Late secondary TR after left sided heart disease correction: is it predictable and preventable

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Professor of Cardiothoracic surgery
PREDICT
Incidence of secondary TR after MV surgery

- up to 50% of mitral valve (MV) surgery patients develop tricuspid regurgitation (TR) to various degrees.
- impacts secondary TR mortality: 1-year survival
  - Absent TR, 91%
  - Mild TR, 90%
  - Moderate TR 70%
  - Severe TR 60%
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 % )

Yilmaz O., Suri R.M. et al,
J Thorac Cardiovasc Surg. 2011 Jan 28
N=699. MV repair without TV intervention

Secondary tricuspid dilatation with or without regurgitation

Postoperative tricuspid regurgitation

<table>
<thead>
<tr>
<th>TR grade</th>
<th>M.V.R.</th>
<th>M.V.R.+T.V.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pre</td>
<td>post</td>
</tr>
<tr>
<td>0</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>102</td>
<td>33</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>67</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

### TRICUSPID VALVE REPAIR DURING MV SURGERY: Why?

<table>
<thead>
<tr>
<th>TR grade</th>
<th>Baseline</th>
<th>5 years</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>54</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>102</td>
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<td>4</td>
<td>0</td>
<td>15</td>
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</tr>
<tr>
<td>Mean</td>
<td>0.7 ± 0.5</td>
<td>2.1 ± 1.0</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

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

AHA/ACC 2006 Guidelines for TR management

**Indications for intervention in functional TR**

**Class**

**I C**
- Severe TR in a patient undergoing left-sided valve surgery

**IIa C**
- Moderate secondary TR with dilated annulus (>40mm) in a patient undergoing left-sided valve surgery
TR ASSESSMENT BEFORE SURGERY

Pre-operative T.R. assessment is NOT reliable

TR severity is dependent on physiological conditions which cannot be controlled / quantified
- preload
- afterload
- RV function

Changes in preload, afterload can unmask previously undiagnosed significant TR.
TR - STANDARD ASSESSMENT

• Echocardiography Assessment
  – No TR - mild TR
  – mild TR – moderate TR
  – severe TR
Annular dilatation is more relevant than regurgitation grading.

Tricuspid annular diameter $> 3.4$ cm seems a better marker than TR grading to predict secondary significant TR.
<table>
<thead>
<tr>
<th>TR GRADING</th>
<th>LEAFLET COAPTATION MODE</th>
<th>ANNULAR DILATATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>No TR / Mild TR</td>
<td>At annular plane</td>
<td>Below 35/40 mm</td>
</tr>
<tr>
<td>Mild TR / Moderate TR</td>
<td>Below annular plane</td>
<td>Above 35/40 mm</td>
</tr>
<tr>
<td>Severe TR</td>
<td>Surface vs edge to edge</td>
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**FUNCTIONAL AND ANATOMICAL TR CLASSIFICATION**

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
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<tr>
<td>No TR/ mild TR</td>
<td>Mild / Moderate TR</td>
<td>Severe TR</td>
</tr>
<tr>
<td>No TAD dilation</td>
<td>TAD dilation</td>
<td></td>
</tr>
<tr>
<td>Normal leaflet coaptation</td>
<td>Little coaptation/</td>
<td>Lack of coaptation</td>
</tr>
<tr>
<td></td>
<td>No effective coaptation</td>
<td>with or without leaflet tethering</td>
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<tr>
<td></td>
<td></td>
<td>(tethering height &gt;8 mm)</td>
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FUNCTIONAL AND ANATOMICAL TR CLASSIFICATION

STAGE 1
FUNCTIONAL AND ANATOMICAL TR
CLASSIFICATION

• Stage 2
  – Mild TR/
    Moderate TR
  – TAD dilation
  – Little
    coaptation/No
    effective
    coaptation
FUNCTIONAL AND ANATOMICAL TR CLASSIFICATION

STAGE 2
FUNCTIONAL AND ANATOMICAL TR CLASSIFICATION

STAGE 2
Stage 3
- Severe TR
- Lack of coaptation
- WITH or WITHOUT LEAFLET TETHERING (tethering height >8 mm)
FUNCTIONAL AND ANATOMICAL TR CLASSIFICATION

Stage 3
PREDICT
What the guidelines ignore?
What the guidelines ignore?

1. TRICUSPID ANNULAR DILATATION

Normal tricuspid annular diameter: 35 mm.
Dilated > 70 mm in 48% of patients undergoing mitral valve surgery.

Dreyfus GD Ann ThoracSurg 2005
What the guidelines ignore?

2. ABNORMAL COAPTATION MODE

- EDGE TO EDGE COAPTATION
- NO COAPTATION
- SEVERE TETHERING
What the guidelines ignore?

3. Less than moderate TR in patients undergoing MV surgery
Others determinants of late TR

Longer time from onset of MV disease to surgery *Wang*

Larger LA *Song et al.*

Atrial fibrillation *Kim et al.*

Dysfunction of mitral prosthesis *Shiran and Sagie*

Right chambers dilatation *De Bonis*
PREVENT
**FUNCTIONAL AND ANATOMICAL TR CLASSIFICATION**

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TRICUSPID VALVE REPAIR DURING MV SURGERY: HOW?

• Stage 1 – **No annuloplasty**

• Stage 2 - **annuloplasty alone** when TAD > 70 mm in operative room (Echo based /Surgical checking)

• Stage 3 - **annuloplasty alone** (without tethering)
  - **complex REPAIR** – (with tethering) achieve TV coaptation
BEST VALUES OF PREDICTORS OF FUNCTIONAL TR

Kim HK et al. Am J Cardiol 2006
Tethering & Annular Dilatation
Tethering & Annular Dilatation
METHODS

Study aim

To determine the effects of tricuspid leaflet augmentation on indices of tricuspid leaflet tethering

Inclusion criteria

All patients receiving concomitant tricuspid valve repair.

Study period

1 March 2009 and 31 May 2010.
METHODS

Tricuspid valve assessment

1. TR severity
   • 0: none, 1: mild, 2: moderate, 3: severe

2. Annular diameter
   • Distance between insertion sites of septal and anterior leaflets in four-chambers view

3. Tethering indices
   • Tethering height
   • Tenting area
Indications for concomitant tricuspid valve repair

- Irrespective of TR grading
- Significant tricuspid annular dilatation
  - > 40 mm by echo
  - > 70 mm intra-operatively

Indications for anterior leaflet augmentation

- Significant leaflet tethering
  - Tethering height > 8 mm.
METHODS

**Group 1** (n = 43)

Tricuspid annuloplasty alone performed.

- CE Classic Tricuspid Annuloplasty Ring.
- Sized by measurement of anterior leaflet.

**Group 2** (n = 13)

Complex tricuspid repair with AL Augmentation

Tricuspid annuloplasty + leaflet augmentation.
## RESULTS - BASELINE

<table>
<thead>
<tr>
<th></th>
<th>Group 1 Annuloplasty</th>
<th>Group 2 AL Augmentation</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>65.9 (2.3)</td>
<td>58.2 (6.0)</td>
<td>0.15</td>
</tr>
<tr>
<td>NYHA class (1-4)</td>
<td>2.8 (0.2)</td>
<td>3.5 (0.2)</td>
<td>0.03</td>
</tr>
<tr>
<td>LVESD (mm)</td>
<td>38.9 (1.3)</td>
<td>36.2 (2.8)</td>
<td>0.35</td>
</tr>
<tr>
<td>Ejection fraction (%)</td>
<td>63.8 (1.7)</td>
<td>56.3 (3.4)</td>
<td>0.04</td>
</tr>
<tr>
<td>PA (mmHg)</td>
<td>40.6 (2.0)</td>
<td>50.3 (6.2)</td>
<td>0.06</td>
</tr>
</tbody>
</table>
## RESULTS - BASELINE

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<th>Group 1 Annuloplasty</th>
<th>Group 2 AL Augmentation</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tricuspid valve data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR grade (0-3)</td>
<td>2.0 (0.1)</td>
<td>2.9 (0.1)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Ann diameter (mm)</td>
<td>43.4 (0.6)</td>
<td>43.8 (1.1)</td>
<td>0.89</td>
</tr>
<tr>
<td>Tethering height (mm)</td>
<td>7.5 (0.4)</td>
<td>12.4 (1.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Tethering area (mm²)</td>
<td>188.0 (15.6)</td>
<td>354.4 (30.0)</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
# RESULTS - OPERATIVE

<table>
<thead>
<tr>
<th></th>
<th>Group 1 Annuloplasty</th>
<th>Group 2 AL Augmentation</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPB time (min)</td>
<td>127.5 (6.0)</td>
<td>133.9 (11.2)</td>
<td>0.55</td>
</tr>
<tr>
<td>Cross clamp time (min)</td>
<td>101.1 (5.4)</td>
<td>95.1 (10.4)</td>
<td>0.64</td>
</tr>
<tr>
<td>Annuloplasty ring size (mm)</td>
<td>32.6 (0.3)</td>
<td>32.5 (0.5)</td>
<td>0.77</td>
</tr>
<tr>
<td>Associated procedures</td>
<td>39 MV surgery, 4 AVR, 5 AF ablation, 1 CABG, 1 ASD closure</td>
<td>10 MV surgery, 1 AVR, 2 CABG, 2 AV repair</td>
<td></td>
</tr>
</tbody>
</table>
RESULTS – POST-OP

Changes in RV dimensions

(Group 1: Annuloplasty)

-10.5% P<0.0001
-9.1% P=0.0002
-5.0% P=0.046

Pre-op
Post-op

RV basal diameter
RV mid diameter
RV base to apex
RESULTS – POST-OP

Changes in RV dimensions

(Group 2: Leaflet Augmentation)
# RESULTS – POST-OP

<table>
<thead>
<tr>
<th></th>
<th>Group 1 Annuloplasty</th>
<th>Group 2 AL Augmentation</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR grade (0-3)</td>
<td>0.4 (0.1)</td>
<td>0.7 (0.3)</td>
<td>0.15</td>
</tr>
<tr>
<td>Tethering height mm</td>
<td>6.4 (0.3)</td>
<td>7.6 (0.6)</td>
<td>0.04</td>
</tr>
<tr>
<td>Δ mm</td>
<td>-0.9 (0.4)</td>
<td>-4.5 (1.0)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Δ %</td>
<td>-10.0 (4.4)</td>
<td>-30.6 (8.4)</td>
<td>0.03</td>
</tr>
<tr>
<td>Tethering area mm²</td>
<td>107 (7)</td>
<td>131 (12)</td>
<td>0.19</td>
</tr>
<tr>
<td>Δ mm²</td>
<td>-63 (11)</td>
<td>-191 (29)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Δ %</td>
<td>-28.5 (4.8)</td>
<td>-56.5 (4.5)</td>
<td>0.004</td>
</tr>
</tbody>
</table>
CONCLUSION

Functional tricuspid pathology should be revised completely taking into consideration:
- grading / annular dilatation / leaflet coaptation

Significant leaflet tethering is an entity of its own
- which is not addressed by annuloplasty alone
- which can explain high incidence of early failure after tricuspid annuloplasty
Tricuspid regurgitation (TR) grade