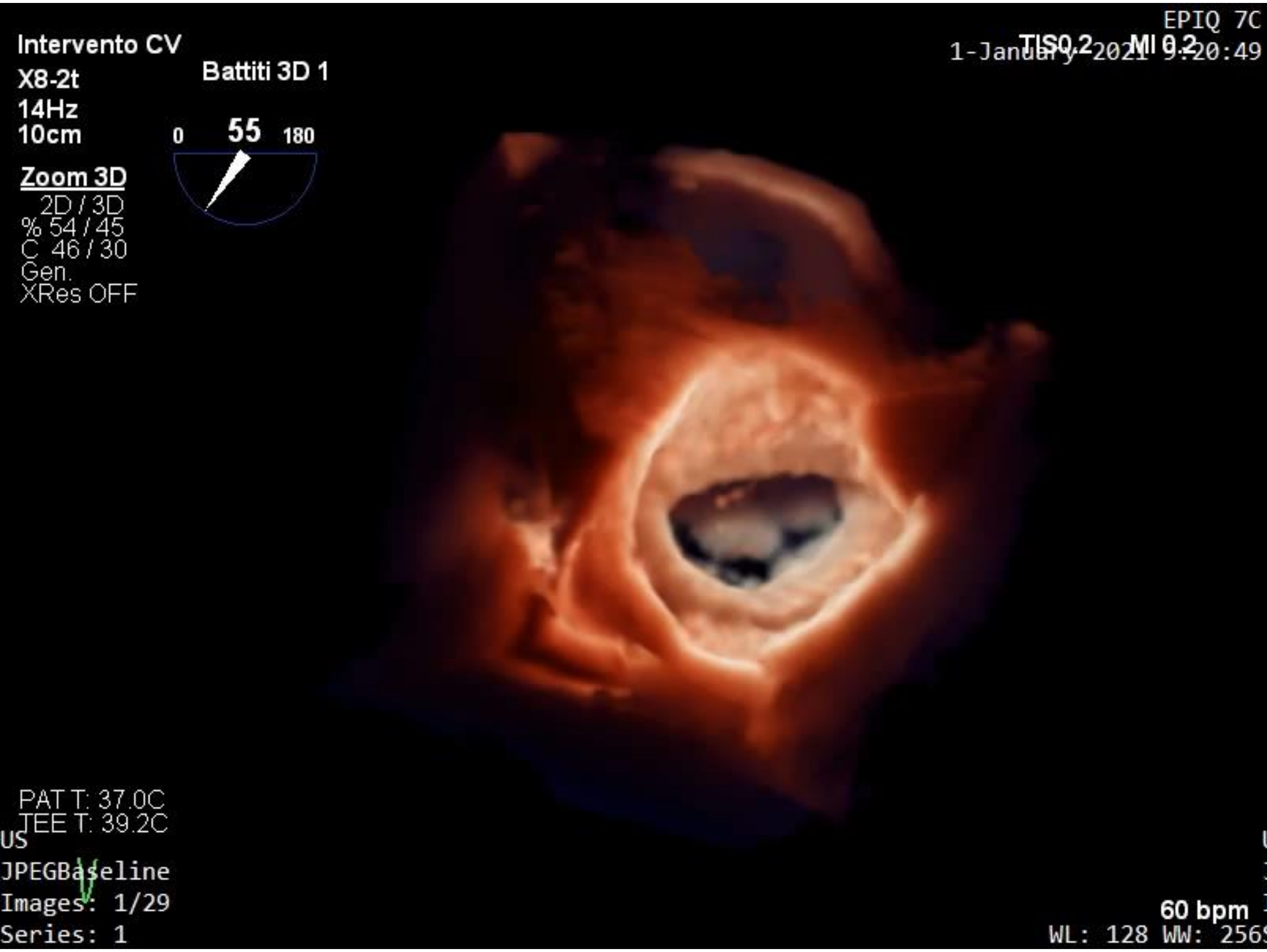
Valcare Amend direct Transseptal Mitral Anuloplasty:

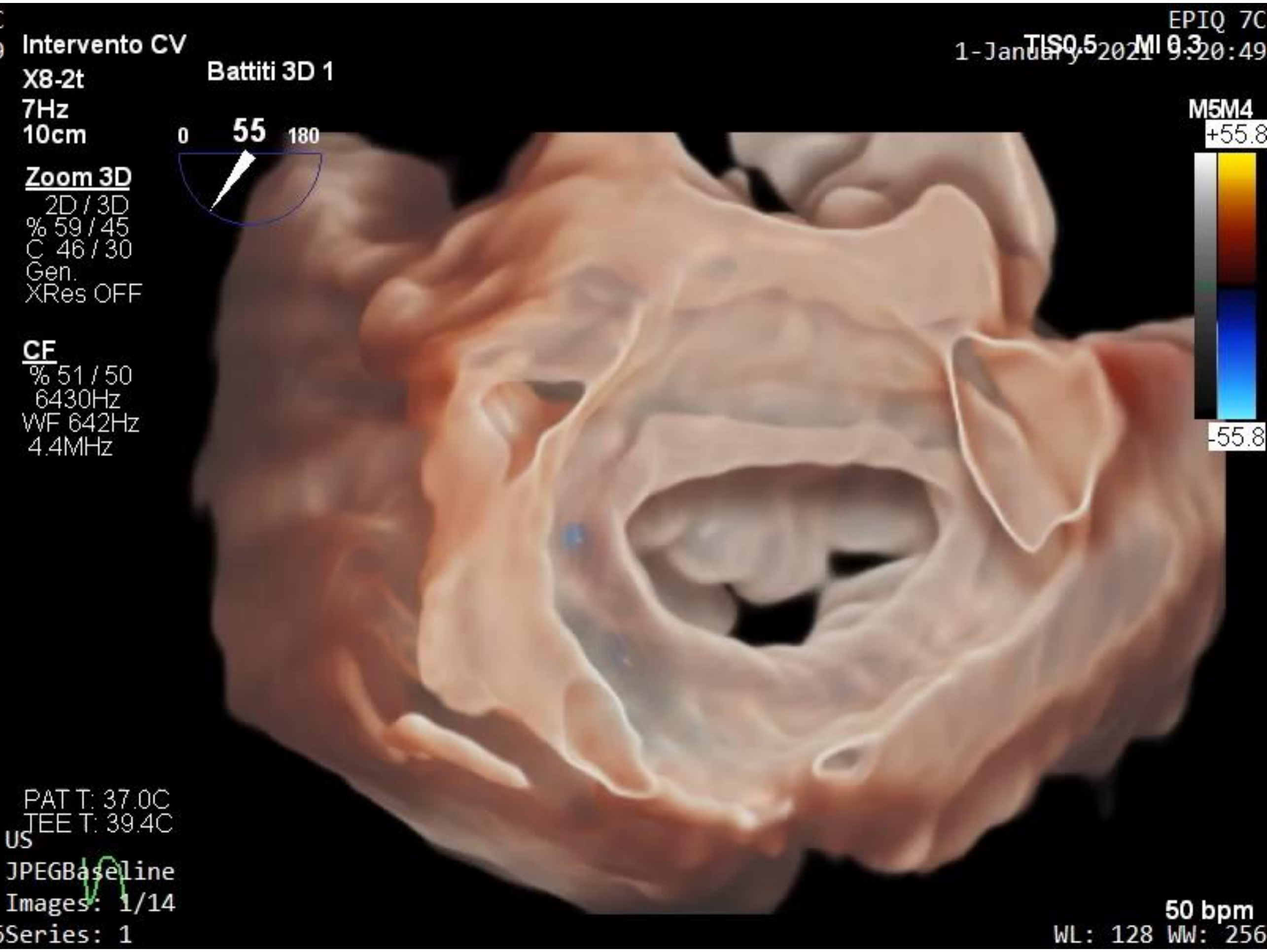
intraoperative TEE guidance



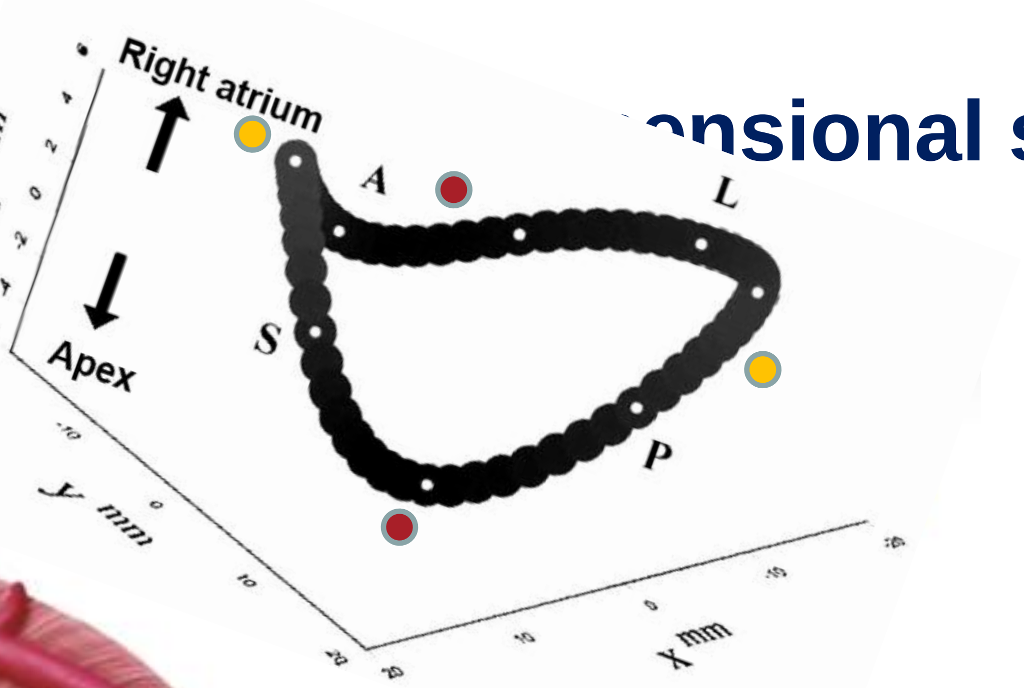


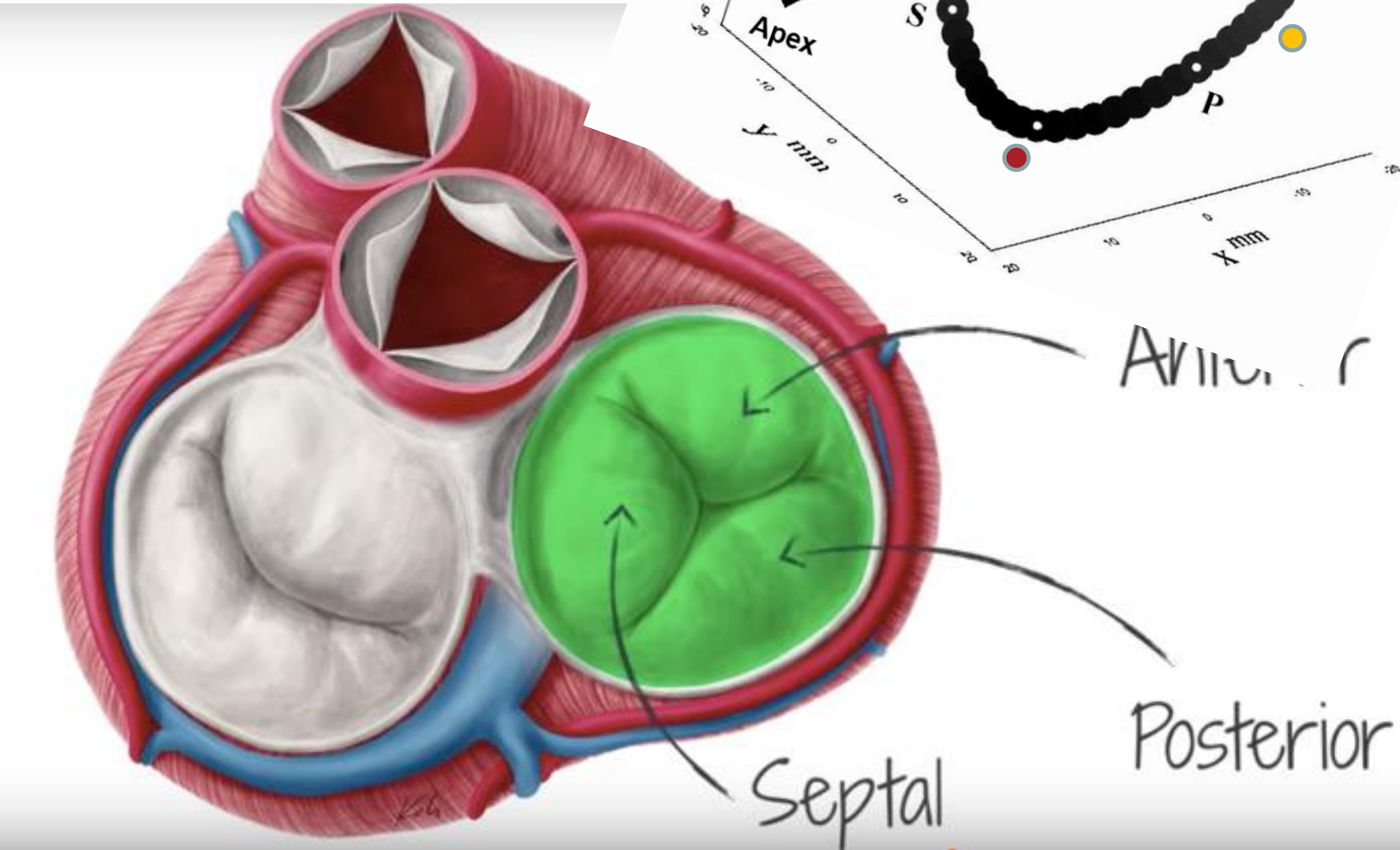
Valcare Amend direct Transseptal Mitral Anuloplasty: results

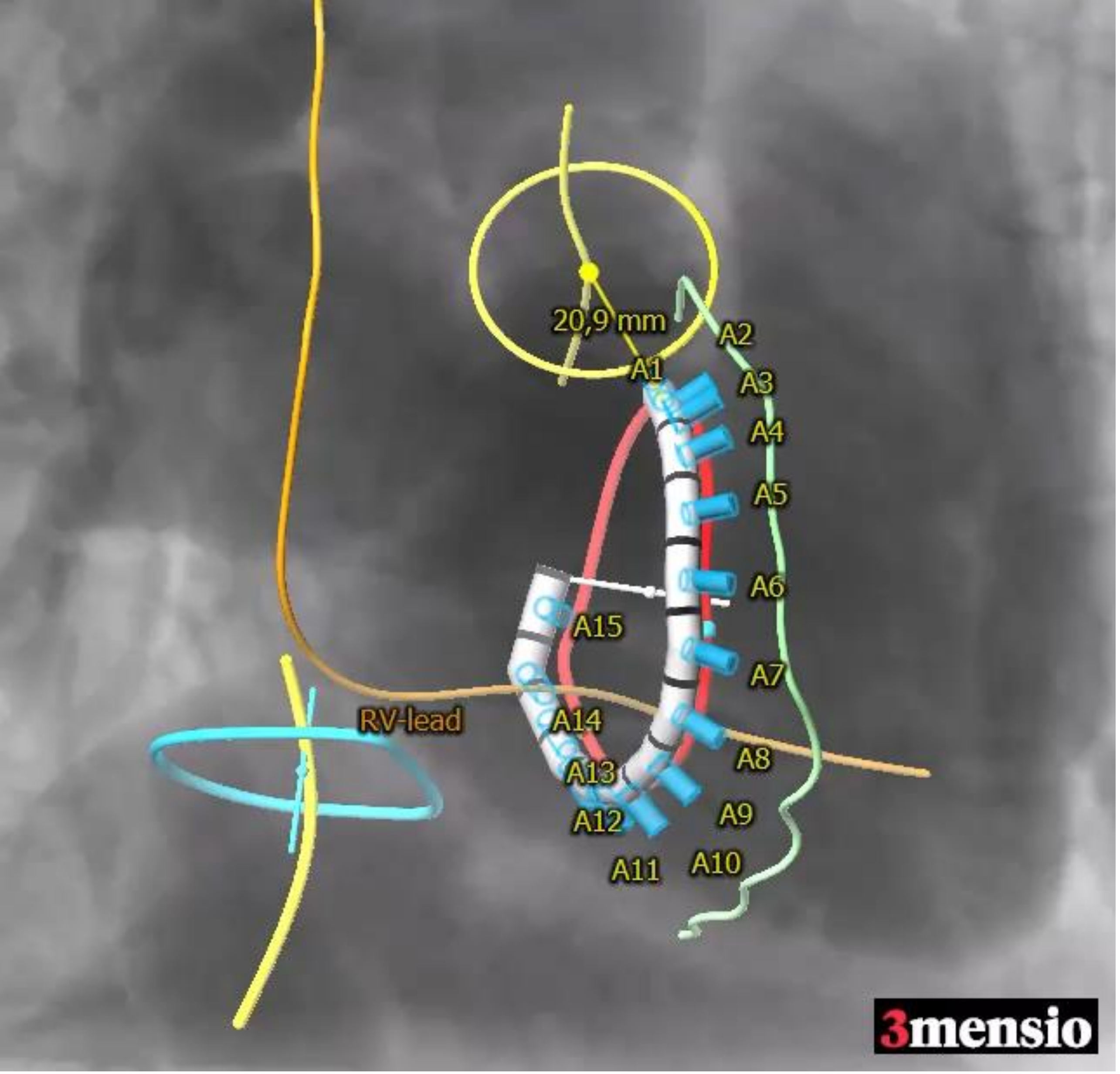




Tricuspid valve: nsional structure







Cardioband Tricuspid Pre-procedural Planning

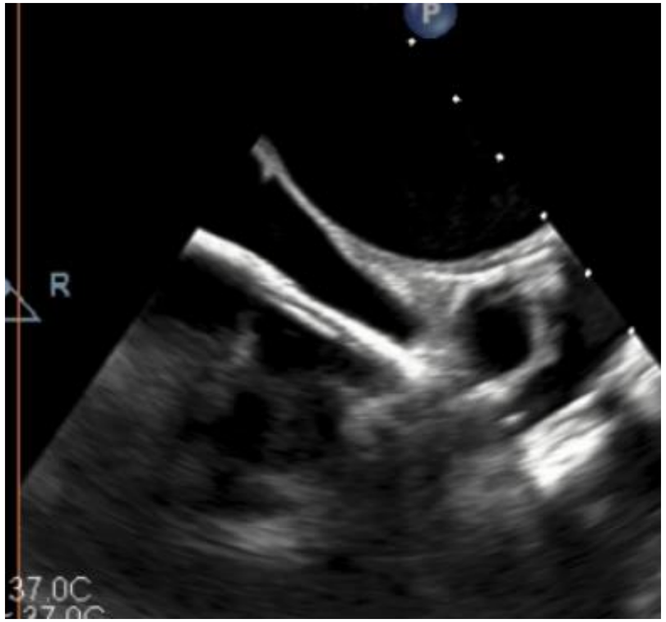
1st Anchor to Distal CS Ostia: 102mm

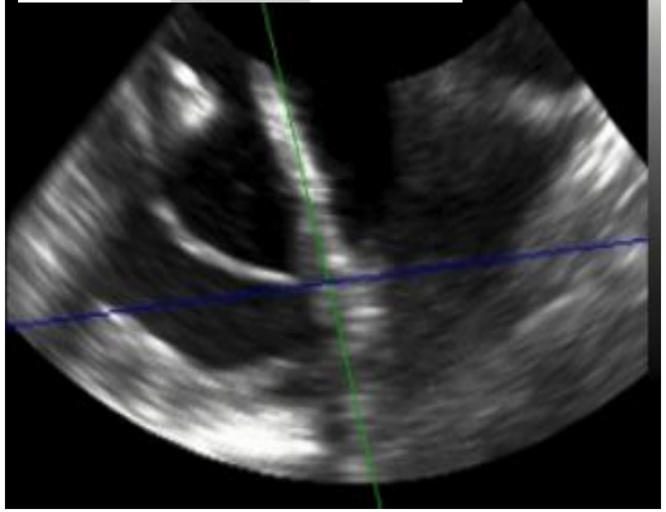
	Recommended measurement range of tricuspid valve annulus from Aorta to Coronary Sinus (mm)	Recommended Cardioband Tricuspid Implant Size	Approximate Cardioband Implant Working Length (mm)
☐	73-80 mm	A	76
☐	81-88 mm	B	84
☐	89-96 mm	C	92
☑	97-104 mm	D	100
☐	105-112 mm	E	108
☐	113-120 mm	F	116

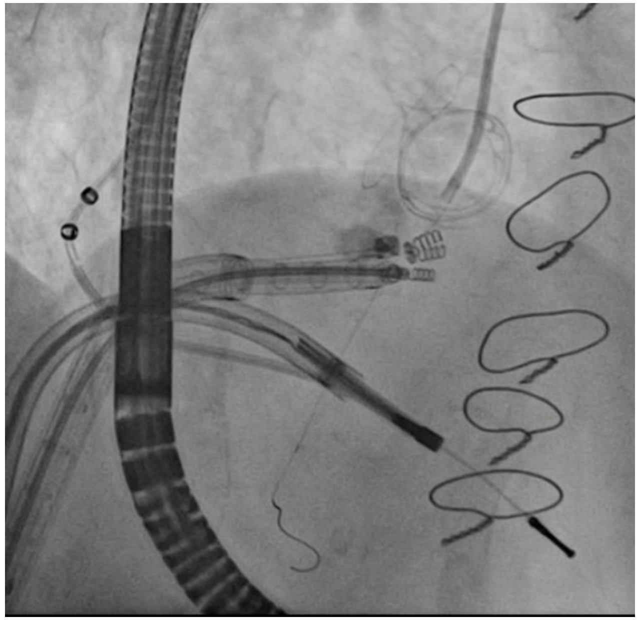
Annulus Area Diastole	14,4 cm²
1st Anchor to AoV	20,9 mm
Predicted Annular Device Coverage	73,0%
Annulus Area Systole	
Anchors Proximal to RCA	

Cardioband Tricuspid System Intraprocedural Echo guidance

Intra-
procedural



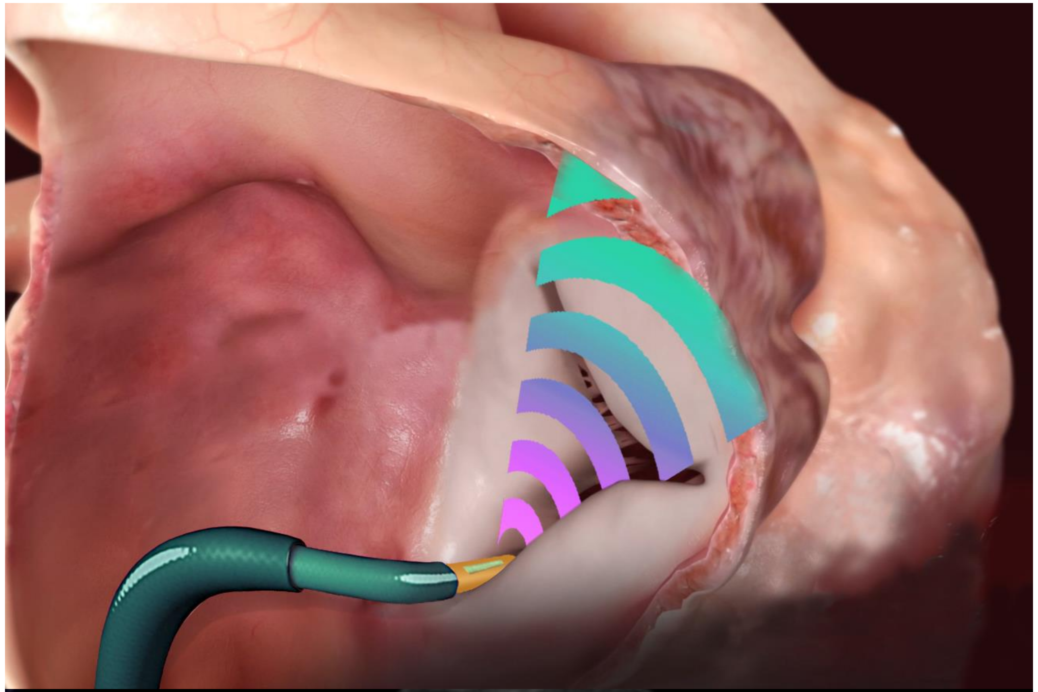


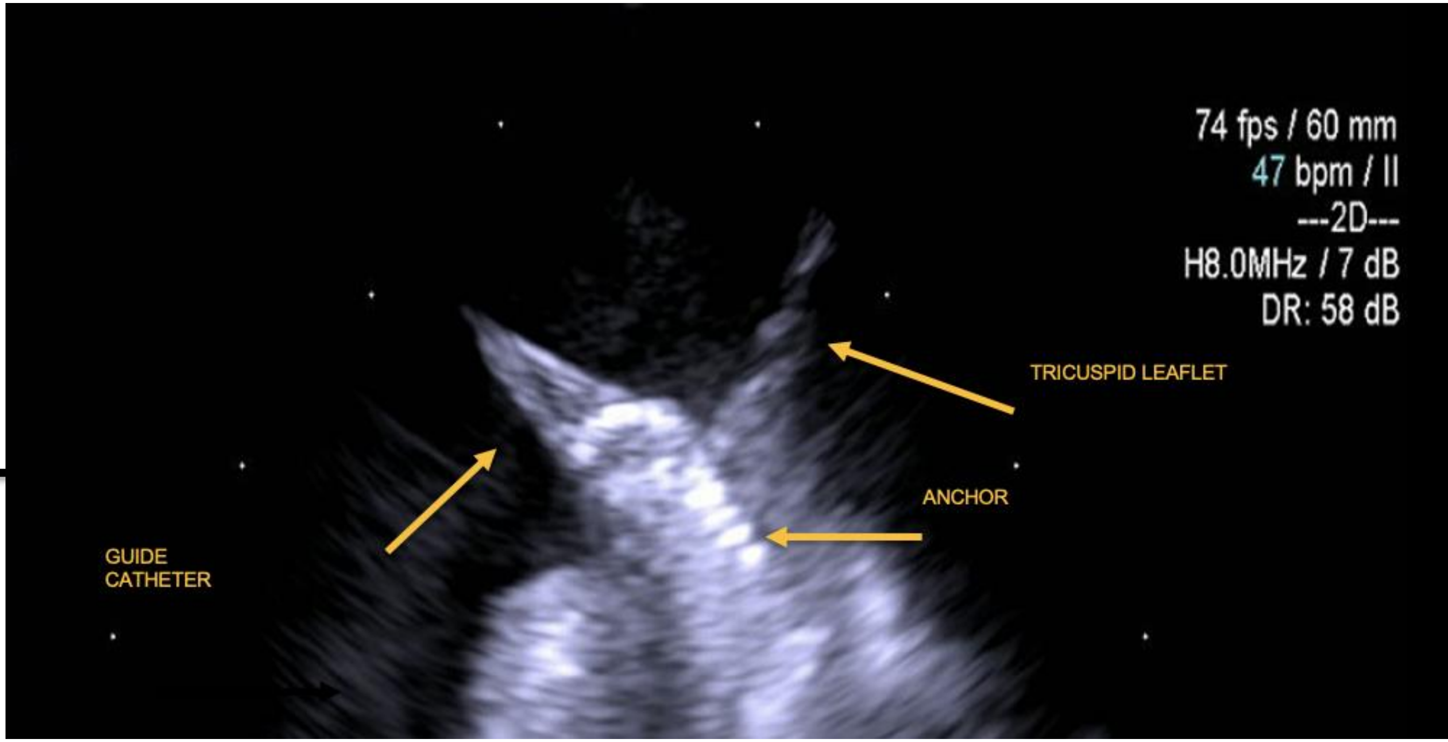


TEE

Fluoro

Cardioband Tricuspid System: the additional value of Intracardiac Echocardiography



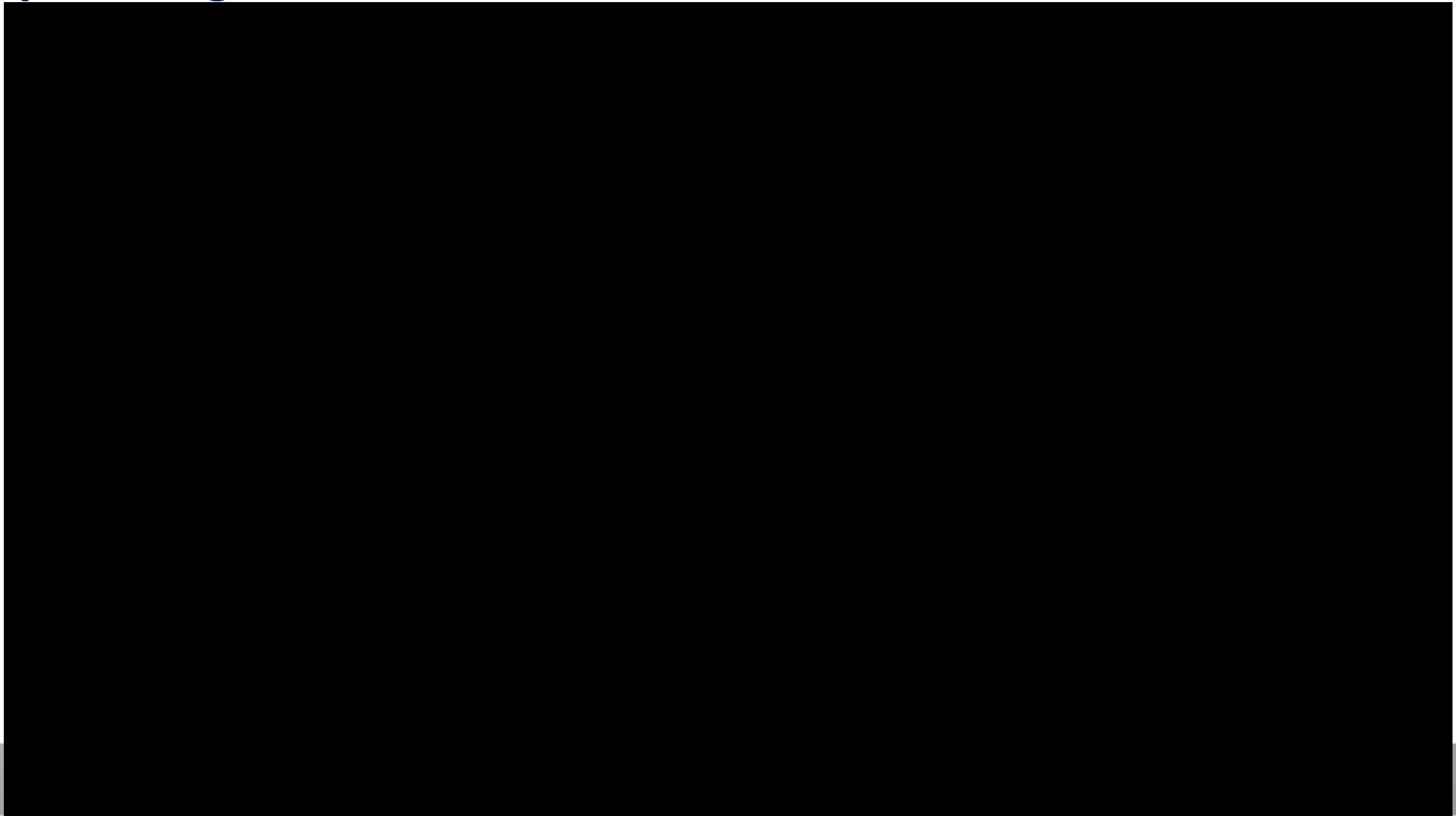


Advantages of ICE:

- High-resolution real-time visualization of cardiac structures
- Early recognition of procedural complications (e.g. thrombus formation)
- Avoidance of general anaesthesia
- Reduction of radiation exposure

Personalized predictive modelling for pre-operative TAVI planning

FEOPS insights for excellence



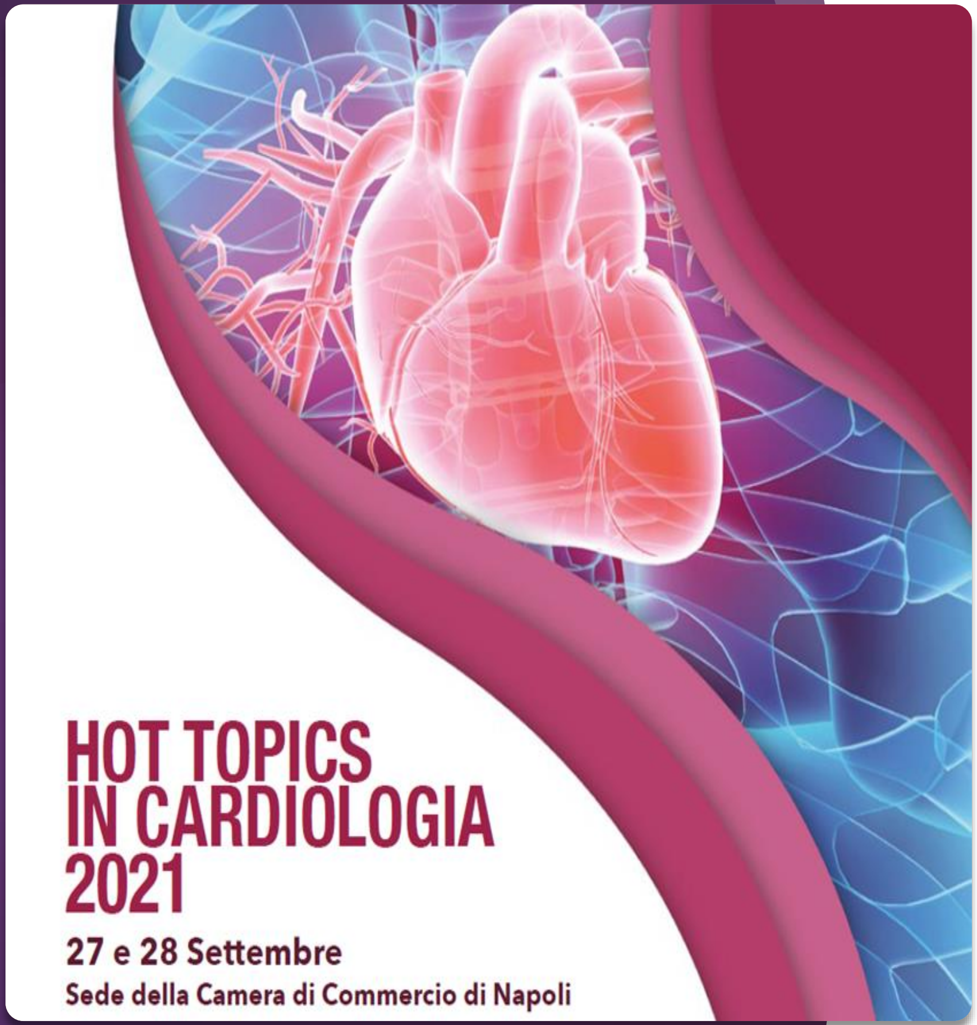
Conclusions

- Multimodal cardiac imaging plays a central role in patient and device selection, before and during the VALVULAR heart disease interventions

- Familiarization with 2D- and 3D- imaging modalities (TTE, TEE, CTA, MRI, and ICE) is mandatory for Cardiologist

- New imaging modalities (Fusion-imaging, predictive modeling, etc.) greatly facilitates the planning and execution of interventions

- the cardiac imaging field is able to envision a future of excellence, quality, and innovation and has outlined concrete steps to realize this potential



GISE Società Italiana di Cardiologia Interventistica

Valvulopatie ed imaging multimodale

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Link profitable solutions

Consiglio Nazionale delle Ricerche

Fondazione Monasterio la ricerca che cura