Pericardial Disease: Tamponade and Constriction

FEBRUARY 16, 2016

Sanjiv J. Shah, MD, FASE
Associate Professor of Medicine
Director, Heart Failure with Preserved EF Program
Division of Cardiology, Department of Medicine
Northwestern University Feinberg School of Medicine
sanjiv.shah@northwestern.edu

Questions

- In a patient with pericardial effusion, how can I diagnose tamponade (i.e., who needs an urgent pericardiocentesis?)
- Why is there no Kussmaul sign in tamponade? Why is there loss of Y-descent?
- What are the echo clues to constriction?
- Why is septal > lateral e' in constriction?
- In constriction, why does hepatic vein flow reversal increase with *expiration* but JVP goes up with *inspiration* (+Kussmaul)?

Cardiac tamponade

Case presentation

- 52-year-old woman with malaise, CP
  - » Low-grade fever, malaise, fatigue x 2 weeks
  - » CP x 1 week, pleuritic, worse when supine, better when sitting forward, positional
  - » No lightheadedness, dizziness, orthopnea, PND, syncope, or palpitations
- No prior medical history, no medications

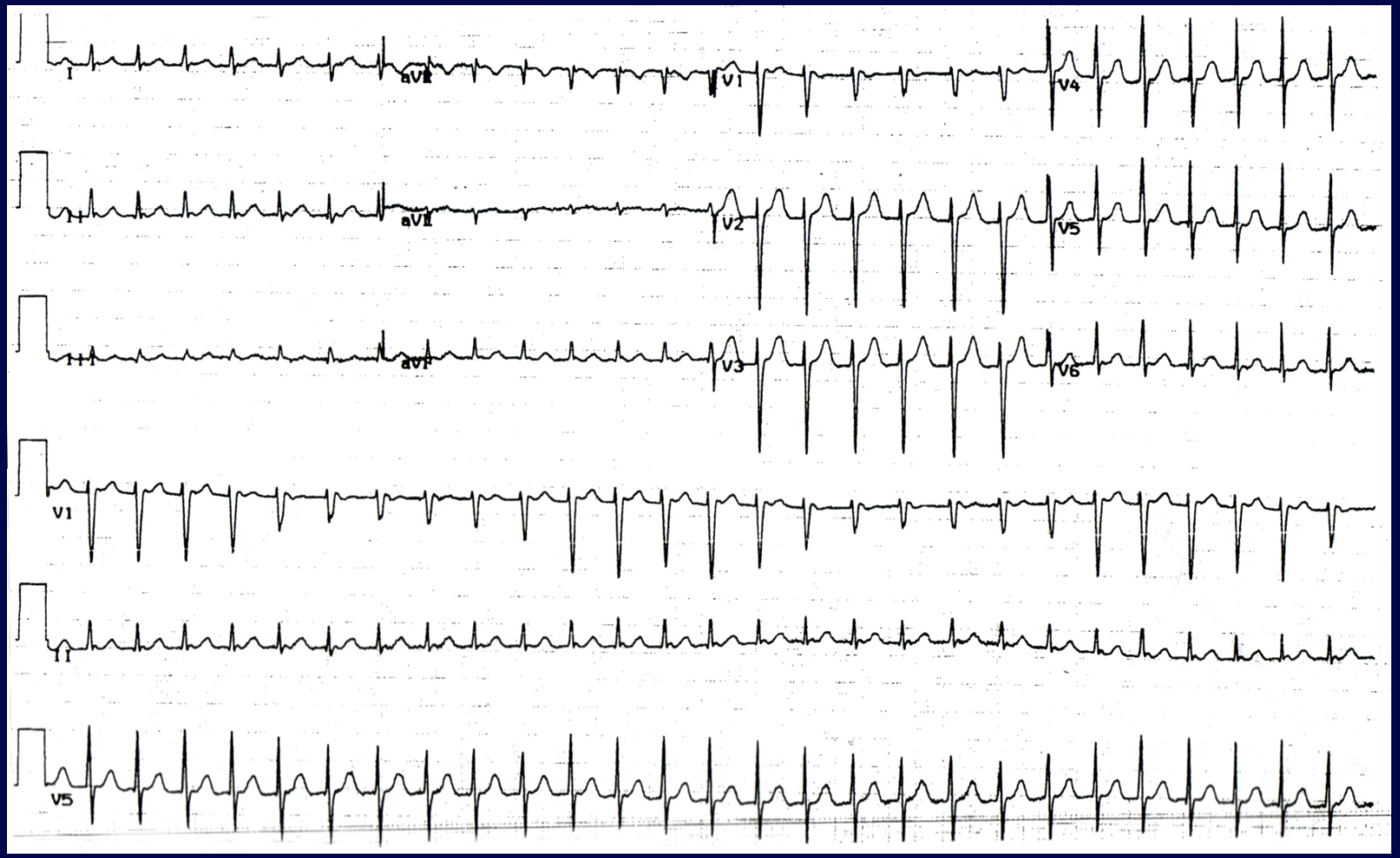
Case presentation (continued)

- Laboratory work-up:
  - » ANA, rheumatoid factor: normal
  - » Chem panel, CBC: normal
  - » PPD: nonreactive; HIV: negative
- Echocardiogram: normal
- Prescribed NSAIDs
- Symptoms resolved within 2-3 days

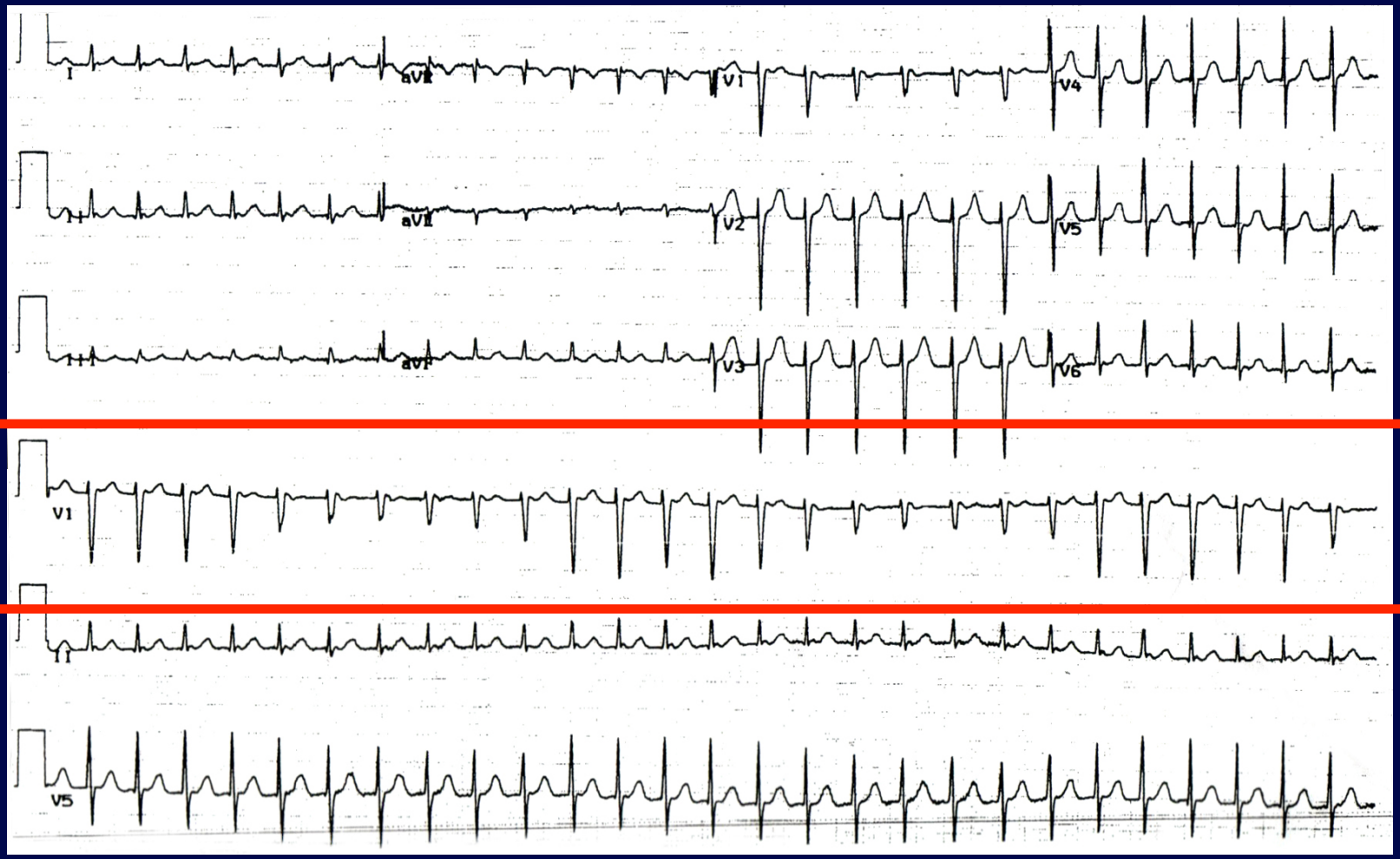
Case presentation (continued)

- 2 weeks later: recurrence of malaise, fatigue, low grade fevers, pleuritic CP; +SOB/dizziness
- Physical exam:
  - » 99.8, 98/80, 110, 22, 96% on RA
  - » JVP to earlobes
  - » Lungs CTA bilaterally
  - » Distant HS, tachy, regular, no m/g/r
  - » Abdominal exam: benign
  - » Ext: 1+ edema to knees

Electrocardiogram



Electrocardiogram



It's 2am in ER: What now??

- STAT echocardiogram
- STAT chest CT
- STAT cardiac MRI
- Insert IJ central line at bedside
- None of the above

It's 2am in ER: What now??

- STAT echocardiogram
- STAT chest CT
- STAT cardiac MRI
- Insert IJ central line at bedside
- None of the above

Cardiac tamponade… a clinical Dx

- Don’t forget pulsus paradoxus at the bedside…
  - » Inflate BP cuff until you can’t hear Korotkoff sounds
  - » Start deflating until you hear sounds intermittently (sounds disappear with inspiration) - Note SBP #1
  - » Keep deflating until you hear sounds continuously (during inspiration and expiration) - Note SBP #2
  - » Pulsus paradoxus = SBP #1 – SBP #2
    - — Value > 10 mmHg? sens 98%, spec 70%, +LR 3.3, -LR 0.03
    - — Value > 12 mmHg? sens 98%, spec 83%, +LR 5.9, -LR 0.03

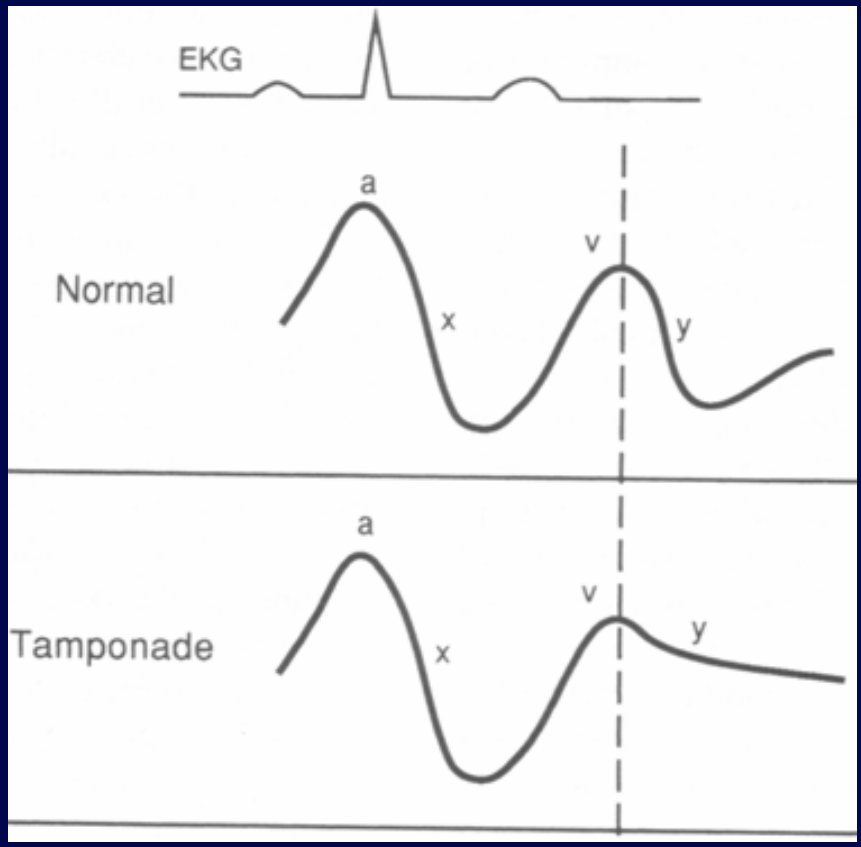
Case presentation (continued)

- Pulsus paradoxus done at bedside:
  - » Value = 18 mmHg
- ER team calls for STAT echocardiogram
- While waiting, R IJ central line placed…

CVP tracing in tamponade

- V wave:
  - » Passive filling of the RA during RV systole
- Y descent:
  - » TV opens, passive RA emptying
- A wave:
  - » RA contraction
- X descent:
  - » RA relaxation

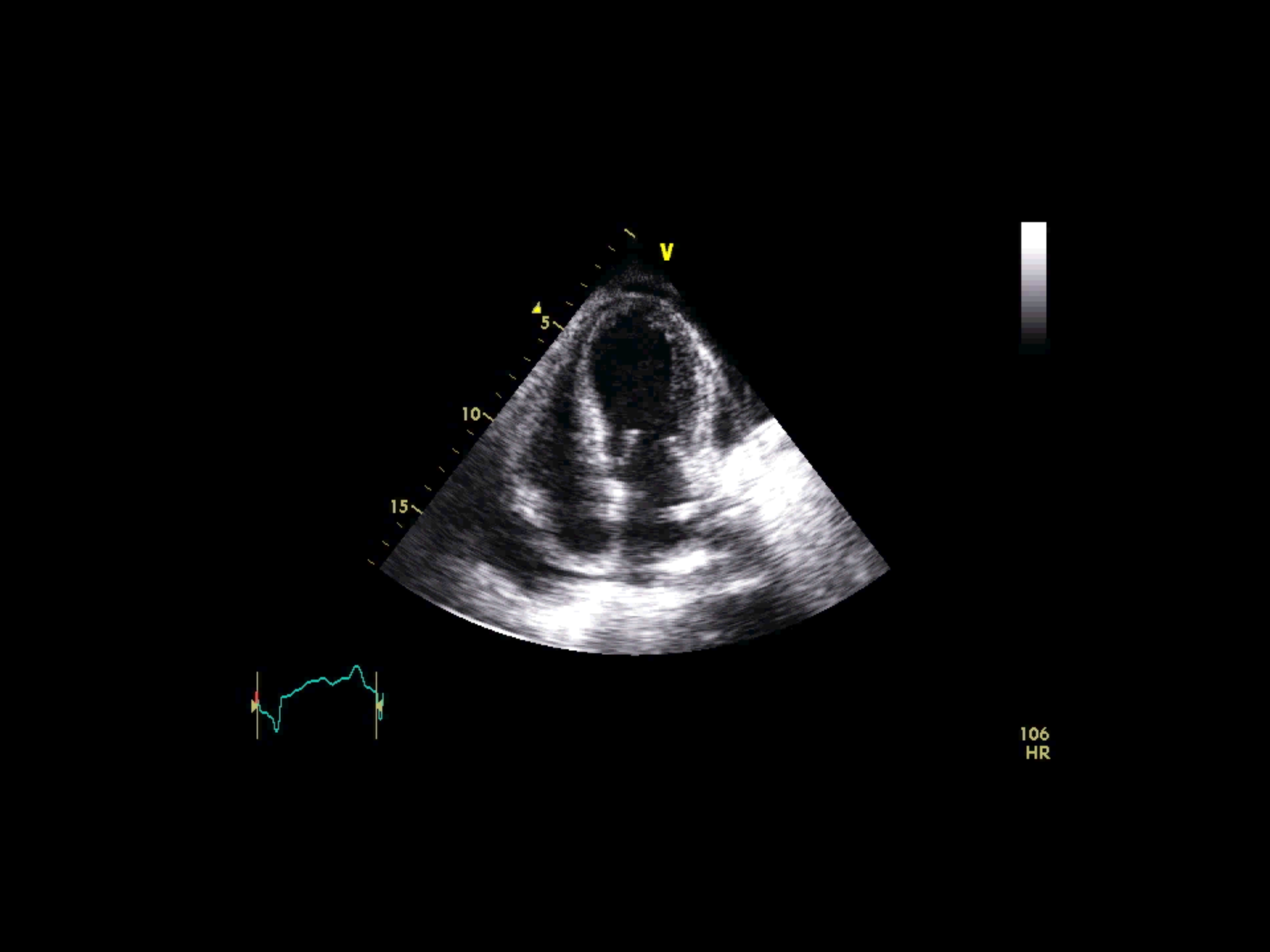
- <u>Tamponade</u>:
  - » Blunted Y descent
  - » Passive emptying of RA is dependent on pressure difference between RA and RV: *in tamponade, the pericardial pressure takes over all other diastolic pressures (= loss of Y descent)*

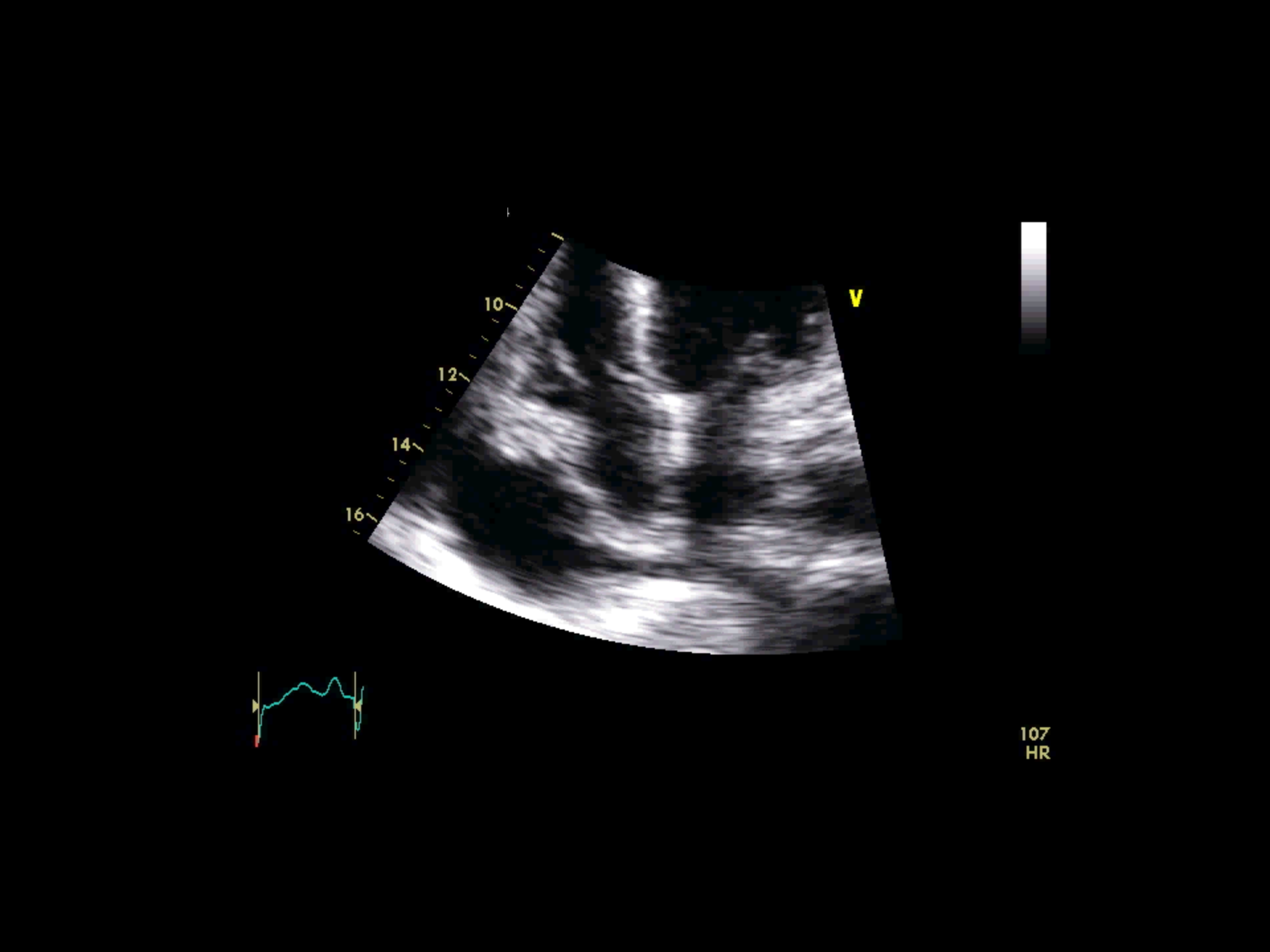


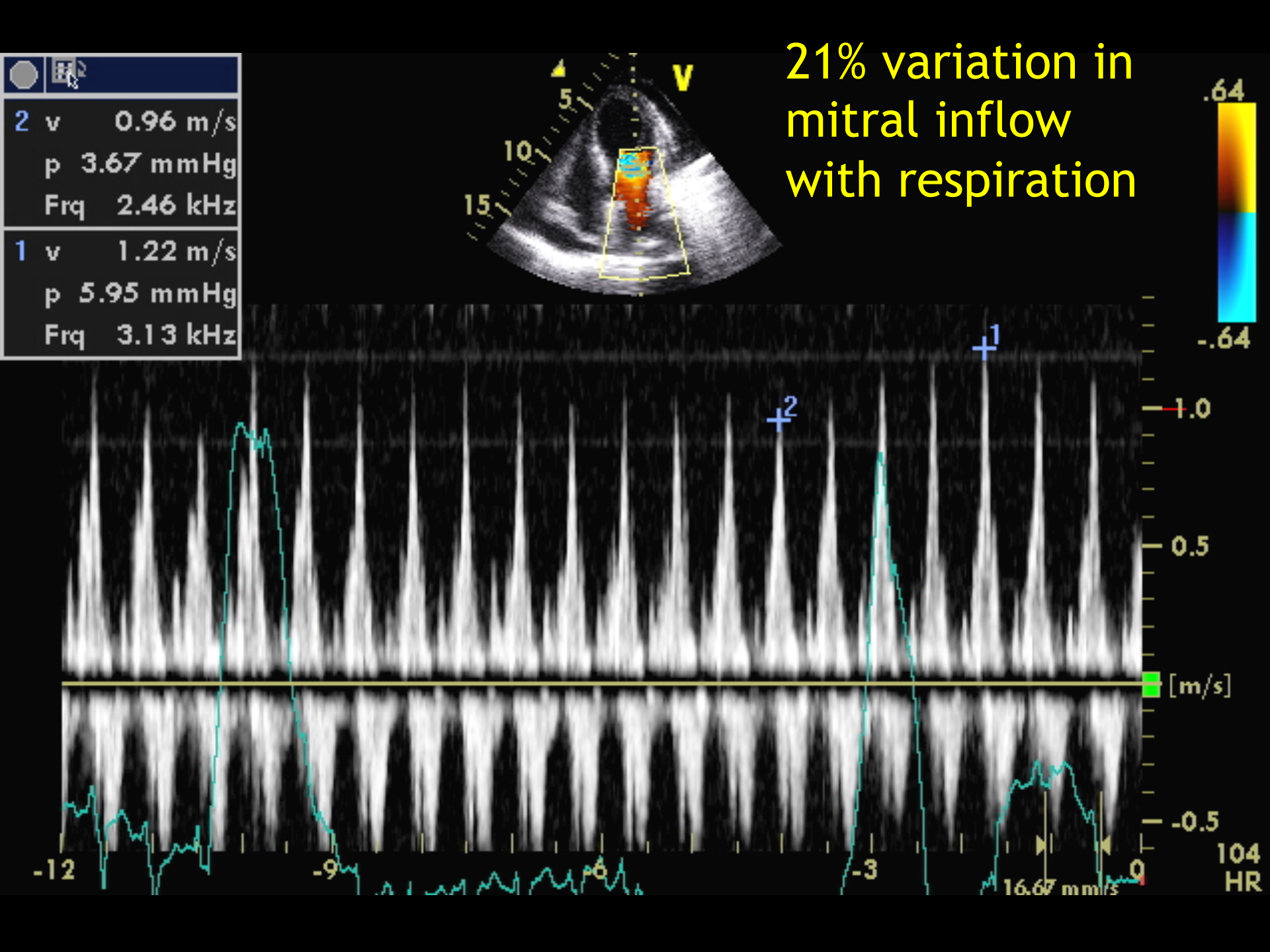
Cardiac tamponade: echo signs

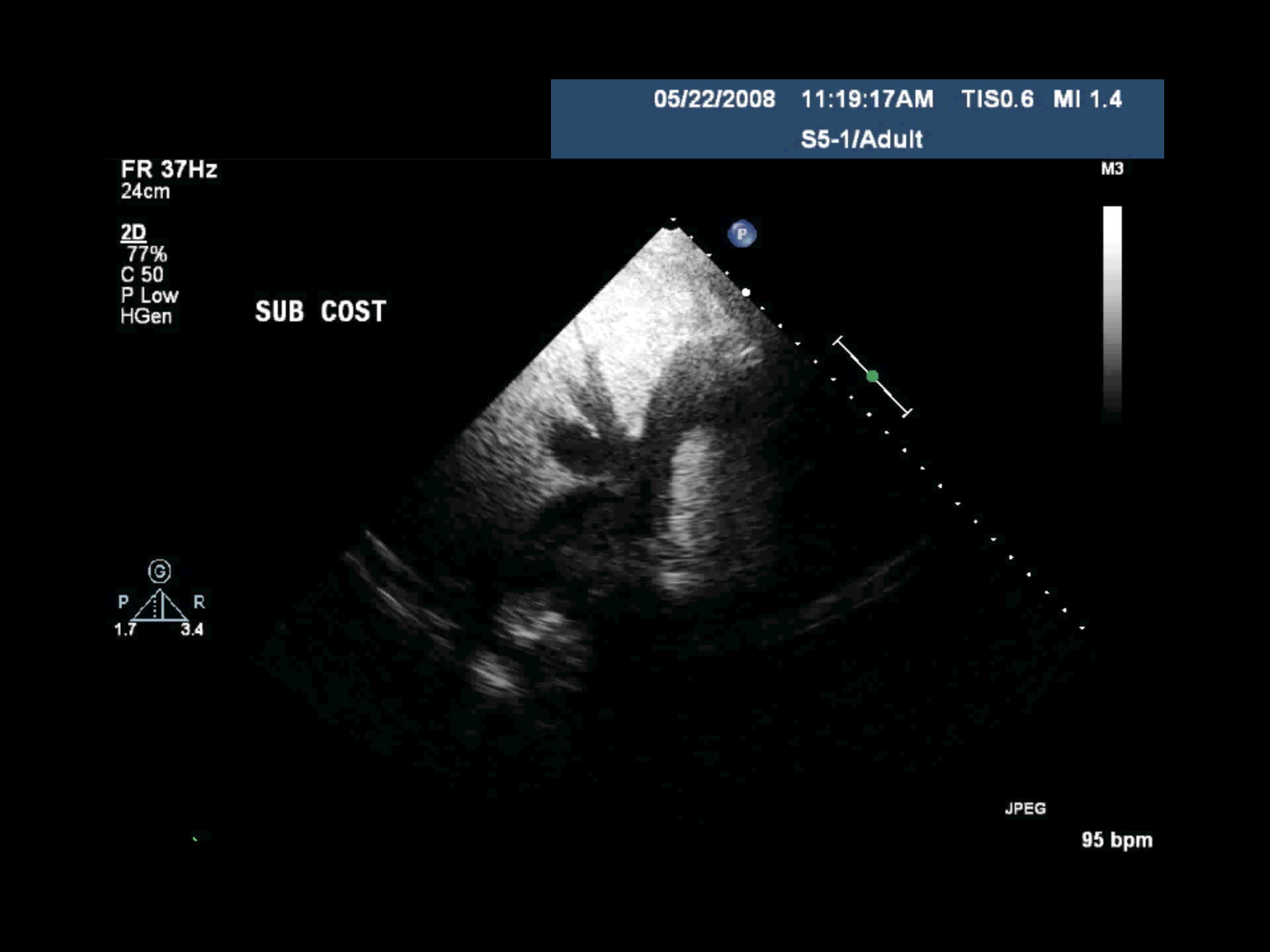
- Early signs:
  - » IVC dilated, not collapsing
  - » Increased respiratory variation in mitral (> 25%) and tricuspid (> 40%) inflows
- Late signs:
  - » RA/RV collapse
- Very late signs:
  - » LA/LV collapse


V
10
20
30
118
HR


V
5
10
15
106
HR

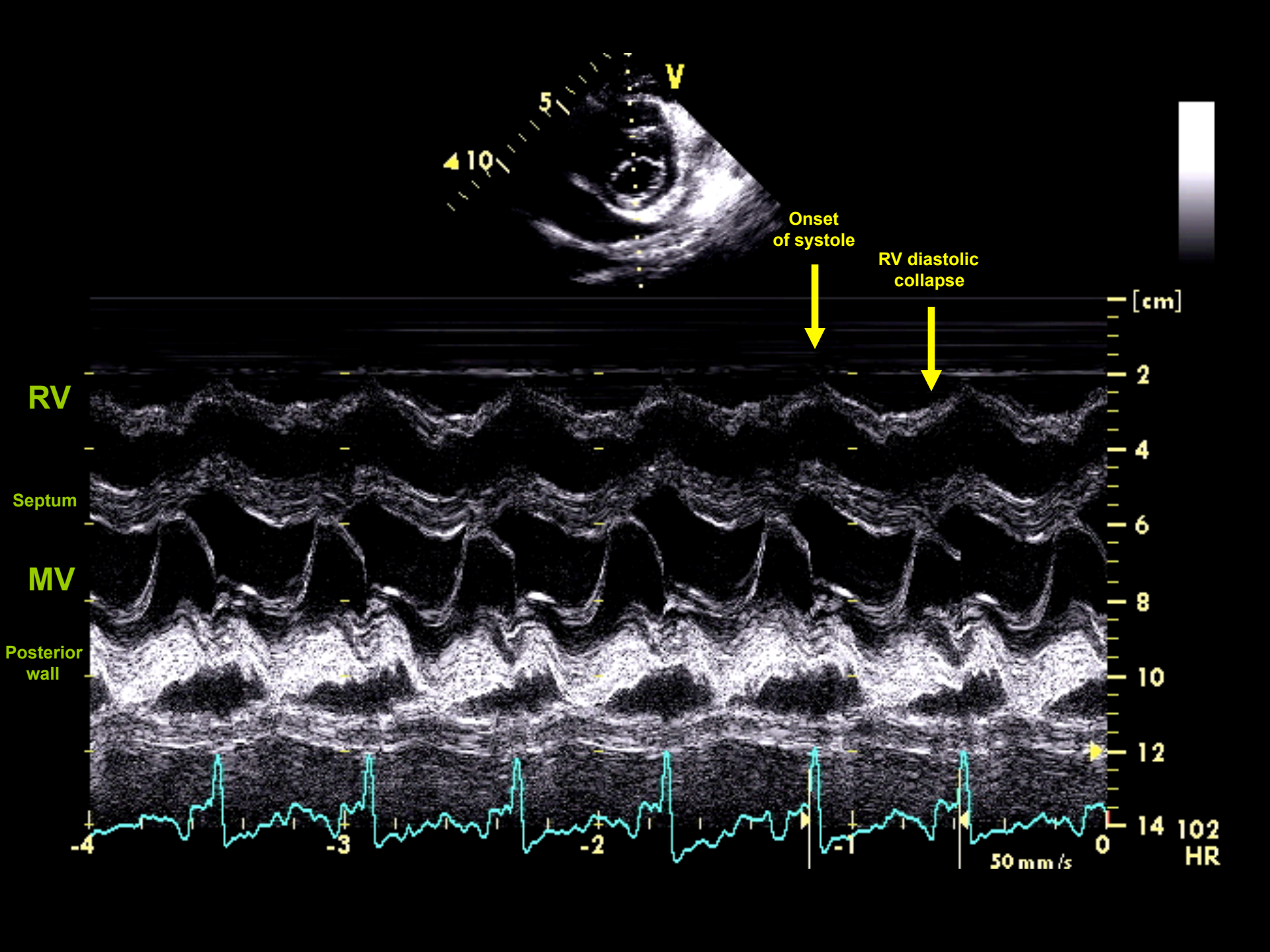

10
12
14
16
V
107
HR

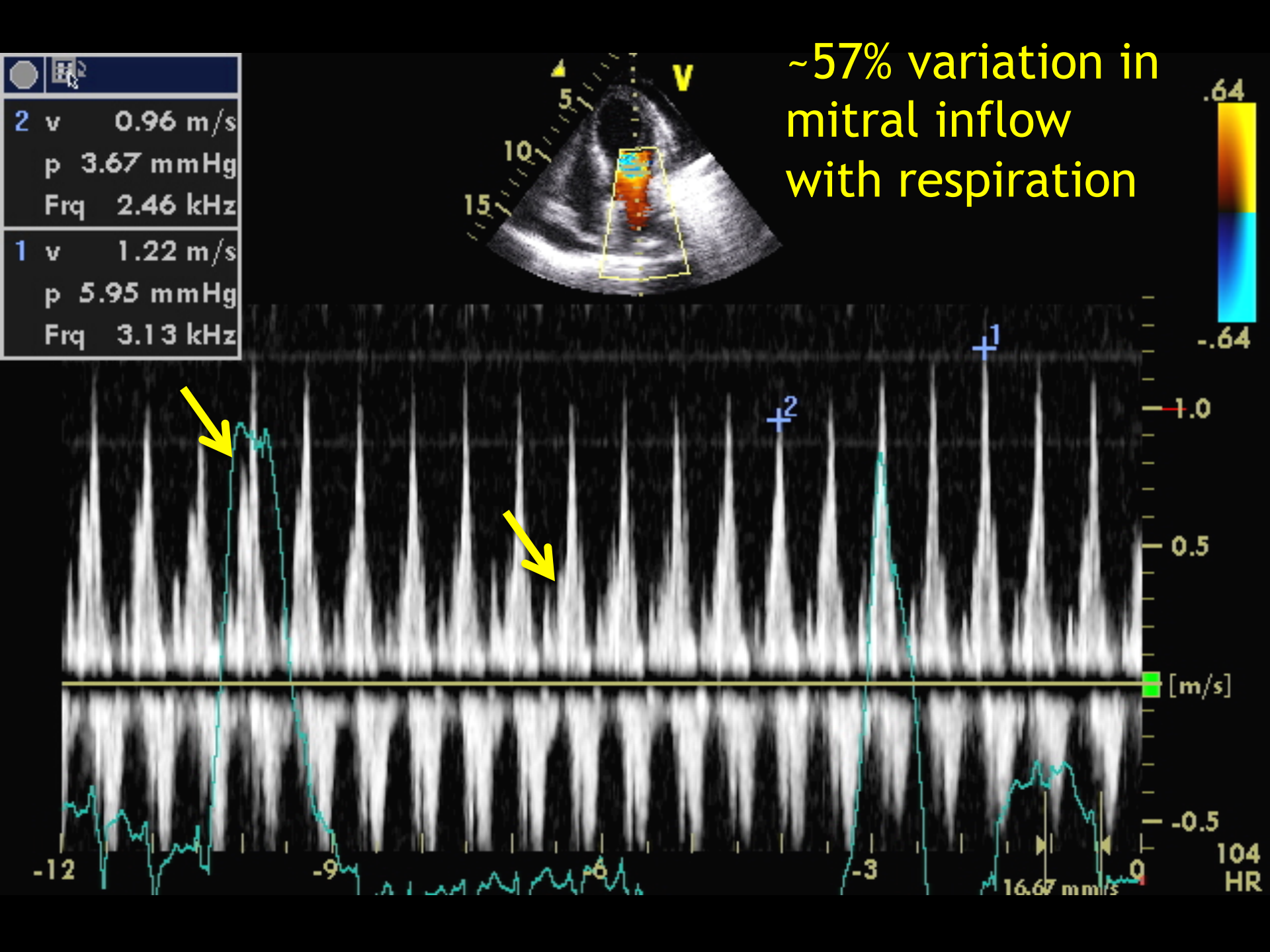

21% variation in mitral inflow with respiration
2 v 0.96 m/s
p 3.67 mmHg
Frq 2.46 kHz
1 v 1.22 m/s
p 5.95 mmHg
Frq 3.13 kHz
.64
-.64
1.0
0.5
[m/s]
-0.5
104
HR
-12
-9
-6
-3
0
16.67 mm/s

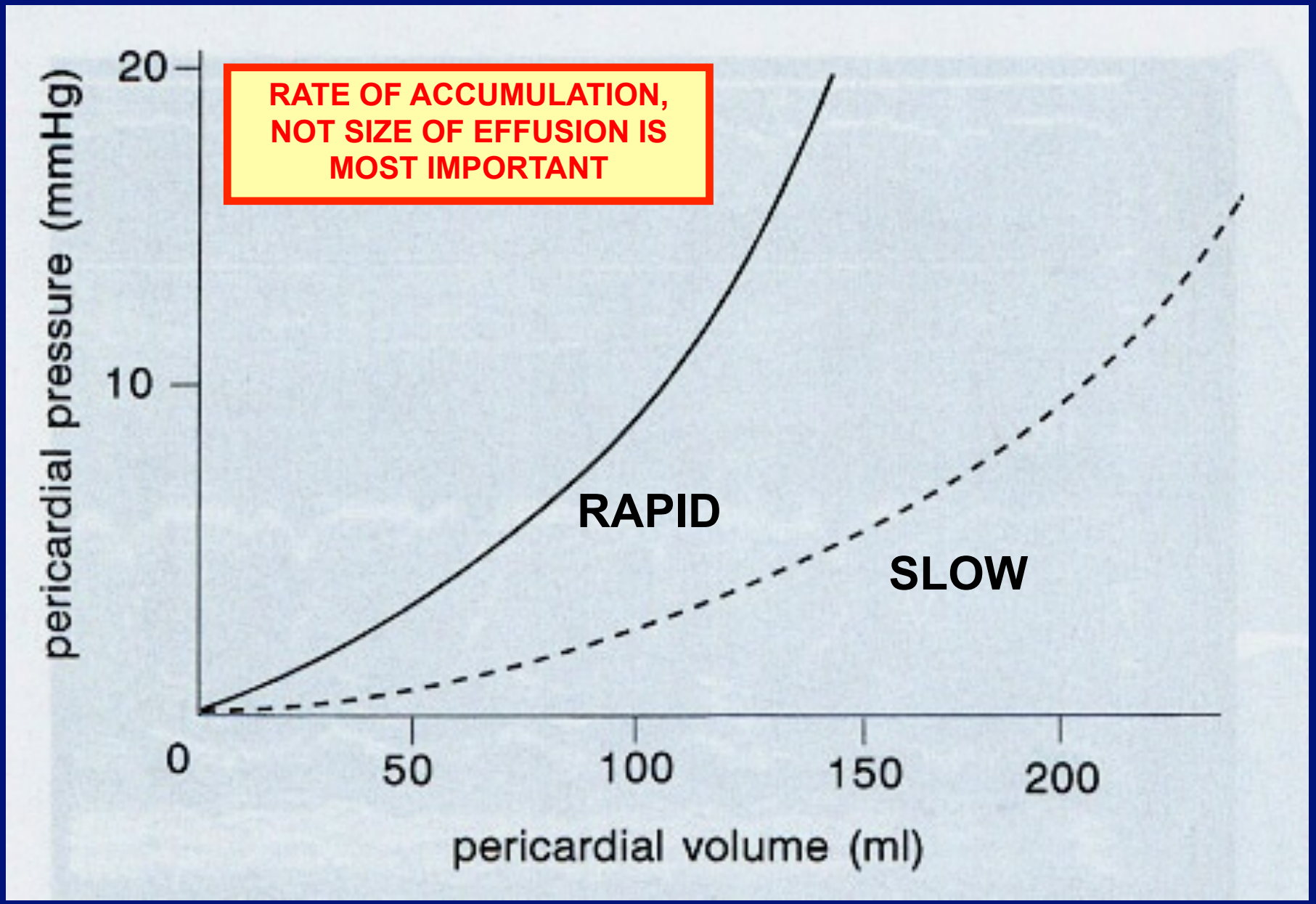

05/22/2008 11:19:17AM TIS0.6 MI 1.4
S5-1/Adult
FR 37Hz
24cm
2D
77%
C 50
P Low
HGen
SUB COST
M3
P
G
P
R
1.7
3.4
JPEG
95 bpm

Urgent pericardiocentesis?

- Is the IVC dilated?
- Is there increased respiratory variation in the MV, TV inflows?
- Is there RV/RA collapse?
- Is pulsus paradoxus present?


V
5
10
Onset
of systole
RV diastolic
collapse
[cm]
RV
Septum
MV
Posterior
wall
2
4
6
8
10
12
14
-4
-3
-2
-1
0
50 mm/s
102
HR


2 v 0.96 m/s
p 3.67 mmHg
Frq 2.46 kHz
1 v 1.22 m/s
p 5.95 mmHg
Frq 3.13 kHz
~57% variation in mitral inflow with respiration
.64
-.64
1.0
0.5
[m/s]
-0.5
104 HR
-12
-9
-6
-3
0
16.67 mm/s


RATE OF ACCUMULATION, NOT SIZE OF EFFUSION IS MOST IMPORTANT
pericardial pressure (mmHg)
20
10
0
50
100
150
200
pericardial volume (ml)
RAPID
SLOW

Tamponade: take home points

- Cardiac tamponade is a clinical diagnosis: integrate echo with pulsus paradoxus and other clinical findings to determine need for pericardiocentesis
- Pericardial pressure takes over everything in tamponade: diastolic pressure equalization; ⇧JVP, doesn't change with respiration (-Kussmaul sign); no Y descent
- Rate of accumulation is more important than size of effusion

Constrictive pericarditis

Case presentation (continued)

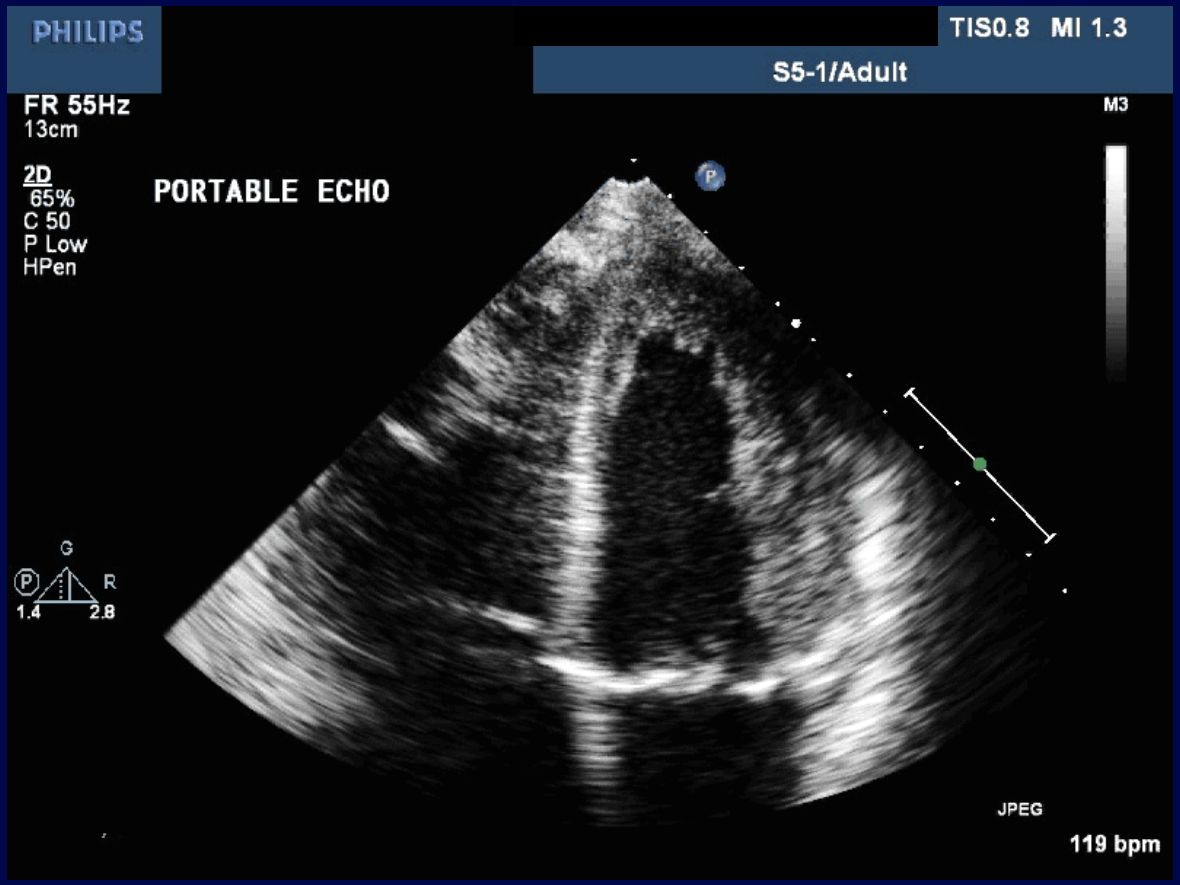
- The patient underwent successful pericardiocentesis (750 cc straw-colored fluid)
- Pericardial drain left in for 2 days and then successfully removed
- Transudate by Light's criteria
- Cytology negative
- 6 months later… admitted with progressive right-sided heart failure

Case presentation (continued)

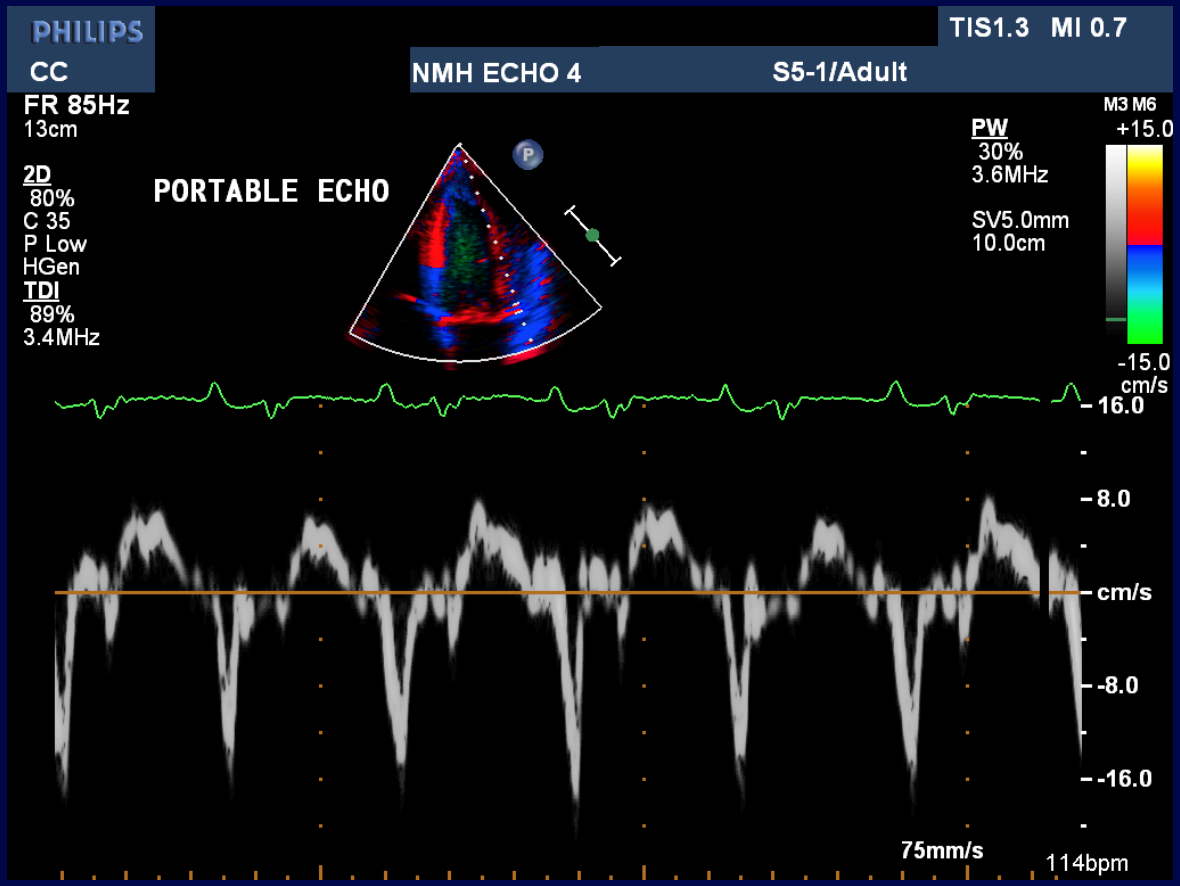
- 110/62, 92, 24, 94% on RA
- JVP 14 cm, increases with inspiration
- Lungs CTA bilaterally, decr BS at bases
- Irreg irreg, nl S1 S2, no murmurs, +diastolic extra sound
- Abd:+ascites
- Ext 2+ edema to thighs

Kussmaul's sign: JVP rises with inspiration

Case presentation (continued)

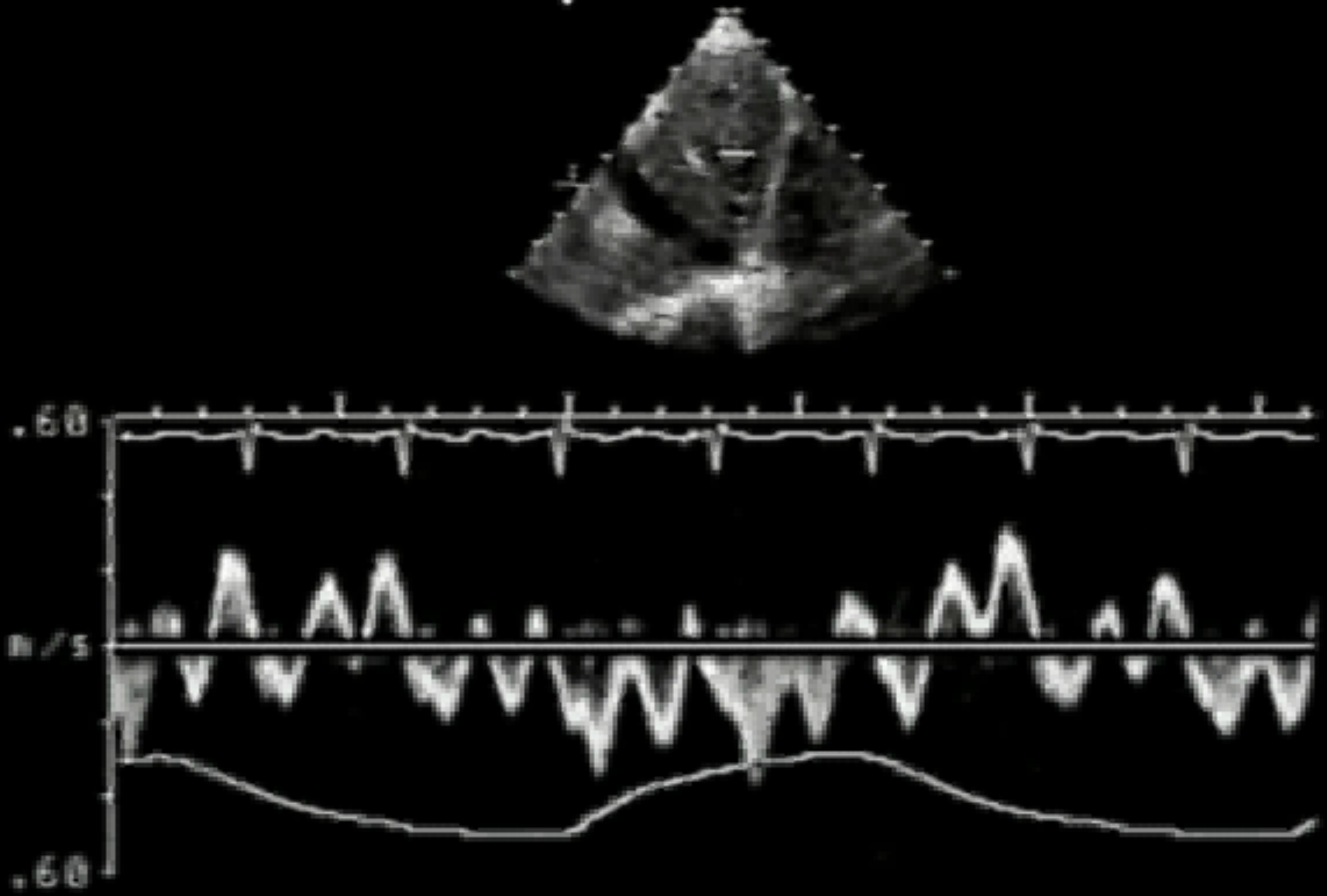


Case presentation: tissue Doppler imaging



e’ = 16 cm/s

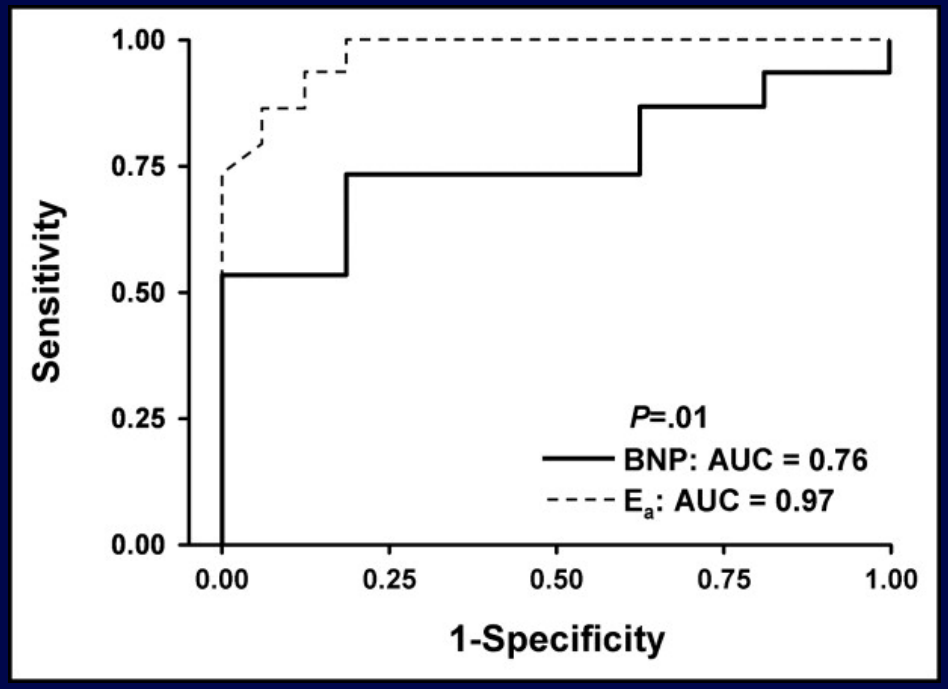
Hepatic Vein



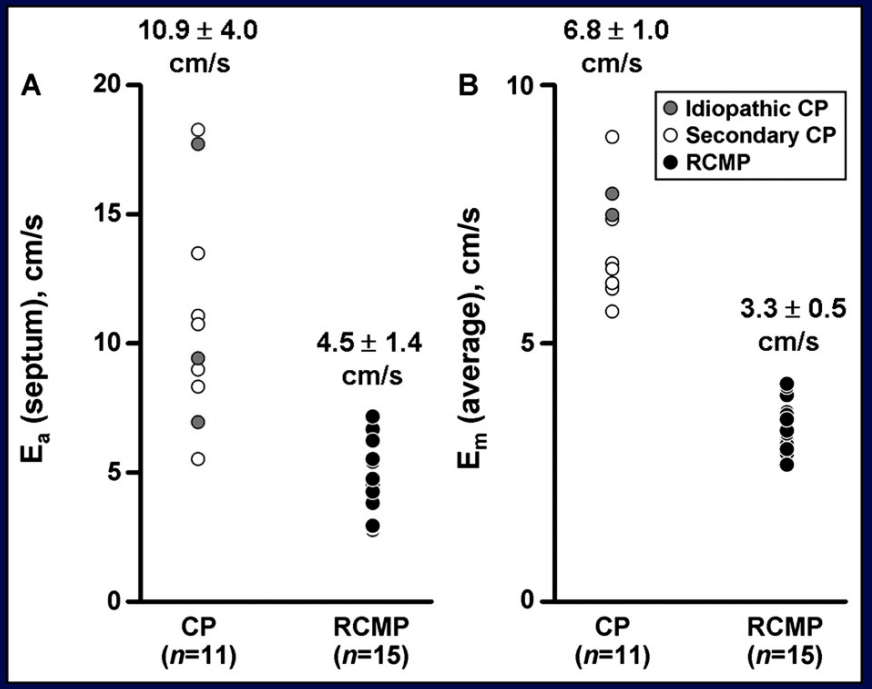
Cardiac MRI

Constriction vs. restriction

Echo is better than BNP



Average the e' velocities



Sengupta PP et al, Am J Cardiol 2008

Constriction vs. restriction

Parameter	Constriction	Restriction
⇧⇧E velocity, ⇧E/A Short E decel time	Present	Present
Mitral inflow respiratory variation	Present	Absent
Tissue Doppler e' velocity	Normal or increased	Severely reduced
PA systolic pressure	Normal	Increased
Hepatic vein imaging	Flow reversal during *expiration*	Flow reversal during *inspiration*

Kussmaul / hepatic vein discordance?

- In constriction:
  - JVP increases with *inspiration*
  - Hepatic vein flow reversal increases with *expiration*
- During inspiration:
  - IVC flow competes with SVC flow
  - Diaphragm squeezes abdomen → ⇧IVC flow

Kussmaul / hepatic vein discordance?

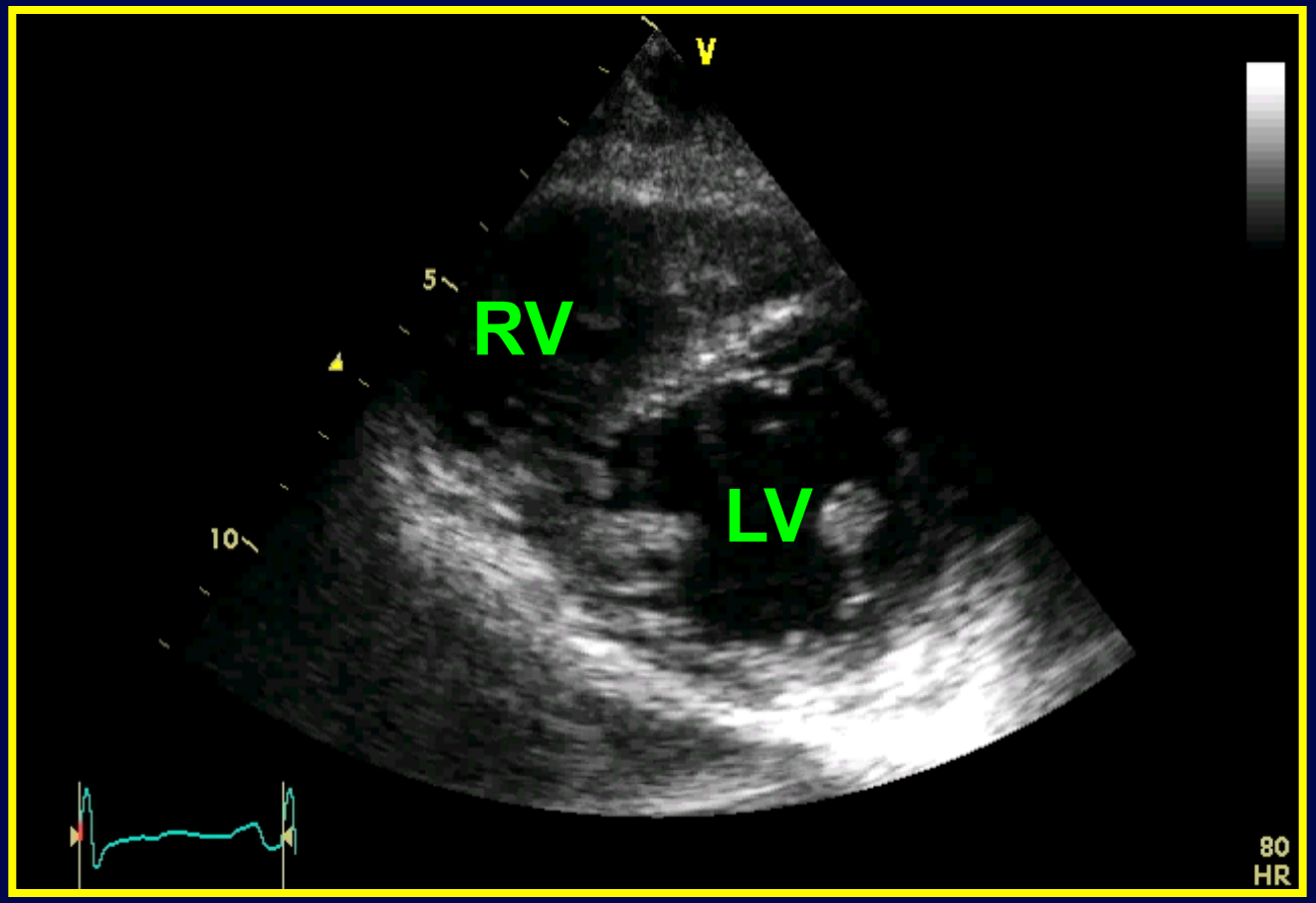
- In constriction:
  - JVP increases with *inspiration*
  - Hepatic vein flow reversal increases with *expiration*
- During inspiration:
  - IVC flow competes with SVC flow
  - Diaphragm squeezes abdomen → ⇧IVC flow
  - IVC flow pushes blood up into RA, impedes SVC flow coming into RA → pushes blood up into neck veins → Kussmaul's sign

Case #1:
The binge drinker who almost got a liver transplant…

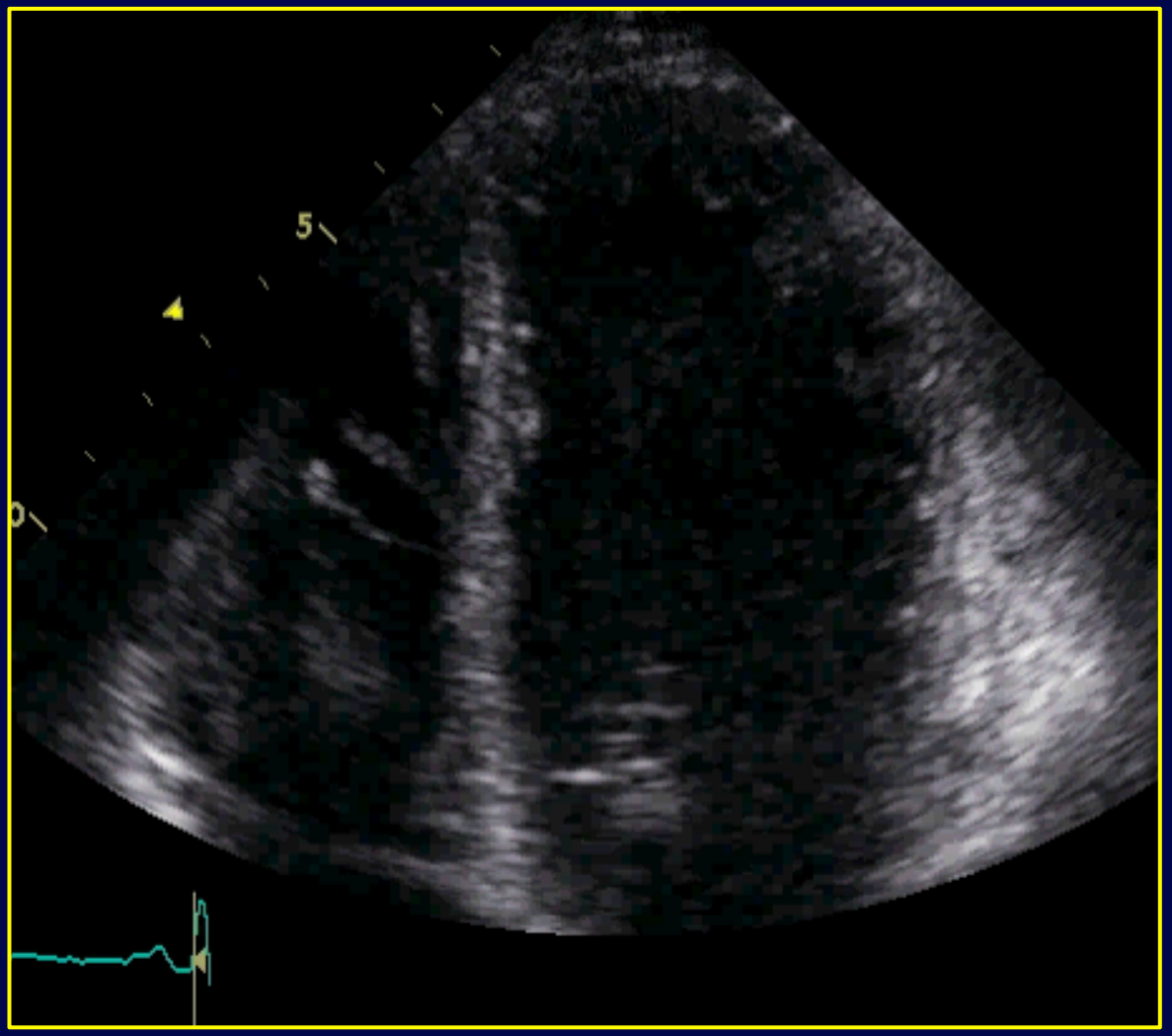
Constriction: checklist

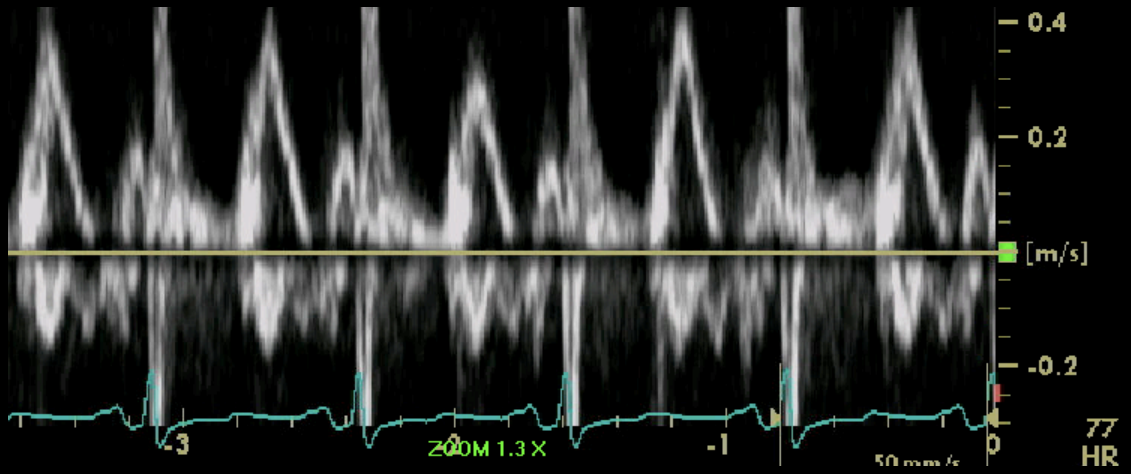
- Echo diagnosis of constriction is all about pattern recognition:
  - ✓ Diastolic septal bounce
  - ✓ Mitral inflow ⇧resp. variation, ⇧E/A, decreased E deceleration time
  - ✓ Preserved e' velocity (septal ≥ lateral)
  - ✓ Dilated IVC
  - ✓ Diastolic flow reversal during expiration
  - ✓ Reduced radial function, preserved longitudinal function

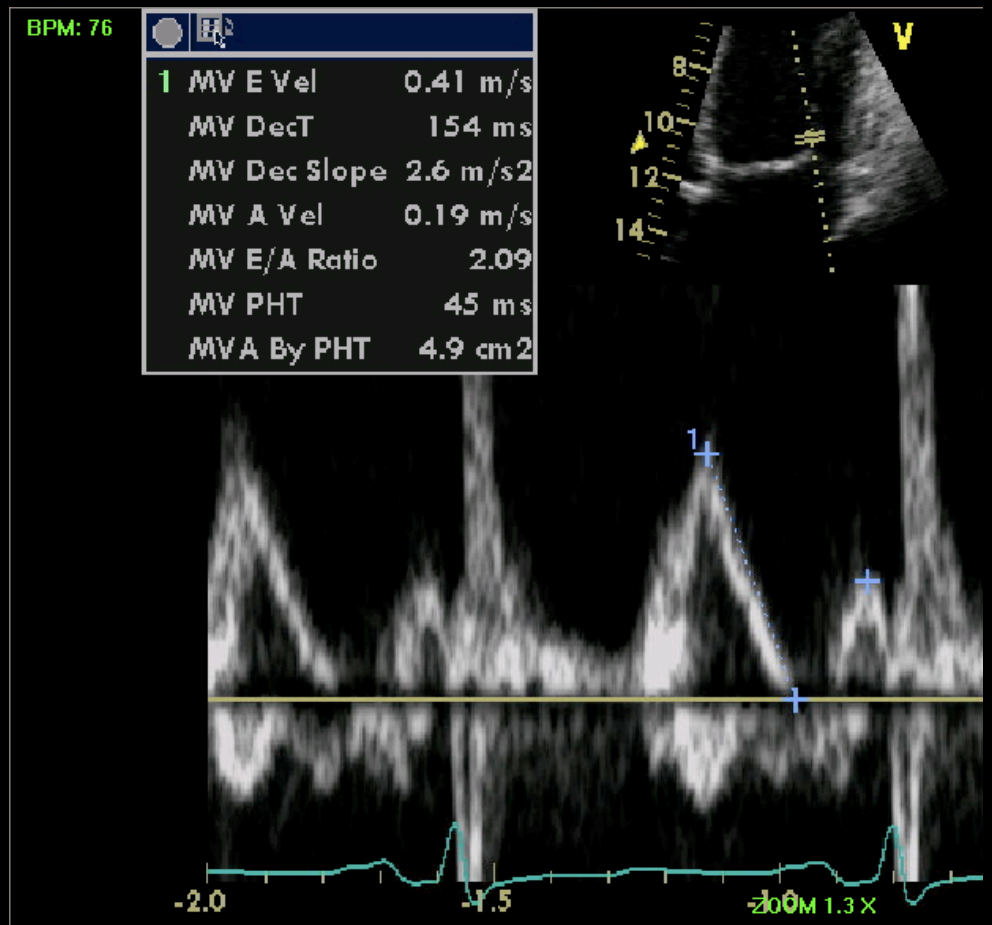
44-year-old man with chronic ascites

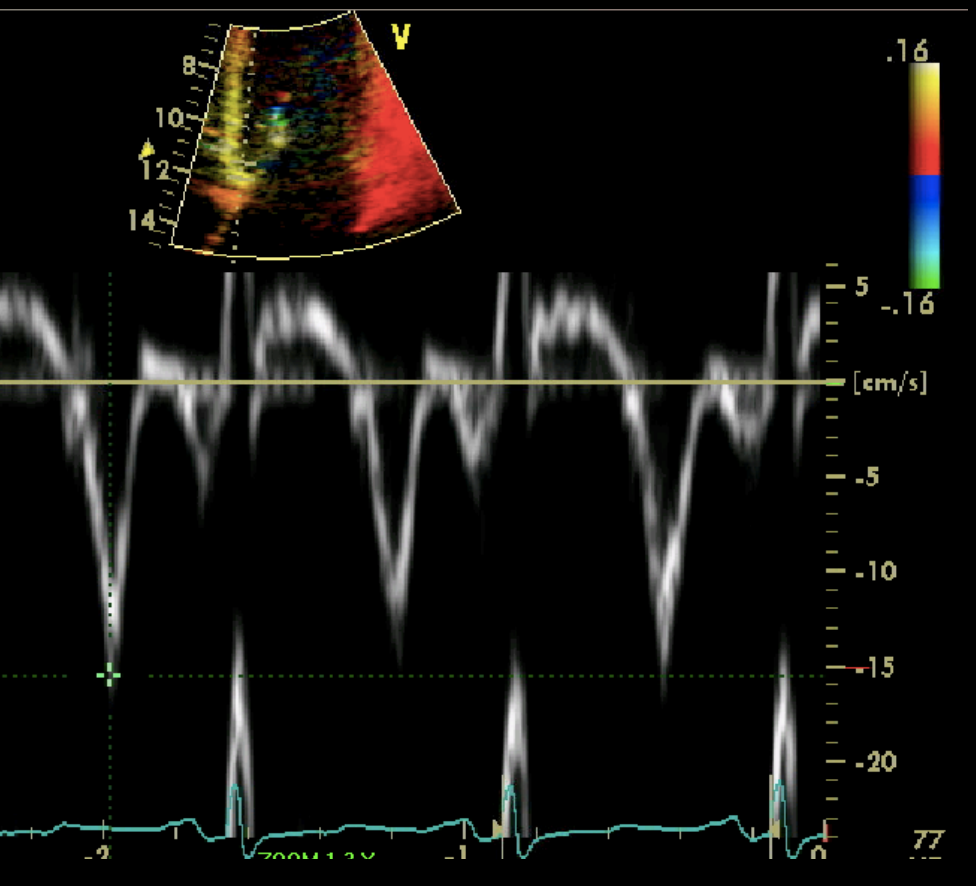


44-year-old man with chronic ascites

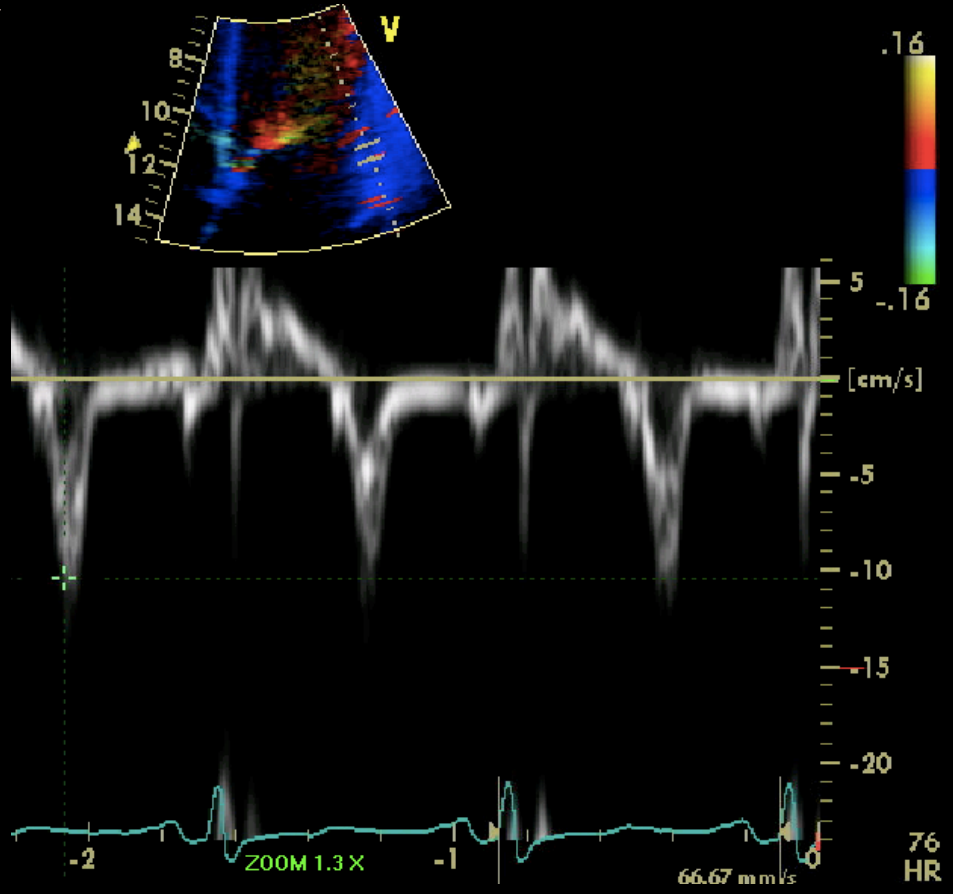



0.4
0.2
[m/s]
-0.2
-3
ZOOM 1.3 X
-1
0
77
HR


BPM: 76
1 MV E Vel 0.41 m/s
MV DecT 154 ms
MV Dec Slope 2.6 m/s2
MV A Vel 0.19 m/s
MV E/A Ratio 2.09
MV PHT 45 ms
MVA By PHT 4.9 cm2
V
8
10
12
14
1
-2.0
-1.5
ZOOM 1.3 X

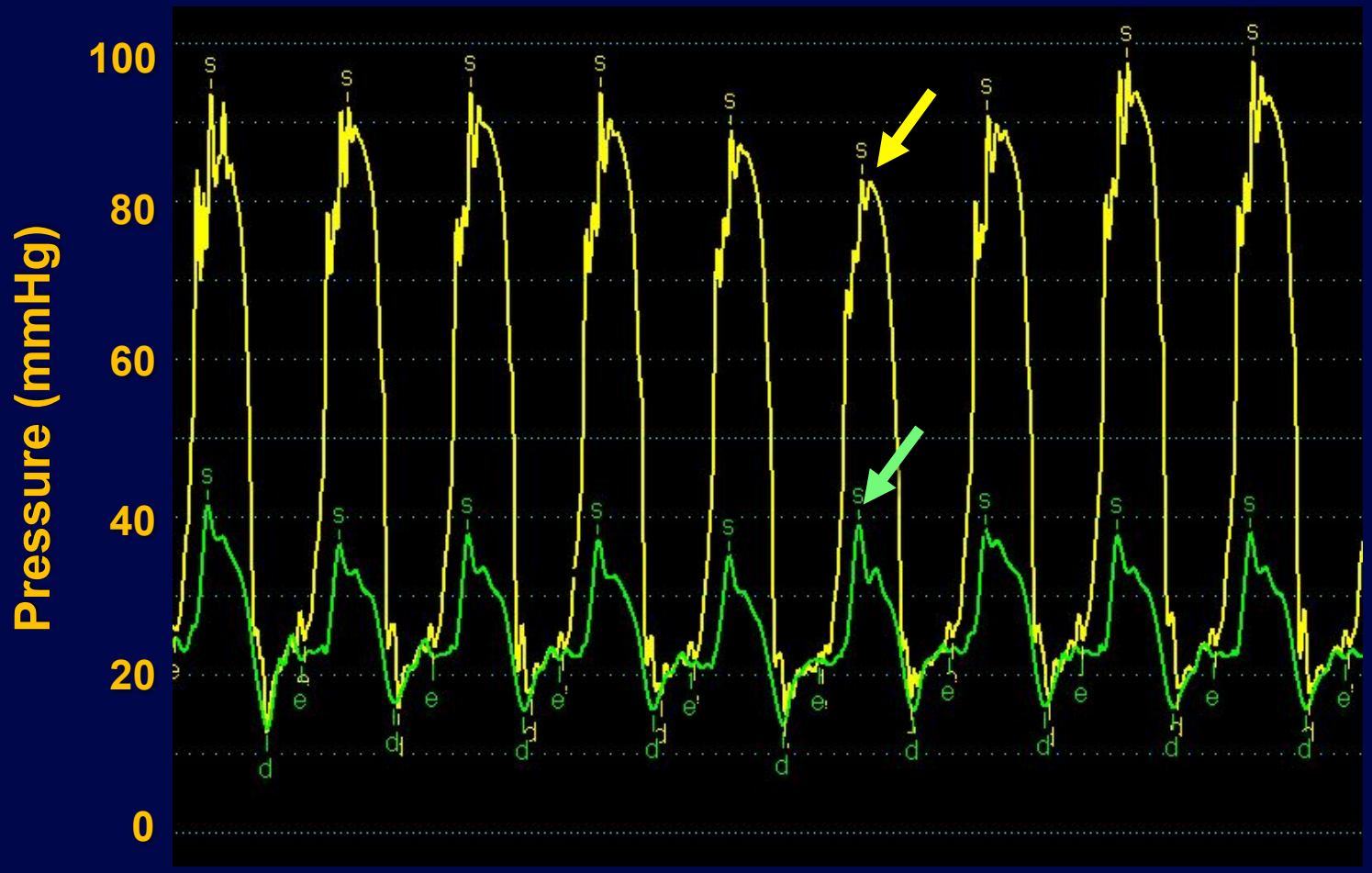


Septal e’ = 15 cm/s

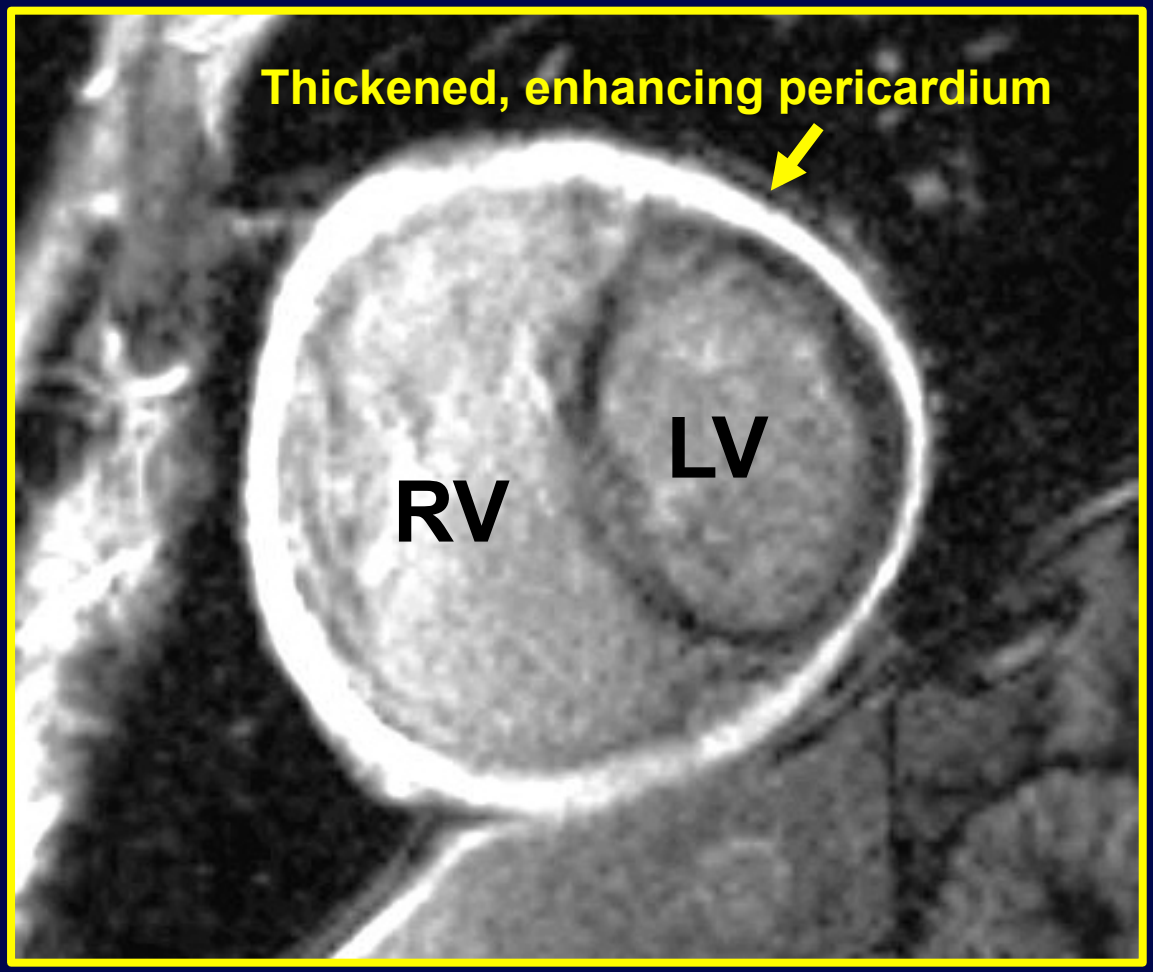


Lateral e’ = 10 cm/s

44-year-old man with chronic ascites

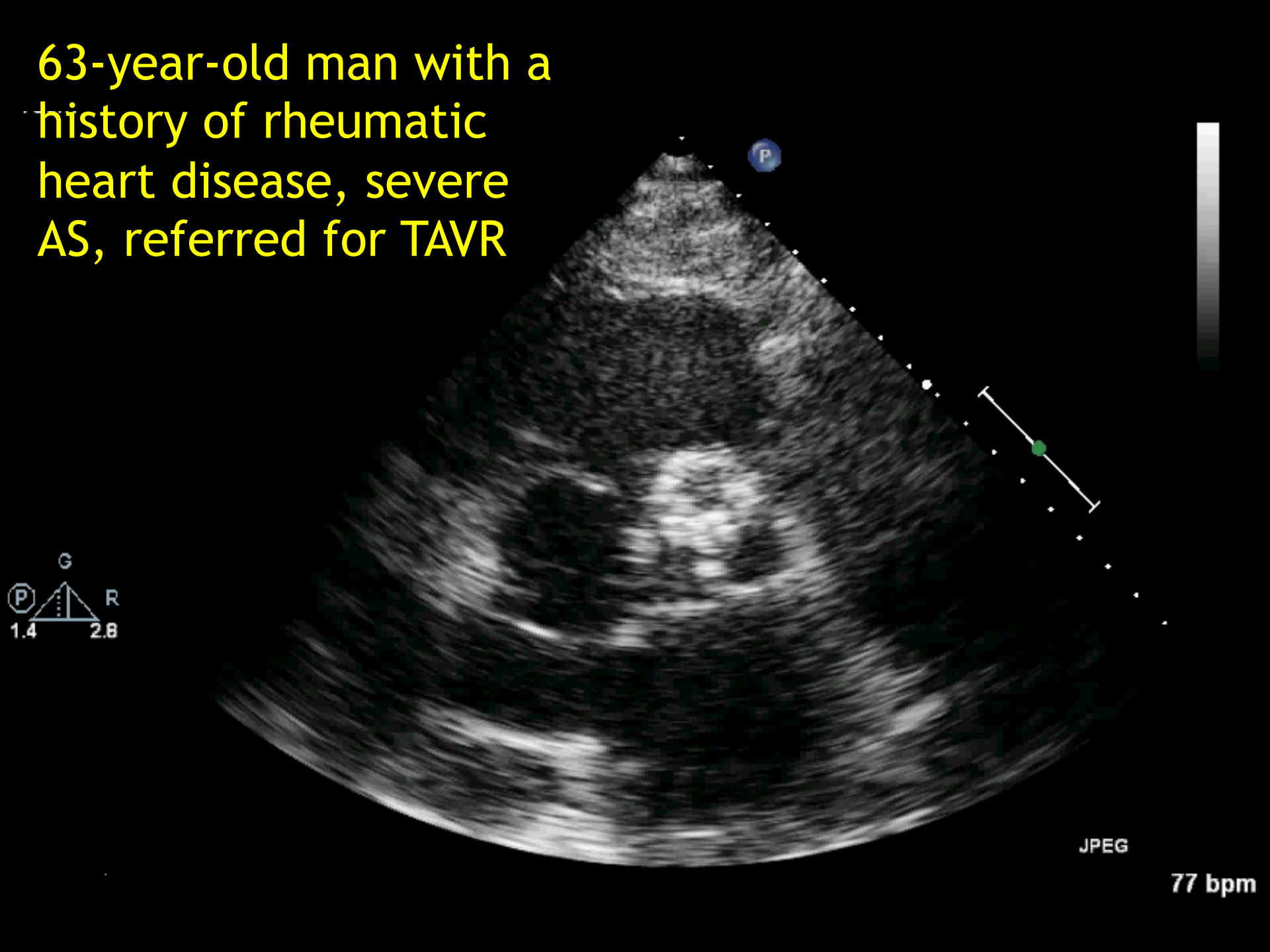


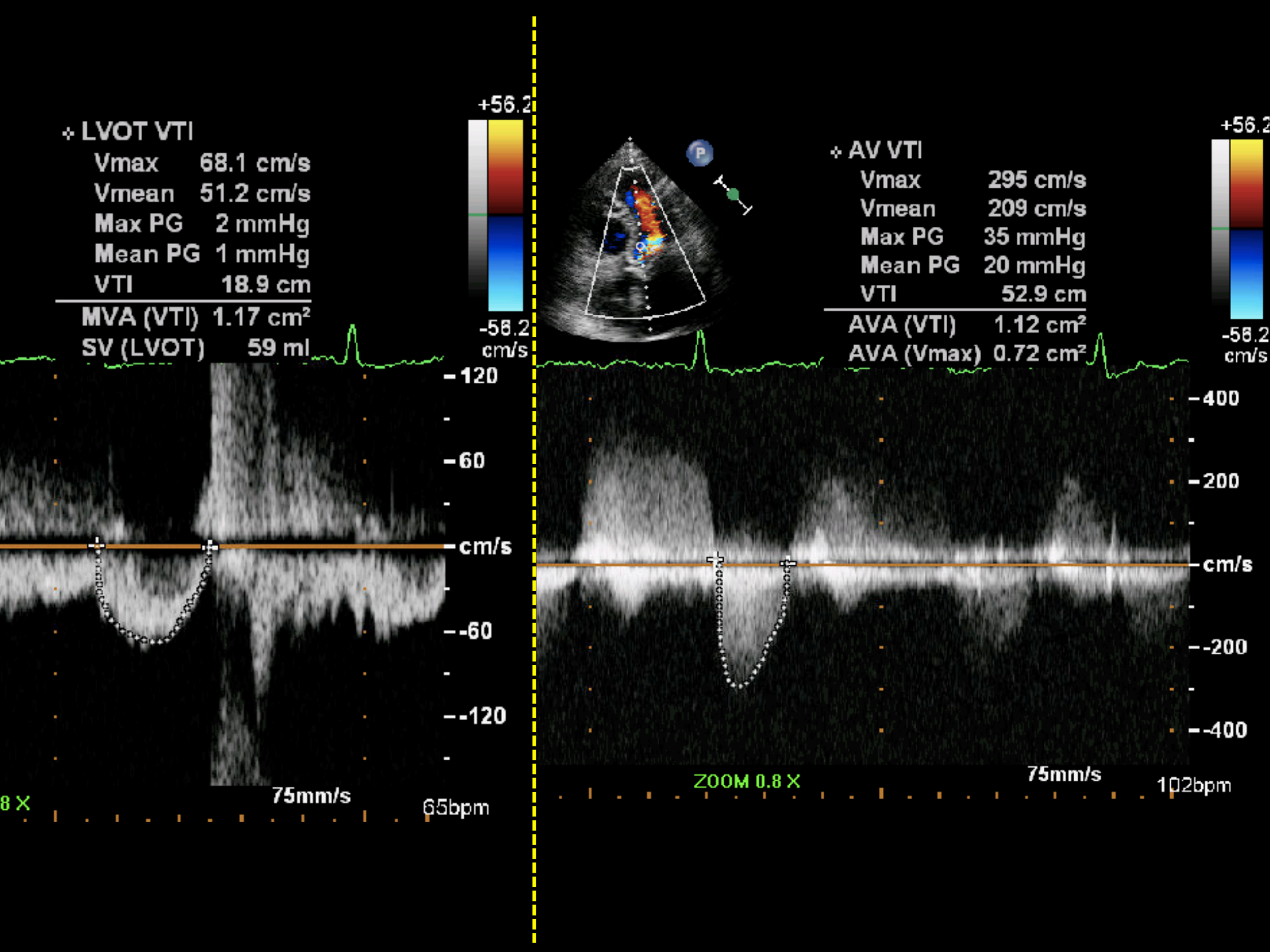
44-year-old man with chronic ascites

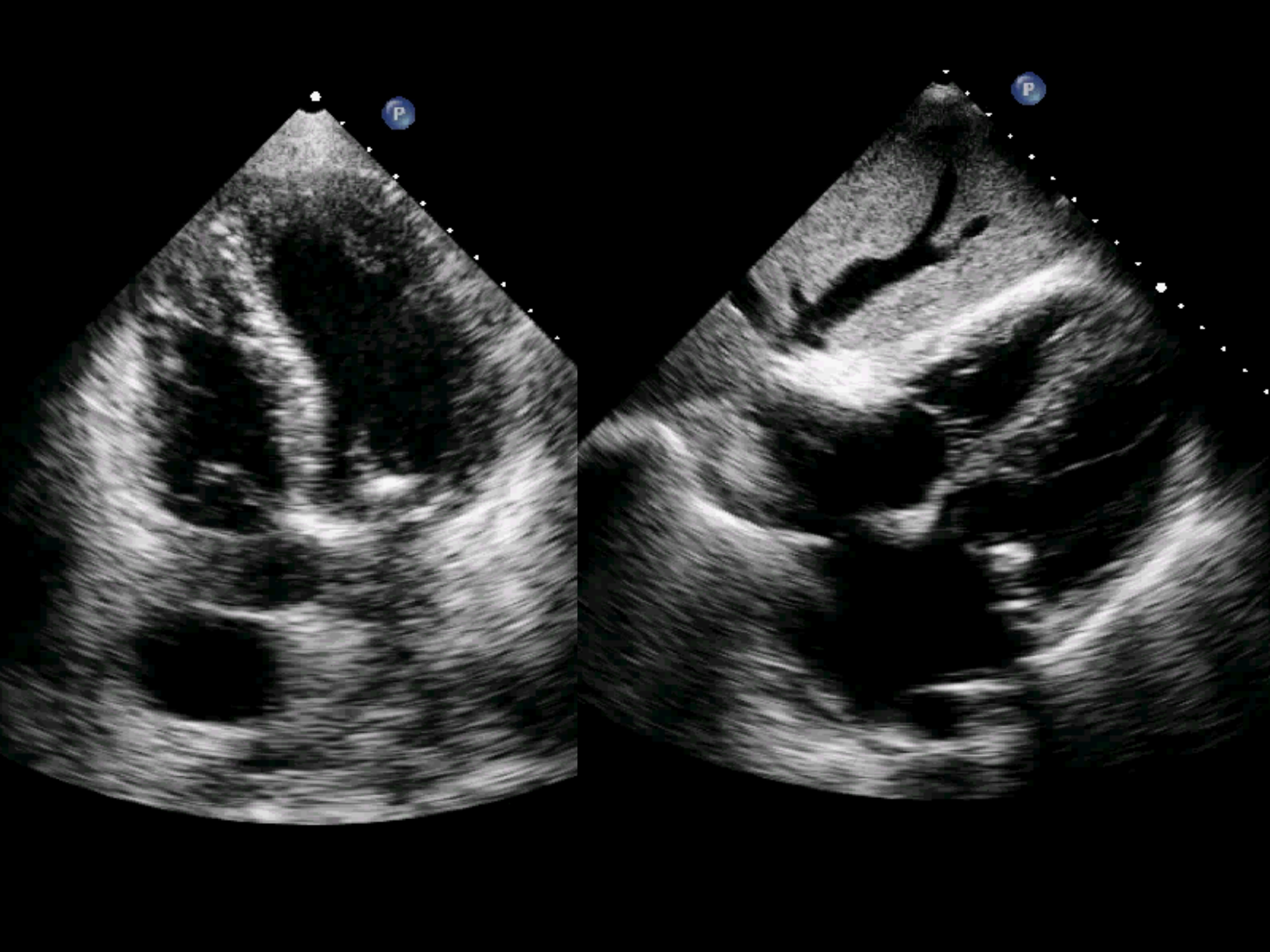


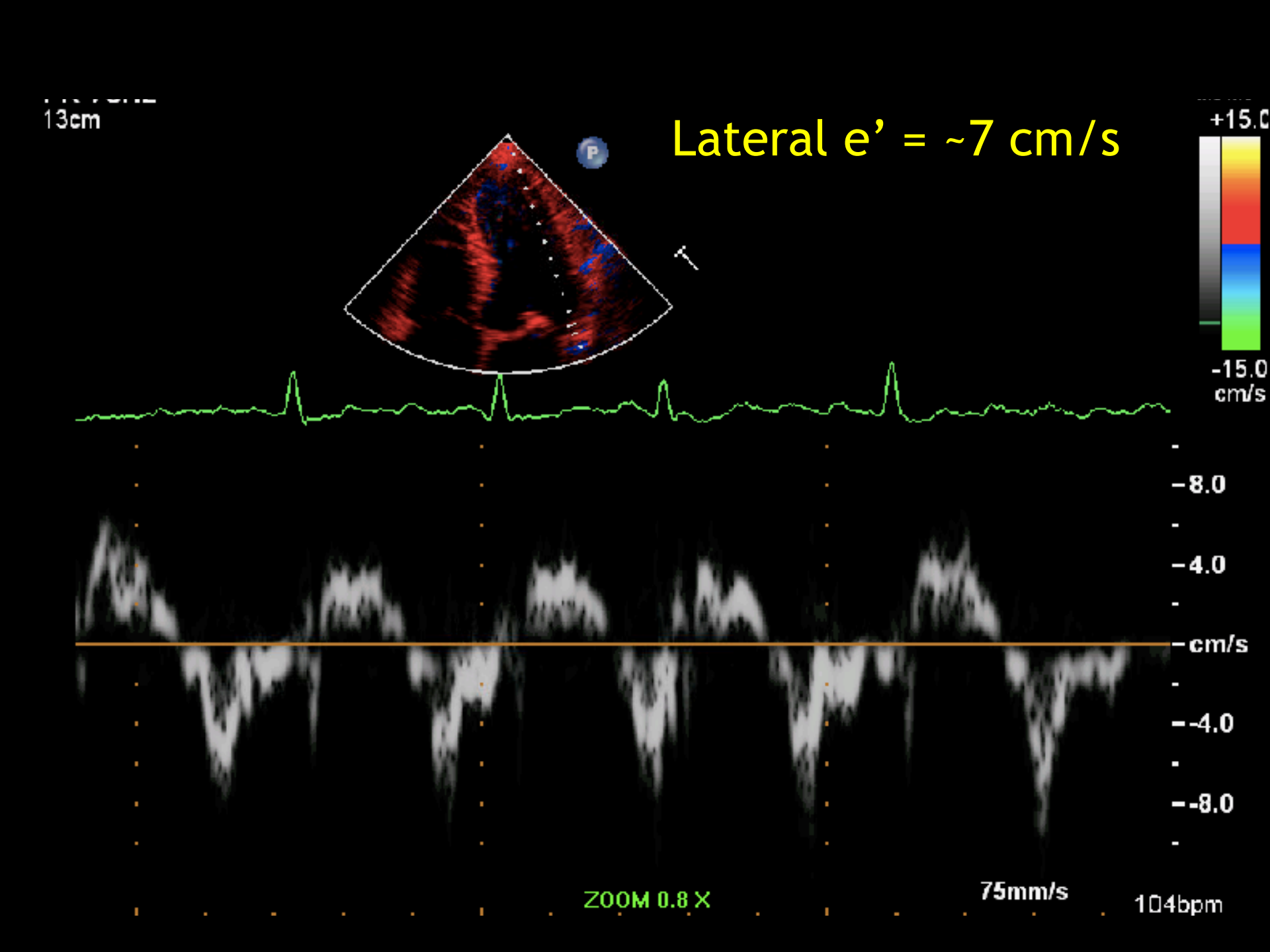
Case #2:
Low-flow, low-gradient aortic stenosis… with a twist

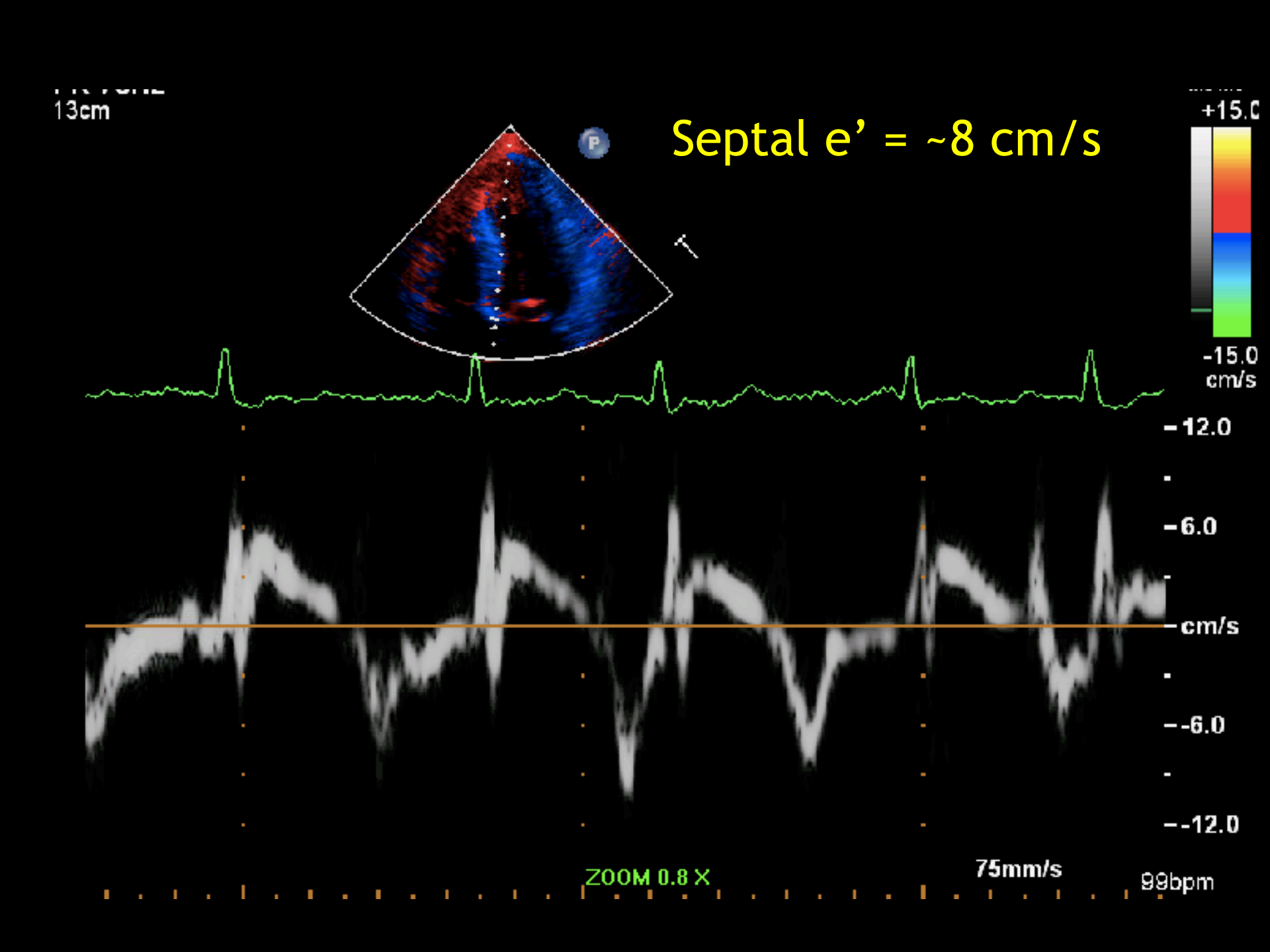
63-year-old man with a history of rheumatic heart disease, severe AS, referred for TAVR

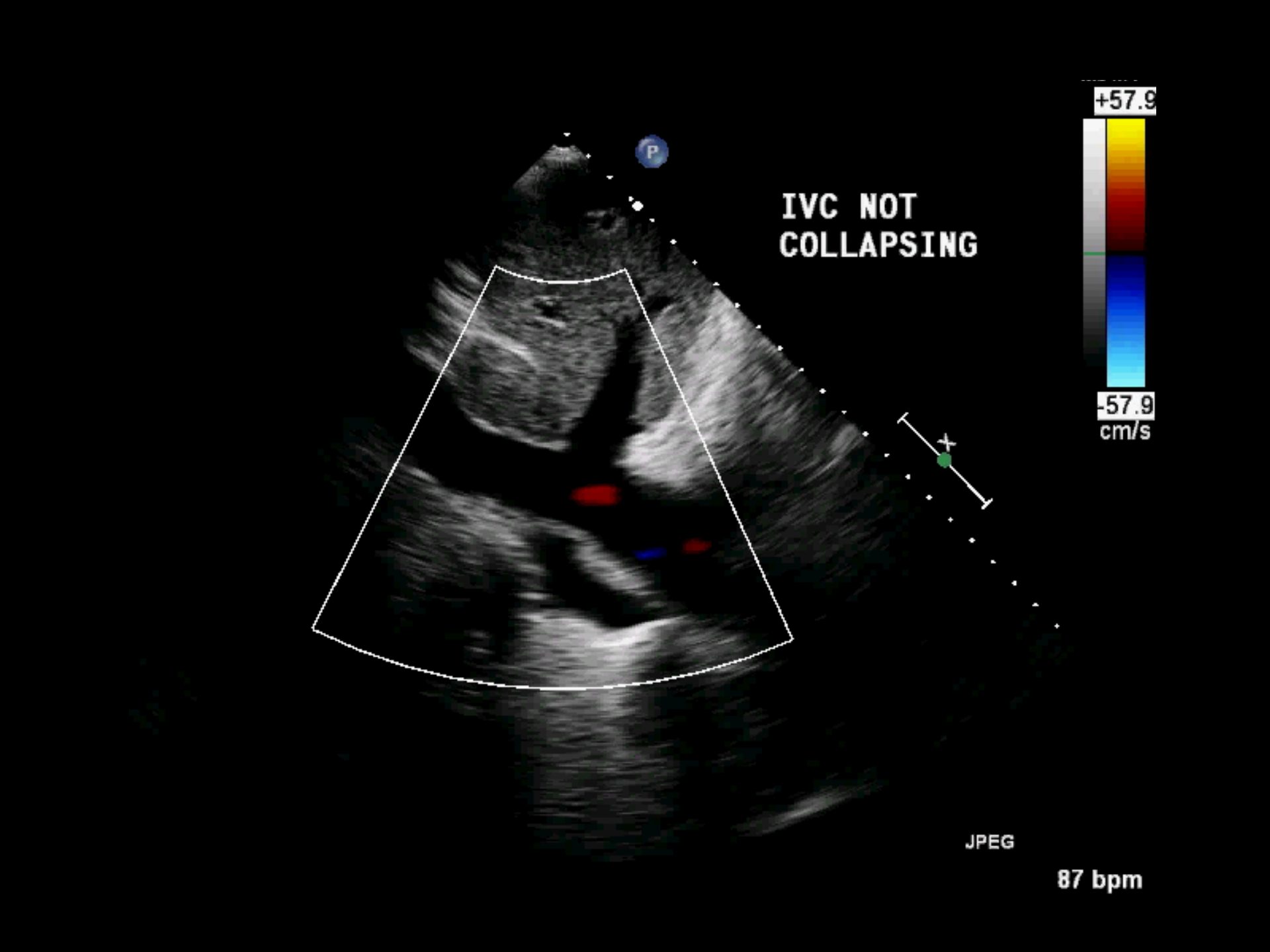


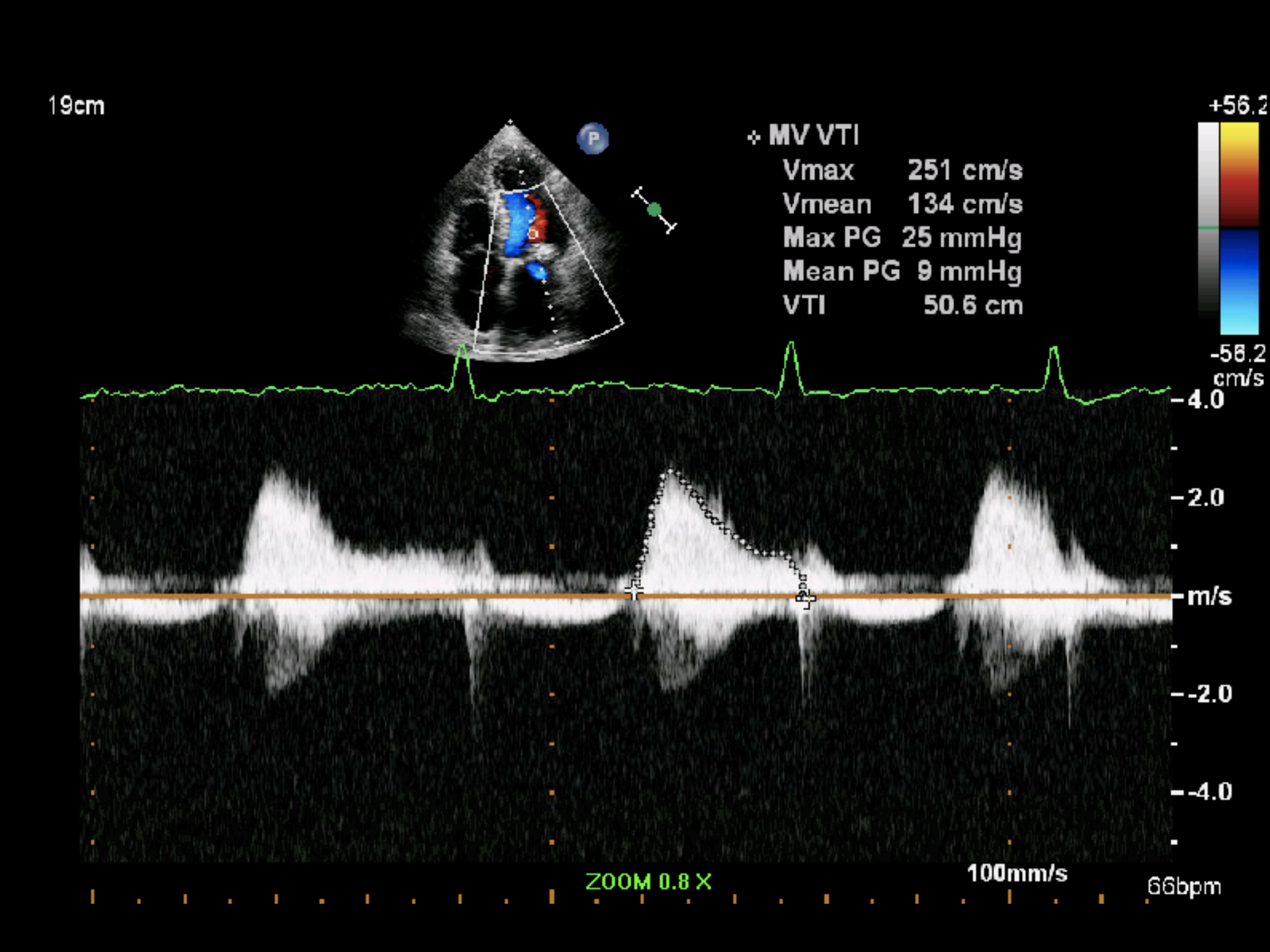

LVOT VTI
Vmax 68.1 cm/s
Vmean 51.2 cm/s
Max PG 2 mmHg
Mean PG 1 mmHg
VTI 18.9 cm
MVA (VTI) 1.17 cm²
SV (LVOT) 59 ml
+56.2
-56.2
cm/s
120
60
cm/s
-60
-120
8 X
75mm/s
65bpm
AV VTI
Vmax 295 cm/s
Vmean 209 cm/s
Max PG 35 mmHg
Mean PG 20 mmHg
VTI 52.9 cm
AVA (VTI) 1.12 cm²
AVA (Vmax) 0.72 cm²
+56.2
-56.2
cm/s
400
200
cm/s
-200
-400
ZOOM 0.8 X
75mm/s
102bpm




13cm
Lateral e’ = ~7 cm/s
+15.0
-15.0
cm/s
-8.0
-4.0
cm/s
-4.0
-8.0
ZOOM 0.8 X
75mm/s
104bpm


13cm
Septal e' = ~8 cm/s
+15.0
-15.0
cm/s
-12.0
-6.0
cm/s
-6.0
-12.0
ZOOM 0.8 X
75mm/s
99bpm


IVC NOT
COLLAPSING
+57.9
-57.9
cm/s
JPEG
87 bpm

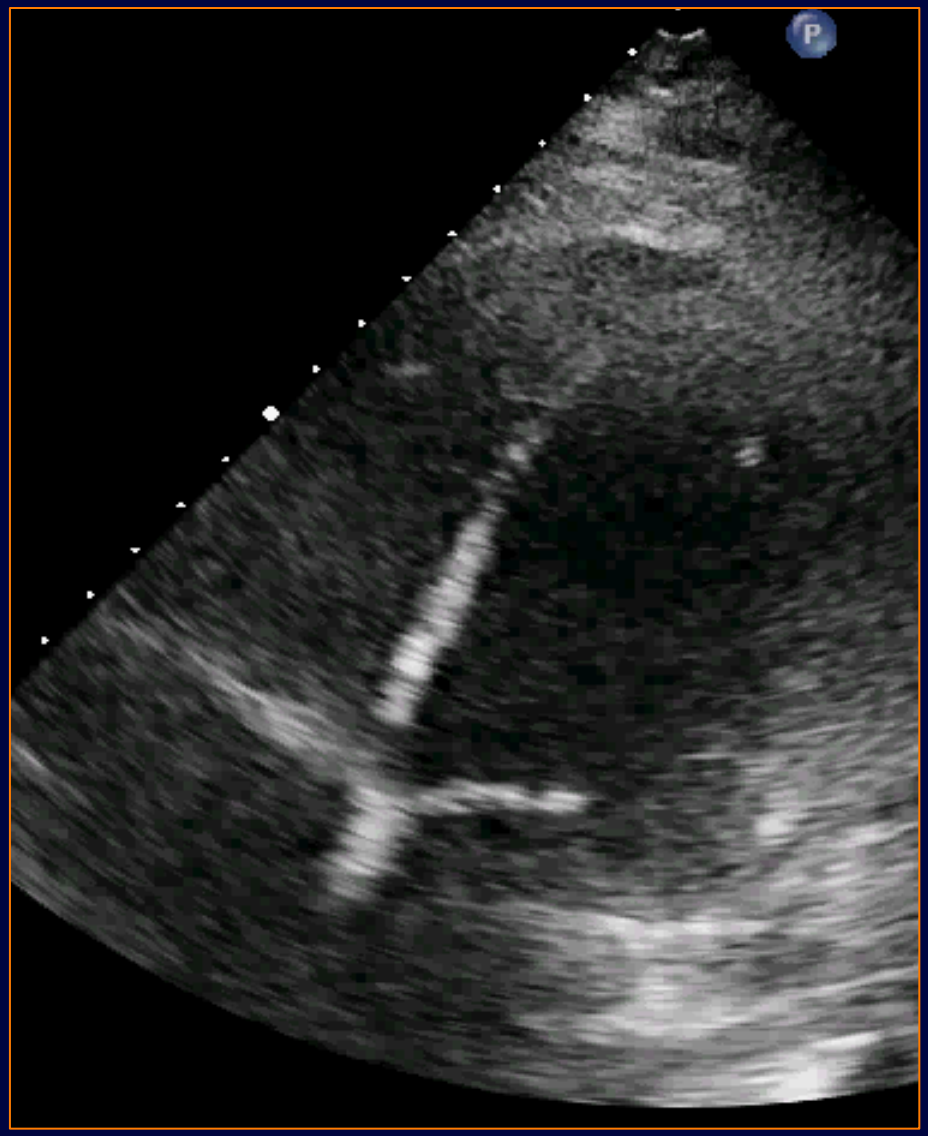

19cm
MV VTI
Vmax 251 cm/s
Vmean 134 cm/s
Max PG 25 mmHg
Mean PG 9 mmHg
VTI 50.6 cm
+56.2
-56.2
cm/s
4.0
2.0
m/s
-2.0
-4.0
ZOOM 0.8 X
100mm/s
66bpm

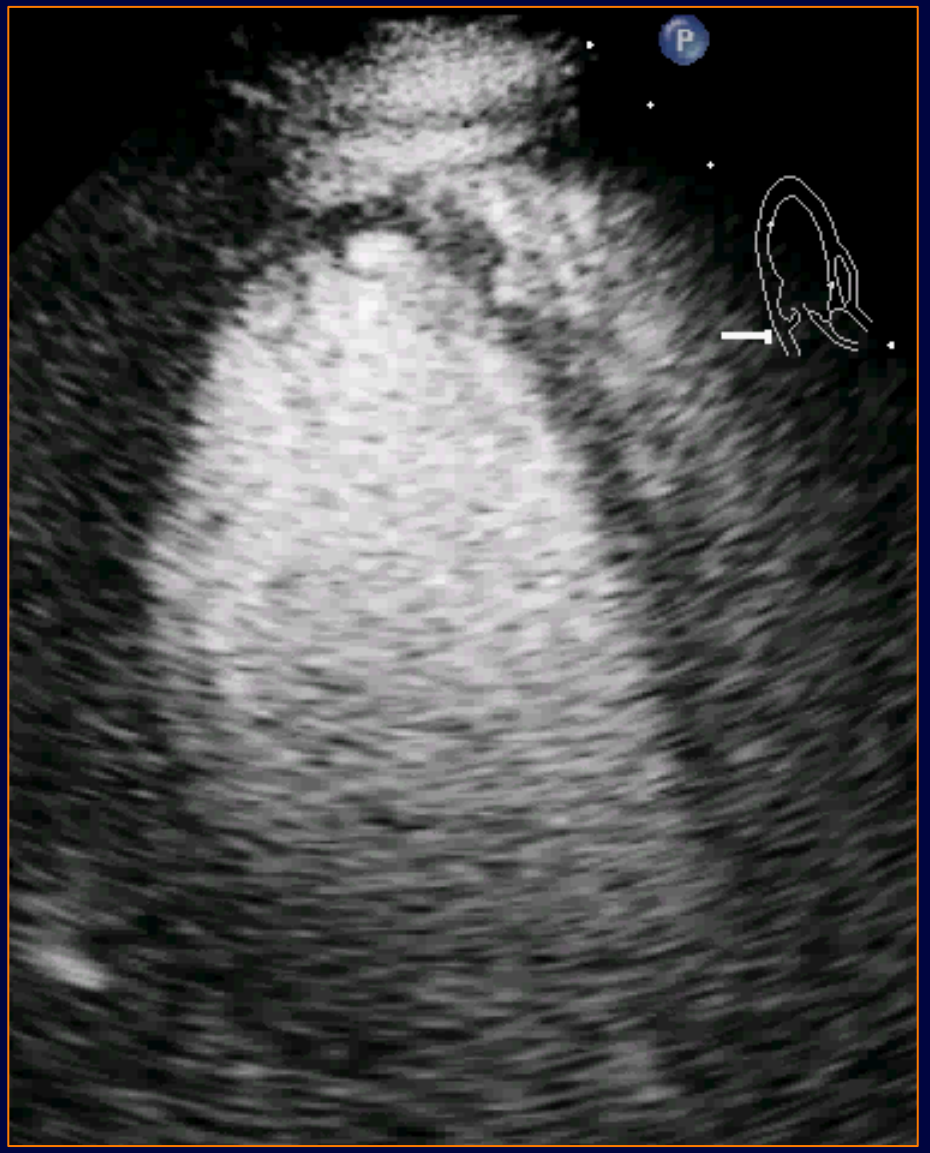
63-year-old man with low-flow, low-gradient AS

- Cardiac catheterization:
  - » Discordant RV and LV pressures
- CT: pericardial thickening (8 mm)
- Went to OR for AVR, MVR, pericardial stripping (“thick, leathery, adherent pericardium”)
- Improved symptoms but still with heart failure symptoms (NYHA class II)

Case #3:
“Get with the guidelines” gone bad…
(i.e., try not to be a guideline-directed robot)

Case #2: *74-year-old man with history of CAD s/p CABG, HFrEF, progressively worsening dyspnea, and exertional dizziness*

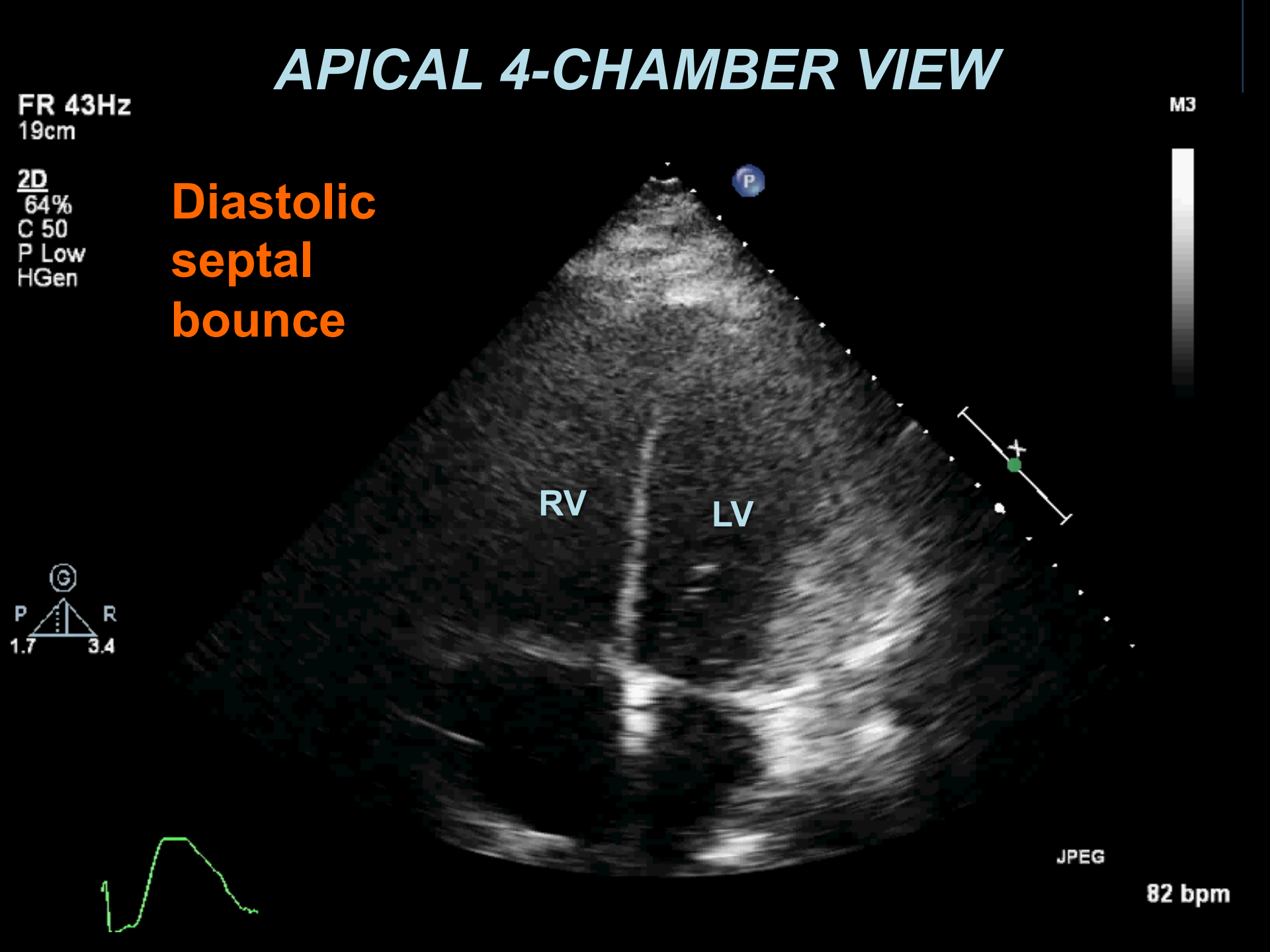




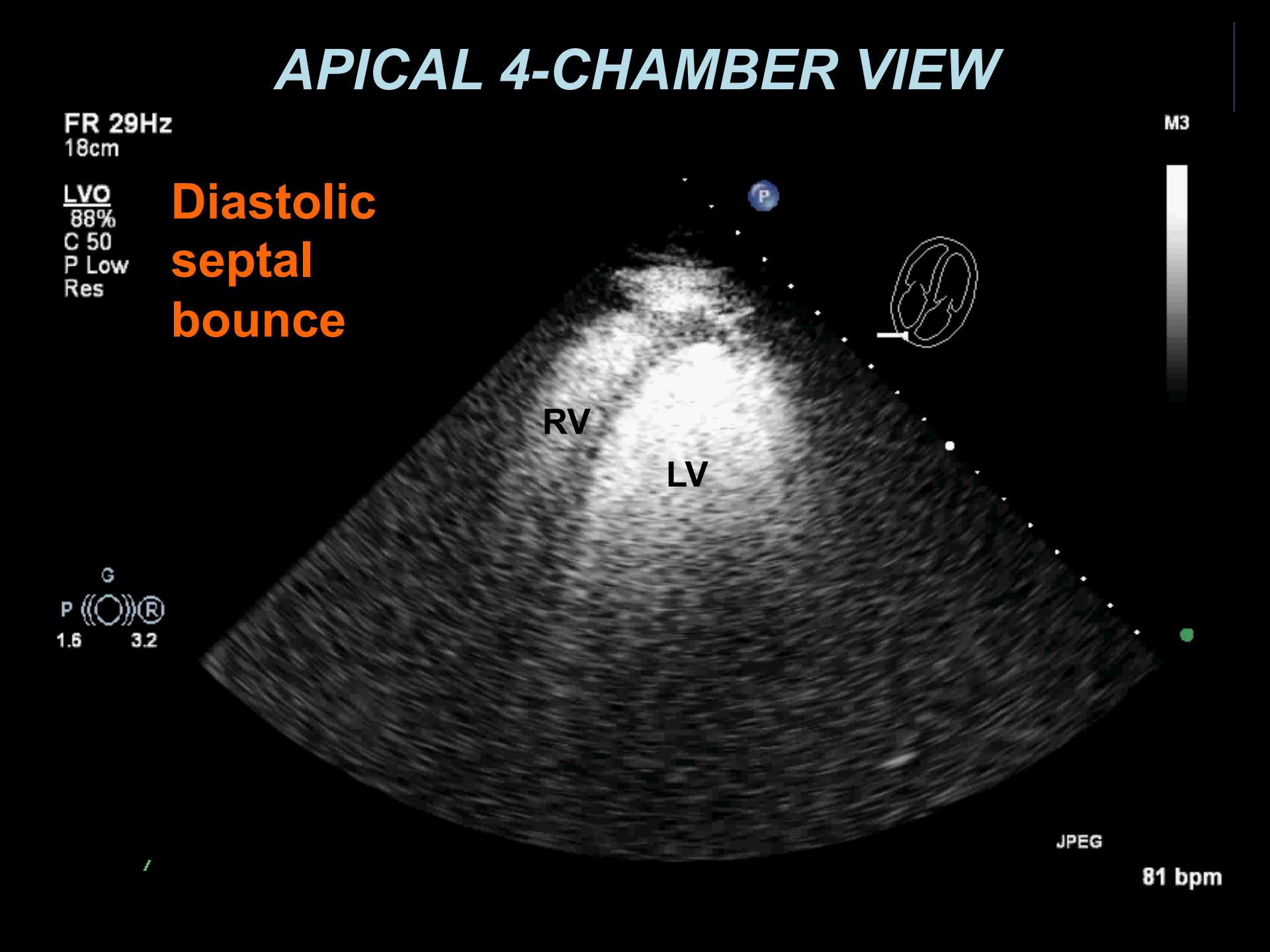
74-year-old man with HFrEF

- ACE-I and beta-blocker stopped
- Diuresed 5L, feels much better
- Attending switches on day of discharge
  - » “Start guideline-directed medical therapy”
  - » Low-dose ACE-I and beta-blocker started
  - » Pt has syncope while walking in room, develops subdural hematoma…

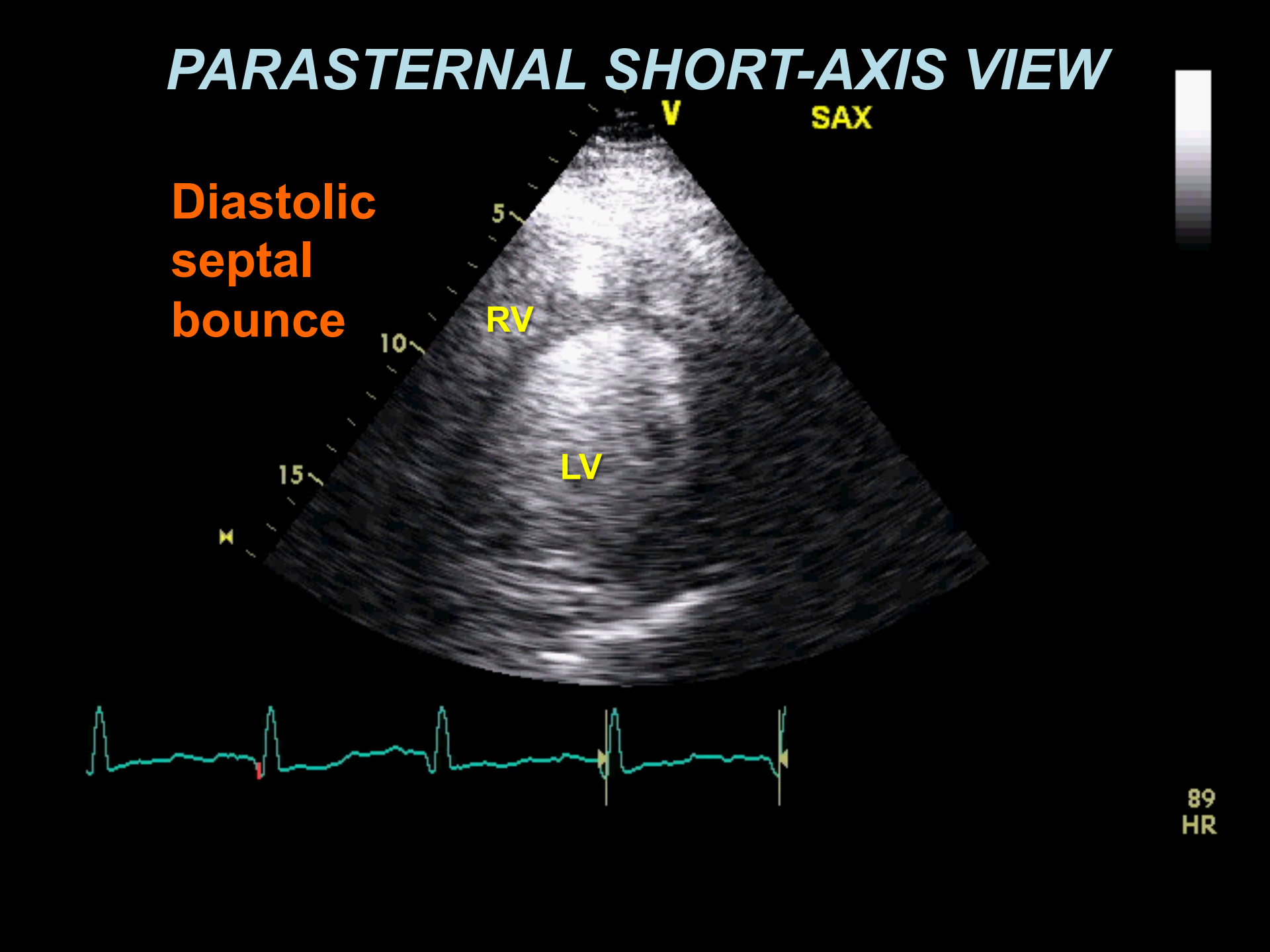
APICAL 4-CHAMBER VIEW



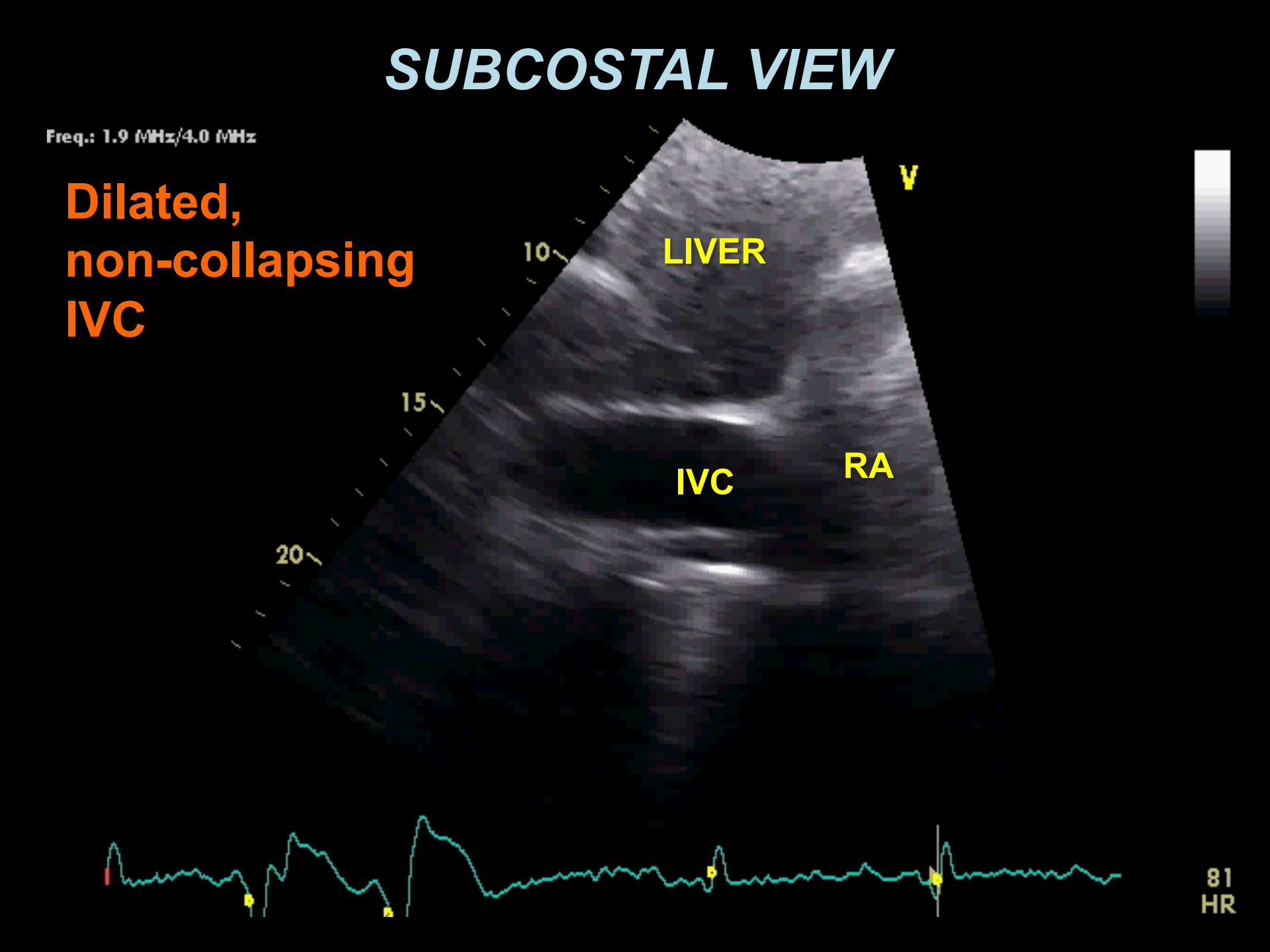
APICAL 4-CHAMBER VIEW

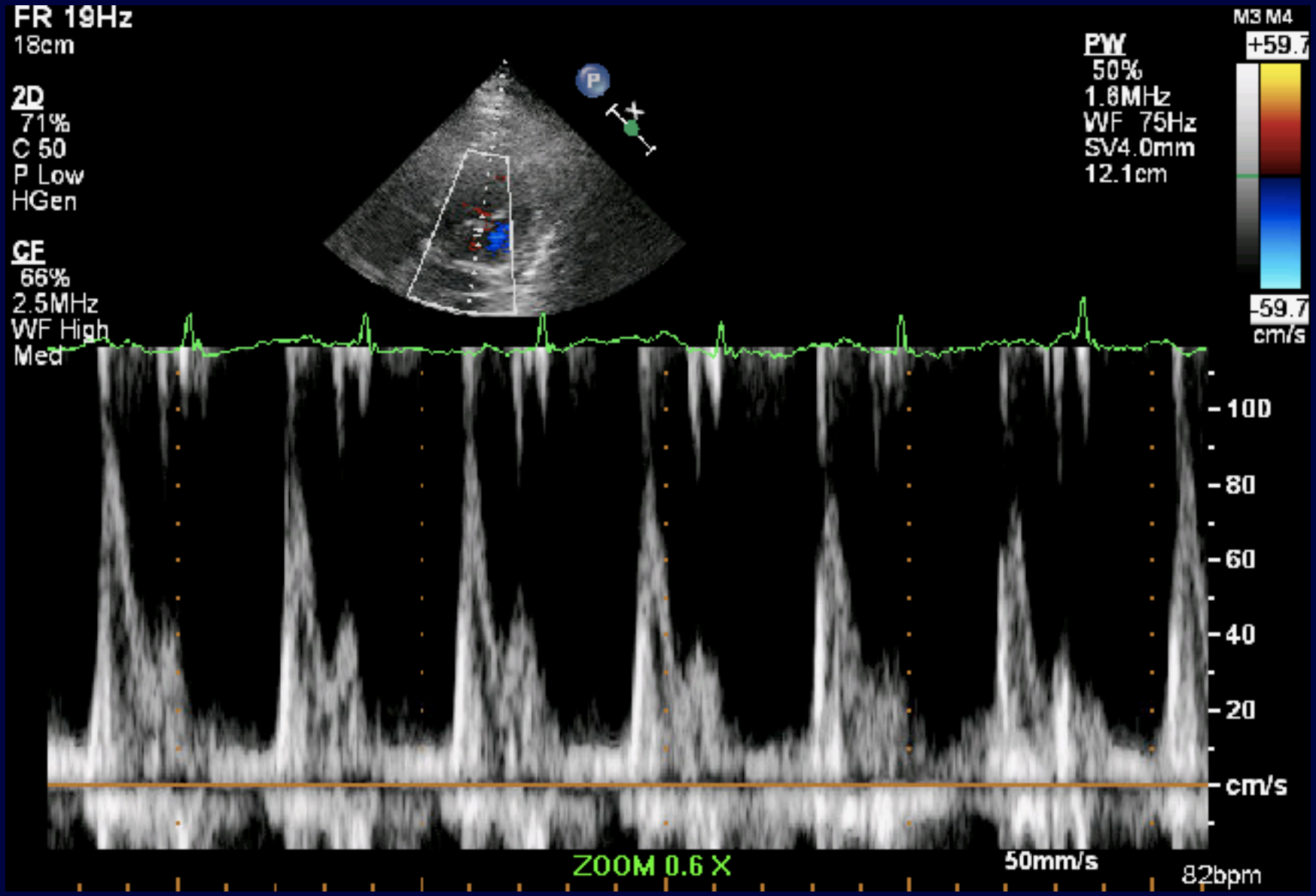


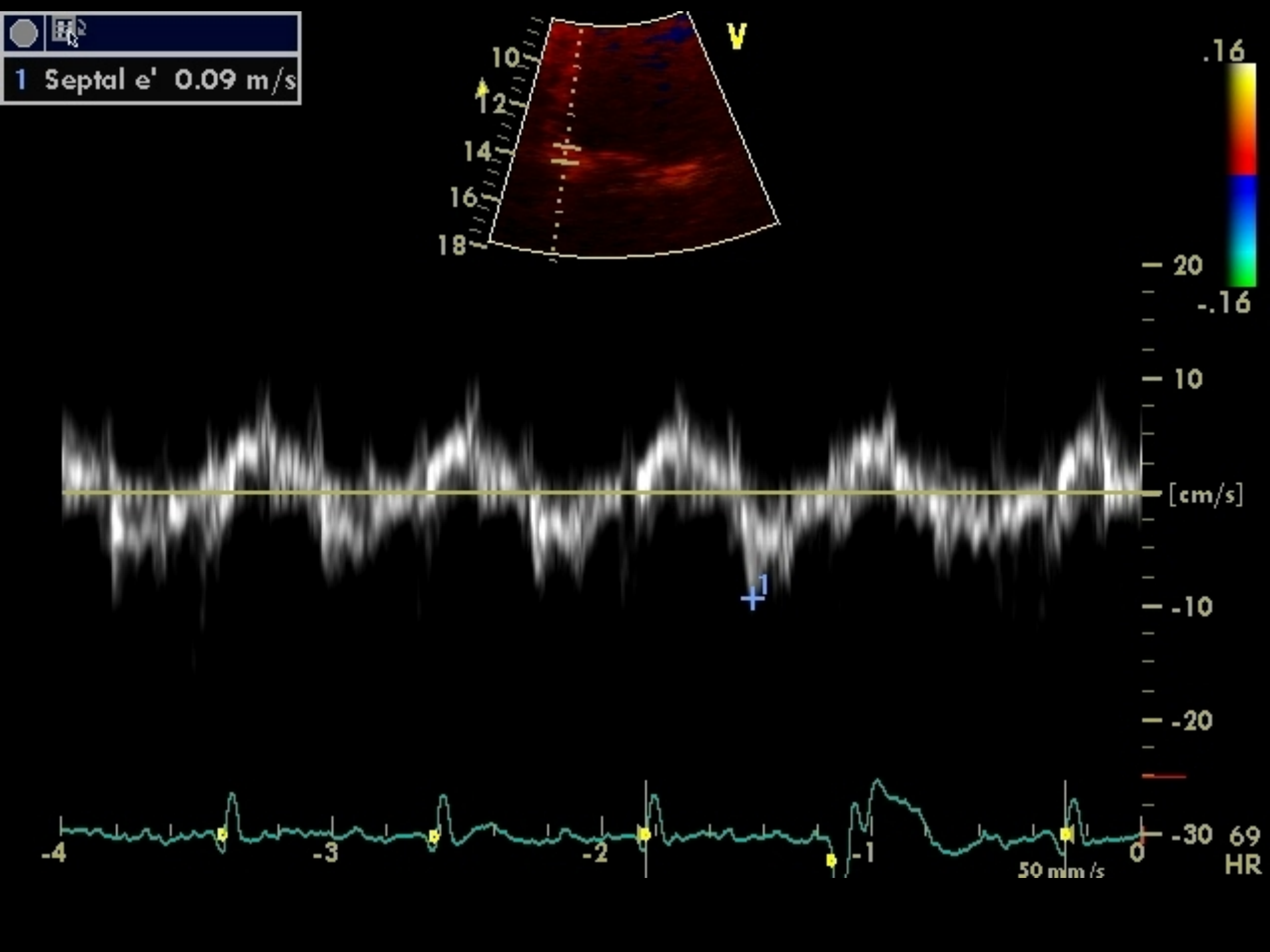
PARASTERNAL SHORT-AXIS VIEW

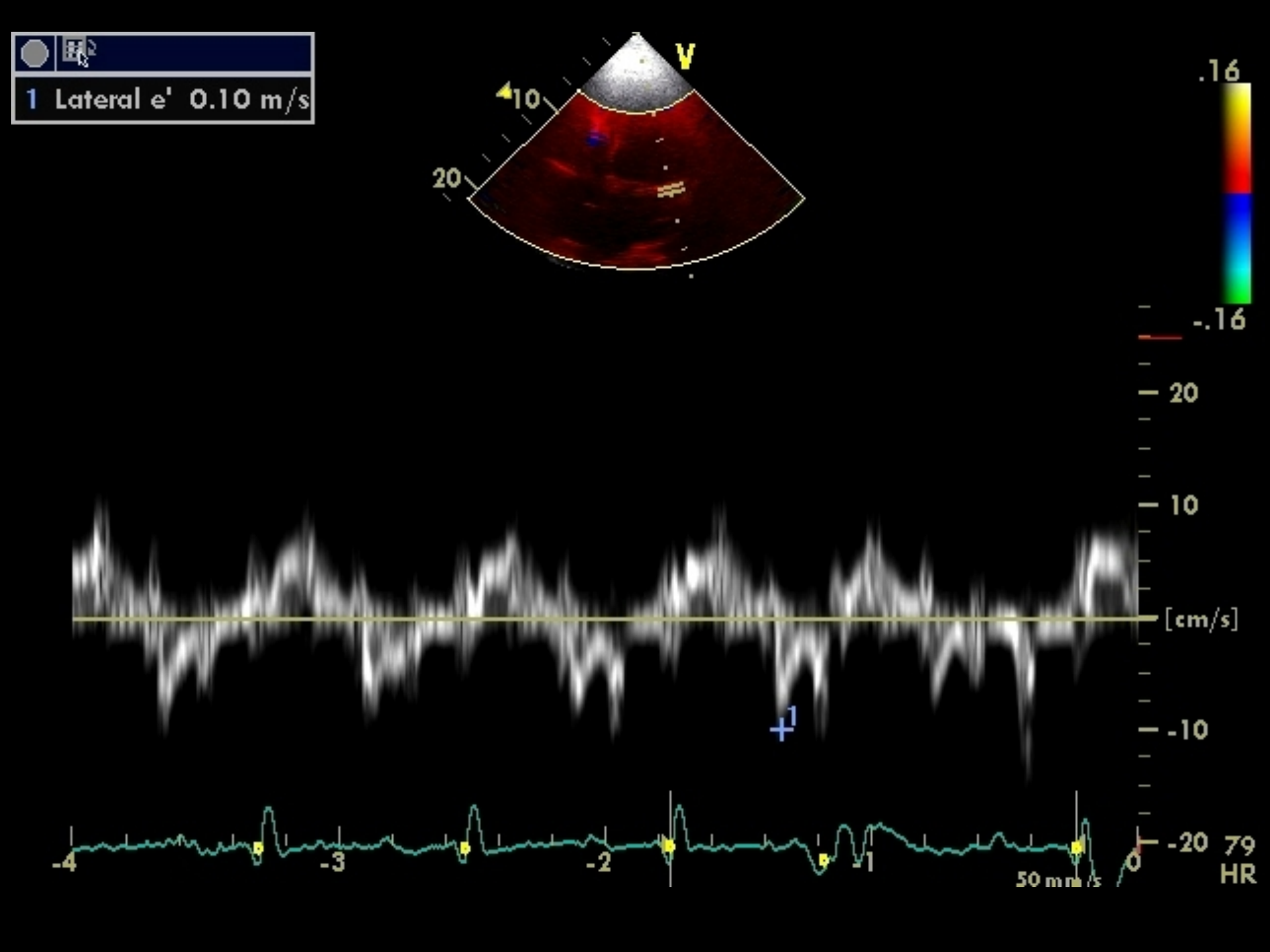


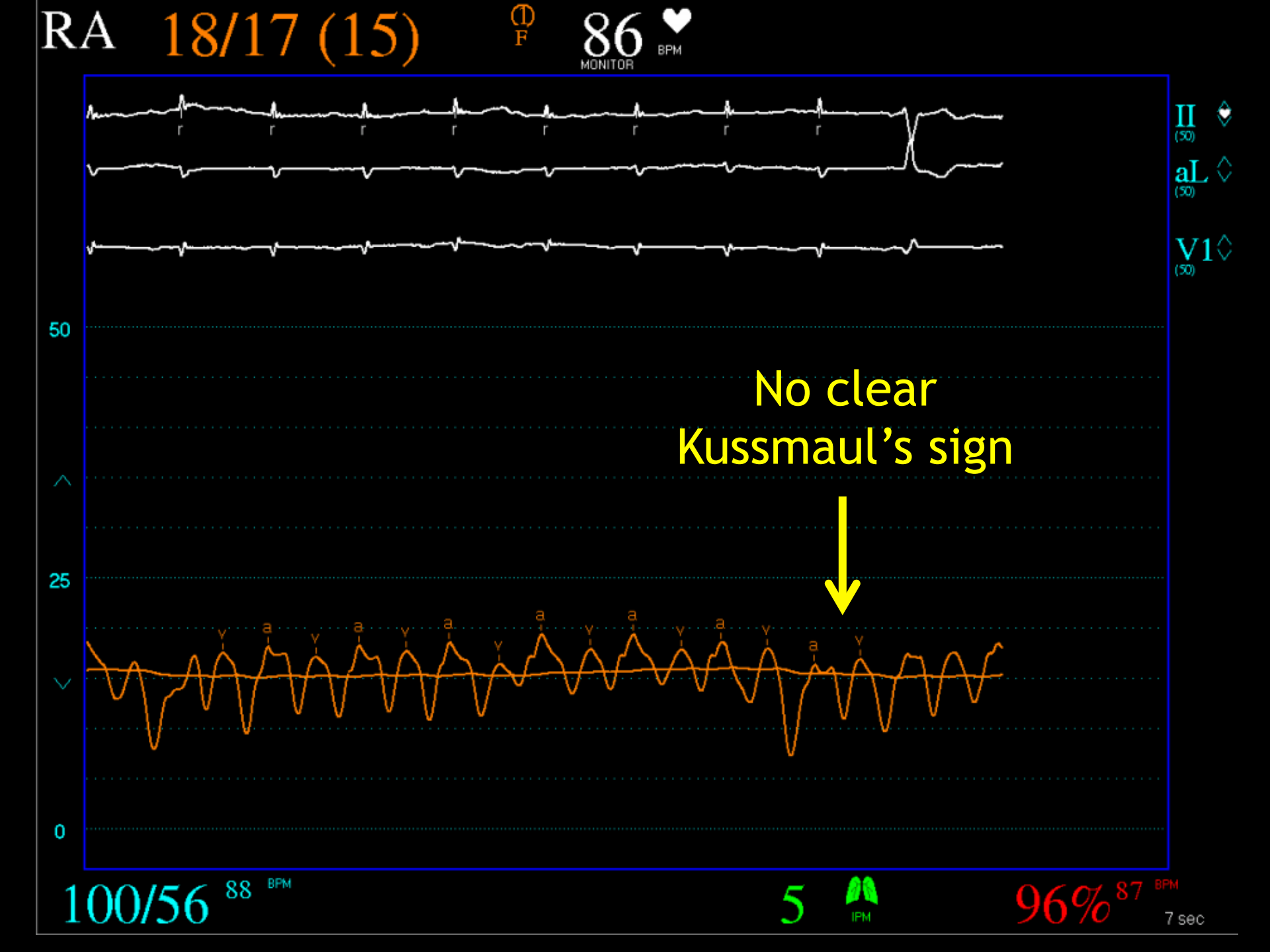
SUBCOSTAL VIEW

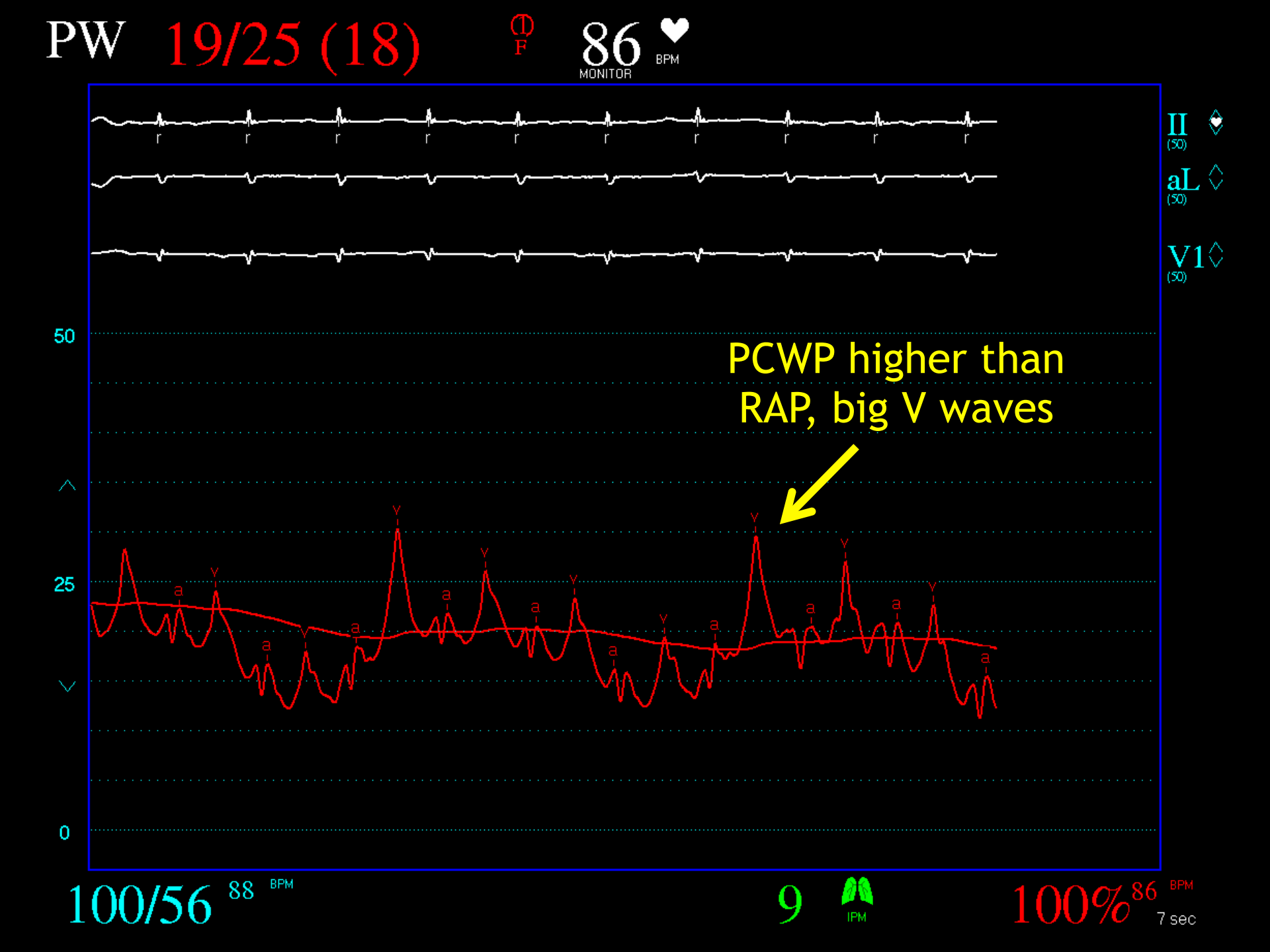


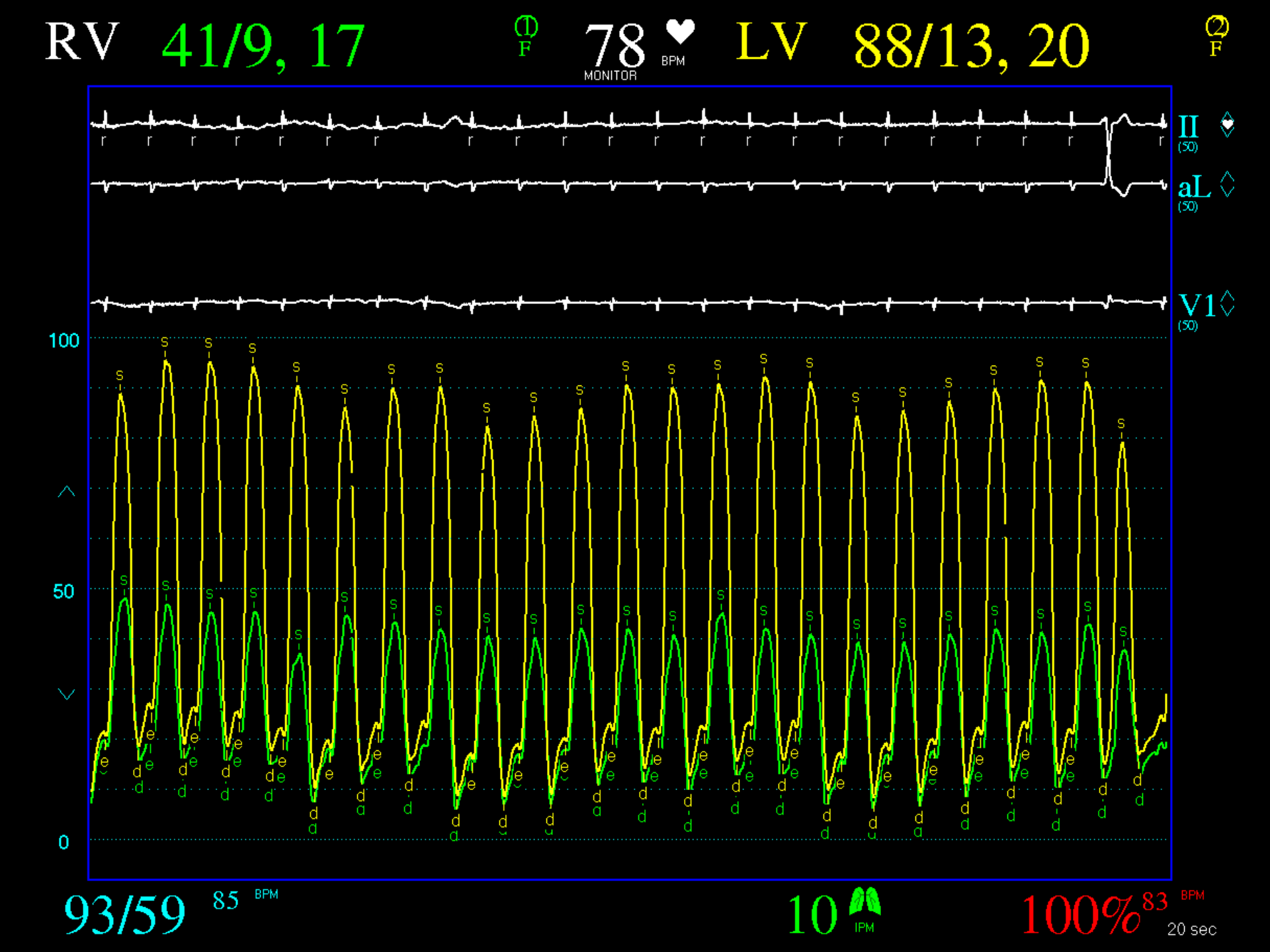

FR 19Hz
18cm
2D
71%
C 50
P Low
HGen
CE
66%
2.5MHz
WF High
Med
PW
50%
1.8MHz
WF 75Hz
SV4.0mm
12.1cm
M3 M4
+59.7
-59.7
cm/s
100
80
60
40
20
cm/s
ZOOM 0.6 X
50mm/s
82bpm

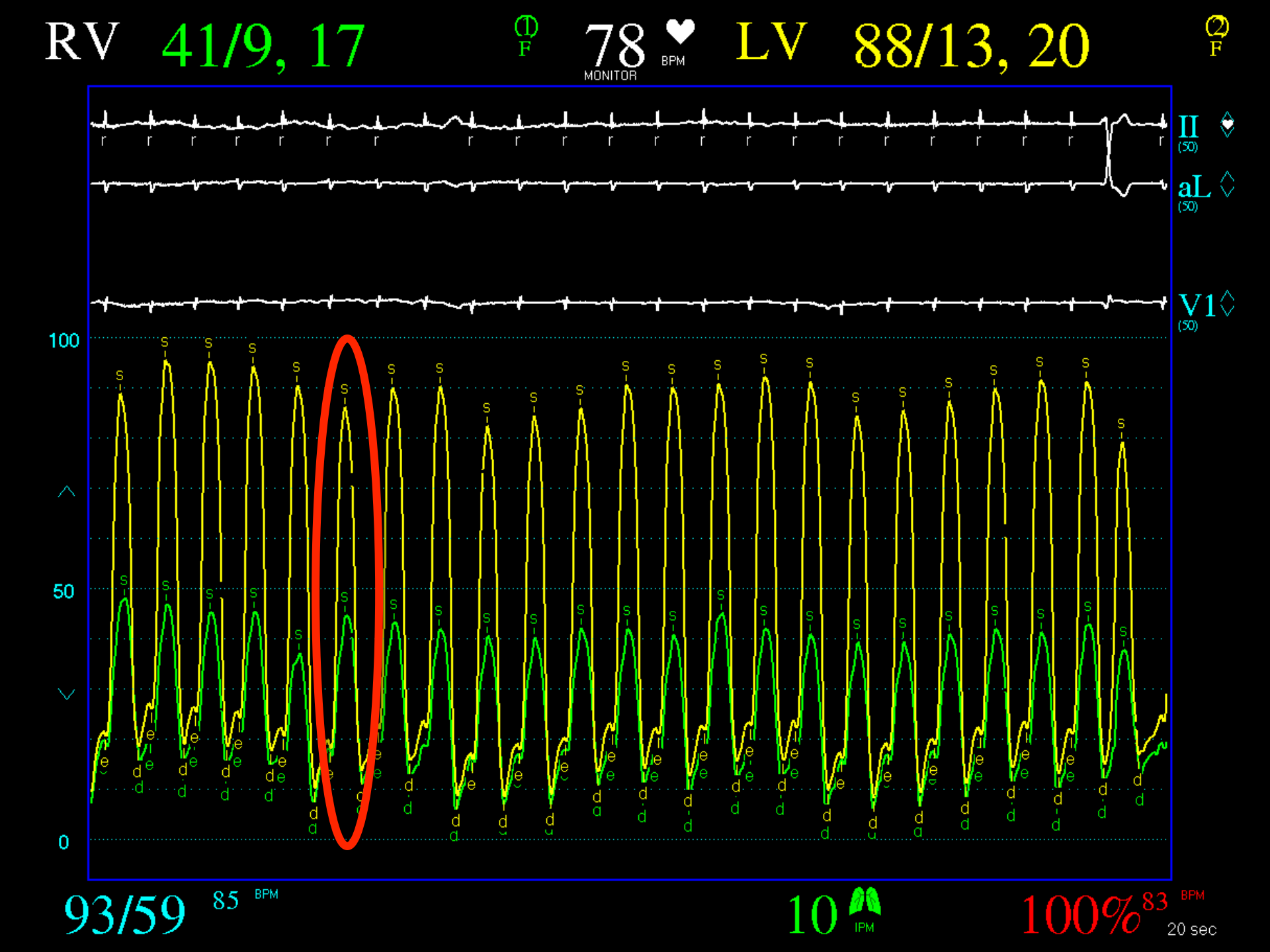

1 Septal e' 0.09 m/s
V
10
12
14
16
18
.16
-.16
20
10
[cm/s]
-10
-20
-30
-4
-3
-2
-1
0
50 mm/s
69
HR


1 Lateral e' 0.10 m/s
V
10
20
.16
-.16
20
10
[cm/s]
-10
-20
-4
-3
-2
-1
0
50 mm/s
79
HR


RA 18/17 (15)
86 BPM
MONITOR
II (50)
aL (50)
V1 (50)
50
25
0
No clear
Kussmaul's sign
100/56 88 BPM
5 IPM
96% 87 BPM
7 sec


PW 19/25 (18)
86 BPM
MONITOR
II (50)
aL (50)
V1 (50)
50
25
0
PCWP higher than
RAP, big V waves
100/56 88 BPM
9 IPM
100% 86 BPM
7 sec


RV 41/9, 17
F
78
BPM
MONITOR
LV 88/13, 20
F
II
(50)
aL
(50)
V1
(50)
100
50
0
93/59
85 BPM
10
IPM
100%
83 BPM
20 sec


RV 41/9, 17
F
78
MONITOR
BPM
LV 88/13, 20
F
II
(50)
aL
(50)
V1
(50)
100
50
0
93/59
85 BPM
10
IPM
100%
83 BPM
20 sec

74-year-old man with HFrEF

- Constrictive pericarditis diagnosed
- Underwent pericardial stripping
- Still with mild HFrEF but now NYHA class II and no further syncopal events

Constriction: take home points

- Echo diagnosis of constriction is all about pattern recognition:
  - ✓ Diastolic septal bounce
  - ✓ Mitral inflow ⇧resp. variation, ⇧E/A, decreased E deceleration time
  - ✓ Preserved e' velocity (septal ≥ lateral)
  - ✓ Dilated IVC
  - ✓ Diastolic flow reversal during expiration
  - ✓ Reduced radial function, preserved longitudinal function


thank you!