Echo assessment of acute and chronic aortic regurgitation

Jacinta Warburton

ECHO AUSTRALIA

17-19 March 2025

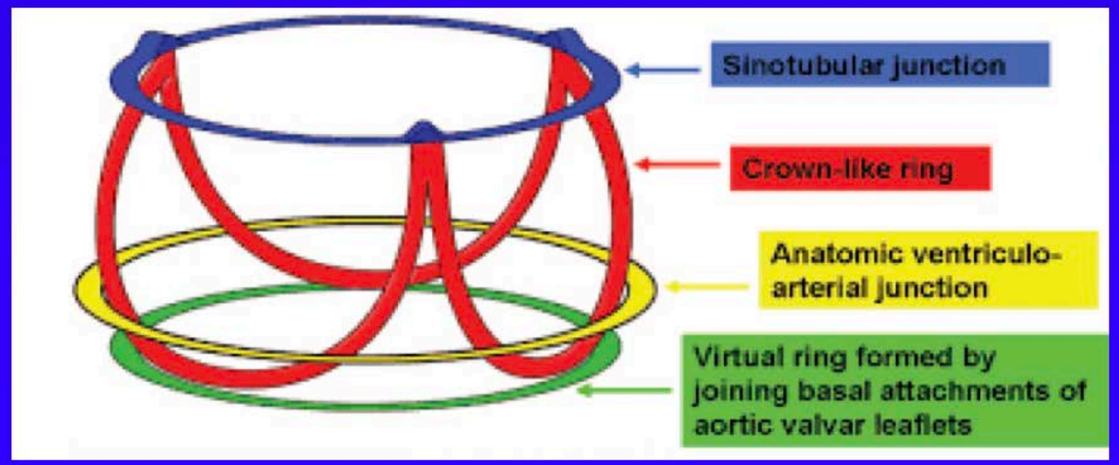
No Disclosures

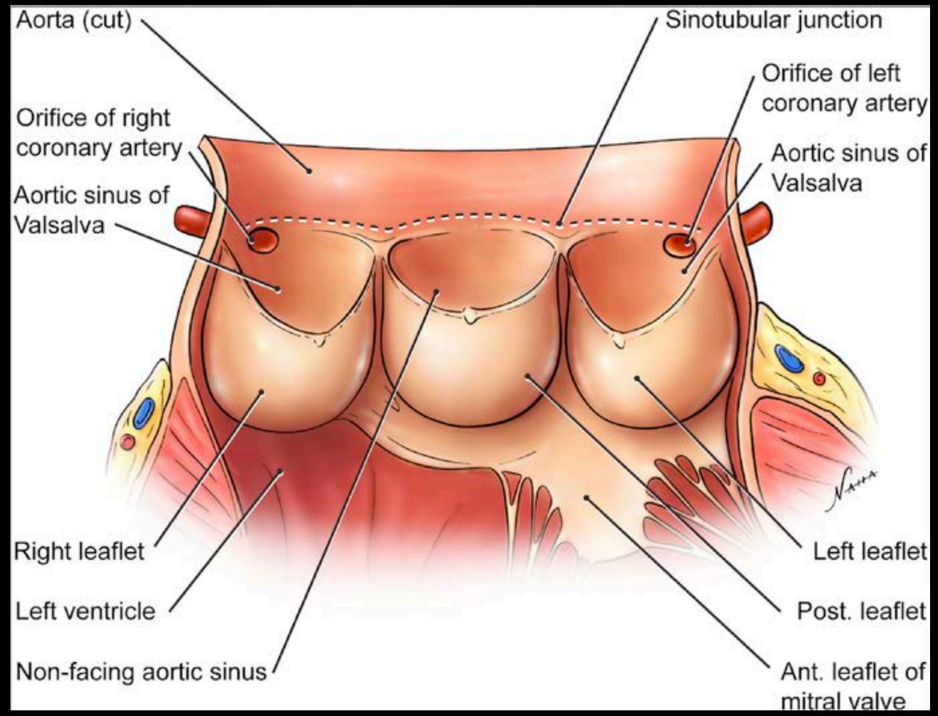
Summary

- Anatomy
- Etiology
- Chronic AR
- Grading severity (Qualitative, Semi-quantitative and Quantitative assessment)
- Acute AR

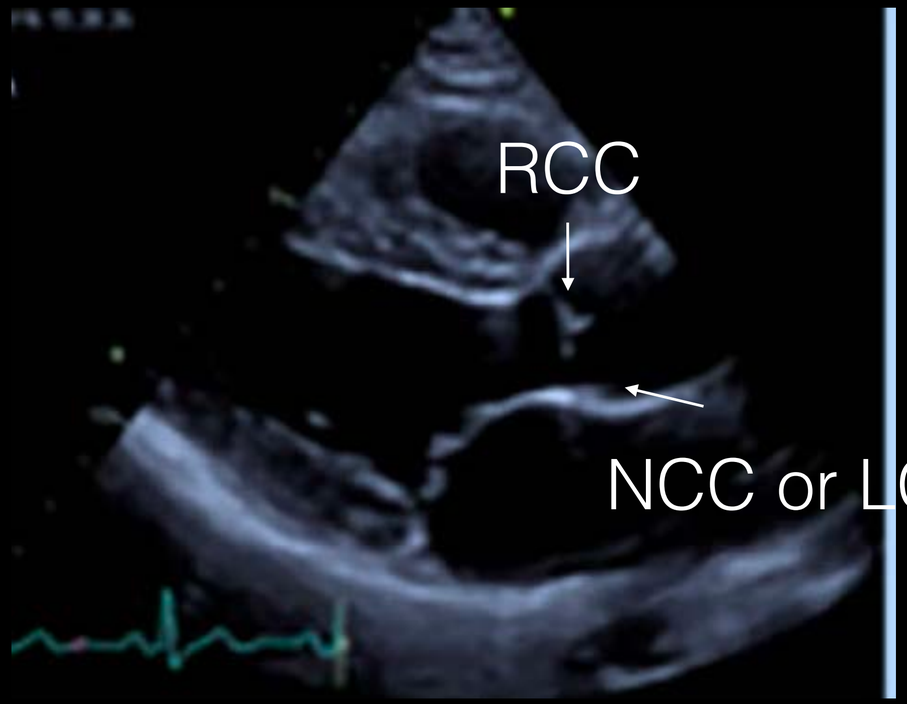
Anatomy

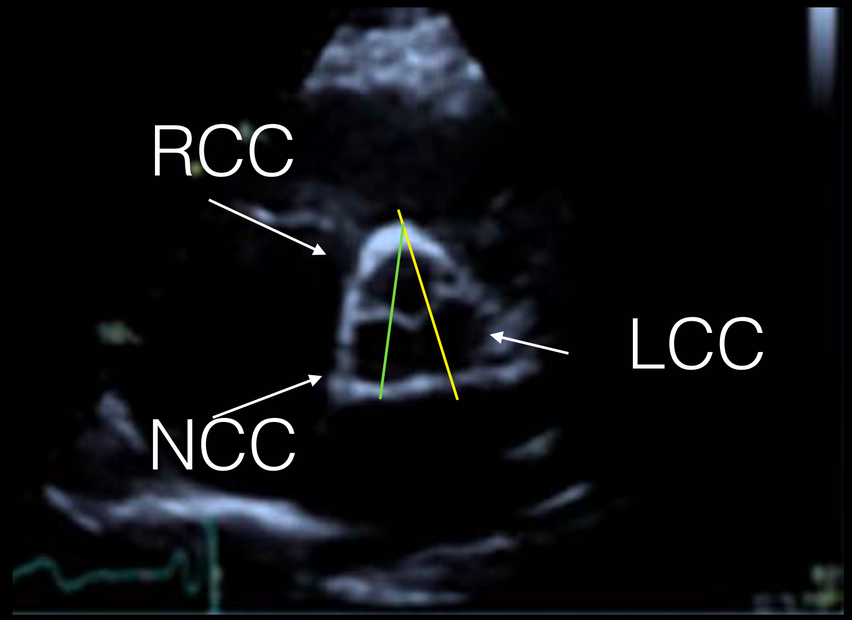
Valve cusps are not planar





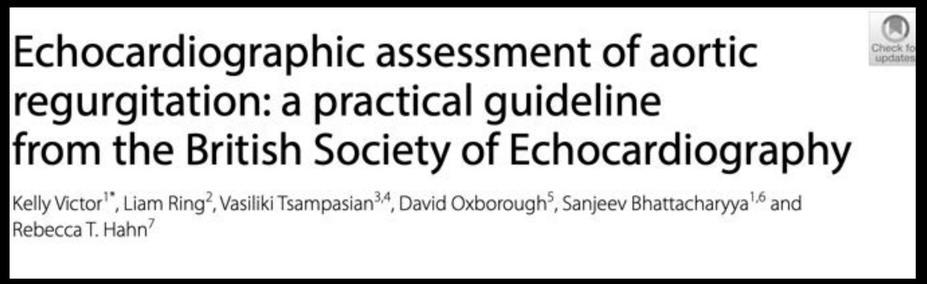
Anatomy





Insertion of cusps

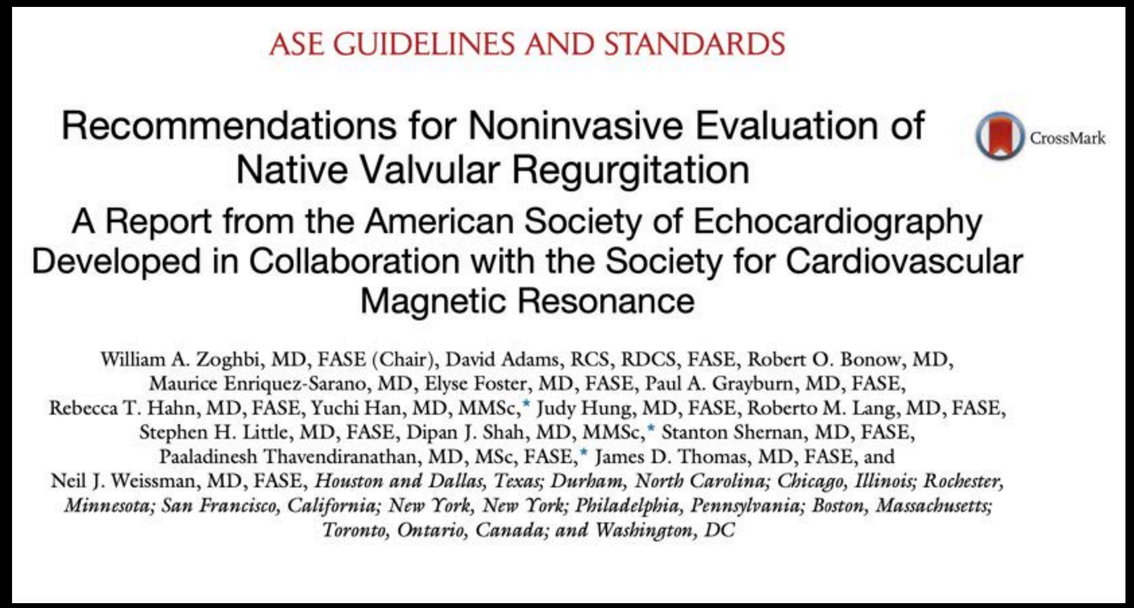
Echocardiographic assessment of aortic regurgitation: a practical guideline from the British Society of Echocarcardiography, 2025



Echocardiographic assessment of aortic regurgitation: a practical guideline from the British Society of Echocardiography

Kelly Victor[1*], Liam Ring[2], Vasiliki Tsampasian[3,4], David Oxborough[5], Sanjeev Bhattacharyya[1,6] and Rebecca T. Hahn[7]

American Society of Echocardiography Recommendations for the non-invasive evaluation of valvular regurgitation 2017



ASE GUIDELINES AND STANDARDS

Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation

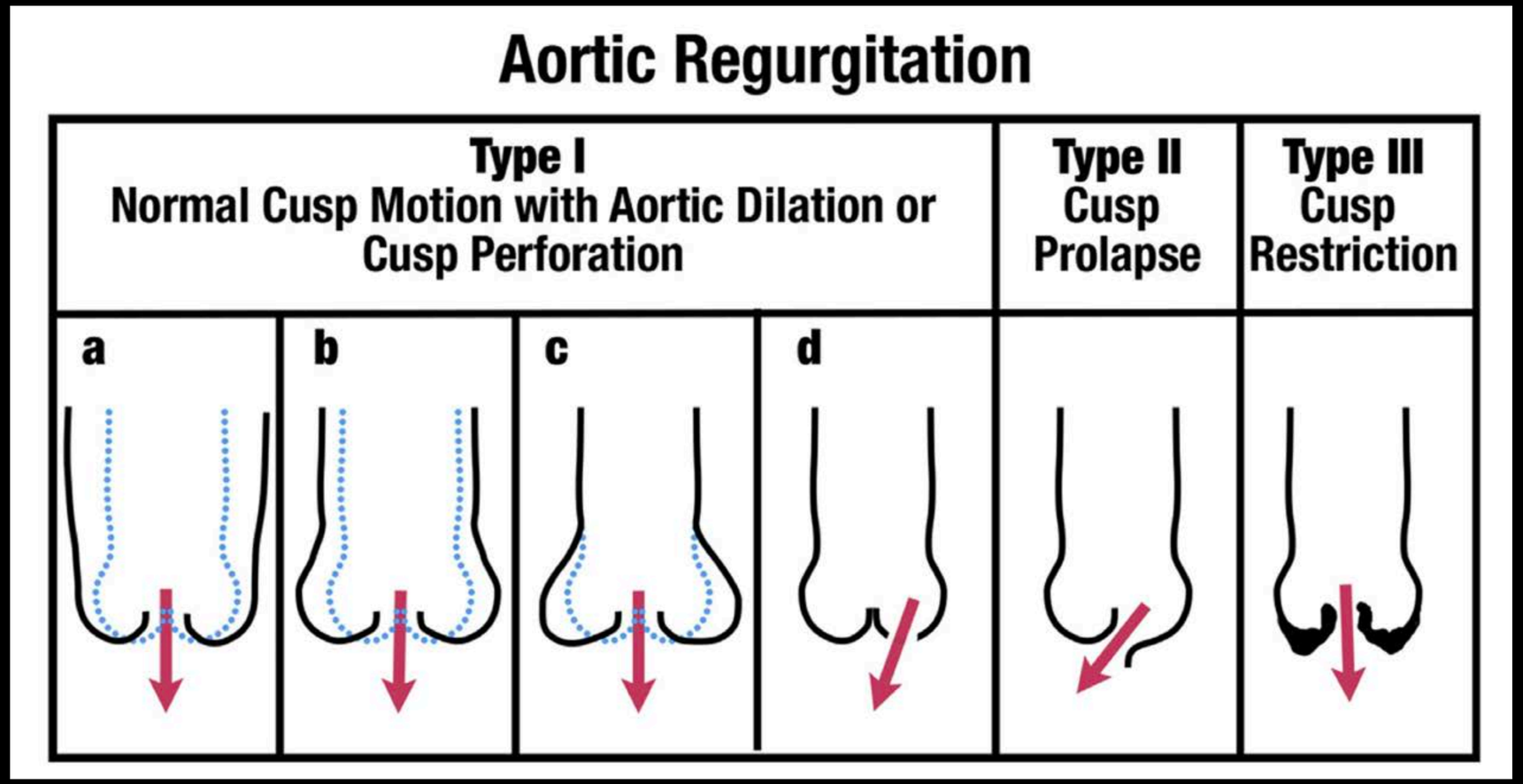
A Report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance

William A. Zoghbi, MD, FASE (Chair), David Adams, RCS, RDCS, FASE, Robert O. Bonow, MD, Maurice Enriquez-Sarano, MD, Elyse Foster, MD, FASE, Paul A. Grayburn, MD, FASE, Rebecca T. Hahn, MD, FASE, Yuchi Han, MD, MMSc,* Judy Hung, MD, FASE, Roberto M. Lang, MD, FASE, Stephen H. Little, MD, FASE, Dipan J. Shah, MD, MMSc,* Stanton Shernan, MD, FASE, Paaladinesh Thavendiranathan, MD, MSc, FASE,* James D. Thomas, MD, FASE, and Neil J. Weissman, MD, FASE, *Houston and Dallas, Texas; Durham, North Carolina; Chicago, Illinois; Rochester, Minnesota; San Francisco, California; New York, New York; Philadelphia, Pennsylvania; Boston, Massachusetts; Toronto, Ontario, Canada; and Washington, DC*

Aortic Regurgitation

- Third most common valve lesion
- Prevalence increases with age
- An increasing burden due to ageing population
- Echo central to diagnosis, monitoring and clinical decision making

Classification of Aortic Regurgitation (JASE 2017)



AR - Aetiology

	Abnormal leaflets	Abnormal aorta
Congenital	Bicuspid Unicuspid Quadracuspid VSD	Bicuspid AV Annuloaortic ectasia CT disease
Acquired	Endocarditis Rheumatic Calcification Radiation Anorectic drugs	HTN SLE Ankylosing spondylitis Dissection Syphilis Trauma

Most common - Aortic dilatation with secondary AR

AR assessment

- What is the aetiology?
- What are the haemodynamics like?
- How severe is the regurgitation?

Chronic Severe Aortic Regurgitation

Evolves slowly due to compensatory mechanisms

Often asymptomatic until overt signs of congestive heart failure develop

LV volume and pressure overload, reduced in LVEF

ACC/AHA guidelines recommend AV surgery

-In symptomatic patients or those with reduced EF (class I)

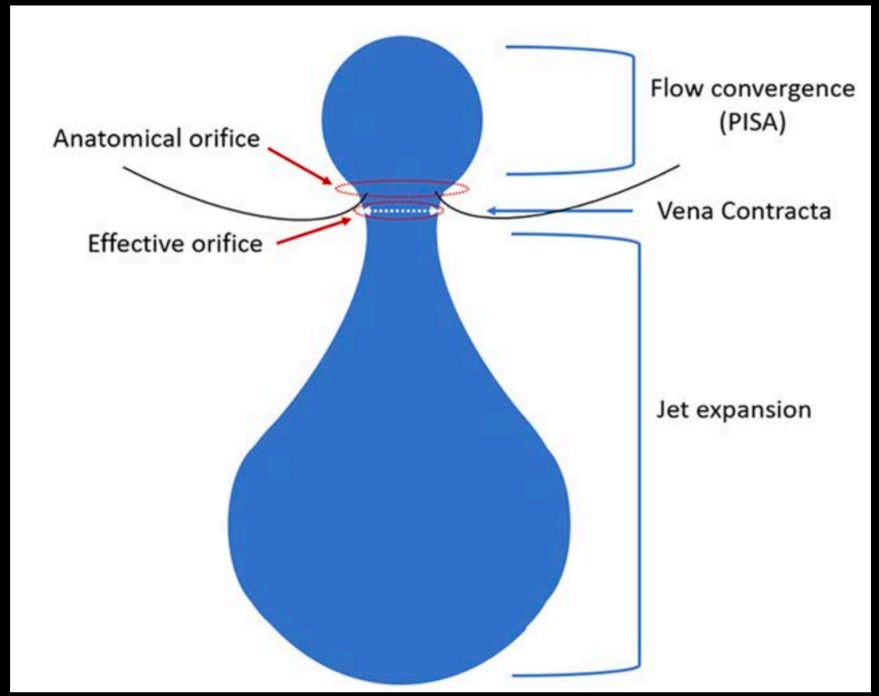
-In asymptomatic patients with preserved EF and significantly dilated LV (class II)

Grade the severity of AR

Visualise 3 components of the colour jet

Jet area -dependant on BP and ventricular compliance

- Structural parameters
- Qualitative Doppler parameters
- Semi-quantitative Doppler parameters
- Quantitative Doppler parameters



Structural Parameters

	AR severity		
	Mild	Moderate	Severe
Aortic leaflets	Normal or abnormal	Normal or abnormal	**Abnormal/flail, or wide coaptation defect**
LV size	**Normal***	Normal or dilated	Usually dilated†

-LV dilatation with preserved function suggests significant AR
-LV size, geometry and function are important
markers for surgical intervention

- Stress echo - rule out coronary disease and assess functional capacity

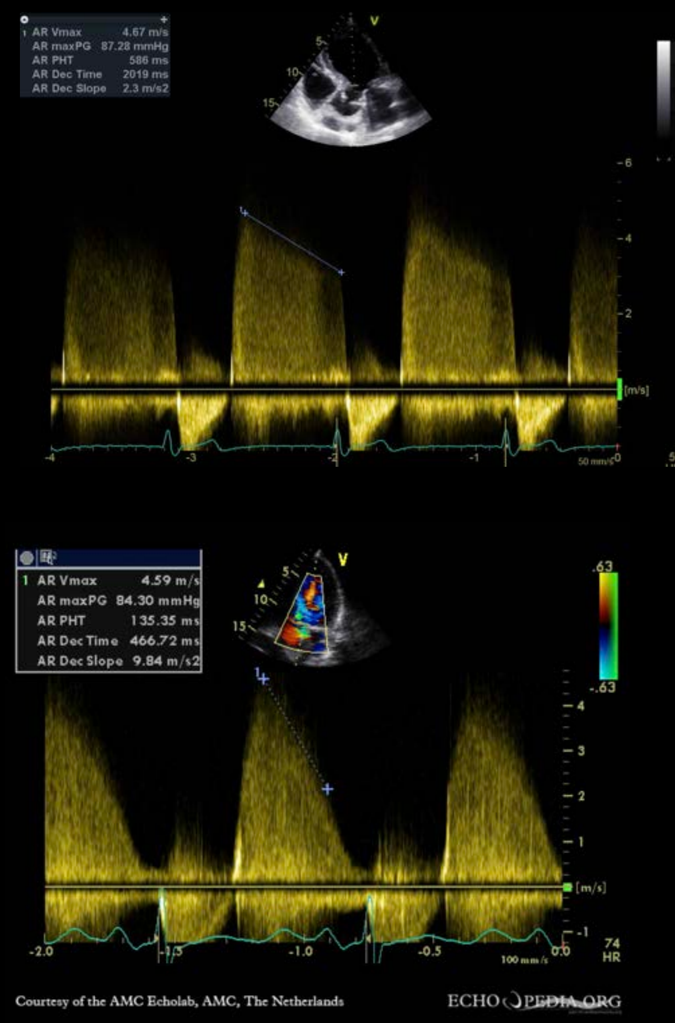
Qualitative Doppler Parameters

	AR severity		
	Mild	Moderate	Severe
Jet width in LVOT, color flow	**Small in central jets**	Intermediate	**Large in central jets**; variable in eccentric jets
Flow convergence, color flow	**None or very small**	Intermediate	**Large**
Jet density, CW	**Incomplete or faint**	Dense	Dense
Jet deceleration rate, CW (PHT, msec)‡	Incomplete or faint Slow, >500	Medium, 500-200	**Steep, <200**
Diastolic flow reversal in descending aorta, PW	**Brief, early diastolic reversal**	Intermediate	**Prominent holodiastolic reversal**

Rapid
Simple
Faint CW signal = trivial/mild AR

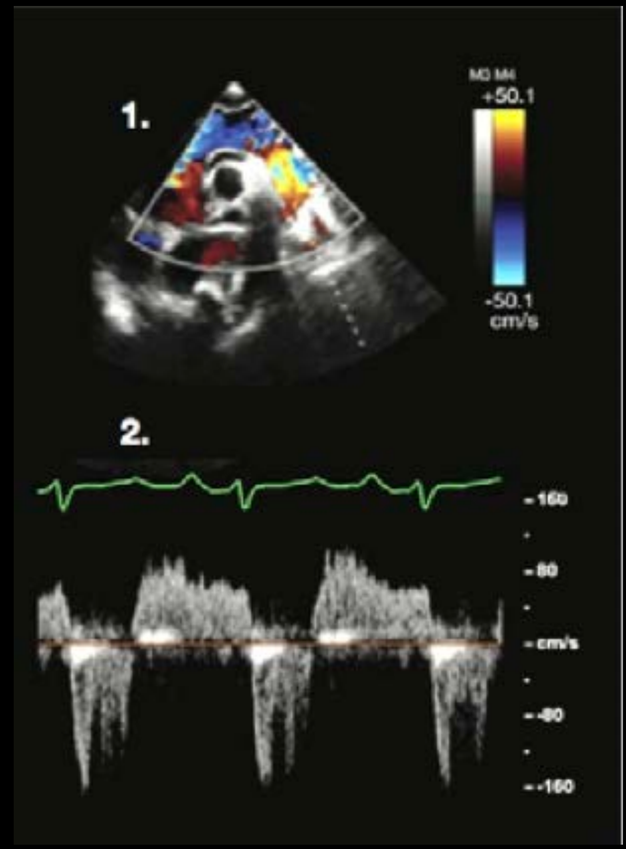
Jet Deceleration rate

- Simple
- Specific sign of pressure relationship between aorta and LV
    - If PHT short = significant AR **or** high LV filling pressure
- Disadvantage - poor alignment -> lower PHT



Diastolic flow reversal in the aorta

- Simple
- Holodiastolic flow reversal with end diastolic vel ≥20cm/s = severe AR
- More specific if seen in abdominal aorta
- Disadvantage - depends of compliance of aorta and brief flow reversal can be normal
- **Acute AR - short or absent**



Semi-quantitative Doppler Parameters

	AR severity			
	Mild	Moderate		Severe
VCW (cm)	<0.3	0.3-0.6		>0.6
Jet width/LVOT width, central jets (%)	<25	25-45	46-64	≥65
Jet CSA/LVOT CSA, central jets (%)	<5	5-20	21-59	≥60

Journal of the American Society of Echocardiography
Volume 30 Number 4

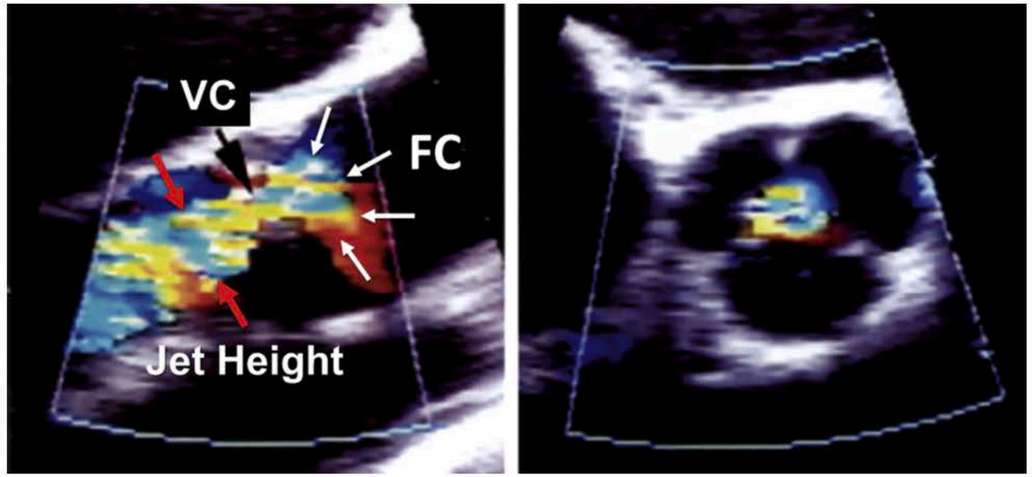
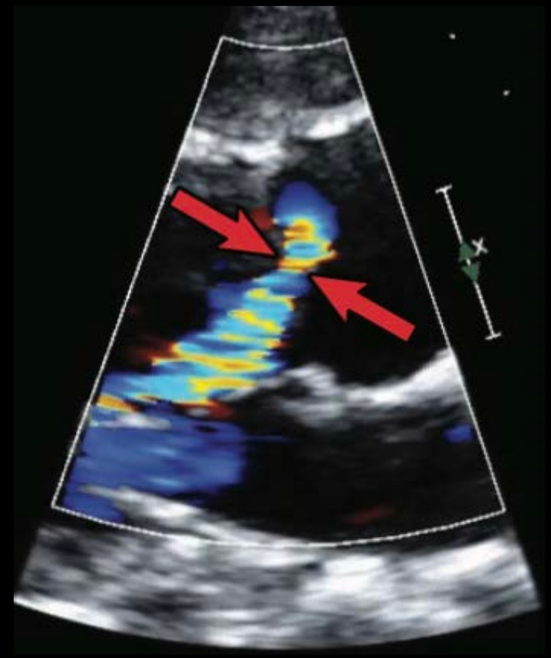


Figure 20 Color flow Doppler of AR in the parasternal long- and short-axis views. The three components of the jet are shown with arrows: flow convergence (FC), VC, and jet height (or width) in the LV outflow.

Vena Contracta width



- Good at identifying Mild <0.3cm and Severe >0.6cm
- Surrogate for EROA
- Valid in eccentric jets
- Independent of flow rate and driving pressure
- Less dependant on technical factors
- Disadvantage - Presence of multiple jets, Convergence zone needs to be visualised, Direction of jet will impact on its appearance, Assumes circular EROA

Jet width / LVOT diameter

- Jet width - measure in **diastole** within 1cm of VC
- Simple
- Sensitive
- Rapid
- Disadvantage - Underestimates AR in eccentric jets, overestimate AR in central jets, affected by size of LVOT

Quantitative Doppler Parameters

	AR severity			
	Mild	Moderate		Severe
RVol (mL/beat)	<30	30-44	45-59	≥60
RF (%)	<30	30-39	40-49	≥50
EROA (cm^2)	<0.10	0.10-0.19	0.20-0.29	≥0.30

Two methods to calculate RV

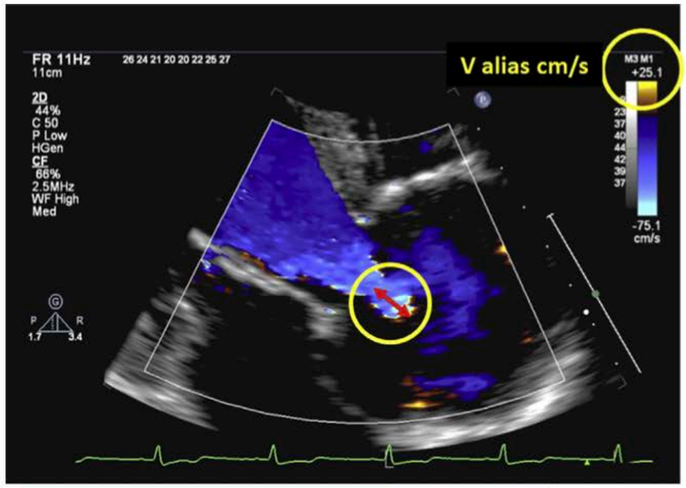
- RV = EROA x VTI AR. (PISA. Flow convergence method)
- RV = SVAo - SVMv (Continuity method)

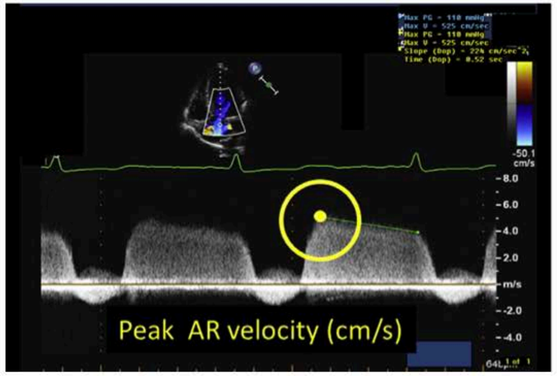
Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation JASE 2017

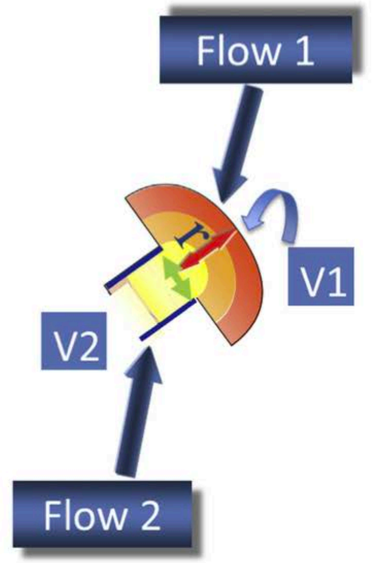
ECHO AUSTRALIA

Flow convergence Method (PISA)
- to calculate EROA and RV

- Lower colour Doppler baseline in direction of jet
- Measure PISA radius
- CW Doppler







$Q_{prox} = Q_{distal}$

$A_1 V_1 = A_2 V_2$

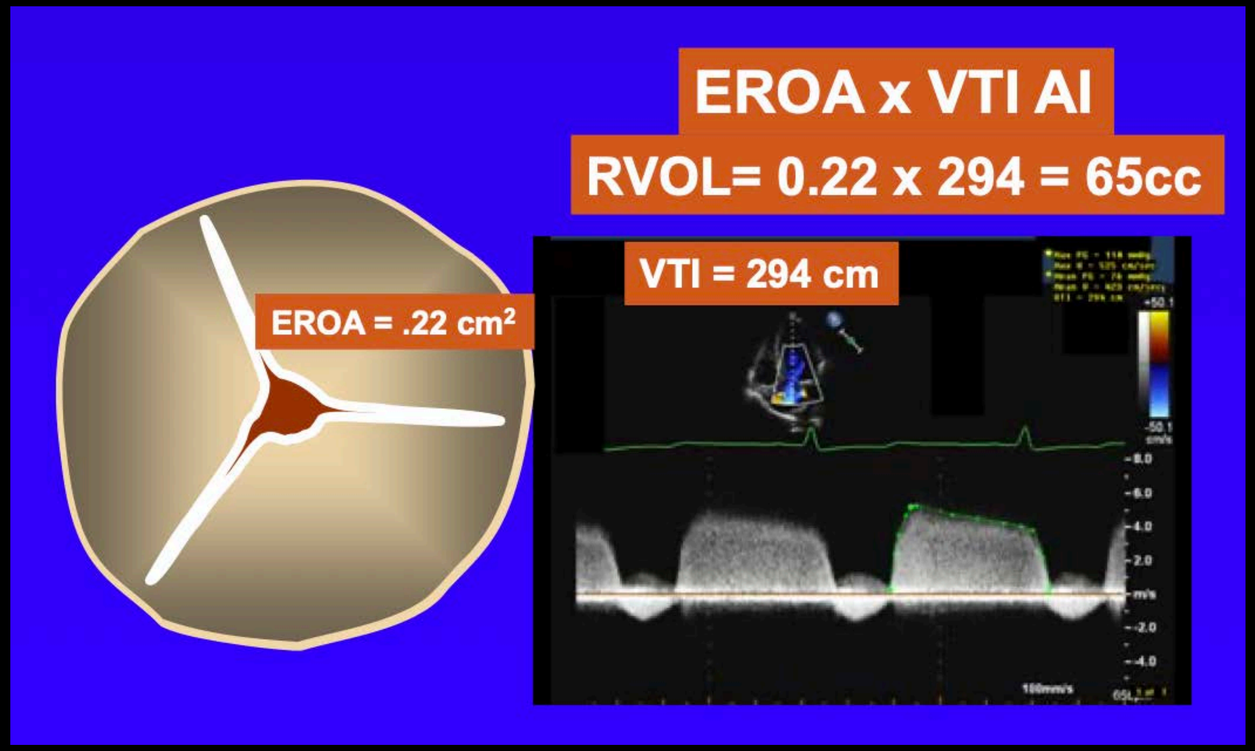
$(2\pi r^2) \times Va = EROA \times PkV_{AR}$

$6.28\ (.86)^2 \times 25.1 = EROA \times 525$

$116.6 = EROA \times 525$

$116.6/525 = .22\ cm^2 = EROA$

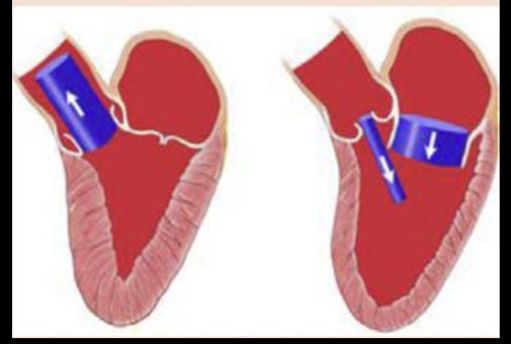
Flow convergence Method (PISA)
- to calculate EROA and RV



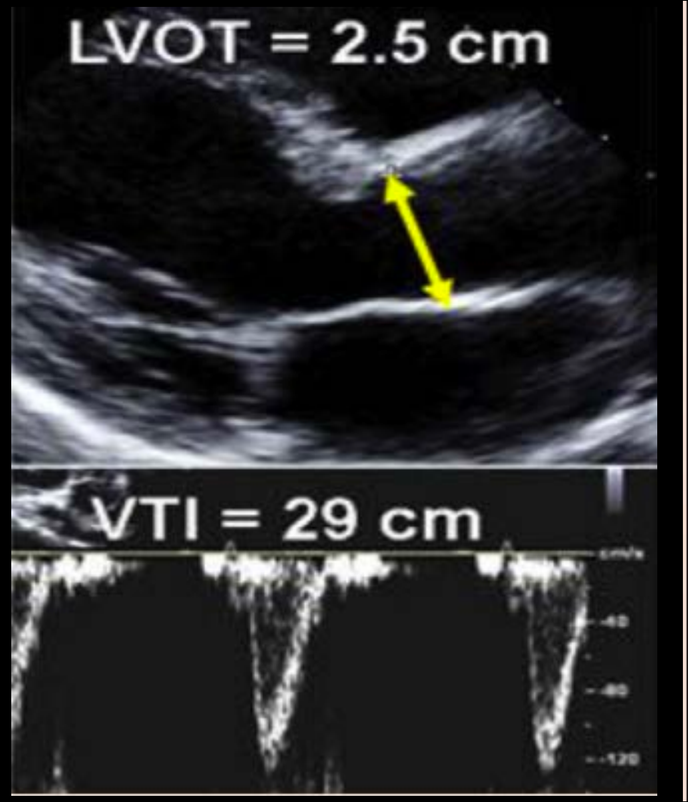
Advantages	Disadvantages
• Rapid • Provides details on severity (EROA) and volume overload (RVol)	• Limited by calcification • Not valid in multiple jets • Less accurate in eccentric jets • Small errors in radius measurement can produce large errors in EROA

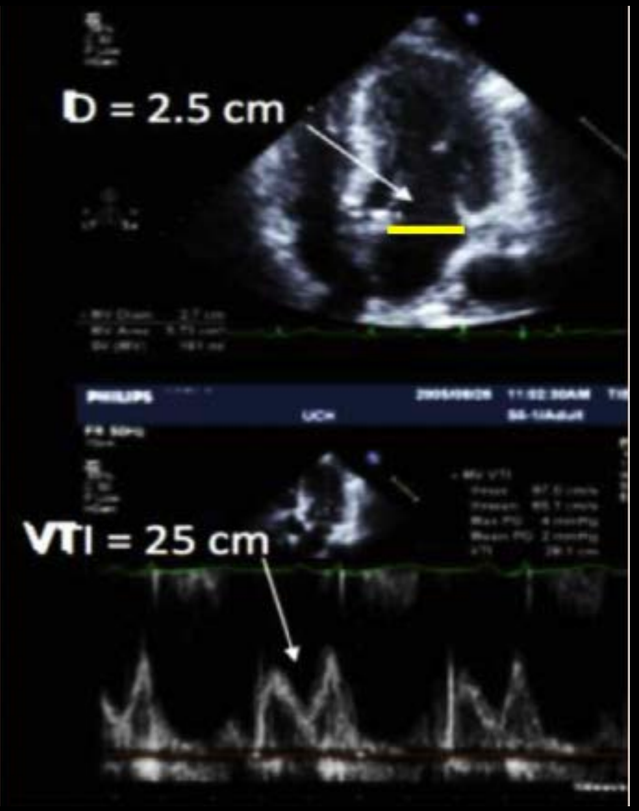
Regurgitant volume

Continuity Method to calculate RV



- RV = SVAo - SVMv
  1. LVOTd (systolic)
  2. LVOT VTI - PW Doppler
  3. Mitral annulus diameter
  4. MV VTI - PW Doppler





Regurgitant volume - Continuity method

Advantages	Disadvantages
• Valid for multiple jets • Provides details on severity (EROA, RF) and volume overload (RVol)	• Difficulties measuring mitral annulus diameter • If there is MR, use pulmonary stroke volume • Cumbersome, need training • Small diameter errors can produce large errors in EROA

Regurgitant Fraction (RF)

- RF = RVar / SVao x 100
- Useful in those with reduced LVEF or reduced CO where a small RV is proportionally more significant

When is TTE not enough?

- TOE - valve morphology and mechanism or AR
- CMR - has less acoustic window limitations

    - LV size and function, RV and quantification of cardiac remodelling

- Cardiac CT - define the size and shape of the aorta

Timing intervention - Chronic severe AR?

Chronic AR

- Record size of LV and aorta (indexed)
- Define severity of AR
- Serial echoes in asymptomatic severe AR
- Be prepared for discrepant results

Prompt referral for intervention
LVESd > 50 mm
LVESdi ≥ 25 mm/m2
LVEF ≤ 55%
Ascending aorta diameter ≥ 55 mm in all patients
Ascending aorta diameter ≥ 45 mm in special populations
Rapid dilatation of the LV approaching surgical threshold

Acute Aortic Regurgitation

Rapid onset pulmonary oedema and hypotension or cardiogenic shock

May also present as myocardial ischaemia or aortic root dissection

Medical emergency

Causes of Acute Severe AR

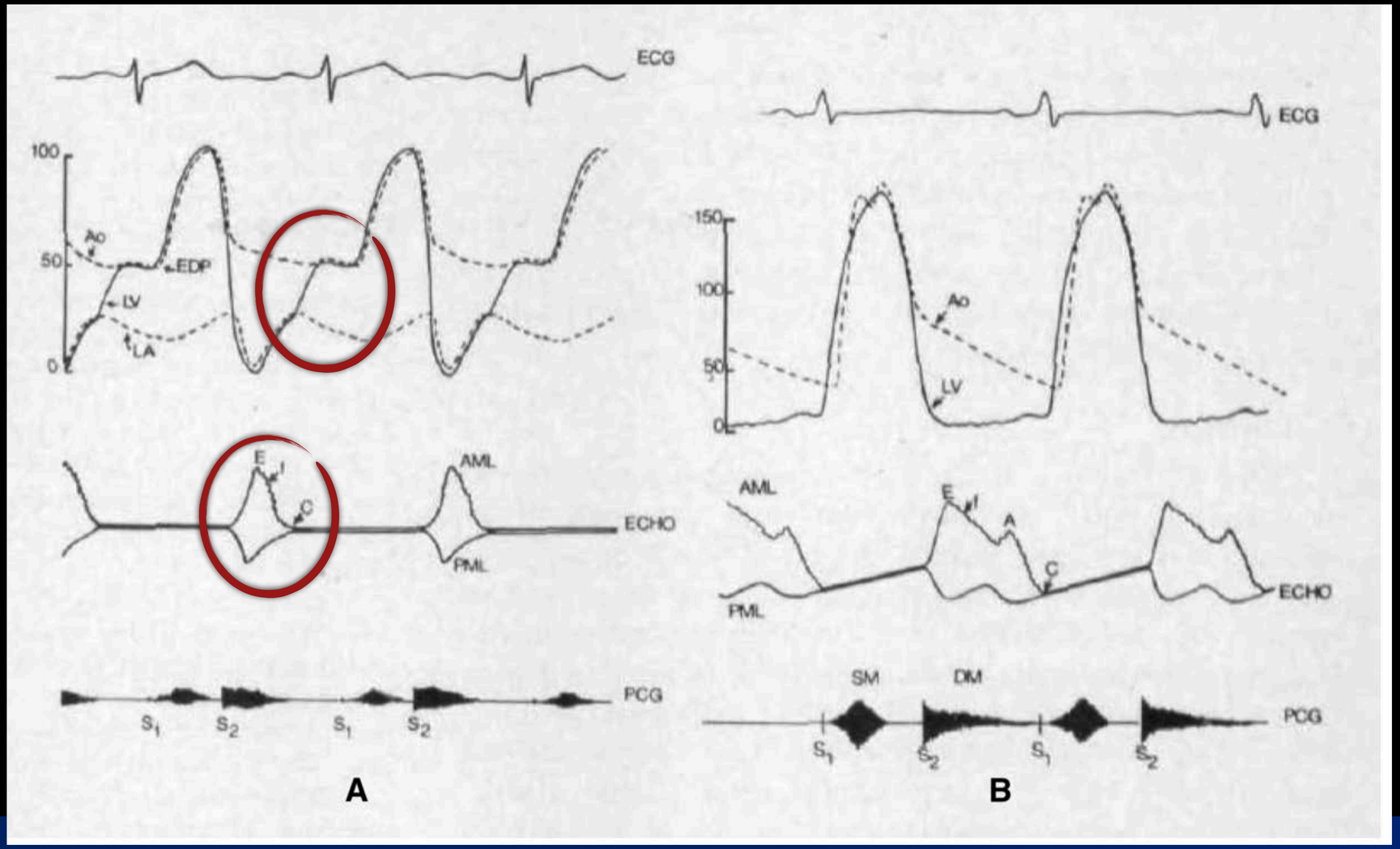
- Dissection with disruption of the valve commissures
- Endocarditis
- Chest trauma

Severe AR

***Assessment of acute severe AR is very different to chronic AR

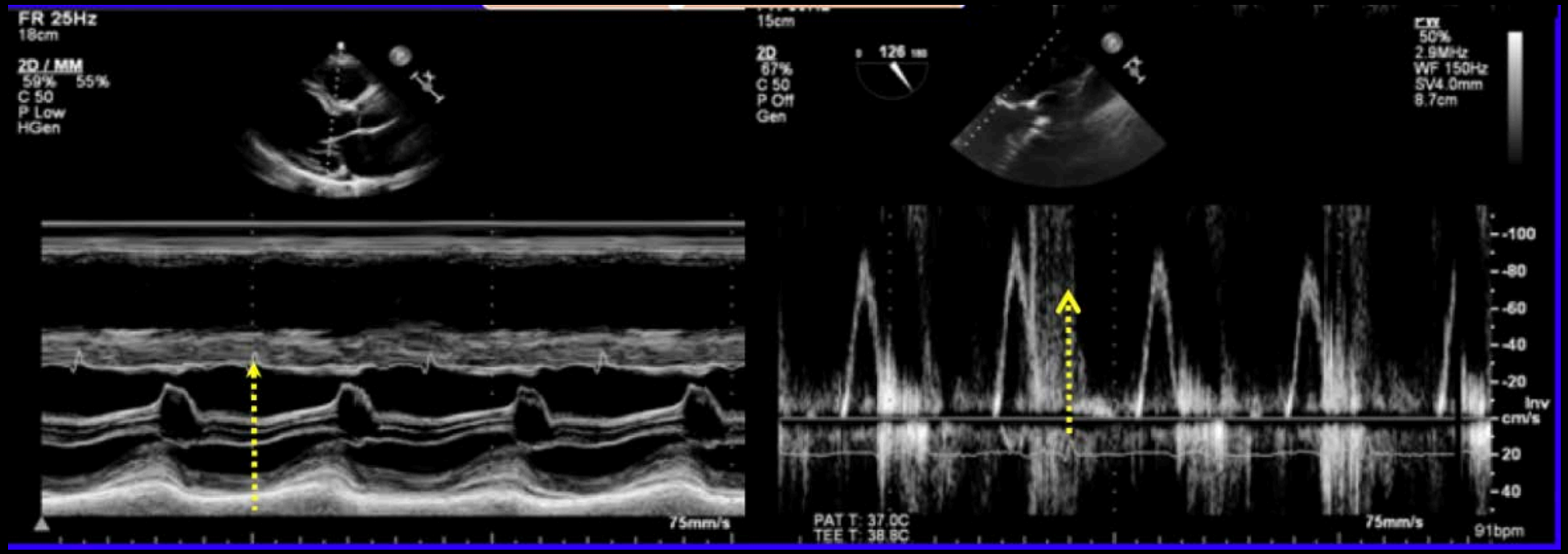
Chronic	Acute
LV dilatation	LV may not be dilated
AR jet visible in all views	Jet may appear small or not visible
EF reduction occurs late	Normal or hyperdynamic LV function
Normal LVEDP	High LVEDP
	Premature closure AV
	Diastolic MR
	Early MV closure
	Early termination of Diastolic flow reversal
	Decreased MV deceleration time

Acute v Chronic AR



Severe Acute AR

Early diastolic closure of the mitral valve
Decreased MV deceleration time



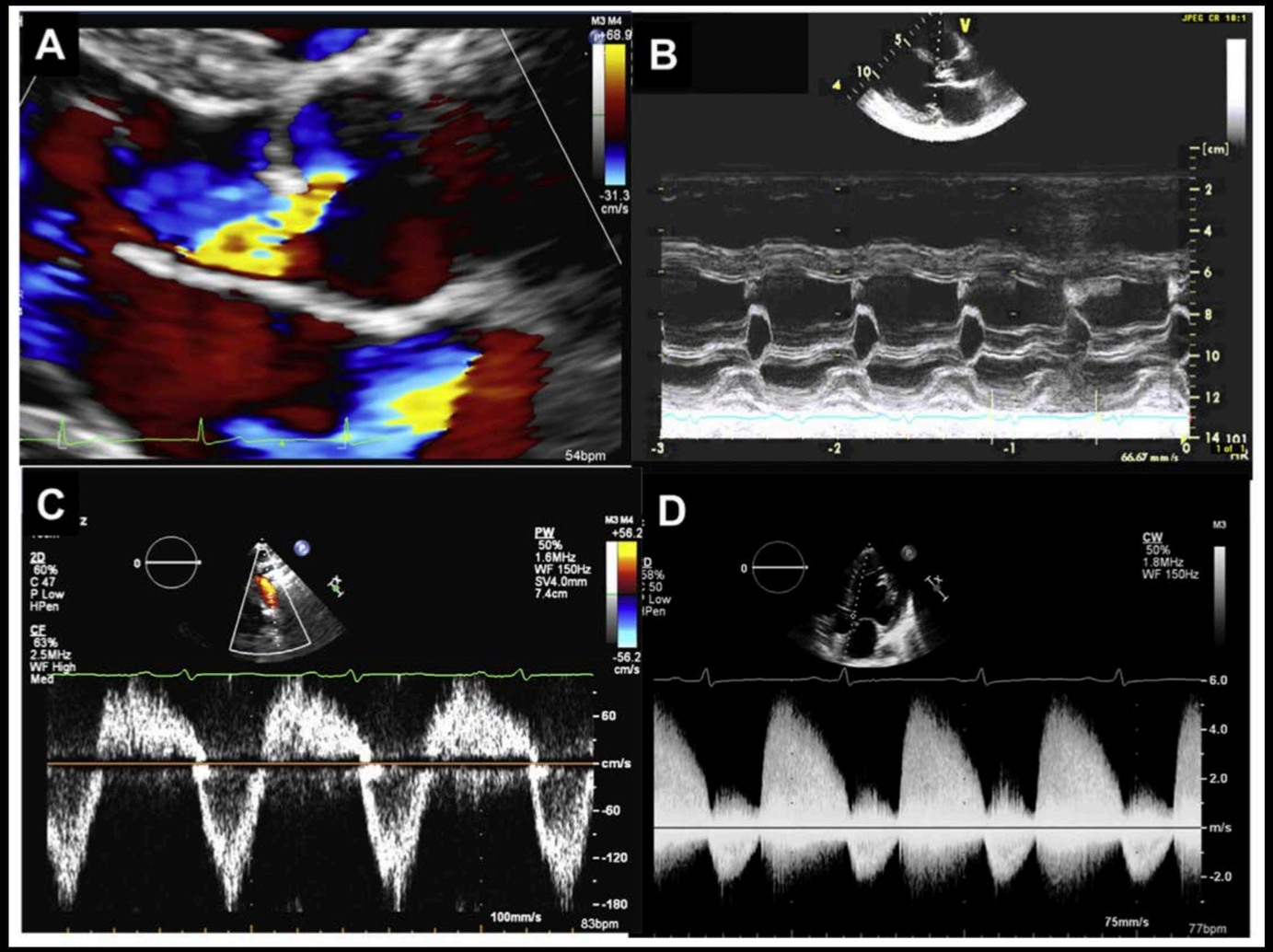
Severe AR

A) Moderate eccentric AR due to AV prolapse

B) Early closure MV

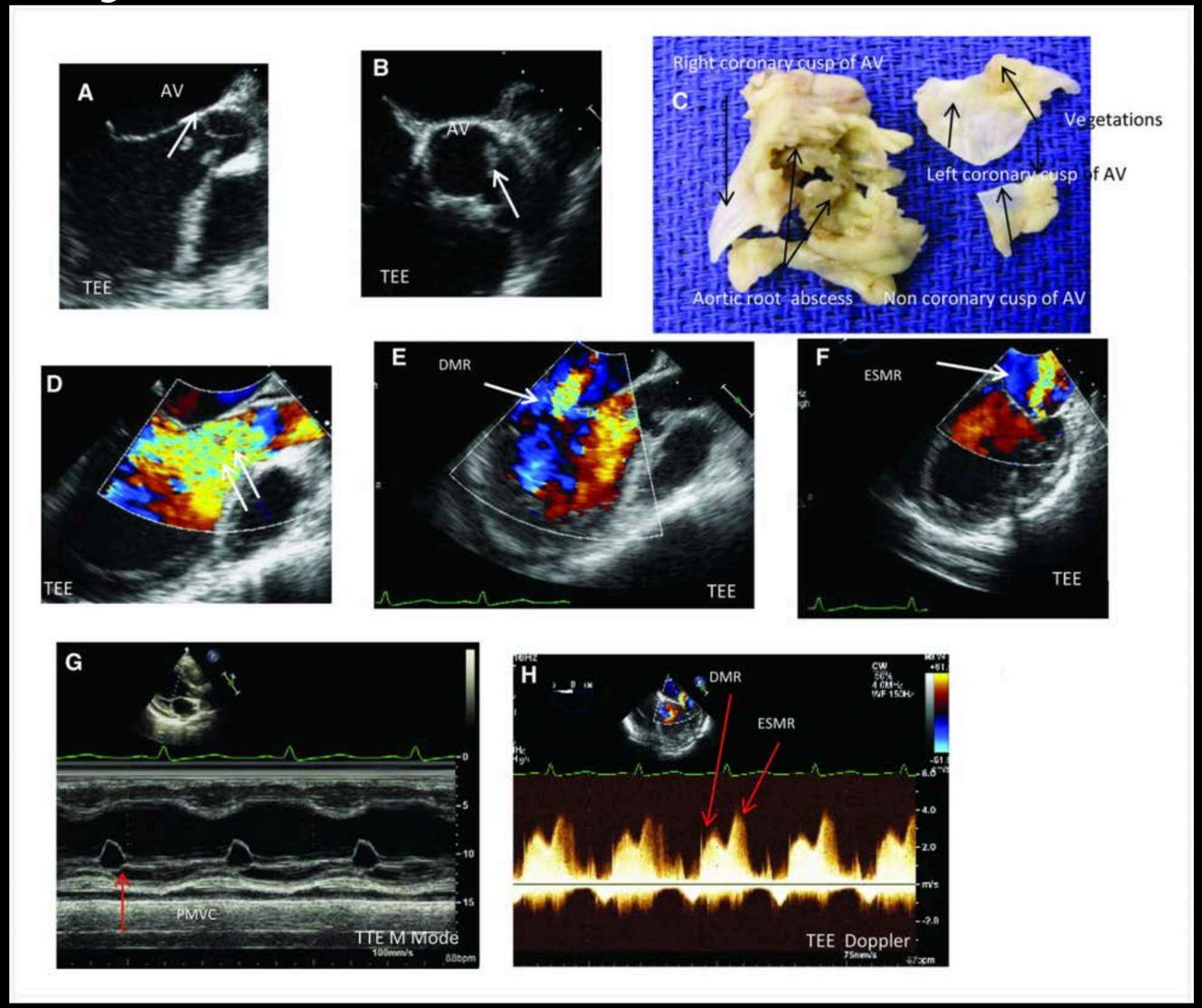
C) Holodiastolic flow reversal

D) CW Doppler severe acute AR, short PHT, density similar to forward flow



Acute AR - Case study

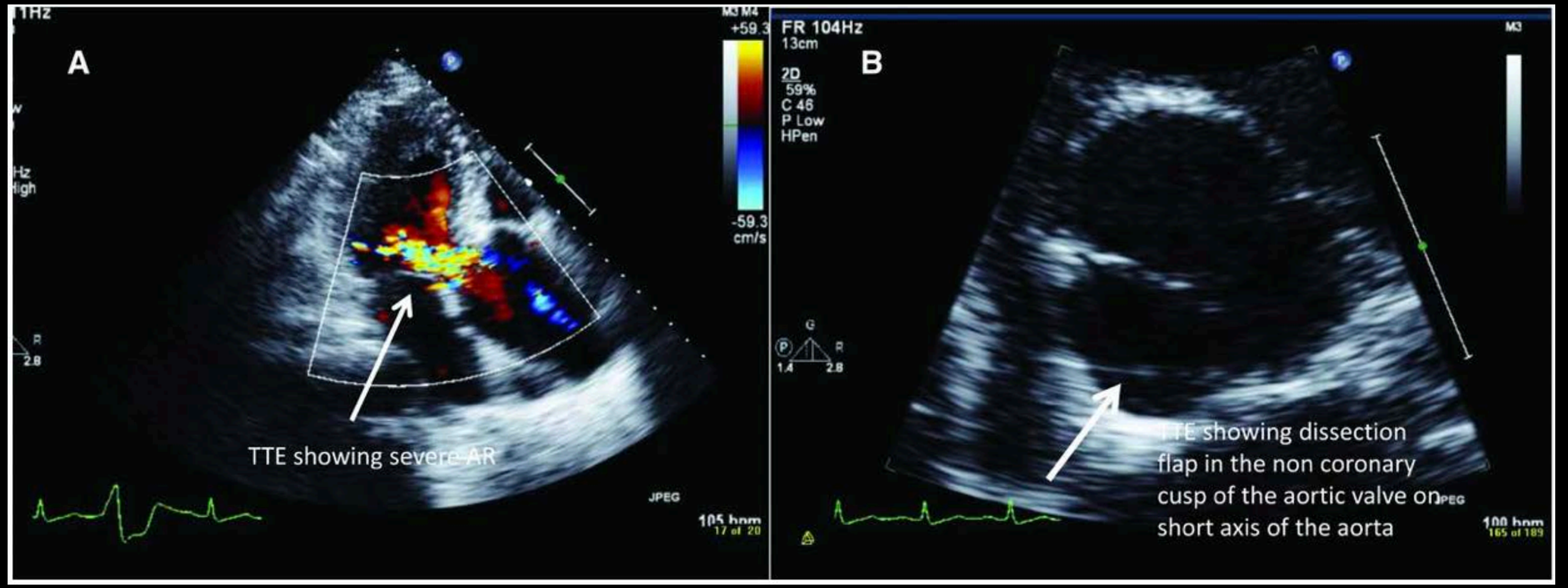
- 23yo man
- Staphylococcus bacteraemia
- Soft heart sounds and to-and-fro murmur



Hamirani et al, Acute Aortic Regurgitation, Circulation 2012

ECHO AUSTRALIA

Acute AR - Case study



- 59yo male, chest and back pain, syncope
- Acute type A Dissection is uncommon and usually catastrophic, incidence 3-4/100,000
- Pre admission mortality 20%, inpatient mortality 30%

Hamirani et al, Acute Aortic Regurgitation, Circulation 2012

ECHO AUSTRALIA

Timing of intervention for severe aortic regurgitation (AR) is a clinical decision

Chronic AR

- Record size of LV and aorta (indexed)
- Define severity of AR
- Serial echoes in asymptomatic severe AR
- Be prepared for discrepant results

Prompt referral for intervention
LVESd > 50 mm
LVESdi ≥ 25 mm/m2
LVEF ≤ 55%
Ascending aorta diameter ≥ 55 mm in all patients
Ascending aorta diameter ≥ 45 mm in special populations
Rapid dilatation of the LV approaching surgical threshold

Acute AR

- Identify cause of AR
- Assess haemodynamics
- Imaging can be hard
- High index of suspicion to ensure its not missed

**Acute severe AR is a medical emergency