Strategies for differentiating and confirming truly severe AS

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Aortic Stenosis

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AHA & ACC Guidelines

Indicator	Mild	Moderate	Severe
Jet velocity	< 3.0 m/s	3.0 – 4.0	> 4.0 m/s
Mean gradient	< 25 mmHg	25 – 40	> 40 mmHg
Valve area	> 1.5 cm^2	1.0 – 1.5	< 1.0 cm^2

Relation of AS Gradient & Area

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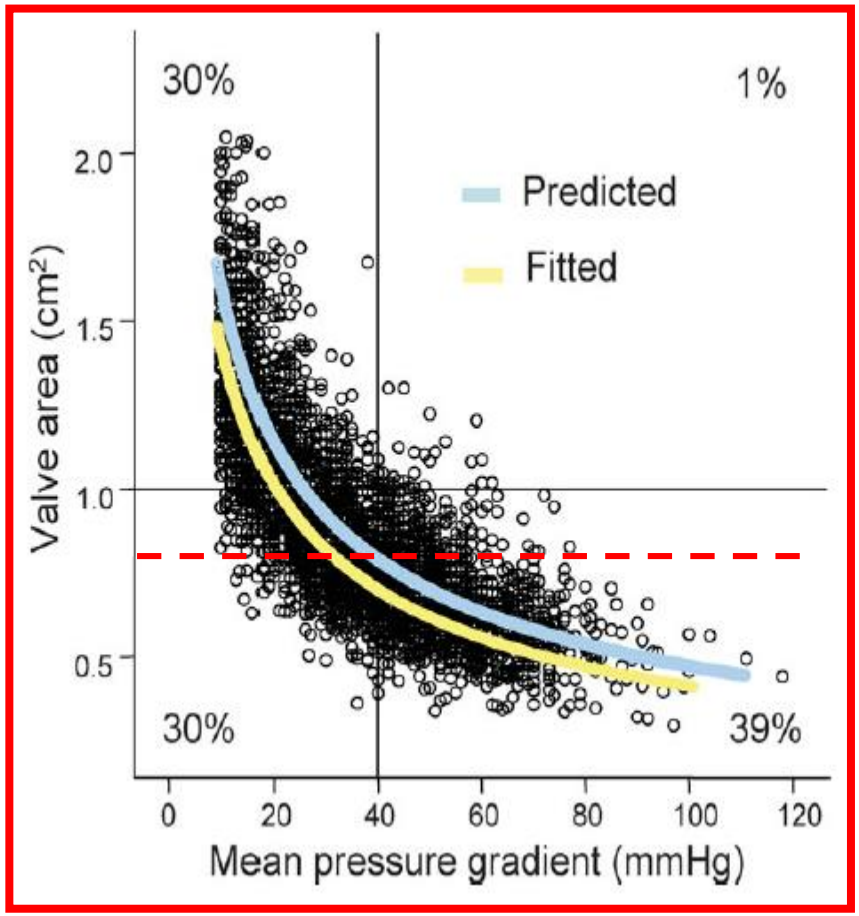
Gradient cut-off of >40 mmHg specific for severe AS

Valve Area < 1 cm^2 is more sensitive

Gradient vs. Valve Area



Minners J et al European Ht J 2008: 29, 1043

Ensuring Vmax capture

Takes patience, skill, commitment

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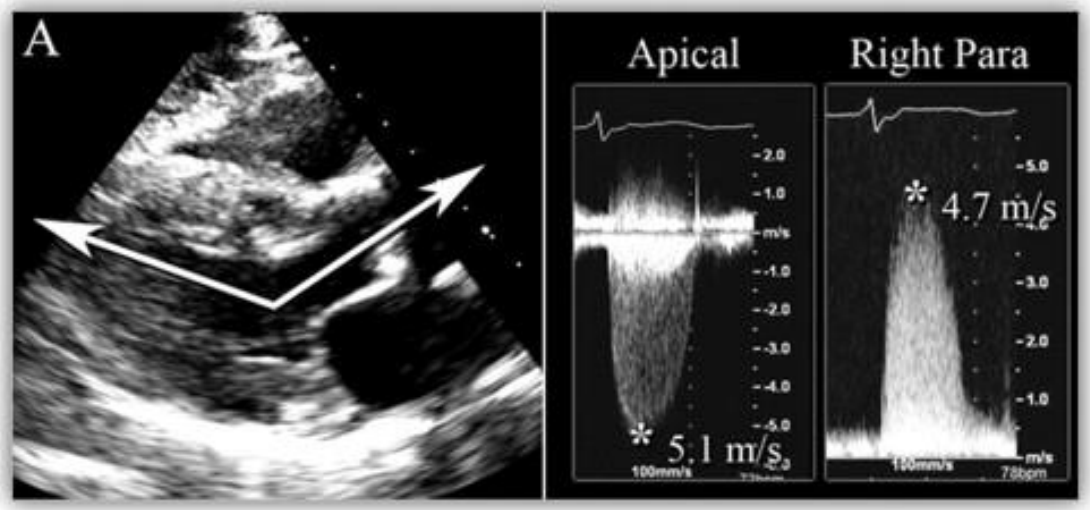

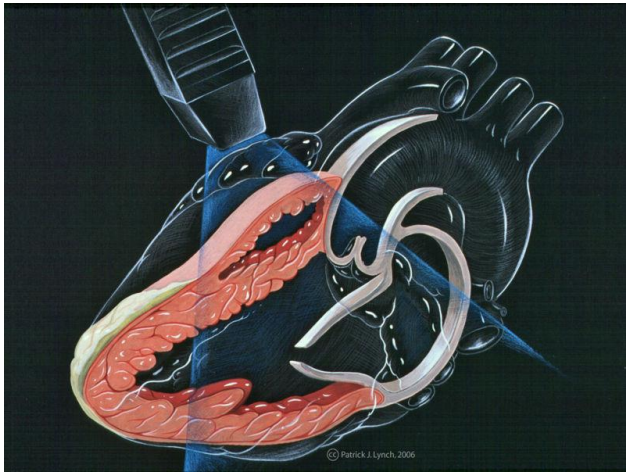

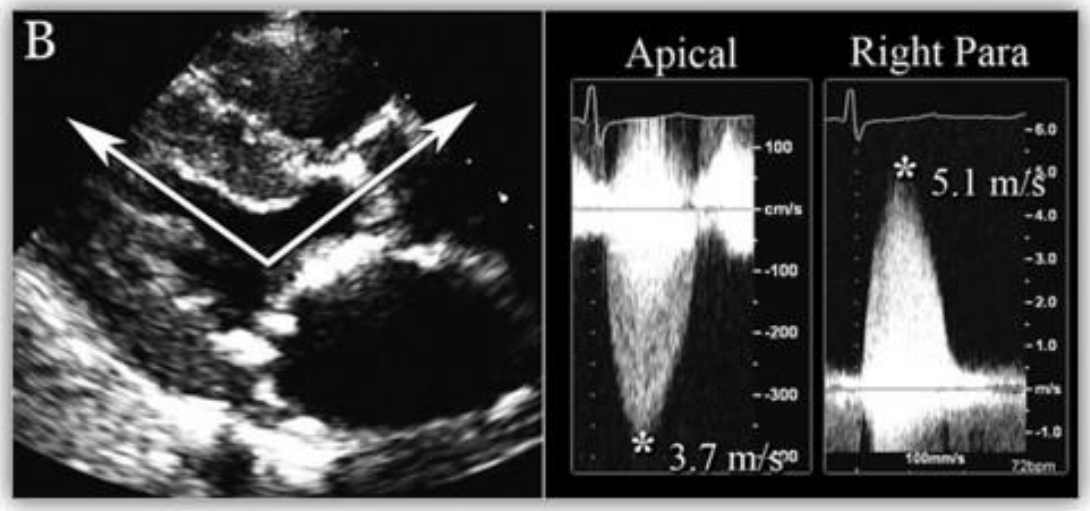

Vmax:

- RPS in 50%
- apex in 39%

Thadden et al. JASE 2015; 28:780-5

Continuity Equation Pitfalls

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- Accuracy of the LVOT diameter
  - error is squared
- LVOT velocity
  - Angle θ
  - Use laminar flow before pre-stenotic acceleration
- CW aortic velocity inaccuracy
  - measure signal at multiple windows
  - Distinguishing AS from MR
- Non-simultaneous measurement of LVOT and
- peak velocities
  - Varying cycle lengths

In patients with aortic stenosis

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1. A low-flow state may occur with reduced LV ejection fraction (LVEF) (i.e., *classic low flow*)

2. or with preserved LVEF (i.e., *paradoxical low flow*)

Aortic valve pressure gradient is highly flow-dependent.

Patterns of Aortic Stenosis

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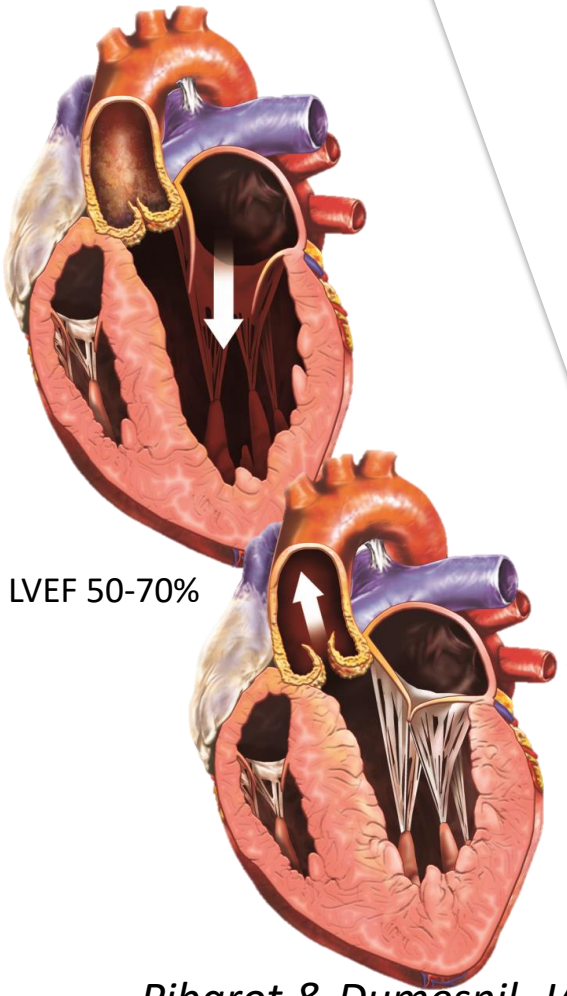
Normal-LVEF
Normal-Flow, High-Gradient



LVEF 50-70%

Pibarot & Dumesnil, JACC

Valve Guideline Definition

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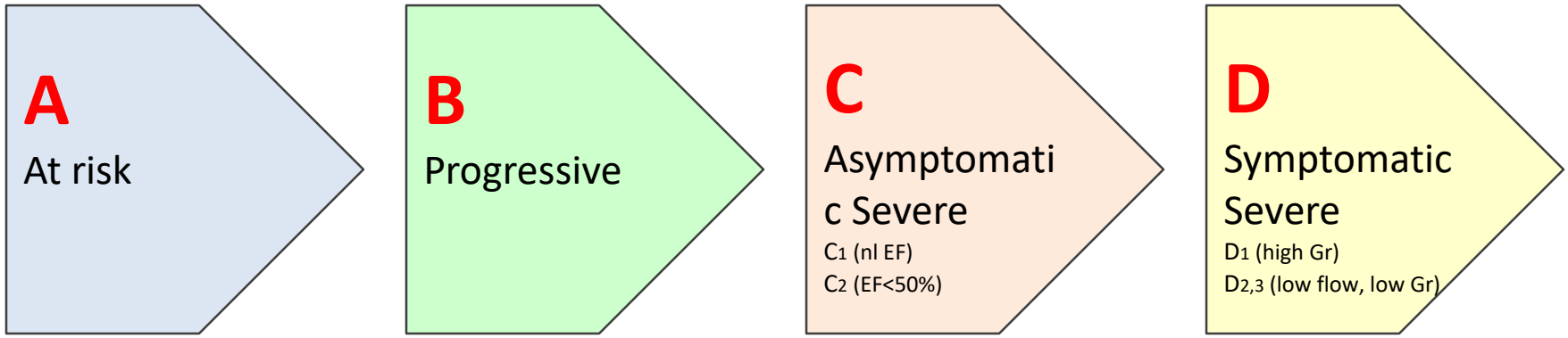
Stages of Valvular Aortic Stenosis



"paradoxical" LF/LG as a D3 stage of aortic stenosis, which is defined as an aortic valve area (AVA) of <1.0 cm^2, an indexed AVA of <0.6 cm^2/m^2, a mean gradient of <40 mm Hg, a LVEF of >50%, and a stroke volume index (SVi) of <35 ml/m^2.

Low Flow Scenarios

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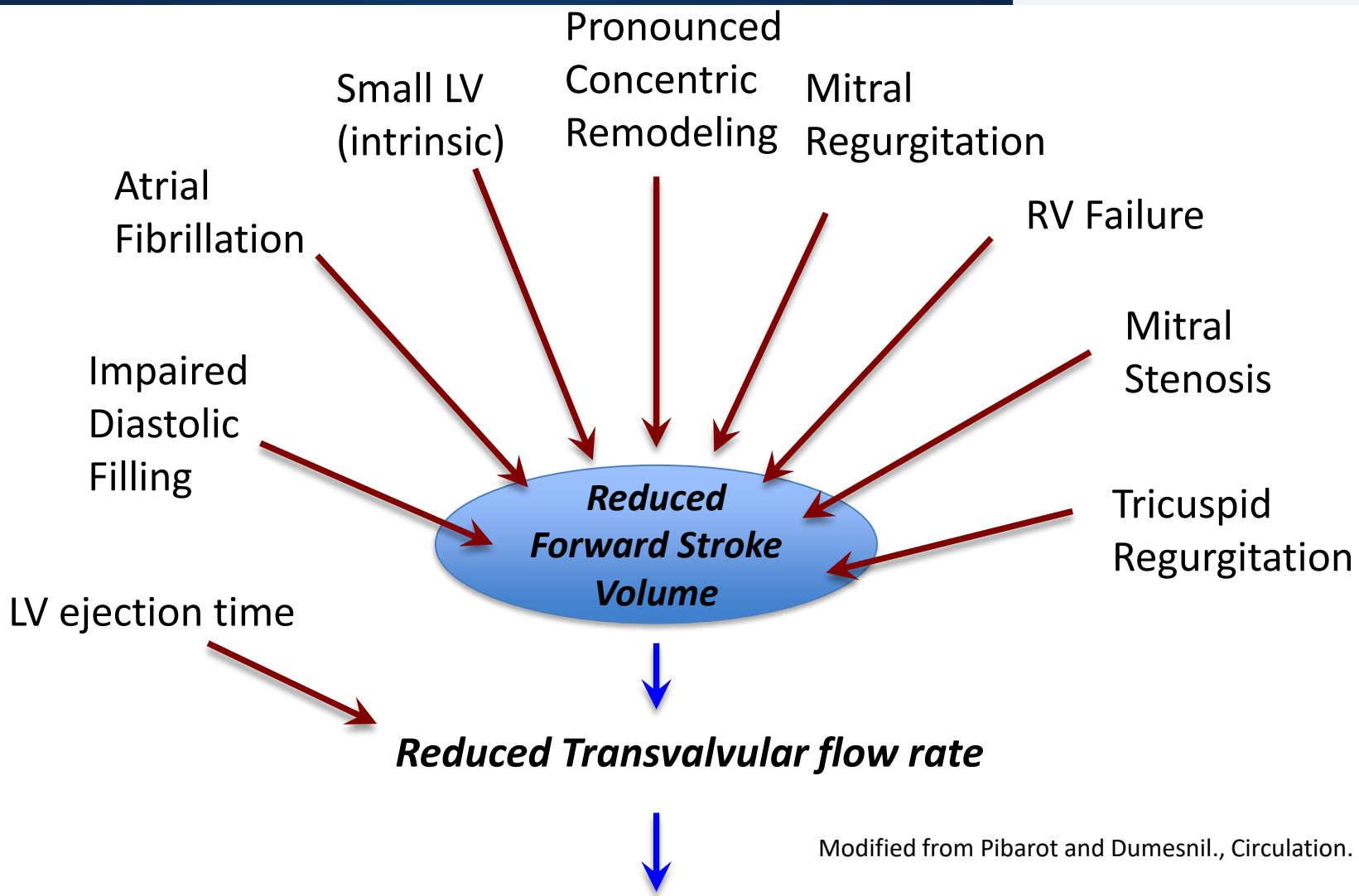

Modified from Pibarot and Dumesnil., Circulation. 2013;128:1729

Case 1: 75M with AS & NYHA Class III Heart Failure

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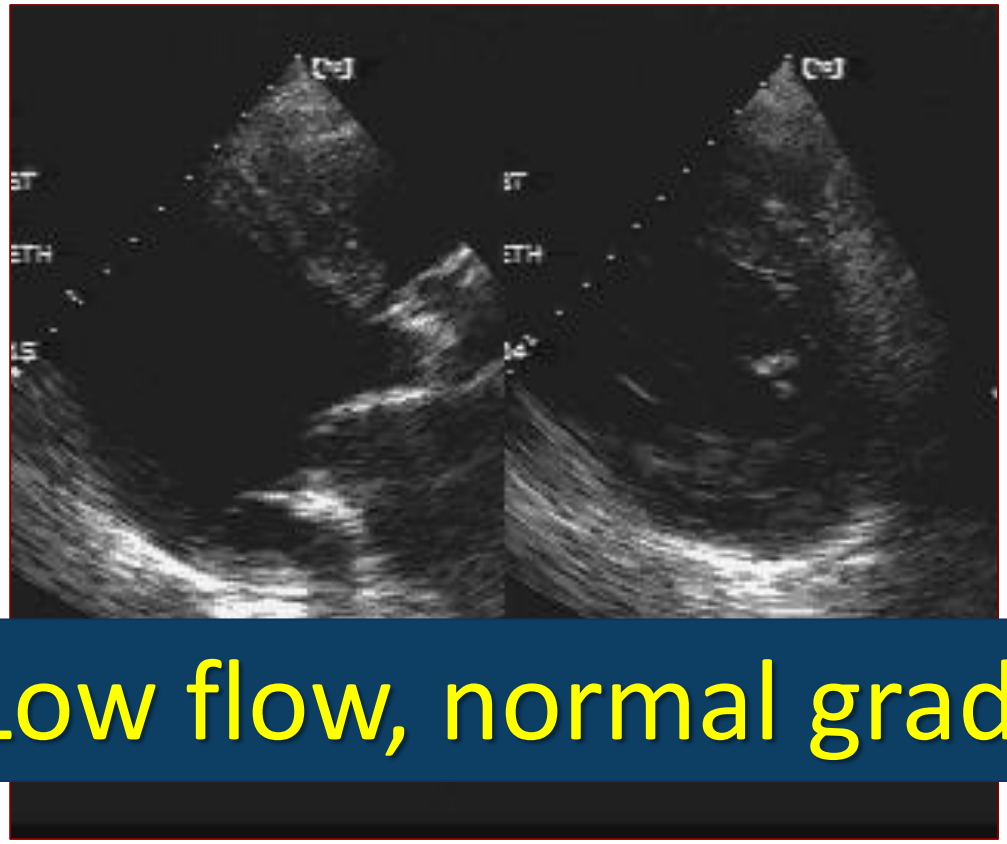
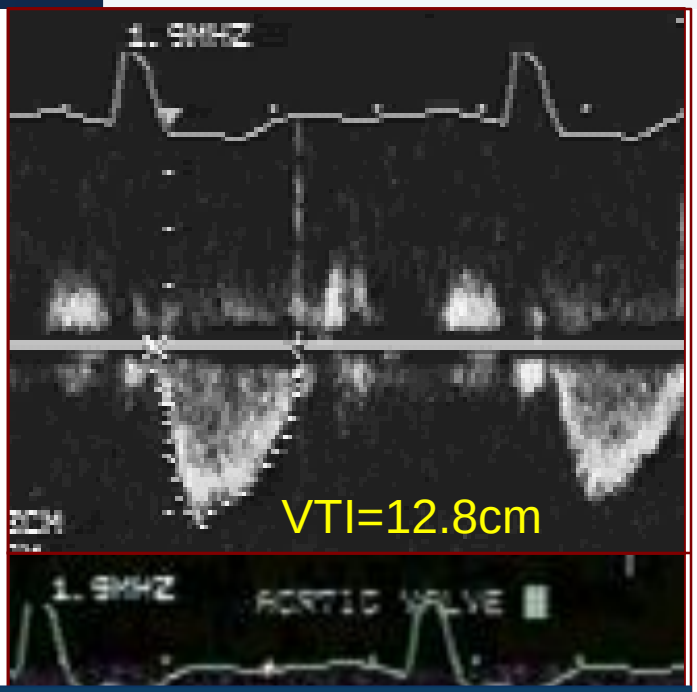
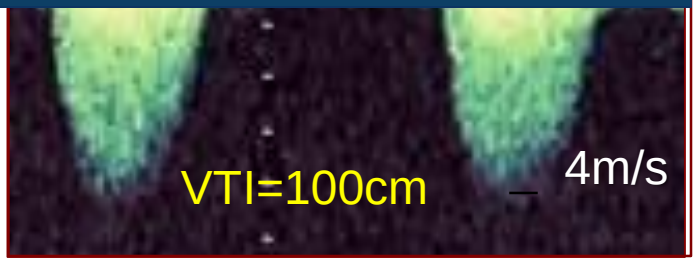




Low flow, normal gradient Severe AS



SV = 40 ml
Mn Gr = 46 mmHg
AVA = 0.40cm^2

CASE 2: Severe AS?

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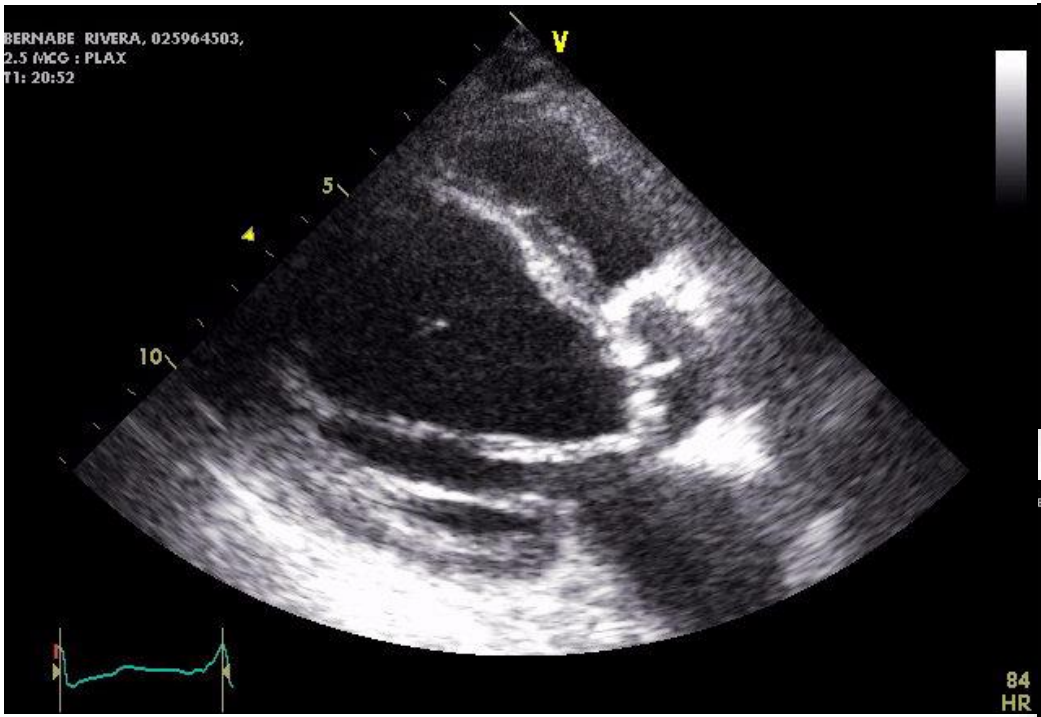

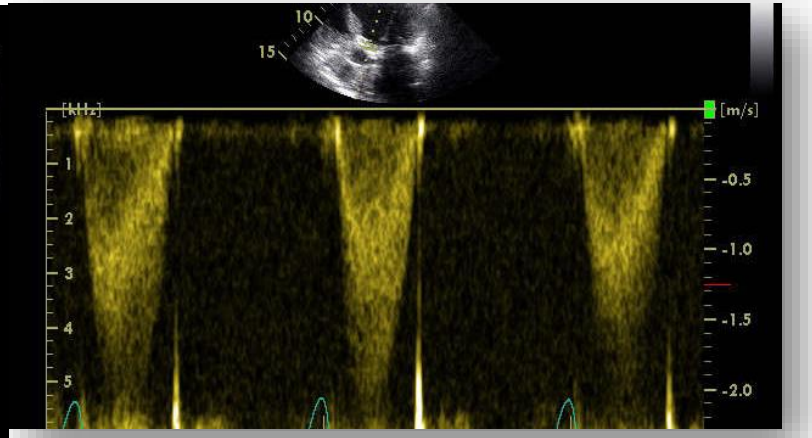

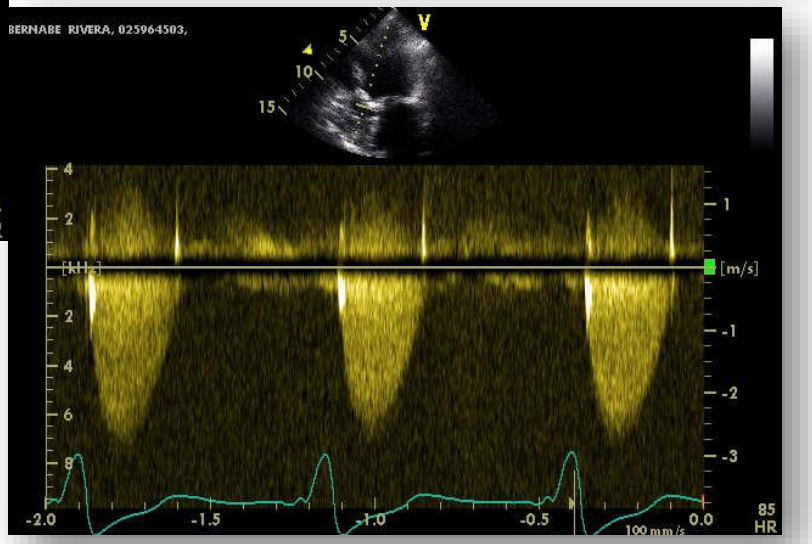

LVEF 29%
SV 44ml
Peak vel 2.7 m/s
Mean gradient 16mmHg
AVA 0.94 cm^2

Aortic valve stenosis is…

CASE 2: Severe AS?

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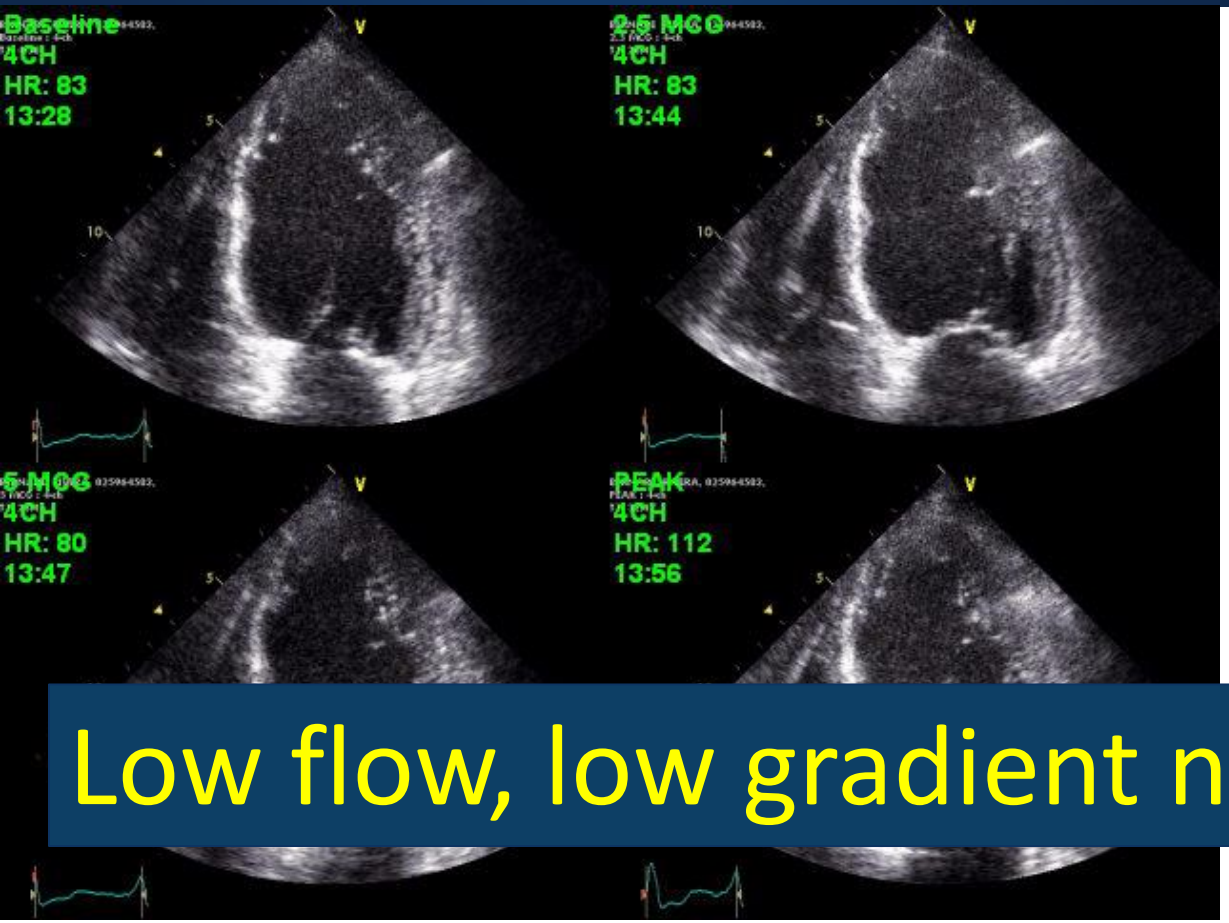

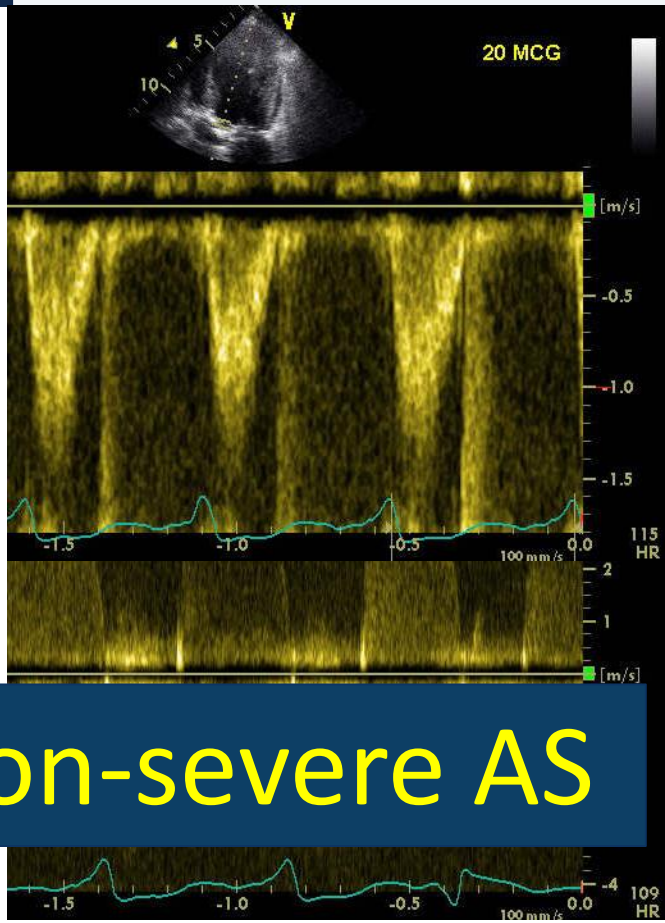

Low flow, low gradient non-severe AS

LVEF 35%
SV 65ml
Peak vel 3.0 m/s
Mean gradient 23mmHg

AVA 1.4 cm^2

Aortic valve stenosis is…

mild

CASE 3: Severe AS ?

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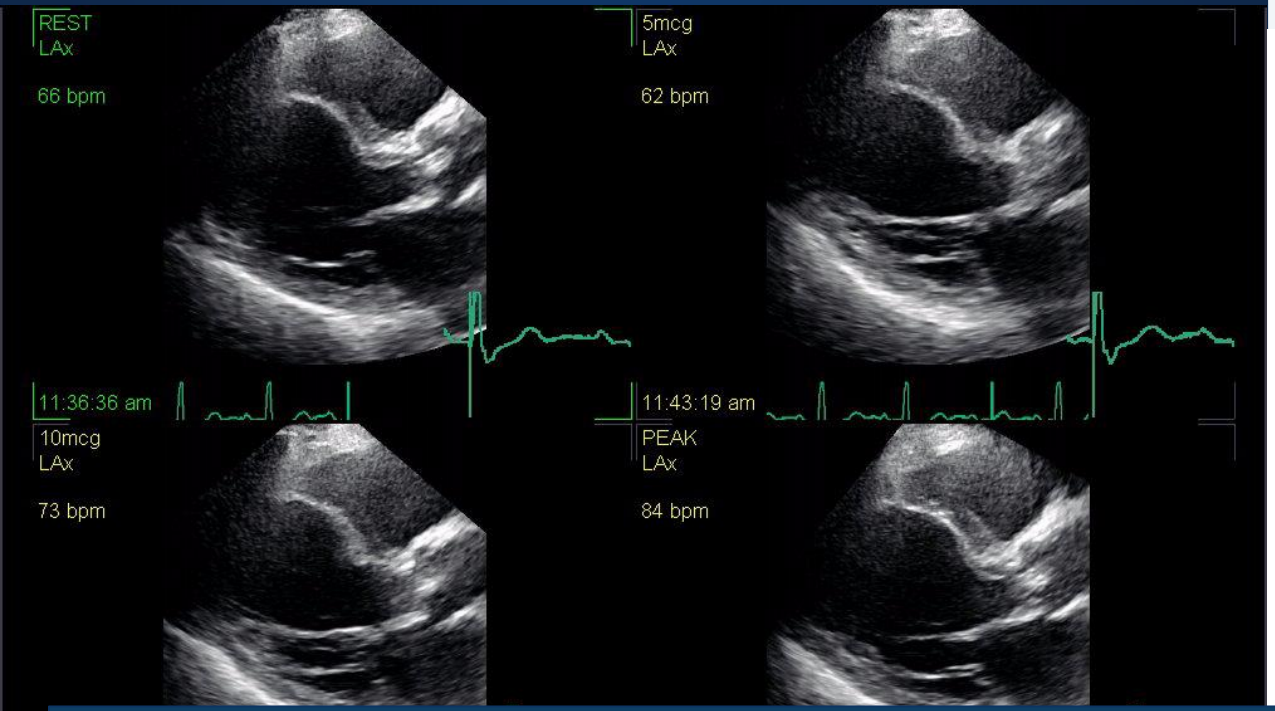

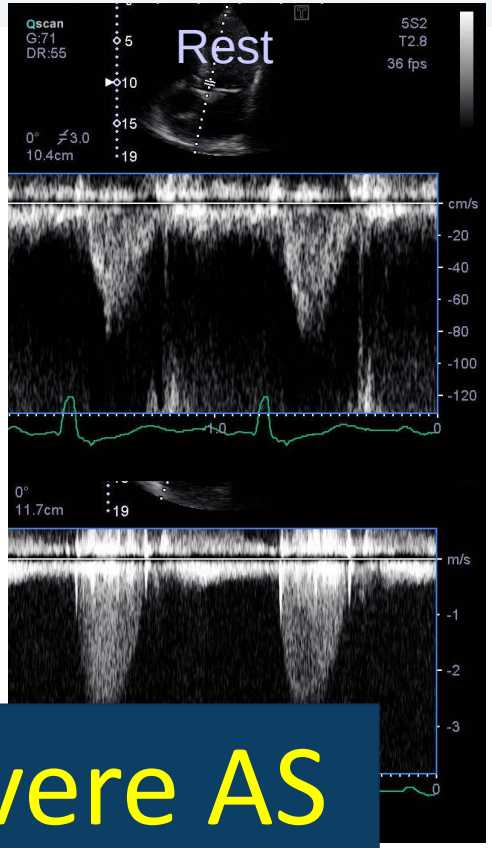

Low flow, low gradient Severe AS

Stress:
Pk vel 4.1
Mean Grad. 40 mmHg
SV 65 ml
AVA 0.8cm^2

Rest:
Pk vel 2.7
Mean Grad. 18 mmHg
SV 45 ml
AVA 0.7cm^2

Case 4: 83 yr Female, remote CABG, now with dyspnea

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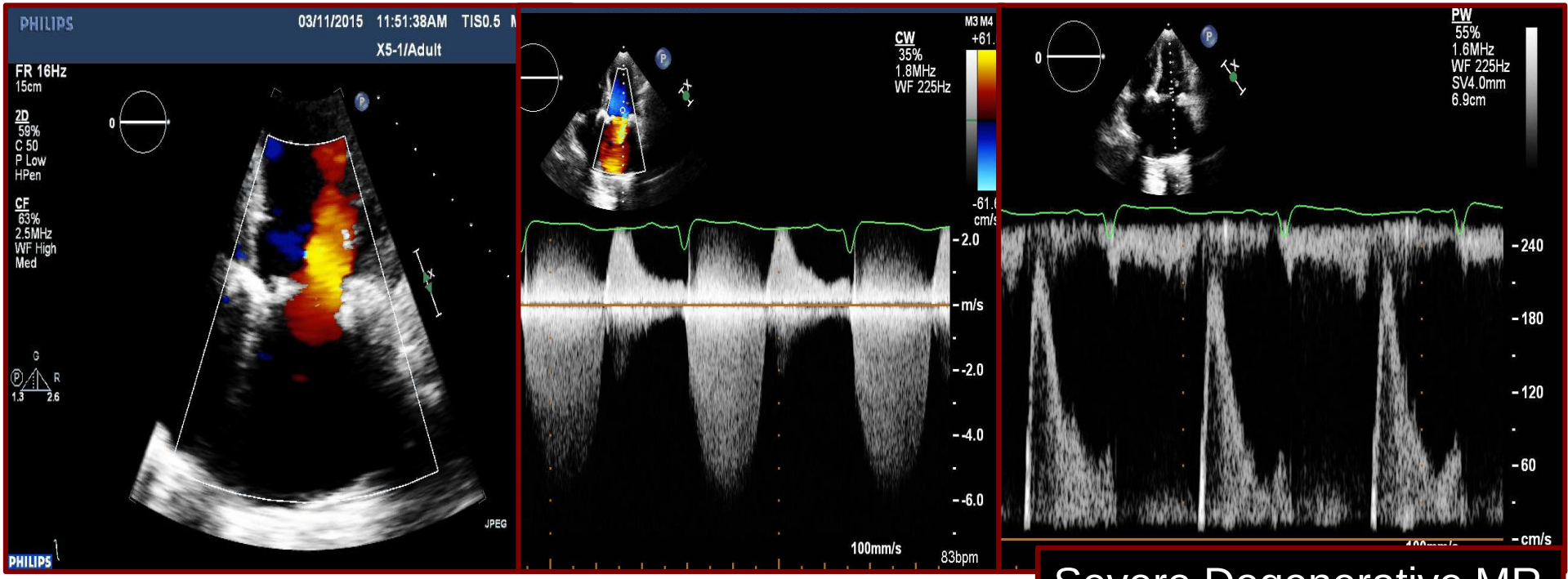

Severe Degenerative MR

83 yr Female, remote CABG, now with dyspnea

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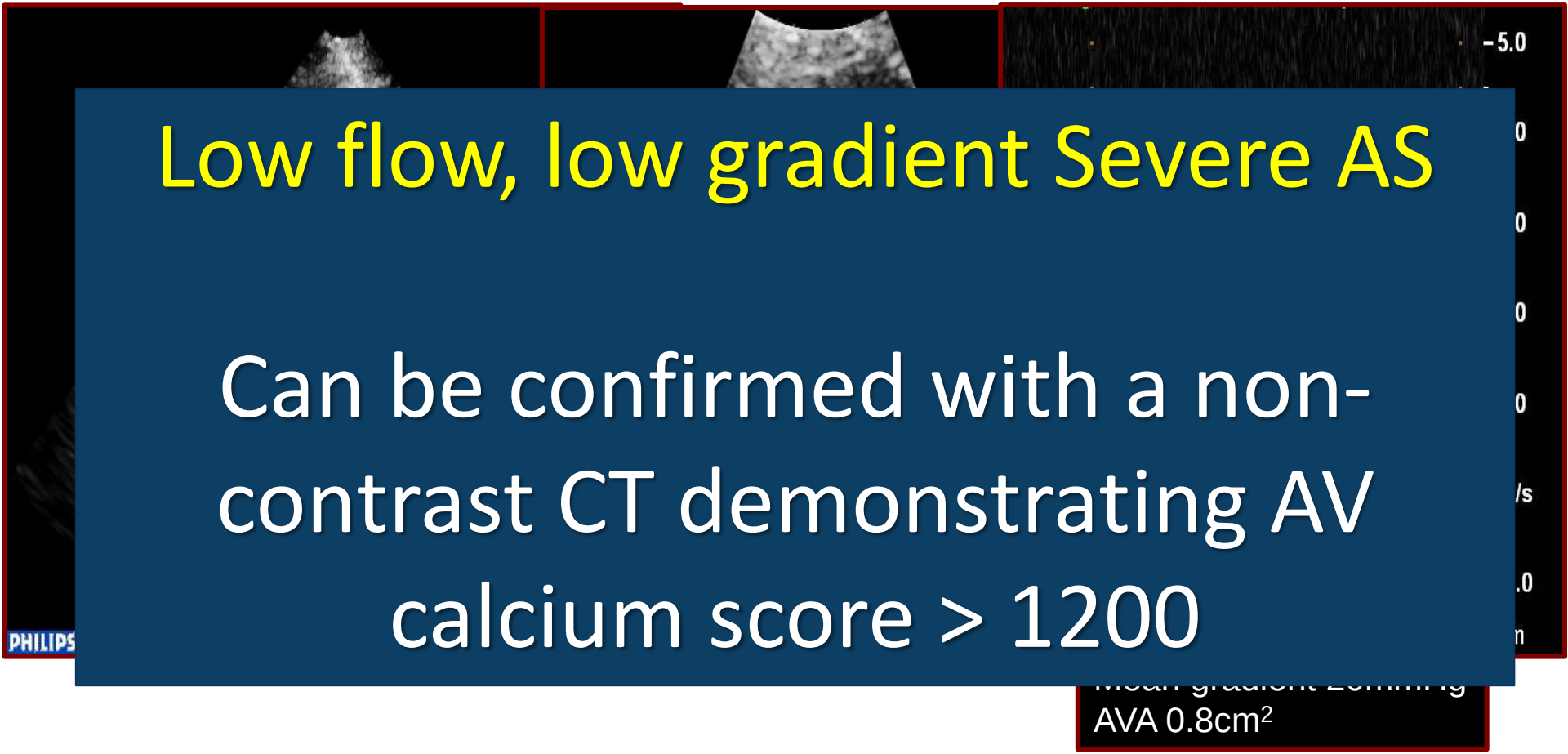

Low flow, low gradient Severe AS

Can be confirmed with a non-contrast CT demonstrating AV calcium score > 1200

Low flow ("lost flow") Severe Aortic Stenosis?

Low flow (lost flow?)

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- AS severity may be underestimated
  - As MR gets worse, a lower systemic stroke volume results in a lower AV pressure gradient
  - This is amplified in patients with depressed LV

Case 5

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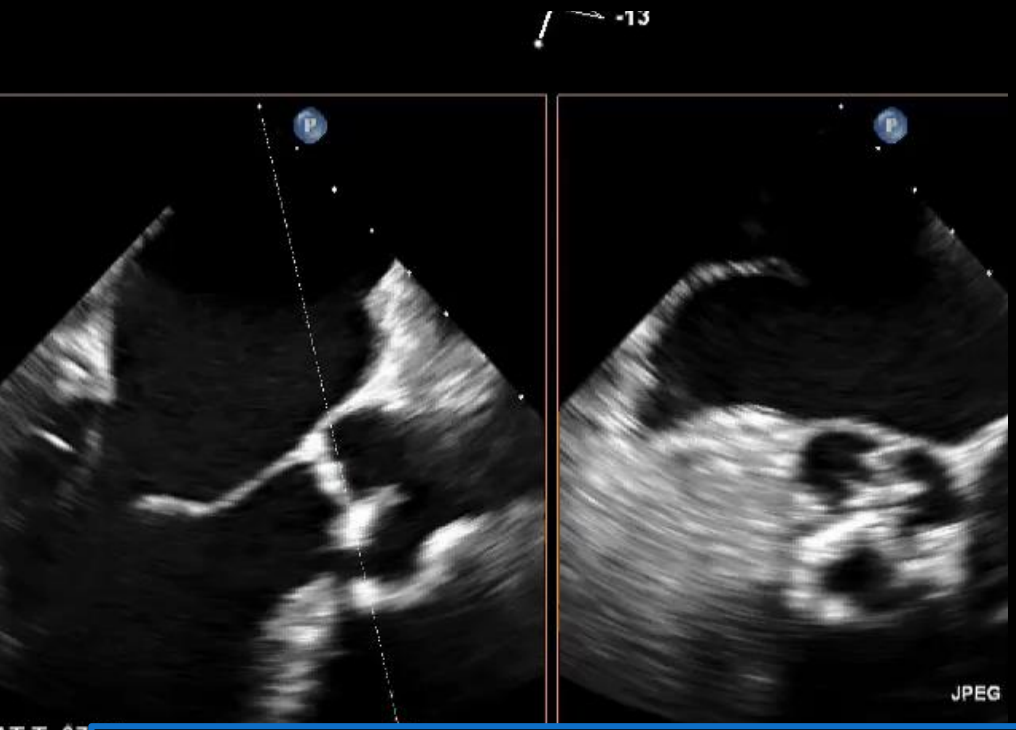
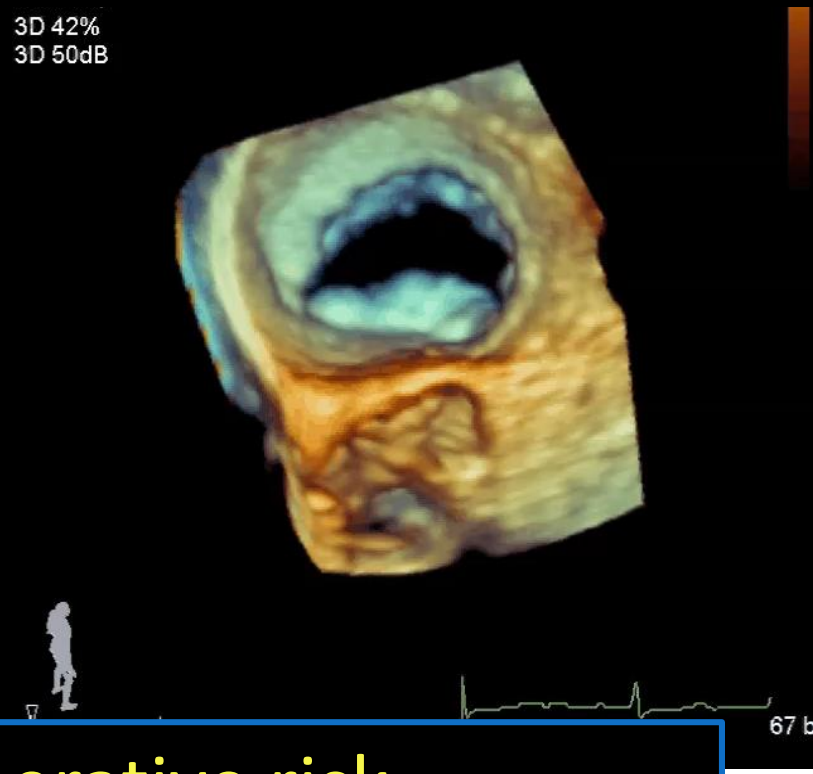
91 yr Male, remote CABG, now with dyspnea





High (prohibitive) operative risk.
Treatment priority is AS or MR or both?

Hemodynamic Scenarios of Severe AS

(EOAi < 0.6, preferably < 0.4 cm^2/m^2)

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	High Gradient	Low Gradient
Normal Flow	**Normal flow, high gradient** SVi ≥ 35ml/m^2 Mean Gradient ≥ 40 mmHg	**Normal flow, low gradient** SVi ≥ 35ml/m^2 Usually AS is not severe
Low Flow	**Low flow, high gradient** SVi < 35ml/m^2 Mean Gradient ≥ 40 mmHg	**Low flow, low gradient** SVi < 35ml/m^2 Mean Gradient < 40 mmHg

Normal or Depressed LVEF

Case 6: Clinical History

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- 82 yr female
- Assisted living
- c/o profound fatigue, dyspnea on exertion

- Referred to your echo lab…

Is LV function normal?

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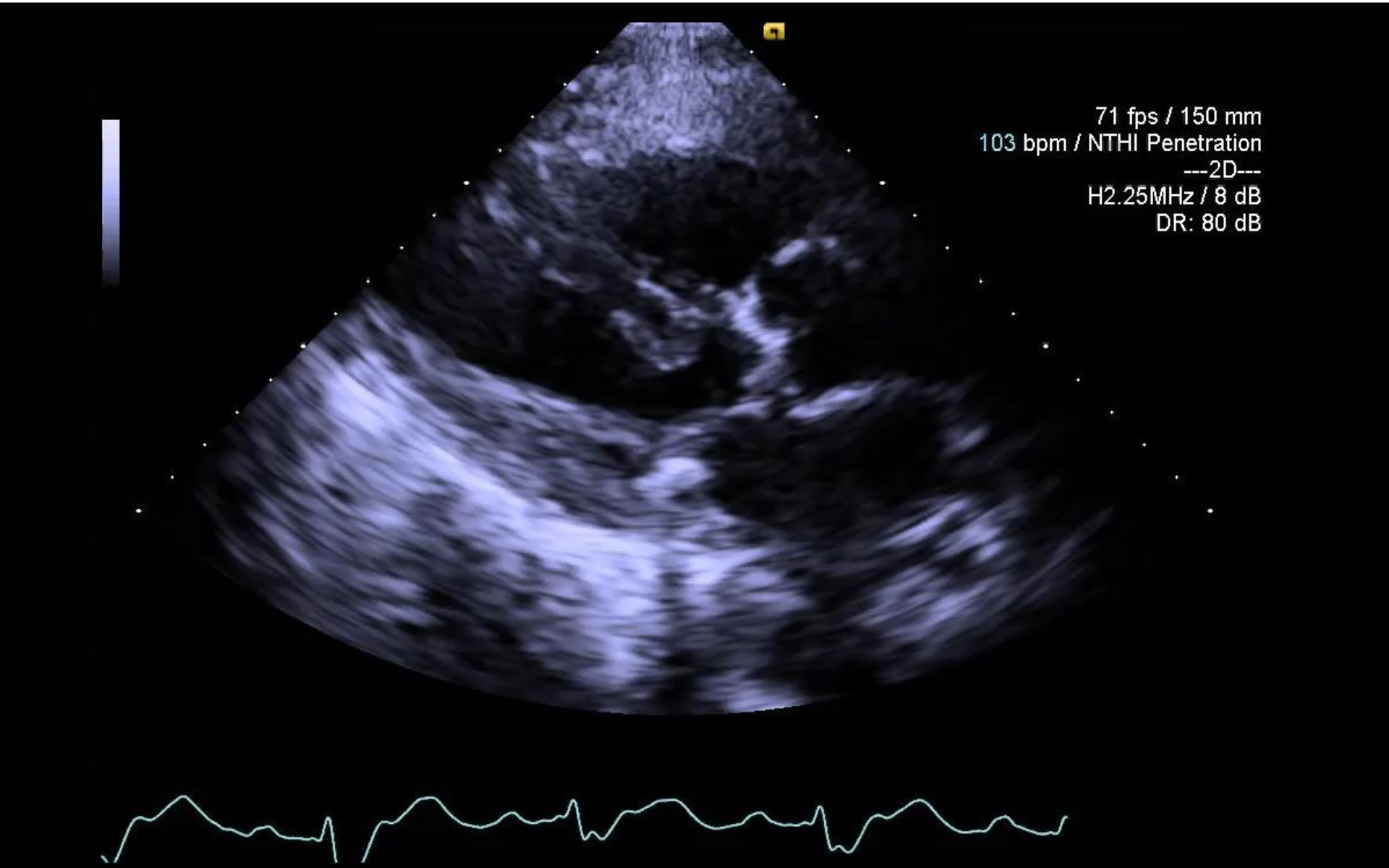

What is the AS severity?

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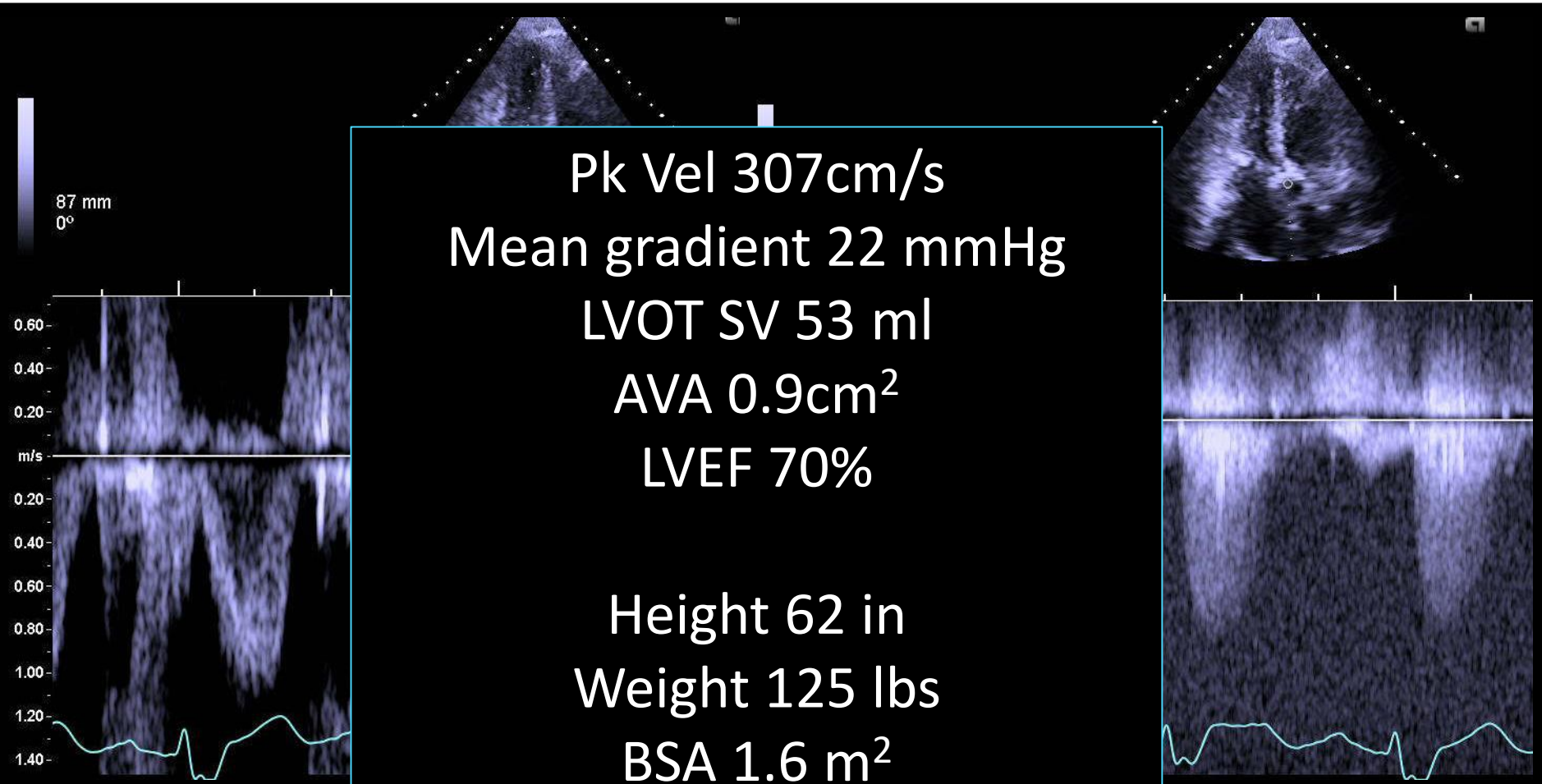


Pk Vel 307cm/s

Mean gradient 22 mmHg

LVOT SV 53 ml

AVA 0.9cm^2

LVEF 70%

Height 62 in

Weight 125 lbs

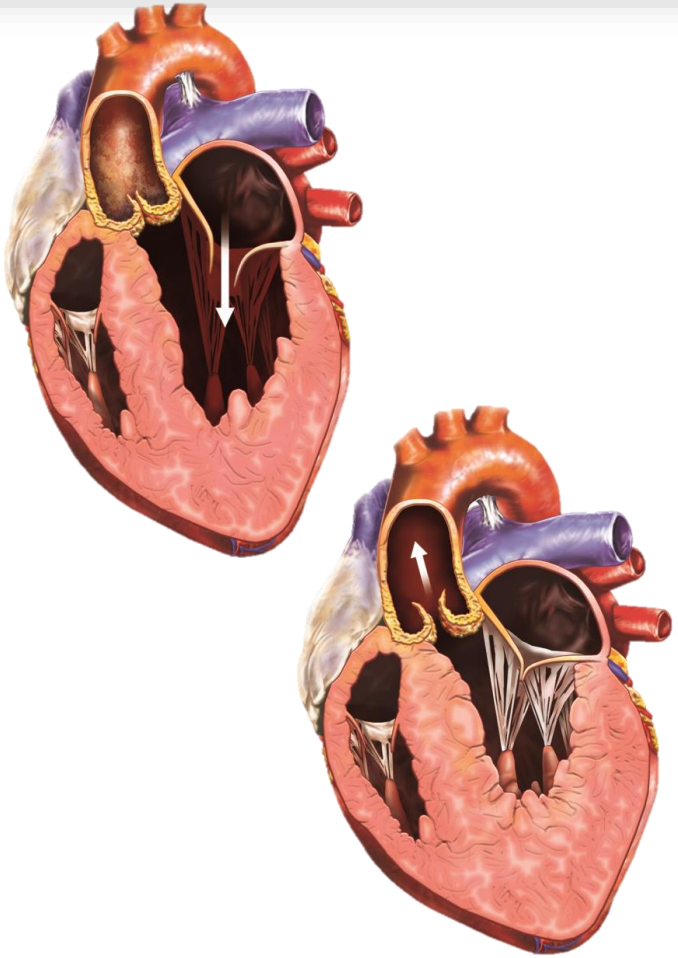
BSA 1.6 m^2

SV index 33 ml/m^2

AVA index 0.56 cm^2

Paradoxical Low-Flow, Low-Gradient Severe Aortic Stenosis Despite Preserved Ejection Fraction Is Associated With Higher Afterload and Reduced Survival

Zeineb Hachicha, MD; Jean G. Dumesnil, MD; Peter Bogaty, MD; Philippe Pibarot, DVM, PhD



- Advanced age
- Women
- Hypertension
- Diabetes/metabolic syndrome

Hachicha Z et al., Circulation, 2007
Dumesnil et al. Eur Heart J, 2009
Pibarot & Dumesnil JACC, 2012

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Low Flow, Low Gradient Severe Aortic Stenosis

Mean Gr < 40 mmHg, SVi < 35ml/m^2 *and AVA < 0.4-0.6* cm^2/m^2

- The entity exists and has multiple etiologies, leading to a small ventricle with preserved LVEF
- Carries poor prognosis, likely exacerbated by the underlying/concomitant cardiac conditions
- Need to be vigilant in deriving valve area (error in diameter of LVO, Pulsed or CW Doppler mal-position)
- Low Stroke Volume by Doppler needs to be corroborated by LV volume (small) and function.

LV strain imaging

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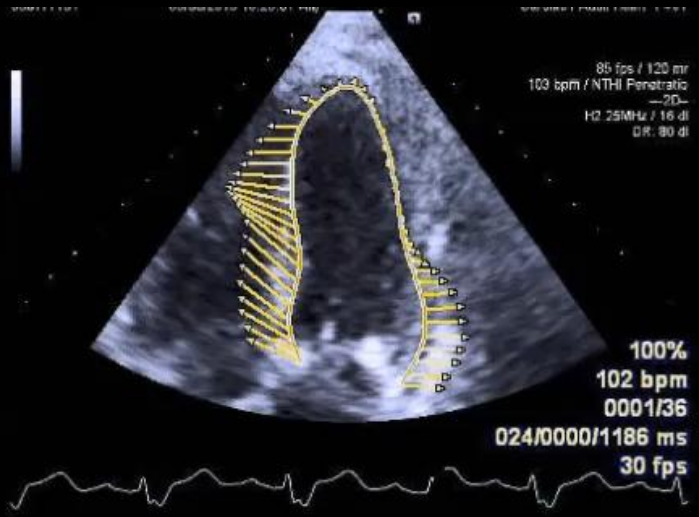

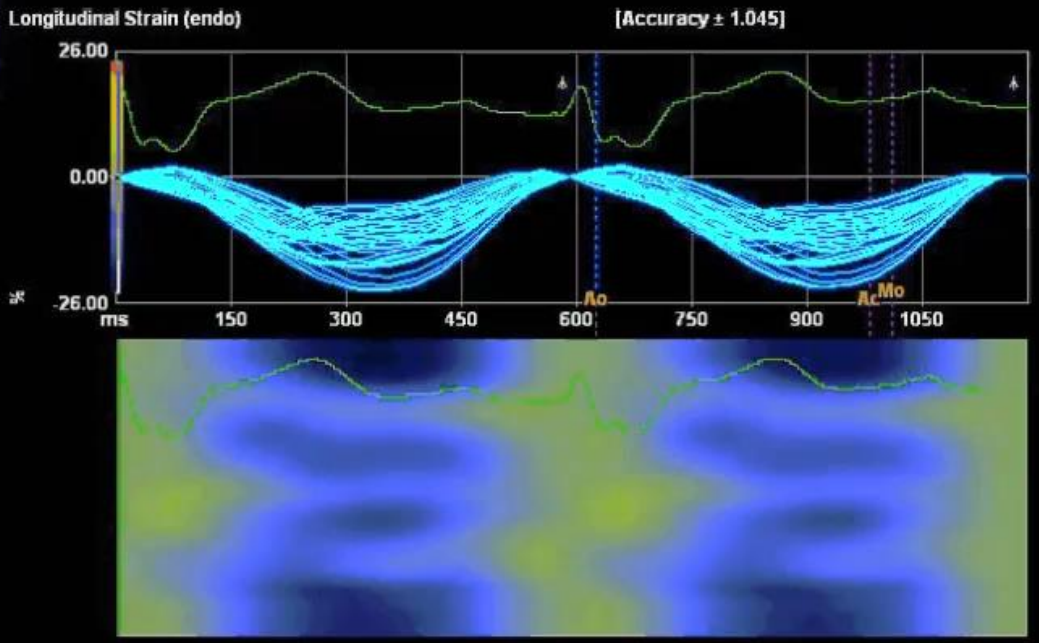

LV strain is reduced

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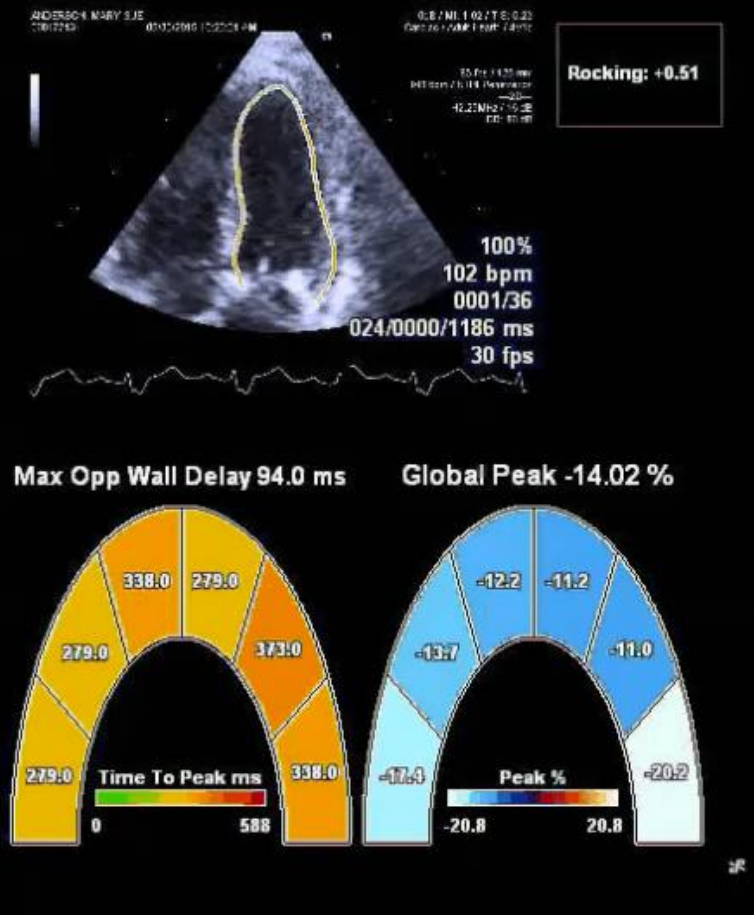

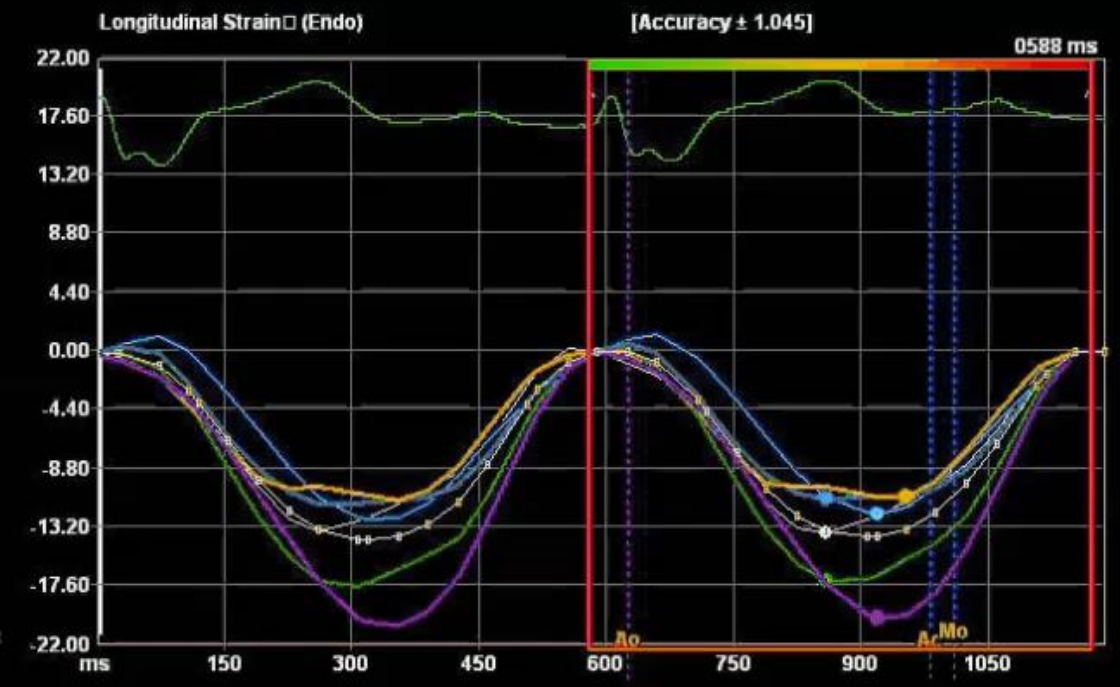

GLS < - 15%

Paradoxical low-flow AS have abnormal systolic function

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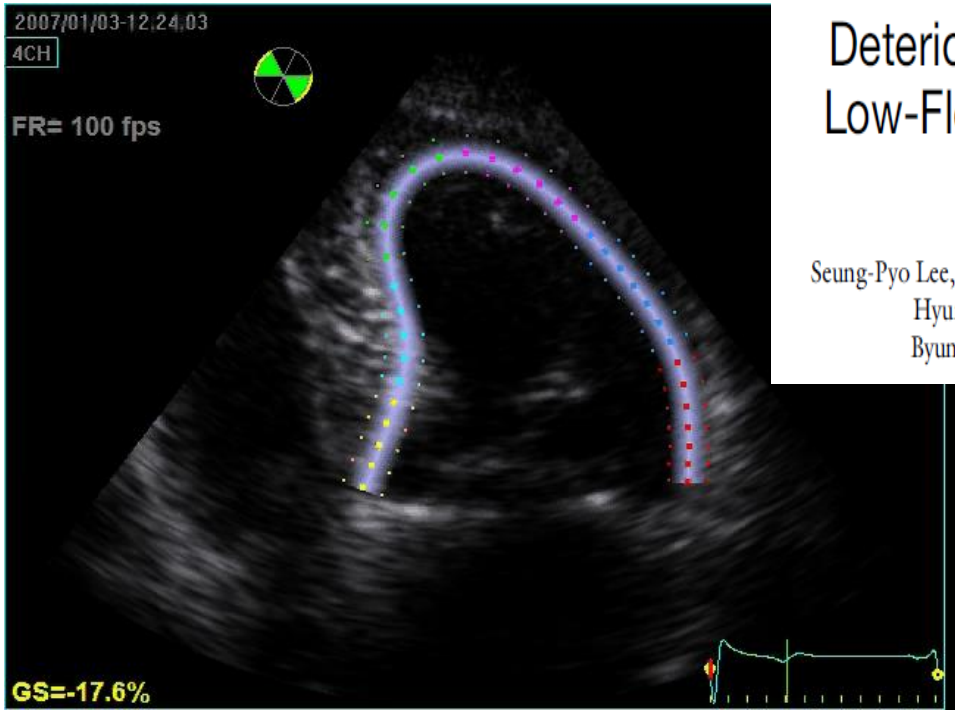
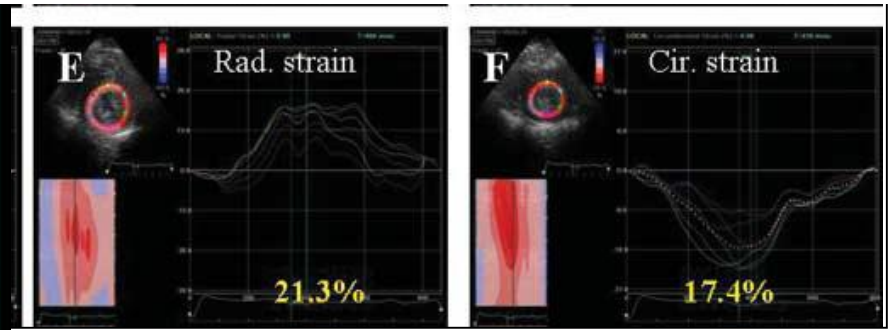


Deterioration of Myocardial Function in Paradoxical Low-Flow Severe Aortic Stenosis: Two-Dimensional Strain Analysis

Seung-Pyo Lee, MD, Yong-Jin Kim, MD, PhD, Ji-Hyun Kim, MD, Kyungil Park, MD, Kyung-Hee Kim, MD, Hyung-Kwan Kim, MD, PhD, Goo-Yeong Cho, MD, PhD, Dae-Won Sohn, MD, PhD, Byung-Hee Oh, MD, PhD, and Young-Bae Park, MD, PhD, *Seoul and Seongnam, Korea*



Lancellotti et al. Eur J Echo 2010

Lee et al. J Am Soc Echocardiogr, 2011

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Low-Flow, Low-Gradient Severe Aortic Stenosis Despite Normal Ejection Fraction Is Associated With Severe Left Ventricular Dysfunction as Assessed by Speckle-Tracking Echocardiography : A Multicenter Study

Jérôme Adda, Christopher Mielot, Roch Giorgi, Frédéric Cransac, Xavier Zirphile, Erwan Donal, Catherine Sportouch-Dukhan, Patricia Réant, Stéphane Laffitte, Stéphane Cade, Yvan Le Dolley, Franck Thuny, Nathalie Touboul, Cécile Lavoute, Jean-François Avierinos, Patrizio Lancellotti and Gilbert Habib

Circ Cardiovasc Imaging 2012;5;27-35; originally published online November 22, 2011; DOI: 10.1161/CIRCIMAGING.111.967554

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 Print ISSN: 1941-9651. Online ISSN: 1942-0080

- LFLG AS is observed in 9% of patients with severe AS and normal ejection fraction
- Is associated markedly reduced longitudinal systolic function

Echo Features of Paradoxical Low-Flow, Low-Gradient AS

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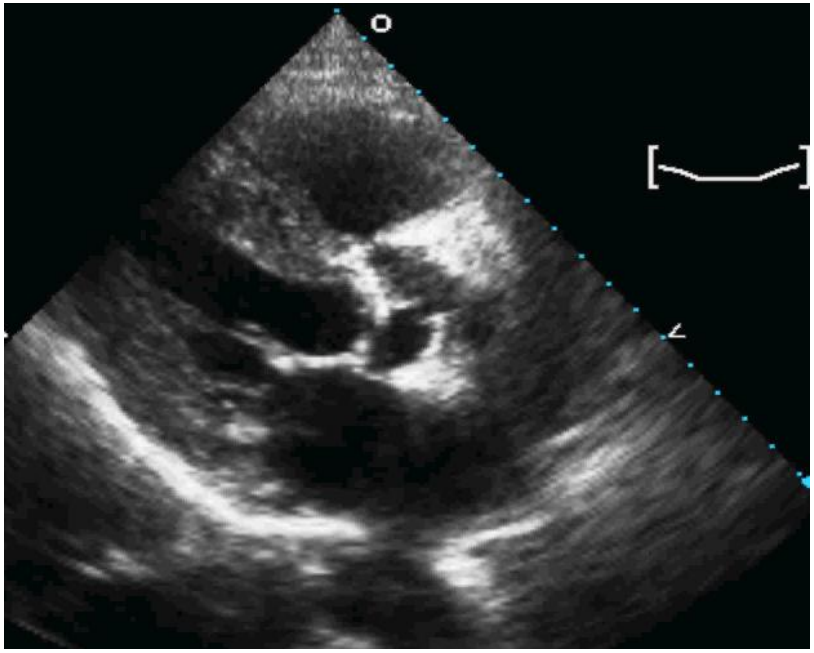
The Aortic Valve:

- AVA< 1.0 cm^2 AVAi < 0.6 cm^2/m^2 DVI<0.25
- Severely thickened/calcified valve
- Mean gradient <40 mmHg
- Valvulo-arterial impedance > 4.5 $mmHg.ml^{-1}.m^{-2}$

The Left Ventricle



- EDD<47 mm EDV< 55 mL/m^2
- RWT ratio > 0.50
- Myocardial fibrosis
- Impaired LV filling
- LVEF > 50%
- SVi < 35 mL/m^2
- **GLS < 15%**

Pibarot & Dumesnil, JACC 58;413-415, 2011

Summary of AS

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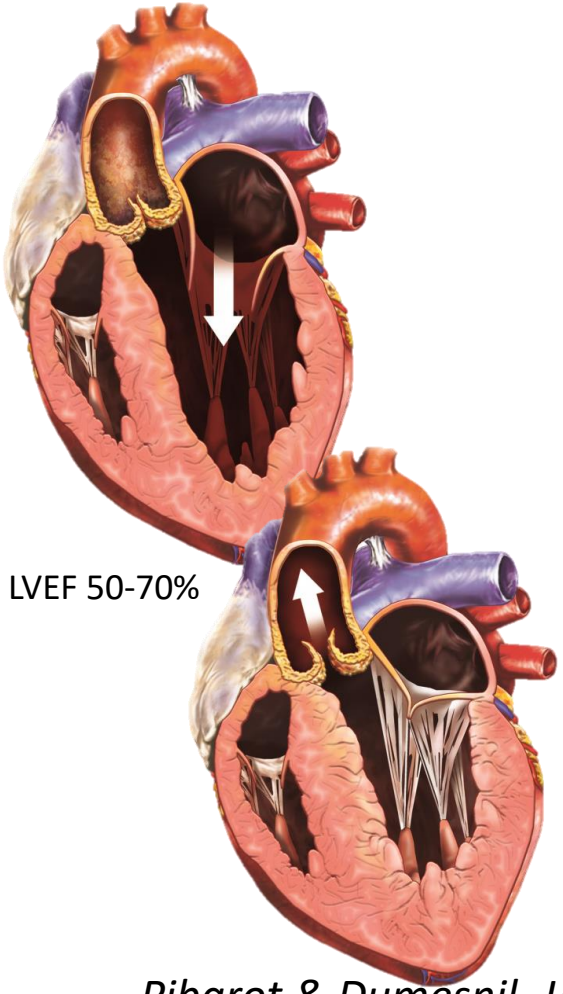
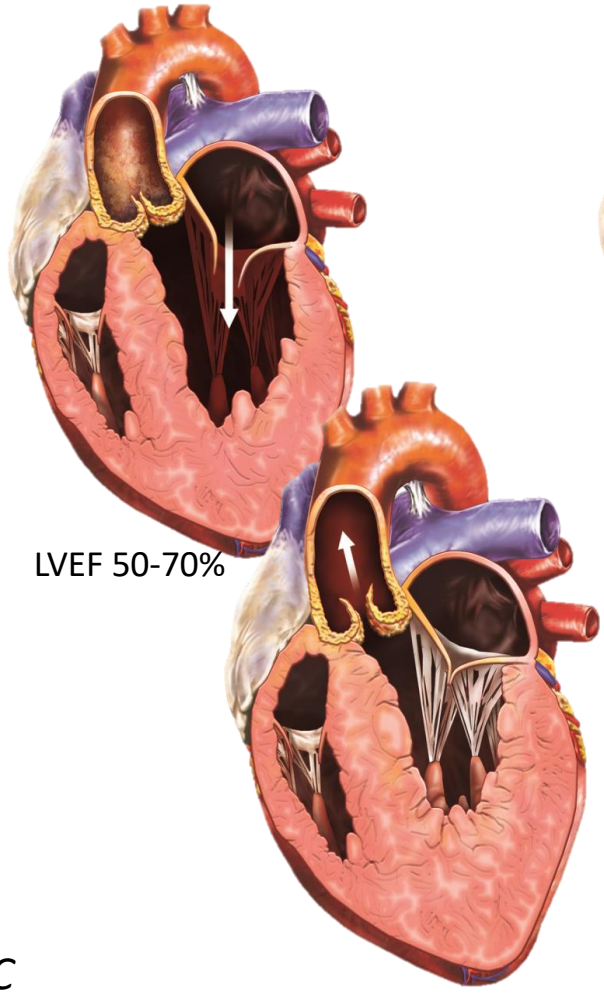
Normal-LVEF
Normal-Flow, High-Gradient



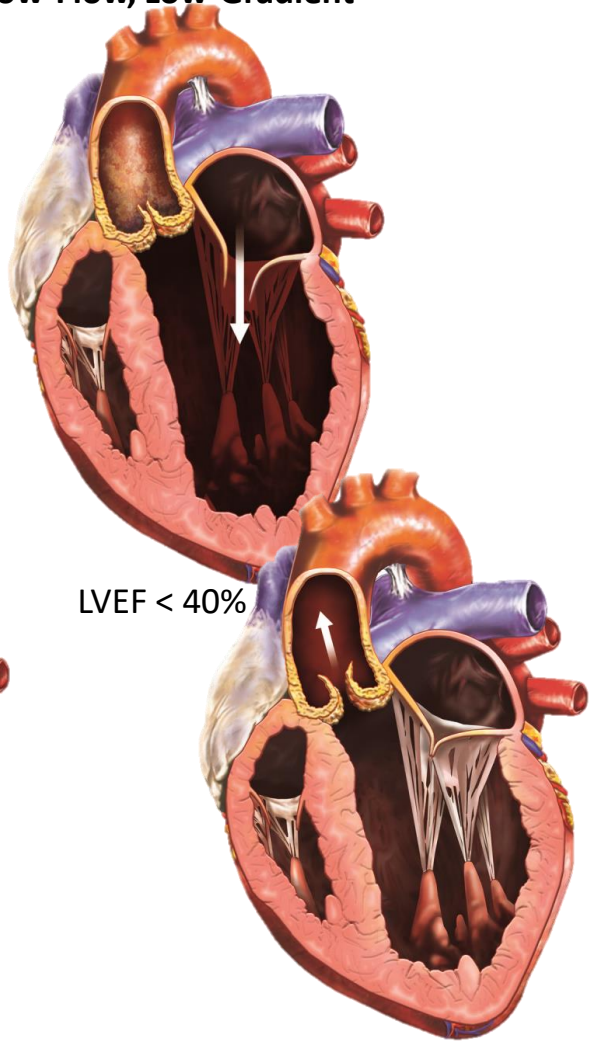
LVEF 50-70%

Normal-LVEF
«PARADOXICAL»
Low-Flow, Low-Gradient



LVEF 50-70%

Low-LVEF
«CLASSICAL »
Low-Flow, Low-Gradient



LVEF < 40%

Pibarot & Dumesnil, JACC

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