

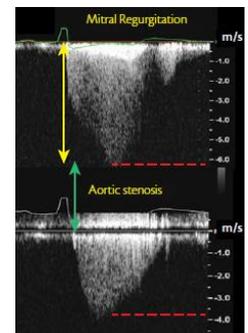
MULTIPLE VALE DISEASES

Multiple valve diseases have an effect on each other through changing the **volume flow rate and loading conditions**.

		...the diagnosis of the following lesion might be impaired			
		AS	AR	MS	MR
In the presence of...	AS		Pressure half-time method unreliable	Low-flow, low-gradient MS Pressure half-time method unreliable	High RV; increased area of mitral regurgitant jet using CF mapping ERO less affected
	AR	Simplified Bernoulli equation may be inapplicable Gorlin formula using thermodilution invalid		AR jet should not be mistaken for the MS jet Continuity equation unreliable Pressure half-time method unreliable	Doppler volumetric method inapplicable
	MS	Low-flow, low-gradient AS	MS may blunt the hyperdynamic clinical picture		Not significantly affected
	MR	Low-flow, low-gradient AS MR jet should not be mistaken for the AS jet	Doppler volumetric method inapplicable Pressure half-time method may be unreliable	Continuity equation unreliable Pressure half-time method unreliable Gorlin formula using thermodilution invalid	

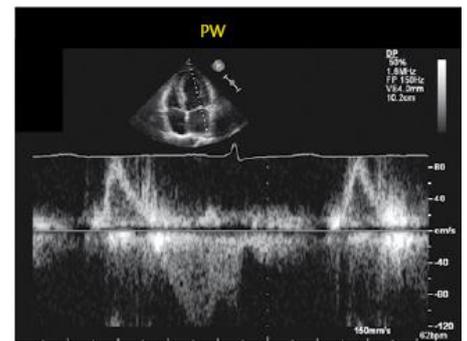
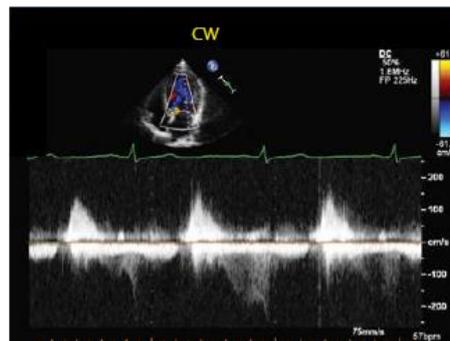
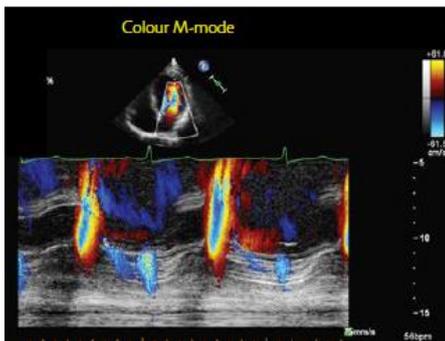
PITFALLS IN THE ECHO ASSESSMENT OF AS

- **Preferred method:** **continuity equation is preferred method** for AVA calculation. Continuity equation is not affected by increased flow rate (valid in presence of associated AR/MR- whereas cannot be used to assess MVA in presence of AR or MR), but continuity equation cannot be used if the LVOT is not circular, as in HOCM or subvalvular stenosis, or if there are serial stenoses, i.e. sub/supralvular stenoses.
- The AV Doppler flow should be differentiated from **associated MR** Doppler flow in the apical 5C view. Associated **MR Doppler flow starts within the QRS** whereas the **AV Doppler flow starts after the QRS**. Also, an associated **MR Doppler flow usually has a greater maximum velocity** than the AV Doppler flow (**AS Doppler has later onset and lower velocity**). The terminology **“pre-ejection time”** fits better for the time duration between the onset of MR and the onset of ejection through the AV rather than the term IVCT as, in cases with MR, the use of terms such as IVCT and IVRT is inappropriate, since during these time periods blood is constantly ejected back to the left atrium lowering the left ventricular blood volume.
- In general, pressure gradients are affected by flow rate/SV, such that conditions that increase the flow rate/SV (associated AR, pregnancy) increase pressure gradient and overestimate the severity of AS, whereas conditions that decrease flow rate (LV dysfunction and associated MS) decrease the pressure gradient and underestimate the severity of AS.
- Low flow low gradient AS is not infrequent finding in presence of **associated MR or MS**.
- Simplified Bernoulli equation and Gorlin formula using thermodilution may be invalid for AS in case of associated AR. In cases of AS with associated severe AR, proximal velocity is frequently > 1 m/s and cannot be ignored for transaortic pressure gradient determination. The following formula should be used: pressure gradient = (V₂² - V₁²), where V₂ = transvalvular velocities obtained with CW Doppler and V₁ = LVOT velocities obtained with PW Doppler
- Maximal anterograde transaortic velocity reflects both AS and AR severity in patients with moderate or severe AS and associated moderate or severe AR and preserved LV function
- Indexing on BSA overestimates the severity of valve stenosis in obese patients, because valve area does not increase with excess body weight.



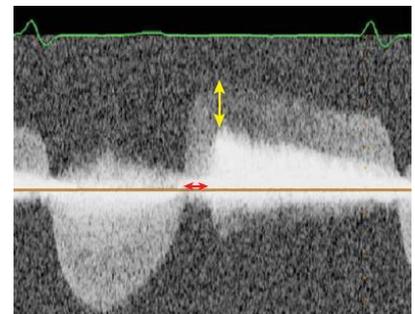
PITFALLS IN THE ECHO ASSESSMENT OF AR

- **Preferred method:** for AR assessment, consider multi-parametric evaluation including PISA method if feasible, vena contracta, demonstration of holodiastolic flow reversal in the descending aorta and of a dense CW retrograde Doppler signal across the AV.
- **PHT method unreliable in presence of**
 - Associated AS (prolonged in the presence of LVH with impaired relaxation, or shortened if there is AS-induced elevation in LVDP)
 - Associated MR
- **Doppler volumetric method** (using Doppler mitral inflow and LVOT stroke volume) is inapplicable in presence of associated MR
- Associated MS may blunt the hyperdynamic clinical picture
- In acute AR, the presence of diastolic MR (a marker of premature mitral valve closure) should be assessed



PITFALLS IN THE ECHO ASSESSMENT OF MS

- **Preferred method:**
 - **Direct planimetry** of mitral valve orifice is the **preferred method for rheumatic MS and MS with associated MR**.
 - **Angulating the probe too far upwards** (towards the LA) → failure to planimeter the mitral leaflets at their tips → **overestimates the MVA by planimetry** → underestimate the severity of MS calculated by planimetry
 - **High gain** → **underestimates the MVA by planimetry** → overestimates the severity of MS calculated by planimetry
 - **Heavy calcification** of the mitral leaflet edges → inaccurate **planimetry** of the MVA.
 - **Continuity equation** is accurate for MVA calculation, and is the **preferred method in the absence of MR/AR (even in presence of associated AS)**, but is **invalid in the presence of associated MR or AR (or AF)** as this equation relies on the equality of the transmitral stroke volume (during diastole) and the LVOT stroke volume (during systole), which is inaccurate because of added regurgitant flow the **increases the anterograde flow** through the MV or LVOT. Stroke volume can, alternatively, be estimated from the pulmonary artery; however, this is rarely performed in practice because of limited acoustic windows. **Remember: continuity equation is valid for calculating the AVA in presence of MR.**
- **PISA method can be used** to calculate MV area in case of MS and is **not affected by presence of associated MR or AR**. However, MVA calculated by PISA method (in presence of MS) should be **multiplied by angle correction factor ($\alpha^\circ / 180^\circ$)** to correct for the funnel angle formed due to doming of the mitral leaflets in MS. Some labs use fixed α° angle value of 100°
- **PHT is unreliable** in the presence of:
 - **MR** (slightly affected) – direct planimetry is the preferred method
 - **AR & ASD** (alter compliance in LA/LV, hence **shorten PHT** overestimating MV area) -direct planimetry is preferred
 - **Eccentric jet of AR** (may overestimate MS due to added functional MS, which would **prolong the PHT**)
 - **Prosthetic MV**
 - **Up to 72 h post mitral valvuloplasty** (due to the alter compliance in LA/LV)
 - **AS/LVH** (continuity equation can be used)
 - LV diastolic dysfunction
- **Low flow low gradient MS** (paradoxical or not) is not infrequent in presence of **associated AS**
- **In general, using Doppler to assess valve area is dependent on HR** because at high HRs, **LA filling per beat is reduced** as the cardiac cycle is shorter and **transmitral flow terminates earlier** as diastole is shorter.
- On using the PW Doppler, the sample volume should typically be located in-between the tips of the MV leaflets
- Angulating the probe too far upwards (towards the LA) → overestimates the MVA by planimetry → underestimate the severity of MS calculated by planimetry
- High gain → underestimates the MVA by planimetry → overestimates the severity of MS calculated by planimetry
- Heavy calcification of the mitral leaflet edges → inaccurate planimetry of the MVA.
- Failure to planimeter the mitral leaflets at their tips → overestimation of orifice area.
- On using CW Doppler, the Doppler beam should be aligned with the flow through the valve.
- In presence of AF, you should obtain the average of several readings (5-10).
- MS jet should not be mistaken for **associated AR jet** (MS has a **lower** velocity and a **later** onset)



PITFALLS IN THE ECHO ASSESSMENT OF MR

- **Preferred method:** PISA derived EROA and vena contracta are preferred methods for assessment of MR (over jet planimetry and calculation of regurgitant volume) in case of **associated AS, AR or status post AVR** as they are less loading conditions dependant. However, PISA and vena contracta methods are typically single frame measurements and, therefore, may **overestimate MR** severity (particularly in MVP with only late systolic MR) compared to 3D measurements. PISA method may also **underestimates the severity of functional MR** due to its ellipsoidal shape in functional MR. However,
- The MR Doppler flow should be differentiated from AV Doppler flow in the apical 5C view (see above)
- The apical 2C view images primarily the anterior leaflet and abnormalities of the posterior leaflet will therefore not be readily evident
- **Aliasing velocity** (Nyquist limit) of 50–60 cm/s is usually appropriate for measurement of jet area and VC width. While for image Acquisition for PISA, adjust the aliasing velocity until you see a clear hemisphere of converging blood flow on the ventricular side of the valve, usually at a setting of 20–40 cm/s.
- Peak velocity of the regurgitant jet is not a marker of severity per se.
- **Associated AS** increases the intraventricular pressure leading to increased mitral regurgitant volume and increased mitral colour flow jet planimetry, while mitral EROA is less affected by presence of associated AS. Therefore, EROA (and/or vena contracta) are the **preferred methods** for MR assessment in presence of associated AS.
- **Doppler volumetric method** (using Doppler mitral inflow and LVOT stroke volume) is inapplicable in the presence of **associated AR**
- **MR echo findings are not significantly affected by presence of associated MS**
- **Functional MR associated with AV disease is likely to regress after AVR**, predominantly the ones with a tenting area $< 2.5 \text{ cm}^2$.
- TR associated with MV disease is usually functional. Measurement of tricuspid annulus is essential in such a case as **tricuspid annuloplasty** should be considered, with any plan for MV surgery, when tricuspid annulus is dilated ($> 40 \text{ mm}$ or $> 21 \text{ mm/m}^2$ as measured from the middle of the septal annulus to the middle of the anterior annulus in the four-chamber view).
- **Remember:** if mitral regurgitation is present, take the opportunity to assess the LV systolic function by measuring dP/dt

PITFALLS IN THE ECHO ASSESSMENT OF TV and PV

- Severe TR may cause underestimation of PS severity by decreasing pulmonary pressure gradient ('low-flow, low-gradient' PS)
- Severe TS may aggravate TR