Challenging clinical situations

A patient with multiple valve disease

Philippe Unger
CHU Saint-Pierre
Brussels, BE
I have no financial relationships to disclose.
• 28 y-o woman

• Born in Morocco, lives in Belgium, two children

• h/o rheumatic heart disease

• Increasing dyspnea during the last years; currently s.o.b. on minimal exertion
Rheumatic heart disease
Rheumatic heart disease
Mitral valve
Mitral stenosis

Vmax 250 cm/s
Vmean 195 cm/s
ITV 101 cm
PG max 25 mm Hg
PG mean 16 mm Hg

PHT 275 ms

MVA (PHT): 0.80 cm²
ITV_{LVOT} 20.0 cm
SV_{ITV} 83 ml
(44 ml/m²)

MVA (continuity): 0.82 cm²
Rheumatic MS+AR

1. Continuity equation is accurate to assess MVA

2. Pressure half-time method is accurate to assess MVA

3. Both methods are accurate

4. None of these methods are accurate
In the presence of AR, MVA is overestimated by the continuity equation.
In the presence of AR, MVA is overestimated by the pressure half-time method.


Moro E et al. *Eur Heart J* 1988;9:1010
Main diagnostic caveats in multiple and mixed valve disease

<table>
<thead>
<tr>
<th>In the presence of</th>
<th>AS</th>
<th>AR</th>
<th>MS</th>
<th>MR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td></td>
<td></td>
<td>Pressure half-time method unreliable</td>
<td>High RV; increased area of mitral regurgitant jet using CF mapping ERO less affected</td>
</tr>
<tr>
<td>AR</td>
<td>Simplified Bernoulli equation may be inapplicable</td>
<td>Gorlin formula using thermodilution invalid</td>
<td>AR jet should be mistaken of MS jet Continuity equation unreliable Pressure half-time method unreliable</td>
<td>Doppler volumetric method inapplicable</td>
</tr>
<tr>
<td>MS</td>
<td>Low flow low gradient AS</td>
<td>MS may blunt the hyperdynamic clinical picture</td>
<td>Not significantly affected</td>
<td></td>
</tr>
<tr>
<td>MR</td>
<td>Low flow low gradient AS MR jet should not be mistaken for the AS jet</td>
<td>Doppler volumetric method inapplicable Pressure half-time method may be unreliable</td>
<td>Continuity equation unreliable Pressure half-time method unreliable Gorlin formula using thermodilution invalid</td>
<td></td>
</tr>
</tbody>
</table>

...the diagnosis of the following lesion might be impaired

Mitral valve planimetry

MVA (planimetry): 0.64 cm²
Aortic stenosis

Mean PG 24 mm Hg
Max velocity 3.15 m/s
Velocity ratio 0.30

Stroke vol 44 ml/m²

AVA 1.1 cm²
Aortic regurgitation
**Quantification of AR severity**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHT, ms</td>
<td>&gt;500</td>
<td>200-500</td>
<td>&lt;200</td>
</tr>
<tr>
<td>VC width, mm</td>
<td>&lt;3</td>
<td>3-6</td>
<td>&gt;6</td>
</tr>
<tr>
<td>EROA, cm²</td>
<td>&lt;10</td>
<td>10-30</td>
<td>≥30</td>
</tr>
<tr>
<td>R Vol, ml</td>
<td>&lt;30</td>
<td>30-60</td>
<td>≥60</td>
</tr>
</tbody>
</table>

- ERO 23 mm²
- R Vol 55 ml
- Vena contracta width 7 mm
- PHT 455 ms
Pitfalls in mixed aortic valve disease: pressure half-time

+ = No LVH, $r = -0.62$, $p < 0.005$

□ = LVH, $r = -0.16$, NS

Moderate AR

Severe AR

de Marchi et al. Heart 1999;82:607
Pitfalls in mixed aortic valve disease: gradient and flow
Pitfalls in mixed aortic valve disease: Bernoulli’s equation

\[ \Delta P = 1/2 \rho (V_{max}^2 - V_{prox}^2) + \rho \frac{dv}{dt} dx + R(v) \]

Convective acceleration

Flow acceleration

Viscous friction

\[ \Delta P = 4(V_2^2) \]

\[ \Delta P = 4(V_2^2 - V_1^2) \]
Pitfalls in mixed aortic valve disease: catheterization

AVA = CO/44.5 \times SEP \times \sqrt{\text{mean PG}}

Thermodilution
- Right heart level

Pressure gradient
- Aortic valve level

GORLIN R, GORLIN SG Am Heart J 1951;41(1):1
Tricuspid valve
Tricuspid stenosis

Table 10  Findings indicative of haemodynamically significant tricuspid stenosis

Specific findings
Mean pressure gradient
Inflow time-velocity integral $T_{1/2}$
Valve area by continuity equation$^a$

Supportive findings
Enlarged right atrium $\geq$ moderate
Dilated inferior vena cava

$^a$Stroke volume derived from left or right ventricular outflow. In the presence of more than mild TR, the derived valve area will be underestimated. Nevertheless, a value $\leq 1 \text{ cm}^2$ implies a significant haemodynamic burden imposed by the combined lesion.

2 mm Hg
39.3 cm
170 ms
1.9 cm$^2$

Haemodynamically non significant TS

EAE/ASE RECOMMENDATIONS
Eur J Echocardiogr 2009;10,1
Tricuspid regurgitation

- IVC 18/12 mm
- ERO 30 mm²
- R Vol 32 ml
- Moderate TR
LA volume 58 ml/m²

LVIDD 4.8cm
LVIDS 3.3 cm
FS 33%
EF 59%

sPAP 50-55 mm Hg
### Summary

28 y-o woman; symptomatic RHD

<table>
<thead>
<tr>
<th>Valve</th>
<th>Lesion</th>
<th>Additional findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral</td>
<td>(very) severe MS</td>
<td>Sinus rhythm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LA dilatation</td>
</tr>
<tr>
<td>Aortic</td>
<td>Moderate AS</td>
<td>sPAP 50-55 mm Hg</td>
</tr>
<tr>
<td></td>
<td>Moderate-to-severe AR</td>
<td></td>
</tr>
<tr>
<td>Tricuspid</td>
<td>Moderate <em>primary</em> TR</td>
<td>No LV dilatation; EF 60%</td>
</tr>
<tr>
<td></td>
<td>Non severe TS</td>
<td></td>
</tr>
</tbody>
</table>
Which treatment?

1. Watchful waiting under medical treatment
   beta-blocker, diuretics, VKA

2. Double valve surgery
   AVR + MVR (or surgical commissurotomy)

3. Triple valve surgery
   AVR + MV surgery + TVR

4. Percutaneous mitral commissurotomy
Combined and multiple valve diseases

• “There is a lack of data on mixed and multiple valve diseases. This does not allow for evidence-based recommendations.”

• Predominant VHD? Follow the recommendations

• Non-severe multiple lesions? Should be based on a global assessment of the consequences of the different valve lesions. Intervention can be considered if associated with symptoms or with LV impairment.
Indications for PMC in MS with MVA ≤1.5 cm²

<table>
<thead>
<tr>
<th>Class</th>
<th>Level</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B</td>
<td>160, 170</td>
</tr>
</tbody>
</table>

PMC is indicated in symptomatic patients with favourable characteristics.1

Contraindications to PMC

- Mitral valve area >1.5 cm²
- Left atrial thrombus
- More than mild mitral regurgitation
- Severe or bicommissural calcification
- Absence of commissural fusion
- Severe concomitant aortic valve disease, or severe combined tricuspid stenosis and regurgitation
- Concomitant coronary artery disease requiring bypass surgery

Non-severe multiple lesions?

Guidelines on the management of valvular heart disease. Eur Heart J 2012;33,2451

Bouleti C et al. Circulation 2012;125:2119
Moderate AS defined as AVA 1.0–1.5 cm² (0.6 cm²/m² to 0.9 cm²/m² BSA) or mean aortic PG 25–40 mmHg in the presence of normal flow conditions

### Indications for aortic valve replacement in moderate aortic stenosis

<table>
<thead>
<tr>
<th>AVR should be considered in patients with moderate AS undergoing CABG, surgery of the ascending aorta or another valve.</th>
<th>Class</th>
<th>Level</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IIa</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

Guidelines on the management of valvular heart disease. Eur Heart J 2012;33,2451

### Indications for aortic valve replacement in moderate aortic regurgitation

…In patients with moderate AR, who undergo […] mitral valve surgery, the decision to treat the aortic valve should be based on the aetiology of the AR, age, worsening of LV function, and the possibility of valve repair…
Indications for surgery in tricuspid valve 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 dilatation 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>

Guidelines on the management of valvular heart disease. Eur Heart J 2012;33,2451
(very) severe MS

Moderate AS
Moderate-to-severe AR

Moderate primary TR
Non severe TS

Mitral surgery

AVR (IIa)

TVR (IIa)

PMC *

* In cases with severe MS with moderate aortic valve disease, PMC can be performed as a means of postponing the surgical treatment of both valves…”

Guidelines on the management of valvular heart disease. Eur Heart J 2012;33,2451
“The decision to intervene on multiple valves should take into account the extra surgical risk of combined procedures”

Guidelines on the management of valvular heart disease (version 2012)

Unadjusted Aortic Valve Operative Mortality
Yearly over last 10 years

STS Database

Euro Heart Survey

Courtesy B. Iung

STS database 2013

Long-term survival after double valve surgery

Incidence of major thrombo-embolic and bleeding events according to INR level and valve position

15.5% in-hospital mortality

Median survival = 7.3 years


Long-term survival after triple-valve surgery

8% (30 day) in-hospital mortality

\[ \text{N} = 871 \text{ (RHD)} \]

\[ \text{mean age} \ 42 \pm 11 \text{ y-o (range 7-64)} \]

8% (30 day) in-hospital mortality

\[ \text{Median overall survival} \ 11.5 \text{ yrs} \]

Multivariate analysis in early and late mortality

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>OR</th>
<th>95% CI</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ascites</td>
<td>10.7</td>
<td>1.6–68</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>NYHA class IV</td>
<td>3.1</td>
<td>1.5–8.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lower LVEF (&lt;0.4)</td>
<td>2.2</td>
<td>1.4–7.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Late mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced age</td>
<td>1.09</td>
<td>1.02–1.17</td>
<td>0.03</td>
</tr>
<tr>
<td>NYHA class IV</td>
<td>3.7</td>
<td>1.3–9.8</td>
<td>0.007</td>
</tr>
<tr>
<td>Lower LVEF (&lt;0.4)</td>
<td>4.1</td>
<td>1.4–10.6</td>
<td>0.002</td>
</tr>
</tbody>
</table>

OR: odds ratio; CI: confidence interval; NYHA: New York Heart Association; LVEF: left ventricular ejection fraction.
Outcome of Combined Stenotic and Regurgitant Aortic Valve Disease

Event-Free Survival Stratified by Peak Aortic Jet Velocity at entry

71 asymptomatic patients prospectively followed with ≥moderate AS + ≥moderate AR and LVEF ≥ 55%

p < 0.0001

Event-free survival stratified by severity of AS and AR

- moderate AS + moderate AR
- severe AS + moderate AR
- moderate AS + severe AR
- severe AS + severe AR

AVR-free survival and cumulative survival according to AR severity in patients undergoing PMC

Mean age 55.1 ± 14.7yrs
(Moderate AR: 49.3 ± 6.2yrs)

Sanchez-Ledesma et al. Am heart J 2008;156:361
PMC

MVA 0.64 cm²

MVA 1.90 cm²
4 year follow-up...
2010

MPG 32 mm Hg
Max PG 50 mm Hg
AVA 1.2 cm²

LVIDD 48 mm
LVIDS 33 mm
FS 33%

2014

MPG 35 mm Hg
Max PG 56 mm Hg
AVA 1.2 cm²

LVIDD 51 mm
LVIDS 32 mm
FS 37%
2010

Tric PG 2 mm Hg

2014

Tric PG 3 mm Hg
Take home messages

- Be aware of the diagnostic pitfalls
  - mainly due to haemodynamic interactions
  - prefer load independent indices
- The decision to intervene on multiple valves should take into account
  - the extra surgical risk of combined procedures
  - the risk of leaving a significant lesion untreated/of future reoperation
  - the natural history of the native valve disease
  - the long-term complications of multiple prosthesis

... Heart Team...
Thank you for your attention!