

# **ECOCARDIOGRAFIA 2015** **XVII Congresso Nazionale SIEC**

**Hotel Royal Continental**

**Napoli, 16-18 Aprile 2015**

## ***"Studio della mitrale"***

*Chiara Sordelli*

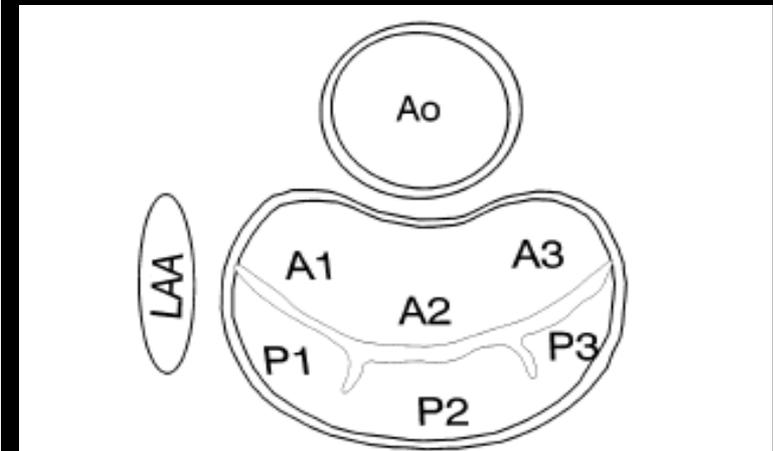
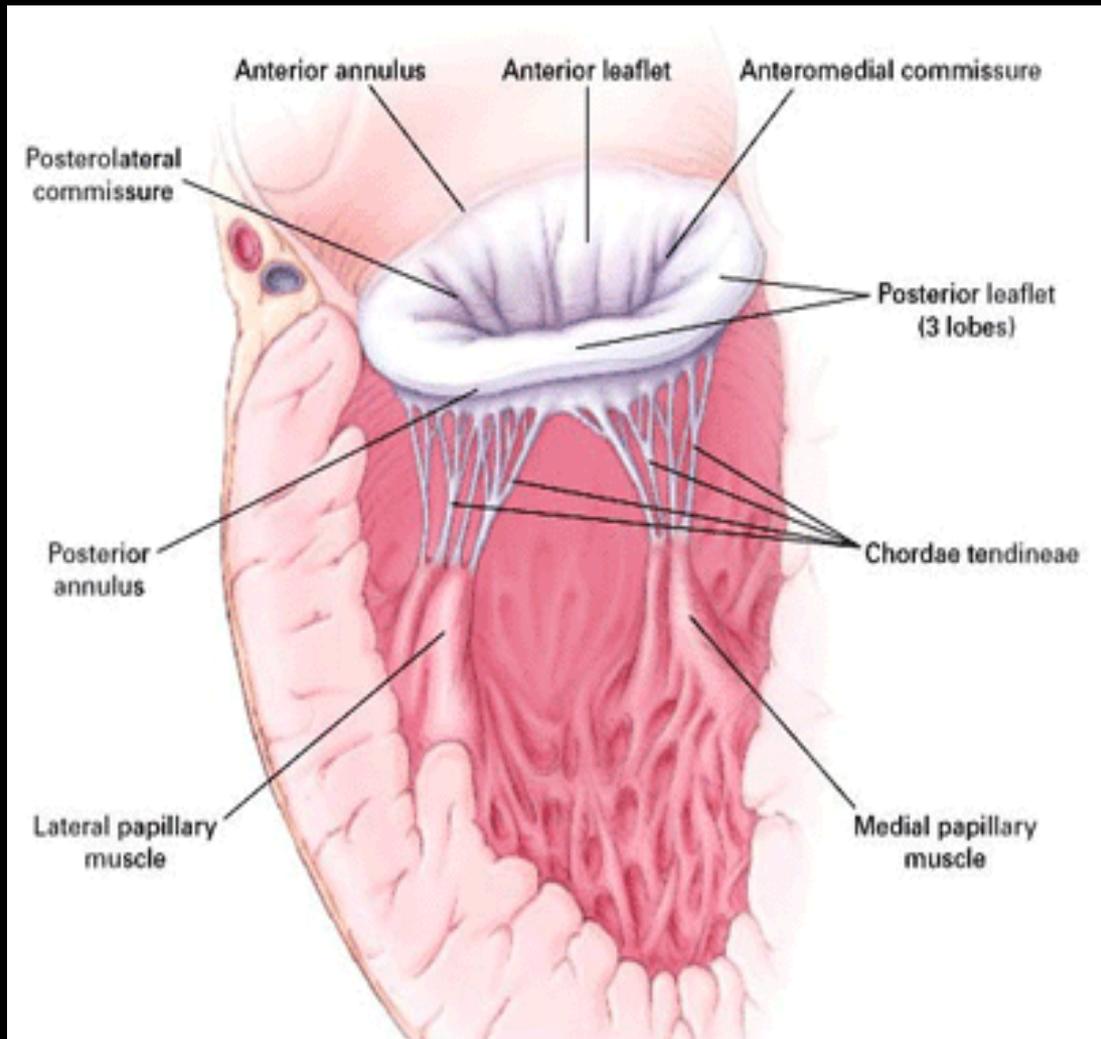
*Sezione di Ecocardiografia  
Clinica Mediterranea  
Napoli*



# Anatomia funzionale della valvola mitrale

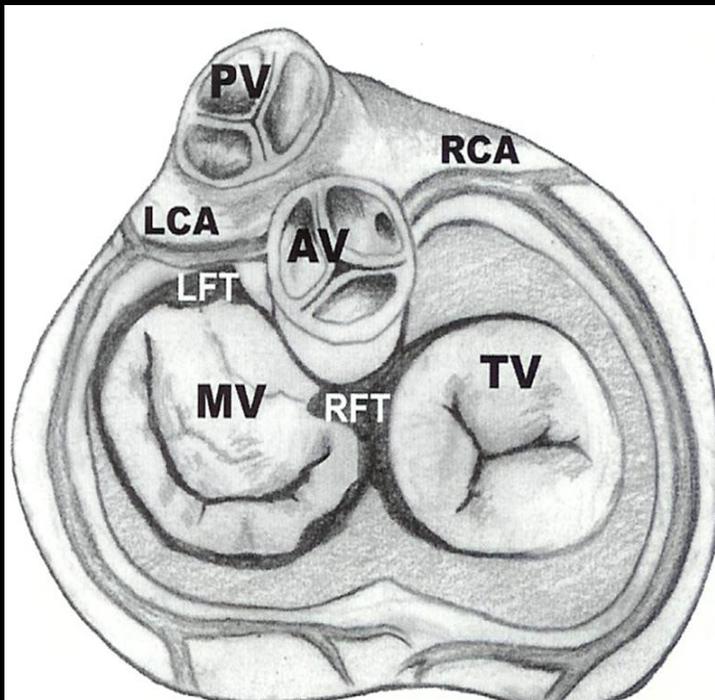
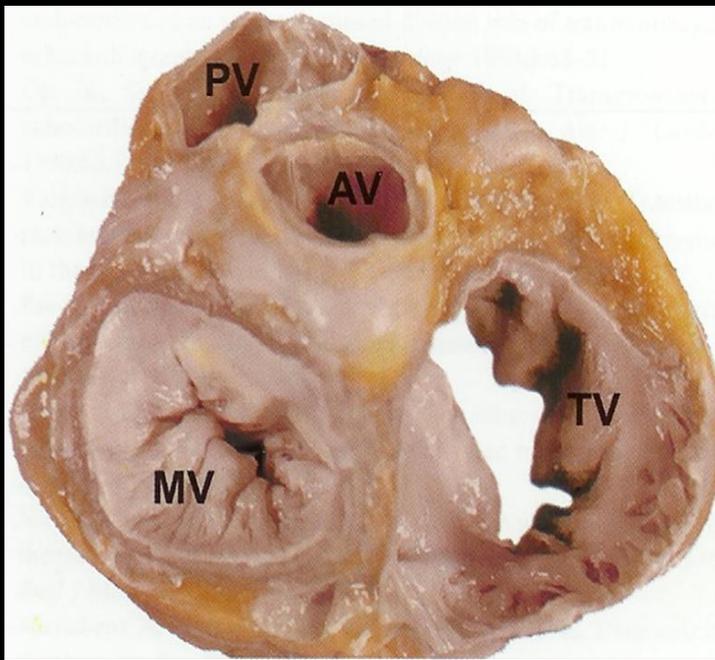
## STRUTTURA COMPLESSA

- *annulus*
- *2 lembi*
- *numerose corde tendinee*
- *2 muscoli papillari*



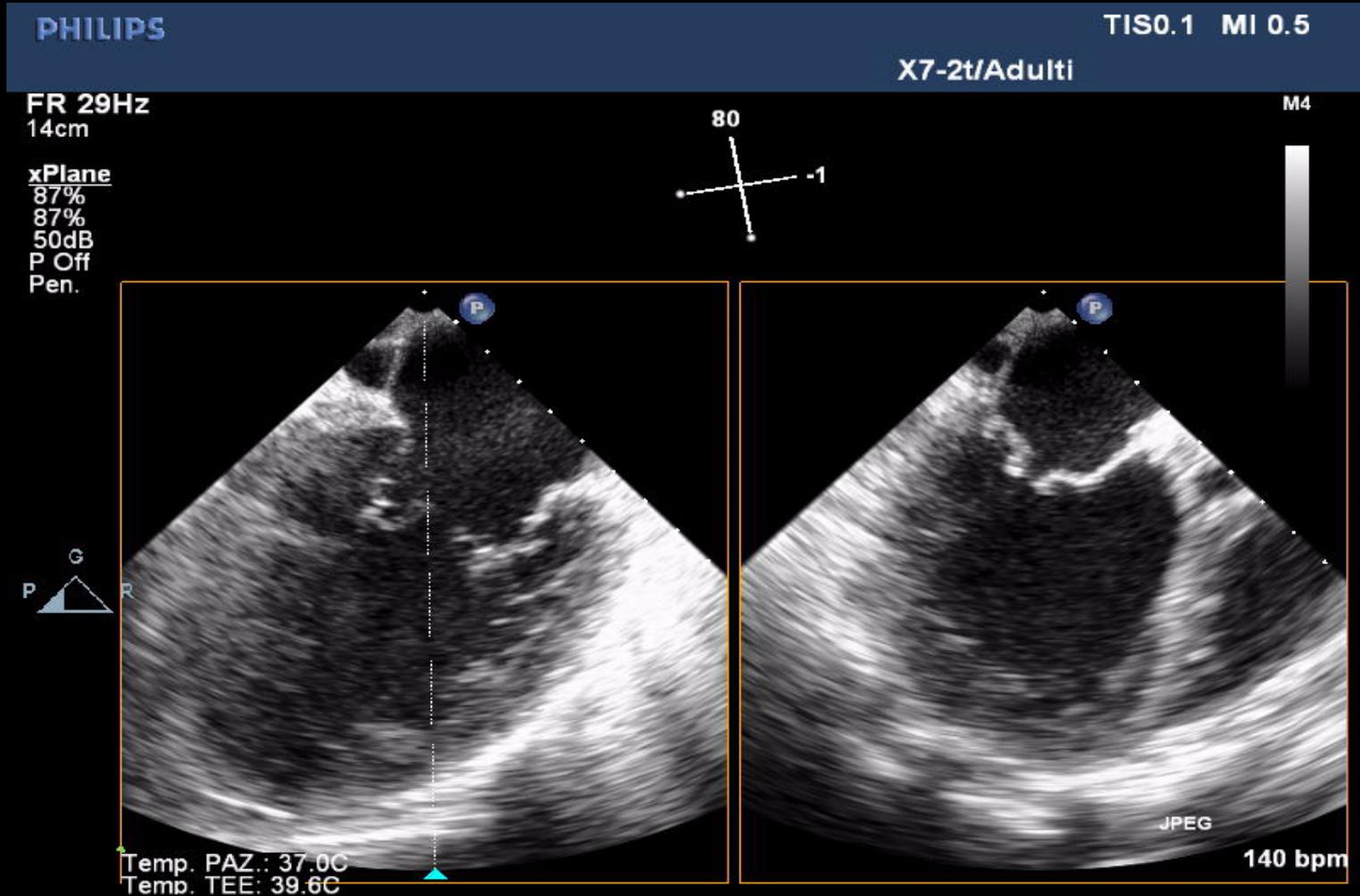
# Anello Valvolare

*Conformazione Sella*  
*Componenti più imp. scheletro fibroso cuore*



- *Anello mitralico*
- *Anello aortico con trigoni dx e sn*
- *Giunzione fibrosa (CAo Cdx-AP)*
- *Intervalvulare Fibrosa (CAo nC-LAM)*
- *Anello tricuspide*

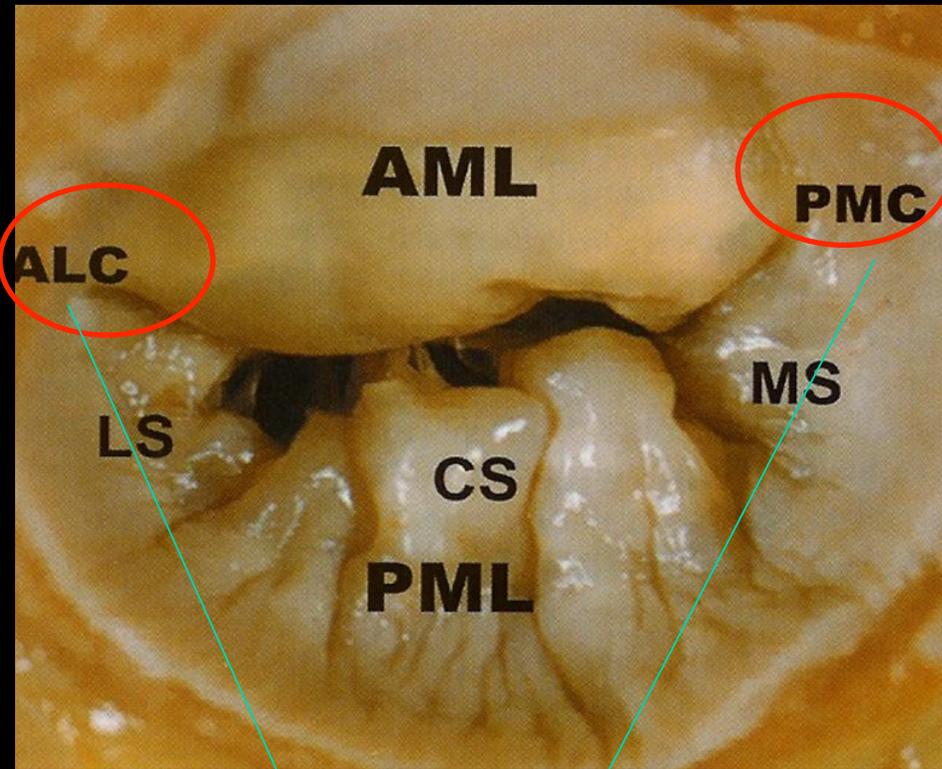
# Anello Valvolare Eco-TEE



Diametro IC

Diametro SL

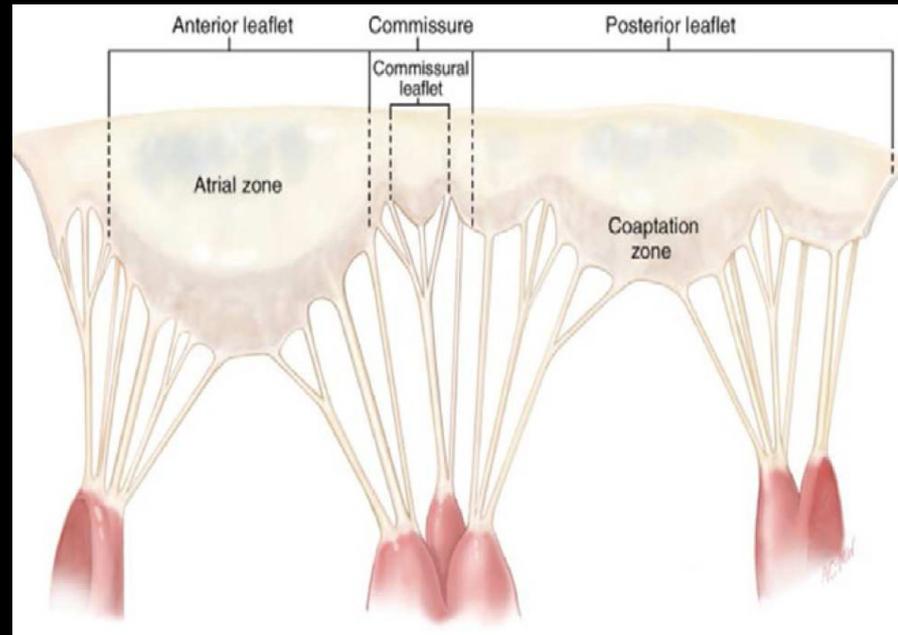
# Lembi Valvolari



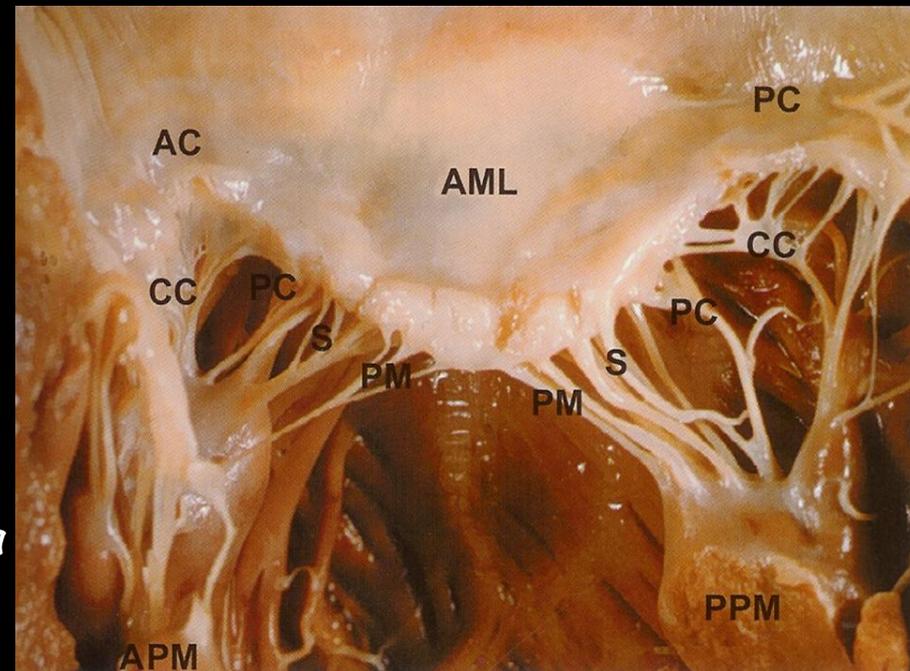
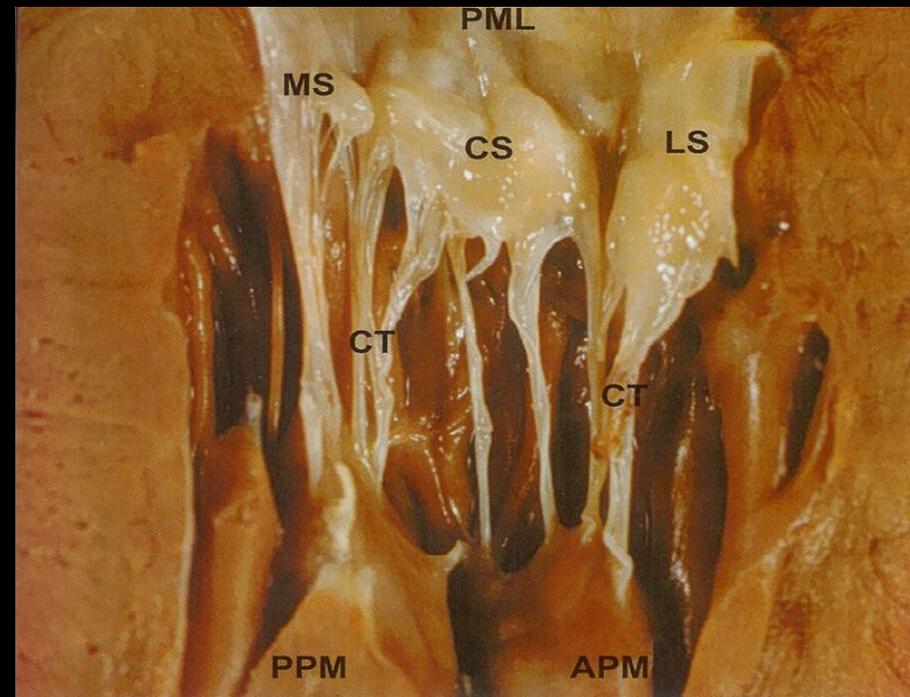
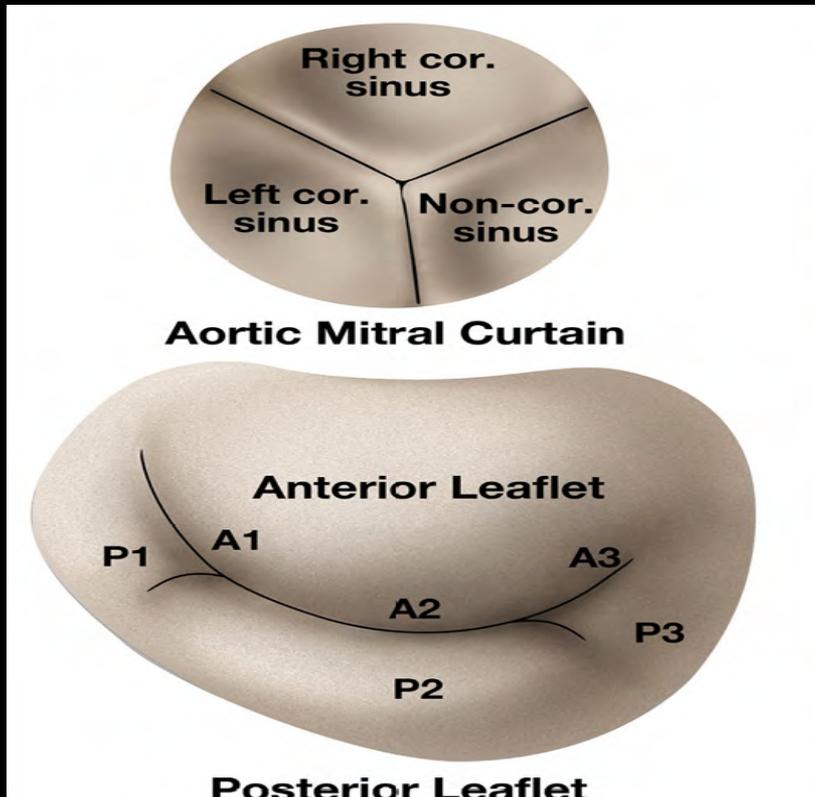
**COMMISSURE**

Imp. punti riferimento anatomico-chirurgico ed ecocardiografico sia x identificazione sede lesioni sia x valutazione funzionale AM

- *LAM: forma triangolare, 35 % circonferenza dell'anello*
- *LMP: forma quadrangolare, 65% circonferenza anulare*
- *Lembi in continuità attraverso commissure*



# Lembi e corde tendinee



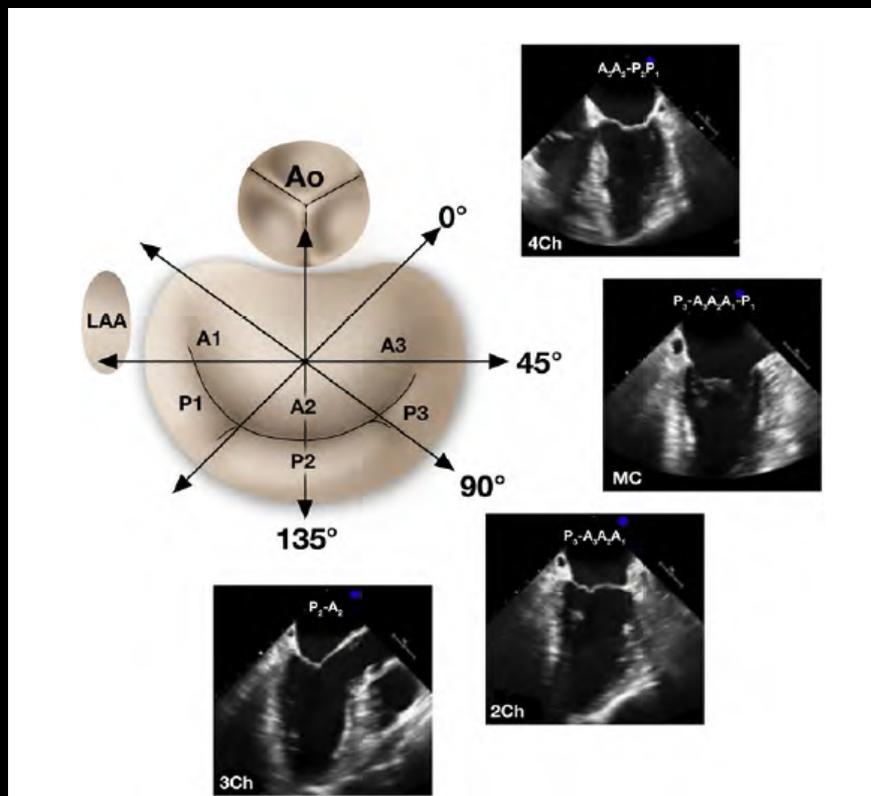
## Classificazione Corde tendinee

- I ordine: margine libero
- II ordine: faccia ventricolare
- III ordine: LMP basale
- Clefts o strut cords: LAM porz intermedia
- Corde commissurali

# Analisi morfo-funzionale della valvola mitrale

## ASE GUIDELINES AND STANDARDS

Guidelines for Performing a Comprehensive Transesophageal Echocardiographic Examination: Recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists



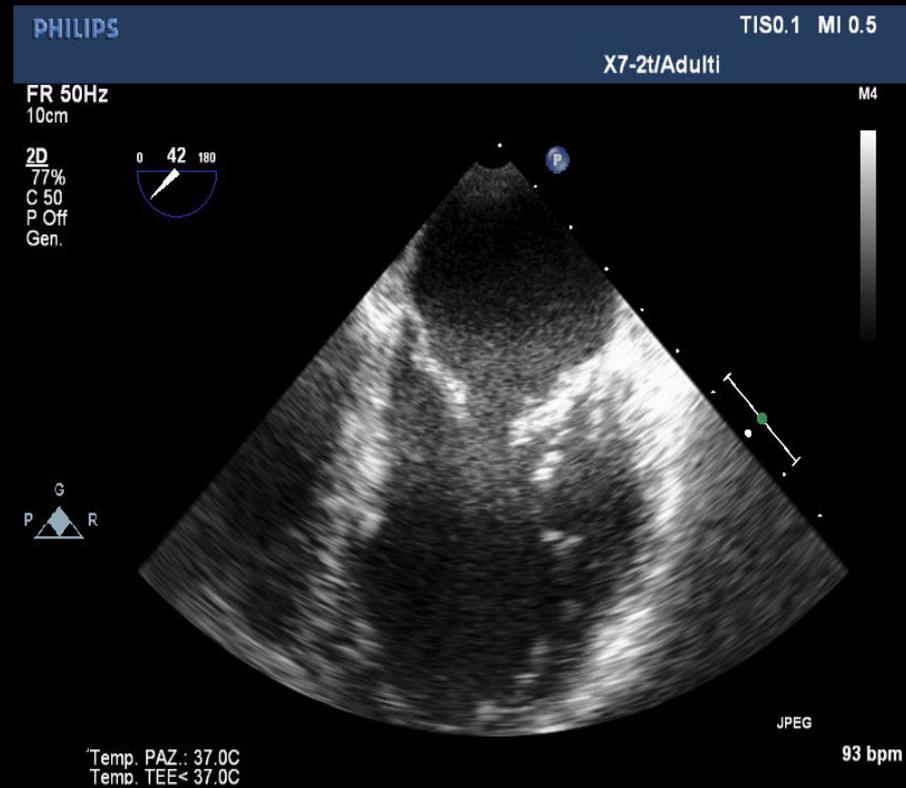
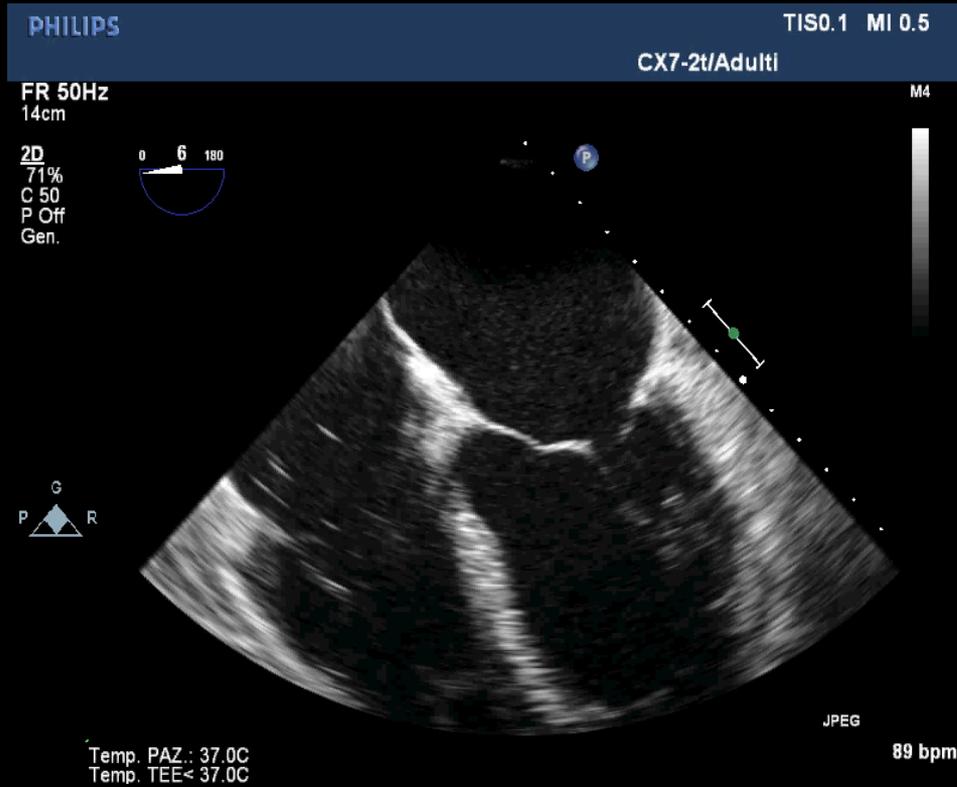
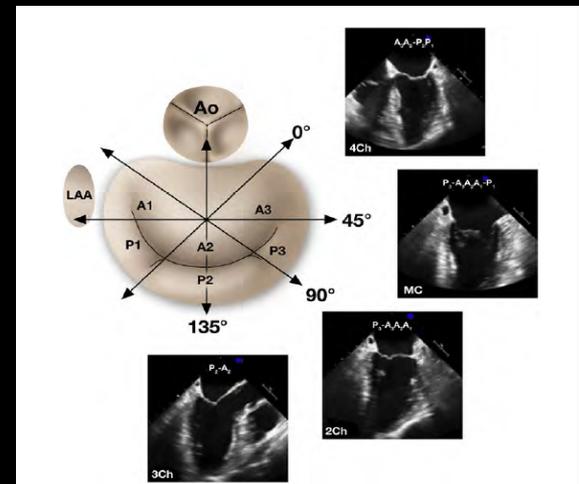
## Sezioni medio-esofagee:

- 4 camere (0-10°)
- Intercommissurale (60°)
- 2 camere (90°)
- Asse Lungo (120°)

# Sezione 4 camere (10-20°)

A3-A2

P2-P1



# Sezione IC (50-70°)

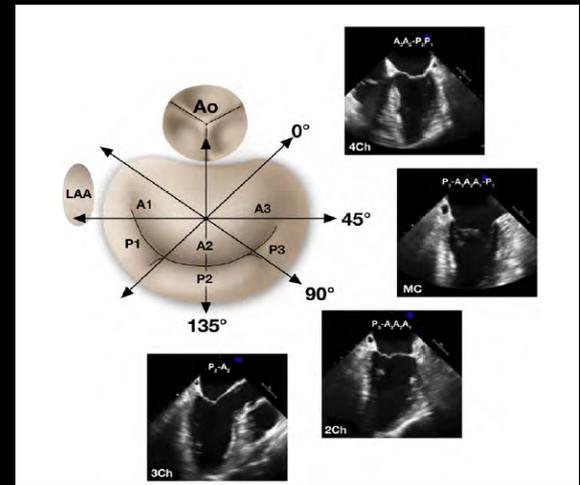
Rot. antior

Rot. or

LMP

P3-A2-P1

LAM



PHILIPS TIS0.1 MI 0.5  
CX7-2t/Adulti M4

FR 50Hz  
14cm

2D 67 180  
69%  
C 50  
P Off  
Gen.

Temp. PAZ.: 37.0C  
Temp. TEE: 37.4C

JPEG 103 bpm

10:08:41

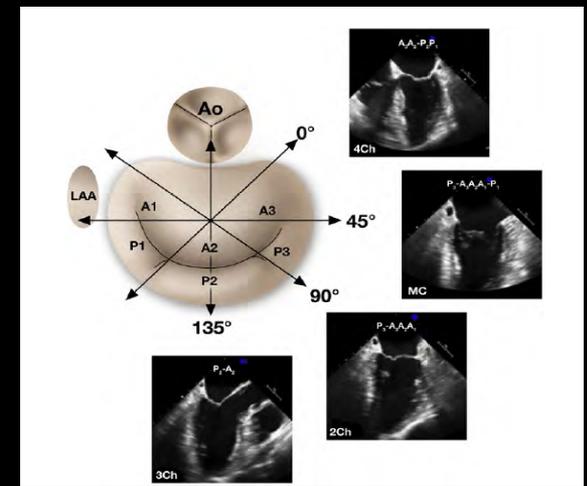
71

77 HR

# Sezione 2 camere (80-100°)



P3-A3-A2-A1



PHILIPS TIS0.1 MI 0.5  
CX7-2t/Adulti

FR 50Hz  
12cm

2D  
67%  
C 50  
P Off  
Gen.

0 81 180

M4

P

G  
P R

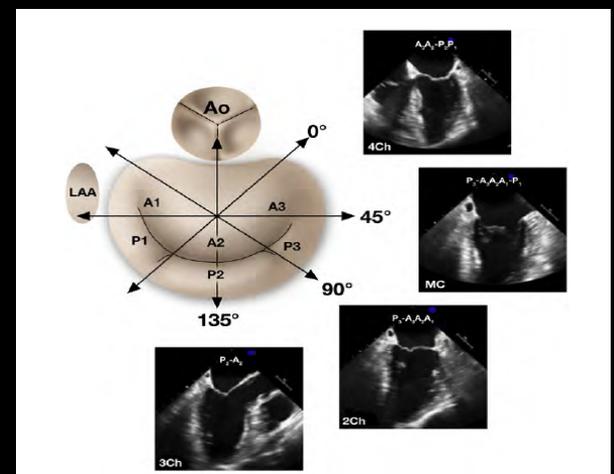
JPEG

Temp. PAZ.: 37.0C  
Temp. TEE< 37.0C

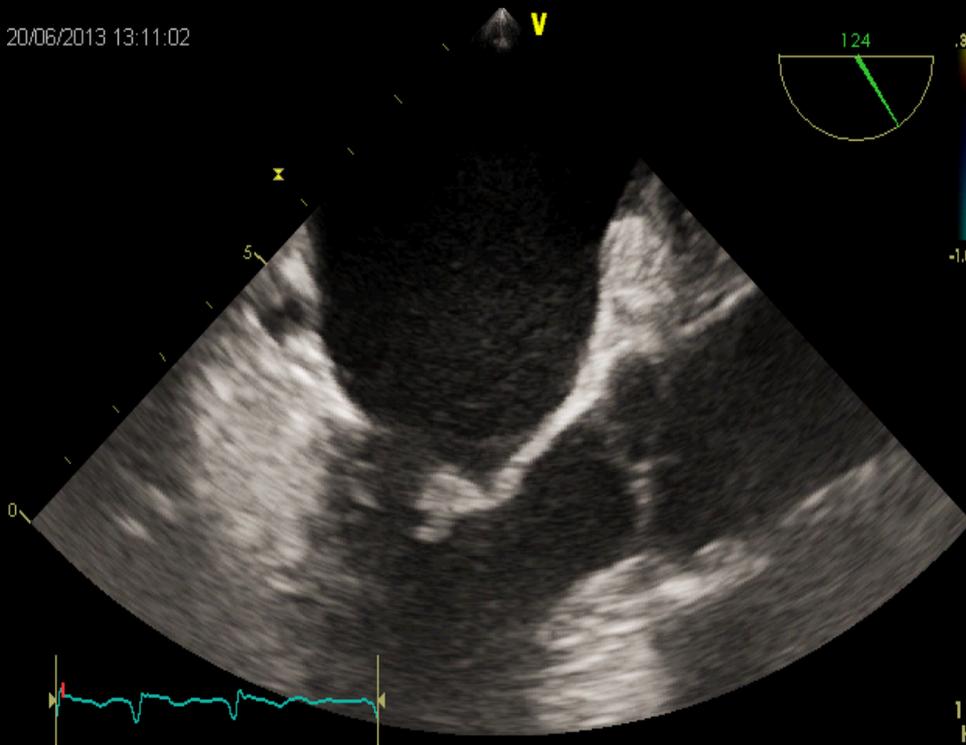
152 bpm

# Sezione 3 camere (120°)

A2-P2



20/06/2013 13:11:02



PHILIPS

TIS0.1 MI 0.5

X7-2t/Adulti

FR 50Hz  
12cm

2D  
72%  
C 50  
P Off  
Gen.



G  
P R

Temp. PAZ : 37.0C  
Temp. TEE : 38.1C

120  
HR

M4

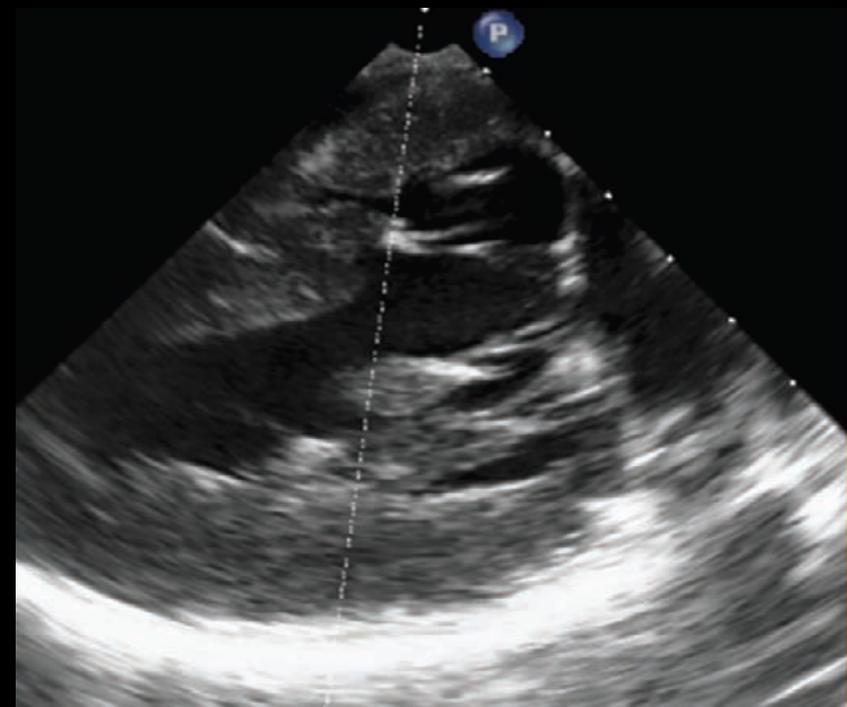
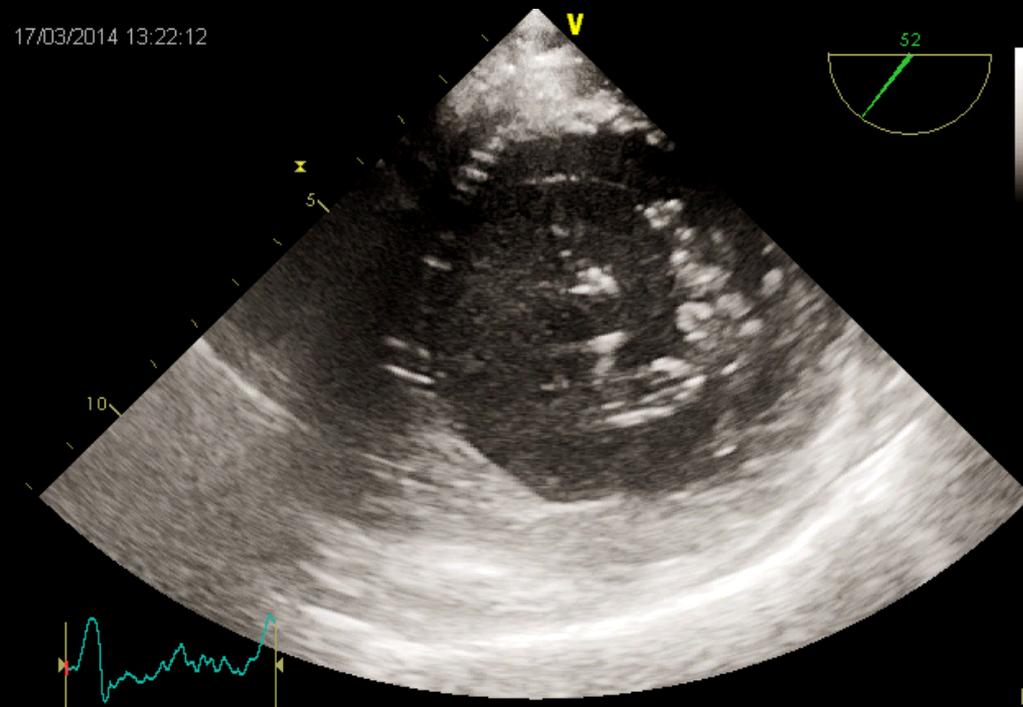
JPEG

85 bpm

# Sezioni transgastriche

Short axis  
(0°)

Asse lungo  
(120°)



# ECO-2D TEE

## Limiti

- Piani scansione limitati e non simultanei
- Multiple sezioni per valutazione VM

Table 1  
Echocardiographic views of the mitral valve

	Transthoracic	Transesophageal
2D	Parasternal short-axis	Midesophageal 4-chamber
	Parasternal long-axis	Midesophageal 2-chamber
	Apical 4-chamber	Midesophageal long-axis
	Apical 2-chamber	Midesophageal mitral commissural
		Transgastric basal short-axis
		Transgastric long-axis
3D	Parasternal long-axis	Any midesophageal view
	Apical 4-chamber	

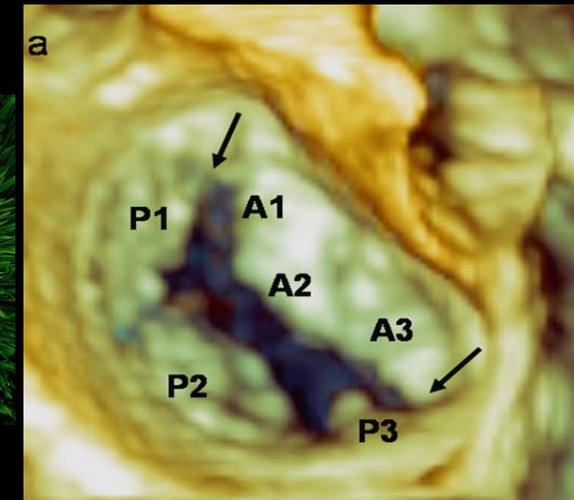


“Valutazione non dettagliata”

# ECO-3D TEE

## Vantaggi

- Piani scansione illimitati
- Migliore risoluzione spaziale e Temporale (full-volume)
- Visualizzazione **SIMULTANEA** di tutto AVM da un'unica finestra acustica



## EAE/ASE Recommendations for Image Acquisition and Display Using Three-Dimensional Echocardiography

Three-dimensional TTE and TEE assessments of mitral valve pathology should be incorporated into routine clinical practice as they provide the best physiologic and morphologic information regarding the mitral valve.

# Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION



American  
Heart  
Association®

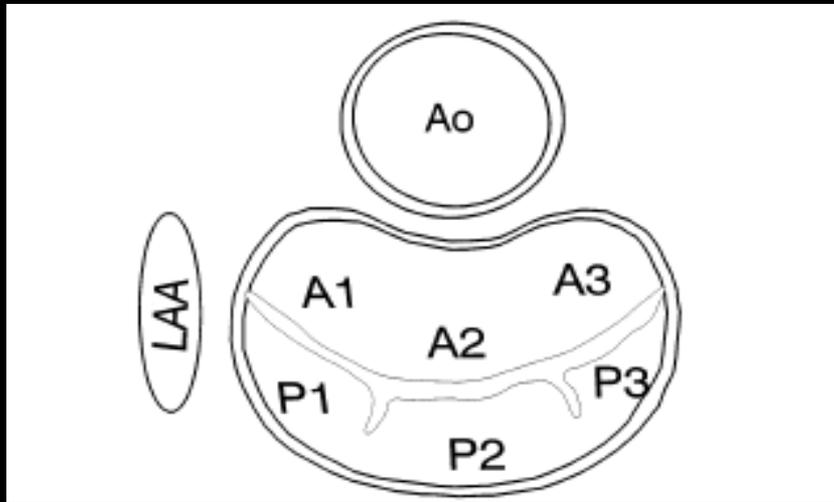
### Three-dimensional Echocardiography Is Essential for Intraoperative Assessment of Mitral Regurgitation

Wendy Tsang and Roberto M. Lang

In particular, 3D TEE has been proven to be superior to 2D TEE in the assessment of both mitral valve anatomy and mitral regurgitation, promoting its use in the operating room (Table 1).<sup>1-3</sup> One reason for this superiority is that 3D TEE allows the mitral valve to be displayed en face in an orientation identical to the surgeon's view of the mitral valve intraoperatively. This surgeon's view greatly facilitates communication with cardiac surgeons because they can easily interpret these images.



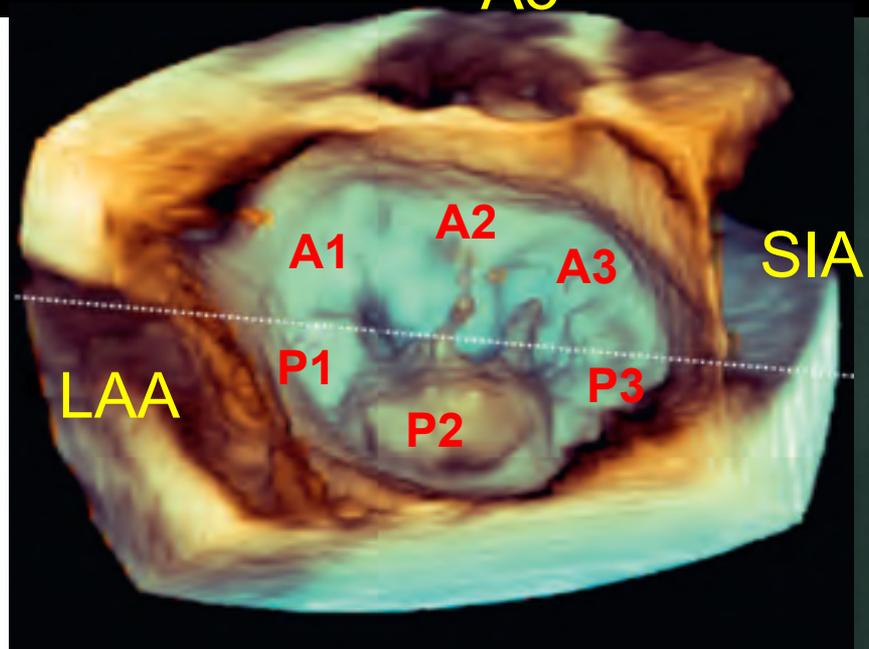
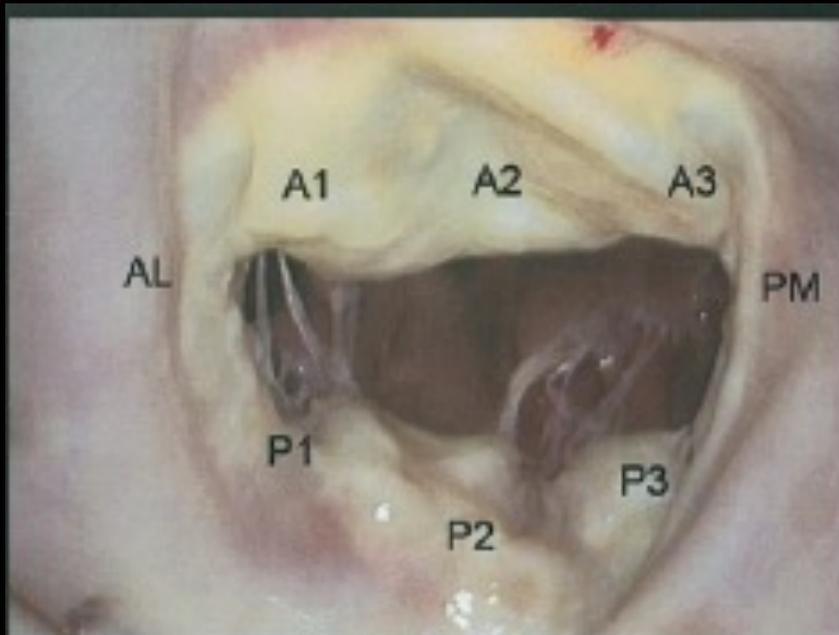
# Anatomia 3D valvola mitrale



*Visione "chirurgica" o "en face" dall'atrio sn*

*RT-3D "ZOOM"*

Ao



# Anatomia 3D valvola mitrale

PHILIPS

08/06/2011 10:02:31 TIS0.3 MI 0.5

X7-2t/Adulti

FR 7Hz  
6.6cm

M4

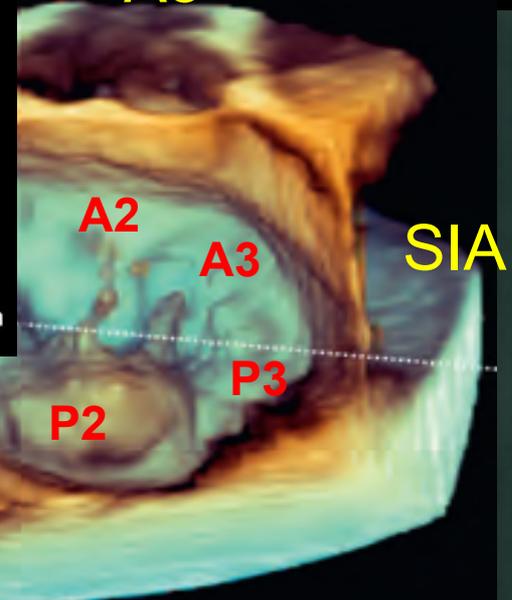
Live 3D  
3D 1%  
3D 40dB  
Pen



*“chirurgica” o “en face”*

*3D “ZOOM”*

Ao



JPEG

77 bpm

LAA

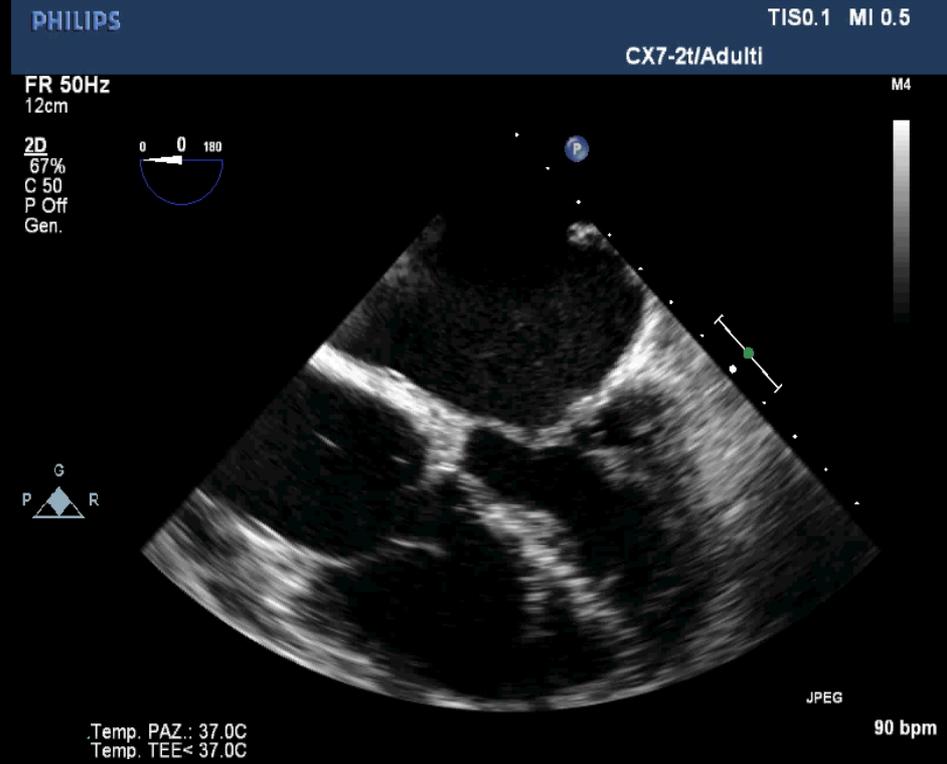
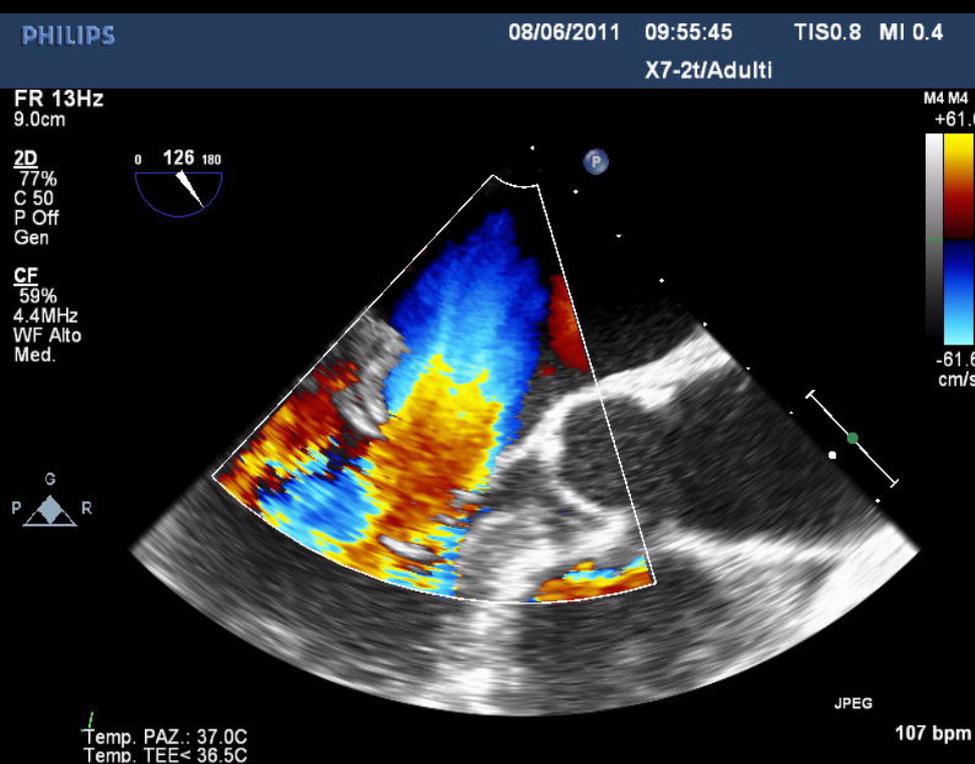
Temp. PAZ.: 37.0C  
Temp. TEE: 39.9C



# Valutazione della patologia mitralica EcoTEE 2D-3D

## Insufficienza mitralica

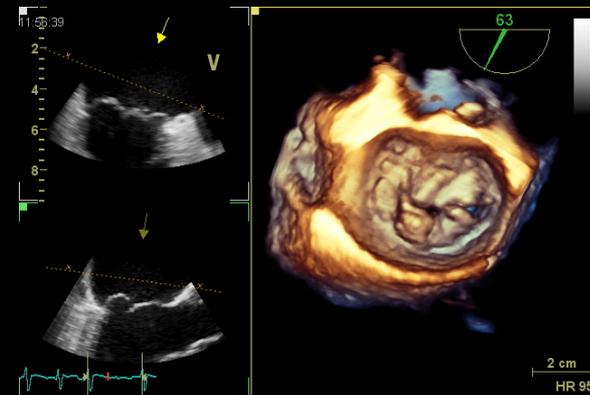
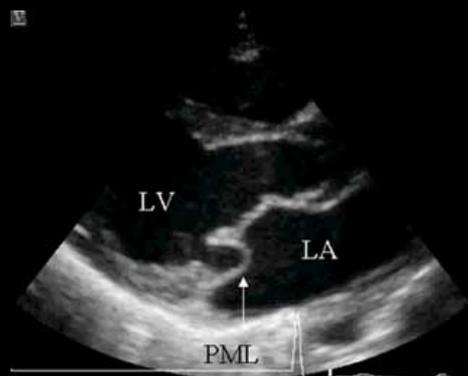
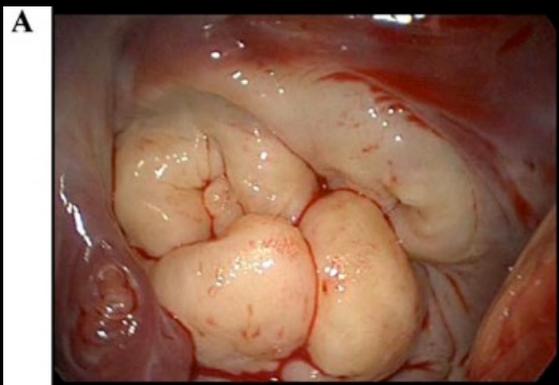
## Stenosi mitralica



## Guidelines on the management of valvular heart disease (version 2012)

- L'insufficienza mitralica rappresenta la seconda valvulopatia più frequente nei paesi occidentali
- Viene classificata in organica e funzionale
- Eziologia più comune → degenerativa

*Degeneraz. mixomatosa*  
*Degeneraz. fibrotica*  
*Deficienza fibroelastica*



# European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 2: mitral and tricuspid regurgitation (native valve disease)

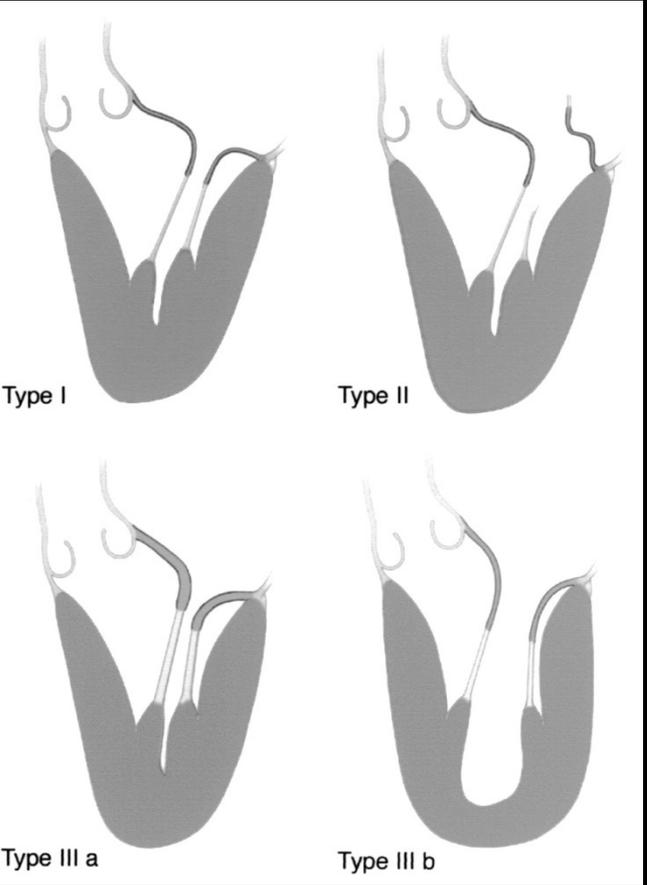
European Journal of Echocardiography (2010)

**Table 3** Grading the severity of organic mitral regurgitation

Parameters	Mild	Moderate	Severe
Qualitative			
MV morphology	Normal/Abnormal	Normal/Abnormal	Flail leaflet/Ruptured PMs
Colour flow MR jet	Small, central	Intermediate	Very large central jet or eccentric jet adhering, swirling and reaching the posterior wall of the LA
Flow convergence zone <sup>a</sup>	No or small	Intermediate	Large
CW signal of MR jet	Faint/Parabolic	Dense/Parabolic	Dense/Triangular
Semi-quantitative			
VC width (mm)	< 3	Intermediate	≥ 7 (> 8 for biplane) <sup>b</sup>
Pulmonary vein flow	Systolic dominance	Systolic blunting	Systolic flow reversal <sup>c</sup>
Mitral inflow	A wave dominant <sup>d</sup>	Variable	E wave dominant (> 1.5 cm/s) <sup>e</sup>
TVI mit /TVI Ao	< 1	Intermediate	> 1.4
Quantitative			
EROA (mm <sup>2</sup> )	< 20	20–29; 30–39 <sup>f</sup>	≥ 40
R Vol (mL)	< 30	30–44; 45–59 <sup>f</sup>	≥ 60

+ LV and LA size and the systolic pulmonary pressure<sup>g</sup>

# Classificazione funzionale IM



• Tipo I → normale movimento lembi

- Dilatazione anulare
- Erosioni
- Perforazioni
- Cleft

• Tipo II → eccessivo movimento lembi

- Prolasso
- Flail

• Tipo III → movimento ristretto dei lembi

Tipo IIIa	Tipo IIIb
M.reumatica	CMD ischemica CMD idiopatica

## Classificazione Carpentier

Meccanismo più frequente → Tipo II

# *ECO-TEE 3D ed insufficienza mitralica: Vantaggi*

1. Accurata localizzazione ed estensione della lesione
2. Identificazione meccanismo rigurgito
3. Valutazione quantitativa insufficienza mitralica
4. Pianificazione della strategia chirurgica
5. Informazioni aggiuntive nel guidare procedure percutanee (*chiusura leak-mitraclip*)

# Localizzazione accurata lesione valvolare

## Real-Time Three-Dimensional Transesophageal Echocardiography for Assessment of Mitral Valve Functional Anatomy in Patients With Prolapse-Related Regurgitation

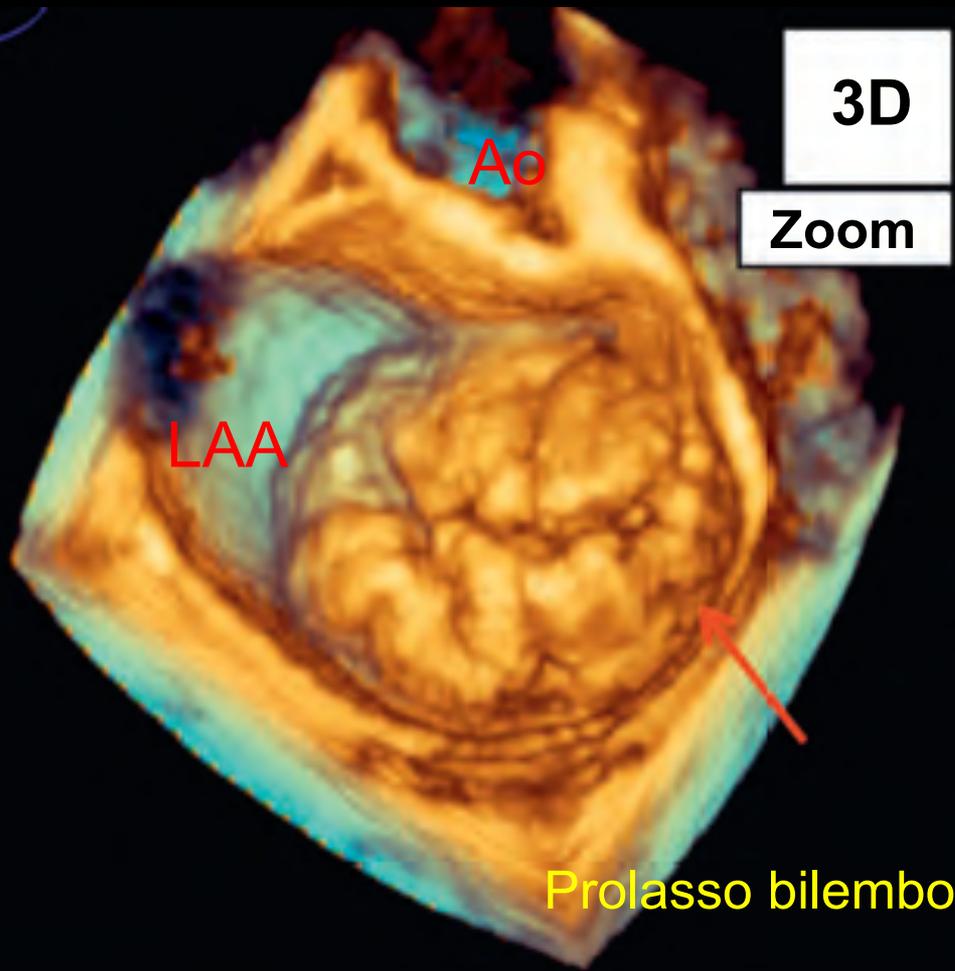
Giovanni La Canna et. Al, Am J Cardiol. 2011.

**RT3D-TEE provided more accurate mapping of MV prolapse than 2D imaging and RT3D-TTE, adding quantitative recognition of dominant and secondary lesions and MV anatomy details**

- Localizzazione prolasso 

Monolembo
Bilembo
Commissurale
Combinato (lambi e commissure)
- Accurata identificazione scallop coinvolti
- Prolasso dominante e secondario 

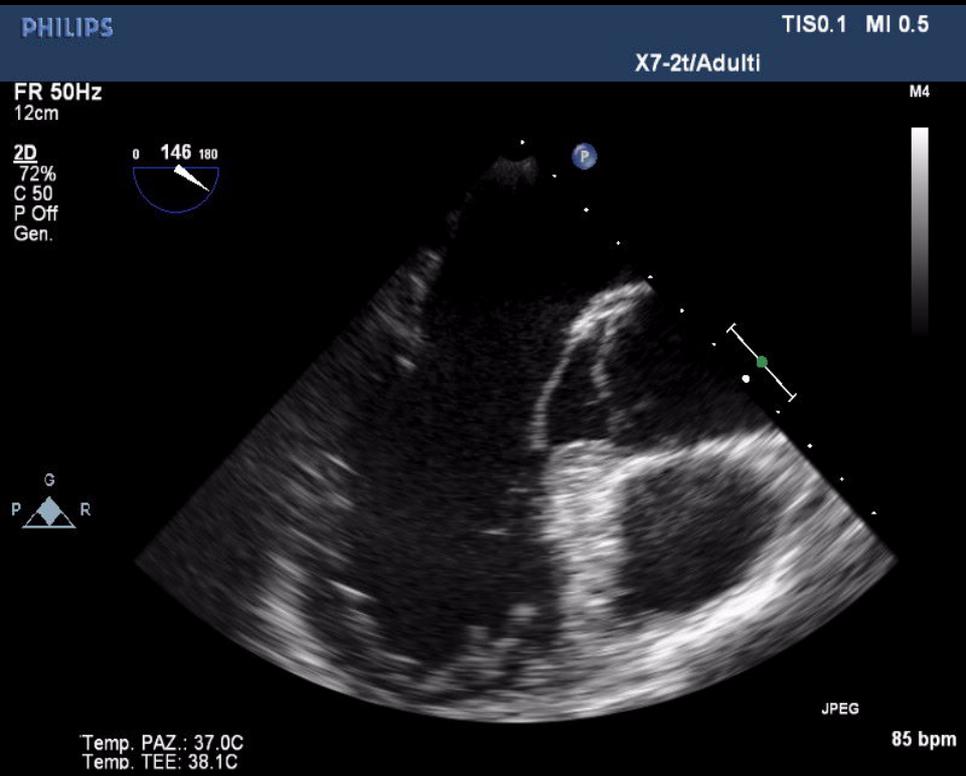
D: > 5 mm
S: 2-5 mm



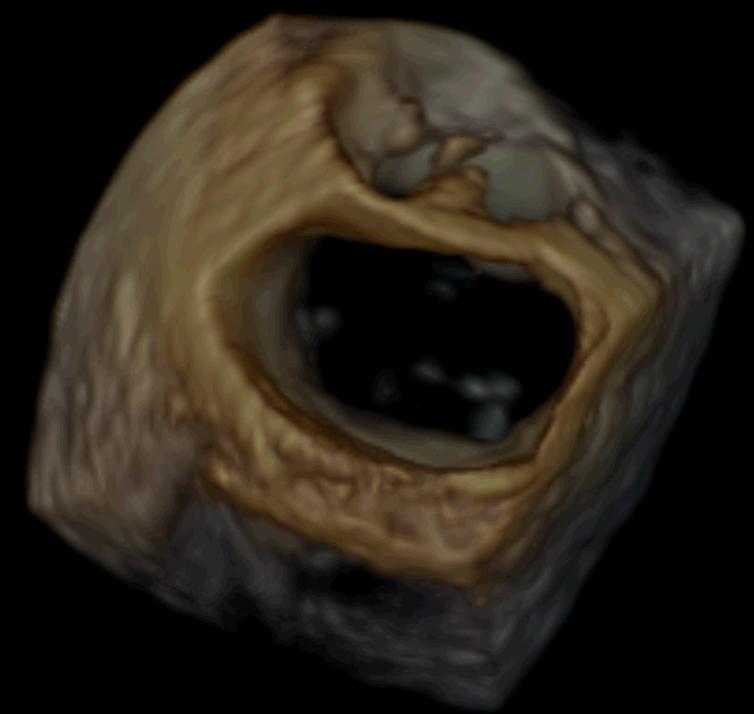
*Mitral valve prolapse: role of 3D echocardiography in diagnosis. Benenstein R, Saric M. Curr Opin Cardiol. 2012*

*Gentile cortesia Dott. Giovanni La Canna*

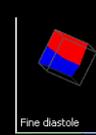
# Identificazione scallop coinvolti



JPEG  
85 bpm

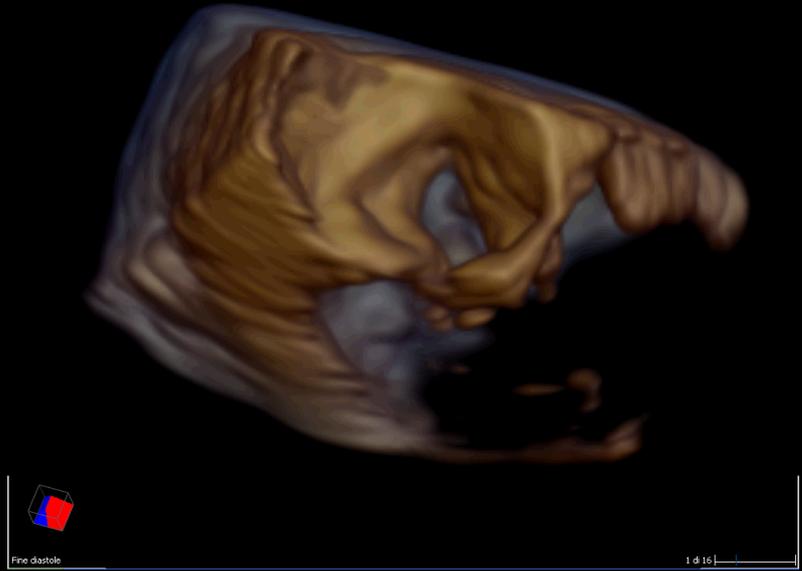
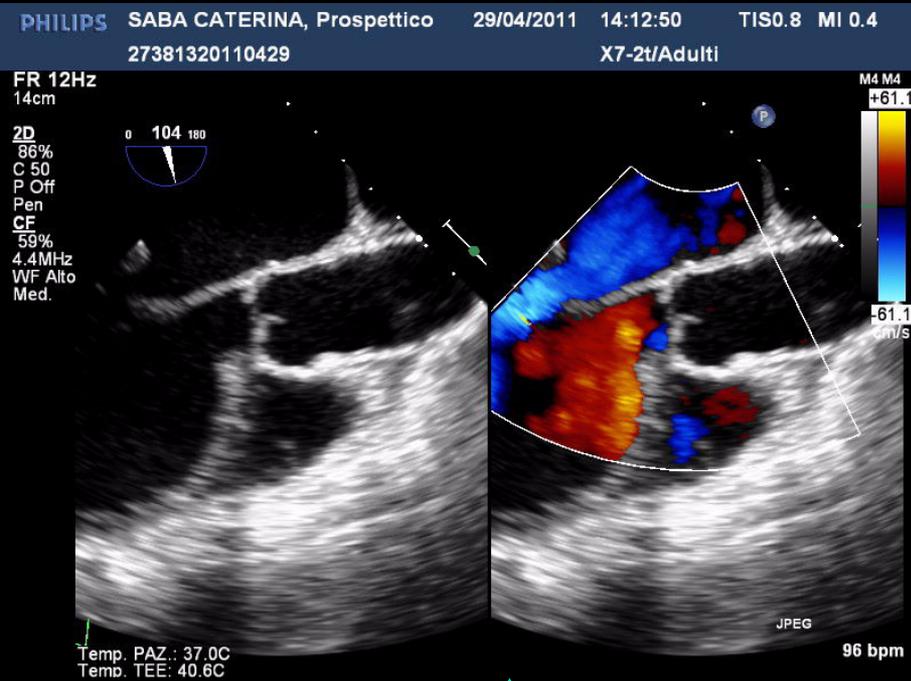


## Prolasso P2



Fine diastole

# Flail P2



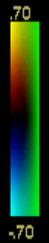
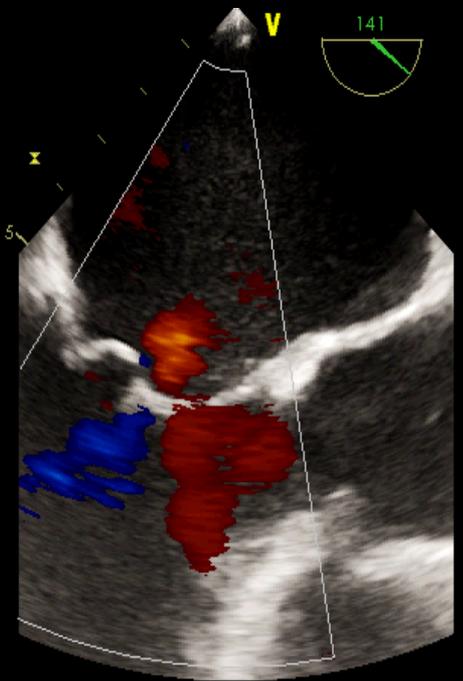
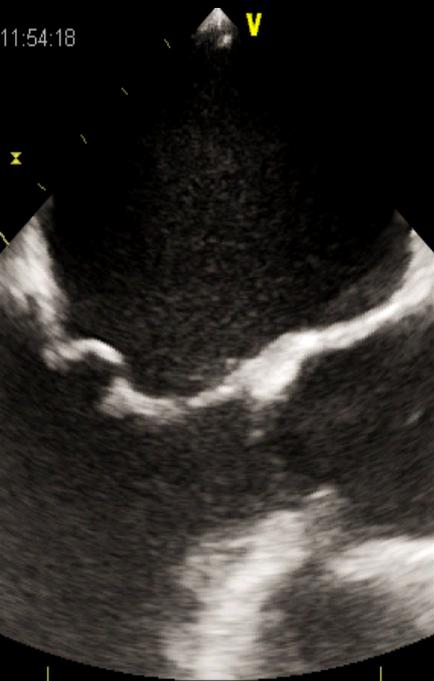
**Importante analisi geometria rigugrito**



mp. PAZ.: 37.0C  
mp. TEE: 39.7C

# Flail P2

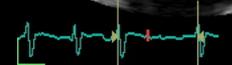
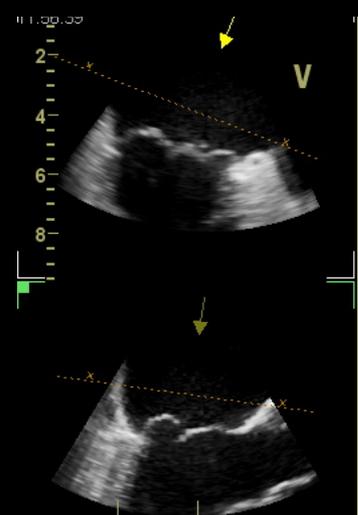
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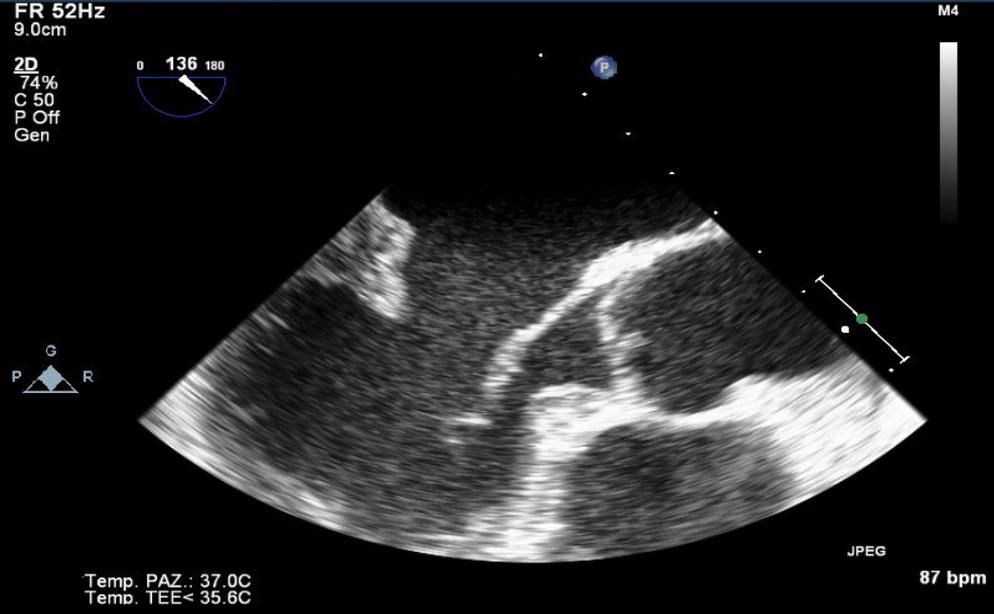
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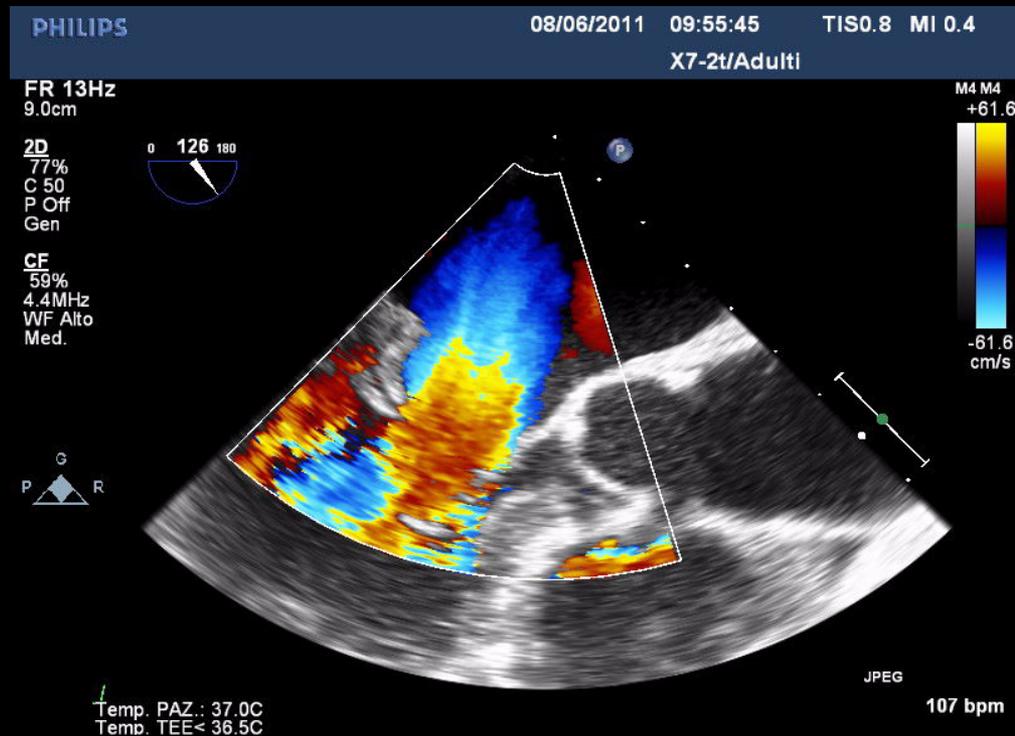
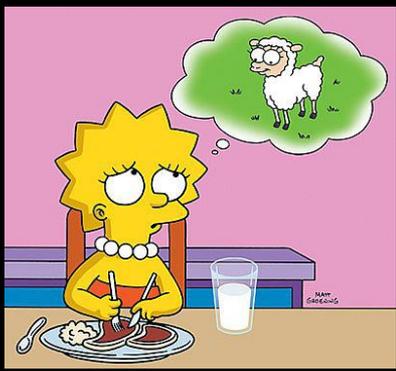
2 cm  
HR 90



2 cm  
HR 95



Prolasso P3..???



FR 7Hz  
6.6cm

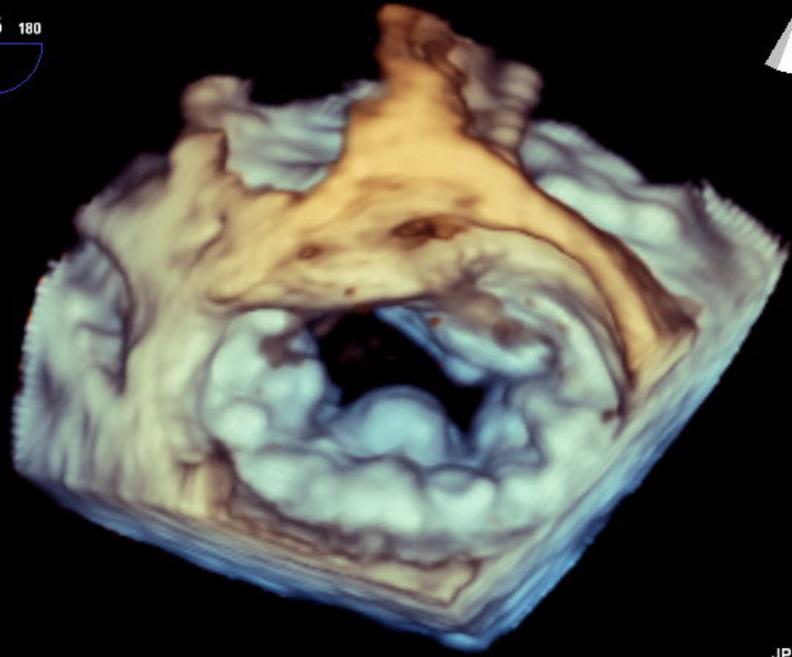
Live 3D  
3D 1%  
3D 40dB  
Pen



M4



Eco-TEE 3d

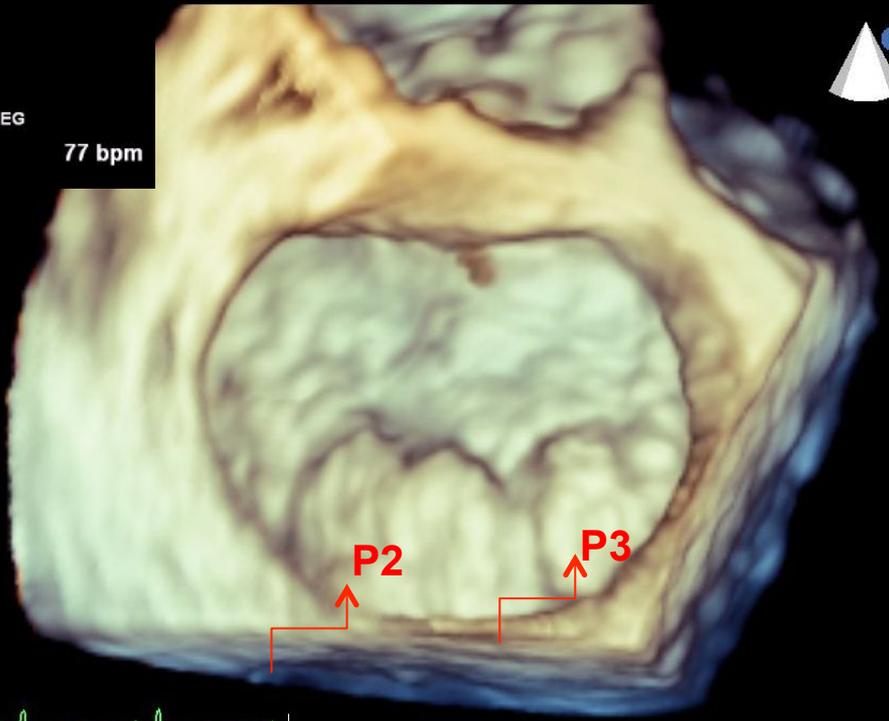


Temp. PAZ.: 37.0C  
Temp. TEE: 39.9C

Prolasso P2-P3

JPEG

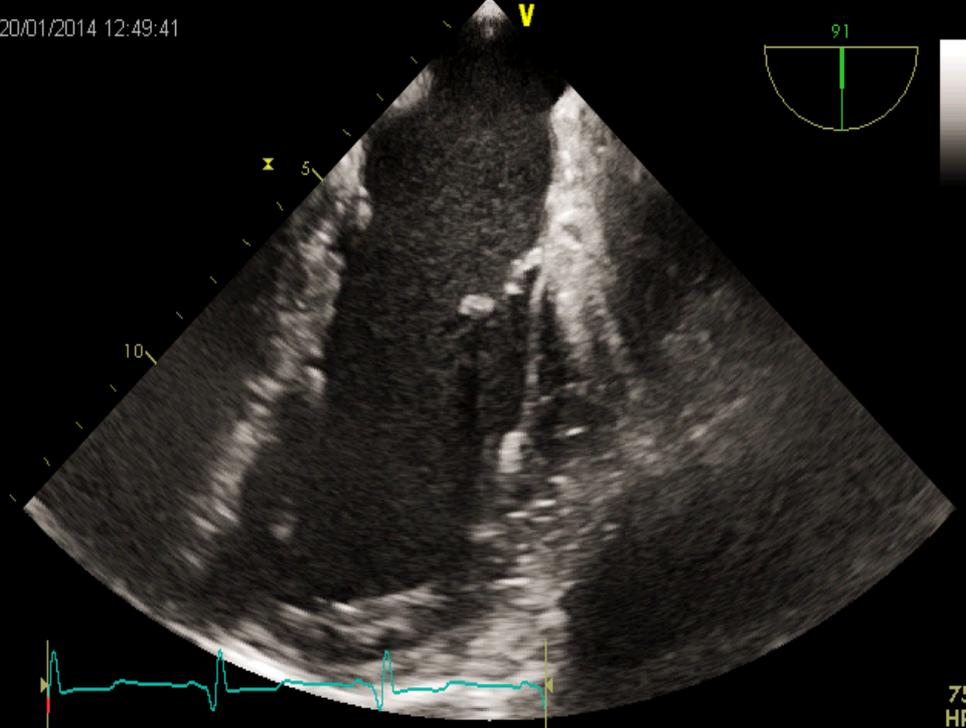
77 bpm



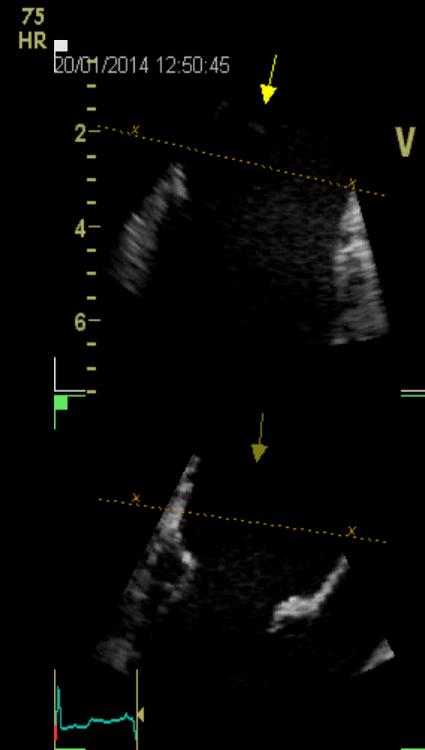
P2

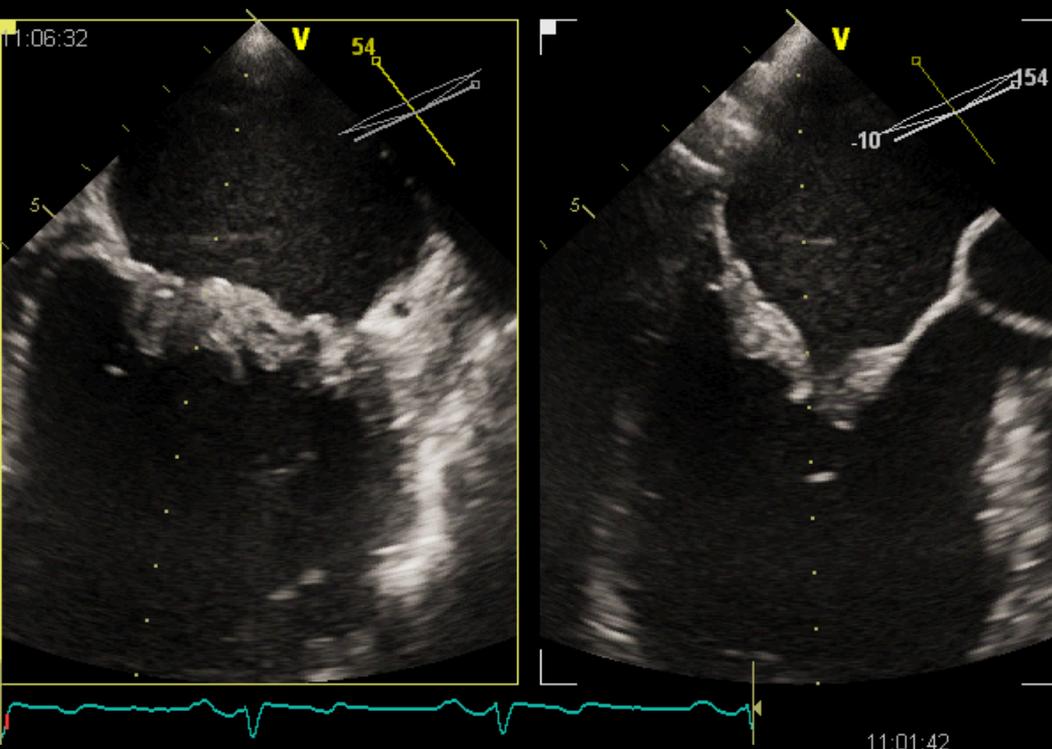
P3





*Prolasso A2*

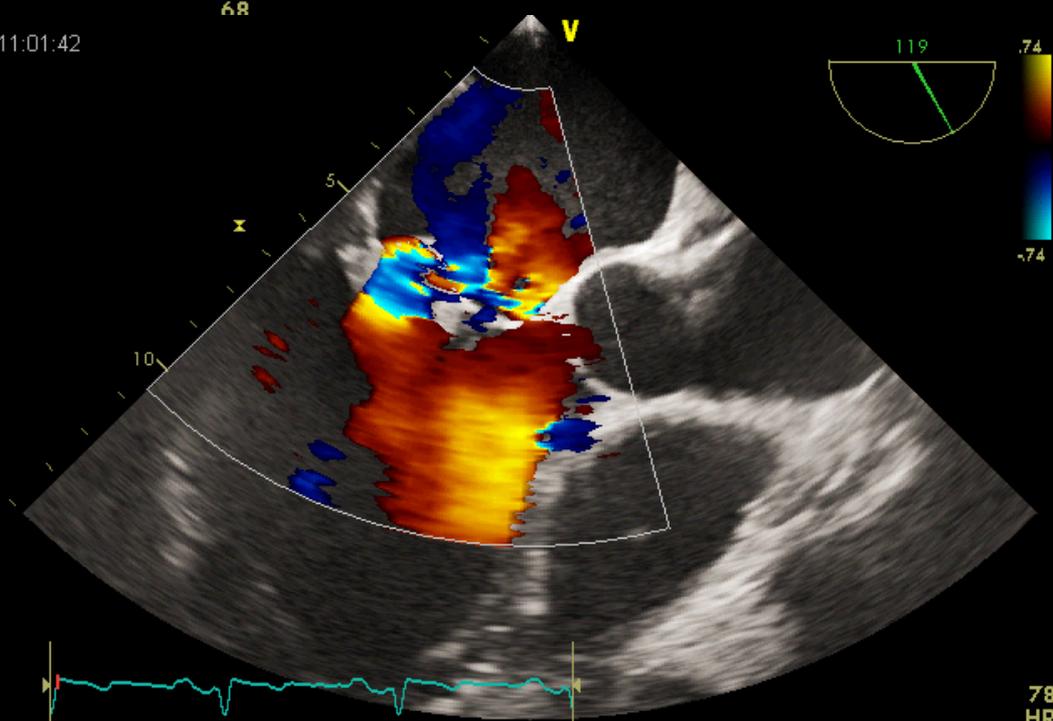




*Eco-TEE 2D*

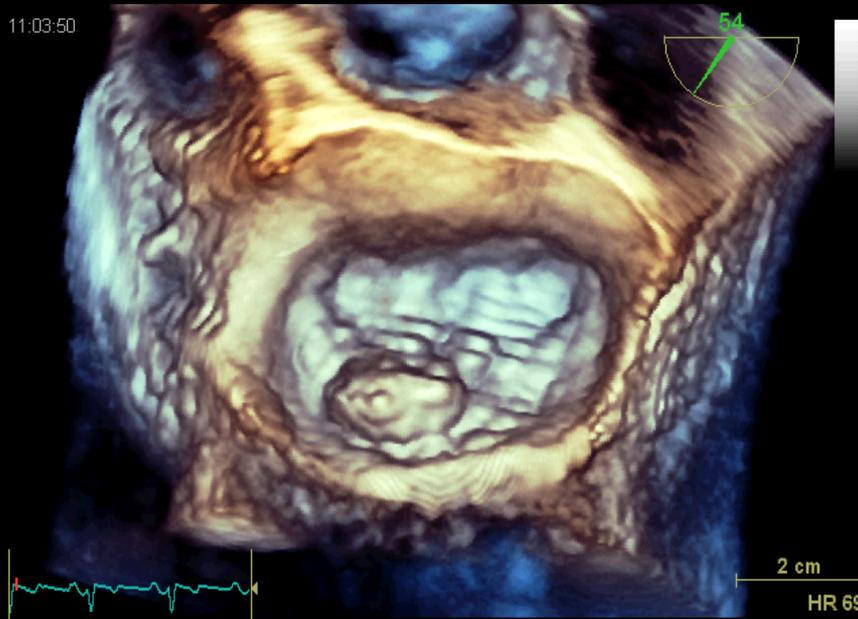
*Prolasso A2-P2  
(simmetrico)*

11:01:42



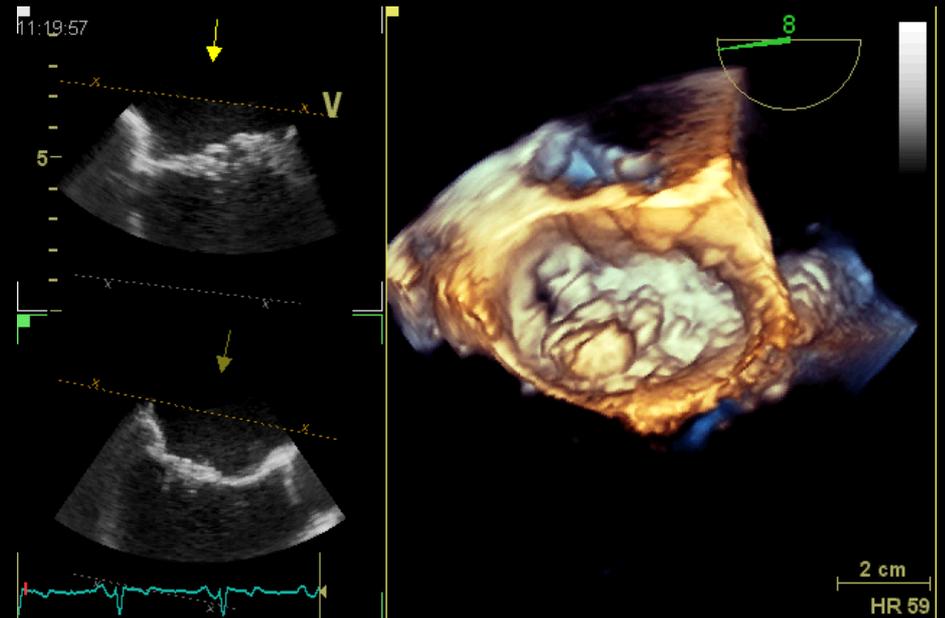
78  
HR

11:03:50



*Eco-TEE 3D*

*Prolasso A2-P2  
(simmetrico)*



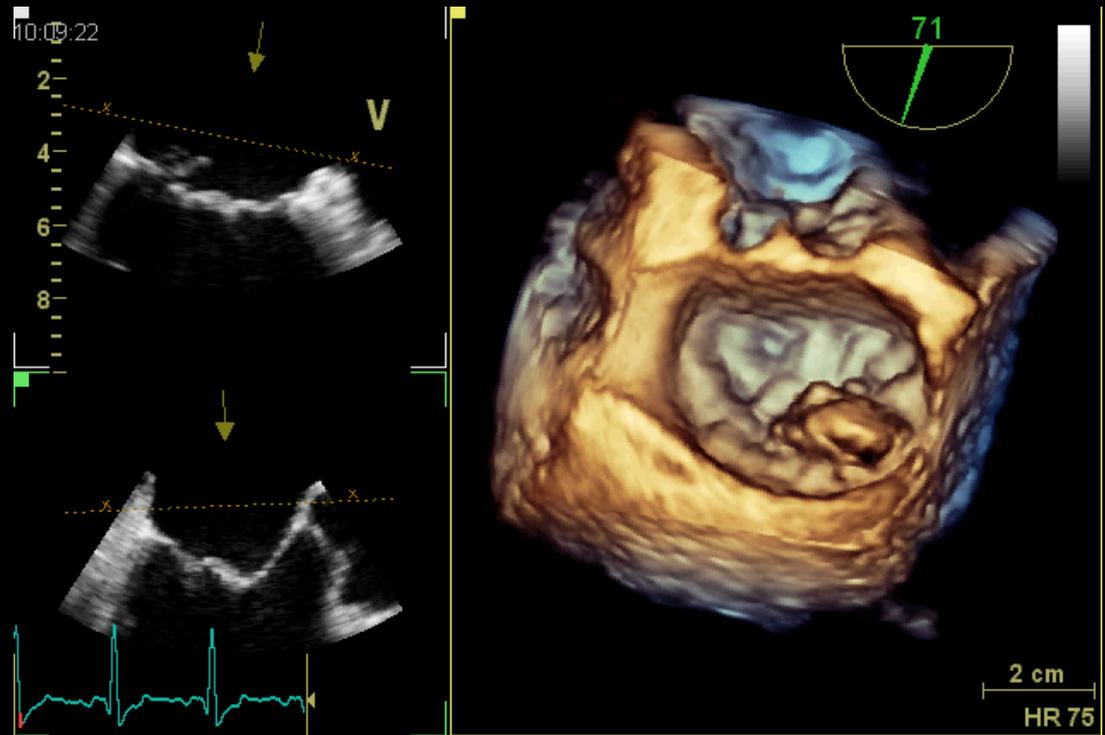
### 3D Echocardiography Improves Lesion Localization and Quantification

Compared with 2D TEE, 3D TEE not only allows better identification of a single prolapsed scallop but also helps identify the dominant lesion in patients with complex prolapse resulting from multisegment involvement or commissural lesions.<sup>1-3,5-9</sup>

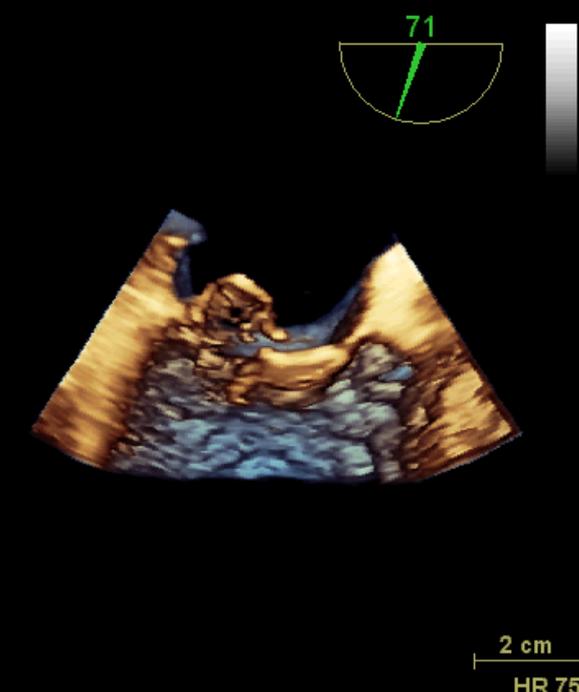
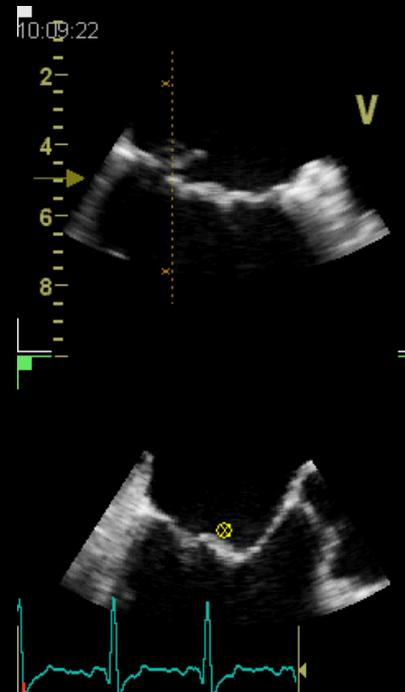
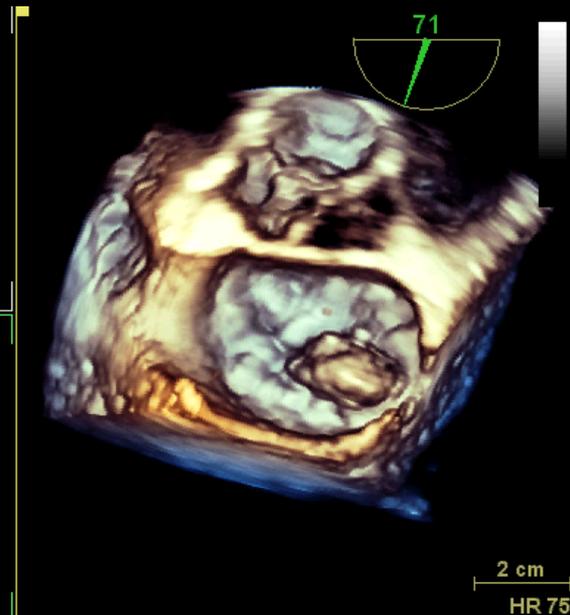
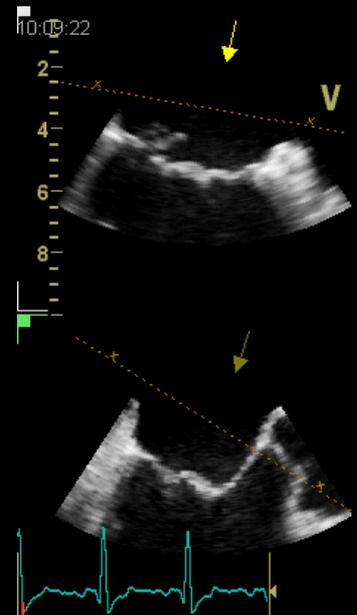
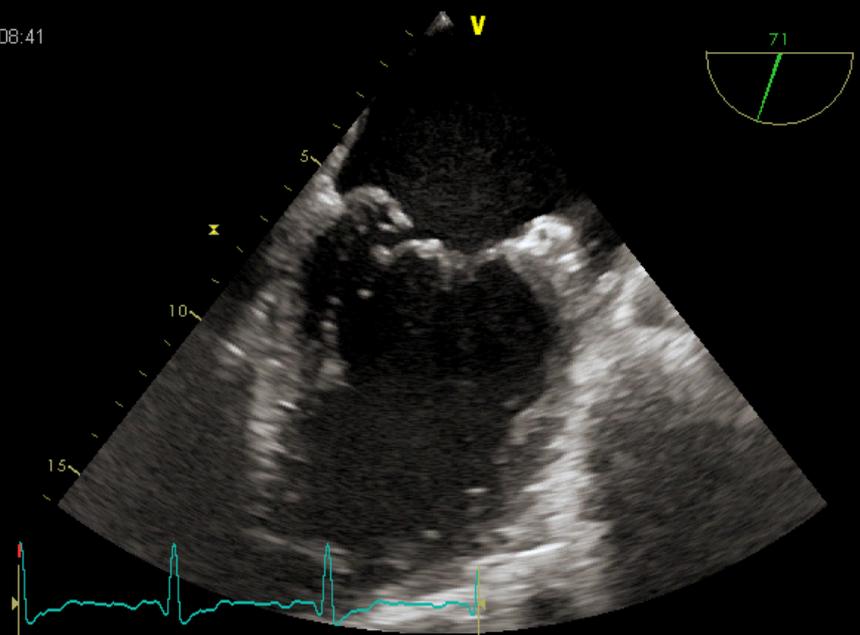
*Circulation. 2013*



*Lesione commissurale*

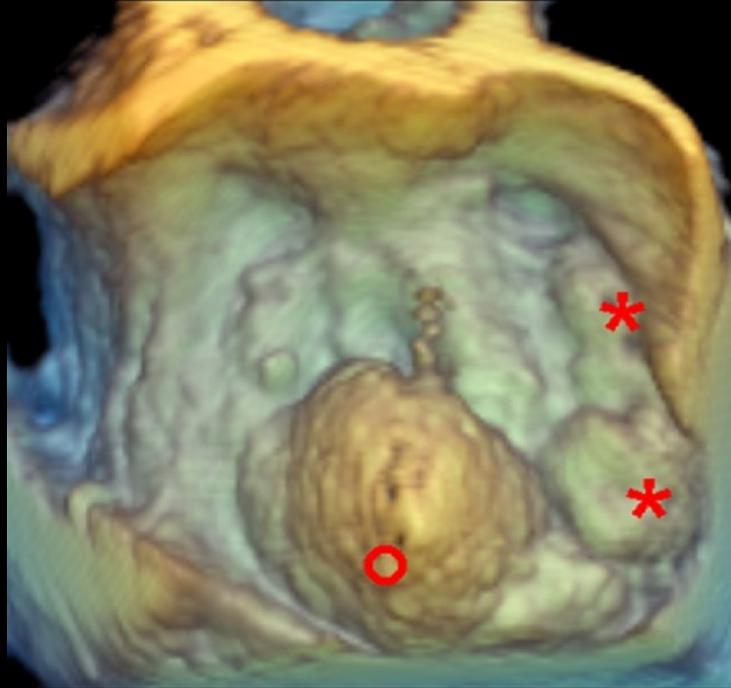


10:08:41



A: Pr.dominante  
B2-3: Pr.secondario

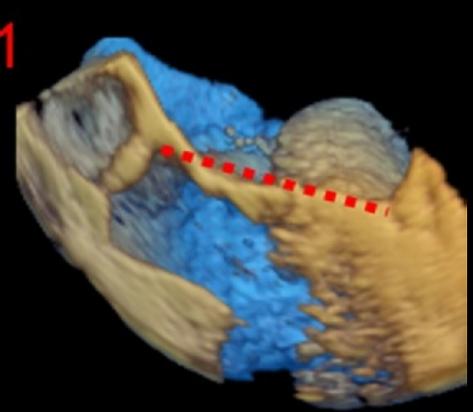
A



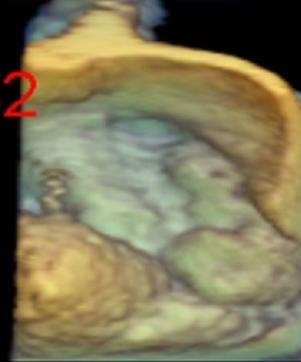
B1



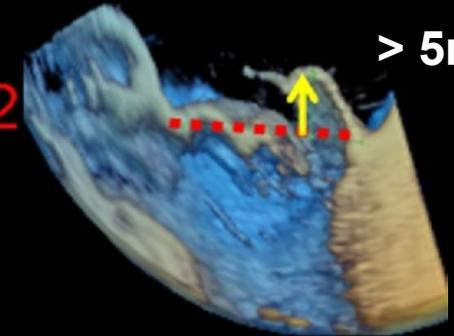
C1



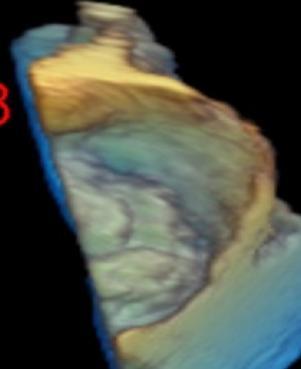
B2



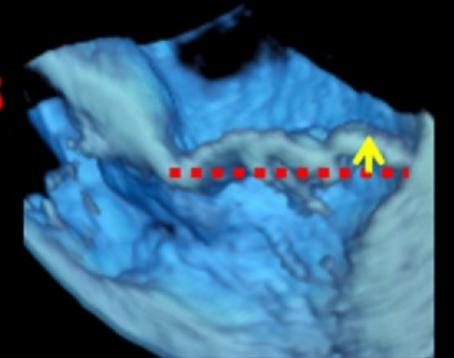
C2



B3



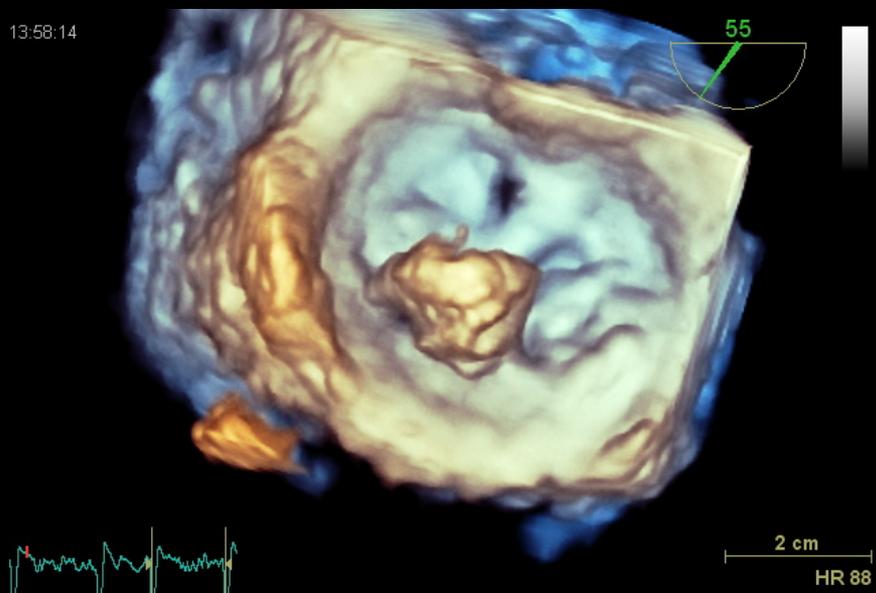
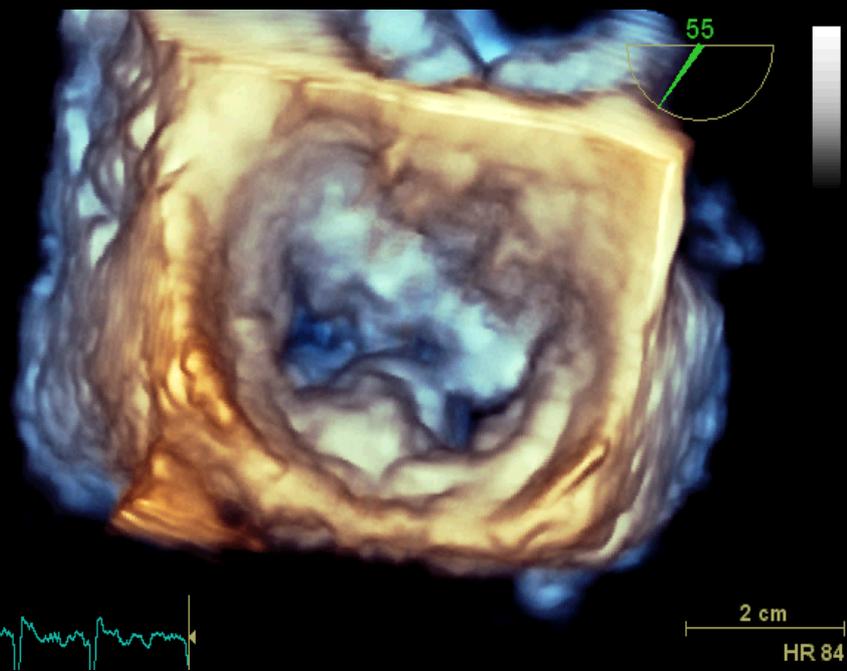
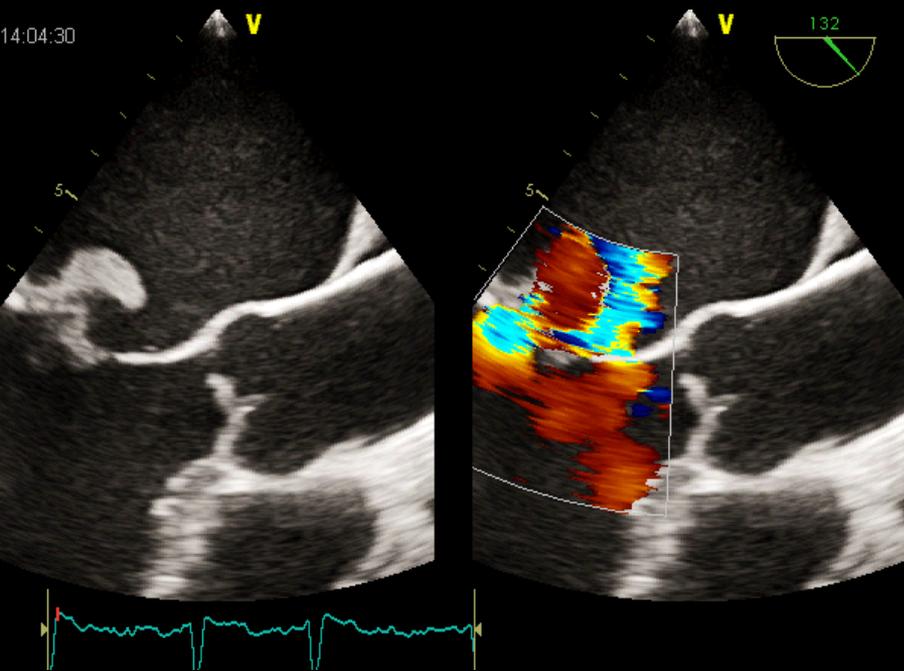
C3



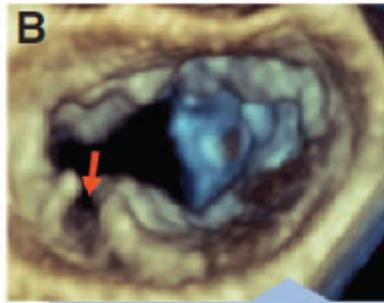
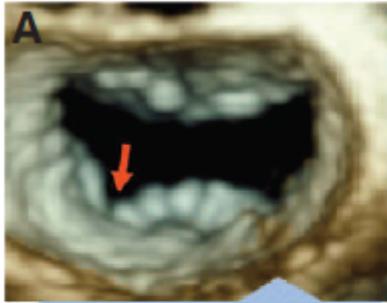
**Real-Time Three-Dimensional Transesophageal Echocardiography for Assessment of Mitral Valve Functional Anatomy in Patients With Prolapse-Related Regurgitation**

Giovanni La Canna et. Al, Am J Cardiol. 2011.

# Endocardite con perforazione LAM



# RT3D-TEE e cleft/subcleft



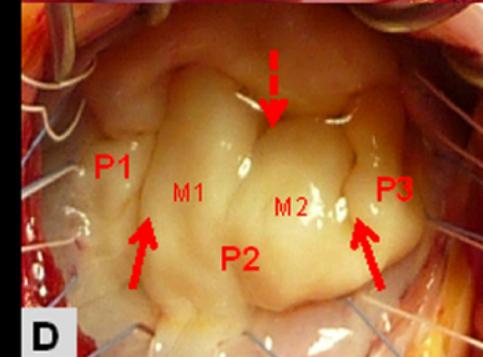
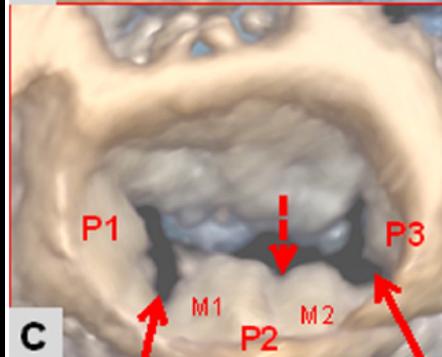
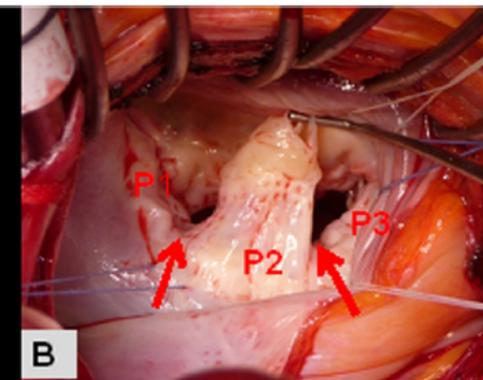
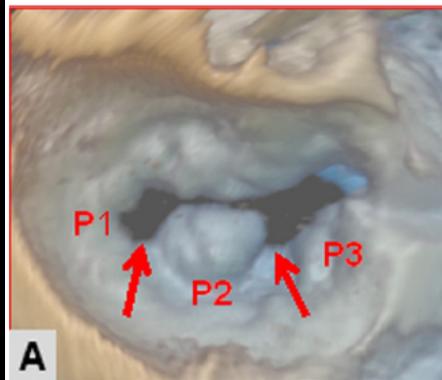
Indentation

- groove <50% of the leaflet

Cleft

- groove >50% of the leaflet

leaflet. In addition, RT3D-TEE provides a clear identification of the subclefts in P2 scallops in most patients, splitting P2 into 2 subsegments, P2-M1 and P2-M2, that receive chordae tendineae from the lateral and medial papillary muscles, respectively, as described by Kumar et al.<sup>12</sup> These additional findings, which can be clearly depicted by RT3D-TEE, might have implications, not only for surgical, but also for ongoing percutaneous valve repair in the clinical arena.<sup>4</sup>

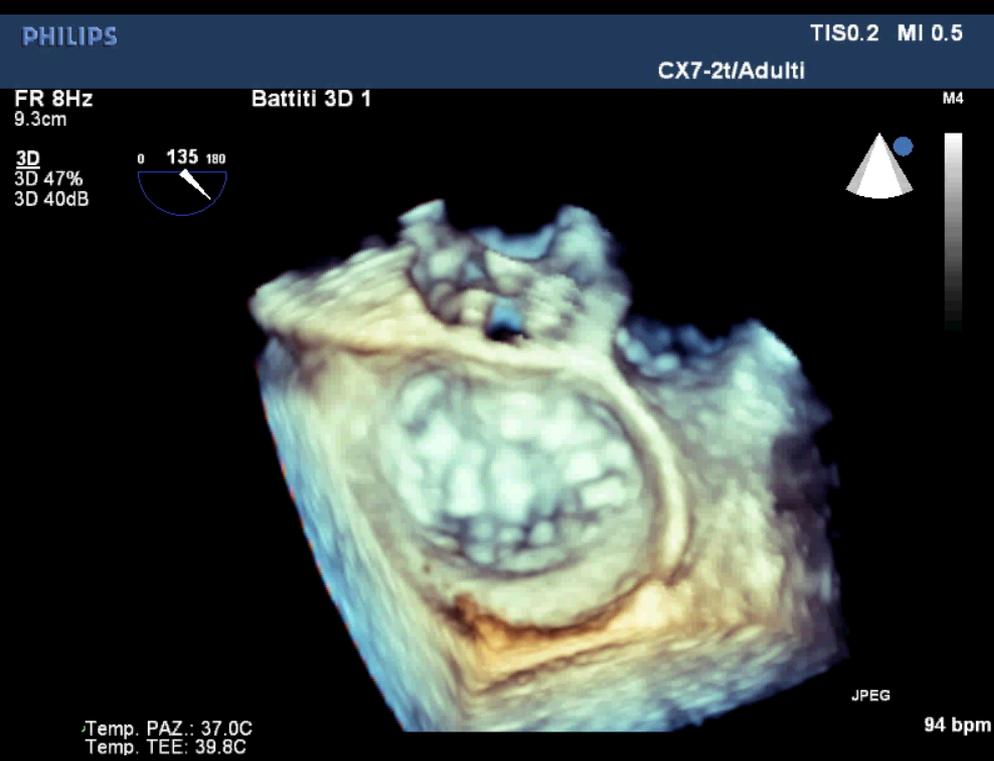


let lengths, respectively (Figure 1).<sup>5</sup> During surgical inspection while the heart is flaccid, these clefts and indentations are difficult to identify, especially when the scallops are diseased. Three-dimensional TEE examination of the mitral valve during ventricular systole improves identification of these leaflet abnormalities, which may be a source of residual postoperative mitral regurgitation (Figure 2). However, it must be noted that

*Circulation 2013*

**Real-Time Three-Dimensional Transesophageal Echocardiography for Assessment of Mitral Valve Functional Anatomy in Patients With Prolapse-Related Regurgitation**  
*Giovanni La Canna et. Al, Am J Cardiol. 2011.*

# RT3D-TEE Cleft P1-P2

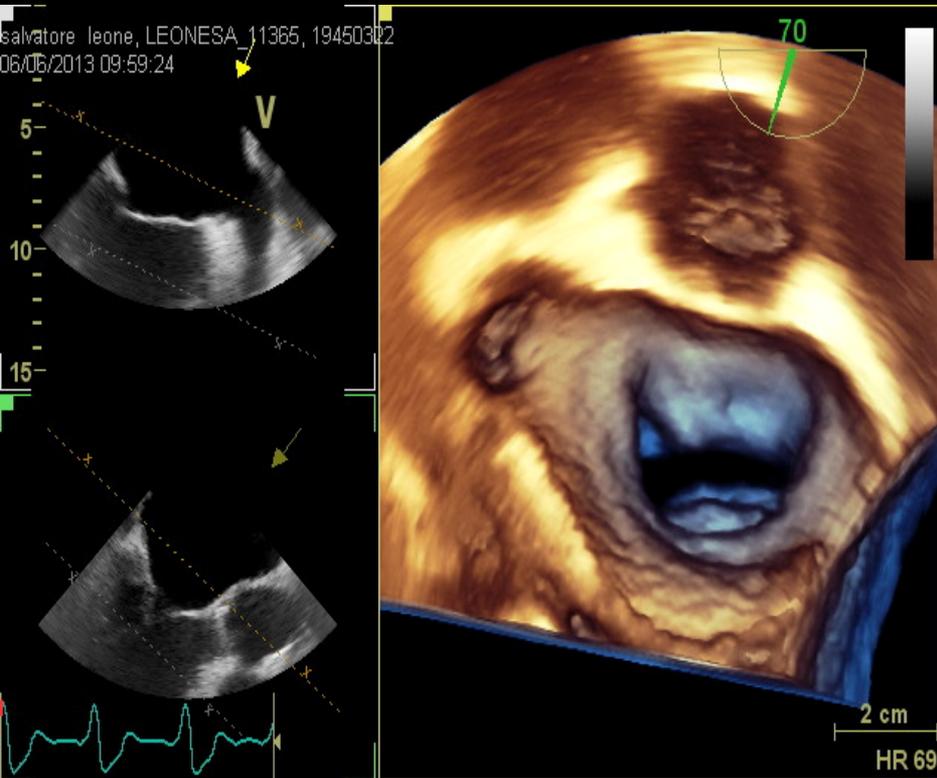


Visione atriale sn

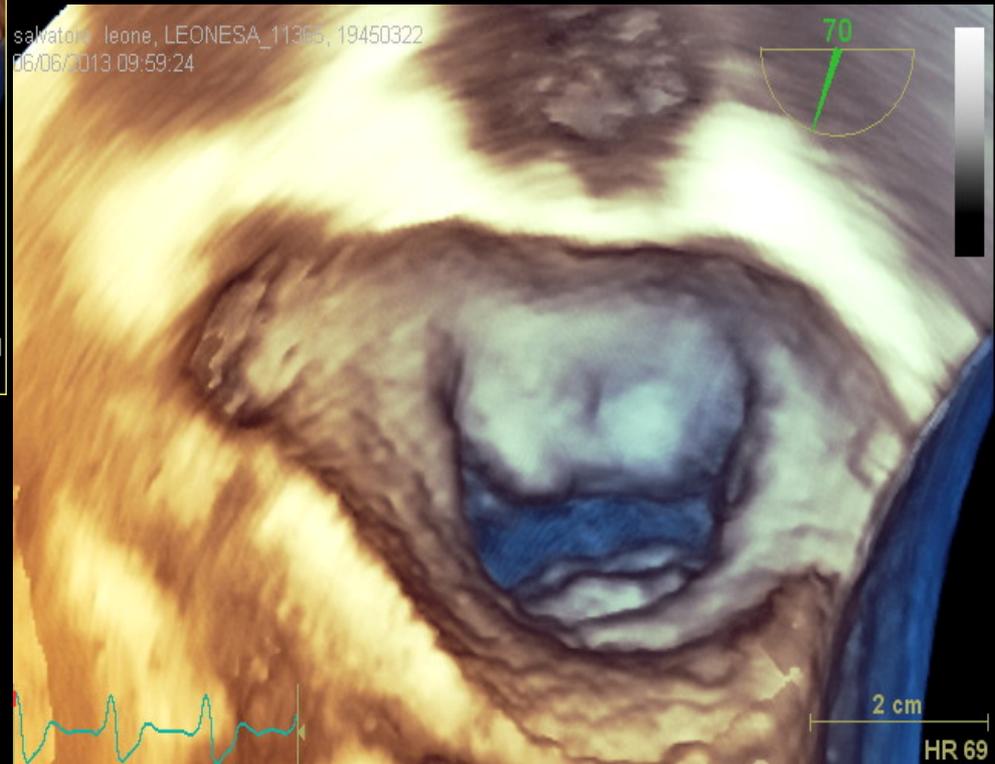


Visione versante Vsn

# 3D Echocardiography Improves the Identification of Mechanisms of Functional and Ischemic Mitral Regurgitation



***Diastasi cleft P1-P2***



# *Valutazione severità insufficienza mitralica Area Vena Contracta (VCA)*

## **Quantitation of Mitral Regurgitation**

Paul A. Grayburn, MD; Neil J. Weissman, MD; Jose L. Zamorano, MD  
Circulation, 2012.

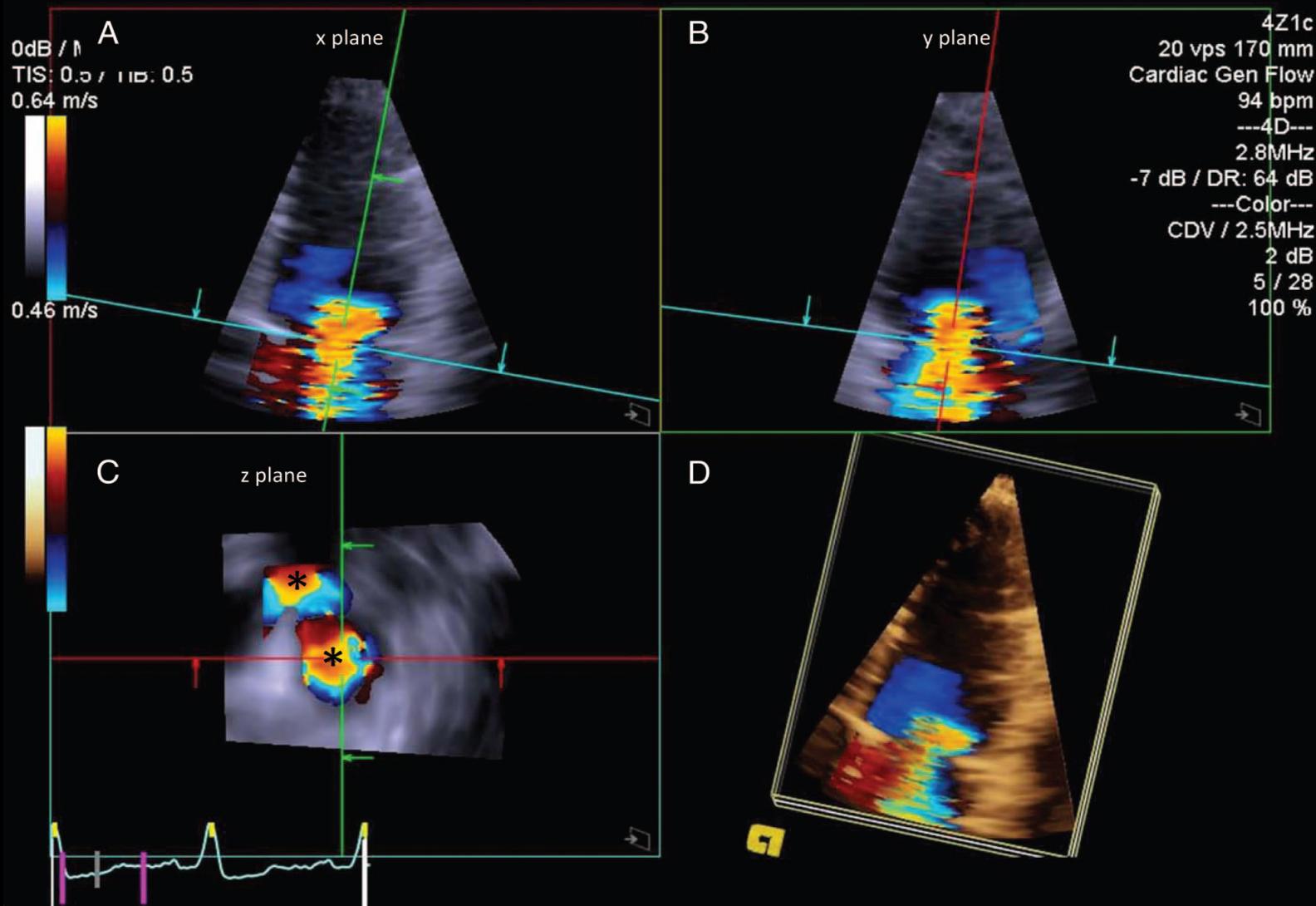
3D imaging with color Doppler allows direct assessment of the VCA, which corresponds to the EROA.

This method is especially useful when orifice shape is noncircular or when there are multiple MR jets.

## **Quantitative Assessment of Mitral Regurgitation**

Paaladinesh Thavendiranathan et al.  
JACC, 2012.

A cutoff of 0.41 cm<sup>2</sup> using 3D-VCA to differentiate moderate from severe MR showed an 82% sensitivity and 97% specificity.



**Full-volume color Doppler 3D-TTE view obtained from a single heartbeat in functional MR.** The vena contracta is assessed by use of the cropping planes (x, y, z) through the data set. **A**, 4-Chamber view with the narrowest vena contracta width (VCW) of the MR jet (x-plane). **B**, 2-Chamber view with the widest VCW of The MR jet (y-plane). **C**, Short-axis view showing the true vena contracta areas (\*) of 2 adjacent MR jets (z-plane).

# Vantaggi VCA

- Non influenzata dalle caratteristiche geometriche EROA

*IM funzionale  
Shape non circolare  
Orificio rigurg asimmetrico*

- Stima accurata in presenza jets multipli (area vs diametro)

Direct Measurement of Multiple Vena Contracta Areas for Assessing the Severity of Mitral Regurgitation Using 3D TEE

*Hyodo E. et al, JACC 2012*

**RESULTS** The correlation of the sum of the multiple 3D VC areas with EROAstd ( $r = 0.90, p < 0.01$ ) was higher than that of the sum of the multiple 2D VC diameters ( $r = 0.56, p < 0.01$ ), particularly with MR degrees greater than mild ( $r = 0.80, p < 0.01$  vs.  $r = 0.05, p = 0.81$ ) and in cases of 3 or more regurgitant jets ( $r = 0.91, p < 0.01$  vs.  $r = 0.46, p = 0.05$ ).

**CONCLUSIONS** Direct measurement of multiple VC areas using 3D transesophageal echocardiography allows for assessing MR severity in patients with multiple jets, particularly for MR degrees greater than mild and in cases of more than 2 jets, for which geometric assumptions may be challenging. (J Am Coll Cardiol Img 2012;5:669–76) © 2012 by the American College of Cardiology Foundation

# Limiti VCA

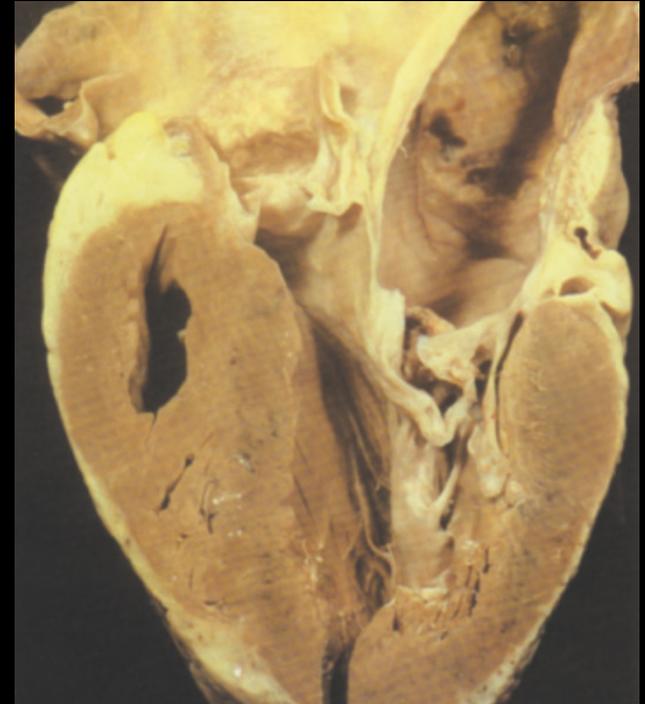


- Limitata dal frame sistolico selezionato
- Appropriata ricostruzione multiplanare → **sovrastima jet eccentrici**
- Dipendenza scala del colore → **sovrastima VCA**
- Angolo dipendenza del segnale Doppler multiplo → **sottostima VCA**
- "Stiching artifacts" (acquisizioni 3D multiple-beat)

# Stenosi mitralica

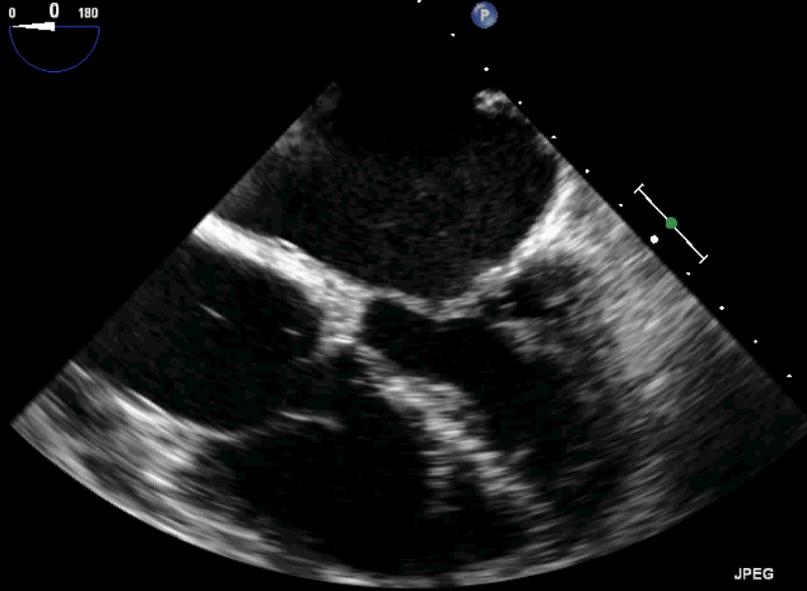
Ostruzione dell'apparato valvolare che separa l'atrio sinistro dal ventricolo sinistro

- Acquisita
  - **Reumatica (oltre 90%)**
  - LES
  - AR
  - Amiloidosi
  - Lesioni neoplastiche o trombotiche atriali sinistre
  - Calcificazione dell'anulus (anziano)
  - Disfunzione protesica
- Congenita (rara): mitrale a paracadute



FR 50Hz  
12cm

M4

2D  
67%  
C 50  
P Off  
Gen.G  
P R

JPEG

Temp. PAZ : 37.0C  
Temp. TEE< 37.0C

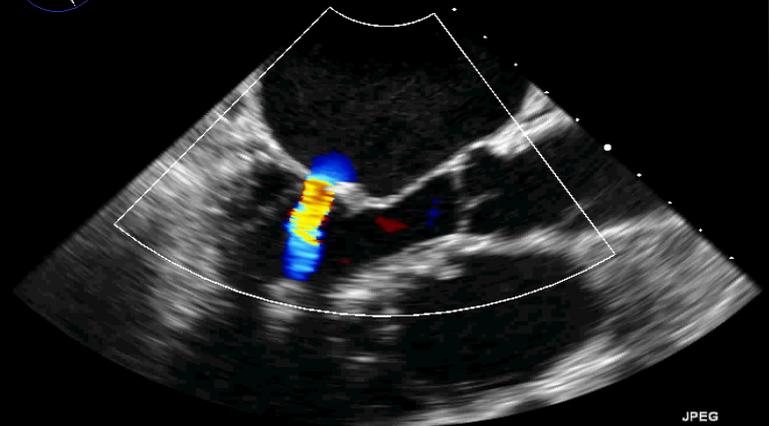
90 bpm

**Eco-TEE 2D**

- **Ridotto movimento apertura lembi**
- **Ispessimento lembi**
- **Incurvatura diastolica (LAM)**
- **IM associata**

FR 12Hz  
12cm

M4 M4

2D  
70%  
C 50  
P Off  
Gen.CF  
59%  
4.4MHz  
WF Alto  
Med.G  
P R+61.6  
-61.6  
cm/sTemp. PAZ : 37.0C  
Temp. TEE< 37.0C

JPEG

92 bpm

# Eco-TEE 3D

PHILIPS

TIS0.2 MI 0.5

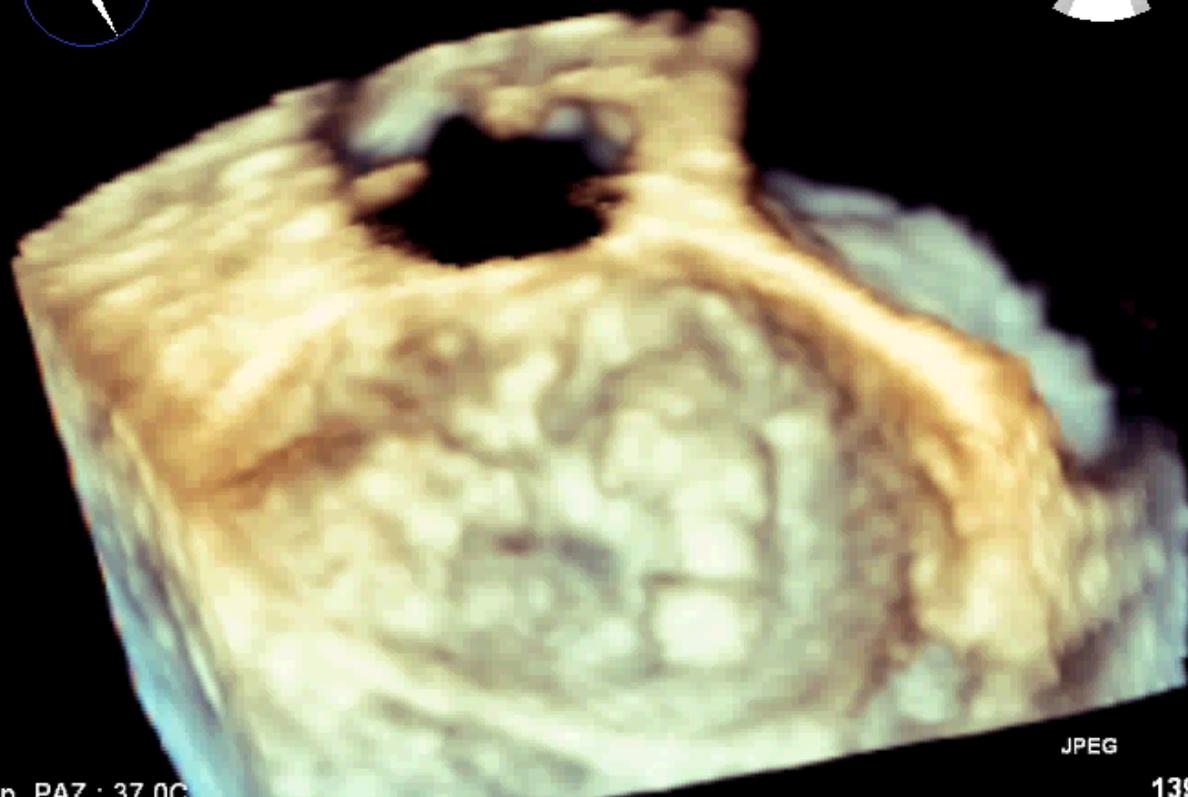
CX7-2t/Adulti

FR 10Hz  
7.5cm

Battiti 3D 1

M4

3D  
3D 48%  
3D 40dB



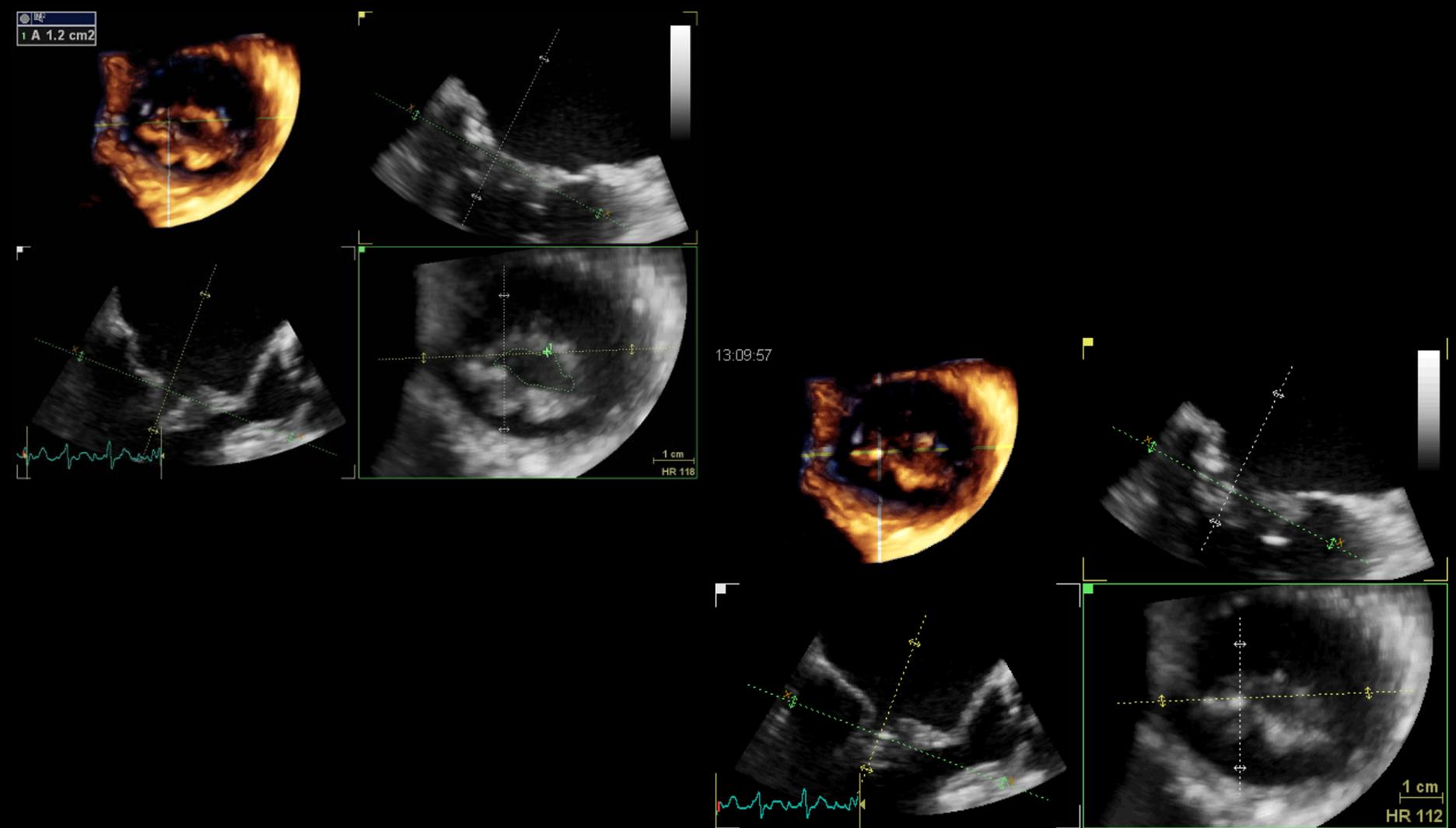
Temp. PAZ.: 37.0C  
Temp. TEE< 37.0C

JPEG

139 bpm

# Stima della severità della stenosi

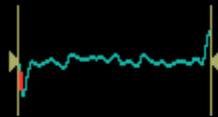
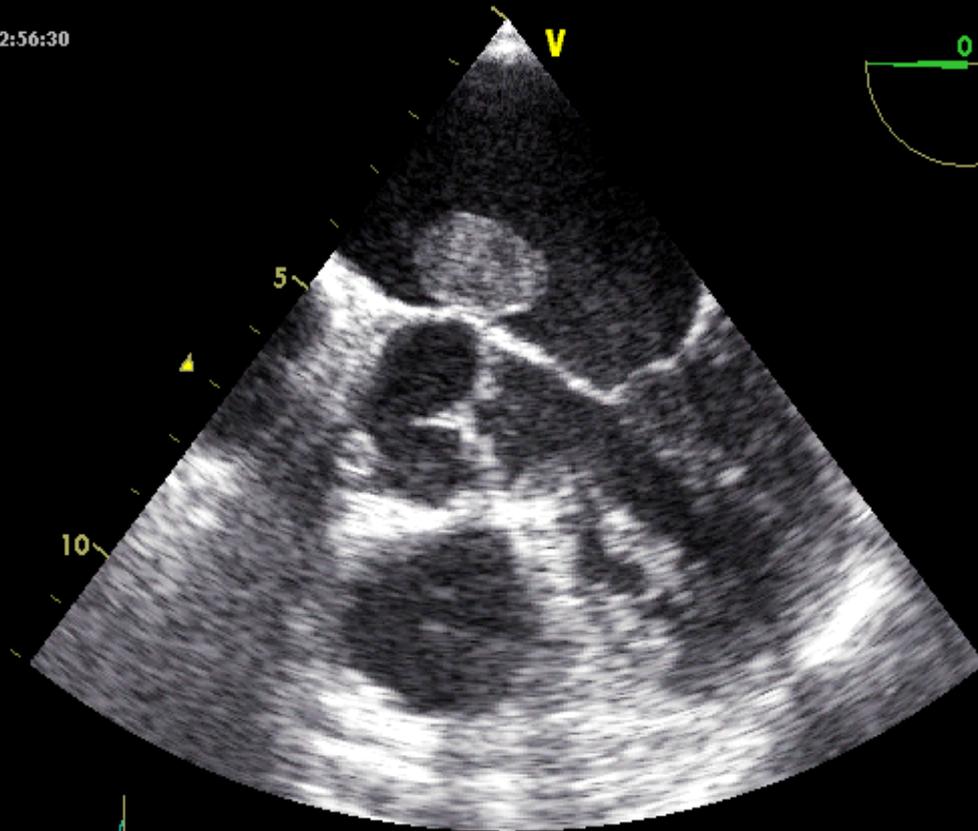
## Area Planimetrica



# Patologie associate

## Trombi

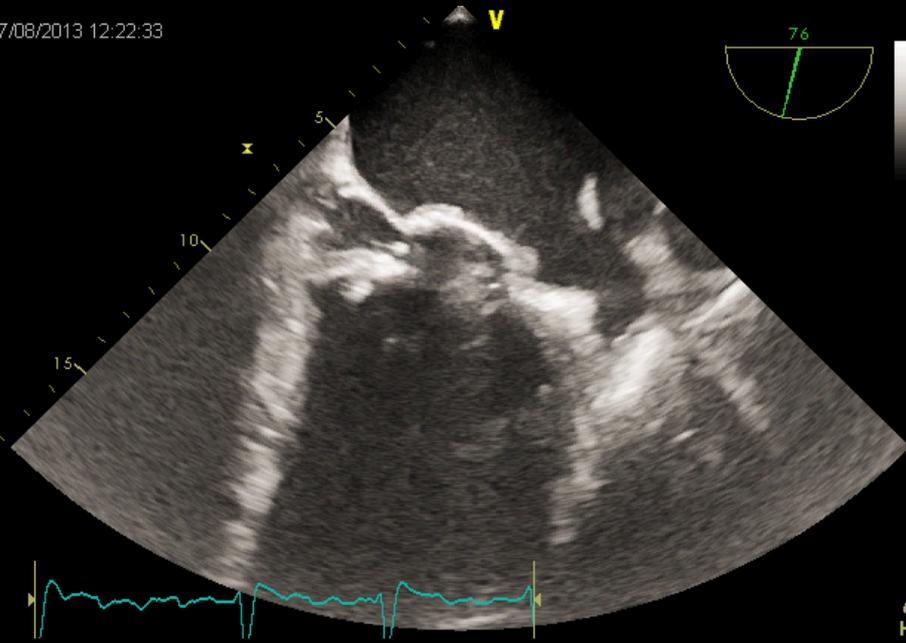
18/10/2007 12:56:30



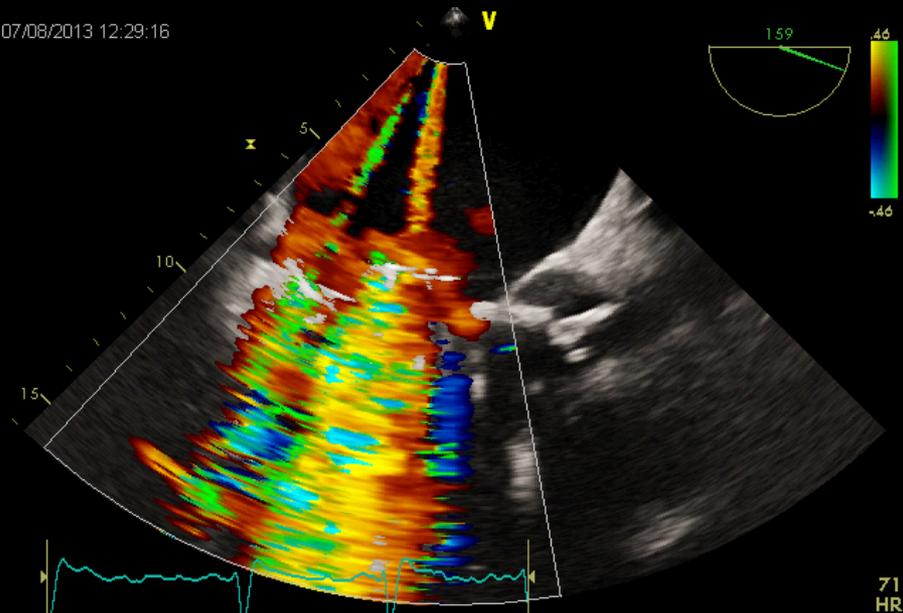
83  
HR

# Studio disfunzione protesica

07/08/2013 12:22:33



07/08/2013 12:29:16



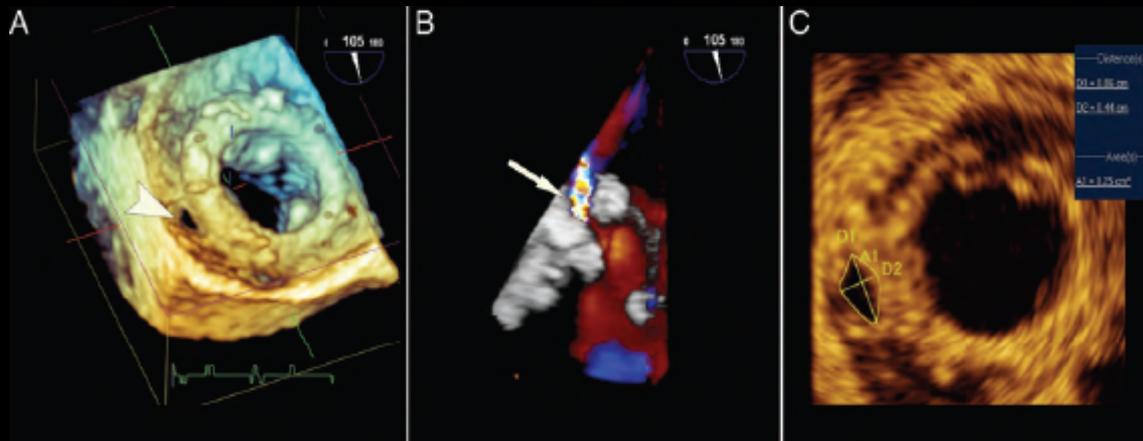
# Studio disfunzione protesica

## Review of surgical prosthetic paravalvular leaks: diagnosis and catheter-based closure

Chad Kliger, Rocio Eiros, Guillermo Isasti, Bryce Einhorn, Vladimir Jelnin, Howard Cohen, Itzhak Kronzon, Gila Perk, Gregory P. Fontana, and Carlos E. Ruiz\*

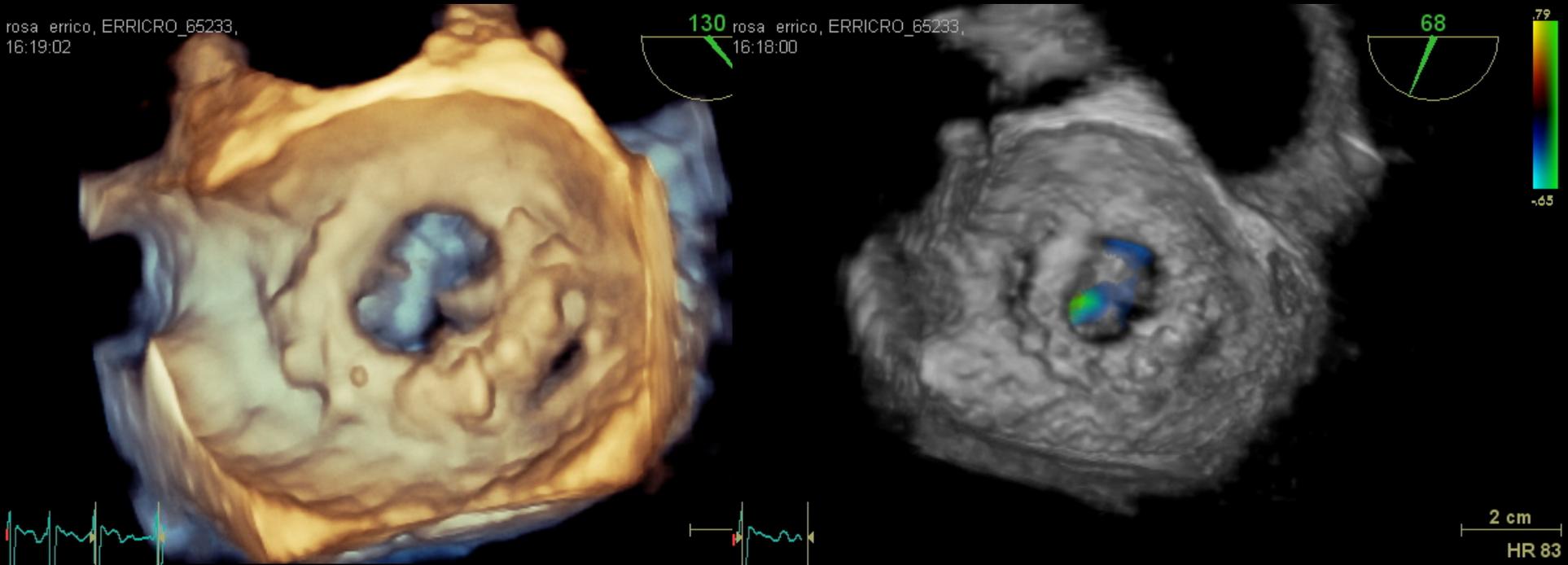


European Heart Journal (2013) 34, 638–648  
doi:10.1093/eurheartj/ehs347



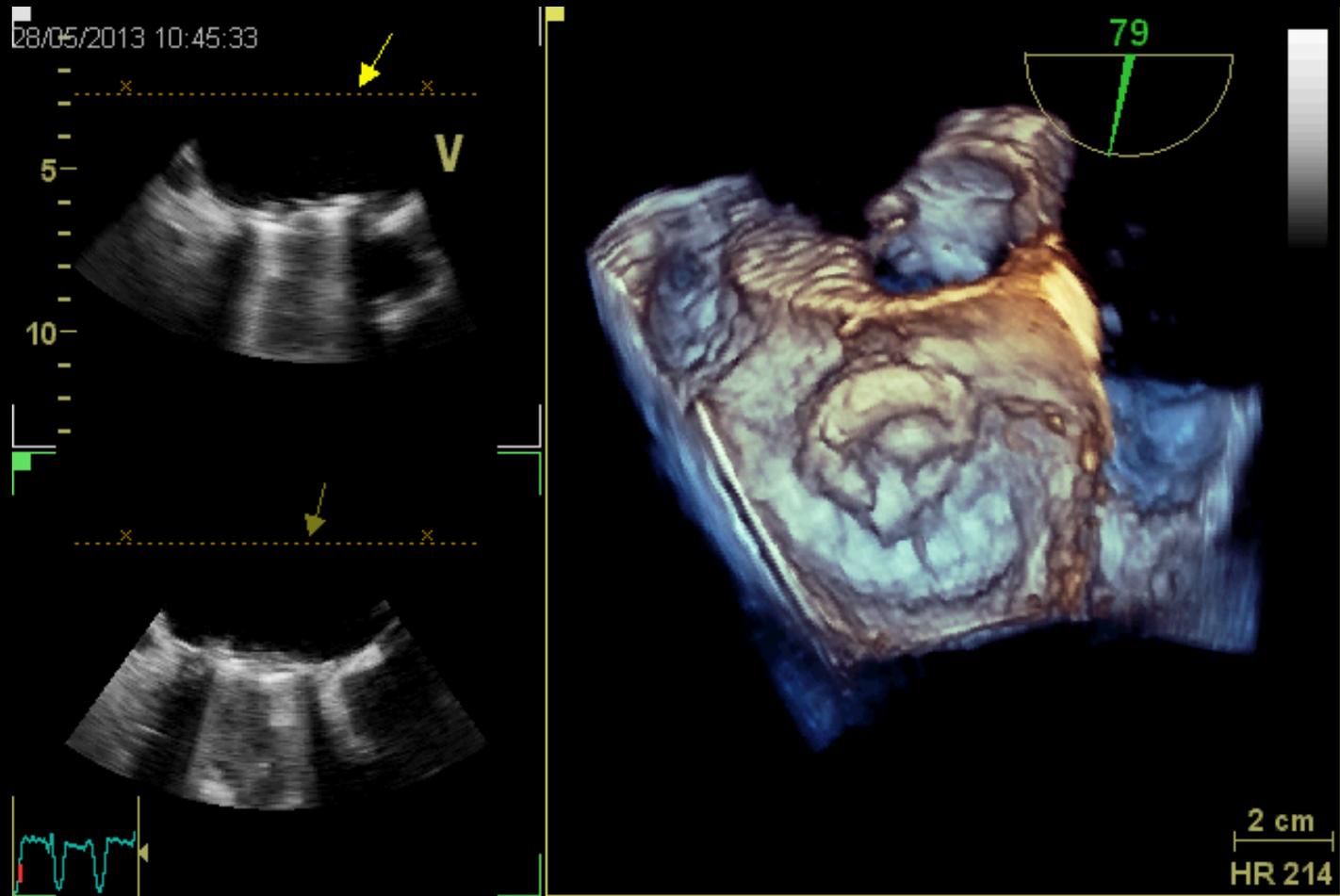
- Migliore localizzazione leak
- Analisi accurata delle dimensioni e dello shape
- Valida guida nella chiusura percutanea

# Studio disfunzione protesica



*Leak paravalvolare mitralico a localizzazione posteromediale  
(ore 3-4)*

# Studio disfunzione protesica



*Ampio leak paravalvolare mitralico a localizzazione antero-laterale  
Morfologia a losanga, non sepimentato*

# *Conclusioni*

## *Eco-TEE e valore incrementale dell'ECO-3D*

- Accurata valutazione anatomico-funzionale della valvola mitrale
- Identificazione del meccanismo anatomico-funzionale del rigurgito con impatto nella pianificazione delle strategie riparative
- Migliore valutazione quantitativa della severità dell'insufficienza mitralica attraverso la tecnica 3D color Doppler (spt nei jet multipli)
- Stima più precisa dell'Area mitralica
- Informazioni aggiuntive nelle procedure percutanee



**ECOCARDIOGRAFIA 2015**  
**XVII Congresso Nazionale SIEC**  
Hotel Royal Continental  
Napoli, 16-18 Aprile 2015

*Grazie per l'attenzione*