



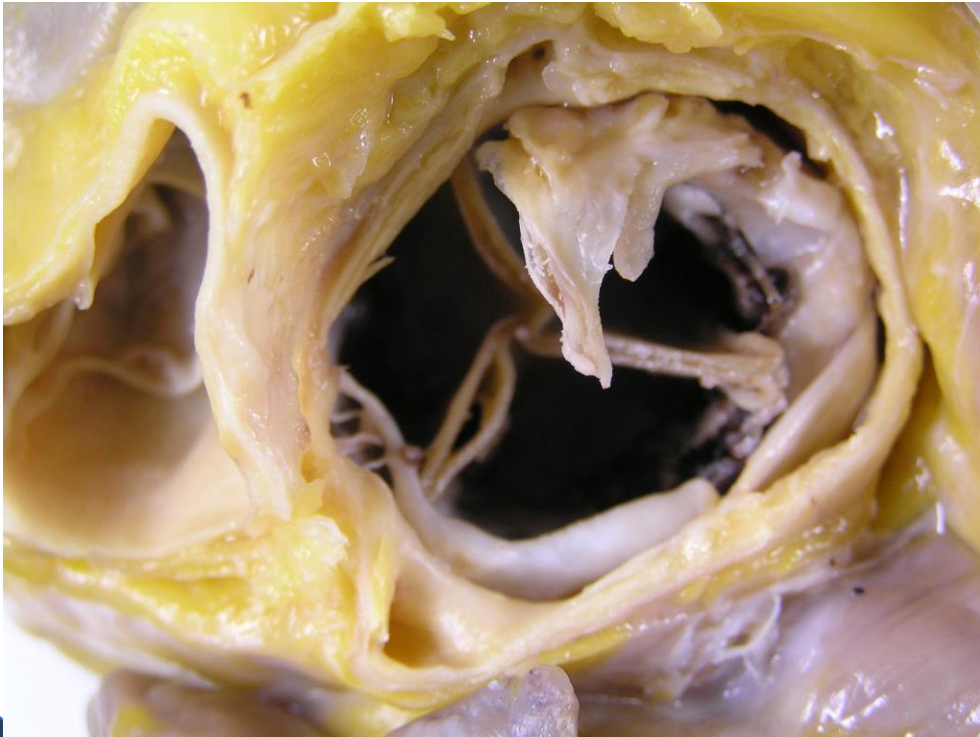
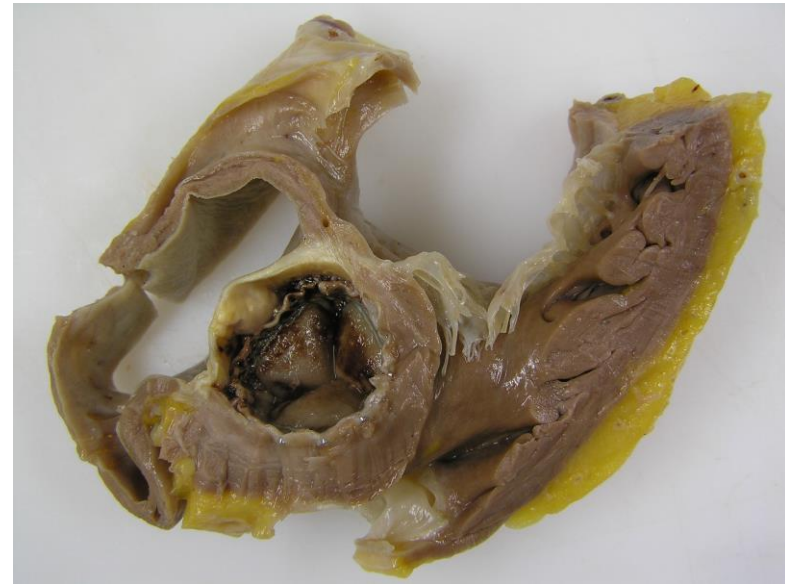
# Factors affecting the outcome of TAVR



**Prof. J Zamorano**







## 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%)**

# Long-Term Outcomes After Transcatheter Aortic Valve Implantation in High-Risk Patients With Severe Aortic Stenosis

The U.K. TAVI (United Kingdom Transcatheter Aortic Valve Implantation) Registry

## Predictors of Mortality at 1 Year

Mortality

870 patients

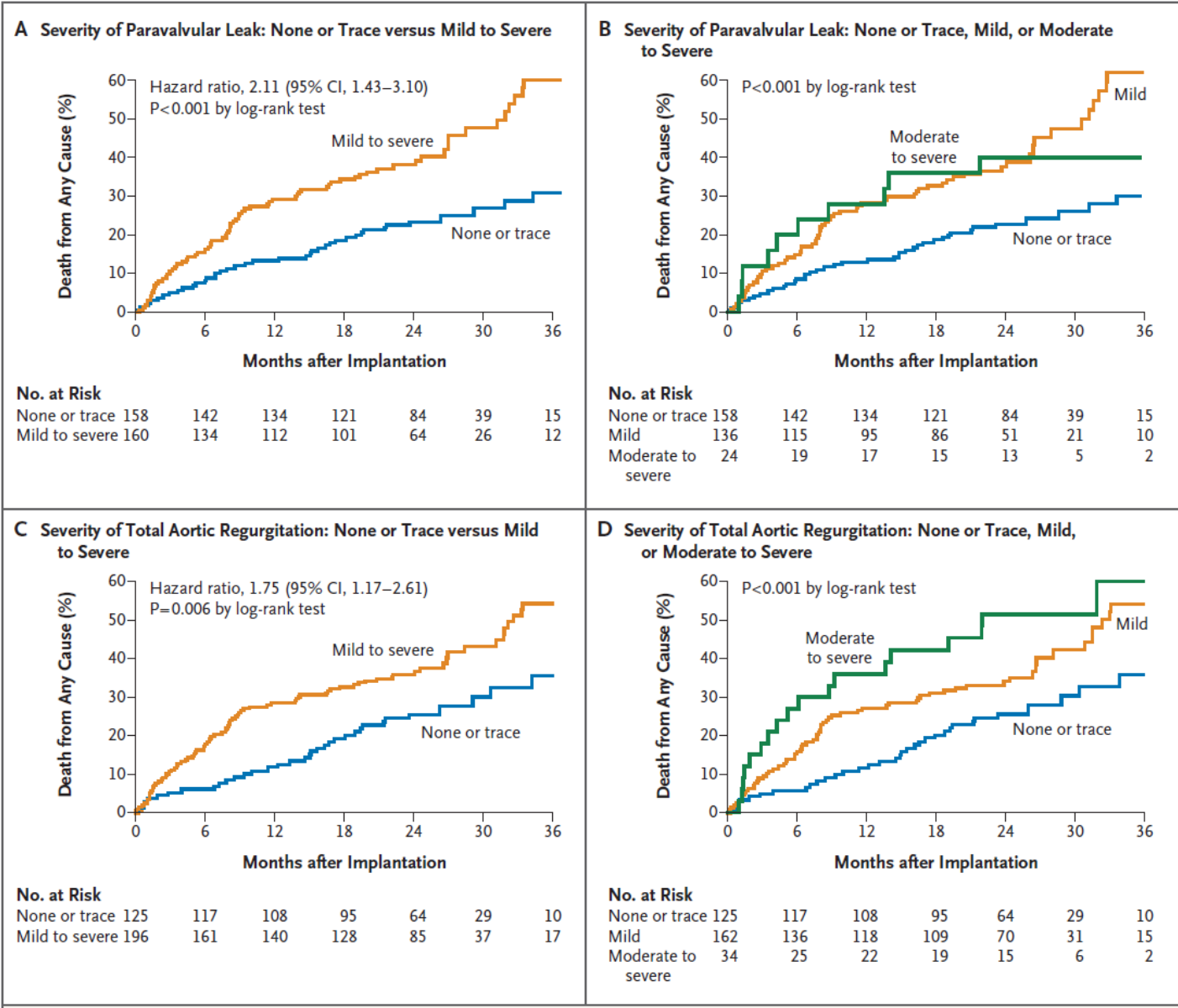
Variables	Multivariate Model	p Value
Edwards SAPIEN		
Medtronic CoreValve		
Route, other		
Route, transfemoral	0.73 (0.52–1.04)	0.08
AR moderate/severe	1.66 (1.10–2.51)	0.016
Major vascular complication		
Permanent pacemaker		
Male		
Age, yrs		
AV gradient		
LVEF ≥50%	1.00	
LVEF 30%–49%	1.49 (1.03–2.16)	0.03
LVEF <30%	1.65 (0.98–2.79)	0.06
NYHA functional class I/II		
NYHA functional class III/IV		
Coronary disease	1.23 (0.88–1.73)	0.23
Any previous cardiac surgery		
PVD		
Diabetes mellitus		
COPD	1.41 (1.00–1.98)	0.05
Creatinine >200 mmol/l	1.55 (0.90–2.68)	0.11

AR 1.66 (1.10–2.51)

Similar results at one year follow-up from the French registry Italian registry

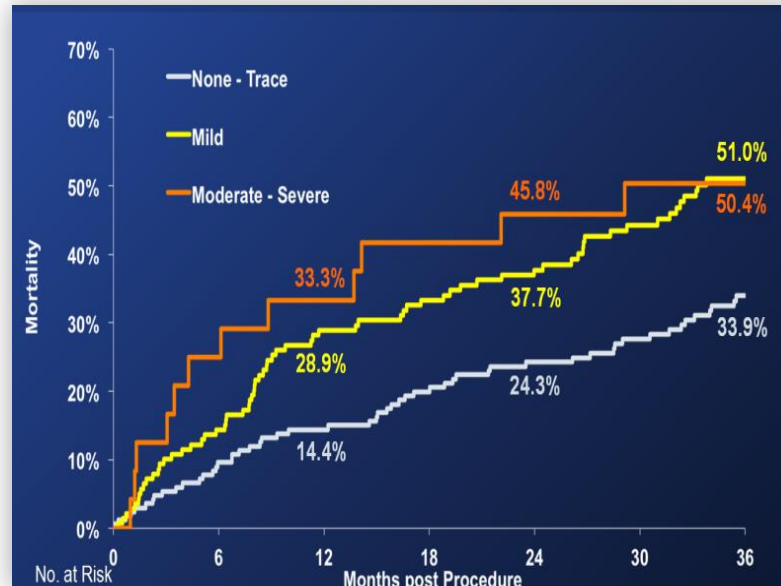
Tamburino, C. *et al* *Circulation* 2011  
Elchaninoff, H. *Eur. Heart J.* 2011

# Two-Year Outcomes after Transcatheter or Surgical Aortic-Valve Replacement



# CLINICAL IMPACT

Moderate or severe PAR. Hazard ratio for 1-year mortality



Vinod H. Thourani, MD. On behalf of The PARTNER Trial Investigators

# Paravalvular regurgitation: Is it relevant / frequent



- Paravalvular AR is common after TAVI
- Moderate or severe paravalvular AR is more common after TAVR than after surgical replacement

**Any AR**



**Moderate to severe AR**

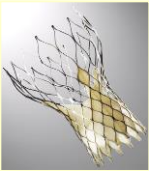


Kodali et al. N Engl J Med. 2012; Leon et al. N Engl J Med 2010 ; Gilard M et al. N Engl J Med. 2012  
Zahn R et al. Heart J 2011; Webb JG, et al. Circulation 2009; Abdel-Wahab M, et al. Heart 2011

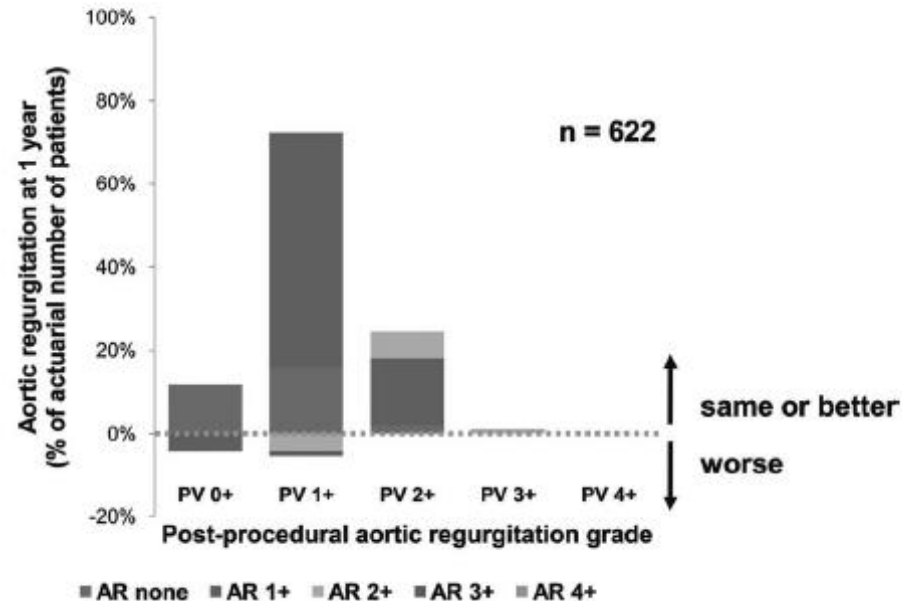
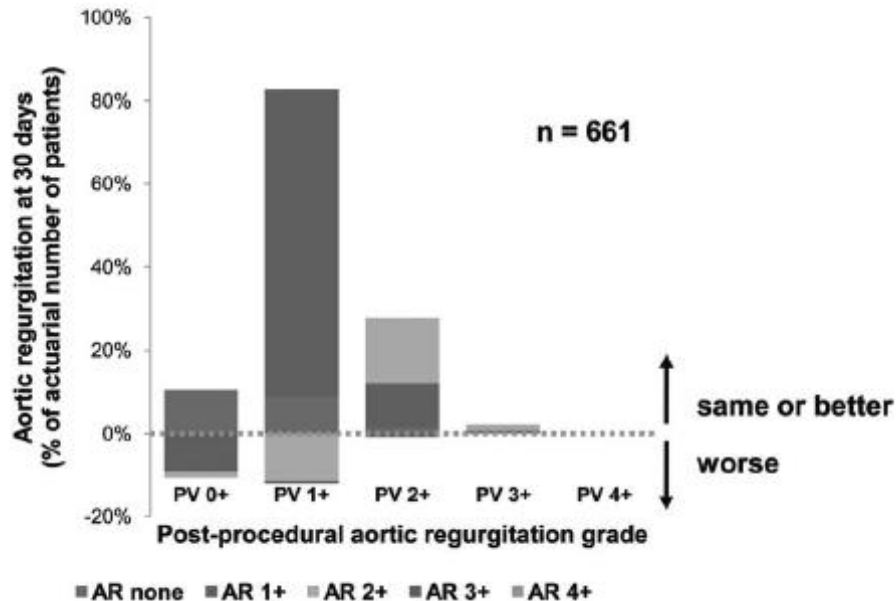


# Paravalvular regurgitation: Is it relevant / frequent

## AR Evolution at 1 years follow-up



Paravalvular leak in relation to post-procedure paravalvular leak



in the majority of the series, post-procedural aortic regurgitation **remains unchanged or tends to reduce**



# Paravalvular regurgitation: Is it relevant / frequent

The NEW ENGLAND  
JOURNAL of MEDICINE

Partner trial



AR Evolution at 2 years follow-up

46.2%

Unchanged

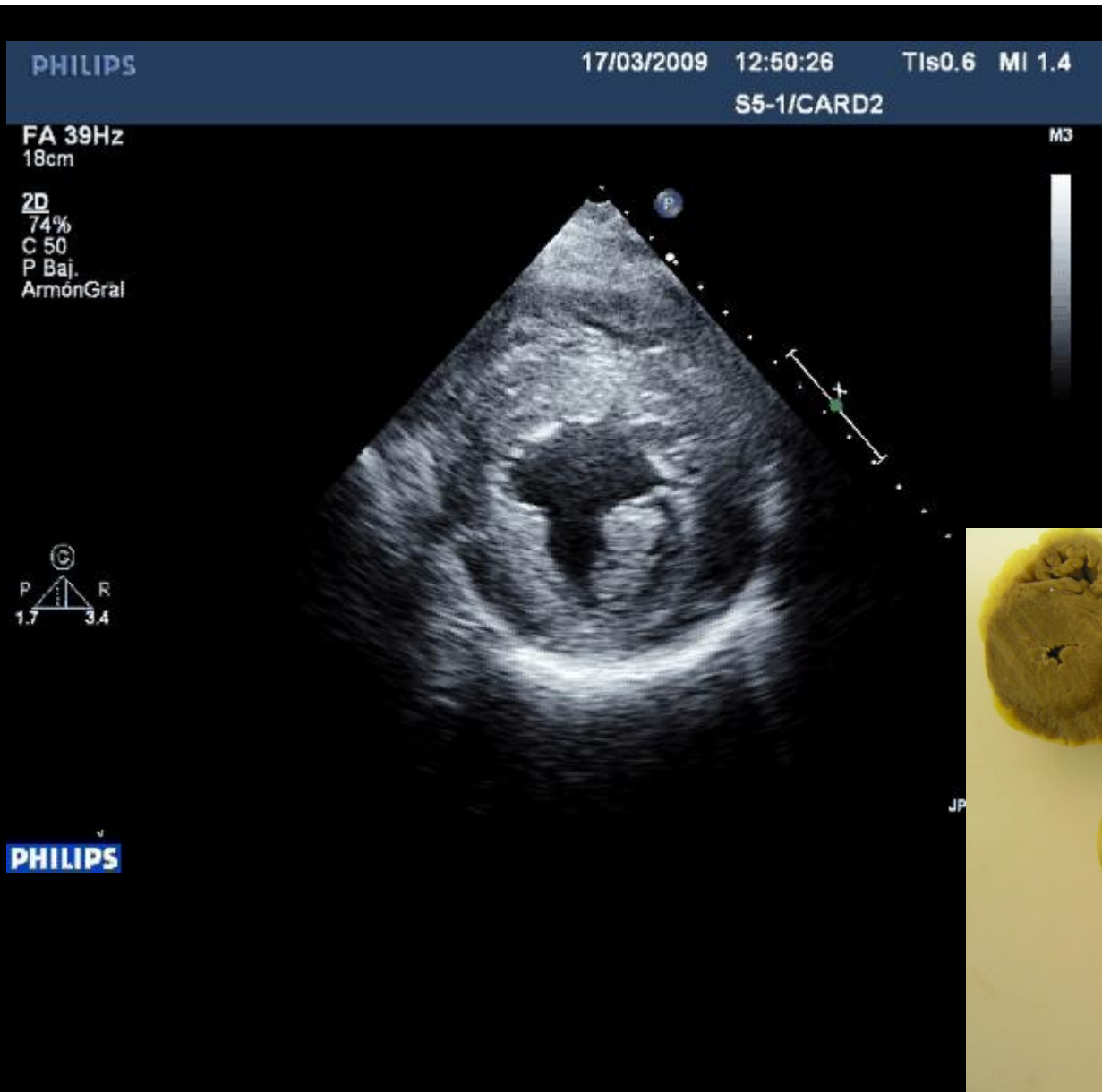
31.5%

Improved

22.4%

Worse

# Paravalvular regurgitation: Is it relevant / frequent: The LVH response;

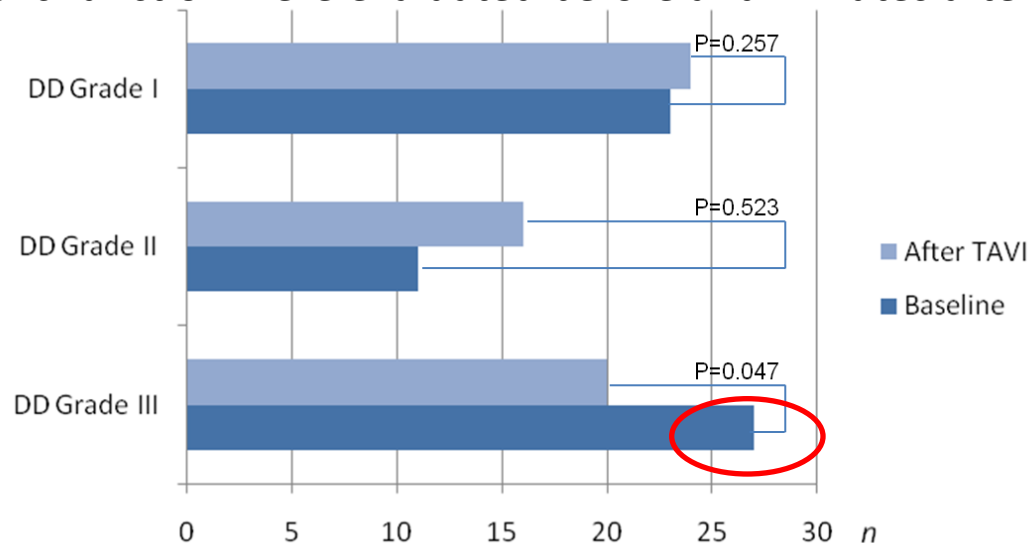


# Acute left ventricle diastolic function improvement after transcatheter aortic valve implantation



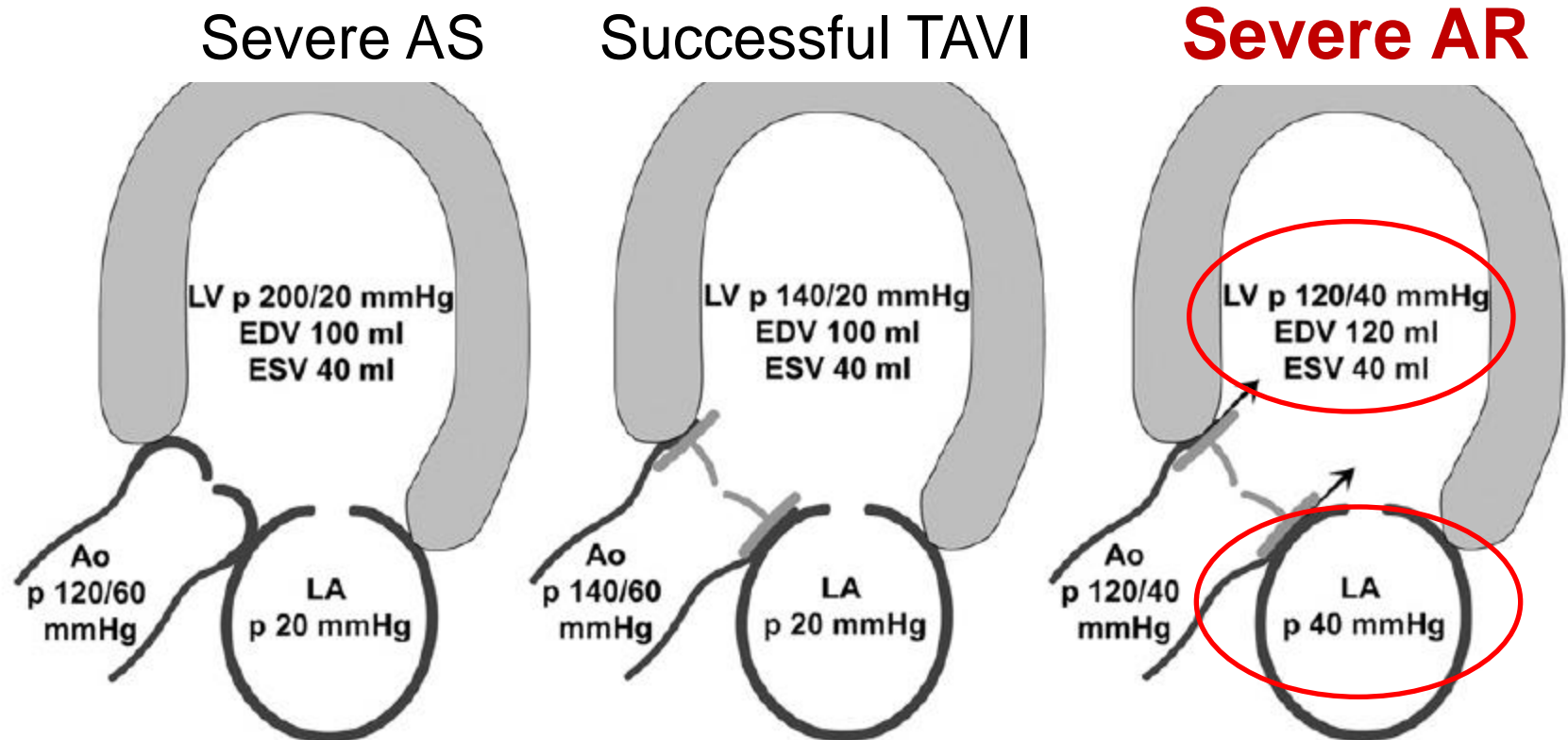
Alexandra Gonçalves<sup>1,2</sup>, Pedro Marcos-Alberca<sup>1</sup>, Carlos Almeria<sup>1</sup>, Gisela Feltes<sup>1</sup>, Enrique Rodríguez<sup>1</sup>, Rosa Ana Hernández-Antolín<sup>1</sup>, Eulogio García<sup>1</sup>, Luis Maroto<sup>1</sup>, Cristina Fernandez Perez<sup>3</sup>, José C. Silva Cardoso<sup>2</sup>, Carlos Macaya<sup>1</sup>, and José Luis Zamorano<sup>1\*</sup>

- 61 patients with preserved LV systolic function submitted to successful TAVI.
- Parameters of diastolic function were evaluated before and minutes after TAVI.



This is the first study describing LV diastolic performance during TAVI. Immediate improvement in diastolic function parameters was described.

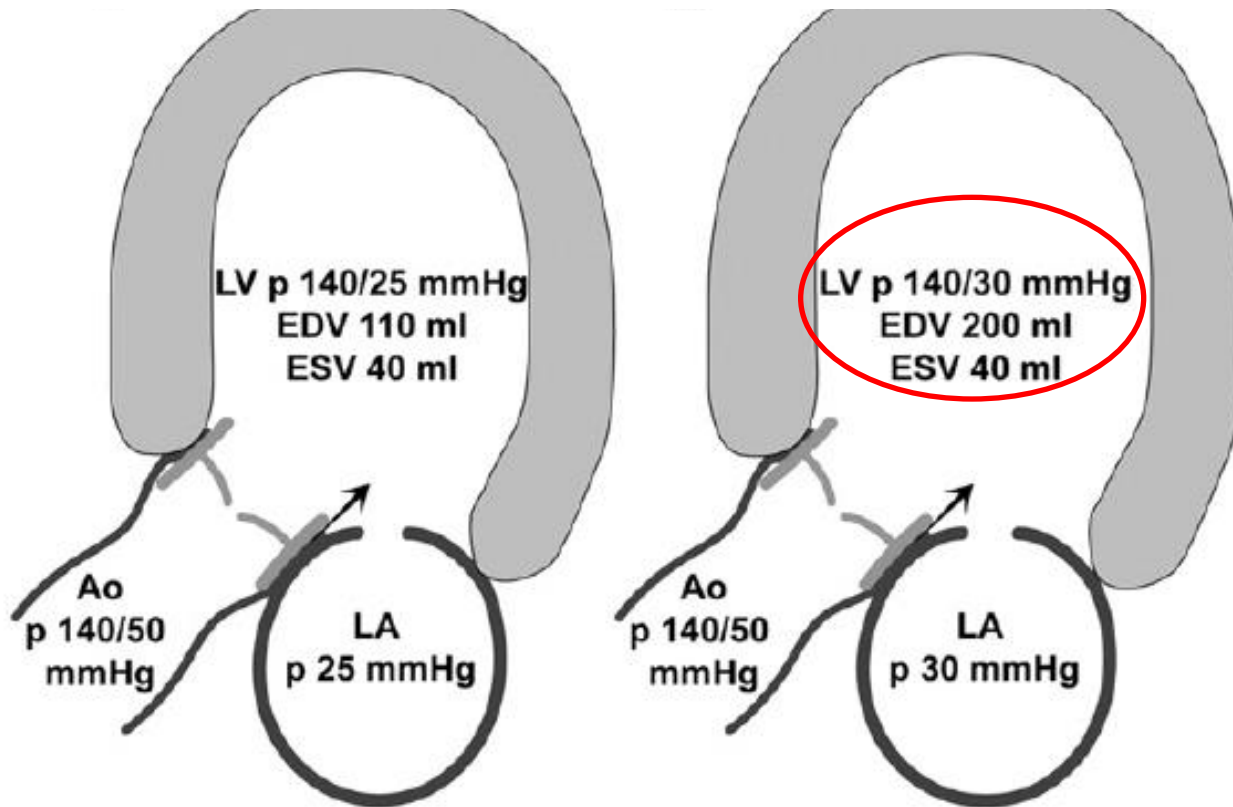
# Paravalvular regurgitation: Changes in LV pressures





# Paravalvular regurgitation: Chronic AR. Medical Tx

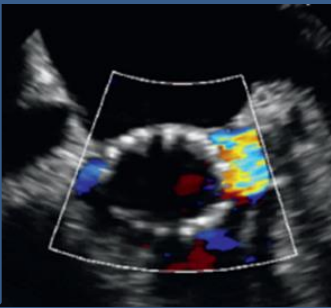
## Chronic AR



# Paravalvular regurgitation: Is it relevant / frequent

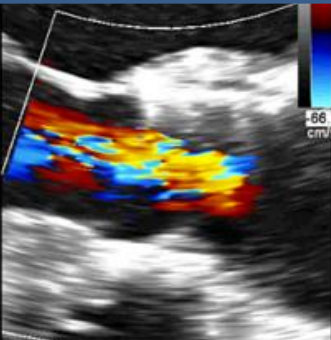
## Causes of AR after TAVI

ParaValv  
AR



Prosthesis malposition/  
under-expansion/ undersizing

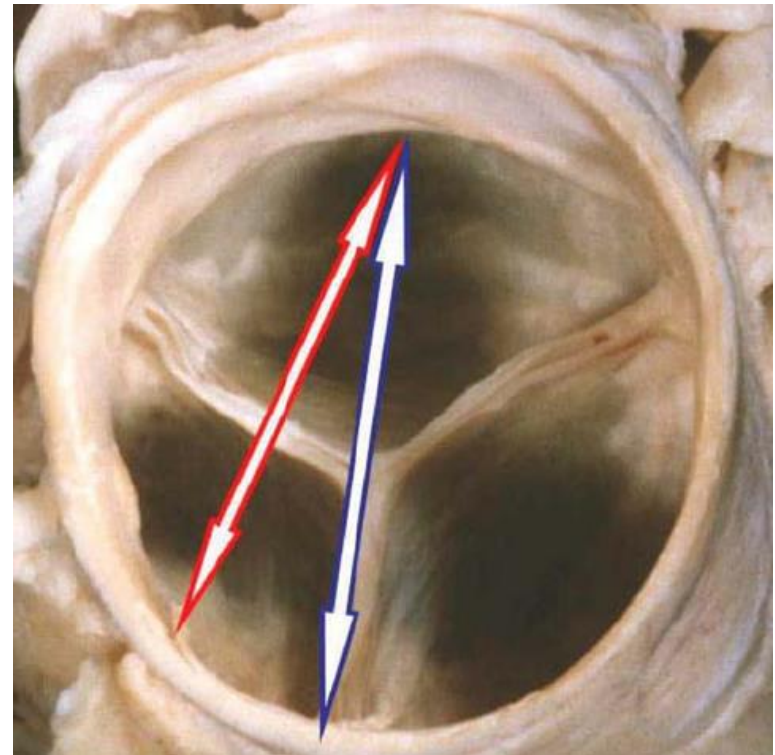
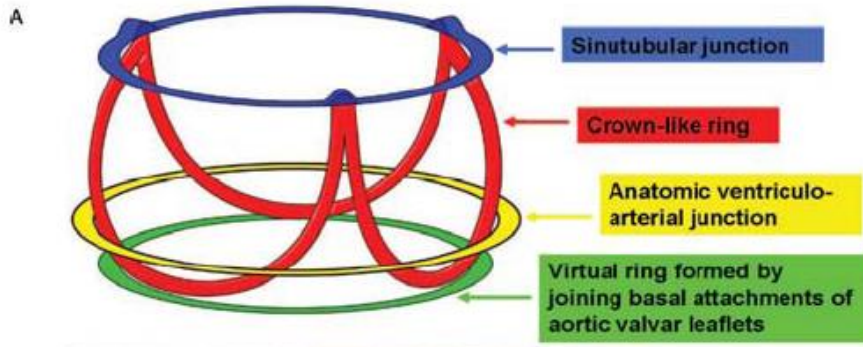
Central  
AR



Incomplete expansion of prosthesis  
Restricted cusp motion

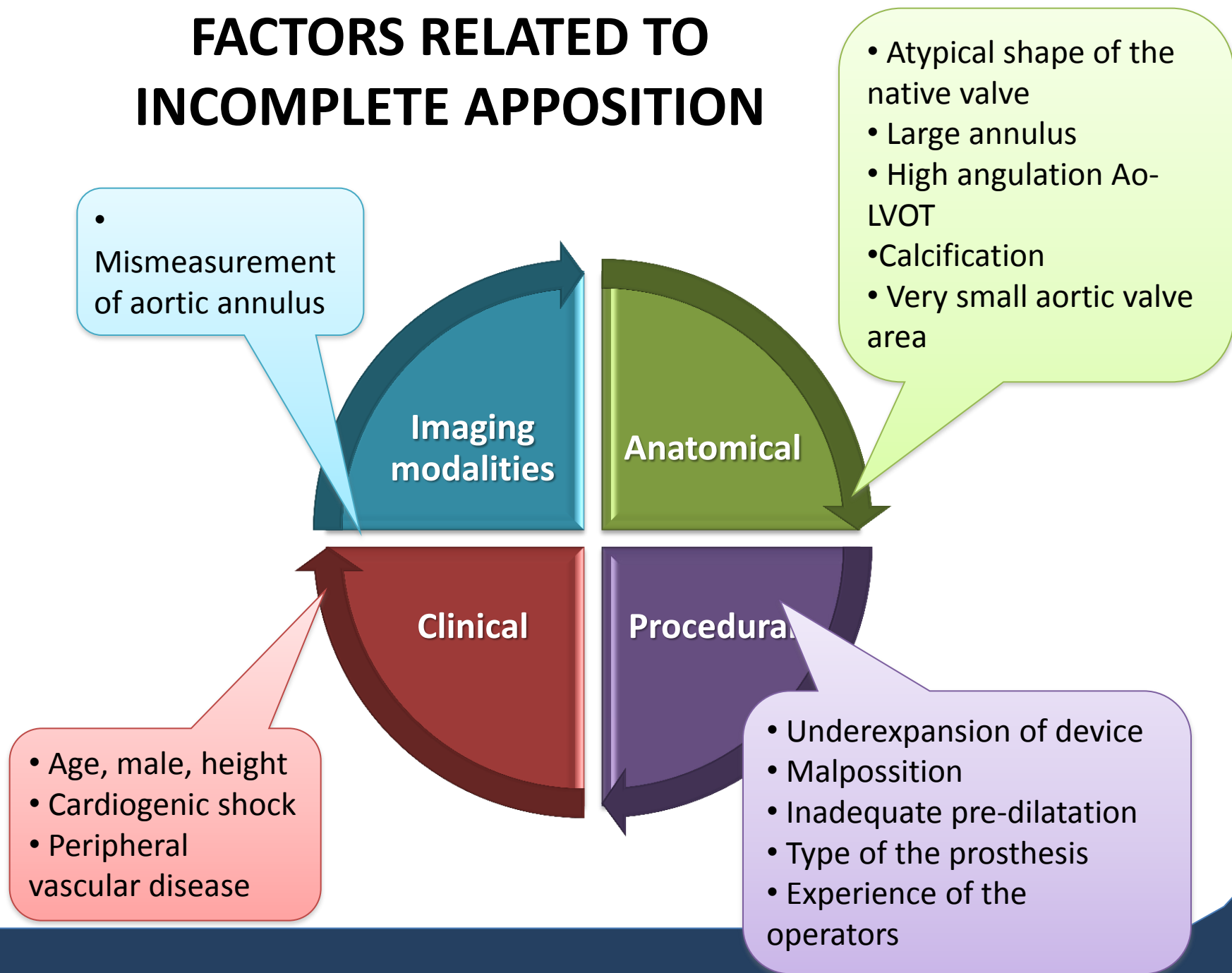
# Paravalvular regurgitation: an integrated approach

**Circulation**  
Cardiovascular Interventions  
JOURNAL OF THE AMERICAN HEART ASSOCIATION

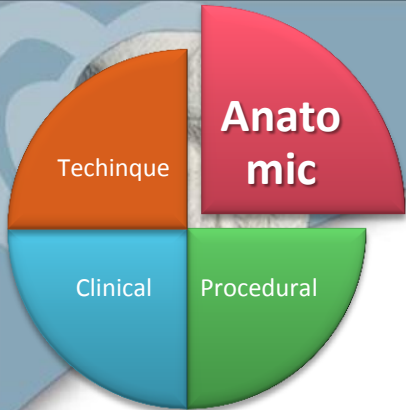


Piazza N et al. *Circ Cardiovasc Interv* 2008

# FACTORS RELATED TO INCOMPLETE APPPOSITION

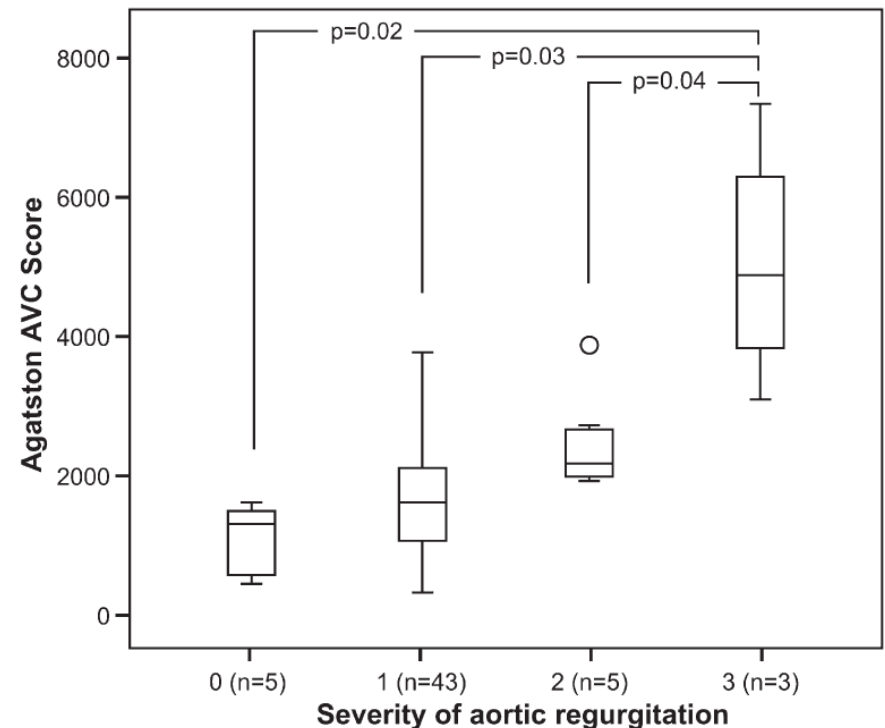
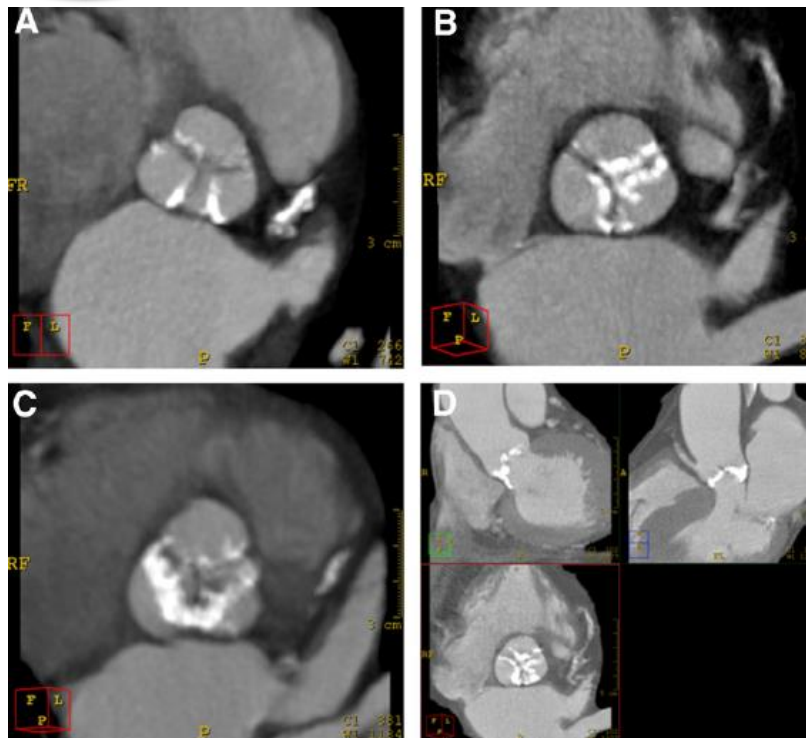






# CALCIFICATION

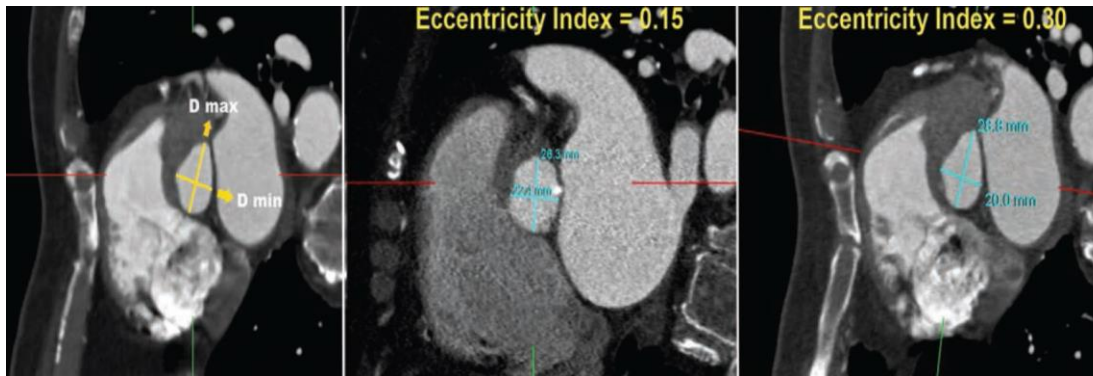
**Patients with severe AVC have an increased risk for a relevant AR after TAVI as well as a trend for increased need for additional procedures.**



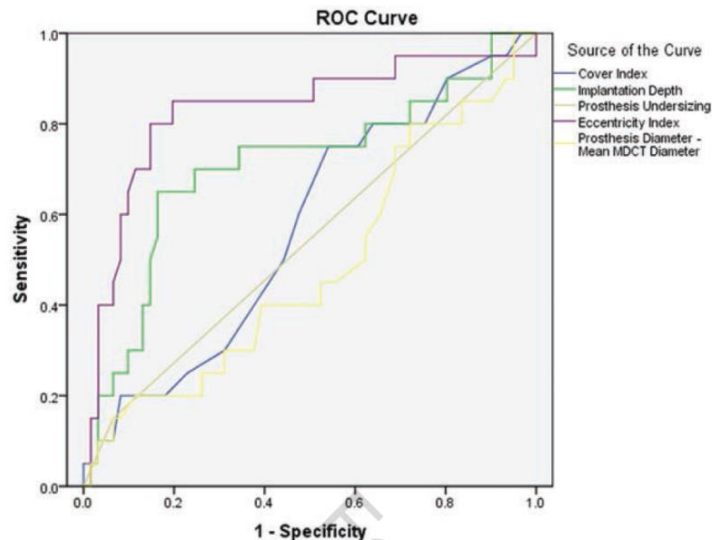


# Relationship of Aortic Annular Eccentricity and Paravalvular Regurgitation Post Transcatheter Aortic Valve Implantation With CoreValve

Dennis T.L. Wong, BSc (Med), MBBS (Hons)<sup>1,2</sup>, Angela G. Bertaso, MBBS<sup>1</sup>, Gary Y.H. Liew, MBBS<sup>1</sup>, Viji S. Thomson, MBBS, MD<sup>1</sup>, Michael S. Cunnington, MBBS, MD<sup>1</sup>, James D. Richardson, MBBS<sup>1</sup>, Robert Gooley, MBBS<sup>2</sup>, Siobhan Lockwood, MBBS<sup>2</sup>, Ian T. Meredith, MBBS (Hons), PhD<sup>2</sup>, Matthew I. Worthley, MBBS, PhD<sup>1</sup>, Stephen G. Worthley, MBBS, PhD<sup>1</sup>



$$\text{Eccentricity index: } 1 - \frac{D \text{ min}}{D \text{ max}}$$

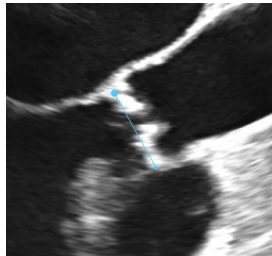


**An eccentricity index > 0.25 was associated with the occurrence of significant PAR after TAVI with a S of 80% and E of 86% (P<0.001)**

# Prosthesis/annulus by three-dimensional echocardiography paravalvular aortic transcatheter a

Ninel Santos, José Alberto Pedro Marcos-Alberca, C. Rosana Hernández-Antolí and José Zamorano\*

Instituto Cardiovascular, Unidad de Imagen Cardíaca, I  
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journal homepage: www.elsevier.com/locate/ijcard



## MSCT guided sizing of the Edwards Sapien XT TAVI device: Impact of different degrees of oversizing on clinical outcome

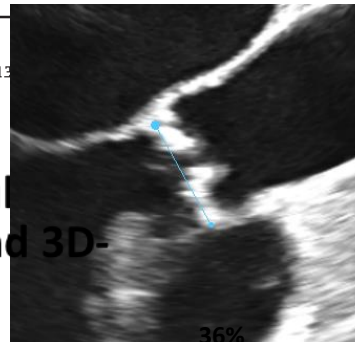
A.W. Leber<sup>a,b,\*</sup>, W. Eichinger<sup>c</sup>, J. Rieber<sup>b</sup>, M. Lieber<sup>c</sup>, S. Schleger<sup>c</sup>, U. Ebersberger<sup>b</sup>, M. Deichstetter<sup>b</sup>, J. Vogel<sup>b</sup>, T. Helmberger<sup>d</sup>, D. Antoni<sup>b</sup>, G. Riess<sup>b</sup>, E. Hoffmann<sup>b</sup>, A.M. Kasel<sup>b,e</sup>

- <sup>a</sup> Schulich Heart Center at Sunnybrook Health Science Center Toronto, Univ. of Toronto, Canada
- <sup>b</sup> Heart Center Munich Bogenhausen at Klinikum München Bogenhausen, Dept. of Cardiology, Munich, Germany
- <sup>c</sup> Heart Center Munich Bogenhausen at Klinikum München Bogenhausen, Dept. of Cardiac Surgery, Munich, Germany
- <sup>d</sup> Klinikum München Bogenhausen, Dept. of Radiology, Munich, Germany
- <sup>e</sup> German Heart Centre Munich, Dept. of Cardiology, Technical University of Munich, Munich, Germany

### ARTICLE INFO

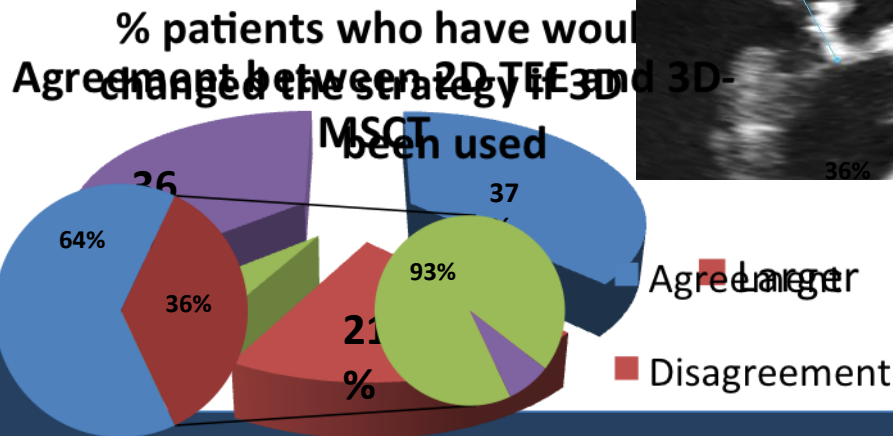
Article history:  
Received 20 July 2012  
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Accepted 17 March 2013  
Available online xxx

### ABSTRACT



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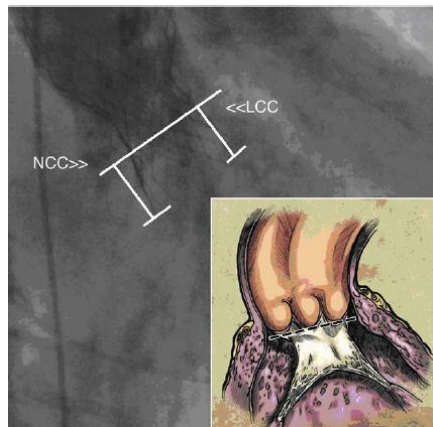
Technique

Anatomic

Clinical

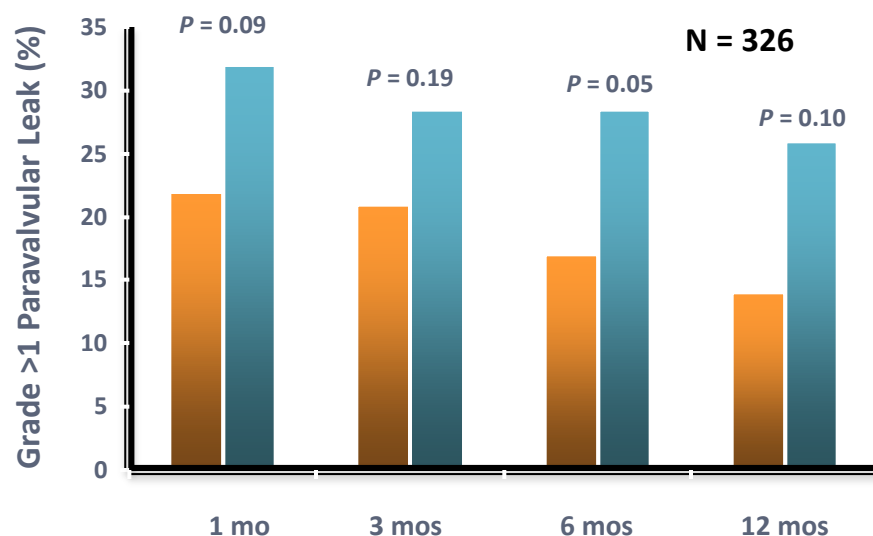
Procedure

# DEPTH OF DEVICE POSITION



The optimal depth of the device is around 10 mm.  
Smaller or larger values of depth increase the chance of AR

Mohammad A. Sherif et al. J Am Coll Cardiol 2010;56:1623–9)



Proper implant location  
defined as 4 to 8 mm below  
annulus.

Good  
Suboptimal



# • Evaluation of success and complications

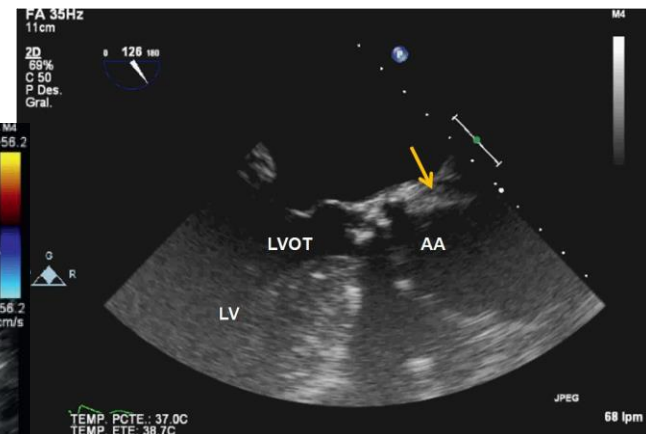
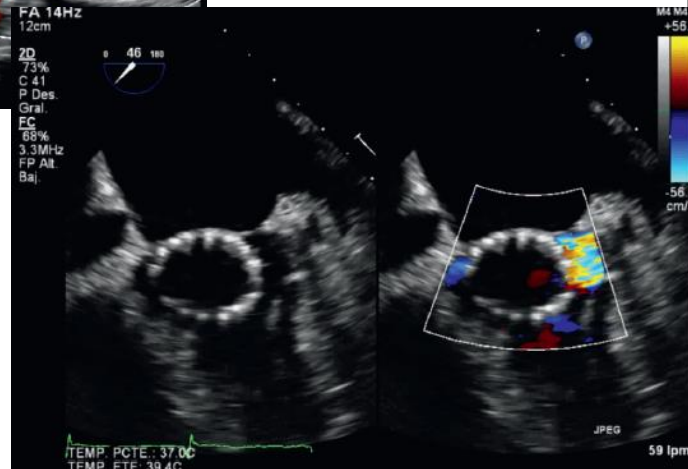
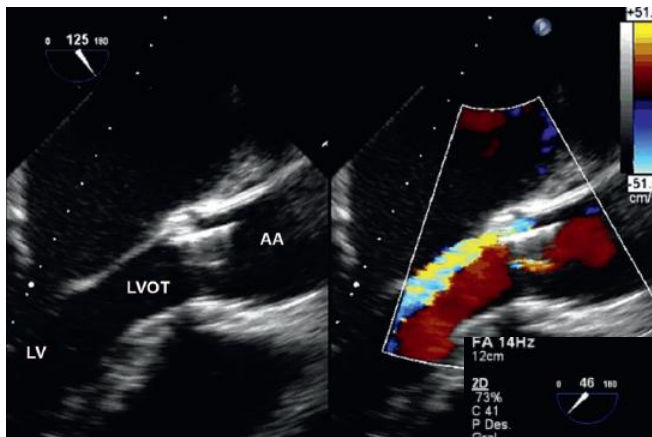
## Echocardiography: guidance during valve implantation **EuroIntervention**

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

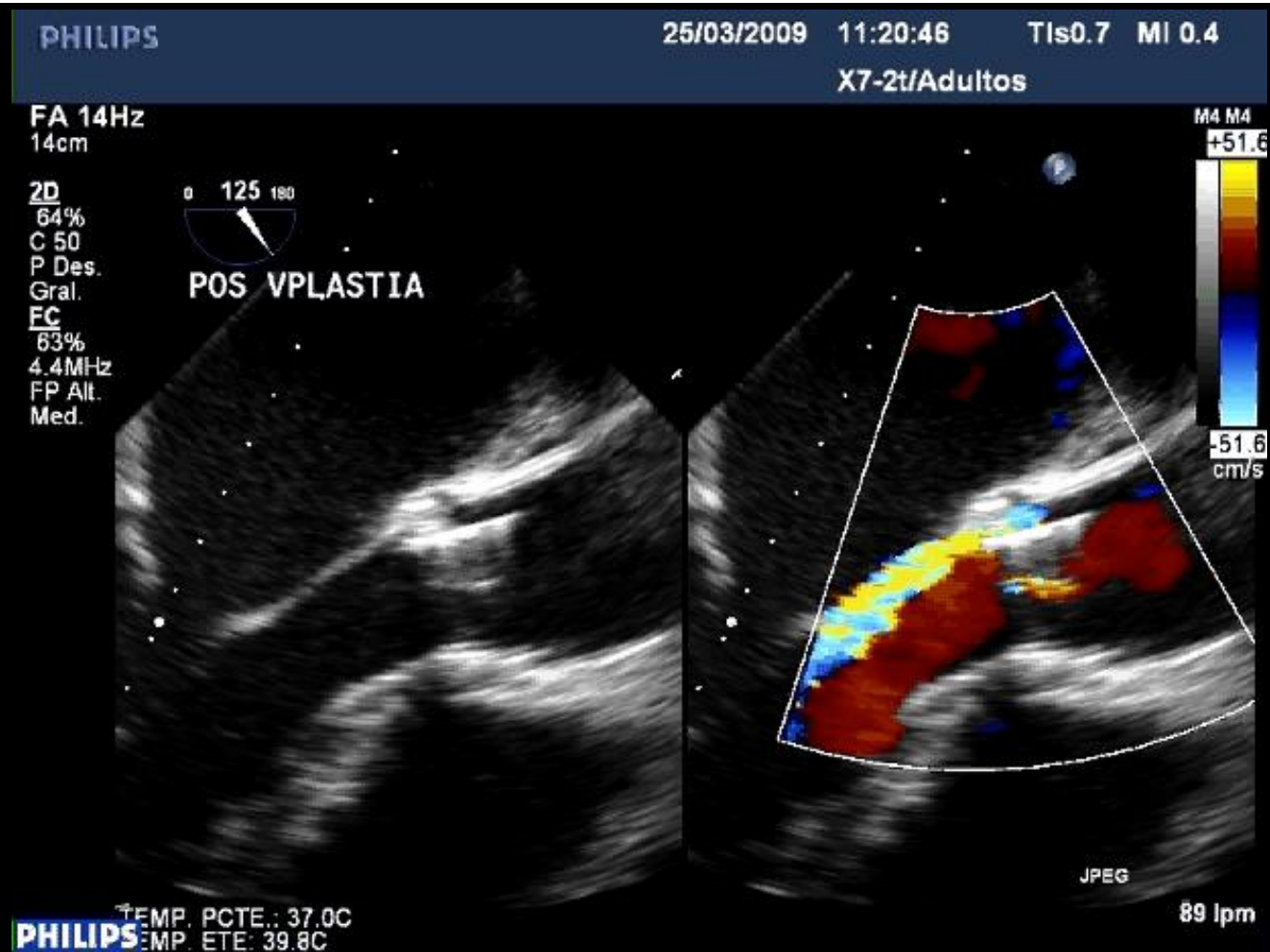
Cardiovascular Institute, Hospital Clínico San Carlos, Madrid, Spain

### 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.



# How to quantify ?



# Paravalvular regurgitation: an integrated approach

## GUIDELINES AND STANDARDS

### Recommendations for Evaluation of Prosthetic Valves With Echocardiography and Doppler Ultrasound


Table 6 Parameters for evaluation of the severity of prosthetic aortic valve regurgitation

Parameter	Mild	Moderate	Severe
Valve structure and motion			
Mechanical or bioprosthetic	Usually normal	Abnormal <sup>†</sup>	Abnormal <sup>†</sup>
Structural parameters			
LV size	Normal <sup>‡</sup>	Normal or mildly dilated <sup>‡</sup>	Dilated <sup>‡</sup>
Doppler parameters (qualitative or semiquantitative)			
Jet width in central jets (% LVO diameter): color*	Narrow ( $\leq 25\%$ )	Intermediate (26%-64%)	Large ( $\geq 65\%$ )
Jet density: CW Doppler	Incomplete or faint	Dense	Dense
Jet deceleration rate (PHT, ms): CW Doppler <sup>§</sup>	Slow ( $>500$ )	Variable (200-500)	Steep ( $<200$ )
LVO flow vs pulmonary flow: PW Doppler	Slightly increased	Intermediate	Greatly increased
Diastolic flow reversal in the descending aorta: PW Doppler	Absent or brief early diastolic	Intermediate	Prominent, holodiastolic
Doppler parameters (quantitative)			
Regurgitant volume (mL/beat)	$<30$	30-59	$>60$
Regurgitant fraction (%)	$<30$	30-50	$>50$

# Paravalvular regurgitation. How to Q ?

## Measurement of paravalvular AR

### For paravalvular jets

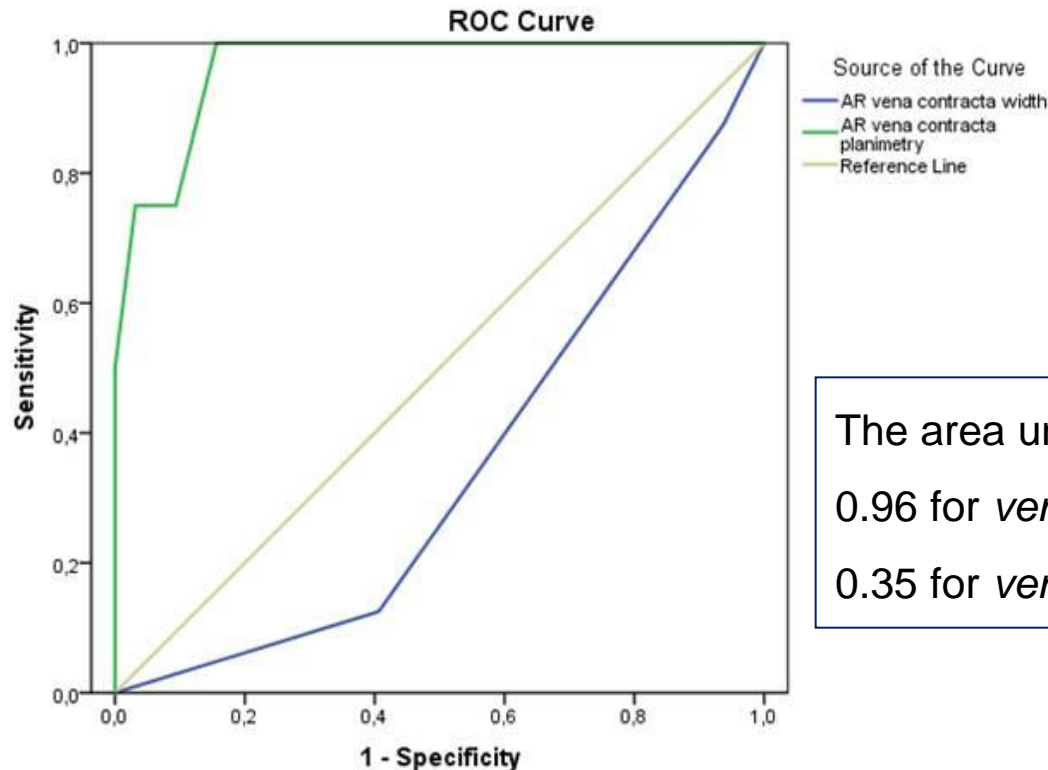
Mild	10% of the sewing ring	
Moderate	10–20% of the sewing ring	
Severe.	20% of the sewing ring	

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



# 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

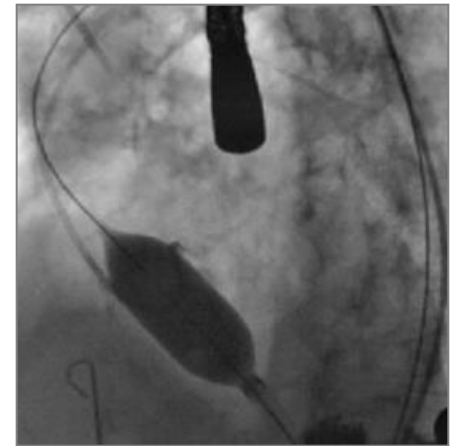
3D TTE *vena contracta* planimetry correlation with AR volume: 0.82,  $p < 0.001$

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

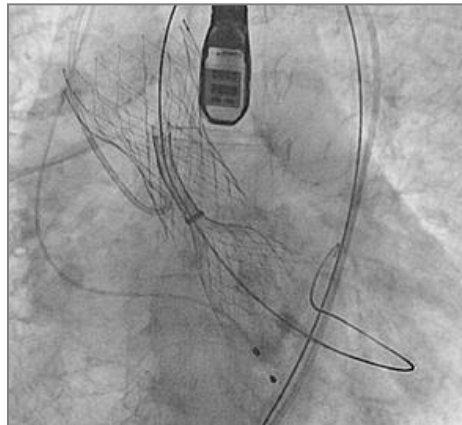
# What to do?

## Treatment of Paravalvular AR

Post implant balloon dilatation

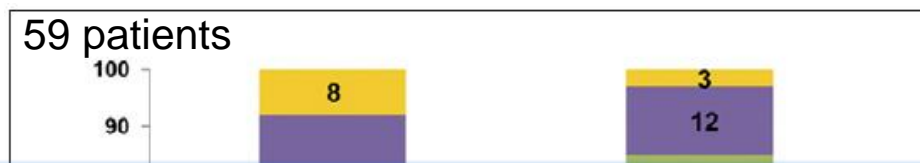


Valve in valve



# What to do?

## Predictive Factors, Efficacy, and Safety of Balloon Post-Dilation After Transcatheter Aortic Valve Implantation With a Balloon-Expandable Valve



- Valve calcification volume best determined the need and a poor response to BPD
- BPD patients - higher incidence of cerebrovascular events at 30 days (11.9% vs. 2.0%,  $p=0.006$ )

post-dilation (BPD).

# What to do?

## Prevention

- Proper study of aortic valve and root anatomy
- Training
- Imaging procedure guidance
- Improvements in the deployment technique

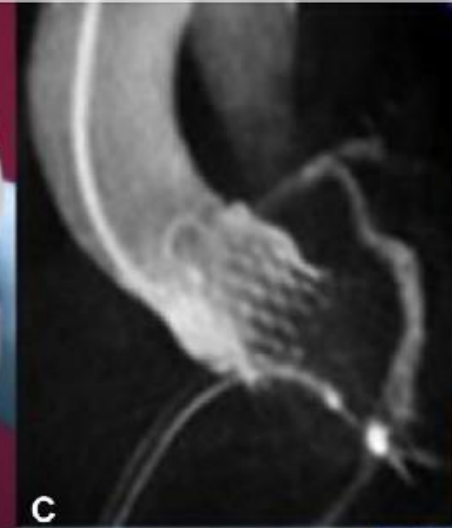
# Innovation



A



B



C



D



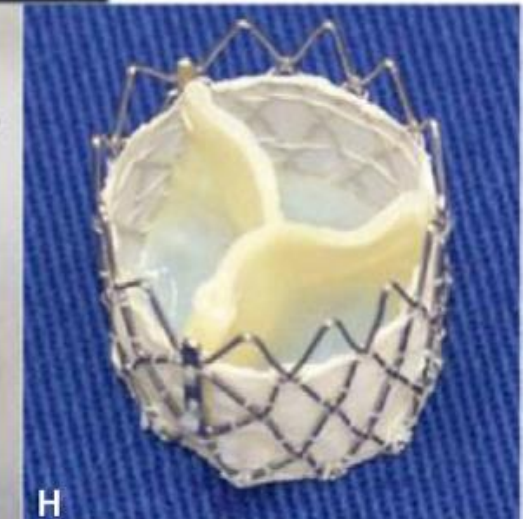
E



F



G

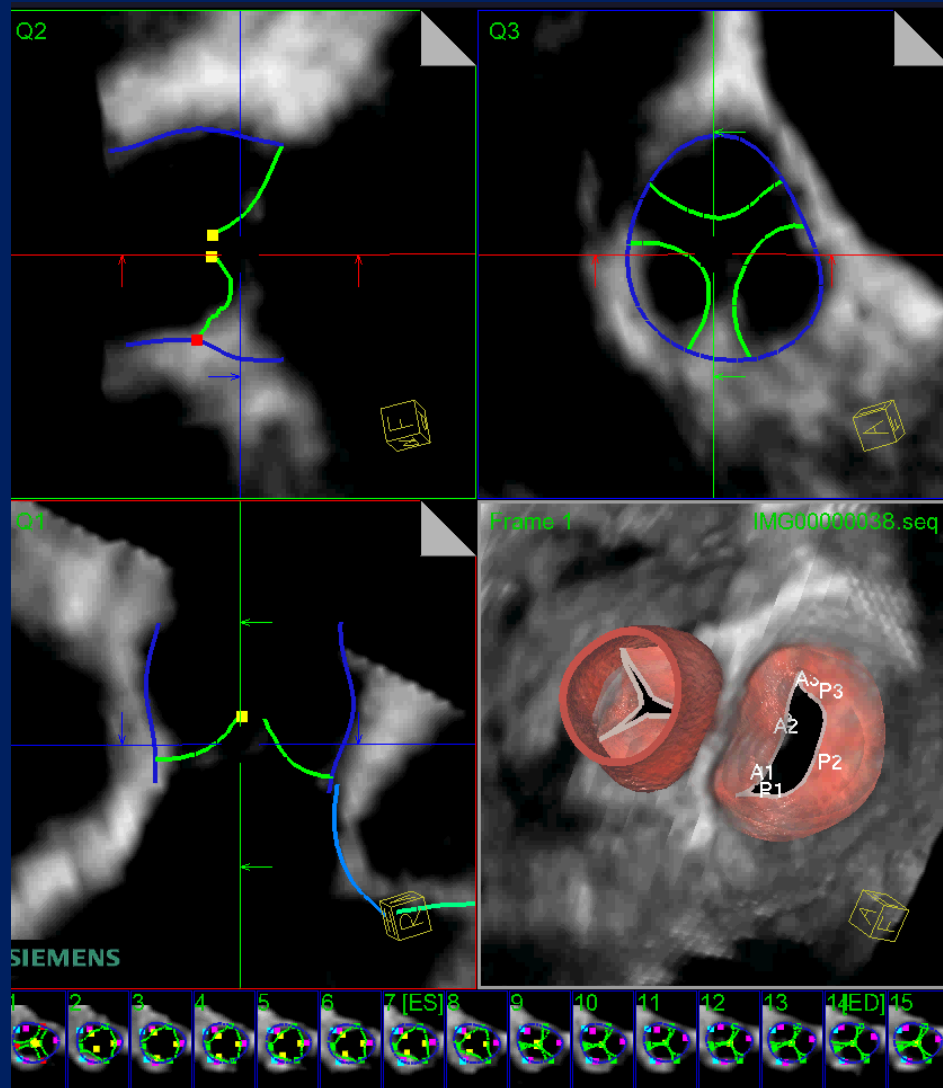


H



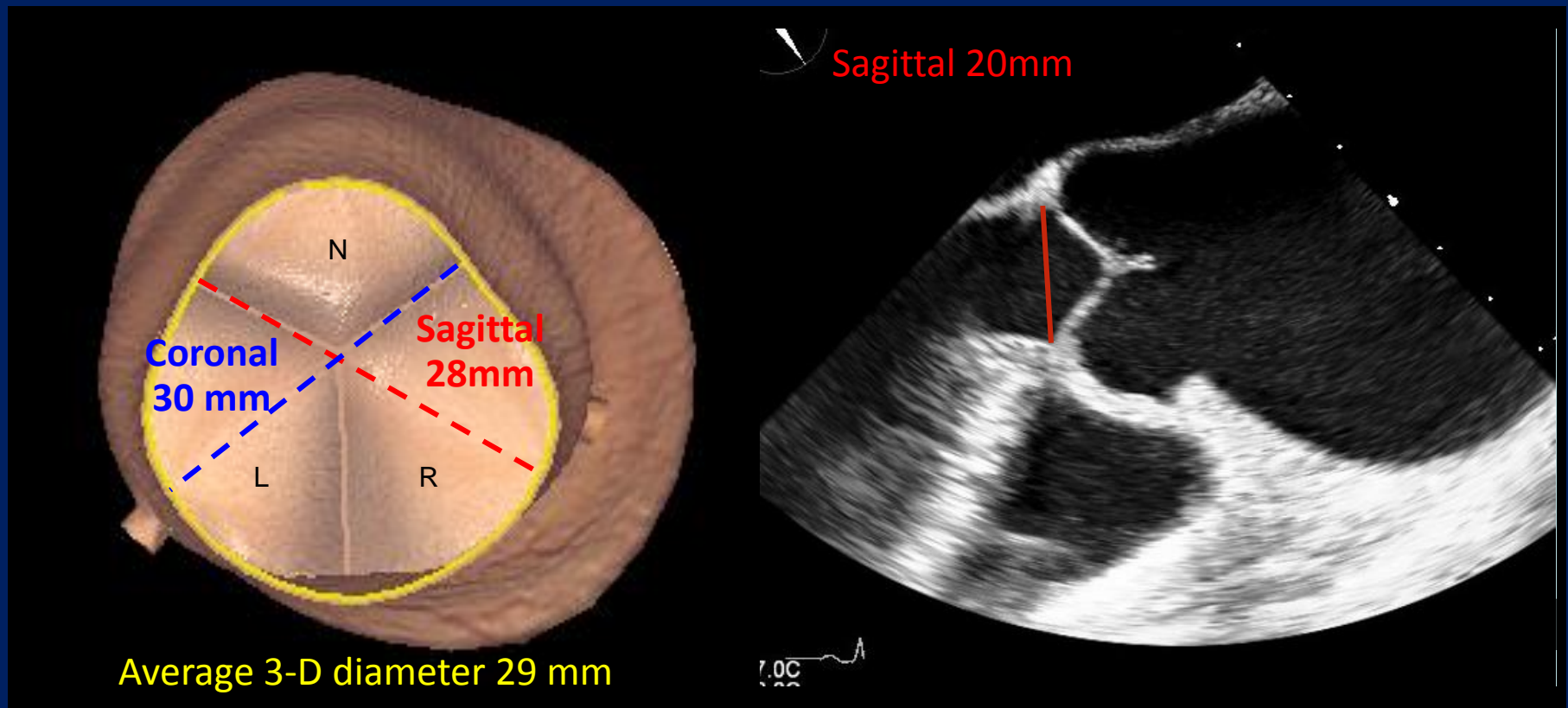
# Automated Quantitative Modeling

## 3-D TEE



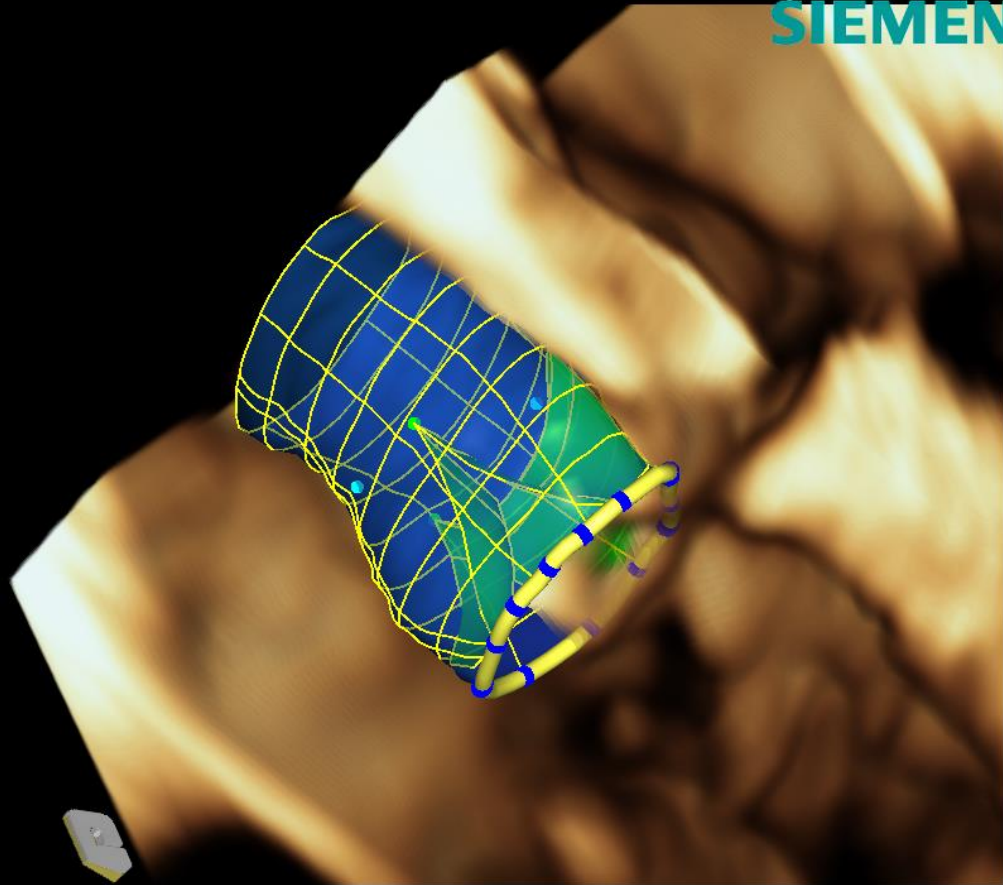
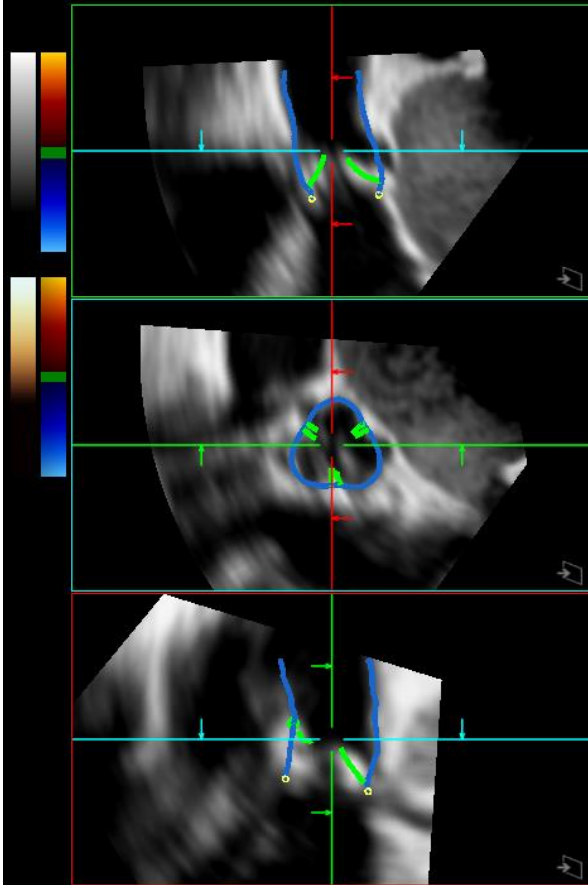
# Automated Quantitative 3-D TEE

## Annulus Diameters



Graft size 30 mm

SIEMENS



# Conclusion

- AR is the most frequent complication after TAVI
- Accurate measurement of paravalvular AR is challenging
- Significant AR is a main contributor to in-hospital death and an independent predictor of 1-year morbidity and mortality

# Conclusion

- There is no effective treatment available
- Prevention of AR is essential for best TAVI results