Simplifying Techniques and Goals to allow for Less Invasive Surgery

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Disclosures

No Relevant Financial Disclosures
Clarifying and Simplifying

• **Program and Ramp up**
  • Training, “Heart Team” composition

• **Arterial Cannulation**
  • Femoral, Central Aortic, Axillary

• **Venous Cannulation**
  • Single Femoral vs. Bi-caval

• **Myocardial Management**
  • Antegrade only with Cross-clamp
  • Antegrade with Endoclamp/IntraClude
  • Retrograde (Endoplege/Endovent)
  • Fibrillatory Arrest
Technical Tips

- Team building and composition philosophy
  - Surgeons, anesthesia, RN/Tech, perfusion, single lung ventilation management
- Advancing your technique armamentarium
- Specific mitral tips/tricks
  - Exposure, retraction and using your “third” arm
  - Leaflet techniques, rigid rings, advancing pathology
Minimal Access or Robotic Mitral Repair is not “easier” to do than sternotomy

There is a Learning Curve even if you are an expert mitral surgeon. This is steeper than sternotomy and all non-mitral related

Best results with robotic mitral repair occur when you remain consistent with your open technique for mitral repair

It’s not about you, it’s always the team.
Robotic Program Development

• A single Cardiac Surgeon as Team Leader of Program
  • Dedicated Anesthesia and Perfusion teams for first 20 cases
• At least 120 career intra-cardiac non-AVR procedures, 60 over 2 years prior to robotics, and 25 of them should be isolated mitral repairs
• At least 80% repair rate in degenerative disease
• At least 15 cases of peripheral cardiopulmonary bypass over 2 years prior to commencing robotic (total of >30)
• Experience with open and minimally invasive Mitral, Tricuspid, and MAZE procedures
Robotic Program Development

- OR video/head-cam capabilities “smart room”
- Robotic training modules
- **Team training** – external or site-specific
- Cardiology team with imaging – Mitral Heart Team
- Structural heart experience with Imaging and CT mapping

- Maintenance of robotic program of at least 20 cases/year
Team Building Tips

• Pick your wing man carefully then stick with him/her for several cases if not all (PA, surgeon, fellow)
• Pick your scrub tech/RN and circulators carefully – knowledgeable about the products, instruments and ability to troubleshoot
• Perfusion tryouts – pick the ones with best mastery of the vacuum dial
• Anesthesia – slick and cool, particularly with innovation
• Team training and building – compartmentalize the case
• Make sure your partners and administration have your back and a supportive environment is created
WVU Robotic Mitral Program

- Two surgeons, both > 10 years mitral repair experience
- Minimally invasive thoracotomy or video-assisted experience > 10 years
- Transitioned from Sternotomy and Mini to Robotic in 2013. Now, robotic is standard approach for all isolated mitrals, mitral with concomitant surgical ablation for AF, stand-alone surgical ablation
- Excellent team – scrub, anesthesia, perfusion
- “All-comer” strategy without age limit depending on imaging and peripheral anatomy
Evolution of Perfusion Management in Minimally Invasive Mitral Operations

**ERA 1:** 1996 – 2000
Representing the developmental experience of new technology
- large cannulae, ‘heart-port’ platform
- learning phase of malperfusion, myocardial protection

**ERA 2:** 2000 – 2010
Case selection, technologic advancements
- early failures in femoral retrograde led to transition to central aortic
- registry and large series advocating for changing strategies
- development of image-guided triage

**ERA 3:** 2010 – present
Return to routine use of femoral perfusion, improved outcomes
- smaller cannulae, strategies to avoid malperfusion
- selective use of endoclamp technology
- routine image-guided case selection with expanding opportunities in complexity and advancing age

*Semin Thorac Cardiovasc Surg 2015;27:104-5*
1996-2000

Introduction of “heart-port” system with simultaneous new technologies
- 21-24 Fr femoral arterial cannula
- Balloon aortic occlusion to facilitate cardioplegic arrest
- Instrumentation, retractors, exposure devices
- Experience mixed – dedicated centers with good results but new series of complications
  - Vanerman, 75 pts, 2 aortic dissections (2.7%)
  - Mohr, 51 pts, 9.8% mortality, 3.9% aortic dissections

Semin Thorac Cardiovasc Surg 1999;11:223-34
2000-2010

Existing perfusion technology, wider adoption but limited reproducibility – leading to adaptations of technique

Applied to all patients - ages, case type, redo operations

*Grossi E, J Thorac Cardiovasc Surg 2012;143:68-70*
- 1282 patients over 12 years
- Stroke reduced from 4.7% to 1.2% with transition from retrograde endoballoon to antegrade crossclamp

*Murzi M, Eur J Cardiothorac Surg 2013;43;167-72*
- 1280 patients over 11 years
- Stroke difference from 5% to 1% and dissection from 1.7% to 0 between retrograde endoballoon to antegrade crossclamp
2004-2008

Femoral cannulation only a surrogate for Mini

5% did not actually have a mini

After excluding fibrillatory arrest, stroke rate was 1.52%
Evolution of Cannulation Techniques for Minimally Invasive Cardiac Surgery
A 10-Year Journey

Edward Y. Chan, MD, Dennis M. Lumbao, MBA, BA, Alexander Iribarne, MD, Rachel Easterwood, BA, Jonathan Y. Yang, MD, Faisal H. Cheema, MD, Craig R. Smith, MD, and Michael Argenziano, MD

Evolution of Cannulation Strategies

- Arterial:
  - Femoral (67%)
  - Central Aortic (83%)

- Venous:
  - Right IJ (78%)
  - Direct SVC (67%)
  - Femoral Dual Stage (52%)

- Aortic Occlusion:
  - Endoaortic Balloon (33%)
  - Transaxillary Clamp (92%)

Time (Minutes)

- Average CPB Time
- Average XC Time

. Cannulation timeline. CPB, cardiopulmonary bypass; SVC, superior vena cava; XC, cross-clamp.

Innovations 2012;7:9-14
2010-2015

Refinement of technology, case selection, echo, CT imaging, cardioplegia options, and cost all show improvement in reproducible outcomes.

Resurgence of the safety and routine efficacy of retrograde femoral perfusion facilitating expansion of complexity in experienced centers.

Endoclamp technology shown as non-inferior in experienced centers with refined case selection.
2010-2015

Femoral perfusion can be performed in mitral operations with < 2% stroke, 1-3% mortality

Suri RM, J Thorac Cardiovasc Surg 2011;142:970-79
Moodely S, J Thorac Cardiovasc Surg 2013;146:262-8
Ramzy D, J Thorac Cardiovasc Surg 2014;147;228-35
La Pietra A, J Thorac Cardiovasc Surg 2014;148:156-60
Ward AF, J Thorac Cardiovasc Surg 2014;148;769-72
Endo Clamp

PRO:

- limited incisions
- limited need for intra-thoracic dissection
- enhancing therapeutic options (i.e. redo)

CON:

- large bore femoral cannula (21-24Fr)
- vigilance of perfusion and anesthesia to avoid migration
- risk of complications over conventional options
- cost
Minimally Invasive Mitral Valve Surgery: Influence of Aortic Clamping Technique on Early Outcomes

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Port Access Cardiac Operations Can Be Safely Performed With Either Endoaortic Balloon or Chitwood Clamp

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Background. Minimally invasive, right thoracotomy (port access) approaches to intracardiac operations (mitral valve, tricuspid valve, atrial septal defect, intracardiac tumors) are becoming increasingly accepted by surgeons, cardiologists, and patients alike. Standard techniques for cardioplectic arrest of the heart have included endoaortic balloons and Chitwood clamps. Concerns have been raised regarding the potential increased risk of vascular adverse events (embolization, dissection, stroke, lower extremity ischemia) associated with endoaortic balloon occlusion. We undertook this study to evaluate the vascular risk associated with endoaortic balloon use.

Methods. All patients undergoing minimally invasive, port access, right thoracotomy operations from 1998 to 2012 at our institution were retrospectively analyzed. Patients undergoing aortic occlusion with the Chitwood clamp (n = 189) were compared with patients undergoing occlusion with the endoaortic balloon (n = 875).

Results. There was no statistical difference in the rate of dissection between patients undergoing aortic occlusion with an endoaortic balloon (1.03%) and those receiving a Chitwood clamp (1.06%). Similarly, there was no difference in the rate of type A dissection between aortic occlusion strategies (endoaortic balloon = 0.57%, n = 5, vs Chitwood clamp = 1.06%, n = 2, p = 0.28). No difference in the incidence of stroke was identified between the endoaortic balloon and the Chitwood clamp (2.2% vs 2.1%, p = 1.0).

Conclusions. Minimally invasive cardiac operations using a peripheral cannulation strategy can be safely performed with minimal vascular adverse events incorporating either endoaortic balloon or Chitwood clamp aortic occlusion. As experience with the endoaortic balloon is gained, the incidence of vascular adverse events can be reduced to nearly negligible rates.

Norman Shumway’s Seven Stages of an Idea

1. Initial stage: “Won’t work; been tried before.”

2. After successful experiments in animals: “Won’t translate to man.”

3. After 1 successful clinical patient: “Very lucky”

4. After 4 or 5 clinical successes: “Highly experimental, too risky, immoral, unethical; I understand they have had a number of deaths they are not reporting.”

5. After 10 to 15 patients: “May succeed occasionally in carefully selected cases.”

6. After a large series of successes: “So and so has been unable to duplicate their results. I hear that a number of their patients are having complications.”

7. Final stage: “This is a very fine contribution. A straightforward solution to a difficult problem. I predicted this”
Myocardial Protection

Essential to achieve complete and sustained RV unloading to avoid passive rewarming and RV dysfunction or low cardiac output syndrome.

Several experienced centers have adopted routine bi-caval drainage strategies.

Nifong, *J Thorac Cardiovasc Surg* 2005;129;1395-1404
Myocardial Protection

4:1 blood cardioplegia provides excellent protection, in similar fashion to open cases. Alternate techniques to minimize surgical interruption and prolong ischemic time:

- Custodial-HTK
- del Nido
- Fibrillatory arrest
Custodial-HTK

Custodial-histidine-tryptophan-ketoglutarate
(Brettschneider; Koehler Chemie, Alsbach-Haenlien, Germany)

- intracellular cardioplegic solution
- histidine, buffering acidosis
- tryptophan, membrane stabilizer
- ketoglutarate, Kreb’s cycle intermediary
- mannitol, minimize edema

- Up to 2 hours of ischemic time
- Cost per case $265-400 (including hemoconcentrator)

del Nido

- blood and Plasmalyte A mixed formula (1:4)
- blocks calcium flux into scavenges hydrogen ions, preserves high-energy phosphates, and promotes anaerobic glycolysis
- Includes lidocaine, magnesium sulphate, and mannitol
- Up to 90 minutes of ischemic time
- Cost per case $75 *(including hemoconcentrator)*

*4:1 Blood - $18 (if include ‘hot shot’ - $126)*
Minimally invasive mitral valve surgery without aortic cross-clamping and with femoral cannulation is not associated with increased risk of stroke compared with traditional mitral valve surgery: a propensity score-matched analysis†

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Abstract

OBJECTIVES: Open-heart surgery with fibrillatory arrest has been reported to be associated with an increased risk of stroke. We examined whether minimally invasive mitral valve surgery with fibrillatory arrest conferred a higher risk of stroke/transient ischaemic attack (TIA) and other major complications compared with median sternotomy and cardioplegic arrest.

METHODS: Data were collected prospectively for 387 patients who had mitral valve surgery; 239 had a minimally invasive surgical approach and 148 had median sternotomy. All minimally invasive surgeries were performed by surgeons who were experienced in minimally invasive techniques. The effect of operative approach on risk of stroke/TIA and major morbidity was examined. After propensity score matching (PSM) was conducted between the two groups, 76 patients remained in each group.

RESULTS: Before matching, the incidence of stroke/TIA did not differ between patients who had minimally invasive surgery (0.5%, n = 1) and those who had median sternotomy (1.4%, n = 2; P = 0.56). Patients who had minimally invasive surgery had a lower incidence of other major morbidity (0.8%, n = 2) than patients who had median sternotomy (6.1%, n = 9; P = 0.004). After adjustment for age and Society of Thoracic Surgeons predicted risk, there was no effect of operative approach on the odds for stroke/TIA (odds ratio [OR] = 0.41, P = 0.49) or other major morbidity (OR = 0.40, P = 0.31). After PSM, patients were balanced on preoperative characteristics. No patient in either matched group experienced permanent stroke/TIA, and major morbidity did not differ between the two groups (minimally invasive, 1.3%, n = 1; median sternotomy, 1.3%, n = 1; P > 0.99).

CONCLUSIONS: A minimally invasive approach for mitral valve surgery on a fibrillating heart was not associated with a greater incidence of stroke/TIA than was median sternotomy. When performed by highly experienced surgeons, the minimally invasive approach with fibrillatory arrest did not increase the risk of perioperative stroke.
WVU Protocol and Preparation

• Coronary angiography site avoid right femoral
• Preop planning with CT angiography and TEE
• Femoral size < 7 mm – graft or alternate cannulation, incorporate distal perfusion as routine
• Avoid moderate or greater Aortic Insufficiency
• Bi-caval venous – long dual stage or separate cannula
• Vacuum assist always, moderate hypothermia
• Antegrade 4:1 cardioplegia (can add retrograde if AI)
• Transthoracic cross-clamp
• Full bilateral ventilation when weaning from CPB
SVC drainage
5Fr x 10cm Micro-Introducer

25Fr Multi-stage Venous

15-17Fr Arterial

1/16th inch pressure tubing

IVC drainage
Isolated Mitral Valve Surgery

Robotic Mitral Valve Repair
Isolated Mitral Valve Surgery

Robotic Mitral Valve Repair
Isolated Mitral Valve Surgery

Robotic Mitral Valve Repair
Pathoanatomic Continuum of Primary MR
Image-Guided Preoperative Planning

- Good preoperative evaluation (TEE)
- Preoperative planning of the repair
- Understand the mechanism of MR as this invariably dictates the repair and enables avoidance of systolic anterior motion
- Objective for Anatomic Restoration
Team Approach for Quality Improvement

• Refinements in Anesthesia
  • Intra-thecal narcotics preoperatively
  • Surgical inter-costal nerve blockade
  • In-room extubation as a growing standard for all

• Perioperative Care Standardization
  • Out of bed to steps on POD 0
  • DC home target POD 3-4
Summary Tips

• Begin with Direct Vision, Videoscopic
  • At least 25 cases (or much more)
• Train your Team, Excellence Table Side
• Maintain the Open Surgical Standard
• TEAM APPROACH ESSENTIAL
  • Intraop Teams: Table side, Anesthesia, Perfusion
Experience in Complex Mitral Repair

Experience with Peripheral CPB (Mini Rt Thorac Mitral)

Excellence in Imaging (TEE, CT reconstruction)

Team Excellence (Anesthesia, Perfusion)

Successful Minimal Access Program