Robotic Cardiothoracic Surgery

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Evolution of minimally-invasive surgery

- Port access, avoid large incisions
- Technology enables complex operations despite limited access
Operation controlled by surgeon sitting at remote console

- “The robot” cannot perform any actions on its own
- Procedure entirely controlled by surgical team
Computer-driven motion control

- Surgeon’s hand movements replicated as precise movements of tiny instruments inside patient’s body
- Tremors filtered
- Robotic “wrists” greatly increase flexibility of motion compared with traditional shafted thoracoscopic instruments
Superior Vision

- 3D HD image
  - Depth perception
  - More intuitive than traditional 2D video

- Magnification (10x)
Robotic cardiothoracic surgery at Riverbend

- Intracardiac surgery
  - Mitral valve
  - Tricuspid valve
  - Intracardiac tumors
  - ASD repairs

- Robotically-assisted CABG
  - LIMA-LAD, small thoracotomy

- Pulmonary lobectomy
- Mediastinal mass resection
Robotic Mitral Valve Surgery

- Right chest access through small incisions
  - 8mm ports, 30mm working incision
- Femoral cannulation
- Lateral approach = excellent visualization/access
- Repair or Replacement
  - Resections
  - Artificial cords
  - Annuloplasty
  - Valve replacements
Robotic Mitral Surgery
Robotic Mitral Surgery
Video: Mitral valve repair
Video: Mitral valve replacement
Postop Mitral Repair

Totally Endoscopic Mitral Valve Repair VS Conventional Sternotomy
Cardiac Tumor resection

- R chest access via small incisions, No sternotomy
- RA or LA approachable
- Equivalent or improved visualization, depending on location of tumor.
- Standard surgical techniques to excise mass
Video: Cardiac Tumor resection
Minimally-invasive Thoracic Surgery

Posterolateral Thoracotomy

Video-Assisted Thoracoscopic (VATS) Lobectomy
- Port access; no rib retraction
- Procedure of choice at SHMC-RB for early stage lung cancer
  - ~70% of cancer resections
Minimally-invasive Surgery

**MAIN ADVANTAGE of VATS:**

- Less unnecessary trauma
  - Minimal muscle division
  - No rib retraction
  - LESS PAIN

**DISADVANTAGES**

- Perceived difficulty (limited maneuverability, no true depth perception, “hand/monitor” coordination)
- Safety concerns

**Recent CMS data:** <10% lobectomies performed with VATS
## Robotics to the rescue?

<table>
<thead>
<tr>
<th>VATS DISADVANTAGES</th>
<th>IMPACT OF ROBOTICS</th>
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<tr>
<td>Monocular vision (↓↓ depth perception)</td>
<td>3D HD vision = “natural” vision restored</td>
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<tr>
<td>Rigid “instruments on a stick” (↓↓ dexterity)</td>
<td>Articulated wrists = dexterity restored</td>
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<td>Limited tactile feedback</td>
<td>Essentially no tactile feedback</td>
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<tr>
<td>Safety concerns (bleeding, limited immediate access)</td>
<td>Primary surgeon at console</td>
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Video: Robotic Lobectomy
Robotic Thoracic Surgery OHVI

Potential advantages seem to outweigh disadvantages

- Build on VATS experience
- Future miniaturization
- Improvements in instrumentation: e.g. robotic staplers

Initial thoracic robotic case: Mediastinal mass resection

- Complete resection
- Discharged POD1
- Back to full-time employment

Anticipate initiation of robotic lobectomy program in near future
Outcomes

Ideally achieve results at least as good as open surgery

Must be as safe as traditional operations

Must offer some significant benefit over open surgery
Efficacy: Mitral repair

585 consecutive mitral procedures (26 concomitant TV repairs)

Successful repair >90%

Significant learning curve

- Year 1: 75%
- Year 2-6: >90%

Murphy, 2009
Efficacy: Cardiac Tumor Excision

52 consecutive patients

Successful robotic excision 100%

Mortality 0%

Murphy, 2009
Efficacy: ASD Repair

110 consecutive ASD repairs
- Secundum, primum, sinus venosus

Successful robotic repair 100%

Mortality 0%

Murphy, 2009
Efficacy: Robotic Lobectomy

- Initial experience at UAB (Cerfolio 2010): 82 patients
  - No prior large significant VATS experience

- Conversion for bleeding: 1 (0 PRBCs transfused)

- Mortality: 0

- Morbidity: 25%
  - Afib 5, prolonged air leak 5, chylothorax 2, reintubation, pulmonary edema, pneumothorax

  - Compare Thoracotomy: 38% (Allen 2006)
  - Compare VATS: 16% (McKenna 2006)
Safety: Intracardiac procedures

Retrospective series of >800 robotic intracardiac procedures

- Mortality 1%
- Major complication rate comparable to open procedures
  - Low CO, MI, Pacemaker, Stroke, Resp failure, ARF
- Bleeding (chest wall): 3%

At OHVI, anecdotally:

- less blood loss,
- less chest tube output

Murphy, 2009
Robotic experience at SHMC-RB

- Mitral Valve Repair 15
  - No mortality
  - 1 early failure due to postop MI

- Mitral Valve Replacement 2

- Cardiac myxoma 2

- CABG 31
  - 1 death due to dysrhythmia

- Mediastinal mass resection 1
Potential benefits of robotics for the patient

Precise control + excellent visualization
  - Closely replicate standard cardiac surgical techniques

Decreased wound infections

Reduced transfusions?

Avoidance of sternotomy → more rapid return to normal activities.
  - Functional recovery as soon as 3-4 weeks after surgery vs. 8-12 weeks
Summary 1: Robotic CT Surgery

For properly selected patients, results of robotic cardiothoracic procedures compare favorably with open operations.

Can be performed safely.

Steep learning curve for surgical team → mandates thoughtful, stepwise application of robotics.

Offers significant potential benefits:
- Less pain
- More rapid functional recovery
- Fewer transfusions
Summary 2: Robotic CT Surgery

- Mitral valve repair (degenerative, functional)
- Mitral valve replacement (rheumatic)
- Tricuspid valve repair
- ASD repair
- Cardiac tumor excision
- Maze procedure
- CABG (highly selected)
- Mediastinal mass resections
- Lung resections
Questions?