Summary episode 4

Multiple Valvular Heart Disease
Mixed Valvular Heart Disease

Nina Ajmone Marsan

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Aortic stenosis combined with aortic regurgitation: which imaging approach can solve the diagnostic challenges

Marie-Annick Clavel, DMV, PhD

Professor – Université Laval (Québec, Canada)

2025

Moderate AS + mpderate AR

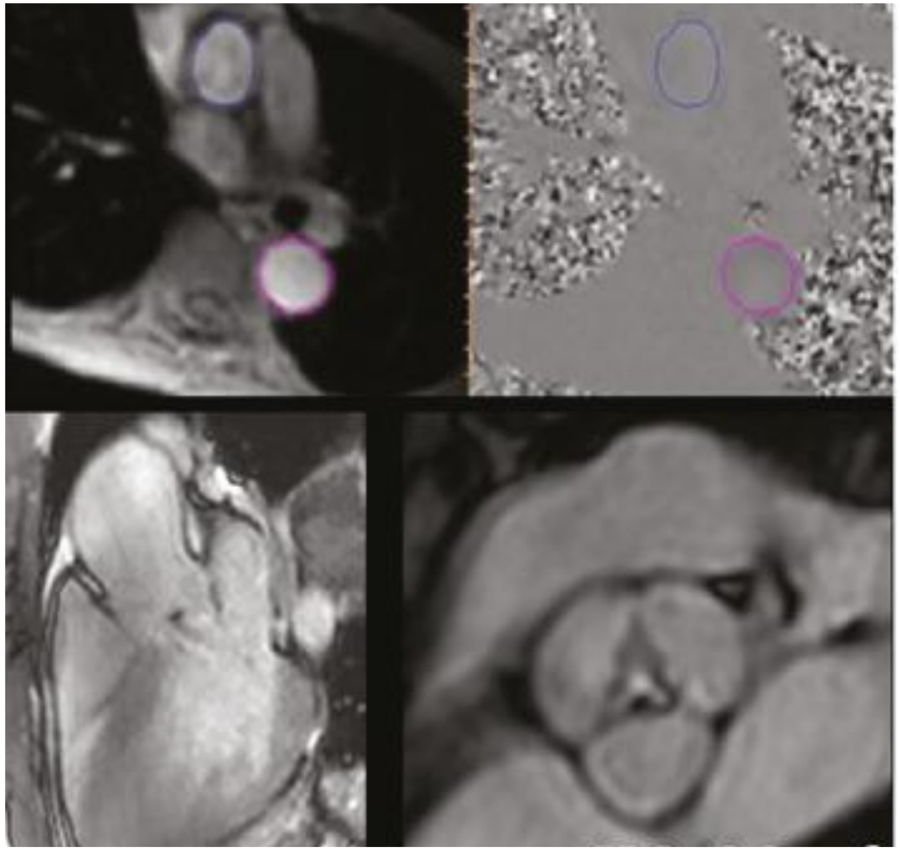
	Mild AR	Moderate AR	Severe AR
Mild AS	Mild or moderate MAVD*	Moderate MAVD*	Severe MAVD**
Moderate AS	Moderate MAVD*	Likely severe MAVD***	Severe MAVD**
Severe AS	Severe MAVD**	Severe MAVD**	Severe MAVD**

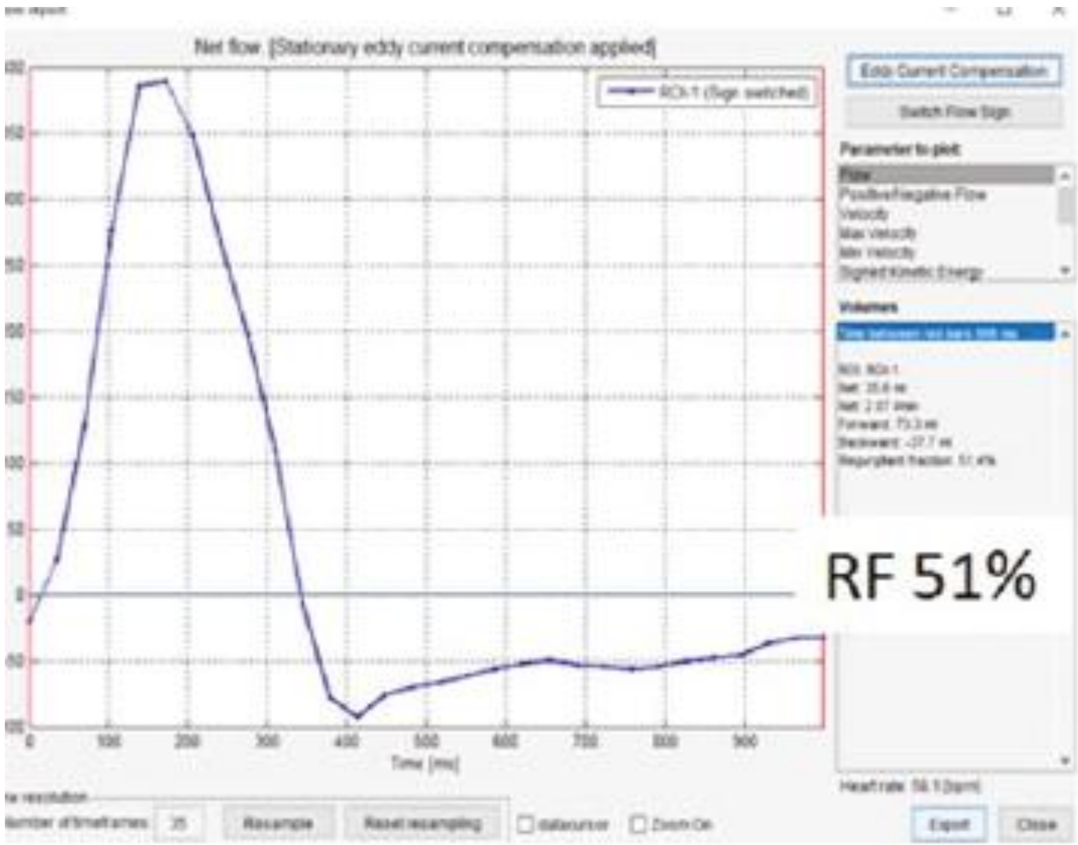
Unger, Clavel. Struct Heart2020

Evaluation of AR

Jet, volume, ERO…. Underestimated by low flow

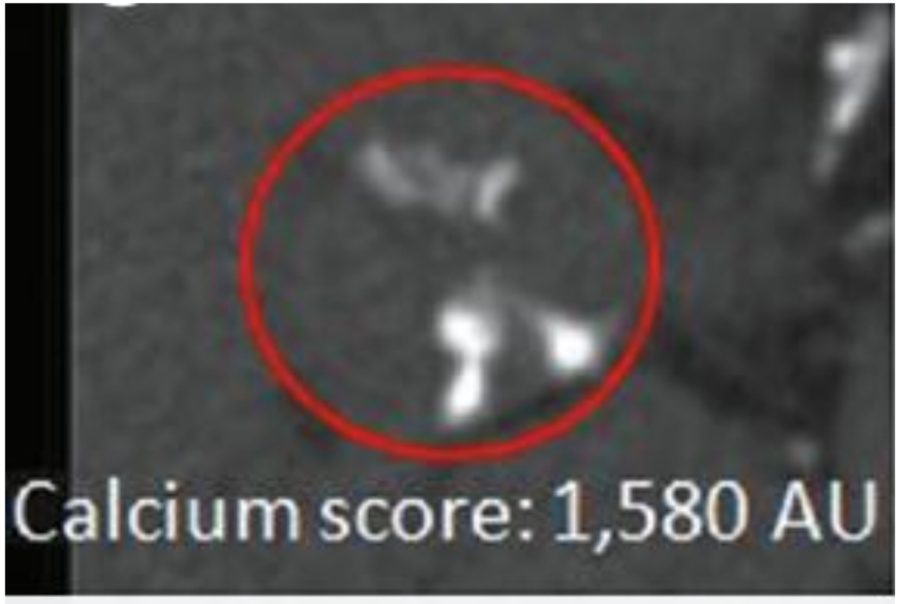
Regurgitant fraction remain valid

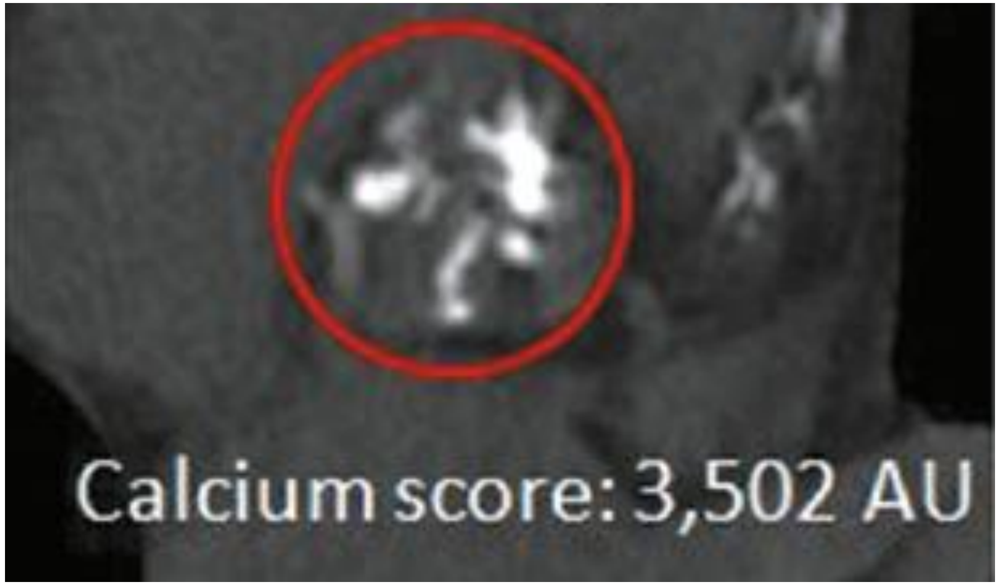




Evaluation of AS

AVA, gradient, velocity, DVI underestimated by low flow





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When and how should we treat mixed AV disease

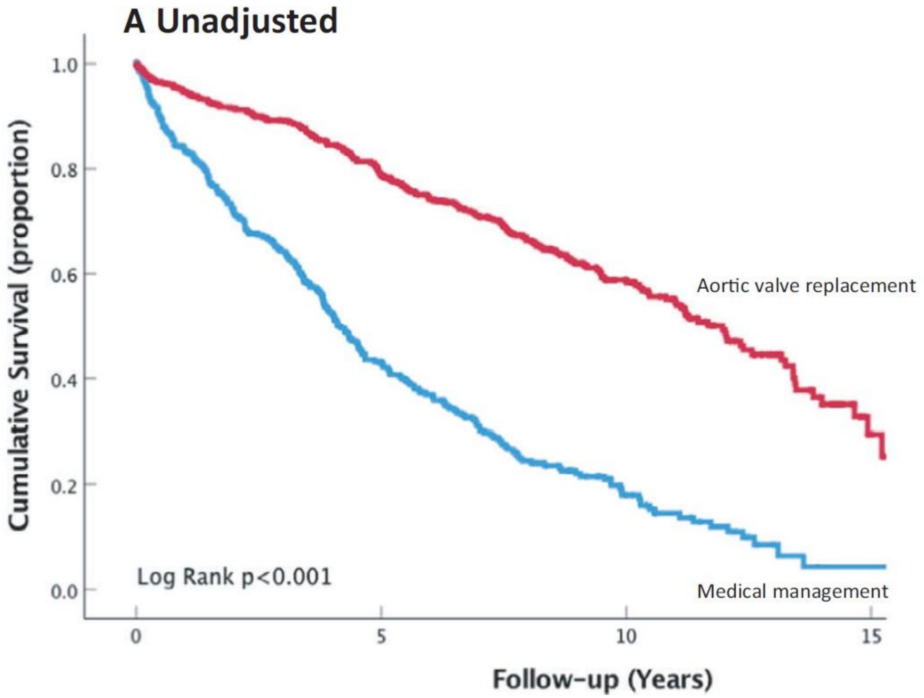
Madalina Garbi MD MA FRCP

Royal Papworth Hospital, Cambridge, UK

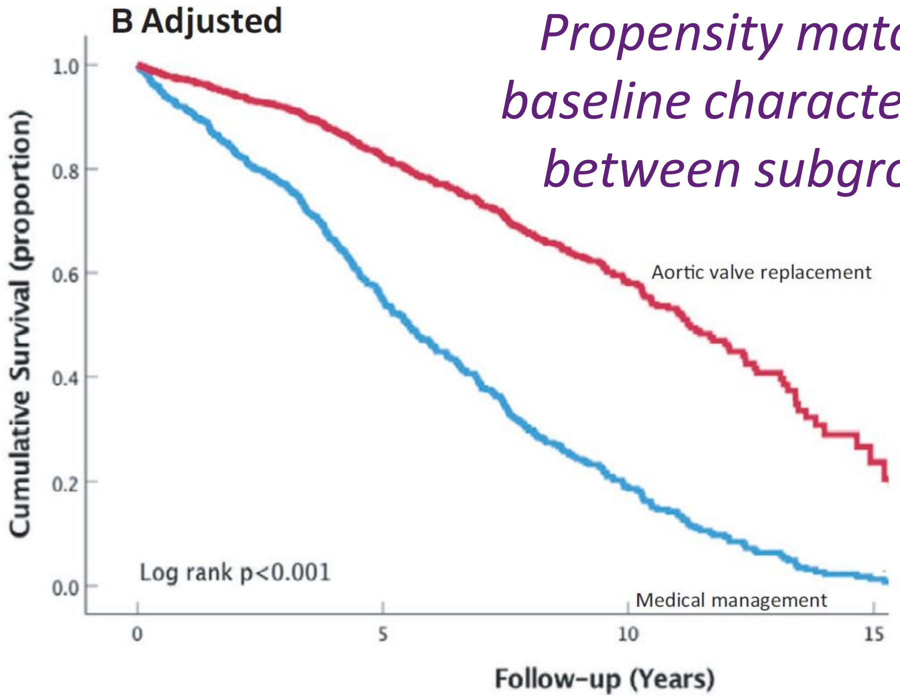
2025

Mixed AV disease outcomes

At least moderate AS + moderate AR & normal LV



Years	0	2.5	5	7.5	10	12.5	15
AVR	504	355	293	218	114	55	8
Medical	356	200	117	64	28	7	1

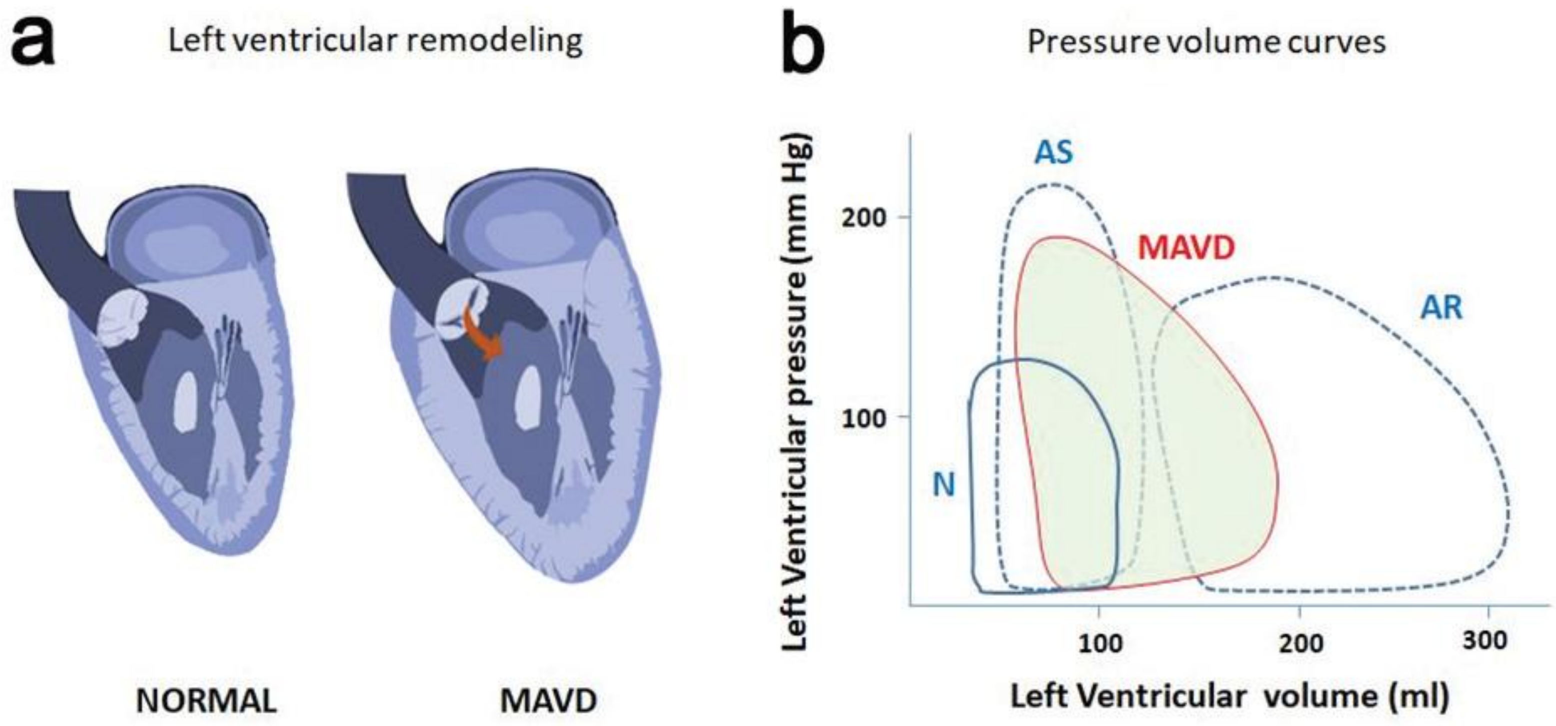


Propensity matched baseline characteristics between subgroups

Years	0	2.5	5	7.5	10	12.5	15
AVR	504	355	293	218	114	55	8
Medical	356	200	117	64	28	7	1

Isaza et al, JAHA 2020

Severe LVH + mild dilatation



Unger Clavel, Structural Heart, 2020

How do I choose my TAVR strategy and device in case of combined aortic stenosis and aortic regurgitation?

Martin Swaans, MD, PhD, FESC, FEACVI, FSCAI
Cardiologist St.Antonius Hospital
Nieuwegein, The Netherlands

TAVR in MAVD

- Individualized approach to address MAVD.
- TAVR is the preferred option in many cases of MAVD.
- However, SAVR may be considered in bicuspid valve cases

- There is no specific TAVR device for MAVD.

- Both Self-Expanding and Balloon-Expanding Valves types are used in MAVD, but there is no clear evidence of superiority for either in this specific population.

- The choice is based on the anatomy, comorbidities, and availability

TAVR device selection

- MAVD patients are more likely to receive a larger prosthesis
- MAVD patients are at increased risk of PVL due to anatomical and hemodynamic changes, such as a larger annulus, calcification, and elevated transvalvular flow.
- MDCT evaluation is crucial

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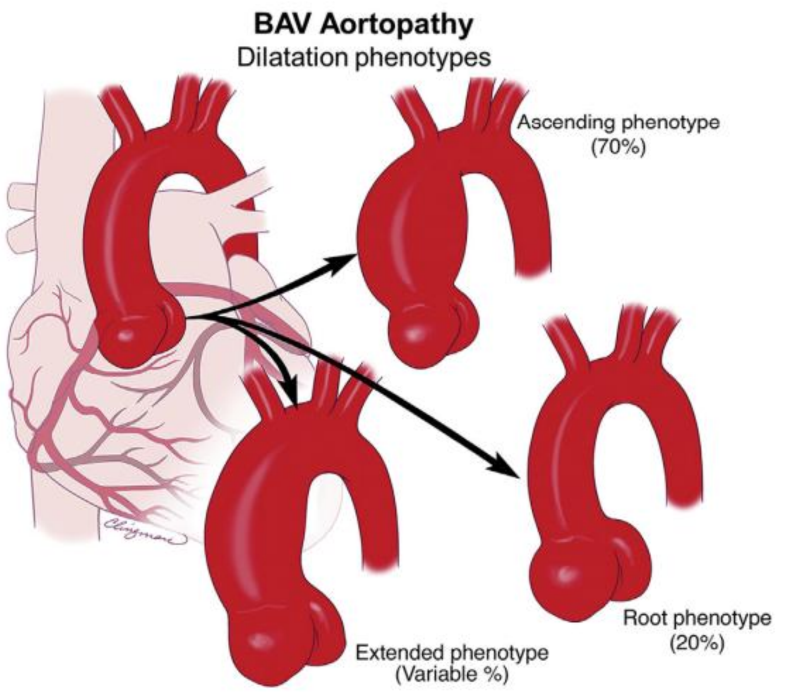
Aortic valve disease concomitant to aortic pathology: which comes first in the decision-making?

Laura Galian Gay, MD, PhD, FESC
Clinical Coordinator Valve Disease Unit
Hospital Universitari Vall d'Hebron, Barcelona

2025

Where aortic valve disease meets aortic pathology

Bicuspid aortic valve (BAV) is the most common congenital heart disease and the most important clinical implications are aortic dilation and dissection and aortic valve dysfunction



Aortic disease in BAV			Valve disease in BAV	
Aortic root	20-30%	⟷ RL ⟷	23-70%	Aortic regurgitation (AR)
Ascending aorta	60-80%	⟷ RN ⟷	14-50%	Aortic stenosis (AS)

Aortic root:
- Earlier age
- Male sex

Ascending aorta:
- Older age

Michelena HI. Ann Thorac Surg. 2021 Sep;112(3):e203-e235.

If severe aortic dilation comes first

Surgery should be performed in patients with a BAV, who have a maximal aortic diameter ≥50/53 mm

2024 ESC Guidelines for the management of peripheral arterial and aortic diseases

Developed by the task force on the management of peripheral arterial and aortic diseases of the European Society of Cardiology (ESC)

Surgery for bicuspid aortopathy is recommended when the maximum aortic diameter is ≥55 mm.[70,172,899,969,1001]	I	B
Surgery for bicuspid aortopathy of the root phenotype[c] is recommended when the maximum aortic diameter is ≥50 mm.[70,893,981,986,1001,1519,1523]	I	B
In patients with low surgical risk, surgery for bicuspid aortopathy of ascending phenotype[d] should be considered when the maximum aortic diameter is >52 mm.[153,172,981]	IIa	B

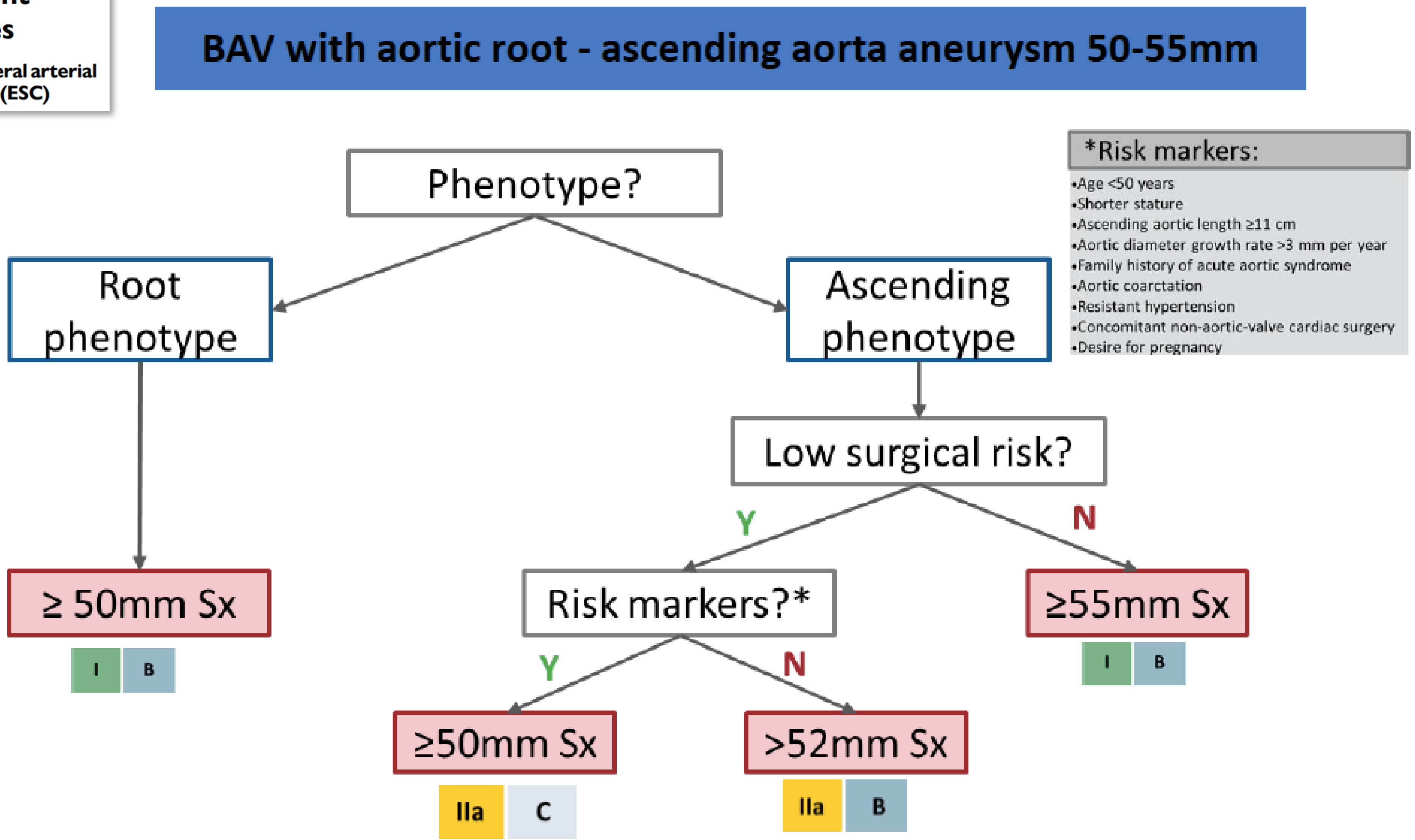
In patients with low surgical risk and ascending phenotype bicuspid aortopathy, surgery should be considered at a maximum diameter ≥50 mm if any of the following is the case:[70,153,155,981,1001] • Age <50 years • Shorter stature[e] • Ascending aortic length ≥11 cm[f] • Aortic diameter growth rate ≥3 mm per year[g] • Family history of acute aortic syndrome • Aortic coarctation • Resistant hypertension[h] • Concomitant non-aortic-valve cardiac surgery • Desire for pregnancy	IIa	C

European Heart Journal (2024) 45, 3538–3700

If severe aortic dilation comes first

2024 ESC Guidelines for the management of peripheral arterial and aortic diseases

Developed by the task force on the management of peripheral arterial and aortic diseases of the European Society of Cardiology (ESC)

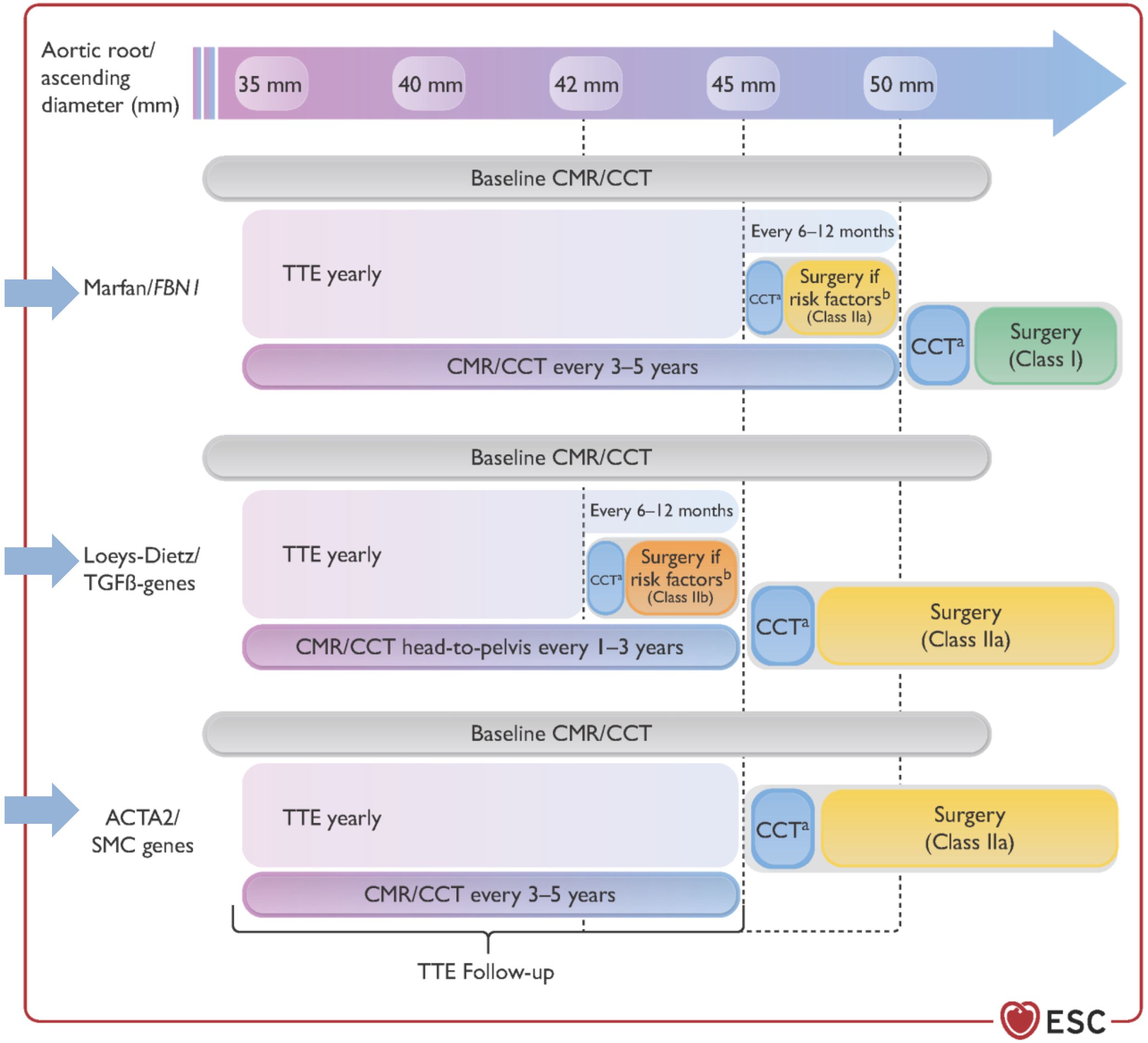


Syndromic aortic diseases: aortopathy guides treatment

Algorithm for imaging surveillance and surgery in patients with syndromic and non-syndromic heritable thoracic aortic disease

Prophylactic aortic surgery intervention thresholds before in heritable aortic disease

European Heart Journal (2024) 45, 3538–3700



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Multivalvular Diseases:
How to properly diagnose severity of aortic stenosis and of mitral regurgitation when they coexist

Dr. Alison Duncan

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The Royal Brompton Hospital

Part of Guys and St. Thomas' NHS Foundation Trust

London, UK

2025

Haemodynamic interactions that impact AS with MR

Severe AS:

Long-standing increased afterload

LVH and remodelling, dilatation, dysfunction of the LV

Secondary MR due to leaflet tethering and mitral annular dilatation

Concomitant CAD in AS: association ischaemic MR

Increased afterload due to AS:

↑ trans MV systolic pressure gradient

↑ MR volume for any given MV ERO

Problem with quantifying AS combined with MR:

Significant MR ↓ forward flow across aortic valve

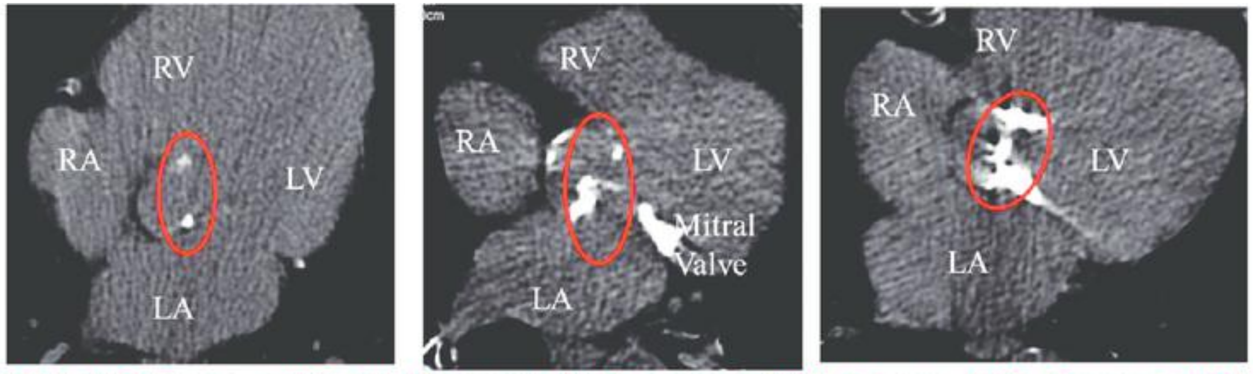
MR-induced low-flow state reduces ↓ transaortic pressure gradient (LF-LG AS)

1. low-flow, low-gradient AS frequent
2. AS associated with ↑ MV anterograde flow and gradient
3. Continuity equation inapplicable when transvalvular flows are unequal
4. PHT methods invalid in the presence of altered LV compliance/relaxation
5. DSE may fail to induce significant increase in LV outflow with severe MR

Problem with quantifying AS combined with MR:

- Prognostic tools recommended for single VHD not substantially validated in MVD
- Accepted cut-off values may not be applicable
- Management, timing, type (TCV vs Sx) of associated lesions <severe challenging

- **MMI may be useful**
- Load-independent measures such as valve planimetry (TOE, MSCT, MRI)
- AoV calcium score by MSCT (>2000AU men, >1200AU women)



Mild AVC. Score = 200 AU Moderate AVC. score = 800 Severe AVC. Score = 2000

PCR madrid IMAGING VALVES

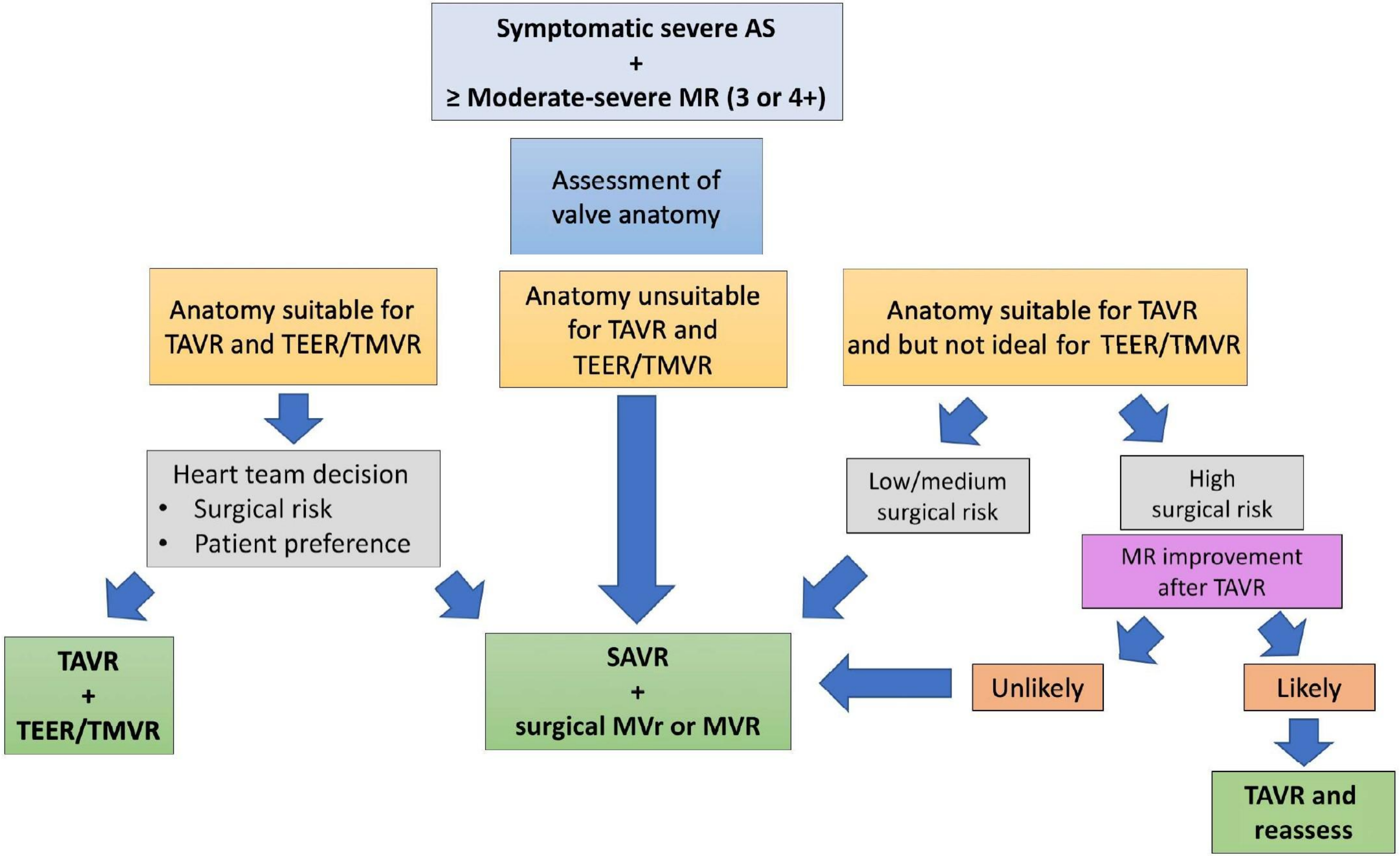
How to predict the effect of AS intervention on concomitant MR

Madalina Garbi MD MA FRCP

Royal Papworth Hospital, Cambridge, UK

2025

Significance depends on type of treatment planned



Reed Kapadia, JAHA 2023

AS + secondary MR

Unanswered questions:

TAVR for LFLG severe AS with ≥ moderate-severe MR

Why does MR improve?

LFLG severe AS with reduced LVEF

(1) Improved LVEF → Improved LV dimensions → Less MV annular dilation → Reduced FMR
(2) Reduced LV afterload → Reduced FMR

LFLG AS with preserved LVEF (Paradoxical)

(1) Improved LV afterload → Reduced Filling Pressures → LV/LA dimensions → Reduced FMR

Why does MR Not Improve?

(1) Failure of improvement in LVEF and/or dimensions
(2) Primary MR (Degenerative, MAC related)
(3) Failure to improve hemodynamics (LVEDP/LAP)
(4) Atrial MR (Severe annular dilatation)

Treatment strategies?

Mild or Moderate (1 or 2+) MR → Medical Management / TAR

≥ Moderate-severe (3 or 4+) MR → GDMT → Consider CRT if eligible → TEER or TMVR or TAR

Reed Kapadia, JAHA 2023

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Mitral regurgitation combined with tricuspid regurgitation

Always treat first left? What is the role of aetiology in decision making?

Dr Bushra Rana
Consultant Cardiologist
Clinical Lead Cardiac Diagnostics and Echocardiography Services
Imperial College Healthcare Trust, Hammersmith Hospital, London
Imperial College London
Cleveland Clinic London

2025

Mitral regurgitation combined with tricuspid regurgitation

Key Facts

Significant TR is a predictor of outcomes following LH valve surgery
S-TR will resolve following successful MV surgery
Current ESC guidelines *TA dilatation* ≥40mm or ≥21 mm/m²
≥ Mild TR

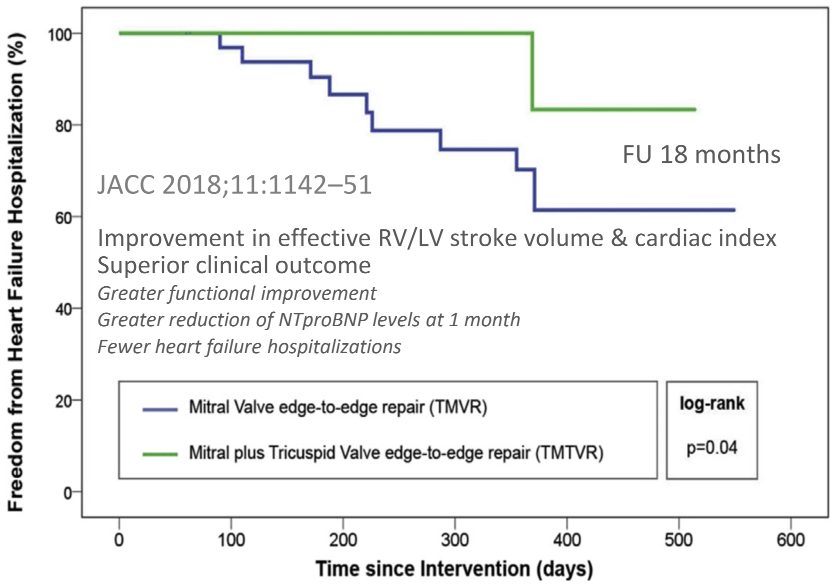
Surgical multicentre RCT 2y FU
Concomitant TV repair ↓progression to severe TR
Moderate rather than mild TR, at expense of PPM implantation

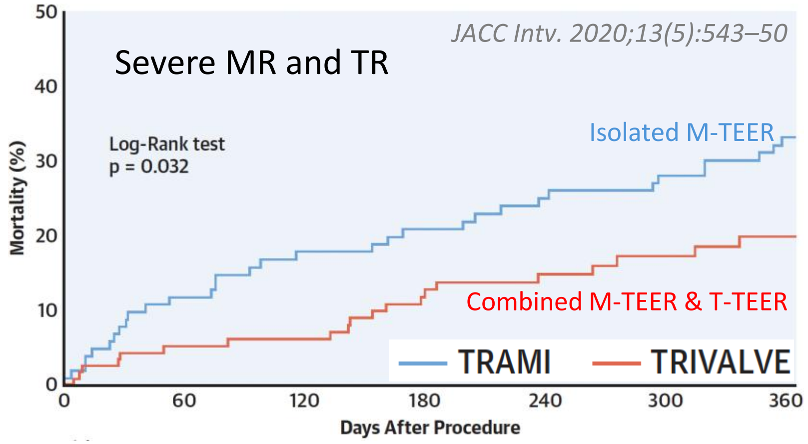
M-TEER cohort, 70% of TR does not regress, in 15% TR worsens
Significant TR at baseline 22%, 80% secondary TR
Higher comorbidities ↓LVEF, ↑LA, older age, female, AF, ↓RV, ↑PH, liver/renal dis, anaemia
Post M-TEER no change in TR severity at 1 month
Worse outcome at 1yr

Concomitant TV intervention associated with superior clinical outcomes

Gammie et al NEJM 2022;386:327-39

Rates of HF Hospitalization following TMTVR and TMVR





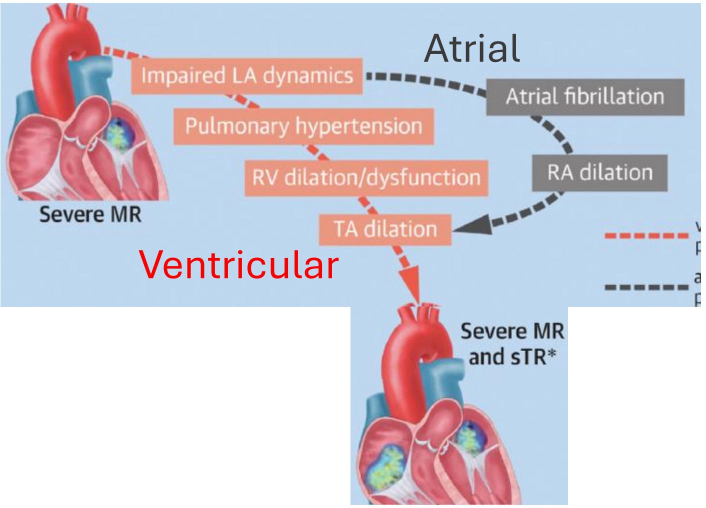
Pathophysiology of TR in M-TEER: Role of aetiology

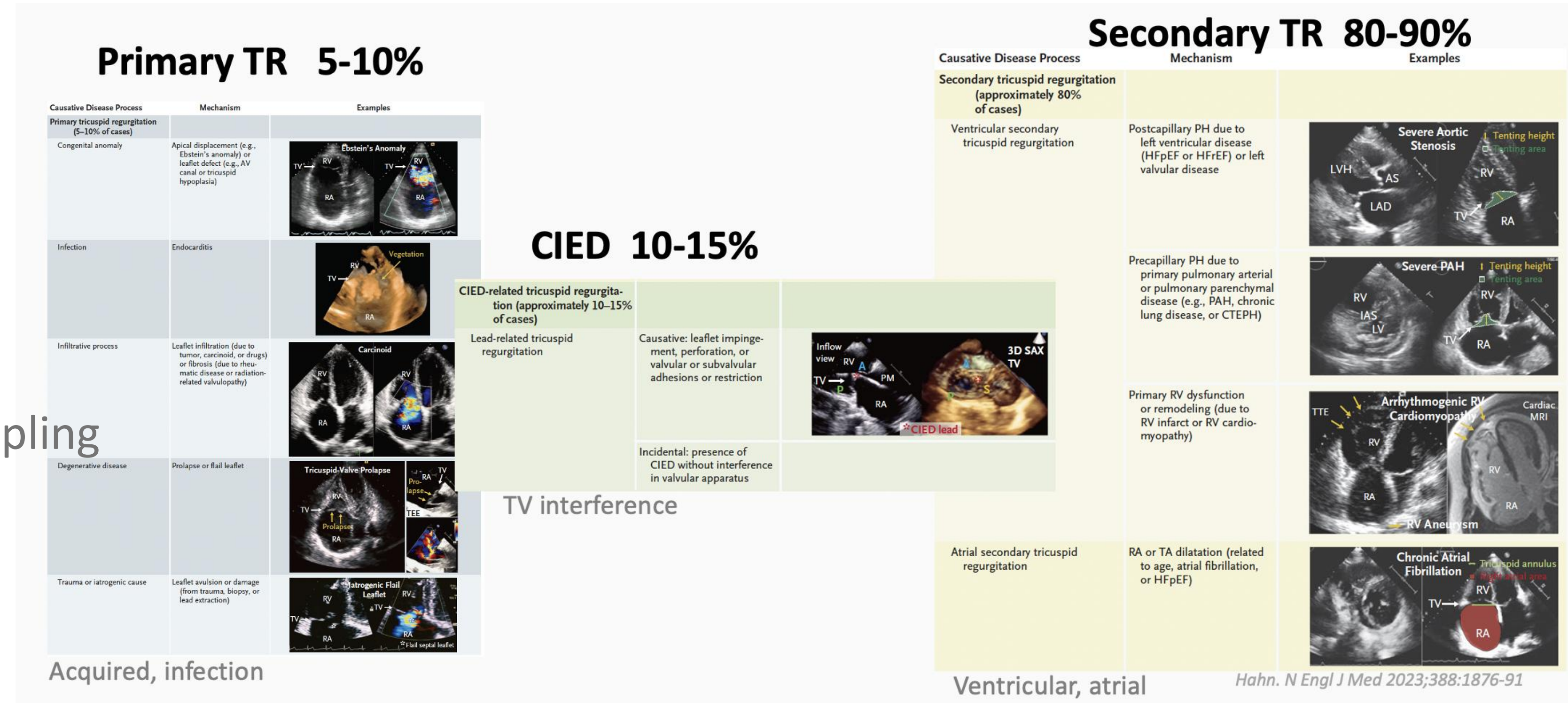
Secondary TR

Atrial *versus* Ventricular

Atrial phenotype

Severe RA dilatation, AF
TV annulus dilatation
No PH or IpcPH, with
RV function preserved, RV-PA coupling





Primary TR 5-10%

Causative Disease Process	Mechanism	Examples
Primary tricuspid regurgitation (5–10% of cases)		
Congenital anomaly	Apical displacement (e.g., Ebstein's anomaly) or leaflet defect (e.g., AV canal or tricuspid hypoplasia)	Ebstein's Anomaly
Infection	Endocarditis	Vegetation
Infiltrative process	Leaflet infiltration (due to tumor, carcinoid, or drugs) or fibrosis (due to rheumatic disease or radiation-related valvulopathy)	Carcinoid
Degenerative disease	Prolapse or flail leaflet	Tricuspid-Valve Prolapse
Trauma or iatrogenic cause	Leaflet avulsion or damage (from trauma, biopsy, or lead extraction)	Iatrogenic Flail Leaflet

Acquired, infection

CIED 10-15%

Causative Disease Process	Mechanism	Examples
CIED-related tricuspid regurgitation (approximately 10–15% of cases)		
Lead-related tricuspid regurgitation	Causative: leaflet impingement, perforation, or valvular or subvalvular adhesions or restriction	Inflow view; 3D SAX TV; *CIED lead
	Incidental: presence of CIED without interference in valvular apparatus	

TV interference

Secondary TR 80-90%

Causative Disease Process	Mechanism	Examples
Secondary tricuspid regurgitation (approximately 80% of cases)		
Ventricular secondary tricuspid regurgitation	Postcapillary PH due to left ventricular disease (HFpEF or HFrEF) or left valvular disease	Severe Aortic Stenosis
	Precapillary PH due to primary pulmonary arterial or pulmonary parenchymal disease (e.g., PAH, chronic lung disease, or CTEPH)	Severe PAH
	Primary RV dysfunction or remodeling (due to RV infarct or RV cardiomyopathy)	Arrhythmogenic RV Cardiomyopathy; RV Aneurysm
Atrial secondary tricuspid regurgitation	RA or TA dilatation (related to age, atrial fibrillation, or HFpEF)	Chronic Atrial Fibrillation

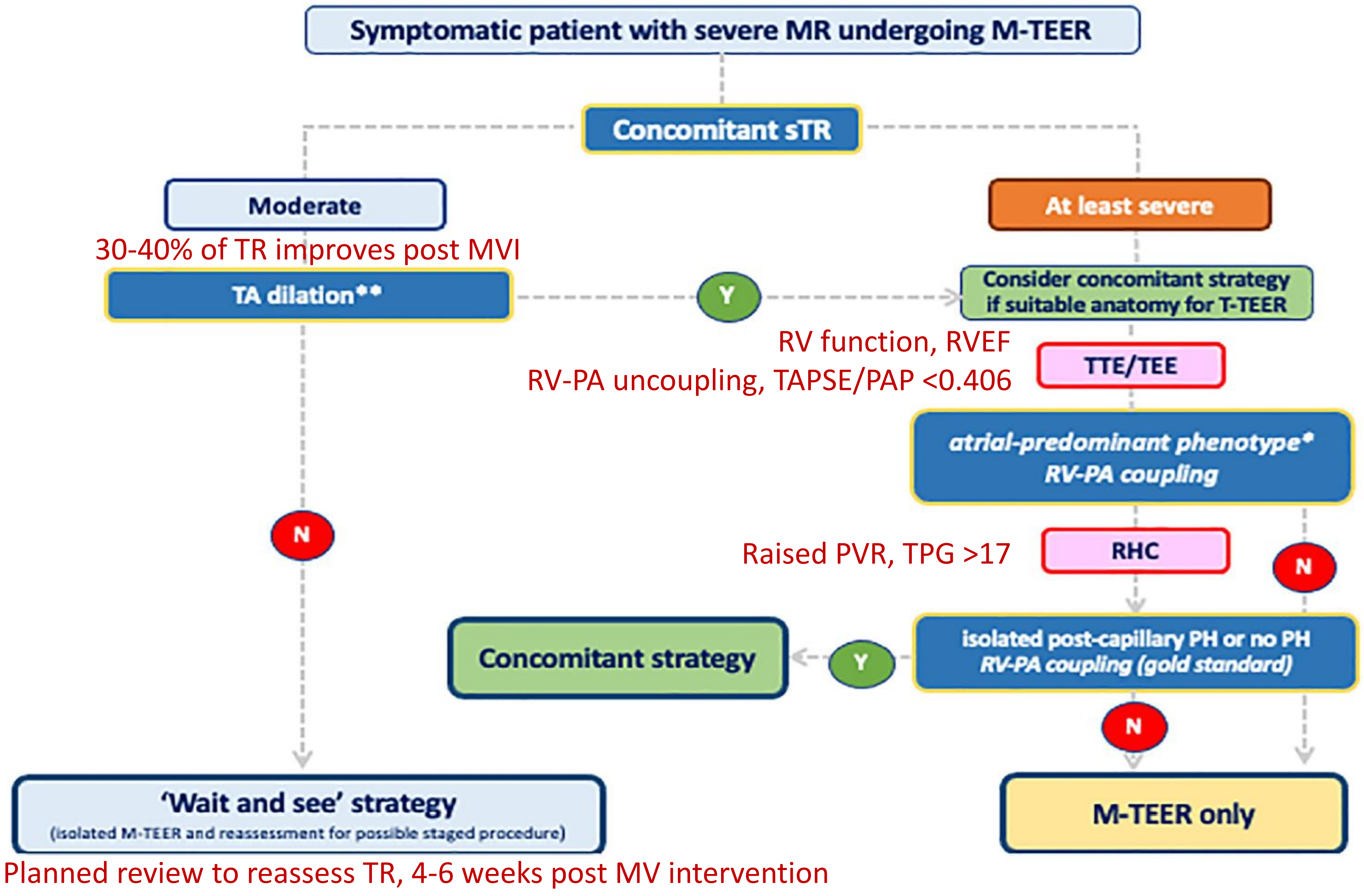
Ventricular, atrial

Hahn. N Engl J Med 2023;388:1876-91

Multimodality assessment

TTE TR severity/phenotypes RV function, PAP, TAPSE/PAP ratio
TOE TR grade, anatomy, annulus size, TVI suitability
RHC PH presence/type PVR/reversibility
CMR RV volumes, RVEF, scar burden

Patient selection for concomitant TV intervention



Severe TR, Moderate TR may improve

Aetiology will TR resolve?
Primary TR, Atrial STR, CIED related

Disease staging
RV function matches afterload
Absence of pulmonary vasculopathy

Clinical signs of ↓cardiac reserve
RHF/systemic venous congestion
Low CO, low BP
LV impairment
High NTproBNP

Severe LA dilatation

?Futility
TRI-score ≥ 6, may reflect end-stage dis
Severe pulmonary vasculopathy

JACC *2023;16:127-139*

Key Messages

Following transcatheter MV intervention, significant TR does not resolve in 60-70%

TR negatively impacts clinical outcomes

Concomitant transcatheter TV intervention for severe TR at the time of MV intervention appears to confers superior clinical outcomes

Management of TR at time of M-TEER should include an understanding of…

- TR severity: moderate TR adopt 'wait & see' with planned review to reassess TR 4-6 weeks post MV intervention
- TR phenotype: Atrial *versus* Ventricular secondary TR Severe RA/TV annulus dilatation, no PH or IpcPH, with RV-PA coupling
- Multi-modality approach: TTE TR severity , TV anatomy/annulus dilatation, RV function, PAP, TAPSE/PAP ratio
  - TOE TR grading, aetiology, anatomical suitability for TEER
  - RHC PH phenotype (no PH *v* IpcPH *v* CpcPH), TPG, DPG, PVR, reversibility
- Consider concomitant TV intervention in secondary atrial TR
- Staging of disease guides decision making clinical, biochemical, haemodynamic parameters

Transcatheter treatment of combined MR and TR:
a case when I treated first left and one when I treated first right!

Nina Ajmone Marsan, MD, PhD, FESC

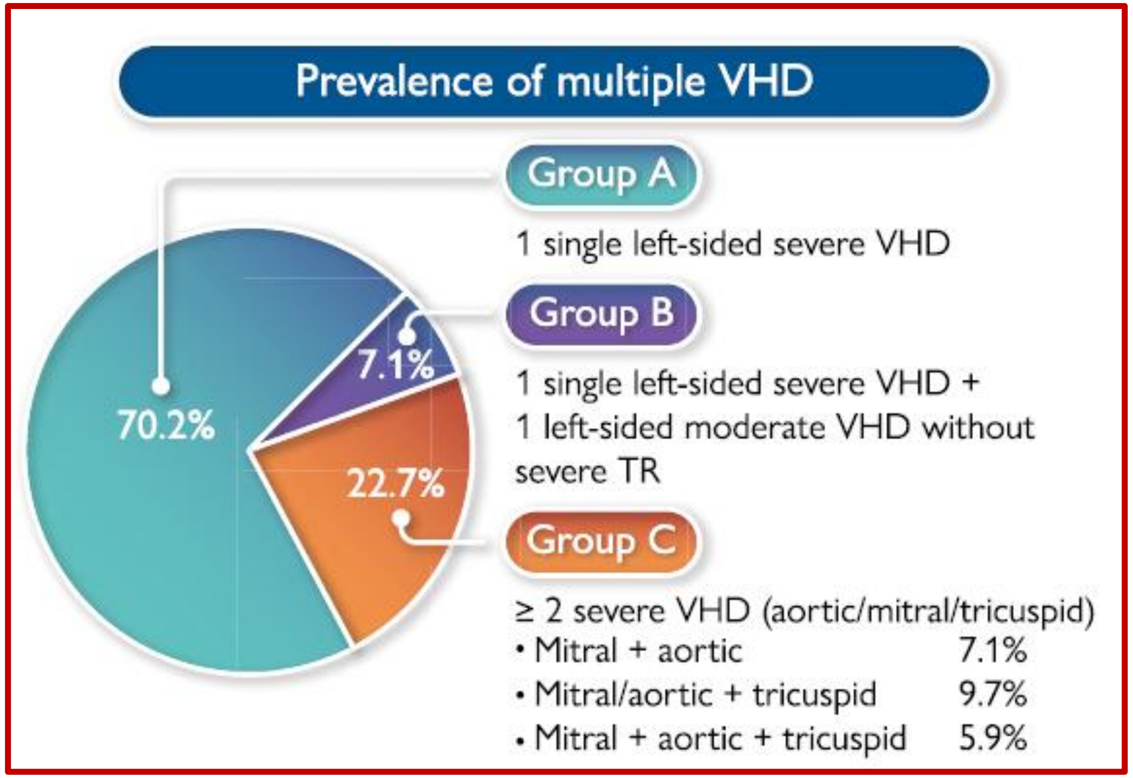
2025

Tricuspid regurgitation in MVD

In the EURORP VHD II Survey the combination of severe left-sided VHD + severe TR was 15.6%

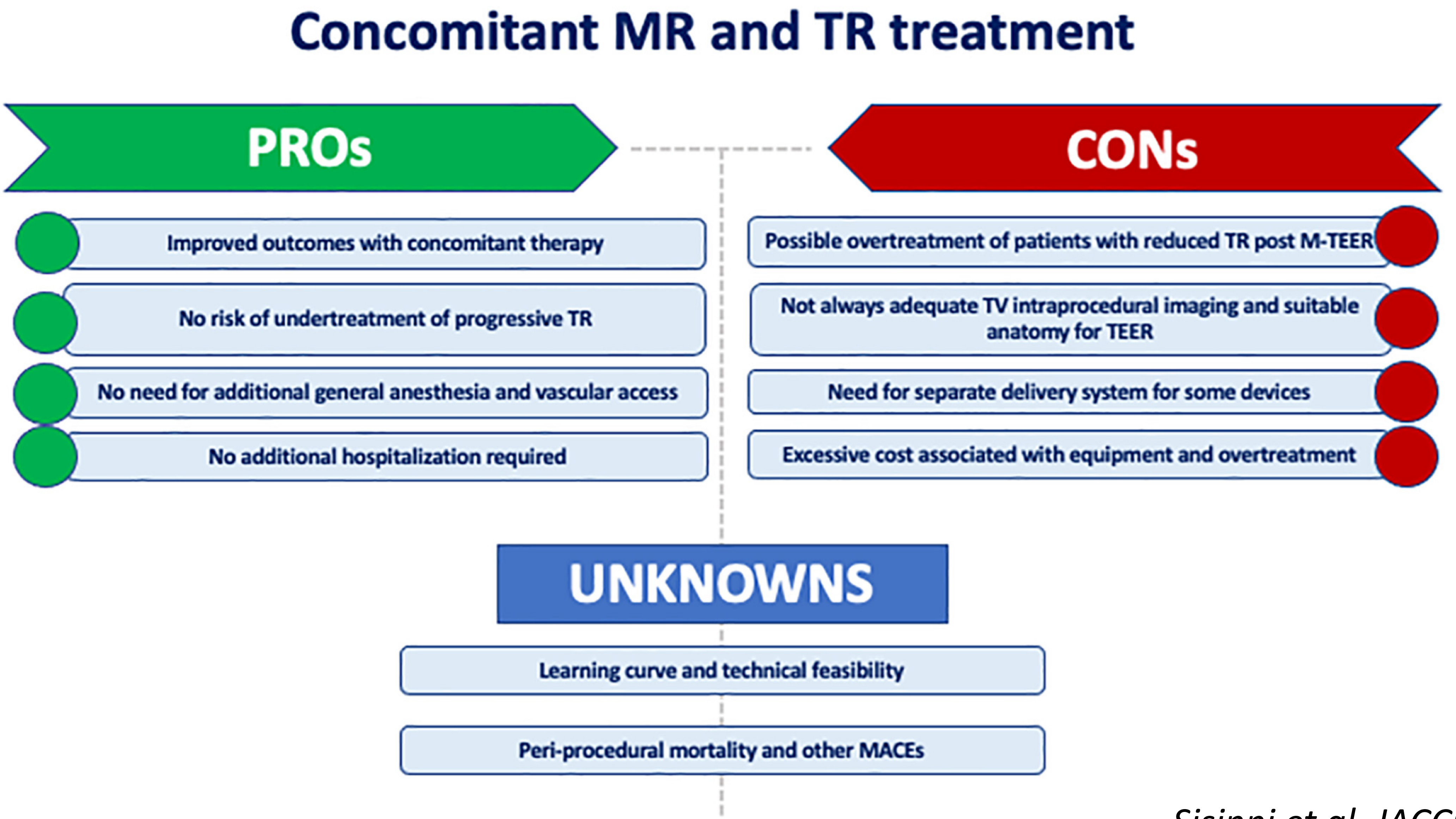
Moderate or severe secondary TR is observed in about 1/3 of patients undergoing surgical or transcatheter mitral valve intervention…

…also in approximately 15% of patients undergoing TAVR

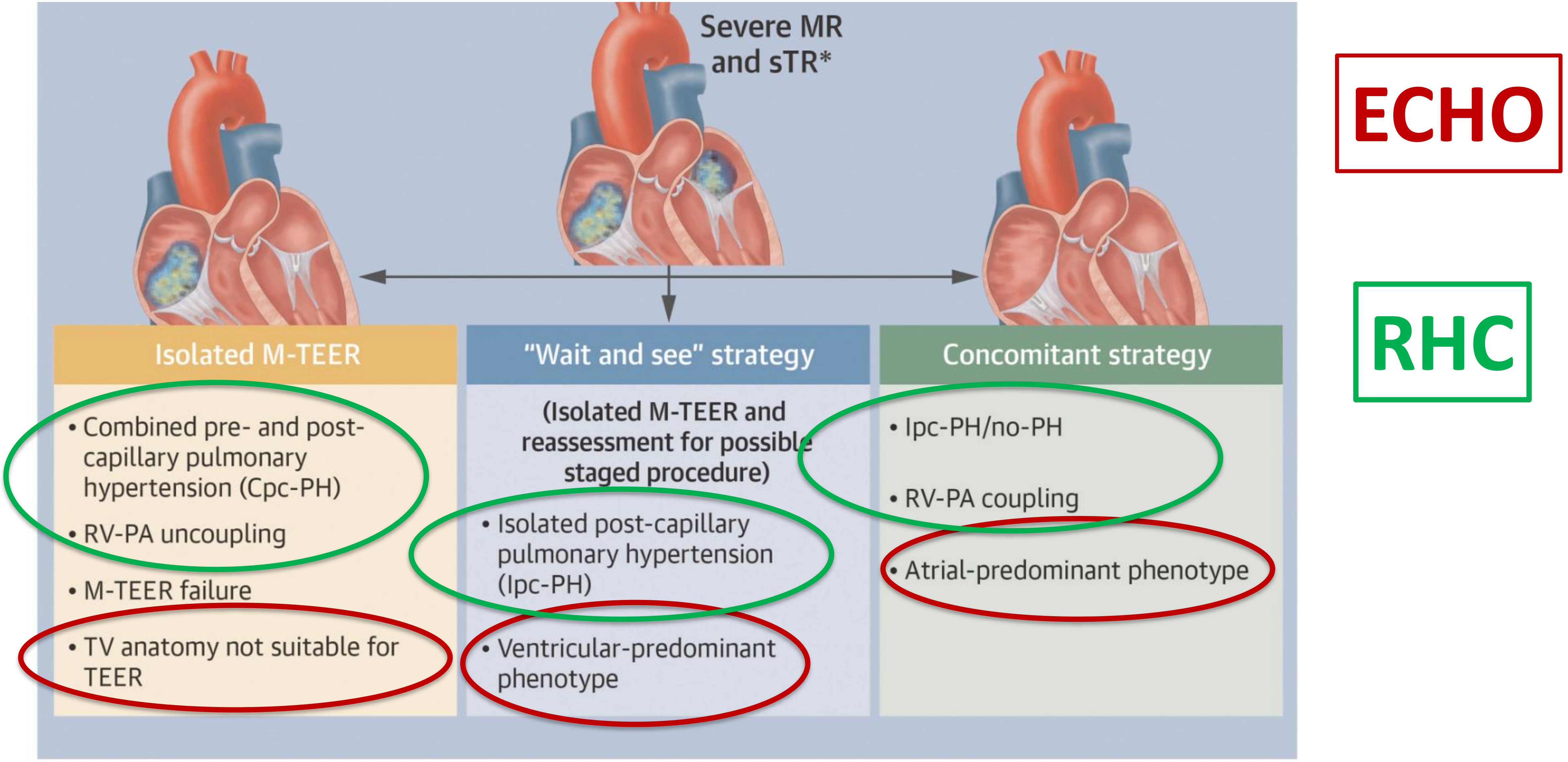


Triboully et al, EHJ 2022
Sisinni et al, JACCint 2023
Tomii et al JACCint 2021

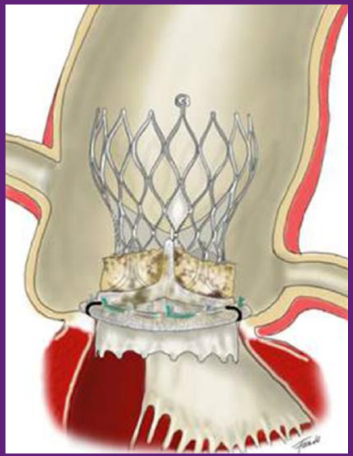
FIGURE 3 Pros and Cons of Concomitant MR and TR Percutaneous Treatment



Sisinni et al, JACCint 2023



Sisinni A, et al. J Am Coll Cardiol Intv. 2023;16(2):127-139.



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Aortic valve in valve procedures
New frontiers in planning

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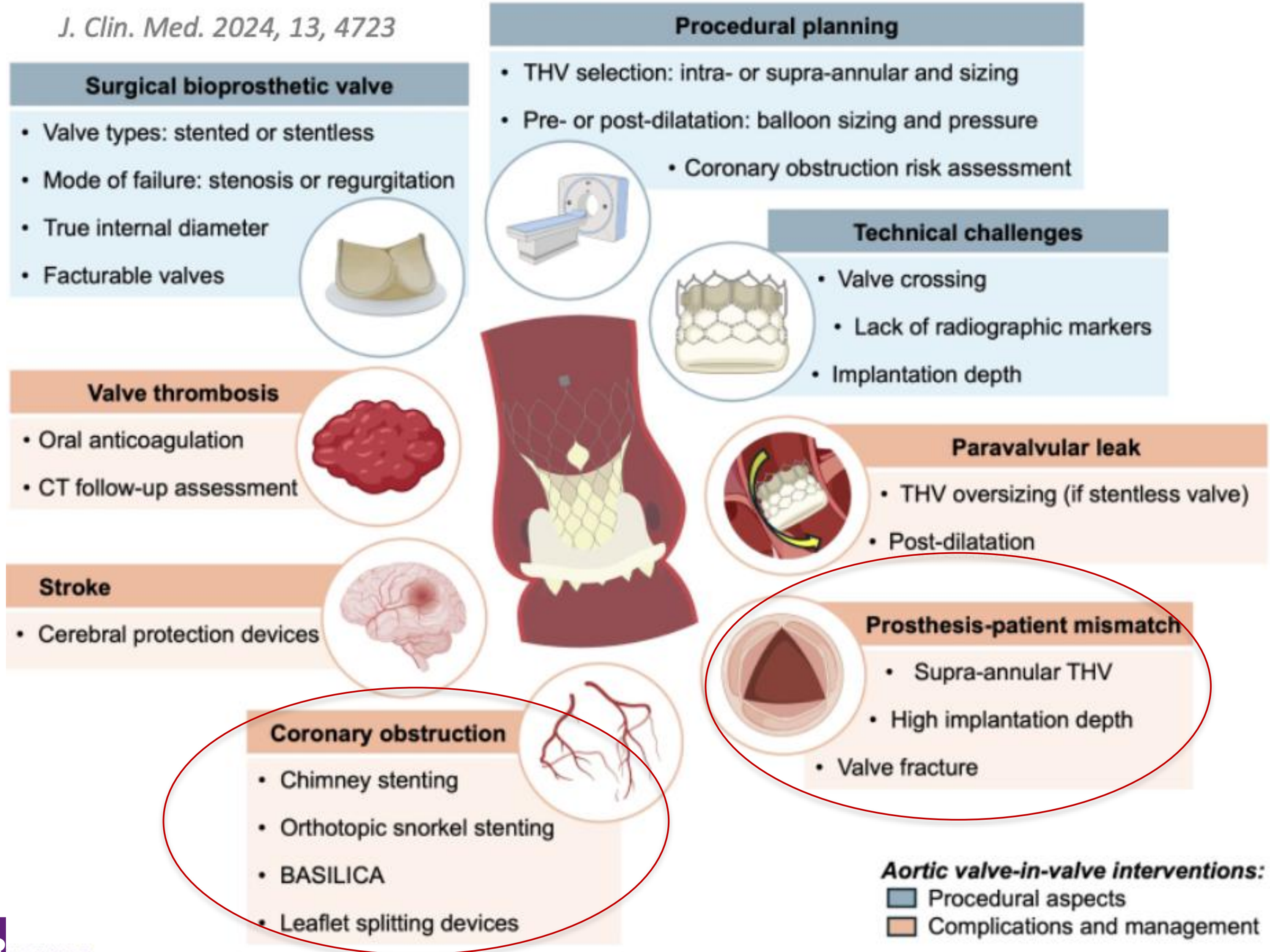
Imperial College London

Cleveland Clinic London

2025

Special thanks to Marjolein Bierman for 3mensio images

Challenges in aortic ViV procedures



Key concepts

Surgical AVR design

SVD aetiology & valve failure

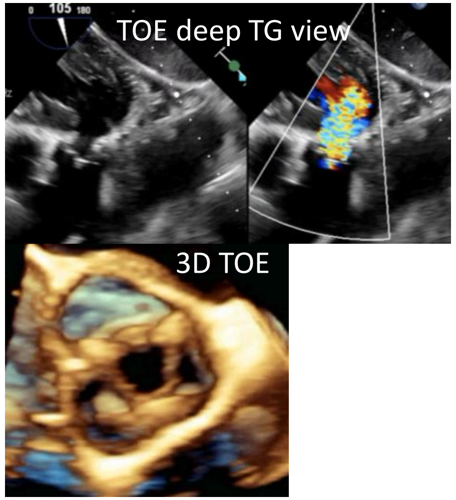
Prosthetic valve function

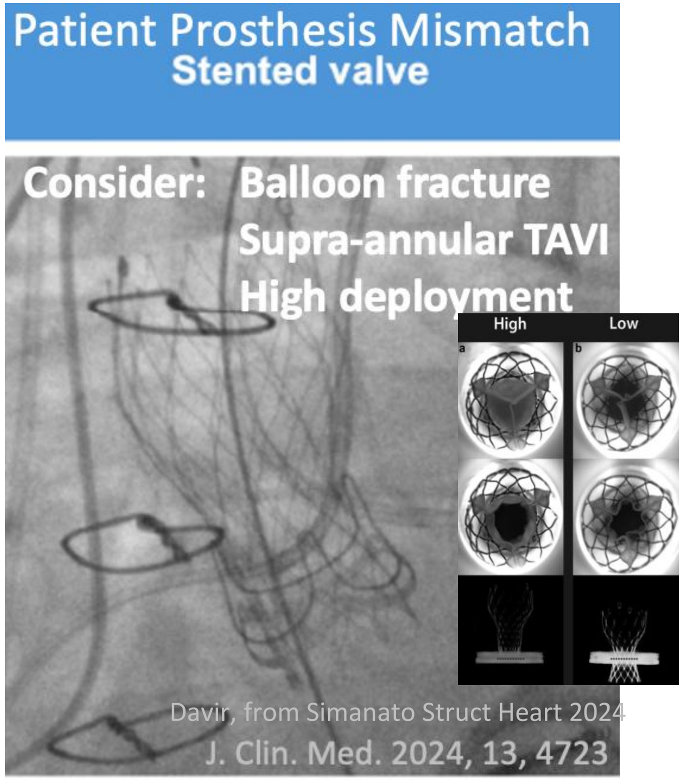
Anatomical features

Planning aortic valve-in-valve procedures

Patient prosthesis mismatch

High gradients associated with ↑mortality
mnAVG >20, EOAi <0.65 (if BMI >30 EOAi 0.55)





High risk features

Small prosthesis ≤ 21, smaller true ID
Baseline high gradient serial data, immediate post-op
TTE and TOE key role valve anatomy & haemodynamics

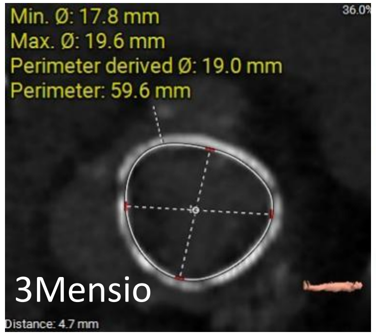
True internal diameter

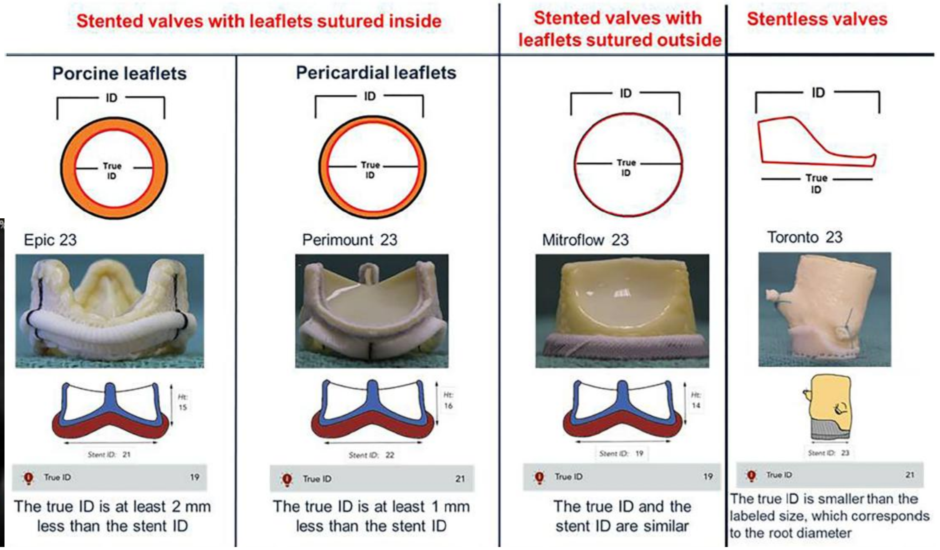
TAVI vale sizing

True ID
typically < label size
measured by CT
3mensio/Feops
perimeter derived diam

Perimount RSR 2800 Valve,* Magna 3000 Valve

Surgical Valve Size	19 mm	21 mm	23 mm
Inner Diameter	18	20	22
Height	14	15	16





Commissural misalignment

Disrupts local flow profile
↑risk of leaflet thrombosis

Planning aortic valve-in-valve procedures

Risk of coronary obstruction

High risk features

Small aortic root or sinotubular junction

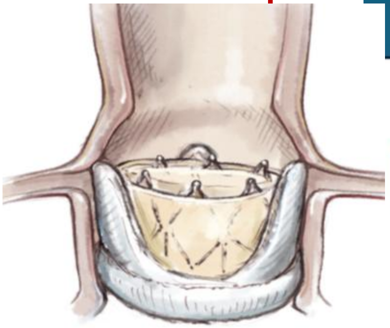
Low coronary height

Prosthesis type *esp leaflets external to stent frame*

Optimal TAVI placement:

Commissural alignment

Avoid over sizing, over expansion

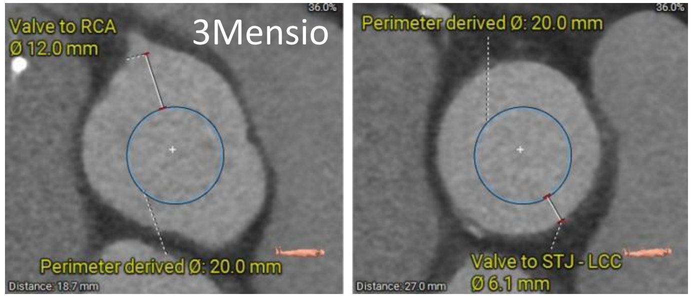


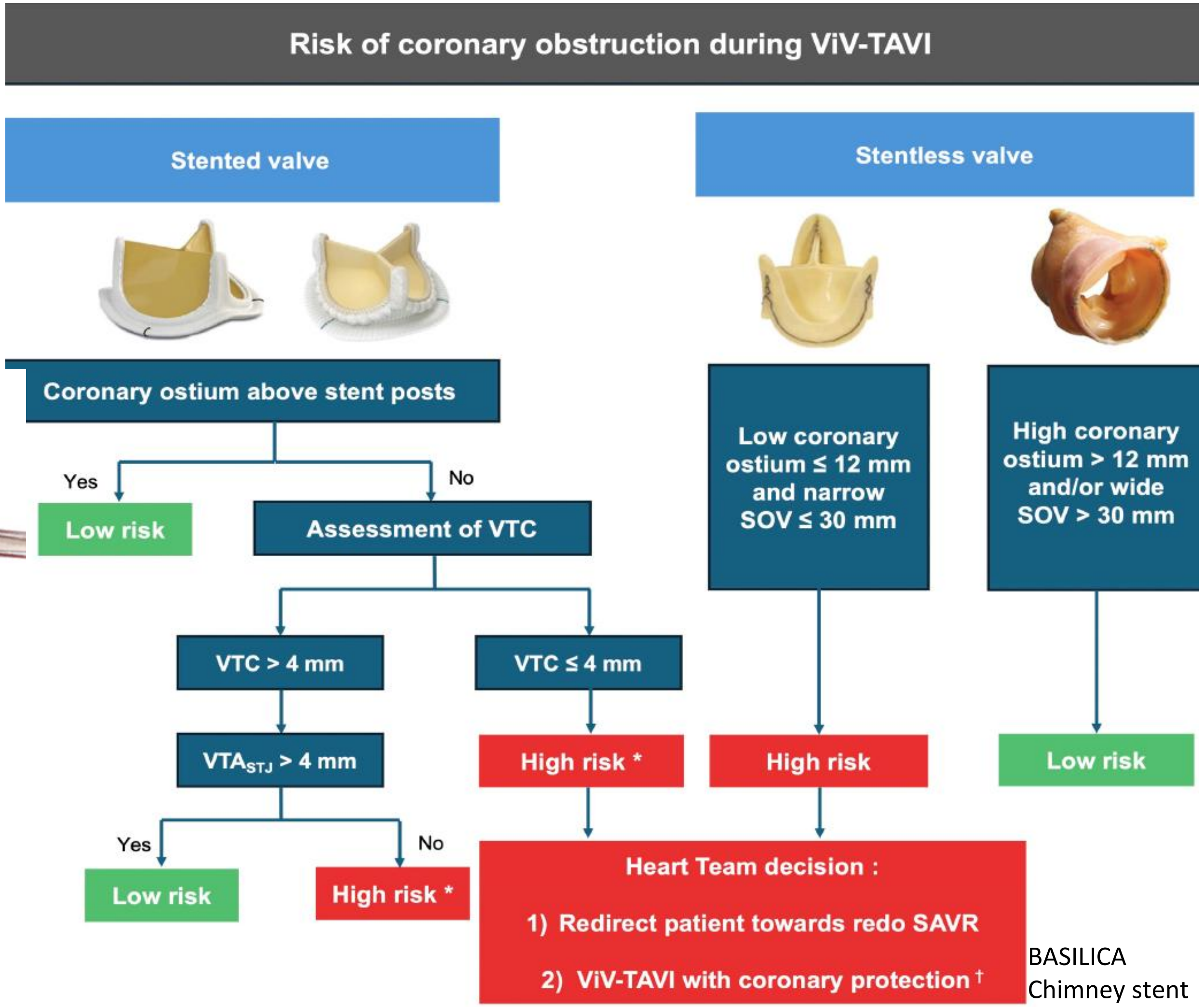
CT parameters

VTC *virtual valve to coronary distance*

VTSTJ *valve to sinotubular jct*

≤ 4mm





BASILICA
Chimney stent

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The challenge of treating mitral annular calcification (MAC): is surgery the only option?

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2025

A growing population, combined AS and MS: mitral calcification in TAVI patients

The International Journal of Cardiovascular Imaging (2023) 39:2183–2192
https://doi.org/10.1007/s10554-023-02931-w

ORIGINAL PAPER

Hemodynamic implications of mitral annular calcification in patients undergoing transcatheter aortic valve implantation for severe aortic stenosis

Kensuke Hirasawa[1,2] · Steele C. Butcher[1,3] · Ana Rita Pereira[1,4] · Maria Chiara Meucci[1,5] · Jan Stassen[1] · Philippe van Rosendael[1] · Nina Ajmone Marsan[1] · Jeroen J Bax[1,6] · Victoria Delgado[1,7]

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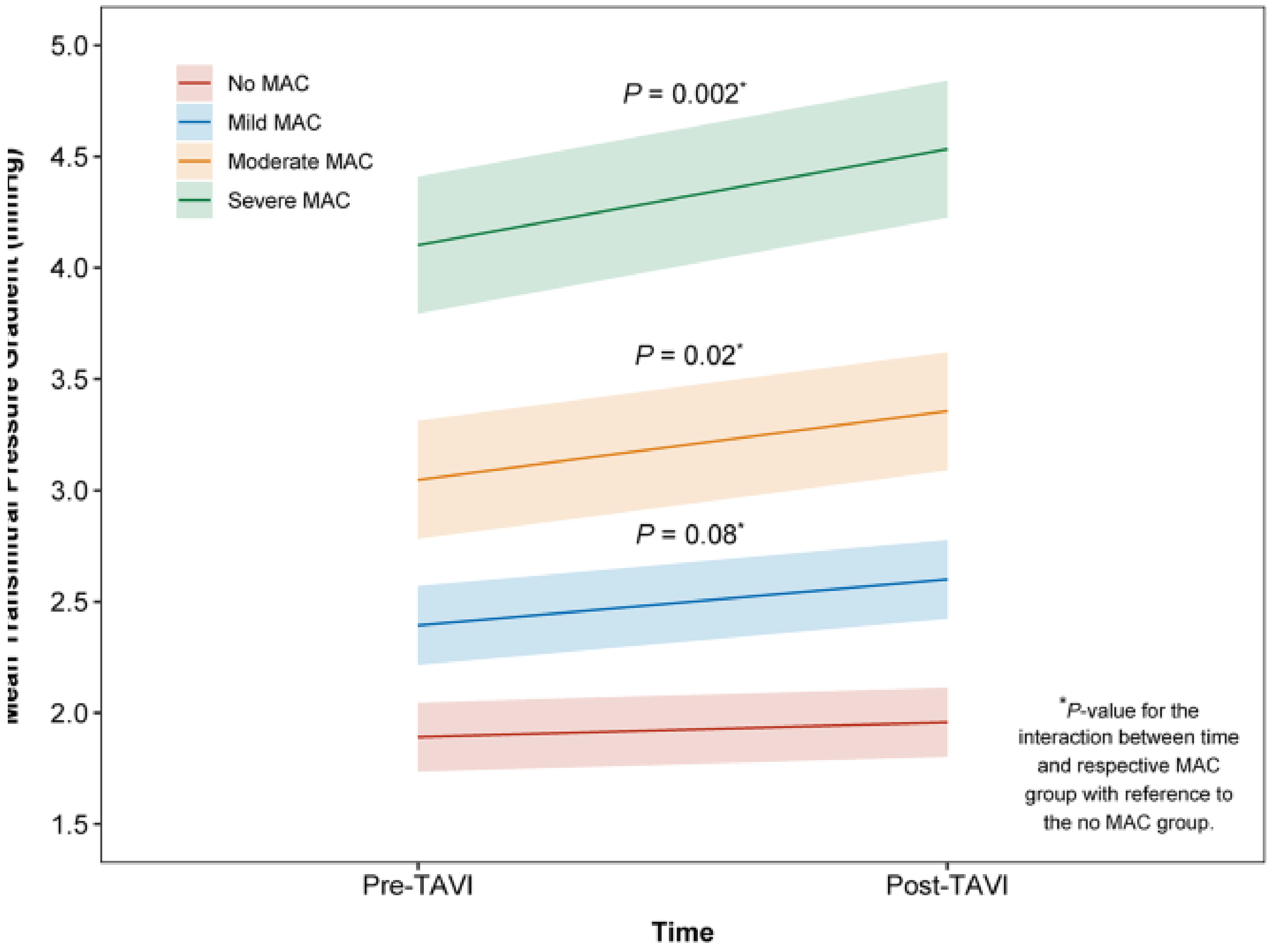
Abstract

Purposes Predicting hemodynamic changes of stenotic mitral valve (MV) lesions with mitral annular calcification (MAC) following transcatheter aortic valve implantation (TAVI) may inform clinical decision-making. This study aimed to investigate the association between the MAC severity quantified by computed tomography (CT) and changes in mean transmitral gradient (mTMG), mitral valve area (MVA) and stroke volume index (SVi) following TAVI.

Methods and results A total of 708 patients (median age 81, 52% male) with severe aortic stenosis (AS) underwent pre-procedural CT and pre- and post-TAVI transthoracic echocardiography. According to the classification of MAC severity determined by CT, 299 (42.2%) patients had no MAC, 229 (32.3%) mild MAC, 102 (14.4%) moderate MAC, and 78 (11.0%) severe MAC. After adjusting for age and sex, there was no significant change in mTMG following TAVI (Δ mTMG = 0.07 mmHg, 95% CI -0.10 to 0.23, P = 0.92) for patients with no MAC. In contrast, patients with mild MAC (Δ mTMG = 0.21 mmHg, 95% CI 0.01 to 0.40, P = 0.018), moderate MAC (Δ mTMG = 0.31 mmHg, 95% CI 0.02 to 0.60, P = 0.019) and severe MAC (Δ mTMG = 0.43 mmHg, 95% CI 0.10 to 0.76, P = 0.0012) had significant increases in mTMG following TAVI, with greater changes associated with increasing MAC severity. In contrast, there was no significant change in MVA or SVi following TAVI.

Conclusion In patients with severe AS undergoing TAVI, MAC severity was associated with greater increases in post-procedural mTMG whereas MVA or SVi remained unchanged. MAC severity should be considered for potential subsequent MV interventions if TAVI does not improve symptoms.

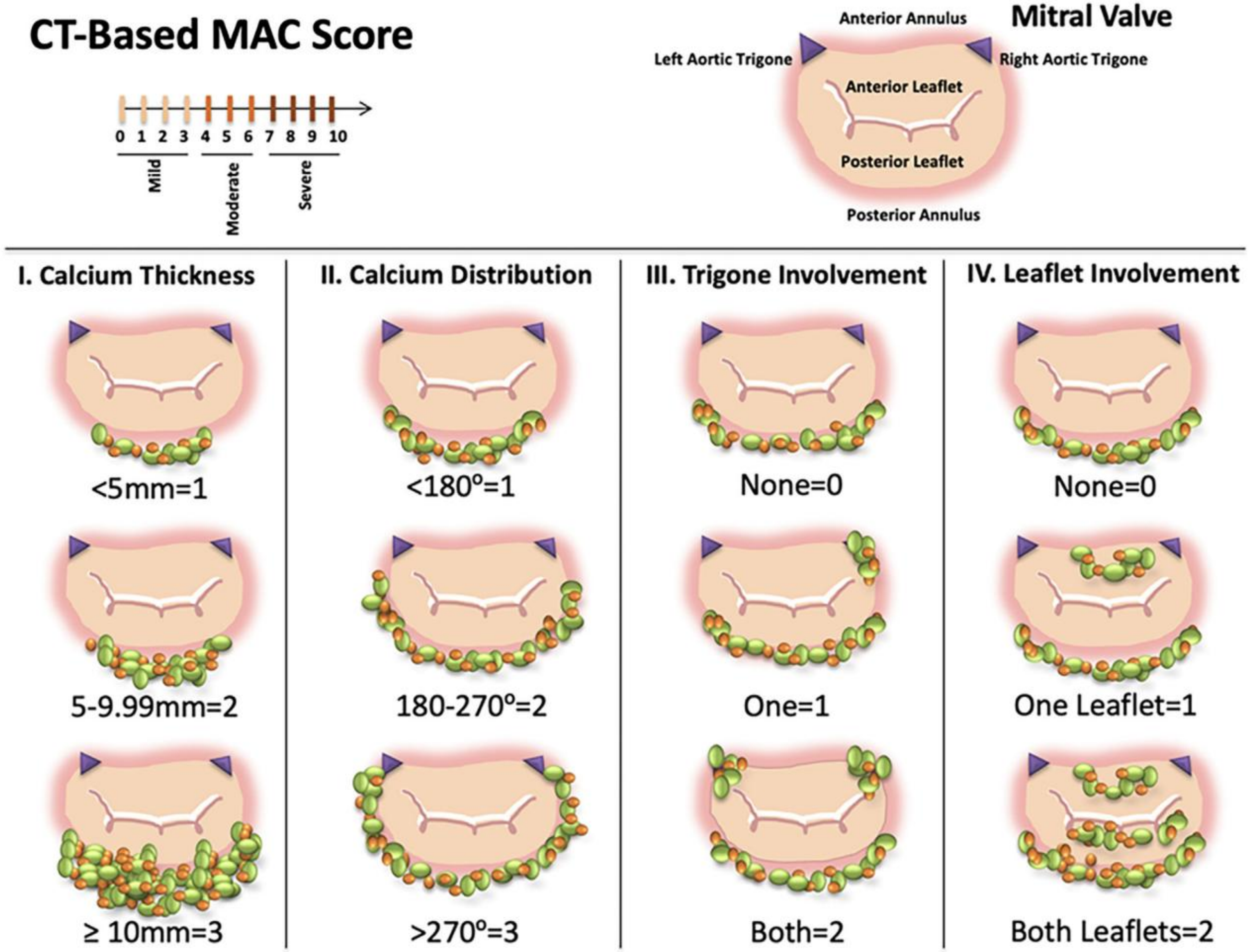
Keywords Transcatheter aortic valve intervention · Aortic stenosis · Mitral annular calcification · Mitral stenosis · Hemodynamics



MAC SCORE

	Transthoracic Echocardiography
Mild	<180° MAC circumference
Moderate	180°-270° MAC circumference
Severe	≥270° MAC circumference or ventricular wall calcification

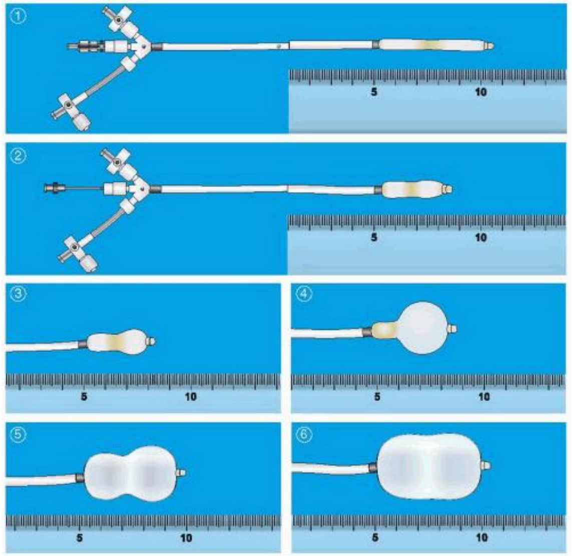
	TEE and/or Cardiac CT Imaging
Mild	MAC score <3
Moderate	MAC score 4-6
Severe	MAC score ≥7 or ventricular wall calcification or volume > 1,000 mr

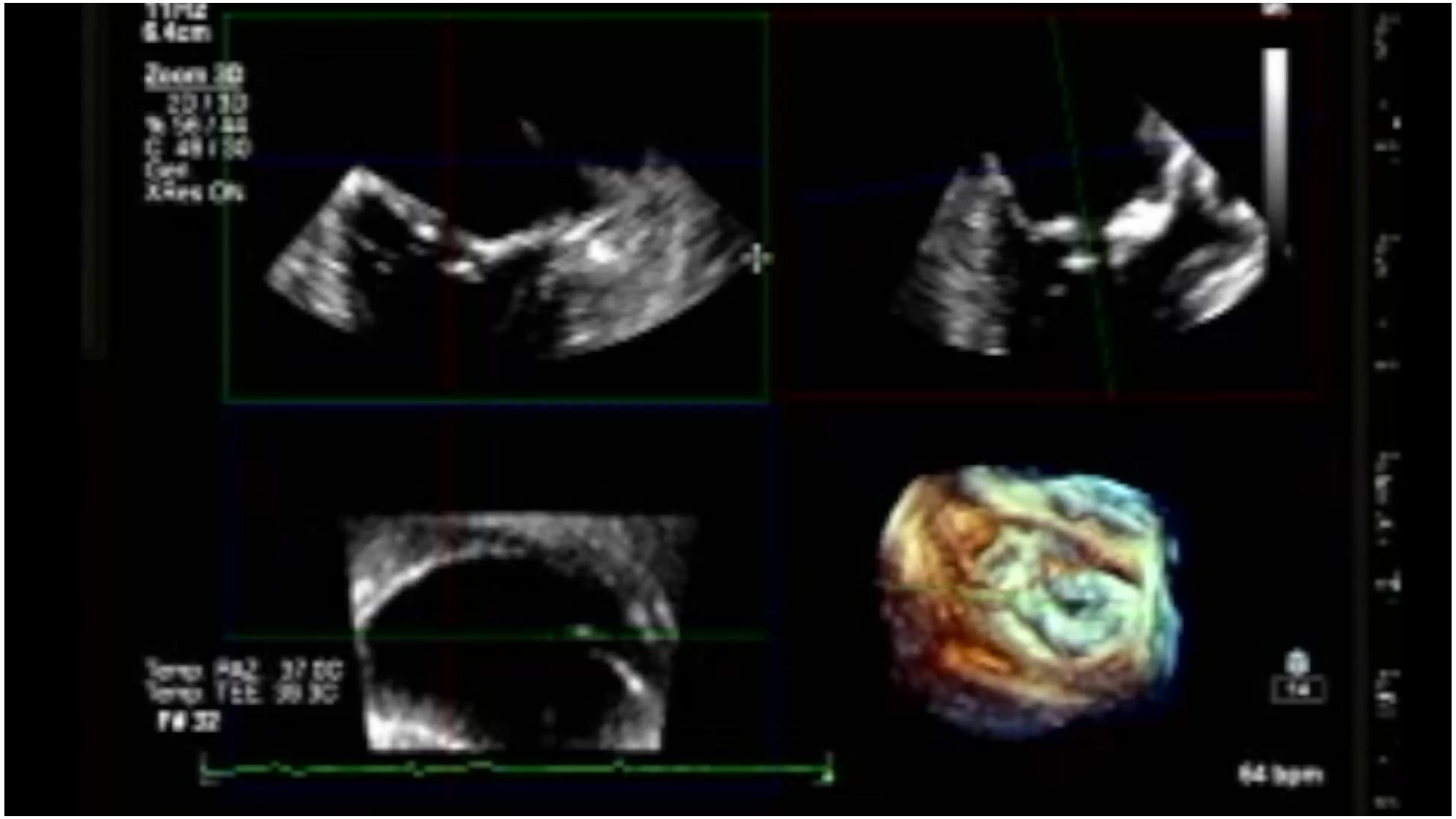


GUERRERO M ET AL. J Am Coll Cardiol Intv 2023;16:2195–2210

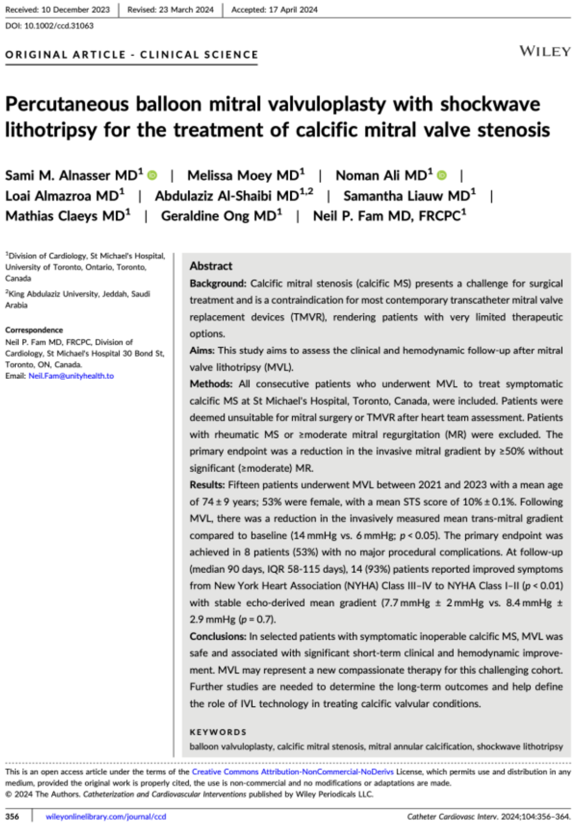
«modern» Percutaneous commissurotomy

- Hybrid room with potential for conversion
- TEE guided valve crossing
- Sequential dilation
- Echo-guided valve assessment





Lithotripsy for calcific MS



Received: 10 December 2023 | Revised: 23 March 2024 | Accepted: 17 April 2024
DOI: 10.1002/ccd.31063

ORIGINAL ARTICLE - CLINICAL SCIENCE
WILEY

Percutaneous balloon mitral valvuloplasty with shockwave lithotripsy for the treatment of calcific mitral valve stenosis

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Abstract

Background: Calcific mitral stenosis (calcific MS) presents a challenge for surgical treatment and is a contraindication for most contemporary transcatheter mitral valve replacement devices (TMVR), rendering patients with very limited therapeutic options.

Aims: This study aims to assess the clinical and hemodynamic follow-up after mitral valve lithotripsy (MVL).

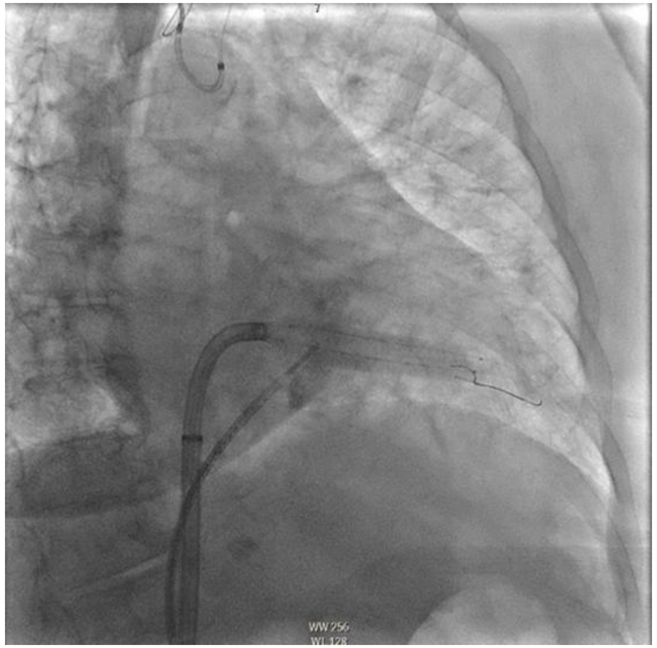
Methods: All consecutive patients who underwent MVL to treat symptomatic calcific MS at St Michael's Hospital, Toronto, Canada, were included. Patients were deemed unsuitable for mitral surgery or TMVR after heart team assessment. Patients with rheumatic MS or ≥moderate mitral regurgitation (MR) were excluded. The primary endpoint was a reduction in the invasive mitral gradient by ≥50% without significant (≥moderate) MR.

Results: Fifteen patients underwent MVL between 2021 and 2023 with a mean age of 74 ± 9 years; 53% were female, with a mean STS score of 10% ± 0.1%. Following MVL, there was a reduction in the invasively measured mean trans-mitral gradient compared to baseline (14 mmHg vs. 6 mmHg; $p < 0.05$). The primary endpoint was achieved in 8 patients (53%) with no major procedural complications. At follow-up (median 90 days, IQR 58-115 days), 14 (93%) patients reported improved symptoms from New York Heart Association (NYHA) Class III–IV to NYHA Class I–II ($p < 0.01$) with stable echo-derived mean gradient (7.7 mmHg ± 2 mmHg vs. 8.4 mmHg ± 2.9 mmHg ($p = 0.7$).

Conclusions: In selected patients with symptomatic inoperable calcific MS, MVL was safe and associated with significant short-term clinical and hemodynamic improvement. MVL may represent a new compassionate therapy for this challenging cohort. Further studies are needed to determine the long-term outcomes and help define the role of IVL technology in treating calcific valvular conditions.

KEYWORDS
balloon valvuloplasty, calcific mitral stenosis, mitral annular calcification, shockwave lithotripsy

356 | wileyonlinelibrary.com/journal/ccd | *Catheter Cardiovasc Interv*. 2024;104:356–364.

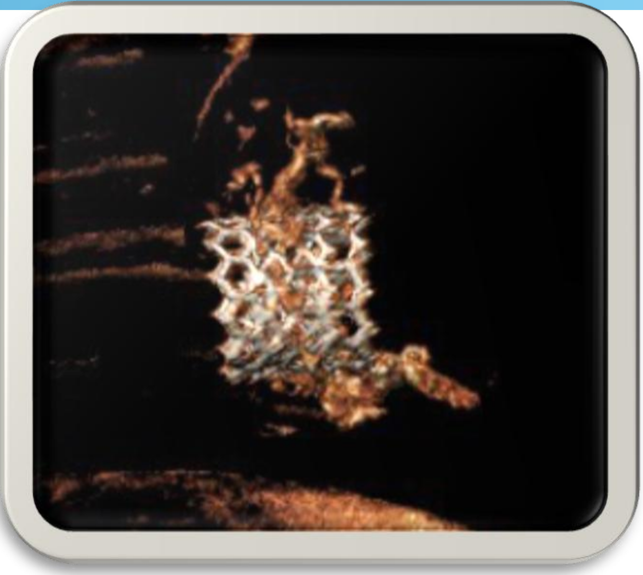
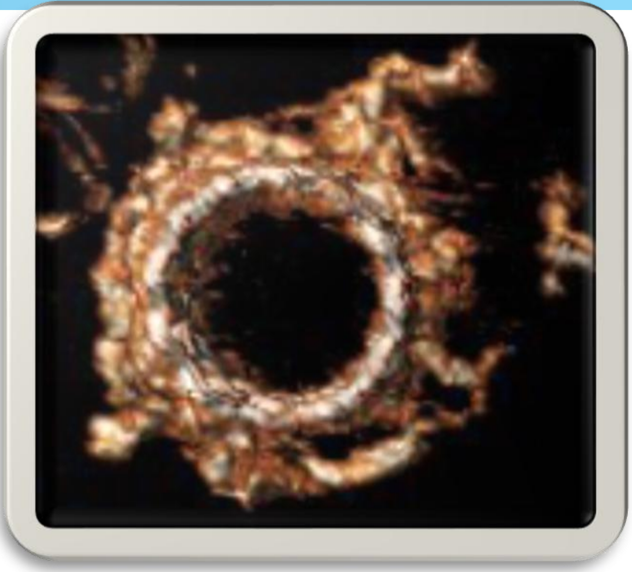
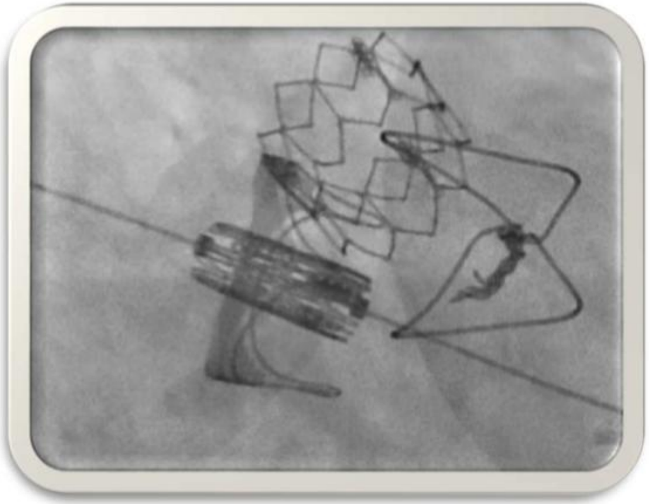
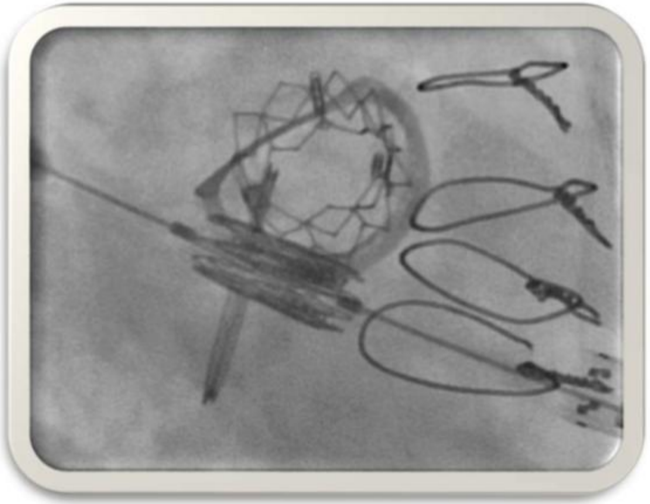


Procedural outcomes	
Procedural success* (*n*, %)	8 (53%)
Major procedural complications** (*n*, %)	0 (0%)
Reduction in transmittal gradient >30% compared to baseline (*n*, %)	15 (100%)
Reduction in transmittal gradient >70% compared to baseline (*n*, %)	4 (27%)
Reduction in mean gradient (mean, SD) (mmHg)	8 (4)♦
Reduction in left atrial pressure (mean, SD) (mmHg)	9 (7)♦
Change in mitral valve area (mean, SD) (cm^2)	+0.75 (0.5)♦

madrid IMAGING VALVES

mitral valve replacement / implantation

- valve in valve
- valve in ring
- valve in MAC
- TMVI

Transcatheter mitral valve implantation in patients with severe mitral annular calcification:

early results from the Tendyne MAC study

2020 PCR e-Course

Paul Sorajja, MD

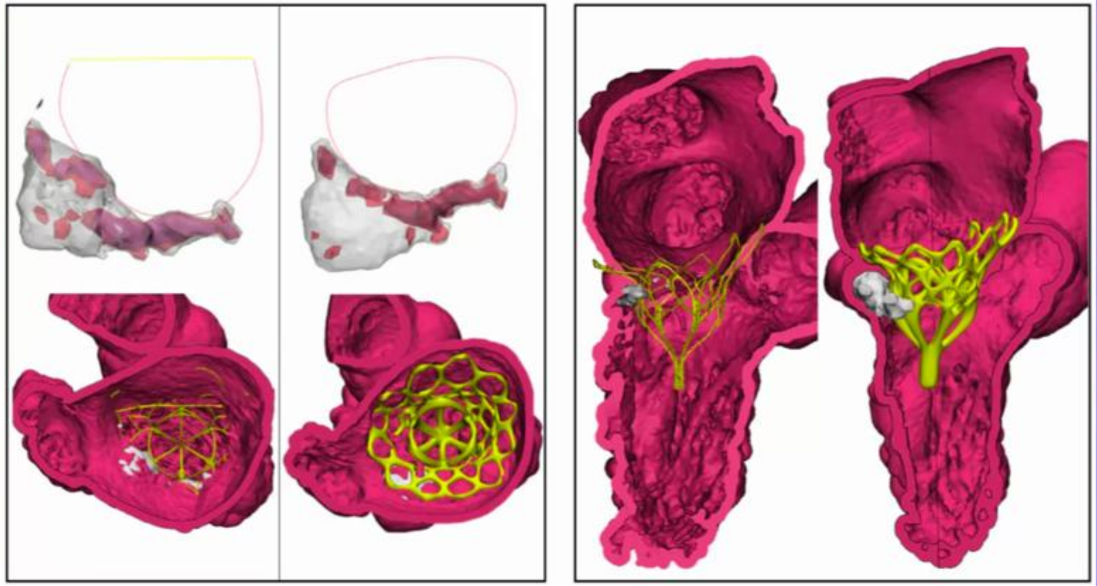
Results: 6-month Outcomes

- **Low all-cause mortality** through 6-mos
  - One death (mesenteric ischemia) at 16 days
- **Low rates of adverse events:**
  - 1 non-disabling stroke at 4 days
  - 1 moderate PVL resolved at 3 mos with plug
  - 2 subjects with new-onset AF; 1 cardioverted to NSR
- **Mean gradient, 4 ±1 mmHg**
- **No MR or PVL at 6-mos**

6-month outcomes	MAC FS (N=11)
All-cause mortality	9.1% (1/11)
Cardiac death	9.1% (1/11)
Stroke or TIA	9.1% (1/11)
Myocardial infarction	0.0% (0/11)
Cardiac arrest	0.0% (0/11)
New cardiac arrhythmia	18.2% (2/11)
MV re-intervention*	9.1% (1/11)
Bioprosthetic valve dysfunction	0.0% (0/11)
Endocarditis	0.0% (0/11)
Echo at 6-month Visit	
MR grade ≥ 1+	0.0% (0/9)
PVL ≥ 1+	0.0% (0/9)

* Site-reported

Procedural Results in Caseous Calcification



PCR madrid IMAGING VALVES

EPISODE 4: Multivalvular diseases

Aortic paravalvular leakages: how do I diagnose it and treat it percutaneously?

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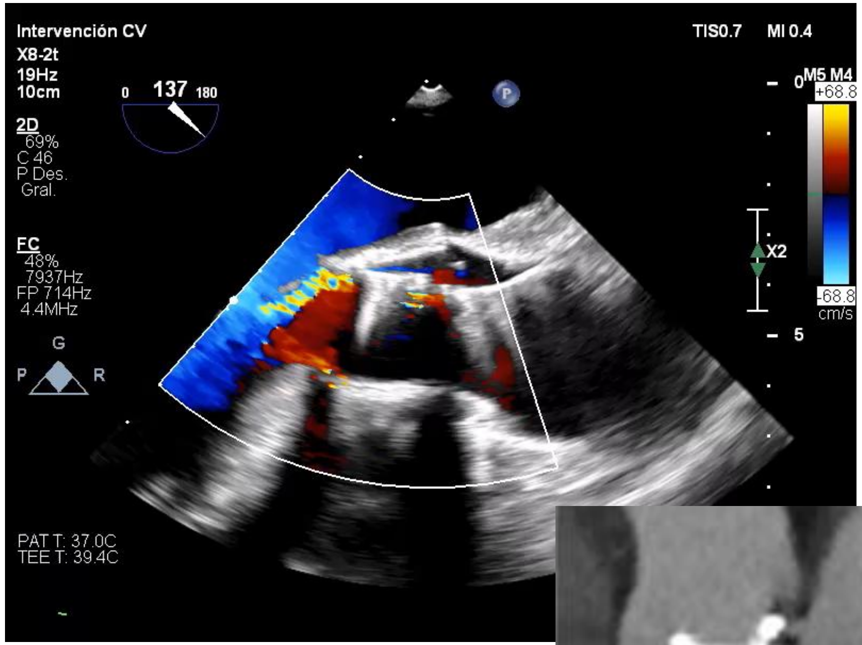
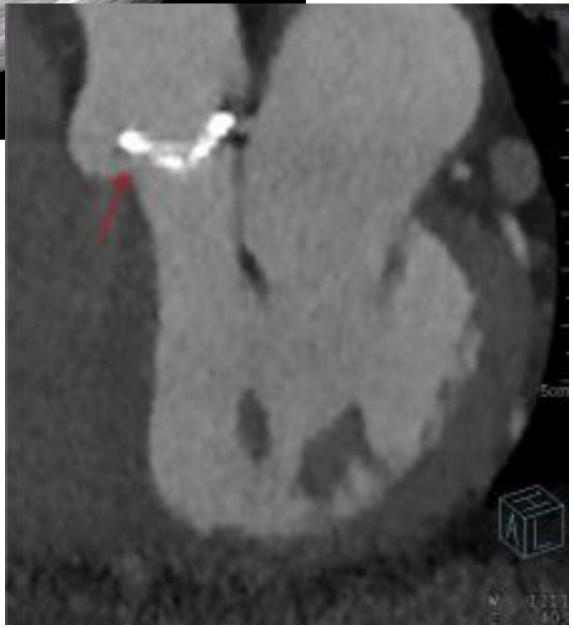
2025

Diagnosis & Severity assessment





European Heart Journal (2017) 00, 1–22
doi:10.1093/eurheartj/ehx211

SPECIAL ARTICLE

Clinical Trial Principles and Endpoint Definitions for Paravalvular Leaks in Surgical Prosthesis

An Expert Statement

Carlos E. Ruiz[1]*, Rebecca T. Hahn[2], Alain Berrebi[3], Jeffrey S. Borer[4], Donald E.

3-Class Grading Scheme	None/Trace	Mild		Moderate		Severe
4-Class Grading Scheme	1	1	2	2	3	4
Unifying 5-Class Grading Scheme	Trace	Mild	Mild to Moderate	Moderate	Moderate to Severe	Severe

Primary Criteria for Mild AVR PVL
- Normal Sewing Ring Motion
- Jet Features: narrow jet width, infrequent multiple, no proximal flow convergence
- % LVOT diameter <30%
- Circumferential extent <10%

Secondary Criteria for Mild AVR PVL
- Normal LV size
- Vena contracta width <4 mm
- Incomplete or faint spectral Doppler
- PHT >500 ms
- Diastolic flow reversal absent or brief

- **Quantitative Criteria for Mild AVR PVL**
- RVol <30 ml
- RF <30%
- EROA <0.1 cm^2

Primary Criteria for Severe AVR PVL
- Sewing Ring Motion Usually Abnormal
- Jet Features: wide jet width, frequently multiple, proximal flow convergence visible
- % LVOT diameter ≥60%
- Circumferential extent ≥30%

Secondary Criteria for Severe AVR PVL
- Moderately/severely dilated LV size
- Vena contracta width ≥6 mm
- Dense spectral Doppler
- PHT <200 ms
- Holodiastolic flow reversal (end-diastolic velocity >20-30 cm/s)

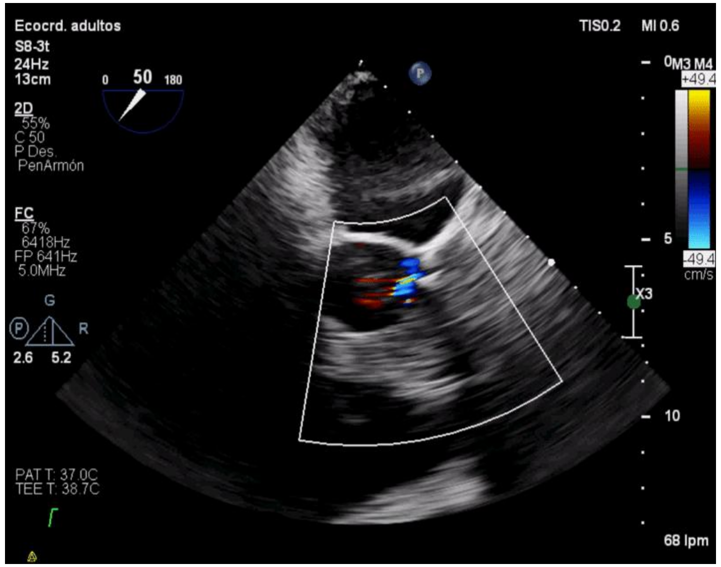
- **Quantitative Criteria for Severe AVR PVL**
- RVol ≥60 ml
- RF ≥50 %
- EROA ≥0.3 cm^2

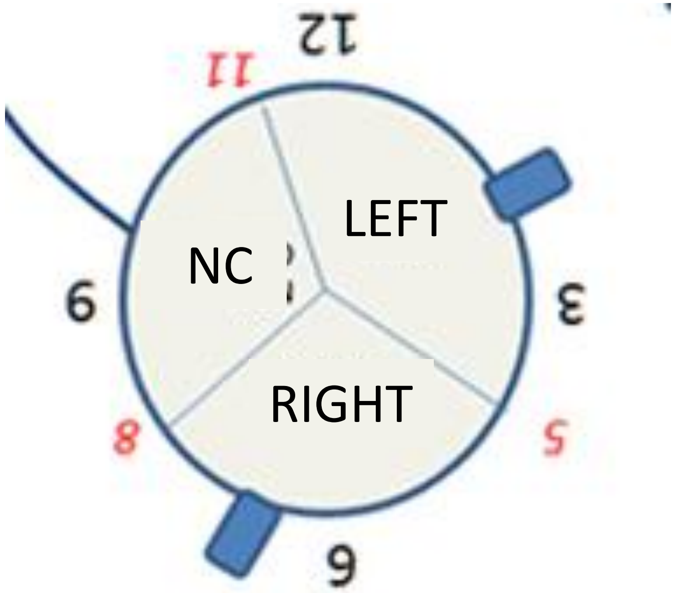
Note: CT and CMR may be used as adjunctive imaging modalities

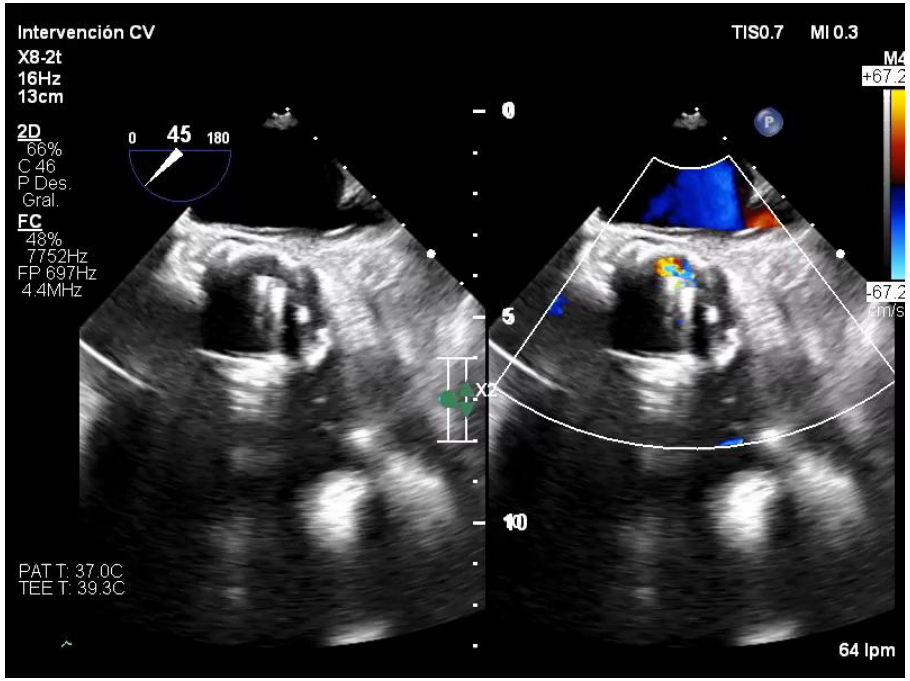
Number & location

Clinical diagnosis: Heart failure ± hemolysis

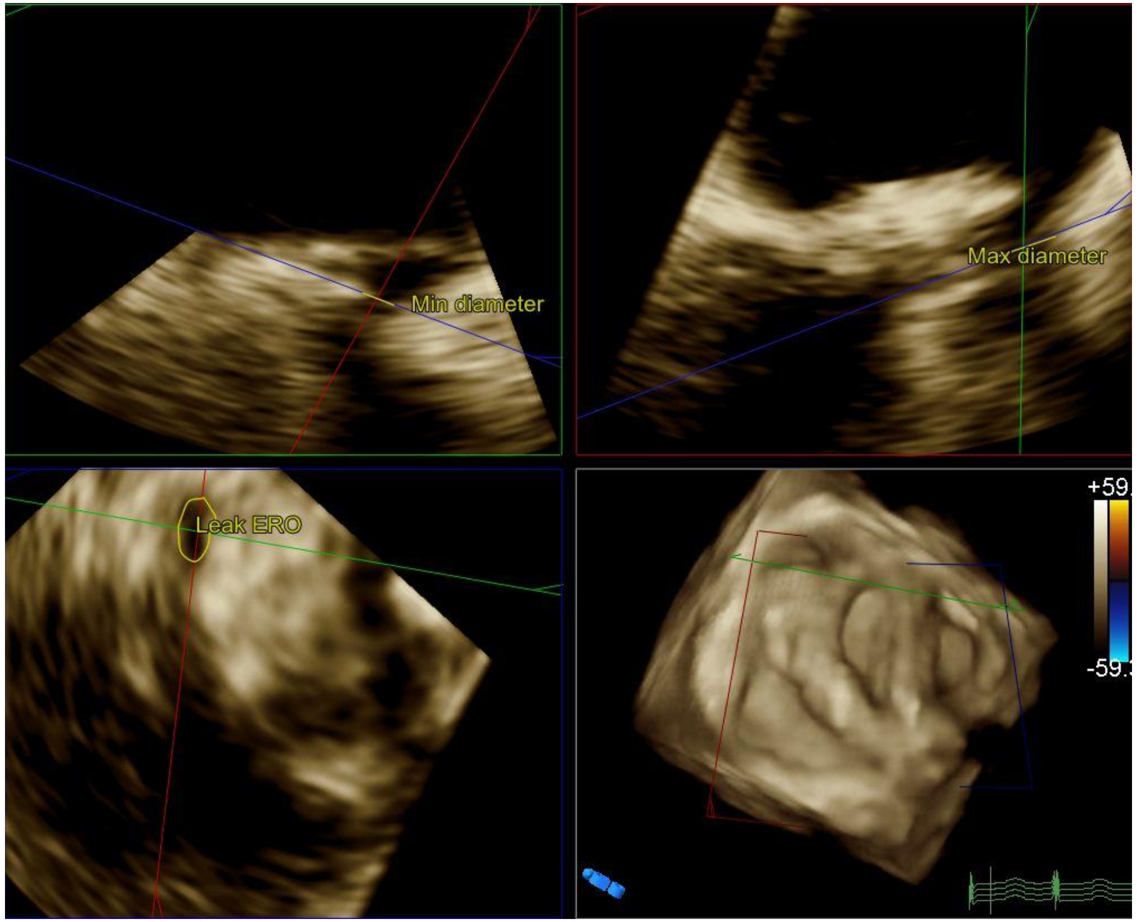
Echo diagnosis: TTE + TEE

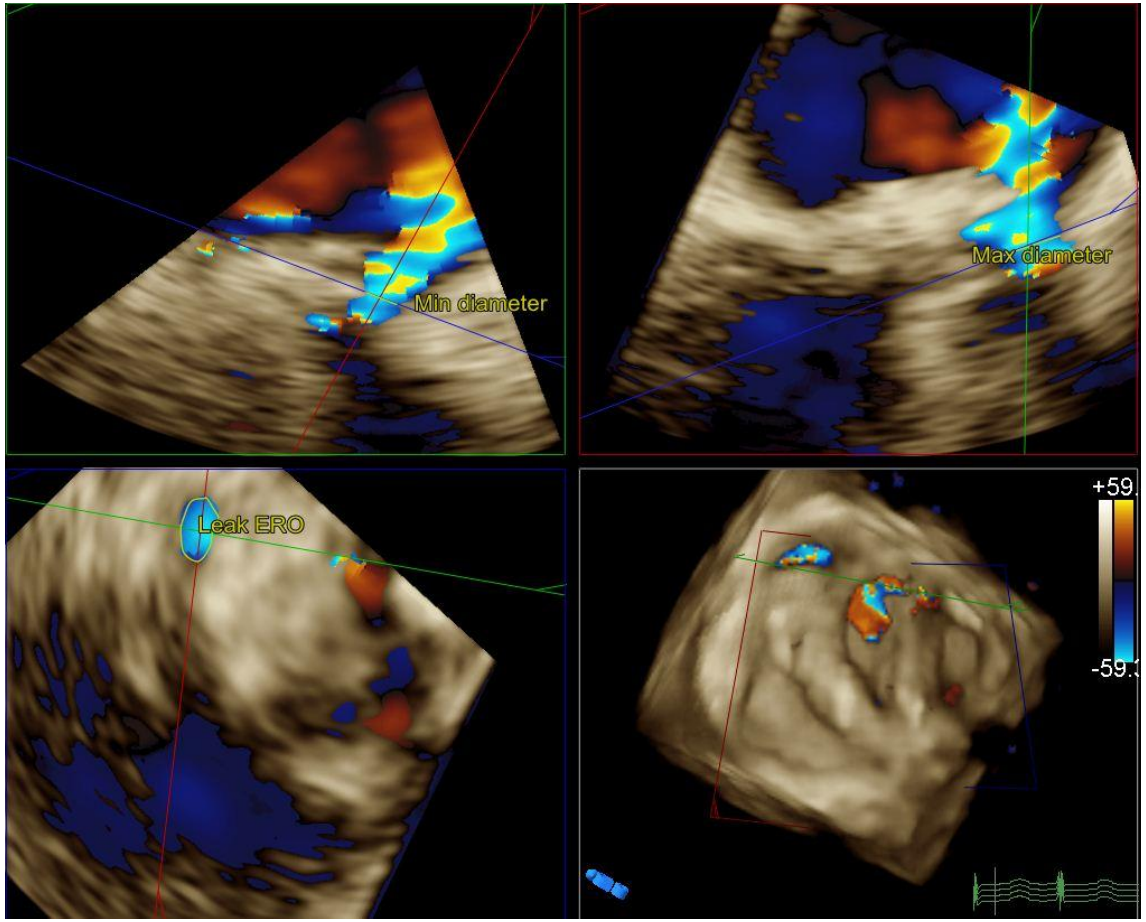




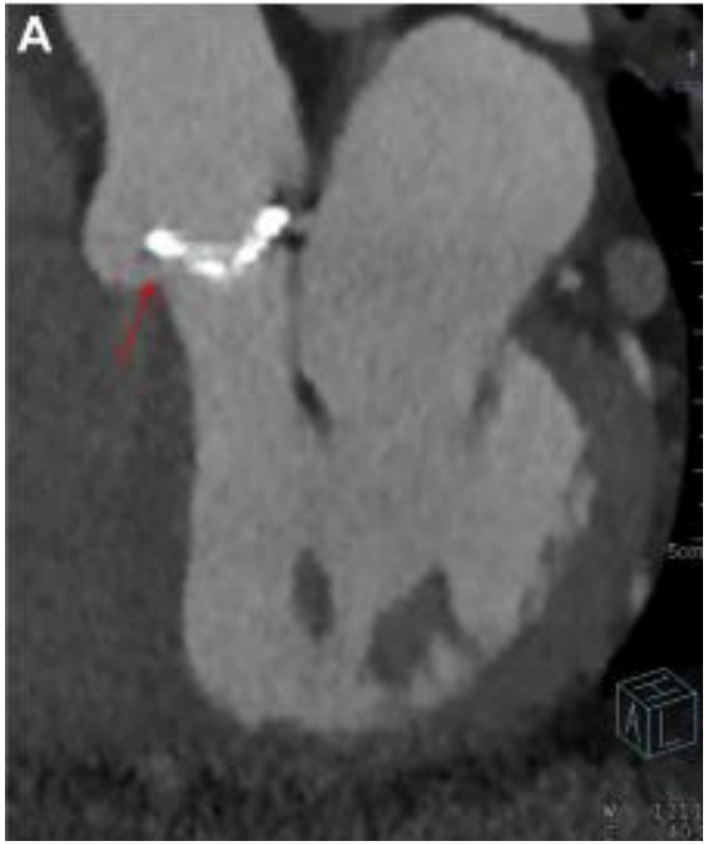


Size measurement



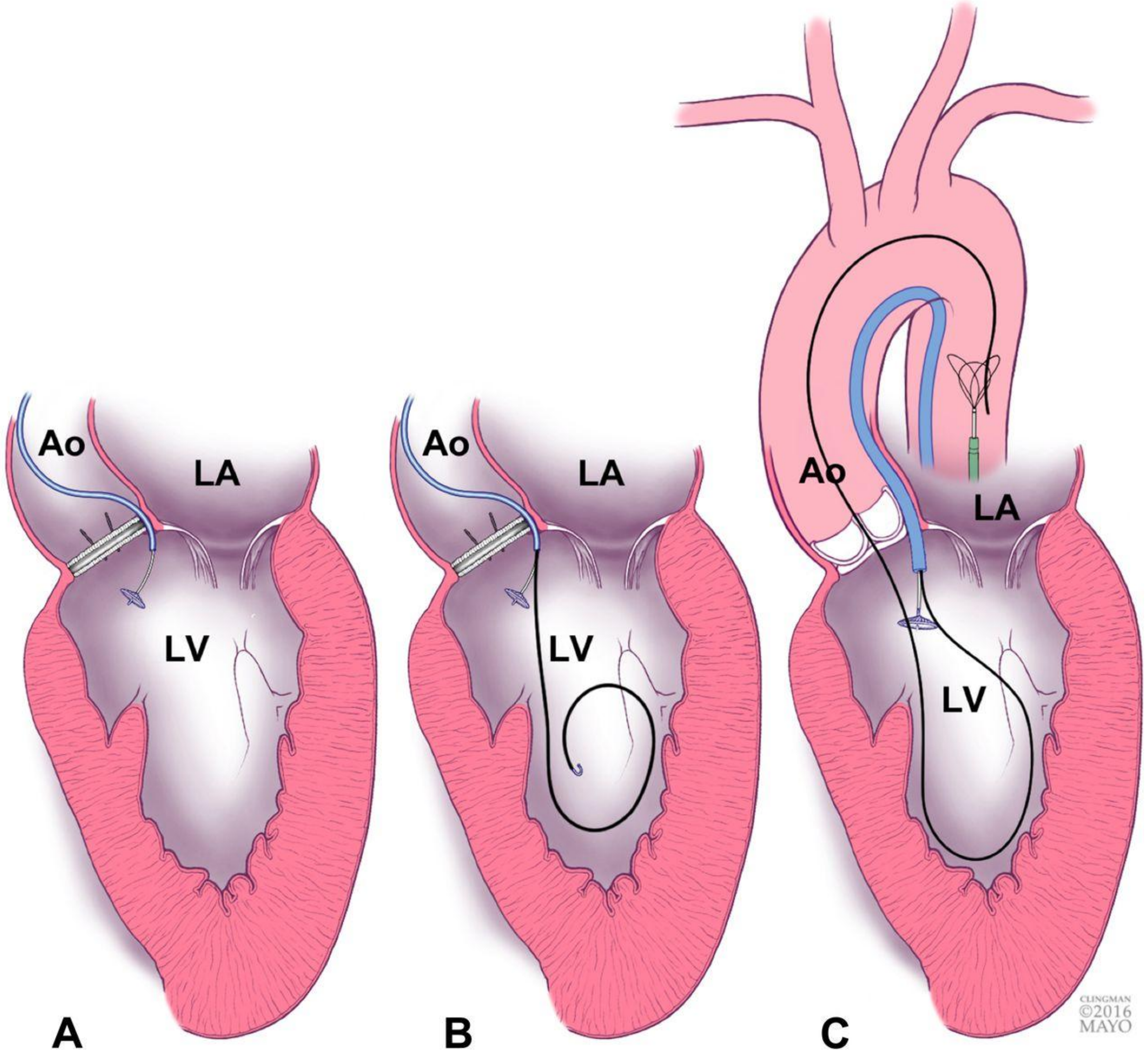


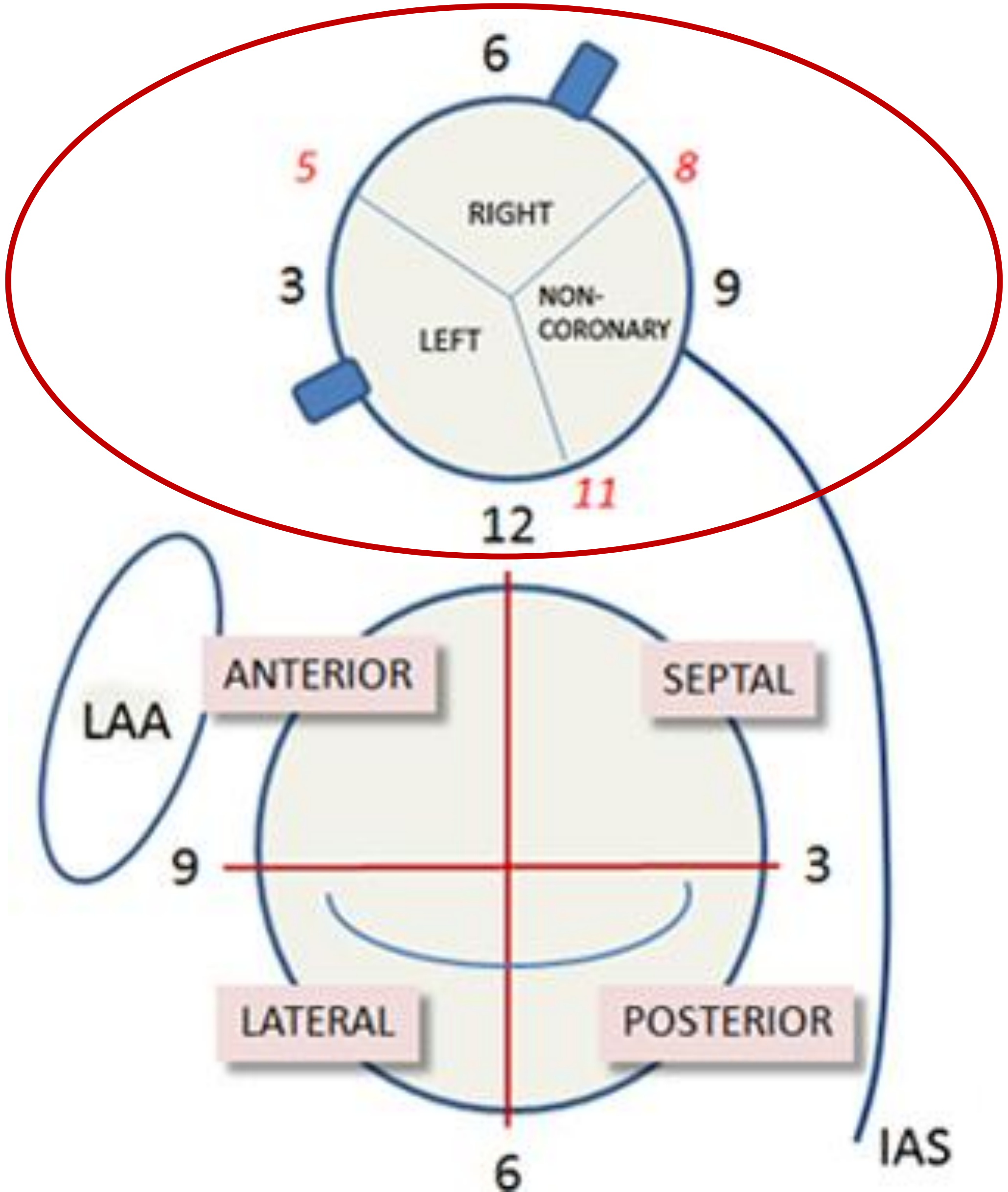
Alternative imaging modalities



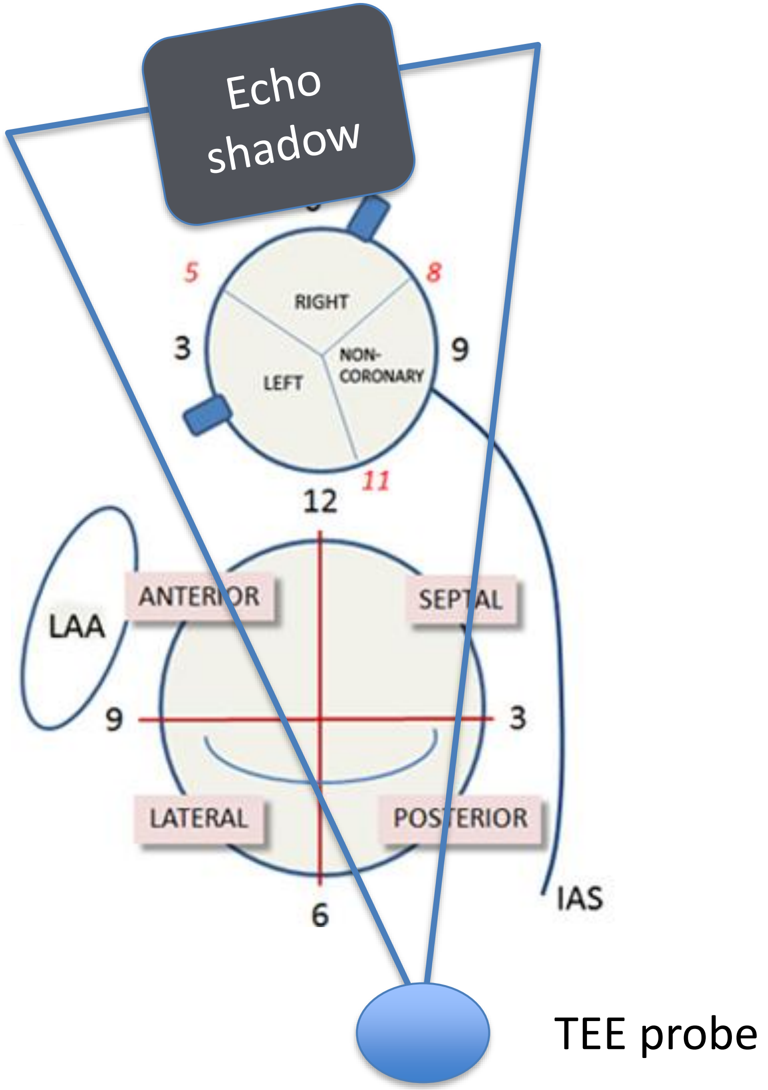
Lesser JR, et al. JCCT. 2015

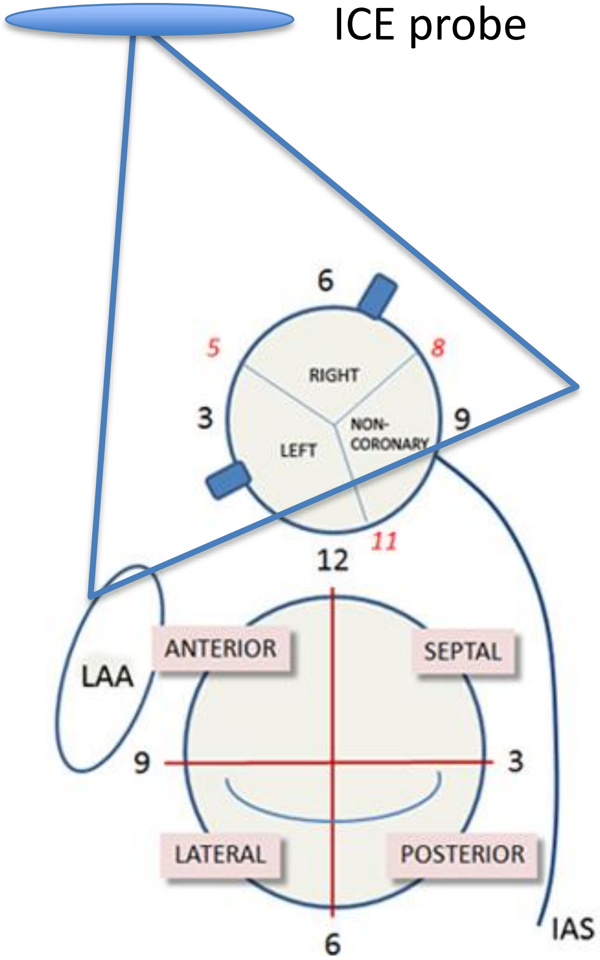
Intraprocedural guidance

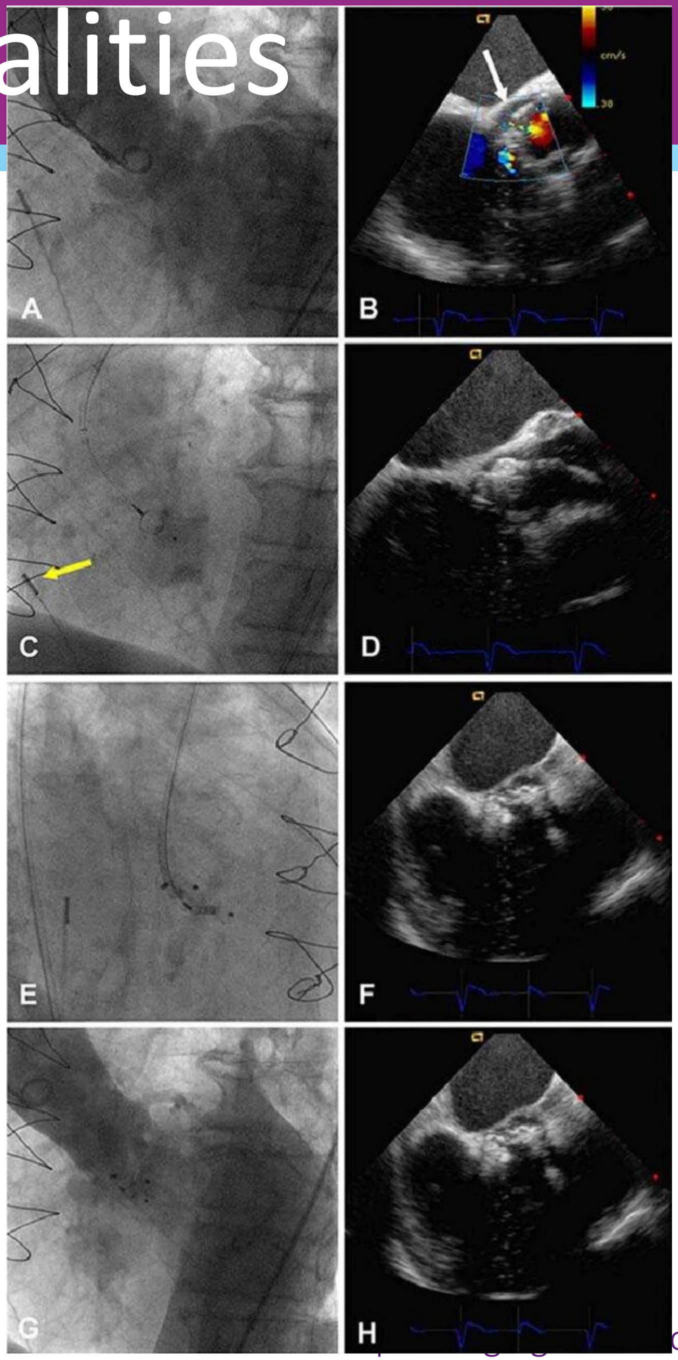




Alternative imaging modalities

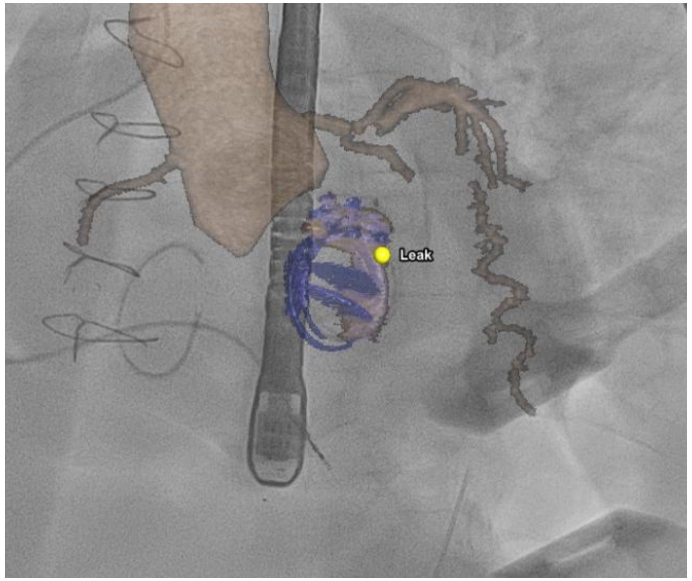


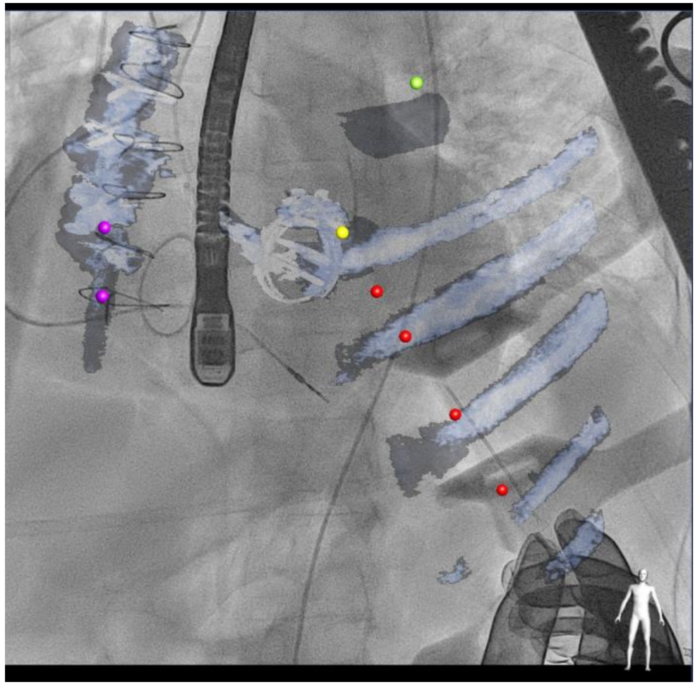


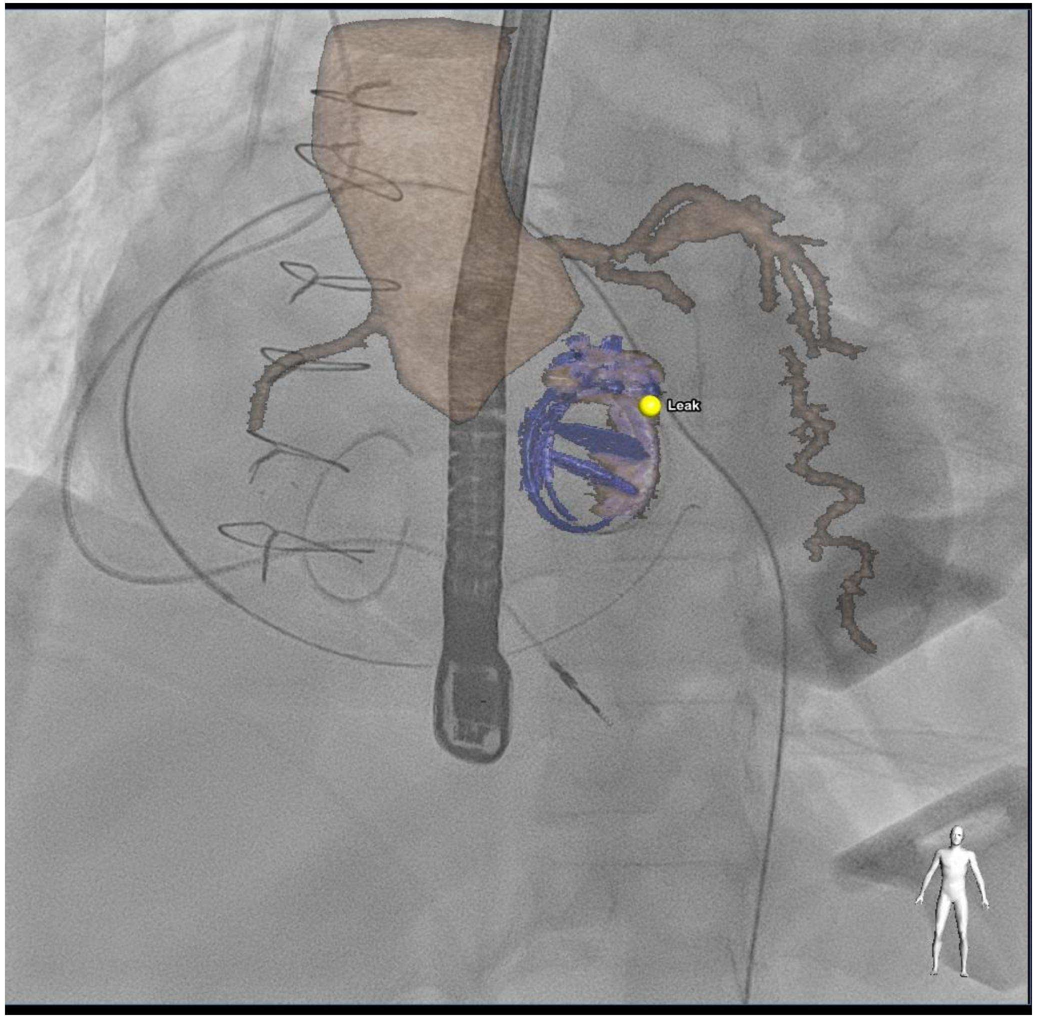


Ruparelia L et al. Catheter Cardiovascular Interv. 2021

CT fusion





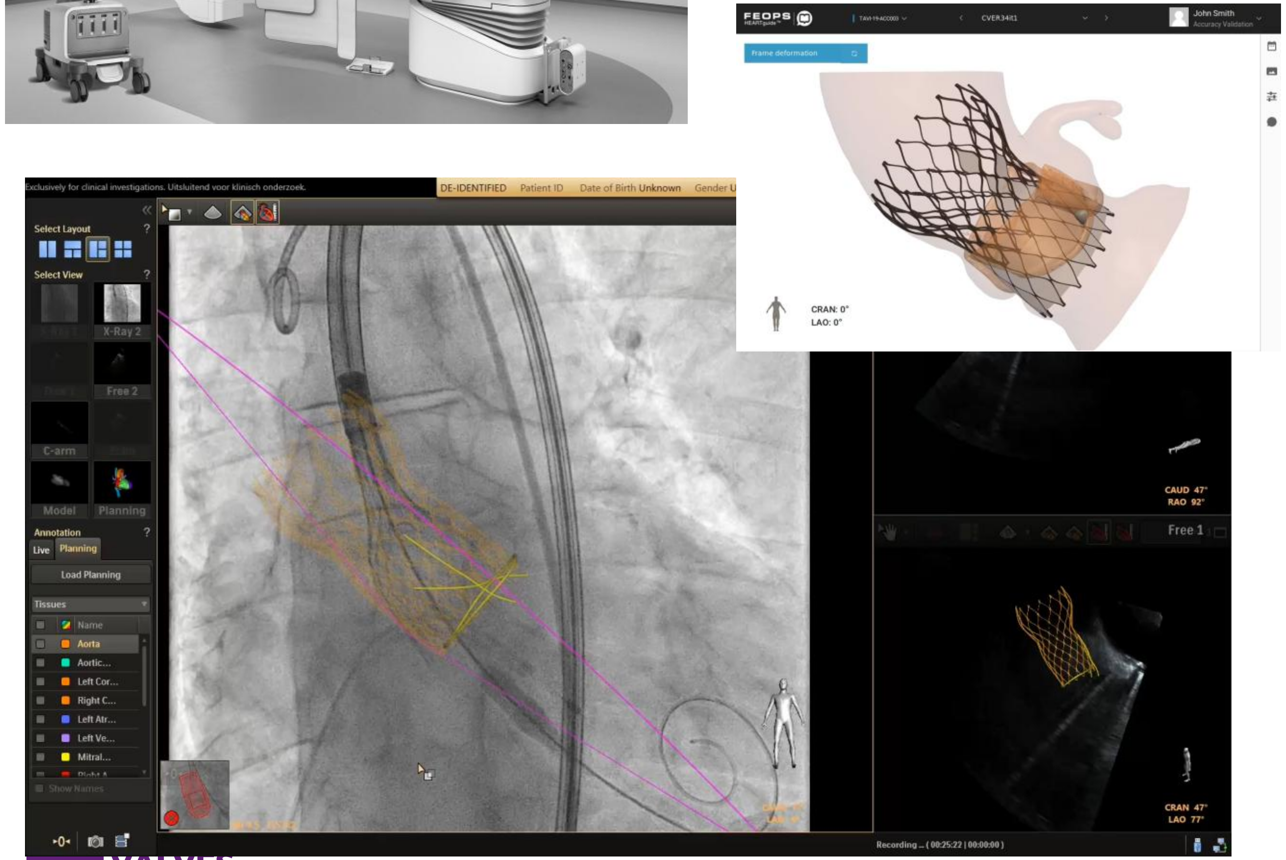


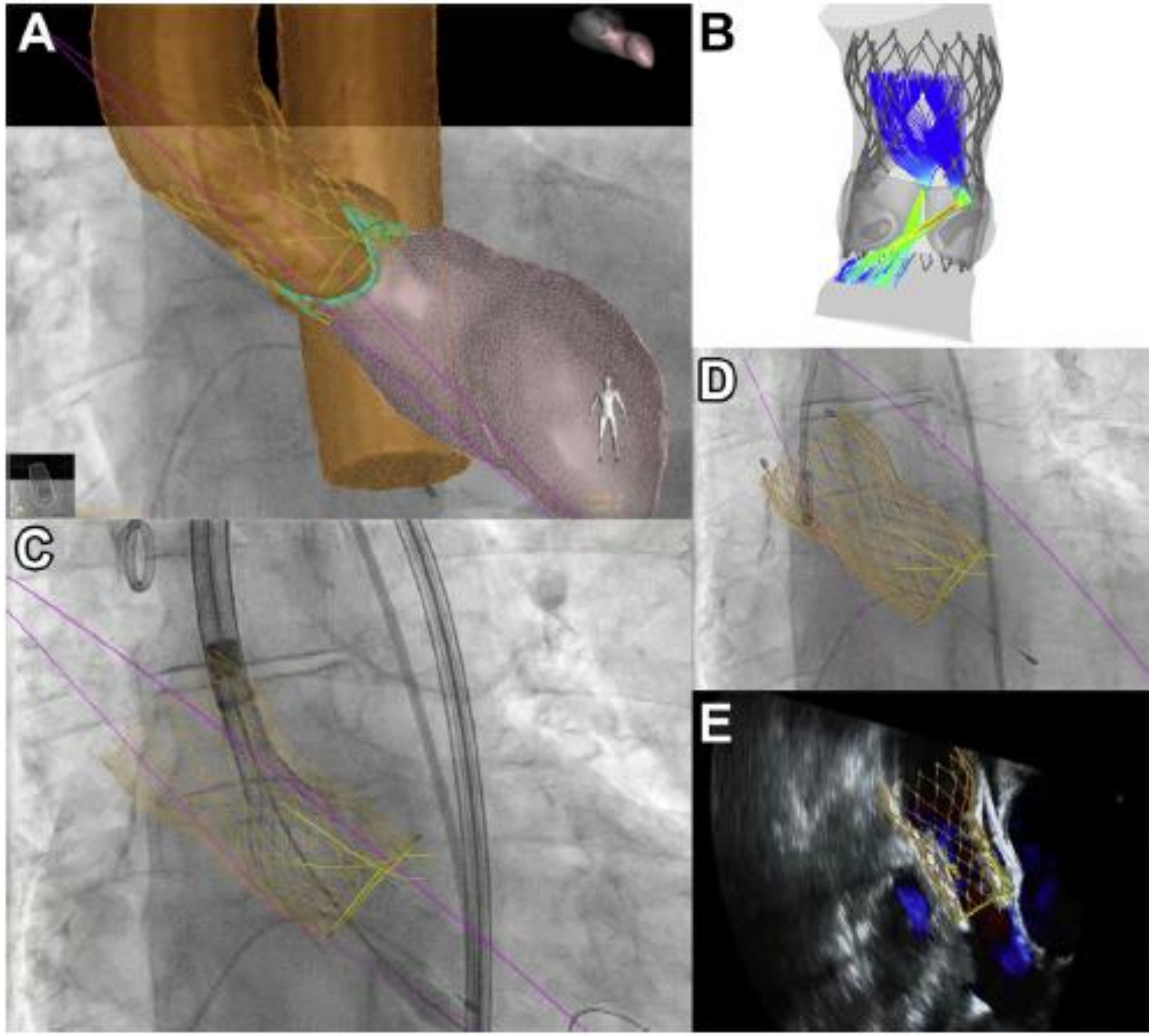
Advanced Echo fusion

IMAGES IN INTERVENTION

First Use of Futuristic Image Fusion Technology During Transcatheter Aortic Valve Replacement

Jorn Brouwer, MD, Jurriën M. ten Berg, MD, PhD, Benno J.W.M. Rensing, MD, PhD, Martin J. Swaans, MD, PhD





PCR madrid IMAGING VALVES

EPISODE 4: Multivalvular diseases

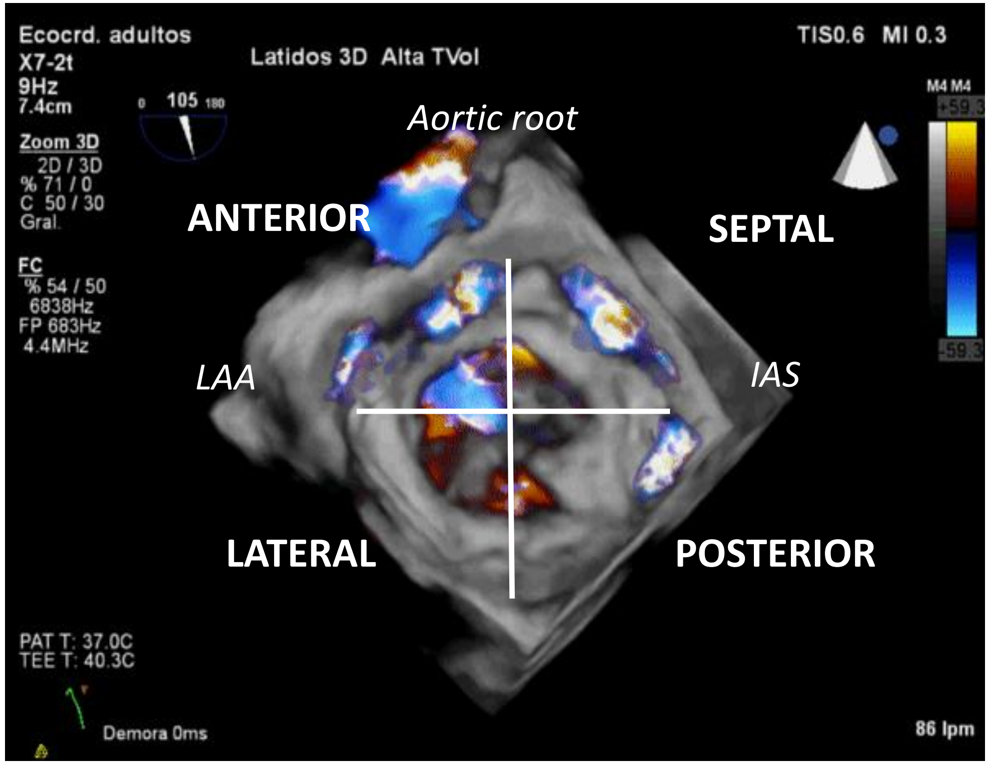
Mitral paravalvular leakages: how to diagnose and treat

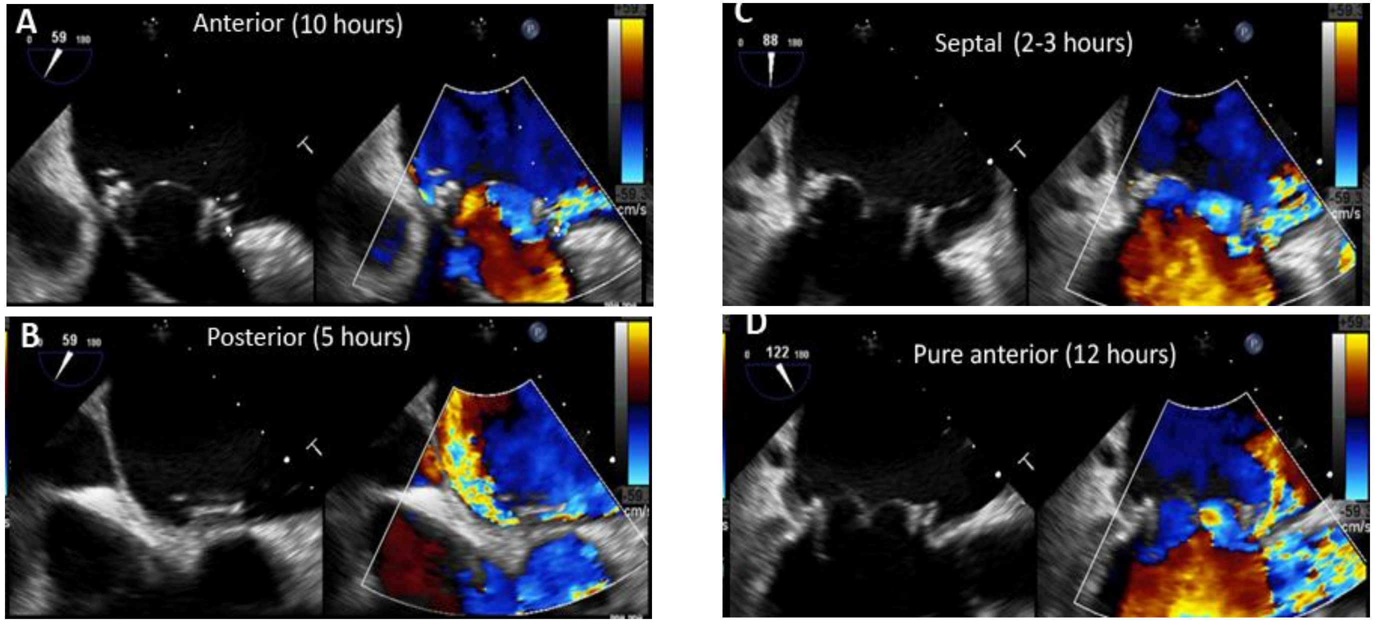
Manuel Barreiro Pérez
Cardiac Imaging. Cardiology Department
Hospital Universitario Álvaro Cunqueiro, Vigo
manuelbarreiroperez@gmail.com
@manuelbarreirop

2025

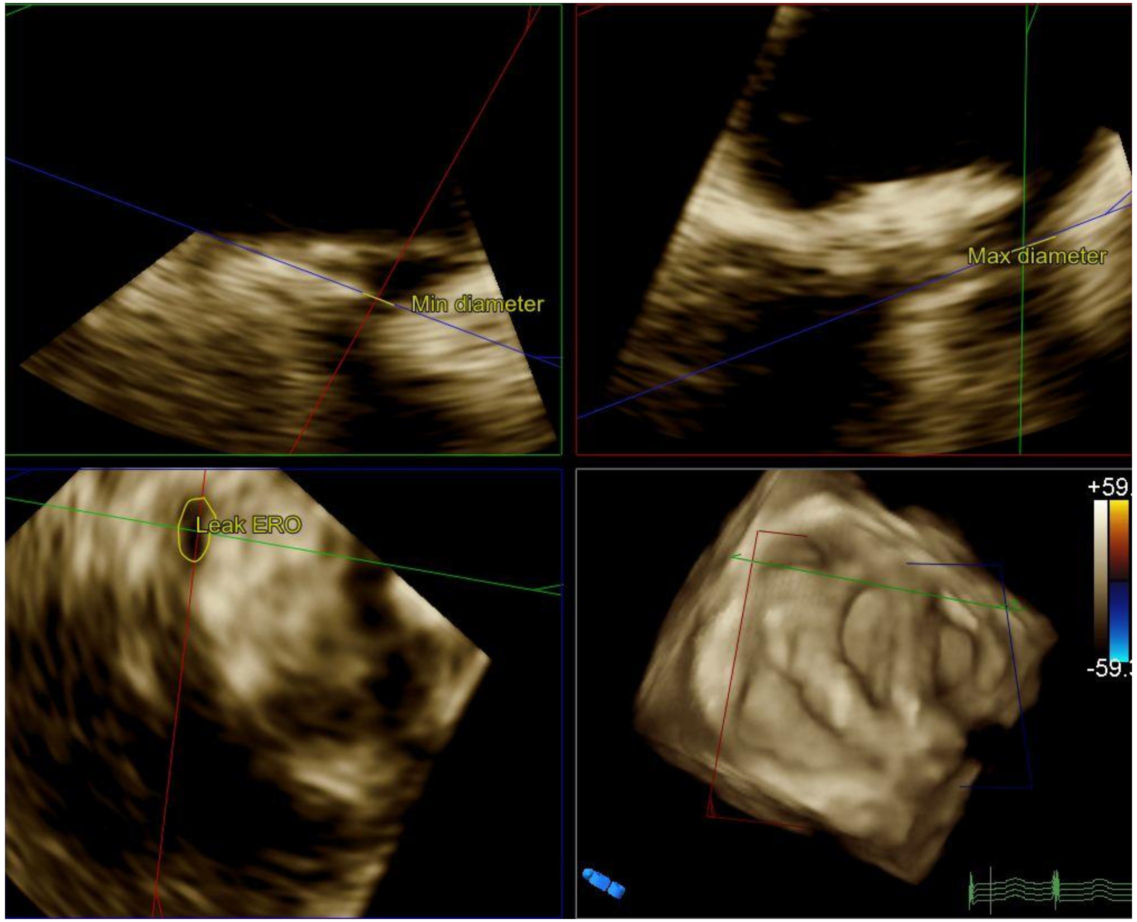
Number & location

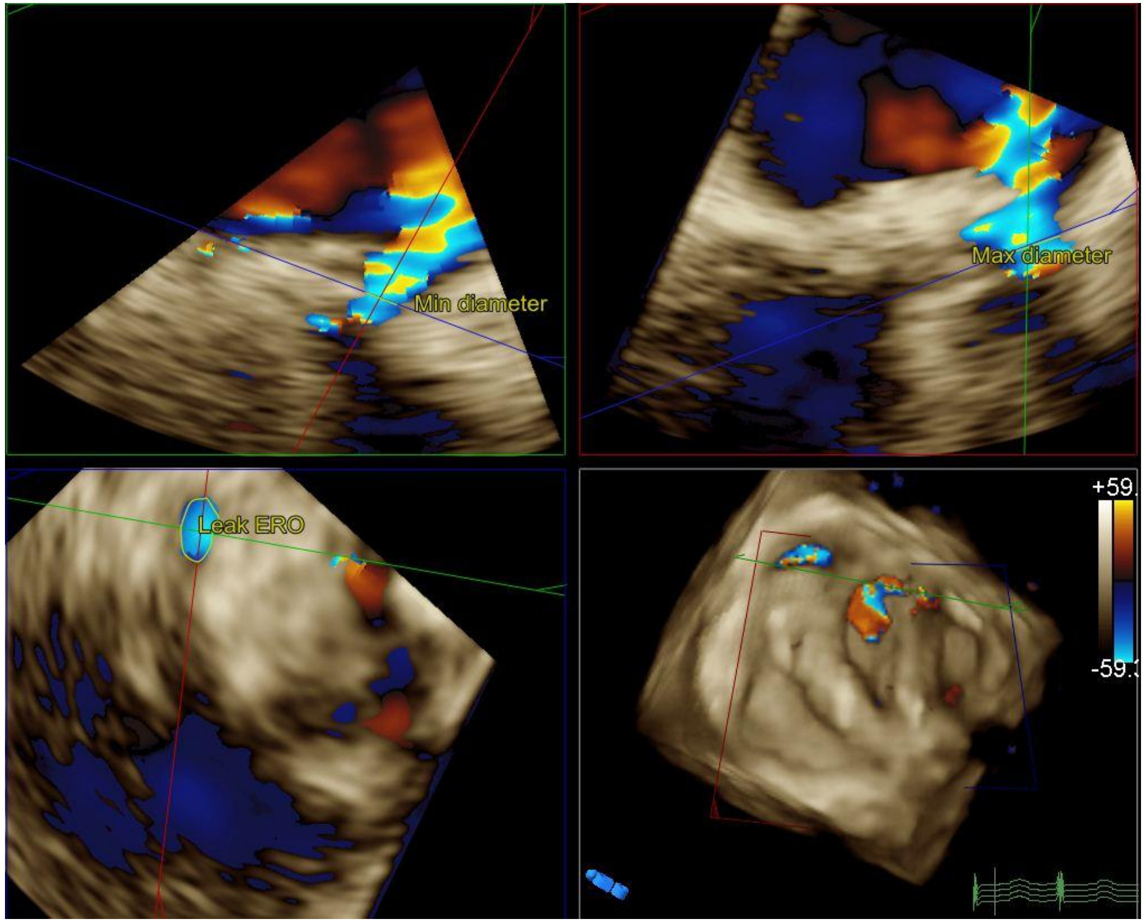
Clinical diagnosis: Heart failure ± hemolysis
Echo diagnosis: TTE + TEE



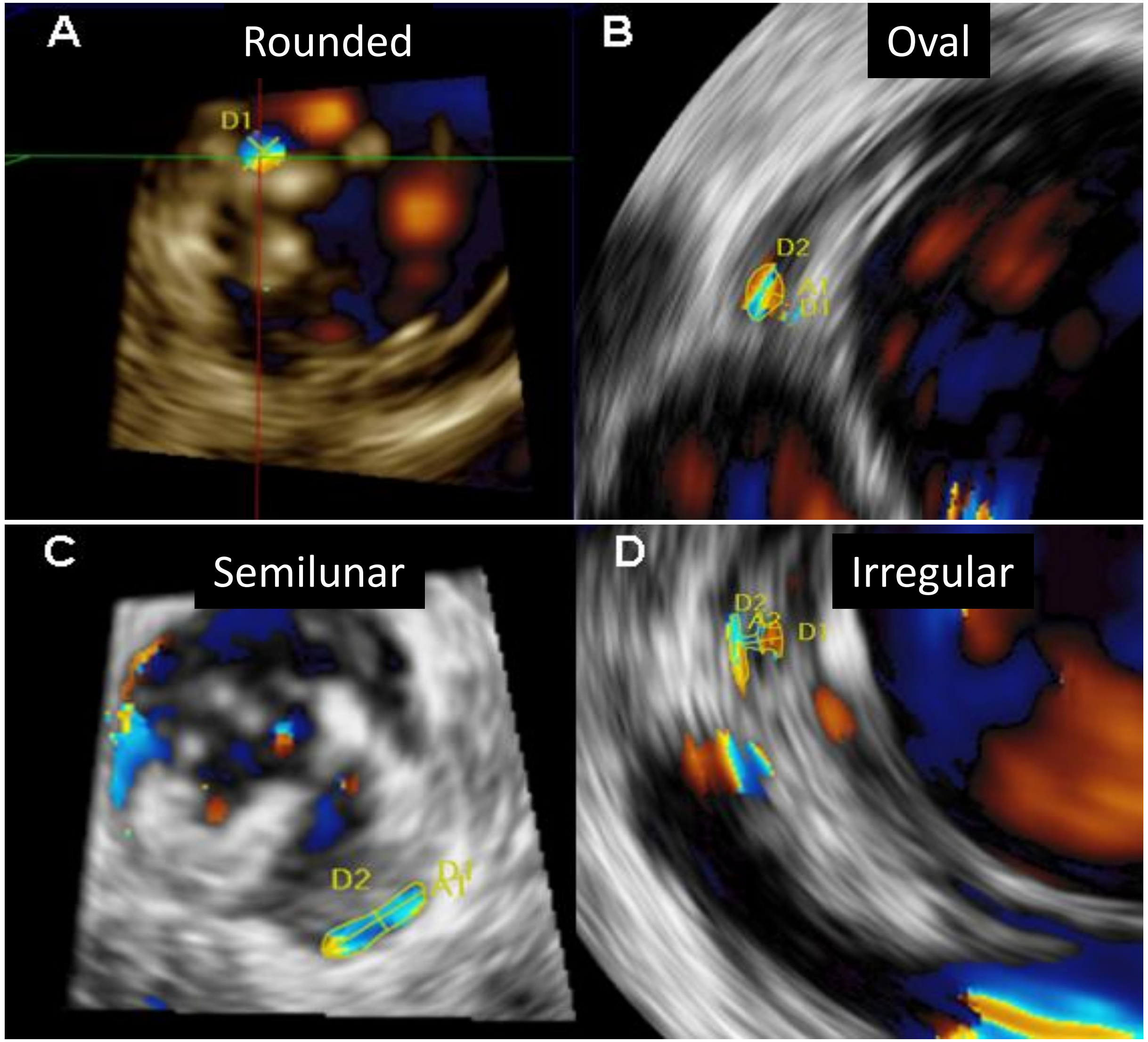


Size measurement

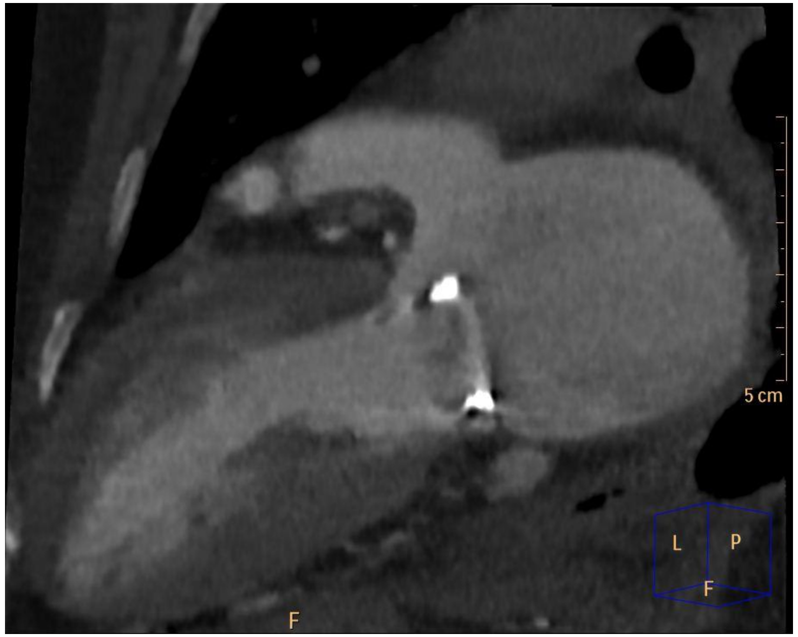


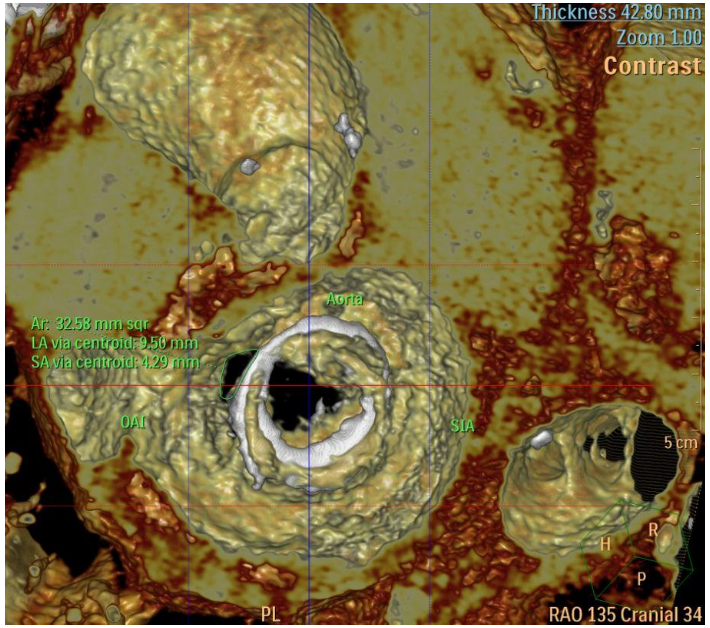


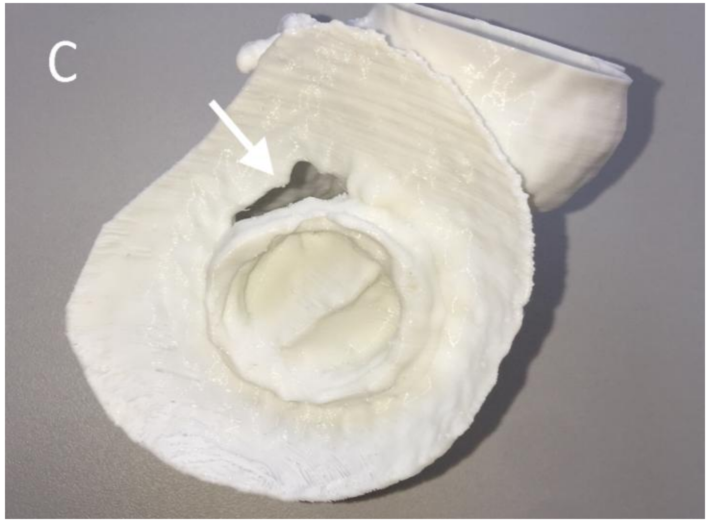
Shape

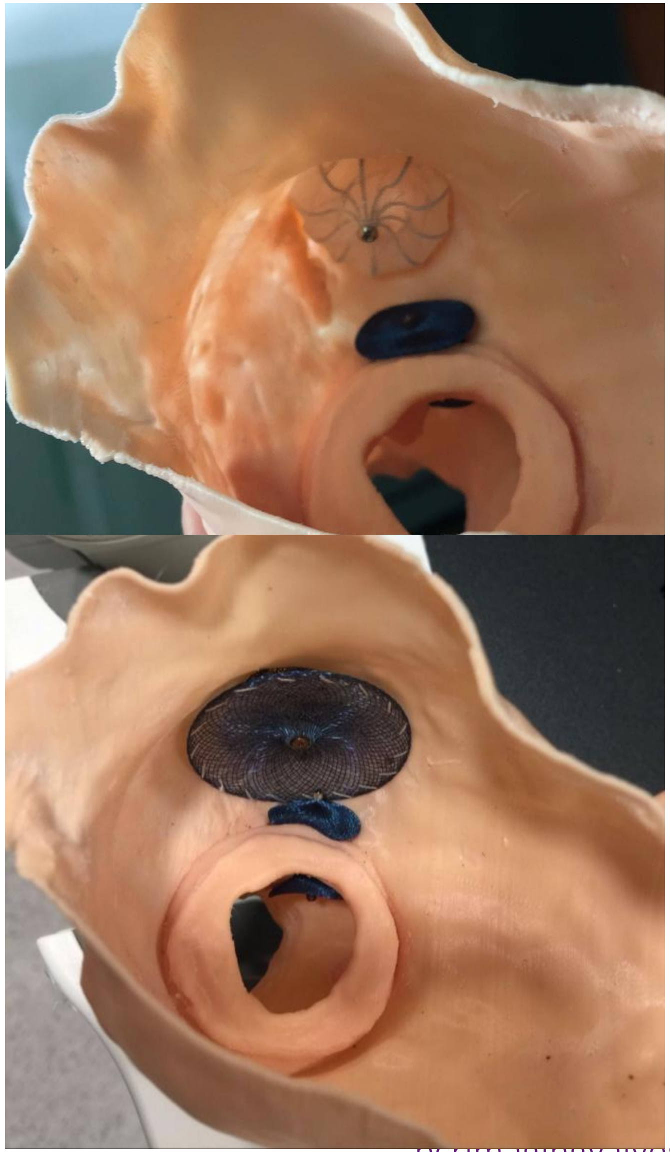


Alternative imaging modalities

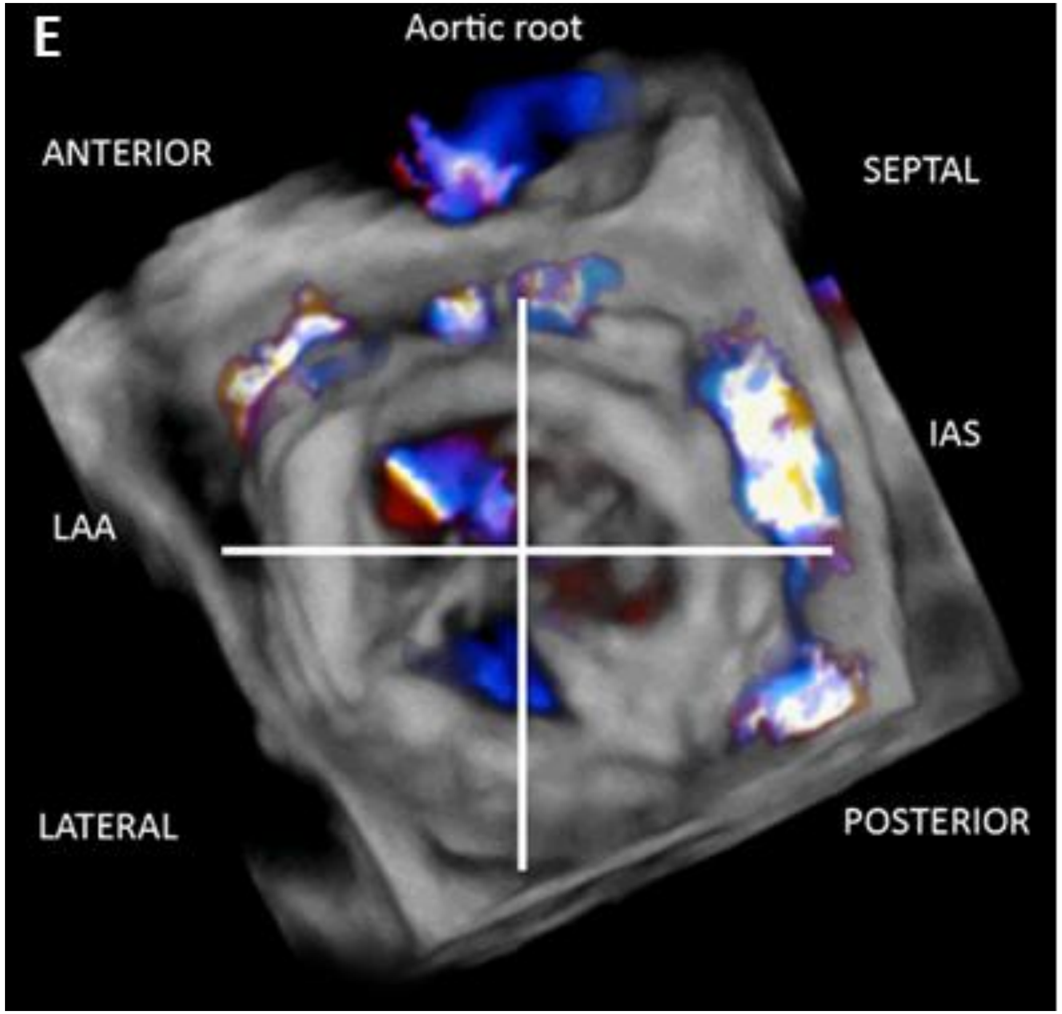


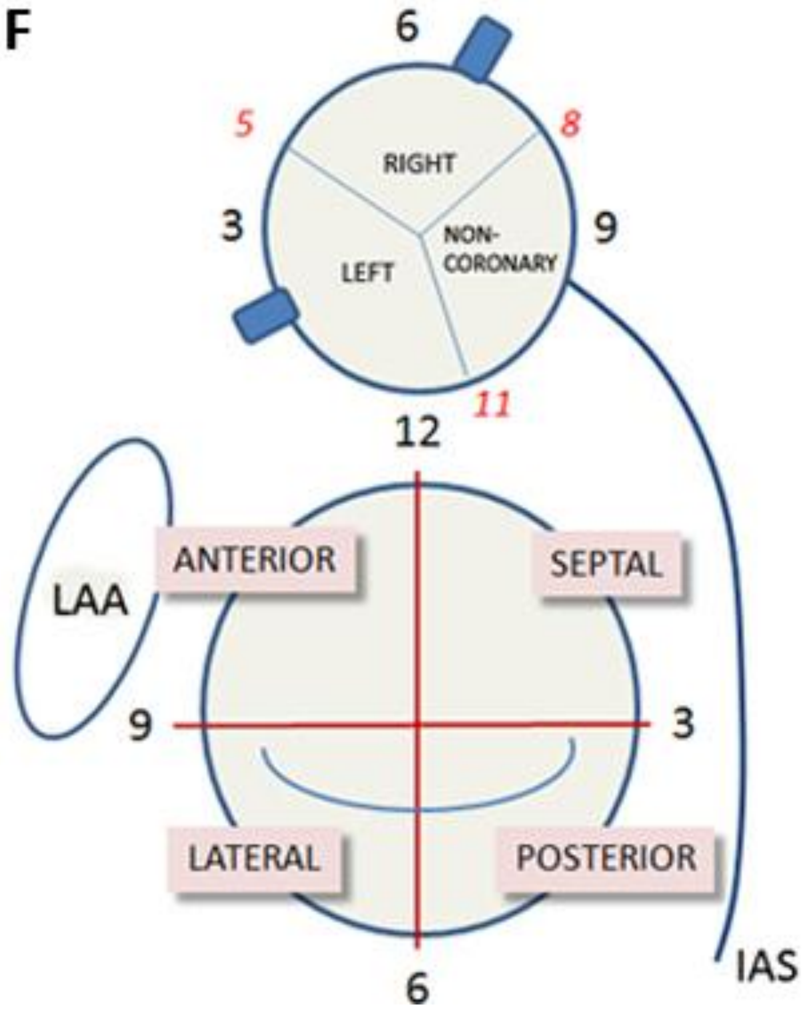


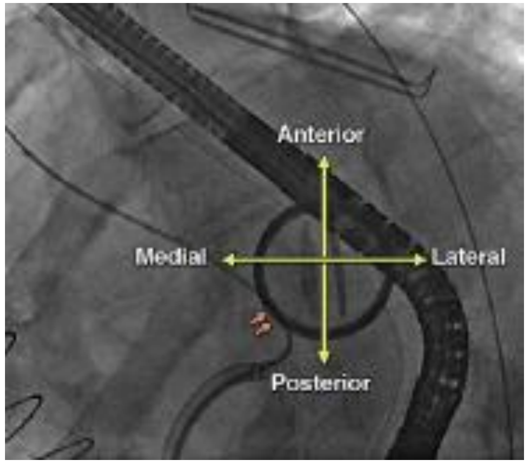


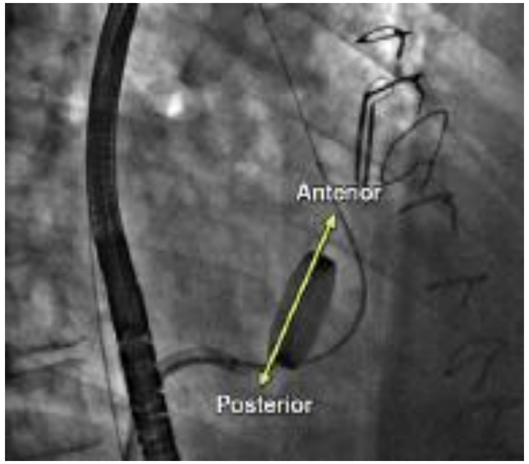


Same language in the cath lab









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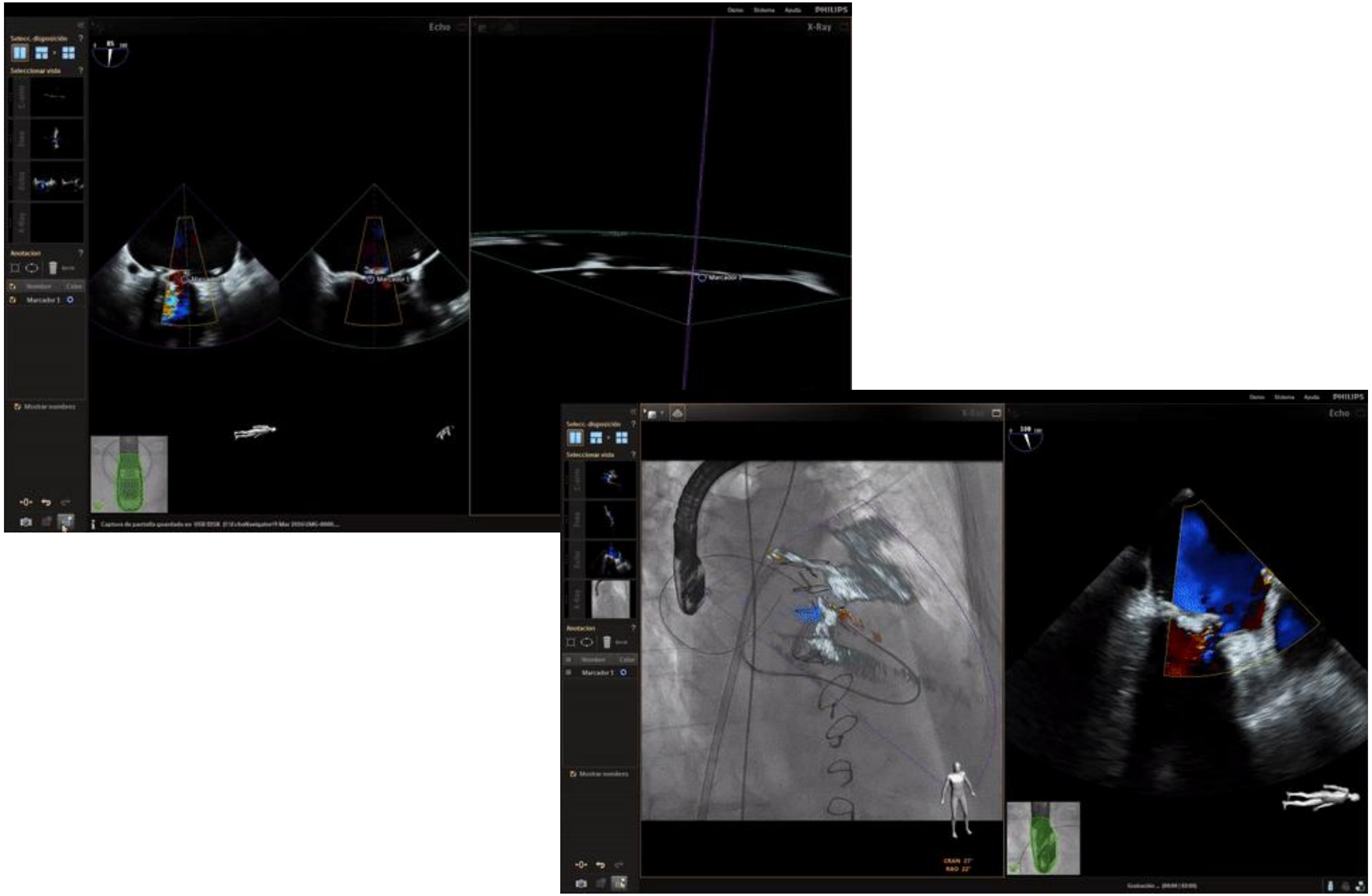

madrid
PCR IMAGING VALVES

Same language in the cath lab