Ischemic Mitral Regurgitation
diagnosis and management

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No disclosures

Different types of MR act differently

• Degenerative MR
  – Mild MR in pt with degenerative MR well tolerated for many years

• Ischemic / Functional MR (FMR)
  – Even mild FMR in a patient with reduced LVEF has prognostic implications

Ischemic MR – a consequence of MI and marker of reduced survival

Grigioni et al, Circulation 2001
Ischemic MR – mortality risk increases as function of MR severity

ERO
Regurgitant Volume

Grigioni et al, Circulation 2001

3 cases of MR

- All associated with coronary artery disease
- Mechanisms differ
- Treatments differ

Case 1
hypotension post-RCA stent for acute MI

TTE – small hypercontractile LV
Persistent hypotension post-RCA stent TEE

Acute Mitral Regurgitation

Papillary muscle rupture

CASE #2
62 year old female, type II DM, HTN presents with 4-5 days of epigastric pain.
CASE #2

Inferior MI with inferior wall akinesis; trace MR; relatively preserved LV function

Uncomplicated post MI course

CASE #2
Presents 5 years later with dyspnea…
Patient with remote inferior myocardial infarction and aneurysm formation

Case # 3
HF in 72 yo M s/p multiple MIs

Understanding MR etiology requires defining the anatomy
The Mitral Valve Complex

The Mitral valve is more than just a couple of leaflets!
MR associated with CAD

- Mechanisms
  - Papillary muscle transections
  - LV remodeling / papillary muscle displacement
    - Global vs Regional LV dysfunction
- Normal leaflets, abnormal supporting structures

Ischemic mitral regurgitation: what information can echo provide?

- Etiology
  - Mechanical complication
    - Small LV, hypercontractile LV, flail leaflet
  - Functional MR (FMR)
    - Ventricular Remodeling
      - Global
        » Large LV, incomplete closure of leaflets
      - Regional
        » Distorted wall, tethered leaflet
    - Annular remodeling

Incomplete mitral leaflet closure: Is it due to tethering forces (LV dilation) or decreased closing forces (LV dysfunction)?
Development of MR relates to alterations in 3D geometry which can be assessed by echo: direct relationship tethering distance to MR degree

Multivariate determinants of MR jet area after MI:
- LVEDV
- Posterior PM tethering distance
- Inferior location of MI
- Mitral annular area
Development of annular enlargement

- ISCHEMIC
- Papillary Muscle Displacement
- Mitral Valve Tethering
- Restricted Closure
- Annular Dilation

Identifying other signs of leaflet tethering on echo: tethering forces exerted on the body of the anterior leaflet

- Basal (strut) Chordae
- Marginal Chordae
- Papillary tips

Post-Infarct
- Papillary Muscle Displacement
- Messas et al., Circulation 2001

Post-Infarct MR
### Treatment goals for FMR

- Reduce LV volume, dysfunction
  - Beta blockers, coronary revascularization
    - Improved outcome, QoL
- Reduce annular dilation
- Reduce volume load of the MR
  - Not clear that interventions that solely target reduction of MR are better than medical therapy
  - FMR recurs due to progressive nature of the LV disease (in contrast to degenerative MR)

### Therapies for ischemic MR

- Medical therapy
- Revascularization
  - PCI, CABG
    - Acute therapy – reduce MI size/remodeling, reduced MR
- MV repair with annular ring
  - May exacerbate tethering
  - Requires asymmetric plasty
- CRT
- Modifying LV
  - External constraint
    - Infarct plication, remodeling devices
- Modifying chords
  - Chordal lengthening, cutting, neochords
- Catheter based repairs

### Effects of CRT on Ischemic MR:

- Reduction of MR occurs in many with CRT
- Several possible etiologies
  - Improved contractility (closing forces)
  - Synchrony of papillary muscle contraction
  - Reverse remodeling of LV (geometry)
Is the effect on MR more than just LV volume?

LV End Systolic and Diastolic Volumes

MR area

Pacing No pacing

Pacing No pacing

Maximum effect on MR before maximum effect on volume

Deterioration in MR before LV change


PM dyssynchrony- an etiology for MR?

Kanzaki et al, JACC 2004;44:1619-25
3D echocardiography

Tenting volume and mitral annulus after CRT

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Pre-CRT</th>
<th>Post-CRT</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (bpm)</td>
<td>77±14</td>
<td>73±10</td>
<td>0.4</td>
</tr>
<tr>
<td>Mean BP (mmHg)</td>
<td>85±12</td>
<td>80±13</td>
<td>0.1</td>
</tr>
<tr>
<td>EDV (ml)</td>
<td>249±120</td>
<td>220±112</td>
<td>0.003</td>
</tr>
<tr>
<td>ESV (ml)</td>
<td>201±104</td>
<td>168±102</td>
<td>0.0007</td>
</tr>
<tr>
<td>EF (%)</td>
<td>18±6</td>
<td>25±11</td>
<td>0.001</td>
</tr>
<tr>
<td>MAA (cm²)</td>
<td>11.6±4.3</td>
<td>10.6±3.4</td>
<td>0.005</td>
</tr>
<tr>
<td>MAA corr (%)</td>
<td>0±1.06</td>
<td>0.1±0.06</td>
<td>0.1</td>
</tr>
<tr>
<td>TV (ml)</td>
<td>5.8±3.3</td>
<td>4.4±2.2</td>
<td>0.008</td>
</tr>
<tr>
<td>Leaflet Area (cm²)</td>
<td>15.6±5</td>
<td>14±2</td>
<td>0.005</td>
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</tbody>
</table>

Solis-Martin J. Circulation Imaging 2009

post-CRT Improvement in LV volume and MR

- **Acute**
  - MR Reduction with synchronous contraction
  - Force balance relationship on mitral valve
  - PM synchrony
  - Predicts LV pacing at the site of maximal electrical delay
- **Chronic**
  - Favorable changes in mitral valve geometry decreasing tenting volume;
  - Reverse remodeling
- **Reverse LV Remodeling**
  - + reduced MR with CRT
    - Predicts functional response
    - Predicts clinical outcome

Uncertainty in How to Treat Ischemic MR

Early versions of ring annuloplasty associated with recurrence of MR and no clear mortality benefit
There is an approximately 30 to 40% recurrence rate of IMR following ring annuloplasty.

<table>
<thead>
<tr>
<th>Authors</th>
<th>N</th>
<th>% with significant MR (moderate) Post ring</th>
<th>Follow-Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liel Cohen et al.; Circulation 1997</td>
<td>31</td>
<td>58%</td>
<td>6 yrs</td>
</tr>
<tr>
<td>Calafiore et al.; Ann Thorac Surg. 2001</td>
<td>16</td>
<td>70%</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Tahta et al.; J. Heart Valve Dis. 2002</td>
<td>100</td>
<td>50%</td>
<td>3 yrs</td>
</tr>
<tr>
<td>McGee and Cosgrove; J. Thorac Cardiovasc Surg 2004</td>
<td>422</td>
<td>28%</td>
<td>6 mo</td>
</tr>
<tr>
<td>Galisomo et al; EHU 2007 (Restrictive Annuloplasty)</td>
<td>251</td>
<td>43%</td>
<td>5 yrs</td>
</tr>
</tbody>
</table>

MV Quantification: 3D TEE

3D echocardiography

Loss of Saddle shape with infarction


Gelsomino et al; EHJ 2007 (Restrictive Annuloplasty)
Changes in Ring Design

Planar

Non Planar

- Very little data demonstrating improvement in survival or functional status in patient who undergo mitral valve repair at time of CABG surgery

Mihaljevic T. and Lytle B et al. JACC 2007;49:2191-2201

Retrospective analysis comparing patients with 3 or 4+ MR who either underwent CABG alone (N=100) or CABG plus MV annuloplasty (N=290).

No difference in survival or long term functional class between the two groups.

Mihaljevic T. and Lytle B et al. JACC 2007;49:2191-2201
### Randomized Ischemic Mitral Evaluation Trial (RIME)

- 73 pts moderate ischemia MR on cMR
  - EROA 0.2-0.39 sq cm, RV 30-59 ml/bt, VC width 0.3-0.69 cm
  - Goal was 100 pts
- Randomize to
  - CABG plus MV Repair vs. CABG alone
- 1 year data available for only 59
- MV repair group increased post-op issues
  - Op time, LOS, transfusion, IABP use, re-exploration, etc

### RIME Trial

- 1° endpoint
  - MV repair better pk O₂ consumption
- 2° endpoints
  - MV repair better LVESV, RV, BNP, NYHA class
  - 1 yr mortality not reported (sample size small)
  - 50% of CABG alone pts had 0 or 1+ MR at 1 yr
- While firm conclusions cannot be drawn and more data needed, MV repair not unreasonable
  - ? Addition of CRT

### CTSN TRIAL: Randomized Clinical Trial

<table>
<thead>
<tr>
<th>Moderate MR</th>
<th>Severe MR</th>
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<tr>
<td>CABG</td>
<td>CABG plus MV repair</td>
</tr>
<tr>
<td>CABG plus MV Repair</td>
<td>CABG MV Repair</td>
</tr>
<tr>
<td>CABG MV Repair</td>
<td>CABG MV Replacement</td>
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</tbody>
</table>

(CTSN TRIAL: Randomized Clinical Trial Patients undergoing CABG with either moderate or severe ischemic MR:)
Percutaneous MV repair: targets

- Leaflets
  - Coaptation, plication, ablation
- Annulus
  - Direct
    - Cinching – mechanical or energy mediated
  - Indirect
    - Cor sinus
- Chords
  - Implantation, cutting
- LV remodeling

MV clip mimics Alfieri stitch creating double orifice MV
(surgical Alfieri procedure includes annular ring)

From Rogers, et al. Percutaneous Approaches to Mitral Regurgitation
Everest II Trial

The NEW ENGLAND JOURNAL of MEDICINE

Percutaneous Repair or Surgery for Mitral Regurgitation

Feldman et al NEJM 2011; 363;1597-607

CONCLUSIONS

Although percutaneous repair was less effective at reducing mitral regurgitation than conventional surgery, the procedure was associated with superior safety and similar improvements in clinical outcomes. (Funded by Abbott Vascular EVEREST II ClinicalTrials.gov number: NCT01005174)

Direct catheter-based annuloplasty (cinching)

Tensioning Cable

anchors in LV wall

14F Guide catheter

Guided delivery systems (courtesy of J. Rogers)

Indirect catheter based annuloplasty

Cardiac dimensions web site
Transcatheter MV implantation

Percutaneous MV repair for MR

- Most of MV clip trial subjects have been degenerative yet clip may be better suited for functional
  - Everest I, II (~73% prolapse, 27% FMR)
  - COAPT - FMR population
- Interventions on annulus or LV may hold promise
- Surgical repair works on multiple aspects of MV complex but current percutaneous devices do not
- Biochemistry of leaflet lengthening

Ischemic MR + echo

- Several mechanisms
  - Papillary muscle transection (less common)
  - Papillary muscle displacement (most common)
    • A ventricular problem not a valvular problem
- Echo can
  - Identify the mechanism
    • LV, MV leaflets, MV coaptation point, annulus and geometric relationships
  - Quantify response to treatment
  - Help develop new therapies
Ischemic MR

- RCTs of surgical MV repair for FMR in progress
- Percutaneous, transcatheter interventions in evolution