Endobronchial Ultrasound-guided Transbronchial Needle Aspiration

Felix J. F. Herth, MD,* Mark Krasnik, MD,† Kazuhiro Yasufuku, MD,‡ Robert Rintoul, MD,§ and Armin Ernst, MD¶

Abstract: The increasing use of minimally invasive techniques has renewed interest in transbronchial needle aspiration (TBNA) for obtaining biopsies of mediastinal lymph nodes. However, conventional TBNA relies on “blind” needle puncture guided only by static computed tomography scans. The success of the technique is highly operator-dependent: reported sensitivities vary between 15% and 78%. In addition, many pulmonologists are so discouraged by the results of their initial experience with the technique that only 20% to 30% use TBNA. Here, we describe our technique for performing endobronchial ultrasound-TBNA using a curved linear array ultrasonic bronchoscope that allows aspiration biopsy under real-time ultrasound imaging.

Key Words: endobronchial ultrasound, transbronchial needle aspiration, lung cancer, lymph node, biopsy

Although it allows good access to the anterior mediastinum, access to the posterior and inferior mediastinum is limited. As a result, its sensitivity for detecting cancer in mediastinal lymph nodes varies between 80% and 90%.3 The increasing use of minimally invasive techniques and day case procedures has renewed interest in transbronchial needle aspiration (TBNA) for obtaining biopsies of mediastinal lymph nodes. However, conventional TBNA relies on “blind” needle puncture guided only by static CT scans. The technique is highly operator dependent: reported sensitivities vary between 15% and 78%.3,4 In addition, many operators are so discouraged by the results of their initial experience with the technique that only 20% to 30% of pulmonologists use TBNA.5,6

Here, we describe our technique for performing endobronchial ultrasound-TBNA (EBUS-TBNA) using a curved linear array ultrasonic bronchoscope that allows aspiration biopsy under real-time ultrasound imaging.

MATERIALS AND METHODS

Bronchoscope

The bronchoscope (BF-UC160F-OL8/BF-UC260F-OL8; Olympus Medical Systems Corp, Tokyo, Japan) is similar to a standard bronchovideoscope. It has an outer diameter of 6.9 mm, a 2.0-mm instrument channel, and 35-degree forward oblique-viewing optics. An electronic curved linear array ultrasonic transducer is mounted at the distal end and is covered by a water-inflatable balloon. Scanning is performed at a frequency of 7.5 MHz and allows a tissue penetration of 20 to 50 mm. Image processing is performed by an endoscopic ultrasound center (EU-C60/EU-C2000; Olympus Medical Systems Corp, Tokyo, Japan).

Needle Aspiration

The inner diameter of the instrument channel is 2.0 mm. A dedicated 22-gauge needle (NA-201SX-4022 Olympus Medical Systems Corp, Tokyo, Japan) was developed to perform EBUS-TBNA. The inner diameter of this needle is nearly equal to that of a conventional

Received for publication July 1, 2005; accepted December 15, 2005. From the *Department of Pneumology and Critical Care Medicine, Thoraxklinik University, Heidelberg, Germany; †Department of Cardiothoracic Surgery, Gentofte University Hospital, Copenhagen, Denmark; ‡Department of Thoracic Surgery Chiba University, Graduate School of Medicine, Chiba, Japan; §Papworth Hospital, Cambridge, UK; and ¶Interventional Pulmonology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, USA. Funded by Olympus Medical Systems Corporation provided EBUS bronchoscopes and equipment on loan to the authors.

Reprints: Armin Ernst, MD, Director, Interventional Pulmonology, Beth Israel Deaconess Medical Center, One Deaconess Road, Deaconess 201, Boston, MA 02215 (e-mail: aernt@bidmc.harvard.edu).

Copyright © 2006 by Lippincott Williams & Wilkins

How I Do It
21-gauge needle, which allows the sampling of histologic cores in some cases. The needle is also equipped with a stylet, which is withdrawn after passing the bronchial wall, avoiding contamination during EBUS-TBNA. The needle can be visualized through the optics and on the ultrasound image.

Fine needle aspiration is performed by passing the needle through the airway wall and into the lymph nodes under real-time ultrasound control. Needle punctures are performed using the “jabbing” method. Integrated Color Power Doppler mode can be used to identify intervening vessels immediately before needle puncture.

**Illustrated EBUS-TBNA Procedure**

Prepare the patient as usual, and insert the endoscope into the trachea. The posterior part of the trachea is vertically structured (resembling long vertical plies) and easy to distinguish from the arch-shaped cartilage structures (the horizontal support of the bronchial tree). The trachea then separates into the left and right main bronchi at the main carina (Fig. 1). The appearance of the main carina, in conjunction with the structure of the trachea, makes distinguishing the left main bronchus from right main bronchus easy.

To enter the right main bronchus, lever the tip of the endoscope and turn it slightly to the right. Successful insertion of the endoscope into the right main bronchus is indicated when the right upper lobe comes into view only 2 to 3 cm after the tip passes the main carina (Fig. 2).

Having visualized—but not entering—the right upper lobe, and after straightening the endoscope, follow the intermediate bronchus distally. Follow the intermediate bronchus until the diameter of the bronchial tree prevents the endoscope from being advanced further. This point is usually beyond the subcarina, which branches into the middle and right lower lobes. In patients with large

---

**FIGURE 1.** A, Intraluminal view of the main carina showing the openings to the left and right main bronchi. B, Position of the bronchoscope tip when visualizing the main carina.

**FIGURE 2.** A, Intraluminal view of the subcarina showing the branch to the right upper lobe. B, Position of the bronchoscope tip when visualizing the upper lobe carina right.
FIGURE 3. A 58-year-old smoker with small-cell lung cancer. A, Intraluminal view of the subcarina showing branches into the middle and right lower lobes, adjacent to lymph node station 11 R. B, CT image of enlarged node in station 11 R. C, Position of the bronchoscope tip when visualizing the subcarina of the middle and right lower lobes. D, EBUS image shows the enlarged, inhomogeneous node.

FIGURE 4. A 55-year-old man with a solitary pulmonary nodule in the left upper lobe (2 cm in diameter) and an enlarged node at station 10 R. The diagnosis was adenocarcinoma (T1N3M0). A, Intraluminal view of the subcarina dividing into right upper lobe and the intermediate bronchus at the level of lymph node station 10 R. B, CT image of the enlarged node in station 10 R. C, Position of the bronchoscope tip when visualizing the area of lymph node station 10 R. D, The node is clearly visible, close to the pulmonary artery.
FIGURE 5. A 59-year-old man with adenocarcinoma of the right upper lobe. His chest CT scan showed lymph node enlargement at station 7. A, Intraluminal view of the main carina. B, CT image of LN station 7. C, Position of the bronchoscope tip when visualizing lymph node station 7. D, Two fused lymph nodes with sharp margins are visible on the EBUS image.

FIGURE 6. A patient with a small (<1 cm) lymph node at station 4 R. A, Intraluminal view of lymph node station 4 R. B, CT image of the node in station 4 R. C, Position of the bronchoscope tip when visualizing lymph node station 4 R. D, EBUS image showing a homogeneous node adjacent to the pulmonary artery (orange in color power Doppler flow).
FIGURE 7. A 38-year-old woman with multiple enlarged mediastinal nodes. The diagnosis was sarcoidosis. A, Intraluminal view of lymph node station 4 L. B, CT image of the enlarged nodes in station 4 L. C, Position of the bronchoscope tip when visualizing the area of node 4 L. D, EBUS image showing a node directly above the left pulmonary artery (orange).

FIGURE 8. A 48-year-old man, with weight loss and an enlarged lymph node at station 10 L. The diagnosis was adeno-carcinoma. A, Intraluminal view of the carina of the left upper and lower lobes in the area of lymph node station 10 L. B, CT image of node station 10 L. C, Position of the bronchoscope tip when visualizing the carina of the left upper and lower lobes. D, EBUS image of the puncture procedure, the needle is visible within the node.
FIGURE 9. A 38-year-old woman, heavy smoker with a lesion in the right upper lobe. EBUS-TBNA diagnosed N3 station positive squamous cell carcinoma. A, Intraluminal view of the at the level of the proximal part of the lower lobe. B, CT image of station 11 L showing enlarged nodes. C, Position of the bronchoscope tip when visualizing the lymph node station 11 L. D, In the EBUS image 2 nodes are visible.

FIGURE 10. A 46-year-old man with a coin lesion in the left lower lobe (NSCLC). EBUS-TBNA shows normal lymphocytes, confirmed by mediastinoscopy. A, Intraluminal view with the probe against the right tracheal wall at the 3-o’clock position to examine the upper paratracheal lymph nodes at station 2 R. B, In the CT slightly enlarged nodes are visible. C, Position of the bronchoscope tip when visualizing the lymph node station 2 R. D, EBUS image of the node in 2 R.
airways, the endoscope can sometimes be advanced further, beyond the carinas of the basal group.

The area just beyond the subcarina, at the 2-o’clock to 4-o’clock position, is adjacent to lymph node station 11 R. Entrance into this area marks the start of the ultrasonic examination (Fig. 3). Withdraw the endoscope slightly from the subcarina, just proximal the entrance to the right upper lobe. The endoscopic image shows the subcarina dividing into right upper lobe and the intermediate bronchus. After confirming correct placement of the tip, continue the ultrasonic examination at the level of lymph node station 10 R. Any lymph node in this area is at the 2-o’clock position (Fig. 4).

Switching to the endoscopic image, see the carina of the upper lobe. Turn the endoscope to the 9-o’clock position and press the tip of the endoscope (ultrasonic transducer) against the bronchial wall of the right main bronchus, just below the main carina. The ultrasonic examination continues at the level of lymph node station 7 (Fig. 5).

Withdraw the endoscope just proximal to the main carina, turn it to the 3-o’clock position, and check lymph node station 4 R for lymph nodes. Station 4 R is close to the vena cava and azygos vein (Fig. 6).

Turn the tip of the endoscope to the 3-o’clock position and examine subcarinal lymph node station 7 again, this time from the left main bronchus. After confirming the successful placement of the endoscope through the intraluminal view, continue the ultrasonic examination by scanning to the right side of the station (the side facing the mediastinum).

Turn the endoscope to the 9-o’clock position and scan the area of lymph node station 4 L. The aortic arch can be followed posteriorly to the aortopulmonary window; the aortic arch will be proximal and the left pulmonary artery will be distal (Fig. 7).

Under the endoscopic image, push the endoscope further into the left main bronchus, toward the carina of the left upper and lower lobes. Press the tip of the endoscope (ultrasonic transducer) to the bronchial wall at the 11-o’clock position, the area of lymph node station 10 L (Fig. 8).

With the endoscopic image still focused on the wall of the left upper lobe, turn the endoscope and approach the left lower lobe. Rotate the endoscope to the 2-o’clock position, at the level of the proximal part of the lower lobe. This is the area of the interlobar lymph nodes, lymph node station 11 L (Fig. 9).

Withdraw the endoscope back beyond the carina. In the middle trachea, press the tip of the endoscope (ultrasonic transducer) against the right tracheal wall at the 3-o’clock position to examine the upper paratracheal lymph nodes on the right side of the body (Fig. 10).

By turning the endoscope to the 9-o’clock position on the contralateral side of the tracheal wall, lymph node station 2 L can be scanned. This station is the area of the aortic arch (Fig. 11).

A further rotation of the endoscope to the 6-o’clock position brings the endoscope to the area of lymph node

---

**FIGURE 11.** A patient with adeno carcinoma (T2N2M0) in the left lower lobe. A, Intraluminal view of the tracheal wall at lymph node station 2 L. B, CT image showing a slightly enlarged node at station 2 L. C, Position of the bronchoscope tip when visualizing the lymph node station 2 L. D, EBUS image of the node in 2 L.
station 3, the prevascular and retrotracheal lymph nodes. This visualization is possible in only a few patients.

DISCUSSION

EBUS-TBNA is a useful and accurate diagnostic technique that is easy to master. We have suggested how to perform the examination and have provided a standard framework for any EBUS-TBNA procedure. With more and more data showing the superior accuracy of EBUS-TBNA over 90%, comparable with the data of routine mediastinoscopy, we expect this ultrasound-guided approach to become a standard component in evaluating patients with mediastinal lymphadenopathy.

REFERENCES