Session 1: Thoracoscopic Lobectomy
State of the Art

Shanda H. Blackmon, M.D., M.P.H., FACS

Duke Masters of Minimally Invasive Surgery Meeting 2014
Disclosure

• I have no Disclosures
Thoracoscopic Lobectomy: State of the Art

What does that mean?

• The term "state of the art" refers to the highest level of general development, as of a device, technique, or scientific field achieved at a particular time.

• It also refers to the level of development reached at any particular time as a result of the common methodologies employed.

• State of the Art” is often used to convey that a product is made with the best possible technology…
Thoracoscopic Lobectomy: State of the Art

• The cornerstone of therapy for early-stage lung cancer is anatomic individual vessel ligation and division by surgical lobectomy with concomitant removal of the draining nodal basin.

• This includes:
  • Camera visualization of the dissection
  • No rib spreading
  • No serratus or latissimus muscle cutting
Thoracoscopic Lobectomy: State of the Art

• Surgeons have successfully performed thoracoscopic lobectomy for more than 2 decades, with such technology disseminating throughout the thoracic surgical community establishing it as a standard for the management of early-stage non-small cell lung cancer (NSCLC)
If there were a standardized approach, what would it be?

VATS R side

- Trachea
- Esophagus
- Azygos vein
- Left bronchus
- Right bronchus
- Pulmonary artery

Blackmon/de la Flor © 2013
VATS RUL

Posterior ascending artery
Superior segmental artery
RUL
RML
RLL
PV
PA
TA
Heart
Phrenic nerve
Pulmonary vein dissection
Caudal
Cranial

Blackmon/de la Flor © 2013

©2014 MFMER | slide-7
VATS RUL
VATS RML

- Middle lobe bronchus
- Middle lobe artery
- Middle lobe vein
- RML
- RUL
- PV
- PA
- TA
- Heart
- Phrenic nerve
- Caudal
- Cranial
- Middle lobe vein dissection
- Medial
VATS RML

Middle lobe bronchus dissection

RUL

RML

RLL

PV

PA

TA

Heart

Caudal

Cranial

Medial

Blackmon/de la Flor © 2013
VATS RML

Middle lobe artery dissection

Caudal

Cranial

Medial

RUL

RLL

PV

PA

TA

Heart

Blackmon/de la Flor © 2013

©2014 MFMER | slide-12
VATS RLL
VATYS RLL
VATS RLL
VATS RLL alternative approach

Pulmonary artery to right lower lobe dissected

RUL

RML

RLL

PA

Blackmon/de la Flor © 2013
VATS RLL alternative approach
VATS LUL

- Anterior axillary line
- Posterior axillary line
- Utility port (4cm)
- Camera port (1cm)
- Optional port (1cm)

- Upper lobe bronchus
- Inferior pulmonary vein
- Superior pulmonary vein dissected
- Phrenic nerve
- PA
- Heart
- Cranial
- Caudal
- Antero-medial
- Postero-lateral

Blackmon/de la Flor © 2013
VATS LUL
VATS LUL

- Upper lobe bronchus dissection
- Cranial
- Postero-lateral
- Caudal
- Antero-medial
VATS LLL
Thoracoscopic Lobectomy: State of the Art

Thoracoscopic lung resection can be performed safely in selected patients aged 80 years and older, in those with marginal pulmonary function, and in those with pathologic response to neoadjuvant therapy.

**Table:**

<table>
<thead>
<tr>
<th>1ST Author</th>
<th>#</th>
<th>Year</th>
<th>Patient Group</th>
<th>Procedure Performed</th>
<th>Conversion, %</th>
<th>LOS, Med/mean</th>
<th>Peri-op morbidity, %</th>
<th>Peri-op Mortality, %</th>
<th>Survival, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>McKenna</td>
<td>1100</td>
<td>2006</td>
<td>Stage I-III NSCLC</td>
<td>Lobectomy</td>
<td>2.5</td>
<td>4.8</td>
<td>15</td>
<td>0.8</td>
<td>5Y: 1A=84.5; 1B=70.5; 2A=13.5; 2B 14; 3A=27.5</td>
</tr>
<tr>
<td>Onaitis</td>
<td>500</td>
<td>2006</td>
<td>Benign + NSCLC</td>
<td>Lobectomy</td>
<td>1.6</td>
<td>3</td>
<td>NR</td>
<td>1.0</td>
<td>2Y:80</td>
</tr>
<tr>
<td>Yim</td>
<td>214</td>
<td>1998</td>
<td>Benign + NSCLC</td>
<td>Lobectomy +</td>
<td>0.9</td>
<td>6.8/NR</td>
<td>22</td>
<td>0.5</td>
<td>23 mo = 93</td>
</tr>
<tr>
<td>Kaseda</td>
<td>204</td>
<td>2000</td>
<td>Benign + NSCLC</td>
<td>Lobectomy +</td>
<td>1.5</td>
<td>NR/NR</td>
<td>2.3</td>
<td>0.8</td>
<td>5Y stage I = 97</td>
</tr>
<tr>
<td>Roviaro</td>
<td>171</td>
<td>2003</td>
<td>cIa NSCLC</td>
<td>Lobectomy +</td>
<td>5.3</td>
<td>NR/NR</td>
<td>8.7</td>
<td>0.6</td>
<td>3 y = 77; 5Y = 63.6</td>
</tr>
<tr>
<td>Walker</td>
<td>159</td>
<td>2003</td>
<td>Stage I, II NSCLC</td>
<td>Lobectomy, Lingulectomy</td>
<td>11.2</td>
<td>NR/6</td>
<td>NR</td>
<td>1.8</td>
<td>Stage I = 77.9; stage II = 51</td>
</tr>
<tr>
<td>Iwasaki</td>
<td>140</td>
<td>2004</td>
<td>Stage IA NSCLC</td>
<td>Lobectomy + Segment</td>
<td>2.1</td>
<td>NR</td>
<td>NR</td>
<td>0</td>
<td>5y = 70</td>
</tr>
<tr>
<td>Swanson</td>
<td>128</td>
<td>2002</td>
<td>Benign + NSCLC</td>
<td>Lobectomy</td>
<td>13</td>
<td>3</td>
<td>8.2</td>
<td>2.1</td>
<td>NR</td>
</tr>
<tr>
<td>Daniels</td>
<td>110</td>
<td>2002</td>
<td>Benign + NSCLC</td>
<td>Lobectomy</td>
<td>1.8</td>
<td>NR/3</td>
<td>19</td>
<td>3.6</td>
<td>NR</td>
</tr>
<tr>
<td>Ohtsuka</td>
<td>106</td>
<td>2004</td>
<td>Stage I NSCLC</td>
<td>Lobectomy +</td>
<td>10</td>
<td>7.6</td>
<td>NR</td>
<td>0.9</td>
<td>3y = 79</td>
</tr>
<tr>
<td>Solaini</td>
<td>105</td>
<td>2001</td>
<td>Benign + NSCLC</td>
<td>Lobectomy +</td>
<td>5.7</td>
<td>6.2/NR</td>
<td>12</td>
<td>NR</td>
<td>3y = 85</td>
</tr>
<tr>
<td>Sugi</td>
<td>100</td>
<td>2000</td>
<td>Stage IA NSCLC</td>
<td>Lobectomy</td>
<td>4.2</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>5y = 90</td>
</tr>
<tr>
<td>Shiraishi</td>
<td>95</td>
<td>2006</td>
<td>T1 N0 Mo NSCLC</td>
<td>Lobectomy</td>
<td>14/95</td>
<td>NR</td>
<td>NR</td>
<td>0</td>
<td>5y = 89</td>
</tr>
<tr>
<td>Kirby</td>
<td>61</td>
<td>1995</td>
<td>Stage I NSCLC (6 excluded)</td>
<td>Lobectomy</td>
<td>10</td>
<td>7.1</td>
<td>6</td>
<td>0</td>
<td>NR</td>
</tr>
<tr>
<td>Whitson</td>
<td>59</td>
<td>2007</td>
<td>Stage I NSCLC</td>
<td>Lobectomy</td>
<td>11/70</td>
<td>6.4/NR</td>
<td>NR</td>
<td>NR</td>
<td>4y = 72</td>
</tr>
<tr>
<td>Total</td>
<td>3,252</td>
<td>98-07</td>
<td></td>
<td></td>
<td>0.9-15%</td>
<td>3-6.8d</td>
<td>2.3-22%</td>
<td>0-3.6</td>
<td>5Y average =</td>
</tr>
</tbody>
</table>

Thoracoscopic Lobectomy: State of the Art
The New Gold Standard

- Thoracoscopic lobectomy is performed with increasing frequency for early-stage lung cancer.
- Thoracoscopic lobectomy is now clearly supported by evidence-based treatment guidelines [4]
  - 3 of the 4 published RCT of VATS lobectomy versus open lobectomy demonstrated an advantage in the VATS group [5-8].

Thoracoscopic Lobectomy: State of the Art
The New Gold Standard

• Some of the advantages of VATS lobectomy compared to thoracotomy include:
  • less postoperative pain [9-11]
  • less blood loss [5, 8, 10, 12]
  • improved inflammatory response [13]
  • shorter chest tube duration [9, 10, 13-15]
  • improved post-operative independence [14]
  • better pulmonary function [16-19]
  • comparable operative times [9, 13, 14, 20]
  • shorter hospitalization [2, 3, 5, 13-15, 21-24]
  • more cost-effective [16]
  • improved delivery of adjuvant chemotherapy to eligible patients [15, 17]

*Please see references at end of talk for notation…
Thoracoscopic Lobectomy: State of the Art
The New Gold Standard

- A recent assessment of morbidity and mortality after thoracoscopic lobectomy demonstrated improved results for many additional outcomes [18, 20, 25-30].

Thoracoscopic Lobectomy: State of the Art
The New Gold Standard

• Despite the many published advantages, thoracoscopic lobectomy is underutilized.

• Analyzing the board-certified thoracic surgeons participating in the General Thoracic Surgery component of the Society of Thoracic Surgeons database from 1999 to 2006
  • only 20% of all lobectomies for NSCLC were thoracoscopically performed [31].

Thoracoscopic Lobectomy: State of the Art
The New Gold Standard

• In light of these advantages and with evidence of oncologic equivalence, thoracoscopic lobectomy is considered a gold standard for the treatment of early-stage lung cancer
VATS Lobectomy
Instrumentation has improved
Thoracoscopic Lobectomy: State of the Art
3-D Imaging; is it better?

• Robotic proponents often advocated the 3-d visualization is what made robotic surgery better;
  • Well, now it is available for VATS

• There are currently 2 systems available:
  • Storz
  • Olympus
Thoracoscopic Lobectomy: State of the Art
Expanding the Horizon…

• Chest wall resection
• Pneumonectomy
• Bronchoplasty
• Segmentectomy
• Bronchiectasis
VATS Consensus Statement
Worldwide Expert Opinion

Indications for VATS lobectomy
- ≤7 cm (T1, T2a and T2b)
- N0 or N1 status

Contraindications for VATS lobectomy
- Chest wall involvement including rib(s)
- Centrality of tumour if invading hilar structure(s)
- Previous thoracic surgery or pleurisy is not a contraindication
- FEV1 <30%
- DLCO <30%

Preoperative Investigations
- PET/CT and sampling of positive mediastinal lymph nodes
- Sampling of positive lymph nodes by EBUS/EUS
- VATS assessment at the time of surgery
- Total ipsilateral lymph node dissection in all patients

VATS Consensus Statement
Worldwide Expert Opinion

Future directions

- Establishment of multi-institutional database  
  Recommended
- Increased exposure of VATS lobectomy to trainees  
  Highly recommended
- Establishment of standardized VATS lobectomy workshops  
  Highly recommended

VATS Consensus Statement
Worldwide Expert Opinion

Indications for conversion to open thoracotomy

- Major bleeding: Highly recommended
- Significant chest wall involvement: Recommended
- Vascular sleeve: Highly recommended
- Bronchial sleeve: Highly recommended
- Broncho-vascular sleeve: Highly recommended

Training

- Number of cases to overcome steep learning curve: 50
- Resident case volume of a training centre: >50/year
- Minimum case volume to maintain VATS skills: >20/year
- Proctoring should be necessary in all new VATS surgeons

Interesting Cases

- **Subxiphoid Single-Incision Thoracoscopic Left Upper Lobectomy**

*Available online 23 August 2014*
Chia-Chuan Liu, Bing-Yen Wang, Chih-Shiun Shih, Yun-Hen Liu JTCVS
Interesting Cases

• # tumor cells in PV

Yao X, Williamson C, Adalsteinsson VA et al. Tumor cells are dislodged into the pulmonary vein during lobectomy. JTCVS 20142014 Jul 23 Epub ahead of print
Interesting Cases
New Devices: energy

• Forty-nine PA branches were sealed in 14 patients.
• The mean PA branch diameter was 7.4 mm (1.8-14.5 mm).
• Ten patients had normal PA pressure and 3 had PA hypertension

Interesting Cases
New Devices: energy

• The mean bursting pressure in each was as follows:

<table>
<thead>
<tr>
<th>Device</th>
<th>Mean bursting pressures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonic Ace group</td>
<td>415.5 mm Hg (137.1-1388.4 mm Hg),</td>
</tr>
<tr>
<td>Thunderbeat group</td>
<td>875 mm Hg (237.1-2871.3 mm Hg)</td>
</tr>
<tr>
<td>LigaSure group</td>
<td>214.7 mm Hg (0-579.6 mm Hg)</td>
</tr>
<tr>
<td>Enseal group</td>
<td>133.7 mm Hg (0-315.38 mm Hg)</td>
</tr>
</tbody>
</table>

Interesting Cases
New Devices: energy

• There were 2 complete sealing failures:
  • LigaSure (diameter 6.78 mm)
  • Enseal (diameter 8.3 mm)

Interesting Cases
New Devices: energy

- Forty-nine PA branches were sealed in 14 patients.
- The mean PA branch diameter was 7.4 mm (1.8-14.5 mm).
- In this pilot study to examine energy sealing of PA branches in a simulated ex vivo model, vascular sealing using energy was effective and was able to sustain high intraluminal bursting pressures.
- Further research is needed to determine the in vivo and long-term safety of PA branch energy sealing.

VATS Lobectomy
What about the robot?

• VATS is the least expensive surgical approach
• Robotic cases must be shorter in operative time or reduce supply costs, or both, to be competitive
• Lessening operating time, eradicating unnecessary laboratory work, and minimizing intensive care unit stays will help decrease direct hospital costs

Questions & Discussion
VATS Lobectomy
What about ROL?

VATS ROL References


VATS ROL References


VATS ROL References


VATS ROL References


VATS ROL References


VATS ROL References


VATS Consensus Statement

<table>
<thead>
<tr>
<th>Indications and contraindications for VATS lobectomy</th>
<th>Number of respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T status for tumour</strong></td>
<td></td>
</tr>
<tr>
<td>≤5 cm (T1 and T2a)</td>
<td>16 (32)</td>
</tr>
<tr>
<td>≤7 cm (T1, T2a and T2b)</td>
<td>31 (64)</td>
</tr>
<tr>
<td>None of above</td>
<td>3 (6)</td>
</tr>
<tr>
<td><strong>N status for tumour</strong></td>
<td></td>
</tr>
<tr>
<td>N0 only</td>
<td>1 (2)</td>
</tr>
<tr>
<td>N0 + N1</td>
<td>28 (56)</td>
</tr>
<tr>
<td>N0 + N1 + N2</td>
<td>21 (42)</td>
</tr>
<tr>
<td><strong>Chest wall involvement is</strong></td>
<td></td>
</tr>
<tr>
<td>A contraindication if involving parietal pleura</td>
<td>3 (6)</td>
</tr>
<tr>
<td>A contraindication if involving rib(s)</td>
<td>31 (62)</td>
</tr>
<tr>
<td>Not a contraindication for VATS lobectomy</td>
<td>16 (32)</td>
</tr>
</tbody>
</table>

## VATS Consensus Statement

Indications and contraindications for VATS lobectomy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centrality of tumour is</strong></td>
<td></td>
</tr>
<tr>
<td>An absolute contraindication if invading hilar structure(s)</td>
<td>12 (24)</td>
</tr>
<tr>
<td>A relative contraindication if invading hilar structure(s)</td>
<td>32 (64)</td>
</tr>
<tr>
<td>Not a contraindication</td>
<td>6 (12)</td>
</tr>
<tr>
<td><strong>Previous thoracic surgery/pleurisy is</strong></td>
<td></td>
</tr>
<tr>
<td>An absolute contraindication</td>
<td>0</td>
</tr>
<tr>
<td>A relative contraindication</td>
<td>10 (20)</td>
</tr>
<tr>
<td>Not a contraindication</td>
<td>40 (80)</td>
</tr>
</tbody>
</table>

## VATS Consensus Statement

### Indications and contraindications for VATS lobectomy

<table>
<thead>
<tr>
<th>FEV1 Predicted (%)</th>
<th>Number of Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;80%</td>
<td>0</td>
</tr>
<tr>
<td>&lt;70%</td>
<td>1 (2)</td>
</tr>
<tr>
<td>&lt;60%</td>
<td>0</td>
</tr>
<tr>
<td>&lt;50%</td>
<td>5 (10)</td>
</tr>
<tr>
<td>&lt;40%</td>
<td>6 (12)</td>
</tr>
<tr>
<td>&lt;30%</td>
<td>38 (76)</td>
</tr>
</tbody>
</table>

VATS lobectomy is contraindicated if DLCO is

<table>
<thead>
<tr>
<th>DLCO Predicted (%)</th>
<th>Number of Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;80%</td>
<td>0</td>
</tr>
<tr>
<td>&lt;70%</td>
<td>0</td>
</tr>
<tr>
<td>&lt;60%</td>
<td>0</td>
</tr>
<tr>
<td>&lt;50%</td>
<td>8 (16)</td>
</tr>
<tr>
<td>&lt;40%</td>
<td>10 (20)</td>
</tr>
<tr>
<td>&lt;30%</td>
<td>32 (64)</td>
</tr>
</tbody>
</table>

---

VATS Consensus Statement

VATS Consensus Statement