ABORDAGEM HETEROTÓPICA TRICÚSPIDE

- DR MÁRCIO MONTENEGRO
- COORDENADOR DO CENTRO DE
- TRATAMENTO DE VALVA
- INSTITUTO ESTADUAL DE CARDIOLOGIA ALOYSIO DE CASTRO

XLIX Jornadas SOLAC

17° Región Centroamérica y el Caribe

7 y 8 de noviembre 2024

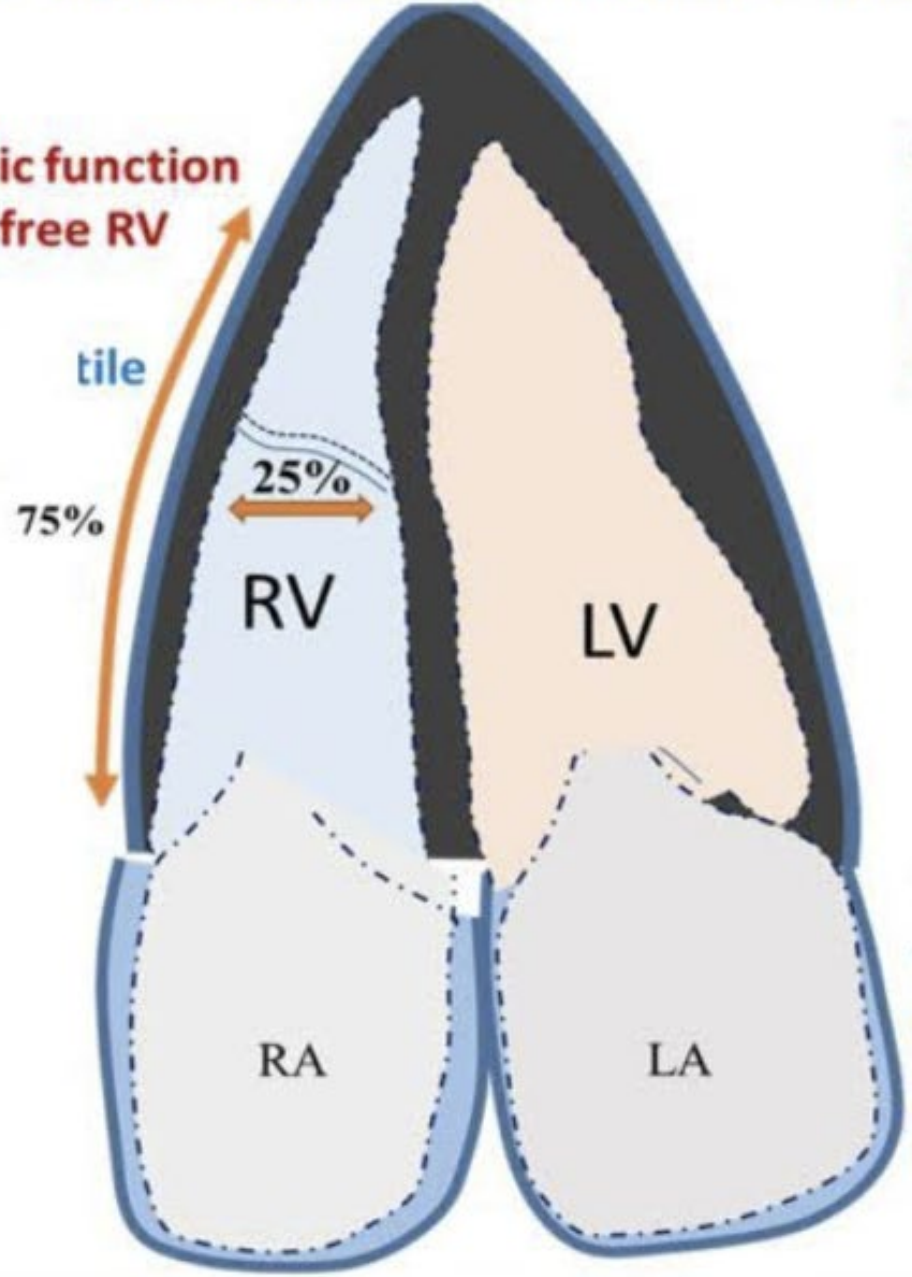
EL SALVADOR

CONFLITO DE INTERESSE

- PROCTOR P&F

Right Ventricular Structure and Function

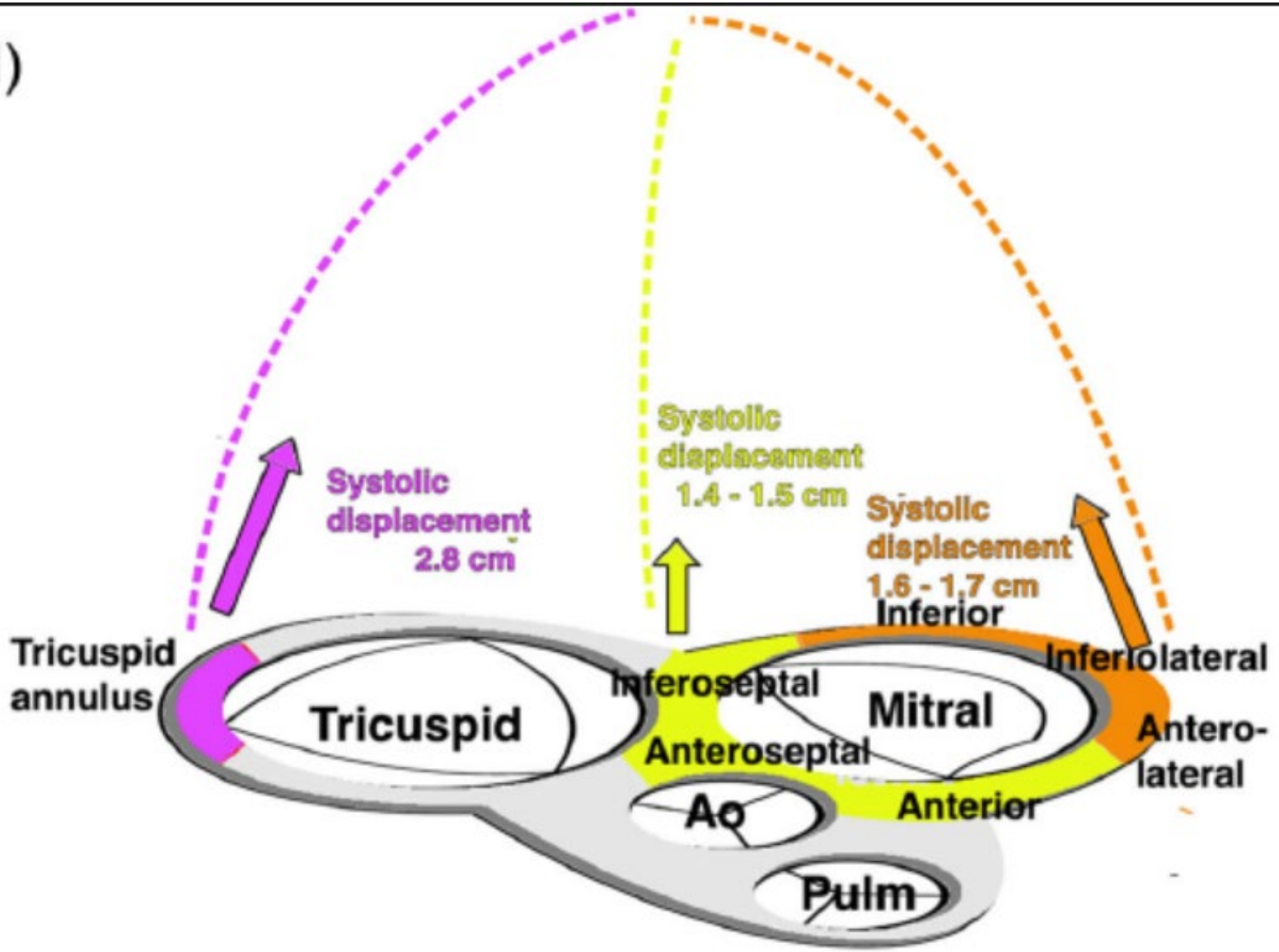
Almost 75 % of the RV systolic function is dependent in longitudinal free RV wall motion.



The RV contraction is sequential and peristaltic: Inlet toward the trabecular RV free wall and end up with RV infundibulum.

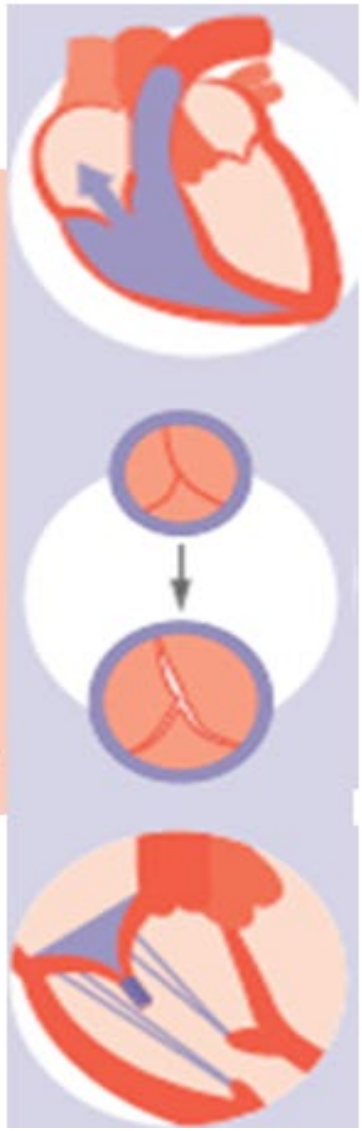
The epicardial layer is mainly made by circumferential muscle and the endocardial is mainly longitudinal muscle

(d)


Systolic displacement 2.8 cm
Systolic displacement 1.4 - 1.5 cm
Systolic displacement 1.6 - 1.7 cm
Tricuspid annulus
Tricuspid
Inferoseptal
Anteroseptal
Mitral
Inferior
Inferiolateral
Antero-lateral
Anterior
Ao
Pulm

Anatomical stages in FTR

Stage 1	Stage 2	Stage 3
TR severity: None or mild	TR severity: Mild or moderate	TR severity: Severe
Annular diameter: <40 mm	Annular diameter: >40 mm	Annular diameter: >40 mm
Coaptation mode: Normal (body-to-body), with no leaflet tethering	Coaptation mode: Abnormal (edge-to-edge), with or without tethering of <8 mm below the annular plane	Coaptation mode: No coaptation, with or without tethering of >8 mm below the annular plane



ANNULAR DILATION

↓

ABNORMAL COAPTATION (edge to edge → loss of coaptation)

↓

Progessive RV REMODELING and dysfunction

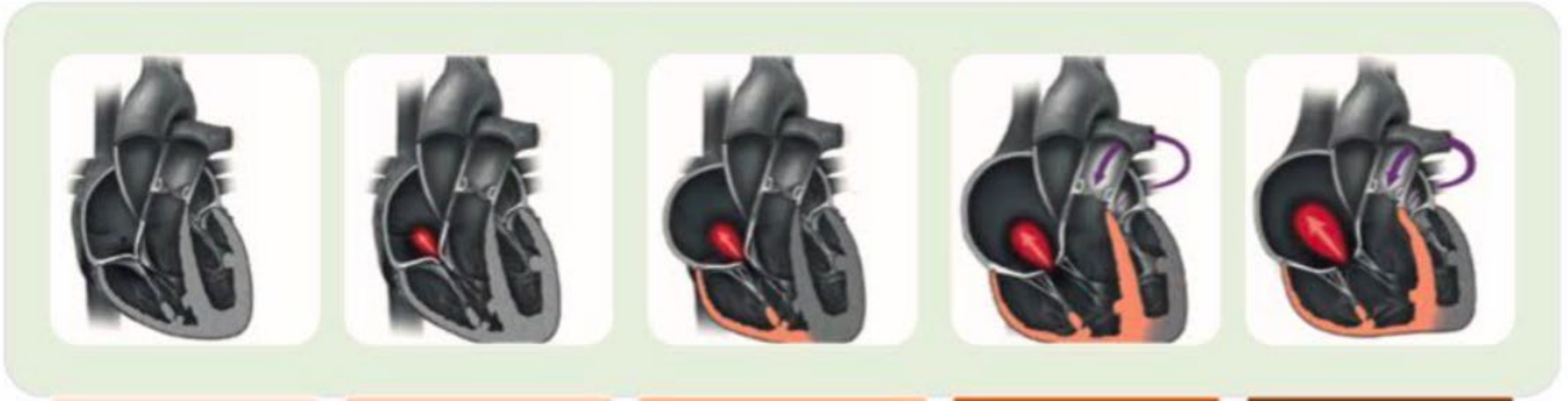
↓

+++++

Vicious TR/RV circle

Taramasso et al. EHJ 2015

Dreyfus, G.D. et al. J Am Coll Cardiol. 2015



Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
- No symptoms - TR < 2+ - Normal RV function, no remodelling - No treatment	- No symptoms - TR ≥ 3+ - Normal RV function, mild remodelling - None/low-dose diuretics	- Vague symptoms - Severe TR - Mild RV dysfunction/remodelling - Diuretics	- Previous RHF episodes - Severe TR - > moderate RV dysfunction/remodelling - moderate-high dose diuretics	- Overt RHF and/or organ damage - Torrential TR - Severe RV dysfunction - high-dose diuretics/IV diuretics

Fig. 1. 5 Stages classification and determinants/characteristics for distribution of patients [Reproduced with permission from Sala et al. [35]].

Parameter	Atrial FTR	Ventricular FTR	CIED-Related	Primary TR	
				Prolapse (I)	RHD (IIIA)
Leaflet Tethering	-	+++	++	-	-
Leaflet Restriction	-	Systole	Systole/Diastole	-	Diastole
RA/TA Dilatation	+++	++	+/-	++	++
RV Dilatation	+/-	+++	+/-	+/-	+/-
RV Dysfunction	+/-	+++	+/-	+/-	+/-

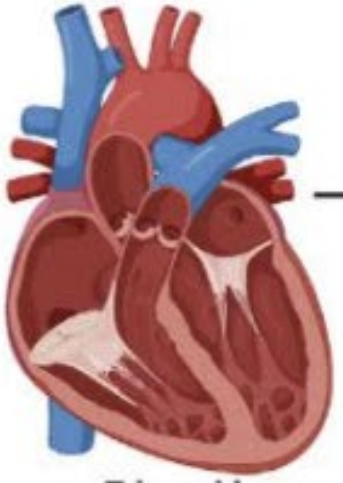
Figure 3 Classification of tricuspid regurgitation.

European Heart Journal - Cardiovascular Imaging (2022) **00**, 1–17
https://doi.org/10.1093/ehjci/jeac009

TR Patient's Journey

Appearance of symptoms

- Volume overload
- Shortness of breath
- Fatigue



Tricuspid Regurgitation

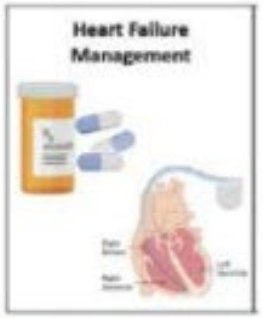
Diagnosis

- TTE
- TEE
- Cardiac MRI
- CT

Heart Team Evaluation

- Heart Failure specialist
- Electrophysiologist
- Interventional Cardiologist
- Imaging specialist
- CT surgeon

Treatment choice



Medical Management

- Medical therapy
- Surgery
- Transcatheter therapy

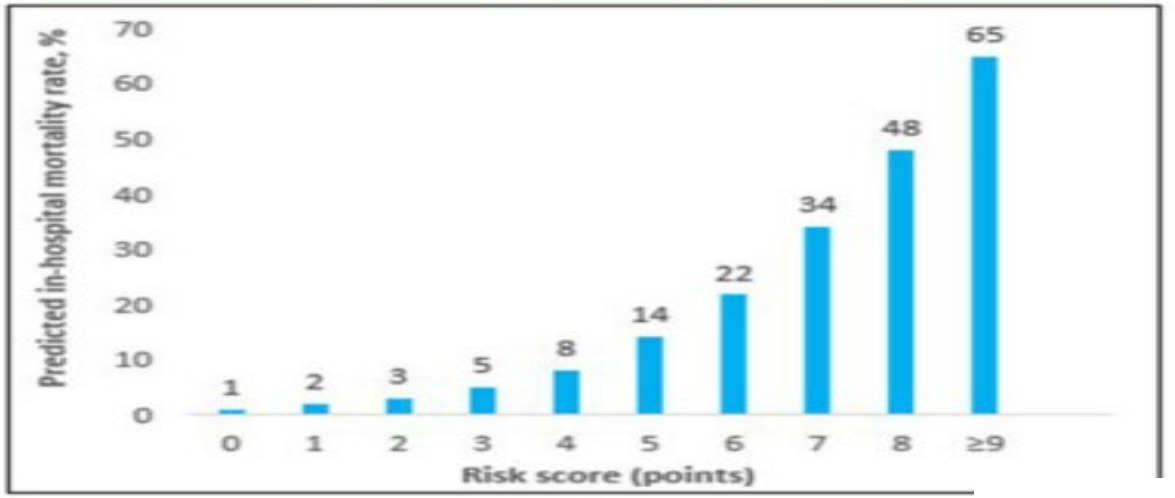
Tricuspid Valve Surgery

Transcatheter Tricuspid Valve Intervention

Risk factors and scoring system for in-hospital mortality after isolated tricuspid valve surgery

Risk factors (final model from multivariate analysis)	Scoring
Age ≥ 70 years	1
NYHA functional class III-IV	1
Right-sided heart failure signs	2
Daily dose of furosemide ≥ 125mg	2
Glomerular filtration rate < 30 ml/min	2
Elevated total bilirubin	2
Left ventricular ejection fraction < 60%	1
Moderate/severe right ventricular dysfunction	1
Total	12

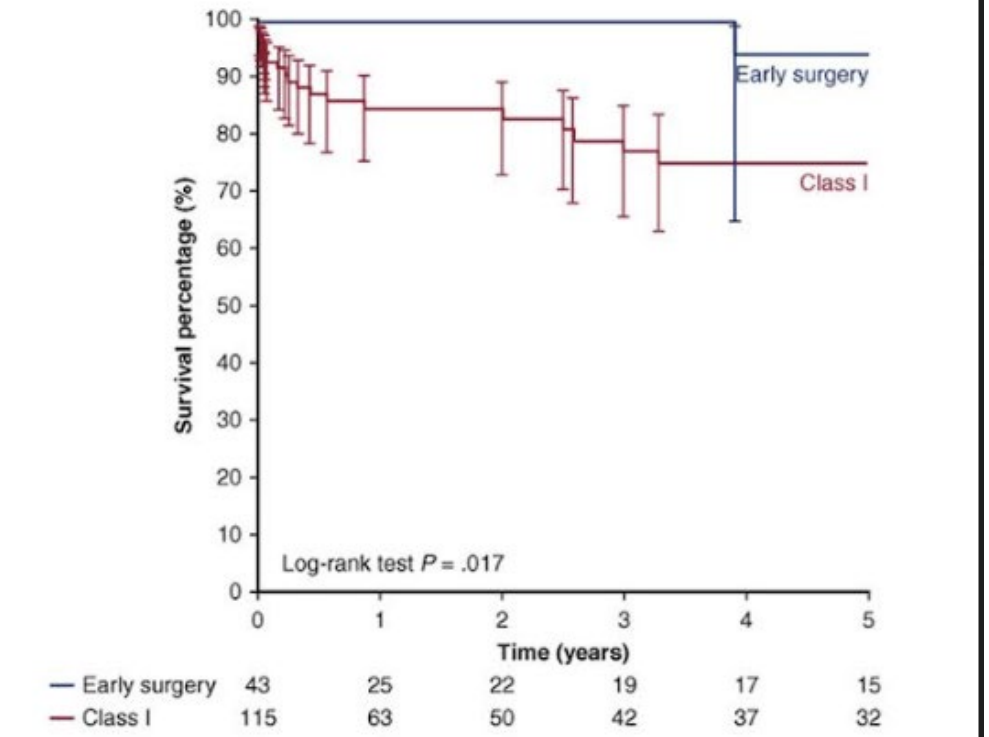
Predicted in-hospital mortality rate according to the final risk score model



European Heart Journal (2022) 43, 624–632
https://doi.org/10.1093/eurheartj/ehab816

Early surgery is associated with improved survival in isolated severe tricuspid regurgitation

Outcome	Class I (n = 115)	Early surgery (n = 44)
Operative mortality	8 (7.0%)	0 (0.0%)
Composite morbidity	41 (35.7%)	8 (18.2%)



Summary: This cohort study compared early surgery versus the presence of class I indications in 159 patients undergoing surgery for isolated severe tricuspid regurgitation during 2004-2018. The primary outcome is all-cause mortality during follow-up, and the main results are presented above.

Key message: This study supports early surgery in isolated severe tricuspid regurgitation give its association with reduced mortality during follow-up.

Heterotopic devices

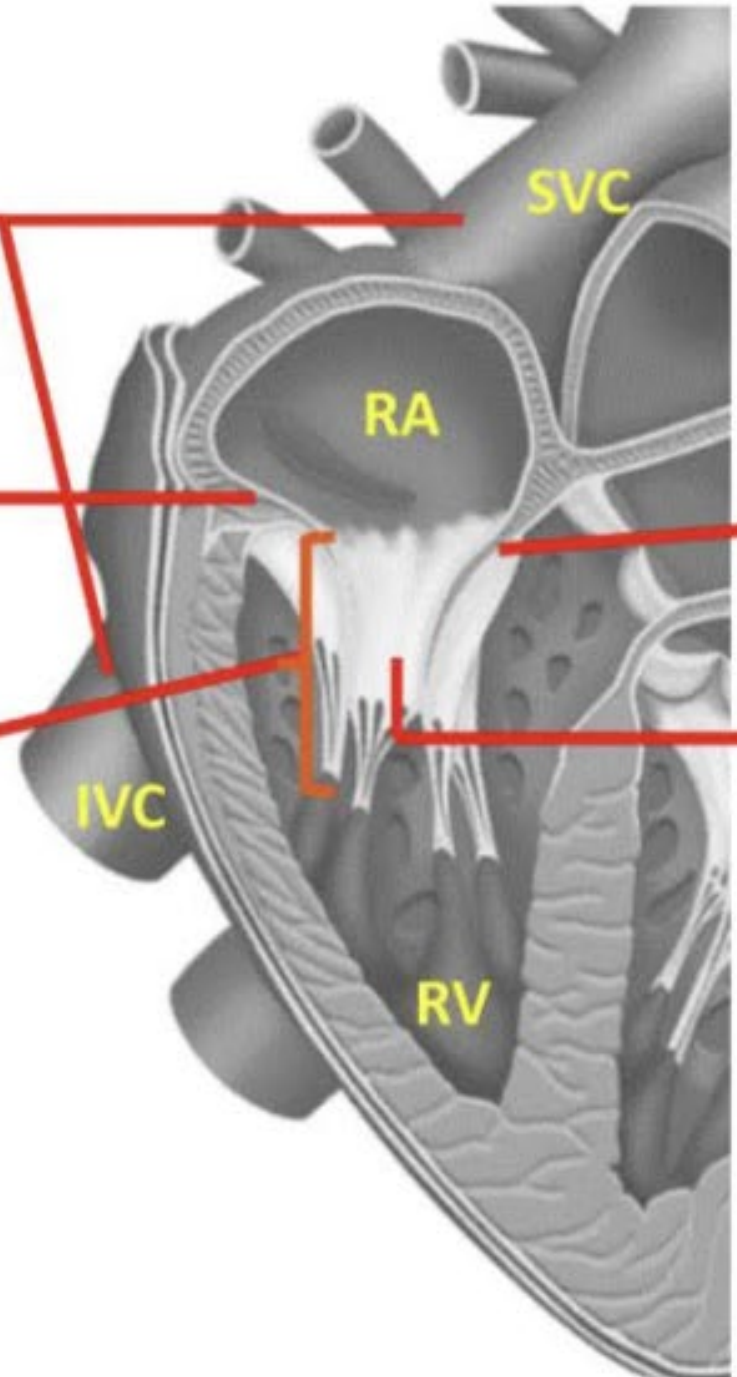
Goal: to reduce the venous congestion and backflow associated with TR for symptomatic improvement

Annulus

Goal: reducing the annular dilation
- Restrictive Annuloplasty
- Direct Annuloplasty

Tricuspid valve replacement

Goal: implantation of bioprosthetic valve within the tricuspid annulus

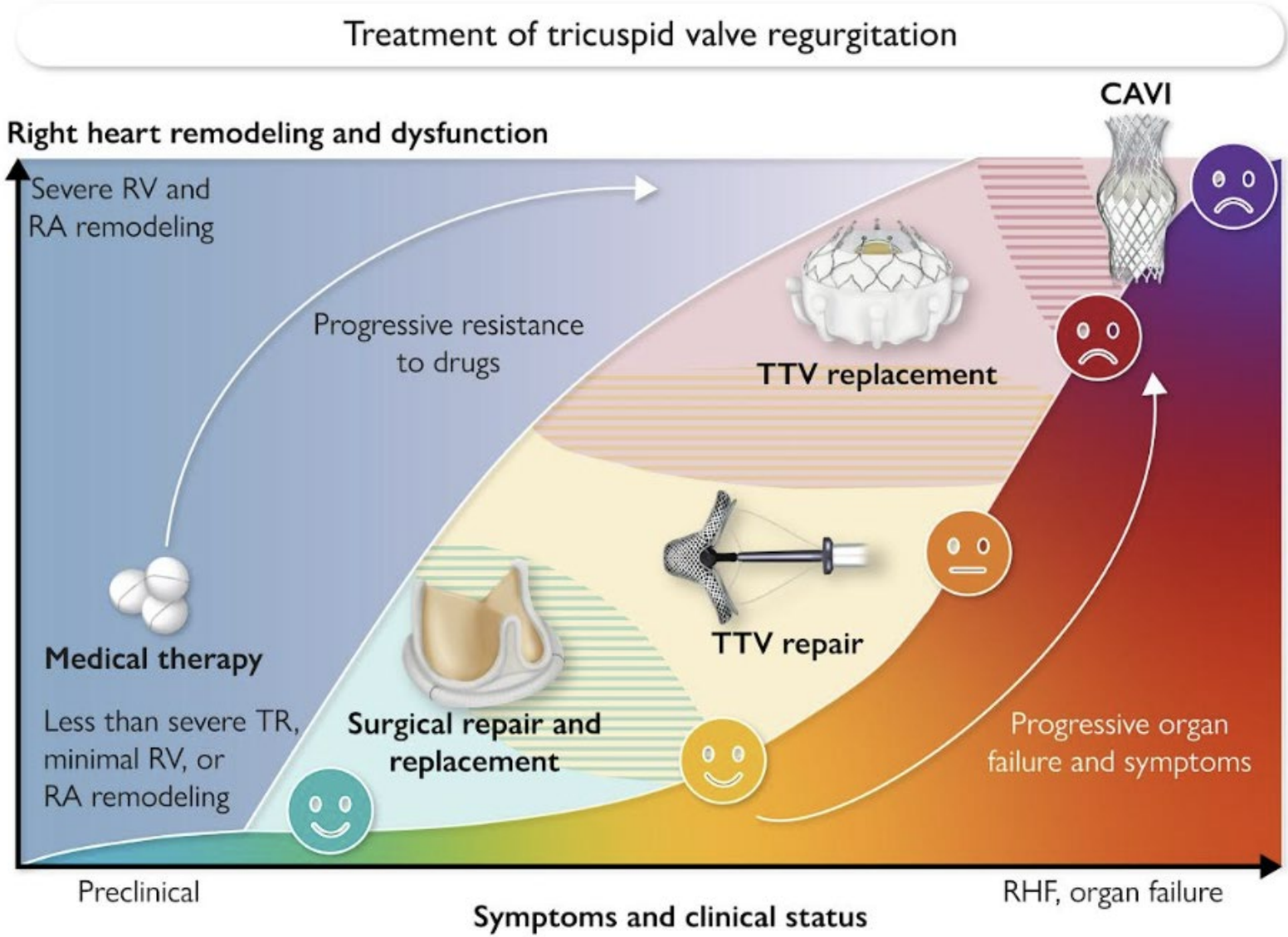


Leaflet

Goal: restoration of coaptation and reduction of regurgitant orifice area.

Coaptation enhancement

Goal: to fill or eliminate the coaptation defect

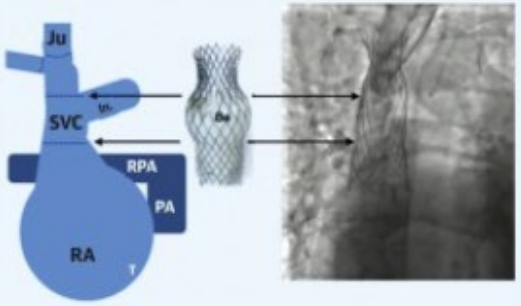


European Heart Journal (2024) **00**, 1–19
https://doi.org/10.1093/eurheartj/ehae082

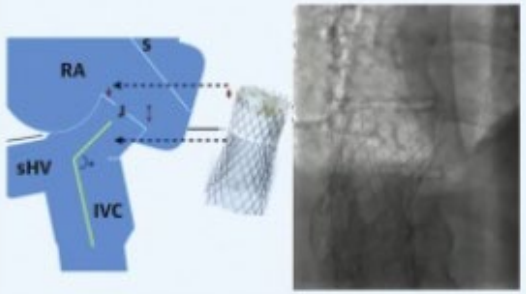
CENTRAL ILLUSTRATION: 6-Month Outcomes of the TricValve System for Severe TR: TRICUS EURO Study (N = 35)

Device & Procedure

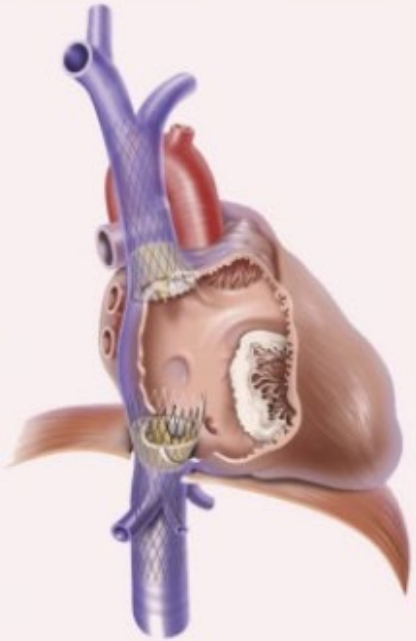
SVC



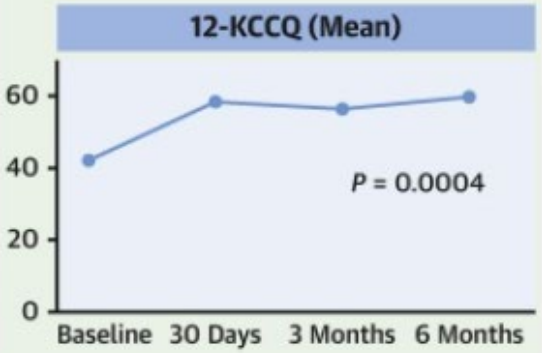
IVC



- 97% Technical success
- 0% 6-month cardiac death
- Persistent functional improvement



Functional



Estévez-Loureiro R, et al. J Am Coll Cardiol Intv. 2022;15(13):1366-1377.

TRICVALVE BICAVAL SYSTEM MULTICENTER REGISTRY (TRIC-BICAVAL)

Multicenter registry initiated by investigators and not supported by any external funding

27 hospitals
204 patients

RHF due to severe TR

Inoperable and unsuitable for transcatheter orthotopic repair/replacement

Rejected for CAVI:
TAPSE < 13
LVEF < 40%
PSP > 65 mmHg
V-wave < 15 mmHg

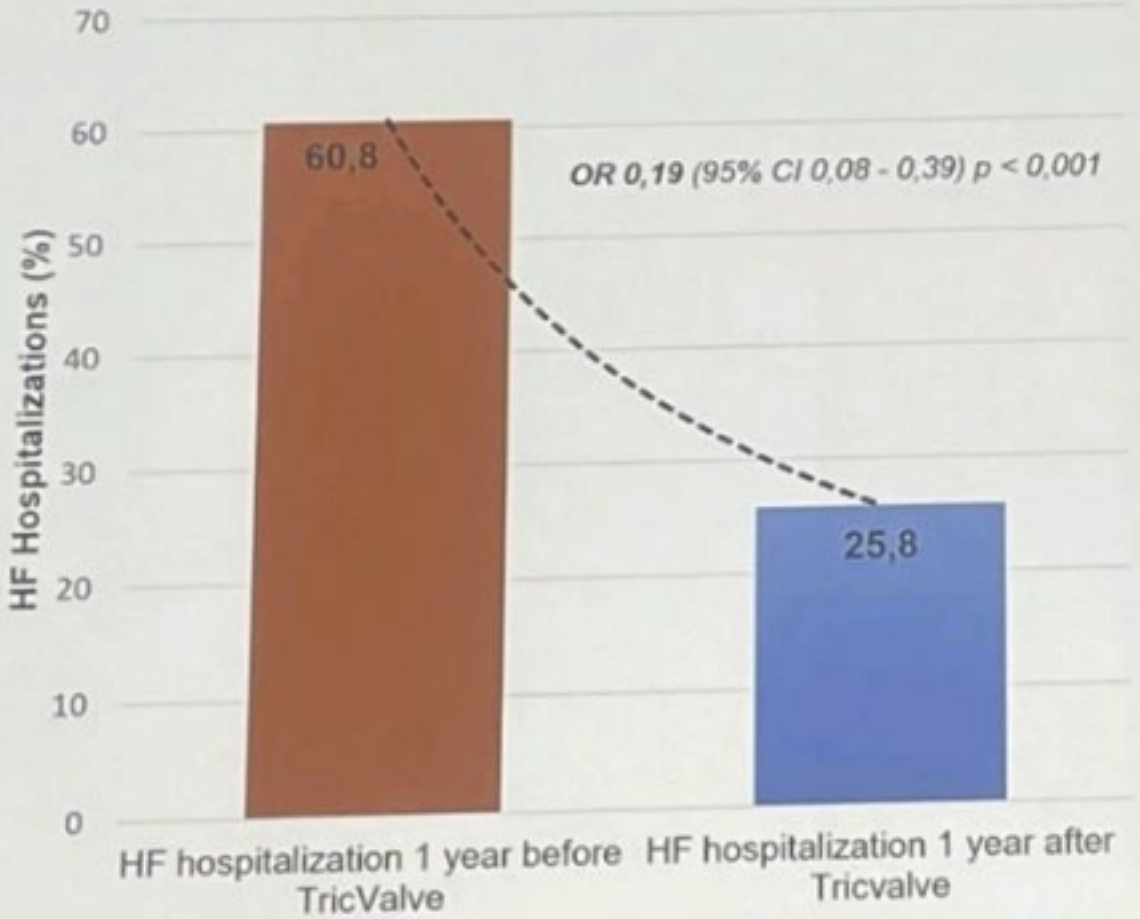
Bicaval suitable Anatomy (CT-scan)

Participating Centers

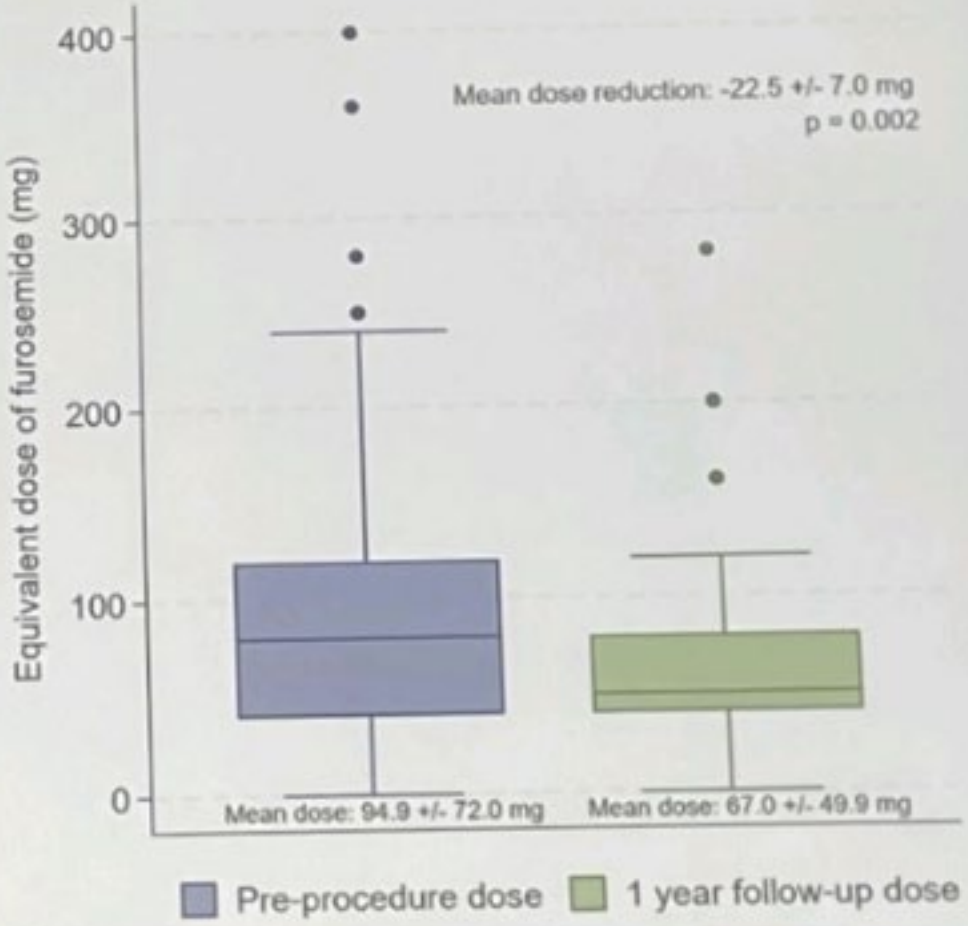
SPAIN	University Hospital Ramon y Cajal
	University Hospital Clinico San Carlos
	University Hospital Valladolid
	University Hospital Salamanca
	University Hospital Doce Octubre
	University Hospital Clinic Barcelona
	University Hospital Badajoz
	University Hospital Reina Sofia Cordoba
	University Hospital La Paz
	University Hospital Alvaro Cunqueiro. Vigo
	University Hospital Puerta de Hierro
	University Hospital Valdecilla Santander
	University Hospital Toledo
	University Hospital Navarra
	University Hospital Germans Trias i Pujol
	University Hospital La Coruña
PORTUGAL	University Hospital Santa Marta. Lisboa
GERMANY	University Hospital Immanuel Heart Center Brandenburg
	University Hospital Asklepios Klnik Nord Heidberg
	University Hospital Heart Center Cologne
	University Hospital Heart Center Munster
ITALY	University Hospital Pierangeli Pescara
BELGIUM	University Hospital ASZ Aalts
	University Heart Center St. Antonius
	University Hospital Maria Middelares
IRELAND	University Hospital Galway
BRASIL	Valve Center IECAC. Rio de Janeiro. Brasil.

TRIC-BICAVAL REGISTRY: Re-hospitalizations & diuretic dose

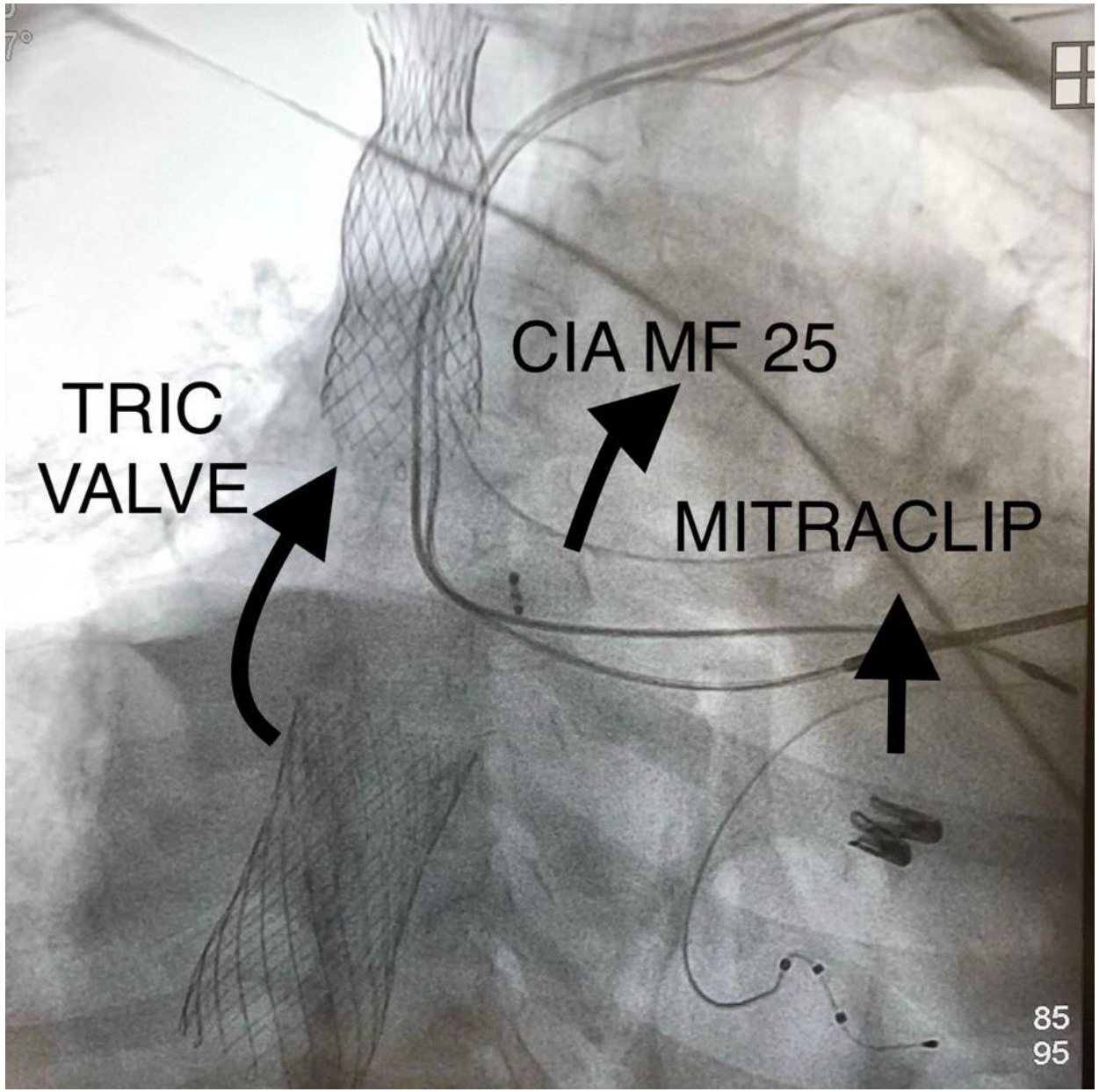
Reduction in Heart Failure Hospitalizations

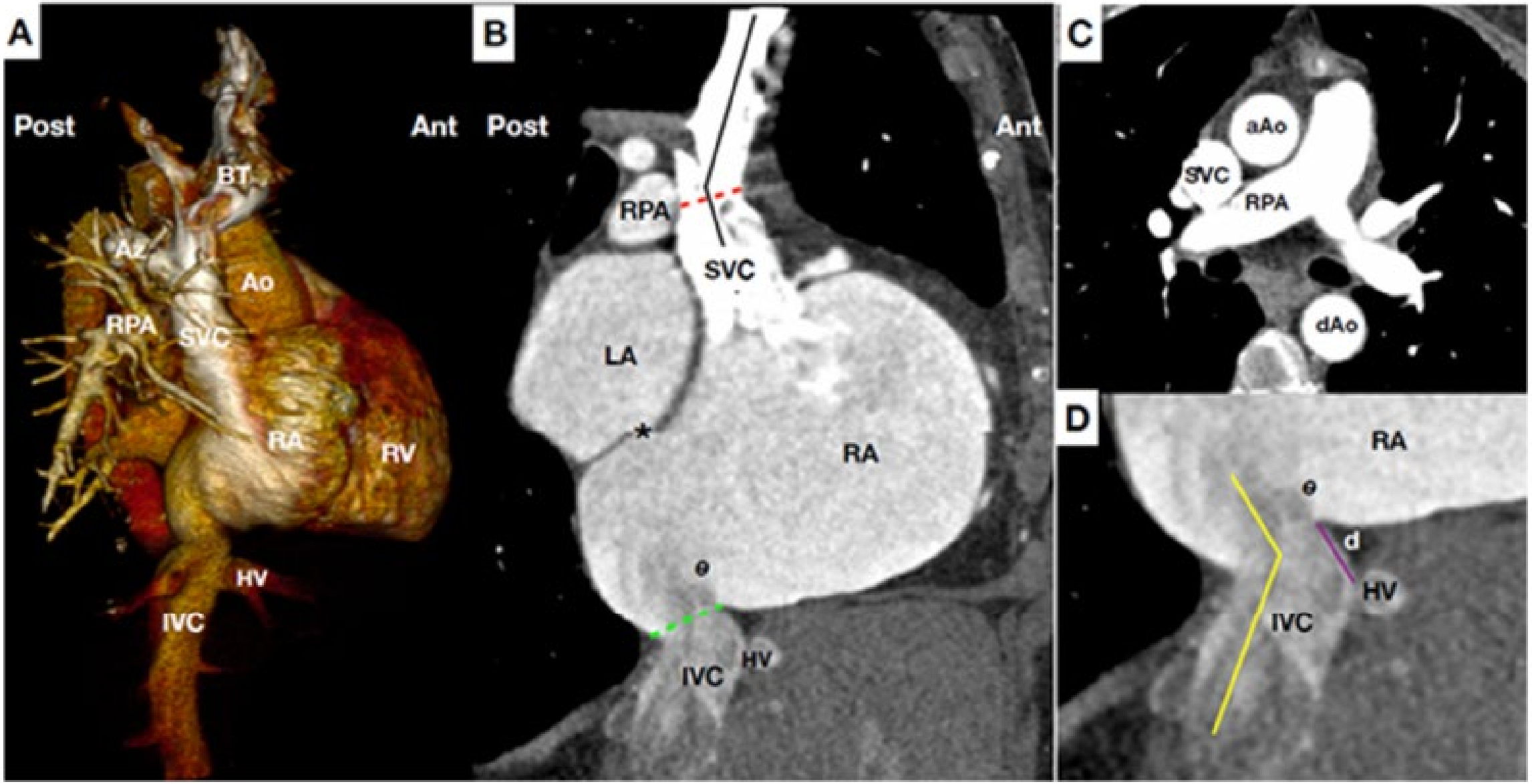


Change in diuretic dose at 1 year follow-up



PRIMEIRA TRICVALVE NO BRASIL




A
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SVC
RPA
dAo
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RA
d
HV
IVC

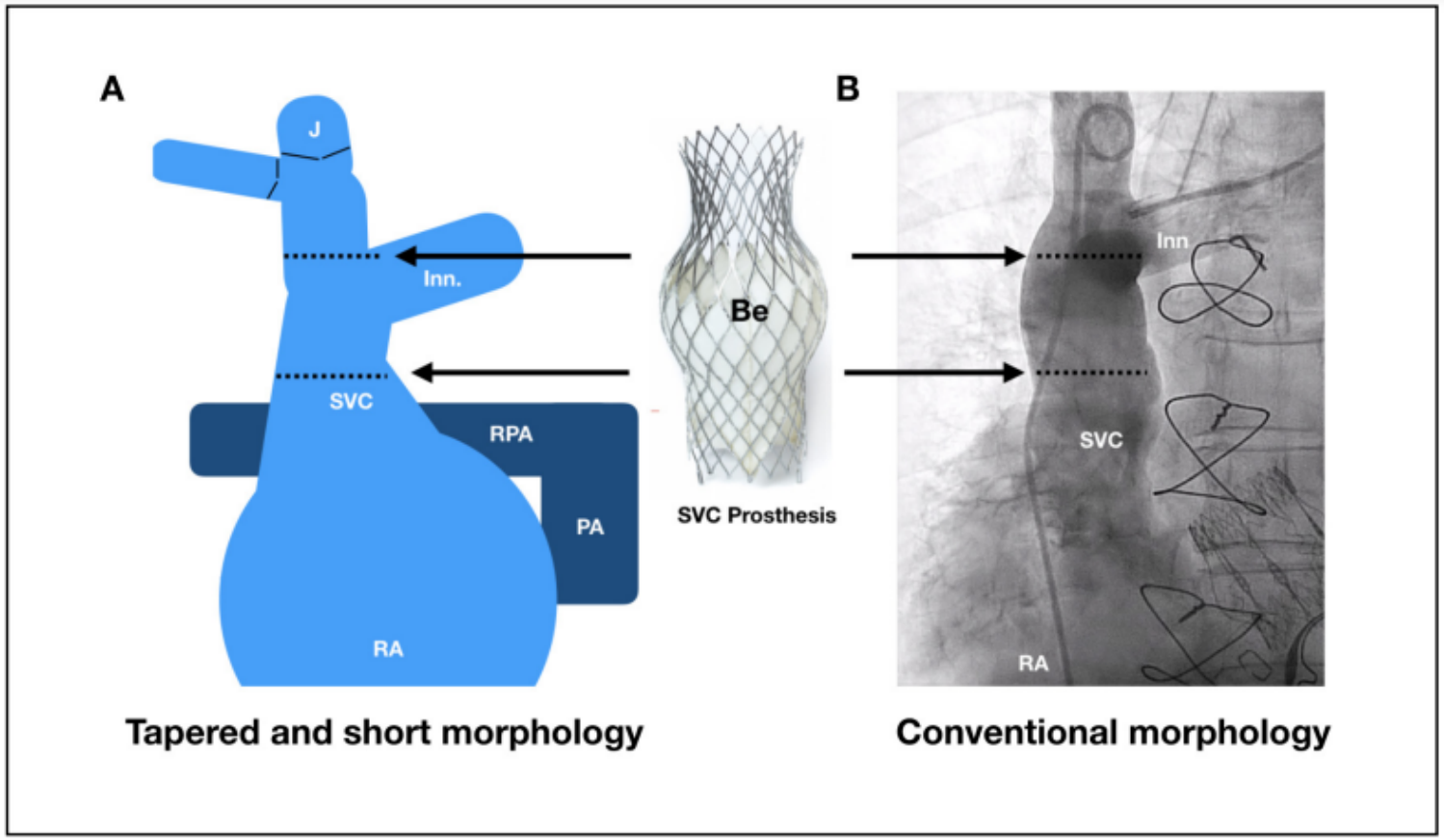


Figure 2. Anatomical diagram and angiographic view of superior vena cava. (**A**) Anatomical diagram of a tapered and short superior vena cava (SVC). The morphology of the superior vena cava showed in the diagram increases the risk of prosthesis migration/embolization into the right atrium (RA). A high implantation is thus recommended to prevent it (target position is to implant the belly part of the SVC prosthesis at the level of the innominate plane without obstructing the ostium). (**B**) Angiographic view at posterior-anterior plane showing a SVC with conventional morphology. In these cases target position is to place the belly part of the SVC prosthesis at the level where the right pulmonary artery crosses the SVC. Be: Belly part of the superior prosthesis. J: common Jugular vein. Inn: Innominate vein. PA: Pulmonary Artery. RA: Right Atrium. RPA: Right Pulmonary Artery. SVC: Superior Vena Cava. T: Tricuspid Valve.

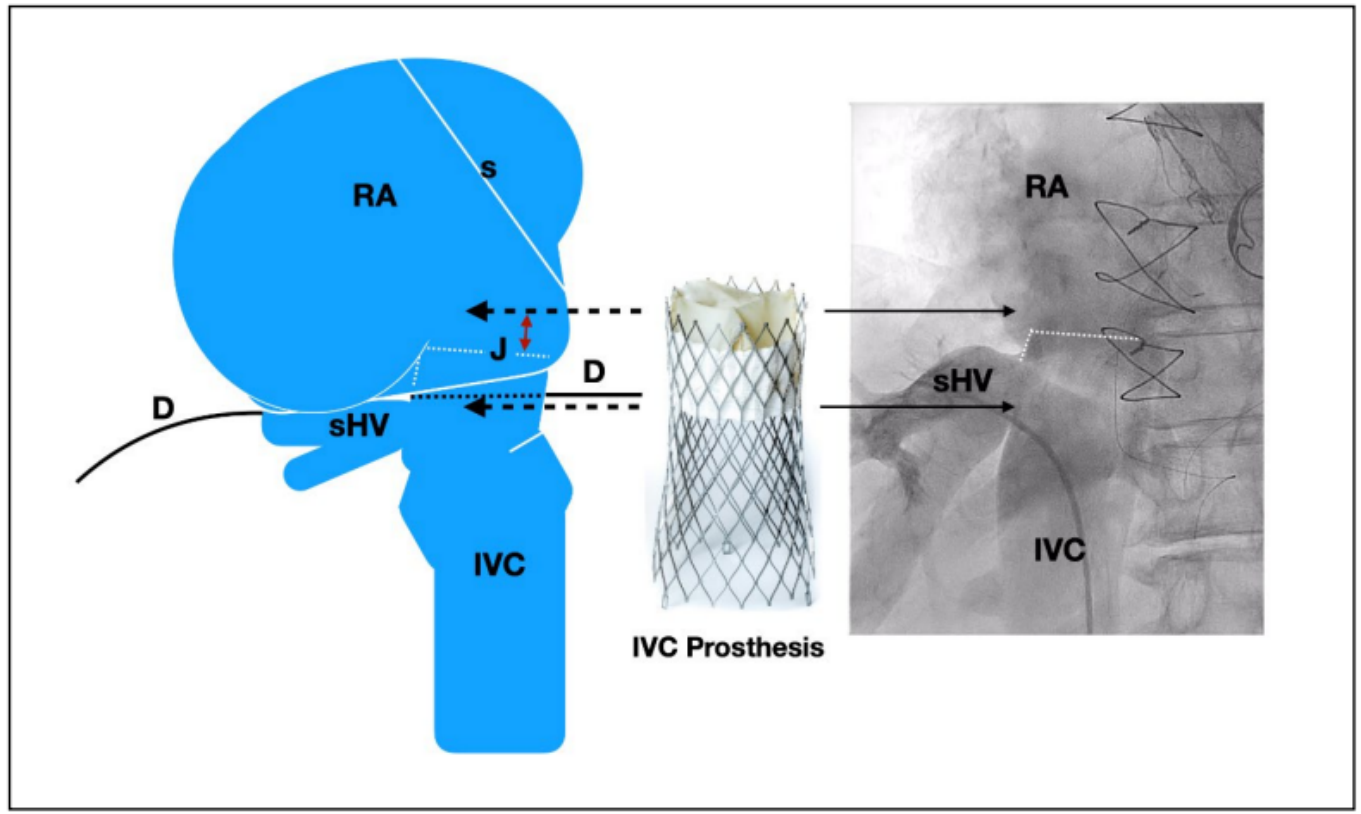
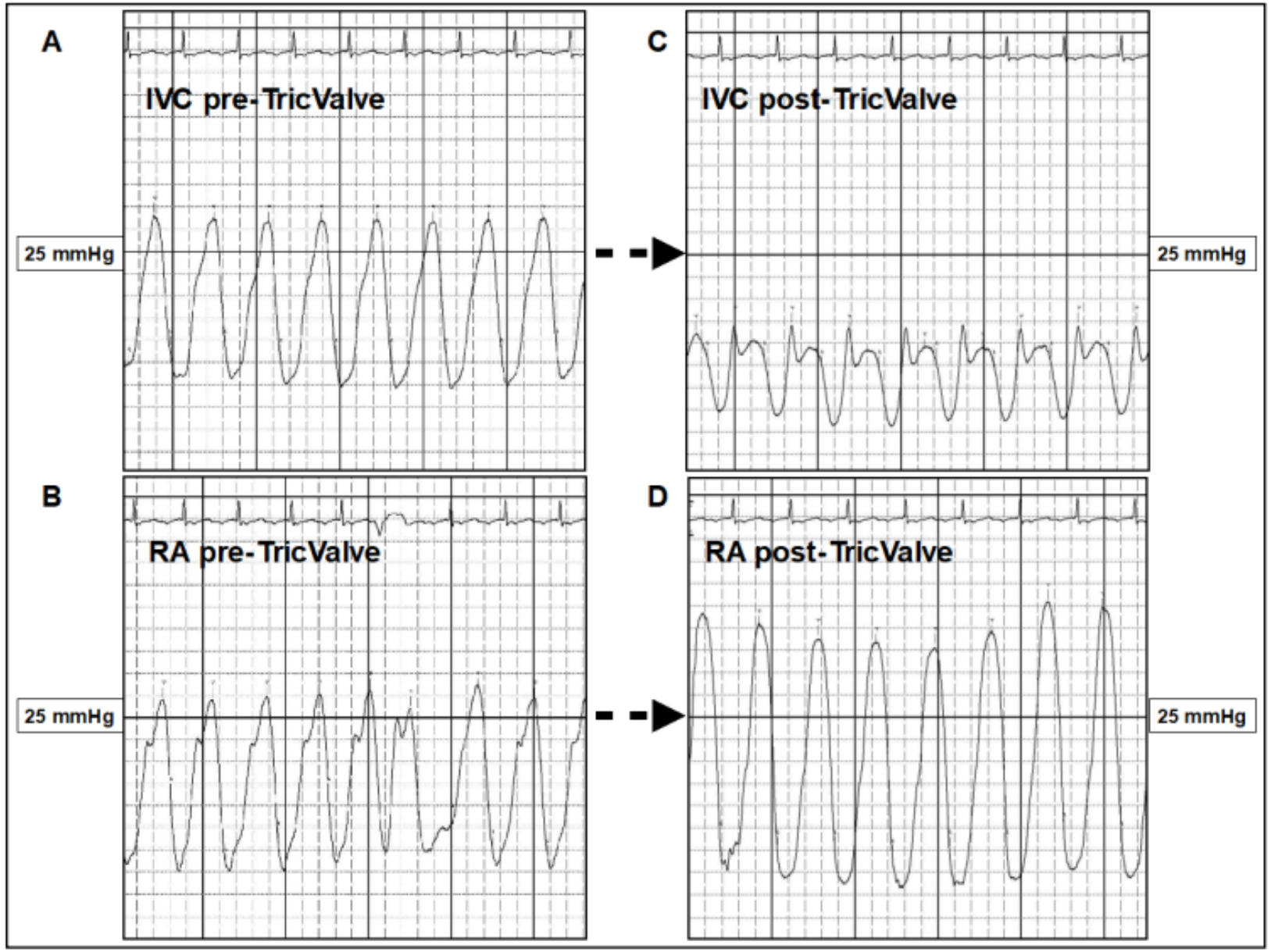
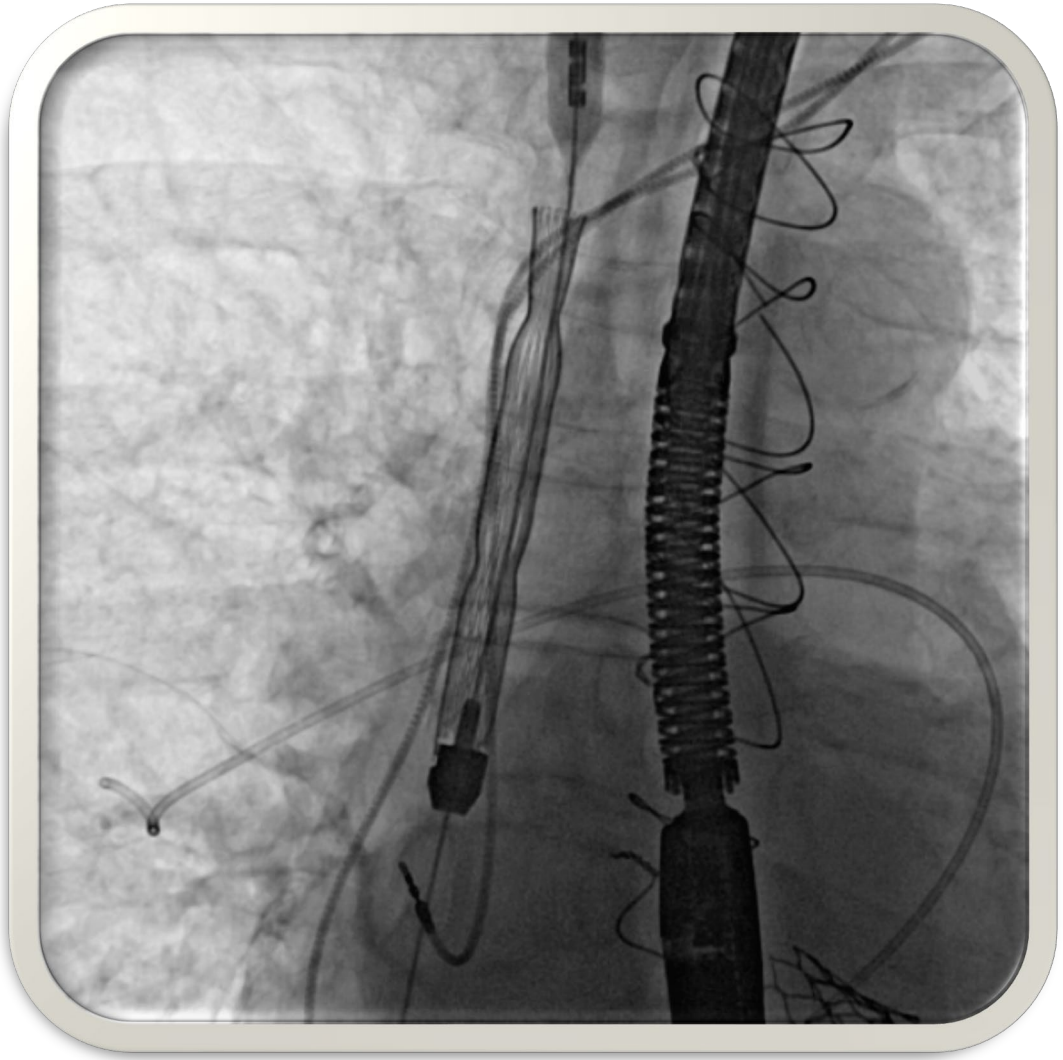


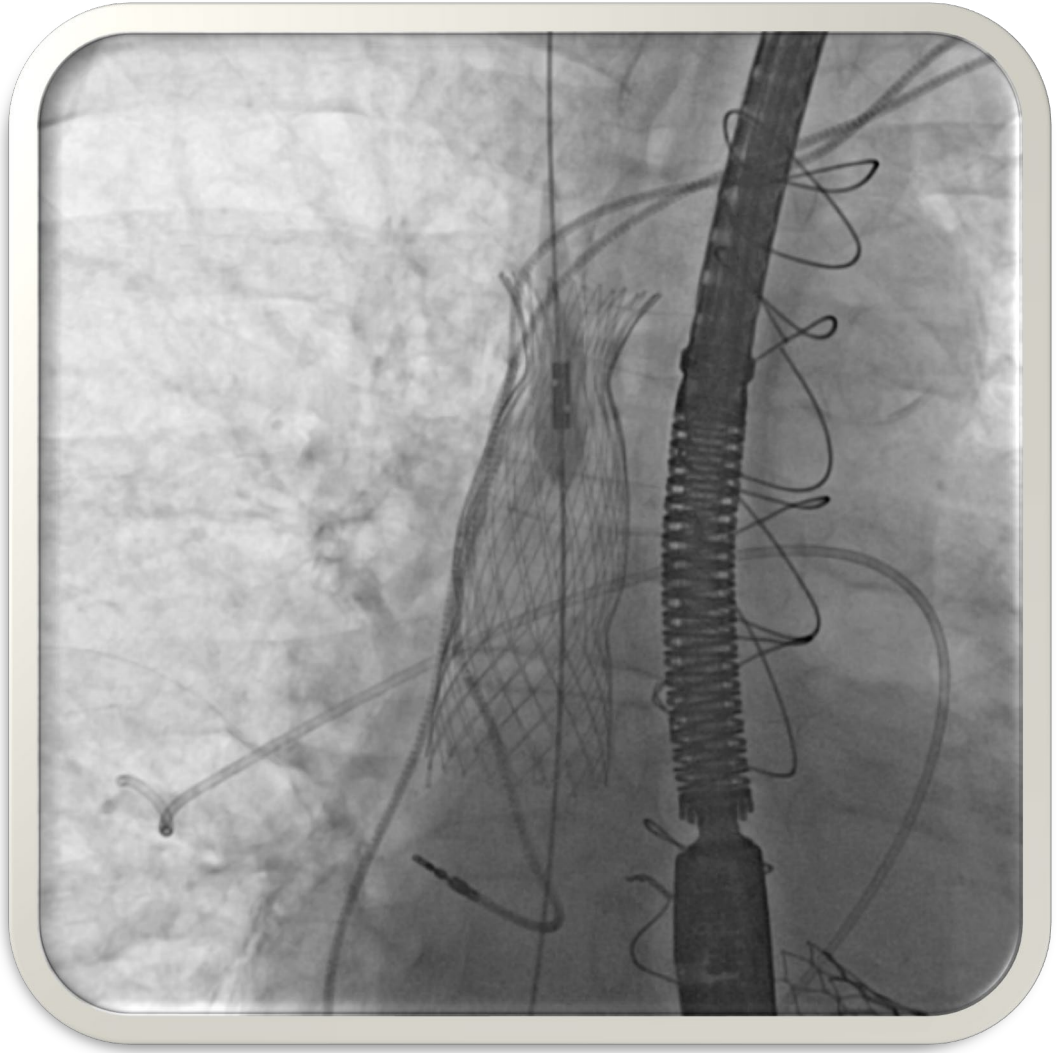
Figure 3. Anatomical diagram and angiographic view of the inferior vena cava. Anatomical diagram and angiographic view at posterior-anterior plane of the inferior vena cava (IVC), cavo-atrial junction (J) and right supra-hepatic vein (sHV). Ideally the target position for TricValve® implantation is to place the proximal edge of the inferior prosthesis between 5 to 12 mm into RA (red double arrows). The proximal part of the inferior prosthesis has high radial force and is partially covered by a skirt (only covers the 20 mm proximal of the prosthesis). Distance between cavo-atrial junction and sHV is usually around 5 to 15 mm. Diaphragm (D) and branches of the phrenic nerves are the notable structures that could be damaged during the implantation of the inferior vena cava prosthesis. Important angulations between IVC, sHV and cavo-atrial junction hinder the prosthesis deployment. In such cases, a very slow deployment and low implantation is recommended. Be: Belly part of the superior prosthesis. D: Diaphragm. Inn: Innominate vein. IVC: Inferior Vena Cava. J: cavo-atrial Junction. PA: Pulmonary Artery. RA: Right Atrium. RPA: Right Pulmonary Artery. S: Intra-atrial septum. SVC: Superior Vena Cava vein.

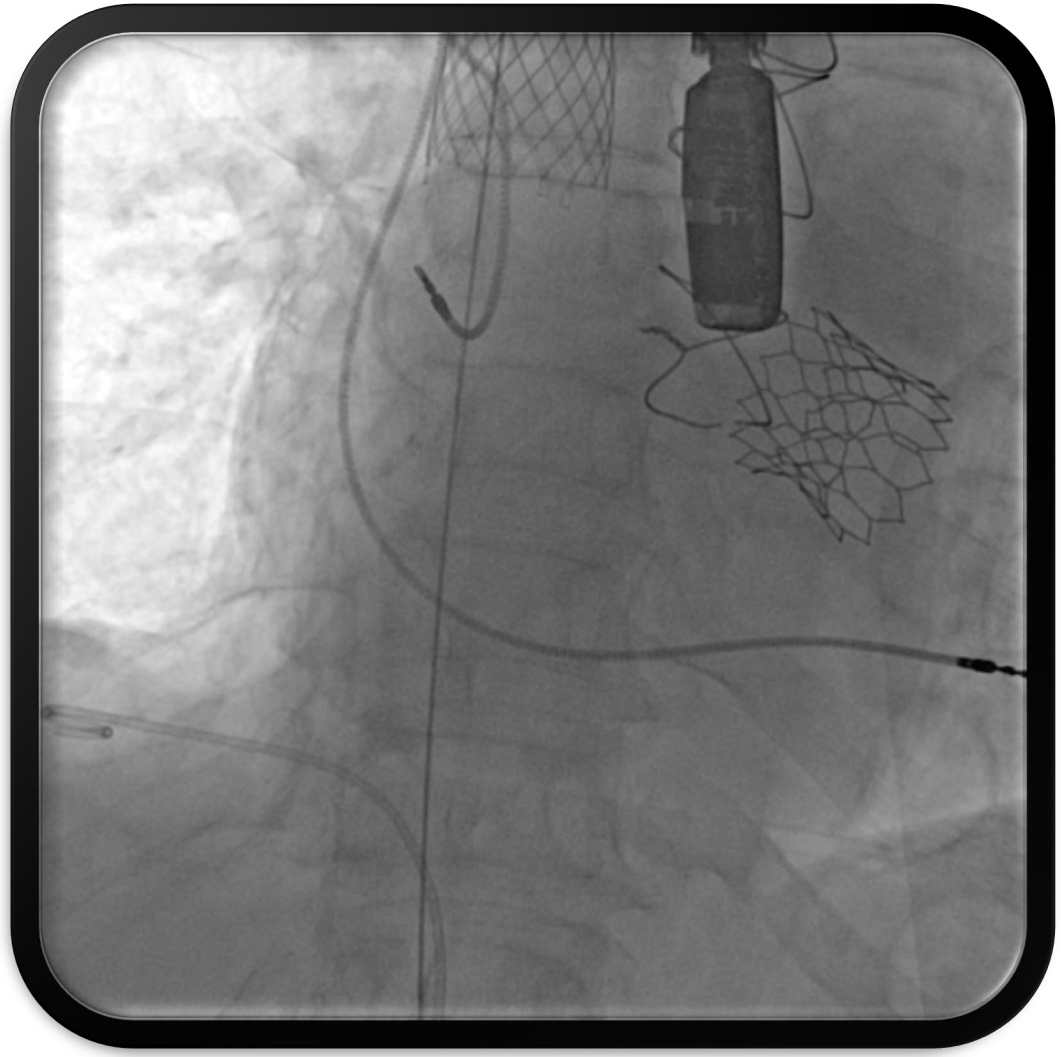

A
IVC pre-TricValve
25 mmHg
C
IVC post-TricValve
25 mmHg
B
RA pre-TricValve
25 mmHg
D
RA post-TricValve
25 mmHg

POS IMPLANTATION CARE

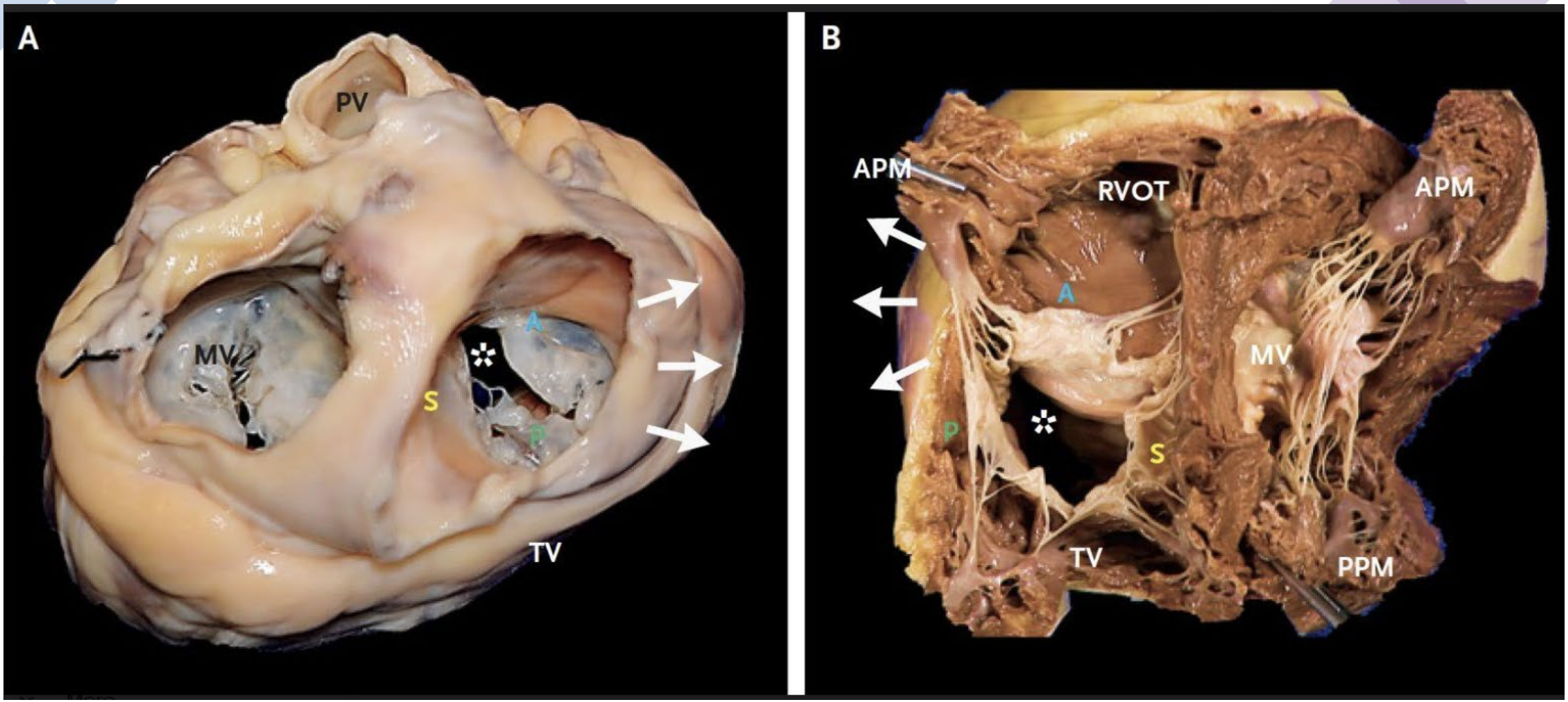
- VENTRICULARIZATION OF RA PRESSURE
- RV DYSFUNCTION
- PROSTHESIS MALFUNCTION WITH MINIMUM BACKFLOW
- SHOULDER PAIN
- TEMPORARY PLATELET COUNT DECREASE
- MIGRATION







MUITO OBRIGADO POR SUA ATENÇÃO!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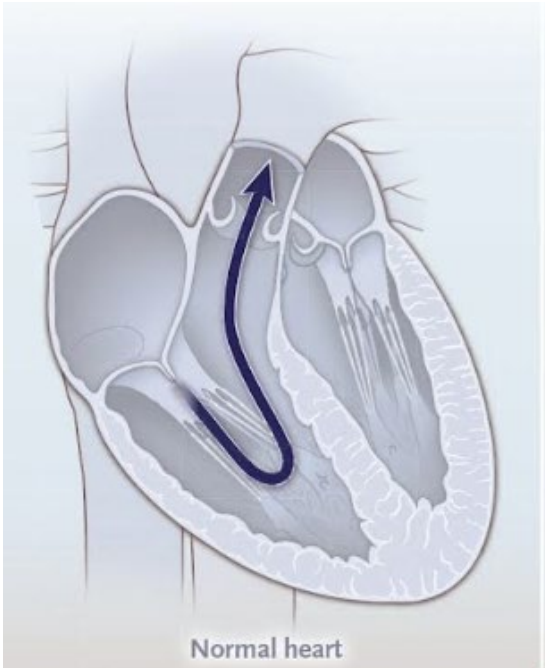

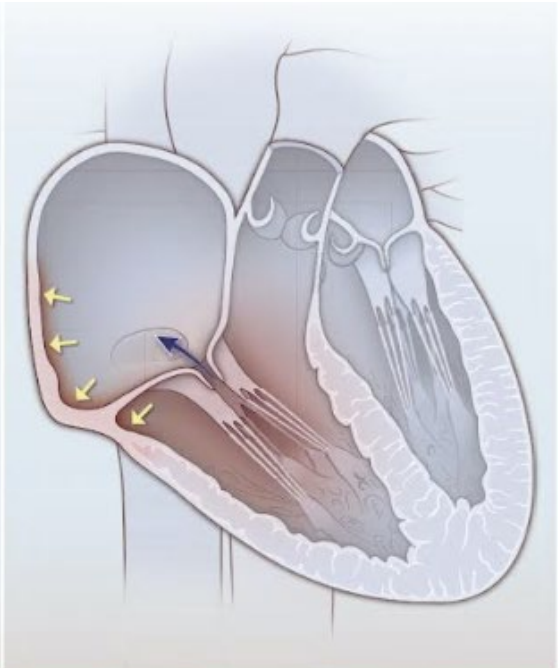

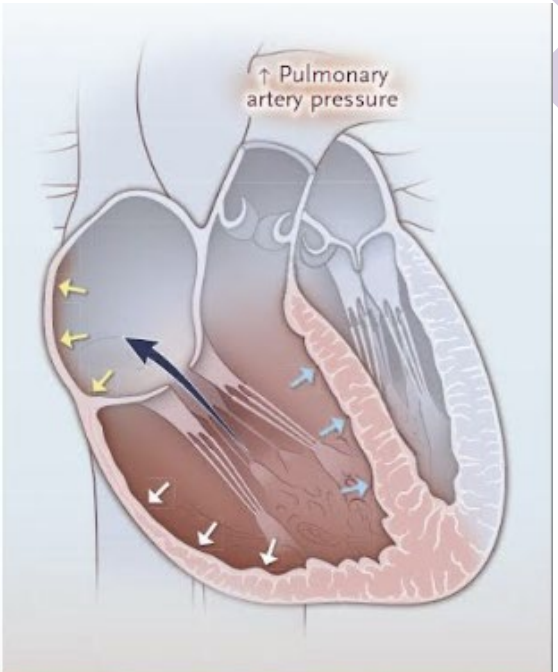

	Atrial secondary tricuspid regurgitation	Ventricular secondary tricuspid regurgitation
Female or male	More often female	More often male
Left ventricular ejection fraction	Usually normal (>60%)	Often reduced (<50%)
Left atrial size	↑	↑↑
Tenting parameters	Normal to ↑ (height ≤10 mm)	↑↑
Tricuspid annular 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 ↓	↓

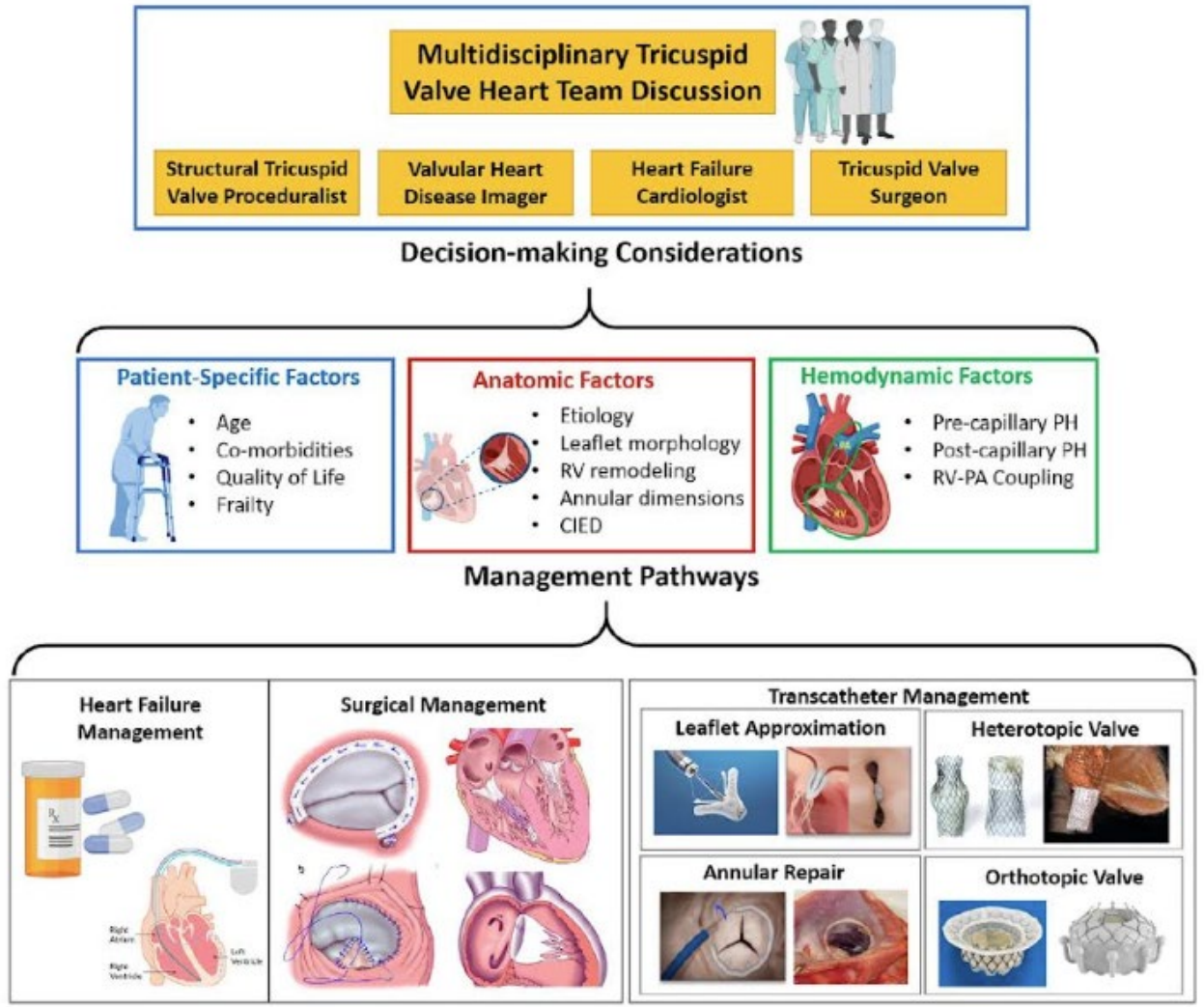

Fig. 2. The make-up of a multidisciplinary Tricuspid Valve Heart Team is shown with some of the patient-specific, anatomic, and hemodynamic factors that are incorporated into the decision-making for appropriate heart failure management, which may be augmented with surgical or transcatheter therapies.

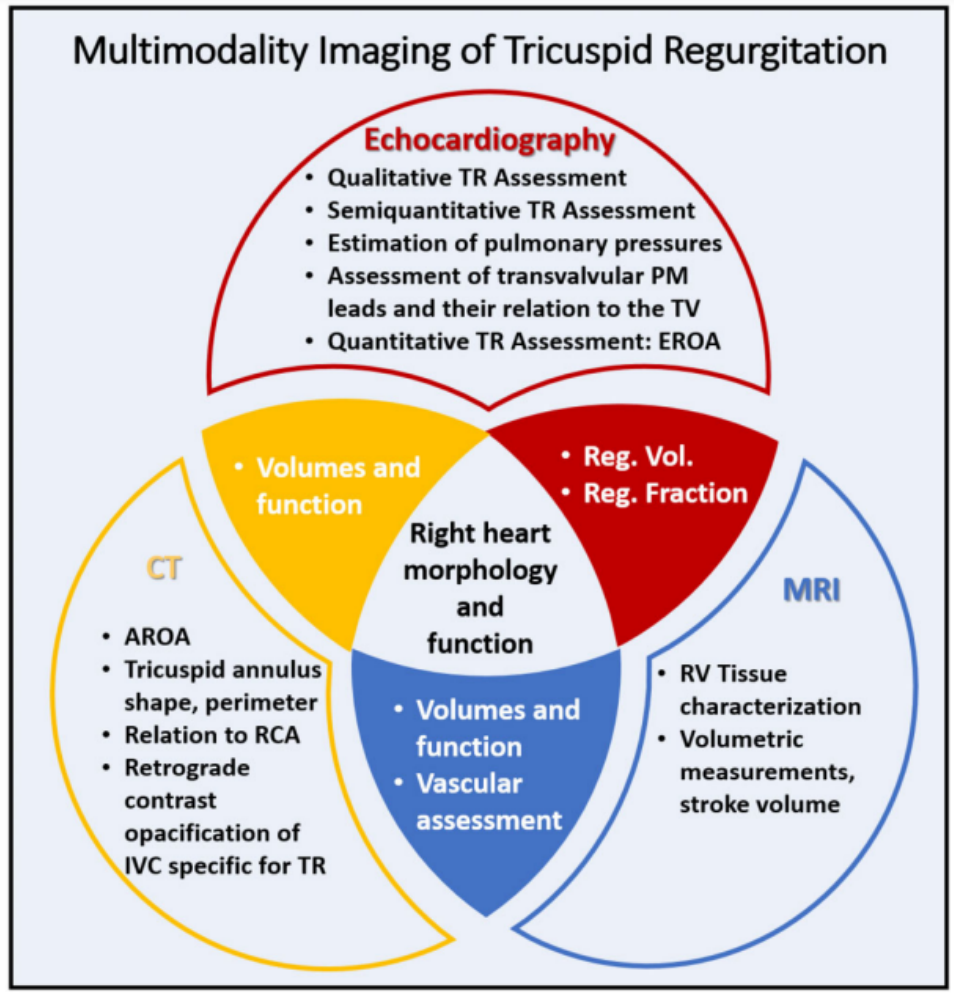

Figure 5 Multimodality assessment of tricuspid regurgitation severity. Different imaging methods give complementary information about tricuspid regurgitation aetiology, anatomic and functional substrates as well as TR severity. AROA = anatomic regurgitant orifice, EROA = effective regurgitant orifice area, CT = computed tomography, IVC = inferior vena cava, MRI = magnetic resonance imaging, PM = pacemaker, RCA = right coronary artery, Reg. Fraction = regurgitant fraction, Reg.Vol. = regurgitant volume, RV = right ventricle, TR = tricuspid regurgitation, TV = tricuspid valve.

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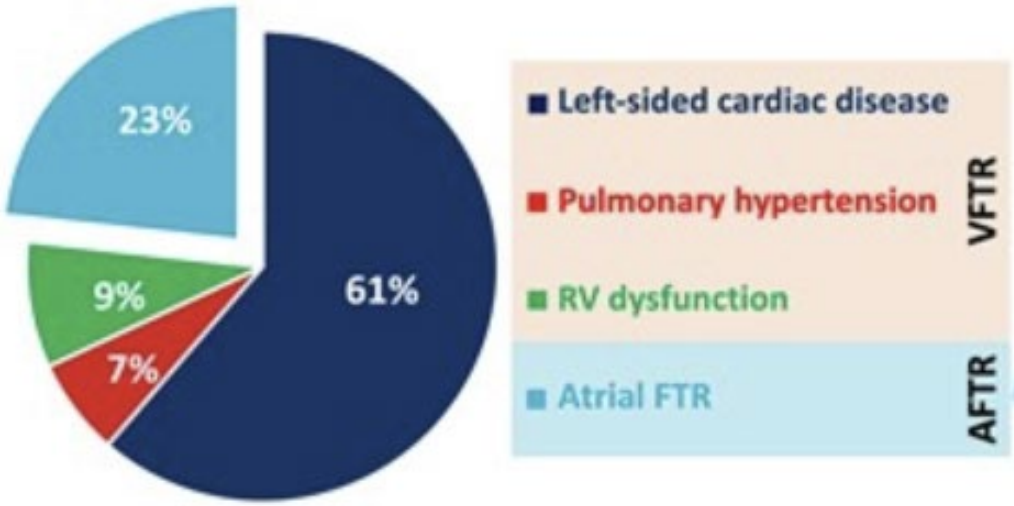
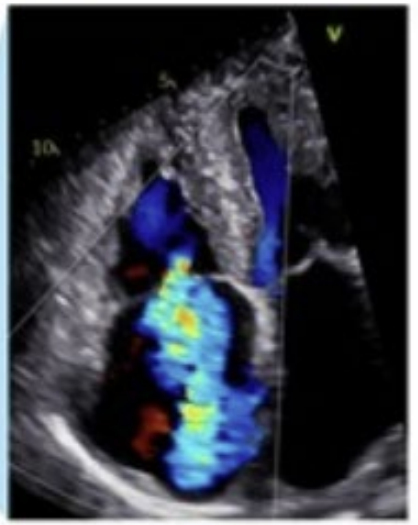
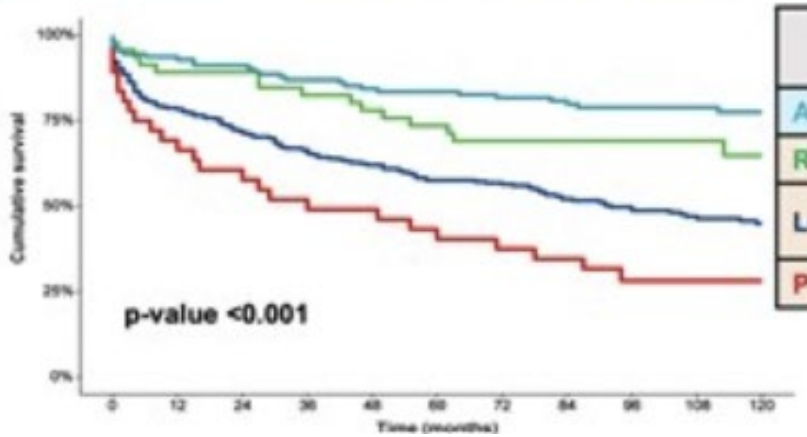
https://doi.org/10.1093/ehjci/jeac009

Distribution of severe functional TR



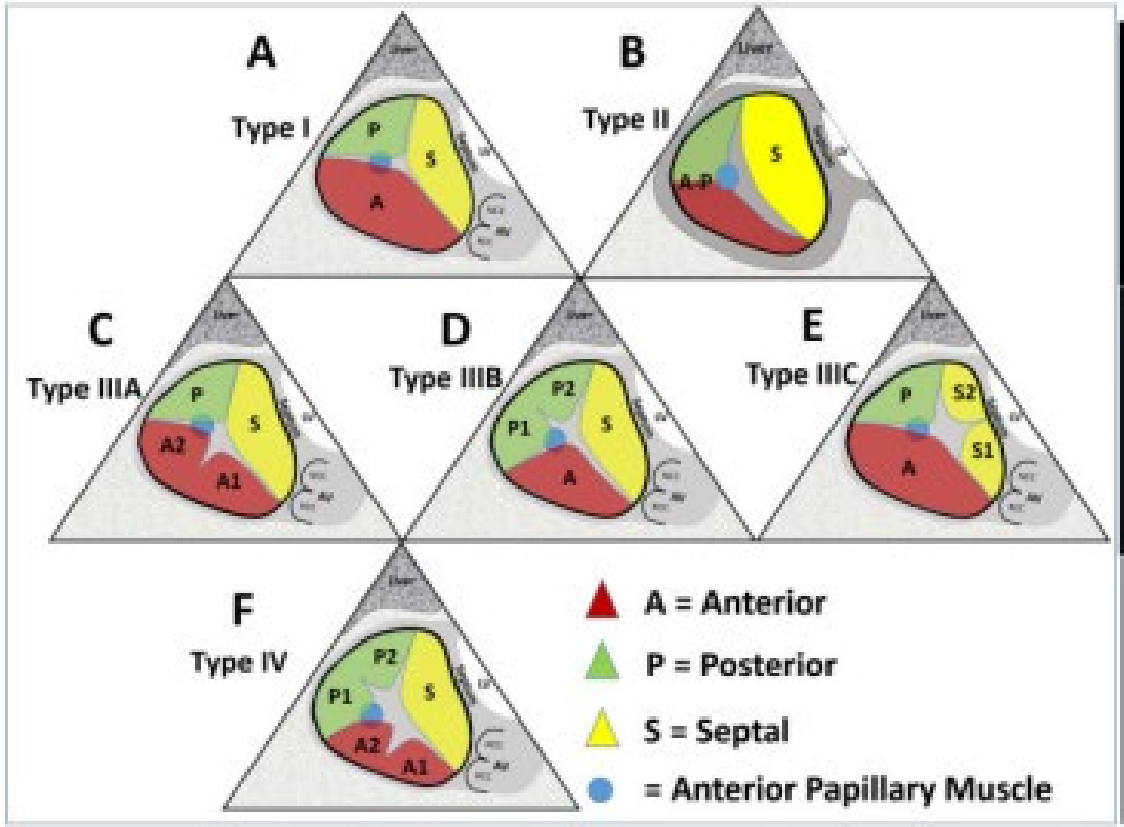


Overall survival of severe functional TR

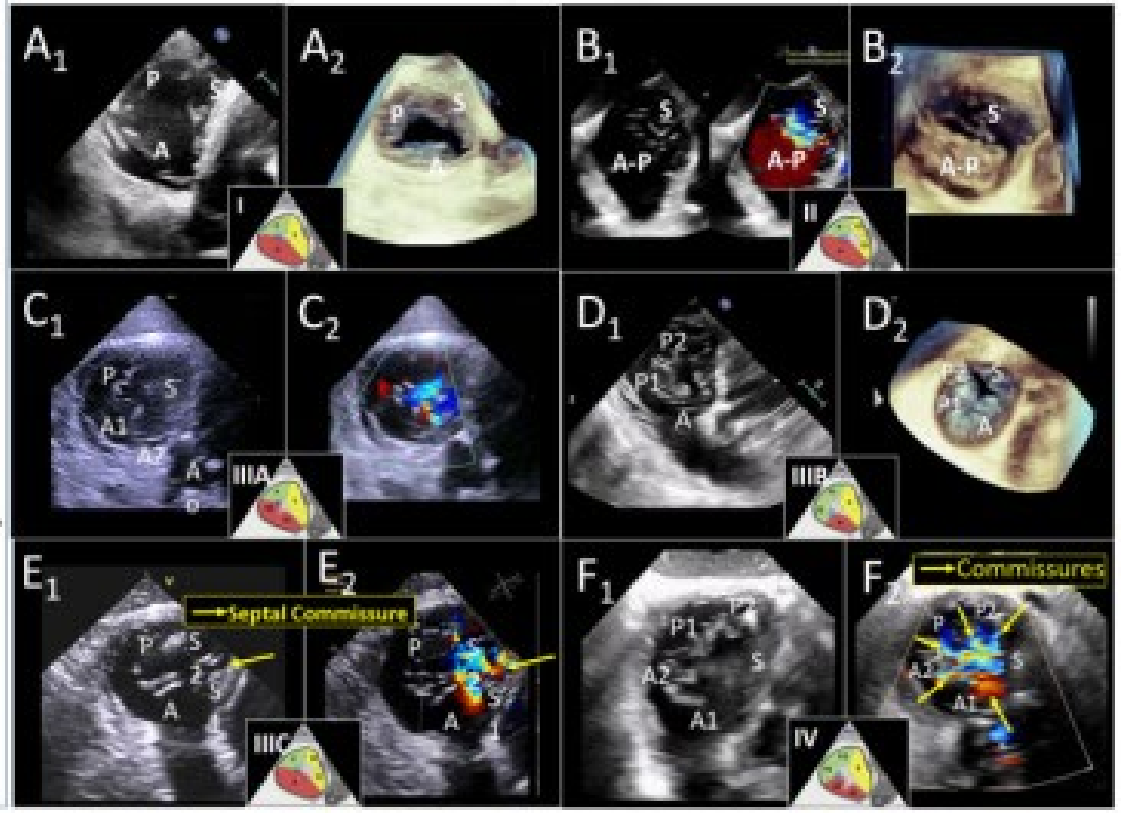


	1-year survival	5-year survival	10-year survival
Atrial FTR	94%	84%	78%
RV dysfunction	89%	74%	65%
Left-sided cardiac disease	79%	58%	45%
Pulmonary hypertension	69%	43%	28%

1. Proposed Tricuspid Nomenclature



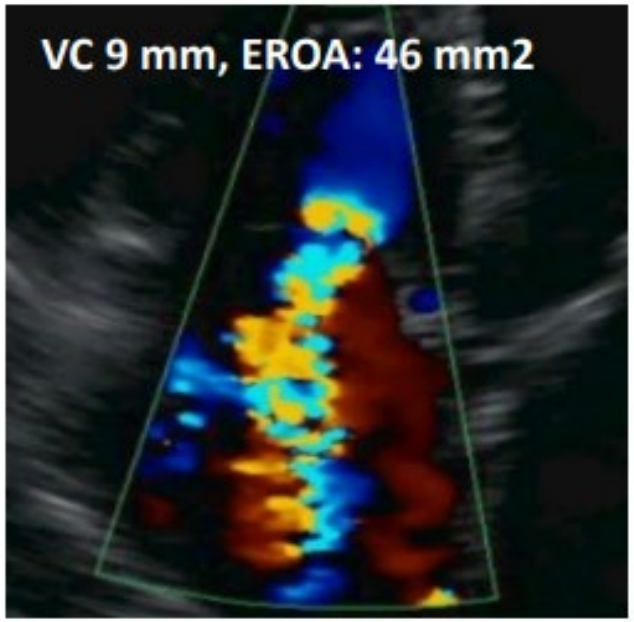
2. Echocardiographic Examples of Tricuspid Valve Morphologies

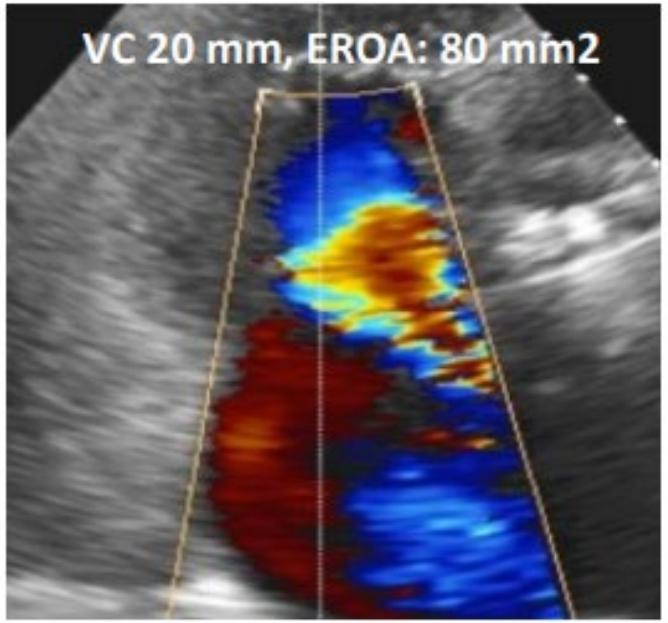


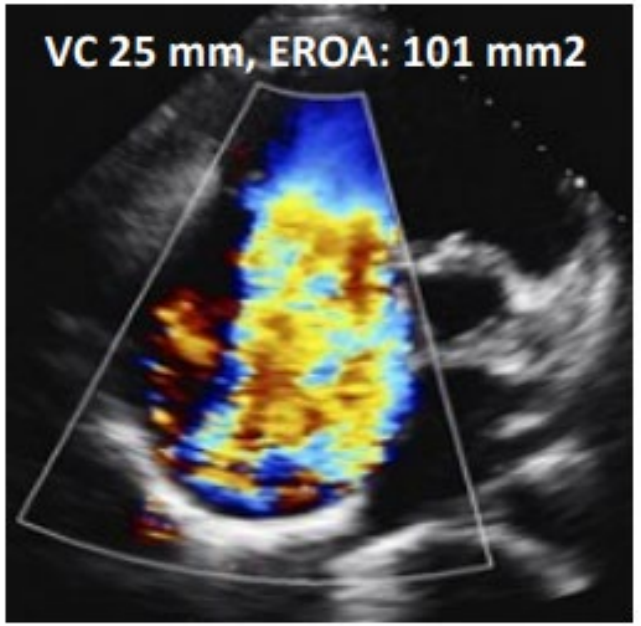
European Heart Journal - Cardiovascular Imaging (2022) **00**, 1–17
https://doi.org/10.1093/ehjci/jeac009

More than one grade of severity of TR

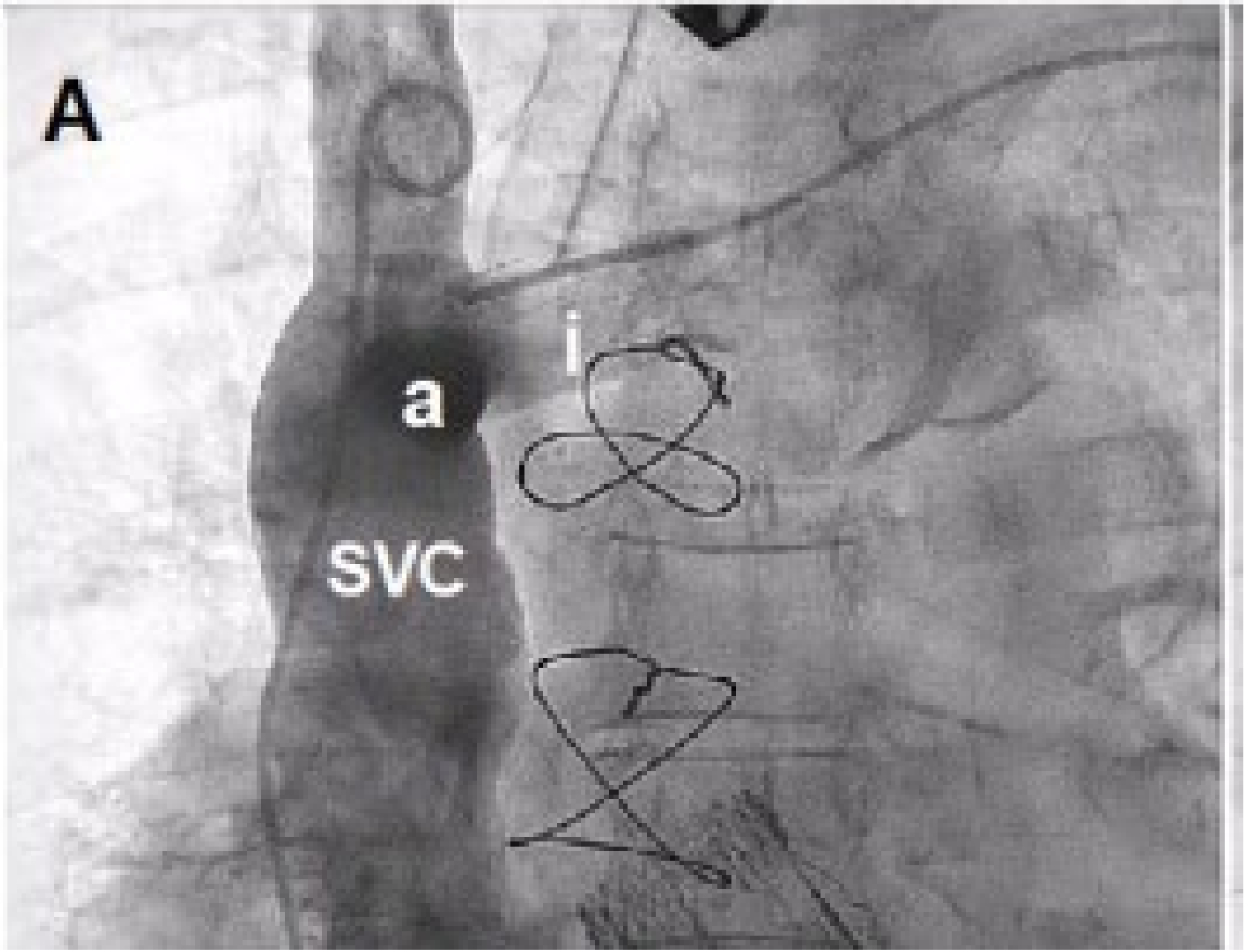
Variable	Mild	Moderate	Severe	Massive	Torrential
VC (biplane)	<3 mm	3-6.9 mm	7–13 mm	14–20 mm	≥21 mm
EROA (PISA)	<20 mm^2	20–39 mm^2	40–59 mm^2	60–79 mm^2	≥80 mm^2
3D VCA or quantitative EROA			75–94 mm^2	95–114 mm^2	≥115 mm^2





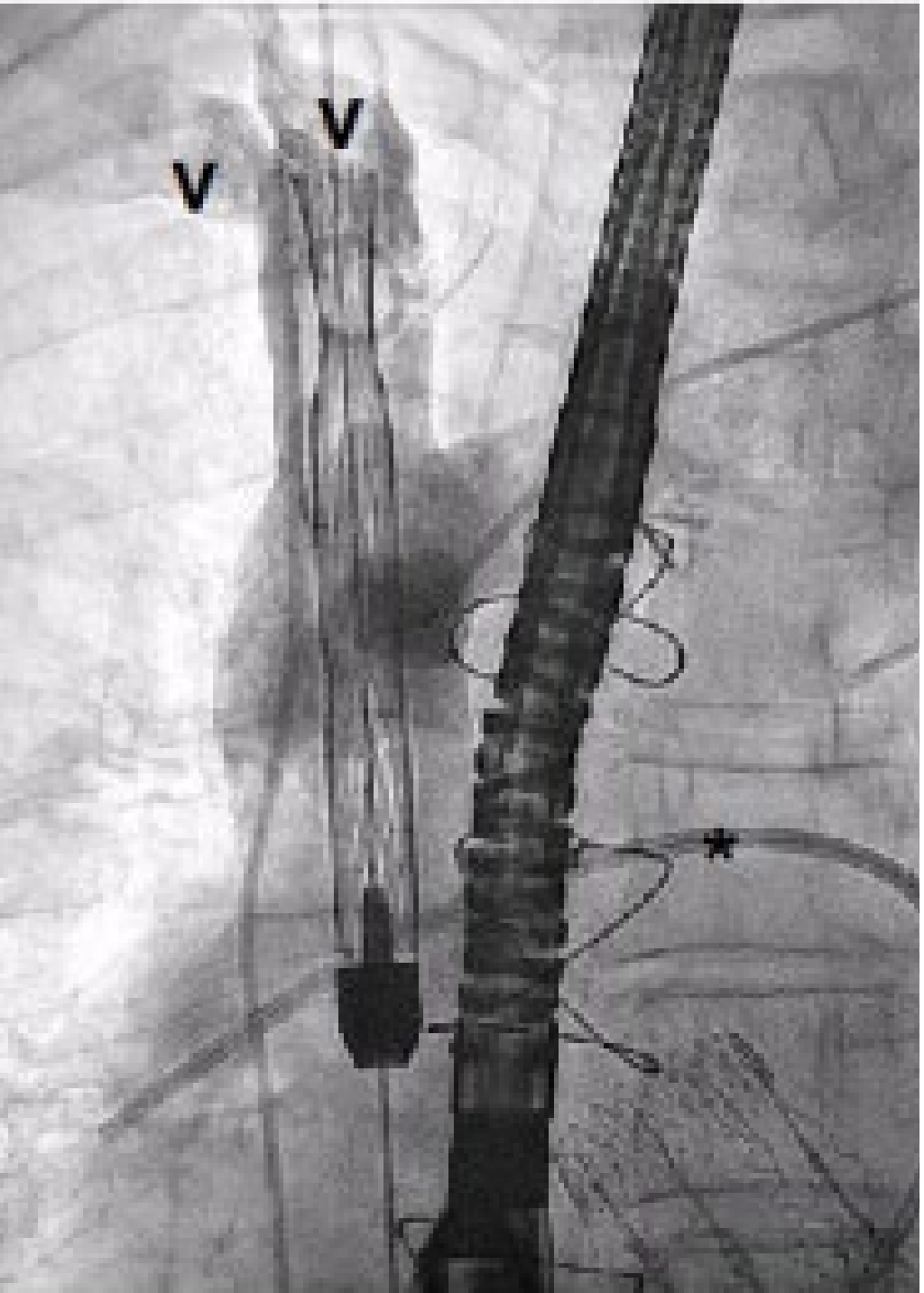


Hahn R, Zamorano JL. Eur Heart J Cardiovasc Imaging. 2017



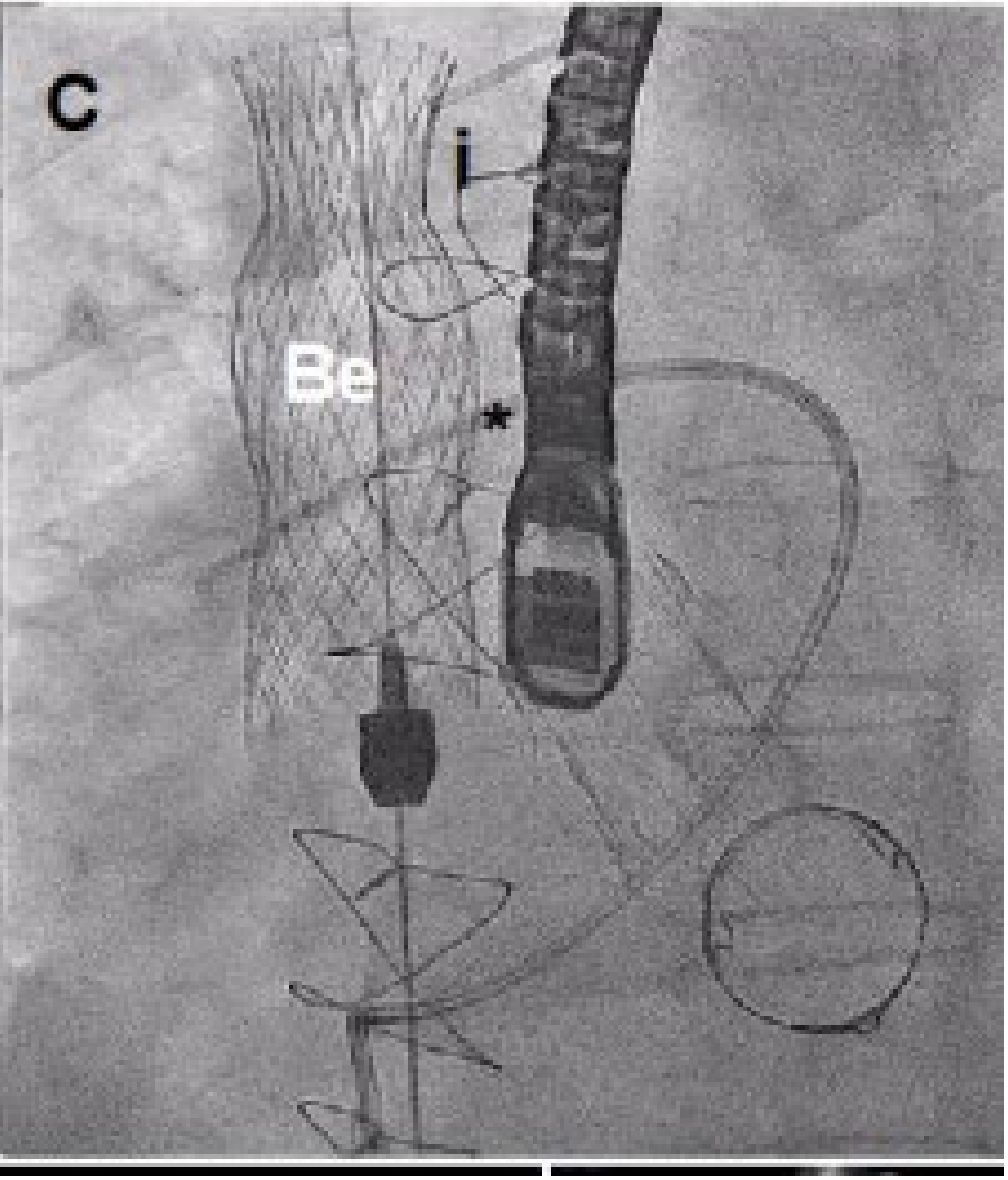
VENOGRAMA

- i: Inomminate with MP
- a: Aziguous
- SVC: Superior vena cava



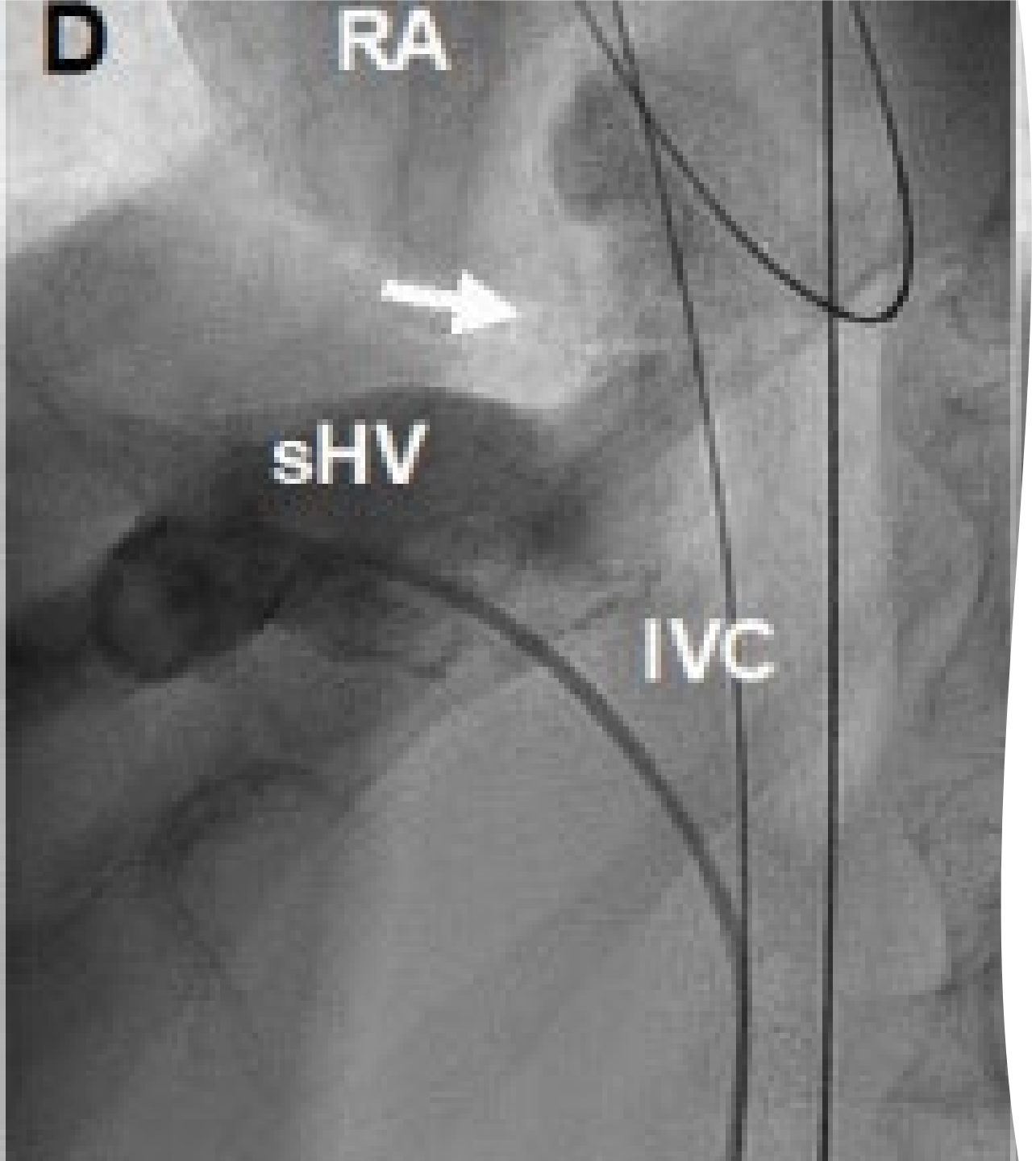
TARGET POSITION

- V : Subclavian and jugular veins
- * : Swann-Ganz catheter in Right Pulmonary Artery



IMPLANT

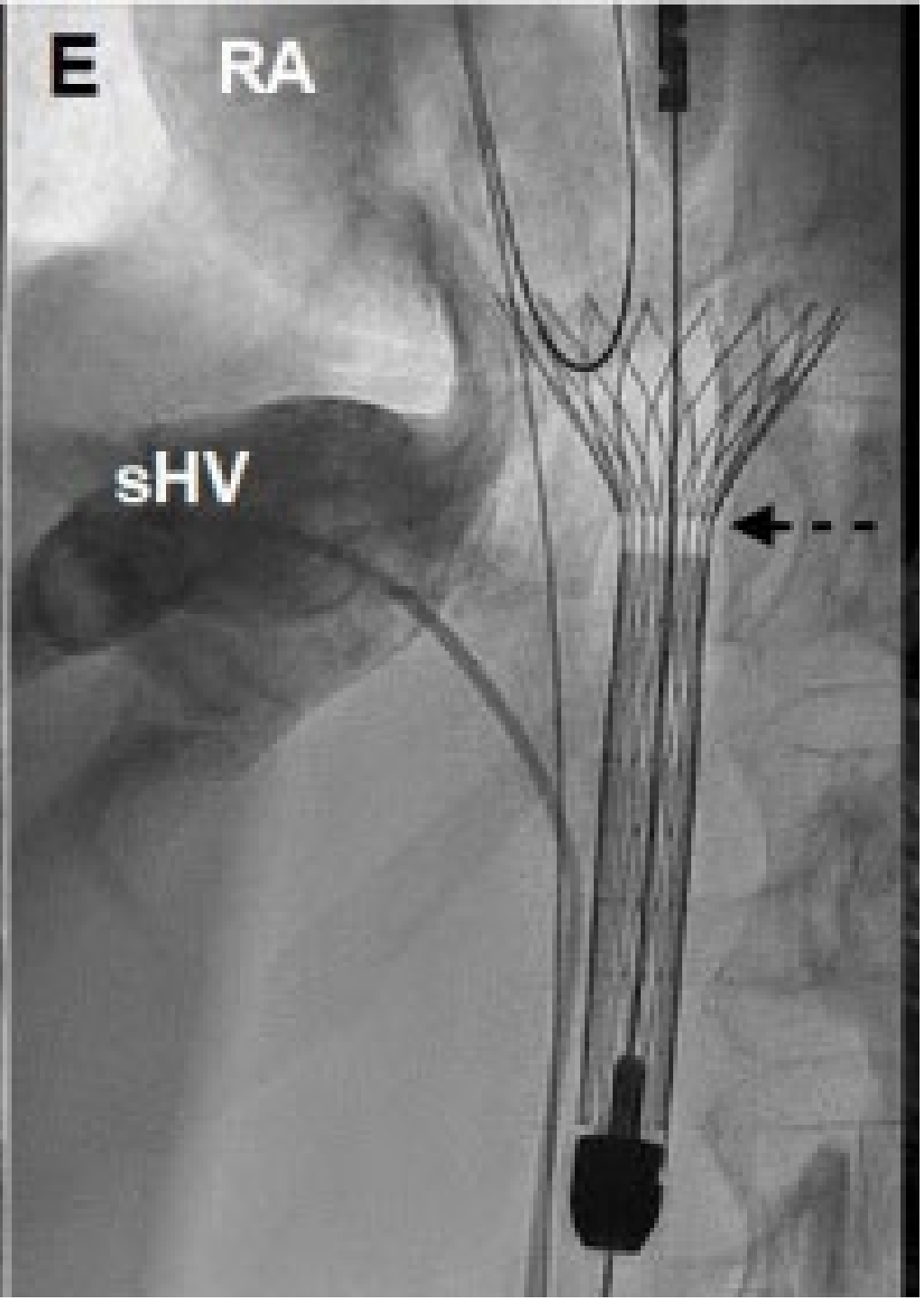
- i: Inomminate with MP
- * : Swann-Ganz catheter in Right Pulmonary Artery



VENOGRAM

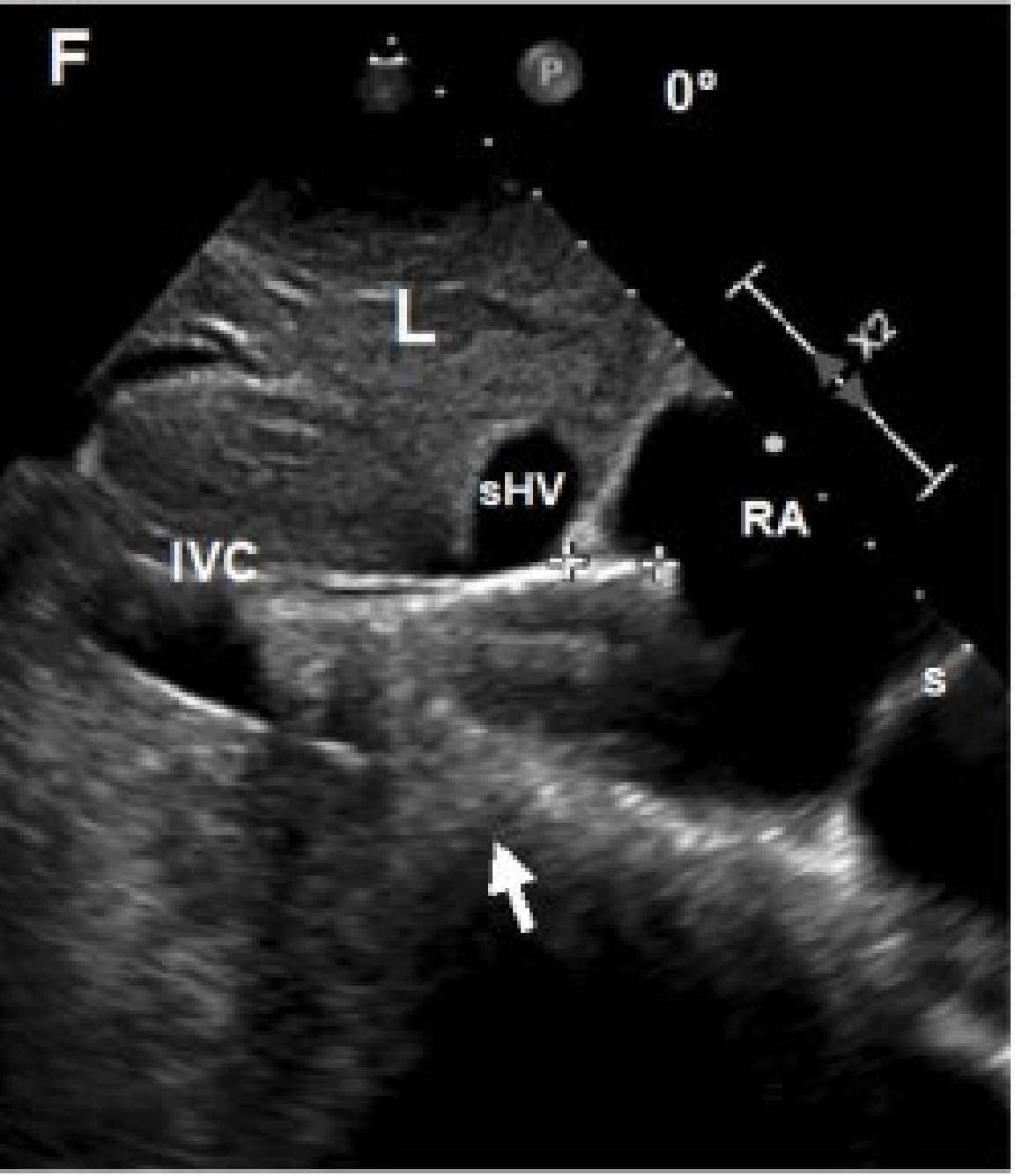
- SUPRA HEPATIC VEIN CONFLUENCE INFERIOR VENA CAVA AND JUNCTION WITH THE RIGHT ATRIUM (WHITE ARROW)

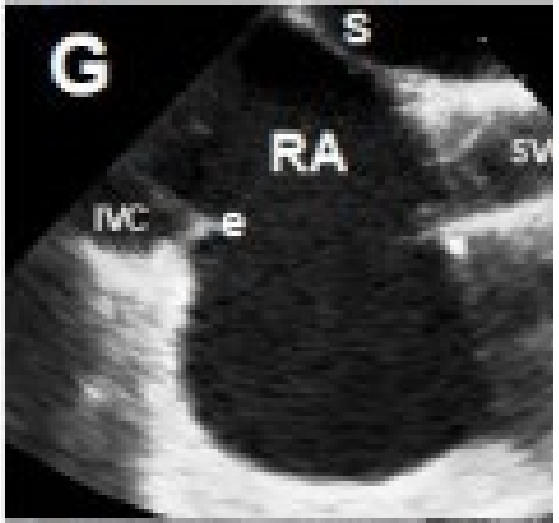
J. Clin. Med. **2021**, *10*, 4601

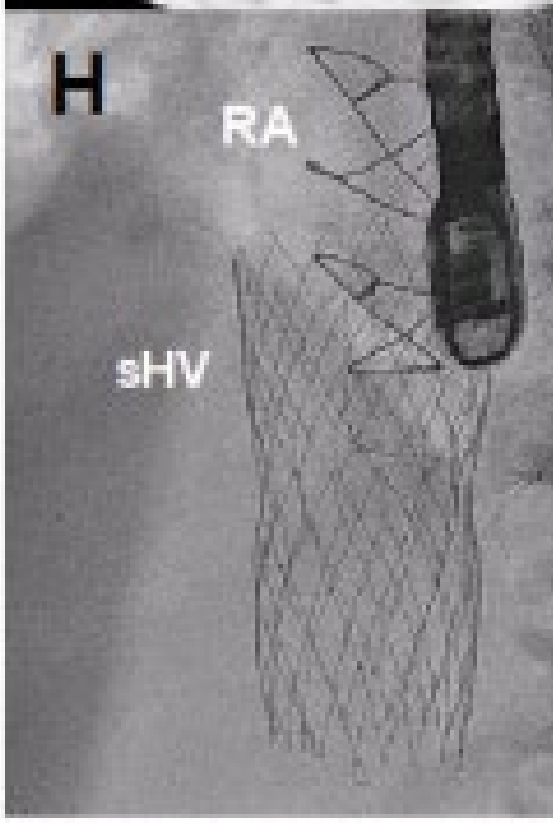


POSITIONING

- sHV: Suprahepatic vein
- RA: right atrium
- Black arrow: radiolucent mark shows where the skirt of the valve ends







- L : liver
- sHV: suprahepatic vein
- RA: right atrium
- s: septum
- e: eustachian valve
- + +: Tricvalve entering 11mm in right atrium

Device Choice: Complex and Multi-factorial

Device Choice Parameters	Annuloplasty	Leaflet Repair	Replacement
Primary Etiology	🔴	🟢	🟢
Coaptation Gap > 7mm	🟡	🔴	🟢
Complex Subvalvar Anatomy	🟡	🔴	🟡
CIED with Impingement	🔴	🟡🔴[a]	🟢
Leaflet tethering >10mm	🔴	🟢	🟢
Leaflet Morphology (>3)	🟢🟡	🟡	🟢
Large Annulus	🔴	🟢	🔴
Small RV dimensions	🟢	🟢	🟡🔴[b]
Poor RV function	🟢🟡	🟢🟡	🟡🔴
Anticoagulation C/I	🟢	🟢	🟡🔴
Difficult TEE Imaging[c]	🟡🔴	🟡🔴	🟢🟡

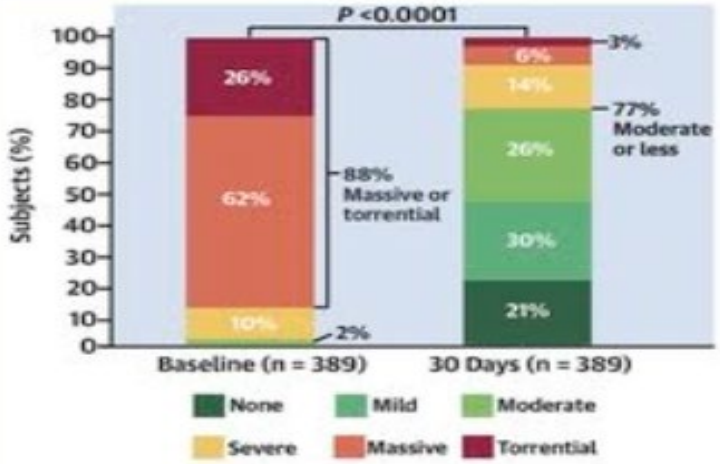
Fig. 4. Shown are the anatomic, patient-specific, and imaging factors that are considered in the decision-making for either repair with annuloplasty or repair versus replacement. [a]Dependent on location of TR, [b]Dependent on Device, [c]ICE Imaging may be useful.

CENTRAL ILLUSTRATION: Transcatheter Tricuspid Valve Repair Safe and Effective in Real-World Population

Real-World Population

- Mean age: 78.9 years
- Mean LVEF 55.8%
- NYHA functional class III/IV: 88%
- Male: 44%
- Prior HF Hospitalization: 40.3%
- Baseline KCCQ score: 44.52

Reduction in TR at 30 Days



Safety Profile at 30 Days

Major Adverse Event	2.7%
• Cardiovascular mortality	0.8%
• Myocardial infarction	0.0%
• Stroke	0.4%
• New onset renal failure	1.4%
• Endocarditis requiring surgery	0.0%
• Nonelective CV surgery for device-related AE	0.2%

MAEs adjudicated by independent clinical events committee

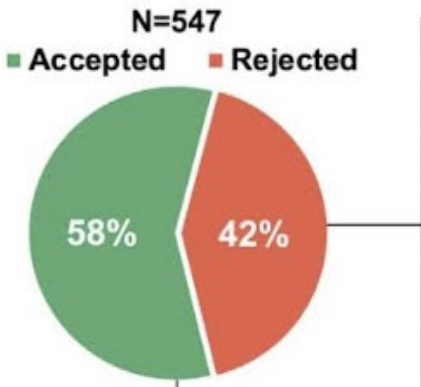
Lurz P, et al. J Am Coll Cardiol. 2023;82(4):281-291.

Screening for Transcatheter Tricuspid Valve Intervention

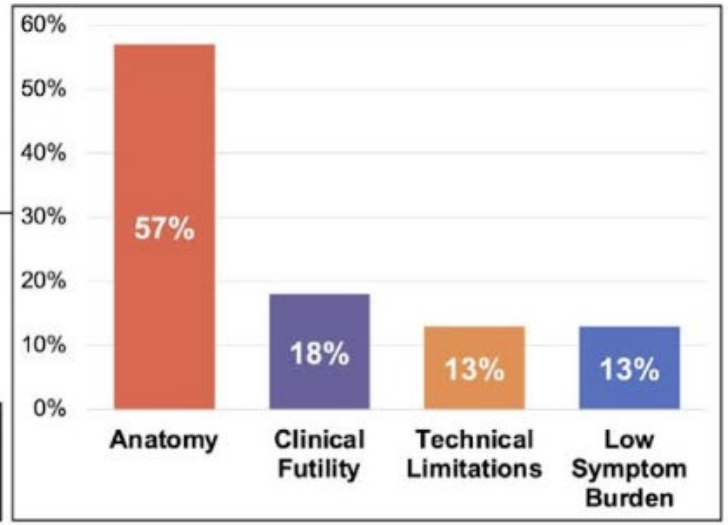
TriSelect Study

Northwestern (Chicago), Bad Oeynhausen, Cologne

N=547



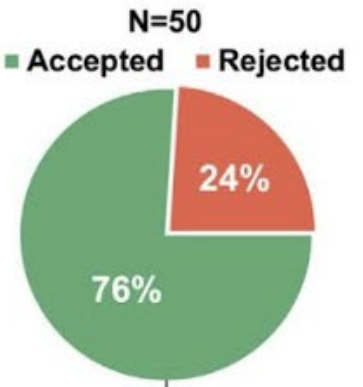
- **62%** Transcatheter Edge-to-Edge Repair
- **38%** Transcatheter valve annuloplasty



Montefiore

New York

N=50



- **50%** TTVR
- **47%** TEER
- **3%** Other (Caval Valve)

Future Innovations and Clinical Needs

- Broad Toolbox of TTVI Therapies (e.g., TTVR)
- Earlier Referral & Volume Optimization
- Imaging Innovation (e.g., 4D-ICE, AI)
- Alternative Permanent Pacing Strategies