EUROVALVE

VAN DER VALK SELYS HOTEL LIÈGE

SAVE THE DATE

SEPTEMBER 25&26 2025

COURSE DIRECTORS
Patrizio Lancellotti, Belgium
Khalil Fattouch, Italy
Gilbert Habib, France
José Luis Zamorano, Spain
Philippe Pibarot, Canada
Mani Vannan, USA
Bernard Cosyns, Belgium
Augustin Coisne, France

LOCAL HOSTS
Patrizio Lancellotti, Belgium
Vincent Tchana-Sato, Belgium

MAC insights: pathophysiology & imaging

Augustin Coisne, MD, PhD, FESC
Professor in Cardiology
Coordinator of the Valves Center
Department of Echocardiography and Cardiovascular Physiology
Lille University Hospital, Lille, France

Société Française de Cardiologie
Valvulopathies

FIC FILIALE IMAGERIE CARDIOVASCULAIRE SFC

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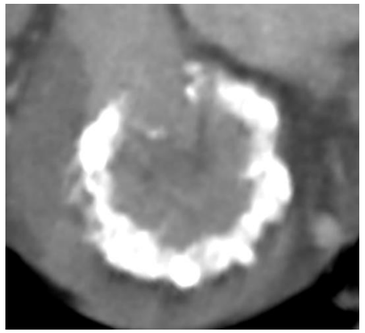
VALVES CENTER
Lille University Hospital

ufr3s Sciences de Santé et du Sport

Definition

Deposition of calcium in and around the fibrous base of the mitral valve



- **Prevalence**: 8-15% in the general population (>40% in elderly patients)
- **Posterior annulus** > Anterior annulus involvement
- Dominant etiology of **Mitral Stenosis** in Western populations

  but: MAC with elevated transmitral gradient in only 0.2-2.5%

- Factors associated with **MAC incidence**

  age, female gender, diabetes, smoking, hypertension, ethnicity, obesity, inflammation, renal failure, aortic stenosis, prior chest radiation

Epidemiology

The Framingham Heart Study

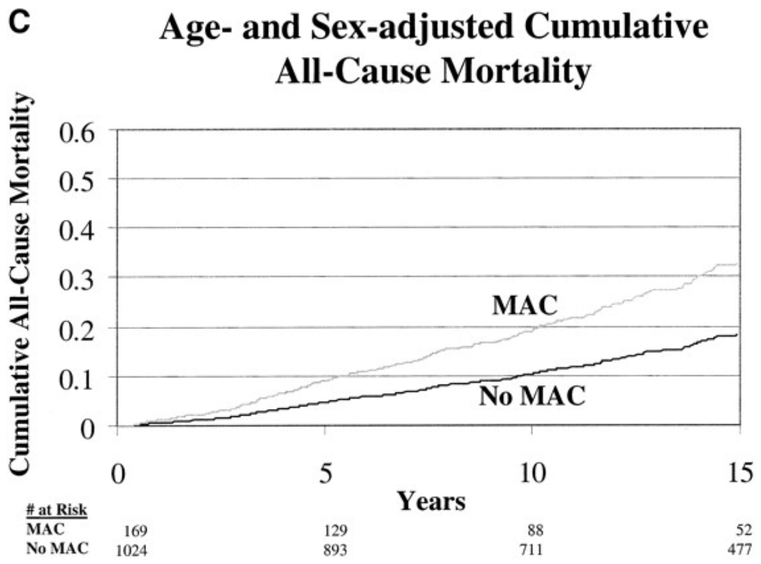
- 1,197 patients (1979-1981)
- with available echo data on MAC
- follow-up (CVD events): 16 years

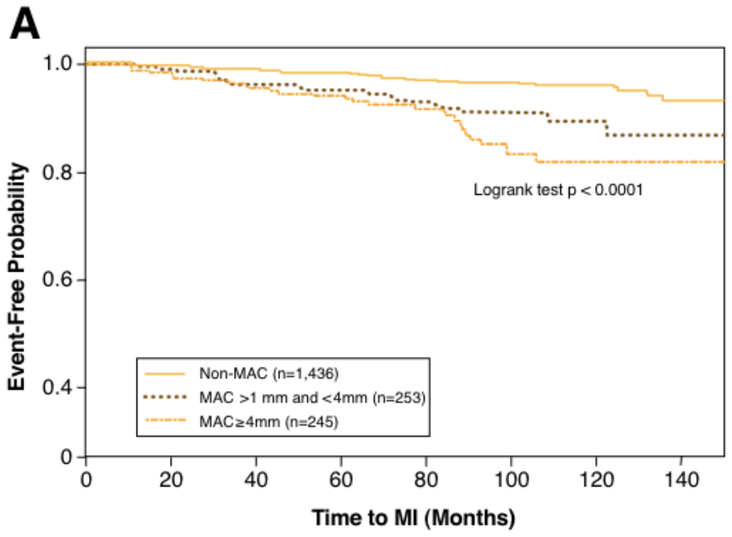
The Northern Manhattan Study

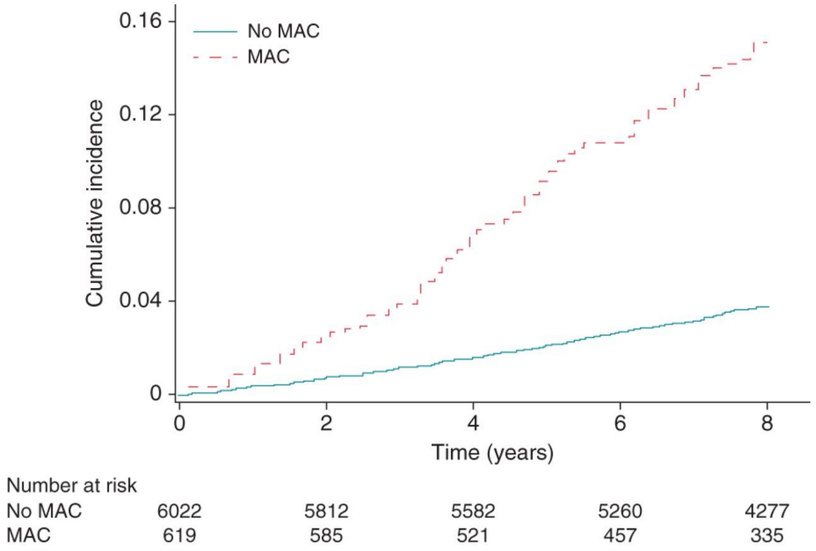
- 1,955 patients (1993-2001)
- 2D-TTE MAC assessment
- Mean follow-up: 7.4 years

Multi-Ethnic Study of Atherosclerosis (MESA)

- 6,641 patients (2000-2002)
- with available CT data on MAC
- MAC = Agatston score >0
- Median follow-up: 8.5 years

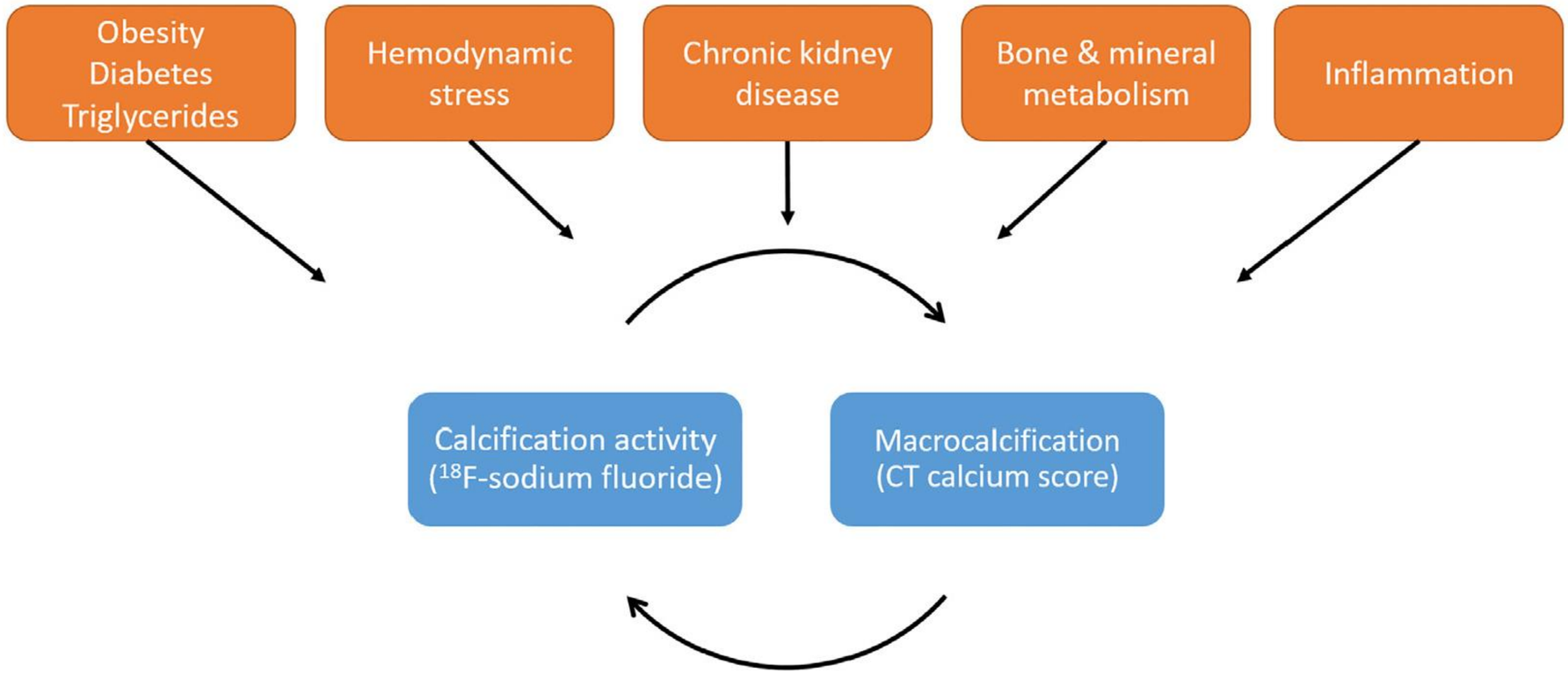






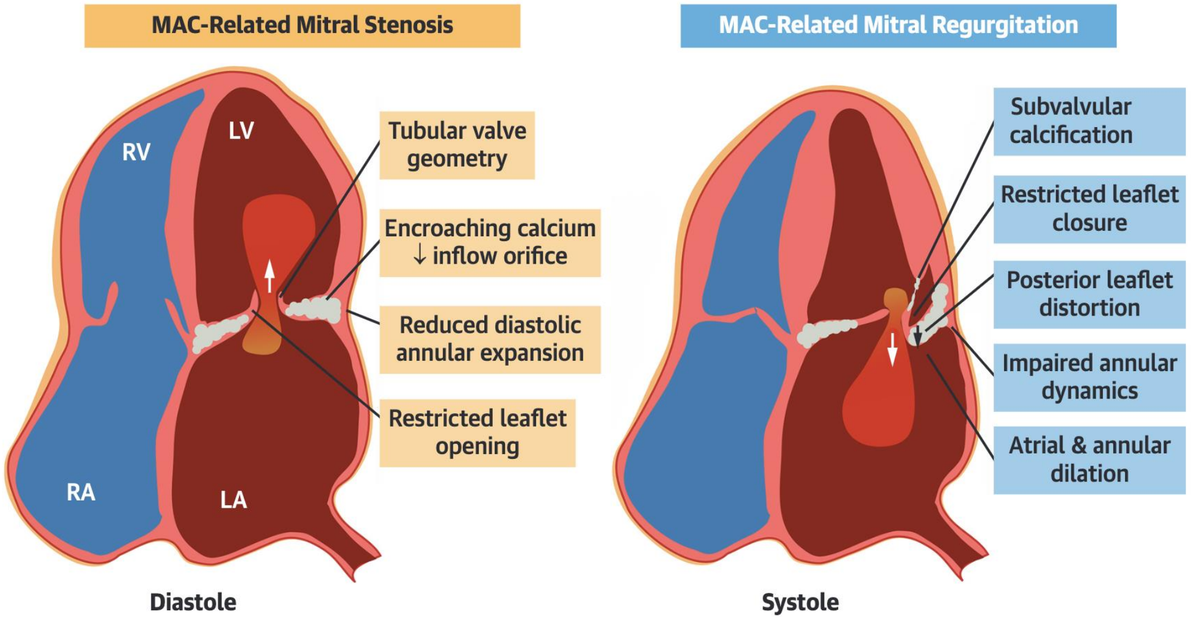
Physiopathology

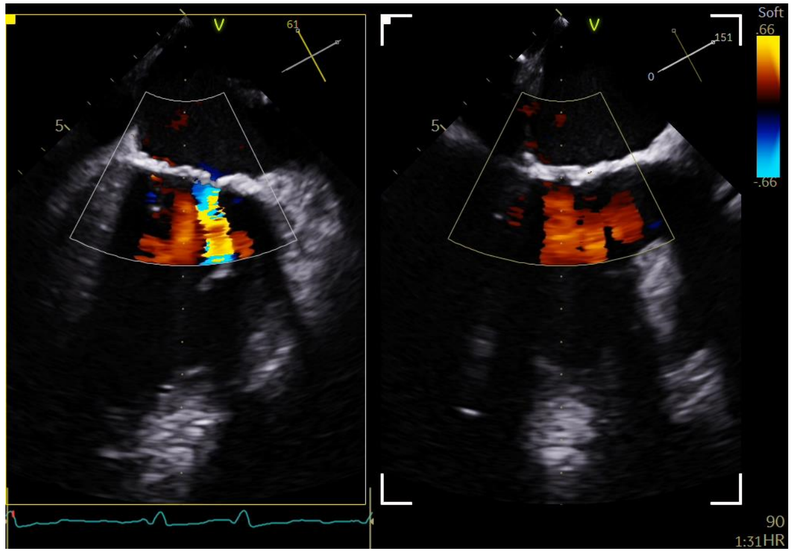
the vicious cycle of calcification activity



Massera D et al. Trends Cardiovasc Med. 2020 Jul;30(5):289-295

MAC-related MV disease



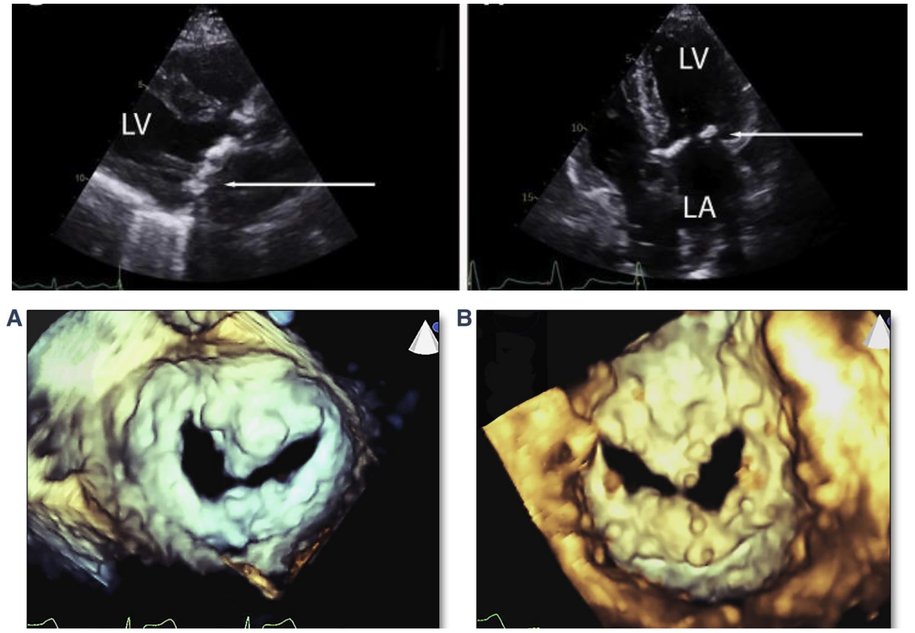


Severe MAC-Related Mitral Valve Dysfunction				
Stenosis	**OR**	*Mixed Valve Disease*	**OR**	*Regurgitation*
MVA ≤1.5 cm^2		TMG >8-10 mm Hg		MR > Moderate

Churchill et al. J Am Coll Cardiol 2022;80:739–751

Echocardiography

- Visualized as an echodense structure
- Irregular, lumpy appearance
- Accoustic shadowing
- Gold standard for assessment of **degree and type of MVD**

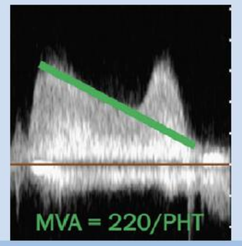
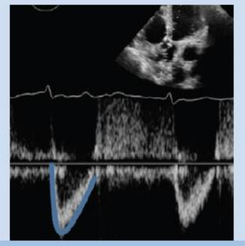
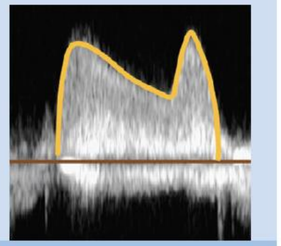


<u>BUT</u>: May not accurately distinguish between dense collagen and true calcification

Eleid M et al. JACC Cardiovasc Imaging. 2016 Nov;9(11):1318-1337

MAC-related MV disease

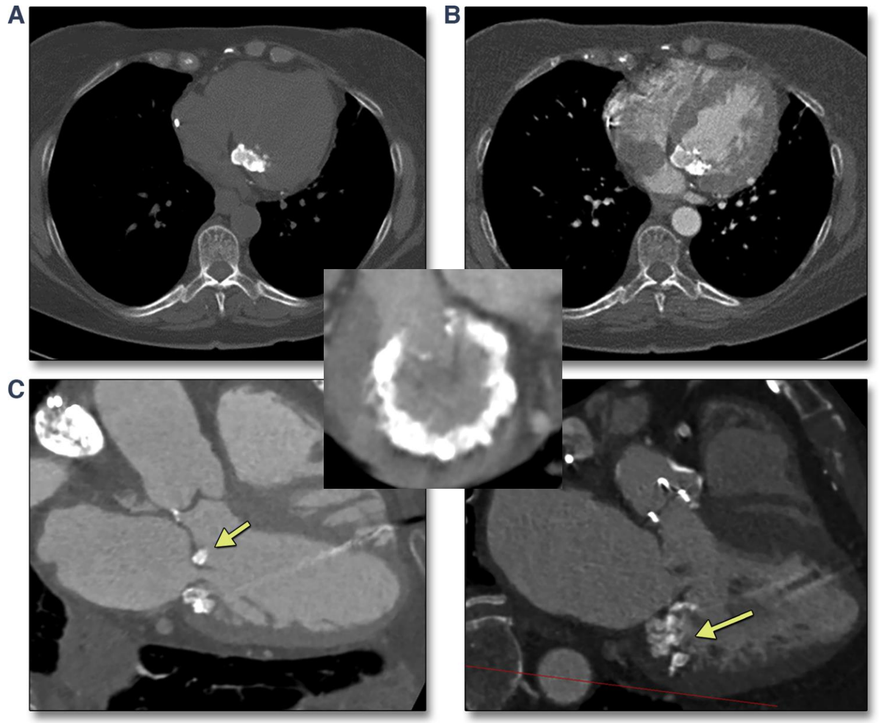
Challenges of Echocardiographic Assessment in MAC-Related MV Dysfunction

	Mitral Valve Area (MVA)				Pressure Gradient
	2D Planimetry	3D Planimetry	Pressure Half-Time (PHT)	Continuity Equation	Mean Pressure Gradient
					
Description	Direct planimetry of the valve opening orifice	Planimetry of MVA from 3D dataset	Empiric calculation extrapolated from rheumatic MS	Calculates MVA based on MV flow and LVOT stroke volume	Mean pressure gradient using continuous wave doppler
Limitations	Poor image quality in presence of MAC	TTE images often inadequate, need for TEE	Overestimates MVA in case of decreased LA/LV compliance	Unreliable in moderate or more MR or AR, irregular rhythms	Flow dependent (heart rate and rhythm, high output states)
Challenges in MAC	Orifice nonplanar, not located at leaflet tips Shadowing due to calcium	Technically difficult Time consuming Acoustic shadowing	MAC population often LVH, AS, decreased compliance	MAC is typically "mixed" VHD, with often some degree of MR; AF common	Heart rate Impact of diastolic dysfunction

Churchill et al. J Am Coll Cardiol 2022;80:739–751

CT-scan

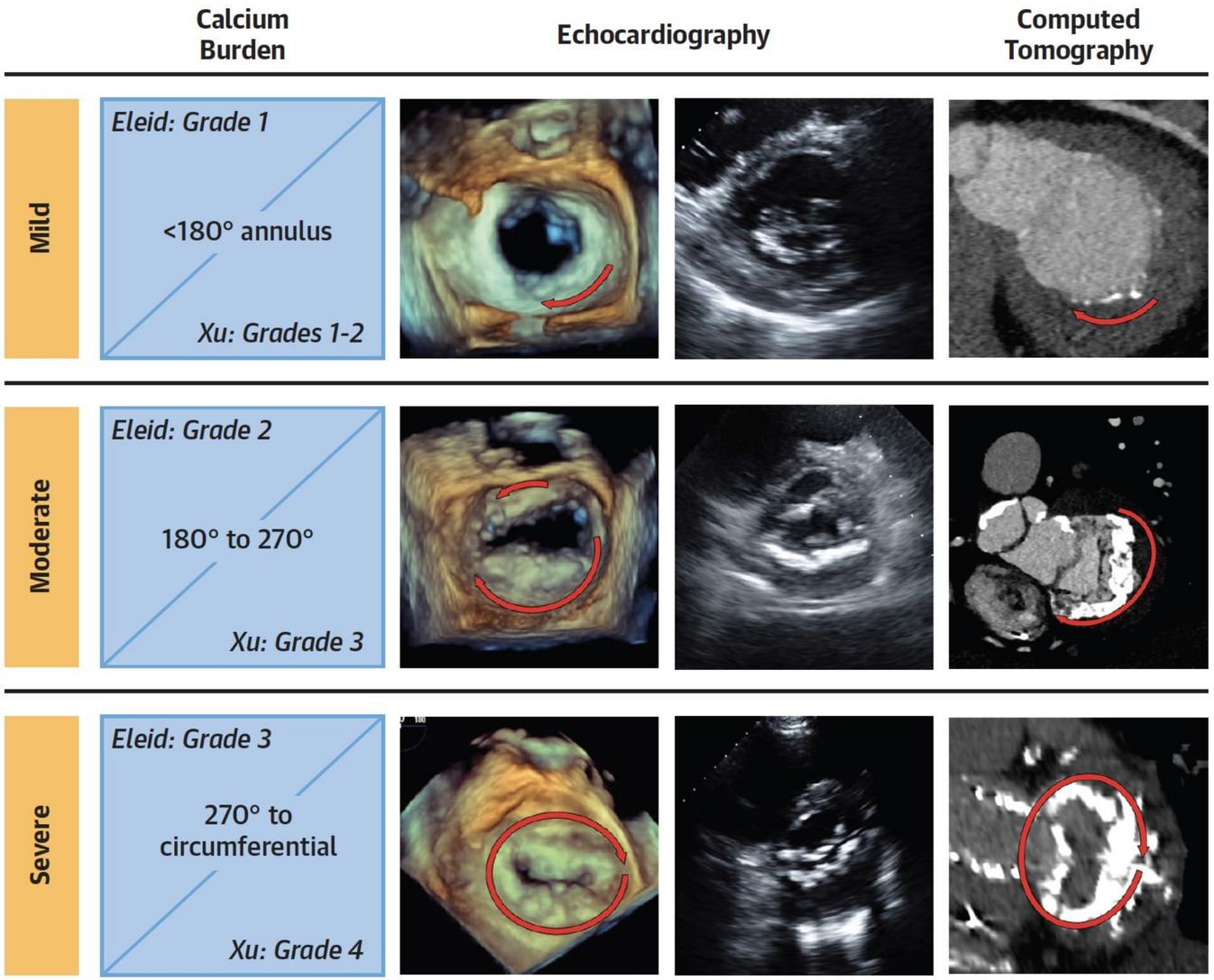
- High degree of spatial resolution
- Standardized quantification
- (non-contrast CT: Agatston Units)
- Assessment of the exact extent and localisation of MAC (MPR)



Gold standard for MAC classification and pre-procedural planning

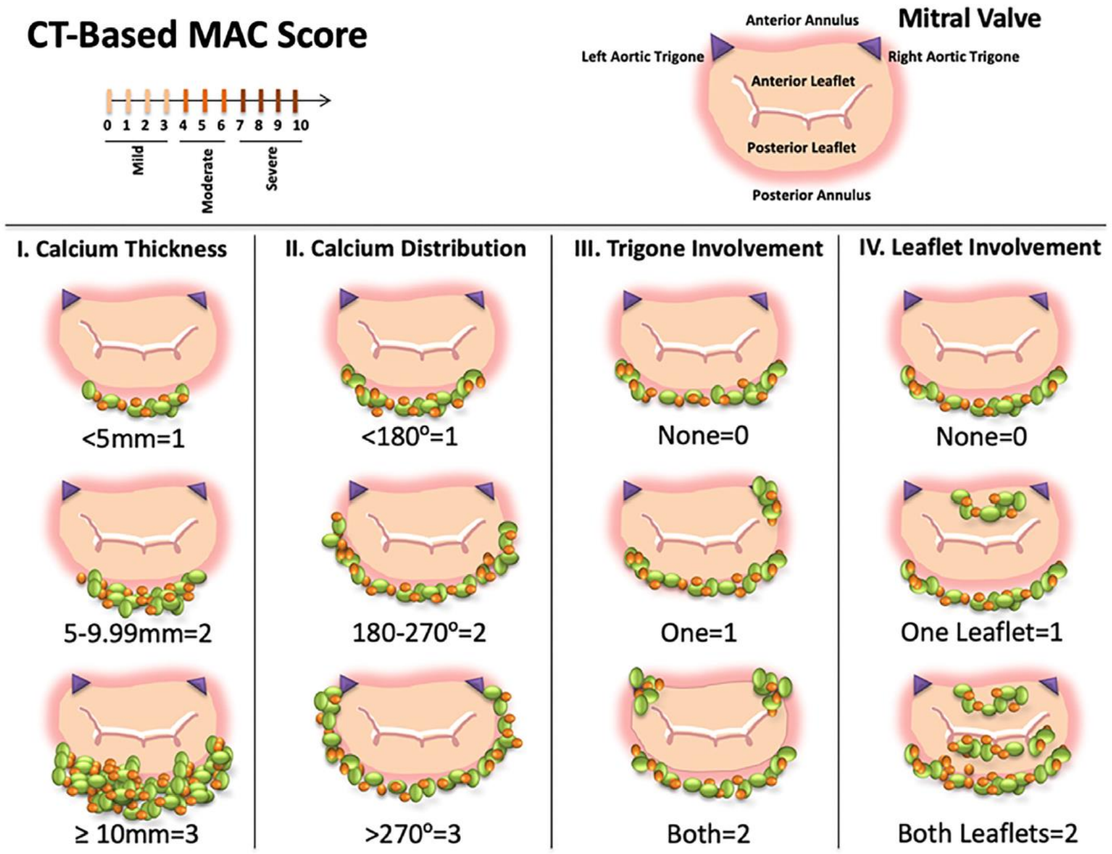
Eleid M et al. JACC Cardiovasc Imaging. 2016 Nov;9(11):1318-1337

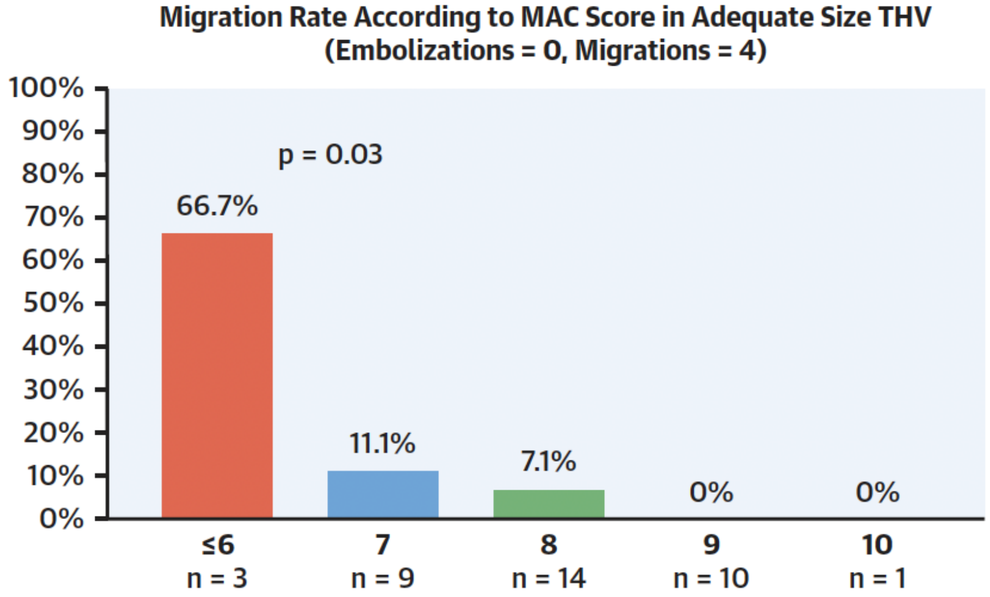
MAC grading



Churchill et al. J Am Coll Cardiol 2022;80:739–751

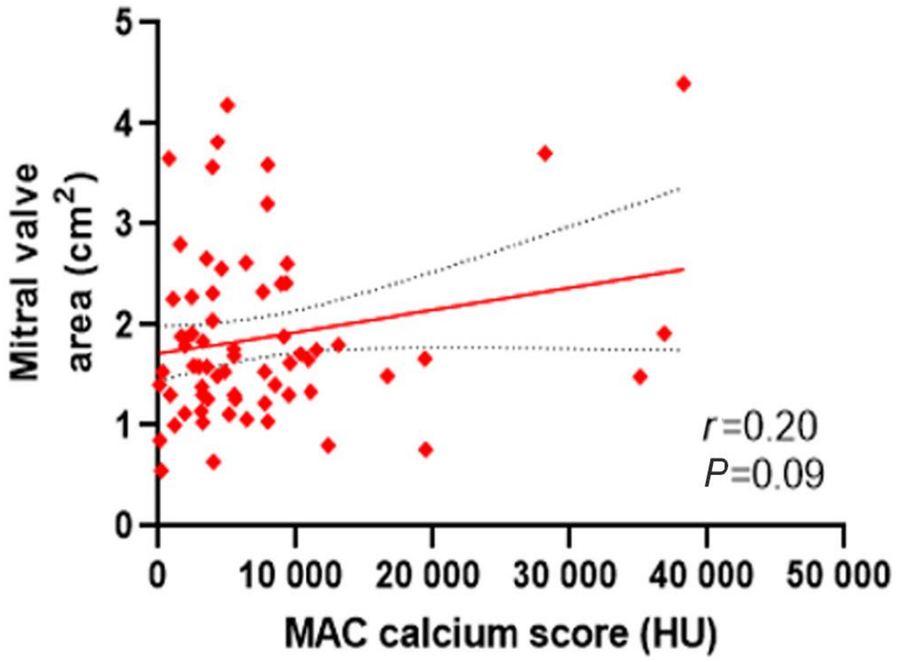
MAC grading

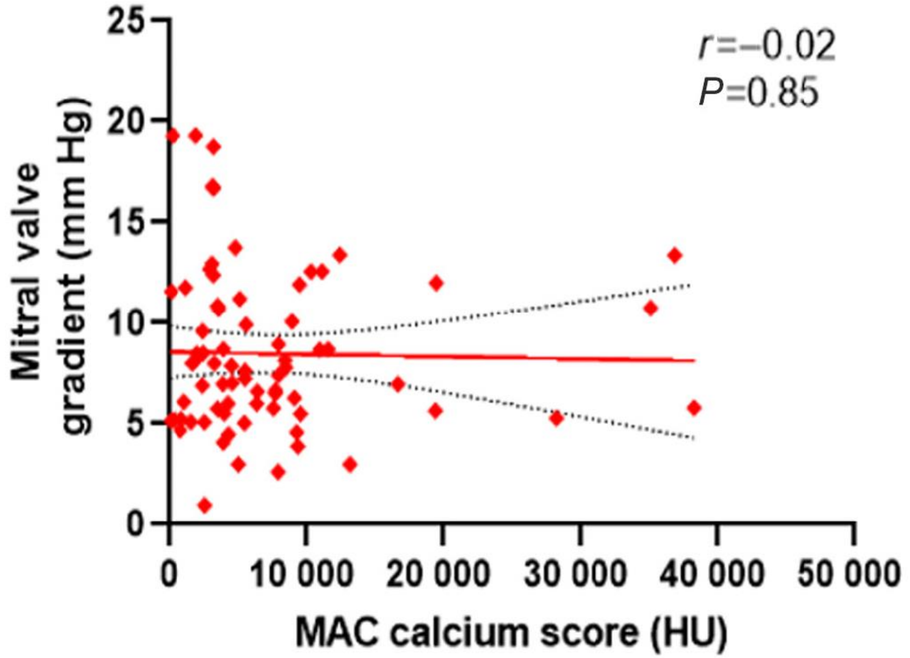




Guerrero M et al. J Am Coll Cardiol Img. 2020;13(9):1945–57.

MAC score and hemodynamic evaluation

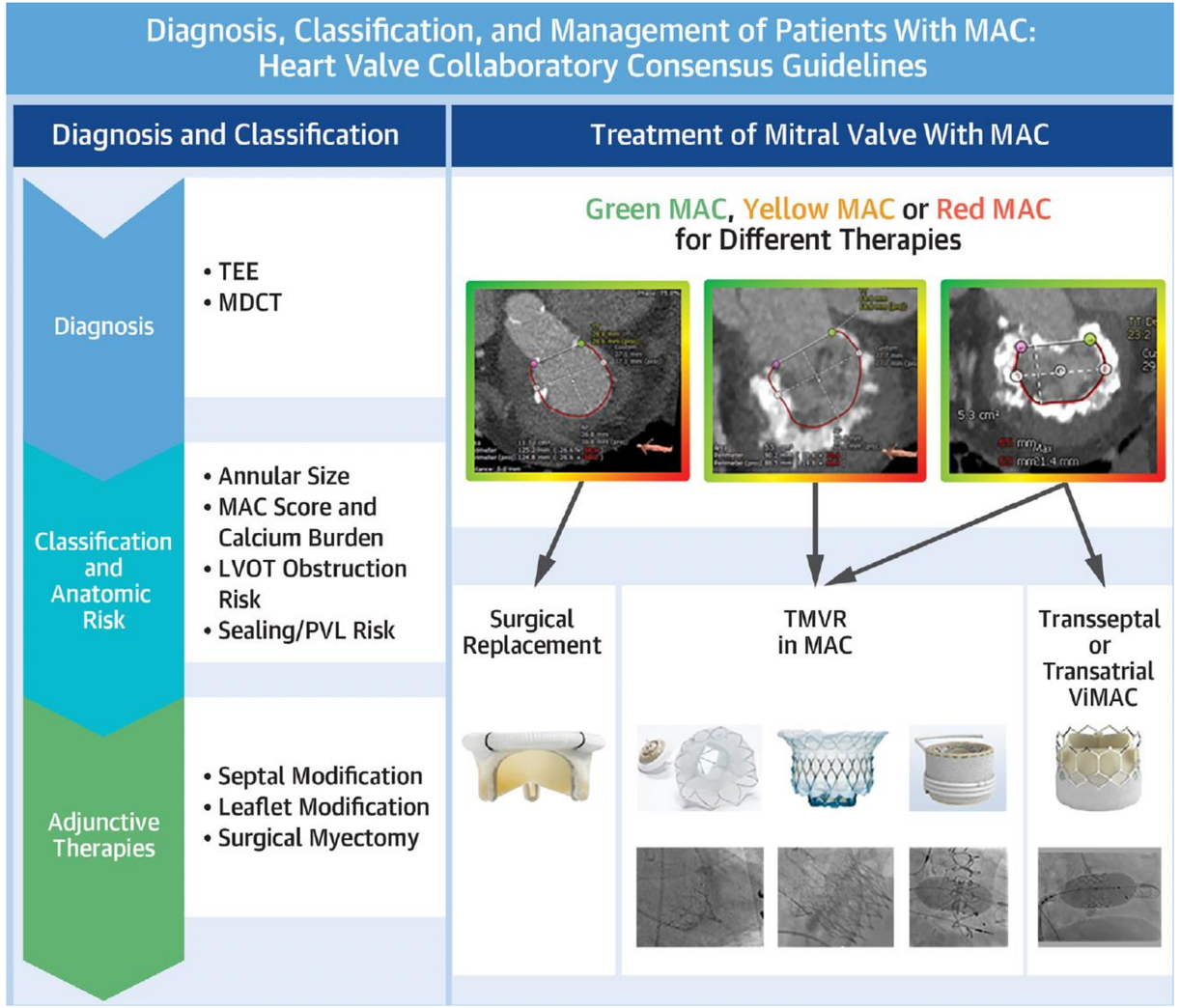




MAC calcium score **do not correlate** with invasively measured MV gradient and MVA in patients with MAC-related mitral stenosis

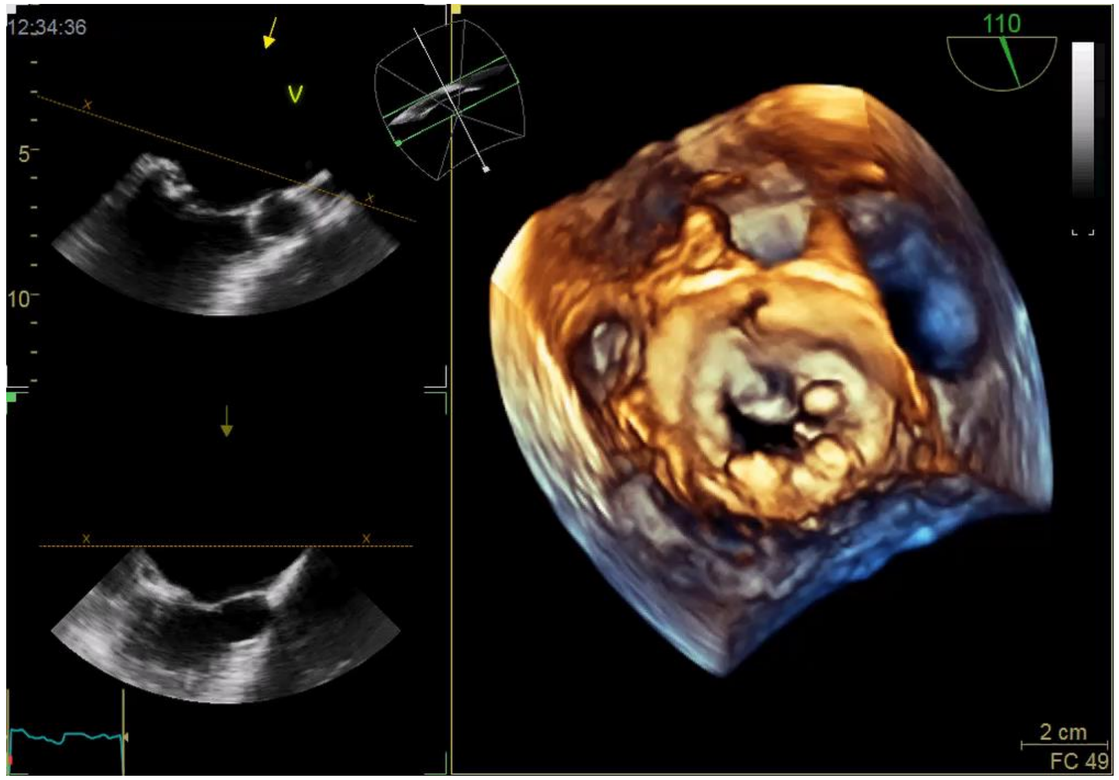
El Sabbagh A et al. J Am Heart Assoc. 2024 Feb 6;13(3):e030540

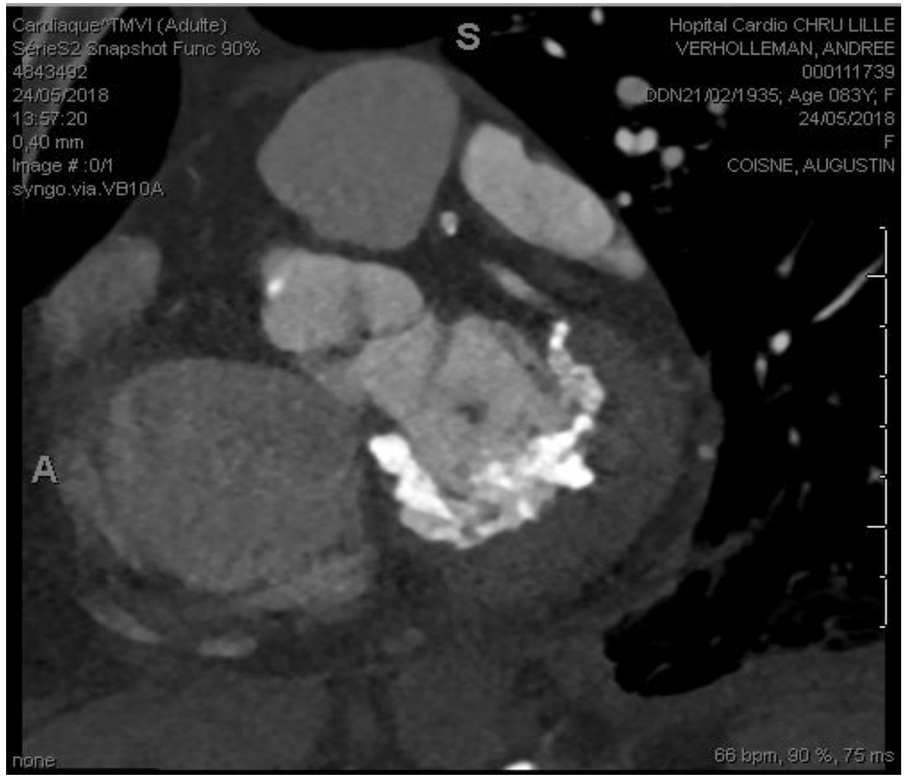
Heart Valve Collaboratory position statement



Churchill et al. J Am Coll Cardiol 2022;80:739–751

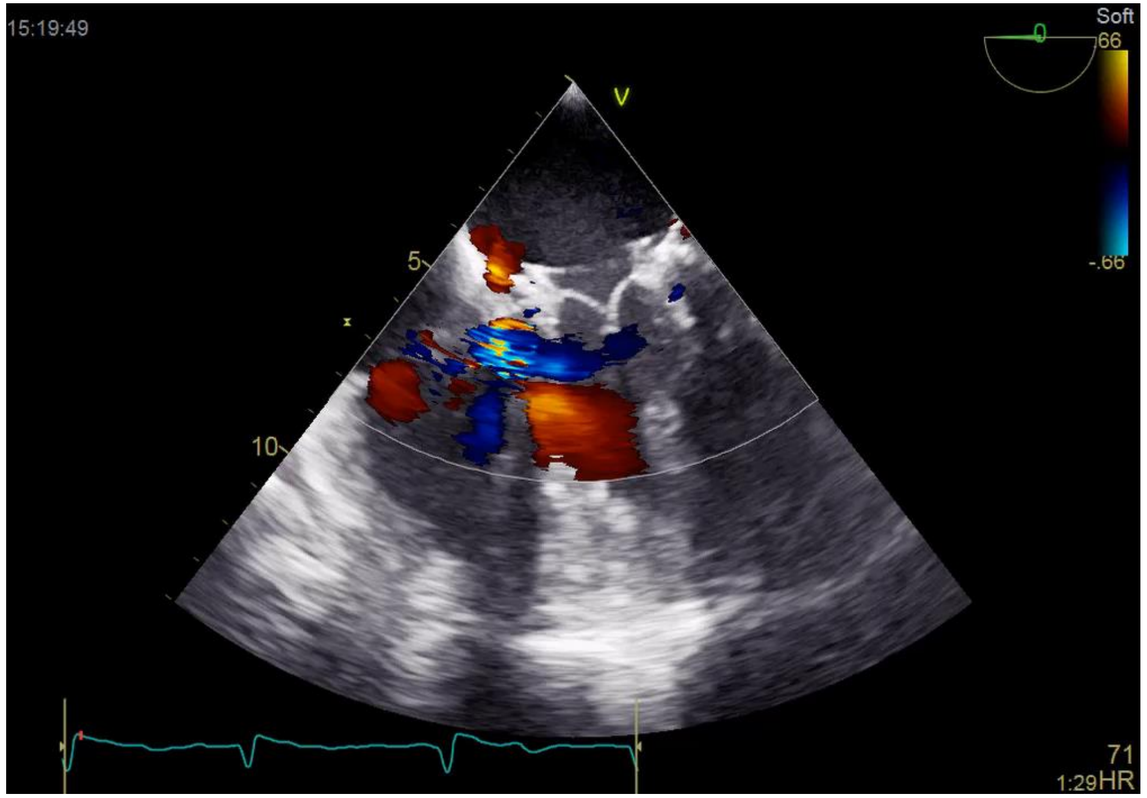
Echo / CT correlation?

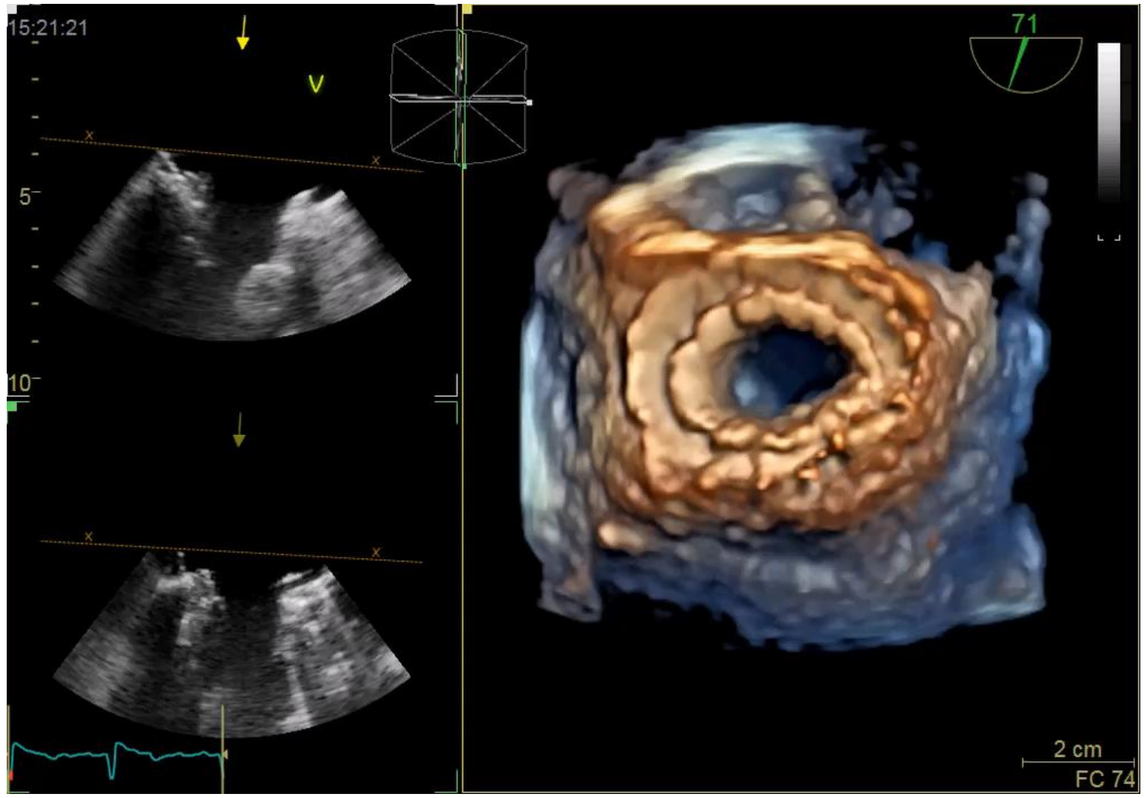




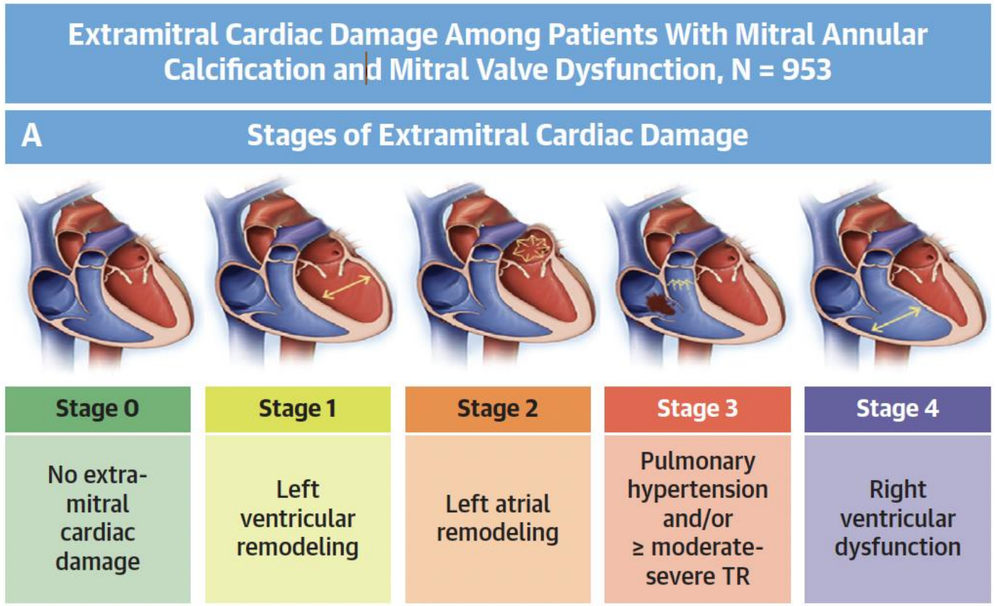
“White“ does not always means calcification

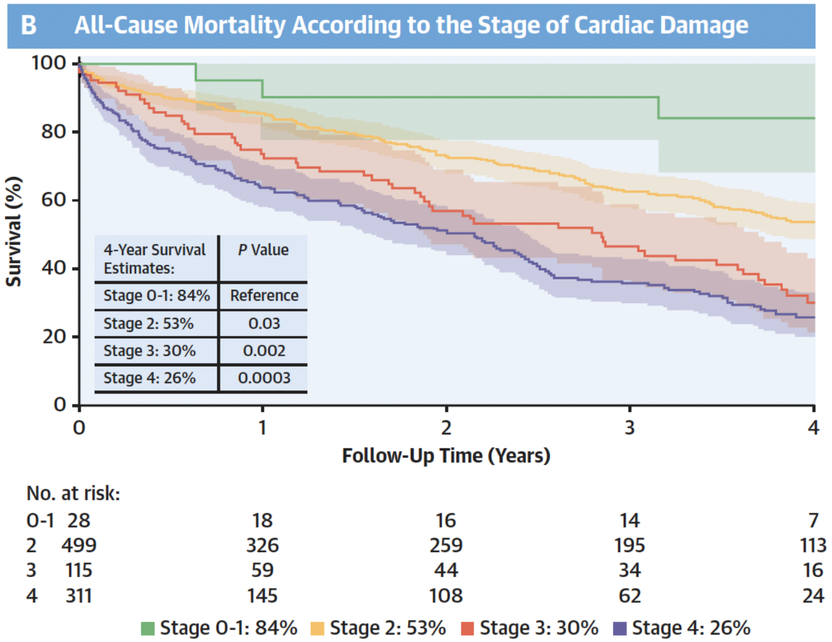
Echo / CT correlation?





Look beyond the valve

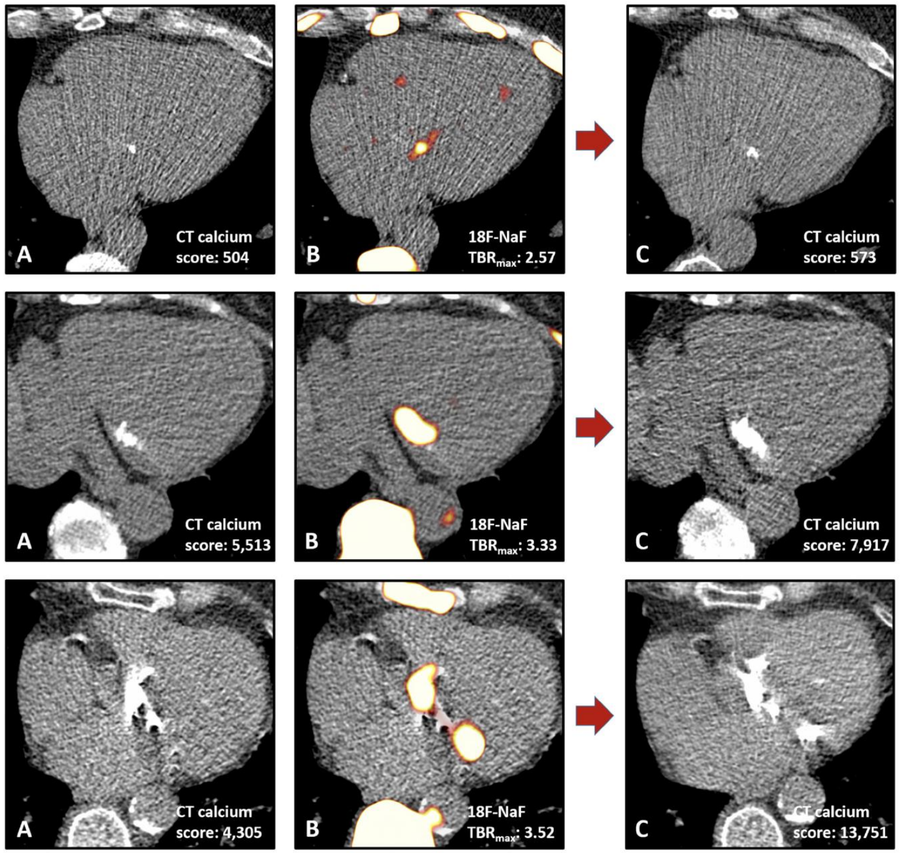




Higher stages of extra mitral cardiac damage were associated with increased **all-cause mortality and heart failure hospitalization**

Al-Abcha. JACC Cardiovasc Interv 2024;17:1577–1590

A glimpse of the future



Baseline CT-MAC, 18F-fluoride PET activity and 2-year progression in 3 patients

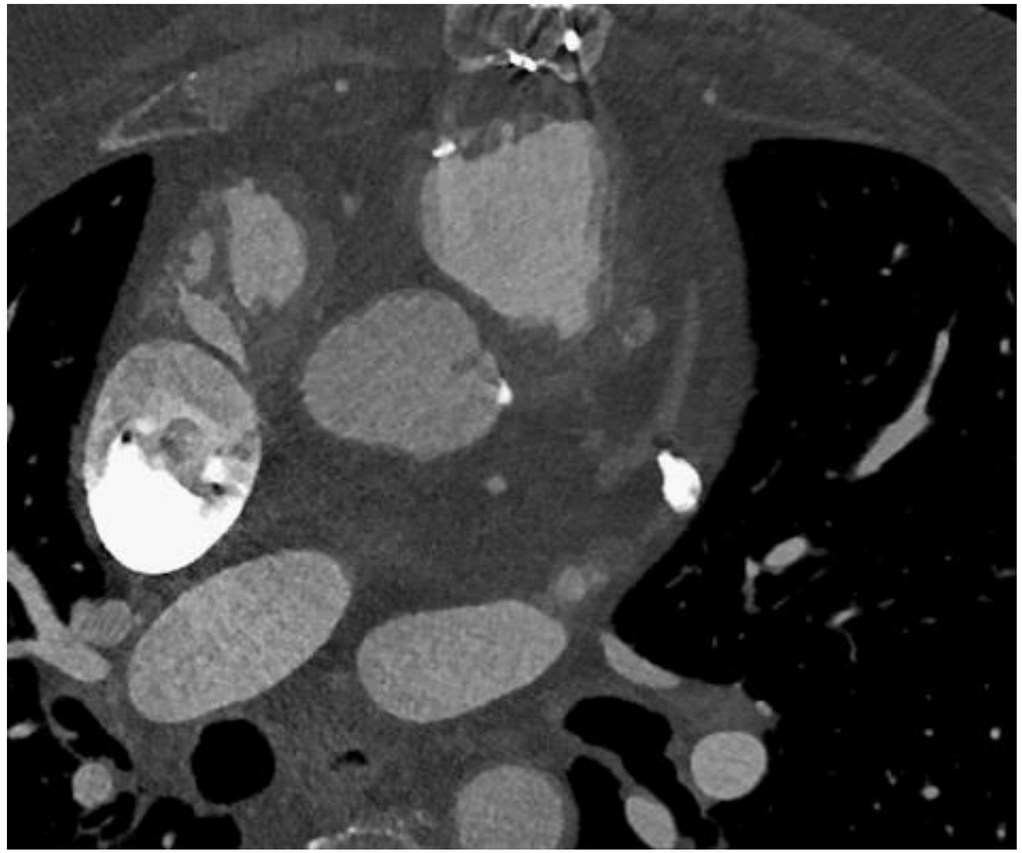
MAC is characterized by increased local calcification activity and inflammation

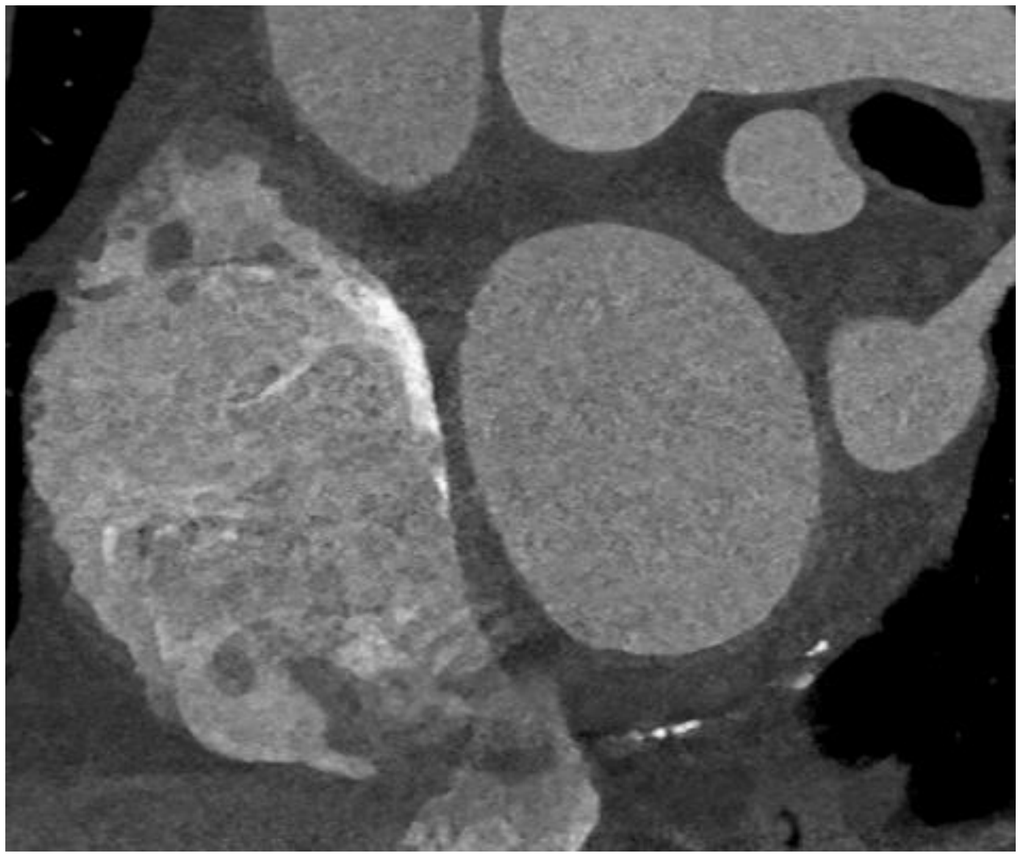
↓

PET-CT may help understand the disease activity

Massera D et al. Circ Cardiovasc Imaging. 2019 Feb;12(2):e008513

A glimpse of the future

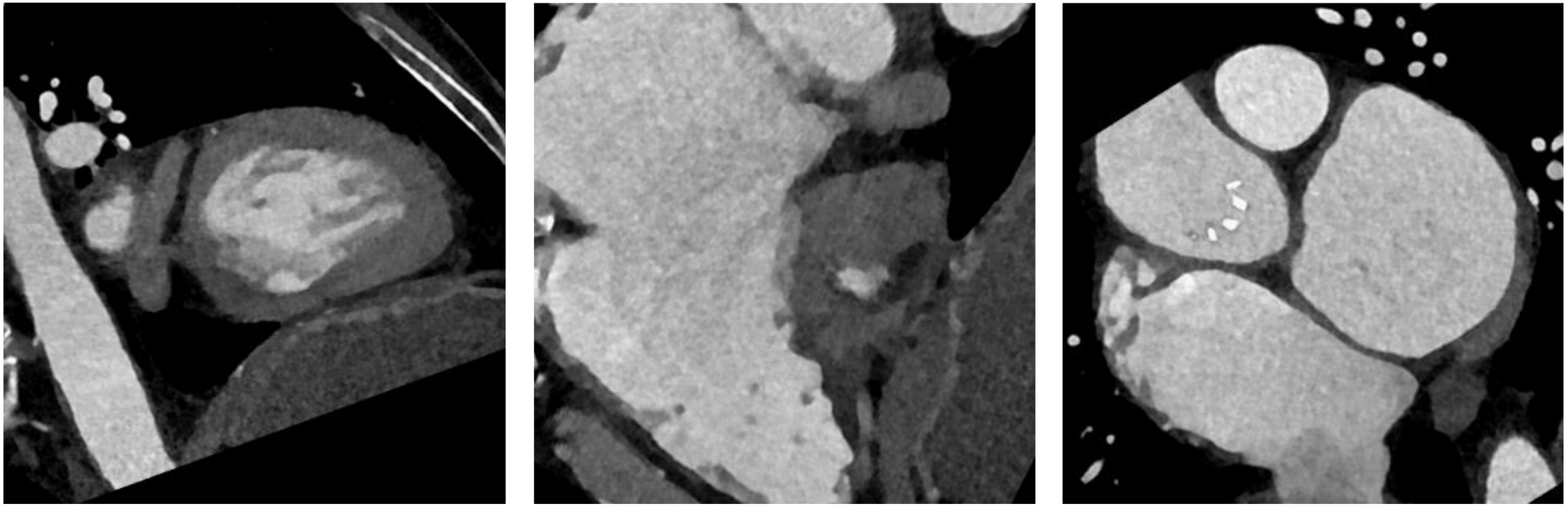




Photon-counting detector CT. Ultra High Resolution mode
Patient with severe MAC and pericardial calcifications (constriction)

Courtesy of Pr. PONTANA, Dr LONGERE and the Radiology team

A glimpse of the future



TAVR in aortic prosthetic valve and TAVR in mitral prosthetic valve.
High tension acquisition to limit metal artifacts. The MAC remains nicely depicted

Courtesy of Pr. PONTANA, Dr LONGERE and the Radiology team

Conclusions

- MAC is highly prevalent in the elderly population and is associated with a poor prognosis.

- MAC-related MV disease = MVA ≤1.5 cm^2, TMVG >8–10 mmHg, or >moderate MR

- Multimodality Imaging Approach:
  - *Echocardiography*: quantify MV dysfunction severity (MR and MS)
  - *CT Scan*: Grade the extent of MAC, using classifications such as Guerrero's
  - *Advanced Imaging*: Move beyond calcium quantification to assess MAC composition and activity using PET imaging and photon-counting detector

ATOMIC registry

-

chAracterizaTiOn of patient with MItral Calcification

Cardiovascular Research Foundation®

augustin.coisne@chu-lille.fr

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