Aortic Regurgitation

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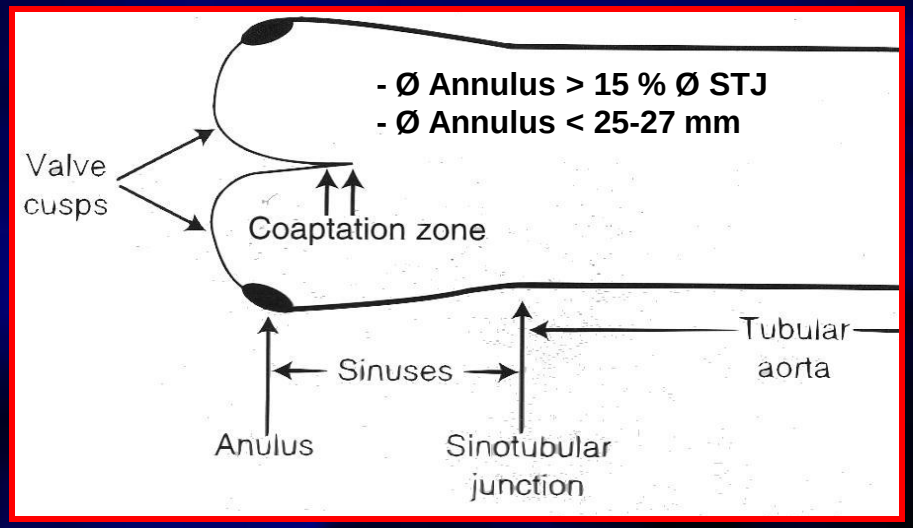
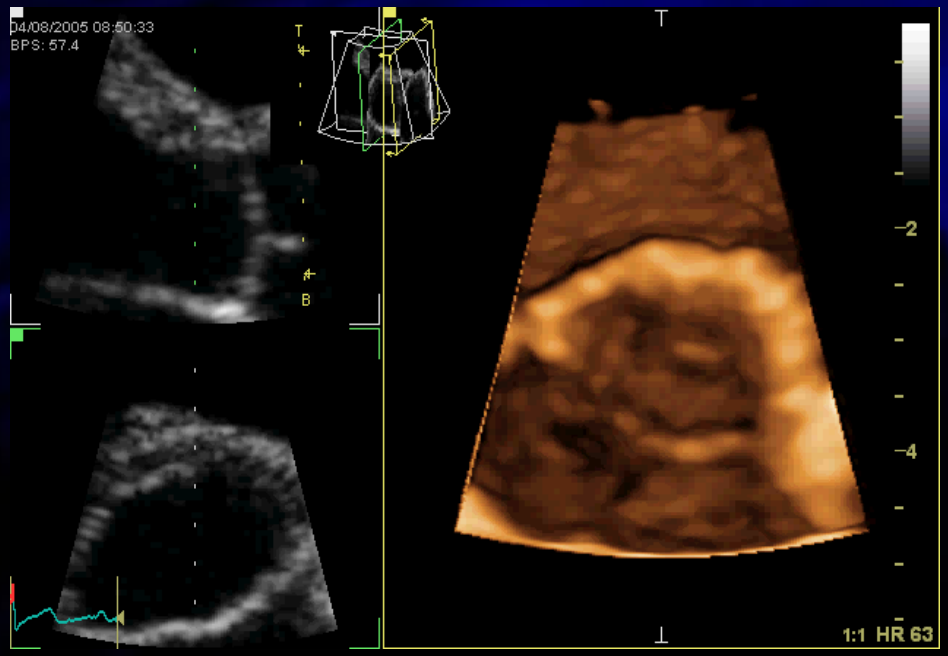
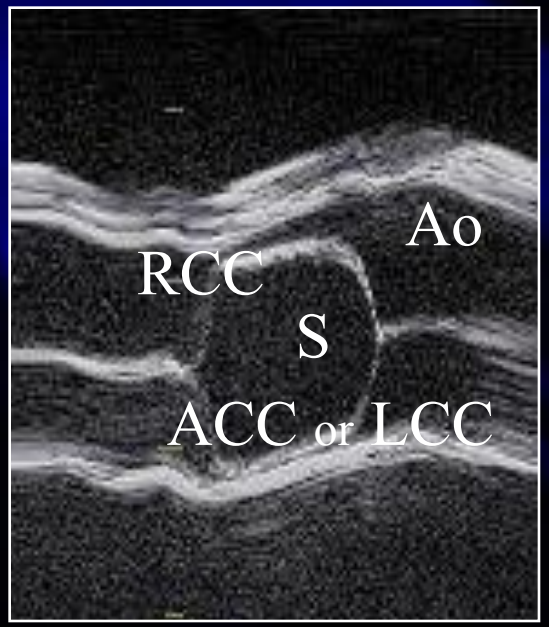
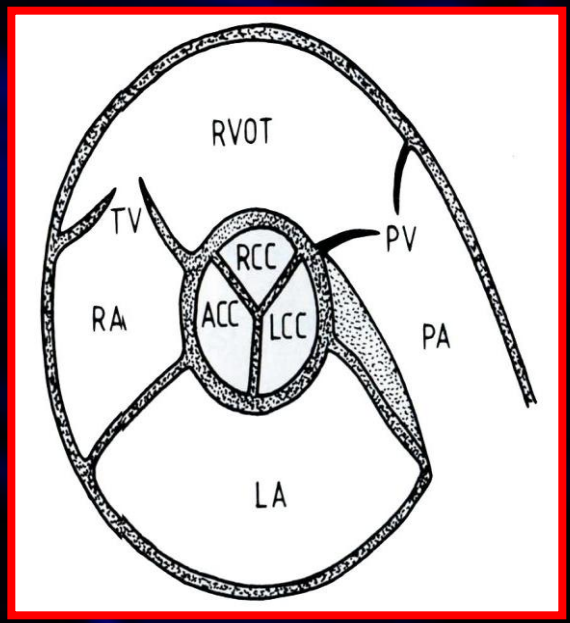
Anatomical structure of the aortic valve









Etiology

ACUTE AR	CHRONIC AR
1. Infective endocarditis 2. Acute rheumatic fever 3. Prosthetic valve dysfunction 4. Aortic dissection 5. Trauma 6. Systemic hypertension	1. Idiopathic aortic root dilation 2. Infective endocarditis 3. Bicuspid aortic valve 4. Rheumatic 5. Congenital lesions: AS, VSD 6. Connective tissue disease : Marfan's syndrome, Ehlers-Danlos, Osteogenesis imperfecta 7. Autoimmune diseases: SLE, Ankylosing spondylitits, Reiter's syndrome 8. Aortitis :Takayasu's aortitis, Syphilitic

VALVE ANALYSIS

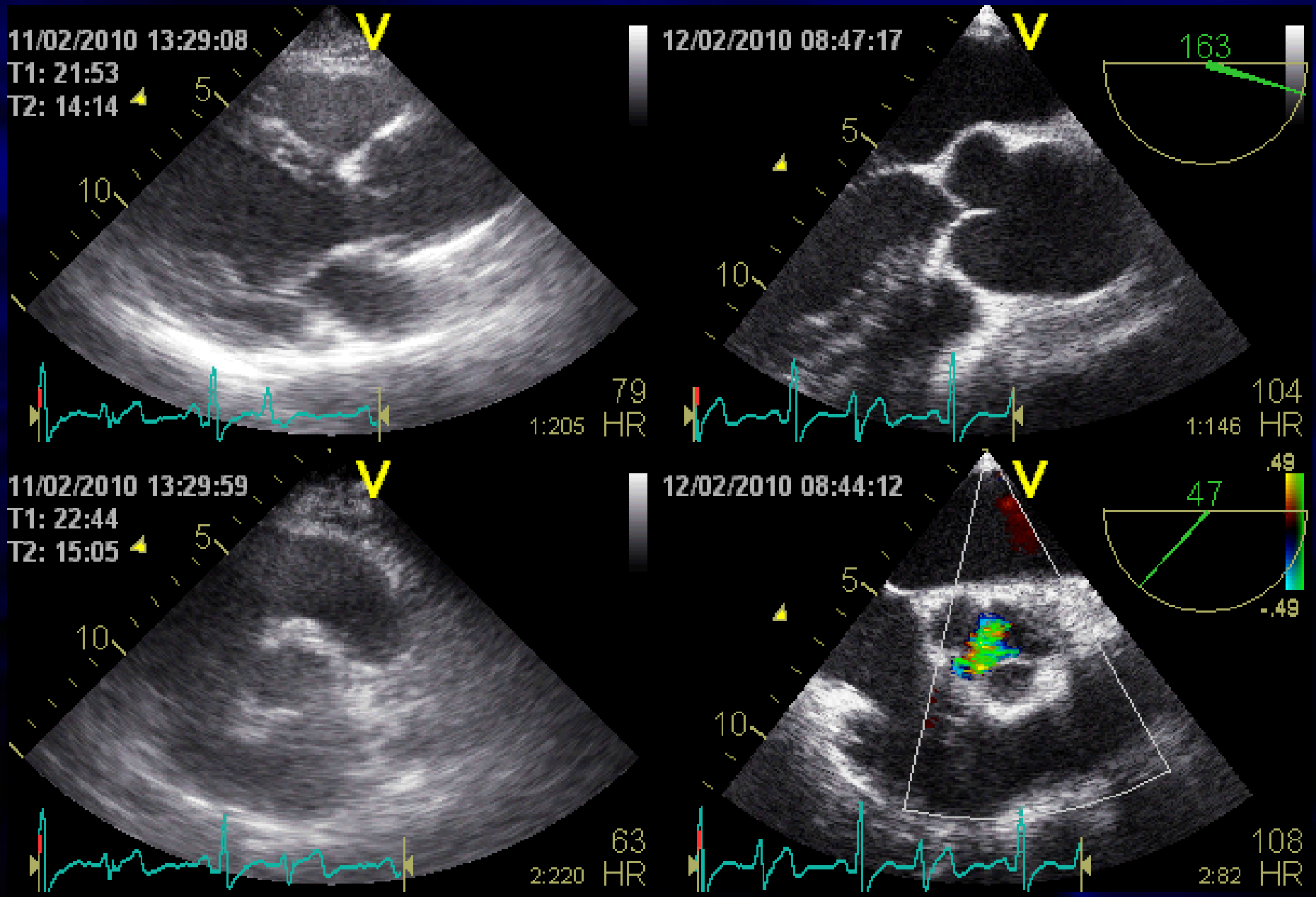
Etiology → The Cause of Valve Disease

Lesions → The Result of the Disease Process

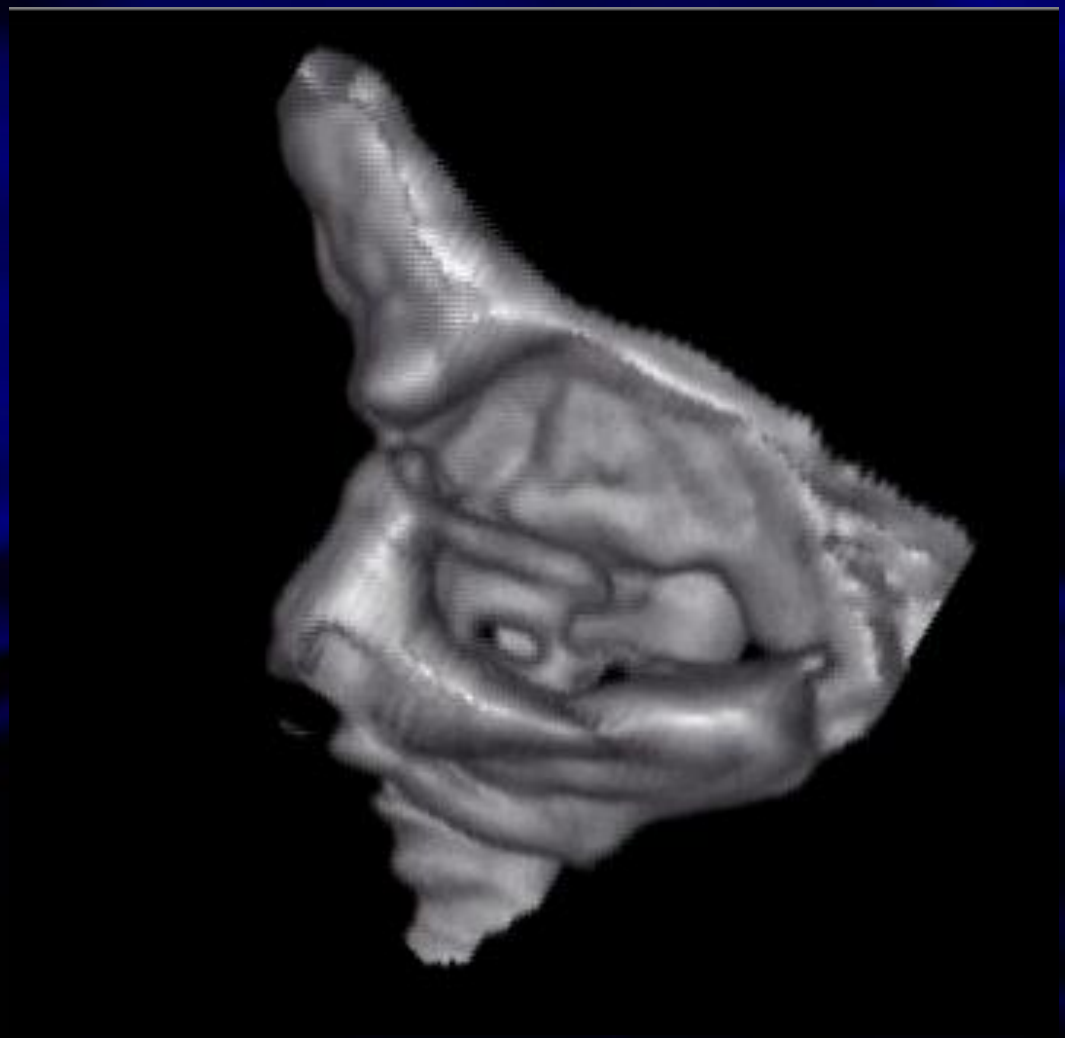
Dysfunction → The Result of the Lesions

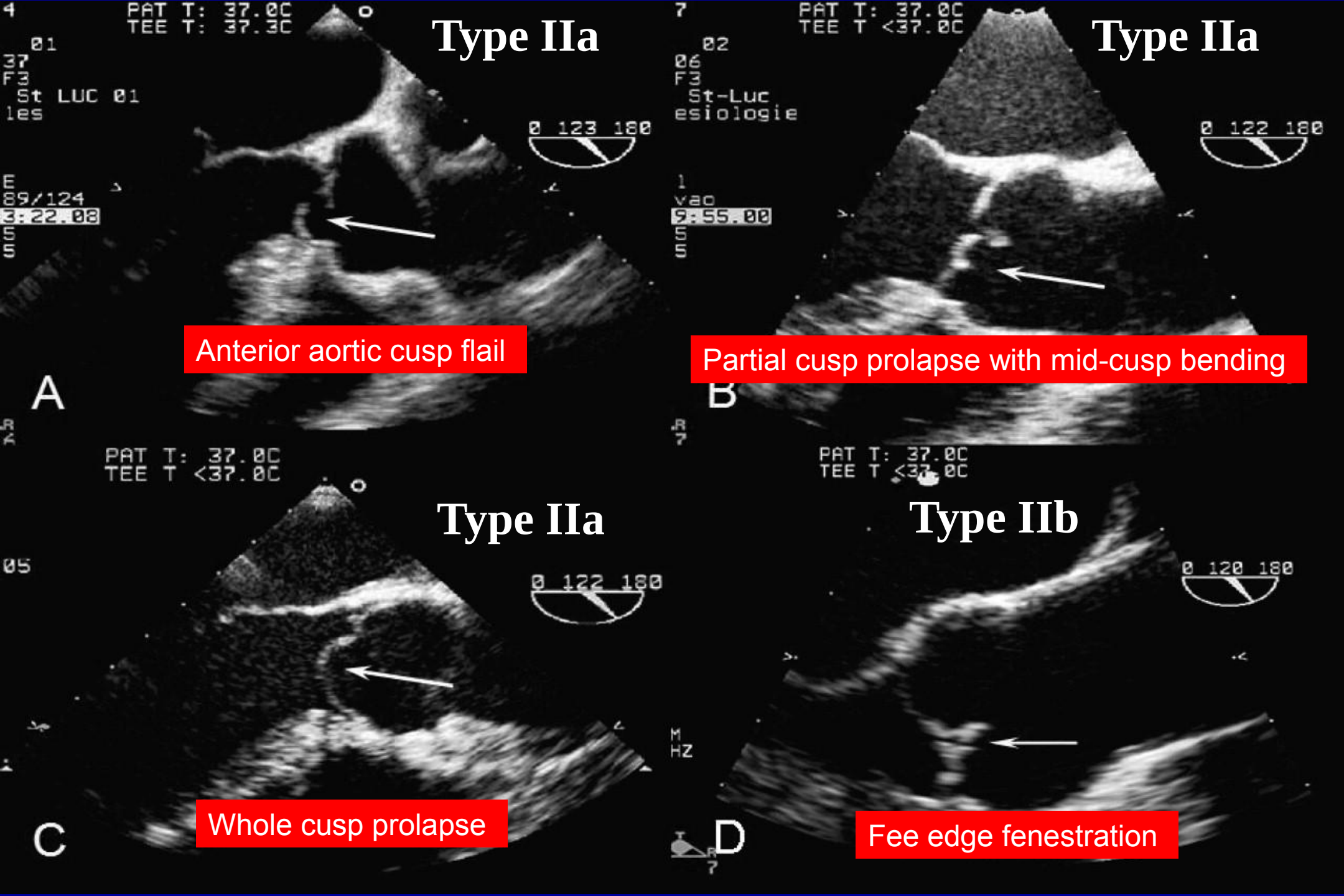
Dysfunction	Lesions
Type I Normal leaflet motion	• Enlargement of the aortic root • Leaflet perforation
Type II Excessive leaflet motion	• Cusp prolapse or fenestration
Type III Reduced leaflet motion	• Poor cusp tissue quality or quantity (Thickening, Calcifications, Fusion,…)

Type I

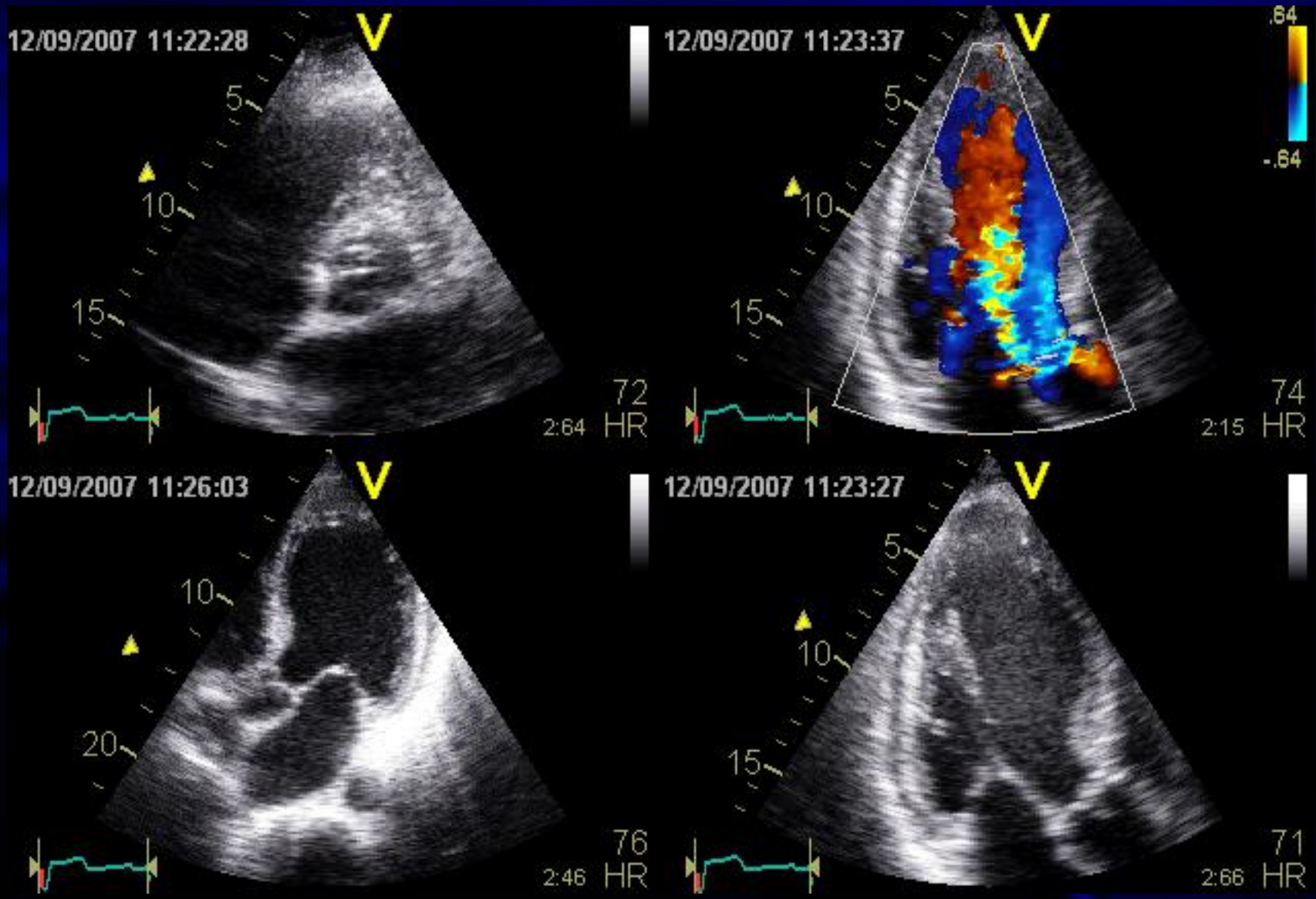

11/02/2010 13:29:08
T1: 21:53
T2: 14:14
79
1:205 HR
12/02/2010 08:47:17
163
104
1:146 HR
11/02/2010 13:29:59
T1: 22:44
T2: 15:05
63
2:220 HR
12/02/2010 08:44:12
.49
47
-.49
108
2:82 HR

Type I

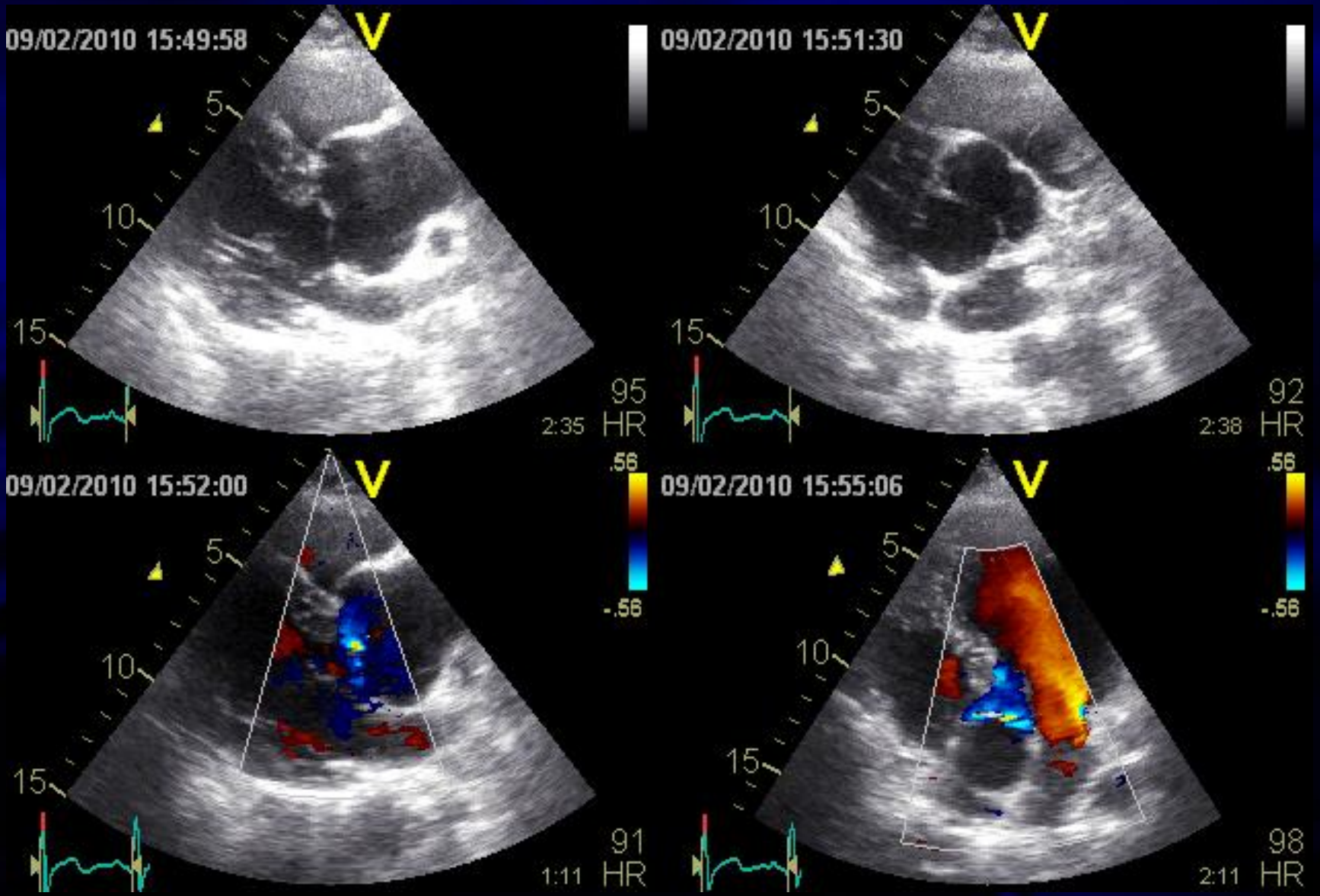


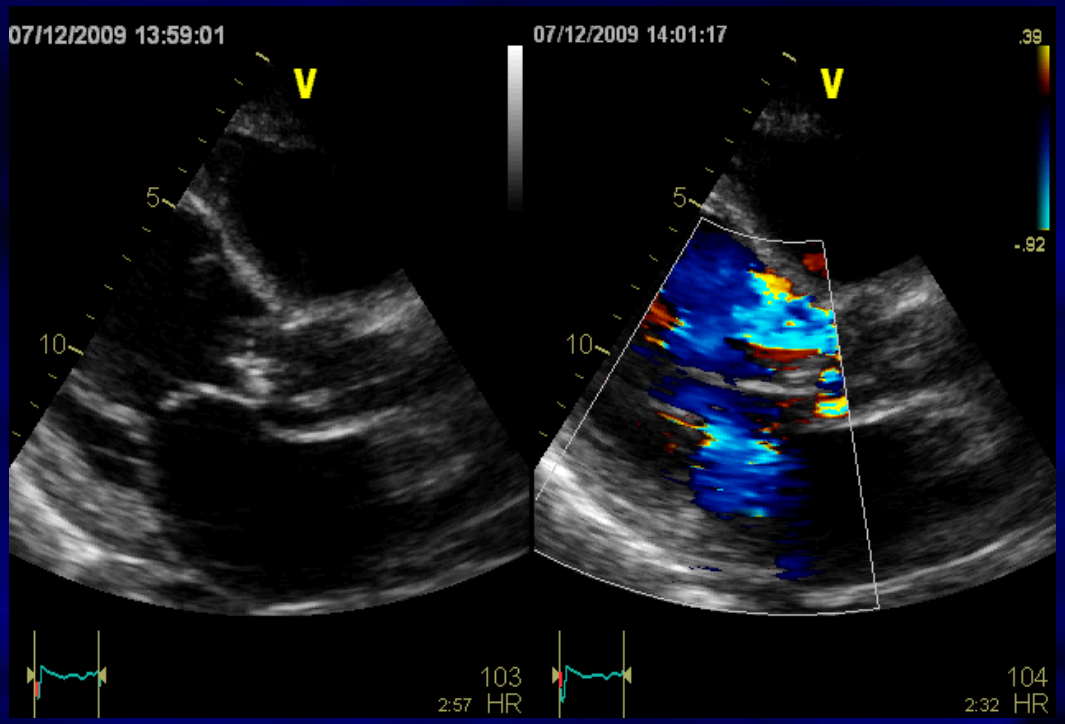

Type IIa
Anterior aortic cusp flail
A
Type IIa
Partial cusp prolapse with mid-cusp bending
B
Type IIa
Whole cusp prolapse
C
Type IIb
Fee edge fenestration
D

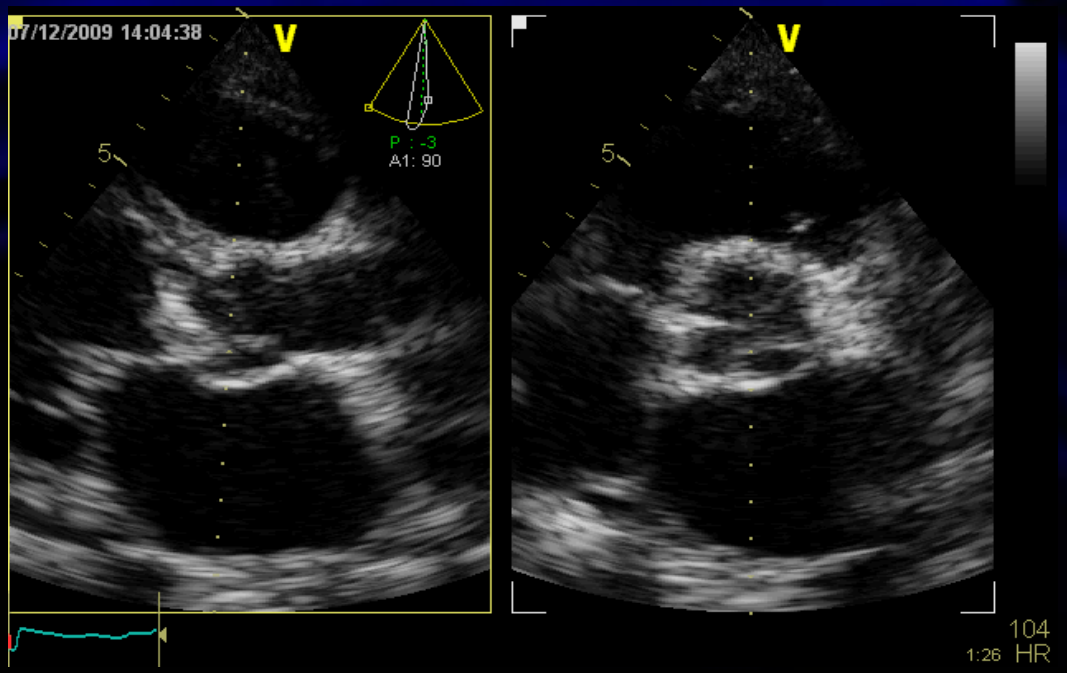
Type IIa: Tricuspid leaflet + Normal Aorta



Type IIa: Bicuspid leaflet + Aortic Dilatation

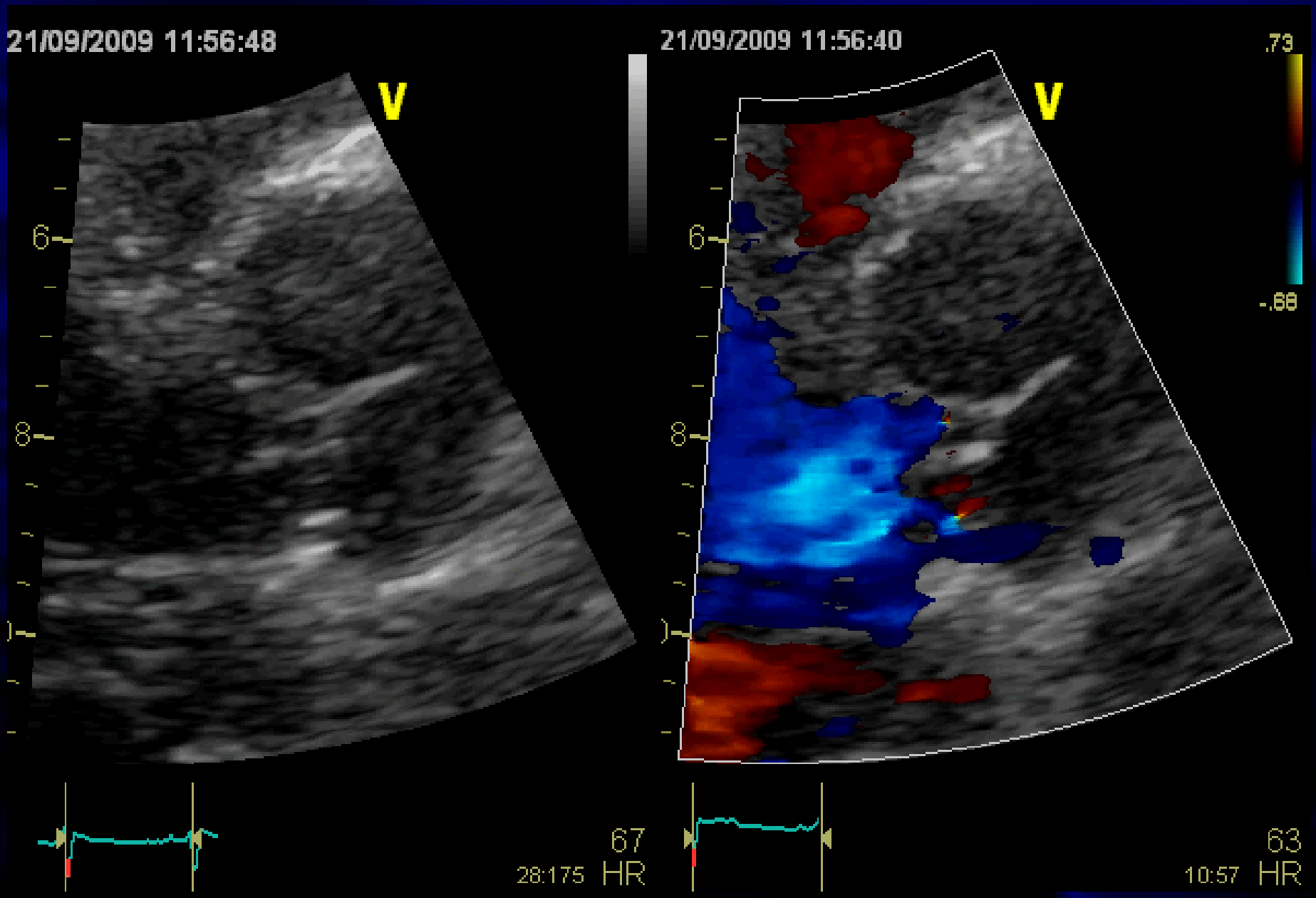




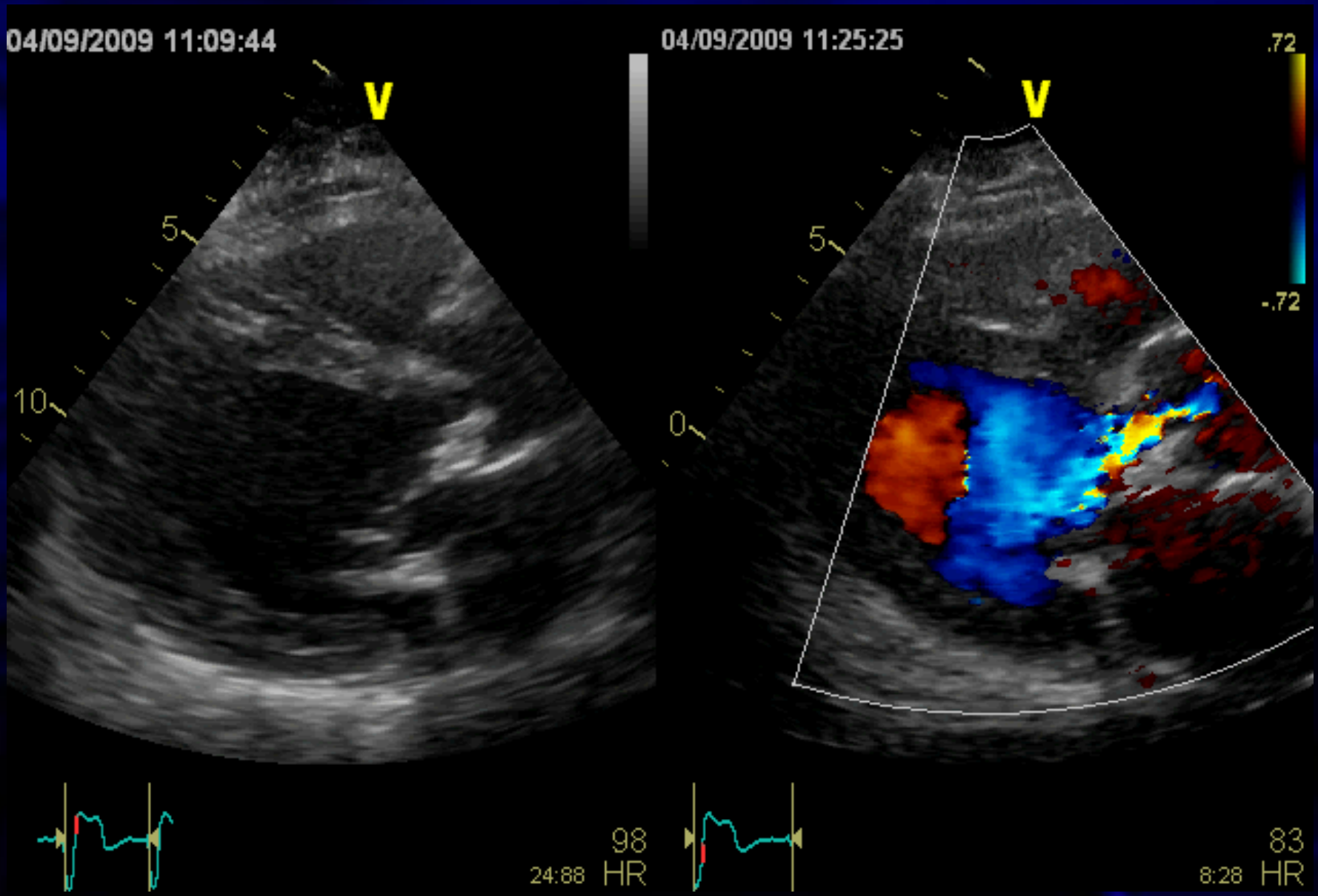


Type IIa: Endocarditis

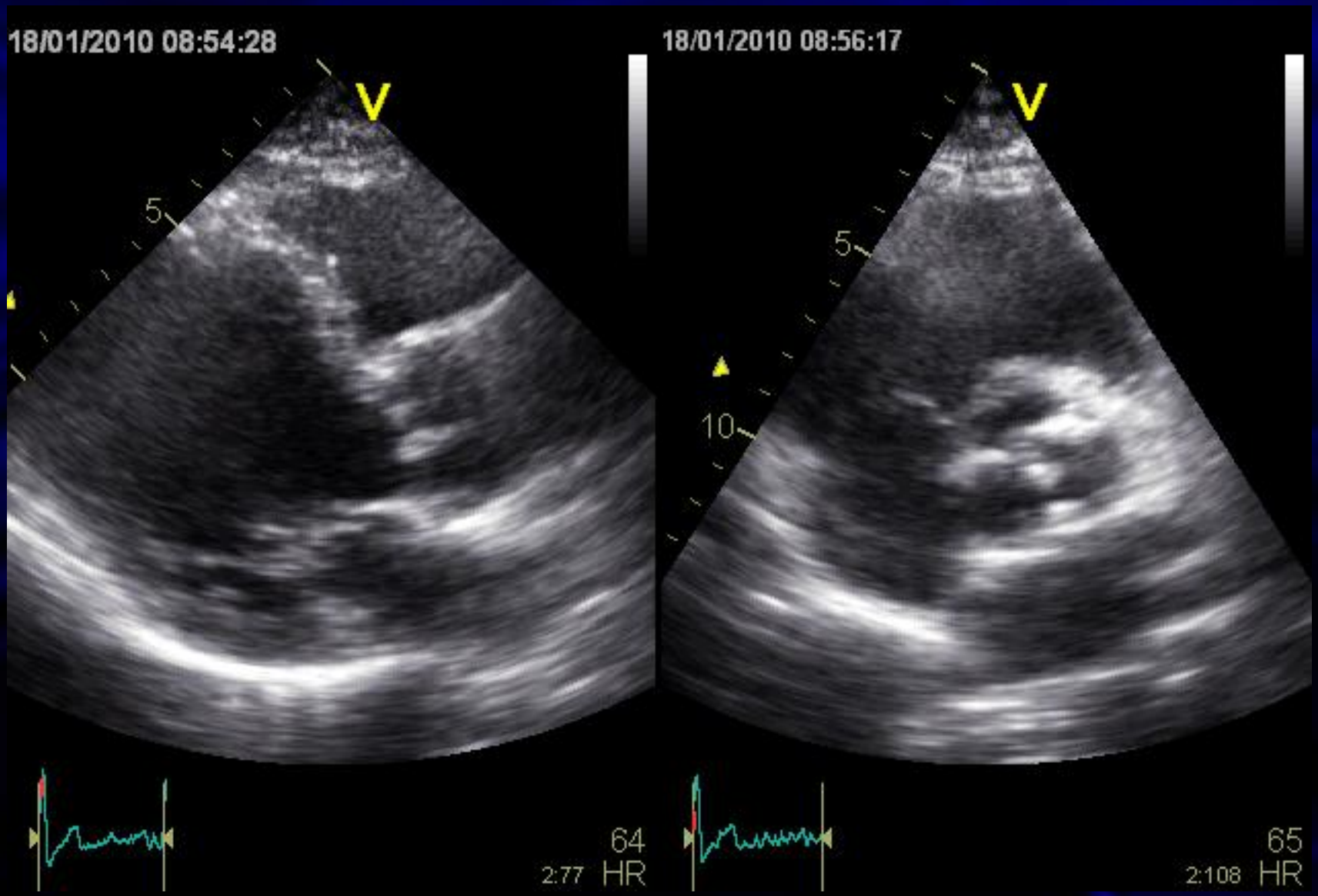
Type IIb: Fenestration



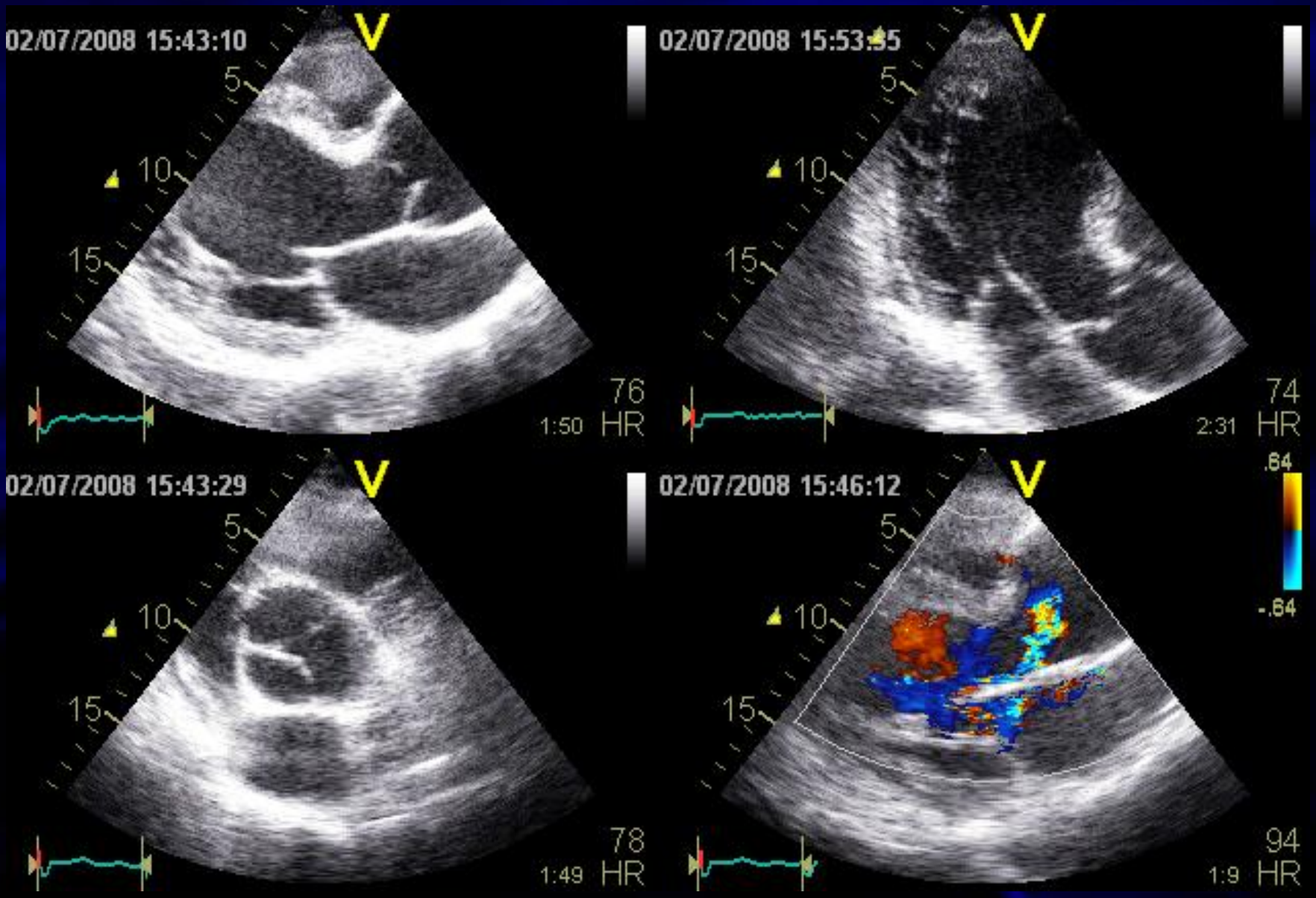
Type III: Leaflet retraction: Tricuspid valve



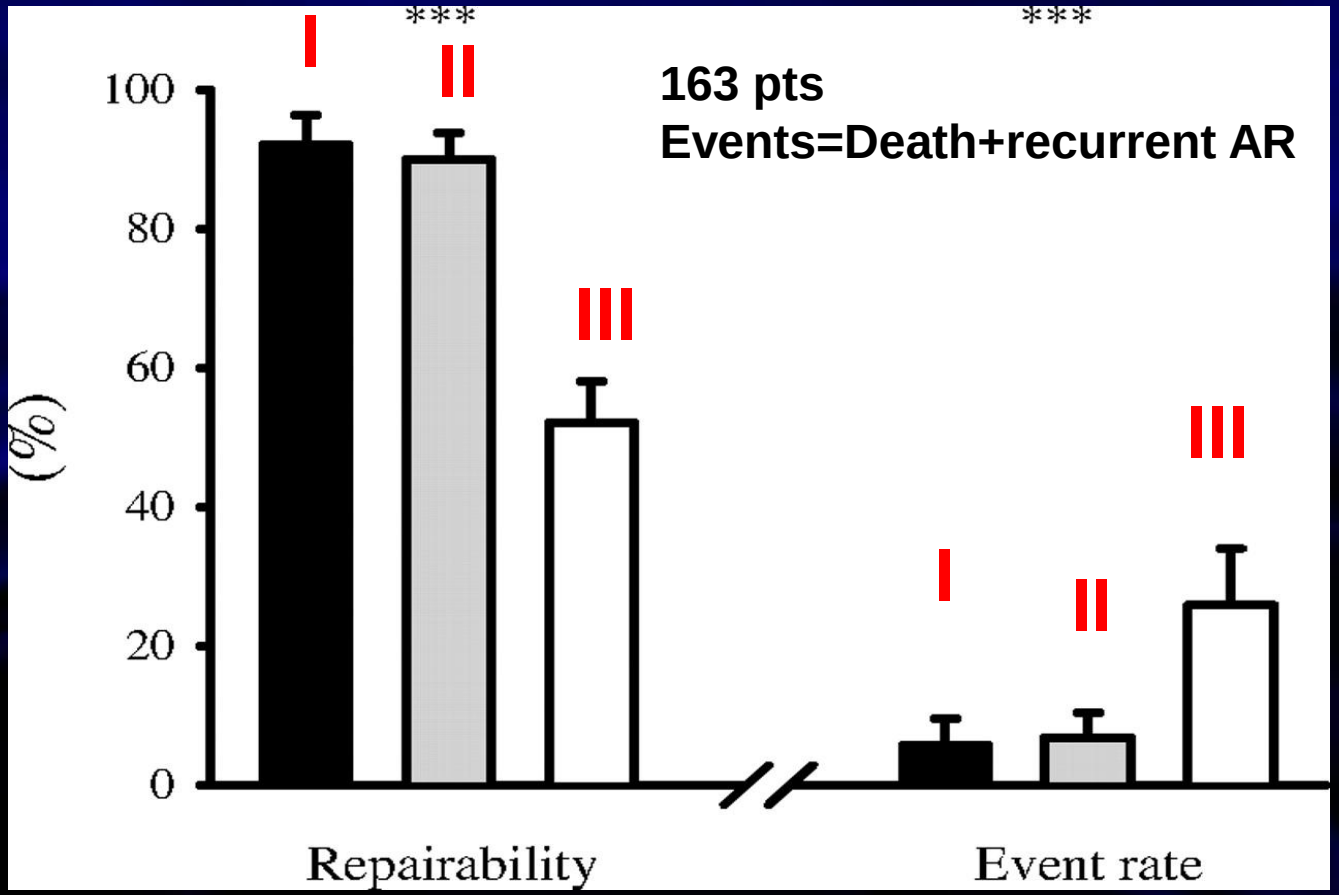
Type III: Leaflet retraction: Bicuspid valve



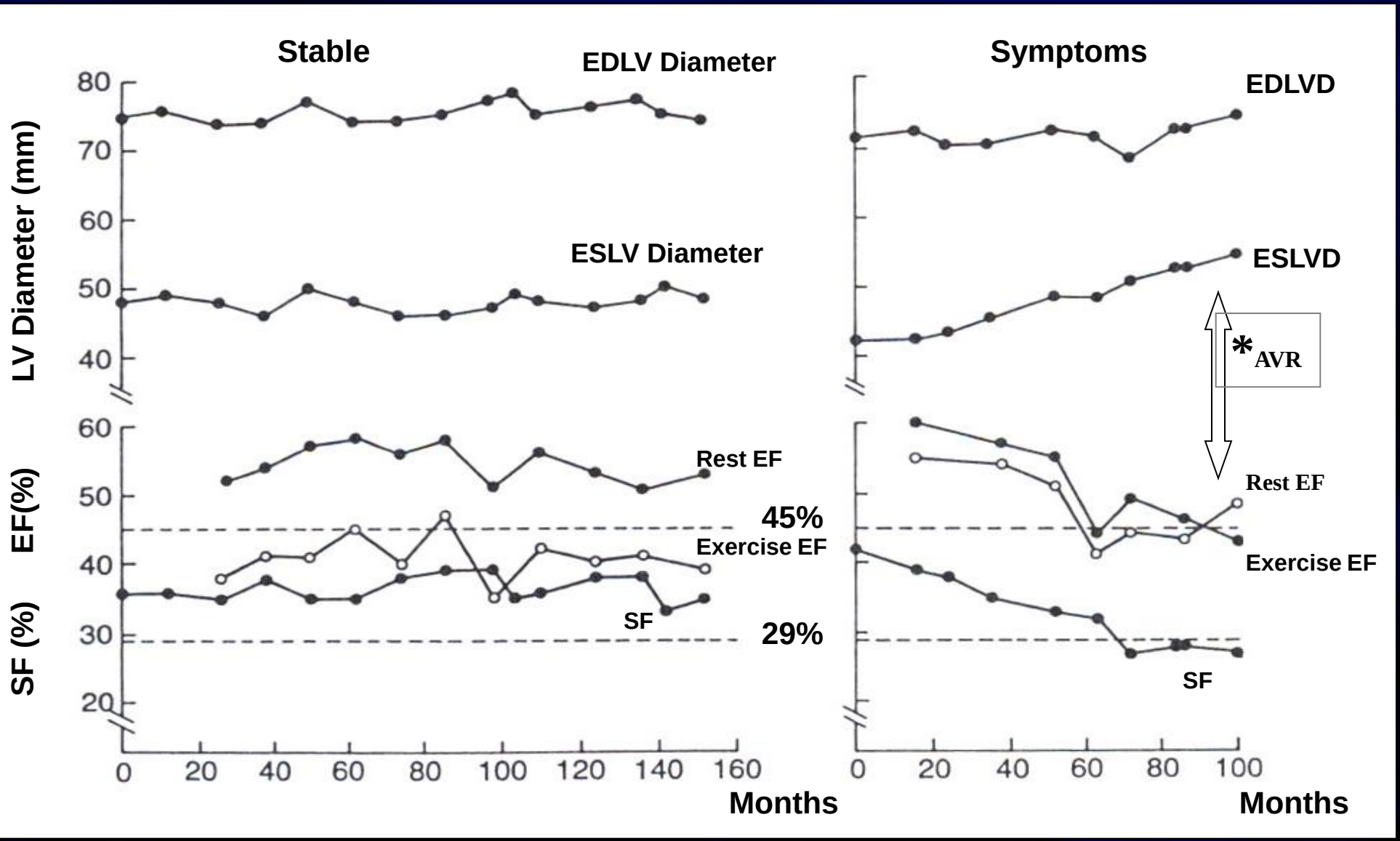
Type ???


02/07/2008 15:43:10
5
10
15
76
1:50 HR
02/07/2008 15:53:55
5
10
15
74
2:31 HR
02/07/2008 15:43:29
5
10
15
78
1:49 HR
02/07/2008 15:46:12
5
10
15
.64
-.64
94
1:9 HR

Incidence of valve sparing or repair surgery according to anatomic classification by TEE



le Polain de Waroux, J.-B. et al. Circulation 2007;116:I-264-I-269



Circulation 1991 ; 84 : 1625-35

Natural History of AR

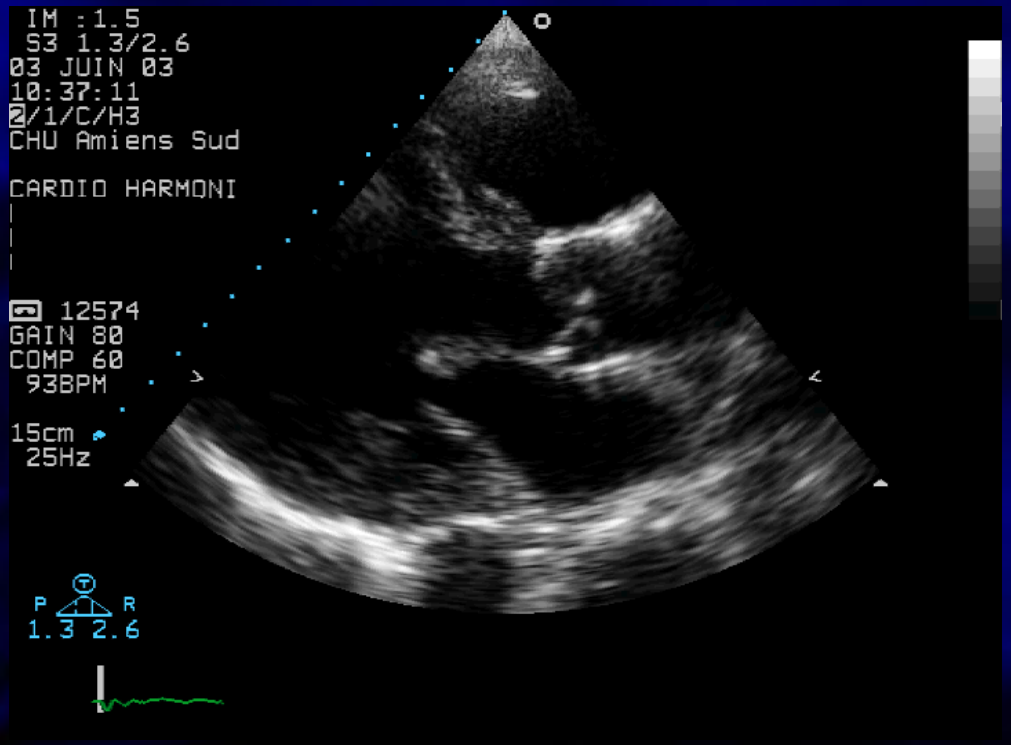
- Asymptomatic patients with normal left ventricular (LV) systolic function
  - Progression to symptoms and/or LV dysfunction < 6%/year
  - Progression to asymptomatic LV dysfunction <3.5%/year
  - Sudden death <0.2%/year
- Asymptomatic patients with LV systolic dysfunction
  - Progression to cardiac symptoms >25%/year
- Symptomatic patients
  - Mortality rate >10%/year

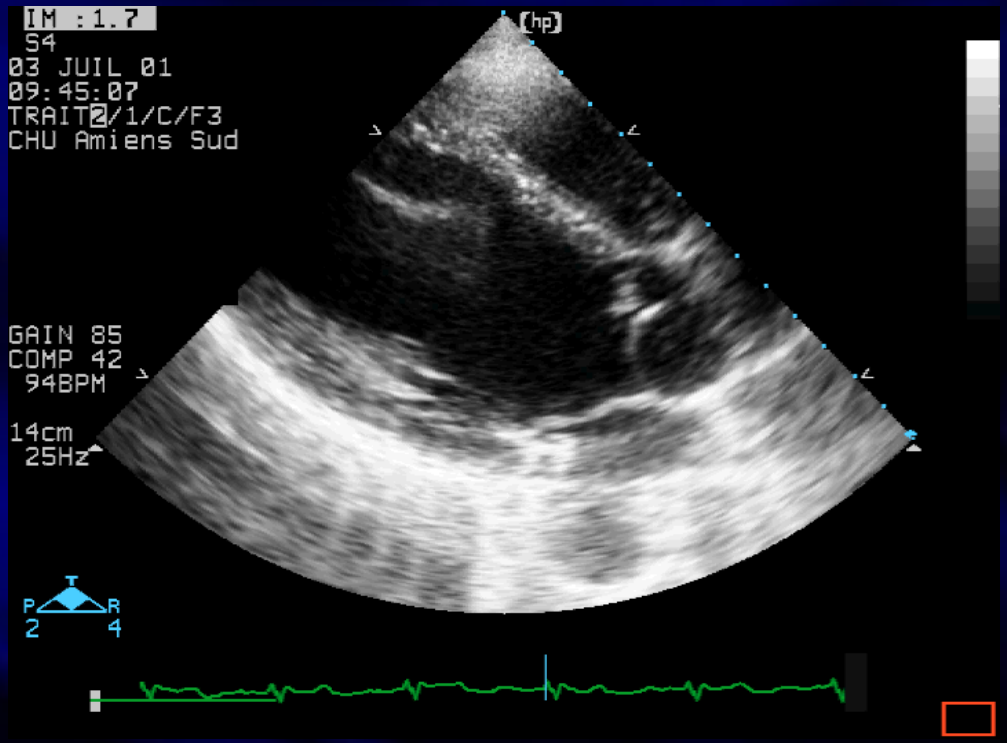
Adapted from Bonow, RO, Caraballo, B, de Leon, AC, JR, et. Al, ACC/AHA Task Force Report. J Am Coll Cardiol 1998; 5:1486.

AORTIC REGURGITATION
6 Key Questions

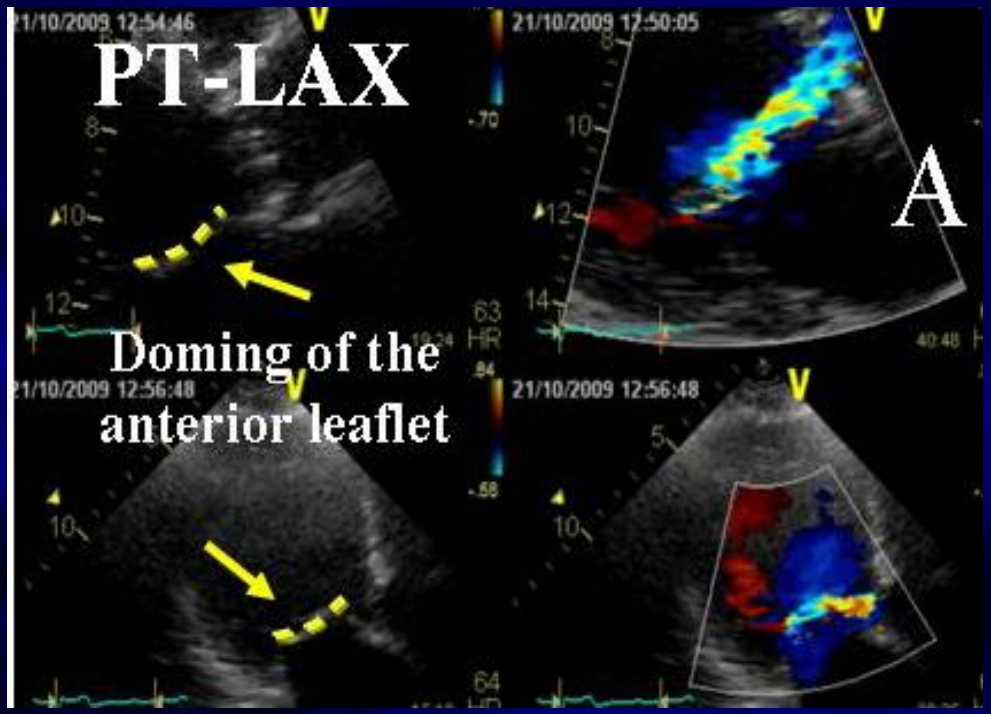
1. Is the patient asymptomatic?
2. Is the AR severe?
3. What is the impact on the LV?
4. What is the degree of the dilatation of ascending aorta?
5. What is the mechanism and etiology of AR?
6. What is the operative risk?

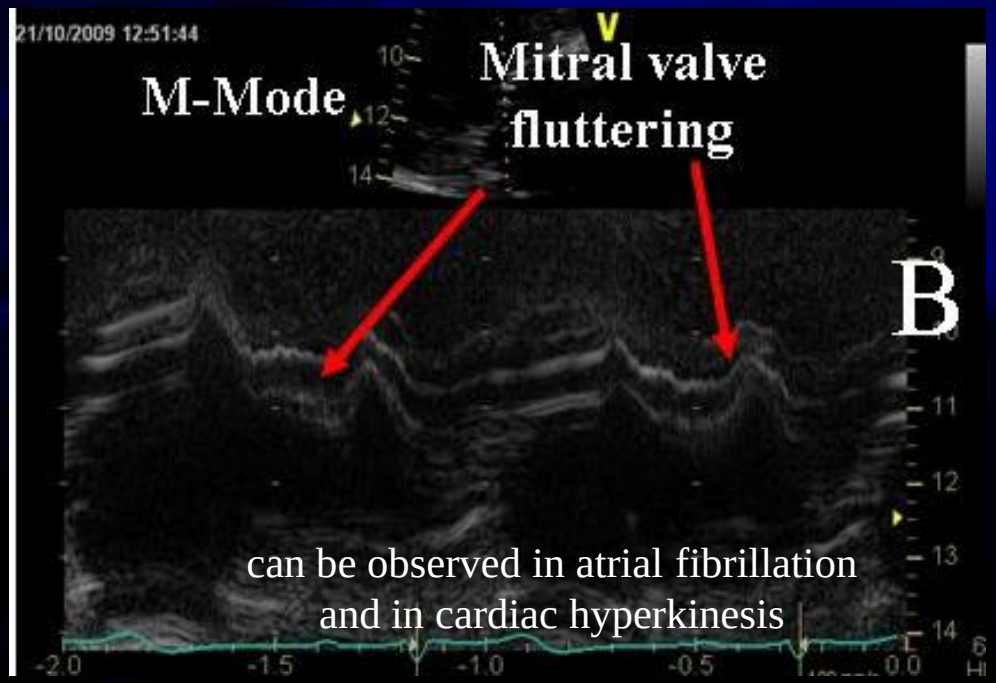
Is the AR severe?

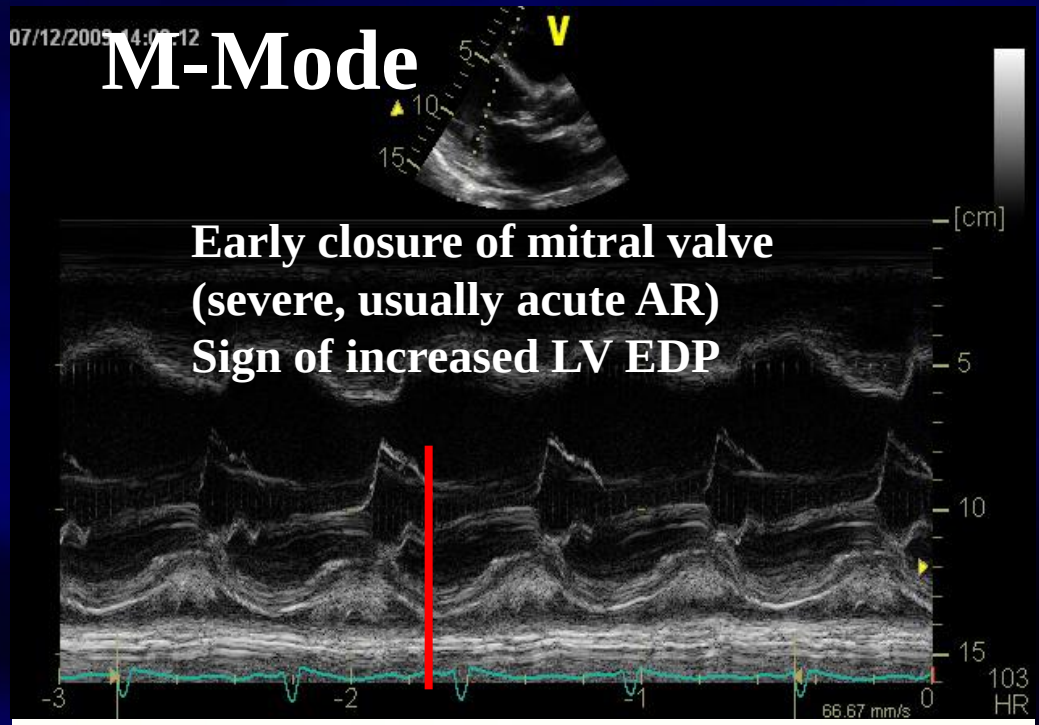


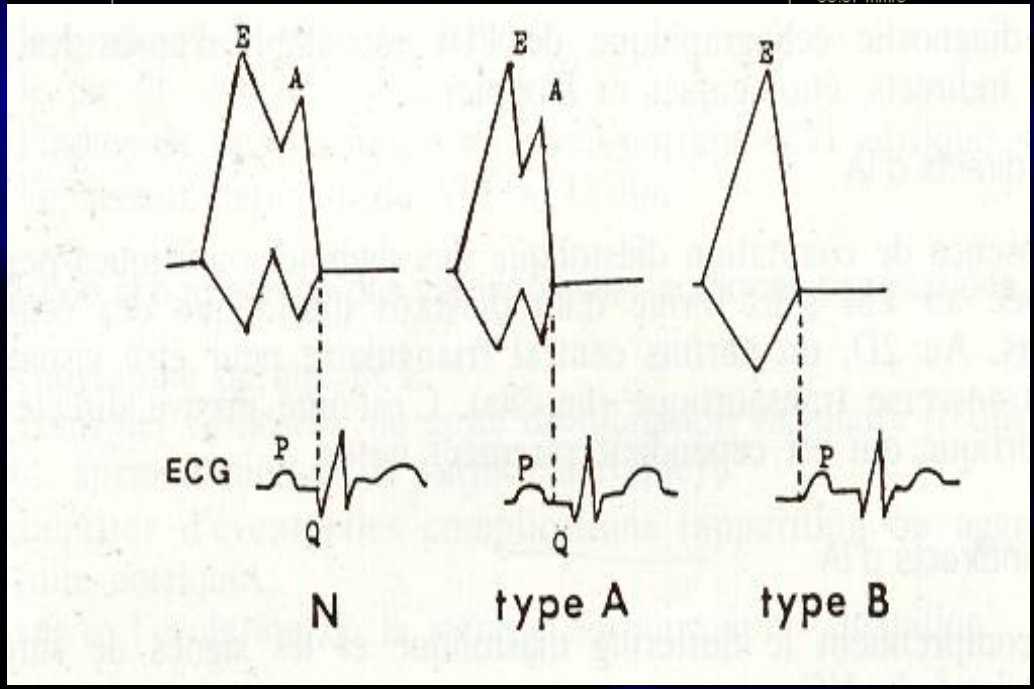


Yes, if there is a defect of coaptation on 2D echo

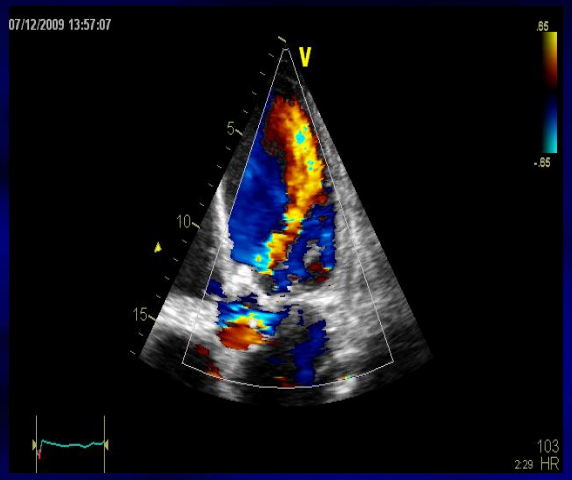

PT-LAX
A
Doming of the
anterior leaflet

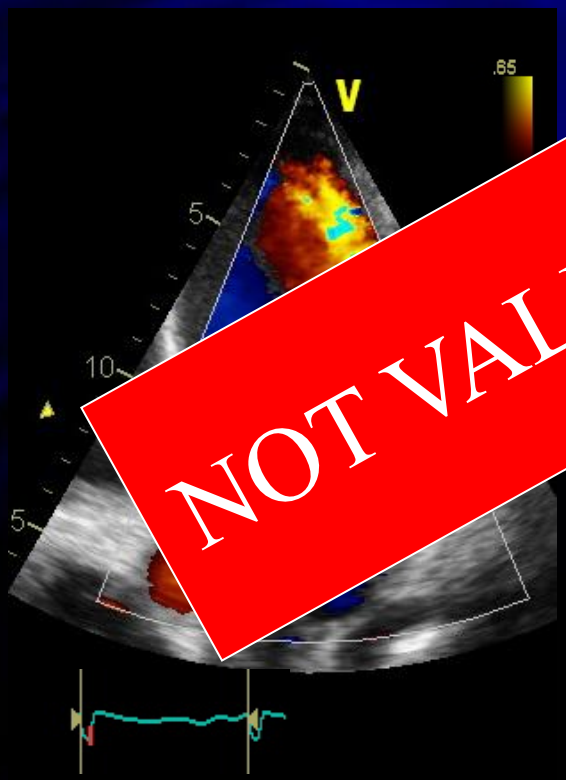

M-Mode
Mitral valve
fluttering
B
can be observed in atrial fibrillation
and in cardiac hyperkinesis


M-Mode
Early closure of mitral valve
(severe, usually acute AR)
Sign of increased LV EDP


E
A
ECG
P
Q
N
type A
type B

Color Flow Imaging



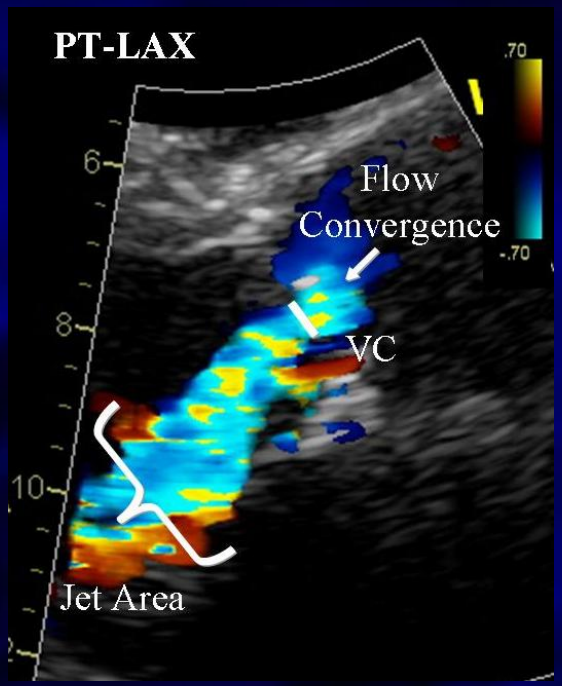


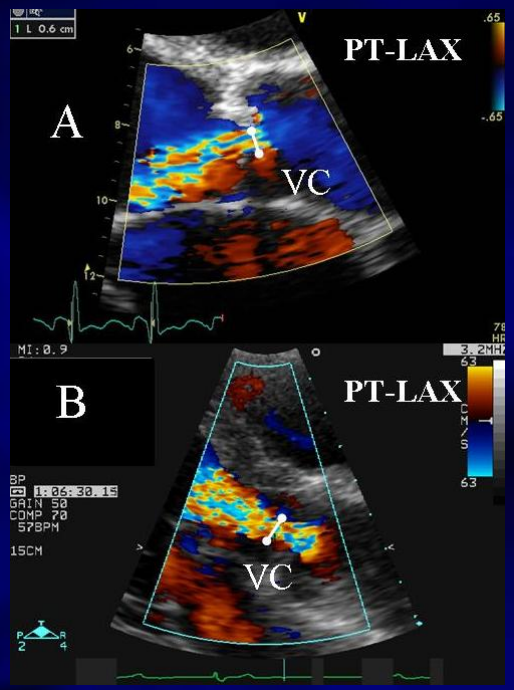
- Ease of use
- Evaluates the spa… …AR jet
- Quick sc…

NOT VALID FOR AR QUANTIFICATION

- …nical factors (Gain settings, PRF)
- Inaccurate for eccentric jet
- Loading conditions
- Expands unpredictably below the orifice

Vena Contracta Width





Limitations

- Not valid for multiple jets
- Small values (large % error)
- Intermediate values need confirmation
- Affected by changes in regurgitant flow
- Orifice often non-circular

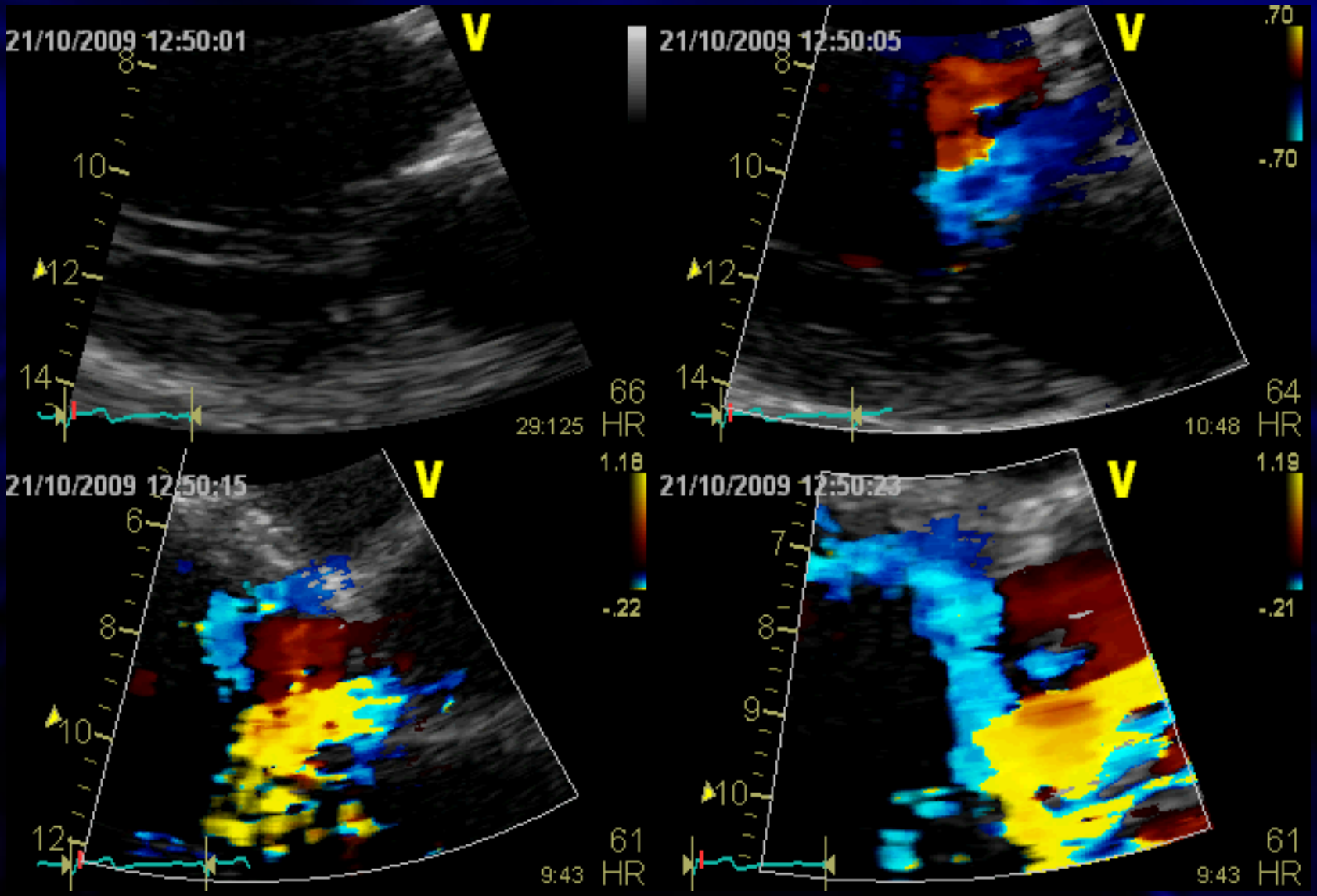
- PT-LAX
- Zoom to optimize visualization
- Color sector as narrow as possible
- Small influence of haemodynamics
- Not affected by other valve leak

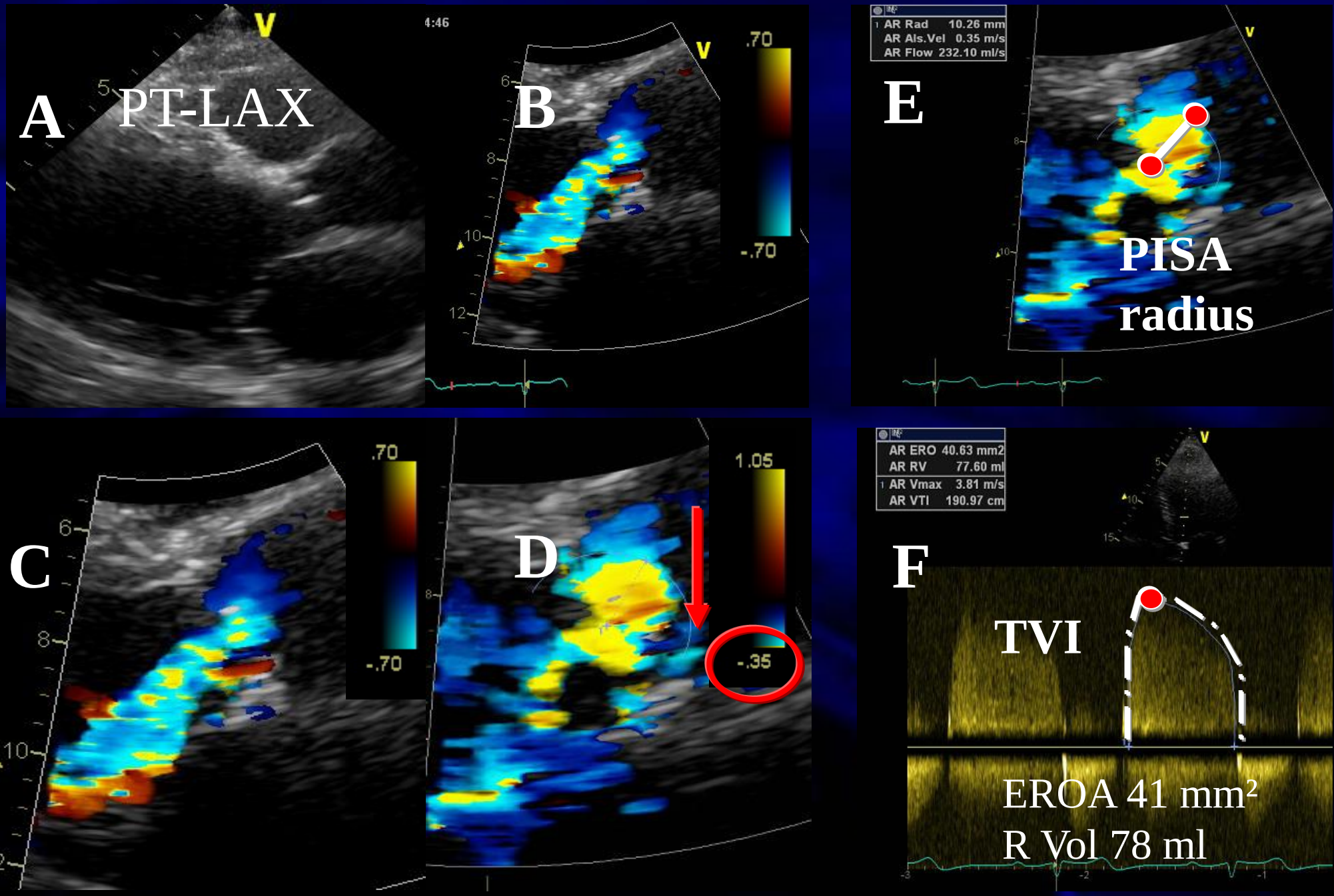
Mild < 3 mm

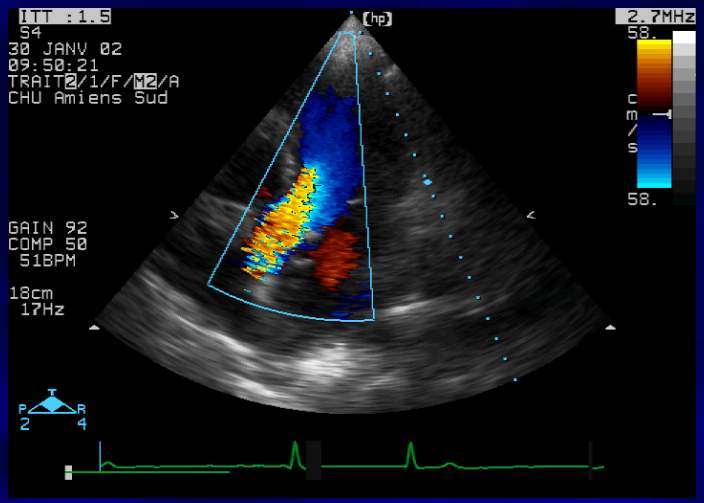
Moderate 3-6 mm

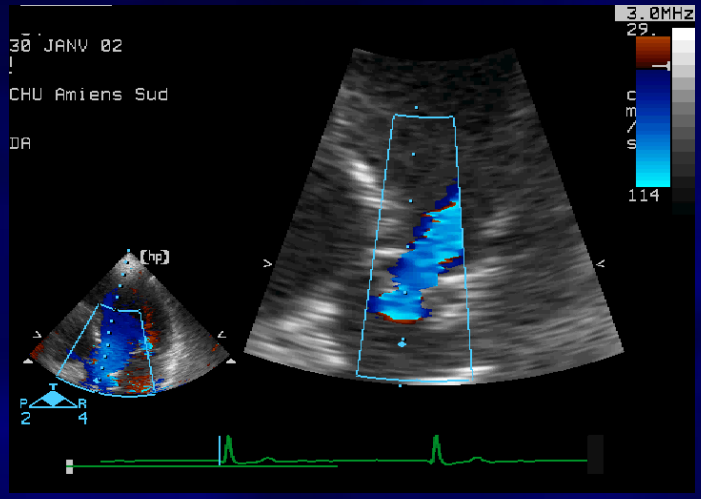
Severe > 6 mm

PISA METHOD


21/10/2009 12:50:01
V
66
29:125
HR
21/10/2009 12:50:05
V
.70
-.70
64
10:48
HR
21/10/2009 12:50:15
V
1.18
-.22
61
9:43
HR
21/10/2009 12:50:23
V
1.19
-.21
61
9:43
HR


A
PT-LAX
B
.70
-.70
E
AR Rad 10.26 mm
AR Als.Vel 0.35 m/s
AR Flow 232.10 ml/s
PISA
radius
C
.70
-.70
D
1.05
-.35
AR ERO 40.63 mm2
AR RV 77.60 ml
AR Vmax 3.81 m/s
AR VTI 190.97 cm
F
TVI
EROA 41 mm²
R Vol 78 ml





Mild AR ERO < 10 mm² ; Severe AR ERO > 30 mm²

Advantages (ERO)

- Independent of HR
- Small influence of haemodynamics
- Can be used in eccentric jet

Pitfalls (ERO)

- Underestimation of ERO
- if obtuse angle (Ao aneurysm)

PISA shape affected

- by the aliasing velocity
- in case of non-circular orifice
- by systolic changes in regurgitant flow
- by adjacent structures (flow constrainment)

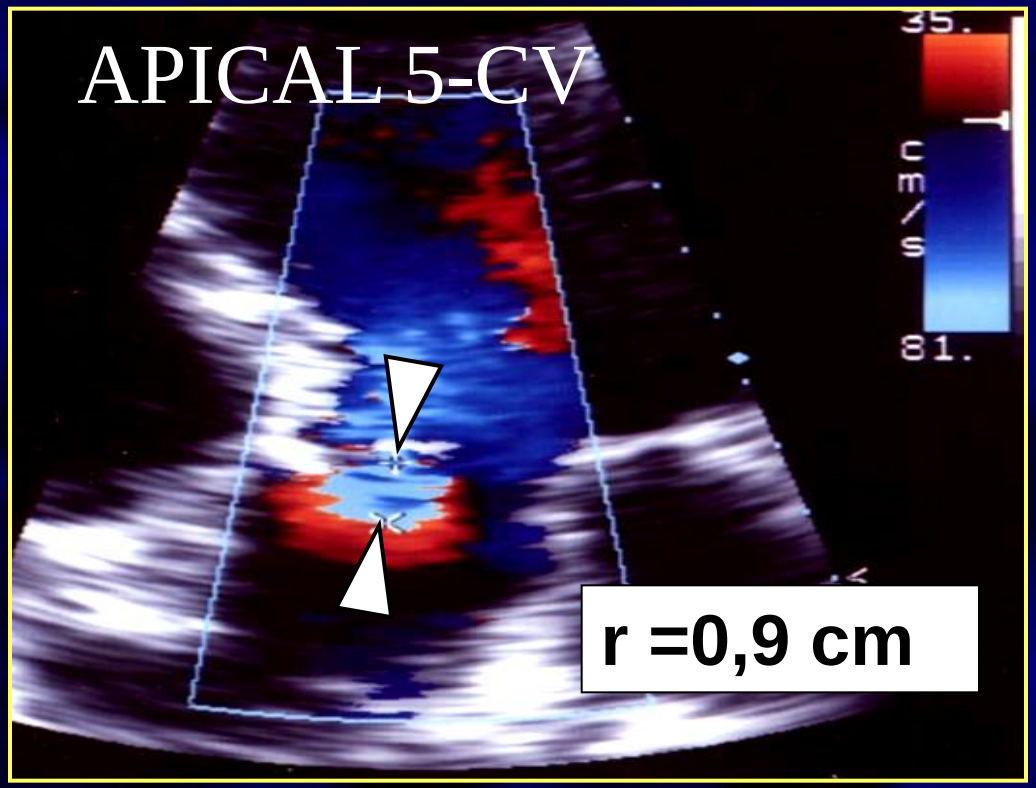
PISA radius is more a hemi-ellipse

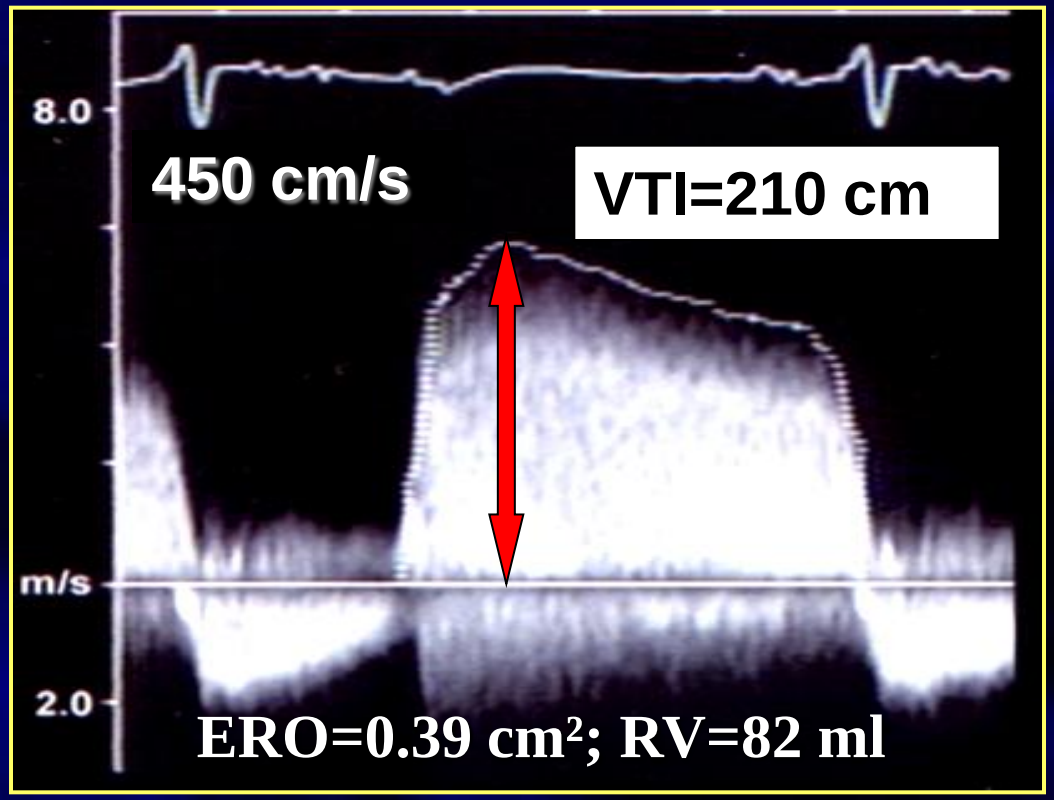
Errors in PISA measurement are squared

Inter-observer variability

Not valid for multiple jets

Feasibility limited by aortic valve calcifications



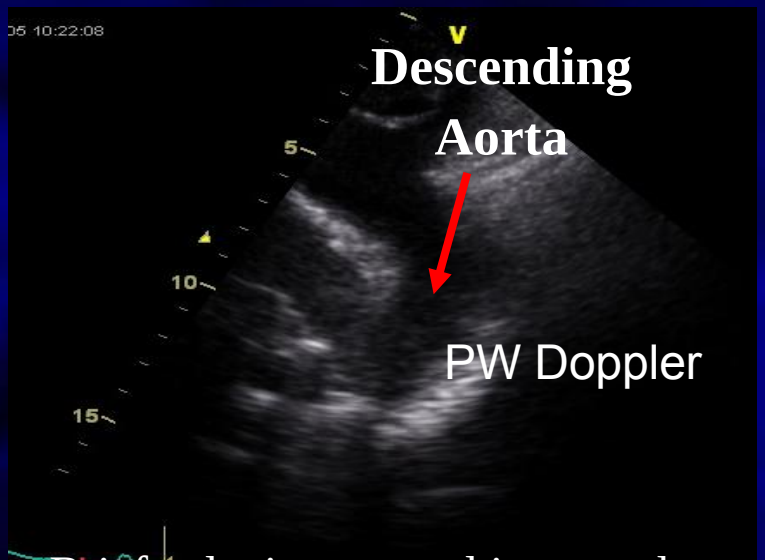


A

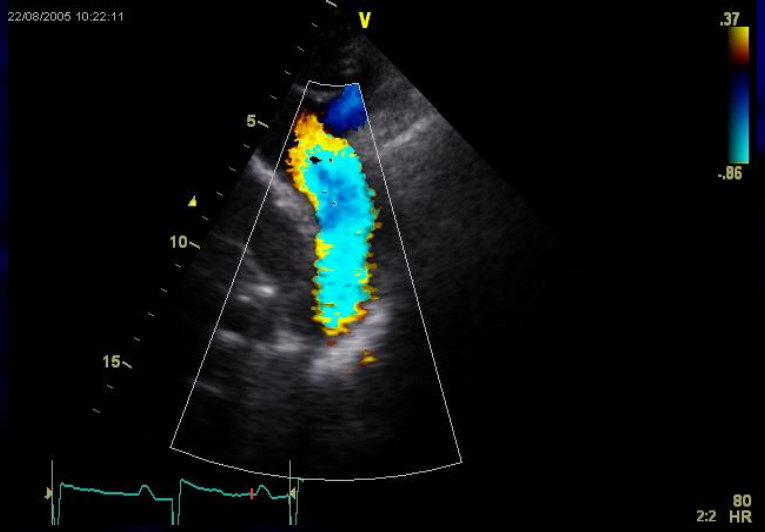
ERO = Flow / Peak velocity = 178/450 = 0.39 cm^2

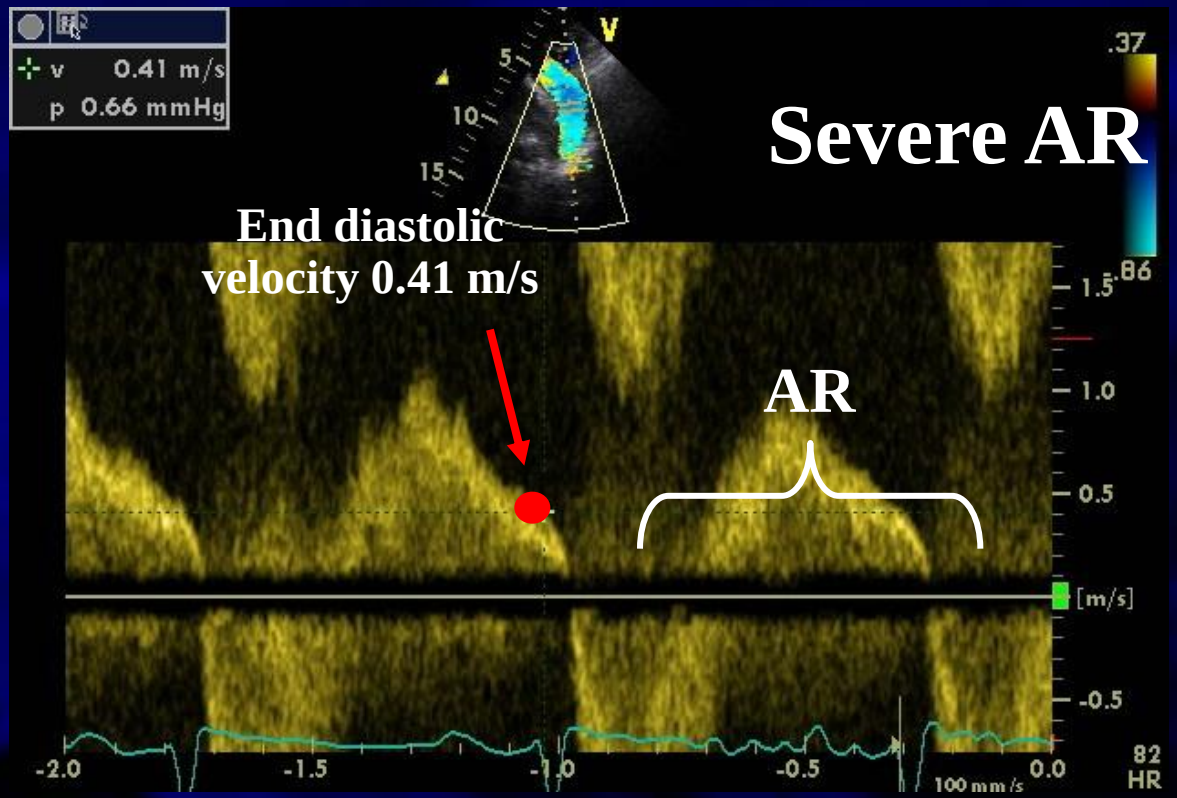
R Vol. = EROA x TVI = 0.39 cm^2 x 210 cm = 82 ml

Diastolic flow reversal in the descending aorta



Brief velocity reversal is normal





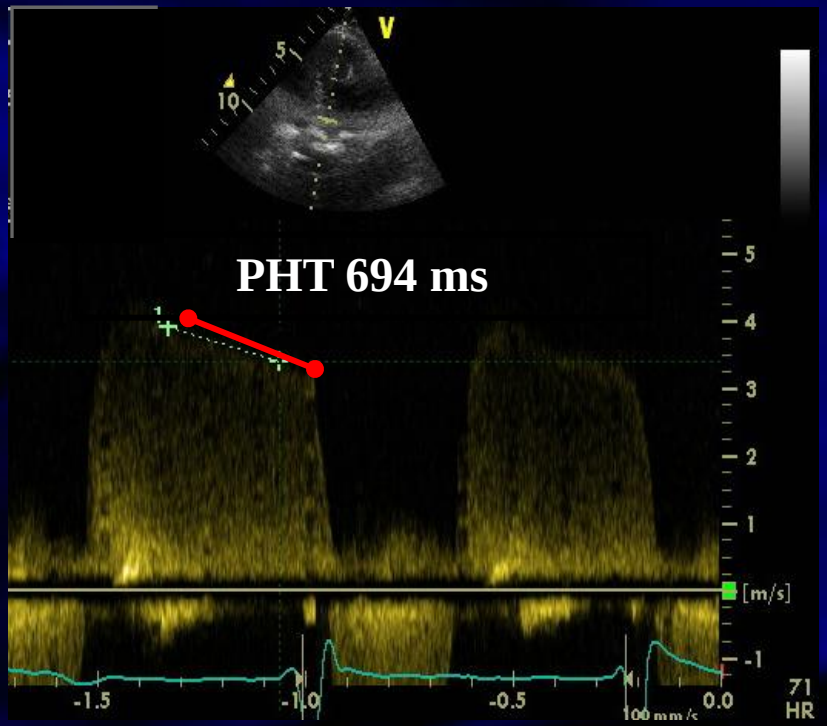
Cut-off validated for distal aortic arch

In severe AR: holodiastolic flow reversal/EDV>20 cm/s

Affected by sample volume location and acuity of AR

Affected by aortic compliance

Pressure half-time

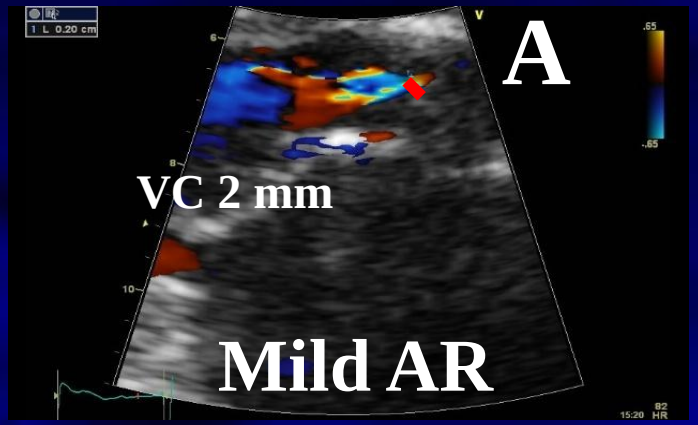


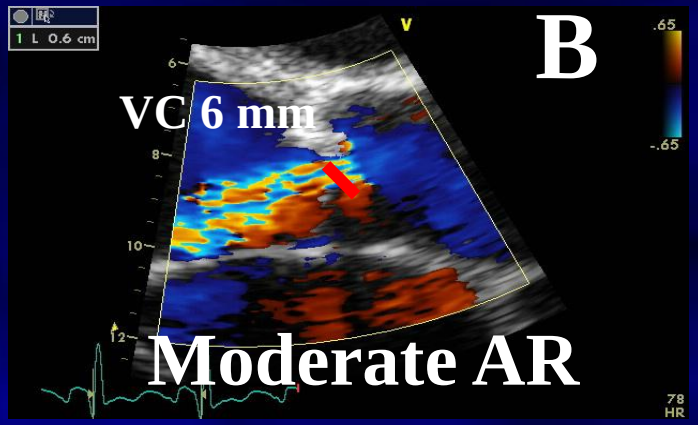
Mild AR > 500 ms, Severe AR < 200 ms

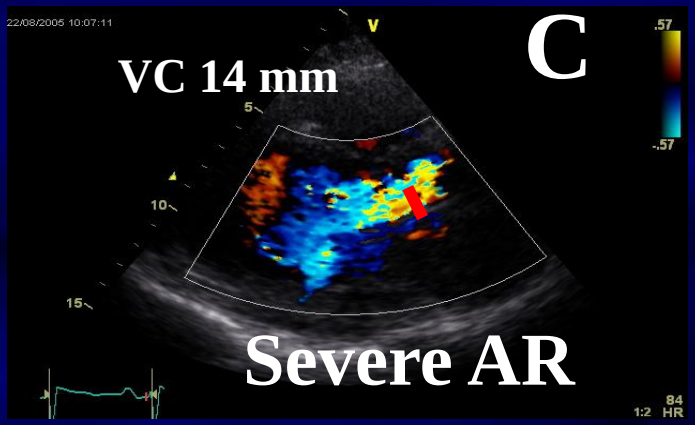
Pitfalls

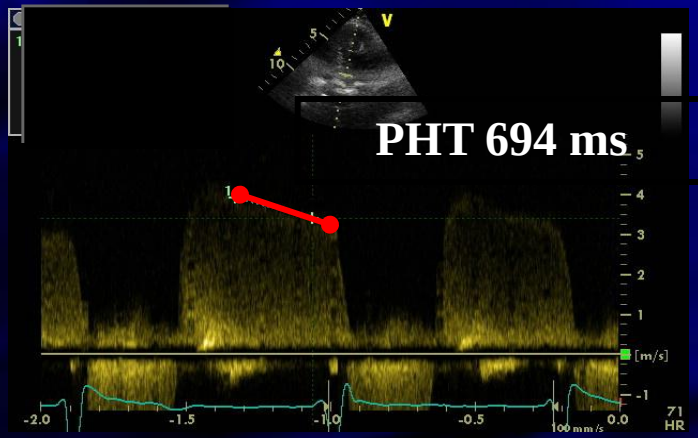
- ↓ PHT when
  - ↑ SVR
  - ↑ LVED
  - ↑ Aortic compliance
  - ↓ LV relaxation
- Adequate spectrum definition

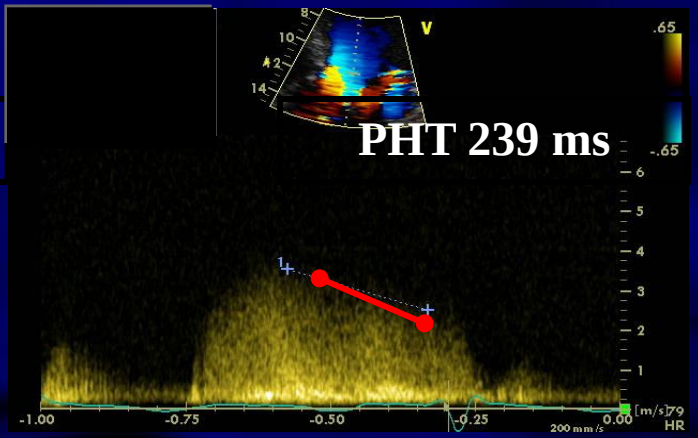
- Apical 5-chamber
- Simple, easily available
- Qualitative, Complementary finding
- Complete signal difficult to obtain in eccentric jet

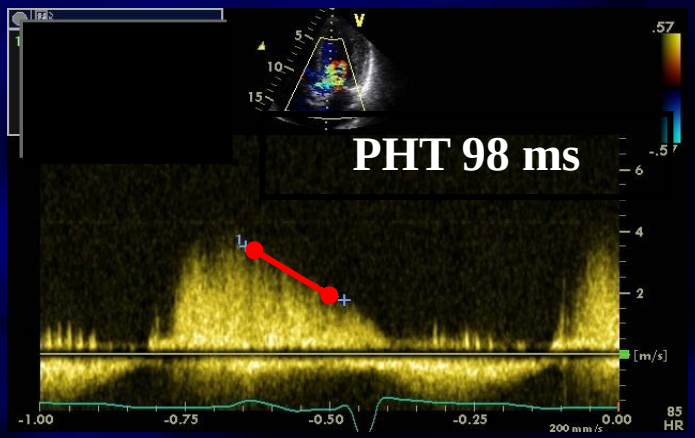

A
VC 2 mm
Mild AR

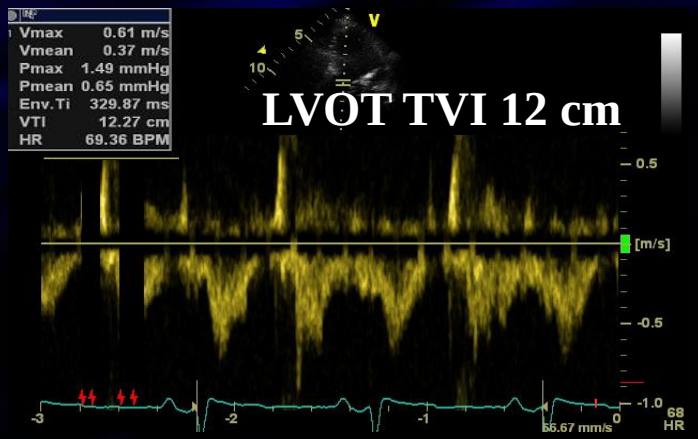

B
VC 6 mm
Moderate AR

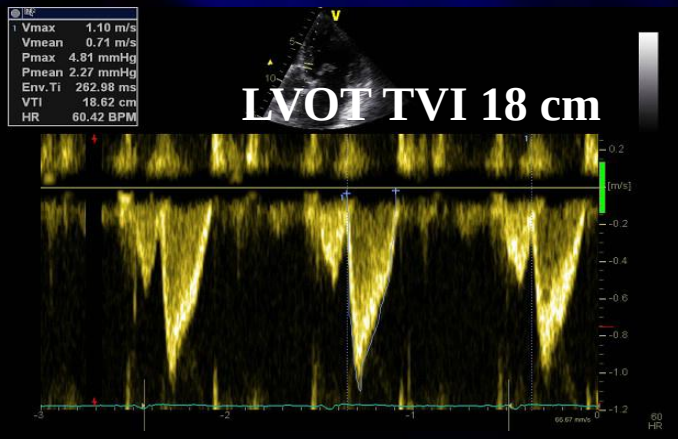

C
VC 14 mm
Severe AR

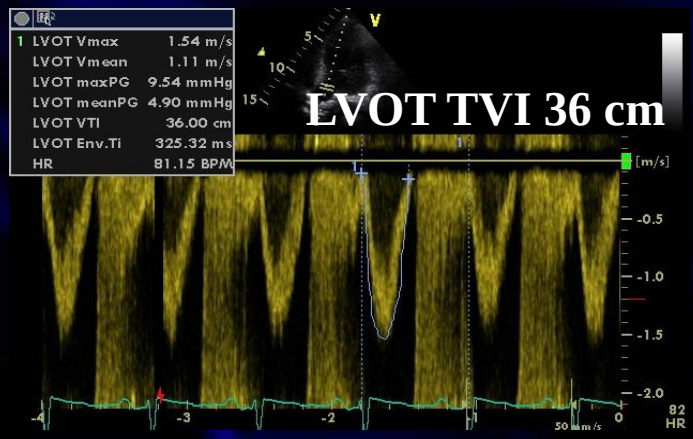

PHT 694 ms


PHT 239 ms


PHT 98 ms


Vmax 0.61 m/s
Vmean 0.37 m/s
Pmax 1.49 mmHg
Pmean 0.65 mmHg
Env.Ti 329.87 ms
VTI 12.27 cm
HR 69.36 BPM
LVOT TVI 12 cm


Vmax 1.10 m/s
Vmean 0.71 m/s
Pmax 4.81 mmHg
Pmean 2.27 mmHg
Env.Ti 262.98 ms
VTI 18.62 cm
HR 60.42 BPM
LVOT TVI 18 cm


LVOT Vmax 1.54 m/s
LVOT Vmean 1.11 m/s
LVOT maxPG 9.54 mmHg
LVOT meanPG 4.90 mmHg
LVOT VTI 36.00 cm
LVOT Env.Ti 325.32 ms
HR 81.15 BPM
LVOT TVI 36 cm

Integrating indices of AR severity

Parameters	Mild	Moderate	Severe
Qualitative			
Aortic valve morphology	Normal/Abnormal	Normal/Abnormal	Abnormal/ Flail/ Large coaptation defect
Colour flow AR jet width **$**	Small in central jets	Intermediate	Large in central jet, variable in eccentric jets
CW signal of AR jet	Incomplete/Faint	Dense	Dense
Diastolic flow reversal in descending aorta	Brief, protodiastolic flow reversal	Intermediate	Holodiastolic flow reversal (end-diastolic velocity > 20 cm/s)
Semi-quantitative			
VC width (mm)	< 3	Intermediate	≥ 6
Pressure half-time (ms) **£**	> 500	Intermediate	< 200
Quantitative			
EROA (mm^2)	< 10	10-19 ; 20-29!	≥ 30
R Vol (ml)	< 30	30-44 ; 45-59!	≥ 60

+ LV size §

European Journal of Echocardiography (2010) **11**, 223–244
doi:10.1093/ejechocard/jeq030

RECOMMENDATIONS

European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 1: aortic and pulmonary regurgitation (native valve disease)

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