

Advanced 4D transthoracic echocardiography for accurate assessment of tricuspid regurgitation

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Patient history/pathology

- 66-year-old man
- Unremarkable previous medical history. No cardiovascular risk factor
- On May 2025, the patient went to the E.R. presenting paroxysmal atrial fibrillation treated with amiodarone e.v.
- Systolic murmur identified at physical examination. Patient referred to echocardiography exam

Challenges

- Quantifying non-holosystolic regurgitant jets
- Utilizing the conventional PISA method to quantify tricuspid regurgitation
- Identifying the anatomy of the tricuspid valve and understanding the pathophysiology of tricuspid regurgitation

System, probe and device used

- Vivid™ Pioneer
- 4Vc-D probe
- EchoPAC™

Step-by-step procedure

1. Assess the timing of MR (holosystolic vs. non-holosystolic)
2. 4D volumetric assessment of MR severity
3. Corrected PISA method to assess severity of TR
4. Transthoracic 4D to assess the morphology of the tricuspid valve
5. Apical RV focus view to calculate RA volume
6. 4D measurement of LV and RV volumes
7. 4D volumetric assessment of TR severity
8. Identify the pathophysiology and classification of TR

Conclusion

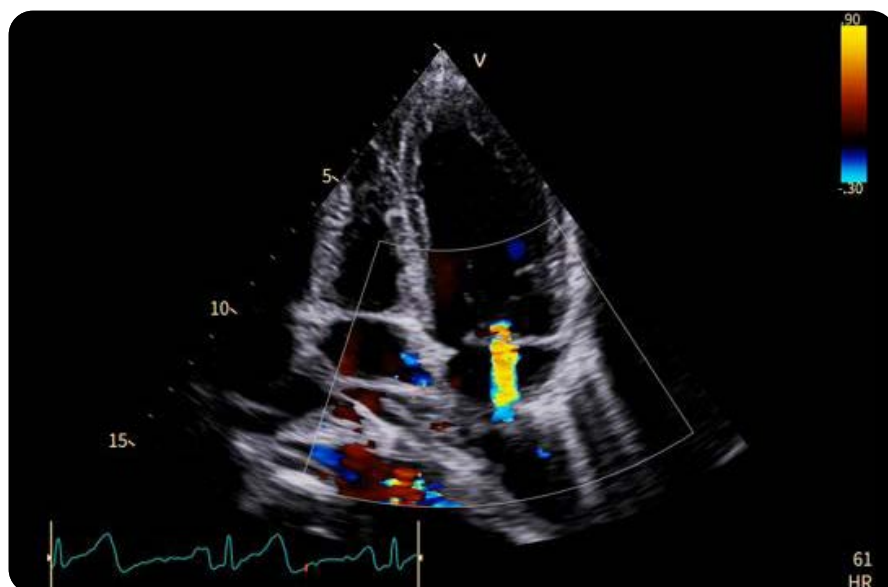
The use of quantitative 4D transthoracic echocardiography and dedicated tools (angle and jet velocity corrected PISA method) and views (RV focused apical view to measure right atrial volume) allowed to determine the correct etiology of TR and its severity to plan personalized follow-up and treatment goals.

Imaging follow-up

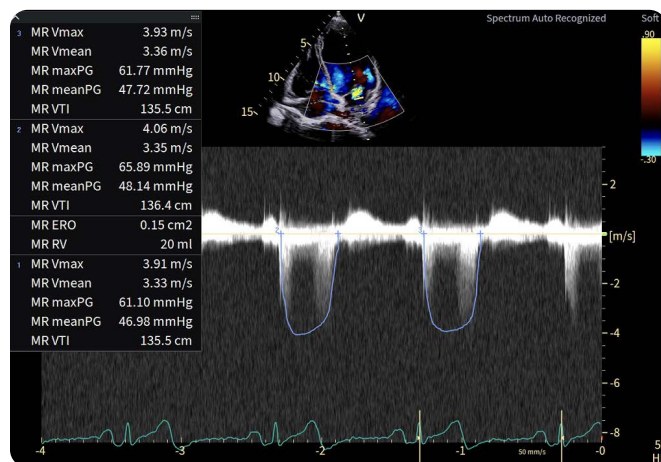
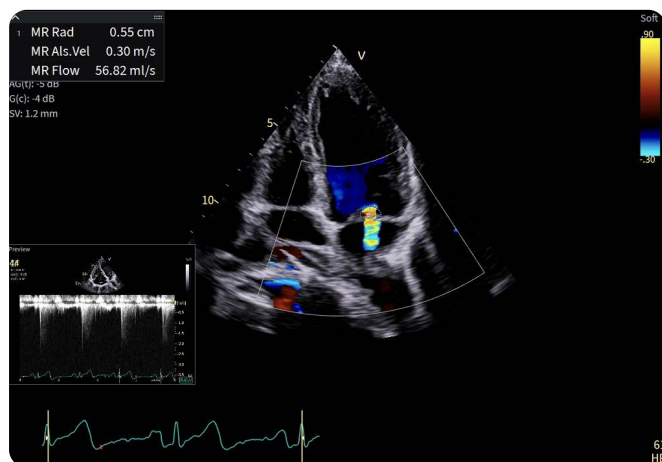
Repeat 4D transthoracic echocardiography at 6 months to check for progression of TR severity and right heart chamber remodeling.

Aggressive treatment to maintain sinus rhythm.

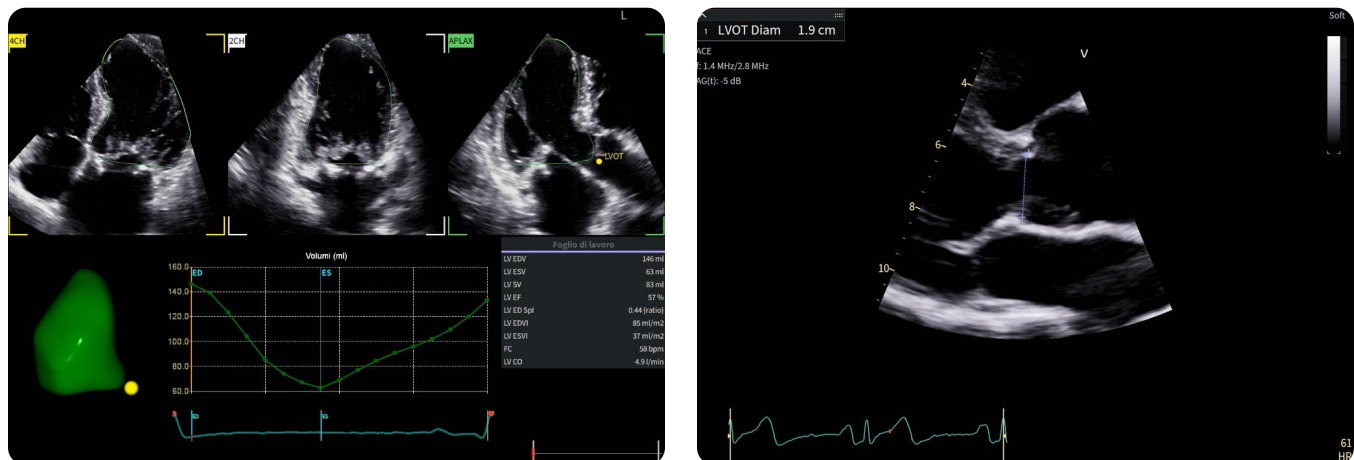
1) Apical 4CH view – Mitral regurgitation



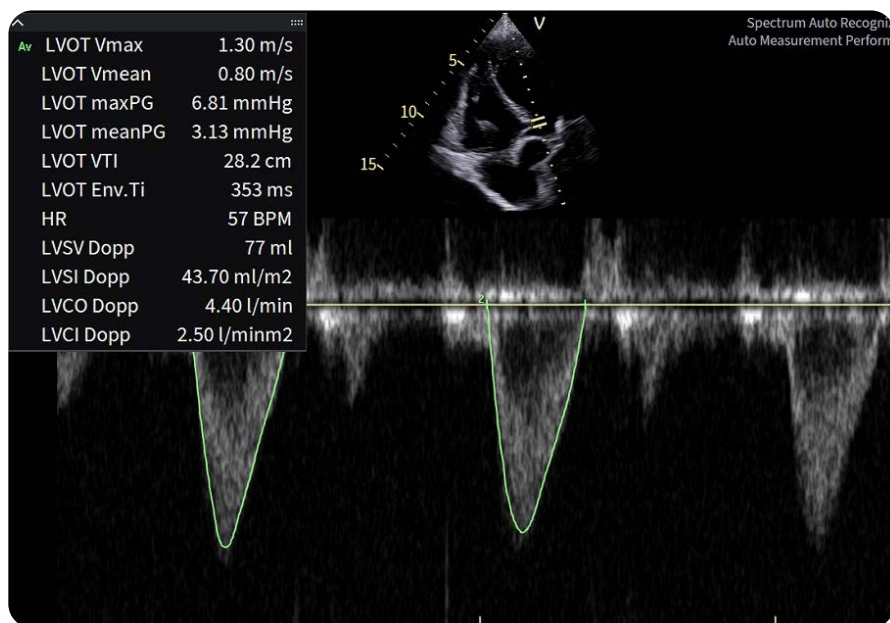
2) Mitral regurgitation quantitation using conventional PISA method



3) Mitral regurgitation 4D quantitation with 4D LHQ

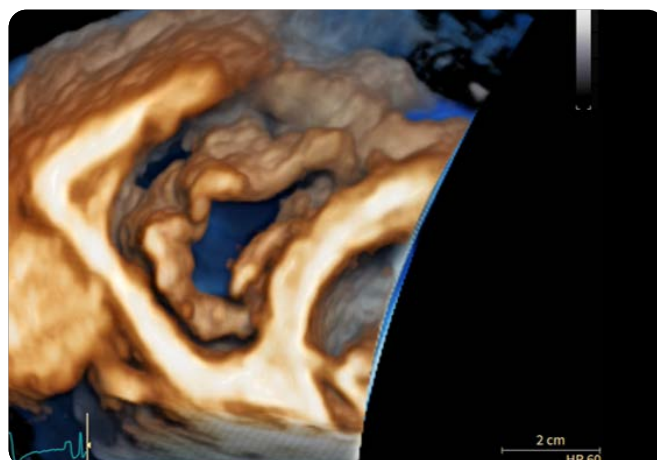
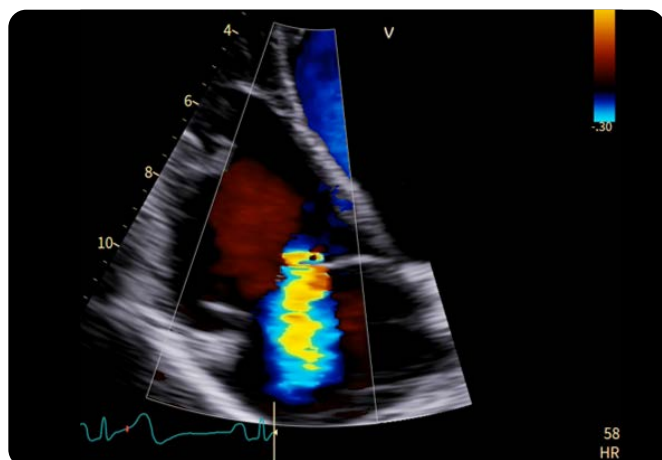


A close examination of the envelope of the regurgitant jet reveals protosystolic and telesystolic components, while no regurgitation is observed during mid-systole. In this case, the conventional PISA method is likely to overestimate the severity of MR.



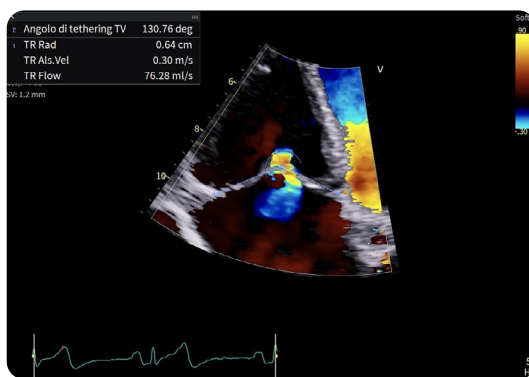
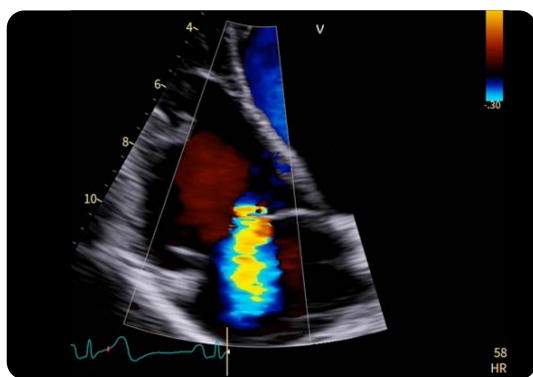
Regurgitant volume = $SV_{LV} - SV_{LVOT} = 83 - 77 = 6 \text{ mL}$. Confirms mild MR.

4) Tricuspid valve function and anatomy assessment



4D transthoracic – single beat acquisition. High quality anatomical images.

5) Tricuspid regurgitation – PISA method, challenges and considerations

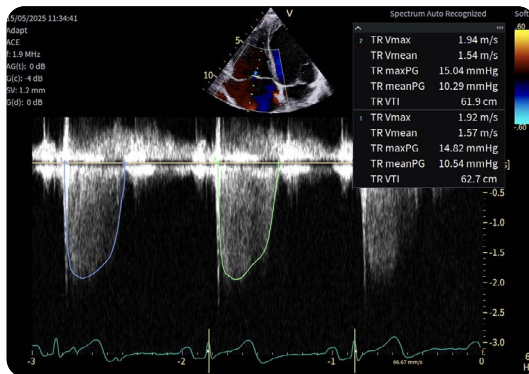
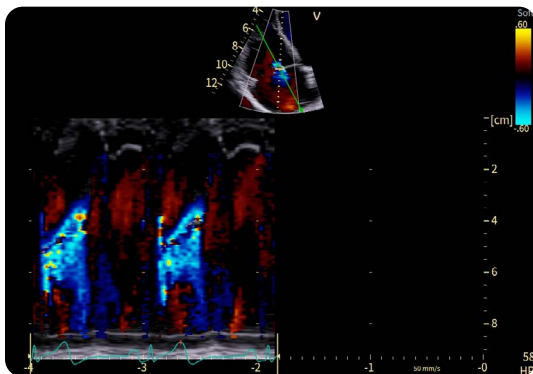


Conventional PISA method:

Regurgitant volume = 20 mL

EROA = 0.33 cm²

Moderate TR



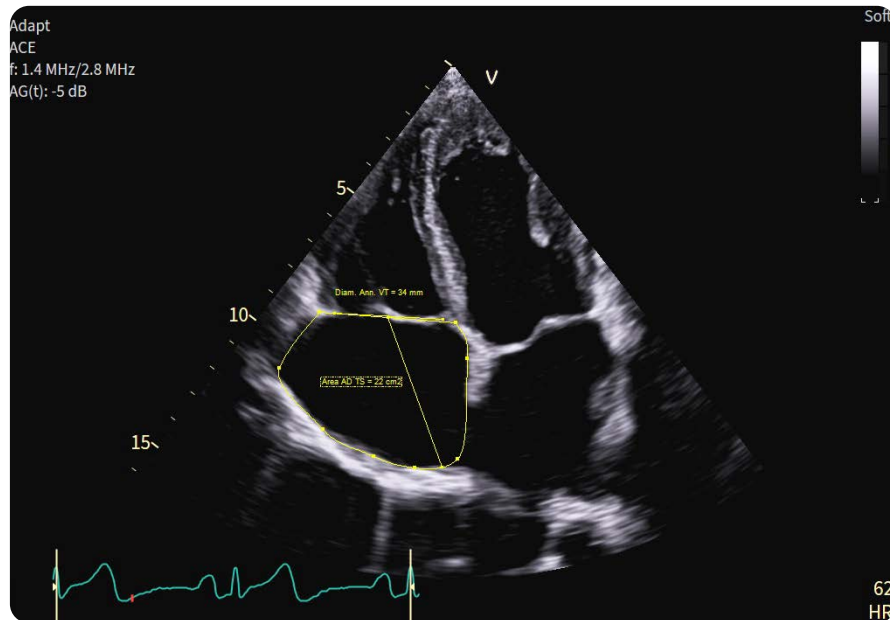
Corrected PISA method:

Regurgitant volume = 26 mL

EROA = 0.42 cm²

Severe TR

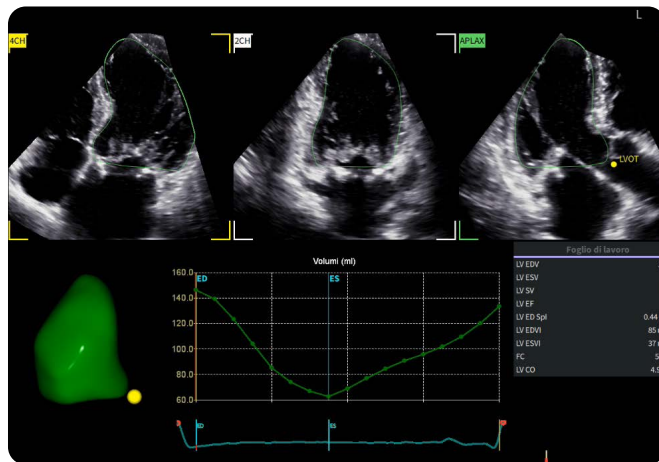
6) Etiology of tricuspid regurgitation – guideline recommended echo



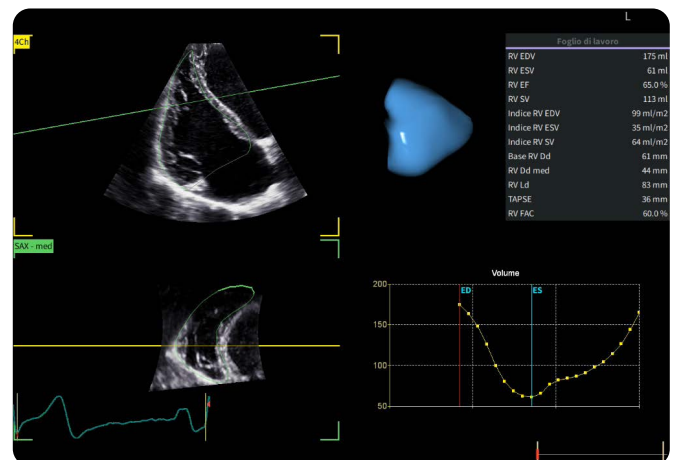
- Moderate tricuspid regurgitation
- Normal LV ejection fraction (57%)
- No significant left heart disease
- Mildly dilated left atrium = 40 mL/m²
- Pulmonary artery systolic pressure = 25 mm Hg
- Mildly dilated right ventricle (ED area = 13.9 cm²)
- Normal RV function (FAC = 50%; TAPSE = 2.5 cm)
- Mildly dilated right atrium = 40 mL/m²
- Increased end-systolic RA/RV area ratio = 1.59
- Normal tricuspid annulus diameter = 34 mm
- No leaflet tenting

Conclusion: Based on the green parameters, findings are consistent with atrial secondary tricuspid regurgitation. However, the normal diameter of the tricuspid annulus is in contrast with this diagnosis.

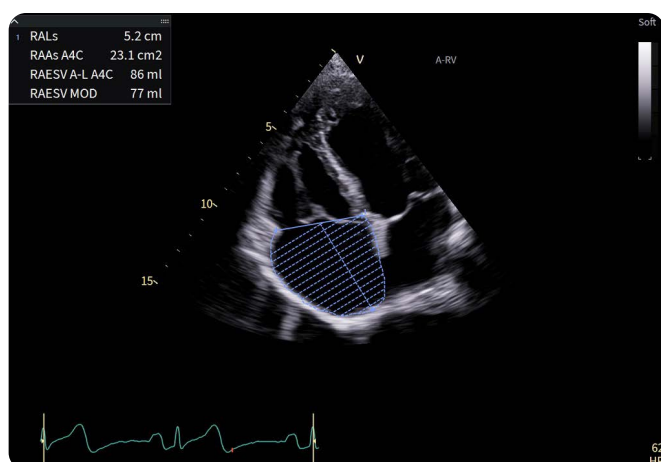
7) Tricuspid regurgitation – 4D volumetric method



Regurgitant volume = $SV_{RV} - SV_{LV} = 113 - 83 = 30$ mL
 EROA = Regurgitant Volume/ $VTI_{TR} = 0.48$ cm²
 Regurgitant Fraction = Regurgitant Volume/ $SV_{RV} = 27\%$



Effective RV Ejection Fraction = 47% (increased risk if < 20%)
 Forward $SV_{RV}/ESV_{RV} = 1.36$ (increased risk if < 0.4)



- Severe tricuspid regurgitation
- Normal LV ejection fraction (57%)
- No significant left heart disease
- Mildly dilated left atrium = 40 mL/m²
- Pulmonary artery systolic pressure = 25 mm Hg
- Mildly dilated right ventricle

- Normal RV function
- Severely dilated right atrium = 51 mL/m²
- Increased end-systolic RA/RV volume ratio = 1.45 (significant > 1.4)
- Dilated tricuspid annulus area = 17.2 cm² (normal < 13.1 cm²)
- Mild leaflet tenting – height 9 mm, volume = 4.3 mL

Conclusion: By using a 4D dataset and measuring the tricuspid annulus with Auto TVQ, the actual size of the tricuspid annulus is measured. Now all the parameters remain consistent with the diagnosis. Atrial secondary tricuspid regurgitation can be confidently confirmed.



References

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