

The International Association for the Study of Lung Cancer Lymph Node Map: A Radiologic Atlas and Review

Jin Hwan Kim, M.D., Ph.D.¹, Edwin JR van Beek, M.D., Ph.D.², John T Murchison, M.D., Ph.D.³, Aleksander Marin, M.D.² and Saeed Mirsadraee, M.D., Ph.D.²

¹Department of Radiology, Chungnam National University, School of Medicine, Daejeon, Korea, ²Clinical Research Imaging Centre, University of Edinburgh, Edinburgh, ³Department of Clinical Radiology, Royal Infirmary of Edinburgh, Edinburgh, UK

Accurate lymph node staging of lung cancer is crucial in determining optimal treatment plans and predicting patient outcome. Currently used lymph node maps have been reconciled to the internationally accepted International Association for the Study of Lung Cancer (IASLC) map published in the seventh edition of TNM classification system of malignant tumours. This article provides computed tomographic illustrations of the IASLC nodal map, to facilitate its application in day-to-day clinical practice in order to increase the appropriate classification in lung cancer staging.

Keywords: Lung Neoplasms; Neoplasm Staging; Lymphatic Diseases

Introduction

In 2009, the American Joint Committee on Cancer (AJCC) and the Union Internationale Contre le Cancer (UICC) published the seventh edition of the TNM Classification of Malignant Tumors, which was introduced for use in clinical practice from January 1, 2010. The seventh edition of the classification system applies to non-small cell lung cancer (NSCLC), small-cell lung cancer (SCLC)¹ and bronchopulmonary carcinoids^{2,3}. The lymph node map proposed by the International Association for the Study of Lung Cancer (IASLC) was incorporated

into the new TNM staging for lung cancer⁴.

Prior to the publication of the seventh edition, some discrepancies existed in lymph node nomenclature between the two lymph node maps most widely used in clinical practice, the Japanese (Naruke)⁵ and the Mountain-Dressler modification of the American Thoracic Society map (MD-ATS)⁶. The most significant difference between these relates to the description of subcarinal lymph node. The new IASLC lymph node map attempted to reconcile the differences between these two lymph node maps and to provide more precise anatomic definitions for all lymph node stations⁴. This internationally agreed uniform classification system is crucial for treatment planning, for assessing treatment outcomes, and for optimizing future analyses of the prospective international database currently being collected, to facilitate evidence based adjustments for the upcoming eighth edition of the UICC and AJCC staging manuals due to be completed in 2016.

Currently, computed tomography (CT) and positron emission tomography-CT are used routinely for clinical staging of lung cancer, CT having the advantage of greater spatial resolution and availability. The aim of this article is to review the anatomical definitions of the IASLC lymph node map and provide practical illustration of the mapping system on CT. Moreover, we will give a detailed account of the important changes incorporated in the seventh edition, which affect tumor staging. This simplified illustration of the nodal map

Address for correspondence: Jin Hwan Kim, M.D., Ph.D.

Department of Radiology, Chungnam National University Hospital, 282 Munhwa-ro, Jung-gu, Daejeon 301-721, Korea

Phone: 82-42-280-7333, **Fax:** 82-42-253-0061

E-mail: michelan@cnu.ac.kr

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provides a useful tool for use in day-to-day clinical practice not only for radiologists but also oncologists, surgeons and pathologists who are involved with the staging and management of patients with lung carcinoma.

Classification of the Lymph Node Staging (N) in the IASLC Map

The N classification labels the extent of lymph node metastases. The N staging is unchanged on the IASLC map compared with the sixth edition with the N staging validated by survival analysis. The nodal groups by N stage are as follows: N1, ipsilateral intrapulmonary, peribronchial and hilar; N2, ipsilateral mediastinal and subcarinal; and N3, contralateral mediastinal or hilar nodes, ipsilateral or contralateral supraclavicular nodes⁷. Positive nodes outside the above-defined regions are classified as distant metastasis (M1b).

CT Anatomy of Lymph Node Stations

The anatomic descriptions of each lymph node station have been more precisely described to avoid any overlap in definition between stations. In the IASLC map, the number of lymph

node stations is the same as that of sixth edition. However, the 14 stations are reorganized from four groups into seven zones. This new grouping is based on retrospective survival analyses of international databases and lays the foundation for future prospective database centered survival analyses⁸⁻¹⁰.

1. Supraclavicular zone: station 1

The location description and anatomic boundaries of station 1 are shown in Table 1 and Figure 1.

In the MD-ATS map, the supraclavicular zone lymph nodes were classified as superior mediastinal nodes. However, in the IASLC map station 1 nodes are considered extrathoracic lymph node and all station 1 lymph nodes are classified as N3 disease.

2. Upper zone: station 2R, 2L, 3a, 3p, 4R, and 4L

The location descriptions and anatomic boundaries of station 2, 3, and 4 are shown in Table 2 and Figures 2 and 3.

The upper border of stations 2, and 3 is the apex of the lung and pleural space, and in the midline, the upper border of the manubrium. The lower borders of stations 3, 4R, and 4L differ from each other (Figure 2A, B). The lower border of 2R serves as the upper border of 4R, and the same applies for the bor-

Table 1. Anatomic boundary of station 1

Station	Upper border	Lower border	Border between 1R and 1L
1	Low cervical, supraclavicular, and sternal notch nodes	Lower margin of the cricoid cartilage	Clavicle bilaterally and, in the midline, the upper border of the manubrium

Adapted from Rusch VW et al. *J Thorac Oncol* 2009;4:568-77, with permission⁴.

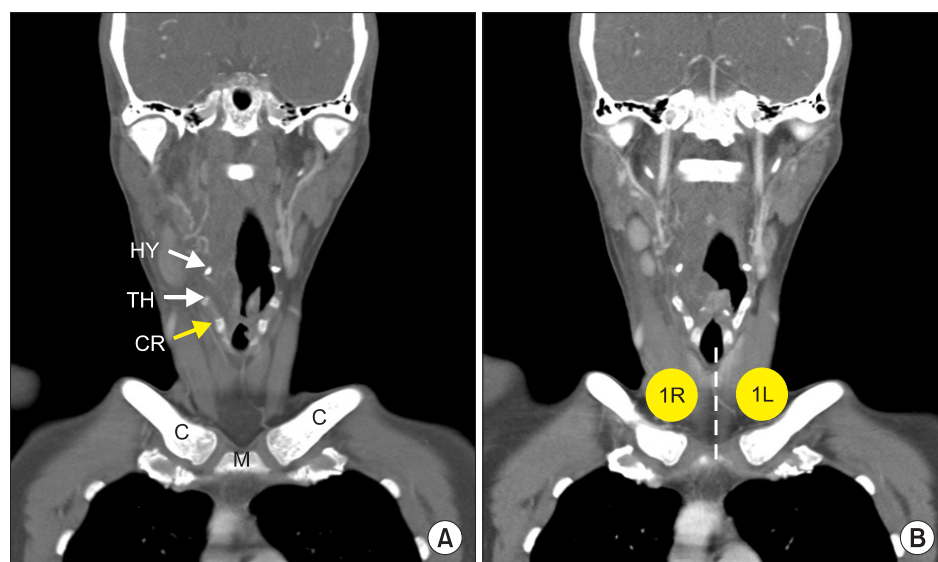


Figure 1. Station 1. (A) The upper border of station 1 is the lower margin of the cricoid cartilage (yellow arrow). The lower border is clavicles bilaterally (C), in the midline, the upper border of the manubrium (M). (B) The border between 1R and 1L is the midline of the trachea (dashed line). C: clavicle; CR: cricoid cartilage; HY: hyoid bone; M: manubrium; TH: thyroid cartilage.

Table 2. Anatomic boundaries of Station 2, 3, and 4 in the upper zone

Station		Upper border	Lower border	Border between right and left side	Other anatomic landmarks
2R	Right upper paratracheal nodes	Apex of the right lung and pleural space, and in the midline, the upper border of the mediastinum	Intersection of caudal margin of innominate vein with the trachea	Left lateral border of the trachea	-
2L	Left upper paratracheal nodes	Apex of the left lung and pleural space, and in the midline, the upper border of the mediastinum	Superior border of the aortic arch	Left lateral border of the trachea	-
3a	Prevascular nodes	Apex of chest (right and left side)	Level of carina	Midline of the trachea	Anterior border: posterior aspect of sternum Posterior border: anterior border of superior vena cava on the right, and left carotid artery on the left
3p	Retrotracheal nodes	Apex of chest (right and left side)	Carina	-	Anterior border: posterior wall of the trachea
4R	Right lower paratracheal nodes	Intersection of caudal margin of innominate vein with the trachea	Lower border of azygos vein	Left lateral border of the trachea	
4L	Left lower paratracheal nodes	Superior border of the aortic arch	Upper rim of the left main pulmonary artery	Left lateral border of the trachea	Medial to the ligamentum arteriosum

Adapted from Rusch VW et al. J Thorac Oncol 2009;4:568-77, with permission⁴.

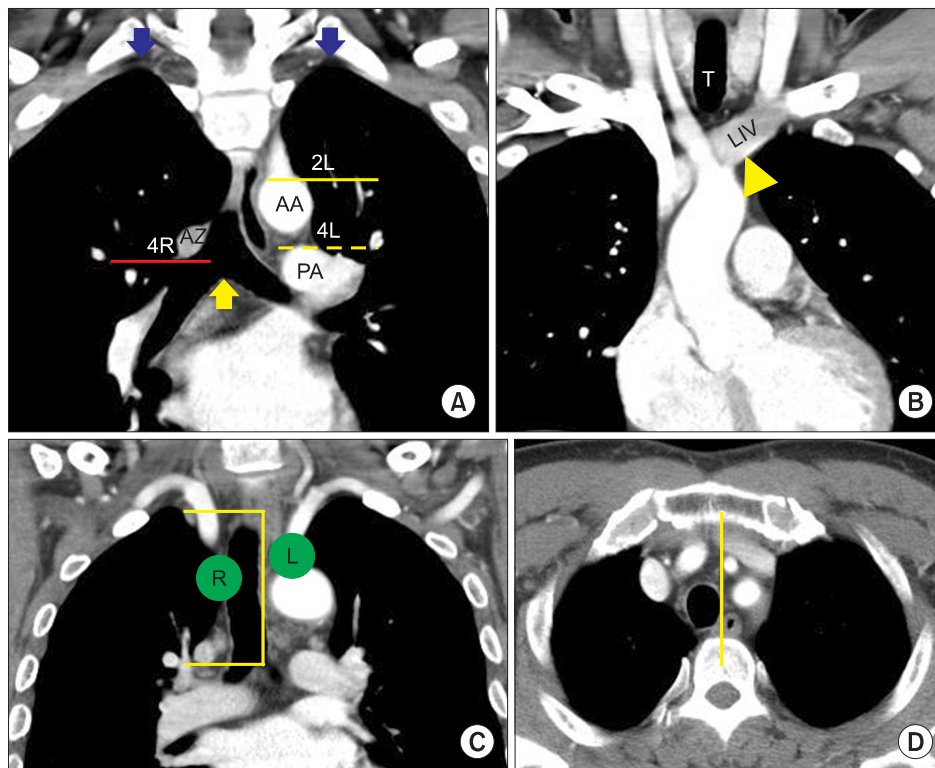


Figure 2. Upper zone: stations 2R, 2L, 3a, 3p, 4R, and 4L. (A, B) Upper and lower borders of stations 2, 3 and 4. The upper border of station 2R, 2L, 3a and 3p is the apex of each lung and pleural space (blue arrows), and in the midline, the upper border of the manubrium. The lower borders of the stations are different from station to station: station 2R: the intersection of caudal margin of innominate vein with the trachea (yellow triangle in B); station 2L: the superior border of the aortic arch (yellow line); station 3a and 3p, the level of carina (yellow arrow); station 4R: the lower border of the azygos vein (red line); station 4L: the upper rim of the left main pulmonary artery (yellow dashed line). (C, D) The border between 2R and 2L and between 4R and 4L moves from the midline of trachea to the left lateral border of the trachea. AA: aortic arch; AZ: azygos vein; LIV: left innominate vein; PA: left main pulmonary artery; T: trachea.

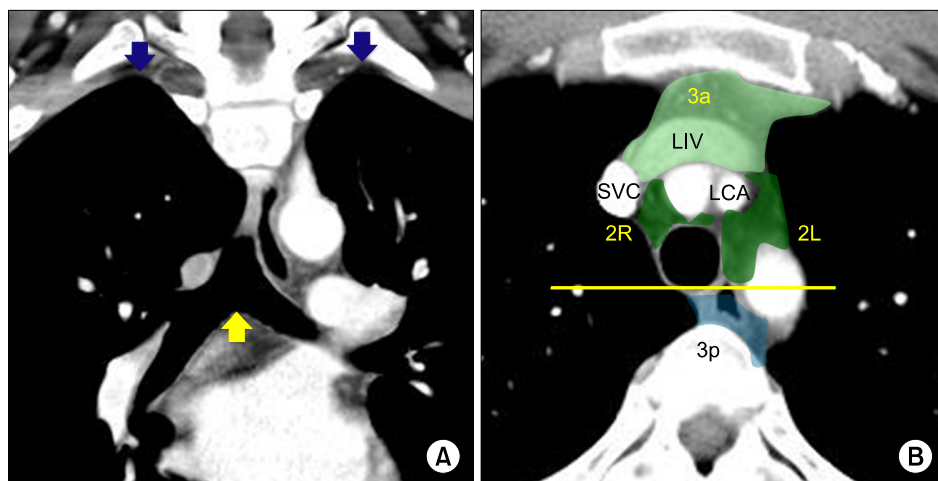


Figure 3. Stations 3a and 3p. (A) The upper border of station 3a and 3p is the apex of chest (blue arrows) and lower border is the level of carina (yellow arrow). (B) The anterior border of 3a is the posterior aspect of the sternum, and the posterior border is the anterior border of the superior vena cava on the right and left carotid artery on the left. Station 3p is a retrotracheal lymph node. LCA: left common carotid artery; LIV: left innominate vein; SVC: superior vena cava.

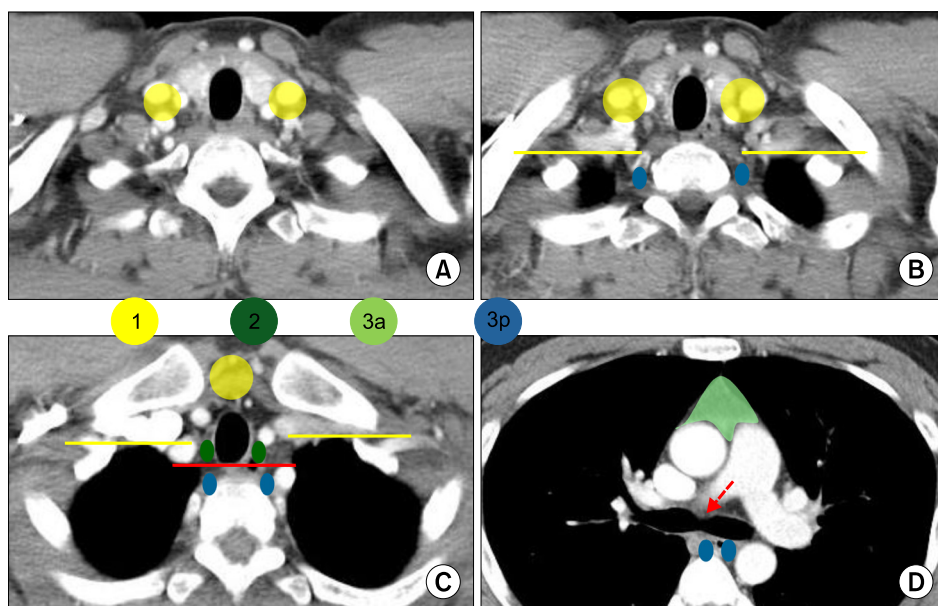


Figure 4. Boundary distinction among stations 1, 2 and 3. (A) Station 1 supraclavicular lymph node. (B) Inferior to the lung apex, the yellow line running horizontally from anterior margin of both lung pleura interface separates station 1 from station 3p. (C) At the suprasternal notch, the yellow line running horizontally from anterior margin of both lung pleura interface separates station 1 from station 2. The red line running along posterior wall of trachea separates station 2 from 3p. (D) Station 3a and 3p at the level of tracheal bifurcation (dashed red arrow).

der between 2L and 4L. For both station 2 and 4, the border between 2R and 2L and between 4R and 4L moves from the midline of the trachea to the left lateral border of the trachea in the IASLC map. This is one of the major changes made in N mapping in the seventh edition (Figure 2C, D).

In the IASLC map definition, the lower border of station 1 is the clavicle bilaterally and, in the midline, the upper border of the manubrium and the upper border of station 2 and 3 extends higher up to the lung apex than the lower border of station 1. Therefore, on axial image, the posterior border of station 1 can abut the anterior border of station 2 or 3p (Figure 4). Because the definitions of the lower border of station 1 nodes are not identical to the definition of the upper border of station 2 and 3 nodes and because the position of the clavicles can vary depending on the level of arm elevation, the inferior-lateral border of station 1 nodes may vary leading to overlap

between these nodal groups. The lymph nodes that are closer to the midline are hardly ever affected by the position of the arms¹¹. It would be helpful if the definition of the lower border of station 1 and the upper border of station 2 were identical. This is an improvement, which might be considered for the eighth edition.

3. AP zone: stations 5 and 6

The location descriptions and anatomic boundaries of station 5 and 6 are listed in Table 3.

The medial border of station 5 is the ligamentum arteriosum (Figure 5), which is difficult to identify on axial CT unless calcified. The prevalence of ligamentum arteriosum calcification on CT is higher in children (37.8%) than in adults (11.2%) with peak prevalence in 6–10 years, afterwards declining with

Table 3. Anatomic boundaries of stations 5 and 6

Station		Upper border	Lower border	Other anatomic landmarks
5	Subaortic nodes (aortopulmonary window)	The lower border of the aortic arch	Upper rim of the left main pulmonary artery	Lateral to the ligamentum arteriosum
6	Para-aortic nodes (ascending aorta or Phrenic)	A line tangential to the upper border of the aortic arch	The lower border of aortic arch	Anterior border: imaginary horizontal line extending from the anterior wall of the aortic arch

Adapted from Rusch VW et al. *J Thorac Oncol* 2009;4:568-77, with permission⁴.

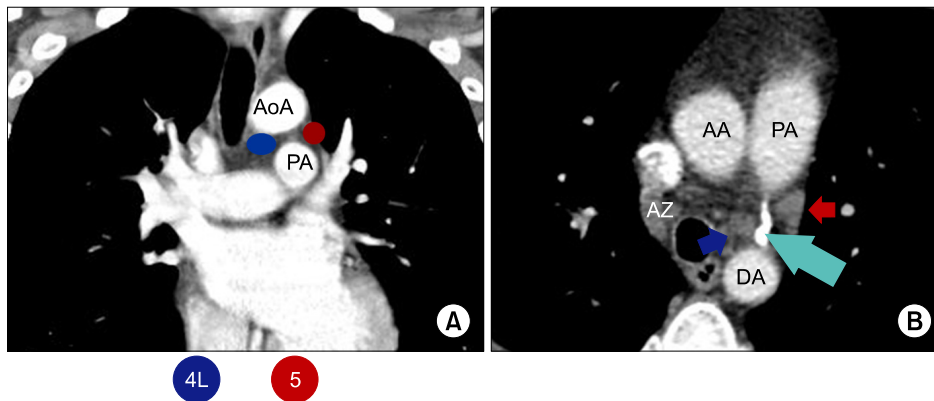


Figure 5. Station 5. (A) The upper border of station 5 is the lower border of aortic arch (AoA), and lower border is the upper rim of the left main pulmonary artery (PA). (B) The border between station 4L and station 5 is the ligamentum arteriosum (sky-blue arrow). Station 4L nodes locate medial to the ligamentum arteriosum (blue arrow), and station 5 is the lymph node lateral to the ligamentum arteriosum (brown arrow). AA: ascending aorta; AZ: azygos vein; DA: descending aorta.

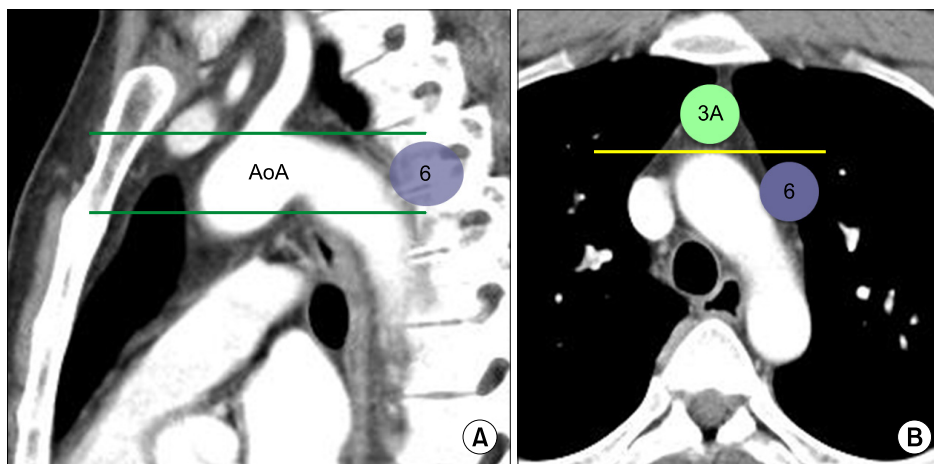


Figure 6. Station 6. (A) The upper border of station 6 is a line tangential to the upper border of the aortic arch and lower border is the lower border of aortic arch (green lines). (B) The anterior border of station 6 is the imaginary horizontal line extending from the anterior wall of the aortic arch (yellow line), which discriminates station 6 from station 3a. AoA: aortic arch.

age¹². Although usually invisible on CT the expected location can be estimated by identifying the closest position of the upper pulmonary artery and the aortic arch on coronal reconstructions.

Station 6 lymph nodes lie anterior and lateral to the ascending aorta and aortic arch (Figure 6). The anterior border of station 6 is the imaginary horizontal line extending from the anterior wall of the aortic arch (Figure 6B). In radiological staging it is not clinically important to differentiate stations 5 and 6, both of which lie in the aorto-pulmonary nodal region and differentiation does not affect staging.

4. Subcarinal zone: station 7

The location description and anatomic boundary of station 7 is listed in Table 4.

Station 7 encompasses a larger area in the new seventh edition IASLC map than on previous map versions and is most easily identified on the coronal images (Figure 7A). This is one of the major changes and reconciles the Naruke and MD-ATS maps¹¹.

The nodes located in the space between the medial margins of both main bronchi are station 7 and nodes outside of the space are station 10 (Figure 7B)^{4,13}. Below the carina of the

Table 4. Anatomic boundary of station 7

Station	Upper border	Lower border	Other anatomic landmarks	
7	Subcarinal nodes	The carina of the trachea	The upper border of the lower lobe bronchus on the left; the lower border of the bronchus intermedius on the right	Lateral border: medial margin of the right main bronchus and bronchus intermedius and left main bronchus

Adapted from Rusch VW et al. J Thorac Oncol 2009;4:568-77, with permission⁴.

Table 5. Anatomic boundary of stations 8 and 9

Station	Upper border	Lower border	Border between right and left side
8	Paraesophageal nodes	The upper border of the lower lobe bronchus on the left; the lower border of the bronchus intermedius on the right	Midline of the esophagus
9	Pulmonary ligament nodes	The inferior pulmonary vein	-

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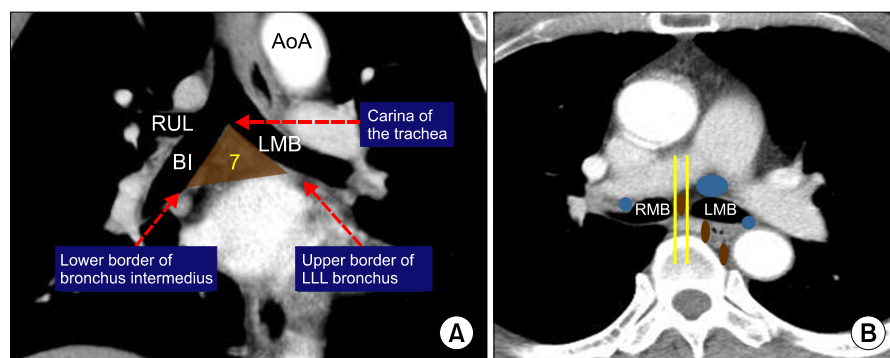


Figure 7. Subcarinal zone: Station 7. (A) Upper and lower borders of station 7 are well identified on coronal image. (B) Station 7 nodes are noted in the space between the medial margin of both main bronchi (yellow lines) and nodes outside of the space are station 10. Station 7 extends posteriorly around the esophagus. AoA: aortic arch; BI: bronchus intermedius; LLL: left lower lobe; LMB: left main bronchus; RMB: right main bronchus; RUL: right upper lobe.

trachea, the nodes in the posterior mediastinum are station 7 and above this level 3p. Within the cranio-caudal boundary of the subcarinal zone, the posterior margin of station 7 extends posteriorly to the paraesophageal area at this level (Figure 7B) with station 8 upper boundary below this level. Station 7 nodes are considered ipsilateral (N2) with the primary tumor irrespective of side.

5. Lower zone: station 8 and 9

The location descriptions and anatomic boundaries of station 8 and 9 are listed in Table 5.

Below the lower border of subcarinal zone, station 8 nodes lay adjacent to the wall of the esophagus and to the right or left of the midline (Figure 8).

Station 9 nodes are located within the inferior pulmonary ligament (Figure 9) and separation of station 8 and 9 is easy at surgery. In the region of the inferior pulmonary vein, the mediastinal and visceral pleura merge to form the inferior pulmonary ligament. It extends downwards toward the hemidiaphragm anchoring the lower lobes to the mediastinum. The length of this ligament may vary both from person to person

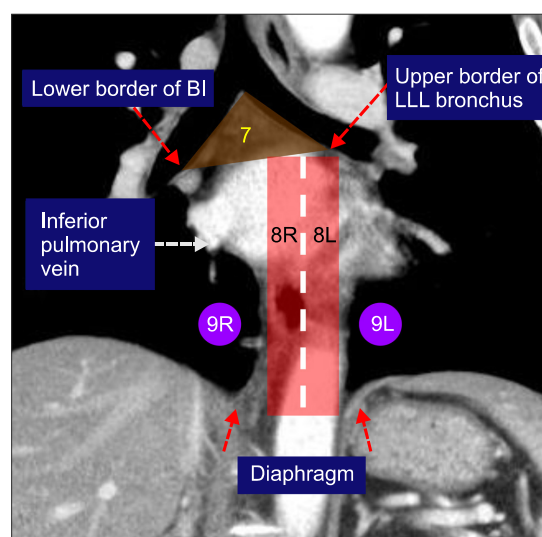


Figure 8. Lower zone: stations 8 and 9. The upper border of station 8 is the upper border of the left lower lobe (LLL) bronchus on the left side and the lower border of the bronchus intermedius (BI) on the right side. The upper border of the station 9 is the inferior pulmonary vein. The lower border of station 8 and 9 is the diaphragm. The border between 8R and 8L is the midline (dashed line).

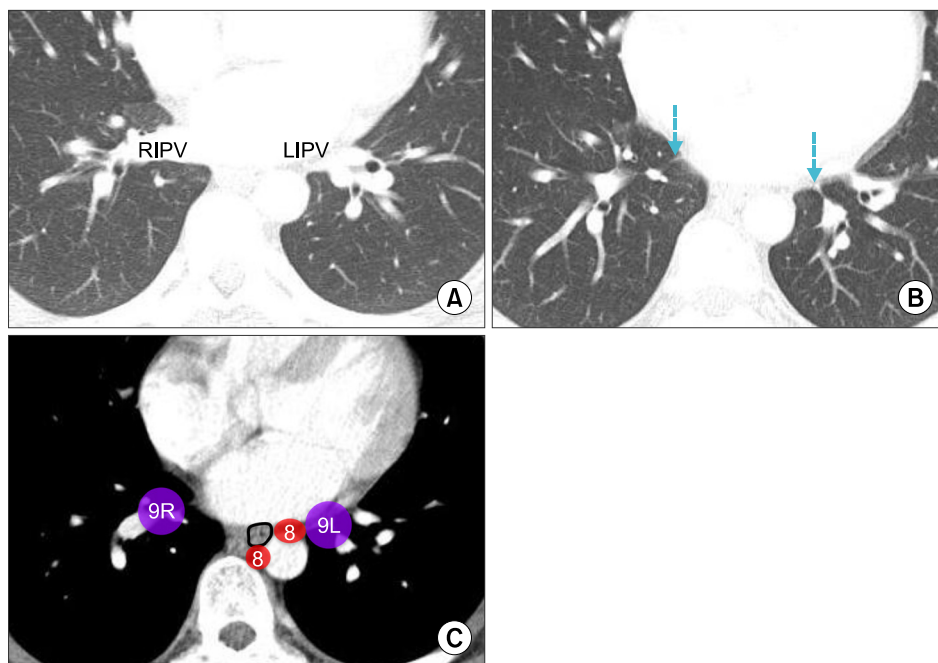


Figure 9. Station 9 and the inferior pulmonary ligament. (A) Both inferior pulmonary veins joining the left atrium can be easily identified on computed tomography images. (B) Right and left inferior pulmonary ligaments (sky-blue dashed arrows) attach each lower lobe to the diaphragm. (C) Stations 8 and 9 nodes on axial image. Station 9 nodes locate in the inferior pulmonary ligament. Station 8 nodes are present adjacent to the esophagus (black circle). LIPV: left inferior pulmonary vein; RIPV: right inferior pulmonary vein.

Table 6. Anatomic boundary of station 10

Station		Upper border	Lower border	Border between right and left
10	Hilar nodes	The lower rim of azygos vein on right; upper rim of the left main pulmonary artery on left	Bilateral interlobar region	Above the carina: the midline of the trachea Below the carina: vertical line drawn from the medial margin of the both main bronchi

Adapted from Rusch VW et al. *J Thorac Oncol* 2009;4:568-77, with permission⁴.

and in the same individual^{14,15}.

6. Hilar/interlobar zone: station 10 and 11

The location descriptions and anatomic boundary of station 10 and 11 are listed in Tables 6 and 7, respectively.

Station 10 includes the nodes immediately adjacent to the mainstem bronchus and hilar vessels such as the proximal portions of the pulmonary veins and main pulmonary arteries. There is a change of the borders between station 4 and 10 with the pleural reflection no longer serving as the border between them (Figure 10)⁴. The lymph nodes around the both main bronchi within the mediastinum are considered as station 10; the nodes below the lower margin of the azygos vein as 10R, and the nodes below the upper rim of the left main pulmonary artery as 10L. Therefore, some tumors previously staged as N2 are now staged as N1. Pitson et al.¹⁶ and El-Sharief et al.¹⁷ discussed a potential ambiguity for lymph nodes at the level of the tracheal bifurcation below the level of the superior vena cava- azygos vein junction, and grouped lymph nodes anterior to the tracheal bifurcation with the lower paratracheal station¹⁷. However, Lee et al.¹⁸ reported that

the changed definition between N1 and N2 diseases by IASLC map works well in classifying patient prognosis.

Station 10 also has a common boundary with station 7 and border is a vertical line from the medial margin of the both main bronchi (Figure 7B).

Station 11 is subdivided into 11Rs and 11Ri and their anatomic definition is shown in Table 7 and Figure 11.

7. Peripheral zone: station 12, 13, and 14

Station 12 is a node adjacent to the lobar bronchi. Station 13 is a node adjacent to the segmental bronchi. Station 14 is a node adjacent to the subsegmental bronchi. These nodes are intrapulmonary and for staging purposes are to be differentiated from intrapulmonary metastasis. Differentiation affects staging as an intrapulmonary metastasis in the same lobe as the primary tumour would be a T3 cancer while station 12, 13, or 14 nodes would be N1 disease. Nodes are usually peribronchovascular often at areas of bronchial branching.

Table 7. Anatomic definition of station 11

Station	Border
11 Interlobar nodes	Between the origin of the lobar bronchi Medial border: the lateral border of the main bronchus
11Rs Superior interlobar nodes	Between the upper lobe bronchus and bronchus intermedius on the right
11Ri Inferior interlobar nodes	Between the middle and lower lobar bronchi on the right

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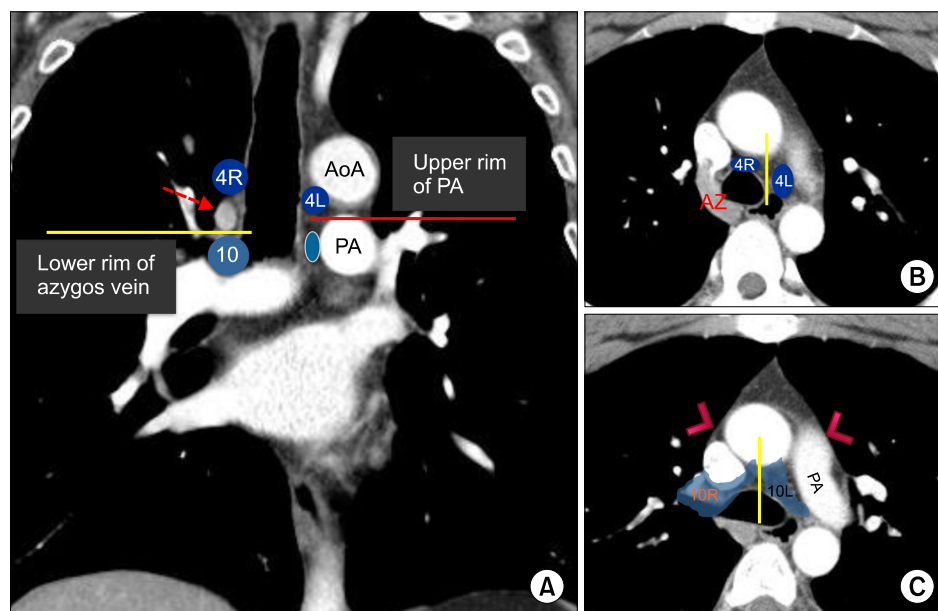


Figure 10. Station 10. (A) The border between station 4R and 10R is the lower rim of the azygos vein (red dashed arrow). The border between station 4L and 10L is the upper rim of the left main pulmonary artery (red line). (B) Station 4R and 4L nodes at the level of azygos vein. Note the border between station 4R and 4L is the left lateral wall of the trachea (yellow line). (C) Stations 10R and 10L below the azygos vein. The pleural reflection (pink arrowhead) no longer serves as the border between station 4 and 10. The border between station 10R and 10L is the midline of tracheal bifurcation (yellow line). AoA: aortic arch; AZ: azygos vein; PA: left pulmonary artery.

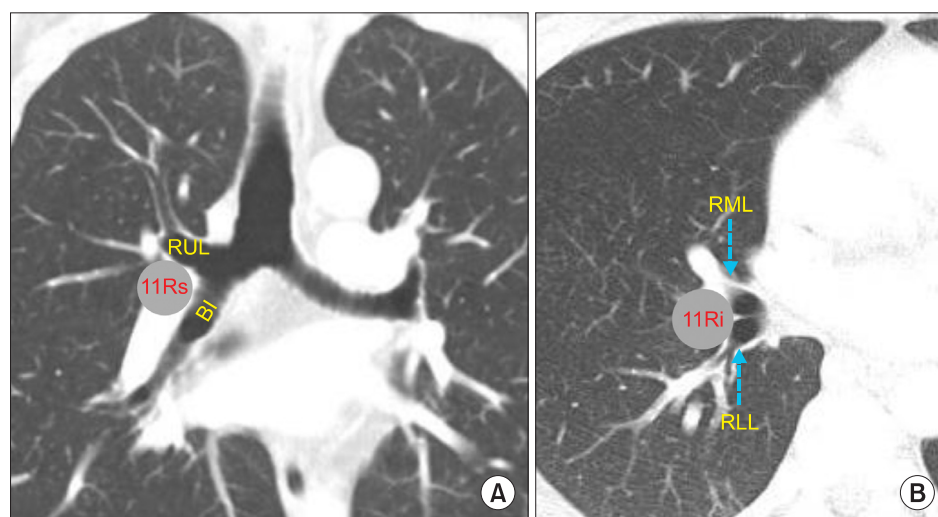


Figure 11. Station 11R. (A) Station 11Rs is located between the right upper lobe bronchus and bronchus intermedius. (B) Station 11Ri is present between the right middle and lower lobe bronchi. Lung window setting is useful to define the bronchial details. BI: bronchus intermedius; RLL: right lower lobe; RML: right middle lobe; RUL: right upper lobe.

Future Analyses for the Next Edition

The seventh edition IASLC map was formulated after

retrospective analysis of outcome data for a multinational database. The seventh edition IASLC map therefore provided more precise anatomic definitions than that of sixth edition,

however there remain several outstanding areas of uncertainty, which could be addressed, in later editions.

(1) There is no specific definition of the border between right and left side for station 3a, 3p, and 8, which is necessary to classify N2 or N3 tumour. It is unclear whether this should be the midline or the left side of the trachea as when categorising station 2 and 4 nodes.

(2) Some lymph nodes in the thorax, which lung cancer only occasionally metastasises to, are not included in the IASLC lymph node map at all. These include anterior, middle, and posterior diaphragmatic nodes, intercostal nodes, internal mammary node, retrocrural nodes and axillary node. It is unclear whether these should be classed as N2 or N3 disease.

(3) The IASLC classification doesn't relate the relationship between overall survival and lymph node burden addressing issues such as single metastases versus multiple metastases, the significance of skip metastases and extranodal tumour spread.

Uniform application of the IASLC map will provide the database for future prospective analysis to solve the ambiguities and to make more complete lymph node classification.

Summary

The seventh TNM staging and IASLC map are applied to NSCLC, SCLC, and bronchopulmonary carcinoids.

The major changes in the IASLC nodal map are as follows: (1) border between station 2R and 2L moves from the midline of trachea to the left lateral wall of the trachea (Figure 2C, D); (2) border between station 4R and 4L moves from the midline of trachea to the left lateral wall of the trachea (Figure 2C, D); (3) station 7 encompasses a larger area in the IASLC map and this reflects reconciliation between the Naruke and MD-ATS maps (Figure 7); (4) there is a change of the borders between station 4 and 10 with the pleural reflection no longer serving as the border between the two stations (Figure 10).

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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