SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIAC TECHNOLOGY-II YEAR

UNIT IV : ECHO ASSESSMENT OF PROSTHETIC VALVE

Echocardiographic Evaluation Of Prosthetic Cardiac Valves

Learning Points in Presentation

- When we should asses Prosthetic valve function ?
- What are parameters that need to be assessed?
- How should we assess?
- ECHO images of assessment of patients with prosthetic valve

Timing of assessment of prosthetic valve

- An echocardiographic examination performed **6 weeks to 3 months** after valve implantation
- It allows for an assessment of the effects and results of surgery
- Serves as a baseline for comparison should complications or deterioration occur later

Timing of assessment of prosthetic valve

- Asymptomatic uncomplicated patient is usually seen at 1–year intervals for a cardiac history and physical examination
- No further echocardiographic testing is required after the initial postoperative evaluation in patients with mechanical valves

➢ Who are stable

➢ Who have no symptoms

➢ No clinical evidence of prosthetic valve or ventricular dysfunction or dysfunction of other heart valves.

Timing of assessment of prosthetic valve

Class I

1. **An initial TTE study is recommended in patients after prosthetic valve implantation for evaluation of valve hemodynamics (522-525).** ***(Level of Evidence: B)***

2. Repeat TTE is recommended in patients with prosthetic heart valves if there is a change in clinical symptoms or signs suggesting valve dysfunction. *(Level of Evidence: C)*

3. **TEE is recommended when clinical symptoms or signs suggest prosthetic valve dysfunction.** ***(Level of Evidence: C)***

Class IIa

1. **Annual TTE is reasonable in patients with a bioprosthetic valve after the first 10 years, even in the absence of a change in clinical status. (*Level of Evidence: C*)**

Imaging of valve

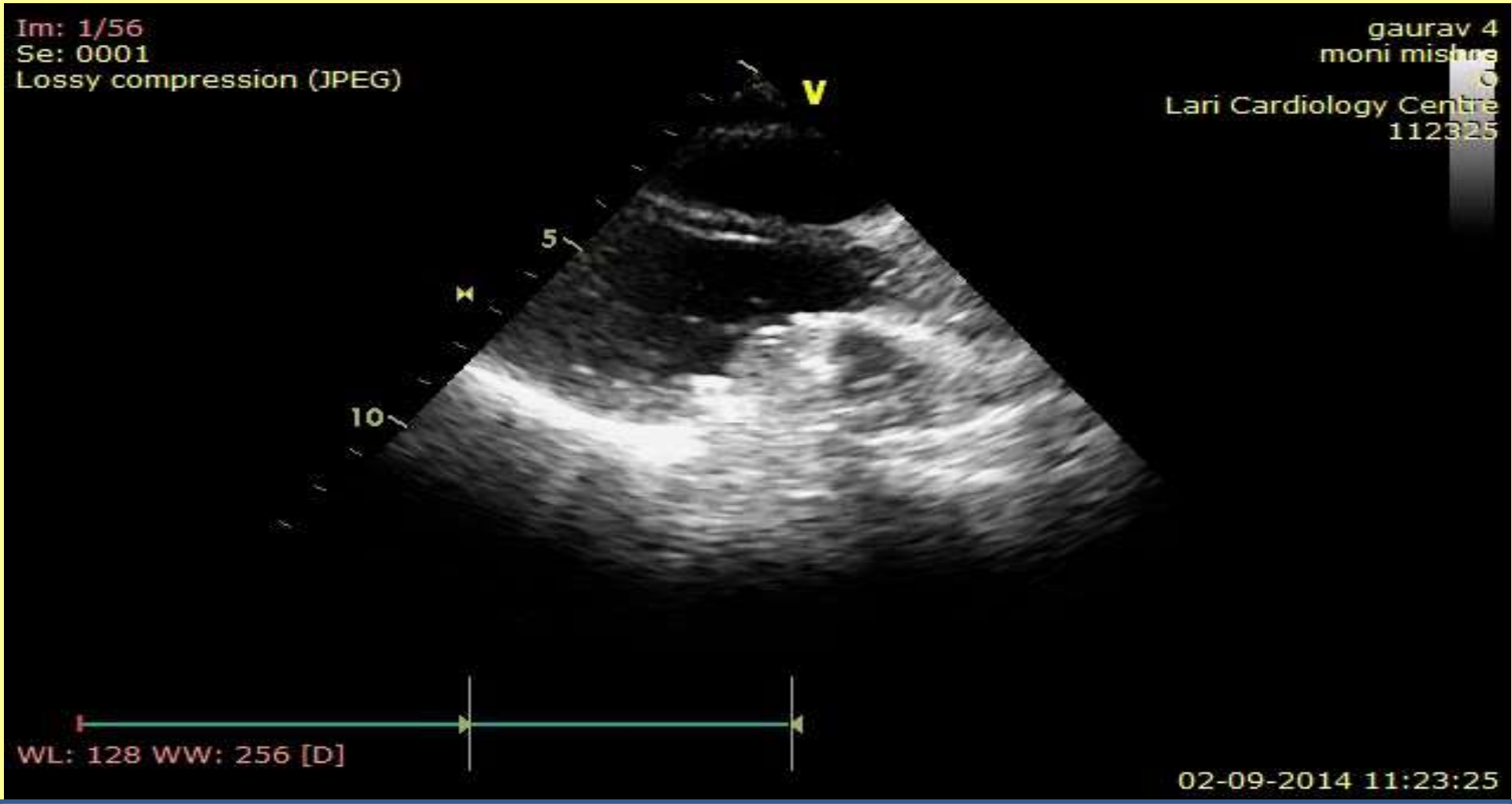
- Motion of leaflets or occluder
- Presence of calcification on the leaflets
- Any abnormal densities on the various components of the prosthesis
- Valve sewing ring integrity and motion

Doppler Study of Prosthetic valve

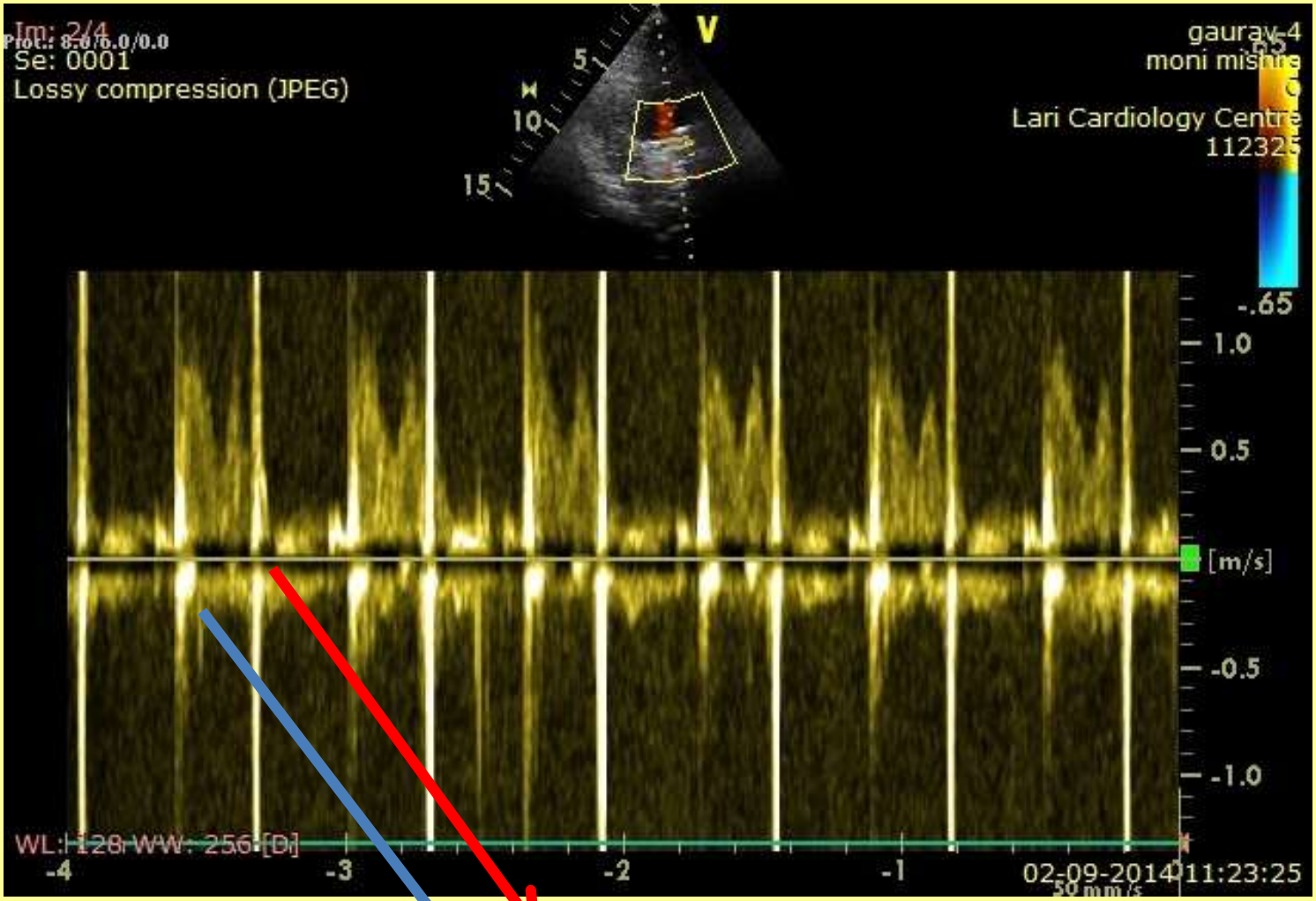
- Contour of jet velocity signal
- Peak velocity and gradient
- Mean pressure gradient
- VTI of the jet
- DVI
- Pressure half time in MV and TV
- EOA
- Presence, location and severity of regurgitation

Case 1

- 27 yr female ,Post MVR (SJM) 1 yr back



Leaflet excursion normal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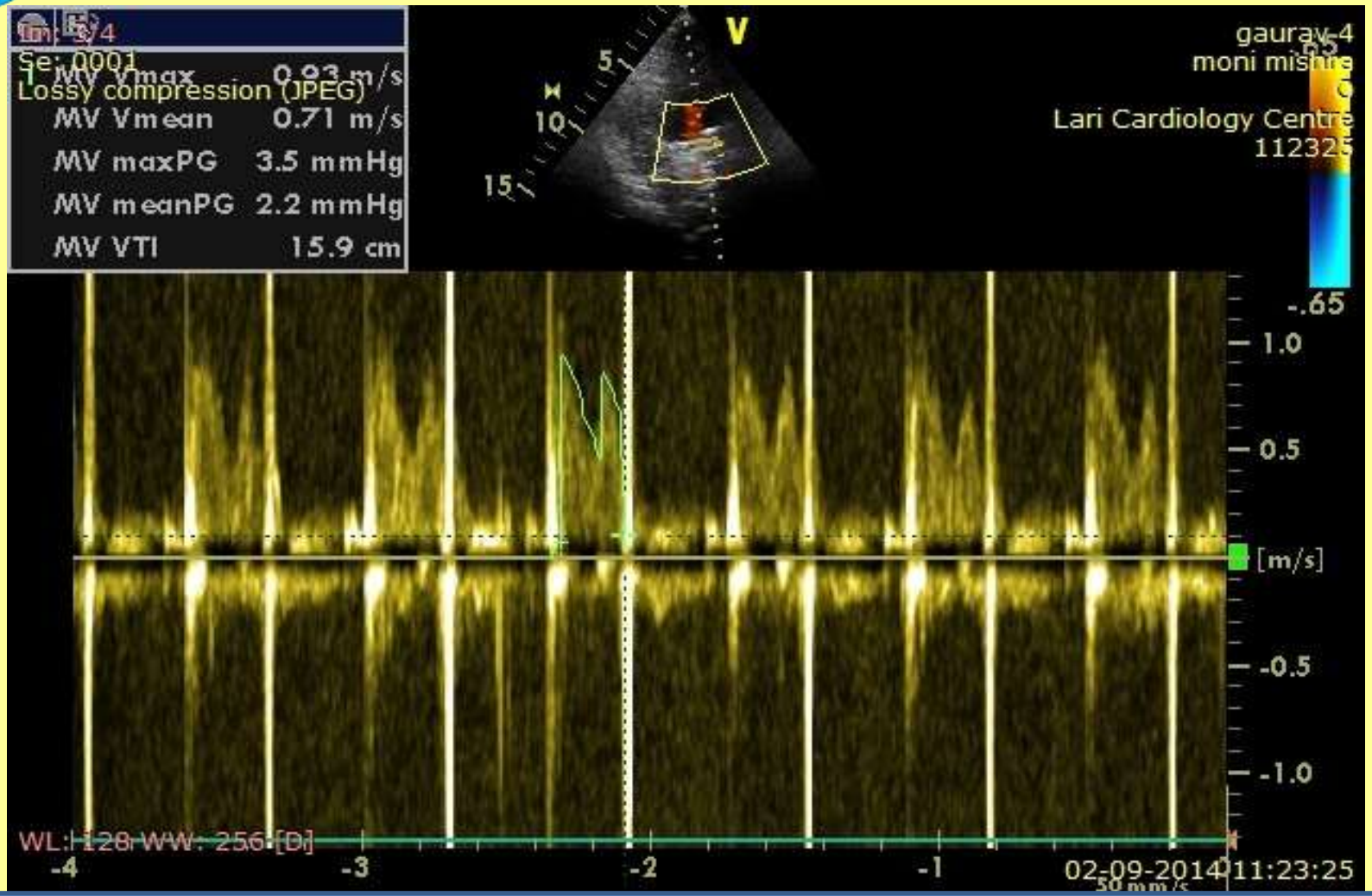
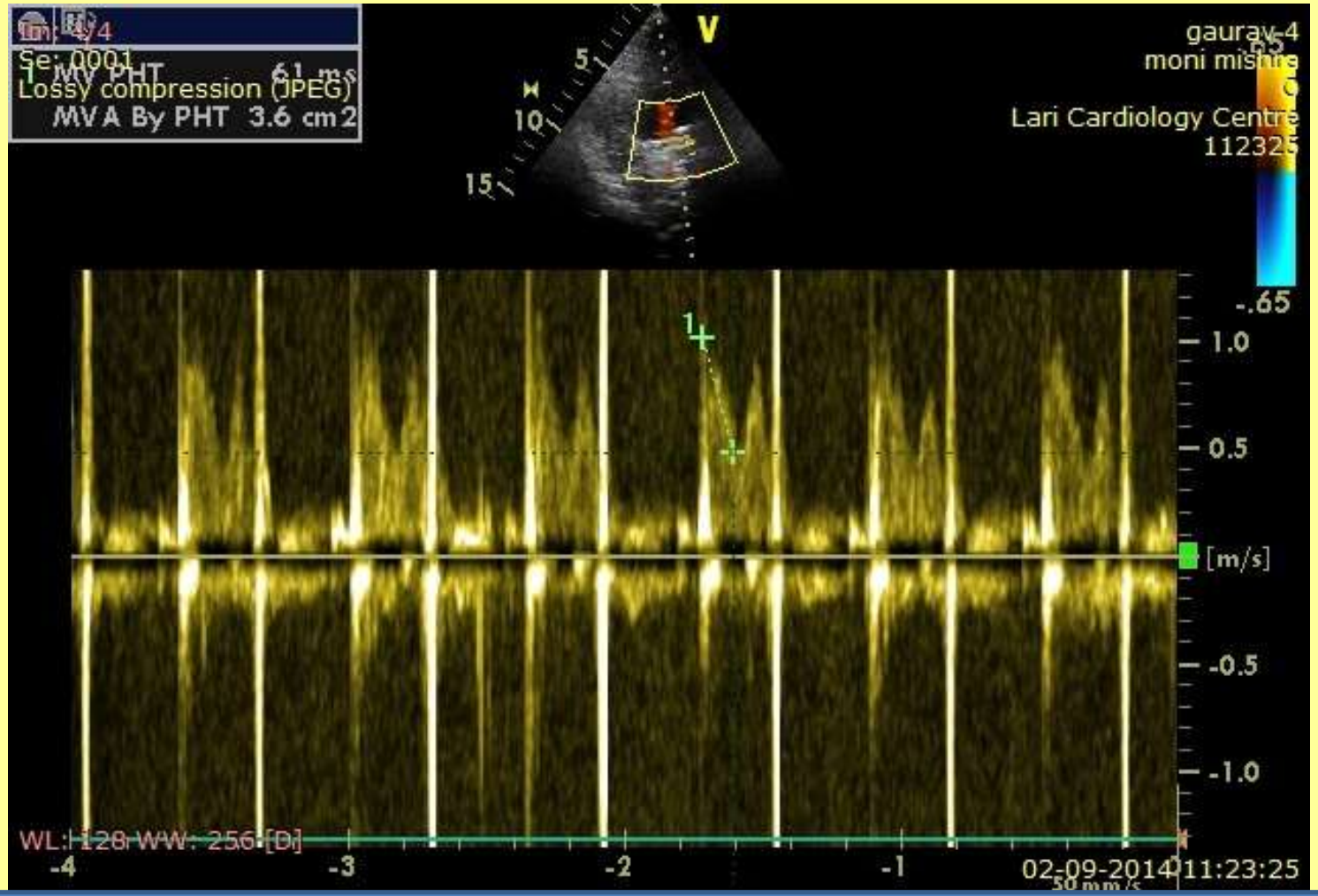


PG/MG= 3.5/2.2 mm Hg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MVA =3.6 cm2

Doppler parameters of prosthetic mitral valve function

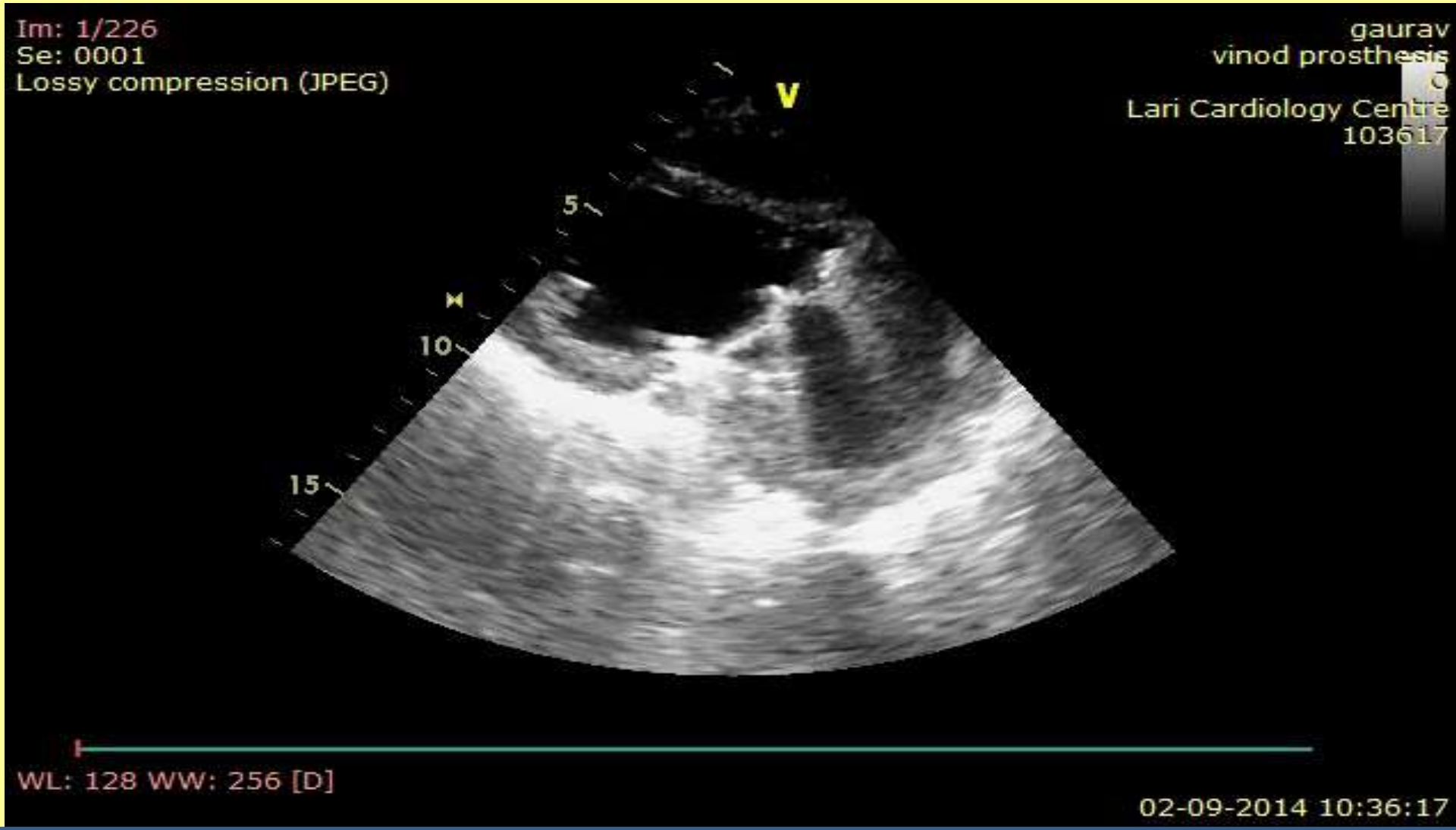
	Normal*	Possible stenosis‡	Suggests significant stenosis*,‡
Peak velocity (m/s)†,§	<1.9	1.9-2.5	≥2.5
Mean gradient (mm Hg)†,§	≤5	6-10	>10
VTI_{PrMV}/VTI_{LVO}†,§	<2.2	2.2-2.5	>2.5
EOA (cm^2)	≥2.0	1-2	<1
PHT (ms)	<130	130-200	>200

PHT, Pressure half-time; *PrMV*, prosthetic mitral valve.

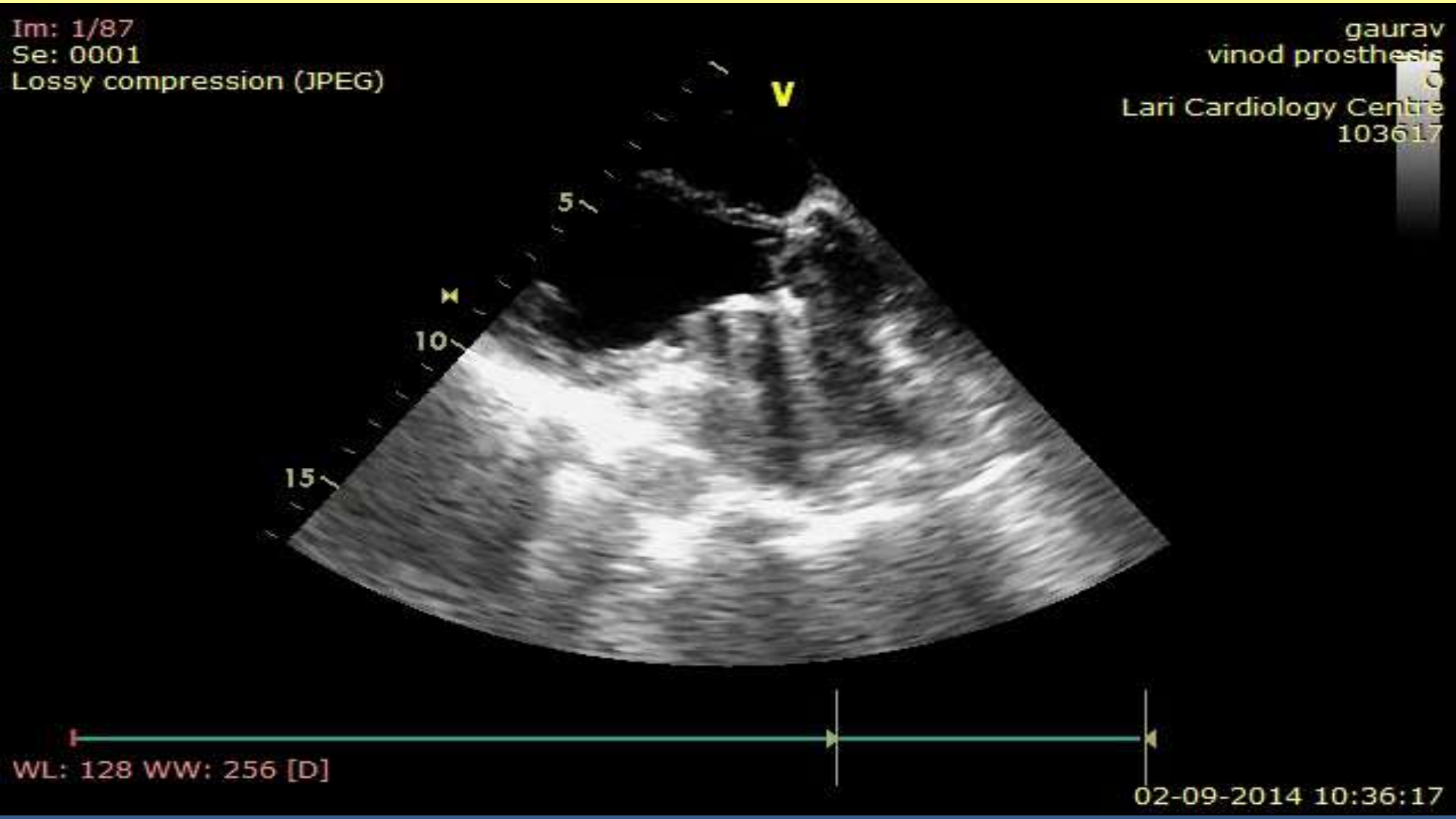
Recommendations for Evaluation of Prosthetic Valves With Echocardiography and Doppler Ultrasound, JASE 2009

Case 2

- 35 yr male Post DVR (MVR+AVR) , SJM ,August 2014



Normal leaflet excursion ,posterior leaflet ?Calcification/Pannus



Normal leaflet excursion with acoustic shadowing

Pannus versus Thrombus

- Fibrous pannus, is usually annular in location
- Pannus formation is more frequent on aortic than on mitral prostheses
- On mitral prosthetic valves, they most often occur on the atrial side of the prosthesis
- Typically presenting as a very dense immobile echo, pannus are typically seen in patients with

➢ Normal anticoagulation profile
➢ Subacute or chronic symptoms

Pannus versus Thrombus

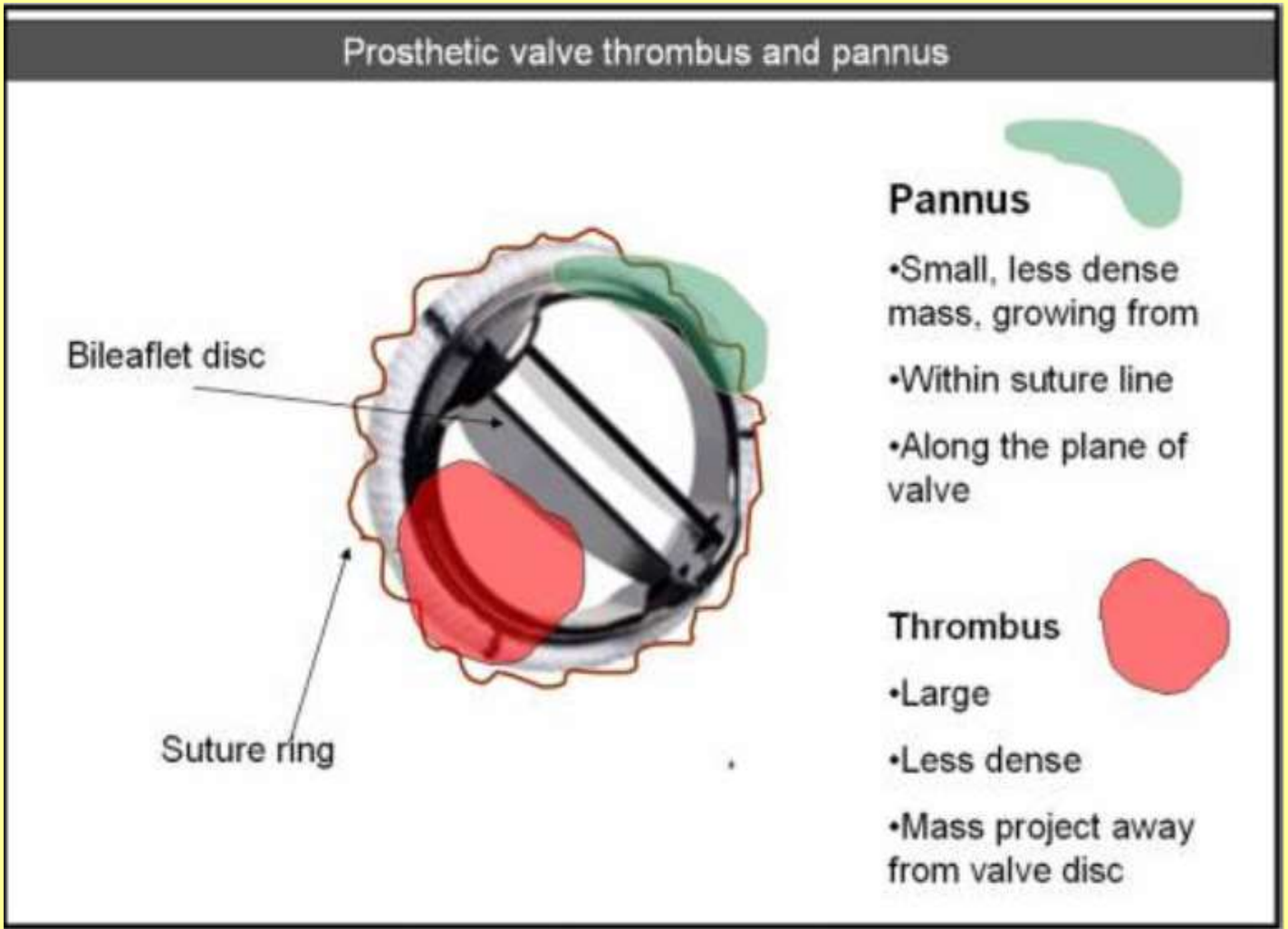
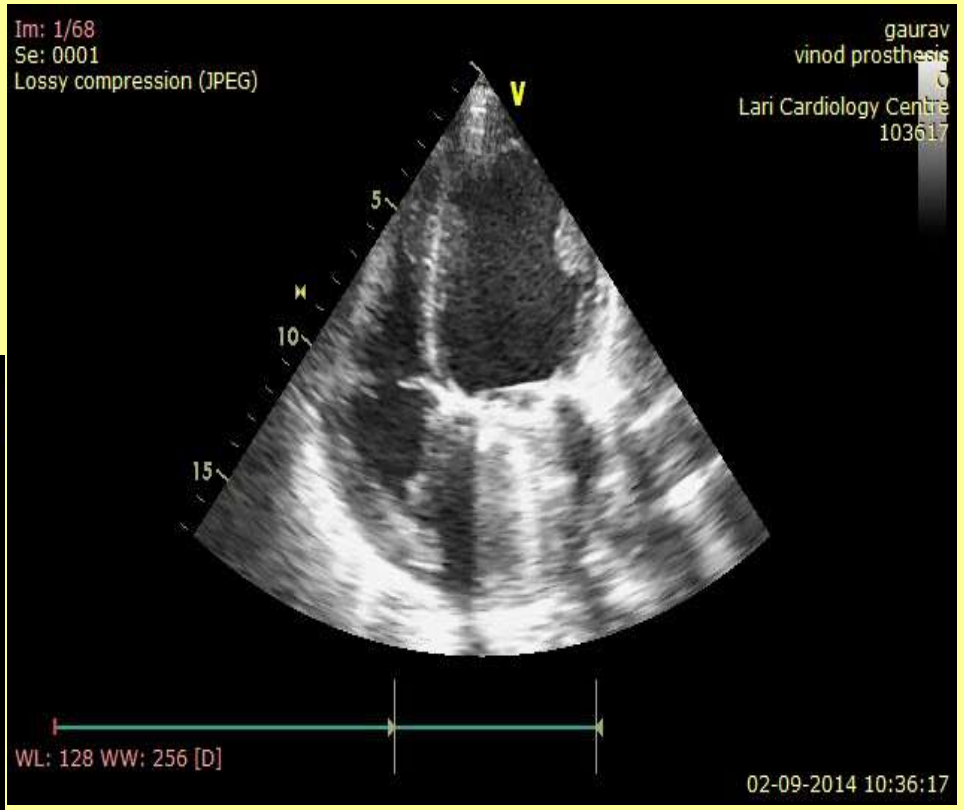


Figure 5 Pannus formation on a St Jude Medical valve prosthesis in the aortic position as depicted by TEE. The mass is highly echogenic and corresponds to the pathology of the pannus at surgery. The pannus is depicted by the *arrows*. *LA*, Left atrium; *LV*, left ventricle.

Pannus formation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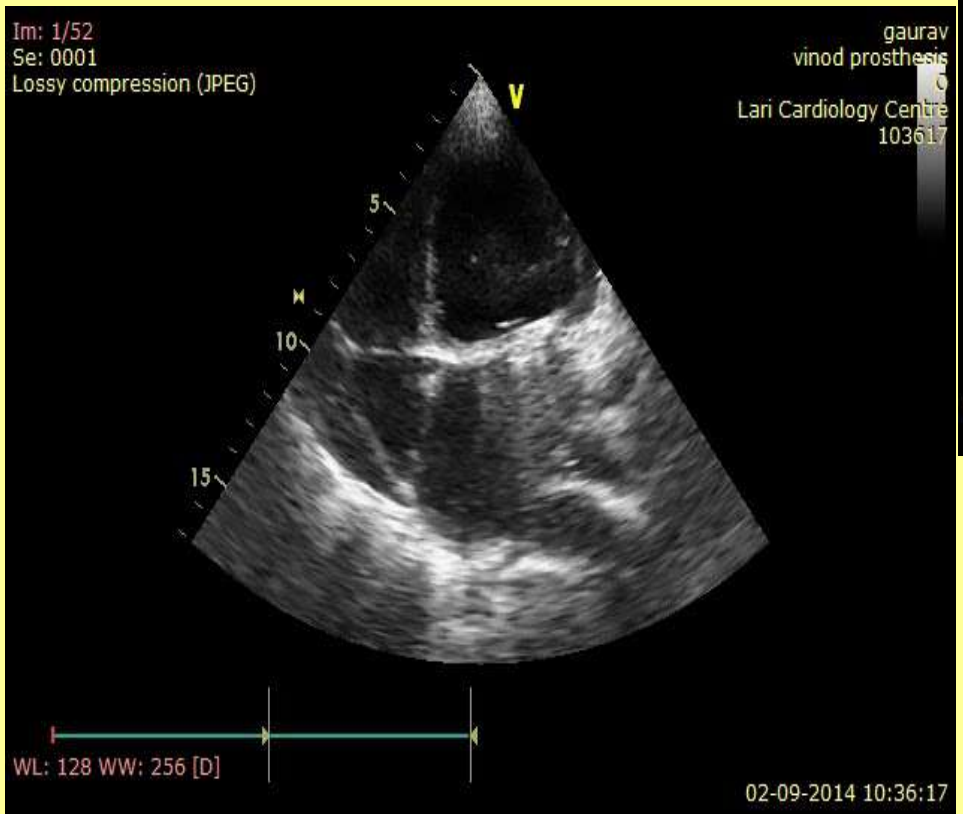
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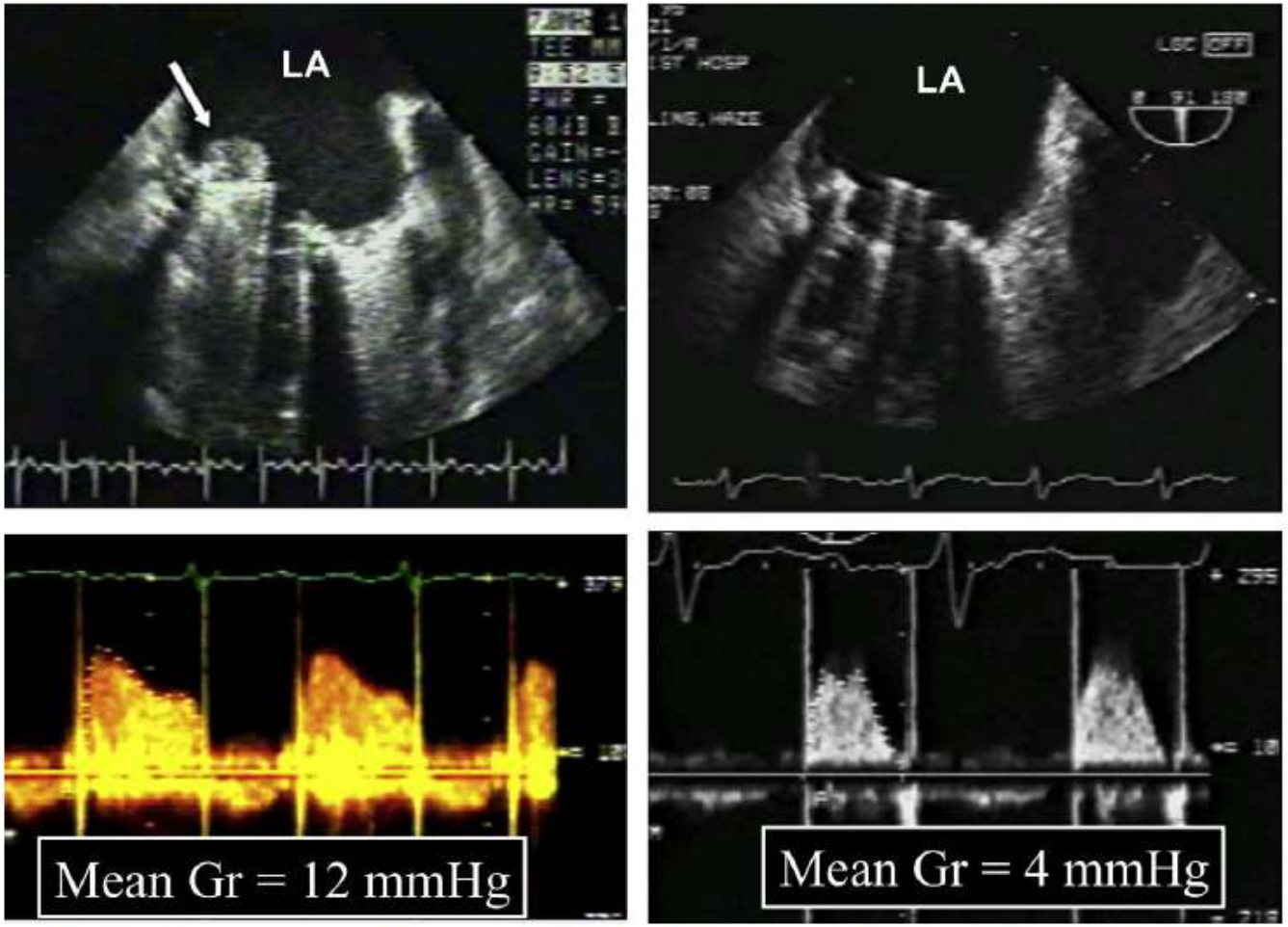
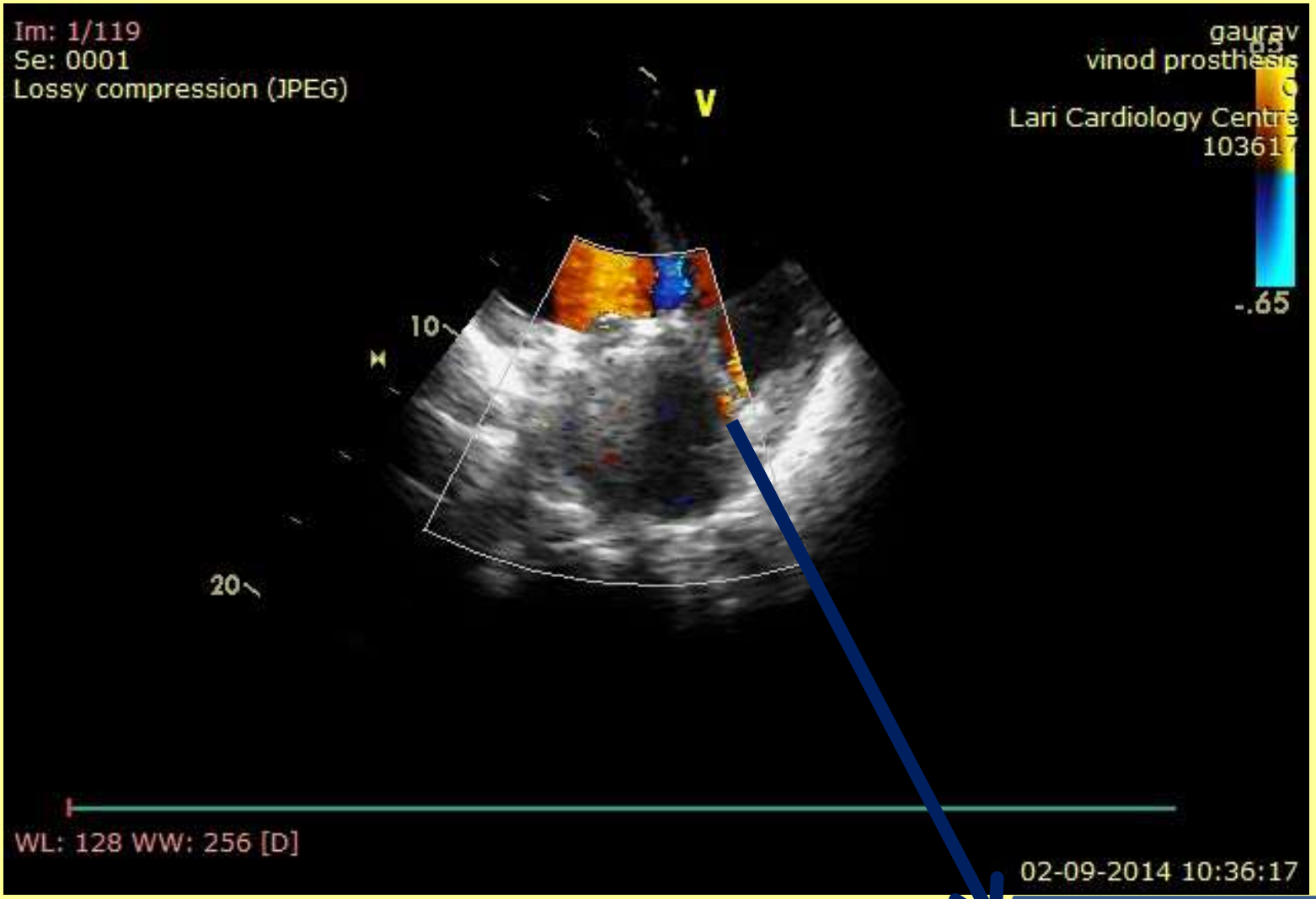


Figure 6 Prosthetic St Jude Medical valve thrombosis in the mitral position *(arrow)* obstructing and immobilizing one of the leaflets of the valve. After thrombolysis, leaflet mobility is restored, and the mean gradient (Gr) is significantly decreased. *LA*, Left atrium.

Thrombus on prosthetic valve



Mild paravalvular leak

Table 9 Transthoracic echocardiographic findings suggestive of significant prosthetic MR in mechanical valves with normal pressure half-time

Finding	Sensitivity	Specificity	Comments
Peak mitral velocity ≥1.9 m/s*	90%	89%	Also consider high flow, PPM
$VTI_{PrMV}/VTI_{LVO} \geq 2.5$*	89%	91%	Measurement errors increase in atrial fibrillation due to difficulty in matching cardiac cycles; also consider PPM
Mean gradient ≥ 5 mmHg*	90%	70%	At physiologic heart rates; also consider high flow, PPM
Maximal TR jet velocity > 3 m/s*	80%	71%	Consider residual postoperative pulmonary hypertension or other causes
LV stroke volume derived by 2D or 3D imaging is >30% higher than systemic stroke volume by Doppler	Moderate sensitivity	Specific	Validation lacking; significant MR is suspected when LV function is normal or hyperdynamic and VTI_{LVO} is <16 cm
Systolic flow convergence seen in the left ventricle toward the prosthesis	Low sensitivity	Specific	Validation lacking; technically challenging to detect readily

PrMV, Prosthetic mitral valve.
*Data from Olmos et al.[148] When both peak velocity and VTI ratio are elevated with a normal pressure half-time, specificity is close to 100%.

Table 10 Echocardiographic and Doppler criteria for severity of prosthetic MR using findings from TTE and TEE

Parameter	Mild	Moderate	Severe
Structural parameters			
LV size	Normal*	Normal or dilated	Usually dilated‡
Prosthetic valve‖	Usually normal	Abnormal¶	Abnormal¶
Doppler parameters			
Color flow jet area‖ #	Small, central jet (usually <4 cm^2 or <20% of LA area)	Variable	Large central jet (usually >8 cm^2 or >40% of LA area) or variable size wall-impinging jet swirling in left atrium
Flow convergence**	None or minimal	Intermediate	Large
Jet density: CW Doppler‖	Incomplete or faint	Dense	Dense
Jet contour: CW Doppler‖	Parabolic	Usually parabolic	Early peaking, triangular
Pulmonary venous flow‖	Systolic dominance§	Systolic blunting§	Systolic flow reversal†
Quantitative parameters††			
VC width (cm)‖	<0.3	0.3-0.59	≥0.6
R vol (mL/beat)	<30	30-59	≥60
RF (%)	<30	30-49	≥50
EROA (cm^2)	<0.20	0.20-0.49	≥0.50

EROA, Effective regurgitant orifice area; *RF*, regurgitant fraction; *R vol*, regurgitant volume; *VC*, vena contracta.

*LV size applied only to chronic lesions

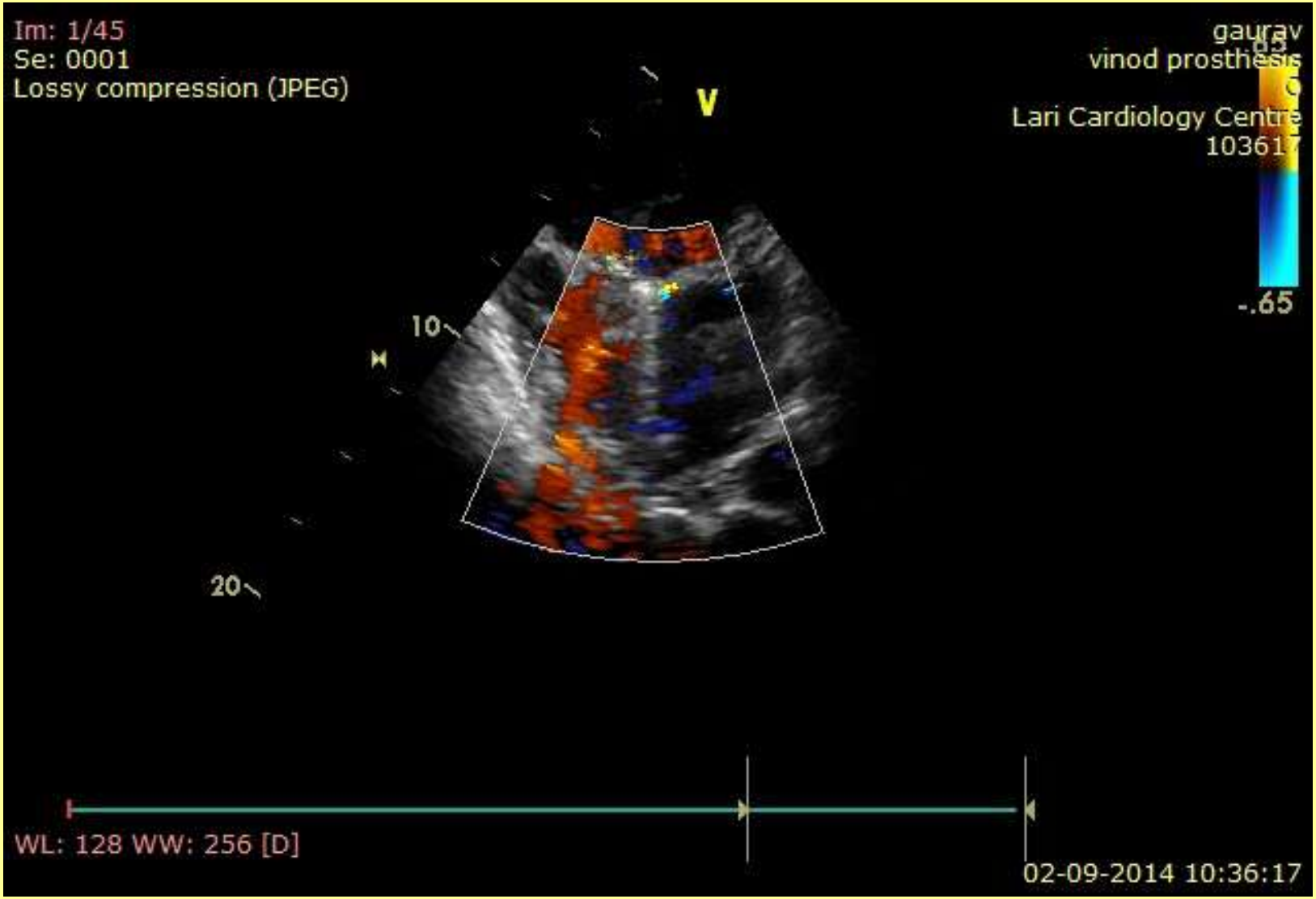

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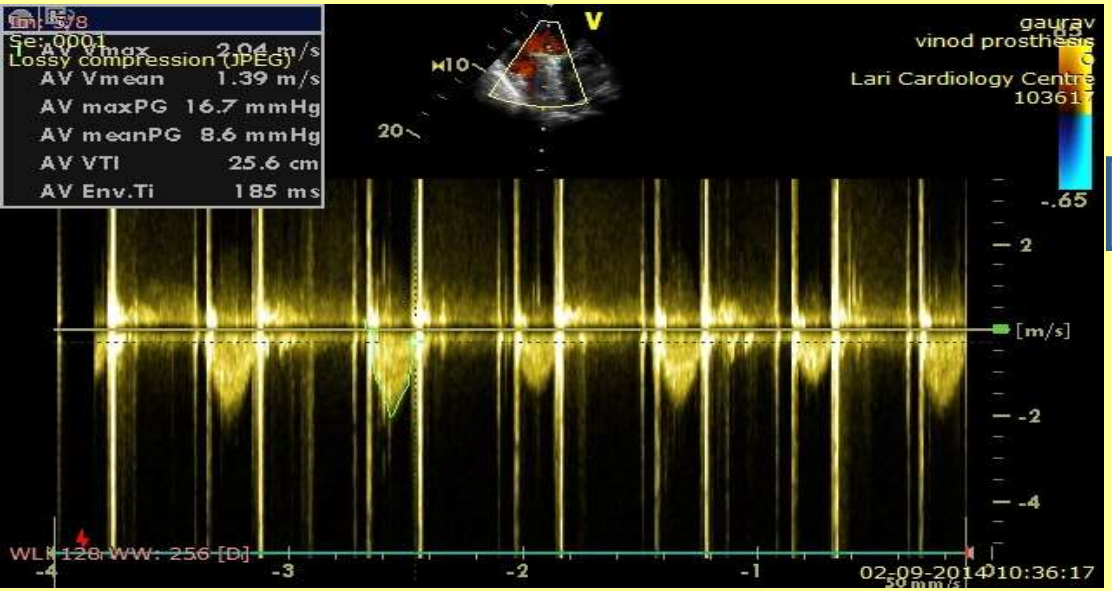
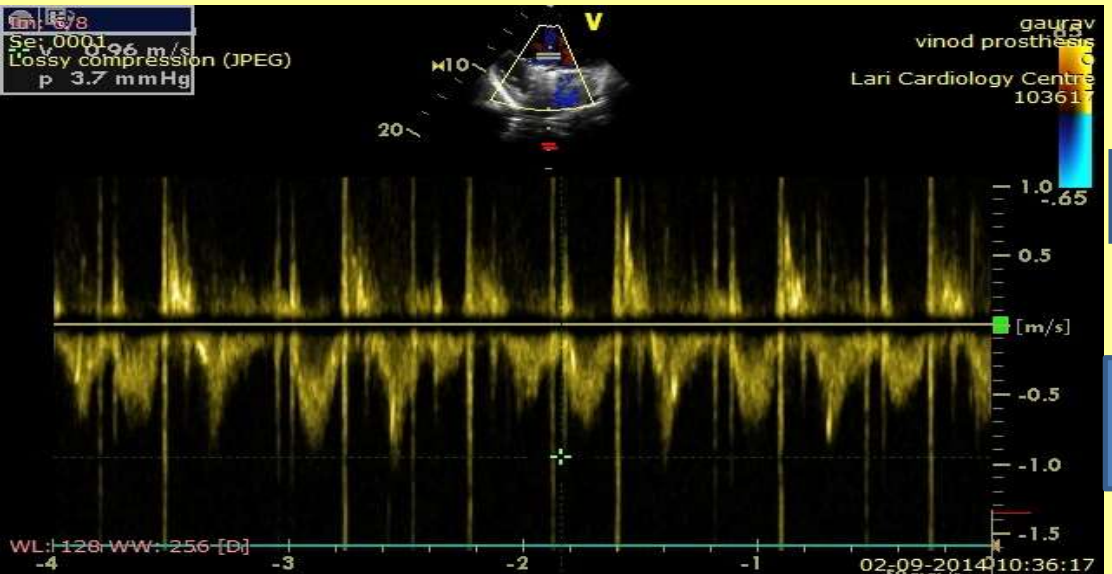
Table 6 Parameters for evaluation of the severity of prosthetic aortic valve regurgitation

Parameter	Mild	Moderate	Severe
Valve structure and motion			
Mechanical or bioprosthetic	Usually normal	Abnormal†	Abnormal†
Structural parameters			
LV size	Normal‡	Normal or mildly dilated‡	Dilated‡
Doppler parameters (qualitative or semiquantitative)			
Jet width in central jets (% LVO diameter): color*	Narrow (≤25%)	Intermediate (26%-64%)	Large (≥65%)
Jet density: CW Doppler	Incomplete or faint	Dense	Dense
Jet deceleration rate (PHT, ms): CW Doppler§	Slow (>500)	Variable (200-500)	Steep (<200)
LVO flow vs pulmonary flow: PW Doppler	Slightly increased	Intermediate	Greatly increased
Diastolic flow reversal in the descending aorta: PW Doppler	Absent or brief early diastolic	Intermediate	Prominent, holodiastolic
Doppler parameters (quantitative)			
Regurgitant volume (mL/beat)	<30	30-59	>60
Regurgitant fraction (%)	<30	30-50	>50

PHT, Pressure half-time.



Velocity at prosthetic valve level 2m/s



Velocity at LVOT level 1m/s

DVI =1/2=.5

DVI (Doppler velocity index)

DVI is a dimensionless ratio of the proximal velocity in the LVO tract to that of flow velocity through the prosthesis:

- DVI = VLVO/VPrAV

Normal prosthetic valve function

- Mean DVI, 0.39; range - 0.28-0.55

- A DVI < 0.25 is highly suggestive of significant valve obstruction

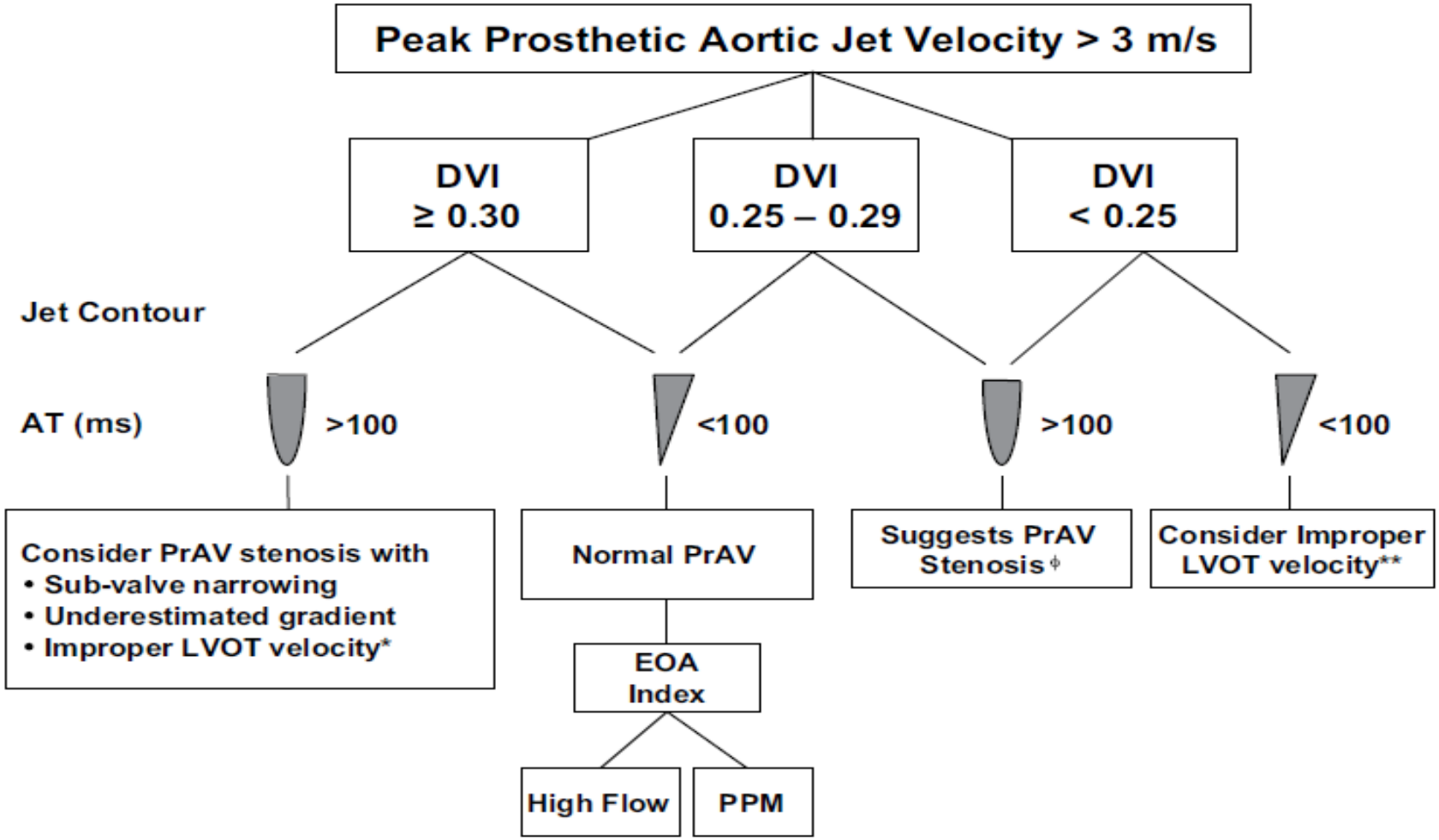
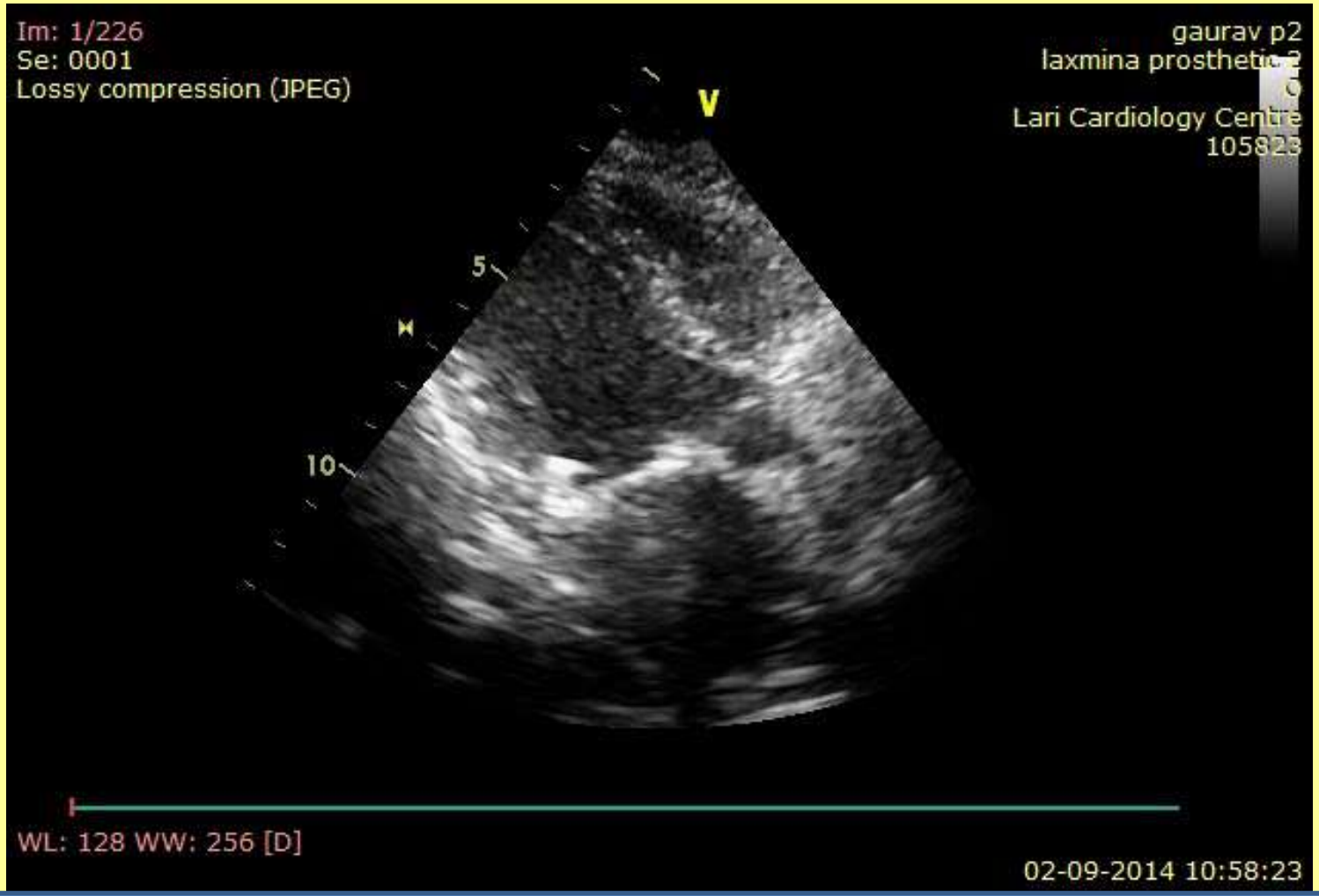


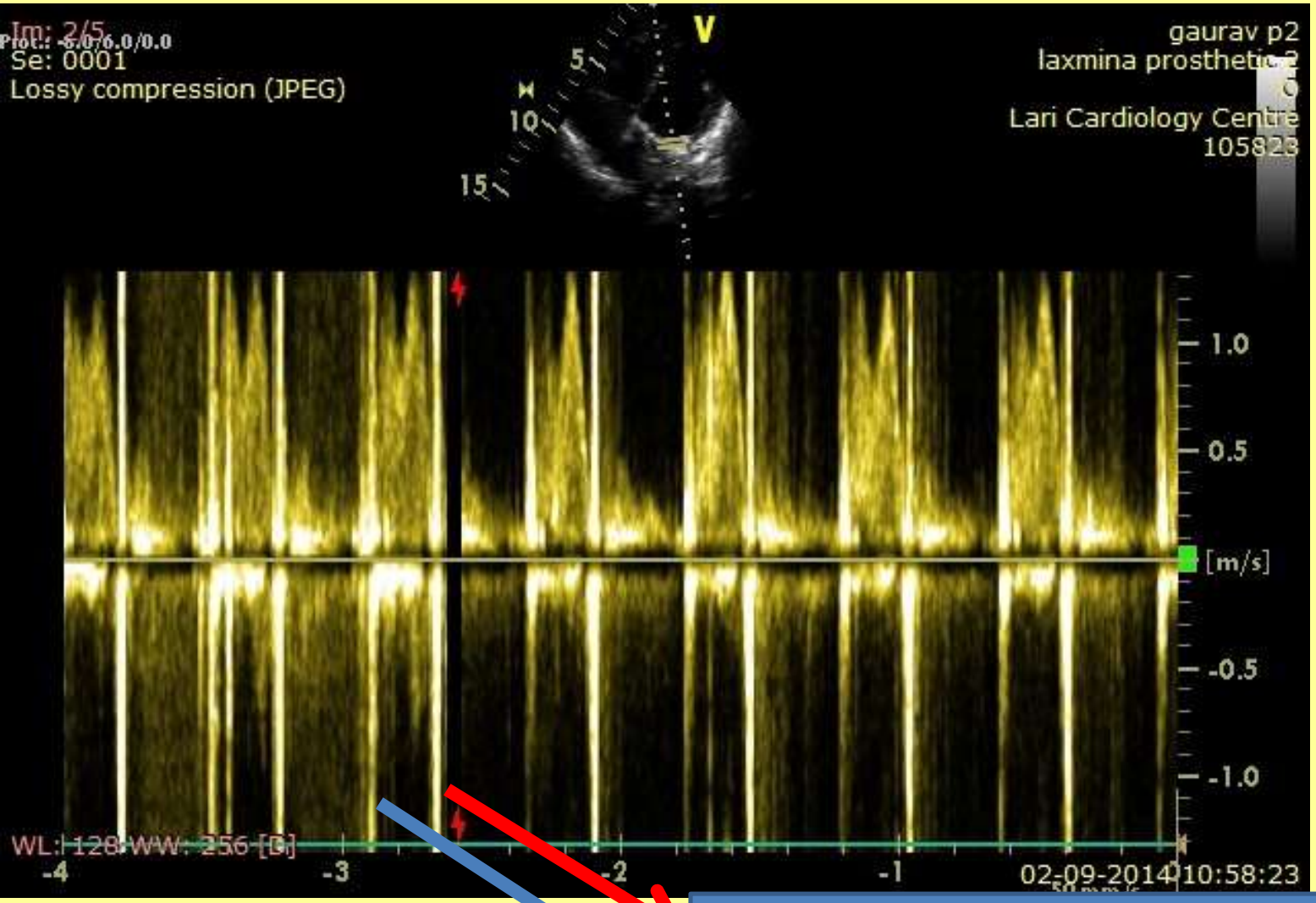
Figure 10 Algorithm for evaluation of elevated peak prosthetic aortic jet velocity incorporating DVI, jet contour, and AT. *PW Doppler sample too close to the valve (particularly when jet velocity by CW Doppler is ≥4 m/s). **PW Doppler sample too far (apical) from the valve (particularly when jet velocity is 3-3.9 m/s). φStenosis further substantiated by EOA derivation compared with reference values if valve type and size are known. Fluoroscopy and TEE are helpful for further assessment, particularly in bileaflet valves. *AVR*, Aortic valve replacement.

Case 3

- 30 yr female ,post MVR (SJM)



Leaflet excursion normal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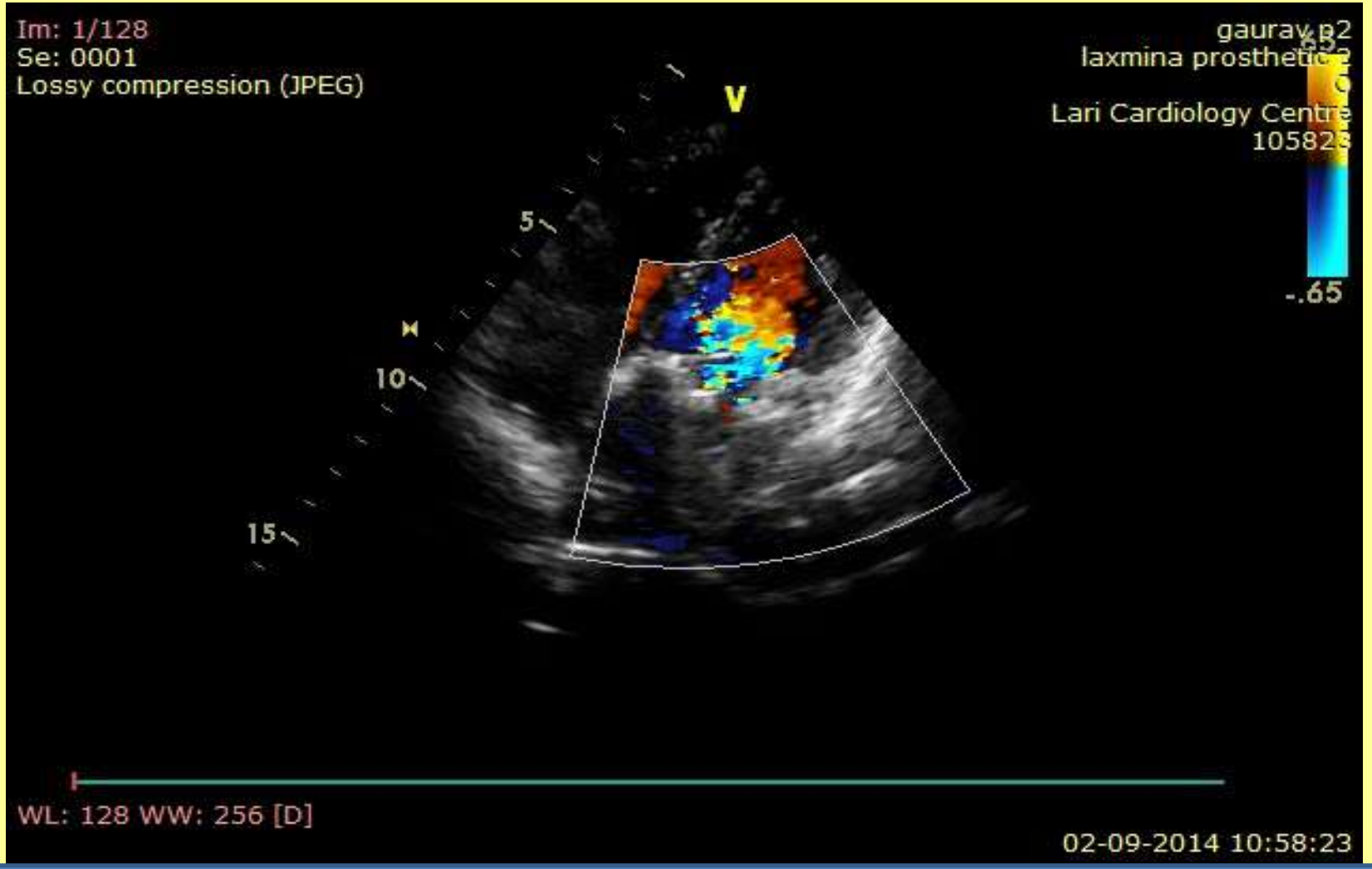


Trivial paravalvular leakage

TTE Can be deceptive sometimes !!!!!

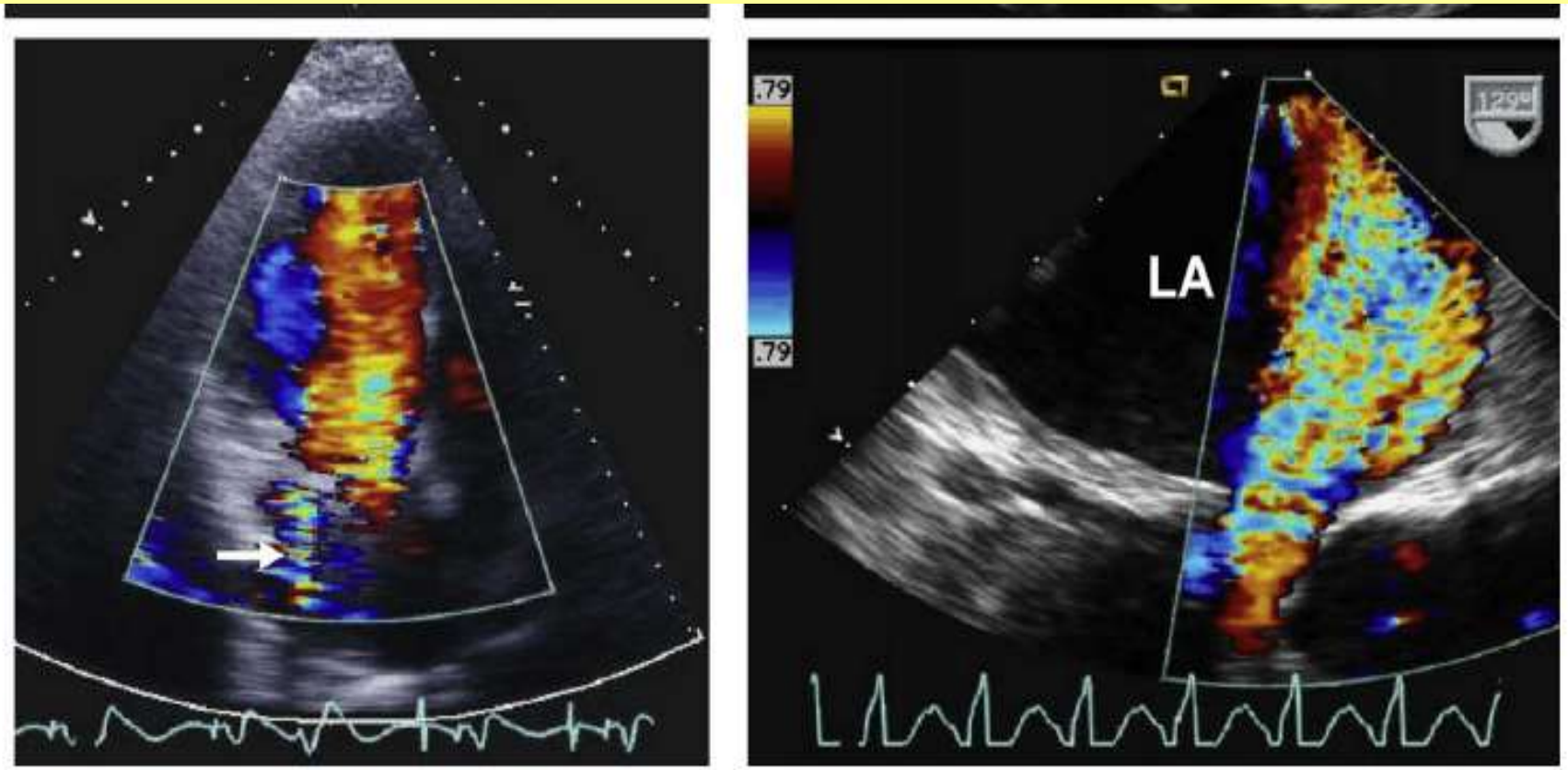
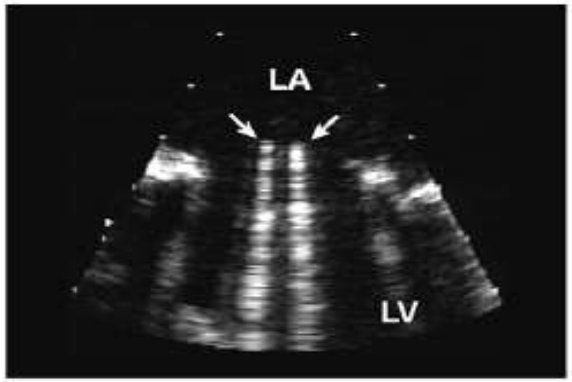


Figure 12 Transthoracic versus transesophageal echocardiographic and Doppler images in a patient with severe paravalvular MR. Shadowing on TTE of the left atrium *(arrows)* masked significantly the regurgitant jet by color Doppler *(single white arrow)*. The extent of valvular dehiscence is shown by the *green arrow* on TEE as well as the severity of regurgitation by color Doppler. See Videos 13 to 16. View video clips online.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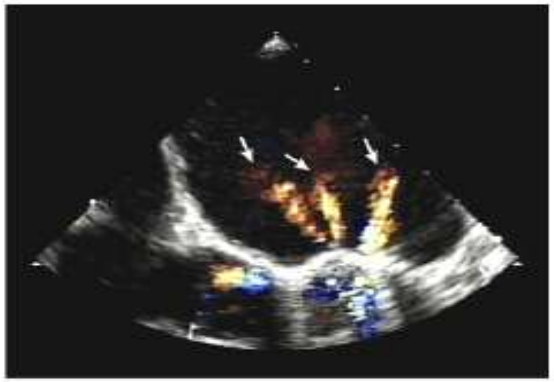


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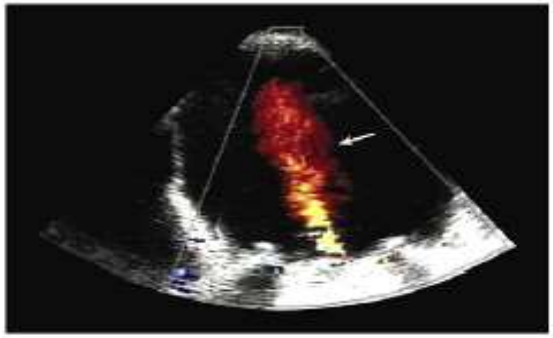

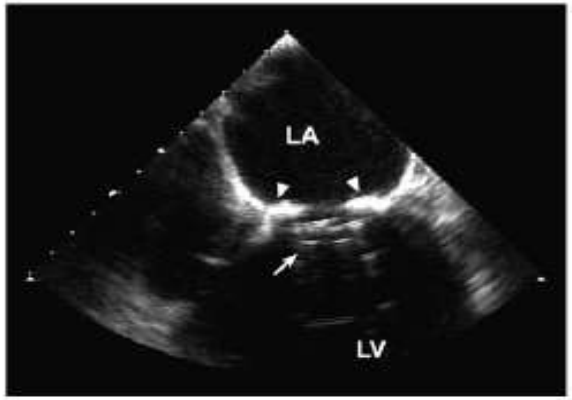
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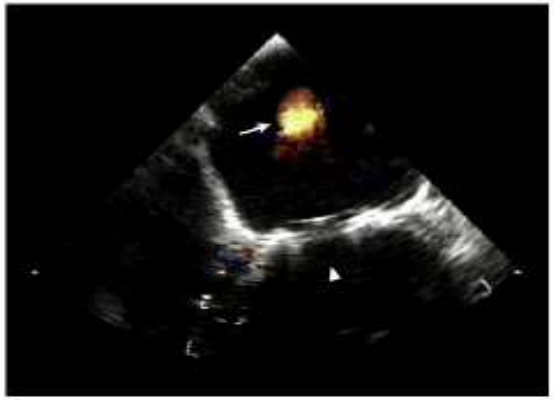

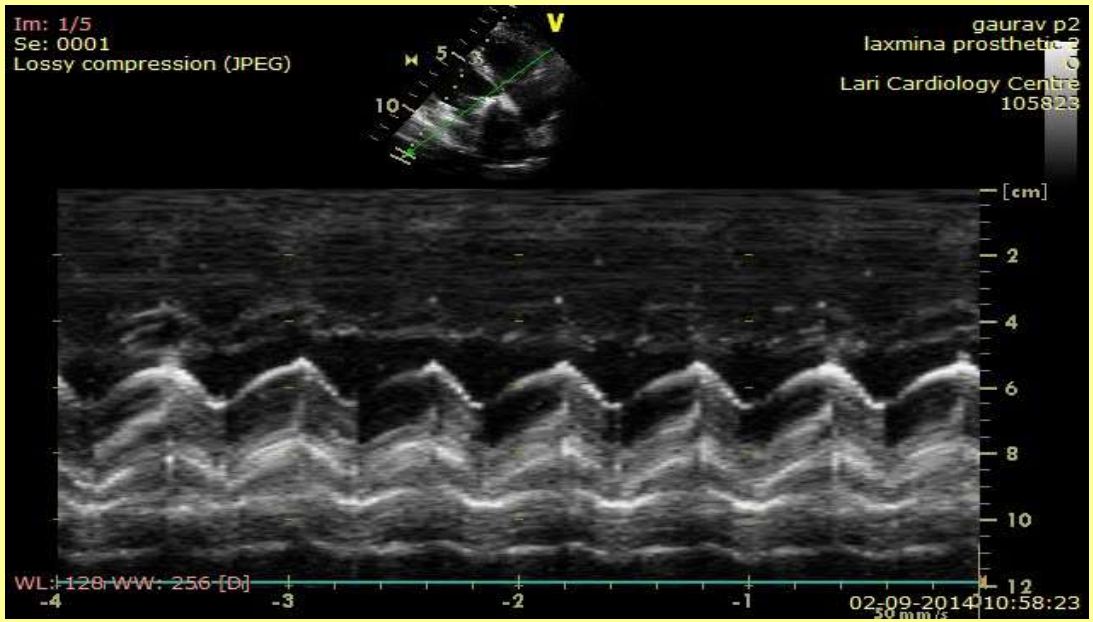
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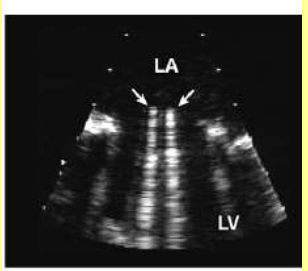
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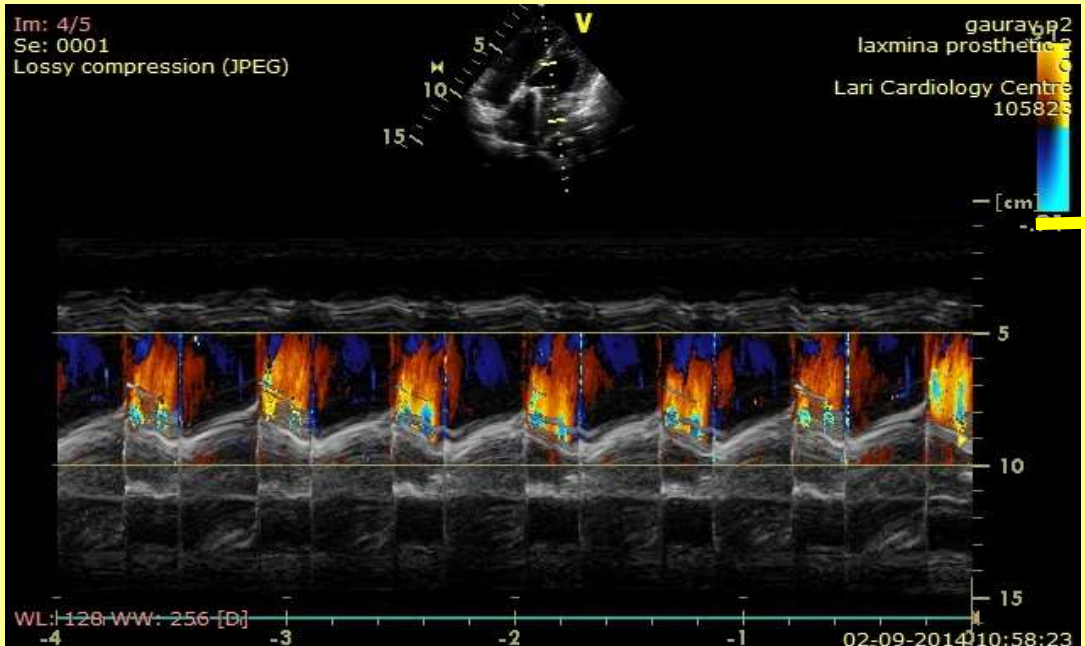
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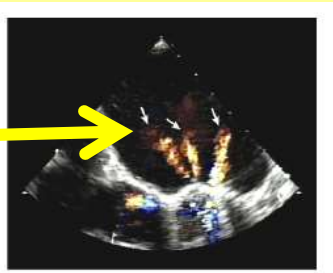


Prosthetic valve stenosis/regurgitation …..

Prosthetic Valve Stenosis

Class I

1. **Repeat valve replacement is indicated for severe symptomatic prosthetic valve stenosis.** ***(Level of Evidence: C)***

Prosthetic Valve Regurgitation

Class I

1. **Surgery is recommended for operable patients with mechanical heart valves with intractable hemolysis or HF due to severe prosthetic or paraprosthetic regurgitation (617, 618).** ***(Level of Evidence: B)***

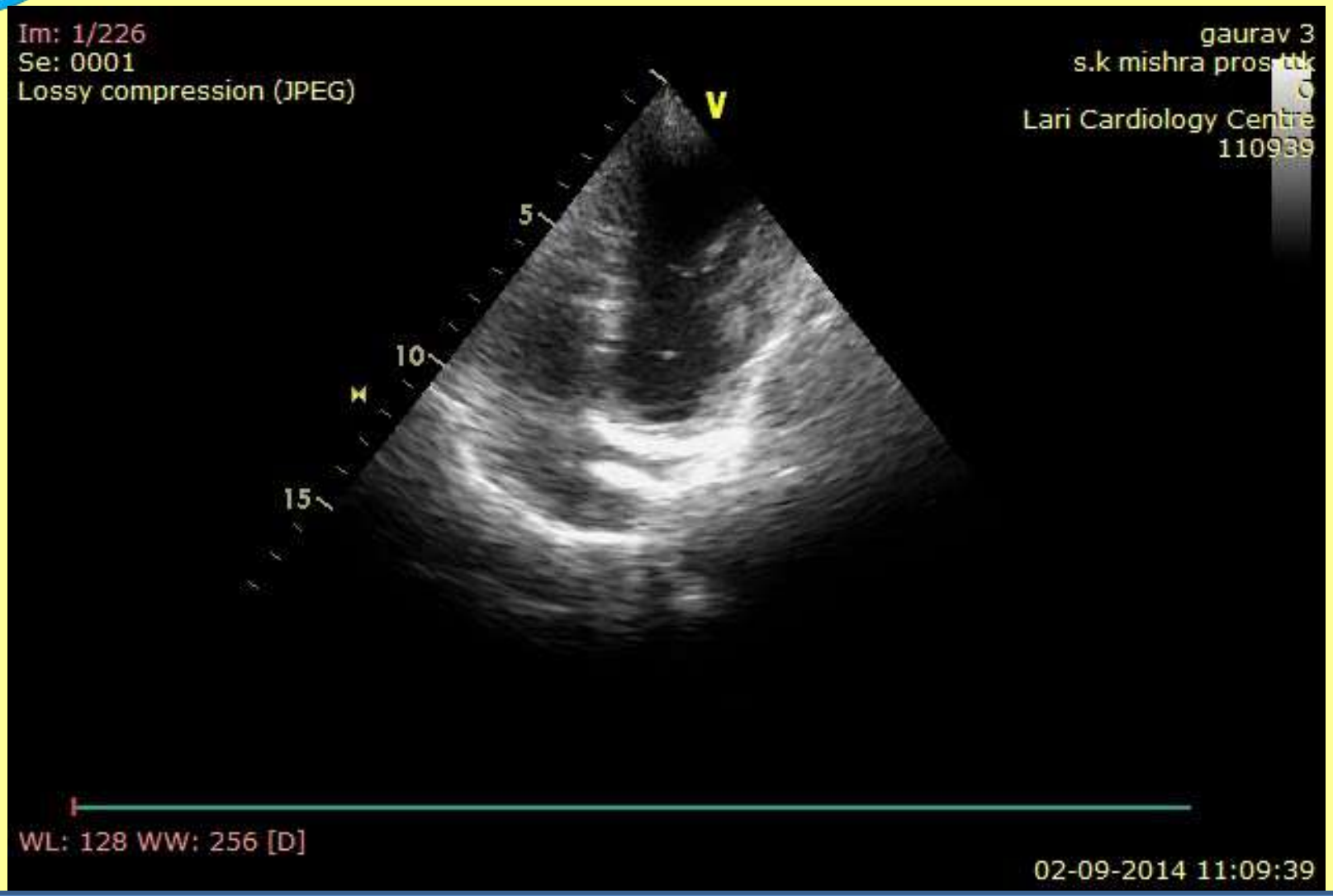
Class IIa

1. **Surgery is reasonable for operable patients with severe symptomatic or asymptomatic bioprosthetic regurgitation.** ***(Level of Evidence C)***

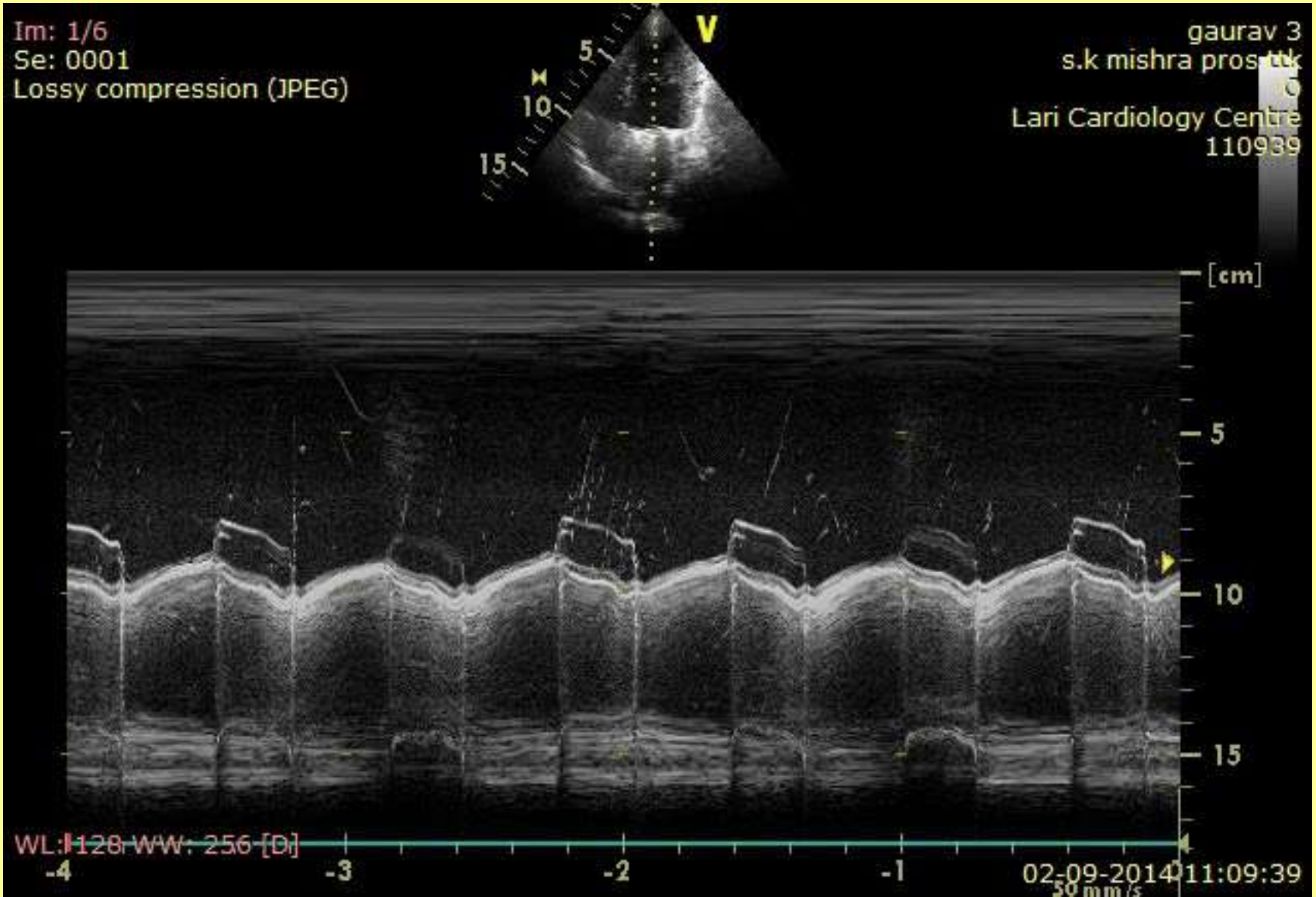
2. **Percutaneous repair of paravalvular regurgitation is reasonable in patients with prosthetic heart valves and intractable hemolysis or NYHA class III/IV HF who are at high risk for surgery and have anatomic features suitable for catheter-based therapy when performed in centers with expertise in the procedure (620-622).** ***(Level of Evidence B)***

Case 4

- 35 yr male ,Post MVR (TTK 29 Chitra) in oct 2008



Single Tilting disc excursion normal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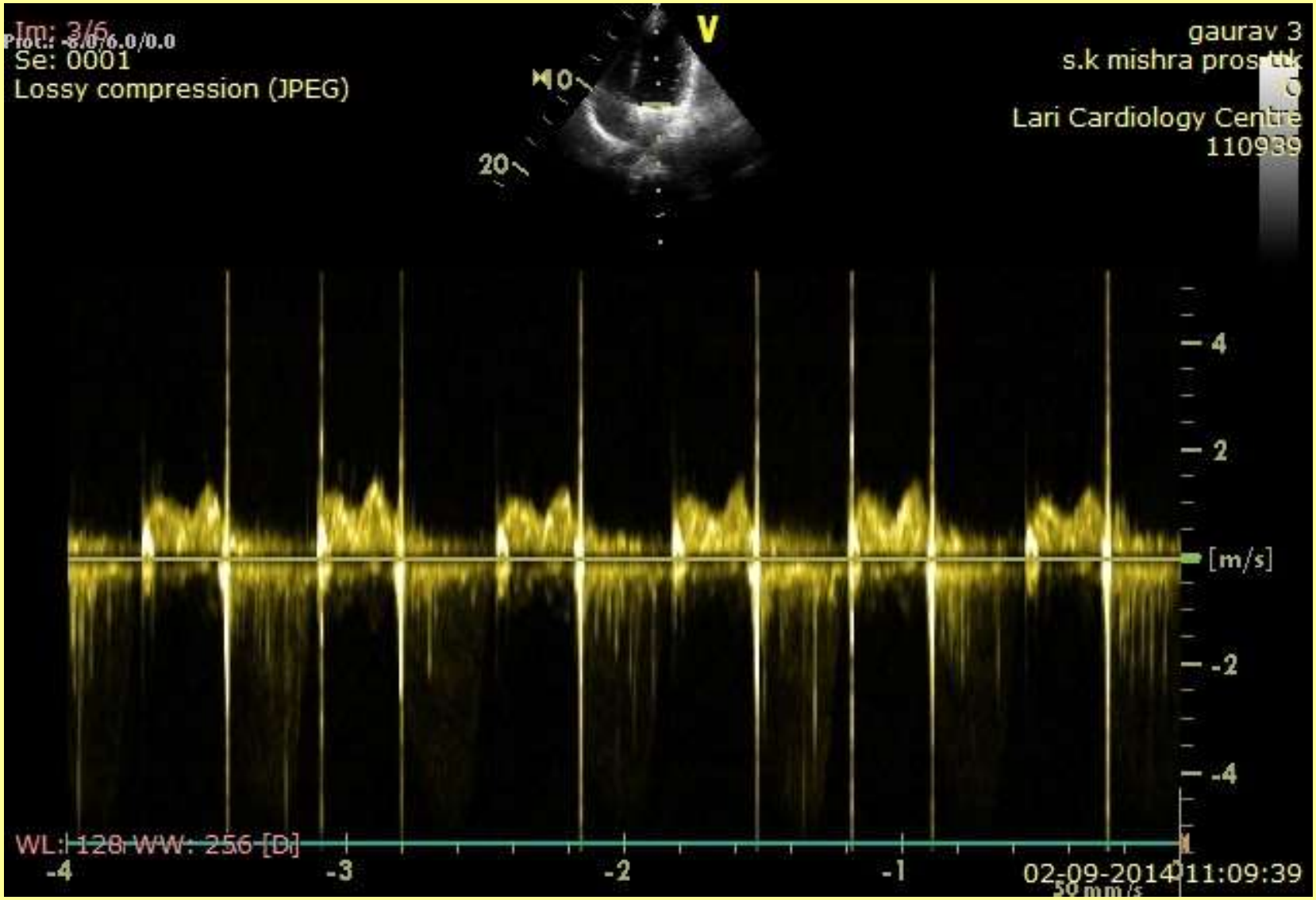
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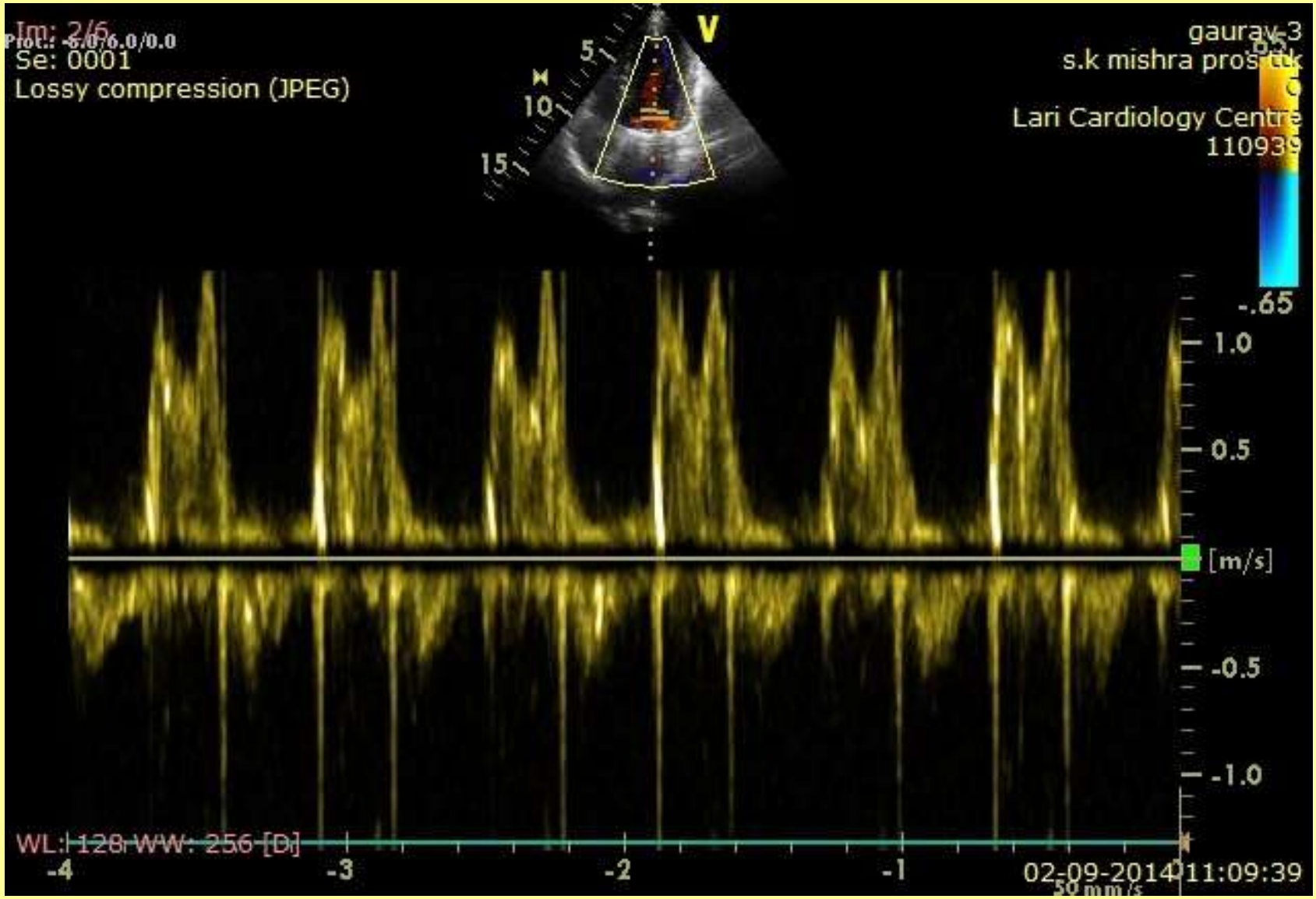
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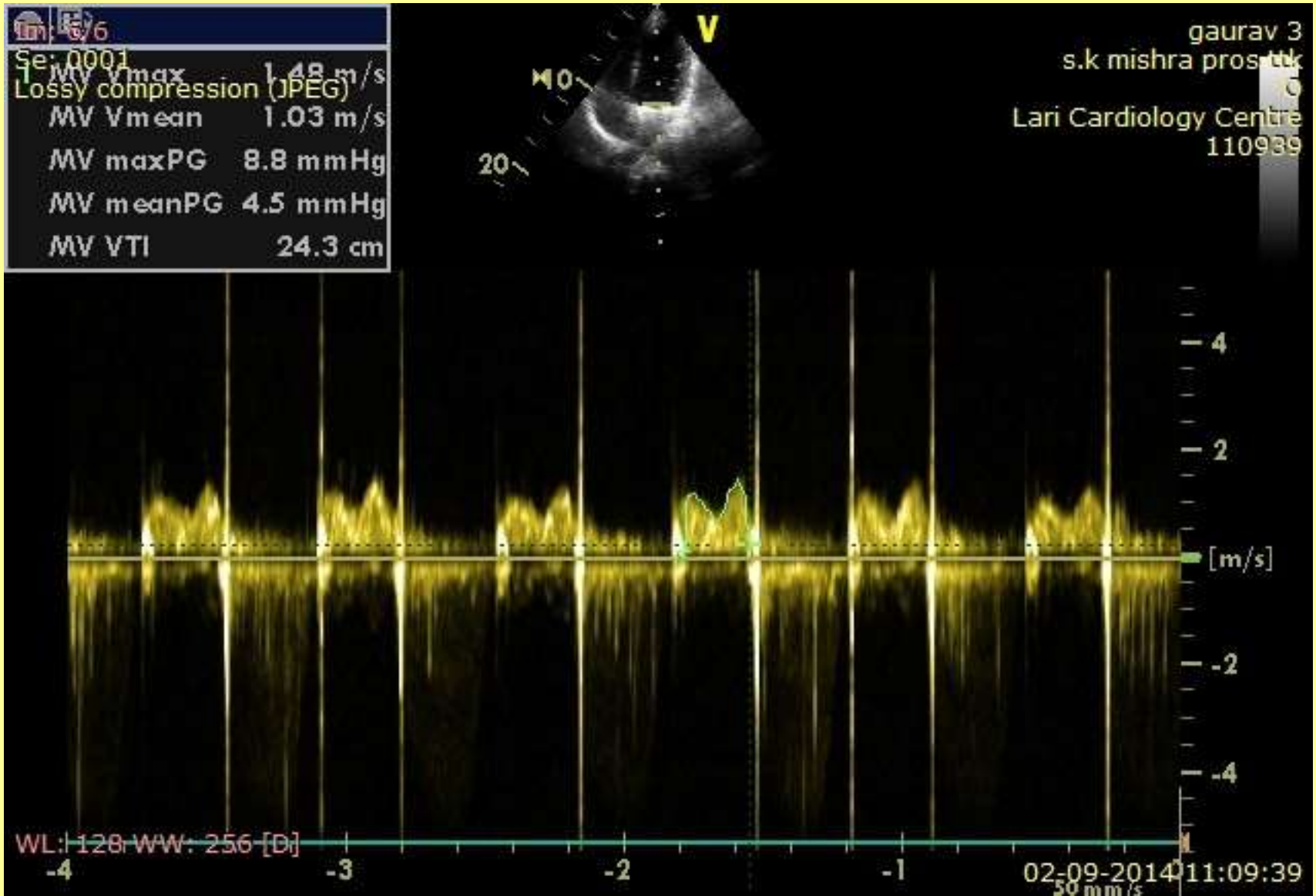
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Lossy compression (JPEG)
MV Vmax 1.48 m/s
MV Vmean 1.03 m/s
MV maxPG 8.8 mmHg
MV meanPG 4.5 mmHg
MV VTI 24.3 cm
gaurav 3
s.k mishra pros ttk
Lari Cardiology Centre
110939
20
0
V
4
2
[m/s]
-2
-4
WL: 128 WW: 256 [D]
-4
-3
-2
-1
02-09-2014 11:09:39
50 mm/s

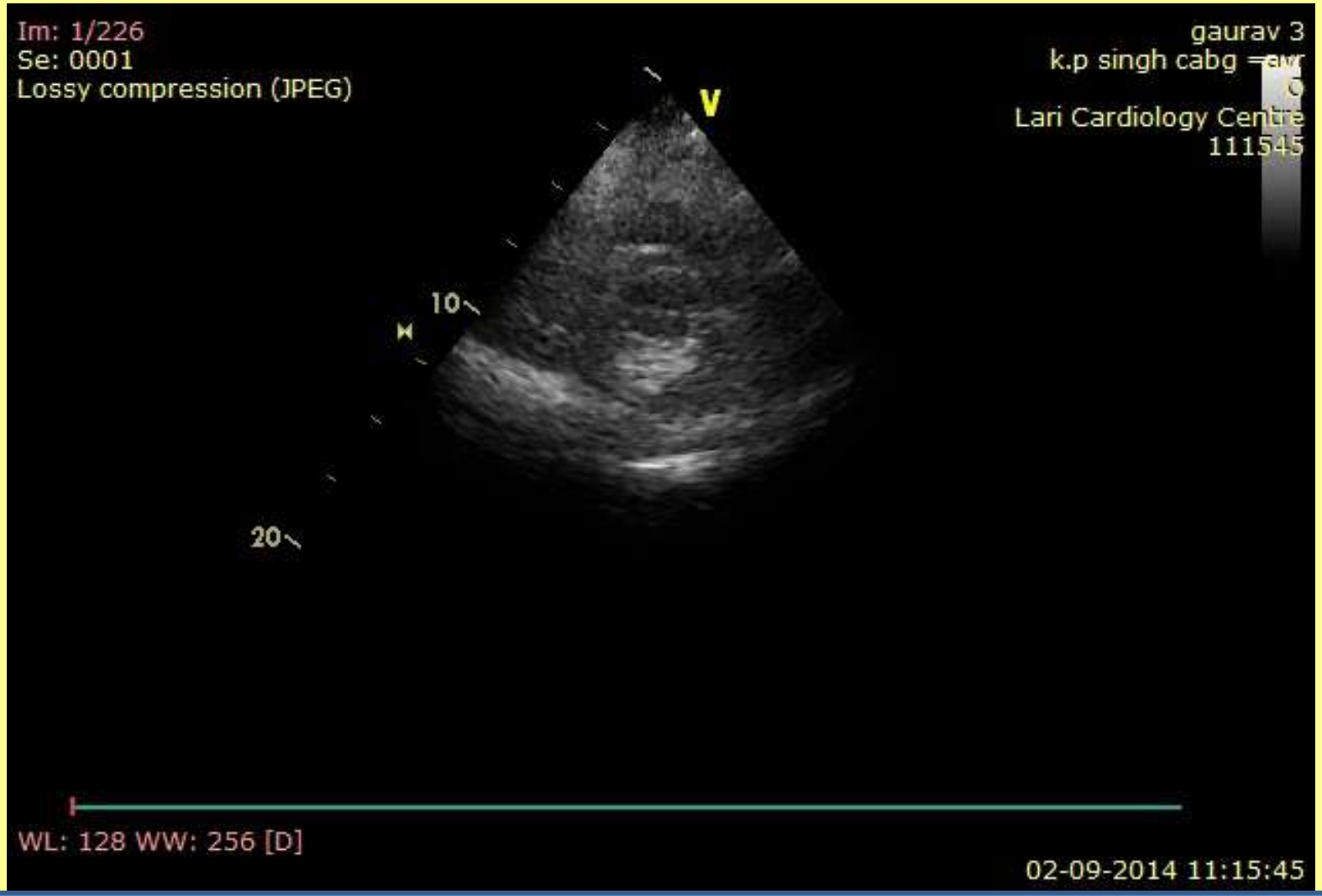
TTK chitra valve

- Tilting disc valve
  - Metallic housing (cobalt based wrought alloy)
  - Circular disc high molecular weight polyethylene
  - Polyester suture ring

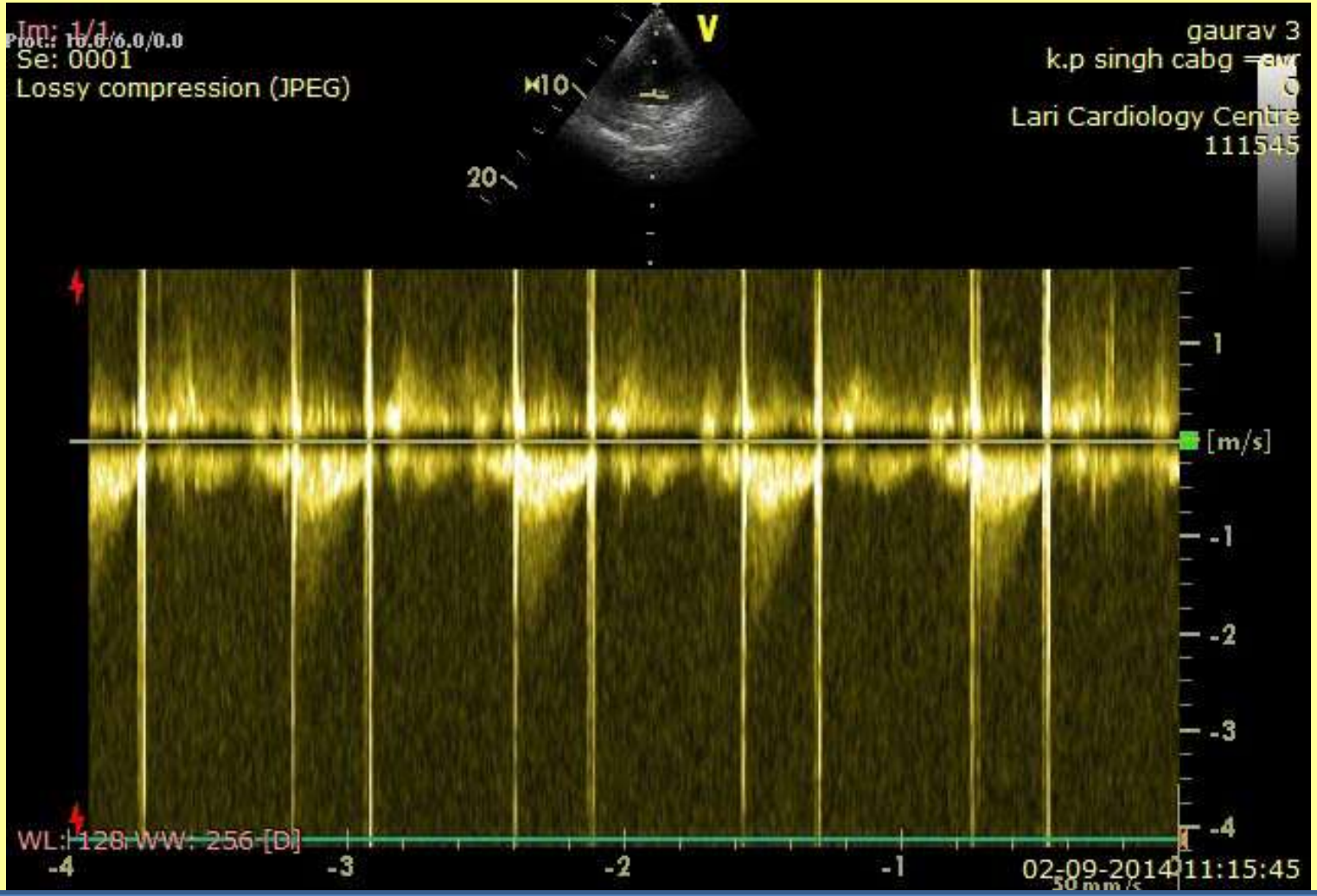
- Hemodynamically comparable to other mechanical valves
- Valve related complications are similar

Case 5

- 65 yr male Post CABG (LIMA –LAD,SVG-RCA) + AVR (21 A –SJM) in may 2014



Well preserved LVEF



Trivial AR, No significant gradient across Prosthetic valve

Patient-prosthesis mismatch (PPM)

- It is *Nonstructural dysfunction,* a composite category that includes any abnormality that results in stenosis or regurgitation of the operated valve that is not intrinsic to the valve itself, exclusive of thrombosis and infection
- This includes inappropriate sizing, which is called *valve prosthesis–patient mismatch (VP-PM)*
- When the effective prosthetic valve area, after insertion into the patient less than that of a normal valve
- Patients with aortic PHV have obstruction to left ventricular outflow (similar to aortic stenosis), and patients with mitral PHV have obstruction to left atrial emptying (similar to mitral stenosis)

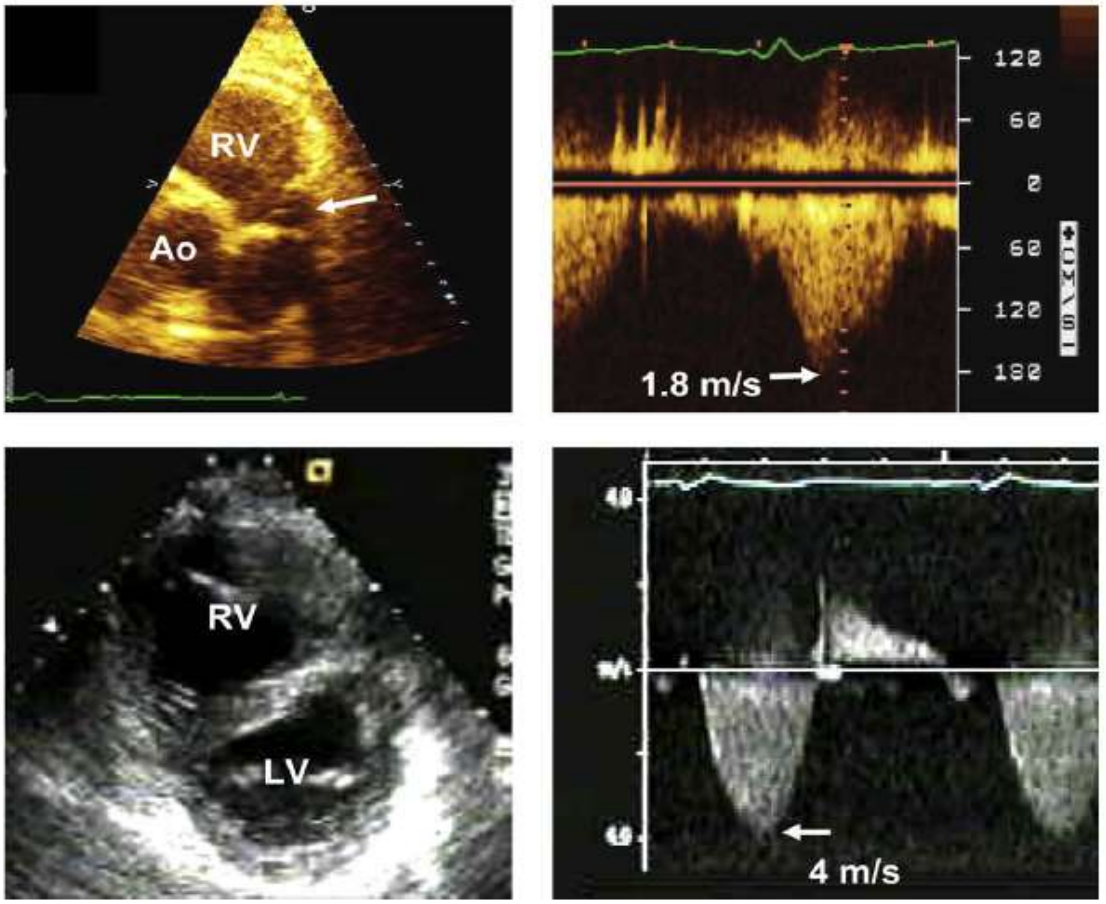
Patient-prosthesis mismatch (PPM)

Table 3. Threshold Values of Indexed Prosthetic Valve EOA for the Identification and Quantification of PPM

	Mild or Not Clinically Significant, cm^2/m^2	Moderate, cm^2/m^2	Severe, cm^2/m^2
Aortic position	>0.85 (0.8–0.9)	≤0.85 (0.8–0.9)	≤0.65 (0.6–0.7)
Mitral position	>1.2 (1.2–1.3)	≤1.2 (1.2–1.3)	≤0.9 (0.9)

Numbers in parentheses represent the range of threshold values that have been used in the literature.

Normal
Pr PV



Obstructed
Pulmonary
Homograft

Figure 15 Examples of a normal prosthetic pulmonary valve and that of an obstructed pulmonary homograft showing dilatation of the right ventricle and a deformed septum. The obstructed homograft had a maximal gradient of 64 mm Hg.

Bioprosthesis evalvation

Table 5 Doppler parameters of prosthetic aortic valve function in mechanical and stented biologic valves*

Parameter	Normal	Possible stenosis	Suggests significant stenosis
Peak velocity (m/s)†	<3	3-4	>4
Mean gradient (mm Hg)†	<20	20-35	>35
DVI	≥0.30	0.29-0.25	<0.25
EOA (cm^2)	>1.2	1.2-0.8	<0.8
Contour of the jet velocity through the PrAV	Triangular, early peaking	Triangular to intermediate	Rounded, symmetrical contour
AT (ms)	<80	80-100	>100

PrAV, Prosthetic aortic valve.

*In conditions of normal or near normal stroke volume (50-70 mL) through the aortic valve.

†These parameters are more affected by flow, including concomitant AR.

THANK YOU