Mediastinal Staging: PET, EBUS, Mediastinoscopy, VAMLA

Todd L. Demmy

Masters MITS '2015
No Disclosures
Objectives - Staging

• Review Staging and Nodal Gold Standard
  – PET and related technologies, Mediastinoscopy (MS) & Videomediast. (VMS)
• Review Enhanced Imaging Methods
  – Navigational Bronch
  – EBUS/EUS
• New lymphadenectomy (LA) methods & results:
  – Video-Assisted Mediastinal (VAMLA)
  – Transcervical Extended Mediastinal (TEMLA)
Mediastinal Lymph Nodes
Mediastinal Lymph Nodes
PET-CT for assessing mediastinal lymph node involvement in patients with suspected resectable non-small cell lung cancer (Review)

“accuracy of PET-CT is insufficient to allow management based on PET-CT alone.”

Based on meta-analysis of 45 Studies

CT & PET or PET-CT

- Negative (N0)
  - cN0, peripheral tumour ≤3cm
    - Surgery
  - cN1, central tumour >3cm
    - EBUS/EUS or VA Med.
    - Negative

- Positive (N2-N3)
  - Tissue confirmation EBUS/EUS
    - "-"
    - VA Med.

- Multimodality Rx or Definitive
  - Positive
    - "+

Adapted from Transl Lung Cancer Res 2014;3(4):225-233
• Metabolic Tumor Volume > 22cm³ has worse prognosis
  – AJR 2015; 205:623–628
Fluoroazomycin Arabinoside (18F-FAZA) positron emission tomography

Journal of Medical Imaging and Radiation Oncology 57 (2013) 475–481

TUMOR Hypoxia (18F-FAZA)

TUMOR Metabolism (18F-2-deoxyglucose FDG)
Advances in PET & MRI
Diffusion Weighted Imaging

Slower H2O Transit = More Measurable Brownian Motion in Tumor

Ann Thorac Surg 2011;91:1689–95

Masters MITS '2015
Apparent Diffusion Coefficient = Water molecule diffusion
Cancer cf. Normal Tissue

Ann Thorac Surg 2011;91:1689 –95

Masters MITS '2015
ADC < 1.7 is Worse

PET > 2.4 is Worse

Ann Thorac Surg 2011;91:1689 –95
Apparent Diffusion Coefficient = Water molecule diffusion
Cancer cf. Normal Tissue

Ann Thorac Surg 2011;91:1689–95

Masters MITS '2015
## Advances in PET & MRI Diffusion Weighted Imaging

<table>
<thead>
<tr>
<th>Primary Detection</th>
<th>DWI</th>
<th>FDG-PET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detectable</td>
<td>61 Lung cancers</td>
<td>54 Lung cancers</td>
</tr>
<tr>
<td>Not detectable</td>
<td>2 Lung cancers</td>
<td>9 Lung cancers</td>
</tr>
<tr>
<td>Detection rate</td>
<td>0.97</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Ann Thorac Surg 2011;91:1689 –95

Masters MITS '2015
Advances in PET & MRI Diffusion Weighted Imaging

CT

1.264

DWI

Ann Thorac Surg 2011;91:1689–95

Masters MITS '2015
## Advances in PET & MRI Diffusion Weighted Imaging

<table>
<thead>
<tr>
<th></th>
<th>pN0</th>
<th>pN1</th>
<th>pN2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DWI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cN0</td>
<td>38</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>cN1</td>
<td>1</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>cN2</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td><strong>PET-CT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cN0</td>
<td>38</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>cN1</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>cN2</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

51 Match

45 Match

Ann Thorac Surg 2011;91:1689 –95

Masters MITS '2015
Meta-analysis
Thoracic Cancer 6 (2015) 123–132

SROC Curve

Masters MITS '2015
Stage IIIb, Squamous Cell Carcinoma

Fused Images

PLOS ONE | DOI:10.1371/journal.pone.0116277

Masters MITS '2015
Lung Staging - VATS

- SVC
- Azygous
- R Apex
- Esophagus
- 2R
- 4R
- 7
- 8
- 9
VATS Restaging

Prospective phase II trial of preresection thoracoscopic mediastinal restaging after neoadjuvant therapy for IIIA (N2) non–small cell lung cancer: Results of CALGB Protocol 39803

Michael T. Jaklitsch, MD, a Lin Gu, MS, b Todd Demmy, MD, c David H. Harpole, MD, d Thomas A. D’Amico, MD, d Robert J. McKenna, MD, e Mark J. Krasna, MD, f Leslie J. Kohman, MD, g Scott J. Swanson, MD, a Malcolm M. DeCamp, MD, h Xiaofei Wang, PhD, b Susan Barry, BS, b David J. Sugarbaker, MD, a and the CALGB Thoracic Surgeons

<table>
<thead>
<tr>
<th>VATS outcome</th>
<th>Patients (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation dose (cGy)</td>
<td>None</td>
</tr>
<tr>
<td>Success</td>
<td>11</td>
</tr>
<tr>
<td>Failure</td>
<td>5</td>
</tr>
<tr>
<td>Inadequate sampling</td>
<td>5</td>
</tr>
</tbody>
</table>

Jaklitsch, J Thorac Cardiovasc Surg 2013;146:9-16

Masters MITS '2015
# VATS Restaging

<table>
<thead>
<tr>
<th>Side</th>
<th>False Neg Station</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>2 - Upper paratracheal</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4 - Lower paratracheal</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>7 - Subcarinal</td>
<td>3</td>
</tr>
<tr>
<td>Left</td>
<td>5 - Aortopulmonary</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>6 - Anterior mediastinal</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>9 - Pulmonary ligament</td>
<td>1</td>
</tr>
</tbody>
</table>
VATS Restaging for IIIA
N=70

- Successful 76%
- Unsuccessful 24%
  - Adhesions/fibrosis (11)
  - Tumor blocking access (4)
  - Airway injury (1)
  - Inadequate lung deflation (1)
- Sensitivity 75%
- Specificity 100%
- NPV 75.8%

- 4 pleural carcinomatosis
- 17 persistent N2 disease
- 19 had 3 (-) nodal stations

Journal of Clinical Oncology, 2005 ASCO Proceedings. Vol 23, No. 16S, Part I of II (June 1 Supplement), 2005: 7065

Masters MITS '2015
Mediastinoscopy
Contemporary Series - MSK

- 3391 cases
- 0.4% major hemorrhage
- 1 hospital death

J Thorac Cardiovasc Surg 2003;126:726-731

Masters MITS '2015
Masters MITS '2015

Mediastinoscopy
Duke Series (N=2145)

- 546 positive nodes
- Positive N2 (23.5%)
- 1019 thoracotomies
  - 5.5% Missed N2 (false negative)
  - 57% of missed in levels 5, 6, 8, or 9

Ann Thorac Surg 2006;82:1185–90

Masters MITS '2015
Pre vs. Post Induction Mediastinoscopy
Discovery of N2-N3

- Pre Induction (N=195)
  - Sensitivity 87%
  - Specificity 100%
  - Accuracy 96%
  - Complications 4%

- Post Induction (N=24)
  - Sensitivity 81%
  - Specificity 100%
  - Accuracy 91%
  - Complications 0%


Masters MITS '2015
Mediastinoscopy and Restaging

Pre

Post

**Accuracy**

60% 20% 82% 57% 64%
Is there dislike for or waning experience with mediastinoscopy?

Are We at the Dusk of Mediastinoscopy in Modern Clinical Practice?

To the Editor:
We read with great interest the article by Um et al., reporting on a prospective study of mediastinoscopy in the management of lymphadenopathy.

Reply to “Are We at the Dusk of Mediastinoscopy in Modern Clinical Practice?”

An Irresistible Trend

J Thorac Oncol. 2015 Sep;10(9):e91-2.
29% Use of Mediastinoscopy
ACOSOG Z0030 -- N = 1023

<table>
<thead>
<tr>
<th>Stage</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>41.5</td>
</tr>
<tr>
<td>IB</td>
<td>40.9</td>
</tr>
<tr>
<td>IIA</td>
<td>3.6</td>
</tr>
<tr>
<td>IIB</td>
<td>9.5</td>
</tr>
<tr>
<td>IIIA</td>
<td>2.7</td>
</tr>
<tr>
<td>IIIB</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Randomized trial of mediastinal lymph node sampling versus complete lymphadenectomy during pulmonary resection in the patient with N0 or N1 (less than hilar) non–small cell carcinoma

“EBUS-TBNA was superior to mediastinoscopy … for mediastinal staging of cN1–3 NSCLC. Because … less invasive and … superior … sensitivity, it should be the first-line procedure performed in patients with NSCLC.”

*J Thorac Oncol.* 2015;10: 331–337
Disuse of Mediastinoscopy

Diagnostic Performance of EBUS-TBNA and Mediastinoscopy on a Per-Person Basis ($n = 127$)

<table>
<thead>
<tr>
<th></th>
<th>EBUS-TBNA</th>
<th>Mediastinoscopy</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>88%</td>
<td>81%</td>
<td>0.0039</td>
</tr>
<tr>
<td>Specificity</td>
<td>100%</td>
<td>100%</td>
<td>NA</td>
</tr>
<tr>
<td>Accuracy</td>
<td>93%</td>
<td>89%</td>
<td>0.0001</td>
</tr>
<tr>
<td>PPV</td>
<td>100%</td>
<td>100%</td>
<td>NA</td>
</tr>
<tr>
<td>NPV</td>
<td>85%</td>
<td>79%</td>
<td>0.0018</td>
</tr>
</tbody>
</table>

*J Thorac Oncol. 2015;10: 331–337*

Masters MITS '2015
## Disuse of Mediastinoscopy

### Mediastinal nodal stations

<table>
<thead>
<tr>
<th>Mediastinal nodal stations</th>
<th>No. of patients with nodal station sampled at mediastinoscopy (n =127)</th>
<th>% Recovered</th>
<th>Yasufuku (n = 153) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2R</td>
<td>48</td>
<td><strong>38%</strong></td>
<td><strong>75%</strong></td>
</tr>
<tr>
<td>2L</td>
<td>9</td>
<td><strong>7%</strong></td>
<td><strong>17%</strong></td>
</tr>
<tr>
<td>4R</td>
<td>121</td>
<td><strong>95%</strong></td>
<td><strong>99%</strong></td>
</tr>
<tr>
<td>4L</td>
<td>98</td>
<td><strong>77%</strong></td>
<td><strong>86%</strong></td>
</tr>
<tr>
<td>7</td>
<td>120</td>
<td><strong>94%</strong></td>
<td><strong>97%</strong></td>
</tr>
</tbody>
</table>

*J Thorac Oncol.* 2015;10: 331–337

Masters MITS '2015
Disuse of Mediastinoscopy

• “Mediastinoscopy seems to have limited utility in these patients with T1 and T2 clinically staged N0 by positron emission tomography/computed tomography.”

• ~5% Patients were N2 upstaged

J Thorac Cardiovasc Surg 2015;149:35-42

Masters MITS '2015
Disuse of Mediastinoscopy

- Prospective cohort study
- T2N0 or T1N0 with a maximum SUV greater than 10 by PET/CT scans
- 5 Busy High profile Academic Institutions
- 5 years

J Thorac Cardiovasc Surg 2015;149:35-42

Masters MITS '2015
## Disuse of Mediastinoscopy

<table>
<thead>
<tr>
<th>Mediastinal nodal stations</th>
<th>No. of patients with nodal station sampled at mediastinoscopy (n = 90)</th>
<th>% Recovered</th>
<th>Yasufuku (n = 153) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2R</td>
<td>50</td>
<td>56%</td>
<td>75%</td>
</tr>
<tr>
<td>2L</td>
<td>1</td>
<td>1%</td>
<td>17%</td>
</tr>
<tr>
<td>4R</td>
<td>86</td>
<td>96%</td>
<td>99%</td>
</tr>
<tr>
<td>4L</td>
<td>51</td>
<td>57%</td>
<td>86%</td>
</tr>
<tr>
<td>7</td>
<td>87</td>
<td>97%</td>
<td>97%</td>
</tr>
</tbody>
</table>

J Thorac Cardiovasc Surg 2015;149:35-42
Summary 1

• Mediastinoscopy is safe and effective for most lung cancer scenarios but not always applied
Mediastinoscopy

Masters MITS '2015
VideoMediastinoscopy
VideoMed vs Traditional Med

**Conventional vs Video**
- **Bleeding**: Conventional 4.00% vs Video 0.00%
p = 0.03
- **Vocal cord palsy**: Conventional 3.50% vs Video 0.50%
p = 0.03

**Nodes Found and Left**
- **Nodes Found**: Conventional 9.00 vs Video 6.00
p = 0.006
- **Nodes Left**: Conventional 7.00 vs Video 8.00
p = 0.001

*Ann Thorac Surg 2011;92:1007-1011*

Masters MITS '2015
Esophageal Ultrasound (EUS)
L Adrenal gland 97% accessibility

EUS FNA

Semin Thorac Cardiovasc Surg
19:206-211
2007
EUS FNA

Semin Thorac Cardiovasc Surg
19:206-211
2007

Masters MITS '2015
## Selected EUS Series

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNEMA 2005</td>
<td>100</td>
<td>76</td>
<td>97</td>
<td>92</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>ELOUBEIDI 2005</td>
<td>93</td>
<td>93</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>97</td>
</tr>
<tr>
<td>ANNEMA 2005</td>
<td>215</td>
<td>91</td>
<td>100</td>
<td>100</td>
<td>74</td>
<td>93</td>
</tr>
<tr>
<td>TOURNOY 2005</td>
<td>67</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>FERNANDEZ-ESPARRACH 2006</td>
<td>47</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>88</td>
<td>89</td>
</tr>
</tbody>
</table>

Eur Respir J 2006; 28: 1264–1275

Masters MITS '2015
Factors Affecting TBNA Yield

- Presence of LN enlargement on CT scan
- Type of needle
- Site of the tumor or LN
- Number of aspirates performed
- Availability of rapid on-site cytopathologic examination
- Ability and experience of the operators
- Nature of the lesion (malignancy, type of malignancy)

Eur Respir J 2006; 28: 1264–1275

Masters MITS '2015
Limitation of FNA (EUS)

EUS-FNA sensitivity

<table>
<thead>
<tr>
<th>LN size</th>
<th>N</th>
<th>True positive</th>
<th>False negative</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>59</td>
<td>7</td>
<td>9</td>
<td>43.8</td>
</tr>
<tr>
<td>Enlarged</td>
<td>49</td>
<td>25</td>
<td>7</td>
<td>75</td>
</tr>
<tr>
<td>Bulky disease</td>
<td>12</td>
<td>11</td>
<td>1</td>
<td>91.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tumour location</th>
<th>N</th>
<th>True positive</th>
<th>False negative</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>64</td>
<td>16</td>
<td>16</td>
<td>50</td>
</tr>
<tr>
<td>Left</td>
<td>46</td>
<td>23</td>
<td>1</td>
<td>95.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lymph node station</th>
<th>N</th>
<th>True positive</th>
<th>False negative</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>96</td>
<td>29</td>
<td>7</td>
<td>80.6</td>
</tr>
<tr>
<td>5/6</td>
<td>35</td>
<td>15</td>
<td>4</td>
<td>78.9</td>
</tr>
<tr>
<td>4R</td>
<td>66</td>
<td>5</td>
<td>16</td>
<td>23.8</td>
</tr>
<tr>
<td>4L</td>
<td>49</td>
<td>3</td>
<td>9</td>
<td>25</td>
</tr>
</tbody>
</table>


Masters MITS '2015
Limitation of FNA (EUS)

Level 5 FNA - False Neg


Masters MITS '2015
Various Surgical Staging Methods
Comparative Anatomic Access

European Journal of Cardio-thoracic Surgery 32 (2007) 1—8

Masters MITS '2015
EBUS Miniforceps


Masters MITS '2015
EBUS Miniforceps
Sheath facilitation


Masters MITS '2015
Guideline for the Acquisition and Preparation of EBUS TBNA Specimens for the Diagnosis and Molecular Testing of Patients with Known or Suspected Lung Cancer
World Bronchology and Interventional Pulmonology Task Force

- At least 3 passes needed for optimal performance.
- Molecular analysis (i.e. EGFR, KRAS and ALK) can be routinely performed.
- Miniforceps may be better for sarcoid/lymphoma.

WHAT DOES NOT MATTER!!
- Specimen preparation (i.e. slide staining, cell blocks or core tissue)*
- Needle gauge/Miniforceps
- Suction
- Sedation/anesthesia type
- ROSE rapid on-site

*likely because of interinstitutional differences in pathologist expertise or preference.

Respiration 2014;88:500–517

Masters MITS '2015
# Learning Curve to Achieve Cancer Diagnosis by EBUS

<table>
<thead>
<tr>
<th>Cases</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>NPV (%)</th>
<th>PPV (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 10</td>
<td>16.70%</td>
<td>100%</td>
<td>100%</td>
<td>44.40%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Next 46</td>
<td>96.20%</td>
<td>100%</td>
<td>100%</td>
<td>95.00%</td>
<td>97.80%</td>
</tr>
<tr>
<td>Total</td>
<td>81.30%</td>
<td>100%</td>
<td>100%</td>
<td>79.30%</td>
<td>89.10%</td>
</tr>
</tbody>
</table>

*Ann Thorac Surg 2008;86:1104-1110*
## EBUS

### Subcarinal vs. Other Stations

<table>
<thead>
<tr>
<th>Cases</th>
<th>Yield TBNA</th>
<th>Yield EBUS</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcarinal</td>
<td>74%</td>
<td>86%</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Others</td>
<td>58%</td>
<td>84%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*CHEST 2004; 125:322–325*

*Masters MITS '2015*
EBUS vs Mediastinoscopy
Randomized

<table>
<thead>
<tr>
<th>Clinical stage</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>47 (31)</td>
</tr>
<tr>
<td>IB</td>
<td>26 (17)</td>
</tr>
<tr>
<td>IIA</td>
<td>3 (2)</td>
</tr>
<tr>
<td>IIB</td>
<td>10 (7)</td>
</tr>
<tr>
<td>IIIA</td>
<td>59 (39)</td>
</tr>
<tr>
<td>IIIB</td>
<td>5 (3)</td>
</tr>
<tr>
<td>IV</td>
<td>3 (2)</td>
</tr>
</tbody>
</table>

N2/N3 disease was 35% (53/153).

J Thorac Cardiovasc Surg. 2011 Dec;142(6):1393-400
EBUS vs Mediastinoscopy
Randomized

**EBUS**

- Sensitivity – 81%
- Neg Predict Value – 91%
- Accuracy – 93%
- Insufficient N = 122

**Mediastinoscopy**

- Sensitivity – 79%
- Neg Predict Value – 90%
- Accuracy – 93%
- Insufficient N = 10

J Thorac Cardiovasc Surg. 2011 Dec;142(6):1393-400

n = 153
FALSE BOTH EBUS and MEDIASTINOSCOPY

<table>
<thead>
<tr>
<th>Station</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>4R</td>
<td>4R positive on final pathology</td>
</tr>
<tr>
<td>6</td>
<td>6 positive on final surgical staging</td>
</tr>
<tr>
<td>5</td>
<td>5, 6 positive on final surgical staging</td>
</tr>
<tr>
<td>5,6</td>
<td>5 positive on final surgical staging</td>
</tr>
</tbody>
</table>

n = 153

J Thorac Cardiovasc Surg. 2011 Dec;142(6):1393-400

Masters MITS '2015
EBUS vs Mediastinoscopy
Randomized

**FALSE EBUS**

<table>
<thead>
<tr>
<th>Station</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Micrometastasis</td>
</tr>
<tr>
<td>4L</td>
<td>Micrometastasis, not sampled by EBUS</td>
</tr>
<tr>
<td>2R</td>
<td>Not sampled by EBUS</td>
</tr>
<tr>
<td>2R</td>
<td>N3 lymph node not sampled by EBUS</td>
</tr>
<tr>
<td>4R</td>
<td>Micrometastasis</td>
</tr>
<tr>
<td>7</td>
<td>Micrometastasis, PET negative</td>
</tr>
</tbody>
</table>

J Thorac Cardiovasc Surg. 2011 Dec;142(6):1393-400

\( n = 153 \)
### FALSE Mediastinoscopy

<table>
<thead>
<tr>
<th>Station</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>4L</td>
<td>Enlarged and hard node on mediastinoscopy</td>
</tr>
<tr>
<td>4L</td>
<td>Grossly normal on mediastinoscopy</td>
</tr>
<tr>
<td>4R</td>
<td>Enlarged node on mediastinoscopy</td>
</tr>
<tr>
<td>7</td>
<td>Grossly normal on mediastinoscopy</td>
</tr>
<tr>
<td>4L</td>
<td>4R (N2) positive, 4L (N3) negative on mediastinoscopy</td>
</tr>
<tr>
<td>7</td>
<td>Grossly normal on mediastinoscopy</td>
</tr>
<tr>
<td>4L</td>
<td>2R, 4R (N2) positive, 4L (N3) negative on mediastinoscopy</td>
</tr>
</tbody>
</table>

\[ n = 153 \]

---

J Thorac Cardiovasc Surg. 2011 Dec;142(6):1393-400

Masters MITS '2015
Combined endobronchial and esophageal endosonography for the diagnosis and staging of lung cancer: European Society of Gastrointestinal Endoscopy (ESGE) Guideline, in cooperation with the European Respiratory Society (ERS) and the European Society of Thoracic Surgeons (ESTS)

**Complementary EBUS & EUS**

- Enlarged or fluorodeoxyglucose (FDG)-PET-avid ipsilateral hilar nodes
- Primary tumor without FDG uptake
- Tumor size ≥3 cm

Endoscopy 2015; 47: 545–559

Masters MITS '2015
Enhancing Bronchoscopic Success

Masters MITS '2015
Real-time Location Information

Masters MITS '2015
## DIAGNOSTIC YIELD

<table>
<thead>
<tr>
<th>Size</th>
<th>≤15 mm</th>
<th>&gt;15 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENB-TBNA</td>
<td>29/44 (65.9%)*</td>
<td>30/37 (81.1%)†</td>
</tr>
<tr>
<td>C-TBNA</td>
<td>5/18 (27.8%)</td>
<td>22/46 (47.8%)</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.05</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Eligible for resection; †Eligible for other treatment.


Masters MITS '2015
nodes [n]

p<0.0001 (Mann-Whitney U)

Thoracotomy  VAMLA
VAMS/ VAMLAA Result (N=186)

- 8.7 grams (2 to 23.7 grams).
- Positive N2/N3 (32.8%)
- Operation time 54.1 minutes (40 to 175)
- Nine complications (3.98%)
  - 1 R and 4 L recurrent laryngeal nerve palsies
  - 2 azygos vein lacerations
  - 1 mediastinitis
  - 1 aortic arch bleeding


Masters MITS '2015
VAMLAL (N=144)
Discovery of N2-N3

• 130 cases went to thoracotomy
  – Sensitivity 100%
  – Specificity 94%
  – False Neg 0.9%

# TEMLA Effect on VATS Lobectomy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VATS only N=14</th>
<th>VAMLA/VATS N=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissected mediastinal</td>
<td>Mean 3.6 (range 2—6) stations</td>
<td>Mean 6.4 (range 5—9) stations</td>
</tr>
<tr>
<td>stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mediastinal sample weight</td>
<td>Median 5.5 (range 0.6—15) gram</td>
<td>Median 11.2 (range 2.7—21.4) gram</td>
</tr>
</tbody>
</table>


Masters MITS '2015
# Effect on VATS Lobectomy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VATS only N=14</th>
<th>VAMLA/VATS N=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total operation time</td>
<td>Median 202 (range 135—275) min</td>
<td>Median 200 (range 125—263) min</td>
</tr>
<tr>
<td>Conversions</td>
<td>One (pos. bronchial margin)</td>
<td>One (PA anatomical variety)</td>
</tr>
<tr>
<td>Blood loss</td>
<td>Median Hb difference -1.3 (range 0.5—4.4) g%</td>
<td>Median Hb difference -1.25 (range 0—3.6) g%</td>
</tr>
<tr>
<td>Perioperative transfusions</td>
<td>Four units in one patient</td>
<td>Six units in two patients</td>
</tr>
<tr>
<td>Chest tubes</td>
<td>Median 6 (range 3—10) days</td>
<td>Median 5.5 (range 2—17) days</td>
</tr>
<tr>
<td>Opioids first postoperative week</td>
<td>Median 315 (range 95—486) mg</td>
<td>Median 286.5 (range 35—550) mg</td>
</tr>
</tbody>
</table>


Masters MITS '2015
## Effect on VATS Lobectomy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VATS only N=14</th>
<th>VAMLA/VATS N=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative adverse events</td>
<td>Minor bleeding 3</td>
<td>Minor bleeding 1, Stapler malfunction 1</td>
</tr>
<tr>
<td>Postoperative adverse events</td>
<td>Eight events in six patients: hematoma 1, lower airway infection 2, arrhythmias 2, other medical 2</td>
<td>Eight events in four patients: hematoma 1, lower airway infection 3, arrhythmias 1, other medical 3</td>
</tr>
</tbody>
</table>

Effect on Left VATS Lobectomy


Masters MITS '2015
Enhanced Staging Effect on VATS Lobectomy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VATS only N=14</th>
<th>VAMLA/VATS N=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissected mediastinal stations</td>
<td>Mean 3.6 (range 2—6) stations</td>
<td>Mean 6.4 (range 5—9) stations</td>
</tr>
<tr>
<td>Mediastinal sample weight</td>
<td>Median 5.5 (range 0.6—15) gram</td>
<td>Median 11.2 (range 2.7—21.4) gram</td>
</tr>
</tbody>
</table>

VAML A - Turkey

**VAML A N=44**
- Nodes 8.4
- Complications 11.3%

**Video Med N=113**
- Nodes 7.6
  - (p=0.001)
- Complications 2.6%
  - (p=0.04)
Sensitivity and NPV better

Sayar, Gen Thor and CV Surg 2011:59(12) 793-798

Masters MITS '2015
<table>
<thead>
<tr>
<th>N status</th>
<th>Med_scopy (n=344)</th>
<th>VAMLA (n=89)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0, no. (%)</td>
<td>288 (83.7)</td>
<td>53 (59.6)</td>
<td>0.023</td>
</tr>
<tr>
<td>N2-3, no. (%)</td>
<td>56 (16.2)</td>
<td>36 (40.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Specificity</td>
<td>100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>67.5</td>
<td>95.5</td>
<td>0.001</td>
</tr>
<tr>
<td>False-negative value</td>
<td>9.4</td>
<td>3.4</td>
<td>0.04</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>90.6</td>
<td>94.3</td>
<td>0.03</td>
</tr>
<tr>
<td>Accuracy</td>
<td>92.2</td>
<td>96.6</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Turna, J Thorac Cardiovasc Surg 2013;146:774-80
VAMLA - Turkey

Turna, J Thorac Cardiovasc Surg 2013;146:774-80

Masters MITS '2015
VAMLA - Turkey

Turna, J Thorac Cardiovasc Surg 2013;146:774-80
VAMLA & ECM
Affected Staging in 78%

VAMLA & ECM
Affected Staging in 78%

Sensitivity 94%
Specificity 100%
NPV 96%

VAMLTA + Extended Mediastinoscopy
Suspect Left Sided Lung Cancer N=110

Lung carcinoma
n = 92

VAMLTA positive
n = 21

Both positive
n = 7

ECM positive
n = 17


Masters MITS '2015
EBUS and Restaging

124 NSCLC IIIA-N2 treated with induction chemotherapy

58 stable disease on CT

- 17 EBUS negative
  - Thoracotomy 3 negative
  - Thoracotomy 14 positive

- 41 EBUS positive
  - Thoracotomy 41 positive

66 partial response on CT

- 18 EBUS negative
  - Thoracotomy 4 negative
  - Thoracotomy 14 positive
  - Thoracotomy 48 positive

- 48 EBUS positive

NPV = 20%

J Clin Oncol 2008; 26:3346-3350

Masters MITS '2015
Endoscopic FNA

- **Pros**
  - Approaches Surgical Accuracy for Targeted Areas
  - Enables access to multiple cavities
  - No incision

- **Cons**
  - Fewer nodes/stations
  - Miss micro disease
  - Imaging dependent
  - Restaging may be more difficult

Surgical staging

- **Pros**
  - More nodal resection
  - More cytoreduction
  - Better for restaging
  - Potentially therapeutic

- **Cons**
  - Excessively invasive for certain stages

Masters MITS '2015
TEMLA – Technique
Introduced 2004, Zakopane Poland

- 5-8cm collar incision
- Elevation sternum – RUL Tract
- Nerves visualized

*J Thorac Oncol. 2007;2: 370–372*

Stations: 1, 2R, 4R, 3A, 3P, 2L, 4L, 5, 6, 7 and superior station 8

Masters MITS '2015
Retractor System RUL - Tract
TEMLA Setup

Masters MITS '2015
TEMLA Setup
TEMLA Setup

Masters MITS '2015
TEMLA Setup

Masters MITS '2015
TEMLA Setup
TEMLA Setup
NIM Monitoring
TEMLA Setup
Zielinski Semin Thoracic Surg 22:236-243

www.ctsnet.org/sections/clinicalresources/thoracic/

Masters MITS '2015
www.ctsnet.org/sections/clinicalresources/thoracic/

Masters MITS '2015
Zielinski Semin Thoracic Surg 22:236-243

www.ctsnet.org/sections/clinicalresources/thoracic/

Masters MITS '2015
TEMLA Result (N=256)

- 39 nodes/case (15-85)
- Positive N2 (31.3%)
- 138 thoracotomies
  - 5 Missed N2
- Mean 24 month followup
  - Only one locoregional recurrence
  - 77% survival if TEMLA negative

*J Thorac Oncol. 2007;2: 370–372*
RESULTS (2004-2013):
994 patients with NSCLC
  807 men
  age 41-79 (mean 62.8)
Time of operation was 35 to 330 min
(mean 107 min). In the last 100 patients
mean time of operation was 91.5 min.
## Complications of 994 TEMLA procedures

<table>
<thead>
<tr>
<th>Complication</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury of the esophagus and the right main bronchus with formation of the</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>esophago-bronchial fistula managed successfully with right thoracotomy,</td>
<td></td>
</tr>
<tr>
<td>suturing of the esophagus and repair of the bronchus with intercostal flap</td>
<td></td>
</tr>
<tr>
<td>Injury of the right main bronchus</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Injury of the right segment 1 bronchus</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Injury of the right pulmonary artery</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Injury of the azygos vein</td>
<td>2 (0.2%)</td>
</tr>
<tr>
<td>Postoperative bleeding requiring revision</td>
<td>2 (0.2%)</td>
</tr>
<tr>
<td>Late pulmonary haemorrhage</td>
<td>2 (0.2%)</td>
</tr>
<tr>
<td>Haemorrhagic brain infarct</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Cardiac infarct</td>
<td>2 (0.2%)</td>
</tr>
<tr>
<td>Sudden cardiac arrest</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Pleural effusion (conservative treatment)</td>
<td>12 (1.2%)</td>
</tr>
<tr>
<td>Laryngeal recurrent nerve palsy- overall</td>
<td>26 (2.6%)</td>
</tr>
</tbody>
</table>
## Complications of 994 TEMLA procedures

<table>
<thead>
<tr>
<th>Complication</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary left laryngeal recurrent nerve palsy</td>
<td>17</td>
<td>(1.7%)</td>
</tr>
<tr>
<td>Temporary right laryngeal recurrent nerve palsy</td>
<td>2</td>
<td>(0.2%)</td>
</tr>
<tr>
<td>Temporary bilateral laryngeal recurrent nerve palsy</td>
<td>2</td>
<td>(0.2%)</td>
</tr>
<tr>
<td>Permanent laryngeal recurrent nerve palsy</td>
<td>5</td>
<td>(0.5%)</td>
</tr>
<tr>
<td>Pneumothorax (necessitating chest drainage)</td>
<td>4</td>
<td>(0.4%)</td>
</tr>
<tr>
<td>Respiratory insufficiency (ventilator)</td>
<td>5</td>
<td>(0.5%)</td>
</tr>
<tr>
<td>Postoperative psychosis</td>
<td>2</td>
<td>(0.2%)</td>
</tr>
<tr>
<td>Perforation of the peptic ulcer</td>
<td>1</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>Cerebral ischemia</td>
<td>1</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>1</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>Cardiovascular insufficiency</td>
<td>3</td>
<td>(0.3%)</td>
</tr>
<tr>
<td>Overall morbidity</td>
<td>69</td>
<td>(6.9%)</td>
</tr>
<tr>
<td>Death</td>
<td>6</td>
<td>(0.6%)</td>
</tr>
</tbody>
</table>
TEMLA in discovery of N2-3 nodes was
Sensitivity of 96.2 %
Specificity was 100%
Accuracy was 99.0%
Negative Predictive Value (NPV) 98.7%
Positive Predictive Value (PPV) 100%
EBUS (N=226)
Confirmed by TEMLA if Negative

- All cases
  - Sensitivity 89%
  - Specificity 100%
  - Accuracy 92.9%
  - PPV 100%
  - Neg Pred Value 83.5%

16 positive TEMLA of 97 Negative EBUS cases

<table>
<thead>
<tr>
<th>Level</th>
<th>Percentage of Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>27% of 118 nodes</td>
</tr>
<tr>
<td>4L</td>
<td>24% of 34 nodes</td>
</tr>
<tr>
<td>4R</td>
<td>48% of 50 nodes</td>
</tr>
<tr>
<td>5</td>
<td>42% of 38 nodes</td>
</tr>
<tr>
<td>6</td>
<td>2 of 4 nodes</td>
</tr>
</tbody>
</table>

Restaging after neoadjuvant therapy

- Induction (neoadjuvant) therapy is an accepted modality for stage IIIA-N2 NSCLC.
- Patient selection for surgery after induction therapy is important for obtaining optimal results.
- Pathological downstaging predicts better outcome for these patients.

Albain KS et al, Lancet 2009
EBUS Downstaging 16% to allow surgery

EBUS-TBNA = 152

Non-diagnostic = 7

Benign = 32

Presumed Malignant = 113

Underwent Surgery = 20

Nonsurgical = 93

Non-small cell lung cancer = 16

Primary Lung
Non-small cell = 46
Small cell = 9

Diagnosed by EBUS-TBNA = 28
Sarcoid: 18
Normal/Reactive: 8
Nondiagnostic: 7
Fungal elements: 1
Bacterial infection: 1

Diagnosed by Surgery = 4
Non-caseating granuloma = 2
Histoplasmosis = 1
Leiomyoma = 1

Other malignancy
Papillomatosis/Tracheal Squamous Carcinoma = 1
Esophageal Squamous = 3
Breast Adenocarcinoma = 3
Renal Adenocarcinoma = 2
Ovarian Adenocarcinoma = 1
Endometrial Adenocarcinoma = 1
Prostate Adenocarcinoma = 1
Gastric Adenocarcinoma = 1
Primary Head/Neck Squamous = 3
Adenocarcinoma of unk. Primary = 1
Hodgkin Lymphoma = 1

Ann Thorac Surg
2008; 85:224-230

Masters MITS '2015
Comparison of Endobronchial Ultrasound and/or Endoesophageal Ultrasound with Transcervical Extended Mediastinal Lymphadenectomy for Staging and Restaging of Non-Small-Cell Lung Cancer

Marcin Zielinski, MD, PhD,* Artur Szlubowski, MD, PhD,† Marcin Kołodziej, MD,‡ Stanislaw Orzechowski, MD,‡ Ewa Laczynska, MD,‡ Juliusz Pankowski, MD, PhD,§ Magdalena Jakubiak, BS,§ and Anna Obrochta, BS§

Background: To compare the diagnostic yield of endobronchial ultrasound (EBUS) and/or endoesophageal ultrasound (EUS) with transcervical extended mediastinal lymphadenectomy (TEMLA) for primary staging and repeated staging (restaging) of non–small-cell lung cancer (NSCLC).

Key Words: Lung cancer, Staging, Endobronchial ultrasound, Esophageal ultrasound, Mediastinal lymphadenectomy.

(J Thorac Oncol. 2013;8: 630–636)
Primary Staging TEMLA

### Table: Diagnostic Performance Comparison

<table>
<thead>
<tr>
<th></th>
<th>EBUS/EUS 623 Patients (%)</th>
<th>TEMLA 276 Patients (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>87.8</td>
<td>96.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Specificity</td>
<td>98.7</td>
<td>100</td>
<td>0.03</td>
</tr>
<tr>
<td>NPV</td>
<td>82.5</td>
<td>99.6</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>PPV</td>
<td>99.1</td>
<td>100</td>
<td>0.07</td>
</tr>
<tr>
<td>Prevalence</td>
<td>63.1</td>
<td>18.4</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

Zielinski, J Thorac Oncol. 2013;8:630–636)

Masters MITS '2015
Restaging TEMLA

**EBUS/EUS**

- **Patients (%)**:
  - EBUS: 78
  - EUS: 6
  - CUS: 50
  - Patients: 105

**TEMLA**

- **Patients (%)**:
  - EBUS: 78
  - EUS: 6
  - CUS: 50
  - Patients: 78

<table>
<thead>
<tr>
<th></th>
<th>EBUS/EUS 105 Patients (%)</th>
<th>TEMLA 78 Patients (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>64.3</td>
<td>96.6</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Specificity</td>
<td>100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>NPV</td>
<td>82.1</td>
<td>98.5</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>PPV</td>
<td>100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Prevalence</td>
<td>40</td>
<td>19.2</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

*Zielinski, J Thorac Oncol. 2013;8: 630–636*
Diagnostic yield of the largest reported series of restaging of NSCLC.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>True positive (TP)</td>
<td>40</td>
<td>20</td>
<td>89</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>True negative (TN)</td>
<td>47</td>
<td>71</td>
<td>7</td>
<td>52</td>
<td>40</td>
</tr>
<tr>
<td>False positive (FP)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>False negative (FN)</td>
<td>17</td>
<td>13</td>
<td>28</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Overall</td>
<td>104</td>
<td>104</td>
<td>124</td>
<td>93</td>
<td>63</td>
</tr>
</tbody>
</table>

Sensitivity (confidence intervals): (0.65, 0.72) (0.52, 0.61) (0.74, 0.77) (0.50, 0.71) (0.87, 0.96)

Negative predictive value (NPV): (0.69, 0.73) (0.81, 0.85) (0.13, 0.20) (0.50, 0.71) (0.93, 0.98)


Masters MITS '2015
Imprint Cytology Speeds TEMLA

Table 3: Results of imprint cytology according to the 453 nodal stations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value (%)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>95.5</td>
<td>0.772-0.999</td>
</tr>
<tr>
<td>Specificity</td>
<td>100</td>
<td>0.992-1.000</td>
</tr>
<tr>
<td>Accuracy</td>
<td>99</td>
<td>0.985-1.000</td>
</tr>
<tr>
<td>PPV</td>
<td>100</td>
<td>0.839-1.000</td>
</tr>
<tr>
<td>NPV</td>
<td>99.8</td>
<td>0.987-1.000</td>
</tr>
</tbody>
</table>


Masters MITS '2015
TEMLA improves Bronchial Mobility
RPCI TEMLA N = 100
April 2009 – Sept 2012

• Mean age – 66
• Histology
  – 38 (58.5%) Adeno
  – 20 (30.8%) Squamous
• Median Hospital - 5
• Median ICU - 1
RPCI TEMLA N = 100

- Neoadjuvant chemo – 55%
- Neoadjuvant chemorad – 15%
- Anatomic resection
  - Lobectomy 81.5%
  - Pneumonectomy 7.7%
- Duration 115±30 min
## RPCI TEMLA
### Stage Data N=100

<table>
<thead>
<tr>
<th>Clinical Stage</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3 (4.6%)</td>
</tr>
<tr>
<td>II</td>
<td>15 (23.1%)</td>
</tr>
<tr>
<td>IIIA</td>
<td>33 (50.8%)</td>
</tr>
<tr>
<td>IIIB</td>
<td>6 (5.2%)</td>
</tr>
<tr>
<td>IV</td>
<td>8 (12.3%)</td>
</tr>
</tbody>
</table>
No vascular complications
Recurrent laryngeal nerve injury – 3%
Average 17 nodes
N2 18.5%
N3 4.6%
Of 3 patients inaccurately classified by TEMLA, only 1 had N2 in TEMLA Accessible Nodes.
<table>
<thead>
<tr>
<th></th>
<th>PET/CT (%)</th>
<th>TEMLA (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>50</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>86.7</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>PPV</td>
<td>50</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>NPV</td>
<td>88.5</td>
<td>94.6</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>80</td>
<td>95.4</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>
### RPCI Results

**TEMLA vs. PET-CT**

<table>
<thead>
<tr>
<th></th>
<th>Path +</th>
<th>Path -</th>
<th>PET +</th>
<th>PET -</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEMLA +</strong></td>
<td>9</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>TEMLA -</strong></td>
<td>3</td>
<td>53</td>
<td>9</td>
<td>47</td>
</tr>
<tr>
<td><strong>PET +</strong></td>
<td>6</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PET -</strong></td>
<td>5</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Accuracy:** 95.4% vs. 80%; P<0.05

Masters MITS '2015
Conclusions

• TEMLA is safe in restaging the mediastinum

• TEMLA can be safely combined with concomitant anatomic resection

• TEMLA is more accurate than PET-CT for restaging the mediastinum after induction therapy for NSCLC
TEMLA/VAMLA Caveat

• Can create hilar fibrosis that can affect dissection later
• Mediastinoscopy is safe and effective for many lung cancer scenarios but not always applied

Current preference Confirmation of Nodal Status before resection in medium risk non-induction patients (+/- EBUS)
• TEMLA/VAMLA Preferences

(1) Induction patients:
EBUS for staging,
Then Chemo +/- XRT
Then TEMLA/VAMLA at time of resection
VATS for the Level 5,6 modes
(2) Unfavorable biology patients
TEMLA/VAMLA Conclusions

• Stages patients better than thoracotomy-based approaches
• Enhances dissection and its extra time is offset by limiting VATS lymphadenectomy
• Therapeutic for some tumors???
Thank you!!
Question

- Is there a therapeutic benefit to Staging?


Masters MITS '2015
Question

• Is there a benefit to dissection Staging?

Stage IB (pT2 N0 M0)

J Thorac Cardiovasc Surg 2009;138:426-433
• Extended cervical lymph node dissection procedures have the potential to better stage patients than thoracotomy based approaches and may be therapeutic for some patients.
TEMLA Result  (N=256)

- 39 nodes/case (15-85)
- Positive N2 (31.3%)
- 138 thoracotomies
  - 5 Missed N2
- Mean 24 month followup
  - Only one locoregional recurrence
  - 77% survival if TEMLA negative

J Thorac Oncol. 2007;2: 370–372
• All cases
  – Sensitivity 96.2%
  – Specificity 100%
  – Accuracy 99%
  – Neg Pred Value 98.7%

• 445 thoracotomies after 513 negative
  – Missed N2 in 7 (1.6%)

• 128 minutes (45-330)
• 0.7% mortality
• 6.6% morbidity

Laryngeal nerve palsy temp/perm (2.3/0.8%)

Pneumonol Alergol Pol. 2011;79(3):196-206

Masters MITS '2015
• Cervical Mediastinoscopy
  – Sensitivity 38%
  – Neg Pred Value 67%

• TEMLA
  – Sensitivity 100%
  – Neg Pred Value 100%

p = 0.019

Methods of Re-staging and their Accuracy


- **EBUS-FNA**: Accuracy 77%, NPV 20% (Herth et al JCO 2008)

- **Mediastinoscopy**: Sensitivity 50-74%, false negative rate of 20% (de Cabanayes C et al JTO 2010)
## RPCI Results

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodal positivity</td>
<td></td>
</tr>
<tr>
<td>TELMA N2</td>
<td>9 (13.8%)</td>
</tr>
<tr>
<td>TELMA N3</td>
<td>3 (4.6%)</td>
</tr>
<tr>
<td>TELMA duration (minutes) Mean (SD)</td>
<td>115.23 (30.3)</td>
</tr>
<tr>
<td>Number of nodes obtained –mean (SD)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>17.0 (11.9)</td>
</tr>
<tr>
<td>Level 2</td>
<td></td>
</tr>
<tr>
<td>2 (unspecified)</td>
<td>0.1 (0.5)</td>
</tr>
<tr>
<td>2R</td>
<td>2.0 (2.3)</td>
</tr>
<tr>
<td>2L</td>
<td>0.5 (1.0)</td>
</tr>
<tr>
<td>Level 4</td>
<td></td>
</tr>
<tr>
<td>4R</td>
<td>5.4 (5.4)</td>
</tr>
<tr>
<td>4L</td>
<td>2.6 (2.9)</td>
</tr>
<tr>
<td>Paratracheal (unspecified)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>0.8 (2.5)</td>
</tr>
<tr>
<td>Left</td>
<td>0.1 (0.6)</td>
</tr>
<tr>
<td>Level 7</td>
<td>5.0 (5.3)</td>
</tr>
<tr>
<td>Post-operative complications</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>8 (12.3%)</td>
</tr>
<tr>
<td>MI</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>8 (12.3%)</td>
</tr>
</tbody>
</table>
CONCLUSIONS

TEMLA is a new minimally invasive surgical procedure providing unique possibility to perform very extensive, bilateral mediastinal lymphadenectomy with very high diagnostic yield in staging of NSCLC.

Almost all intraoperative surgical complications of TEMLA can be managed with conversion to sternotomy/thoracotomy.

The new Aorta Pulmonary retractor will probably facilitate performance of various thoracic operations from transcervical approach.
Index Case F.L. 8/2013

Masters MITS '2015
Index Case F.L. 8/2013

Masters MITS '2015
Primary staging of NSCLC

There was a significant difference between EBUS or EUS and TEMLA for sensitivity (87.8% and 96.2%; p< 0.01) and negative predictive value (82.5% and 99.6%; p< 0.01) in favor of TEMLA.

Restaging of NSCLC

There was a significant difference between EBUS or EUS and TEMLA for sensitivity (64.3% and 100%; p< 0.01) and negative predictive value (82.1% and 100%; p< 0.01) in favor of TEMLA.