Challenges in aortic stenosis : Why and what to say to the interventionists?

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- Patients selection for TAVI

Indications

Severe Aortic Stenosis	Ao Valve area < 1cm² or 0,6 cm²/m² (Edwards Inc. → AVA <0,8 cm²) Max. Velocity > 4 m/s Mean LV/Ao gradient > 40 mmHg
Symptoms	III-IV NYHA
High risk	Logistic EuroScore >20% or STS score >10%
Contraindication to surgery	
Other possible indications:	degenerative bioprosthesis

At this stage, TAVI is not recommended for patients who simply refuse surgery on the basis of personal preference.

Vahanian A. Et al. Eur Heart J 2008;29:1463–70.

- Introduction

Issues

Patient's selection

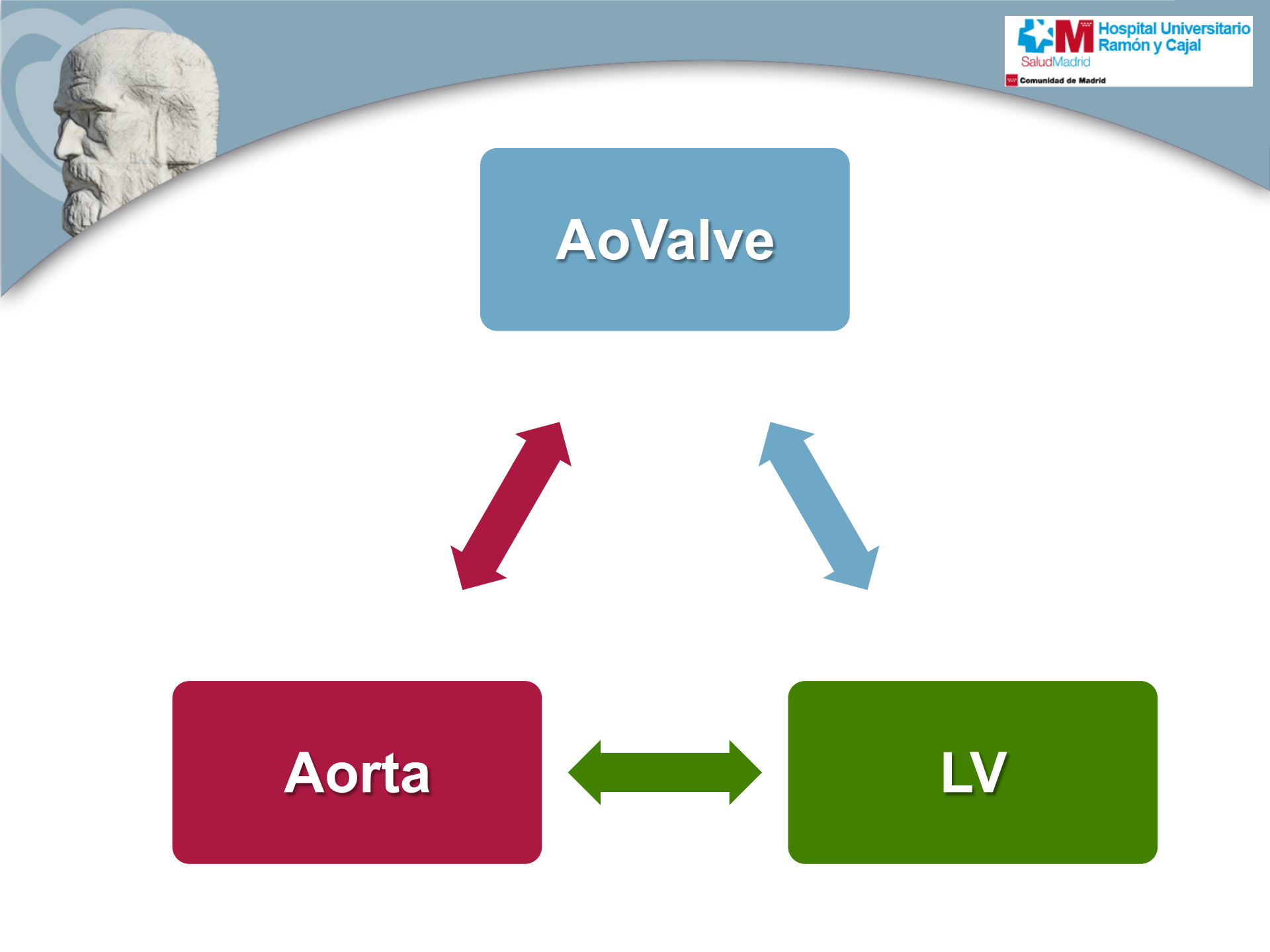
Best management during the procedure

Complications

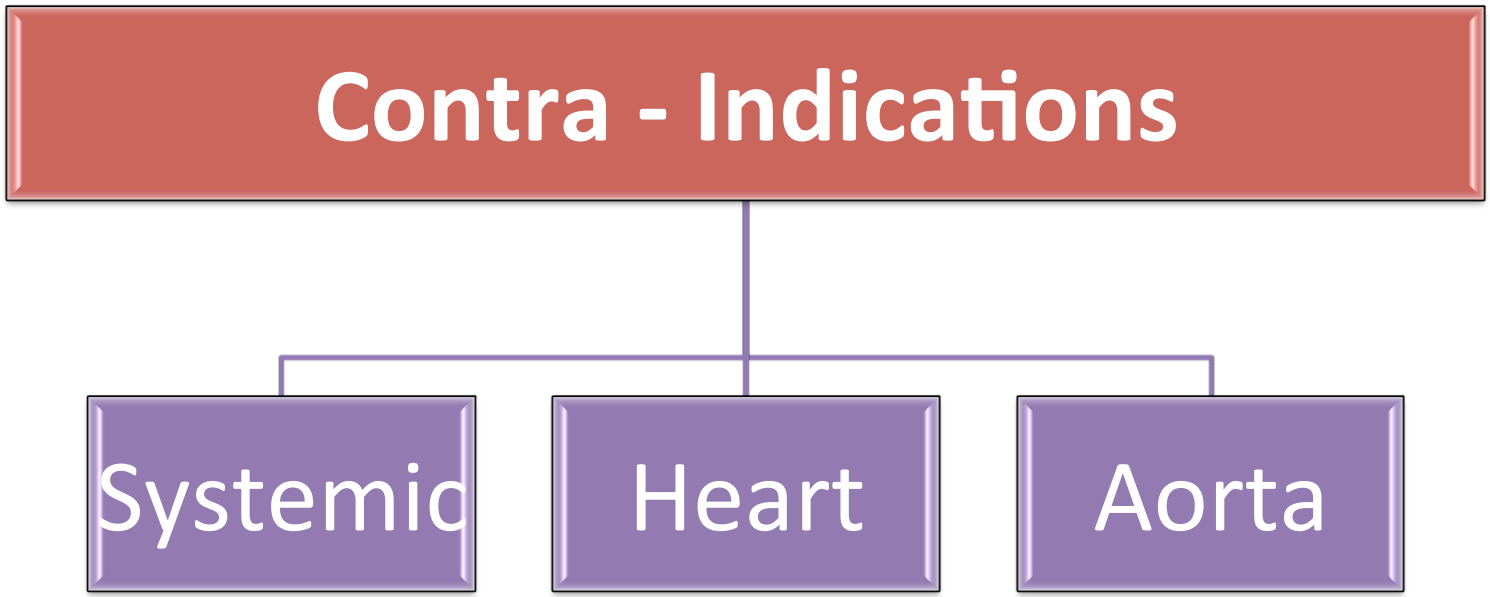
Results at mid- and long-term follow-up

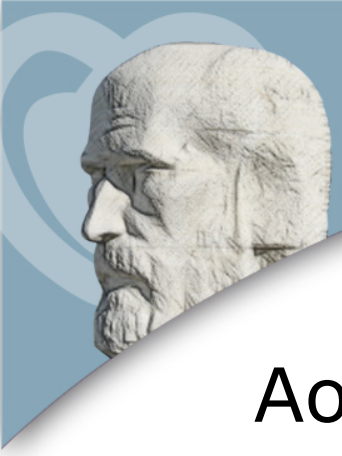
What information of anatomy can I give you with the imaging techniques?

- Patients selection for TAVI
- Guiding the procedure
- Evaluation of success and complications


AoValve
Aorta
LV

- Patients selection for TAVI





1.- Aortic valve

ECHOCARDIOGRAM

AoS severity

MG> 40 mmHg ; Peak Velocity > 4m/s

AVA < 1 cm2 AVA index < 0,5 cm2/ m2

Tri or bicuspid

Calcification severity and distribution

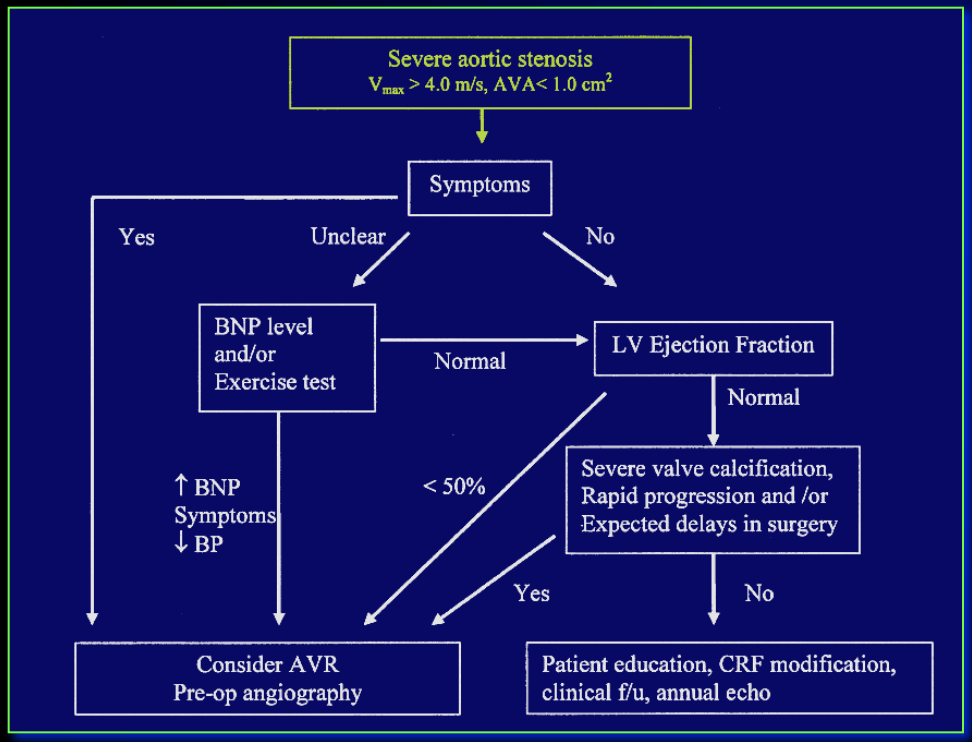
Leflets thickness

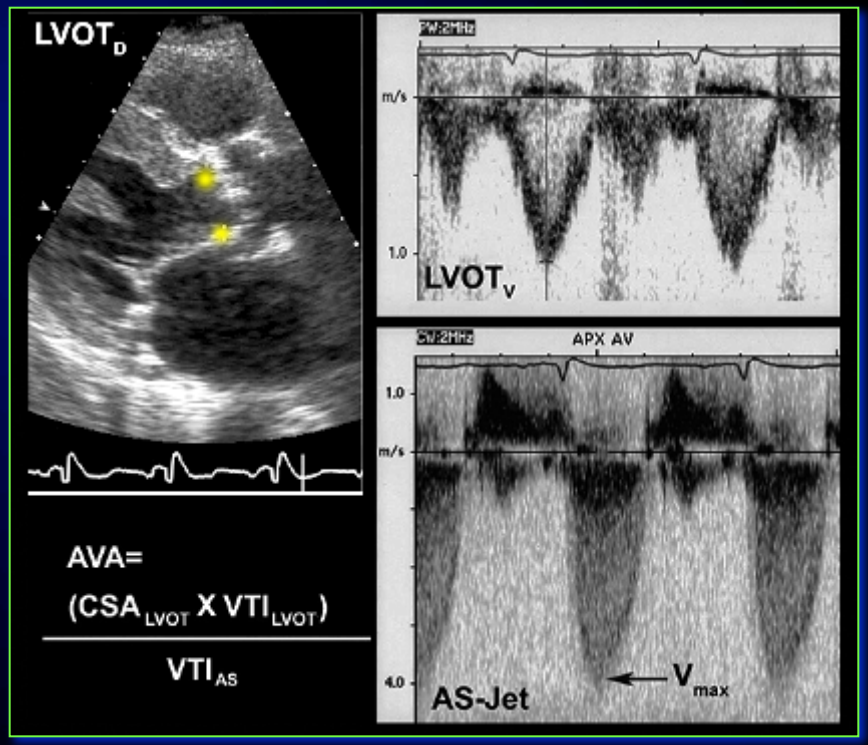
Anullus

Aortic Valvular Area

"Aortic stenosis is accurately quantified by Doppler measurements of instantaneous and mean transvalvular gradients and estimation of valve area by the continuity method"

AHA/ACC Guidelines Echocardiography Update 2003





Otto C y cols. J Am Coll Cardiol 2006

Continuity Equation

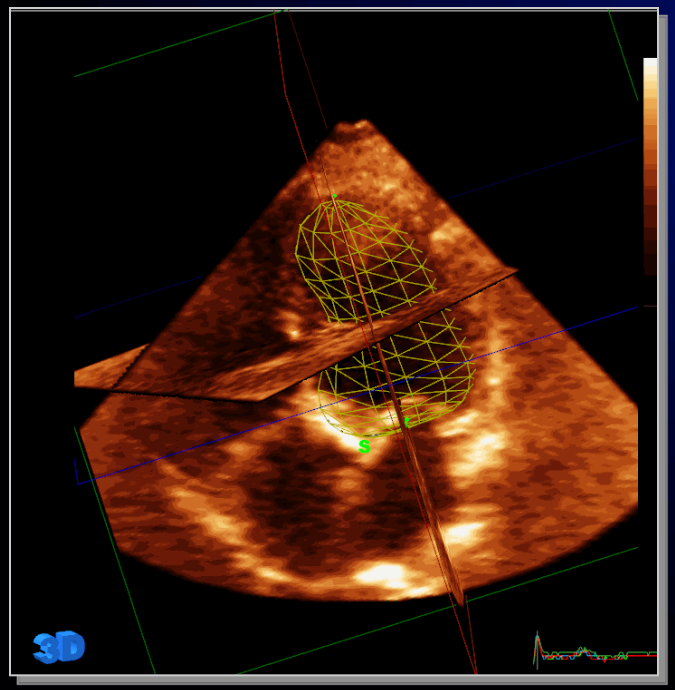
- Assumptions on:
  - LVOT geometry (is assumed to be circular)
  - Uniform velocity in the LVOT is assumed

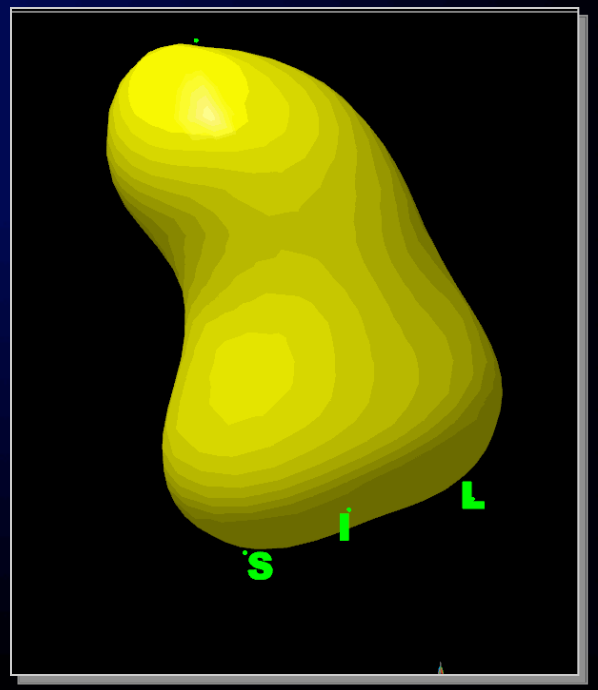
- Simultaneous measurements in time and location are not obtained

Eur Heart J 2008

Real-time three-dimensional echocardiography in aortic stenosis: a novel, simple, and reliable method to improve accuracy in area calculation

Juan Luis Gutiérrez-Chico[1]*, José Luis Zamorano[2], Elsa Prieto-Moriche[2], Rosa Ana Hernández-Antolín[2], Marisol Bravo-Amaro[1], Leopoldo Pérez de Isla[2], Marcelo Sanmartín-Fernández[1], José Antonio Baz-Alonso[1], and Andrés Íñiguez-Romo[1]





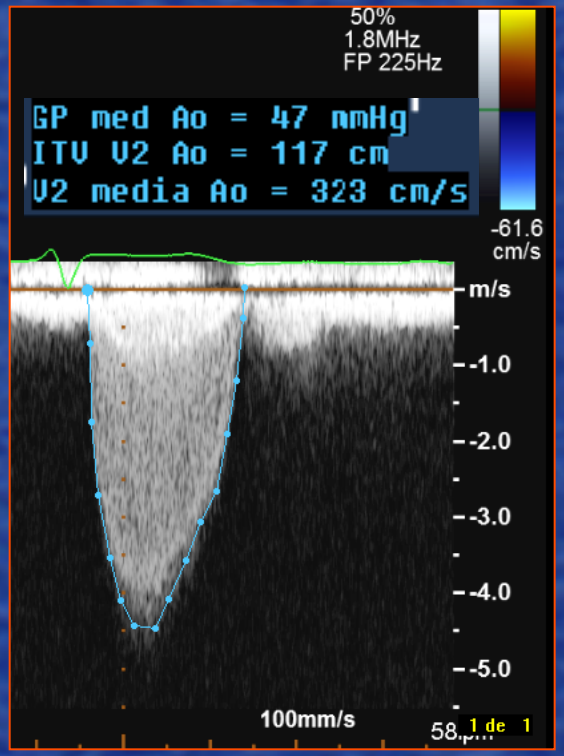
Aortic stenosis: Continuity equation

- Cumulative error in several parameters
- Depending on good parasternal & apical acoustic windows

TSVI

IVT TSVI

$$A_{Ao} = \pi \left(\frac{D_{TSVI}}{2}\right)^2 \frac{IVT_{TSVI}}{IVT_{Ao}}$$



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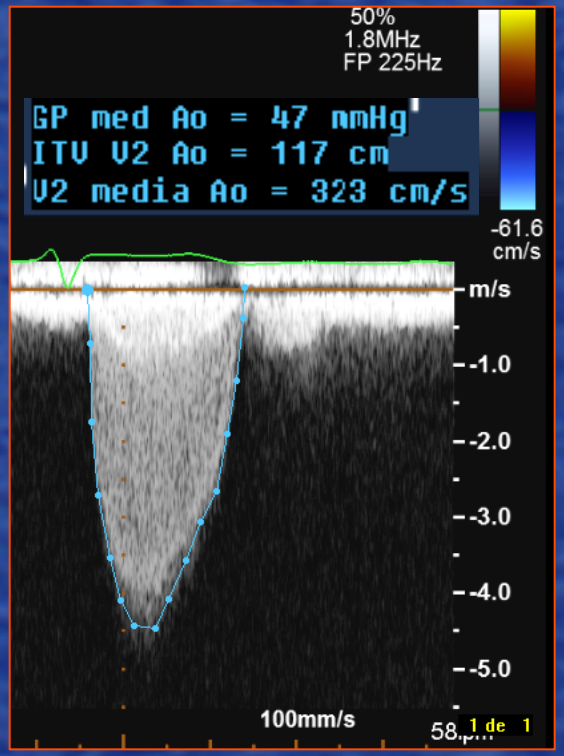
STROKE VOLUME



Aortic stenosis: Continuity equation

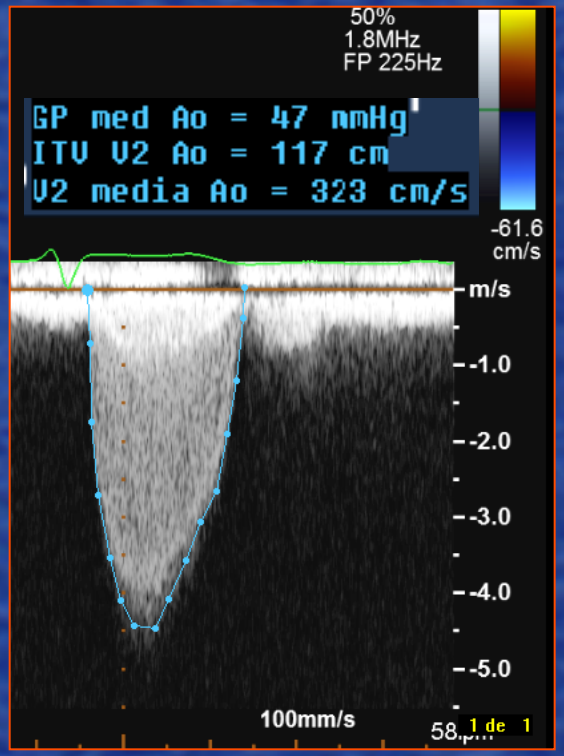
- Cumulative error in several parameters
- Depending on good parasternal & apical acoustic windows

TSVI

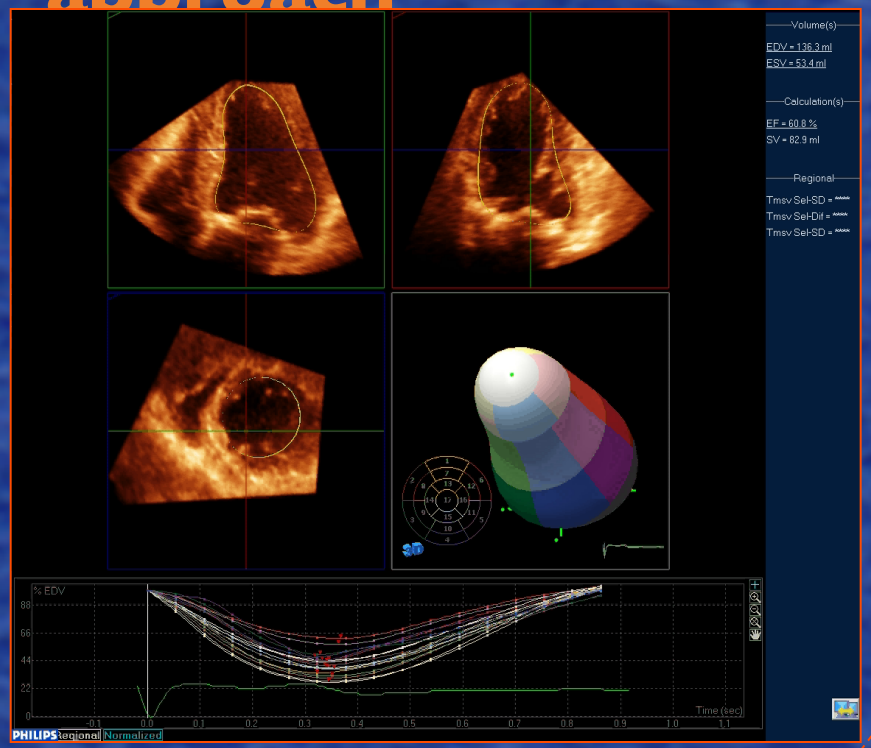
IVT TSVI

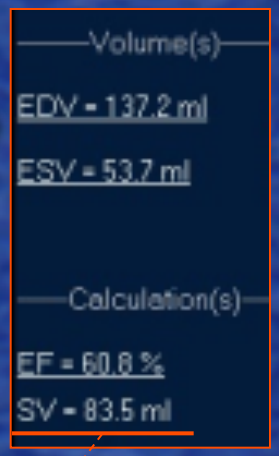
$$A_{Ao} = \frac{SV}{IVT_{Ao}}$$

STROKE VOLUME

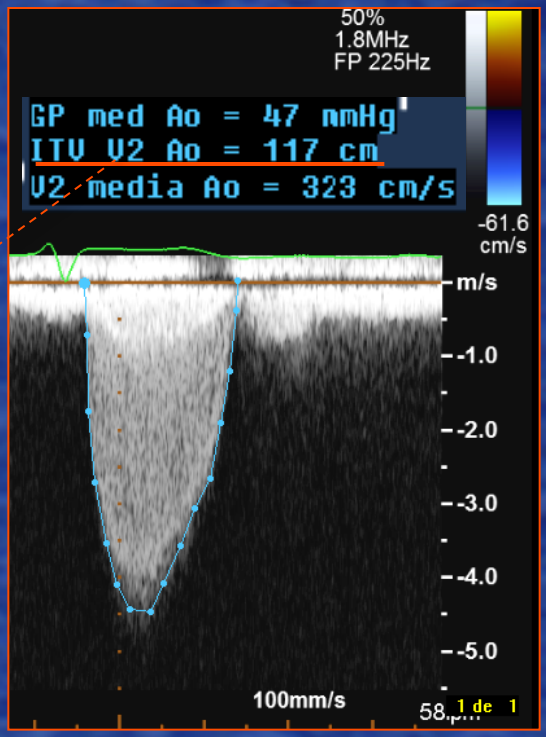


Aortic area: RT3D-Doppler hybrid approach





$$\text{Aortic area} = \frac{SV_{3D}}{TVI_{Ao}}$$

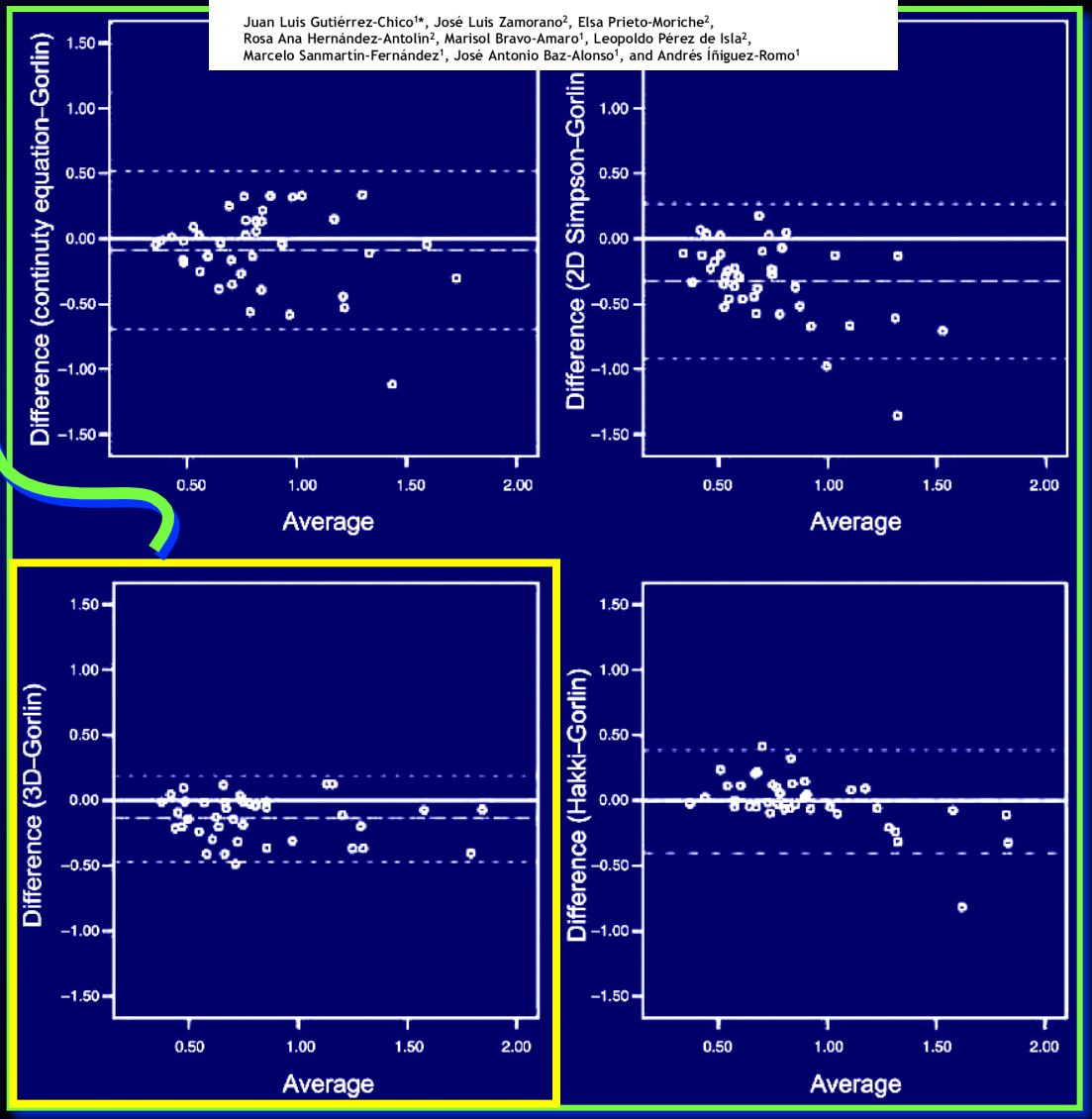


- Excellent agreement between 3D-Echo and Gorlin
- 3D-Echo understimates aortic valvular area ±0.06 cm^2
- Using 3D-Echo the number of severe stenosis was higher than using continuity equation

European Heart Journal Advance Access published November 6, 2007
European Heart Journal
doi:10.1093/eurheartj/ehm467
Clinical research

Real-time three-dimensional echocardiography in aortic stenosis: a novel, simple, and reliable method to improve accuracy in area calculation

Juan Luis Gutiérrez-Chico[1]*, José Luis Zamorano[2], Elsa Prieto-Moriche[2], Rosa Ana Hernández-Antolín[2], Marisol Bravo-Amaro[1], Leopoldo Pérez de Isla[2], Marcelo Sanmartín-Fernández[1], José Antonio Baz-Alonso[1], and Andrés Íñiguez-Romo[1]



Eur Heart J 2008

AORTA

ECHOCARDIOGRAM

Calcification

Dimensions

Aneurism

Tortuosity

Atherosclerosis

Distance to coronaries

- Patients selection for TAVI

Contra - Indications

Aorta

Aortic valve	Bicuspid
	Severe and asymmetric calcification
Aortic Annulus	<18mm or >25mm Edwards-Sapien <20mm or >27mm CoreValve
Sinotubular Junction	>45mm (CoreValve)
Aorta (percutaneous assess)	Severe angulation Severe aortic arch atheroma Coarctation Abdominal Ao aneurysm with thrombus

Zamorano JL, et al EAE/ASE recommendations for the use of echocardiography in new transcatheter interventions for valvular heart disease. Eur Heart J. 2011

LV

ECHOCARDIOGRAM

LVH severity and distribution

LV EF

Dimensions

Thrombus

- Patients selection for TAVI

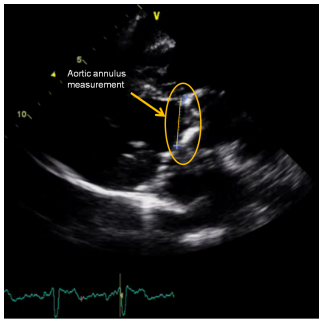
Contra - Indications

Heart

- LV thrombus
- Severe LV disfunction with contractile reserve < 20%.
- Subaortic disease causing severe stenosis: CoreValve if septum > de 17mm. Both if HOCM.
- Mitral regurgitation > II/IV (CoreValve)
- Coronary arteries: Proximal severe stenosis non suitable for PTCA. Lower implantation.
- Recent AMI.

- Patients selection for TAVI

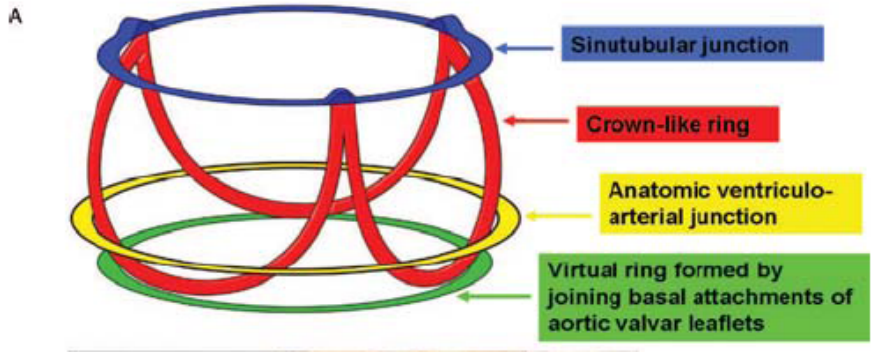
Issues

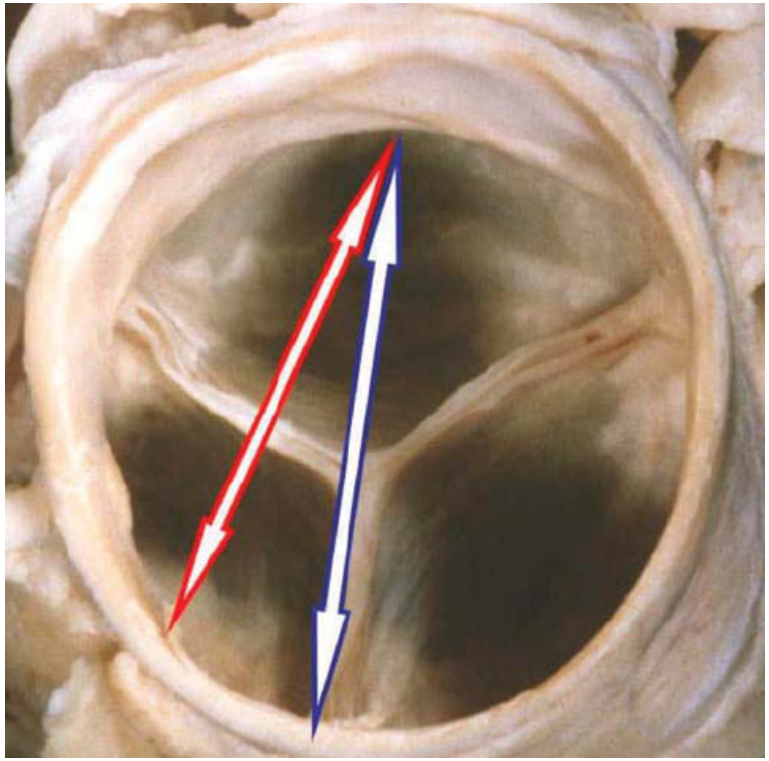


What is the most appropriate method for aortic annulus measurement?

• Patients selection for TAVI

Circulation
Cardiovascular Interventions
JOURNAL OF THE AMERICAN HEART ASSOCIATION





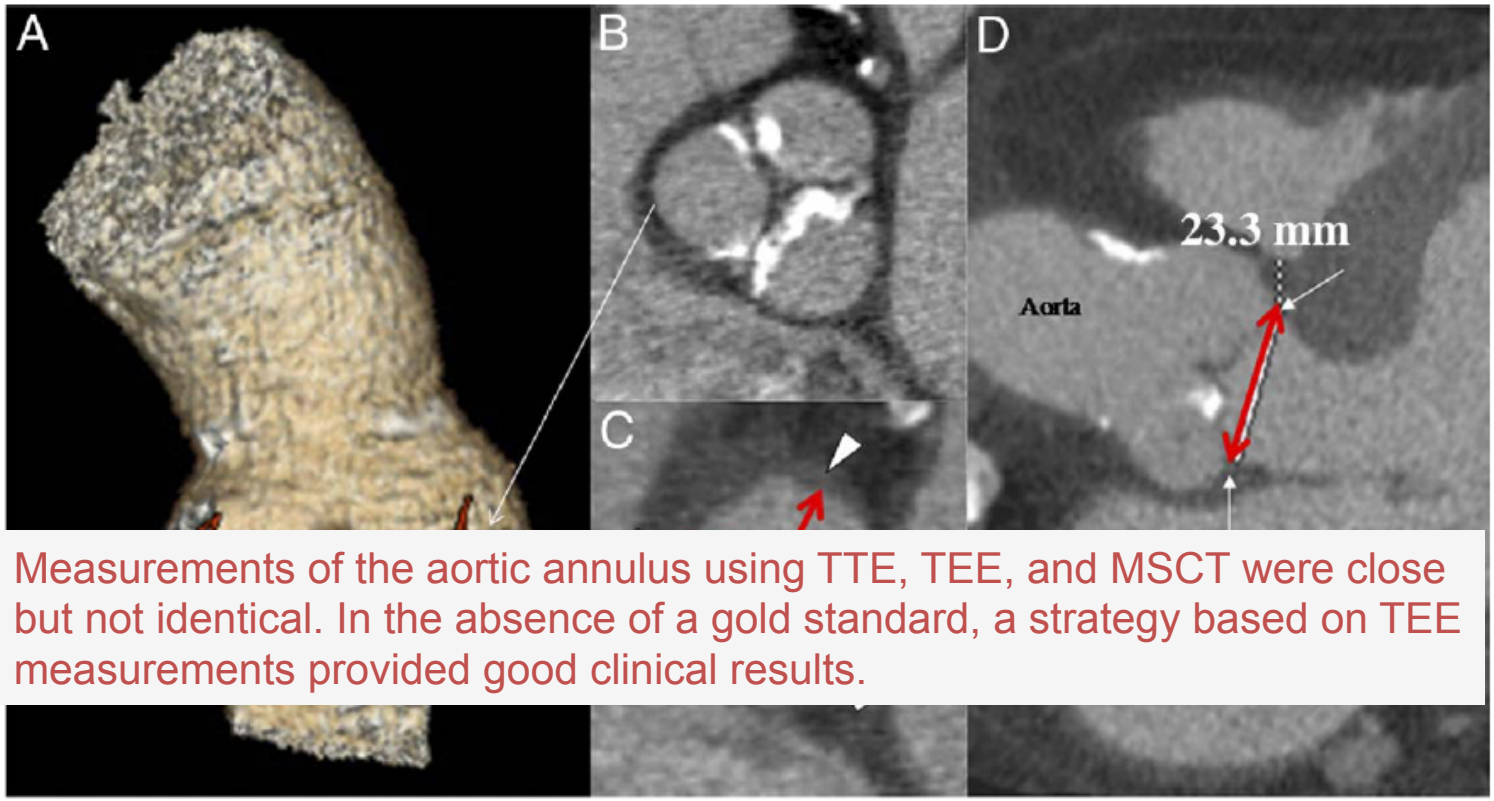
Nicoló Piazza et al. *Circ Cardiovasc Interv 2008;1;74-81*

CT Scan

Multimodal Assessment of the Aortic Annulus Diameter

Implications for Transcatheter Aortic Valve Implantation

David Messika-Zeitoun, MD, PHD,*‡ Jean-Michel Serfaty, MD, PHD,† Eric Brochet, MD,‡ Gregory Ducrocq, MD,‡ Laurent Lepage, MD,‡ Delphine Detaint, MD,‡ Fabien Hyafil, MD,‡ Dominique Himbert, MD,‡ Nicoletta Pasi, MD,† Jean-Pierre Laissy, MD, PHD,† Bernard Iung, MD,‡ Alec Vahanian, MD‡

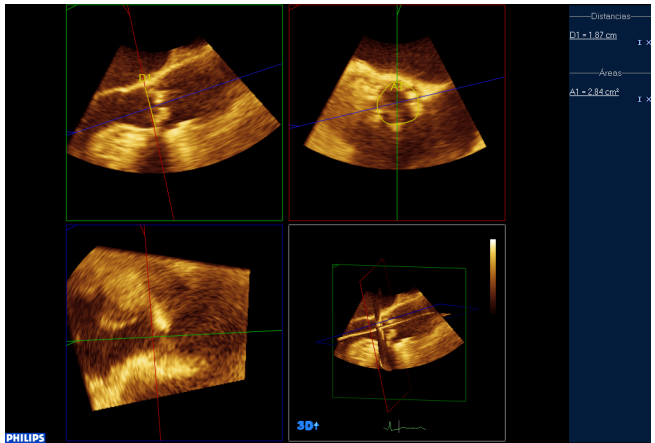


Measurements of the aortic annulus using TTE, TEE, and MSCT were close but not identical. In the absence of a gold standard, a strategy based on TEE measurements provided good clinical results.

J Am Coll Cardiol 2010;55:186–94

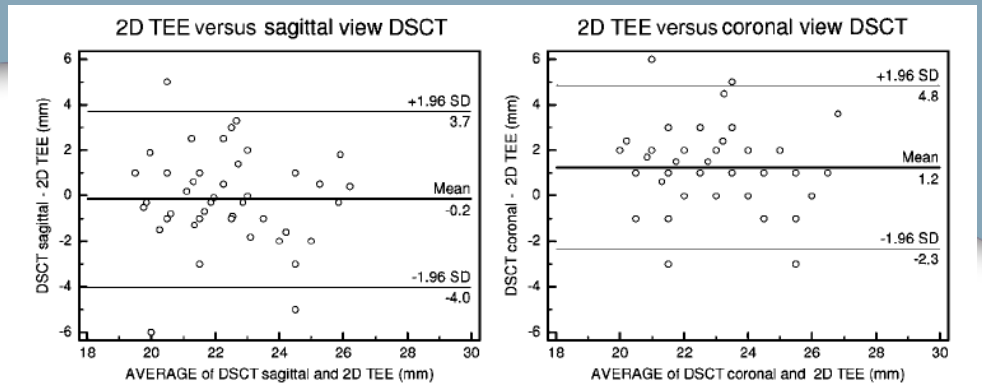
CT vs 2D vs 3D

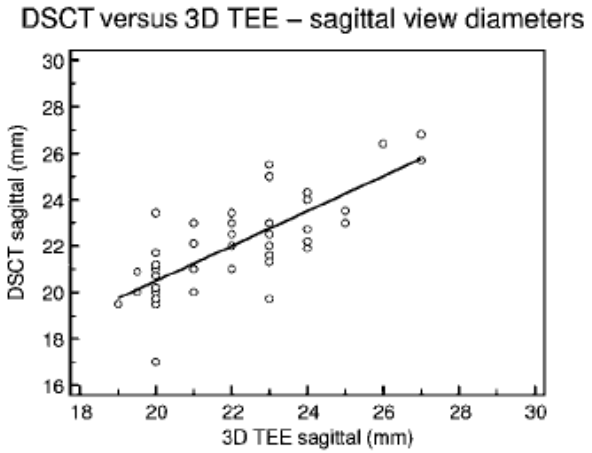
	Aortic annulus diameter derived from sagittal cut plane (mm)	Aortic annulus diameter derived from coronal cut plane (mm)
TTE	21.91±1.87*	–
2D TEE	22.35±2.16*	–
Angiography	22.54±2.07†	23.42±2.08‡
3D TEE	22.27±2.01*	23.46±2.07§
DSCT	22.19±1.96*	23.60±1.89§

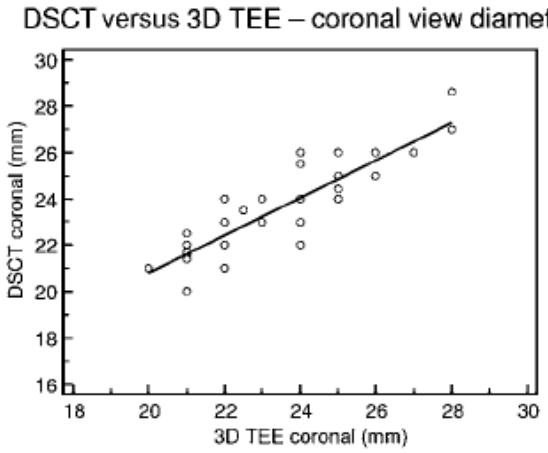


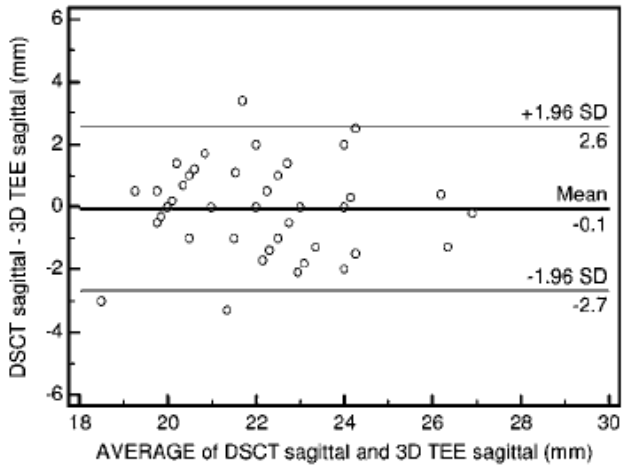
Heart 2011;97:1578-1584

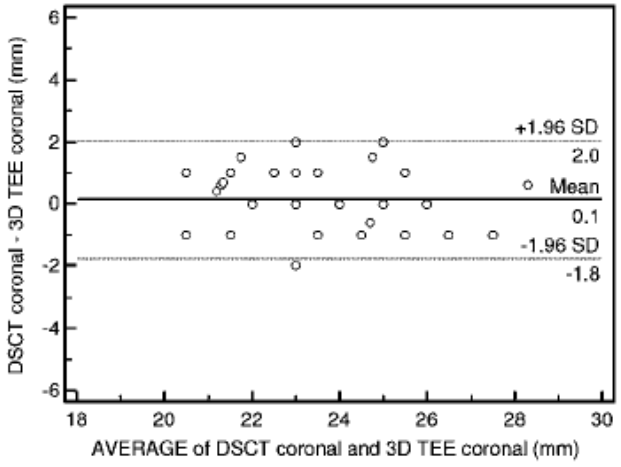
CT vs 2D vs 3D











Heart 2011;97:1578-1584

Aortic annulus

Hospital Universitario Ramón y Cajal
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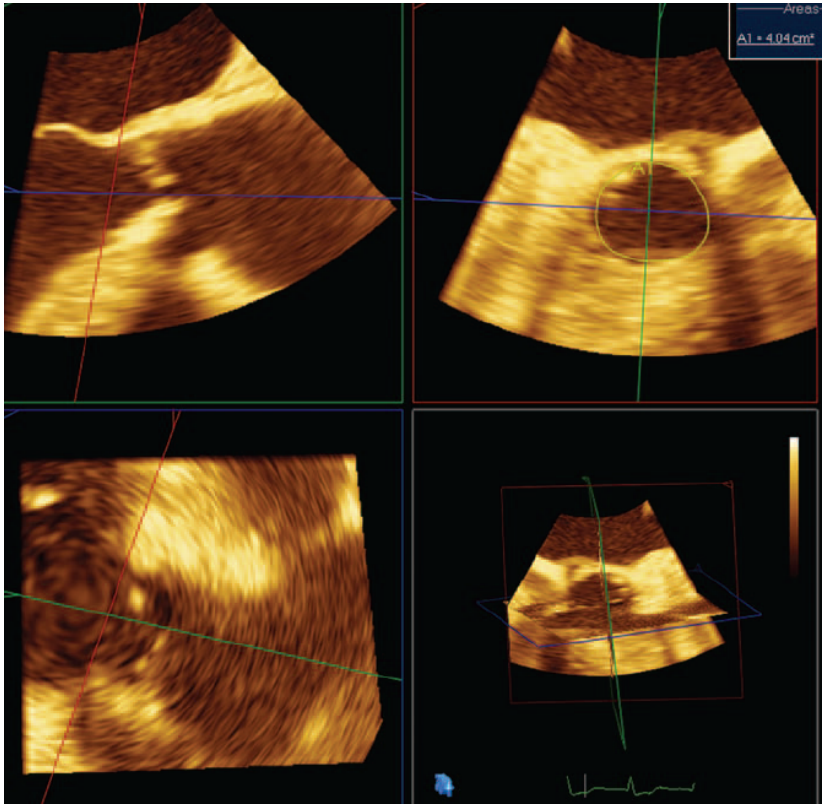
Comunidad de Madrid

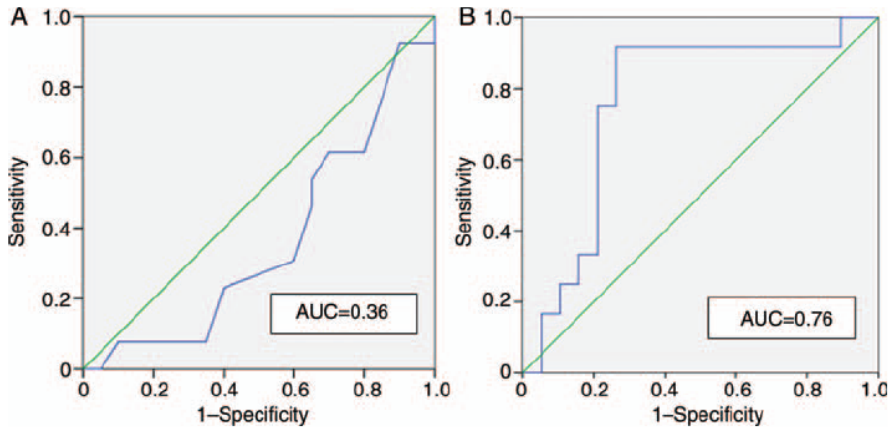
Prosthesis/annulus discongruence assessed by three-dimensional transoesophageal echocardiography: A predictor of significant paravalvular aortic regurgitation after transcatheter aortic valve implantation

Eur Heart J Cardiovasc Imaging. 2012 ;11:931-7

AORTIC ANNULUS

Mismatch index for 2D circular area	−1.02 ± 0.42	−0.96 ± 0.46	−1.13 ± 0.32	0.2
Mismatch index for 3D planimetered area	0.19 ± 0.89	−0.06 ± 0.88	0.65 ± 0.75	0.03





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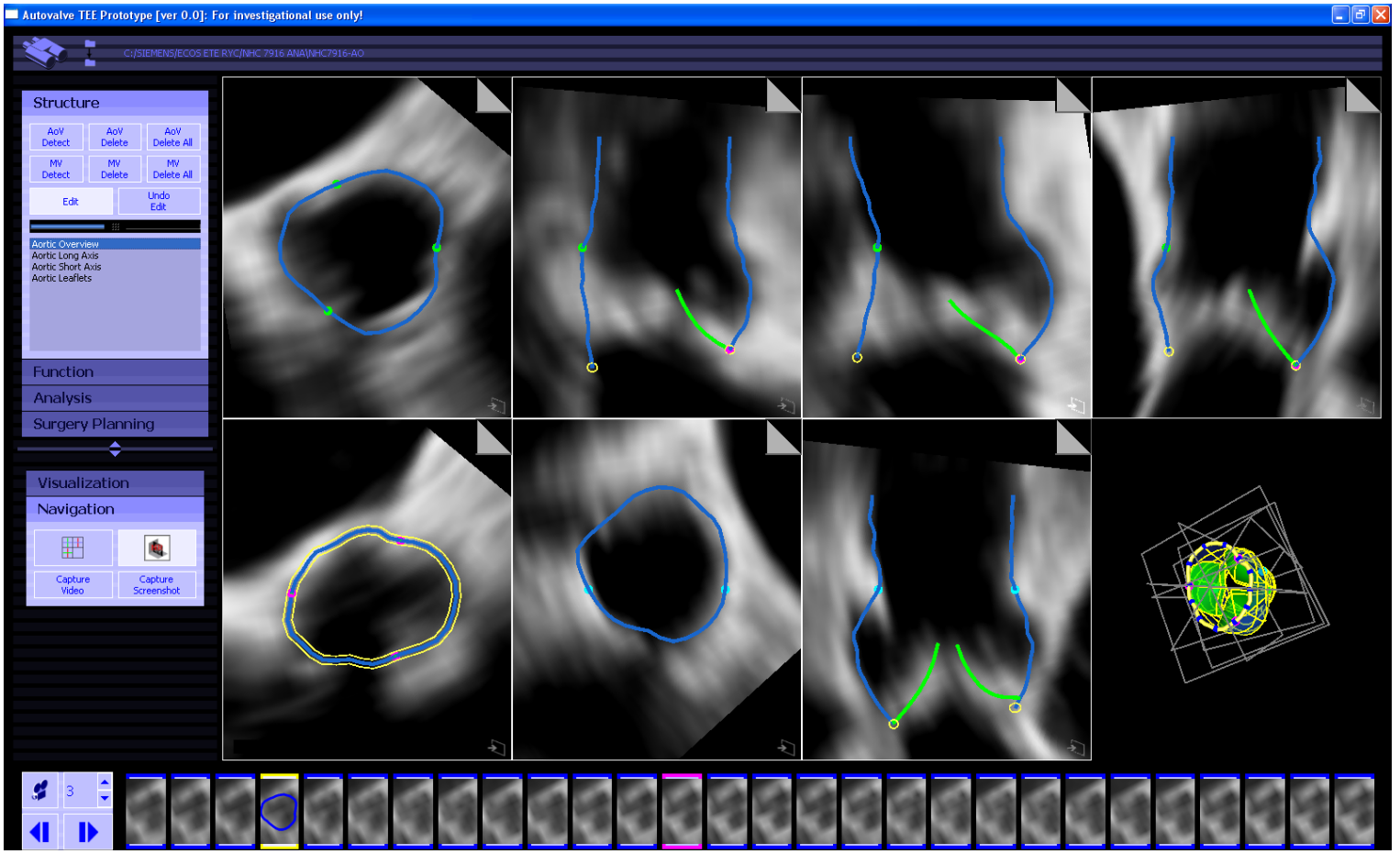
NEW DEVELOPMENTS



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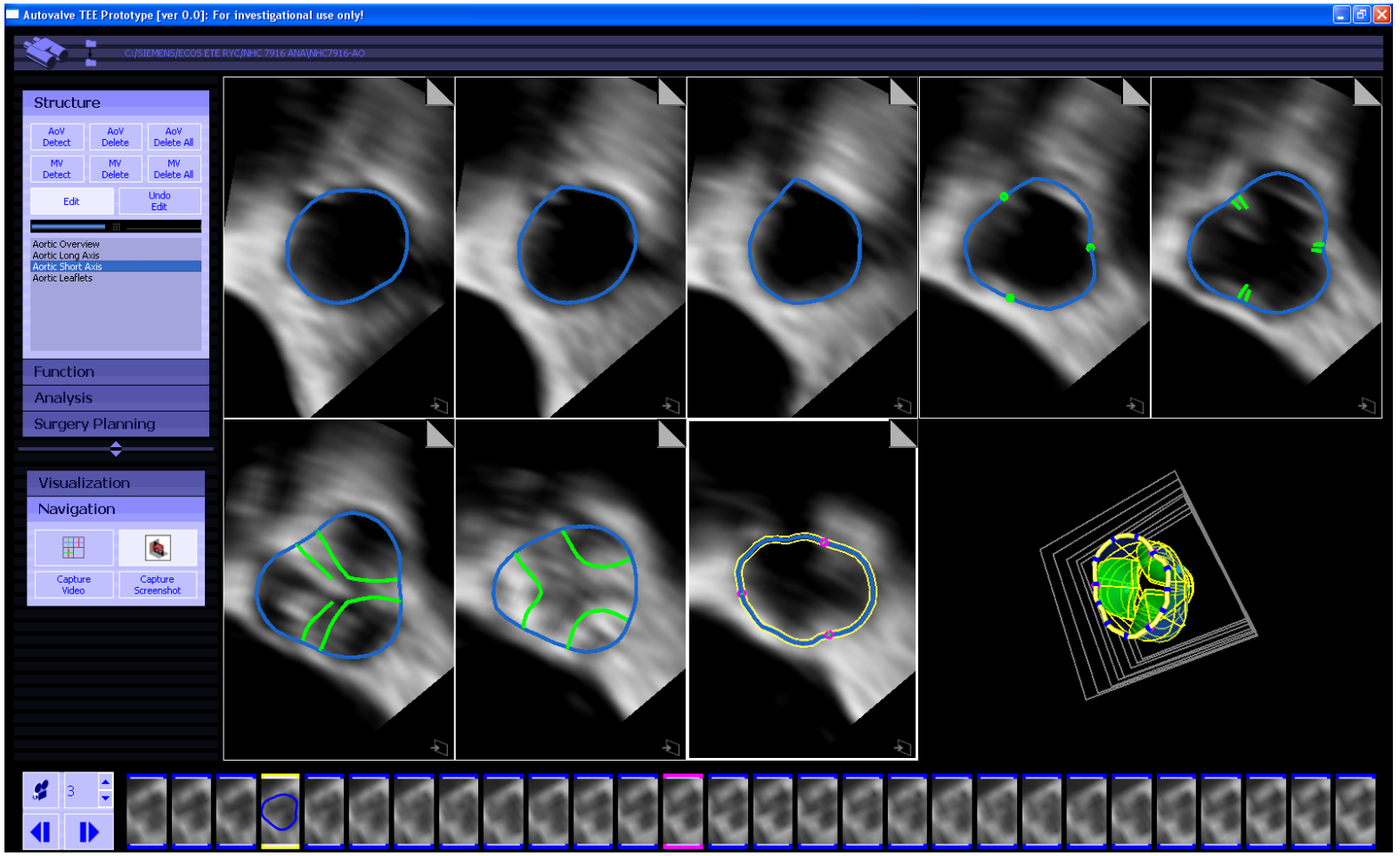

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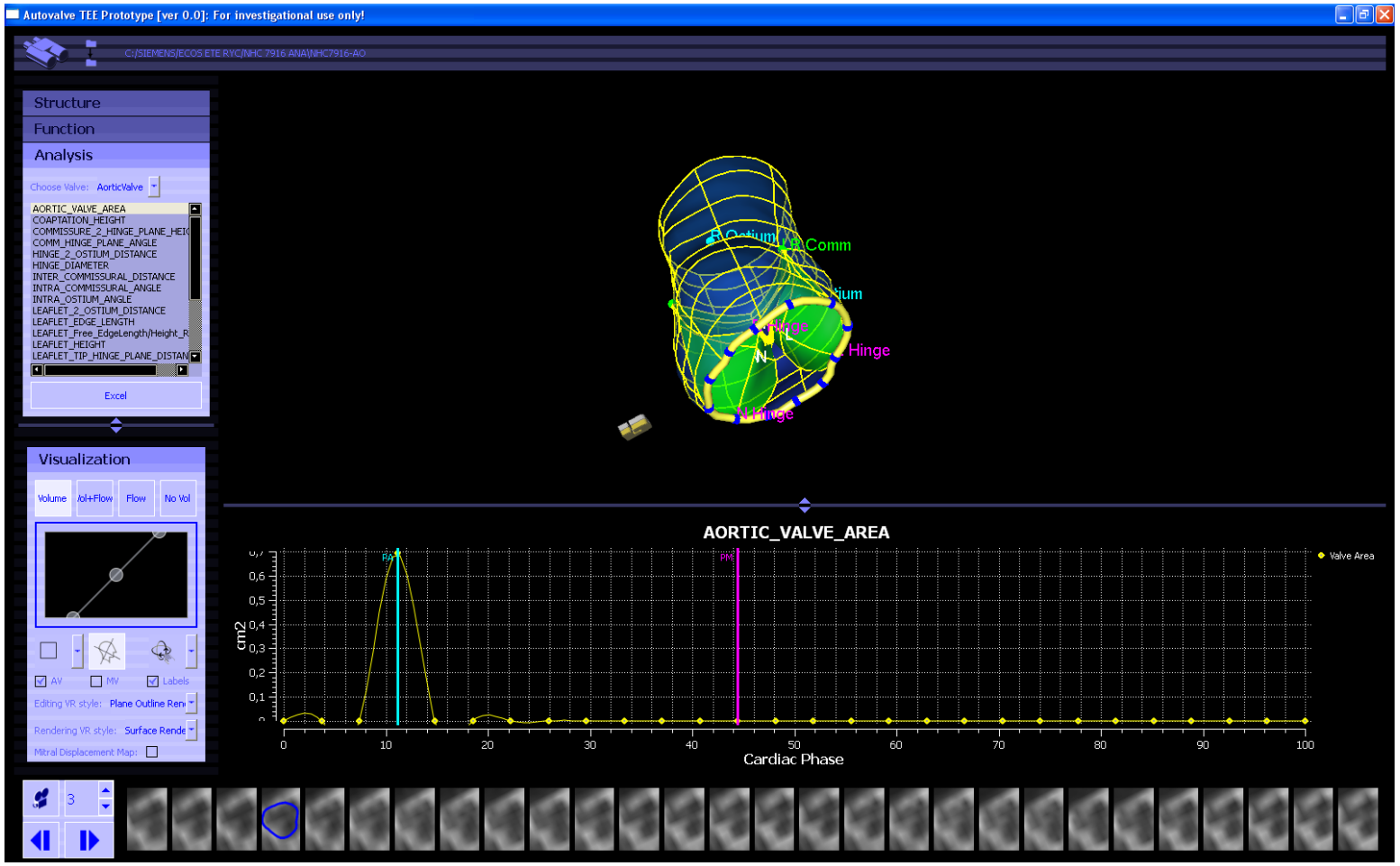
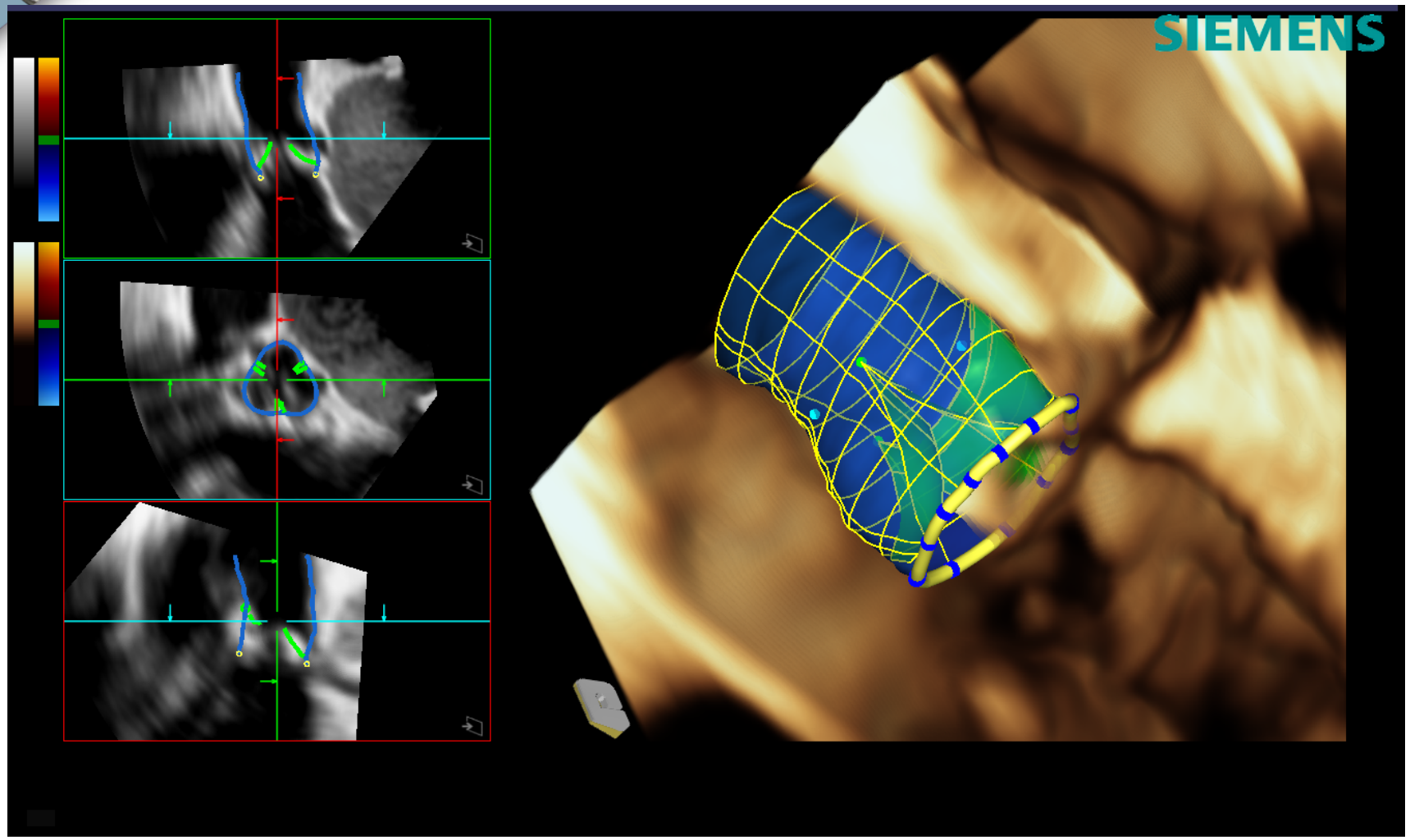
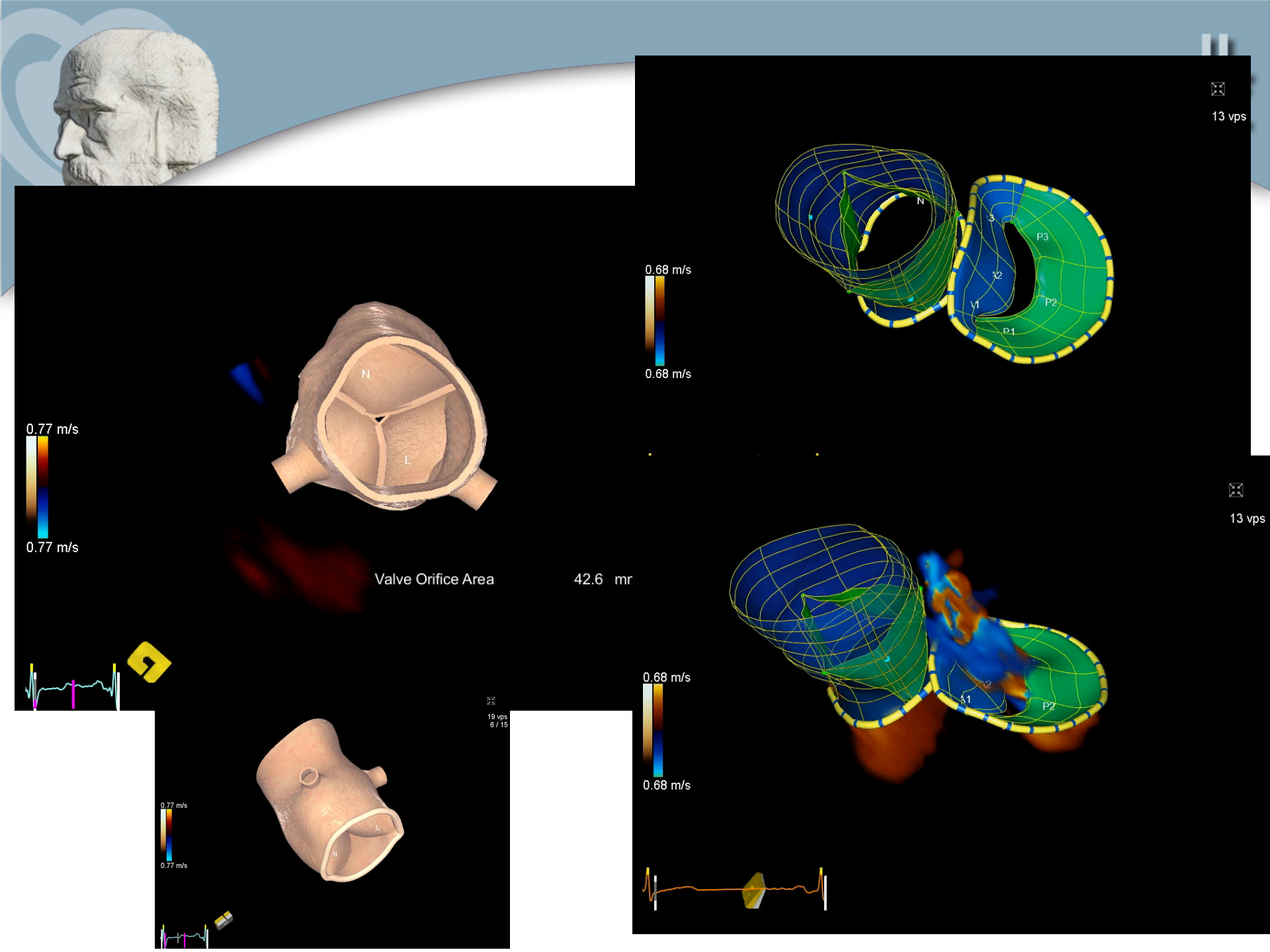
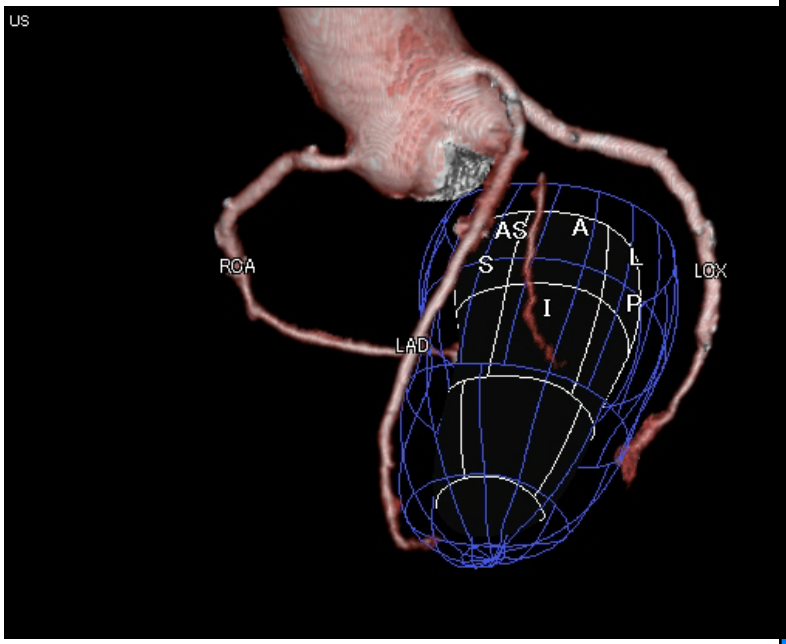
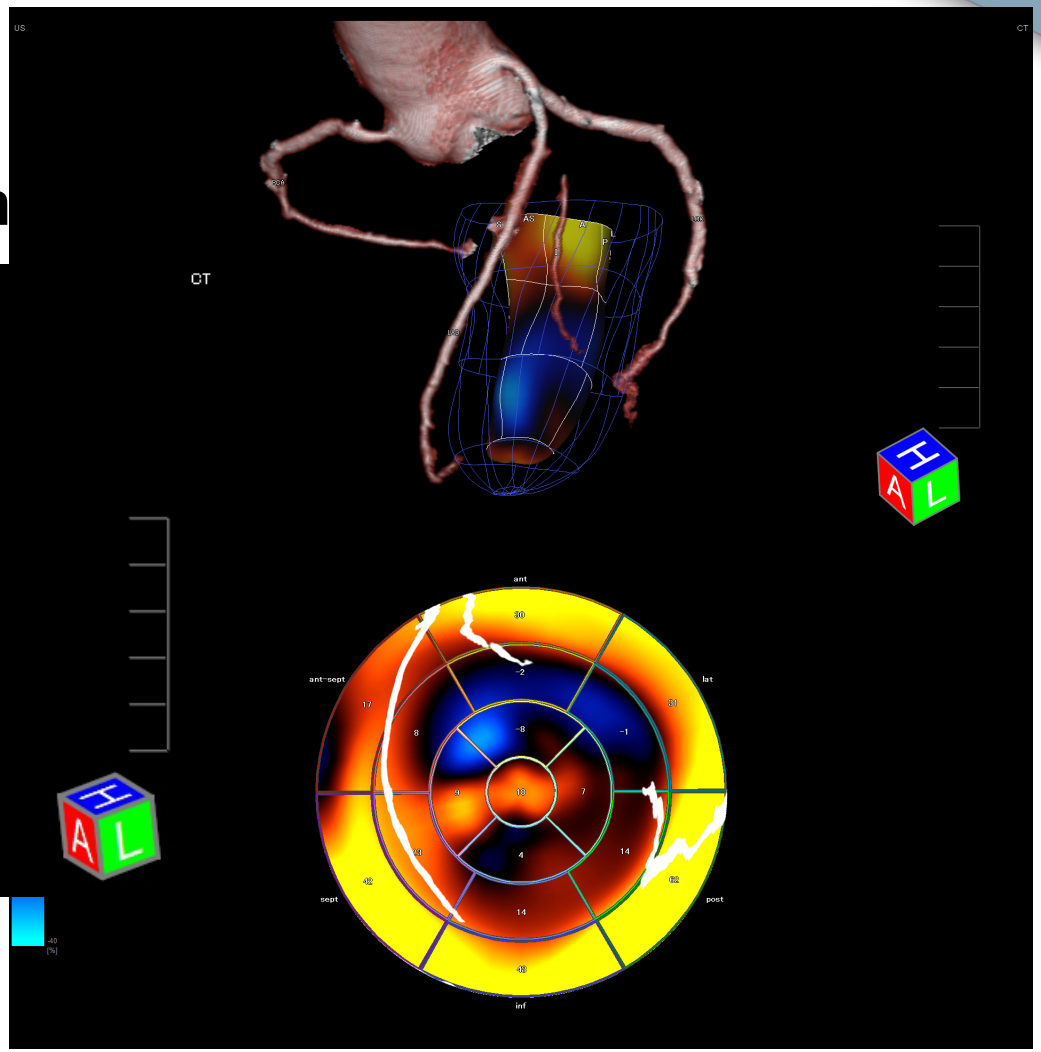



SIEMENS

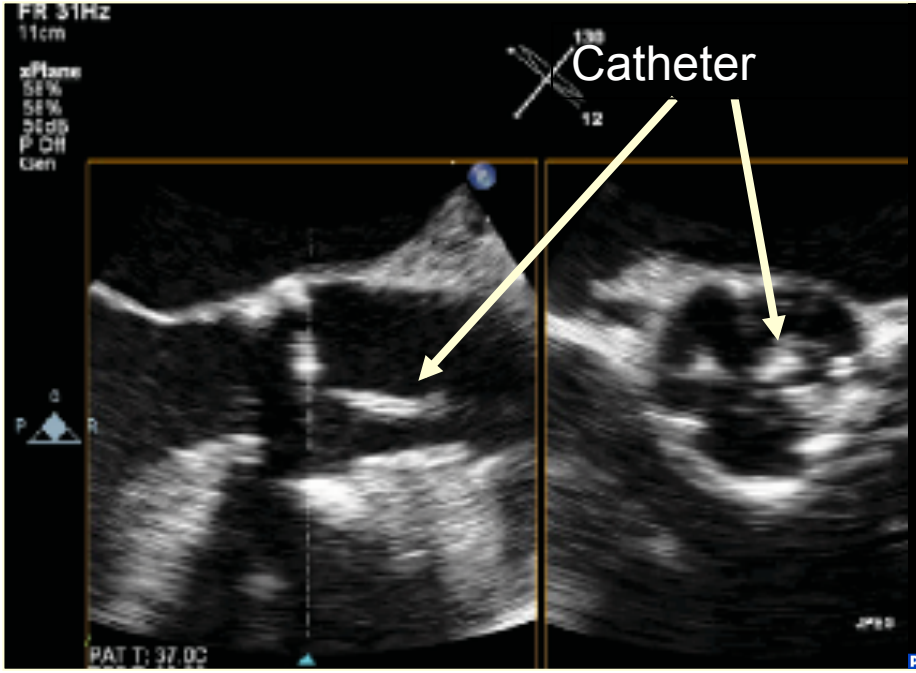

13 vps
0.68 m/s
0.68 m/s
N
P3
P2
P1
0.77 m/s
0.77 m/s
N
L
Valve Orifice Area
42.6 mr
13 vps
0.68 m/s
0.68 m/s
P2
19 vps
6 / 15
0.77 m/s
0.77 m/s

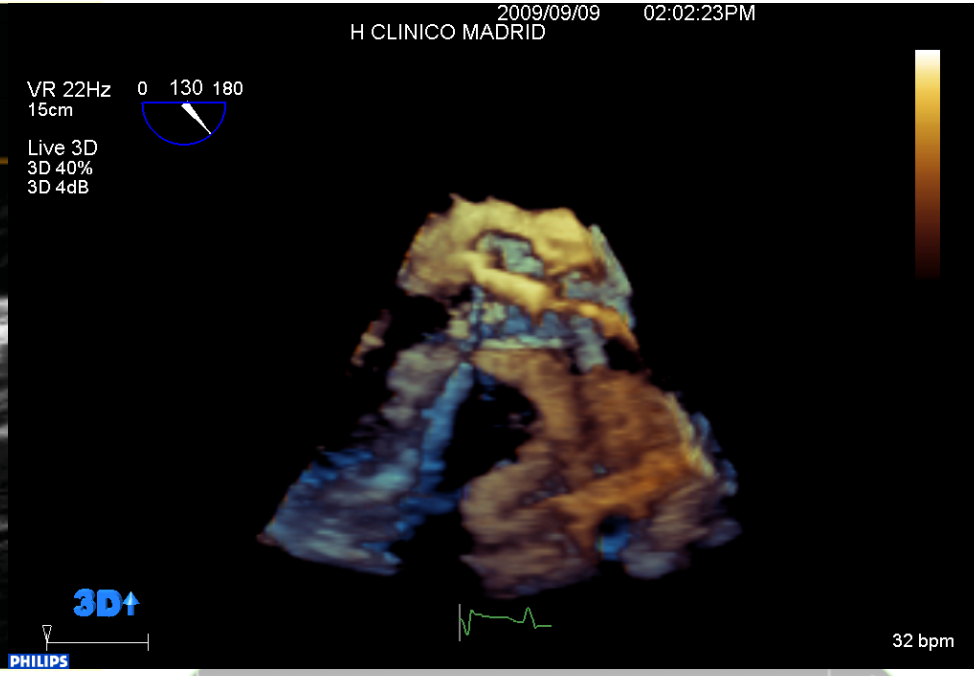
Diagonal branch occlusion





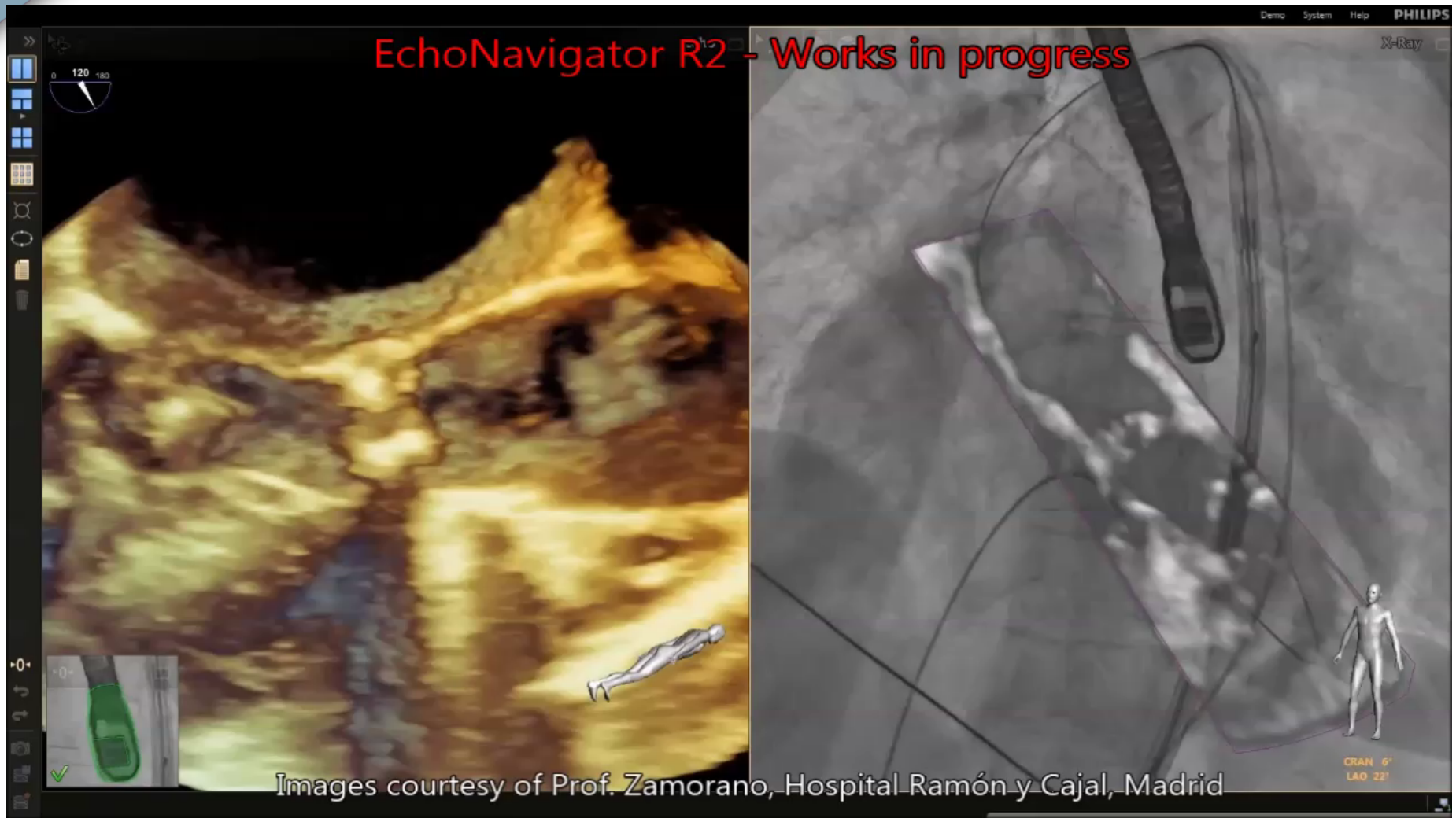
- Per- procedure



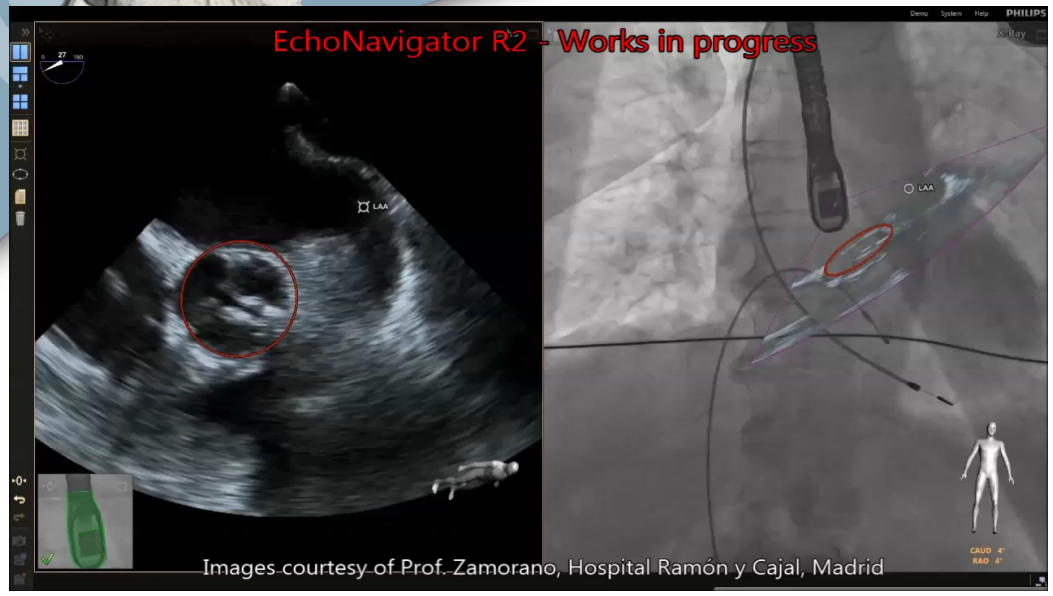


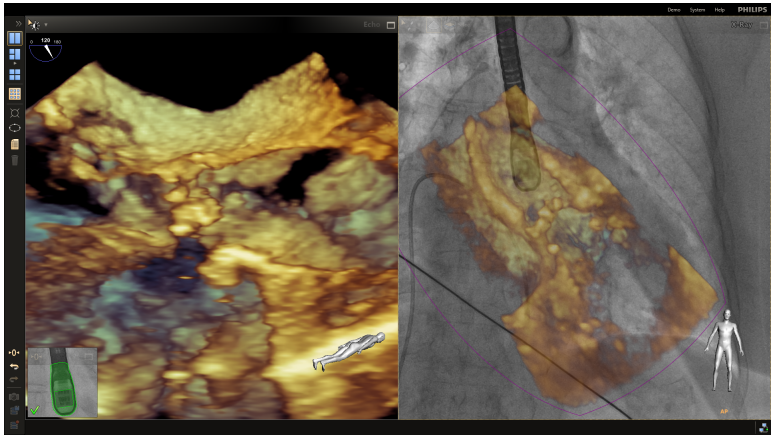

PHILIPS
PHILIPS
C-arm View
Sonographer View
X-ray

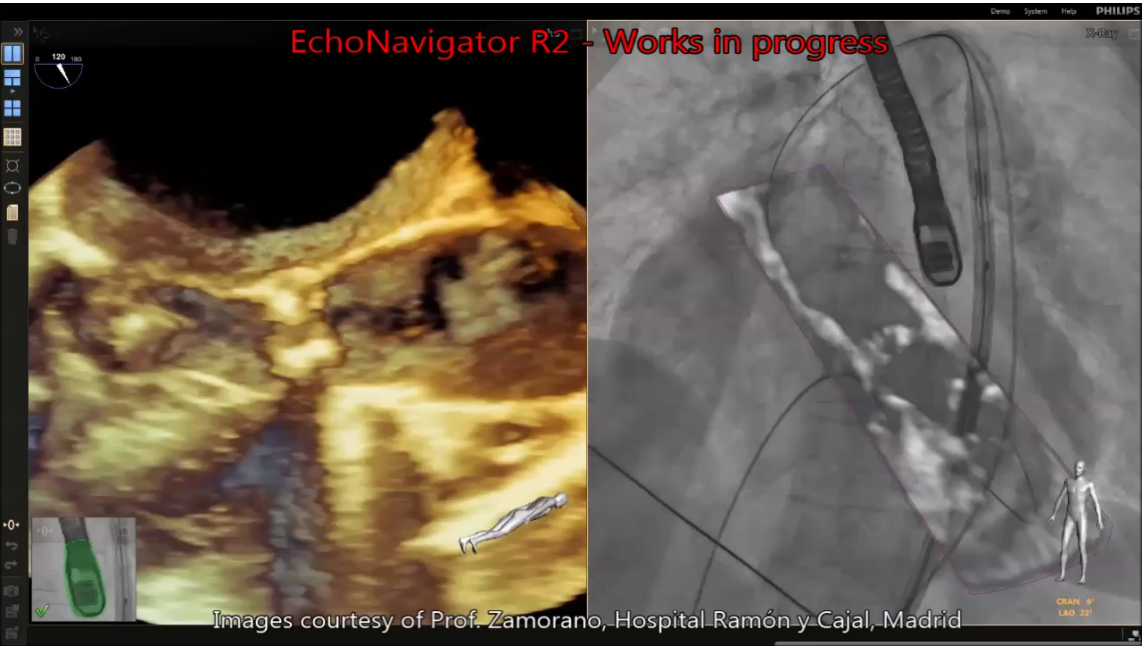
One Image more than 1000 words

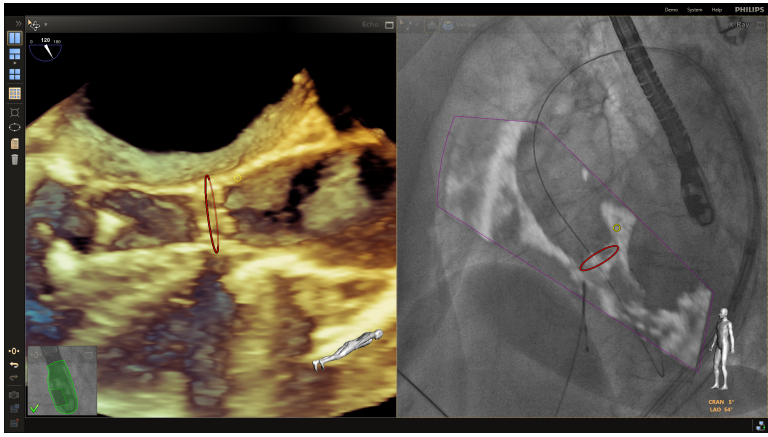


Where are we going ?

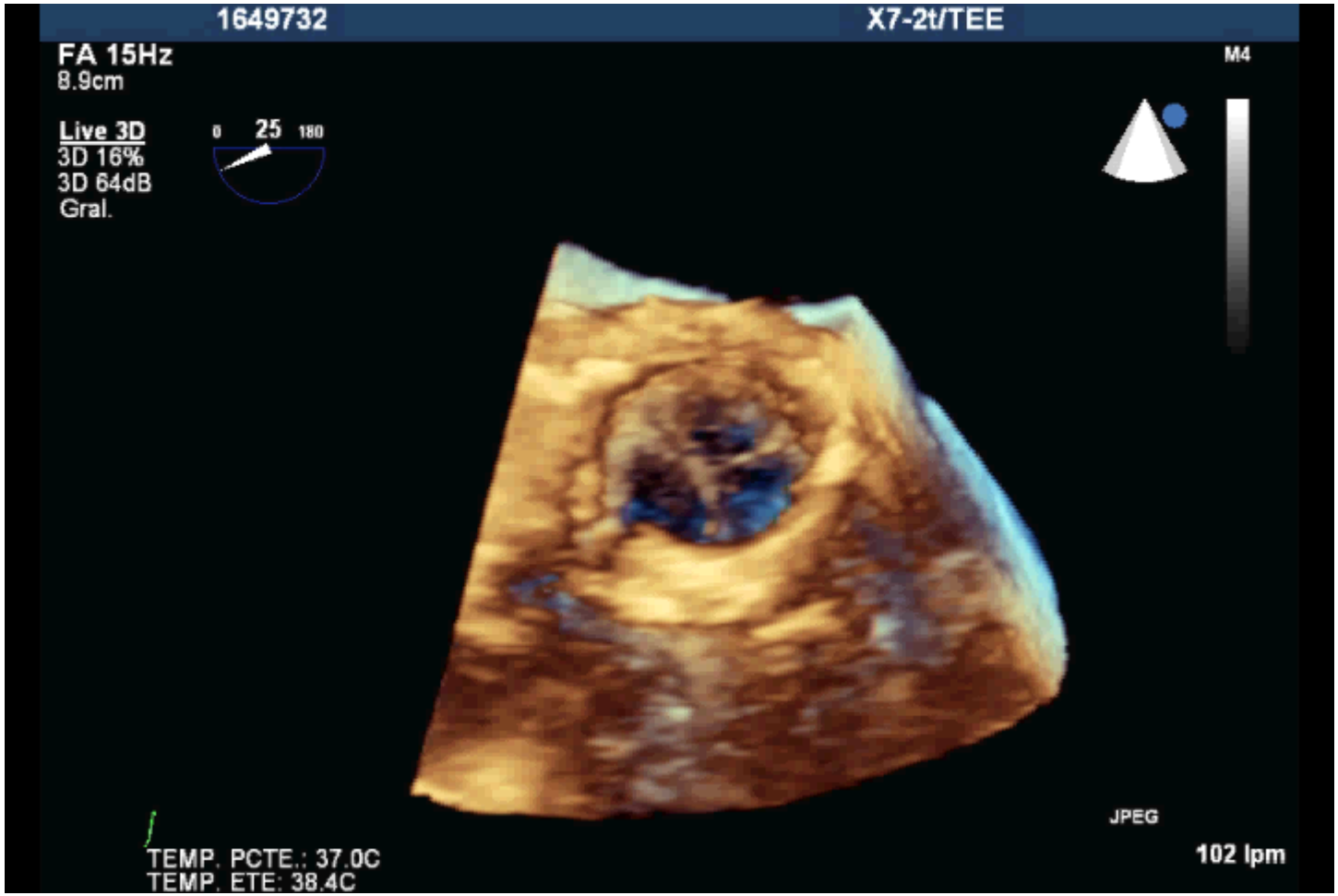








- Evaluation of success and complications



• Evaluation of success and complications

Echocardiography: guidance during valve implantation

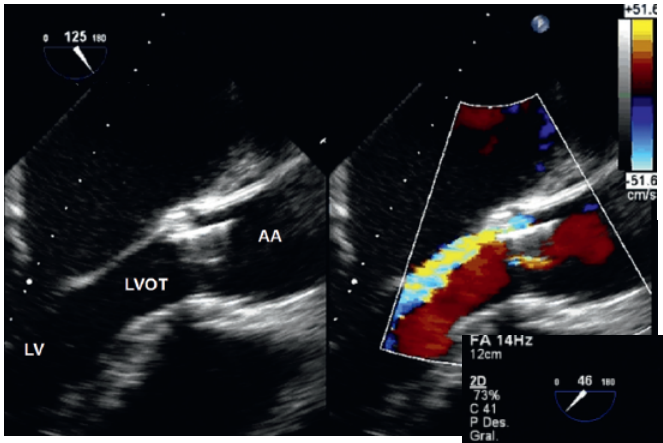
EuroIntervention

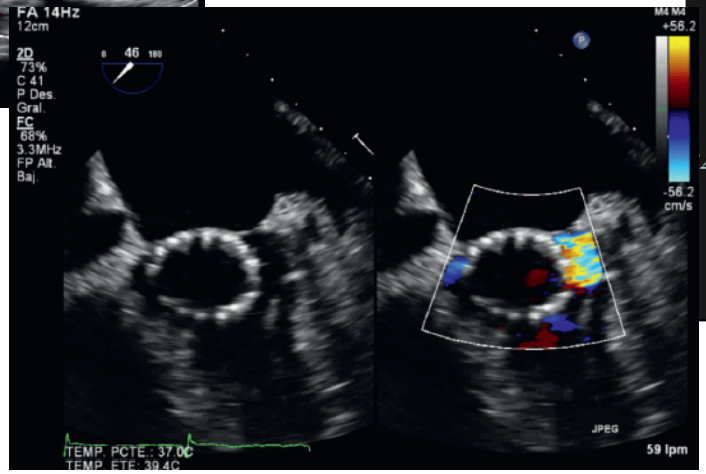
Alexandra Gonçalves, MD; Pedro Marcos-Alberca, MD, PhD; José Luis Zamorano*, MD, PhD, FESC

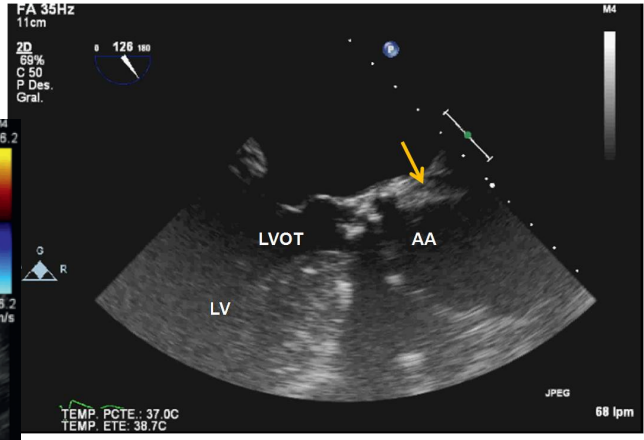
Cardiovascular Institute, Hospital Clínico San Carlos, Madrid, Spain

Abstract

Transcatheter aortic valve implantation (TAVI) by percutaneous or transapical aproach has emerged as an effective and less-invasive treatment for patients with severe symptomatic aortic valve stenosis and high surgical risk. Echocardiography is a fundamental tool in patients' selection for TAVI, for guiding the intervention as well as evaluating the position, deployment and function of the prosthesis. This review describes the role of echocardiography during the intervention, in procedure guidance and in the assessment of complications.



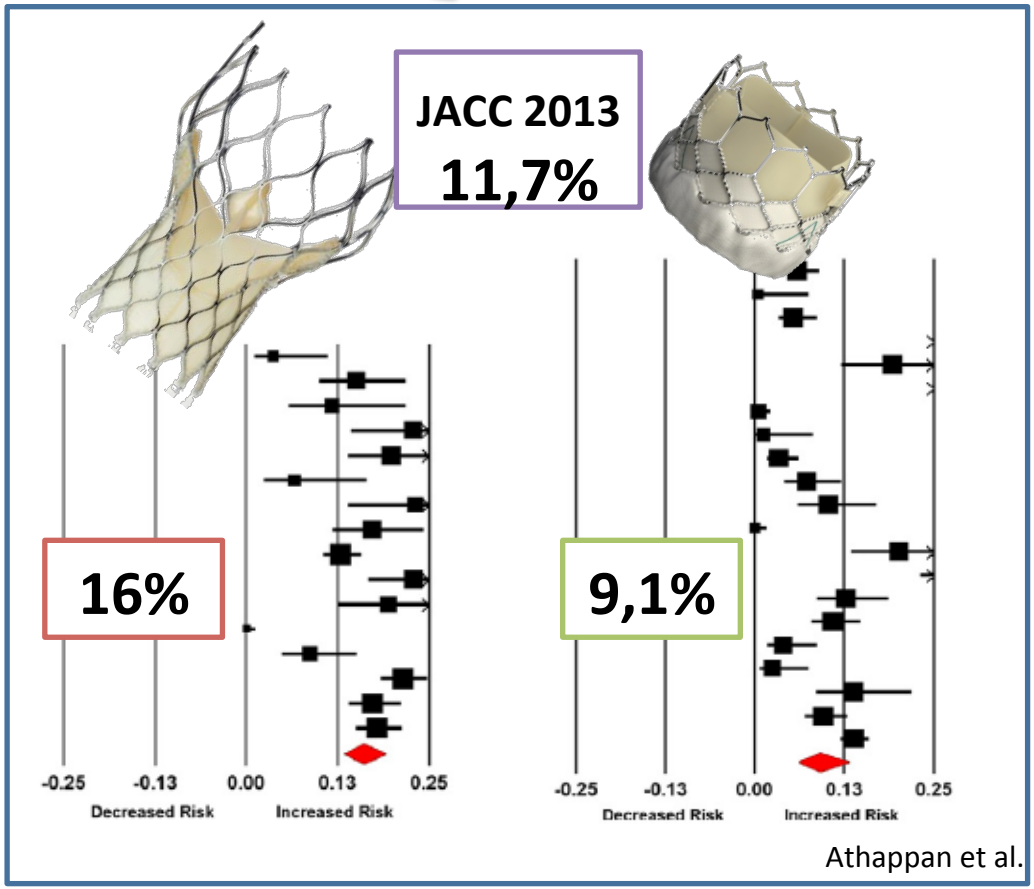




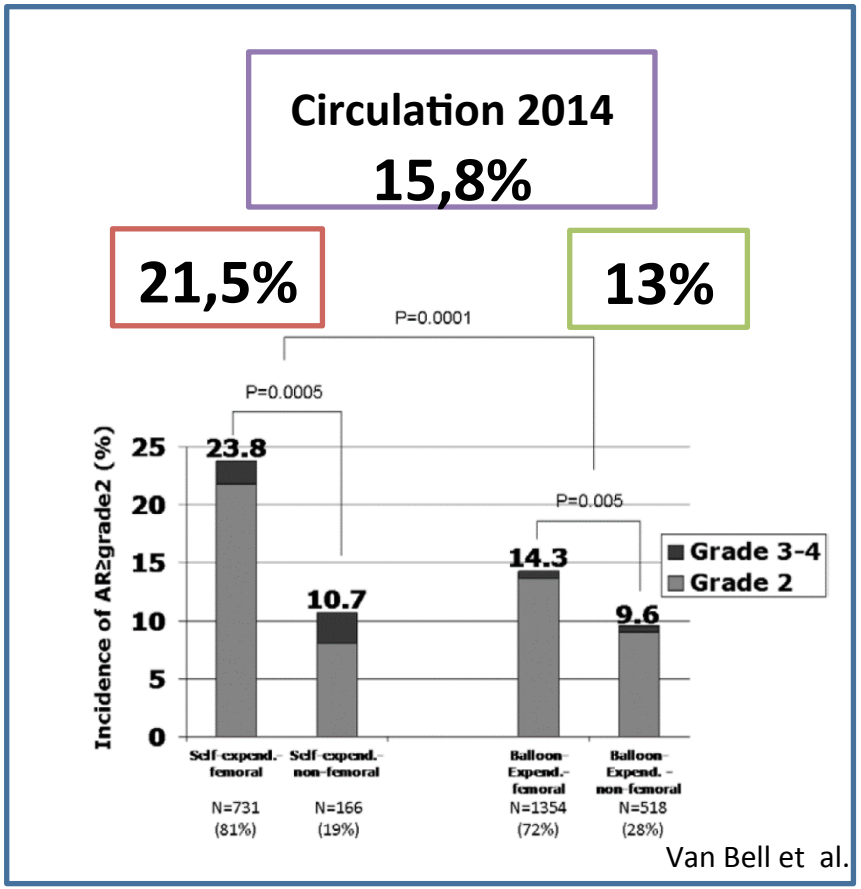
Ao.Reg POST-TAVI - INCIDENCE

Limitations of TAVI

- Vascular complications 11-13%
- Stroke 2-6%
- AV block with Pacemaker 3-4%
- **Ao Reg. valvular or paravalvular 70%**
  - **Significant (moderate or severe) 15-20%**



Athappan et al.



Van Bell et al.

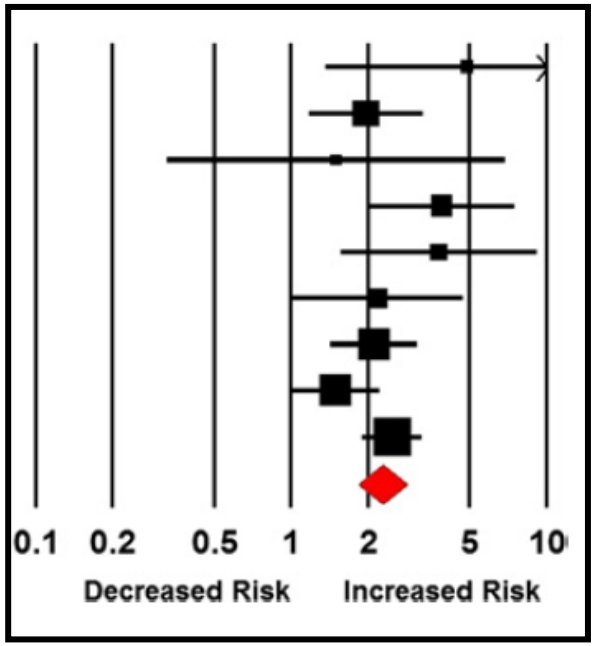
Ao. Reg POST-TAVI – WHY RELEVANT ?

Ao Reg. Mod or Severe related to poor prognosis (short and long term)

JACC 2013

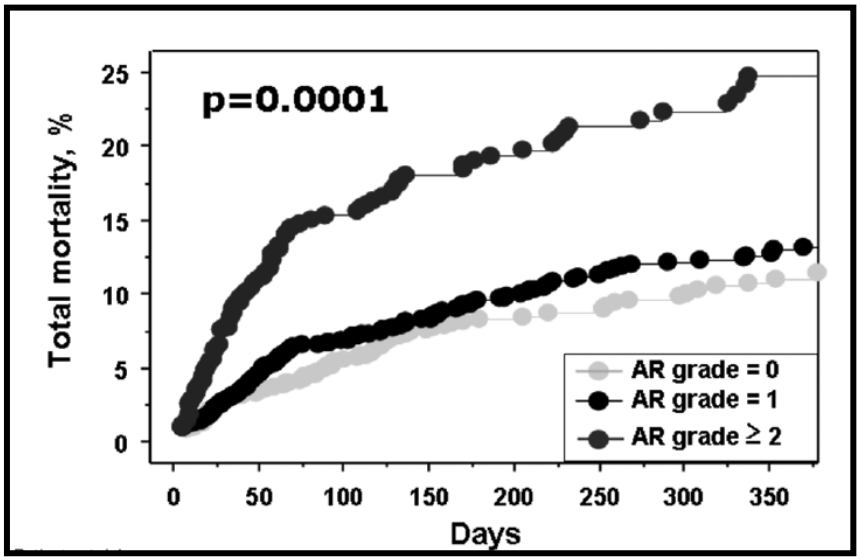
HR 2.27

(1.84-2.89)



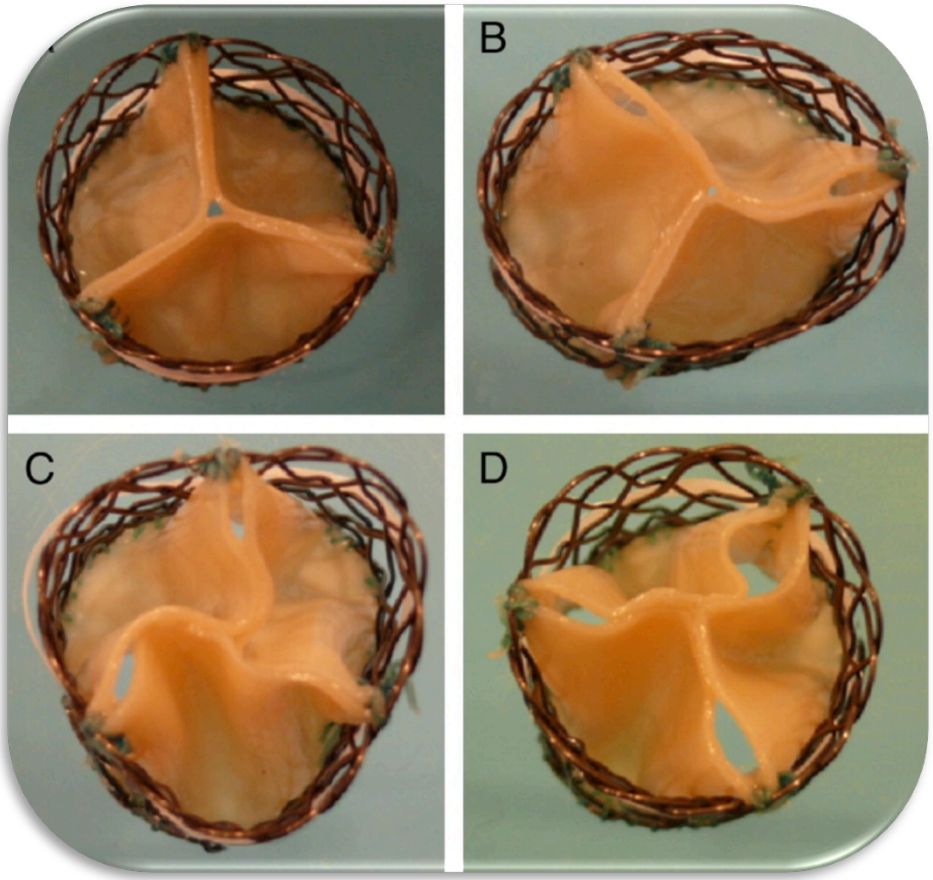
- OR 1 month mortality: 2.95 (1.73-5.02)

Circulation 2014: HR 2.33 (1.82-2.99)

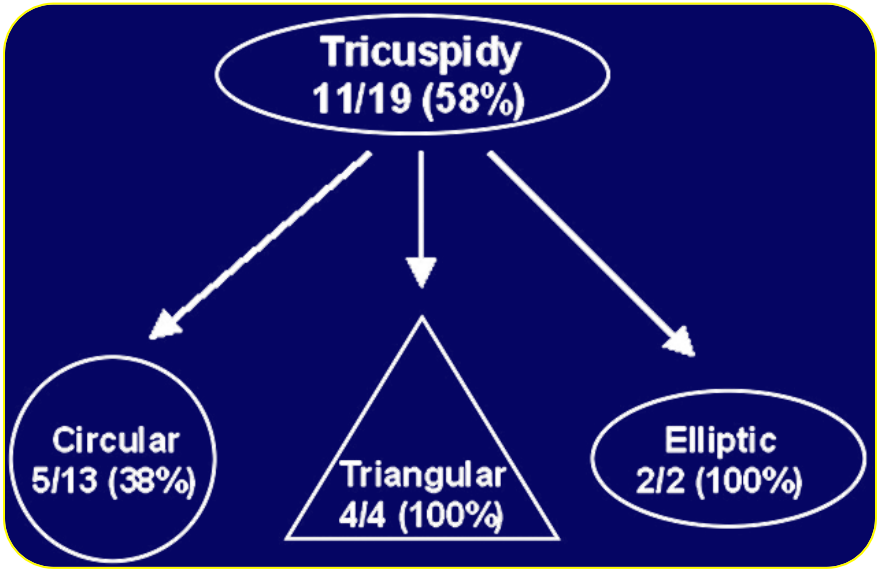


- **Independent predictor** mortality (any cause at 1 year) .
- Strongest Predictor.

- Per- procedure →→ Complications



Zegdi, R. et al. J Am Coll Cardiol 2008;51:579-584

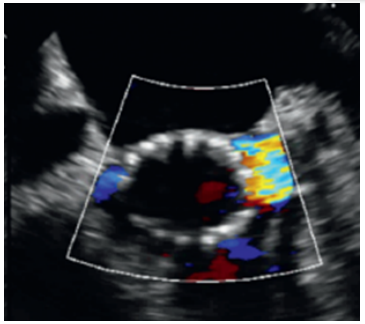


Factors influencing circularity

- Ammount of calcium and distribution
- Involvement of intervalvular fibrosa
- Mitral Prosthesis or rings

- At follow-up

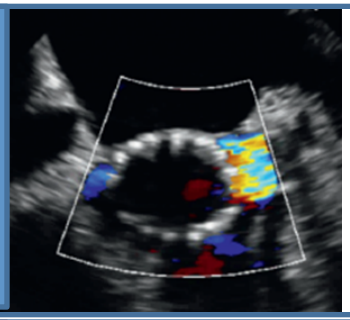
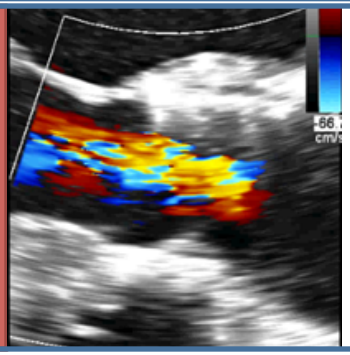
Issues



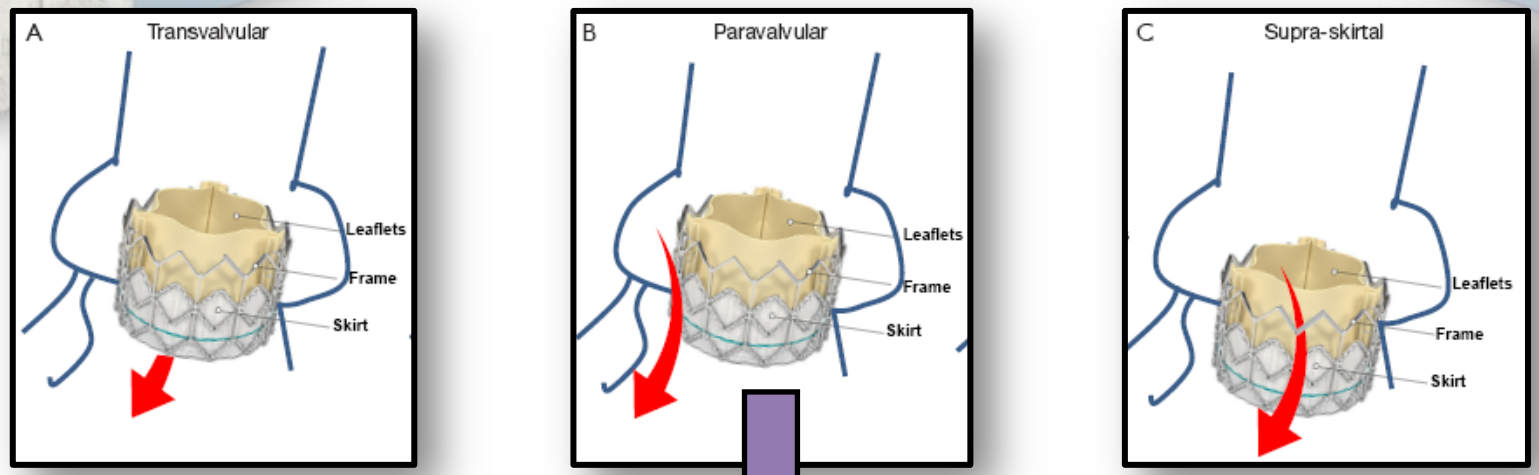
How to evaluate PAR after TAVI?

Paravalvular regurgitation

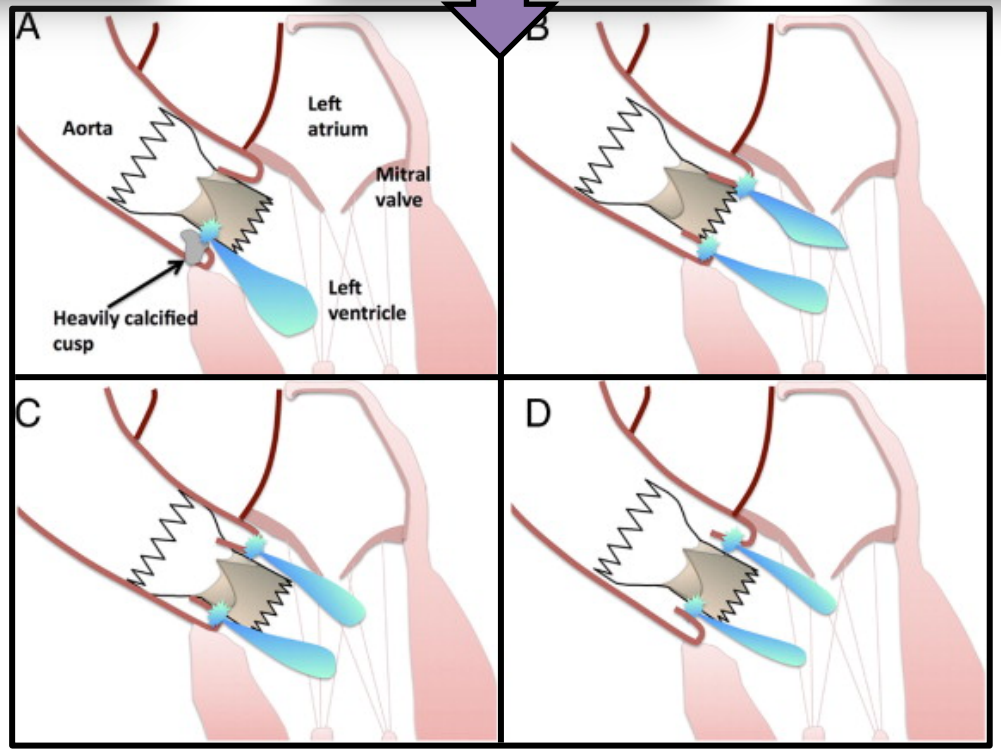
Causes of AR after TAVI

ParaValv AR		Prosthesis malposition/ under-expansion/ undersizing
Central AR		Incomplete expansion of prosthesis Restricted cusp motion

Ao. Reg POST-TAVI – CAUSES ?



Severe Cusp Calcifications of native valve



Valve Malposition due to a high implantation

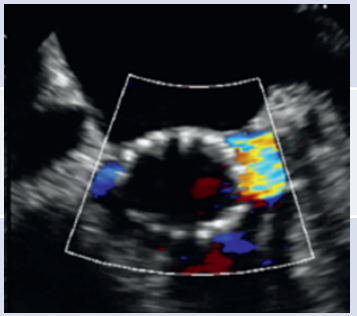
Valve Malposition due to a Low implantation

Mismatch between annulus and prosthesis diameter

Paravalvular regurgitation

Measurement of paravalvular AR

For paravalvular jets	
Mild	10% of the sewing ring
Moderate	10–20% of the sewing ring
Severe.	20% of the sewing ring



However, this assumes continuity of the jet which may not be the case for transcatheter valves.

2D ECHOCARDIOGRAPHY - SEVERITY

- Haemodynamic changes
- Acustic shadowing
- Semiquantitative

ECHO PARAMETERS

Qualitative

- Color jet área and length
- CW signal

Semi-quantitatives

- Vena contracta
- Time ½
- Reversed diastolic flow

Quantitative

- Reg Volume
- Reg Fracction
- EROA

	Prosthetic aortic valve regurgitation		
	Mild	Moderate	Severe
Semiquantitative parameters			
Diastolic flow reversal in the descending aorta—PW	Absent or brief early diastolic	Intermediate	Prominent, holodiastolic
Circumferential extent of prosthetic valve paravalvular regurgitation (%)**	<10%	10%-29%	≥30%
Quantitative parameters‡			
Regurgitant volume (mL/beat)	<30 mL	30-59 mL	≥60 mL
Regurgitant fraction (%)	<30%	30-49%	≥50%
EROA (cm^2)	0.10 cm^2	0.10-0.29 cm^2	≥0.30 cm^2

VARC2. Kappetein et al. European Journal of Cardio-Thoracic Surgery 42 (2012) S45–S60

Three-Dimensional Echocardiography in Paravalvular Aortic Regurgitation Assessment after Transcatheter Aortic Valve Implantation

Journal of the JASE American Society of Echocardiography

Aortic Regurgitation

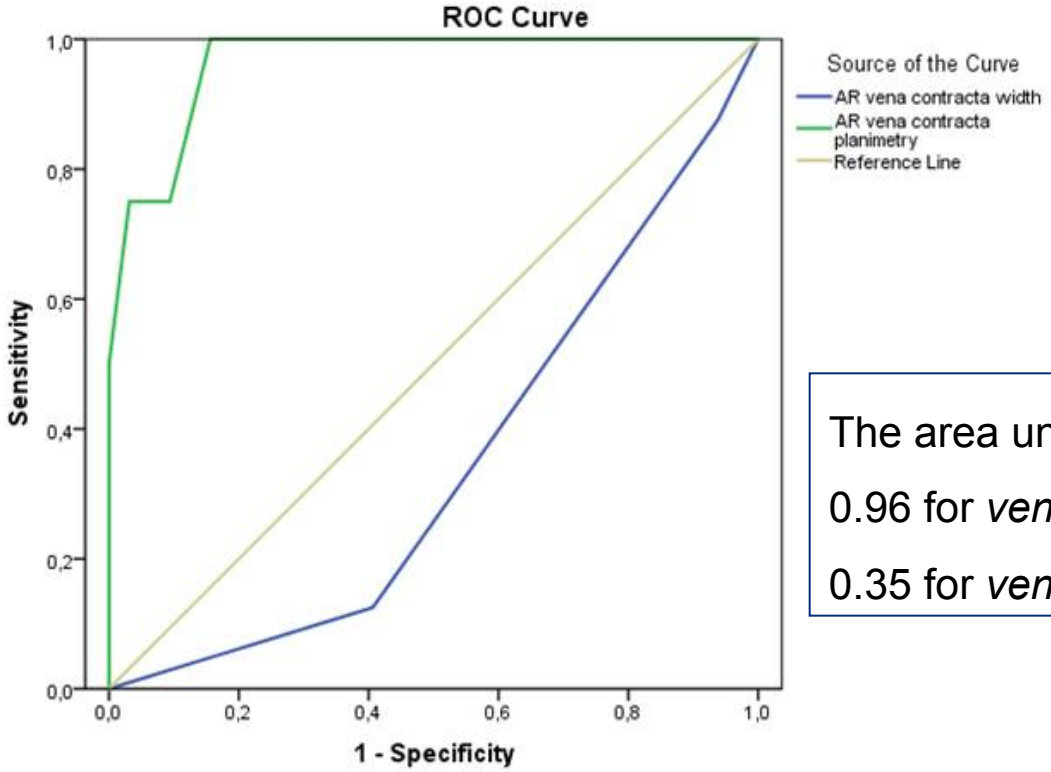
	None (n=29)	Mild (n=35)	p value*	Moderate (n=8)	p value**
LV ejection fraction (%)	63.9 (11.4)	60.4 (10.6)	0.227	58.6 (13.2)	0.696
LV mass (g/m^2)	121.9 (39.1)	125.4 (42.6)	0.769	130.0 (27.7)	0.784
Ao peak pres grad (mmHg)	17.6 (10.0)	14.9 (7.4)	0.245	17.4 (7.8)	0.437
Mean Ao pres grad (mmHg)	8.4 (4.5)	7.5 (3.4)	0.418	9.0 (5.1)	0.395
LV end diast volume (ml/m^2)	44.0 (16.3)	48.4 (21.9)	0.477	66.1 (18.6)	0.044
Aortic valvular area (cm^2)	1.9 (0.6)	2.0 (0.6)	0.605	1.9 (0.6)	0.680
AR volume (ml)	----------	22.2 (5.5)	----------	41.3 (6.4)	<0.001
Vena contracta width (mm)	----------	1.9 (0.16)	----------	2.1(0.53)	0.139
Vena contracta planimetry (cm^2)	----------	0.09 (0.06)	----------	0.29 (0.1)	0.001

* p value from none AR vs. mild AR
** p value from mild AR vs. moderate AR

Three-Dimensional Echocardiography in Paravalvular Aortic Regurgitation Assessment after Transcatheter Aortic Valve Implantation

Alexandra Gonçalves, MD, Carlos Almeria, MD, Pedro Marcos-Alberca, MD, PhD, FESC, Gisela Feltes, MD, Rosana Hernández-Antolín, MD, PhD, Enrique Rodríguez, MD, José C. Silva Cardoso, MD, PhD, Carlos Macaya, MD, PhD, FESC, and José Luis Zamorano, MD, PhD, FESC, *Madrid, Spain; Porto, Portugal*

Journal of the JASE American Society of Echocardiography



The area under the ROC curve:

0.96 for *vena contracta* planimetry

0.35 for *vena contracta* width

3D TTE *vena contracta* planimetry correlation with AR volume: 0.82, $p<0.001$

2D TTE *vena contracta* width correlation with AR volume: 0.66, $p<0.001$

CONCLUSIONS

- Integration imaging modalities.

  Selection

- Guide for interventionalists

- Safer and more efficient procedure