

EL COR DRET TAMBÉ EXISTEIX:

***Les tècniques de imatge en l'avaluació de
la insuficiència tricupidea***

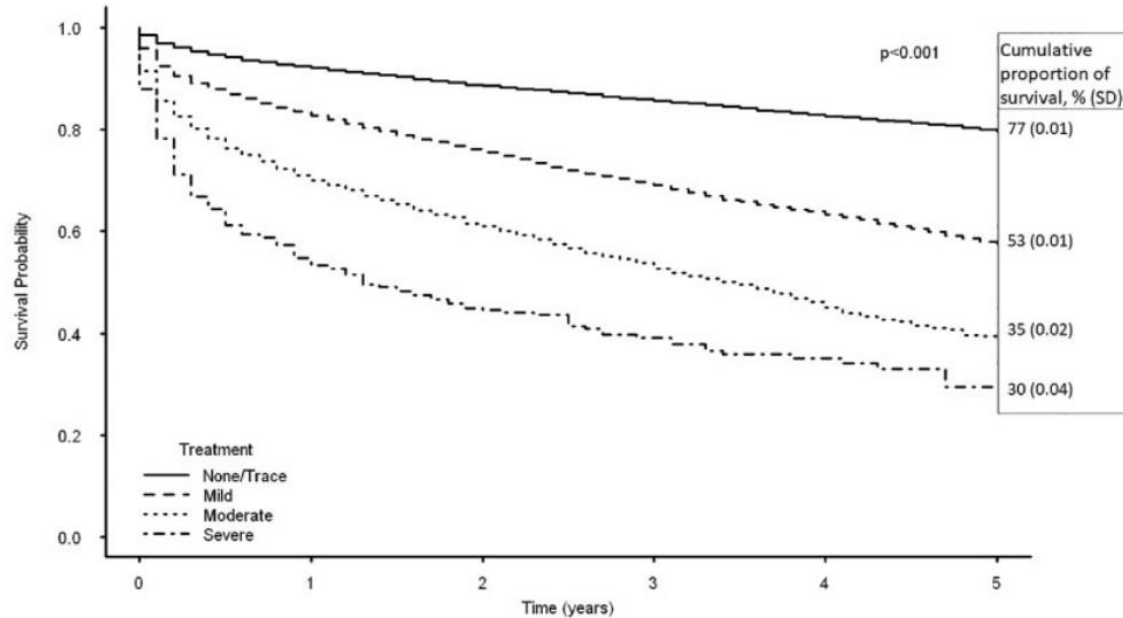
Laura Sanchis MD, PhD

ICCV, Hospital Clínic Barcelona

Conflicte de interesos

- Speaker honoraria from Abbott, Menarini
- Proctor for Mitraclip implantation Abbott

IMPORTÀNCIA DE LA IT

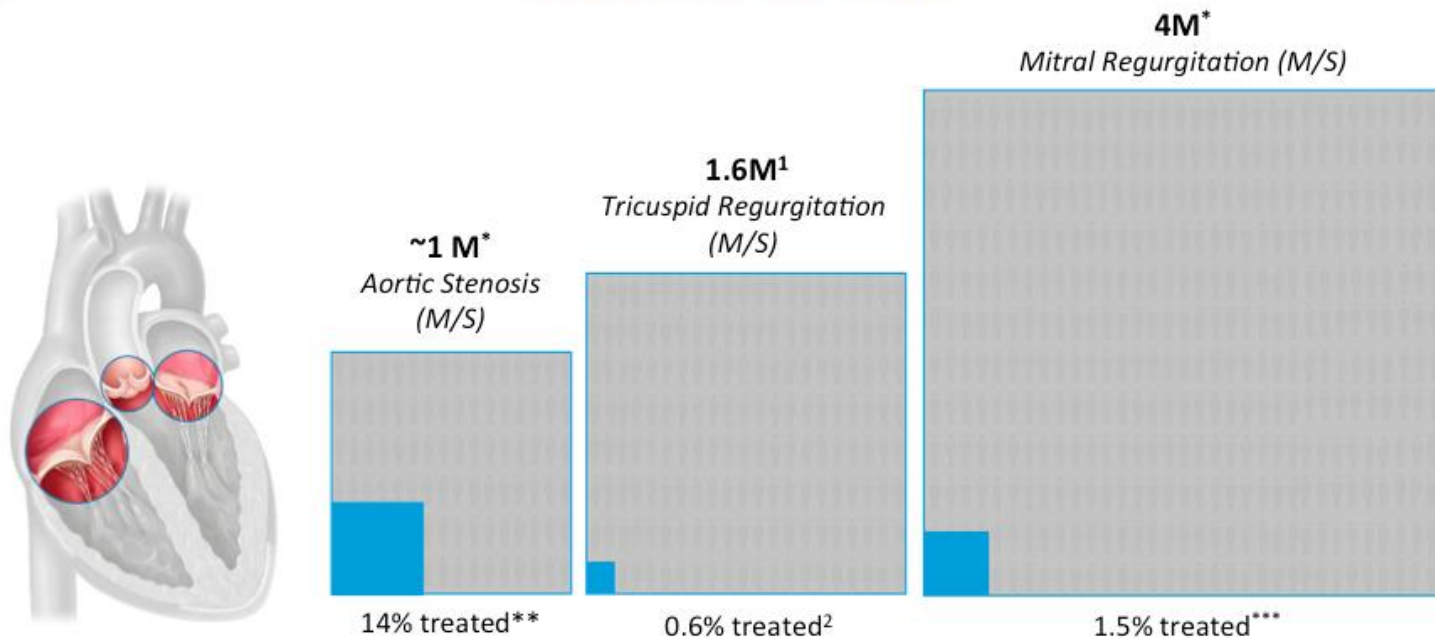


Number at risk:	0	1	2	3	4	5
None/Trace	23045	20957	15985	11374	7183	2956
Mild	7297	6000	4455	2970	1750	805
Moderate	2682	1867	1230	764	432	177
Severe	281	152	101	65	42	14

Conclusions

The presence of any degree of TR is associated with adverse clinical outcome. At least moderate TR is independently associated with increased mortality.

U.S. DISEASE PREVALENCE





ESC

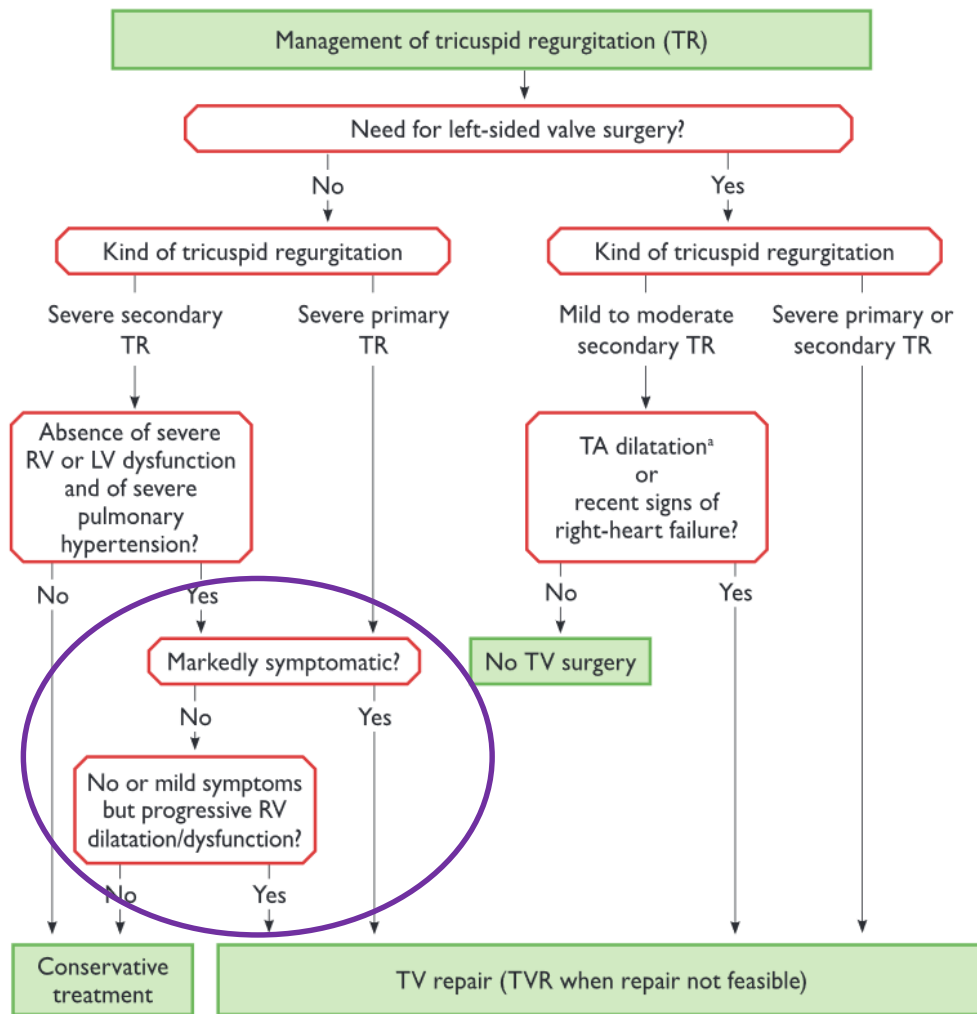
European Society
of Cardiology

European Heart Journal (2017) 38, 2739–2791
doi:10.1093/eurheartj/ehx391

ESC/EACTS GUIDELINES

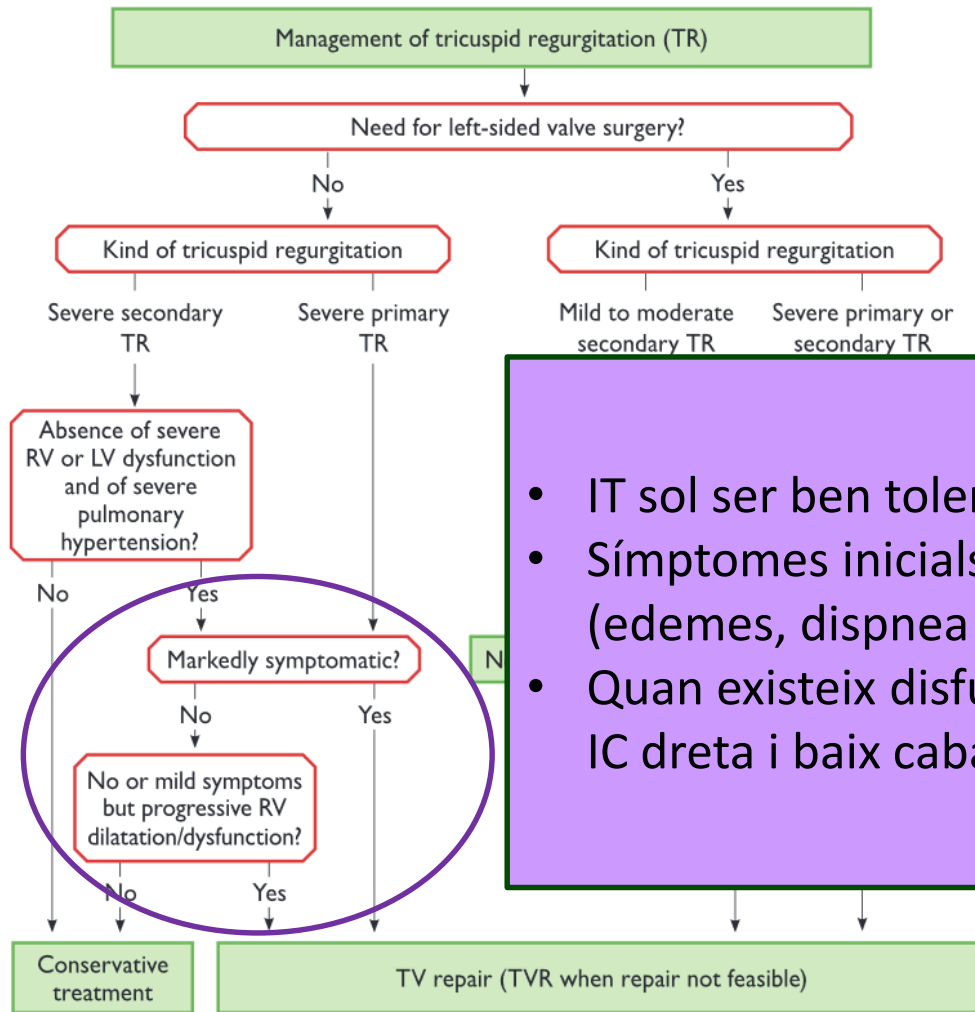
2017 ESC/EACTS Guidelines for the management of valvular heart disease

**The Task Force for the Management of Valvular Heart Disease of
the European Society of Cardiology (ESC) and the European
Association for Cardio-Thoracic Surgery (EACTS)**



Indications for tricuspid valve surgery

Recommendations	Class ^a	Level ^b
Recommendations on tricuspid stenosis		
Surgery is indicated in symptomatic patients with severe tricuspid stenosis. ^c	I	C
Surgery is indicated in patients with severe tricuspid stenosis undergoing left-sided valve intervention. ^d	I	C
Recommendations on primary tricuspid regurgitation		
Surgery is indicated in patients with severe primary tricuspid regurgitation undergoing left-sided valve surgery.	I	C
Surgery is indicated in symptomatic patients with severe isolated 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 severe isolated primary tricuspid regurgitation and progressive RV dilatation or deterioration of RV function.	IIa	C
Recommendations on secondary tricuspid regurgitation		
Surgery is indicated in patients with severe secondary tricuspid regurgitation undergoing left-sided valve surgery.	I	C
Surgery should be considered in patients with mild or moderate secondary tricuspid regurgitation with a dilated annulus (≥ 40 mm or > 21 mm ² by 2D echocardiography) undergoing left-sided valve surgery.	IIa	C
Surgery may be considered in patients undergoing left-sided valve surgery with mild or moderate secondary tricuspid regurgitation even in the absence of annular dilatation when previous recent right-heart failure has been documented.	IIb	C
After previous left-sided surgery and in absence of recurrent left-sided valve dysfunction, surgery should be considered in patients with severe tricuspid regurgitation who are symptomatic or have progressive RV dilatation/dysfunction, in the absence of severe RV or LV dysfunction and severe pulmonary vascular disease/hypertension.	IIa	C



- IT sol ser ben tolerada per molt temps
- Síntomes inicials inespecífics (edemes, dispnea ...)
- Quan existeix disfunció VD signes de IC dreta i baix cabal

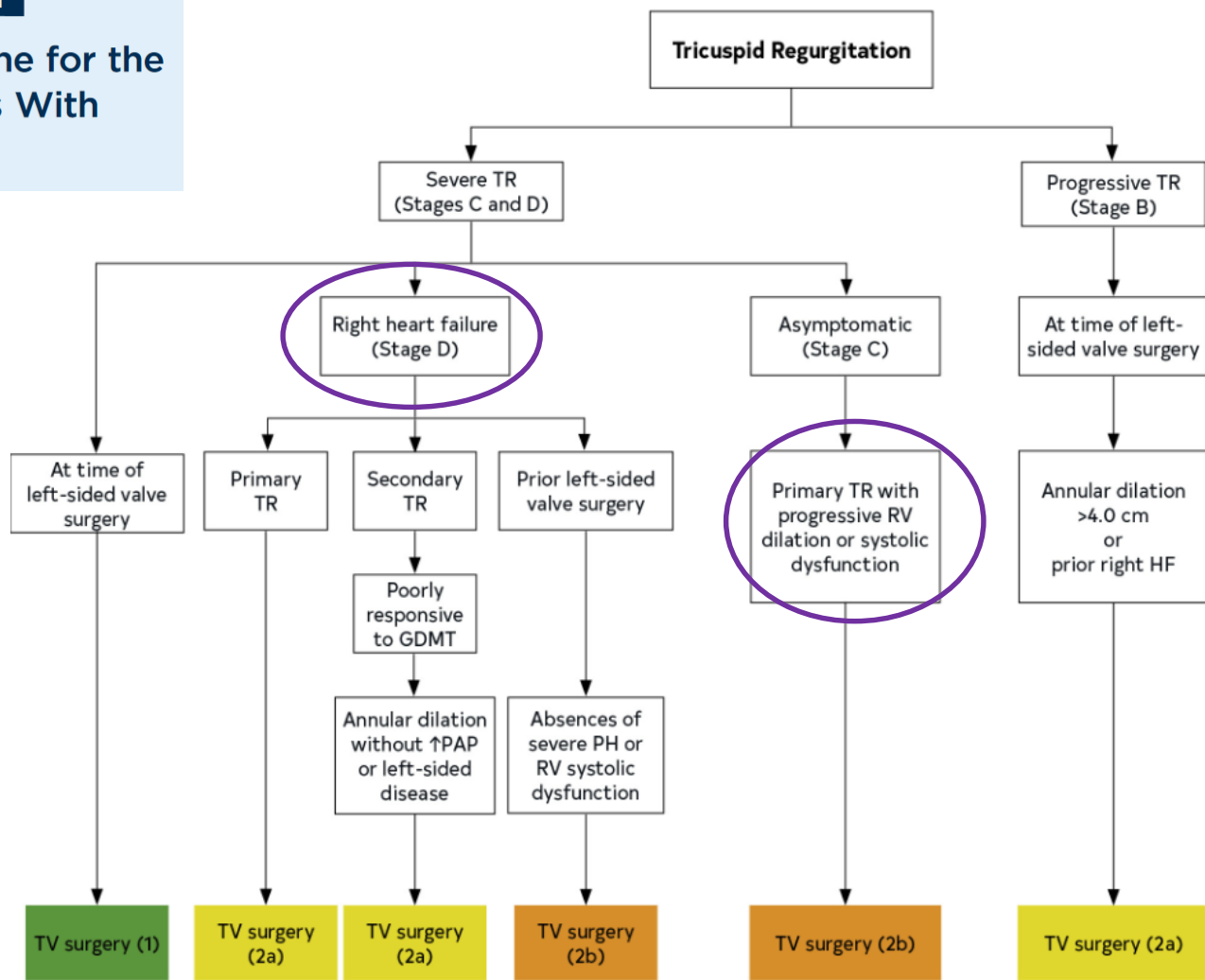
Indications for tricuspid valve surgery

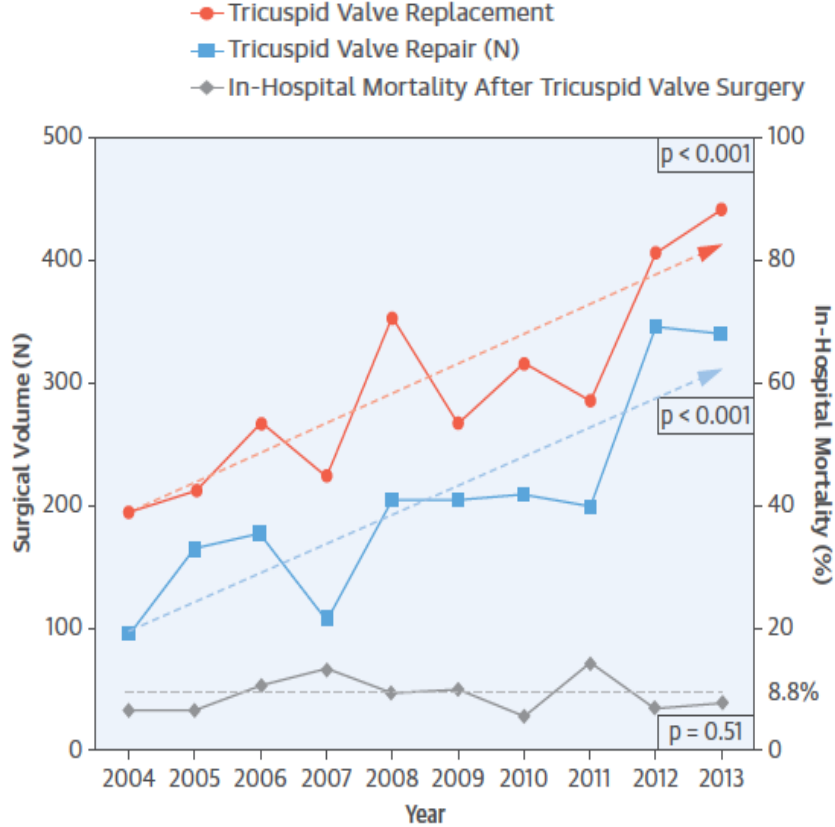
Recommendations	Class ^a	Level ^b
Recommendations on tricuspid stenosis		
Surgery is indicated in symptomatic patients with severe tricuspid stenosis. ^c	I	C
Surgery is indicated in patients with severe tricuspid stenosis undergoing left-sided valve intervention. ^d	I	C
Recommendations on primary tricuspid regurgitation		
Surgery is indicated in patients with severe primary tricuspid regurgitation undergoing left-sided valve surgery.	I	C
Surgery is indicated in symptomatic patients with severe isolated primary tricuspid regurgitation.	I	C

After previous left-sided surgery and in absence of recurrent left-sided valve dysfunction, surgery should be considered in patients with severe tricuspid regurgitation who are symptomatic or have progressive RV dilatation/dysfunction, in the absence of severe RV or LV dysfunction and severe pulmonary vascular disease/hypertension.

IIa C

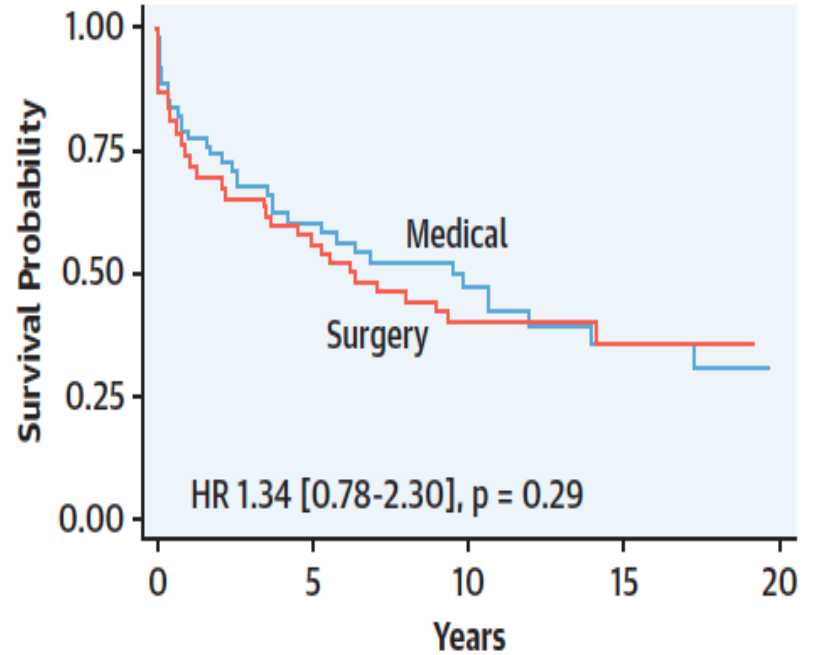
2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease





Zack et al. *J Am Coll Cardiol.* 2017;70:2953-60

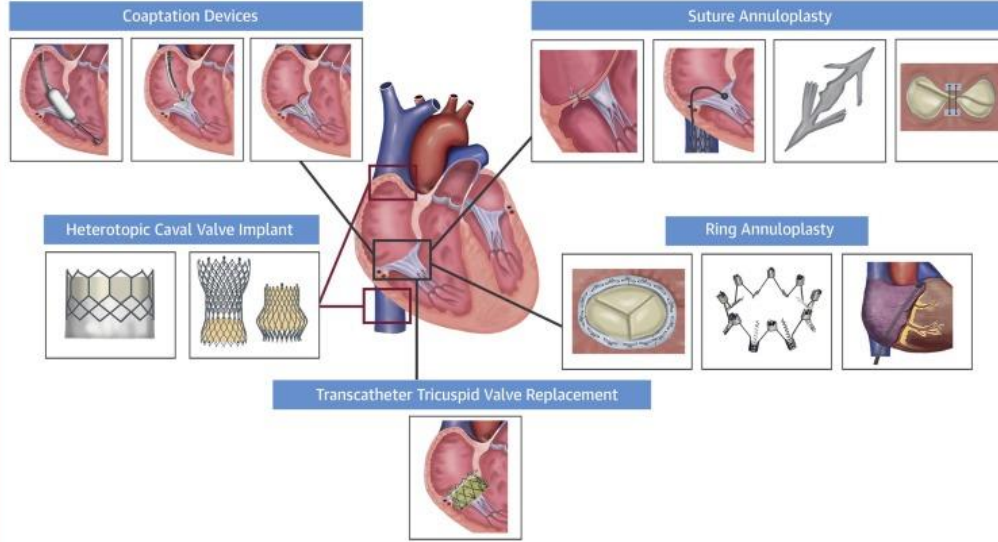
Isolated TR



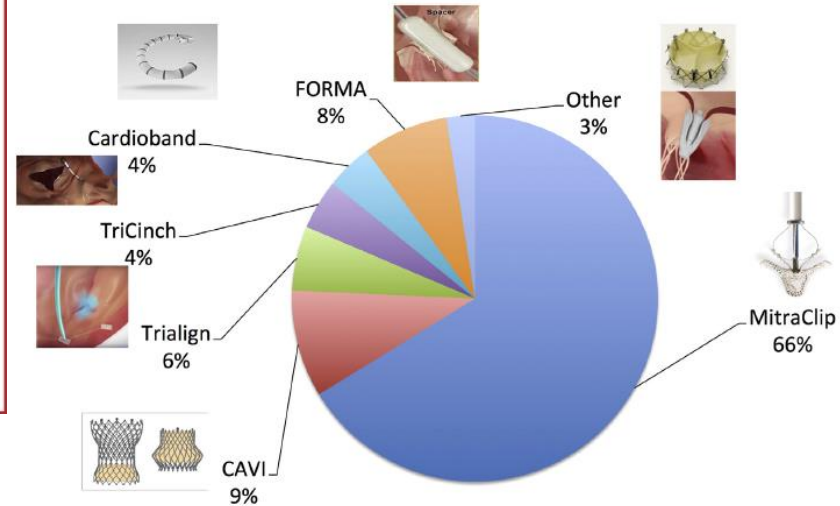
Axtell et al. *J Am Coll Cardiol.* 2019

QUÉ HA CANVIAT?

CENTRAL ILLUSTRATION: Transcatheter Tricuspid Landscape



Asmarats, L. et al. J Am Coll Cardiol. 2018;71(25):2935-56.



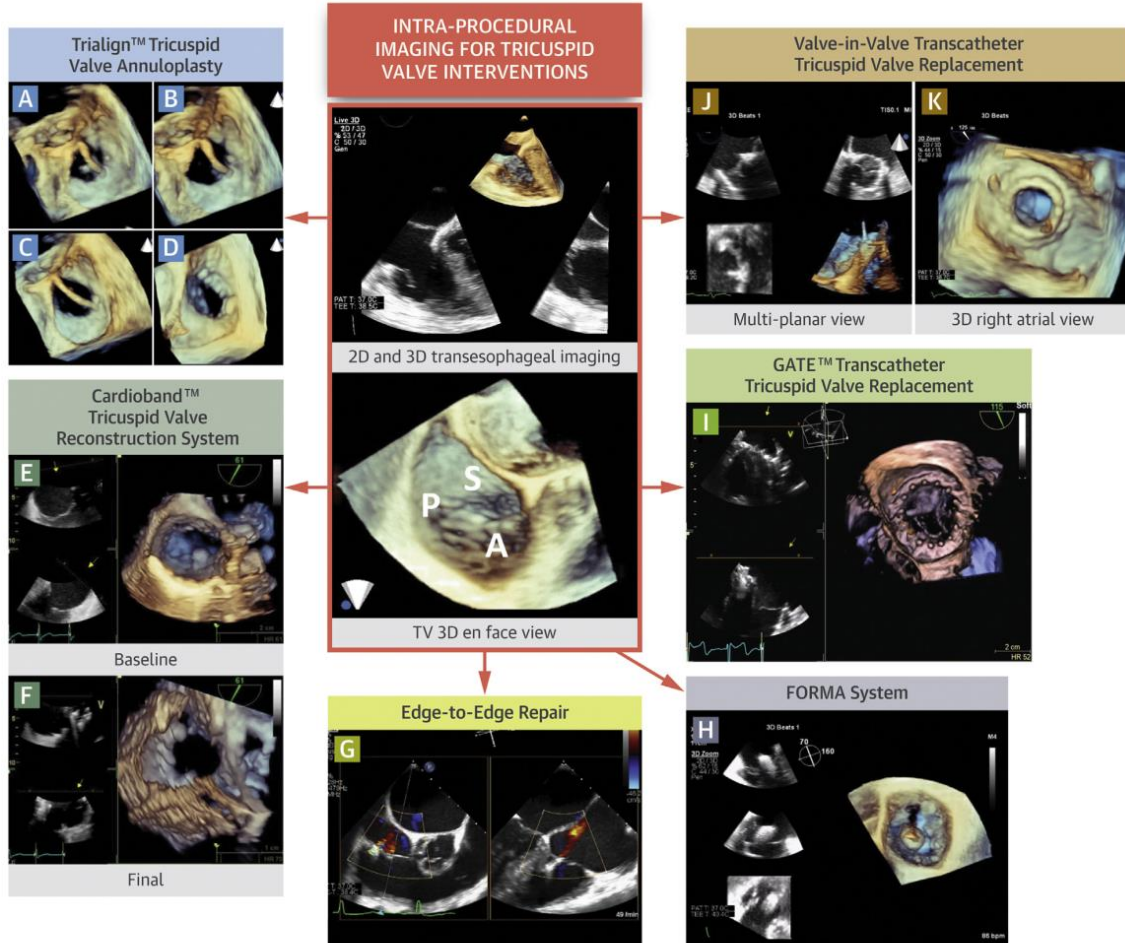
Tamarasso et al. JACC CI. 2018

THE LANCET

Transcatheter edge-to-edge repair for reduction of tricuspid regurgitation: 6-month outcomes of the TRILUMINATE single-arm study

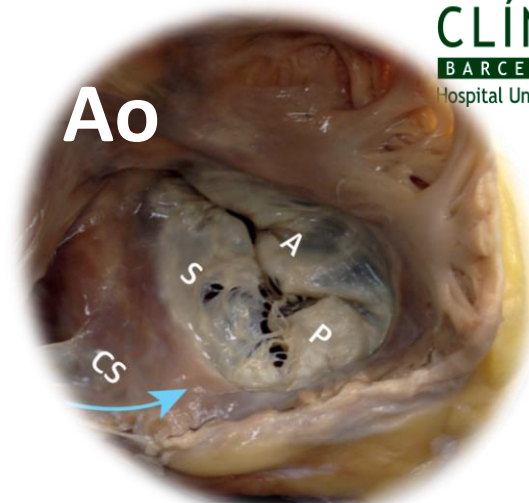
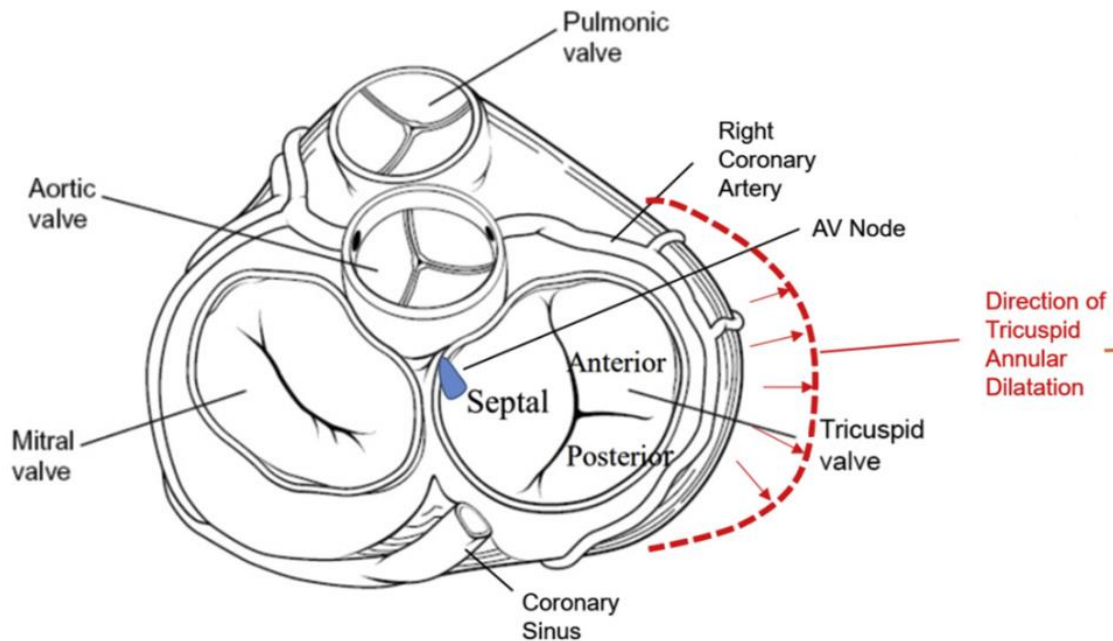
Georg Nickenig*, Marcel Weber*, Philipp Lurz, Ralph Stephan von Bardeleben, Marta Sitges, Paul Sorajja, Jörg Hausleiter, Paolo Denti, Jean-Noël Trochu, Michael Näbauer, Abdellaziz Dahou, Rebecca T Hahn

Volume 394, ISSUE 10213, P2002-2011, November 30, 2019

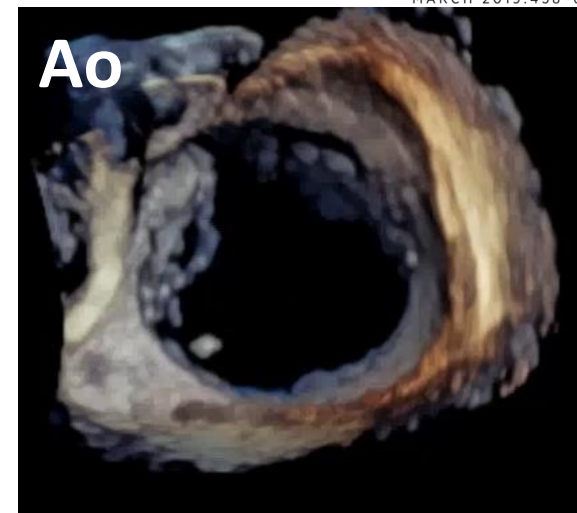


La imatge
cardiaca es
fonamental per la
selecció i guia del
intervencionisme
tricuspídi

ANATOMIA I FISIOPATOLOGIA



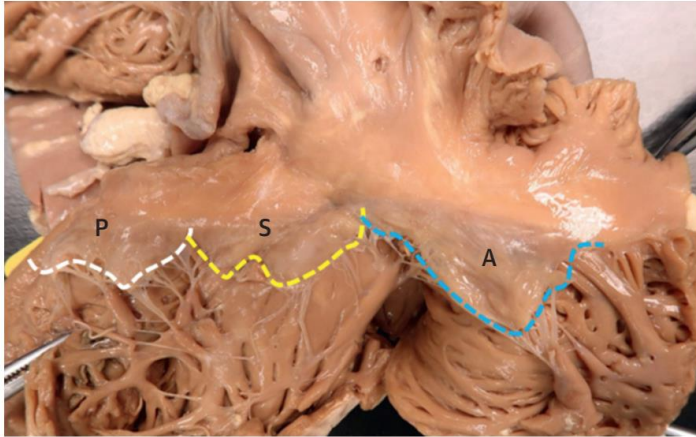
JACC: CARDIOVASCULAR IMAGING, VOL. 12, NO. 3, 2019
MARCH 2019:458-68



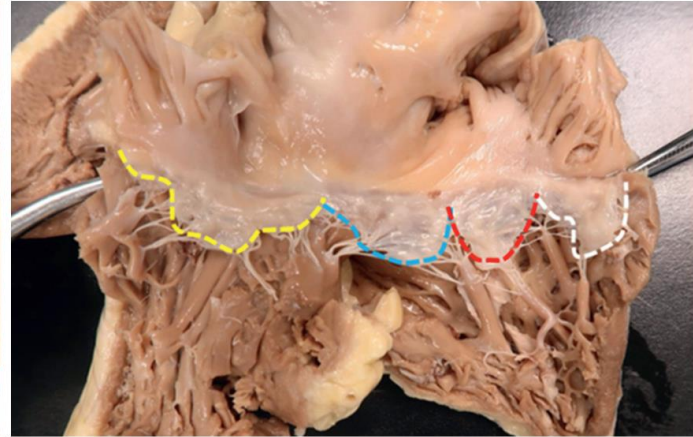
Dahou, A. et al. J Am Coll Cardiol Img. 2019;12(3):458-68.

FIGURE 2 Variable Tricuspid Leaflets

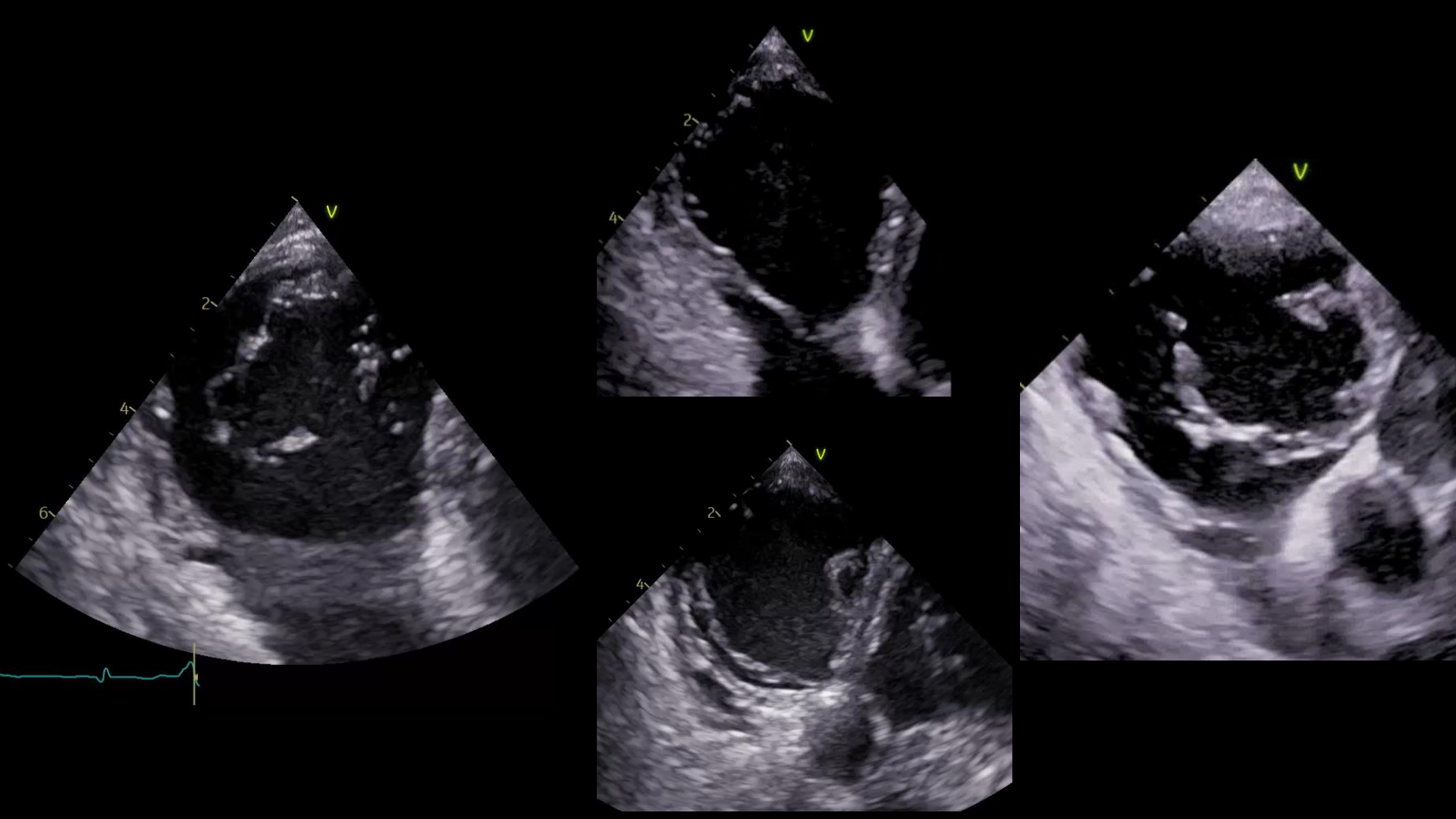
A

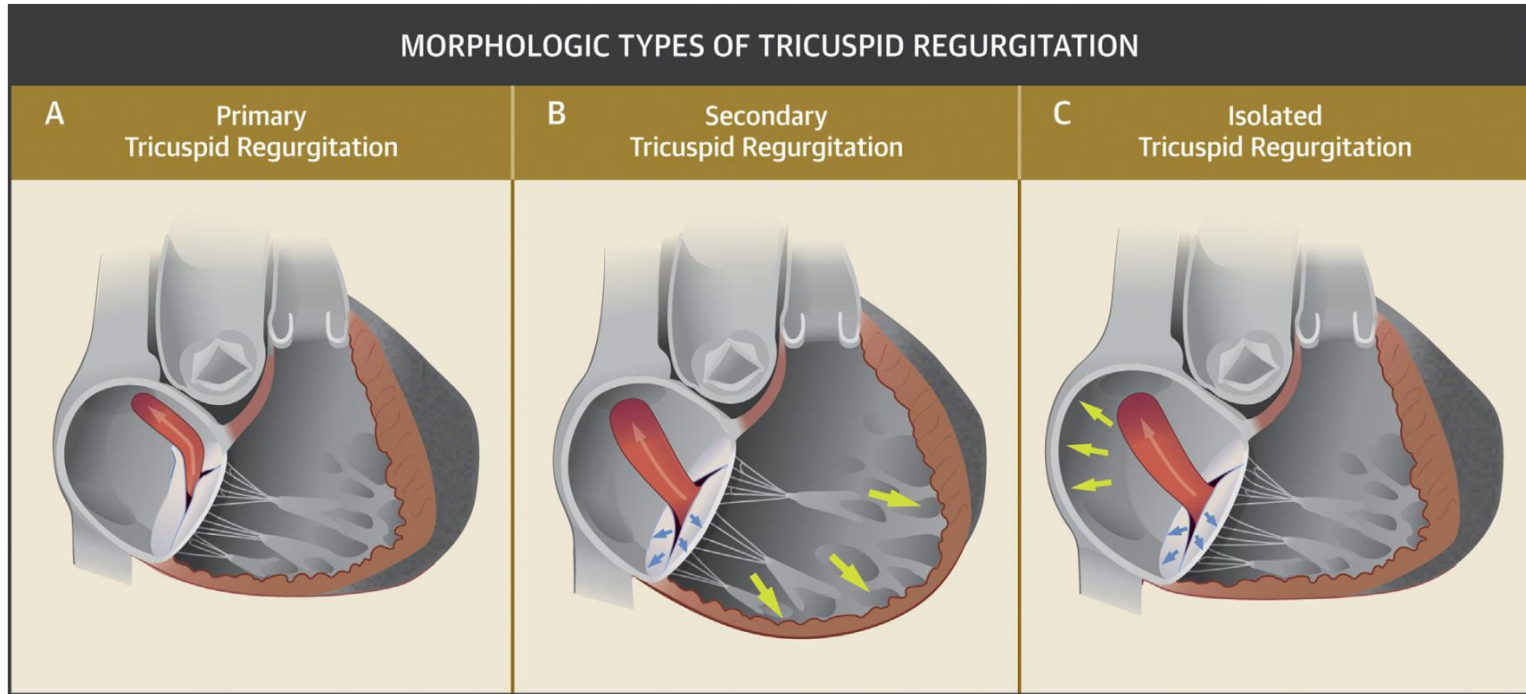


B



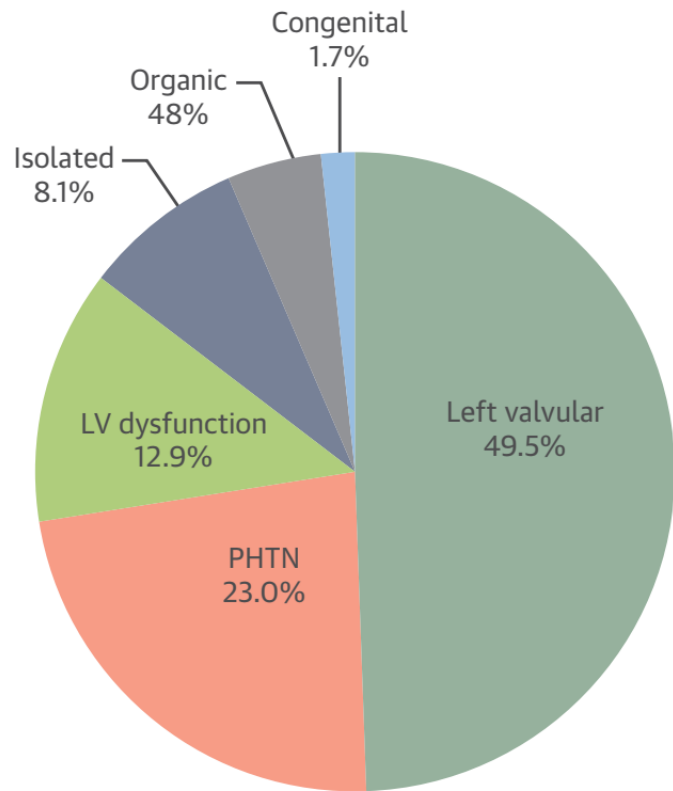
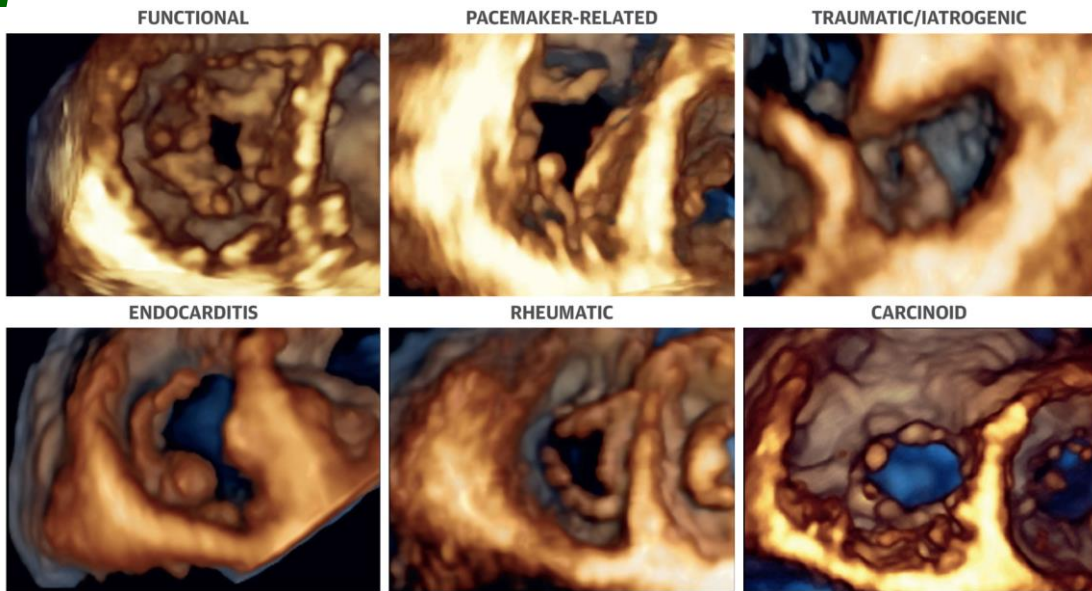
The number of tricuspid leaflets is highly variable. The most common configuration is a 3- leaflet valve (**A**). In this figure, the **white line** indicating the P leaflet, the **yellow line** indicates the S leaflet, and the **blue line** indicates the A leaflet. Frequently, more than 3 leaflets are seen (**B**). The **orange line** (**B**) represents the fourth leaflet in this quadricuspid valve. A = anterior leaflet; P = posterior leaflet; S = septal leaflet.





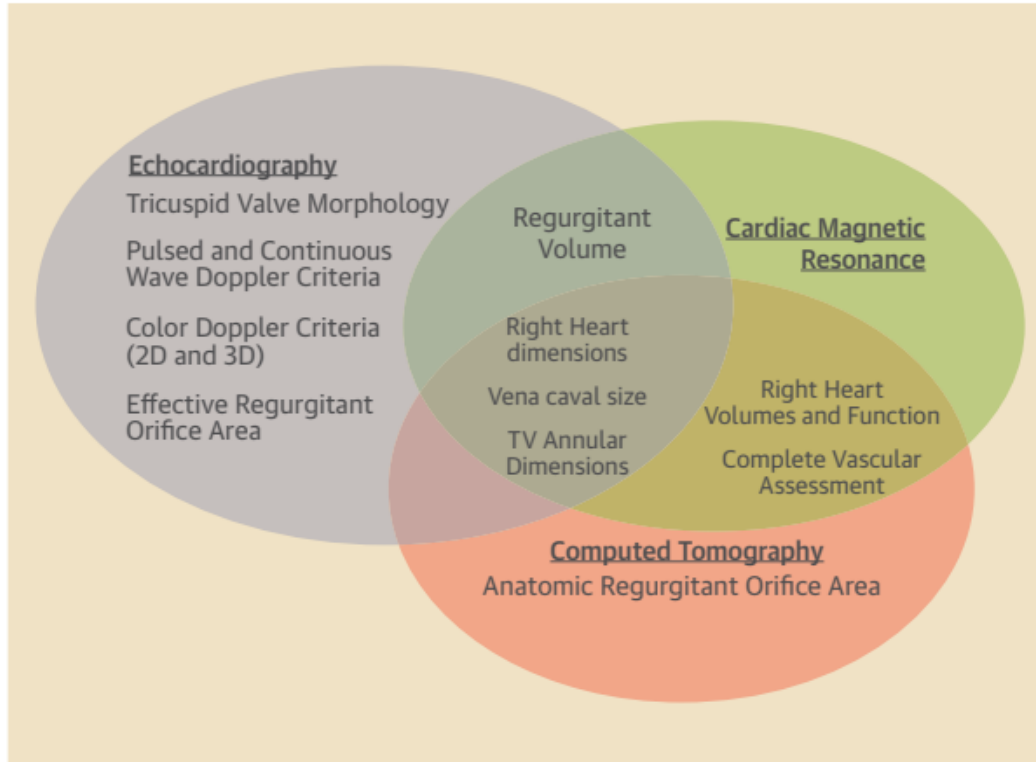
Prihadi, E.A. et al. *J Am Coll Cardiol Img.* 2019;12(3):491-9.

Primary tricuspid regurgitation **(A)**, where there is primary damage of the tricuspid valve apparatus (prolapse of the posterior leaflet in this example). Secondary tricuspid regurgitation **(B)**, due to significant dilation of the right ventricle (**arrows**) and tethering of the tricuspid valve leaflets and coaptation gap. Isolated tricuspid regurgitation **(C)** with dilation of the tricuspid annulus due to dilation of the right atrium (**arrows**) in the presence of atrial fibrillation.



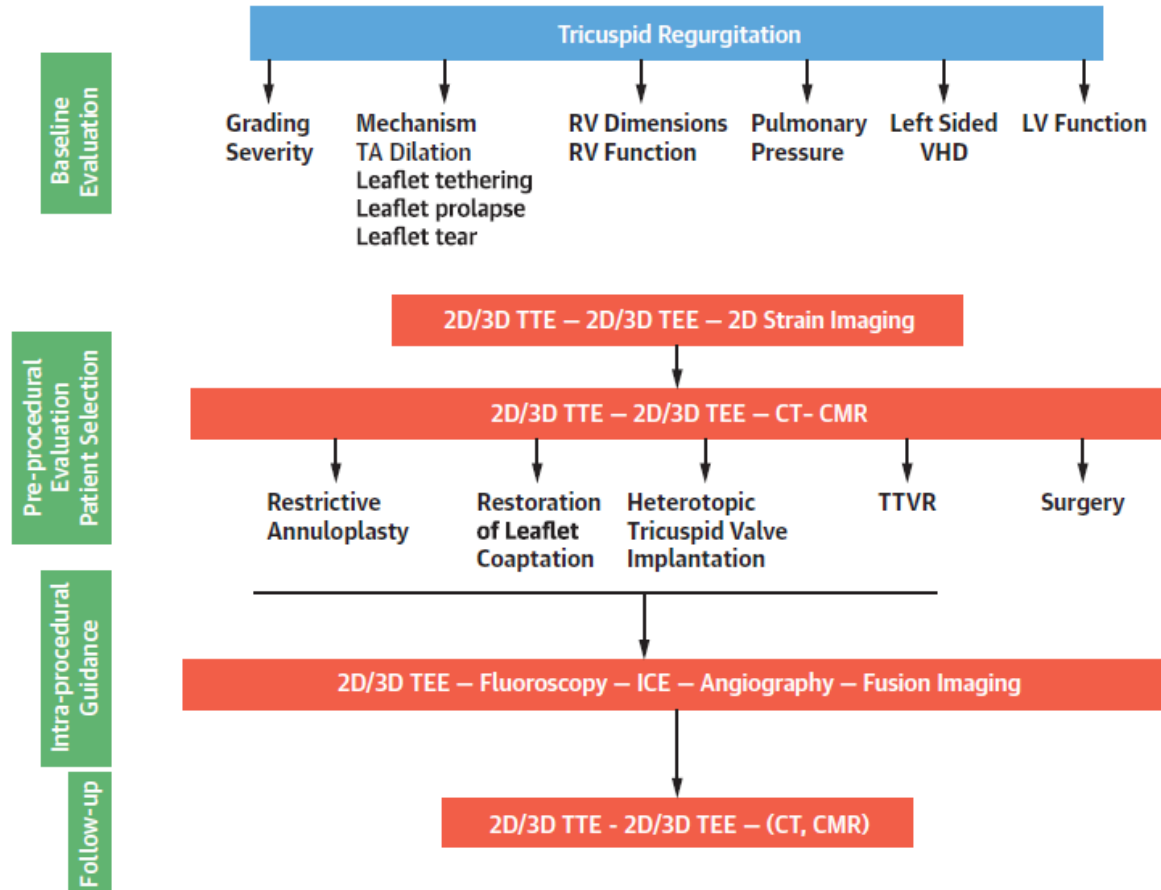
TÈCNIQUES DE IMATGE PER L'ESTUDI DE LA INSUFICIÈNCIA TRICUSPIDEA

Multi-modality Imaging for Assessment of Tricuspid Regurgitation Severity



Hahn, R.T. et al. J Am Coll Cardiol Img. 2019;12(3):469-90.

CENTRAL ILLUSTRATION Multimodality Imaging for Assessing Eligibility and Guiding Procedure for Transcatheter Tricuspid Valve Intervention



CMR



- right heart size and function
- tissue characterization (scar/infiltration)
- TR quantification
- leaflet morphology
- subvalvular apparatus

Khalique, O.K. et al. J Am Coll Cardiol Img. 2019;12(3):516-31.

FIGURE 5 Creation of RV Long-Axis Views From the Short-Axis Views

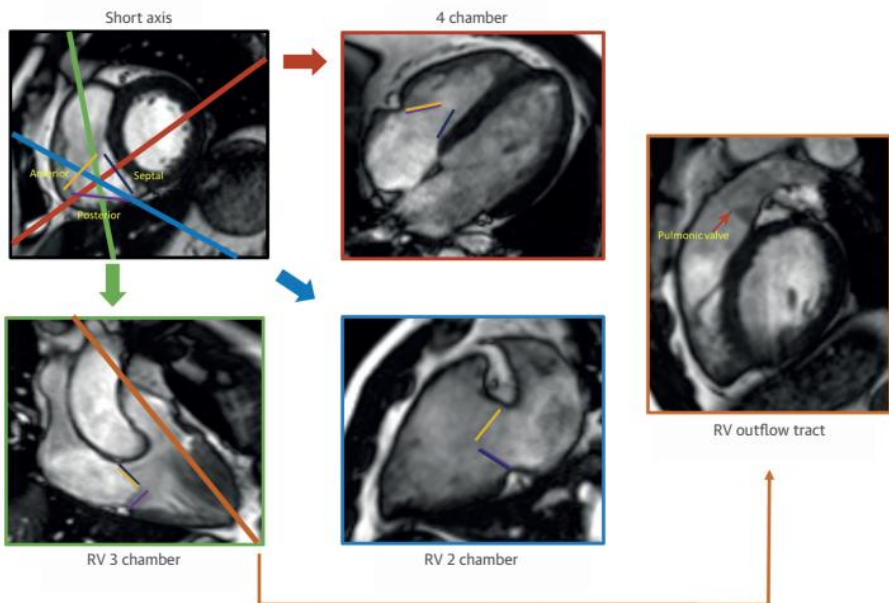


FIGURE 6 Simpson's Approach to RV Volumes With Colocalization Between Short-and Long-Axis Images, Using Post-Processing Software

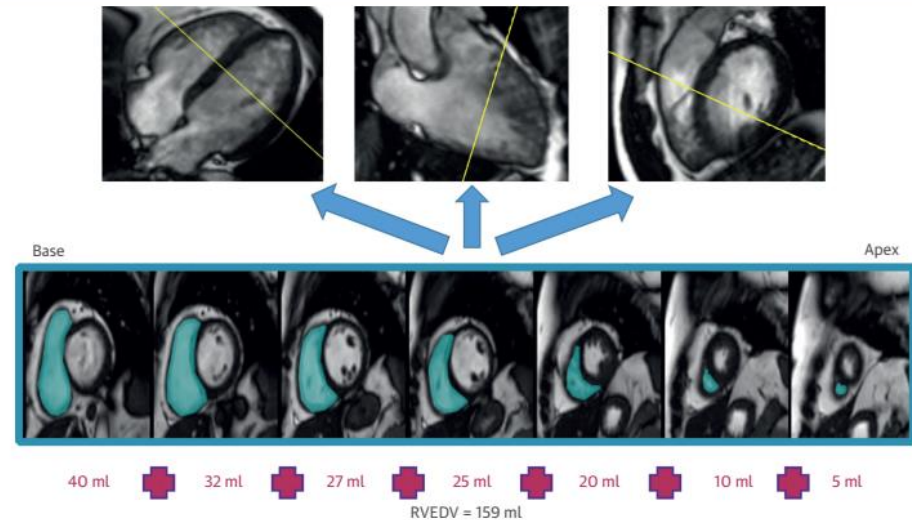
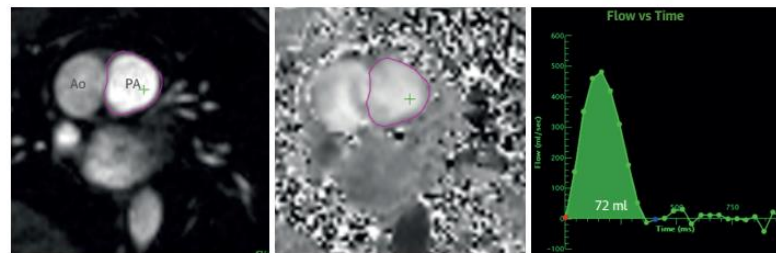
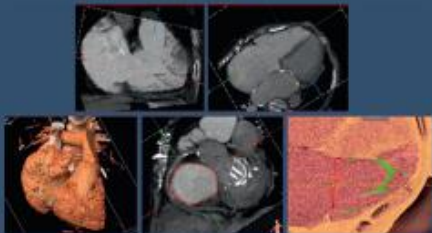


FIGURE 7 Pulmonic Phase Contrast Imaging to Determine Velocities and Flow



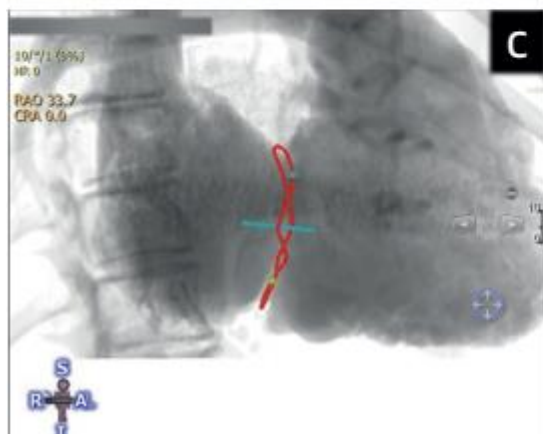
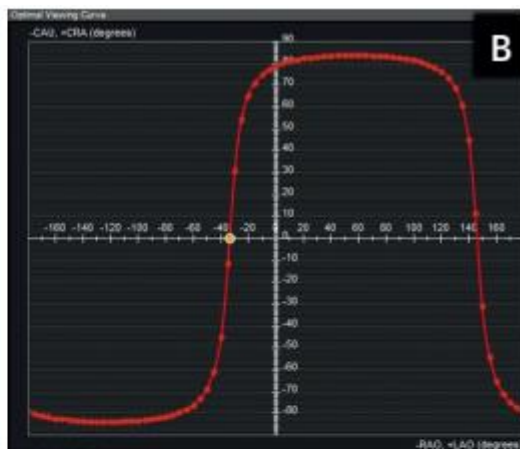
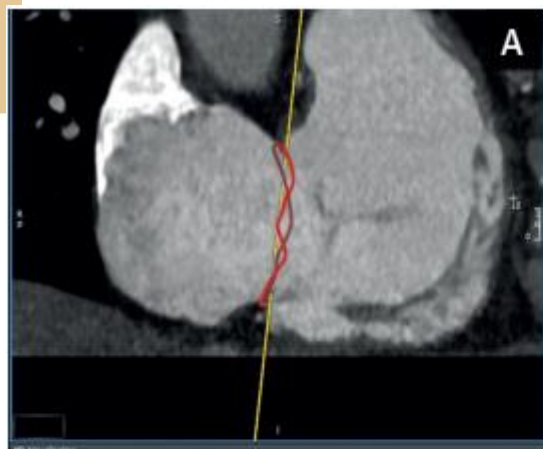
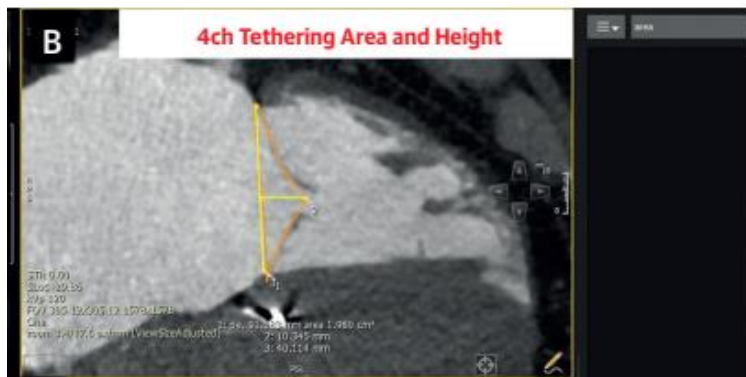
(Left) Anatomical cine image. (Middle) Velocity map measuring flow through the main pulmonary artery (purple outline). (Right) Integral of flow-time curve to determine stroke volume using post-processing software. AO = Aorta; PA = pulmonary artery.

MDCT



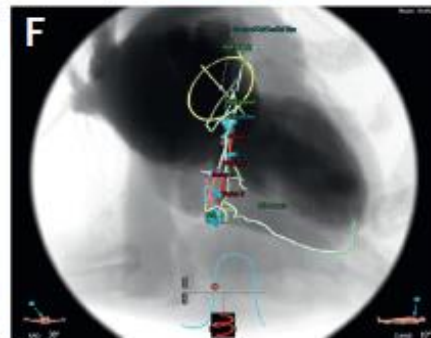
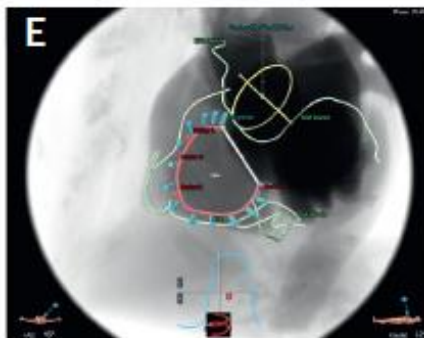
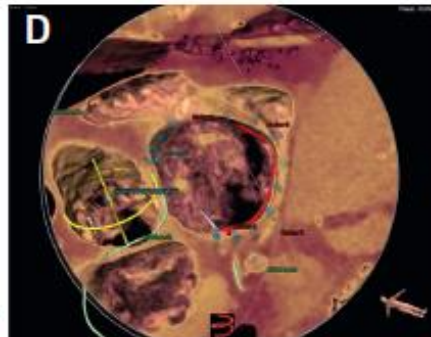
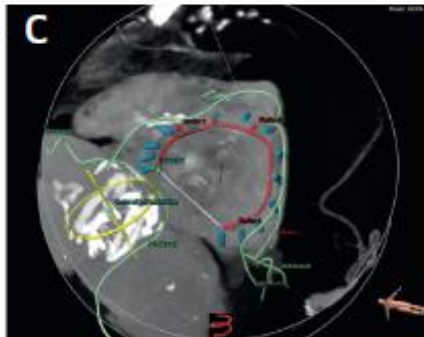
- annulus size
- right heart size and function
- subvalvular apparatus
- trabeculations
- coronary visualization
- vena cavae and femoral veins
- procedural planning

Khalique, O.K. et al. *J Am Coll Cardiol Img.* 2019;12(3):516-31.

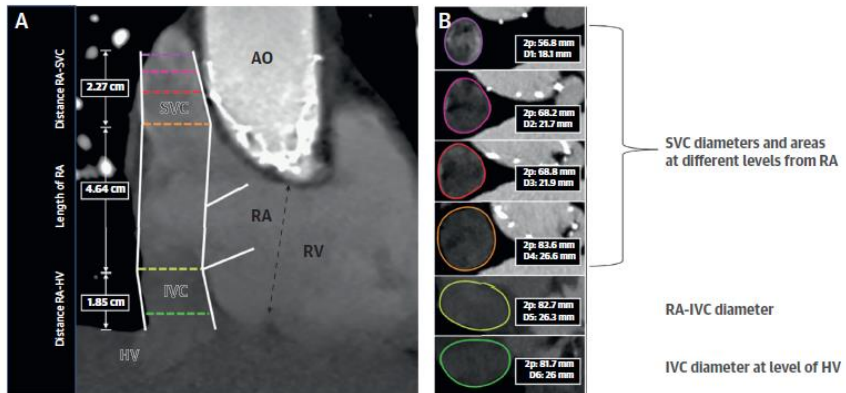




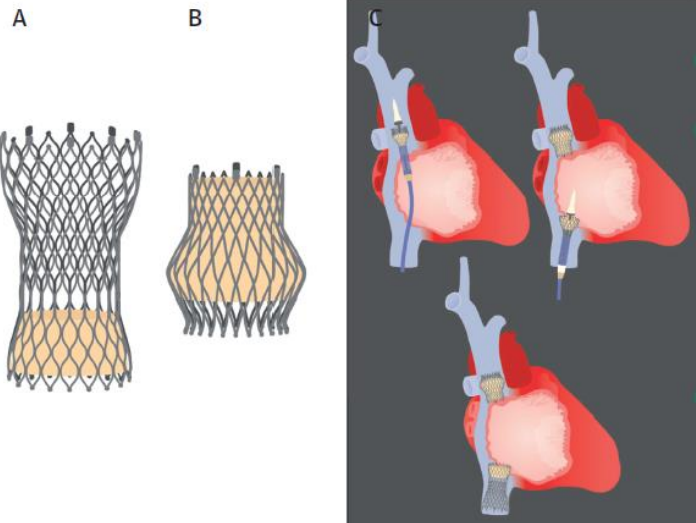
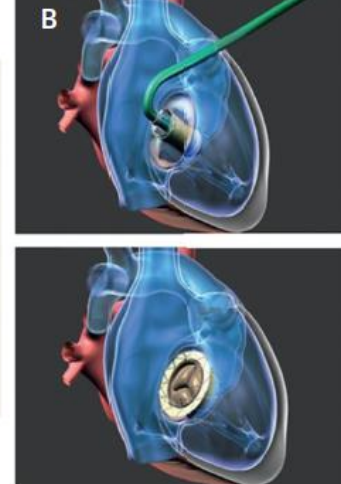
C



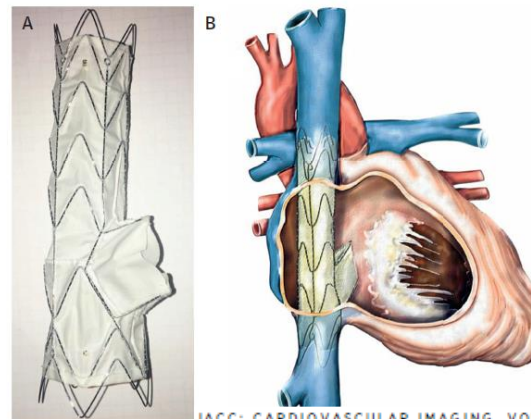
TriValve



Navigate Valve



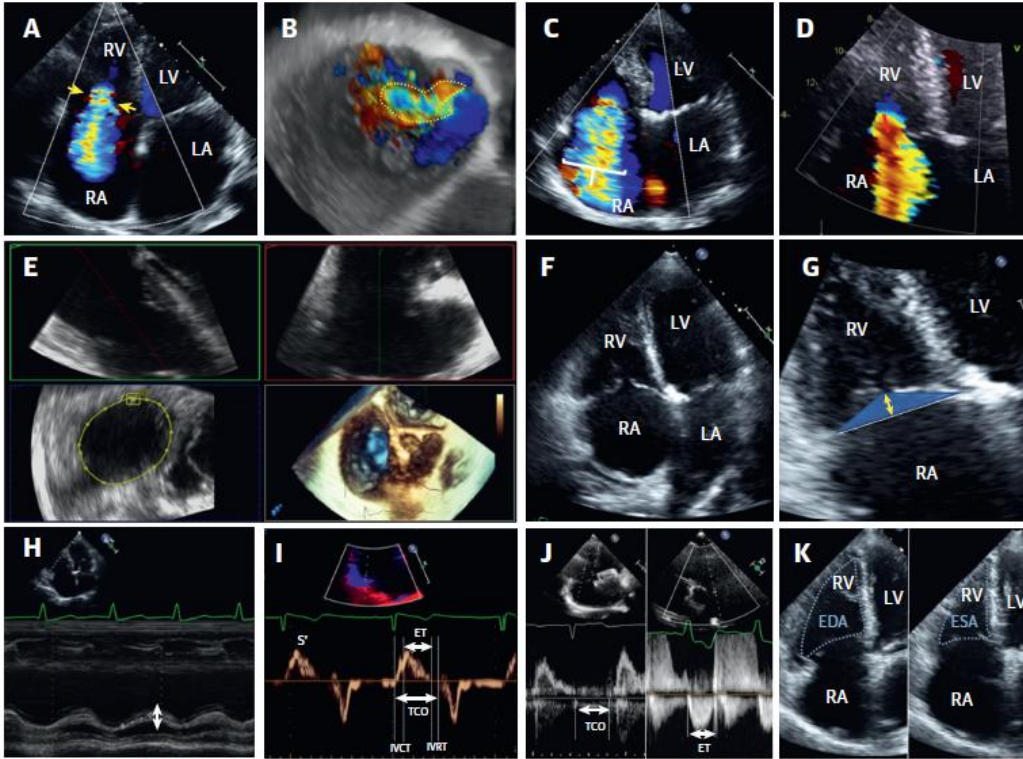
Tricento Valve

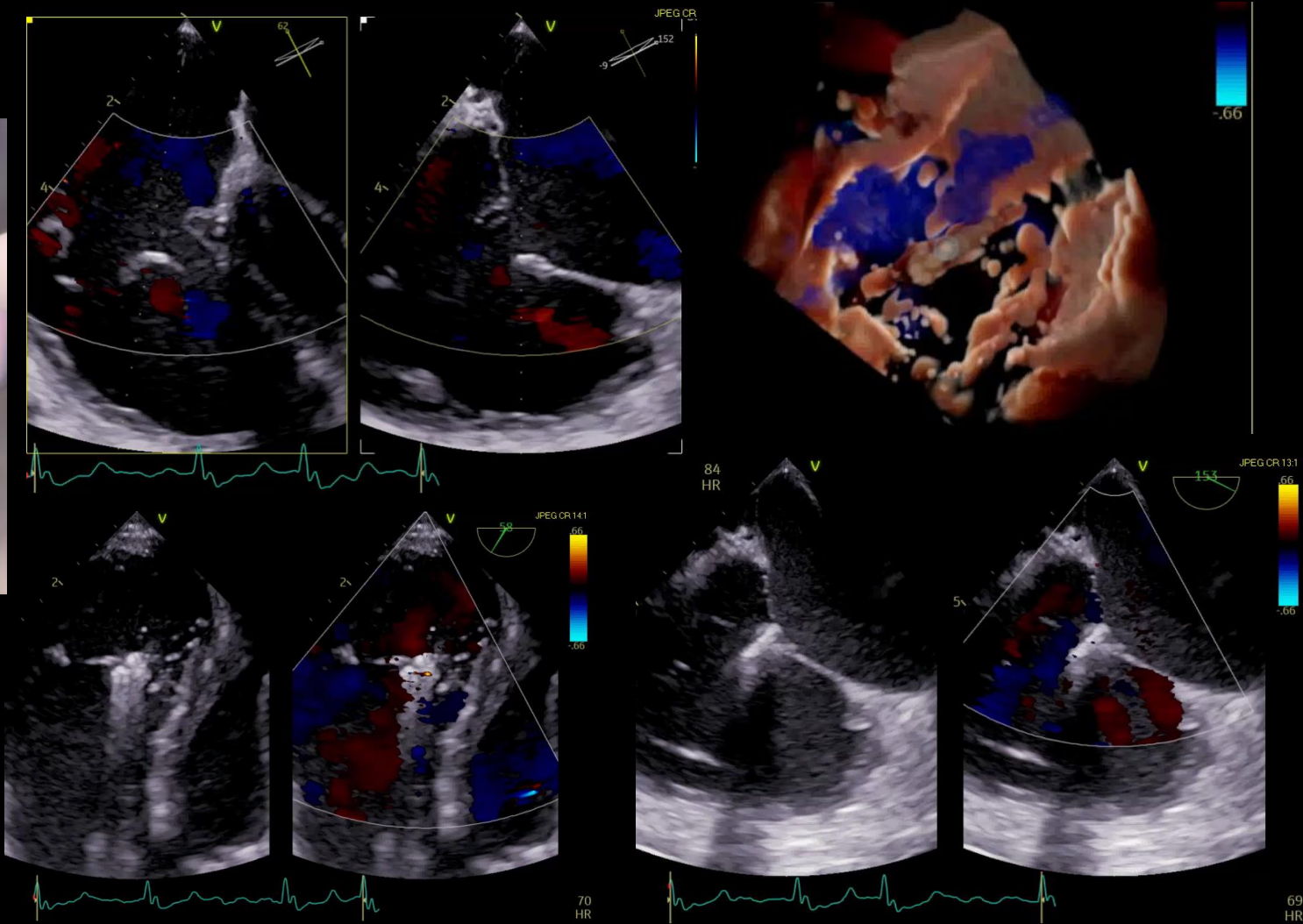


Ecocardiografia

Limitacions

- La posició anterior de la vàlvula dificulta la imatge amb ETE
 - Artefactes i ombra acústica de cavitats esquerres i SIA al ETE
- Dificultat per adquisició i interpretació. Requereix entrenament
- No pot avaluar les caves / CD
- Avaluació VD no sempre senzilla





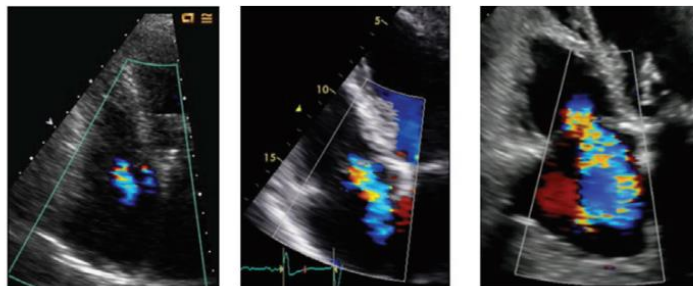
Ideal TR for edge-to-edge repair	Edge-to-edge repair to be considered	Edge-to-edge repair not recommended or only in exceptional cases
Secondary TR with structurally normal appearing leaflets	Secondary TR with normal appearing leaflets or primary TR with leaflet prolapse*	Severe leaflet (rheumatic) thickening 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

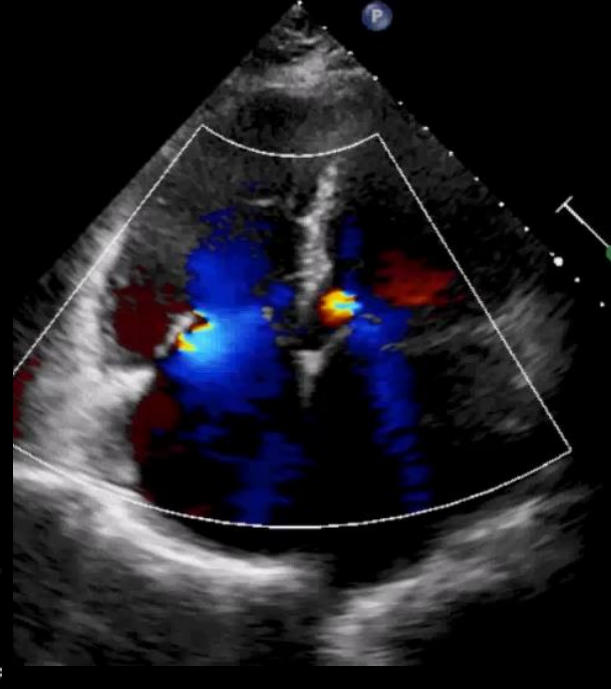
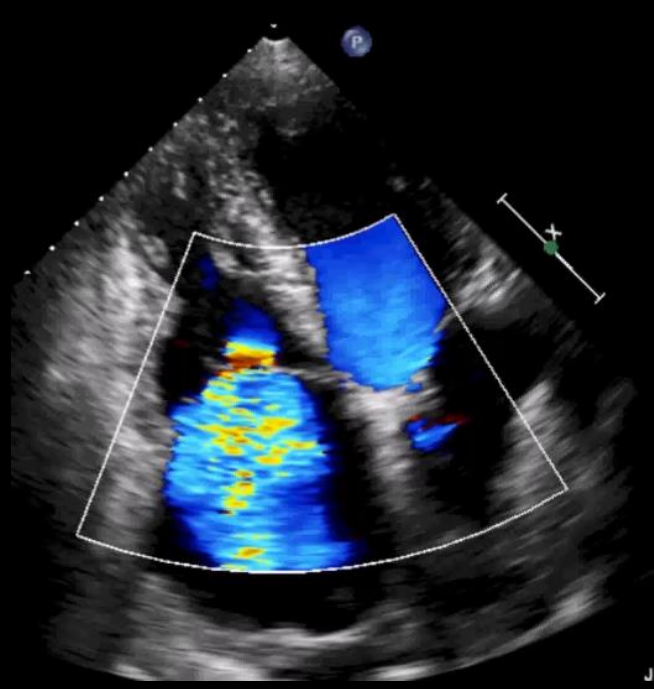
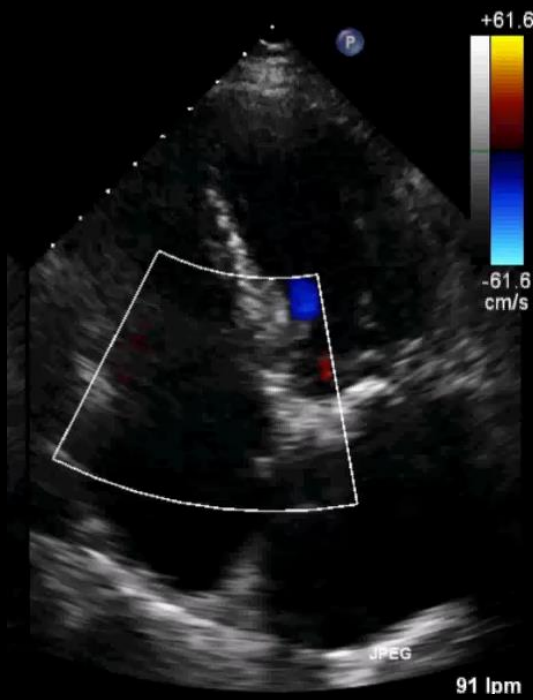
In addition to the displayed suitability criteria for tricuspid edge-to-edge (E2E) repair, all patients should (a) be symptomatic with right-sided heart failure symptoms, (b) be at high or prohibitive surgical risk, and (c) have severe TR. *Leaflet prolapse width <10-12 mm and flail gap <10 mm. ** Size 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

Gradació de la IT

Parameters	MILD	MODERATE	SEVERE
Vena Contracta width (biplane average)	<3 mm	3-6.9 mm	7 mm - 13 mm
EROA by PISA	<20 mm ²	20-39 mm ²	40-59 mm ²
3D Vena Contracta Area or Quantitative Doppler EROA	-	-	75-94 mm ²

Example:



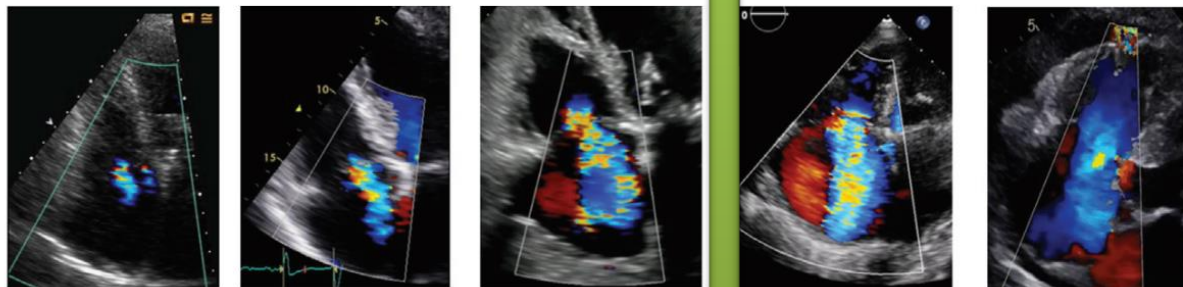


Gradació de la IT

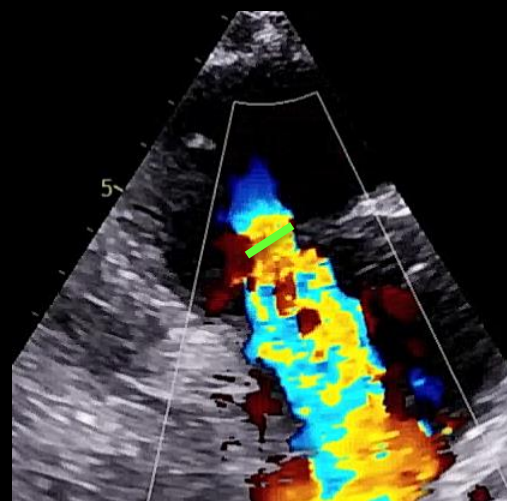
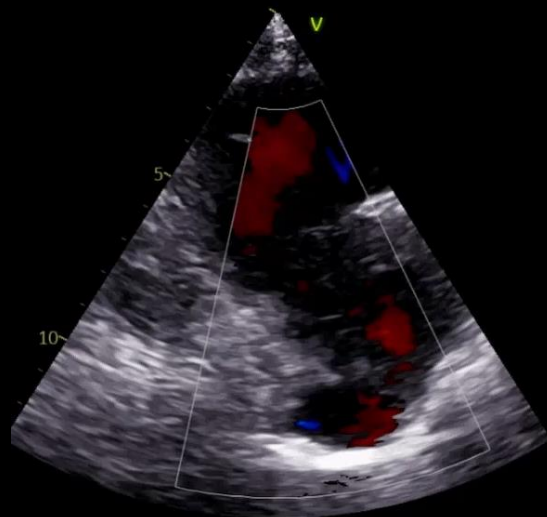
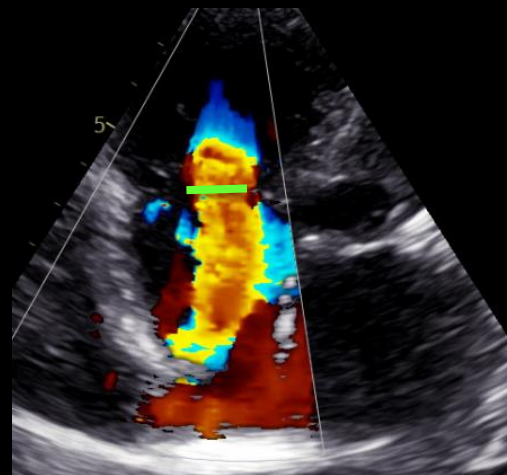
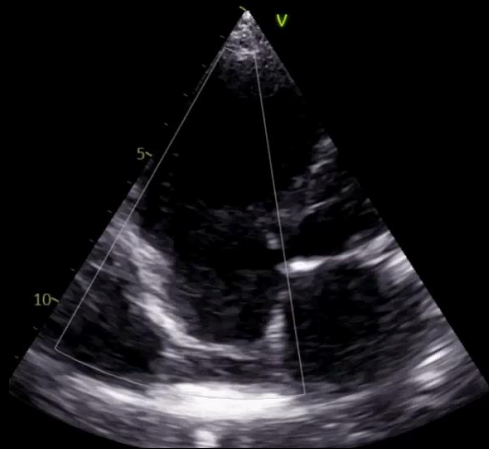


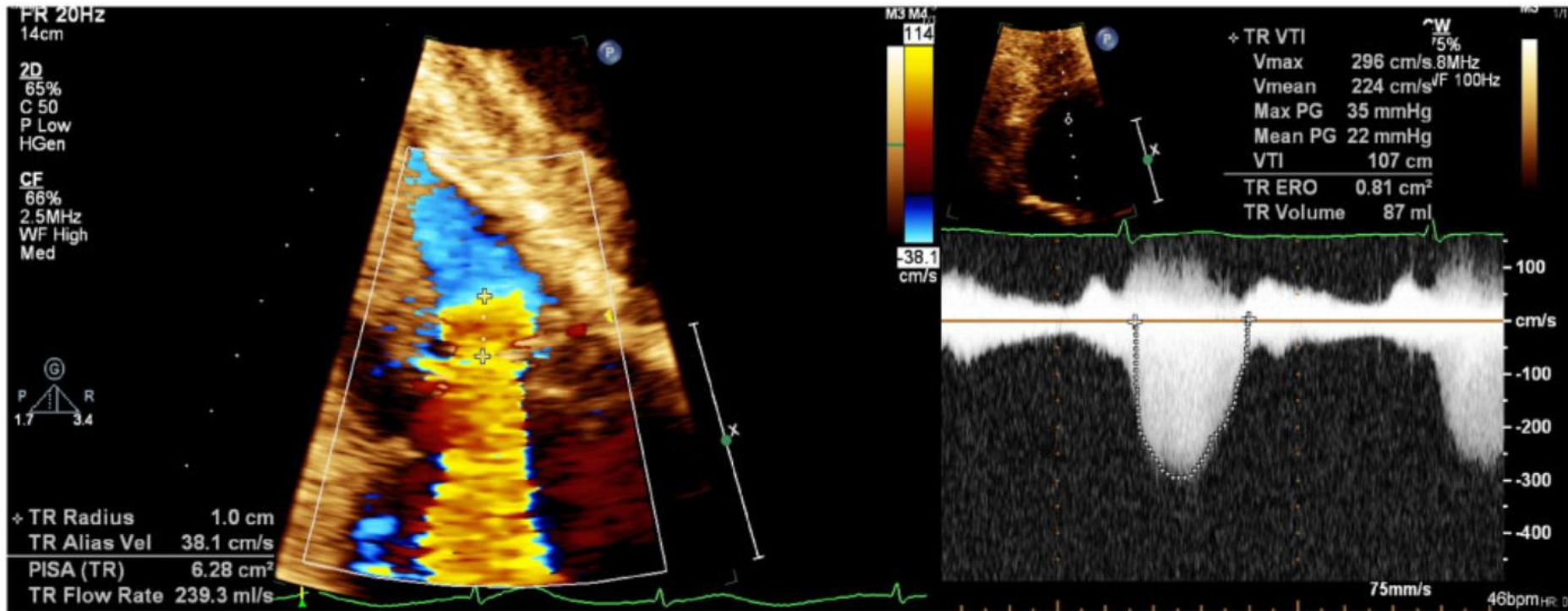
Parameters	MILD	MODERATE	SEVERE	MASSIVE	TORRENTIAL
Vena Contracta width (biplane average)	<3 mm	3-6.9 mm	7 mm - 13 mm	14-20 mm	≥21 mm
EROA by PISA	<20 mm ²	20-39 mm ²	40-59 mm ²	60-79 mm ²	≥80 mm ²
3D Vena Contracta Area or Quantitative Doppler EROA	-	-	75-94 mm ²	95-114 mm ²	≥115 mm ²

Example:



VC bi- pla

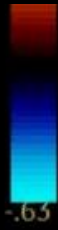
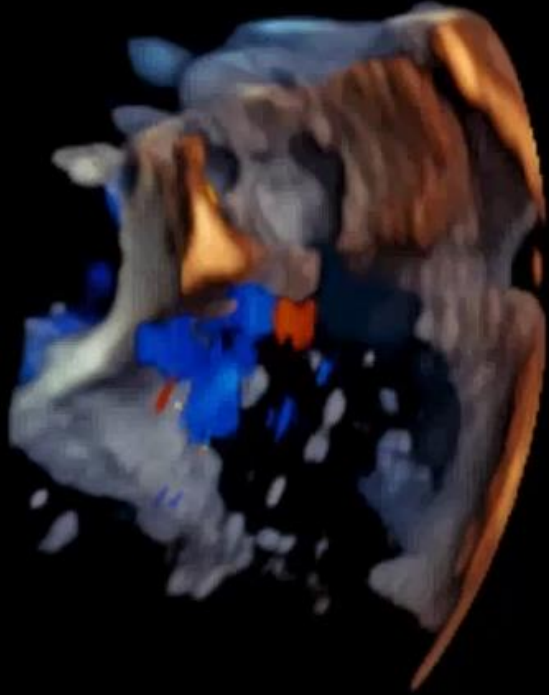




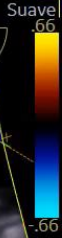
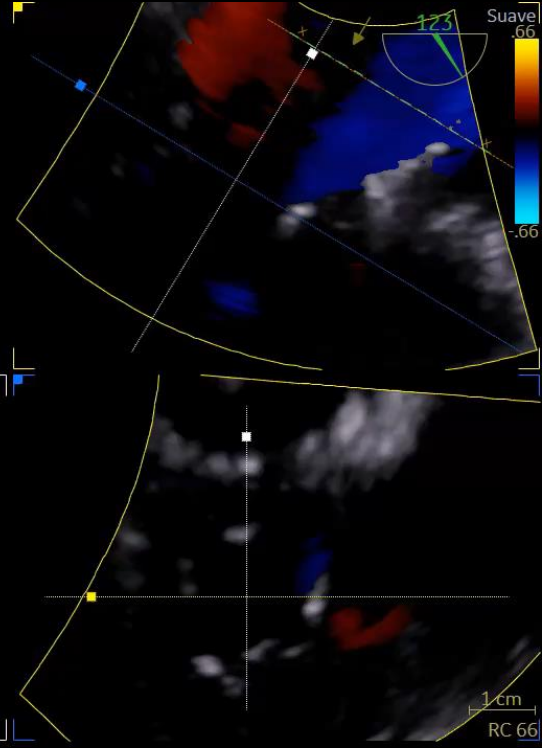
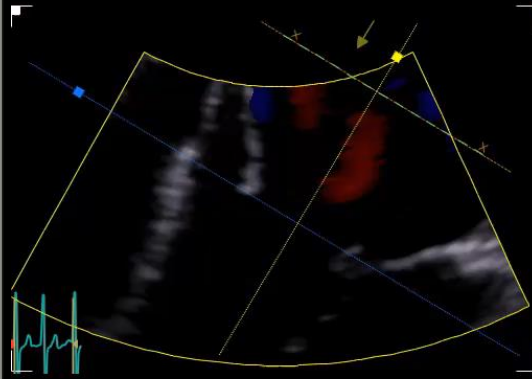
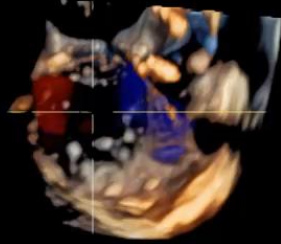
$$\text{TR Flow Rate} = \text{TR Radius}^2 \times 2\pi \times \text{Aliasing Velocity} = 1.0\text{cm}^2 \times 3.14 \times 2 \times 38.1\text{cm/s} = 239.3\text{cm}^3/\text{s}$$

$$\text{TR ERO} = \text{TR Flow Rate} / \text{Peak TR Velocity} = 239.3\text{cm}^3/\text{sec} / 296\text{cm/s} = 0.8 \text{ cm}^2$$

$$\text{TR Regurgitant Volume} = \text{ERO} \times \text{TR VTI} = 0.8\text{cm}^2 \times 107\text{cm} = 87\text{cm}^3 \text{ (cc)}$$

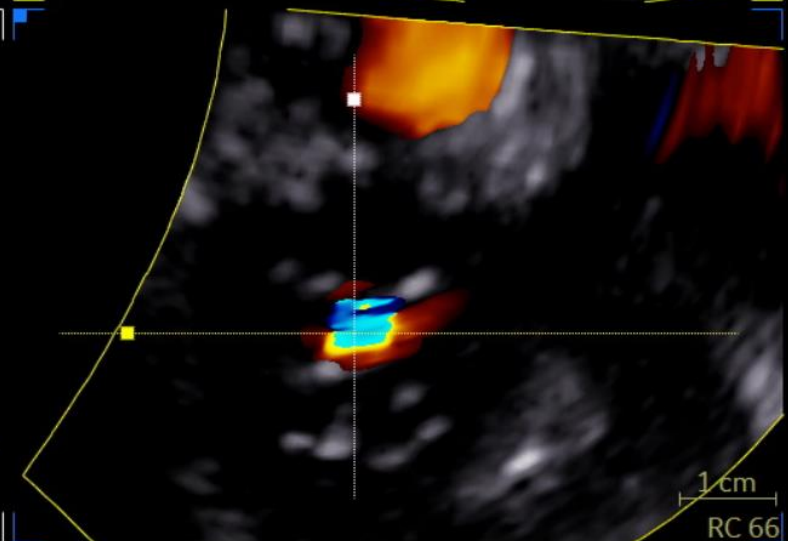
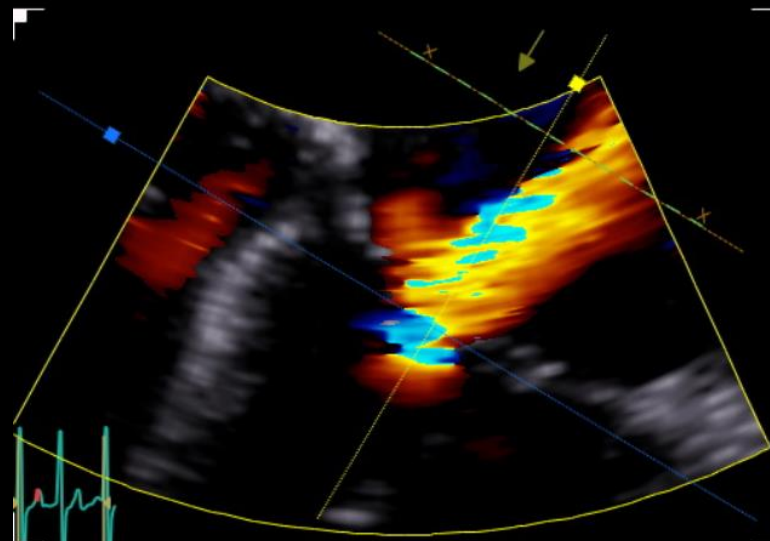
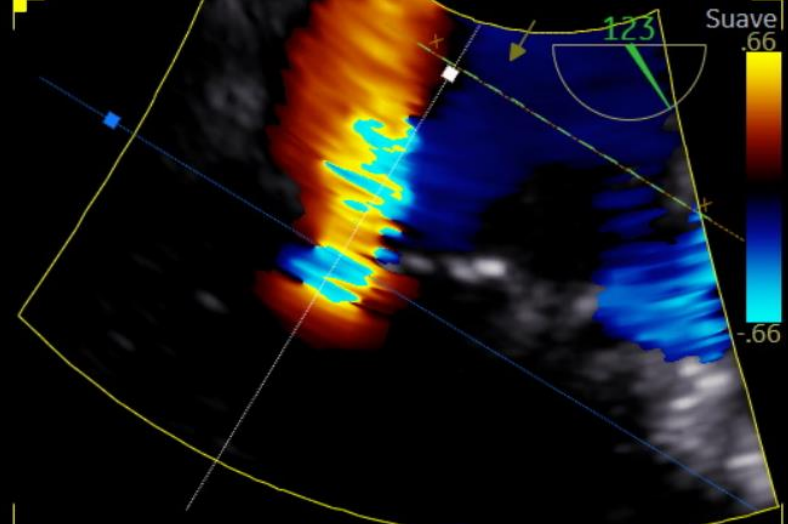
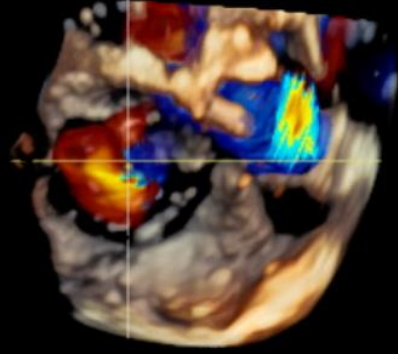


25/11/2020 09:17:05



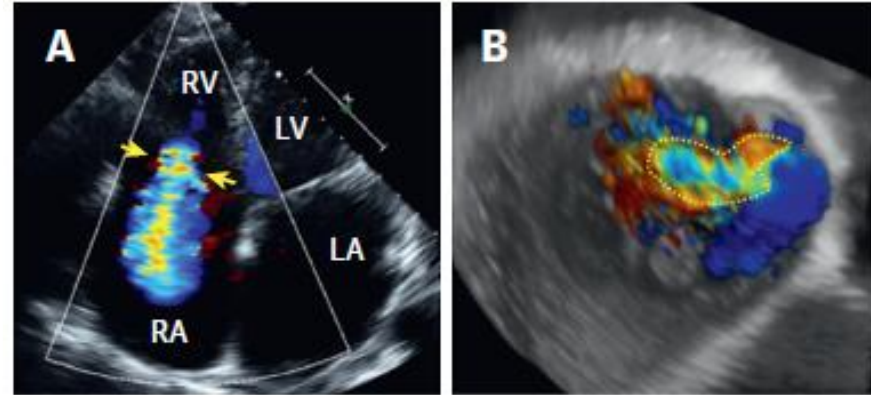
1 cm
RC 66

25/11/2020 09:17:05

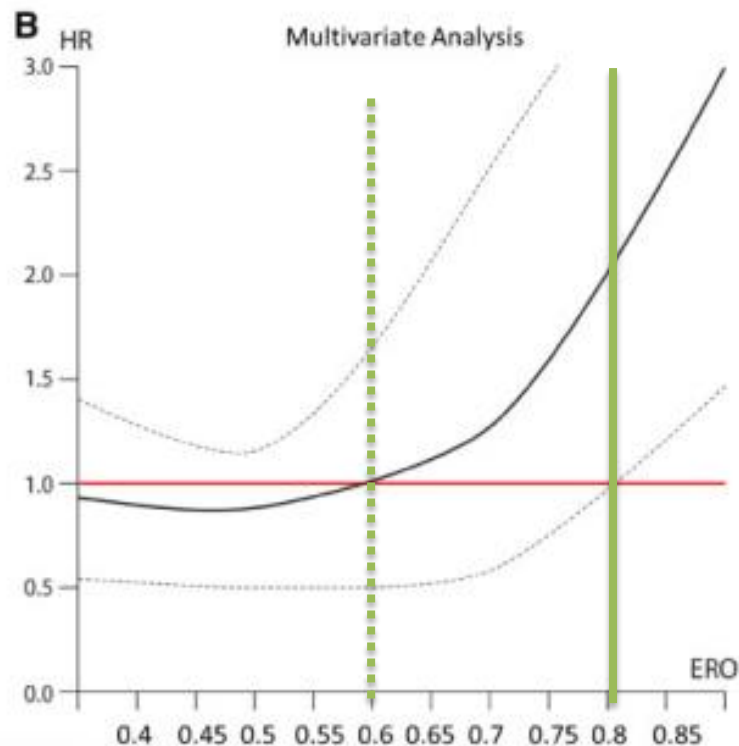
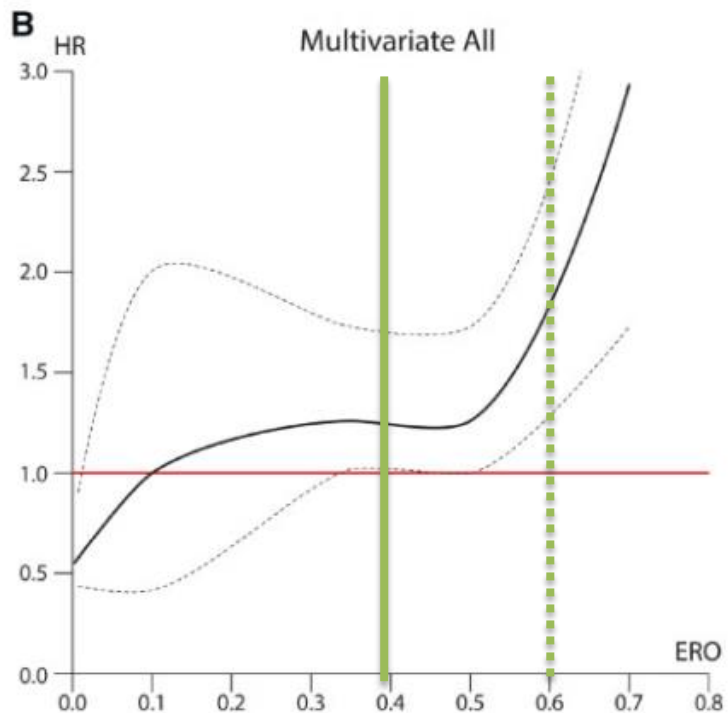


Problemes en la quantificació:

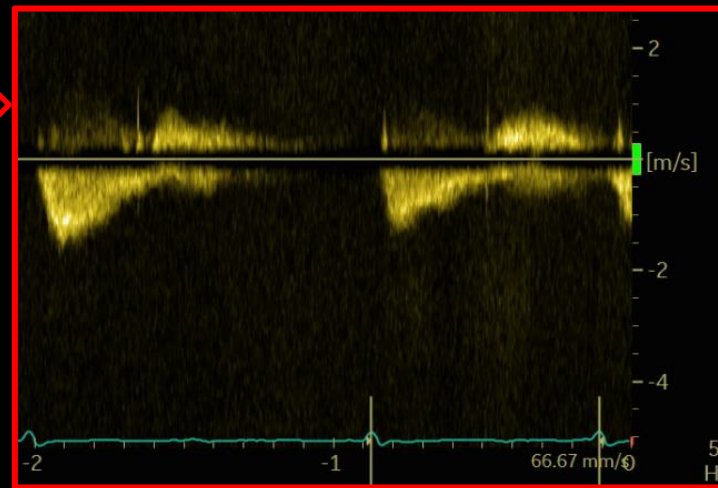
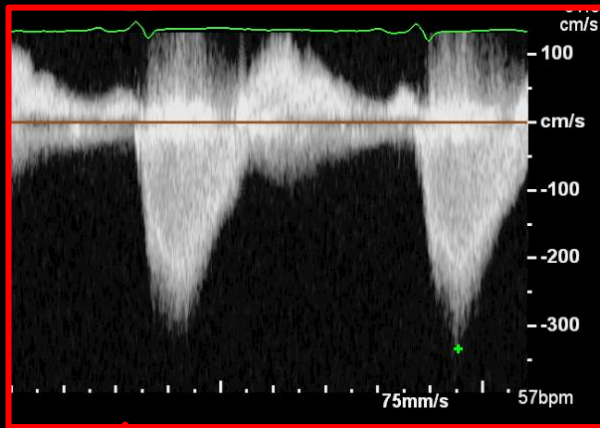
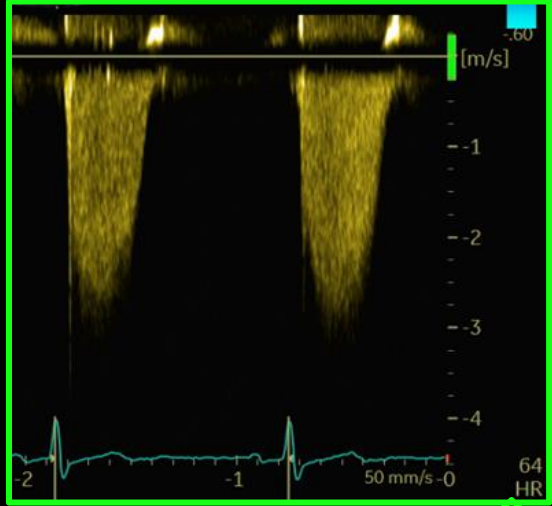
- Gran dependència de volèmia
- Variació de batec a batec
- Càlcul de PISA limitat
 - ORE no sempre circular
 - PISA no hemisfèric



Am Coll Cardiol Img 2021;14:61–11

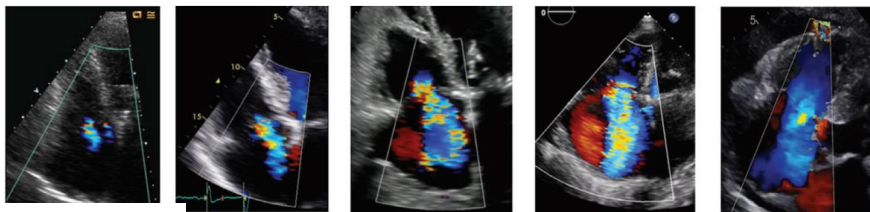







Importantly, lesser degrees of TR (<severe) by qualitative assessment were sometimes associated with ERO above 0.4 cm^2 , suggesting that for optimal risk assessment, quantization should be performed whenever qualitative assessment suggests moderate, or higher TR grades.



Parameters	MILD	MODERATE	SEVERE	MASSIVE	TORRENTIAL
Vena Contracta width (biplane average)	<3 mm	3-6.9 mm	7 mm - 13 mm	14-20 mm	≥21 mm
EROA by PISA	<20 mm ²	20-39 mm ²	40-59 mm ²	60-79 mm ²	≥80 mm ²
3D Vena Contracta Area or Quantitative Doppler EROA	-	-	75-94 mm ²	95-114 mm ²	≥115 mm ²

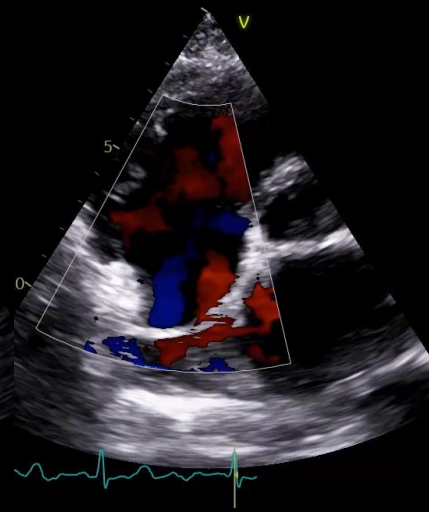
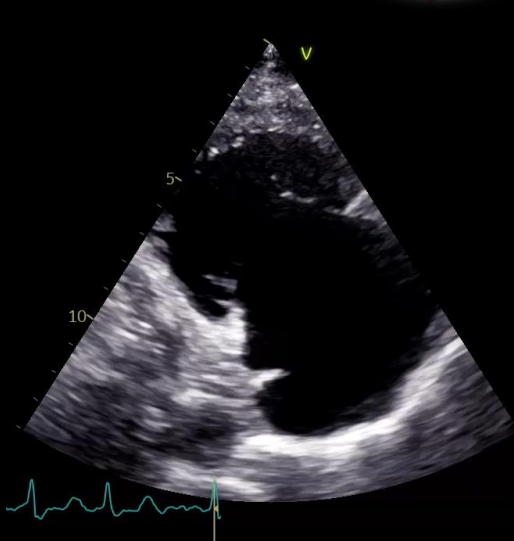
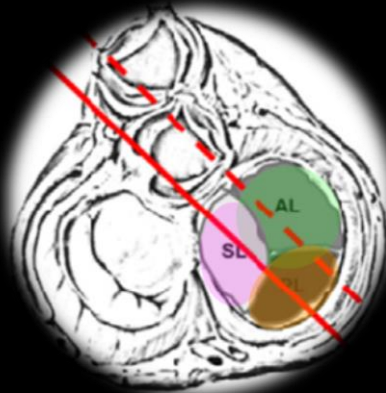
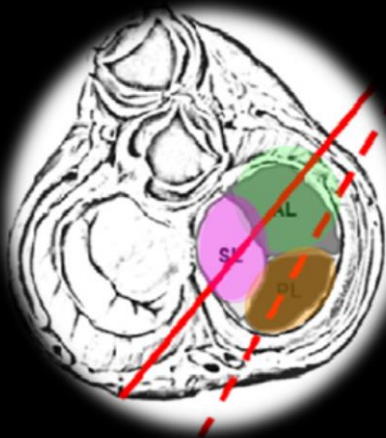
Example:



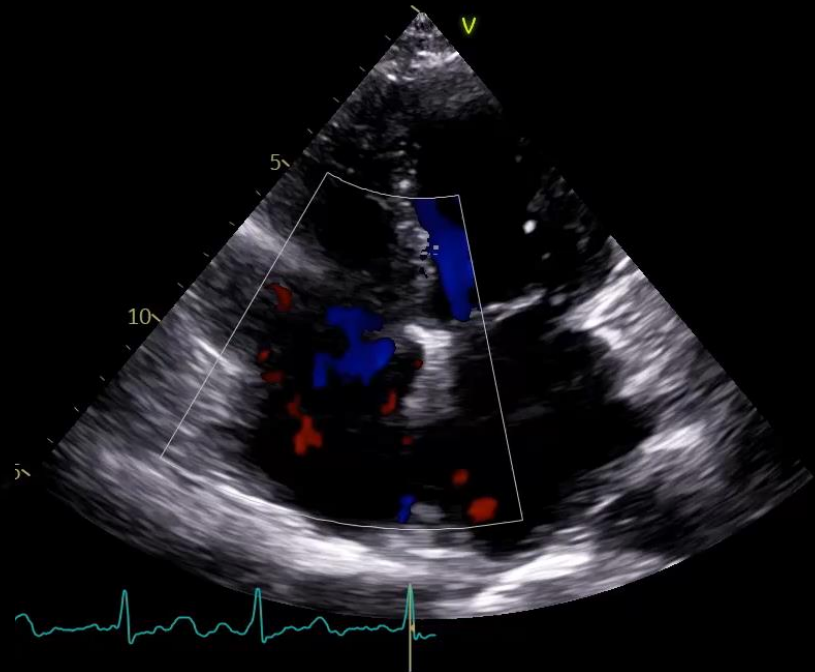
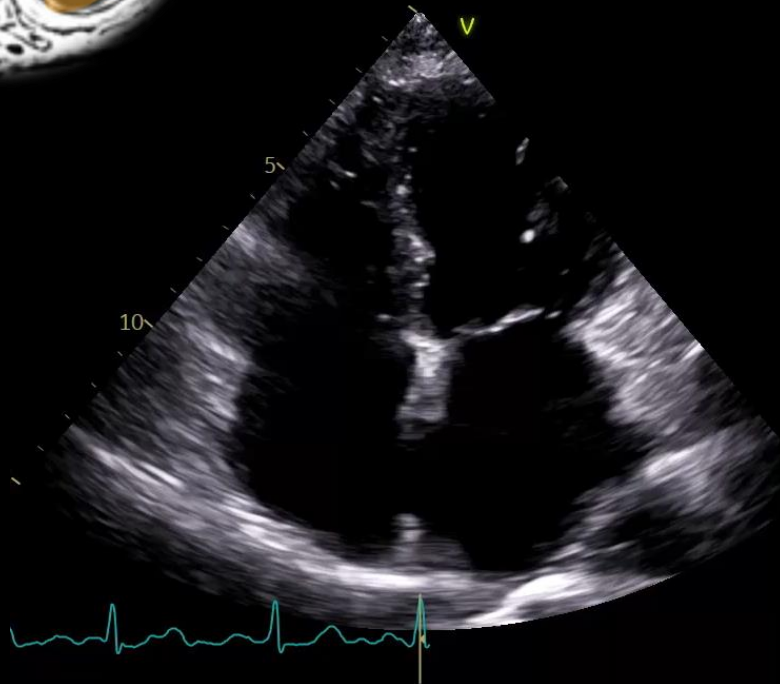
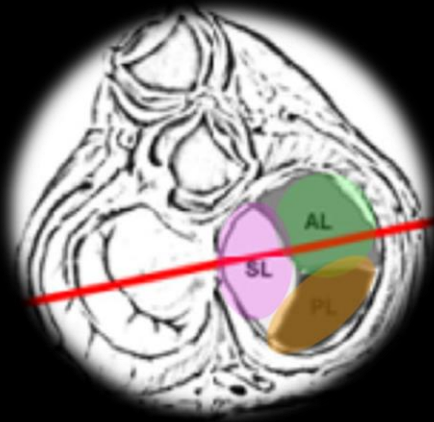
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
					
Symptoms	None	None*	None-vague*	Current or previous episodes of RHF	Overt RHF and/or end-organ damage due to chronic RV volume overload#
TR grade	Less than moderate	>Moderate	Severe	Severe	Torrential
Annular remodeling	Normal	Normal or mildly remodeled	Present	Moderate-severe	Severe
Leaflet coaptation	Normal	Mildly abnormal	Abnormal	Coaptation gap	Large coaptation gap
Tethering	None	None or mildly abnormal (<8 mm)	Abnormal (usually <8 mm)	Significantly abnormal with varying degree of tethering	Significantly abnormal (usually >8 mm)
RV function and remodeling	Normal	Normal function Absent or mild remodeling	Mild RV dysfunction and/or remodeling	>Moderate dysfunction and remodeling	Severe RV dysfunction and remodeling

AVALUACIÓ MORFOLÒGICA

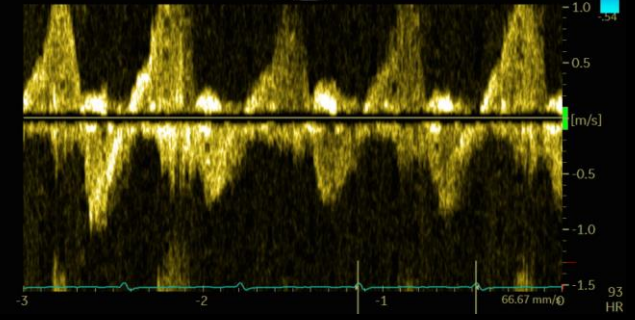
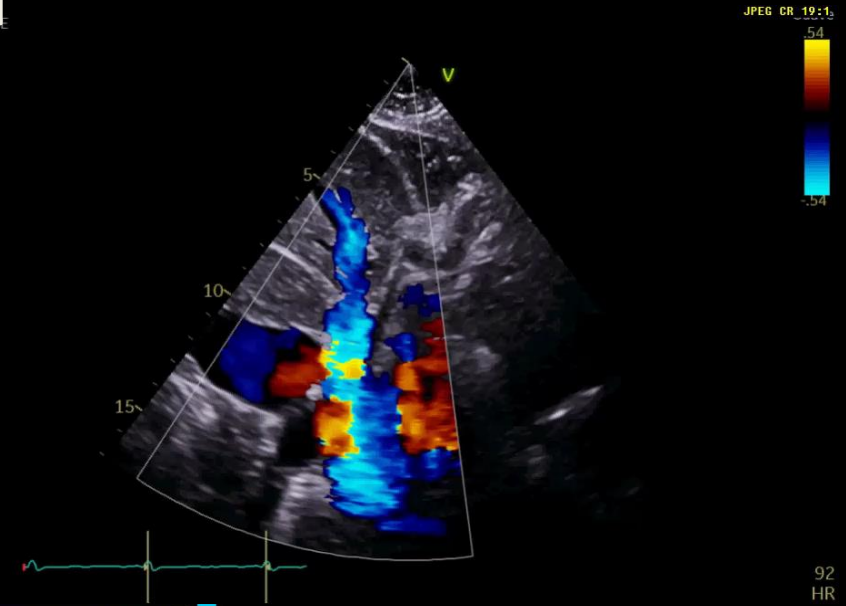
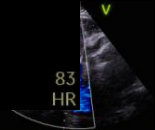
ETT



ETT



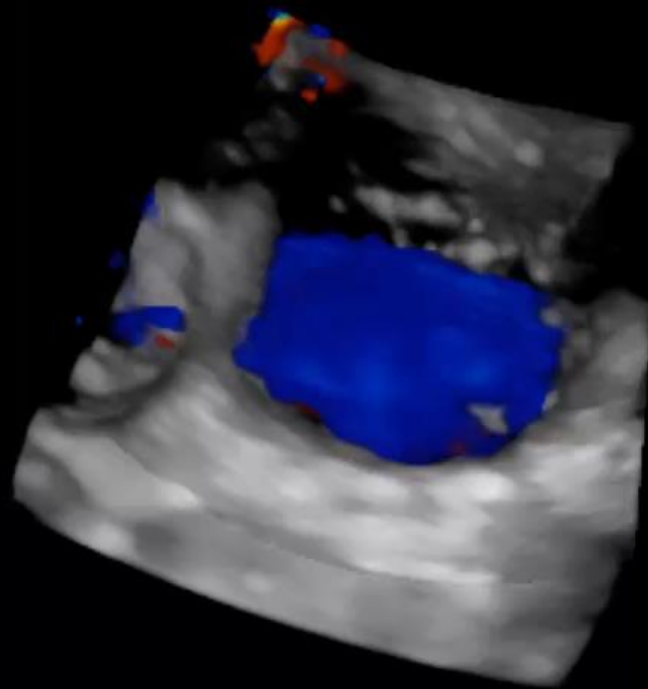
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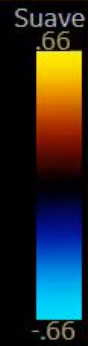
ETT



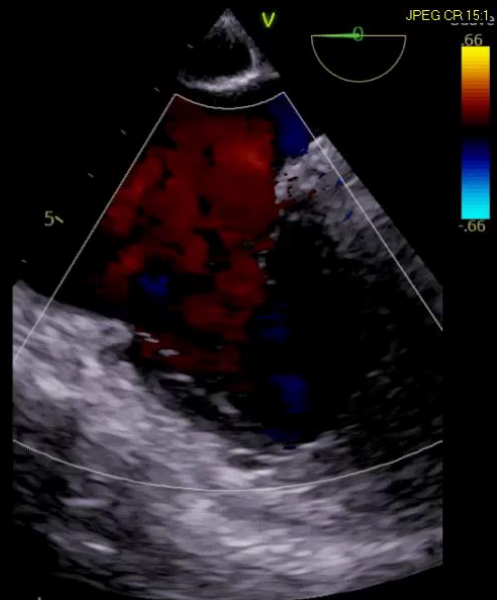
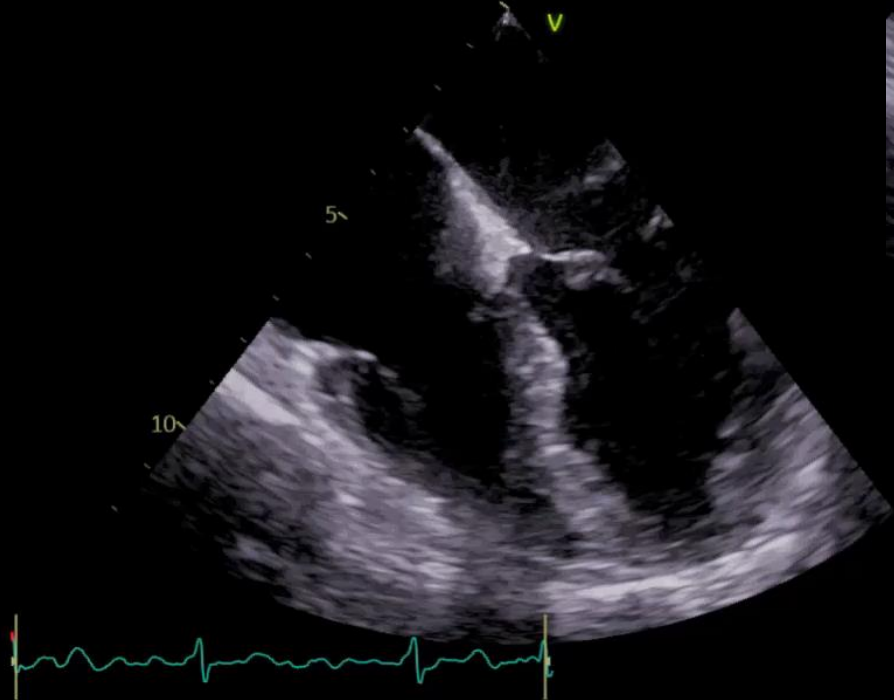
2 cm



2 cm
RC 79



ETE



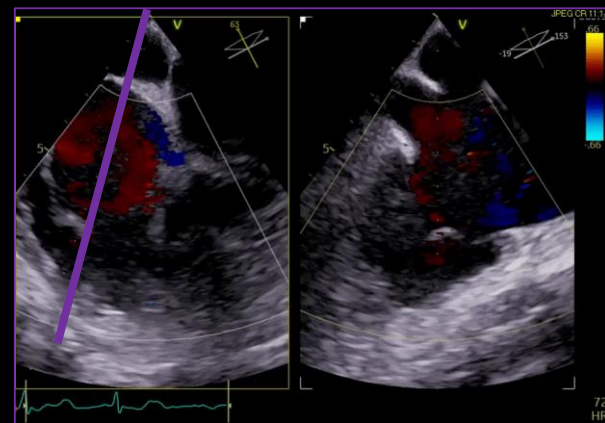
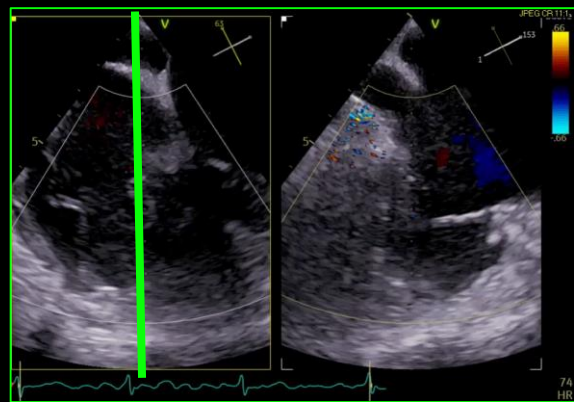
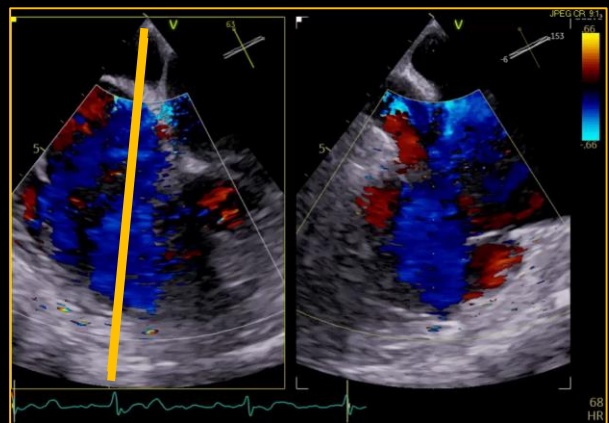
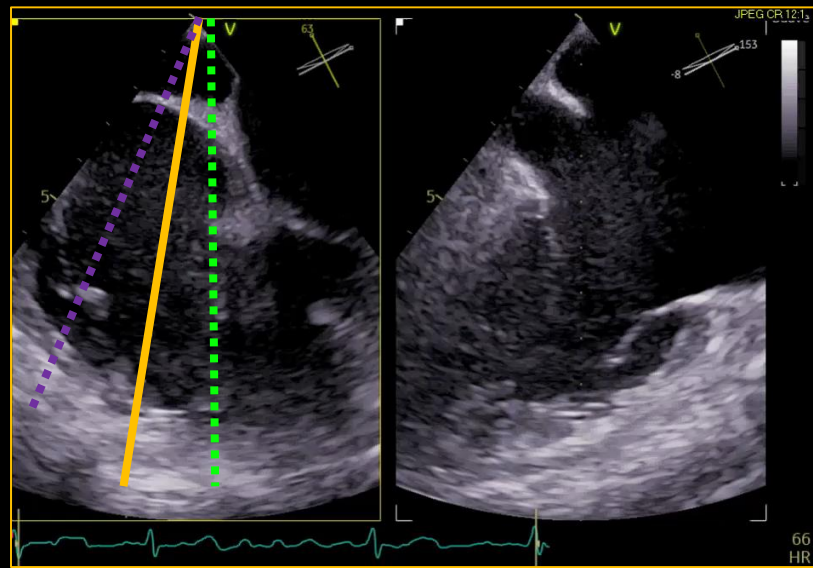
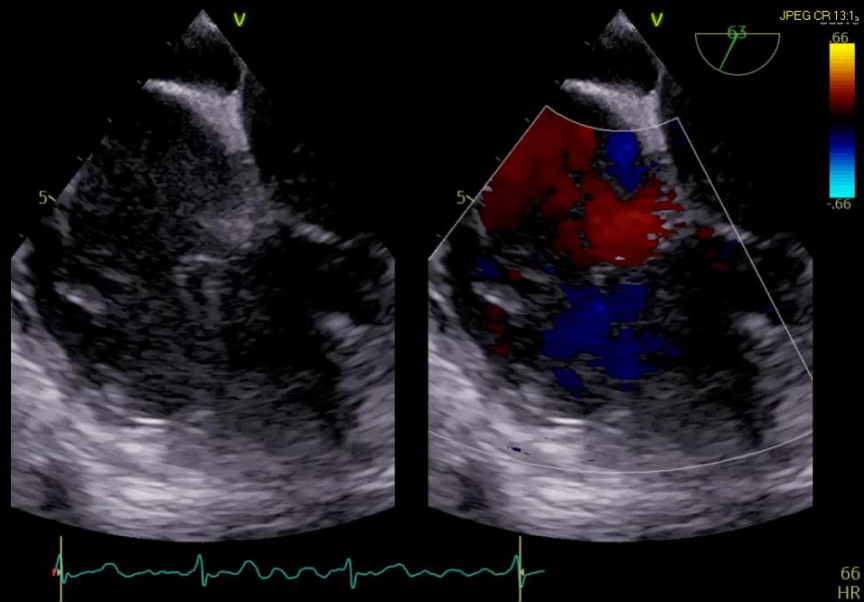
JPEG CR 15:13

66

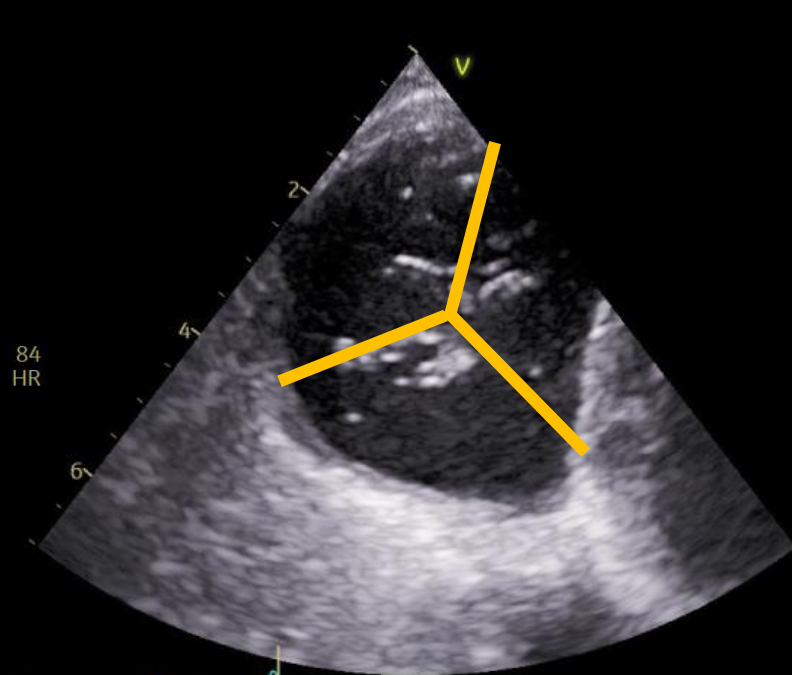
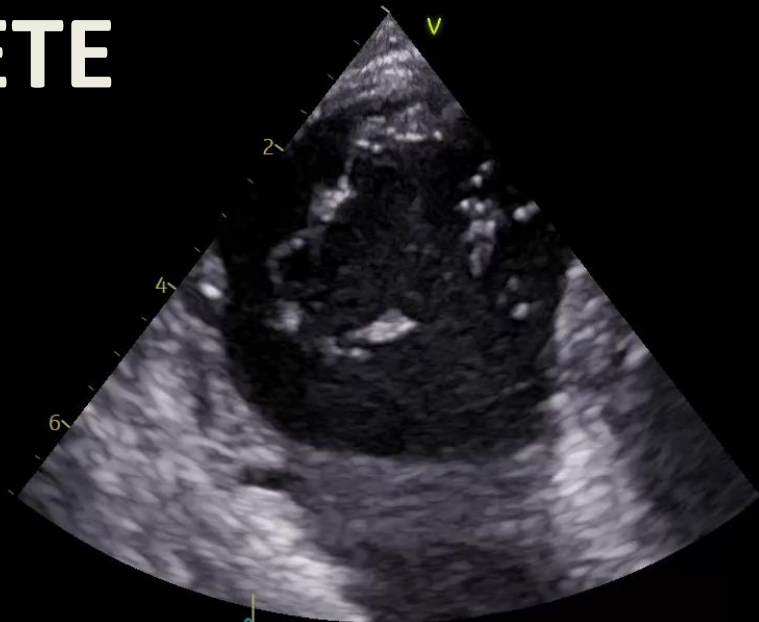
-66

77
HR

75
HR



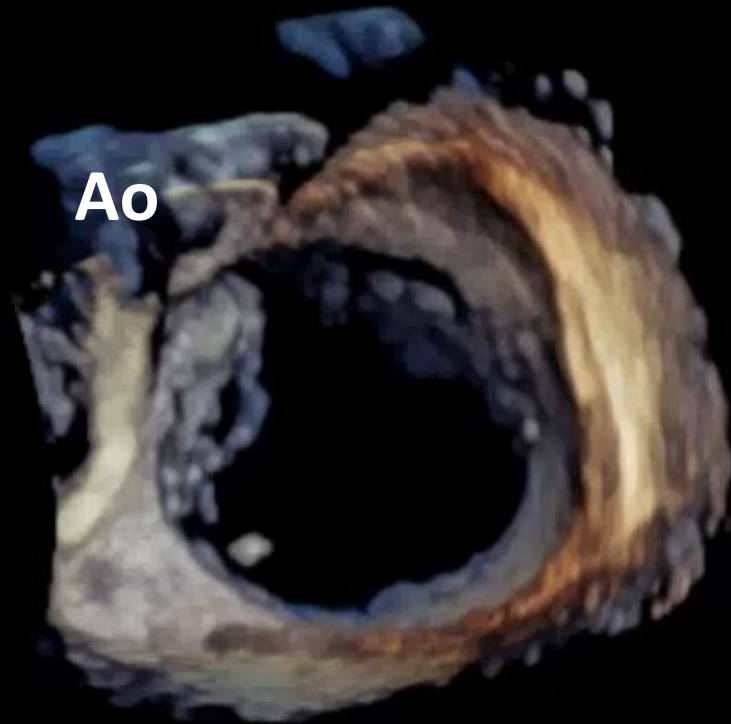
ETE



ETE



Ao



Conclusions

- La vàlvula tricúspide es mes complexa que la mitral i la seua anatomia es variable
- La gradació de la severitat de la IT ha estat ampliada amb 2 graus addicionals
- La IT s'associa amb mortalitat (sobre tot > severa)
- Les tècniques de imatges son fonamentals per a la planificació del tractament de la insuficiència tricuspidea

@Isanchisruiz



Isanchis@clinic.cat