Minimally Invasive Mitral Valve Surgery: Crossing the Chasm

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DISCLOSURE

- Consultant for AtriCure
- Speaker for Edwards
- Research and educational grants over the last 2 years:
  - AtriCure
  - Edwards

Minimally Invasive Valve Surgery: Definition

- Valve repair or replacement performed without a full sternotomy.
Interventional Approaches to Valvular Heart Disease

Conventional Surgery
- Median Sternotomy

Minimally Invasive Surgery
- Partial Sternotomy
- Mini-thoracotomy
- Thoracoscopy
- Transcatheter

Why minimally invasive valve surgery?
- Our traditional operative approach is felt to be too invasive in certain patients both by cardiologists and the patients themselves.
  - asymptomatic
  - elderly, high risk

2014 AHA/ACC Guideline
A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

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**MITRAL VALVE REPAIR**

**Class IIa Indications**

- MV repair is reasonable in asymptomatic patients with chronic severe primary MR (stage C1) with preserved LV function (LVEF > 60% and LVESD < 40mm) in whom the likelihood of a successful and durable repair without residual MR is greater than 95% with an expected mortality rate of less than 1% when performed at a Heart Valve Center of Excellence. (Level of Evidence: B)

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Median sternotomy for mitral valve surgery

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Right Mini-thoracotomy for Mitral Valve Surgery
Why minimally invasive valve surgery?

- As long as clinical outcomes are at least equivalent to traditional surgery, there is a compelling advantage to minimally invasive approaches.

Minimally Invasive Mitral Valve Surgery

History

<table>
<thead>
<tr>
<th>Year</th>
<th>Author(s)</th>
<th>Details</th>
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<tbody>
<tr>
<td>1996</td>
<td>Carpentier</td>
<td>First video-assisted mitral valve repair</td>
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<tr>
<td>1997</td>
<td>Coggrove, Cohn</td>
<td>Limited sternotomy approaches</td>
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<tr>
<td>1997</td>
<td>Stanford Group</td>
<td>Port-access approaches introduced</td>
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<td>1997</td>
<td>Chitwood</td>
<td>Transsthoracic cross-clamp</td>
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<tr>
<td>1998</td>
<td>Molr</td>
<td>First video-assisted mitral valve repair with robotic assistance</td>
</tr>
<tr>
<td>1998</td>
<td>Carpentier</td>
<td>First completely robotically-assisted mitral valve repair</td>
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Minimally Invasive Valve Surgery: The introduction of two new technologies spurred surgical innovation

- Heartport™ system
  - Developed by the Stanford group in the mid 1990s
- Surgical robotic systems
  - Computer Motion
  - Intuitive Surgical
  - First clinical cases in 1998
Minimally Invasive Valve Surgery
Less Invasive Cardiopulmonary Bypass

Robotic Surgical System

Robotically-assisted Cardiac Surgery
My robotic experience:
- inanimate trainer - 11/96
- cadaver models - 2/97
- live animals - 4/97
- first case in Europe – 10/98
- first clinical robotic case in North America – 12/98
2/22/2016

Minimally Invasive Valve Surgery:
Reasons for slow adoption

- Where are we in 2016?
- Twenty years after the introduction of minimally invasive valve surgery, these techniques still remain confined to early adopters in the US and have not crossed over to the majority of cardiac surgeons.

The Chasm in Technology Adoption

Geoffrey Moore
Crossing the Chasm 1999
Minimally Invasive Valve Surgery: Factors that impeded widespread adoption

- The difficulty and complexity of the new instrumentation and procedures
- The high cost of robotic systems
- The lack of studies showing any benefit of minimally invasive approaches and the potential harm caused by the expensive ‘enabling’ technology
  - Port access surgery – higher incidence of stroke and aortic dissection
  - Robotic surgery – increased length of surgery

Minimally Invasive Valve Surgery: Our approach at Washington University

- Develop a cost-effective, simplified approach that can be easily adopted by all surgeons and easily taught to our fellows.
- Utilize existing techniques for less-invasive cardiopulmonary bypass that do not require expensive instrumentation and dedicated teams.
- Use low cost, reusable instrumentation that has been developed to facilitate MIS, as in other disciplines.
- Take advantage of superb visualization with high definition endoscopy.

How to Manage Difficulties in Minimally Invasive Mitral Valve Surgery; Femoral Cannulation: Imaging

- All patients over the age of 40 or who have risk factors for atherosclerotic disease undergo preoperative CT angiography of the aorta, iliac and femoral vessels with 3D reconstruction.
- In patients with severe vascular disease or small femoral vessels (<5mm), we favor a sternotomy approach or direct cannulation of the aorta via a larger thoracotomy.
Case Presentation:

- 53 y.o. woman with a history of mitral valve prolapse
- Several month history of dyspnea on exertion, NYHA class II
- Cardiac catheterization: normal coronaries

Case Presentation: Preoperative Echocardiogram
Case Presentation:
Preoperative 3D Echocardiogram

Minimally Invasive Mitral Valve Repair:
Posterior leaflet prolapse

Case Presentation:
Postoperative Echocardiogram
**Known advantages of minimally invasive mitral valve surgery**

- Cosmetically superior incision
- Quicker recovery – return to full activity in 2 weeks
- Lower wound infection rate

**A minimally invasive Cox maze IV procedure is as effective as sternotomy while decreasing major morbidity and hospital stay**

Christopher P. Leverano, MD, Matthew C. Ikuta, MD, Jacob R. Miller, MD, Laurie A. Sier, RN, BSN, Richard B. Schoeppel, MD, Herb S. Murrah, MD, and Ralph J. Dumiano, Jr., MD

Objective: The Cox maze IV procedure has been the standard of care for surgical intervention of atrial fibrillation. Minimally invasive mitral valve surgery has been traditionally performed through a minithoracotomy and mitral valve repair. We compared these approaches at a single center in consecutive patients.

Methods: Patients undergoing Cox maze IV procedure (n = 770) were prospectively enrolled from January 2002 to February 2014. Patients were stratified into 2 groups: right mini-thoracotomy (n = 366) and sternotomy (n = 404). Preoperative and postoperative variables were compared as well as long-term outcomes. Patients were followed up to 2 years and death was confirmed with an electronic computer or posthumous monitoring.

Results: Freedom from cardiovascular death and postoperative strokes was 74% and 90% at 1 and 2 years, respectively, using an RRT approach and was not significantly different from the ST group at these same time points. The overall complication rate was lower in the RRT group (22 vs. 17%, P = .065), as was 30-day mortality (0% vs. 4%, P = .35). Median length of stay in the intensive care unit was lower in the RRT group than in the ST group (2 days [IQR: 0–5] days vs 1 day [IQR: 1–5] days, P = .001) as was median hospital length of stay (7 days [IQR: 4–10] days vs 9 days [IQR: 6–13] days, P = .01).

Conclusions: The Cox maze IV procedure performed through a right mini-thoracotomy is an effective as sternotomy in the treatment of atrial fibrillation. This approach was associated with lower complications, decreased mortality, and decreased length of stay in the intensive care unit and hospital length of stay. J Thorac Cardiovasc Surg 2016;156:1150–52

**Results:**

- 356 consecutive patients between January 2002 – February 2014 were examined with data were collected prospectively and analyzed. All patients received a Cox maze IV procedure ± mitral valve procedure. 104 patients received a mini-thoracotomy, 252 underwent a sternotomy.
Sternotomy vs Mini-Thoracotomy Maze IV
Perioperative Outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mini (n=164)</th>
<th>Sternotomy (n=255)</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Operative time (min)</td>
<td>18.4±11</td>
<td>15.6±8.5</td>
<td>0.001</td>
</tr>
<tr>
<td>Major complications (%)</td>
<td>6 (10%)</td>
<td>15 (5.9%)</td>
<td>0.044</td>
</tr>
<tr>
<td>Median ICU LOS in days (range)</td>
<td>2 (0-13)</td>
<td>3 (1-14)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Median hospital LOS in days (range)</td>
<td>7 (4-35)</td>
<td>9 (3-111)</td>
<td>0.0001</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>0</td>
<td>1 (0.4%)</td>
<td>0.290</td>
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</table>

Minimally invasive approach provides at least equivalent results for surgical correction of mitral regurgitation: A propensity-matched comparison

Minimally Invasive versus Sternotomy Approach for Mitral Valve Repair

- 201 well matched pairs
- 99% repair rate in all patients, not influenced by approach
- Less transfusion in the minimally invasive group (14 vs 23%, p = 0.03)
- No difference in stroke, infection, MI, renal failure, AF or mortality rates between groups

A meta-analysis of minimally invasive versus conventional mitral valve repair for patients with degenerative mitral disease


More than 20,000 patients from 43 studies were examined.
Minimally Invasive Versus Conventional Valve Surgery

- No difference in mortality or stroke rates
- No difference in rate of reexploration for bleeding
- MI valve surgery had significantly longer cross clamp and pump times

Sündermann SH, et al.

Advantages of Minimally Invasive Mitral Valve Surgery

- Significantly less
  - Bleeding
  - Transfusion
  - ICU and hospital length of stay
  - Respirator dependance
  - Postoperative atrial fibrillation
  - Total hospital costs

Sündermann SH, et al.

Minimally Invasive Mitral Valve Repair: Conclusions

- The field of minimally invasive valve surgery has developed steadily over the last 20 years and is now set for crossing the chasm to widespread acceptance.
- There is ample evidence that minimally invasive have similar results as conventional approaches in terms of mortality and major complications with the advantages of less bleeding, shorter LOS and better patient acceptance.
Minimally Invasive Mitral Valve Repair: Conclusions

- The introduction of transcatheter valve technology will necessitate changes in our current surgical approach if we hope to continue to operate on a substantial number of patients.
- There are exciting new developments in minimally invasive techniques and technology that should allow for a further evolution of surgical procedures and continue to decrease the morbidity of valve surgery.

Thank you for your attention