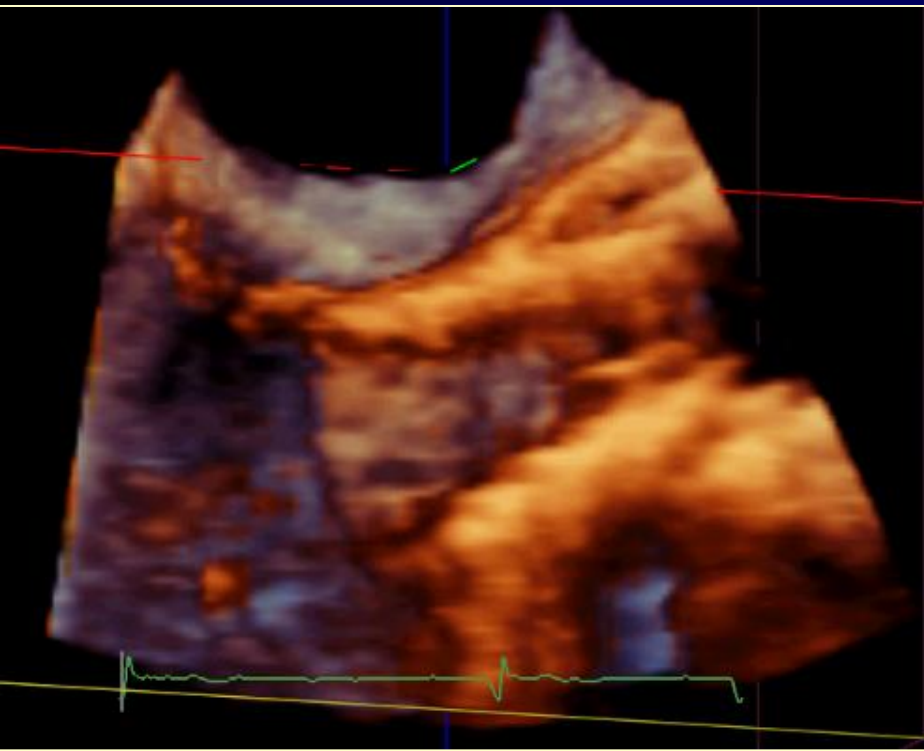


# ECHOCARDIOGRAPH INSIDE THE CATH LAB. TAVI THE ROLE OF IMAGING

J Zamorano



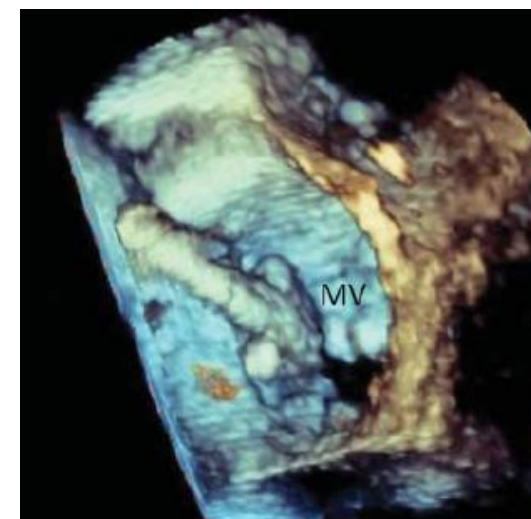
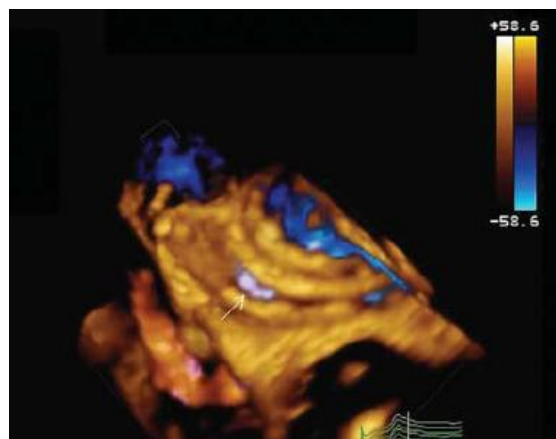
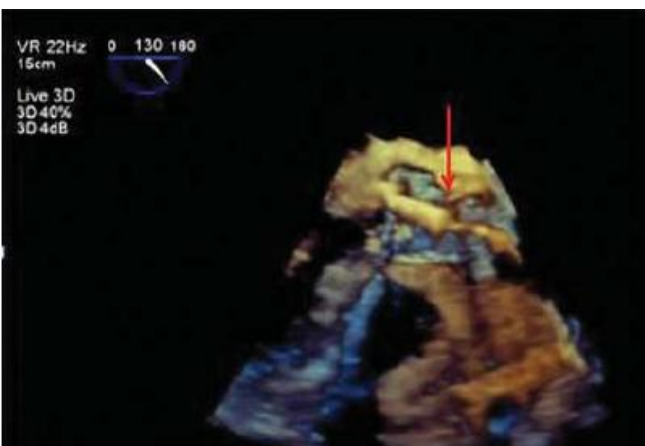
# EAE/ASE recommendations for the use of echocardiography in new transcatheter interventions for valvular heart disease

Jose L. Zamorano<sup>1\*†</sup>, Luigi P. Badano<sup>2</sup>, Charles Bruce<sup>3</sup>, Kwan-Leung Chan<sup>4</sup>, Alexandra Gonçalves<sup>5</sup>, Rebecca T. Hahn<sup>6</sup>, Martin G. Keane<sup>7</sup>, Giovanni La Canna<sup>8</sup>, Mark J. Monaghan<sup>9</sup>, Petros Nihoyannopoulos<sup>10</sup>, Frank E. Silvestry<sup>7</sup>, Jean-Louis Vanoverschelde<sup>11</sup>, and Linda D. Gillam<sup>12‡</sup>

**Transcatheter aortic valve  
implantation**

**Percutaneous transcatheter repair  
of paravalvular regurgitation**

**Percutaneous mitral valve  
intervention**



## • Introduction

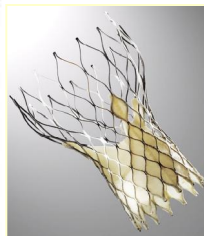
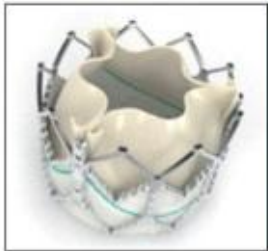
TAVI was first described by Andersen in 1992 by implanting an expandable aortic valve by a catheter technique in a closed chest pig model.



First human TAVI procedure, by Alain Cribier.

Performed in April 2002 on a 57-year-old man with end-stage inoperable aortic stenosis.

> 20 000 patients had undergone TAVI worldwide.



The first human implanted CoreValve was reported in 2005 by Grube et al.

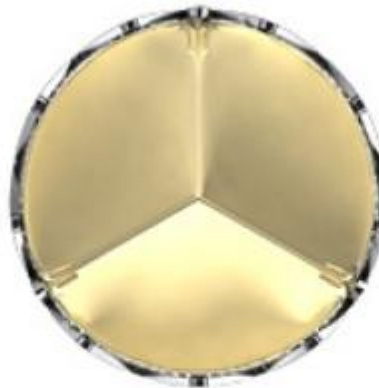
- Introduction

# Edwards-Sapien

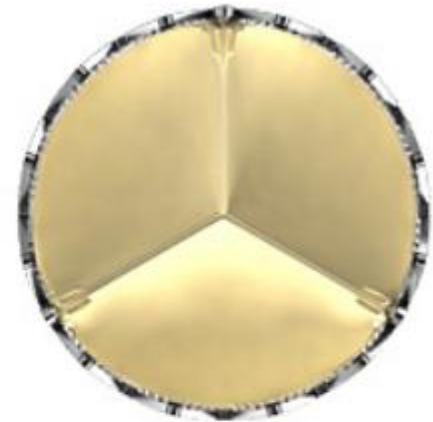
23 mm



26 mm



29 mm



14.3 mm



17.2 mm



19.1 mm



- Introduction

## CoreValve



**26 mm**

For 20-23 mm  
annulus diameters



**29 mm**

For 23-27 mm  
annulus diameters



**31 mm**

For 26-29 mm  
annulus diameters

# • Introduction



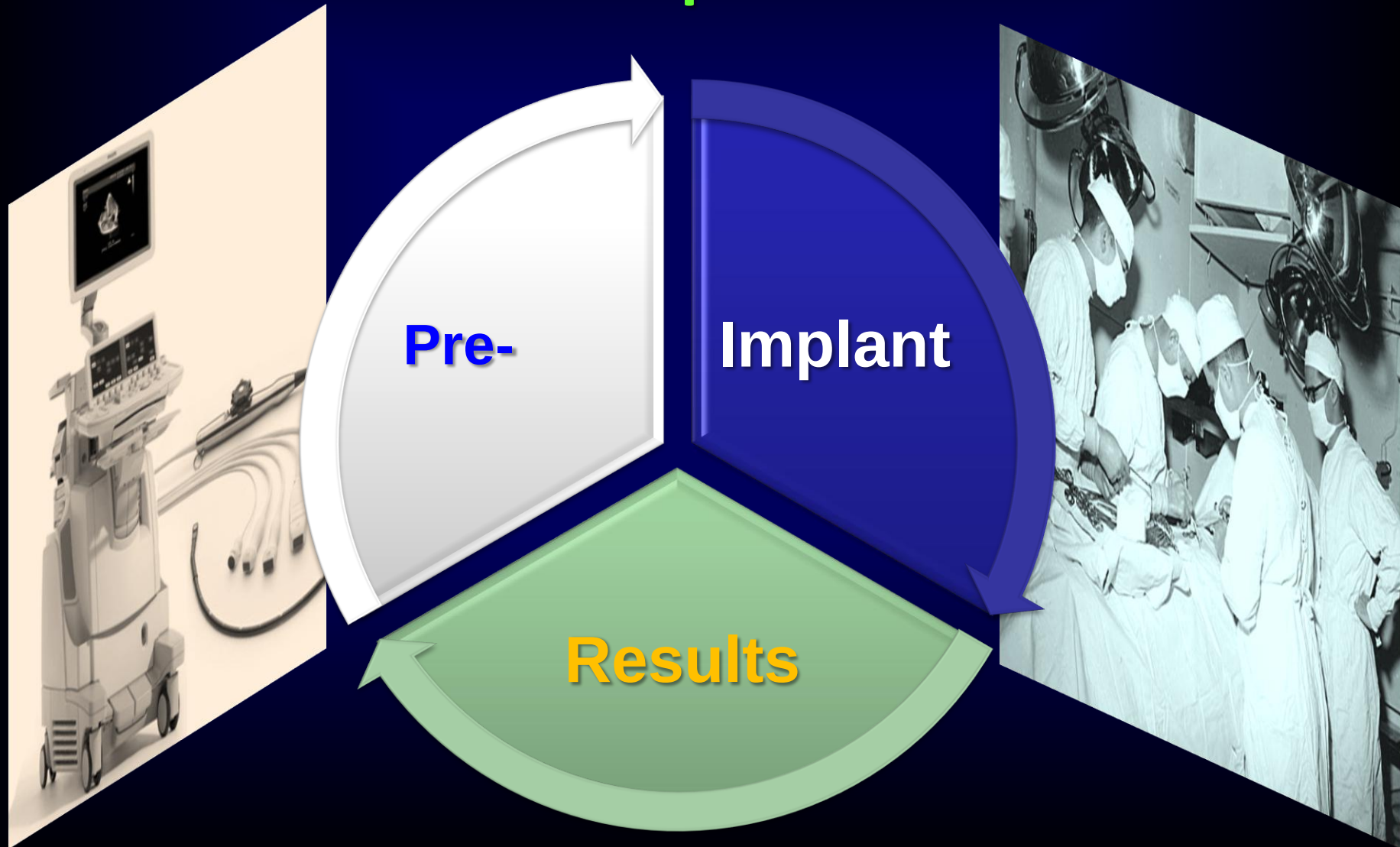
| CoreValve | Tamaño | Anillo | S. Valsalva | Union ST  |
|-----------|--------|--------|-------------|-----------|
|           | 26     | 20-23  | $\geq 27$   | $\leq 40$ |
|           | 29     | 23-27  | $\geq 28$   | $\leq 43$ |
|           | 31     | 26-29  | $\geq 28$   | $\leq 43$ |



| Edwards-Sapien | Tamaño | Anillo | S. Valsalva | Union ST |
|----------------|--------|--------|-------------|----------|
|                | 23     | 18-21  | -           | -        |
|                | 26     | 21-25  | -           | -        |
|                | 29     | 25-27  |             |          |

# TAVI Monitoring

**Standardization** → **Optimization**



- 
- Patients selection for TAVI

## Indications

|                                    |                                                                                                                                                                                                     |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Severe Aortic Stenosis</b>      | Ao Valve area $< 1\text{cm}^2$ or $0,6\text{ cm}^2/\text{m}^2$<br>(Edwards Inc. $\rightarrow$ AVA $< 0,8\text{ cm}^2$ )<br>Max. Velocity $> 4\text{ m/s}$<br>Mean LV/Ao gradient $> 40\text{ mmHg}$ |
| <b>Symptoms</b>                    | III-IV NYHA                                                                                                                                                                                         |
| <b>High risk</b>                   | Logistic EuroScore $> 20\%$ or STS score $> 10\%$                                                                                                                                                   |
| <b>Contraindication to surgery</b> |                                                                                                                                                                                                     |
| <b>Other possible indications:</b> | degenerative bioprosthesis                                                                                                                                                                          |

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

- 
- Patients selection for TAVI

## Contra - Indications

Systemic

Heart

Aorta

- 
- Patients selection for TAVI

## Contra - Indications

### Aorta

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

- 
- Patients selection for TAVI

## Contra - Indications

### Heart

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

# CoreValve

01/07/2008

13:04:54

TIs0.1

JPEG CR 19:1

● Diámetro anular VAo = 2.0 cm

✚ Diámetro TSUI = 1.6 cm

■ Longitud = 2.2 cm

▲ Aorta ascendente = 3.2 cm

✦ Longitud = 2.2 cm

M4

12cm

Annulus:

- ✓ 26mm: 20-23mm.
- ✓ 29 mm: 24-27mm.

Sinus of Valsalva:

- ✓ 26mm:  $\geq 27$ mm
- ✓ 29mm:  $\geq 28$ mm



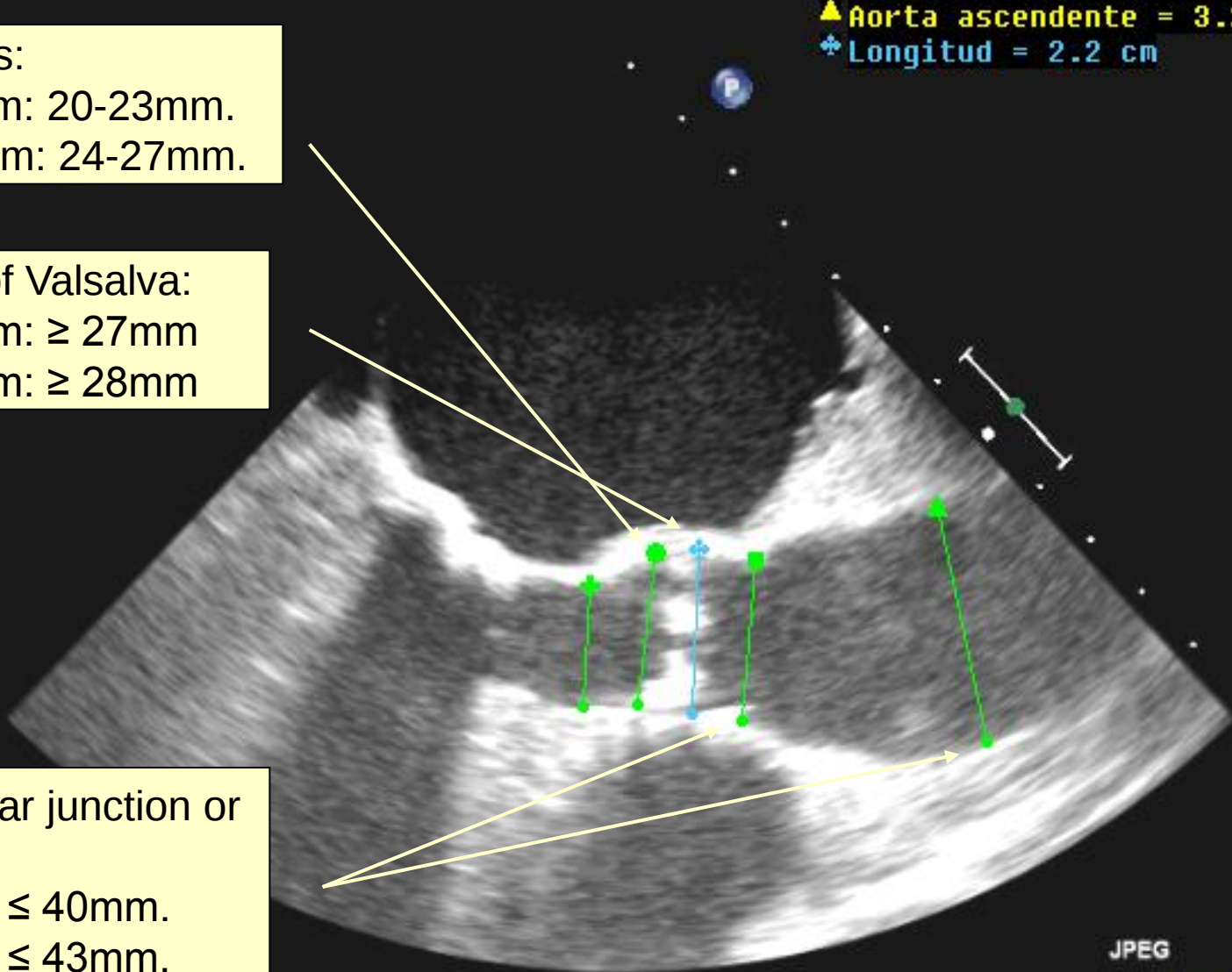
Sinotubular junction or  
Ao asc:

- ✓ 26mm:  $\leq 40$ mm.
- ✓ 29mm:  $\leq 43$ mm.

TEMP. PCTE.: 37.0C  
TEMP. ETE: 38.3C

JPEG

10 de 50



# Edwards-Sapien

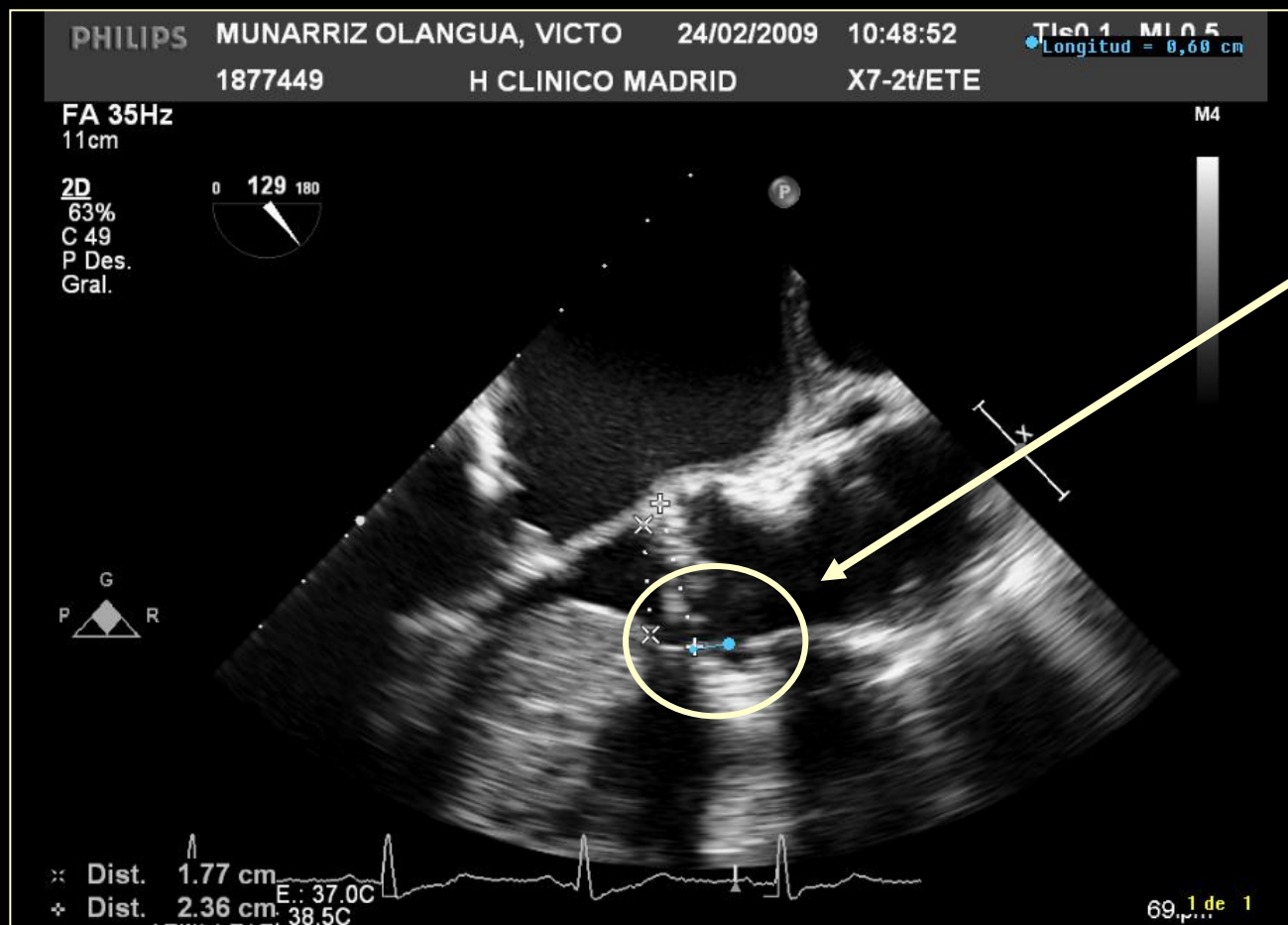
Annulus:

- ✓ 23mm: 18-21mm.
- ✓ 26mm: 22-25mm.

Not necessary sinus  
or sinotubular junction

× Dist. 3.26 cm  
+ Dist. 2.49 cm  
E.: 37.0C  
39.5C

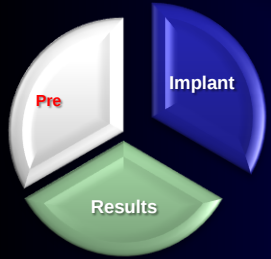
# Right Coronary artery



Edwards-Sapiens

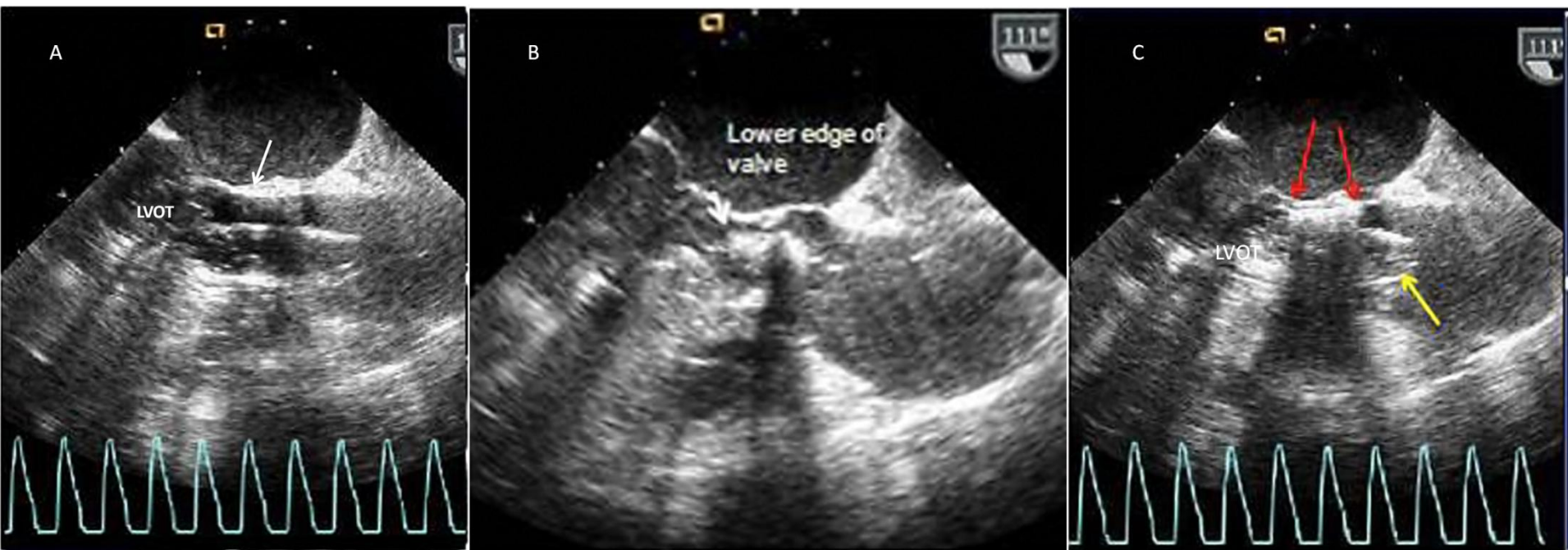
✓ 23mm:  $\geq 10$ mm

✓ 26mm:  $\geq 11$ mm

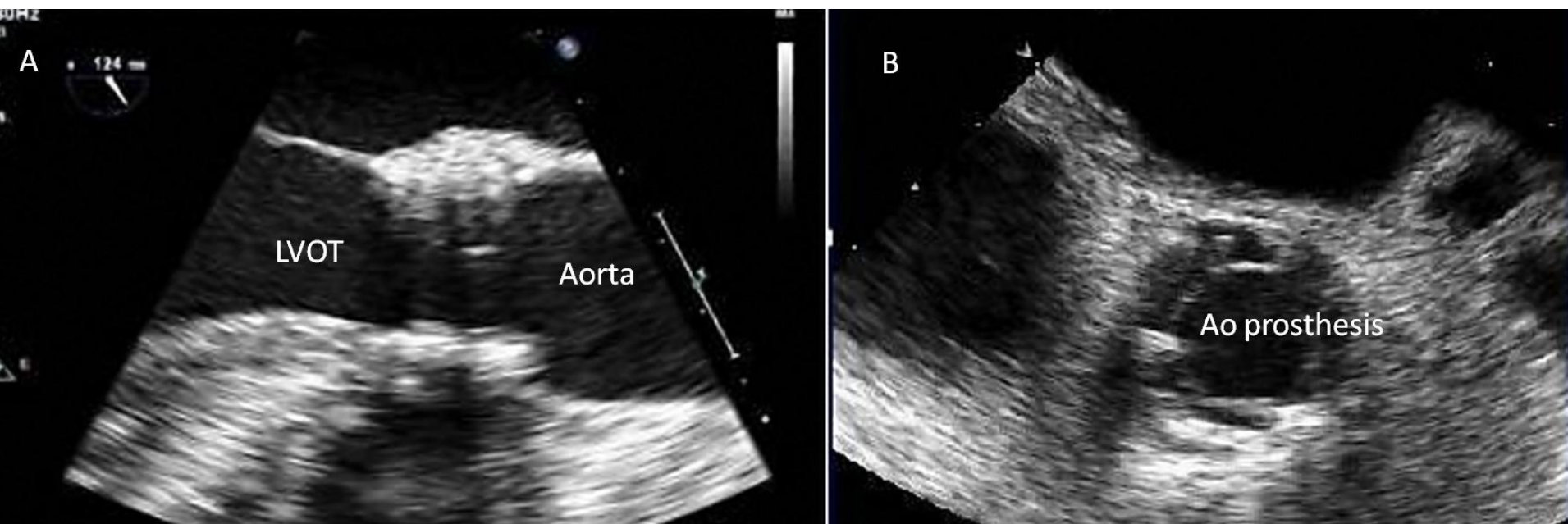


## • During procedure

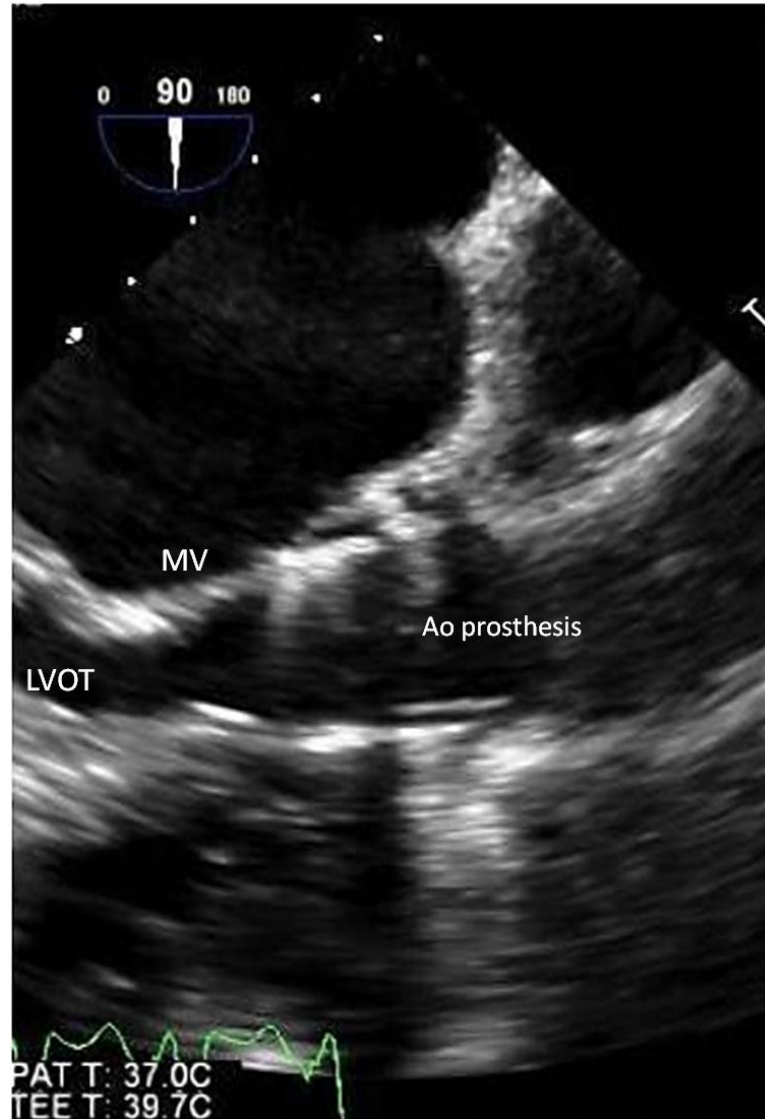
- 1) Cross the valve.
- 2) Valvuloplasty.
- 3) Position and implantation.
- 4) Postimplantation



**TEE may be used to confirm a stable position during inflation and to monitor the behavior of the calcified aortic cusps during inflation**



**The optimal position for the Edwards SAPIEN™ Valve is with the ventricular side of the prosthesis positioned 2-4mm below the annulus**



**CoreValve™ should be placed 5–10 mm below the aortic valve annular plane.**

PHILIPS

PONS CATCHOT, ANTONIA

24/06/2009

12:14:44

TIs0.1

MI 0.7

1724665

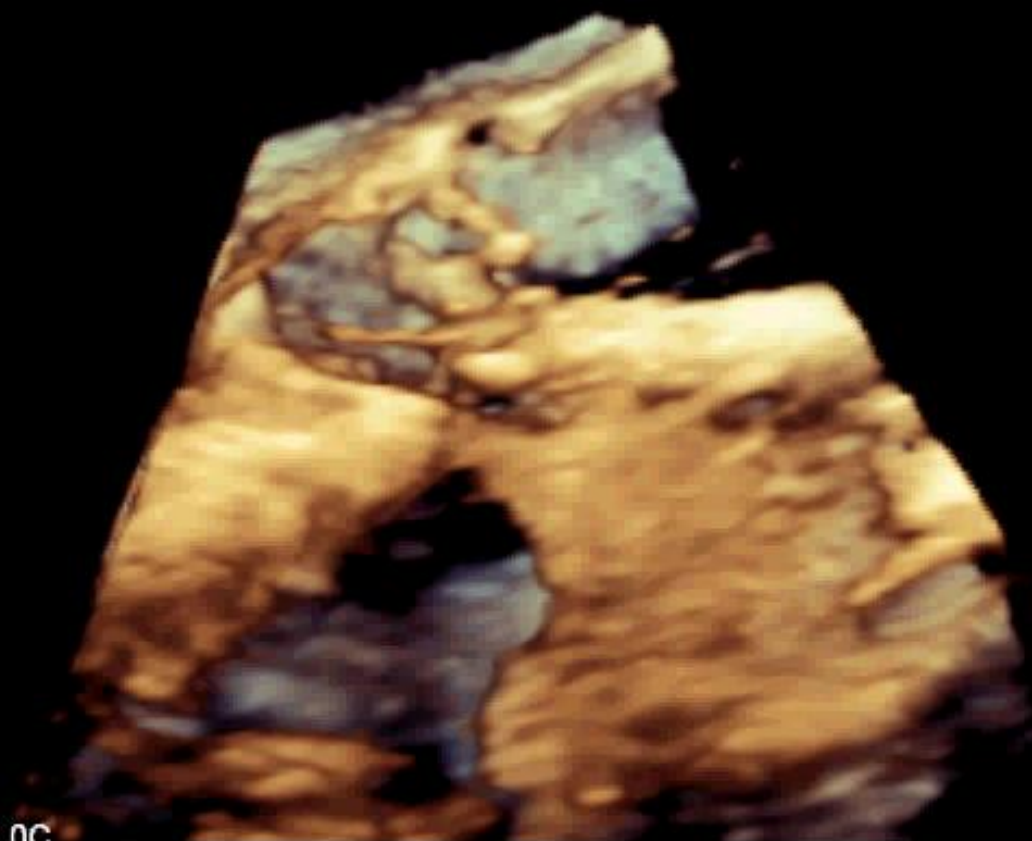
X7-2t/TEE

FA 30Hz  
10cm

Live 3D  
3D 21%  
3D 23dB  
Gral.



M4



JPEG

TEMP. PCTE.: 37.0C  
TEMP. ETE: 39.2C

85 lpm

PHILIPS

PONS CATCHOT, ANTONIA

24/06/2009

12:15:52

TIs0.1

MI 0.7

1724665

X7-2t/TEE

FA 30Hz

10cm

Live 3D

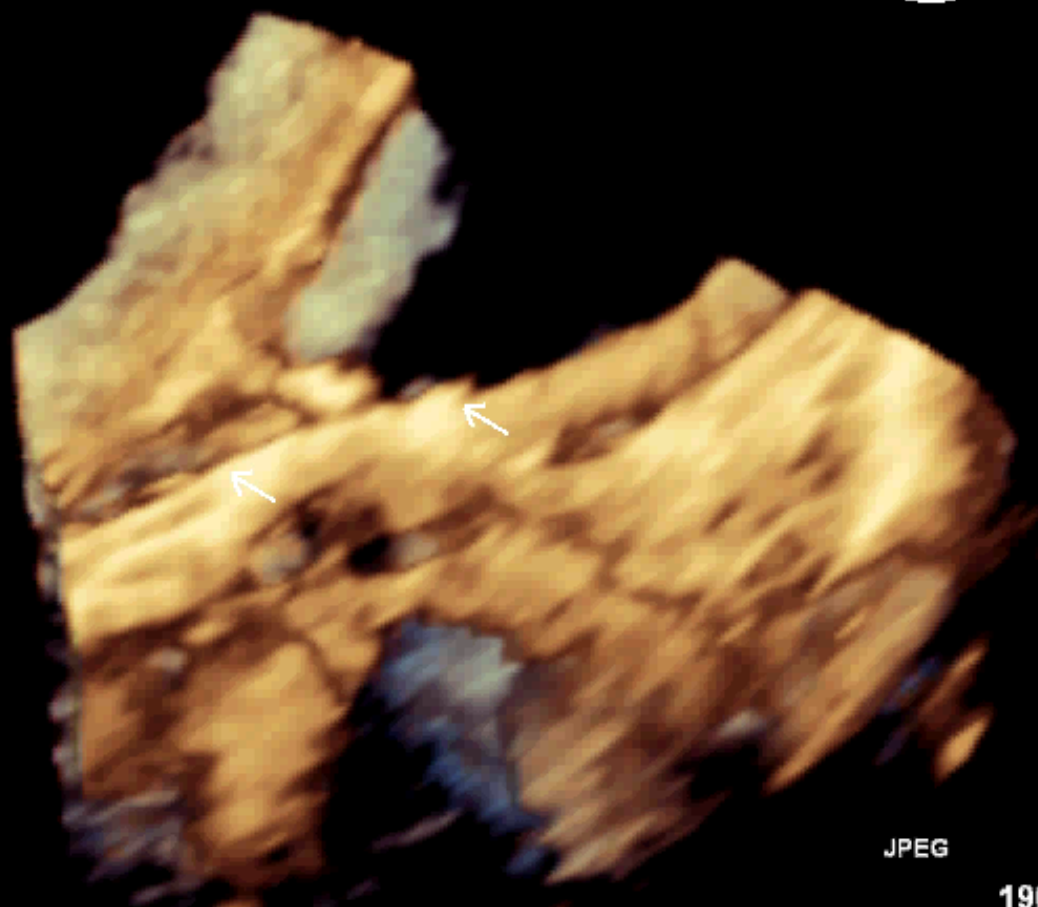
3D 2%

3D 23dB

Gral.



M4



JPEG

TEMP. PCTE.: 37.0C  
TEMP. ETE: 39.1C

190 lpm

PHILIPS

PONS CATCHOT, ANTONIA

24/06/2009

12:29:09

TIs0.1

MI 0.7

1724665

X7-2t/TEE

FA 9Hz  
6.8cm

Live 3D  
3D 7%  
3D 21dB  
Gral.



M4



JPEG

TEMP. PCTE.: 37.0C  
TEMP. ETE: 38.7C

87 lpm

# • Evaluation of success and complications

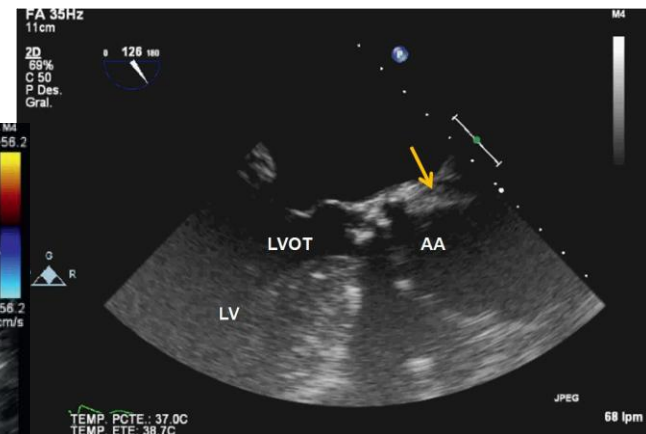
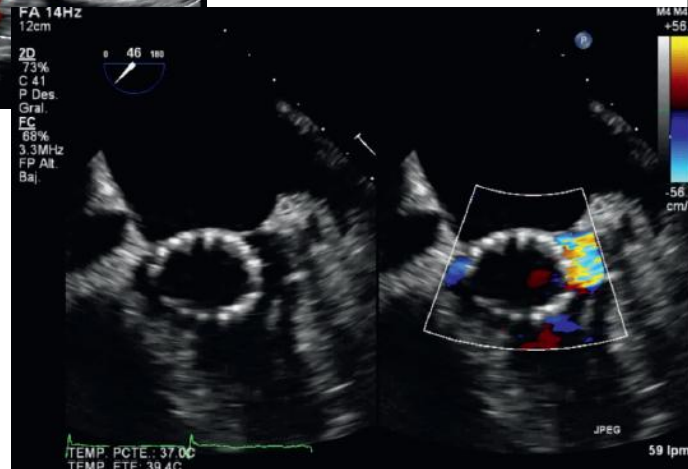
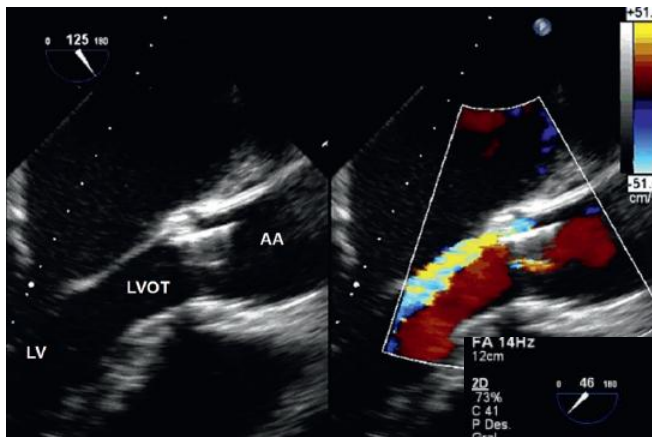
## Echocardiography: guidance during valve implantation **EuroIntervention**

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 approach 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.



## Aortic prosthesis misplacement

Embolization towards the aorta or left ventricle

Deployed valve is positioned too high (towards the aorta) or too low (towards the mitral valve apparatus)

## Aortic regurgitation

Central

Paravalvular

## Mitral regurgitation

Aortic prosthesis impinges on the anterior mitral leaflet

Left ventricle asynchrony caused by right ventricular pacing

Damage or distortion of the subvalvular mitral apparatus by delivery system

## New left ventricular wall motion abnormalities

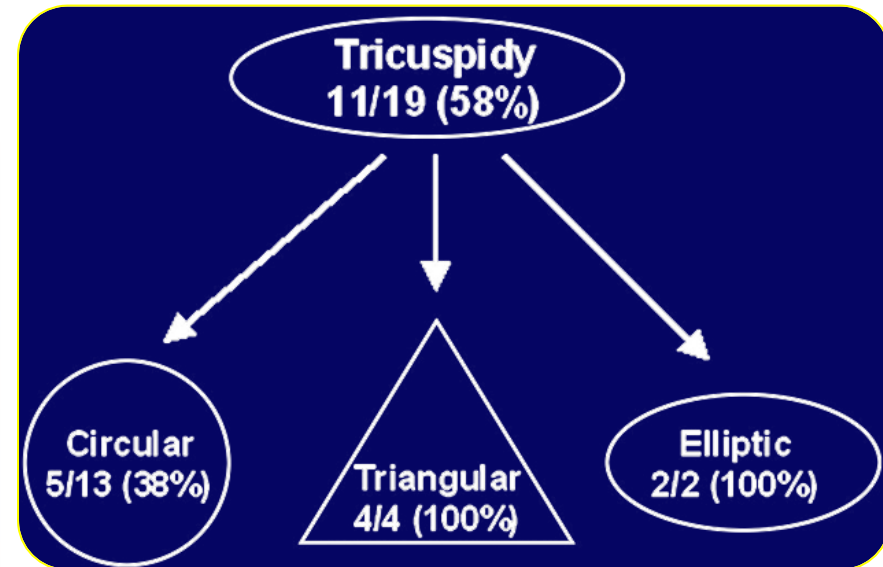
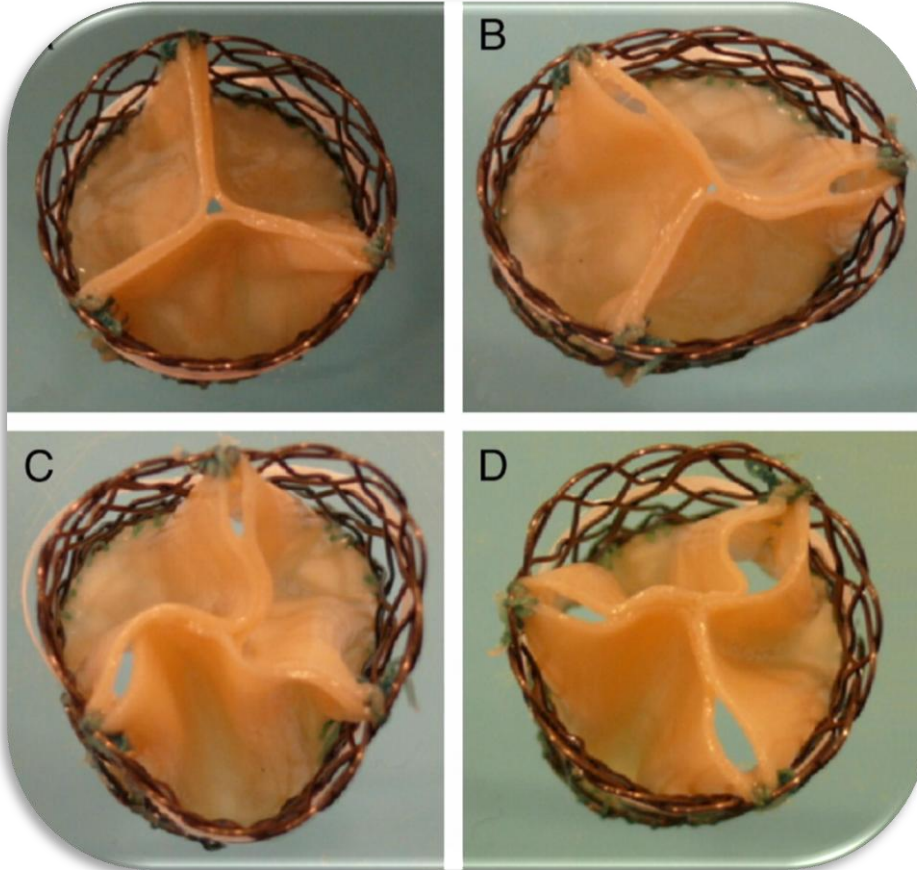
Acute coronary ostial occlusion

## Cardiac tamponade

Perforation of the left or right ventricle

**Dissection or rupture of the aortic root (0-4%)**  
**Stroke (0-10%)**

## • Per- procedure →→ Complications



### Factors influencing circularity

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

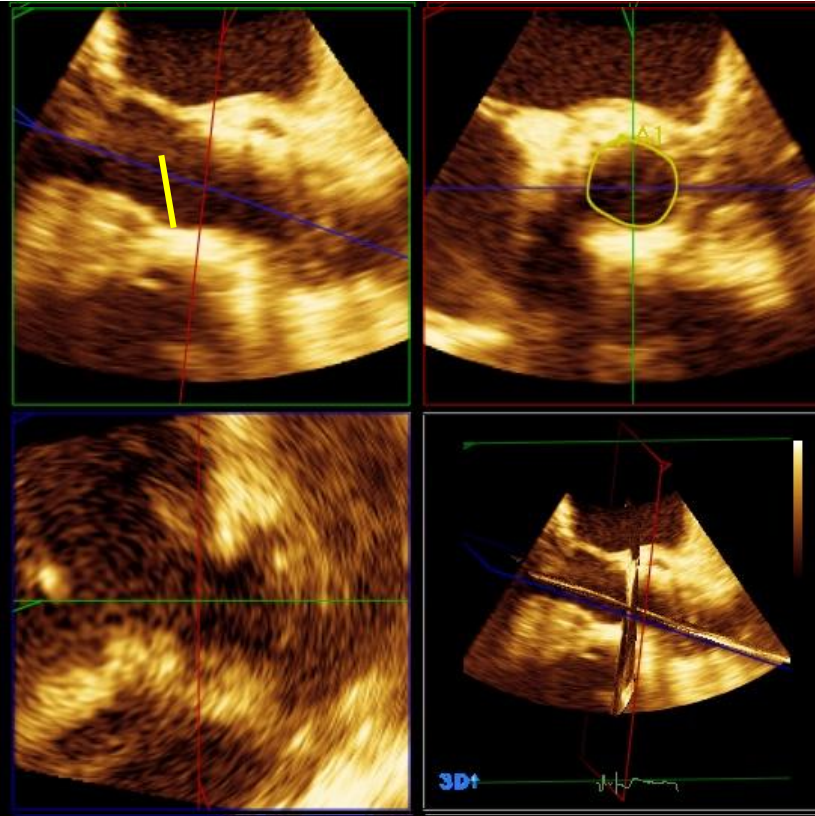
# Non-coaptation index predicts perivalvular aortic regurgitation after TAVI

74 pts - 2D and 3D TEE per procedure

Measurement:

- ✓ Aortic cusps calcification
- ✓ Annulus diameter
- ✓ Annulus area by planimetry
- ✓ Aortic prosthesis area by planimetry

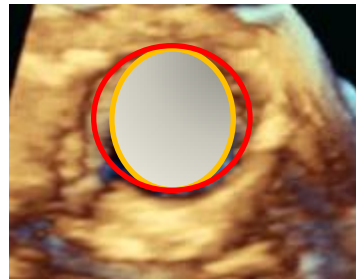
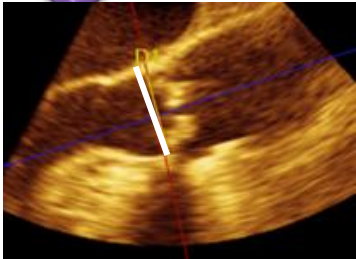
PHILIPS



## Non-coaptation index

aortic annulus area - aortic prosthesis area/ aortic annulus area

# • Per- procedure →→ Complications



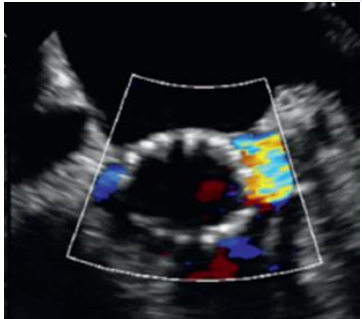
|                              | No AR<br>N=26 | Parav AR<br>N=27 | P Value |
|------------------------------|---------------|------------------|---------|
| Aortic annulus diameter (mm) | 20.5 ± 2.0    | 21.8±2.3         | 0,046   |
| Non-coaptation index         | 0.18±0.22     | 0.36±0.2         | 0,011   |
| Asymmetric Ao calcification  | 3 (11,5%)     | 5 (18,5%)        | 0,265   |
| LV diast. volume (ml/m2)     | 44,0 (16,3)   | 48,4 (21,9)      | 0,383   |

Baseline characteristics, type of procedure, prosthesis kind or size were not predictors of AR at follow-up.

Non-coaptation index ≥ 0.3 – increased risk of AR [7.1 IC95% (1.8-28.9)].

- At follow-up

## Issues



How to evaluate PAR after TAVI?

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

## Aortic Regurgitation

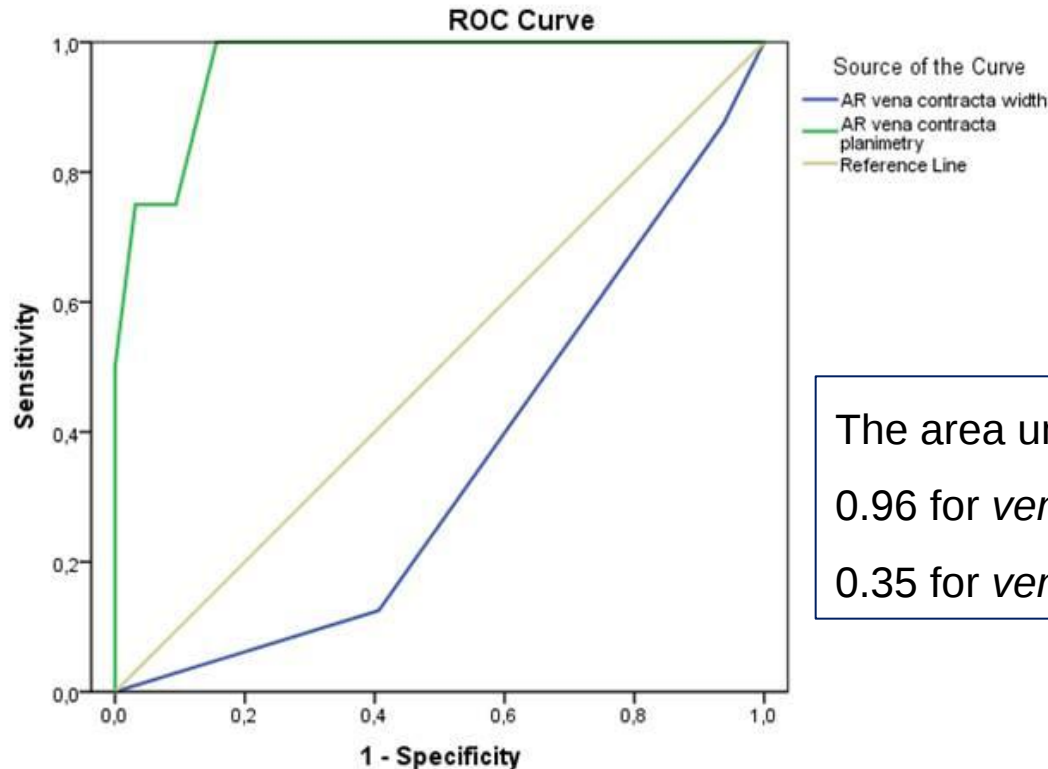
|                                              | None (n=29)  | Mild (n=35)  | p value* | Moderate (n=8) | p value** |
|----------------------------------------------|--------------|--------------|----------|----------------|-----------|
| LV ejection fraction (%)                     | 63.9 (11.4)  | 60.4 (10.6)  | 0.227    | 58.6 (13.2)    | 0.696     |
| LV mass (g/m <sup>2</sup> )                  | 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 <sup>2</sup> )     | 44.0 (16.3)  | 48.4 (21.9)  | 0.477    | 66.1 (18.6)    | 0.044     |
| Aortic valvular area (cm <sup>2</sup> )      | 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 <sup>2</sup> ) | -----        | 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*



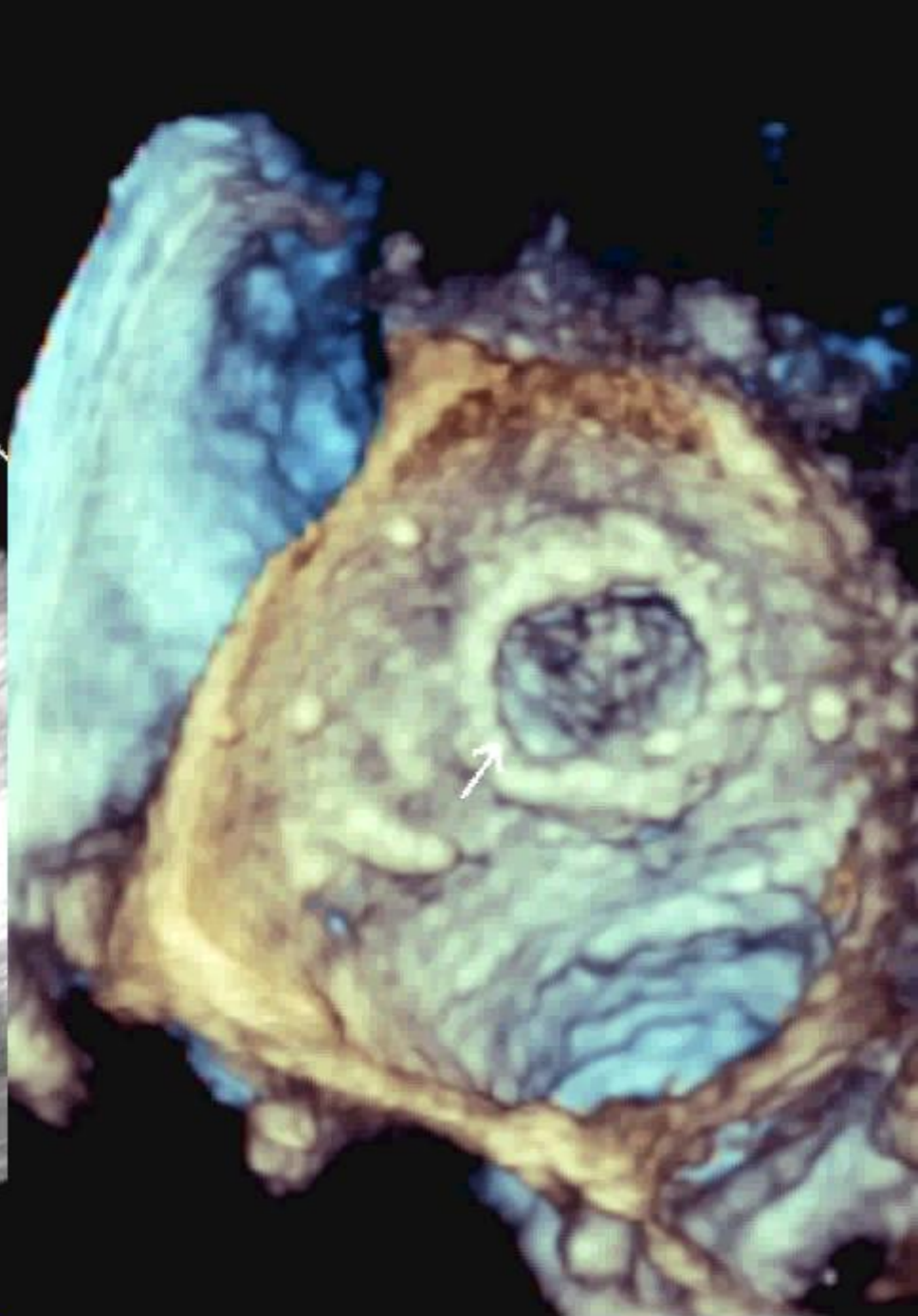
The area under the ROC curve:  
0.96 for *vena contracta* planimetry  
0.35 for *vena contracta* width

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,  $p < 0.001$

# Sometimes not easy nor nice ii

- Quick evaluation of potential complications
  - Aorta
  - LV
  - Mitral
  - Pericardium



90%

588457

H CLINICO MADRID

X7-2t/ETE

FA 52Hz

12cm

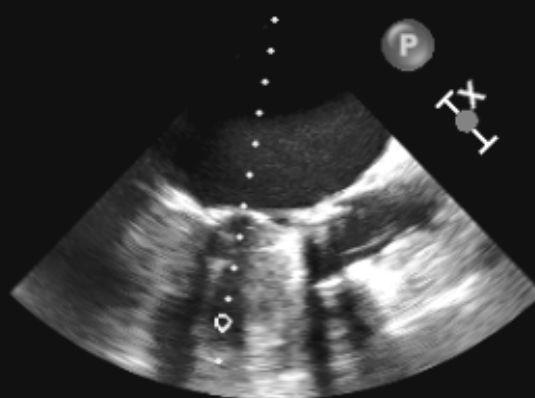
2D

65%

C 50

P Des.

Gral.



× T½p VM

V<sub>máx</sub>

207 cm/s

Pendiente

391 cm/s<sup>2</sup>

T½p

155 ms

÷ IVT VM

V<sub>máx</sub>

205 cm/s

V<sub>media</sub>

135 cm/s

GP máx

17 mmHg

GP med

8 mmHg

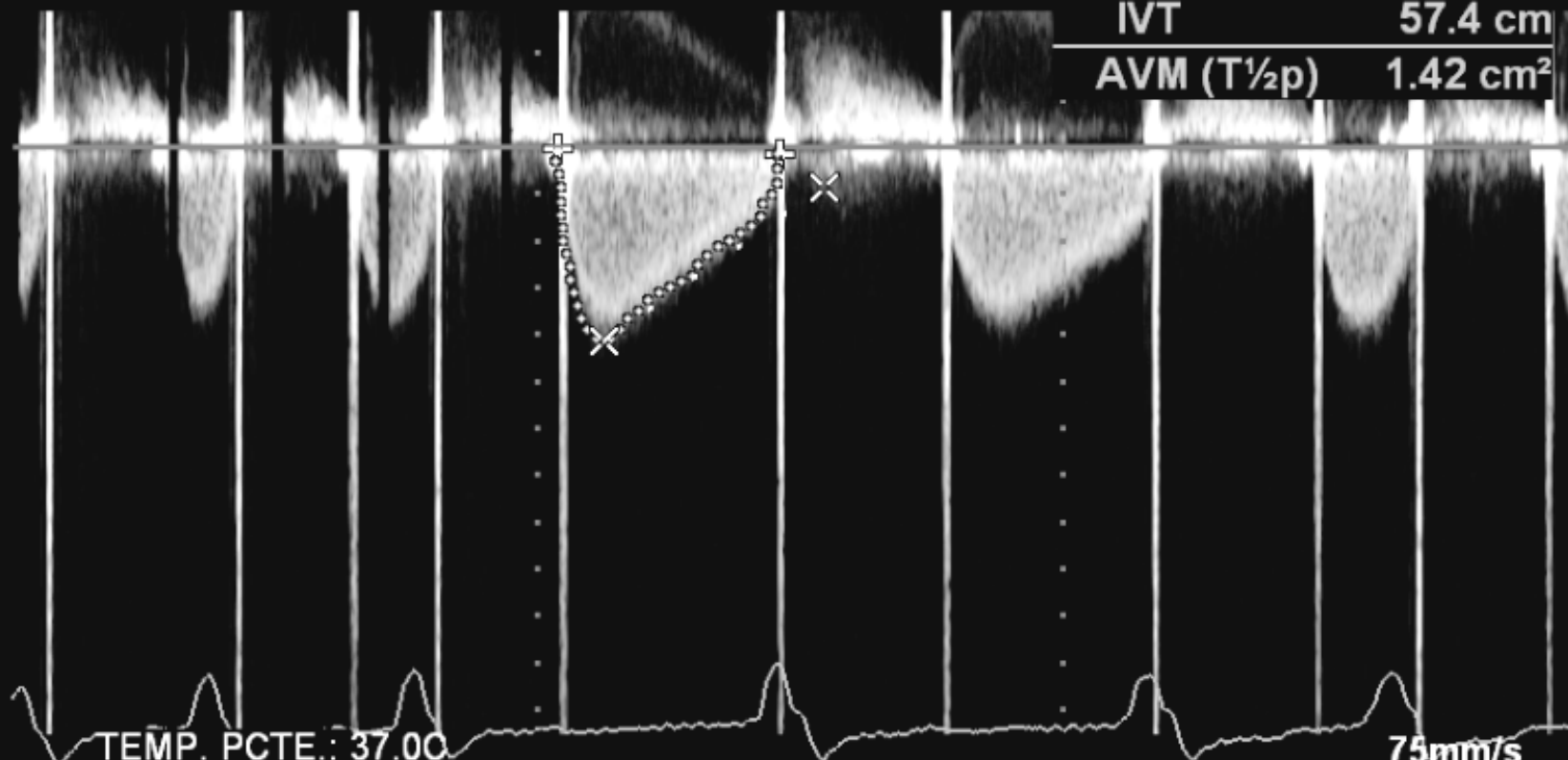
IVT

57.4 cm

AVM (T½p)

1.42 cm<sup>2</sup>

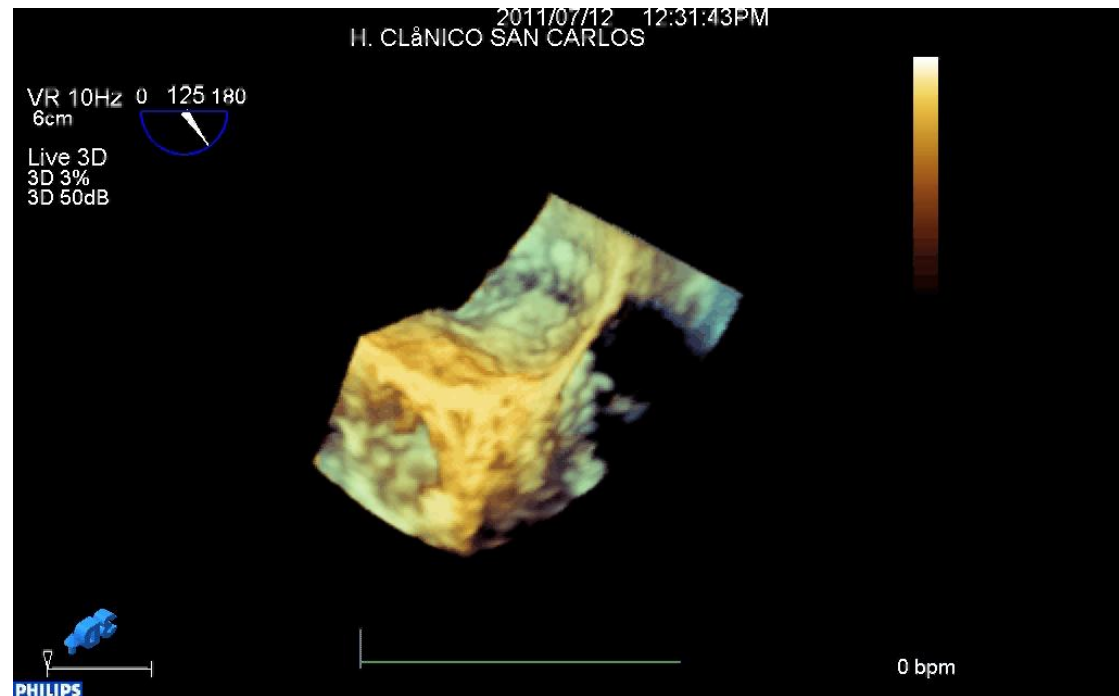
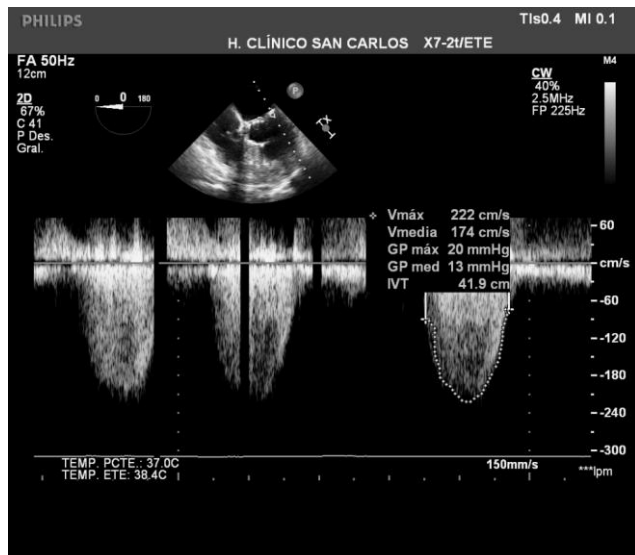
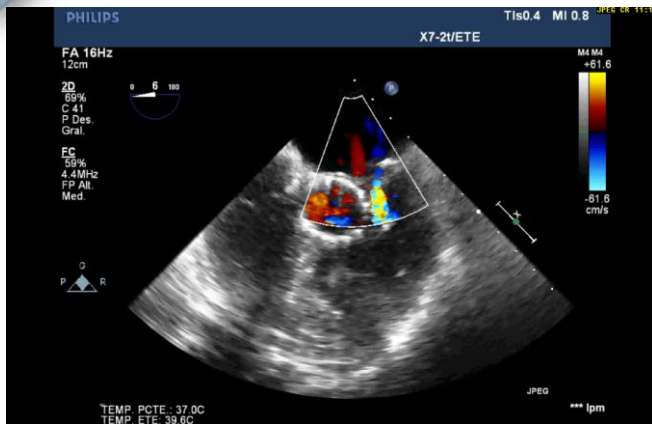
M4

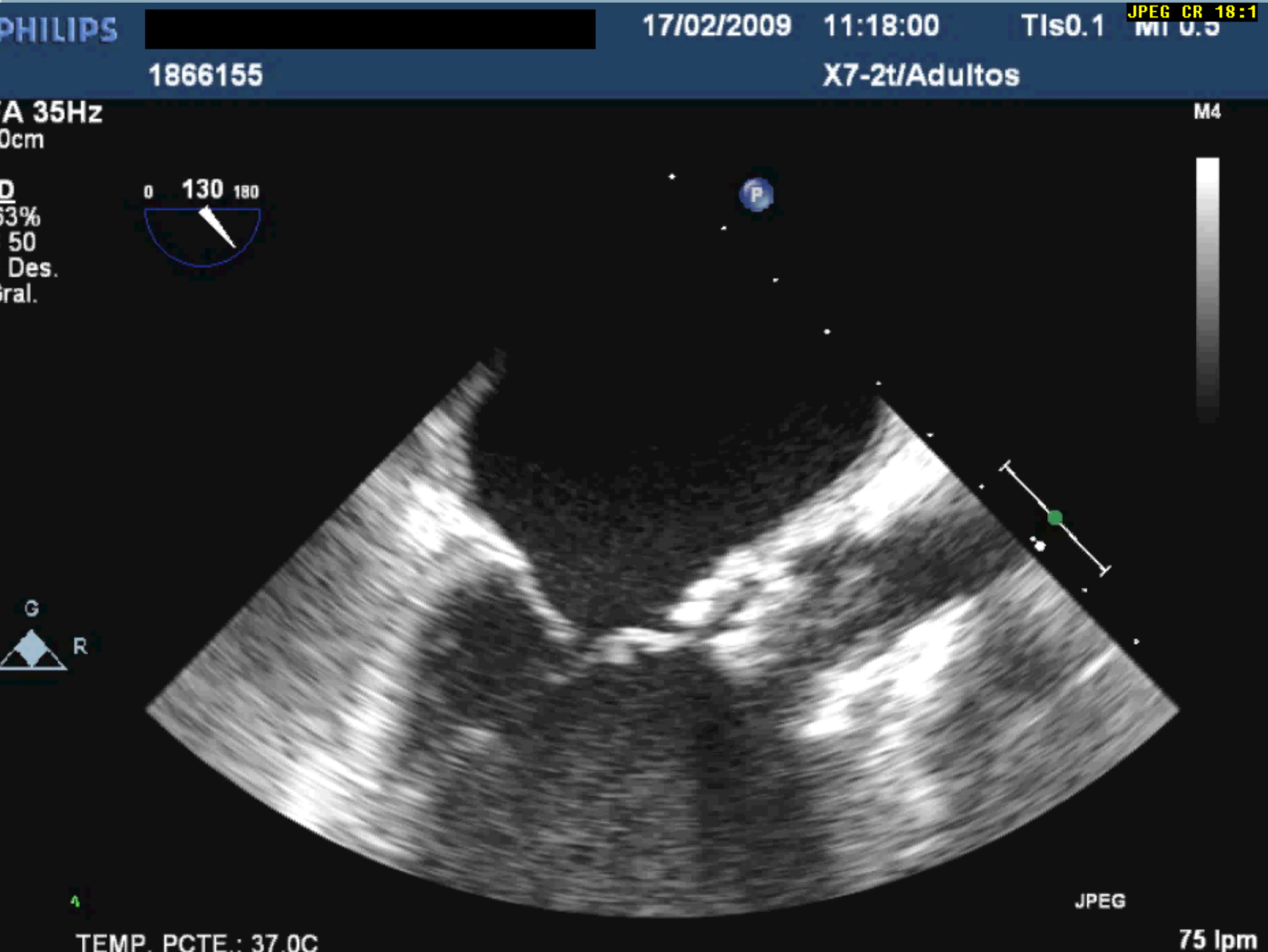


TEMP. PCTE: 37.00

75mm/s

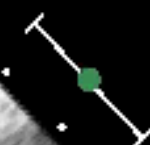
# Post TAVI Acute Pulmonary edema







P



R

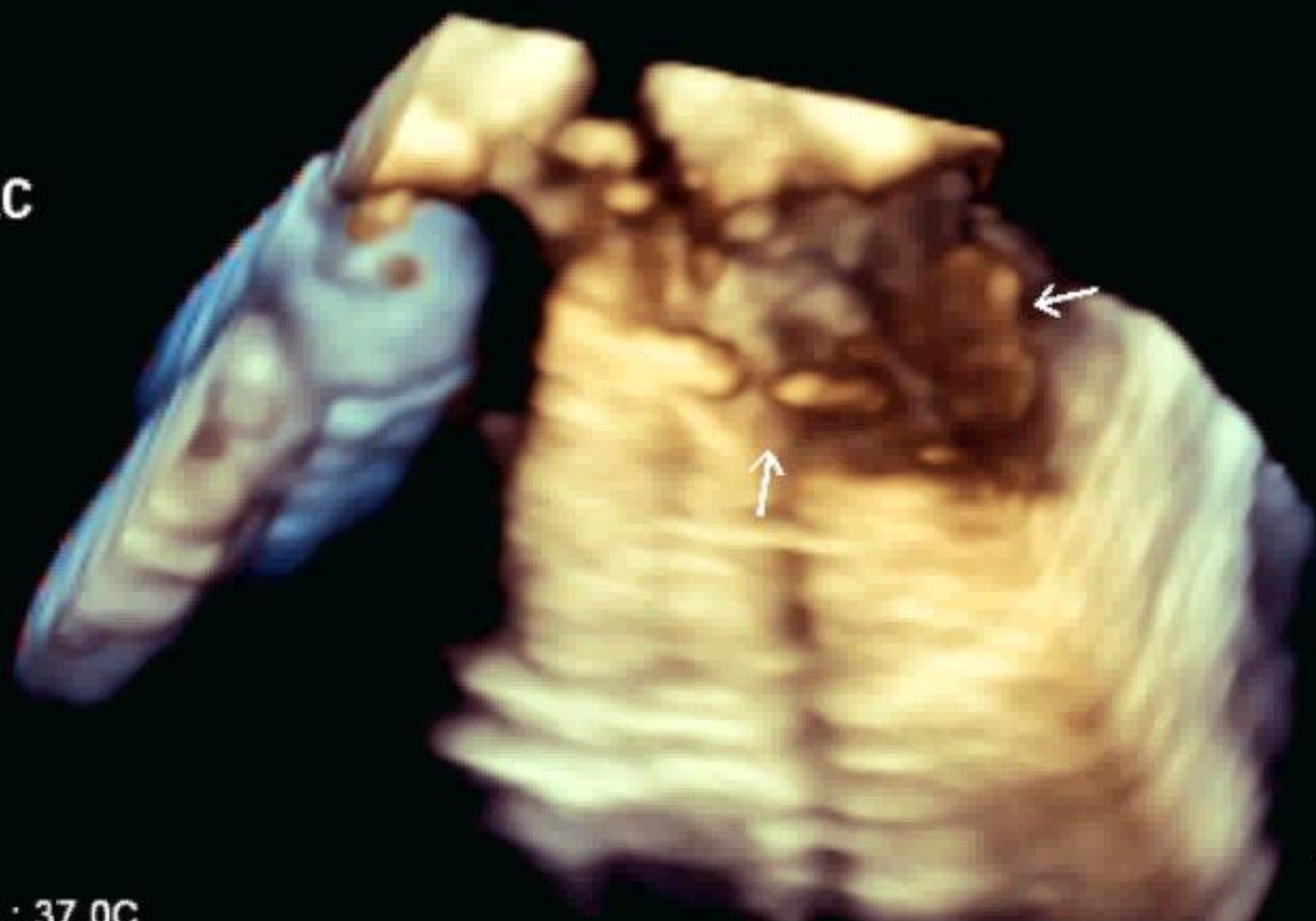
2Hz

M4

1D  
%  
dB



DISEC



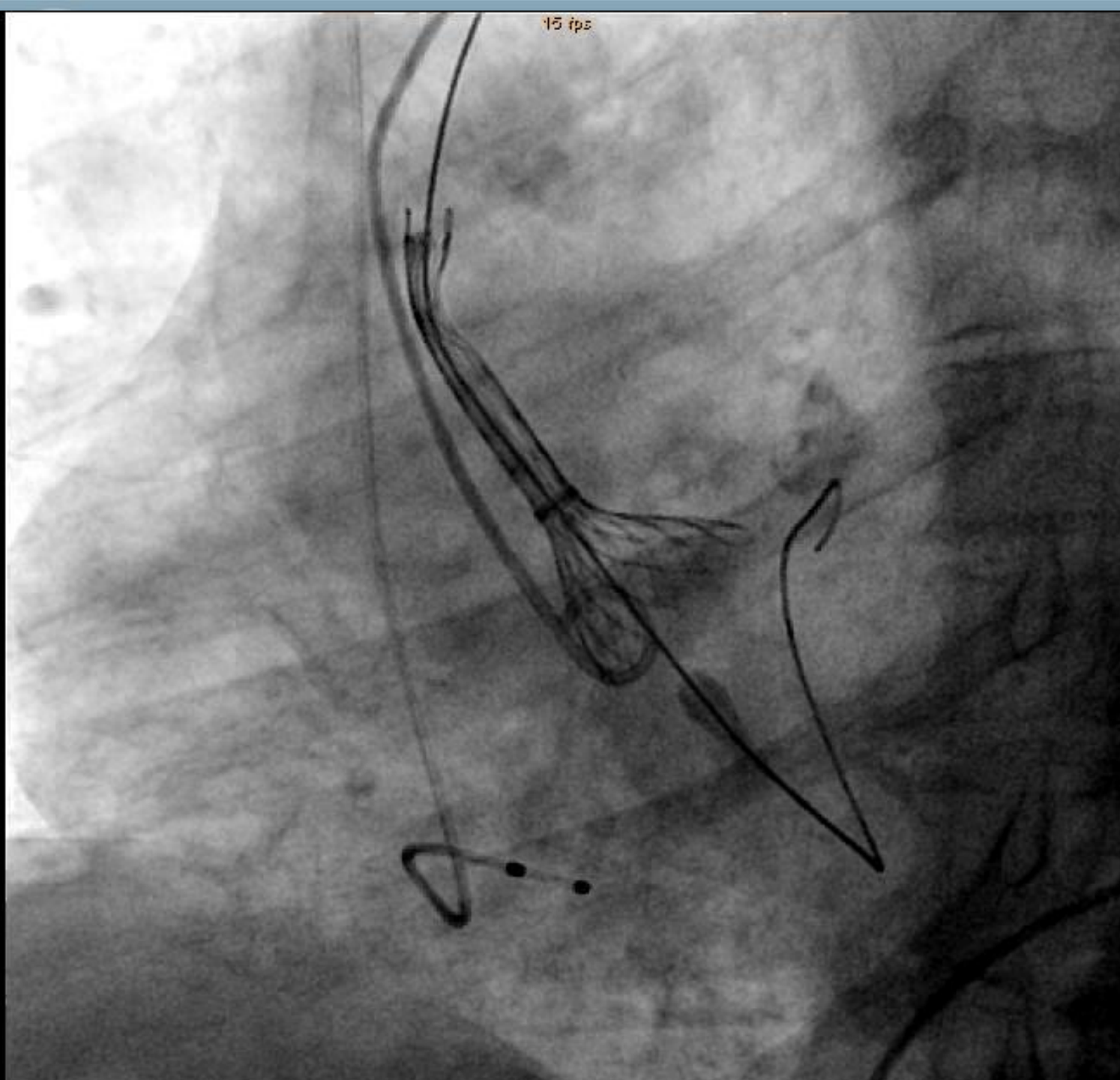
JPEG

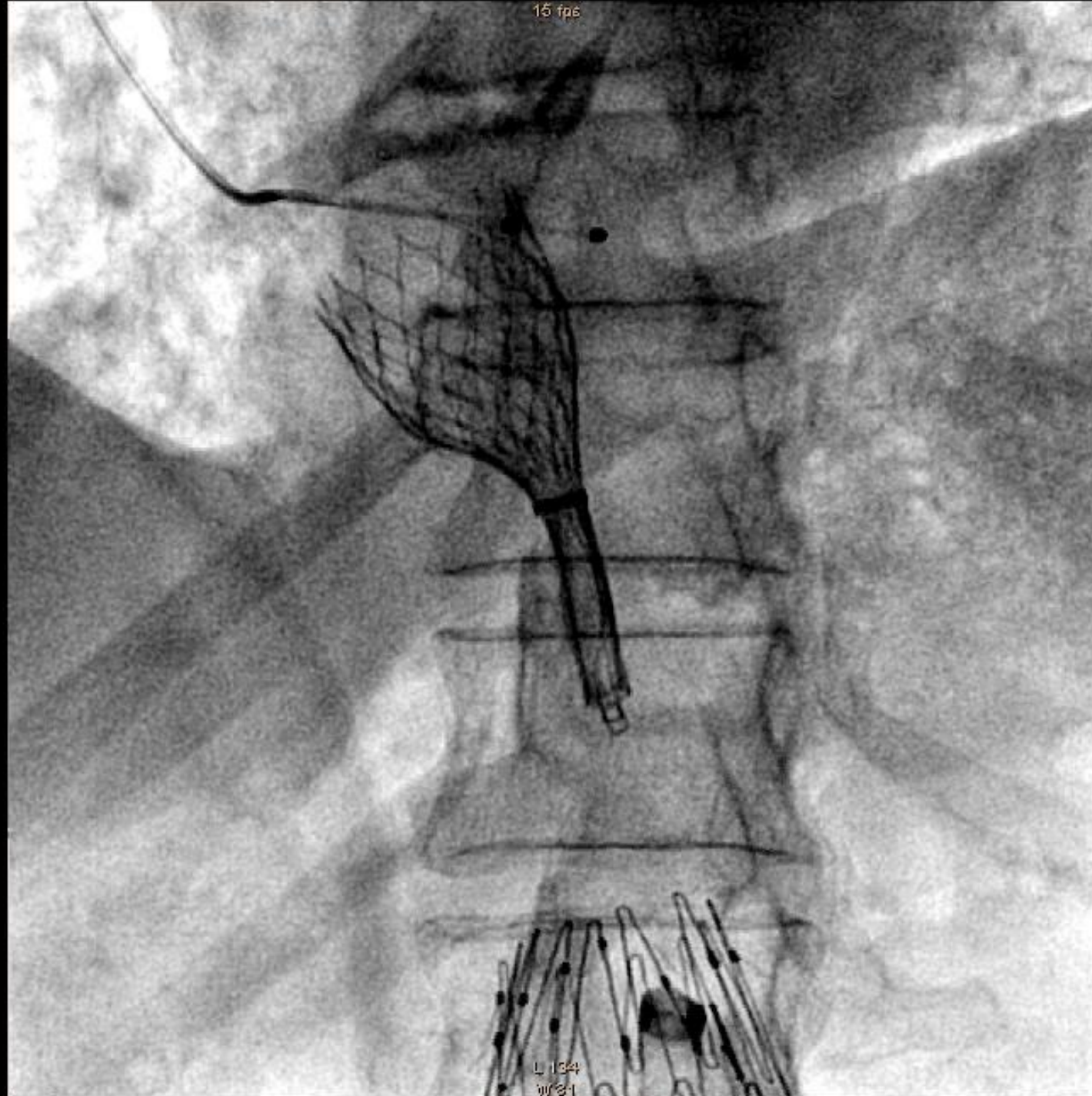
TEMP. PCTE.: 37.0C  
TEMP. ETE: 30.8C

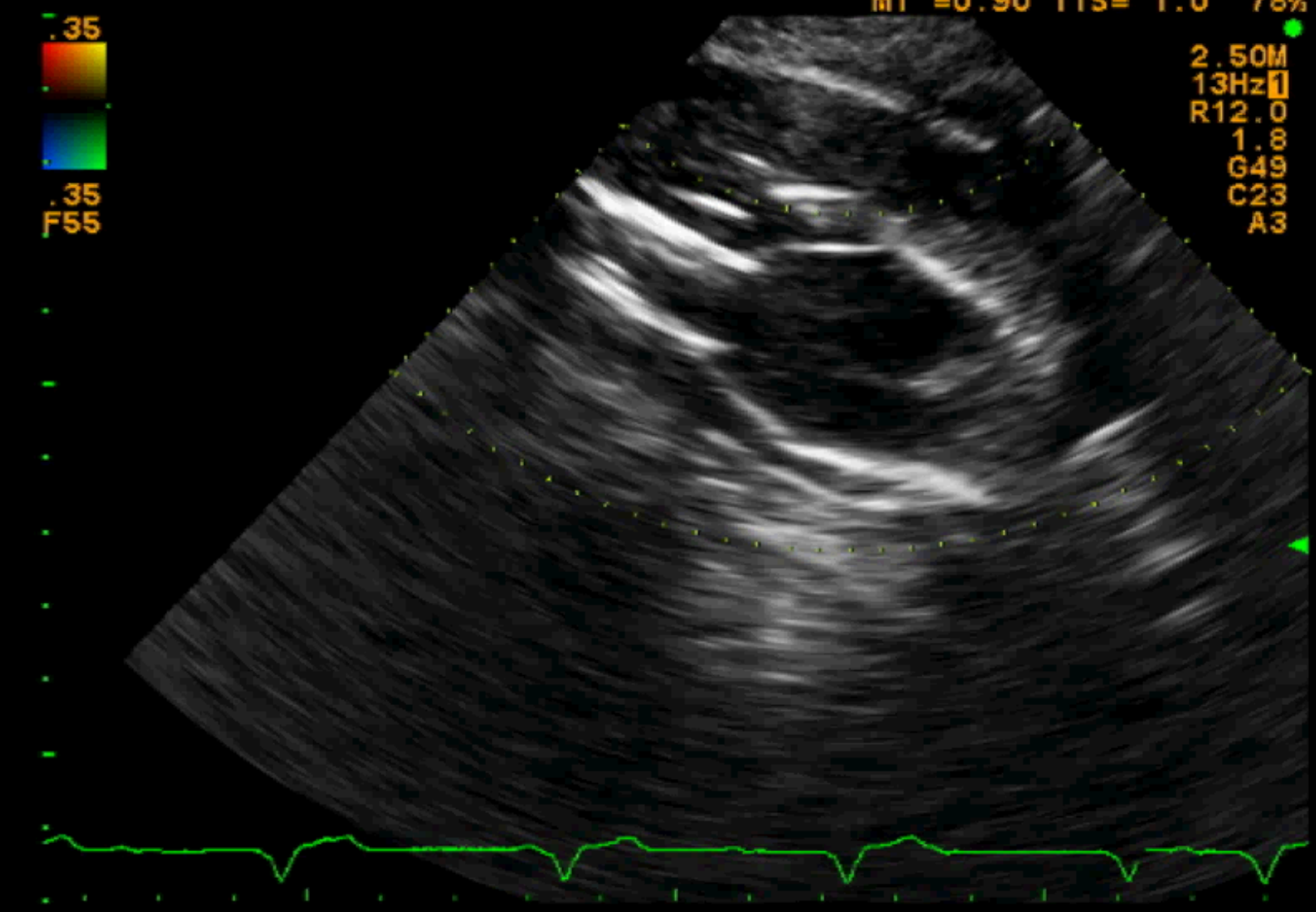
67

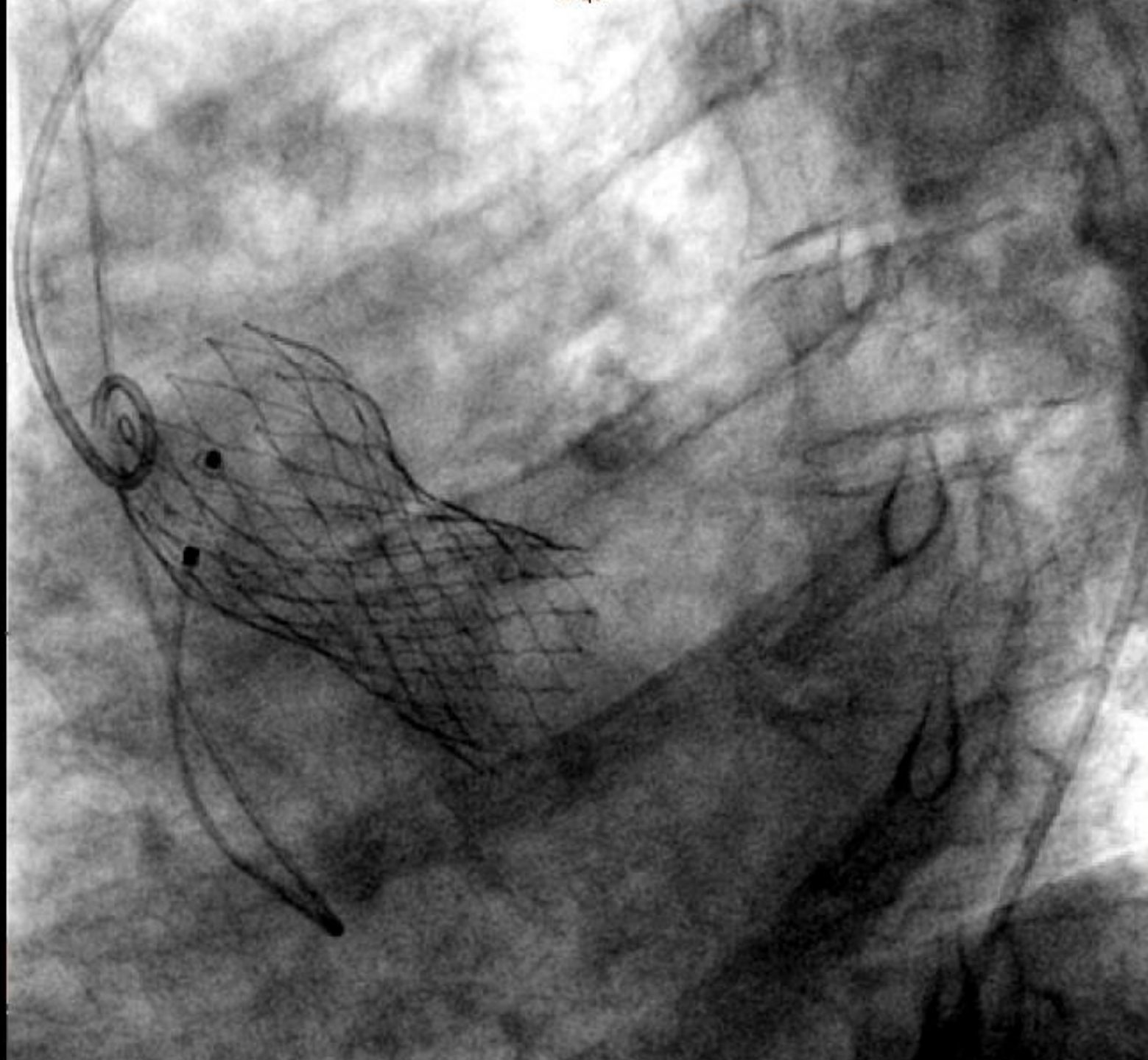
15 fps

H. Clínico San C  
78.7kV, mAs, 908m  
Zoom 1









# Imaging - TAVI

## Conclusions

- **Imaging is crucial in the selection of candidates.**
  - Not only Looking at valve ii
  - CT needed for pre- look distal arteries
- **Echo should be done during the procedure for an adequate implantation**
- **Intra . Procedure assessment of result is also crucial.**
- **Assess complications iii**