Il ruolo clinico dell'ecocardiografia 3D

Francesco F Faletra
Fondazione Cardiocentro Ticino

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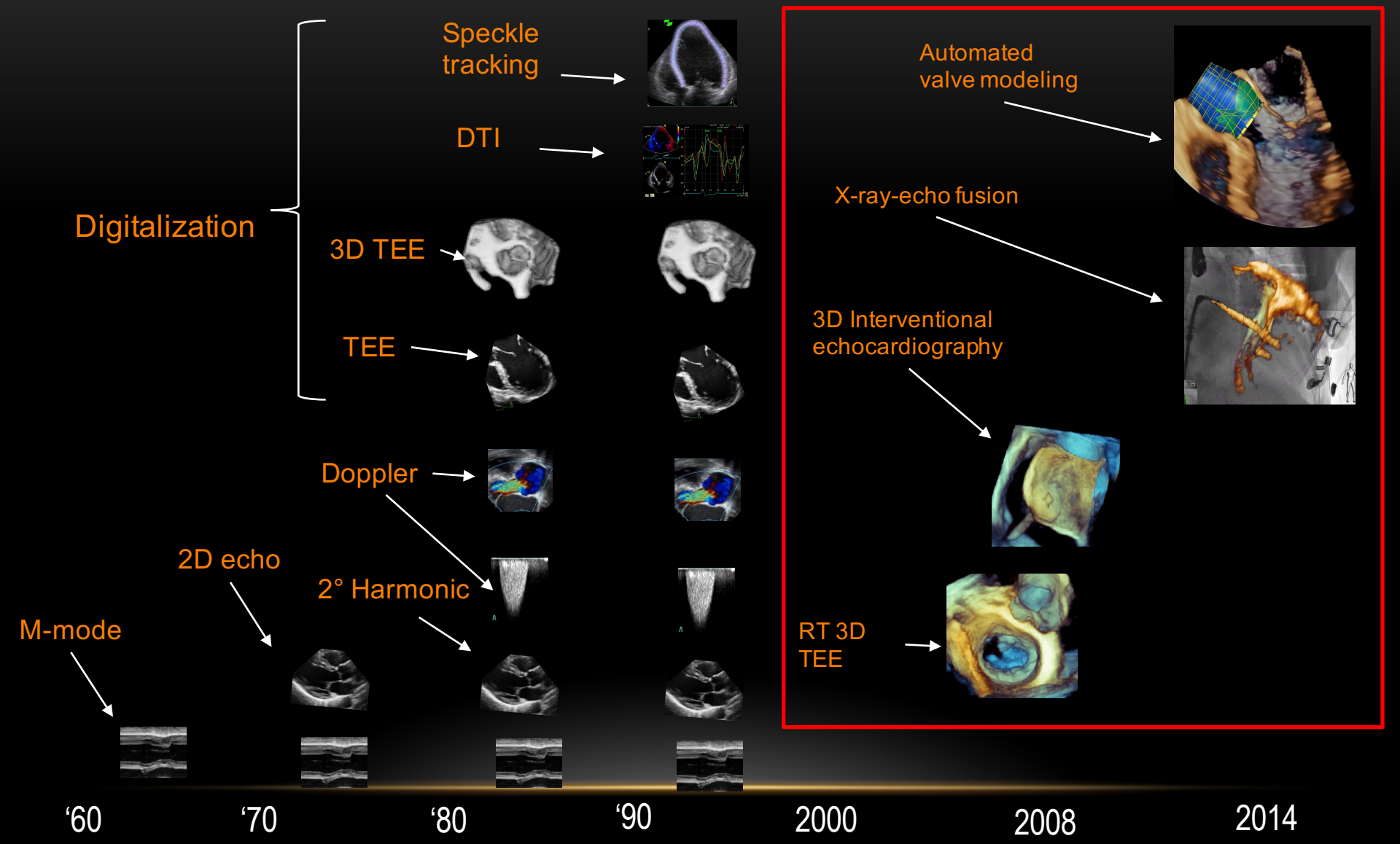
The evolution of echocardiography



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The clinical role of 3D echocardiography

- Quantitative assessment of cardiac chambers
- Teaching cardiac anatomy
- Anatomical assessment of structural heart disease
- Guidance of interventional procedures
- Automated valve quantitative modeling

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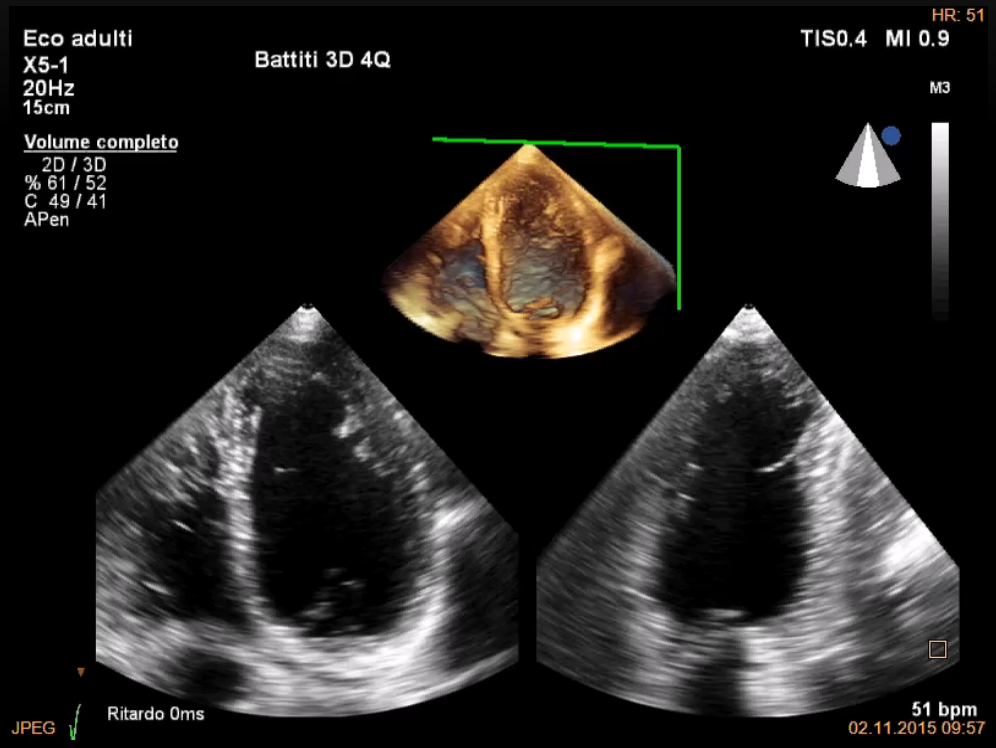
LV Volumes



Average

EF	63.42 %
EDV	122.87 ml
ESV	44.92 ml
SV	77.95 ml

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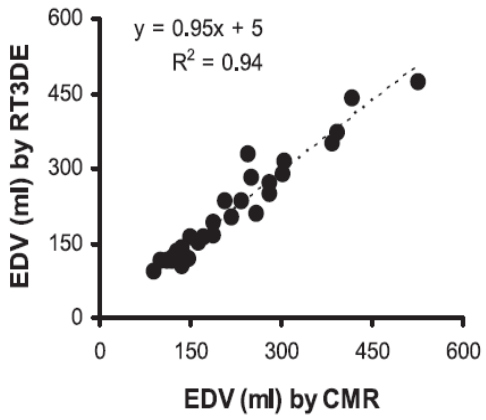
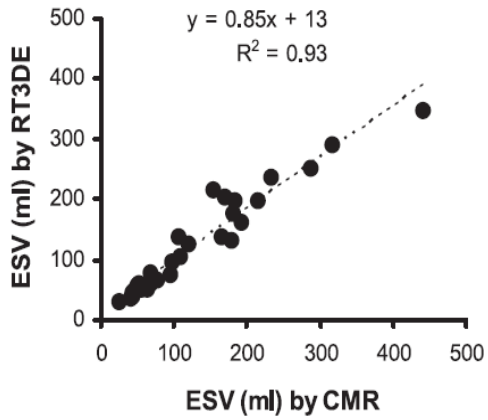
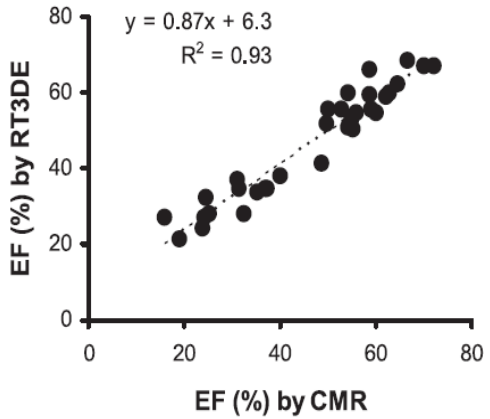
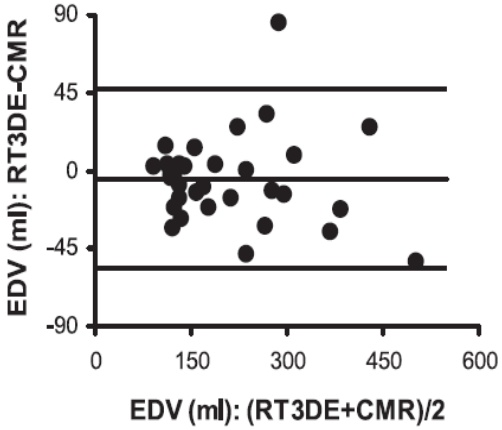
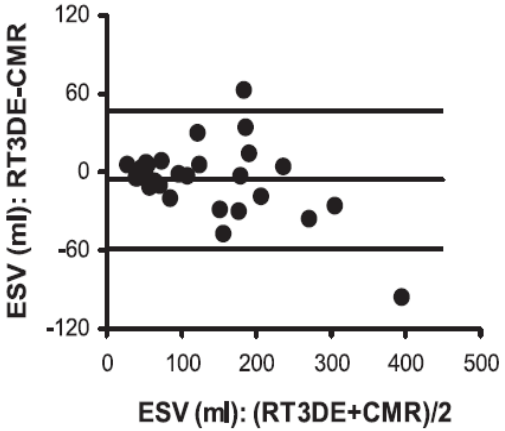
Quantitati[illegible]tion

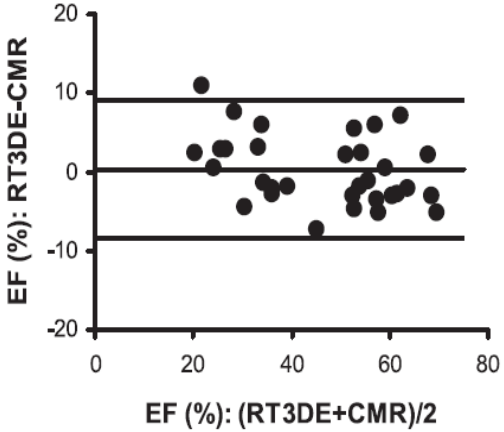












variability. (***Circulation*. 2006;114:654-661.**)

Key Words: imaging ■ echocardiography ■ magnetic resonance imaging ■ tomography

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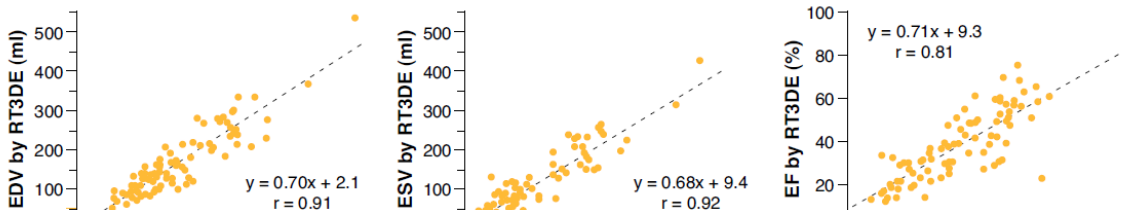
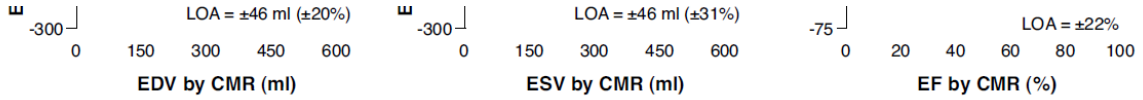
Real-Time 3-Dimensional Echocardiographic Quantification of Left Ventricular Volumes

Multicenter Study for Validation With Magnetic Resonance Imaging and Investigation of Sources of Error

Victor Mor-Avi, PhD,* Gaby Jenkins, MS,† Harald P. Kühl, MD,†



CONCLUSIONS The RT3DE-derived LV volumes are underestimated in most patients because RT3DE imaging cannot differentiate between the myocardium and trabeculae. To minimize this difference, tracing the endocardium to include trabeculae in the LV cavity is recommended. With the understanding of these intermodality differences, RT3DE quantification of LV volume is a reliable tool that provides clinically useful information. (J Am Coll Cardiol Img 2008;1:413–23) © 2008 by the American College of Cardiology Foundation



RESULTS The RT3DE-derived LV volumes correlated highly with CMR values (EDV: r = 0.91; ESV: r = 0.93), but were 26% and 29% lower consistently across institutions, with the magnitude of the bias being inversely related to the level of experience. The RT3DE measurements were less reproducible (4% to 13%) than CMR measurements (4% to 7%). Minimal changes in endocardial surface position (1 mm) resulted in significant differences in measured volumes (11%). Exclusion of trabeculae and mitral valve plane from the CMR reference eliminated the intermodality bias.

CONCLUSIONS The RT3DE-derived LV volumes are underestimated in most patients because RT3DE imaging cannot differentiate between the myocardium and trabeculae. To minimize this difference, tracing the endocardium to include trabeculae in the LV cavity is recommended. With the understanding of these intermodality differences, RT3DE quantification of LV volume is a reliable tool that provides clinically useful information. (J Am Coll Cardiol Img 2008;1:413–23) © 2008 by the American College of Cardiology Foundation

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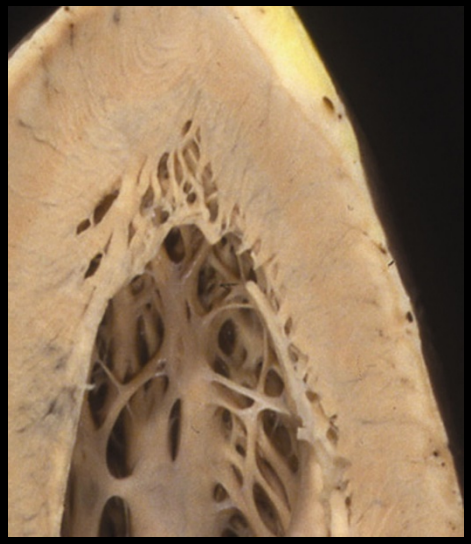
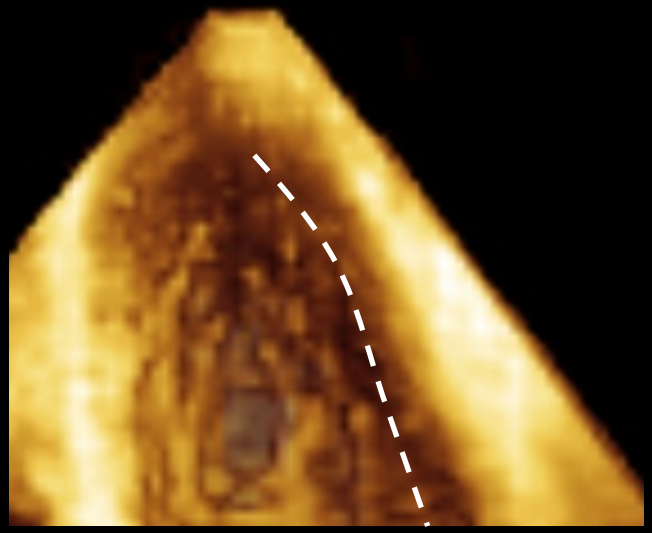
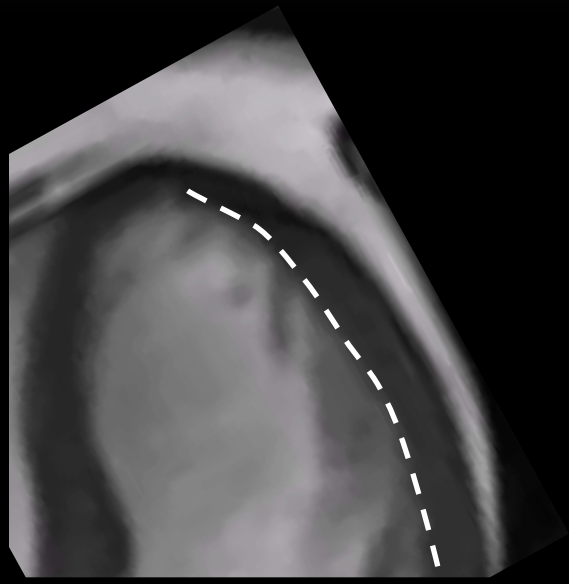
LV Volumes







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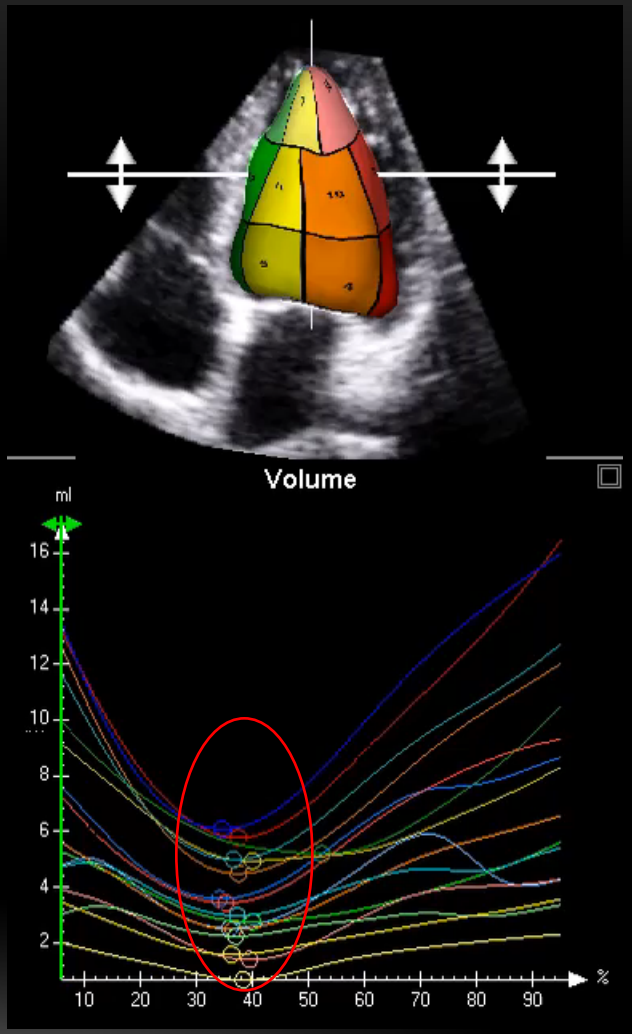
LV synchronicity



Dyssynchrony

Real-Time Three-Dimensional Echocardiography

A Novel Technique to Quantify Global Left Ventricular Mechanical Dyssynchrony

S. Kapetanakis, MBBS; M.T. Kearney, MD; A. Siva, PhD; N. Gall, MD; M. Cooklin, MD; M.J. Monaghan, PhD

Background—Left ventricular (LV) mechanical dyssynchrony (LVMD) has emerged as a therapeutic target using cardiac resynchronization therapy (CRT) in selected patients with chronic heart failure. Current methods used to evaluate LVMD are technically difficult and do not assess LVMD of the whole LV simultaneously. We developed and validated real-time 3D echocardiography (RT3DE) as a novel method to assess global LVMD.

Methods and Results—Eighty-nine healthy volunteers and 174 unselected patients referred for routine echocardiography underwent 2D echocardiography and RT3DE. RT3DE data sets provided time-volume analysis for global and segmental LV volumes. A systolic dyssynchrony index (SDI) was derived from the dispersion of time to minimum regional volume for all 16 LV segments. Healthy subjects and patients with normal LV systolic function had highly synchronized segmental function (SDI, 3.5±1.8% and 4.5±2.4%; $P=0.7$). SDI increased with worsening LV systolic function regardless of QRS duration (mild, 5.4±0.83%; moderate, 10.0±2%; severe LV dysfunction, 15.6±1%; P for trend <0.001). We found that 37% of patients with moderate to severe LV systolic dysfunction had significant dyssynchrony with normal QRS durations (SDI, 14.7±1.2%). Twenty-six patients underwent CRT. At long-term follow-up, responders demonstrated reverse remodeling after CRT with a significant reduction in SDI (16.9±1.1% to 6.9±1%; $P<0.0001$) and end-diastolic volume (196.6±17.3 to 132.1±13.5 mL; $P<0.0001$) associated with an increase in LV ejection fraction (17±2.2% to 31.6±2.9%; $P<0.0001$).

Conclusions—RT3DE can quantify global LVMD in patients with and without QRS prolongation. RT3DE represents a novel technique to identify chronic heart failure patients who may otherwise not be considered for CRT. (***Circulation*. 2005;112:992-1000.**)

Key Words: bundle-branch block ■ heart failure ■ pacing ■ echocardiography ■ echocardiography, three-dimensional

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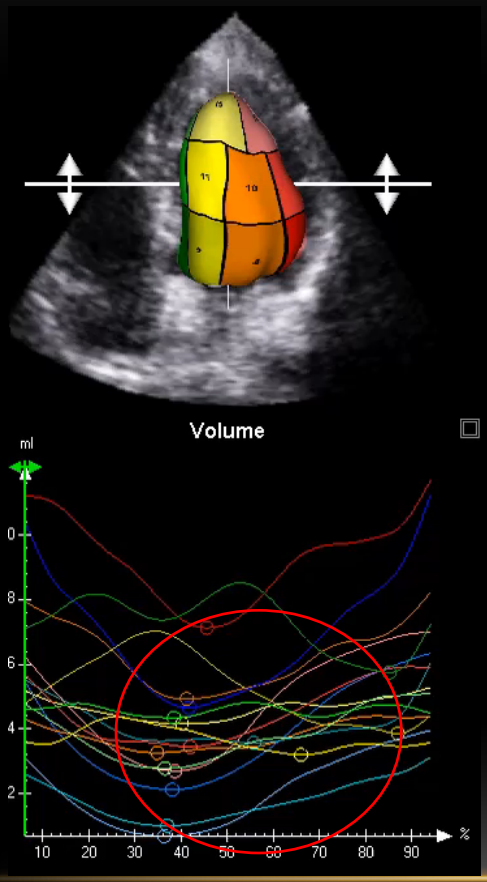
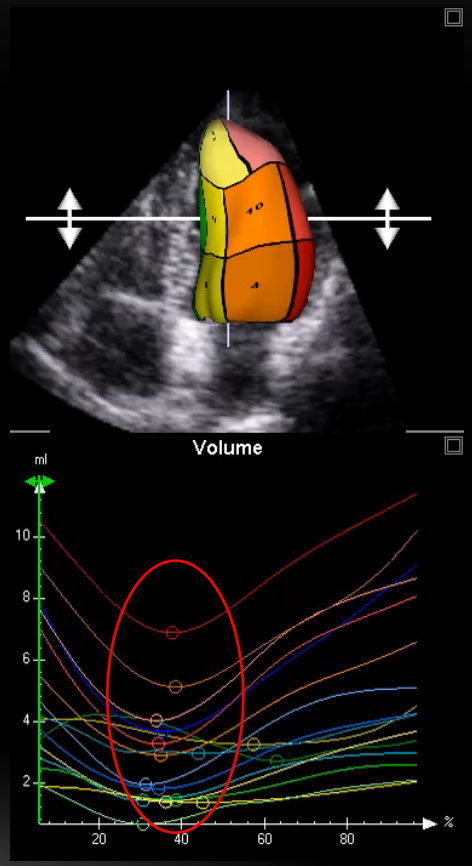
Dyssynchrony

LBBB



After Resynchronization



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Yale medical students, graduating class of 1902; John Hay Whitney Medical Library, Yale University

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Teaching anatomy without cadavers

John C McLachlan,[1] John Bligh,[1] Paul Bradley[1] & Judy Searle[2]

Biomedical Research 2012; 23 (2): 215-218

Students, perception of computer assisted teaching and learning of anatomy-in a scenario where cadavers are lacking.

Fazal-Ur-Rehman[1], Sheeba Nuzhat Khan[2], S. Mobashir Yunus[1]

[1]Department of Anatomy, Jawahar Lal Nehru Medical College, Aligarh Muslim University, Aligarh, 202002, India
[2]Department of Kulliyat Ajamal Khan Tibbiya College, Aligarh Muslim University, Aligarh, 202002, India

Abstract

Computer software program for three dimensional (3D) modeling of anatomical ...ructures in the human body that presents detailed and step by step cadaver dissecti... be used for computer assisted teaching and learning of anatomy. Anatom... odels, skeletons, and live demonstrations supplement the classroom l... can provide detailed human anatomical training for student... ver facility. The multimedia equipped interactive An... ce both memorization and visual learning skill ... aid (Guy & Frisby, 1992), they will imp... advance in determining prognos... vey student's opinion/perc... omy and to determi... to bachelor o... place o...

Review paper

Living anatomy in the 21st century: how far can we go?

Pallab K Ganguly[1], Lap Ki Chan[2]

Abstract:

Living anatomy, defined as the anatomy revealed on living humans, i... anatomy education, and has even been considered to replace... discussed the modalities through which living anatomy can b... them to replace cadaver-based anatomy. We believe... modalities of living anatomy, namely, surface anatom... a foundation of sound knowledge of the three-dimensio...

While a cadaver is still the best study material for the cor... anatomy, considering the pressure to reduce the hours g... anatomy in 21st century must be revolutionized to utilize... contemporary anatomy course. Such modalities allow stude... to a positive outcome in anatomy education. The problem ... anatomy, the time necessary for dissection needs to be minim... that the time has come to address this issue in the anatomy cur...

Keywords: anatomy; medical education; cadaver dissection; livi...

New medical school offers cadaver-free anatomy lessons

There weren't any cadavers, let alone a dissecting room, when the first students arrived at the Peninsula Medical School in Plymouth and Exeter, UK, this fall. The brand-new school had become the first in the UK to teach anatomy without using cadavers.

School spokesperson Dr. John McLachlan, who says modern medical imaging techniques have made the change possible, thinks students will benefit. "The dissecting room can be a traumatic experience for first-year students, and perhaps it is not the best introduction to the whole issue of death and dying."

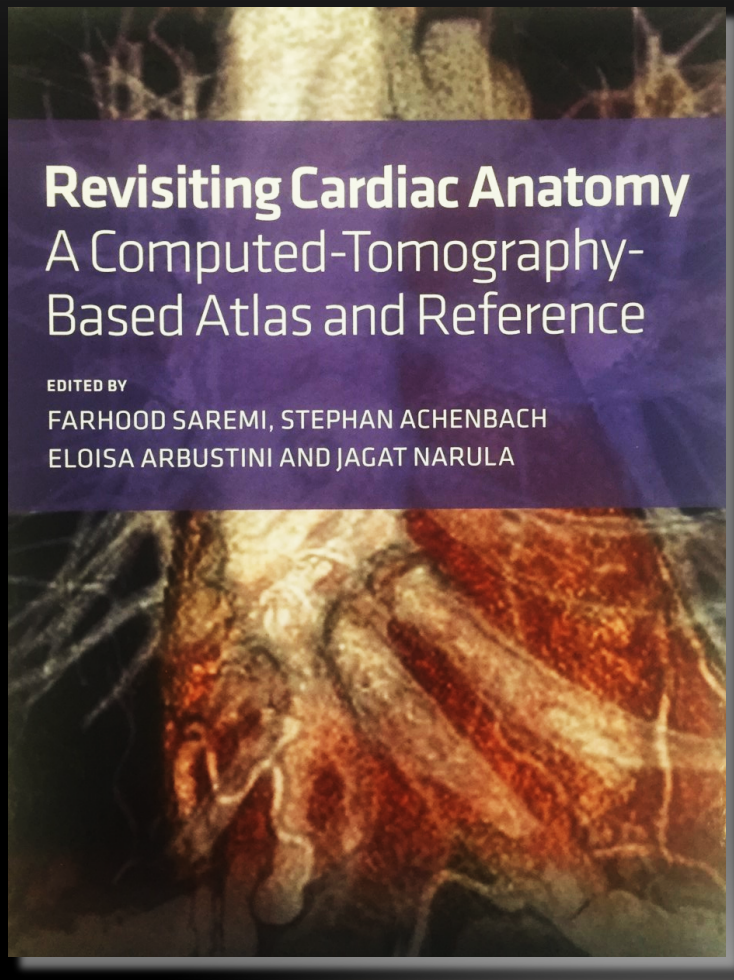
Anatomy will be taught using a combination of techniques, supported by models and 3-dimensional images and reconstructions. McLachlan thinks students will adapt easily because of their exposure to technology. At a more advanced stage, although probably not in the first year, the university will employ sophisticated simulations that will allow students to employ methods similar to those used to train airline pilots.

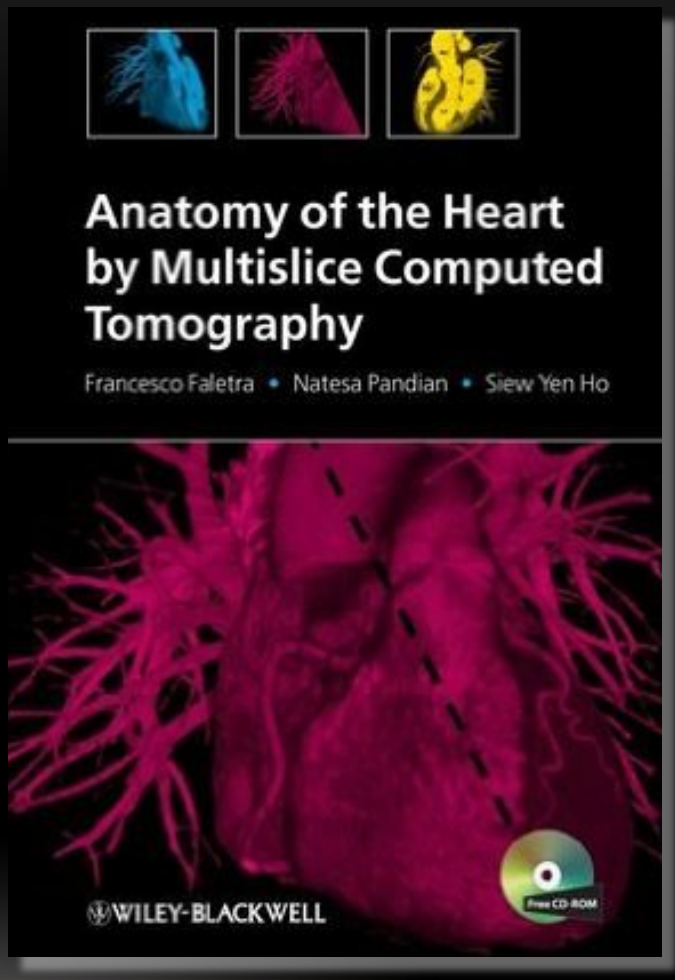
McLachlan disagrees with critics who maintain that dissection is a necessary part of medical training. "A cadaver does not bear much resemblance to a living body. To the uninitiated, it would be difficult to distinguish between a nerve fibre and a blood vessel." As well, he says chemicals used to preserve cadavers, when combined with post-mortem changes, make the consistency of the tissue and organs quite different from that encountered in live patients.

The General Medical Council (GMC), which is responsible for setting standards for undergraduate education, says its main concern involves outcomes, not the teaching process. However, GMC personnel will visit Peninsula to ensure that standards are maintained.

Peninsula is 1 of 2 new schools to open in the UK this year. They are part of a plan to increase intake by 1100 medical students a year by 2005. — *Cathel Kerr, Fife, Scotland*

Teaching anatomy





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Siew Yen Ho
Head of Cardiac Morphology Brompton Hospital
Imperial College London

Teaching "dynam 3D echocardiogr

Real-time three dimensional transoesophageal echocardiography in imaging key anatomical structures of the left atrium: potential role during atrial fibrillation ablation

Francesco Fulvio Faletra,[1] Siew Yen Ho,[2] François Regoli,[1] Marta Acena,[1] Angelo Auricchio[1]

EVIEWS

STATE-OF-THE-ART PAPER

Anatomy of Right Atrial Structures by Real-Time 3D Transesophageal Echocardiography

Francesco F. Faletra, MD,* Siew Y. Ho, PHD,† Angelo Auricchio, MD, PHD*
Lugano, Switzerland; and London, United Kingdom

Anatomy of Pulmonary Veins by Real-Time 3D TEE

Implications for Catheter-Based Pulmonary Vein Ablation

Francesco F. Faletra, MD,* Gaetano Nucifora, MD,* François Regoli, MD, PHD,* Siew Yen Ho, MD, PHD,† Tiziano Moccetti, MD,* Angelo Auricchio, MD, PHD*

Anatomy of the left atrium for interventional echocardiography

Siew Yen Ho[1]*, Karen P. McCarthy[1], and Francesco F. Faletra[2]

[1]Cardiac Morphology Unit, Royal Brompton and Harefield NHS Foundation Trust and Imperial College London, London SW3 6NP, UK; and [2]Division of Cardiology, Fondazione Cardiocentro Ticino, Lugano, Switzerland

The anatomy of the left atrium is reviewed with relevance to various interventional transcatheter procedures requiring manoeuvres within or passage through the left atrium. The component parts of the atrium—the atrial body with a vestibule, appendage, venous component, and the atrial septum—are described with emphasis on their spatial relationships to neighbouring cardiac and extra-cardiac structures. Normal variations are discussed for a better understanding of the anatomy so as to reduce the risk of potential complications during procedures.

CLINICAL INVESTIGATIONS

3D TRANSESOPHAGEAL ECHO IN CONGENITAL & ACQUIRED HEART DISEASE

Imaging the Atrial Septum Using Real-Time Three-Dimensional Transesophageal Echocardiography: Technical Tips, Normal Anatomy, and Its Role in Transseptal Puncture

Francesco F. Faletra, MD, Gaetano Nucifora, MD, and Siew Yen Ho, PhD, *Lugano, Switzerland; London, United Kingdom*

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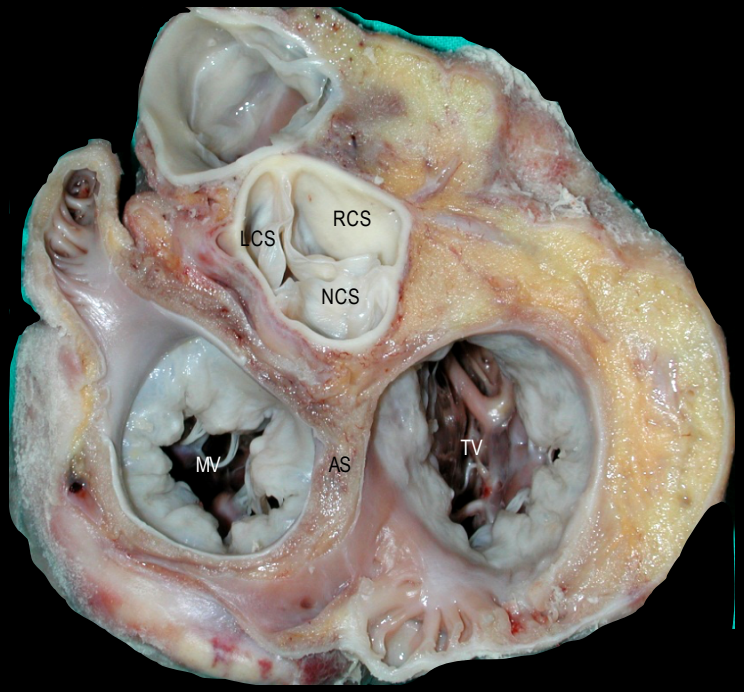
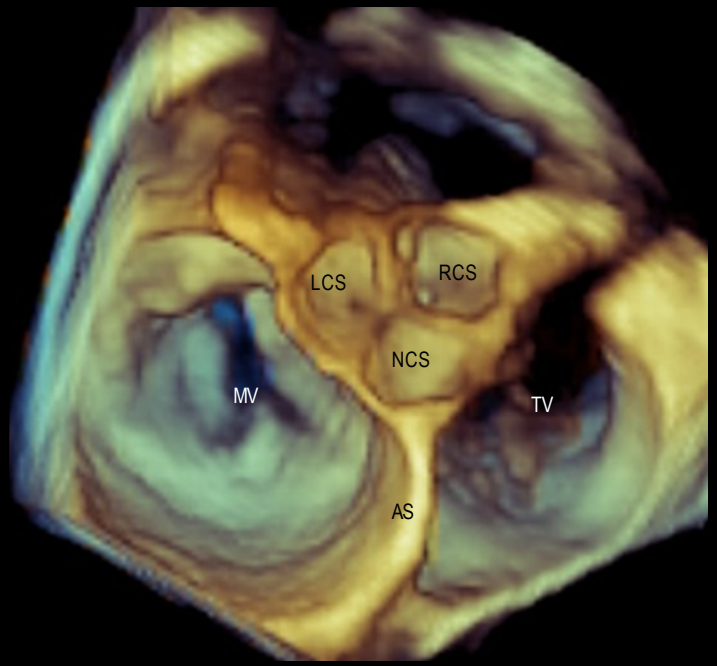
Echo-live Anatomy

Anatomic specimen



Echo-live specimen



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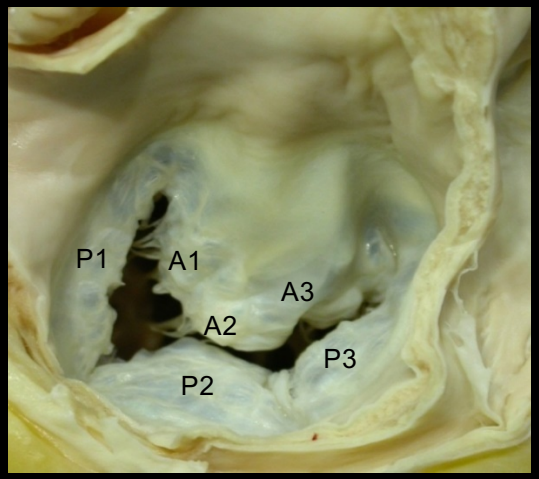
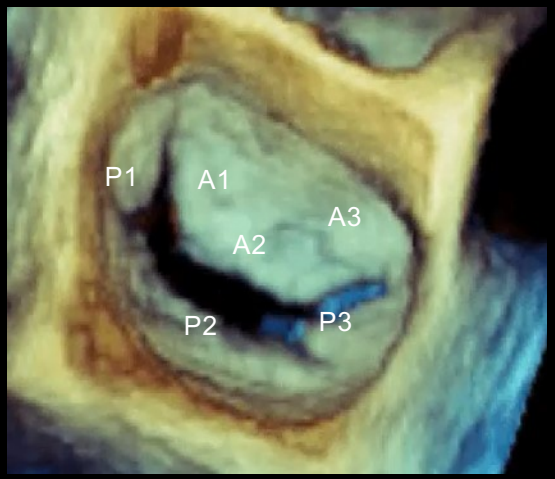
Echo-live Anatomy

Mitral valve





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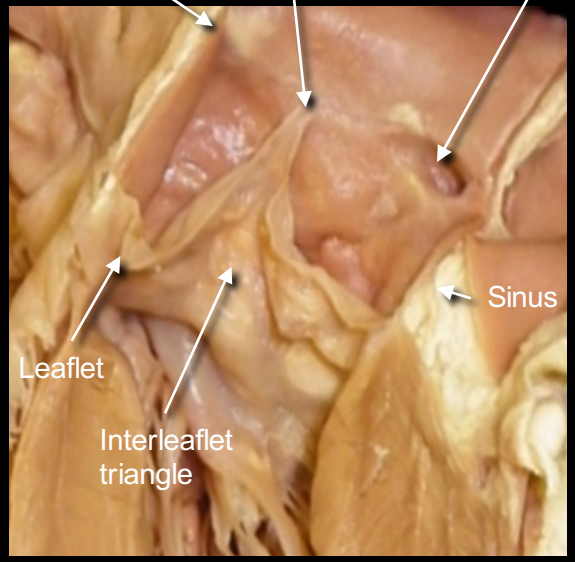
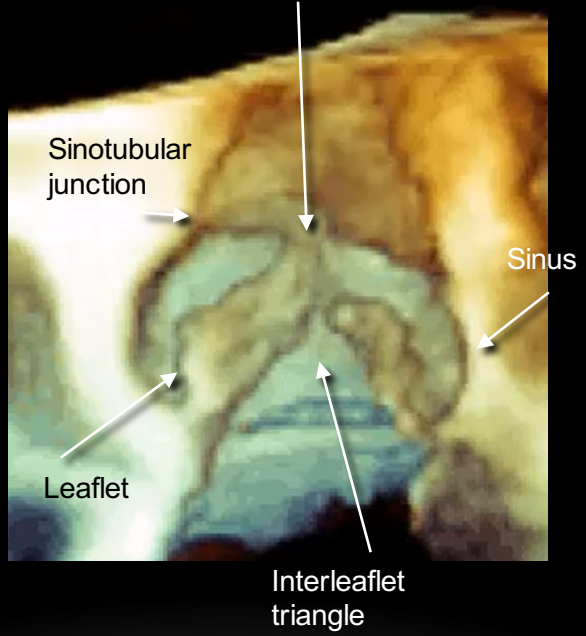
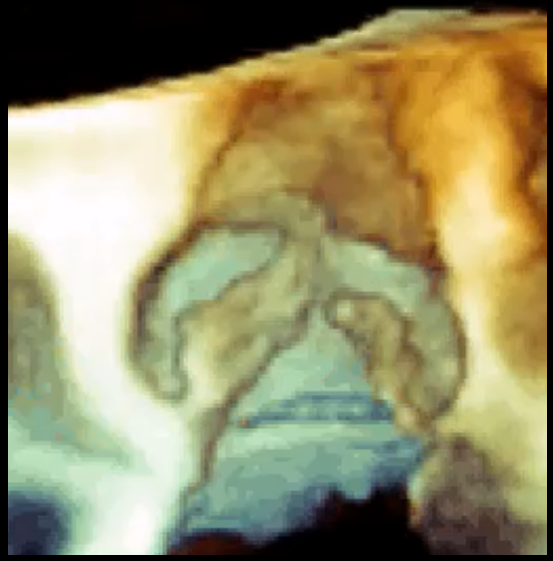
Echo-live Anatomy

Aortic valve







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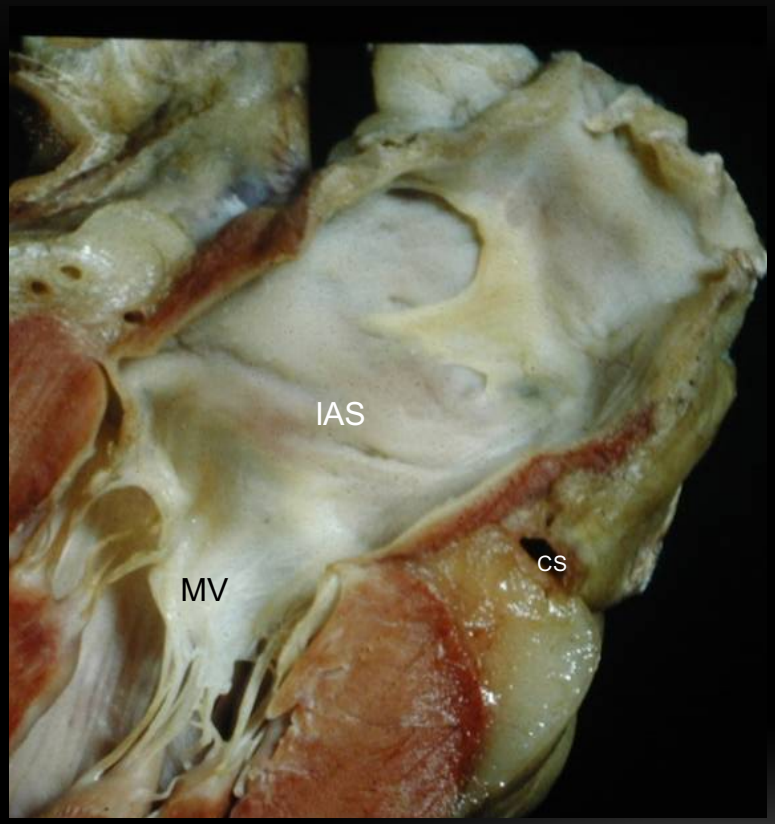
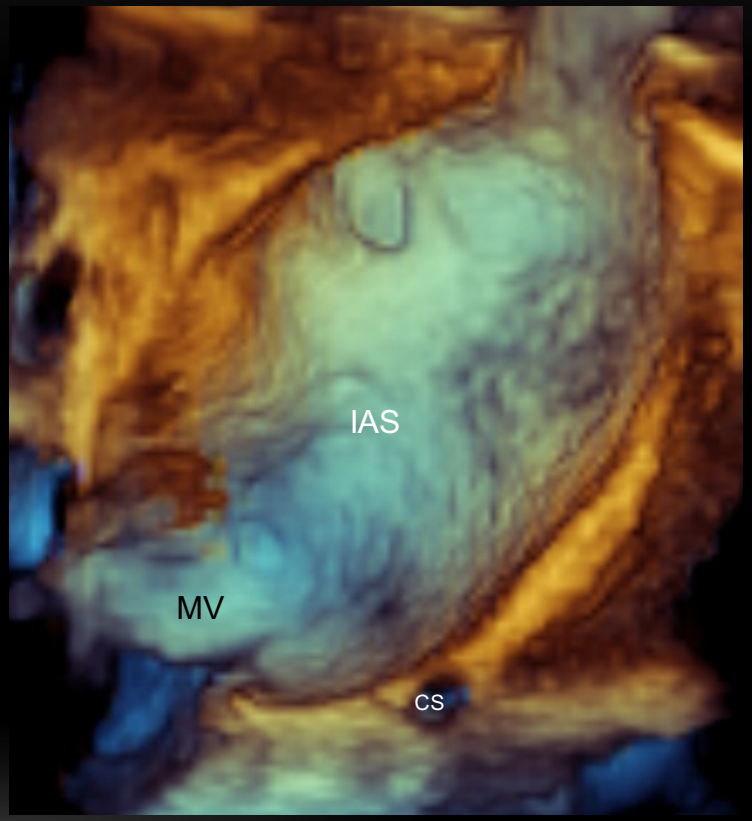
Echo-live Anatomy

Interatrial septum





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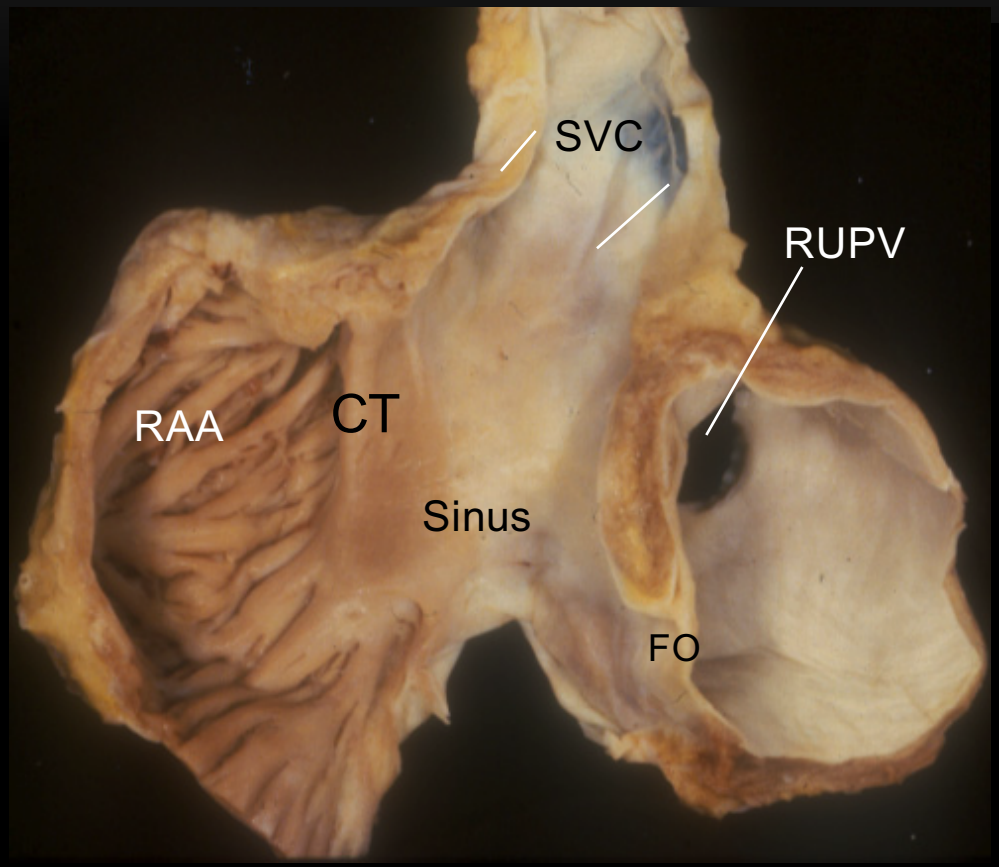
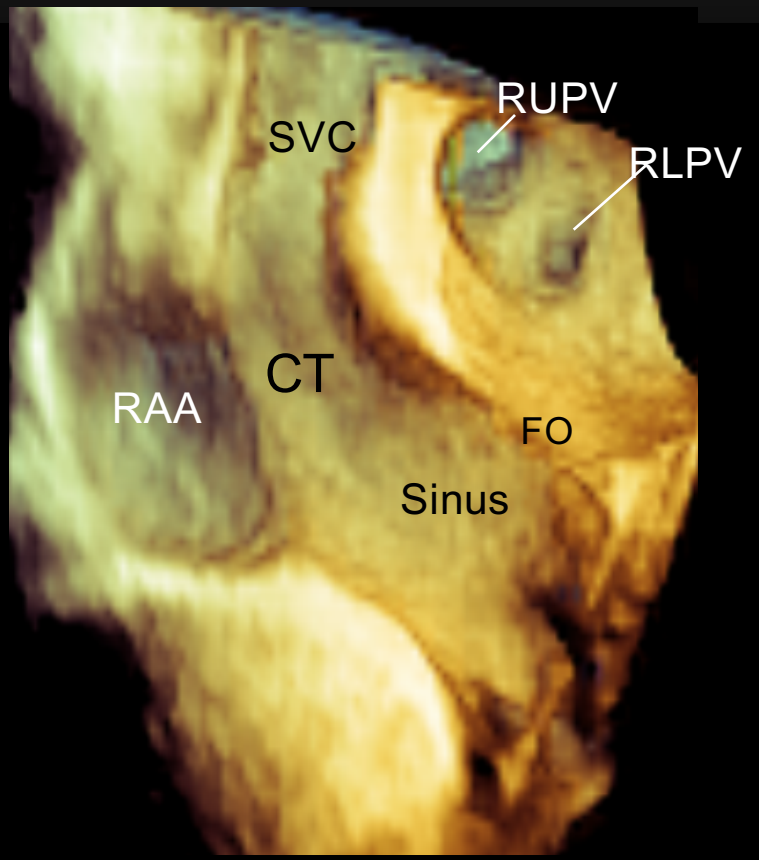
Echo-live Anatomy





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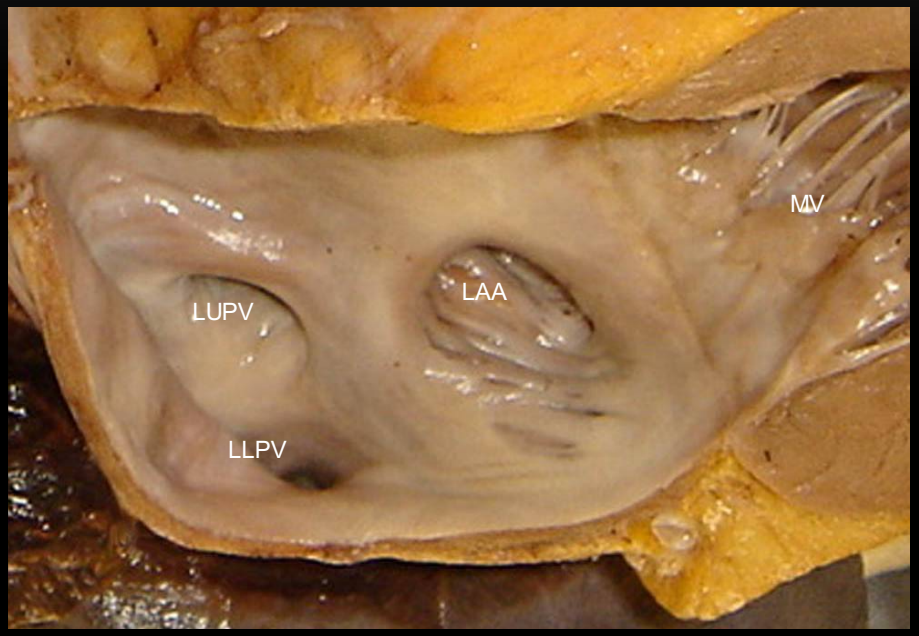
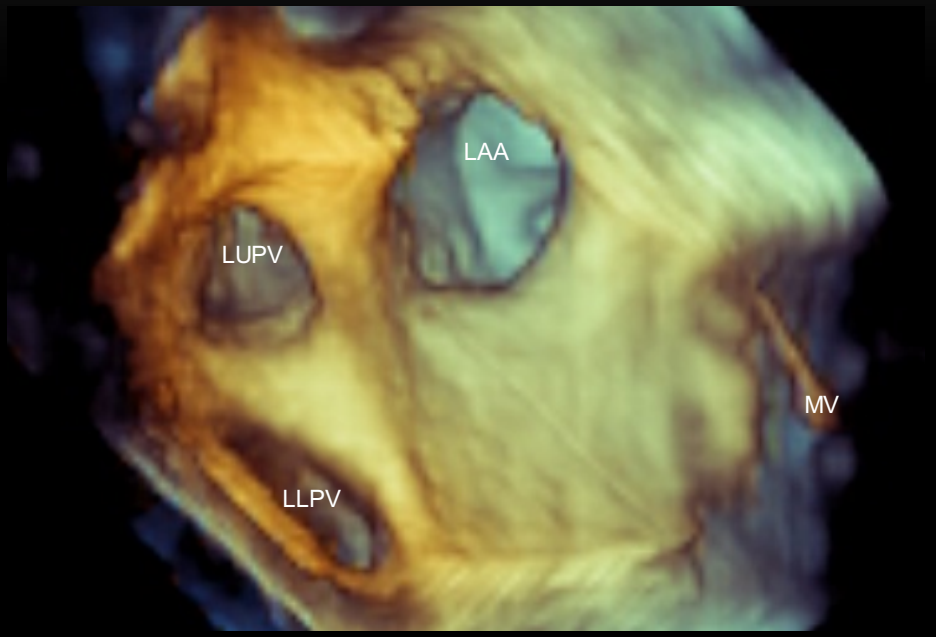
Echo-live Anatomy

Pulmonary veins





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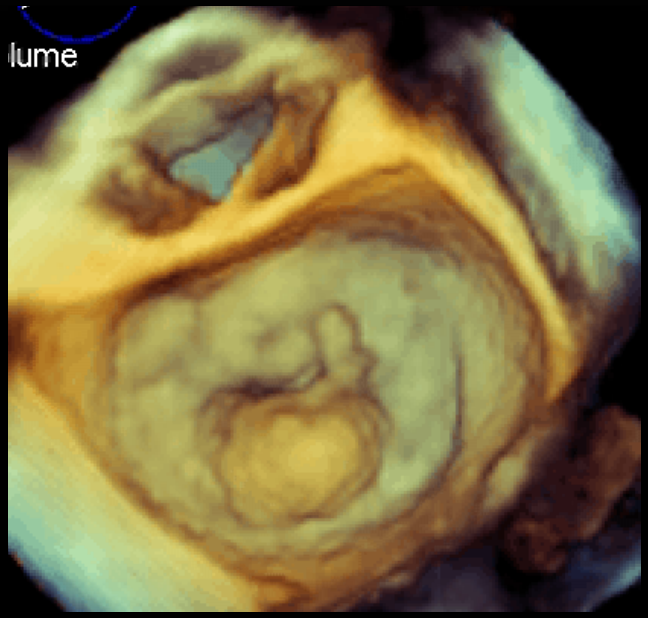
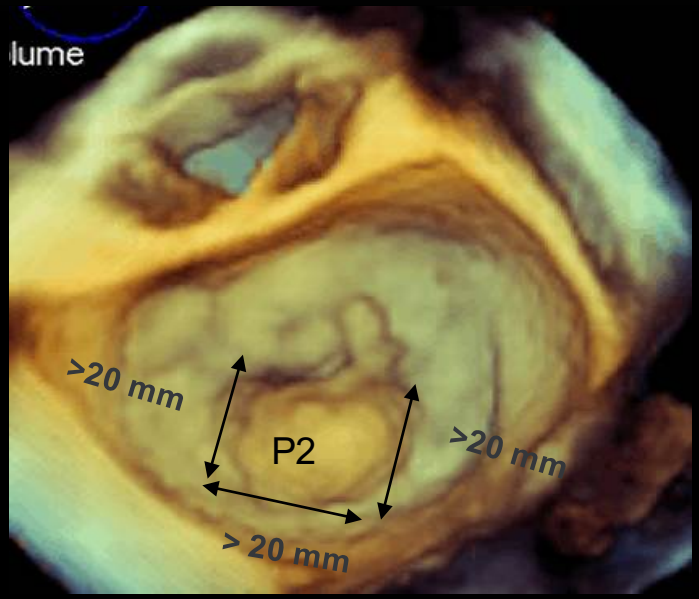
Anatomical assessment of SHD

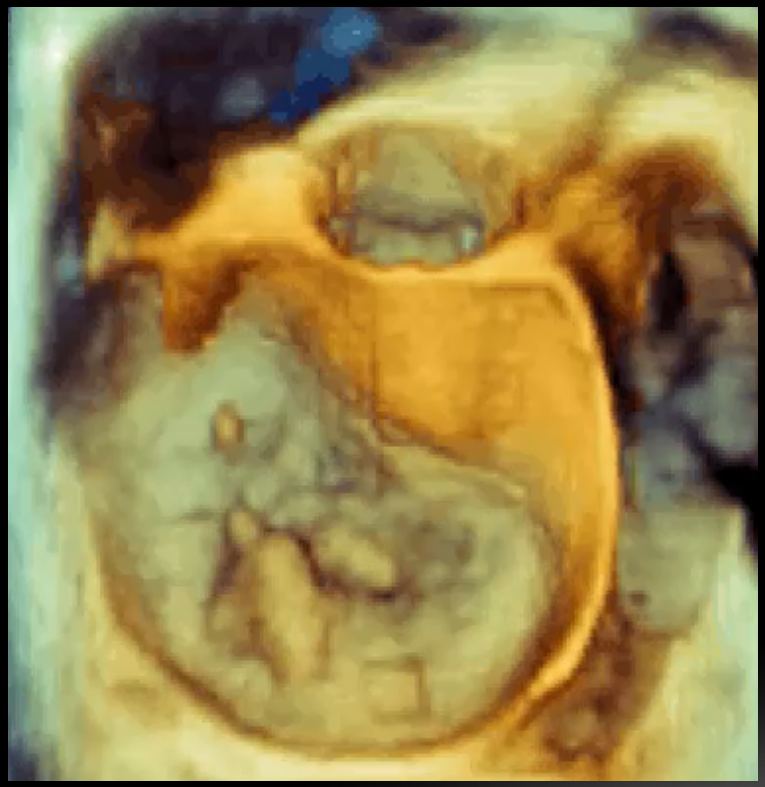
Degenerative mitral regurgitation

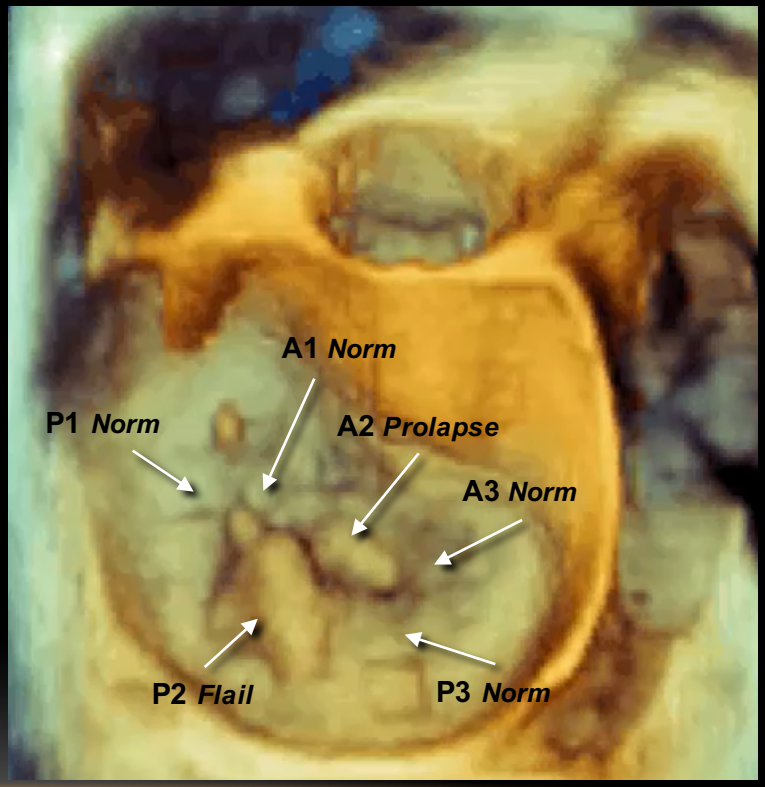




Anatomical assessment of SHD

Degenerative mitral regurgitation





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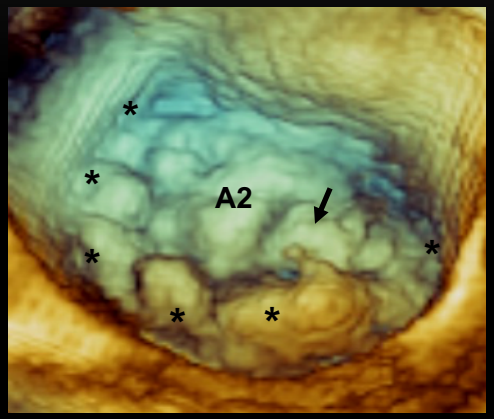
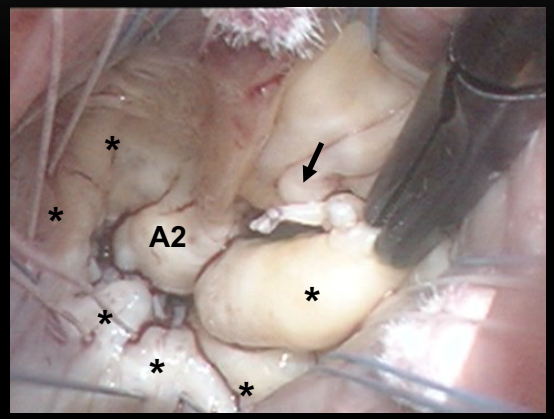
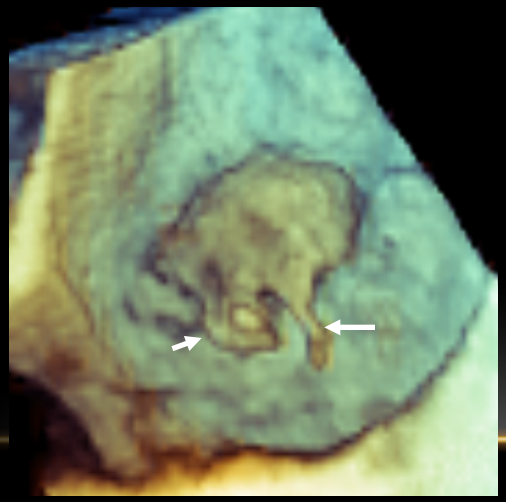
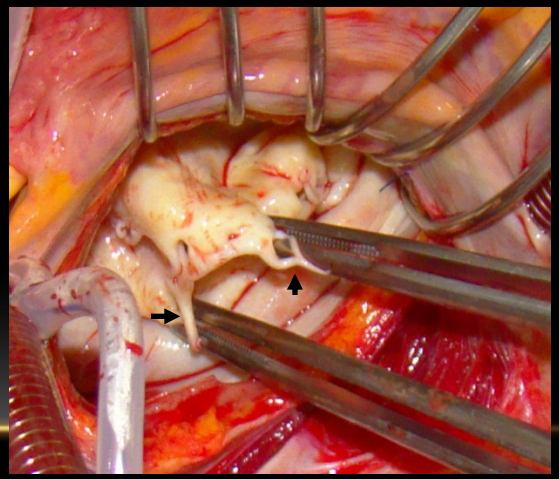
Anatomical assessment of SHD

Degenerative mitral regurgitation









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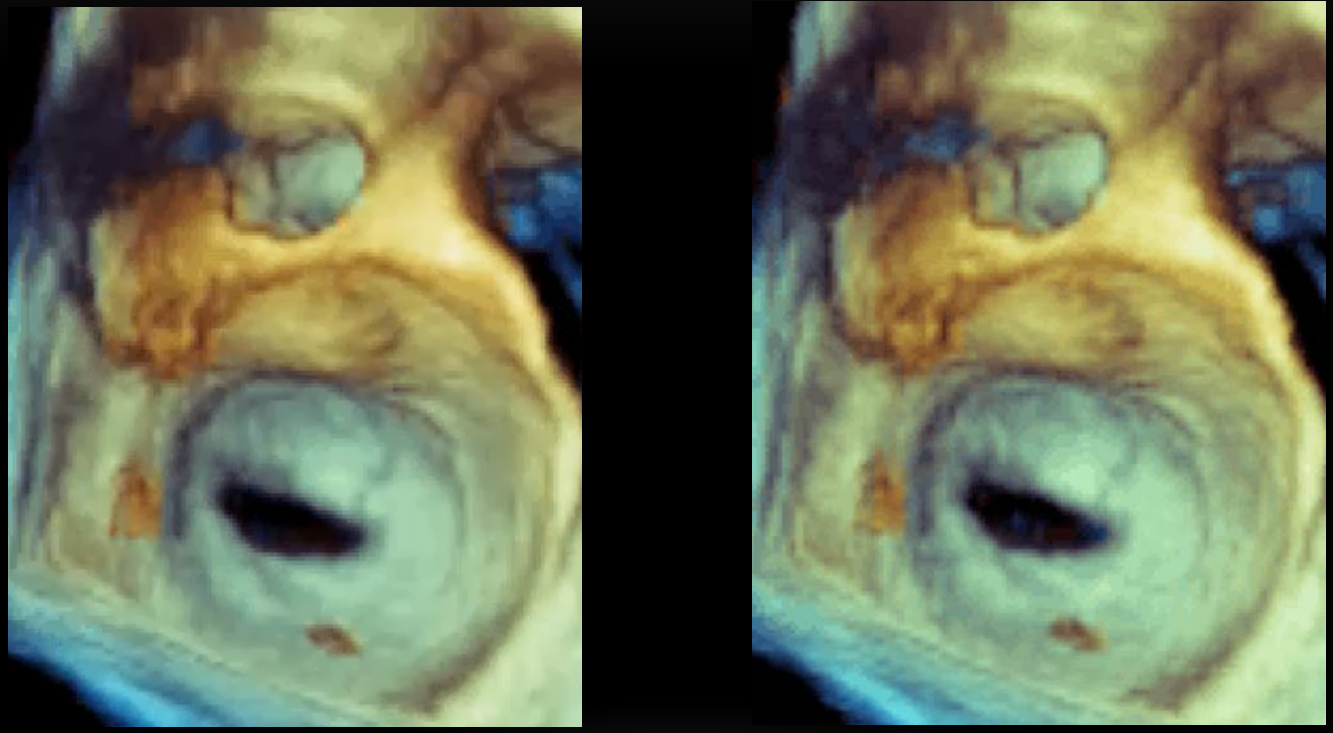
Anatomical assessment of SHD

Mitral stenosis



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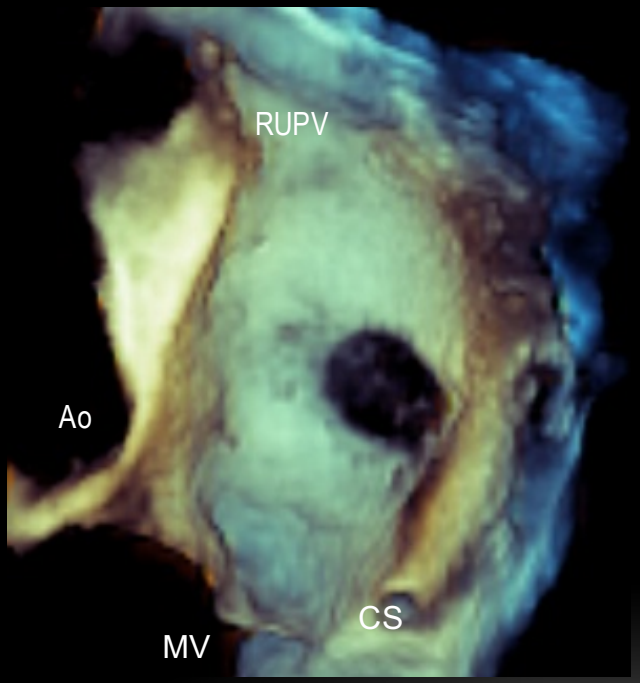
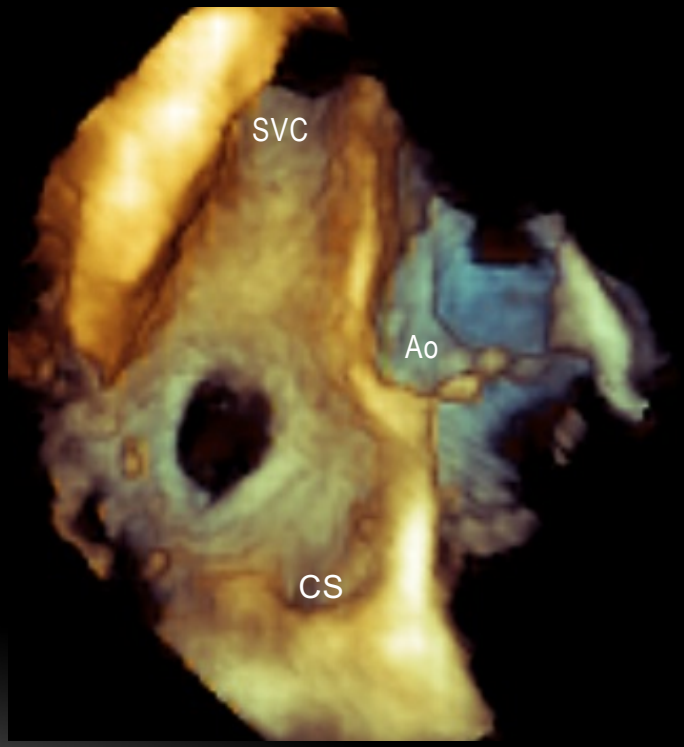
Anatomical assessment of SHD

Atrial Septal Defect

Left side



Right side



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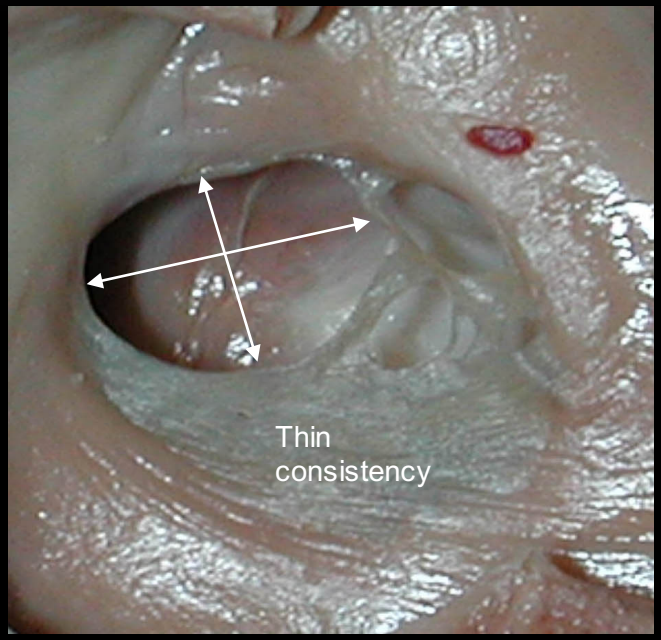
Anatomical assessment of SHD

Atrial Septal Defect



Courtesy of Edgardo Bonacina

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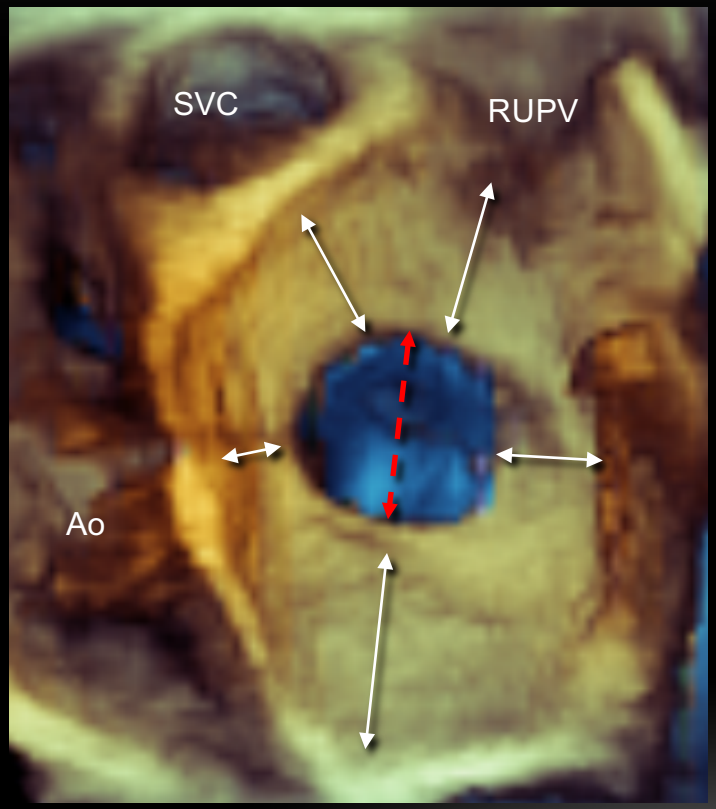
Anatomical assessment of SHD

Atrial Septal Defect



Size	< 35 mm
Posterior, inferior and superior rims	> 5 mm
Anterior (aortic) rim	> 2mm

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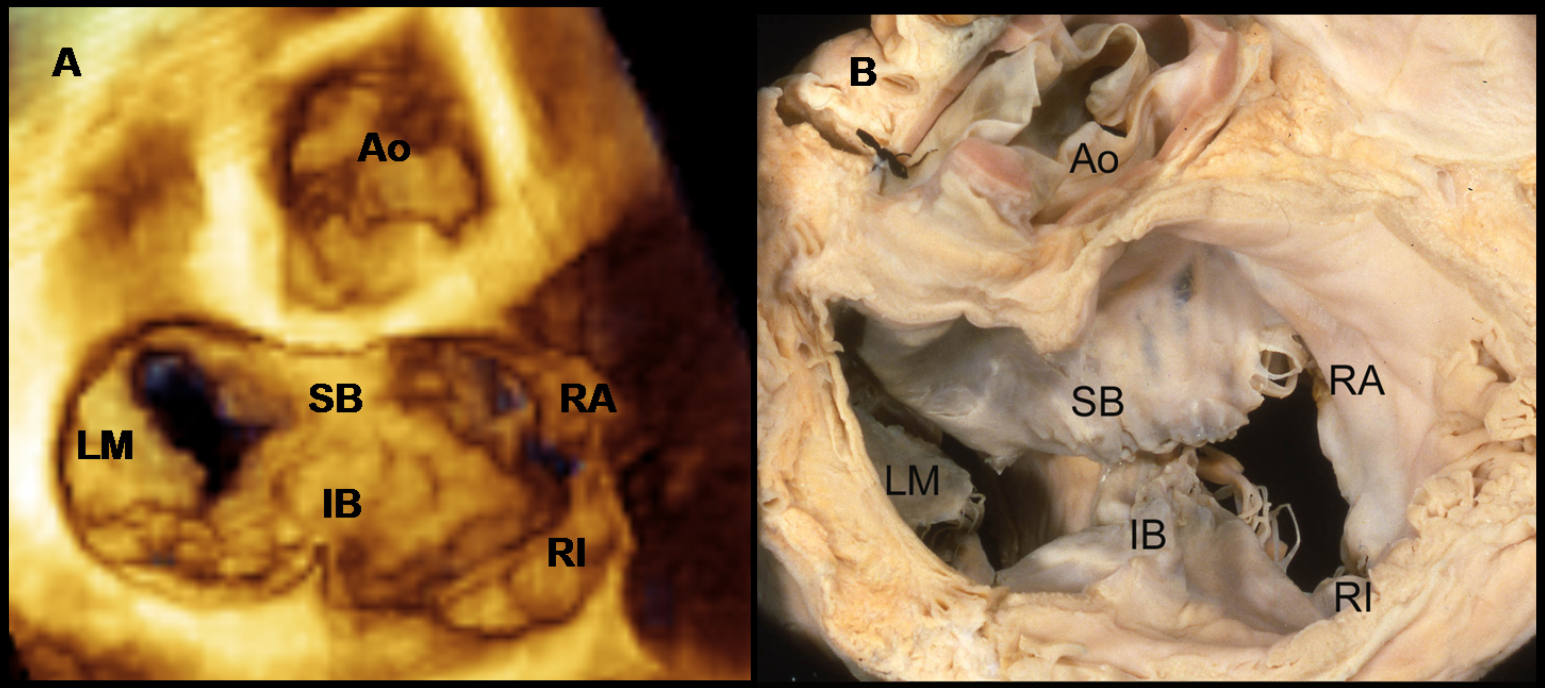
Anatomical assessment of SHD

Atrioventricular septal defect



Faletra FF et al. Circ Cardiovasc Imaging

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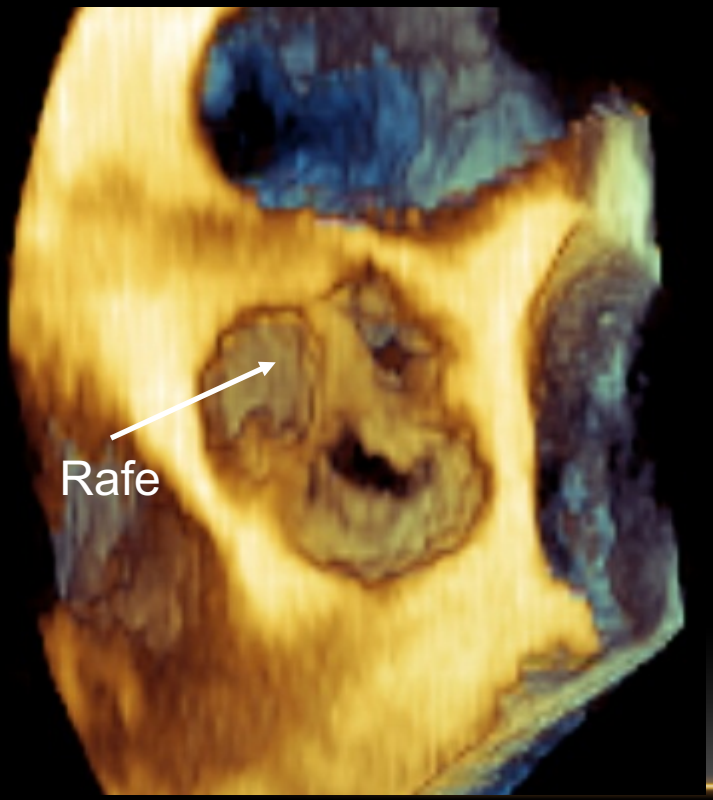
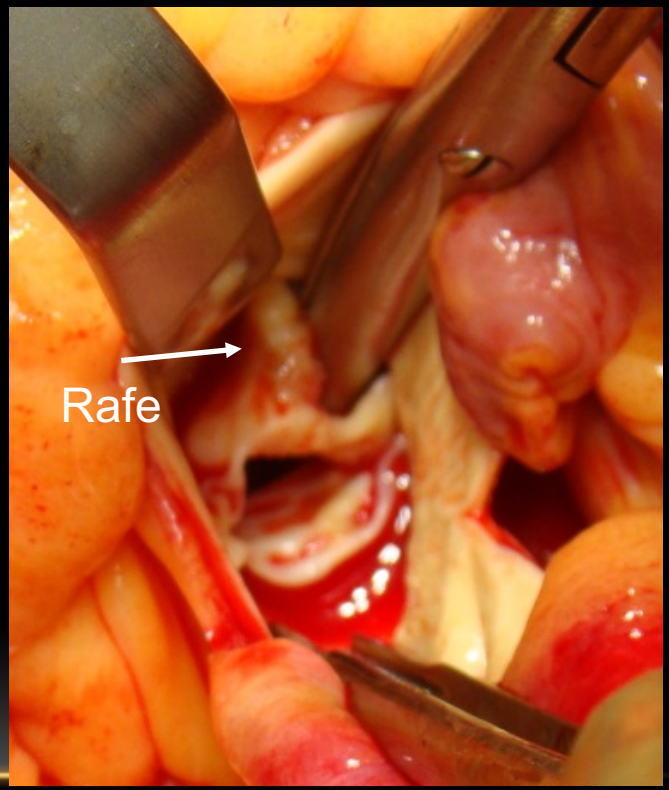
Anatomical assessment of SHD

Bicuspid valve





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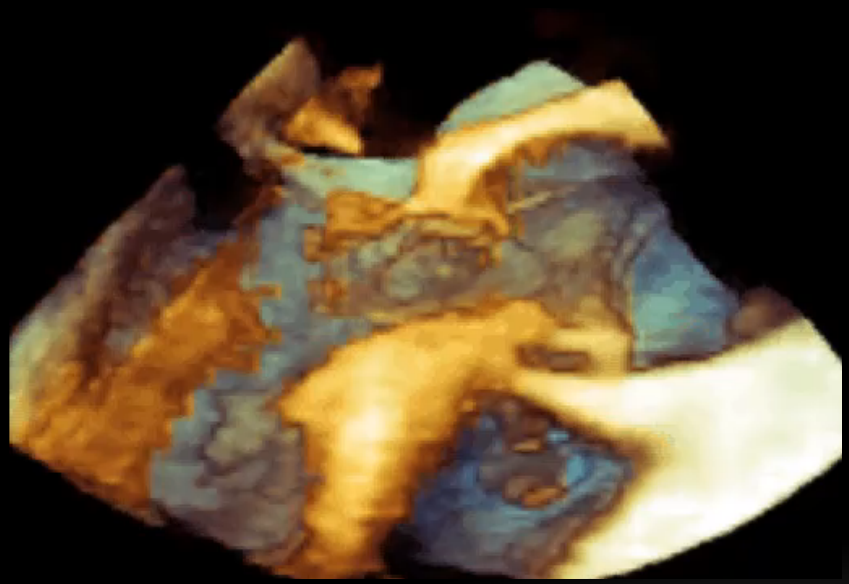
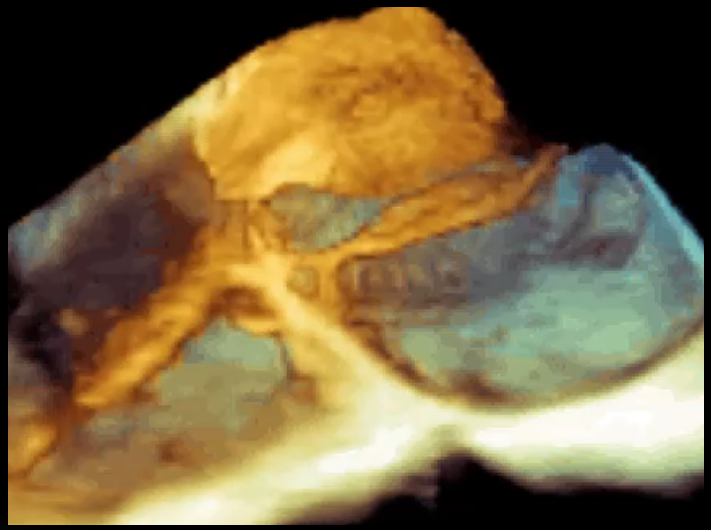
Anatomical assessment of SHD

Aortic dissection





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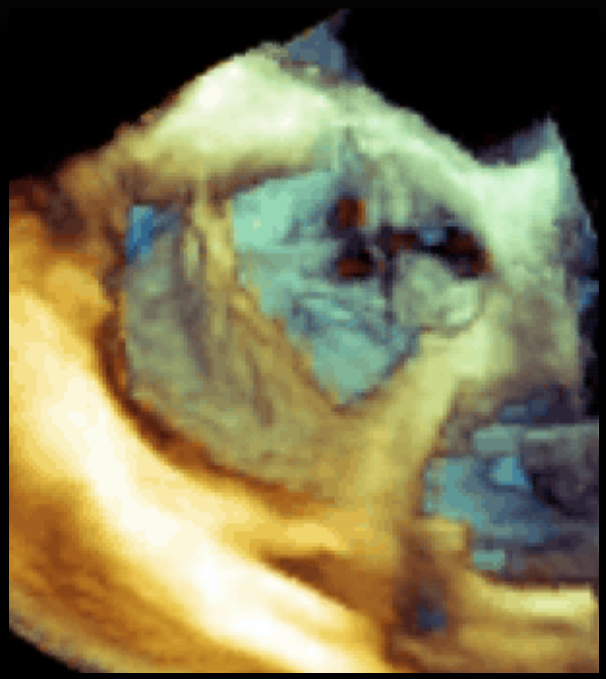
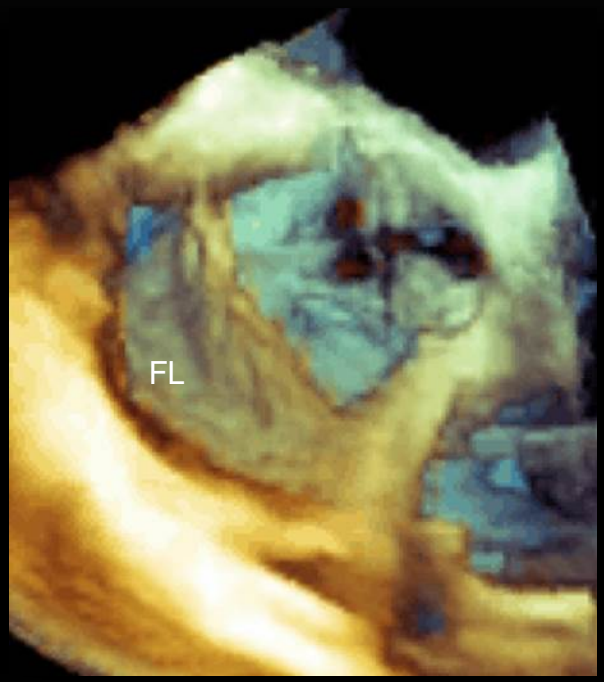
Anatomical assessment of SHD

Aortic dissection





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The clinical role of 3D echocardiography

- Quantitative assessment of cardiac chambers
- Teaching cardiac anatomy
- Anatomical assessment of structural heart disease
- Guidance of interventional procedures
- Automated valve quantitative modeling

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Echo Guidance of PFO/ASD closure

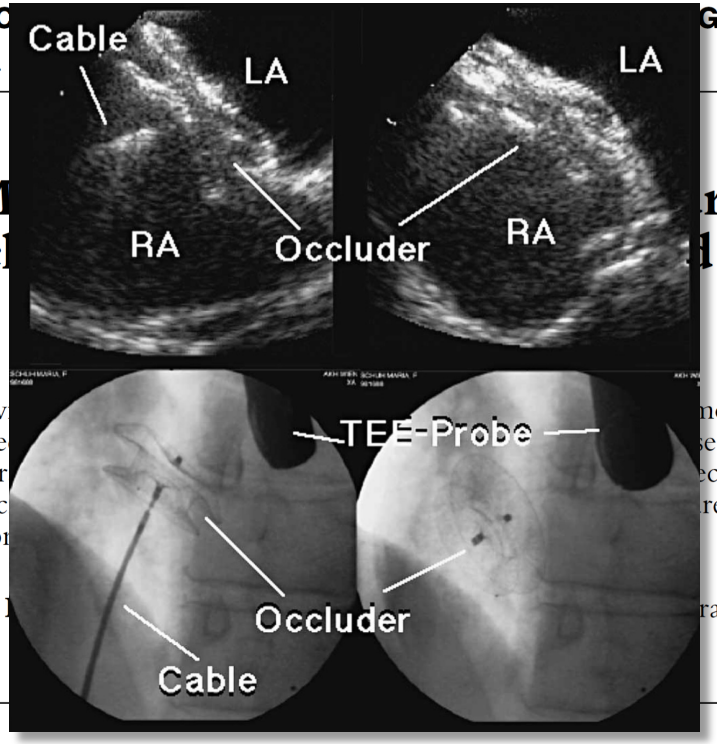
FOC GRAPHY

Monitoring of Invasive Procedures *J Clin Basic Cardiol 2002; 5: 139*

M res –
The Role of Ec l Operating Room

Echocardiography is now w nodynamic monitoring, guiding and immediate assessment of proce ent review article focuses on the role of periprocedural echocardiogr cts of its role in different settings are discussed. Furthermore, a desc res such as ASD closure, septal abla- tion or port access surgery is pr

raphy,



STATE-OF-THE-ART PAPER

3D TEE During Catheter-Based Interventions

Francesco Fulvio Faletra, MD, Giovanni Pedrazzini, MD, Ele
Stefano Muzzarelli, MD, Maria Cristina Dequarti, MD, Rom
Susanne Anna Schlossbauer, MD, Iveta Petrova Slater, MD,
Lugano, Switzerland

Guidance of catheter-based procedures is performed using fluoroscop
echocardiography (TEE). Both of these imaging modalities have sig
dimensional (3D) nature, 3D TEE allows visualizing the entire scenario in
place (including long segments of catheters, tips, and the devices)
undeniable advantages, 3D TEE has not yet gained wide acceptance ar
and echocardiographists. One reason for this reluctance is probably the
for obtaining 3D perspectives that provide the most comprehensive i
specific procedure. Therefore, the purpose of this review is to describe
3D perspectives in the following catheter-based percutaneous interv
foramen ovale/atrial septal defect closure; left atrial appendage occlusi
paravalvular leaks. (J Am Coll Cardiol Img 2014;7:292–308) © 2014 b
Foundation

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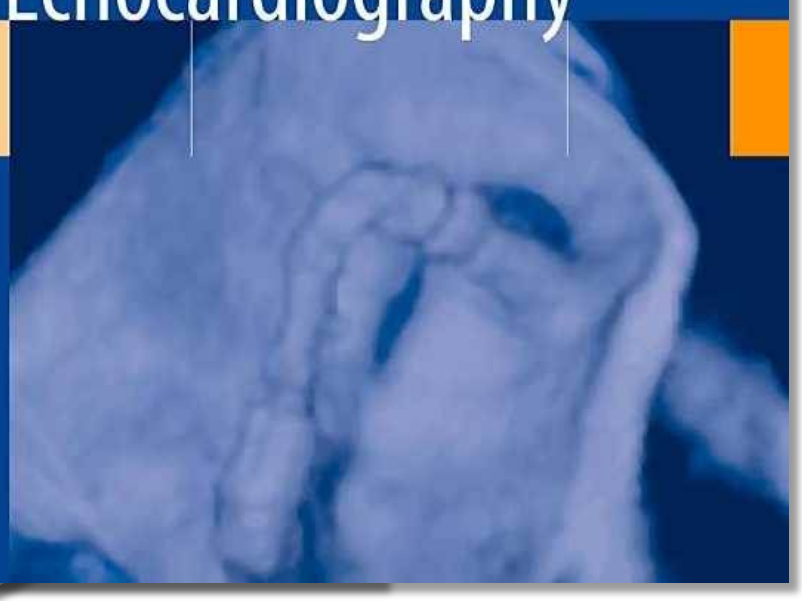
Francesco Fulvio Faletra · Gila Perk
Natesa G. Pandian · Hans-Joachim Nesser
Itzhak Kronzon

Real-Time 3D Interventional Echocardiography



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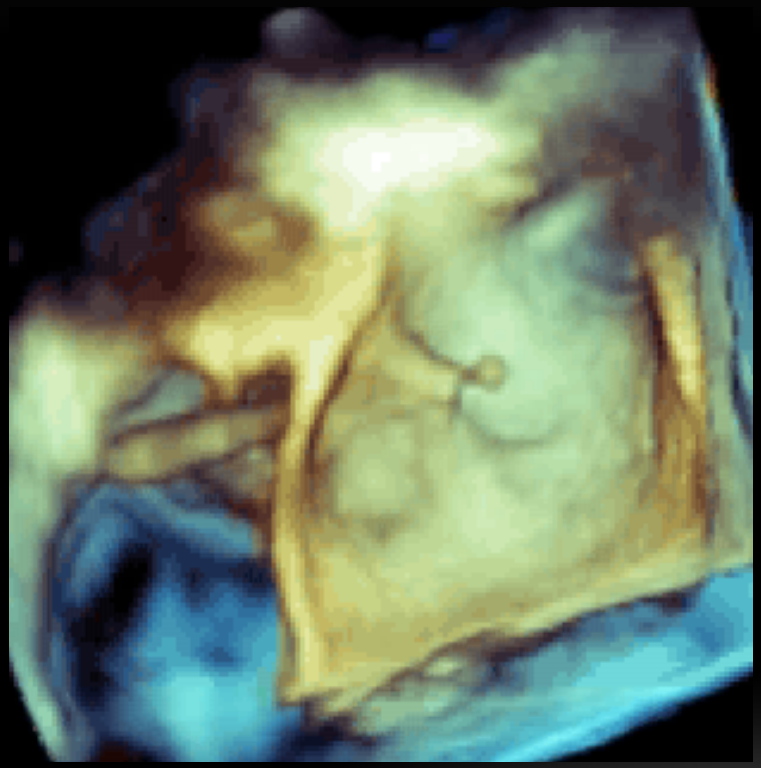
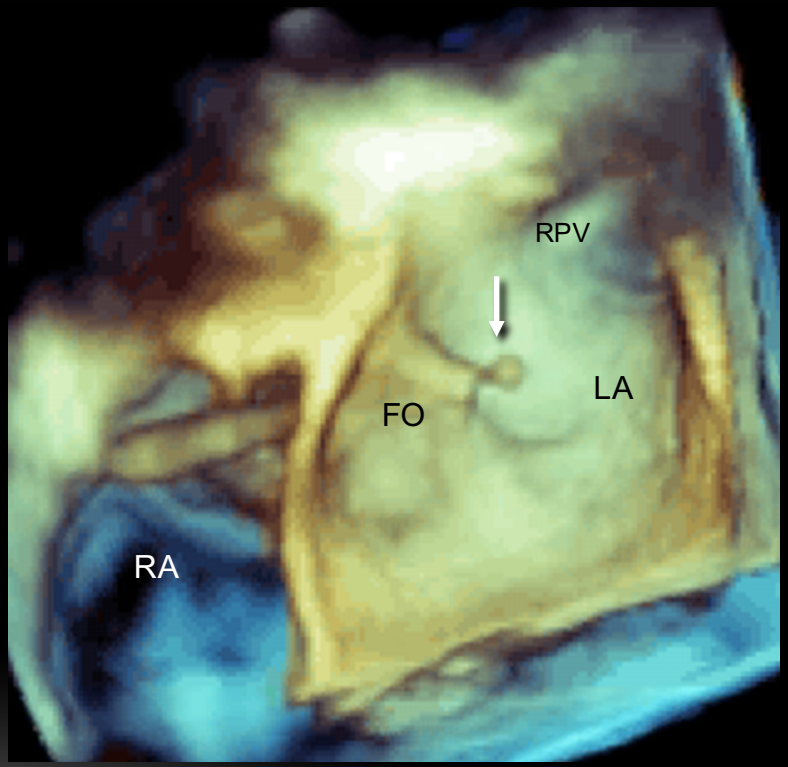
Clear spatial relation-ship between catheters, devices and soft structures

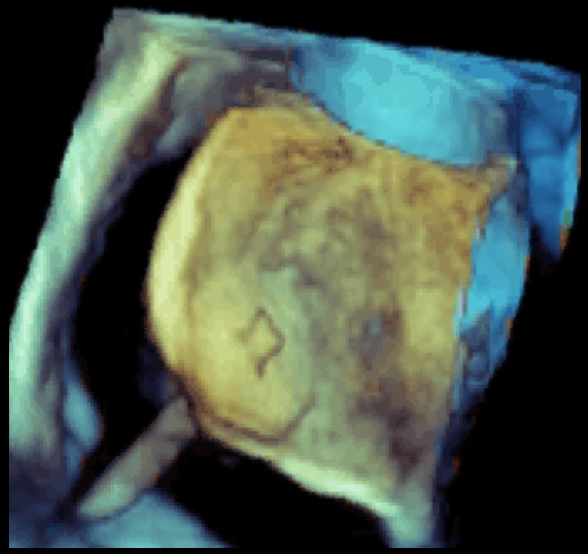
Trans-septal crossing

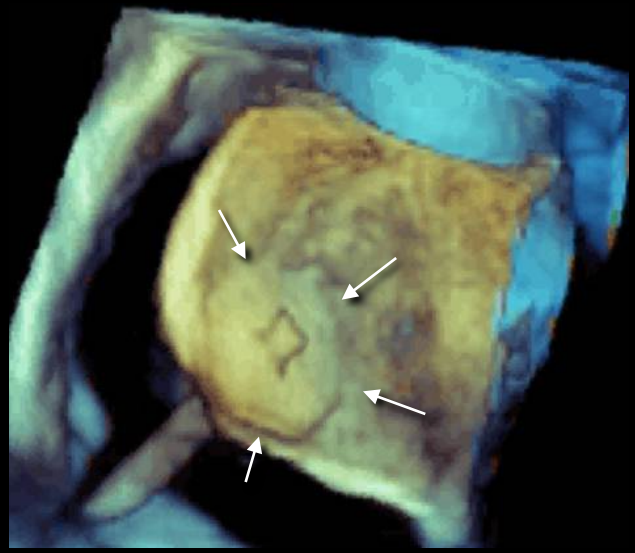




Clear spatial relation-ship between catheters, devices and soft structures

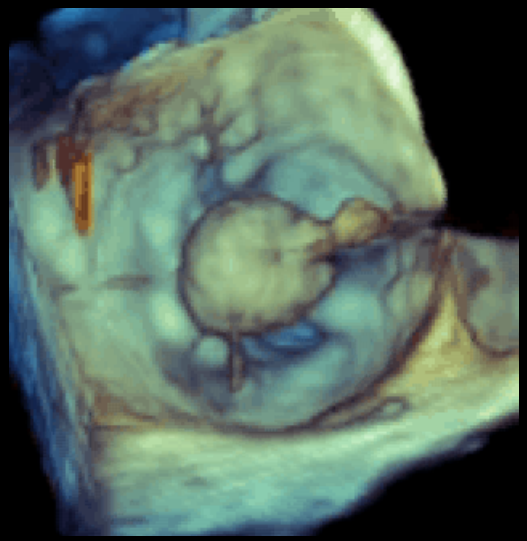
PFO closure





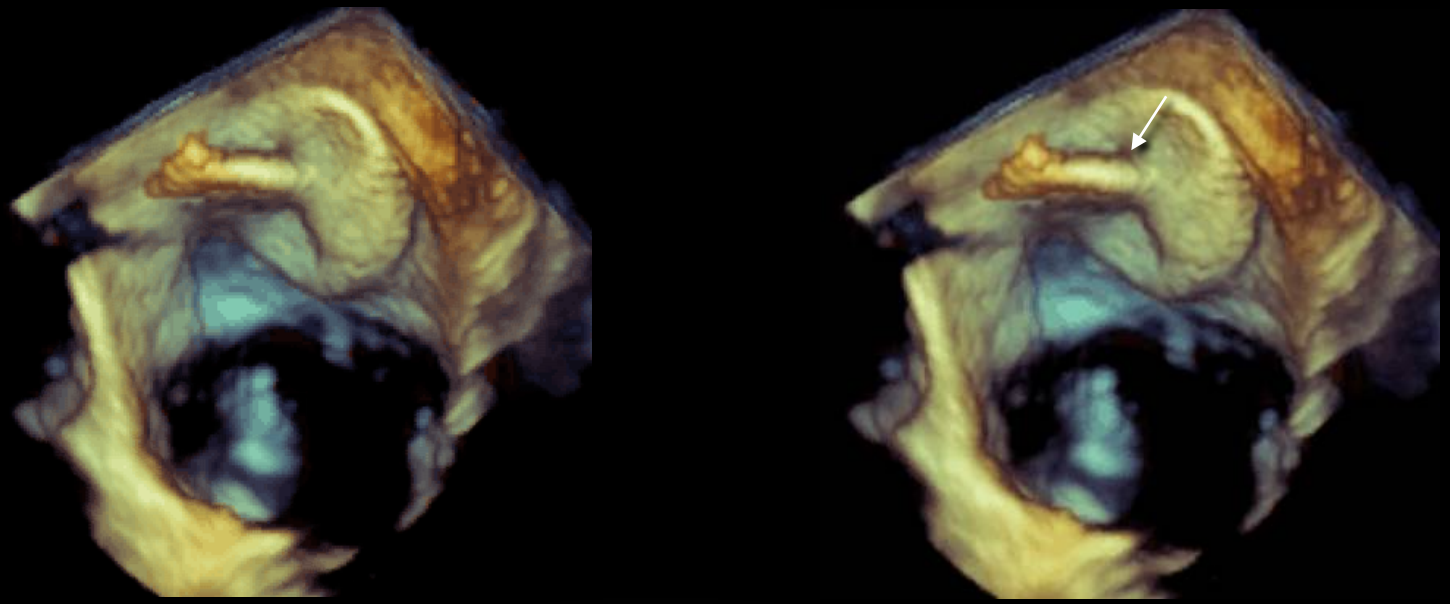
Clear spatial relation-ship between catheters, devices and soft structures

Balloon valvulo-plasty

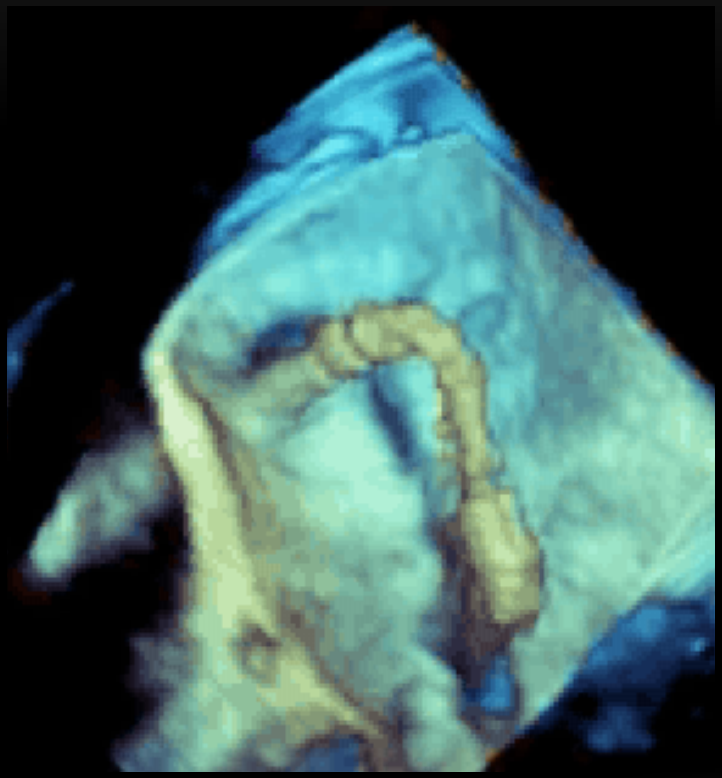


Clear spatial relation-ship between catheters, devices and soft structures

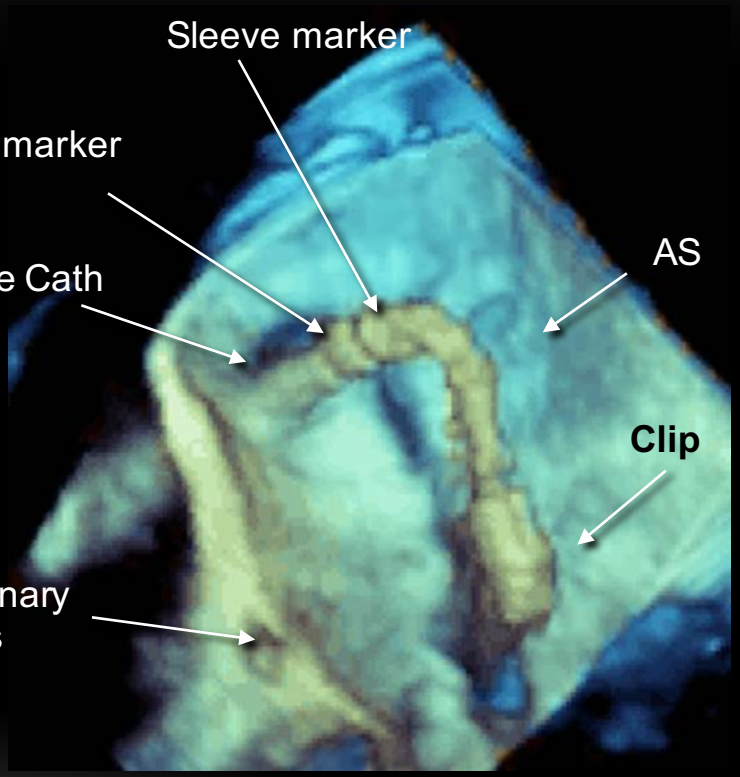
LAA occluder



Clear spatial relation-ship between catheters, devices and soft structures

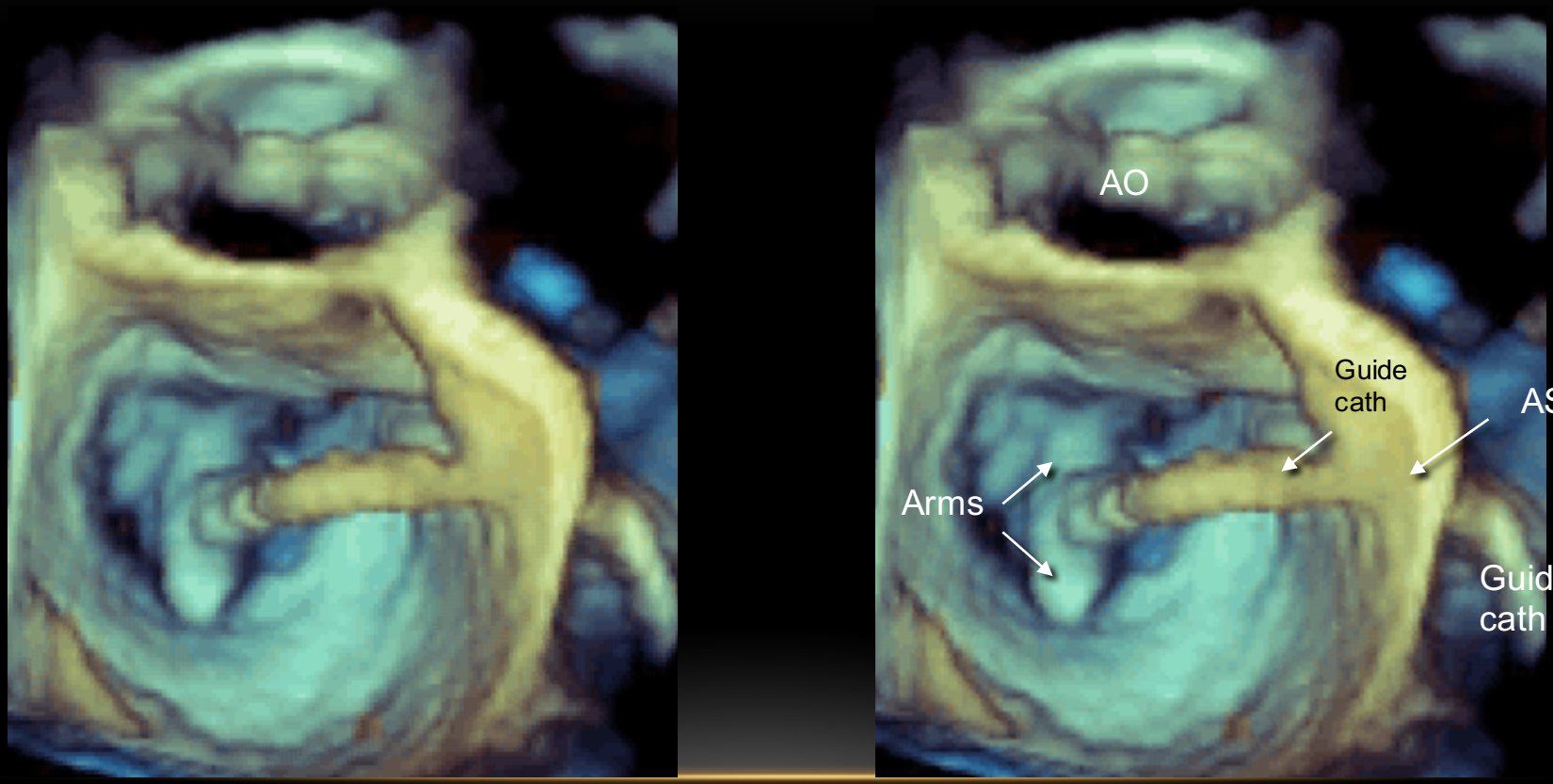


Mitral clip



Clear spatial relation-ship between catheters, devices and soft structures

Mitral clip



A new step forwards in the field of image-guided percutaneous intervention

The x-ray-echo fusion imaging

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University of Zurich
CARDIOCENTRO TICINO

The rational

- ✓ Echo and fluoroscopy are based on different physical principles (ultrasound mechanical waves versus electromagnetic waves)
- ✓ Echo and fluoroscopy have remarkable differences in imaging generation (echoes versus attenuation)
- ✓ Nevertheless, they *fit perfectly when fused together* in a single image

Weaknesses of X-ray are off-set by strengths of Echo and viceversa

Faletra FF, Monaghan Mark
EHJ cardiovasc. Imaging. Submitted

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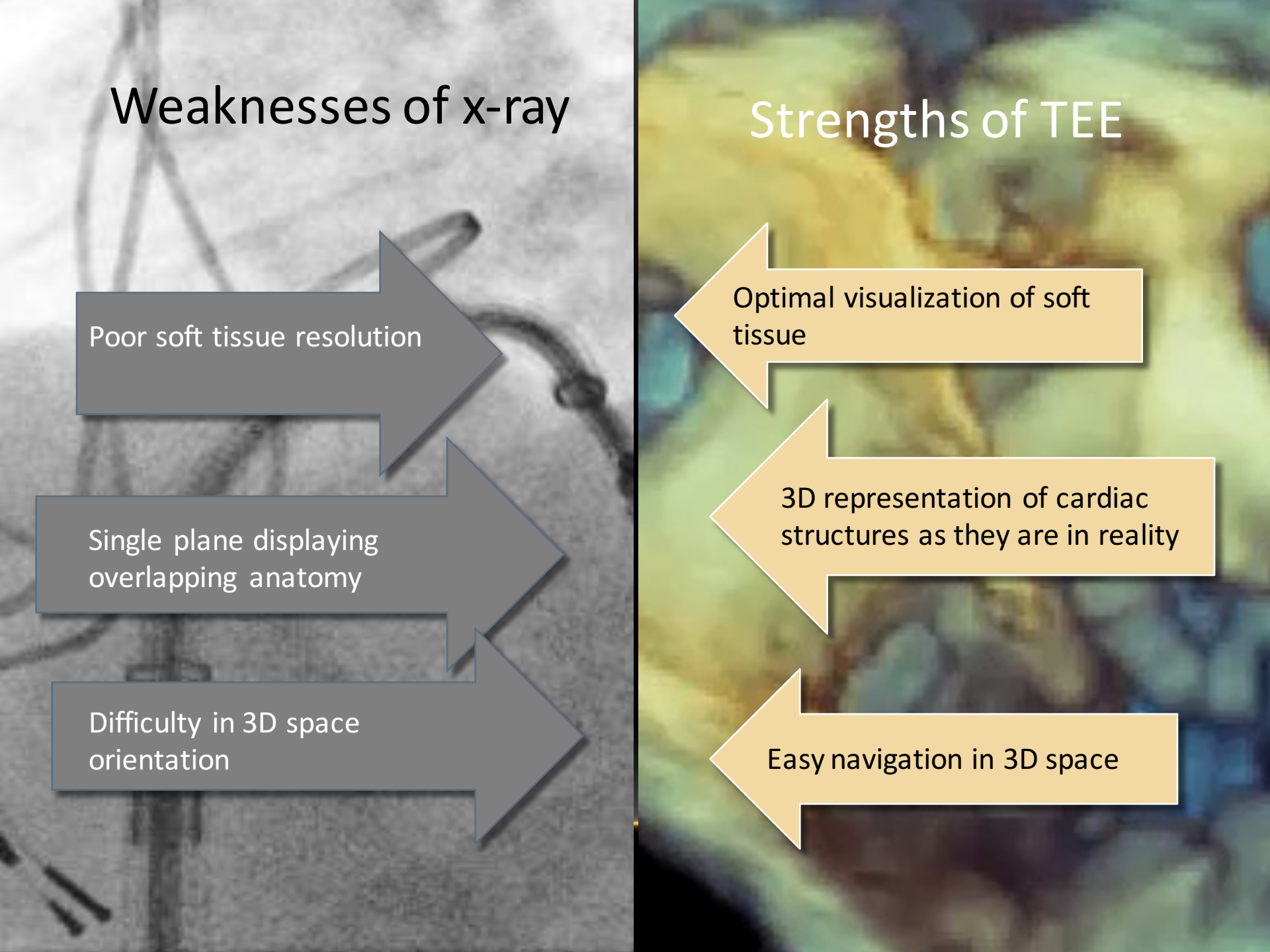
Weaknesses of x-ray
Poor soft tissue resolution
Single plane displaying overlapping anatomy
Difficulty in 3D space orientation
Strengths of TEE
Optimal visualization of soft tissue
3D representation of cardiac structures as they are in reality
Easy navigation in 3D space

Weaknesses of TEE

- Narrow field of view
- Poor definition of catheters, wires and devices
- Relatively low spatial and temporal resolution (3D TEE)
- Depend on image quality and operator's experience

Strengths of x-ray

- Large field of view
- Optimal definition of wire, catheters and devices.
- High temporal(30 frame/sec)and spatial(0.3 mm)resolution
- Easy to get and use

The x-ray-echo fusion

The system

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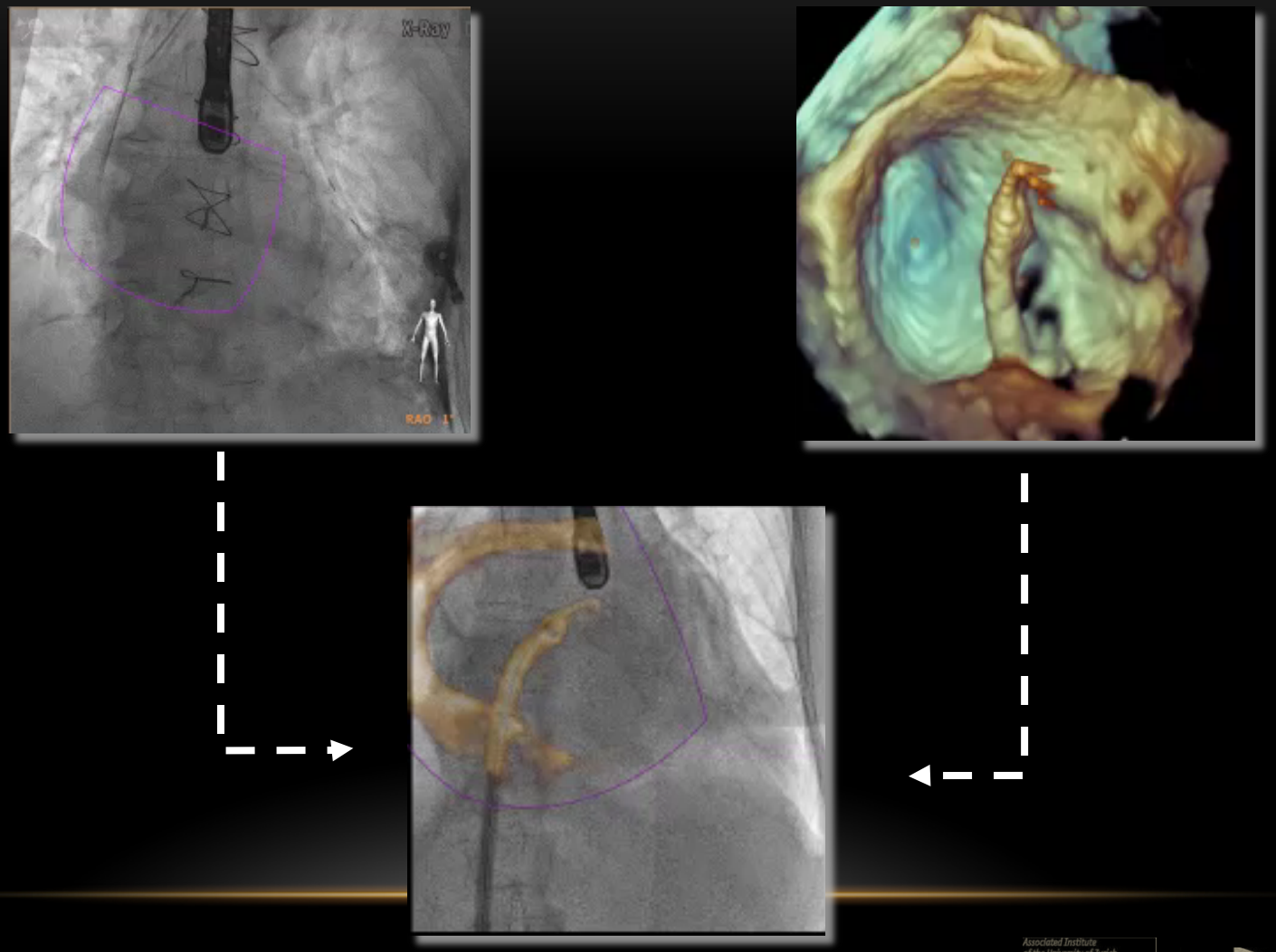
X-ray-echo fusion

The system



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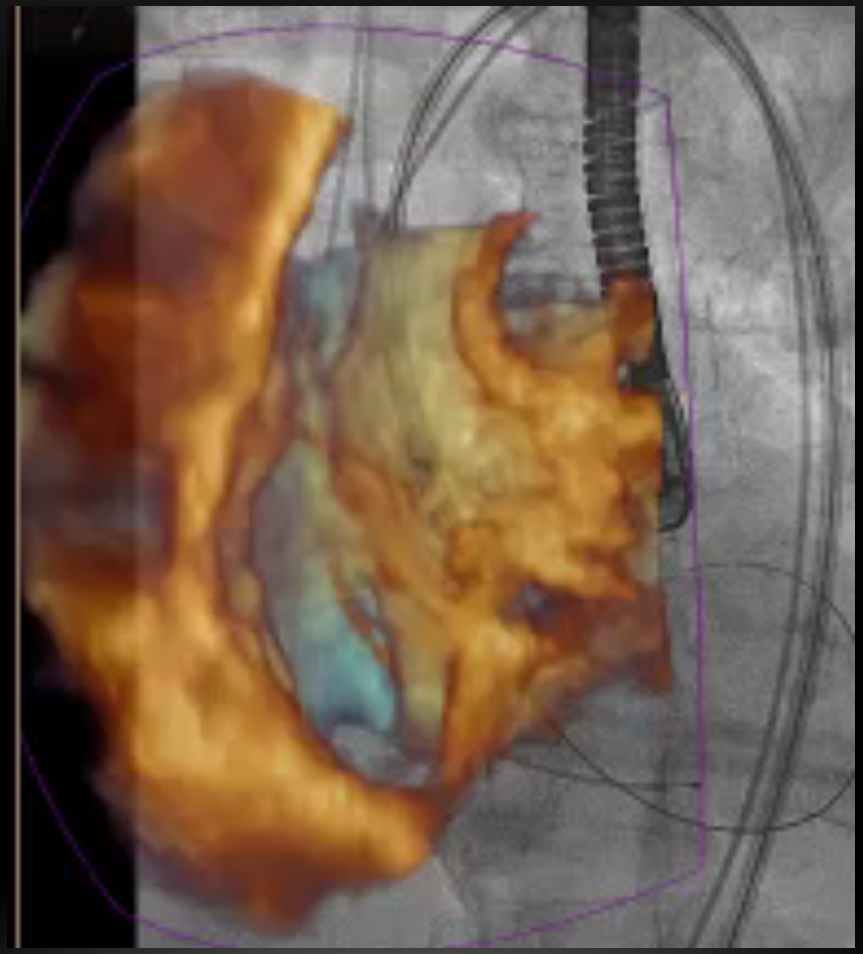
The x-ray-echo fusion



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The x-ray-echo fusion

Potential role in SHD interventions

Examples of transseptal puncture , closure of paravalvular leak and TAVI

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University of Zurich
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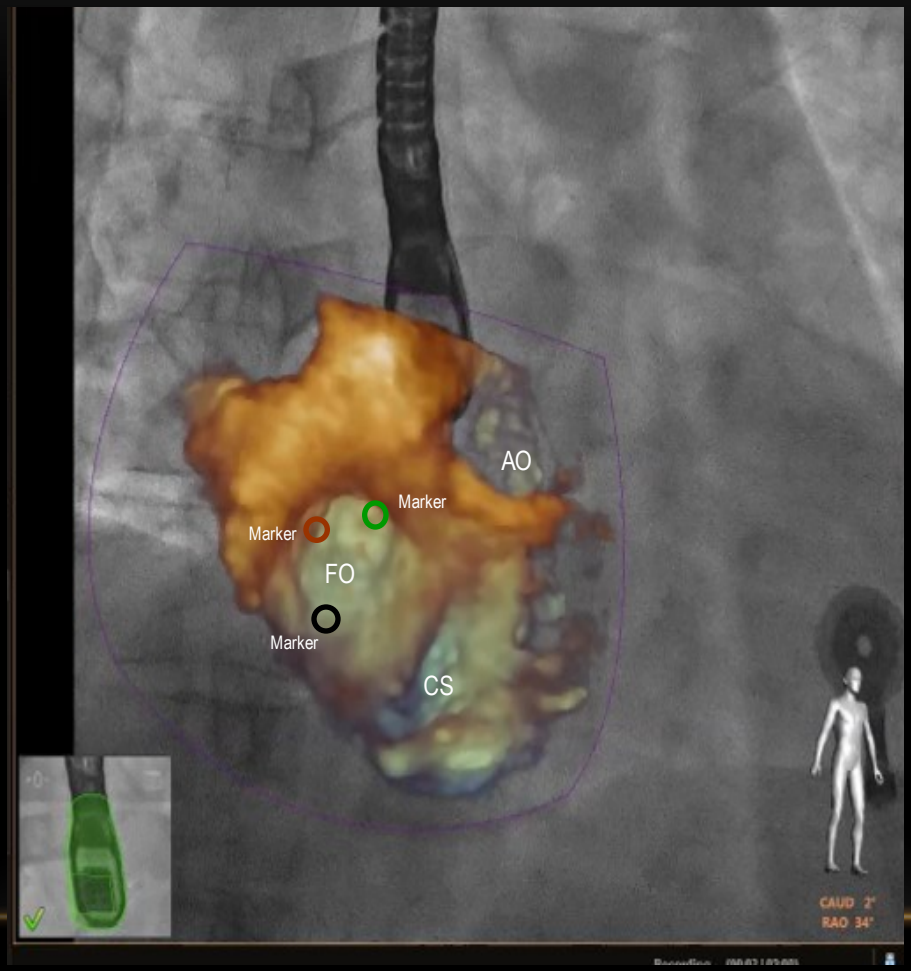
Transseptal puncture

An easier localization of site-specific TSP



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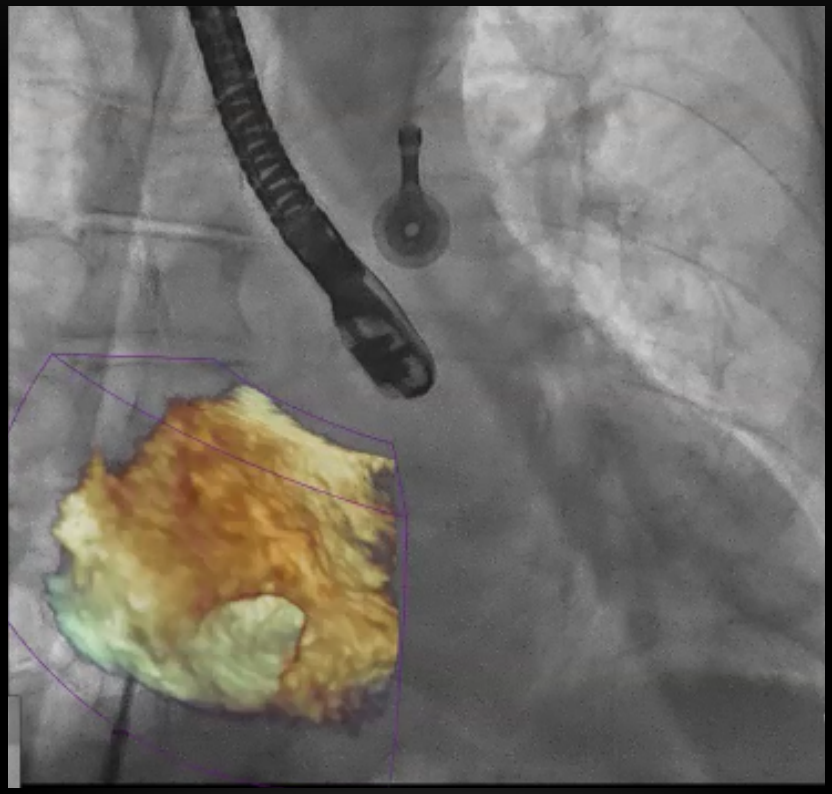
Transseptal puncture

Following the needle



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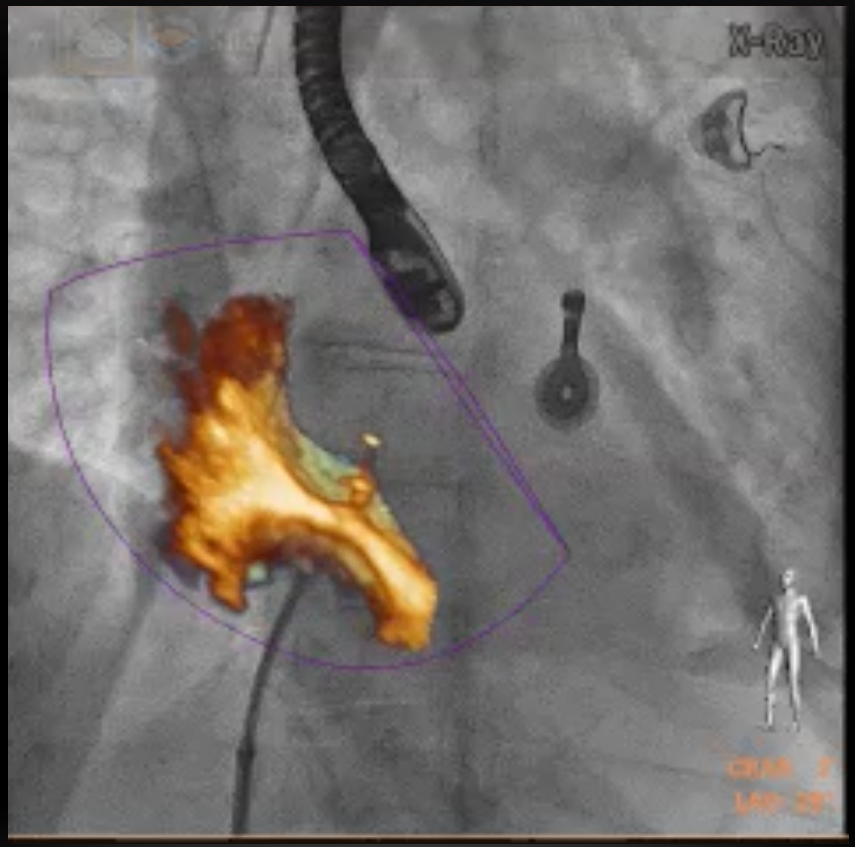
Transseptal puncture

Visualizing the “tenting” on the fluoroscopic image



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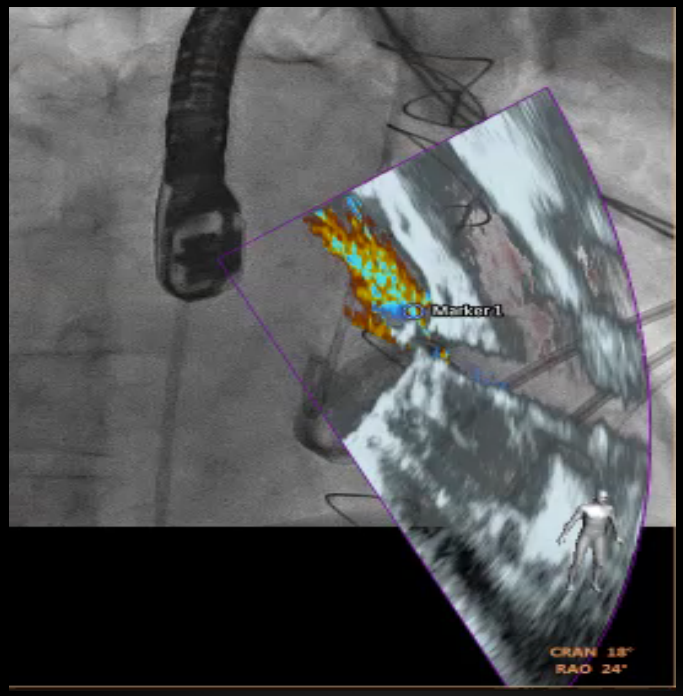
Closure of paravalvular leak

Localizing the paravalvular leak on the fluoroscopic image



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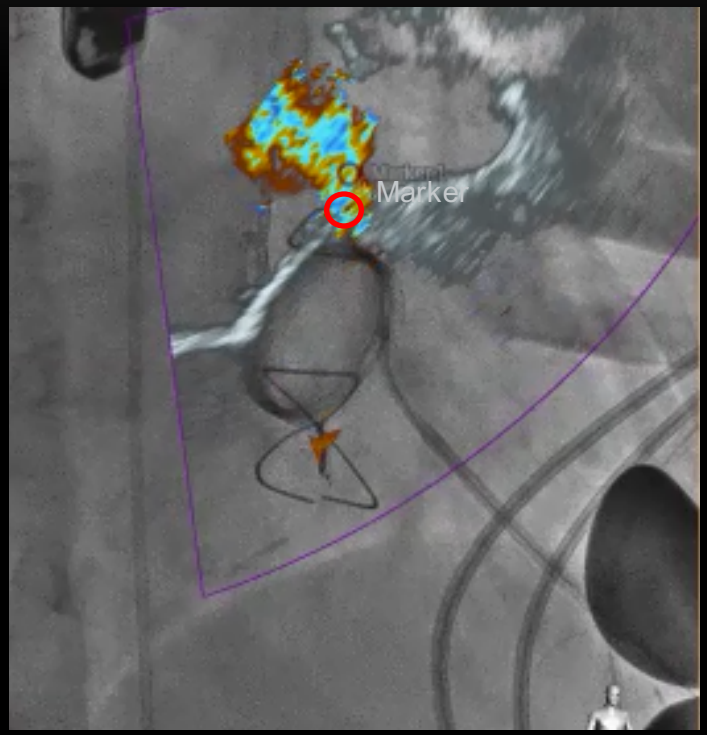
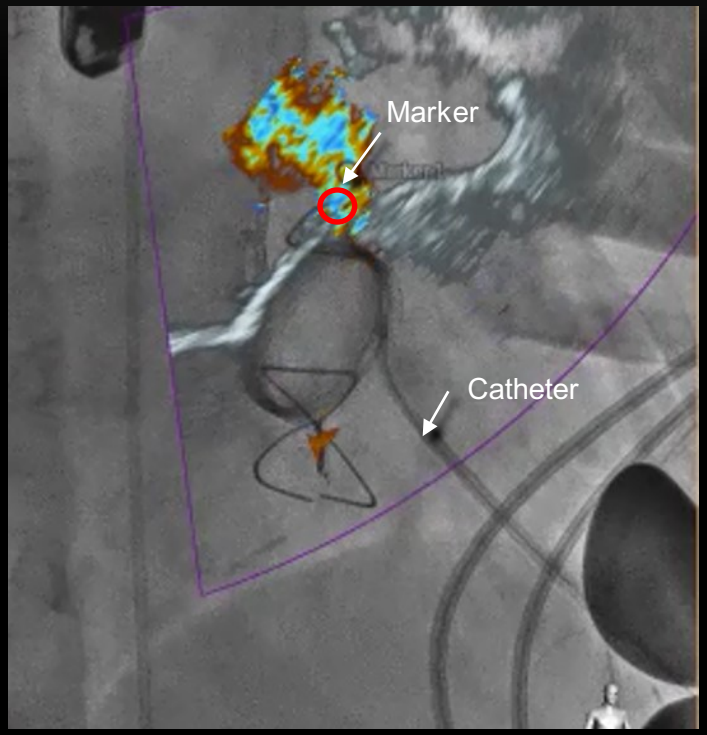
Closure of paravalvular leak





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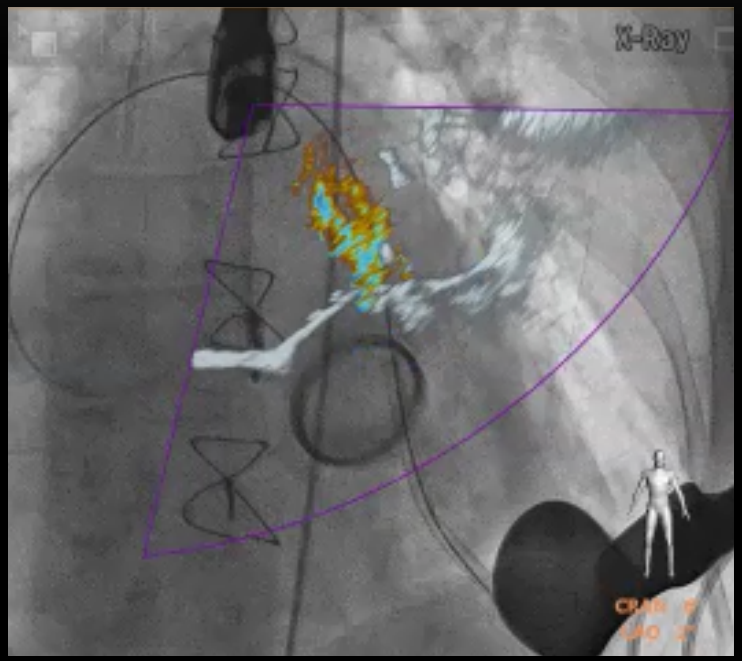
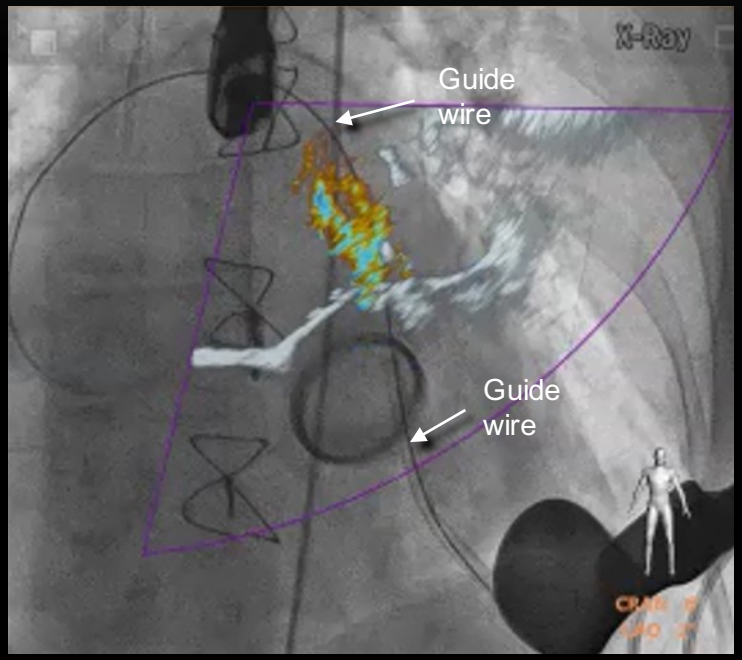
Closure of paravalvular leak





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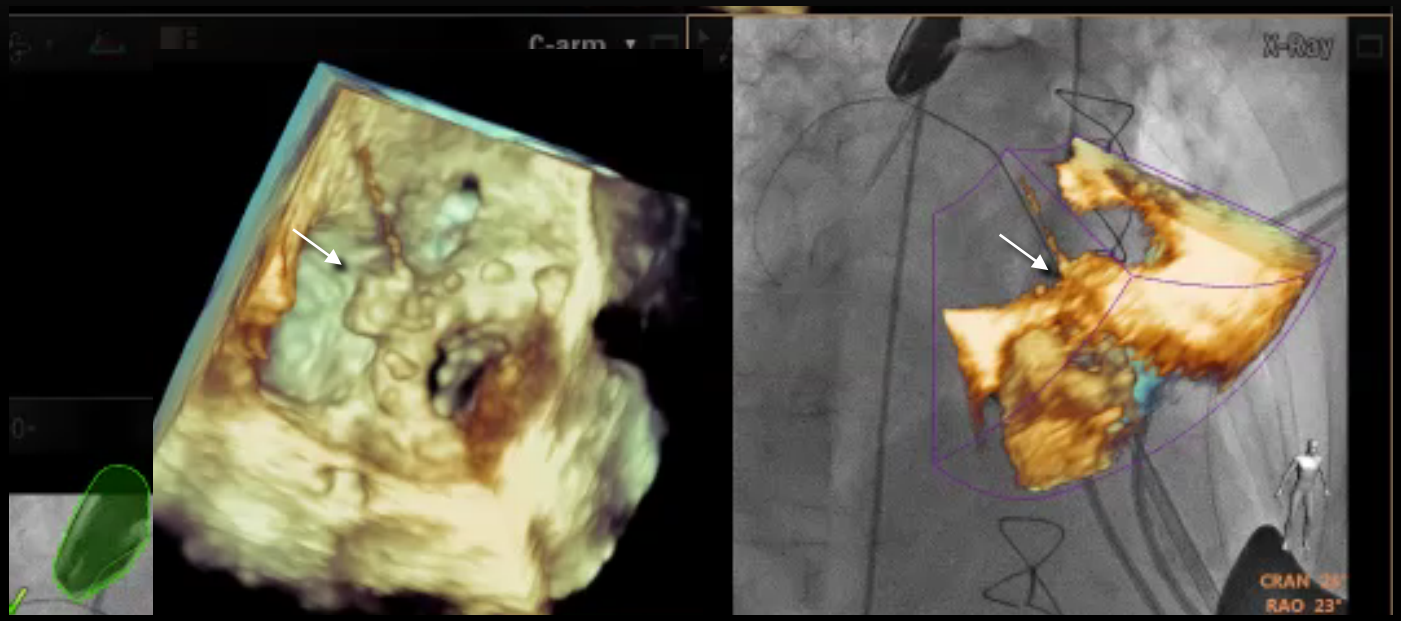
Closure of paravalvular leak



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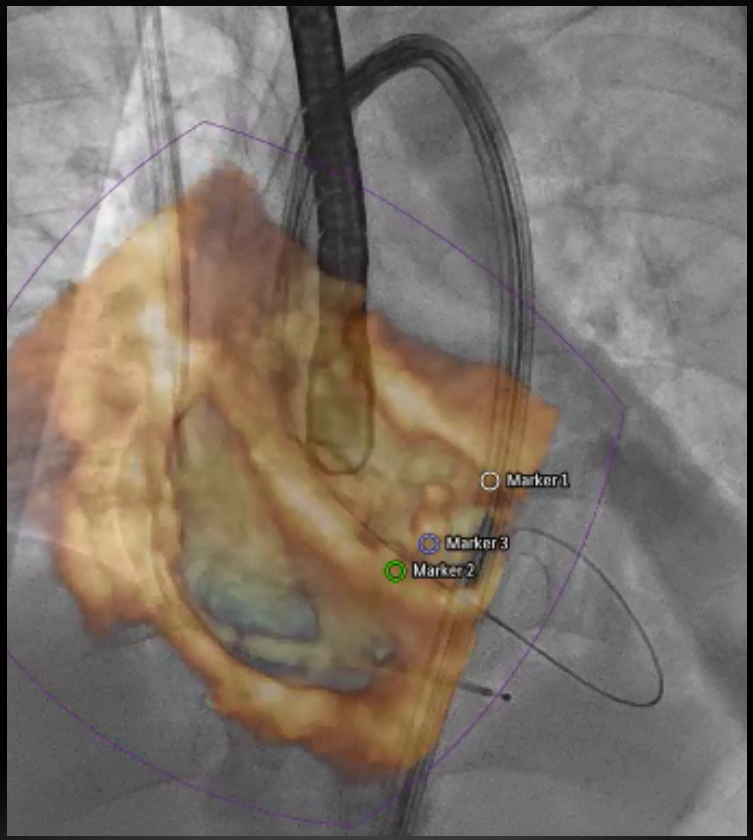
TAVI

“zero contrast”



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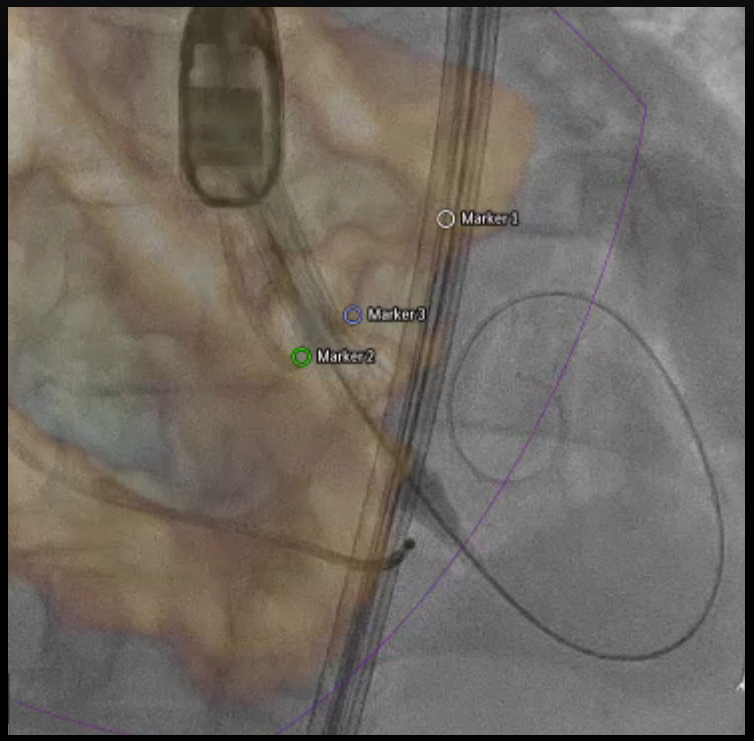
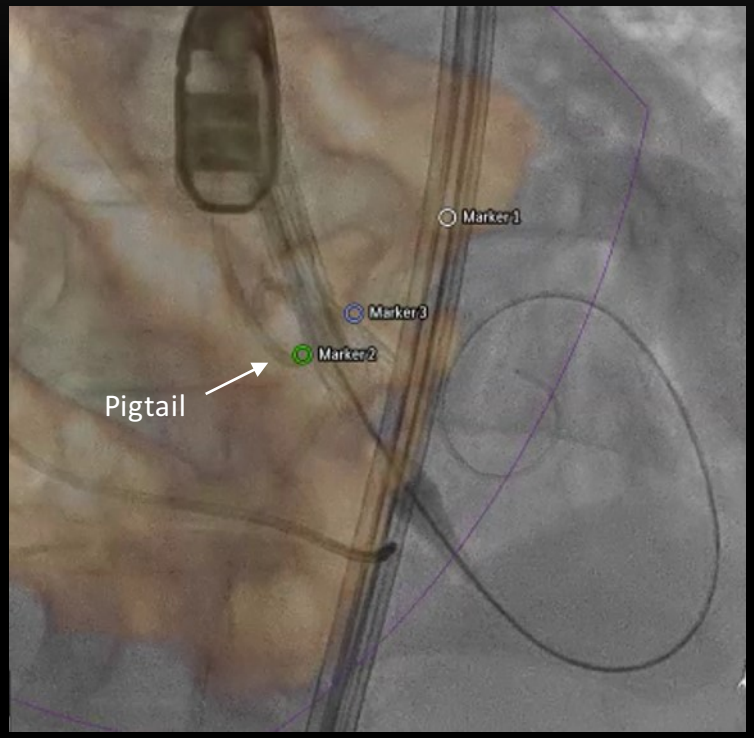
TAVI

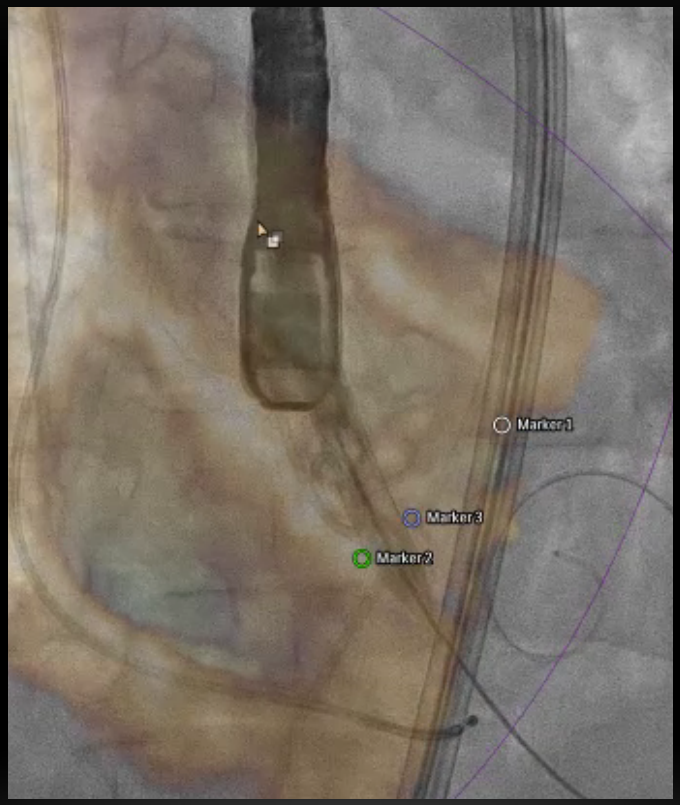
“zero contrast”





TAVI

“zero contrast”



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The clinical role of 3D echocardiography

- Direct evaluation of cardiac chamber volumes
- The “surgical view” of mitral valve
- Teaching cardiac anatomy
- Guidance of interventional procedures in structural heart disease (x-ray-echo fusion)
- Automated valve quantitative modeling

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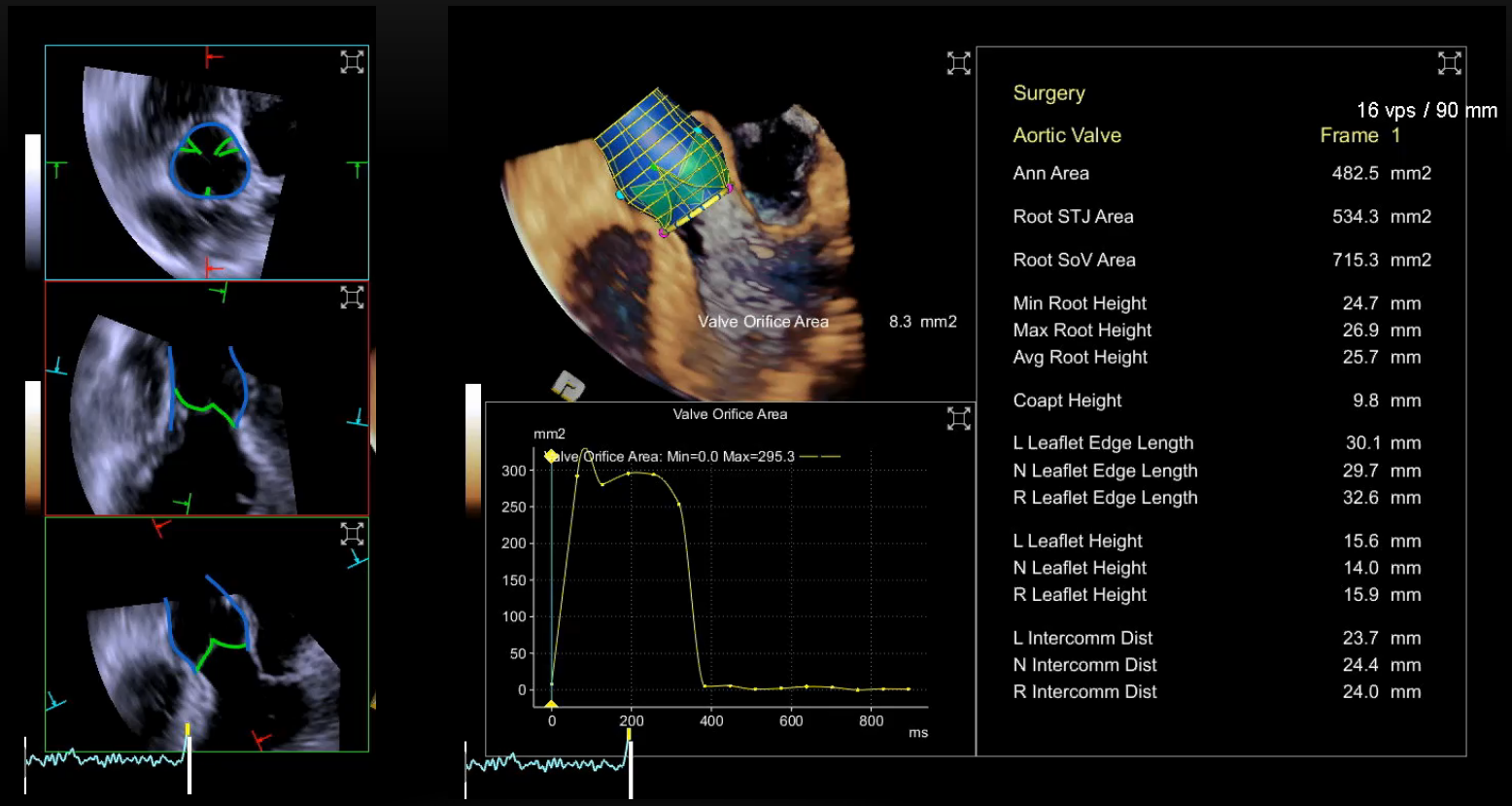
CARDIOCENTRO TICINO

Automated quantitative valve modeling



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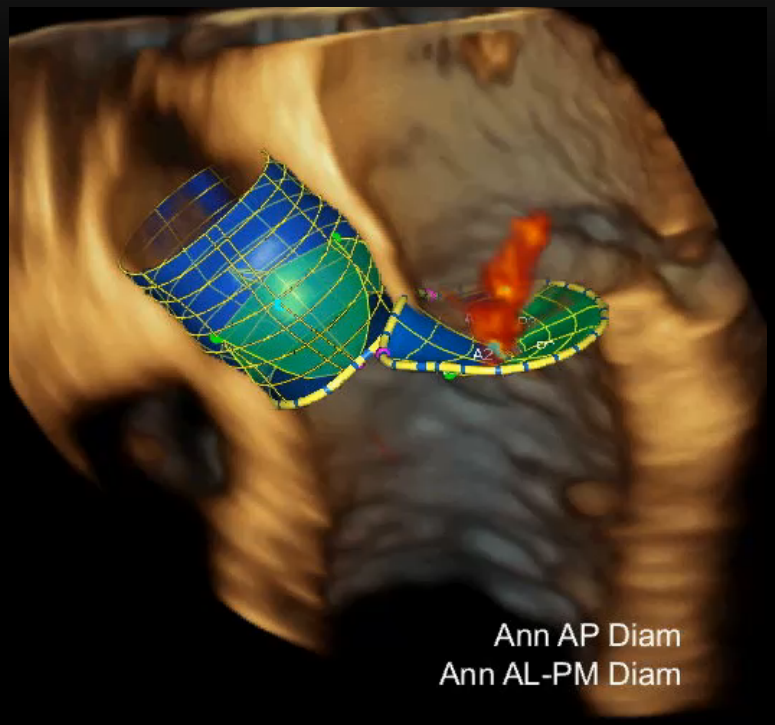

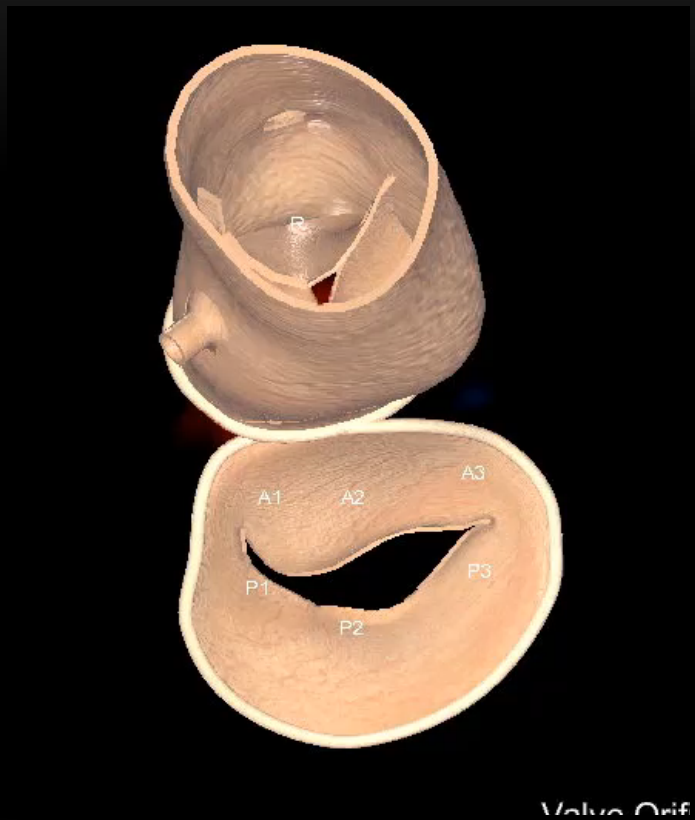

Food for thoughts

- Echocardiography has been in use since 1960s giving a tremendous impulse in the diagnosis of cardiac disease
- The *"evolution"* of echocardiography has eventually generated the *"real time" 3D echocardiography*.
- This new modality provides realistic *anatomical imaging* of normal and pathological cardiac structures, and plays *a pivotal role* in guiding percutaneous SHD intervention.
- Finally, it provides the ideal framework for a *completely automated heart valve modeling*

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Thank you for your kind attention