Advances in Percutaneous Mitral Valve Repair and Replacement
Scott M Lilly MD PhD, Interventional Cardiology
The Ohio State University Contemporary Multidisciplinary Cardiovascular Conference
Orlando, Florida
September 17th, 2016

Outline

• Scope of the Problem and Guidelines

• Available Percutaneous Strategies and Outcomes

• Emerging Annuloplasty strategies

• Transcatheter Mitral Valve Replacement
**Scope of the Problem**

The frequency of repair has doubled over the last 10-15 years, and exceeded the rate of valve replacement.

Badhwar et al. 2016, Trends CV Medicine

**European Survey on Valvular Heart Disease**
92 Centers, 25 countries over 4 months

Those not offered surgery were older, with more co-morbidities (diabetes, atherosclerotic vascular disease, lung disease), heart failure admissions, and overall comorbidity indices.

Mirabel et al 2007; Eur Heart Journal, Alan Schwartz, TCT 2014
Scope of the Problem

Surgery for degenerative mitral regurgitation (n = 284), stratified by degree of pulmonary hypertension

Coincident valve disease, need for CABG excluded. Mean ejection fraction 55%.

At the time of intervention, comorbidities* may drive outcome more strongly than the valve disease itself.

* Ejection fraction, heart failure admissions, left atrial size, atrial fibrillation

Characterization of Mitral Regurgitation

<table>
<thead>
<tr>
<th></th>
<th>Primary MR (or Organic MR)</th>
<th>Secondary MR (or Functional MR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve structure</td>
<td>Abnormal</td>
<td>Normal</td>
</tr>
<tr>
<td>Mechanism</td>
<td>Primary valve / subvalvular lesion</td>
<td>Distortion of the valvular apparatus due to LV remodelling</td>
</tr>
<tr>
<td>Causes</td>
<td>Degenerative / Rheumatic / Endocarditis / Other</td>
<td>Ischaemic heart disease / Cardiomyopathy</td>
</tr>
<tr>
<td>LV dysfunction</td>
<td>Consequence</td>
<td>Cause</td>
</tr>
</tbody>
</table>
Characterization of Mitral Regurgitation

**Primary MR**
- Majorit of total MR
  - Myxomatous
  - Endocarditis
  - MAC, RHD, Radiation
  - Can Cause LV dysfunction

**Secondary MR**
- Majorit of Severe MR
  - Ischemic CM
  - Dilated CM
  - HOCM
  - Caused by LV dysfunction

Goals of Intervention

- Improve Survival
- Decrease Symptoms
- Prevent ventricular dysfunction
- Prevent atrial fibrillation
- Prevent pulmonary hypertension

Scope of the Problem
**Scope of the Problem**

ACC/AHA 2014 Guidelines for Surgery in *Primary* Mitral Regurgitation

<table>
<thead>
<tr>
<th>Indication</th>
<th>Class</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptomatic Patients, LVEF &gt;30%</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Asymptomatic Patients LVEF 30%-60% or LVESD ≥ 40 mm</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Asymptomatic Patients LVEF &gt; 60% and LVESD &lt; 40 mm Likelihood of durable repair is &gt;95% Mortality rate of &lt;1% (Heart Valve Center)</td>
<td>Ila</td>
<td>B</td>
</tr>
<tr>
<td>Asymptomatic Patients New onset atrial fibrillation Resting PASP &gt; 50 mm Hg</td>
<td>Ila</td>
<td>B</td>
</tr>
<tr>
<td>Chronic Severe Primary MR and LVEF ≤ 30%</td>
<td>IIb</td>
<td>C</td>
</tr>
</tbody>
</table>

*Not too early, not too late = Close surveillance!*  
Moderate: Every 1-2 years  
Severe asymptomatic: Every 6-12 months

Nishimura et al, ACC/AHA 2014 Valve Guidelines

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**Scope of the Problem**

ACC/AHA 2014 Guidelines for Surgery in *Secondary* Mitral Regurgitation

<table>
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<th>Indication</th>
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<tr>
<td>Stage C and D Mitral Regurgitation, undergoing CABG or AVR</td>
<td>Ila</td>
<td>C</td>
</tr>
<tr>
<td>NYHA III/IV with Stage D Mitral Regurgitation</td>
<td>IIb</td>
<td>B</td>
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</table>

*Treat Heart Failure, Revascularize, Temper Expectations*

*But – Secondary mitral regurgitation represents the most prevalent form of severe MR, and this group has poorer overall outcomes.*  
*Underscores an unmet clinical need.*

Nishimura et al, ACC/AHA 2014 Valve Guidelines
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Percutaneous Strategies

Mitral Valve Repair

- MitraClip
- Annuloplasty

Mitral Valve Replacement
Percutaneous Strategies: MitraClip

Prolapsed Leaflet  Restricted Motion

EVEREST I and II  Surgical Candidates
COAPT  Symptomatic or Asymptomatic
RESHAPE-HF  MVR Indication

Compared to surgery, MitraClip had:
- Fewer adverse events (30-d)
- Comparable mortality
- Comparable symptomatic improvement
- Greater residual MR
- Higher rate of subsequent MV surgery (~20%)

The goal of any trial is simple – to live longer or better.

Surgical candidates (n = 279), with operative indication.
2:1 MitraClip:Surgery

Feldman and Young 2014, JACC

Feldman et al. 2011, 2015 NEJM; Feldman and Young 2014, JACC
MitraClip EVEREST II Trial

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If procedural outcomes and reduction in residual MR can be improved, might a percutaneous approach be preferred?

*Death, mitral valve surgery, 3-4+ mitral regurgitation

Feldman et al. 2015 NEJM
Surgical Therapies for Ischemic MR

Mitral-Valve Repair versus Replacement for Severe Ischemic Mitral Regurgitation

**Surgical Repair**
- Lower operative mortality*
- Lower 30-d rehosp

**Surgical Replacement**
- Less residual MR
- Less Reoperation*

Comparable NYHA, 12-mo Mortality

Ventricle continues to remodel, left ventricular function not routinely restored, and there is no mortality difference

MitraClip FDA Approved

The MitraClip Delivery System is indicated for the percutaneous reduction of significant symptomatic mitral regurgitation due to primary abnormality of the mitral apparatus (degenerative MR) in patients who are at prohibitive risk for mitral valve surgery.

What about Functional Mitral Regurgitation?

COAPT Trial
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## Percutaneous Strategies

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<tr>
<td>MitraClip</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Annuloplasty</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>Mitral Valve Replacement</td>
<td>+</td>
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Indirect Mitral Annuloplasty

Coronary Sinus Annuloplasty
- Carillon Device (Cardiac Dimensions)
- Delivered via jugular vein
- Anchors distal and ostial coronary sinus
- Reduces septal-lateral annulus dimension

Experience
- AMADEUS, TITAN Trials
- Functional Mitral Regurgitation
- Improves MR grade, NYHA class
- ~70% implant success
  - Compression of LCx
  - Unable to access CS
  - Insufficient MR reduction
- CE Mark Approved 2011

Direct Mitral Annuloplasty

Mitralign (Mitralign Inc)
- RFA-assisted puncture
- Place pledges, draw together

Accucinch (Guided Delivery Systems)
- Anchors below MV
- Nitinol wire to cinch

Cardioband (Valtech)
- Above MV
- Sequential Anchors
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Percutaneous Strategies

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<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Mitral Valve Replacement</td>
<td>+</td>
<td>+</td>
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Percutaneous Mitral Replacement

**Structural Considerations**
- Varied pathophysiological states
- Annulus size, 3-dimensional anatomy
- Subvalvular apparatus
- Ventricular size, geometry, function
- Dynamic pressure environment

**Technical Considerations**
- Securely fix prosthesis
- Avoid left ventricular outflow tract
- Avoid paravalvular leak
- Manage potential areas of stasis
- Implantation route and safety

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### Percutaneous Mitral Replacement

<table>
<thead>
<tr>
<th>Mitral Frame</th>
<th>Trileaflet</th>
<th>Approach</th>
<th>Delivery System</th>
<th>Acute Animal</th>
<th>Chronic Animal</th>
<th>First-In-Human</th>
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<tbody>
<tr>
<td>CardiaQ</td>
<td>+</td>
<td>T-aps/T-ap</td>
<td>32F</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Tiara</td>
<td>+</td>
<td>T-ap</td>
<td>32F</td>
<td>+</td>
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<tr>
<td>Tendyne</td>
<td>+</td>
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<td>+</td>
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</tr>
</tbody>
</table>

**Here, or coming soon:**
- Edwards: CardiaQ
- Neovasc: Tiara
- Abbott: Tendyne
- Medtronic: Intrepid/Twelve

De Backer et al. 2014, Circ Cardiovasc Interv
### Percutaneous Mitral Replacement

<table>
<thead>
<tr>
<th>Device</th>
<th>Delivery Method</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twelve (Medtronic)</td>
<td>TA delivery, Inner/Outer Stent, Repositionable</td>
<td></td>
</tr>
<tr>
<td>CardiaQ (Edwards)</td>
<td>TA, TF delivery, Supra-annular, Repositionable</td>
<td></td>
</tr>
<tr>
<td>Tendyne (Abbott)</td>
<td>TA delivery, Tethered to apex, Repositionable</td>
<td></td>
</tr>
<tr>
<td>Tiara (Neovasc)</td>
<td>TA delivery, Avoids LVOT, No anchoring</td>
<td></td>
</tr>
</tbody>
</table>

**Twelve (Medtronic)**
- 11 implanted
- 3 deaths

**CardiaQ (Edwards)**
- 9/11 implanted
- 2 proc mortality
- 30-d mort 6/11

**Tendyne (Abbott)**
- 10/10 implanted
- No deaths

**Tiara (Neovasc)**
- 9/11 implanted
- 2 emergent surgery
- 30-d mort 3/11
- 1 septum erosion

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### Image Descriptions

- **Twelve (Medtronic)**
- **CardiaQ (Edwards)**
- **Tendyne (Abbott)**
- **Tiara (Neovasc)**
Conclusions

• Percutaneous MV therapies are rapidly developing
• Heterogeneous population, different expectations
• High-risk surgical candidates have commercial percutaneous options
• Percutaneous strategies to date are not as effective as surgery
• Transcatheter mitral valve replacement is on the horizon

THANK YOU

Scott M Lilly MD PhD
Interventional Cardiology
The Ohio State University
scott.lilly@osumc.edu