When to Operate on the Right Ventricle

Vivek Rao, MD, PhD, FRCS (C)

Chief, Cardiovascular Surgery
Surgical Director, Mechanical Circulatory Support Program
Peter Munk Cardiac Centre, Toronto General Hospital
Munk Professor in Advanced Cardiac Therapeutics
Professor of Surgery, University of Toronto
Disclosures

Medtronic Inc: Member, Surgical Advisory Board
Abbott Labs: Consultant
CorMatrix Cardiovascular: Member, Medical Advisory Board

I will discuss off-label uses for CorMatrix ECM™
Objectives

1. Review indications for tricuspid valve interventions

2. When to refer patients for tricuspid interventions

3. How to optimize patients preoperatively for right heart interventions
Audience Polling Question #1

What are the indications for tricuspid valve intervention?

1. Acute/Chronic tricuspid valve endocarditis
2. Moderate TR during surgery for Mitral valve disease
3. Isolated TR in the setting of RV dysfunction
4. All of the above
5. None of the above
Nishimura, RA et al.
2014 AHA/ACC Valvular Heart Disease Guideline

2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease: Executive Summary

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines
8.2.3 Intervention

Class I

1. Tricuspid valve surgery is recommended for patients with severe TR undergoing left-sided valve surgery

   Level of Evidence: C

Class IIa

1. Tricuspid valve intervention can be beneficial for patients with mild, moderate or greater functional TR (stage B) at the time of left-sided valve surgery with either 1) Tricuspid annular dilatation (40mm) or 2) prior symptoms of right sided heart failure

   Level of Evidence: B
Recommendations for Intervention

Class IIa

1. Tricuspid valve intervention can be beneficial for patients with symptoms due to severe TR that are unresponsive to medical therapy

   Level of Evidence: C

Class IIIb

1. Tricuspid valve repair may be considered for moderate functional TR and pulmonary hypertension at the time of left sided valve surgery

   Level of Evidence: C
Class IIIb

1. Tricuspid valve surgery can be considered for asymptomatic or minimally symptomatic patients with severe primary TR and progressive degrees of moderate or greater RV dilation and/or systolic dysfunction

*Level of Evidence: C*

Class IIIb

1. Reoperation for isolated tricuspid valve repair or replacement may be considered for persistent symptoms due to severe TR in patients who have undergone previous left-sided surgery and who do not have severe pulmonary hypertension or significant RV systolic dysfunction

*Level of Evidence: C*
The Evidence

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

Table 1. Clinical and Echocardiographic Features of Patients With Tricuspid Regurgitation

<table>
<thead>
<tr>
<th></th>
<th>No TR (n = 600)</th>
<th>Mild TR (n = 3,804)</th>
<th>Moderate TR (n = 620)</th>
<th>Severe TR (n = 199)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>62.2 ± 12.8</td>
<td>66.0 ± 12.6</td>
<td>71.9 ± 11.7</td>
<td>71.9 ± 12.4</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>57.3 ± 9.1</td>
<td>55.4 ± 11.6</td>
<td>47.1 ± 15.6</td>
<td>40.4 ± 17.2</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>RV dilation</td>
<td>8%</td>
<td>11%</td>
<td>35%</td>
<td>66%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>RV dysfunction</td>
<td>3%</td>
<td>8%</td>
<td>30%</td>
<td>61%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Dilated IVC</td>
<td>6%</td>
<td>11%</td>
<td>44%</td>
<td>76%</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

Data are presented as the mean value ± SD or percentage of patients.
IVC = inferior vena cava; LVEF = left ventricular ejection fraction; RV = right ventricular; TR = tricuspid regurgitation.
The Evidence

A

PA Systolic > 40mmHg

B

PA Systolic < 40mmHg
The Evidence

LVEF <50%

LVEF >50%
The Evidence

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chi-Square</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>0.15</td>
<td>0.70</td>
</tr>
<tr>
<td>Moderate</td>
<td>2.65</td>
<td>0.10</td>
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<tr>
<td>Severe</td>
<td>5.79</td>
<td>0.02</td>
</tr>
<tr>
<td>Age</td>
<td>65.75</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>LVEF</td>
<td>4.28</td>
<td>0.04</td>
</tr>
<tr>
<td>IVC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dilated</td>
<td>13.95</td>
<td>0.0002</td>
</tr>
<tr>
<td>Dilated without collapse</td>
<td>21.15</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>RV enlargement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>0.90</td>
<td>0.34</td>
</tr>
<tr>
<td>Moderate and severe</td>
<td>4.05</td>
<td>0.04</td>
</tr>
<tr>
<td>RV dysfunction</td>
<td>2.12</td>
<td>0.14</td>
</tr>
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</table>

*Using a proportional hazards model. Abbreviations as in Table 1.
The Anatomy

Tricuspid Annuloplasty

Kay “Bicuspidization”
Why don’t we operate on the Tricuspid?

1. Severe isolated TR is usually associated with severe RV dysfunction.

2. Combined TV repair and MV surgery increases risk of pacer implant.

3. Options for TV replacement are not appealing.

4. Isolated TV repair associated with poor durability.

5. TR resolves with correction of left sided heart lesions.
Survival after Tricuspid Valve Repair

Age/Gender Adjusted Expected Survival

Even patients with minimal symptoms and severe TR have impaired survival
Survival after Mitral Valve Repair

Waiting for symptoms or LV dysfunction adversely impacts survival after MV repair.
Survival with Medical Therapy

A. MR Due to Flail Leaflets

- Expected
- Observed

B. Asymptomatic MVP

- ERO < 20 mm² (91±3%)
- ERO 20-39 mm² (66±6%)
- ERO ≥ 40 mm² (58±9%)

C. Asymptomatic Quantified MR

- ERO < 20 mm²
- ERO 20-39 mm²
- ERO ≥ 40 mm²

P-values:
- A: P=0.016
- B: P(diff)<0.001
- C: P<0.01

References:
- Circulation 106:1355, 2002
Survival after Mitral Valve Repair

Panel A: Flail leaflet treated early vs waiting for indications

Panel B: Quantitated severe MR treated early vs waiting for indications
Extrapolating to Tricuspid Valve Repair

While we have good data correlating the degree of TR with reduced survival, we have been unable to show:

- TV repair improves survival over medical therapy
- earlier referral for surgery, before symptoms +/- RV dysfunction improves survival after TV repair
- do we need a randomized trial?
What would surgeons need for TVR??

Referral when echo parameters consistent with severe TR or moderate TR and a) annular dilatation b) atrial fibrillation, c) mild RV dysfunction

Referral PRIOR to the development of hepatorenal syndrome rendering operative risk prohibitive
Transcatheter Tricuspid Interventions

Challenges of Transcatheter Therapies for Tricuspid Regurgitation

- Large tricuspid annulus dimensions
- Nonplanar and elliptical annulus shape
- Absence of calcium
- Right ventricular morphology
- Proximity of other structures (coronary sinus, AV node and His bundle, vena cava, right coronary artery)


UHN Peter Munk Cardiac Centre
Transcatheter Tricuspid Interventions

Edwards FORMA Tricuspid Repair System
Native tricuspid removed
CorMatrix ECM Suspended Valve
Novel Tricuspid Interventions

View of annulus and papillary attachment

2 papillary attachments used
Novel Tricuspid Interventions

5 month ECM Tricuspid atrial view
Novel Tricuspid Interventions

Remodeling at 7 months
Novel Tricuspid Interventions

First in Man – Tricuspid Valve Repair with CorMatrix Membrane

53 y.o. Male with remote history of tricuspid valve endocarditis.

- initially treated with prolonged IV antibiotics
- resolved sepsis, no vegetations but residual TR
- lost to medical f/u

- presents 10 years later with Anasarca, renal insufficiency
- 2D echo demonstrates laminar TR, severe RV dilatation
- referred for tricuspid repair/replacement
Novel Tricuspid Interventions

Surgical Issues

- morbidly obese (BMI 47), wheel chair bound and immobile
- admitted to cardiology ward for intravenous diuretics and optimization
- 40kg wt loss in 4 weeks
- repeat 2D echo confirms persistent RV dysfunction with laminar TR
Novel Tricuspid Interventions

Surgical Options:

- tricuspid repair with undersized annuloplasty band
  - poor remnant tissue, risk of dehiscence

- tricuspid valve replacement with mechanical valve
  - requirement for coumadin

- tricuspid valve replacement with tissue valve
  - poor durability in 53yo male.

? Novel tricuspid valve repair with biologic material
- Rehydrated CorMatrix (7x10cm)
- 10 min in sterile crystalloid solution

- 2.5 cm reinforced edge
- trim distal edge as required (left at 5cm)
- Annular band approximated to initiate tube formation
- 4-0 prolene tacking sutures

- SPV stentless sizer employed for distal end of tube
- Seam sewn with continuous 3-0 vicryl
- 10cm width results in ~30mm tube
Tricuspid Insufficiency is not a “benign” disease

There are novel surgical and percutaneous options to treat functional TR

Data extrapolated from our Mitral Repair experience suggests that earlier referral and surgical intervention will improve the postoperative survival of patients with severe tricuspid insufficiency