MITRAL VALVE REGURGITATION

OVERVIEW OF DIAGNOSIS AND CLASSIFICATION OF DISEASE

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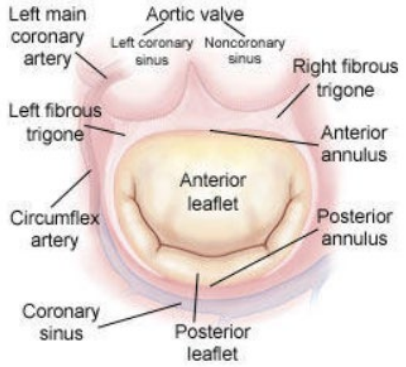
MITRAL REGURGITATION

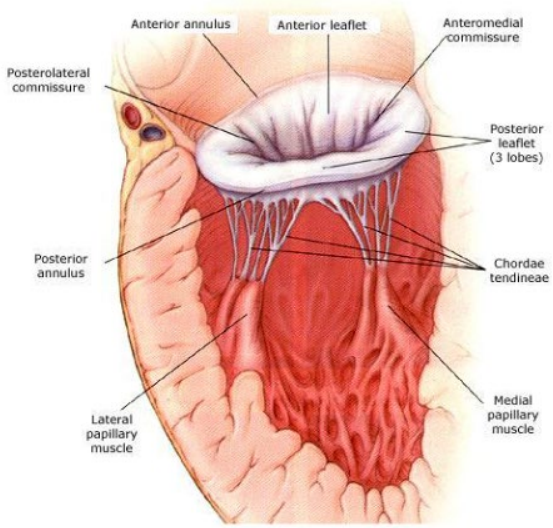
- Structure of the mitral valve complex
- Classification of Mitral Regurgitation
  - Primary vs. Secondary
    - *Etiology of Primary MR: Carpentier Classification (based on leaflet position and motion)*
  - Acute vs. Chronic
- Diagnosis of Mitral Regurgitation
  - Physical Exam
  - EKG/Biomarkers
  - Echocardiogram: 2D with strain, TEE and 3D
  - Cardiac MRI

NORMAL MITRAL VALVE ANATOMY

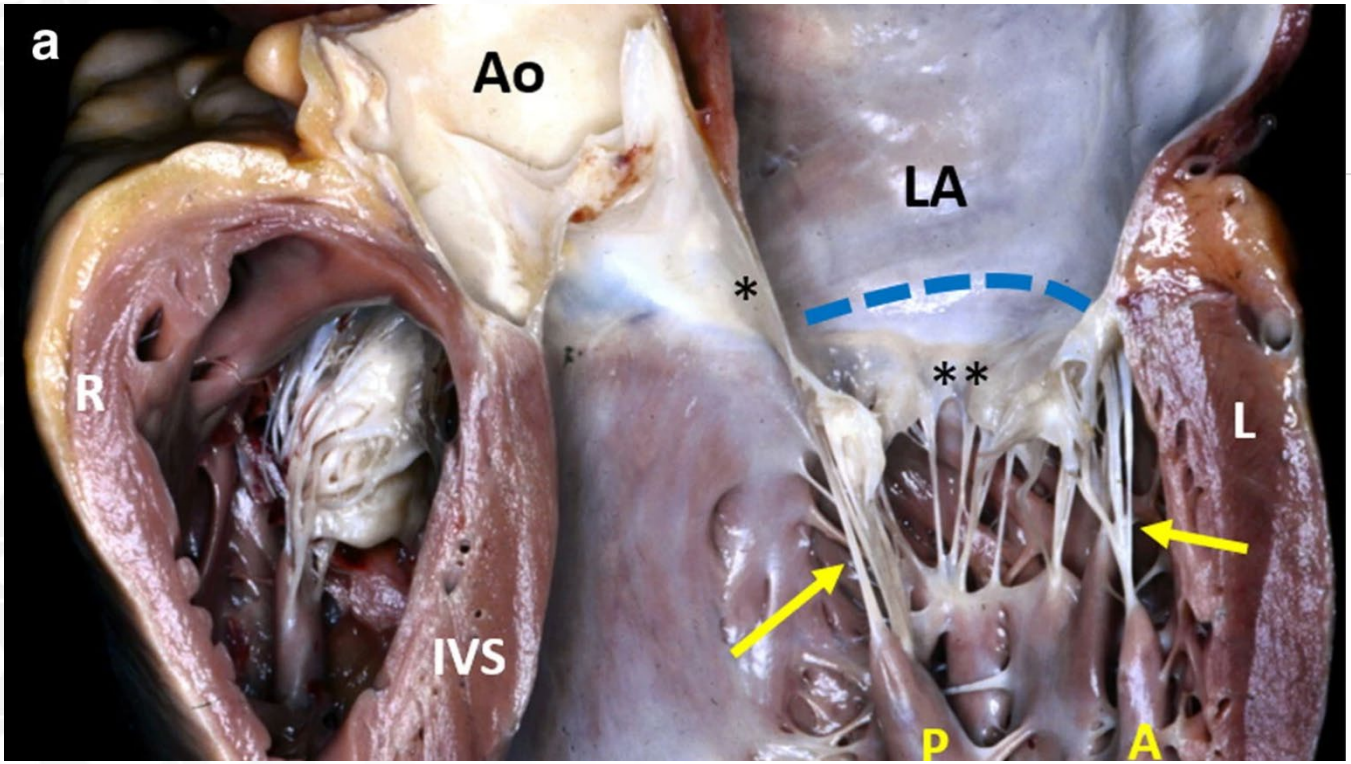
- Dynamic structure with complex interactions with surrounding anatomy
- The mitral valve and the left ventricular function are interdependent on each other
- Mitral valve apparatus: LA, Annulus, leaflets, papillary muscle with chordae tendineae and LV wall that attaches to the papillary muscle
- Diseases and dysfunction of any one of these structures can lead to mitral valve regurgitation
- In many instances the dysfunction in more than one part of the apparatus

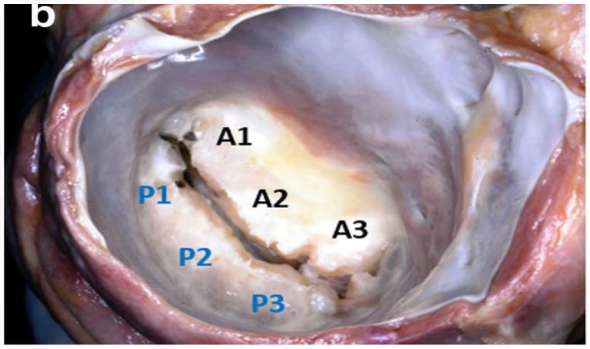


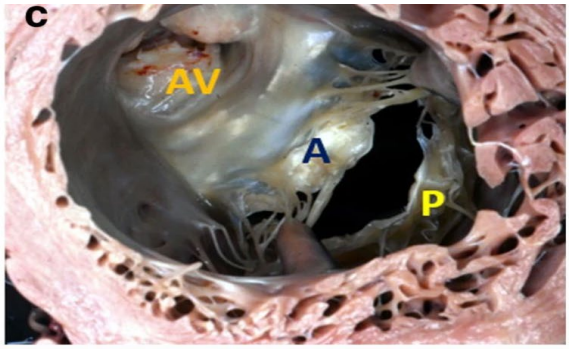
Top View Of Mitral Valve



Side View Of Mitral Valve

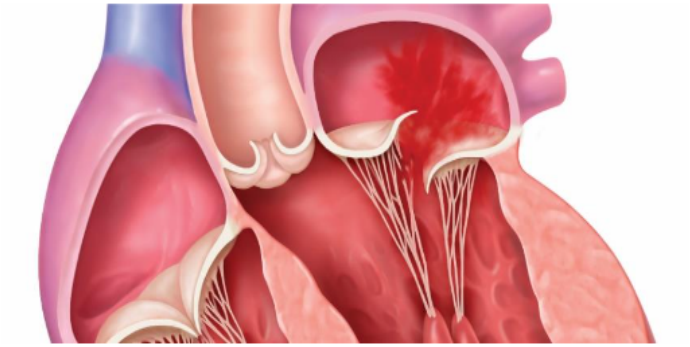






Mitral valve anatomy. **a** Gross photograph of the heart cut along the long axis of the left ventricle. The mitral apparatus consists of the posterior wall of the left atrium (LA), an annulus (*blue dotted line*), anterior (*) and posterior (**) leaflets, chordae tendineae (*yellow arrows*), posterior (P) and anterior (A) papillary muscles, and left ventricular wall (L). Other structures seen from this view include the right ventricular free wall (R), the aorta (Ao), and the interventricular septum (IVS). **b** View of the mitral valve from the left atrium (inflow surface). Conceptually, the anterior and posterior leaflets can be subdivided into three segments, A1 A2 A3 and P1 P2 P3, respectively. c View of the mitral valve from the left ventricle (outflow surface). The anterior mitral leaflet (A) is continuous with the aortic valve (AV), whereas the posterior mitral leaflet (P) attaches to the left ventricular wall

There Are 2 Types of Mitral Regurgitation (MR)



PRIMARY (DEGENERATIVE) MR

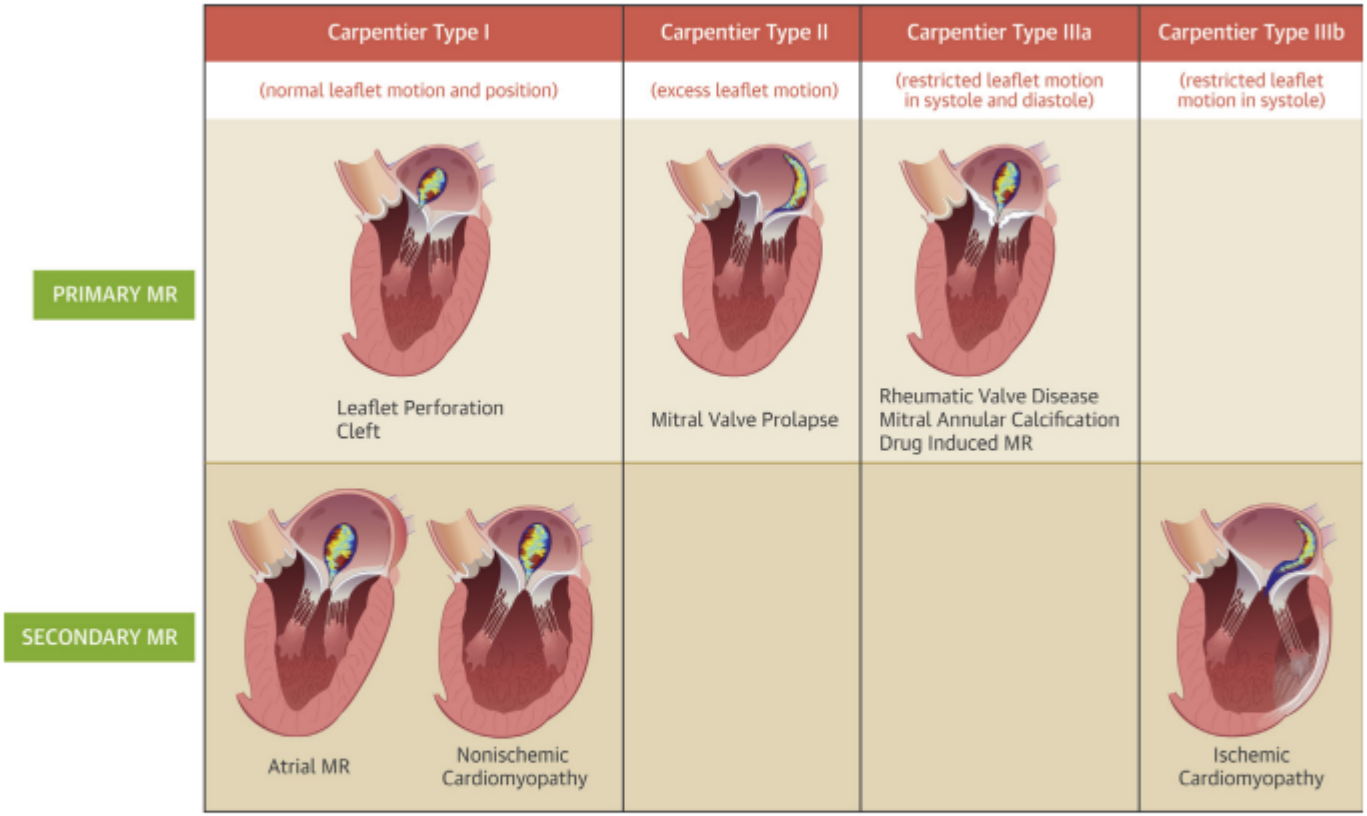
- A faulty valve does not close properly or completely, allowing blood to flow backward into the left atrium
- Can be caused by age, congenital valve abnormality, heart disease, coronary artery disease, or rheumatic fever

SECONDARY (FUNCTIONAL) MR

- Abnormalities in the left ventricle distort or separate the mitral valve leaflets, allowing blood to flow backward into the left atrium
- Develops after heart disease causes the left ventricle to enlarge, misshape, or weaken

Cioffi G, et al. *Eur J Heart Fail.* 2005;7(7):1112-1117.

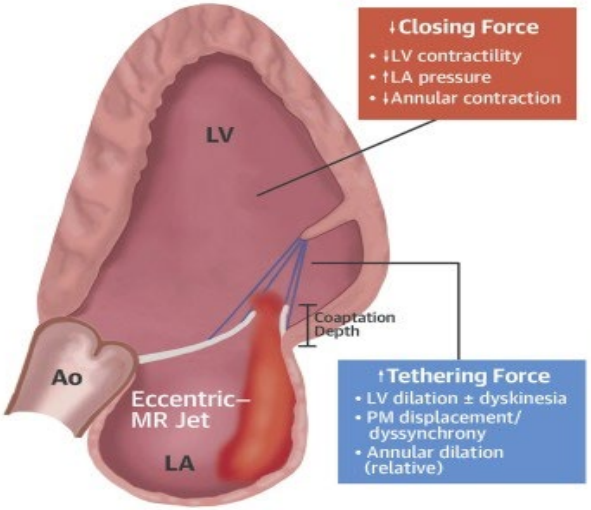
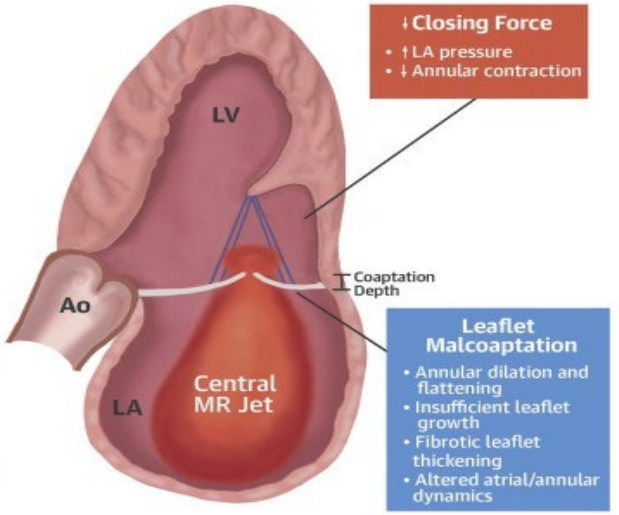
CENTRAL ILLUSTRATION Classification of the Etiology of MR



El Sabbagh, A. et al. J Am Coll Cardiol Img. 2018;11(4):628–43.

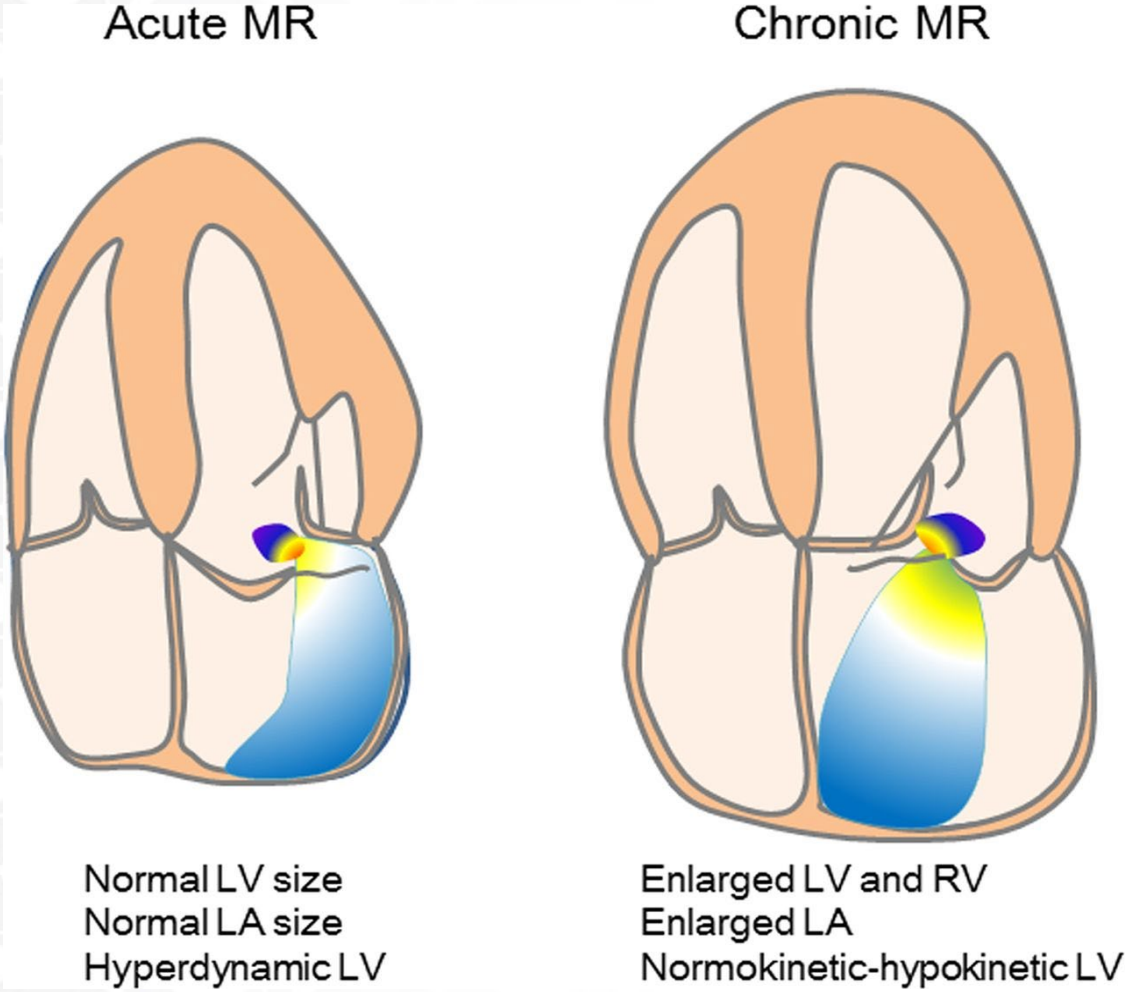
Primary and secondary mitral valve regurgitation (MR) groupings with their respective Carpentier's functional classification. Carpentier type I represents normal leaflet motion and position. Carpentier type II represents excess leaflet motion. Carpentier type IIIa represents restricted leaflet motion in systole and diastole. Carpentier type IIIb represents restricted leaflet motion in systole.

CENTRAL ILLUSTRATION: Secondary Mitral Regurgitation Versus Atrial Functional Mitral Regurgitation

Secondary Mitral Regurgitation	Atrial Functional Mitral Regurgitation
	
Etiology and Prevalence	
• 11%-59% post myocardial infarction • >50% in dilated cardiomyopathy	• 6%-7% in lone AF • Up to 53% in HFpEF
Diagnosis	
• Systolic LV dysfunction • Restricted leaflet motion and tethering • Eccentric jet > central jet • Relative LA dilation	• Normal systolic LV function • Normal leaflet motion • Central jet • Severe LA dilation
Management	
• Optimal HF therapy • Cardiac resynchronization therapy • Revascularization • MitraClip	• Address AF/HFpEF risk factors and lifestyle • HF therapy, diuretics as indicated • Early sinus restoration strategy • ?Intervention, annuloplasty, MitraClip

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

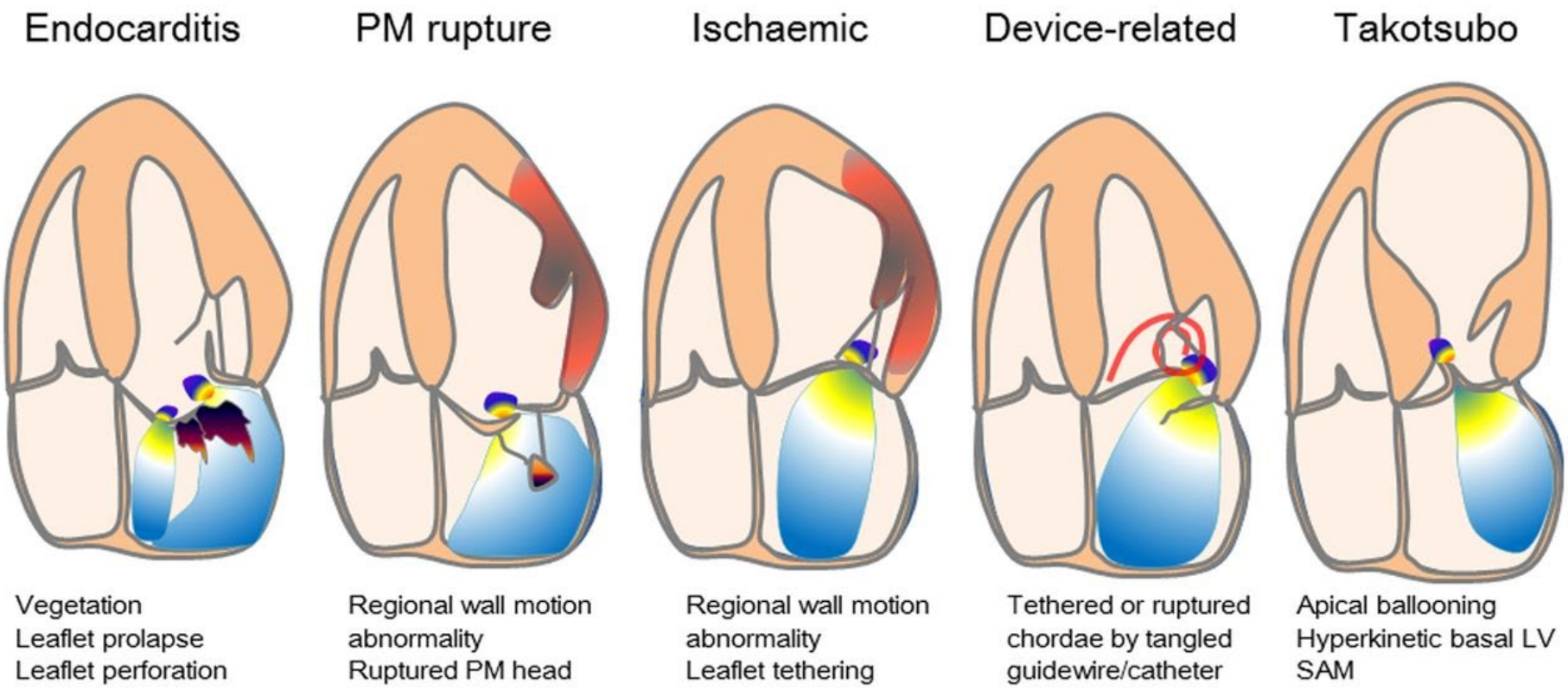
ACUTE VS. CHRONIC MITRAL REGURGITATION



Watanabe N. Acute mitral regurgitation *Heart* 2019;105:671-677.

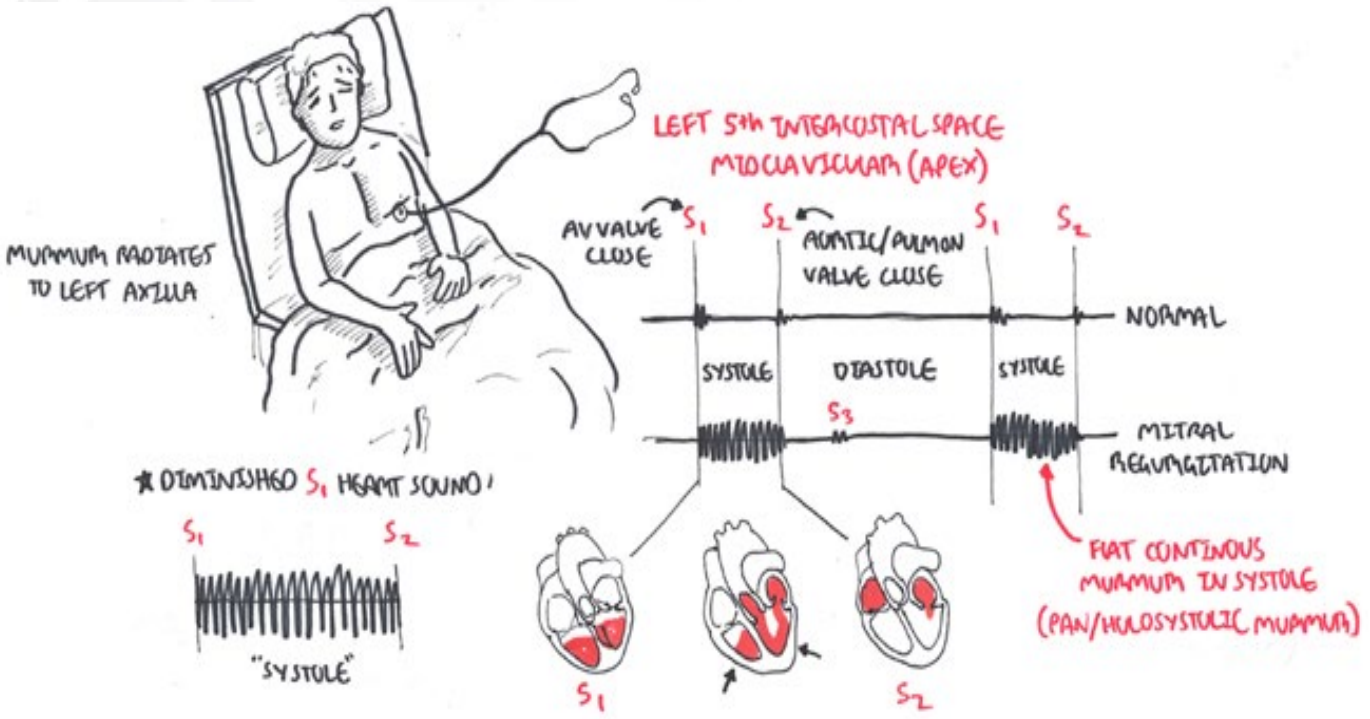
ACUTE MITRAL REGURGITATION

Figure 2



Watanabe N. Acute mitral regurgitation *Heart* 2019;105:671-677.

DIAGNOSIS OF MITRAL REGURGITATION- Physical Exam



https://armandoh.org/disease/mitral-regurgitation-incompetence/

DIAGNOSIS OF MITRAL REGURGITATION: ECG AND BIOMARKERS

P Mitrale ECG Lead II

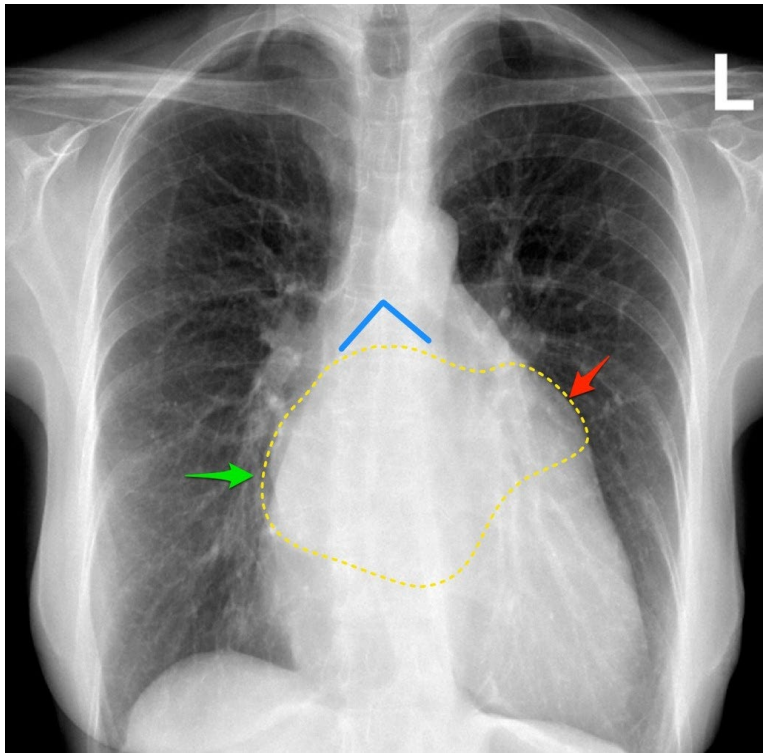
Atrial fibrillation

Table 3. Role of brain natriuretic peptide levels in decision making for patients with organic mitral regurgitation

Study	Year	Pts	Inclusion criteria	End point	Cut-off value
Pizarro et al.[24]	2009	269	Asymptomatic severe MR EF >60%	HF, LV dysfunction, death	105 pg/mL
Detaint et al.[25]	2005	126	Organic MR (symptomatic/asymptomatic)	HF, death	31 pg/mL
Klaar et al.[26]	2011	87	Asymptomatic severe MR EF >60% LV end-systolic diameter index <26 mm/m^2, SPAP <50 mm Hg, no atrial fibrillation	HF LV dysfunction	145 pg/mL
Magne et al.[27]	2012	135	Asymptomatic moderate/severe MR	Cardiac event free survival	40 pg/mL
Magne et al.[28]	2012	113	Asymptomatic moderate/severe MR	Death, HF, mitral valve surgery due to symptoms, LV dilatation, LV dysfunction	Increasing BNP level at exercise

Pts: number of patients, MR: mitral regurgitation, LV: left ventricle, EF: ejection fraction, SPAP: systolic pulmonary artery pressure, BNP: brain natriuretic peptide, HF: heart failure

Korean Circ J. 2015 Mar;45(2):96-105.
https://doi.org/10.4070/kcj.2015.45.2.96



The rough outline of the left atrium (yellow) can be inferred by the presence of a double border on the right (green arrow), splaying of the carina (blue) and prominence of the left atrial appendage (red arrow).

https://radiopaedia.org/cases/mitral-valve-regurgitation

DIAGNOSIS OF MITRAL REGURGITATION: IMAGING MODALITIES

TABLE 1 Quantitative and Qualitative Measures of the Severity of MR

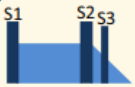
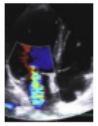
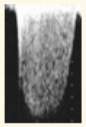
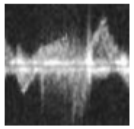
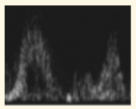
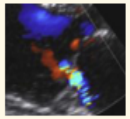
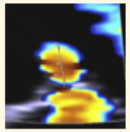
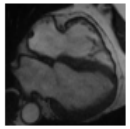
Qualitative Parameters		
Parameter	**Severe MR**	**Disadvantages**
Physical examination 	Loud, holosystolic, with diastolic murmur; outward displaced apical impulse	Findings can be nonspecific for severe MR
LA and LV size 	Normal excludes severe MR	Nonspecific; can be secondary to other conditions.
MV apparatus anatomy 	Flail leaflet	Not sensitive
Color flow Doppler 	Large jet area	Affected by transducer settings and hemodynamic loading conditions; underestimates eccentric jets
CWD signal 	Dense and triangular signal; decreased slope of positive dp/dt suggests LV dysfunction	Underestimates in eccentric jets or if poor gain
Pulmonary vein signal 	Systolic flow reversal	Affected by LA pressure, direction of jet, and atrial fibrillation
Peak E-wave 	E-wave >1.2 m/s	Affected by LA compliance, LV diastolic function and atrial fibrillation

TABLE 1 Continued

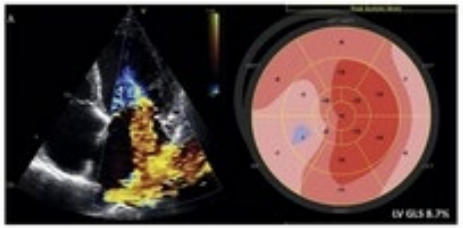
Quantitative Parameters		
Parameter	**Severe MR**	**Disadvantages**
Vena contracta 	≥0.7 cm	Not valid in multiple jets; overestimates MR if not holosystolic
Continuity equation 	RVol ≥60 ml/beat RF ≥50% EROA ≥0.4 cm^2	Measurement of flow at MV annulus prone to error especially if calcified; not valid with concomitant AR
PISA 	RVol ≥60 ml/beat RF ≥50% EROA ≥0.4 cm^2	Not valid in multiple jets; less accurate in eccentric jets or crescent-shaped orifices
Cardiac MRI 	RVol ≥60 ml/beat RF ≥50%	Severity thresholds not well established; less accurate with atrial fibrillation
Left ventriculogram 	4+ Mitral regurgitation	Invasive; requires contrast use.

AR = aortic regurgitation; CW = continuous wave; dp/dt = the rate of early systolic left ventricular pressure rise; LA = left atrial; LV = left ventricular; MV = mitral valve; MR = mitral valve regurgitation; PISA = proximal isovelocity surface area.

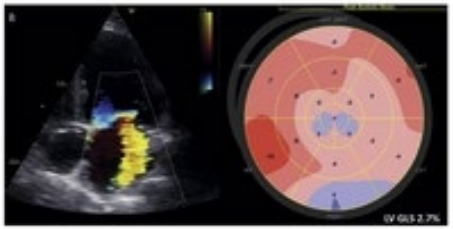
MITRAL REGURGITATION AND GLOBAL LONGITUDINAL STRAIN (GLS)

CENTRAL ILLUSTRATION: Association of Left Ventricular Global Longitudinal Strain and All-Cause Mortality in Patients With Significant Secondary Mitral Regurgitation

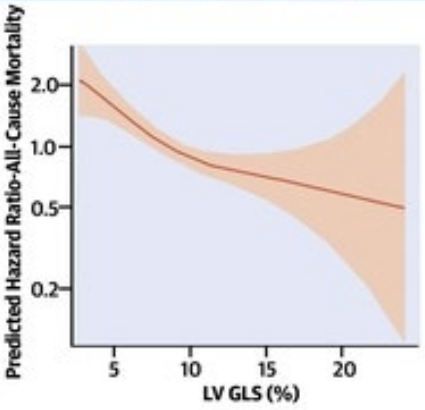
A Patient With Severe Mitral Regurgitation, LVEF 21% and LV Global Longitudinal Strain >7%



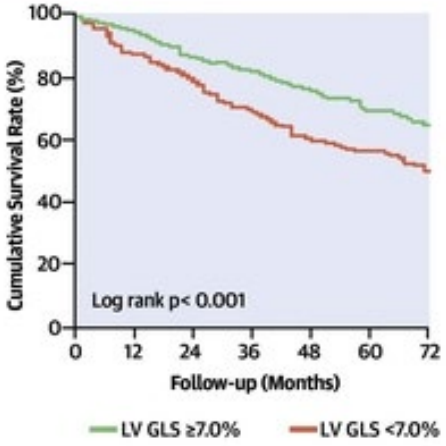
B Patient With Severe Mitral Regurgitation, LVEF 20% and LV Global Longitudinal Strain <7%



C Association Between LV Global Longitudinal Strain and All-Cause Mortality



D Survival Analysis



Namazi, F. et al. J Am Coll Cardiol. 2020;75(7):750-8.

SUBCLINICAL LV DYSFUNCTION: Asymptomatic MR, EF>60%, abnormal GLS

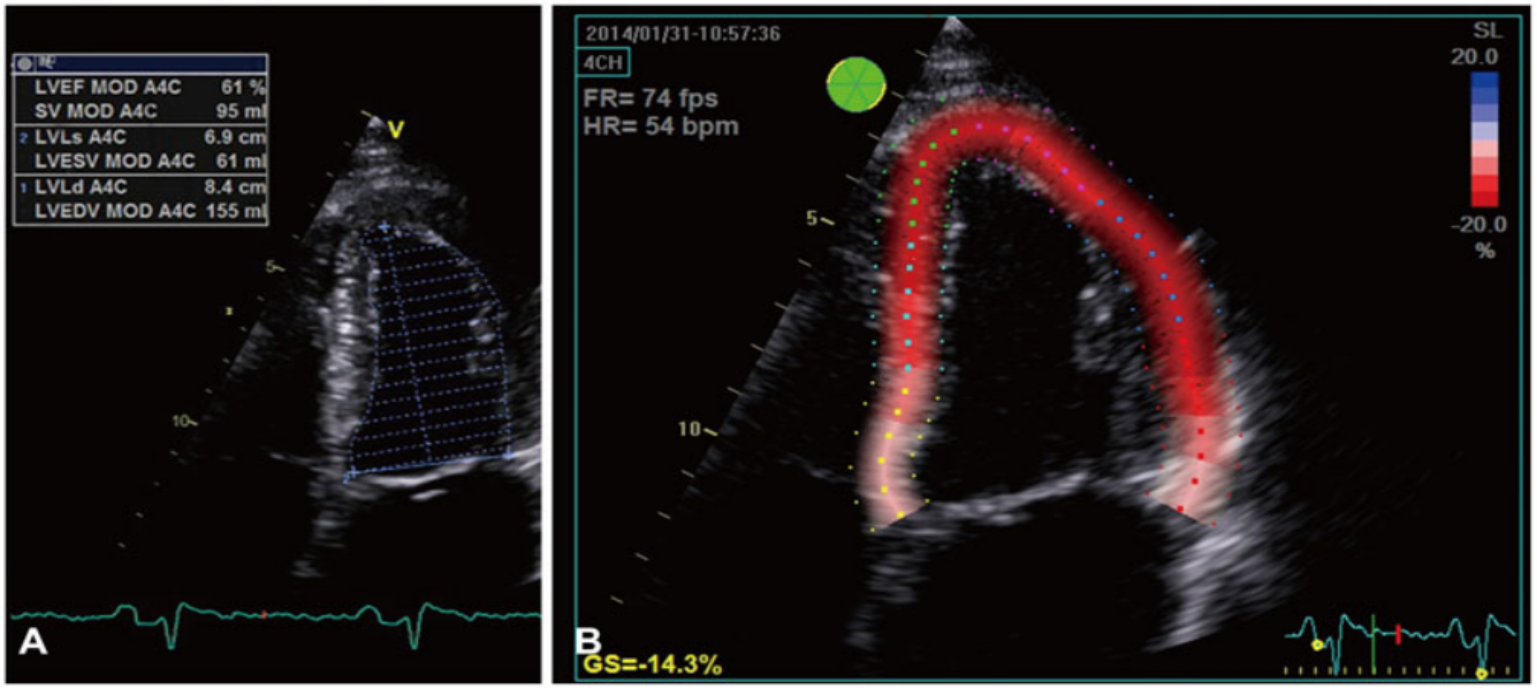


Fig. 4. Echocardiographic images from a patient with severe asymptomatic mitral regurgitation. There is a preserved left ventricular (LV) ejection fraction calculated by Simpson's method (61%) (A), but reduced global longitudinal strain (-14.3%) (B), suggesting subclinical LV systolic dysfunction (Supplementary Video 6 in the online-only Data Supplement). LVEF: left ventricular ejection fraction, SV: stroke volume, LVESV: left ventricular end systolic volume, LVEDV: left ventricular end diastolic volume.

Korean Circ J. 2015 Mar;45(2):96-105.
https://doi.org/10.4070/kcj.2015.45.2.96

ECHO: 3D TEE

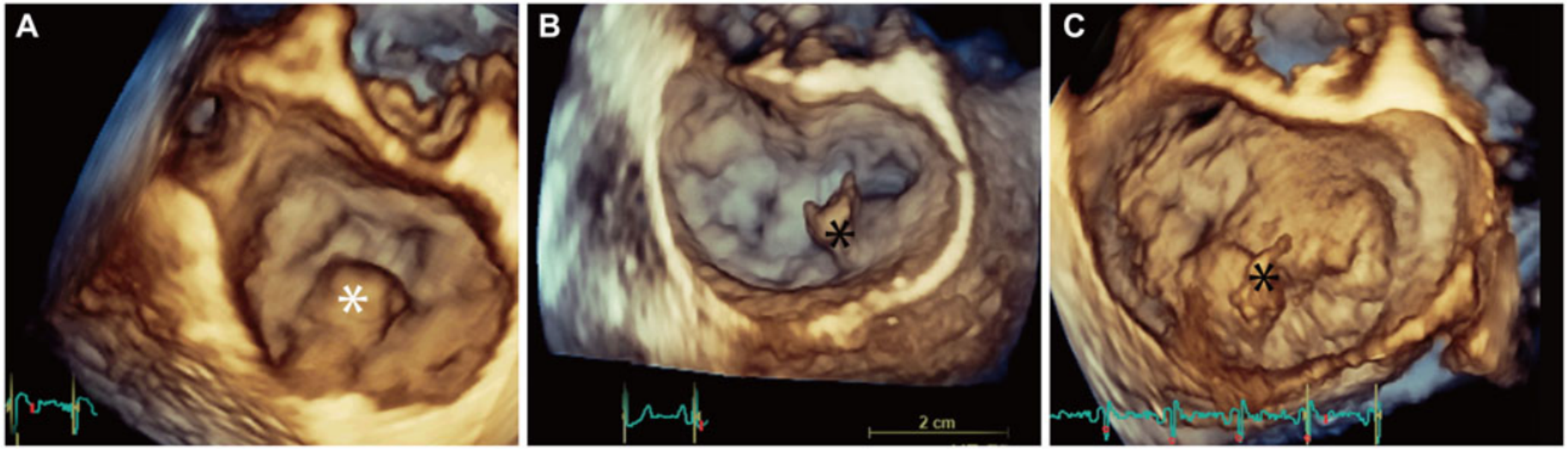


Fig. 1. Mitral valve lesions in severe organic mitral regurgitation, assessed by three-dimensional transoesophageal echocardiography. A: severe mitral regurgitation determined by a simple lesion with a high probability of successful mitral valve repair. 3D transoesophageal surgical view of the mitral valve showing isolated P2 scallop prolapse (asterisk) (Supplementary Video 1 in the online-only Data Supplement). B: severe mitral regurgitation determined by complex lesions with a possibly successful mitral valve repair by an experienced surgeon. 3D transoesophageal surgical view of the mitral valve showing P3 scallop prolapse and flail (asterisk) involving the posterior commissure (Supplementary Video 2 in the online-only Data Supplement). C: severe mitral regurgitation determined by a very complex lesion with an unlikely chance of successful mitral valve repair. 3D transoesophageal surgical view in a patient with Barlow disease and P2 flail (asterisk) (Supplementary Video 3 in the online-only Data Supplement). 3D: three-dimensional.

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CARDIAC MRI: QUANTIFICATION OF MITRAL REGURGITATION SEVERITY

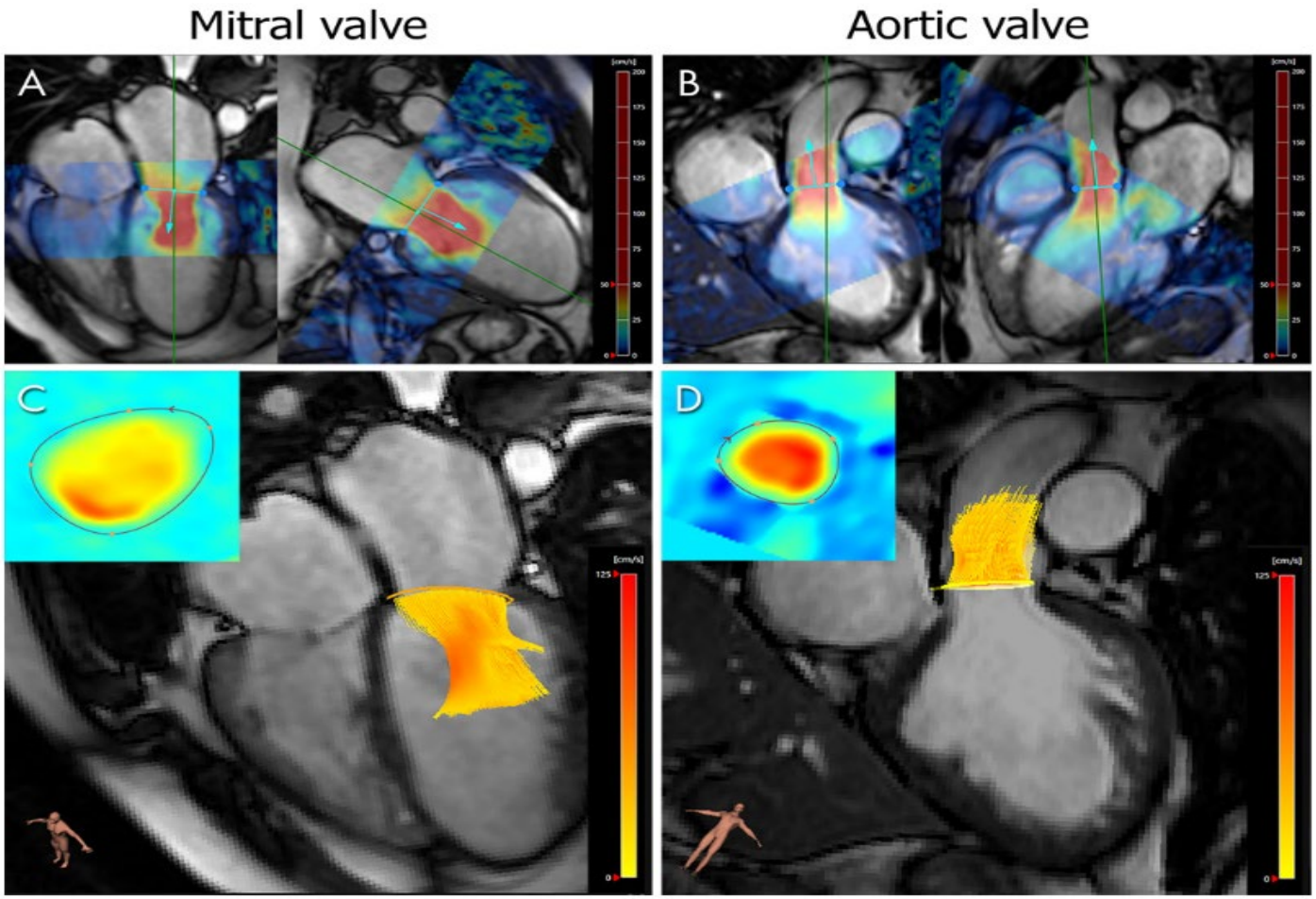
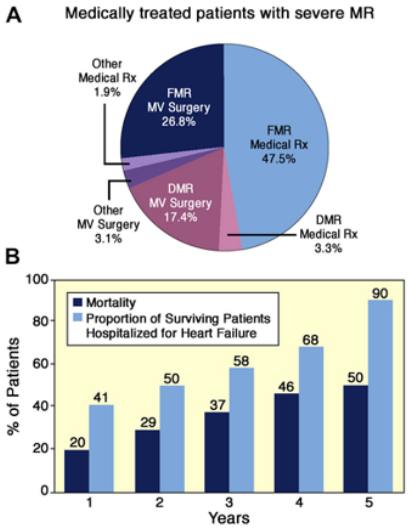


Figure 4: Forward flow quantification with four-dimensional (4D) flow MRI across the mitral valve (MV) and aortic valve in a 45-year-old man with moderate MV regurgitation diagnosed with echocardiography. *A*, *B*, Semiautomated valve tracking on two orthogonal long-axis cine balanced steady-state free precession images for each valve. Colors represent the in-plane velocity measured with 4D flow MRI. *C*, *D*, The 4D flow MRI through-plane velocity measurements are projected onto the valve-tracking plane (inset), and time-resolved streamlines are generated from within the contour.

Radiology: Cardiothoracic Imaging 2020; 2(5):e200004 • https://doi.org/10.1148/ryct.2020200004

CONCLUSIONS: MITRAL REGURGITATION

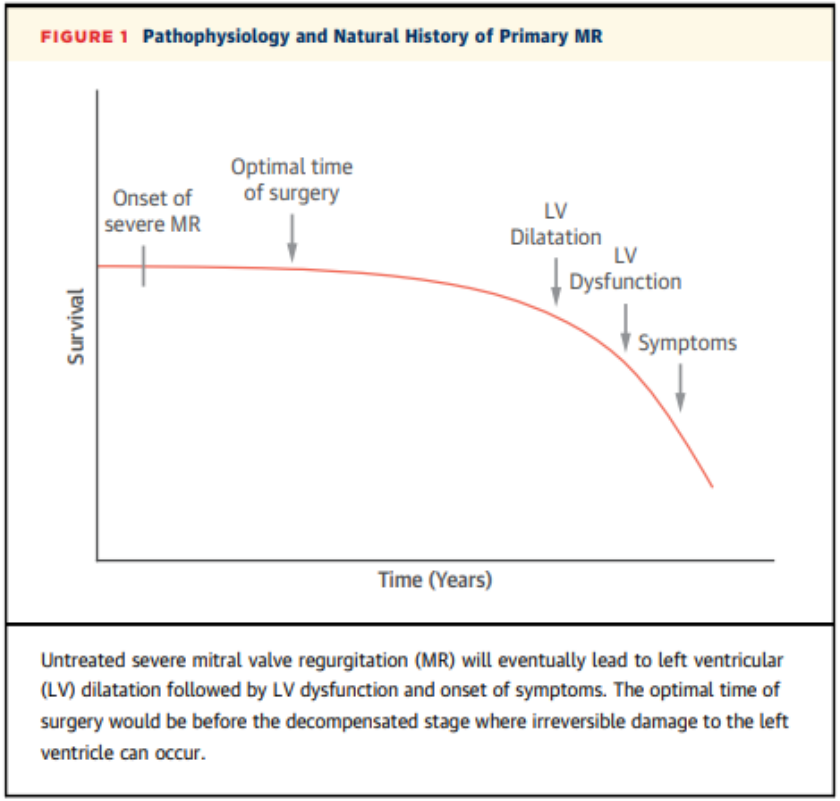


Sachin S. Goel et al. *J Am Coll Cardiol* 2013; 63:185-186.

Prevalence and Outcomes of Unoperated Patients With Severe Symptomatic MR and Heart Failure

(A) Pie chart showing mechanism and management of 1,095 patients with severe symptomatic MR. (B) Mortality and rates of hospitalization for heart failure in unoperated patients with severe MR. DMR = degenerative mitral regurgitation; FMR = functional mitral regurgitation; MR = mitral regurgitation; MV = mitral valve. Figure by Craig Skaggs.

The overall 1-year and 5-year mortality rate in unoperated patients was 20% and 50%, respectively (**Fig. 1**B). In these unoperated patients, the proportion of surviving patients hospitalized for heart failure increased from 41% in the first year to 90% by 5 years. Of 474 unoperated patients with symptomatic severe FMR with a good-quality echocardiogram available for review, 171 patients (36%) would have been eligible for MitraClip based on published criteria.



al. JACC: CARDIOVASCULAR IMAGING, VOL. 11, NO. 4, 2018 Diagnosis and Management of Mitral Valve

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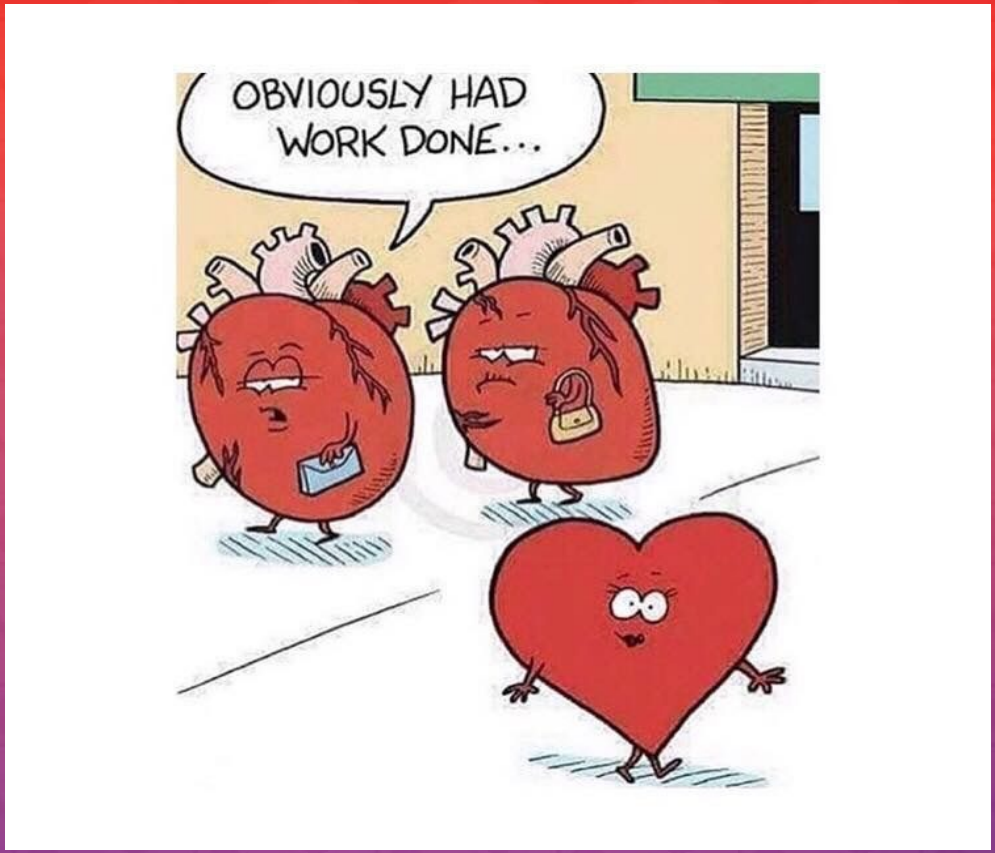

THANK YOU