VATS Sleeve Lobectomy and Pneumonectomy

Todd L. Demmy
Disclosures/
Questions
Objectives

- **Sleeve Resections**
  - Hybrid
  - Complete VATS (Robotic)
- **Pneumonectomy**
  - Technique updates
  - Outcomes updates
## Hybrid VATS Sleeve

<table>
<thead>
<tr>
<th>Ref</th>
<th>N</th>
<th>Deaths</th>
<th>Complications</th>
<th>EBL (ml)</th>
<th>Time</th>
<th>HospStay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santambrogio, 2002</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Okada, 2005</td>
<td>34</td>
<td>1</td>
<td>?</td>
<td>166</td>
<td>164</td>
<td>?</td>
</tr>
<tr>
<td>He, 2007</td>
<td>109</td>
<td>0</td>
<td>0</td>
<td>320</td>
<td>150</td>
<td>9</td>
</tr>
<tr>
<td>Pettiford, 2010</td>
<td>12</td>
<td>0</td>
<td>4</td>
<td>?</td>
<td>123</td>
<td>9.5</td>
</tr>
<tr>
<td>Yen, 2010</td>
<td>1</td>
<td>0</td>
<td>trach</td>
<td>?</td>
<td>37</td>
<td>?</td>
</tr>
<tr>
<td>He, 2011</td>
<td>148</td>
<td>0</td>
<td>12/146</td>
<td>185</td>
<td>190</td>
<td>6</td>
</tr>
</tbody>
</table>
Hybrid L VATS Sleeve Pneumonectomy -1 (Right Thor)

- R Thor for sleeve
  - left main stem bronchus sewn closed
- L VATS to remove lung
  - three 1.2-cm incisions
  - one 4.5-cm incision
- Patient well 2½ years after procedure

Hybrid L VATS Sleeve Pneumonectomy (Right Thor)

- Adenoid Cystic Ca
- Three-step
  - rigid bronchoscopy to core out
  - Right Thor carinal tracheobronchoplasty
  - Left thoracoscopic pneumonectomy


Masters MITS '2013
Hybrid L VATS Sleeve Pneumonectomy - 2 (Right Thor)

- Adenoid Cystic Ca
- Three-step
  - rigid bronchoscopy to core out
  - Right Thor carinal tracheobronchoplasty
  - Left thoracoscopic pneumonectomy


Masters MITS '2013
Chamberlain for Control

## Complete VATS Sleeve

<table>
<thead>
<tr>
<th>Ref</th>
<th>N</th>
<th>Deaths</th>
<th>Complications</th>
<th>EBL (ml)</th>
<th>Time</th>
<th>Hosp Stay</th>
<th>Only Plasty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nakanishi, 2007</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>265</td>
<td>600</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mahtabifard, 2008</td>
<td>13</td>
<td>0</td>
<td>4/13</td>
<td>250</td>
<td>167</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Kamiyoshihara, 2008</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>?</td>
<td>?</td>
<td>&lt;7</td>
<td>*</td>
</tr>
<tr>
<td>DeArmond, 2008</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>?</td>
<td>?</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Kamiyoshihara, 2011</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>165</td>
<td>225</td>
<td>7</td>
<td>*</td>
</tr>
<tr>
<td>Mei, 2012</td>
<td>4</td>
<td>0</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Agasthian, 2013</td>
<td>21</td>
<td>0</td>
<td>1</td>
<td>?</td>
<td>287</td>
<td>5.2</td>
<td>*</td>
</tr>
<tr>
<td>Li, 2013</td>
<td>15</td>
<td>0</td>
<td>1</td>
<td>150</td>
<td>165</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
First VATS Sleeve

- 15 yo female
- 5cm muscle sparing access
- "uneventful" course
- Mucoepidermoid carcinoma

PDT to enable VATS RUL Sleeve

- 62-year-old woman, 15 days initial Rx
  - Flexible/rigid bronchoscopy with PDT, debridement, YAG laser
- 1 month after the initial treatment, negative video cervical mediastinoscopy
- T3N0 (IIB) NSCLC resected

VATS Sleeve Resection


Masters MITS '2013
VATS WEDGE Bronchoplasty

- 5-8 Cm
- 70% direct visualization
  - handling the needle: scooping, rotating, and turning
- 30% monitor
  - confirm each needle insertion site and anastomotic line
- Polyurethane wound retractor (Applied Medical, Rancho Santa Margarita, CA, USA).

VATS WEDGE Bronchoplasty


Masters MITS '2013
## Robot Sleeve

<table>
<thead>
<tr>
<th>Ref</th>
<th>N</th>
<th>Deaths</th>
<th>Complications</th>
<th>EBL (ml)</th>
<th>Time</th>
<th>HospStay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dylewski, 2011</td>
<td>3</td>
<td>0</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Schmid, 2011</td>
<td>1</td>
<td>0</td>
<td>syncope</td>
<td>“minimal”</td>
<td>365</td>
<td>15</td>
</tr>
</tbody>
</table>
Robotic Sleeve

- Cadaveric Experiment


Masters MITS '2013
Robotic Sleeve

- Rabbit Experiment


Masters MITS '2013
• 5cm access plus 3 ports
• three-steps
  • three cartilage interrupted stay sutures (Biosyn 3.0; Ethicon, Somerville, NJ) middle and 2 corners
  • pars cartilaginea anastomosis completed 2 running sutures (Biosyn 4.0; Ethicon) kept loose until the stay sutures tightened
  • running suture for the pars membranacea (Biosyn 4.0)
• 50 min for the anastomosis

Two-Port Sleeve Case

Two-Port Sleeve Case


Masters MITS '2013
Uniportal Sleeve Case

55 year old, post induction therapy

Gonzalez-Rivas, J Thorac Cardiovasc Surg 2013;145:1676-7
Uniportal Sleeve Case

Gonzalez-Rivas, J Thorac Cardiovasc Surg 2013;145:1676-7
- 58 yo female
- Hx breast ca
- Hemoptysis
- Inflammatory myofibroblastic tumor
PD - Index Case 7/2013

- 58 yo female
- Hx breast ca
- Hemoptysis
- Inflammatory myofibroblastic tumor
TiKnot Device
LUL Sleeve
Feb 2008 to Aug 2013

- 8 VATS Sleeves
- 7 VATS Bronchoplasty
- 2 VATS Sleeves with tracheoplasty
- 3 VATS PA/SVC resections/repairs
- 42 Other Bronchoplasty, PA plasty, Sleeves
RUL Sleeve with Superior Segmentectomy
# Thoracoscopic Pneumonectomy Experience

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Author</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>6</td>
<td>Craig</td>
<td><em>Thorax 50</em>:392-395</td>
</tr>
<tr>
<td>1999</td>
<td>Case</td>
<td>Roviaro</td>
<td><em>Chest Surg Clin N Am. 9</em>:419-36</td>
</tr>
<tr>
<td>2003</td>
<td>Case</td>
<td>Conlan</td>
<td><em>J Thorac Cardiovasc Surg 126</em>:2083-2085</td>
</tr>
<tr>
<td>2005</td>
<td>Case</td>
<td>Cadière</td>
<td><em>Surg Endosc. 19</em>:1282-3</td>
</tr>
<tr>
<td>2006</td>
<td>14*</td>
<td>McKenna</td>
<td><em>Ann Thorac Surg 81</em>:421–6</td>
</tr>
<tr>
<td>2006</td>
<td>7</td>
<td>Nwogu</td>
<td><em>Ann Thorac Surg 82</em>:3-4</td>
</tr>
<tr>
<td></td>
<td>(32 attempted)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Case</td>
<td>Piwkowski</td>
<td>*Videosurgery Miniinv 2012; 7 (3): 197-201</td>
</tr>
</tbody>
</table>
Methods
Technique

- No rib spreading
- Thoracoscopic exploration
- Adequate exposure for proximal PA control
- Sequential division of veins, artery and bronchus (last)
- Lymphadenectomy
- Diamond-Flex™ for Tissue Control
JK - Index Case 9/2011

- 71 yo female
- yT2N0 RLL Squamous Cell
- Induction chemo VATS resect Dec 2008
- R hilar recurrence 4/2009 rx by concurrent chemo/RT
JK - Index Case 9/2011

- 71 yo female
- yT2N0 RLL Squamous Cell
- Induction chemo VATS resect Dec 2008
- R hilar recurrence 4/2009 rx by concurrent chemo/RT
JK - Index Case 9/2011

- VO2 max 11 ml/min/kg
- DLCO 41.4%
- FEV-1 52.1%
- PA Balloon occlusion tolerated
R Completion
Pneumonectomy Technique
Clamping Near Main PA
Left Pneumonectomy
GC Index Case 1/2011
GC Index Case 1/2011

- 58 yo male
- 10 x 7 cm LLL, T3N1
- 3 cycles Induction chemo
GC Index Case 1/2011

- 58 yo male
- 10 x 7 cm LLL, T3N1
- 3 cycles Induction chemo
GC Index Case 1/2011

- 58 yo male
- 10 x 7 cm
- LLL, T3N1
- 3 cycles
- Induction chemo
Restaple Stump
Methods
1/1/2002 to 12/31/2012

- Retrospective review
- Pneumonectomy for lung cancer
- Intent-to-treat and subgroup analysis

Patient Selection
- Central lesions not amenable to sleeve resections
- Synchronous, central, ipsilateral upper and lower lobe malignancies
Patient Groups (Intent-to-Treat)

107 Pneumonectomies
- 40 Intended Open*
- 67 Intended VATS*

50 Successful
17 Conversion

25% Conversion

*Completion pneumonectomy (10 VATS/ 4 Open)
*Emergent pneumonectomy (2 VATS/ 5 Open)
Patient Groups (Intent-to-Treat)

Masters MITS '2013
Stage $(7^{th} \text{ ed})$ of Cancers

- Stage 0: 1%
- Stage 1: 22%
- Stage 2: 46%
- Stage 3: 30%
- Stage 4: 1%
Stage (7th ed) of Cancers Between Groups

- Thoracoscopic
- Open
- Conversion

p=0.05

2010 Analysis

Masters MITS '2013
Decrease in Conversion Rate and Growth of Thoracoscopy

2002-2006:
- Open: 12
- VATS: 27
- Conversion: 8

2007-2012:
- Open: 36
- VATS: 8
- Conversion: 10

p < 0.001
Conversions $N=17$

- Pathology/Size 2
- Adhesions 7
- Bleeding 1
- Exposure 7
Groups (Intent-to-Treat)

- Age: 
  - VATS: 64
  - Open: 60
  - p=0.07

- Female (Percent): 
  - VATS: 57
  - Open: 30
  - p=0.007

Masters MITS '2013
Groups (Intent-to-Treat)

Comorbidities (number)

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>VATS</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD/MI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrhythmia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulm fibrosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asbestos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Smoker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steroids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wt loss</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

p=0.001
Groups (Intent-to-Treat)

- Open: 36%
- VATS: 38%

$p=0.6$
OR Results (Intent-to-Treat)

- OR time (min - median)
  - VATS: 289
  - Open: 225
  - p = 0.001

- EBL (ml - median)
  - VATS: 400
  - Open: 325
  - p = 0.84
Results (Intent-to-Treat)

- ICU Stay: VATS 3, Open 2, p=0.2
- Stay: VATS 6, Open 5, p=0.2
- Mortality*: VATS 8, Open 6, p=0.7

*non-emergent
Results (Intent-to-Treat)

- **Days till Adjuvant**
  - VATS: 49.5
  - Open: 69
  - p = 0.1

- **Stage 1&2 Survival (mo - median)**
  - VATS: 26
  - Open: 26
  - p = 0.7
Groups (Intent-to-Treat)

Complications (number)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrhythmia</td>
<td></td>
</tr>
<tr>
<td>DVT</td>
<td></td>
</tr>
<tr>
<td>Bleeding_anemia</td>
<td></td>
</tr>
<tr>
<td>Empyema</td>
<td></td>
</tr>
<tr>
<td>Sepsis</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td></td>
</tr>
<tr>
<td>Air leak</td>
<td></td>
</tr>
<tr>
<td>Pneumothorax</td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td></td>
</tr>
<tr>
<td>BPF</td>
<td></td>
</tr>
<tr>
<td>Hoarseness</td>
<td></td>
</tr>
<tr>
<td>Vocal_cord_paralysis</td>
<td></td>
</tr>
<tr>
<td>Post-thor_pain</td>
<td></td>
</tr>
<tr>
<td>Bacteremia_Infection</td>
<td></td>
</tr>
<tr>
<td>HeartFail</td>
<td></td>
</tr>
<tr>
<td>Pulmonary_RespFail</td>
<td></td>
</tr>
<tr>
<td>Other_major</td>
<td></td>
</tr>
</tbody>
</table>

VATS: 3.1
Open: 3

p=0.8
Groups (Intent-to-Treat)

Stage 1

Percent survival

0 20 40 60 80 100

0

50

100

VATS

Open

Months

0 20 40 60 80 100
Groups (Intent-to-Treat)

Stage 2

Percent survival vs. Months

- VATS
- Open
Groups (Intent-to-Treat)

Stage 3

Percent survival

0 20 40 60

0

50

100

VATS

Open

Months
VATS Pneumonectomy Intent to Treat Update 2012

Multivariate predictors that remained in model

<table>
<thead>
<tr>
<th>Factor</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>7th Edition Stage_path</td>
<td>.001</td>
</tr>
<tr>
<td>DxAge</td>
<td>.001</td>
</tr>
</tbody>
</table>

Approach did not affect survival
Effect of Conversion – Early Stage

Early Stage Survival

Percent survival

VATS
Open
Conversion

OS_month

Masters MITS '2013
Longer Persistence of Severe and Moderate Pain for Open Pneumonectomy Patients might relate to survival.
Thoracoscopic pneumonectomy

- Feasible.
- Early complication rates are similar to open.
- A learning curve exists but skills from other advanced cases are transferrable.
- Operative times are longer.
- As conversion rates fall, expect decreased ICU stay, hospital stay, blood loss and time to adjuvant treatment.
Conclusions

- Attempting VATS pneumonectomy appears to be a safe strategy that does not compromise short-term or long-term oncologic goals.
Thank you!!