Robotic Thoracoscopic Lobectomy

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  - Educational and research grants from Olympus Medical Systems Corp.

- Consultant
  - Olympus America Inc.
  - Intuitive Surgical Inc.
  - Covidien
  - Johnson and Johnson

- Research Collaboration
  - Siemens
  - Novadaq Corp.

Source: Intuitive Surgical
da Vinci Surgical Systems – Canada 1999 - 2013

Source: Intuitive Surgical
da Vinci Surgical Systems – Global

Source: Intuitive Surgical
Robotic Platforms

• “standard” da Vinci – 1999
  • Surgeon’s console
  • Patient Cart
  • Vision Cart

• da Vinci S – 2006
  • Tile Pro function
  • Docking improvements
  • Reduced footprint of patient cart

• da Vinci Si – 2009
  • Camera improvements
  • HD optics
  • Customizable console
  • Finger clutching
da Vinci Robotic Lobectomy
Robotic Lobectomy – Approach (R Lung ca)
Robotic Surgery – Approach (L Lung ca)
Robotic Lobectomy – Oncologic results

• Multi-institutional retrospective review (n=325)
  • Majority clinical stage I (IA, 247; IB, 63)
  • Conversion rate: 8% (27/325)
  • Morbidity 25.2% (82/325)
  • Mortality 0.3% (1/325)
  • Major complication rate 3.7% (12/325)
  • p stage: IA, 54%, IB, 22%, IIA, 13%, IIB, 5%, IIIA, 6%

• Overall 5 year survival 80% (CI 73-88)
  • IA 91%, IB 88%, II 49%

Robotic Lobectomy – Comparison to open

• Single institution experience
  • Completely portal 4-arm robotic operation (CPRL-4) (n=168)

• CPRL-4 (n=106) vs Thoracotomy (n=318)
  • Propensity-matched comparison
  • Morbidity (27% vs 38%, p=0.05)
  • Mortality (0% vs 3.1%, p=0.11)
  • Mental QOL (53 vs 40, p<0.001)
  • Hospital stay (2.0 vs 4.0 days, p=0.02)

Increasing number of Robotic lobectomy

- Open vs VATS vs Robotic: Review of National Database
  - Comparison using State Inpatient Databases (2008-2010)
  - Propensity-matched analysis for comparison of outcomes

- Results
  - 33,095 pts (Open: 20,238; VATS: 12,427; Robotic: 430)
  - Case volumes for robotic increased from 0.2% to 3.4%

Increasing number of Robotic lobectomy

• Open vs VATS vs Robotic: Review of National Database
  • Robotic vs Open
  • Significant reduction in mortality, LOS, overall survival
  • Robotic vs VATS
  • Reduction in mortality, LOS, overall complication rates but not statistically significant

Table 4. Propensity-Matched Analysis of Patients Undergoing Open, Video-Assisted Thoracic Surgery (VATS) or Robotic Pulmonary Resection

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Open (n = 1,233)</th>
<th>VATS (n = 1,233)</th>
<th>Robotic (n = 411)</th>
<th>$p$ Value$^a$</th>
<th>$p$ Value$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>25 (2.0%)</td>
<td>14 (1.1%)</td>
<td>1 (0.2%)</td>
<td>0.122</td>
<td>0.016</td>
</tr>
<tr>
<td>LOS (mean)</td>
<td>8.2</td>
<td>6.3</td>
<td>5.9</td>
<td>0.454</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Routine discharge</td>
<td>734 (59.5%)</td>
<td>795 (64.5%)</td>
<td>262 (63.7%)</td>
<td>0.828</td>
<td>0.214</td>
</tr>
<tr>
<td>Prolonged LOS</td>
<td>118 (9.6%)</td>
<td>85 (6.9%)</td>
<td>18 (4.4%)</td>
<td>0.118</td>
<td>0.003</td>
</tr>
<tr>
<td>Any complication</td>
<td>667 (54.1%)</td>
<td>558 (45.3%)</td>
<td>180 (43.8%)</td>
<td>0.674</td>
<td>0.003</td>
</tr>
<tr>
<td>Bleeding complication</td>
<td>24 (1.9%)</td>
<td>16 (1.3%)</td>
<td>7 (1.7%)</td>
<td>0.633</td>
<td>0.795</td>
</tr>
</tbody>
</table>

$^a$ Between robot and VATS resections.  $^b$ Between robot and open resections.

Learning Curve

- Learning is more rapid with Robotic compared to VATS surgery

Table: Number of operations required to achieve proficiency with VATS lobectomy and robotic lobectomy

<table>
<thead>
<tr>
<th>Study</th>
<th>Ref. no.</th>
<th>Year</th>
<th>Lung operation</th>
<th>No. of operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gharagozloo et al.</td>
<td>[16]</td>
<td>2009</td>
<td>Robotic lobectomy</td>
<td>20</td>
</tr>
<tr>
<td>Veronesi et al.</td>
<td>[38*]</td>
<td>2010</td>
<td>Robotic lobectomy</td>
<td>18</td>
</tr>
<tr>
<td>Louie et al.</td>
<td>[27**]</td>
<td>2012</td>
<td>Robotic lobectomy</td>
<td>6</td>
</tr>
<tr>
<td>Lee et al.</td>
<td>[41]</td>
<td>2009</td>
<td>VATS lobectomy</td>
<td>30–50</td>
</tr>
<tr>
<td>Belgers et al.</td>
<td>[42]</td>
<td>2010</td>
<td>VATS lobectomy</td>
<td>25–30</td>
</tr>
<tr>
<td>Petersen and Hansen</td>
<td>[43]</td>
<td>2010</td>
<td>VATS lobectomy</td>
<td>50</td>
</tr>
</tbody>
</table>

VATS, video-assisted thoracic surgery.

Robotics: Higher Costs and operating time?

- Comparison of Robotic vs VATS lobectomy/wedge resection (Multihospital database)
  - Robotic is associated with higher hospital costs and longer OR time without any differences in adverse events

<table>
<thead>
<tr>
<th></th>
<th>Lobectomy</th>
<th></th>
<th></th>
<th>Wedge resection</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RATS</td>
<td>VATS</td>
<td>P value</td>
<td>RATS</td>
<td>VATS</td>
<td>P value</td>
</tr>
<tr>
<td><strong>Length of stay (d)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4</td>
<td>4</td>
<td></td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>6.07</td>
<td>5.83</td>
<td>.6131</td>
<td>5.23</td>
<td>5.38</td>
<td>.7188</td>
</tr>
<tr>
<td>SD</td>
<td>6.44</td>
<td>5.03</td>
<td></td>
<td>5.18</td>
<td>5.27</td>
<td></td>
</tr>
<tr>
<td><strong>Total hospital costs ($)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>21,833.34</td>
<td>18,080.11</td>
<td></td>
<td>17,341.33</td>
<td>13,640.52</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>25,040.70</td>
<td>20,476.58</td>
<td>&lt;.0001</td>
<td>19,592.42</td>
<td>16,600.13</td>
<td>.0001</td>
</tr>
<tr>
<td>SD</td>
<td>13,164.01</td>
<td>10,977.67</td>
<td></td>
<td>9,293.64</td>
<td>10,367.82</td>
<td></td>
</tr>
<tr>
<td><strong>Operating room time (h)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4.25</td>
<td>4</td>
<td></td>
<td>2.93</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.49</td>
<td>4.23</td>
<td>.0959</td>
<td>3.26</td>
<td>2.86</td>
<td>.0003</td>
</tr>
<tr>
<td>SD</td>
<td>1.98</td>
<td>1.73</td>
<td></td>
<td>1.41</td>
<td>1.31</td>
<td></td>
</tr>
</tbody>
</table>

Robotic Surgery - advantages

- 3D, HD vision
- 10x magnification
- Motion scaling
  - Tremor filtration
- Improved surgeon ergonomics
- Increased dexterity & precisio
Robotic Surgery - disadvantages

• Lack of haptic/tactile feedback
  • interface with new surgical platform

• Surgeon in non-sterile field
  • reliance on bedside assistant
  • training issues

• Docking and OR setup time

• Cost $$$
Robotic Lobectomy

• Robotic lung cancer resection offer comparable radicality and safety to VATS and open surgery

• Intuitive movements, greater flexibility and 3D, high definition vision allow surgeons to perform surgery easier with shorter learning curve than VATS

• High capital and running costs, limited instrument availability and long OR times are important disadvantages
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University Health Network

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Thank you