Staging of Bronchogenic Carcinoma by Bronchoscopy*

Ko-Pen Wang, M.D., F.C.C.P.

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AJCC=American Joint Committee on Cancer; ATS=American Thoracic Society; FCNA=percutaneous needle aspiration; TBNA=transbronchial needle aspiration

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since the development of the techniques of computed tomographic (CT) scanning and transbronchial needle aspiration, the staging of bronchogenic carcinoma has changed. Previous staging, mainly by plain chest x-ray films and surgery, was developed by the American Joint Committee on Cancer (AJCC) and has been used since the early 1970s.1,2 The current modification of the AJCC system is designed to reflect modern philosophies of treatment and to resolve differences between the AJCC system and the system of the Union Internationale Contre le Cancer (UICC) (widely used in Europe) and of the Japan Joint Committee of Lung Cancer; this modification has provided the opportunity for progression to an international unified system.3-7 This report is intended to stimulate the development of an international system of bronchoscopic staging and to incorporate that system into the new AJCC system.

In the past, bronchoscopy played a limited role in the staging of bronchogenic carcinoma, and the major use of bronchoscopy was to assess the T (tumor) status. Lesions beyond the lobar bronchus were considered as T1; tumors involving the main bronchus 2 cm or more distal to the carina were considered as T2; tumors in the main bronchus within the 2-cm distance from the carina, but without involvement of the carina, were considered T3; and, finally, tumors invading the carina were considered as T4. Development of the CT scan has expanded the role of the radiologist in the staging of bronchogenic carcinoma, compared with the limited use and value of routine plain chest x-ray film and tomography. Numerous reports have been published about the staging of lung cancer by CT scan, in particular about its usefulness in evaluating the nodal status.8-10 The general conclusion is that the CT scan, when used to evaluate the mediastinum, is very sensitive, but not too specific. The value of flexible bronchoscopic techniques of transbronchial needle aspiration (TBNA) in staging bronchogenic carcinoma has also been reported. In general, transbronchial needle aspiration is sensitive and specific for the diagnosis of lymph node involvement10-12 The combined use of these two relatively new techniques, the CT scan and TBNA, has provided us with a great opportunity for noninvasive staging of bronchogenic carcinoma. As previously stated, bronchoscopy without TBNA has only limited merit in evaluating the intrabronchial extent of the tumor and has no role for evaluating the lymph nodal status. Therefore, the use of bronchoscopy is limited mainly to evaluation and diagnosis of the airway.

The development of the TBNA technique has markedly expanded the role of bronchoscopy from diagnosis to staging. The ability of TBNA to sample the mediastinum and hilar lymph nodes potentially can reduce the need for mediastinoscopy for right paratracheal lesions, the need for mediastinotomy for left paratracheal or aortic pulmonary window lesions, and the need for open thoracotomy for posterior, subcarinal, and hilar lesions. The noninvasive nature of this technique is most promising for the staging of bronchogenic carcinoma. The combined use of TBNA with the CT scan can have a major impact on the management of lung cancer; however, one major problem with TBNA is that it has not been used as widely as it should be, mainly because it is a relatively new procedure with unpredictable results. The sensitivity of TBNA could be improved with proper knowledge of anatomy and technique. This report is intended to describe the relevant anatomy and technique in using TBNA to assess the mediastinum and hilar lymph nodes in order to evaluate the "N" status in bronchogenic carcinoma. When used together, CT scanning and bronchoscopy retain the sensitivity of the CT scan in discovering abnormal lymph nodes and incorporate the specificity of TBNA to diagnose the cell type of a metastatic lesion in the lymph node.

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*From the Chest Diagnostic Center, Harbor Hospital Center, Baltimore.
Reprint requests: Dr. Wang, 3001 South Hanover, Baltimore 21225
Definitions or nomenclature of the lymph nodes and how they relate to the AJCC system and the system of the American Thoracic Society (ATS) are described. It is not the intent of the author to create a new system, but rather to use the CT scanning and TBNA advances to describe the mediastinum and hilar lymph node anatomy in a simple, practical manner. The value and definition of the AJCC and ATS lymph node mapping systems are accepted and recognized; changing the numbering system is to accommodate TBNA technique. The most commonly involved lymph nodes and airway branches, used as landmarks for TBNA, are included. By following these landmarks it is possible to sample even normally sized lymph node tissue from the mediastinum and hilar areas. Four bronchoscopic views or sections from the CT scan are used as key reference points: (1) the lower trachea near the carina; (2) the right main bronchus near the right upper lobe orifice; (3) the bronchus intermedius near the middle lobe orifice; and (4) the left main bronchus, near the lower or upper lobe spur.

Eleven nodal stations were named: (1) anterior carina lymph node; (2) posterior carina lymph node; (3) right paratracheal lymph node; (4) left paratracheal lymph node (aortic pulmonary window); (5) right main bronchus lymph node; (6) left main bronchus lymph node; (7) right upper hilar lymph node; (8) subcarinal lymph node; (9) right lower hilar lymph node; (10) subsubcarinal lymph node; and (11) left hilar lymph node. The location of the lymph node by CT image and TBNA puncture site is described in detail (Fig 1-3; Tables 1 and 2).

**Carina**

At the first level, from the lower end of the trachea, while viewing the carina and both main bronchi, six nodal stations can be identified: (1) anterior carina; (2) posterior carina; (3) right paratracheal; (4) left paratracheal; (5) right main bronchus; and (6) left main bronchus (Fig 1, stations 1 to 6). Carinal lymph nodes are divided into anterior and posterior. At this level, the anterior carina is defined as the lymph node in front of and between the proximal end of the right and left main bronchi. The posterior carina is defined as behind and between the proximal portion of the right and left main bronchi or often directly behind the right main bronchus (Fig 2, station 1 and 2). For the selection of the sites for TBNA puncture, consideration should be given to the length of the needle and the angle of entrance because, in spite of an attempt to puncture the airway perpendicularly as possible, a certain degree of angulation will result. The length of the needle should be long enough (1.3 to 1.5 cm) to compensate for the loss from angulation, and the tip of the needle should reach the node to be sampled. For the anterior carina node station 1, the first intercartilaginous space at about 12 to 1 o’clock is punctured (Fig 3, station 1). The puncture site for the posterior carina nodes is exactly opposite to the anterior carina puncture site and is at about 5 to 6 o’clock in the posterior tracheal wall (Fig 3, station 2). The puncture of the anterior carina lymph node occasionally results in bloody aspiration, but there are
no other complications. In order to avoid puncturing the azygoesophageal recess and to avoid the possibility of causing pneumothorax, biopsy of the posterior carina lymph node should only be performed when CT scanning demonstrates enlarged lymph nodes in that area.
Nodal station 3, the right para-tracheal lymph node group, is much more commonly involved, compared to more proximal lymph nodes, such as the higher para-tracheal lymph node (group 2 in the AJCC system), the pre-tracheal and retro-tracheal lymph nodes (group 3 in the AJCC system), and the highest mediastinal lymph node (group 1 in the AJCC system). Of the AJCC system lymph node groups 1 to 4, only group 4, the lower right para-tracheal, was selected in this system as number 3 for the right para-tracheal lymph node. The reason for this selection is that this group of nodes is most frequently involved, and its location can be accurately identified and nodes can be sampled by using the carina or intercartilaginous space of the trachea and the tracheobronchial angulation as a landmark for TBNA. The right para-tracheal lymph node is located above the level of the azygos arch and anterior lateral aspect of the lower trachea, or behind the superior vena cava (ATS) (Fig 2, station 3). The node should be sampled by puncturing at the 1 to 2 o'clock position of the second to fourth intercartilaginous spaces of the lower trachea by counting the lowest intercartilaginous space from the carina as the first and then coming up proximal to the larynx (Fig 3, station 3). This node is most commonly involved in malignant processes and even sarcoidosis. The more proximal nodes, adjacent to the trachea (groups 1, 2, and 3 of the AJCC), are less involved in general. Even if the node is involved, it is difficult to identify its exact location through bronchoscopy unless there is external compression. In the presence of extrinsic compression, the needle is placed from the upper border of the extrinsic compression. In the absence of extrinsic compression, when only higher tracheal lymph nodes are involved and without lower right para-tracheal involvement, fluoroscopic guidance is used to ensure the exact level of needle placement.

The left para-tracheal lymph node was defined as nodal station 4, which includes left lower para-tracheal nodes and some of the aortic pulmonary window lymph nodes (which includes subaortic or suprapulmonic lymph nodes). Both groups can be sampled by TBNA. Usually, those nodes are around the lateral aspect of the lower trachea near the tracheobronchial angulation and below the aortic arch, above the pulmonary artery (Fig 2, station 4). The puncture site is identified as 9 o'clock around the left lower trachea at the same level as the tip of the ca-
Table 2—Wang TBNA Staging System: TBNA Site for Mediastinum and Hilar Lymph Nodes (Defined by Bronchoscopy)

<table>
<thead>
<tr>
<th>Lymph Node</th>
<th>Site</th>
</tr>
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<tbody>
<tr>
<td>1. Anterior carina</td>
<td>First and second intercartilaginous interspace from lower trachea at about 12-1 o'clock position</td>
</tr>
<tr>
<td>2. Posterior carina</td>
<td>Posterior portion of carina at about 5-6 o'clock position</td>
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<tr>
<td>3. Right paratracheal</td>
<td>Second to fourth intercartilaginous interspace of lower trachea at about 1-2 o'clock position</td>
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<tr>
<td>4. Left paratracheal (aortic pulmonary window)</td>
<td>First or second intercartilaginous interspace from lower trachea at about 9 o'clock position</td>
</tr>
<tr>
<td>5. Right main bronchus</td>
<td>First or second intercartilaginous interspace from proximal right main bronchus at about 12 o'clock position</td>
</tr>
<tr>
<td>6. Left main bronchus</td>
<td>First or second intercartilaginous interspace from proximal left main bronchus at about 12 o'clock position</td>
</tr>
<tr>
<td>7. Right upper hilar spur</td>
<td>Anterior portion of right upper lobe</td>
</tr>
<tr>
<td>8. Subcarina</td>
<td>Medial wall of right main bronchus at about 9 o'clock position, proximal to level of right upper lobe orifice</td>
</tr>
<tr>
<td>9. Right lower hilar orifice</td>
<td>Lateral or anterior wall of bronchus intermedius at about 3 o'clock position and 12 o'clock position near or at level of right middle lobe orifice</td>
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<tr>
<td>10. Subsubcarina</td>
<td>Medial wall of bronchus intermedius at about 9 o'clock position, proximal to level of right middle lobe orifice</td>
</tr>
<tr>
<td>11. Left hilar</td>
<td>Lateral wall of left lower lobe bronchus at about 9 o'clock, at level of superior segment orifice of left lower lobe</td>
</tr>
</tbody>
</table>

lymph nodes are the only nodes involved, which is very seldom, they are beyond the reach of TBNA. Under these circumstances, a percutaneous needle aspiration (PCNA), either under fluoroscopic or CT guidance, is an alternative procedure to mediastinotomy. The PCNA is relatively easy to perform because the lesion is nonmobile with respiration. If the needle is placed below the aortic arch, above the pulmonary artery, and lateral to the ascending aorta, and if the depth is controlled in order to prevent reaching the descending aorta, the procedure should be very safe. The pulsation of the needle due to the transmission from the aorta is impressive and fearsome but imposes no serious risk for the PCNA. Nodes in front of the right and left main bronchi are defined as stations 5 and 6 (Fig 1, stations 5 and 6), and the puncture site is at the first or second intercartilaginous space, from 12 o'clock at each main bronchus. The counting of intercartilaginous spaces for the main bronchus is from the carina, counting distally (Fig 3, stations 5 and 6).

**Right Main Bronchus**

In previous reports for TBNA staging, only right and left paratracheal and carina lymph nodes were emphasized. There is less mention of the main bronchus and the different levels of subcarinal or hilar sampling. As experience with the use of CT scanning to visualize the mediastinal and hilar lymph nodes grows, it becomes apparent that the lymph nodes in front of the right upper lobe spur and the subcarinal lymph nodes are quite commonly involved. The CT scanning at the level of the right upper lobe bronchus is chosen to identify the right upper hilar and subcarinal nodes (Fig 1, stations 7 and 8). The right upper hilar node is located in front of and between the right upper lobe bronchus and the bronchus intermedius. The node can be sampled by puncturing the anterior aspect of the right upper lobe spur (Fig 2 and 3, station 7). The subcarinal lymph node is between the right and left main bronchi and near the level of the right upper lobe bronchus and can be sampled by puncturing the medial wall of the right main bronchus at about the 9 o'clock position near the right upper lobe bronchus level (Fig 2 and 3, station 8).

**Bronchus Intermedius**

At the bronchus intermedius near the right middle lobe bronchus, lymph nodes are around the side of the bronchus intermedius. Occasionally, lymph nodes in front of the bronchus intermedius, which can push the pulmonary artery forward, are noticed. Those groups of lymph nodes are defined as group 9, lower right hilar nodes (Fig 1 and 2, station 9). They can be sampled around the right lateral aspect of the lower lobe.
bronchus intermedius (Fig 3, station 9). Puncture of this site frequently results in bloody aspiration, but no increased risk of complication has been seen. Directly opposite to the right lower hilar lymph node at the medial wall of the bronchus intermedius is a subsubcarinal lymph node group. Puncture should be performed at 9 o’clock at the bronchus intermedius (Fig 2 and 3, station 10). Quite often, this group of lymph nodes can extend below the right middle lobe orifice. Those nodes are posterior to the heart, so in spite of their apparent proximity to the left atrium, they possess no increased risk in TBNA (Fig 2, station 10). The paraesophageal lymph nodes and pulmonary ligament lymph nodes are ignored in this system because of their distance from the airway. Very rarely are paraesophageal lymph nodes the only abnormality. In this event, a transesophageal needle aspiration is performed to sample the specimen. Landmarks of the esophageal needle aspiration are guided by external compression. It is not clear whether the subcarina or the subsubcarina, by our definition, represents enlarged paraesophageal or pulmonary ligament lymph nodes (AJCC groups 8 and 9).

LEFT MAIN BRONCHUS

The final cut by CT scan is the level of the left upper lobe and left lower lobe spur; the lymph nodes between the upper lobe and lower lobe bronchus are defined as left hilar station 11 (Fig 1 and 2, station 11). The recommended puncture site is at the midlateral wall of the left lower lobe bronchus at the level of the superior segment orifice, in order to avoid the descending left pulmonary artery and to ensure a deeper penetration of the needle into this group of lymph nodes (Fig 3, station 11). Puncture of the left hilar lymph node can result in bloody aspiration if the puncture is too posterior; however, this occurs much less frequently than in right lower hilar needle aspiration. Most bronchoscopists apply the bronchoscope to their patients and view the airways from above and behind; on the contrary, radiologists view the CT scan of the chest from below (Fig 2). Bronchoscopists must flip the right and left of the CT image in their mind while performing TBNA.

This classification should not confuse the issue. Naruke’s lymph node numbers and the ATS modification are well accepted and serve the purpose well. Our numbering system is a response to the development of newer techniques of CT scanning and TBNA. Use CT scanning as a guide to select the most involved group of lymph nodes; use the airway as a landmark to perform TBNA (Fig 4). This system allows the bronchoscopist, along with the radiologist and the surgeon, to be more actively involved in the staging of lung cancer. This precise and accurate noninvasive staging technique will guide the proper selection of treatment and clinical investigation to determine the value of each treatment.

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