Tricuspid Regurgitation

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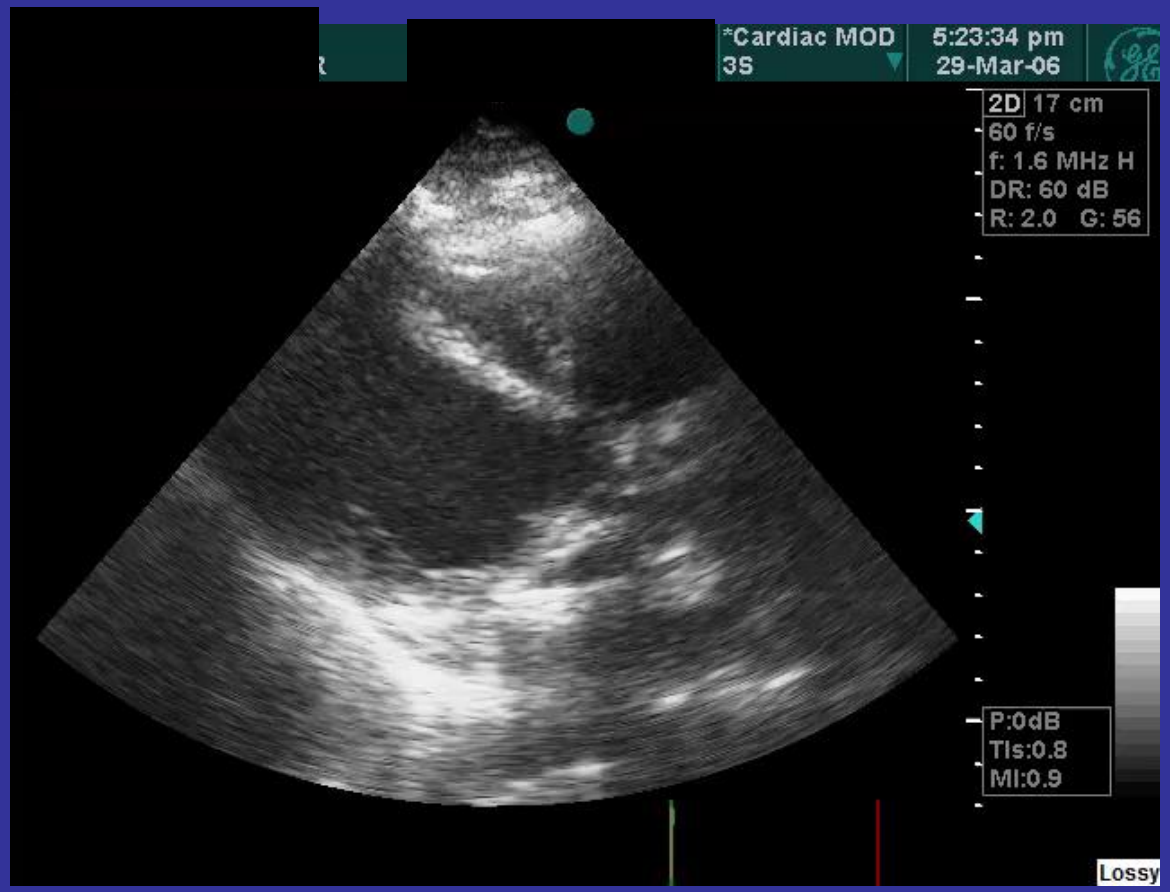
- 67 years old Woman

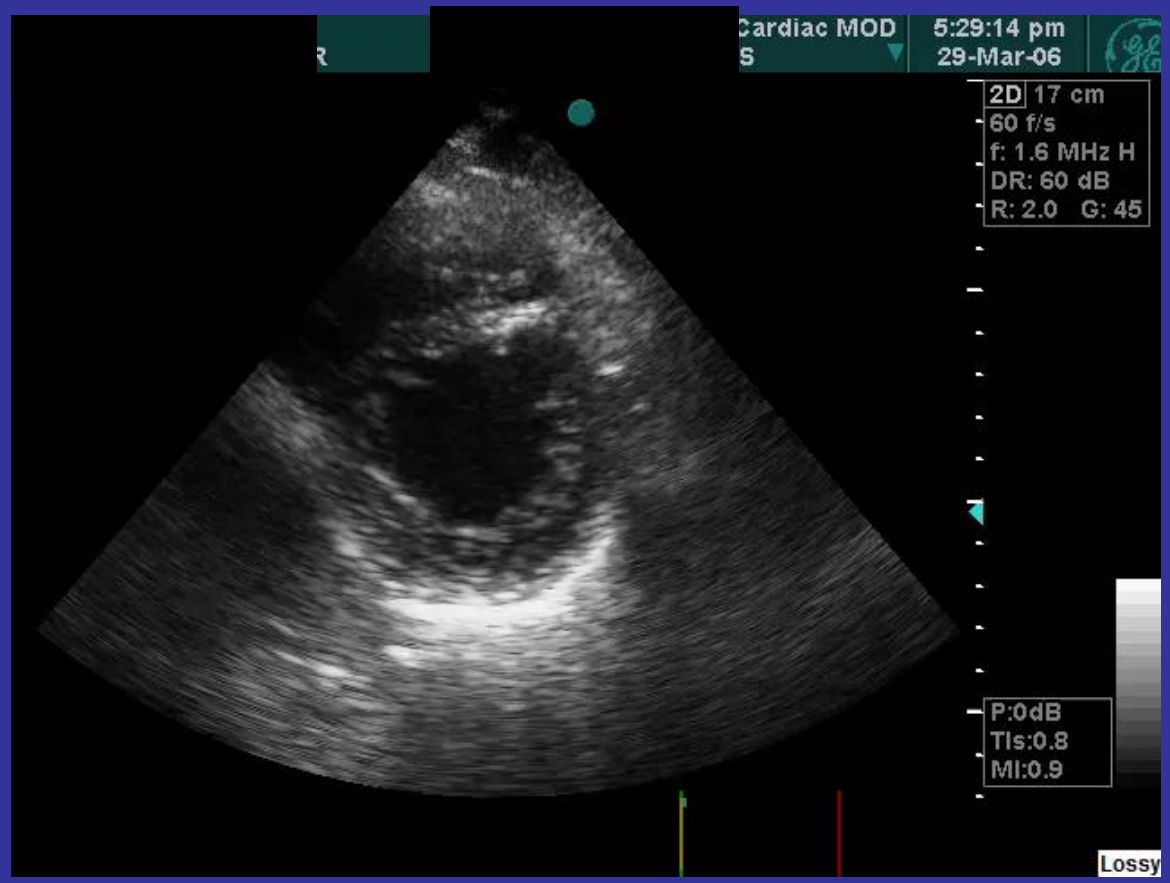
- HTN
- Family history of CAD

Clinical History

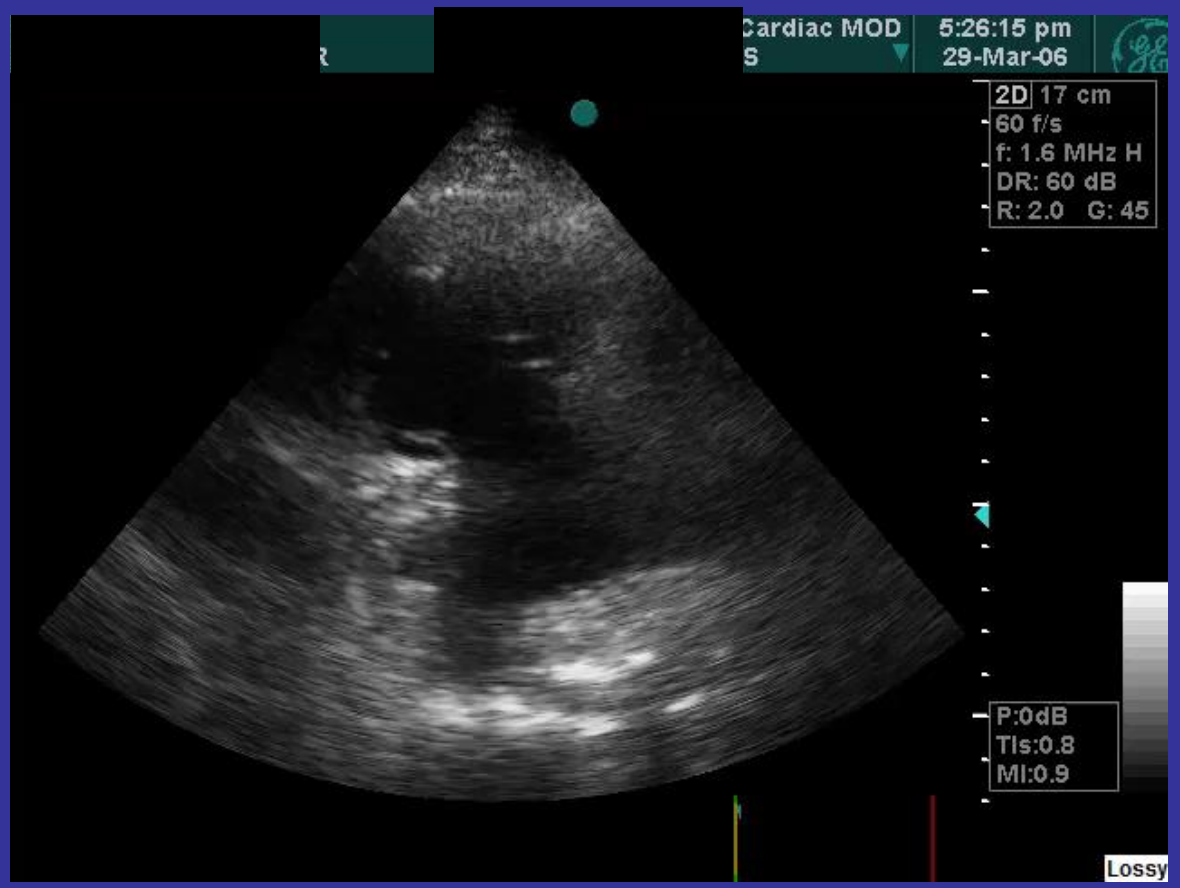
- RHD
- 1st Surgery 1993 – Mechanical MVR d/t RHD – MS.
- Rec PAF

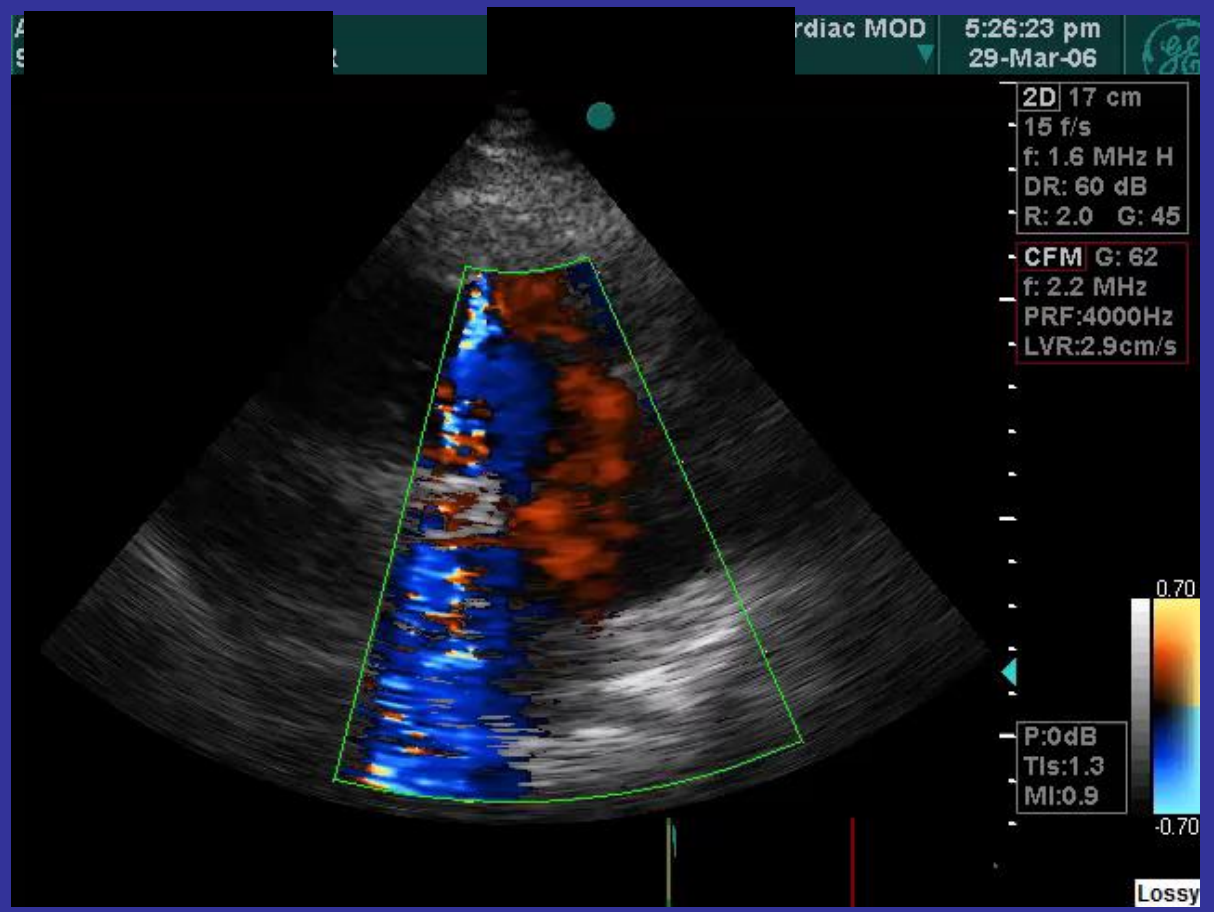
First echo 2006 - Asymptomatic



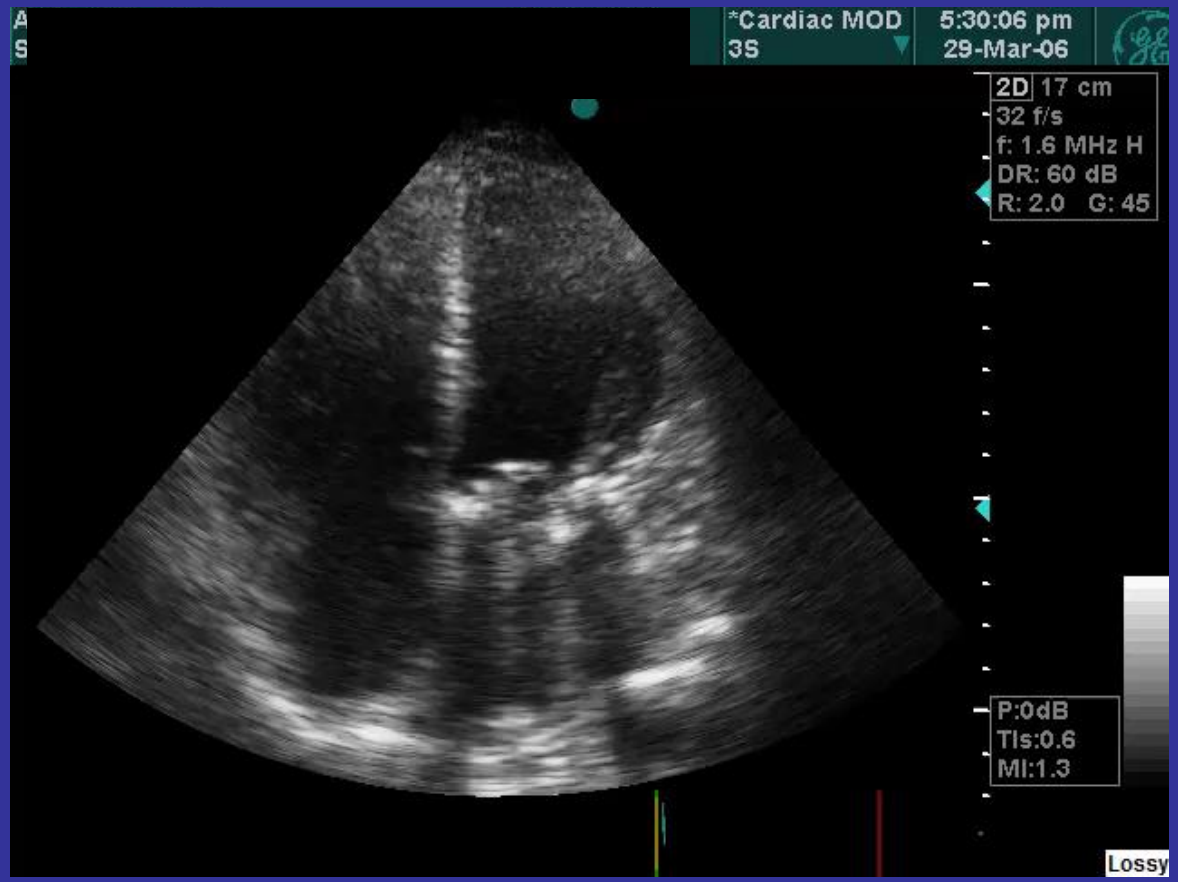


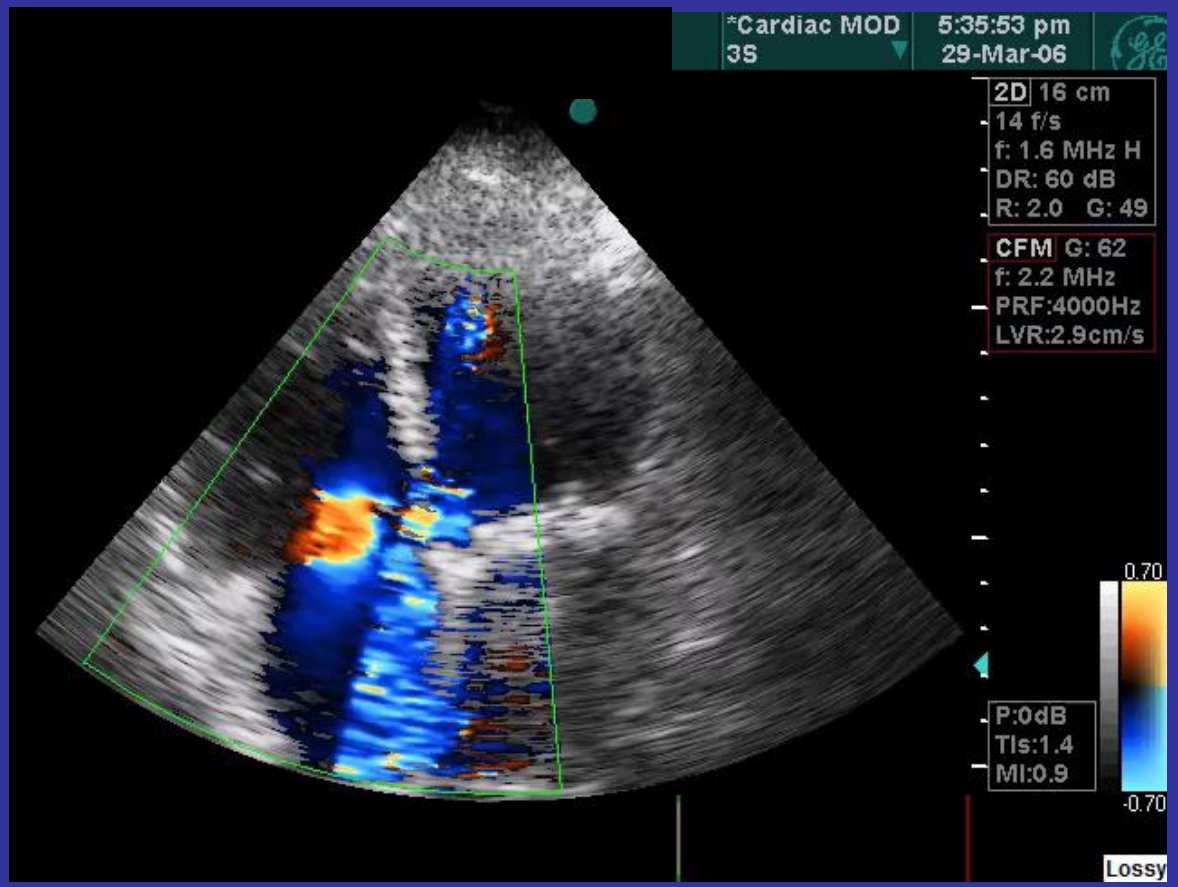
First echo 2006 - Asymptomatic



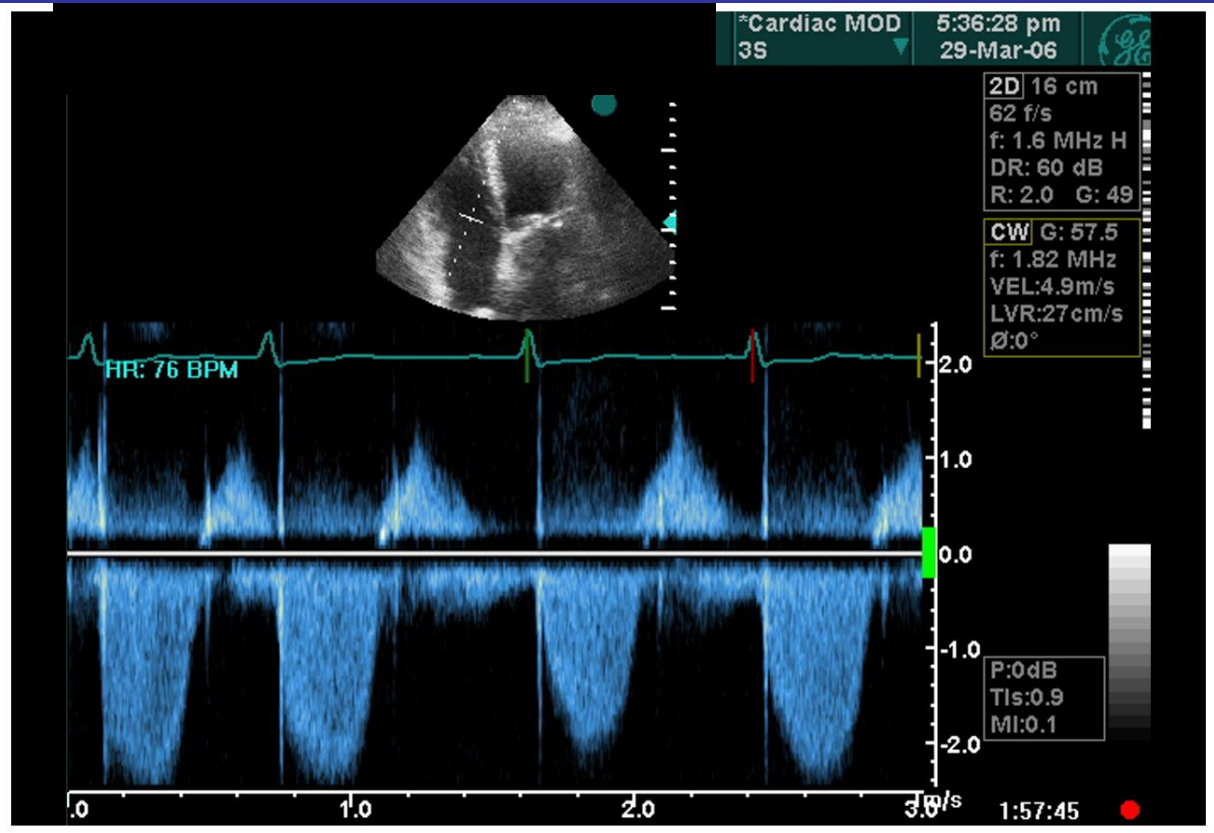


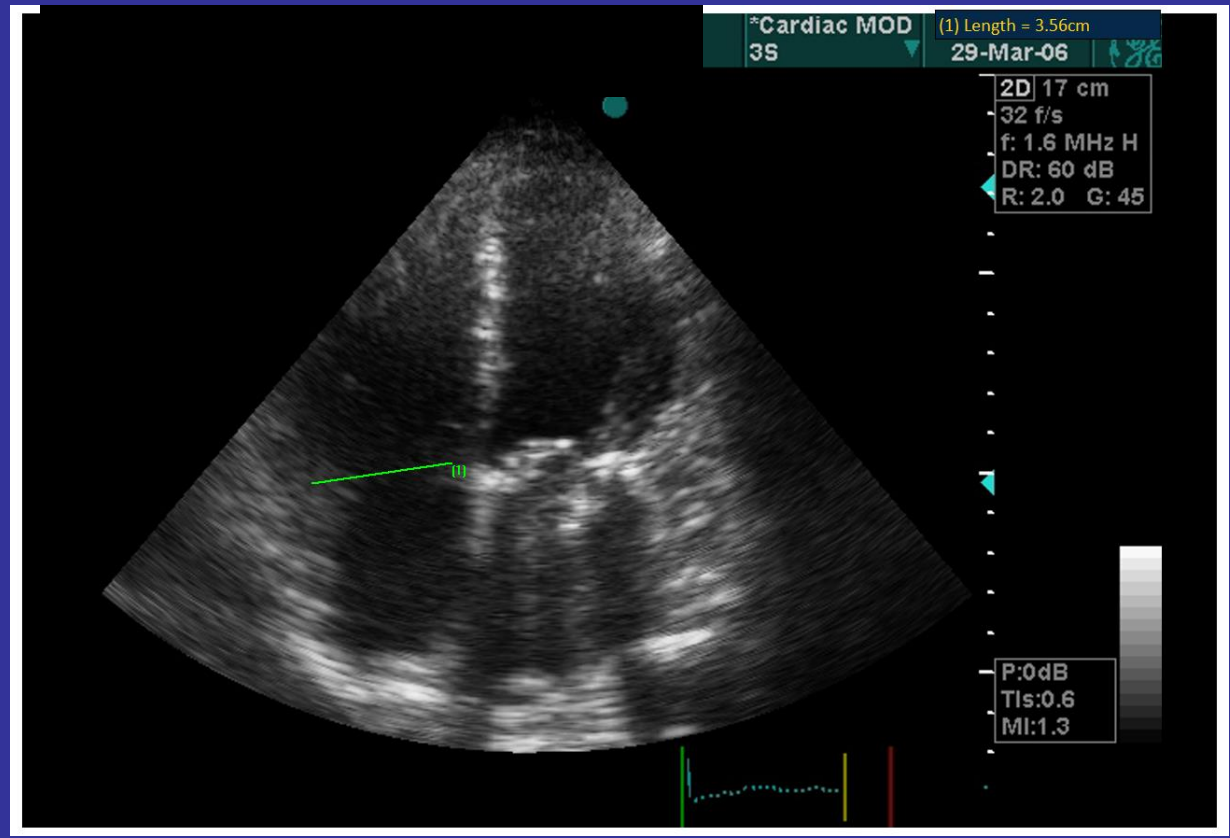
First echo 2006 - Asymptomatic





First echo 2006 - Asymptomatic





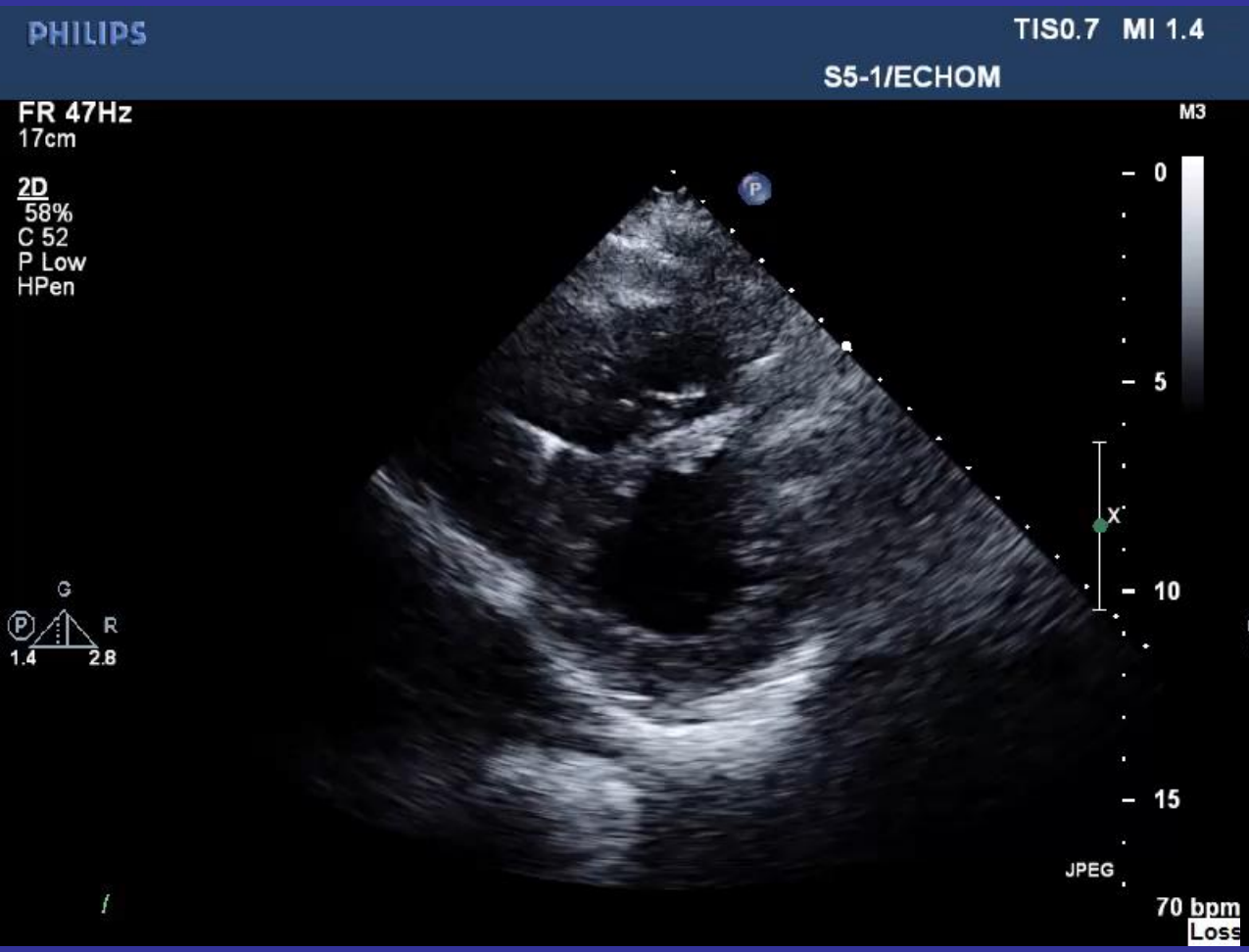
What would you do?

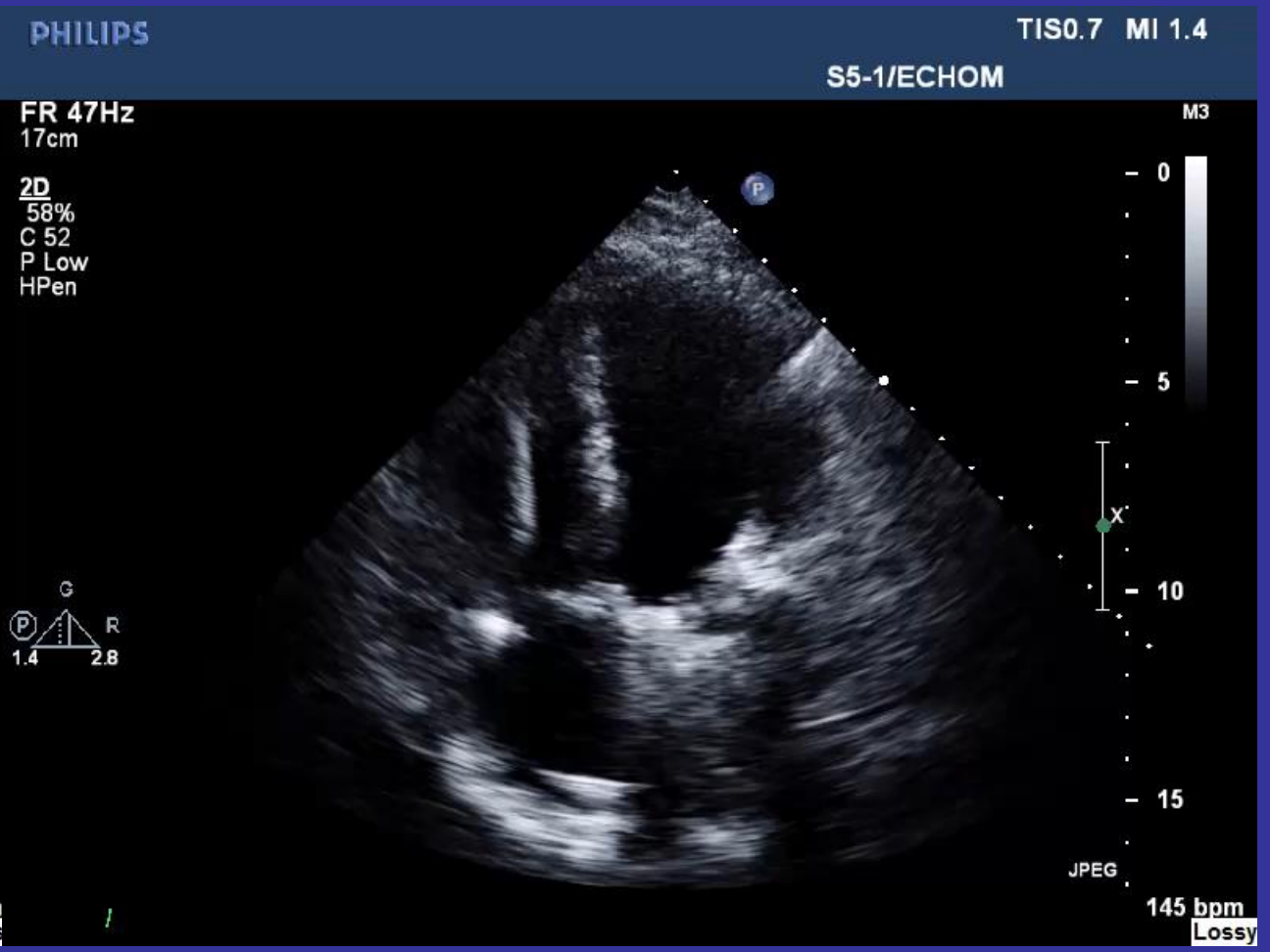
- What would you do?
- Treat TC?
- Aldactone?
- Fusid?
- MRI – RV assessment?
- Rt heart cath?
- Ablation for PAF?

Continue…

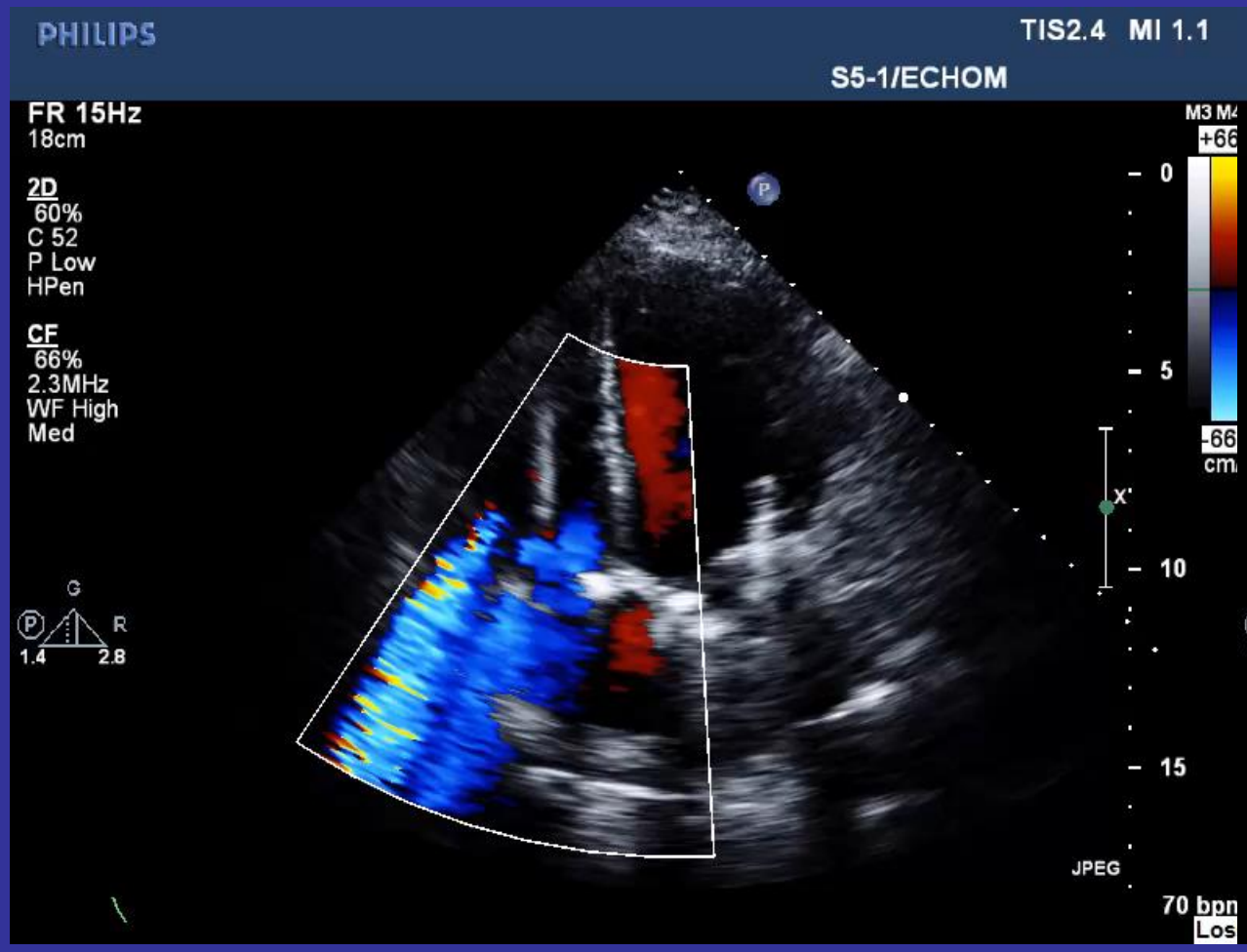
- 2006 - Permanent Pace maker and AV node ablation d/t Rec PAF

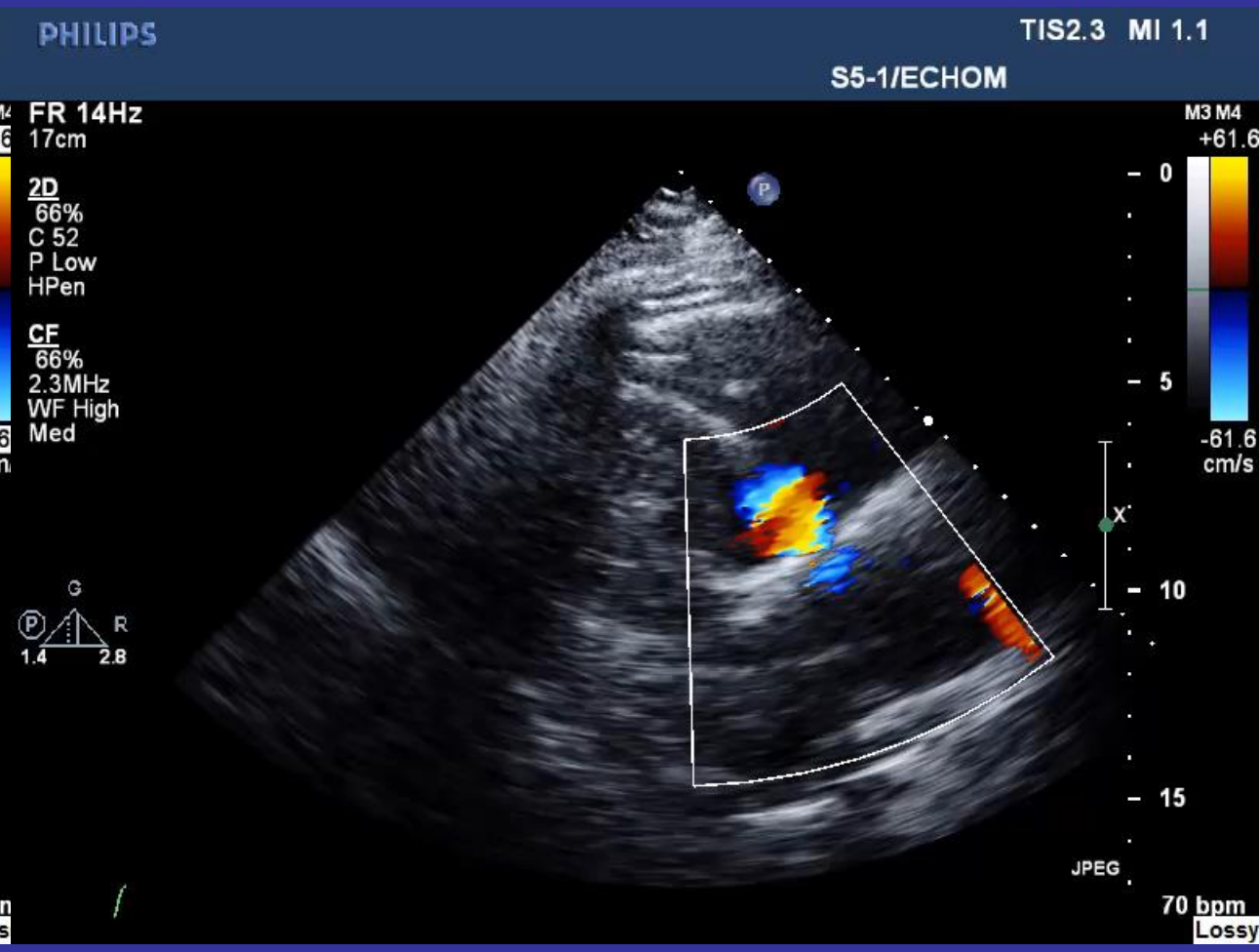
Echo post with Pacemaker



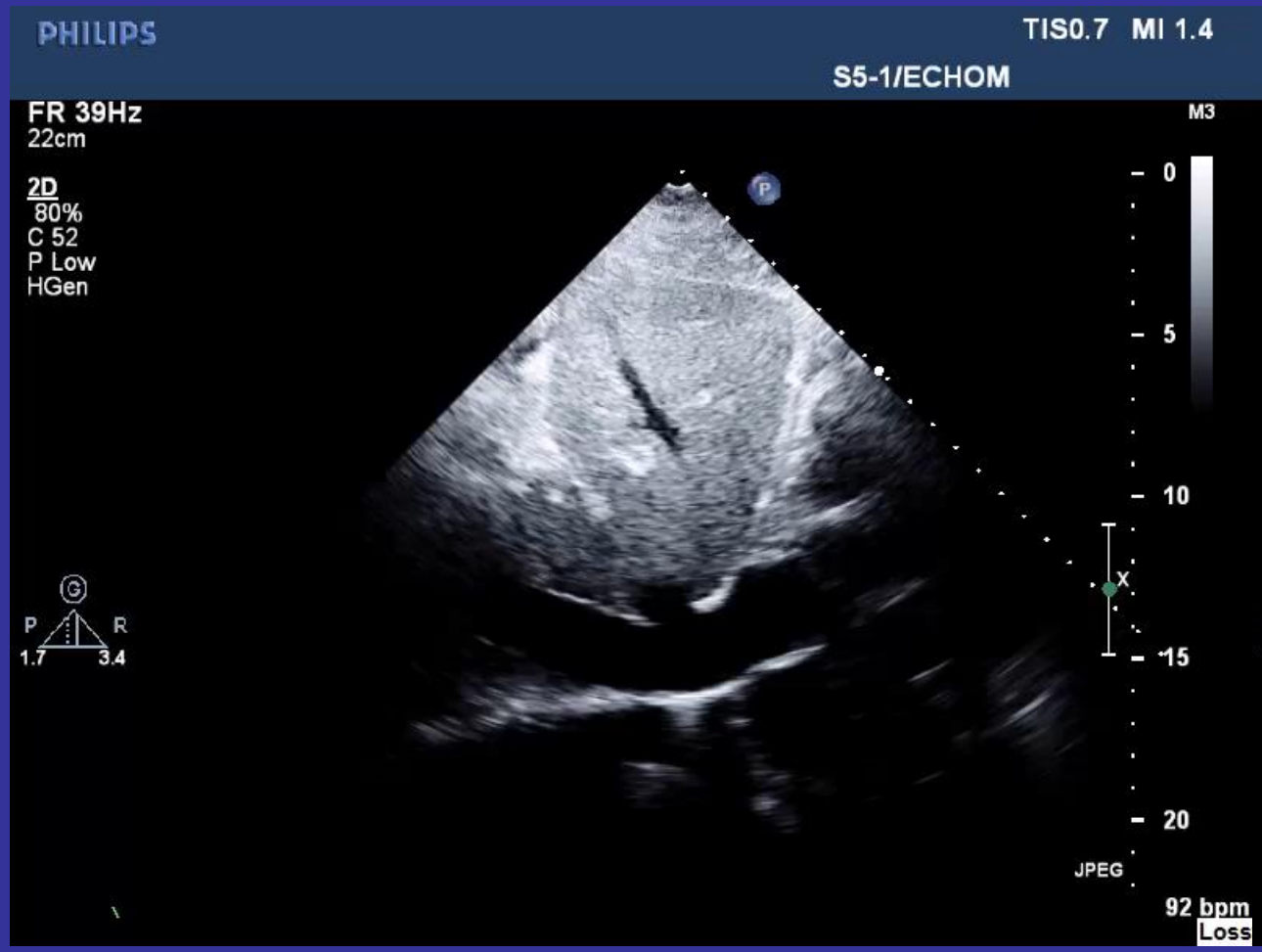


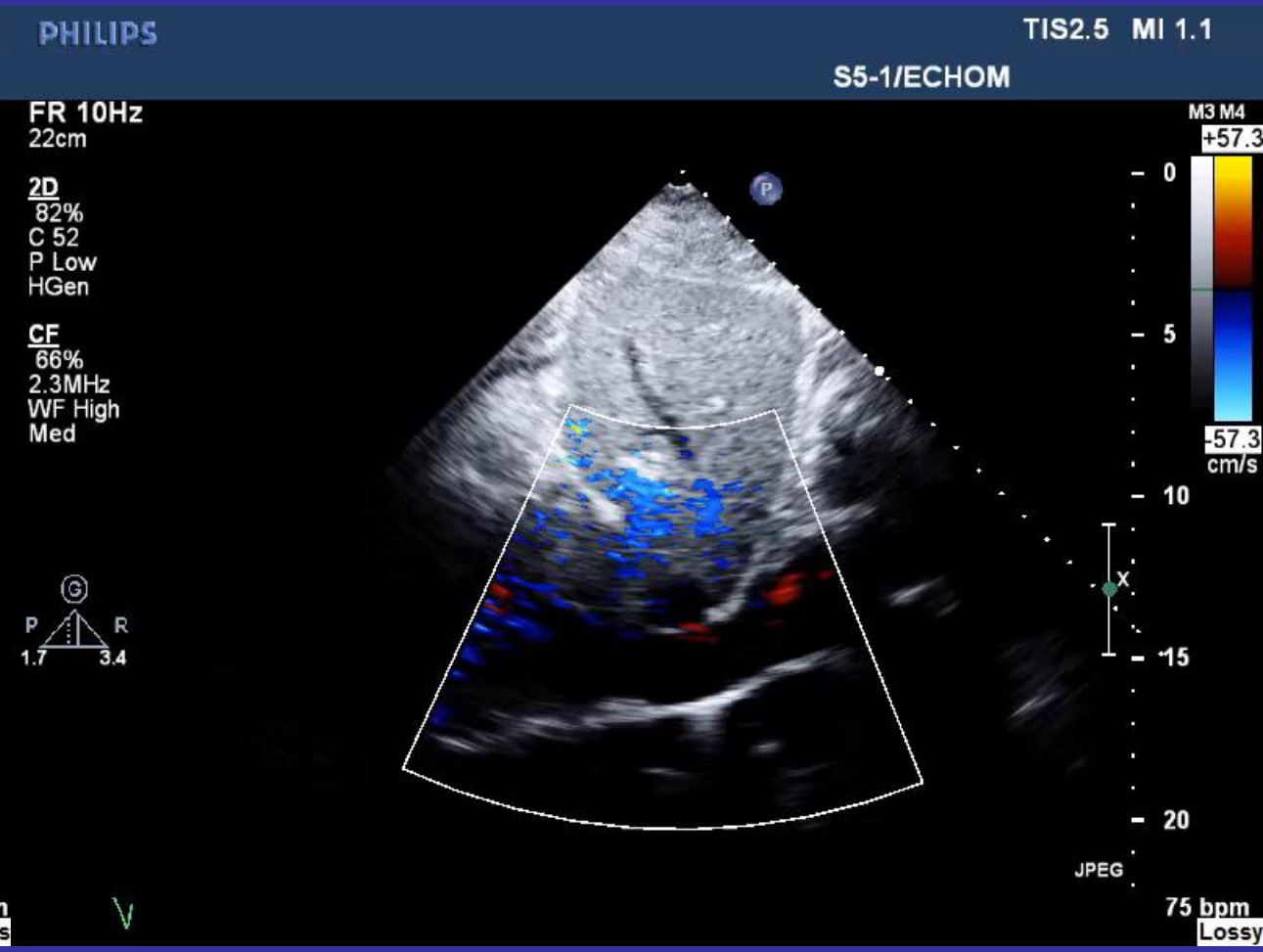
Echo post with Pacemaker





Echo post with Pacemaker



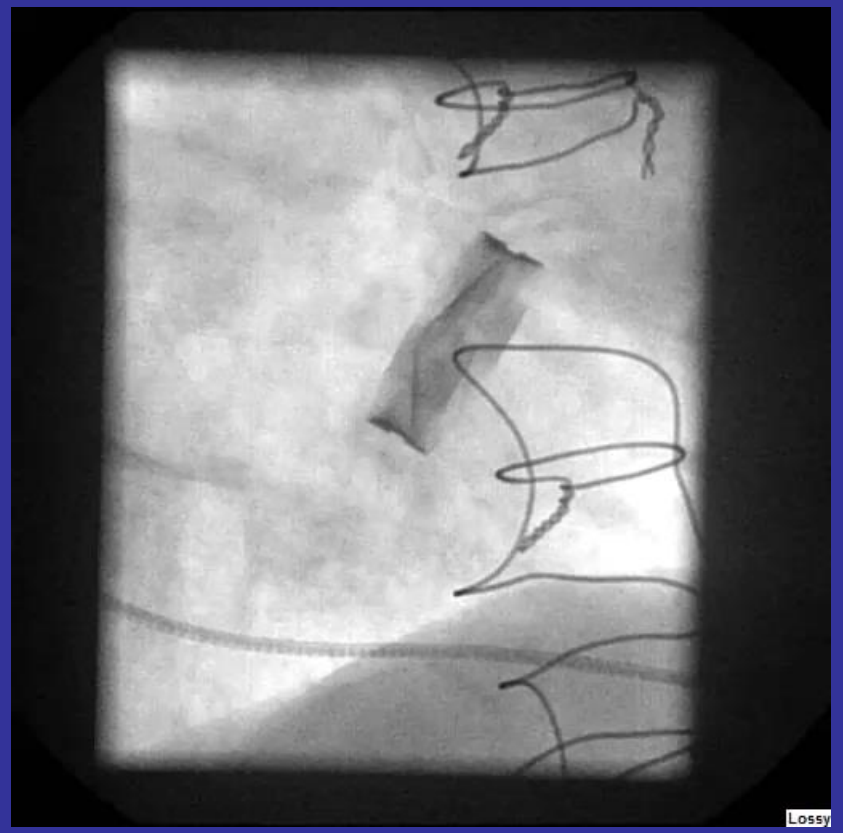


Echo post with Pacemaker

- Pacemaker did not change the TR severity

Couple Days Following Pacemaker Insertion

- Chest pain – Stuck valve



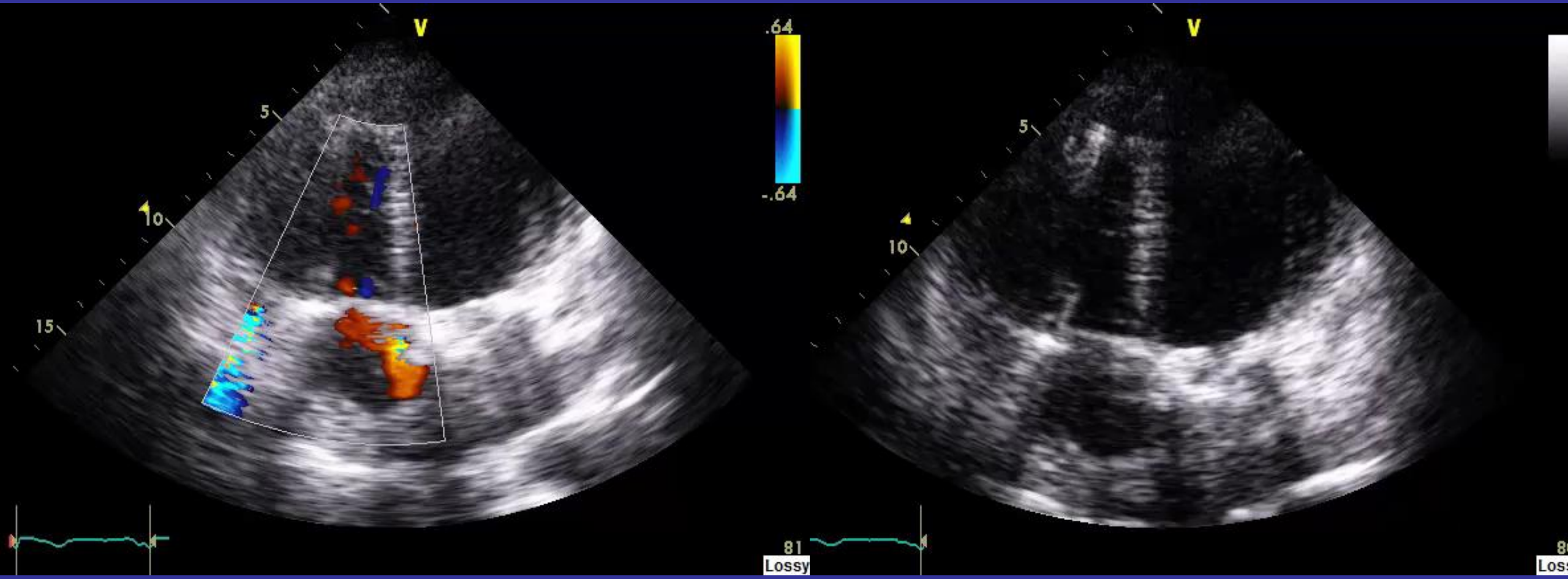
Redo MVR and TC repair

- St Jude 27 mm
- Tricuspid ring with CE 32mm

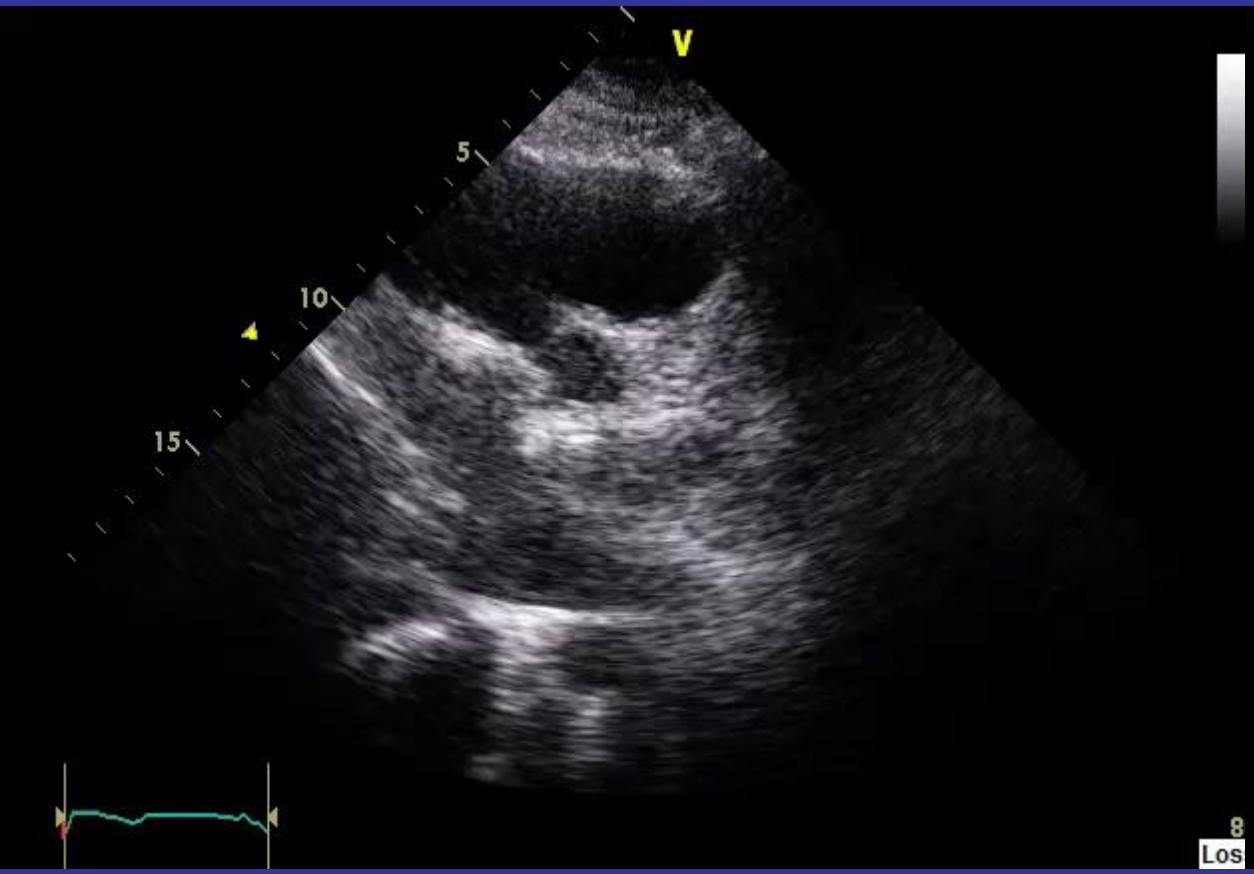
What would you do?

- Would you replace tricuspid or repair?

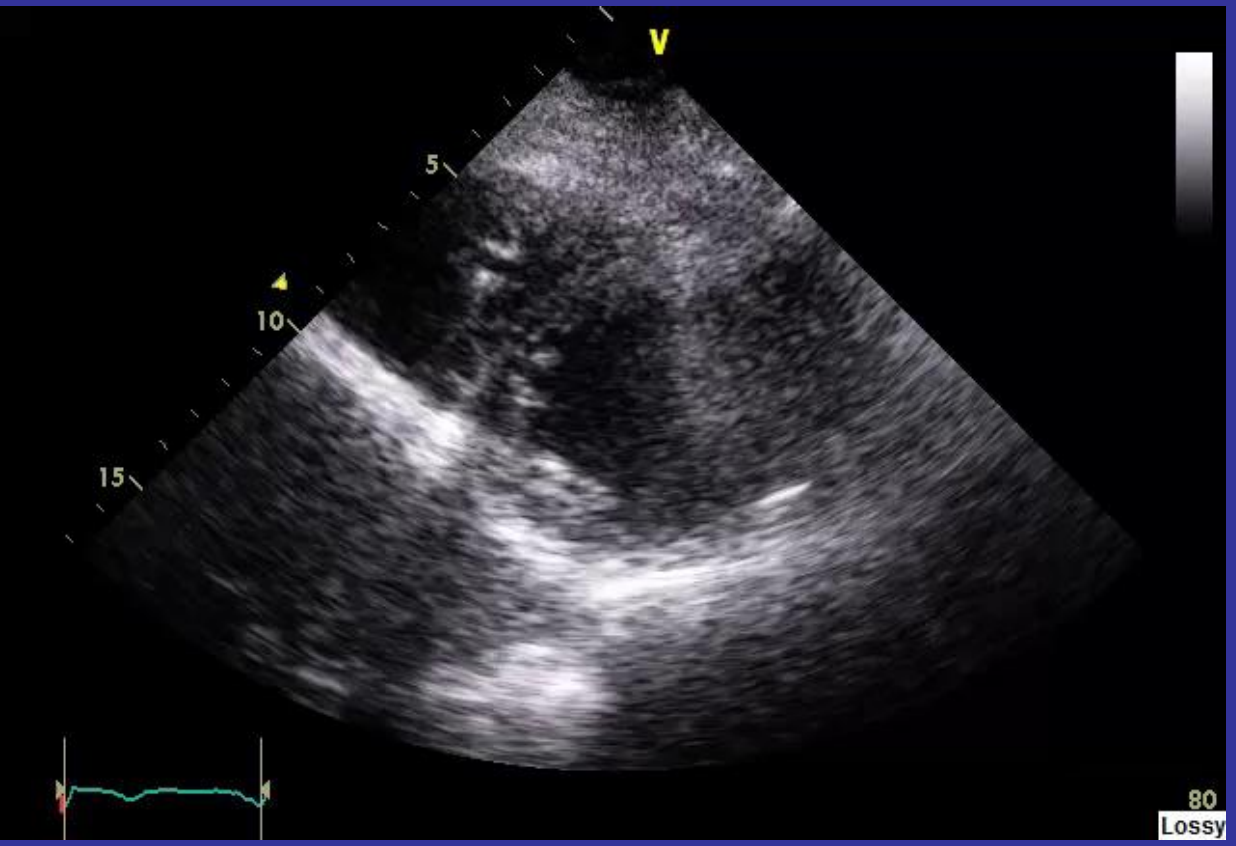
First Echo Postop Period

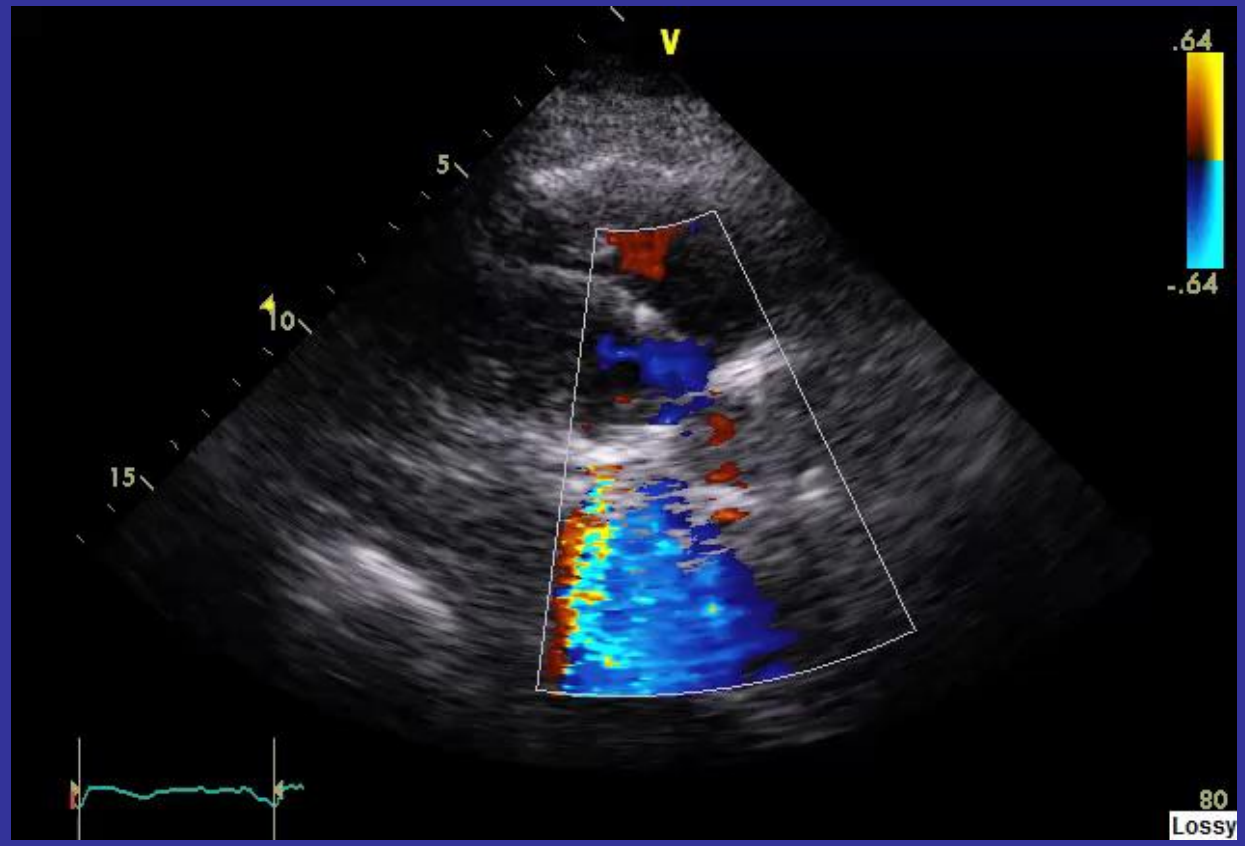


First Echo Postop

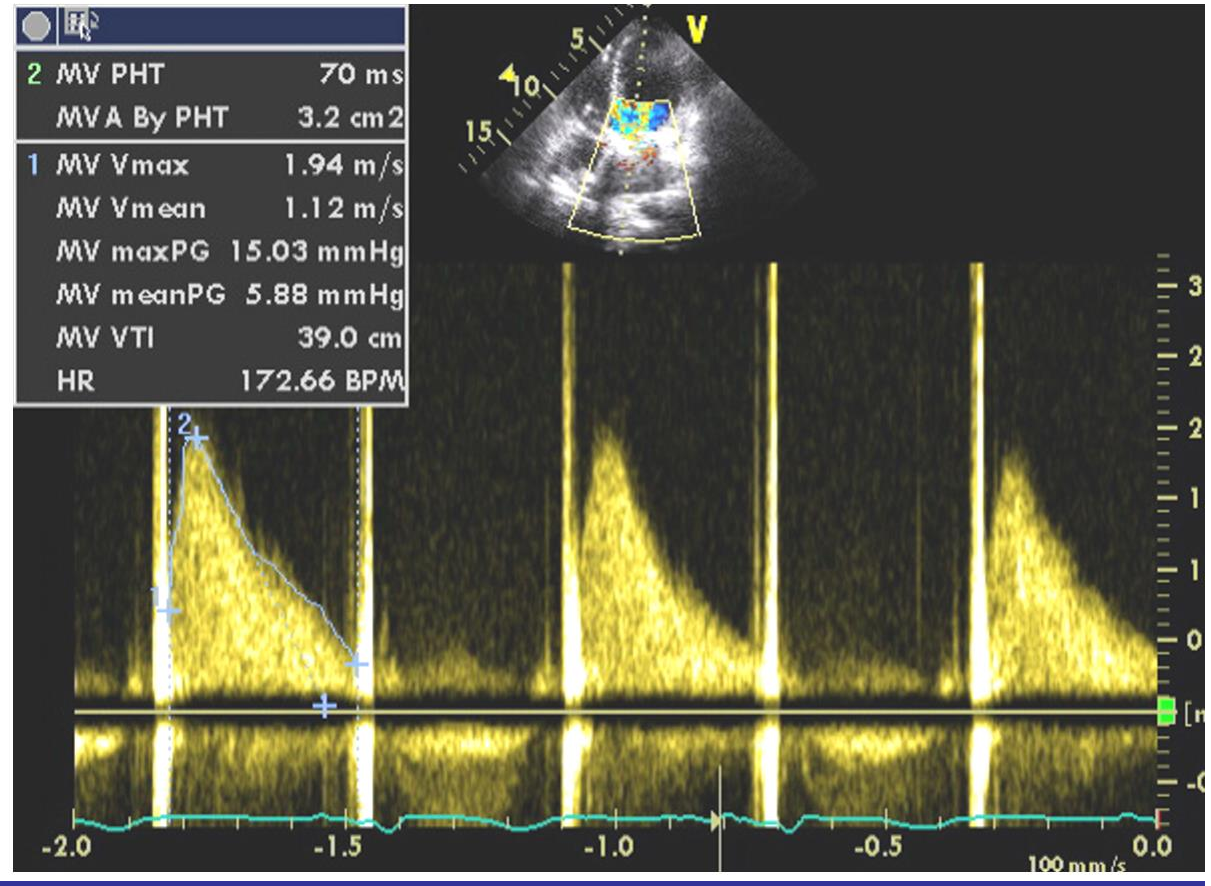


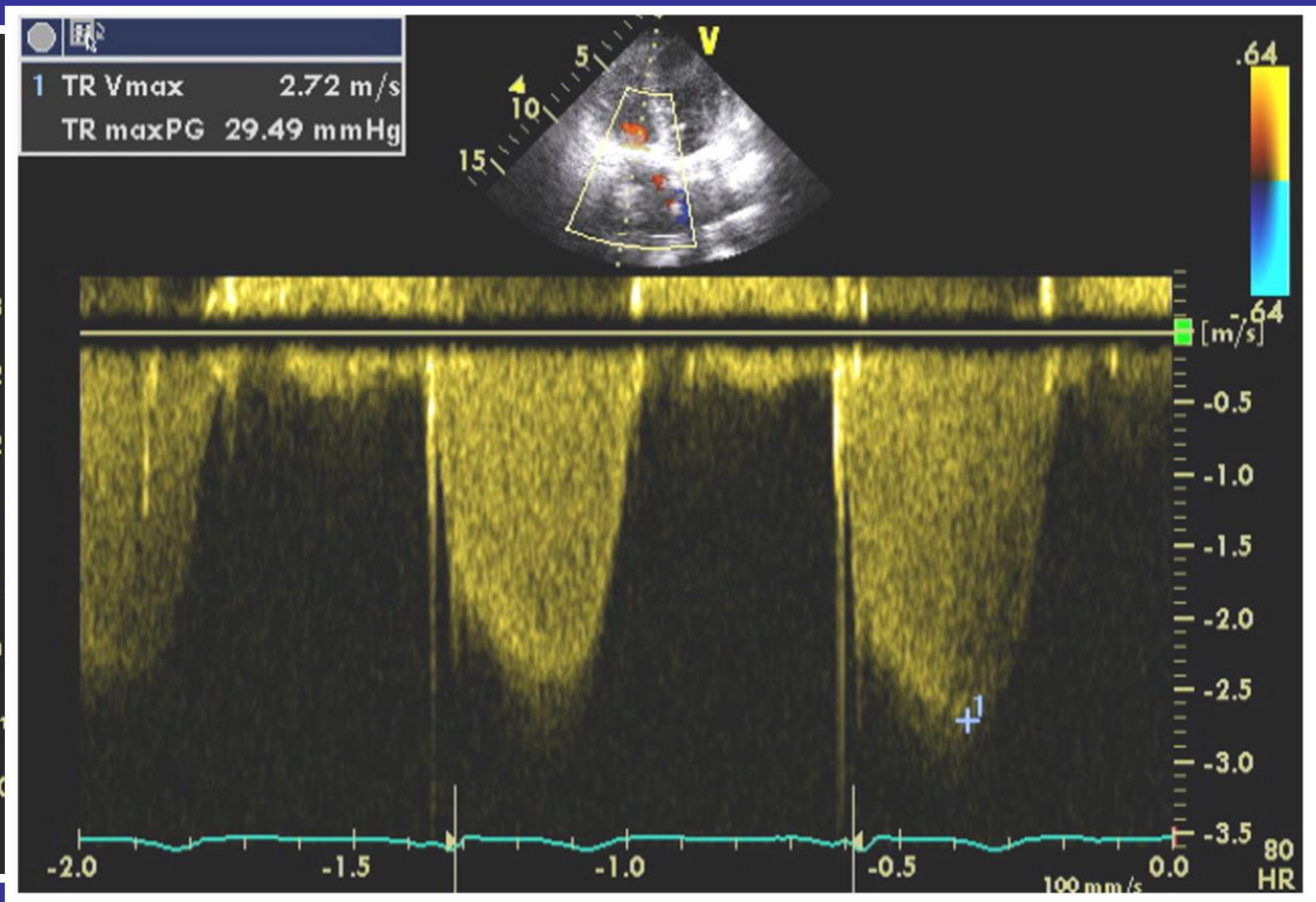
First Echo Postop





First Echo Postop

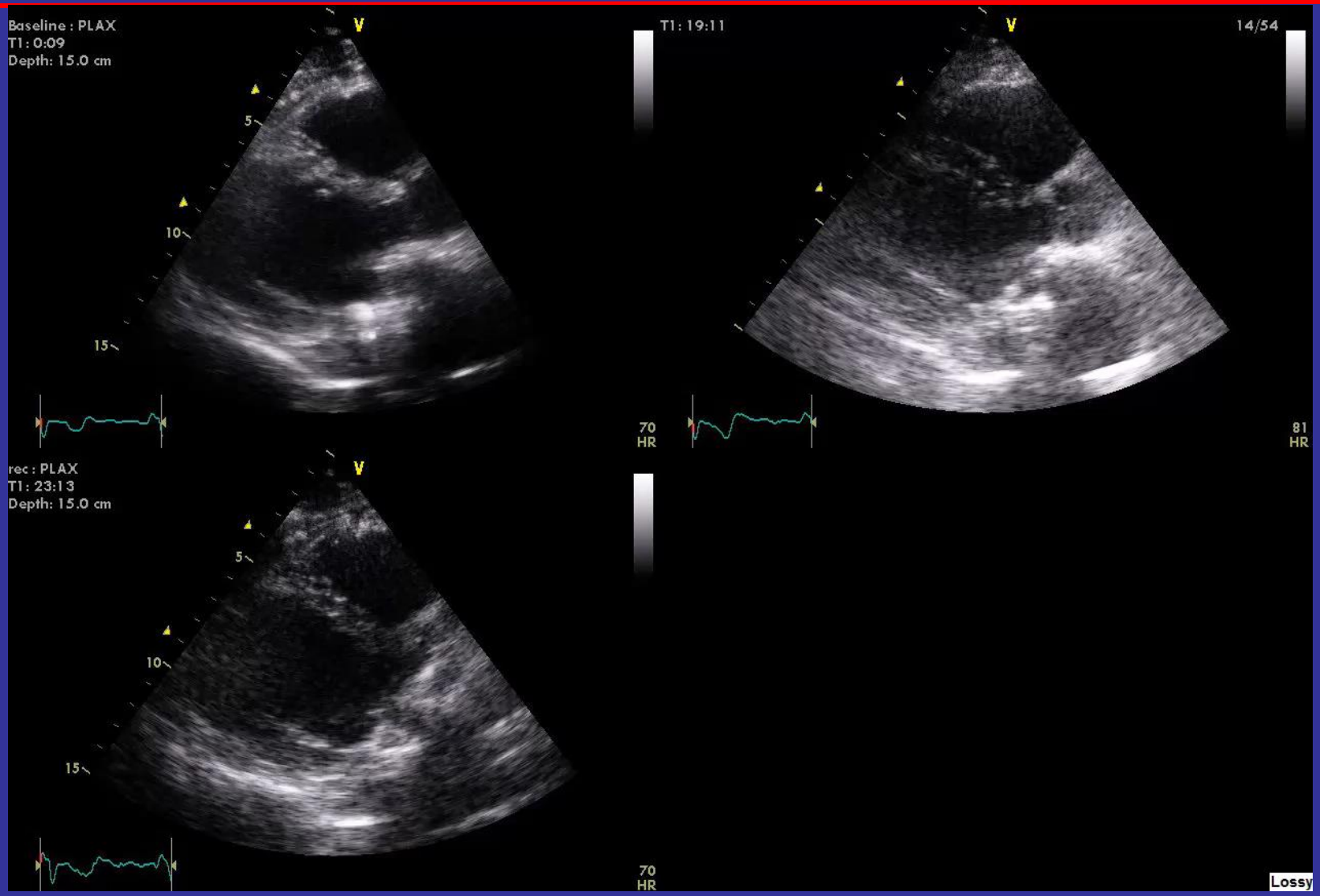




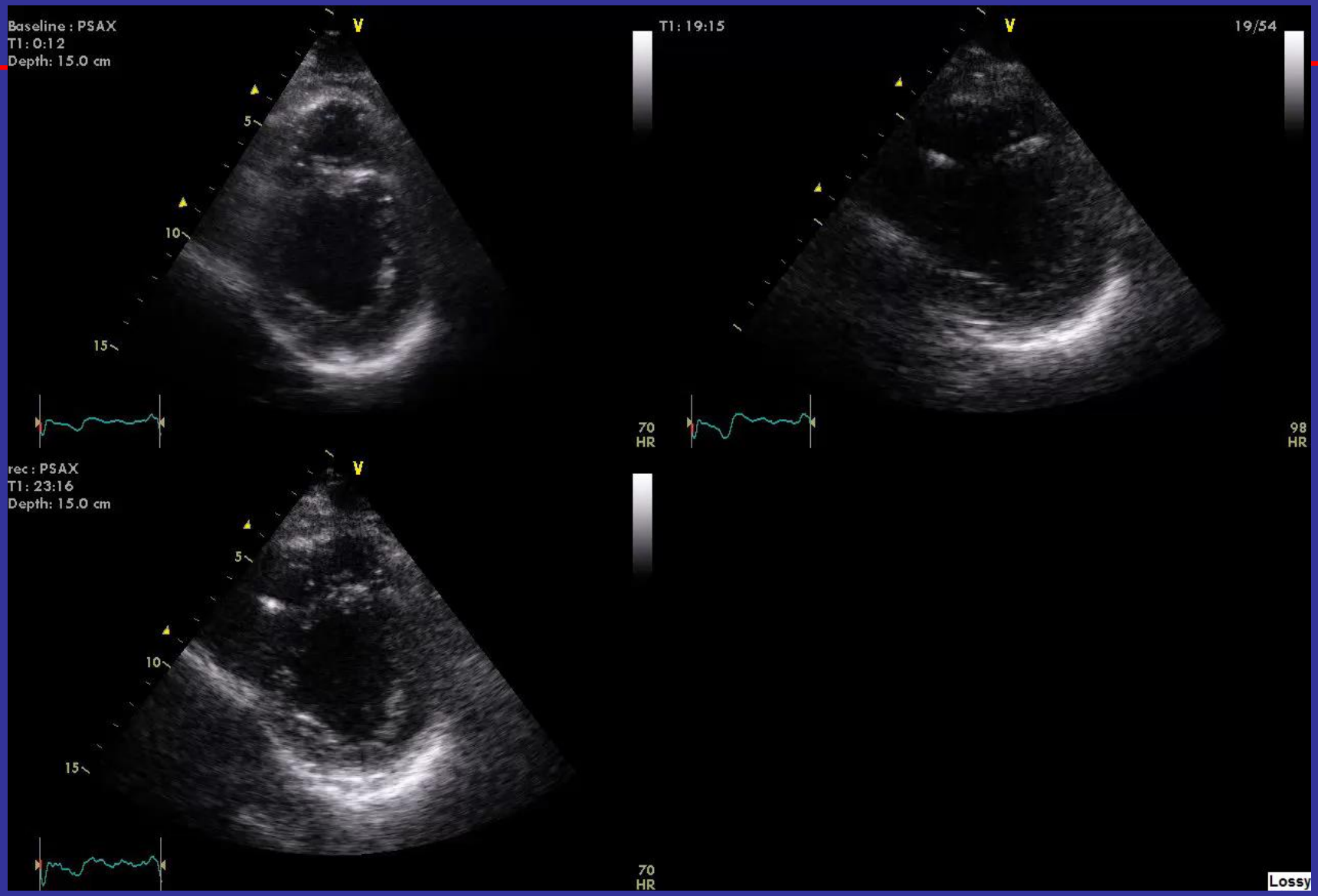
What would you do?

- Redo?
- Diuretics?

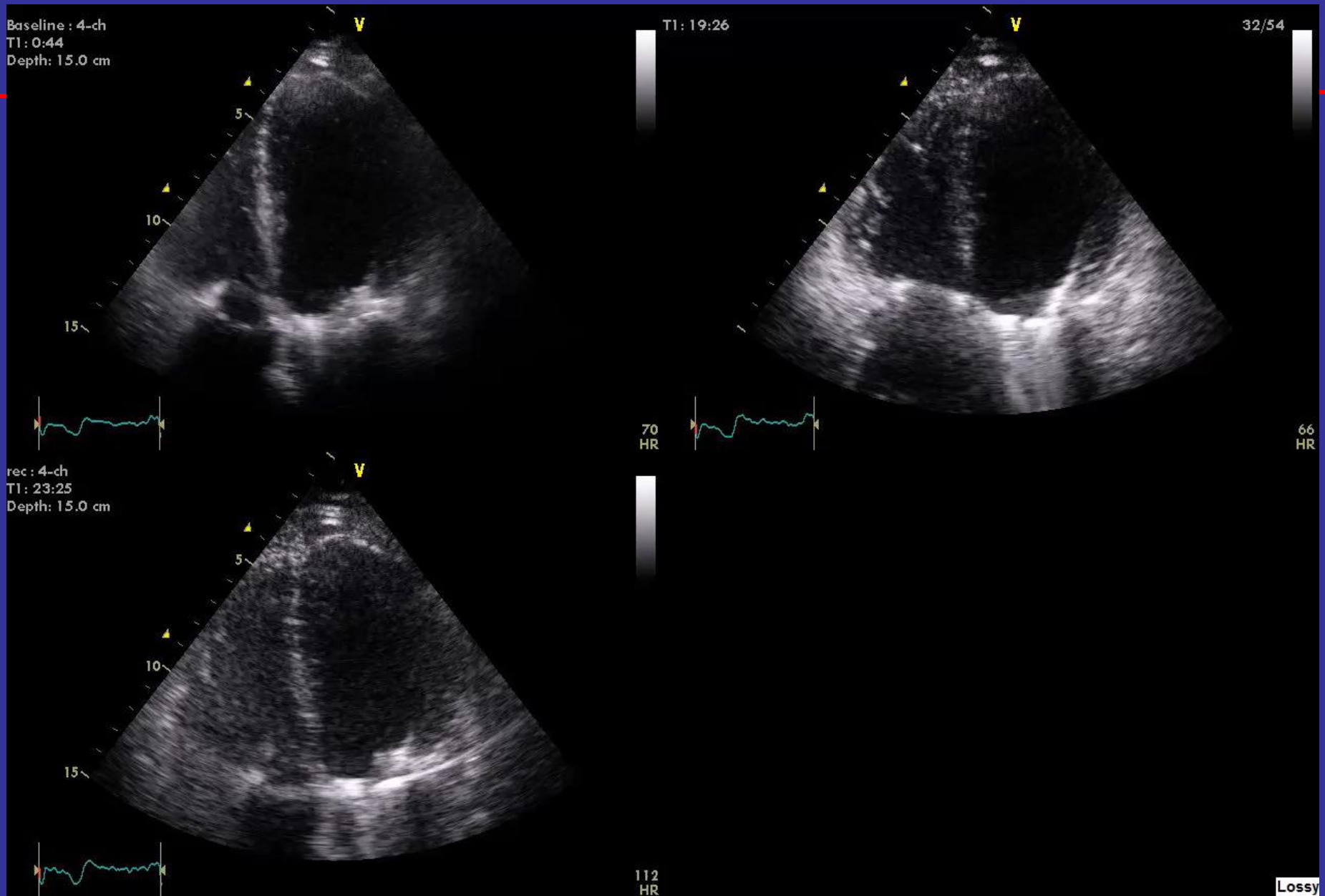
Stress Echo


Baseline : PLAX
T1 : 0:09
Depth: 15.0 cm
5
10
15
70
HR
T1 : 19:11
14/54
81
HR
rec : PLAX
T1 : 23:13
Depth: 15.0 cm
5
10
15
70
HR
Lossy

Stress Echo

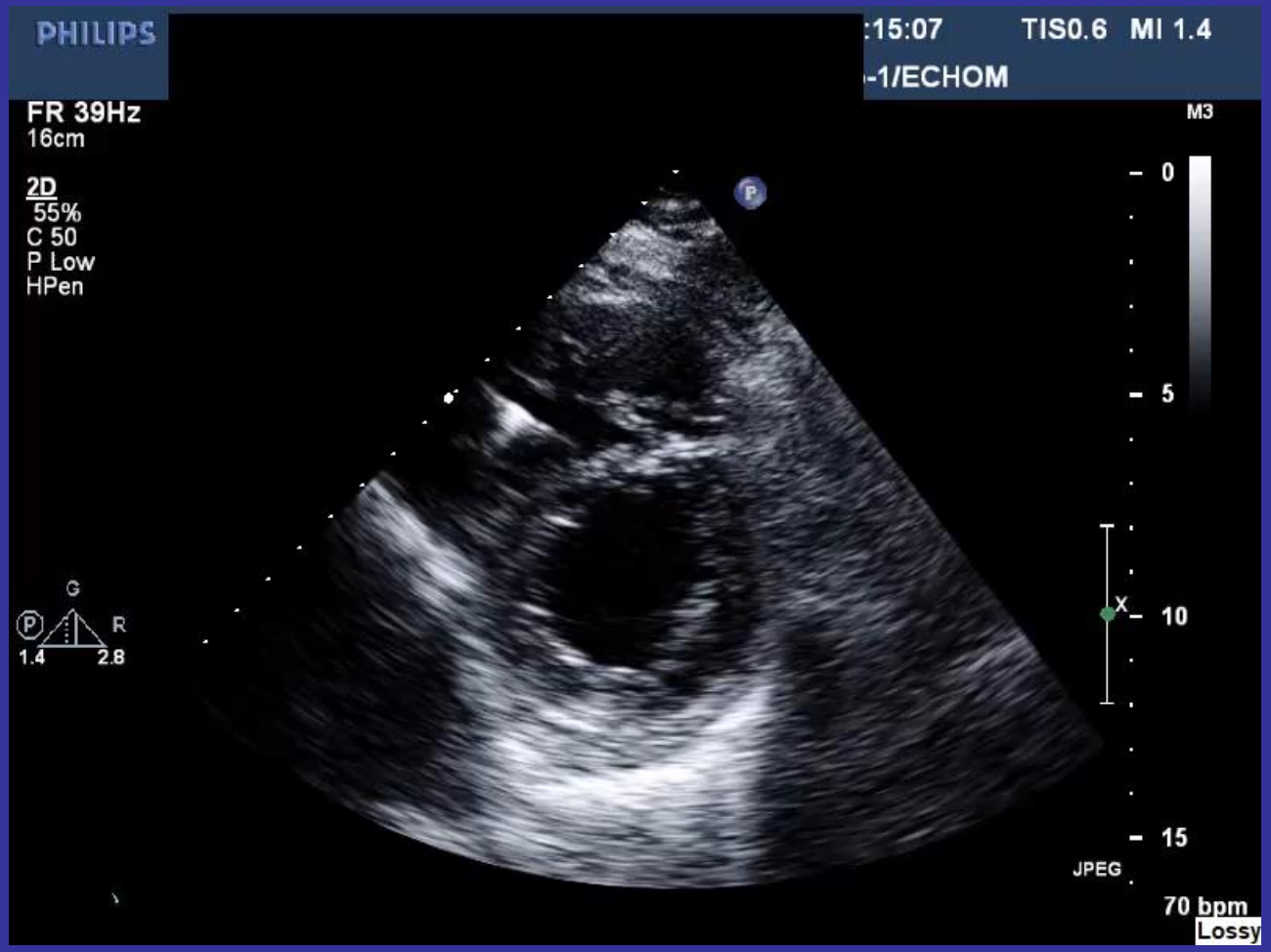

Baseline : PSAX
T1 : 0:12
Depth: 15.0 cm
5
10
15
70
HR
T1 : 19:15
19/54
98
HR
rec : PSAX
T1 : 23:16
Depth: 15.0 cm
5
10
15
70
HR
Lossy

Stress Echo

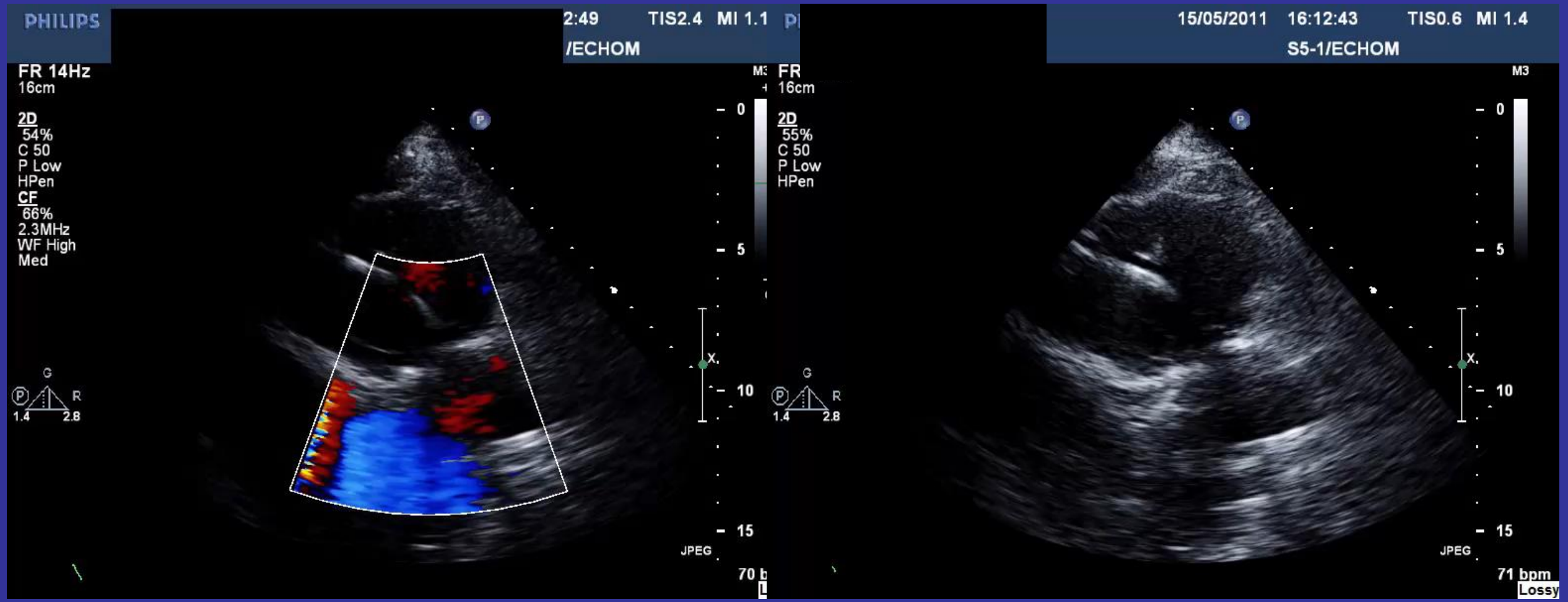

Baseline : 4-ch
T1 : 0:44
Depth: 15.0 cm
5
10
15
70
HR
T1 : 19:26
32/54
66
HR
rec : 4-ch
T1 : 23:25
Depth: 15.0 cm
112
HR
Lossy

- Conservative follow up was decided.

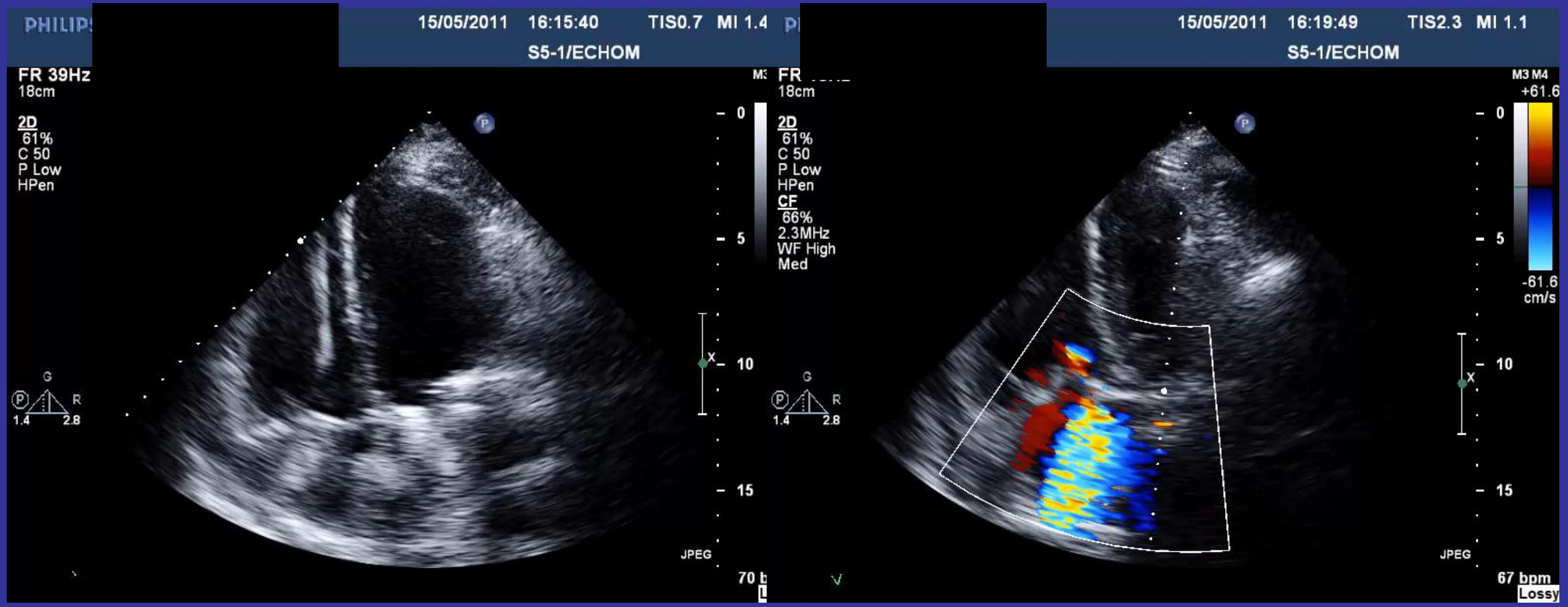
Next Echo - 2011



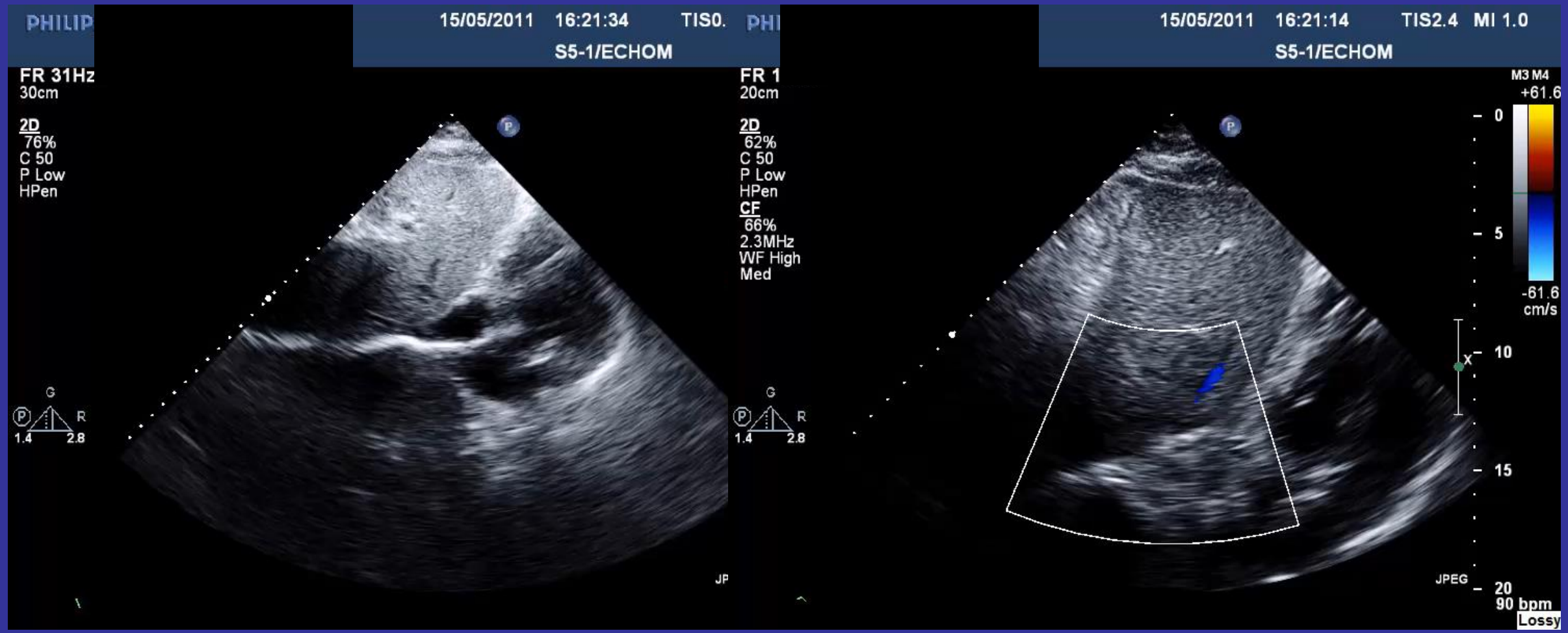
Next Echo - 2011



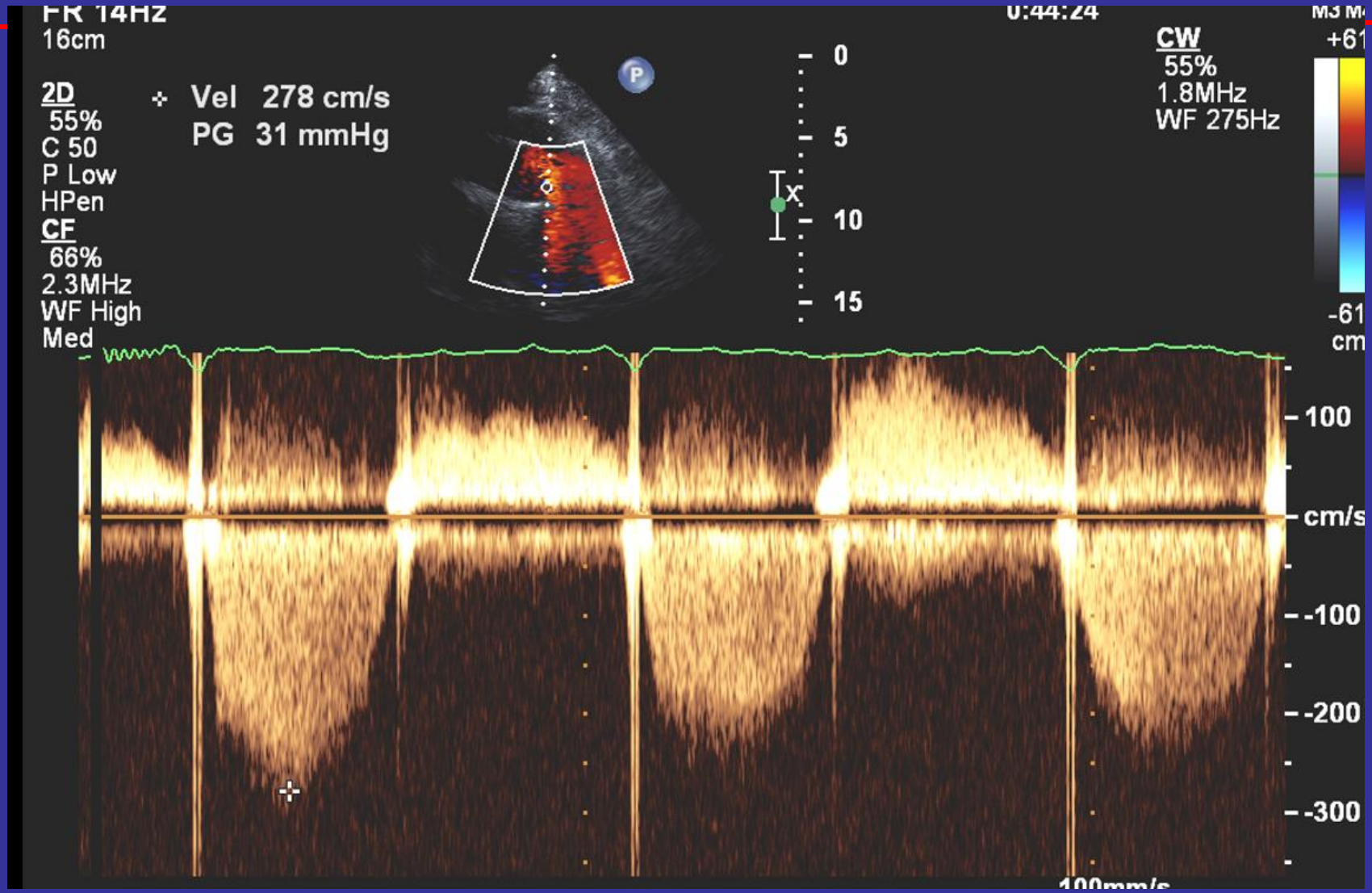
Next Echo - 2011



Next Echo - 2011



Next Echo - 2011

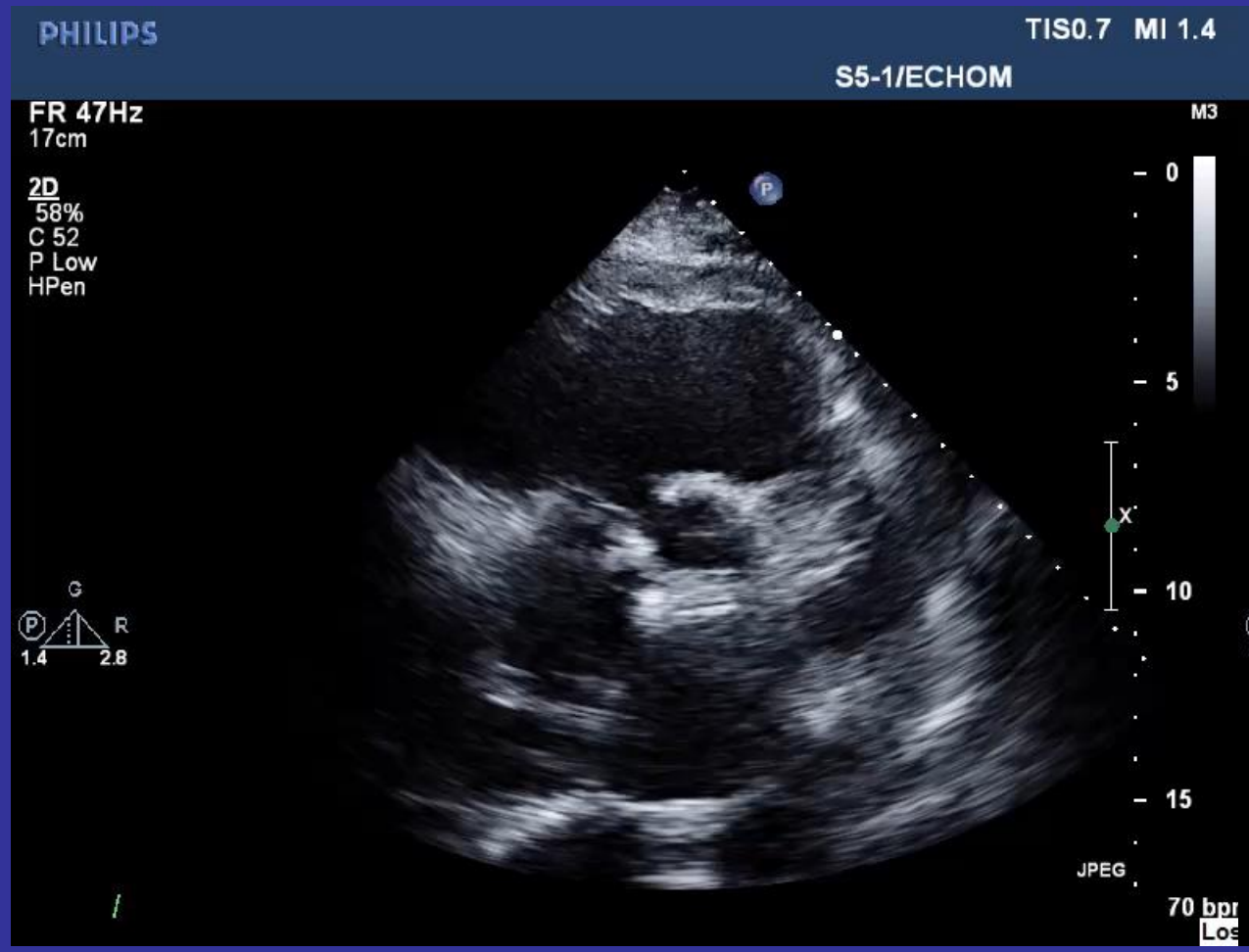


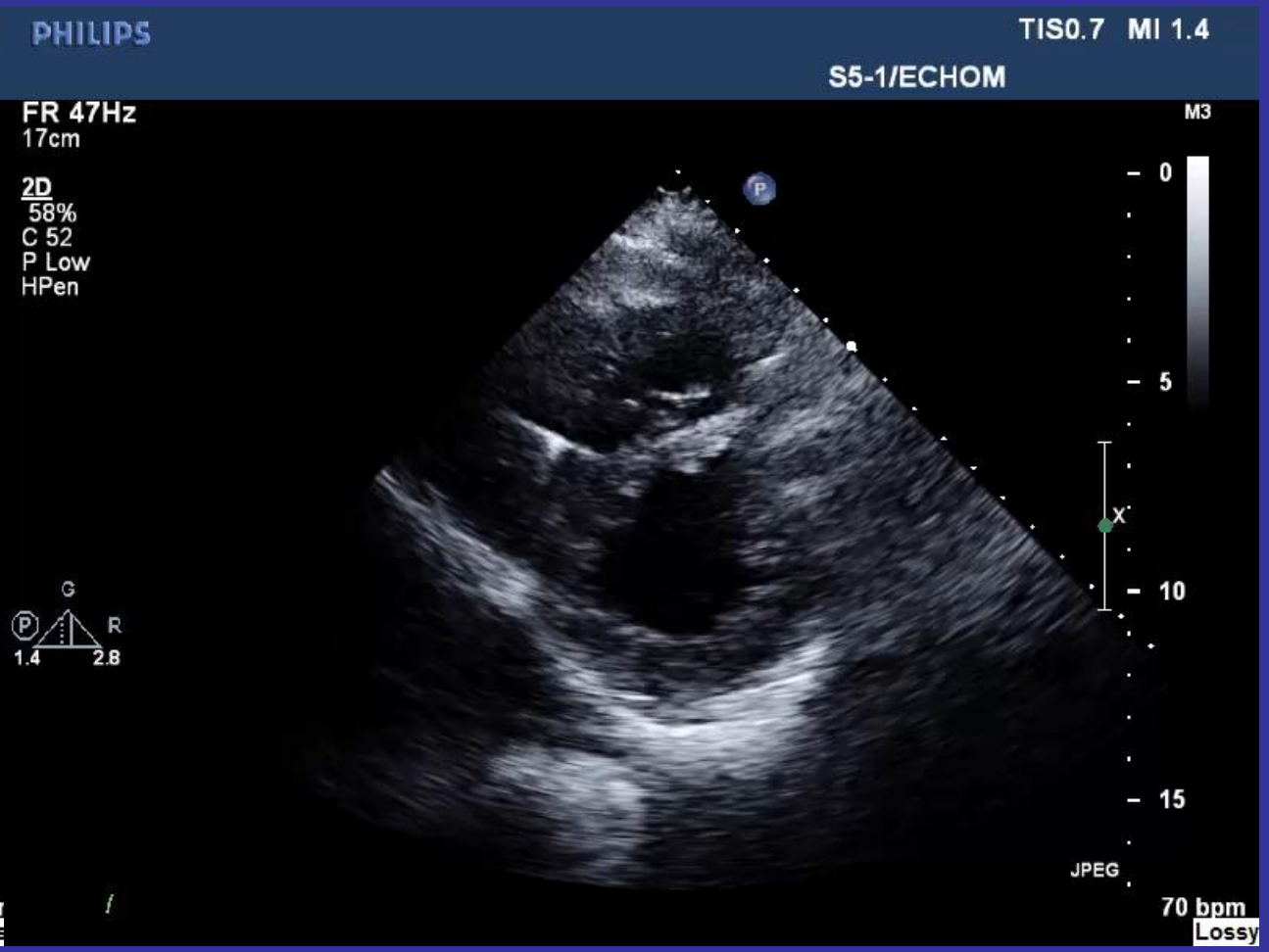
Would you offer procedure at that time?

2016

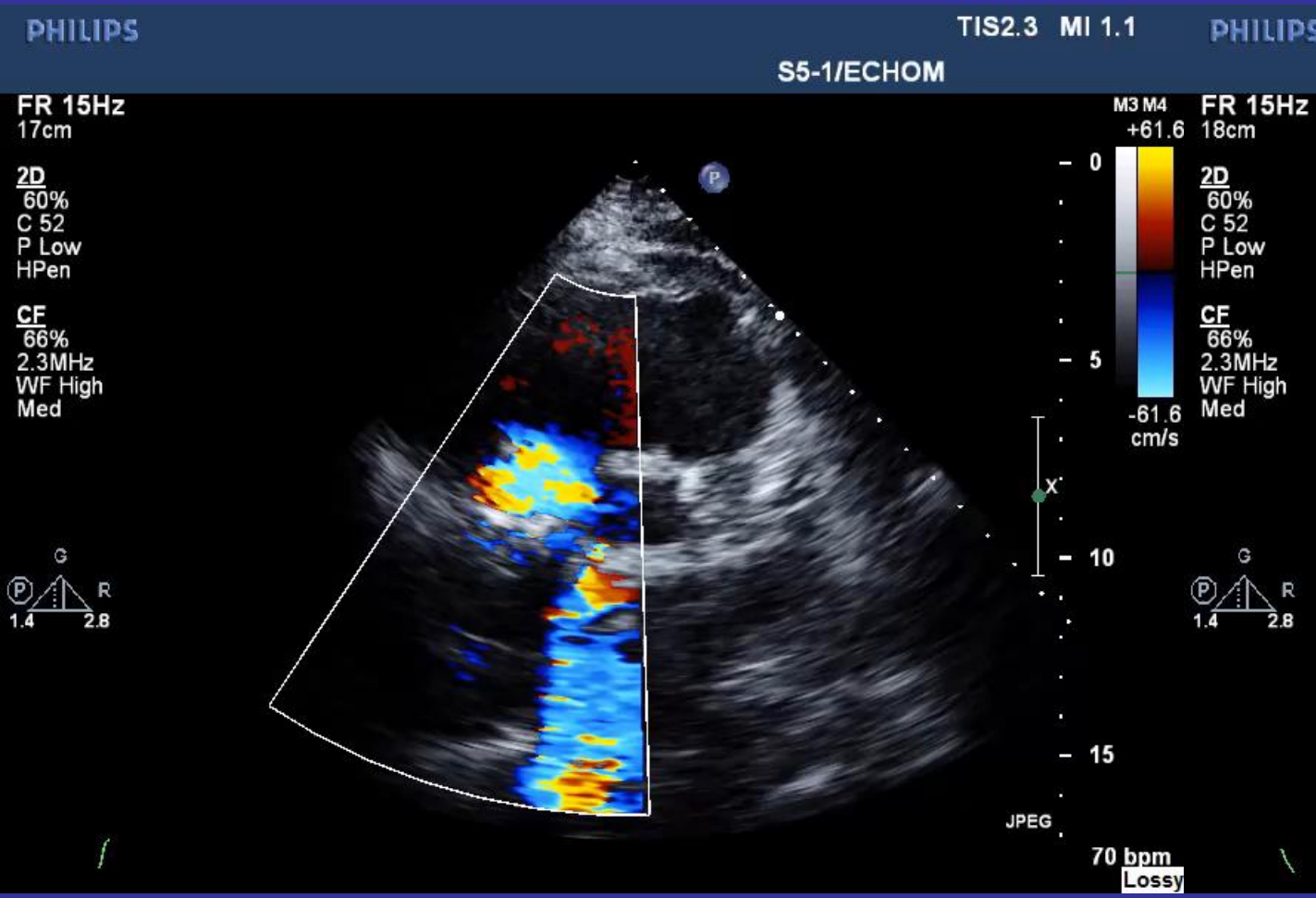
- Patient asymptomatic – mild fatigue.

2016


PHILIPS
TIS0.7 MI 1.4
S5-1/ECHOM
FR 47Hz
17cm
2D
58%
C 52
P Low
HPen
M3
0
5
10
15
G
R
1.4
2.8
JPEG
70 bpm
Lossy

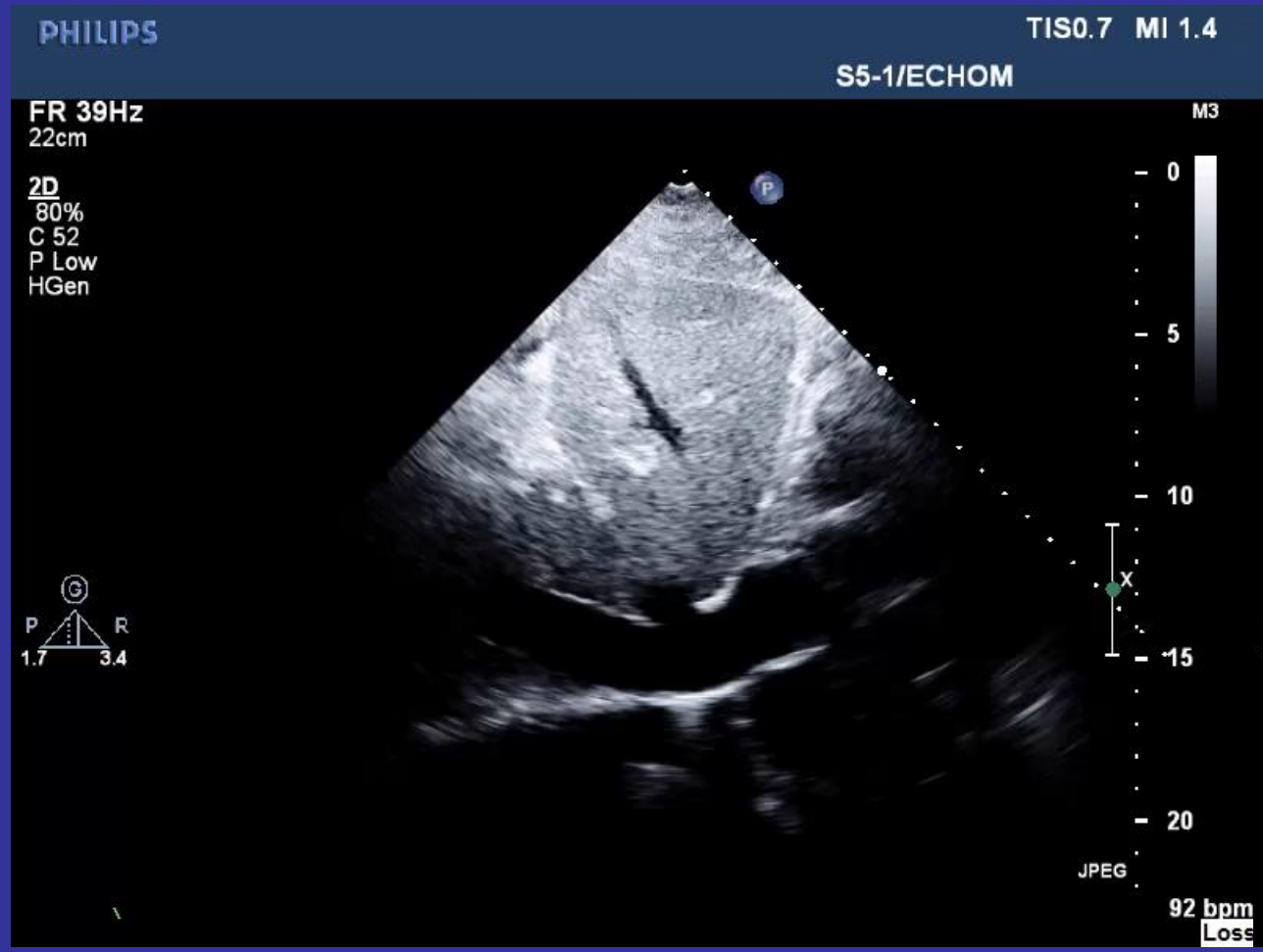

PHILIPS
TIS0.7 MI 1.4
S5-1/ECHOM
FR 47Hz
17cm
2D
58%
C 52
P Low
HPen
M3
0
5
10
15
G
R
1.4
2.8
JPEG
70 bpm
Lossy

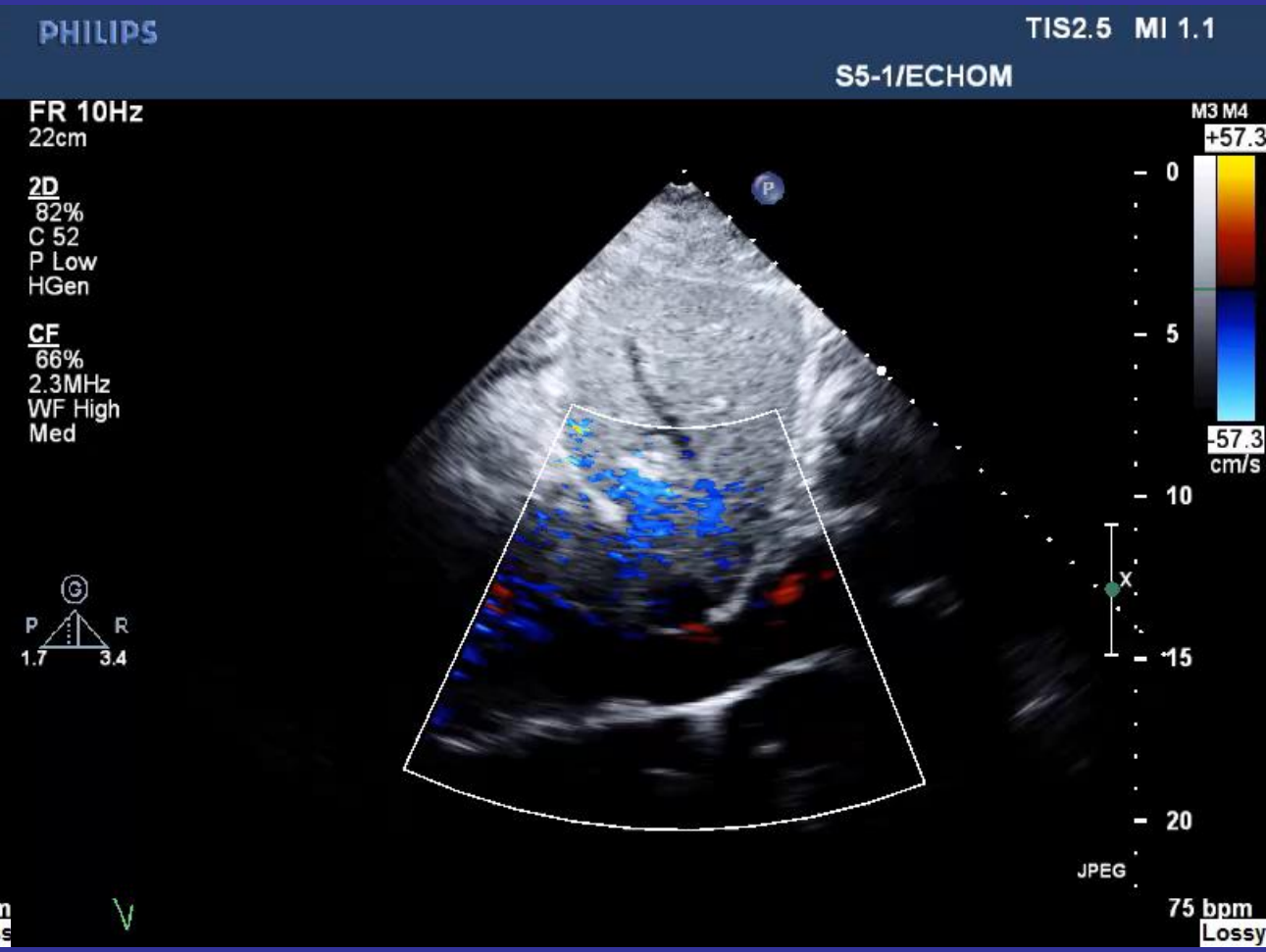
2016


PHILIPS
TIS2.3 MI 1.1
S5-1/ECHOM
FR 15Hz
17cm
2D
60%
C 52
P Low
HPen
CF
66%
2.3MHz
WF High
Med
M3 M4
+61.6
-61.6
cm/s
0
5
10
15
G
R
1.4
2.8
JPEG
70 bpm
Lossy
PHILIPS
FR 15Hz
18cm
2D
60%
C 52
P Low
HPen
CF
66%
2.3MHz
WF High
Med
G
R
1.4
2.8

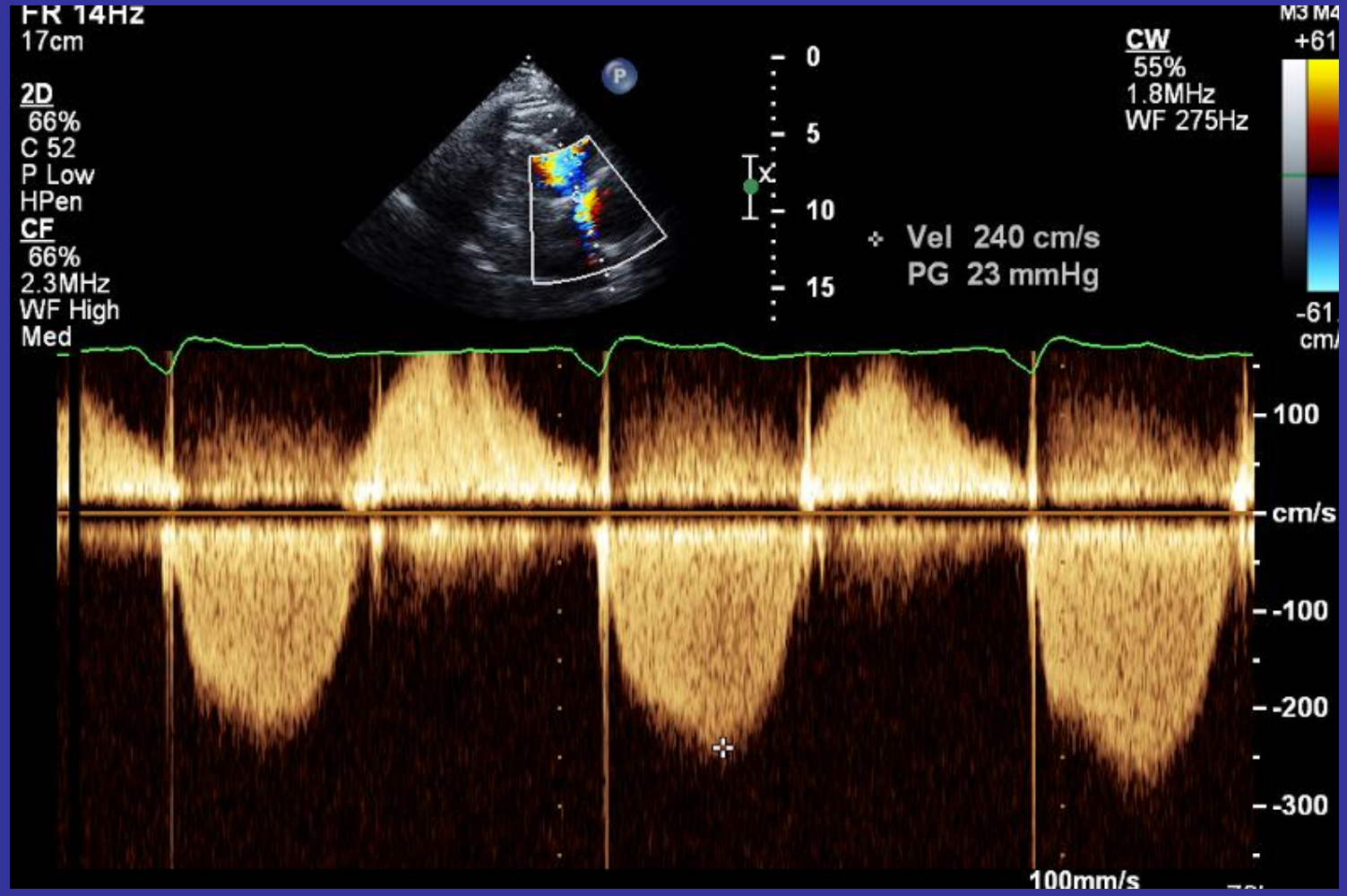

PHILIPS
TIS2.4 MI 1.1
S5-1/ECHOM
M3 M4
+66.4
-66.4
cm/s
0
5
10
15
JPEG
70 bpm
Lossy

2016


PHILIPS
TIS0.7 MI 1.4
S5-1/ECHOM
FR 39Hz
22cm
2D
80%
C 52
P Low
HGen
M3
0
5
10
15
20
JPEG
92 bpm
Loss
P
R
1.7
3.4

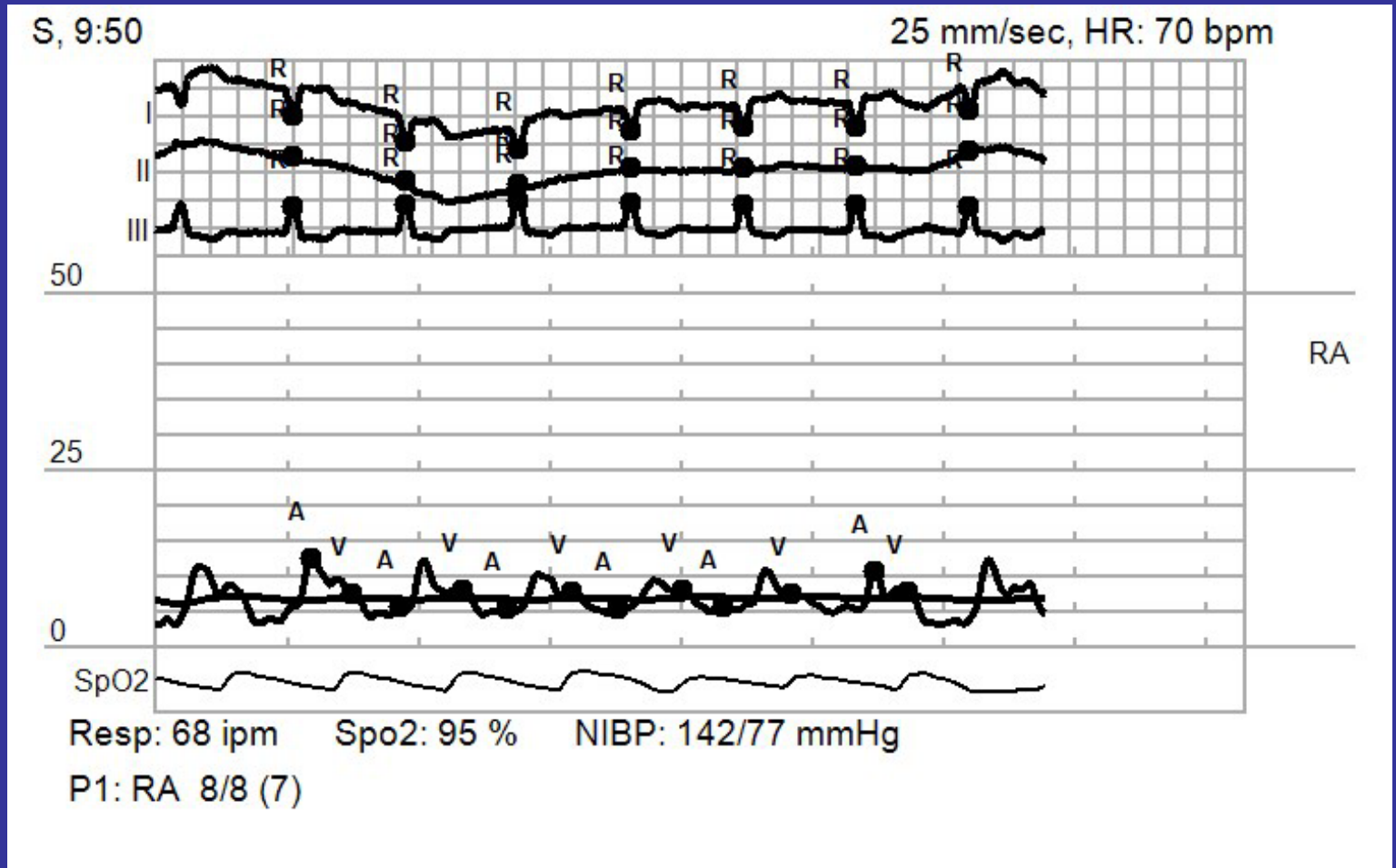

PHILIPS
TIS2.5 MI 1.1
S5-1/ECHOM
FR 10Hz
22cm
2D
82%
C 52
P Low
HGen
CF
66%
2.3MHz
WF High
Med
M3 M4
+57.3
-57.3
cm/s
0
5
10
15
20
JPEG
75 bpm
Lossy
P
R
1.7
3.4

2016


FR 14Hz
17cm
2D
66%
C 52
P Low
HPen
CF
66%
2.3MHz
WF High
Med
CW
55%
1.8MHz
WF 275Hz
0
5
10
15
Vel 240 cm/s
PG 23 mmHg
+61
-61
cm/
100
cm/s
-100
-200
-300
100mm/s

Rt Heart Catheterization

- No significant V wave in RA tracing – not consistent with significant TR



לחצים

מיקום	לחץ
PCW	(20) 14/35
PA	(27) 41/13
RV	4, 37/1
RA	(7) 8/8
AO	(106) 117/91

Cardiac Output

שיטה	(CO (l/min	(CI (l/min/m2	(SV (ml
Fick	3.31	1.9	47.42

Shunts

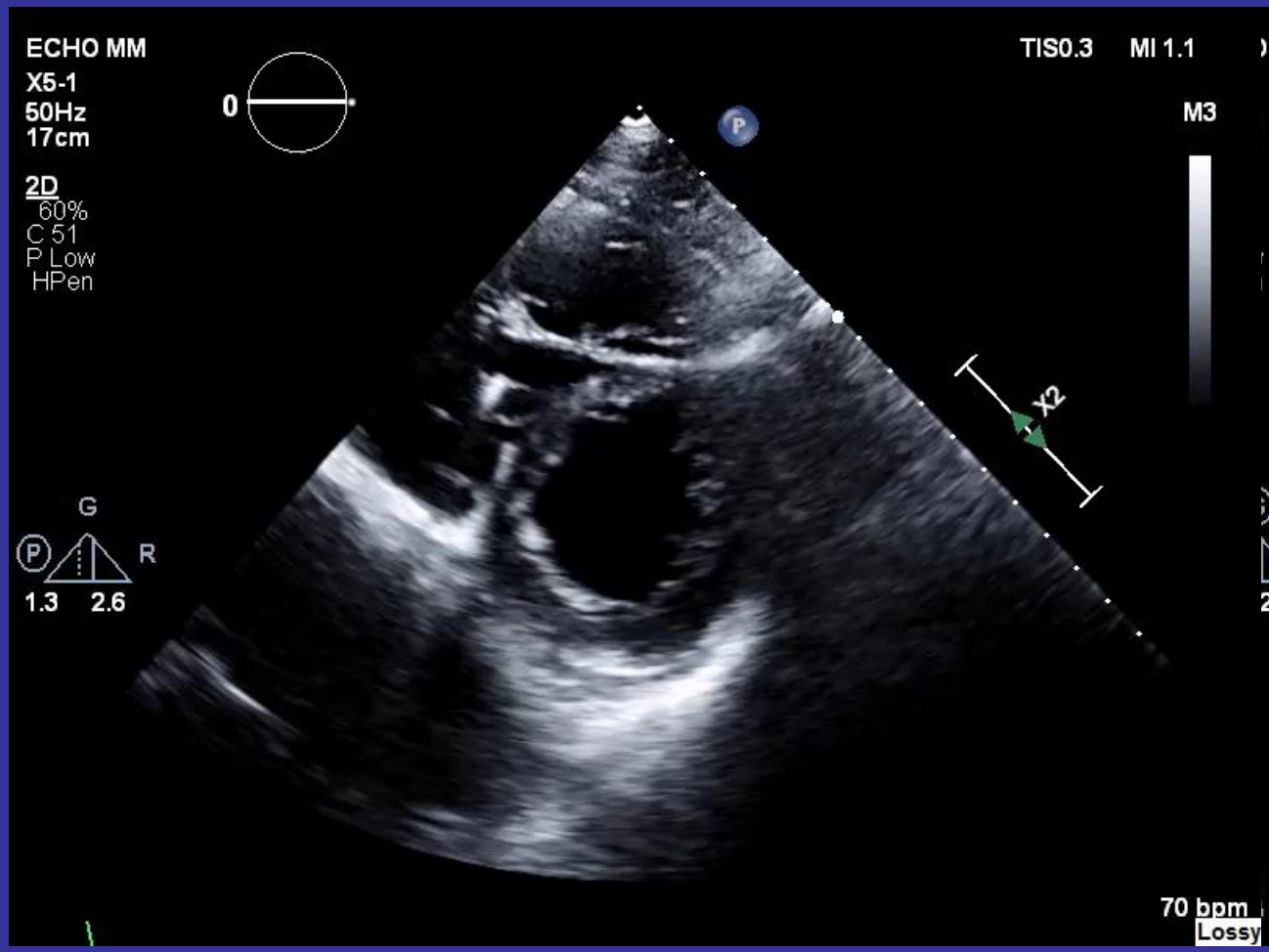
Oxygen Values			
O2 Capacity	163.2	O2 Consumption	167.61
(Flows (l/min			
Qs	3.31		

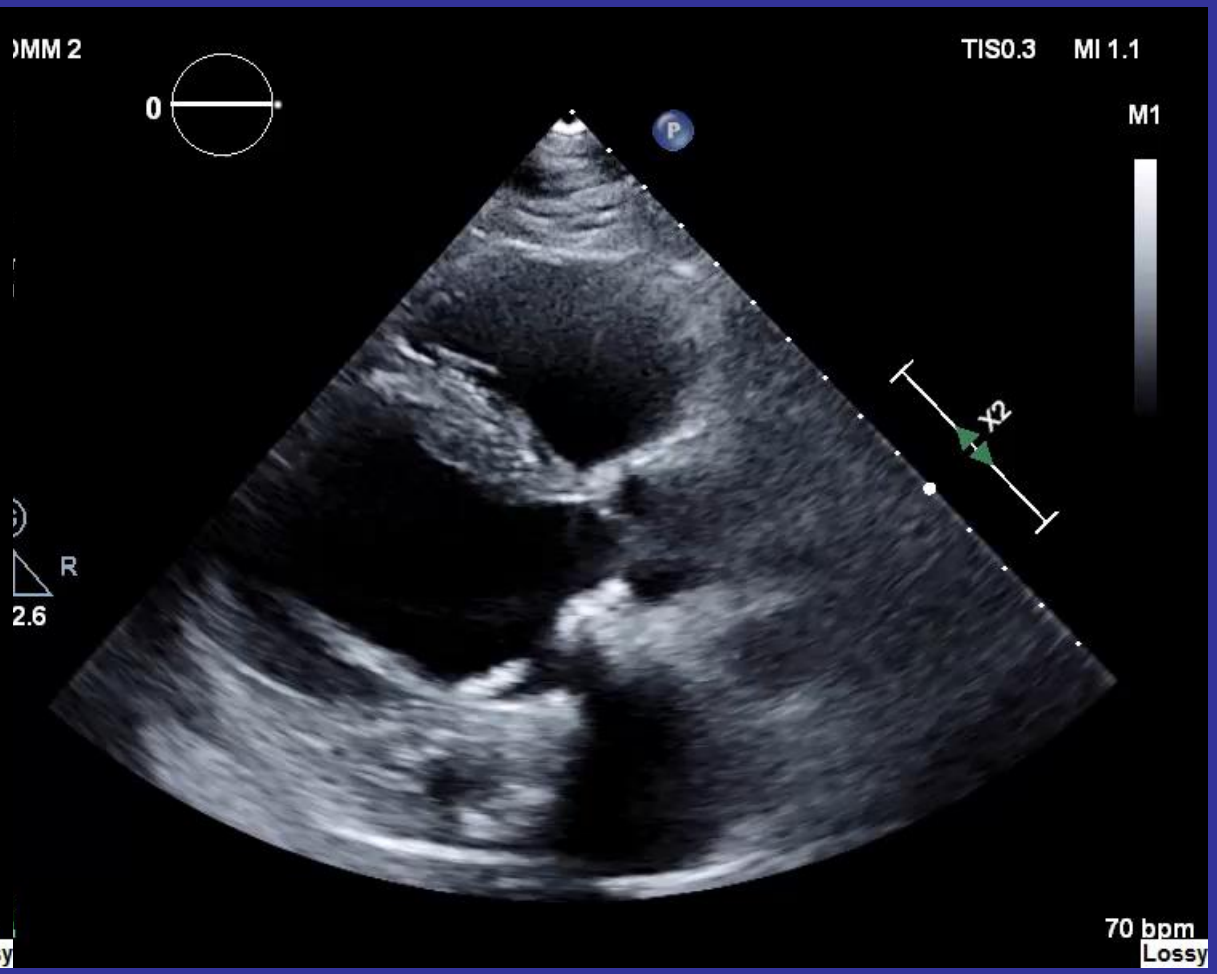
Vascular Resistance

CO method	TSVR	SVR	TPVR	PVR	TPVR/TSVR	PVR/SVR
Fick	31.94	29.84	8.01	2.07	0.25	0.07
Qp/Qs	31.94	29.84				

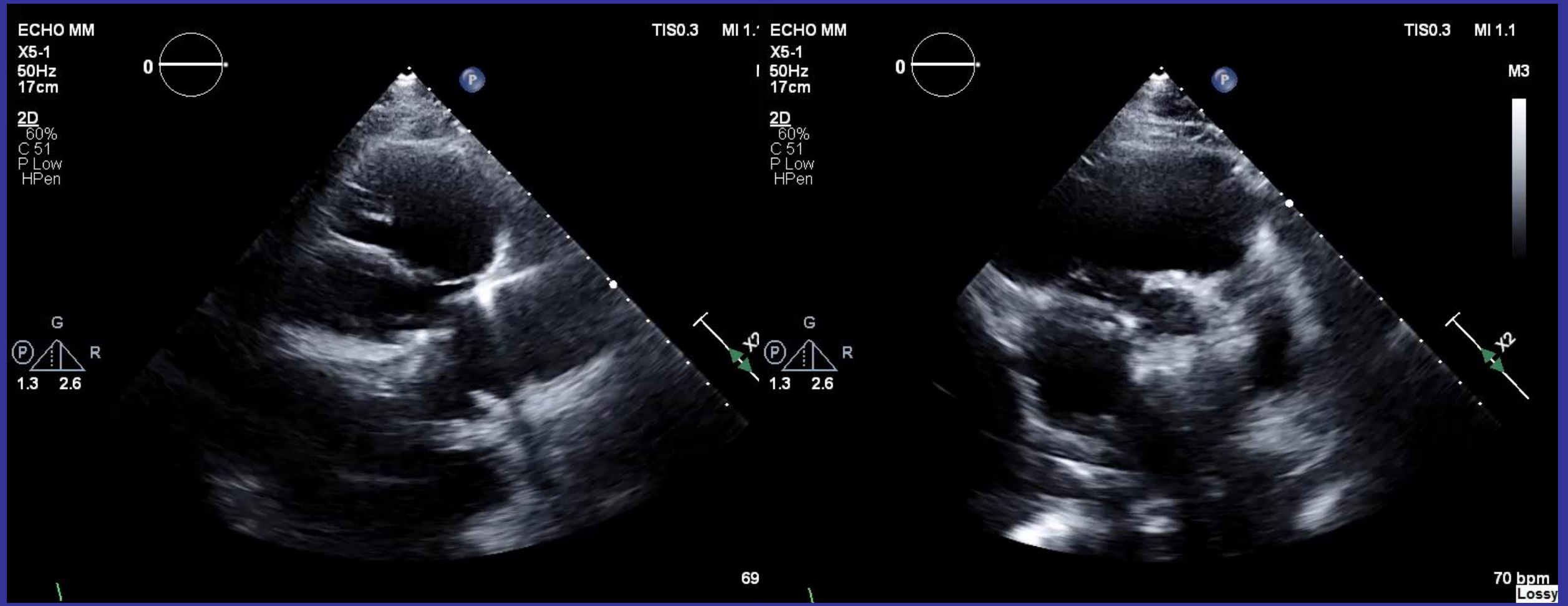
- Decision: wait and watch

2019

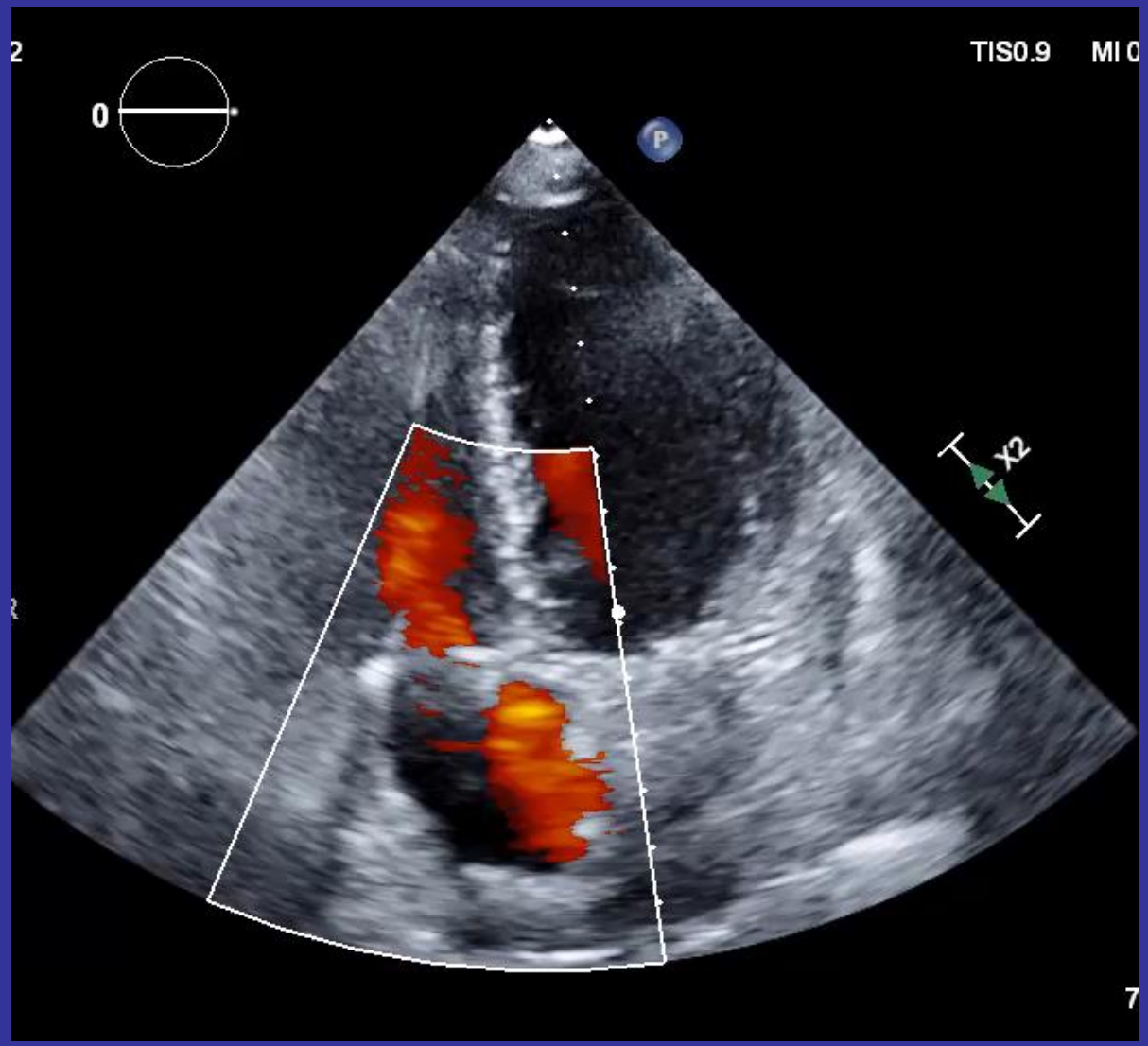

ECHO MM
X5-1
50Hz
17cm
2D
60%
C 51
P Low
HPen
TIS0.3 MI 1.1
M3
X2
G
P
R
1.3 2.6
70 bpm
Lossy

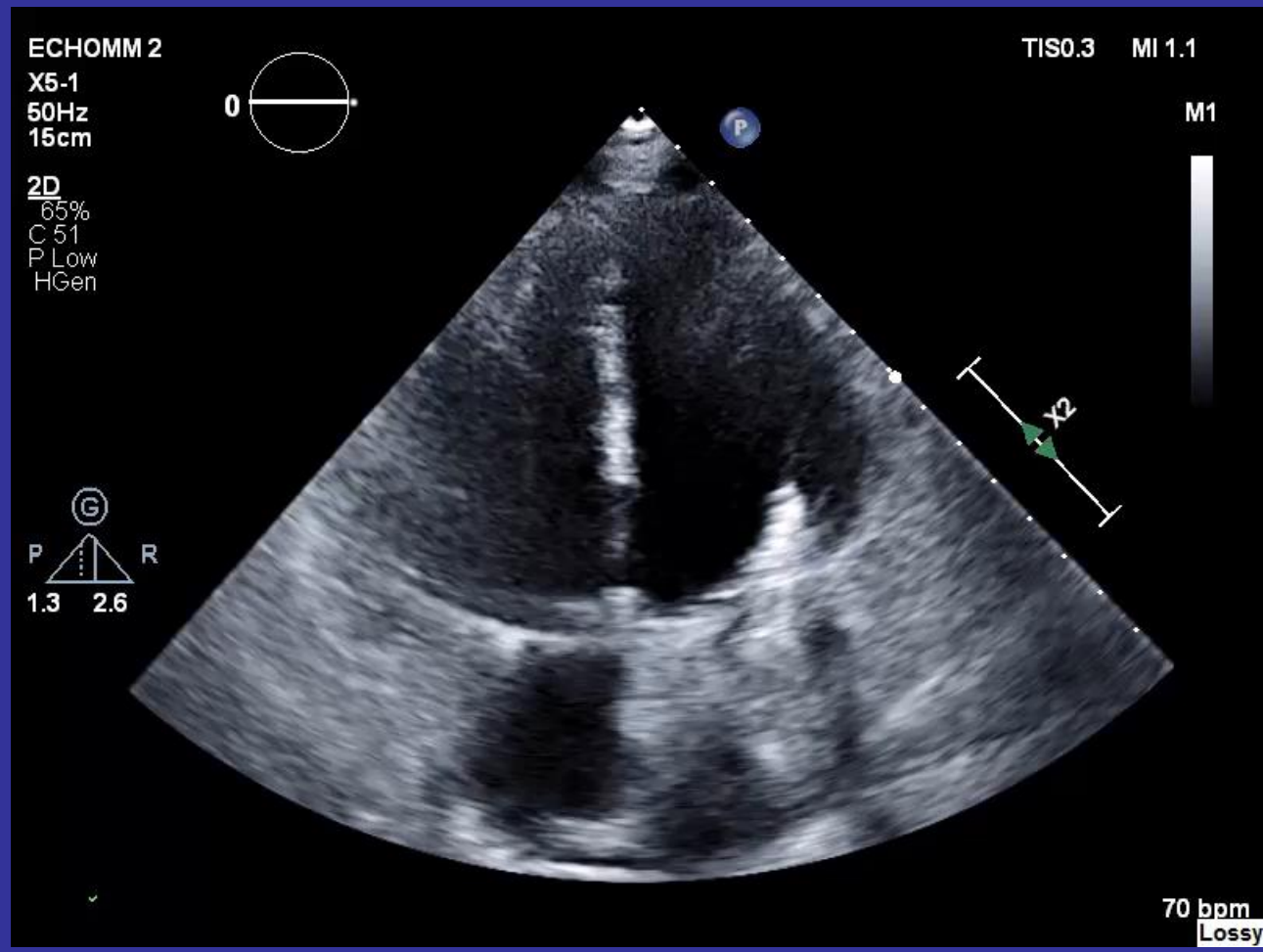

TIS0.3 MI 1.1
M1
X2
R
2.6
70 bpm
Lossy

2019

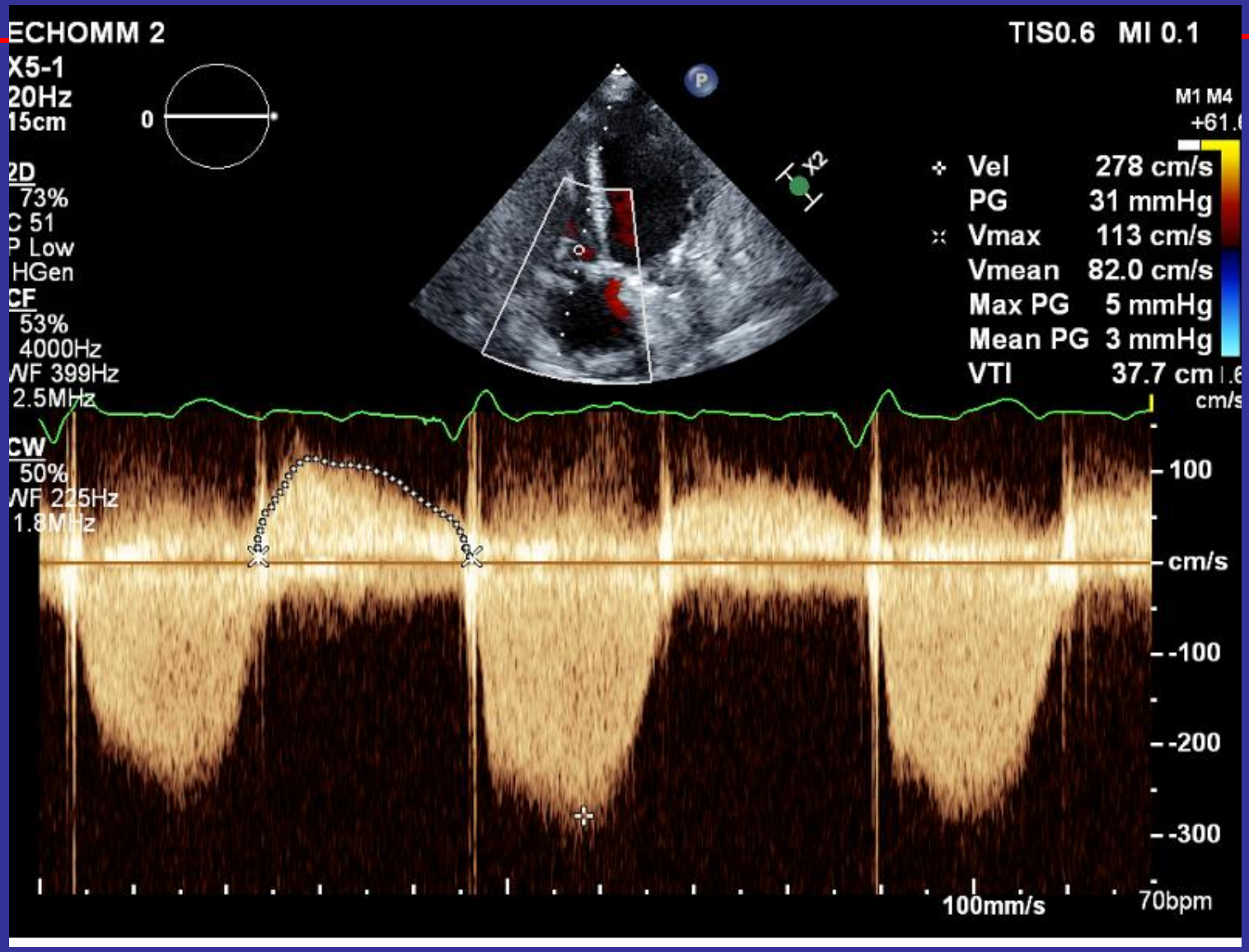

ECHO MM
X5-1
50Hz
17cm
2D
60%
C 51
P Low
HPen
TIS0.3
MI 1.
G
R
1.3
2.6
69
ECHO MM
X5-1
50Hz
17cm
2D
60%
C 51
P Low
HPen
TIS0.3
MI 1.1
M3
70 bpm
Lossy

2019

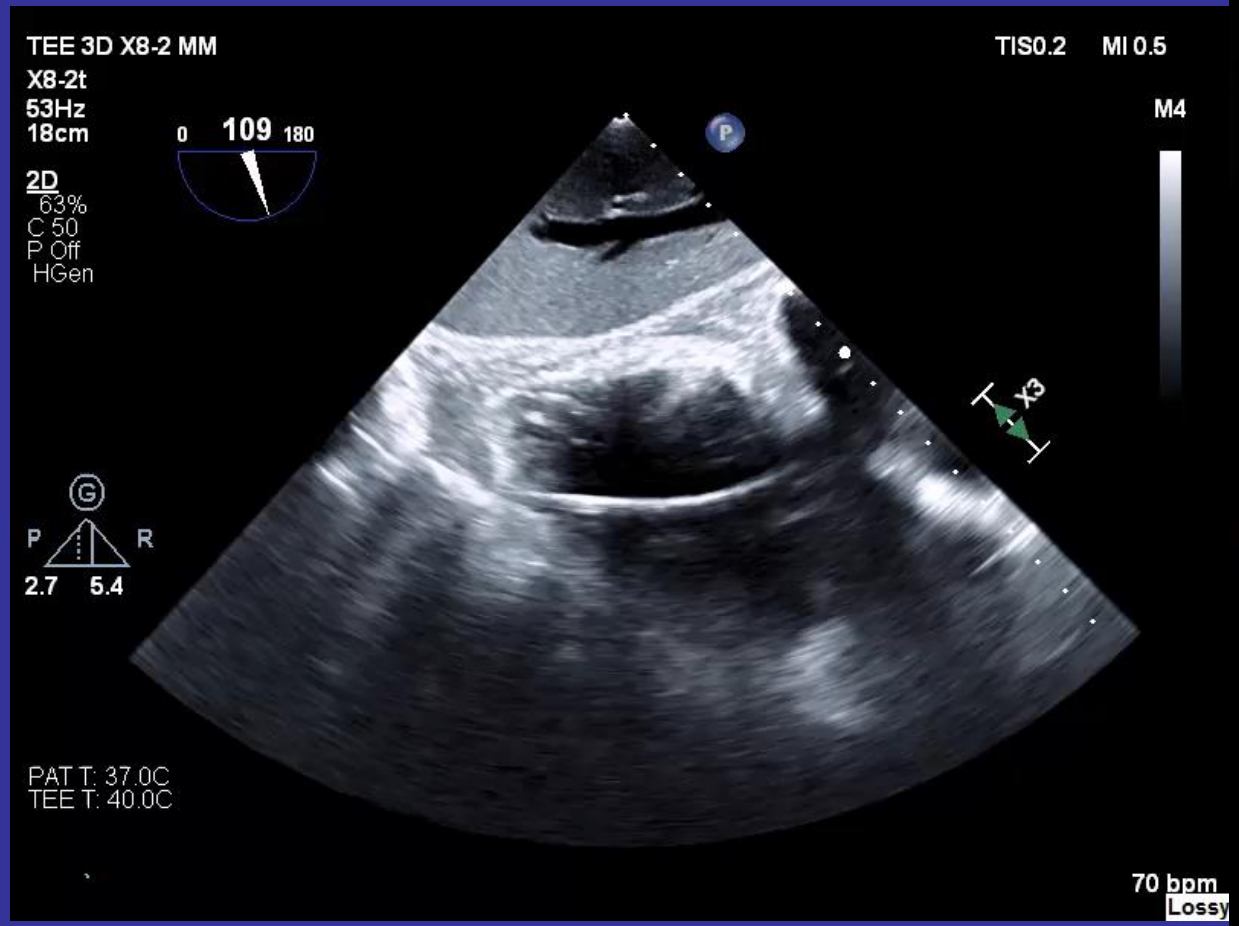

TIS0.9
MI 0
X2

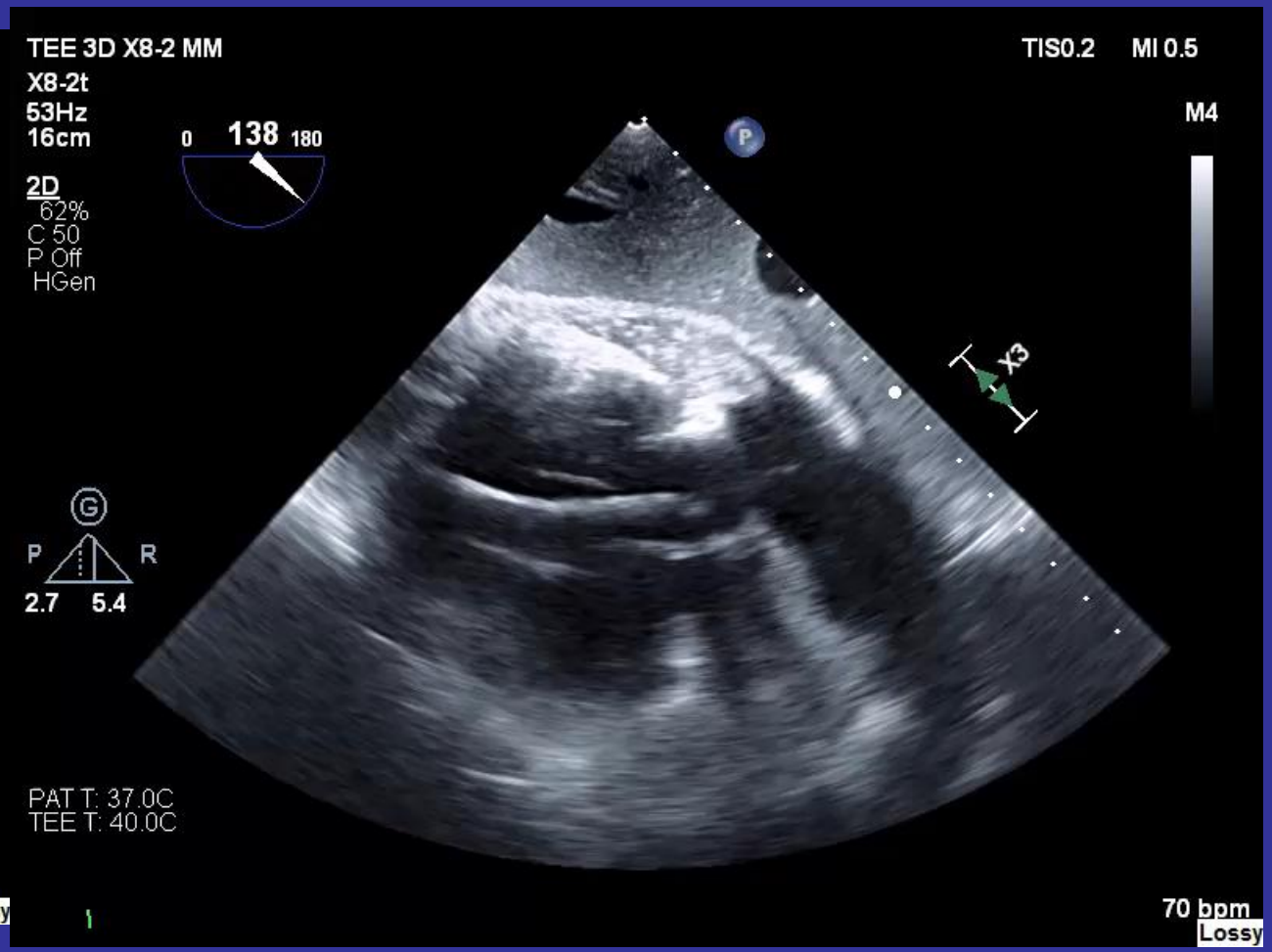

ECHOMM 2
X5-1
50Hz
15cm
2D
65%
C 51
P Low
HGen
TIS0.3
MI 1.1
M1
X2
P
R
1.3
2.6
70 bpm
Lossy

2019

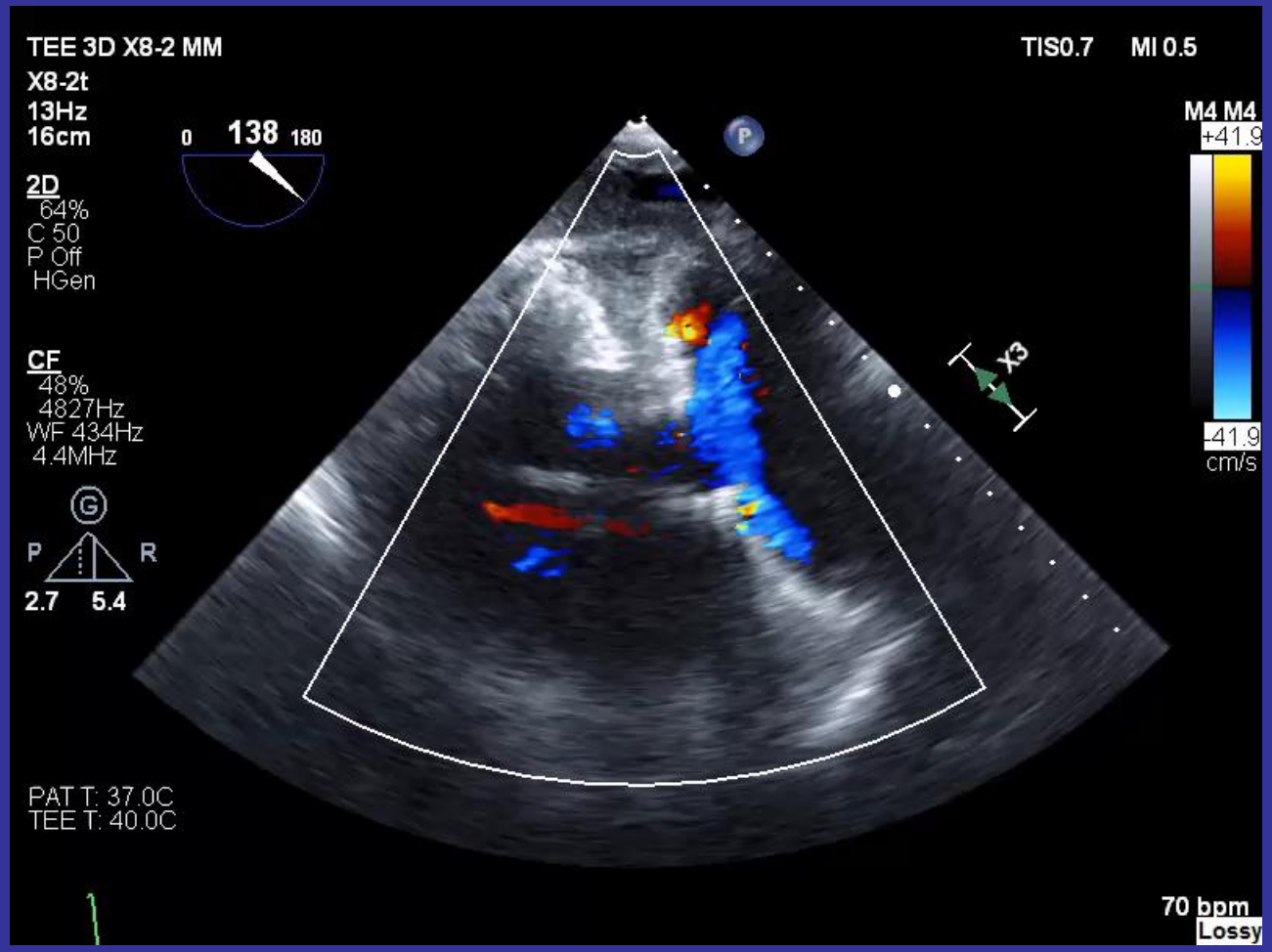

ECHOMM 2
X5-1
20Hz
15cm
TIS0.6 MI 0.1
M1 M4
Vel 278 cm/s
PG 31 mmHg
Vmax 113 cm/s
Vmean 82.0 cm/s
Max PG 5 mmHg
Mean PG 3 mmHg
VTI 37.7 cm
100
cm/s
-100
-200
-300
100mm/s
70bpm

TEE 2019


TEE 3D X8-2 MM
X8-2t
53Hz
18cm
2D
63%
C 50
P Off
HGen
0 109 180
TIS0.2 MI 0.5
M4
X3
P R
2.7 5.4
PAT T: 37.0C
TEE T: 40.0C
70 bpm
Lossy


TEE 3D X8-2 MM
X8-2t
53Hz
16cm
2D
62%
C 50
P Off
HGen
0 138 180
TIS0.2 MI 0.5
M4
X3
P R
2.7 5.4
PAT T: 37.0C
TEE T: 40.0C
70 bpm
Lossy

TEE

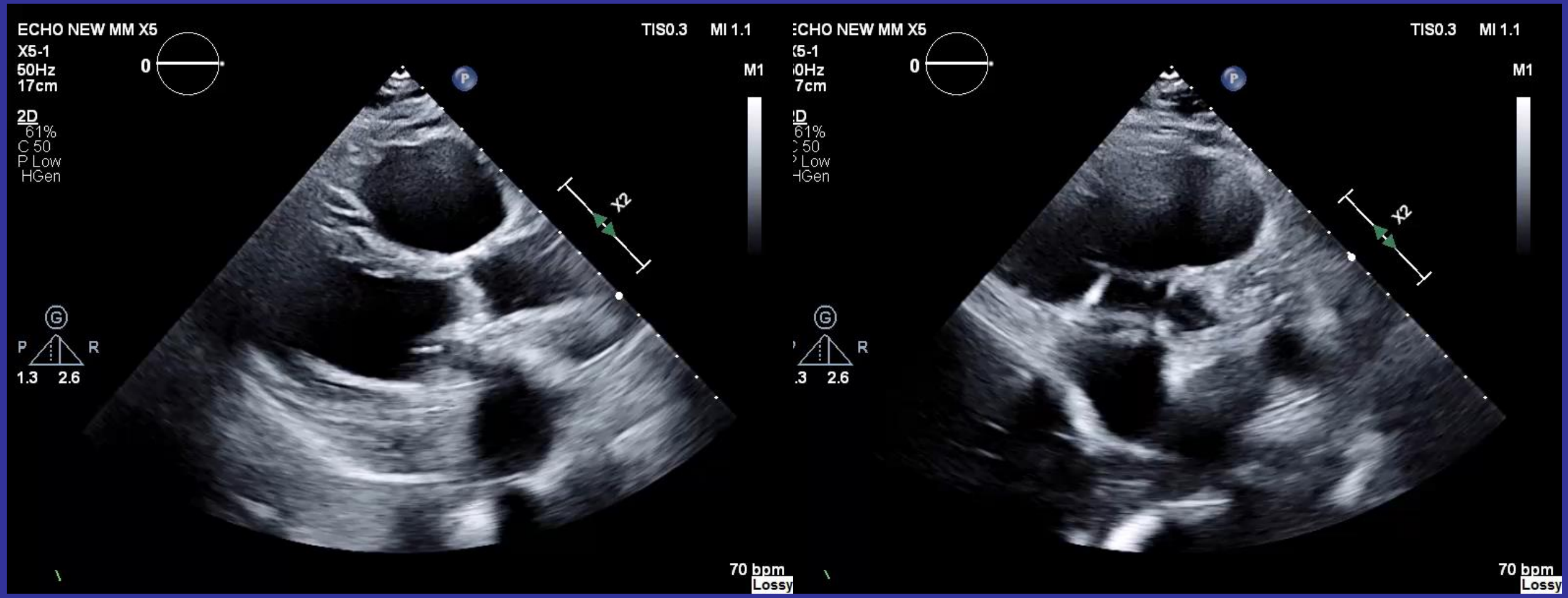

TEE 3D X8-2 MM
X8-2t
13Hz
16cm
0 138 180
2D
64%
C 50
P Off
HGen
CF
48%
4827Hz
WF 434Hz
4.4MHz
P R
2.7 5.4
TIS0.7 MI 0.5
M4 M4
+41.9
-41.9
cm/s
X3
PAT T: 37.0C
TEE T: 40.0C
70 bpm
Lossy

2019 - What would you do?

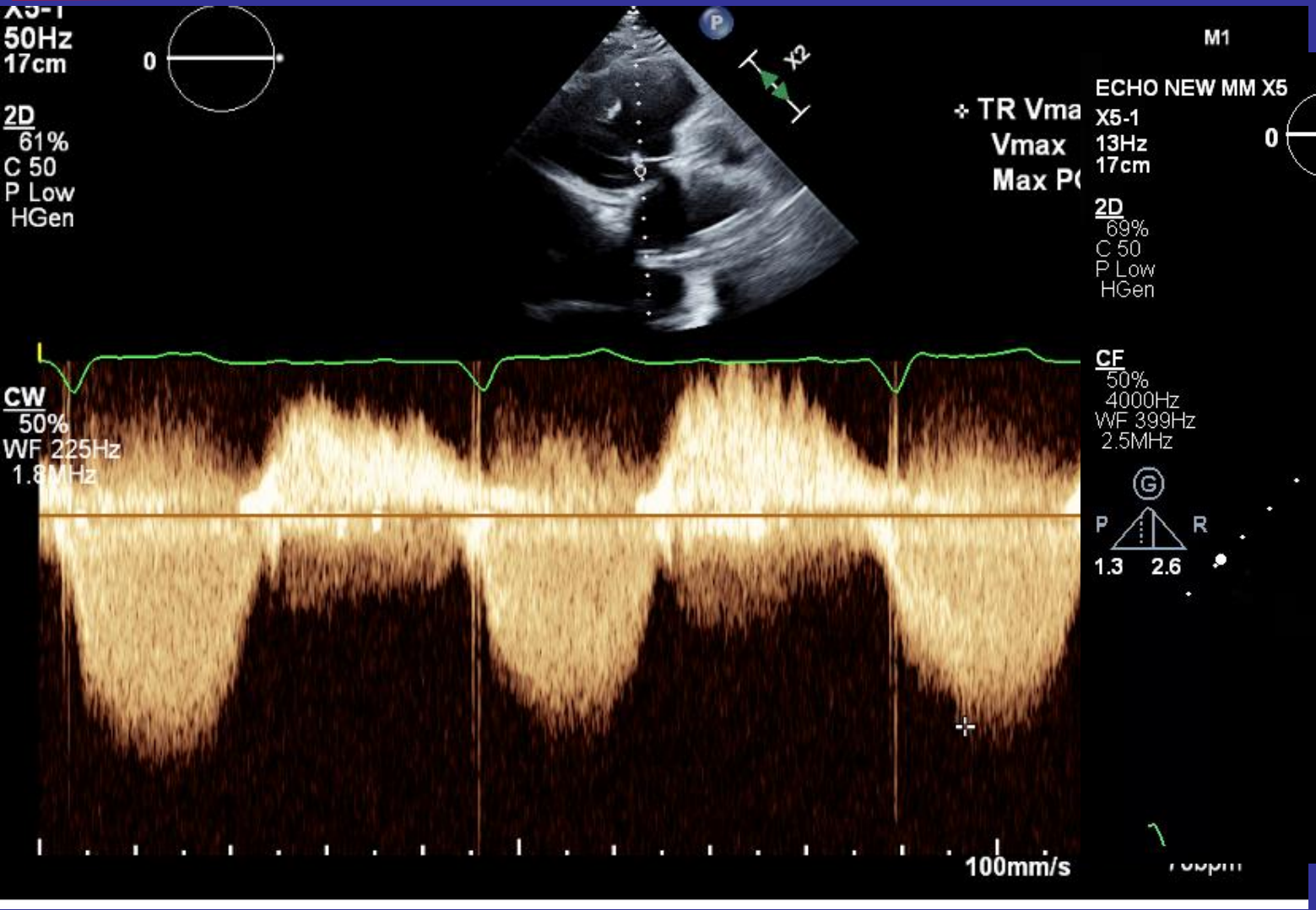
- VinR with pacemaker?
- Clip? – not suitable
- Redo?
- Pacemaker Extraction?

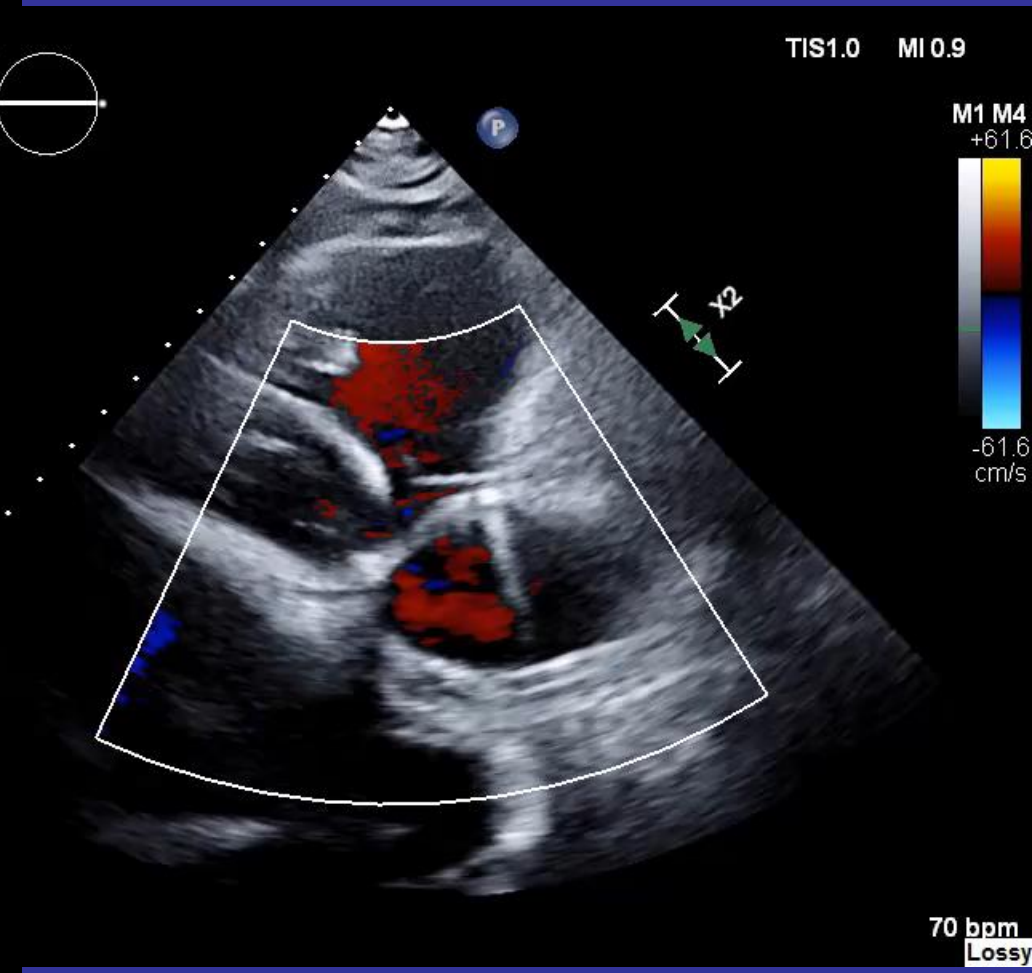
- Another discussion about intervention – the decision was to withhold intervention

2022

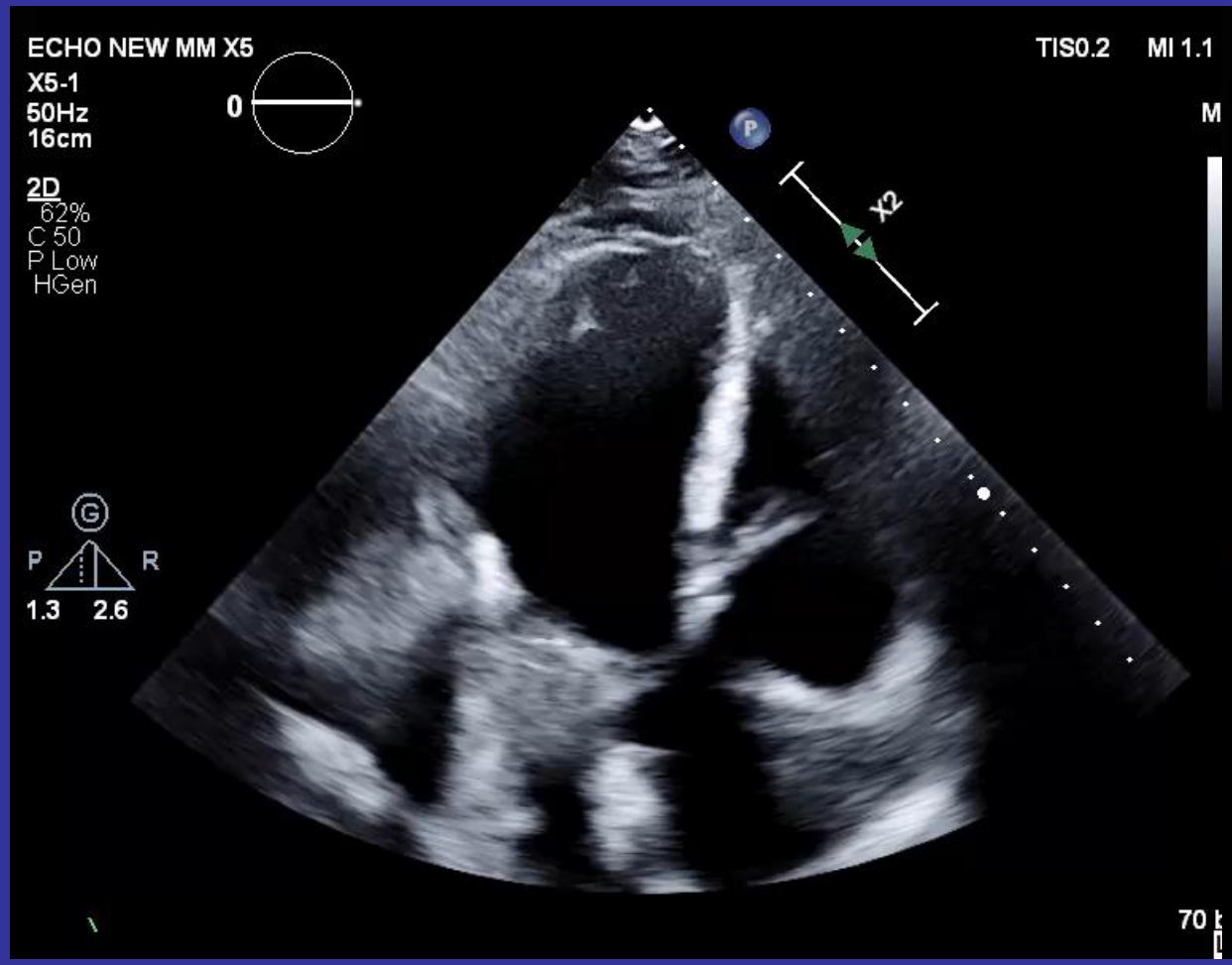

ECHO NEW MM X5
X5-1
50Hz
17cm
2D
61%
C 50
P Low
HGen
TIS0.3
MI 1.1
M1
X2
P
R
1.3
2.6
70 bpm
Lossy

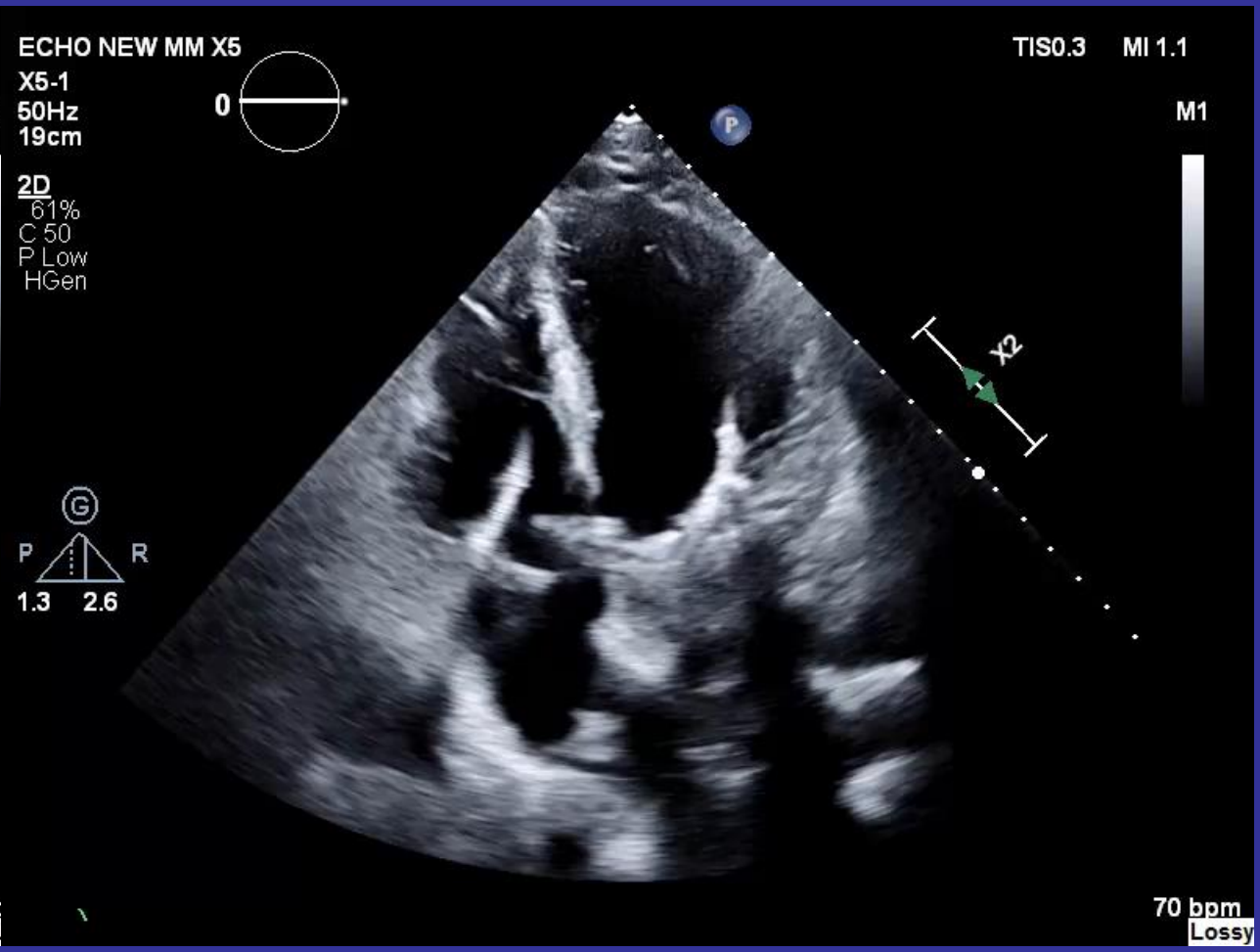
2022


50Hz
17cm
2D
61%
C 50
P Low
HGen
TR Vma
Vmax
Max P
M1
ECHO NEW MM X5
X5-1
13Hz
17cm
2D
69%
C 50
P Low
HGen
CF
50%
4000Hz
WF 399Hz
2.5MHz
1.3
2.6
CW
50%
WF 225Hz
1.8MHz
100mm/s


TIS1.0
MI 0.9
M1 M4
+61.6
-61.6
cm/s
70 bpm
Lossy

2022


ECHO NEW MM X5
X5-1
50Hz
16cm
2D
62%
C 50
P Low
HGen
TIS0.2
MI 1.1
M
X2
P
R
1.3
2.6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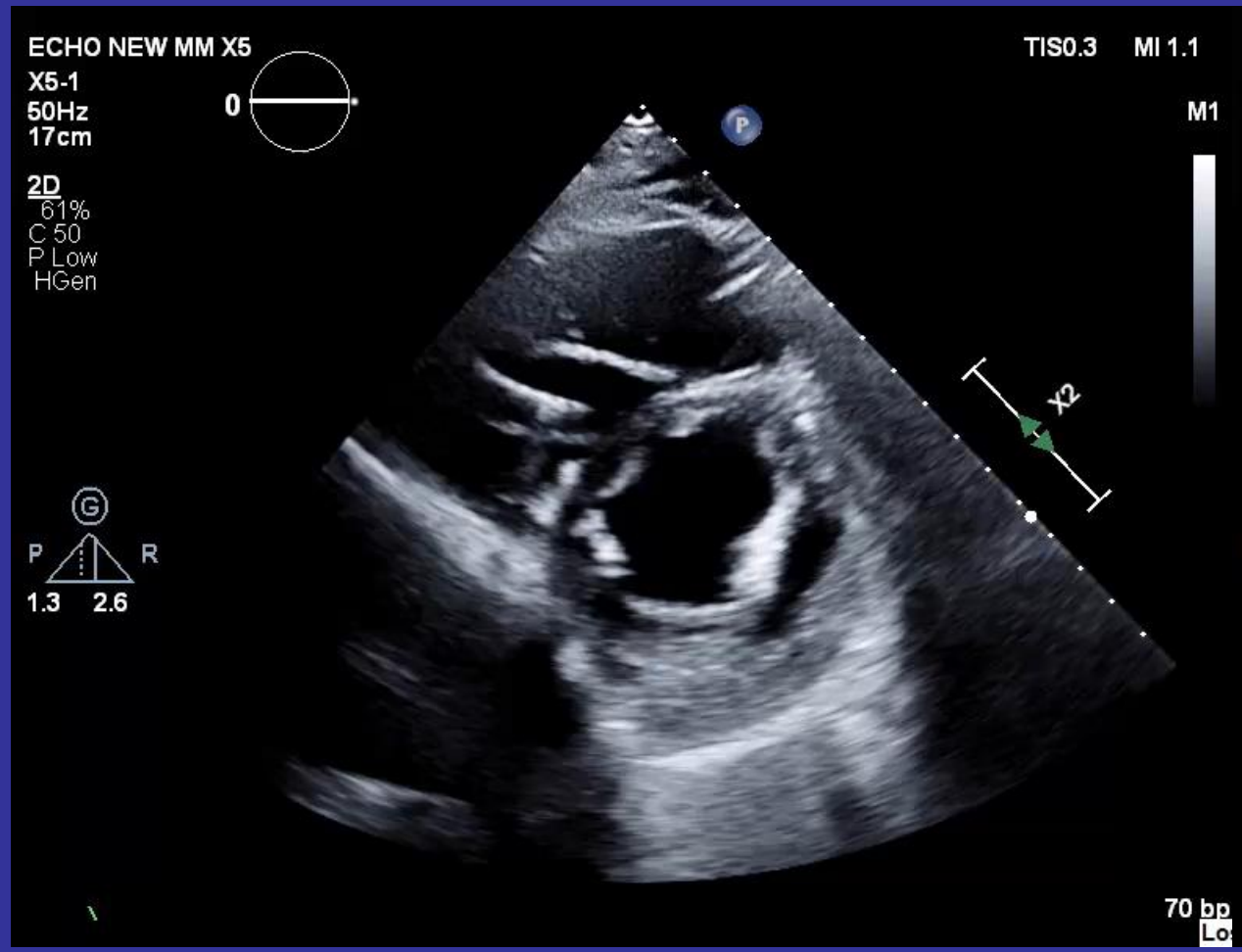
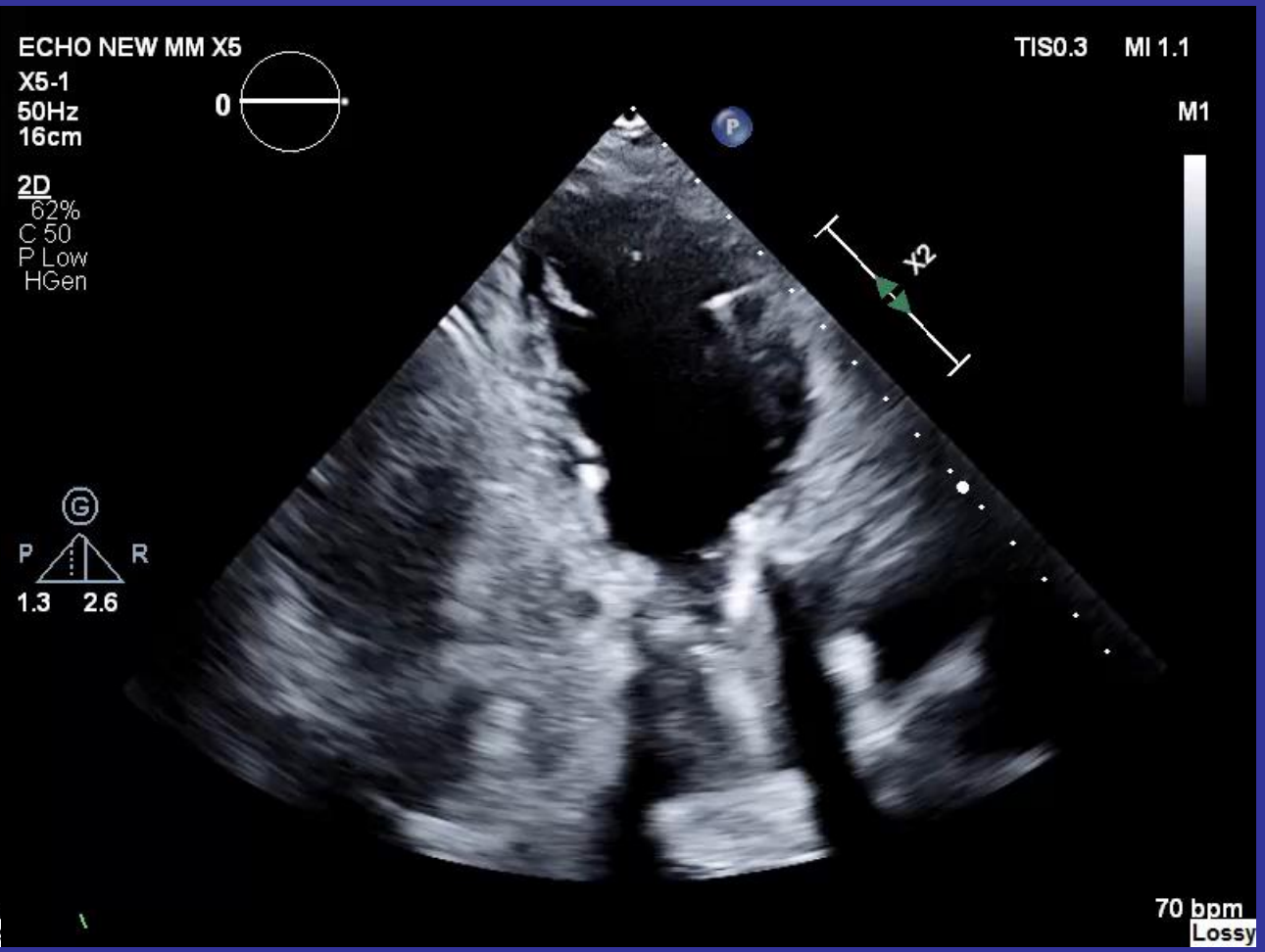
X5-1
50Hz
19cm
2D
61%
C 50
P Low
HGen
TIS0.3
MI 1.1
M1
X2
P
R
1.3
2.6
70 bpm
Lossy

2022


ECHO NEW MM X5
X5-1
50Hz
17cm
2D
61%
C 50
P Low
HGen
TIS0.3
MI 1.1
M1
X2
P
R
1.3
2.6
70 bp

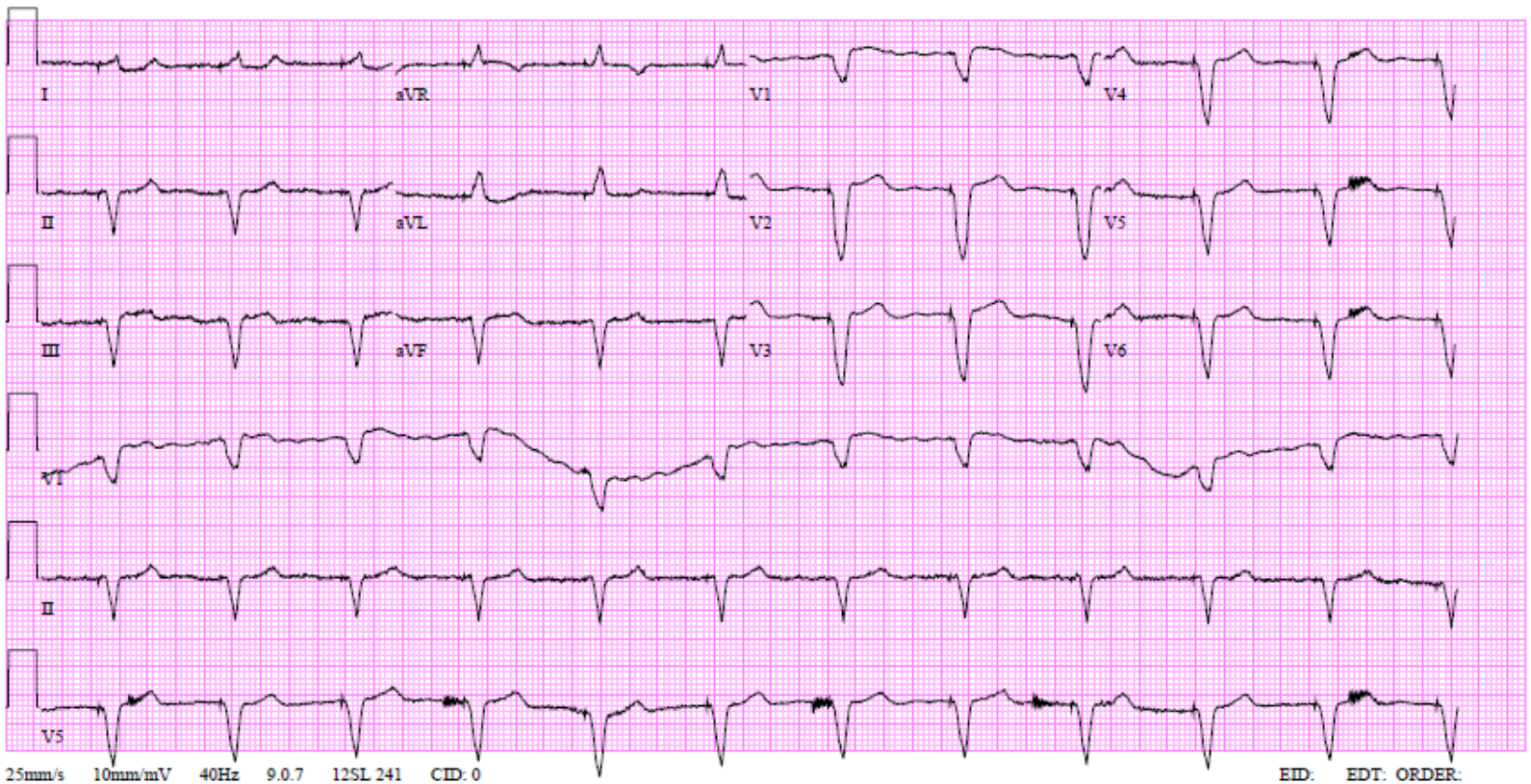

ECHO NEW MM X5
X5-1
50Hz
16cm
2D
62%
C 50
P Low
HGen
TIS0.3
MI 1.1
M1
X2
P
R
1.3
2.6
70 bpm
Lossy

2022 - Clinical Symptoms

- Fatigue
- RV is dilated and borderline function
- LV is deteriorating

- Medication
  - Fusid 40mg
  - Aldospirone 25mg

Unconfirmed



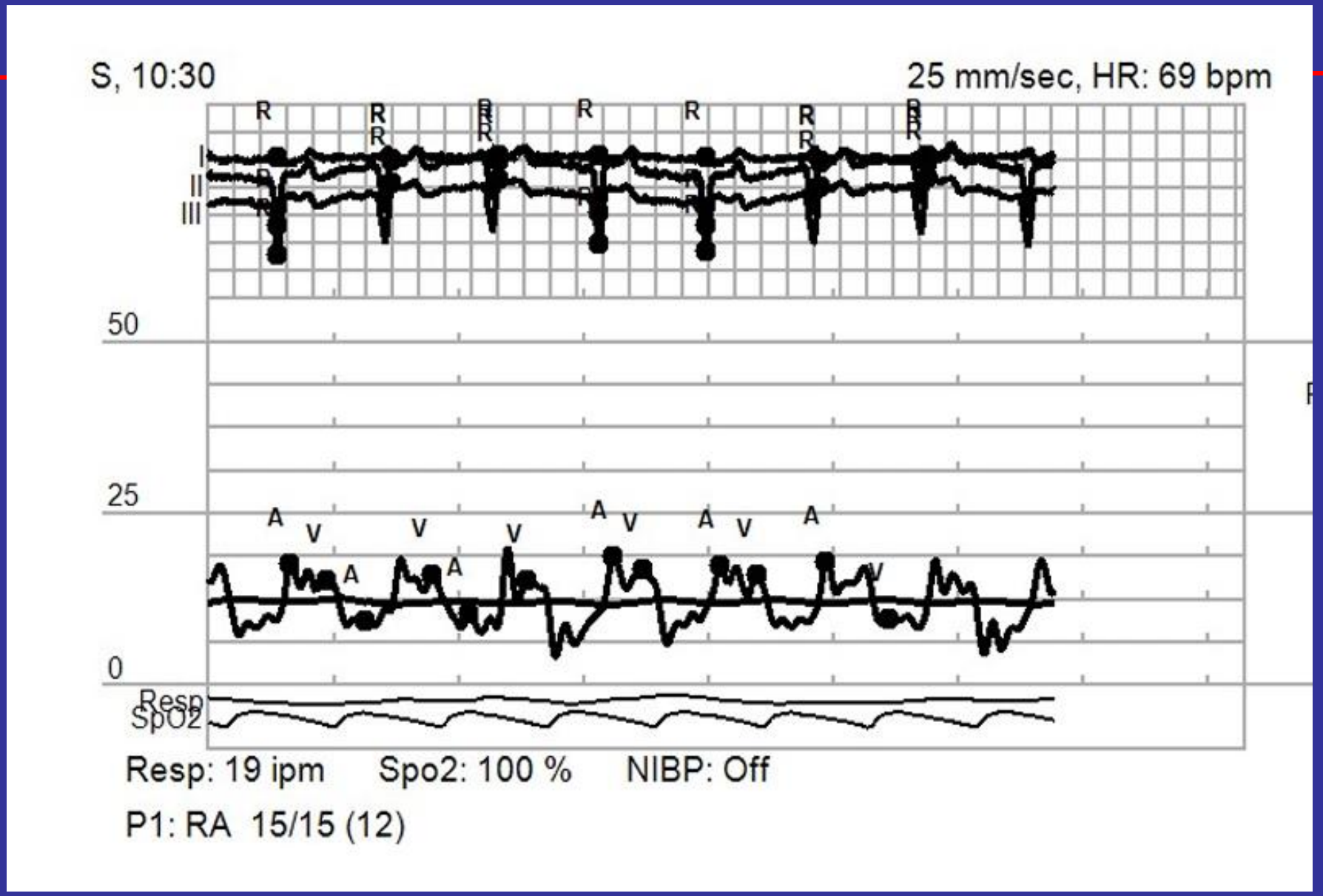
25mm/s 10mm/mV 40Hz 9.0.7 12SL 241 CID: 0

EID: EDT: ORDER:

לב ריאה

- 2021 RER – 0.95 VO2 MAX – 13ml/kg/min 63% predicted
- 2022 RER – 0.95 0.VO2 MAX – 13.9ml/kg/min 67% predicted

Rt Heart Cath 2023



תנאי: Rest

מוערך: 217.50 **דופק:** 69 bpm

רווית חמצן

מיקום	pCO2	pO2	Saturation %	Hgb	O2 Content
AO			100		
PA			58		

לחצים

מיקום	לחץ
PA	(29) 41/15
PCW	(20) 13/34
RV	8, 2-/45
RA	(12) 15/15
LV	14, 143/1
LV	14, 145/1
AO	(97) 143/68
AO	(97) 141/66
LV	13, 146/0

Cardiac Output

שיטה	(CO (l/min	(CI (l/min/m2	(SV (ml
Fick	3.81	2.2	55.29

Valve Gradients and Areas

Valve	Peak	Mean	Area	Index	Flow	Source
Aortic	5	3	2.57	1.48	197.41	Fick
Aortic	5	3				

Shunts

Oxygen Values

O2 Capacity 136 O2 Consumption 217.5

(Flows (l/min

Qs 3.81

Vascular Resistance

Rt Heart Cath 2023


ELHARAL YAFA
52248333 F/67Y
9 Mar, 2022 / 17:37:12.86
0%, iDose (5)
Series 402 - Slice 0
iDose (5)
SHEBA MEDICAL CENTER
Philips, iCT 256
Thickness 0.68 mm
Zoom 1.00
Contrast
R
5 cm
P

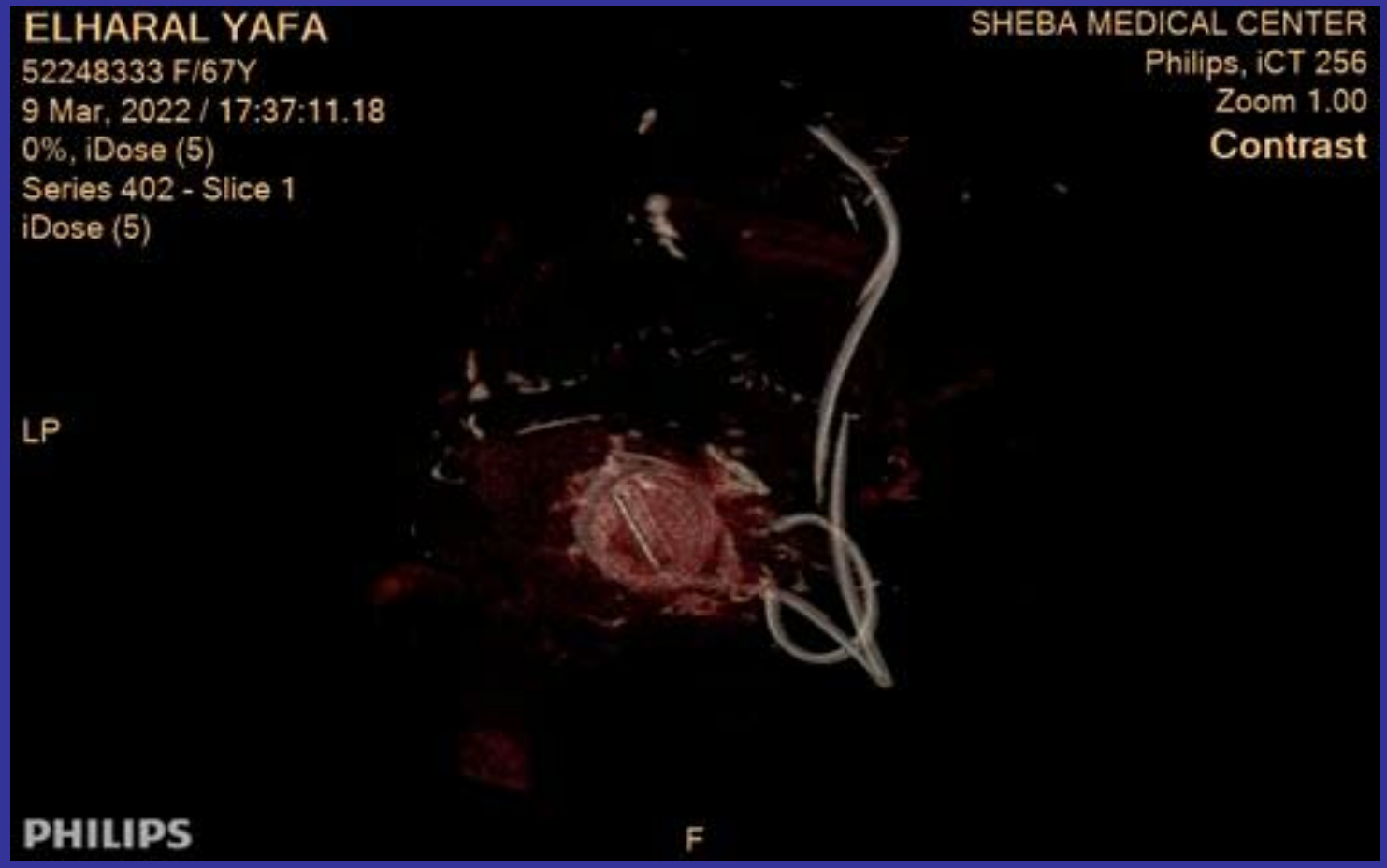
ELHARAL YAFA
52248333 F/67Y
9 Mar, 2022 / 17:37:12.86
0%, iDose (5)
Series 402 - Slice 0
iDose (5)
SHEBA MEDICAL CENTER
Philips, iCT 256
Thickness 0.81 mm
Zoom 1.00
Contrast
RP
5 cm
F


ELHARAL YAFA
52248333 F/67Y
9 Mar, 2022 / 17:37:12.86
0%, iDose (5)
Series 402 - Slice 0
iDose (5)
SHEBA MEDICAL CENTER
Philips, iCT 256
Thickness 0.82 mm
Zoom 1.00
Contrast
AR
5 cm
F

F

CT

CT

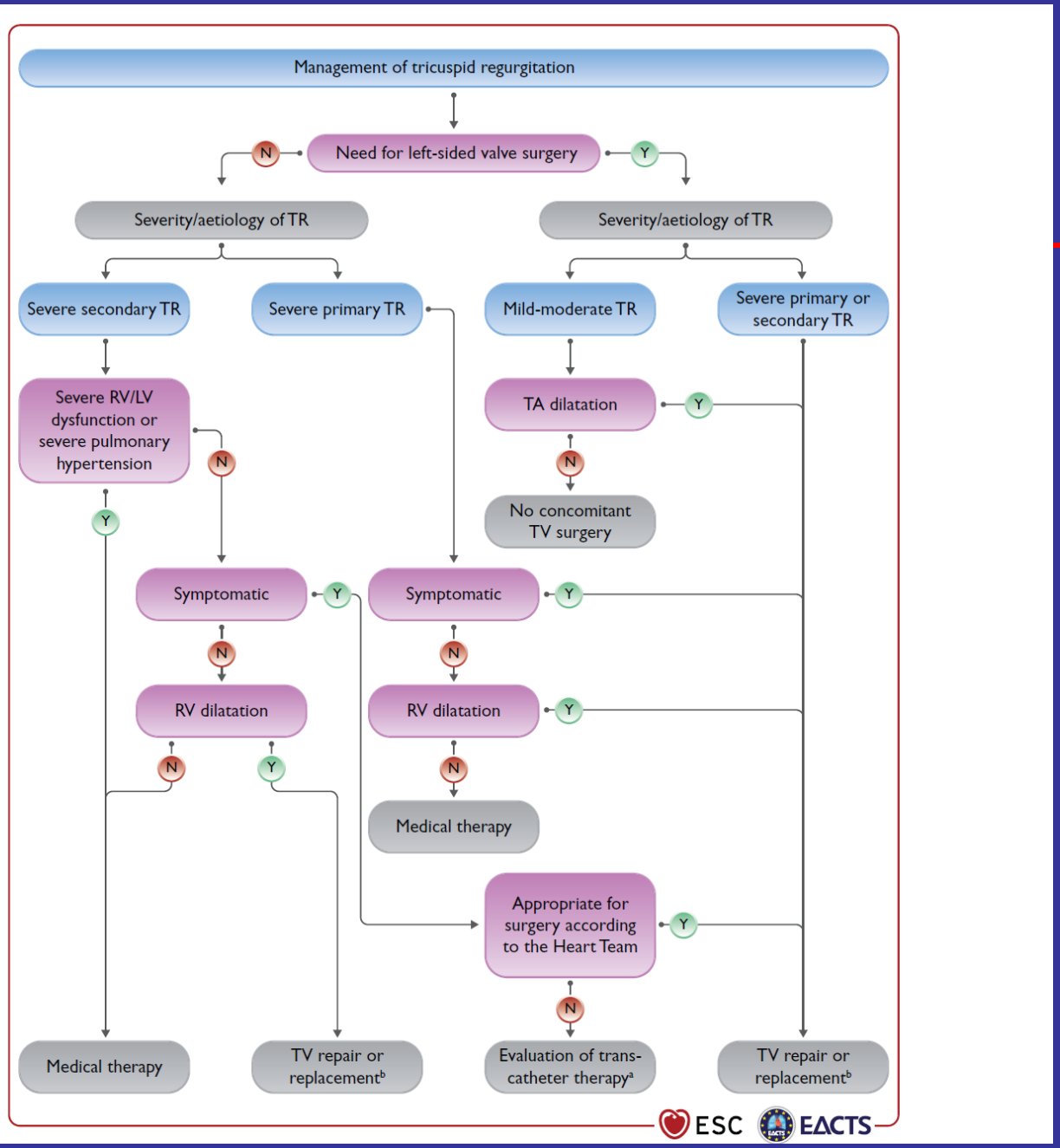

ELHARAL YAFA
52248333 F/67Y
9 Mar, 2022 / 17:37:11.18
0%, iDose (5)
Series 402 - Slice 1
iDose (5)
SHEBA MEDICAL CENTER
Philips, iCT 256
Zoom 1.00
Contrast
LP
PHILIPS
F

What would you do?

- Should we offer any procedure?
- VinR? (pacemaker) New Percutaneous valve?
- Surgery? (pacemaker)
- Should we upgrade the pacemaker?

Decision

- Redo Tricuspid
- Extraction f the old leads
- Epicardial leads with upgrade to CRT


Management of tricuspid regurgitation
Need for left-sided valve surgery
N
Y
Severity/aetiology of TR
Severity/aetiology of TR
Severe secondary TR
Severe primary TR
Mild-moderate TR
Severe primary or secondary TR
Severe RV/LV dysfunction or severe pulmonary hypertension
TA dilatation
No concomitant TV surgery
Symptomatic
Symptomatic
RV dilatation
RV dilatation
Medical therapy
Appropriate for surgery according to the Heart Team
Medical therapy
TV repair or replacement[b]
Evaluation of trans-catheter therapy[a]
TV repair or replacement[b]
ESC
EACTS

Recommendations on primary tricuspid regurgitation		
Surgery is recommended in patients with severe primary tricuspid regurgitation undergoing left-sided valve surgery.	I	C
Surgery is recommended in symptomatic patients with isolated severe primary tricuspid regurgitation without severe RV dysfunction.	I	C
Surgery should be considered in patients with moderate primary tricuspid regurgitation undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in asymptomatic or mildly symptomatic patients with isolated severe primary tricuspid regurgitation and RV dilatation who are appropriate for surgery.	IIa	C

Recommendations on secondary tricuspid regurgitation		
Surgery is recommended in patients with severe secondary tricuspid regurgitation undergoing left-sided valve surgery.[423–427]	I	B
Surgery should be considered in patients with mild or moderate secondary tricuspid regurgitation with a dilated annulus (≥40 mm or >21 mm/m^2 by 2D echocardiography) undergoing left-sided valve surgery.[423,425–427]	IIa	B
Surgery should be considered in patients with severe secondary tricuspid regurgitation (with or without previous left-sided surgery) who are symptomatic or have RV dilatation, in the absence of severe RV or LV dysfunction and severe pulmonary vascular disease/hypertension.[418,433 e]	IIa	B
Transcatheter treatment of symptomatic secondary severe tricuspid regurgitation may be considered in inoperable patients at a Heart Valve Centre with expertise in the treatment of tricuspid valve disease.[f]	IIb	C

Table 9 Proposed grading of the severity of residual tricuspid regurgitation by echocardiography after tricuspid valve interventions

Parameters	Mild	Moderate	Severe
Qualitative			
Color jet area*	Small, narrow, central	Moderate central	Large central jet or eccentric wall-impinging jet(s) of variable size swirling in RA
Flow-convergence zone†	Not visible or small	Intermediate in size	Large
TR CW Doppler velocity waveform (density and shape)	Faint/partial/parabolic	Dense, parabolic or triangular	Dense, often triangular
Tricuspid inflow	A-wave dominant	Variable	E-wave dominant‡§
Semi-quantitative			
VC width (cm)*	<0.3	0.3-0.69	≥0.7 or ≥2 moderate jets
PISA radius (cm)†	≤0.5	0.6-0.9	>0.9
Hepatic vein flow‡	Systolic dominance	Systolic blunting	Systolic flow reversal
Quantitative			
EROA (cm^2)‖	<0.20	0.20-0.39	≥0.40
RVol (mL)‖	<30	30-44	≥45

Figure 10. Tricuspid Regurgitation

Colors corresponds to Table 2

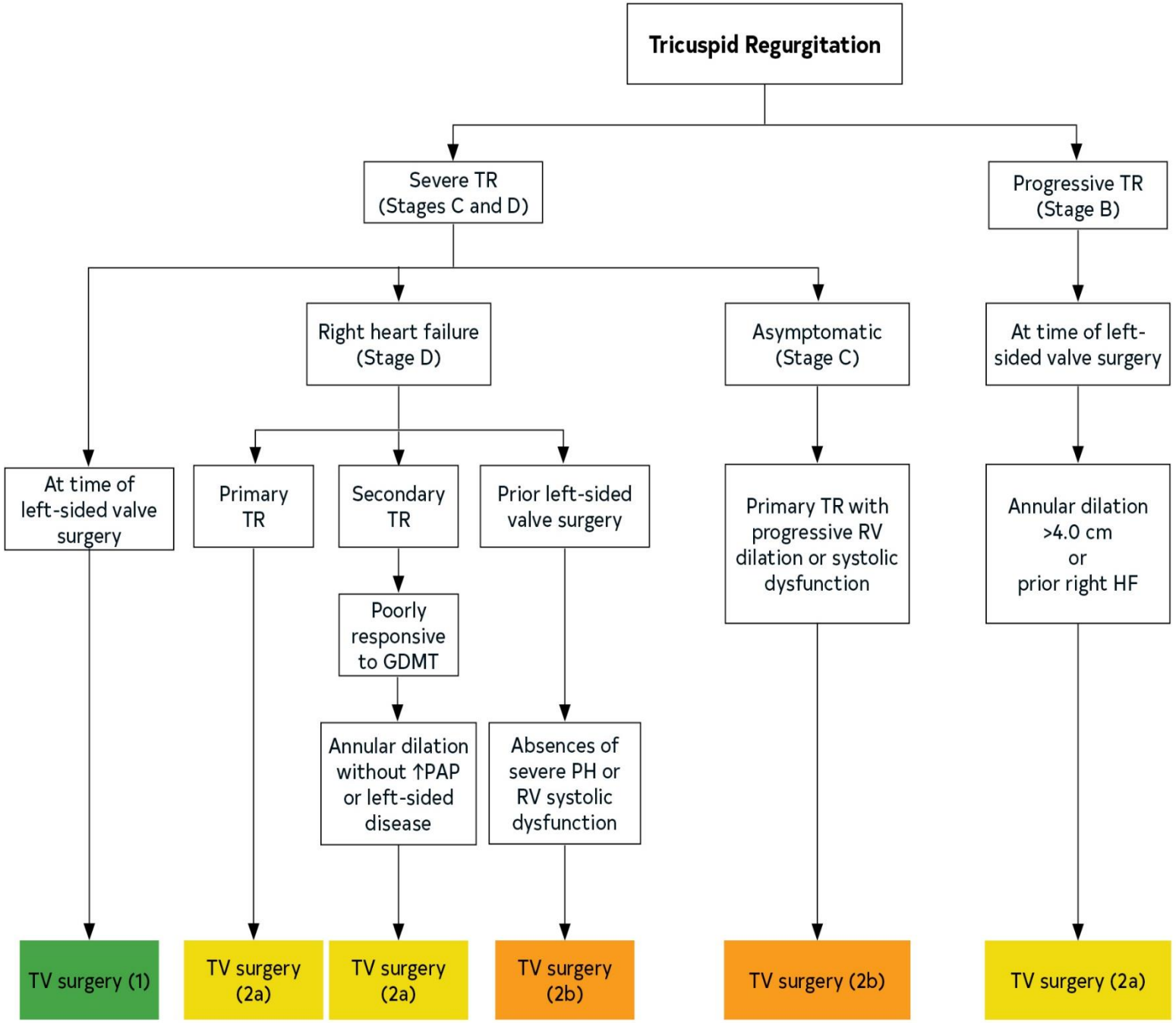


Table 19. Classification of TR

Primary	Secondary
• Rheumatic • Infective endocarditis • Iatrogenic (device leads, endomyocardial biopsy) • Congenital (e.g., Ebstein's, levo-transposition of the great arteries.) • Other (trauma, carcinoid, drugs, irradiation, etc.)	• Pulmonary hypertension with RV remodeling (primary or secondary to left-sided heart disease) • Dilated cardiomyopathy • Annular dilation (associated with AF)* • RV volume overload (shunts/ high output)

*Isolated TR is associated with AF and has LVEF >60%, pulmonary artery systolic pressure <50 mm Hg, and no left-sided valve disease, with normal-appearing tricuspid valve leaflets

Table 20. Stages of TR

Stage	Definition	Valve Hemodynamics	Hemodynamic Consequences	Clinical Symptoms and Presentation
B	Progressive TR	• Central jet < 50% RA • Vena contracta width < 0.7 cm • ERO < 0.40 cm^2 • Regurgitant volume < 45 mL	None	None
C	Asymptomatic severe TR	• Central jet ≥50% RA • Vena contracta width ≥0.7 cm • ERO ≥0.40 cm^2 • Regurgitant volume ≥45 mL • Dense continuous wave signal with triangular shape • Hepatic vein systolic flow reversal	• Dilated RV and RA • Elevated RA with “c-V” wave	• Elevated venous pressure • No symptoms
D	Symptomatic severe TR	• Central jet ≥50% RA • Vena contracta width ≥0.7 cm • ERO ≥0.40 cm^2 • Regurgitant volume ≥45 mL • Dense continuous wave signal with triangular shape • Hepatic vein systolic flow reversal	• Dilated RV and RA • Elevated RA with “c-V” wave	• Elevated venous pressure • Dyspnea on exertion, fatigue, ascites, edema

Diagnosis of Tricuspid Regurgitation

COR	LOE	Recommendations
1	C-LD	1. In patients with TR, TTE is indicated to evaluate the presence and severity of TR, determine the etiology, measure the sizes of the right-sided chambers and inferior vena cava, assess RV systolic function, estimate pulmonary artery systolic pressure, and characterize any associated left-sided heart disease.
2a	C-LD	2. In patients with TR, invasive measurement of the cardiac index, right-sided diastolic pressures, pulmonary artery pressures, and pulmonary vascular resistance, as well as right ventriculography, can be useful when clinical and noninvasive data are discordant or inadequate.

Medical Therapy for Patients with Tricuspid Regurgitation

COR	LOE	Recommendations
2a	C-EO	1. In patients with signs and symptoms of right-sided HF attributable to severe TR (Stages C and D), diuretics can be useful.
2a	C-EO	2. In patients with signs and symptoms of right-sided HF attributable to severe secondary TR (Stages C and D), therapies to treat the primary cause of HF (e.g., pulmonary vasodilators to reduce elevated pulmonary artery pressures, GDMT for HF with reduced LVEF, or rhythm control of AF) can be useful.

COR	LOE	Recommendations
1	B-NR	1. In patients with severe TR (Stages C and D) undergoing left-sided valve surgery, tricuspid valve surgery is recommended.
2a	B-NR	2. In patients with progressive TR (Stage B) undergoing left-sided valve surgery, tricuspid valve surgery can be beneficial in the context of either 1) tricuspid annular dilation (tricuspid annulus end diastolic diameter>4.0 cm) or 2) prior signs and symptoms of right-sided HF.
2a	B-NR	3. In patients with signs and symptoms of right-sided HF and severe primary TR (Stage D), isolated tricuspid valve surgery can be beneficial to reduce symptoms and recurrent hospitalizations.

ning of Intervention of TR

COR	LOE	Recommendations
2a	B-NR	4. In patients with signs and symptoms of right-sided HF and severe isolated secondary TR attributable to annular dilation (in the absence of pulmonary hypertension or left-sided disease) who are poorly responsive to medical therapy (Stage D), isolated tricuspid valve surgery can be beneficial to reduce symptoms and recurrent hospitalizations.
2b	C-LD	5. In asymptomatic patients with severe primary TR (Stage C) and progressive RV dilation or systolic dysfunction, isolated tricuspid valve surgery may be considered.
2b	B-NR	6. In patients with signs and symptoms of right-sided HF and severe TR (Stage D) who have undergone previous left-sided valve surgery, reoperation with isolated tricuspid valve surgery may be considered in the absence of severe pulmonary hypertension or severe RV systolic dysfunction.

ning of Intervention of TR