Regional Changes in Leaflet Coaptation Geometry Following Reduction Annuloplasty in Patients with Functional Mitral Regurgitation

David G. Greenhouse, MD
CF Schwartz, SL Dellis, DF Loulmet, LB Balsam, Aubrey C. Galloway, Eugene A. Grossi

Department of Cardiothoracic Surgery
NYU School of Medicine

2011 Mitral Conclave
Reduction annuloplasty (RA) for functional mitral regurgitation (FMR) improves leaflet coaptation, but effects on regional geometry have not been well defined.

16 patients with severe FMR underwent RA with a semirigid device. Intraoperative 3DTEE was taken pre & post repair.

Offline analysis assessed coaptation zone geometry in 3 regions; differences were quantified with RMANOVA.
## Patient Characteristics

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>Male Gender (n)</td>
</tr>
<tr>
<td>Ischemic Etiology (n)</td>
</tr>
<tr>
<td>Concomitant CABG (n)</td>
</tr>
<tr>
<td>Concomitant TVR (n)</td>
</tr>
<tr>
<td>Annuloplasty Size (Mean±SD)</td>
</tr>
</tbody>
</table>
• Measurements were performed in three planes (regions) orthogonal to the annulus, transecting the posterior leaflet scallops.
Schematic Representation of Coaptation Measurements

Diastolic Measurements:
• Septo-lateral annular dimension
• Anterior Leaflet Length
• Posterior Leaflet Length

Systolic Measurements:
• Anterior Coaptation Distance
• Coaptation Depth
• Anterior Coaptation Length
• Posterior Coaptation Length
### Regional Mitral Valve Geometry Pre versus Post Reduction Annuloplasty for FMR

<table>
<thead>
<tr>
<th></th>
<th>Region 1: Pre vs Post</th>
<th>Region 2: Pre vs Post</th>
<th>Region 3: Pre vs Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septo-Lateral Annular Dimension</td>
<td>31.4±8.0 vs 20.2±5.5*</td>
<td>34.7±5.9 vs 22.0±5.5*</td>
<td>30.3±5.9 vs 19.8±4.9*</td>
</tr>
<tr>
<td>Coaptation Distance</td>
<td>19.9±6.1 vs 15.7±4.6*</td>
<td>23.3±5.9 vs 15.9±4.7*</td>
<td>18.4±5.5 vs 14.5±4.4*</td>
</tr>
<tr>
<td>Coaptation Depth</td>
<td>7.2±2.6 vs 6.4±2.6**</td>
<td>8.2±3.3 vs 6.7±2.6**</td>
<td>6.5±2.5 vs 6.3±2.1**</td>
</tr>
<tr>
<td>Anterior Leaflet Coaptation Length†</td>
<td>3.6±2.1 vs 4.3±2.2*</td>
<td>2.9±2.6 vs 5.5±2.5*</td>
<td>3.6±2.2 vs 4.8±2.6*</td>
</tr>
<tr>
<td>Posterior Leaflet Coaptation Length</td>
<td>2.2±1.6 vs 2.9±2.1*</td>
<td>2.6±2.4 vs 4.0±2.1*</td>
<td>1.8±1.4 vs 2.9±1.3*</td>
</tr>
</tbody>
</table>

Measurements in millimeters.
RMANOVA: Effect of RA on all regions: *p<0.01, **p=0.08.
Effect of region on coaptation length by RA: †p=0.01.
Effects of Reduction Annuloplasty

- Reduction annuloplasty was associated with increased leaflet coaptation lengths in all regions (*p<0.01).

- Increased anterior coaptation length was non-uniform between regions, with the greatest increase in Region 2 as assessed by RMANOVA (†p=0.01).
Absolute and Relative Changes in Mitral Valve Geometry Pre versus Post Reduction Annuloplasty for FMR

<table>
<thead>
<tr>
<th></th>
<th>Region 1 (mm)</th>
<th>Region 2 (mm)</th>
<th>Region 3 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septo-Lateral Annular Dimension *</td>
<td>-11.2 (-35.7%)</td>
<td>-12.7 (-36.6%)</td>
<td>-10.5 (-34.7%)</td>
</tr>
<tr>
<td>Coaptation Distance *</td>
<td>-4.2 (-21.1%)</td>
<td>-7.4 (-31.8%)</td>
<td>-3.9 (-21.2%)</td>
</tr>
<tr>
<td>Coaptation Depth **</td>
<td>-0.8 (-11.1%)</td>
<td>-1.5 (-18.3%)</td>
<td>-0.2 (-3.1%)</td>
</tr>
<tr>
<td>Anterior Leaflet Coaptation Length†</td>
<td>0.7 (19.4%)</td>
<td>2.6 (89.7%)</td>
<td>1.2 (33.3%)</td>
</tr>
<tr>
<td>Posterior Leaflet Coaptation Length *</td>
<td>0.7 (31.8%)</td>
<td>1.4 (53.8%)</td>
<td>1.1 (61.1%)</td>
</tr>
</tbody>
</table>

RMANOVA: Effect of RA on all regions: *p<0.01, **p=0.08. Effect of region on coaptation length by RA: †p=0.01.
# Ventricular Measurements

<table>
<thead>
<tr>
<th></th>
<th>Pre-op (Mean±SD)</th>
<th>Post-op (Mean±SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MR Severity (1-4+)</strong></td>
<td>3.8±0.5</td>
<td>0.1±0.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Ejection Fraction (%)</strong></td>
<td>34.5±18.1%</td>
<td>27.8±5.4%</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>LVEDD (cm)</strong></td>
<td>4.82±0.71cm</td>
<td>4.41±0.66cm</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>LVESD (cm)</strong></td>
<td>4.09±0.79cm</td>
<td>4.05±0.65cm</td>
<td>0.29</td>
</tr>
</tbody>
</table>

- RA for FMR significantly reduced the grade of FMR from 3.8 to 0.1 (scale 0-4).
Conclusions

• RA in FMR produces varying changes in coaptation zones:
  • Leaflet coaptation lengths increased in all regions.
  • This increase varies by region, with region 2 showing the greatest increase.
  • Annular septo-lateral dimension and coaptation distance decreased significantly in all regions.

• Regional analysis of mitral valve coaptation creates a mathematical framework to better understand the mechanisms of surgical success/failure of RA for FMR.