Challenge of the Multivalvular Heart Disease

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Distribution of Valvular Heart Diseases in the Euro Heart Survey

5001 patients

Native Valve Disease: 72%
- AS: 34%
- AR: 10%
- MS: 10%
- MR: 25%
- Multiple: 20%
- Right: 1%

Previous Valvular Intervention: 28%
- Valve Repair: 18%
- Valve Replacement: 82%


Aetiologies of Single Valvular Heart Diseases in the Euro Heart Survey

- 43% AS
- 13% AR
- 32% MR
- 12% MS

- Other
- Ischemic
- Congenital
- Inflammatory
- Endocarditis
- Rheumatic
- Degenerative

Lung et al. Eur Heart J 2003;24:1244-53

Echocardiographic criteria for the definition of severe valve stenosis: an integrative approach

<table>
<thead>
<tr>
<th></th>
<th>Aortic stenosis</th>
<th>Mitral stenosis</th>
<th>Tricuspid stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve area (cm²)</td>
<td>&lt; 1.0</td>
<td>&lt; 1.0</td>
<td>–</td>
</tr>
<tr>
<td>Indexed valve area (cm²/m² BSA)</td>
<td>&lt; 0.6</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Mean gradient (mmHg)</td>
<td>&gt; 40</td>
<td>&gt; 10</td>
<td>≥ 5</td>
</tr>
<tr>
<td>Maximum jet velocity (m/s)</td>
<td>&gt; 4.0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Velocity ratio</td>
<td>&lt; 0.25</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Echocardiographic criteria for the definition of severe valve regurgitation: *an integrative approach*

<table>
<thead>
<tr>
<th></th>
<th>Aortic regurgitation</th>
<th>Mitral regurgitation</th>
<th>Tricuspid regurgitation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Qualitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Valve morphology</strong></td>
<td>Abnormal/flail/large</td>
<td>Flail leaflet/ruptured</td>
<td>Abnormal/flail/large</td>
</tr>
<tr>
<td></td>
<td>coaptation defect</td>
<td>papillary muscle/large</td>
<td>coaptation defect</td>
</tr>
<tr>
<td><strong>Colour flow</strong></td>
<td>Large in central jets,</td>
<td>Very large central jet</td>
<td>Very large central jet</td>
</tr>
<tr>
<td><strong>regurgitant jet</strong></td>
<td>variable in eccentric</td>
<td>or eccentric jet adhering, swirling, and reaching the posterior wall of the left atrium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>jets</td>
<td></td>
<td>or eccentric wall impinging jet</td>
</tr>
<tr>
<td><strong>CW signal of</strong></td>
<td>Dense</td>
<td>Dense/triangular</td>
<td>Dense/triangular with early peaking (peak vel &lt; 2 m/s in massive TR)</td>
</tr>
<tr>
<td><strong>regurgitant jet</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Holodiastolic flow reversal in descending aorta (EDV &gt; 20 cm/s)</td>
<td>Large flow convergence zone</td>
<td>—</td>
</tr>
</tbody>
</table>

Adapted from Lancellotti, EAE Recommendations. *Eur J Echocardiogr.* 2010;11:223-244 and 307-332
Think about inflammatory or toxic origin!

Tribouilloy et al. Circulation 2013
### Echocardiographic criteria for the definition of severe valve regurgitation: an integrative approach

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<tr>
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<th>Mitral regurgitation</th>
<th>Tricuspid regurgitation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semiquantitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vena contracta width (mm)</td>
<td>&gt; 6</td>
<td>≥ 7 (&gt; 8 for biplane)</td>
<td>≥ 7</td>
</tr>
<tr>
<td>Upstream vein flow</td>
<td>–</td>
<td>Systolic pulmonary vein flow reversal</td>
<td>Systolic hepatic vein flow reversal</td>
</tr>
<tr>
<td>Inflow</td>
<td>–</td>
<td>E-wave dominant ≥ 1.5 m/s</td>
<td>E-wave dominant ≥ 1 m/s</td>
</tr>
<tr>
<td>Other</td>
<td>Pressure half-time &lt; 200 ms</td>
<td>TVI mitral/TVI aortic &gt; 1.4</td>
<td>PISA radius &gt; 9 mm</td>
</tr>
<tr>
<td><strong>Quantitative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EROA (mm²)</td>
<td>≥ 30</td>
<td>≥ 40</td>
<td>≥ 20</td>
</tr>
<tr>
<td>R Vol (ml/beat)</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 30</td>
</tr>
<tr>
<td>+ enlargement of cardiac chambers/ vessels</td>
<td>LV</td>
<td>LV, LA</td>
<td>RV, RA, inferior vena cava</td>
</tr>
</tbody>
</table>

Adapted from Lancellotti, EAE recommendations. *Eur J Echocardiogr*. 2010;11:223-244 and 307-332
Valvular surgery Experience from 2007 to 2011 in Rennes University Hospital
(4015 valvular surgery including 3795 planned surgery)
At the time of aortic valve replacement, many patients with aortic stenosis (AS) exhibit varying degrees of mitral regurgitation (MR).

The aetiology of MR is often (but not systematically):

► **functional** *in nature, occurring in the absence of any significant intrinsic valvular lesion.*

- Increased afterload,
- LV-remodelling,
- fluid overload and
- concomitant ischaemic heart dysfunction

**may account for the development of functional MR.**
Pathophysiology of interactions between aortic stenosis and mitral regurgitation

Aortic stenosis

↓ Functional tolerance

Diagnostic challenge

LV remodelling

↑ LV pressure

↑ LV-LA pressure gradient

Mitral valve deformation

↑ Mitral regurgitation

↓ Forward stroke volume

Low flow low gradient aortic stenosis

Impedes detection of subclinical myocardial dysfunction

↑ EF

Atrial fibrillation

Unger et al. Heart 2011
Severe Ao S

Significant MR

Decrease forward Stroke Volume
>> reduced aortic Pressure Gradient
>> making detection of AS more Challenging

Afib …further reduce forward output

severe MR may impede the detection of subclinical myocardial dysfunction by preserving ejection phase indices of myocardial performance
The decision to operate on both valves requires:

- assessment of MR severity (ERO)
- knowledge of the functional or organic aetiology of MR and
- determination of the suitability for mitral valve repair.

For Quantifying the MR associated to the AoS: no American or ESC guidelines
Look at the valve!

- Diameter of the annulus
- Size and localization of the calcifications
- Prolapsus
- Chordae?
- …
- Precise description of the anatomy using TEE if necessary
Functional MR – most of the time, systolic restriction – Carpentier IIIb

results from an imbalance between tethering forces—annular dilatation, LV dilatation, papillary muscles displacement, LV sphericity and closing forces, reduction of LV contractility, global LV dyssynchrony, papillary muscle dyssynchrony, altered mitral systolic annular contraction.
A retrospective review identified 408 consecutive elderly (>70yo) patients who underwent isolated AVR from January 1983 to February 2004.

Moderate MR is an independent risk factor impacting long-term survival in elderly patients undergoing AVR. Therefore, patients with intrinsic mitral valve disease should be considered for concomitant MV surgery.

AS patients with FMR ≥2 and a left atrial diameter >5 cm, preoperative mean aortic valve gradient <40 mm Hg, or atrial fibrillation have a significantly higher risk of CHF and persistent mitral regurgitation after AVR than other AS patients.

AI patients with FMR ≥2 and a left ventricular end-systolic diameter <45 mm preoperatively are also at increased risk
Effects of functional mitral regurgitation at the time of aortic valve replacement on postoperative mitral regurgitation at a mean of 18 months postoperatively.

Additional risk factors are:
- left atrial diameter >5 cm,
- peak aortic gradient <60 mm Hg,
- mean aortic gradient <40 mm Hg,
- atrial fibrillation

## Indications for surgery in tricuspid disease

<table>
<thead>
<tr>
<th>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 (≥ 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>
Left sided-valve surgery

+ TR

Severe
- Class Ib (ACC/AHA)
  - Class Ic (ESC)
  - TR surgery
    - Preferably repair

Moderate
- Organic
  - Class IIa (ESC)
  - Pulmonary HT?
    - Yes: No tricuspid surgery
    - No: Dilated annulus?
      - Yes: TR Surgery
      - No: Functional

Mild
- ACC/AHA
- ESC

No tricuspid surgery

Unger P et al. Heart 2011;97:272-277
Look at the valve! Look at the RV function!

2D and 3D echo recordings of the tricuspid valve.

Mechanisms of mitral regurgitation according to the Capentier’s functional classification

Type I

Type II

Type IIIa

Type IIIb

Look at the valve!

Diameter of the annulus: parasternal, apical and **sub-costal** views+++ 

The annulus should not > 40mm 

Restriction of the valve motion despite a normal thickness 

Even mild TR: be careful 

Look at the RV size and function 

Look at RA and rhythm!
Functional TR is frequently associated with functional ischemic MR. After MVRep, close to 50% of patients have TR.

124 patients were explored before and followed after Mitral valve repair.

The incidence of postoperative TR increases with time. Preoperative tricuspid annulus dilation might be a predictor of late TR.
Presence of TR during the postoperative period.

- TR ≥ moderate
- TR ≤ mild

<table>
<thead>
<tr>
<th>Post-op</th>
<th>TR ≥ moderate</th>
<th>TR ≤ mild</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>7 (25%)</td>
<td>21 (75%)</td>
</tr>
<tr>
<td>1~3</td>
<td>10 (53%)</td>
<td>9 (47%)</td>
</tr>
<tr>
<td>&gt;3 years</td>
<td>17 (74%)</td>
<td>6 (26%)</td>
</tr>
</tbody>
</table>

Parameters describing the tricuspid valve restriction

% of Tricuspid Regurg

Source of the Curve
- Preoperative %TR
- Tethering distance
- Tethering area

Fukuda S et al. Circulation 2005;111:975-979

216 patients with functional TR had 2D echocardiography before and after TV annuloplasty.
638 patients (age 52 (14) years) who had mild (grade 2/4) TR and underwent successful surgery without any procedure for TR were analyzed.

Development of significant TR definition: TR increase by more than one grade and final TR grade >3/4 at follow-up.

Clinical events: cardiovascular death, repeated open-heart surgery, and congestive heart failure requiring hospital admission.

The overall incidence of late significant TR was 7.7% (49/638).

During clinical follow-up of 101 (24) months, patients who developed late significant TR showed a significantly lower 8-year clinical event-free survival rate (76 (6) vs 91 (1)%, p<0.001).
Changes in severity of tricuspid regurgitation (TR) after open-heart surgery.

Song H et al. Heart 2009;95:931-936
Age (HR, 1.0, 95% CI, 1.0 to 1.1; p=0.005),

female gender (HR, 5.0; 95% CI 2.0 to 12.7; p=0.001),

rheumatic aetiology (HR, 3.8; 95% CI 1.4 to 10.3; p=0.011),

atrial fibrillation (HR, 2.6; 95% CI 1.1 to 6.4; p=0.035)

peak pressure gradient of TR at follow-up (HR, 1.1; 95% CI 1.0 to 1.1; p=0.001)

independent factors associated with development of late significant TR.
Incidence of late significant tricuspid regurgitation (TR) according to the surgical procedure for the underlying valvular lesion.

Song H et al. Heart 2009;95:931-936
Comparison of event-free survival rates in patients who did and did not develop late significant tricuspid regurgitation (TR).

Log rank p < 0.001

Number at risk

<table>
<thead>
<tr>
<th>Years after operation</th>
<th>Late TR (−)</th>
<th>Late TR (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>589</td>
<td>49</td>
</tr>
<tr>
<td>1</td>
<td>584</td>
<td>49</td>
</tr>
<tr>
<td>2</td>
<td>575</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>572</td>
<td>47</td>
</tr>
<tr>
<td>4</td>
<td>562</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>554</td>
<td>44</td>
</tr>
<tr>
<td>6</td>
<td>546</td>
<td>43</td>
</tr>
<tr>
<td>7</td>
<td>441</td>
<td>38</td>
</tr>
<tr>
<td>8</td>
<td>305</td>
<td>27</td>
</tr>
</tbody>
</table>

Song H et al. Heart 2009;95:931-936
Pre-AoV replacement for symptomatic AoS

Post-AoV replacement for symptomatic AoS
Post redux for Tricuspid valve repair
To Conclude

Very low level of evidence

Importance of a careful assessment of the valves anatomy (rhumatismal ≠ degenerative)

Importance of Afib, Atrial size, severity of the global heart disease and after… case to case decision making process