Patient Preparation : Echocardiographic Evaluation of TAVI

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Echo Assessment in TAVI

A Immediate Pre-TAVI

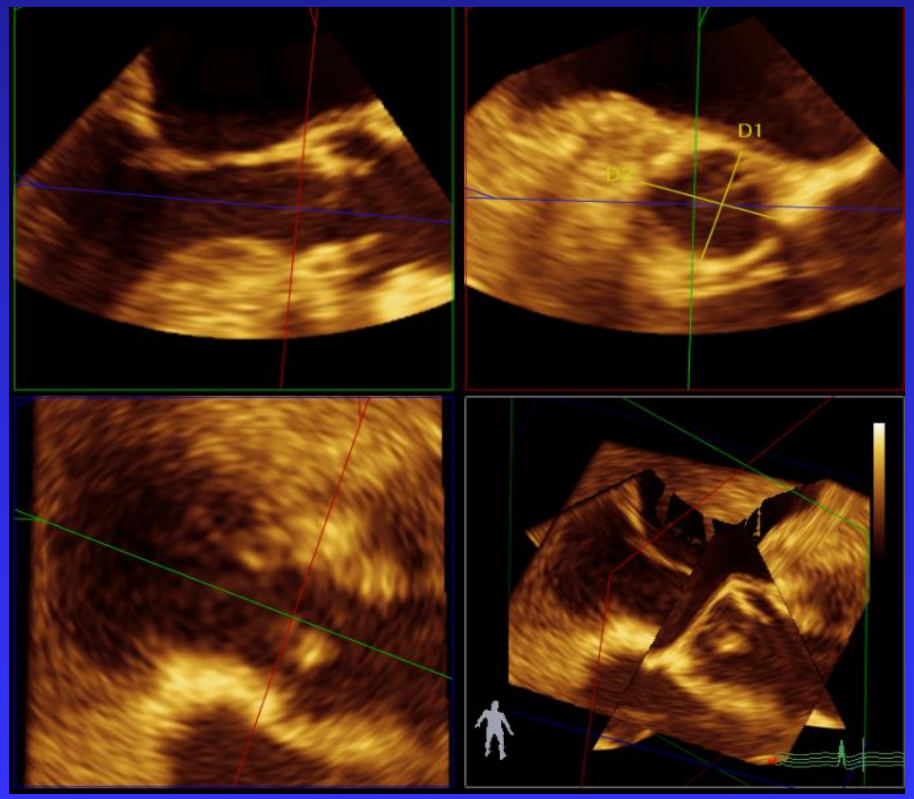
	Suggested Views
1. Locate LV Apex (TA)	
• Ensure final patient position • Perform with cardiac surgeon present	• TTE A4C/A2C • TTE xPlane
2. Review AV & root morphology & confirm AV annulus dimension	
• LVOT-annulus-root morphology, absolute & relative dimensions, prosthesis size • Calcification: annular/leaflet severity & eccentricity, LVOT & root deposits, mobile masses • Position & distance to coronary ostia • AR aetiology/severity • AV gradients	• TEE 2D ME LAX/SAX/5C & TG LAX/DTG ± CFM • TEE 2D UE LAX/SAX • TEE 3D Zoom/MPR • TEE 3D Full Volume/CFM
3. Baseline study	
• MV anatomy, MR aetiology/severity • LVH, basal septal hypertrophy, LV cavity size, LV function, RWMA • RH size/function • Pericardial effusion	• TEE 2D ME 4C/ commissural/2C/3C & TG 2C/LAX/SAX ± CFM • TEE 3D Zoom/Full Volume/CFM

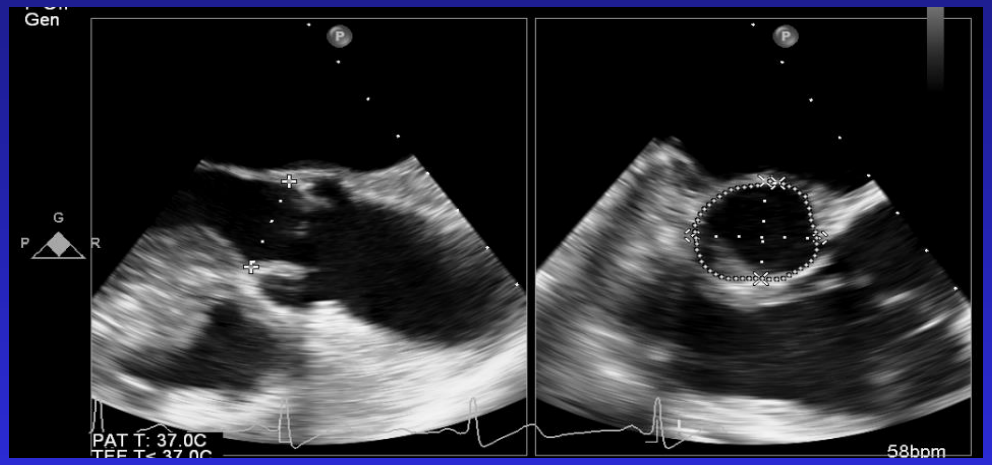
Smith et al. *J Am Soc Echocardiogr 2013;26:359-69*

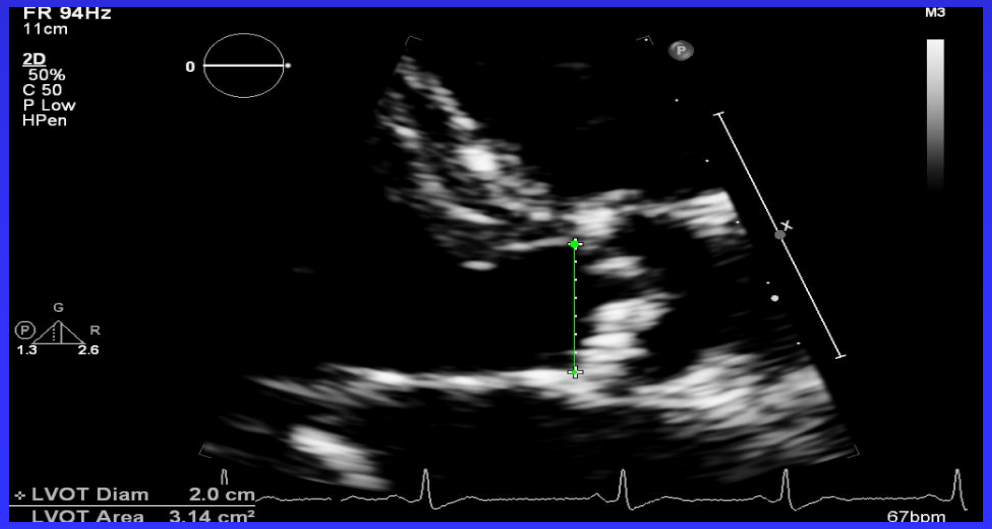
Pre-TAVI Assessment by Echo

- Aortic annular sizing by 2D and 3D echo
- Assessment of aortic stenosis
- Assessment of valve configuration
- Assessment of aortic regurgitation
- Other relevant echo findings

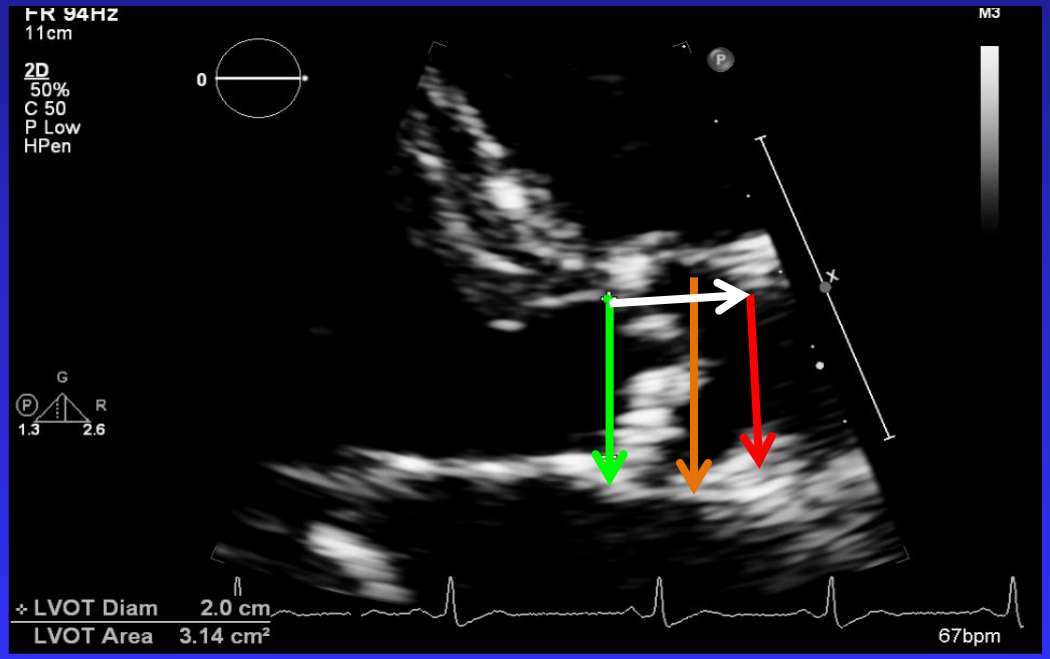
Aortic Annular Sizing by 2D and 3D Echo

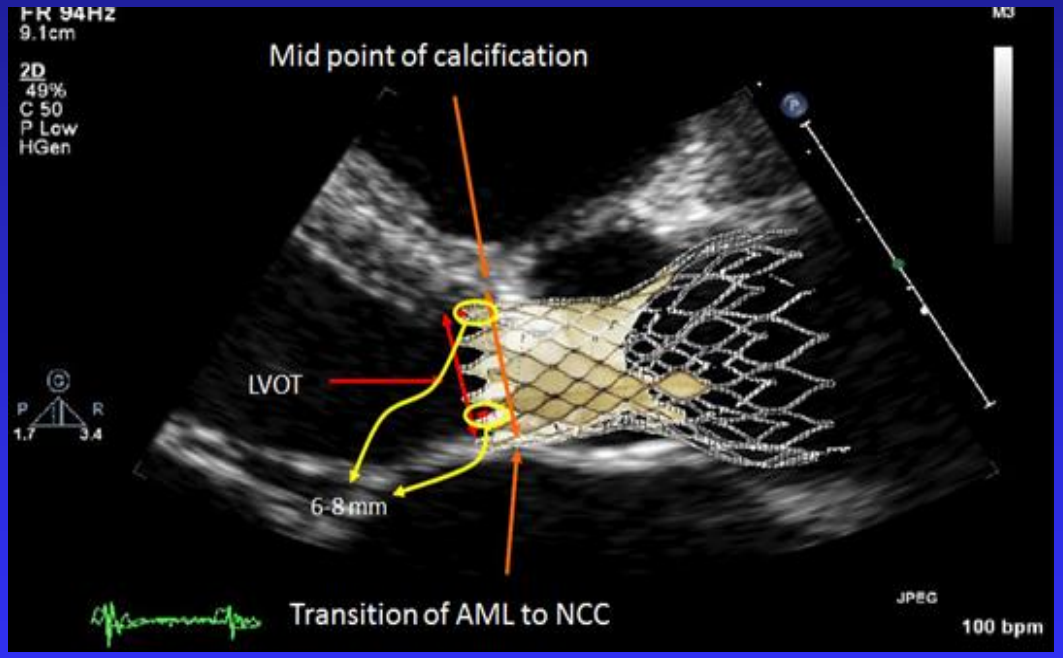






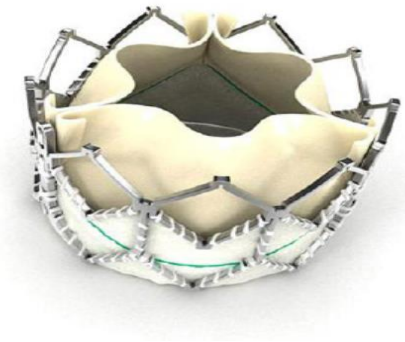
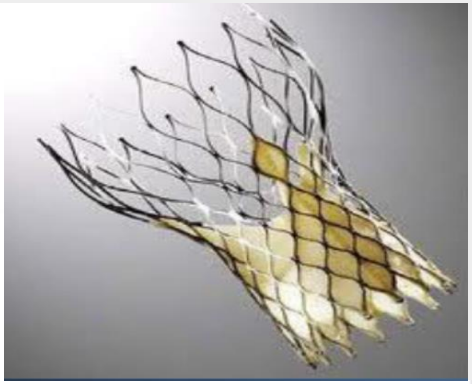
Annulus – LVOT Measurement





Brief Introduction of TAVI

Comparisons between two types of valves

Main Parameters		
Tissue type	Bovine pericardium	Porcine pericaridium
Valve sizes	23 mm, 26 mm	26 mm, 29 mm, 31 mm
Stent height	14.3–16.1 mm	52–55 mm
Frame	Stainless steel	Nitinol frame
Annulus range	18–25 mm	18–29 mm
Approach	Transfemoral, transapical	Transfemoral, subclavian and direct aortic
Deployment	Circular valve deployment via balloon inflation	Self-expanding frame
Anticoagulation	6 months	No recommendation

K.E. O'Sullivan et al. *European Journal of Cardio-Thoracic Surgery 2014;45:826–833*

Device Size Selection : Aortic Annulus Ranges

	Diameter Range (mm)	Perimeter Range (mm)	Area Range (mm^2)
23	18 - 20	56.5 - 62.8	254.5 - 314.2
26	20 - 23	62.8 - 72.3	314.2 - 415.5
29	23 - 27	72.3 - 84.8	415.5 - 572.6
31	26 - 29	81.7 - 91.1	530.9 – 660.5

Recent evidence supports perimeter as the recommended method for TAVI sizing

Device Size Selection : Sinus of Valsalva and Ascending Aorta Ranges

	Sinus of Valsalva Diameter (mm)	Sinus of Valsalva Height (mm)	Ascending Aorta Maximum Diameter (mm)
23	≥ 25	≥ 15	≤ 34
26	≥ 27	≥ 15	≤ 40
29	≥ 29	≥ 15	≤ 43
31	≥ 29	≥ 15	≤ 43

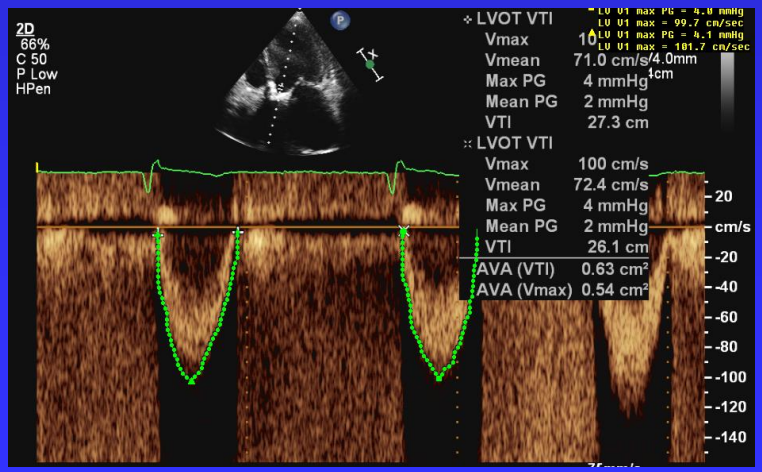
Assessment of Aortic Stenosis Severity

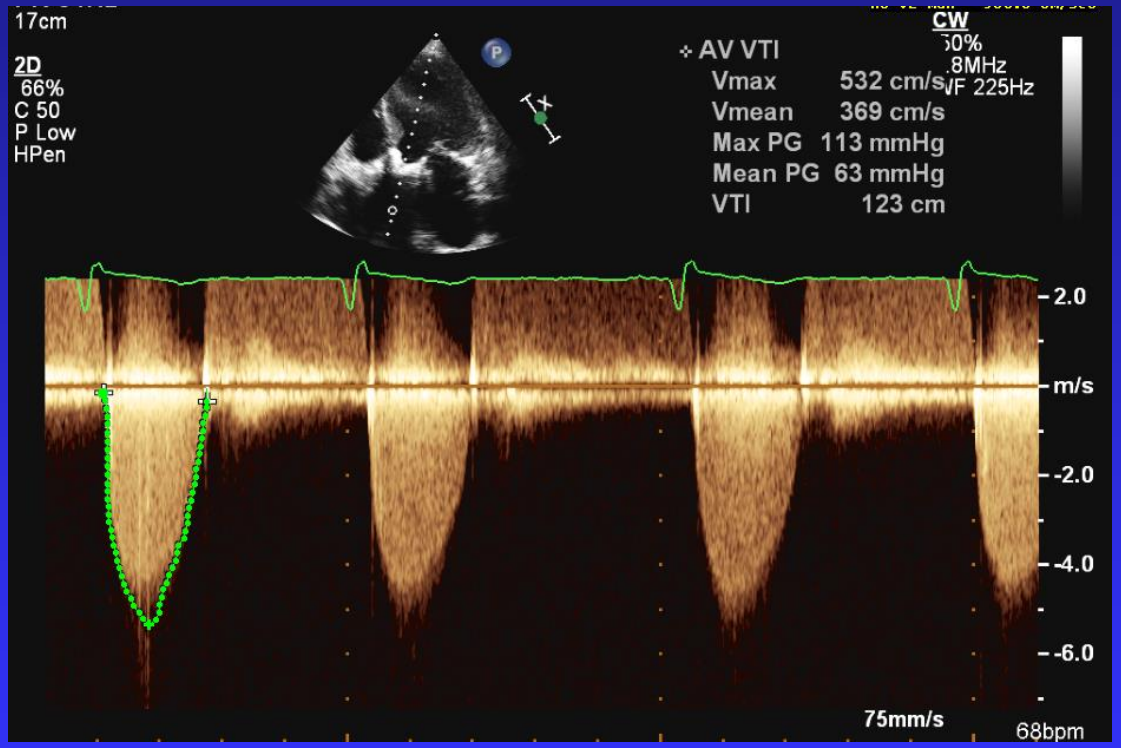
Indicator	Mild	Moderate	Severe
Jet Velocity *(m/s)*	< 3.0	3.0 – 4.0	> 4.0
Mean Gradient (*mmHg*)	< 25	25 – 40	> 40
Valve Area *(cm^2)*	> 1.5	1.0 – 1.5	< 1.0
Valve Area Index *(cm^2/m^2)*	–	–	< 0.6

Bonow RO. ACC/AHA 2006 Guidelines for the Management of Patients with Valvular Heart Disease. *Circulation* 2006;114:84-231.

Assessment of Aortic Stenosis

The continuity equation



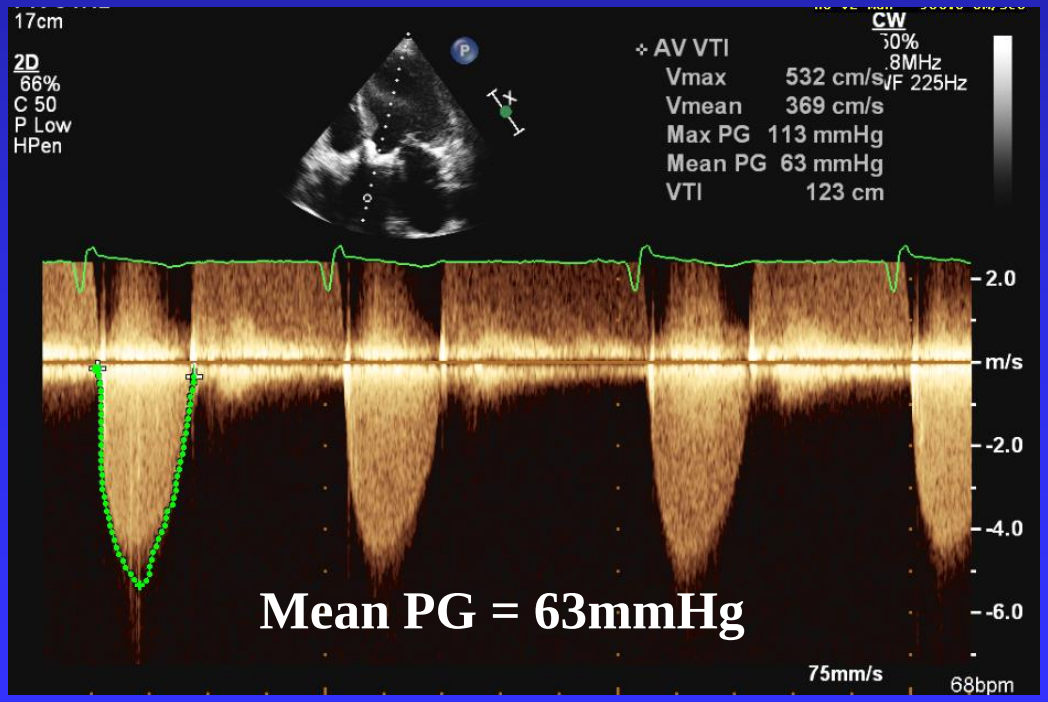


$$\text{Aortic Valve Area (cm2)} = \frac{\text{LVOT diameter2} \times 0.78540 \times \text{LVOT} - \text{VTI}}{\text{Aortic Valve VTI}}$$

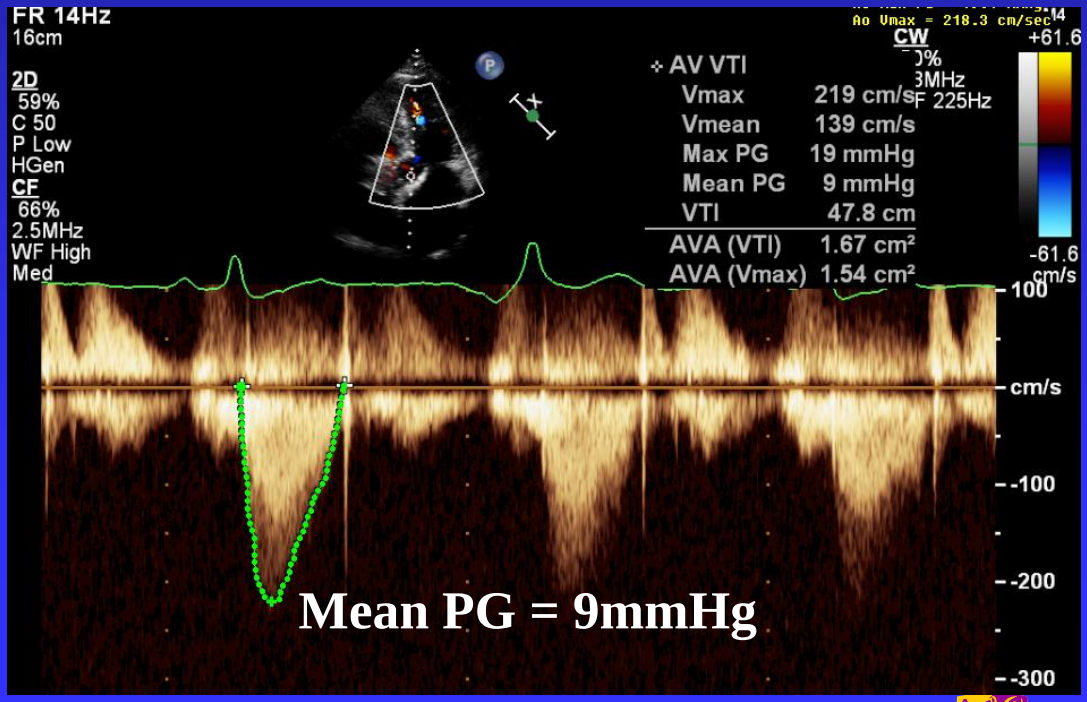
Echo Assessment Pre- / Post-TAVI

Transvalvular gradient

Baseline



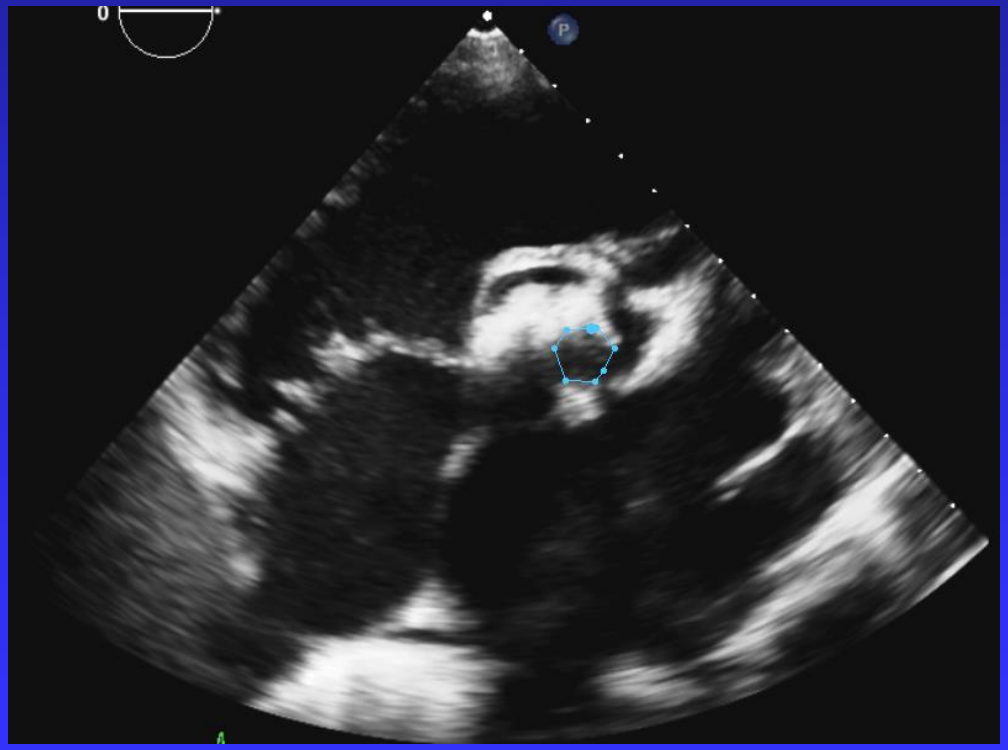
1-Year Follow Up



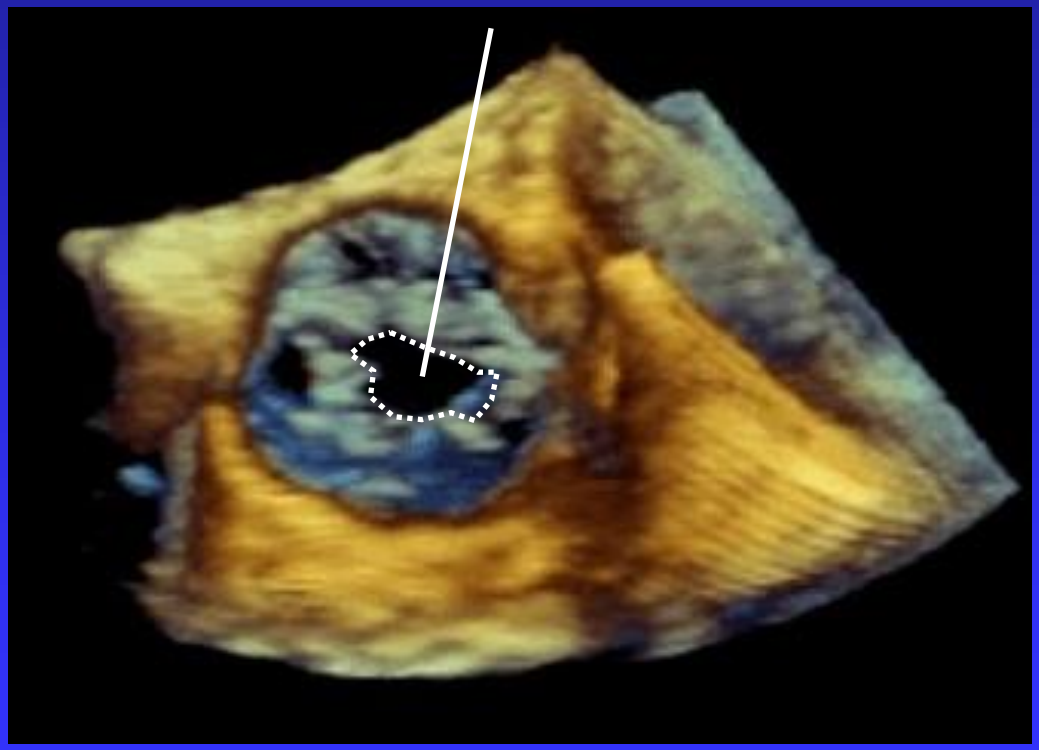
Assessment of Aortic Stenosis

Planimetry

2D Aortic Valve Area



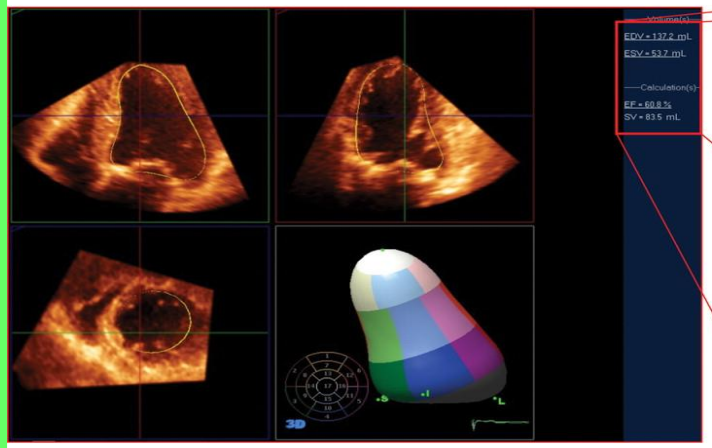
3D Aortic Valve Area



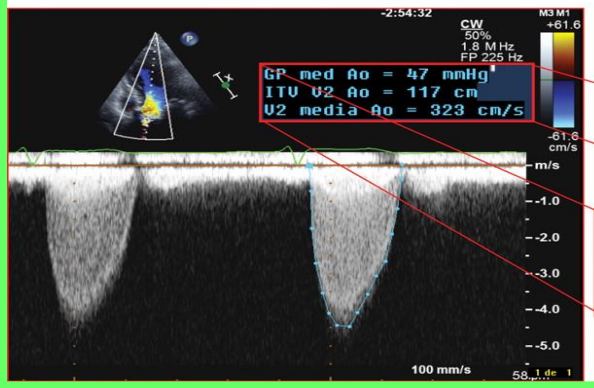
Formula for Aortic Area Calculation with Three-dimensional Echocardiography

$$\text{Aortic area (cm}^2\text{)} = \frac{SV_{3D\ (cm^3)}}{TVI_{Ao\ (cm)}}$$

SV_{3D} : stroke volume by 3D
TVI_{Ao} : time-velocity integral by Doppler in the aortic valve



Volume(s)
EDV = 137.2 mL
ESV = 53.7 mL
Calculation(s)
EF = 60.8%
SV = 83.5 mL



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

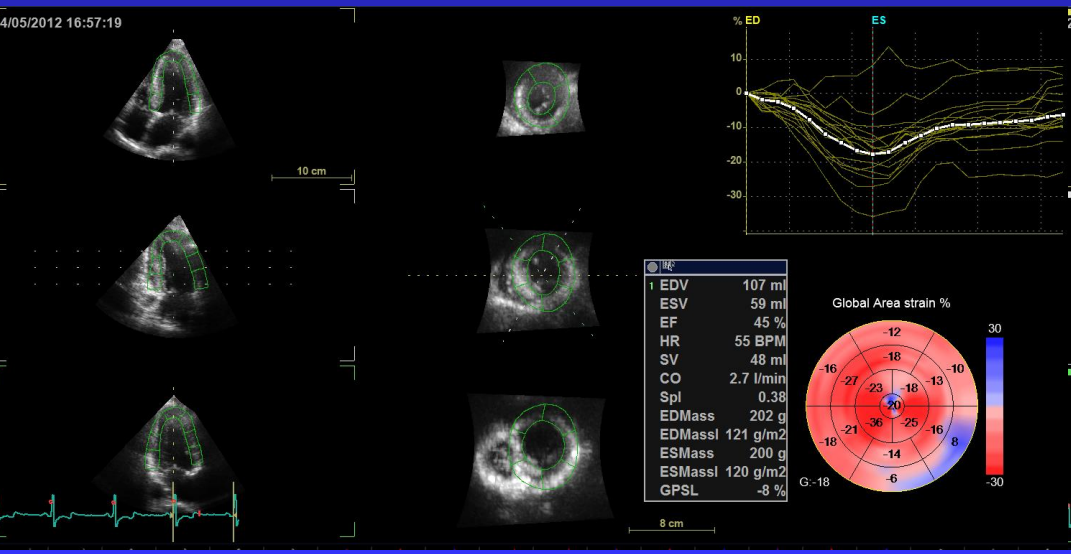
GP med Ao = 47 mmHg
ITV V2 Ao = 117 cm
V2 media Ao = 323 cm/s

Gutiérrez-Chico J L et al. *Eur Heart J* 2008;29:1296-1306

Echo Assessment Post TAVI

LV systolic function

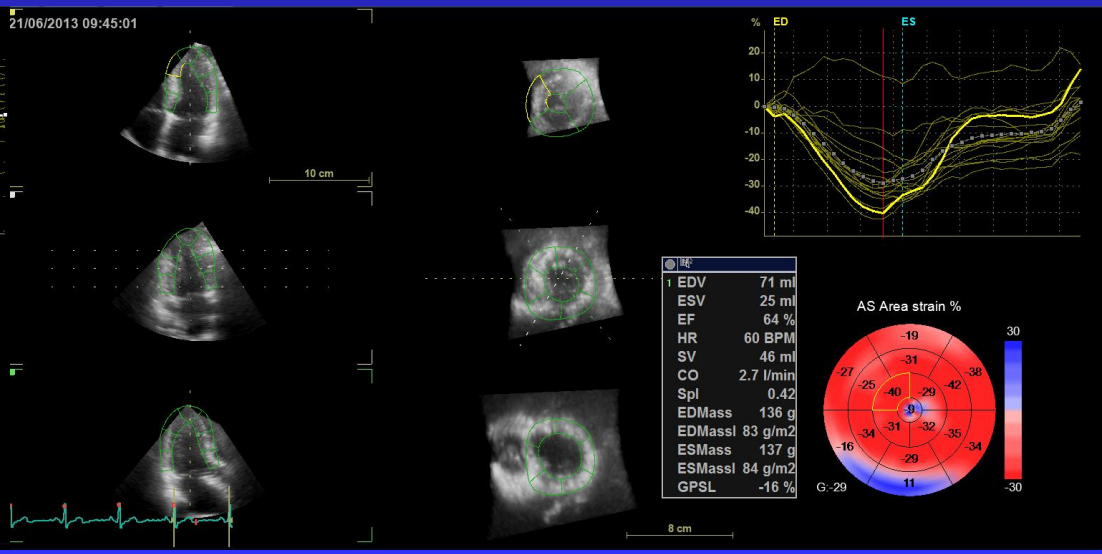
Baseline



LVEF: 45%

3D mass: 202g

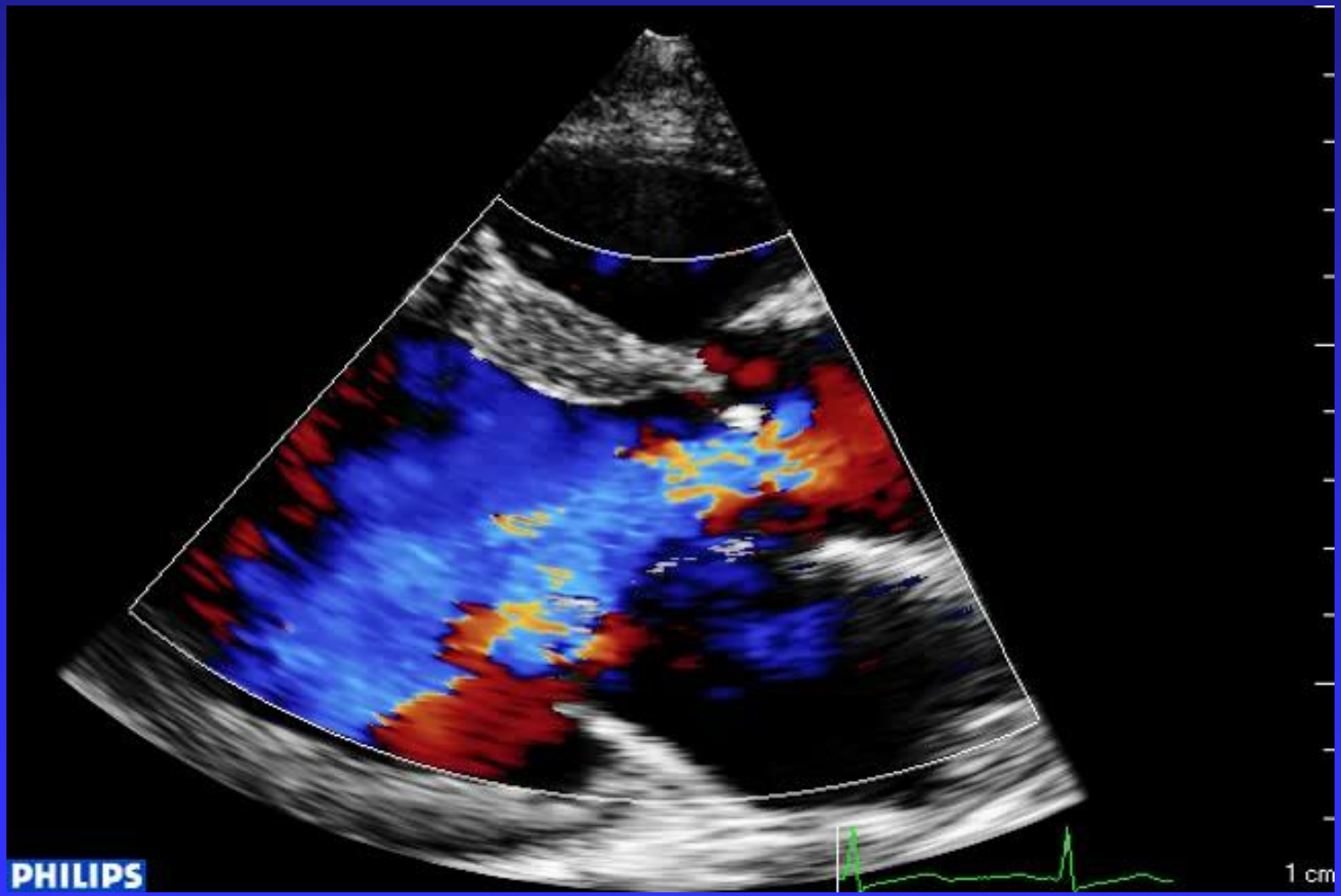
1-year Follow Up



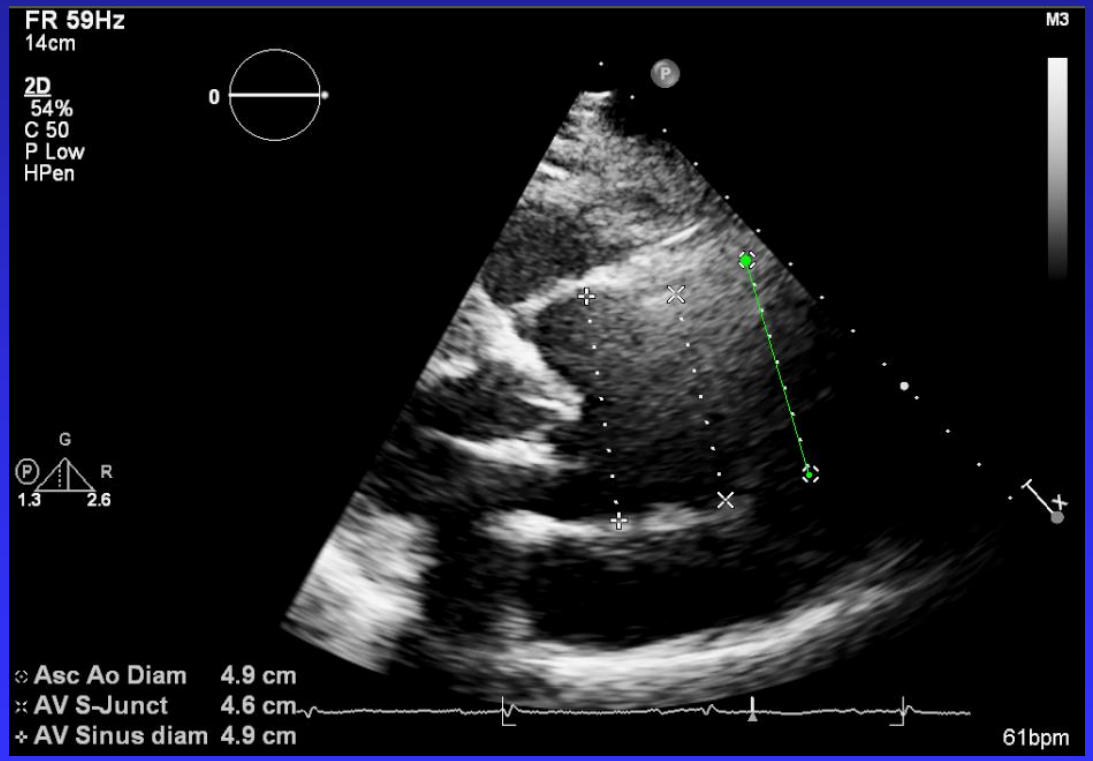
LVEF: 64%

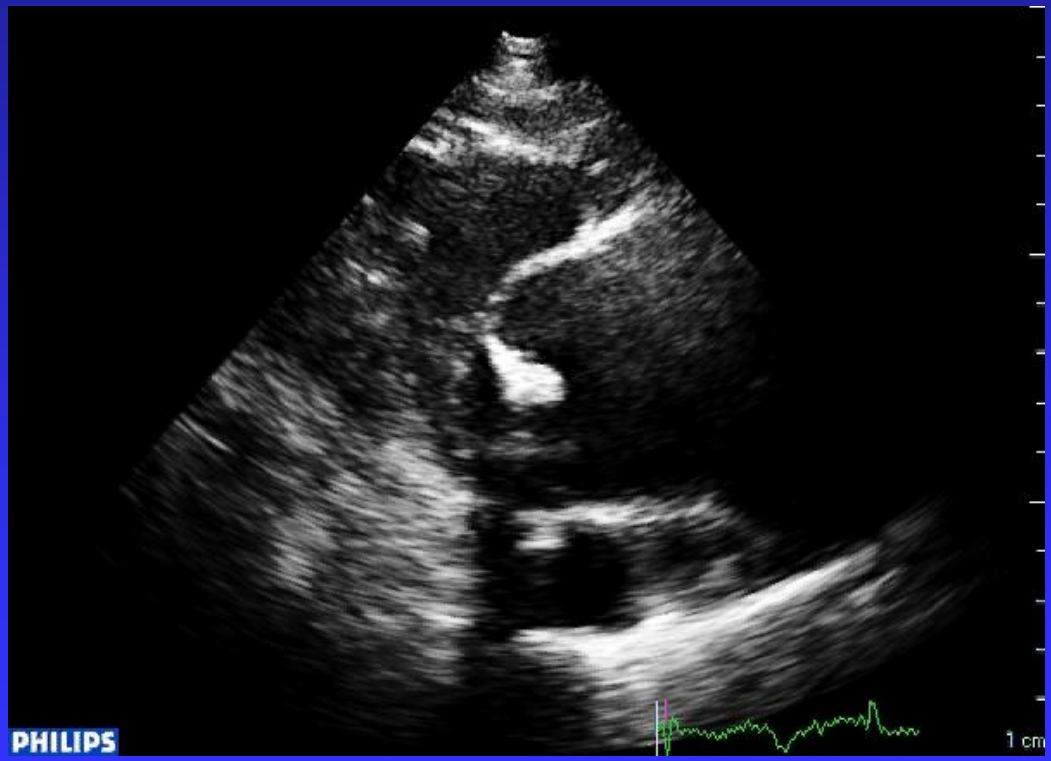
3D mass: 136g

Presence of Aortic Regurgitation before TAVI



Dilated Aortic Root before TAVI





Assessment of Valve Configuration

- Assessment of severity and location of calcification
- Bicuspid or tricuspid aortic valve with AS

Assessment of Severity and Location of Calcification

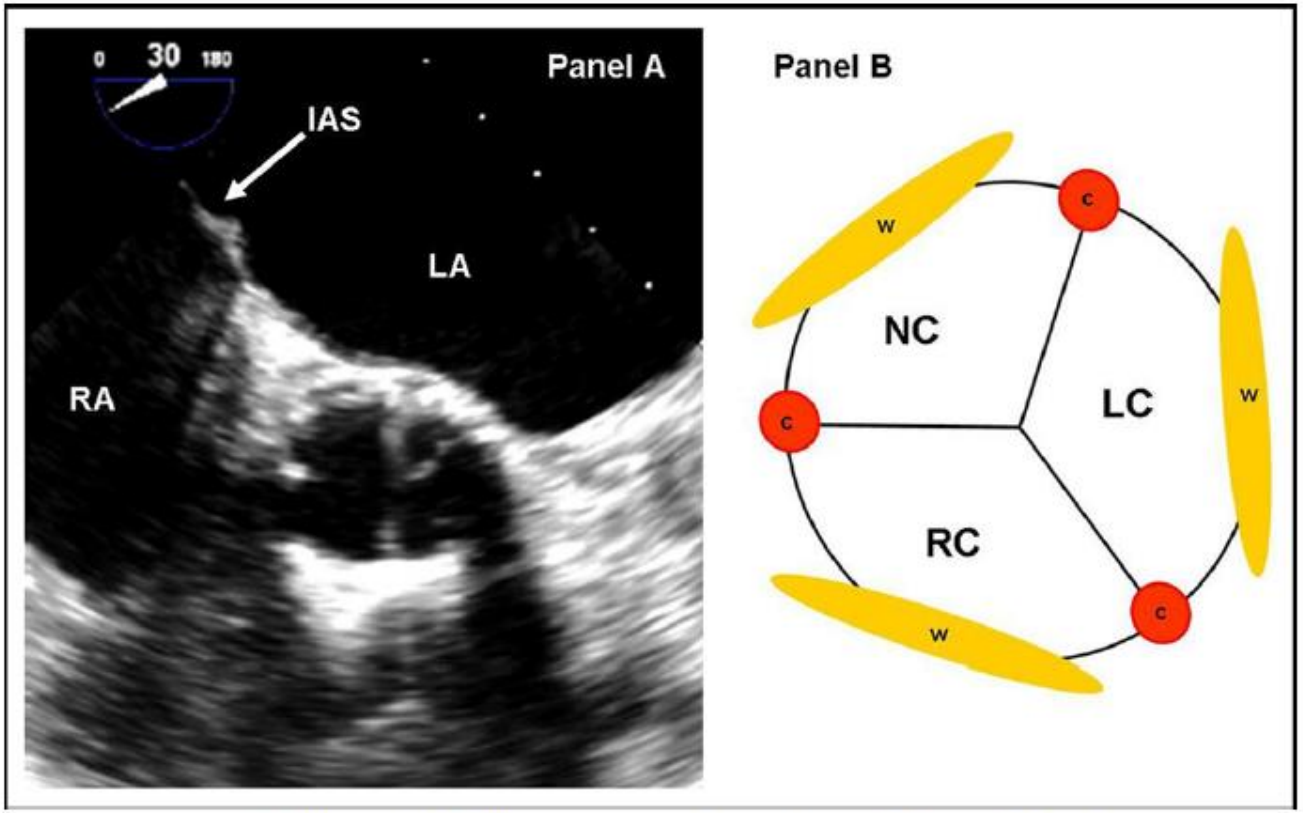
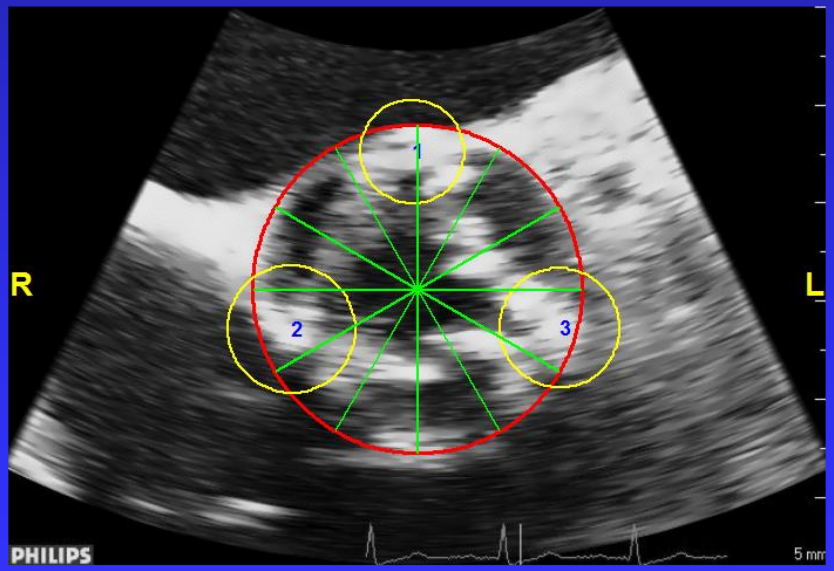


Figure 2. Identification of sites of AR after TAVI using TEE. Short-axis view, at level of proximal (ventricular) end of prosthesis, permits visualization of origin of paravalvular regurgitation. Interatrial septum helps to identify the noncoronary cusp *(A)*. *(B)* Six possible sites of paravalvular regurgitation. c = commissure site; IAS = interatrial septum; LA = left atrium; LC = left coronary cusp; NC = noncoronary cusp; RA = right atrium; RC = right coronary cusp; w = aortic wall site.

Ewe et al. *Am J Cardiol 2011;108:1470 –1477.*

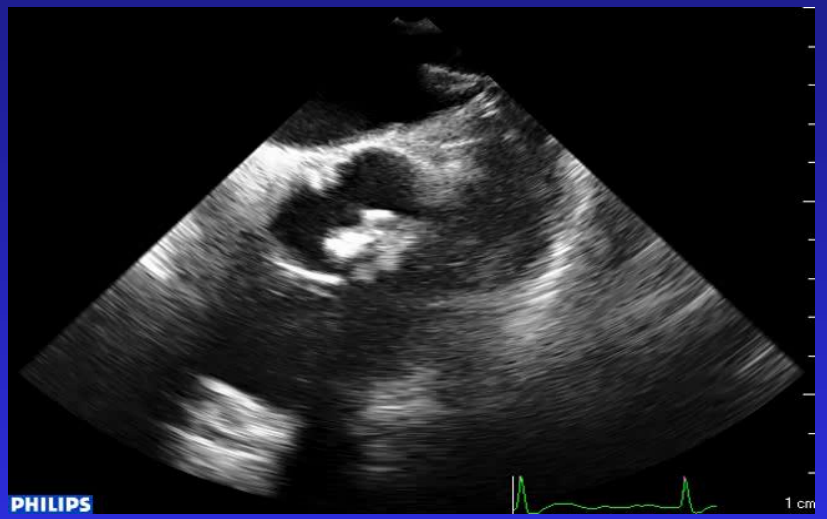
Assessment of Severity and Location of Calcification

- Traditionally by MSCT scan
- Now possible with the use of dedicated echo software



Bicuspid Aortic Valve with AS

- In general considered as contraindication
  - Risk of poor seating
  - Paravalvular regurgitation
- Main reason : severe distortion of the native valve leaflets



TAVI for Bicuspid Aortic Valve with AS

Table. Transcatheter Aortic Valve Implantation and Bicuspid Aortic Valves: Published Case Reports and Series To Date

Author	Year	n	Edwards SAPIEN or XT Valve	Medtronic CoreValve System	Balloon Predilation	Route	Postdeployment Prosthetic Shape	Postdeployment Imaging	Postdeployment Mean Gradient	Post-deployment AR	Follow-up
Delgado et al[9]	2009	1	26 mm	…	NR	TA	Circular	CT	10 mm Hg	NR	1 mo
Chiam et al[10]	2010	1	23 mm	…	Yes	TF	Circular	CT	20 mm Hg	Trivial	6 mo
Ferrari et al[11]	2010	1	26 mm	…	NR	TA	NR	Echo	6 mm Hg	Absent	In-hospital
Wijesinghe et al[12]	2010	11	26 mm (n=10) 23 mm (n=1)	…	Yes	TF=7 TA=4	Circular	Echo	See text	See text	See text
Jilaihawi et al[13]	2010	1	…	29 mm	Yes	TF	Elliptical	Echo	9.8 mm Hg*	Mild*	2-y
Raja et al[14]	2011	1	26 mm	…	Yes	TF	Circular	CT	NR	Mild	10 mo
Kochman et al[15]	2012	1	…	29 mm	NR	TF	Elliptical	CT	16 mm Hg	NR	NR
Baralis et al[16]	2012	1	29 mm XT	…	Yes	TA	Circular	CT	NR	Mild	1 mo
Himbert et al[17]	2012	15	…	29 mm (n=13) 26 mm (n=2)	Yes	TF=14 TS=1	Elliptical	CT (n=11)	See text	See text	See text
Zegdi et al[18]	2012	1	23 mm XT	…	NR	TF	Elliptical	CT	6 mm Hg	Absent	1 mo
Maluenda et al[19]	2013	1	29 mm XT	…	Yes	TF	Circular	CT	NR	Absent	1 mo
Hayashida et al[23]	2013	21	n=11 23 mm (n=5) 26 mm (n=2) 29 mm (n=4)	n=10 29 mm (n=5) 31 mm (n=5)	NR	TF=13 TA=3 TAo=5	Elliptical†	CT†	See text	See text	See text

CT indicates computed tomography; NR, not reported; TA, transapical; TAo, transaortic; TF, transfemoral; and TS, transubclavian.
*Two-year values.
†Postprocedural CT not systematically performed on all patients (number not specified).

O'Sullivan and Windecker et al. *Circ Cardiovasc Interv. 2013;6:204-206*

Bicuspid Aortic Valve with AS

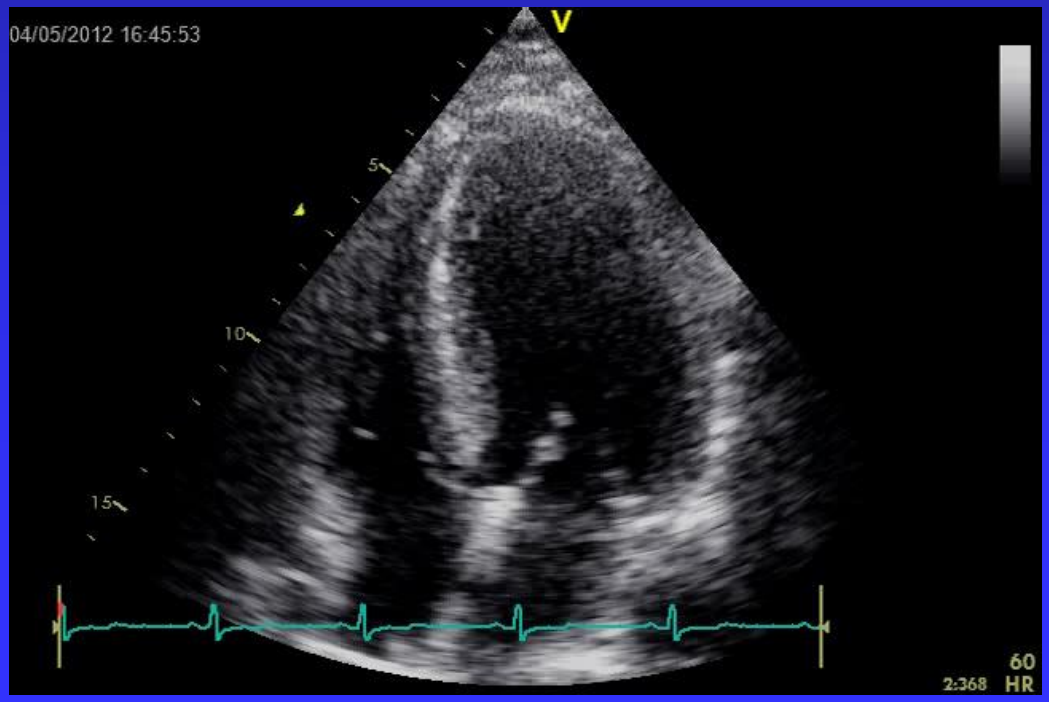
- Potential success: calcified bicuspid AV and predominant aortic stenosis
- Identification if high risk patients :
  - Bulky leaflets
  - Enlarged aortic root
  - Dilated ascending aorta
  - Significant aortic regurgitation

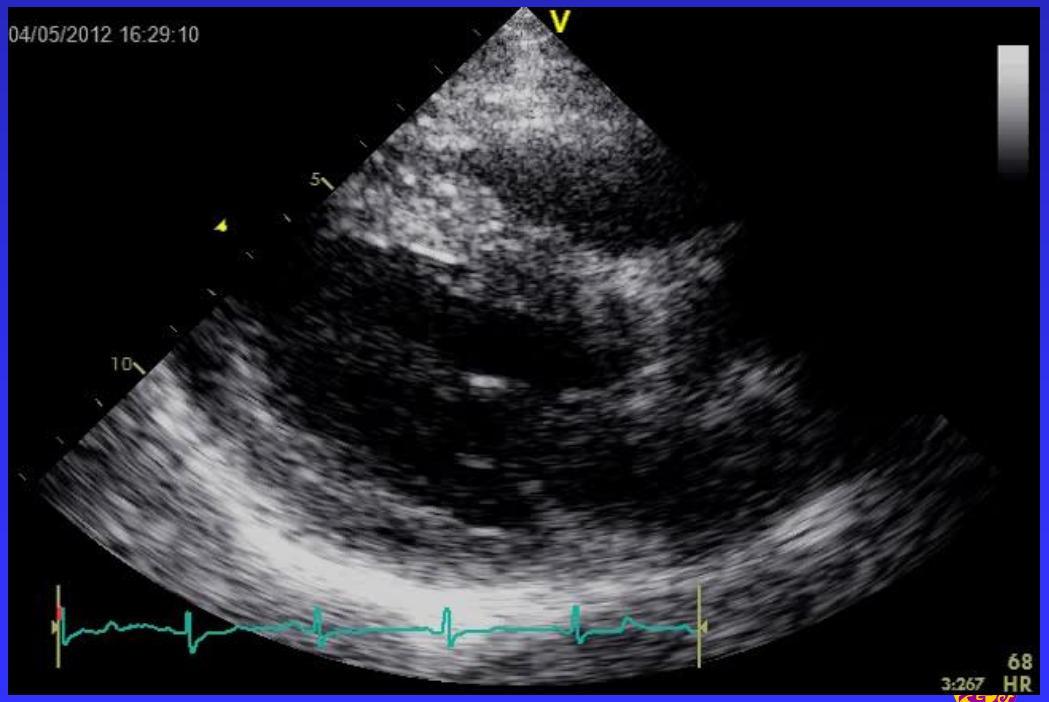
Other Relevant Echo Findings

- Degree of LVH
- LVEF
- LV volume
- Diastolic function and filling pressure
- Mitral valve disease

Degree of LVH

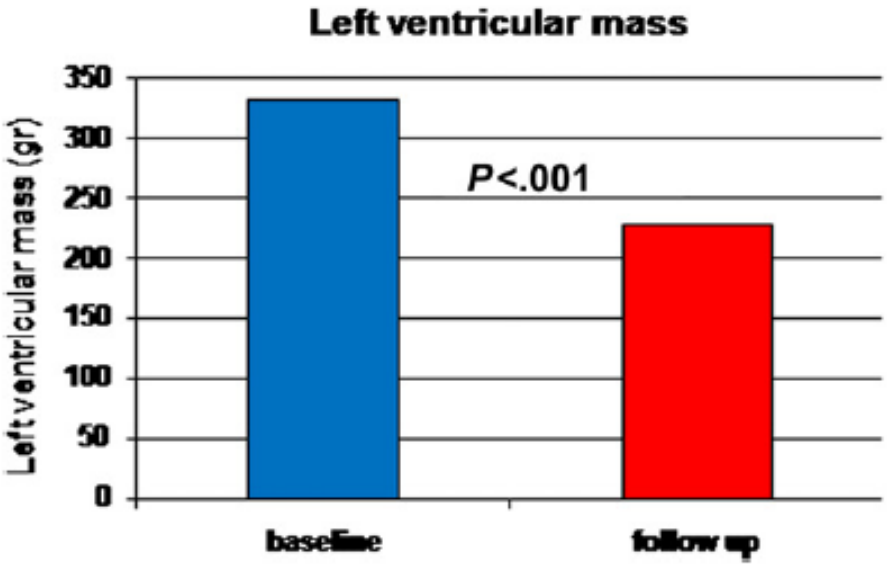
- Pressure overload of AS causes LVH
- Associated with LV systolic & diastolic dysfunction
- Considered as the risk factor for cardiac morbidity and mortality





Degree of LVH

- N=135
- Echo done at baseline and 6m



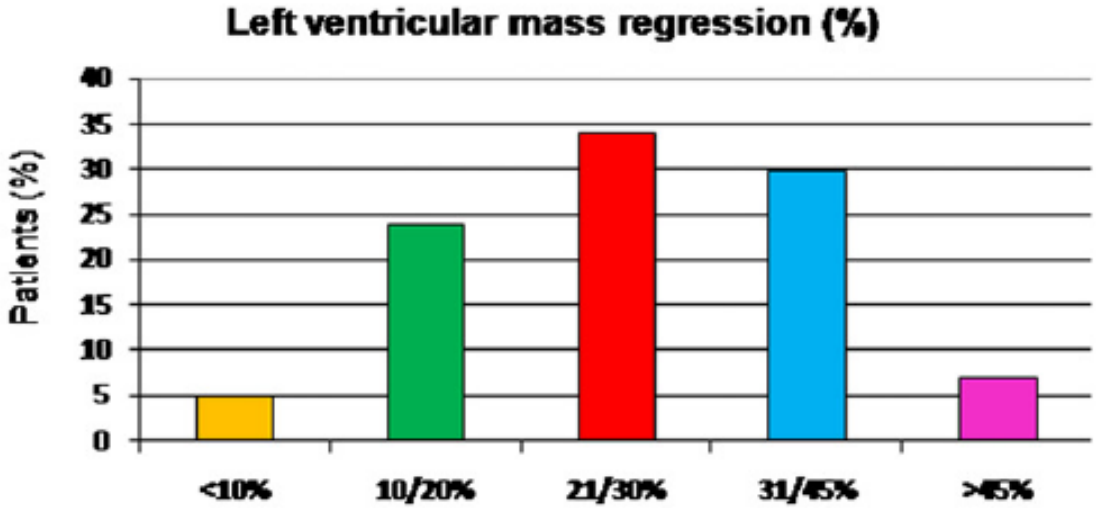
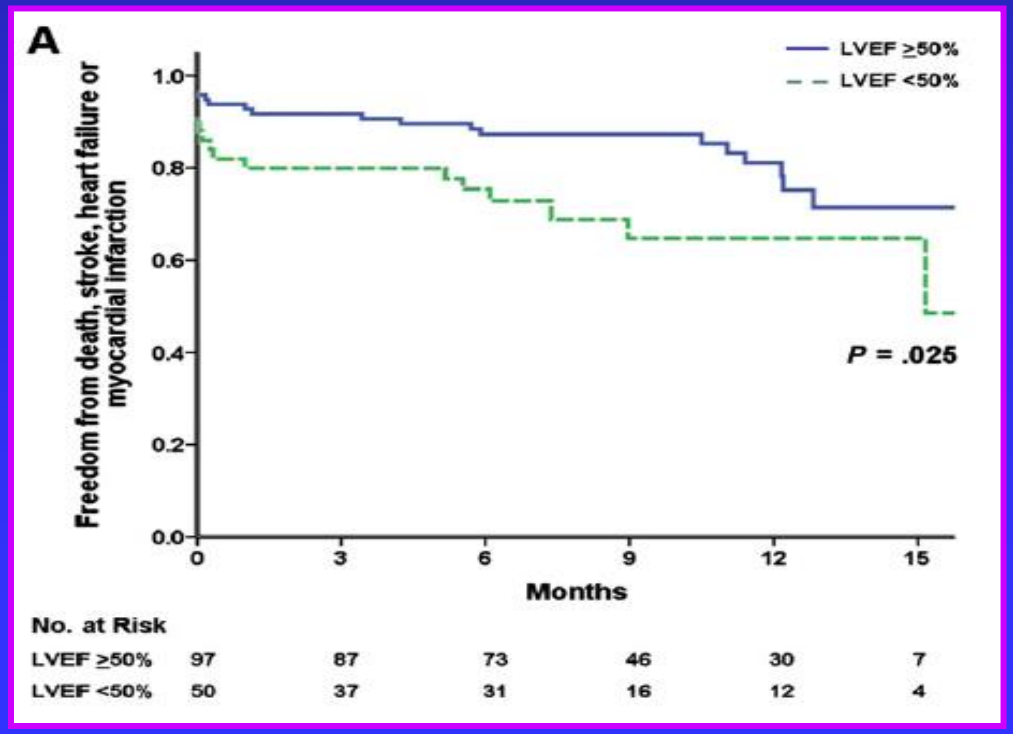


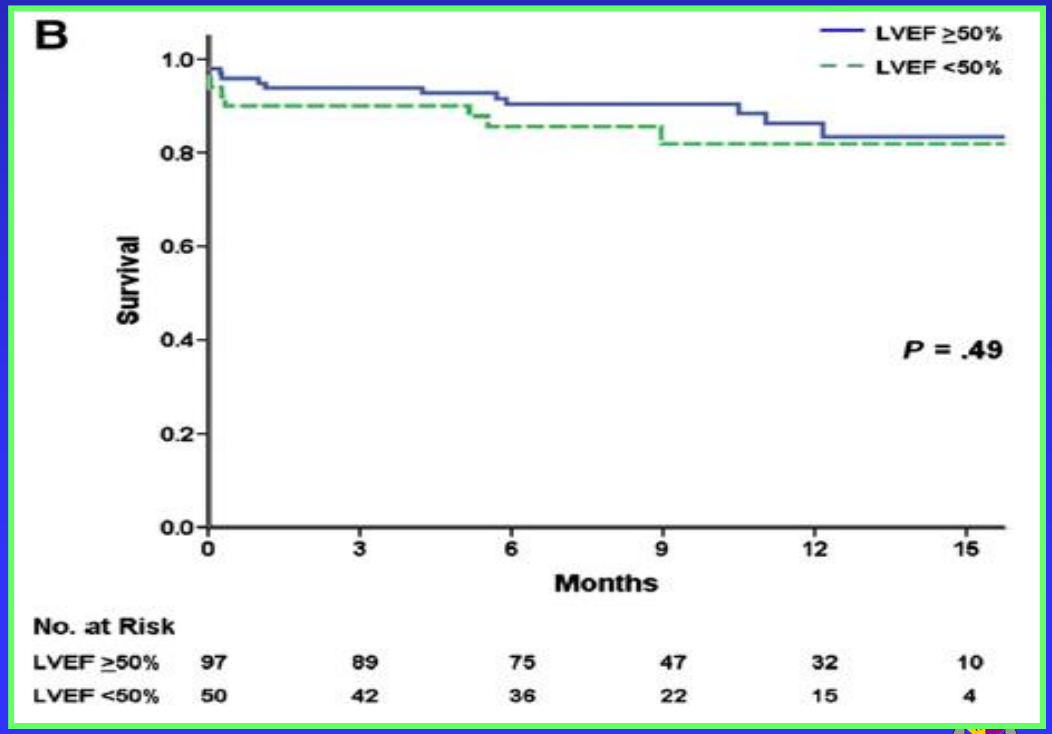
Figure 3 Changes in LVM and percentage of LVM regression after TAVI.

Vizzardi et al . *J Am Soc Echocardiogr 2012;25:1091-8*

Impact of LVEF on Outcome after TAVI

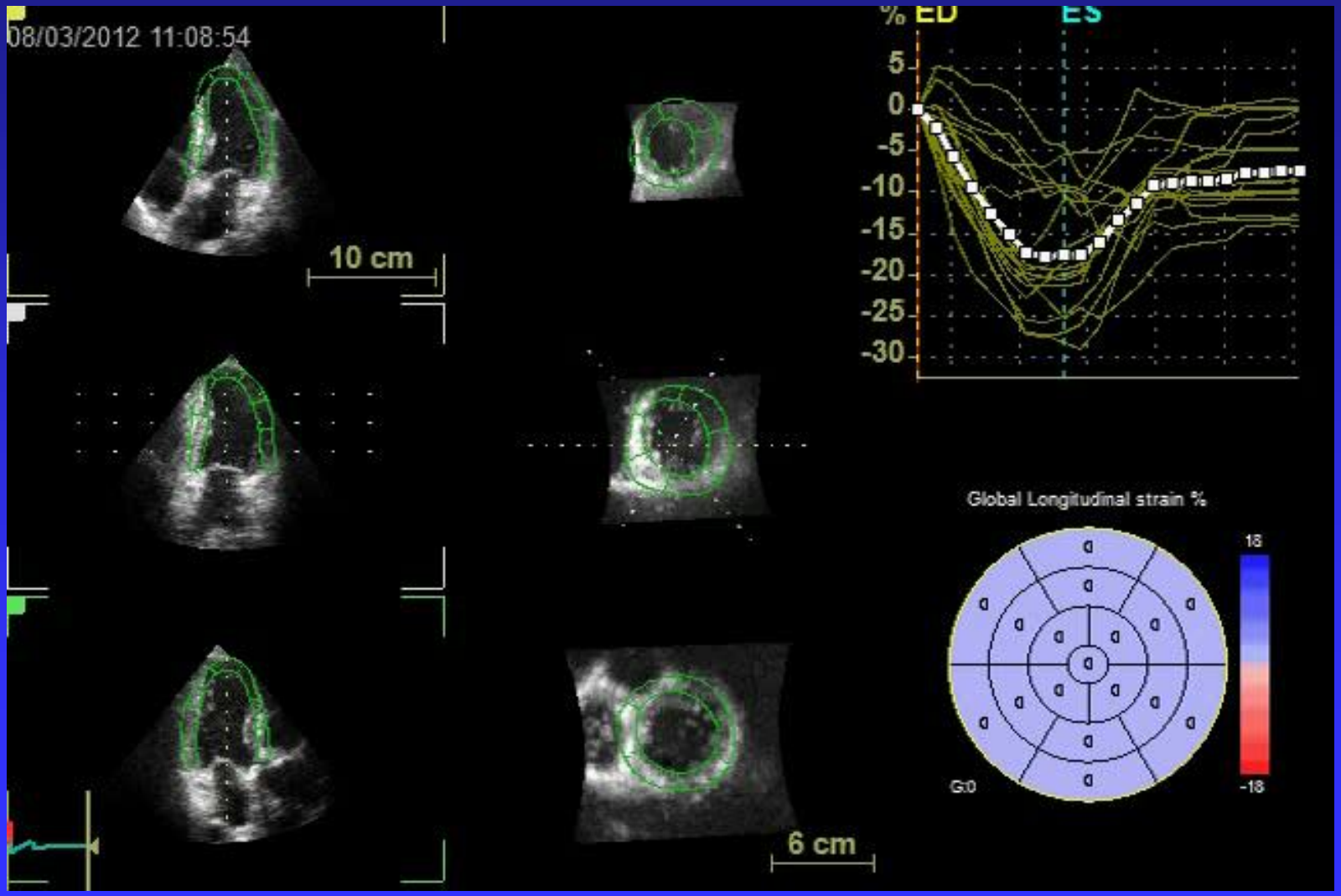
- N=147
- FU: 15 months
- MACE: higher in those with reduced LVEF





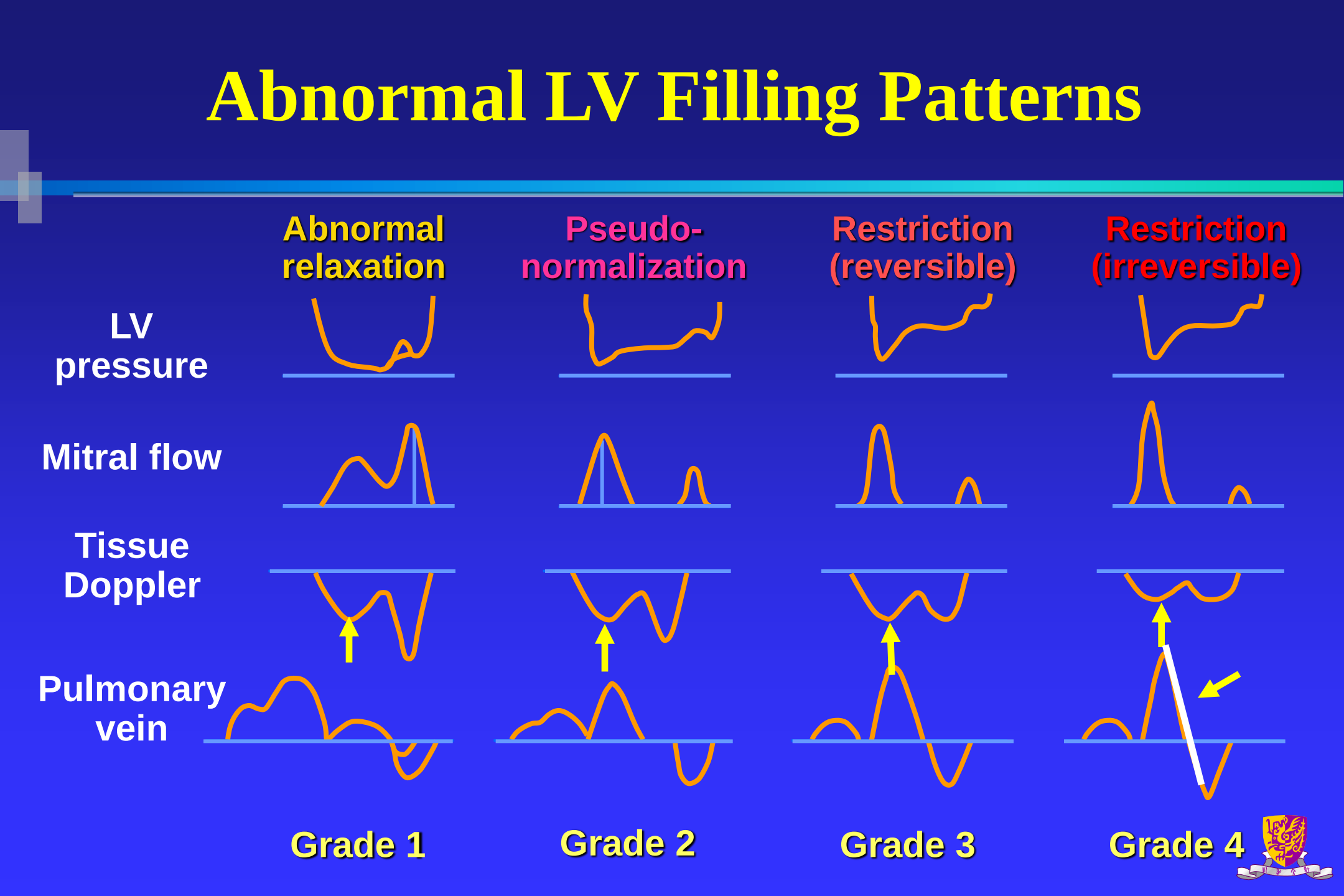
Ewe et al. *Am Heart J 2010;160:1113-20*

LV Volume and LVEF

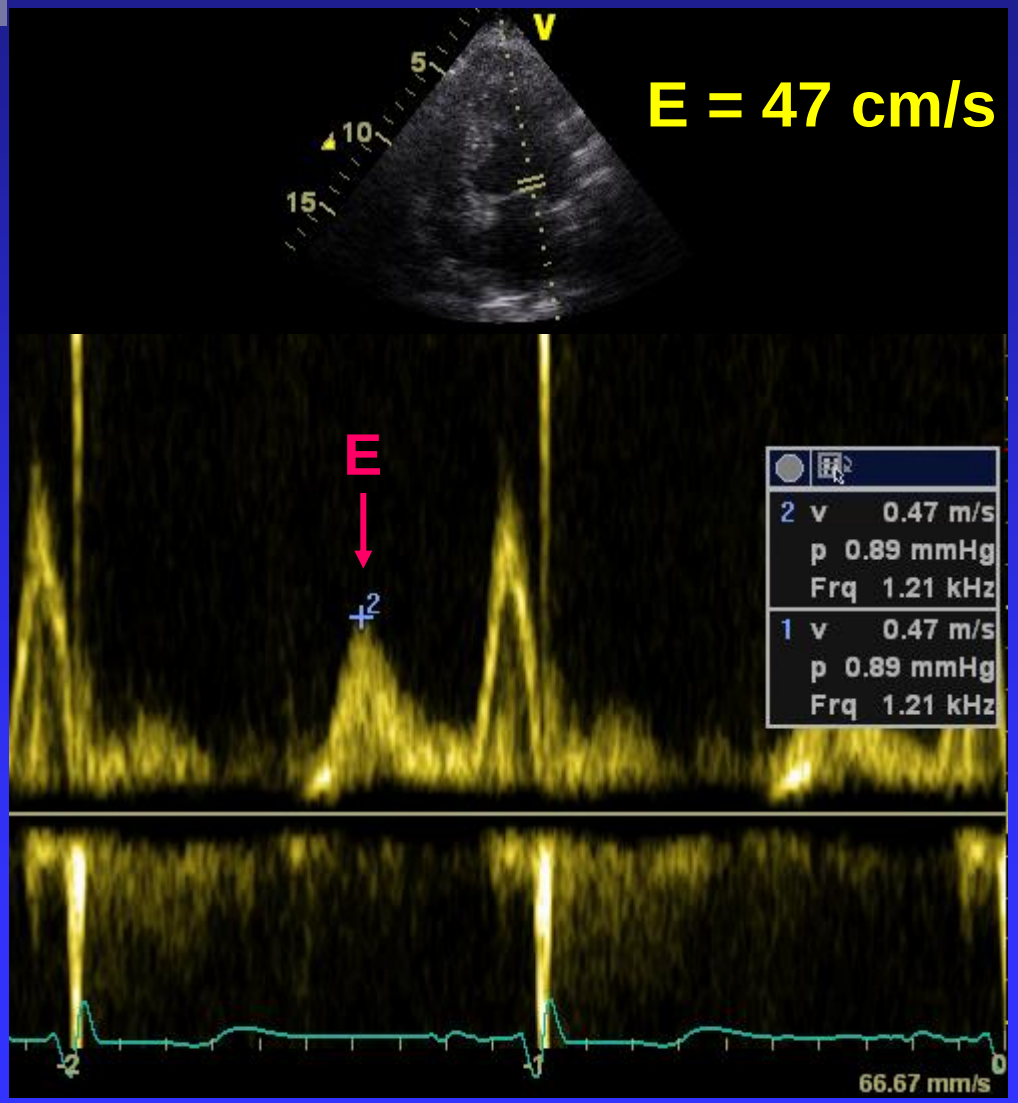


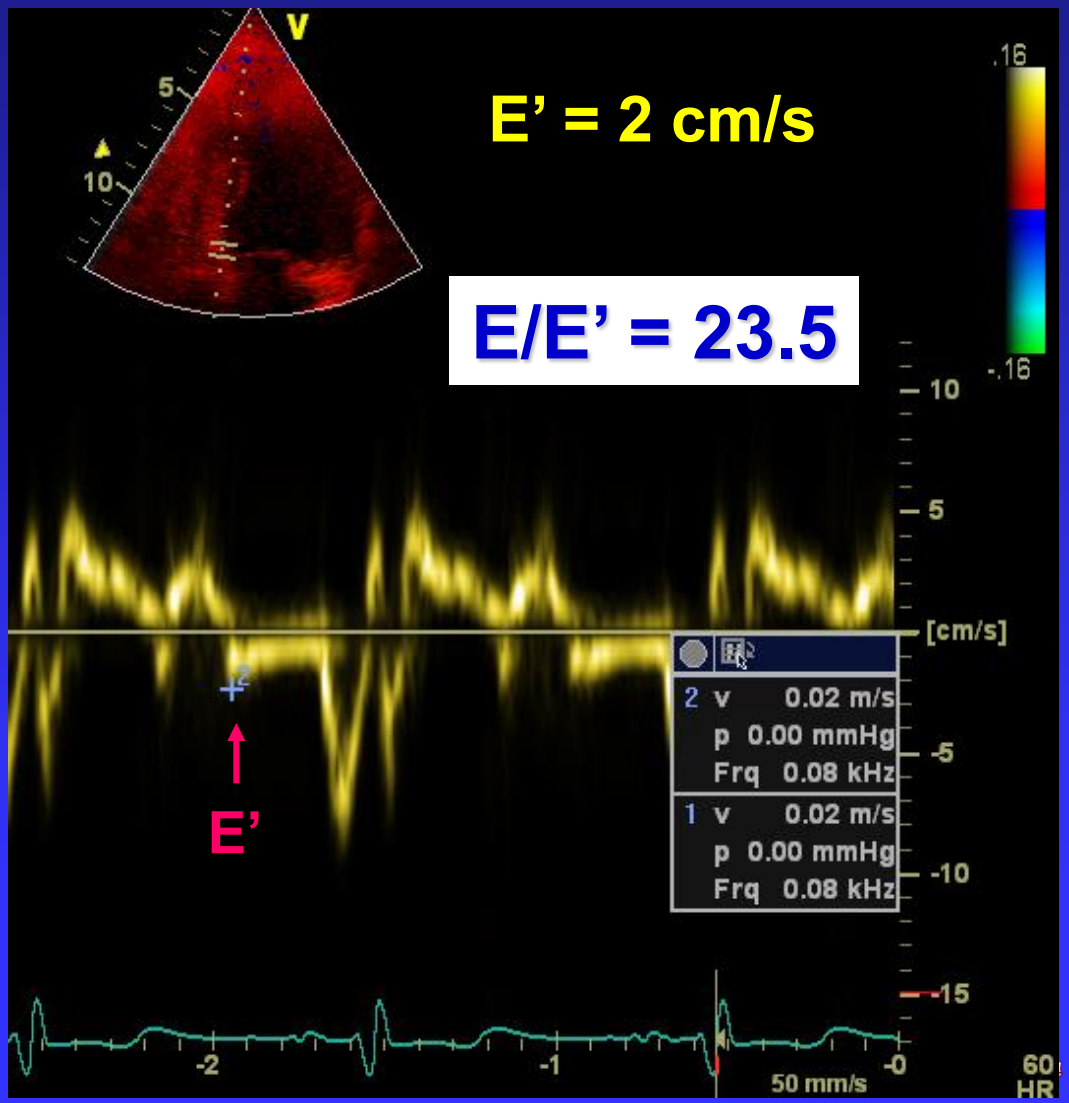
1	EDV	110 ml
	ESV	44 ml
	EF	60 %
	HR	48 BPM
	SV	66 ml
	CO	3.2 l/min
	SpI	0.32
	EDMass	172 g
	ESMass	172 g
	GPSL	-18 %

Abnormal LV Filling Patterns



E/E' : Marker of LV Filling Pressure





LV Diastolic Function after TAVI

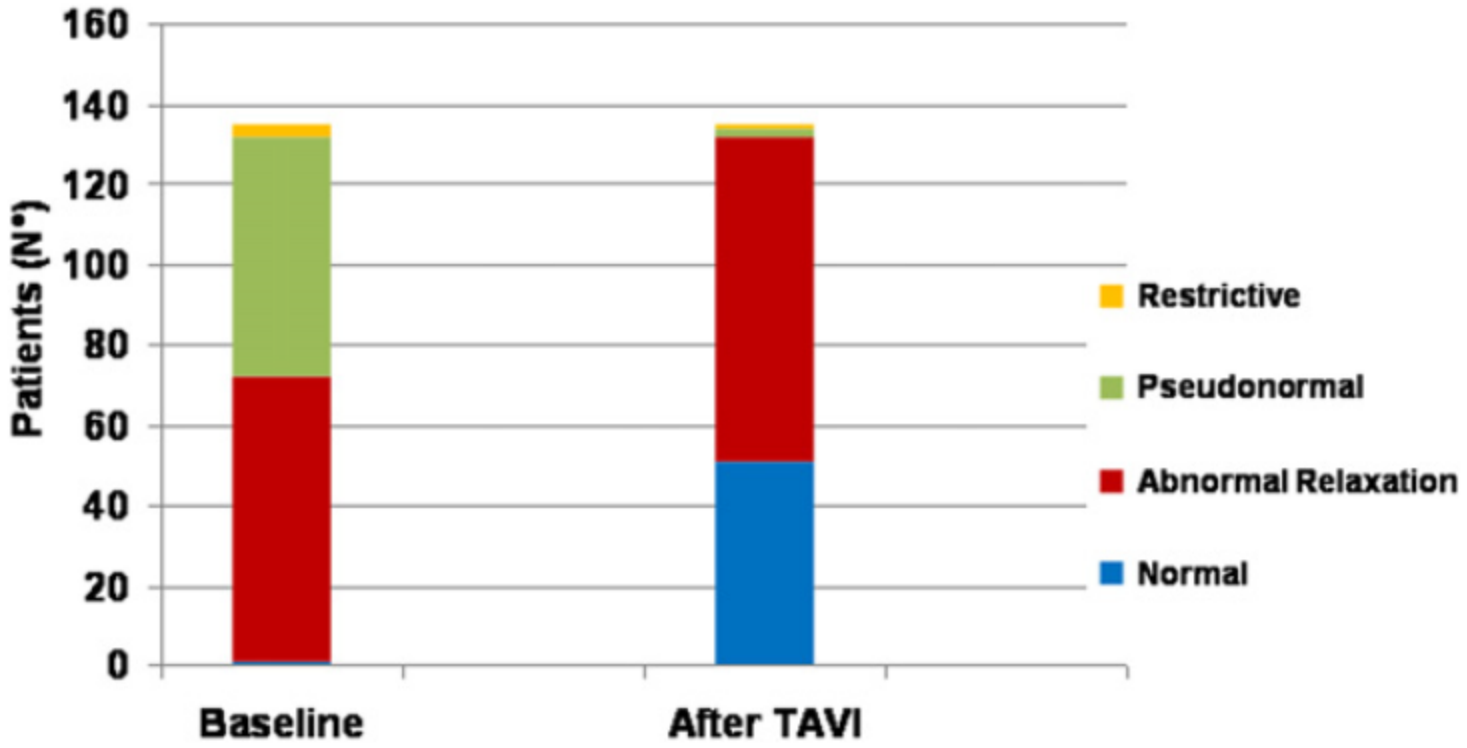


Figure 4 Diastolic dysfunction classification at baseline and after TAVI.

Vizzardi et al . *J Am Soc Echocardiogr 2012;25:1091-8*

LV Diastolic Function after TAVI

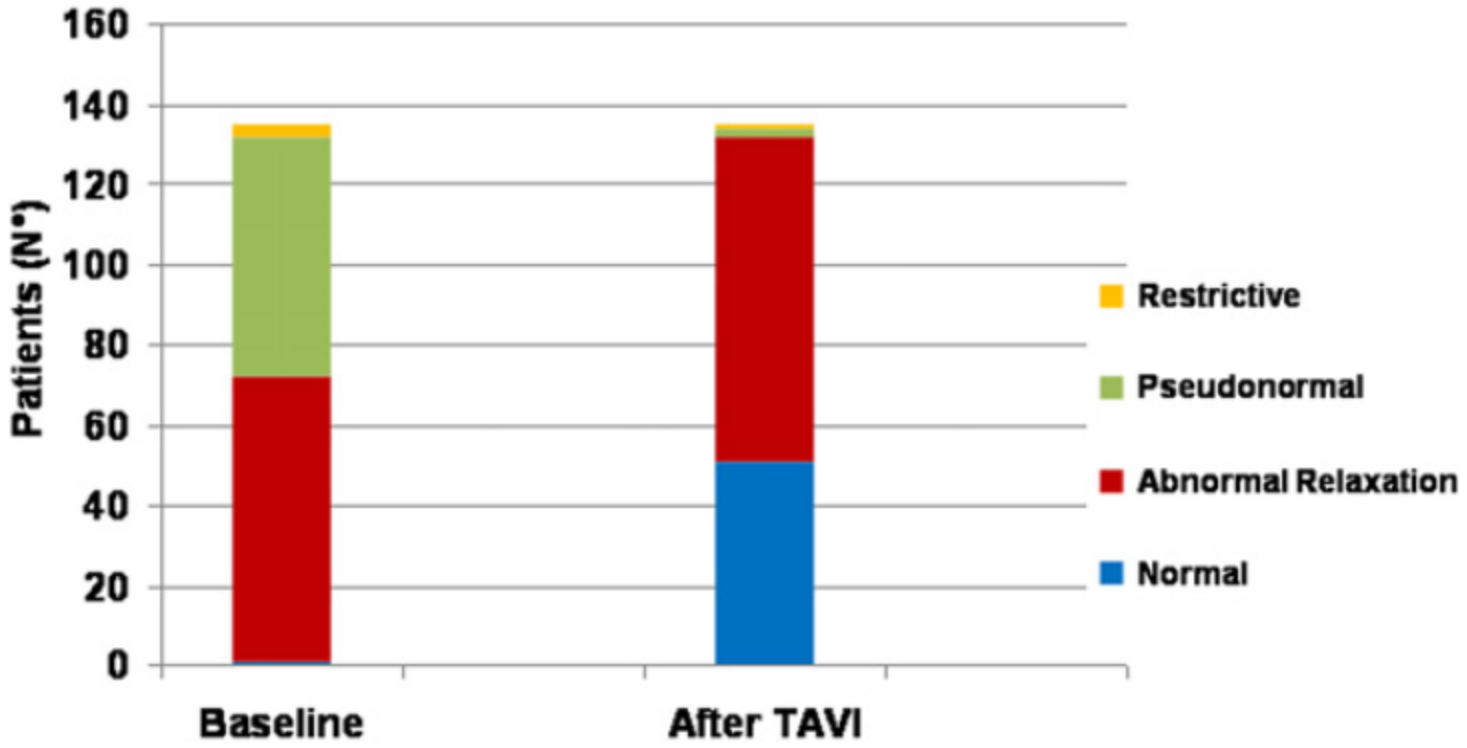
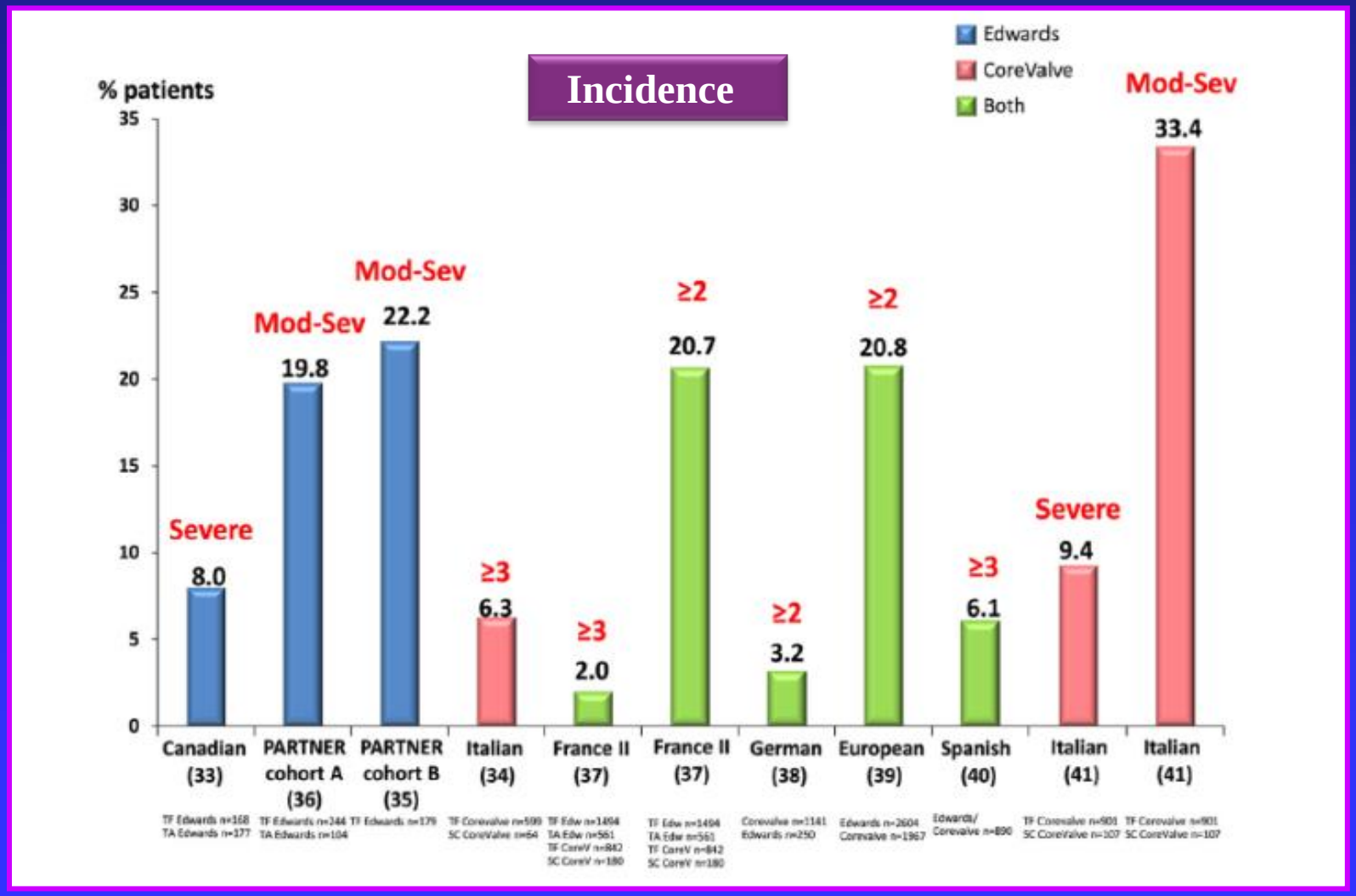


Figure 4 Diastolic dysfunction classification at baseline and after TAVI.

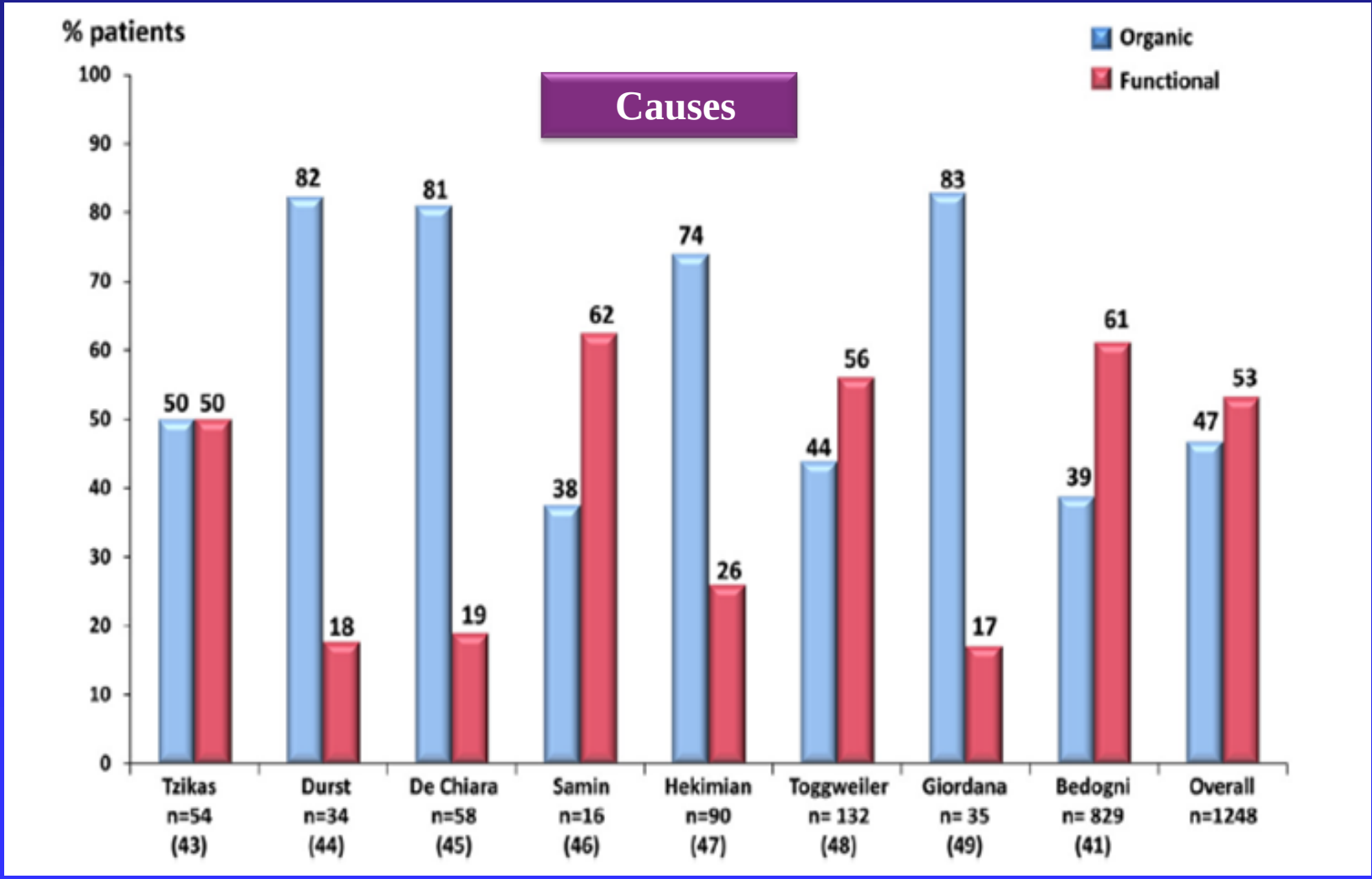
Vizzardi et al . *J Am Soc Echocardiogr 2012;25:1091-8*

Incidence of Mitral Regurgitation before TAVI



Nombela-Franco et al. *J Am Coll Cardiol 2014;63:2643–58*

Causes of Mitral Regurgitation before TAVI



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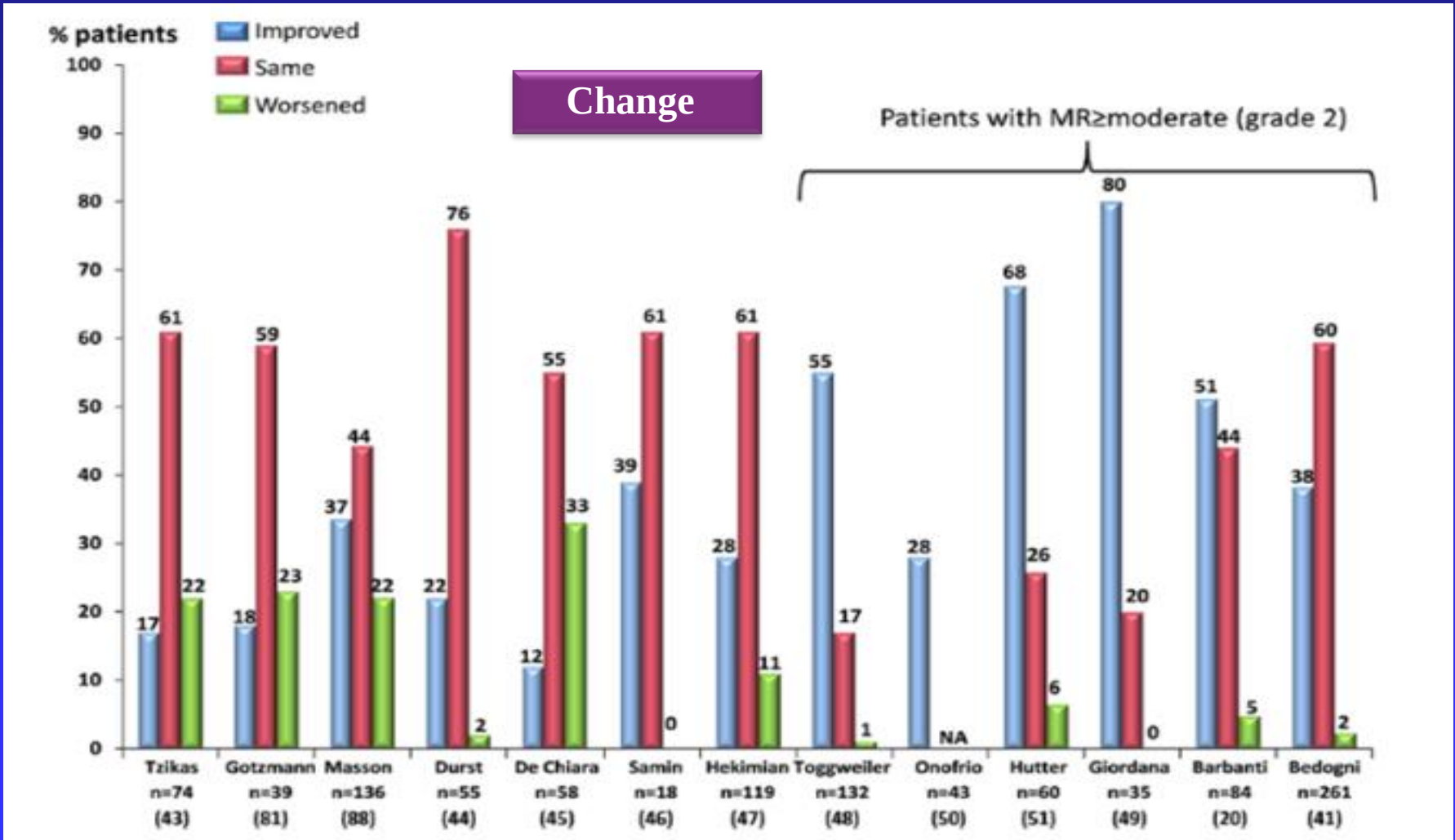
Changes in Mitral Regurgitation after TAVI

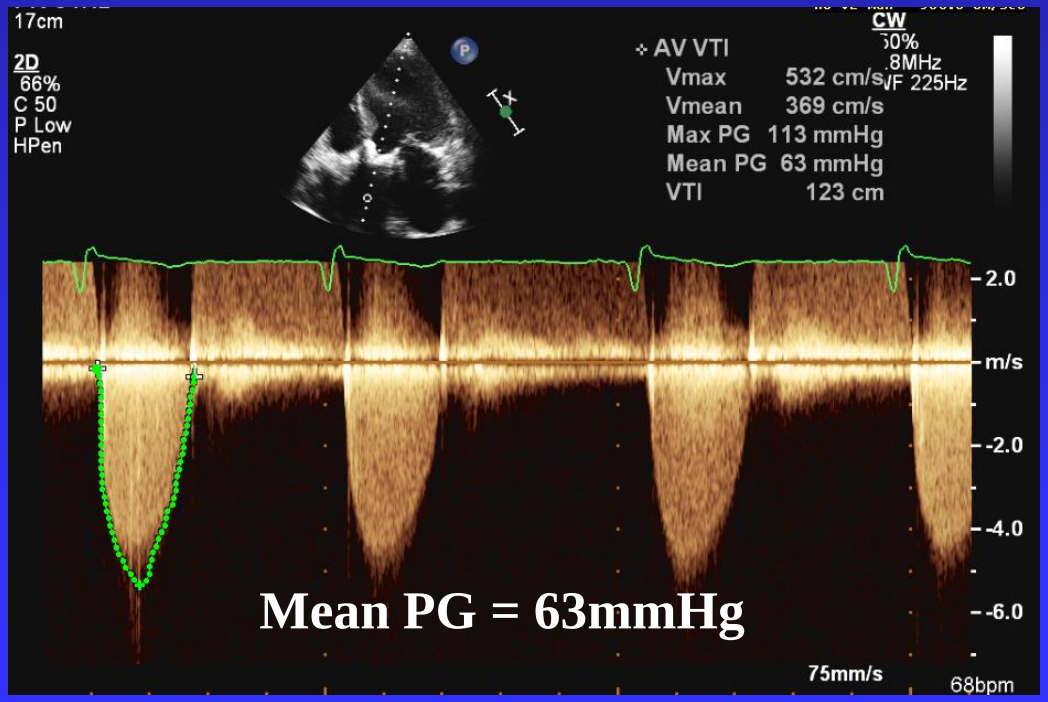


Nombela-Franco et al. *J Am Coll Cardiol 2014;63:2643–58*

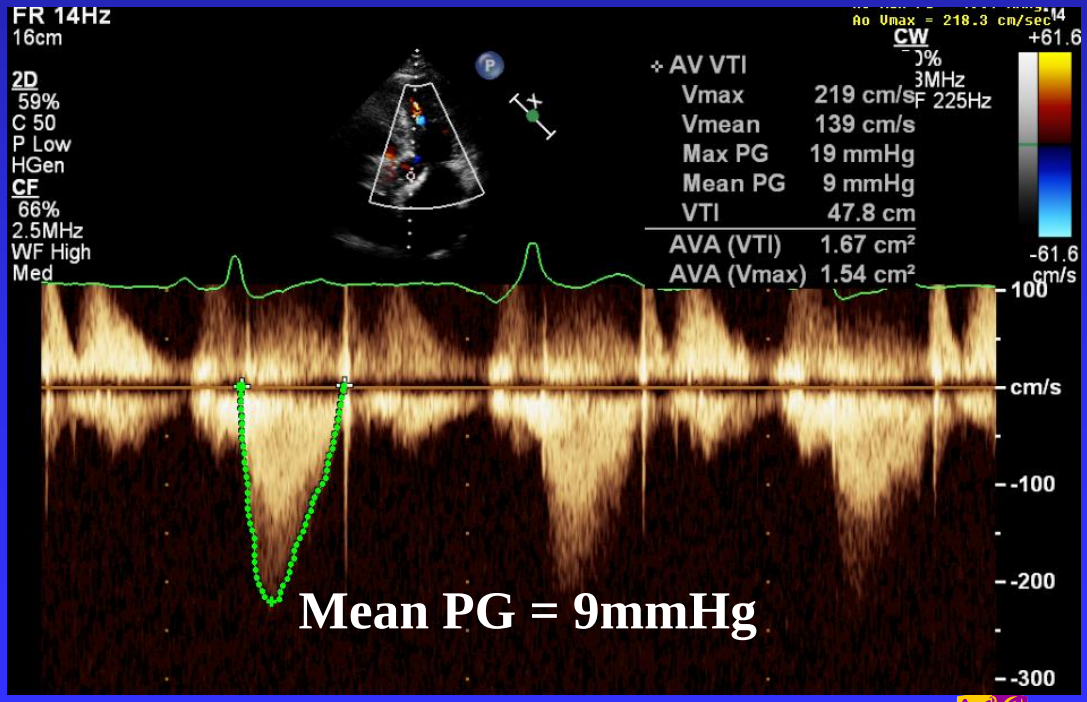
Doppler Echo Assessment Post TAVI

Transvalvular gradient

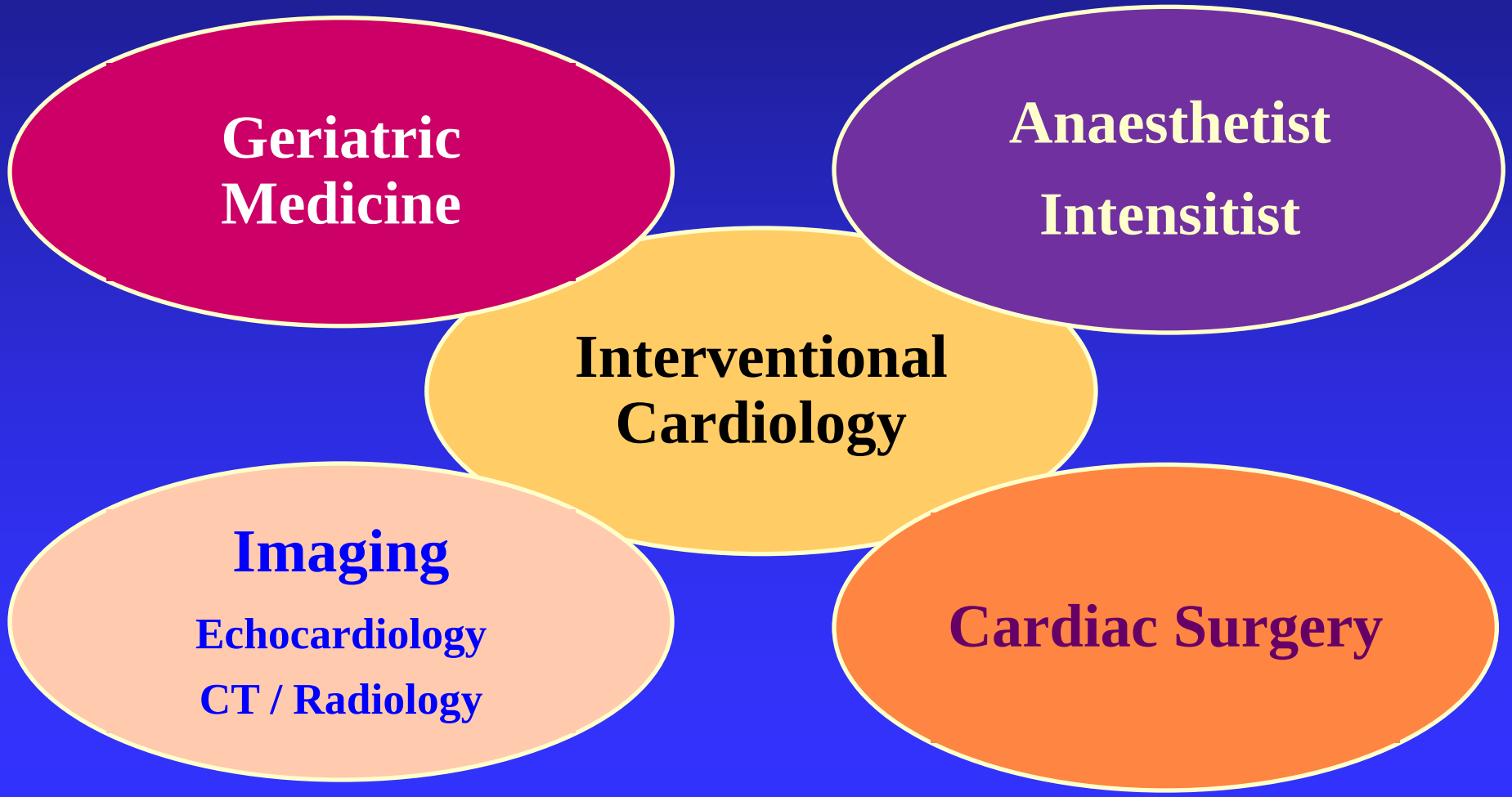
Baseline



1-Year Follow Up



Team Work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Imaging
Echocardiology
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