Rheumatic and Degenerative/Calcific MS

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Disclosures

- Speaker's bureau, Edwards lifesciences

Rheumatic MS

- Most common cause of MS worldwide
- Immune response 2/2 bacterial infection
- Valve inflammation due to cross-reactivity between leaflet tissue and streptococcal antigen
- Begins with formation of tiny nodules along the leaflet coaptation points, then fibrin deposition on leaflets
- Over years to decades: fusion of commissures; thickening, fibrosis and calcification of leaflet cusps; thickening, fusion and shortening of chordae → domed appearance
- Regurgitant process early on, then progresses to stenosis
- Up to 75% of patients with documented recurrences of rheumatic fever have valvular disease at 45 y f/u

Table 8 Approaches to evaluation of mitral stenosis

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}	$Mvres = \frac{P_{Mitral}}{(CSA_{LVOT})(VTI_{Aortic})}$ / 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

2009 ASE/EAE guidelines

Rheumatic MS Evaluation by echo

- MVA planimetry (2D/3D) at leaflet tips
- Pressure ½ time (220/PHT): affected by
- Continuity equation (LV or RV SV/CW MV VTI)
- Mean gradients: affected by HR

Table 13. Stages of MS

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

The transmitral mean pressure gradient should be obtained to further determine the hemodynamic effect of the MS and is usually >5 mm Hg to 10 mm Hg in severe MS; however, due to the variability of the mean pressure gradient with heart rate and forward flow, it has not been included in the criteria for severity.

LA indicates left atrial; LV, left ventricular; MS, mitral stenosis; MVA, mitral valve area; and PASP, pulmonary artery systolic pressure.

2014 ACC/AHA guidelines

Wilkins Score

- The degree of leaflet rigidity (0-4)
- The severity of leaflet thickening (0-4)
- The amount of leaflet calcification (0-4)
- The extent of subvalvular thickening (0-4)
- Better outcomes with PBMV with score <= 8 (no severe MR)

(Circulation. 2002;105(12):1465).

Score >= 10 independently predicts severe MR after PBMV

Table 1. Echocardiographic Score for Severe Mitral Regurgitation After Percutaneous Mitral Valvulotomy

I–II.	Valvular thickening (score each leaflet separately)
1.	Leaflet near normal (4–5 mm) or with only a thick segment
2.	Leaflet fibrotic and/or calcified evenly; no thin areas
3.	Leaflet fibrotic and/or calcified with uneven distribution; thinner segments are mildly thickened (5–8 mm)
4.	Leaflet fibrotic and/or calcified with uneven distribution; thinner segments are near normal (4–5 mm)
III.	Commissural calcification
1.	Fibrosis and/or calcium in only one commissure
2.	Both commissures mildly affected
3.	Calcium in both commissures, one markedly affected
4.	Calcium in both commissures, both markedly affected
IV.	Subvalvular disease
1.	Minimal thickening of chordal structures just below the valve
2.	Thickening of chordae extending up to one-third of chordal length
3.	Thickening to the distal third of the chordae
4.	Extensive thickening and shortening of all chordae extending down to the papillary muscle

The total score is the sum of these echocardiographic features (maximum 16).

Padial et al.
JACC Vol. 27, No. 5 1225
April 1996:1225-31

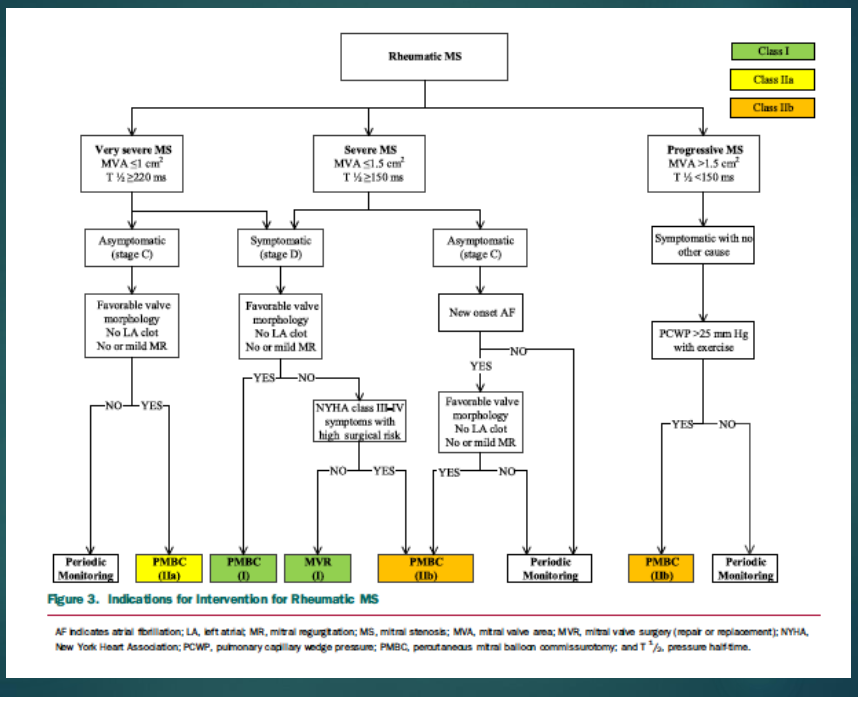


Figure 3. Indications for Intervention for Rheumatic MS

AF indicates atrial fibrillation; LA, left atrial; MR, mitral regurgitation; MS, mitral stenosis; MVA, mitral valve area; MVR, mitral valve surgery (repair or replacement); NYHA, New York Heart Association; PCWP, pulmonary capillary wedge pressure; PMBC, percutaneous mitral balloon commissurotomy; and $T^{1}/_{2}$, pressure half-time.

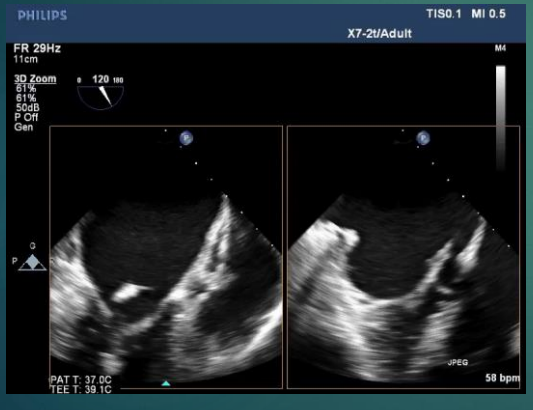
ACC/AHA Class I recs

- 1. Percutaneous mitral balloon commissurotomy is recommendedfor symptomatic patients with severe MS (mitral valve area <=1.5 cm2, stage D) and favorable valve morphology in theabsence of left atrial thrombus or moderate-to-severe MR(280–284,286,328). (Level of Evidence: A)
- Mitral valve surgery (repair, commissurotomy, or valvereplacement) is indicated in severely symptomatic patients(NYHA class III to IV) with severe MS (mitral valve area <=1.5cm2, stage D) who are not high risk for surgery and who are notcandidates for or who have failed previous percutaneous mitralballoon commissurotomy (319–324). (Level of Evidence: B)
- Concomitant mitral valve surgery is indicated for patients withsevereMS (mitral valve area ,=1.5 cm2, stage C or D) undergoingcardiac surgery for other indications. (Level of Evidence: C)

Clinical history

- 48 f
- USOH until she had a stroke at age 37, found to have AF
- Eventually discovered to have rheumatic MS
- Now with progressive symptoms

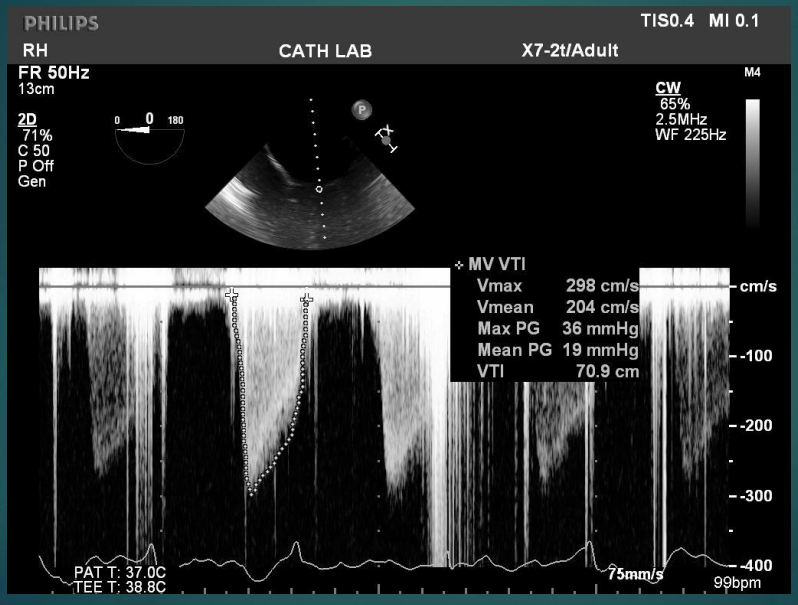
Borderline Wilkins score



The degree of leaflet rigidity (0-4): 2-3

- The severity of leaflet thickening (0-4): 2
- The amount of leaflet calcification (0-4): 2
- The extent of subvalvular thickening (0-4): 2

Total: 8-9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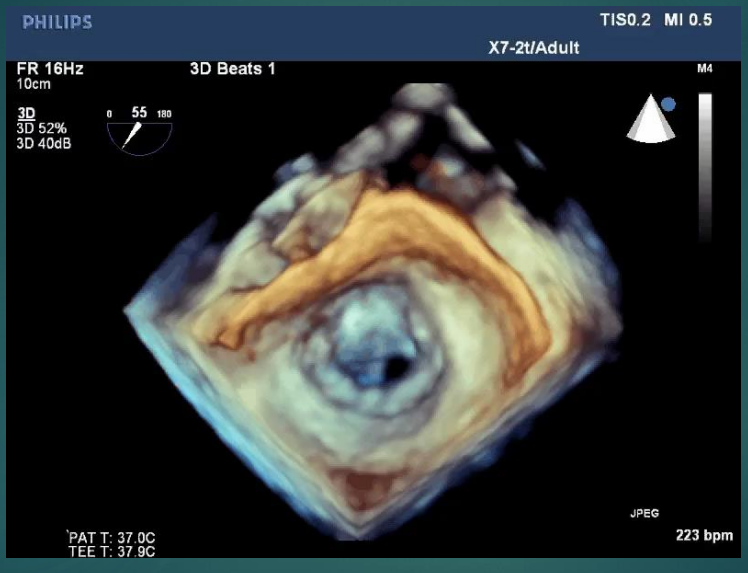
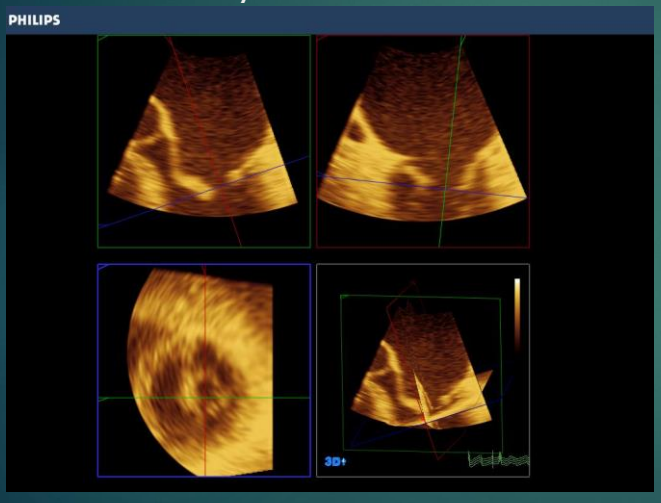
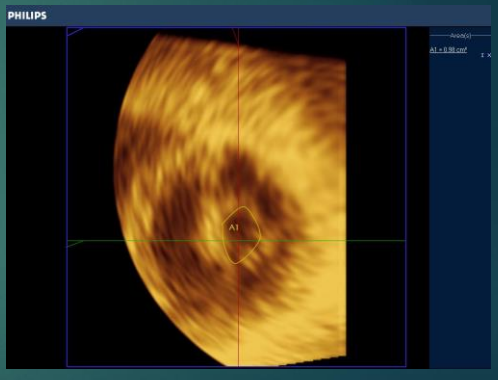
TIS0.4 MI 0.1
RH
CATH LAB
X7-2t/Adult
FR 50Hz
13cm
2D
71%
C 50
P Off
Gen
CW
65%
2.5MHz
WF 225Hz
M4
MV VTI
Vmax 298 cm/s
Vmean 204 cm/s
Max PG 36 mmHg
Mean PG 19 mmHg
VTI 70.9 cm
cm/s
-100
-200
-300
-400
PAT T: 37.0C
TEE T: 38.8C
75mm/s
99bpm

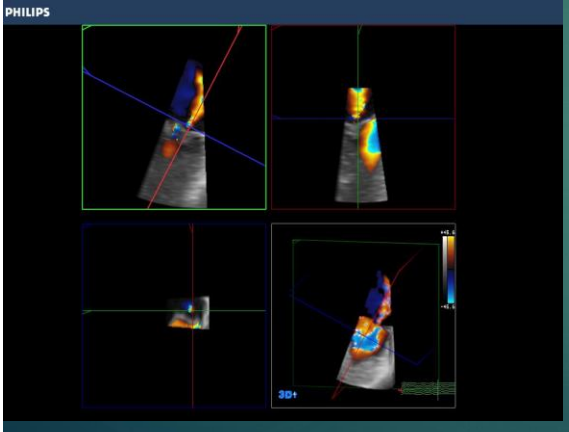

PHILIPS
TIS0.2 MI 0.5
X7-2t/Adult
FR 16Hz
10cm
3D Beats 1
3D
3D 52%
3D 40dB
M4
JPEG
PAT T: 37.0C
TEE T: 37.9C
223 bpm

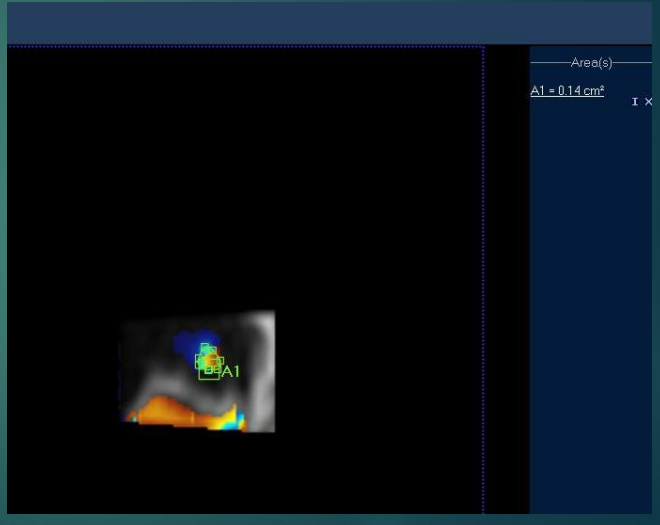
MVA = 0.98 cm2 by 3D planimetry, continuity = 0.96 cm2, PHT = 1.2 cm2

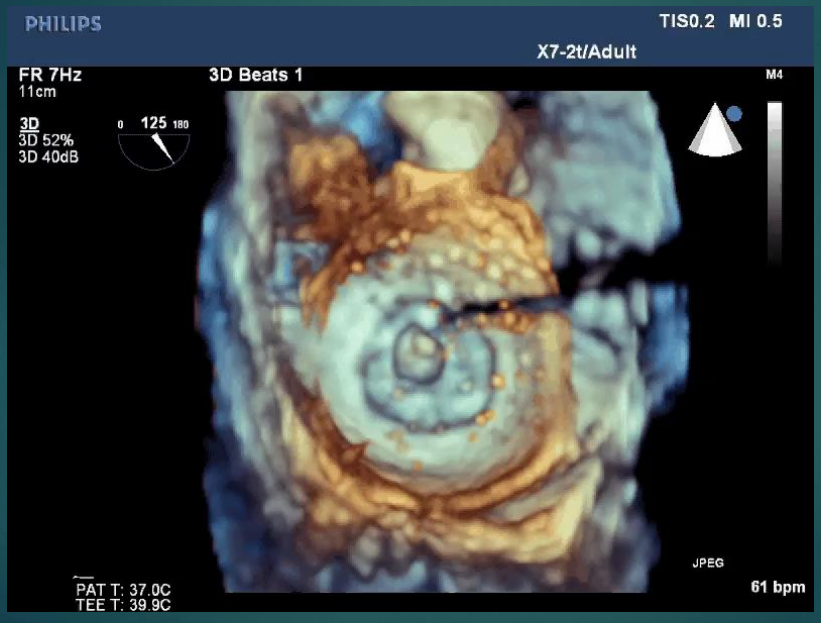


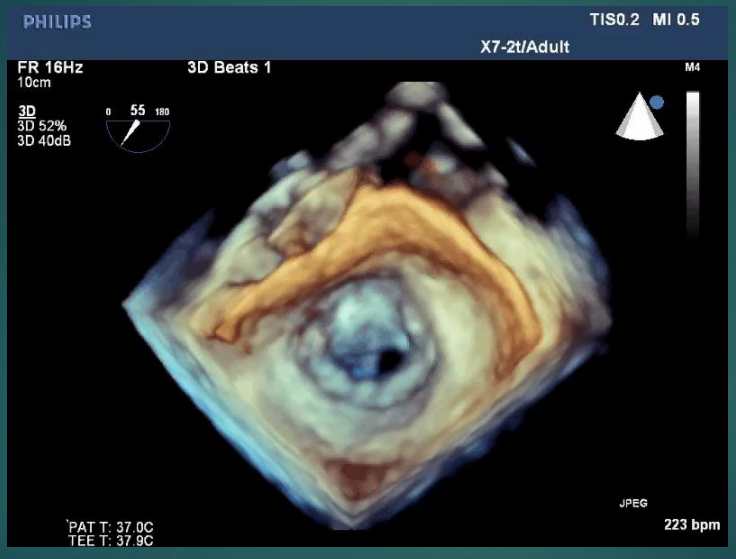


MR EROA = 14 mm2






PHILIPS
TIS0.2 MI 0.5
X7-2t/Adult
FR 7Hz
11cm
3D Beats 1
M4
3D
3D 52%
3D 40dB
0 125 180
JPEG
PAT T: 37.0C
TEE T: 39.9C
61 bpm


PHILIPS
TIS0.2 MI 0.5
X7-2t/Adult
FR 16Hz
10cm
3D Beats 1
M4
3D
3D 52%
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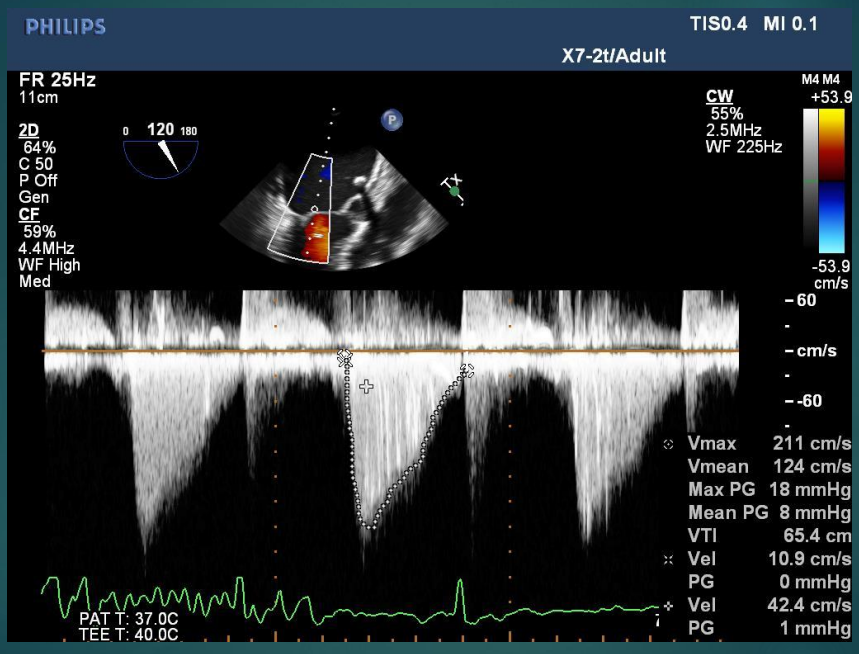
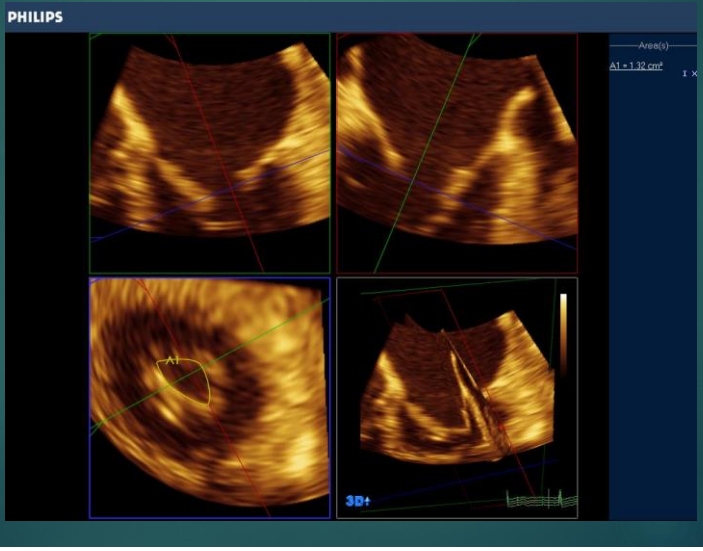
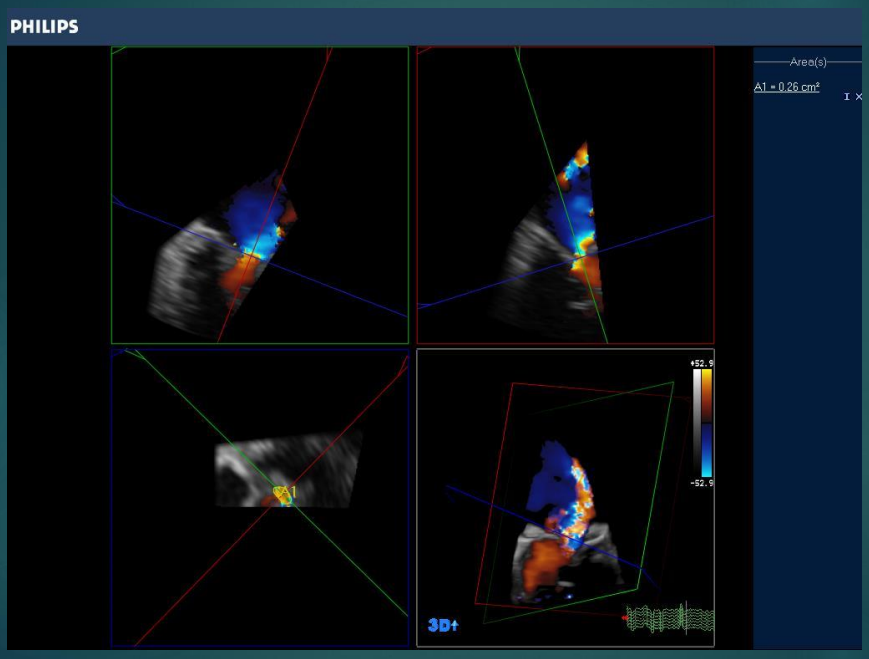
0 55 180
JPEG
PAT T: 37.0C
TEE T: 37.9C
223 bpm



postMVA = 1.3 cm2





No more inflations performed 2/2 moderate MR

Degenerative/calcific MS

ASA/EAE 2009 guidelines - DMS

- "It [degenerative MS] is frequently observed in the elderlyand associated with hypertension, atherosclerotic disease, and sometimes AS. ***However, calcification of the mitral annulus has few or no haemodynamic consequences when isolated*** and causes more often MR than MS. In rare cases, degenerative MS has haemodynamic consequences when leaflet thickening and/or calcification are associated. This is required to cause restriction of leaflet motion since"

Degenerative/Calcific MS

- Mitral annular calcification extending onto the leaflet apparatus creating mitral stenosis
- Not much data or info on pathophysiology
- Associated with AS and CAD (atherosclerosis), age
- More common cause of MS in developed world vs developing (RHD)
- ~ 12-16% of MS cases are due to DMS

Transcatheter Mitral Valve Replacement in Native Mitral Valve Disease With Severe Mitral Annular Calcification

Results From the First Multicenter Global Registry

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Sick population

TABLE 1 Baseline Patient Characteristics

Age, yrs	73 ± 13
Female	40/61 (66)
Diabetes	24/61 (39)
Atrial fibrillation	24/54 (44.4)
Peripheral arterial disease	19/60 (31.7)
Chronic obstructive pulmonary disease	28/61 (45.9)
Chronic renal failure	32/62 (51.6)
Prior TIA or stroke	10/60 (16.7)
Hospitalization due to heart failure during prior 12 months	43/60 (71.7)
Prior CABG	20/61 (32.8)
Prior AVR	34/62 (54.8)
TAVR	9/34 (26.5)
SAVR	25/34 (73.5)
Mechanical	10/25 (40)
Bioprosthetic	15/25 (60)
Receiving long-term anticoagulation	26/50 (52)
Prior MV balloon commissurotomy/valvuloplasty	6/58 (10.3)
STS score	14.4 ± 9.5
NYHA functional class	
II	5/62 (8.1)
III	24/62 (38.7)
IV	33/62 (53.2)
EF	59.5 ± 11.3
Mean MVG	11.4 ± 4.4
MVA	1.18 ± 0.51
Systolic PAP, mm Hg	56.2 ± 19
LVOT gradient	6.4 ± 18.2
3(+) MR	11/61 (18)
4(+) MR	10/61 (16.4)

Values are mean ± SD or n/N (%).

AVR = aortic valve replacement; CABG = coronary artery bypass graft; EF = ejection fraction; LVOT = left ventricular outflow tract; MR = mitral regurgitation; MV = mitral valve; MVA = mitral valve area; MVG = mitral valve gradient; NYHA = New York Heart Association; PAP = pulmonary artery pressure; SAVR = surgical aortic valve replacement; STS = Society of Thoracic Surgeons; TAVR = transcatheter aortic valve replacement; TIA = transient ischemic attack.

Thirty-day all-cause mortality was 29.7%

Challenges with echo diagnosis

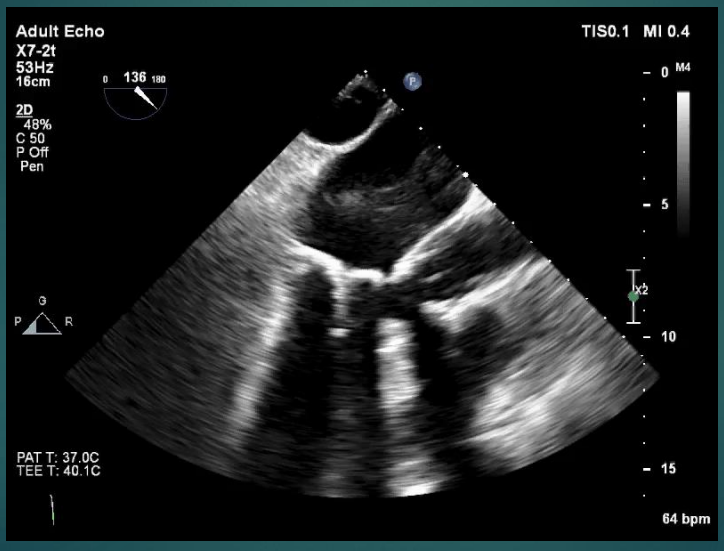
- Many patients in low flow states (concomitance with severe AS) so that transvalvular gradients are lower than expected for MVA
- Variable degrees of MS with severe MAC
- Difficult to see leaflets on TEE due to acoustic shadowing from MAC
- Planimetry: maximum stenosis may not be at tips of leaflets
- PHT does not work

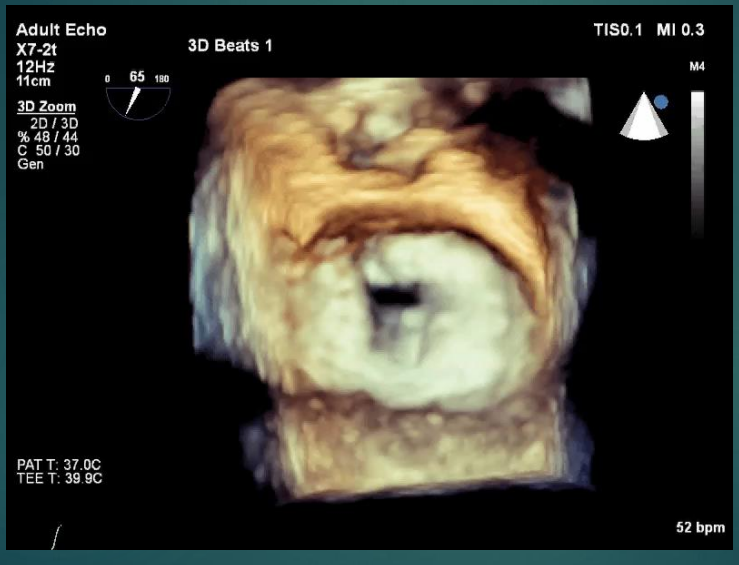
Echo Assessment DMS

- MVA by planimetry (2D/3D reconstruction)
  -CT planimetry
- MVA by continuity (significant MR can cause underestimation)
- Gradients (low flow)

Case

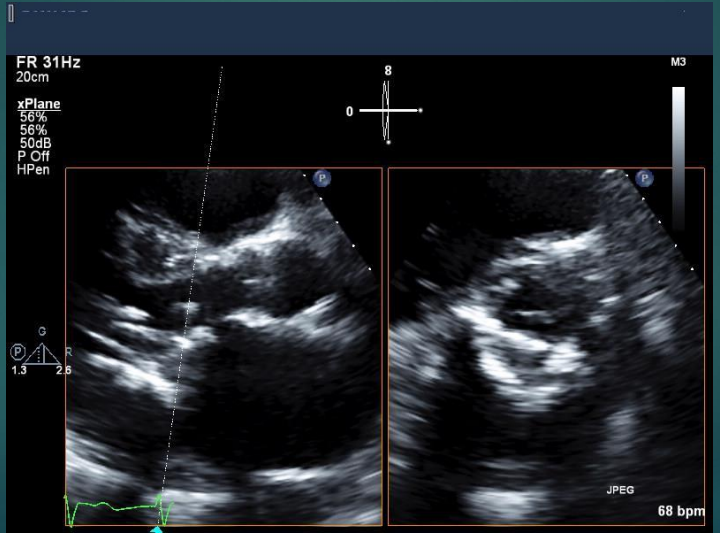
- 74 f
- DM2, OSA, AF, HTN, HLD, Severe AS and CAD s/p CABG/AVR, pHTN
- During prior surgery (6 years prior), MV could not be replaced due to excessive annular calcification
- Increasing symptoms over past several months (exertional dyspnea, edema)
- Admitted for CHF exacerbation and further evaluation


Adult Echo
X7-2t
53Hz
16cm
2D
48%
C 50
P Off
Pen
136
TIS0.1 MI 0.4
M4
0
5
10
15
PAT T: 37.0C
TEE T: 40.1C
64 bpm

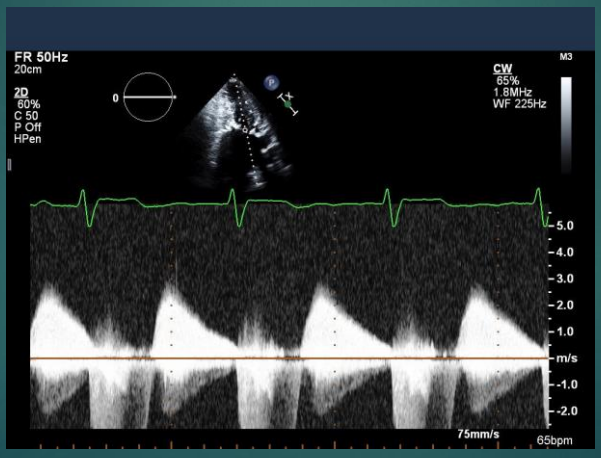

Adult Echo
X7-2t
12Hz
11cm
3D Zoom
2D / 3D
% 48 / 44
C 50 / 30
Gen
3D Beats 1
65
TIS0.1 MI 0.3
M4
PAT T: 37.0C
TEE T: 39.9C
52 bpm

Moderate MR

MVA = 0.99 cm2 by Xplane



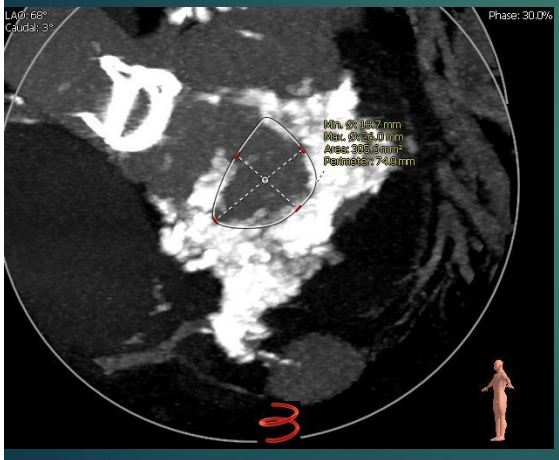
Mean gradient = 11 mm Hg

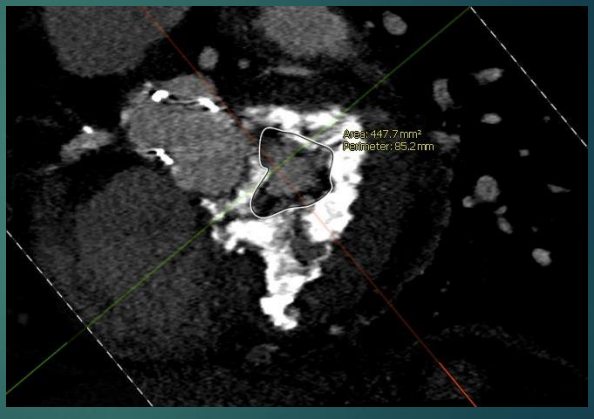


Plan

- Percutanous mitral valve-in-MAC via MITRAL trial (investigational)
- Antegrade (transseptal) access

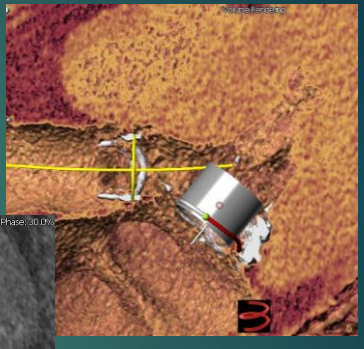
CT planning (annulus area 396-447 mm2)

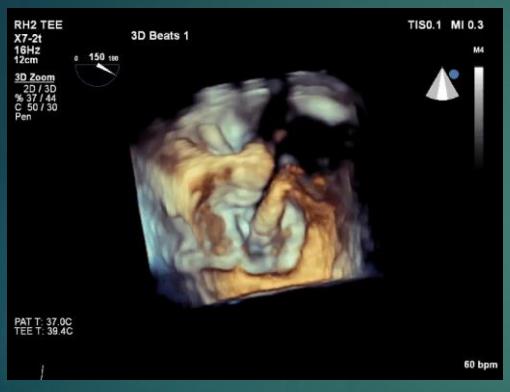


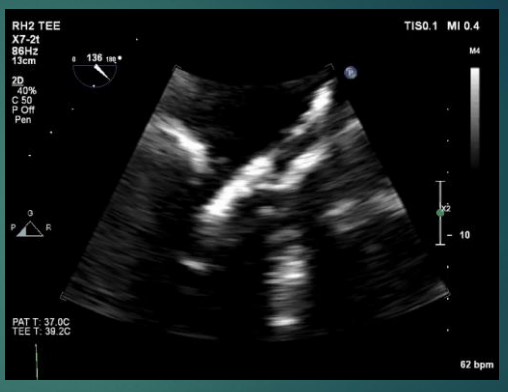


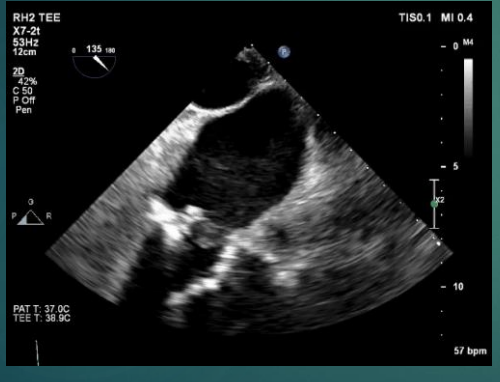
Assess risk of LVOT obstruction (neo LVOT)

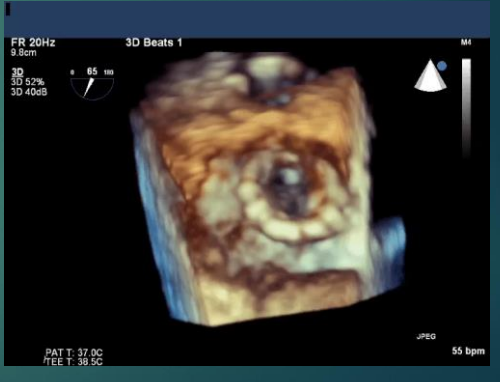
NeoLVOT area =
247 mm2 (low risk)



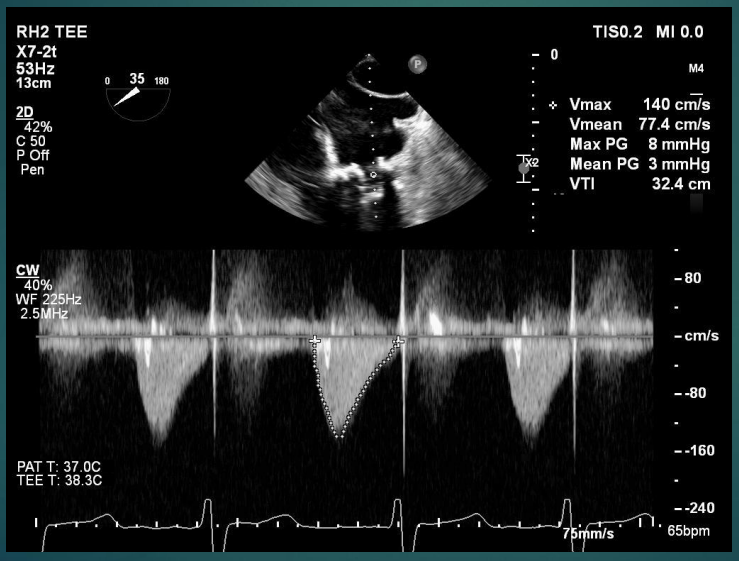

RH2 TEE
X7-2t
16Hz
12cm
3D Zoom
2D / 3D
% 37 / 44
C 50 / 30
Pen
3D Beats 1
TIS0.1 MI 0.3
M4
PAT T: 37.0C
TEE T: 39.4C
60 bpm


RH2 TEE
X7-2t
86Hz
13cm
2D
40%
C 50
P Off
Pen
TIS0.1 MI 0.4
M4
10
PAT T: 37.0C
TEE T: 39.2C
62 bpm

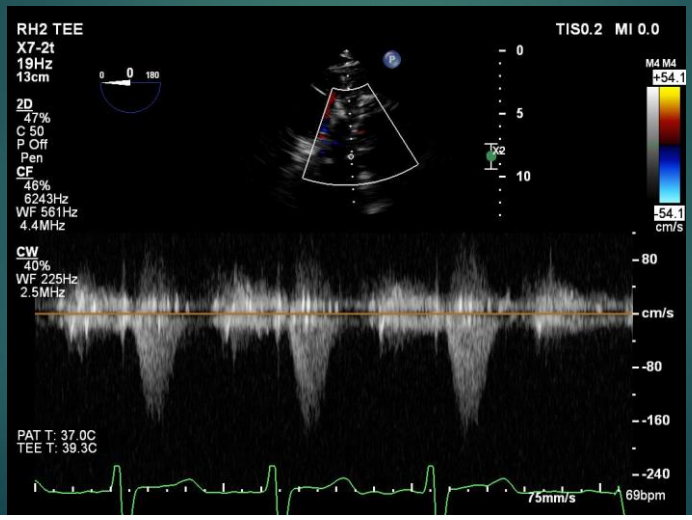

RH2 TEE
X7-2t
53Hz
12cm
2D
42%
C 50
P Off
Pen
TIS0.1 MI 0.4
M4
5
10
PAT T: 37.0C
TEE T: 38.9C
57 bpm


FR 20Hz
9.8cm
3D
3D 52%
3D 40dB
3D Beats 1
M4
PAT T: 37.0C
TEE T: 38.5C
55 bpm

Transmitral MG = 3 mm Hg



Mean LVOT gradient = 4 mm Hg



Thanks