How to handle concomitant TR - the role of TEE -

A. Berrebi, M.D.
Declaration of interest

Consulting

Edwards Lifesciences
Philips Healthcare
How to handle concomitant TR

✓ New paradigm in Functional TR
✓ TR severity: not always reliable
✓ Valve Analysis: Echo protocol
✓ Surgical Implications
CLASS I

1. Tricuspid valve repair is beneficial for severe TR in patients with MV disease requiring MV surgery. (Level of Evidence: B)

CLASS IIb

Tricuspid annuloplasty may be considered for less than severe TR in patients undergoing MV surgery when there is pulmonary hypertension or tricuspid annular dilatation. (Level of Evidence: C)

### Moderate organic TR in a patient undergoing left-sided valve surgery

IIaC

### Moderate secondary TR with dilated annulus (>40 mm) in a patient undergoing left-sided valve surgery

IIaC

### Severe TR and symptoms, after left-sided valve surgery, in the absence of left-sided myocardial, valve, or right ventricular dysfunction and without severe pulmonary hypertension (systolic pulmonary artery pressure > 60 mmHg)

IIaC

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

Gilles D. Dreyfus, MD, Pierre J. Corbi, MD, K. M. John Chan, AFRCS, and Toufan Bahrami, MD

Department of Cardiothoracic Surgery, Royal Brompton and Harefield NHS Trust, Harefield Hospital, Harefield, Middlesex, United Kingdom

311 patients

161 MV repair only

148 MV + TV repair

TV ann < 70 mm

TV ann ≥ 70 mm

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

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<table>
<thead>
<tr>
<th>Grade</th>
<th>Group 1 (MVR)</th>
<th>Group 2 (MVR + TVR)</th>
</tr>
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<tbody>
<tr>
<td>Grade 0</td>
<td>54</td>
<td>38</td>
</tr>
<tr>
<td>Grade 1</td>
<td>102</td>
<td>92</td>
</tr>
<tr>
<td>Grade 2</td>
<td>7</td>
<td>16</td>
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<tr>
<td>Grade 3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Grade 4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean TR grade</td>
<td>0.7 ± 0.5\textsuperscript{a}</td>
<td>0.9 ± 0.6\textsuperscript{a}</td>
</tr>
</tbody>
</table>

\textsuperscript{a} \( p = 0.027 \) Mann–Whitney. \textsuperscript{b} \( p < 0.001 \) Mann–Whitney.

MVR = mitral valve repair; TR = tricuspid regurgitation; TVR = tricuspid valve repair.

88% pts with annulus dilatation TR ≤ grade 1
MVR only group: 45% TR increase ≥ 2 grades (compared to 2% in the MVR + TVR group)
Progression of Tricuspid Regurgitation After Repaired Functional Ischemic Mitral Regurgitation

Akira Matsunaga, MD; Carlos M.G. Duran, MD, PhD

Background—Despite correction of left-sided cardiac lesions, associated functional tricuspid regurgitation (TR) that was surgically ignored can persist. It can also appear de novo. The aim of this study was to analyze TR in a group of patients who underwent successful revascularization and mitral valve repair (MVRep) for functional ischemic mitral regurgitation (MR).

Methods and Results—Among 124 consecutive patients with MVRep, 70 left the operating room with MR ≤1+ and had a preoperative and follow-up transthoracic echocardiogra. Moderate or greater MR or TR was considered significant. Twenty-one patients (30%) had TR before surgery, and only 9 had TR repaired. The postoperative incidence of residual TR was not significantly different whether the tricuspid valve had been repaired (4 of 9 [44%]) or surgically ignored (8 of 12 [67%]). At last follow-up, 34 patients (49%) had significant TR. The incidence of TR increased from 25% at <1 year to 53% between 1 and 3 years and 74% at >3 years. Absence or presence of recurrent MR did not significantly affect TR (14 of 22 [64%] with MR versus 20 of 48 [42%] with no MR). Preoperative and postoperative tricuspid annulus size in patients with late TR was significantly larger than in patients without TR.

Conclusions—Functional TR is frequently associated with functional ischemic MR. After MVRep, close to 50% of patients have TR. The incidence of postoperative TR increases with time. Preoperative tricuspid annulus dilation might be a predictor of late TR. (Circulation. 2005;112[suppl I]:I-453–I-457.)
Pathophysiology of Functional TR

Adapted from Shiran, J Am Coll Cardiol 2009;53:401
« A long lasting evolution of functional tricuspid regurgitation creates the conditions of irreversible dysfunction »

Carpentier A. (chapt 18)
How to handle concomitant TR

✓ New paradigm in Functional TR
✓ TR severity: not always reliable
✓ Valve Analysis: Echo protocol
✓ Surgical Implications
## European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 2: mitral and tricuspid regurgitation (native valve disease)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
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<tbody>
<tr>
<td>Qualitative</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Tricuspid valve morphology</td>
<td>Normal/abnormal</td>
<td>Normal/abnormal</td>
<td>Abnormal/flail/large coaptation defect</td>
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<tr>
<td>Colour flow TR jet</td>
<td>Small, central</td>
<td>Intermediate</td>
<td>Very large central jet or eccentric wall impinging jet</td>
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<tr>
<td>CW signal of TR jet</td>
<td>Faint/Parabolic</td>
<td>Dense/Parabolic</td>
<td>Dense/Triangular with early peaking (peak &lt; 2 m/s in massive TR)</td>
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<tr>
<td>Semi-quantitative</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>VC width (mm)</td>
<td>Not defined</td>
<td>&lt;7</td>
<td>≥7</td>
</tr>
<tr>
<td>PISA radius (mm)</td>
<td>≤5</td>
<td>6–9</td>
<td>&gt;9</td>
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<td>Hepatic vein flow</td>
<td>Systolic dominance</td>
<td>Systolic blunting</td>
<td>Systolic flow reversal</td>
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<tr>
<td>Tricuspid inflow</td>
<td>Normal</td>
<td>Normal</td>
<td>E wave dominant (≥1 cm/s)</td>
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<tr>
<td>Quantitative</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EROA (mm²)</td>
<td>Not defined</td>
<td>Not defined</td>
<td>≥40</td>
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<tr>
<td>R Vol (mL)</td>
<td>Not defined</td>
<td>Not defined</td>
<td>≥45</td>
</tr>
<tr>
<td>RA/RV/IVC dimension</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VCW > 6.5mm identified severe TR with 88.5% sensitivity and 93.3% specificity
3D Vena Contracta Area in TR

> 0.75 cm$^2$ in severe TR

Velayudhan et al. Echocardiography 2006;23:793-800
functional TR is characterized by its variability in a given patient
Reasons of Variability

«Peculiar» sensitivity to loading conditions of the thin wall of RV

Volemia, Medical Rx (diuretics, vasodilators), anesthetic drugs

RV Function and Cardiac Output
Do we adress: the right questions with appropriate tools and reliable criteria?
How to handle concomitant TR

- New paradigm in Functional TR
- TR severity: not always reliable
- Valve Analysis: Echo protocol
- Surgical Implications
Functional analysis in Secondary TR

- **Type I**: Annular distension
- **Type II**: Right ventricular dysfunction
- **Type IIIa**: Restricted leaflet motion
- **Type IIIb**: Leaflet prolapse

Mechanisms of TV insufficiency
Valve Analysis: Echo protocol

✓ Type I: Normal leaflet motion
  - annular dilatation
  - leaflet coaptation distance
  - right atrial dilatation

✓ Type IIIb: Restrictive leaflet motion
  - RV dilatation and/or deformation
  - Tenting height and surface
Valve Analysis: Echo protocol

✓ Type I: Normal leaflet motion
  - annular dilatation
  - leaflet coaptation distance
  - right atrial dilatation

✓ Type IIIb: Restrictive leaflet motion
  - RV dilatation and/or deformation
  - Tenting height and surface
Dysfunction type I
Tricuspid Annular Dilatation

Normal Annulus

Dilated Annulus

Deloche et al., Ann Chir Thorac Cardiovasc, 1973, 12
Annulus Dilatation

Surgical cut-off value: 70 mm

Annulus Dilatation

Echo cut-off value: 40 mm or 21 mm/m²
Which incidence to measure annular Ø?
Low 4 chamber view (mitral A3P3)
Valve Analysis: Echo protocol

✅ Type I: Normal leaflet motion
  - annular dilatation
  - leaflet coaptation distance
  - right atrial dilatation

✅ Type IIIb: Restrictive leaflet motion
  - RV dilatation and/or deformation
  - Tenting height and surface
Look at coaptation length

Normal 5-6 mm

Poor < 3 mm
Valve Analysis: Echo protocol

☑ Type I: Normal leaflet motion
  - annular dilatation
  - leaflet coaptation distance
  - right atrial dilatation (surgical)

☑ Type IIIb: Restrictive leaflet motion
  - RV dilatation and/or deformation
  - Tenting height and surface
RA dimensions

- **ESA**: > 18 cm²
- **Major**: > 53 mm
- **Minor**: > 44 mm

Rudski et al. JASE 2010;23:685-713
Valve Analysis: Echo protocol

✓ Type I: Normal leaflet motion
  - annular dilatation
  - leaflet coaptation distance
  - right atrial dilatation

✓ Type IIIb: Restrictive leaflet motion
  - RV dilatation and/or deformation
  - Tenting height and surface
RV Dimensions

RV basal (RVD1)  > 42 mm
RV mid (RVD2)  > 35 mm
RV long (RVD3)  > 86 mm

Rudski et al. JASE 2010;23:685-713
sphericity index a/b  eccentricity index c/d > 2

Kim HK et al. Am J Cardiol 2006;98:236-242
Assessment of Right Ventricular Function Using Echocardiographic Speckle Tracking of the Tricuspid Annular Motion: Comparison with Cardiac Magnetic Resonance

Valve Analysis: Echo protocol

Type I: Normal leaflet motion
- annular dilatation
- leaflet coaptation distance
- right atrial dilatation

Type IIIb: Restrictive leaflet motion
- RV dilatation and/or deformation
- Tenting height and surface
Extreme tethering type IIIb ++
Tenting distance/area
Tricuspid Valve Tethering Predicts Residual Tricuspid Regurgitation After Tricuspid Annuloplasty

Shota Fukuda, MD; Jong-Min Song, MD; A. Marc Gillinov, MD; Patrick M. McCarthy, MD; Masao Daimon, MD; Vorachai Kongsaerepong, MD; James D. Thomas, MD; Takahiro Shiota, MD

> 8 mm

> 1,6 cm²

Multivariate analysis revealed that age, tethering distance, and severity of preoperative TR (all P<0.001) were independent parameters predicting residual TR. The sensitivity and specificity in predicting residual TR were 86% and 80% for tethering distances >0.76 cm and 82% and 84% for tethering areas >1.63 cm², respectively.

Conclusions—Severe TV tethering predicted residual TR after TV annuloplasty, whereas preoperative TV annular dimension was not associated with outcome of TV annuloplasty. (Circulation. 2005;111:975-979.)
How to handle concomitant TR

✓ New paradigm in Functional TR
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✓ Surgical Implications
Surgical implications

✓ For indications
- Severity (not enough)
- Annular dilatation +++ (cut off 40 mm)
- Coaptation distance (cut off < 3 mm)
- RA dilatation (surgical inspection)

✓ For techniques
- Type I: Remodeling annuloplasty
- Type IIIb: Remodeling annuloplasty + Patch or Replacement
Surgical implications

✓ For indications
  - Severity (not enough)
  - Annular dilatation +++ (cut off 40 mm)
  - Coaptation distance (cut off < 3 mm)
  - RA dilatation (surgical inspection)

✓ For techniques
  - Type I: Remodeling annuloplasty
  - Type IIIb: Remodeling annuloplasty + Patch or Replacement
TOA > LSA
Tricuspid Valve Reconstruction

Measuring Leaflet Surface Area
Tricuspid Valve Reconstruction

Remodeling Annuloplasty
Goal of repair: to restore a good surface of coaptation
Goal of repair: to restore a good surface of coaptation

Pre: 2.3 mm

Post: 4.7 mm
Surgical implications

✓ For indications
  - Severity (not enough)
  - Annular dilatation +++ (cut off 40 mm)
  - Coaptation distance (cut off < 3 mm)
  - RA dilatation (surgical inspection)

✓ For techniques
  - Type I: Remodeling annuloplasty
  - Type IIIb: Remodeling annuloplasty + Patch or Replacement
How-to-do-it

Tricuspid leaflet augmentation to address severe tethering in functional tricuspid regurgitation

Gilles D. Dreyfus\textsuperscript{a,b,*}, Shahzad G. Raja\textsuperscript{a}, Kok Meng John Chan\textsuperscript{a,b}

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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) RV Wall
(b) AL Autologous Pericardial Patch

(c) AL Patch
(d) Patch

Native AL
Coaptation Surface

Ring Annuloplasty
Conclusion

Don’t forget Tricuspid
the unknown valve !