Echocardiographic assessment of mitral stenosis

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This is how it started...
Mitral stenosis at a glance
2D echo

- narrow diastolic opening of MV leaflets
- valve doming (‘hockey-stick’)
- thickened leaflets ± calcifications
- chordal thickening and fusion
- dilated LA
- ± dilated RV, paradoxical septal motion
Etiology
Echocardiography in MS

The main method to assess:

- Extent of anatomic lesions
- Severity
- Consequences

Extent of anatomic lesions

- Assessment by 2D echo:
  - leaflet mobility
  - calcification
  - commissural fusion
  - subvalvular involvement

- Scores to assess the feasibility for PMC:
  (percutaneous mitral commissurotomy)
  - Wilkins (Boston)
  - Cormier
Severity of MS (quantitation)

- 2D (3D) echo: MV area (planimetry)

- Doppler:
  - pressure gradients
  - MV area (pressure half-time)
  - PISA
  - continuity equation
### Grading severity of MS

<table>
<thead>
<tr>
<th>SPECIFIC</th>
<th>MILD</th>
<th>MODERATE</th>
<th>SEVERE</th>
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<tbody>
<tr>
<td>Valve area (cm²)</td>
<td>&gt; 1.5</td>
<td>1 - 1.5</td>
<td>&lt; 1</td>
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<table>
<thead>
<tr>
<th>SUPPORTIVE</th>
<th></th>
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<tbody>
<tr>
<td>Mean grad (mmHg)</td>
<td>&lt; 5</td>
<td>5 - 10</td>
<td>&gt; 10</td>
</tr>
<tr>
<td>SPAP (mmHg)</td>
<td>&lt; 30</td>
<td>30 - 50</td>
<td>&gt; 50</td>
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Planimetry

Yields anatomical area

Aim for cut no. 1!

Gingham C, Popescu BA, Jurcut R. Essentials in echocardiography, 2005:83
Planimetry

Limitations:

• Funnel-shaped structure of the stenotic MV
  ➔ overestimation of MVA if inadequate scanning

• Instrumentation settings:
  ➤ gain ➔ underestimation of MVA (’blooming’)

• Commissurotomy
  - irregular orifice, difficult to planimeter

• Technical requirements:
  - adequate 2D image quality, zoom, freeze
3D echo

Strengths:

• Higher accuracy in MVA planimetry than 2DE (true smallest orifice, independently of its orientation)

• Less experience-dependent and more reproducible

• Detailed information on commissural and subvalvular apparatus involvement (indication and results of PMC)

• Applicable also when PSAX view has inadequate image quality

Pressure Half-Time

- Time the pressure gradient needs to drop to half its initial value

- Because $PG \sim v^2$, i.e. $\sqrt{PG} \sim v$:
  
  Time velocity needs to drop to $1/\sqrt{2}$ of its initial value:

\[
MVA [\text{cm}^2] = \frac{220}{t_{1/2} [\text{ms}]}
\]
Noninvasive Assessment of Atrioventricular Pressure Half-time by Doppler Ultrasound

Liv Hatle, M.D., Bjørn Angelsen, dr. techn., and Arve Tromsdal, M.D.
Doppler-derived PHT: relation to mitral valve area

Figure 7. Pressure half-time obtained from ultrasonic recording of maximal velocity in mitral flow related to mitral valve area calculated from catheterization data; \( r = -0.74 \). ○ = mitral stenosis; ● = mitral stenosis and regurgitation.

Pressure Half-Time (PHT) method

Yields functional area

Pro: it also works in the presence of significant MR
Factors that may affect Pressure Half Time by influencing LA pressure decline

More rapid LA pressure decline will lead to a shortened PHT
Factors that may affect Pressure Half Time by influencing LA pressure decline

1. If the LA empties into a second chamber (eg ASD):
   - LA pressure will drop more rapidly
   - PHT will be shortened

2. If the LA is stiff (low atrial compliance)
   - LA pressure may drop rapidly
   - PHT will be shortened
Factors that may affect Pressure Half Time by influencing LV pressure rise

More rapid rise in LV pressure will lead to a shortened PHT
Factors that may affect Pressure Half Time by influencing LV pressure rise

1. If the LV fills from a second source (eg AR):
   - LV pressure will rise more rapidly
   - PHT will be shortened

2. If the LV is stiff (low ventricular compliance)
   - LV pressure may rise rapidly
   - PHT will be shortened
All factors affecting PHT (AR, ASD, reduced LA- or LV compliance) lead to overestimation of MVA

- Therefore, PHT never underestimates MVA
- Therefore, if PHT is > 220 ms, MS is severe
- However, if PHT is < 220 ms, consider:
  - mean transmitral gradient
  - MVA by planimetry
  - pulmonary artery pressure
  - exercise echocardiography
PHT method limitations

**Technique-related:**

- Non-parallel alignment to the transmitral flow
- Non-linear slope (leading to difficult/incorrect meas.)
- PW Doppler recordings

**Principle-related:**

- Factors affecting PHT (other than MS severity)
- Immediately after PMC (ASD)
Pitfalls in PHT measurement

Correct: modal velocity
Incorrect: peak velocity
Pressure gradients

- Derived by Bernoulli’s law from measured velocity
  - Highly rate- and flow-dependent

Problems: tachycardia, significant coexistent MR
(when gradients overestimate MS severity)
17 pts with MS underwent transseptal cardiac catheterization

Simultaneous measurements of transmitral gradient were performed by:

1. direct LA and LV pressures
2. PCW and LV pressures
3. Doppler echocardiography

### Consequences of MS

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<tr>
<th>HEMODYNAMIC</th>
<th>THROMBOEMBOLIC</th>
<th>INFECTION</th>
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<tr>
<td>↑ LAP</td>
<td>LA dilation</td>
<td>Endocarditis</td>
</tr>
<tr>
<td>↑ PVP</td>
<td>Atrial Fib</td>
<td>Recurrent episodes of rheumatic fever</td>
</tr>
<tr>
<td>↑ PAP</td>
<td>LA thrombus</td>
<td></td>
</tr>
<tr>
<td>RV dysfx</td>
<td>Systemic embolisation</td>
<td></td>
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<tr>
<td></td>
<td>Systemic congestion</td>
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- Acute pulmonary edema
- RV dysfx
- Systemic congestion
Spontaneous echo contrast

Thromboembolic risk

Reduced LAA emptying velocities
LA thrombus (TTE and TEE)
Pulmonary HT and RV dysfx
Echocardiography plays a key role in decision making regarding the optimal treatment

- **Anticoagulant therapy** even in SR when:
  - LA thrombus (class I C)
  - dense SEC (class IIa C)
  - enlarged LA > 50 mm (class IIa C)

- Guidance of **cardioversion** to sinus rhythm

Percutaneous Mitral Comissurotomy

When considering percutaneous treatment of MS echocardiography is essential to:

- assess MV morphology
- rule-out LA thrombi and significant MR
- monitor procedure (eg septal puncture)
- assess result
Leaflet mobility and calcification, coexisting MR
 PMC indicated? Assess MV morphology
Indications for PMC in MS with valve area < 1.5 cm²

- Symptomatic pts with **favourable characteristics** for PMC (Class IB):
  - **ABSENCE** of several of the following:

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<th>Clinical characteristics</th>
<th>Anatomic characteristics</th>
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<td>Old age</td>
<td>Wilkins score &gt; 8</td>
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<tr>
<td>History of commissurotomy</td>
<td>Cormier score 3</td>
</tr>
<tr>
<td>NYHA class IV</td>
<td>Very small MVA</td>
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<tr>
<td>Atrial fibrillation</td>
<td>Severe TR</td>
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<tr>
<td>Severe pulmonary hypertension</td>
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- Symptomatic pts with contraindication or high risk for surgery (Class IC)

Rule out LA/LAA thrombus

Interatrial septum morphology
Exercise echocardiography

- To unmask symptoms in pts with MVA <1.5 cm² and no or doubtful complaints
- When there is a discrepancy between resting Doppler echocardiographic findings and clinical findings
Remember

Always measure:
- Mean pressure gradient
- MVA by ≥ 2 methods (planimetry, PHT)
- SPAP using peak TR jet velocity
- LA size

Carefully look at the other valves (Tricuspid!)

When severity in doubt: exercise echo

TEE in selected cases (inconclusive TTE, to rule out thrombi, to decide for PMC)