Doppler Evaluation of Valvular Stenosis;

Is he a reliable guy or an ugly liar?

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Echocardiographic evaluation of Valvular Stenosis

- Valve anatomy
- Stenosis severity
- Cardiac remodeling
- Co-existing valvular regurgitation
- Pulmonary vasculature
- Other findings

Comprehensive Evaluation!

Using all the techniques available

The importance of 2D images

- Evaluation of valve anatomy
- Determination of etiology of valvular stenosis
- Measurement of stenotic lesion severity with planimetry

Doppler evaluation

Flow dynamics across stenosis

A1 < A2 → **V1 > V2** → **ΔP**

Simplified Bernoulli's Equation

$$\Delta P = 4v^2$$

A Golden Rule?

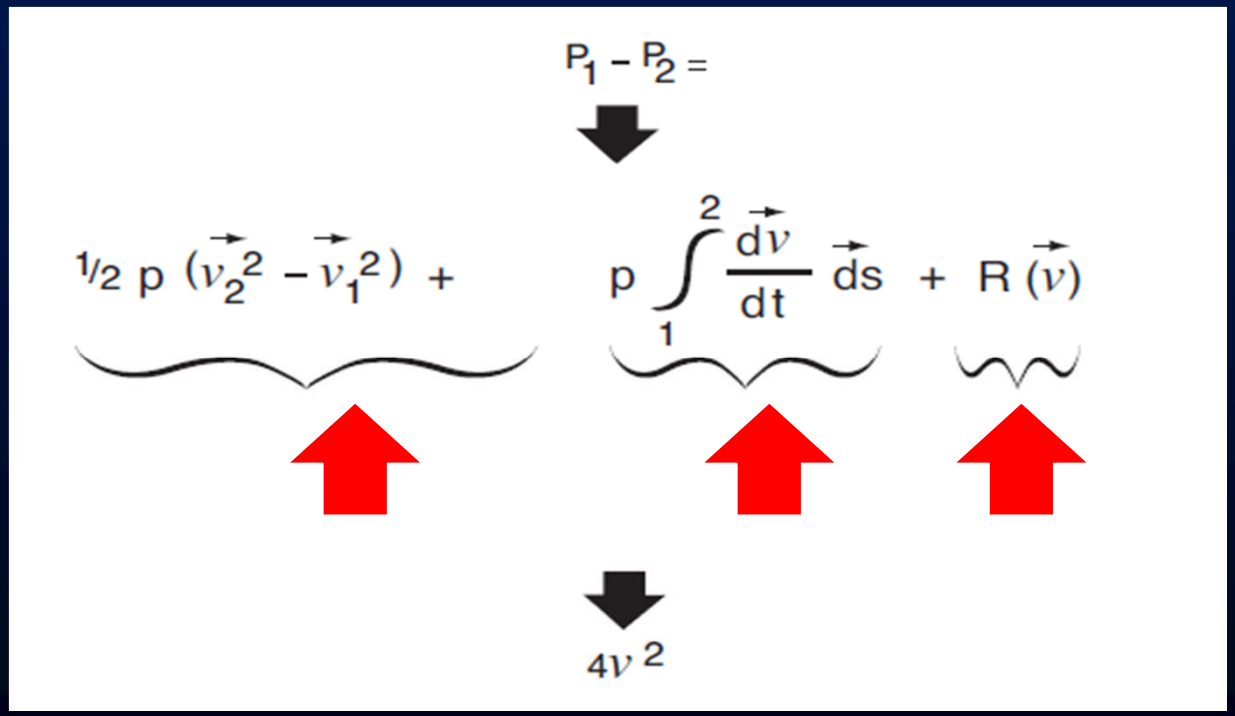
Maybe not!

For example,

there is one thing

that we have to think about.

“Simplified” Bernoulli Equation: $\Delta P = 4V^2$



The main hypothesis

V1 should be much higher than V2 to use the simplified Bernoulli's equation.

$\Delta P = 4(V_1^2 - V_2^2)$

The more complete form of the equation should be used

- In AS cases where the proximal velocity is >1.5 m/s and the distal velocity is only modestly elevated (<3.5 m/s)
- Some cases of MS
- Some cases of TS

Doppler evaluation is a double edged sword.

Advantages

Pitfalls

Doppler evaluation

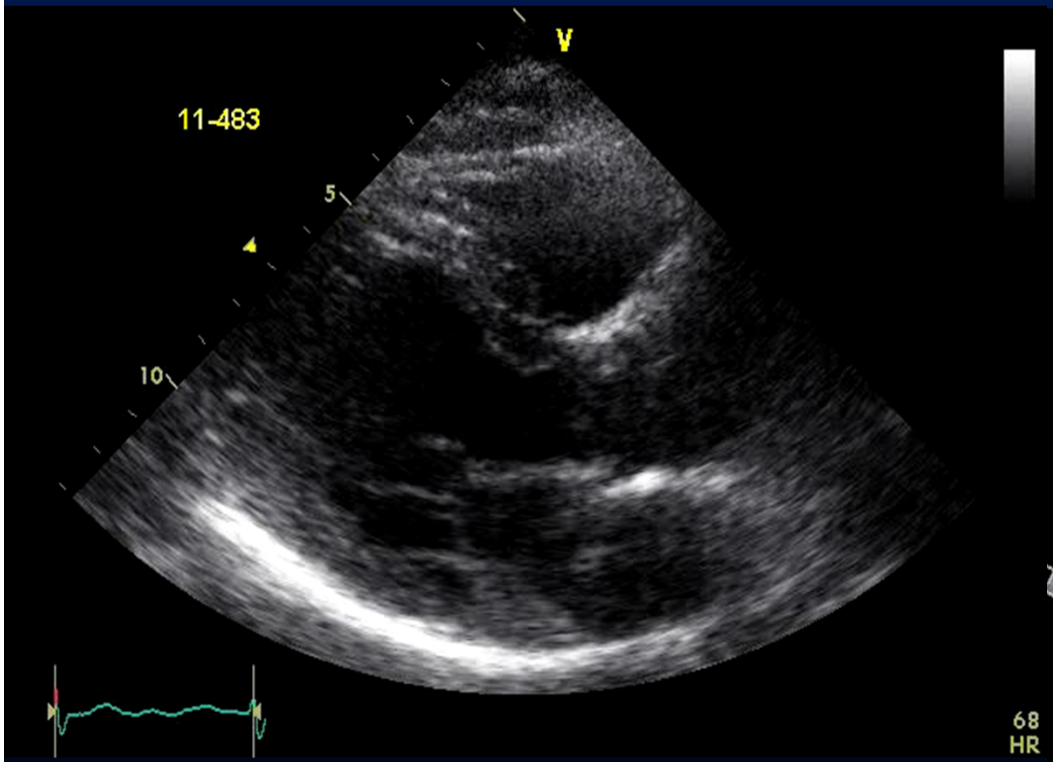
A very sharp and reliable guy At least sometimes……

Doppler evaluation

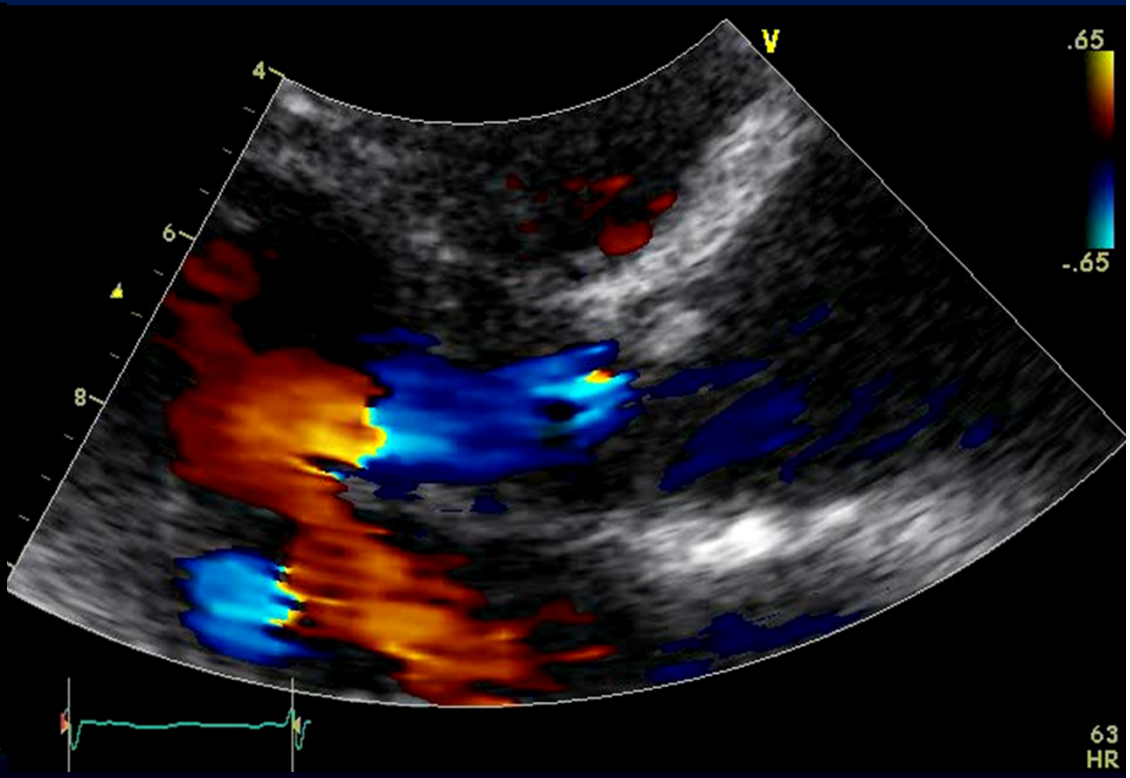
A ugly
Big fat liar
Maybe
in othertimes……

Case # 1. M/41 with systolic murmur

TTE



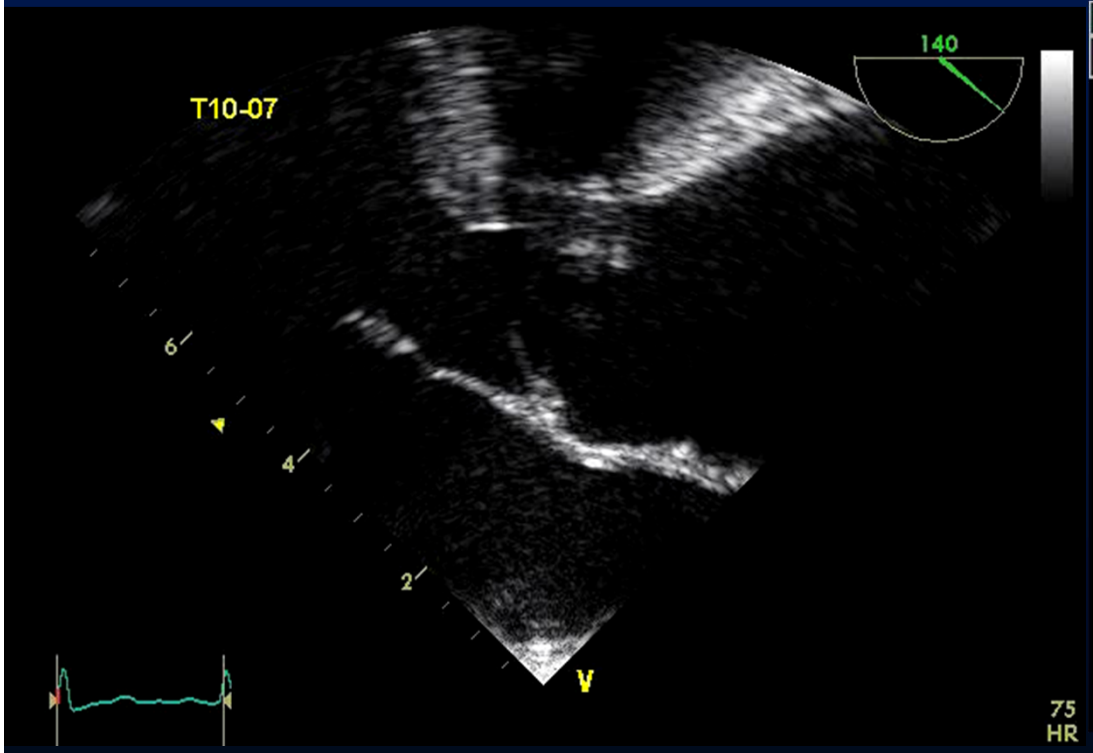
Doming AV

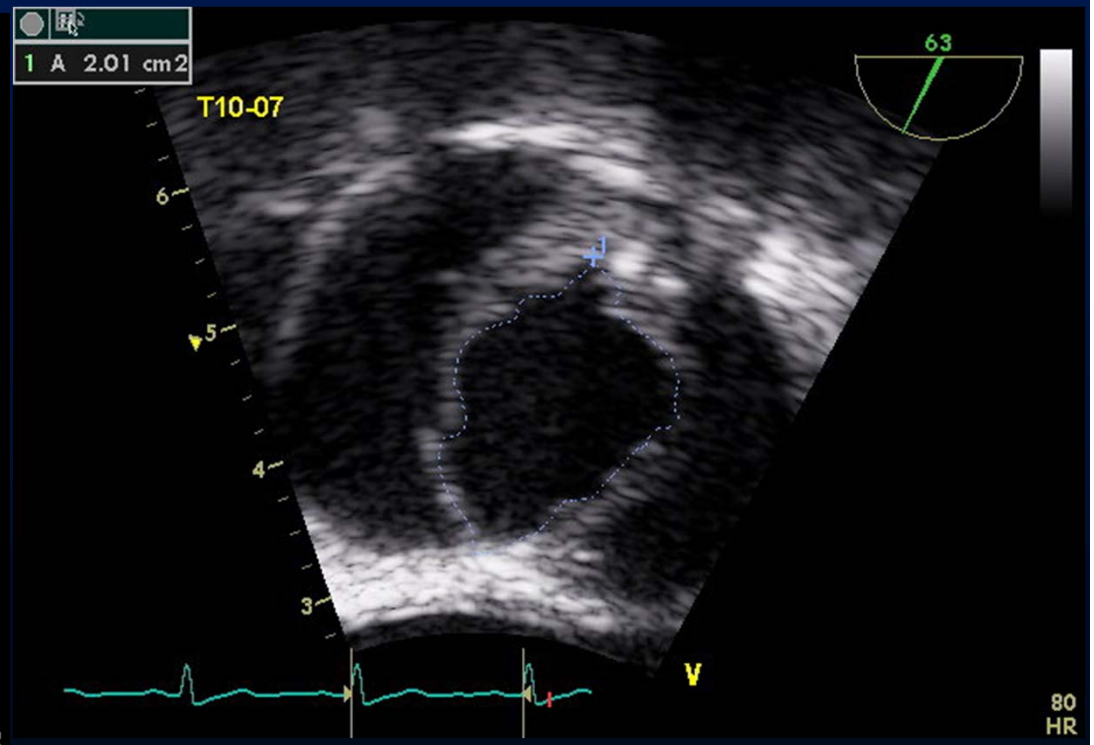


Turbulent flow across AV

Case # 1. M/41 with systolic murmur

TEE



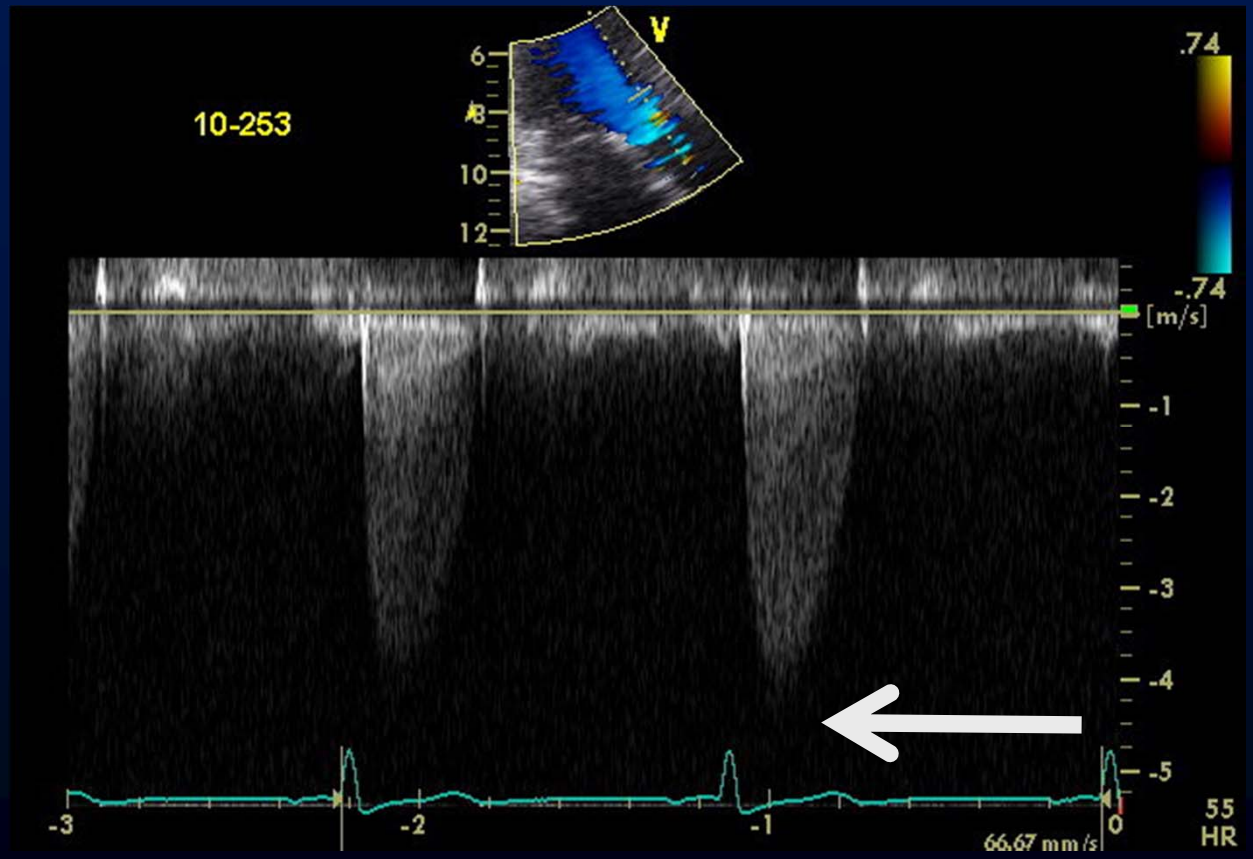


Bicuspid AV

AVA: 2.01cm^2 with planimetry

Case # 1. M/41 with systolic murmur

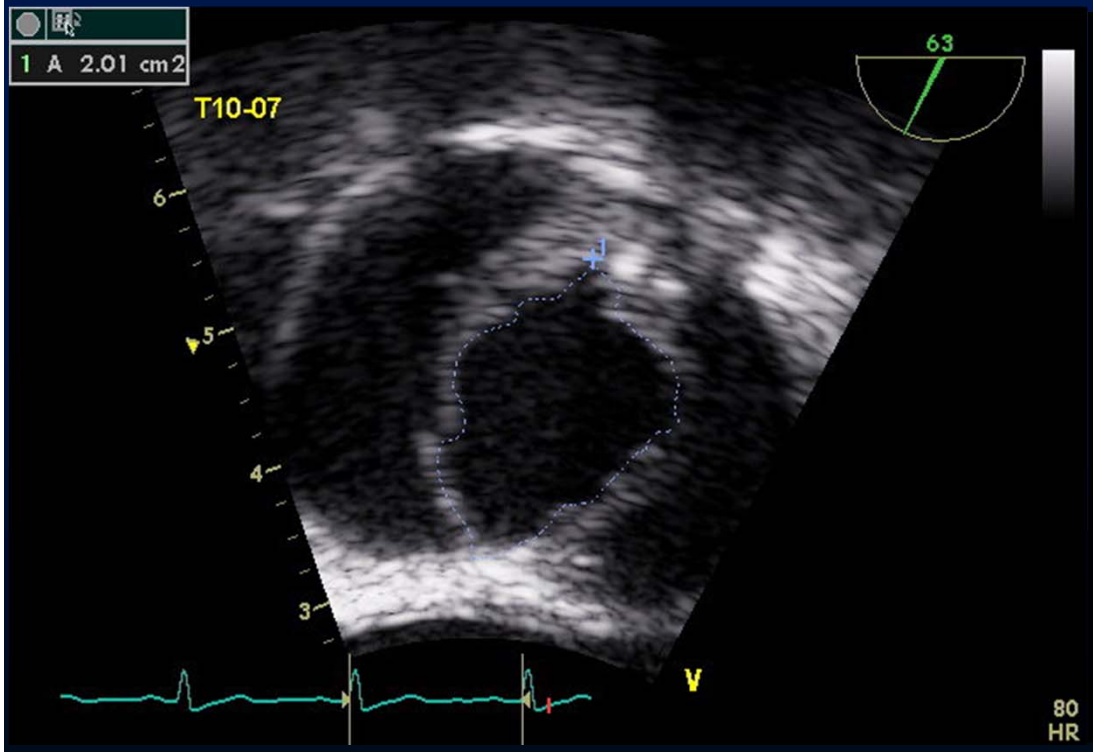
Doppler evaluation

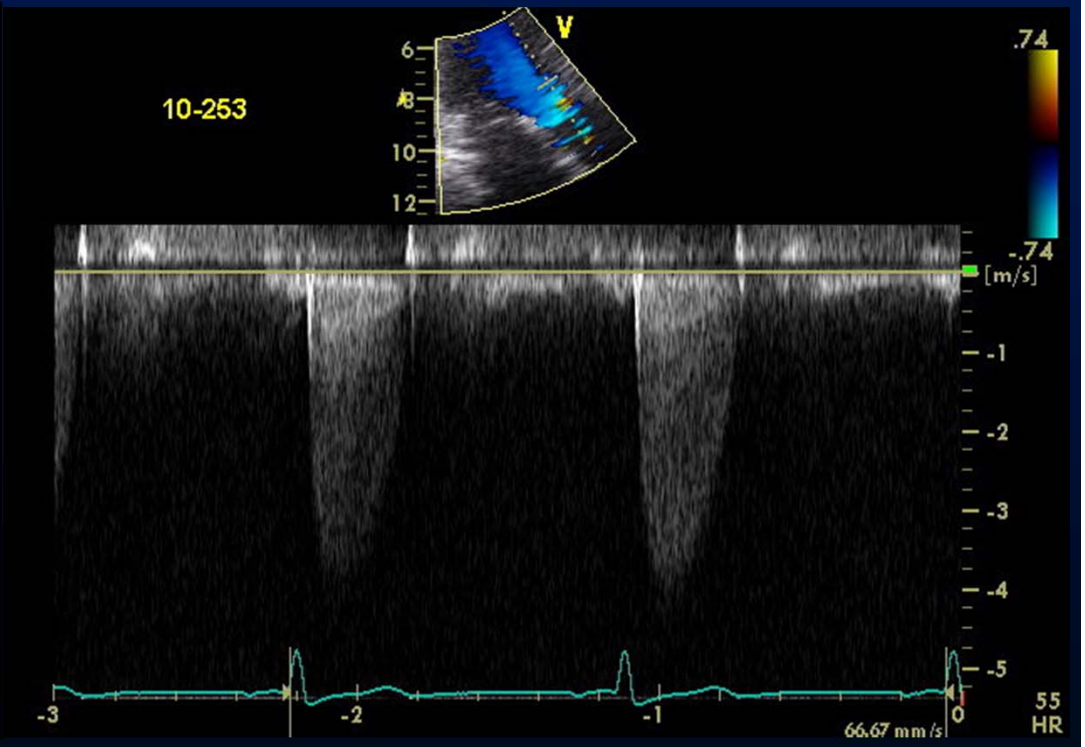


Peak velocity: 4.5 m/s

Mean PG: 42 mm Hg

How can we explain the discrepancy?



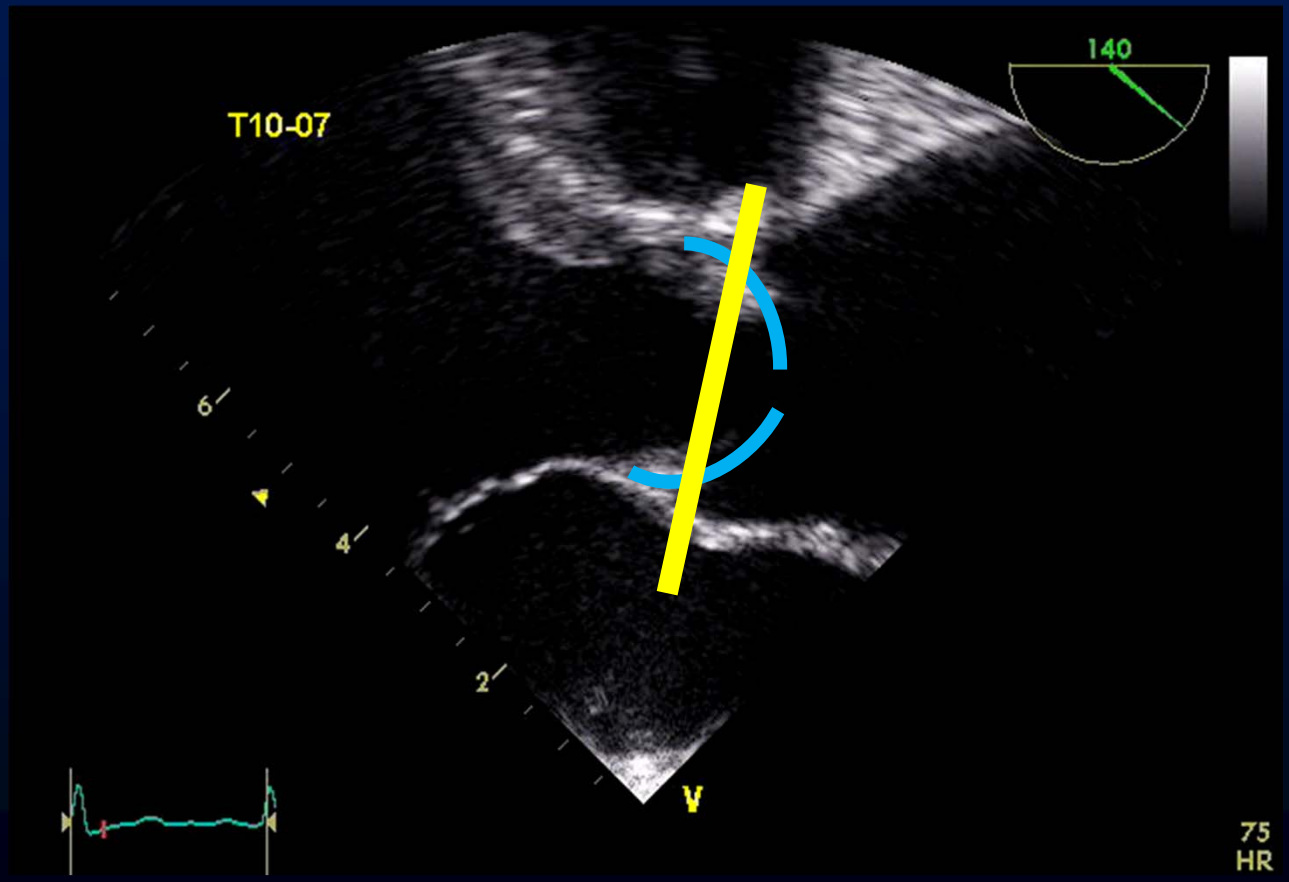


Insignificant AS?

Severe AS?

Doppler evaluation > 2D evaluation

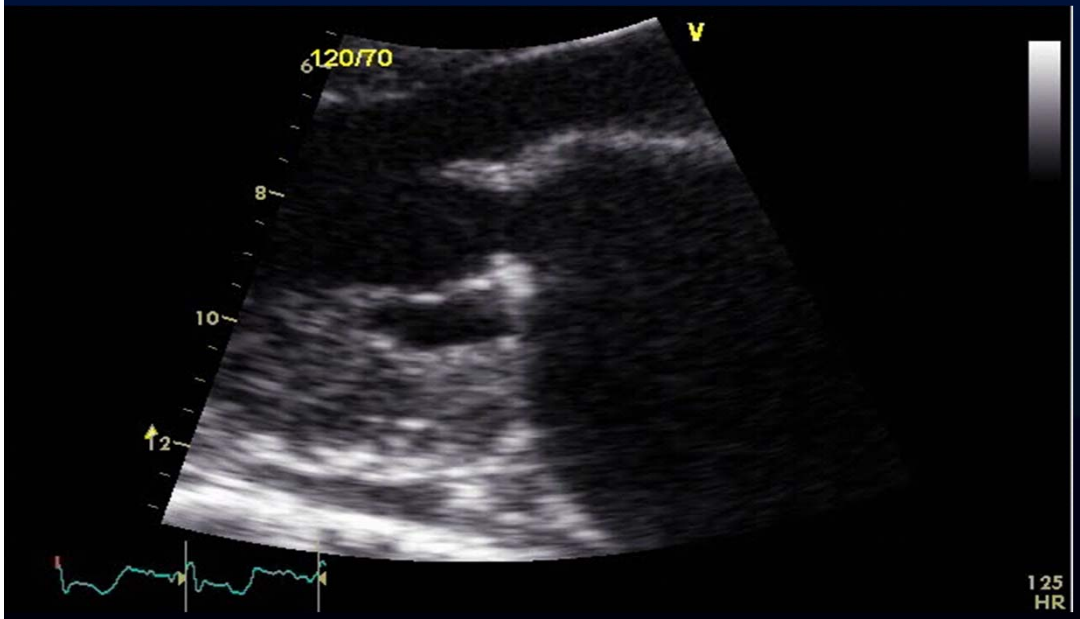
inappropriate cutting plane

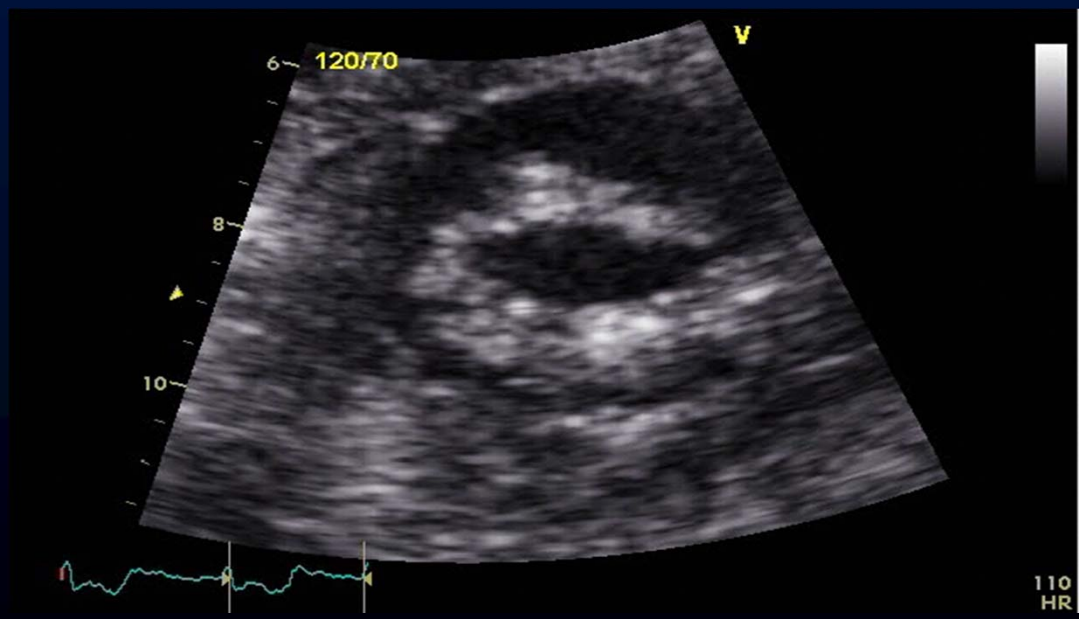


Probably significant AS

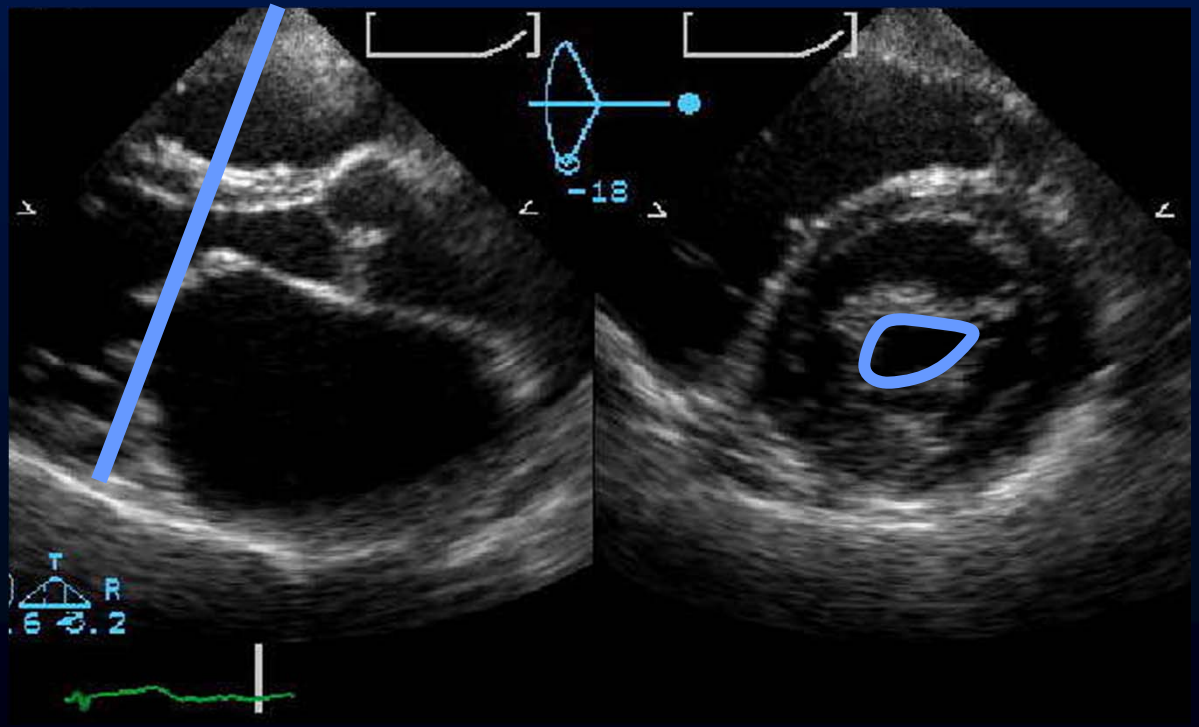
Case # 2. Moderate Mitral Stenosis

- F/35, pregnant
- Dyspnea on exertion (NYHA II/IV)
- Diastolic murmur at the apex



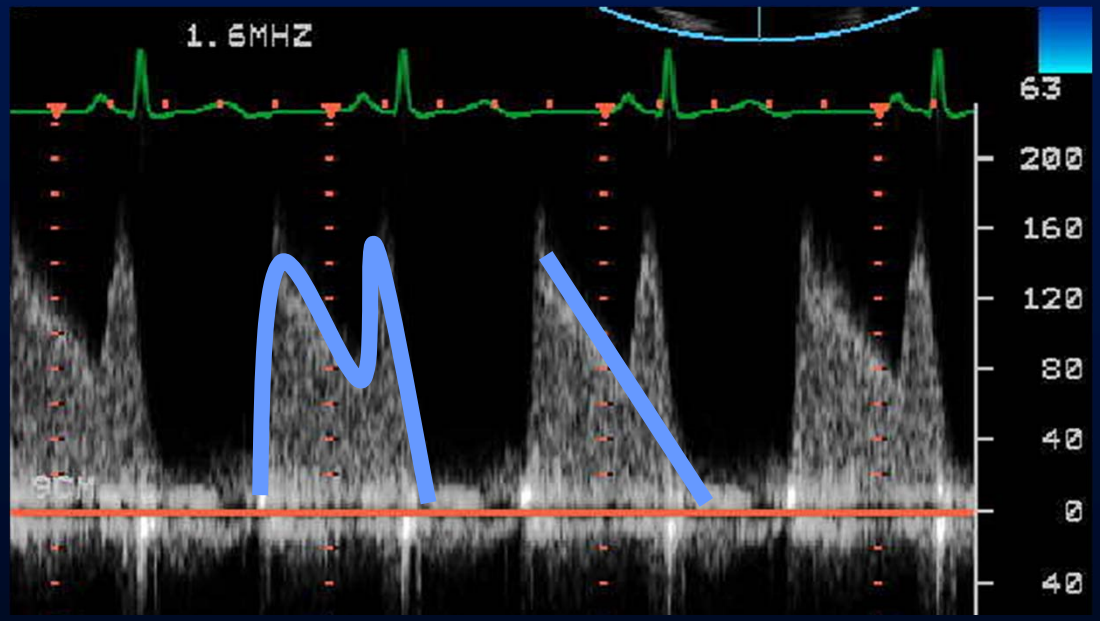


Two dimensional evaluation



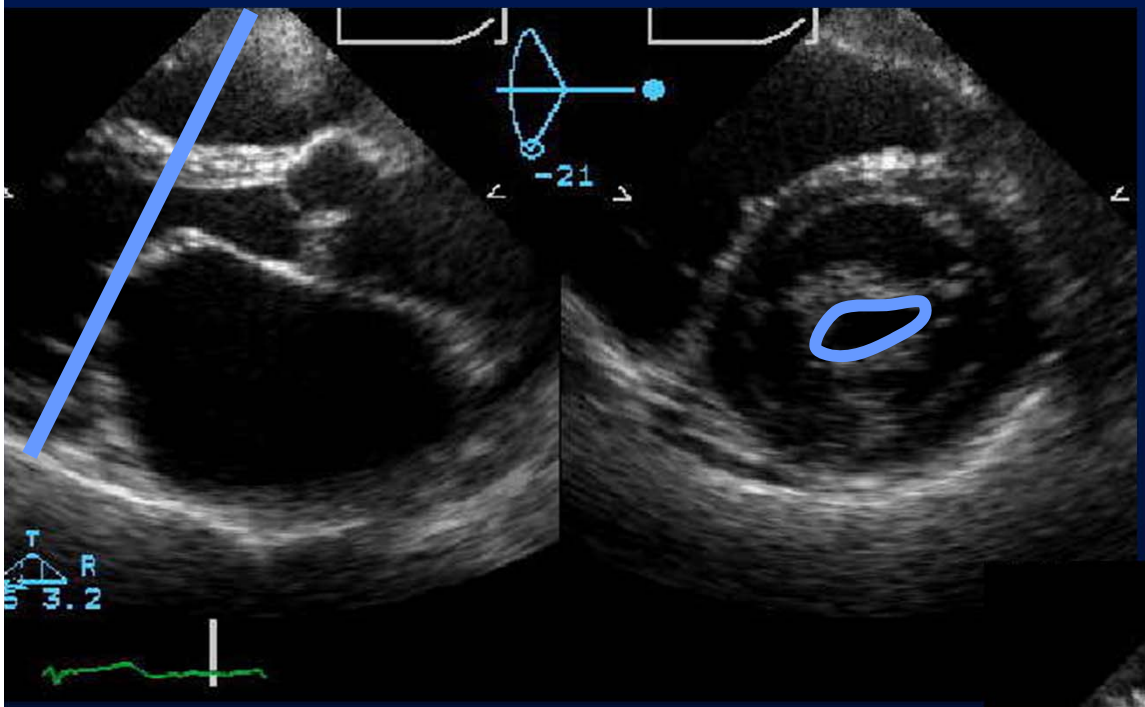
MVA = 1.4 cm^2

Doppler evaluation

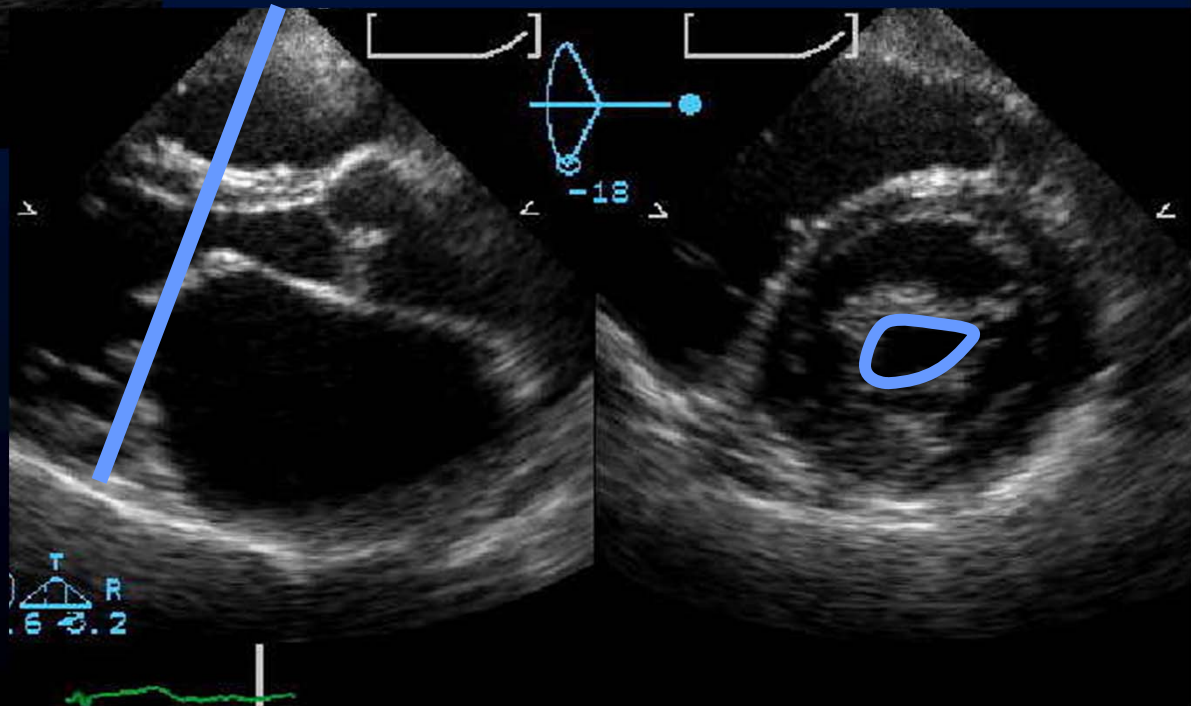


MVA= 1.1cm²
MDPG=6.5 mm Hg

Pitfall in 2D planimetry of VA

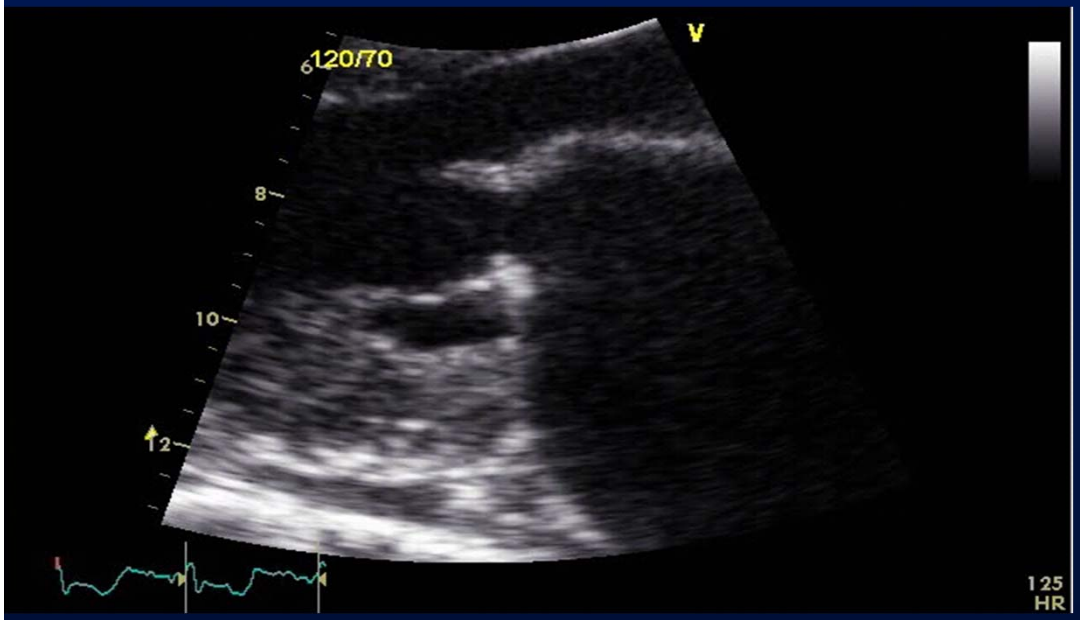


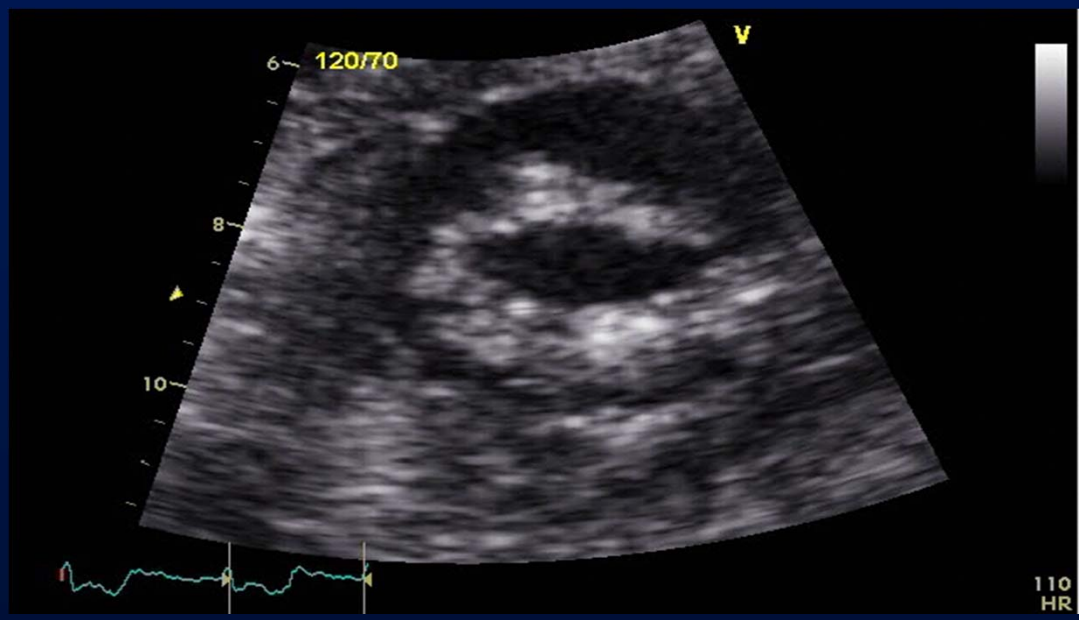
MVA = 1.4cm²

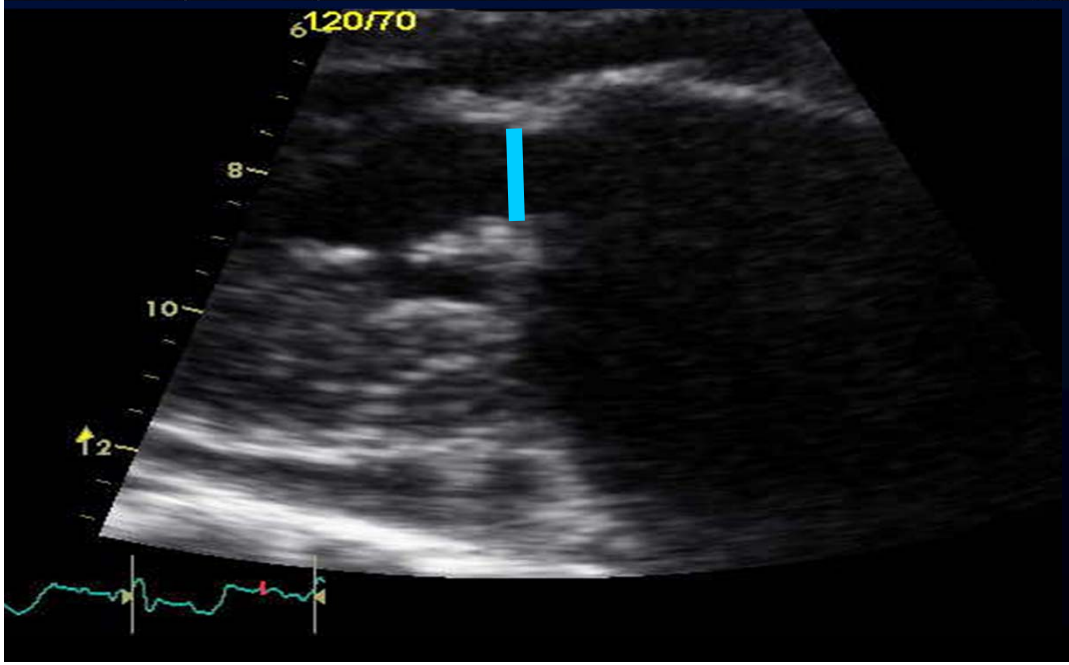


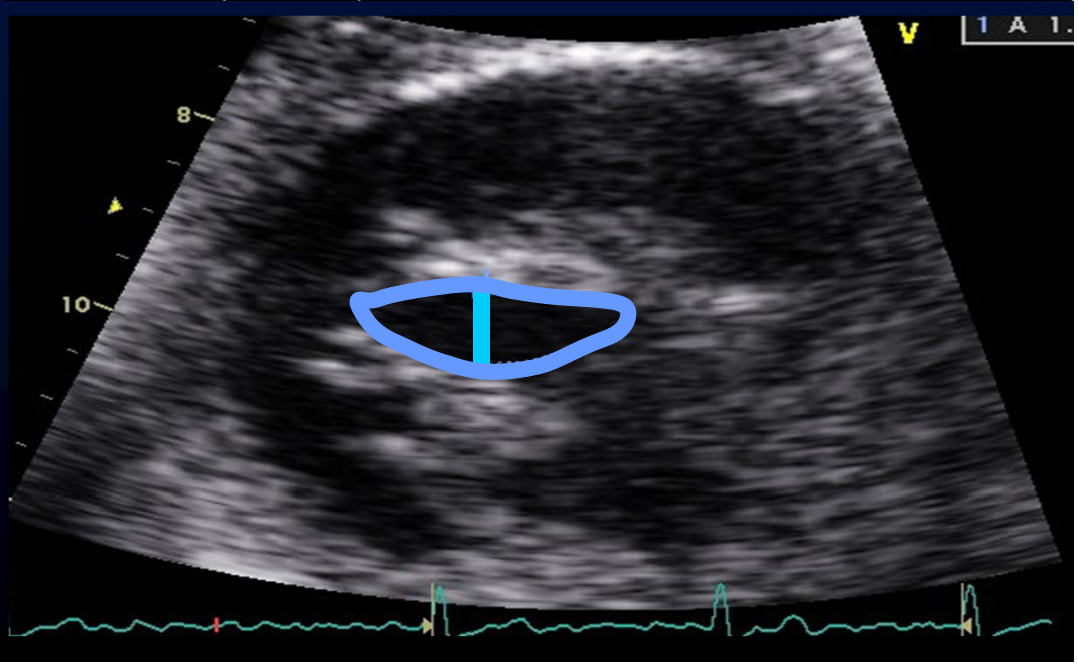
MVA = 1.0cm²

Identify the minimal valve area









Another application of Doppler evaluation

Doppler evaluation during exercise in patients with stenotic valve

Argument for a Doppler echocardiography during exercise in assessing asymptomatic patients with severe aortic stenosis

Guillaume Leurent[1†], Erwan Donal[1*†], Christian de Place[1], Céline Chabanne[1], Renaud Gervais[1], Claire Fougerou[2], Alain le Helloco[1], Jean-Claude Daubert[1], Philippe Mabo[1], and Marcel Laurent[1]

- Asymptomatic 44 patients with severe AS and preserved LV systolic function
- EST with Doppler evaluation
- 26 patients showed Sx., inadequate BP increase, suboptimal exercise capacity, EKG change or VT (EST +)

Leurent et al. Eur J Echocardiogr, 2009

Methods

- Patients were divided into 2 groups

  Group 1: EST +

  Group 2: EST –

- Echocardiographic parameters were compared

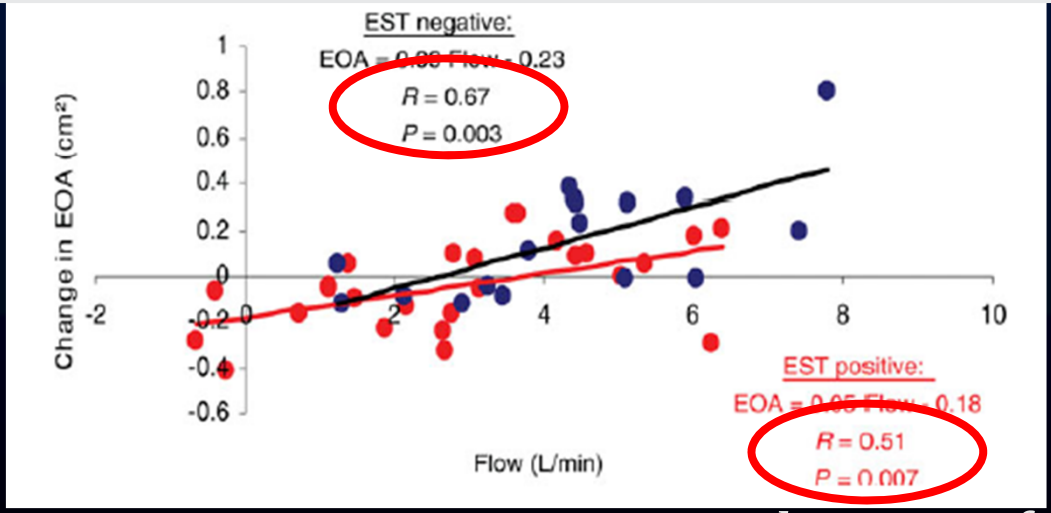
Principal findings

- Resting echocardiographic parameters were not able to predict the EST results in asymptomatic severe AS patients.
- Doppler measurement changes during exercise are related with the EST results

Leurent et al. Eur J of Echocardiogr, 2009

Doppler: useful tool in exercise echocardiography in AS

	Exercise stress test		
	Positive (Group 1) ($n = 26$)	Negative (Group 2) ($n = 18$)	*P*-value
Aortic area (cm^2)	-0.04 ± 0.18	$+0.15 \pm 0.24$	0.015
Cardiac output (L/min)	$+2.9 \pm 2$	$+4.3 \pm 1.8$	0.04
Heart rate (bpm)	$+51.8 \pm 15$	$+50.5 \pm 8$	0.9
Mean gradient (mmHg)	$+12 \pm 11$	$+8 \pm 8$	0.3
Peak gradient (mmHg)	$+20 \pm 17$	$+11 \pm 15$	0.09
Trans-aortic Vmax (m/s)	$+2.17 \pm 0.9$	$+1.5 \pm 1.1$	0.1
Stroke volume (mL)	-6.2 ± 19	$+3.6 \pm 16$	0.08
Tricuspid leak Vmax (m/s)	$+1.36 \pm 0.5$	$+1.1 \pm 0.6$	0.4



Leurent et al. Eur J of Echocardiogr, 2009

Conclusion # 1

Valve compliance assessed with Doppler during EST

- Different response to exercise might be related to "valve compliance"

Conclusion # 2

Doppler evaluation during EST

- **Doppler evaluation during exercise can assess the mechanisms behind a abnormal hemodynamic response.**

Conclusion # 3

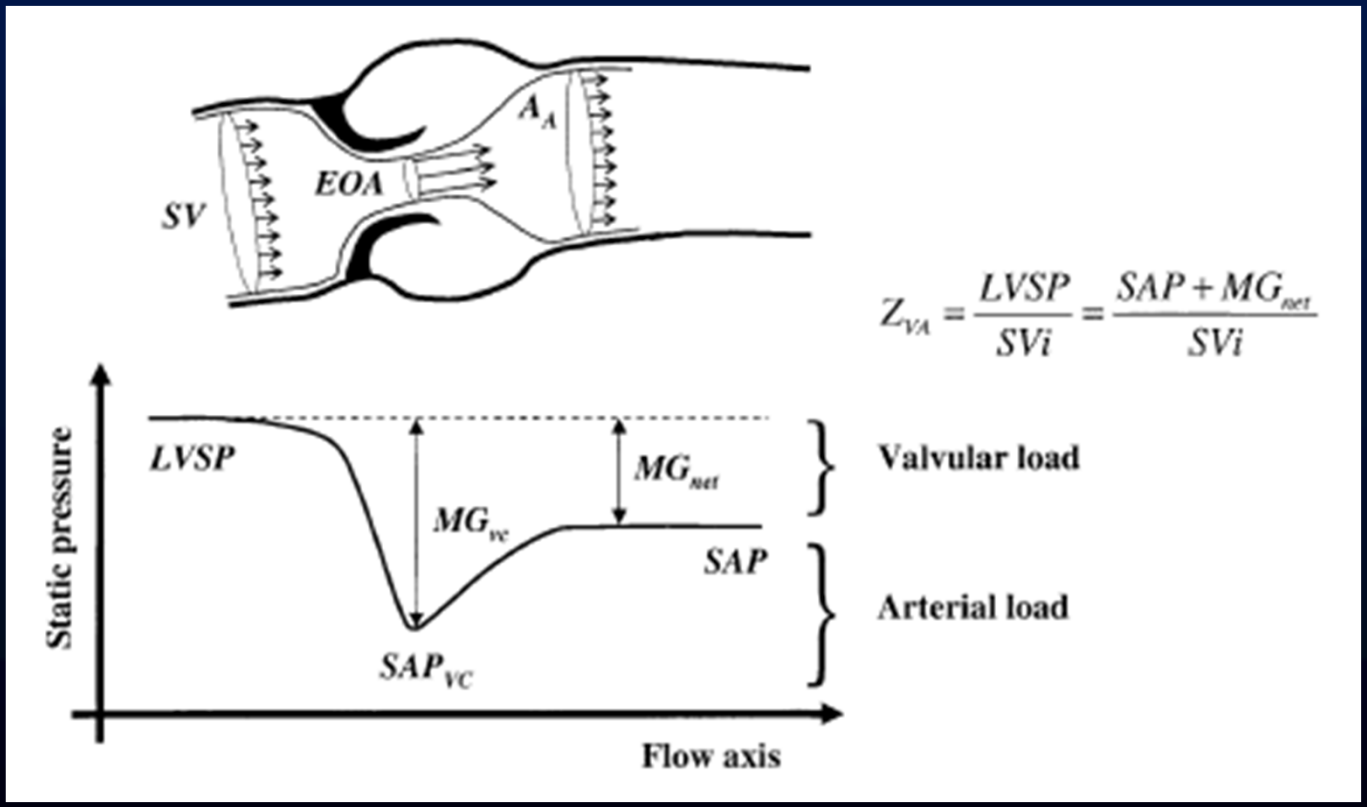
Doppler evaluation in patients with severe AS without Sx.

- **It may represent a promising tool in patients with severe asymptomatic AS.**

One more novel concept in AS

Global LV afterload

=valvular load + arterial load



Briand et al. JACC, 2005

Risk stratification in asymptomatic moderate to severe aortic stenosis: the importance of the valvular, arterial and ventricular interplay

Patrizio Lancellotti,[1] Erwan Donal,[2] Julien Magne,[1] Marie Moonen,[1] Kim O'Connor,[1] Jean-Claude Daubert,[2] Luc A Pierard[1]

- **163 asymptomatic significant AS pts.**
- **Exercise Doppler evaluation**
- **Predictor of outcomes**

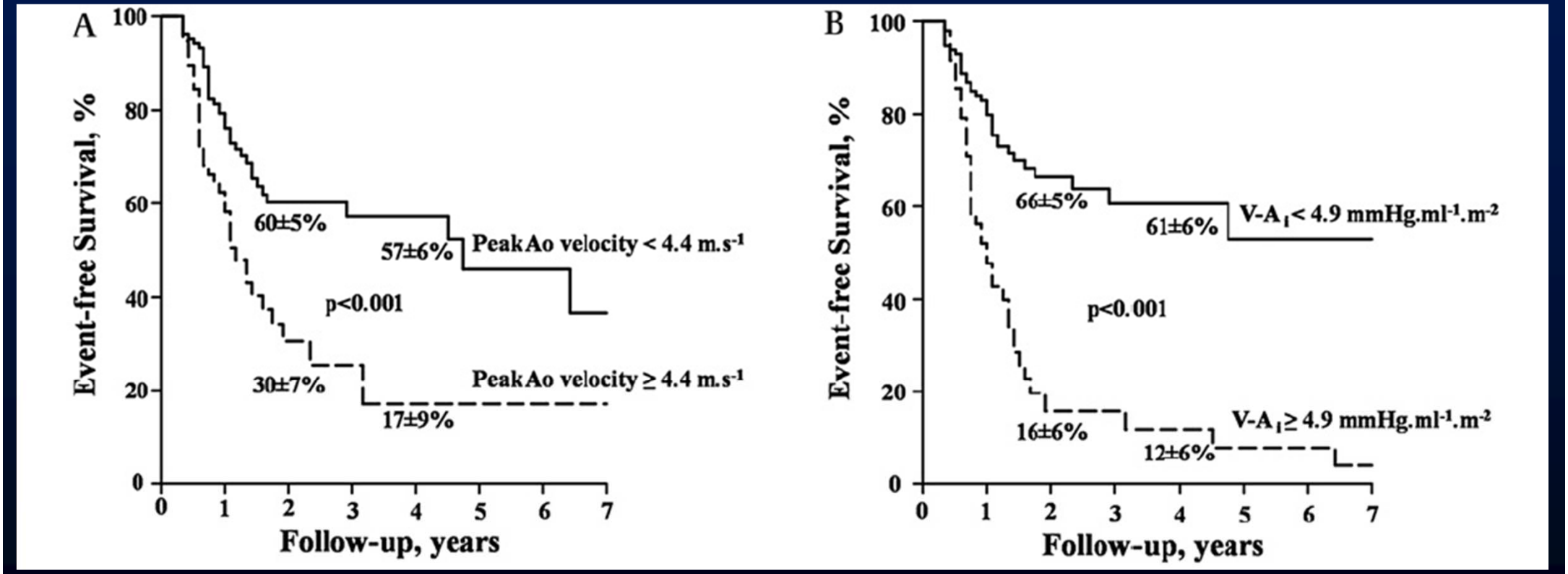
Lancelloti et al. Heart, 2011

Four predictors of outcomes

- Aortic jet velocity: stenosis severity
- Valvulo-arterial impedance: an estimate of global LV afterload
- LA size: a marker of LV diastolic function
- LV long-axis movement: an indicator of subclinical LV systolic function.

Lancelloti et al. Heart, 2011

AS severity and net LV afterload



Lancelloti et al. Heart, 2011

Conclusion

AS depends not only on stenosis severity but also on the level of LV load and its consequences on LV function.

Lancelloti et al. Heart, 2011

Novel application of Doppler echocardiography

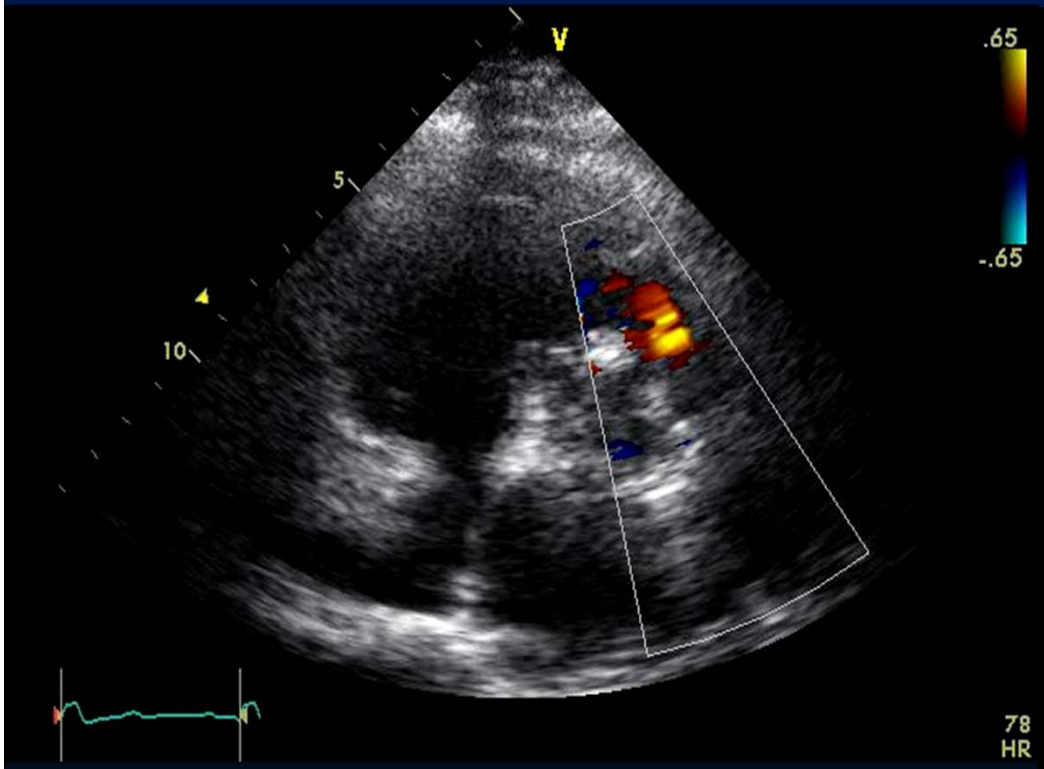
Doppler evaluation is a simple but promising and unique tool for comprehensive evaluation of valvular stenosis.

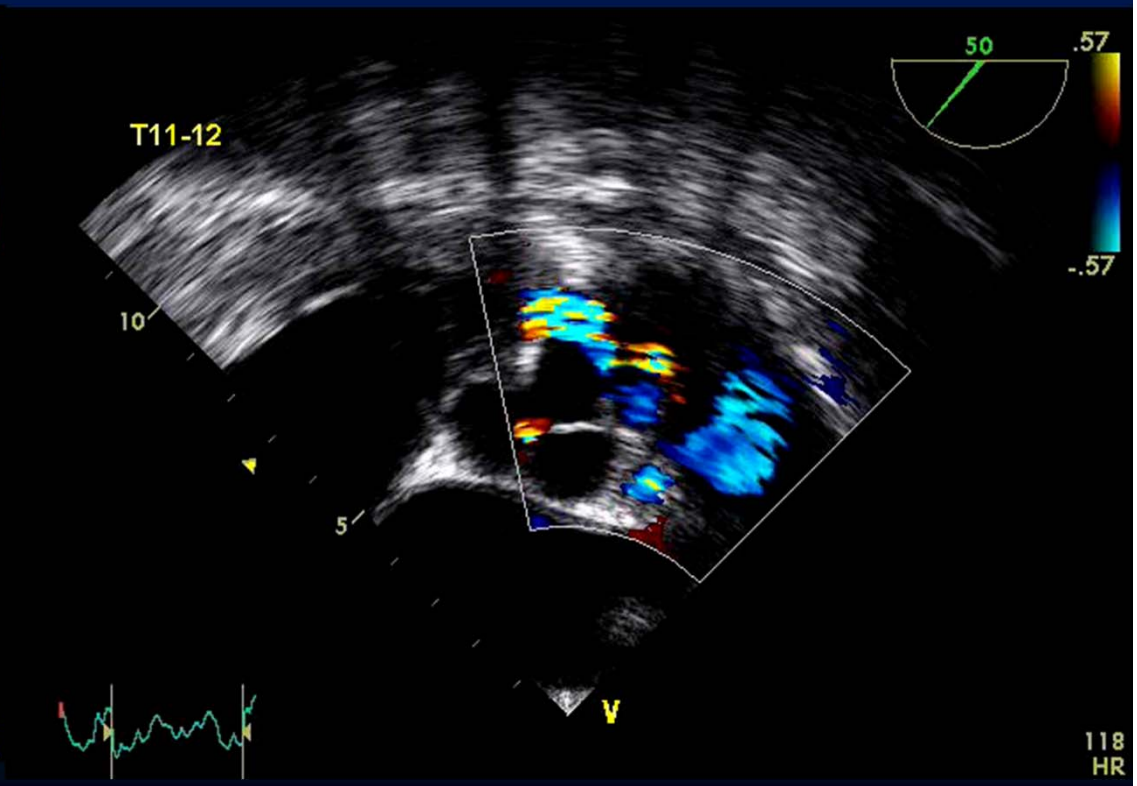
However……

Doppler evaluation can be transformed into a liar.

Case # 3. F/65 with systolic murmur

TTE and TEE

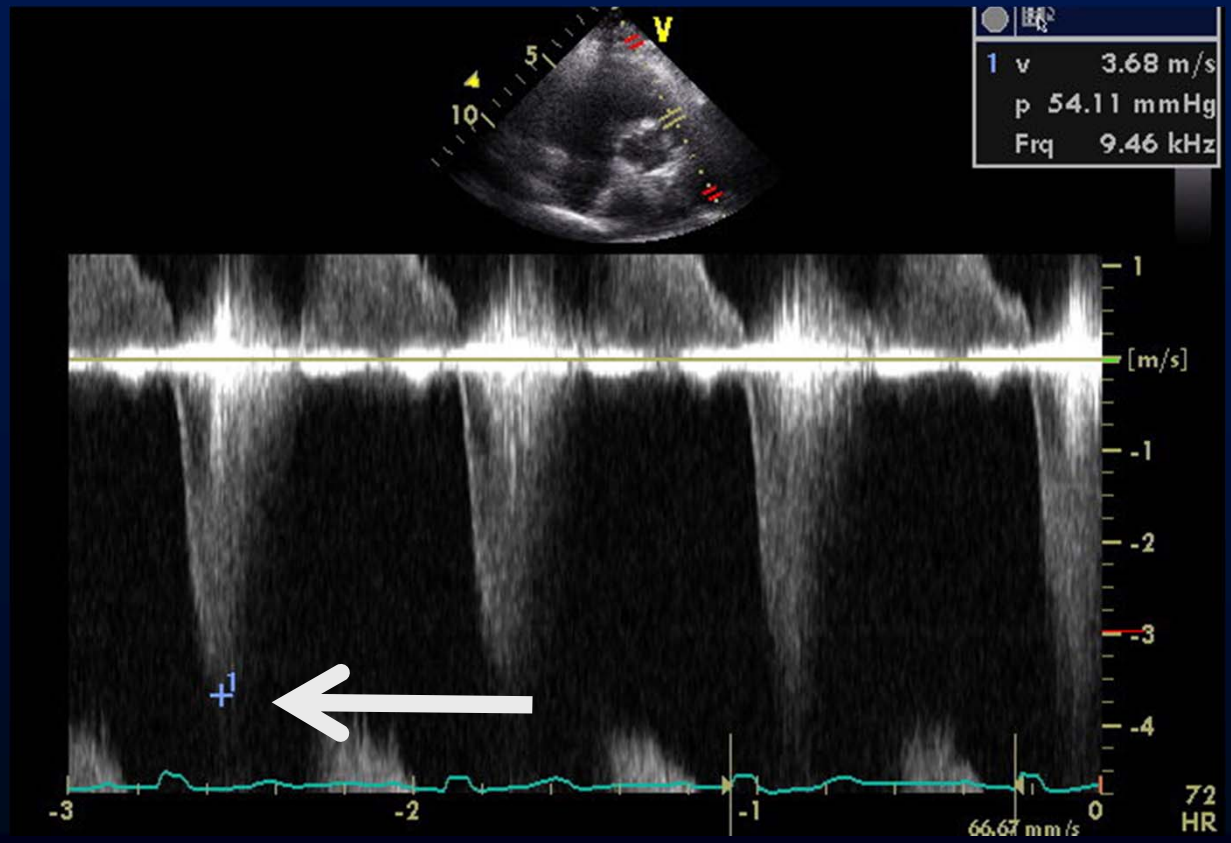




Turbulent flow at RVOT

Case # 3. F/65 with systolic murmur

TTE and TEE

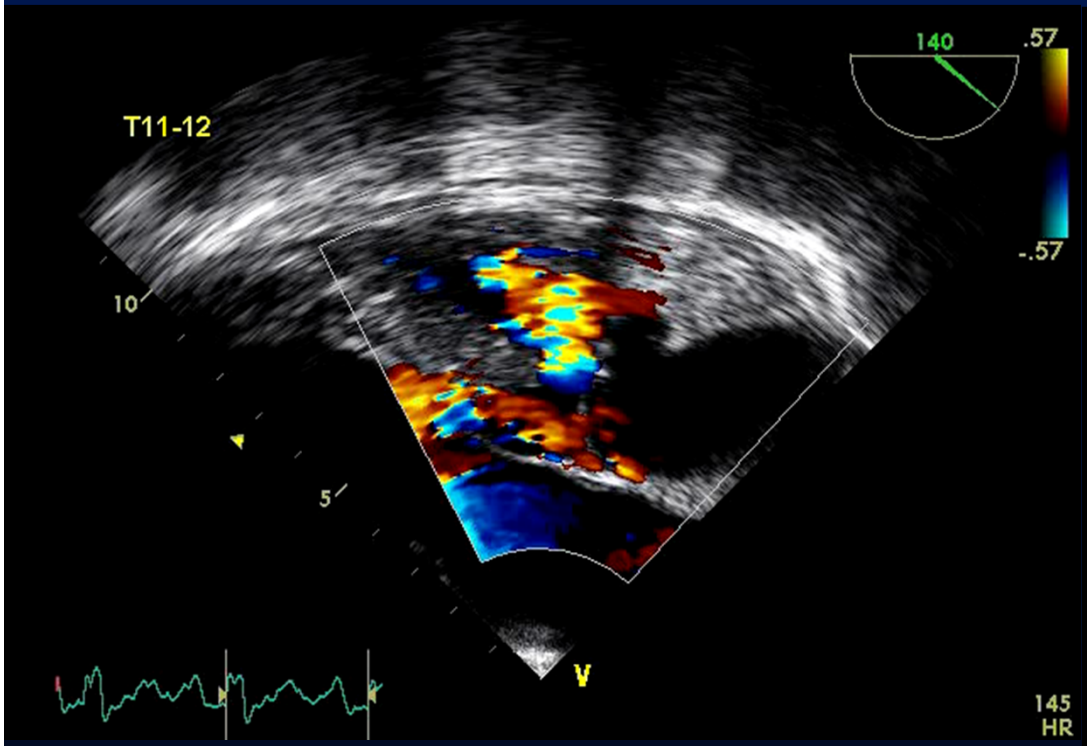


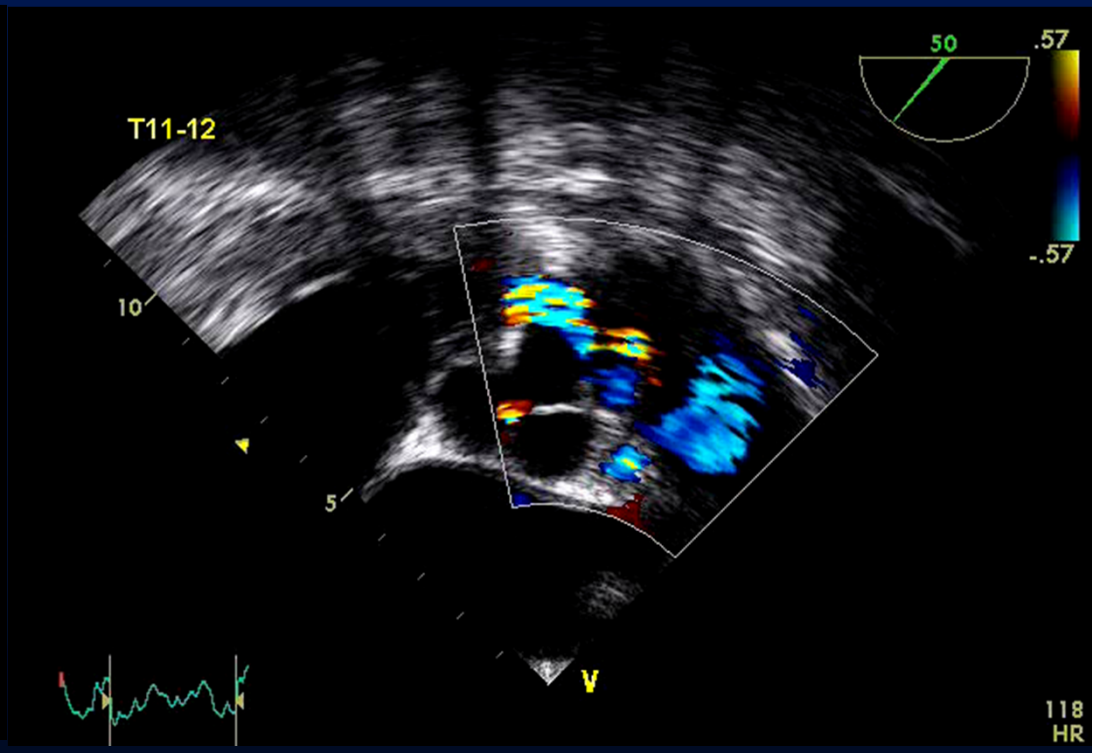
Peak velocity: 3.7 m/s
Peak PG: 54 mm Hg

→ **Severe PS?**

Case # 3. F/65 with systolic murmur

TEE





VSD

Increased flow at RVOT

Case # 3. F/65 with systolic murmur

VSD

- Severe PS? Are you sure?
- Increased velocity should not be directly translated into a valvular stenosis.
- Because the blood flow velocity is also dependent on flow rate, along with valve stenosis.

Be careful!

When using Doppler evaluation in valvular stenosis

Take Home Messages

- Comprehensive evaluation is required in determining the severity of valvular stenosis.
- Be well-acquainted with advantages and pitfalls of Doppler evaluation.

Thank you for your attention