Catching a glimpse: Aortic Stenosis and Mitral Regurgitation

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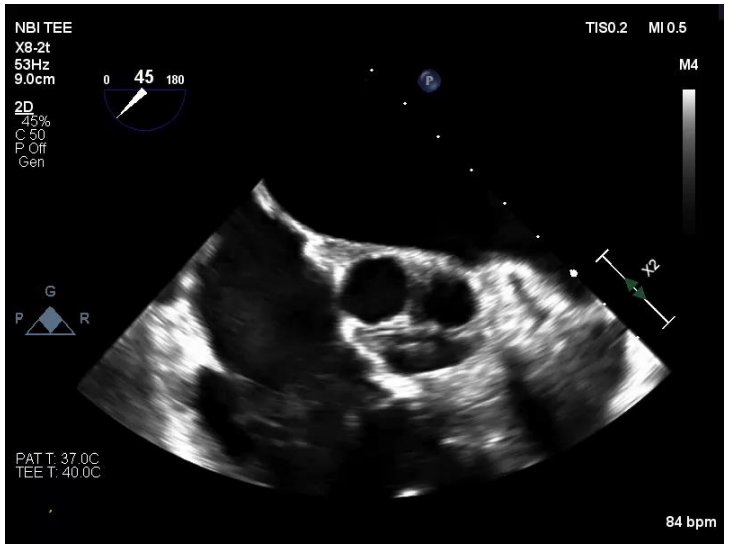
Disclosures

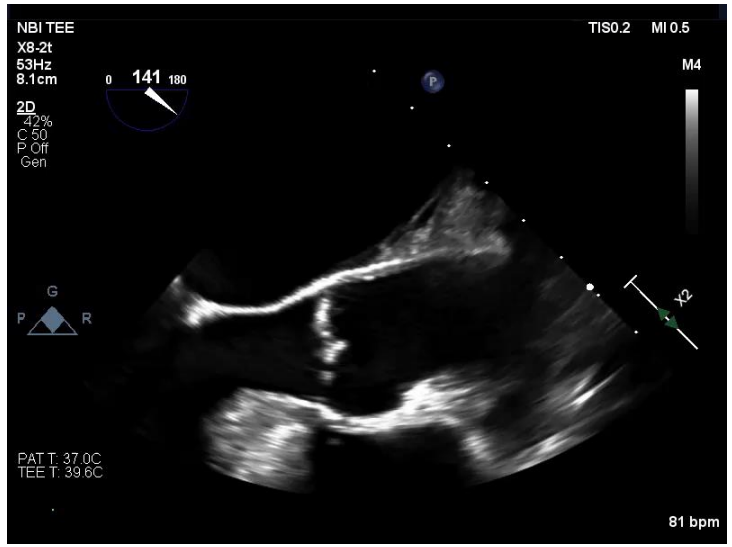
No relevant disclosures

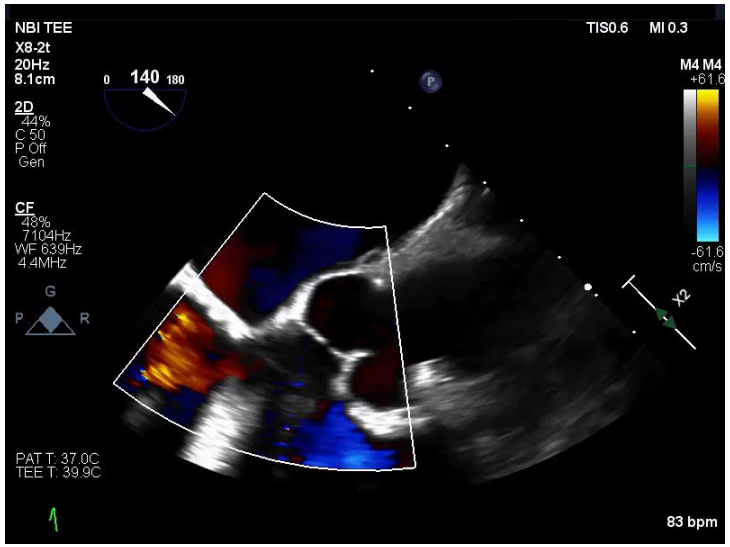
Agenda

- Spectrum of disease: from normal to abnormal
- Establishing the severity of valvular pathology
- Guiding future management

Aortic Valve: normal to abnormal







Three leaflets, mobile, thin. No evidence of restricted motion or hypermobile motion.

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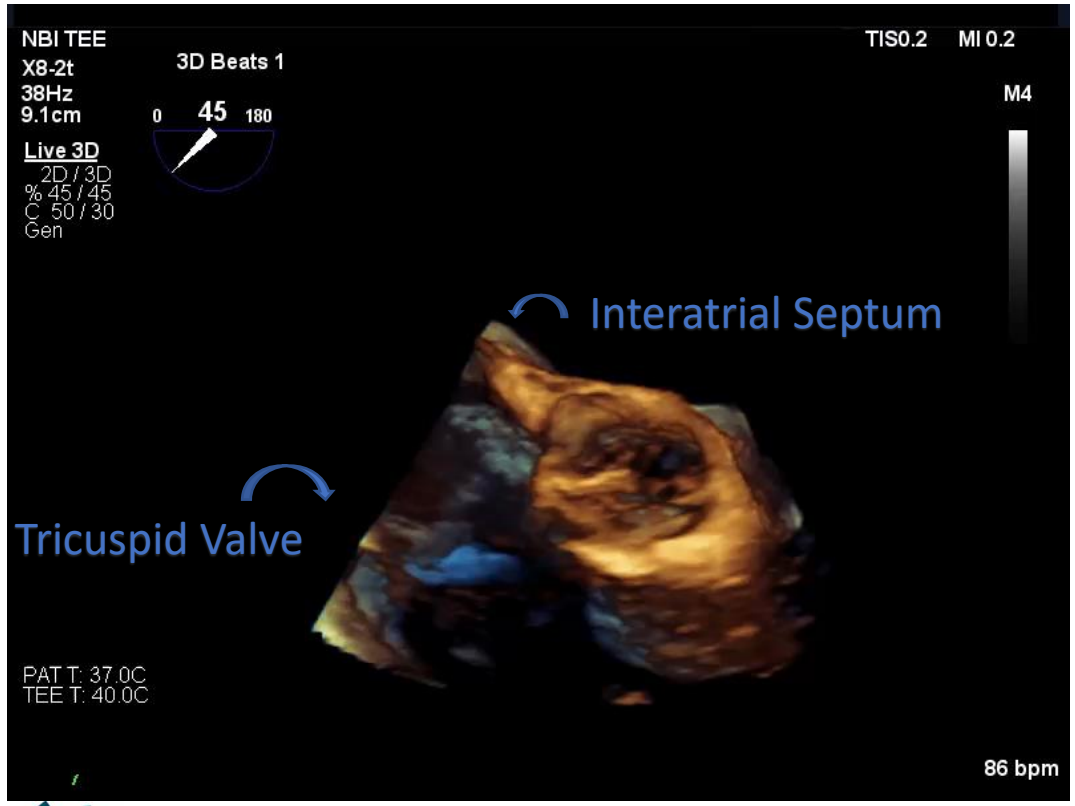
Normal 3D of the Aortic Valve



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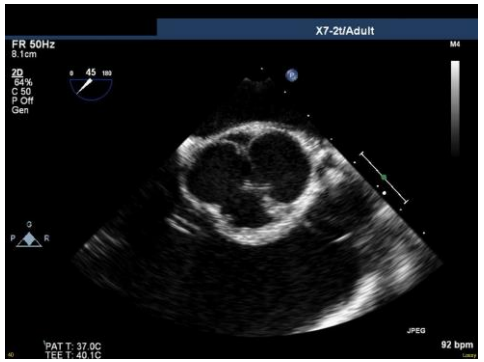
Types of aortic valve



Unicuspid Aortic Valve

Rare in adults (0.02%)

Fatal AS in children who are <1 years old

Sometimes 1 commissure, sometimes no commissure

Aortic Stenosis associated with ascending aortic aneurysm

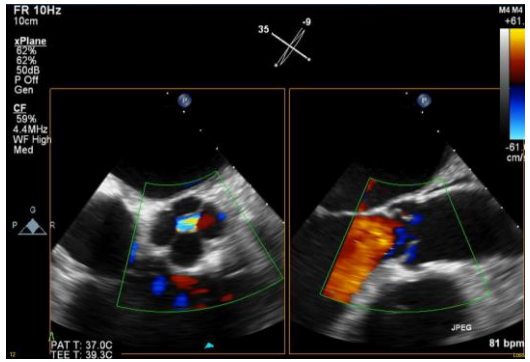
Bicuspid Aortic Valve

Fusion of the 2 cusps

Associated with aortic stenosis and aortic regurgitation

Frequent 1-2% of the patients

Associated with aortic pathology

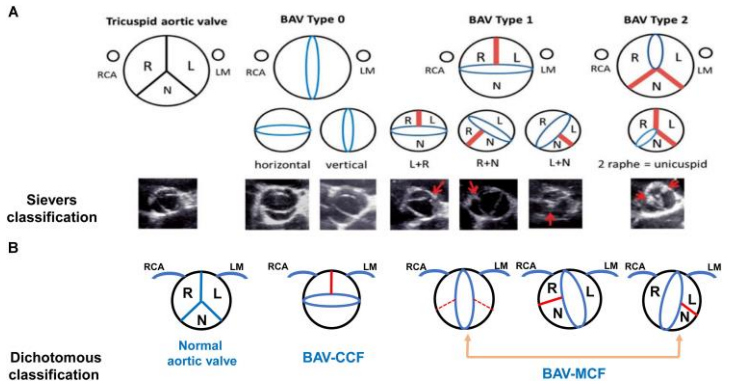


Quadracuspid Aortic Valve

Unequal cusp size

More aortic regurgitation than stenosis

Associated with anomalous coronaries



Dencker and Stagmo. Cardiovascular US 2006.

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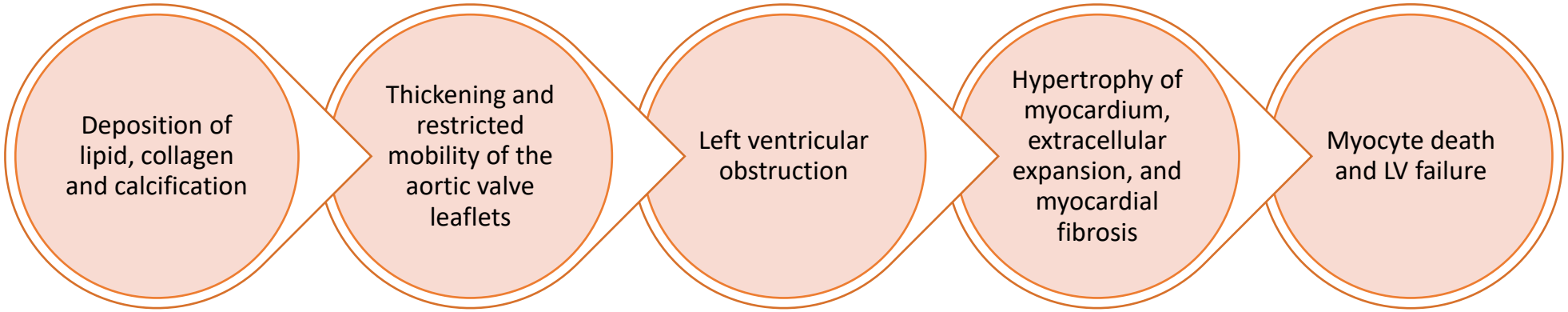
Aortic Stenosis

- Affects more than 7 million people over 75 years of age in Europe and North America
- Most common valvular pathology in developed countries



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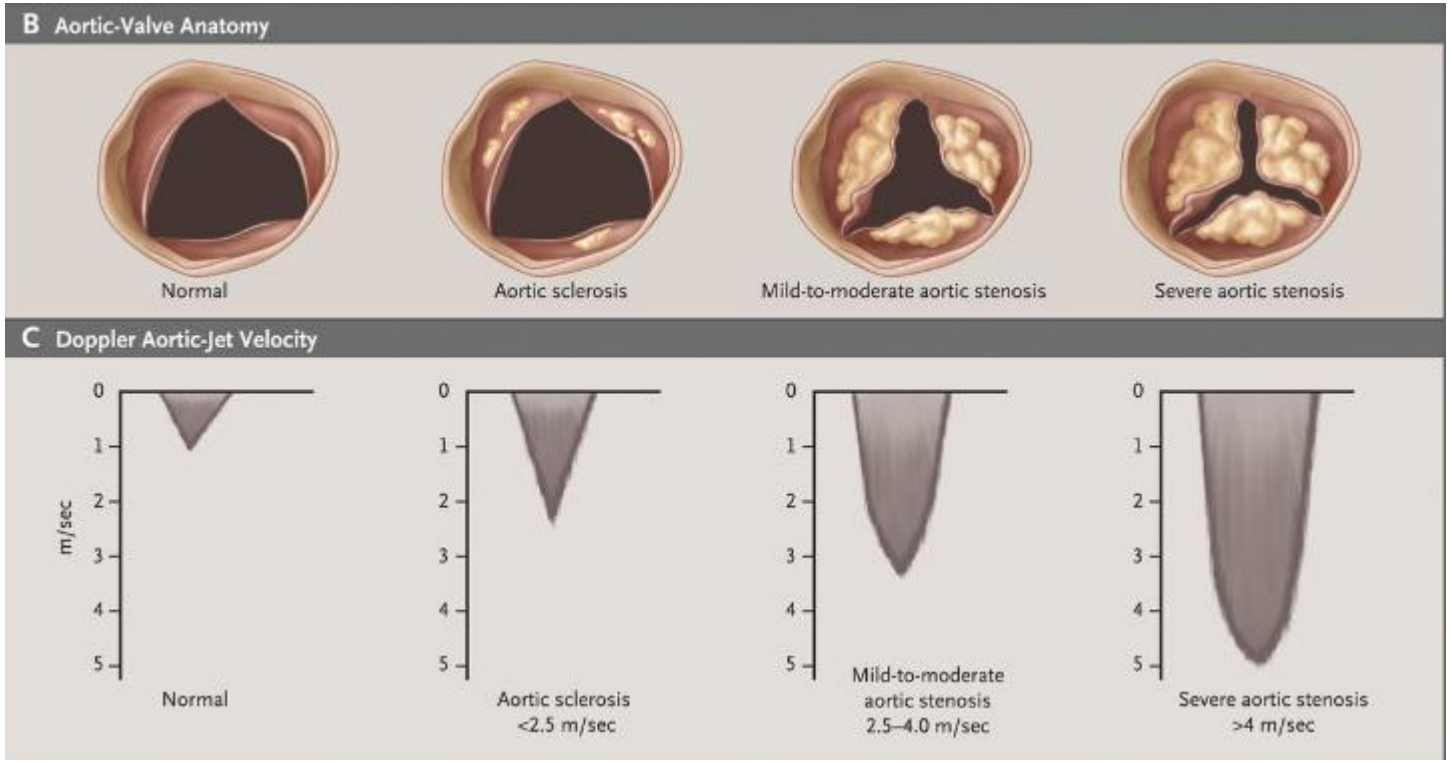
Otto CM. NEJM, 2008:359:1395-8

Progression of aortic stenosis



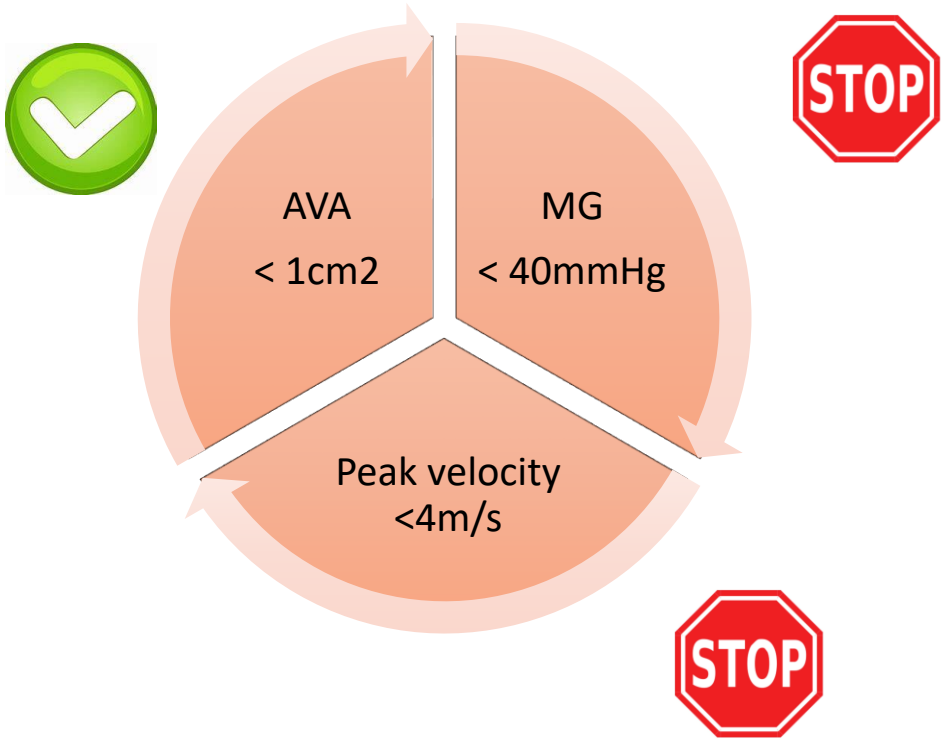
- Transthoracic Echo is the clinical standard for screening for AS and evaluating severity
- ACC/AHA guidelines: Vmax >4m/s, mean gradient >40mmHg and AVA <1cm2
- AS severity assessment is challenging in patients with LV dysfunction

Otto CM. NEJM, 2008:359:1395-8

Discordant Aortic Stenosis

Is this Moderate vs Severe Aortic Stenosis?

65-70% of patients have concordant findings
BUT
25-30% have discordant



Step 1: Make sure LVOT is not underestimated. LVOT measurement is the most common error. Use 3D or CT to confirm LVOT size
Step 2: Confirm low gradient: multi-window interrogation (suprasternal and right parasternal)
Step 3: Confirm low flow state and identify cause

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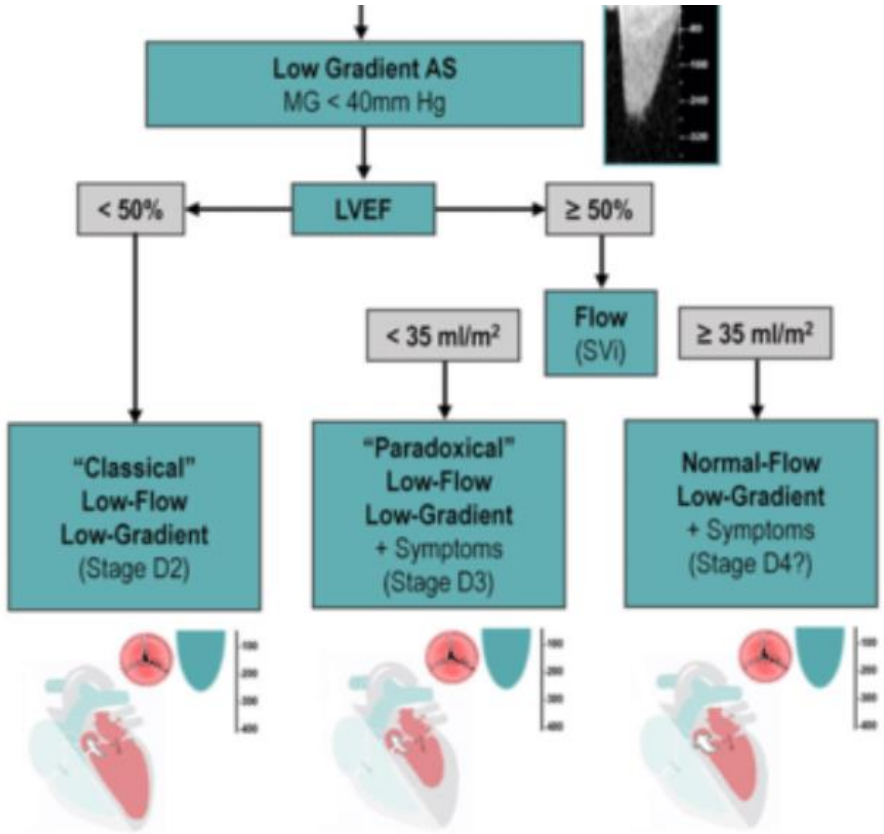
Classification of AS

- Classical Low-Flow Low-Gradient AS
  - Pseudosevere vs severe AS
  - LVEF <50%
- Paradoxical Low-Flow Low-Gradient AS
  - Normal LVEF (>50%)
  - Low stroke volume indexed (<35cc/m2)
- Normal-flow Low-Gradient
  - Normal LVEF and normal stroke volume



Guzzetti et al. *Front Cardiovasc Med* 2020

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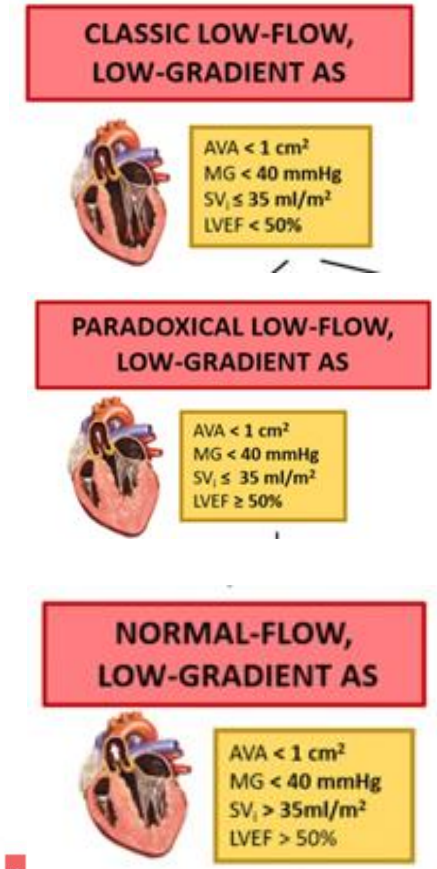
Diagnostic Pathways



Dobutamine Stress Echo
Pseudo-severe: AVA >1cm2 and MG <40mmHg
Severe AS: AVA <1cm2 and MG >=40mmHg
Indeterminate

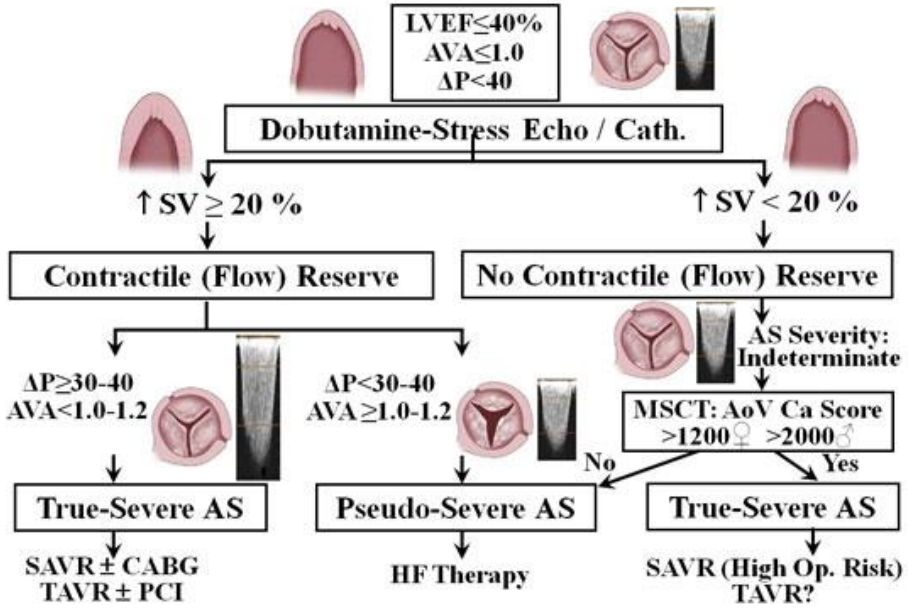
Non-contrast CT for aortic valve calcium score
Severe AS
Women >1,200
Men > 2,000

Silva et al. *JACC* 2022.

Goes back to 1995

- DeFilippe et al. evaluated 18 patients with dobutamine stress echo: AVA ≤0.5cm^2/m^2, mean gradient ≤30 mm Hg and LVEF ≤45%.
- Dobutamine was started at 5 µg/kg/min and increased to a peak of 20 µg/kg/min at 3-min intervals.

Contractile reserve - increase in peak velocity of 0.6m/s, stroke volume 20% and MPG 10mmHg with dobutamine
True SEVERE AS – small change/no change in AVA but gradients across AV increase
Pseudo-severe AS – AVA increases by 0.3cm2. AV gradient increases slightly or no change



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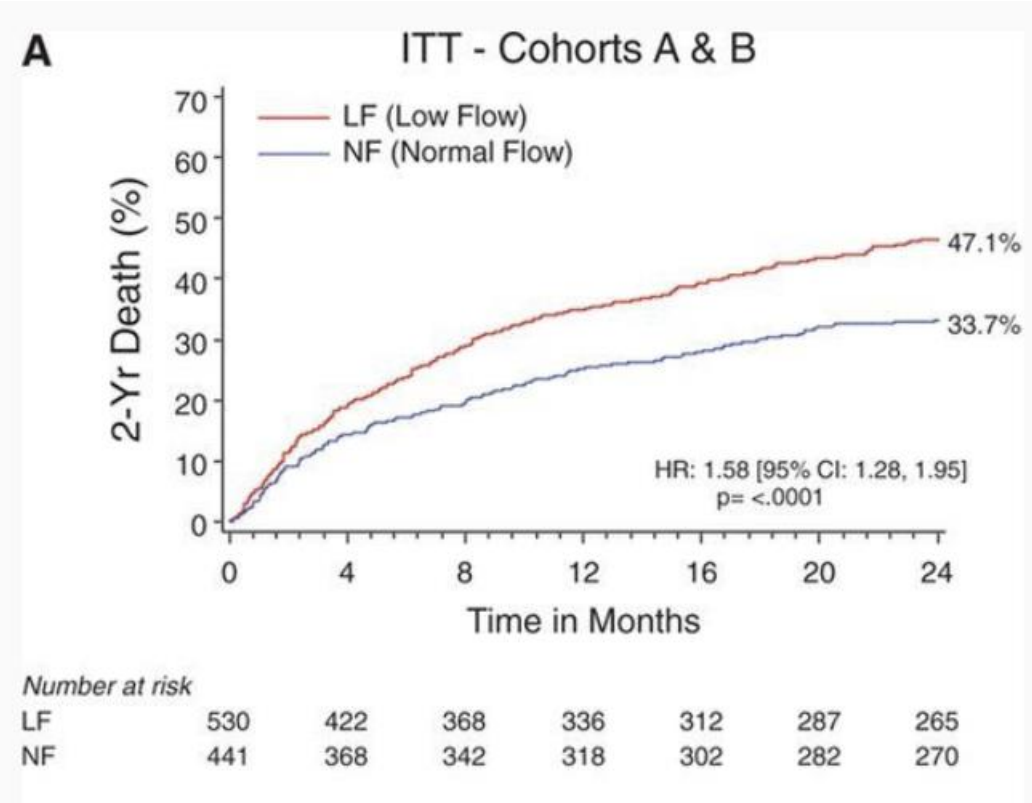
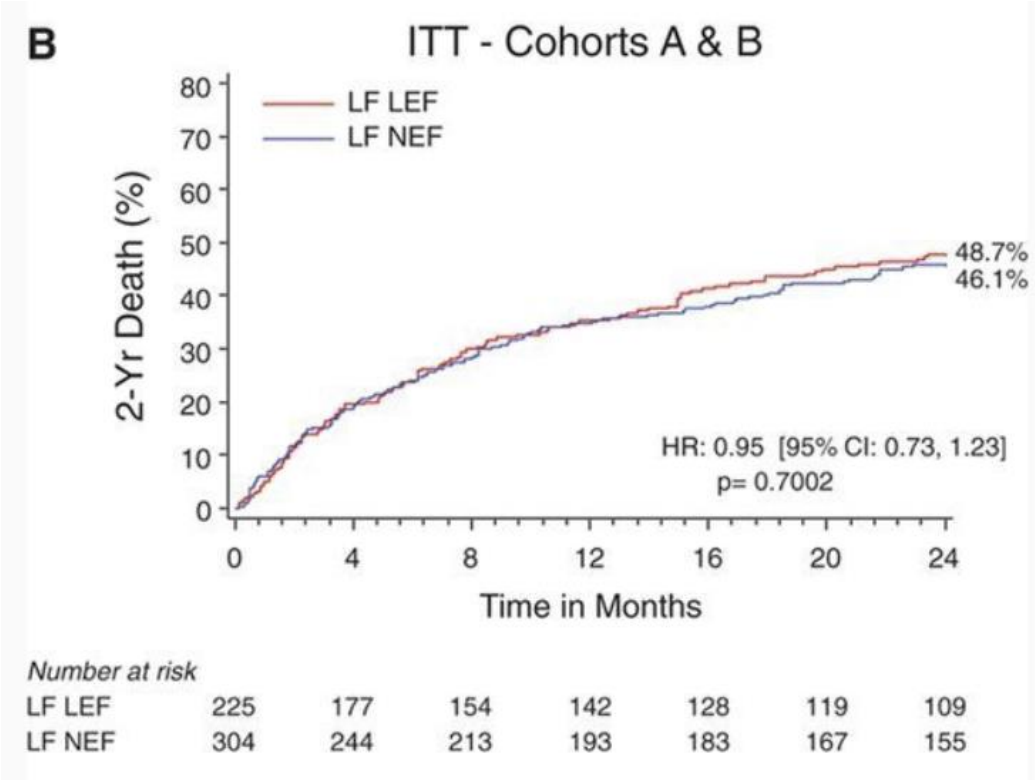
Why is low flow so important?





Herrmann et al. Circulation 2013; 127:2316-2326

AS management

1. In adults with severe high-gradient AS (Stage D1) and symptoms of exertional dyspnea, HF, angina, syncope, or presyncope by history or on exercise testing, AVR is indicated.[1–7]

3. In asymptomatic patients with severe AS (Stage C1) who are undergoing cardiac surgery for other indications, AVR is indicated.[12–16]

4. In symptomatic patients with low-flow, low-gradient severe AS with reduced LVEF (Stage D2), AVR is recommended.[17–24]

Stage C:

C1: Asymptomatic Severe

Vmax >=4m/s and MG >=40mmHg, AVA < 1cm2

C2: Asymptomatic Severe with LV dysfunction

LVEF < 50%

Stage D:

D1: Symptomatic severe High gradient AS

D2: Symptomatic severe low-flow, low-gradient AS with reduced LVEF

D3: Symptomatic severe low gradient AS with normal LVEF or Paradoxical low-flow severe AS

2. In asymptomatic patients with severe AS and an LVEF <50% (Stage C2), AVR is indicated.[8–11]

5. In symptomatic patients with low-flow, low-gradient severe AS with normal LVEF (Stage D3), AVR is recommended if AS is the most likely cause of symptoms.[25–27]

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Moving on to Mitral Valve

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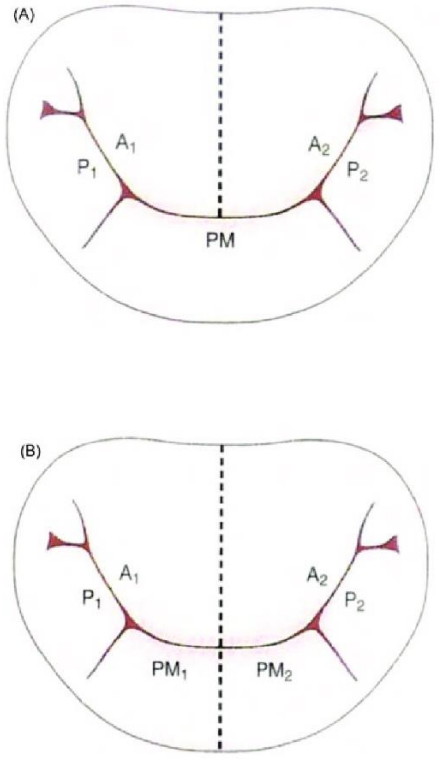
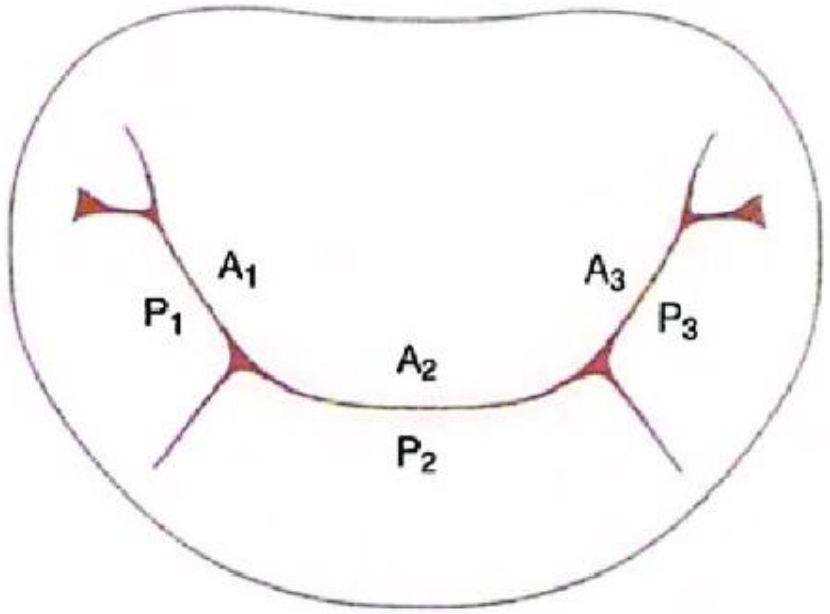
Mitral Valve Nomenclature

- Duran classification



- Carpentier classification



Iroegdu et al. 2018

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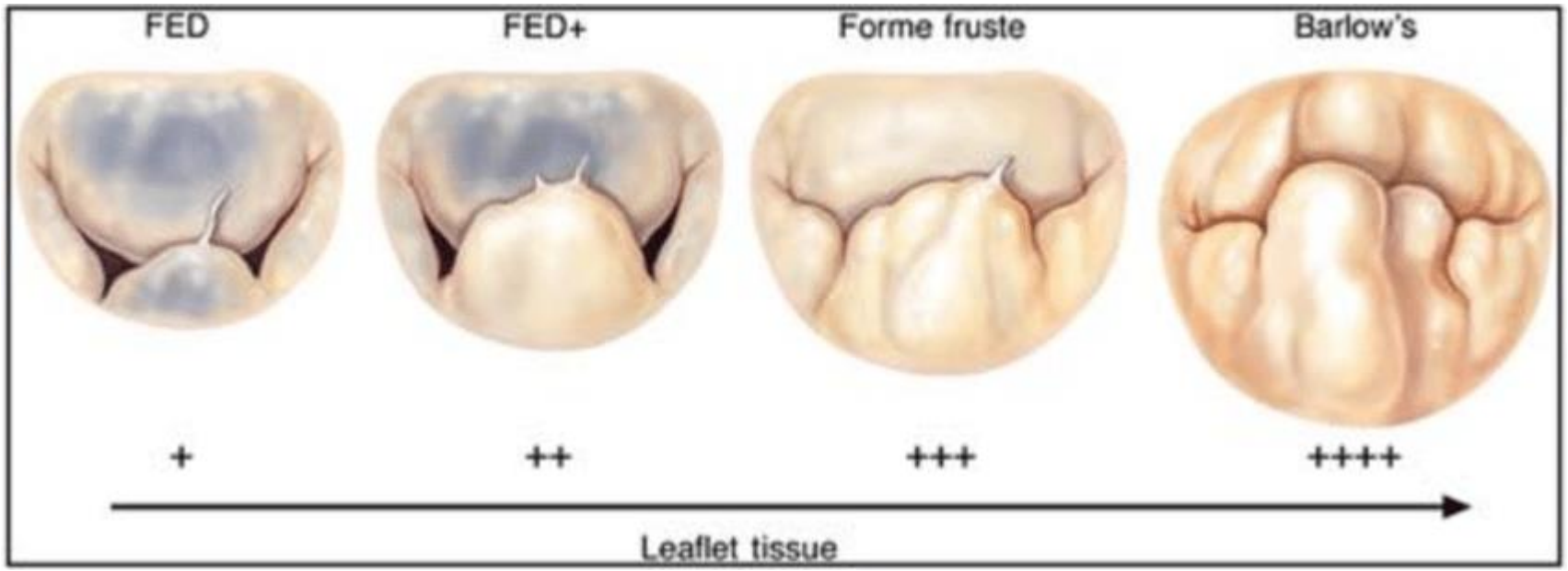
Primary Mitral Regurgitation

1. Abnormality of the MV apparatus
2. Most common cause is myxomatous degeneration

    Ranges from focal prolapse to Barlow's disease

3. Other causes: leaflet perforation, cleft mitral leaflet, rheumatic heart disease, radiation and connective tissue disease

Spectrum of Mitral Valve Prolapse



Adams DH, Rosenhek R, Falk V. European Heart Journal. 2010;31(16):1958-1966).

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Secondary Mitral Regurgitation

1. Disease of the atrium or ventricle
2. Non-ischemic: increased EROA from annular dilation and loss of annular contraction. Lack of coaptation
3. Atrial MR: severe left atrial enlargement (due to persistent atrial fibrillation)
4. Ischemic: regional inferior wall motion abnormality leading to posterior leaflet tethering and posterior MR. Anterior leaflet override. Can also have central MR due to global wall motion abnormalities

CENTRAL ILLUSTRATION: Classification of the Etiology of MR

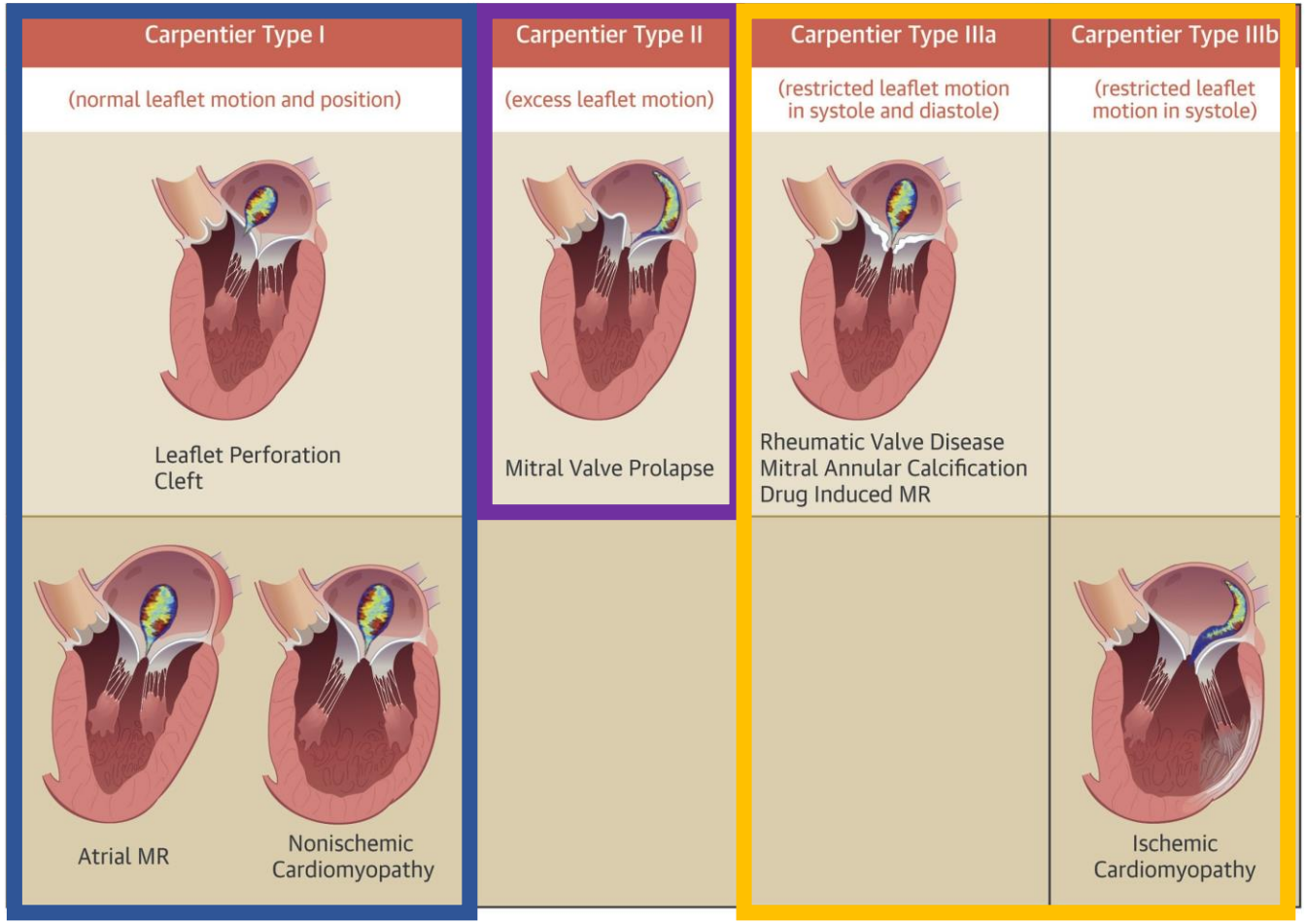
Normal Leaflet Motion:
Leaflet perforation
Annular Dilation

Excessive Leaflet Motion:
Degenerative MV ds
Endocarditis
Trauma

Restricted leaflet motion
IIIa – systole and diastole (rheumatic MV and inflammatory)
IIIb – systole (ischemic and infiltrative)

PRIMARY MR

SECONDARY MR



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

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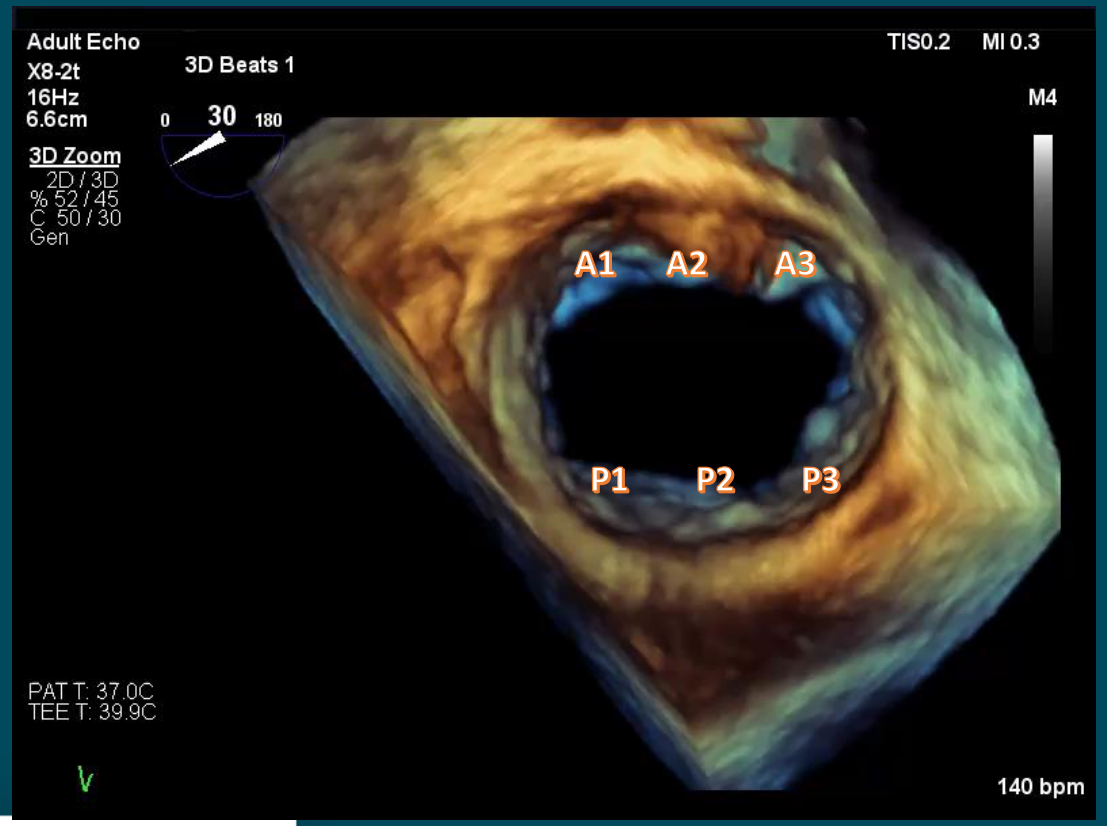
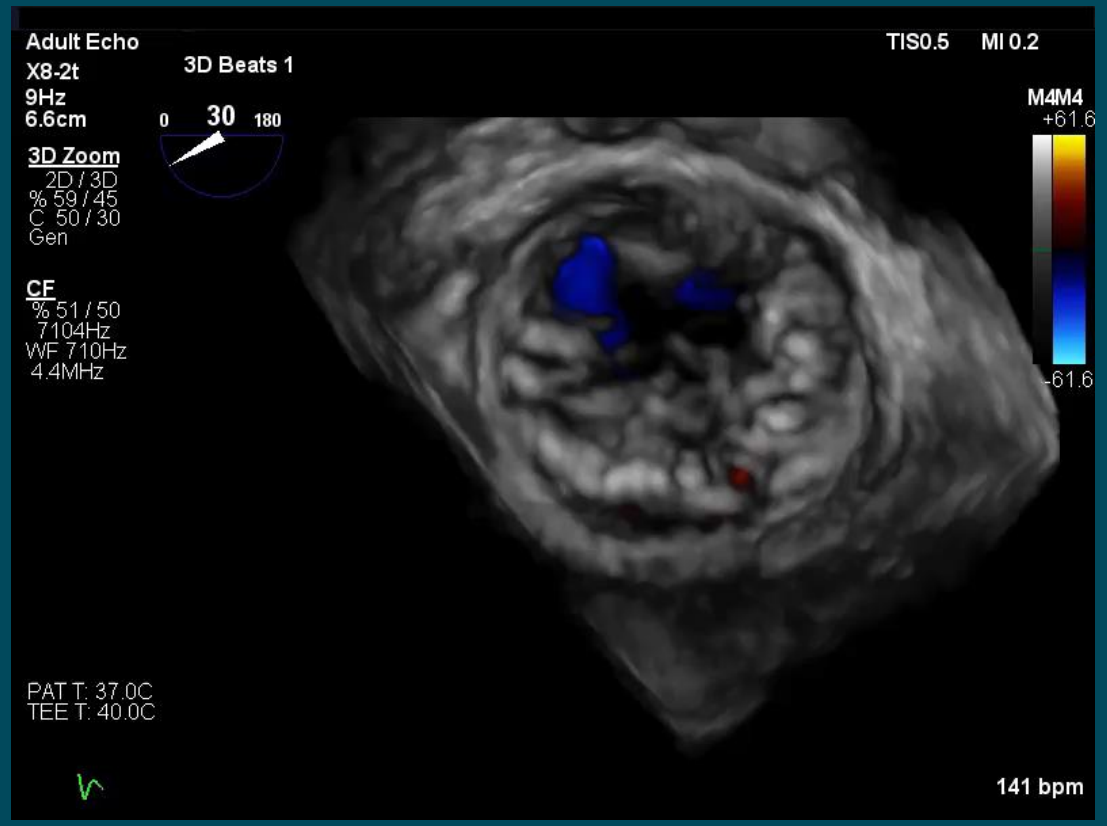
Normal Mitral Valve 3D





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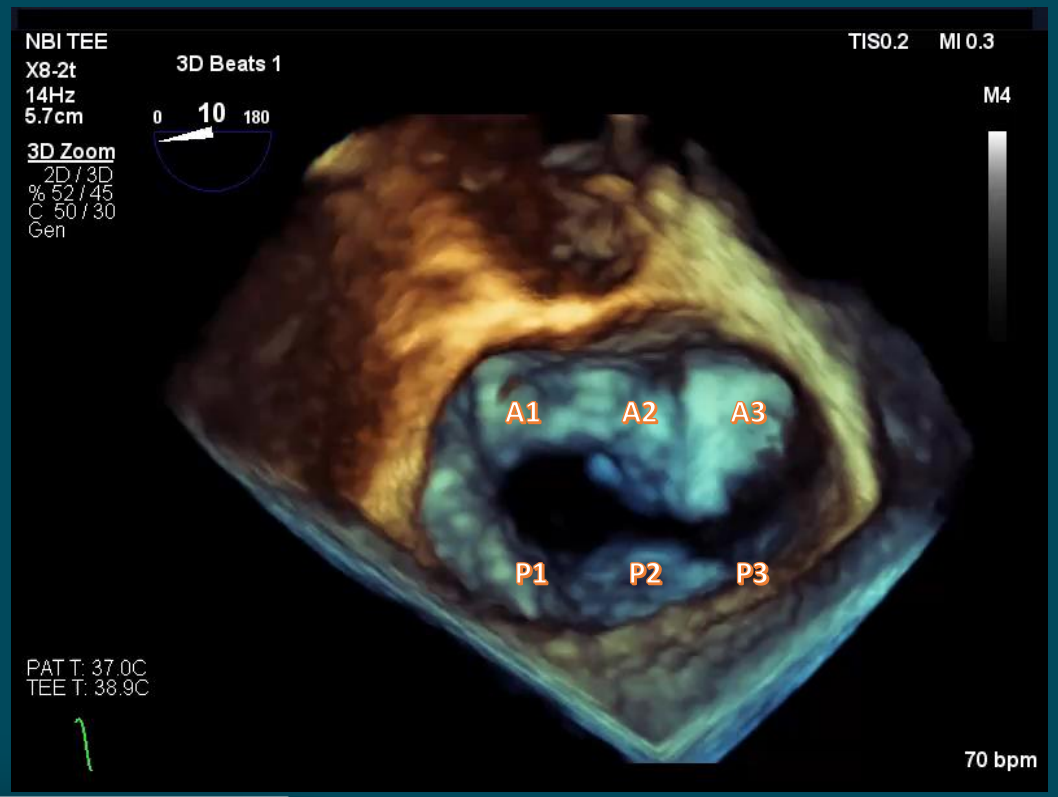
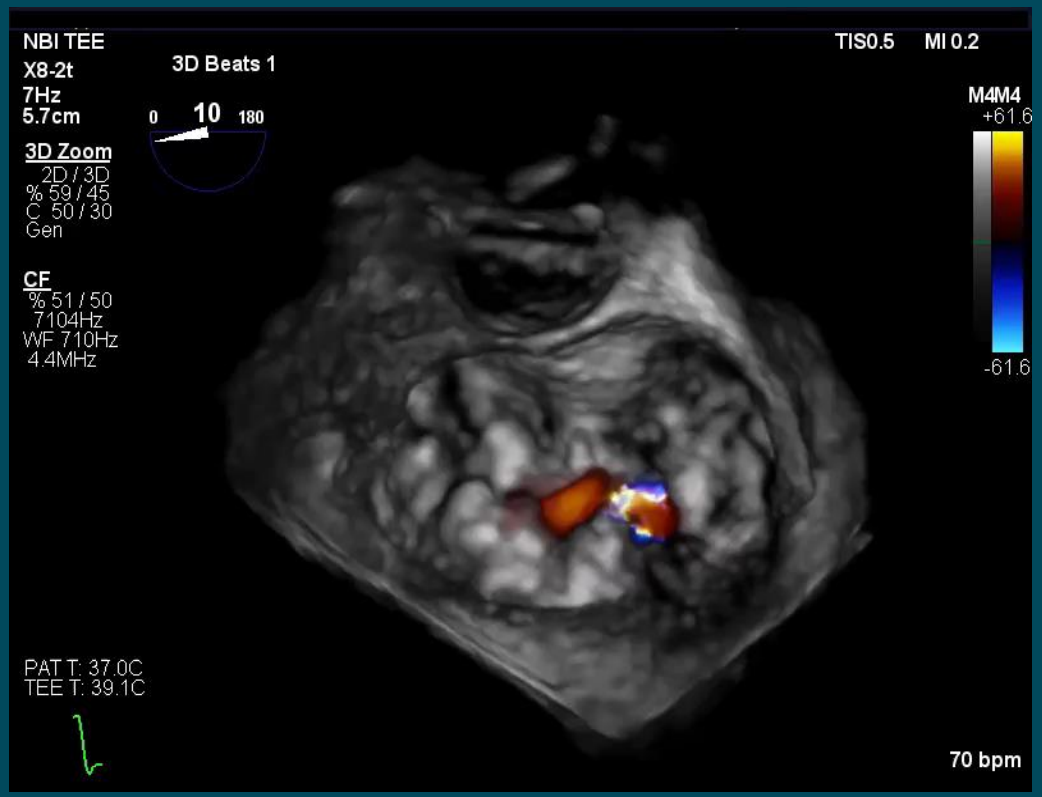
Focal Prolapse (P2)





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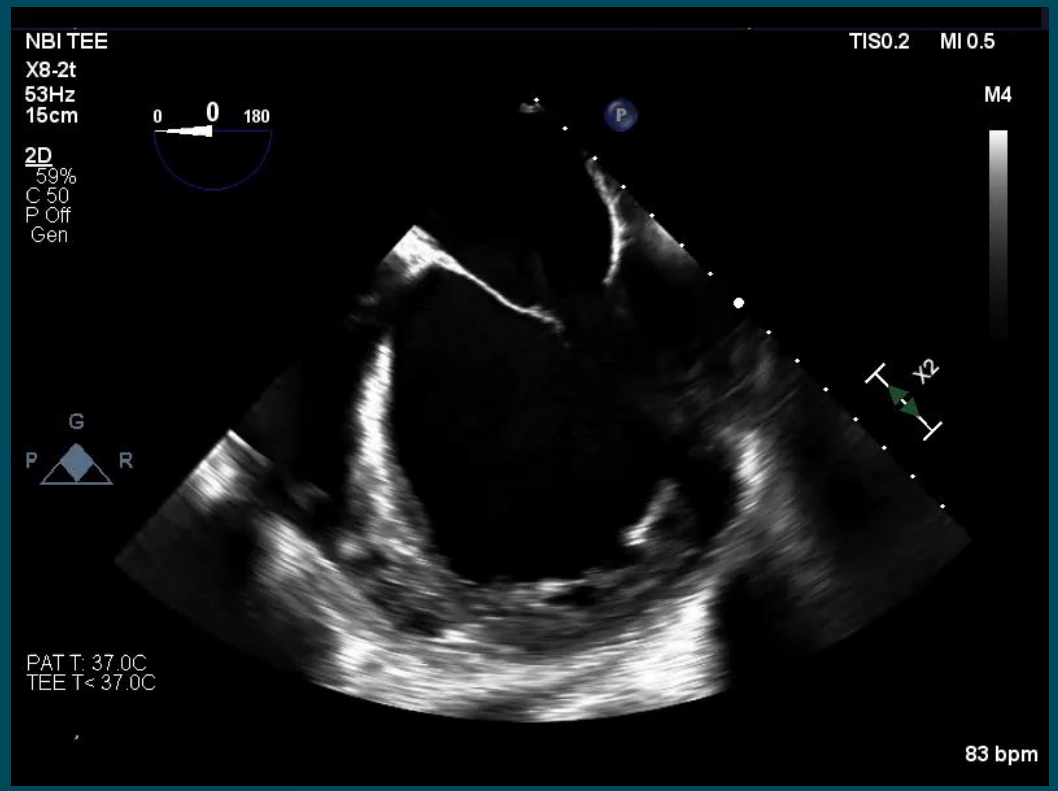
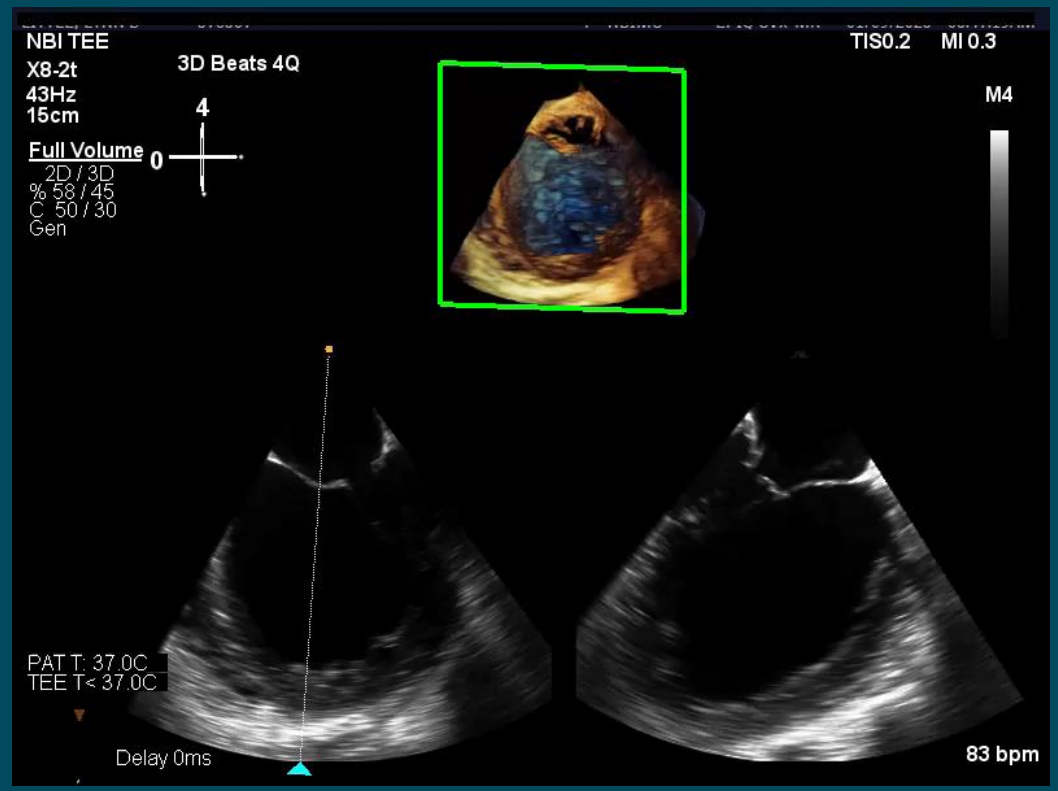
Non-ischemic CM





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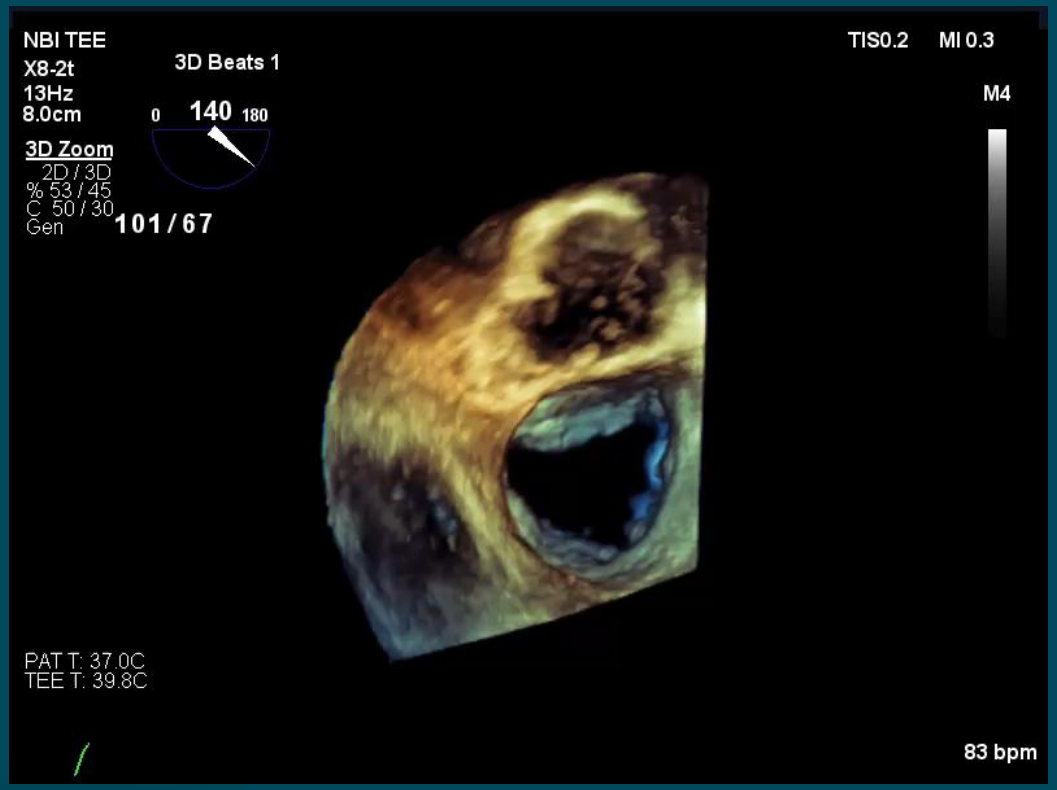
Using 3D to identify pathology



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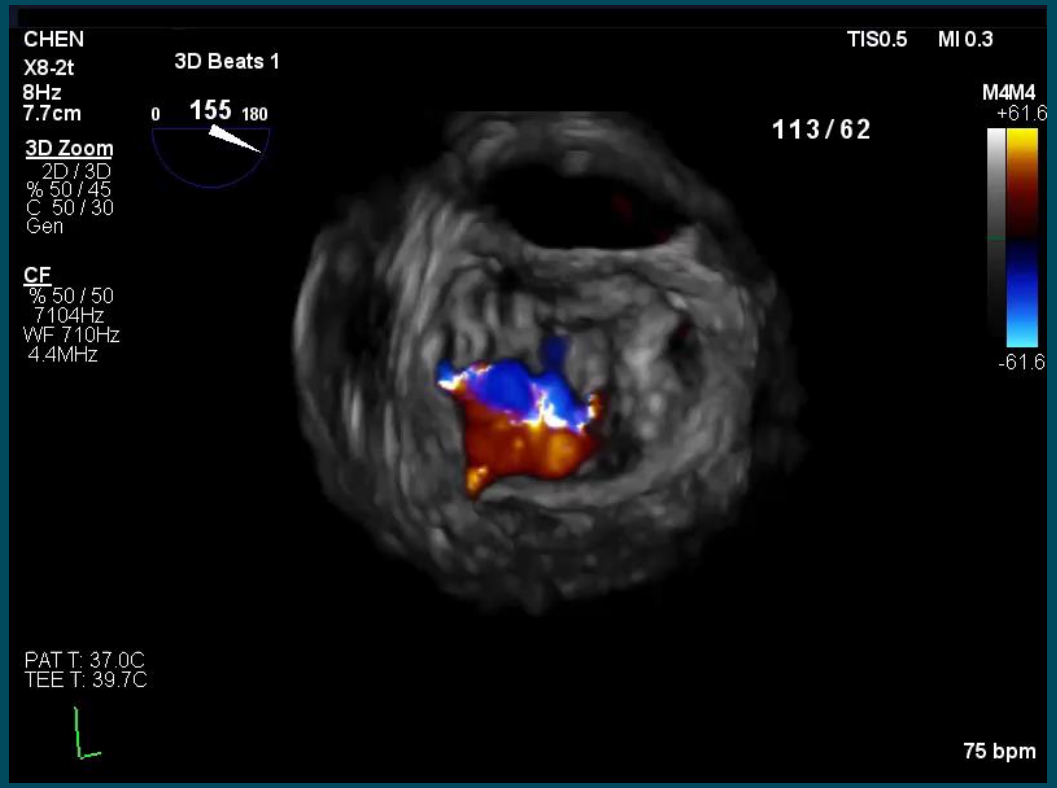
Myxomatous Mitral Valve



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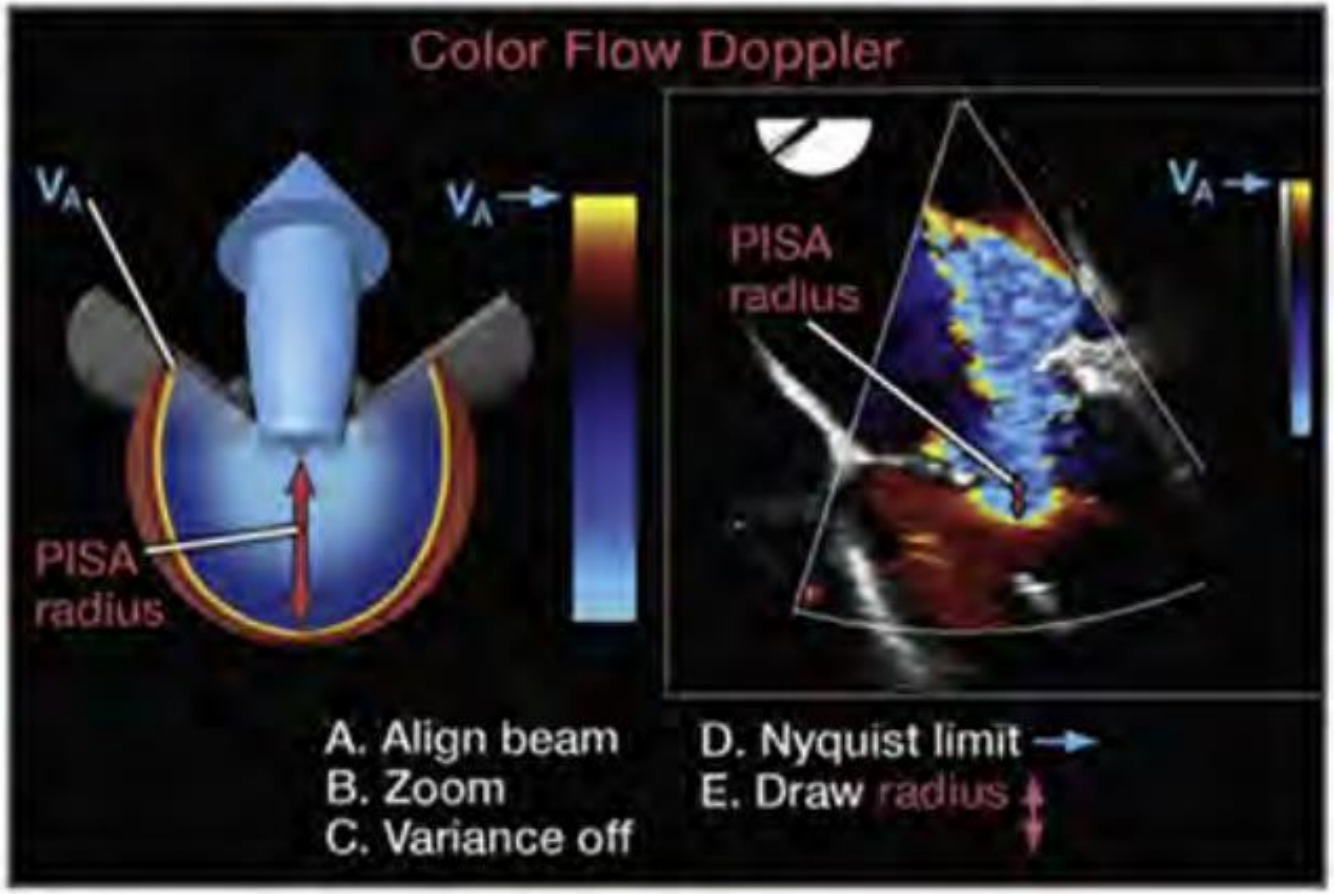
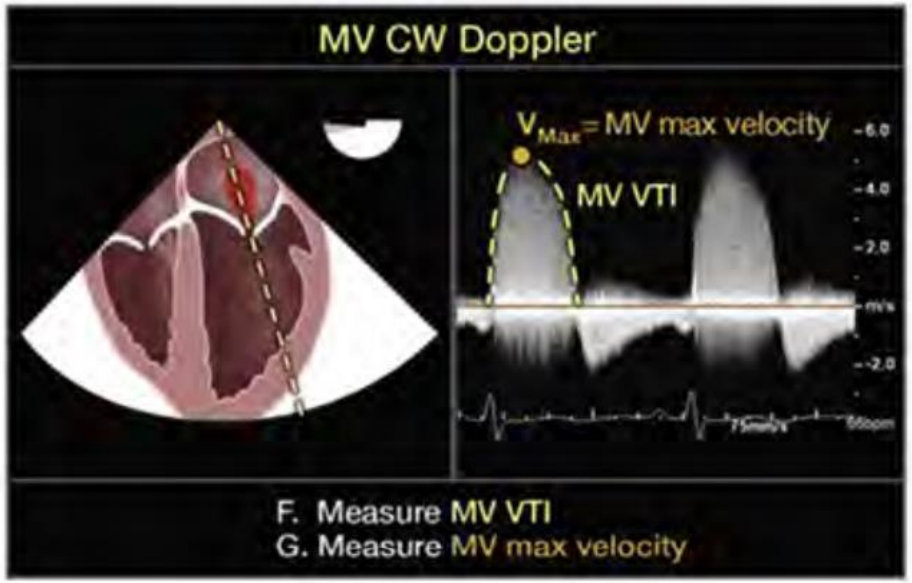
Establishing Severity of MR: PISA





$$PISA = 2 \times \pi \times r^2$$

$$\text{Regurgitant flow} = 2 \times \pi \times r^2 \times V_A$$

$$ERO = \frac{\text{Reg. flow}}{V_{Max}} = \frac{2 \times \pi \times r^2 \times V_A}{V_{Max}}$$

$$RVol = ERO \times VTI \qquad RF = \frac{RVol}{\text{Stroke volume}^*}$$

* Calculated as forward stroke volume (either using transmitral inflow or the sum of LVOT flow and RVol)

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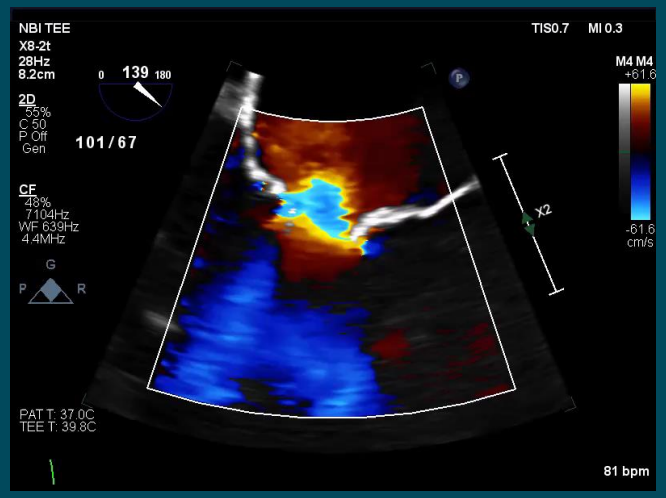
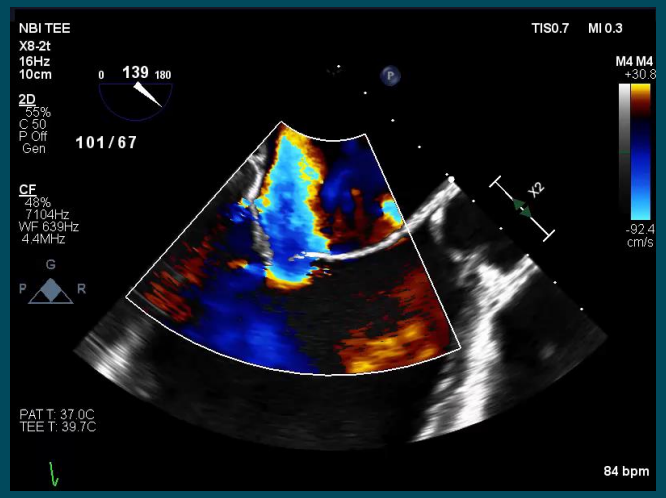
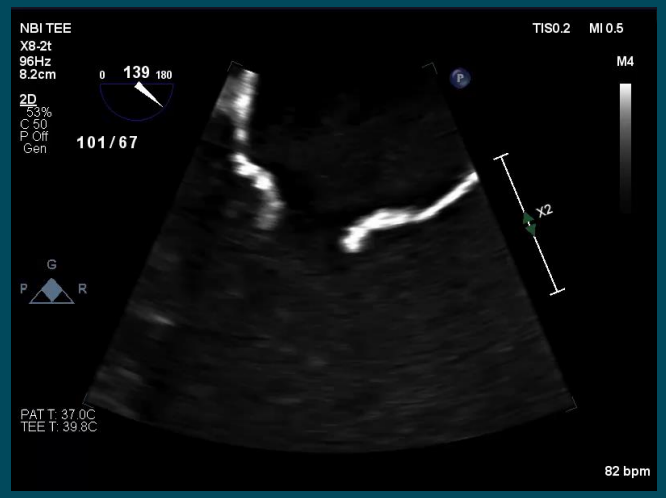
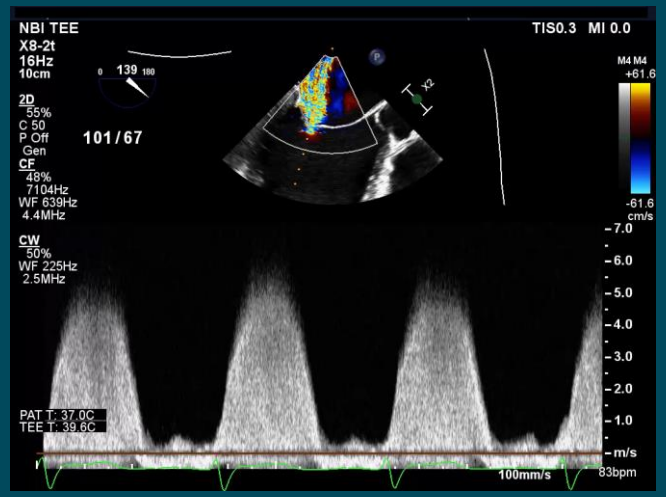
Hahn et al. Recommended Standards for the Performance of TEE for SHI. JASE 2022

Quantitative Evaluation - PISA









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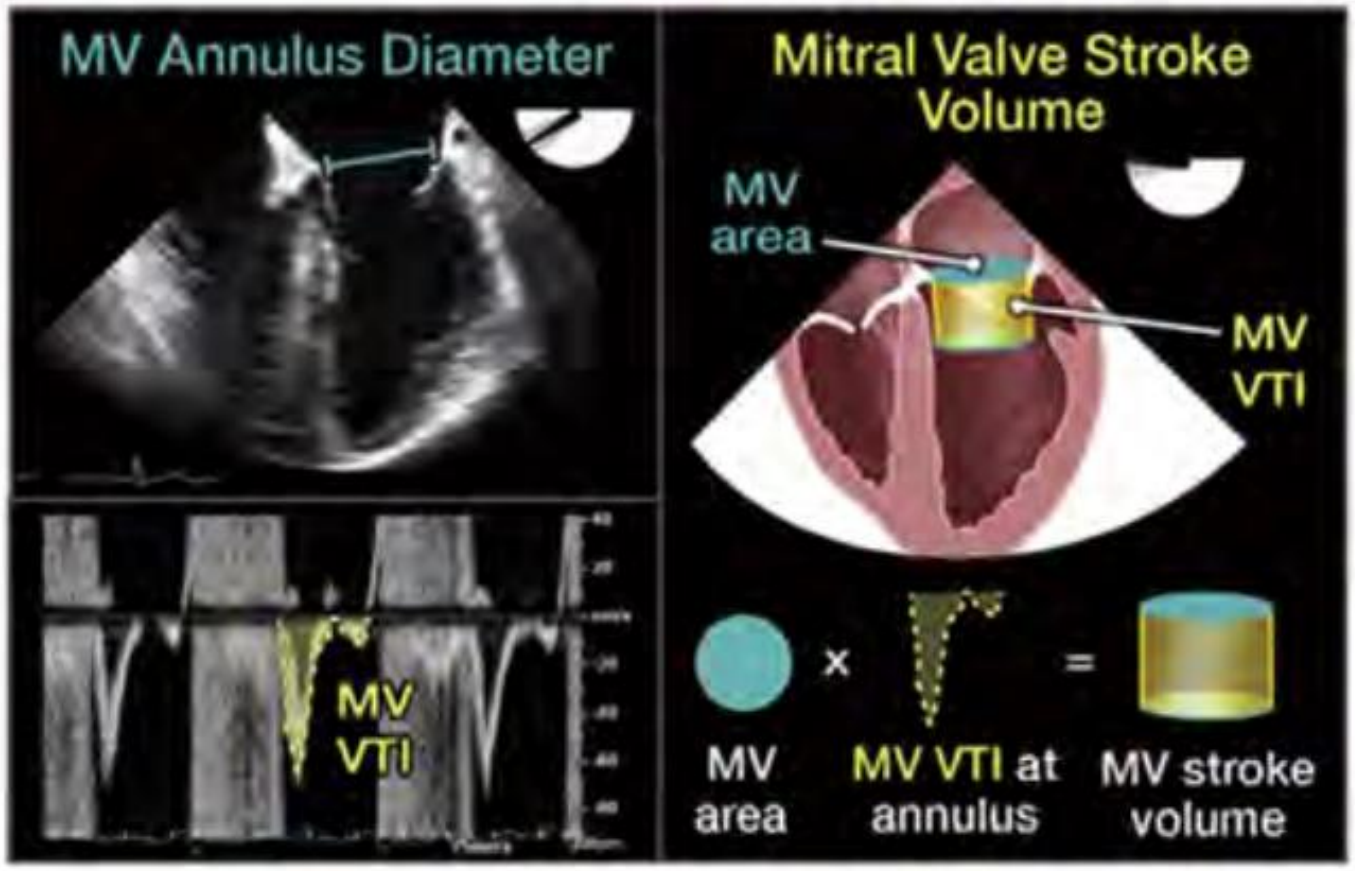
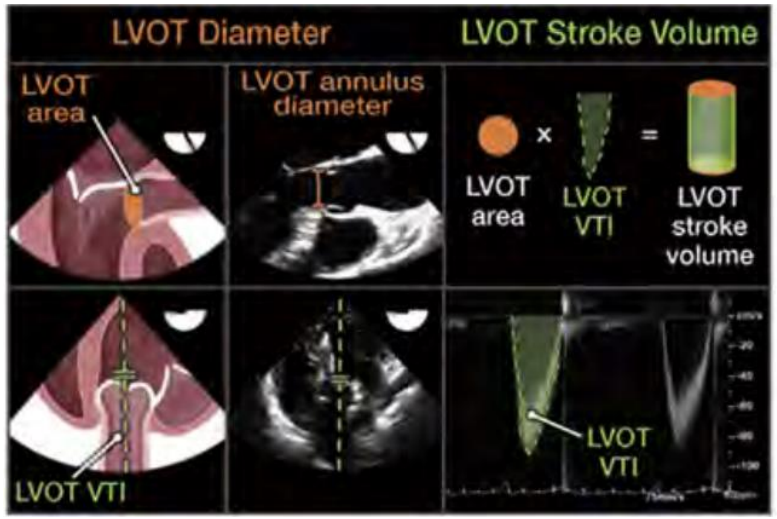
Establishing Severity of MR





$$RVol = \text{Mitral valve SV} - \text{LVOT SV}$$

$$RVol = (\text{MV area} \times \text{MV VTI}) - (\text{LVOT area} \times \text{LVOT VTI})$$

$$RVol = \left\{\pi \times \left(\frac{\text{MV annulus diameter}}{2}\right)^2 \times \text{MV VTI}\right\} - \left\{\pi \times \left(\frac{\text{LVOT diameter}}{2}\right)^2 \times \text{LVOT VTI}\right\}$$

$$\text{EROA (cm}^2\text{)} = \frac{RVol}{\text{MR VTI}} \qquad \text{RF (\%)} = \frac{RVol}{\text{MV SV}}$$

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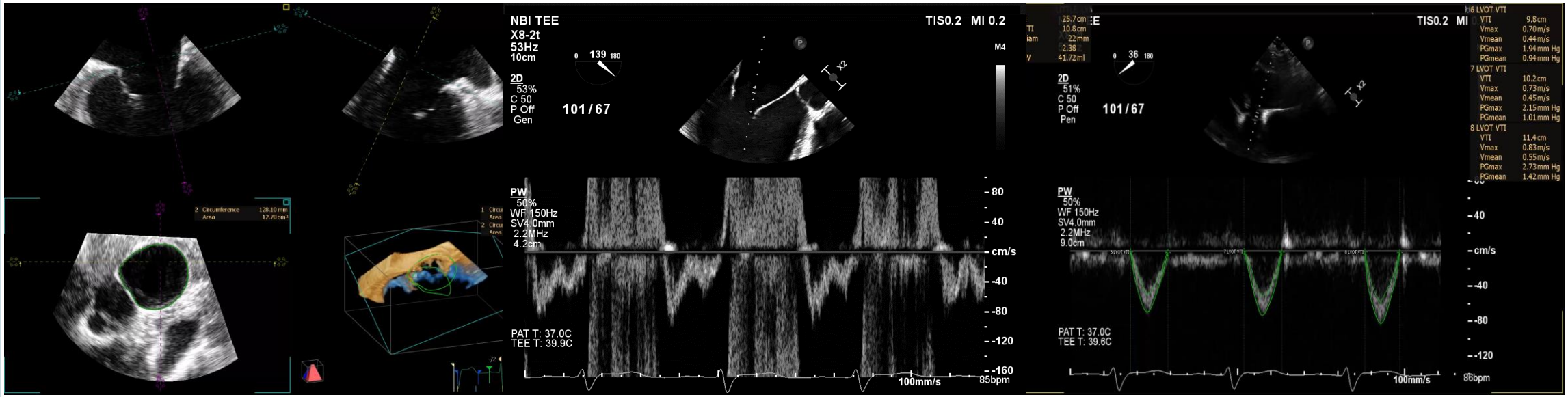
Hahn et al. Recommended Standards for the Performance of TEE for SHI. JASE 2022

Quantitative Evaluation



3D mitral annulus area is 12.7cm and MV annulus VTI is 14cm
LVOT diameter is 2.2cm and LVOT VTI is 11cm
LVOT stroke volume = 42cc. EROA by CE is 0.8cm2 and regurgitant volume is 136cc.

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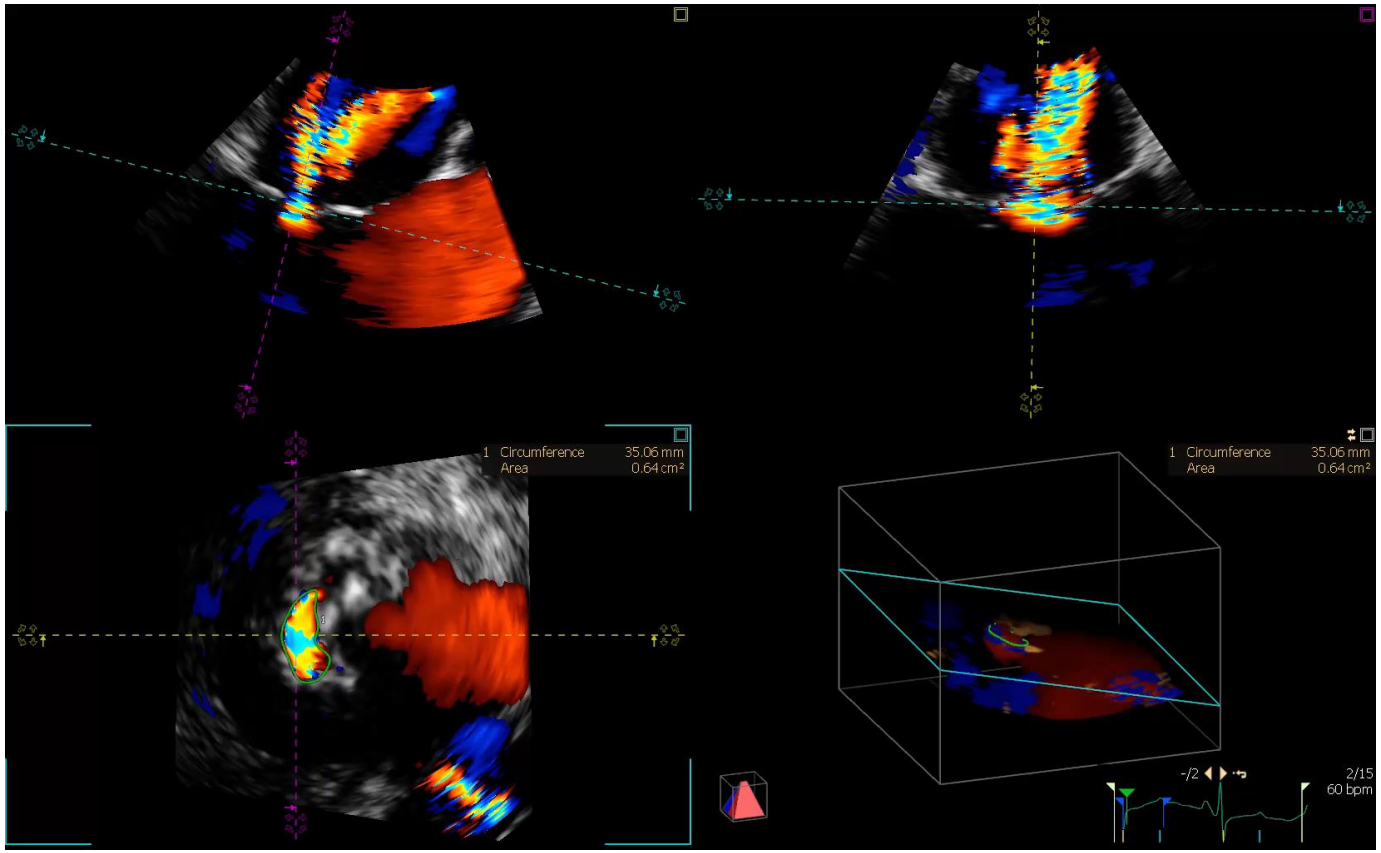
3D Vena Contracta



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Stages of Primary Mitral Regurgitation

Stage A: At risk for MR. Mild mitral valve prolapse with normal coaptation. No MR

Stage B: Progressive MR.

Stage C: Asymptomatic Severe MR

C1: LVEF > 60% and LVESD < 40mm

C2: LVEF <=60% and/or LVESD >=40mm.

Stage D: Symptomatic Severe MR

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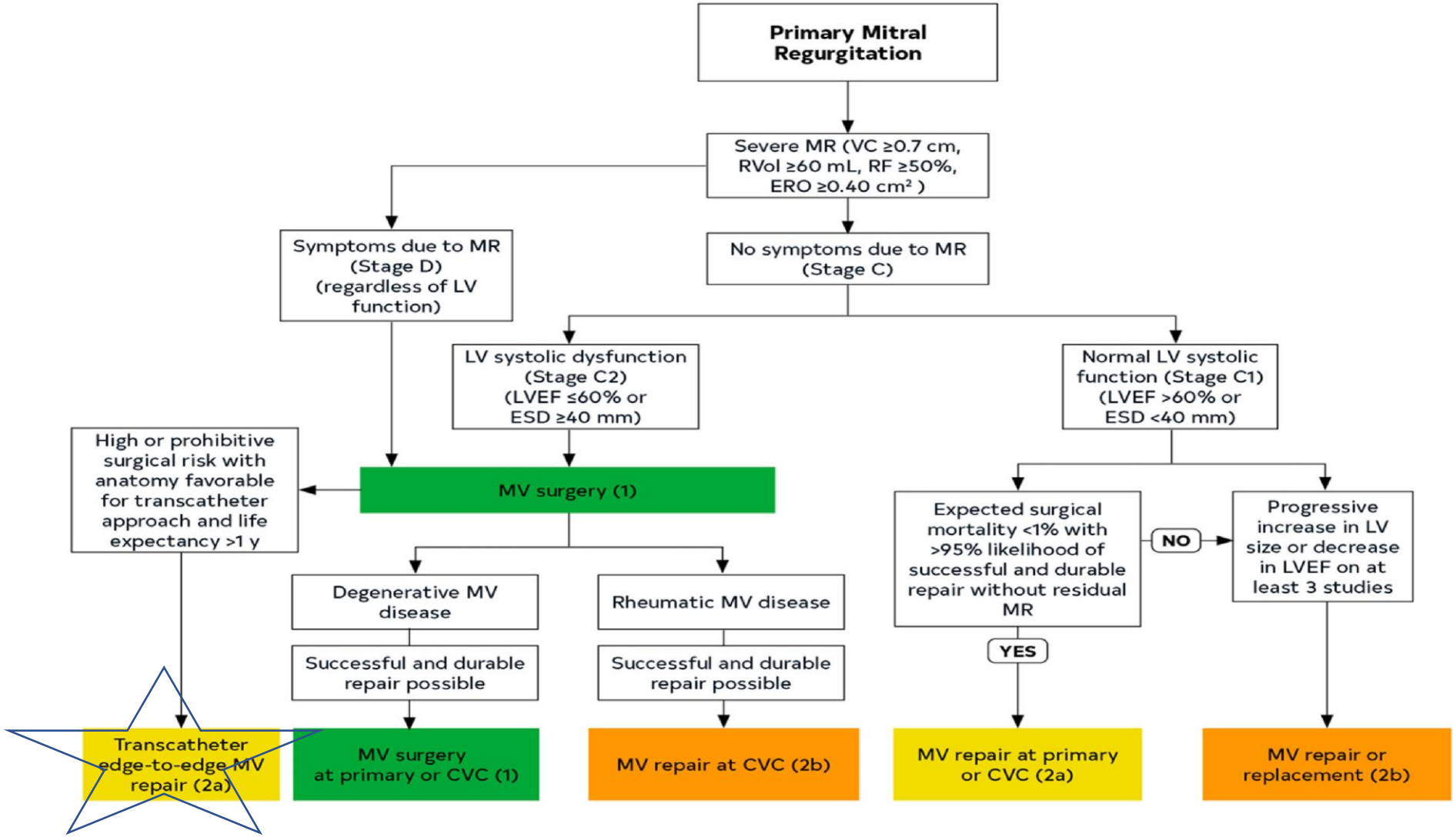

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Otto CM et al. JACC 2021; 77:450-500. 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Stages of Secondary Mitral Regurgitation

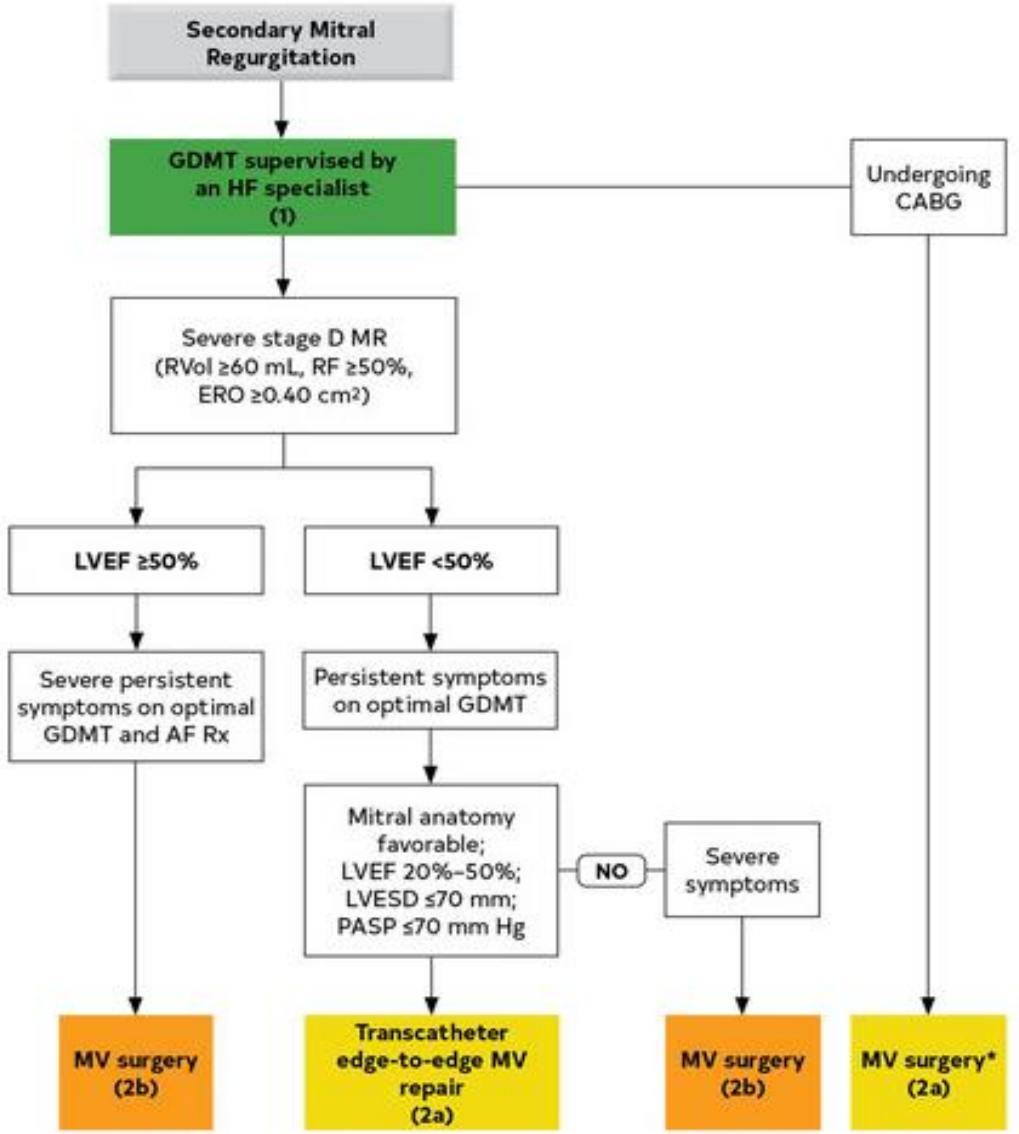
Stage A: At risk for MR. Normal valve leaflets, chords and annulus in patient with CAD or CM

Stage B: Progressive MR. Regional wall motion abnormalities with mild tethering

Stage C: Asymptomatic Severe MR. Regional wall motion abnormalities with severe tethering. Annular dilation and loss of coaptation

Stage D: Symptomatic Severe MR. Regional wall motion abnormalities with severe tethering. Annular dilation and loss of coaptation + HF symptoms, dyspnea and decrease in exercise tolerance

Management of Secondary Mitral regurgitation



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Summary

1. Aortic Stenosis is not only pathology of the valve, but disease of myocardium
2. Classification and grading of aortic stenosis is tricky and requires systematic approach
3. Important to describe mitral valve anatomy and quantify regurgitation severity
4. Team approach to patient care

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