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AORTIC REGURGITATION

Echocardiographic assessment of aortic regurgitation

- 1. description of morphology
- 2.description of function
- 3. measurement of quantitative and qualitative parameters
- 4. planimetry of valvular regurgitation orifice
- 5. secondary structural and functional findings
- 6. special examinations

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

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Acquired valvular heart diseases: aortic regurgitation

- Symptoms(by Roskamm and Reindell):
  - Stage I
    - Asymptomatic, compensation through increased systolic function
  - Stage II
    - Symptoms in moderate exertion, regurgitation volume more than 30% of left ventricular stroke volume. LVEDV 10-250ml.
  - Stage III
    - Symptoms in mild exertion, LVEDP increased above normal range.
  - Stage IV
    - Symptoms at rest, clinical signs of left heart failure (congestion and low cardiac output)

Etiology of aortic regurgitation

Cause of leaflet abnormalities

- Senile leaflet calcification
- Bicuspid aortic valve
- Infective endocarditis
- Rheumatic fever

Aortic causes

- Annuloaortic ectasia
- Idiopathic root dilatation
- Marfan's syndrome
- Aortic dissection
- Collagen vascular disease
- syphilis

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Capentier functional classification of AR

- Type I : normal leaflet motion
  - Aortic root dilatation
  - Leaflet perforation
- Type II: increase and excessive leaflet mobility
  - Prolapse of one or more cusps
- Type III: reduced leaflet motion
  - Rheumatic fever
  - Secondary significant calcification

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Capentier functional classification

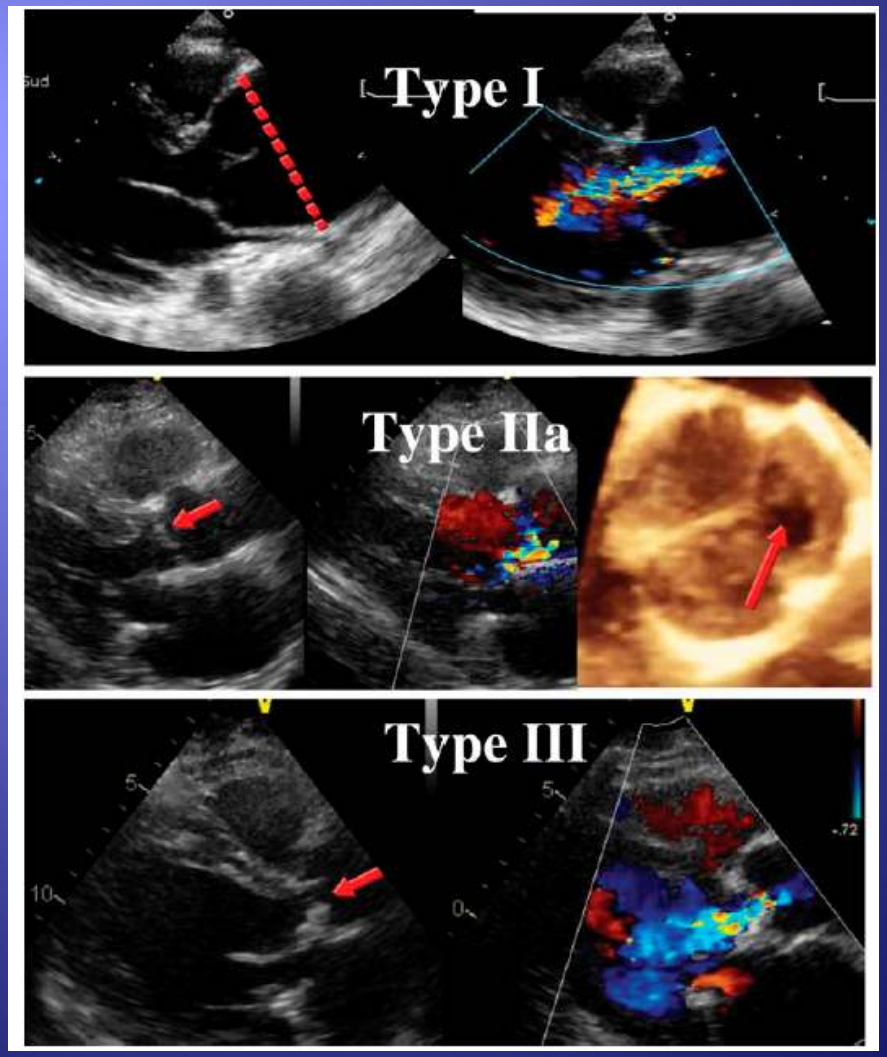

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Table I Functional classification of AR lesions

Dysfunction	Echo findings
I: enlargement of the aortic root with normal cusps	Dilatation of any components of the aortic root (aortic annulus, sinuses of Valsalva, sinotubular junction)
IIa: cusp prolapse with eccentric AR jet	
Cusp flail	Complete eversion of a cusp into the LVOT in long-axis views
Partial cusp prolapse	Distal part of a cusp prolapsing into the LVOT (clear bending of the cusp body on long-axis views and presence of a small circular structure near the cusp free edge on short-axis views)
Whole cusp prolapse	Free edge of a cusp overriding the plane of aortic annulus with billowing of the entire cusp body into the LVOT (presence of a large circular or oval structure immediately beneath the valve on short-axis views)
IIb: free edge fenestration with eccentric AR jet	Presence of an eccentric AR jet without definite evidence of cusp prolapse
III: poor cusp quality or quantity	Thickened and rigid valves with reduced motion
	Tissue destruction (endocarditis)
	Large calcification spots/extensive calcifications of all cusps interfering with cusp motion

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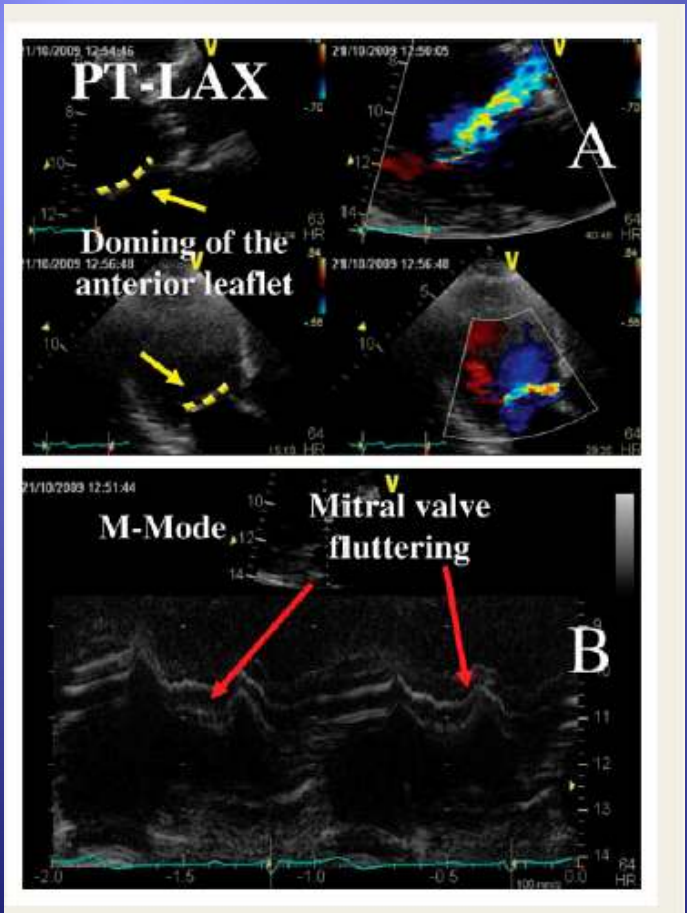
M-mode: fluttering motion on anterior mitral leaflet



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M-mode

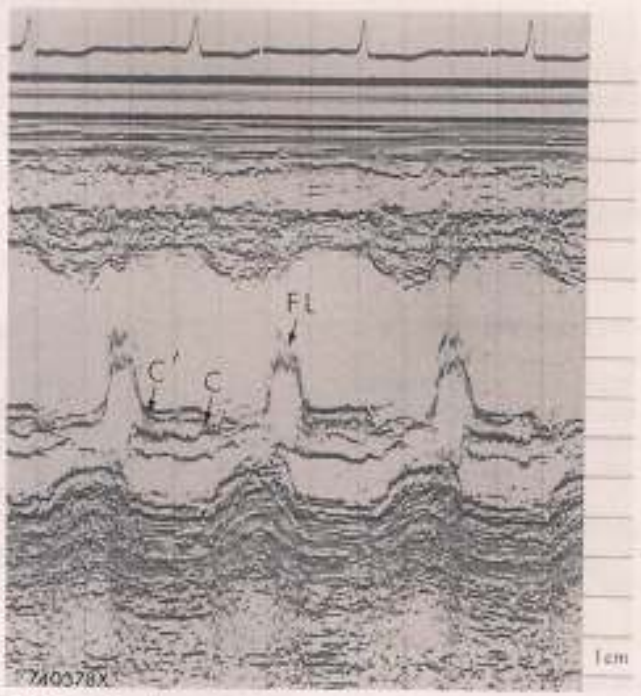

FIGURE 11.31. An M-mode recording from a patient with acute and severe aortic regurgitation demonstrates both fluttering (FL) of the anterior mitral leaflet and premature closure (C') of the mitral valve, the result of rapidly increasing diastolic left ventricular pressure.

Assessments of AR severity

- Color flow Doppler
  - Color flow image
  - Vena contracta width
  - The flow convergence method
- Pulse Doppler
- Diastolic flow reversal in the descending aorta
- Continuous wave Doppler of AR jet

Color flow image

- Parasternal views are preferred.[a]
- The color jet area and length are **weakly correlated** with the degree of AR.[b]
- Both jet area and length are often overestimated in the apical views.[c]

- ***Serve as a visual assessment of AR***

Color flow Doppler

- Central jet
  - Rheumatic disease
- Eccentric jet
  - Aortic valve prolapse or perforation

Color M-mode

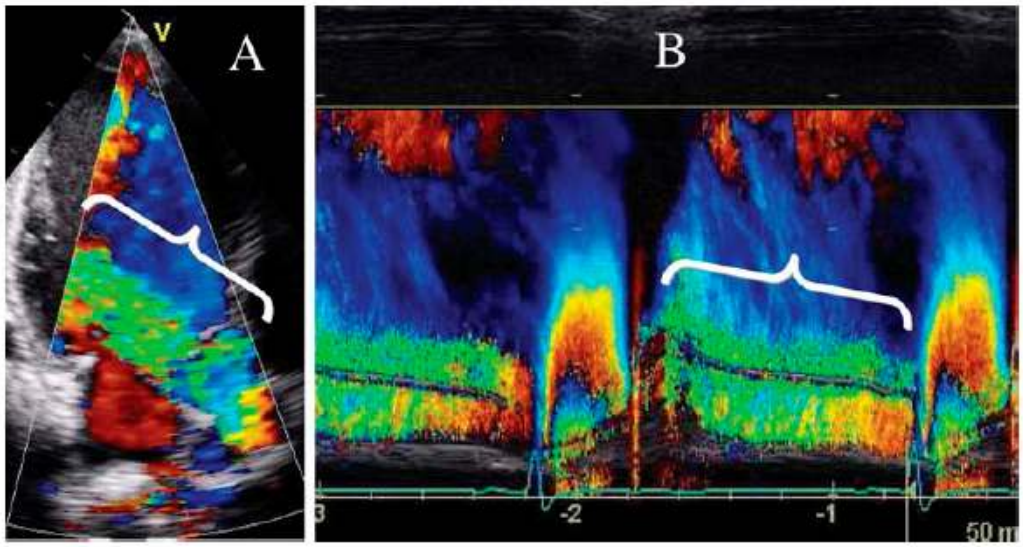

Figure 7 (*A*) Colour Doppler showing a severe aortic regurgitation; (*B*) colour-coded M-mode depicting the time dependency of flow signal during the heart cycle.

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Vena Contracta (VC)

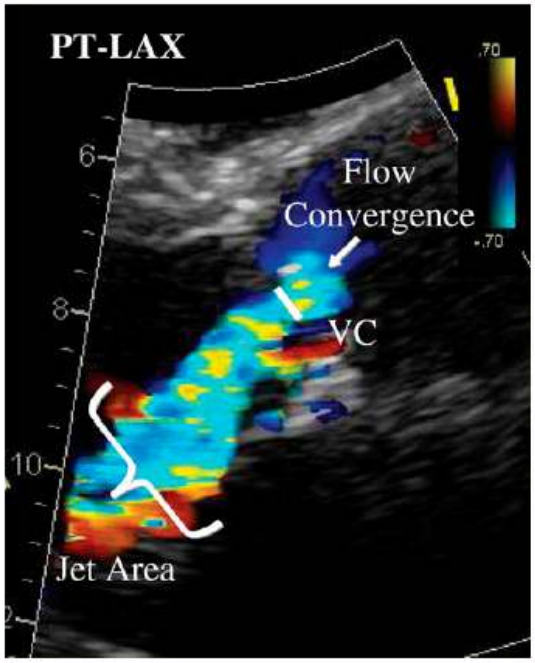

Figure 8 Semi-quantitative assessment of aortic regurgitation severity using the vena contracta (VC) width. The three components of the regurgitant jet (flow convergence zone, vena contracta, jet turbulence) are obtained. PT-LAX, parasternal long-axis view.

- Parasternal long-axis view
- Represents the smallest flow diameter at the level of the aortic valve in the LVOT

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Vena Contracta (VC)

- Using a Nyquist limit of 50-60 cm/s
  - A vena contracta width
    - < 3mm : mild AR
    - > 6mm : severe AR

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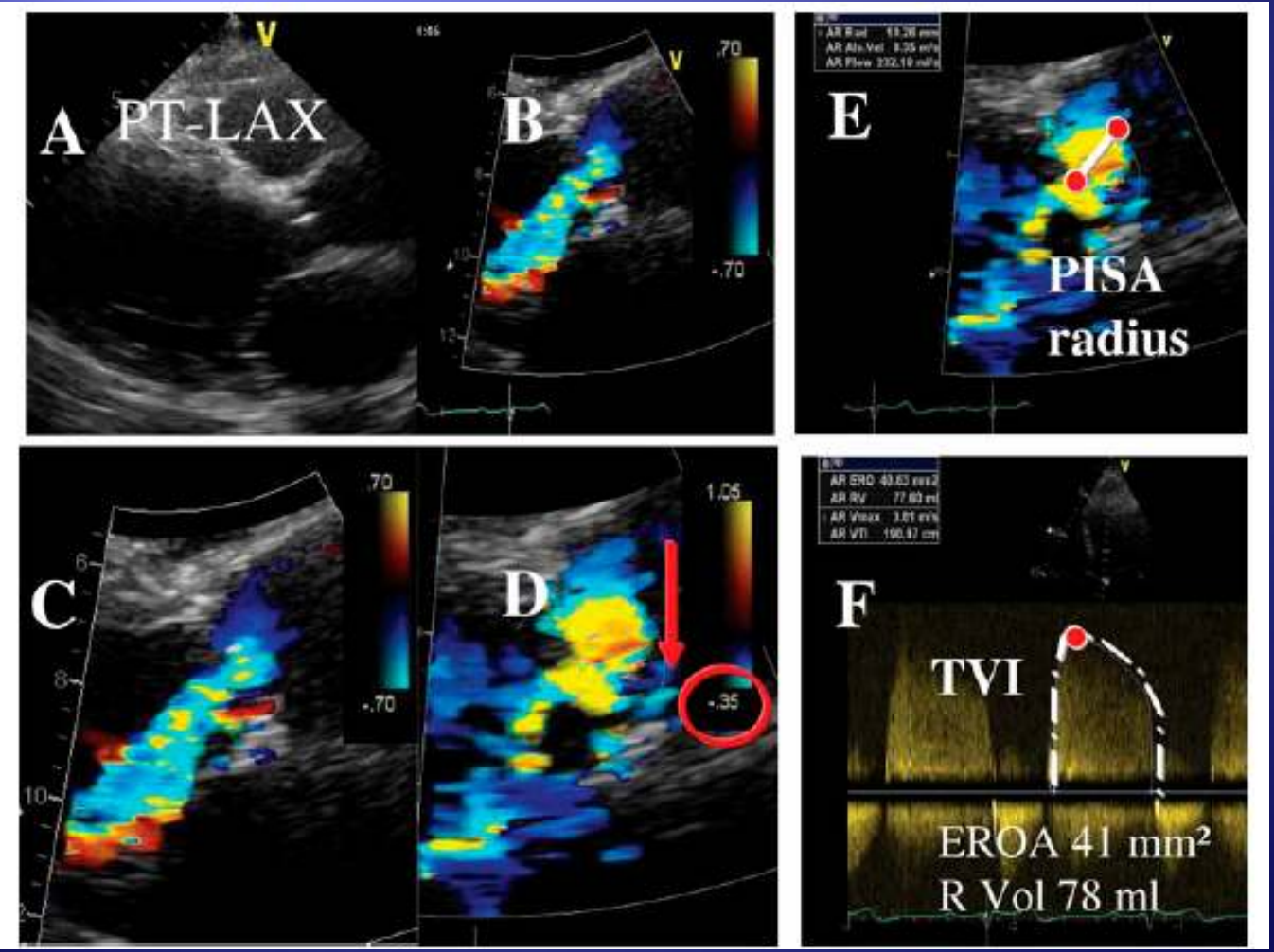
The flow convergence method (PISA method)

- Apical 3- or 5- chamber view
- Parasternal long axis view
- Upper right parasternal views

- *For **eccentric** AR, PISA will underestimate the severity from the apical views**, parasternal** views are preferred.*
- *For **central** AR, PISA will be the most appropriate from the **apical** views*

Quantification of AR severity by PISA method



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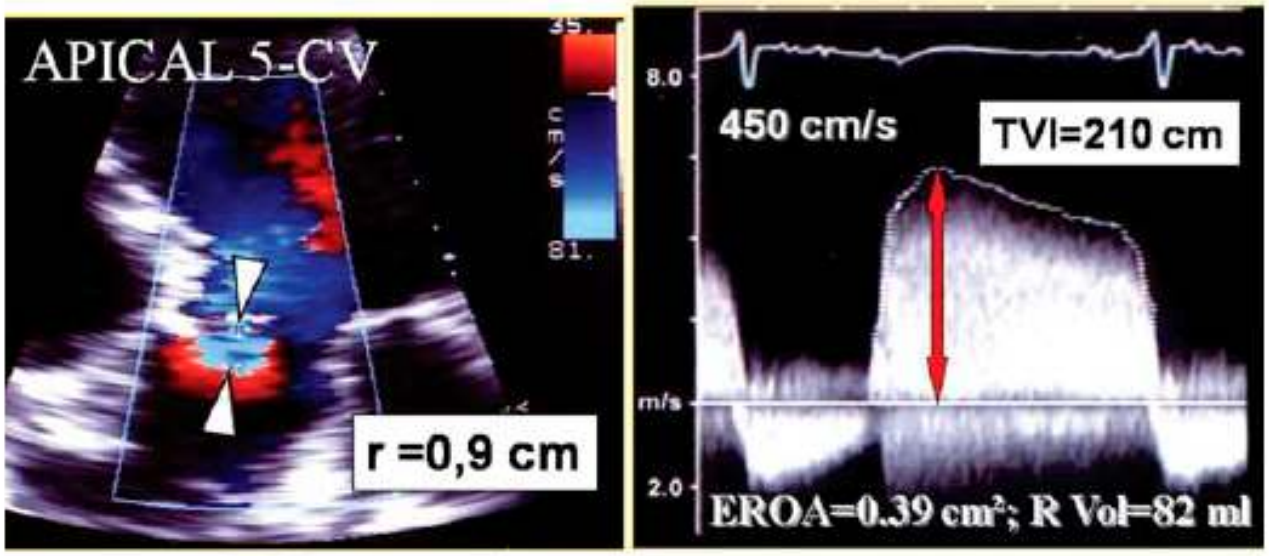
- PISA (hemisphere) = $2\pi r^2$
- Flow at PISA = PISA x $V_{aliasing}$
- Flow at orifice = ERO x $V_{orifice}$
- Flow at PISA = Flow at orifice
  - PISA x $V_{aliasing}$ = ERO x $V_{orifice}$

PISA method



$$\text{ERO} = \text{Flow/Peak velocity} = 178/450 = 0.39\ \text{cm}^2$$

$$\text{R Vol} = \text{EROA} \times \text{TVI} = 0.39\ \text{cm}^2 \times 210\ \text{cm} = 82\ \text{mL}$$

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Grading severity of AR by PISA method

	Mild	Mild to moderarte	Moderate to severe	Severe
EROA (mm^2)	< 10	10-19	20-29	≥ 30
R. Vol (ml)	< 30	30-44	45-59	≥ 60

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Limitations of PISA method

- Not feasible for significant percentage of patients with AR
  - Difficulty in correctly identifying the flow convergence zone
- Non-planar or confined flow convergence zone are potential causes of either under- or over-estimation of AR severity.

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Don't believe the jet area

Estimation of the severity of valvular regurgitation: recommendations

(1) The colour flow area of the regurgitant jet is not recommended to quantify the severity of valvular regurgitation.

(2) Both the vena contracta measurement and the PISA method are the recommended approaches to evaluate the severity of regurgitation when feasible.

(3) Adjunctive parameters should be used when there is discordance between the quantified degree of regurgitation and the clinical context.

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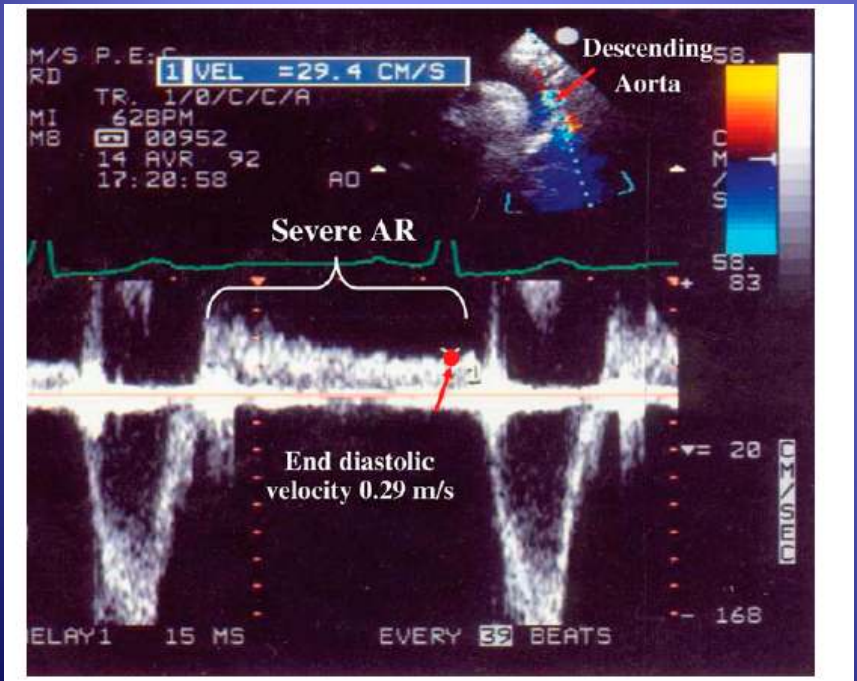
Diastolic flow reversal in the descending aorta



- An end-diastolic flow velocity > 20 cm/s is indicative of severe AR.
- Significant holodiastolic reversal in the abdominal aorta is also a sensitive sign of severe AR.

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Continuous wave Doppler of AR jet

- Reflects the pressure difference between the aorta and LV during disastole.
- Obtained from apical 5-chamber view
  - Eccentric: better from right parasternal view
- CW density
  - Not useful information about the severity of AR
  - Qualitative grading of AR

Continuous wave Doppler of AR jet

- Pressure half time
  - < 200 ms : severe AR
  - > 500 ms: mild AR
  - Influenced by chamber compliance and chamber pressure

AR

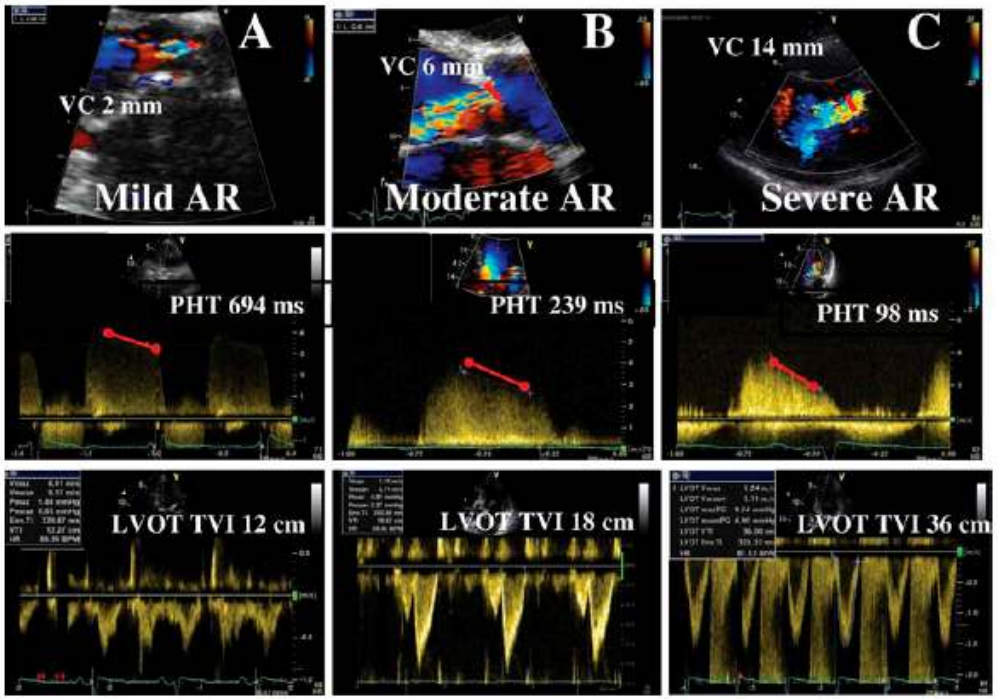

Figure 13 Three examples of aortic regurgitation (AR) are provided, all taken from the parasternal long-axis view using colour Doppler (top) and from the apical five-chamber view using continuous-wave Doppler (mid). The vena contracta (VC) increases with the severity of AR. The pressure half-time (PHT) decreases with more severe AR, whereas the left ventricular outflow time–velocity integral (LVOT TVI) increases.

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Surgery of severe AR

- LVEF $\leq$ 50%
- LVESD > 50 mm (25 mm/m^2)
  - Less preload dependent
- LVESV index $\geq$ 45 ml/m^2

Table 2 Grading the severity of AR

Parameters	Mild	Moderate	Severe
Qualitative			
Aortic valve morphology	Normal/Abnormal	Normal/Abnormal	Abnormal/flail/large coaptation defect
Colour flow AR jet width[a]	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)[b]	>500	Intermediate	<200
Quantitative			
EROA (mm^2)	<10	10–19; 20–29[c]	≥30
R Vol (mL)	<30	30–44; 45–59[c]	≥60
+LV size[d]			

Recommended follow up

- Asymptomatic patients with mild AR, no LV dilatation and normal LVEF at rest
  - Every 2-3 years
- Asymptomatic patients with severe AR, LVEDD 60-65mm and normal LVEF
  - Every 12 months
- Asymptomatic patients with severe AR, LVEDD close to 70mm, and LVESD close to 5omm(25 mm/m^2)
  - Every 6 months

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the evaluation of the aortic valve and of the aorta