Mediastinal Lymph Node Sampling: Transbronchial Needle Aspiration (TBNA) and Endobronchial Ultrasound (EBUS)

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Conflict of Interest/Disclosures

- Received honoraria from Olympus, Inc. for teaching in thoracoscopy courses
- Receive stipend for editing Up to Date sections
- Received honoraria from Forrest, Inc, for speaker’s bureau
- Have stock in various healthcare related companies
Importance of Nodal Staging--
Lung Cancer

- Prognosis


- Remember bronchoscopic biopsies are part of clinical staging. Pathologic stage is based on surgery specimens.
Approaches to lymph nodes in the mediastinum

**Anterior view**
- Esophagus
- Pulmonary ligament
- Aortic arch
- Pulmonary artery

**Posterior view**
- Esophagus
- Superior vena cava
- Azygous vein
- Pulmonary vein
- Inferior vena cava

- Green circle: Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA)
- Yellow circle: Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA)

**Lymph node stations:**
- 1 = High mediastinal
- 2 = Upper paratracheal
- 3 = Prevascular and retrotracheal (not shown)
- 4 = Lower paratracheal
- 5 = Aortopulmonary window
- 6 = Para-aortic (not shown)
- 7 = Subcarinal
- 8 = Paraesophageal
- 9 = Pulmonary ligament
- 10 = Hilar
- 11 = Interlobar
- 12 = Lobar
Nodal Staging

- $N_x =$ cannot be assessed
- $N_0 =$ no regional nodal metastasis
- $N_1 =$ metastasis to ipsilateral peribronchial and/or hilar nodes and intrapulmonary nodes by direct tumor extension
- $N_2 =$ metastasis to ipsilateral mediastinal and/or subcarinal nodes
- $N_3 =$ metastasis to contralateral hilar or mediastinal nodes or any scalene or supraclavicular nodes
## Lung Cancer Staging And Prognosis

<table>
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T X: IA, IB, IIB, IIIA, IIIB
N X: N0, N1, N2, N3
M X: M0, M1
## Lung Cancer Prognosis

<table>
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<th>Clinical Stage</th>
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<th>Pathol. stage</th>
<th>5-year survival (%)</th>
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<td>I/B</td>
<td>38</td>
<td>I/B</td>
<td>57</td>
</tr>
<tr>
<td>II/A</td>
<td>34</td>
<td>II/A</td>
<td>55</td>
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<tr>
<td>II/B</td>
<td>24</td>
<td>II/B</td>
<td>39</td>
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<tr>
<td>III/A</td>
<td>13</td>
<td>III/A</td>
<td>23</td>
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<td>III/B</td>
<td>5</td>
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Approaches to lymph nodes in the mediastinum

**Anterior view**

- Aortic arch
- Pulmonary artery
- Esophagus
- Pulmonary ligament

**Posterior view**

- Superior vena cava
- Azygous vein
- Inferior vena cava
- Diaphragm

**Lymph node stations:**

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- **Green Circle:** Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA)
- **Yellow Circle:** Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA)
Nodal Map

- Standardizes node location *(station)*
- Allows for accurate communication
- You need to know *nodal stations*
TBNA: without or with EBUS
“Blind TBNA”

- Generally, yield of 40-50%, but range from 17-100% if adenopathy on CT scan to 8-14% if absent
- If carinal abnormality visible on bronchoscopy, yield 38-71%, but 9-35% if absent
- Subcarinal nodal station maybe equal to EBUS
- Rapid on-site evaluation (ROSE)-- cytology

Dasgupta and Mehta, Clinics in Chest Medicine, 1999.
TBNA-- Many MDs Do Not Perform

- Never learned
- Safety
- "Blind"
- Lack cytology support
- Damage bronchoscope
- Which needle?
- Cannot replicate literature results

"Pull out, Betty! Pull out! ... You've hit an artery!"
TBNA

- Before you learn EBUS you need to know TBNA:
  1. Principles
  2. Anatomy
  3. Equipment
  4. Technique
TBNA: Anatomy
Subcarinal Area

Main carina

Right main stem bronchus

Subcarinal lymph nodes

Left main stem bronchus

Subcarinal area

Left pulmonary veins

Right pulmonary veins

Pulmonary trunk

Left main stem bronchus

Right main stem bronchus

Aorta

Superior vena cava

Trachea
TBNA: Anatomy
Right Paratracheal Area
TBNA-- Indications

1. Mediastinal / hilar lymph nodes
2. Endobronchial exophytic or submucosal lesion
3. Peripheral nodules
4. Mediastinal cysts
5. Mediastinal abscess
6. Paratracheal masses
TBNA : Needle
Excelon TBNA Needle
TBNA : Techniques

Only extend/ “push out” the needle if you see the catheter

Jabbing Method
TBNA: Techniques

Hub Against the Wall Method
TBNA : Techniques

Piggyback Method
TBNA: Techniques
TBNA : Techniques
TBNA : Technique

- Perpendicular orientation
- Quick thrust
- Bury needle-- minimal needle (shaft) visible
- Confirm puncture visually
- Aspirate and agitate
TBNA: Technique

Needle to wall angle > 45°

Needle insertion to its fullest length
TBNA : Technique
TBNA : Technique

- **Avoid contamination**
- TBNA should be performed prior to other sampling
- Sample “worst” nodal station first
- Release suction prior to needle withdrawal
- Withdraw needle into catheter before withdrawing catheter from bronchoscope
SPECIMEN PREPARATION

Cytology specimen
TBNA:
What Not To Do
TBNA:
What Not To Do
TBNA:
What Not To Do
TBNA : Technician

- Specific instructions in needle use
- Rehearsals
- Good suction
- Stop suction before withdrawing needle
- Use direct smear technique (not saline filled specimen)
- Process all material (flush through the needle with air)
# TBNA

## Rapid on Site Examination

<table>
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<tr>
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<th>Conventional</th>
<th>ROSE</th>
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<tbody>
<tr>
<td>Yield</td>
<td>31%</td>
<td>56%</td>
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<tr>
<td>Dry tap</td>
<td>56%</td>
<td>18%</td>
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Davenport R, Chest, 1990; 98: 59
### How Many Aspirates?

<table>
<thead>
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<th>Positive Aspirate</th>
<th>Single station Yield%</th>
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<tbody>
<tr>
<td>1</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
<td>86</td>
</tr>
<tr>
<td>4</td>
<td>93</td>
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<td>5</td>
<td>97</td>
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<tr>
<td>6</td>
<td>97</td>
</tr>
<tr>
<td>7</td>
<td>98</td>
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Chin R, AJRCCM 2002;166:377
TBNA Complications

- Bleeding (4/630, .6%)
- Pneumothorax-- for mediastinal sampling, similar to non-transbronchial forceps bronchoscopy, 1%
- Pneumomediastinum (1/630, .2%)
- Others as for bronchoscopy in general

- EBUS TBNA similar complication rates
“Blind” vs. EBUS TBNA

- Is EBUS-guided TBNA superior to conventional TBNA?
- Subcarinal lymph nodes (7) were randomized and analyzed separately
- Patients with lymph nodes in position 2, 4, or aortic-pulmonary window were randomized in group B

Radial Probe

Distal tip of scope
The RP is placed through the working channel of a standard bronchoscope but must be removed before any biopsy.
Conventional vs. EBUS TBNA

- **Group A** (Subcarinal lymph node)
  - TBNA was **74%**
  - EBUS was **86%**

- In group B
  - TBNA was **58%**
  - EBUS-guided group **84%**

- The combined yield for groups A and B was **71%** for conventional TBNA vs. **80%** for EBUS guidance (**p < 0.05**)

*Chest. 2004;125(1):322-5*
Direct real-time EBUS-guided TBNA of mediastinal and hilar lymph nodes

Endobronchial ultrasound transducer and processor as part of distal end of scope; thus, perform TBNA under direct US guidance and visualization
Ultrasound

- Water is much better conductor than air of sound waves, where air really limits or prevents image generation.

- Convex/linear EBUS incorporates both the transducer and processor and utilizes a water-filled balloon at the point of sound wave generation and reception.
Convex/Linear EBUS

Scanning Range: 50 degrees
Transducer: 7.5 MHz

Instrument Channel: 2.0mm

Outer Diameter: 6.9mm

Direction of View: 35 degrees forward oblique
Convex/Linear EBUS
Needle for Aspiration
Chest CT and Ultrasound

- Think of CT scan axial image as “X and Y” axes and ultrasound image as “Z” axis

US image is a 50° “pie” slice, parallel to long axis of the bronchoscope
Procedure

- Conscious sedation with topical anesthetic
- Insertion of the EBUS scope-- oral, LMA, tough to pass through < 7.5 ETT
- Airway inspection
- Contact the bronchus
- Inflate balloon, if needed, to improve image
- Confirmation lesion
- EBUS-TBNA → ROSE
TBNA

Ultrasound and Doppler Image of TBNA

Sheski, F. D. et al. Chest 2008;133:264-270
Ultrasound Image-- Node/Lesion Appearance

- **Color**-- grey, black, shades. Vessel is black. Doppler to distinguish

- **Texture**-- gain and contrast controls for color and "graininess"

- If lesion contains calcification, can see white "flecks"

- **Shape**-- normal ~ "kidney bean"
Does Node/Lesion Appearance Suggest Benign or Malignant?

- Size, shape, border clarity, texture (homogenous versus heterogeneous,) and echogenicity (hypo- versus hyper-)

- Lesion appearance is neither sensitive nor specific and a biopsy is needed to establish diagnosis

Falcone, et. al., Respiration, 70: 2003
TBNA

- Choose target and establish good ultrasound image. **Minimize air between transducer and airway wall**—press tip against wall, inflate balloon with water. Adjust gain and contrast.

- Align target with angle of needle entry (green dot is starting point.)

- Extend catheter from bronchoscope, set needle depth, and then extend needle into target
Stations 4R and 4L

Courtesy Kazuhiro Yasufuku
(Convex/Linear) EBUS Limitations

- **6.9 mm outer diameter** and direction of view of the scope is **35° forward oblique**
- Scope manipulation can be problematic
- Size limits inspection to large airways
- Size limits use to paratracheal/peribronchial lesions
- Need “three or four hands” to biopsy
How Do I Learn EBUS?

- ERS/ATS statement-- 40 supervised to gain and 25/year to maintain competency
  Eur Respir J. 2002:356-73

- ACCP guidelines-- 50 supervised to gain and 20/year to maintain competency
  Chest. 2003 May;123(5):1693-717

- “We” needed 5-10 for comfort with equipment and needed 20-25 for comfort with CT/US imaging and with biopsy techniques: **but am continually learning**

- Courses, EBUS-trained colleagues, GI EUS-trained colleagues, company
## Linear EBUS-TBNA for Mediastinal Lymph Nodes

<table>
<thead>
<tr>
<th>Author (yr)</th>
<th>Pts</th>
<th>LNs</th>
<th>CA (%)</th>
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<th>Spec</th>
<th>Comp</th>
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<td>15</td>
<td>13 (87)</td>
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<tr>
<td>Yasafuku ('04)</td>
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<td>70</td>
<td>45 (64)</td>
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<tr>
<td>Yasafuku ('05)</td>
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<td>163</td>
<td>101 (94)</td>
<td>95</td>
<td>100</td>
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<tr>
<td>Vilman ('05)</td>
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<td>28 (90)</td>
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<td>Rintoul ('05)</td>
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<td>18</td>
<td>14 (78)</td>
<td>85</td>
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<td>Herth ('06)</td>
<td>502</td>
<td>572</td>
<td>493 (98)</td>
<td>94</td>
<td>100</td>
<td>None</td>
</tr>
</tbody>
</table>

Yields, ~89-96%

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Krasnik M et al. Thorax 2003
Yasafuku K et al. Chest 2004 and Lung Cancer 2005
Vilman P et al. Endoscopy 2005
Rintoul RC et al. Eur Respir J 2005
Herth FJF et al. Thorax 2006

Courtesy of John DeWitt, MD
EUS + EBUS vs. Mediastinoscopy

Mountain CF et al. Chest 1997;111:1718-1723
Rintoul R et al. Endoscopy 2006; 38:S110-S113
Conclusion

- You need learn standard TBNA
- EBUS with either technique (radial probe or convex/linear) is accurate and safe
- The convex/linear EBUS provides for real-time biopsy
- Combination of EBUS and EUS for diagnosing and staging lung cancer could possibly eliminate the use of mediastinoscopy