Minimally Invasive Esophagectomy

General Thoracic Skills and Decision Making Course
AATS 2013

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University of Pittsburgh Medical Center
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Overview

- Disclosure
- Definition of a Minimally Invasive esophagectomy
- Evolution of technique
- Esophagectomy: Results of MIE
- Pitt Experience, Other sites, Multi-Center Trial

Can a surgeon accomplish the operative approach of their choice in a minimally invasive fashion?
Answer: yes

Using evidence-based medicine, can we determine the ideal operative approach to esophagectomy?
Answer: No
Why consider a less-invasive surgical approach for esophageal cancer?

• Improve the surgical standard of care
  • Decrease morbidity
  • Shorten hospital stay
  • More rapid return to daily activities

• Increase in early stage referrals from Barrett’s surveillance, seeking low-morbidity options

• Must compete with evolving non-surgical options: phototherapy, Definitive Chemo-RT, Endomucosal resection (EMR and others)
Technique: Laparoscopic-Transhiatal versus thoracoscopic/laparoscopic

- **Lap-THE:**
  - **PRO:**
    - No repositioning pt
    - No single lung ventilation
  - **CON:**
    - small working space
    - Limited access to thoracic nodes
    - Gastric tip ischemia
    - RLN injury

- **Lap/VATS:**
  - **PRO:**
    - better exposure /dissection of mediastinum
    - Better esophageal margins
    - ? Survival/local recurrence benefit
  - **CON:**
    - repositioning required
    - double lumen tube required
    - Delayed abdominal assessment

- **MIE Ivor Lewis:**
  - **PRO:**
    - pros of lap/vats
    - No pharyngeal/RLN issues
  - **CON:**
    - Less gastric tip ischemia
    - Larger diameter anastomosis
    - less strictures
    - Better gastric margins

N=15, initial approach  N=>500  N=>1000, current approach

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Methods

• Initial selection included only T-1 tumors and high-grade dysplasia
• As experience was gained, T2 (n=71) and T3N1 (n=81) included
• Selection: resectable tumor by EUS and CT scanning, laparoscopic staging if questionable
• Prospective data base of standard outcomes
• Two quality of life (QOL) instruments
  – SF-36
  – Heartburn-related QOL
Updated Series U Pittsburgh
American Surgical Association 2011

• 1011 patients (80% men, 20% women)
• Average age 64 years (39-89)
• 31% received preoperative chemo and/or radiotherapy
• Malignant Disease 95%
• Pathology
  • Barrett’s high-grade dysplasia 95 (13%)
  • Stage I 135 (18%)
  • Stage II 239 (31%)
  • Stage III 241 (32%)
  • Stage IV 48 (6%)

Luketich JD et al, ASA, Ann Surg 2011
Minimally Invasive Esophagectomy Approaches

• McKeown 3 incision Minimally invasive esophagectomy with neck anastomosis (1997-2006, n=481; 48%)
• Ivor-Lewis Minimally invasive esophagectomy with chest anastomosis (2006-2010, n=530; 52%)

Luketich JD et al, ASA, Ann Surg 2011
### Preoperative Patient Demographics

- **MIE-Neck** (n=481; 48%)
- **MIE-Chest** (n=530; 52%)
- No differences in preoperative patient characteristics between MIE-Neck and MIE-Chest

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n=1011</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (median, IQR)</td>
<td>64 (56, 72)</td>
<td>0.307</td>
</tr>
<tr>
<td>Male Sex</td>
<td>80%</td>
<td>0.272</td>
</tr>
<tr>
<td>Caucasian Race (n, %)</td>
<td>97%</td>
<td>0.502</td>
</tr>
<tr>
<td><strong>BMI (kg/m^2; median, IQR)</strong></td>
<td>28 (25, 32)</td>
<td>0.212</td>
</tr>
<tr>
<td>BMI less than 30</td>
<td>63%</td>
<td>0.382</td>
</tr>
<tr>
<td>BMI 30 or greater</td>
<td>37%</td>
<td></td>
</tr>
</tbody>
</table>
### Indication for Operation and Co-morbid Conditions

<table>
<thead>
<tr>
<th></th>
<th>n=980</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Malignant Disease (%)</strong></td>
<td>95%</td>
<td>0.112</td>
</tr>
<tr>
<td>Use of induction therapy</td>
<td>31%</td>
<td>0.758</td>
</tr>
<tr>
<td><strong>Co-morbid Conditions (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-adjusted CCI &gt;3</td>
<td>49%</td>
<td>0.823</td>
</tr>
<tr>
<td>COPD/Emphysema</td>
<td>12%</td>
<td>0.078</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>23%</td>
<td>0.990</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>19%</td>
<td>0.997</td>
</tr>
<tr>
<td>GERD</td>
<td>71%</td>
<td>0.616</td>
</tr>
<tr>
<td>Chronic Renal Insufficiency (baseline Cr&gt;2 or HD)</td>
<td>3%</td>
<td>0.895</td>
</tr>
<tr>
<td>Prior gastric or esophageal surgery</td>
<td>11%</td>
<td>0.735</td>
</tr>
</tbody>
</table>

Luketich JD et al, ASA, Ann Surg 2011
Laparoscopic Port Placement

4 5-mm ports
one 10-mm port

Self-retaining liver retractor
Lymph node Dissection and Staging, Division of Left Gastric Artery and Vein
Laparoscopic Gastric Tubularization
Laparoscopic Steps: Gastric Tubularization, Celiac node dissection, stapling of left gastric vessels
Other Steps

- Needle Catheter Jejunostomy (our standard)
- Pyloroplasty (our standard, but may not be necessary with narrow gastric tube)
- Celiac LN dissection (our standard)
Laparoscopic J-Tube Using Basic Seldinger Technique
Tack Gastric Tube to Mobilized GE-Junction Tumor For Chest/Neck Retrieval
Typical Location of Surgeon and Assistant Instruments
Ivor Lewis: VATS Portion of Operation

- Standard LN dissection
- Open phrenoesophageal ligament and retrieve specimen and deliver gastric tube into chest
- Transect esophagus
- Remove specimen
- Insert anvil and perform intrathoracic EEA anastomosis (preferably 28 mm, or 25 EEA)
VATS Video Complete of MIE McKeown
VATS Esophageal Lymph node Dissection
Modifications to Minimally Invasive Esophagectomy

- Ivor-Lewis with thoracoscopic intrathoracic anastomosis, for distal third esophageal cancers, especially with cardia involvement
- Prone VATS mobilization: may have technical advantages for VATS visualization
VATS Transection of Intrathoracic Esophagus, Specimen Removal, and EEA Anastomosis (Ivor Lewis Approach, 1 min 30 sec)
Omental Flap

Dai et al. Surg 2011
Omental Flap

Dai et al. Surg 2011
Completed anastomosis with omental pedicle
Completed Reconstruction With Cervical (McKweon) or Intrathoracic Anastomosis (Ivor-Lewis)

Open crura

Tack gastric tube to hiatus
Laparoscopic Ports 3 Weeks Post-op
Thoracoscopic Ports 3-Weeks Post-op
Ivor Lewis Approach

- Less gastric tube needed, better margins for cardia involvement, less ischemia
- Avoid neck dissection and potential recurrent laryngeal nerve injury
- Less aspiration
- Downside: intrathoracic leak can be more difficult to manage, no third field of LN dissection
- Easier technically overall, Learning curve to the VATS intrathoracic anastomosis
Quality of Life Results

• SF-36 Global QOL
  – Physical Component Score: 44 post-op, no significant difference compared to pre-op values or age-matched norms
  – Mental Component score: 51 post-op, no significant difference compared to pre-op values or age-matched norms

• Heartburn-Related QOL
  – Post-op score 4.6 consistent with normal population score
  – Only 4% of patients had a post-op score in the severe reflux range (>15)
Operative Data: n=1000

• Median operative time:
  – Overall 6.7 hours
  – Non-resident case: 4 hours
• Conversion to Open: 4%
• Median ICU stay: 2.0 days
• Median hospital stay: 8 days
• Median number of lymph nodes dissected 21
• 98% with negative surgical margins
## Pathology

<table>
<thead>
<tr>
<th>Pathologic Results</th>
<th>MIE-Neck</th>
<th>MIE-Chest</th>
<th>Total</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal/distal margins negative</td>
<td>98%</td>
<td>98%</td>
<td>98%</td>
<td>0.600</td>
</tr>
<tr>
<td>Number of LN examined</td>
<td>19</td>
<td>23</td>
<td>21</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adenocarcinoma Tumor Type</td>
<td>68%</td>
<td>83%</td>
<td>76%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nodal metastasis at esophagectomy</td>
<td>39%</td>
<td>49%</td>
<td>44%</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Luketich JD et al, ASA, Ann Surg 2011
Perioperative Outcomes
Mortality

• Mortality (30 day) for all patients (n=1011): 1.68%

• Ivor-Lewis MIE: 0.9%

Luketich JD et al, ASA, Ann Surg 2011
## Major Complications-1

### Technique-related

<table>
<thead>
<tr>
<th></th>
<th>Incidence(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>17 (1.68)</td>
</tr>
<tr>
<td>Anastomotic leak – overall</td>
<td>5%</td>
</tr>
<tr>
<td>Leak requiring surgery</td>
<td></td>
</tr>
<tr>
<td>Gastric tip necrosis/right empyema</td>
<td>2%</td>
</tr>
<tr>
<td>Chylothorax</td>
<td>4%</td>
</tr>
<tr>
<td>Vocal cord paresis/ palsy</td>
<td>4%</td>
</tr>
</tbody>
</table>

Orringer Series
First 1,000 cases

- Mortality: 4%
- Anastomotic leak – overall leak requiring surgery: 5%
- Gastric tip necrosis/right empyema: 2%
- Chylothorax: 4%
- Vocal cord paresis/ palsy: 4%

Luketich JD et al, ASA, Ann Surg 2011
### Morbidity: Comparison

<table>
<thead>
<tr>
<th>Condition</th>
<th>MIE-Neck</th>
<th>MIE-Chest</th>
<th>Total</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative Mortality (30 day)</td>
<td>12 (2.5)</td>
<td>5 (0.9)</td>
<td>17 (1.68)</td>
<td>0.126</td>
</tr>
<tr>
<td>Vocal Cord Paresis/Paralysis</td>
<td>8%</td>
<td>1%</td>
<td>4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Empyema</td>
<td>6%</td>
<td>5%</td>
<td>6%</td>
<td>0.431</td>
</tr>
<tr>
<td>ARDS</td>
<td>4%</td>
<td>2%</td>
<td>3%</td>
<td>0.026</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>0.809</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>4%</td>
<td>2%</td>
<td>3%</td>
<td>0.033</td>
</tr>
<tr>
<td>Anastomotic leak requiring surgery</td>
<td>5%</td>
<td>4%</td>
<td>5%</td>
<td>0.439</td>
</tr>
<tr>
<td>Gastric tube necrosis</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td>0.140</td>
</tr>
</tbody>
</table>

Luketich JD et al, ASA, Ann Surg 2011
Overall Survival Following MIE As Good or Better Than Most Open Esophagectomy Series
Recurrence-Free Survival by Pathologic Stage

Years After MIE

Proportion Surviving

0  2  4  6  8  10
0.0  0.2  0.4  0.6  0.8  1.0

CR
0
I
II
III
IV

Log rank $p < .0001$
Pubmed Search For Minimally Invasive Esophagectomy Papers: Interest Amongst Surgeons Skyrockets, But no prospective, multi-center trials

• 378 papers (1990-April 2011)
• 3 meta-analyses
• 100 review articles
• 230 non-review articles
• US: 13 states, 26 countries
Open Versus Minimally Invasive Esophagectomy in England:

Proportion of Esophagectomies carried out using a minimally invasive technique

The Interest in the U.S. Led to a Multicenter Study of Minimally Invasive Esophagectomy Eastern Cooperative Oncology Group E2202, Presented at ASCO 2009

J Luketich, A Pennathur, P Catalano, S Swanson, A de Hoyos, M Maddaus, N Nguyen, A Benson, H Fernando
ECOG 2202

- The First prospective phase II trial of Minimally Invasive Esophagectomy
- Total of 106 patients enrolled from 16 institutions in the United States (ECOG, CALGB, ACOSOG).
- MIE was performed in 99 patients

Luketich J et al ASCO
Results: ECOG 2202

Early Outcomes:
- Mean Number of lymph nodes removed: 20
- Resection Complete (R0) with negative margins in 95%
- Median length of ICU Stay: 2 Days
- Pneumonia: 4.9%, Anastomotic leak: 7.8%
- Operative Mortality: 1.9%

Intermediate Outcomes: Stage Specific survival similar to open series

ASCO: 2009  Luketich, et al
Summary of Results of Minimally Invasive Esophagectomy

• Pittsburgh Experience:
  – 1996-2003 in 500 consecutive three hole MIE’s median nodal harvest 18
  – 2003-present Ivor Lewis MIE (n=800) median lymph node harvest 24
  – 30-day mortality 0.9% in MIE Ivor Lewis group

• Prospective Study of 17 Centers Performing MIE (ECOG 2202)
  – Median Nodal Harvest n=20, 30-day mortality 1% in patients undergoing MIE
  – Loco-regional recurrence at three years 6.7%
  – 3 year survival 58%
Conclusions

• The Medical community and lay public generally view open esophagectomy as an excessively morbid treatment option for esophageal cancer
• Many centers continue to struggle with a high morbidity and mortality following open esophagectomy
• Competition and options to avoid esophagectomy are becoming more and more commonplace for early stage esophageal cancers, resectable advanced stages, and palliative issues
• Our minimally invasive Ivor Lewis esophagectomy includes a 2-field lymph node dissection, has a low mortality rate (0.9%), acceptable morbidity, short hospital stay (7 days) and preserved QOL (compares favorably to open surgery)
  – Survival, stage for stage no different from open surgery results
  – Local recurrence rates less than 5%
• ECOG 2202 demonstrated that MIE can be performed by skilled MIS surgeons outside of Pittsburgh (1.9% mortality at 16 centers)
Thank You

The Point in Pittsburgh