Hot topics in heart valve disease

Tricuspid valve repair: surgery or transcatheter

VINCENZO POLIZZI
DIRETTORE UOC CARDIOLOGIA,
PO V.CERVELLO
AOOR VILLA SOFIA - CERVELLO, PALERMO

Il Sottoscritto Vincenzo Polizzi qualità di relatore ai sensi *ai sensi dell'art. 76, comma 4 dell'Accordo Stato- Regioni del 2 febbraio 2017 e del paragrafo 4.5. del Manuale nazionale di accreditamento per l'erogazione di eventi ECM,*

dichiara

che negli ultimi due anni **NON** ha avuto rapporti anche di finanziamento con soggetti portatori di interessi commerciali in campo sanitario.

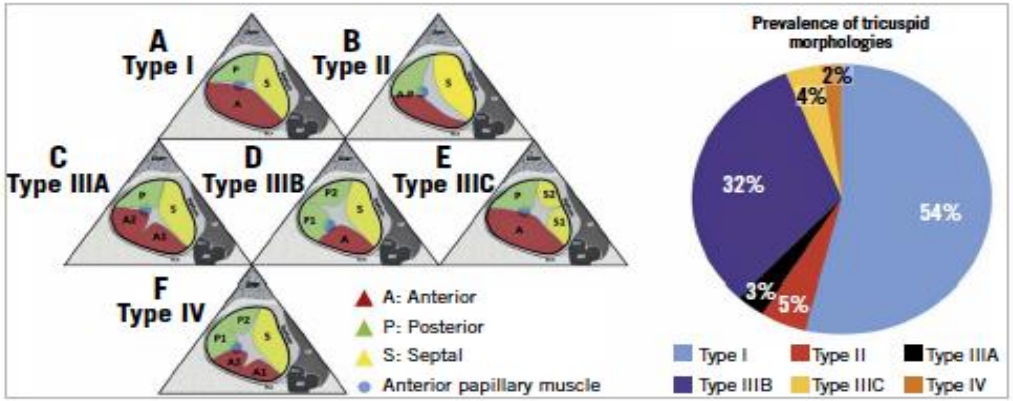

Figure 1. *Proposed nomenclature for tricuspid valve classification. Left panel. Proposed nomenclature for tricuspid valve classification scheme (anterior papillary muscle [blue circle] defines separation of anterior and posterior leaflets). A) Type I: 3-leaflet configuration. B) Type II: 2-leaflet configuration. C) – E) Type III: 4-leaflet configurations. F) Type IV: 5-leaflet configuration. Right panel. Incidence of each morphology. A: anterior leaflet; AV: aortic valve; P: posterior leaflet; S: septal leaflet. Adapted from Hahn et al[9], with permission.*

EuroIntervention 2021;17:791-808

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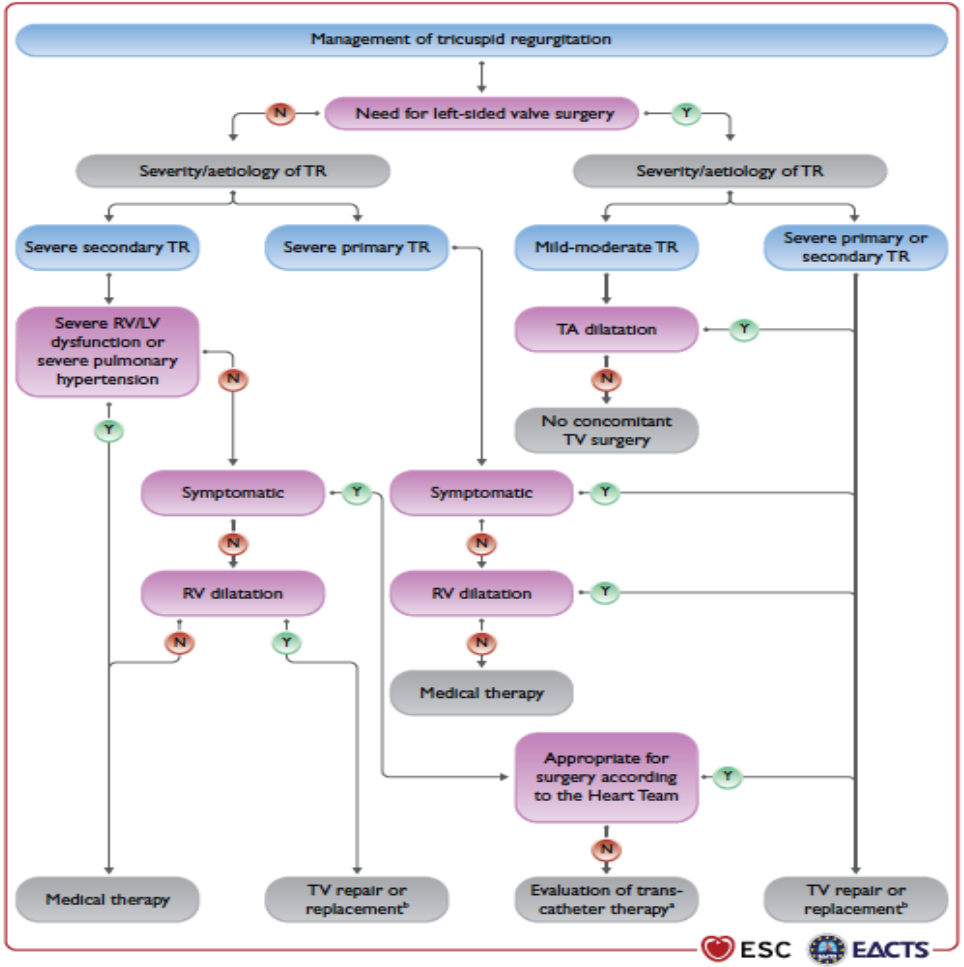

2021 ESC/EACTS Guidelines for the management of valvular heart disease

ESC European Society of Cardiology
European Heart Journal (2021) 00, 1–72
doi:10.1093/eurheartj/ehab395

ESC/EACTS GUIDELINES

2021 ESC/EACTS Guidelines for the management of valvular heart disease

Tricuspid regurgitation

Recommendations on primary tricuspid regurgitation		
Surgery is recommended in patients with severe primary tricuspid regurgitation undergoing left-sided valve surgery.	I	C
Surgery is recommended in symptomatic patients with isolated severe primary tricuspid regurgitation without severe RV dysfunction.	I	C
Surgery should be considered in patients with moderate primary tricuspid regurgitation undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in asymptomatic or mildly symptomatic patients with isolated severe primary tricuspid regurgitation and RV dilatation who are appropriate for surgery.	IIa	C

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ESC/EACTS GUIDELINES

2021 ESC/EACTS Guidelines for the management of valvular heart disease

Recommendations on secondary tricuspid regurgitation		
Surgery is recommended in patients with severe secondary tricuspid regurgitation undergoing left-sided valve surgery.[423–427]	I	B
Surgery should be consi… mild or moderate secor… tion with a dilated annul… mm/m^2 by 2D echocard… left-sided valve surgery.[…]		
Surgery should be consi… severe secondary tricus… without previous left-sid… symptomatic or have RV… absence of severe RV or LV dysfunction and severe pulmonary vascular disease/hyperten-sion.[418,433 e]		
Transcatheter treatment of symptomatic secon-dary severe tricuspid regurgitation may be con-sidered in inoperable patients at a Heart Valve Centre with expertise in the treatment of tricus-pid valve disease.[f]	IIb	C

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ESC/EACTS GUIDELINES

2021 ESC/EACTS Guidelines for the management of valvular heart disease

Tricuspid regurgitation

Qualitative

Variable	1 Mild	2 Moderate	3 Severe	4 Massive	5 Torrential
VC (biplane)	< 3 mm	3 - 6.9 mm	7 - 13 mm	14 - 20 mm	≥ 21 mm
EROA (PISA)	< 20 mm²	20 - 39 mm²	40 - 59 mm²	60 - 79 mm²	≥ 80 mm²
3D VCA or quantitative EROA[a]			75 - 94 mm²	95 - 114 mm²	≥ 115 mm²

chambers/vessels

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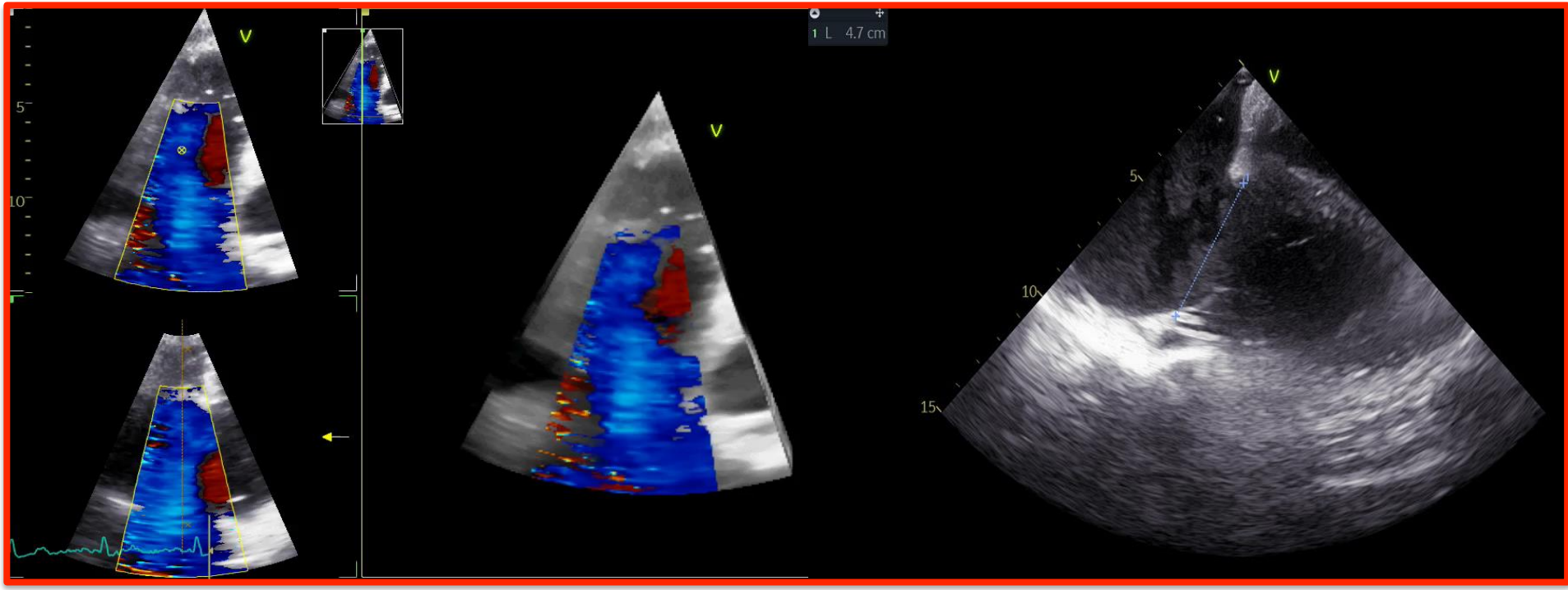

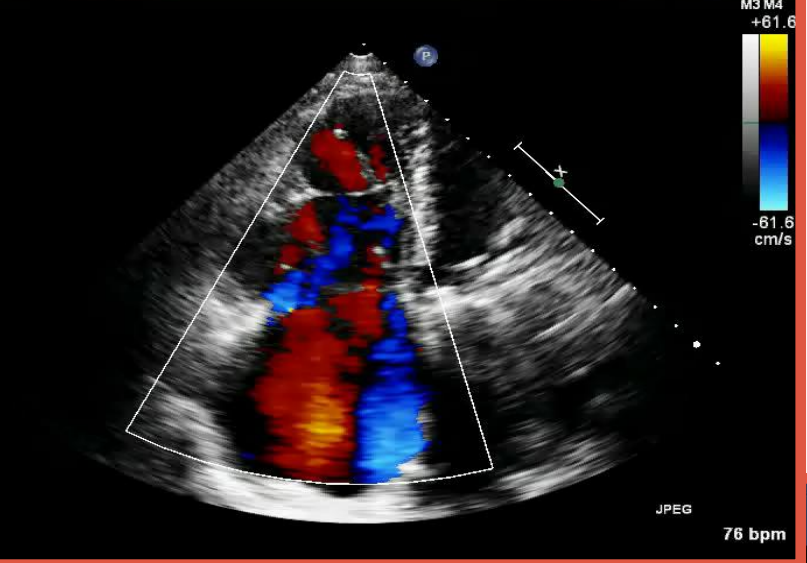
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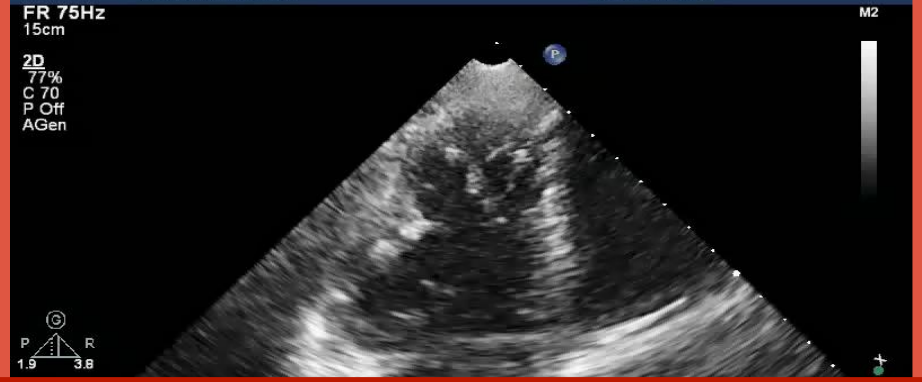
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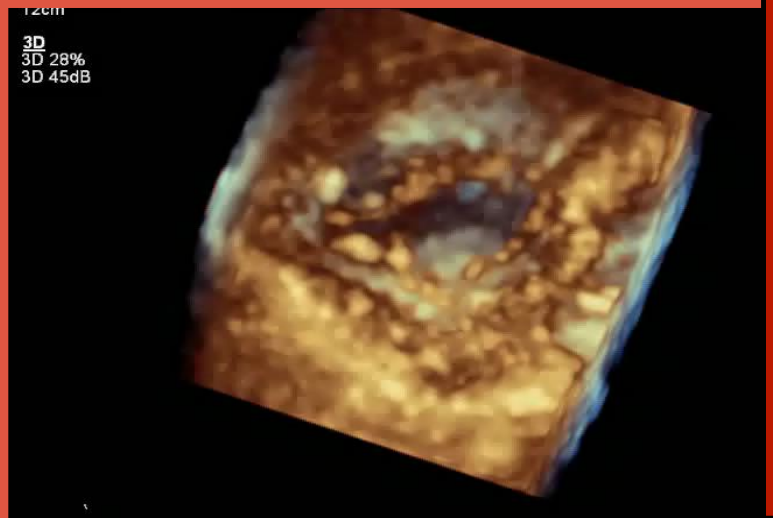
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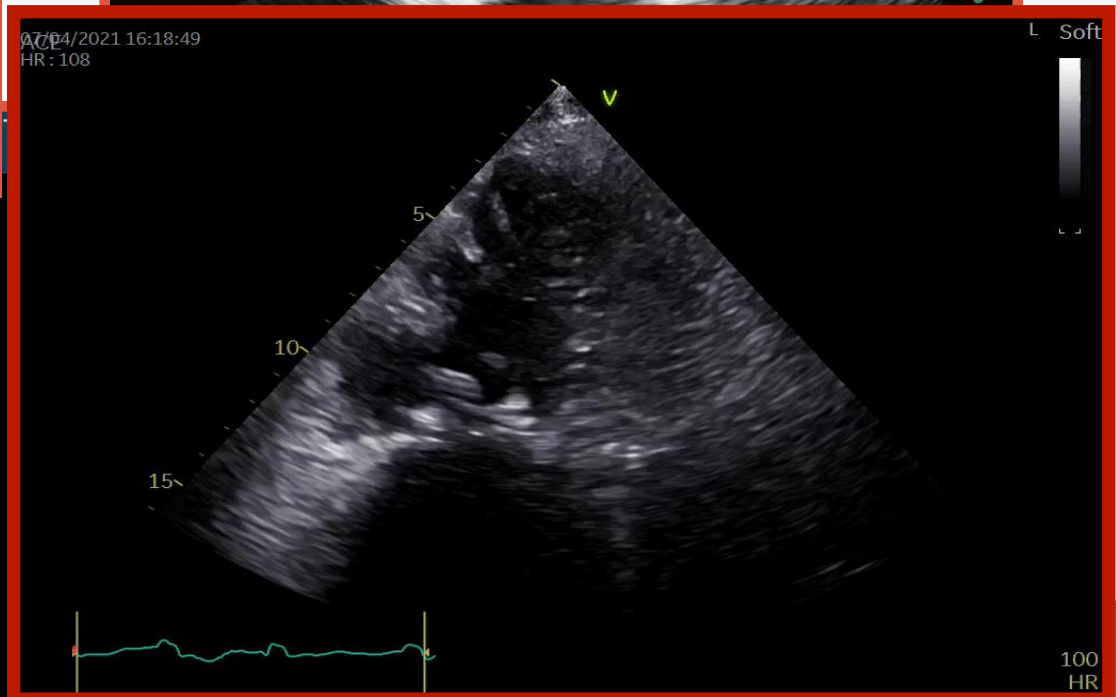
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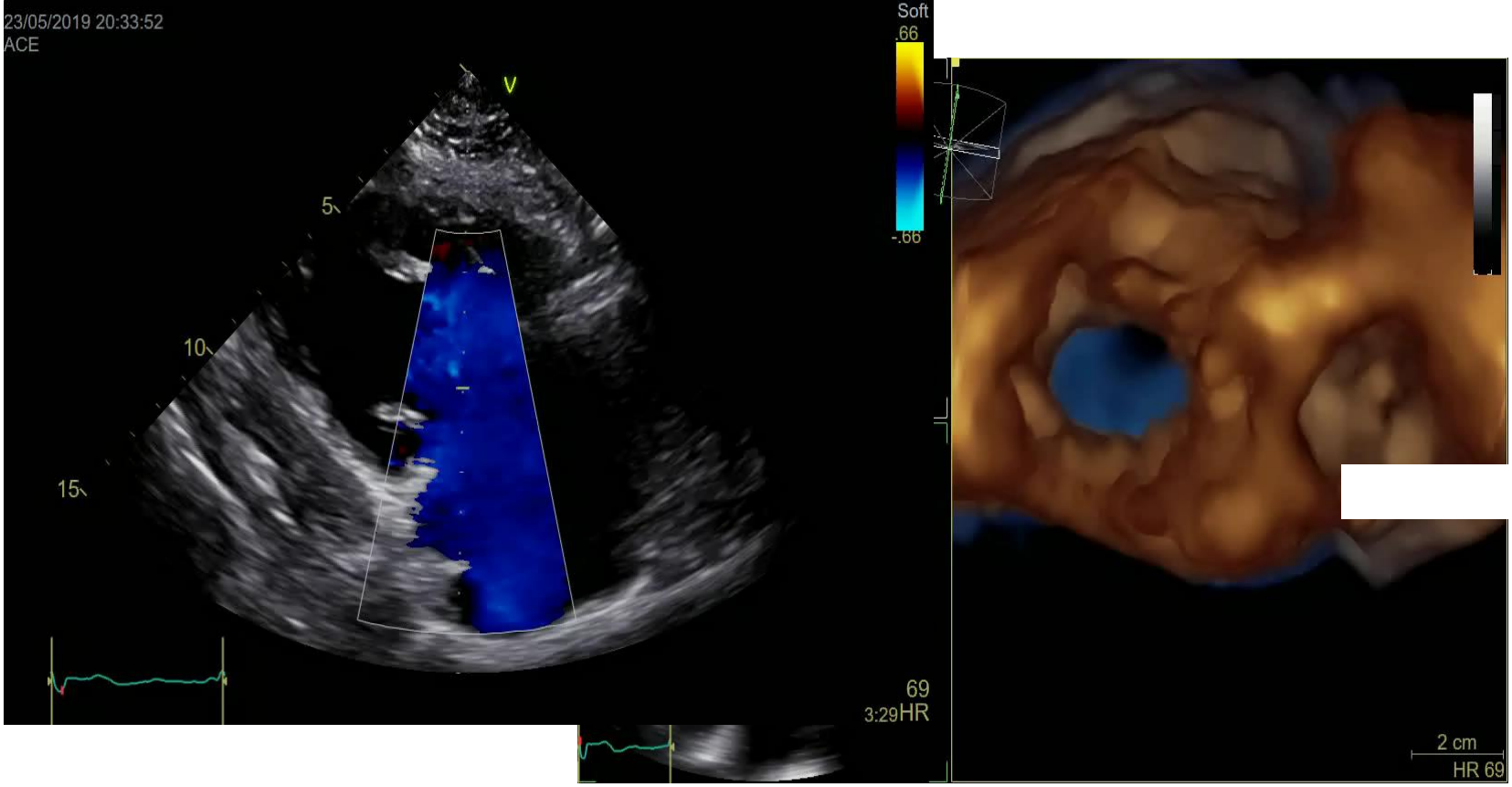
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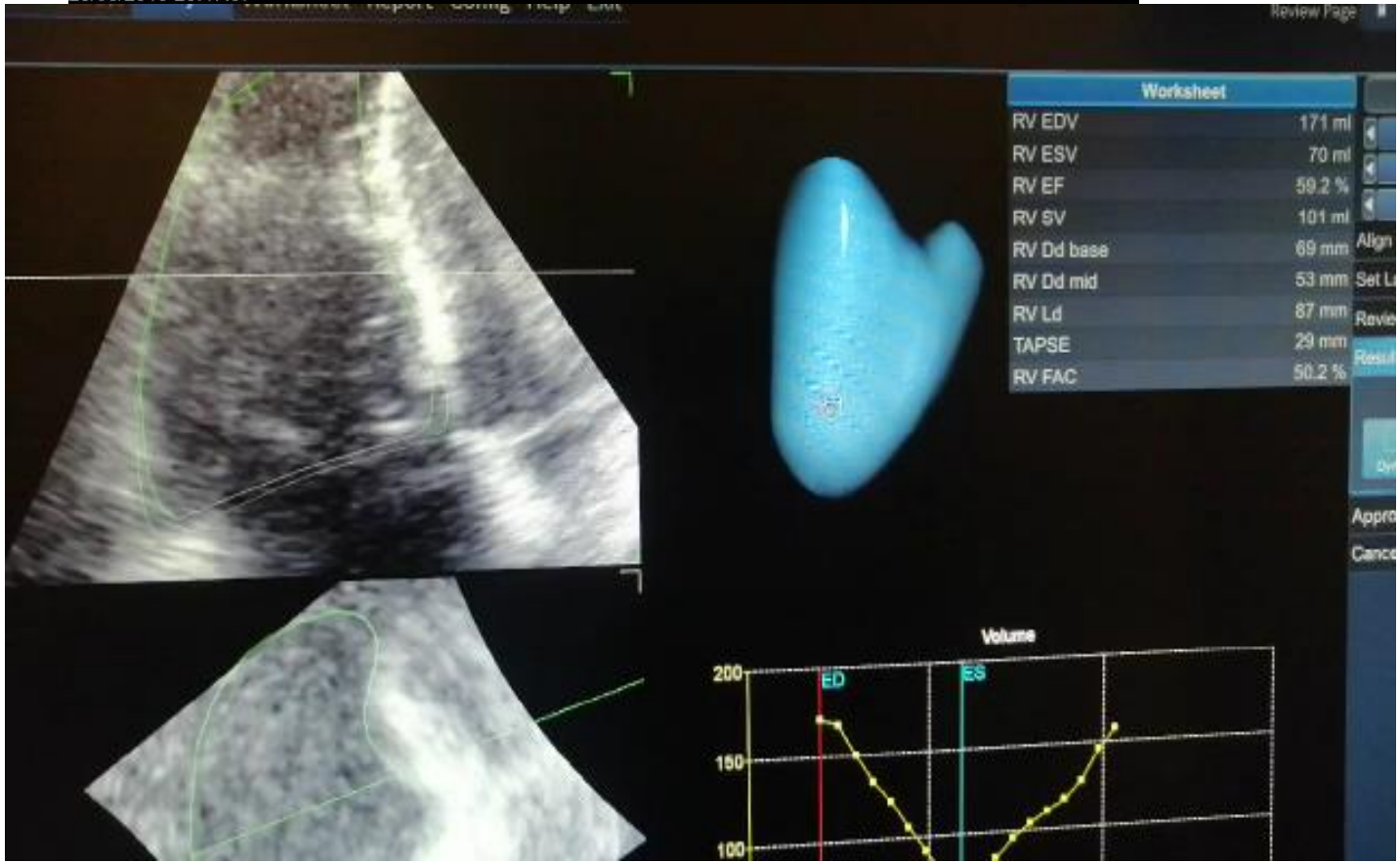
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RV EF 59.2 %
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RV Ld 87 mm
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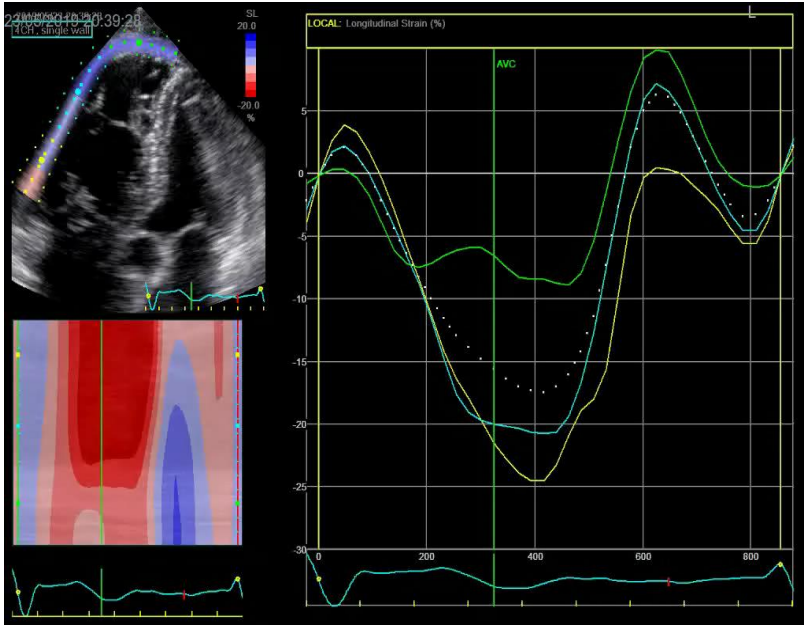

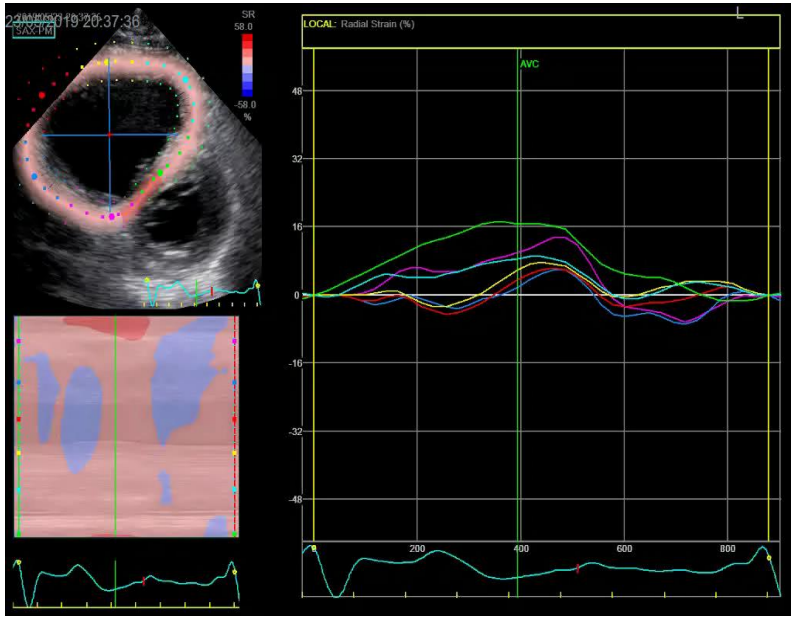

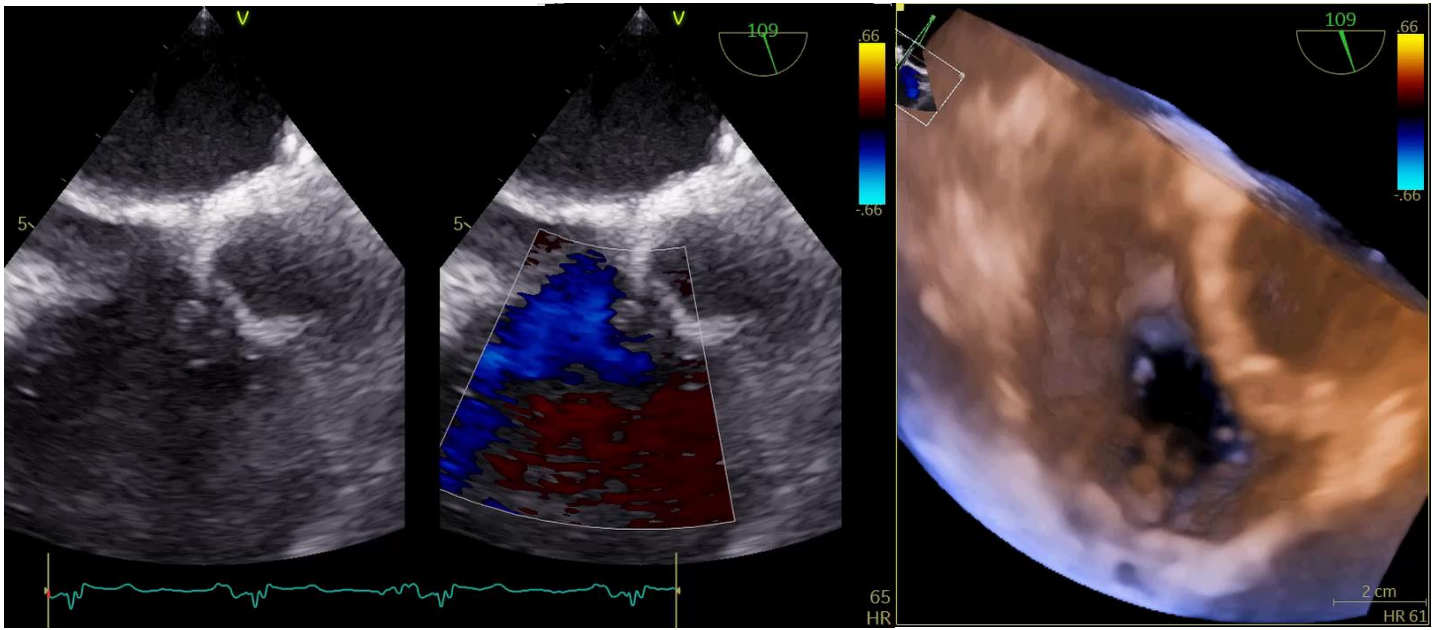
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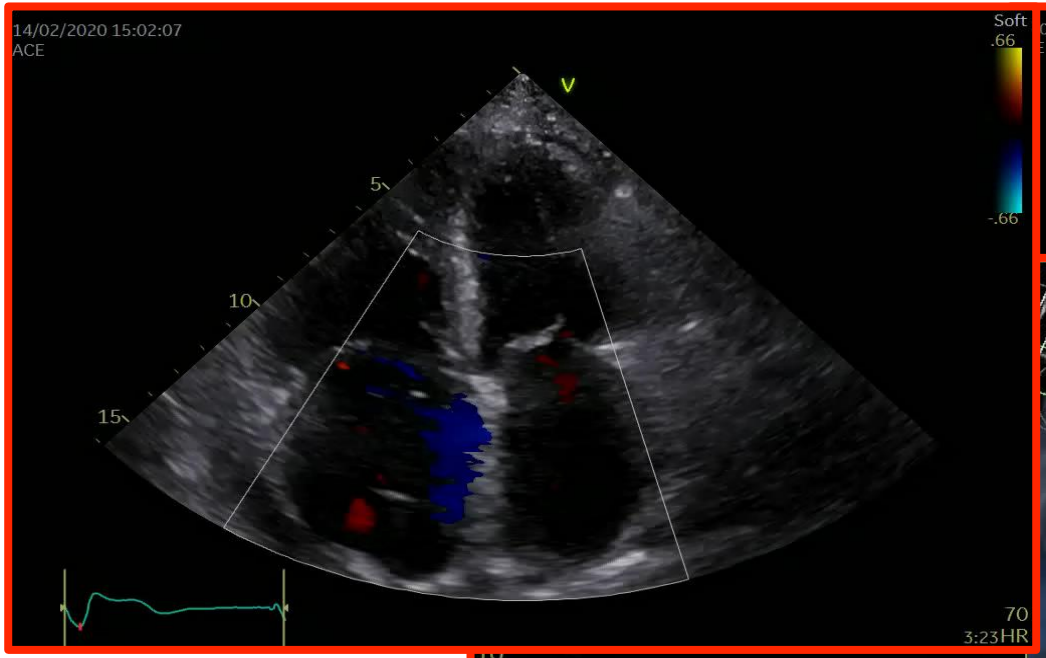
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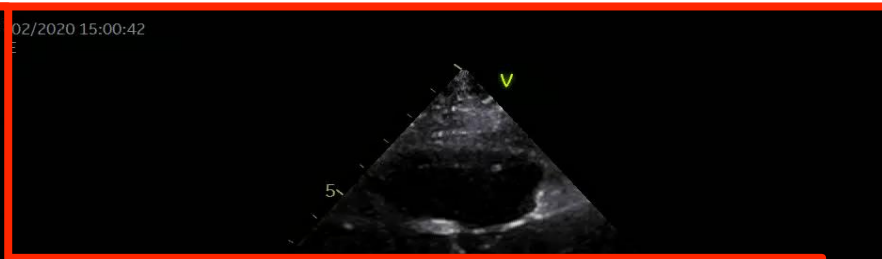
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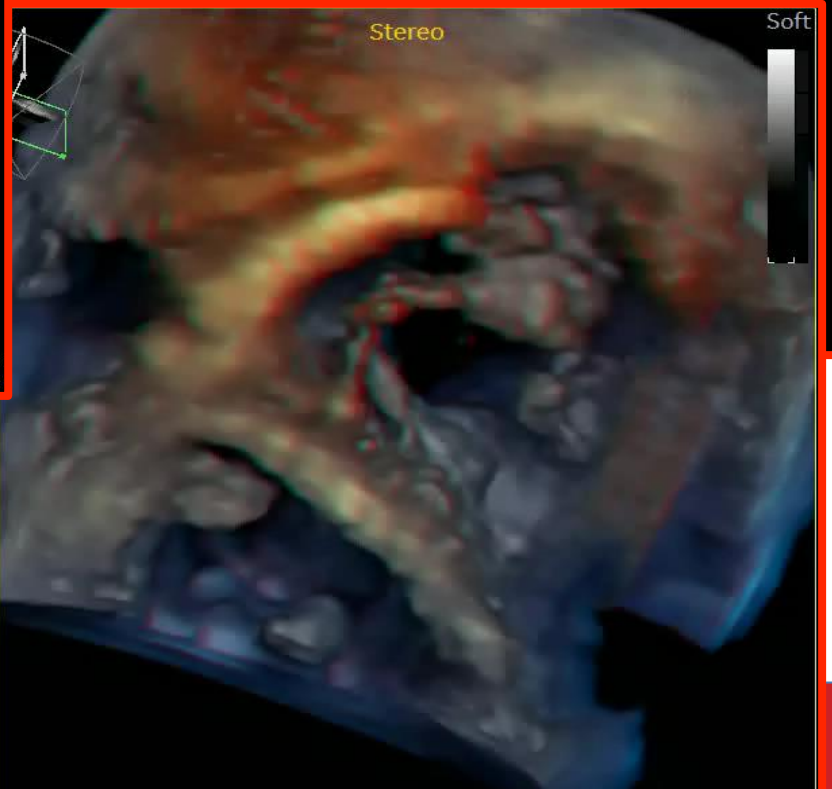
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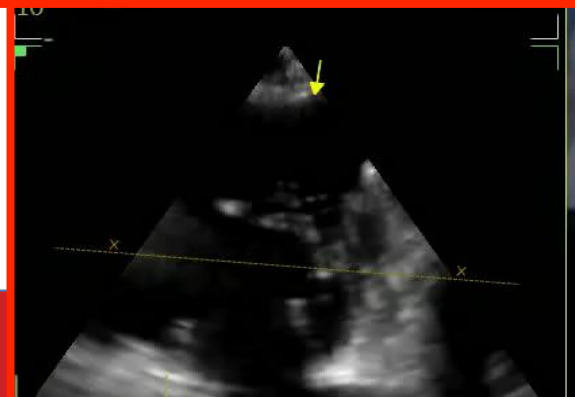

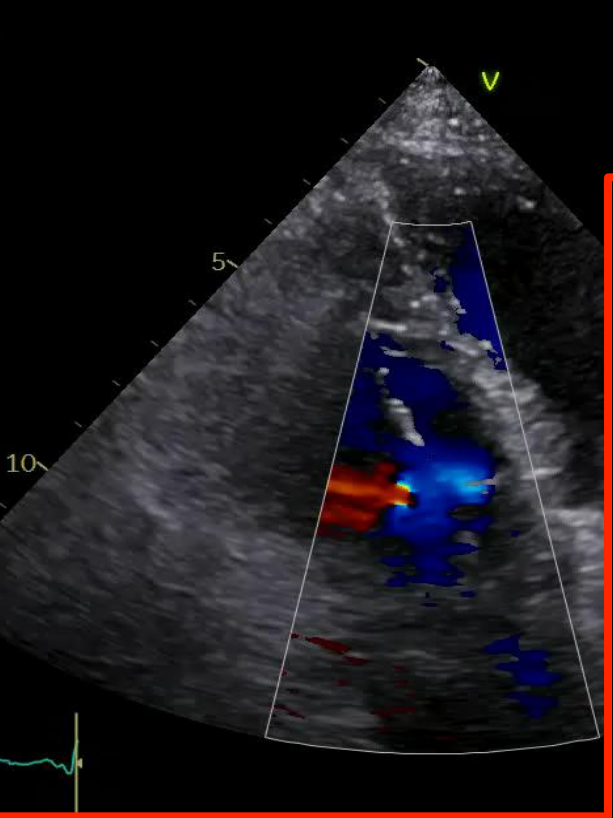
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The NEW ENGLAND JOURNAL of MEDICINE

REVIEW ARTICLE

Jane A. Leopold, M.D., *Editor*

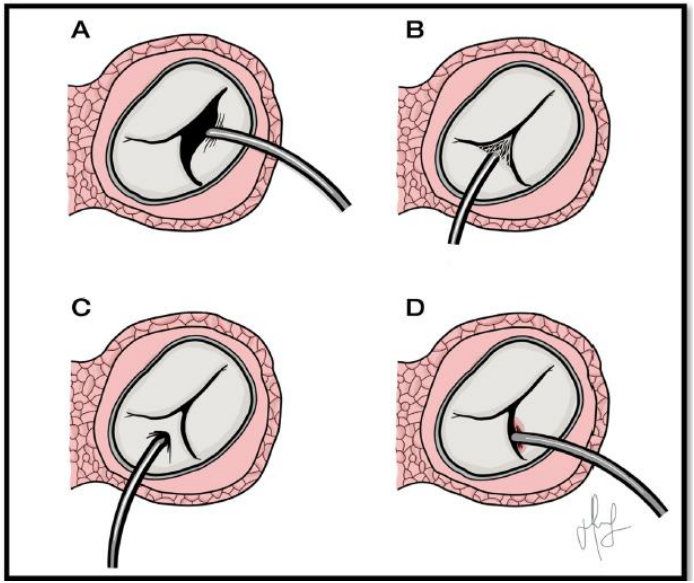
Tricuspid Regurgitation

Rebecca T. Hahn, M.D.

CIED-related tricuspid regurgitation (approximately 10–15% of cases)		N Engl J Med 2023;388:1876-91.
Lead-related tricuspid regurgitation	Causative: leaflet impingement, perforation, or valvular or subvalvular adhesions or restriction	
	Incidental: presence of CIED without interference in valvular apparatus	

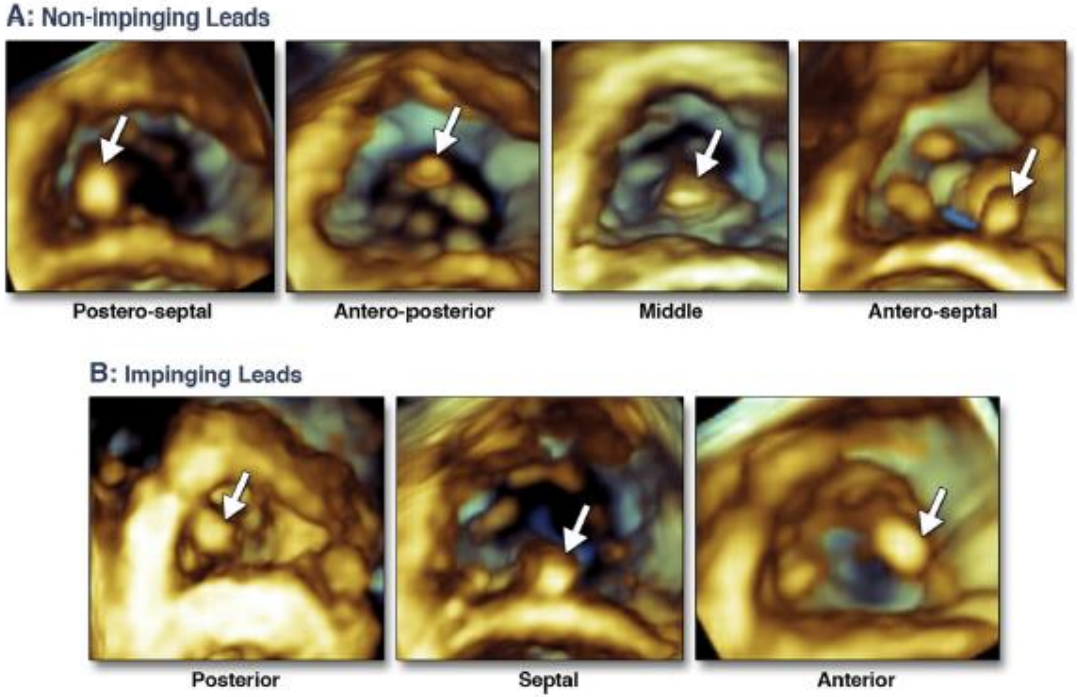
STATE-OF-THE-ART-REVIEW

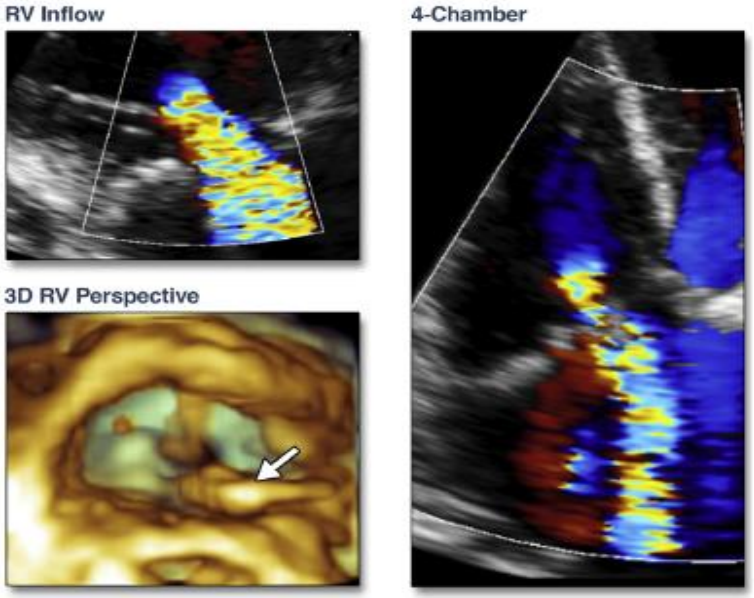
Tricuspid Regurgitation Related to Cardiac Implantable Electronic Devices: An Integrative Review



Journal of the American Society of Echocardiography
November 2022

3D Echocardiographic Location of Implantable Device Leads and Mechanism of Associated Tricuspid Regurgitation





(J Am Coll Cardiol Img 2014;7:337–47)

(J Am Coll Cardiol Img 2019;12:622-36)

CENTRAL ILLUSTRATION Pictorial Representation of Possible Decision Pathway for a Patient Who Presented With Severe Tricuspid Regurgitation in the Presence of a Device Lead

CIED IMPLANTATION

Failed medical management, progressive right ventricular dilatation/dysfunction, signs/symptoms of right heart failure due to severe TR

Consider lead extraction

Consider percutaneous tricuspid valve replacement if feasible and surgical risk prohibitive

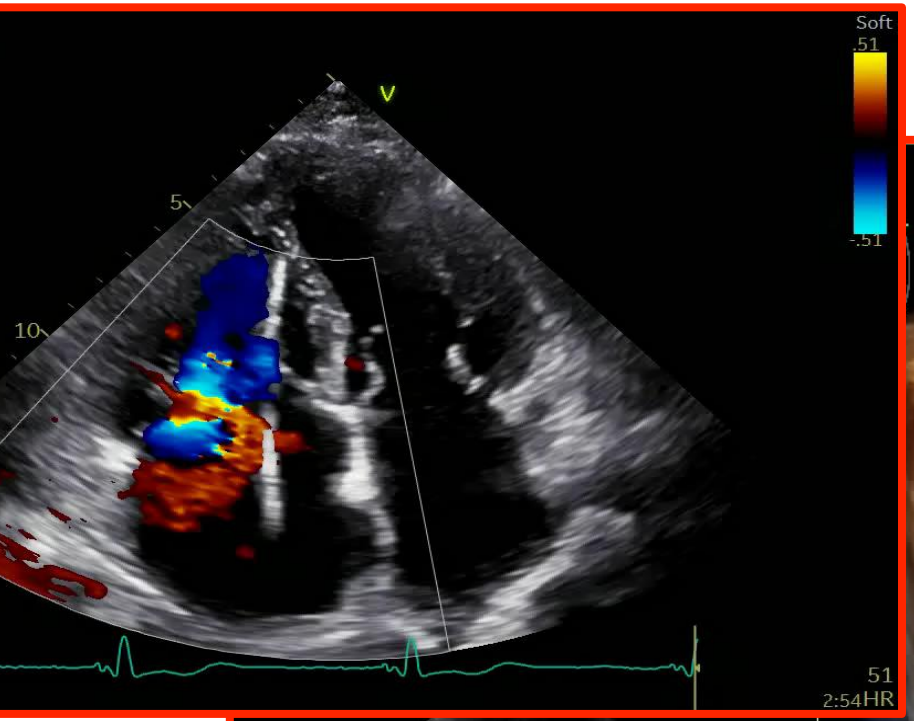
Consider surgical lead removal/exchange/ repositioning

Consider lead extraction

Consider percutaneous tricuspid valve replacement if feasible and surgical risk prohibitive

Consider surgical lead removal/exchange/ repositioning

Addetia, K. et al. J Am Coll Cardiol Img. 2019;12(4):622-36.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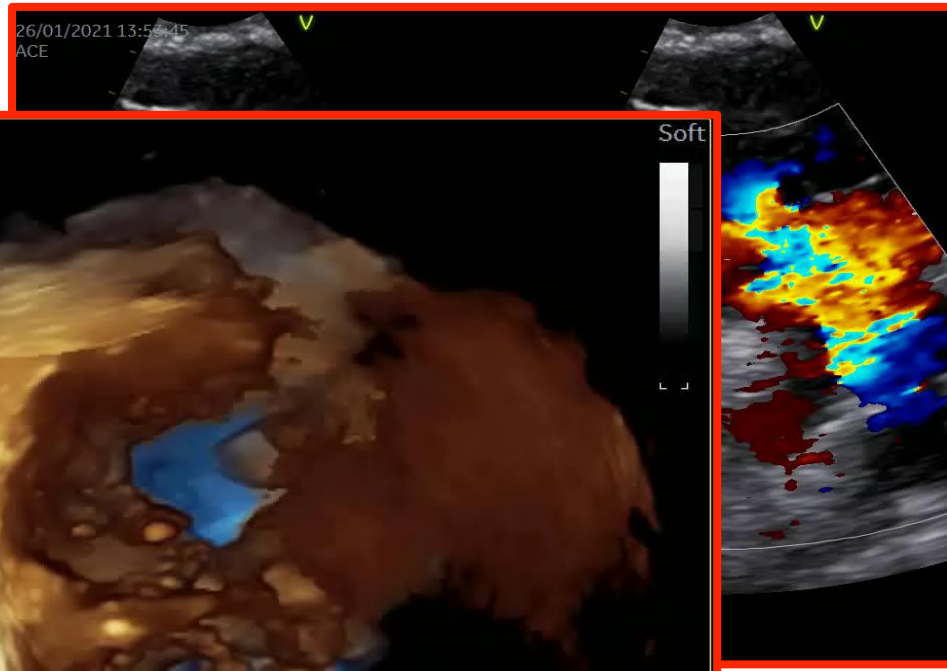
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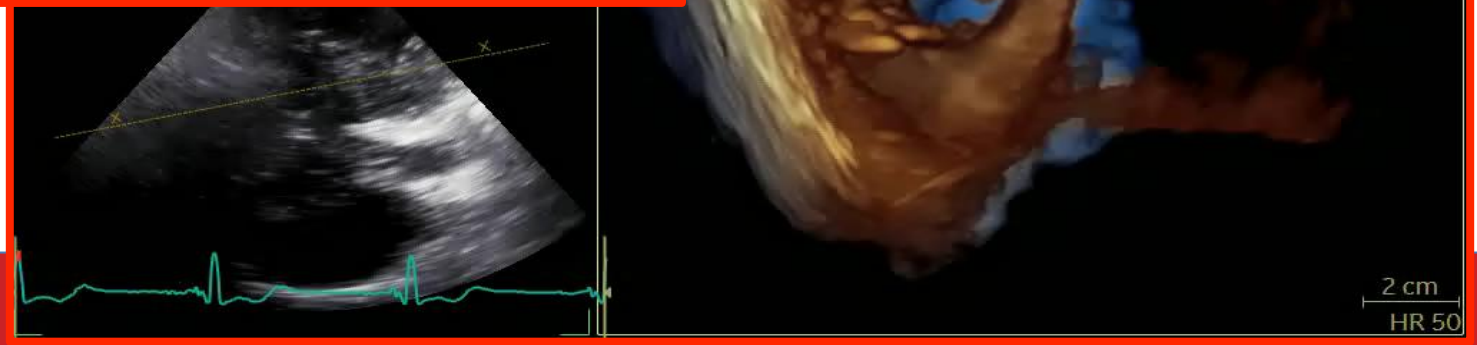

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Table 1. Proposed new integrated classification of TR.

	Leaflet structure	Pathophysiology	Aetiology	Imaging
Secondary (functional)				
A. Atrial	Normal	RA enlargement and dysfunction leading to significant isolated annular dilation; RV often normal*	Carpentier I: Atrial fibrillation/flutter[101] Age[102] Heart failure with preserved ejection fraction[103,104]	Marked **TV annular dilation** is the dominant mechanism TV leaflet tethering is absent or minimal (except for late stages with secondary RV dysfunction) TV leaflet mobility is typically normal (Carpentier type I) RA is significantly dilated RV volume is typically normal (except in late stages)
B. Ventricular	Normal	RV enlargement and/or dysfunction leading to significant leaflet tethering and annular dilation	Carpentier IIIB: Left-sided ventricular or valve disease[11,12] Pulmonary hypertension[102] RV cardiomyopathy RV infarction	Marked **TV leaflet tethering** is the dominant mechanism TV leaflet mobility is typically restricted in systole (Carpentier type IIIB) TV annulus, RV and RA are dilated and/or dysfunctional
CIED-related	Normal/ abnormal	Leaflet impingement Leaflet/chordal entanglement/ chordal rupture Leaflet adherence Leaflet laceration/perforation Leaflet avulsion (following lead extraction)	Pacemaker Implantable cardiac defibrillator (ICD) Cardiac resynchronisation therapy (CRT) devices[105-108]	**TV leaflet structural abnormalities** may be present TV leaflet mobility is variable (all Carpentier types) TV annulus, RV and RA are typically dilated (except for acute TR)
Primary (organic)	Abnormal	Lack of leaflet coaptation due to intrinsic changes leading to restricted or excessive leaflet mobility or leaflet perforation	Carpentier I: Congenital Endocarditis Carpentier II: Myxomatous disease Traumatic Post biopsy Carpentier IIIA: Carcinoid[109] Rheumatic Radiotherapy Tumours	**TV leaflet structural abnormalities** characteristic of each primary aetiology are the dominant mechanisms TV leaflet mobility is variable (all Carpentier types) TV annulus, RV and RA are typically dilated (except in acute TR)

*RV basal diameter may appear abnormal due to the conical RV shape. CIED: cardiac implantable electronic device; CRT: cardiac resynchronisation therapy; ICD: implantable cardiac defibrillator; RA: right atrium; RV: right ventricle; TR: tricuspid regurgitation; TV: tricuspid valve

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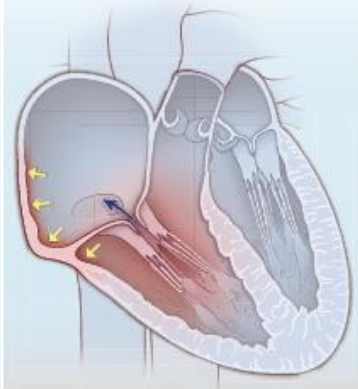
REVIEW ARTICLE

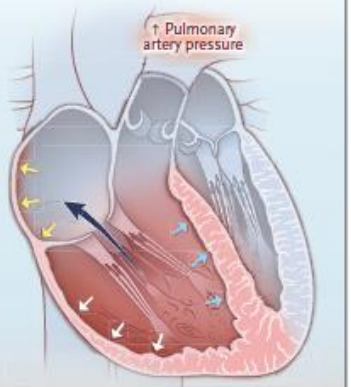
Tricuspid Regurgitation

Rebecca T. Hahn, M.D.

N Engl J Med 2023;388:1876-91.

MAY 18, 2023





	Atrial secondary tricuspid regurgitation	Ventricular secondary tricuspid regurgitation
Female or male	More often female	More often male
Left ventricular ejection fraction	Usually normal (>60%)	Often reduced (<50%)
Left atrial size	↑	↑↑
Tenting parameters	Normal to ↑ (height ≤10 mm)	↑↑
Tricuspid annular size	↑↑	↑
Right atrial size	↑↑	↑
Right ventricular diameter (midventricle)	Normal to ↑ (≤38 mm)	↑↑
Right atrial:right ventricular dimension ratio	↑↑	↑
Pulmonary artery systolic pressure	Normal to ↑	↑↑ (≥50 mm Hg)
Right ventricular function	Normal to ↓	↓

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REVIEW ARTICLE

Jane A. Leopold, M.D., *Editor*

Tricuspid Regurgitation

Rebecca T. Hahn, M.D.

N Engl J Med 2023;388:1876-91.

TRICUSPID REGURGITATION ASSOCIATED WITH AN IMPLANTABLE ELECTRONIC DEVICE

Although tricuspid regurgitation associated with cardiac implantable electronic devices was once categorized as a primary form of tricuspid regurgitation, it has features of both primary and secondary tricuspid regurgitation.[70-72] However,

three-dimensional echocardiography[71] and computed tomography (CT),[73] although in most studbrillation or previous open-heart surgery.[79] If tricuspid regurgitation is caused by the cardiac implantable electronic device, lead removal performed in a timely fashion may prevent the development of severe right ventricular dilatation and dysfunction,[80] but removal results in worsening of tricuspid regurgitation in approximately 10% of patients, with injury to the valve in approximately 3%.[81]

ESC European Society of Cardiology

European Heart Journal (2020) **41**, 1932–1940
doi:10.1093/eurheartj/ehz614

CLINICAL REVIEW
Controversies in cardiovascular medicine

Uncertainties and challenges in surgical and transcatheter tricuspid valve therapy: a state-of-the-art expert review

ESC European Society of Cardiology
European Heart Journal (2020) 41, 1932–1940
doi:10.1093/eurheartj/ehz614
CLINICAL REVIEW
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Table 1 Five-stepwise approach for evaluations of patients with suspected or established tricuspid regurgitation

Target	Imaging modalities needed to evaluate
Tricuspid valve morphology (TV annulus dilatation and leaflet tethering)	TTE and TOE (2DE and 3DE)
TR severity	2DE/3DE with Doppler, CMR if unclear
Haemodynamic impact	2DE with Doppler
Preload (RV filling)	2DE and M-mode for longitudinal function
Afterload (pulmonary atrial pressure and pulmonary vascular resistance)	3DE for RV volumes
RV size and function	
Left-sided heart disease	2DE/3DE
Right heart remodelling and function	Ideally 3D modality for RV size and function CMR or 4D MSCT or 3DE > 2DE 3DE >> 2DE For preclinical studies and first-in-man studies or small efficacy studies, CMR and 4D CT may be appropriate. For Large studies and routine care, 3DE is good alternative

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CLINICAL REVIEW
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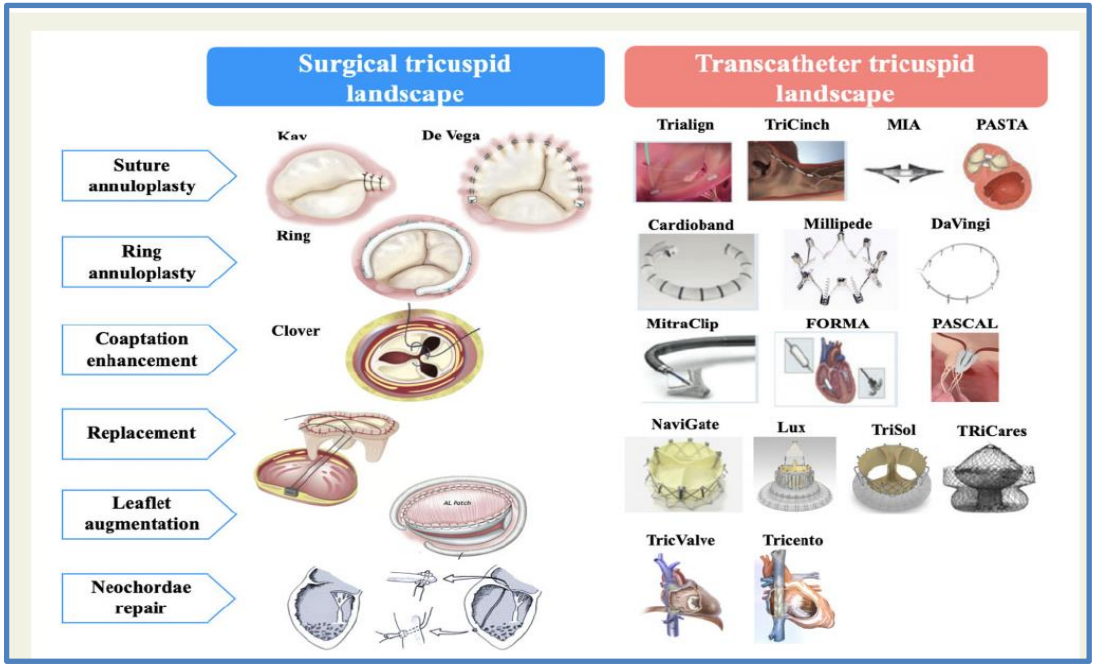
Uncertainties and challenges in surgical and transcatheter tricuspid valve therapy: a state-of-the-art expert review



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1. Demographic

e.g. age, Sex

2. Clinical symptoms

e.g. NYHA functional class

3. Comorbidities

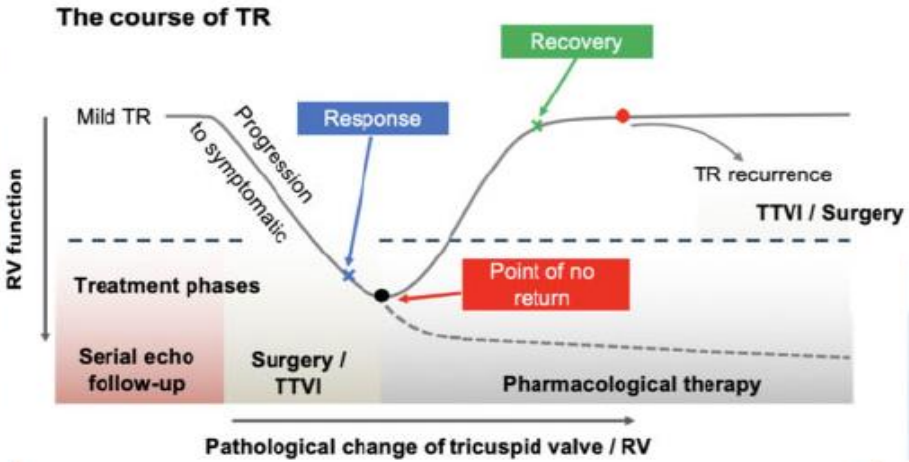
e.g. stroke, COPD, renal, liver failure

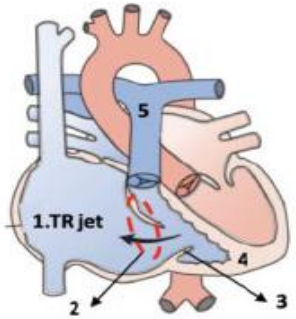
4. Cardiac disease

e.g. combined left-sided disease

5. Surgical characteristics

e.g. isolated, combined



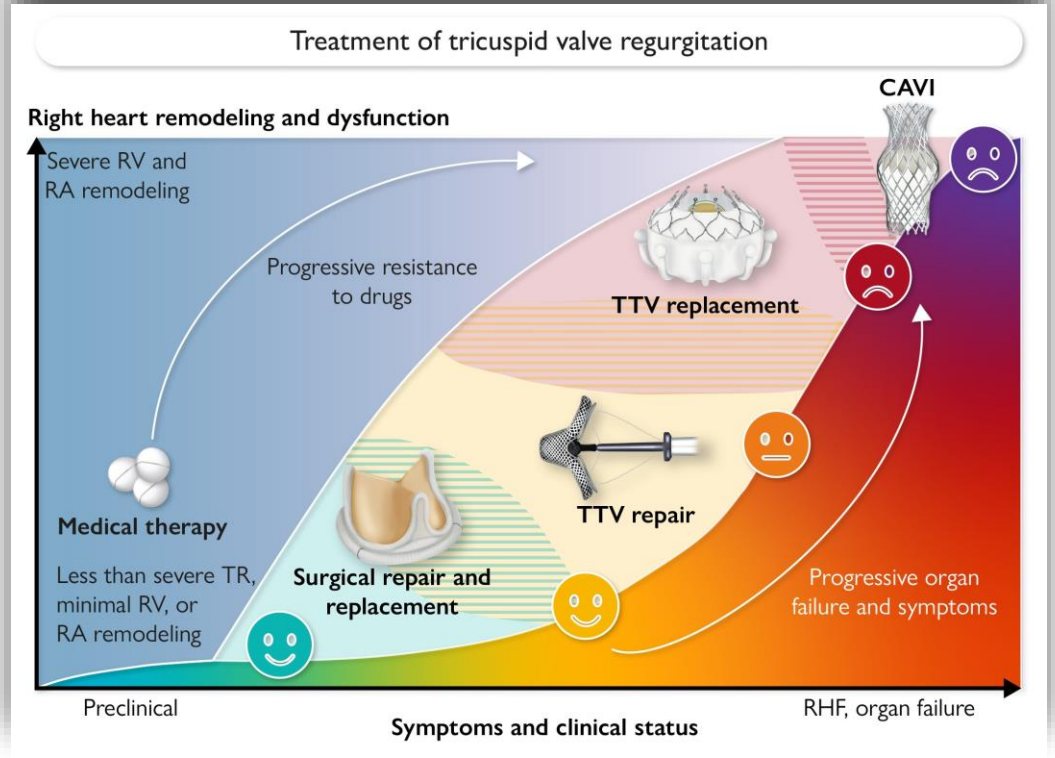


1. TR severity
2. Annulus size
3. Tricuspid valve morphology
4. RV remodelling
5. Pulmonary vascular resistance

Patient risk stratification

Heart team decision-making

Cardiac pathological remodelling



Eur Heart J, Volume 45, Issue 11, 14 March 2024, Pages 876–894, https://doi.org/10.1093/eurheartj/ehae082

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ESC European Society of Cardiology
European Heart Journal (2024) 45, 586–597
https://doi.org/10.1093/eurheartj/ehad585

FASTTRACK CLINICAL RESEARCH
Valvular heart disease

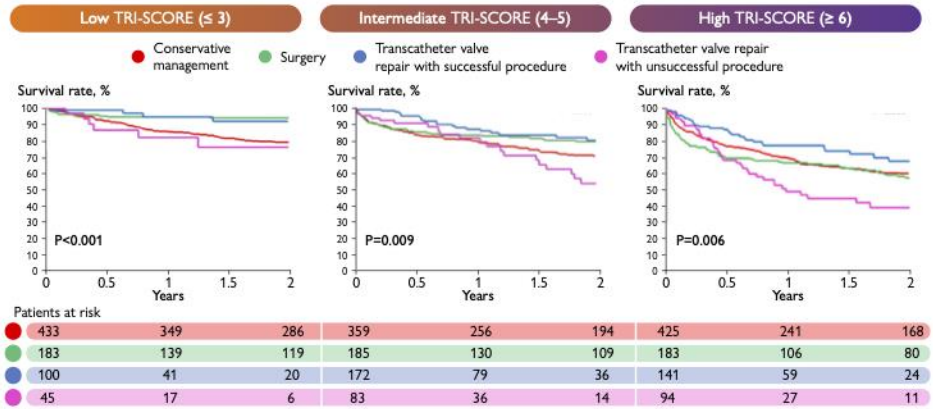
TRI-SCORE and benefit of intervention in patients with severe tricuspid regurgitation

TRIGISTRY: multicenter registry (33 centers, 10 countries)

2413 patients with severe isolated functional tricuspid regurgitation

Comparison of survival rates at 2 years between different treatment modalities according to TRI-SCORE categories (low, intermediate and high)

- 1217 patients conservatively managed
- 551 underwent isolated tricuspid valve surgery
- 645 underwent transcatheter valve repair



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FASTTRACK CLINICAL RESEARCH
Valvular heart disease

TRI-SCORE and benefit of intervention in patients with severe tricuspid regurgitation

Table 2 Distribution of TRI-SCORE parameters according to TRI-SCORE category

Characteristics	Low TRI-SCORE (*n* = 764)	Intermediate TRI-SCORE (*n* = 800)	High TRI-SCORE (*n* = 849)	*P*-value
Age ≥ 70years—no. (%)	441 (58)	549 (69)	628 (74)	<.001
New York Heart Association functional class III–IV—no. (%)	258 (34)	567 (71)	737 (87)	<.001
Right-sided heart failure signs—no. (%)	114 (15)	547 (68)	770 (91)	<.001
Daily dose of loop diuretics ≥ 125 mg—no. (%)	20 (3)	75 (9)	306 (36)	<.001
Glomerular filtration rate < 30 mL/min—no. (%)	10 (1)	54 (7)	202 (24)	<.001
Elevated total bilirubin—no. (%)	33 (4)	158 (20)	497 (59)	<.001
Left ventricle ejection fraction < 60%—no. (%)	407 (53)	526 (66)	672 (79)	<.001
Moderate/severe right ventricular dysfunction—no. (%)	195 (26)	300 (38)	506 (60)	<.001

Conclusion

TRIGISTRY confirmed and extended the predictive value of the TRI-SCORE and showed that a tricuspid valve intervention, irrespective of the modality as long as enabling a successful TR correction, was associated with significantly better survival rates than conservative management in the low and, to a lower extent, intermediate TRI-SCORE categories while survival was similar across groups in the high TRI-SCORE category. Our result better defines the optimal timing to treat patients with severe TR promoting a curative intervention at an earlier disease stage as assessed by the TRI-SCORE and will guide the design of future randomized controlled trials.

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Clinical Outcomes Following Isolated Transcatheter Tricuspid Valve Repair

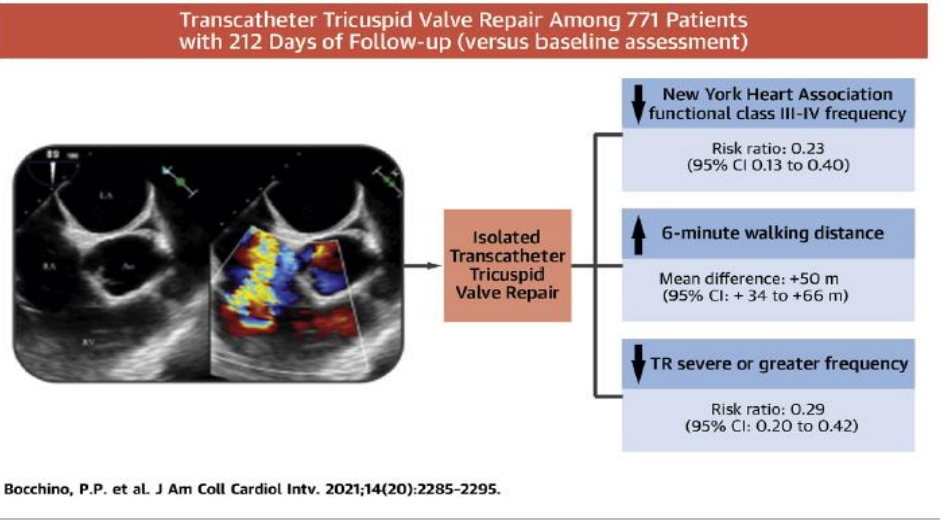
A Meta-Analysis and Meta-Regression Study

Pier Paolo Bocchino, MD,[a,*] Filippo Angelini, MD,[a,*] Alessandro Vairo, MD,[a] Alessandro Andreis, MD,[a] Federico Fortuni, MD,[a,b] Luca Franchin, MD,[a] Simone Frea, MD,[a] Claudia Raineri, MD,[a] Stefano Pidello, MD,[a] Federico Conrotto, MD,[a] Antonio Montefusco, MD,[a] Gianluca Alunni, MD,[a] Gaetano Maria De Ferrari, MD, PhD[a]

CONCLUSIONS

Patients undergoing ITTVR for at least moderate TR experienced significant improvements in NYHA functional status and 6MWD and a significant reduction in TR severity at mid-term follow-up. Prospective studies and randomized controlled trials addressing the impact of ITTVR on clinical outcomes at long-term follow-up are warranted.

CENTRAL ILLUSTRATION Outcomes Following Isolated Transcatheter Tricuspid Valve Repair



Bocchino, P.P. et al. J Am Coll Cardiol Intv. 2021;14(20):2285-2295.

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Outcomes After Current Transcatheter Tricuspid Valve Intervention

Mid-Term Results From the International TriValve Registry

FIGURE 1 Distribution of the Devices Used in the Registry

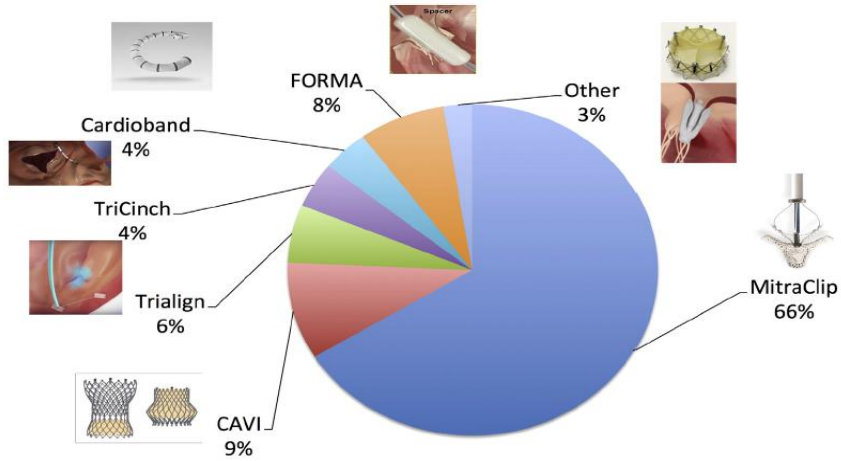
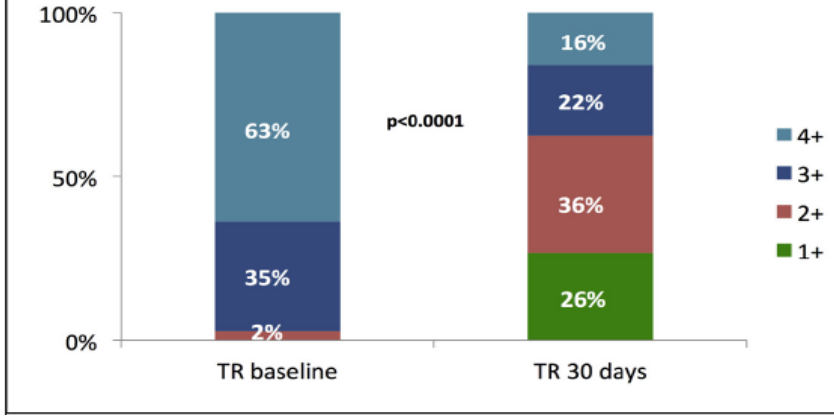


FIGURE 2 Comparison of TR Grade at Baseline and at 30 Days



(J Am Coll Cardiol Intv 2019;12:155–65)

Outcomes After Current Transcatheter Tricuspid Valve Intervention

Mid-Term Results From the International TriValve Registry

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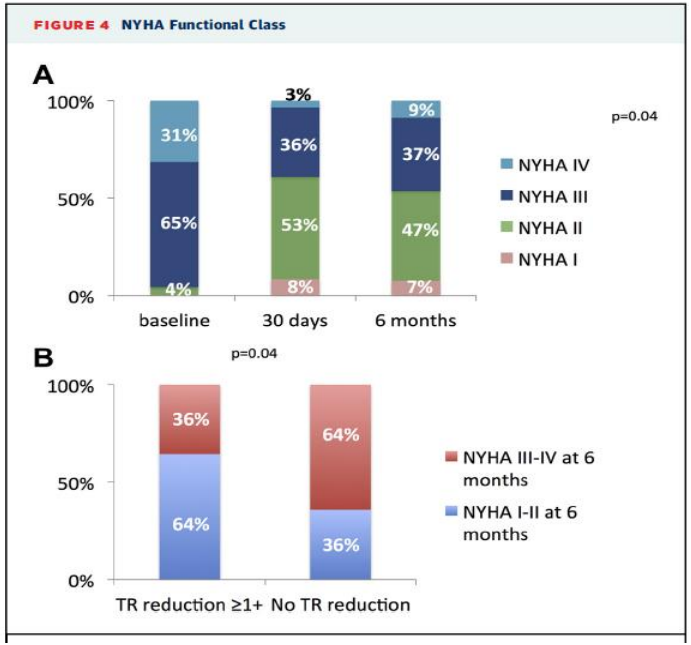

CONCLUSIONS

TTVI is feasible with different technologies. Overall procedural success rate is reasonable and it is improving with the increasing of the procedures, as a consequence of learning curve process and better patient selection. Currently, TTVI is associated with low mortality and significant clinical improvement. Mid-term survival was excellent in this high-risk population. Greater coaptation depth (>1 cm) is independently associated with reduced success rate, which is a strong predictor of mortality at follow-up even in isolated tricuspid procedures. This last observation suggests the importance of proper procedural timing, in order to treat the patients before advanced RV remodeling occurs.

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Transcatheter Repair for Patients with Tricuspid Regurgitation

Paul Sorajja, M.D., Brian Whisenant, M.D., Nadira Hamid, M.D., Hursh Naik, M.D., Raj Makkar, M.D., Peter Tadros, M.D., Matthew J. Price, M.D., Gagan Singh, M.D., Neil Fam, M.D., Saibal Kar, M.D., Jonathan G. Schwartz, M.D., Shamir Mehta, M.D., Richard Bae, M.D., Nishant Sekaran, M.D., Travis Warner, M.D., Moody Makar, M.D., George Zorn, M.D., Erin M. Spinner, Ph.D., Phillip M. Trusty, Ph.D., Raymond Benza, M.D., Ulrich Jorde, M.D., Patrick McCarthy, M.D., Vinod Thourani, M.D., Gilbert H.L. Tang, M.D., Rebecca T. Hahn, M.D., and David H. Adams, M.D., for the TRILUMINATE Pivotal Investigators*

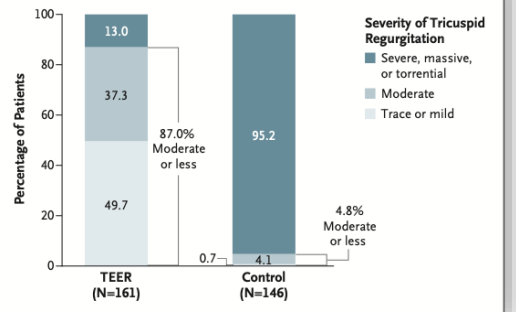

Figure 3. Severity of Tricuspid Regurgitation at 30 Days.

Table 2. Primary and Secondary End Points.*

End Point	TEER Group (N=175)	Control Group (N=175)	Difference (95% CI)	P Value
Primary				
Hierarchical composite of death from any cause or tricuspid-valve surgery; hospitalization for heart failure; and improvement of ≥15 points in KCCQ score at 1 yr — no. of wins†	11,348	7643	1.48 (1.06 to 2.13)	0.02
Secondary, listed in hierarchical order				
Kaplan–Meier estimate of percentage of patients with freedom from major adverse events through 30 days after the procedure (lower 95% confidence limit)‡	98.3 (96.3)	—	—	<0.001
Change in KCCQ score from baseline to 1 yr — points§	12.3±1.8	0.6±1.8	11.7 (6.8 to 16.6)	<0.001
Tricuspid regurgitation of no greater than moderate severity at 30-day follow-up — no. of patients/total no. (%)¶	140/161 (87.0)	7/146 (4.8)	—	<0.001
Change in 6-min walk distance from baseline to 1 yr — m‖	−8.1±10.5	−25.2±10.3	17.1 (−12.0 to 46.1)	0.25

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ORIGINAL RESEARCH: STRUCTURAL

Percutaneous Edge-to-Edge Repair for Tricuspid Regurgitation

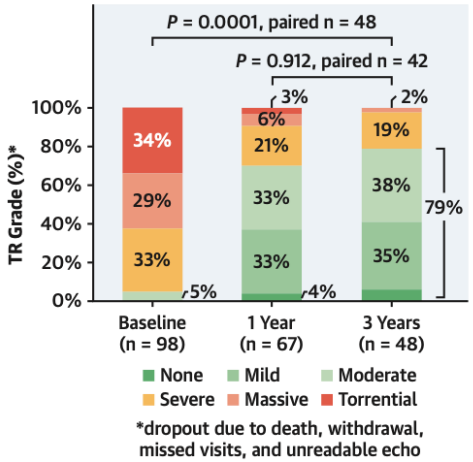
3-Year Outcomes From the TRILUMINATE Study

Georg Nickenig, MD,[a] Philipp Lurz, MD, PhD,[b] Paul Sorajja, MD,[c] Ralph Stephan von Bardeleben, MD,[b] Marta Sitges, MD,[d] Gilbert H.L. Tang, MD, MSc, MBA,[e] Jörg Hausleiter, MD,[f,g] Jean-Noel Trochu, MD,[h] Michael Näbauer, MD,[f] Megan Heitkemper, PhD,[i] Shih-Wa Ying, MSc,[i] Marcel Weber, MD,[a] Rebecca T. Hahn, MD,[j] the TRILUMINATE Investigators

CENTRAL ILLUSTRATION Tricuspid Regurgitation Repair Through 3 Years

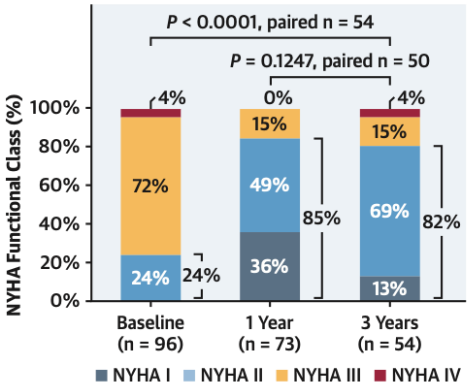
TriClip™ Transcatheter Tricuspid Valve Repair: TRILUMINATE Trial 3-Year Outcomes

A Long-Term TR Assessment



*dropout due to death, withdrawal, missed visits, and unreadable echo

B Functional Class Over Time



*dropout due to death, withdrawal, missed visits

- At 3-year follow-up, there was a substantial and durable reduction in TR following TEER
- NYHA functional class improved following TEER, and this benefit remained over time

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TriClip
Transcatheter Tricuspid Valve Repair

SAX TRANSGASTRIC VIEW 20°-50°

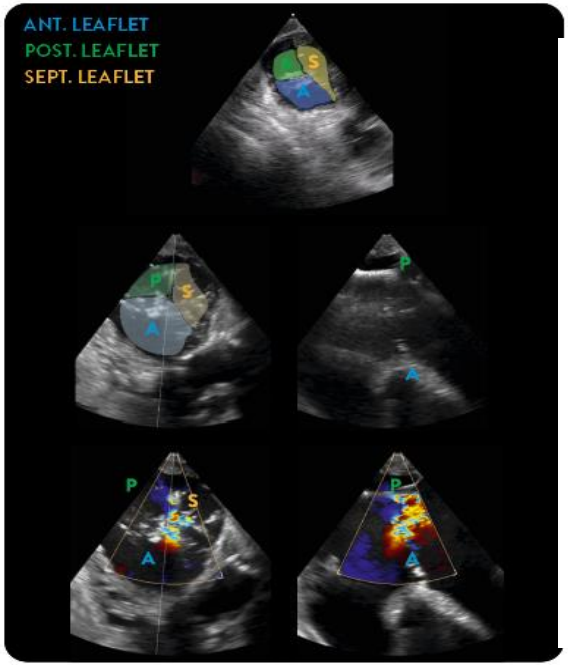
Represents the most important view to analyze the distribution of the tricuspid valve regurgitation and to plan for TriClip™ treatment strategy.

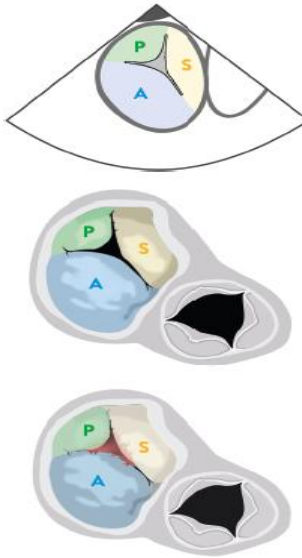
Optimal view settings

- Identify all tricuspid leaflets and commissures
- Visualize zones of coaptation and all coaptation gaps
- Align the view parallel to the annulus of the tricuspid valve and focus on the leaflets tips at closure
  - Utilize the biplane modality. In the resulting biplane generated 90° image the annulus and leaflet tips should be in a vertical position

Focus on

- Distribution of the tricuspid regurgitation origin and size of the coaptation gap(s)





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DEEP (MID) ESOPHAGEAL RV INFLOW/OUTFLOW (MULTIPLANE) 60°-100°

Represents AP view parallel to the septal leaflet of the tricuspid valve (analog to the intercommisural view of the mitral valve)

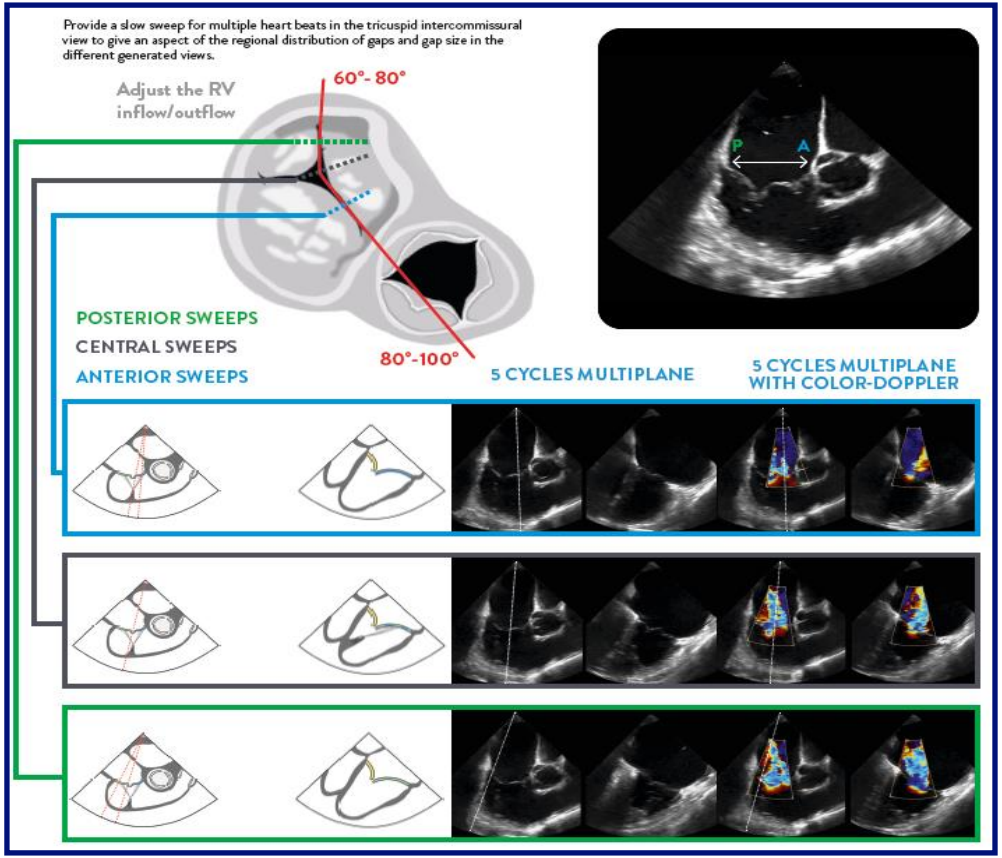
Advance probe preferred to DE and pull up to ME if image quality is insufficent

Optimal view settings

- Try to align the tricuspid annulus to a horizontal plane
- Anterior papillary muscle may help you to differentiate the anterior and posterior leaflets

Focus on

- Coaptation, coaptation gaps and leaflet length in the biplane generated 4 Chamber view



Grazie per l'attenzione!

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