Mitral Valve Surgery in the 21st Century

ANTICIPATED ADVANTAGES

- Decreased pain and overall trauma
- Less blood, eliminate sternal infections
- Decreased hospital stay / recovery time
- Better cosmetics and patient satisfaction

Minimally-invasive approaches originally received a lot of pushback, many surgeons felt they were being pushed out of their "comfort zone."

Minimally-invasive Mitral Valve surgery at NYU

- 1994: NYU and Stanford publish experimental work on "port access" with very encouraging results
- In the following years, NYU remained at the forefront of minimally-invasive mitral surgery
Mitral Valve Surgery in the 21st Century

Originally pure “Port Access”

1. Mini-thoracotomy
2. Peripheral or percutaneous bypass
3. Balloon endo-aortic occlusion
4. Percutaneous coronary sinus catheter

Obstacles to widespread adoption:

1. Too complex for great proportion of institutions
2. Learning curve – steep in some instances
3. Ancillary staff needs extra training
4. Relyed on retrograde arterial perfusion
5. Too expensive

Evolution of the NYU approach: 2000s

1. Conceptually simplify as much as possible
2. Limit robotics and endoscopes
3. Put operation totally in the hands of the surgeon using conventional tools under direct vision
4. Routine antegrade arterial perfusion
5. Cut costs and OR times
Set-up for Minimally-invasive direct MVsurgery

- Mini-thoracotomy (3rd or 4th interspace)
- Direct ascending aorta cannulation
- Femoral venous cannulation
- Direct external crossclamp
- Conventional retrograde cardioplegia
- CO2 field flooding

Minimally-invasive MV surgery at NYU – Procedures and techniques Initial Experience

Sternotomy vs Right Thoracotomy for MV surgery
Sternotomy vs Right Thoracotomy for MV surgery

No compromise in Repair Complexity

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Sternotomy N</th>
<th>Right Thoracotomy N</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior resection</td>
<td>380 (23.7%)</td>
<td>75 (14.2%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Any anterior leaflet procedure</td>
<td>493 (30.8%)</td>
<td>140 (26.4%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Annuloplasty device</td>
<td>1601 (100%)</td>
<td>1001 (100%)</td>
<td>NA</td>
</tr>
<tr>
<td>Posterior leaflet resection</td>
<td>1207 (75.4%)</td>
<td>385 (72.6%)</td>
<td>0.07</td>
</tr>
<tr>
<td>Sliding plasty</td>
<td>18 (1.1%)</td>
<td>5 (0.9%)</td>
<td>0.63</td>
</tr>
<tr>
<td>Folding plasty</td>
<td>588 (36.7%)</td>
<td>68 (12.8%)</td>
<td>&lt;0.002</td>
</tr>
</tbody>
</table>

Can complex mitral valve repair be performed with robotics?

- What is a complex repair?
- Can we perform complex repairs with robotics?
- What can we accomplish?

What makes MV repair difficult?

- Lack of leaflet tissue
- Bad quality of tissue
- The extent of lesions (number of segments involved)
- Limited exposure
- The type of techniques we use to treat the lesions:
  - Level I complexity
  - Level II complexity
  - Level III complexity
  - Level IV complexity
History: Robotics and the Mitral Valve – late 1990s

Robotics and the Mitral Valve – late 1990s
Technology not quite there
Lacking:
- exposure tools
- facilitating suture tech
- good results

Both groups stepped back from robotic mitrals
WR Chitwood – pursued with mini-thoracotomy
robotic assisted approach

2010 @ NYU
2 surgeons became colleagues

2012 started a team for total endoscopic robotic mitral program. For 3 months we re-trained with clinical scenarios, simulations, wet lab courses, & ‘expert’ observation.

We refused to compromise integral parts of operation:
Cardioplegic arrest
Use of annuloplasty device
Totally endoscopic robotic mitral repair (TERMVR): could not afford a significant learning curve – practice in the competitive environment of New York

- Training – Dedicated Team Commitment (Institutional)
- Team Participants – Communication – no music
- Process Control – Attention to detail
- Team Brief / Debrief Model

Totally Endoscopic Robotic Mitral Repair: TERMVR

- Training – Dedicated Team Commitment (Institutional)
- Team Participants – Communication – no music
- Process Control – Attention to detail
- Team Brief / Debrief Model

Mitral Valve Surgery in the 21st Century

Can complex mitral repair be performed using robotics? A universal approach for 500 patients

This reports our experience with 500 consecutive patients (May 2017 –August 2017) who had intent-to-treat totally endoscopic robotic mitral valve repair with a focus on complex MV pathologies, concomitant procedures, and analysis of patients not offered this approach.
Preop Evaluation

- Preop eval CTAC-A-P
- 8-12% change (minor/major) in monitoring/operative strategy
- 2.5 cm incision groin
- Seldinger technique and echocardiographic guidance for cannula and endo-balloon placement
- No fluoroscopy/x-ray used
- ITOclusive aortic disease – axillary perfusion

Current OR Plan

- Single lumen endotracheal tube (except reoperations, prior right chest surgery)
- Bilateral radial a-lines
- Right arm dropped below bed on floating board
- 2-3" egg crate foam under right hemithorax
- RIJ Triple lumen; if>1+AI – coronary sinus cardioplegia catheter; or at least 1x week

Port Placement

Working port and scope in same interspace (3rd)
XX-Small Alexis soft tissue retractor – have to force index finger thru to check interspaces

Left arm – 2nd
Right arm – 6th
Retractor arm – medial
Aortic Endoclamp

- Balloon-tipped catheter inserted via femoral artery and inflated 2cm above the sinotubular junction.
- Systemic perfusion of oxygenated blood with isolation of the heart from back-bleeding.

Fluorescence endoballoon guidance

Endoscopic robotic mitral repair in a patient with severe pectus excavatum
### Patient characteristics

<table>
<thead>
<tr>
<th>Age</th>
<th>60.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>314 (62.8%)</td>
</tr>
<tr>
<td>Women</td>
<td>186 (37.2%)</td>
</tr>
</tbody>
</table>

### Etiologies, MV Repair Techniques, and Concomitant Procedures

#### Etiologies

<table>
<thead>
<tr>
<th>Etiology</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barlow's</td>
<td>340</td>
<td>68</td>
</tr>
<tr>
<td>Fibroelastic deficiency</td>
<td>42</td>
<td>8.4</td>
</tr>
<tr>
<td>Functional</td>
<td>37</td>
<td>7.4</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>22</td>
<td>4.4</td>
</tr>
<tr>
<td>Healed endocarditis</td>
<td>17</td>
<td>3.4</td>
</tr>
<tr>
<td>Other</td>
<td>42</td>
<td>8.4</td>
</tr>
</tbody>
</table>

#### Repair Techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior leaflet</td>
<td>274</td>
<td>54.8</td>
</tr>
<tr>
<td>Bileaflet</td>
<td>79</td>
<td>15.8</td>
</tr>
<tr>
<td>MAC excision</td>
<td>61</td>
<td>12.2</td>
</tr>
<tr>
<td>Annuloplasty alone</td>
<td>55</td>
<td>1.0</td>
</tr>
<tr>
<td>Anterior leaflet</td>
<td>31</td>
<td>6.2</td>
</tr>
</tbody>
</table>

#### Concomitant Procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left appendage closure</td>
<td>474</td>
<td>94.8</td>
</tr>
<tr>
<td>PFO/ASD closure</td>
<td>98</td>
<td>19.6</td>
</tr>
<tr>
<td>Cryoablation</td>
<td>97</td>
<td>19.4</td>
</tr>
<tr>
<td>Hybrid PCI revascularization</td>
<td>39</td>
<td>7.8</td>
</tr>
<tr>
<td>Tricuspid repair</td>
<td>31</td>
<td>6.2</td>
</tr>
</tbody>
</table>

#### Posterior leaflet repair

- Triangular excision-suture: 194
- Quadrangular excision: 165
  - Hemisliding plasty: 165
  - Classic sliding plasty: 38
  - Folding plasty: 2
  - Annular plication: 5
  - P1-P2 or P2-P3 cleft closure: 124
- Bovine patch augmentation: 13

#### Posterior subvalvular repair

- Artificial chord implant: 67
- MAC excision: 61
- A-V groove patch repair: 19
### Robotic Mitral Repair (500 patients: May 2011 – August 2017)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior leaflet</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Triangular excision-suture</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Alfieri stitch</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Closure of an aberrant cleft</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Bovine patch augmentation</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Plication of the margin</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Anterior subvalvar</td>
<td>275</td>
<td></td>
</tr>
<tr>
<td>Secondary chordae division</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM repositioning</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Artificial chordae</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Chordal transfer</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Aberrant muscle band excision</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

### Combined procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA appendage closure</td>
<td>474</td>
<td>94.8</td>
</tr>
<tr>
<td>PFO or ASD closure</td>
<td>98</td>
<td>19.6</td>
</tr>
<tr>
<td>CryoMaze</td>
<td>97</td>
<td>19.4</td>
</tr>
<tr>
<td>Hybrid revascularization</td>
<td>39</td>
<td>7.8</td>
</tr>
<tr>
<td>Tricuspid annuloplasty</td>
<td>31</td>
<td>6.2</td>
</tr>
</tbody>
</table>

### Complexity Scores

- Complexity 1: 3%
- Complexity 2: 6%
- Complexity 3: 21%
- Complexity 4: 70%
Robotic Mitral Repair (500 patients: May 2011 – August 2017)

- Cross-clamp time for isolated MV repairs: 85 ± 28 minutes
- Conversion to sternotomy: 7/500 (1.4%)
- Extubation in OR: 320/500 (64%)
- Stroke rate: 6/500 (1.2%)
- 30-day mortality: 2/500 (0.4%)
- Complexity of repair had no effect on length of stay or residual MR

Post-operative echo showed mild residual regurgitation or less in 496/500 (99.2%)

47% patients discharged by POD 3

Repair rate in degenerative diseases: 100%
Conversion to sternotomy: 1.4%
OR extubation: 64%
30-day mortality: 0.4%
Mitral Valve Surgery in the 21st Century
Who did we not attempt with robotics?
(500 patients: May 201 – August 2017)

Which patients were not offered the robot approach in the past 3 years?

- 26/347 patients (7.5%) had isolated MV operations via sternotomy by our two robotic surgeons
- 15 had prior cardiac surgery, 12 had prior MV surgery
- Calcific stenosis or MAC present in 9 patients
Who did we not attempt with robotics?
3rd time cardiac operation for severe MR

Minimally Invasive Valve
(500 patients: May 2016 – August 2017)

Has been a 25 year journey…
• Basic approaches remain the same
• Changes in the technology along the way
• Benefit for out patients

THANK YOU