

# Le ventricule droit dans tous ses états

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CENTRE CARDIO-THORACIQUE DE MONACO

# Secondary Tricuspid Regurgitation or Dilatation: Which Should Be the Criteria for Surgical Repair?

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*Background.* Secondary tricuspid dilatation may or not be accompanied by tricuspid regurgitation (TR). Tricuspid dilatation can be objectively measured whereas TR can vary according to the preload, afterload, and right ventricular function. The purpose of this prospective study was to determine whether surgical repair of the tricuspid valve based on tricuspid dilatation rather than TR could lead to potential benefits.

*Methods.* Between 1989 and 2001, 311 patients underwent mitral valve repair (MVR). The tricuspid valve was examined in each patient. Tricuspid annuloplasty was performed only if the tricuspid annular diameter was

with regard to hospital mortality (group 1 = 1.8%, group 2 = 0.7%) and actuarial survival rate (Kaplan–Meier: group 1 = 97.3%, 96.2%, and 85.5%; group 2 = 98.5%, 98.5%, and 90.3% at 3, 5, and 10 years, respectively). The New York Heart Association (NYHA) functional class was significantly improved in group 2 (group 1 =  $1.59 \pm 0.84$ ; group 2 =  $1.11 \pm 0.31$ ;  $p < 0.001$ ). TR increased by more than two grades in 48% of the patients in group 1 and in only 2% of the patients in group 2 ( $p < 0.001$ ).

*Conclusions.* Remodeling annuloplasty of the tricuspid valve based on tricuspid dilation improves functional status irrespective of the grade of regurgitation. Consider

examined in each patient. Tricuspid annuloplasty was performed only if the tricuspid annular diameter was greater than twice the normal size ( $\geq 70$  mm) regardless of the grade of regurgitation. Patients in group 1 (163

can be present even in the Tricuspid dilatation is an that will, with time, lead to

Thorac Surg 2005;79:127–32) Society of Thoracic Surgeons

# TRICUSPID VALVE SURGERY

## Introduction

The **Tricuspid Valve** is particular because of its :

- **physiology**
- **pathology**
- **difficulty to quantify its regurgitation,**
- **long term silent clinical evolution**
- **our lack of knowledge of RV & LV**

**interaction**

- **limited efficacy of medical treatment**



# TRICUSPID VALVE SURGERY

## Introduction

**Pre-operative assessment is not reliable :**

- **regurgitation grading is related to preload ,  
after  
load , and RV function.**
- **mild / moderate regurgitation does not mean  
mild/  
moderate annular dilatation**



# Tricuspid dilatation or regurgitation

## Introduction

### As tricuspid regurgitation

- always requires some degree of **tricuspid dilatation**
- is not likely to occur without **tricuspid dilatation**

**We believe that tricuspid dilatation is the key factor to be assessed for surgical indication**

# Tricuspid Valve & RVF

## Introduction

- **Preload is often decreased** by vasodilators and diuretics
- **RV function is often / always impaired :**
  - . **RV dilated** ( how dilated is too dilated ? )
  - . **What is an acceptable RV function ?**  
RV dysfunction can be easily / rapidly reversed
- **After load is often / always left sided related**
  - . Early repair of mitral valve allows predictability of lowering after load for the RV

## Introduction

**How can early surgery be justified ?**

- **late surgery** , when renal / liver dysfunction are present still carries out a **20 -30 % mortality**
- **if severe TR appears secondary ; surgical timing remains unclear** ( rarely seen as worth it )

## Tricuspid Valve & RVF

### TR or no TR ?

Once all required features are present :

- chronic LV changes
- moderate pulmonary hypertension
- remodelled RV ( from crescent to spherical )

**Absence of TR can be misleading :**

as any changes in preload , after load, RV function  
can unmask severe TR

**Tricuspid annular dilatation  
rather than regurgitation  
should trigger prophylactic surgery**

# TRICUSPID VALVE SURGERY

## Surgical options

### -De Vega annuloplasty:

- . Cheap, fast
- . Limited durability → fibrotic retraction of leaflets
- . Contraindicated in big annular dilatations

### - Carpentier annuloplasty :

- . Expensive, fast
- . Extensive durability
- . Efficient in big annular dilatations

- True repair or replacement are rare



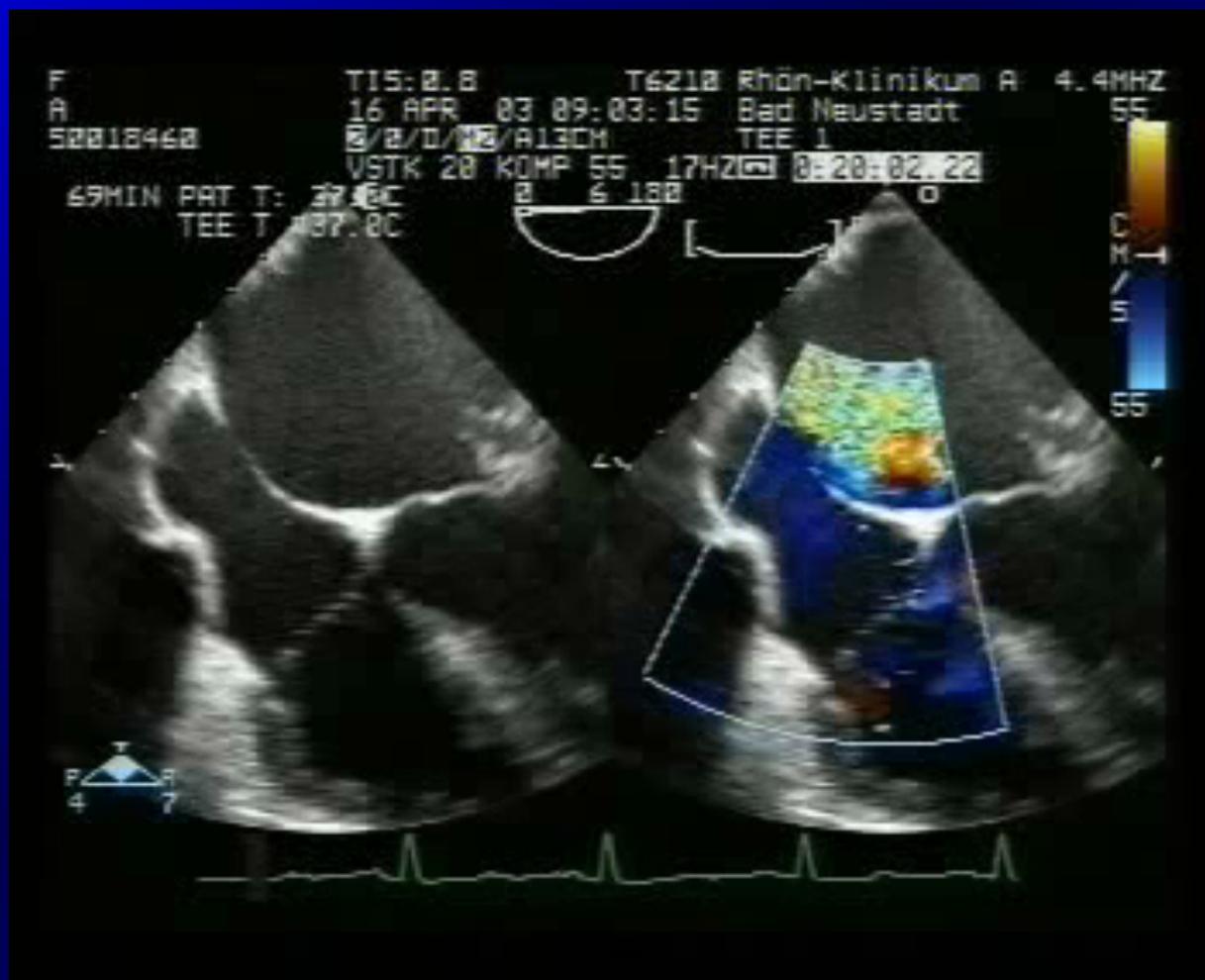
# Tricuspid valve

## Introduction

What should our concerns be ?

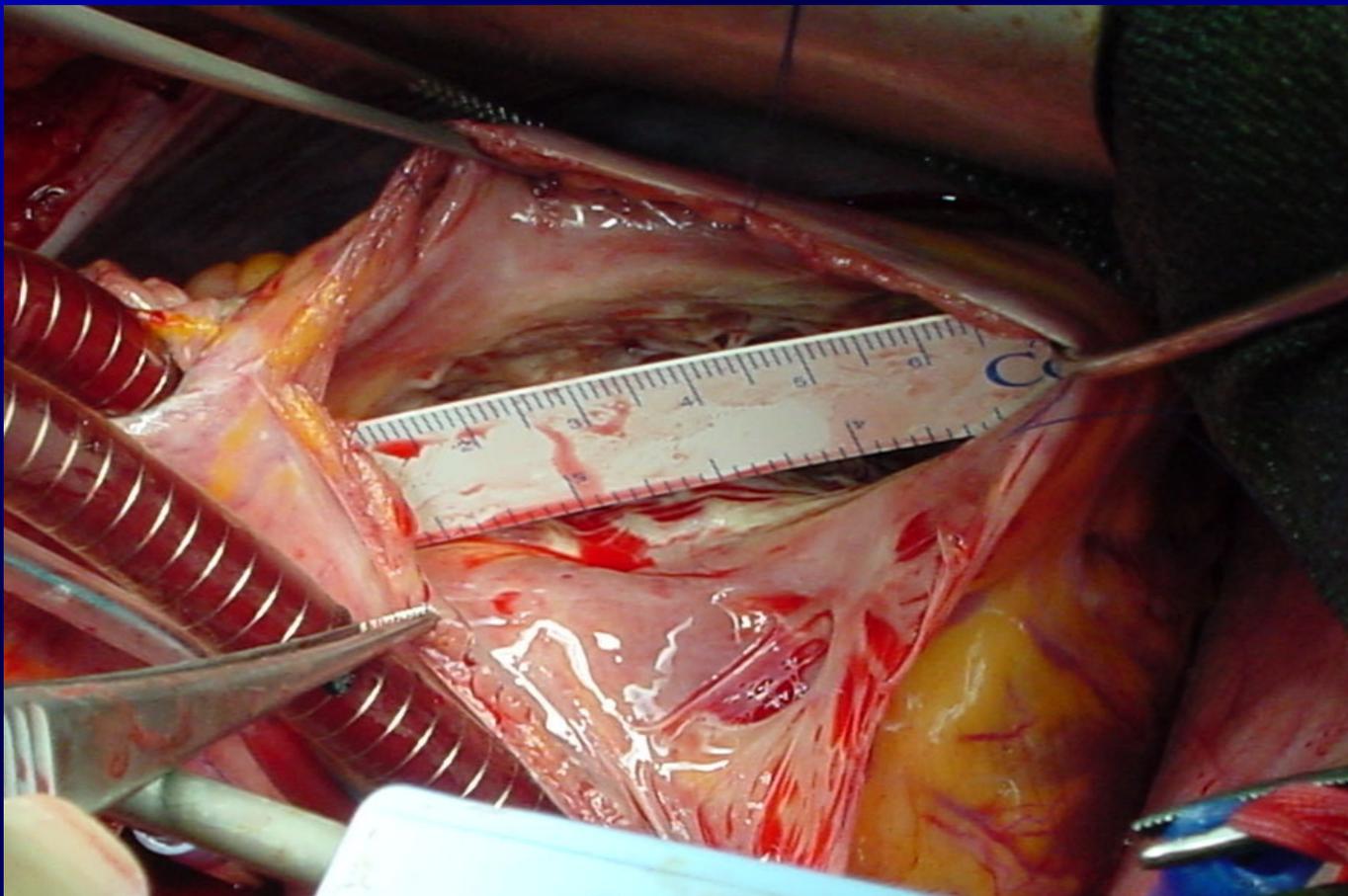
- past medical history : chronic MR ,  
presence of AF
- dilated RV , RA , at inspection
- TOE findings :
  - four chambers view , transverse diameter  $\geq 40$  mm tric. Annulus
  - coaptation height in between Ant . & Sept. leaflets

# Tricuspid dilatation or regurgitation



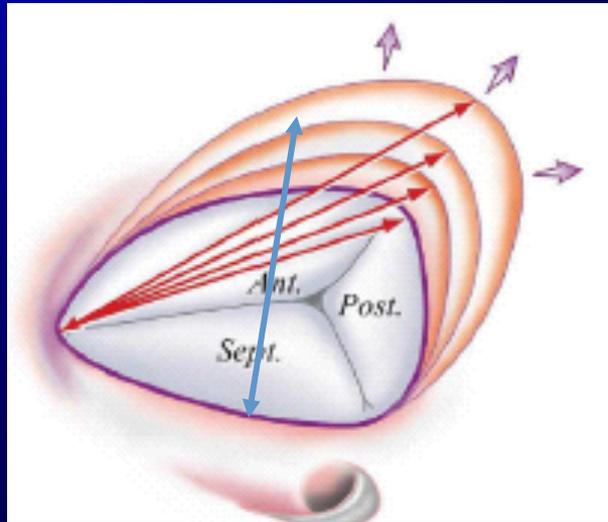
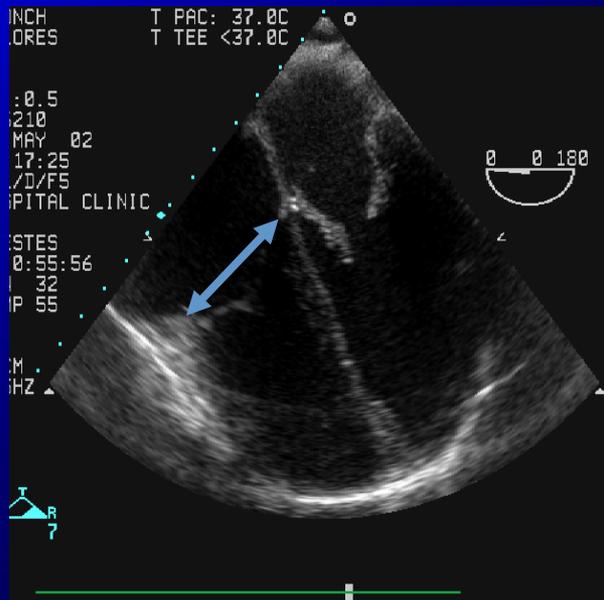
Tricuspid dilatation or regurgitation

## Intra-operative Tricuspid Sizing

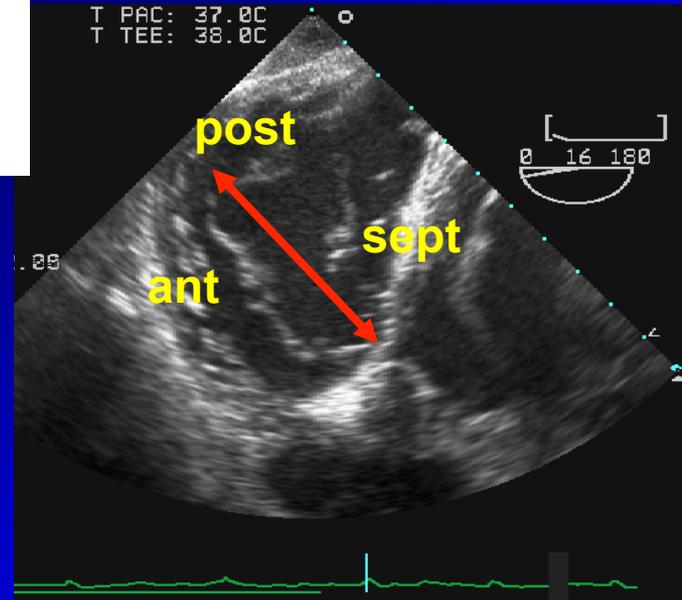


# TR severity: Annulus dilatation

> 4 cm



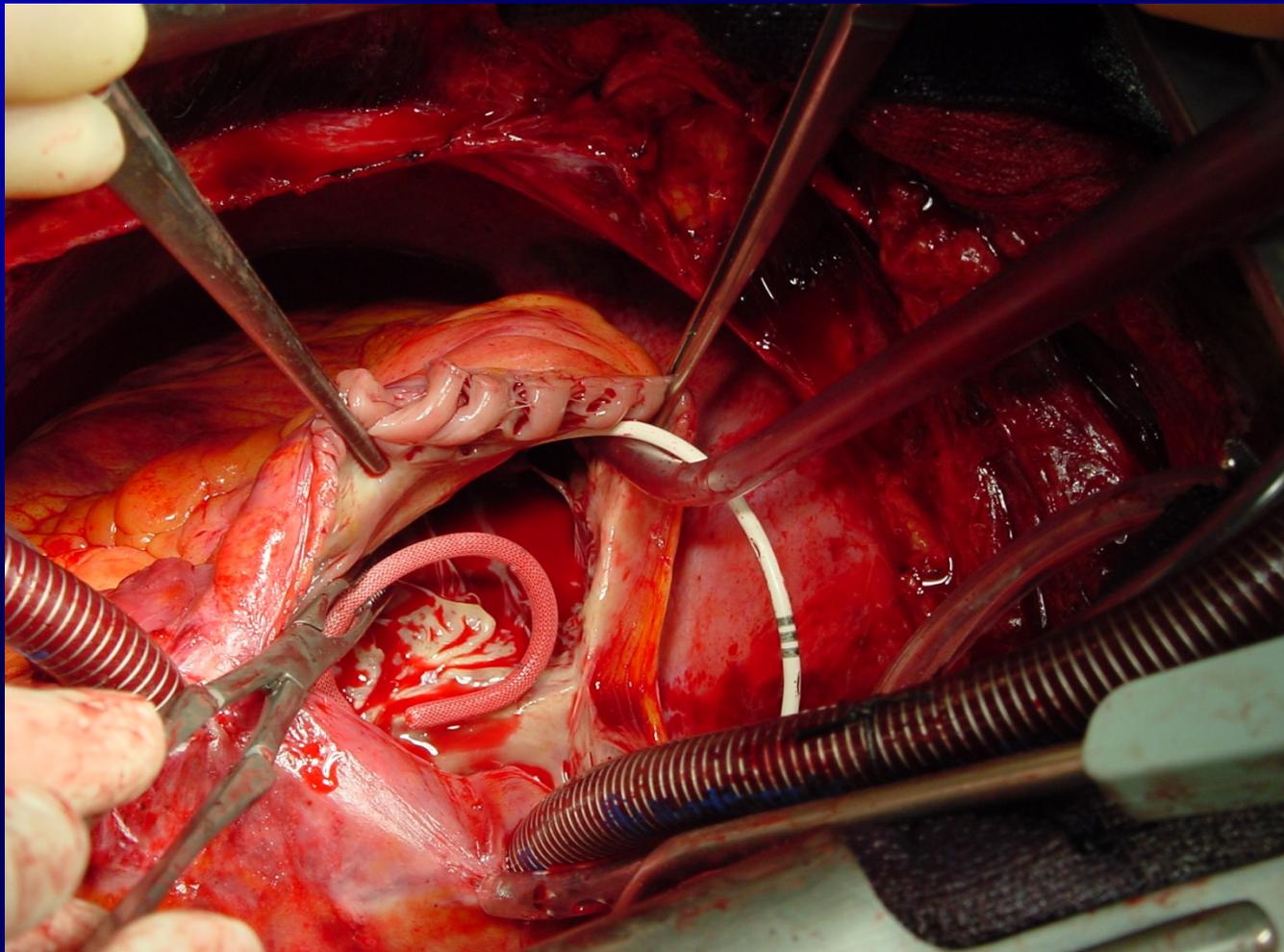
> 7 cm



Colombo et al. *Cardiovasc Surg* 2001;9:369-77  
Dreyfus et al *Ann Thorac Surg* 2005;79:127-32

# Tricuspid dilatation or regurgitation

## Operative Technique



## Tricuspid dilatation or regurgitation

### Prospective study January 1989 to February 2001

<b>Mitral valve repair</b>	<b>311</b>
----------------------------	------------



Mitral valve repair alone	163
Mitral valve + tricuspid valve repair	148

**During M.V.R., all tricuspid valves were analyzed intra operatively and corrected when showing a dilated orifice > 70 mm**

# Tricuspid dilatation or regurgitation

## Etiology

	M.V.R.	M.V.R.+ T.V.R.
- <b>Dystrophic</b>	44 (26.9%)	47 (31.8%)
- <b>Barlow</b>	62 (38.0%)	50 (33.7%)
- <b>Ischaemic</b>	21 (12.8%)	4
(2.8%)		
- <b>Rheumatic</b>	18 (11.1%)	26 (17.5%)
- <b>Endocarditis</b>	11 (6.8%)	3 (2%)
- <b>DCM</b>	7 (4.4%)	18 (12.2%)

## Tricuspid dilatation or regurgitation

### Pre-operative Demographics

	M.V.R.	M.V.R.+ T.V.R.	p
Age	61.2 +/- 13.1	58.5 +/- 14.1	ns
Body Surf	1.83 +/- 0.18	1.81 +/- 0.20	ns
Medication	1.88 +/- 1.29	2.19 +/- 1.22	
	0.024*		
NYHA	2.53 +/- 0.90	2.64 +/- 0.82	ns
MR grade	3.34 +/- 0.56	3.44 +/- 0.56	ns
LVESD	39.2 +/- 6.7	39.9 +/- 6.7	
	ns		
PAP	42.6 +/- 14.1	42.6 +/- 12.8	ns
EF	62.4 +/- 13.4	62.0 +/- 14.8	ns

## Tricuspid dilatation or regurgitation

### Pre-operative TR Grading

	M.V.R.	M.V.R.+ T.V.R.
Grade 0	54	38
Grade 1	102	92
Grade 2	7	16
Grade 3	0	2
Mean TR *	0.71 +/- 0.54	0.88 +/- 0.64

\*  $p = 0.027$  Mann-Whitney



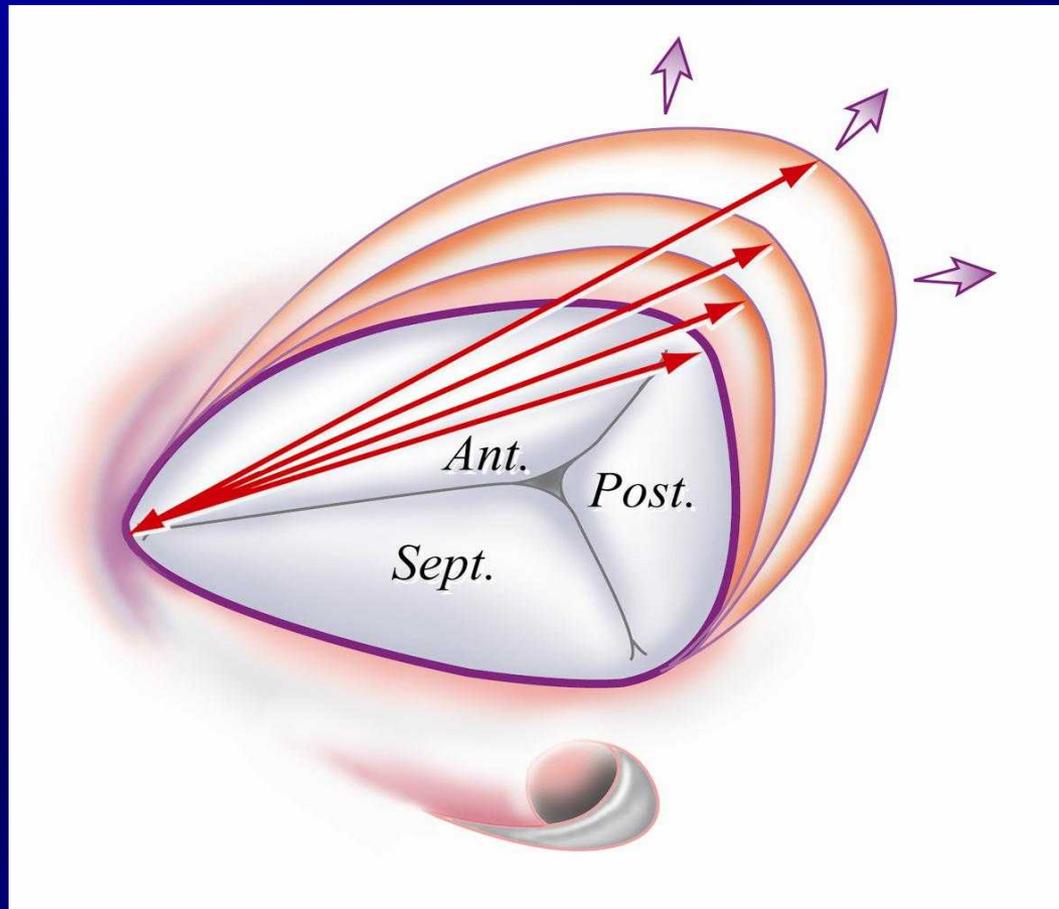
## Tricuspid dilatation or regurgitation

### Operative Technique

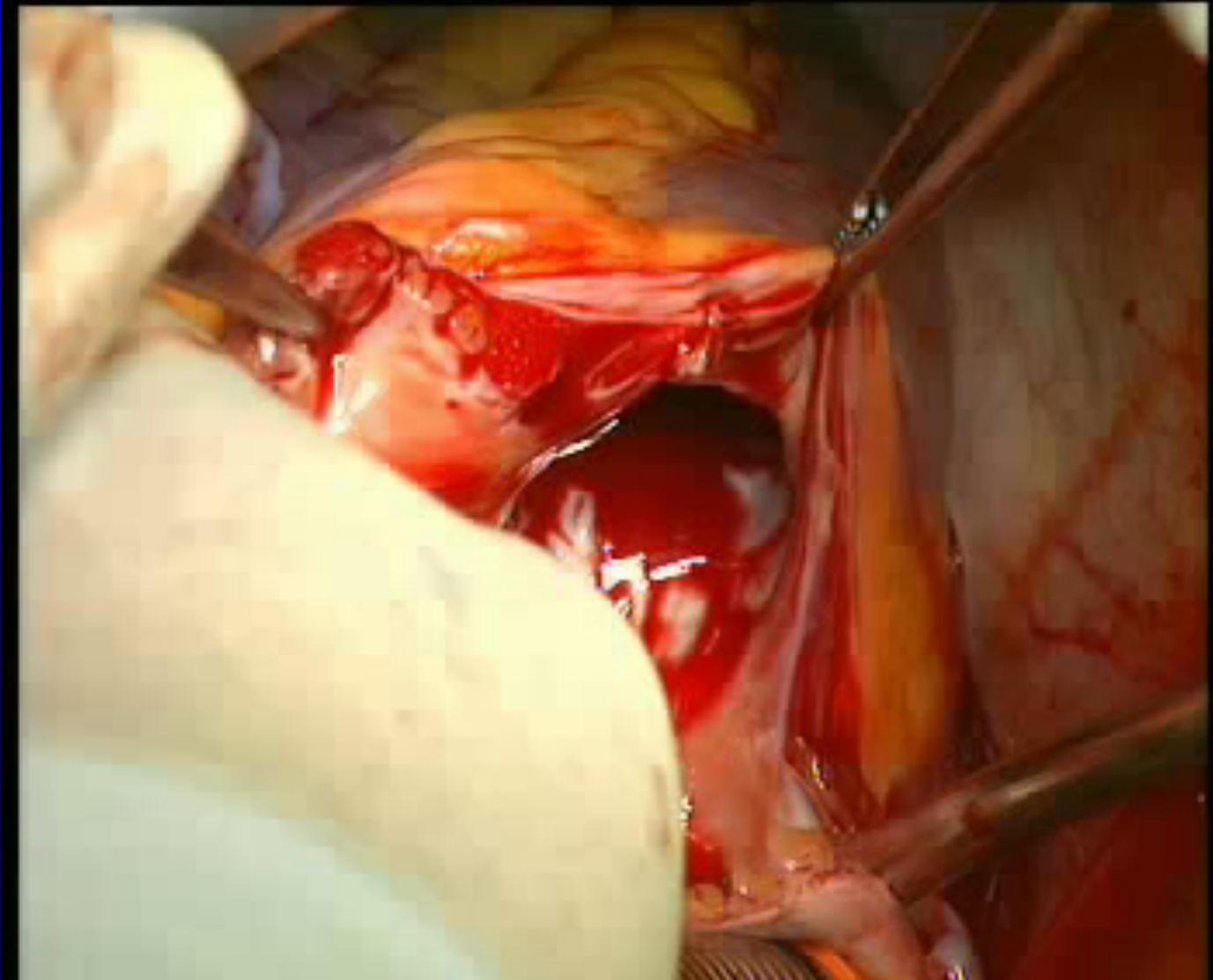
- Vertical incision of right atrium
- Tricuspid annular dimension between anteroseptal and anteroposterior commissure greater than 70mm corrected
- 3/0 interrupted mattress sutures
- Size 34 CE annuloplasty ring for males, 32 for females

## Tricuspid dilatation or regurgitation

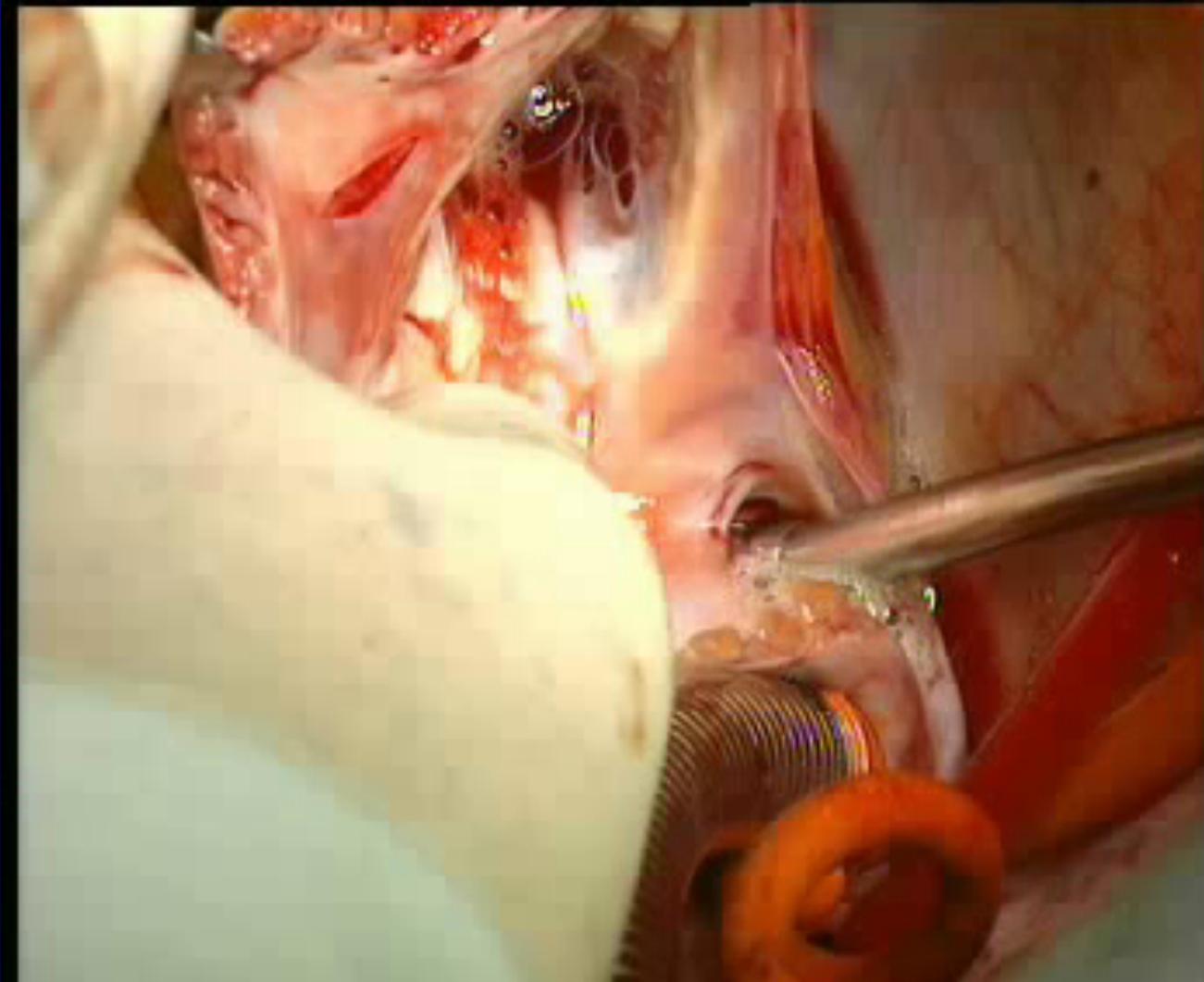
# Pathological process of Tricuspid Valve dilatation



# Tricuspid dilatation or regurgitation



# Tricuspid dilatation or regurgitation



# Tricuspid dilatation or regurgitation

## Results Hospital Mortality

<b>M.V.R. (n=163)</b>	<b>M.V.R. + T.R. (n=148)</b>	<b>p value</b>
<b>3 (1.8%)</b>	<b>1 (0.7%)</b>	<b>n .s.</b>

# Tricuspid dilatation or regurgitation

## Results Morbidity

	M.V.R. (n=163)	M.V.R.+T.R. (n=148)	
Pacemaker	5 (3.1%)	8 (5.4%)	
n.s.			
Myocardial infarction	4 (2.5%)	1 (0.55%)	n.s.
Haemofiltration	4 (2.5%)	2 (1.4%)	n.s.
Sternitis	3 (1.8%)	4 (2.7%)	n.s.
Bleeding	5 (3.1%)	1 (0.55%)	n.s.
Stroke	1 (0.61%)	1 (0.55%)	n.s.

## Tricuspid dilatation or regurgitation

**Clinical and echocardiographic latest data**  
mean follow up =  $4.3 \pm 2.98$  years

	<b>M.V.R.</b>	<b>M.V.R.+ T.V.R.</b>	<b>p</b>
<b>NYHA</b>	$1.59 \pm 0.84$	$1.11 \pm 0.31$	$<0.0001^*$
<b>LVESD</b>	$36.6 \pm 6.1$	$38.0 \pm 7.1$	ns
<b>PAP</b>	$29.3 \pm 7.2$	$28.2 \pm 7.0$	ns
<b>EF</b>	$67.1 \pm 11.0$	$64.3 \pm 13.2$	ns

*\* Mann-Whitney*

## Secondary tricuspid dilatation with or without regurgitation

### Postoperative tricuspid regurgitation

TR grade	M.V.R.		M.V.R.+ T.V.R.	
	pre	post	pre	post
0	54	8	38	102
1	102	33	92	41
2	7	67	16	4
3	0	40	2	1
4	0	15	0	0

## Tricuspid dilatation or regurgitation

### Evolution of tricuspid regurgitation

	M.V.R.	M.V.R.+T.R.	p*
TR grade (pre)	0.71 +/- 0.54	0.88 +/- 0.64	0.027
TR grade (post)	2.07 +/- 0.97	0.36 +/- 0.61	0.0001
Mean change in TR grade	+1.35 +/- 1.12	-0.52 +/- 0.89	
<0.001			

\*(Mann-Whitney)

## Tricuspid dilatation or regurgitation

### Factors Influencing TR

#### Pulmonary hypertension > 50 mmHg

	M.V.R. (n=45)	M.V.R.+T.R. (n=41)	p
Preoperative PAP	62.2	59.6	n.s.
Postoperative PAP	33.1	32.3	n.s.

#### Residual M.R.

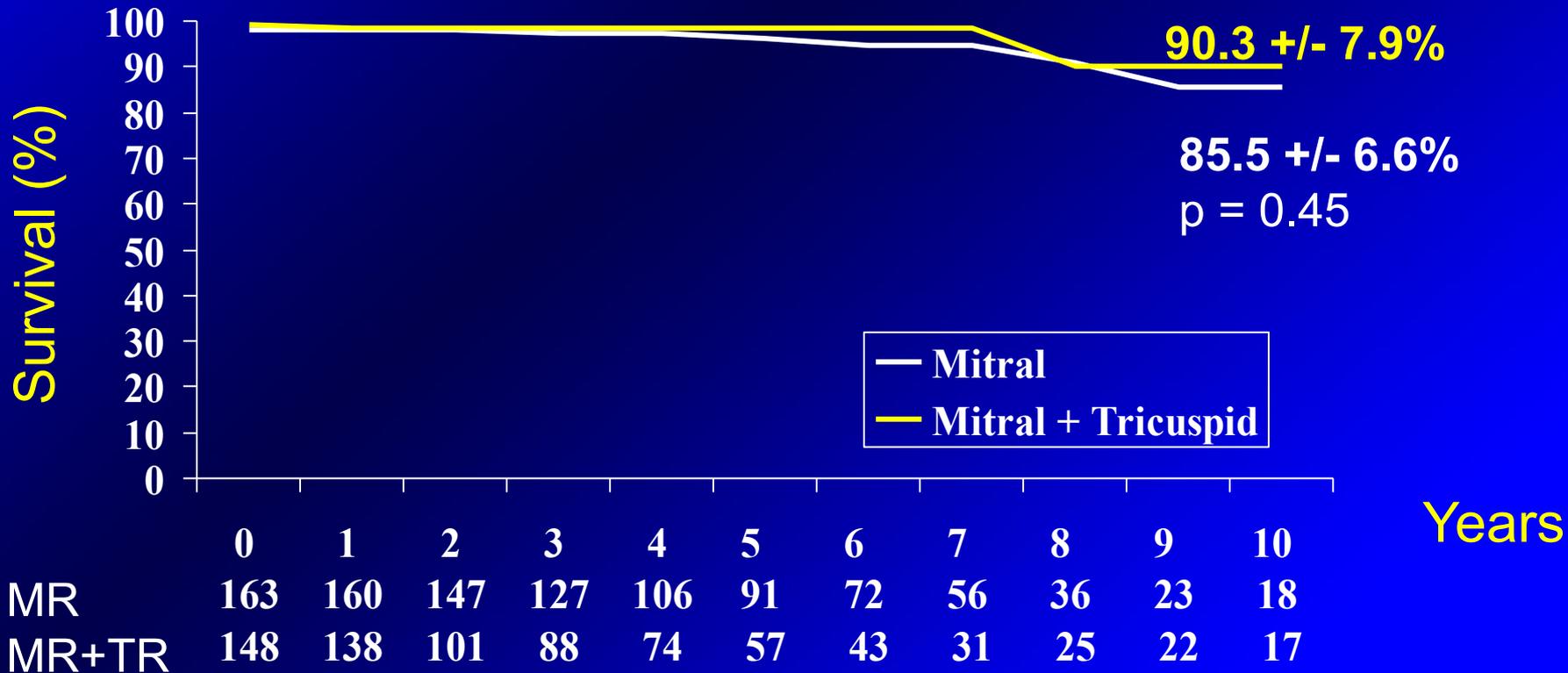
MR grade	0.41 ±0.54	0.60 ±0.66	0.015*
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*\*(Mann-Whitney)*



# Tricuspid dilatation or regurgitation

## Actuarial Survival

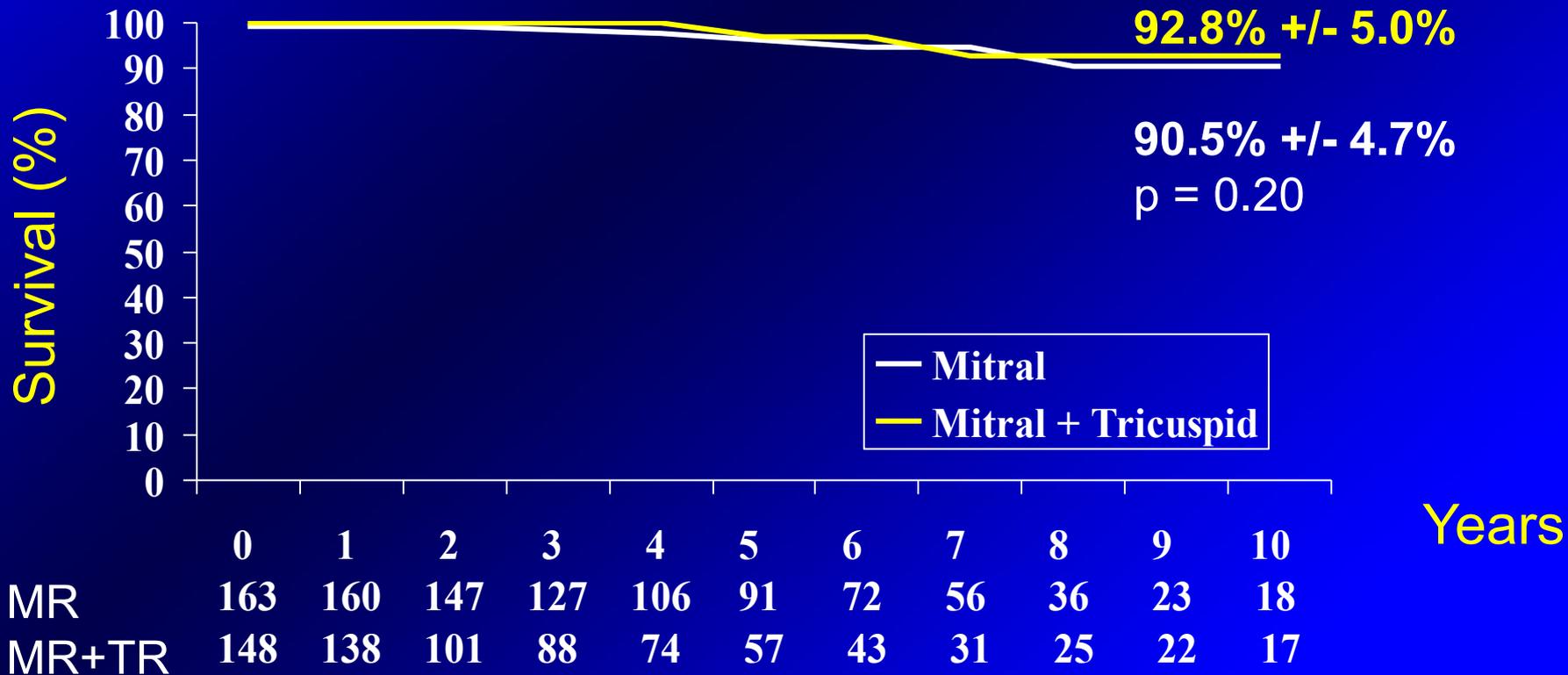


*Kaplan-Meier*



# Tricuspid dilatation or regurgitation

## Event free survival



*Kaplan-Meier*



## Tricuspid dilatation or regurgitation

### Comments

- Tricuspid **dilatation** and **regurgitation** do not correlate well.
- Our criteria to correct tricuspid dilatation was restrictive: no dilatation  $< 70$  mm was corrected.
- **The prevalence** of tricuspid dilatation in this series reaches **50%**.

## Tricuspid dilatation or regurgitation

### Comments

Follow up shows that **tricuspid regurgitation is a self perpetuated process** as:

- 45% in M.V.R. group showed an increase in T.R. of at least 2 grades
- Only 2% in M.V.R. + T.R. group

Incidence of re operation or death is not significantly different.

## Tricuspid dilatation or regurgitation

### Comments

As tricuspid dilatation correlates to right ventricular dilatation/failure:

expected survival in such patients should not be as good as that without dilatation.

Similar survival in both groups suggests that:

**tricuspid valve repair may stabilize or reverse right ventricular failure.**

## Tricuspid dilatation or regurgitation

### Comments

**This theory has some limitations :**

**- huge RV dilatation can be beyond annuloplasty  
as tethering may be the predominant factor**

**in such instances ; TRUE tricuspid repair**



**may be**



- **No annular dilatation**

- **Annular dilatation**

**Whith or without regurgitation**

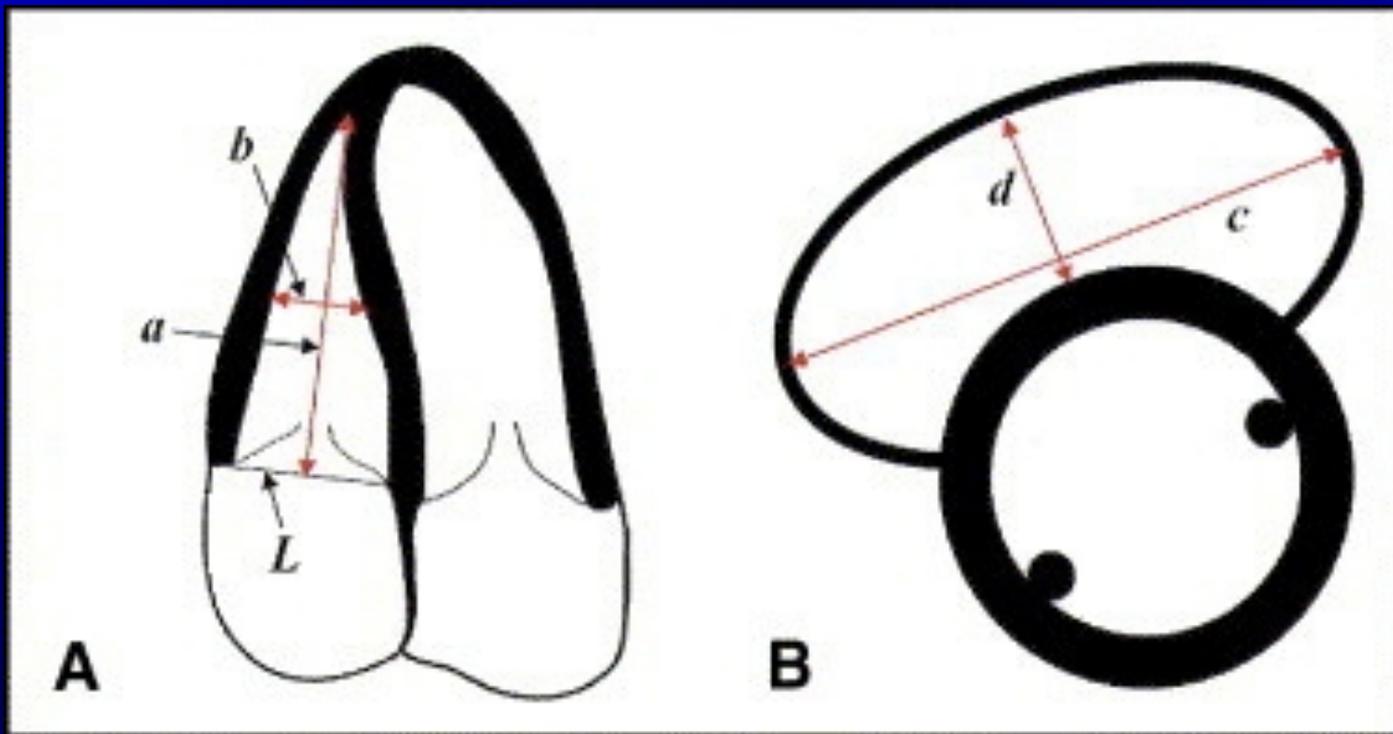
- **Annular dilatation**

**With some degree of TETHERING**

- **Tricuspid valve TETHERING**

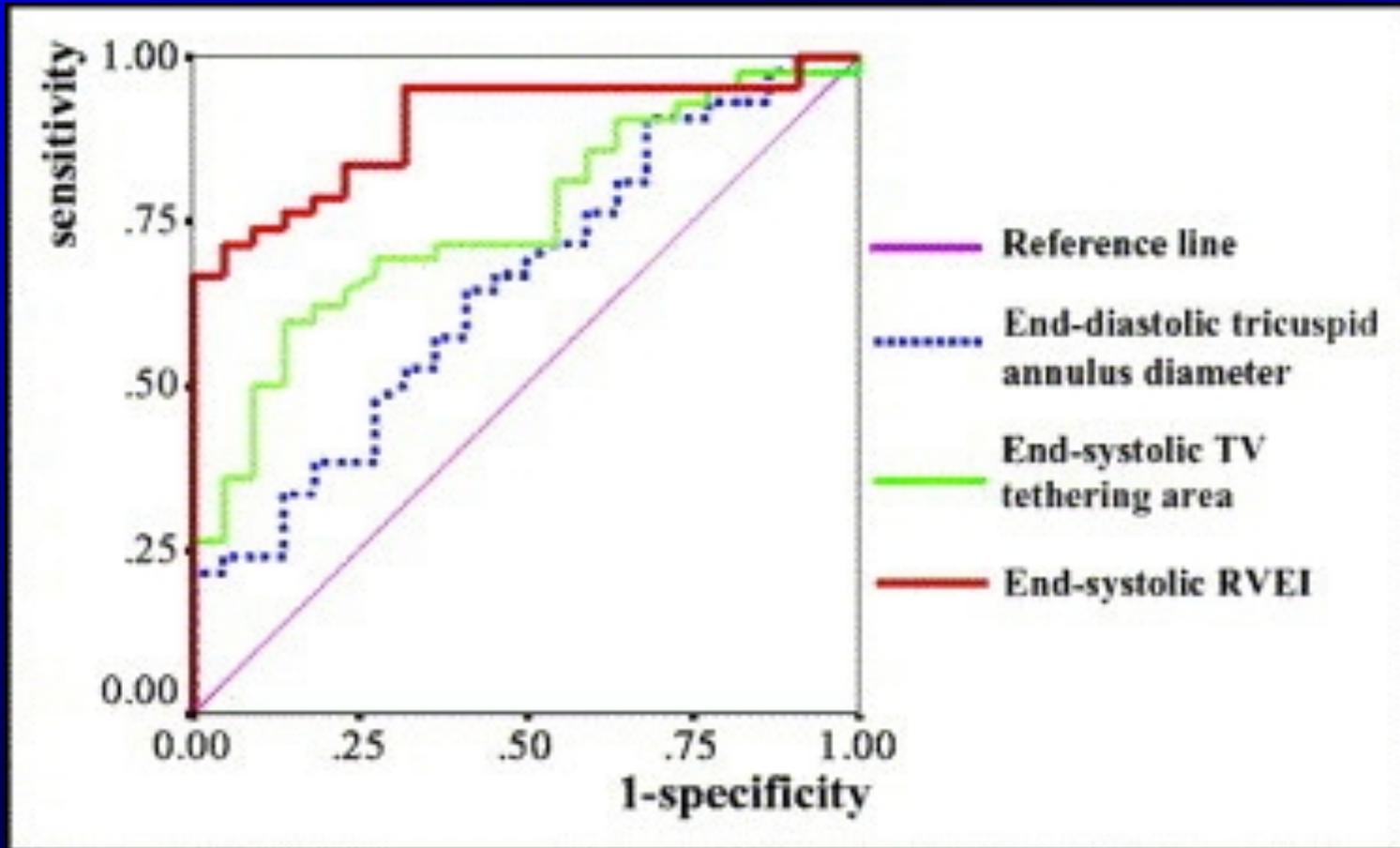
# TRICUSPID VALVE ASSESSMENT

## Assessment of RV sphericity eccentricity



# TRICUSPID VALVE ASSESSMENT

## Best values of Predictors of Functional TR



Kim HK et al. Am J Cardiol 2006;98:236-242



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European Journal of Cardio-thoracic Surgery 34 (2008) 908–910

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SURGERY

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How-to-do-it

## Tricuspid leaflet augmentation to address severe tethering in functional tricuspid regurgitation

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Received 24 April 2008; received in revised form 25 June 2008; accepted 1 July 2008; Available online 9 August 2008

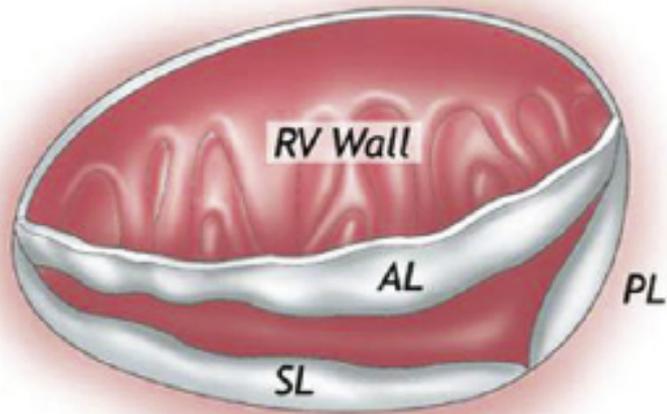
### Abstract

This paper describes a technique for treating severe tricuspid regurgitation due to severe tethering of the tricuspid valve leaflets. The anterior tricuspid leaflet is augmented by use of an autologous pericardial patch, which increases its size, and hence its surface area of coaptation, allowing increased leaflet coaptation to occur with reduced tension within the right ventricle. A Carpentier–Edwards annuloplasty ring is then implanted. We have successfully performed this operation in 15 patients with severe tricuspid regurgitation due to severe leaflet tethering and have achieved complete elimination of tricuspid regurgitation with good coaptation of the tricuspid leaflets. We describe this simple and easily reproducible technique to treat severe tricuspid regurgitation due to tethering of the tricuspid valve leaflets.

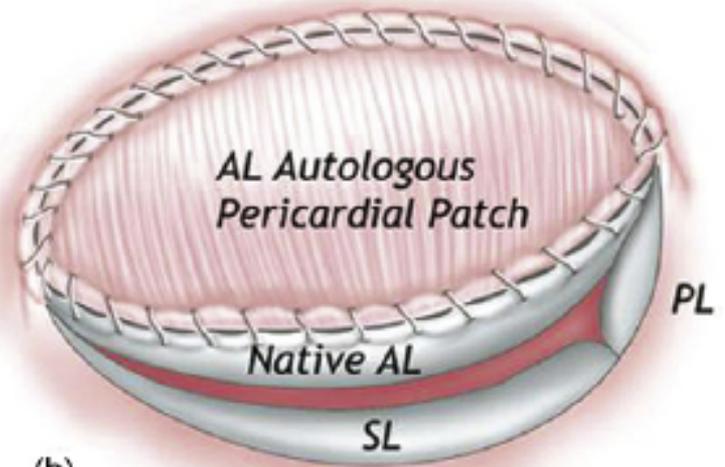
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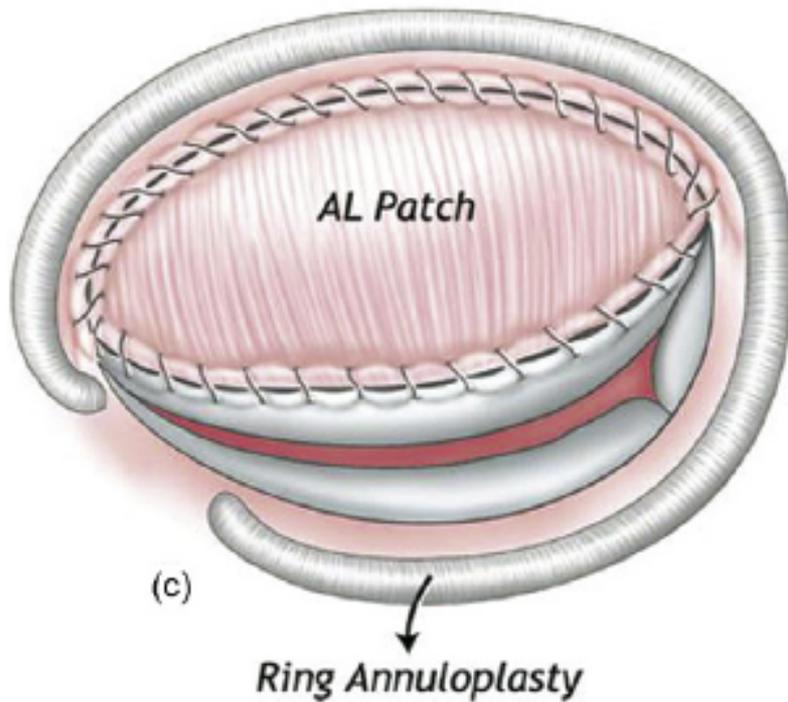
Detached AL from commissure to commissure



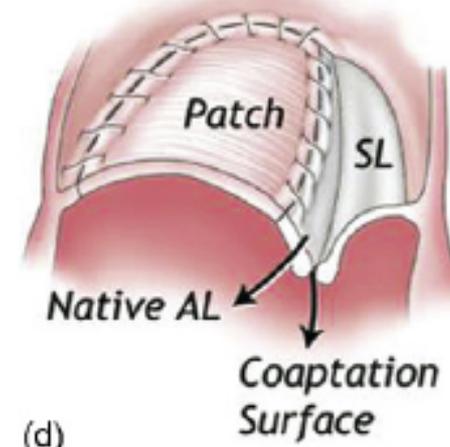
(a)



(b)



(c)



(d)

## THE PRESENT AND FUTURE

### STATE-OF-THE-ART REVIEW

# 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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# **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 ?

European Heart Journal Advance Access published January 9, 2013



EUROPEAN  
SOCIETY OF  
CARDIOLOGY\*

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



C.C.M

# 1. What is Moderate TR ?

**Table 2** Echocardiographic assessment of tricuspid regurgitation severity (modified from Lancellotti et al. <sup>34</sup>)

Parameters	Mild	Moderate	Severe
<b>Qualitative = eye ball</b>			
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)
<b>Semi Quantitative</b>			
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
<b>Quantitative</b>			
EROA (mm <sup>2</sup> )	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.

# Semi Quantitative

## Limits of Vena Contracta

### Vena contracta reflects EROA

- $VC > 6.5 \text{ mm}$   $\longrightarrow$  Severe TR
- **other values NOT ACCURATE:** do not allow to differentiate mild / moderate TR.

Vena contracta should be circular and IS NOT:

Limited correlation in between 2D color Doppler  
3D planimetry of EROA



# Semi Quantitative

## Limits of PISA method

PISA radius  $> 9\text{mm}$   $\longrightarrow$  « significant » TR

PISA radius  $< 5\text{mm}$   $\longrightarrow$  Mild TR

## In between ?

Limits:

- Eccentric jets (beam alignments)
- Tethering (correction of angle)
- Respiratory cycle
- Load dependancy of TR volume.

# 1. What is Moderate TR ?

**Table 2 Echocardiographic assessment of tricuspid regurgitation severity (modified from Lancellotti et al. <sup>34</sup>)**

Parameters	Mild	Moderate	Severe
<b>Qualitative</b>			
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<b>Semi-quantitative</b>			
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)
<b>Quantitative</b>			
R Vol (ml)	Not defined	Not defined	≥40
+ RA/RV/IVC dimension	Not defined	Not defined	≥45

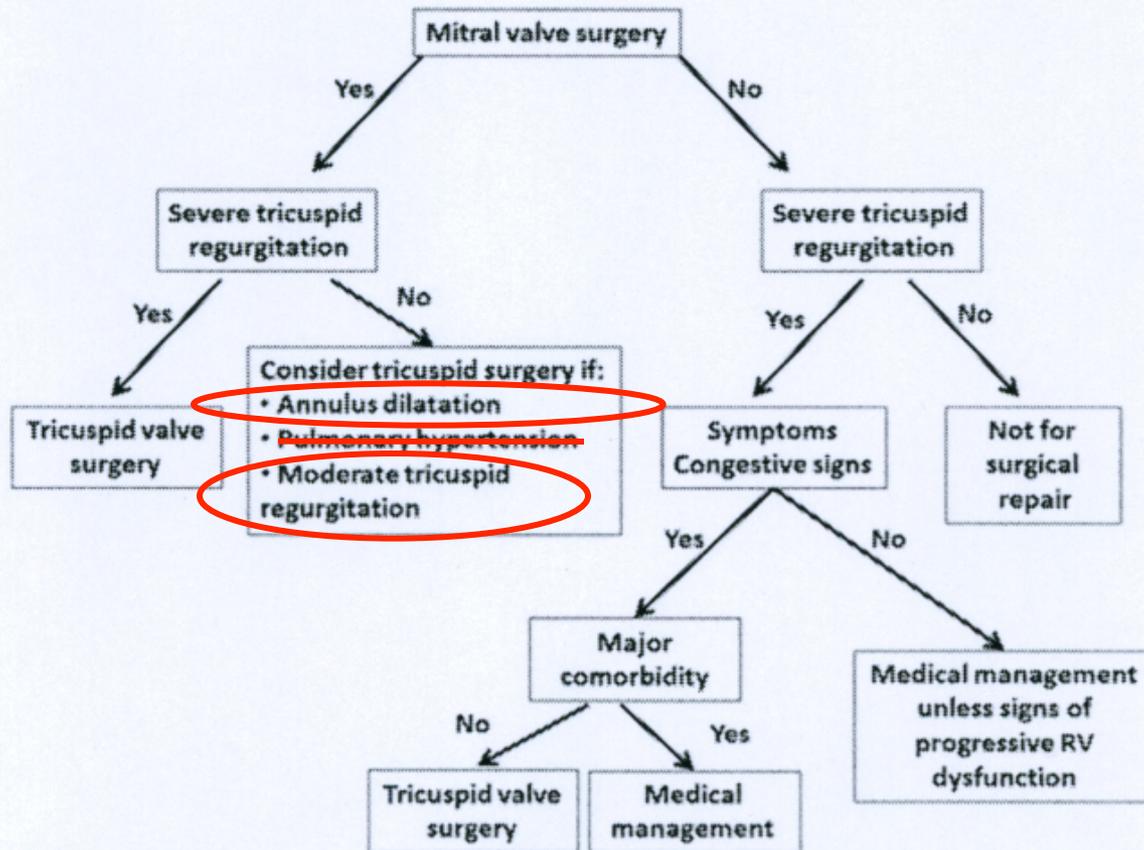
CW, continuous-wave Doppler; EROA, effective regurgitant orifice area; PISA, proximal isovelocity surface area; RA, right atrium; RV, right ventricle; R Vol, regurgitant volume; TR, tricuspid regurgitation; VC, vena contracta.

# 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 Association<sup>50</sup> and the European Society of Cardiology<sup>51</sup> 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 ?

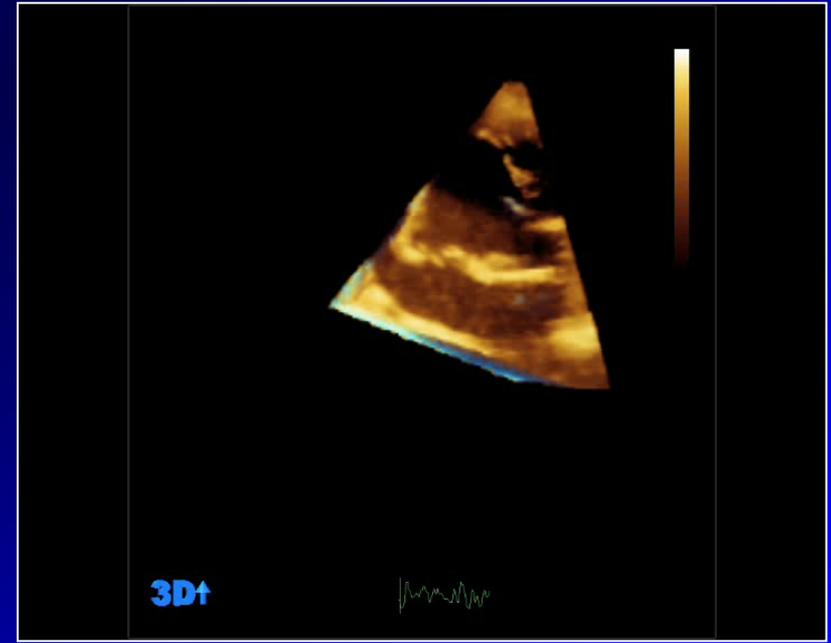
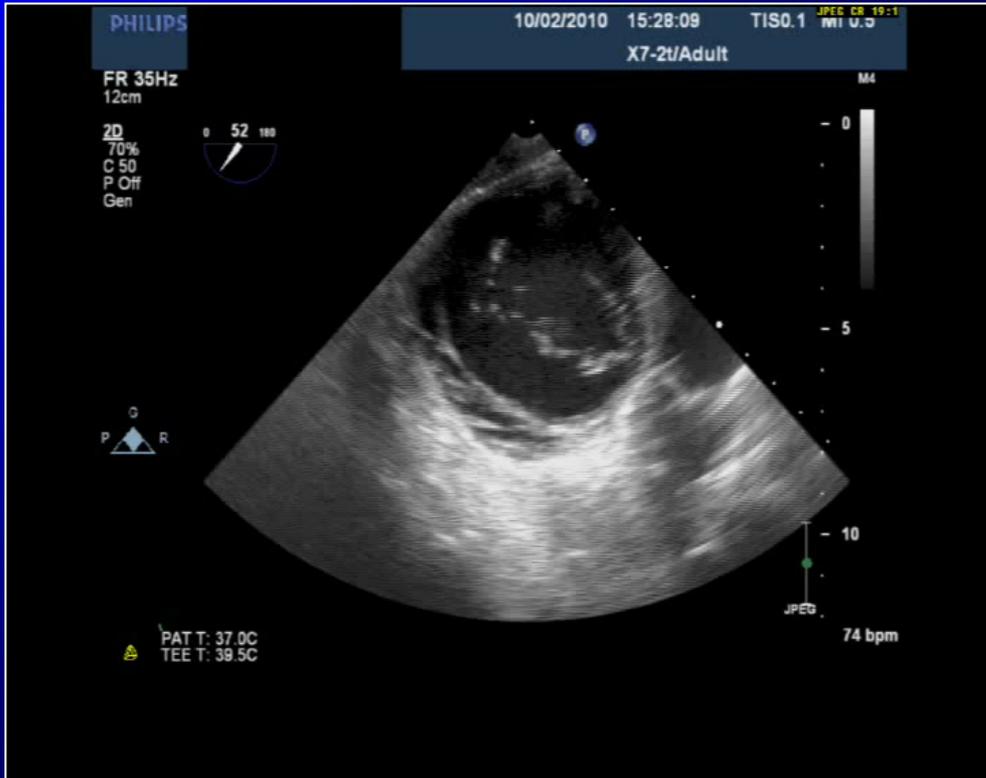
- We don't know +++
- Discussion to treat or not to treat becomes irrelevant

# 3D echo benefits

- **One acquisition to see the entire valve**
- **Real annular tricuspid annular size**
- **Measure of “tenting volume”**
- **Quantification of the anterior leaflet surface**
- **Assessment of RV remodeling**

# TTE 3D pitfalls

- **Sinus rhythm is mandatory (4 cycles)**
- **Image quality remains an issue**
- **Valve thickness distorts imaging**
- **Learning curve is long**
- **Post processing acquisition is complex**



**2. Should we not use  
other parameters than  
grading ?**

## 2. Should we not use other parameters than grading ?

### Annular dilatation

- > 70mm intraoperatively
- 40 mm by transthoracic echocardiography.

# Proposal for « New Assessment »

## TR GRADING

## LEAFLET COAPTATION MODE

## ANNULAR DILATATION

### At annular plane

No TR / Mild  
TR

Surface to surface

Below 40 mm

Edge to edge

Mild TR /  
Moderate TR

**Below annular plane**  
Surface vs edge to edge

Above 40 mm

Tethering > 8mm ?

Severe TR

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

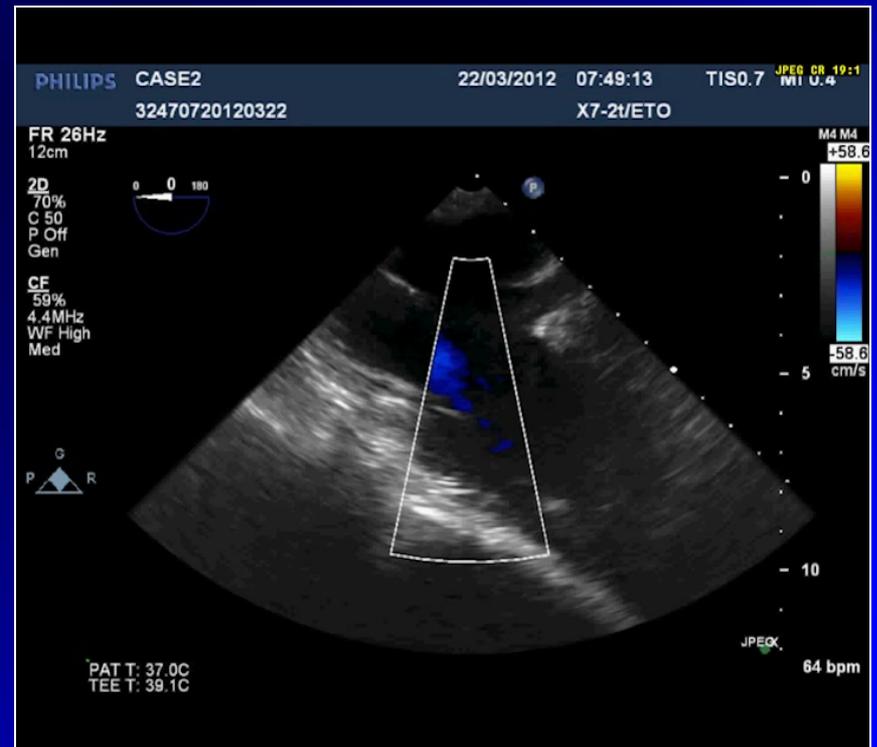
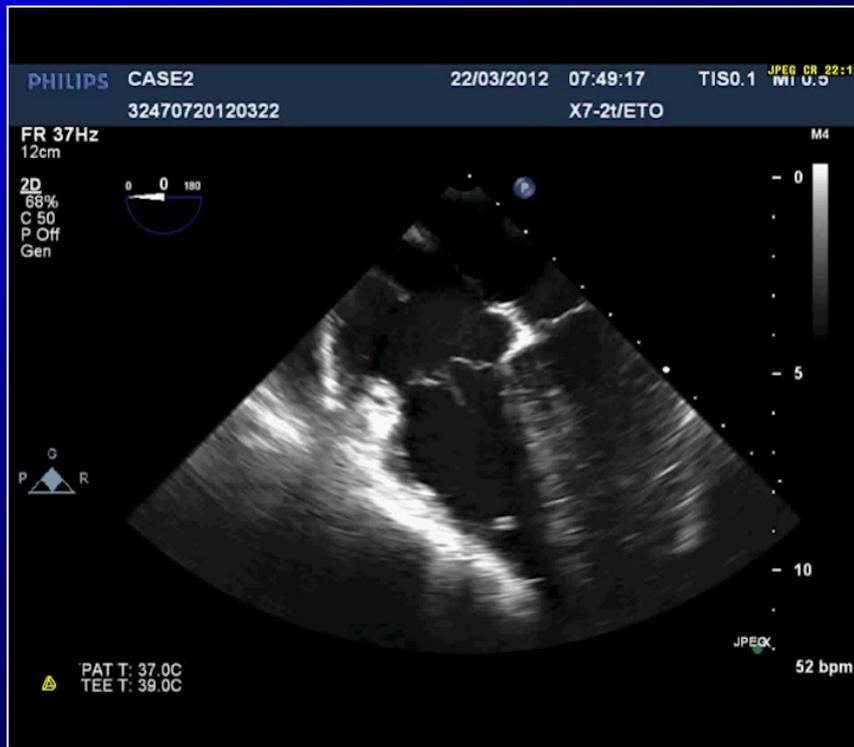
Normal leaflet  
coaptation

Edge to edge coaptation  
No effective coaptation

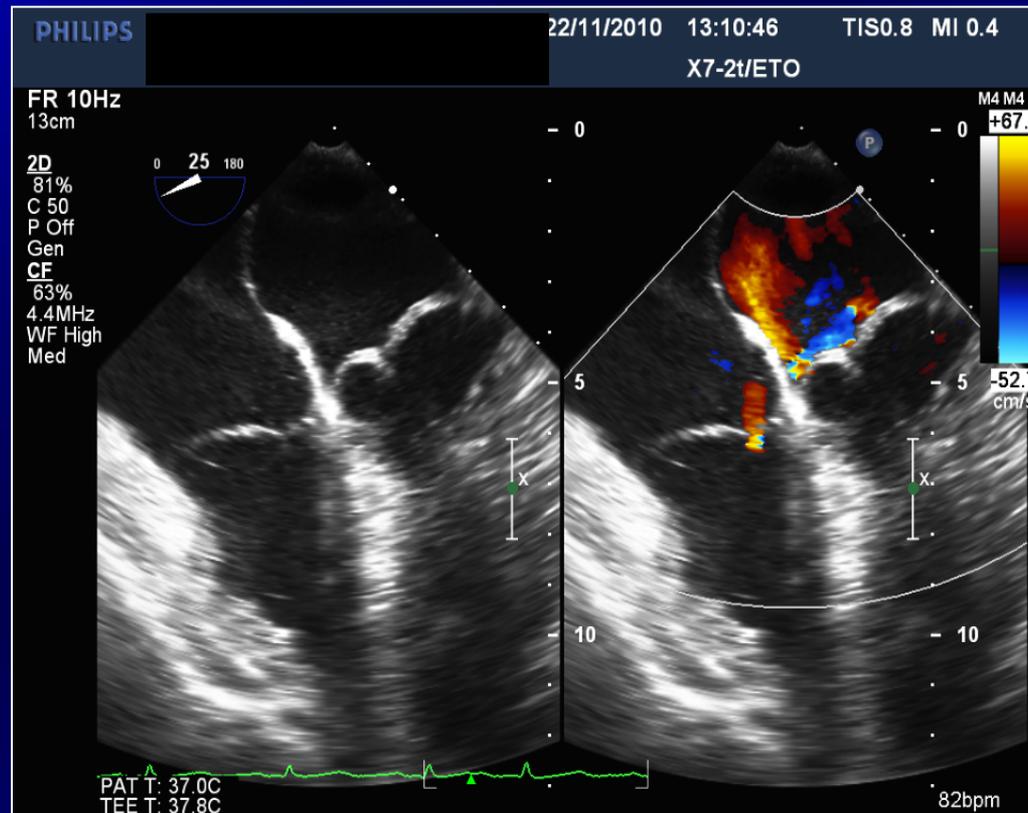
Lack of coaptation  
with or without leaflet  
tethering



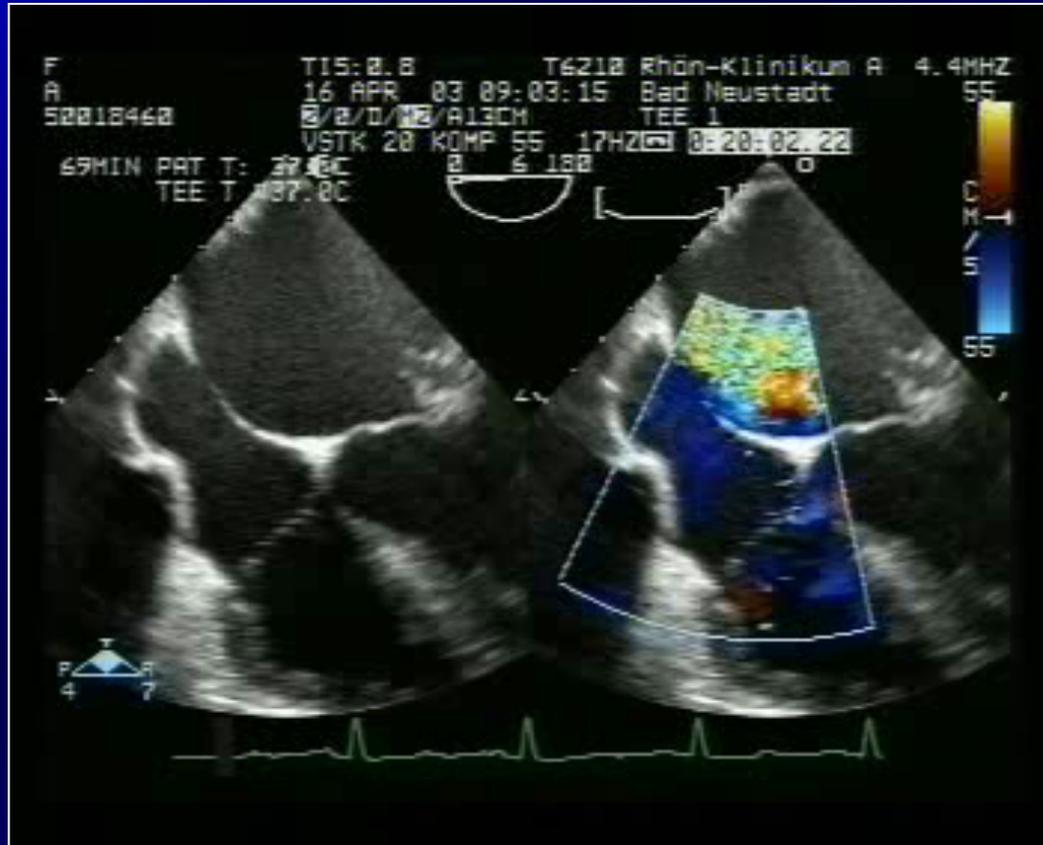
# Stage 1



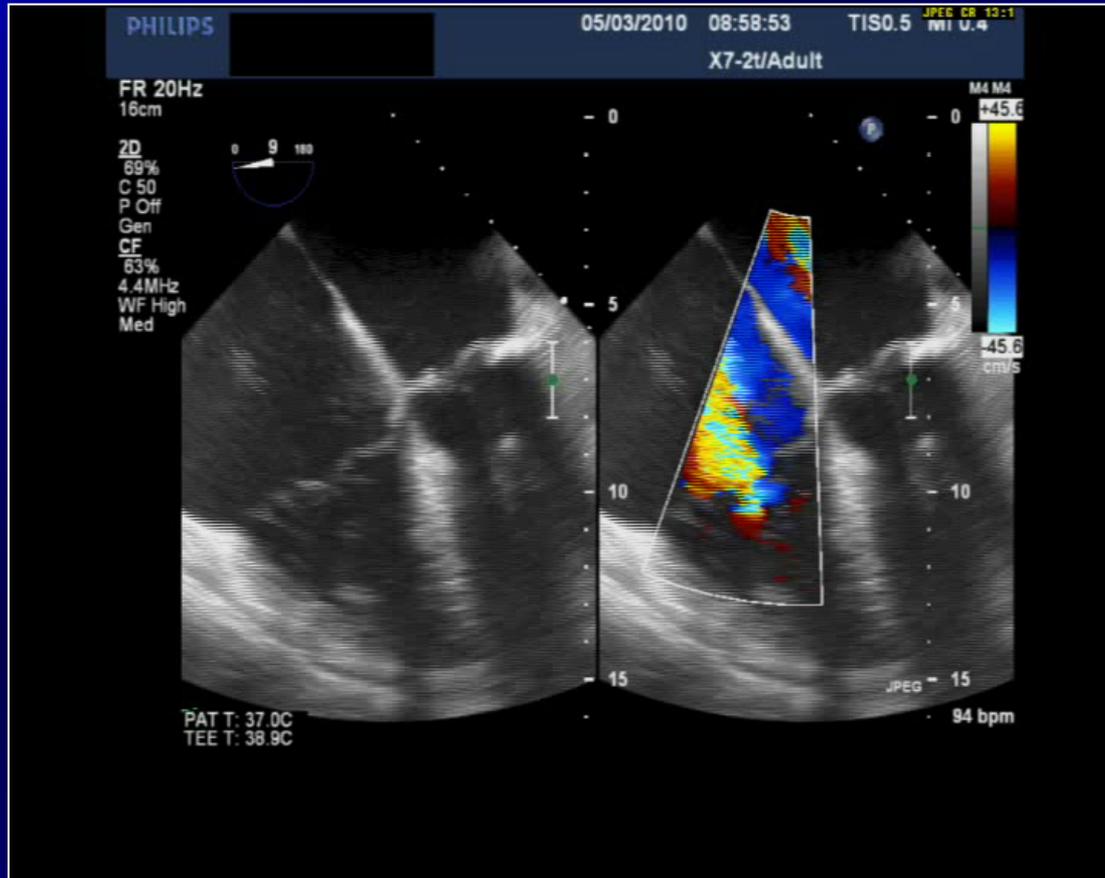
# Stage 2



# Stage 2



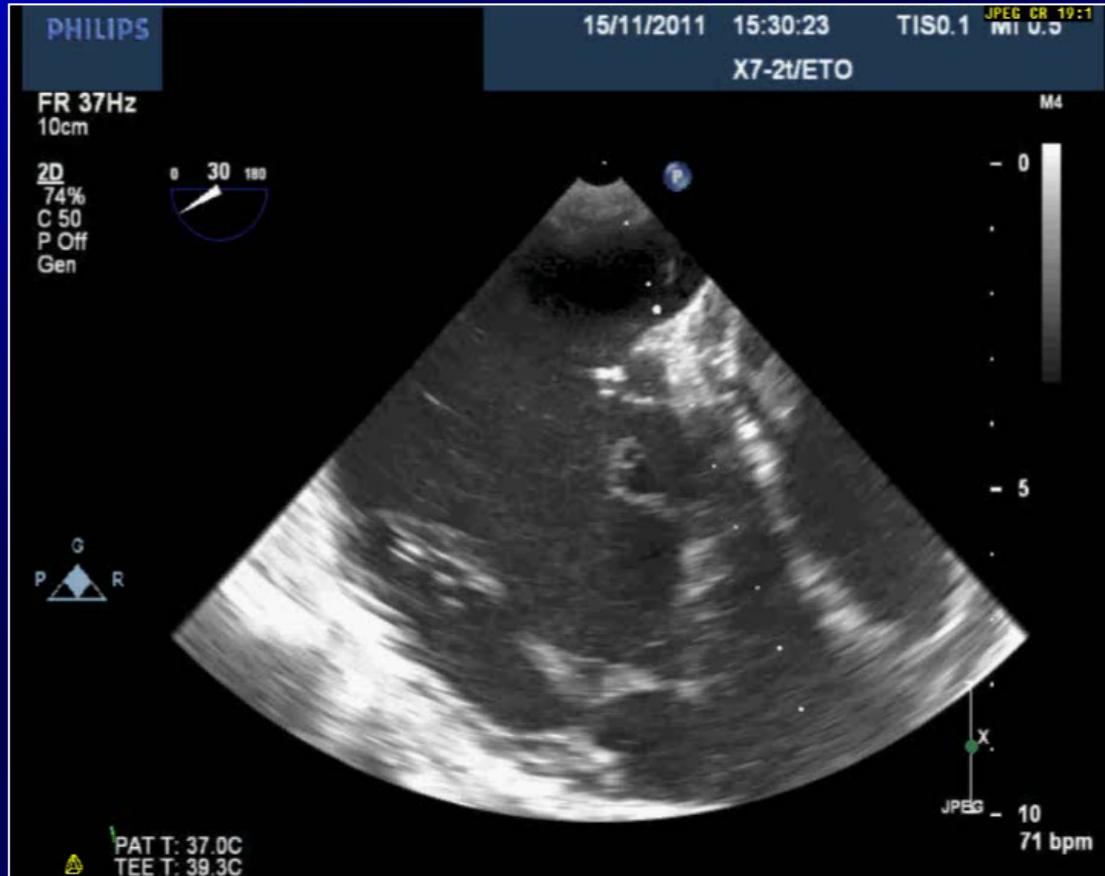
# Stage 2



## 2. Should we not use other parameters than grading ?



# Stage 3



**3. Why should less than  
Severe TR  
be addressed ?**

# 3. Why should less than Severe TR be addressed ?

## Secondary Tricuspid Regurgitation or Dilatation: Which Should Be the Criteria for Surgical Repair?

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absence of substantial TR. Tricuspid dilatation is an ongoing disease process that will, with time, lead to severe TR.

can vary according to the preload, afterload, and right ventricular function. The purpose of this prospective study was to determine whether surgical repair of the tricuspid valve based on tricuspid dilatation rather than TR could lead to potential benefits.

*Methods.* Between 1989 and 2001, 311 patients underwent mitral valve repair (MVR). The tricuspid valve was examined in each patient. Tricuspid annuloplasty was performed only if the tricuspid annular diameter was greater than twice the normal size ( $\geq 70$  mm) regardless of the grade of regurgitation. Patients in group 1 (163 patients; 52.4%) received MVR alone. Patients in group 2 (148 patients; 47.6%) received MVR plus tricuspid annuloplasty.

*Results.* Although not significant there was a difference

90.3% at 3, 5, and 10 years, respectively). The New York Heart Association (NYHA) functional class was significantly improved in group 2 (group 1 =  $1.59 \pm 0.84$ ; group 2 =  $1.11 \pm 0.31$ ;  $p1$ ). TR increased by more than two grades in 48% of the patients in group 1 and in only 2% of the patients in group 2 ( $p < 0.001$ ).

*Conclusions.* Remodeling annuloplasty of the tricuspid valve based on tricuspid dilation improves functional status irrespective of the grade of regurgitation. Considerable tricuspid dilatation can be present even in the absence of substantial TR. Tricuspid dilatation is an ongoing disease process that will, with time, lead to severe TR.

(Ann Thorac Surg 2005;79:127-32)

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# Moderate Tricuspid Regurgitation With Left-Sided Degenerative Heart Valve Disease: To Repair or Not to Repair?

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*Background.* Uncertainty about long-term effects of surgically unaddressed moderate (2+) secondary tricuspid valve (TV) regurgitation (TR) accompanying left

0.001), greater TV tethering height ( $p = 0.0002$ ), and prior concurrent mitral valve procedures ( $p \leq 0.004$ ). In-hospital complications, subsequent TV interventions, and

**Conclusions. A TV repair for moderate TR concomitant with surgery for degenerative left-sided heart valve disease is reasonable to provide an opportunity to prevent its progression and development of right ventricle dys-**

regression analysis was used to identify factors associated with TV repair and for propensity-matched comparison of safety (in-hospital morbidity, mortality) and effectiveness of TV repair (longitudinal echocardiographic assessment of postoperative TR and New York Heart Association class, TV intervention, survival).

*Results.* Factors associated with TV repair of 2+ TR included larger right ventricles and left ventricles ( $p <$

ease is reasonable to provide an opportunity to prevent its progression and development of right ventricle dysfunction, particularly for patients with important right ventricle remodeling and evidence of right ventricular failure, and for patients with advanced left-sided disease requiring mitral valve replacement.

(Ann Thorac Surg 2012;93:59–69)

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## Prophylactic tricuspid annuloplasty in patients with dilated tricuspid annulus undergoing mitral valve surgery

Umberto Benedetto, MD, Giovanni Melina, MD, Emiliano Angeloni, MD, Simone Refice, MD, Antonino Roscitano, MD, Cosimo Comito, MD, and Riccardo Sinatra, MD

**Objective:** Progression of functional tricuspid regurgitation is not uncommon after mitral valve surgery and is associated with poor outcomes. We tested the hypothesis that concomitant tricuspid valve annuloplasty in patients with tricuspid annulus dilatation ( $\geq 40$  mm) prevents tricuspid regurgitation progression after mitral valve surgery.

**Methods:** We enrolled 44 patients undergoing mitral valve surgery (both repair or replacement) showing less than moderate ( $\leq +2$ ) tricuspid regurgitation and dilated tricuspid annulus ( $>40$  mm) at preoperative echocardiography. They were randomized to receive ( $n = 22$ ) or not receive ( $n = 22$ ) concomitant tricuspid annuloplasty (Cosgrove–Edwards annuloplasty ring; Edwards Lifesciences, Irvine, Calif) at the time of mitral valve surgery.

( $n = 15$ ) versus 19% ( $n = 4$ ) of patients in the treatment and control groups, respectively ( $P = .001$ ). Moderate to severe tricuspid regurgitation ( $\geq +3$ ) was present in 0% versus 28% ( $n = 6$ ) of patients in the treatment and control groups, respectively ( $P = .02$ ). Pulmonary artery systolic pressure significantly decreased from baseline in

severe tricuspid regurgitation ( $\geq +3$ ) was present in 0% versus 28% ( $n = 6$ ) of patients in the treatment and control groups, respectively ( $P = .02$ ). Pulmonary artery systolic pressure significantly decreased from baseline in all cases ( $P < .001$ ) and was comparable in the 2 groups ( $41 \pm 8$  mm Hg vs  $40 \pm 5$  mm Hg;  $P = .4$ ). Right ventricular reverse remodeling was marked in the treatment group (right ventricular long axis:  $71 \pm 7$  mm vs  $65 \pm 8$  mm;  $P = .01$ ; short axis:  $33 \pm 4$  mm vs  $27 \pm 5$  mm;  $P = .001$ ) but only minimal in the control group (right ventricular long axis:  $72 \pm 6$  mm vs  $70 \pm 7$  mm;  $P = .08$ ; short axis:  $34 \pm 5$  mm vs  $33 \pm 5$  mm;  $P = .1$ ). The 6-minute walk test improved from baseline in both groups ( $P < .001$ ), but this improvement was greater in the treatment group ( $+115 \pm 23$  m from baseline vs  $+75 \pm 35$  m;  $P = .008$ ).

**Conclusions:** Prophylactic tricuspid valve annuloplasty in patients with dilated tricuspid annulus undergoing mitral valve surgery was associated with a reduced rate of tricuspid regurgitation progression, improved right ventricular remodeling, and better functional outcomes. (*J Thorac Cardiovasc Surg* 2012;143:632-8)

# Contemporary Reviews in Cardiovascular Medicine

## The Tricuspid Valve

### Current Perspective and Evolving Management of Tricuspid Regurgitation

Jason H. Rogers, MD; Steven F. Bolling, MD

**Abstract**—Cardiovascular specialists have entered an era of renewed interest and enthusiasm surrounding the diagnosis and treatment of valvular heart disease, driven in part by emerging percutaneous therapies for the treatment of aortic, pulmonic, and mitral valve disease. Despite this wave of investigation, little or no attention has been given to the treatment of tricuspid valve disease. Tricuspid regurgitation (TR) occurs mainly from tricuspid annular dilation, which can result from left-sided heart failure from myocardial or valvular causes, right ventricular volume and pressure overload, or dilation of cardiac chambers. If untreated at the time of surgical mitral valve repair, significant residual TR negatively impacts perioperative outcomes, functional class, and survival. TR does not reliably resolve after successful mitral valve surgery. If present at the time of mitral valve surgery, TR can usually be effectively addressed with ring annuloplasty. Because reoperations for recurrent TR carry high mortality rates, few patients are offered reoperation for redo tricuspid repair or replacement. As transcatheter therapies for mitral regurgitation arise, parallel percutaneous approaches for TR may be necessary. In this article, we review the anatomy, pathophysiology, and value of mechanical correction of TR, including potential transcatheter therapies for TR. (*Circulation*. 2009;119:2718-2725.)

**Key Words:** valve, tricuspid ■ valves ■ catheters ■ surgery



## Tricuspid regurgitation after successful mitral valve surgery

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### Abstract

The tricuspid valve (TV) is inseparably connected with the mitral valve (MV) in terms of function. Any pathophysiological condition concerning the MV is potentially a threat for the normal function of the TV as well. One of the most challenging cases is functional tricuspid regurgitation (TR) after surgical MV correction. In the past, TR was considered to progressively revert with time after left-sided valve restoration. Nevertheless, more recent studies showed that TR could develop and evolve postoperatively over time, as well as being closely associated with a poorer prognosis in terms of morbidity and mortality. Pressure and volume overload are usually the underlying pathophysiological mechanisms; structural alterations, like tricuspid annulus dilatation, increased leaflet tethering and right ventricular remodelling are almost always present when regurgitation develops. The most important risk factors associated with a higher probability of late TR development involve the elderly, female gender, larger left atrial size, atrial fibrillation, right chamber dilatation, higher pulmonary artery systolic pressures, longer times from the onset of MV disease to surgery, history of rheumatic heart disease, ischaemic heart disease and prosthetic valve malfunction. The time of TR manifestation can be up to 10 years or more after an MV surgery. Echocardiography, including the novel 3D Echo techniques, is crucial in the early diagnosis and prognosis of future TV disease development. Appropriate surgical technique and timing still need to be clarified.

**Keywords:** Functional tricuspid regurgitation • Mitral valve surgery

# Role of concomitant tricuspid surgery in moderate functional tricuspid regurgitation in patients undergoing left heart valve surgery



## Abstract

Functional tricuspid regurgitation (FTR) is frequently present in patients undergoing aortic, and particularly mitral valve, surgery. Untreated FTR may lead to right heart failure. Reoperative cardiac surgery for late FTR is associated with high morbidity and mortality. Therefore, severe FTR has emerged as a Class I indication for concomitant tricuspid valve surgery in patients undergoing left valve surgery. Concomitant tricuspid valve surgery during left heart valve surgery to address moderate and mild FTR is controversial. This review addresses this issue and proposes an algorithm for the treatment of FTR in patients undergoing left heart valve surgery.

**Key words** Functional tricuspid regurgitation • Annular dilatation • Tethering height

**Balakrishnan Mahesh, Francis Wells, Samer Nashef and Sukumaran Nair\***

+ Author Affiliations

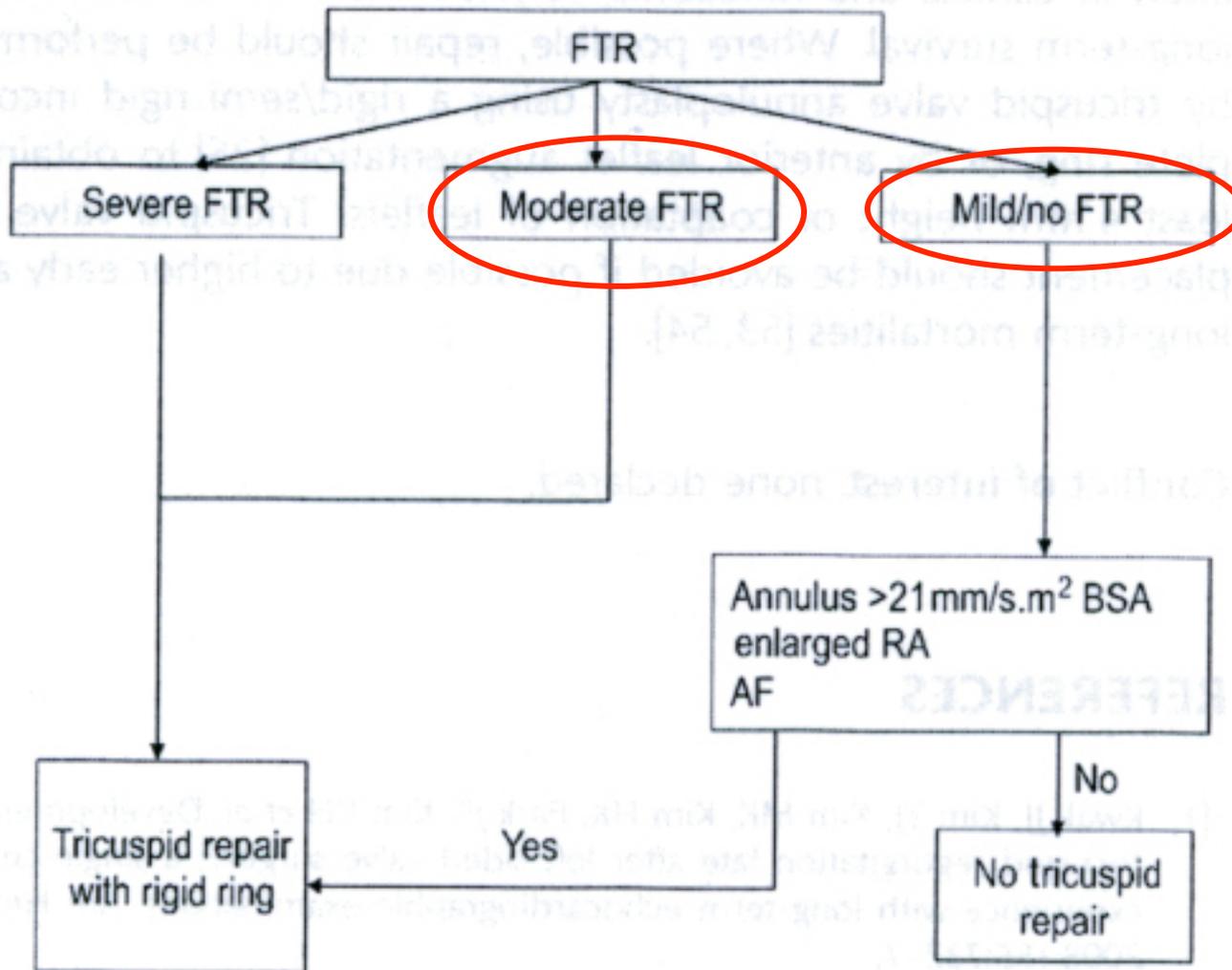
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**Figure 2:** Proposed algorithm for the treatment of functional tricuspid regurgitation (FTR) in patients undergoing left heart valve surgery. RA: right atrium; AF: atrial fibrillation; BSA: body surface area.

# MAYO CLINIC does not agree:

## Functional tricuspid regurgitation at the time of mitral valve repair for degenerative leaflet prolapse: The case for a selective approach

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**Objectives:** It is not clear whether clinically silent tricuspid valve regurgitation should be addressed at the time of mitral valve repair for severe mitral regurgitation due to leaflet prolapse. We examined the clinical and echocardiographic outcomes of patients with tricuspid regurgitation who underwent only mitral valve repair.

**Methods:** We retrospectively analyzed records of patients undergoing mitral valve repair for isolated mitral valve prolapse who had coexistent tricuspid valve regurgitation during an 11-year period at our institution. Echocardiographic data were compared preoperatively, intraoperatively, and postoperatively at less than 1, 1 to 3, 3 to 5, and more than 5 years.

**Results:** In 699 patients who underwent mitral valve repair for severe mitral regurgitation, mean age was 60.4 years and 459 (66%) were male. At the time of mitral valve repair, tricuspid valve regurgitation was grade 3 or more in 115 (16%) patients and less than grade 3 in 584 (84%) patients. After mitral valve repair, overall grade of tricuspid valve regurgitation decreased significantly within the first year ( $P = .01$ ). In patients with grade 3 regurgitation or more, the grade decreased at dismissal and until the third year ( $P < .001$ ). Female sex, preoperative atrial fibrillation, and diabetes mellitus were independent risk factors for increased tricuspid

**Conclusions:** Clinically silent nonsevere tricuspid valve regurgitation in patients with degenerative mitral valve disease is unlikely to progress after mitral valve repair. Tricuspid valve surgery is rarely necessary for most patients undergoing repair of isolated mitral valve prolapse. (J Thorac Cardiovasc Surg 2011;142:608-13)

... BUT

## The Mayo Clinic Data

Conclusion at 5 years relies upon **109 pts ONLY**  
(out of initial cohort of 696 )

TR is separated into 1+ / 2+ vs 3+ / 4+ ( n= 109 )

Preop      1+ / 2+ : n = 93  
              3+ / 4+ : n = 15 ( 13 % )

Postop     1+ / 2+ : n = 77  
              3+ / 4+ : n = 32 ( 29,4 % )



Distribution of functional TR and residual MR over time

Follow-up time	TR			MR	
	Total	Grade < 3 *	Grade ≥ 3 *	Total	Grade ≥ 3 *
Preoperative	696	581 (83.5)	115 (16.5)	699	699 (100)
Predismissal	627	517 (82.4)	110 (17.5)	679	26 (3.8)
≤1 y	250	212 (84.8)	38 (15.2)	278	16 (5.8)
1–3 y	207	165 (79.7)	42 (20.3)	219	18 (8.2)
3–5 y	145	112 (77.2)	33 (22.8)	151	12 (7.9)
>5 y	109	77 (70.6)	32 (29.4)	110	11 (10)

\* Values are no. of patients (%).

MR, Mitral valve regurgitation; TR, **tricuspid** valve regurgitation.

# Secondary tricuspid dilatation with or without regurgitation

## *Postoperative tricuspid regurgitation*

TR grade	M.V.R.		M.V.R.+T.V.R.	
	pre	post	pre	post
0	54	8	38	102
1	102	33	92	41
2	7	67	16	4
3	0	40	2	1
4	0	15	0	0

30%

# Tricuspid valve repair during MV: Why?

TR grade	Baseline	5 years	p
0	54	8	
1	102	33	
2	7	67	
3	0	40	
4	0	15	
<b>Mean</b>	<b>0.7 ± 0.5</b>	<b>2.1 ± 1.0</b>	<b>&lt; 0.001</b>

163 patients undergoing mitral valve repair.  
Significant late TR developed in 34% of patients.

**MAYO CLINIC also claims that secondary TR is rare as they had to reoperate only 1 patient at 5 years.**

- **Criteria for 1st time tricuspid is controversial !**
- **Criteria for 2nd time surgery do not exist !**

**They should also be revisited**



# Discussion

## 1) Reoperation : 1 patient !!!

- Not relevant data as reop criteria are not defined
- Criteria for reop : **not grading**  
**not symptoms**  
**biology ?**

## 2) “Selective approach”

- but how do you select your patients ?
- etiology , AF , gender : **YES** , diabetes ??



**Can we agree that TR grading is not reliable ?**

**Can we agree that TR may progress even without identified factors with time ?**

**Can we agree that other criteria are relevant ?**

## **Can we agree that after tricuspid annuloplasty:**

- TR progression rate is very low and stable ?**
- Functionnal status is improved ?**
- RV shows reverse remodelling ?**
- Survival rate shows a better trend ?**

**If we agree to all  
these statements ;  
no more debate !**