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A quadricuspid tricuspid valve first discovered in an 88y gentleman using transthoracic three-dimensional echocardiography

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Canberra Hospital

Overview

- Brief intro on TV morphology and current research
- Patient Hx and presentation
- Transthoracic echocardiography
- Views to determine TV morphology
- Application of 3D TTE

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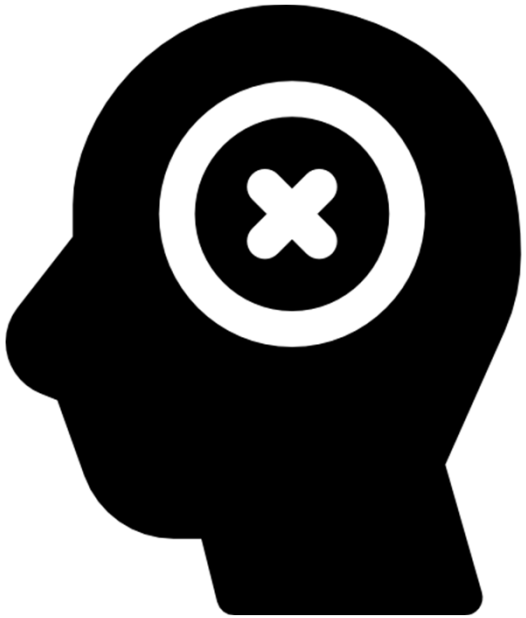
The forgotten valve? No more

- Studies suggest prevalence of severe tricuspid valve (TV) disease is increasing
- Isolated tricuspid regurgitation (TR) associated with increased mortality regardless of outstanding cardiopulmonary comorbidities
- Tricuspid regurgitation may be “silent” before right ventricular (RV) dysfunction or RV failure
- Good amount of attention in the recent years, what now?
  - Need follow through for momentum



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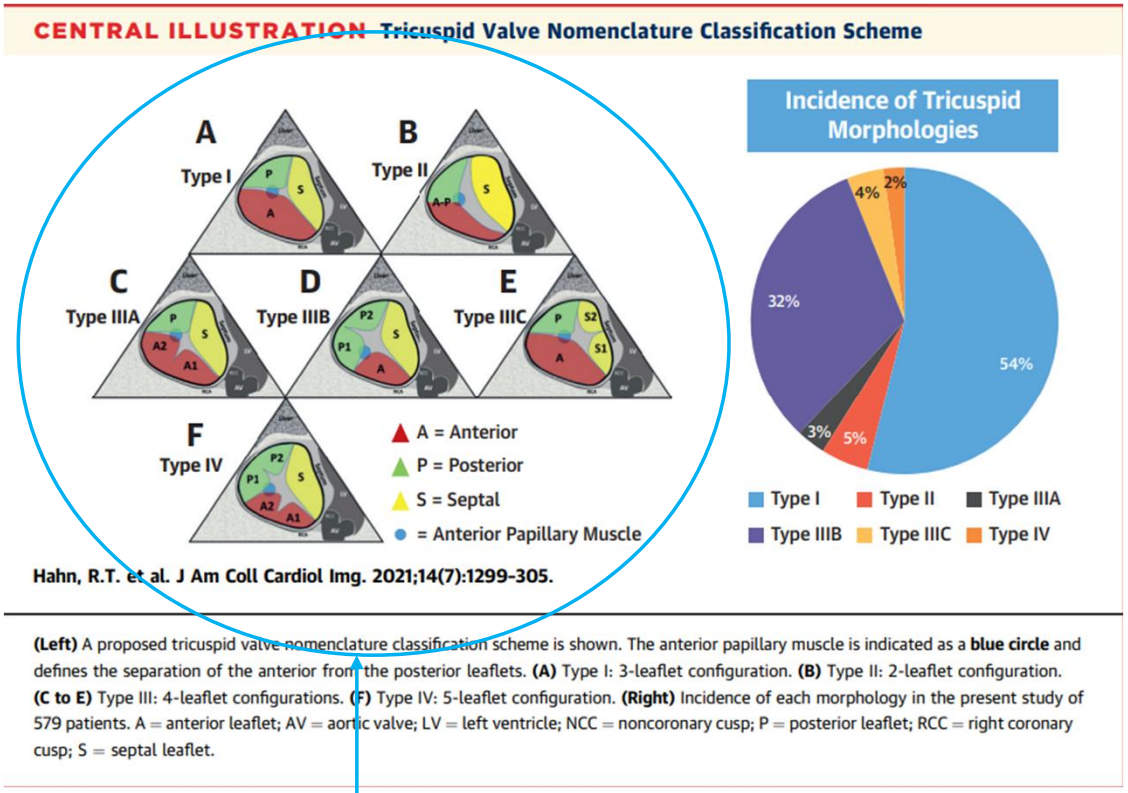
TV morphology recap



Transgastric TOE views

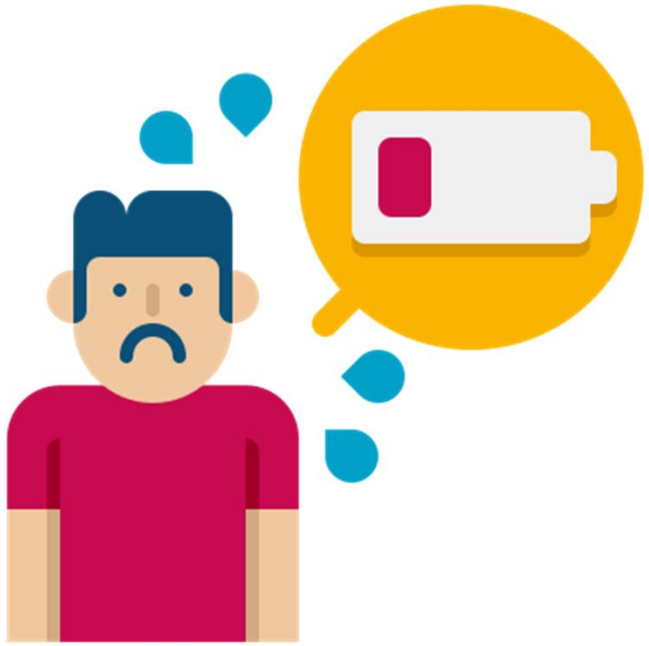
Hahn et al, 2021

As we already know a large population has a non-tricuspid tricuspid valve morphology.

- Non-conventional TV morphology = **46%**
  - Type II: 2 leaflets – 5%
  - Type III: 4 leaflets – **39%**
  - Type IV: 5 leaflets – 2%

Patient presentation

- Presented with lethargy, “generally unwell”, lightheaded, nauseous
- SBP 96 mmHg, ECG: slow AF 57 bpm, TWI V2 – V4
- Trop: 880 -> 727
- CXR: NAD
- No chest pain
- “tired and no energy” for months
- Reduced exercise tolerance, like “walking up a mountain”
- SBP at home was 71 mmHg
- Had leg swelling few weeks ago which improved with elevation



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Case study patient history

- Chronic AF (dx. 20 year ago)
- IHD
  - Positive stress test
  - Positive angiogram
- Pneumonia 2 – 3 years ago with pleural effusion and ICU admission

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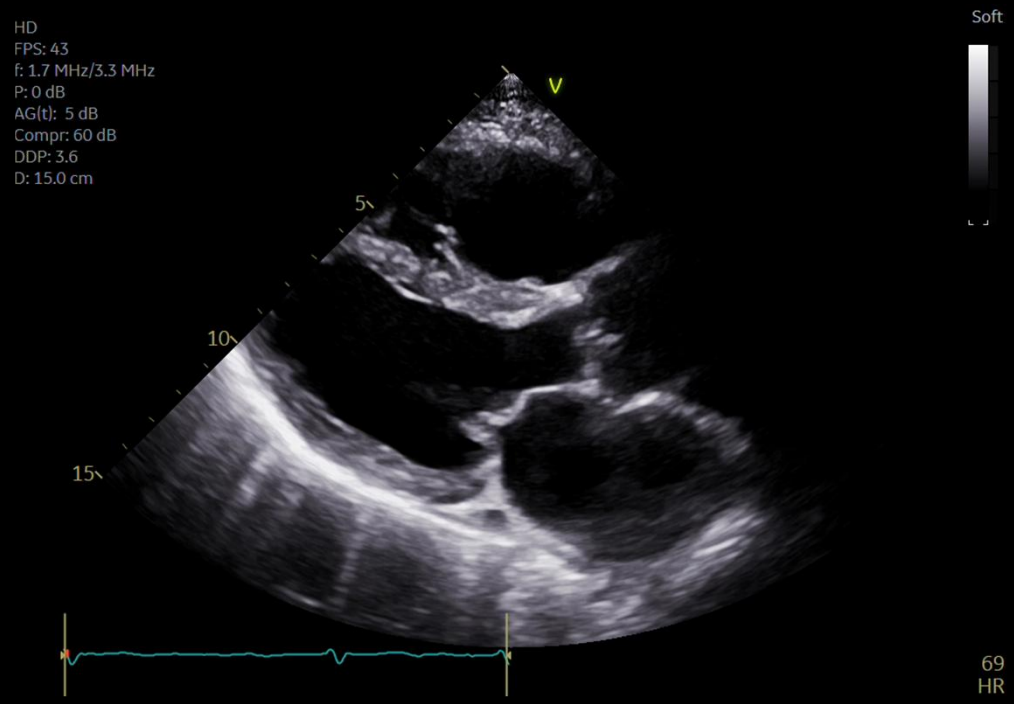
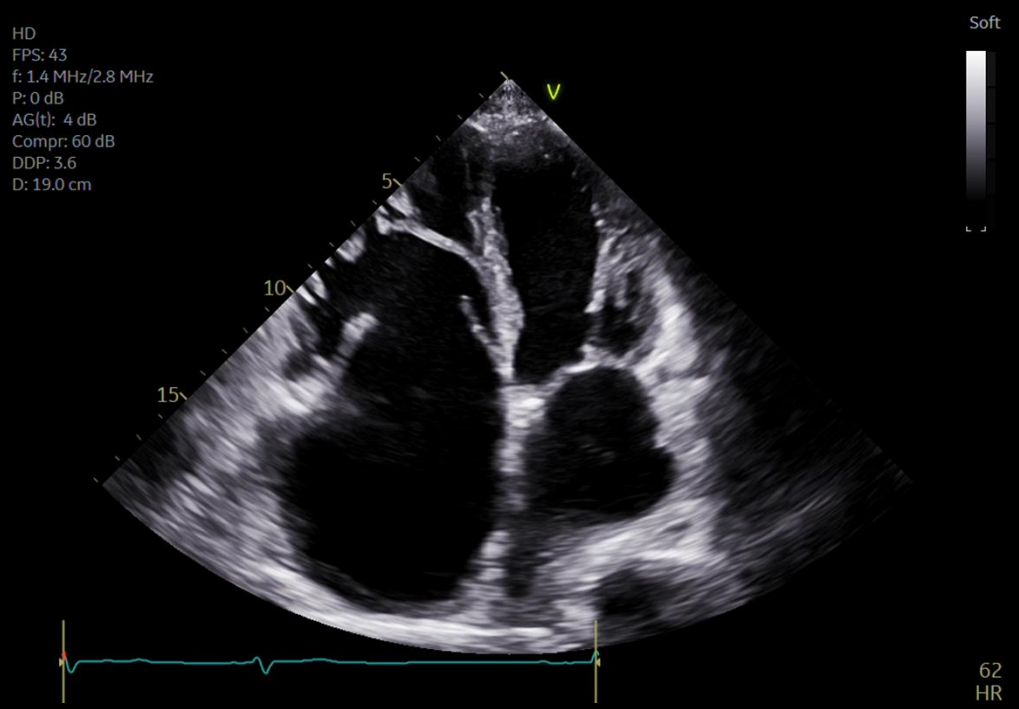
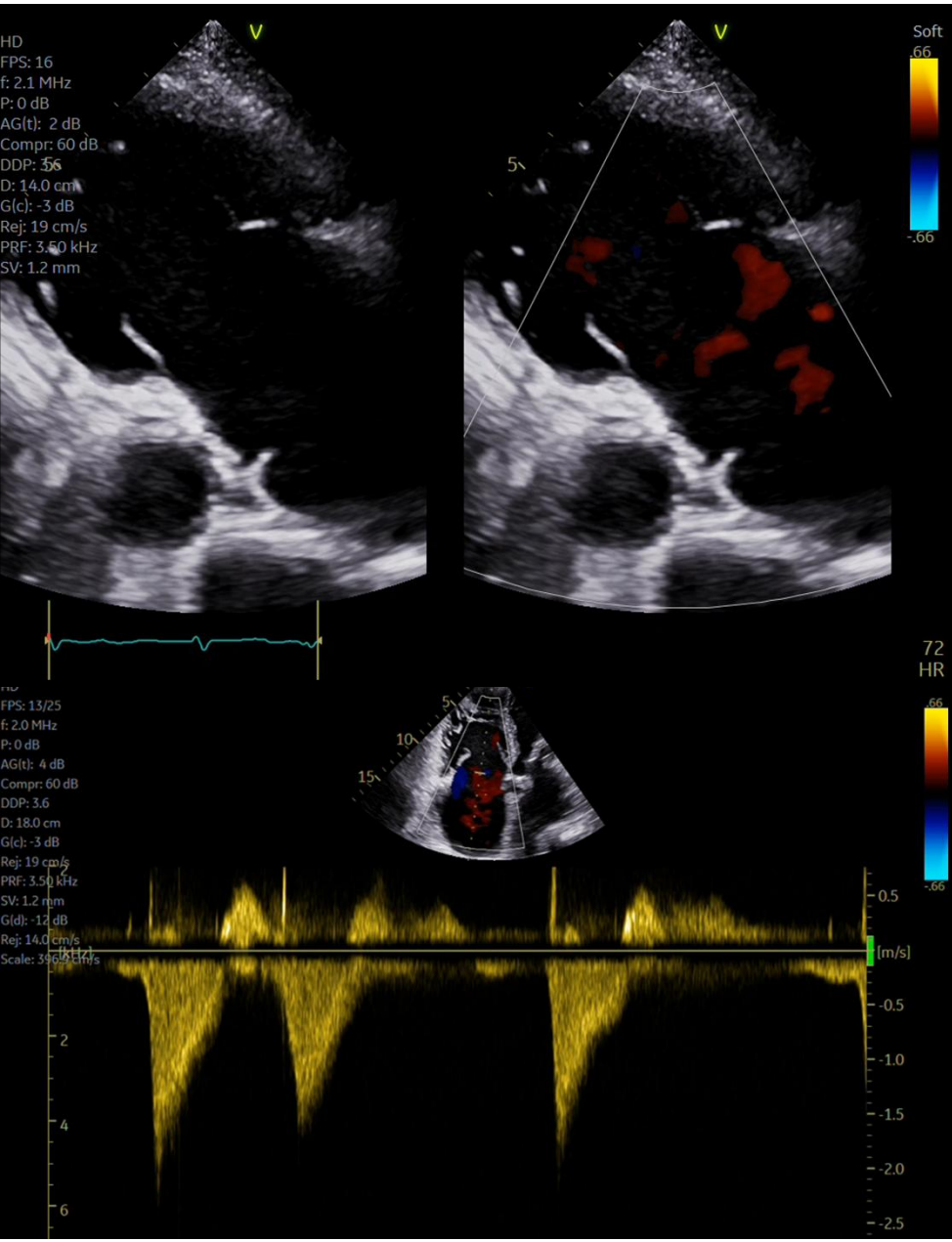
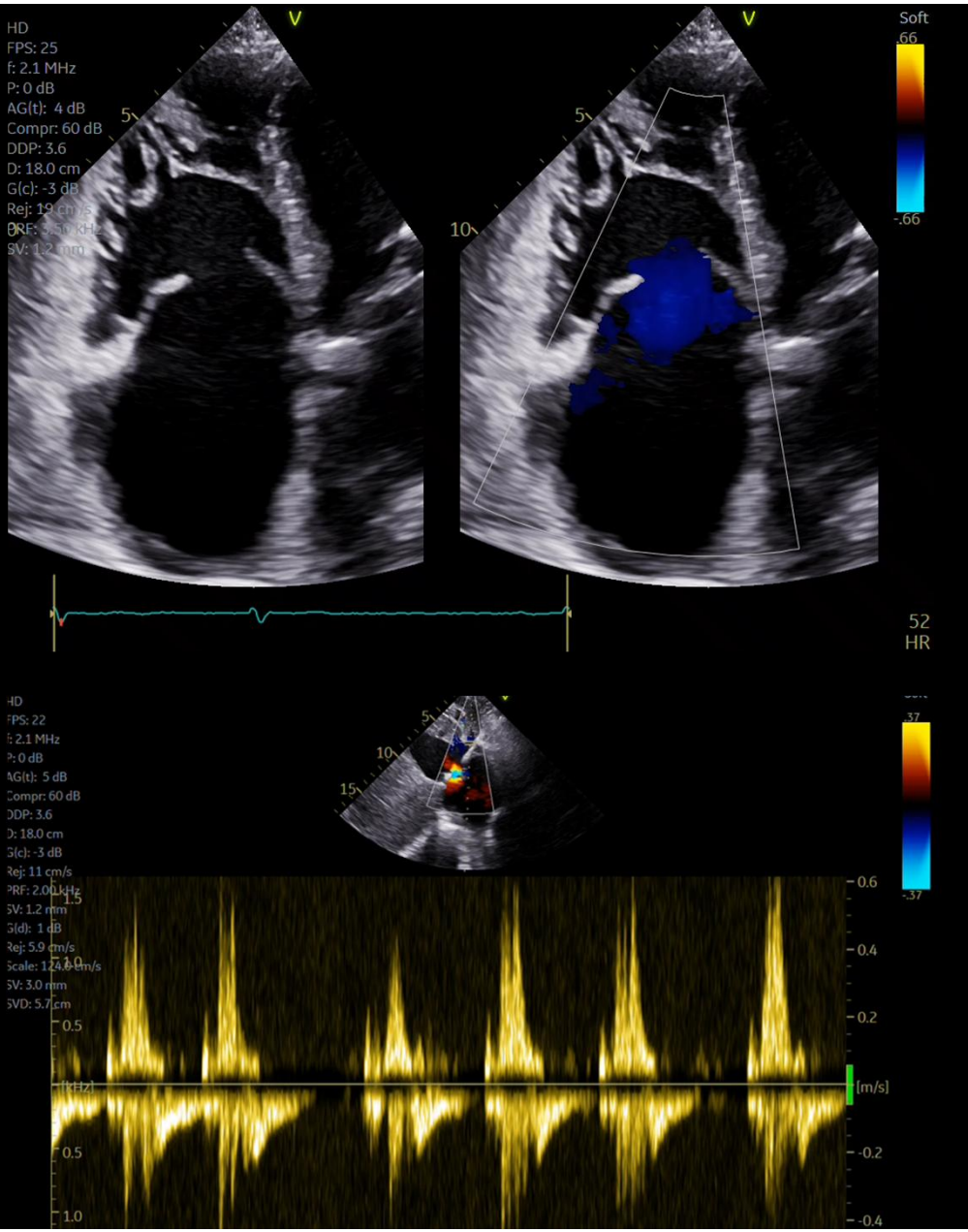
Transthoracic echocardiography



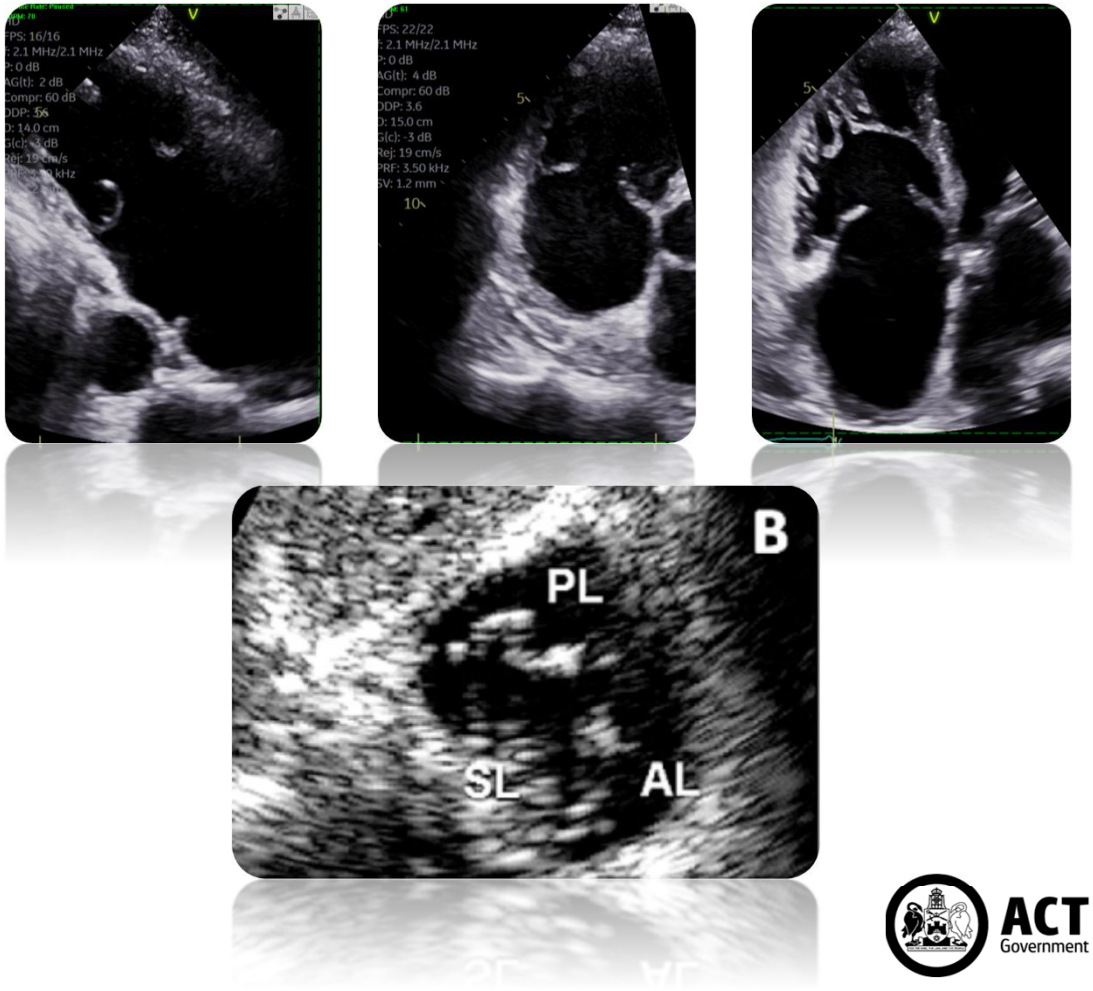


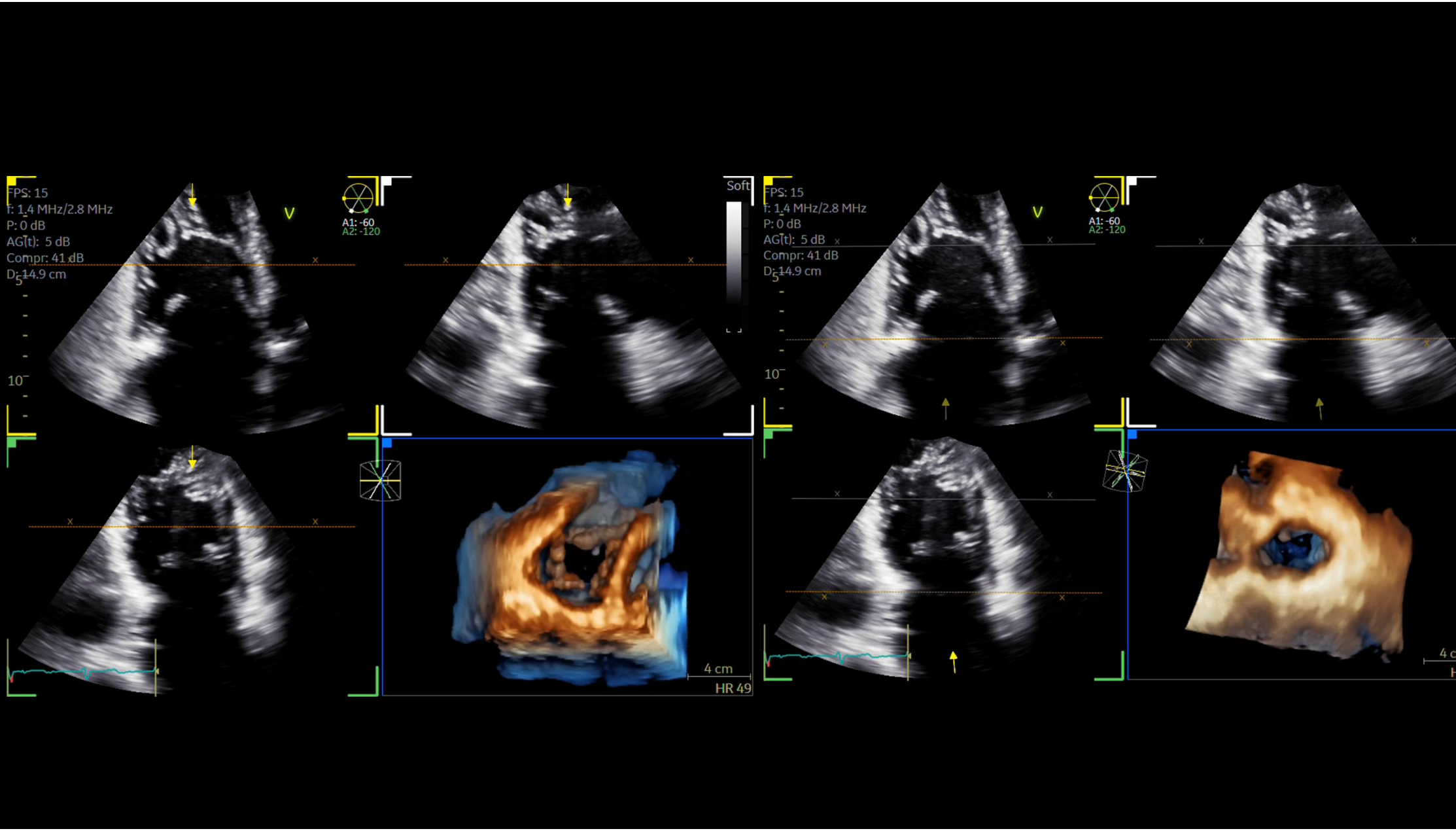

HD
FPS: 16
f: 2.1 MHz
P: 0 dB
AG(t): 2 dB
Compr: 60 dB
DDP: 56
D: 14.0 cm
G(c): -3 dB
Rej: 19 cm/s
PRF: 3.50 kHz
SV: 1.2 mm
Soft
.66
-.66
72
HR
FPS: 13/25
f: 2.0 MHz
P: 0 dB
AG(t): 4 dB
Compr: 60 dB
DDP: 3.6
D: 18.0 cm
G(c): -3 dB
Rej: 19 cm/s
PRF: 3.50 kHz
SV: 1.2 mm
G(d): -12 dB
Rej: 14.0 cm/s
[m/s]
0.5
-0.5
-1.0
-1.5
-2.0
-2.5
2
4
6


HD
FPS: 25
f: 2.1 MHz
P: 0 dB
AG(t): 4 dB
Compr: 60 dB
DDP: 3.6
D: 18.0 cm
G(c): -3 dB
Rej: 19 cm/s
SV: 1.2 mm
Soft
.66
-.66
52
HR
FPS: 22
f: 2.1 MHz
P: 0 dB
AG(t): 5 dB
Compr: 60 dB
DDP: 3.6
D: 18.0 cm
G(c): -3 dB
Rej: 11 cm/s
SV: 1.2 mm
G(d): 1 dB
Rej: 5.9 cm/s
SV: 3.0 mm
SVD: 5.7 cm
[m/s]
0.6
0.4
0.2
-0.2
-0.4
0.5
1.0
1.5

What views are currently available to assess the TV?

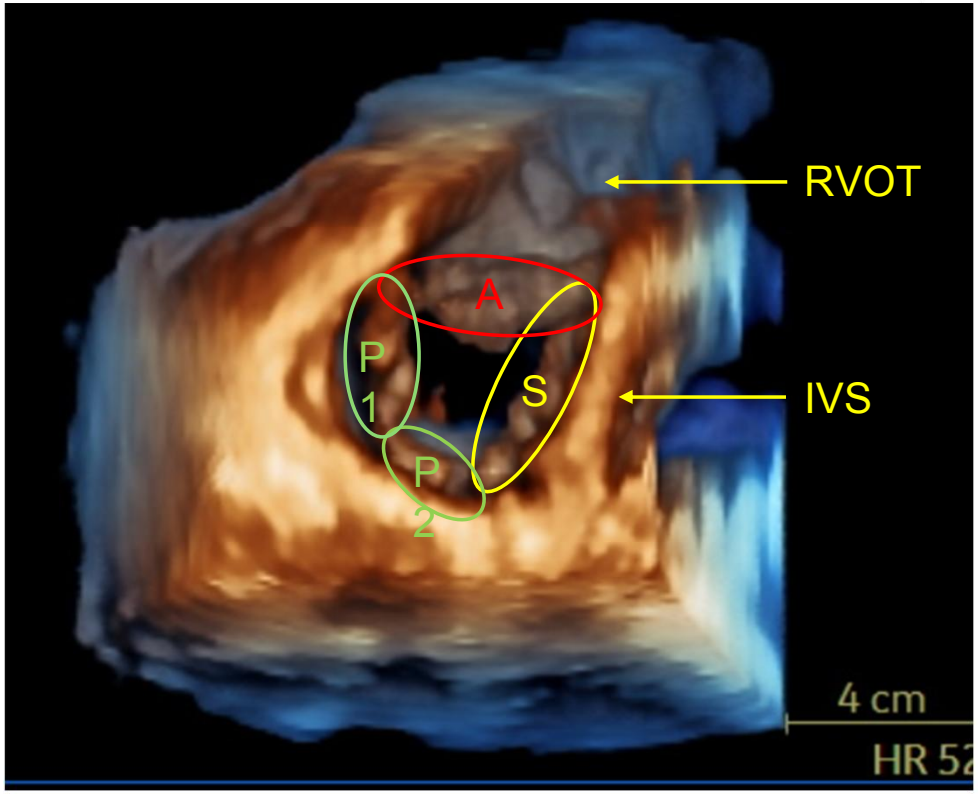
- Standard PLAX, PSAX, apical views
- Subcostal short axis en face view
  - Limitations
    - Very difficult to get full en face view
    - Chordae/leaflet may mimic extra leaflet, difficult to determine if on axis

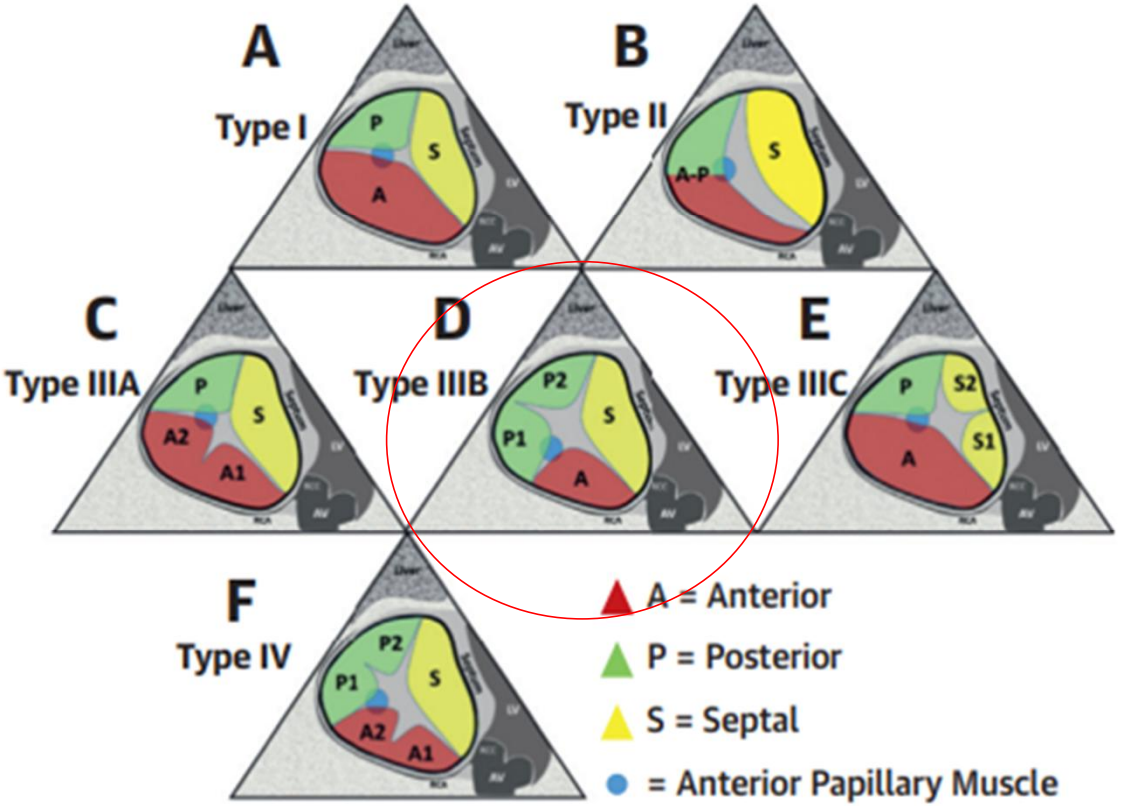



FPS: 15
f: 1.4 MHz/2.8 MHz
P: 0 dB
AG(t): 5 dB
Compr: 41 dB
D: 14.9 cm
A1: -60
A2: -120
Soft
4 cm
HR 49

SAP!

Clockwise: **Atrial**
Counterclockwise: **Ventricular**





Hahn et al, 2021

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Non-conventional valve morphology, what does this mean?

- Does not substitute a pre-procedural TOE
- However, TTE serves as a more readily available tool to determine TV morphology with adequate images
- Sedatives, catecholamines and narcotics which may be used in TOEs may affect TR severity at a certain point in time
- Impacts interventional planning
  - TEER/repair considerations
- Easy to do, does not take too much time, why not?

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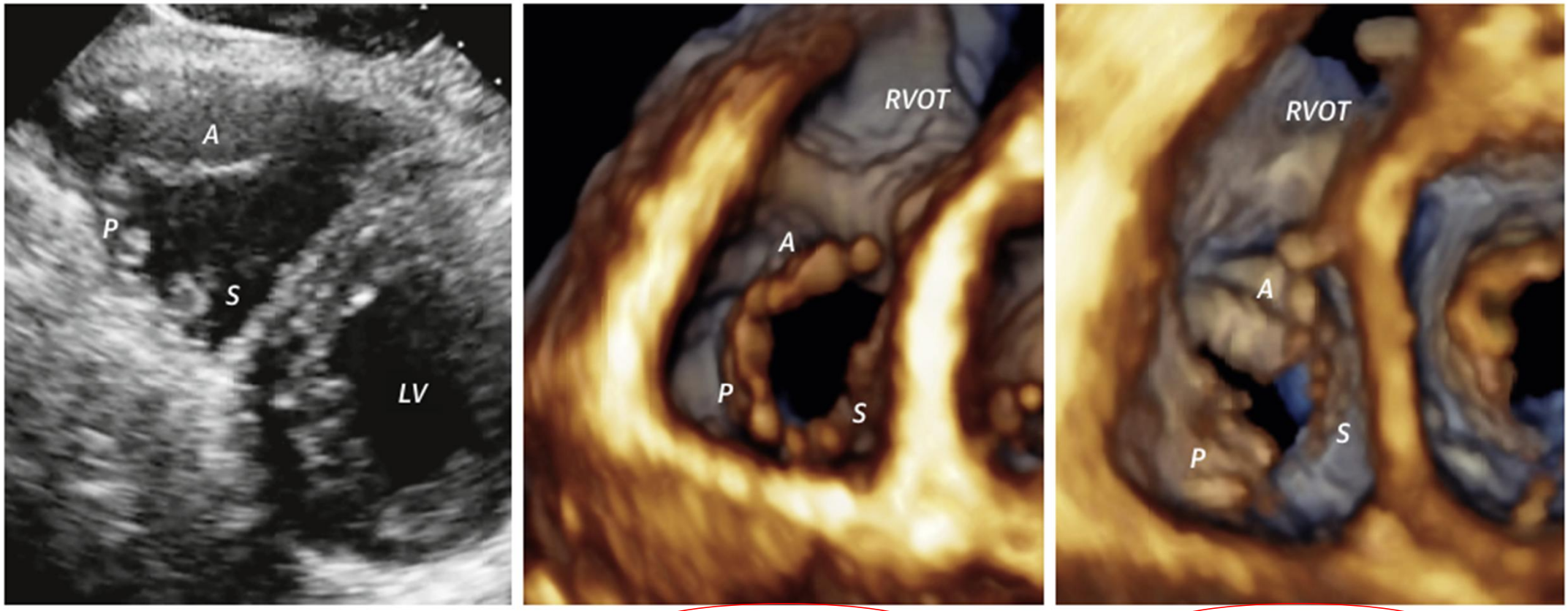
FIGURE 1 **Echocardiographic Imaging of the Tricuspid Valve With Different Echocardiographic Techniques**



2D TTE ≈ 5-10%

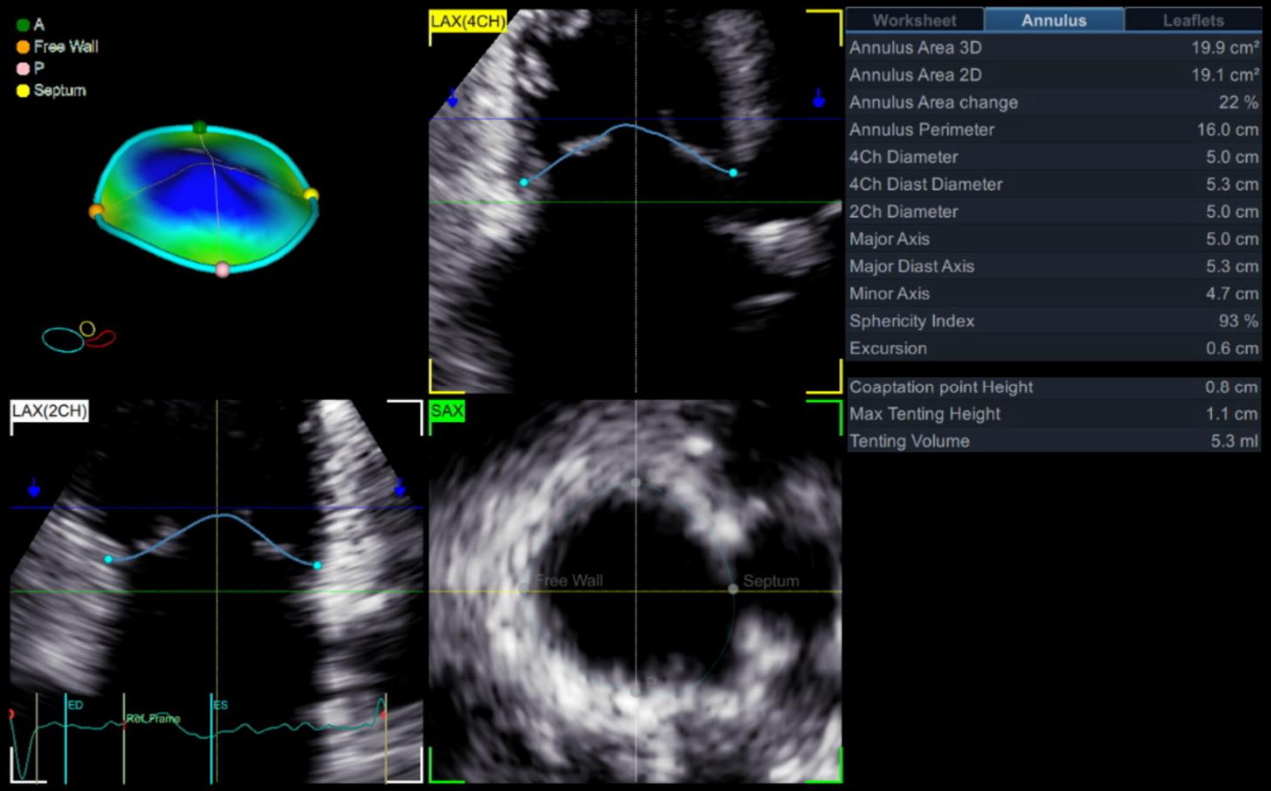
3D TTE ≈ 85-90%

3D TEE ≈ 65-70%

Transthoracic 2-dimensional **(left)** (Video 1), transthoracic 3D **(middle)** (Video 2), and transesophageal 3D **(right)** (Video 3) techniques with the corresponding estimated rates of successful visualization of the entire tricuspid valve in routine patients. 2D TTE = 2D transthoracic echocardiography; 3D TTE = 3D transthoracic echocardiography; 3D TEE = 3D transesophageal echocardiography; A = anterior tricuspid leaflet; LV = left ventricle; P = posterior tricuspid leaflet; RVOT = right ventricular outflow tract; S = septal tricuspid leaflet.

Muraru et al, 2019

Additional 3D measurements



Worksheet	Annulus	Leaflets
Annulus Area 3D		19.9 cm²
Annulus Area 2D		19.1 cm²
Annulus Area change		22 %
Annulus Perimeter		16.0 cm
4Ch Diameter		5.0 cm
4Ch Diast Diameter		5.3 cm
2Ch Diameter		5.0 cm
Major Axis		5.0 cm
Major Diast Axis		5.3 cm
Minor Axis		4.7 cm
Sphericity Index		93 %
Excursion		0.6 cm
Coaptation point Height		0.8 cm
Max Tenting Height		1.1 cm
Tenting Volume		5.3 ml

TVQ (GE):

- 3D annulus area: 19.9 cm^2
  - Usually underestimated with 2DE
- Tenting height: 1.1 cm

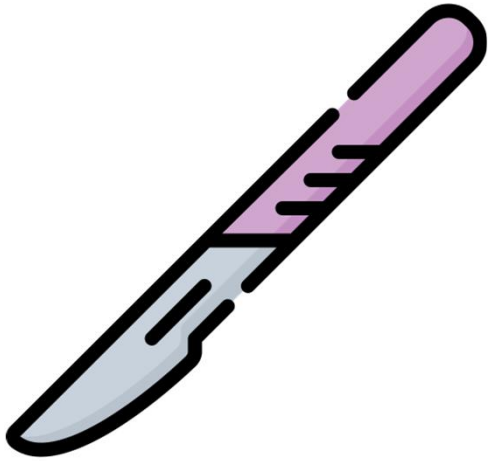
  >0.76 cm predictive of significant residual TR after TV surgery (Zaidi et al, 2020)

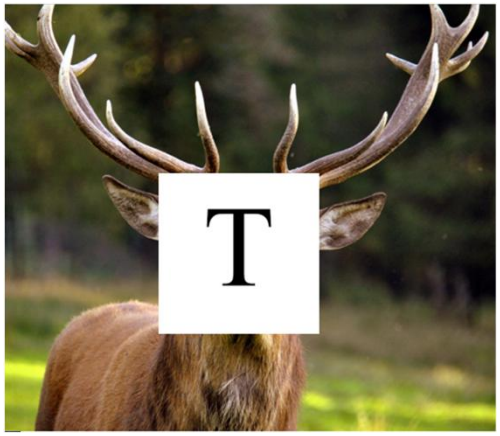
- Tenting Volume: 5.3 mL

  ≥ 2.3 mL predicts severe residual TR after TV annuloplasty for functional TR (Zaidi et al, 2020)

Future planning and available treatments

1. Tricuspid valve surgery (repair>replacement)
2. TEER (Transcatheter edge to edge repair)
3. GDMT (Guideline directed medical therapy)





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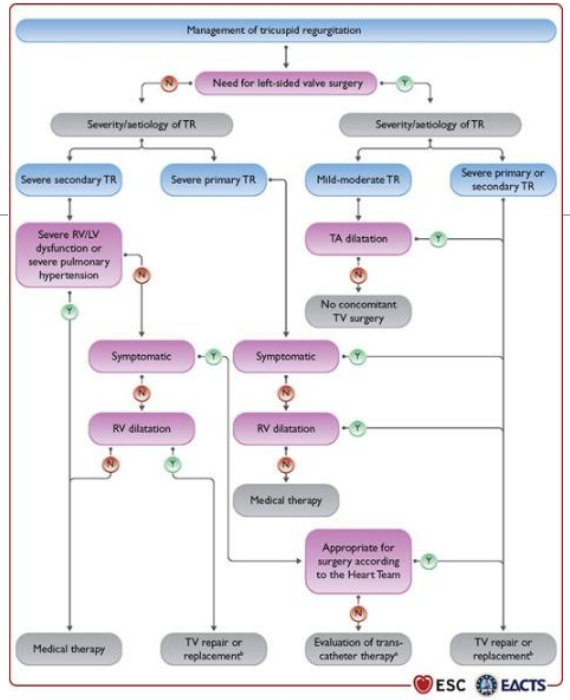

ESC/EACTS guidelines, 2021

Recommendations for Medical Therapy for TR

COR	LOE	Recommendations
2a	C-EO	1. In patients with signs and symptoms of right-sided HF attributable to severe TR (Stages C and D), diuretics can be useful.
2a	C-EO	2. In patients with signs and symptoms of right-sided HF attributable to severe secondary TR (Stages C and D), therapies to treat the primary cause of HF (eg, pulmonary vasodilators to reduce elevated pulmonary artery pressures, GDMT for HF with reduced LVEF, or rhythm control of AF) can be useful[1,2]

ACC/AHA guidelines, 2020

Table 1. Eligibility criteria for tricuspid edge-to-edge repair.

Ideal TR for edge-to-edge repair	Edge-to-edge repair to be considered	Edge-to-edge repair not recommended or only in exceptional cases
Secondary TR with structurally normal appearing leaflets	Secondary TR with normal appearing leaflets or primary TR with leaflet prolapse*	Severe leaflet (rheumatic) thickening or shortening or destruction or very large leaflet prolapse
Small coaptation defect (<3-4 mm**) and good leaflet mobility	Moderate coaptation defect (4-7 mm**), reduced leaflet mobility	Large coaptation defect (>7 mm**) or severe leaflet tethering
Central TR jet extending in the anteroseptal commissure	Central TR jet extending in the posteroseptal or anteroposterior commissure	Non-central or very eccentric jets or jets originating from anteroposterior commissure
Good echocardiographic windows*** for leaflet visualisation	Sufficient echocardiographic windows*** for leaflet visualisation	Insufficient echocardiographic windows*** for leaflet visualisation
No PM/ICD lead	Presence of PM/ICD lead, no significant leaflet interaction and no interaction with clip	PM/ICD lead-induced TR
Normal to moderately reduced RV function, normal to moderate RV dilatation	Moderately reduced RV function, moderate RV dilatation	Severely reduced RV function or severe RV dilatation
Normal sPAP	sPAP <60-65 mmHg and pulmonary capillary resistance <4 WU	sPAP >60-65 mmHg and/or pulmonary capillary resistance >4 WU

In addition to the displayed suitability criteria for tricuspid edge-to-edge (E2E) repair, all patients should (a) be symptomatic with right-sided heart failure symptoms, (b) be at high or prohibitive surgical risk, and (c) have severe TR. *Leaflet prolapse width <10-12 mm and flail gap <10 mm. **Size of the coaptation defect has to be assessed at the location of the planned clip placement orthogonally to the commissural plane. ***Echocardiographic image quality has to be assessed in a "grasping view" at the location of the planned clip placement. ICD: implantable cardioverter-defibrillator; PM: pacemaker; RV: right ventricular; sPAP: systolic pulmonary artery pressure

Hausleiter et al, 2018

Type of intervention	Study name	Design	Devices	Number of patients	TR reduction at 30 days	Post-procedural mortality	Clinical outcomes
Edge-to-edge repair							
	TRILUMINATE Feasibility Study (NCT03227757)	Prospective, single-arm, observational study	TriClip NT	85	At least 1 grade reduction: 86%, TR reduction to ≤2+: 56%	6-month mortality: 5%	Improvement in NYHA class, KCCQ score, and 6MWD 40% reduction of hospitalisation
	CLASP TR Early Feasibility Study (NCT03745313)	Prospective, single-arm, observational study	PASCAL	34	At least 1 grade reduction: 85% TR reduction to ≤2+: 52%	30-day mortality: 0%	Improvement in NYHA class, KCCQ score, and 6MWT at 30 days
	bRIGHT Post-Approval Study (NCT04483089)	Prospective, post-market survey	TriClip G4	511	TR reduction to ≤2+: 77%	30-day mortality: 1.0%	Improvement in NYHA class and KCCQ score
	TRILUMINATE Pivotal Study (NCT03904147)	Prospective randomized control trial (control arm: medical therapy alone)	TriClip G3 or G4	350 (175 for intervention)	TR reduction to ≤2+: 87%	30-day mortality: 0.6%	Improvement in KCCQ score compared to medical therapy alone at 1 year

European society of cardiology, 2024

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Summary

- Various non-conventional tricuspid morphologies are common
- TR still remains a complicated problem associated with high mortality rates
- TTE serves as a readily available imaging modality in determining TV morphology
- TTE > TOE in en face 3D visualisation of the TV
- Other utilities of 3D imaging in more advanced measurements
- 3D TTE is still an underutilized tool in the assessment of the tricuspid valve
- TEER + 3D TTE of the TV

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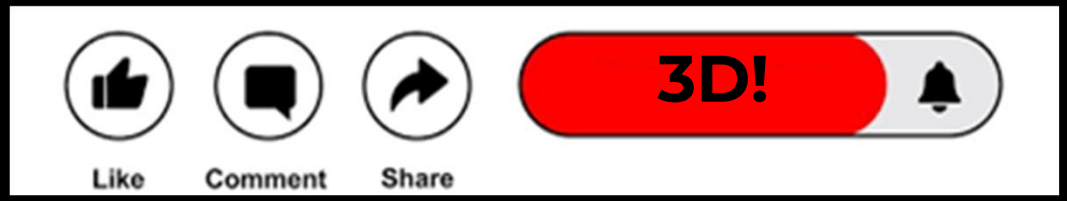
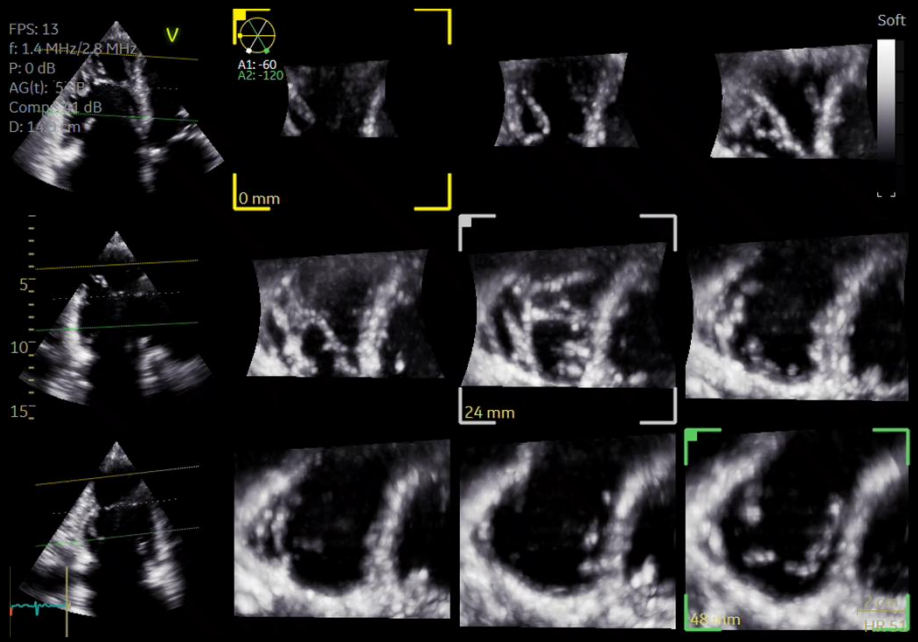
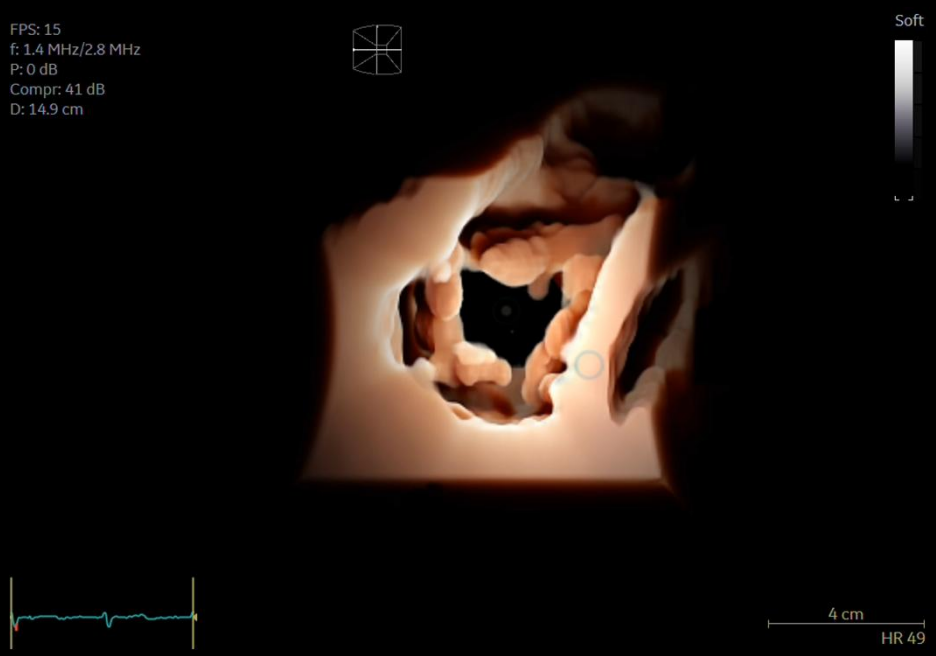
Give the tricuspid valve some love and smash that 3D button!







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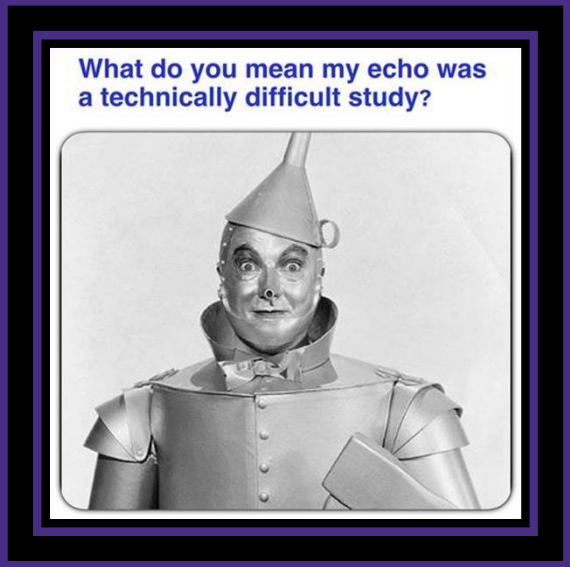
Thank you!

Enjoy the rest of the conference!



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