Evaluation of native mitral regurgitation: Diagnose first

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Director, Intra-operative Echo
Professors Carpentier and McGoon

- Mechanism, resulting from the disease
- Severity of regurgitation, resulting from the mechanism
- Echo → define the mechanism, quantify the regurgitation severity
Etiology and Mechanisms in MR

Primary / organic
Myxomatous / MVP, fibroelastic deficiency, MAC, rheumatic, IE, congenital

Secondary
IMR, Dilated CMP, HCM

Other
Systemic disease, drugs, trauma

I
Normal
Annular Dilatation
Leaflet Perforation

II
Leaflet Flail
Leaflet Prolapse / Chordal Elongation

III
Leaflet / Chordal Retraction
Papillary muscle displacement
Mitral Valve Prolapse
Echo Diagnosis

- PLAX view

- > 2mm systolic displacement of one / both leaflets into LA below plane of mitral annulus

- More specific if leaflets are thickened
  > 5mm (myxomatous)
Mitral Valve Prolapse
Echo Diagnosis
Mitral Regurgitation
Tenting Area

Tenting area $\geq 6 \text{ cm}^2 \sim \geq \text{mod-severe MR}$
Mitral Valve Mechanisms

Organic

Functional
MR Mechanism I

Normal

Annular dilatation

Leaflet perforation
MR Mechanism II

- Flail leaflet
- Leaflet prolapse/chordal elongation
Leaflet/choral retraction

Papillary muscle displacement

MR Mechanism III
Regurgitation Severity Assessment

Perform a comprehensive assessment

= Use all the information available
What Type of Information

- **Specific signs**
- **Supportive signs**
- **Quantitative parameters**
  - **ERO:** Severity of the lesion itself
  - **RVol:** Severity of the volume overload
  - **RF:** Severity of volume overload relative to the size of the ventricle
### MR Severity Assessment

Application of specific and supportive signs, and quantitative parameters in the grading of mitral regurgitation severity

<table>
<thead>
<tr>
<th>Specific signs for MR severity</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small central jet &lt;4 cm² or &lt;20% of LA area</td>
<td>Signs of MR &gt; mild present but no criteria for severe AR</td>
<td>Vena contracta width &gt;&gt;0.7 cm with large central MR jet (area &gt;40% of LA) or with a wall-impinging jet of any size, swirling in LA</td>
<td></td>
</tr>
<tr>
<td>Vena contracta &lt;0.3 cm</td>
<td></td>
<td>Large flow convergence</td>
<td></td>
</tr>
<tr>
<td>No or minimal flow convergence</td>
<td></td>
<td>Systolic reversal in pulmonary veins</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Supportive signs</th>
<th>Intermediate signs/findings</th>
<th>Dense, triangular CW Doppler MR jet</th>
<th>Enlarged LV and LA size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic dominant flow in pulmonary veins</td>
<td>E-wave dominant mitral inflow (E &gt;1.2 m/s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-wave dominant mitral inflow</td>
<td></td>
<td></td>
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<tr>
<td>Soft density, parabolic CW Doppler MR signal</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Normal LV size</td>
<td></td>
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<tr>
<th>Quantitative parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
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<tr>
<td>R vol (mL/beat)</td>
<td>&lt;30</td>
<td>30-44</td>
<td>≥60</td>
</tr>
<tr>
<td>RF (%)</td>
<td>&lt;30</td>
<td>30-39</td>
<td>≥50</td>
</tr>
<tr>
<td>EROA (cm²)</td>
<td>&lt;0.20</td>
<td>0.20-0.29</td>
<td>≥0.40</td>
</tr>
</tbody>
</table>
Define the 3 components of the regurgitant jet!
Mitral Regurgitation

Vena Contracta
Vena Contracta

$\Delta \bar{U} = 0.51 \text{m/s}$

$\text{Dist} = 0.65 \text{cm}$
Vena Contracta
ASE Guidelines

- $< 0.3\text{cm}$ mild MR
- $\geq 0.7\text{cm}$ severe MR
- Values in-between quantify!
Proximal Isovelocity Surface Area
Behavior of Noncompressible Fluid Approaching Hole
Hemisphere That Looks More Like a Circle

Hemisphere $\Delta = 2\pi r^2$

Velocity (aliasing V)

Flow before the hole
Eliciting a PISA Shell

MR Apical 4-C

Aliasing from blue to red

LV
Flow Before the Hole Calculation

Flow = 6.28 \times V_{aliasing} \times r^2 = 6.28 \times 53 \times 0.94^2
= 294 \text{ mL/sec.}

LV

Radius = 0.94 \text{ cm}

LA

Aliasing Velocity
Instantaneous ERO Calculation

Flow = 294 mL/sec                          MR velocity = 557 cm/sec

ERO = flow/velocity = 0.53 cm² or 53 mm²
Mitral Regurgitation and PISA

Flow before the hole

ERO = MR velocity
Quantitation of Regurgitation Concepts

measures

R volume $\rightarrow$ Volume overload

measures

Effective R orifice $\rightarrow$ Lesion severity
MR severity evaluation principles

- Hemodynamics regur lesions = TTE
- Confirmed before OR
- Determination hemodynamic consequence of regur lesions can be complex---no method is perfect---so use many
Real life case--
61 yo male, very active, lawyer, anxious

- Marfanoid habitus
- S/P BAV repair severe AR 2007
- Persistent LV enlargement
- PAF, multiple PVCs
- MVP

- Yearly check-ups since 2008
Parasternal long 2010
Occasional SOB/palps running
LARGE LV

Dist 0.897 cm
Dist 6.72 cm
Color-Doppler
Apical 2-C Color-Doppler

PHILIPS

FR 22Hz
17cm

2D
55%
C 50
P Low
HGen

CF
74%
2.5MHz
WF High
Med

12/14/2010 01:07:24PM TIS2.2 MI 1.2
S5-1/MayoAdult

M3 M4
+63.1

-63.1 cm/s

JPEG
55 bpm
Severity?!?!?! The magic eye of the doctor
The magic eye of the doctor

1. Mild
2. Mild-moderate
3. Moderate
4. Moderate-severe
5. Severe
Whenever you can, count.
— Sir Francis Galton

If you cannot measure it you cannot control it.
— John Grebe
FURTHER EVAL >>>>
PISA and spectral Doppler Doppler End-systolic MR

ERO = \frac{\pi \times r^2 \times Av}{MR V_{max}}

R_{vol} = ERO \times MRTVI

ERO = 0.32 \text{ cm}^2 / R_{vol} = 26 \text{ cc}
What do we do?

1. Mitral repair
2. Mitral replacement
3. Observation
4. something else?
Oxygen consumption stress test
Normal VO2
Satisfactory exercise capacity
No evidence of CO limitation
Mitral Valve Prolapse With Mid-Late Systolic Mitral Regurgitation: Pitfalls of Evaluation and Clinical Outcome Compared With Holosystolic Regurgitation
Yan Topilsky, Hector Michelena, Valentina Bichara, Joseph Maalouf, Douglas W. Mahoney and Maurice Enriquez-Sarano

*circulation. 2012;125:1643*

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<tr>
<th>MR characteristics</th>
<th>Mid-Late Systolic MR (n=111)</th>
<th>Holosystolic MR (n=90)</th>
<th>P</th>
</tr>
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<tbody>
<tr>
<td>ERO, mm²</td>
<td>0.25±0.15</td>
<td>0.25±0.15</td>
<td>0.53</td>
</tr>
<tr>
<td>Jet area, 4-chamber view, cm²</td>
<td>8.3±3.6</td>
<td>8.0±5.2</td>
<td>0.63</td>
</tr>
<tr>
<td>Jet area, 2-chamber view, cm²</td>
<td>8.2±4.0</td>
<td>8.3±5.1</td>
<td>0.93</td>
</tr>
<tr>
<td>Aliasing velocity, cm/s</td>
<td>37.7±7.6</td>
<td>35.0±9.5</td>
<td>0.06</td>
</tr>
<tr>
<td>Flow convergence radius, cm</td>
<td>0.74±0.2</td>
<td>0.78±0.2</td>
<td>0.20</td>
</tr>
<tr>
<td>Regurgitant flow rate, mL/s</td>
<td>139.4±80.1</td>
<td>148.6±80.4</td>
<td>0.42</td>
</tr>
<tr>
<td>Regurgitant peak velocity, m/s</td>
<td>5.7±0.6</td>
<td>5.7±0.5</td>
<td>0.96</td>
</tr>
<tr>
<td>Regurgitant TVI, cm</td>
<td>105.5±21</td>
<td>190.2±29.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MR duration, ms</td>
<td>233±56</td>
<td>426±50</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MR duration/systolic time ratio, %</td>
<td>54.9±10.5</td>
<td>99.7±3.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Regurgitant volume, mL per beat</td>
<td>25.2±13.5</td>
<td>48.5±25.6</td>
<td>&lt;0.0001</td>
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Late 2011...yearly followup
“...I stopped running all together”
Compare

2010

2011
PISA...
ERO=0.64 cm² / Rvol=78 cc
Still have doubts...

- MV Peak E Vel
  Vel  112 cm/s
  PG   5 mmHg

- MV Peak A Vel
  Vel  39.5 cm/s
  PG   1 mmHg

- MV Peak A Vel
  Vel  32.4 cm/s
  PG   0 mmHg

- MV E/A  3.6
Murmur 5/6
LV larger
BNP elevated

Mitral Valve repair ASAP
TAKE HOME POINTS

• Diagnose severity with TTE, confirmed before OR

• End-systolic MR (MVP) can be tricky, Rvol is more important than ERO
Moral responsibility to patients and colleagues to produce an echocardiographic report closest to the truth