Echocardiographic Assessment of Aortic Valve Prosthesis

Susan Wilansky, MD, FRCP(C), FACC, FASE

Mayo Clinic, AZ

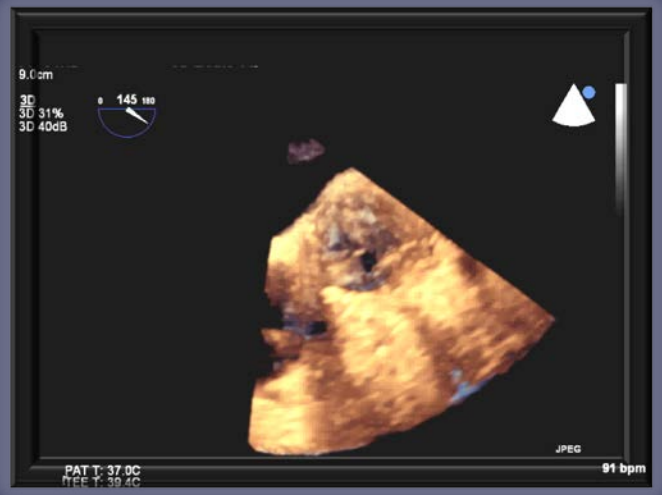
DISCLOSURE

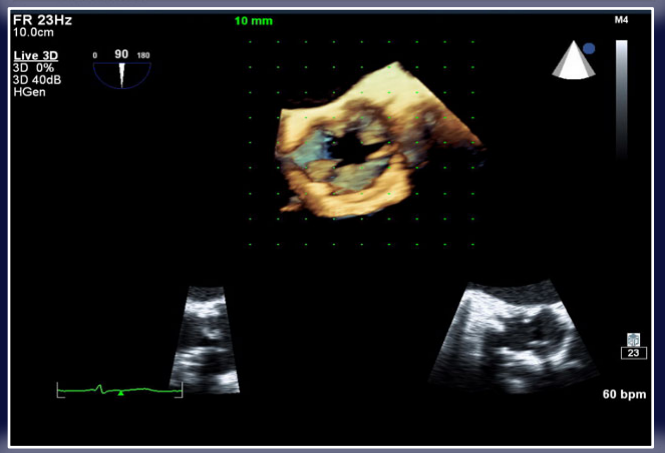
Relevant Financial Relationship(s)

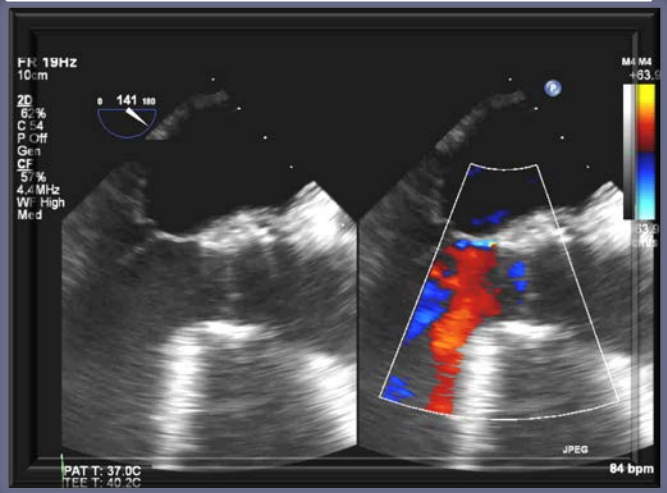
None

Off Label Usage

None


9.0cm
3D
3D 31%
3D 40dB
145
JPEG
PAT T: 37.0C
91 bpm

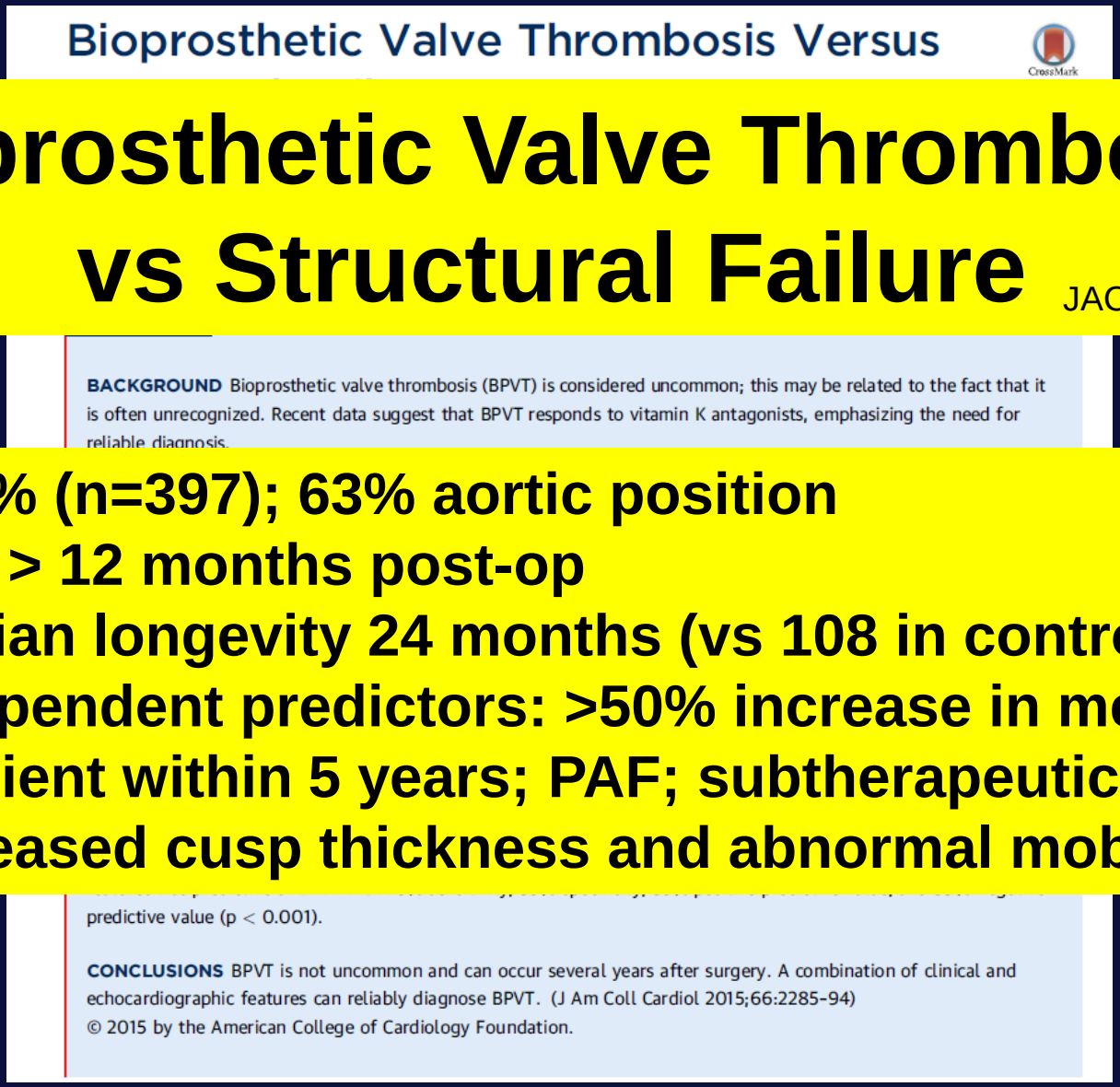

FR 23Hz
10.0cm
10 mm
M4
Live 3D
3D 0%
3D 40dB
HGen
90
23
60 bpm


FR 19Hz
10cm
2D
Gen
CF
4.4 MHz
Med
141
JPEG
PAT T: 37.0C
84 bpm

Bioprosthetic Valve Thrombosis vs Structural Failure

JACC 2015;66:2285

- **11.6% (n=397); 63% aortic position**
- **65% > 12 months post-op**
- **Median longevity 24 months (vs 108 in controls)**
- **Independent predictors: >50% increase in mean gradient within 5 years; PAF; subtherapeutic INR; increased cusp thickness and abnormal mobility**



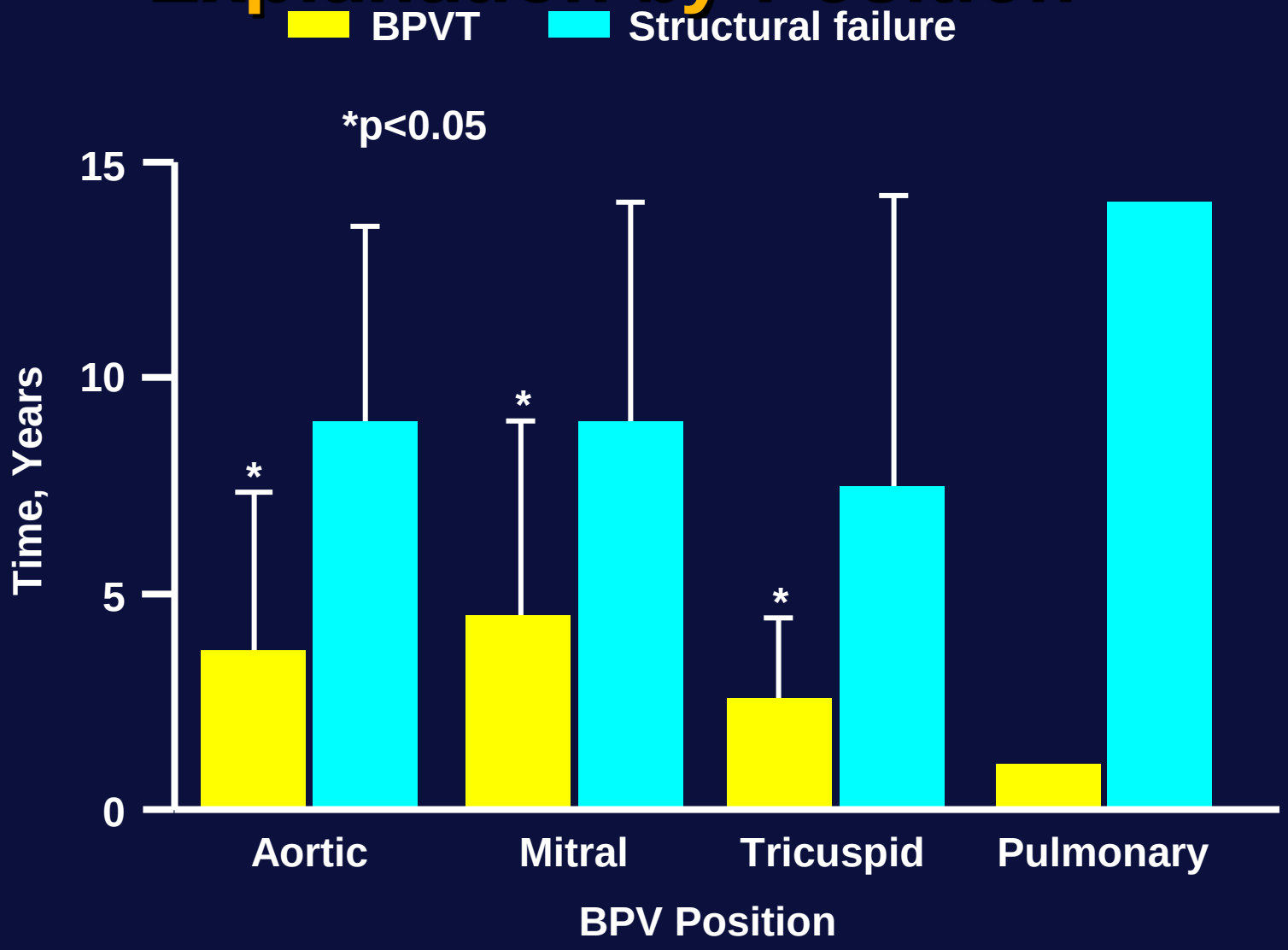
Bioprosthetic Valve Thrombosis Versus

BACKGROUND Bioprosthetic valve thrombosis (BPVT) is considered uncommon; this may be related to the fact that it is often unrecognized. Recent data suggest that BPVT responds to vitamin K antagonists, emphasizing the need for reliable diagnosis.

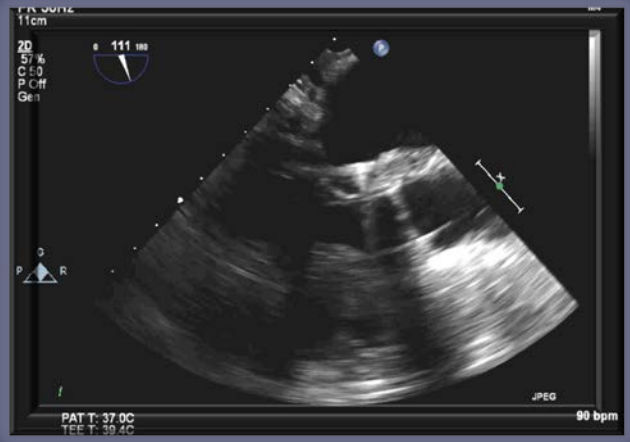
predictive value ($p < 0.001$).

CONCLUSIONS BPVT is not uncommon and can occur several years after surgery. A combination of clinical and echocardiographic features can reliably diagnose BPVT. (J Am Coll Cardiol 2015;66:2285-94)

Timing of Bioprosthetic Valve Explanation by Position



JACC 2015; 66(21): 2285

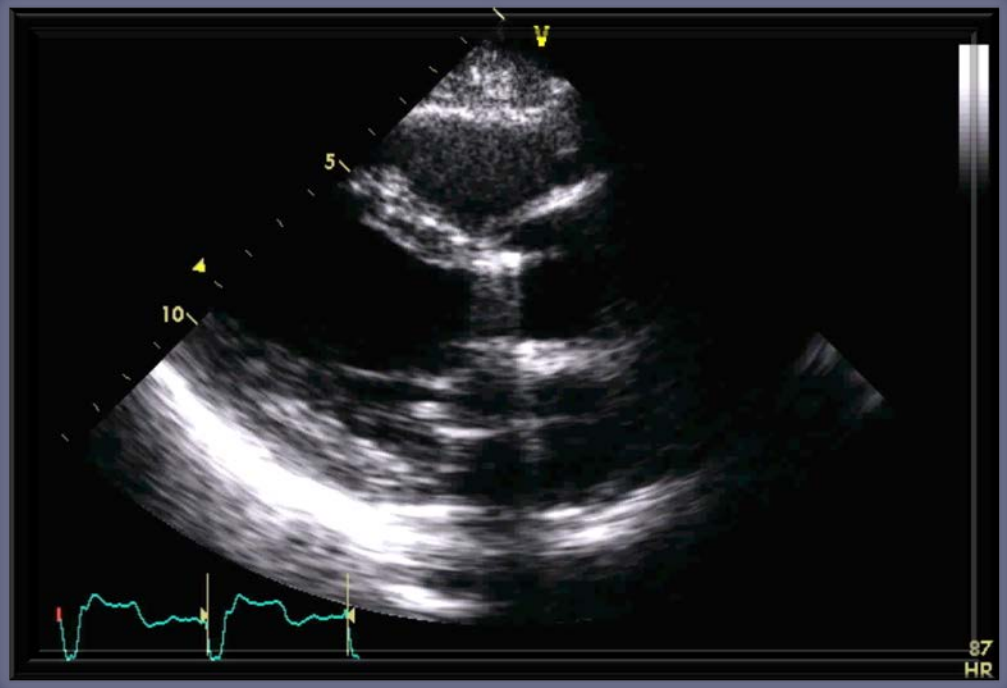

11cm
2D
111
JPEG
PAT T: 37.0C
90 bpm


11cm
2D
34
JPEG
PAT T: 37.0C
66 bpm

Aortic Prosthesis

43 year old female S/P Bentall with #21 St. Jude AVR

Presents for evaluation of shortness of breath



LV size

LVDS 32mm, ESD 32mm

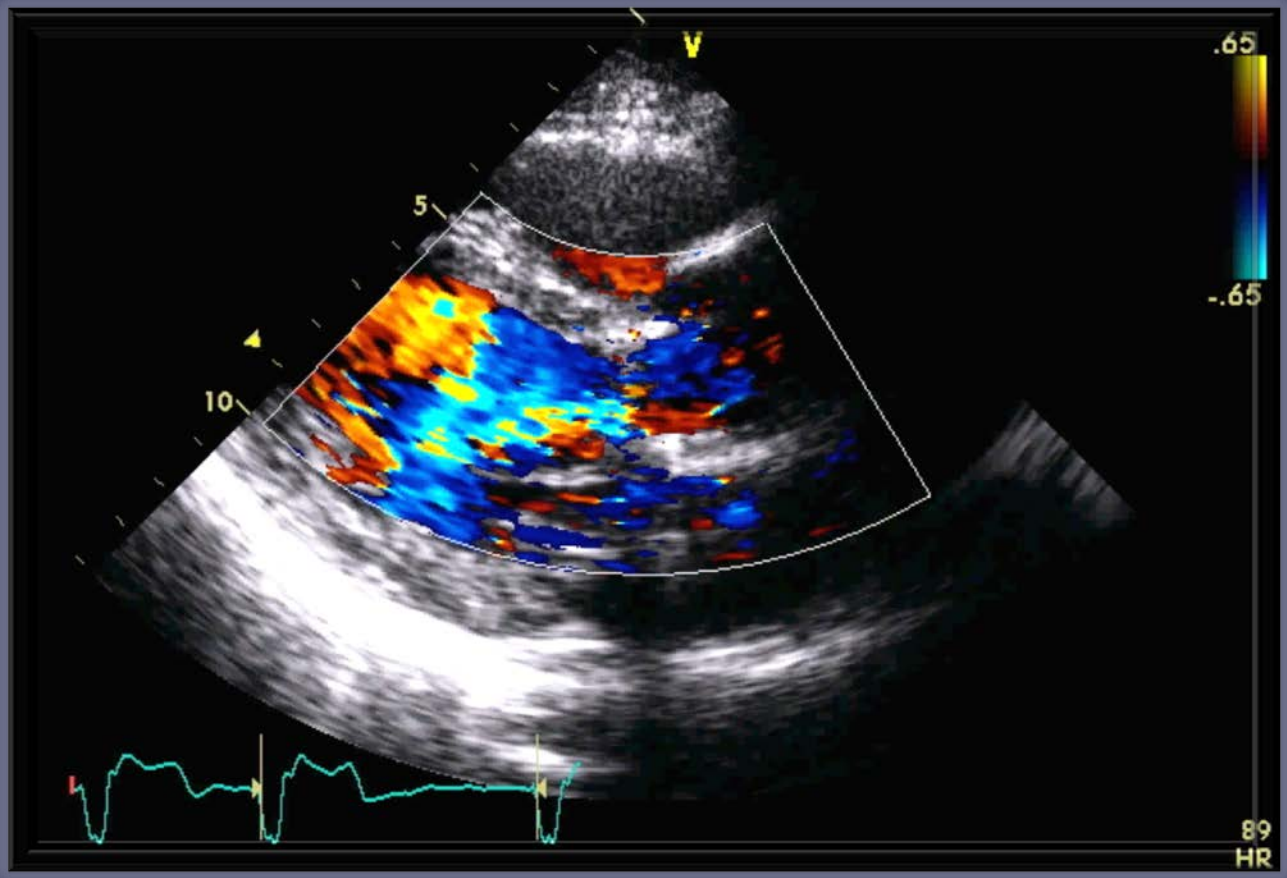
Septum 12mm

Wall thickness

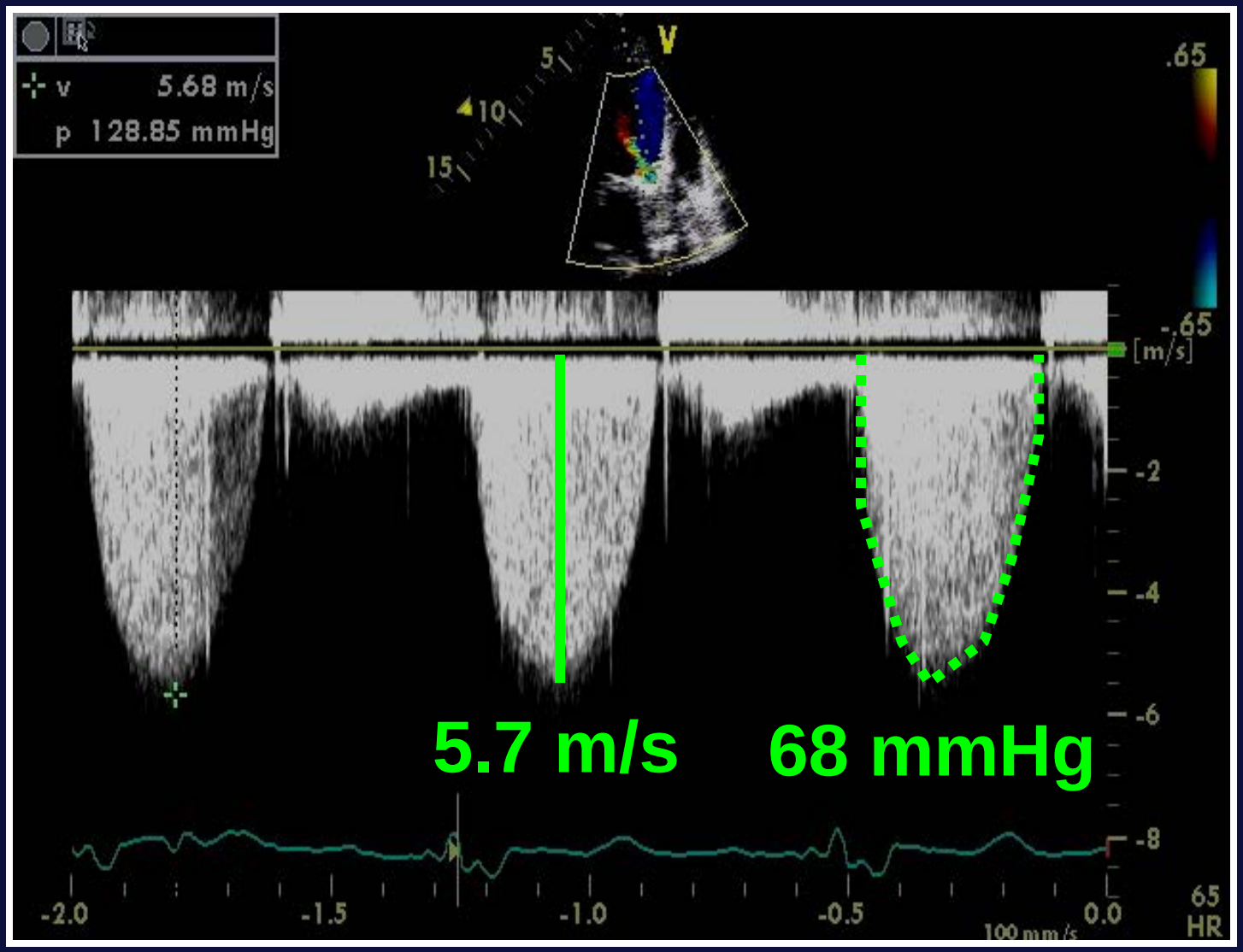
Posterior 12mm

LV function

LVEF 60 %


V
.65
-.65
5
10
89
HR

CW Aortic prosthesis



High Gradients across aortic prostheses

Obstruction

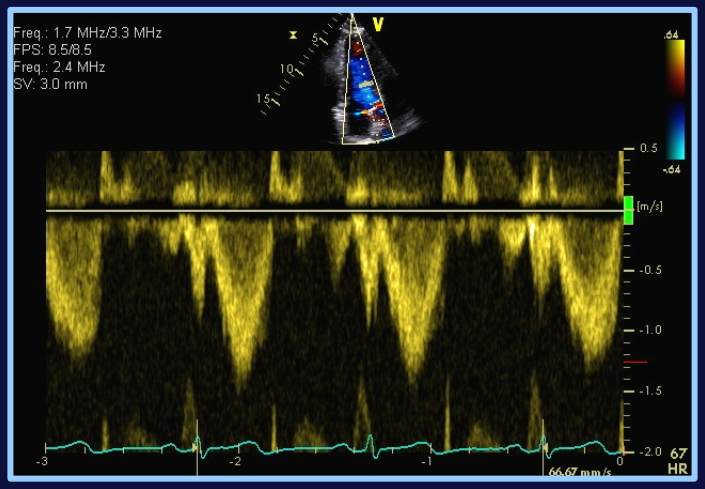
- Thrombus
- Pannus
- Bioprosthetic degeneration
- Subvalvular narrowing

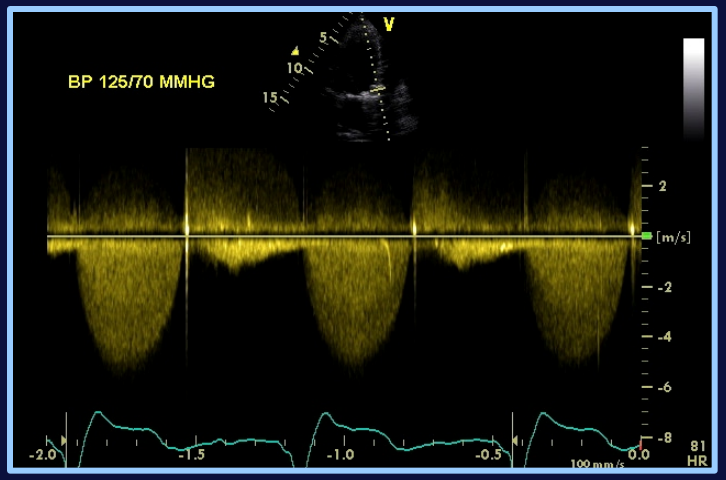
Functional

- Regurgitation
- High flow states
- Pressure recovery

Patient prosthesis mismatch

Dimensionless Index: DVI



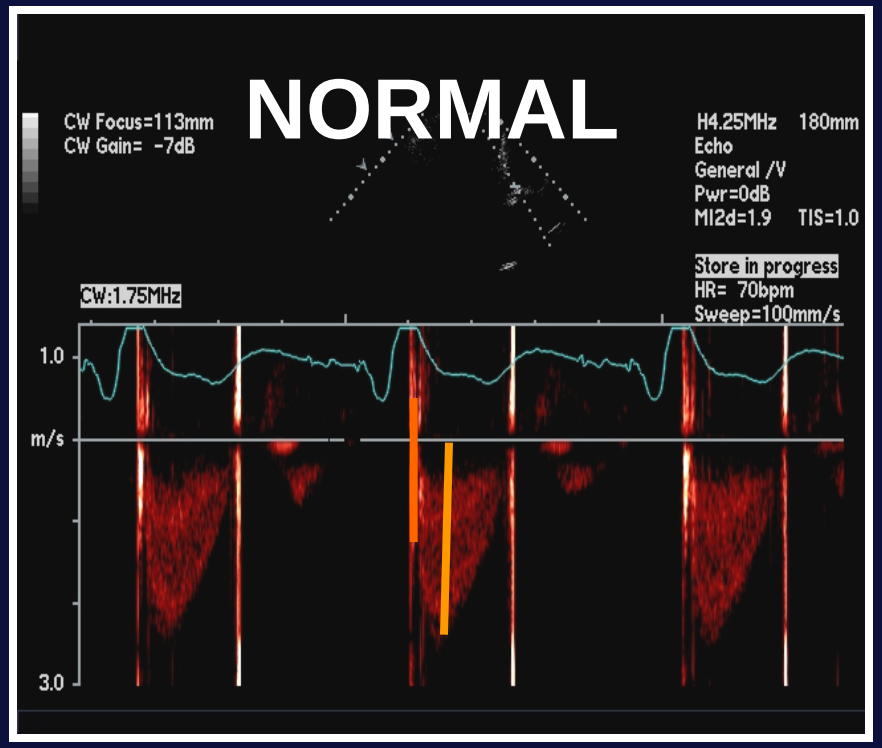


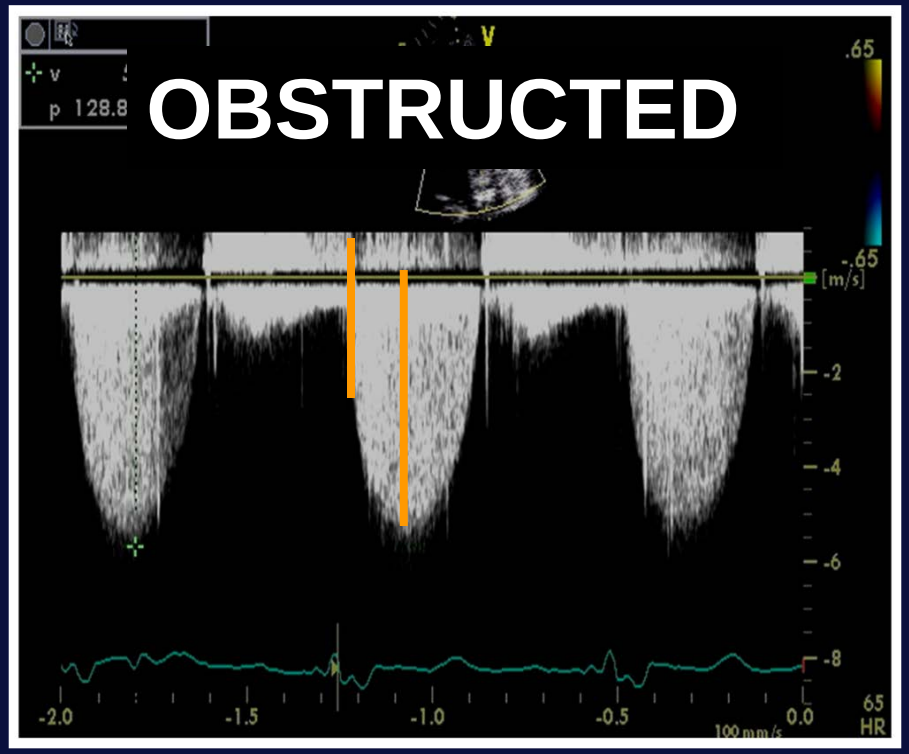
$$\frac{PW_{LVOT}}{CW_{AS}}$$

Normal

≥ .30

Acceleration Time (ms)

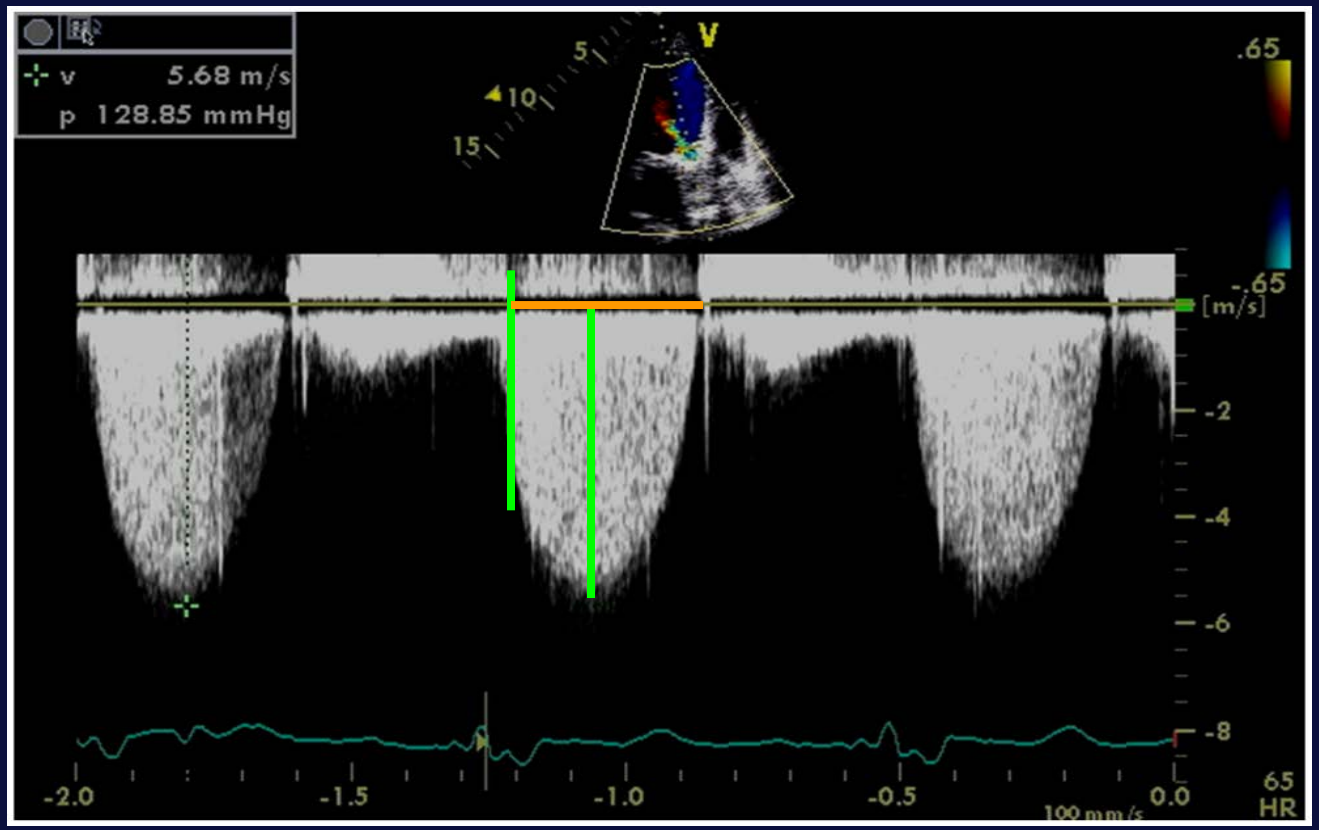




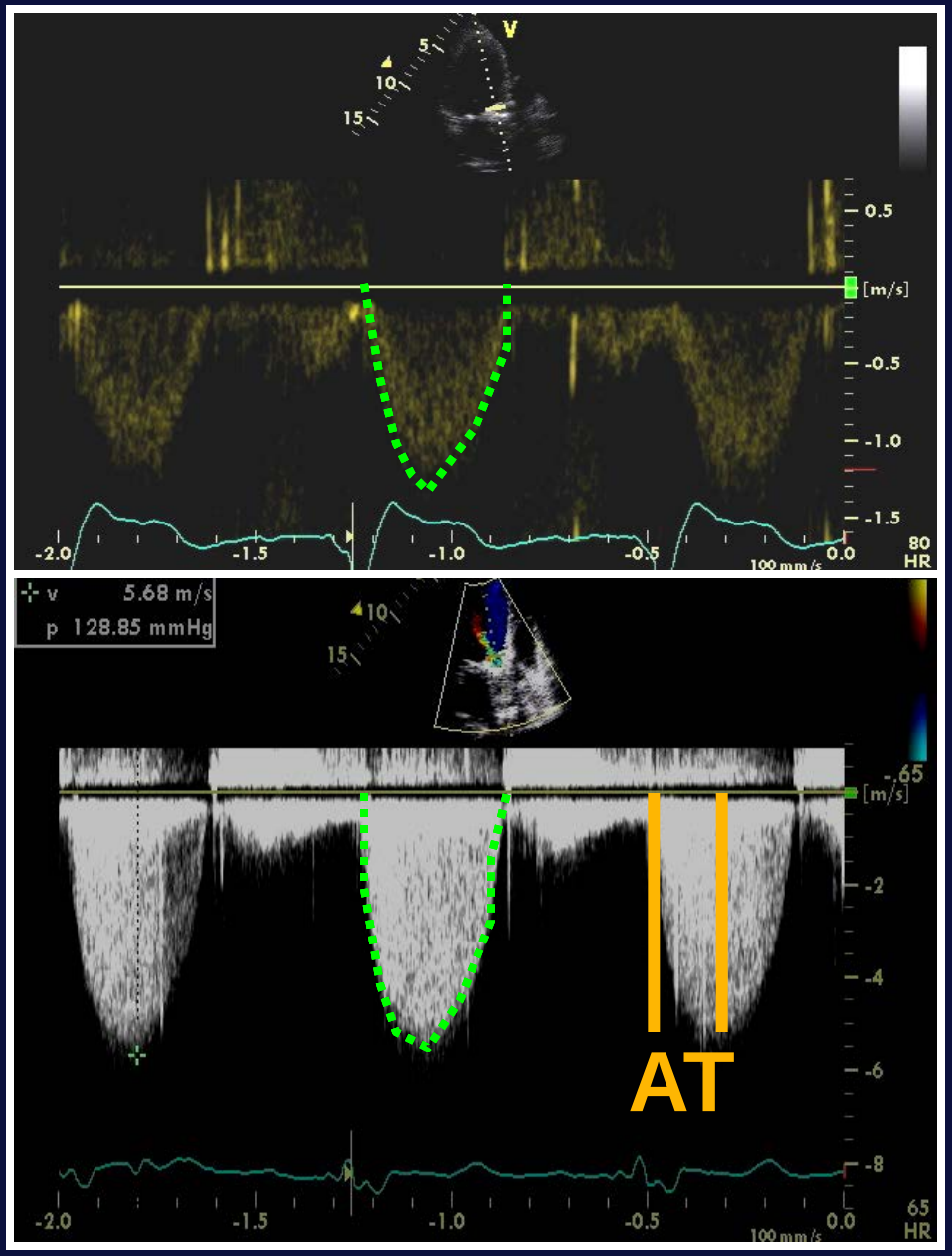
Gradient (mmHg)	14	68
DVI	0.52	0.22
AT (ms)	70	177

AT/ET

Normal: ≤ 0.25 ± 0.05



iJACC 2013;Vol6#2:196



DVI : 0.22

AT : 177

AVA: 0.59 cm²

Expected gradients for normal # 21 St. Jude AVR:

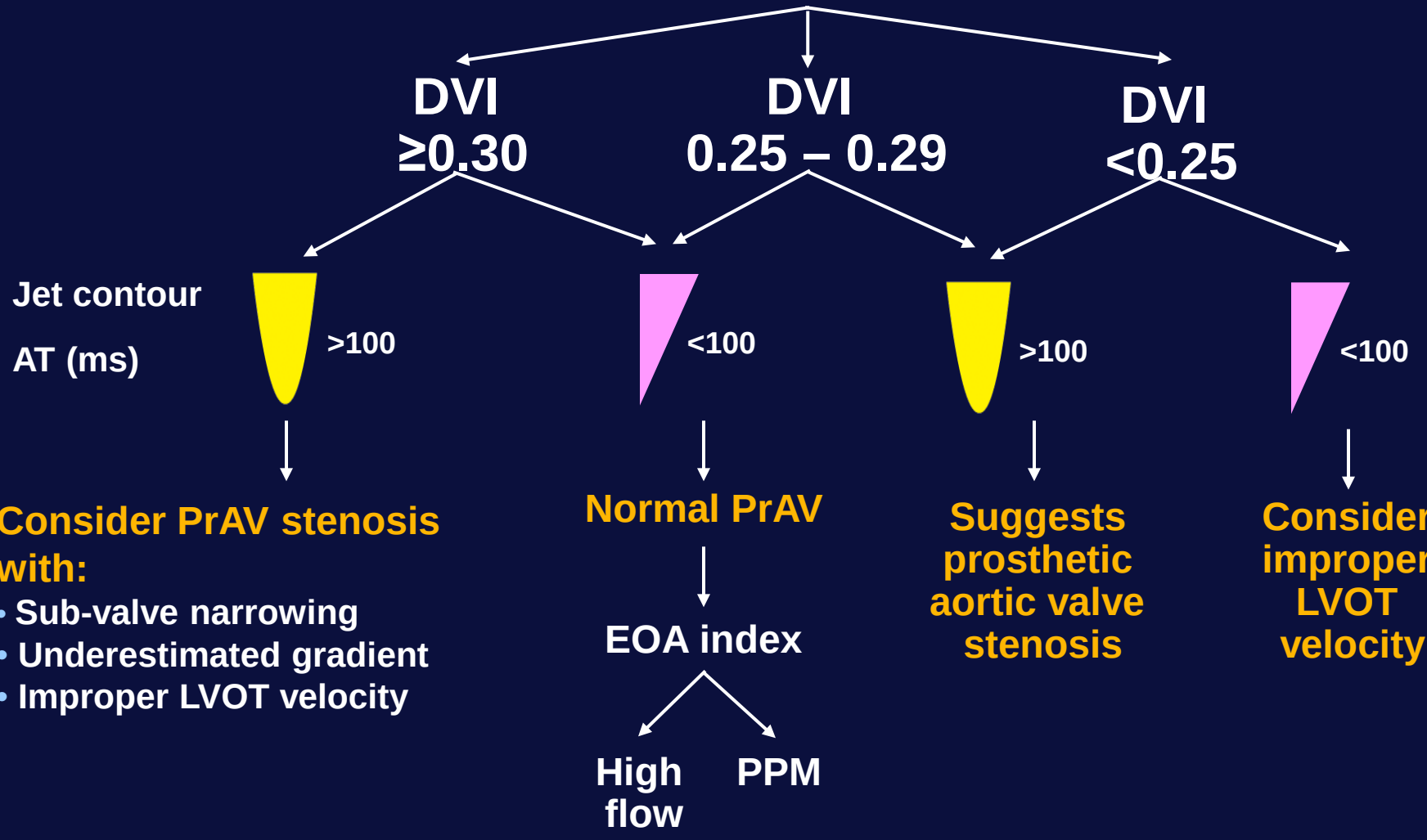
Mean gradient 15±5

EOA:2±0.7 cm²

What is wrong with AVR?

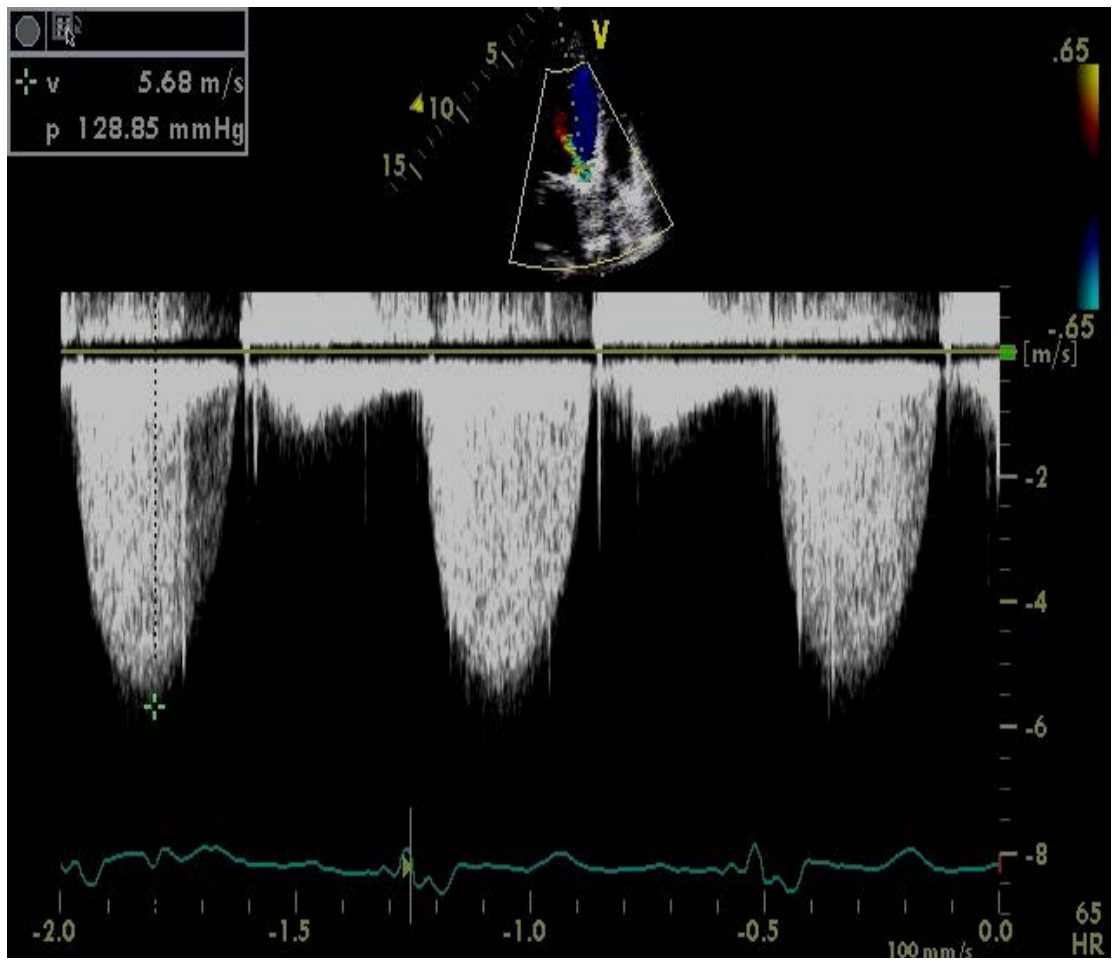
1. Patient-prosthesis mismatch
2. Obstructed
3. Severe AI; mild obstruction
4. High flow state

Comprehensive Evaluation
Peak aortic prosthesis velocity > 3m/s



JASE 2009;22(9):975

Our patient



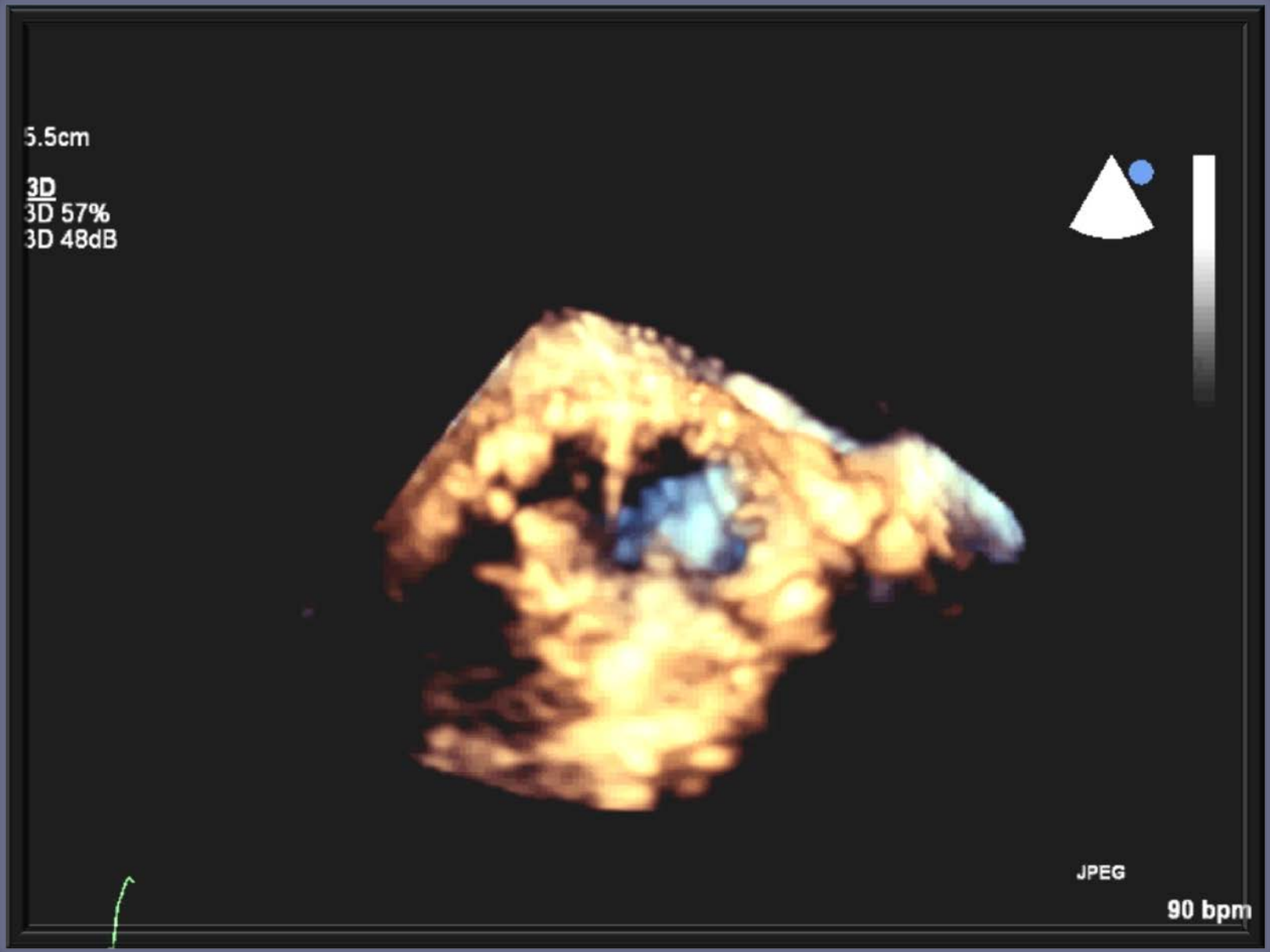
Peak velocity 5.7m/s

Mean grad 68 mmHg

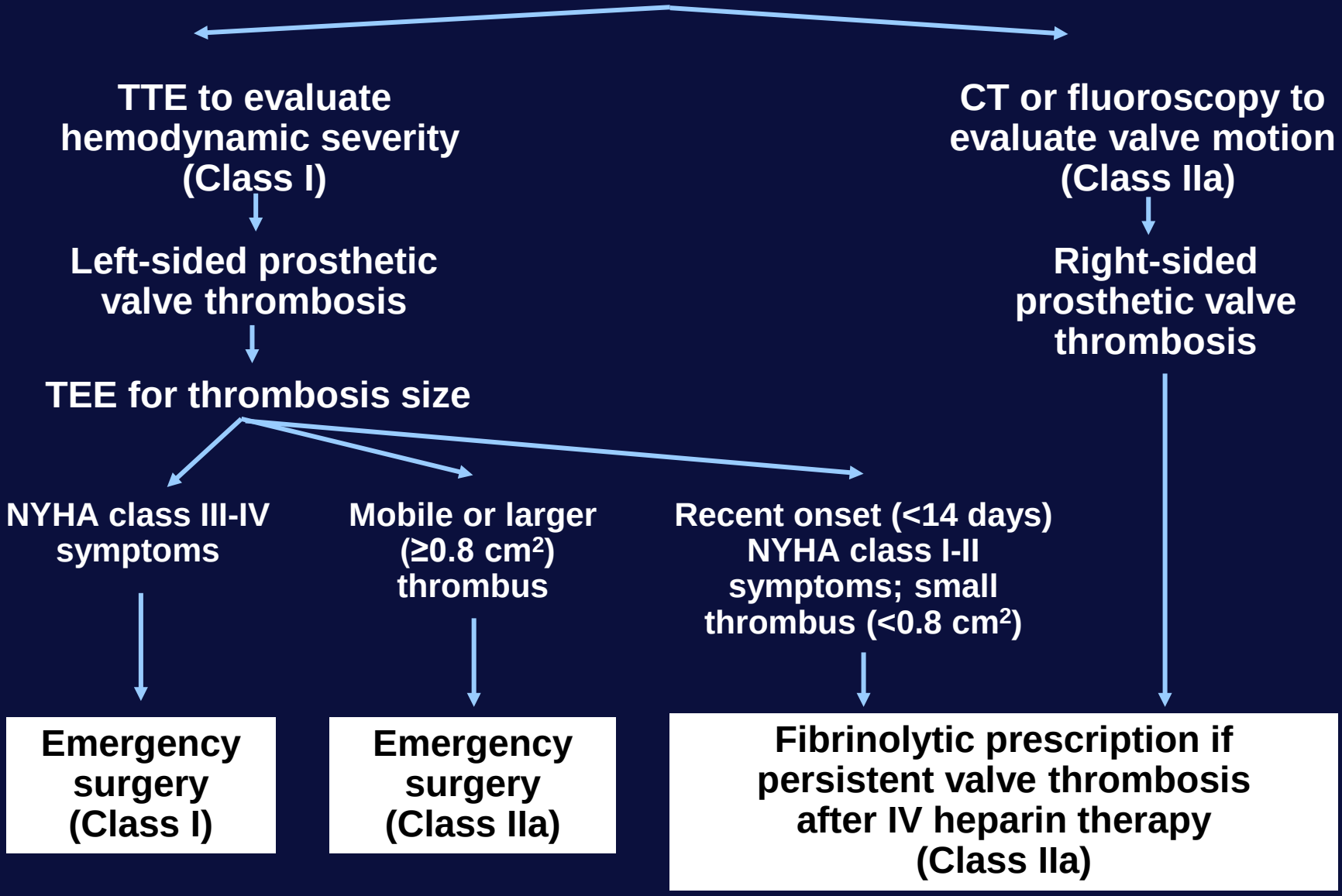
DVI 0.22

AT: 177 msec

Obstructed AVR


5.5cm
3D
3D 57%
3D 48dB
JPEG
90 bpm

Suspected Prosthetic Valve Thrombosis

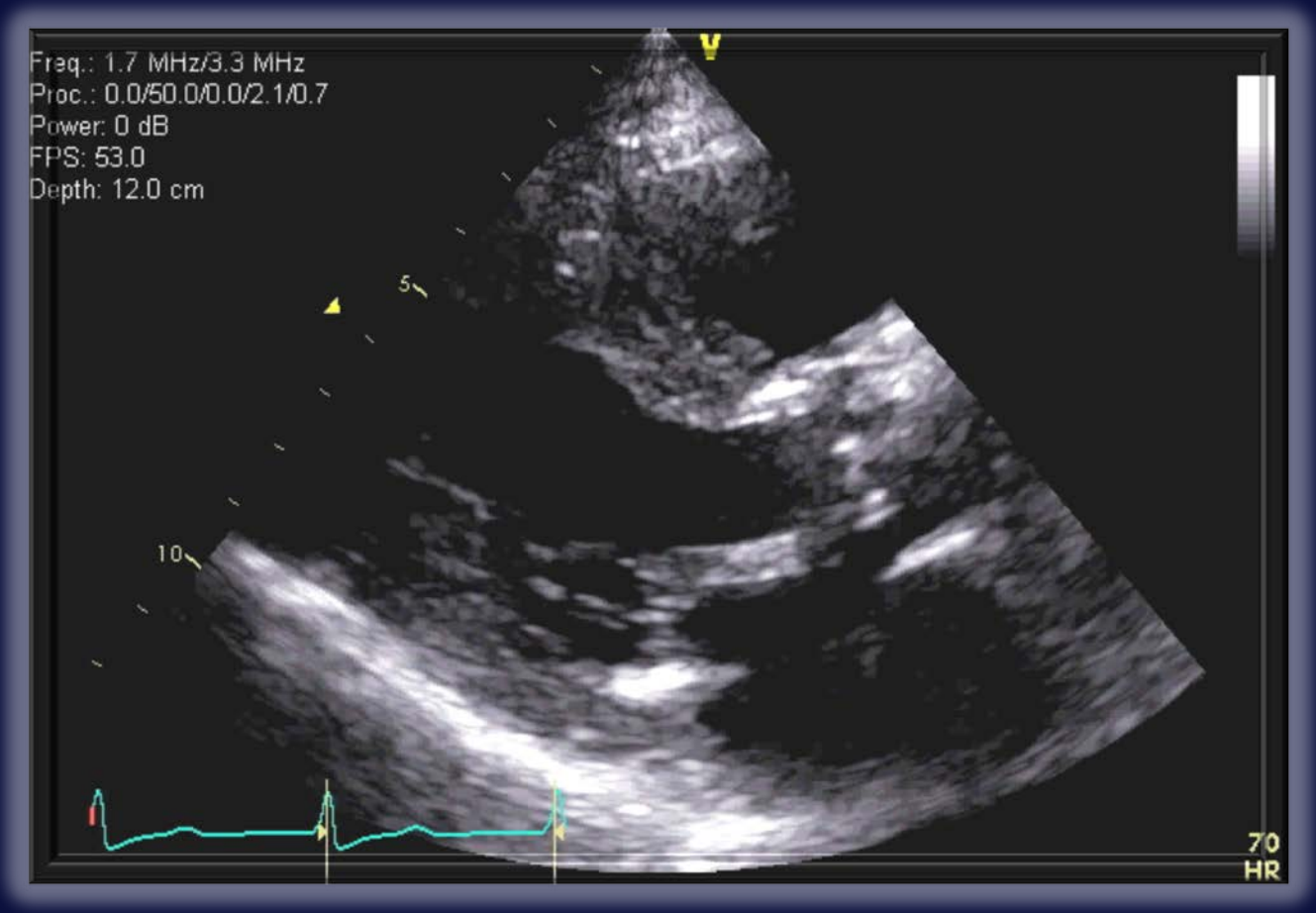


JACC 2014;63(22):2438

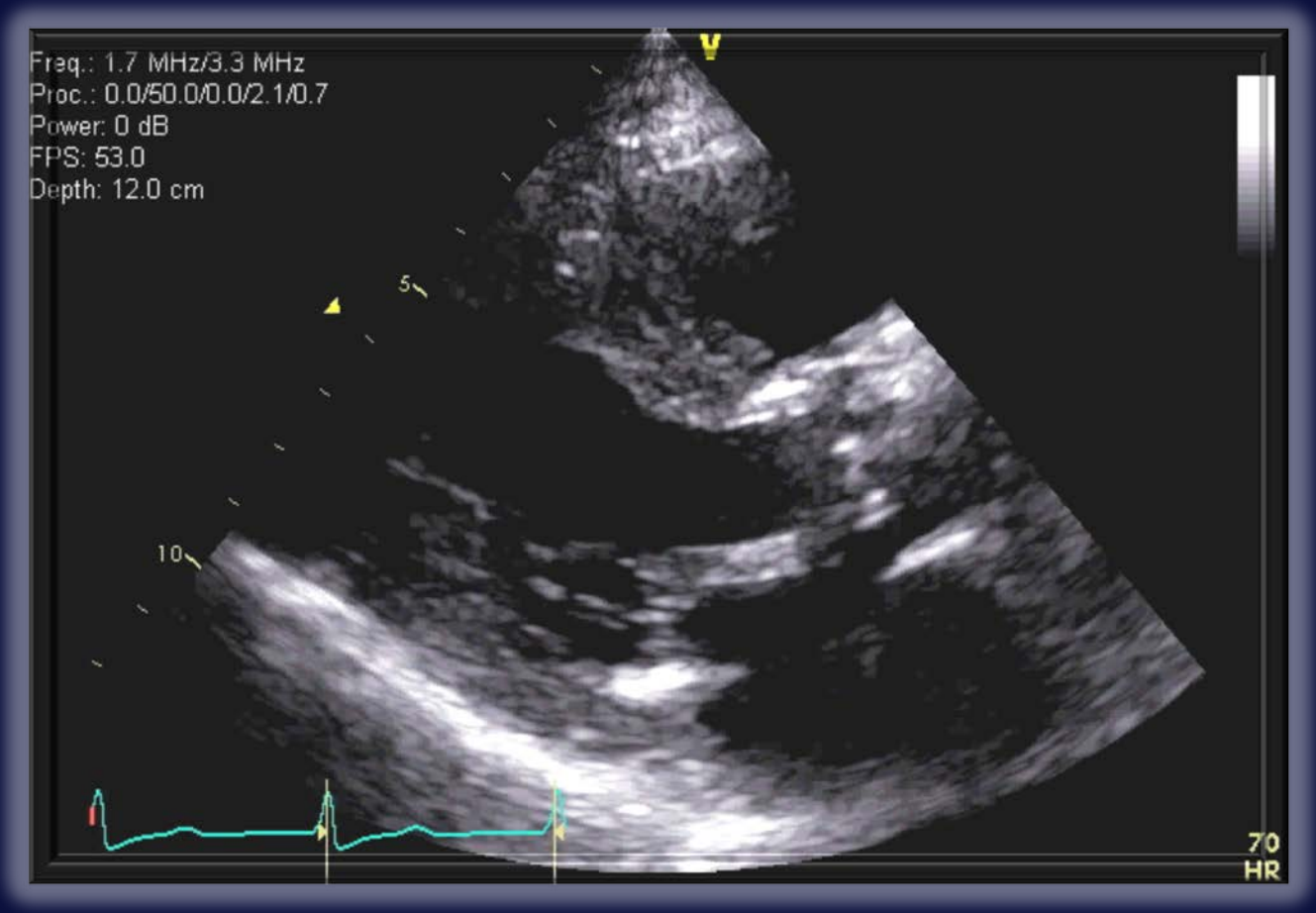
Case

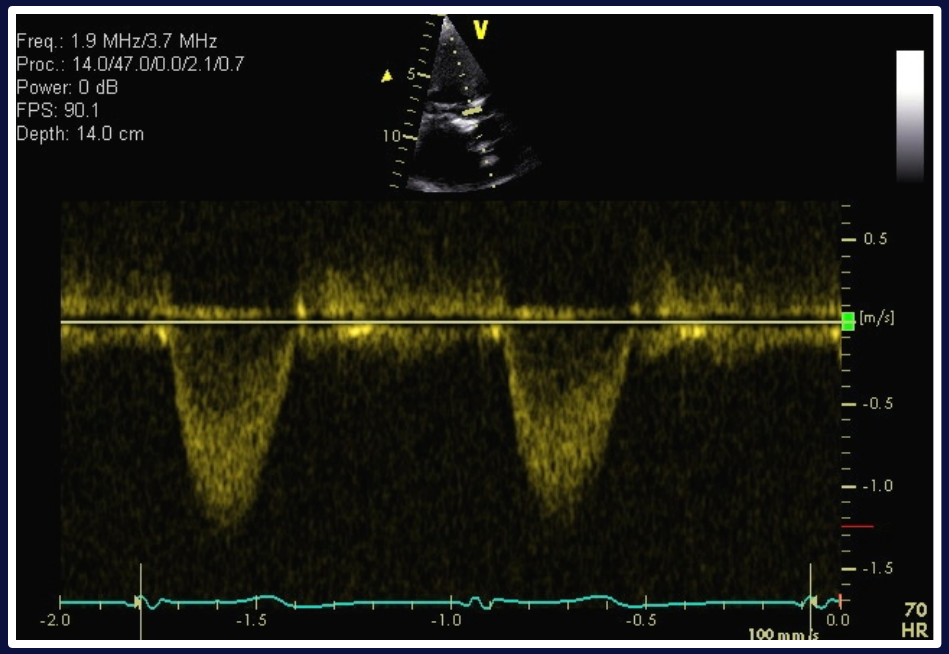
- 80 year old woman: progressive dyspnea on exertion
- NYHA Class III
- S/P tissue AVR #19 2001

Septum/posterior wall 14 mm
EF 63%

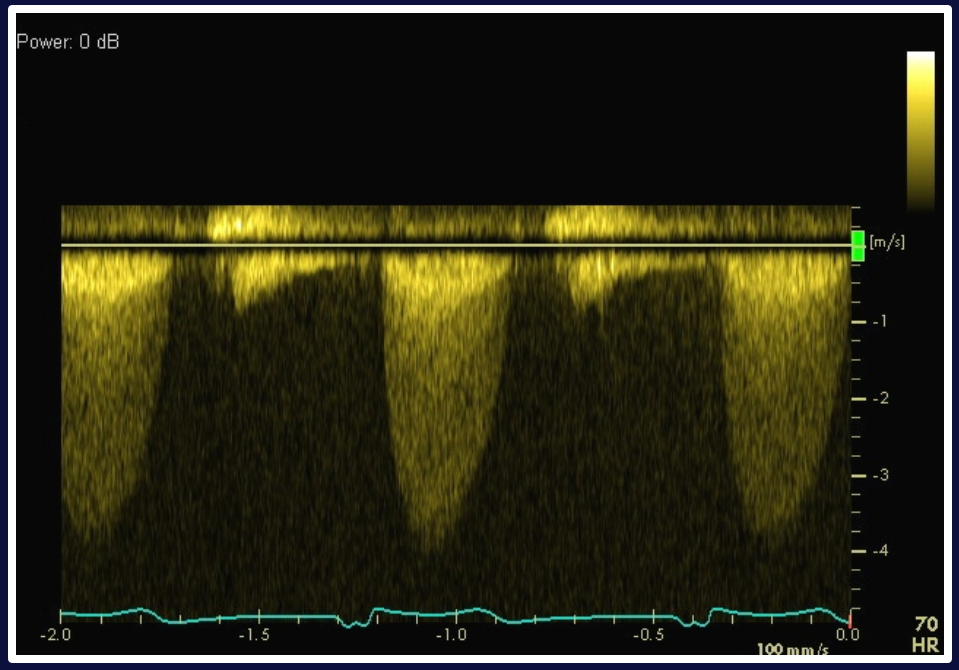


Septum/posterior wall 14 mm
EF 63%





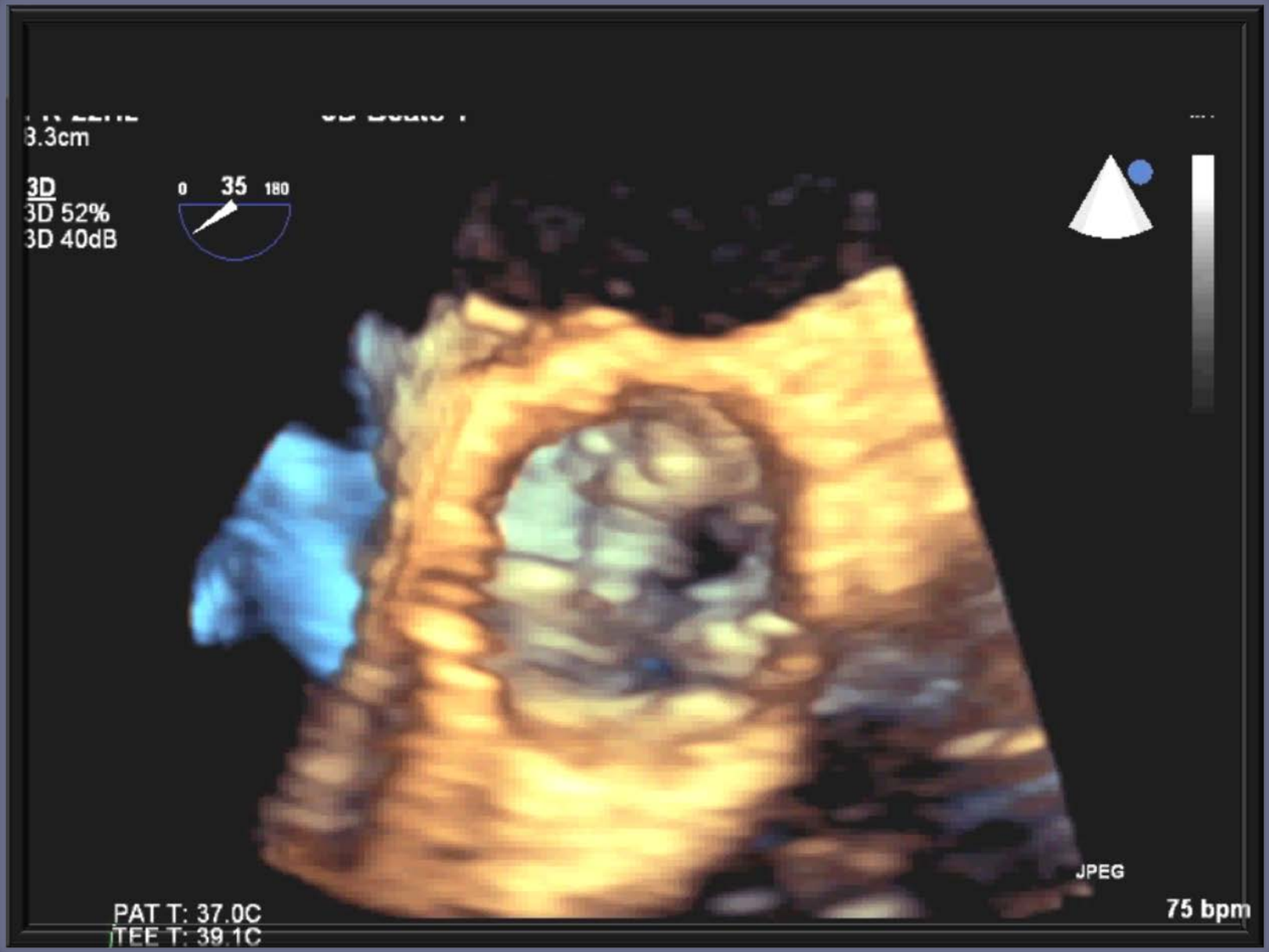
$LVOT_{TVI}$: 21



AS_{TVI} : 99
DVI: 21
EOA: 0.6 cm^2
AT: 100 ms

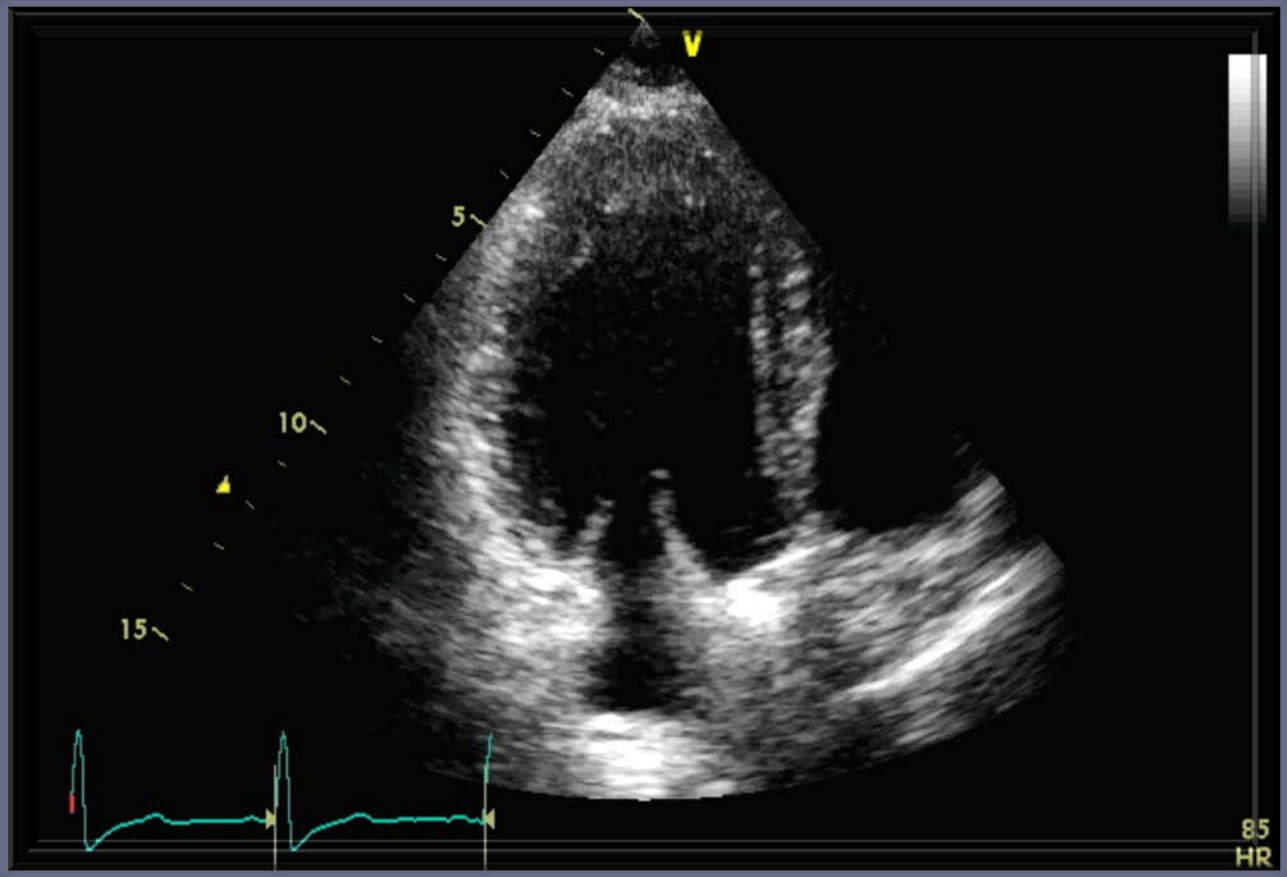
What is wrong with AVR?

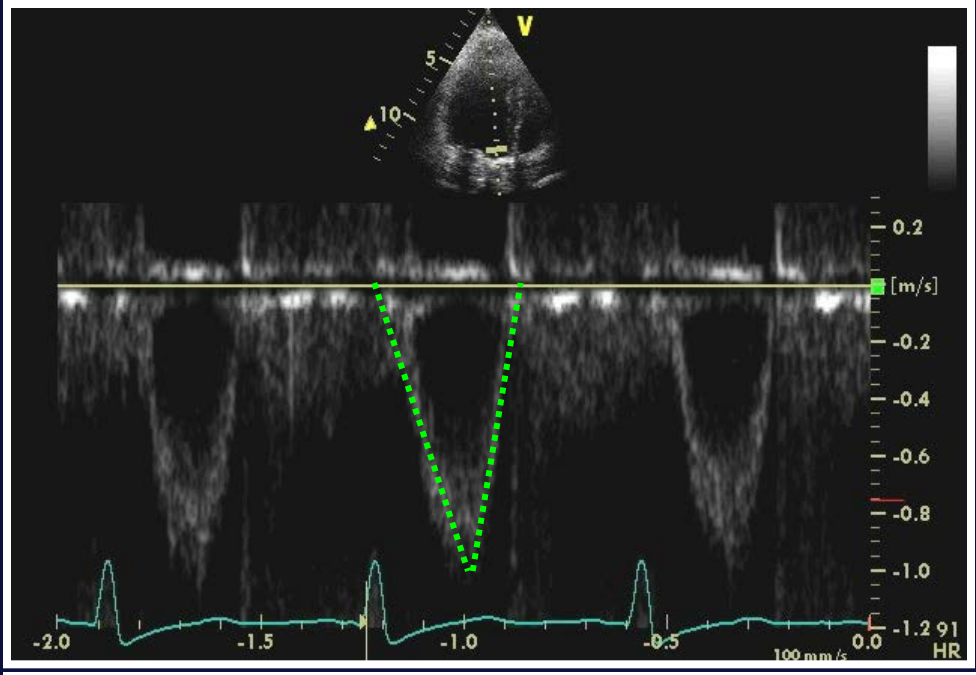
1. Patient-prosthesis mismatch
2. Obstructed
3. Severe AI; mild obstruction
4. High flow state

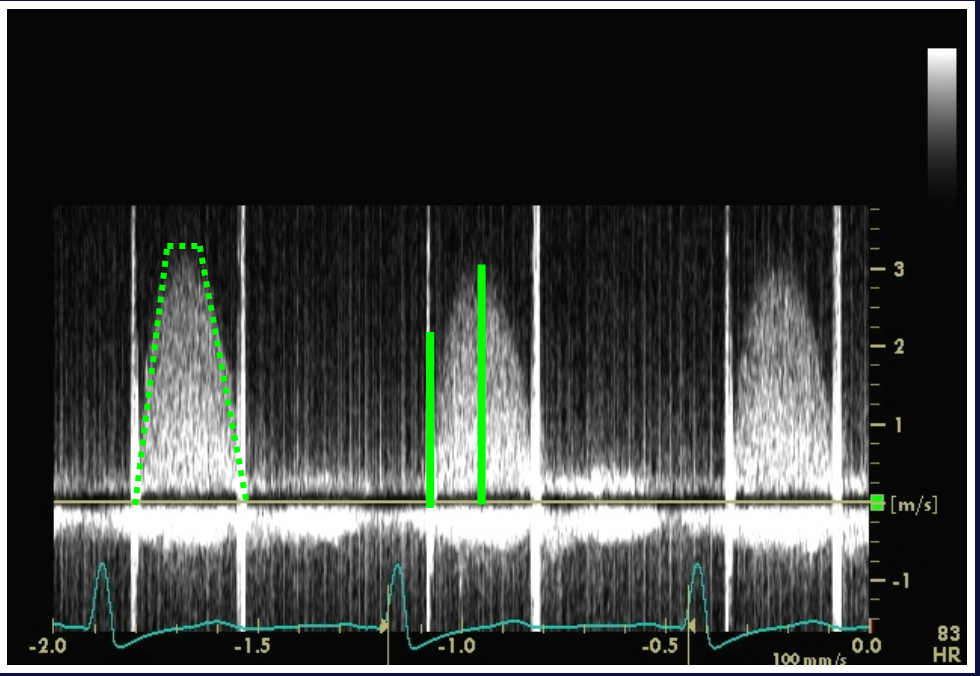

3.3cm
3D
3D 52%
3D 40dB
0
35
180
JPEG
PAT T: 37.0C
TEE T: 39.1C
75 bpm

Case

- 28 year old female ESRD
- S/P AVR 1 year previous size/type unknown
- Functional Class I


V
5
10
15
85
HR





LVOT: 1 m/s

TVI_{LVOT}: 17.6

AV velocity: 3.4 m/s

DI: 0.27

Mean gradient (mmHg): 30

EOA: 1.13 cm^2

AT: 100 ms

What to do next?

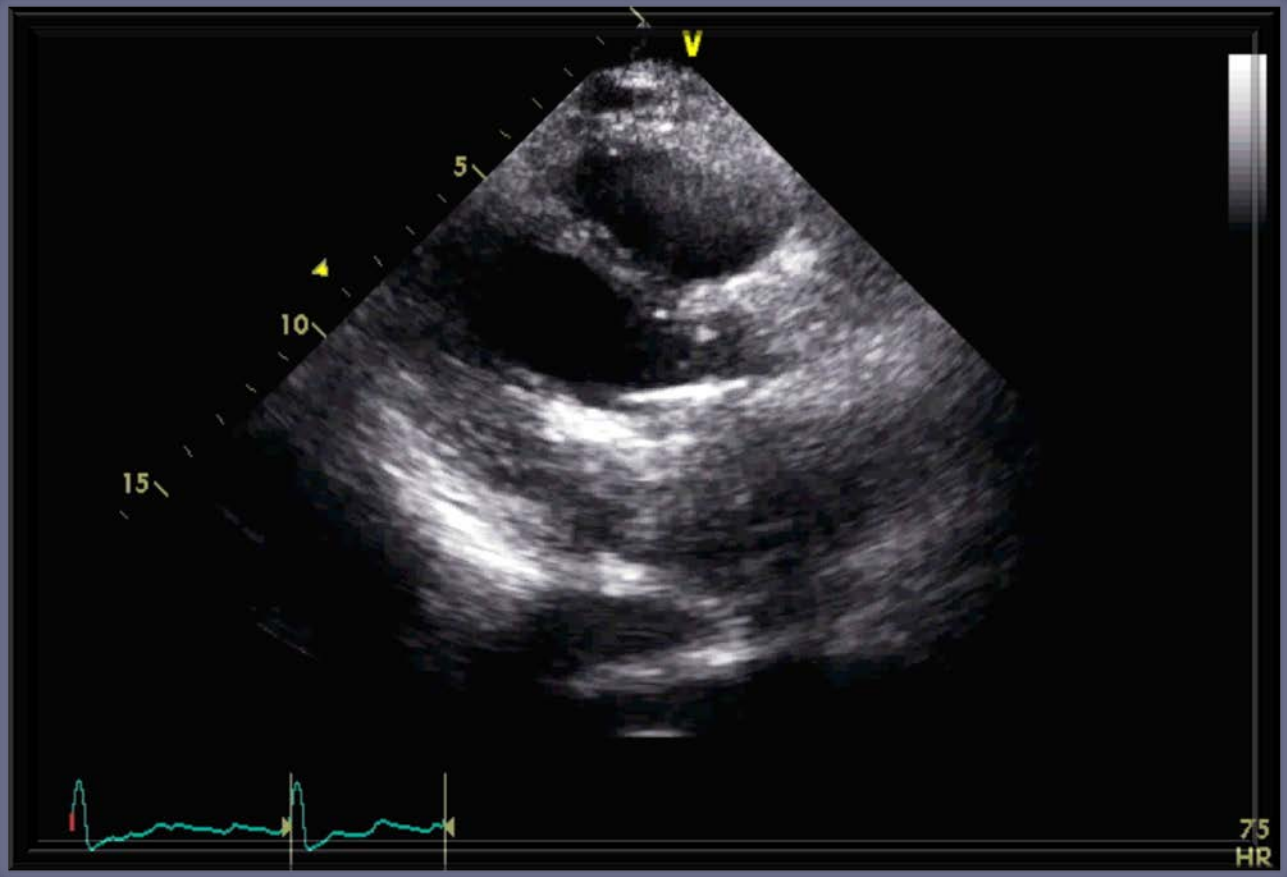
1. Re- do AVR
2. Get valve size
3. TEE
4. Repeat TTE

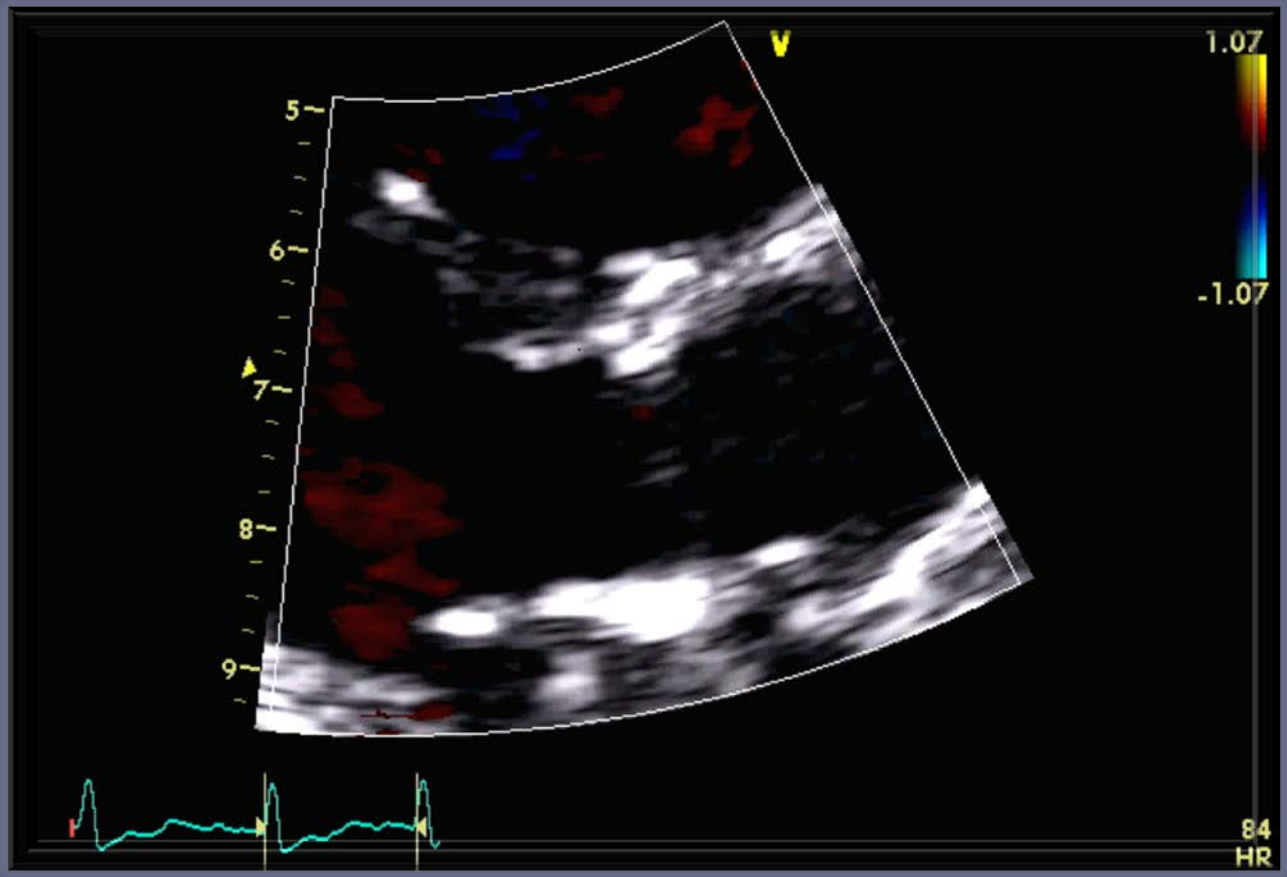
Normal ATS #19

- Peak gradient: 47 ± 12.6 mmHg (46)
- Mean gradient: 25.3 ± 8 mmHg (30)
- EOA: 1.1 ± 0.3 cm^2 (1.13)

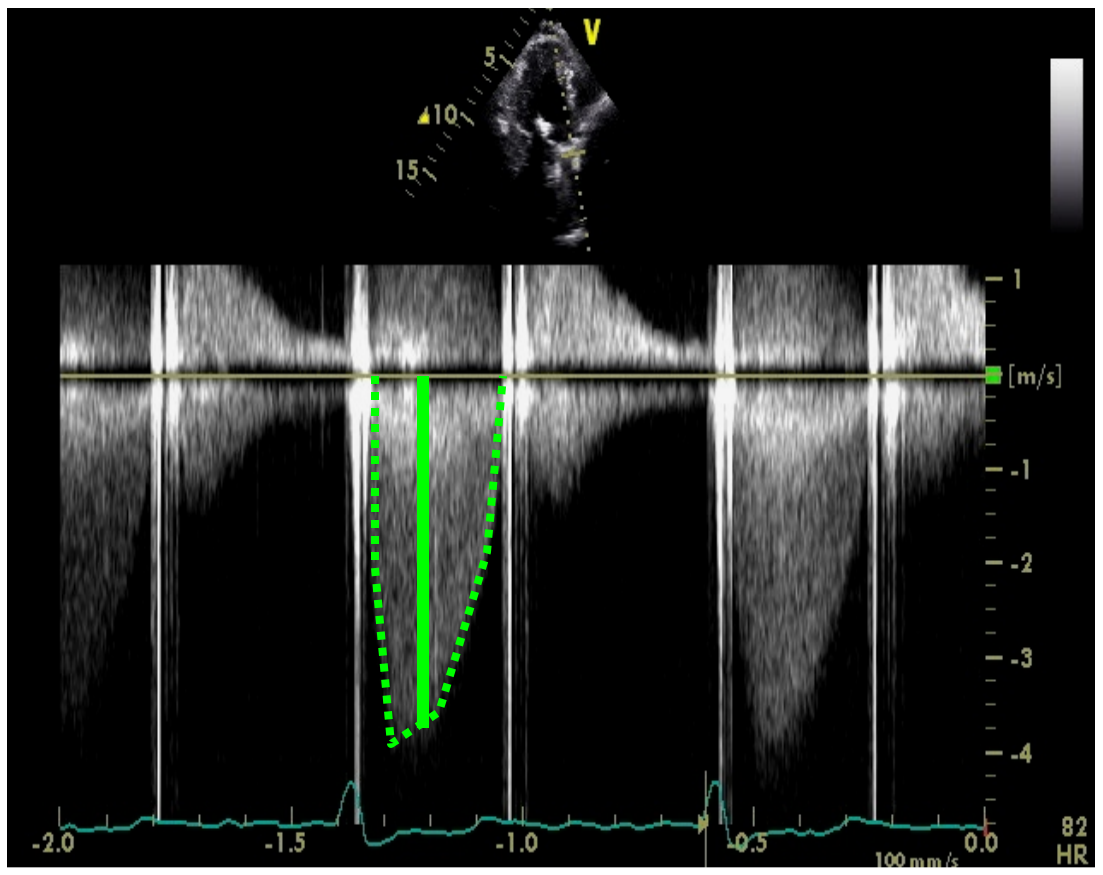
JASE 2009;22(9):975

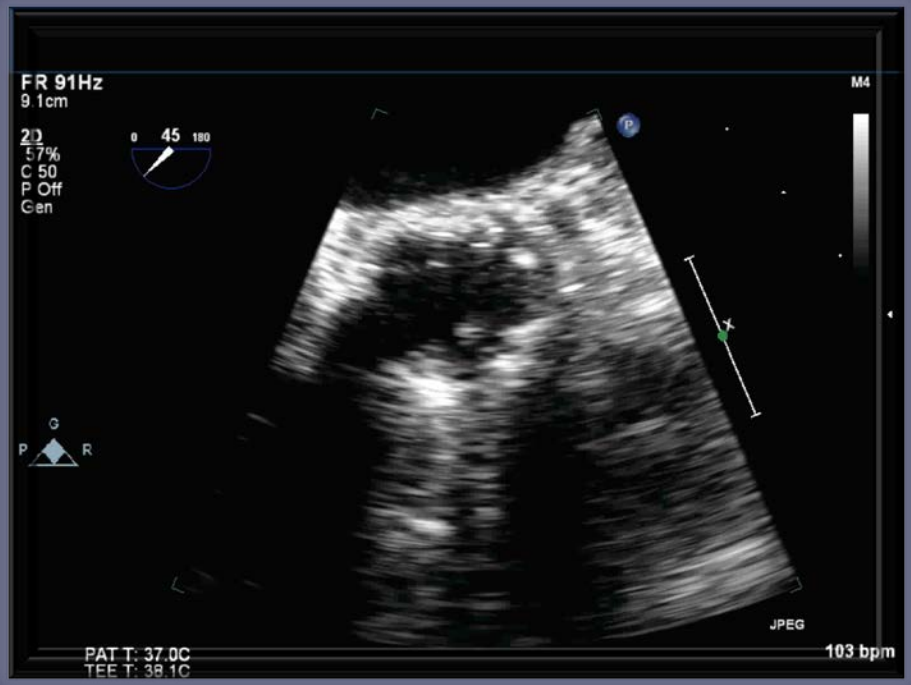
73 year old female; SOBOE; severe COPD
S/P St. Jude AVR #21 and MVR #29

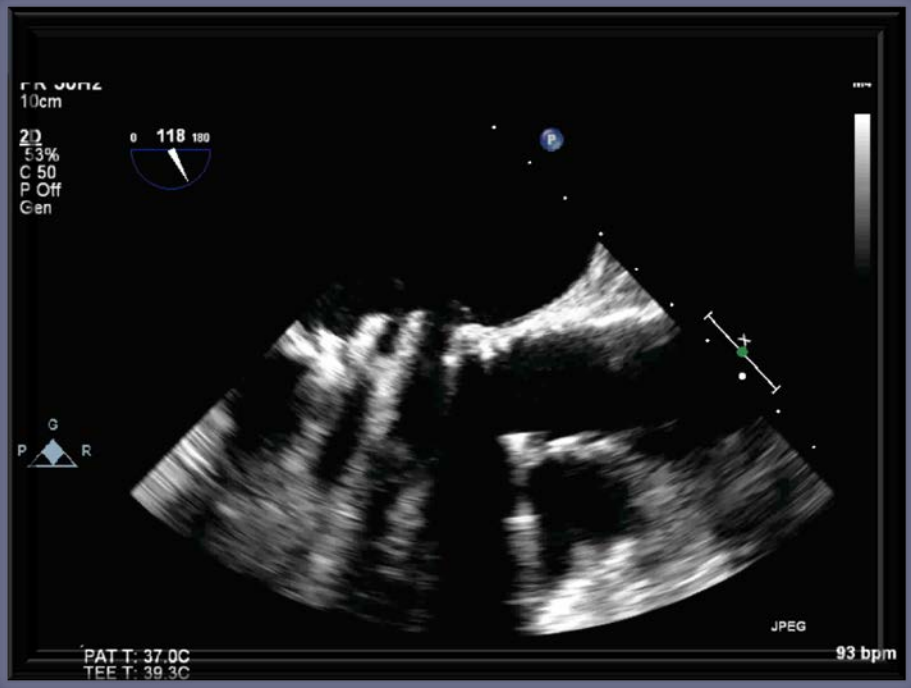



V
1.07
-1.07
5
6
7
8
9
84
HR

CW Aortic prosthesis




FR 91Hz
9.1cm
M4
2D
57%
C 50
P Off
Gen
0 45 180
G
P R
JPEG
PAT T: 37.0C
TEE T: 38.1C
103 bpm

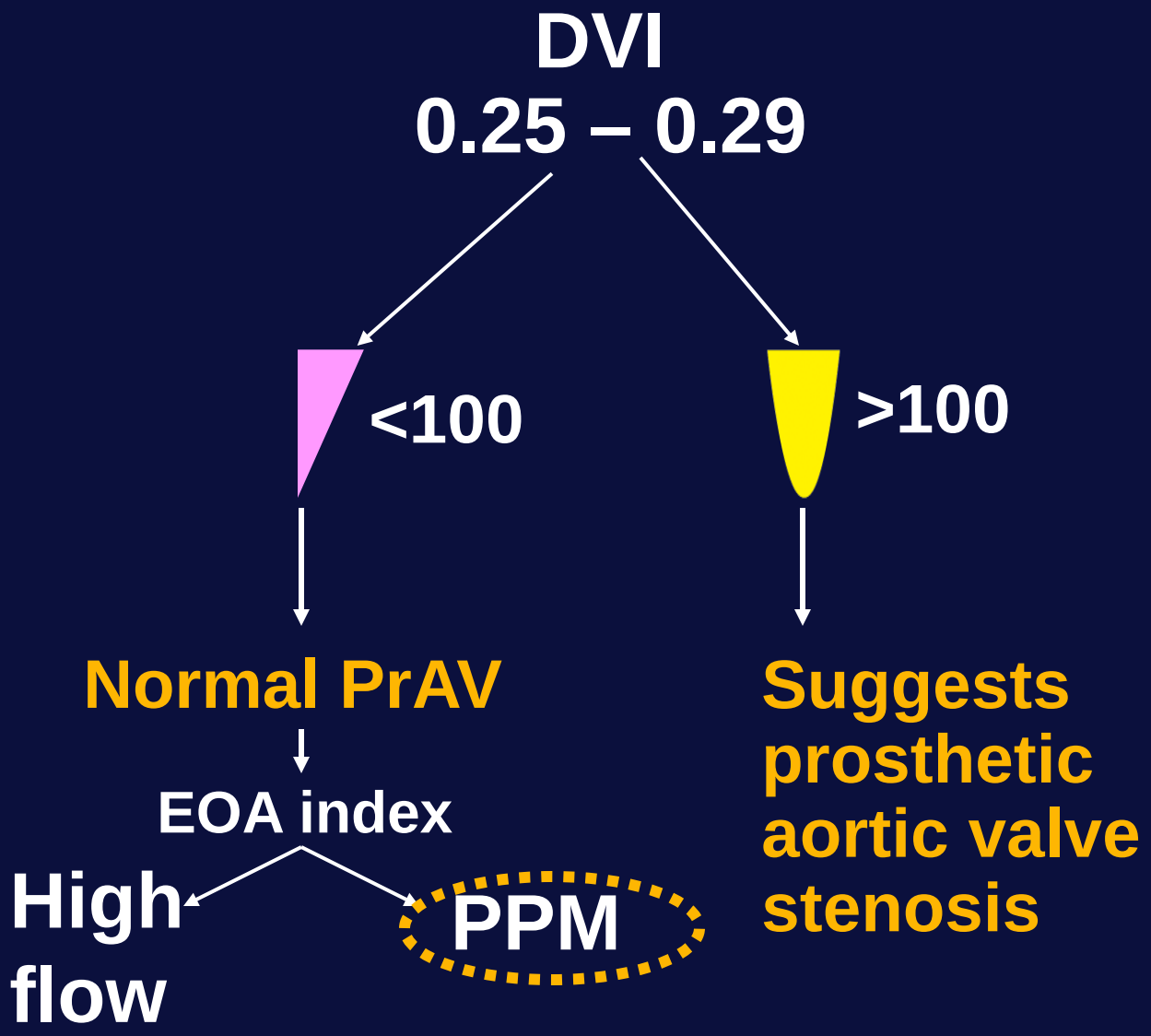

10cm
2D
53%
C 50
P Off
Gen
0 118 180
G
P R
JPEG
PAT T: 37.0C
TEE T: 39.3C
93 bpm


R
%R-R:10
P
RAO 91: CAU 53
1mm/div
w:895 L

What is wrong with AVR?

1. Patient-prosthesis mismatch
2. Obstructed
3. Significant AI; mild obstruction
4. High flow state

Comprehensive evaluation



JASE 2009;22(9):975

Patient Prosthesis Mismatch

“Mismatch can be considered to be present when the effective prosthetic heart valve area, after insertion into the patient, is less than that of a human heart valve. All PHV’s are smaller than normal and inherently stenotic.”

JACC 2012;60(13):1123

Patient Prosthesis Mismatch for Aortic Valve Replacement

Indexed EOA (cm^2/m^2)	PPM
≤ 0.85	Moderate
≤ 0.65	Severe

JACC 2000;36:1131

Mechanical valves

Stented Bioprosthesis

Small valve size (19, 21 mm)

PPM Risk Factors

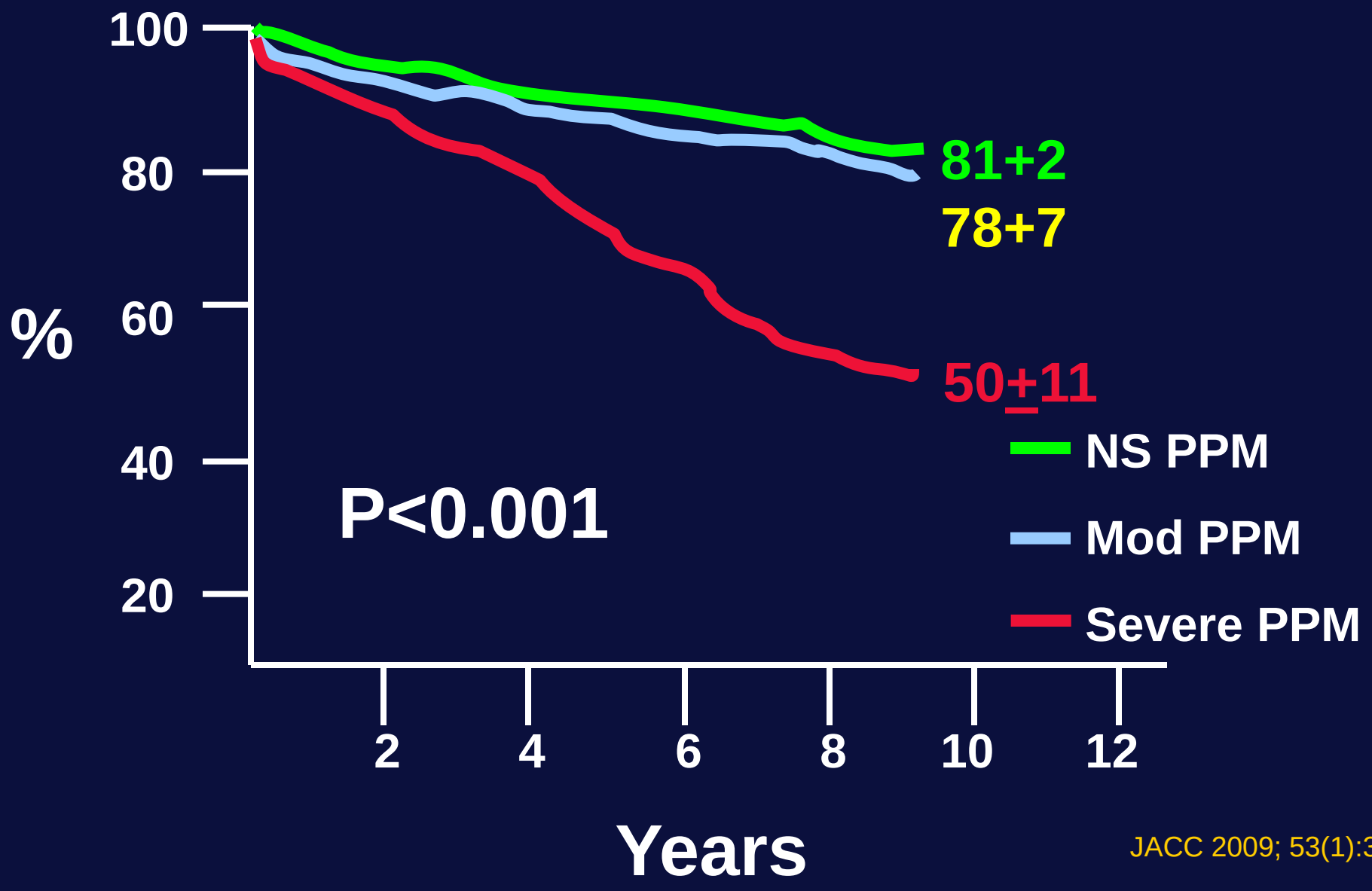
Clinical

HT, DM, obesity, female gender, CAD, CKD

Pre-op AS

JACC 2009; 53(1):39

Freedom from CV Death



JACC 2009; 53(1):39

Doppler Parameters

Parameter	Normal	Possible stenosis	Sugg sig stenosis
Peak velocity (m/s)	< 3	3-4	> 4
Mean grad (mmHg)	< 20	20-35	> 35
DVI	≥ 0.30	0.29-0.25	< 0.25
Jet contour	Early peak	Mid peak	Rounded symmetric
AT (ms)	< 80	80-100	>100

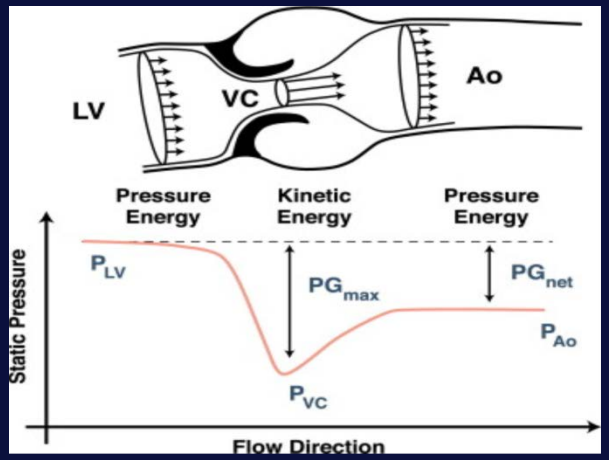
JASE 2009;22(9):975

	Accuracy	Sensitivity	Specificity
MG (mmHg)	75%	83%	74%
DVI	75%	92%	84%
EOAi (cm^2/m^2)	67%	83%	66%
dA (cm^2)	87%	92%	86%
AT (ms)	94%	92%	94%
AT/ET	89%	83%	90%

iJACC 2013;Vol6#2:196

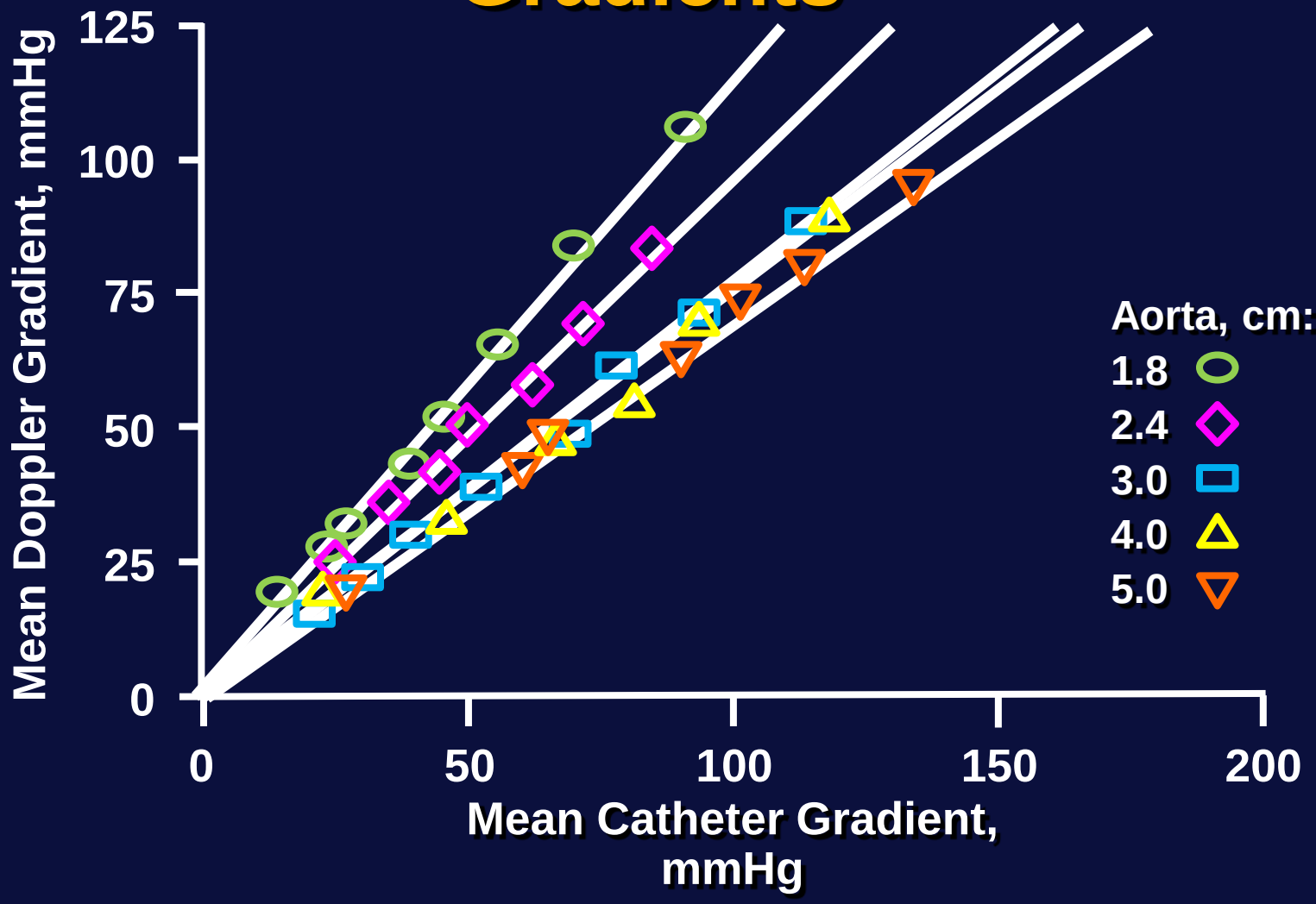
Pressure Recovery

The increase of pressure downstream from the stenosis caused by a reconversion of kinetic to potential energy which can lead to an "overestimation" of gradients by Doppler in certain situations



Circulation 1996;94:1934-1940

Aortic Size and Correlation Between Mean Doppler and Mean Catheter Gradients



Circulation 1996;94:1934-1940


mayo