Echo Evaluation of Mitral Stenosis

7th annual Houston Echo Review 2016: Boot Camp for the Echo Board

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Echo, Mitral Stenosis

Outline

1. Armamentarium (Quiver)
2. Severity Criteria
3. Etiology / Anatomy
4. MV area Planimetry
   a. Traditional 2-D
   b. Real-time 3-D
5. Pressure Half Time
   a. proper application
   b. pitfalls
6. Other methods (mention)
   a. Pressure Gradient
   b. Continuity Equation
   c. Stress Echo
   d. Real-time 3D “anatomy (4-D TTE, TEE)
7. Summary
Why the title?

• **Pressure Half-time method (PHT)**
  - May be overutilized—so EASY
  - Several limitations

• **MV area (2D & now real time 3D)**
  - May be underutilized (rheumatic)
  - Easy / Accurate / improved reproducibility

• **Other methods still have a role**
1. MS can be “multifaceted” prey / enemy.

**Goddess Artemis c. 325 BC**  
(Roman Copy-Diana, Louvre)  
Wiki Media

**Japanese Samurai warrior 5th c.**  
http://sakurajapanesewarfare.devhub.com

**Quiver:** a case for holding arrows; arsenal; armamentarium
MS: What’s in your quiver?

- PHT
- pressure Gradients

www.craftster.org
Complete Echo MS Quiver

- 2D anatomy TTE
- MV gradients
- Systolic PAP
- Continuity Eq
- PHT (T ½)
- 2D / 3D plan
- 3D anatomic
- Stress Echo


http://deerfever.com
2. **Severity “Continuum”**

### Mitral Stenosis Severity

<table>
<thead>
<tr>
<th>Category</th>
<th>Area (cm²)</th>
<th>mm Hg</th>
<th>SPAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>4.0 - 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>1.6 - 2</td>
<td>&gt; 1.5</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.1 - 1.5</td>
<td>1.0-1.5</td>
<td>5-10</td>
</tr>
<tr>
<td>Severe</td>
<td>1.0 - less</td>
<td>&lt; 1.0</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

- < 1.5 cm² rest symptoms can occur
- < 2.5 cm² exertional sx’s can occur

ACC/AHA guidelines, valve disease 2006
3. MS: Etiology / Anatomy

- Rheumatic
- Calcific degeneration (MAC)
  - Congenital
  - Prosthetic
  - Tumor
Rheumatic MS

Calcified Submitral apparatus (chords) & leaflet tips.

Degenerative (MAC)

Mitral annular calcification.
Mitral Annular Calcification

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Rheumatic: Fish mouth Deformity

FIGURE 1. Pathologic specimen: actual fishmouth (A) and fishmouth deformity (B).
4. MVA by Planimetry (TTE)

Pitfalls:

• Gain too high / low (blooming / drop out)
• Bad windows
• Shadowing (Ca++)
• Operator skill
• Funny Morphology

(measure x 3)
N=30 (rh)

- **Planimetry (best)**  \( r = .95 \)
- **PHT (good)**  \( r = .80 \)
- **PISA (good)**  \( r = .87 \)
- **Flow area (poor)**  \( r = .57 \)
Improved Assessment of Mitral Valve Stenosis by Volumetric Real-Time Three-Dimensional Echocardiography

Thomas M. Binder, MD, Raphael Rosenhek, MD, Gerold Porenta, MD, PhD, Gerald Maurer, MD, FACC, Helmut Baumgartner MD, FACC

Vienna, Austria

Figure 1. Real-time volumetric scanning: Images are displayed as two steerable perpendicular conventional B-mode image sectors. "C planes" that transect the scan plane were used to obtain short axis views of the mitral valve from the apical window.
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B. Improved Inter observer variability

A. 3D as good as 2D

C. EASIER!

Binder JACC Vol. 36, No. 4, 2000

- n = 48
- rheumatic
- apical 3D volume
- vs PSLAX 2D & PHT
Real-time 3D Echo in MS

- Perpendicular en-face cut plane of MV orifice
- Accurate area measurement
- Comparison with
  - 2D traditional area
  - Doppler (PHT, PISA)
- 3D planimetry
  - agrees best with Gorlin (cath) MV area
  - Lower intra- and interobserver variability
- Anatomic 3D images can be useful
5. Pressure Half-time

- PHT (or T \( \frac{1}{2} \)) “is defined as the time interval in milliseconds between the max mitral gradient in early diastole and the time point where the gradient is half the maximum initial value”

- MVA = \( \frac{220}{T \frac{1}{2}} \)
Pressure Half-time Method

PHT = peak pressure – to ½ peak pressure (ms)
PHT = (.29) DT
MVA = 220 / PHT

Hatle Circ 1979
Echo, Mitral Stenosis

PHT: Nice quality, correlates with mean gradient

MVA = 220/168 = 1.3 cm²

Mean Grad = 7.2 mm Hg
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PHT: **useful if Atrial fib.**

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PHT = .29 (DT)
DT= 760 MS
PHT = 220 MS
MVA = 220 ÷ PHT = 1.0 cm²
PHT: Dealing with tachycardia
PHT: Dealing with **tachycardia**
Echo, Mitral Stenosis
PHT: Bimodal slopes
Echo, Mitral Stenosis

PHT: TEE: Sinus Rhythm (A) & Atrial fib (B)

a. Sinus Rhythm  
Peak Velocity: 2.12 m/sec
Mean Velocity: 1.48 m/sec
Peak PG: 27.68 mmHg
Mean PG: 9.46 mmHg
VT: 65.03 cm

b. Atrial Fib

Sweep speed too slow 50 mm/sec, try 100 mm/sec
Aortic Regurg: avoid MV PHT if:
Poor Signal or mod-SEV AR

AR jet enters mitral inflow

Significant AR shortens PHT from increased LVEDP (overestimate MVA)
PHT: too short in noncompliant LV

- Poor LV compliance shortens PHT
- Variable with “diastolic” dysfunction
- Variable with assoc. MR, AS, AR

**NOTE:** Avoid PHT in Calcific MS Elderly, ESRD, concomitant pathology including diastolic dysfunction, AS, MR
PHT: Avoid post Mitral Balloon Valvuloplasty

Thomas et al. Inaccuracy of MV T1/2 immediately after percutaneous mitral valvotomy. Dependence on transmitral gradient and left atrial and ventricular compliance. *Circulation* 1988 Oct; 78 (4)
6a. MS severity by **Pressure gradients**

- CW Doppler
- USE **Mean** gradient
- Report HR
- A. Fib / irregular—avg ~ 5
- Increases / decreases with high / low stroke volume
- Increases with MR
6b. MVA by **Continuity Equation**: Also underutilized

\[ A_1 \times TVI_1 = A_2 \times TVI_2 \]

\[ MVA = d^2 \times 0.785 \times \frac{TVI_{LVOT}}{TVI_{MV}} \]

**Warning:**

1. significant **MR** (calc. area too small)
2. significant **AR** (calc. area too large)
3. Irregular rhythm

Nakatani CIRC 1988
6c. Don’t forget Stress echo

• Symptoms (exertional dyspnea)
  – Mild or Mod MS can cause symptoms
  – Non cardiac (COPD)
Case: 69 yr male, CAD, COPD, 2 yrs post 3v ACB.

- 1 yr post op, angina better, remained FC II-III DOE despite revasc.
- repeat cath → grafts patent
- Echo: technically difficult mild MS rest Doppler
Bicycle Stress Echo: 69 yr male, sev. COPD, Mod MS, FC III

TR velocity

Rest

RVSP = 35 mm Hg

3 m/sec

25 watts

RVSP = 88 mm Hg

4.7 m/sec

6c. Don’t forget Stress echo

Mitral inflow

Rest

Mean Grad 6 mm Hg

Mean Grad 12.5 mm Hg

25 watts
Mild or Moderate MS with Symptoms: think Stress Echo

- **Bicycle**
  - MV gradient
    - Incr. HR
    - Incr. SV
  - TR vel $\rightarrow$ PAP

- **Dobutamine**

- **Treadmill**
  - Also ok
6d. Real-time 3-D Anatomic (4D)

- TTE
- TEE
- Quantitation of orifice area not available
- May provide useful information, valve morphology
Three-Dimensional Echocardiography

The Benefits of the Additional Dimension

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David J. Sahn, MD‡

Chicago, Illinois; and Portland, Oregon

Fig. 11  MV commissures (arrows) Before (A) and after (B) balloon valvuloplasty
Echo, Mitral Stenosis

Rheumatic MS

3D TEE
Rheumatic MS
3D TEE
Echo, Mitral Stenosis

Calcific MS
3D TEE

TV AoV
Echo, Mitral Stenosis

Calcific MS
3D TEE
MS from Tumor Obstruction
Congenital Mitral Stenosis

1. Supravalvular ring (membrane)
2. Parachute MV
3. Double Orifice MV
4. Cor Triatriatum

Shone’s
7. Summary:

- **PHT may be overutilized**
  - Good method if limitations recognized.
  - Correlate with other methods (trust but verify)
  - Bi-modal slopes: handle correctly
  - Avoid: poor slope (tachycardia, AR, curved)
  - Avoid: Calcific MS
  - Avoid: mitral valvuloplasty

- **Planimetry is Underutilized** (rheumatic)
  - 2D planimetry has been reference measure
  - 3D planimetry is faster, improved variability
  - Incorporate this method into your “quiver”

- **Other methods** play an important role
Thank you!