Echocardiographic assessment of mitral stenosis

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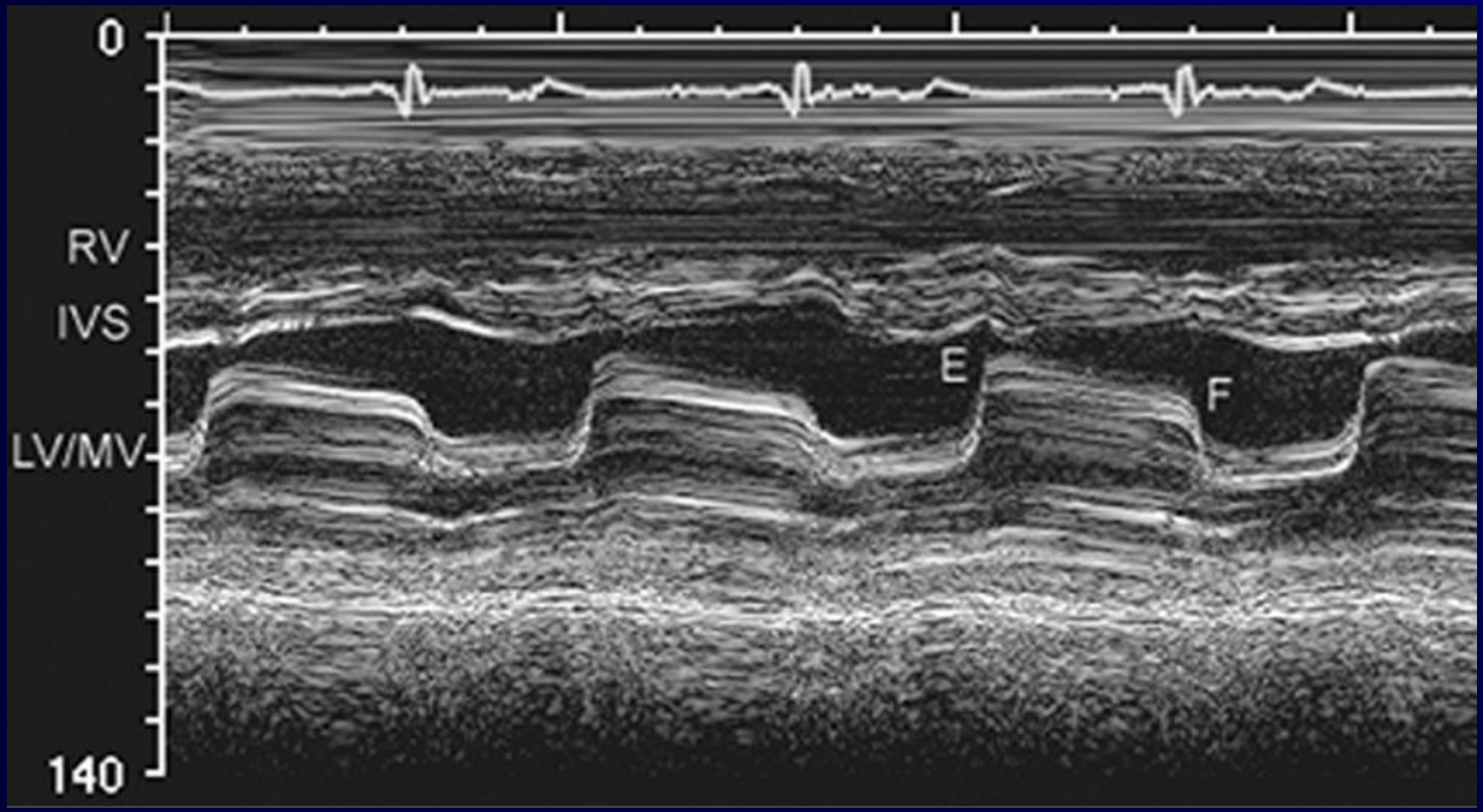
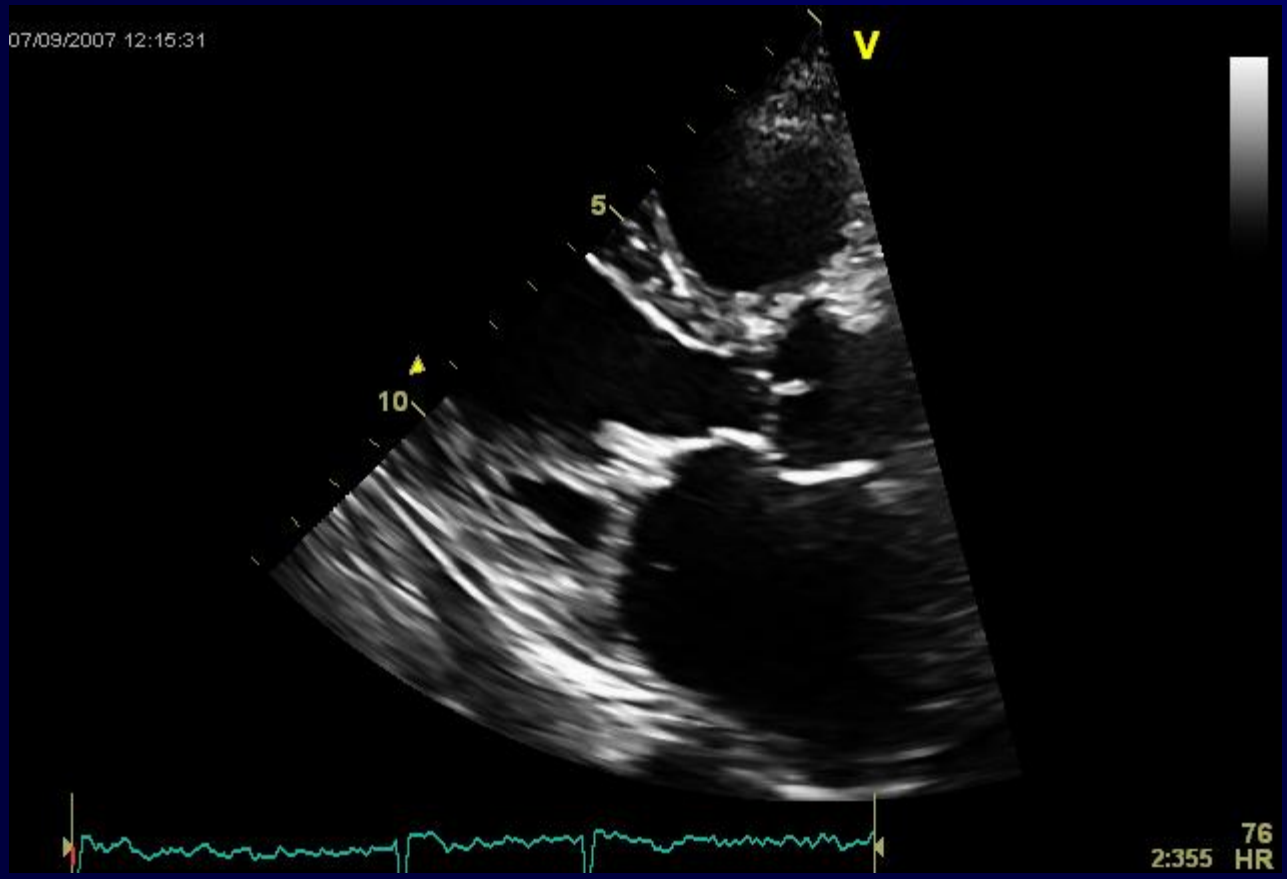
EAE Course, Bucharest, April 2010



This is how it started…

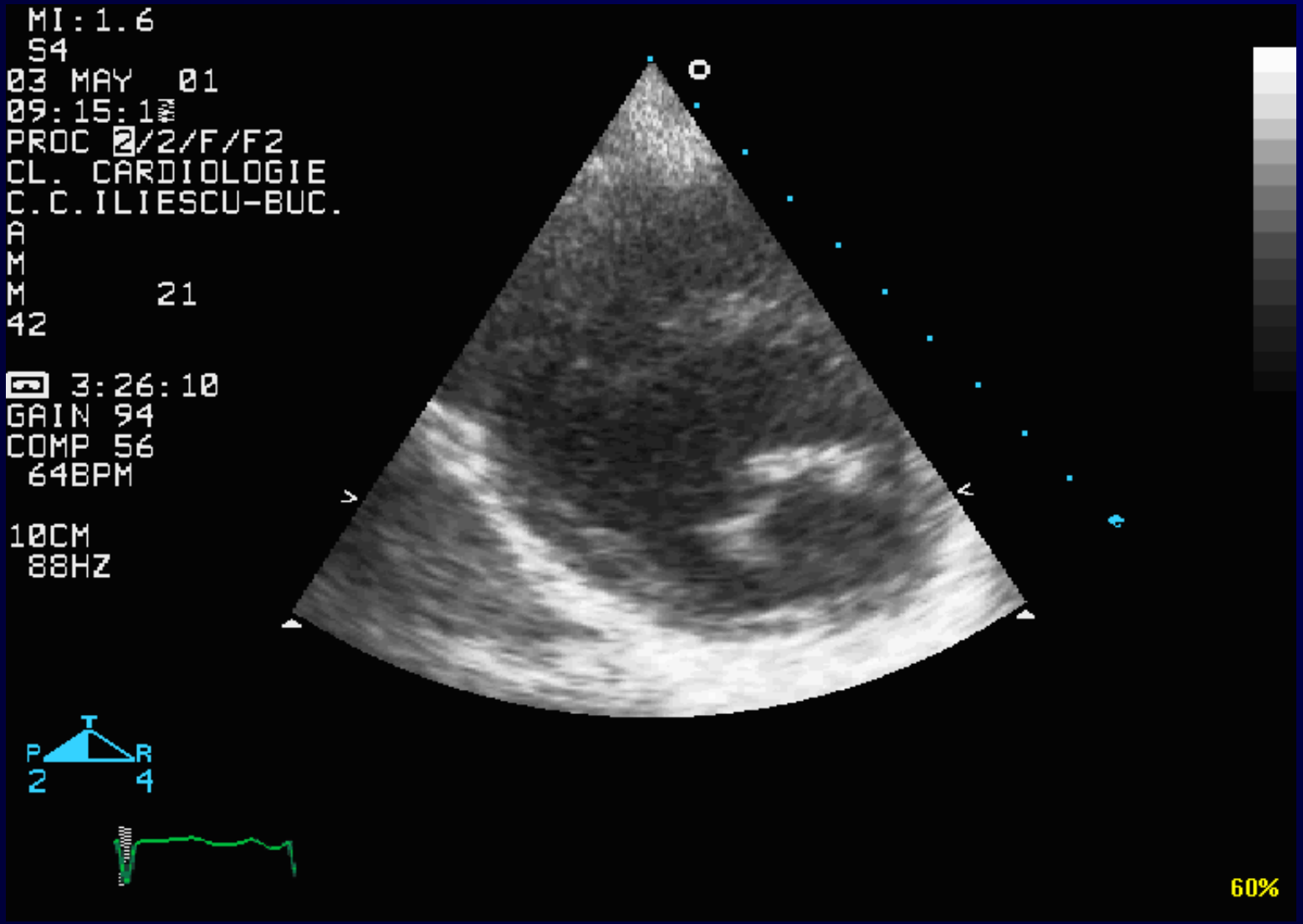
Mitral stenosis at a glance



2D echo

- narrow diastolic opening of MV leaflets
- valve doming (‘hockey-stick”)
- thickened leaflets ± calcifications
- chordal thickening and fusion
- dilated LA
- ± dilated RV, paradoxical septal motion

Etiology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S4
03 MAY 01
09:15:1
PROC 2/2/F/F2
CL. CARDIOLOGIE
C.C.ILIESCU-BUC.
A
M
M 21
42
3:26:10
GAIN 94
COMP 56
64BPM
10CM
88HZ
T
P
R
2
4
60%

Echocardiography in MS

The main method to assess:

- **Extent of anatomic lesions**
- **Severity**
- **Consequences**

ESC Guidelines on the management of valvular heart disease. *EHJ 2007;28:230-68*

Extent of anatomic lesions

- Assessment by 2D echo:
  - leaflet mobility
  - calcification
  - commissural fusion
  - subvalvular involvement

- Scores to assess the feasibility for PMC: (percutaneous mitral commissurotomy)
  - Wilkins (Boston)
  - Cormier

Severity of MS (quantitation)

- 2D (3D) echo:
  - MV area (planimetry)
- Doppler:
  - pressure gradients
  - MV area (pressure half-time)
  - PISA
  - continuity equation

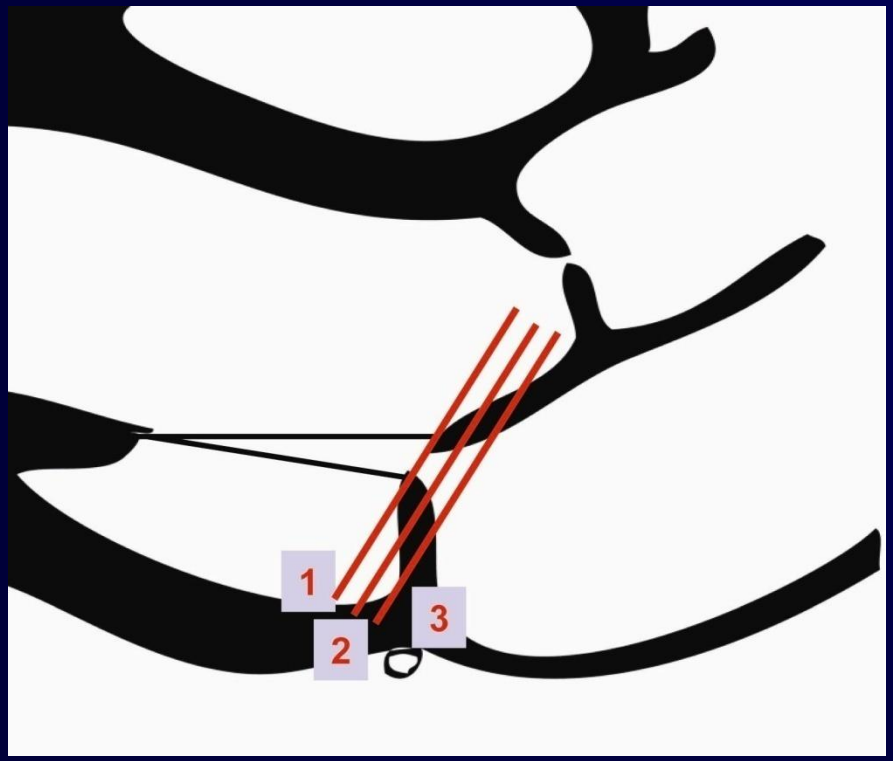
Grading severity of MS

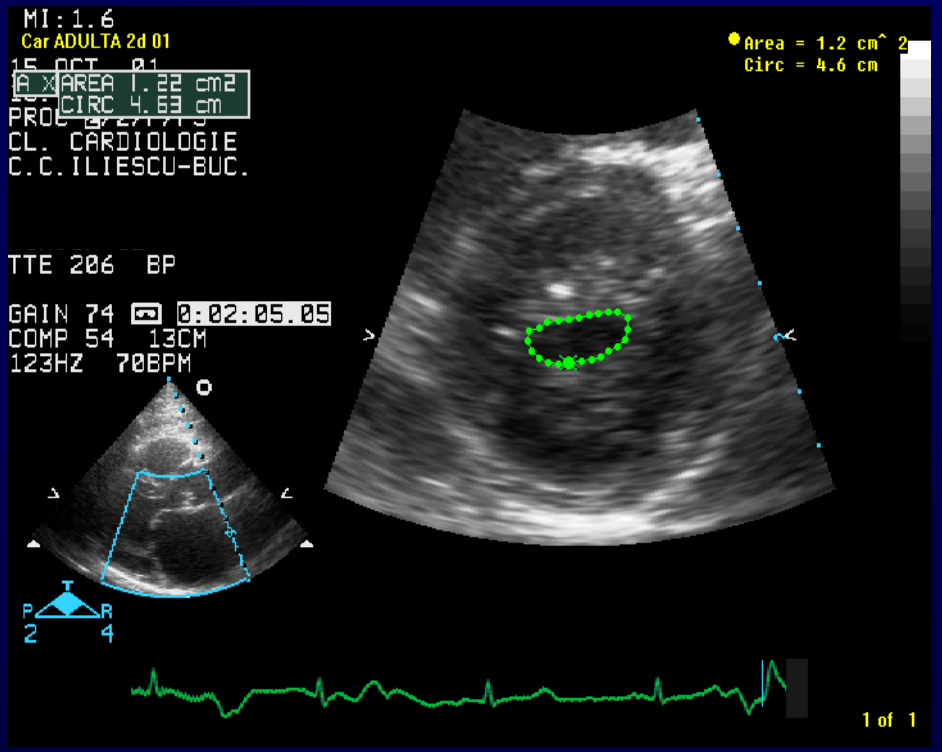
	MILD	MODERATE	SEVERE
SPECIFIC			
Valve area (cm^2)	**> 1.5**	**1 - 1.5**	**< 1**
	NON-SIGNIFICANT	**SIGNIFICANT**	
SUPPORTIVE			
Mean grad (mmHg)	**< 5**	**5 - 10**	**> 10**
SPAP (mmHg)	**< 30**	**30 - 50**	**> 50**

Echocardiographic assessment of valve stenosis: EAE/ASE recommendations for clinical practice. *Eur J Echocardiogr* 2009 May;10(3):47

Planimetry

Yields anatomical area





Aim for cut no. 1!

Ginghina C, Popescu BA, Jurcut R. Essentials in echocardiography, 2005:83

Planimetry

Limitations:

- Funnel-shaped structure of the stenotic MV
  → overestimation of MVA if inadequate scanning

- Instrumentation settings:
  ↑ gain → underestimation of MVA ('blooming')

- Commissurotomy
  - irregular oriffice, difficult to planimeter

- Technical requirements:
  - adequate 2D image quality, zoom, freeze

3D echo

Strengths:

- **Higher accuracy in MVA planimetry than 2DE** (true smallest orifice, independently of its orientation)
- **Less experience-dependent and more reproducible**
- **Detailed information on commissural and subvalvular apparatus involvement** (indication and results of PMC)
- **Applicable also when PSAX view has inadequate image quality**

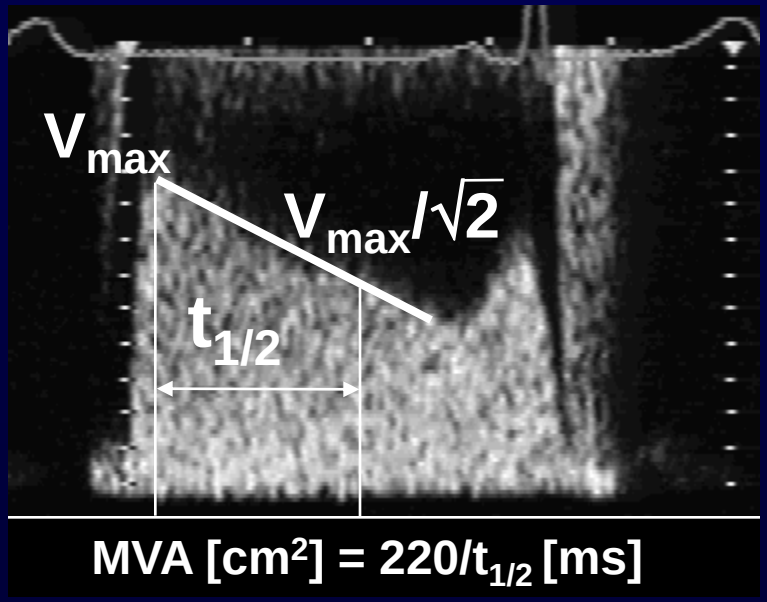
Zamorano J et al. J Am Coll Cardiol. 2004; 43: 2091-6
Xie Mx et al. Am J Cardiol. 2005 ; 95: 1496-9
Messika-Zeitoun D et al. Eur Heart J 2007; 28:72-9

Pressure Half-Time

- Time the pressure gradient needs to drop to half its initial value

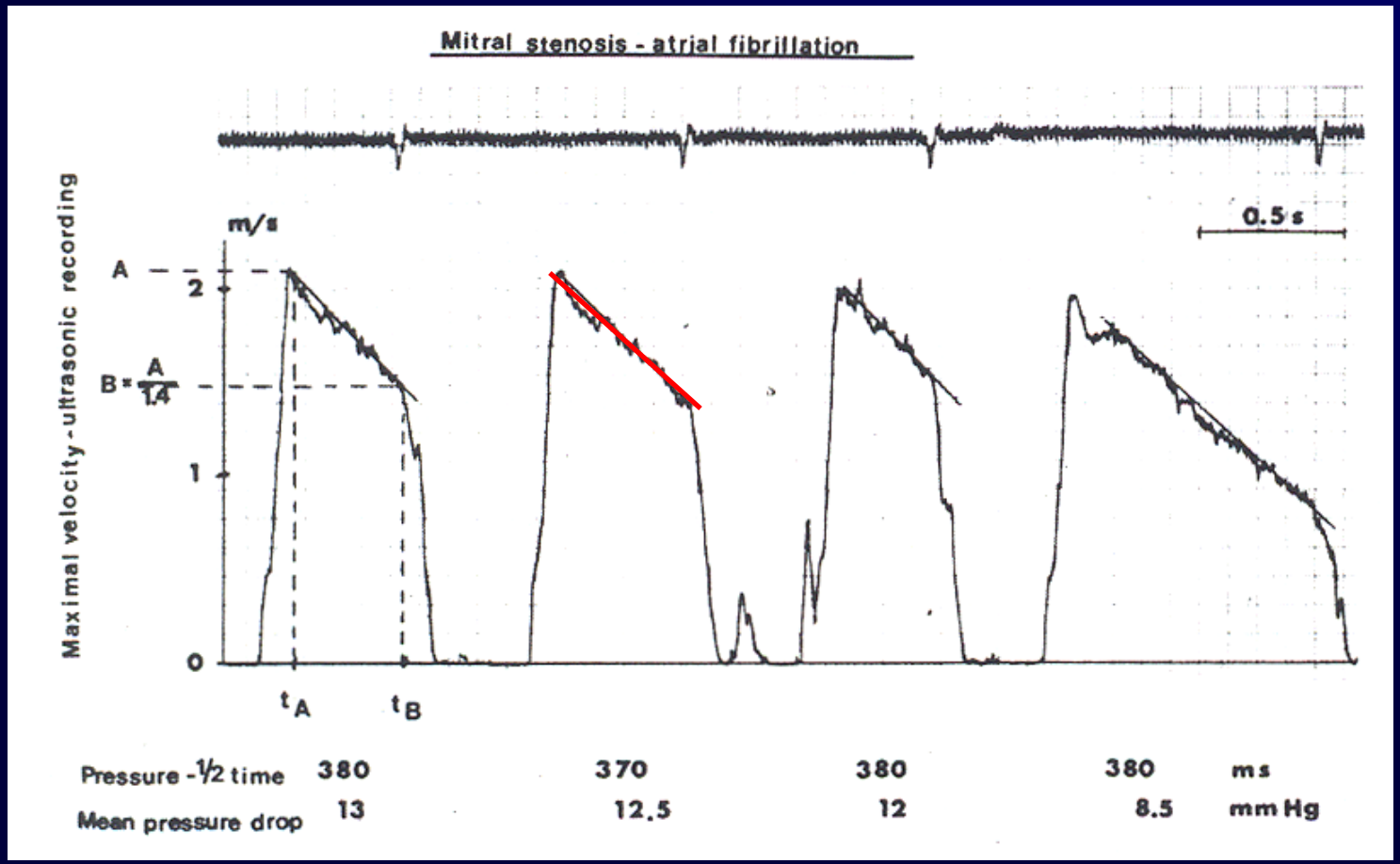
- Because PG $\sim v^2$, i. e. $\sqrt{PG} \sim v$:

  Time velocity needs to drop to $1/\sqrt{2}$ of its initial value:



Noninvasive Assessment of Atrioventricular Pressure Half-time by Doppler Ultrasound

Liv Hatle, M.D., Bjørn Angelsen, dr. techn., and Arve Tromsdal, M.D.



Circulation 1979;60:1096-104.

Doppler-derived PHT: relation to mitral valve area

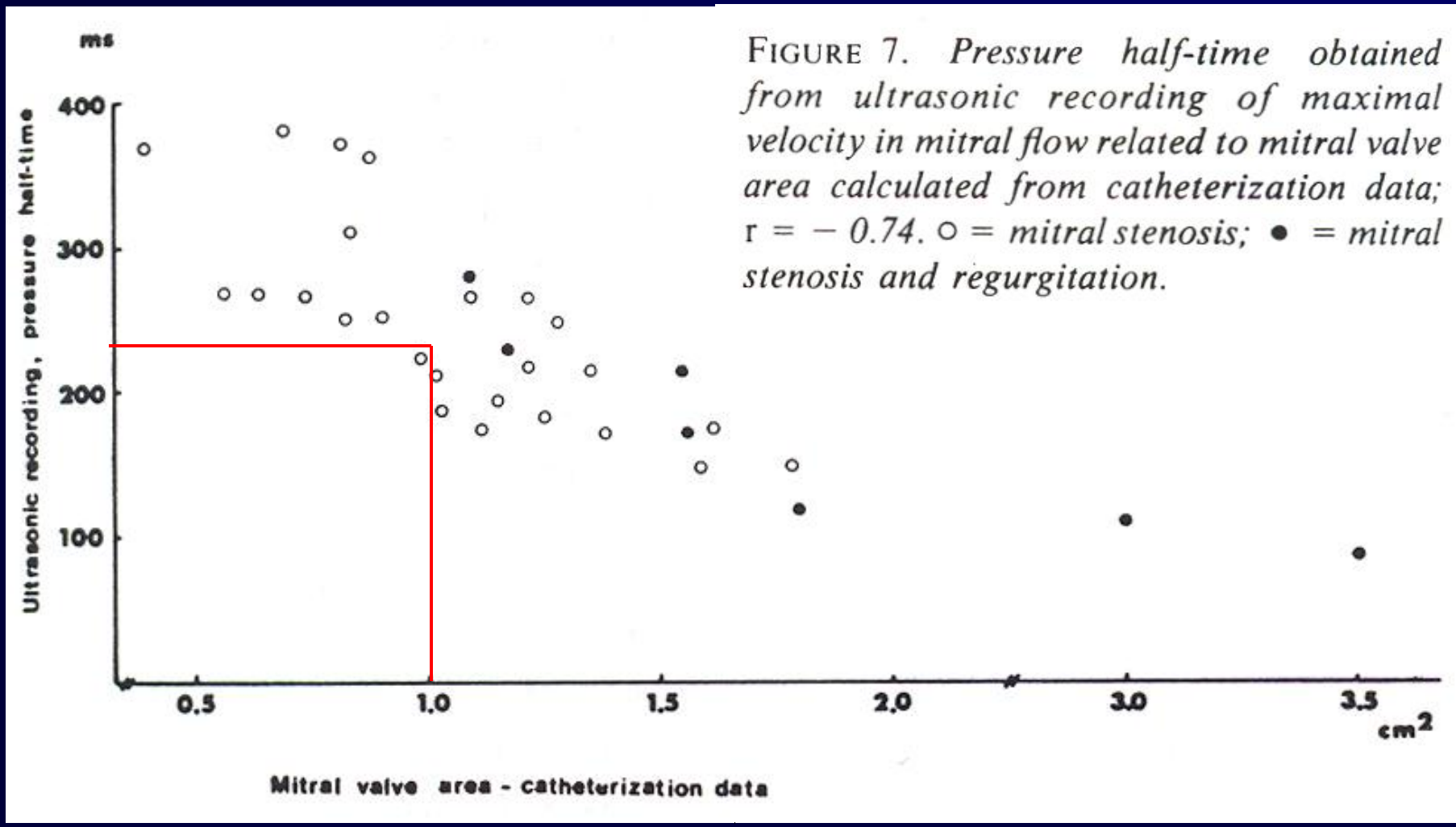
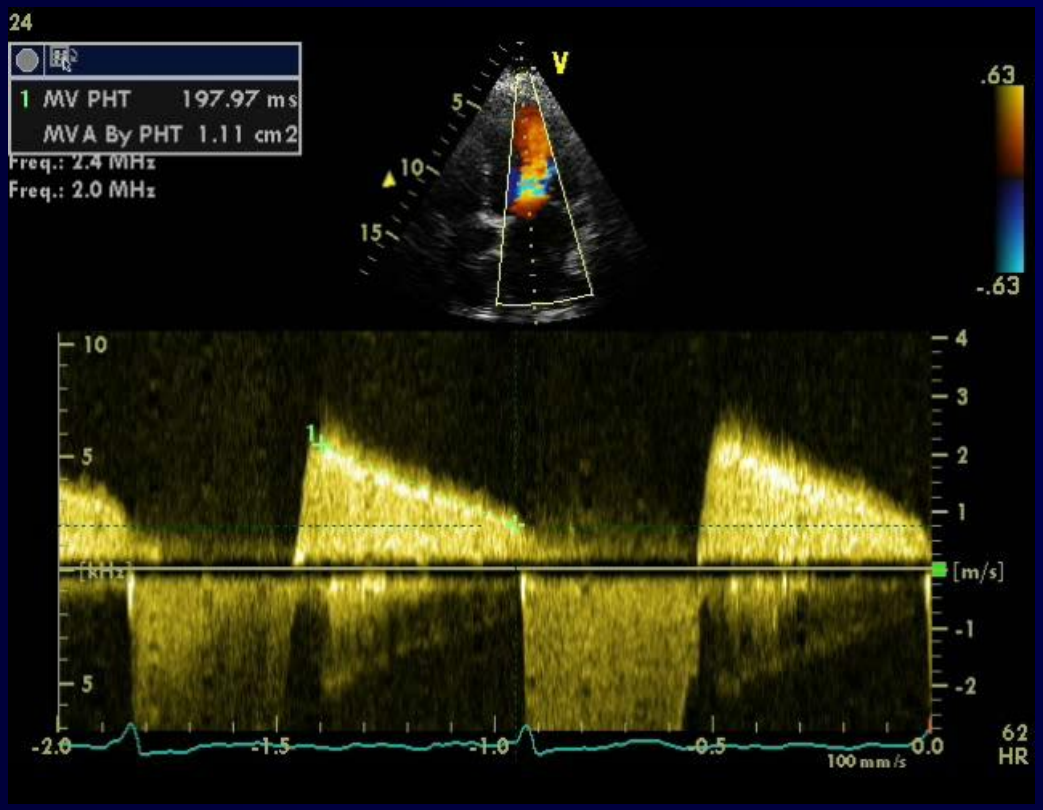


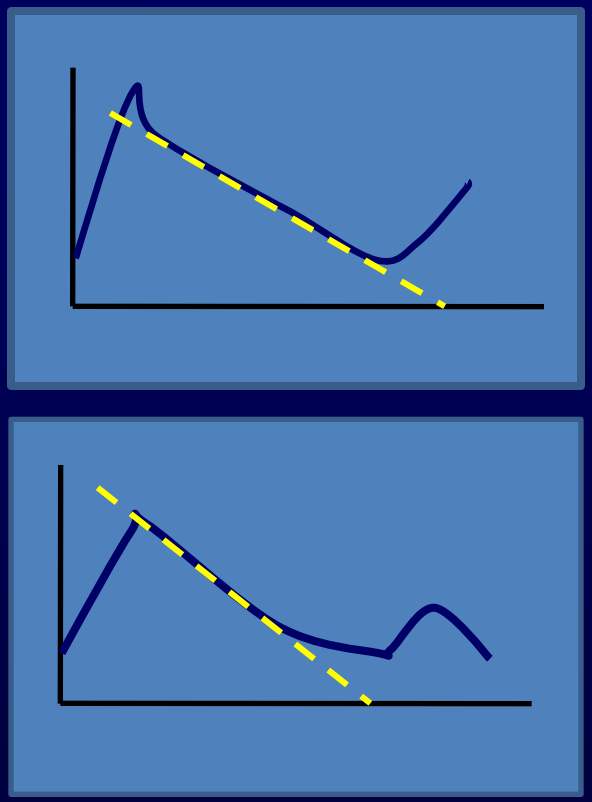
FIGURE 7. *Pressure half-time obtained from ultrasonic recording of maximal velocity in mitral flow related to mitral valve area calculated from catheterization data;* $r = -0.74$. ○ = *mitral stenosis;* ● = *mitral stenosis and regurgitation.*

Hatle L, et al. Circulation 1979;60:1096-104.

Pressure Half-Time (PHT) method

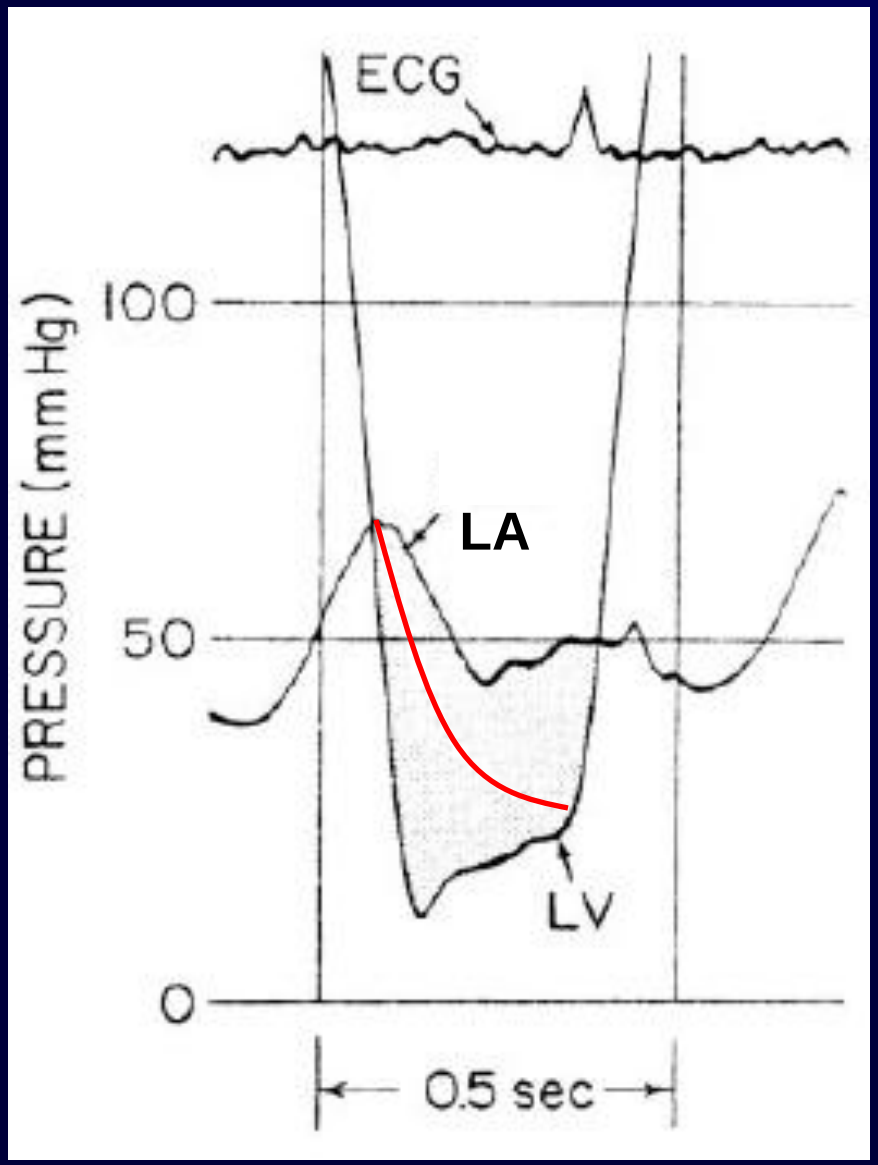
Yields functional area





Pro: it also works in the presence of significant MR

Factors that may affect Pressure Half Time by influencing LA pressure decline



More rapid LA pressure decline will lead to a shortened PHT

Factors that may affect Pressure Half Time by influencing LA pressure decline

1. If the LA empties into a second chamber (eg ASD):

→ LA pressure will drop more rapidly

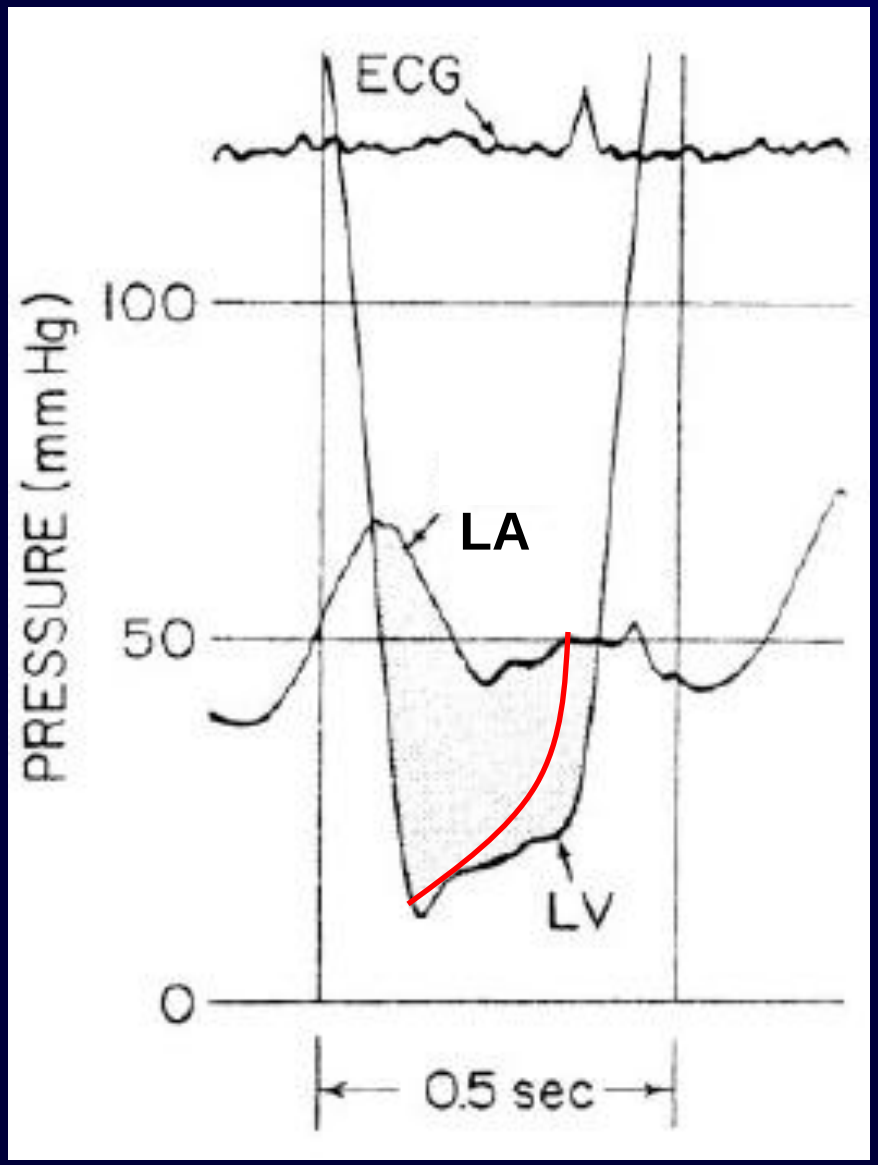
→ PHT will be shortened

2. If the LA is stiff (low atrial compliance)

→ LA pressure may drop rapidly

→ PHT will be shortened

Factors that may affect Pressure Half Time by influencing LV pressure rise



More rapid rise in LV pressure will lead to a shortened PHT

Factors that may affect Pressure Half Time by influencing LV pressure rise

1. If the LV fills from a second source (eg AR):

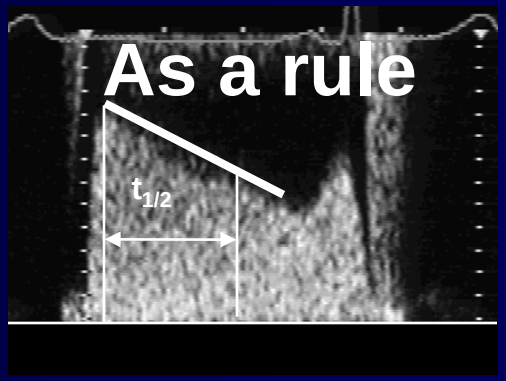
→ LV pressure will rise more rapidly

→ PHT will be shortened

2. If the LV is stiff (low ventricular compliance)

→ LV pressure may rise rapidly

→ PHT will be shortened



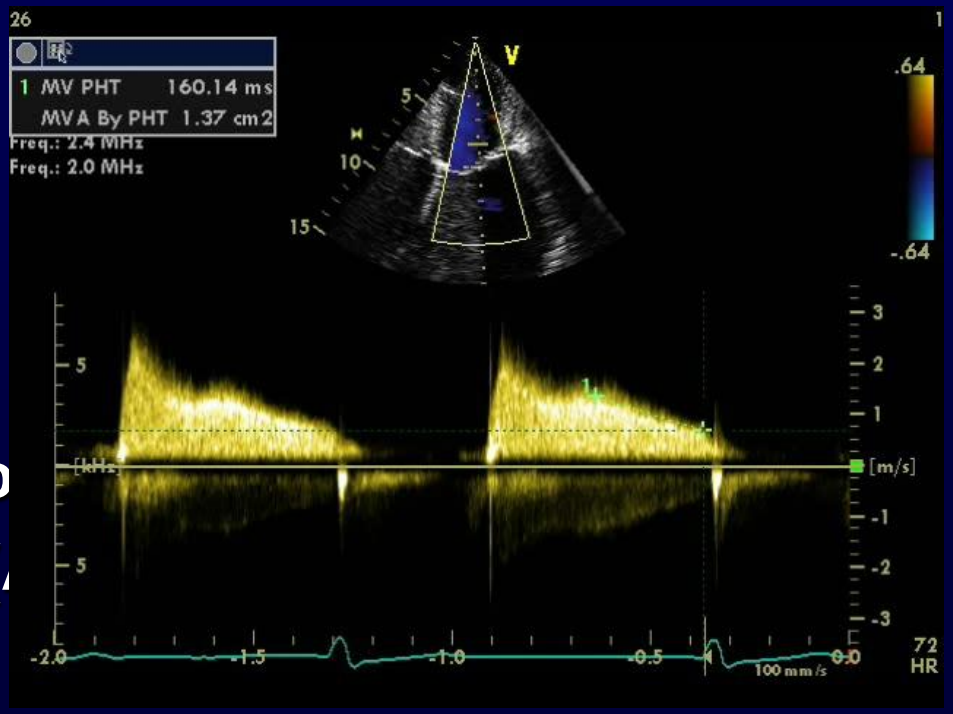
All factors affecting PHT (AR, ASD, reduced LA- or LV compliance) lead to overestimation of MVA

- Therefore, PHT **never underestimates MVA**
- Therefore, **if PHT is > 220 ms, MS is severe**
- However, if PHT is < 220 ms, consider:
  - mean transmitral gradient
  - MVA by planimetry
  - pulmonary artery pressure
  - exercise echocardiography

PHT method limitations

Technique-related:

- Non-paralel alignment to the transmitral flow
- Non-linear slope (leading to difficult/incorrect meas.)
- PW Doppler recordings

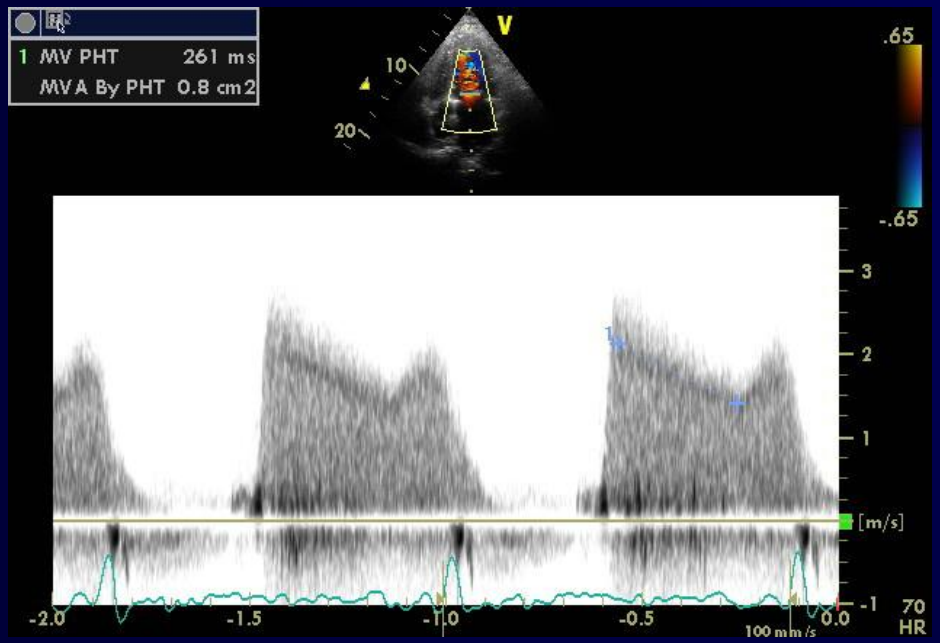


Principle-related:

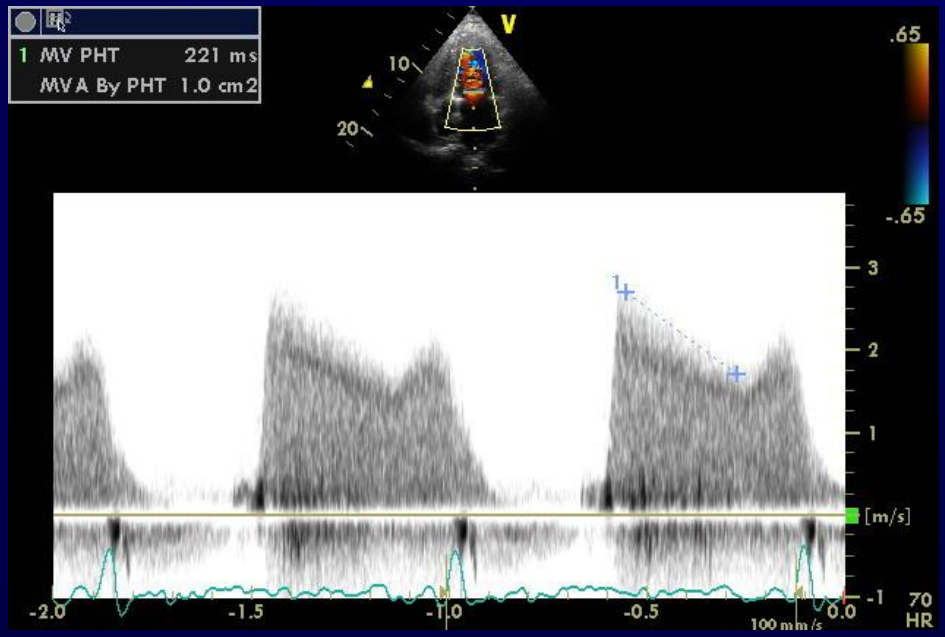
- Factors affecting PHT (o
- Immediately after PMC (

Pitfalls in PHT measurement

Correct: modal velocity

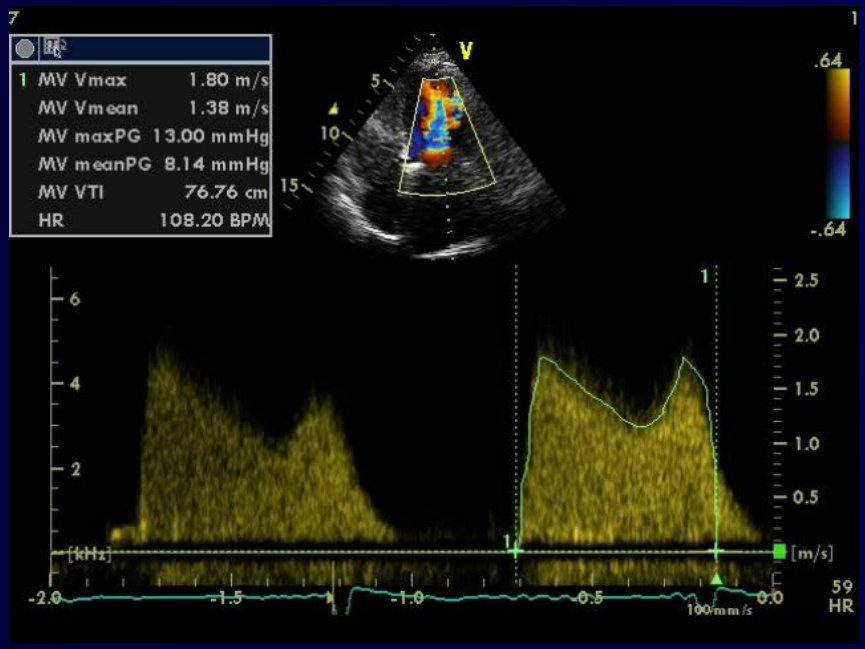


Incorrect: peak velocity



Pressure gradients

- Derived by Bernoulli's law from measured velocity
- Highly rate- and flow-dependent



Mean gradient

Problems: tachycardia, significant coexistent MR (when gradients overestimate MS severity)

Accurate Measurement of the Transmitral Gradient in Patients With Mitral Stenosis: A Simultaneous Catheterization and Doppler Echocardiographic Study

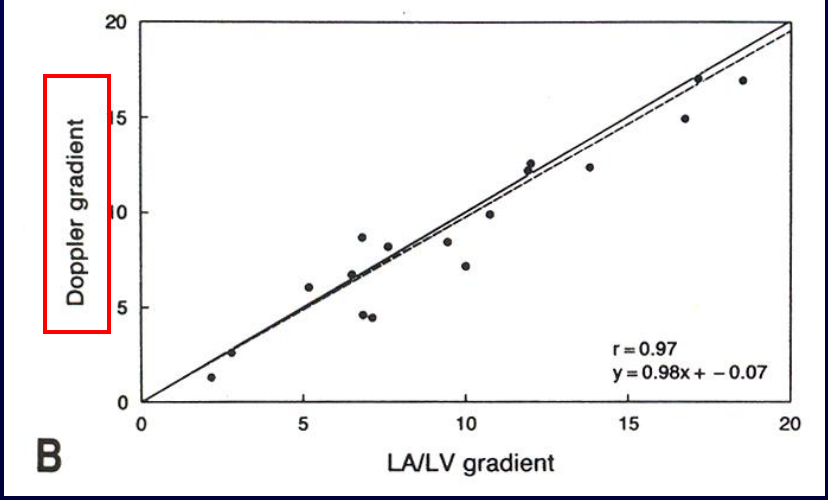
RICK A. NISHIMURA, MD, FACC, CHARANJIT S. RIHAL, MD, A. JAMIL TAJIK, MD, FACC, DAVID R. HOLMES, JR., MD, FACC

Rochester, Minnesota

17 pts with MS underwent transseptal cardiac catheterization

Simultaneous measurements of transmitral gradient were performed by:

1. **direct LA and LV pressures**
2. **PCW and LV pressures**
3. **Doppler echocardiography**



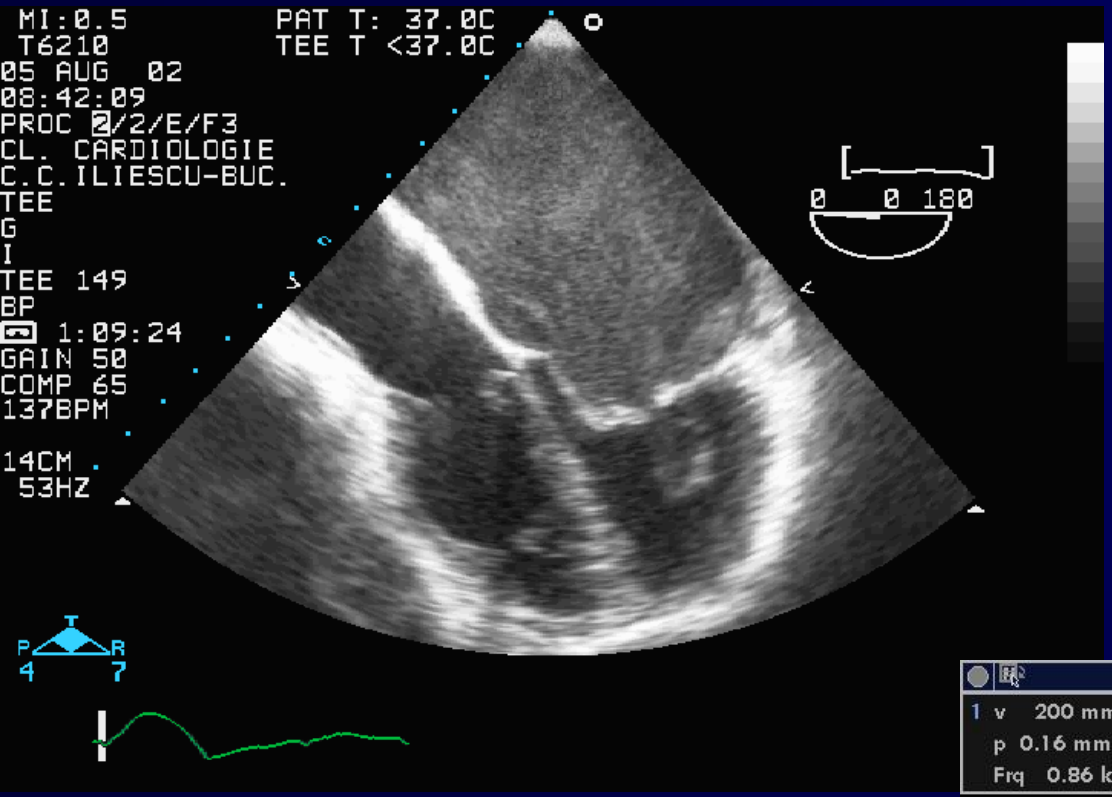
Nishimura RA, et al. J Am Coll Cardiol 1994;24:152-8.

Consequences of MS

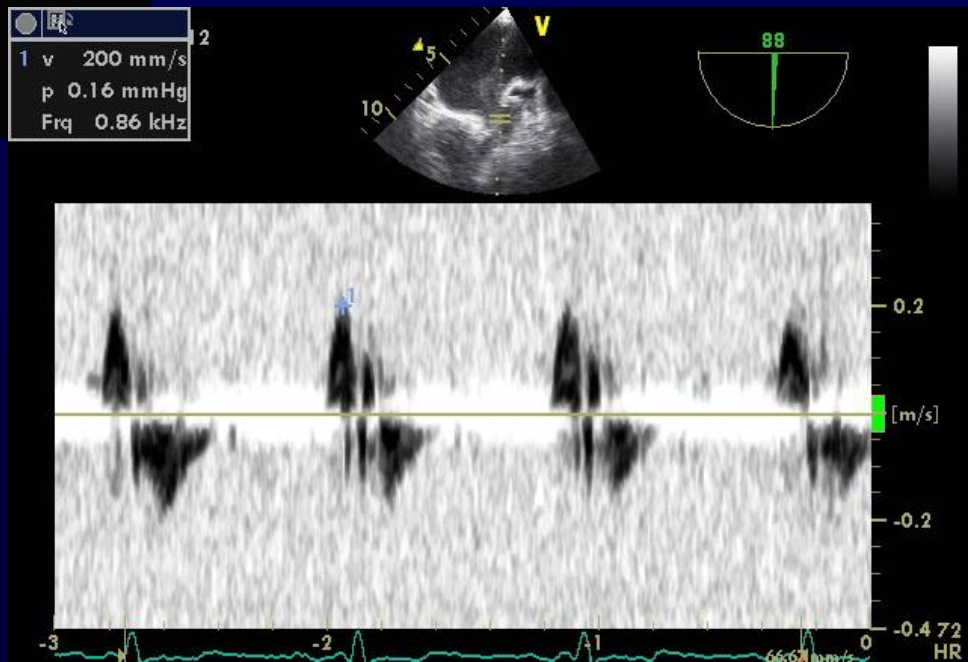
HEMODYNAMIC	THROMBOEMBOLIC	INFECTION
↑ LAP ↑ PVP (Acute pulmonary edema) ↑ PAP RV dysfx ↓ **Systemic congestion**	LA dilation Atrial Fib LA thrombus ↓ **Systemic embolisation**	Endocarditis Recurrent episodes of rheumatic fever

Spontaneous echo contrast

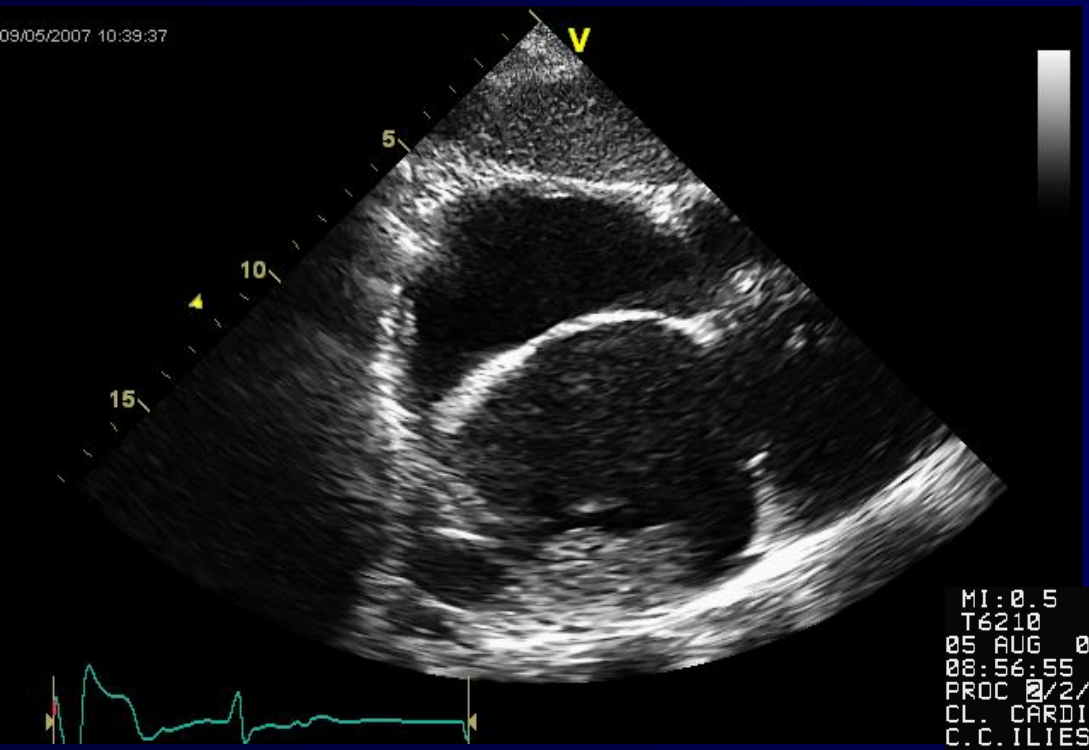
Thromboembolic risk

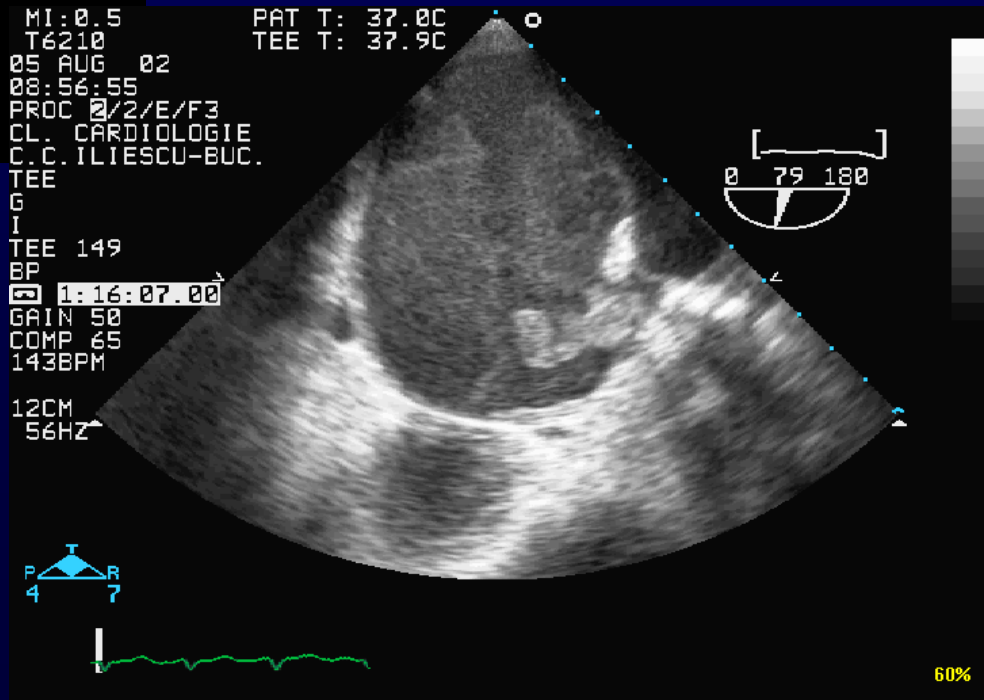


Reduced LAA emptying velocities

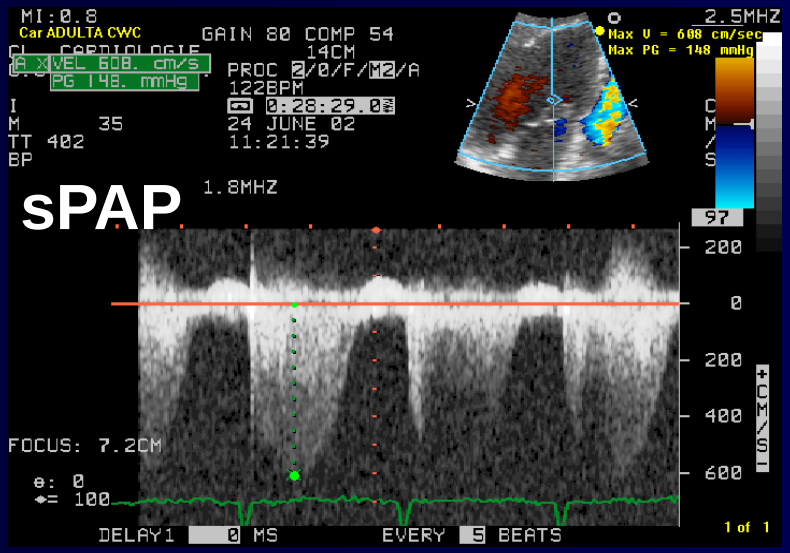


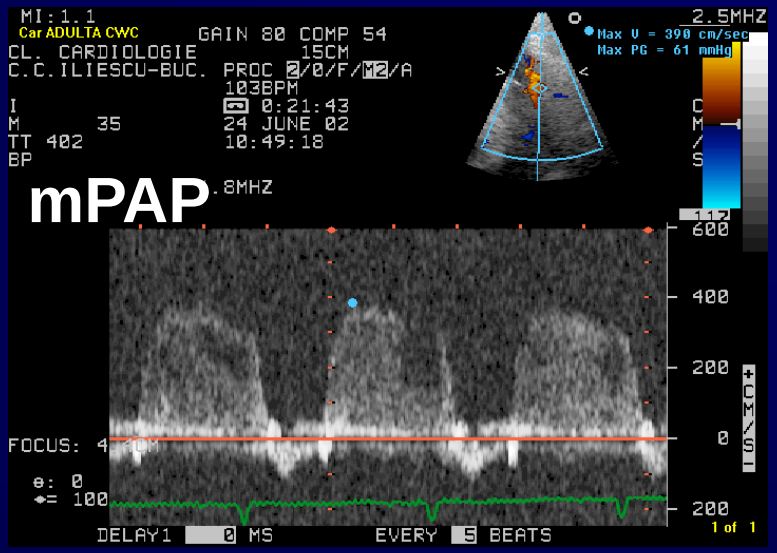
LA thrombus (TTE and TEE)

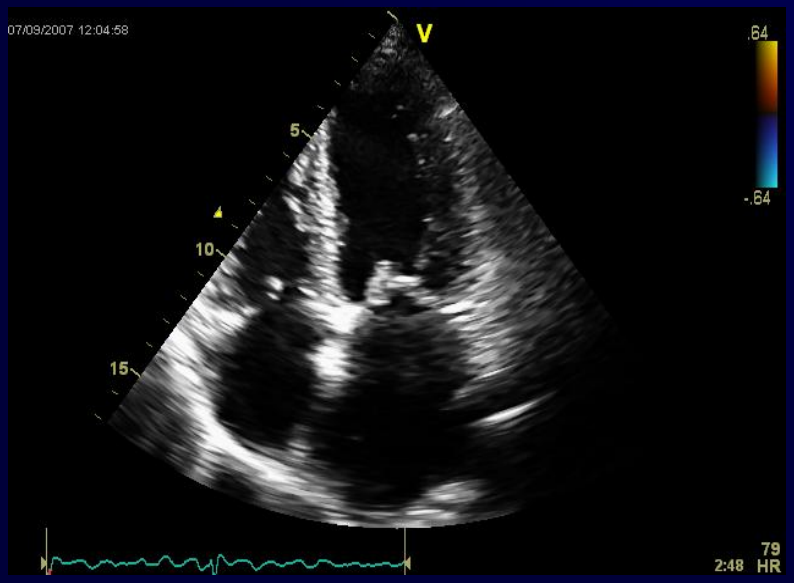


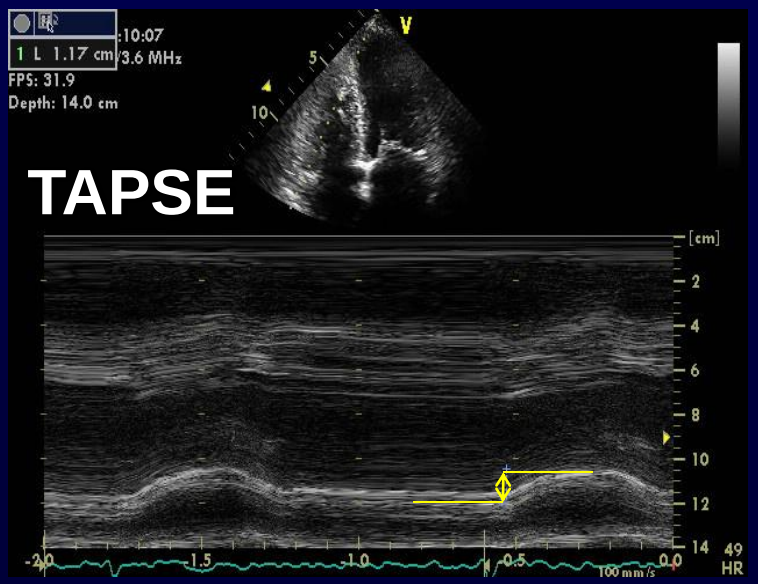


Pulmonary HT and RV dysfx









Treatment selection in MS

Echocardiography plays a key role in decision making regarding the optimal treatment

- **Anticoagulant therapy** even in SR when:
  - LA thrombus (class I C)
  - dense SEC (class IIa C)
  - enlarged LA > 50 mm (class IIa C)
- Guidance of **cardioversion** to sinus rhythm

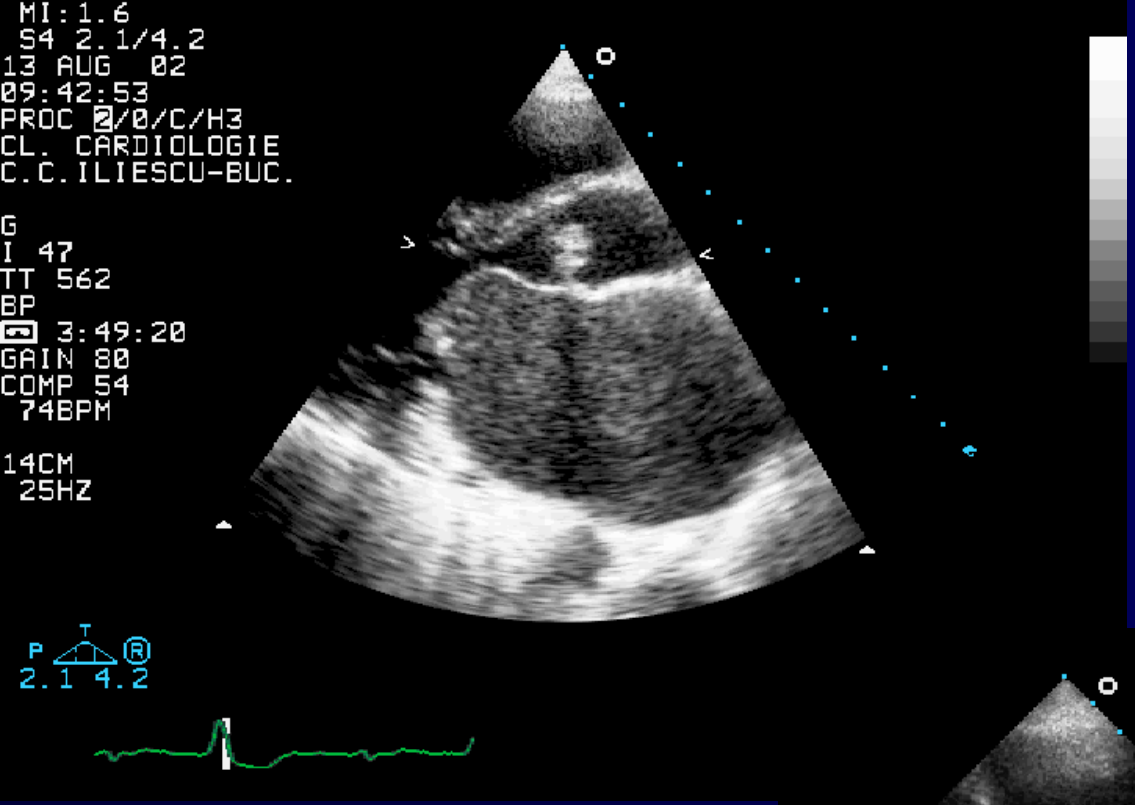
ESC Guidelines on the management of valvular heart disease. *EHJ 2007;28:230-68*

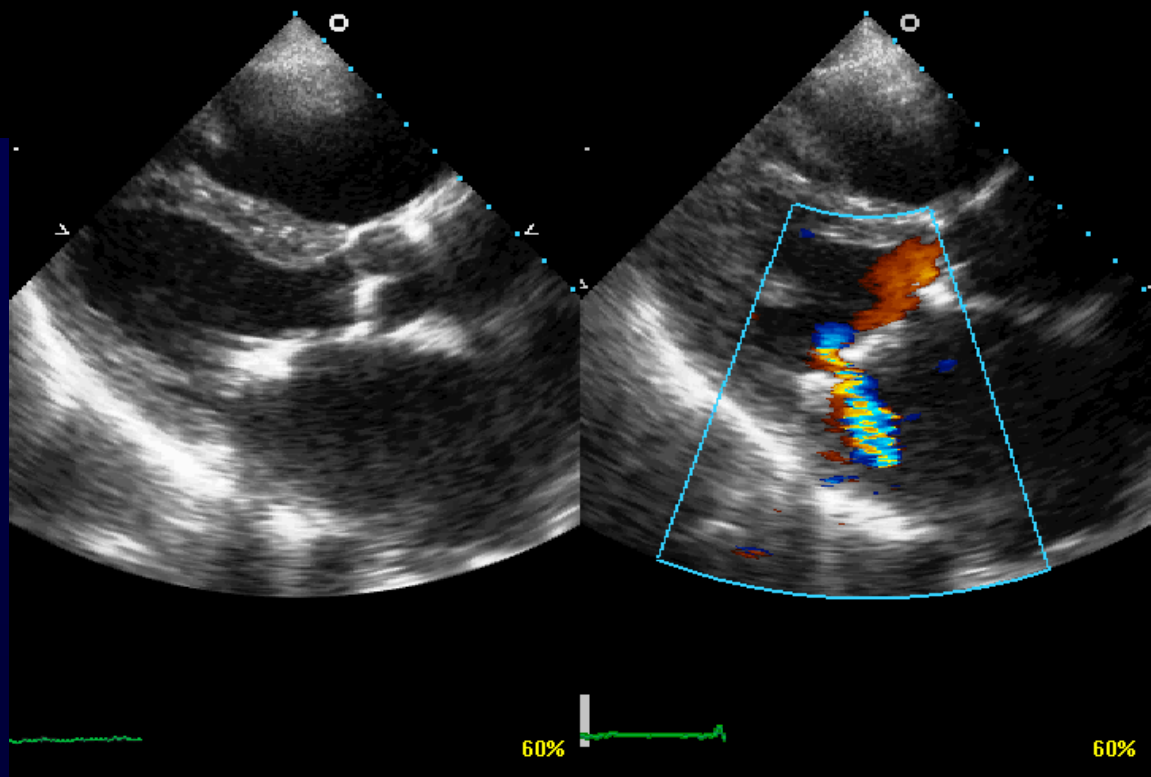
Percutaneous Mitral Comissurotomy

When considering percutaneous treatment of MS echocardiography is essential to:

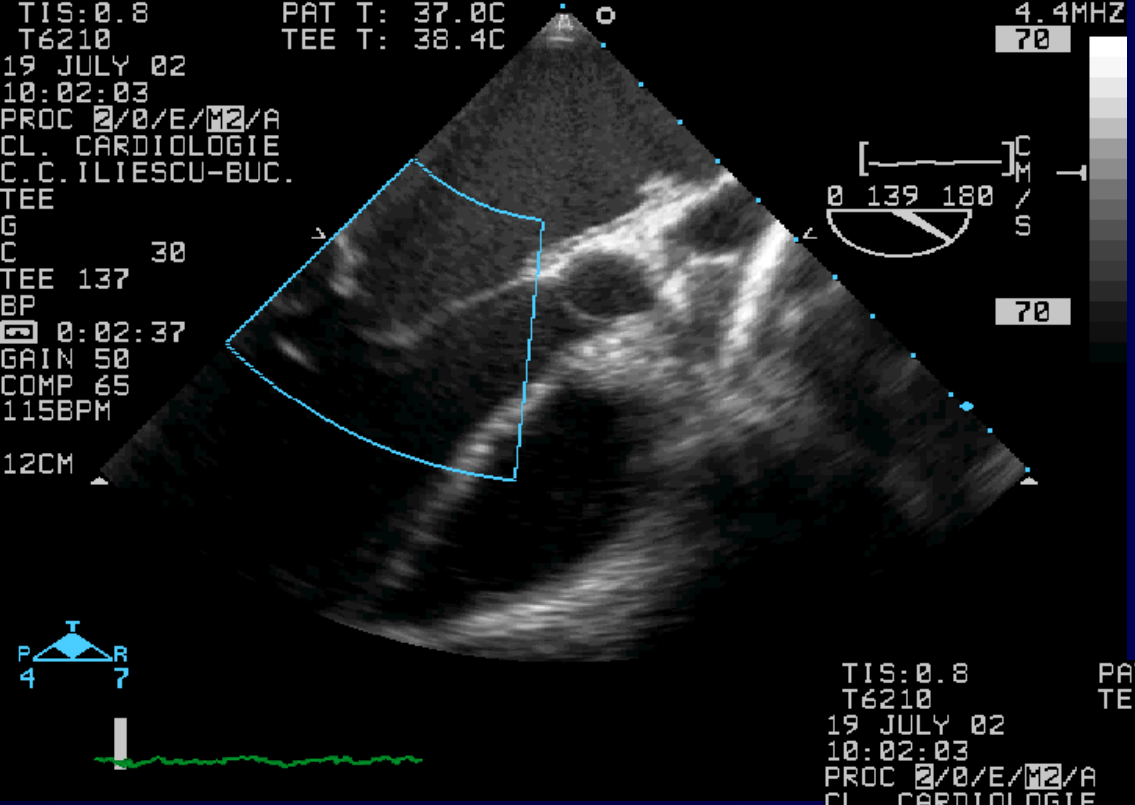
- **assess MV morphology**
- **rule-out LA thrombi and significant MR**
- **monitor procedure (eg septal puncture)**
- **assess result**

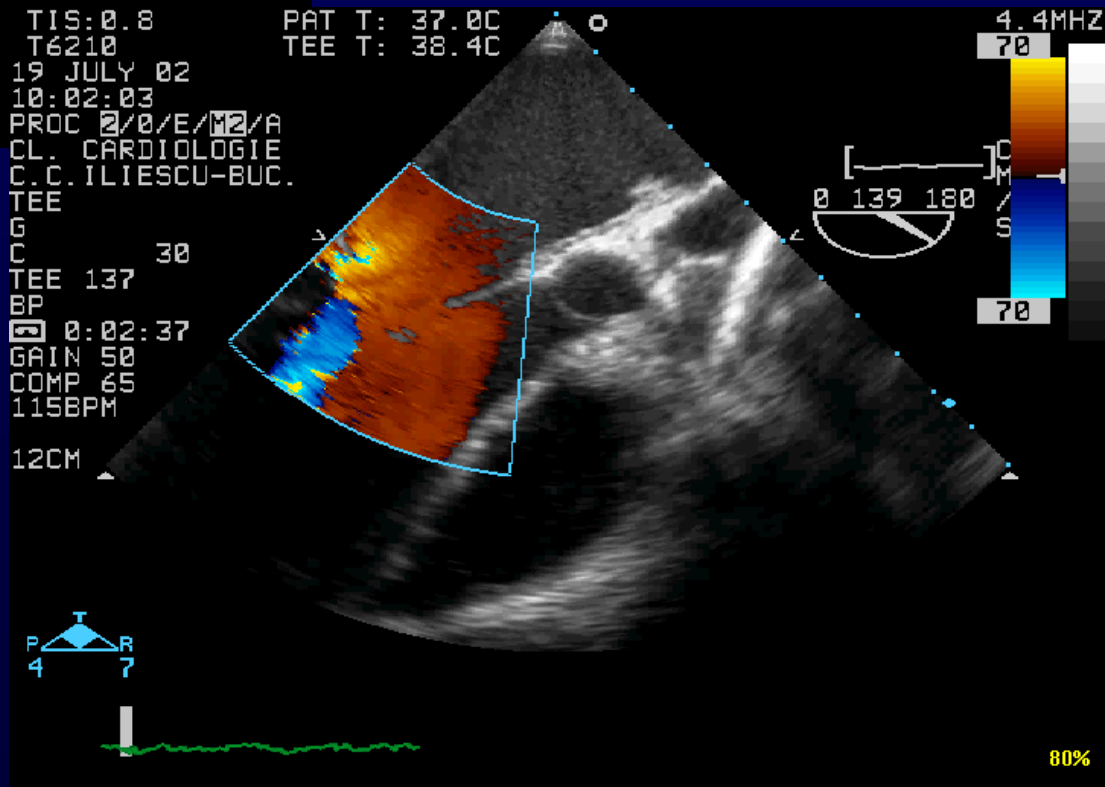
Leaflet mobility and calcification, coexisting MR





PMC indicated? Assess MV morphology





Indications for PMC in MS with valve area < 1.5 cm^2

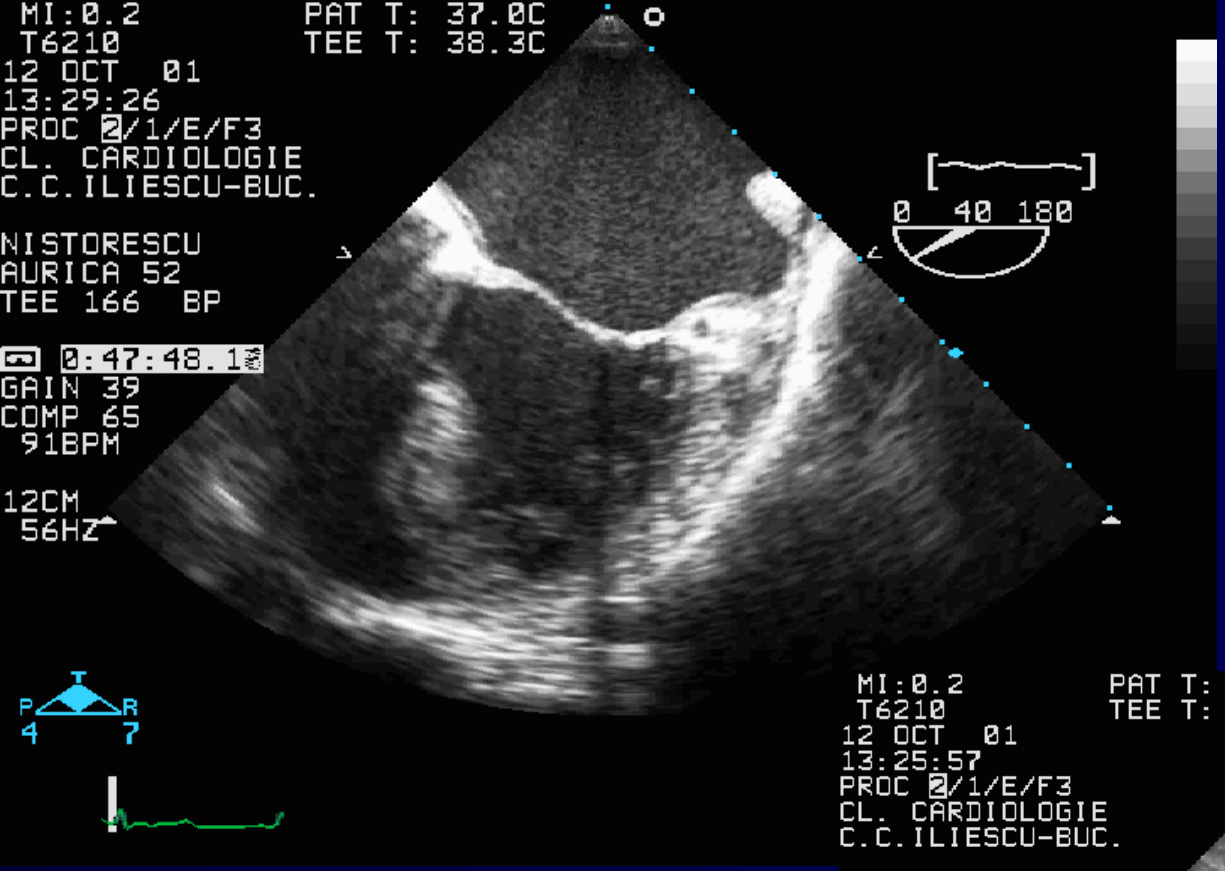
- Symptomatic pts with favourable characteristics for PMC (Class IB):

ABSENCE of several of the following:

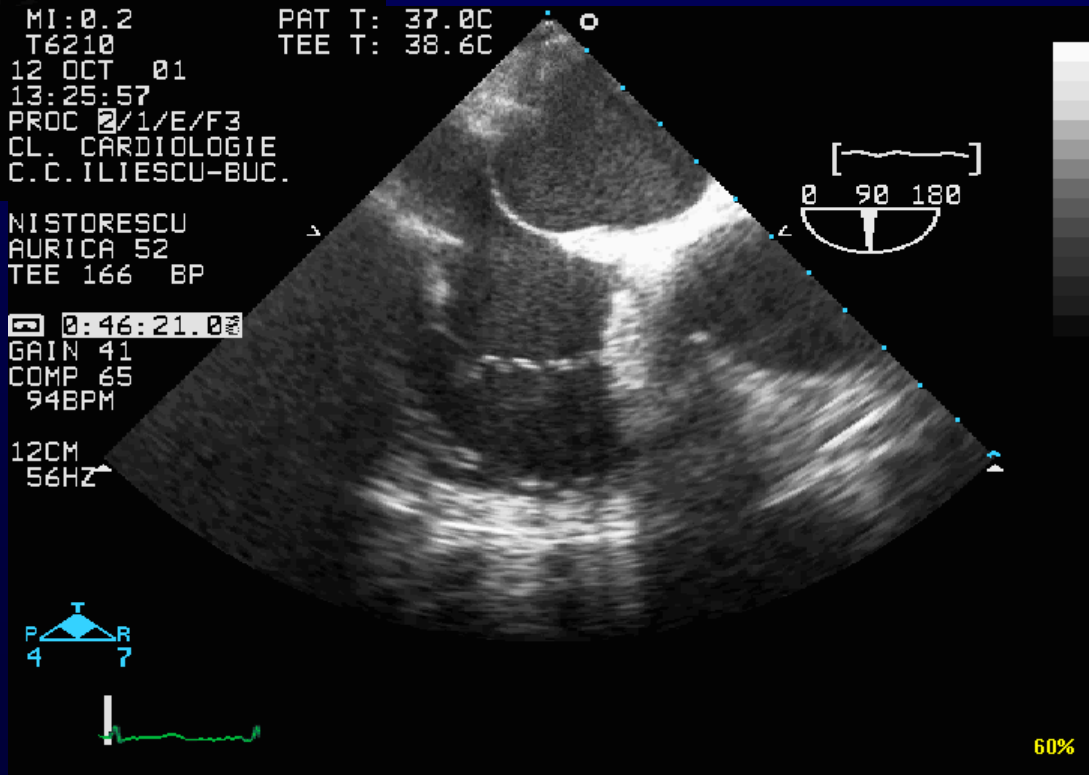
Clinical characteristics	Anatomic characteristics
• Old age	• Wilkins score > 8
• History of commissurotomy	• Cormier score 3
• NYHA class IV	• Very small MVA
• Atrial fibrillation	• Severe TR
• Severe pulmonary hypertension	

- Symptomatic pts with contraindication or high risk for surgery (Class IC)

ESC Guidelines on the management of valvular heart disease. *EHJ 2007; 28: 230-68*



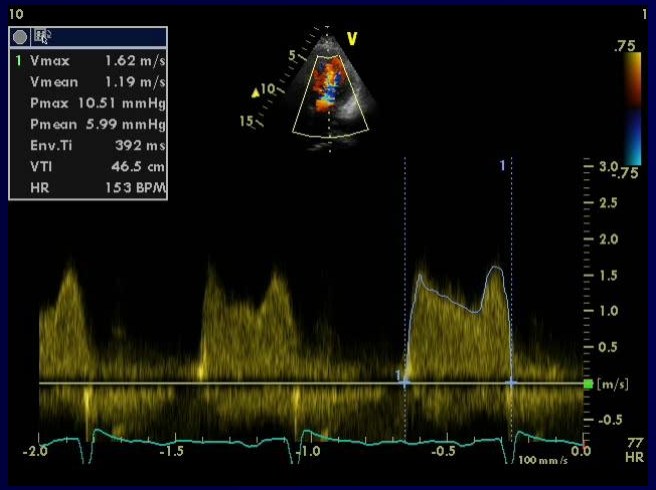
Rule out LA/LAA thrombus

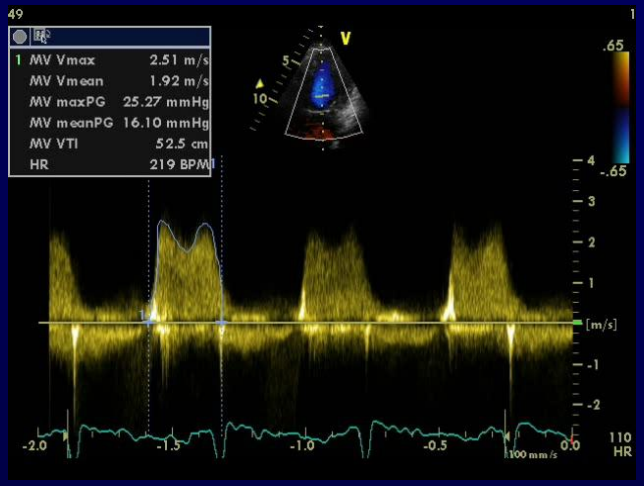


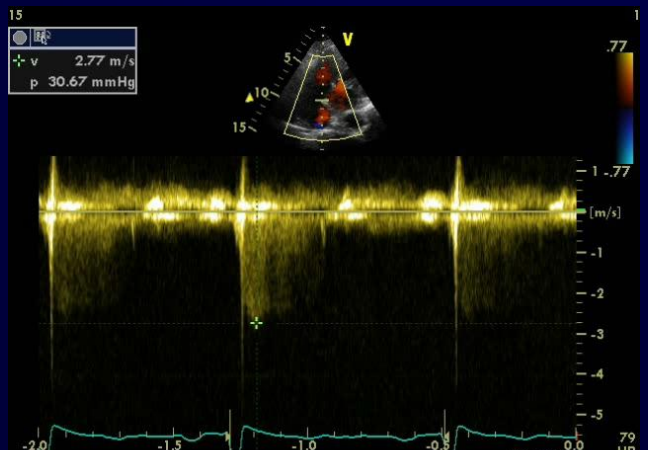
Interatrial septum morphology

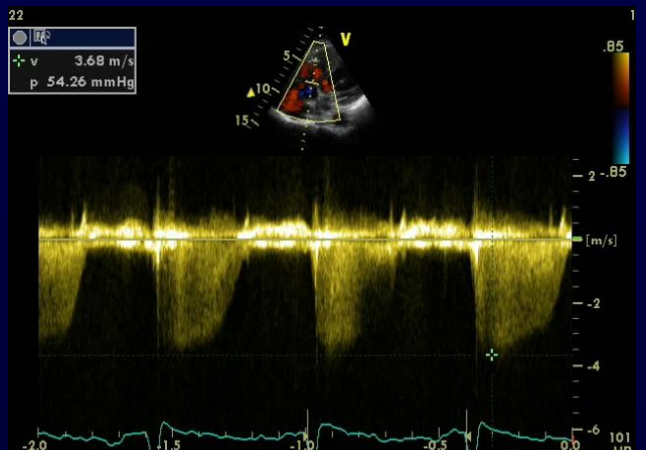
Exercise echocardiography

- To unmask symptoms in pts with MVA <1.5 cm^2 and no or doubtful complaints
- When there is a discrepancy between resting Doppler echocardiographic findings and clinical findings









Remember

- Always measure:
  - Mean pressure gradient
  - MVA by ≥ 2 methods (planimetry, PHT)
  - SPAP using peak TR jet velocity
  - LA size
- Carefully look at the other valves (Tricuspid!)
- When severity in doubt: exercise echo
- TEE in selected cases (inconclusive TTE, to rule out thrombi, to decide for PMC)