Mitral Regurgitation:
When Do You Fix the Leak?

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When do you fix the leak?

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July 4th, 2014
Overview

• Definitions
• Causes/Etiology
• Pathophysiology and Progression
• Natural History
• Assessment/Imaging
• Treatment
  – Medical management
  – Surgical management
  – Percutaneous intervention
Mitral Regurgitation (MR)

- “…systolic retrograde flow of blood from left ventricle (LV) to left atrium (LA)”
  » Enriquez-Sarano et al. Lancet 2009; 373:1382

- Why do we care?
  - MR is the most frequent valve disease in the US
    - Mod-Severe MR affects 2-3 million Americans (2000)
  - Very common in countries where rheumatic fever remains prevalent
  - Intervention can significantly alter natural history if caught in time (before LV dysfunction)
Mitral Regurgitation (MR)

• To avoid MR...so much has to go right.
  – Abnormalities in structure or function in any one component can alter geometry and coaptation and lead to adverse remodeling

  • Mitral annulus
  • Mitral valve leaflets
  • Subvalvular Apparatus
    – Papillary muscles
    – Chordae tendineae
  • Left atrium
  • Left ventricle

Nishimura et al. Mayo 2010
Definitions

• “Organic” MR
  – MR caused predominantly by dysfunction or abnormalities of the valve leaflets and/or chordae
    • Myxomatous degeneration
    • Endocarditis
    • Rheumatic heart disease

• “Functional” MR
  – MR caused predominantly by ventricular dysfunction
    • Cardiomyopathy
    • Ischemic MR
# Etiology

<table>
<thead>
<tr>
<th>Organic</th>
<th>Type II†</th>
<th>Type IIIa‡</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-ischaemic</td>
<td>Degenerative (billowing/flail leaflets); endocarditis (ruptured chordae); traumatic (ruptured Chord/PM); rheumatic (acute RF)</td>
<td>Rheumatic (chronic RF); iatrogenic (radiation/drug); inflammatory (lupus/anticardiolipin, eosinophilic endocardial disease, endomyocardial fibrosis)</td>
<td>Cardiomyopathy; myocarditis; left-ventricular; dysfunction (any cause)</td>
</tr>
<tr>
<td>Ischaemic</td>
<td>Ruptured PM</td>
<td></td>
<td>Functional ischaemic</td>
</tr>
</tbody>
</table>

Table 1: Causes and mechanisms of mitral regurgitation

Enriquez-Sarano et al. Lancet 2009; 373:1382
Major Causes of “Surgical” MR

- Degenerative 60-70%
- Ischemic MR 20%
- Endocarditis 2-5%
- Rheumatic 2-5%
- Other
  - Cardiomyopathy, inflammatory disorders, traumatic, congenital, drug-induced
Etiology

• Degenerative
  – Mitral valve prolapse syndrome
    • Abnormal systolic movement of MV into LA
  – Also rarely associated with heritable diseases
    • Ehlers-Danlos, Marfan, etc
  – Common: affects 1-2.5% overall population
  – Women >> Men
  – Either or both leaflets may prolapse
  – Most common reason for surgery
Etiology

• Ischemic MR
  – Refers primarily to MR in postinfarction patients, not in active ischemia
  – Due to ventricular dysfunction mostly
    • Annular dilatation
    • LV adverse remodeling with papillary muscle displacement/tethering
  – Rarely, MR can develop from acute rupture of papillary muscle
    • Posteromedial papillary muscle most common
Etiology

• Dilated Cardiomyopathy
  – Annular dilatation from LV enlargement
  – Papillary muscle displacement

• Rheumatic
  – May be seen along with MS or alone
  – Thickened, calcified leaflets and chordae

• Endocarditis
  – Leaflet tissue destruction and perforation

• Acute causes:
  – Ruptured papillary muscle, ruptured chordae, infective endocarditis
Case Scenario

- 65 y/o man presents to ED complaining of abrupt onset SOB and orthopnea…
  - Tachycardic
  - Hypotensive
  - Coarse Rales
  - Mild systolic murmur

- Bedside Echo:
  - Normal EF (LVEF > 70%)
  - Mild MR
Pathophysiology: Acute MR

Sudden Large Volume load (LA/LV)

↓

Rapid ↑LVEDP, ↑LAP

↑LV Preload → ↑HR ↑Contractility

↓

Despite this, difficult to maintain forward cardiac output...low resistance LA

- Pulmonary Edema
- Hypotension

Lindman B WU Manual Card Consult 2009
Pathophysiology: Chronic MR

Gradual large volume load (LA/LV)

\[ \uparrow \text{LVEDP}, \uparrow \text{LAP} \]

Compensatory LA dilatation/LV Dilatation and Hypertrophy
LV: \( \uparrow \text{Preload, LVH, reduced afterload} \rightarrow \) Large total SV
Supranormal LVEF

“MR begets more MR” (LVE, annulus enlarges, \( \uparrow \text{MR} \))

LV Contractile Dysfunction: \( \downarrow \text{EF}, \uparrow \text{ESV} \rightarrow \uparrow \text{LVEDP}, \uparrow \text{LAP} \)

Pulmonary HTN and congestion

Reduced forward SV/CO

Lindman B WU Manual Card Consult 2009
Natural History

- Prognosis depends on...
  - Etiology
  - Degree of LV dysfunction
  - Severity of MR at Diagnosis

- MVP + Mild MR + Nml LV = Normal Life Expectancy
  - Minority(<15%) progress to severe MR
  - Asymptomatic, compensated severe MR phase can last years

- Ischemic MR and DCM MR portend worse prognosis
Natural History:
MR due to Flail Leaflet

Natural History: MR Severity

- The more severe the MR, the worse the prognosis

Enriquez-Sarano et al. NEJM 2005; 352:875
History and Physical Exam

Acute MR

- **Symptoms**
  - Rapid onset dyspnea
  - May progress quickly to respiratory failure
  - Depending on ability to compensate, Sx of poor perfusion/forward flow

- **Exam**
  - Tachypnea, distress
  - Tachycardia
  - Systolic murmur, mild at apex if heard at all
  - +/- S3, diastolic murmur
  - Hyperdynamic apical impulse
  - Rales
  - Hypotension, signs of shock
History and Physical Exam

Chronic MR

• Symptoms
  – Depends on degree of compensation: could be asymptomatic
  – Sx of DOE develop as the LV starts to fail
  – Palpitations
  – Fatigue
  – Volume overload/CHF Sx
  – Patients with ischemic MR tend to develop HF Sx earlier given etiology

• Exam
  – Prominent apical holosystolic murmur, radiating to axilla
    • Posterior leaflet prolapsed: radiate to anterior chest
    • Anterior leaflet prolapse: radiate to back
    • MVP: midsystolic click
  – PMI, laterally displaced
  – S3, +/- diastolic murmur, irregularly irregular
  – If pHTN, loud P2
  – CHF/Volume overload(JVD, LE edema, rales)
Diagnostic Testing

• 12 lead ECG
  – Left Atrial Enlargement (LAE)
  – LVH/LVE
  – Atrial Fibrillation
  – Q waves if previous MI

• CXR
  – Pulmonary edema
  – Cardiomegaly
  – LAE
  – Enlarged PAs
Transthoracic Echo

Assess MR etiology
Assess LA size
Assess LV size
Assess Ejection Fraction
Quantify MR severity
MR: Qualitative Assessment

Enriquez-Sarano et al. Lancet 2009; 373:1382
MR: Qualitative Assessment

Mild

Severe
Enriquez-Sarano et al. Lancet 2009; 373:1382
### MR: Quantitative Assessment

<table>
<thead>
<tr>
<th>Specific signs</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small central jet &lt;4 cm$^2$ or &lt;10% of LA,</td>
<td>MR more than mild, without any criteria for severe MR</td>
<td>Vena contracta width ≥0.7 cm with large central MR jet (area &gt;40% of LA) or with a wall-impinging jet of any size; large flow convergence; systolic reversal in pulmonary veins; prominent flail leaflet or ruptured papillary muscle</td>
</tr>
<tr>
<td>vena contracta width &lt;0.3 cm, no or minimum flow</td>
<td></td>
<td></td>
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<tr>
<td>convergence</td>
<td></td>
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<tr>
<td>Systolic dominant flow in pulmonary veins;</td>
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<tr>
<td>A-wave dominant mitral inflow;</td>
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<td></td>
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<tr>
<td>low-density doppler MR signal;</td>
<td></td>
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<tr>
<td>normal LV size</td>
<td></td>
<td></td>
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<tr>
<td>Supportive signs</td>
<td></td>
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<td>Systolic dominant flow in pulmonary veins;</td>
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<tr>
<td>normal LV size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantitative variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RVol (mL per beat)</td>
<td>30–44; 45–59</td>
<td>≥60</td>
</tr>
<tr>
<td>RF</td>
<td>30–39%; 40–49%</td>
<td>≥50%</td>
</tr>
<tr>
<td>ERO area (cm$^2$)</td>
<td>0.20–0.29; 0.30–0.39</td>
<td>≥0.40</td>
</tr>
</tbody>
</table>

Modified from Zoghbi and colleagues. ERO = effective regurgitant orifice area. LA = left atrium. LV = left ventricle. MR = mitral regurgitation. RF = regurgitant fraction. RVol = regurgitant volume.

*Table 2: Gradation of mitral regurgitation by doppler echocardiography*

Enriquez-Sarano et al. Lancet 2009; 373:1382
What is LV dysfunction in setting of MR?

EF < 60%

ESD > 40 mm
Other Modalities

- TEE
  - Better visualization of valve
  - Define prolapsed leaflets
  - Assess for endocarditis
  - Feasibility of repair

- Exercise Testing with Echo
  - Assess functional capacity
  - Clarify if MR worsens with exertion if symptoms suggest worse than that seen at rest
  - Contractile reserve
Other Modalities

• Nuclear Study
  – Assess EF if echo inadequate
  – Viability/Ischemia assessment if ischemic MR

• LHC
  – Eval for CAD if undergoing MV surgery
  – LV gram can assess MR severity

• RHC
  – Rarely used. Can assess pHTN, LA filling pressure
Case Scenarios: Who needs surgery?

Patient # 1: GH
- 58 y/o man with longstanding MR and absolutely no symptoms
  - PMH: HTN, MR, recent AFib
- TTE
  - Severe MR
  - LVEF 59%
  - ESD 42 mm

Patient # 2: MK
- 65 y/o woman with worsening SOB, LE swelling and fatigue
  - PMH: HTN, Chronic MR, HL
- TTE
  - Severe MR
  - LVEF 32%
  - ESD ~ 50mm
Who needs surgery?
Who needs surgery?

- Factors independently associated with increased mortality after surgery...
  - Preoperative LVEF < 60%
  - Severe HF Symptoms: NYHA III-IV
  - Older Age
  - Comorbidities: CAD, AF
  - ERO >40 mm^2
Indications for Operation: Severe MR
ACC/AHA Valve Guidelines

Class I
1. Mitral valve surgery is beneficial for acute symptomatic MR. *(Level of Evidence: B)*
2. Mitral valve surgery is beneficial for patients with chronic severe MR and NYHA functional Class II, III, or IV symptoms in the absence of severe LV dysfunction (defined as end-systolic dimension greater than 55 mm and/or ejection fraction less than 0.30). *(Level of Evidence: B)*
3. Mitral valve surgery is beneficial for asymptomatic patients with chronic severe MR and mild to moderate LV dysfunction, ejection fraction 0.35 to 0.60, and/or end-systolic dimension 40 to 55 mm. *(Level of Evidence: B)*

Class IIa
1. Mitral valve surgery is reasonable for asymptomatic patients with chronic severe MR, preserved LV function and new onset of atrial fibrillation. *(Level of Evidence: C)*
2. Mitral valve surgery is reasonable for asymptomatic patients with chronic severe MR, preserved LV function and pulmonary hypertension (pulmonary artery systolic pressure greater than 50 mm Hg at rest or greater than 60 mm Hg with exercise). *(Level of Evidence: C)*
3. Mitral valve surgery is reasonable for patients with severe LV dysfunction (ejection fraction less than 0.30 and/or end-systolic dimension greater than 55 mm) in whom chordal preservation is highly likely. *(Level of Evidence: C)*
4. Mitral valve surgery can be effective for asymptomatic patients with chronic severe MR with preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm) in whom mitral valve repair is highly likely. *(Level of Evidence: C)*

Class III
1. Mitral valve surgery is not indicated for asymptomatic patients with preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm) in whom significant doubt about the feasibility of repair exists. *(Level of Evidence: C)*
Indications Simplified…

• Patients with severe acute MR should undergo surgery
• Patients with chronic severe MR should undergo surgery if they have...
  – Symptoms
  – LV dysfunction
  – Unless there is prohibitive risk (i.e. LVEF <25% or significant comorbidities)
• It is *reasonable* to consider surgery in asymptomatic patients with severe MR and normal EF if using experienced center with high likelihood of repair
If AF, don’t forget the MAZE…
Role of Medical Therapy

• Acute MR
  – Surgery is indicated
  – While waiting...afterload reduction
    • IV nitroprusside or IABP
    • Improve forward flow
  – Don’t try to rate control and risk hypotension

• Chronic MR
  – In absence of HTN, no indication for AL reduction
  – If LV dysfunction, treat like any other HF patient
Role of CRT
Percutaneous Therapies

New approaches constantly under development…Mitral Clip

- Creates pinched bridge between anterior and posterior leaflets mimicking prior surgical technique
- Recently FDA approved
- Early promise in terms of safety and efficacy
Overview

• Acute MR is a surgical disease…
• If you wait for symptoms with chronic MR, it may be too late
• Close surveillance and earlier intervention is being emphasized
• Even in asymptomatic patients with severe MR, if repair is likely, then surgery is reasonable
• Medical therapy has a limited role in MR management, unless there is comorbid CAD or LV dysfunction
• Less invasive methods are under development, but remain in their infancy
Comments/Questions