Challenges in the assessment of secondary MR

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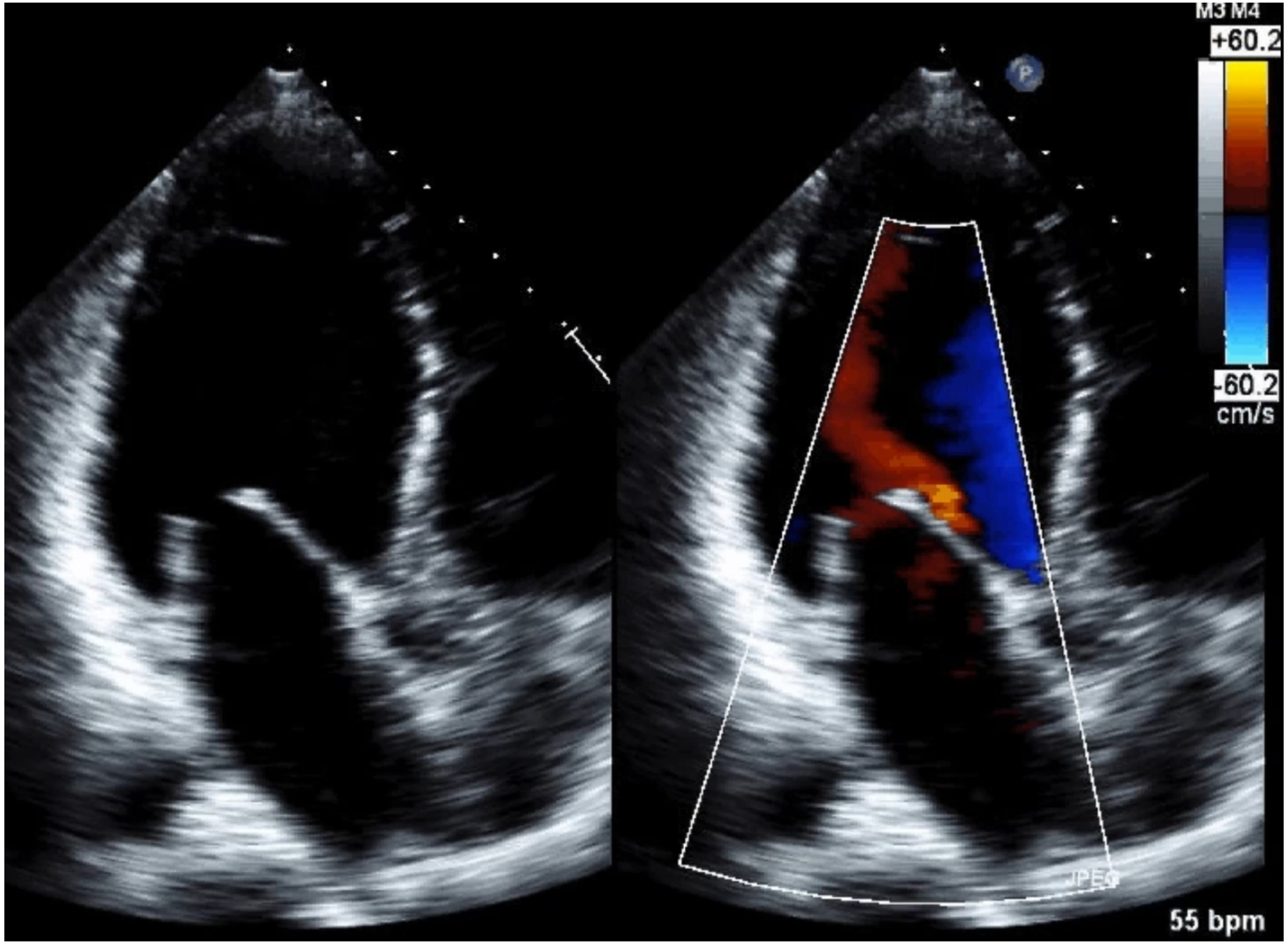
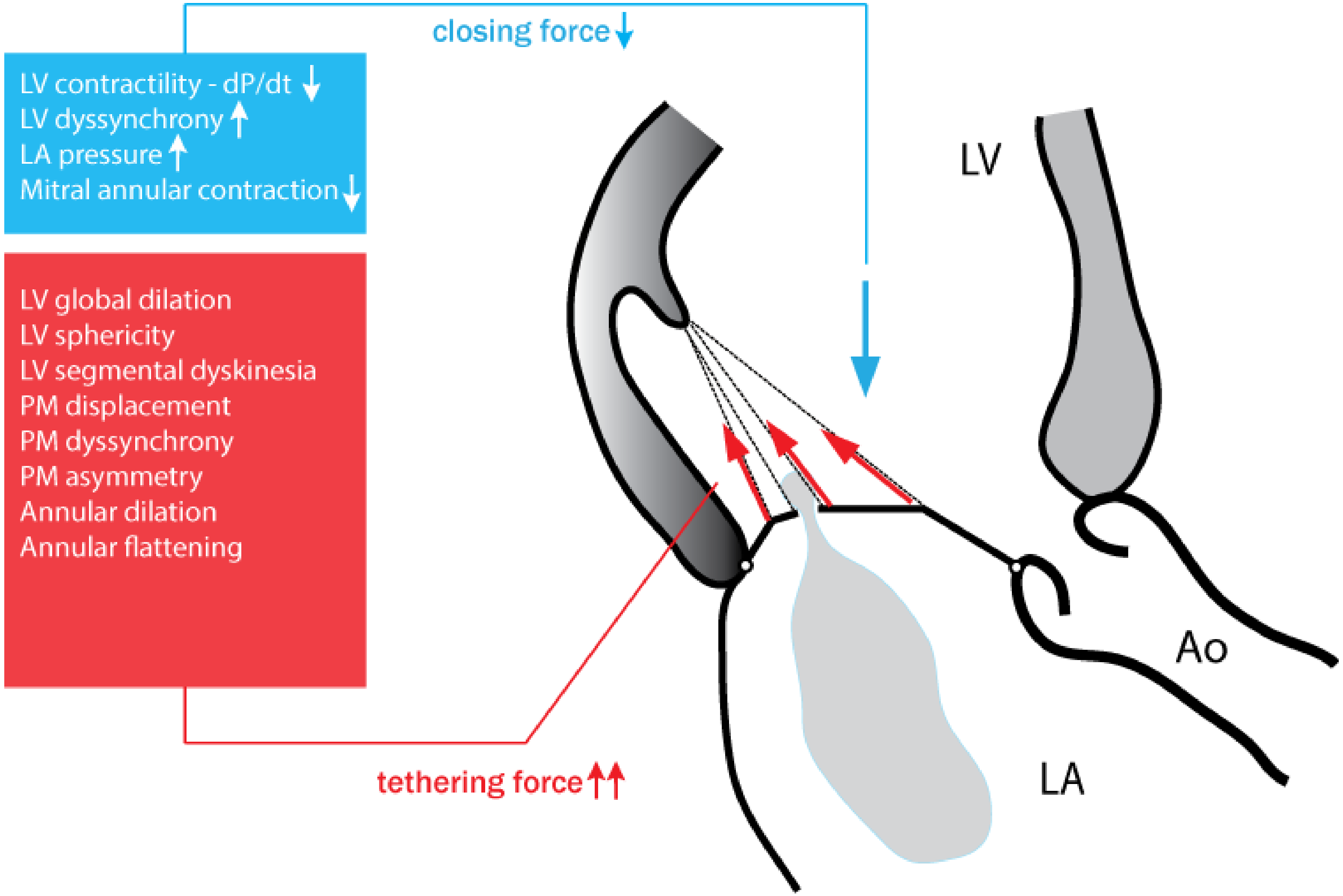
EACVI's Heart Imagers of Tomorrow

No disclosures

Secondary (Functional) Mitral Regurgitation

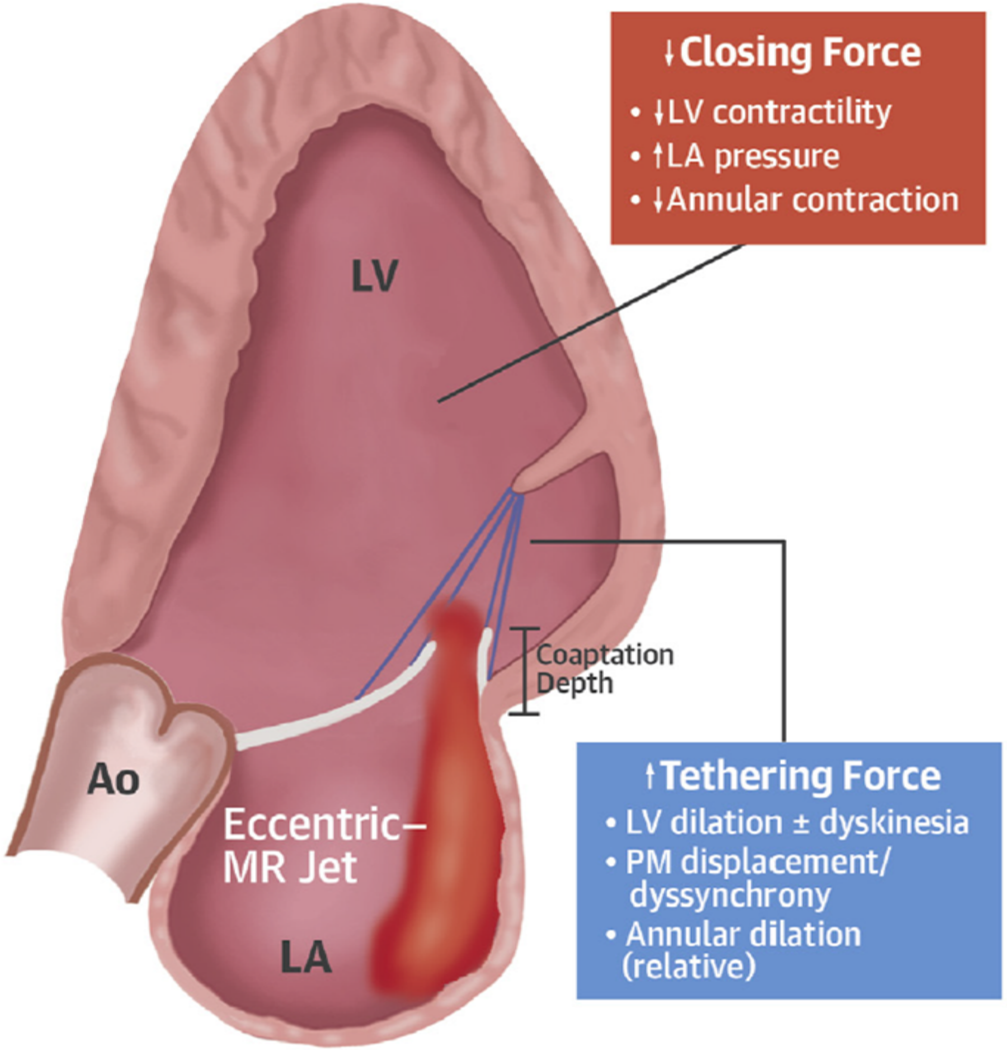


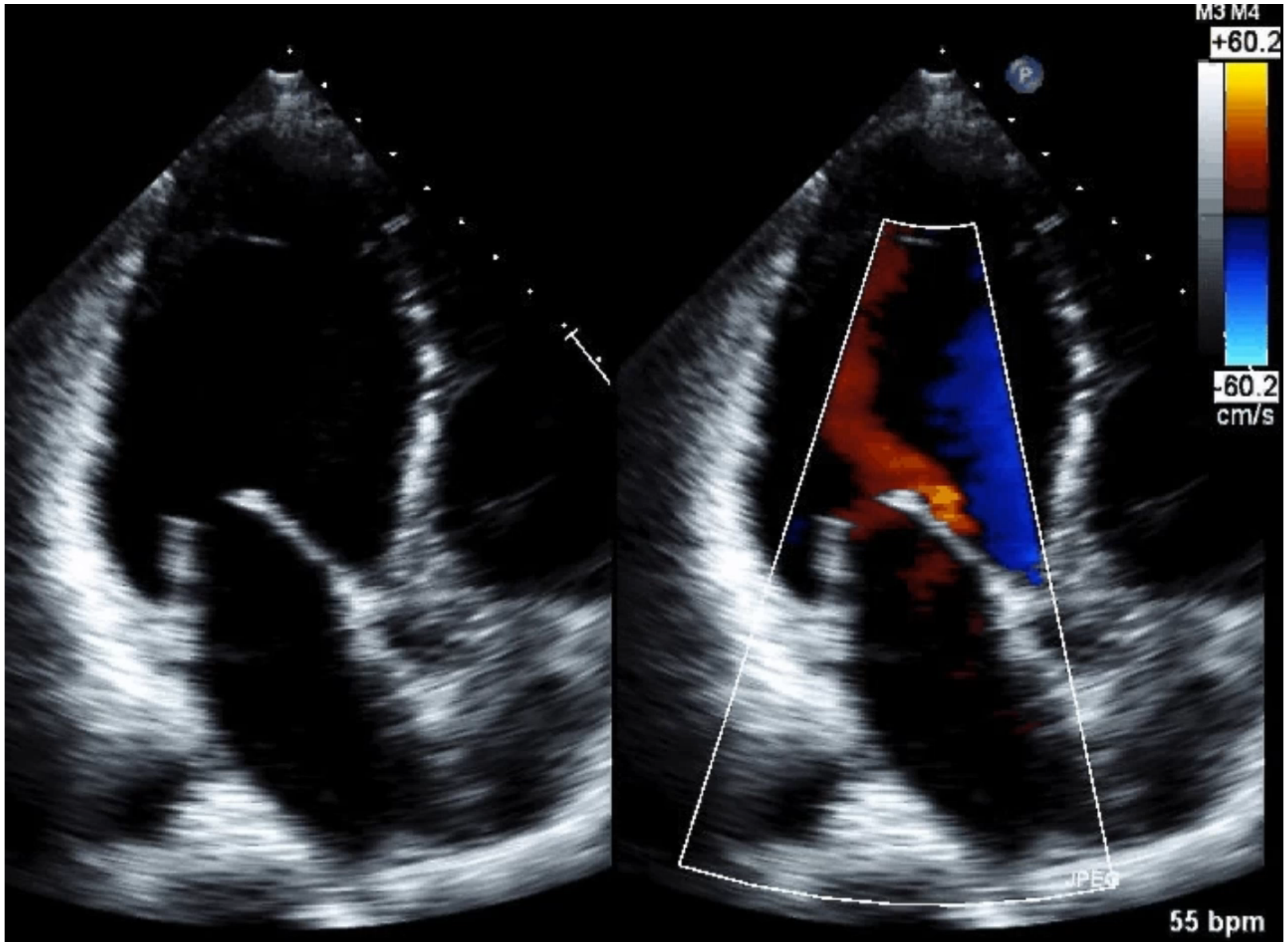
Force-Balance Relationship



Bertrand PB et al, *Circulation.* 2017;135:297–314.

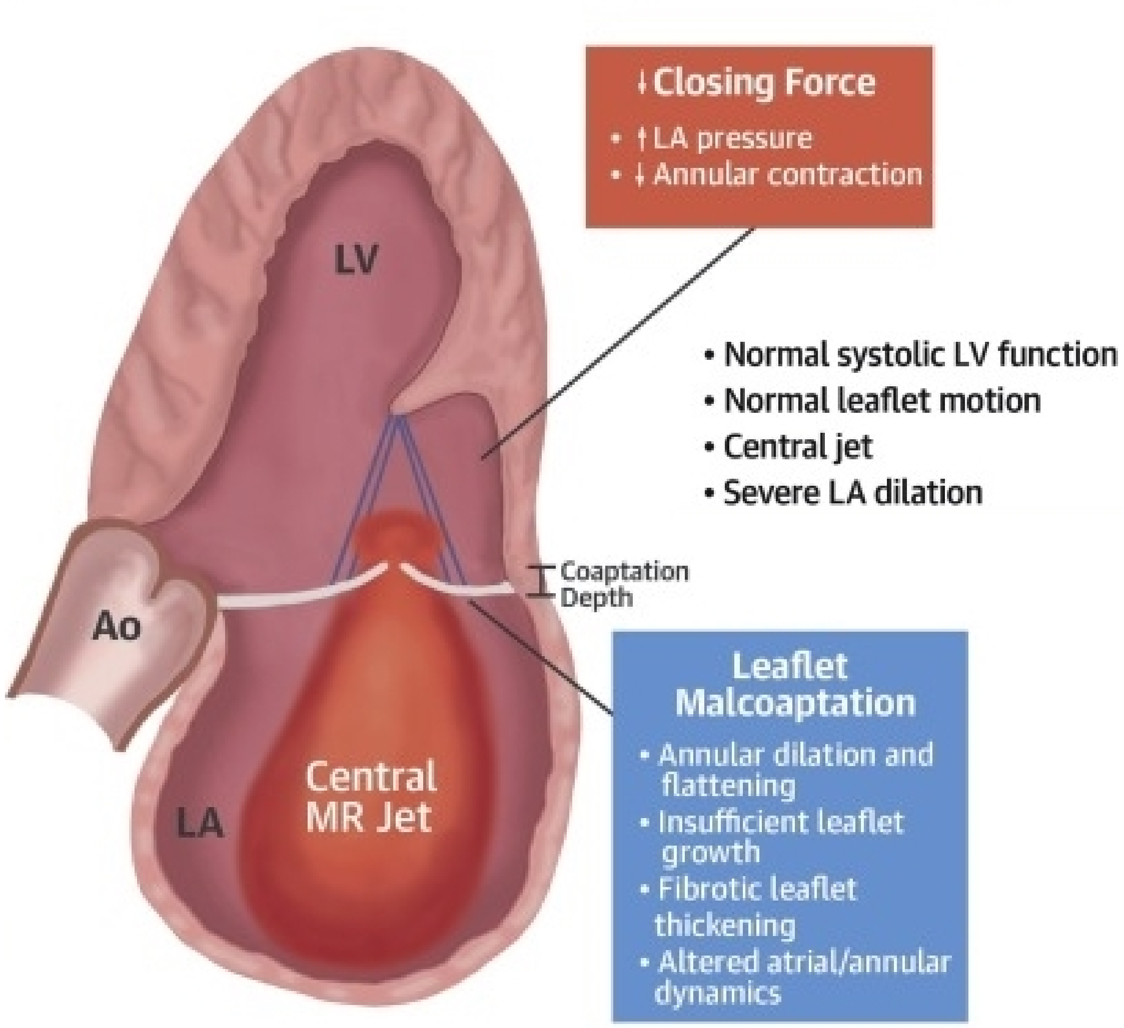
“Ventricular” Functional Mitral Regurgitation

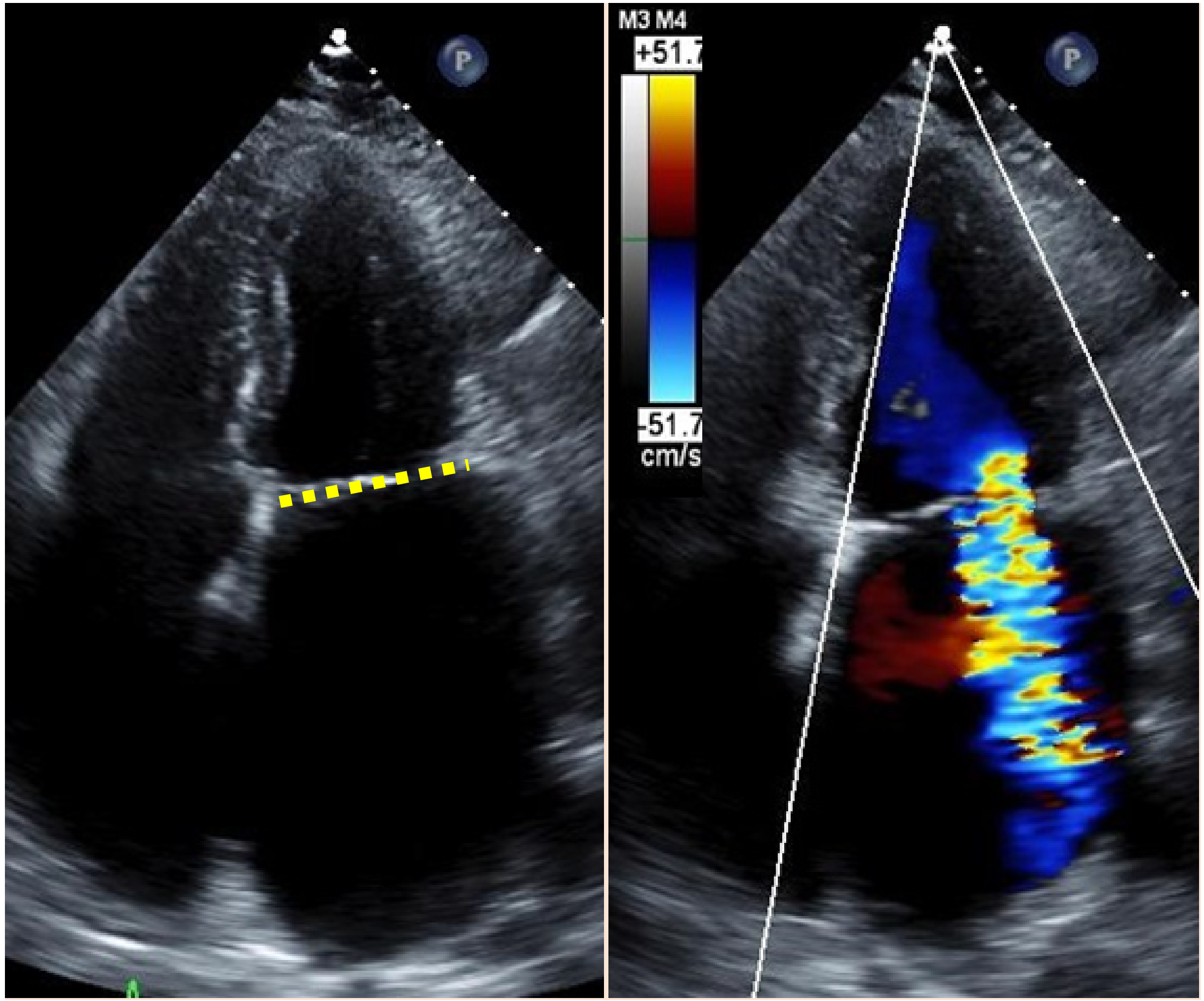




Deferm S, Bertrand PB et al. J Am Coll Cardiol. 2019;73(19):2465-76

“Atrial” Functional Mitral Regurgitation





Deferm S, Bertrand PB et al. J Am Coll Cardiol. 2019;73(19):2465-76

What is "significant" secondary MR?
Updated VHD Guidelines & EACVI MR grading

ESC European Society of Cardiology
European Heart Journal (2022) **43**, 561–632
https://doi.org/10.1093/eurheartj/ehab395
ESC/EACTS GUIDELINES

2021 ESC/EACTS Guidelines for the management of valvular heart disease

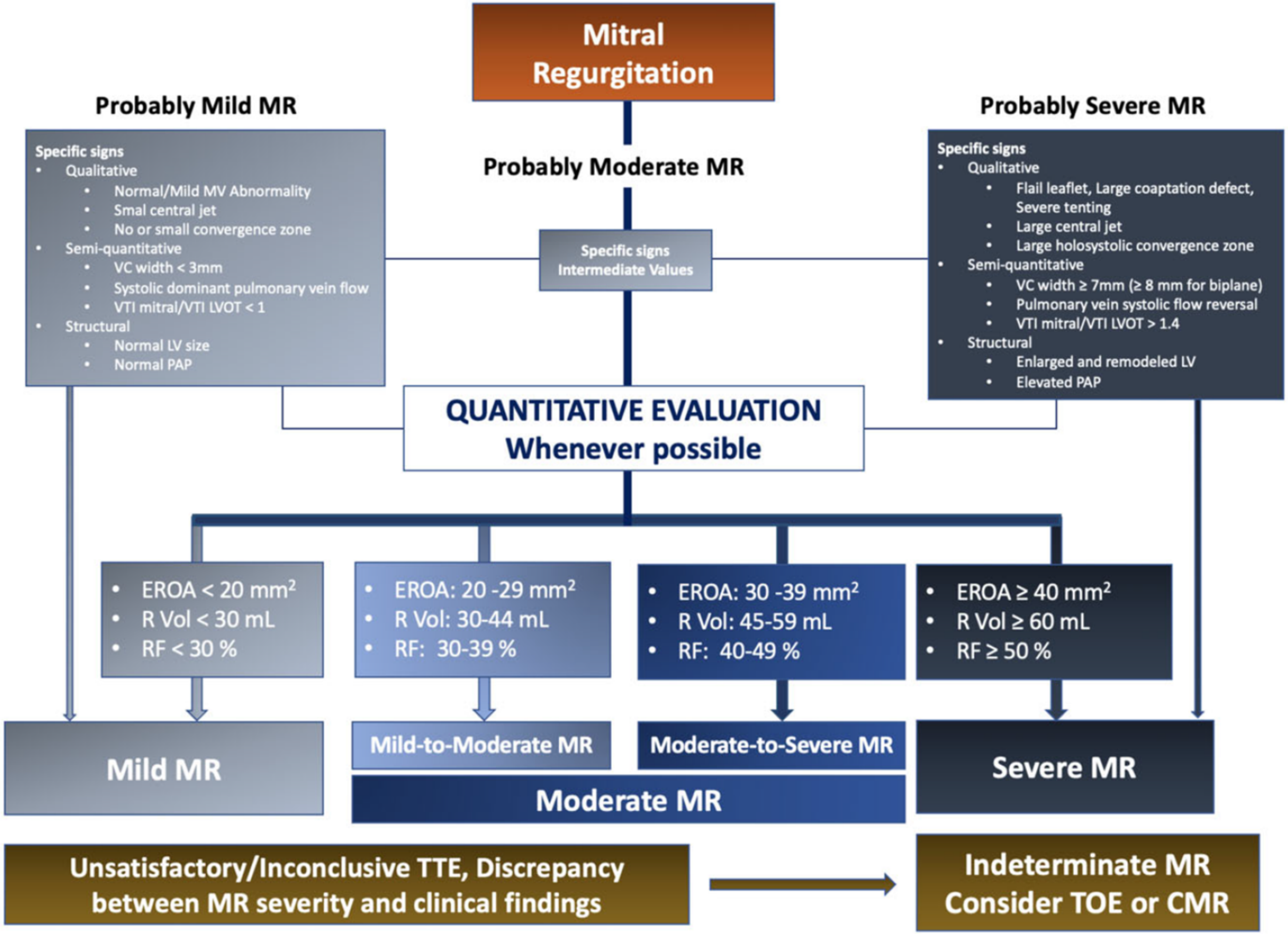
Developed by the Task Force for the management of valvular heart disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

ESC European Society of Cardiology
European Heart Journal - Cardiovascular Imaging (2022) **23**, e171–e232
https://doi.org/10.1093/ehjci/jeab253
EACVI DOCUMENT

Multi-modality imaging assessment of native valvular regurgitation: an EACVI and ESC council of valvular heart disease position paper

Patrizio Lancellotti [1,2,3]*, Philippe Pibarot [4], John Chambers[5], Giovanni La Canna[6], Mauro Pepi[7], Raluca Dulgheru[1], Mark Dweck[8],

Vahanian et al, Eur Heart J, 2022
Lancellotti et al, Eur Heart J CV Imaging, 2022



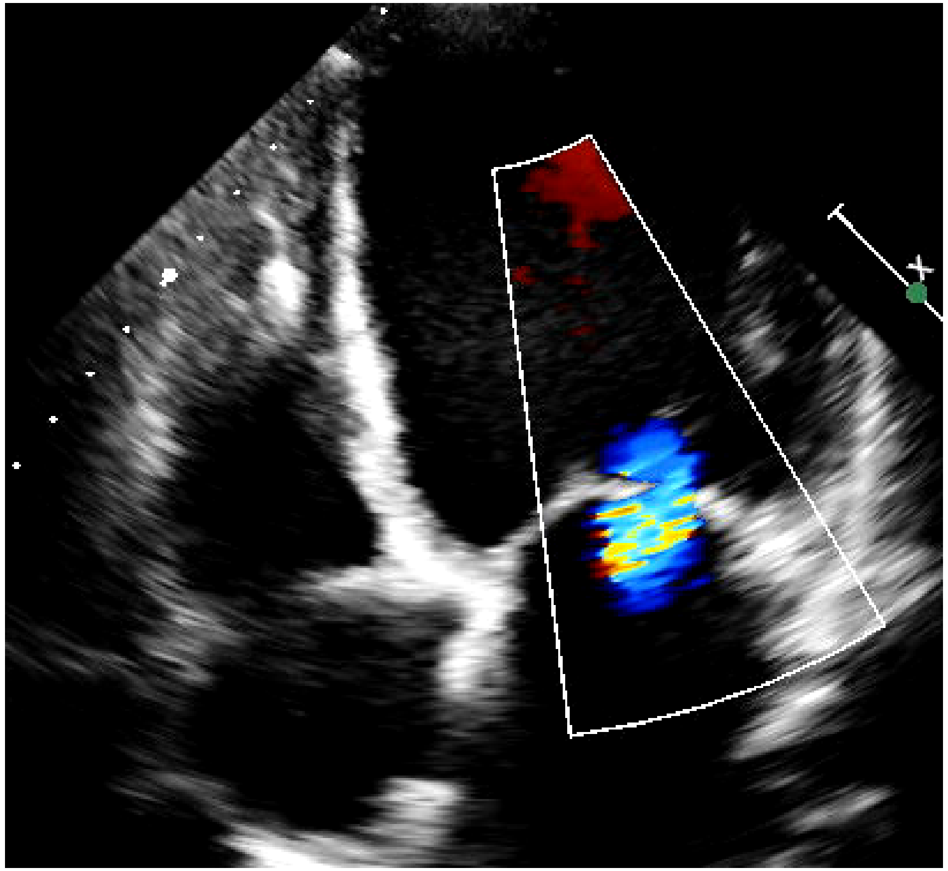
Lancellotti et al, Eur Heart J CV Imaging, 2022

Functional MR = dynamic

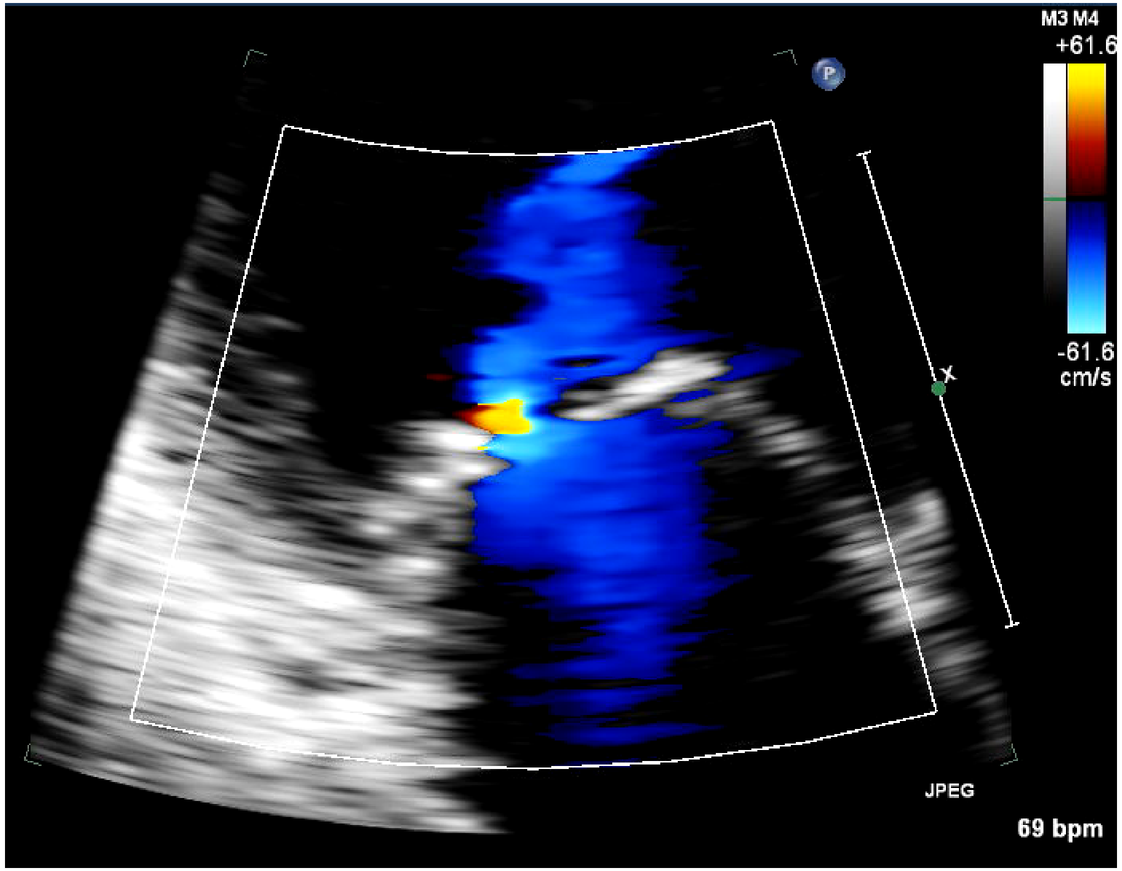
- Within one cardiac cycle
- Loading conditions
- Arrhythmia
- Exercise

Bertrand PB et al, *Circulation.* 2017;135:297–314.

Dynamic MR within one cardiac cycle

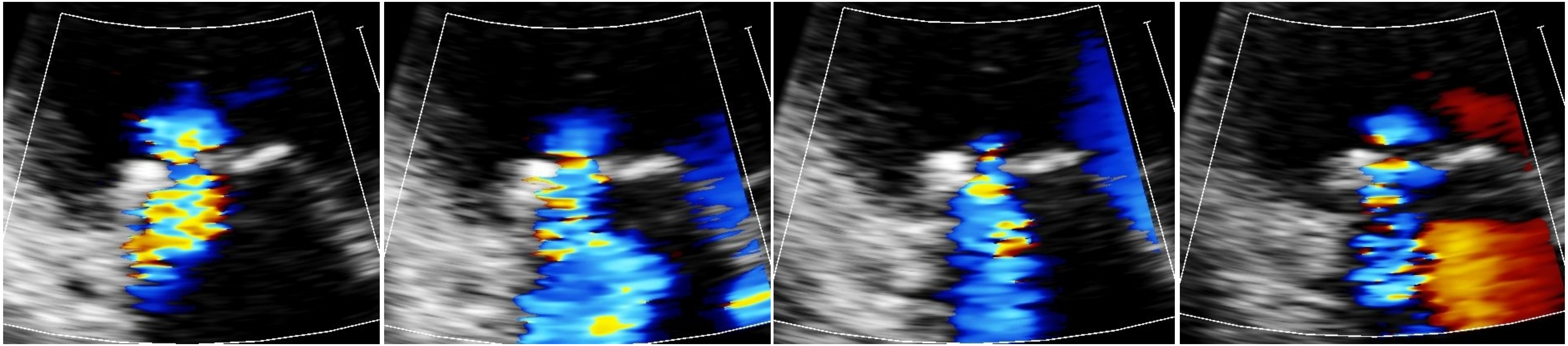


A4Ch



A3Ch

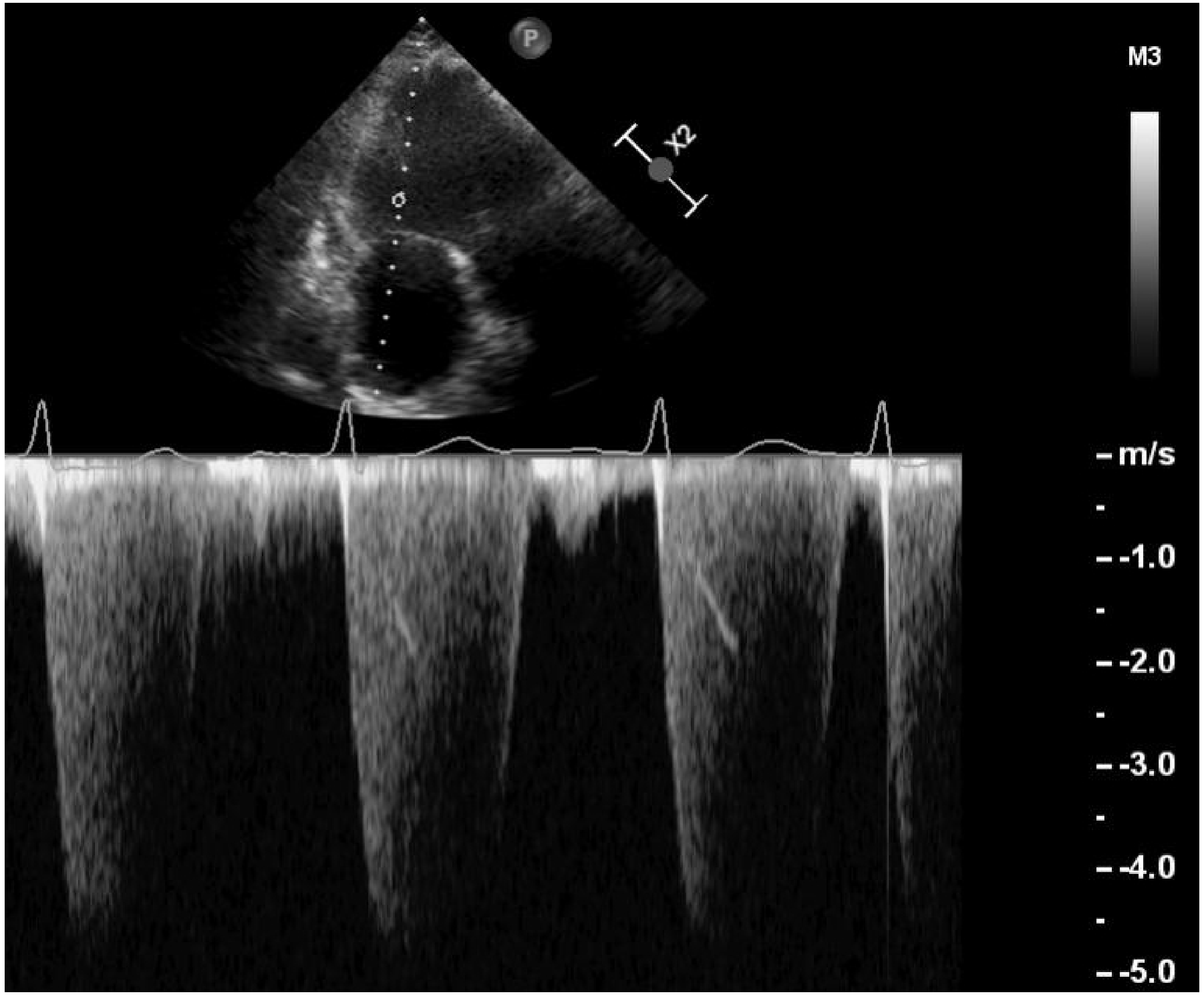
Dynamic MR within one cardiac cycle

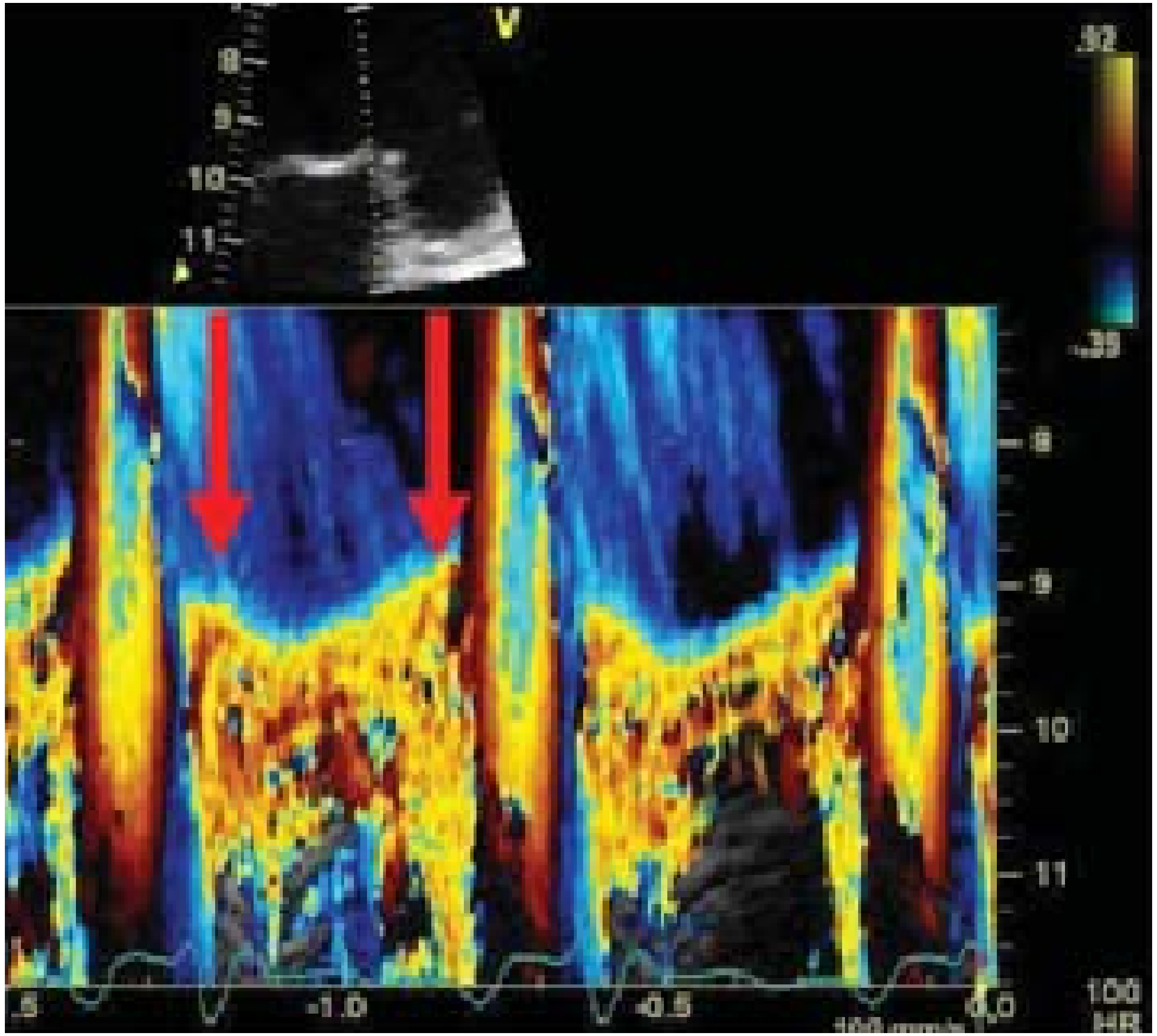


Protosystole

Telesystole

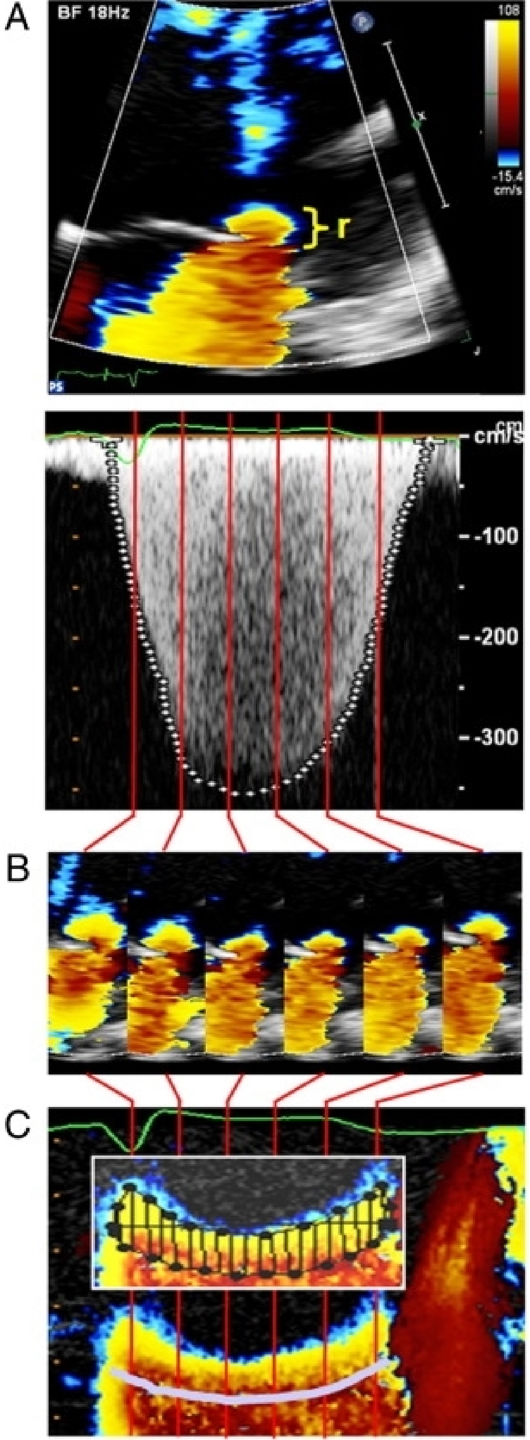
Dynamic MR within one cardiac cycle





Lancellotti et al, Eur J Echocardiogr 2010

“Biphasic MR”



PISA-VTI

$$MRSV = \frac{2\pi \cdot r^2 \cdot v(Ny) \cdot VTI}{v_{max}}$$

$$= \frac{2\pi \cdot (0.7\,cm)^2 \cdot 15.4\,cm/s \cdot 111\,cm}{354\,cm/s}$$

= 14.9 ml

MV VTI	
Vmax	354 cm/s
Vm	249 cm/s
Max PG	50 mmHg
MPG	29 mmHg
VTI	111 cm

Serial PISA

$$MRSV = \sum_1^n \frac{2\pi \cdot r_n^2 \cdot V_{Nyquist}}{\text{color Doppler frame rate}}$$

frame rate = 18 frames/sec

r (cm) = 1.1; 0.9; 0.7; 0.6; 0.8; 0.8

MRSV = 6.5 + 4.4 + 2.6 + 1.9 + 3.4 + 3.4 ml

= 22.2 ml

M-mode PISA

$$MRSV = \frac{8 \cdot Vol(PISA) \cdot v(Ny) \cdot t(PISA)}{length(PISA)}$$

$$= \frac{8 \cdot 1.8\,ml \cdot 15.4\,cm/s \cdot 0.39\,sec}{3.1\,cm}$$

= 27.9 ml

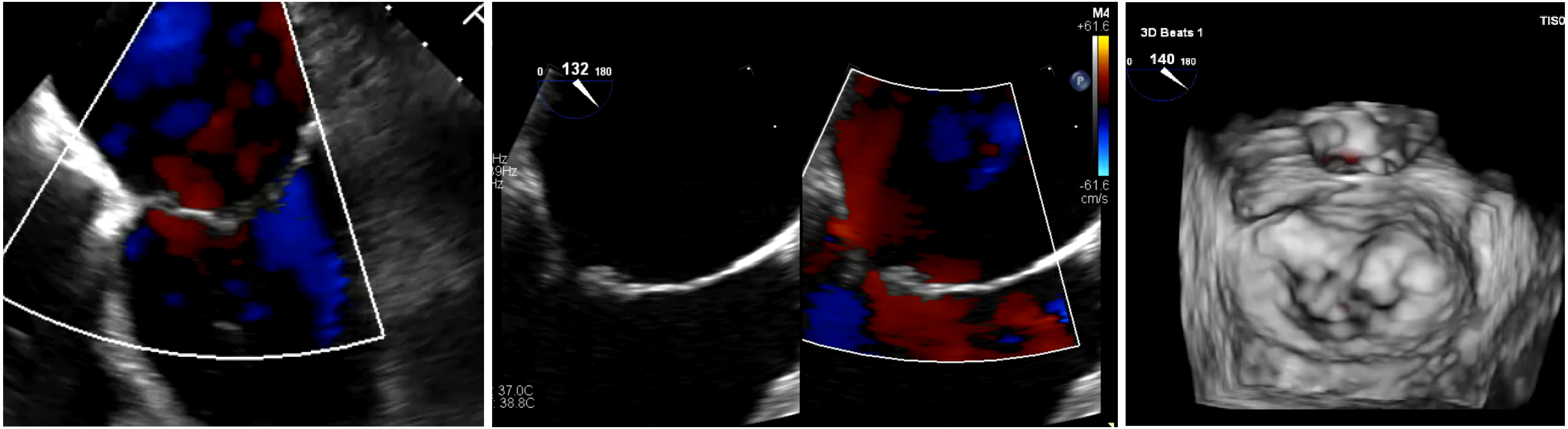
Buck T et al, JACC, 2008

Functional MR = dynamic

- Within one cardiac cycle
- Loading conditions
- Arrhythmia
- Exercise

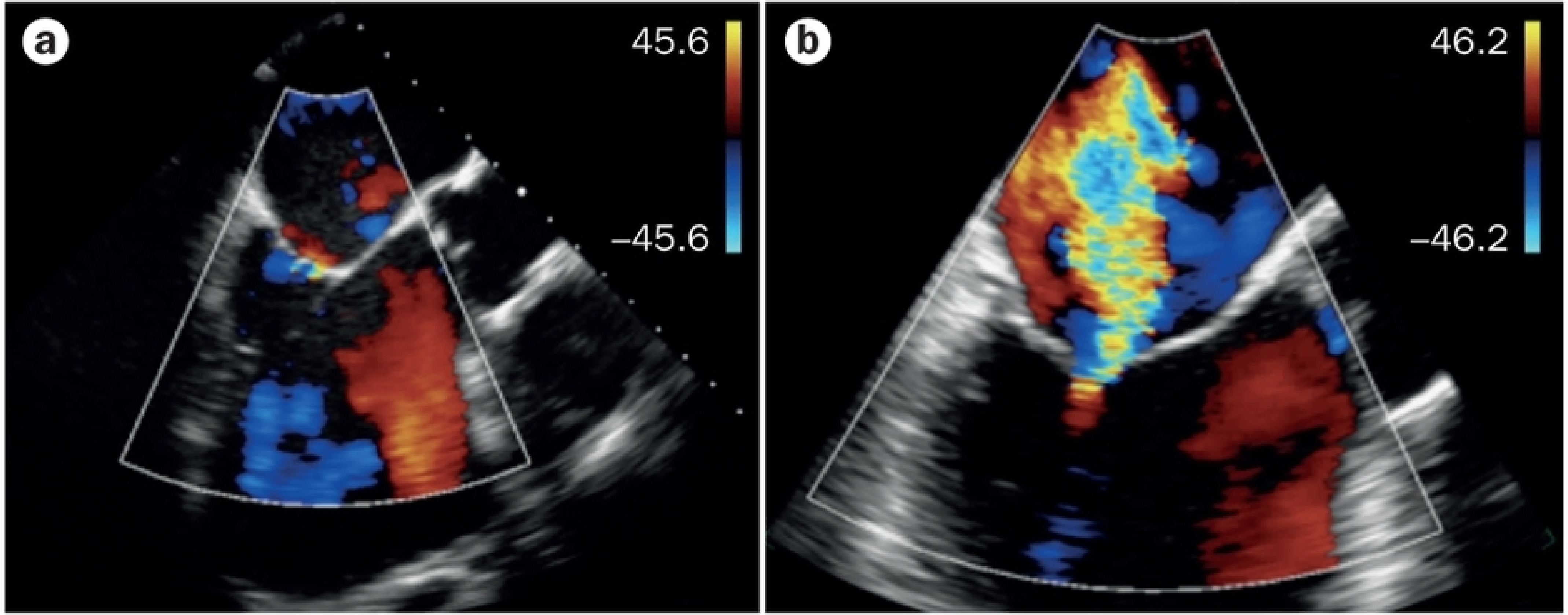
Bertrand PB et al, *Circulation.* 2017;135:297–314.

Dynamic MR with loading



sedation

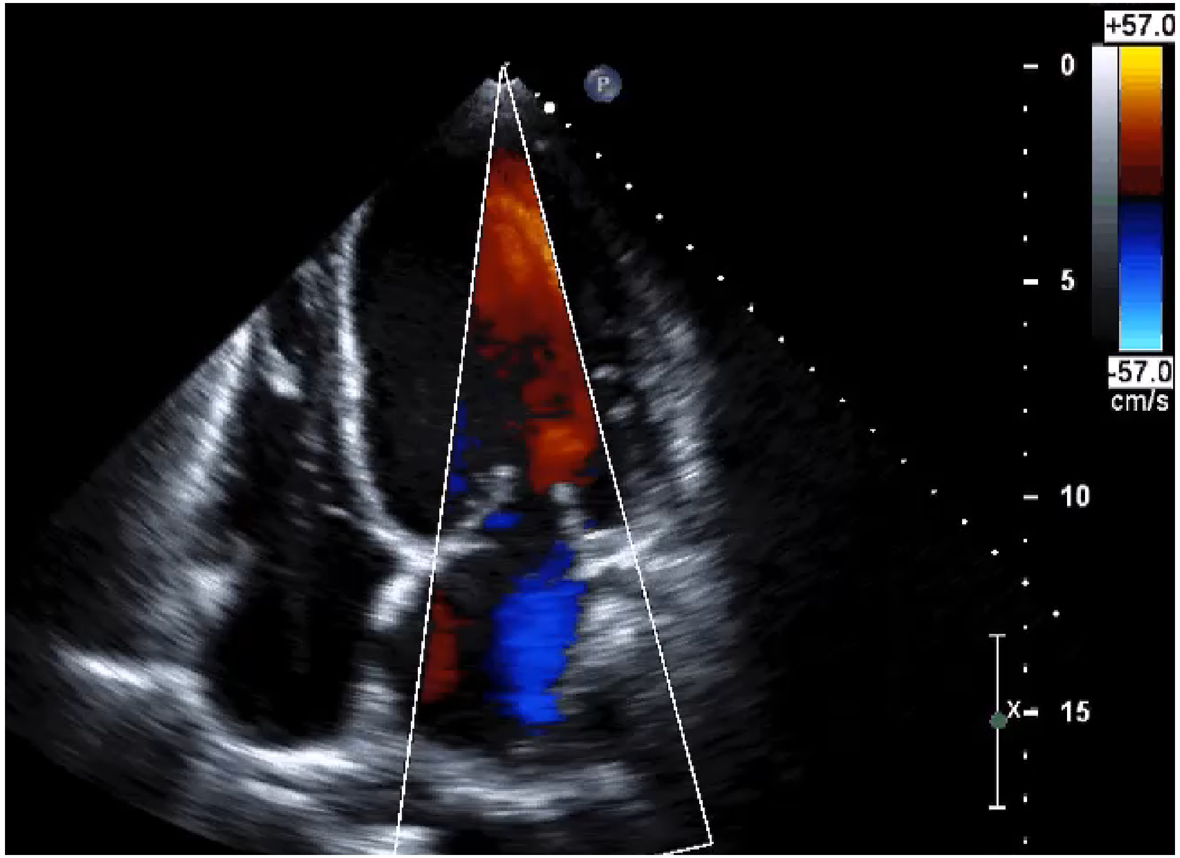
Dynamic MR with loading



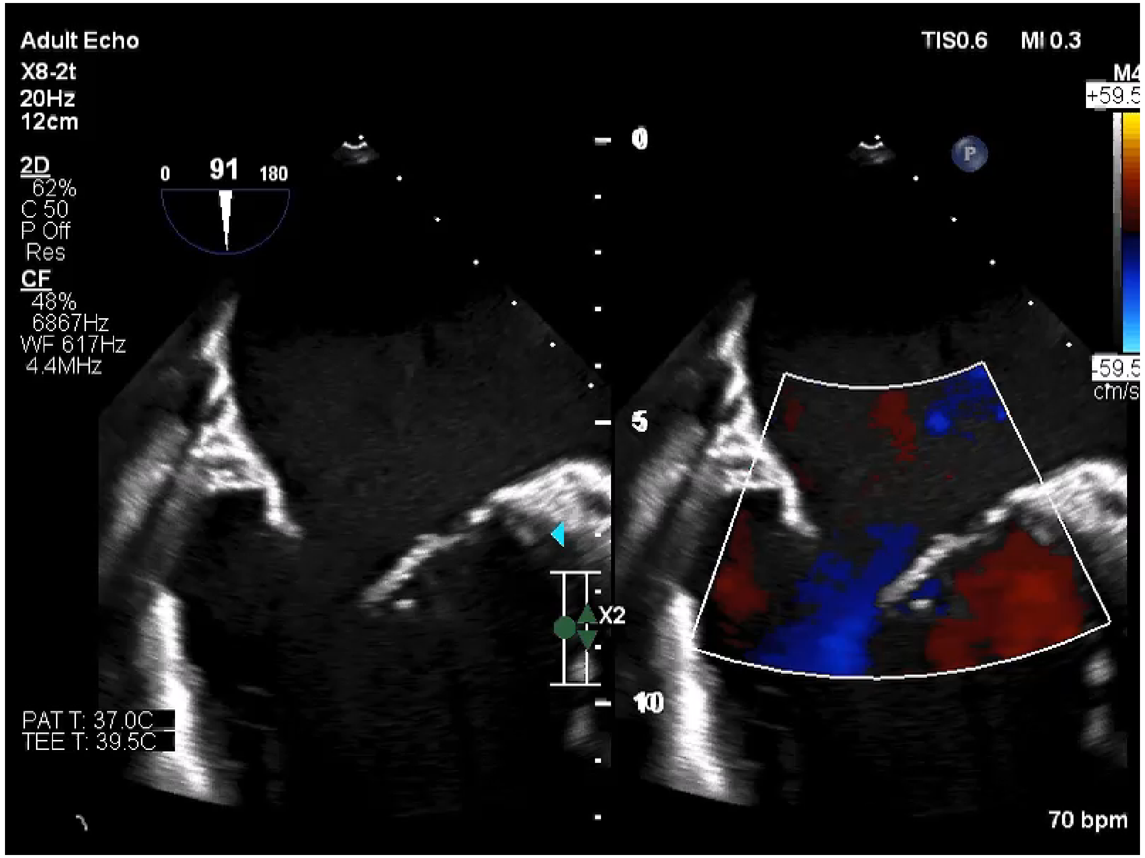
Baseline **Trendelenburg manoever**

Lancellotti P et al, Nat Rev Cardiol. 2015;12(4):212-9

Decreasing MR severity during sedation

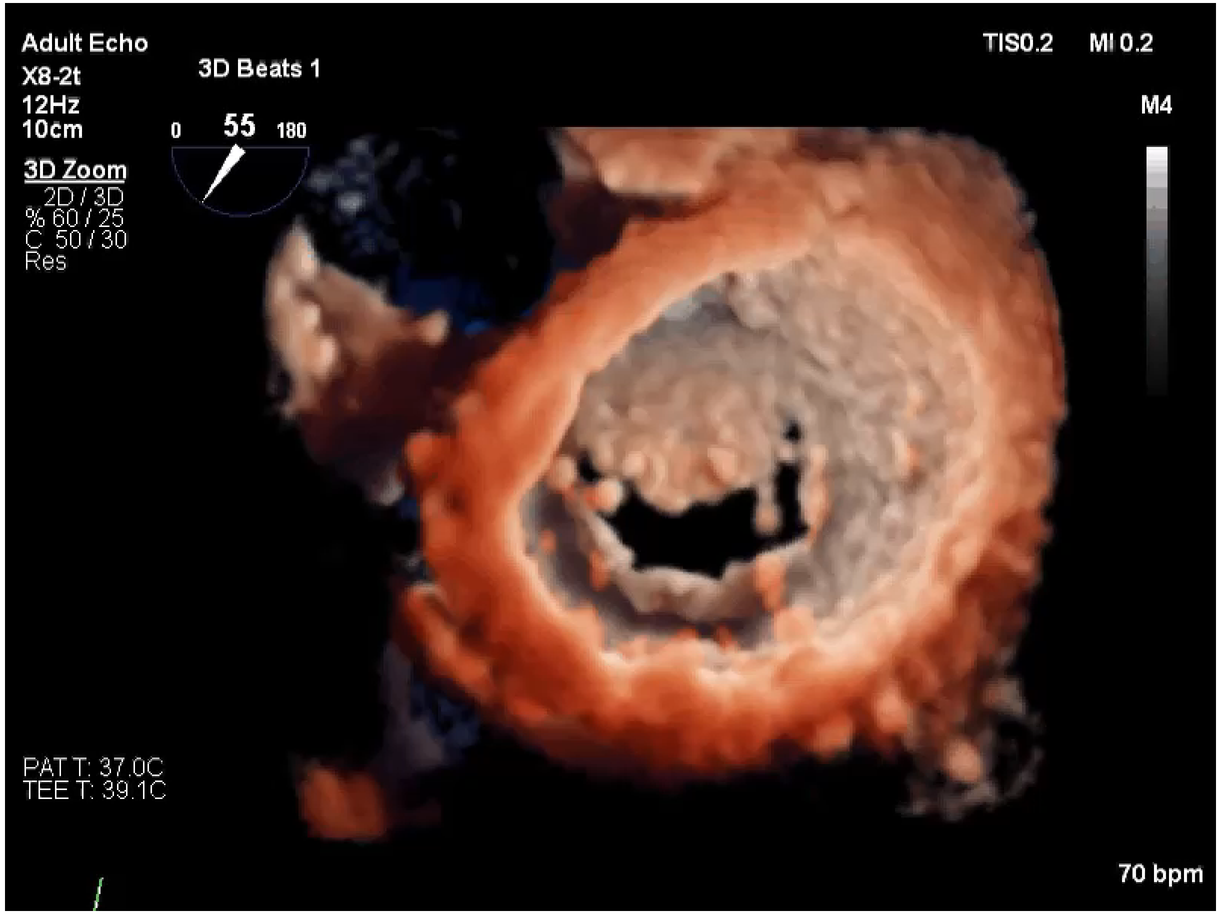


TTE



TEE

TEE for FMR : Anatomy > MR Severity



Functional MR = dynamic

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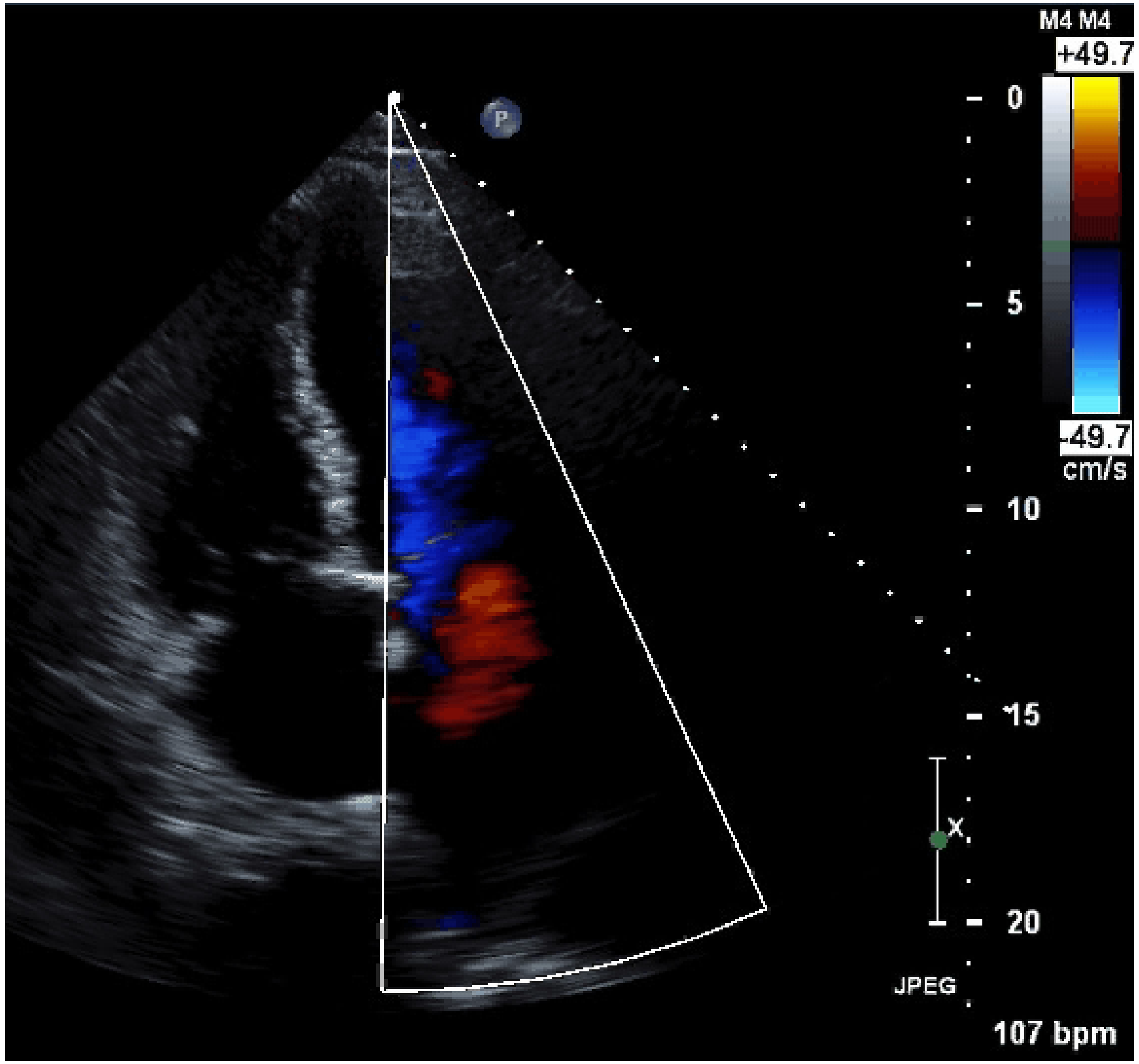
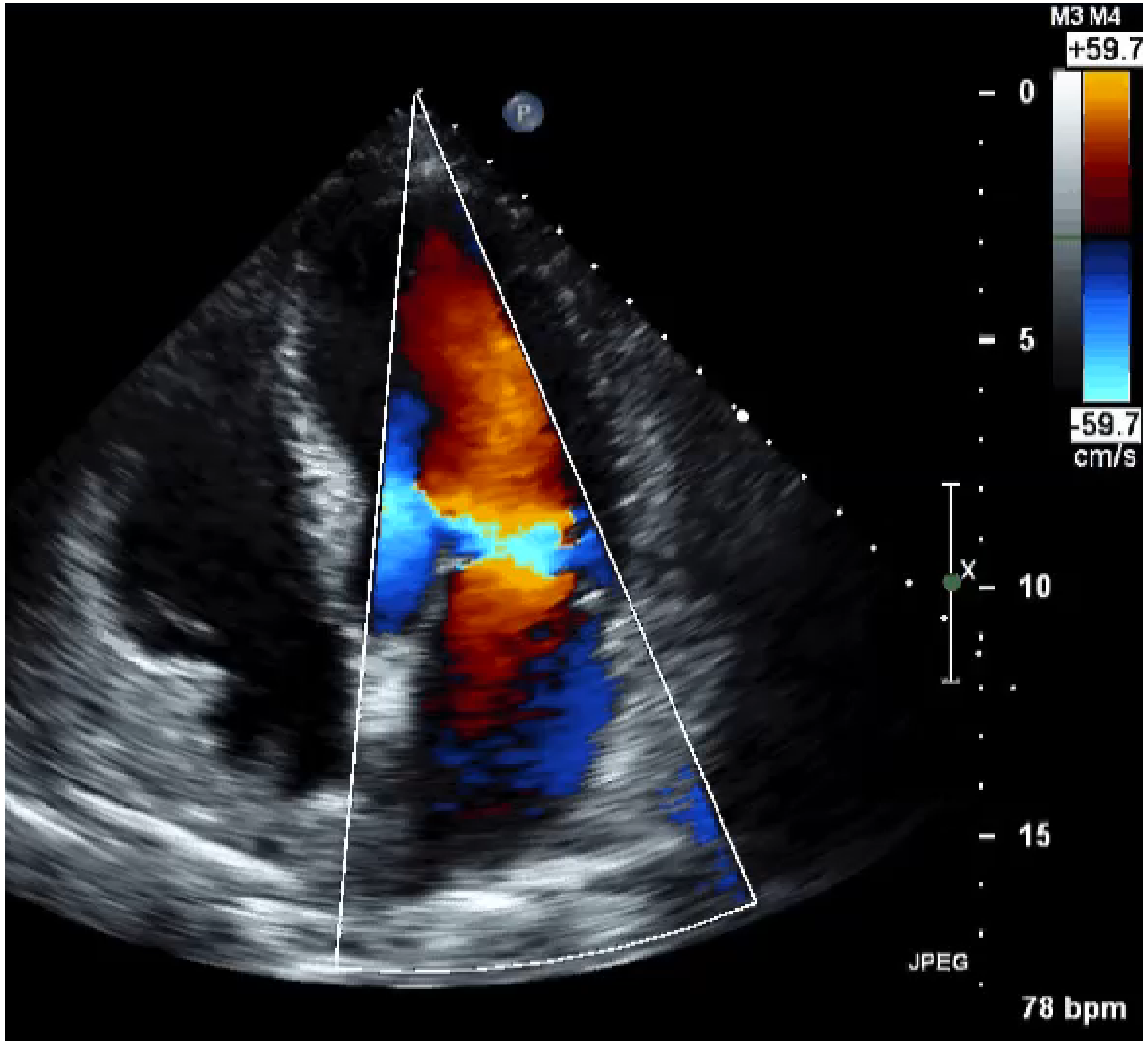
Bertrand PB et al, *Circulation.* 2017;135:297–314.

MR in AF versus Sinus Rhythm

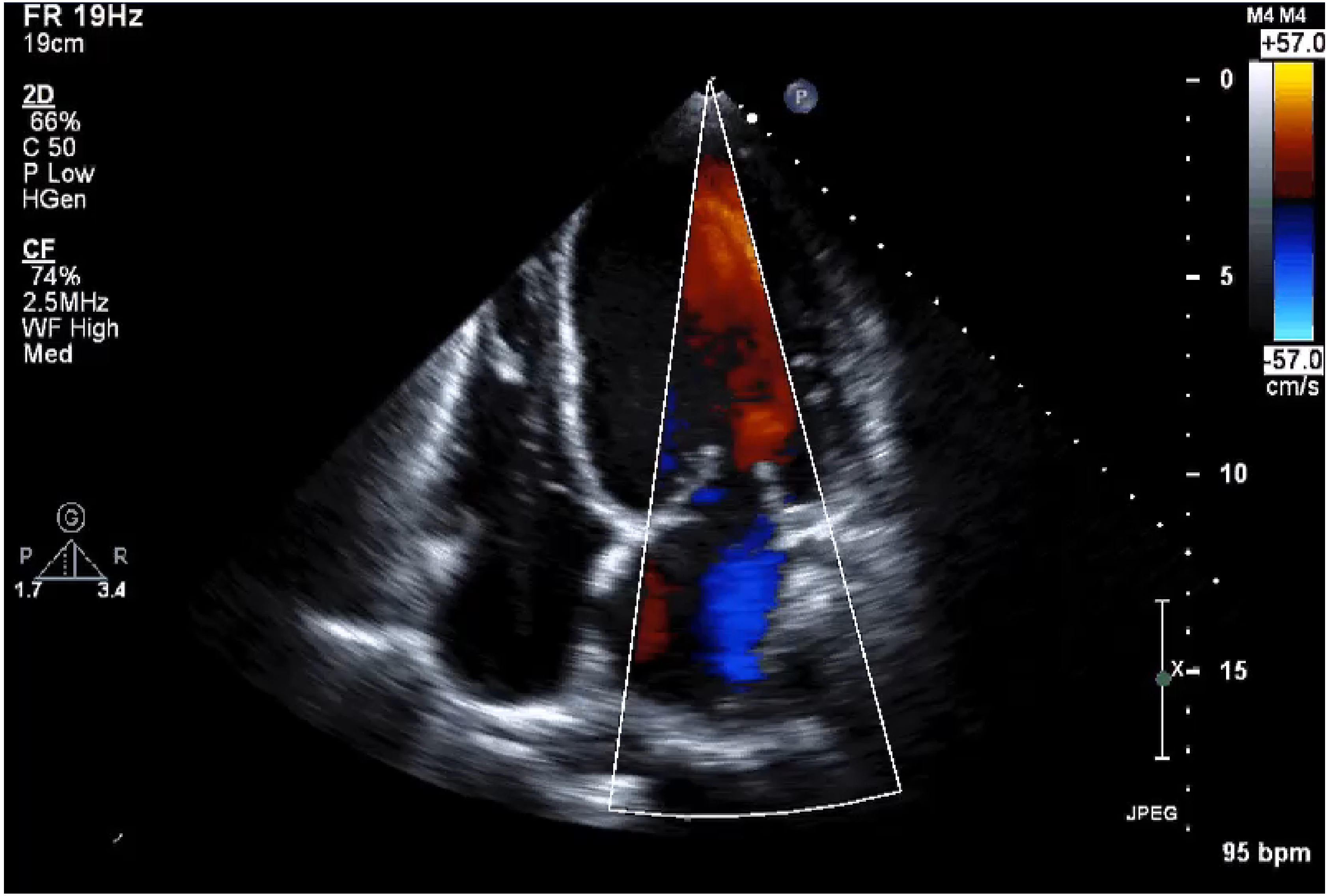


AF



Post-cardioversion

Quantifying MR severity



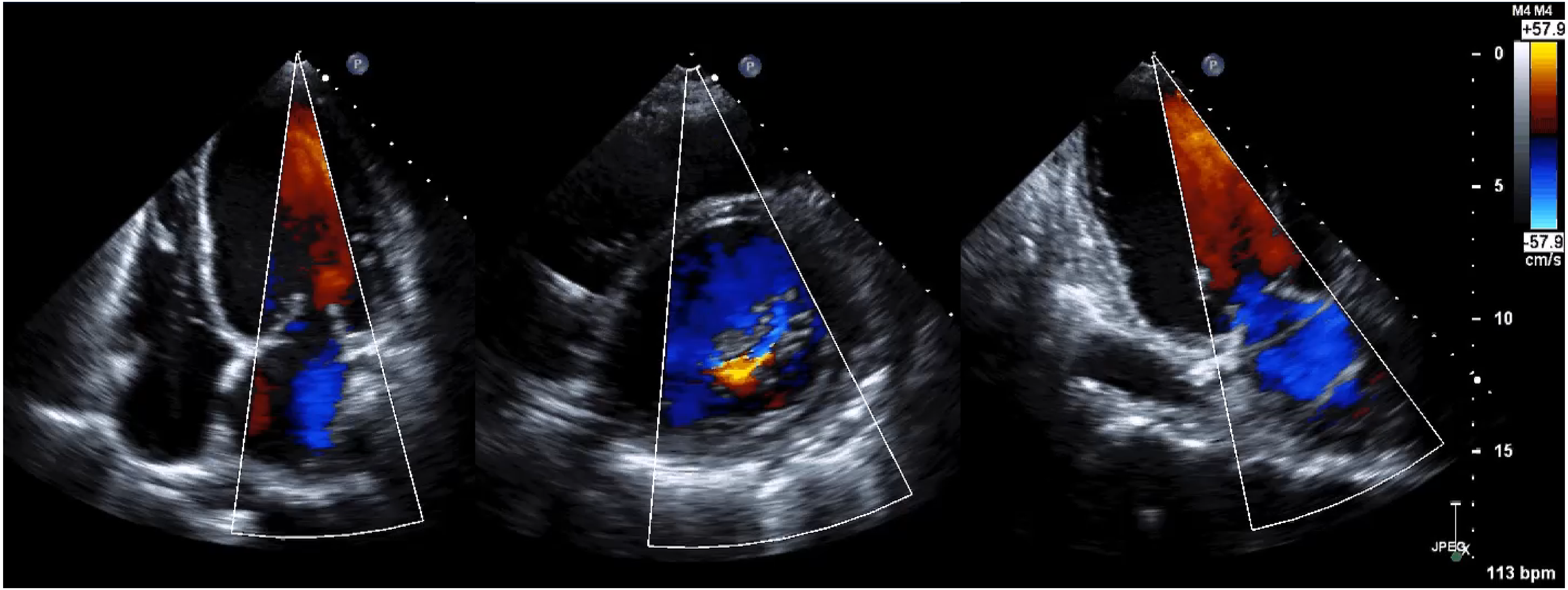
Quantification of Secondary MR

Table 10 Grading the severity of MR

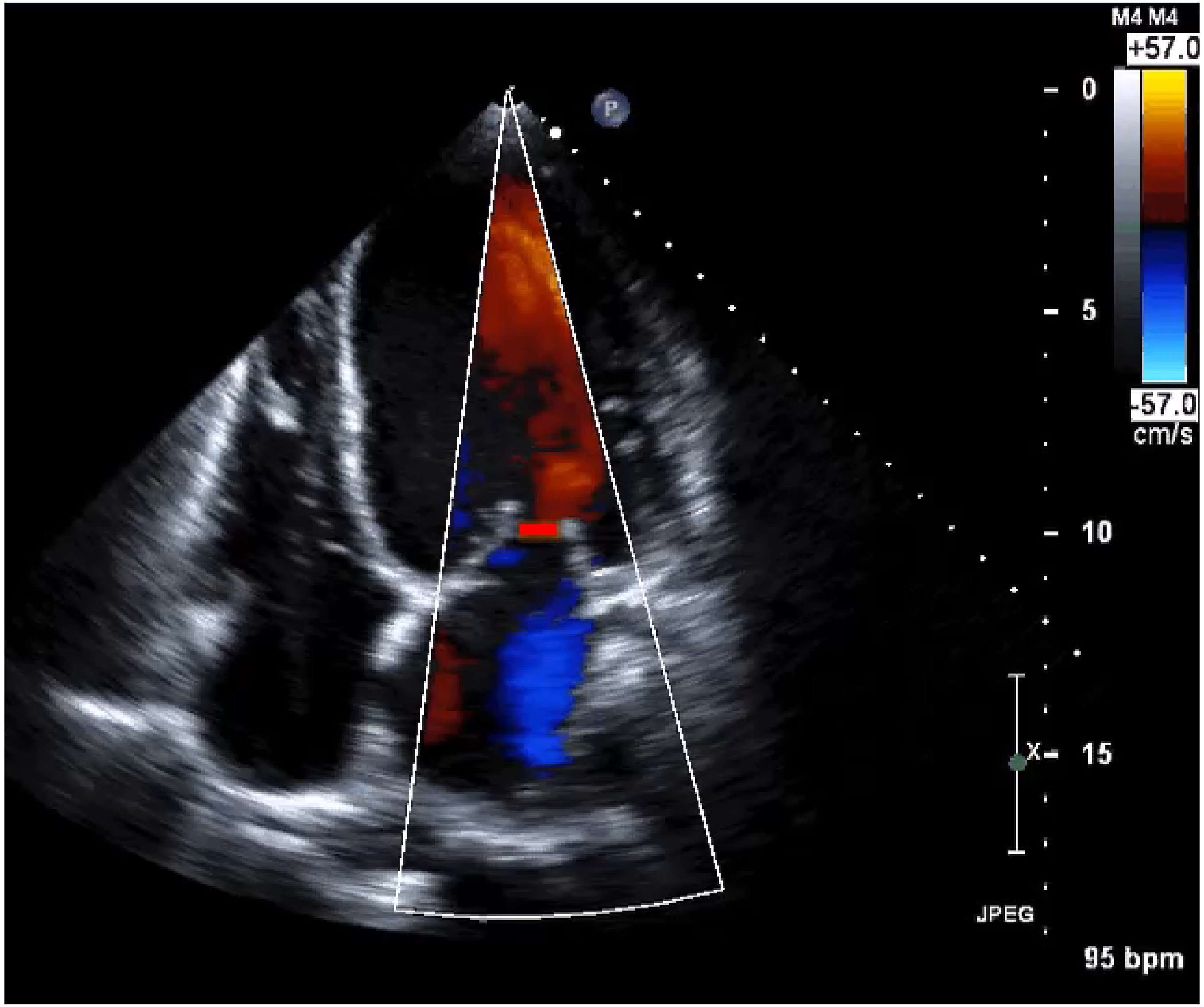
MR severity classes	Mild	Moderate		Severe
MR Severity sub-classes[j]	Mild (Grade 1 or 1+)	Mild-to-moderate (Grade 2 or 2+)	Moderate-to-severe (Grade 3 or 3+)	Severe (Grade 4 or 4+)
Qualitative parameters				
MV morphology	None or mild leaflet abnormality or minimal tenting	Moderate leaflet abnormality or moderate tenting	Moderate leaflet abnormality or moderate tenting	**Flail leaflet/large coaptation defect/severe tenting**
Colour flow MR jet	Small, central (usually <4 cm^2 or <20% of LA area)	Intermediate (usually 4–6 cm^2 or 20–30% of LA area)	Intermediate (usually 6–8 cm^2 or 30–40% of LA area)	**Large central jet** (usually >8 cm^2 or >50% of LA area) or eccentric jet swirling and reaching the posterior wall of the LA
Flow convergence zone[a] CW signal of MR jet	No or small faint/parabolic	Dense, partial or parabolic	Dense, parabolic or triangular	• **Large throughout systole** • Holosystolic/dense/triangular
Semi-quantitative parameters				
VC width (mm)	<3	3 to <5	5 to <7	**≥7 (≥8 for biplane)**[b]
Pulmonary vein flow	Systolic dominance[e]	Normal or systolic blunting	Systolic blunting	Minimal to no systolic flow/**systolic flow reversal**[d]
Mitral inflow	A wave dominant[b]	Variable	E-wave dominant (Peak E > 1.2 m/s)[f]	E wave dominant (Peak E > 1.2 m/s)[f]
VTI mitral/VTI LVOT	<1	Intermediate	>1.2[f]	**>1.4**[f]
Quantitative parameters[h,j,k]				
EROA (mm^2)	<20	20–29	30–39	≥40
R Vol (mL)[i]	<30	30–44	45–59	≥60
RF (%)	<30	30–39	40–49	≥50
CMR parameters				
RF (%)	<30	30–39	40–49	≥50
Structural parameters				
LV and LA size[g]	Usually normal	Normal or dilated	Usually dilated	**Usually dilated**
PA pressures[g]	Usually normal	Normal or elevated	Normal or elevated	**Usually elevated**

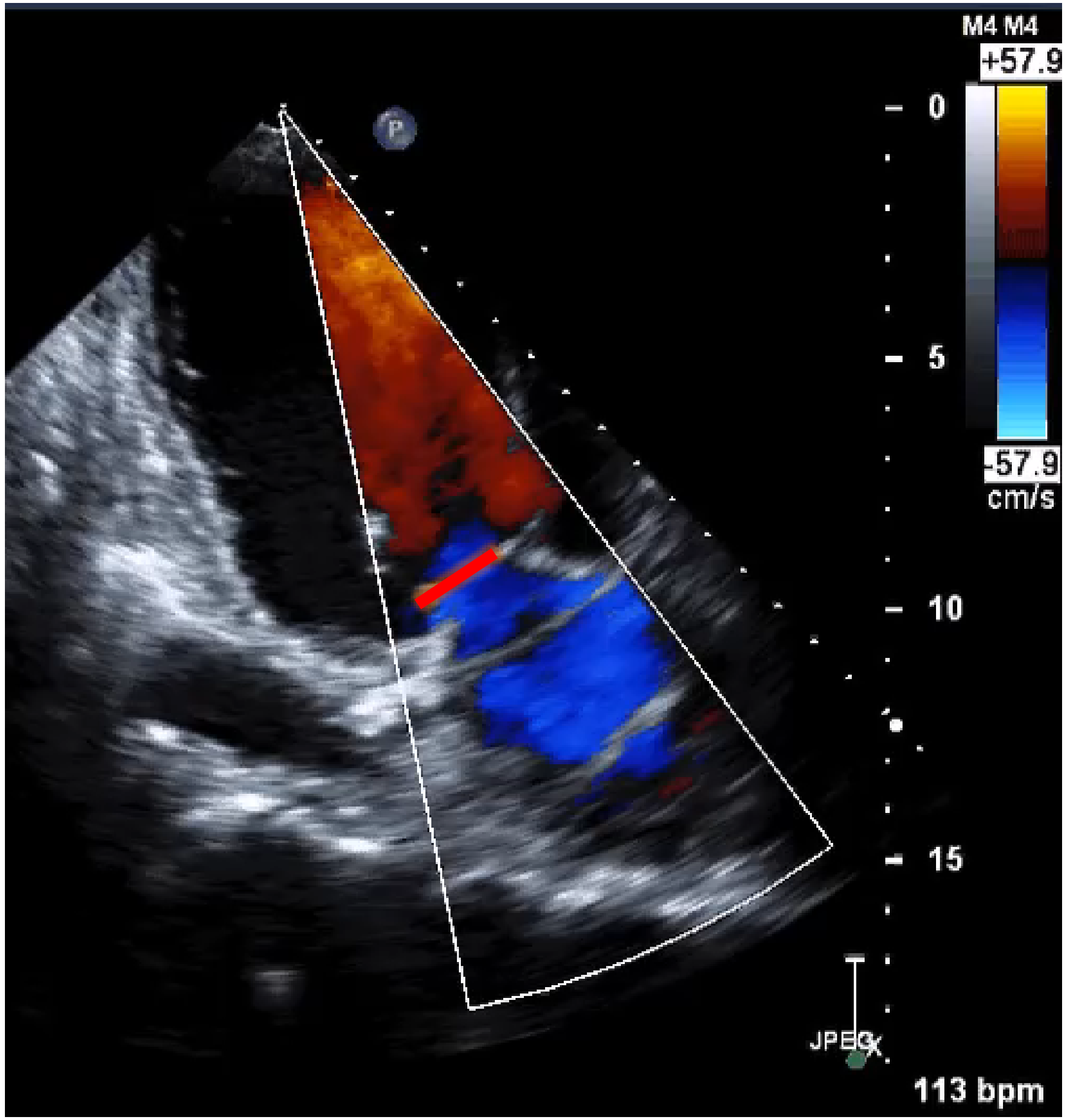
Lancellotti et al, Eur Heart J CV Imaging, 2022

Non-circular EROA in FMR



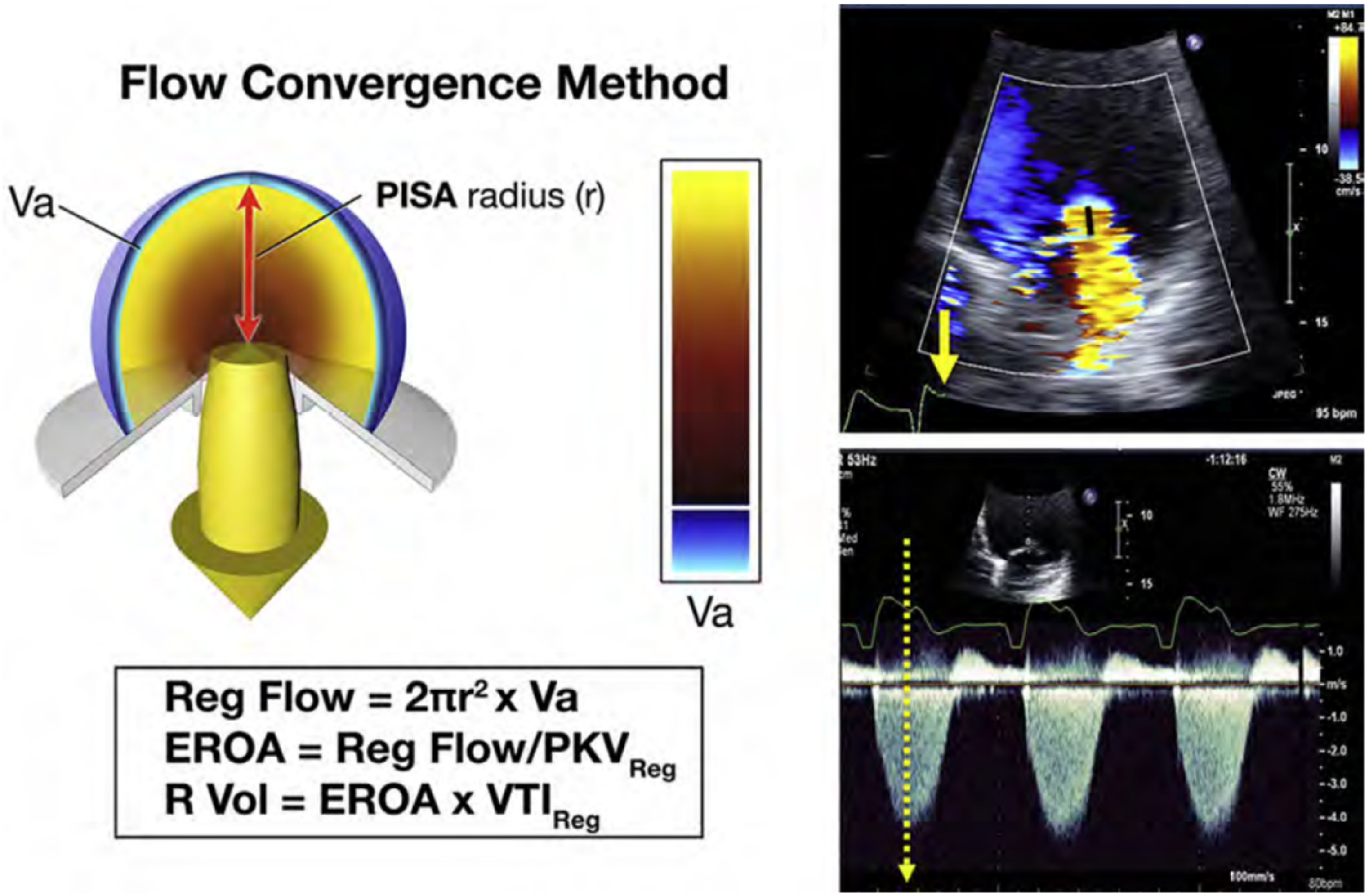
Biplane Vena Contracta



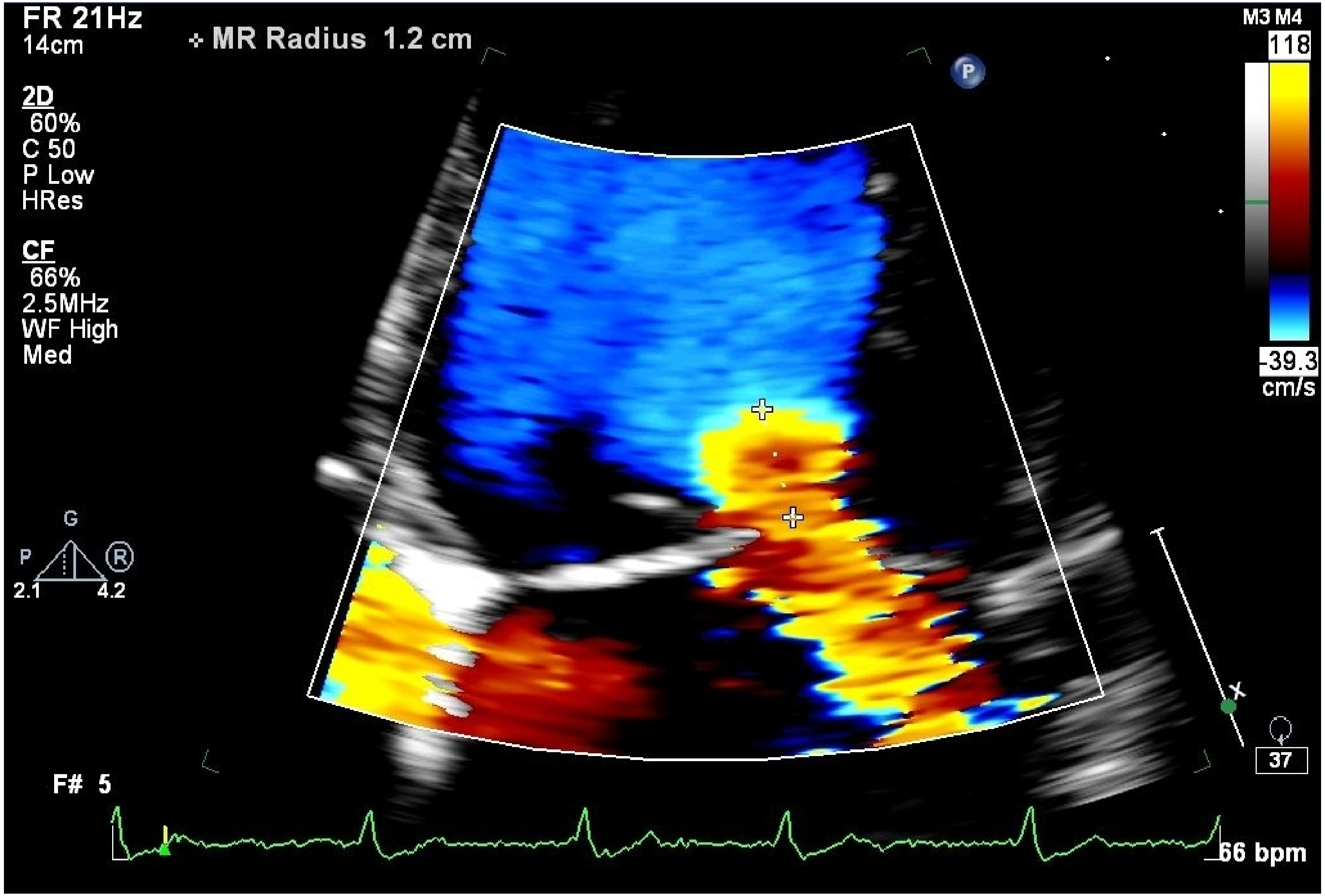


Severe MR ~ ≥8mm biplane VC

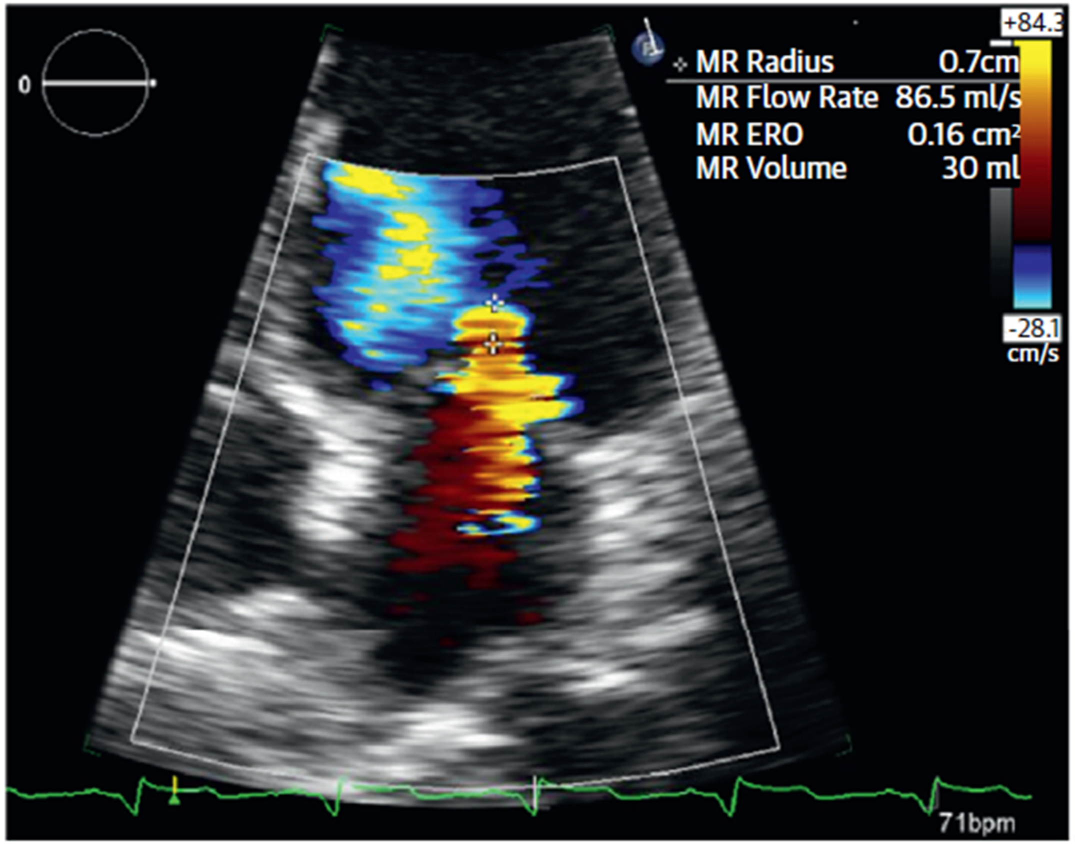
Proximal Isovelocity Surface Area (PISA) method



Proximal Isovelocity Surface Area (PISA) method



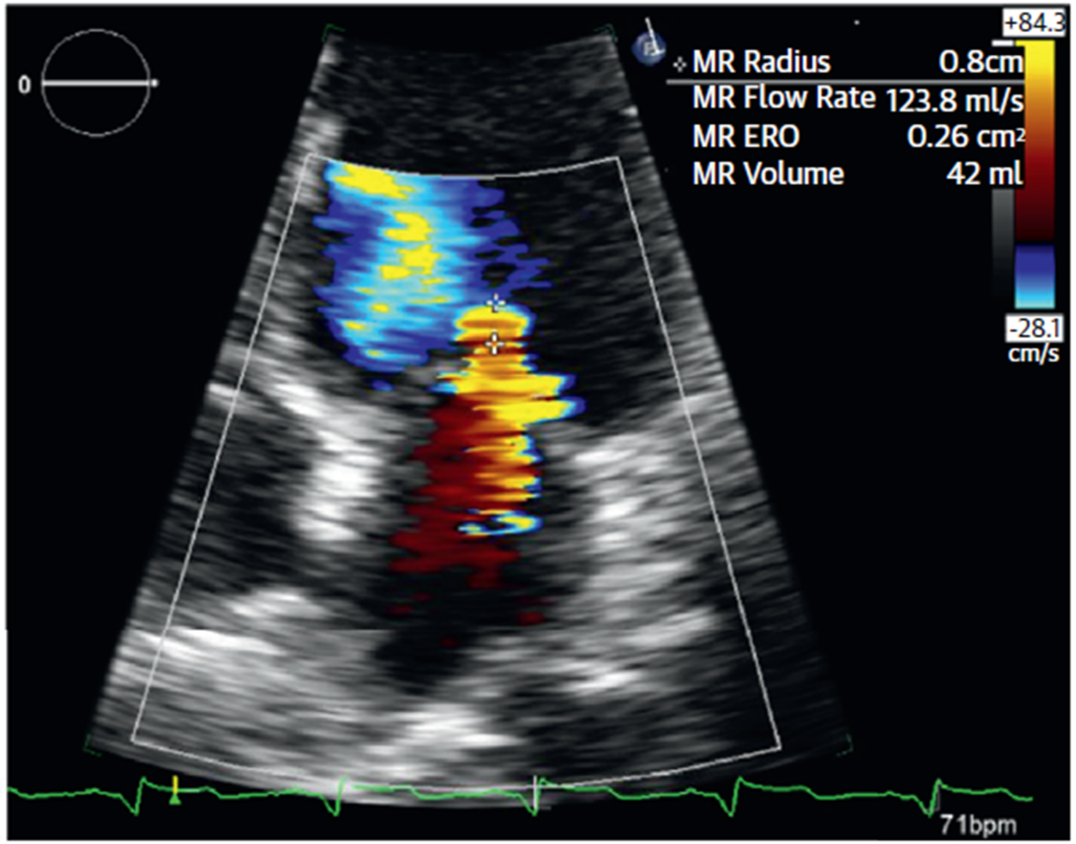
Pitfalls of the PISA method : measurement errors



PISA radius 7 mm

EROA 0.16 cm²

RVol 30 ml



PISA radius 8 mm

EROA 0.26 cm²

RVol 42 ml

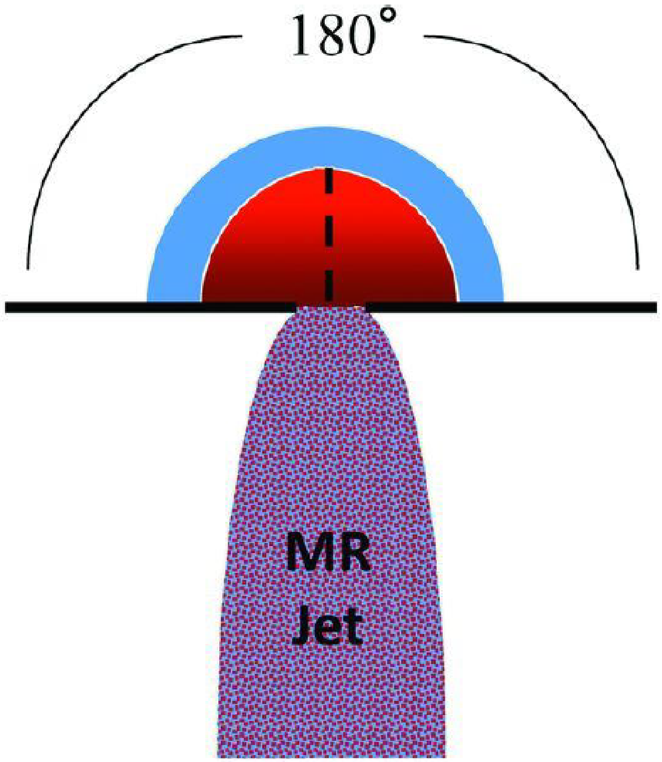
Grayburn PA & Thomas JD, JACC img, 2021

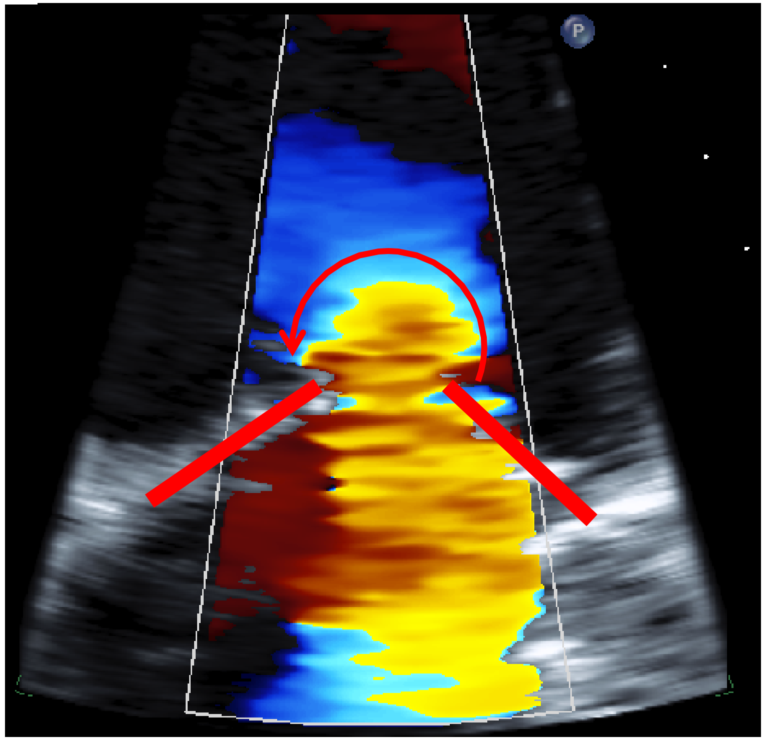
Assumptions of the PISA method

1. Planar orifice (180°)

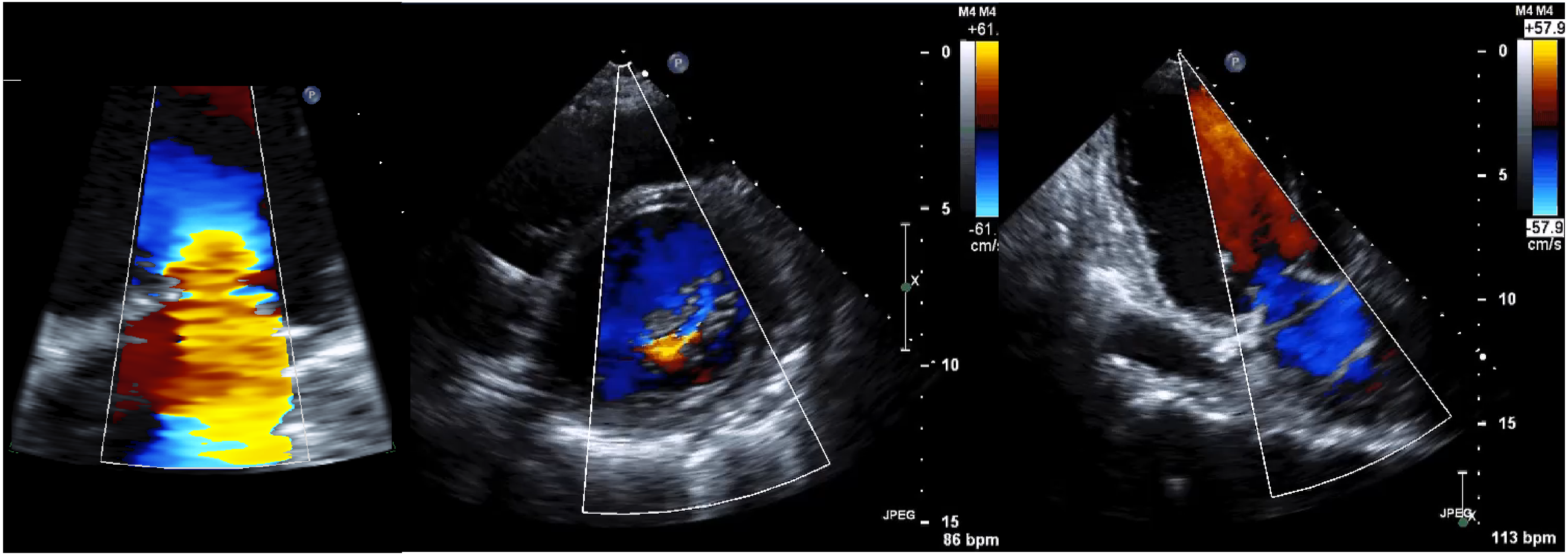
2. Non-dynamic EROA

3. Circular orifice

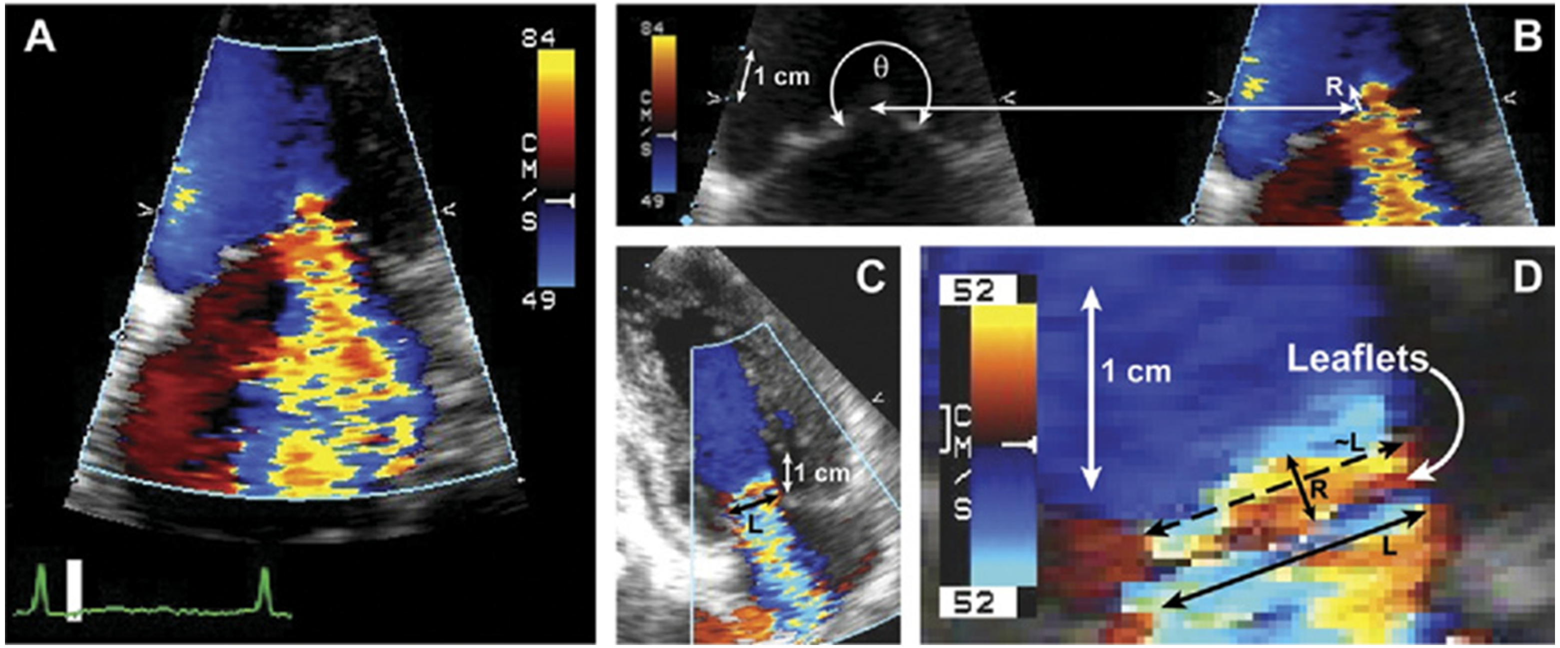


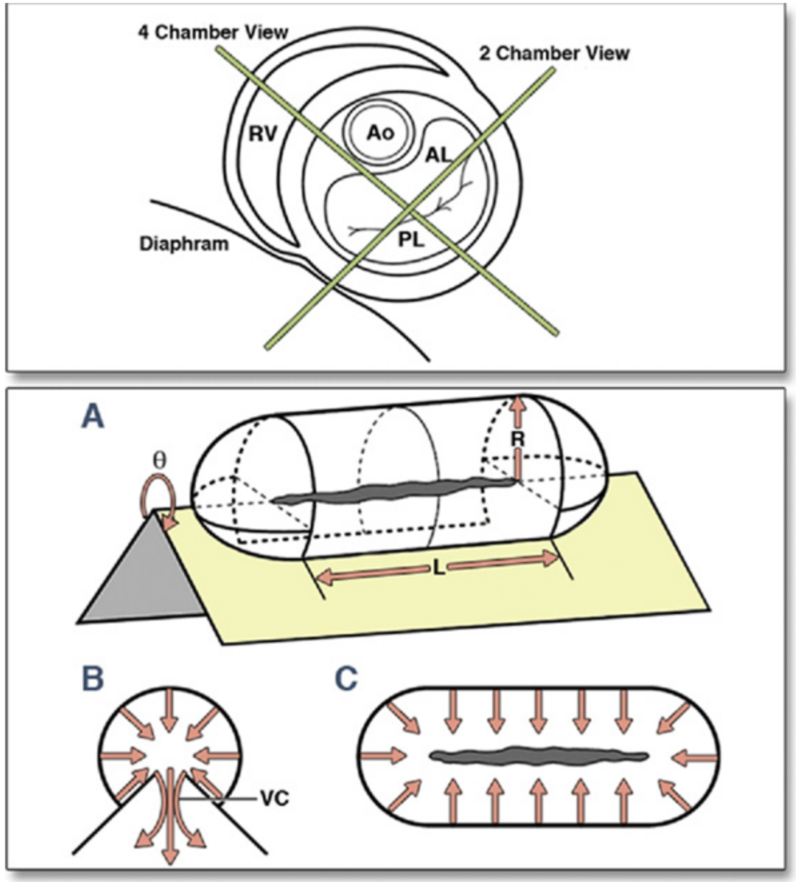


PISA in FMR : non-hemispherical convergence zone



PISA in FMR : non-hemispherical EROA





Rifkin et al, JACC img, 2010

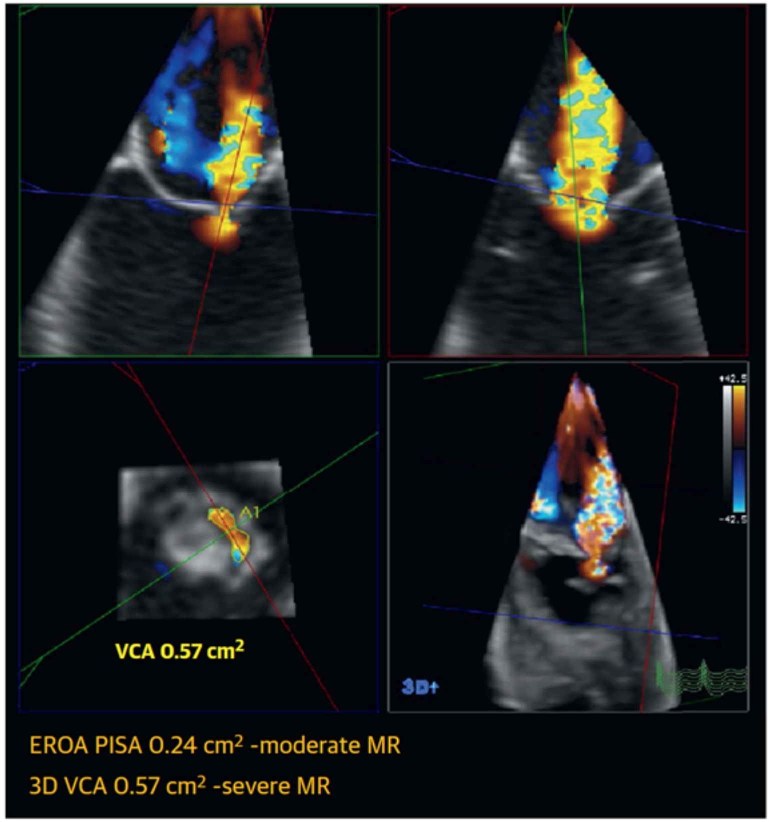
2021 ESC Clinical Valve Guidelines

Table 7 **Severe mitral regurgitation criteria based on 2D echocardiography**

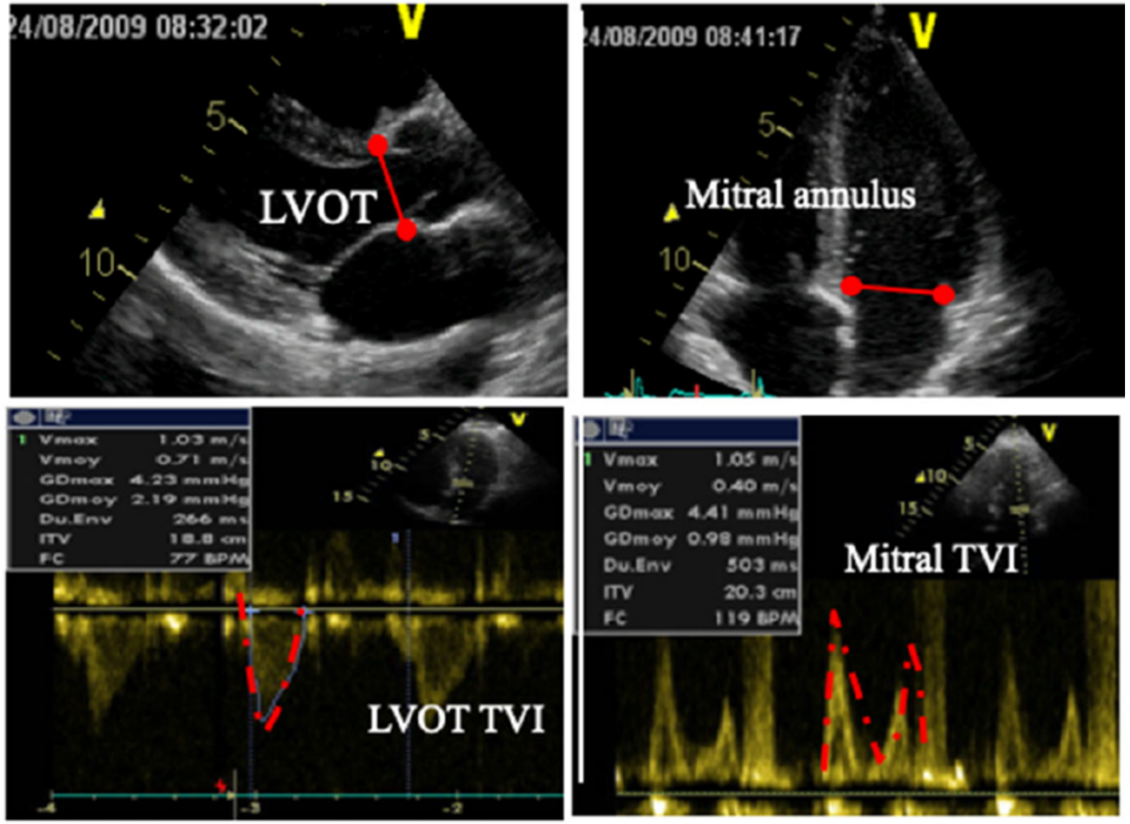
	Primary mitral regurgitation	Secondary mitral regurgitation
Qualitative		
Mitral valve morphology	Flail leaflet, ruptured papillary muscle, severe retraction, large perforation	Normal leaflets but with severe tenting, poor leaflet coaptation
Colour flow jet area	Large central jet (>50% of LA) or eccentric wall impinging jet of variable size	Large central jet (>50% of LA) or eccentric wall impinging jet of variable size
Flow convergence	Large throughout systole	Large throughout systole
Continuous wave Doppler jet	Holosystolic/dense/triangular	Holosystolic/dense/triangular
Semiquantitative		
Vena contracta width (mm)	≥7 (≥8 mm for biplane)	≥7 (≥8 mm for biplane)
Pulmonary vein flow	Systolic flow reversal	Systolic flow reversal
Mitral inflow	E-wave dominant (>1.2 m/s)	E-wave dominant (>1.2 m/s)
TVI mitral/TVI aortic	>1.4	>1.4
Quantitative		
EROA (2D PISA, mm^2)	≥40 mm^2	≥40 mm^2 (may be ≥30 mm^2 if elliptical regurgitant orifice area)
Regurgitant volume (mL/beat)	≥60 mL	≥60 mL (may be ≥45 mL if low flow conditions)
Regurgitant fraction (%)	≥50%	≥50%
Structural		
Left ventricle	Dilated (ESD ≥40 mm)	Dilated
Left atrium	Dilated (diameter ≥55 mm or volume ≥60 mL/m^2)	Dilated

Vahanian et al, Eur Heart J, 2021

Alternatives for FMR assessment?

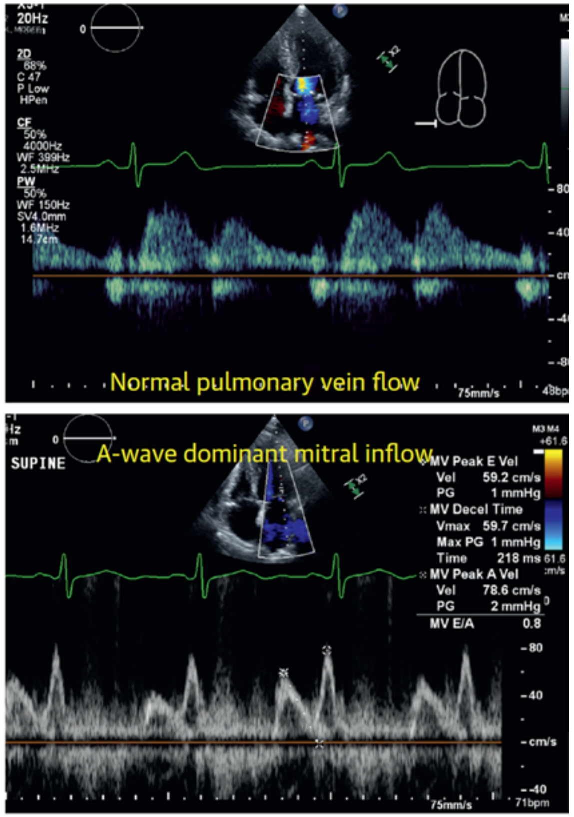


3D Vena Contracta Area (VCA)



Volumetric methods
check plausibility

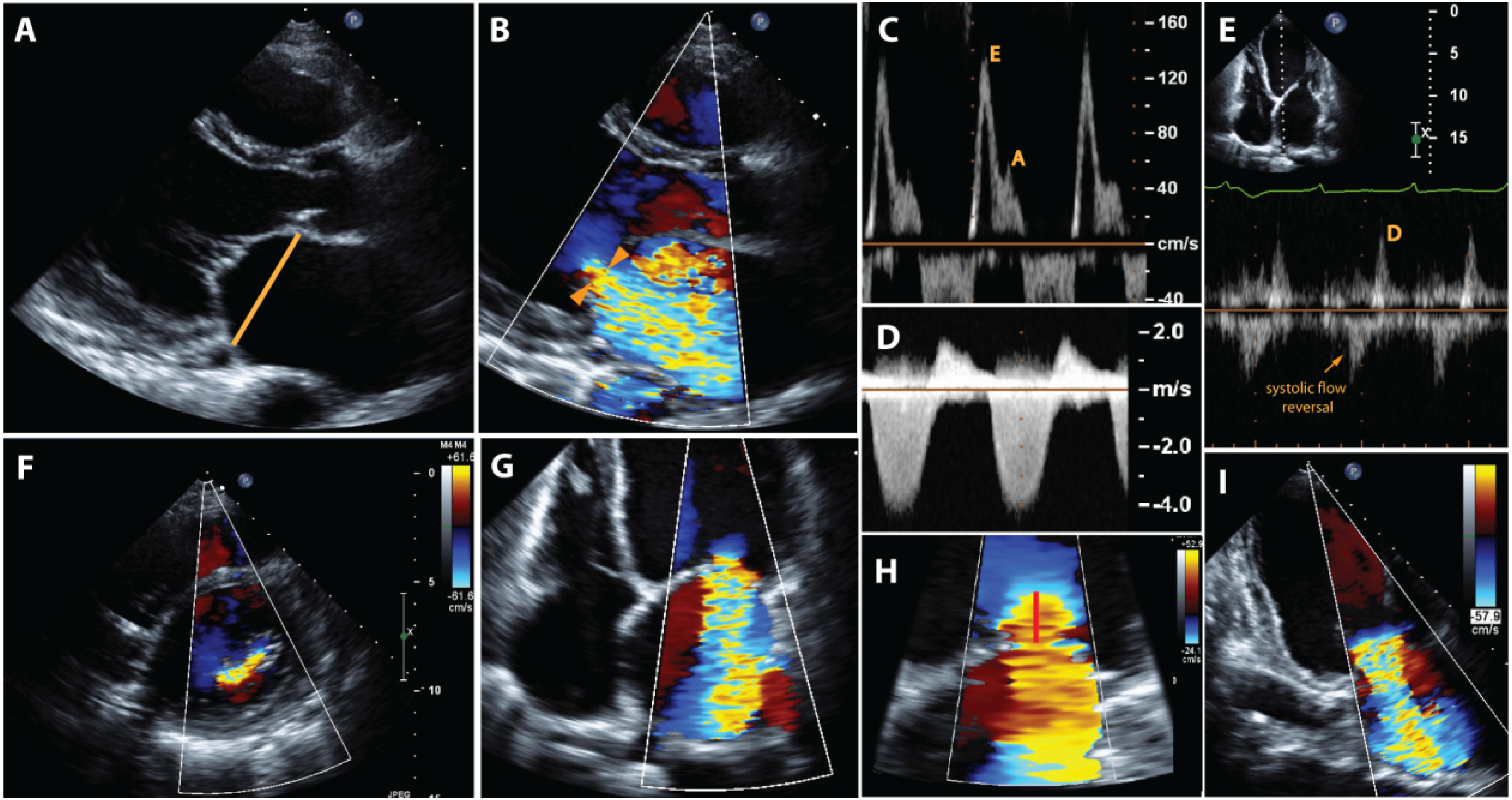
Not Compatible with Severe MR



Integrate all parameters

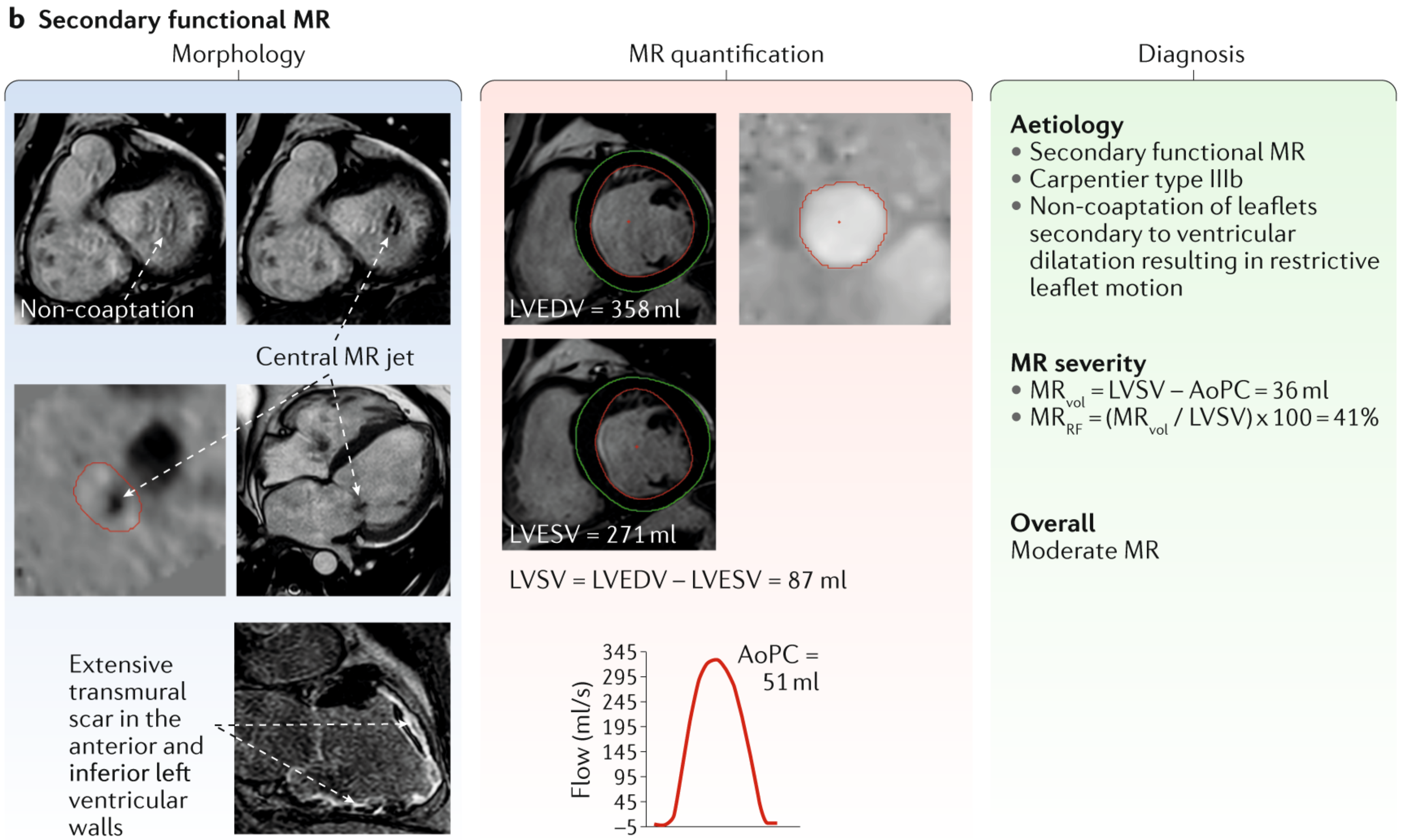
Grayburn PA & Thomas JD, JACC img, 2021
Lancellotti et al, Eur Heart J CV Imaging, 2022

"Integrative" approach



Bertrand PB & Hung J, ASE Comprehensive Echocardiography, 3rd Ed, 2021

CMR for FMR assessment



Garg et al, Nature Reviews Cardiology, 2020

Summary : Challenges in assessing secondary MR

- Accurate assessment of secondary MR is **crucial for management**
- A key challenge is the **dynamic nature** of secondary MR.
- Vena contracta and PISA quantification may underestimate MR due to **non-circular** orifice
- **Integrating** all available parameters with resp. strenghts & weaknesses is recommended.
- In case of doubt, cardiac MRI can be useful.

Thank you

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EuroValve, Milan, 21 September 2023