Ανεπάρκεια τριγλώχινας-διάγνωση, χειρουργική αντιμετώπιση

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Νοσοκομείο ‘Άγιος Παύλος’
Θεσσαλονίκη
Σύγκρουση συμφερόντων

• ΟΧΙ
Figure 6. Pathophysiology of tricuspid regurgitation. ARVD: arrhythmogenic right ventricular dysplasia; LA: left atrial; LV: left ventricular; RA: right atrial; RV: right ventricular.
### TABLE 1  Etiologies of TR

<table>
<thead>
<tr>
<th>Morphological Classification</th>
<th>Disease Subgroup</th>
<th>Specific Abnormality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Congenital</td>
<td>Ebstein’s anomaly</td>
</tr>
<tr>
<td></td>
<td>25%</td>
<td>Tricuspid valve tethering associated with perimembranous VSD and VSA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (giant right atrium)</td>
</tr>
<tr>
<td>Acquired disease</td>
<td>Cardioid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Degenerative (myxomatous)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Endocarditis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Endomyocardial fibrosis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iatrogenic (pacing leads, RV biopsy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rheumatic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toxins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trauma</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other (e.g., ischemic papillary muscle rupture)</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>Left heart disease</td>
<td>LV dysfunction or valve disease</td>
</tr>
<tr>
<td>(&quot;functional&quot;): 75%</td>
<td>Right ventricular dysfunction</td>
<td>RV cardiomyopathy (e.g., ARVD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RV ischemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RV volume overload</td>
</tr>
<tr>
<td>Pulmonary Hypertension</td>
<td>Chronic lung disease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Left-to-right shunt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulmonary thromboembolism</td>
<td></td>
</tr>
<tr>
<td>Right atrial abnormalities</td>
<td>Atrial fibrillation</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Post-operative</td>
<td>Recurrent TR post-surgical intervention</td>
</tr>
</tbody>
</table>

ARVD = arrhythmogenic right ventricular dysplasia; LV = left ventricle; RV = right ventricle; TR = tricuspid regurgitation; VSA = ventricular septal aneurysm; VSD = ventricular septal defect.
Secondary TR: an ongoing process

- Traditional teaching that functional TR resolves on its own if the underlying disease is successfully treated has proven to be incorrect.

- Dreyfus et al. study demonstrates that secondary TR is an ongoing process, as during follow-up an increase in the TR by at least two grades subsequently developed in 45% of the patients who received isolated MVR.

- This untreated TR along with tricuspid annulus dilatation* (+/- tenting) can lead to irreversible right ventricular dysfunction and failure ("restriction-dilatation syndrome" - TR perpetuation).

- * The annulus is partly a component of the valve, but it is also a ventricular component. If the annulus is dilated → the right ventricle is also dilated.

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European Heart Journal (2017) 38, 634–638
Εκτίμηση-Διάγνωση

- Κλινική
- Απεικονιστική
**Table 19. Stages of TR**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Valve Anatomy</th>
<th>Valve Hemodynamics:</th>
<th>Hemodynamic Consequences</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At risk of TR.</td>
<td></td>
<td>No or trace TR.</td>
<td>None</td>
<td>None, or in relation to other left heart or pulmonary/pulmonary vascular disease</td>
</tr>
<tr>
<td>B</td>
<td>Progressive TR</td>
<td></td>
<td>Mild TR.</td>
<td>RV/RA/IVC size normal</td>
<td>None, or in relation to other left heart or pulmonary/pulmonary vascular disease</td>
</tr>
<tr>
<td>C</td>
<td>Asymptomatic, severe TR.</td>
<td></td>
<td>Central jet area = 5.0 cm²</td>
<td>RV/RA/IVC dilated with decreased IVC respiratory variation</td>
<td>None, or in relation to other left heart or pulmonary/pulmonary vascular disease</td>
</tr>
<tr>
<td>D</td>
<td>Symptomatic severe TR.</td>
<td></td>
<td>Central jet area = 10.0 cm²</td>
<td>RV/RA/IVC dilated with increased IVC respiratory variation</td>
<td>Fatigue, palpitations, dyspnea, abdominal bloating, anorexia, edema, and TR, tricuspid regurgitation</td>
</tr>
</tbody>
</table>

- appearance of elevated “c-V” waves in the jugular venous pulse,
- systolic murmur at the lower sternal border that increases in intensity with inspiration,
- pulsatile liver edge
- progressive hepatic dysfunction may occur due to the elevated right atrial pressure

**Functional**
- Normal
- Early anular dilation

**Mild TR**
- Central jet area < 5.0 cm²
- Vena contracts width not defined
- CW jet density and contour: soft and parabolic
- Hepatic vein flow: systolic dominance

**Moderate TR**
- Central jet area 5–10 cm²
- Vena contracts width not defined but < 0.70 cm
- CW jet density and contour: dense, variable contour
- Hepatic vein flow: systolic blunting

**Moderate-to-severe prolapse, limited chordal rupture**

**Postcardiac transplant (biopsy related)**

**Intra-annular RV pacemaker or ICD lead**

**Other (e.g., IE with vegetation, early carcinoid deposition, radiation)**
Clinical evaluation

- Patients present as:
  - asymptomatic (stage A,B,C)
  - with varying degrees of right heart failure:(stageD)
    - fatigue,
    - weakness,
    - shortness of breath,
    - jugular vein distension,
    - ascites,
    - hepato-splenomegaly,
    - pulsatile liver,
    - pleural effusions
    - peripheral oedema.

- In late stages and with hepatic insufficiency,
  - cachexia (loss of weight and fatigue),
  - jaundice and
  - cyanosis
Parasternal long-axis view of RV inflow

- Important view to assess anterior/inferior RV wall and anterior/posterior tricuspid valve leaflets.
- Anterior and posterior papillary muscles, chordal attachment, and orifices of inferior vena cava including the Eustachian valve are visible. The coronary sinus (not shown) may also be seen in this view.
- TR jet parameters can be measured in this view provided the TR jet is parallel to the US beam.

Parasternal short-axis of basal RV

- Shows the basal anterior RV wall, RVOT, tricuspid valve, pulmonary valve and RA.
- Normally used to measure RVOT dimension in diastole.
- TR jet parameters can be measured in this view provided the TR jet is parallel to the US beam.
- Used to assess the interatrial septum for shunts (particularly patent foramen ovale flow) just posterior to the aortic root.

RV focused apical 4-chamber

- Recommended alternative to Apical 4-chamber to measure RV minor dimension in basal segment of the RV.
- Useful view for demonstrating RV/RA size, shape and function, with enhanced visualization of the RV free wall.
- TR jet parameters can be measured in this view provided the TR jet is parallel to the US beam.
The clinical significance of identifying the correct TV leaflets:
A patient may have minimal tricuspid regurgitation when visualizing the TV from one RVIF position (A-S leaflet) and severe tricuspid regurgitation with leaflet malcoaptation (A-P leaflet) when the valve is visualized from a different RVIF position.
Comprehensive Two-Dimensional Interrogation of the Tricuspid Valve Using Knowledge Derived from Three-Dimensional Echocardiography

Karima Addetia, MD, Megan Yamat, RDCS, Anuj Mediratta, MD, Diego Medvedofsky, MD, Mita Patel, MD, Preston Ferrara, RDCS, Victor Mor-Avi, PhD, and Roberto M. Lang, MD
Department of Medicine, University of Chicago Medical Center, Chicago, Illinois

When these six nonstandard 2D views were tested, the agreement of TV leaflet identification for all three readers against 3D MPR was excellent ($\kappa = 0.88$, $\kappa = 0.93$, and $\kappa = 0.98$).
Assessment of TR severity
Severe TR: mid-late systole indentation increased diastolic velocity

FIGURE 14–62 Continuous wave Doppler recording of tricuspid flow in a patient with severe tricuspid regurgitation. Because of the large amount of tricuspid regurgitation, there is an indentation (arrow) in tricuspid regurgitation velocity spectrum during mid-late systole (i.e., V wave). Diastolic velocity is also increased (1.5 m/sec) from increased flow across the tricuspid valve.

### Table 1: Recommendations for the echocardiographic assessment of native valvular regurgitation: an executive summary from the European Association of Cardiovascular Imaging (Lancellotti et al.22)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grading the severity of TR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Qualitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tricuspid valve morphology</td>
<td>Normal/abnormal</td>
<td>Normal/abnormal</td>
<td>Abnormal/flail/large coaptation defect</td>
</tr>
<tr>
<td>Colour flow TR jet&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Small, central</td>
<td>Intermediate</td>
<td>Very large central jet or eccentric wall-impinging jet</td>
</tr>
<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>
</tr>
<tr>
<td><strong>Semi-quantitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC width (mm)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Not defined</td>
<td>&lt;7</td>
<td>&gt;7</td>
</tr>
<tr>
<td>PISA radius (mm)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>≤5</td>
<td>6–9</td>
<td>&gt;9</td>
</tr>
<tr>
<td>Hepatic vein flow&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Systolic dominance</td>
<td>Systolic blunting</td>
<td>Systolic flow reversal</td>
</tr>
<tr>
<td>Tricuspid inflow</td>
<td>Normal</td>
<td>Normal</td>
<td>E-wave dominant (≥ 1 m/s)&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Quantitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EROA (mm&lt;sup&gt;2&lt;/sup&gt;)</td>
<td>Not defined</td>
<td>Not defined</td>
<td>≥40</td>
</tr>
<tr>
<td>RVol (mL)</td>
<td>Not defined</td>
<td>Not defined</td>
<td>≥45</td>
</tr>
</tbody>
</table>

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EAE Recommendations for the assessment of valvular regurgitation


European Heart Journal (2017) 38, 634–638
GUIDELINES AND STANDARDS

Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography

Endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography

Figure 7 Diagram (left) and corresponding echocardiographic apical 4-chamber image (right) showing the right ventricular (RV) basal (RVD1) and mid cavity (RVD2) RV minor dimensions and the RV longitudinal dimension (RVD3). The transducer is adjusted to focus on the RV chamber, with the goal of maximizing RV chamber size. The RV free wall is better seen in this view, also facilitating measurements for fractional area change. Reproduced from J Am Soc Echocardiogr.¹

<table>
<thead>
<tr>
<th>Table 2 Chamber dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
</tr>
<tr>
<td>RV mid cavity diameter (mm) (Figure 7, RVD2)</td>
</tr>
<tr>
<td>RV basal diameter (mm) (Figure 7, RVD1)</td>
</tr>
<tr>
<td>RV longitudinal diameter (mm) (Figure 7, RVD3)</td>
</tr>
<tr>
<td>RV end-diastolic area (cm²) (Figure 9)</td>
</tr>
<tr>
<td>RV end-systolic area (cm²) (Figure 9)</td>
</tr>
<tr>
<td>RV end-diastolic volume indexed (mL/m²)</td>
</tr>
<tr>
<td>RV end-systolic volume indexed (mL/m²)</td>
</tr>
<tr>
<td>3D RV end-diastolic volume indexed (mL/m²)</td>
</tr>
<tr>
<td>3D RV end-systolic volume indexed (mL/m²)</td>
</tr>
<tr>
<td>RV subcostal wall thickness (mm) (Figure 5)</td>
</tr>
<tr>
<td>RVOT PLAX wall thickness (mm) (not shown)</td>
</tr>
<tr>
<td>RVOT PLAX diameter (mm) (Figure 8)</td>
</tr>
<tr>
<td>RVOT proximal diameter (mm) (Figure 8, RVOT-Prox)</td>
</tr>
<tr>
<td>RVOT distal diameter (mm) (Figure 8, RVOT-Distal)</td>
</tr>
<tr>
<td>RA major dimension (mm) (Figure 3)</td>
</tr>
<tr>
<td>RA minor dimension (mm) (Figure 3)</td>
</tr>
<tr>
<td>RA end-systolic area (cm²) (Figure 3)</td>
</tr>
</tbody>
</table>

CI, Confidence interval; LRV, lower reference value; PLAX, parasternal long-axis; RA, right atrial; RV, right ventricular; RVD, right ventricular diameter; RVOT, right ventricular outflow tract; 3D, three-dimensional; URV, upper reference value.
RV dysfunction:
- TAPSE < 15 mm
- TA syst vel < 11 cm/sec (TDI)
- RV end syst area > 20 cm²
- Fractional Area Shortening < 35%

Table 4: Systolic function

<table>
<thead>
<tr>
<th>Variable</th>
<th>Studies</th>
<th>n</th>
<th>LRV (95% CI)</th>
<th>Mean (95% CI)</th>
<th>UERV (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAPSE (mm) (Figure 17)</td>
<td>46</td>
<td>2320</td>
<td>16 (15-18)</td>
<td>23 (22-24)</td>
<td>30 (29-31)</td>
</tr>
<tr>
<td>Pulsed Doppler velocity at the annulus (cm/s)</td>
<td>43</td>
<td>2139</td>
<td>10 (9-11)</td>
<td>15 (14-15)</td>
<td>19 (18-20)</td>
</tr>
<tr>
<td>Color Doppler velocities at the annulus (cm/s)</td>
<td>5</td>
<td>281</td>
<td>6 (5-7)</td>
<td>10 (9-10)</td>
<td>14 (12-15)</td>
</tr>
<tr>
<td>Pulsed Doppler MPI (Figures 16 and 18)</td>
<td>17</td>
<td>666</td>
<td>0.15 (0.10-0.20)</td>
<td>0.26 (0.24-0.32)</td>
<td>0.40 (0.35-0.45)</td>
</tr>
<tr>
<td>Tissue Doppler MPI (Figure 18)</td>
<td>8</td>
<td>590</td>
<td>0.24 (0.16-0.32)</td>
<td>0.39 (0.34-0.45)</td>
<td>0.55 (0.47-0.63)</td>
</tr>
<tr>
<td>FAC (%) (Figure 8)</td>
<td>36</td>
<td>1276</td>
<td>35 (32-38)</td>
<td>49 (47-51)</td>
<td>63 (60-65)</td>
</tr>
<tr>
<td>RV EF (%) (Figure 8)</td>
<td>12</td>
<td>596</td>
<td>44 (38-50)</td>
<td>58 (53-63)</td>
<td>71 (66-77)</td>
</tr>
<tr>
<td>3D RV EF (%)</td>
<td>9</td>
<td>524</td>
<td>44 (39-49)</td>
<td>57 (53-61)</td>
<td>69 (65-74)</td>
</tr>
<tr>
<td>IVA (m/s²)</td>
<td>12</td>
<td>389</td>
<td>2.2 (1.4-3.0)</td>
<td>3.7 (3.0-4.4)</td>
<td>5.2 (4.4-5.9)</td>
</tr>
</tbody>
</table>

CI, confidence interval; EF, ejection fraction; FAC, fractional area change; IV, isovolumic acceleration; LRV, lower reference value; MPI, myocardial performance index; RV, right ventricular; TAPSE, tricuspid annular plane systolic excursion; 3D, three-dimensional; UERV, upper reference value.
Echo Assessment of RV Remodeling and TV Tethering

Annular Diameter >40mm
Tethering Height >1cm
Tethering Area >16mm²
RV Sphericity Index >2.0
RV Eccentricity Index
Coaptation distance >0.8mm
Tending volume >2.3ml

Badano et al. European Heart Journal
doi:10.1093/eurheartj/ehs474
• coaptation height >1.0 cm pre-op has been shown to predict a 55% repair failure immediately after surgery

• if coaptation distance >8 mm or a tenting area >16 mm² → adjunctive procedure (i.e. anterior leaflet elongation with a pericardial patch) → to decrease TR recurrence

• TV tenting volume >2.3 mL (3D echo) showed a sensitivity of 100% and specificity of 84% to predict severe residual TR after tricuspid annuloplasty

Badano et al. European Heart Journal
doi:10.1093/eurheartj/ehs474
TTE / real time 3D/ CMR in TR

- **Class I**
  - TTE is indicated to evaluate severity of TR, determine etiology, measure sizes of right-sided chambers and inferior vena cava, assess RV systolic function, estimate pulmonary artery systolic pressure, and characterize any associated left-sided heart disease. (Level of Evidence:C)

- **Class IIb**
  - 1. CMR or real-time 3D echocardiography may be considered for assessment of RV systolic function and systolic and diastolic volumes in patients with severe TR (stages C and D) and suboptimal 2D echocardiograms. (Level of Evidence: C)
Αντιμετώπιση
Impact of Tricuspid Regurgitation on Long-Term Survival

Jayant Nath, MD,* Elyse Foster, MD, FACC,† Paul A. Heidenreich, MD*
Palo Alto and San Francisco, California

5223pts, 4y follow up

91.7%

1 yr survival 64%

P < .0001

# at Risk 4105 3158 2298 1591 1043 573 183
Clinical Outcome of Isolated Tricuspid Regurgitation

Yan Topilsky, MD,* Vuyisile T. Nkomo, MD,† Ori Vatury, MD,† Hector I. Michelenia, MD,† Thierry Letourneau, MD,† Rakesh M. Suri, MD, DPhil,⇑ Sorin Pislaru, MD,† Soon Park, MD,⇑ Douglas W. Mahoney, MSc,⇑ Simon Biner, MD,* Maurice Enriquez-Sarano, MD†

CONCLUSIONS Isolated TR can be severe and is associated with excess mortality and morbidity, warranting heightened attention to diagnosis and quantitation. Quantitative assessment of TR, particularly ERO measurement, is a powerful independent predictor of outcome, superior to standard qualitative assessment. (J Am Coll Cardiol Img 2014;7:1185–94)

Only 12 of 68 patients (18%) with severe TR underwent surgery. The fact of <40% 10-year survival suggests that a more aggressive approach is justified
Medical therapy

- Diuretics are used to reduce venous congestion.

- Beta-blockers

- Vasodilating agents (e.g., angiotensin-converting enzyme inhibitors and angiotensin receptor blockers)

- This therapy should be started before surgery and continued afterwards to give the chance to the RV to re-remodel and to reduce the diameter of the tricuspid annulus*, further decreasing the grade of regurgitation.

- Restriction of fluid and dietary sodium intake.

*The tricuspid annulus is very dynamic and can change markedly with loading conditions. Even during the cardiac cycle, there is a 30% reduction in annular area with each atrial systole.

Interventional Cardiology, 2012;7(1):59-62
Medical management

- In patients with fixed pulmonary hypertension and right ventricular dysfunction, medical management of TR is generally preferable.
TR indications for surgery

2014 AHA/ACC Valvular Heart Disease Guidelines
2012 ESC Guidelines on the management on valvular heart disease

[Diagram showing decision-making process for tricuspid regurgitation (TR) indications for surgery based on severity and symptoms.]

- Progressive functional TR (stage B)
  - Mild
  - Moderate
  - At time of left-sided valve surgery
    - TA dilation*
    - PHTN without TA dilation
  - TV Repair (IIa)
  - TV Repair (IIb)

- Asymptomatic severe TR (stage C)
  - Functional
  - Progressive RV dysfunction
    - Moderate Primary TR + left sided valve surgery
      - ESC: IIa
    - Severe asymptomatic Primary TR + progressive RV dilatation/ RV dysfunction
      - ESC: IIa
  - TV Repair or TVR (IIb)
  - TV Repair or TVR (I)

- Symptomatic severe TR (stage D)
  - Reoperation
    - Preserved RV function
      - PHTN not severe
        - Sympt severe Primary TR without sev RV dysfunction
          - ESC: I
  - Functional
    - At time of left-sided valve surgery
  - Primary
    - TV Repair or TVR (IIb)
    - TV Repair or TVR (I)
    - TV Repair or TVR (IIa)

Fixed PH* and RV dysfunction* → preferable medical management

*possibility of RV failure after surgery
TR management in pts not previously undergone valve surgery

Figure 8 American College of Cardiology/American Heart Association\textsuperscript{50} and the European Society of Cardiology\textsuperscript{51} guideline-based algorithm for the management of tricuspid regurgitation in patients who have not previously undergone left-sided valve surgery. RV, right ventricular.
Functional Tricuspid Regurgitation – Decision Tree

- **TR Severity**
  - **Severe**
  - **Moderate**
  - **Mild**
    - **MV Disease, PASP > 60mmHg**
    - **TAD > 40mm or 21 mm/m²**
      - Tethering Absent
      - **TVR or TA + Leaflet Augmentation**
      - Intraoperative TAD > 70mm
      - TV Repair Using Annuloplasty Ring

Modified from Raja SG, Dreyfus GD Semin Thorac Surg 2010;22:79-83
**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||

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**TABLE 1 Stages of Functional Tricuspid Regurgitation**

<table>
<thead>
<tr>
<th></th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR severity</td>
<td>None or mild</td>
<td>Mild or moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Annular diameter, mm</td>
<td>&lt;40</td>
<td>&gt;40</td>
<td>&gt;40</td>
</tr>
<tr>
<td>Leaflet coaptation mode</td>
<td>Normal*</td>
<td>Edge-to-edge*</td>
<td>Absent†</td>
</tr>
<tr>
<td>Treatment</td>
<td>Medical treatment</td>
<td>Tricuspid annuloplasty</td>
<td>Tricuspid annuloplasty + leaflet augmentation†</td>
</tr>
</tbody>
</table>

*No leaflet tethering (<8 mm). †Leaflet tethering may be present (≥8 mm). ‡If leaflet tethering is present.

TR = tricuspid regurgitation.
Isolated secondary severe TR

Clinical Evaluation
Physical Examination
Rule-out left sided valvular dysfunction

Symptoms
Right-sided heart failure

RV volumes and EF

EF < 30%
Medical treatment

Pulmonary Pressure ≥ 40 mmHg
Yes

EF 30-45%

No
Consider surgery

EF > 45%

No symptoms
No right-sided heart failure

RV volumes and EF

EF < 50%
Consider surgery

EF ≥ 50%
Follow-up
Echo 12 months
CMR 24 months

Tornos Mas P et al Heart 2015:101
Optimal time for surgery

- The importance of early referral for isolated TV surgery was demonstrated by Topilsky et al. who showed improved outcomes in patients with NYHA class II symptoms compared to NYHA III and IV.

- When patients with severe TR are operated before they develop severe symptoms (NYHA IV), early mortality decreases to 6%.

Repair or replacement

- In patients with primary TR, the extent of valve damage determines whether the valve can be repaired. For complex lesions, specific surgical repair techniques may be required and replacement may be superior to repair.

- In functional TR, there is a clear trend favouring repair, now performed in up to 89% of TV surgeries in the USA.

- Marquis-Gravel et al. however, demonstrated a rate of persistent severe TR (grade 3/4) after TV repair of 13% compared with 2% after replacement.

Arsalan et al, European Heart Journal (2017) 38, 634–638
Residual TR after annuloplasty

- high rates of residual TR despite annuloplasty are reported when leaflet tethering is the primary mechanism.

- Pre-operative coaptation height predicts the severity of residual TR, with a 55% chance of residual TR with a coaptation height >1.0 cm.

- Tenting volume $\geq 2.3$ mL (sensitivity of 100%, specificity of 84%) measured by 3D echocardiography also predicts severe residual TR.

- Anterior leaflet augmentation has been reported to reduce the rate of residual TR by extending the coaptation length and locating the coaptation point deep into the RV.

The main goal of TR repair is the restoration of leaflet coaptation.

- Severe TR: ring annuloplasty should be performed (75.5% restores TV competence, Kilic).
- Annuloplasty rings lower rate of TR recurrence in comparison with De Vega annuloplasty.

Whether flexible or rigid rings should be used is controversial.

- In a retrospective analysis of 2277 patients undergoing TV surgery, Navia et al. (J Thorac Cardiovasc Surg 2010;139:1473–1482 e5) found a lower rate of recurrent TR with a rigid annuloplasty ring compared with a flexible ring or De Vega annuloplasty.
- On the other hand, Pfannmueller and colleagues (J Thorac Cardiovasc Surg 2012;143:1050–1055) reported a higher rate of annuloplasty dehiscence after the implantation of a rigid ring.
TV replacement

- Replacement is indicated over annuloplasty in patients with primary TR with significant valvular pathology.

- However, it is debatable whether mechanical valves or biological valves are preferred. (lifelong anticoagulation vs thrombosis and limited bioprosthetic life expectancy)
Atrial fibrillation

- Chronic atrial fibrillation is a risk factor for late severe TR after left-sided valve surgery.

- Intra-operative ablation can reduce the risk of TR progression.

- However, ablation is only successful in 60–82% of patients at 12-month follow-up.

Circulation 2005;112(9 Suppl.): I14–I19.
### 2012 ESC Indications for surgery in tricuspid disease

<table>
<thead>
<tr>
<th>Surgery indication</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery is indicated in symptomatic patients with severe TS.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Surgery is indicated in patients with severe TS undergoing left-sided valve intervention.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Surgery is indicated in patients with severe primary, or secondary, TR undergoing left-sided valve surgery.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Surgery is indicated in symptomatic patients with severe isolated primary TR without severe right ventricular dysfunction.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Surgery should be considered in patients with moderate primary TR undergoing left-sided valve surgery.</td>
<td>IIa</td>
<td>C</td>
</tr>
<tr>
<td>Surgery should be considered in patients with mild or moderate secondary TR with dilated annulus ($\geq 40$ mm or $&gt; 21$ mm/m²) undergoing left-sided valve surgery.</td>
<td>IIa</td>
<td>C</td>
</tr>
<tr>
<td>Surgery should be considered in asymptomatic or mildly symptomatic patients with severe isolated primary TR and progressive right ventricular dilation or deterioration of right ventricular function.</td>
<td>IIa</td>
<td>C</td>
</tr>
<tr>
<td>After left-sided valve surgery, surgery should be considered in patients with severe TR who are symptomatic or have progressive right ventricular dilatation/dysfunction, in the absence of left-sided valve dysfunction, severe right or left ventricular dysfunction, and severe pulmonary vascular disease.</td>
<td>IIa</td>
<td>C</td>
</tr>
</tbody>
</table>

European Journal of Cardio-Thoracic Surgery 2012 -

Development of Moderate -to- Severe post- operative TR occurs in approximately 10% of patients undergoing MVR and is associated with poorer outcome.
Impact of Late TR after Left-Sided Valve Surgery

- Mortality of patients without late TR 4.9%
  \[ P = 0.004 \]
- Mortality of patients with late TR 16.3%

Log rank \( p < 0.001 \)

Cumulative survival

Years after operation

Number at risk

| Late TR (−) | 589 | 584 | 575 | 572 | 562 | 554 | 546 | 441 | 305 |
| Late TR (+) | 49  | 49  | 48  | 47  | 45  | 44  | 43  | 38  | 27  |
Hospital mortality for late TR surgery

<table>
<thead>
<tr>
<th>Year</th>
<th>Hospital mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>King</td>
<td>1984</td>
</tr>
<tr>
<td>Kaul</td>
<td>1991</td>
</tr>
<tr>
<td>Izumi</td>
<td>2002</td>
</tr>
<tr>
<td>McCarthy</td>
<td>2004</td>
</tr>
<tr>
<td>Dong-A Kwon</td>
<td>2006</td>
</tr>
<tr>
<td>Kwak</td>
<td>2008</td>
</tr>
</tbody>
</table>

- Prevention of late TR by addressing more aggressively and effectively the tricuspid valve during the primary MV operation
- Early surgical treatment of late TR before the occurrence of right ventricular dysfunction
Percutaneous therapies

1) transcatheter valve implants at the level of the vena cava (either both the SVC and IVC or the IVC only) in order to treat the caval reverse backflow associated with severe TR (Sapien and Tric Valve devices)

2) devices dedicated to decreasing the TA dimensions in order to reduce TR severity (Mitralign and TriCinch devices)

3) a device dedicated to improving valve leaflet coaptation and reducing TR by occupying the regurgitant orifice area and providing a surface for native leaflet coaptation (FORMA device).

4) transcatheter edge-to-edge repair of the tricuspid valve has also been applied in patients with TR (Mitraclip device)
Bicaval valve implantation with dedicated self-expandable valves. Caval valve implantation (CAVI)

- The IVC valve is designed with the upper segment protruding into the RA, with the biological valve located above the diaphragm to protect the abdominal vasculature from systolic backflow and avoid occlusion of hepatic veins.
- The SVC valve is mounted on a funnel-shaped stent frame to fit the landing zone at the cavoatrial inflow.
- Both valves are mounted with a trileaflet bovine pericardial valve and a sleeve covering the inside down to the base of the leaflets to prevent paravalvular leakage.

Blue tracing : inferior vena cava; red tracing : right atrium.
The FORMA device.

- It is composed of a rail, which is anchored at the apex of the RV, and a spacer, which serves as the coaptation element (i.e., increases the coaptation surface in order to improve leaflet malcoaptation).
- The spacer consists of a foam-filled polymer balloon.

Rodés-Cabau et al. Transcatheter Treatment and Tricuspid Regurgitation J A C C V O L . 6 7 , N O . 1 5 , 2 0 1 6 : 1 8 2 9 – 4 5
The Mitralign device.

- percutaneous annuloplasty system that reproduces the Kay surgical procedure (53), which converts an incompetent TV into a competent bicuspid valve by plication of both the anterior and posterior tricuspid annulus.
The TriCinch System is composed of a corkscrew anchor, a self-expanding stent, and a Dacron band connecting them (left). Images show the step-by-step procedure for implantation of the TriCinch System (right). Reprinted with permission from Latib et al. (55).
Patients with severe TR were recruited from 10 international centers. Patients with a systolic pulmonary arterial pressure >60 mm Hg were excluded. A severe coaptation defect (>2 cm) of the tricuspid leaflets was also an exclusion criterion (n=10).
<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>Tric Valve n = 5</th>
<th>Sapien Valve n = 10</th>
<th>FORMA n = 7</th>
<th>Mitralign n = 3*</th>
<th>TriCinch n = 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>79 ± 4</td>
<td>69 ± 7</td>
<td>76 ± 13</td>
<td>83 ± 7</td>
<td>66 ± 10</td>
</tr>
<tr>
<td>NYHA functional class ≥III</td>
<td>5 (100)</td>
<td>10 (100)</td>
<td>6 (100)</td>
<td>3 (100)</td>
<td>8 (100)</td>
</tr>
<tr>
<td>Signs of right heart failure</td>
<td>5 (100)</td>
<td>10 (100)</td>
<td>7 (100)</td>
<td>NA</td>
<td>8 (100)</td>
</tr>
<tr>
<td>Logistic EuroSCORE</td>
<td>37.9 ± 17.9</td>
<td>31.5 ± 19.7</td>
<td>25.7 ± 17.4</td>
<td>NA</td>
<td>10 ± 4</td>
</tr>
<tr>
<td>Follow-up data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up time, months</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>NYHA functional class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I–II</td>
<td>2 (40)</td>
<td>6 (60)</td>
<td>7 (100)</td>
<td>NA</td>
<td>3 (100)</td>
</tr>
<tr>
<td>III–IV</td>
<td>0 (0)</td>
<td>4 (40)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Improvement in right heart failure</td>
<td>2 (40)</td>
<td>9 (90)</td>
<td>7 (100)</td>
<td>NA</td>
<td>3 (100)</td>
</tr>
<tr>
<td>TR degree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>1 (10)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>0 (0)</td>
<td>7 (100)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>2 (40)</td>
<td>9 (90)</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>4 (80)</td>
<td>9 (90)</td>
<td>0 (0)</td>
<td>NA</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Abstract

OBJECTIVES: This study sought to describe the first human series of percutaneous tricuspid valve replacements in patients with congenital or acquired tricuspid valve (TV) disease.

BACKGROUND: Percutaneous transcatheter heart valve replacement of the ventriculoarterial (aortic, pulmonary) valves is established. Although there are isolated reports of transcatheter atrioventricular heart valve replacement (hybrid and percutaneous), this procedure has been less frequently described; we are aware of no series describing this procedure for TV disease.

METHODS: We approached institutions with significant experience with the Melody percutaneous pulmonary valve (Medtronic, Inc., Minneapolis, Minnesota) to collect data where this valve had been implanted in the tricuspid position. Clinical and procedural data were gathered for 15 patients. Indications for intervention included severe hemodynamic compromise and perceived high surgical risk; all had prior TV surgery and significant stenosis and/or regurgitation of a bioprosthetic TV or a right atrium-to-right ventricle conduit.

RESULTS: Procedural success was achieved in all 15 patients. In patients with predominantly stenosis, mean tricuspid gradient was reduced from 12.9 to 3.9 mm Hg (p < 0.01). In all patients, tricuspid regurgitation was reduced to mild or none. New York Heart Association functional class improved in 12 patients. The only major procedural complication was of third-degree heart block requiring pacemaker insertion in 1 patient. One patient developed endocarditis 2 months after implant, and 1 patient with pre-procedural multiorgan failure did not improve and died 20 days after the procedure. The remaining patients have well-functioning Melody valves in the TV position a median of 4 months after implantation.

CONCLUSIONS: In selected cases, patients with prior TV surgery may be candidates for percutaneous TV replacement.

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Last remarks...

- The current European (2012) and American (2014) guidelines for the management of valvular heart disease suggest that TV surgery is recommended for patients with severe TR under-going left-sided valve surgery (Class I), and that TV surgery can be valuable for patients with at least moderate TR with tricuspid annular dilation (Class IIa).

- Recurrence of TR long after TV plasty is not as uncommon (as high as 60% at 5 years), and surgery may be needed in up to 20% of patients after 10 years.

- In these patients, as reoperation on the TV carries a very high surgical risk, percutaneous approaches might become valuable alternatives in the near future.

Lancellotiti P, et al, Archives of Cardiovascular Disease (2016) 109, 1—3
ευχαριστώ
TR surgery

- Ring annuloplasty is key to surgery for TR

- Better long-term results are observed with prosthetic rings than with the suture annuloplasty (residual TR 10% vs 20–35% at 5 years)

- When the tricuspid valve is significantly deformed, complementary TV procedures with the objective of reducing residual postoperative TR (i.e. enlargement of the anterior leaflet) may be useful.

- In more advanced forms of tethering and RV dilatation, valve replacement should be considered. The use of large bioprostheses over mechanical valves is currently favoured.

- Adding a tricuspid repair, if indicated, during left-sided surgery, does not increase operative risks.
- Reoperation on the tricuspid valve in cases of persistent TR after mitral valve surgery carries a high risk.
Tricuspid annuloplasty versus a conservative approach in patients with functional tricuspid regurgitation undergoing left-sided heart valve surgery: A study-level meta-analysis

Matteo Pagnesi, Claudio Montalto, Antonio Mangieri, Eustachio Agriopolo, Rishi Puri, Mauro Chiarito, Marco B. Ancona, Damiano Regazzoli, Luca Testa, Michele De Bonis, Neil E. Moat, Josep Rodés-Cabau, Antonio Colombo, Azeem Latib

DOI: http://dx.doi.org/10.1016/j.ijcard.2017.05.014

Abstract

Background
Tricuspid valve (TV) repair at the time of left-sided valve surgery is indicated in patients with either severe functional tricuspid regurgitation (TR) or mild-to-moderate TR with coexistent tricuspid annular dilation or right heart failure. We assessed the benefits of a concomitant TV repair strategy during left-sided surgical valve interventions, focusing on mortality and echocardiographic TR-related outcomes.

Methods
A meta-analysis was performed of studies reporting outcomes of patients who underwent left-sided (mitral and/or aortic) valve surgery with or without concomitant TV repair. Primary endpoints were all-cause and cardiovascular mortality; secondary endpoints were the presence of more-than-moderate TR, TR progression, and TR severity grade. All endpoints were evaluated at the longest available follow-up.

Results
Fifteen studies were included for a total of 2840 patients. TV repair at the time of left-sided valve surgery was associated with a significantly lower risk of cardiovascular-related mortality (odds ratio [OR] 0.38; 95% confidence interval [CI]: 0.25–0.58; p < 0.001), with a trend towards a lower risk of all-cause mortality (OR 0.57; 95% CI: 0.32–1.05; p = 0.07) at a mean weighted follow-up of 5 years. The presence of more-than-moderate TR (OR 0.19; 95% CI: 0.12–0.30; p < 0.001), TR progression (OR 0.03; 95% CI: 0.01–0.05; p < 0.001), and TR grade (standardized mean difference = 1.11; 95% CI: −1.57 to −0.65; p < 0.001) were significantly lower in the TV repair group at a mean weighted follow-up of 4.7 years.

Conclusions
A concomitant TV repair strategy during left-sided valve surgery is associated with a reduction in cardiovascular-related mortality and improved echocardiographic TR outcomes at follow-up.
Functional Tricuspid Regurgitation
A Need to Revise Our Understanding

Gilles D. Dreyfus, MD, PhD;1 Randolph P. Martin, MD;2 K.M. John Chan, PhD;3 Filip Deiguemov, MD;1
Chris Alexandrescu, MD

<table>
<thead>
<tr>
<th>FTR DISEASE PROCESSES</th>
<th>FTR ASSESSMENTS</th>
<th>DIAGNOSIS AND TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-sided heart disease</td>
<td><strong>Tricuspid regurgitation (TR)</strong></td>
<td><strong>Stage 1</strong></td>
</tr>
<tr>
<td>Right ventricular (RV) afterload increase (with or without pulmonary hypertension)</td>
<td>TR is the leakage of blood backwards through the tricuspid valve each time the right ventricle contracts</td>
<td>TR severity: None or mild</td>
</tr>
<tr>
<td>RV remodeling</td>
<td><strong>Color flow jet visualization is used to evaluate PISA radius and effective regurgitant orifice or regurgitant volume</strong></td>
<td>Annular diameter: &lt;40 mm</td>
</tr>
<tr>
<td>Altered RV function</td>
<td><strong>Annular dilation</strong></td>
<td>Annular diameter: &gt;40 mm</td>
</tr>
<tr>
<td>Tricuspid annular dilation. (in some instances leaflet tethering occurs with the same triggering factors)</td>
<td>The annular ring is attached to the tricuspid valve leaflets. Dilation can result in poor leaflet apposition</td>
<td>Coaptation mode: Normal (body-to-body), with no leaflet tethering</td>
</tr>
<tr>
<td></td>
<td>2D-echocardiography coupled with 3D imaging is used to accurately measure annular diameter</td>
<td>Coaptation mode: Abnormal (edge-to-edge), with or without tethering of &lt;8 mm below the annular plane</td>
</tr>
<tr>
<td></td>
<td><strong>Leaflet coaptation mode</strong></td>
<td><strong>Stage 2</strong></td>
</tr>
<tr>
<td></td>
<td>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</td>
<td>Medical treatment. No surgical intervention is indicated</td>
</tr>
<tr>
<td></td>
<td><strong>3D-echocardiography is recommended to measure tenting volume (TV) – the area within the tricuspid leaflets</strong></td>
<td>Concomitant tricuspid valve annuloplasty is recommended</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Stage 3</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TR severity: Severe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annular diameter: &gt;40 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coaptation mode: No coaptation, with or without tethering of &gt;8 mm below the annular plane</td>
</tr>
</tbody>
</table>

Tricuspid annuloplasty vs replacement


Retrospective cohort analysis of 926 tricuspid valve surgeries: clinical and hemodynamic outcomes with propensity score analysis.


+ Author information

Abstract

BACKGROUND: The objectives were to describe morbidity and mortality after tricuspid valve (TV) surgery, to compare outcomes after repair versus replacement, and to assess risk factors for mortality and tricuspid regurgitation (TR) recurrence.

METHODS: A retrospective cohort study including 926 consecutive cases of TV surgery (792 repairs and 134 replacements) performed at the Montreal Heart Institute was conducted. Median follow-up was 4.3 years (4,657 patient-years). Median age was 62 years (interquartile range 53-69 years), and 72% of patients were women.

RESULTS: Operative mortality was 14% (128 patients: 1977-1998 20%, 1999-2008 7%, P < .001). Independent risk factors for operative mortality in the 1999 to 2008 period were hypertension (odds ratio [OR] 6.03, P = .02), daily furosemide dose (by 10 mg) (OR 1.06, P = .05), weight (by 10 kg) (OR 0.36, P < .01), and cardiopulmonary bypass time (by 10 minutes) (OR 1.29, P < .001). Ten-year survival was 49% ± 2% and 38 ± 5% in the repair and replacement groups, respectively (P = .012). At discharge, severity of TR was >3/4 in 13% and 2% of patients in the repair and replacement groups, respectively (P = .01). Propensity score analysis showed that tricuspid repair was associated with higher rates of TR >3/4 at follow-up compared with replacement (hazard ratio 2.15, P = .02). Forty-eight reoperations (7% of patients at risk) were performed during follow-up (repair group, 6%; replacement group, 15%; P = .01). At last follow-up, New York Heart Association functional class was improved compared with baseline in both groups (P < .001).

CONCLUSION: Tricuspid valve surgery is associated with substantial early and late mortalities but with significant functional improvement. Replacement is more effective in early and late corrections of regurgitation, but it does not translate into better survival outcomes.