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Mitral Stenosis

June 2020

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No conflict of interests

Agenda

- Etiology/Pathology
- Pathophysiology
- Physical exam
- Diagnosis: Echo, Stress Echo, Invasive
- Management

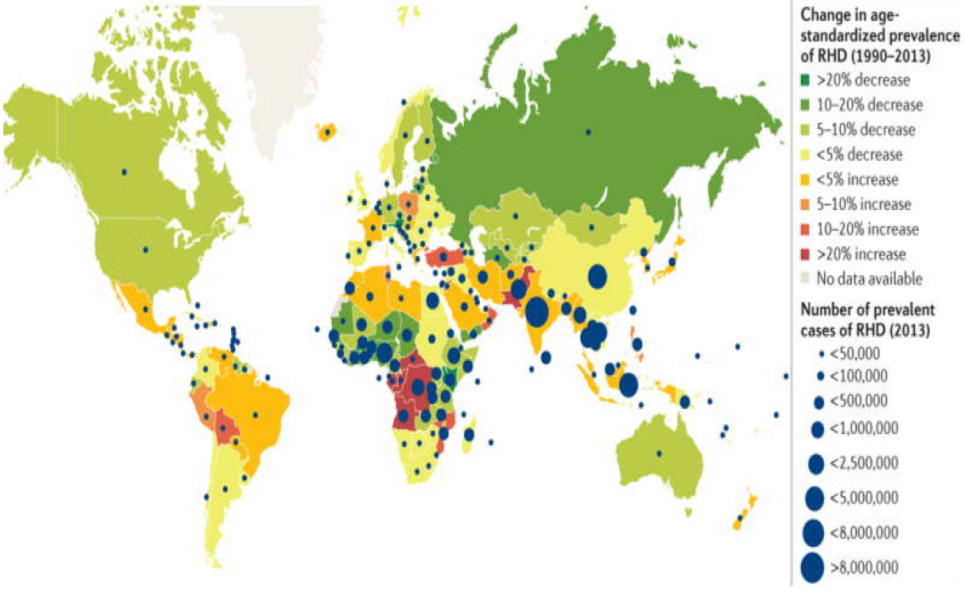
To answer questions:

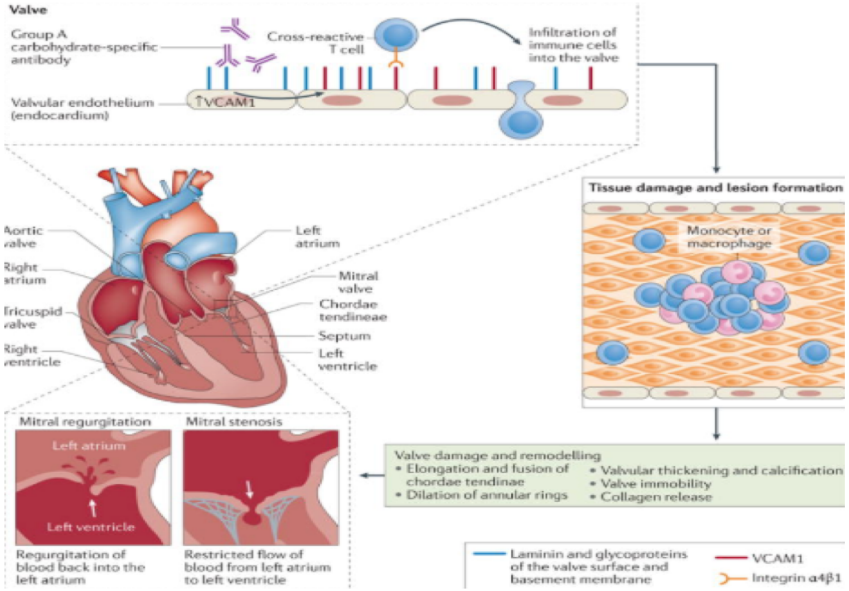
PollEv.com/youssefnasr871

Text: YOUSSEFNASR871 to 22333

Etiology

- Rheumatic heart disease
  - -25% have isolated MS
  - -40% with mixed MS and MR
  - -38% with multi-valve involvement: 35% aortic valve, 6% tricuspid valve (rarely PV)
  - -⅔ patients are women
  - -Only half can recall past hx RF - Time from RF and valve obstruction – few years to > 20y





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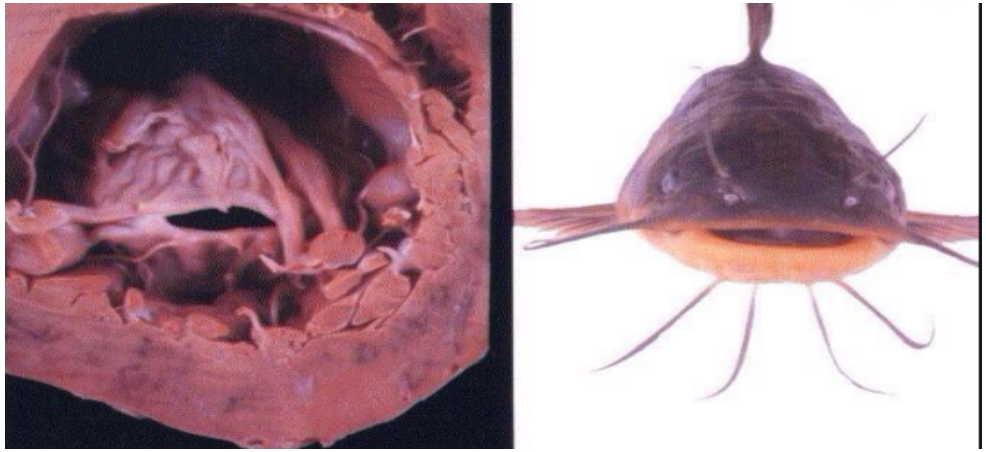
Carapetis et al, Nat Rev Dis Primers 2016 Jan 14;2:15084. doi: 10.1038/nrdp.2015.84

Pathology: Rheumatic Heart disease

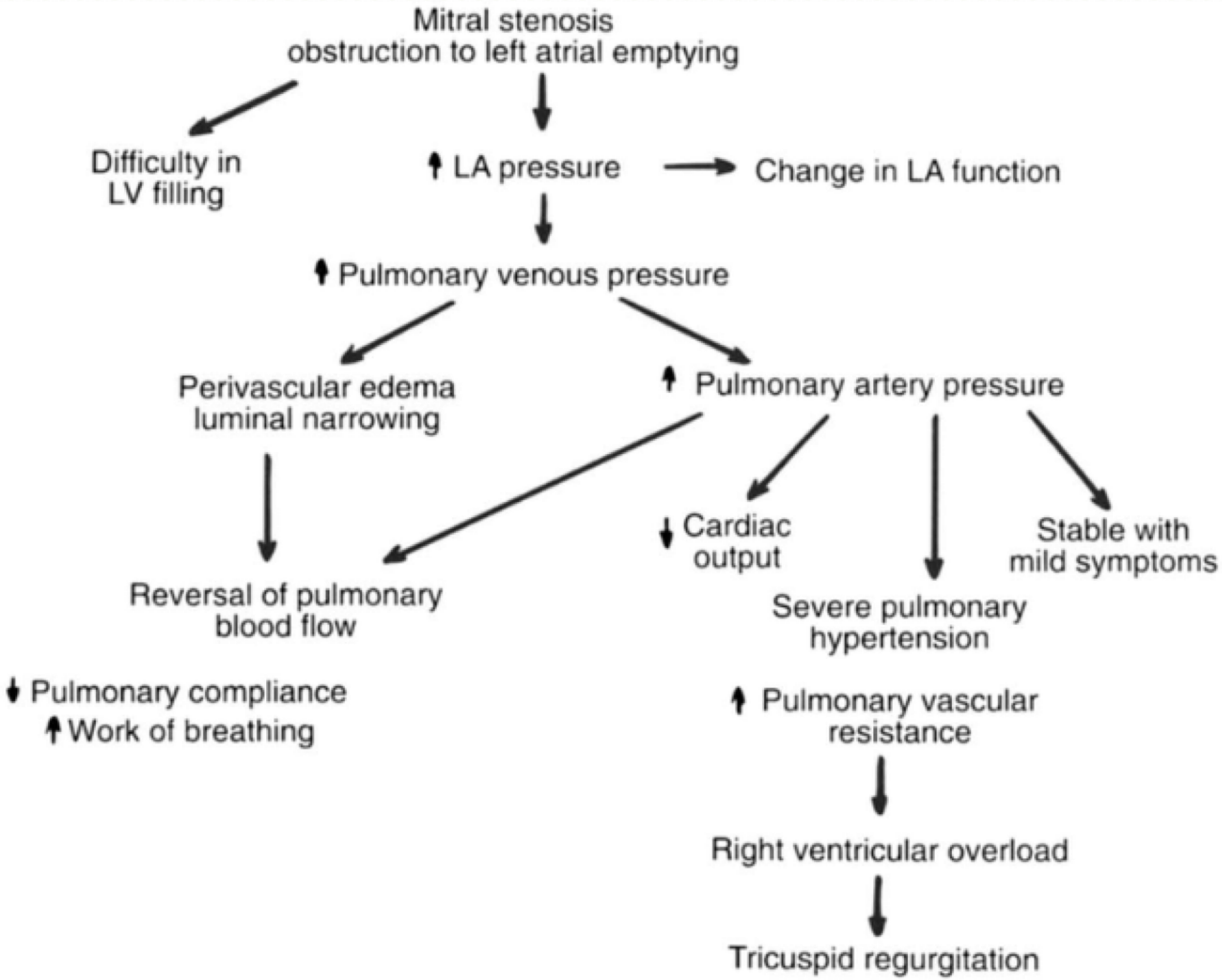
- Fusion of commissures = MS (fish mouth)
  - Restriction of leaflet motion, especially anterior leaflet = diastolic doming
- Thickening of valve leaflets
- Shortening and thickening of chordae
- Funnel shaped valve apparatus; marked obstruction to blood flow from LA to LV



Etiology

- Degenerative Mitral Stenosis; mitral annular calcification (MAC)
- Radiation induced
- Congenital; parachute, double orifice, sub-valvular stenosing ring
- Other acquired: carcinoid, myxoma, thrombus, endocarditis, ergotamine induced…

Pathophysiology



Physical Exam

Question

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Text: YOUSSEFNASR871 to 22333

Which of the following statements regarding mitral stenosis is FALSE?

A. The opening snap (OS) is an early diastolic sound

B. A long A2-OS interval implies severe mitral stenosis

C. In atrial fibrillation, the A2-OS interval varies with cycle length

D. The “snap” is generated by rapid reversal of the position of the anterior mitral leaflet

E. The presence of an opening snap implies a mobile body of the anterior mitral leaflet

Mitral Stenosis: Physical Exam

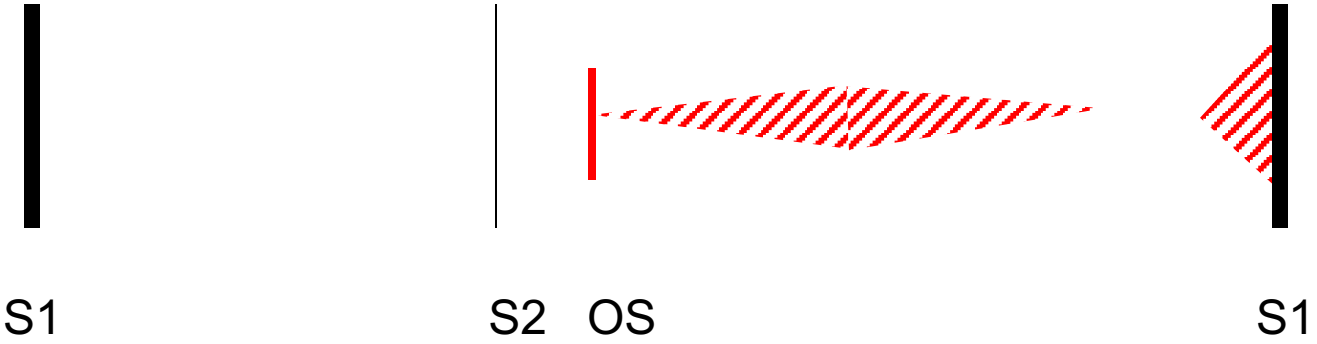
OS

- Diagnostic of MS: Heard when the movement of mitral doming into LV suddenly stops – sudden tensing of valve leaflets after the cups has complete their opening in early diastole
- Med to high frequency
- Intensity doesn't correlate to severity of MS
- Severe MS = narrow A2-OS
- Best heard medial to LV apex, may be better in decubitus

S1

- Loud, snapping S1 is hallmark of MS
- Direct relationship b/w audibility and intensity of S1 and OS
- Loud when MV mobile enough
- When stiff, both quieter
- Loudest over apex and LLSB
- S1 disappears as disease progresses

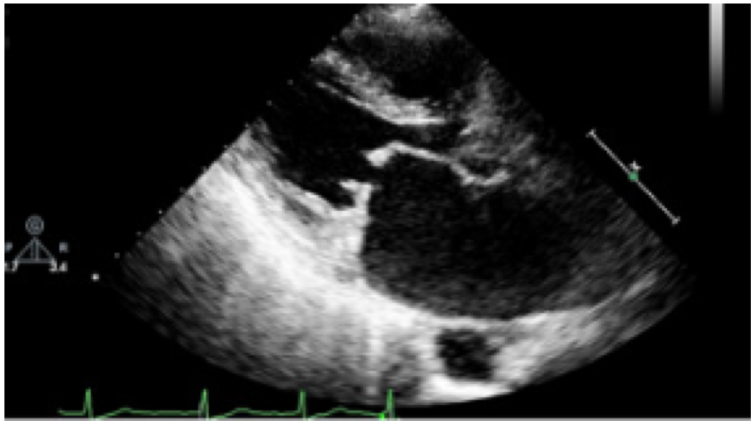
Mitral Stenosis: Physical Exam

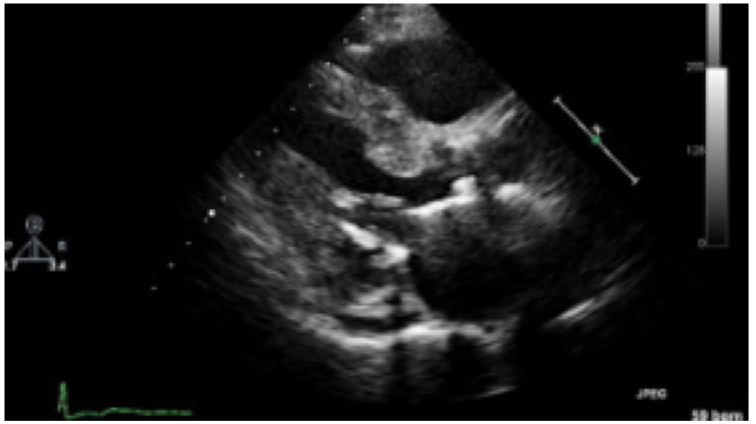


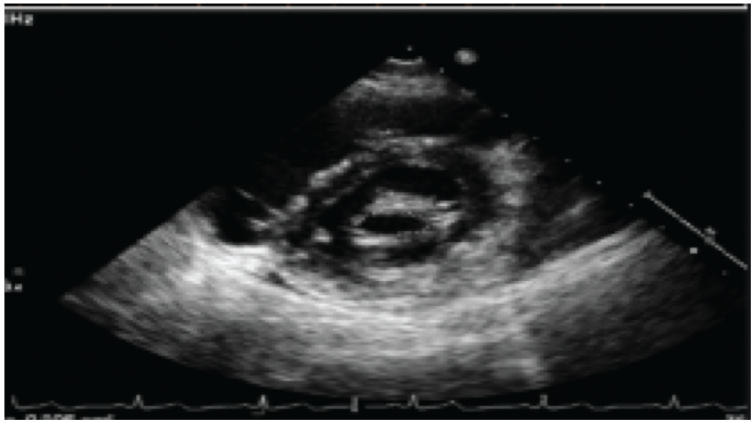
1. First heart sound (S1) is accentuated and snapping
2. Opening snap (OS) after aortic valve closure
3. Low pitch diastolic rumble at the apex
4. Pre-systolic accentuation (esp. if in sinus rhythm)

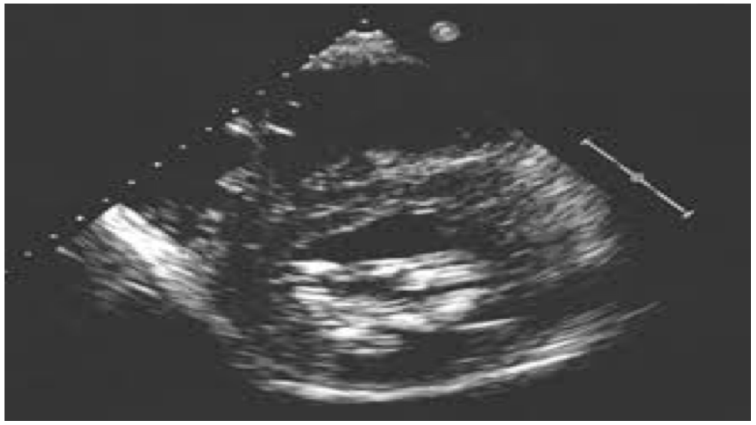
Echocardiography

Parasternal window

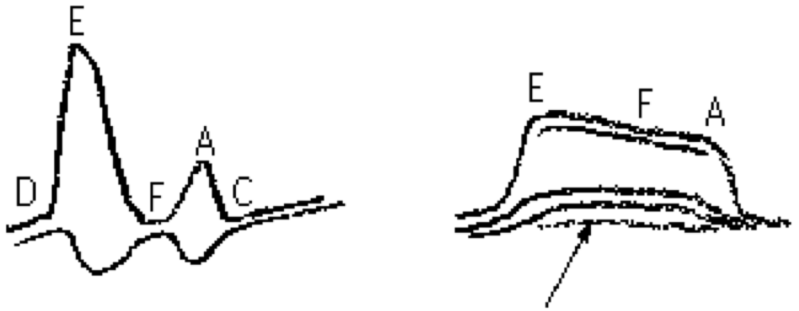




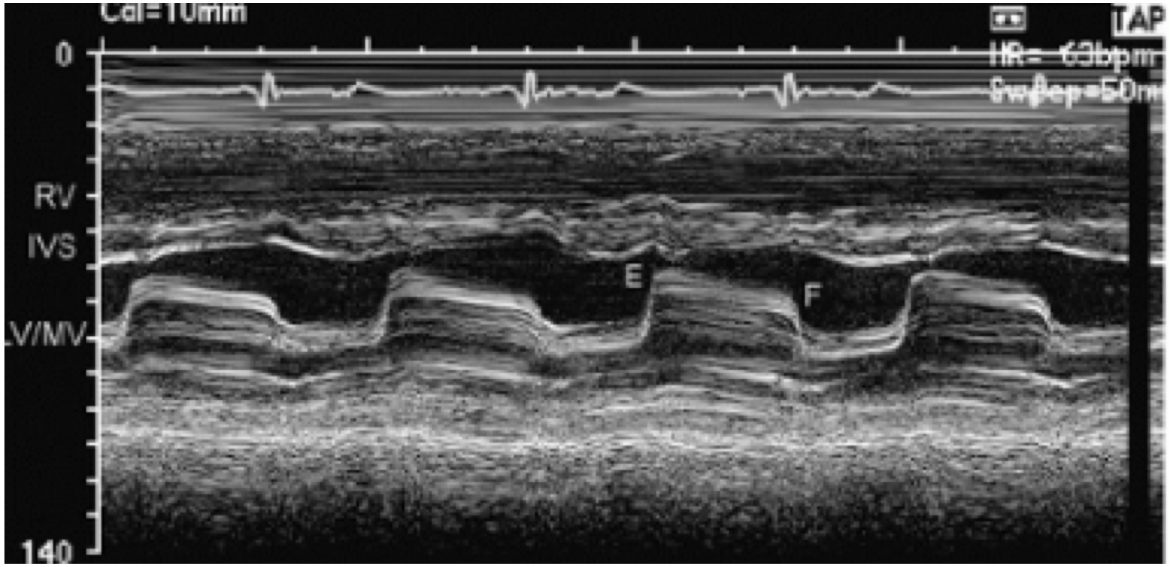




M-Mode



normal thickened immobile leaflets



Wilkins Score
Abascal's Score

Assessment of mitral valve anatomy according to the Wilkins score[5]

Grade	Mobility	Thickening	Calcification	Subvalvular Thickening
1	Highly mobile valve with only leaflet tips restricted	Leaflets near normal in thickness (4-5 mm)	A single area of increased echo brightness	Minimal thickening just below the mitral leaflets
2	Leaflet mid and base portions have normal mobility	Midleaflets normal, considerable thickening of margins (5-8 mm)	Scattered areas of brightness confined to leaflet margins	Thickening of chordal structures extending to one-third of the chordal length
3	Valve continues to move forward in diastole, mainly from the base	Thickening extending through the entire leaflet (5-8mm)	Brightness extending into the mid-portions of the leaflets	Thickening extended to distal third of the chords
4	No or minimal forward movement of the leaflets in diastole	Considerable thickening of all leaflet tissue (>8-10mm)	Extensive brightness throughout much of the leaflet tissue	Extensive thickening and shortening of all chordal structures extending down to the papillary muscles

- The total score is the sum of the four items and ranges between 4 and 16.

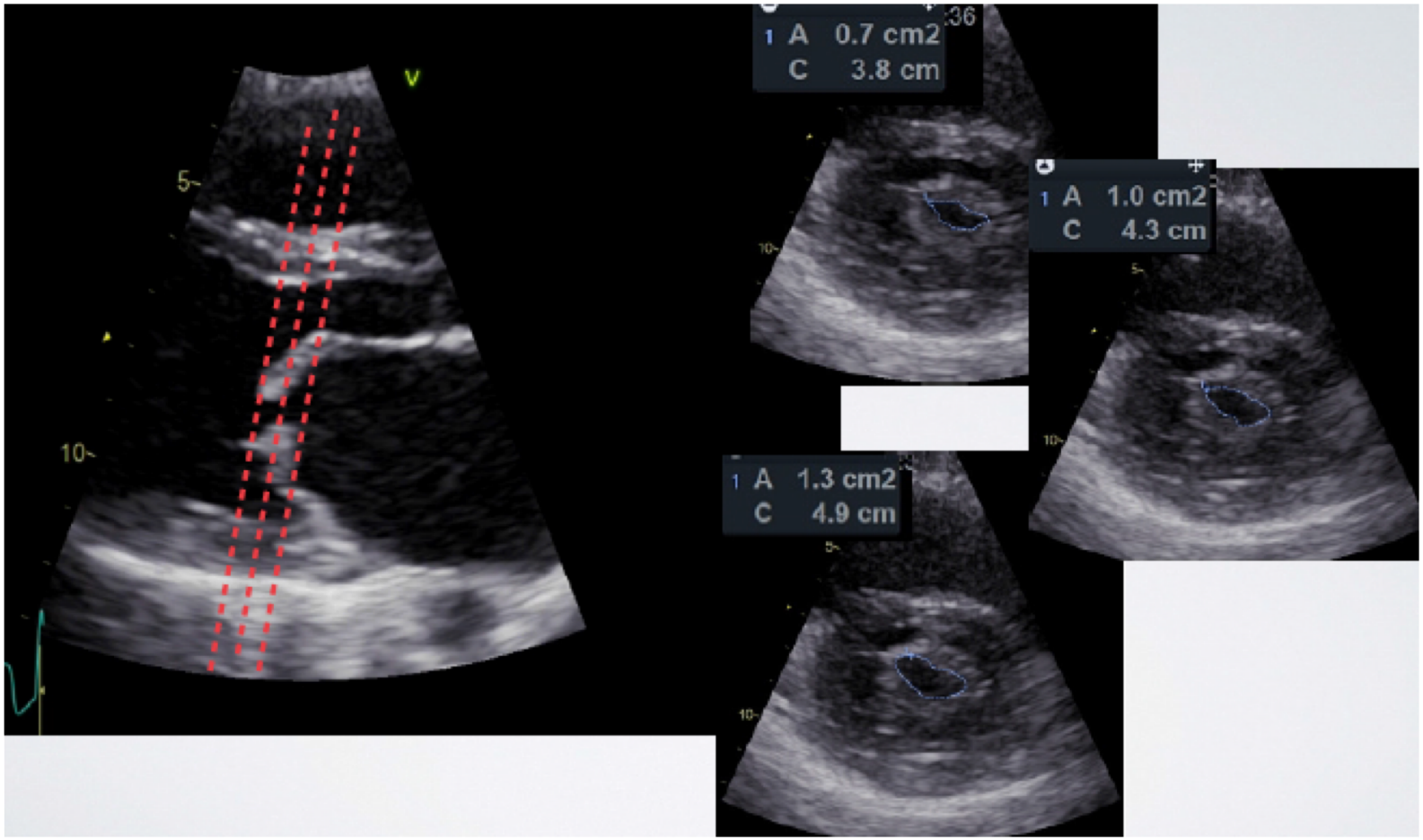
Quantification

- Mitral valve area
  - Planimetry
  - Pressure half time
  - Continuity equation
  - PISA
- Mean diastolic pressure gradient

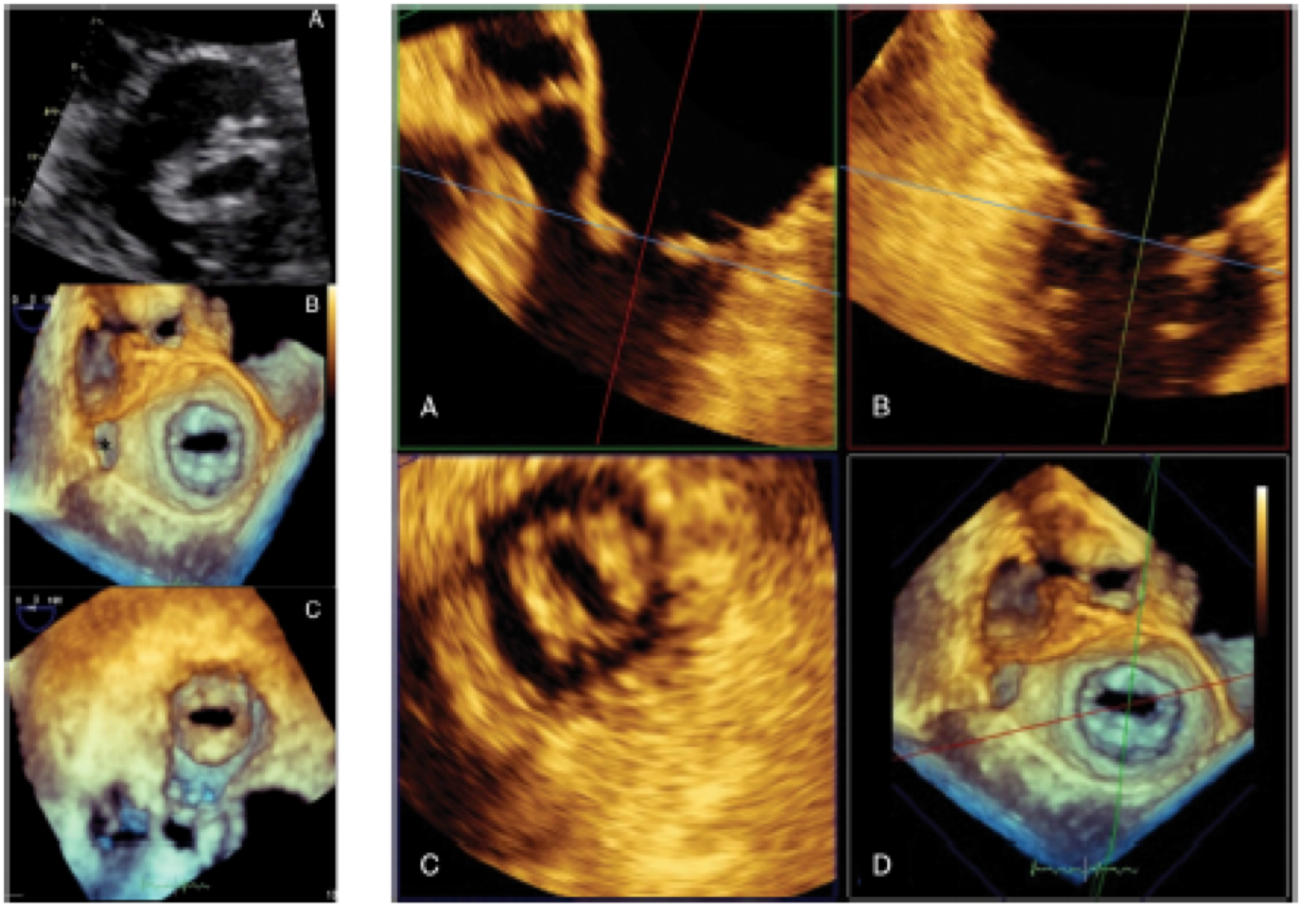
Quantification: Planimetry

- The reference measurement of MVA:
  - It offers the best correlations with anatomic MV Area
  - It is less dependent on flow, heart rate, chamber compliance
- Not influenced by concomitant other valvulopathy (mitral regurgitation, aortic regurgitation, aortic stenosis, tricuspid regurgitation or stenosis)
- The most reliable tool to estimate MVA after PMC

Quantification: Planimetry
2D



Quantification: Planimetry 3D



Julien Dreyfus et al. Eur J Echocardiogr 2011;12:750-755

Question

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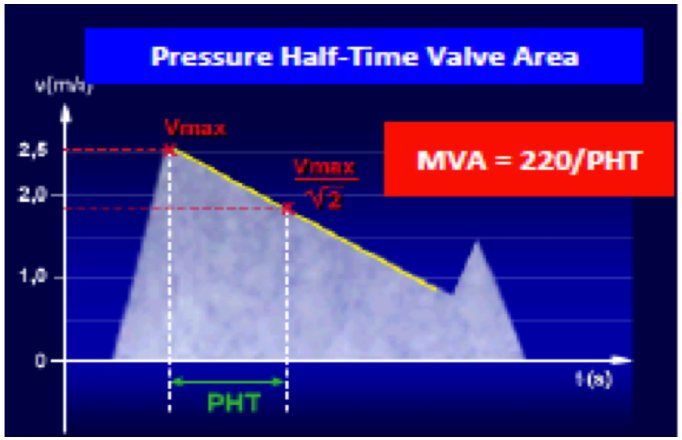
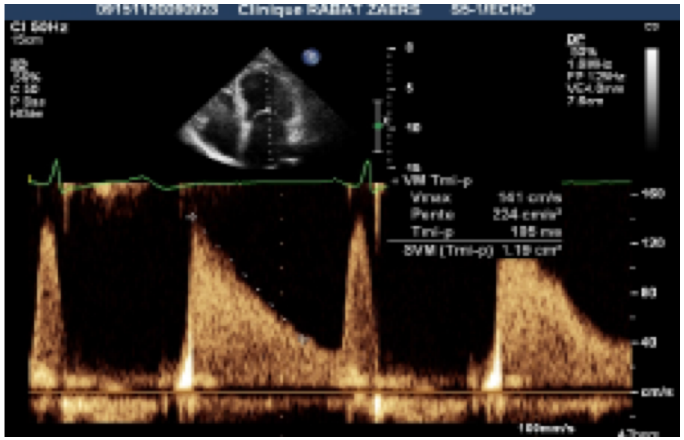
During routine assessment of a patient with known valvular disease, the sonographer measures a mitral inflow deceleration time of 758 ms. Which of the following is a reasonable estimate of the mitral valve area?

A. 1 cm^2.
B. 0.3 cm^2.
C. 3 cm^2.
D. 1.5 cm^2.
E. 2 cm^2.

Quantification: Pressure Half Time (HATLE)

Time interval (ms) between the maximum mitral gradient in early diastole and the time point where the gradient is half the maximum value





PHT=0.29 x DecelerationTime (DT) MVA=750/DT

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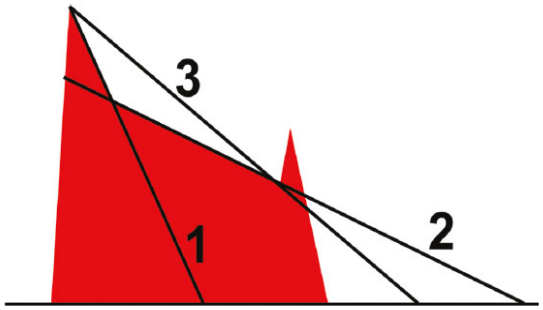
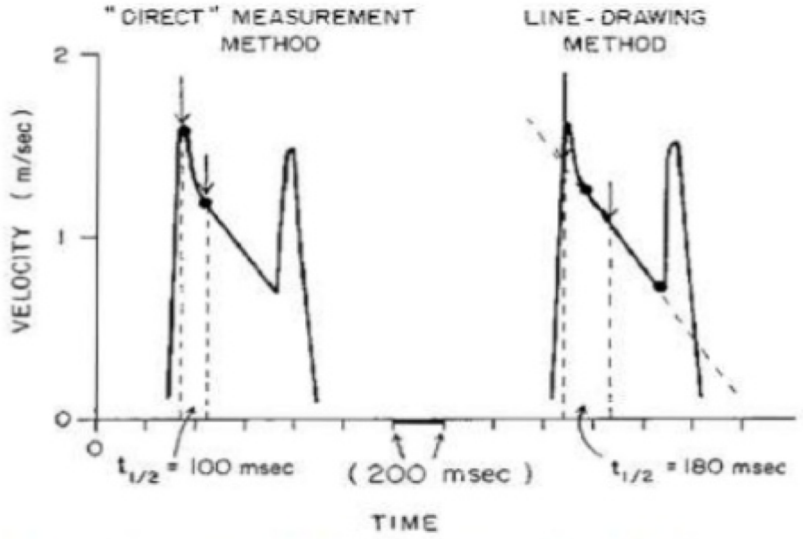
Hatle L. Circulation 1979; 60: 1096-1104

Quantification: Pressure Half Time



Using trace 1 for measuring MVA half-time is a common mistake. The first part of the signal is reflective of both left atrial and ventricular pressure, not only mitral stenosis. Current ASE recommendations suggest the use of trace #2.



Quantification: Pressure Half Time Limitations

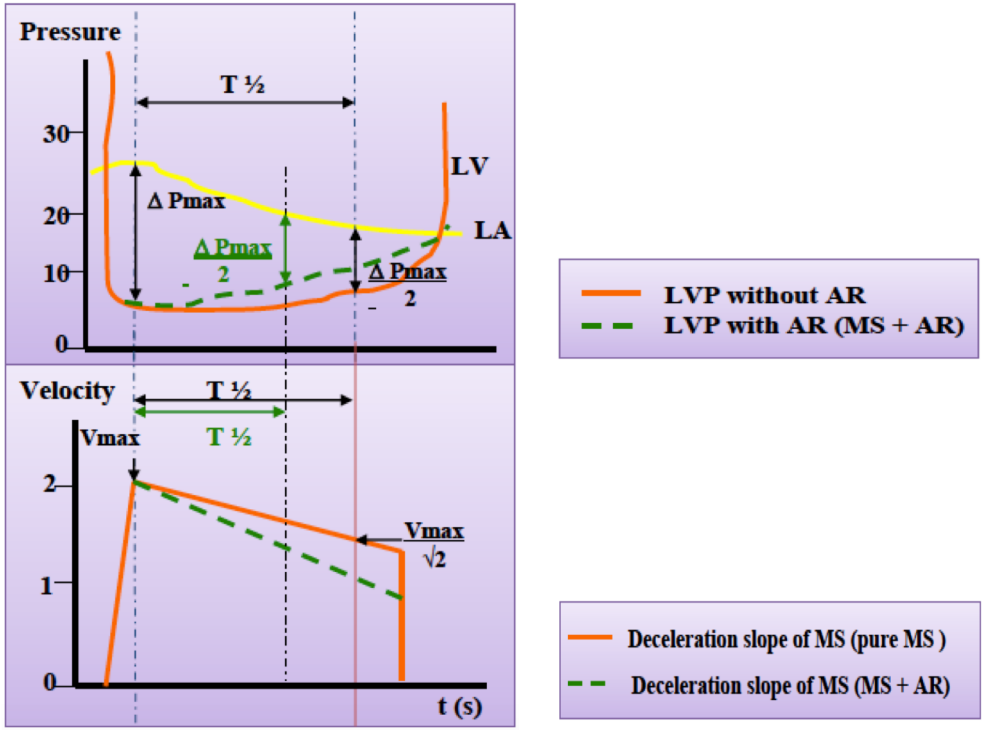
-Atrial fibrillation

-Unreliable Post valvuloplasty

-ASD; MVA is overestimated

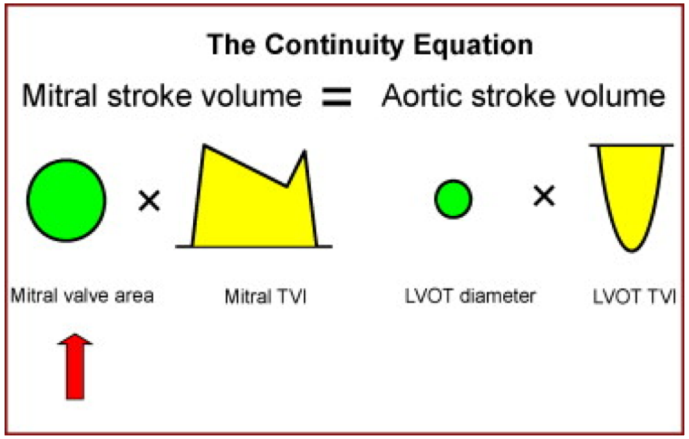
-AI: MVA is overestimated

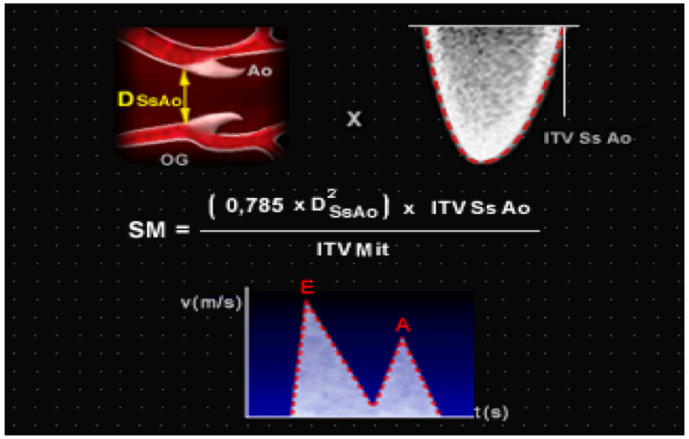
-Increased PHT is not always MS (can be abnormal relaxation; clue E velocity not increased. MG normal)



Mego DM. JASE. 1993; 6:142-8.
Moro E. Eur Heart J. 1988; 9:1010-7

Quantification: Continuity Equation





Limitations:
-Errors in measurements (LVOT diam, LVOT TVI, mitral TVI)
-Afib
-Associated MR or AR
-MS overestimated if severe MR
-MS underestimated if severe AR

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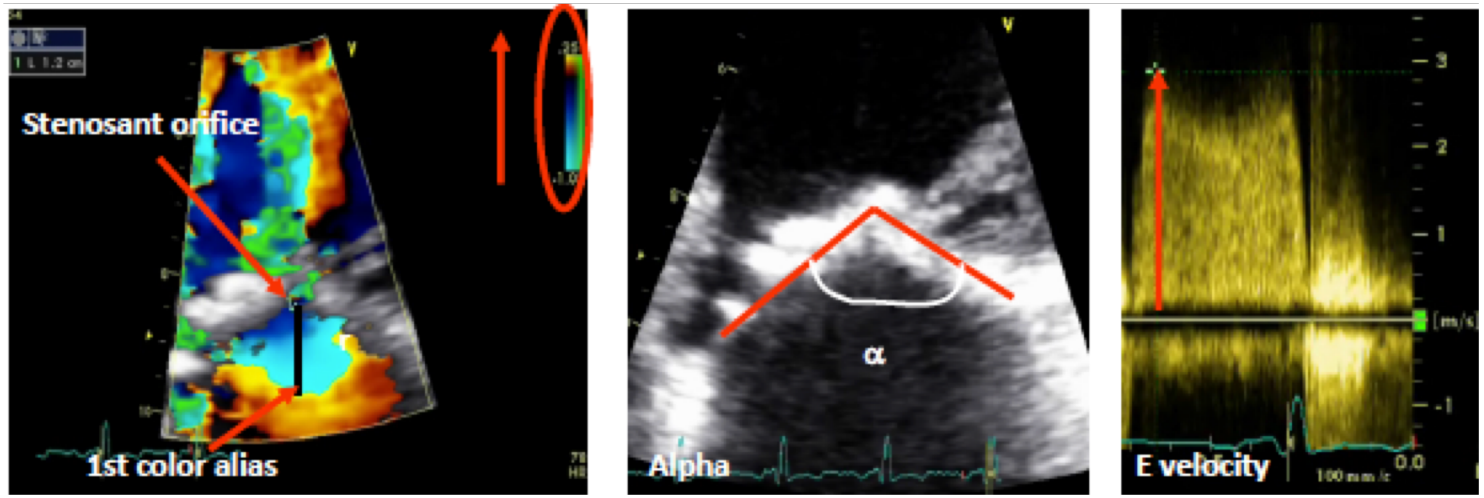
Meissika Zeitoun D. Arch Cardiovascular Dis 2008, 653 – 663
Nakatani S. Circulation 1988; 77: 78-85

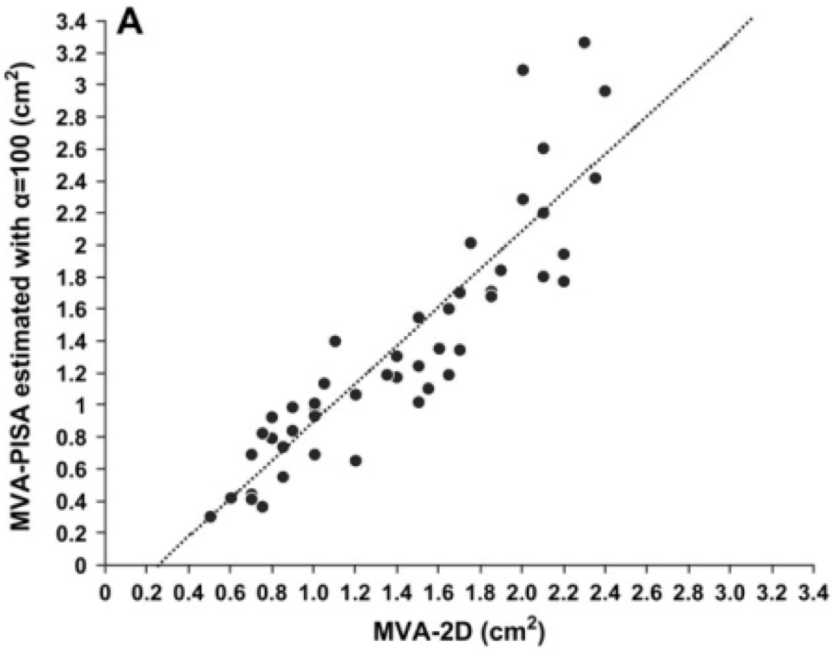
Quantification: Proximal isovelocity surface area (PISA)



MVA= 6.28 x r2 x Vr/Vmax x alpha/180

Quantification: Proximal isovelocity surface area (PISA)

Correlation between MVA assessed by the PISA method (MVA-PISA) using a fixed angle correction of 100° and by planimetry (MVA2D)



SOA = (6.28 r² x Va) x 100 /180 / VE

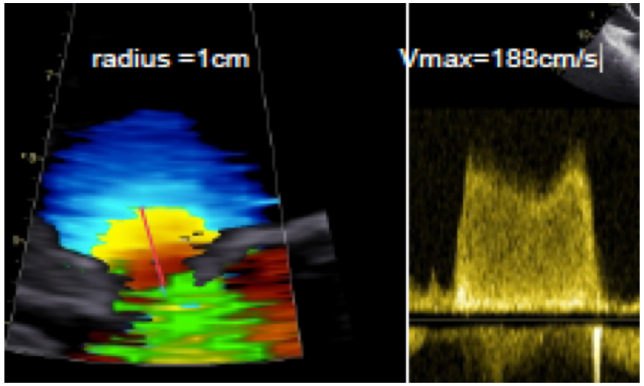
Messika-Zeitoun D. Eur J Echocardiogr 2007 8:116-121

Quantification: Proximal isovelocity surface area (PISA)

Simplifying proximal isovelocity surface area as an assessment method of mitral valve area in patients with rheumatic mitral stenosis by fixing aliasing velocity and mitral valve angle

Alaa Mabrouk Salem Omar [a,*], Mohammed Ahmed Abdel-Rahman [b], Hidekazu Tanaka [c], Osama Rifaie [b]

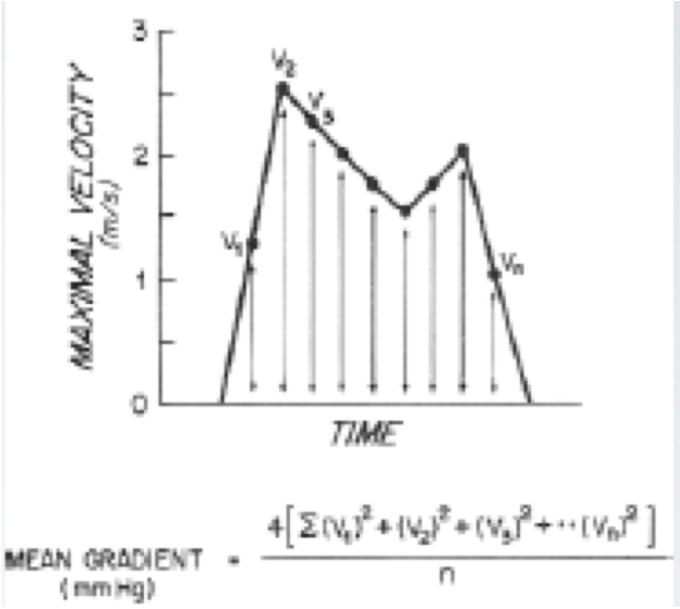
$$\begin{aligned} PISA_{simple} &= 2\pi r^2 \times (Val/Vmax) \times (\alpha/180) \\ &= 2 \times 3.14 \times r^2 \times (33/Vmax) \times (100/180) \\ &= (2 \times 3.14 \times 33 \times 100/180) \times (r^2/Vmax) \\ &= 115 \times r^2/Vmax \end{aligned}$$



MVA= 115 x 1 / 188= 0.61 cm2

Quantification: Mean Pressure Gradient

- The mean pressure gradient is highly dependent on the transvalvular flow and diastolic filling period and will vary greatly with changes in heart rate.
- Report HR in which gradients were obtained and average 5 cardiac cycles in case of Afib



Quantification

Measurement	Units	Formula / Method	Concept	Advantages	Disadvantages
Valve area					
- planimetry by 2D echo	cm^2	tracing mitral orifice using 2D echo	direct measurement of anatomic MVA	- accuracy - independence from other factors	- experience required - not always feasible (poor acoustic window, severe valve calcification)
- pressure half-time	cm^2	$220 / T_{1/2}$	rate of decrease of transmitral flow is inversely proportional to MVA	easy to obtain	dependence on other factors (AR, LA compliance, LV diastolic function…)
- continuity equation	cm^2	$MVA = (CSA_{LVOT})(VTI_{Aortic}) / VTI_{Mitral}$	volume flows through mitral and aortic orifices are equal	independence from flow conditions	- multiple measurements (sources of errors) - not valid if significant AR or MR
- PISA	cm^2	$MVA = \pi(r^2)(V_{aliasing}) / peak\ V_{Mitral} \cdot \alpha/180°$	MVA assessed by dividing mitral volume flow by the maximum velocity of diastolic mitral flow	independence from flow conditions	technically difficult
Mean gradient	mm Hg	$\Delta P = \Sigma 4v^2 / N$	pressure gradient calculated from velocity using the Bernoulli equation	easy to obtain	dependent on heart rate and flow conditions
Systolic pulmonary artery pressure	mm Hg	$sPAP = 4v^2_{Tricuspid}$ + RA pressure	addition of RA pressure and maximum gradient between RV and RA	obtained in most patients with MS	- arbitrary estimation of RA pressure - no estimation of pulmonary vascular resistance
Mean gradient and systolic pulmonary artery pressure at exercise	mm Hg	$\Delta P = \Sigma 4v^2 / N$ $sPAP = 4v^2_{Tricuspid}$ + RA pressure	assessment of gradient and sPAP for increasing workload	incremental value in assessment of tolerance	- experience required - lack of validation for decision-making
Valve resistance	$dyne.sec^{-1}.cm^{-5}$	$Mvres = P_{Mitral} / (CSA_{LVOT})(VTI_{Aortic}) / DFT)$	resistance to flow caused by MS	initially suggested to be less flow-dependent, but not confirmed	no prognostic value no clear threshold for severity no additional value vs. valve area

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Baumgartner D. JASE 2009; 22: 1-23

2014 AHA/ACC Guidelines

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
A	At risk of MS	• Mild valve doming during diastole	• Normal transmitral flow velocity	• None	• None
B	Progressive MS	• Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets • Planimetered MVA >1.5 cm^2	• Increased transmitral flow velocities • MVA >1.5 cm^2 • Diastolic pressure half-time <150 ms	• Mild-to-moderate LA enlargement • Normal pulmonary pressure at rest	• None
C	Asymptomatic severe MS	• Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets • Planimetered MVA ≤1.5 cm^2 • (MVA ≤1.0 cm^2 with very severe MS)	• MVA ≤1.5 cm^2 • (MVA ≤1.0 cm^2 with very severe MS) • Diastolic pressure half-time ≥150 ms • (Diastolic pressure half-time ≥220 ms with very severe MS)	• Severe LA enlargement • Elevated PASP >30 mm Hg	• None
D	Symptomatic severe MS	• Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets • Planimetered MVA ≤1.5 cm^2	• MVA ≤1.5 cm^2 • (MVA ≤1.0 cm^2 with very severe MS) • Diastolic pressure half-time ≥150 ms • (Diastolic pressure half-time ≥220 ms with very severe MS)	• Severe LA enlargement • Elevated PASP >30 mm Hg	• Decreased exercise tolerance • Exertional dyspnea

Stress Echo

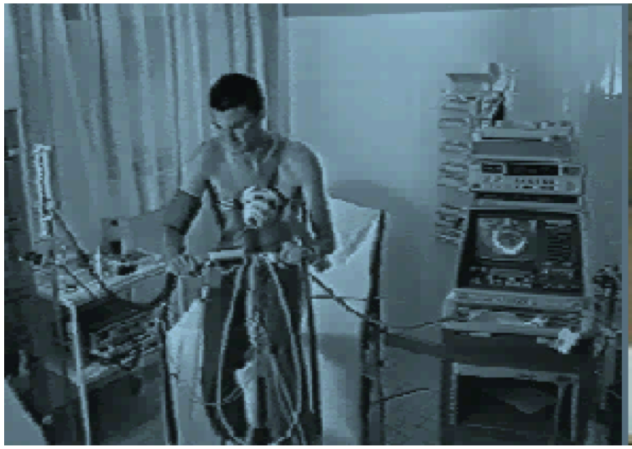
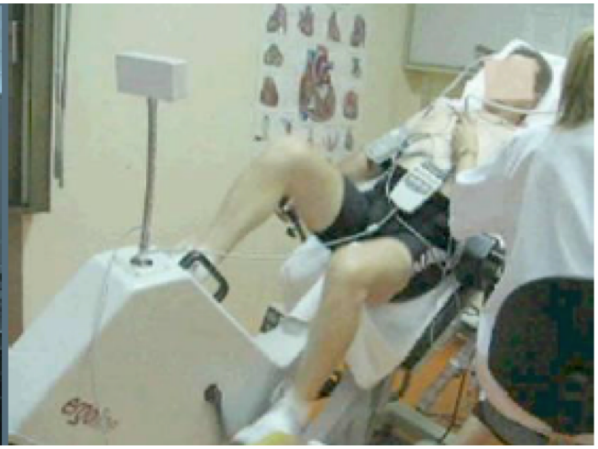
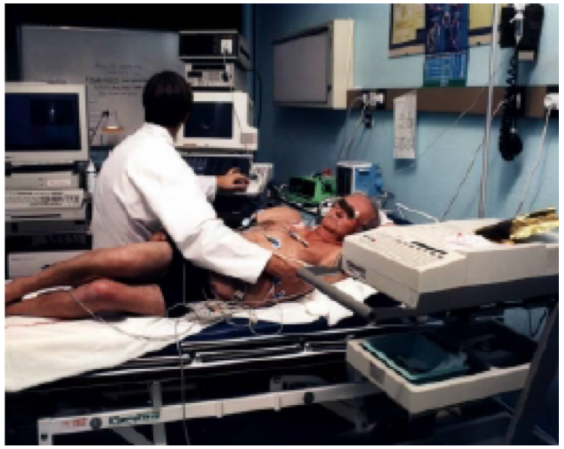
AHA/ACC guideline for the management of patients with valvular heart disease. Circulation 2014

Exercise testing with Doppler or invasive hemodynamic assessment is recommended to evaluate the response of the mean mitral gradient and pulmonary artery pressure in patients with MS when there is a discrepancy between resting Doppler echocardiographic findings and clinical symptoms or signs. (Class I, Level of Evidence: C)

ESC guidelines. European Heart Journal (2012) 33, 2451–2496

Stress testing is indicated in patients with no symptoms or symptoms equivocal or discordant with the severity of MS. Dobutamine or, preferably, exercise echocardiography may provide additional information by assessing changes in mitral gradient and pulmonary pressures.

Stress Echo

-Semi-supine echocardiography exercise is now preferred to post exercise echo
-Allows monitoring gradient and PA pressure in each step of increasing workload

Stress Echo

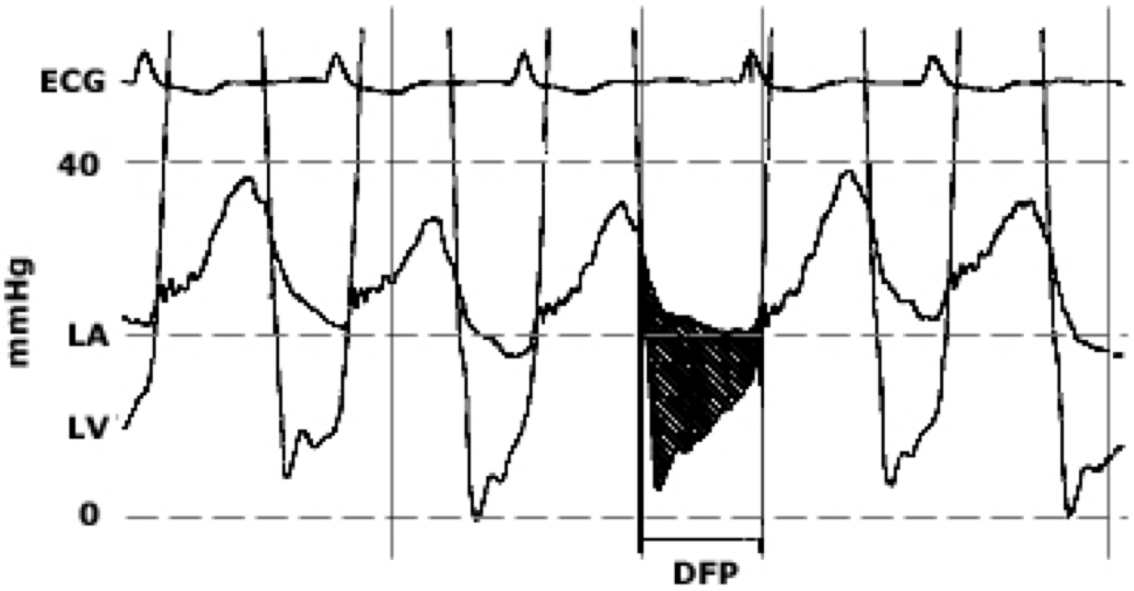
Interpretation :

- Exercise capacity- symptoms?
- Mean trans-mitral gradient > 15 mmHg (or 18 mmHg dobutamine)
- Progression of SPAP (>60 mmHg)

Need of multicentric studies with long follow up:

prognostic value / strongest position in the guidelines

Invasive testing



MVA= cardiac output ÷ [37.7 x DFP x heart rate x sq rt mean gradient]

Redrawn from Kern MJ (Ed). Cardiac Catheterization Handbook, 2nd ed. Mosby-Year Book, St. Louis, 1995.

Question

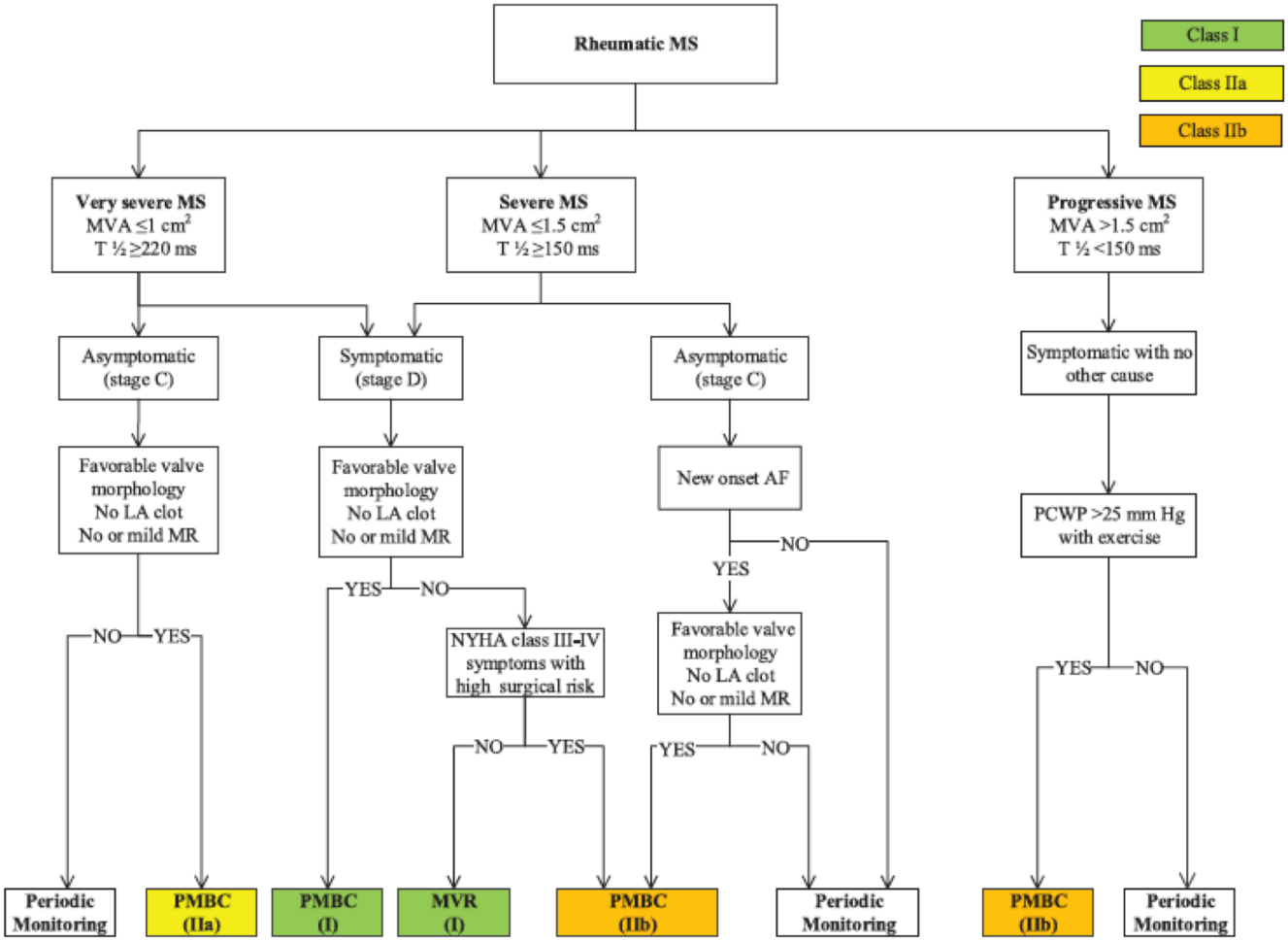
PollEv.com/youssefnasr871
Text: YOUSSEFNASR871 to 22333

A 78-year-old woman has been complaining of worsening dyspnea on exertion for the past 6 months. She has a hypertension that is poorly controlled despite treatment with a diuretic, ACEI and CCB. Her PCP noted a murmur and requested an echocardiogram. This shows presence of a mildly enlarged left ventricle, with calculated ejection fraction of 65%. The aortic valve is sclerotic, with a MG of 10 mm Hg and moderate regurgitation. The mitral annulus and base of mitral valve leaflets are densely calcified, with a mean diastolic gradient of 9 mm Hg at a heart rate of 82 beats/min. The E velocity is 2.1 m/s, with a pressure half-time of 110 ms. The mitral valve area by planimetry in short-axis parasternal view is 1.3 cm^2. Which of the following statements is correct.

A. The mitral valve area is best estimated in this patient by the pressure half-time method.
B. Mitral balloon valvuloplasty is indicated in this symptomatic patient.
C. Mitral valve replacement is indicated in this symptomatic patient.
D. Mitral stenosis severity should be reassessed after blood pressure and heart rate are better controlled.

Management

2014 AHA/ACC Guidelines



2014 AHA/ACC Guidelines

Table 12. Summary of Recommendations for MS Intervention

Recommendations	COR	LOE
PMBC is recommended for symptomatic patients with severe MS (MVA ≤1.5 cm², stage D) and favorable valve morphology in the absence of contraindications	I	A
Mitral valve surgery is indicated in severely symptomatic patients (NYHA class III/IV) with severe MS (MVA ≤1.5 cm², stage D) who are not high risk for surgery and who are not candidates for or failed previous PMBC	I	B
Concomitant mitral valve surgery is indicated for patients with severe MS (MVA ≤1.5 cm², stage C or D) undergoing other cardiac surgery	I	C
PMBC is reasonable for asymptomatic patients with very severe MS (MVA ≤1.0 cm², stage C) and favorable valve morphology in the absence of contraindications	IIa	C
Mitral valve surgery is reasonable for severely symptomatic patients (NYHA class III/IV) with severe MS (MVA ≤1.5 cm², stage D), provided there are other operative indications	IIa	C
PMBC may be considered for asymptomatic patients with severe MS (MVA ≤1.5 cm², stage C) and favorable valve morphology who have new onset of AF in the absence of contraindications	IIb	C
PMBC may be considered for symptomatic patients with MVA >1.5 cm² if there is evidence of hemodynamically significant MS during exercise	IIb	C
PMBC may be considered for severely symptomatic patients (NYHA class III/IV) with severe MS (MVA ≤1.5 cm², stage D) who have suboptimal valve anatomy and are not candidates for surgery or at high risk for surgery	IIb	C
Concomitant mitral valve surgery may be considered for patients with moderate MS (MVA.16–2.0 cm²) undergoing other cardiac surgery	IIb	C
Mitral valve surgery and excision of the left atrial appendage may be considered for patients with severe MS (MVA ≤1.5 cm², stages C and D) who have had recurrent embolic events while receiving adequate anticoagulation	IIb	C

Contraindications to percutaneous mitral commissurotomy

• Mitral valve area >1.5 cm^2
• Left atrial thrombus
• More than mild mitral regurgitation
• Severe or bicommissural calcification
• Absence of commissural fusion
• Severe concomitant aortic valve disease, or severe combined tricuspid stenosis and regurgitation
• Concomitant coronary artery disease requiring bypass surgery

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Thank you

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