

The New ASE Guidelines for Native Valvular Regurgitation

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Disclosure: advisory boards for MSD, Servier, Sanofi, Pfizer, Amgen,
Grant reviewer NMRC, SingHealth, ASTAR

ASE GUIDELINES AND STANDARDS

Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation

A Report from the American Society of Echocardiography
Developed in Collaboration with the Society for Cardiovascular
Magnetic Resonance

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J Am Soc Echocardiogr. 2017 Apr;30(4):303-371

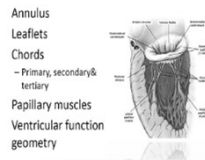
New ASE Valvular Regurgitation Guidelines- *Endorsed by SCMR*

► What is New?

- •Emphasis on identification of ***Etiology/Mechanism*** of regurgitation
- •2D/3D TTE--an ***integrative approach & algorithms*** to assess severity
- •When is ***TTE*** needed
- •Important role of ***CMR*** & CMR methodology
- •The challenge of ***co-existing valvular lesions***
- •A clinical perspective...
- •Library of case studies on the web

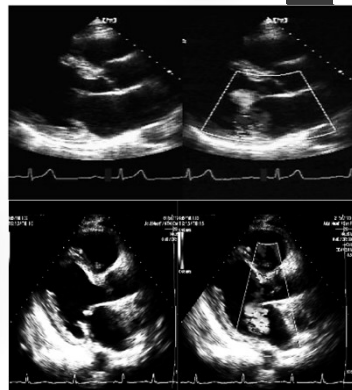
Mitral Regurgitation Indicators of Severity

- ▶ •Mitral valve pathology → **Anatomy**
- ▶ •LV/ LA size → **Color Flow**
- ▶ •Color Doppler: Vena contracta, Jet Area, Flow convergence → **Color Flow**
- ▶ •Mitral E; Pulmonary vein pattern → **Pulsed Doppler**
- ▶ •Regurgitant flow/fraction → **Pulsed Doppler**
- ▶ •CW density and contour → **CW Doppler**

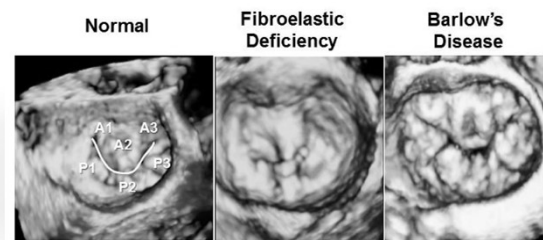


Valve Structure &MR Jet Characteristics

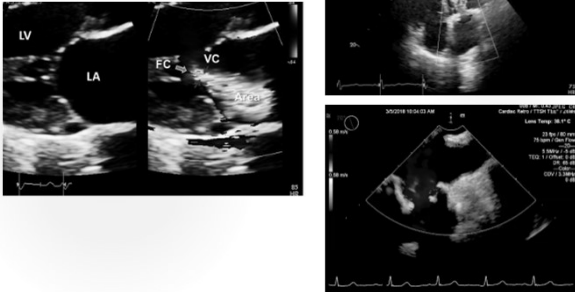
- ▶ Primary MR
- ▶ Secondary MR



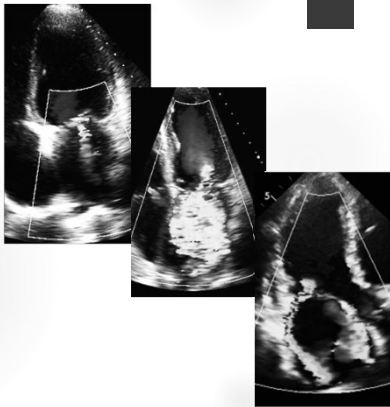
3D Echocardiography-MV



Mitral Regurgitation- Color Doppler
3 Components of the Jet



- ▶ Mild central jet
- ▶ Severe central jet
- ▶ Severe eccentric jet



Vena Contracta Proximal Jet
Width

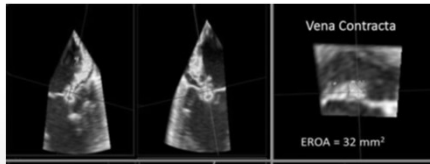


- ▶ VC width (cm)
- ▶ Mild < 0.3
- ▶ Moderate 0.3-0.7
- ▶ Severe > 0.7

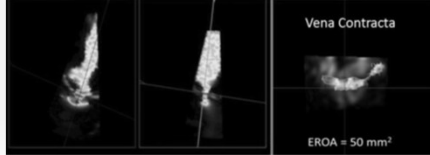
3D Echocardiography in MR

Assessing VC Area- VC Area is often not circular in Secondary MR

► Primary



► Secondary

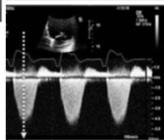
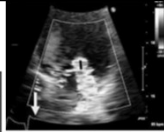


Flow Convergence (PISA)

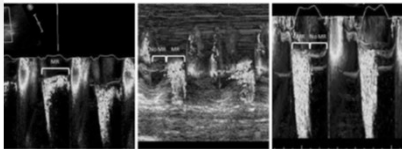
	Mild	Moderate	Severe	
EROA (cm ²)	< 0.2	0.20-0.29	0.30-0.39	≥ 0.4
RVol (ml/beat)	< 30	30-44	45-59	≥ 60

EROA cut-offs in 1st and 2nd MR are similar
RVol may be lower in 2nd MR

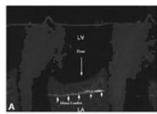
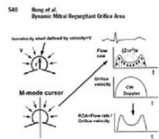
- Assumptions of hemispheric geometry
- Less accurate in eccentric jets
- Variability during the cardiac cycle and limitations in non-holosystolic MR



Holosystolic MR Late Systolic MR Early Systolic MR



Dynamic Nature of FMR

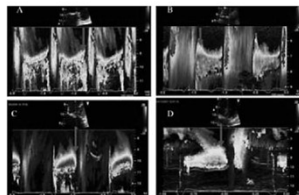


Early and Late systolic peak in flow and orifice area

Hung J et al. JACC 1999;33(2):538-45

Dynamic PISA

- A. FMR: early and Late peaks
- B. FMR: early peak
- C. Rheumatic: Late peak
- D. Organic: late peak

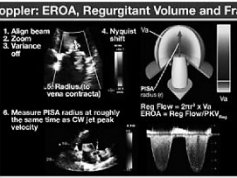


Lancellotti et al. Eur J Echocardiogr 2010;11:307-332

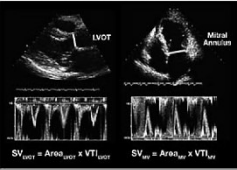
Quantitation of MR

D. Quantitative Doppler: EROA, Regurgitant Volume and Fraction

- Flow Convergence Method (PISA)**
1. See PISA (jet) above
 2. Look for need for angle correction if flow convergence zone is non-planar
 3. Measure PISA radius (red dotted arrow) in image at roughly the same time as CW jet peak velocity
 4. Align beam
 5. Zoom
 6. Measure PISA radius at roughly the same time as CW jet peak velocity



- Stroke Volume Method (Regurgitant Volume = $SV_{\text{LVTOT}} - SV_{\text{Aortic}}$)**
1. LVOT systolic diameter and parasternal Diastolic sample volume from different apices but at same anatomic level (represents forward stroke volume)
 2. Mitral mid-diastolic area and mitral regurgitant flow (display in the assist window) are measured for volume
 3. Total LV stroke volume can also be measured by the difference between LV end-diastolic volume and end-systolic volume (peak by 3D)



Measures EROA and calculates RegVol

Advantages:

- Rapid quantitative assessment of severity (EROA) and volume (stroke Vol)
- Predict outcomes in degenerative and functional MR

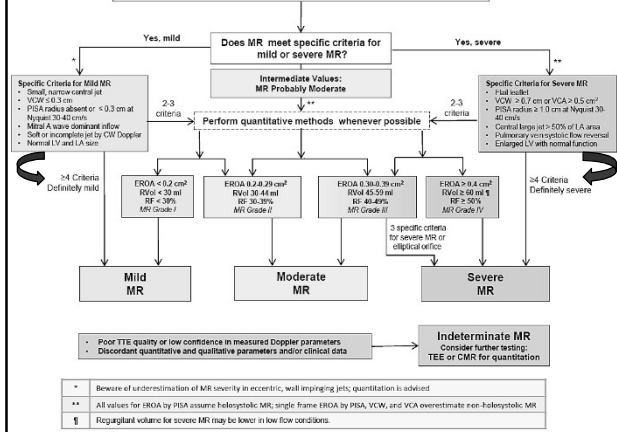
Disadvantages:

- Multiple jets, eccentric jets or crescent-shaped orifices
- Small errors in radius measurement can lead to substantial errors in EROA

Measures RegVol and calculates EROA

Zoghbi WA et al. J Am Soc Echocardiogr 2017; 30: 303-371.

Chronic Mitral Regurgitation by Doppler Echocardiography



2 or 3 Criteria >>>> QUANTITATIVE MEASURES:

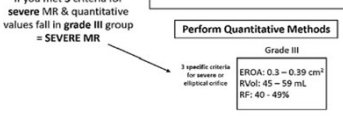
- ▶ The quantitative methods provide us with the following values:
- ▶ 1. Effective Regurgitant Orifice Area (EROA)
- ▶ 2. Regurgitant Volume (RVol)
- ▶ 3. Regurgitant Fraction (RF)

Grade I	Grade II	Grade III	Grade IV
EROA: 0.02 cm ² RVol: < 30 mL RF: < 30%	EROA: 0.2 - 0.29 cm ² RVol: 33 - 44 mL RF: 30 - 39%	EROA: 0.3 - 0.39 cm ² RVol: 45 - 59 mL RF: 40 - 49%	EROA: ≥ 0.4 cm ² RVol: ≥ 60 mL RF: ≥ 50%

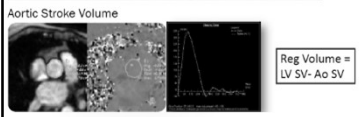
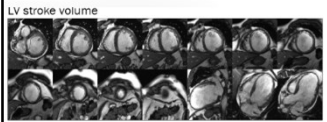
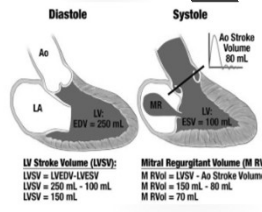


Severe MR Criteria

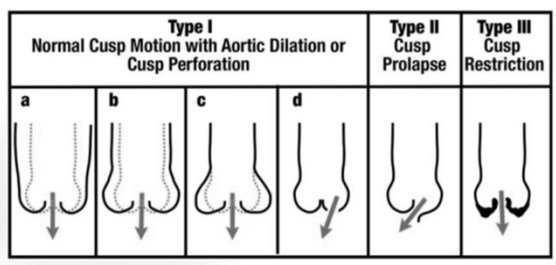
- Full leaflet
- Central large jet > 50% of LA area
- VCW > 0.7 cm
- PISA radius ≥ 1.0 cm at Nyquist Limits 30-40 cm/sec
- Pulmonary vein systolic flow reversal
- Enlarged LV with normal function



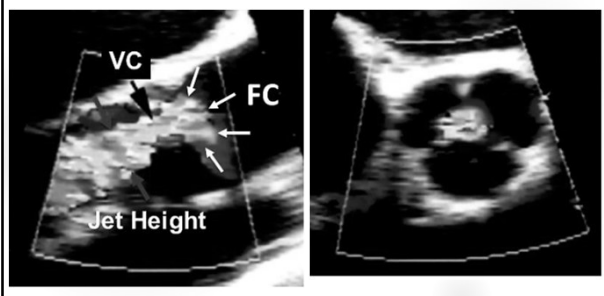
Quantitation of MR with CMR

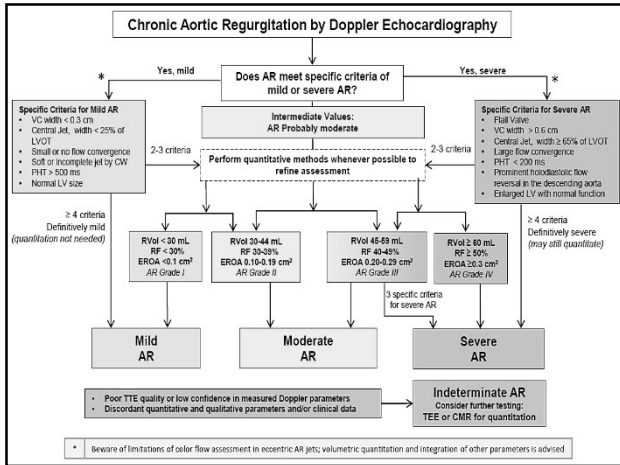


Aortic Regurgitation



Aortic Regurgitation-Color Doppler





Quantitation of AR with CMR

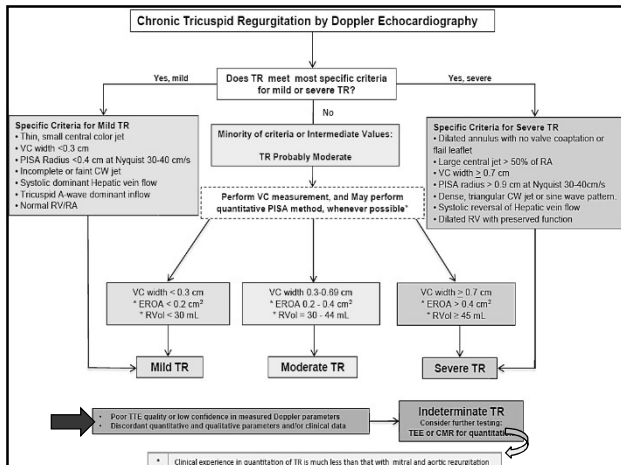
D: Flow Curve
 Forward: 138 mL
 Reverse: 70 mL
 RF: 51%

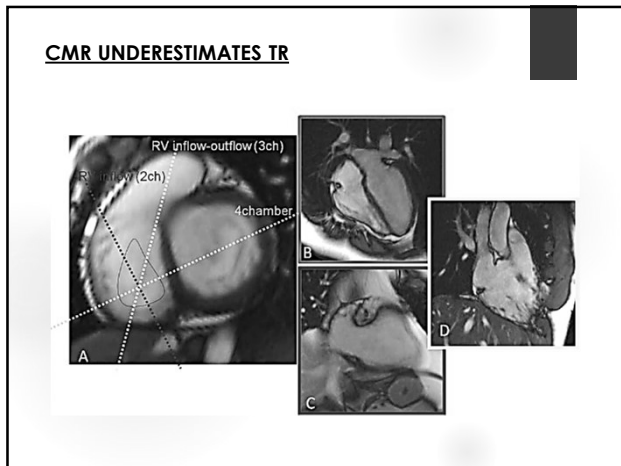
A, B, C, D: Anatomical Images
 A: Axial view showing aortic root and regurgitant jet.
 B: Axial view showing the aortic root.
 C: Axial view showing the aortic root with color flow overlay.
 D: Axial view showing the aortic root.

Tricuspid Valve Regurgitation

Table 14 Grading the severity of chronic TR by echocardiography

Parameters	Mild	Moderate	Severe
Structural			
TV morphology	Normal or mildly abnormal leaflets	Moderately abnormal leaflets	Severe valve lesions (e.g., flail leaflet, severe retraction, large perforation)
RV and RA size	Usually normal	Normal or mild dilatation	Usually dilated*
Inferior vena cava diameter	Normal < 2 cm	Normal or mildly dilated 2.1- 2.5 cm	Dilated > 2.5 cm
Qualitative Doppler			
Color flow jet area [†]	Small, narrow, central	Moderate central	Large central jet or eccentric wall-impinging jet of variable size
Flow convergence zone	Not visible, transient or small	Intermediate in size and duration	Large throughout systole
CWD jet	Faint/partial/parabolic	Dense, parabolic or triangular	Dense, often triangular
Semiquantitative			
Color flow jet area (cm ²) [‡]	Not defined	Not defined	>10
VCW (cm) [§]	<0.3	0.3-0.69	≥0.7
PISA radius (cm) [¶]	≤0.5	0.6-0.9	>0.9
Hepatic vein flow	Systolic dominance	Systolic blunting	Systolic flow reversal
Tricuspid inflow	A-wave dominant	Variable	E-wave >1.0 m/sec
Quantitative			
EROA (cm ²)	<0.20	0.20-0.39 [§]	≥0.40
RVol (2D PISA) (mL)	<30	30-44 [§]	≥45





PR

Table 12. Doppler echocardiography in evaluating severity of PR

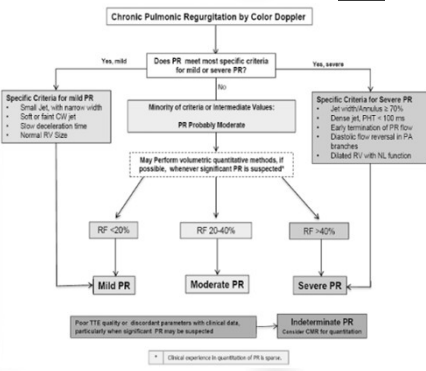
View	Observation	Feature	Advantage	Prize	Utility	Observation	Example	Advantage	Prize	
VC	<ul style="list-style-type: none"> Proximal flow area is smallest near Distal flow area is largest Proximal flow area is larger than distal flow area Color Doppler flow is largest near jet Maximal flow area is largest near jet Maximal flow area is largest near jet 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume
VC/RV inflow	<ul style="list-style-type: none"> Proximal flow area is smallest near Distal flow area is largest Proximal flow area is larger than distal flow area Color Doppler flow is largest near jet Maximal flow area is largest near jet Maximal flow area is largest near jet 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume
RV inflow	<ul style="list-style-type: none"> Proximal flow area is smallest near Distal flow area is largest Proximal flow area is larger than distal flow area Color Doppler flow is largest near jet Maximal flow area is largest near jet Maximal flow area is largest near jet 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume
4ch	<ul style="list-style-type: none"> Proximal flow area is smallest near Distal flow area is largest Proximal flow area is larger than distal flow area Color Doppler flow is largest near jet Maximal flow area is largest near jet Maximal flow area is largest near jet 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume
2ch	<ul style="list-style-type: none"> Proximal flow area is smallest near Distal flow area is largest Proximal flow area is larger than distal flow area Color Doppler flow is largest near jet Maximal flow area is largest near jet Maximal flow area is largest near jet 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 		<ul style="list-style-type: none"> Simple for which regurgitant volume Independent of flow measurement Simple for a fixed orifice Color Doppler flow is largest near jet Color Doppler flow is largest near jet Color Doppler flow is largest near jet 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume 	<ul style="list-style-type: none"> Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume Flow area with regurgitant volume

PR severity

Table 16. Echocardiographic and Doppler parameters useful in grading PR severity

Parameter	Mild	Moderate	Severe
Pulmonic valve	Normal	Normal or abnormal	Abnormal and may not be visible
RV size	Normal*	Normal or dilated	Dilated [†]
Jet size, color Doppler [‡]	Thin (usually <10 mm in length) with a narrow origin	Intermediate	Broad origin; variable depth of penetration
Ratio of PR jet width/pulmonary annulus			>0.7 [‡]
Jet density and contour (CW)	Soft	Dense	Dense; early termination of diastolic flow
Deceleration time of the PR spectral Doppler signal			Short, <260 msec
Pressure half-time of PR jet			<100 msec [§]
PR Index [¶]		<0.77	<0.77
Diastolic flow reversal in the main or branch PAs (PW)			Prominent
Pulmonic systolic flow (VTI) compared to systemic flow (LVOT VTI) by PW ^{**}	Slightly increased	Intermediate	Greatly increased
RF ^{***}	<20%	20%-40%	>40%

- ▶ Good-quality echocardiographic imaging and complete
- ▶ If imaging is technically difficult, consider CMR or TEE.
- ▶ CMR or TEE >> PR severity indeterminate due to poor image quality, technical issues with data, internal inconsistency among echo findings, or discordance with clinical findings.



CMR in PR

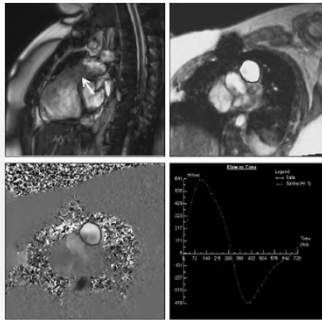


Table 17. Impact of multivalvular disease on assessment of valvular regurgitation with Doppler echocardiography and CMR¹

By the Valvular Lesion	Impact on the Regurgitant Lesion			
	AR	MR	PR	TR
AR	Little impact, although theoretically increases jet area and pressure jet area. For CMR phase contrast plane better in LVOT.	For constant RQA, RVVJ increases in proportion to jet area and jet diameter. For CMR phase contrast flow, RQA may increase if LV dilates.	Little impact unless PR annulus.	Little impact unless PR annulus.
MR	NA	LV dilation may increase RQA especially in secondary MR. Mixed regurgitant lesions make diagnostic methods challenging, as one must find some location reflective of net forward flow (e.g., RVOT). For CMR flow: RVVJ-LVSV - aortic forward flow. MR Reg Fraction = MR RegVol & VVJ - AR RegVol.	Little impact unless PR annulus.	Little impact unless PR annulus.
AS	Little direct impact, although the distorted LV filling might theoretically heighten AR pressure half-time.	may produce and decrease jet area and appearance of jet.	Lesion most likely to increase PAP and thus increase RVVJ and jet area.	Lesion most likely to increase PAP and thus increase RVVJ and jet area. If RV dysfunction occurs, may increase RQA.
MI	Little direct impact, but mixed regurgitant lesions render volumetric methods challenging, as one must find some location reflective of net forward flow (e.g., RVOT). Rapid early filling may decrease MR pressure half-time.	NA	Little impact, although PR and mitral regurgitant jet area. For CMR phase contrast plane better in RVOT.	Little impact, although PR and mitral regurgitant jet area. For CMR phase contrast plane better in RVOT.
PS	Little direct impact.	Little direct impact.	Little impact, although PR and mitral regurgitant jet area. For CMR phase contrast plane better in RVOT.	Increased RVSP will increase RVVJ and jet area. If RV dysfunction occurs, may increase RQA.
PI	Little direct impact.	Little direct impact.	NA	Increased RV volume may increase RQA, which will increase RVVJ and jet area. For CMR: RVVJreg - regurgitant forward flow. TR Reg Fraction = TR RegVol / RVVJ - PR RegVol.
TS	Little direct impact.	Little direct impact.	Little direct impact.	Little direct impact, although TR jet area increases, EG gradient.
TI	Little direct impact.	Little direct impact.	Rapid RV filling from TI may further shorten PR pressure half-time, and cause PR jet more brief.	NA

Multi valve disease

New ASE Valvular Regurgitation Guidelines- Endorsed by SCMR

- ▶ What is New?
 - ▶ •Emphasis on identification of Etiology/Mechanism of regurgitation
 - ▶ •2D/3D TTE--an integrative approach & algorithms to assess severity
 - ▶ •When is TEE needed
 - ▶ •Important role of CMR & CMR methodology
 - ▶ •The challenge of co-existing valvular lesions
 - ▶ •A clinical perspective
 - ▶ •Library of case studies on the web: www.asecho.org/vrcases

THANK YOU
