

FUNCTIONAL T.R. SURGICAL STRATEGY ACCORDING TO TR GRADE

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INDICATIONS TO TREAT TRICUSPID VALVE

- Either you rely on TR grading :treat only severe TR (less than 10 % of the cases)

or

- You treat also less than severe TR (**what is it precisely ?**) and tricuspid annular dilatation



TR is not a benign disease

Impact of tricuspid valve regurgitation in surgical high-risk patients undergoing MitraClip implantation: results from the TRAMI registry



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Abstract

Aims: We sought to assess the impact of tricuspid regurgitation (TR) severity on patient outcome in a collective with relevant mitral regurgitation undergoing MitraClip implantation.

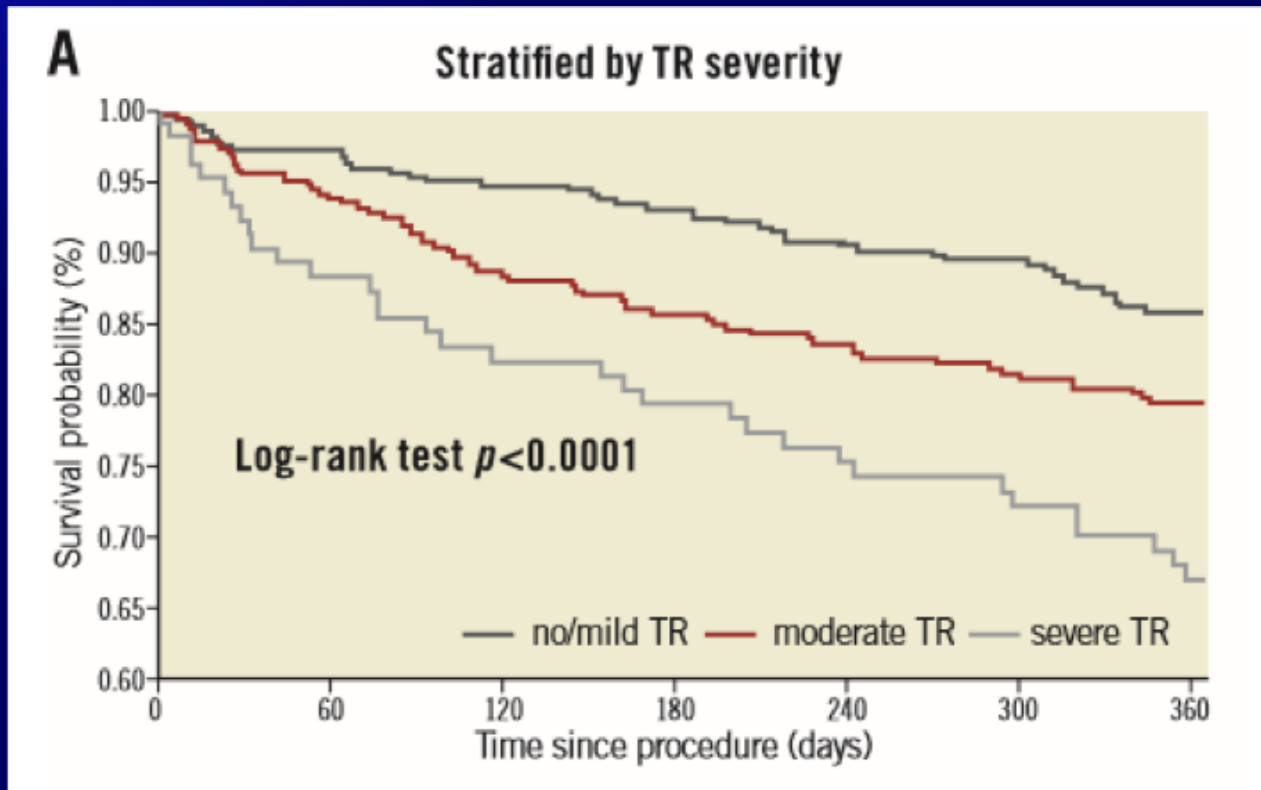
Methods and results: From August 2010 to July 2013, 766 patients (age 75.3±8.5 years, 61% male, median EuroSCORE 24.3%±18.4) were prospectively enrolled in the TRAMI registry and stratified by echocardiography into no/mild, moderate and severe TR. Overall, the mean number of implanted MitraClips was higher in patients with severe TR but increasing TR severity was not associated with procedural success. In-hospital and one-year mortality as well as MACE and MACCE (death, myocardial infarction±stroke) rates were higher with increasing TR severity. Kaplan-Meier curves indicated a significant difference for mortality ($p<0.0001$), but not for rehospitalisation for heart failure. After multivariate Cox regression, severe TR proved to be a predictor for one-year mortality (HR 2.01, 95% CI: 1.25-3.26, $p=0.004$). Higher rates of severe bleeding were more frequent with increasing TR grades.

Conclusions: In patients with MitraClip implantation, increasing TR severity is associated with adverse outcome, higher bleeding rates and decreased survival rates.



TR Prognostic value

TR is not a benign disease



TR is not a benign disease

Ann Thorac Surg. 2018 Apr;105(4):1121-1128. doi: 10.1016/j.athoracsur.2017.11.018. Epub 2018 Mar 2.

Association of Tricuspid Regurgitation With Transcatheter Aortic Valve Replacement Outcomes: A Report From The Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy Registry.

McCarthy FH¹, Vemulapalli S², Li Z², Thourani V³, Matsouaka RA⁴, Desai ND⁵, Kirtane A⁶, Anwaruddin S⁷, Williams ML⁸, Giri J⁹, Vallabhajosyula P⁶, Li RH⁷, Herrmann HC⁷, Bavaria JE⁶, Szeto WY⁶.

⊕ Author information

Abstract

BACKGROUND: The purpose of this study is to evaluate the association of tricuspid regurgitation (TR) severity with outcomes after transcatheter aortic valve replacement (TAVR).

METHODS: We analyzed data from 34,576 patients who underwent TAVR at 365 US hospitals from November 2011 through March 2015 submitted to The Society of Thoracic Surgeon/American College of Cardiology Transcatheter Valve Therapy Registry. We examined unadjusted mortality and heart failure readmission stratified by degree of preoperative TR and used multivariable models for 1-year mortality and heart failure readmission.

RESULTS: Tricuspid regurgitation was present in 80% (n = 27,804) of TAVR patients, with mild TR in 56% (n = 19,393), moderate TR in 19% (n = 6687), and severe TR in 5% (n = 1,724). Increasing TR severity was associated with a number of comorbidities and The Society of Thoracic Surgeons predicted risk of mortality increased (p < 0.001): no TR (7.3 ± 5.4); mild TR (8.0 ± 5.7); moderate TR (9.6 ± 6.8); and severe TR (10.7 ± 7.4). In unadjusted analysis, moderate and severe TR were associated with increased use of cardiopulmonary bypass, longer intensive care unit and hospital stays, new dialysis, in-hospital major adverse cardiac event, in-hospital mortality, observed-to-expected in-hospital mortality ratio, long-term heart failure readmission, and mortality (p < 0.001). Adjusted mortality at 1 year was significantly worse for patients with severe TR when left ventricular ejection fraction greater than 30% (hazard ratio 1.29, 95% confidence interval: 1.11 to 1.50) as was heart failure readmission (hazard ratio 1.27, 95% confidence interval: 1.04 to 1.54).

CONCLUSIONS: Tricuspid regurgitation was common among patients undergoing TAVR. Increasing TR severity was associated with higher risk patients and increased mortality and readmission-particularly for patients with severe TR and left ventricular ejection fraction greater than 30%. The effectiveness of TAVR alone in patients with aortic stenosis and concomitant severe TR may warrant further consideration, particularly for lower risk patients.



SEVERE MR AND MILD / MODERATE TR WITH ANNULAR DILATATION

- 1.What is moderate TR ?**
- 2.Should we not use other parameters than grading ?**
- 3.Why should less than Severe TR be addressed ?**



1. What is moderate TR?



What is Moderate TR ?

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European Heart Journal
doi:10.1093/eurheartj/ehs474

REVIEW

Imaging

Assessment of functional tricuspid regurgitation

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Functional tricuspid regurgitation (FTR) is characterized by structurally normal leaflets and is due to the deformation of the valvulo-ventricular complex. While mild FTR is frequent and usually benign, patients with severe FTR may develop progressive ventricular dysfunction and incur increased mortality. Therefore, FTR should not be ignored, should be appropriately diagnosed and quantified by Doppler echocardiography, and should be evaluated for corrective surgical procedures. At present, referral for surgical correction of FTR is often delayed until patients develop intractable heart failure. However, this strategy frequently translates in poor clinical outcome characterized by notable operative mortality and reduced long-term survival. Appropriate patient selection and proper timing for tricuspid valve (TV) repair or replacement are crucial for optimal outcome, but objective criteria for clinical decision-making remain poorly defined. In the present paper, we review the anatomy of the normal TV, the pathophysiology of FTR, the assessment of its severity and functional significance, and propose an algorithm for selecting patients for surgical treatment.

Keywords

Functional tricuspid regurgitation • Tricuspid valve • Echocardiography • Three dimensional • Rightventricle • Pathophysiology



1. What is Moderate TR ?

Table 2 Echocardiographic assessment of tricuspid regurgitation severity (modified from Lancellotti et al. ³⁴)

Parameters	Mild	Moderate	Severe
Qualitative = eye ball			
Tricuspid valve morphology	Normal/abnormal	Normal/abnormal	Abnormal/flail/large coaptation defect
Colour flow TR jet	Small, central	Intermediate	Very large central jet or eccentric wall impinging jet
CW signal of TR jet	Faint/parabolic	Dense/parabolic	Dense/triangular with early peaking (peak < 2 m/s in massive TR)
Semi Quantitative			
VC width (mm)	Not defined	<6.5	>6.5
PISA radius (mm)	≤5	6–9	>9
Hepatic vein flow	Systolic dominance	Systolic blunting	Systolic flow reversal
Tricuspid inflow	Normal	Normal	E wave dominant (≥ 1 cm/s)
Quantitative			
EROA (mm ²)	Not defined	Not defined	≥40
R Vol (ml)	Not defined	Not defined	≥45
+ RA/RV/IVC dimension			

CW, continuous-wave Doppler; EROA, effective regurgitant orifice area; PISA, proximal isovelocity surface area; RA, right atrium; RV, right ventricle; R Vol, regurgitant volume; TR, tricuspid regurgitation; VC, vena contracta.



1. What is Moderate TR ?

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Tricuspidinflow	Normal	Normal	E wave dominant (≥ 1 cm/s)
Quantitative			
R Vol (ml)	Not defined	Not defined	≥ 40
+ RA/RV/IVC dimension	Not defined	Not defined	≥ 45

CW, continuous-wave Doppler; EROA, effective regurgitant orifice area; PISA, proximal isovelocity surface area; RA, right atrium; RV, right ventricle; R Vol, regurgitant volume; TR, tricuspid regurgitation; VC, vena contracta.



1. What is Moderate TR ?

Mild / Moderate TR has no precise meaning and no method of assessment can be accurate and reliable

Relying upon grading to decide surgical intervention is wrong



1. What is Moderate TR ?

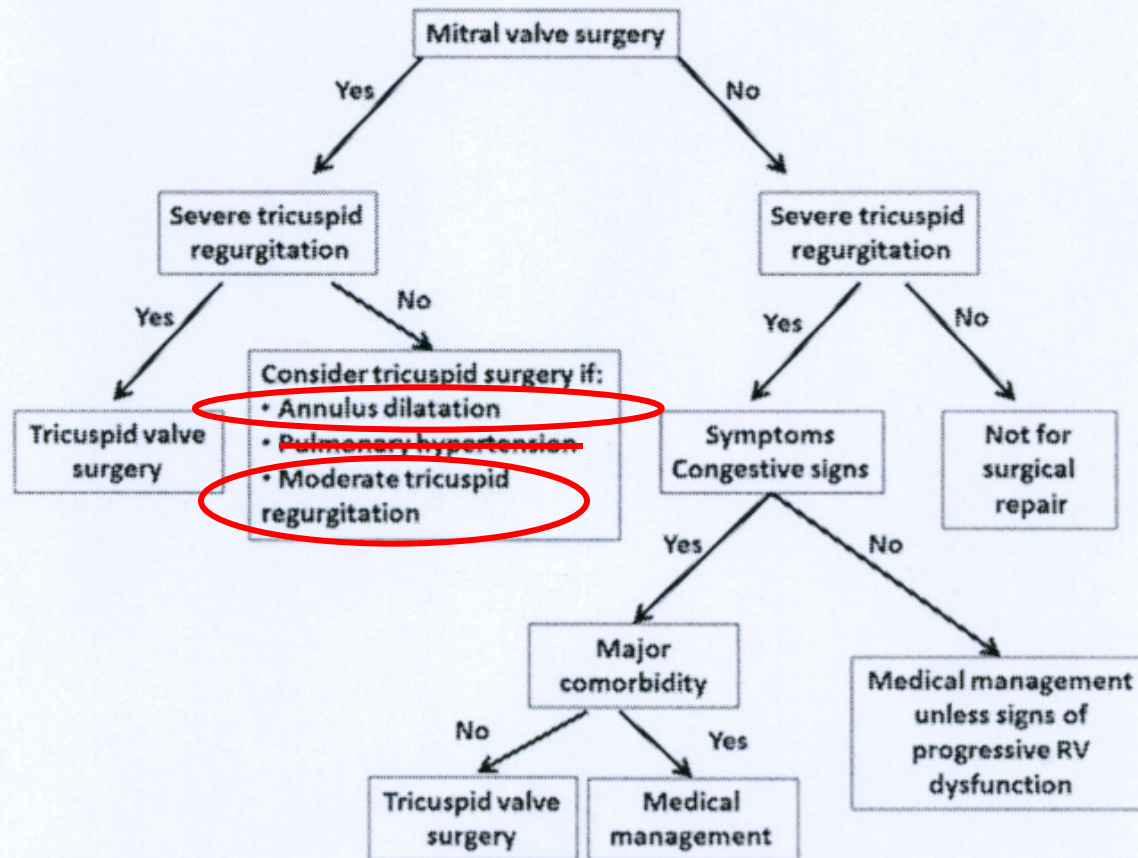


Figure 8 American College of Cardiology/American Heart Association⁵⁰ and the European Society of Cardiology⁵¹ guideline-based algorithm for the management of tricuspid regurgitation in patients who have not previously undergone left-sided valve surgery. RV, right ventricular.



1. What is Moderate TR ?

- Grading is not reliable
- Grading varies accordingly to parameters that cannot be quantified or controlled :
 - Preload
 - Afterload
 - RV function



1. What is Moderate TR ?

- We don't know +++
- Discussion to treat or not to treat becomes irrelevant



MILD / MODERATE TR WITH ANNULAR DILATATION

- 1. What is moderate TR ?**
- 2. Should we not use other parameters than grading ?**
- 3. Why should less than Severe TR be addressed ?**



Proposal for « New Assessment »

TR GRADING

LEAFLET COAPTATION MODE

ANNULAR DILATATION

No TR / Mild TR

At annular plane

Below 40 mm

Surface to surface

Moderate TR

Edge to edge

Severe TR

Below annular plane

Above 40 mm

Surface vs edge to edge

Tethering > 8mm ?

No coaptation



Functional and anatomical TR classification

Stage 1

Stage 2

Stage 3

No TR/ mild TR

Mild / Moderate TR

Severe TR

TAD dilation < 40 mm

TAD dilation > 40 mm

TAD dilation > 40 mm

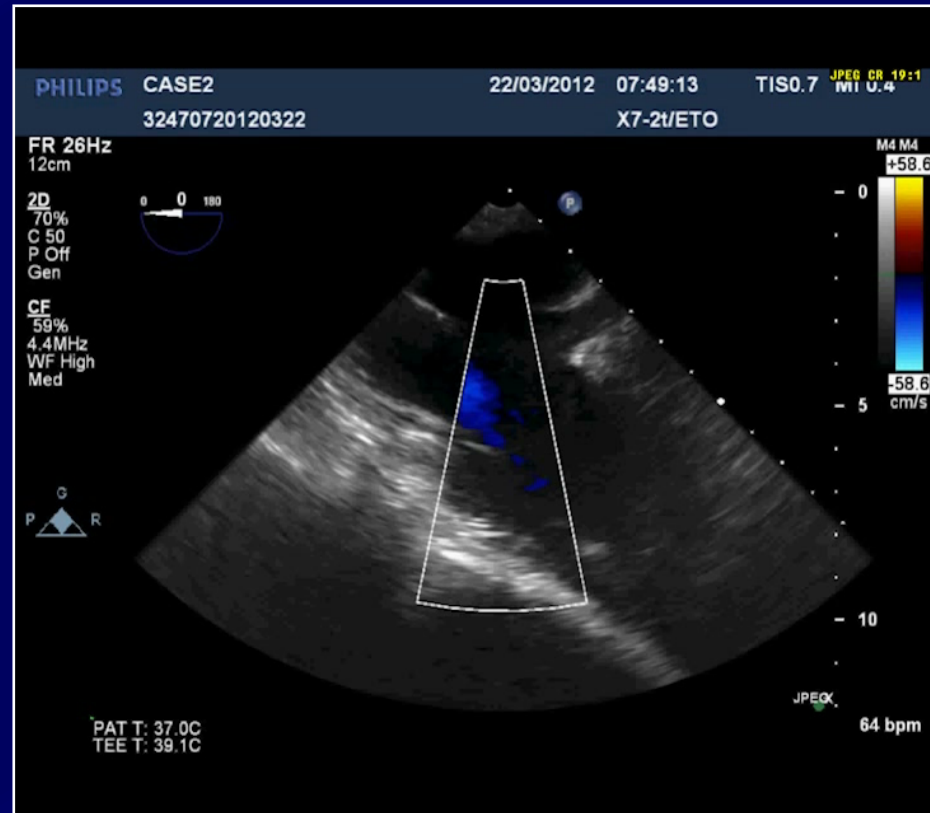
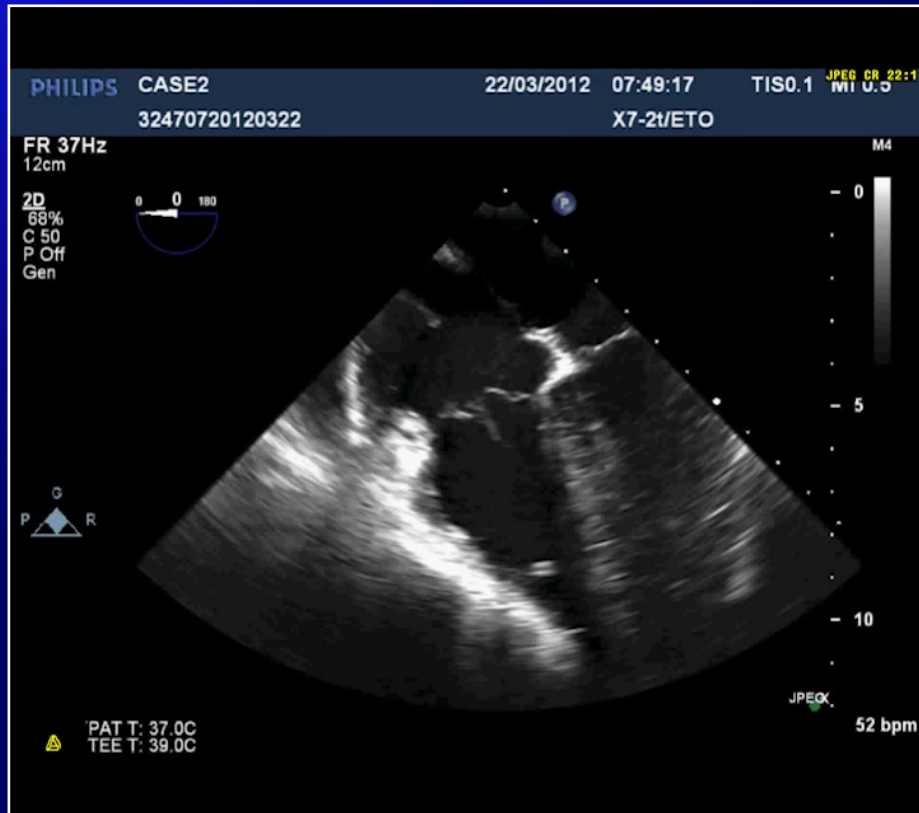
Normal leaflet
coaptation

Edge to edge coaptation
No effective coaptation

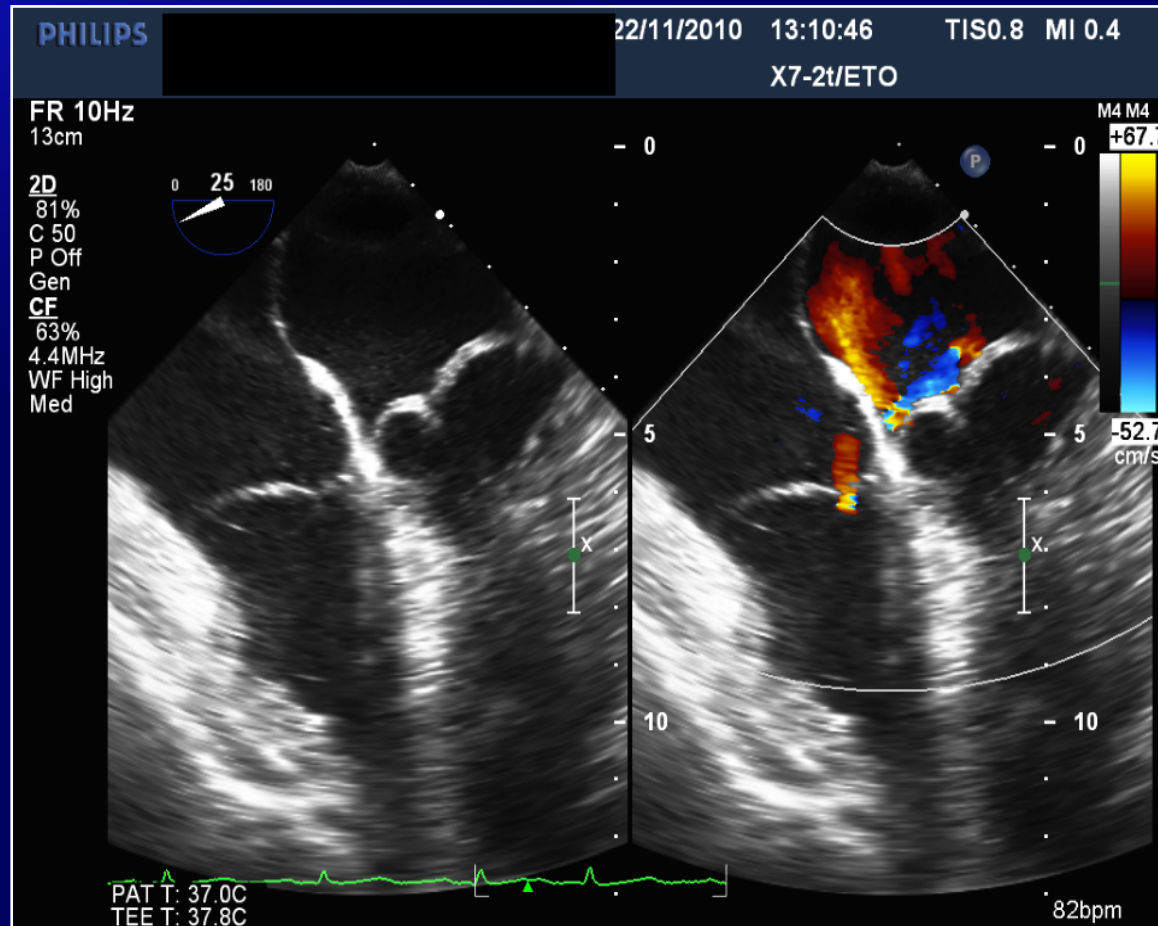
Lack of coaptation
with or without leaflet
tethering



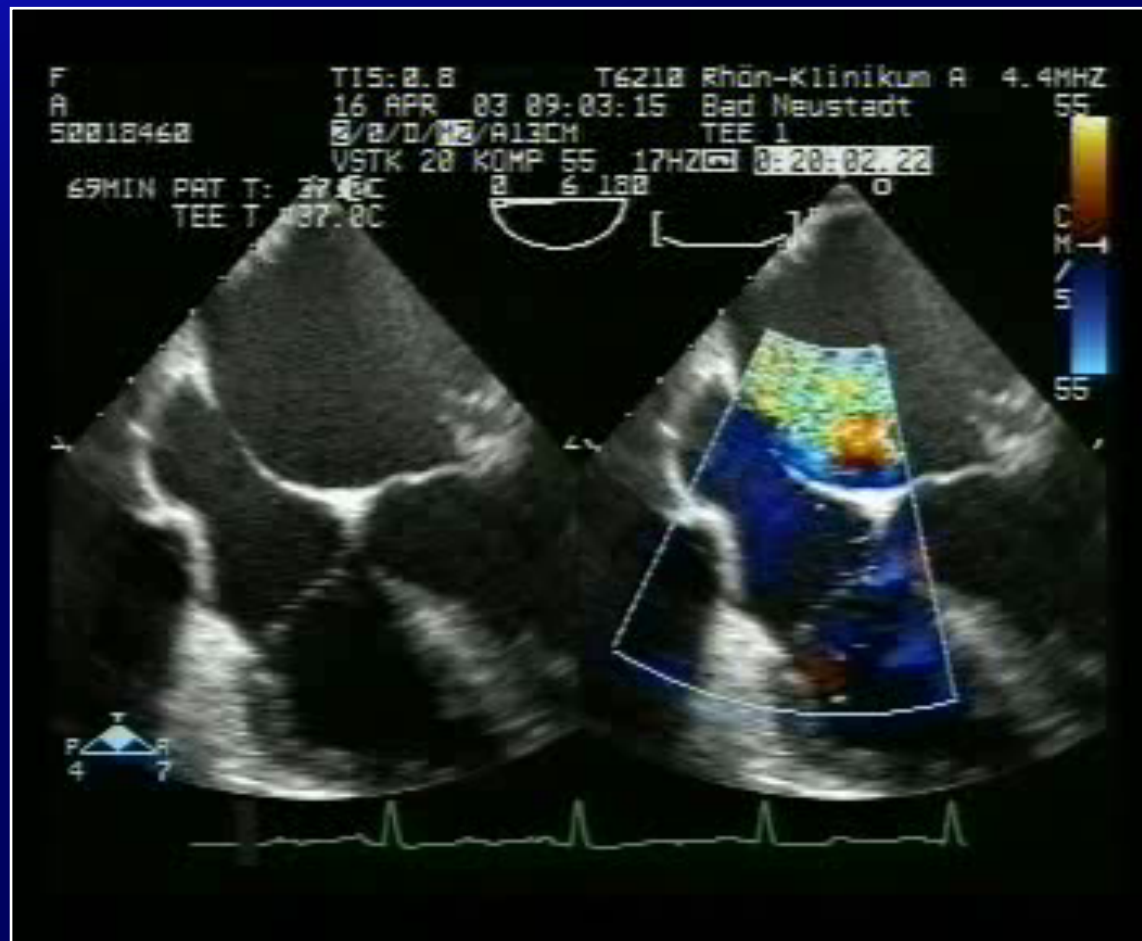
Stage 1



Stage 2



Stage 2



Functional Tricuspid Regurgitation

A Need to Revise Our Understanding



Gilles D. Dreyfus, MD, PhD,^{*†} Randolph P. Martin, MD,[‡] K.M. John Chan, PhD,^{*†§} Filip Dulguerov, MD,^{*}
Clara Alexandrescu, MD^{||}

ABSTRACT

The assessment of the etiology and severity of functional tricuspid regurgitation (FTR) has many limitations, especially when tricuspid regurgitation (TR) is more than severe. Instead of relying solely on TR severity, a new approach not only takes into account the severity of TR, but also pays strict attention to tricuspid annular dilation (size), the mode of tricuspid leaflet coaptation, and tricuspid leaflet tethering—factors often influenced by right ventricular enlargement and dysfunction. To simplify things, we propose a new staging system for functional tricuspid valve pathology using 3 parameters that may more accurately reflect the severity of the disease: TR severity, annular dilation, and mode of leaflet coaptation (extent of tethering). We believe that by utilizing these parameters, cardiologists and cardiac surgeons will be offered a better system for appraisal and decision-making in FTR. (J Am Coll Cardiol 2015;65:2331-6)

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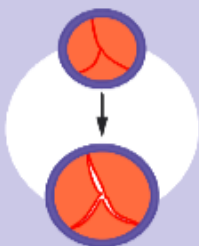




Tricuspid regurgitation (TR)

TR is the leakage of blood backwards through the tricuspid valve each time the right ventricle contracts

Color flow jet visualization is used to evaluate PISA radius and effective regurgitant orifice or regurgitant volume



Annular dilation

The annular ring is attached to the tricuspid valve leaflets. Dilation can result in poor leaflet apposition

2D-echocardiography coupled with 3D imaging is used to accurately measure annular diameter



Leaflet coaptation mode

Coaptation is the surface where the leaflets meet. If decreased, contact is made at the leaflet edge (edge-to-edge), leaflet tethering can restrict leaflet closure

3D-echocardiography is recommended to measure tenting volume (TV) – the area within the tricuspid leaflets

Stage

1

TR severity:
None or mild

Annular
diameter:
<40 mm

Coaptation
mode:
Normal
(body-to-body),
with no leaflet
tethering

Medical
treatment.
No surgical
intervention
is indicated

Stage

2

TR severity:
Mild or moderate

Annular
diameter:
>40 mm

Coaptation
mode:
Abnormal
(edge-to-edge),
with or without
tethering of
<8 mm below
the annular plane

Concomitant
tricuspid valve
annuloplasty is
recommended

Stage

3

TR severity:
Severe

Annular
diameter:
>40 mm

Coaptation
mode:
No coaptation,
with or without
tethering of
>8 mm below
the annular plane

Concomitant
tricuspid valve
annuloplasty
and leaflet
augmentation
(if tethering
is present)



HOW DO SURGEONS TREAT TRICUSPID VALVE ?

- **De Vega technique** : does not apply well to dilated annuli, shows high incidence of recurrent TR
- **Clover technique**
- **Annuloplasty Rings** 
 - Rigid
 - Semi-rigid

Semi-rigid: Importance of septal attachment
Risk of dehiscence



SURGICAL TECHNIQUES

The Clover Technique

Eur J Cardiothorac Surg. 2017 Jul 1;52(1):125-130. doi: 10.1093/ejcts/ezx027.

Long-term results (up to 14 years) of the clover technique for the treatment of complex tricuspid valve regurgitation.

De Bonis M¹, Lapenna E¹, Di Sanzo S¹, Del Forno B¹, Pappalardo F², Castiglioni A¹, Vicentini L¹, Pozzoli A¹, Giambuzzi I¹, Latib A³, Schiavi D¹, La Canna G¹, Alfieri O¹.

Author information

Abstract

OBJECTIVES: To report the long-term results of the clover technique for the treatment of complex forms of tricuspid regurgitation (TR).

METHODS: Ninety-six consecutive patients (mean age 60 ± 16.4 , left ventricular ejection fraction $58 \pm 8.8\%$) with severe or moderately-severe TR due to important leaflets prolapse/flail (81 patients), tethering (13 patients) or mixed (2 patients) lesions underwent clover repair combined with annuloplasty. The aetiology of TR was degenerative in 74 cases (77.1%), post-traumatic in 9 (9.4%) and secondary to dilated cardiomyopathy in 13 (13.5%). All patients but 3 (96.8%) underwent ring (59 patients, 61.5%) or suture (34 patients, 35.4%) annuloplasty. Concomitant procedures (mainly mitral surgery) were performed in 82 patients (85.4%).

RESULTS: Hospital mortality was 7.2%. At hospital discharge 92 (95.8%) patients had no or mild TR. Follow-up was 98% complete (median 9 years, interquartile range 5.1; 10.9). At 12 years the overall survival was $71.6 \pm 7.22\%$ and the cumulative incidence function of cardiac death with non-cardiac death as competing risk $16 \pm 4.1\%$ [95% confidence interval (95% CI) 9.5-25.7]. At 12 years the cumulative incidence function of TR $\geq 3+$ and TR $\geq 2+$ with death as competing risk were $1.2 \pm 1.2\%$ (95% CI 0.1-5.8) and $28 \pm 7.7\%$ (95% CI 14.3-43.5), respectively. Preoperative left ventricular ejection fraction (hazard ratio 0.9, CI 0.9-1, $P = 0.05$) and previous cardiac surgery (hazard ratio 2.7, 95% CI 1-7.1, $P = 0.03$) were predictors of recurrent TR $\geq 2+$ at univariable but not at multivariable analysis.

CONCLUSIONS: Complex forms of TR due to severe prolapse or tethering of the leaflets can be effectively treated with the clover technique with very satisfactory long-term results and extremely low recurrence of severe TR.

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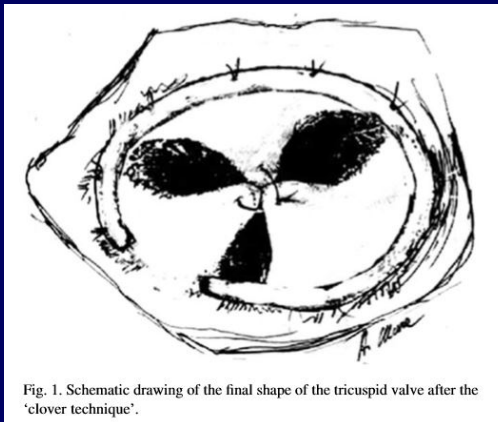


Fig. 1. Schematic drawing of the final shape of the tricuspid valve after the 'clover technique'.



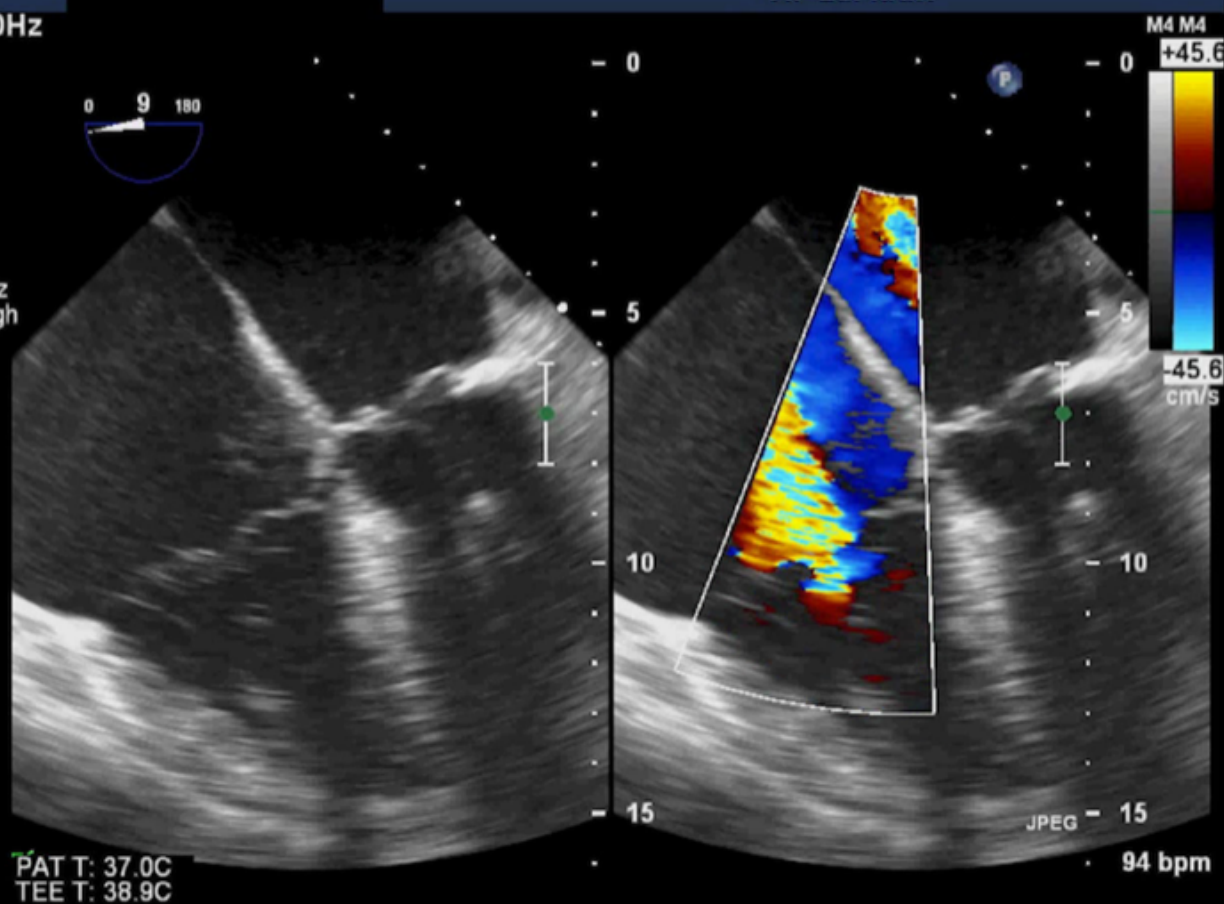
PHILIPS

TIS0.5 JPEG CR 13:1
MI 0.4

X7-2t/Adult

FR 20Hz
16cm

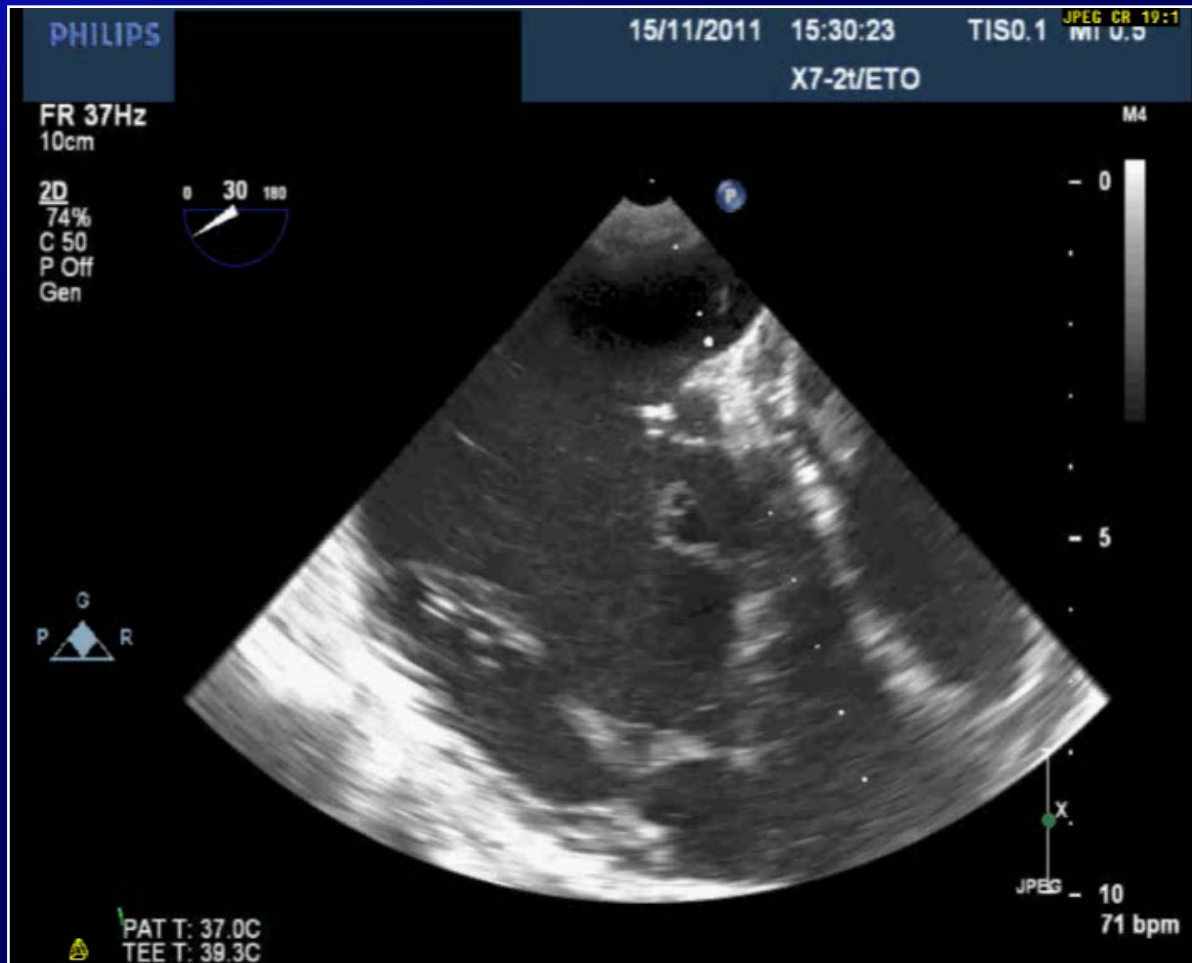
2D
69%
C 50
P Off
Gen
CF
63%
4.4MHz
WF High
Med



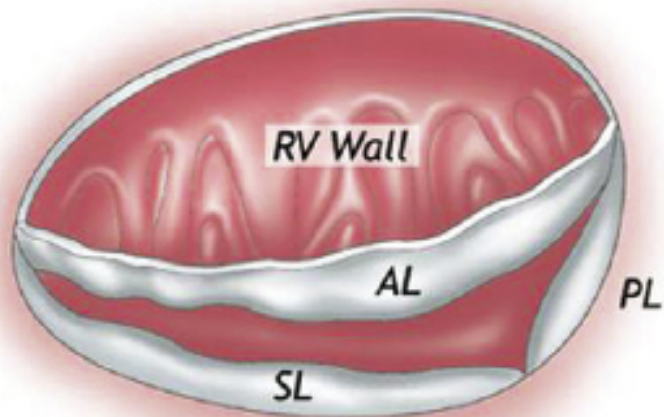
SHOULD WE NOT USE OTHER PARAMETERS THAN GRADING ?



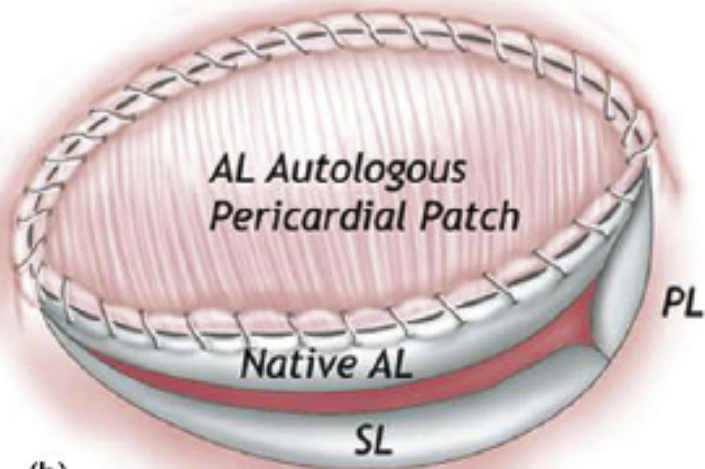
Stage 3



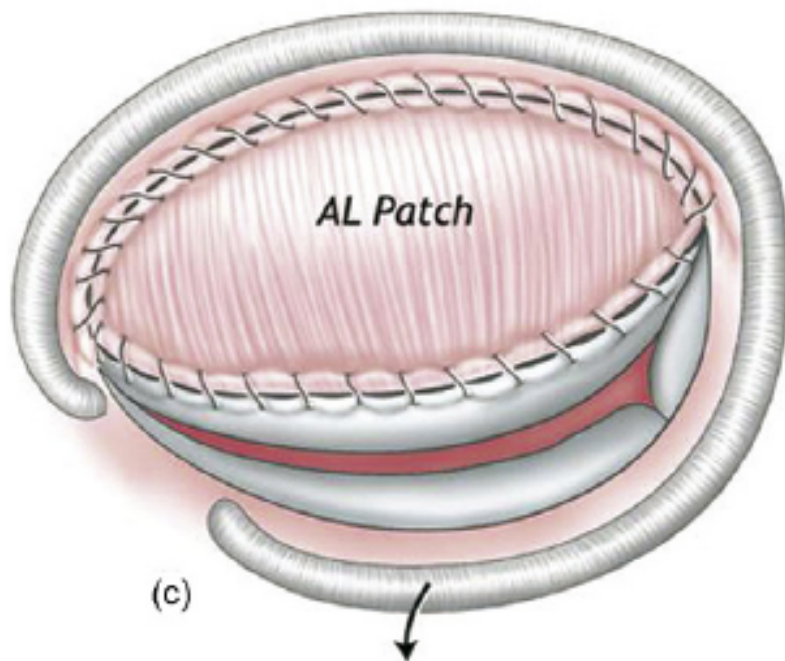
Detached AL from commissure to commissure



(a)

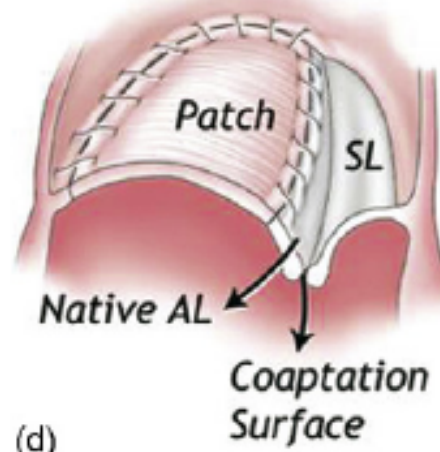


(b)



(c)

Ring Annuloplasty

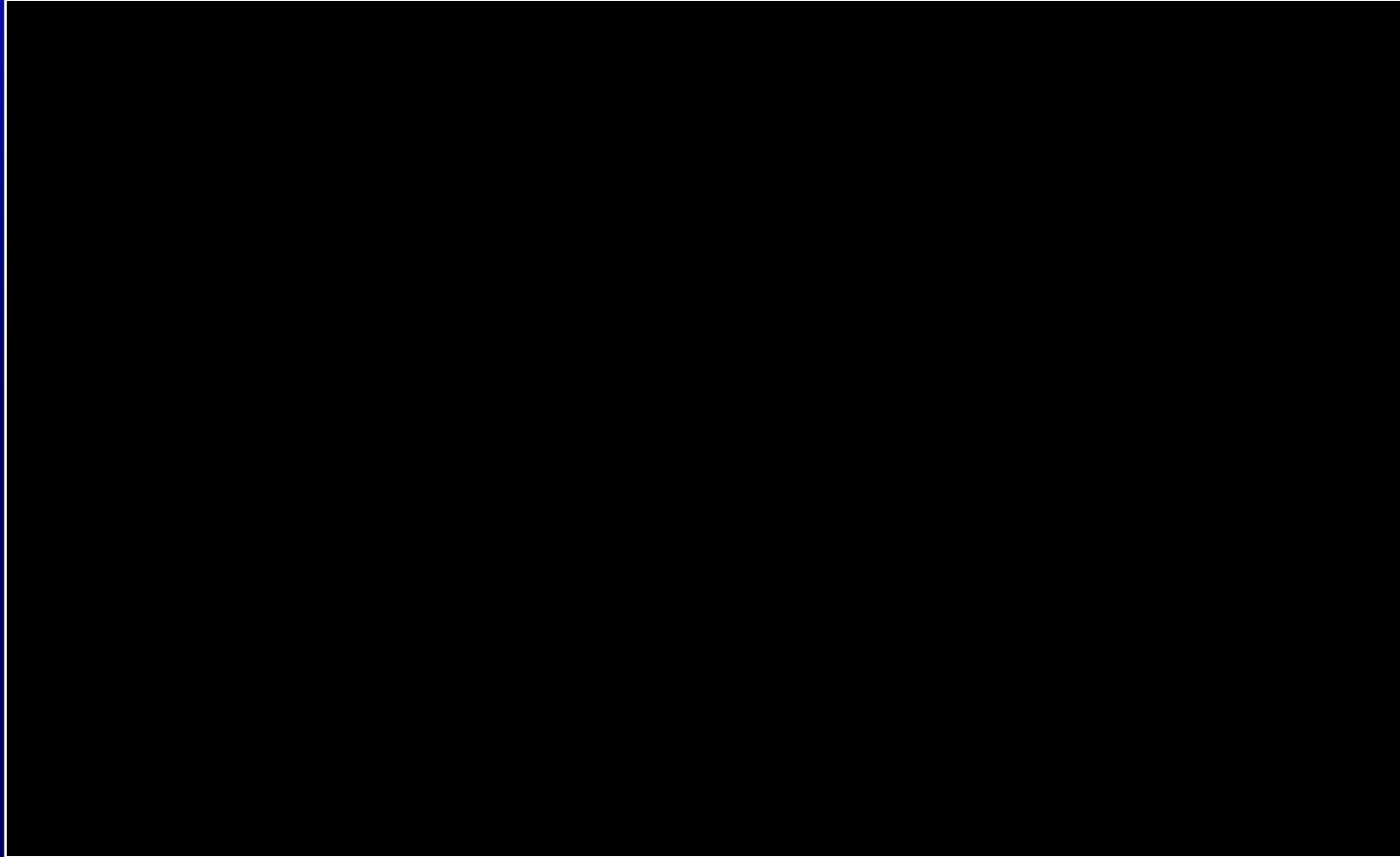


(d)



SURGICAL TECHNIQUES

A.L. extension



SURGICAL TECHNIQUES

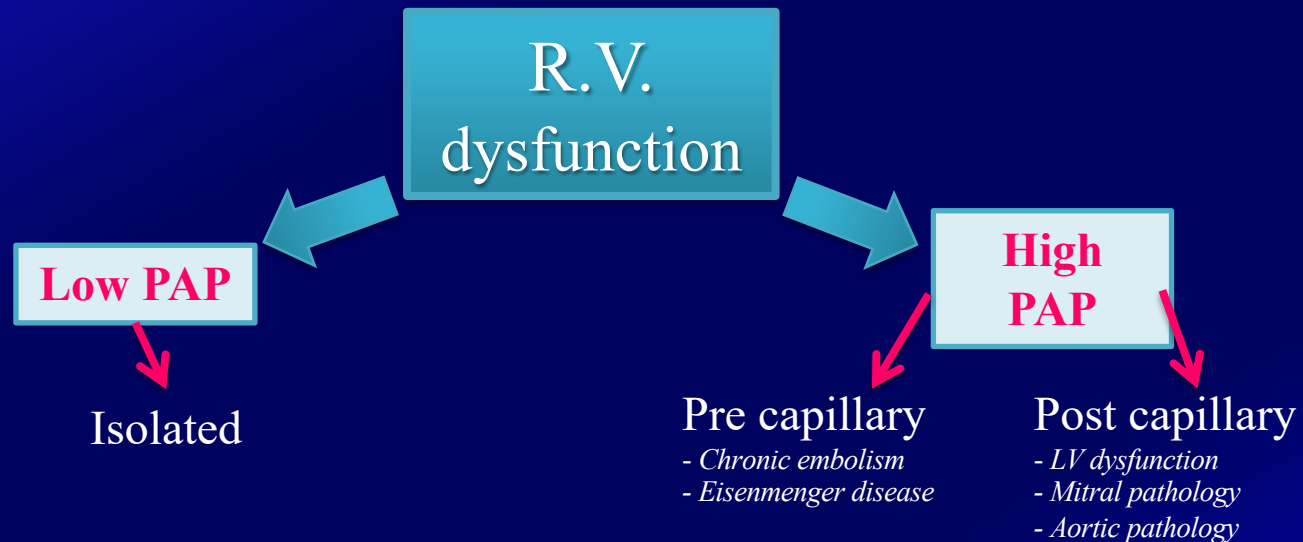
A.L. extension



1. Guidelines
2. What is moderate TR?
3. Should we use other parameters than grading?
4. How do surgeons treat the tricuspid valve?
5. How to assess RV dysfunction?
6. Outcomes following current Guidelines



How to select patients with regards to RV dysfunction



EXCLUDE LOW PRESSURE / LOW FLOW SYNDROME
STROKE VOLUME



How to select patients with regards to RV dysfunction

- TAPSE not reliable
- RVEF not reliable

2 main criteria

- RV stroke volume
- RV VTI



How to select patients with regards to RV dysfunction

True stroke volume (SV) is not EDV – ESV

True SV in the RV outflow tract

-Echo: VTI >10 cm

-MRI: SV >50ml/b



How to select patients with regards to RV dysfunction

If VTI less than 10 cm

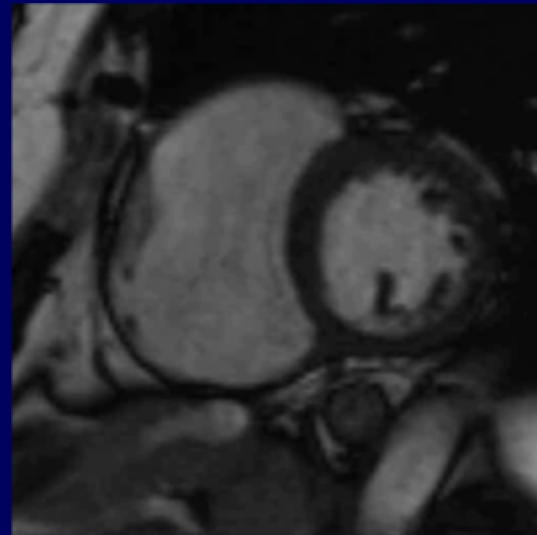
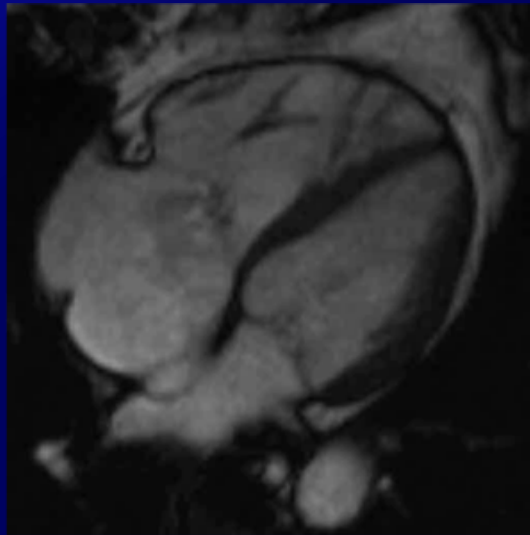
If RVSV less than 50ml/b

Study contractile reserve of RV with stress Dobutamine
echo: 10mcg/kg/mn

- positive if VTI , RVSV : $\uparrow$ more than 25%
- negative if VTI, RVSV : no changes



Ischemic Cardiomyopathy

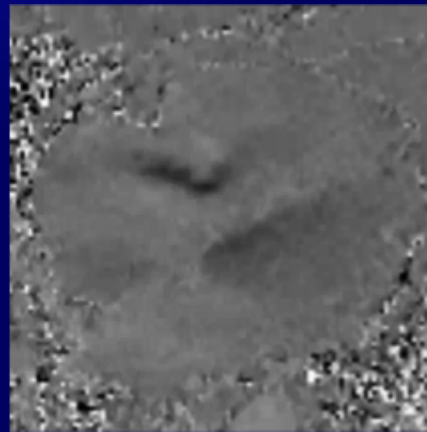


PREOP MRI

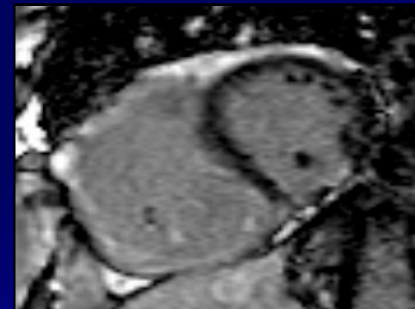
**Severe right ventricular dysfunction
after myocardial infarction**



Ischemic Cardiomyopathy



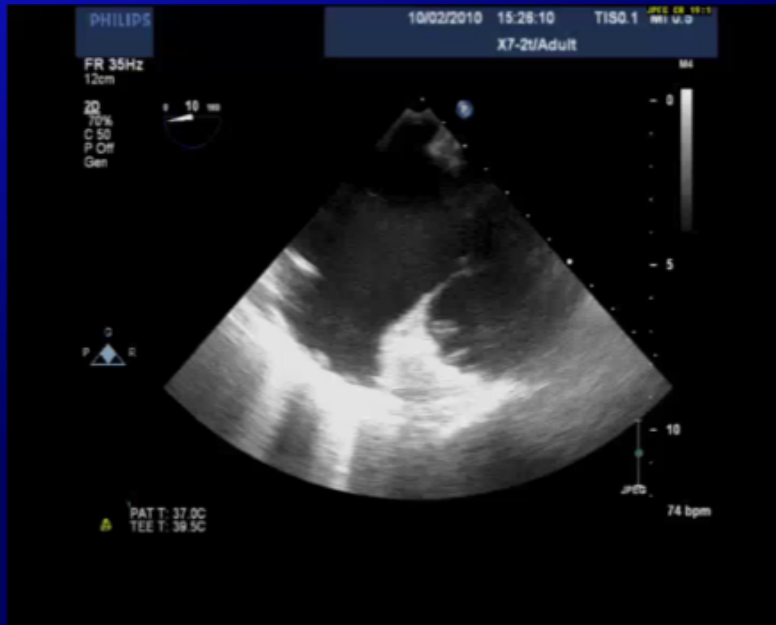
PREOP



L.V. (Ventricule Gauche)			R.V. (Ventricule Droit)		
EF.	58 %	56-78	EF.	42 %	47-80
Mass	54 g m ²	63-95	Mass	N/A g m ²	18-33
EDVI	54 ml m ²	41-81	EDVI	112 ml m ²	48-87
ESVI	23 ml m ²	11-31	ESVI	65 ml m ²	20-32
SV	31 ml m ²	26-56	SV	47 ml m ²	27-57
CI	2.4 l m	1.75-3.8	CI	3.7 l m	.



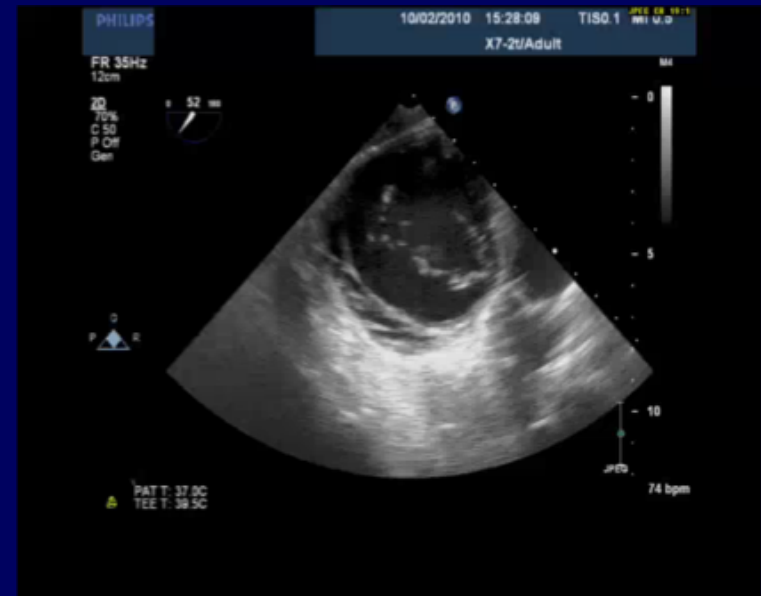
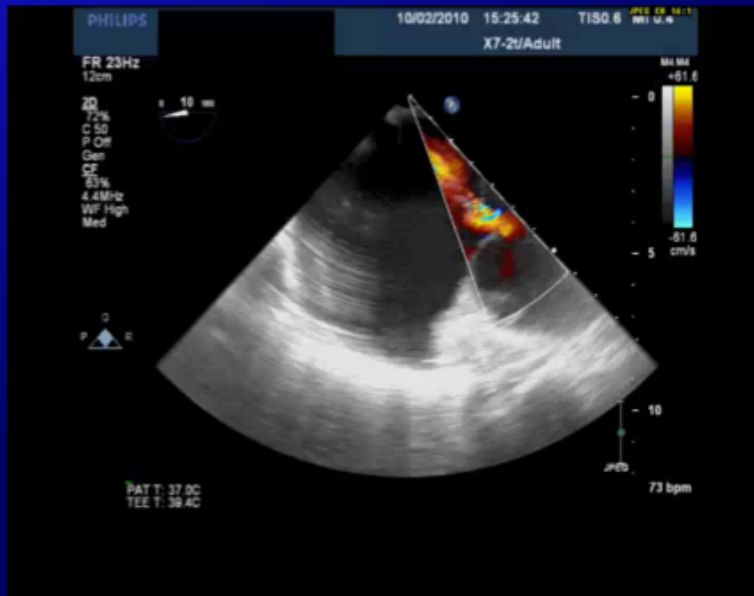
Ischemic Cardiomyopathy



Pre op TOE



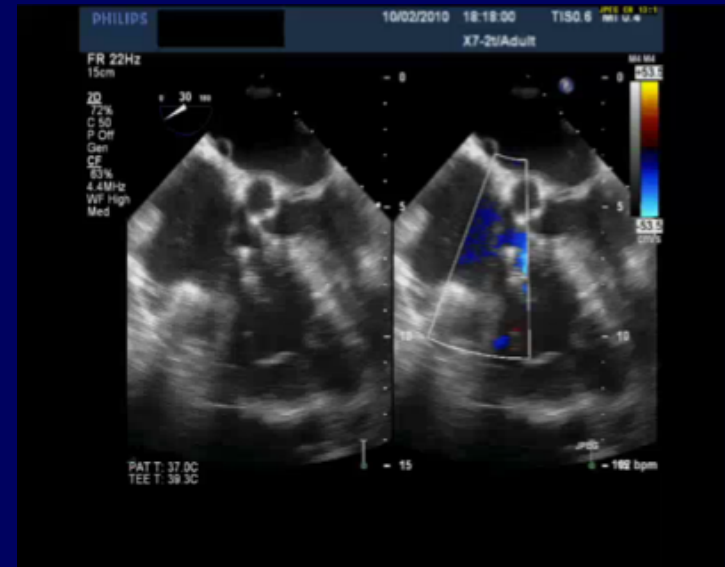
Ischemic Cardiomyopathy



Pre op TOE



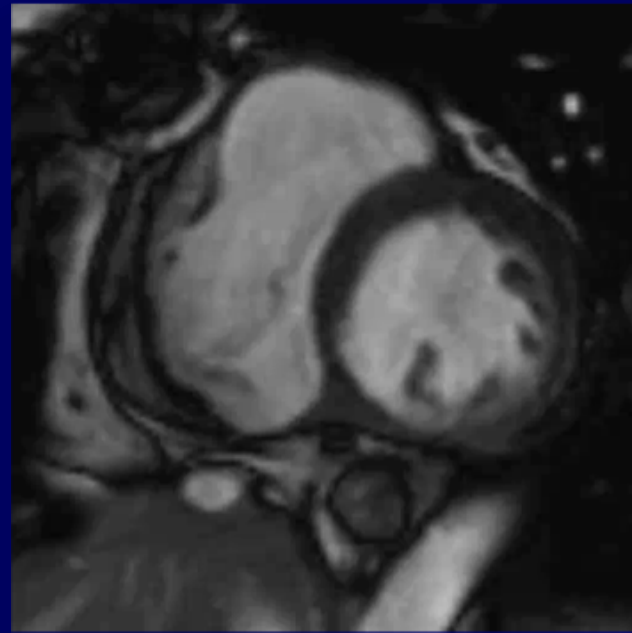
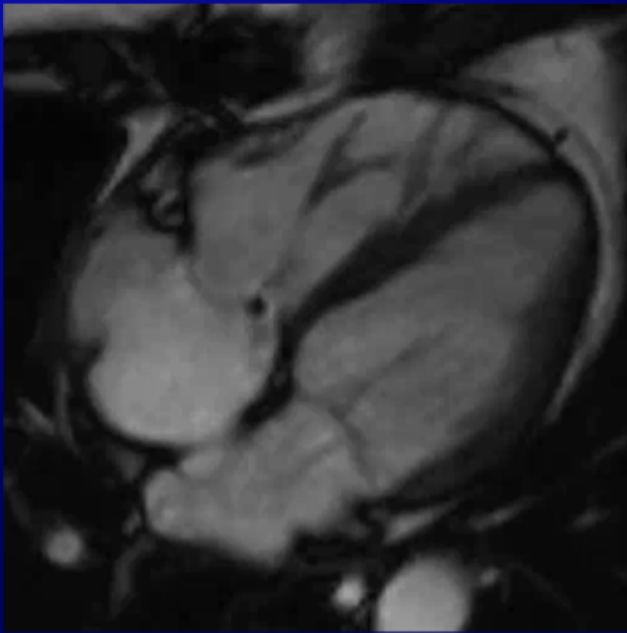
Ischemic Cardiomyopathy



Postop TOE



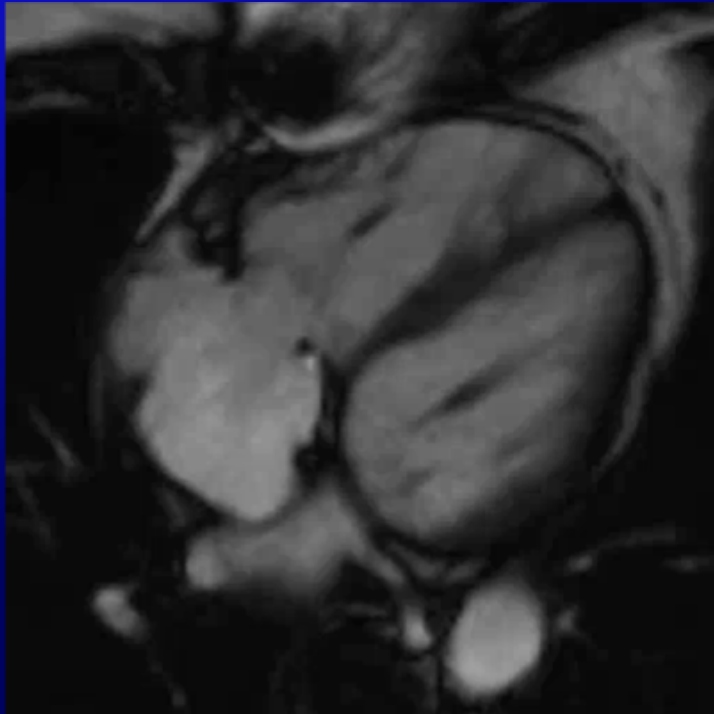
Ischemic Cardiomyopathy



**Post op
MRI**



Ischemic Cardiomyopathy



POSTOP MRI

	Preop	Postop
EF (%)	42	47
EDVol index (ml/m2)	112	94
ESVol Index (ml/ m2)	65	50
SV (ml/m2)	47	44



How to select ?

Perhaps too late

Patients with repeated RV failure episodes:

- **fatigue dyspnea**
- **ascitis**
- **ankle swelling**



How to select?

Surely too late

Patients with biological features:

- **increased bilirubin**
- **increased spontaneous INR**
- **increased creatinine level**



What is a patient beyond surgery?



Patients with severe TR have a degree of the liver dysfunction

The Model for End-Stage Liver Disease - (MELD) score

- used to stratify patients before liver transplantation
- dependent on three variables:
 1. international normalized ratio (INR)
 2. total bilirubin
 3. creatinine

Patients with history of cirrhosis—usually MELD score >15



Tricuspid valve surgery mortality and MELD score

MELD score < 15 = mortality 6,1%

MELD score > 15 = mortality 18.9%

