Review of the International Association for the Study of Lung Cancer Lymph Node Classification System Localization of Lymph Node Stations on CT Imaging

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KEYWORDS
- International Association for the Study of Lung Cancer lymph node map
- Lymph node stations
- Imaging
- CT

KEY POINTS
- The International Association for the Study of Lung Cancer (IASLC) map is the newest lymph node classification system. Compared with previous lymph node maps, it provides fixed, specific anatomic descriptors for all thoracic lymph node stations.
- CT imaging is one of the most important modalities used in the clinical staging of lung cancer patients.
- It is important to be familiar with the IASLC map as well as able to accurately identify the different lymph node stations on CT imaging.
- Lymph node maps have been continuously evolving in past years and may be subject to future amendments as more information becomes available from clinical trials.

INTRODUCTION
Thoracic lymphadenopathy is a common finding in patients with lung cancer and signifies metastatic nodal involvement. The location of the involved thoracic lymph node groups in relation to the primary lung tumor determines the nodal (N) designation of the tumor, node, metastasis (TNM) classification system used in the staging of lung cancer. Accurate detection and classification of the involved thoracic lymph node groups are essential for appropriate staging of lung cancer patients, also determining available treatment options and helping predict patient prognosis.

Funding Sources: Nil.
Conflict of Interest: Nil.
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http://dx.doi.org/10.1016/j.ccm.2013.04.008
0272-5231/13$ – see front matter © 2013 Elsevier Inc. All rights reserved.
Multiple lymph node maps have been published in the past to provide diagrammatic descriptions of thoracic lymph node groups. Although they provide an excellent visual representation of these nodal groups, they are of limited value when clinicians are faced with the challenge of identifying and classifying thoracic lymphadenopathy on CT imaging. This article reviews the most recent thoracic lymph node classification system, proposed by the IASLC in 2009. It describes each of the IASLC lymph node stations with both illustrations and CT images to enable clinicians to better understand and accurately identify these lymph nodes on CT imaging. Although articles in the past have correlated CT images with the previously used Mountain-Dressler American Thoracic Society (ATS) classification, to the authors’ knowledge, this is the first attempt to depict the recently published IASLC lymph node map with representative CT images.

HISTORY OF THORACIC LYMPH NODE MAPS

Thoracic lymph node maps have been in place for the past 40 years. They were developed to provide a systematic, universal approach to gauge the degree of lymph node involvement in lung cancer patients. The general idea behind these maps was to classify the thoracic lymph nodes into numerically labeled regions with fixed anatomic boundary descriptors. The intent was to provide a universally accepted, precise lymph node classification system to guide assessment of patient treatment outcomes and planning of individual patient therapy, and to also allow for comparison of results across multiple institutions and clinical trial designs.

Because these maps directly affect patient management and treatment decisions for a disease with extremely high morbidity and mortality burden, they have been under continuous scrutiny and been revised frequently. Multiple versions of these maps arose throughout the years due to failure of consensus on a single version.

The first lymph node map was proposed by Naruke and colleagues in the 1960s. This was met with widespread acceptance and used in North America, Europe, and Japan. In the 1980s/1990s, attempts were made to revise the anatomic descriptors proposed in the Naruke map. The first revision was the development of the American Thoracic Society (ATS) lymph node map. Subsequently, Mountain and Dressler created another lymph node map, known as the MD-ATS map (Fig. 1), in an attempt to unify the Naruke and ATS maps into a single classification system. The MD-ATS map was adopted by the American Joint Committee on Cancer (AJCC) and the Prognostic Factors TNM Committee of the International Union Against Cancer (UICC) at the 1996 annual meetings of these organizations. Although the MD-ATS map was widely used in North America, it was only sporadically used in Europe. Meanwhile, Japan continued to use the initial Naruke map, as advocated by the Japan Lung Cancer Society.

THE IASLC MAP

The IASLC commenced its first lung cancer staging project in 1998. They discovered that the node (N) descriptors of the MD-ATS and Naruke classification systems had significant discrepancies, which had direct implications on the staging of lung cancer patients. The IASLC committee members were charged with the task of developing a new lymph node classification system with the purpose of (1) reconciling the differences between the MD-ATS and Naruke maps and (2) providing anatomically distinct descriptions for the proposed lymph node stations. In 2009, the IASLC committee proposed a new lymph node map. This new map, known as the IASLC map, grouped the thoracic lymph nodes into 7 specific zones: supraclavicular, upper, aortopulmonary, subcarinal, lower, hilar-interlobar, and peripheral (Table 1). The thoracic lymph nodes are further assigned to 1 of 14 numbered stations (stations 1–14); the descriptor “R” or “L” is added to denote right-sided or left-sided nodes, respectively. The TNM Classification of Malignant Tumours, 7th edition, was also published in 2009, which incorporated the newly formulated IASLC lymph node classification system into its proposals. The IASLC lymph node map is detailed in Fig. 2.

According to the new TNM edition, patients without lymph node involvement are designated as N0. N1 disease is defined as having metastatic lymph node involvement of ipsilateral peripheral or hilar zones (stations 10–14). N2 disease is present if there is extension of tumor metastasis to ipsilateral mediastinal (upper, aortopulmonary, and lower) or subcarinal zones (stations 2–9). The N3 designation signifies metastatic lymph node involvement of the ipsilateral or contralateral supraclavicular zone lymph nodes (station 1) or any nodes in the contralateral mediastinal, hilar-interlobar, and peripheral zones.

RADIOGRAPHIC ANATOMY

The IASLC lymph node classification provides precise anatomic descriptors for lymph node station boundaries. Like previous maps, however, it may
be subject to modifications in the future. Already, a few areas of uncertainty within the IASLC lymph node map have been pointed out by various investigators.

The supraclavicular zone lymph nodes (station 1) were previously termed, highest mediastinal nodes, by the MD-ATS classification system and were defined as lymph nodes lying above a horizontal line at the upper rim of the left innominate vein where it ascends to the left, crossing in front of the trachea at its midline. The IASLC map classifies the supraclavicular zone as station 1 and further subcategorizes it into 3 separate lymph node groups—supraclavicular, lower cervical, and sternal notch nodes (Fig. 3, see Table 1). The latter 2 lymph node groups are a new addition to station 1 and were previously not included by the MD-ATS map. In a recent article, Pitson and colleagues6 pointed out that the definition provided for the lateral aspect of the lower border of the station 1 nodes (clavicles) is unclear in terms of whether the upper or lower border of the clavicles should be used. According to the IASLC map, the lateral borders for the superior margins for both stations 2 and 3 are the lung apex and pleura. Because clavicles can vary in position and can extend inferior to the lung apex, this leads to a region inferior to the lung apex but superior to the clavicles where stations 1, 2, and 3 can all be potentially present. This carries importance because this is a distinction between N2 and N3 disease.

Station 2 lymph nodes are part of the upper zone, and include the right and left upper paratracheal lymph node groups, 2R and 2L, respectively (Figs. 4 and 5). They were previously defined by the MD-ATS classification as lymph nodes lying below the lower margin of the station 1 nodes but superior to an imaginary line drawn horizontally and tangentially to the upper margin of the aortic arch. According to the recent IASLC classification, the upper margin of 2R and 2L is the superior border of the manubrium medially and the lung apex and pleural space laterally. The lower margins of 2R and 2L have been differentiated, however. The inferior border of 2L is now formed by...
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the superior margin of the aortic arch, whereas the inferior border of station 2R is now the caudal margin of the left innominate vein where it intersects the trachea (see Table 1). Recently, Ichimura and colleagues\(^7\) pointed out that this is usually an oblique intersection and can be difficult to identify accurately on axial CT images. Those who created the IALSC map, however, have insisted that the caudal margin of the left innominate vein be followed precisely, regardless of the obliquity of the margin (Fig. 6).\(^8\) Another major change from the previous classification is that the left tracheal
border now forms the border between stations station 2R and 2L (see Fig. 5). Previously, this border was set at the level of the tracheal midline, but readjusting it to the left tracheal border better conforms to the actual lymphatic drainage pattern of the paratracheal region.

Station 3 is also contained in the upper zone and consists of 2 lymph node groups—prevascular (3a) and retrotracheal (3p) (see Fig. 4; Fig. 7). Station 3a refers to the lymph nodes found anterior to the major vessels of the mediastinum. Station 3p includes the lymph nodes posterior to the trachea. The major change in station 3 from the MD-ATS classification system is that its anatomic boundaries have now been precisely defined (see Table 1). According to the IASLC criteria, the posterior margin of 3a is formed by the superior vena cava on the right and the common carotid artery on the left. These 2 structures are not continuous, however, throughout the superoinferior extent of station 3a (ie, lung apex to the carina) and it may be difficult to determine the posterior margin of station 3a on some CT axial sections.

Station 4 lymph nodes are also part of the upper nodal zone, and consist of the right and left lower paratracheal nodes, 4R and 4L, respectively (see Fig. 7, Table 1). Previously, the lower border of 4R was defined as a line extending across the right main bronchus at the upper margin of the right upper lobe bronchus. The IASLC classification now sets the lower border of 4R at the lower border of the azygos vein where it meets the superior vena cava (Fig. 8). Previously, the lower border of 4L was defined as a line extending across the
left main bronchus at the upper margin of the origin of the upper lobe bronchus. It is now at the upper rim of the left main pulmonary artery (Fig. 9). Similar to station 2, the border between 4R and 4L is now formed by the left tracheal border, which is more consistent with the actual lymphatic drainage patterns of the paratracheal region. Another major change from the previous MD-ATS map is that the pleural reflection, which is generally not appreciable on CT, does not serve as a border between stations 4 and 10. The boundary descriptors of the IASLC system (see Table 1), which are easily recognized on CT imaging, allow for much more consistent differentiation between station 4 and station 10 lymph nodes on CT imaging.

Station 5 (subaortic) lymph nodes form a part of the aortopulmonary zone (see Figs. 7A and 8; Fig. 10, see Table 1). Their superoinferior extent is from the lower border of the aortic arch to the upper rim of left main pulmonary artery. The ligamentum arteriosum separates the station 5 nodes from 4L nodes, which are located more medially (Fig. 11).

Station 6 (para-aortic) lymph nodes are also classified as aortopulmonary zone nodes. They are defined as lymph nodes lying anterior and lateral to the ascending aorta and aortic arch (see Fig. 7). Their superoinferior extent is from the upper border of the aortic arch to the lower border of the aortic arch.

Station 7 (subcarinal) nodes are defined as lymph nodes located immediately inferior to the carina (see Fig. 10; Fig. 12). The IASLC classification system extends them more inferior than the previous classification. Their lower border is now formed by the upper border of the lower lobe bronchus on the left and by the lower border of the bronchus intermedius on the right (Fig. 13). This has allowed the inferior border of station 7 to match the superior border of the station 8 nodes.

Station 8 (paraesophageal) nodes lie adjacent to the esophagus, either to the right or left of midline (see Fig. 2A). They extend from the lower border of
station 7 nodes superiorly to the diaphragm inferiorly. Station 9 (pulmonary ligament) nodes lie within the pulmonary ligament. They are generally situated more lateral than station 8 nodes. As Pitson and colleagues\(^6\) point out, it may be difficult to differentiate between station 9 nodes (Fig. 14) that sit inside the pulmonary ligament and station 8 nodes that sit lower, near the pulmonary ligament.\(^6\) Rusch and Asamura, authors of the IASLC map,\(^8\) acknowledge that this may be the case,

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**Fig. 8.** Stations 4R and 5. Coronal chest CT demonstrates an enlarged station 4R lymph node (yellow arrow) adjacent to the azygos vein (white arrow). Note that lower border of the azygos vein (yellow line) demarcates the inferior limit of station 4R. Also shown is an enlarged station 5 lymph node (pink arrow). AoA, aortic arch; LPA, left main pulmonary artery; RPA, right main pulmonary artery.

**Fig. 9.** Stations 2R, 4R, 4L, and 10. Coronal chest CT shows multiple enlarged lymph nodes corresponding to stations 2R (red arrows), 4R (yellow arrows), 4L (blue arrows), and 10 (magenta arrow). Superior border of the aortic arch (yellow line) forms the superior margin of station 4L; superior rim of left main pulmonary artery (blue line) forms the inferior border of station 4L. AoA, aortic arch; LPA, left main pulmonary artery; T, trachea.

**Fig. 10.** Stations 3p, 4L, 5, 7, 10, and 11. Coronal CT of the chest shows multiple enlarged lymph nodes including stations 3p (brown arrow), 4L (blue arrow), 5 (pale pink arrow), 7 (olive green arrow), 10 (magenta arrow), and 11 (bright green arrow). *, carina; AoA, aortic arch; AV, azygous vein; LM, left mainstem bronchus; LPA, left main pulmonary artery; RM, right mainstem bronchus; T, trachea.

**Fig. 11.** Ligamentum arteriosum. Coronal chest CT demonstrates the location of ligamentum arteriosum (white arrow), which is partially calcified. Also shown is an enlarged station 5 lymph node (white arrowhead). AoA, aortic arch; LPA, left main pulmonary artery; T, trachea.
although this distinction is usually straightforward at surgery.

The hilar-interlobar zone includes hilar (station 10) and interlobar (station 11) lymph node groups (see Figs. 9 and 12; Fig. 15). The peripheral zone consists of lobar (station 12), segmental (station 13), and subsegmental (station 14) lymph node groups.

Another cause of confusion, pointed out by Ichimura and colleagues,7 are the lymph nodes that are located such that they extend across the set boundaries and theoretically can be classified into more than one lymph node station (see Fig. 8). This was clarified by Rusch and colleagues, who stated that such lymph nodes should be designated to stations where they predominantly reside.8
SUMMARY

The IASLC map is the newest lymph node classification system. Compared with previous lymph node maps, it provides fixed, specific anatomic descriptors for all thoracic lymph node stations. CT imaging is one of the most important modalities used in the clinical staging of lung cancer patients. Therefore, it is important to be familiar with the IASLC map as well as to accurately identify the different node stations on CT imaging. It is also important to understand that lymph node maps have been continuously evolving in past years and may be subject to future amendments as more information becomes available from clinical trials.

REFERENCES