



Original Research

Approaches to Mediastinal Staging in NSCLC Among Thoracic Surgeons: A Survey Study From Türkiye

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Abstract

Objectives: Mediastinal lymph node staging is a critical step in the treatment algorithm for non-small cell lung cancer (NSCLC). Current guidelines define the patient groups in which invasive or minimally invasive mediastinal lymph node sampling is required during preoperative staging. This study aimed to determine the extent to which thoracic surgeons actively practicing in Türkiye adhere to these guideline recommendations and to assess the concordance between their daily clinical practices and these recommendations.

Methods: A guideline-based survey, including nine case scenarios, was emailed to 417 thoracic surgeons registered with the Turkish Thoracic Surgery Association. The survey collected data on participants' demographic characteristics, institutional profiles, and approaches to each clinical scenario. Responses were analyzed for concordance with guideline recommendations.

Results: The survey response rate was 29.2% (n=122). A total of 48.3% of the participants possessed an academic title, and 77.8% were employed at training and research or university hospitals. In scenarios involving a radiologically positive, single, non-bulky N2 lymph node, 85.2% of respondents indicated that invasive mediastinal staging was required by guidelines. In contrast, among patients without radiologic evidence of N2 disease, the proportion of surgeons recommending mediastinal staging was 19.7% for squamous cell carcinoma >3 cm in size and 36.9% for adenocarcinoma. For centrally located tumors, 59% of participants recommended staging. Notably, there was substantial variation in opinions regarding the necessity of invasive sampling for suspicious aortopulmonary window lymph nodes.

Conclusion: Thoracic surgeons in Türkiye generally exhibit approaches to mediastinal staging that align with guideline recommendations; however, variations exist in certain subgroups. Standardization is particularly needed in the definition of central tumors, the approach to sampling aortopulmonary lymph node stations, and staging strategies based on histologic tumor type. These findings highlight the importance of educational and awareness initiatives aimed at improving the integration of guideline recommendations into clinical practice.

Keywords: Mediastinal staging, Non-small cell lung cancer, survey, Türkiye

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In non-small cell lung cancer (NSCLC), one of the most important prognostic factors is nodal involvement.^[1] In the absence of mediastinal lymph node metastasis detected during preoperative clinical staging, surgery remains the standard treatment approach, whereas in cases where N2

disease is identified, multimodality treatment strategies are considered. In patients with single, non-bulky (<3 cm) N2 involvement, surgery can be incorporated into the multimodality treatment plan following neoadjuvant therapy protocols that achieve downstaging in resectable cases. In

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contrast, for patients with multiple N2 or N3 disease, the treatment approach typically consists of definitive treatment protocols. Therefore, preoperative mediastinal lymph node staging, whether via minimally invasive or invasive techniques, plays a critical role in determining the optimal treatment protocol.

Current guidelines clearly define the indications for mediastinal lymph node (MLN) staging. Accordingly, in cases with a tumor diameter <3 cm (T1), normal-sized lymph nodes on thoracic CT (<1 cm), and a negative PET-CT scan ($SUV_{max}<2.5$) — corresponding to radiological N0 — mediastinal lymph node staging is not recommended. In patients without radiological evidence of N2 disease, sampling of MLNs for staging purposes is recommended when factors increasing the likelihood of N2 involvement are present, such as suspicious N1 lymph nodes, centrally located tumors, or tumors >3 cm in diameter.^[2–4]

In this study, we investigated the approaches of thoracic surgeons practicing in Türkiye toward the indications for MLN staging in NSCLC patients through a survey-based design. The aim was to determine the adherence rates of thoracic surgeons in our country to guideline recommendations for lymph node staging in NSCLC cases.

Methods

A two-part survey was developed by the authors of the study (Table 1). In designing the survey questions, previously conducted similar survey studies were taken into consideration. The first part of the survey aimed to assess the participants' academic qualifications and to evaluate the capacity of their institutions in lung cancer management. The second part focused on evaluating the participants' approaches to the indications for MLN staging in NSCLC cases. During the preparation of the questionnaire, the formats of previously published similar studies were reviewed, and the questions were developed based on current guideline recommendations. The items were revised according to the opinions of four experienced thoracic surgery specialists to ensure content validity. The Google Forms survey was distributed via e-mail invitation to 417 thoracic surgeons registered with the Turkish Thoracic Surgery Association. A total of 122 surgeons (29.2%) responded to the survey. The average time to complete the survey was 8–10 minutes.

Participants were explicitly instructed to answer the questions based on their routine clinical practice rather than guideline-recommended treatment algorithms. The questions were presented in the form of clinical case scenarios, and these cases were selected from patients recorded in the hospital archives. The aim was to reflect the staging decisions most frequently faced by thoracic surgeons in daily practice. The ques-

tions were reviewed by four academic thoracic surgeons for clarity and comprehensibility before finalization. Therefore, the scenarios were not chosen randomly but were selected as typical examples with high clinical representativeness. The survey was active from September 10, 2022, to October 10, 2022, after which data analysis was completed. Results were archived and evaluated in an Excel spreadsheet.

For the radiological evaluation of mediastinal lymph nodes, any lymph node with a short-axis diameter >1 cm on CT and/or an $SUV_{max}>2.5$ on PET-CT was considered radiologically positive. Clinically, nodal involvement was defined as any lymph node >1 cm in the short axis on CT or with metabolic uptake >2.5 SUV on PET-CT. Following neoadjuvant therapy, an SUV_{max} value <2.5 on PET-CT was regarded as a complete or near-complete metabolic response, whereas a reduction in SUV_{max} without falling below this threshold was considered a partial metabolic response.^[5,6]

The study was approved by the Ethics and Scientific Committee of Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital (Approval No. 329-6/24.08.2022) and conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all participants.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics Version 26 (Armonk, NY). The descriptive results of the study are presented as frequencies with the corresponding percentages in the case of nominal or ordinal variables.

The internal consistency of the nine scenario-based questions assessing mediastinal staging practice was analyzed using Cronbach's alpha. The core six questions yielded $\alpha=0.71$, indicating acceptable internal consistency. When the additional three scenarios involving the aortopulmonary window were included, the alpha value was 0.62, reflecting the known heterogeneity in clinical decision-making for this subgroup.

Results

The Google Forms survey prepared on the study topic was distributed via e-mail invitation to 417 thoracic surgeons. A total of 122 surgeons (29.2%) responded to the survey. Of the respondents, 48.4% ($n=59$) held an academic title, while 41.6% ($n=63$) were practicing as specialist physicians. Regarding institutional affiliation, 77.8% ($n=95$) were employed at training and research hospitals or university hospitals, whereas 22.2% ($n=27$) were working in private healthcare institutions or state hospitals. Among the participating surgeons, 16.4% ($n=20$) reported being the sole thoracic surgeon at their institution, 44.3% ($n=54$) worked alongside 1–5 other thoracic surgeons, and 39.3% ($n=48$)

Table 1. Questions and answer options presented to participants for lymph node evaluation

Questions	Responses
<p>1. On PET-CT examination: * Right upper lobe adenocarcinoma case * #4R >1.4 cm and SUVmax 4.8 * No pathological involvement in other mediastinal lymph nodes</p>	<ul style="list-style-type: none"> I would perform pathological sampling of the mediastinal lymph nodes using invasive or minimally invasive methods. If a single N2 is detected in the 4R station, I would recommend neoadjuvant therapy. I would rely on PET-CT findings. I would consider the patient as having single N2 disease and recommend neoadjuvant therapy. I would recommend direct surgery. If N2 is detected in the postoperative pathology report, I would refer the patient for adjuvant therapy.
<p>2. On PET-CT examination: * Right upper lobe NSCLC, T2a (3–4 cm) * No pathological involvement in mediastinal lymph nodes * #4R >1 cm (1.34 cm) Which of the following would you recommend?</p>	<ul style="list-style-type: none"> I would perform pathological sampling of the mediastinal lymph nodes using invasive or minimally invasive methods. If a single N2 is detected in the 4R station, I would recommend neoadjuvant therapy. I would rely on PET-CT findings. I have no suspicion of N2 disease. I would not recommend pathological sampling of the mediastinal lymph nodes. I would proceed directly to surgery.
<p>3. * Right upper lobe adenocarcinoma, T1 (0–3 cm) * Hilar lymph node with SUVmax = 5.2 (suspicious for N1).</p>	<ul style="list-style-type: none"> I would perform pathological sampling of the mediastinal lymph nodes for staging purposes. I would rule out the possibility of N2 disease.
<p>4. * Right upper lobe adenocarcinoma, T1c (2–3 cm) * Centrally located tumor.</p>	<ul style="list-style-type: none"> Based on PET-CT findings, the patient does not have N2 disease. I would proceed directly to surgery.
<p>5. * Right lower lobe adenocarcinoma, T2b (>3 cm, 4–5 cm)</p>	
<p>6. * Right lower lobe squamous cell carcinoma, T2a (>3 cm, 3–4 cm)</p>	
<p>7. Participants were asked whether they would consider a tumor located in the paravertebral region (more than 2 cm from the hilum, in the medial one-third on CT sections) to be a central tumor.</p>	<ul style="list-style-type: none"> I would consider it a central tumor. I would not consider it a central tumor.
<p>8. On PET-CT examination: * Left upper lobe NSCLC, T2a (3–4 cm) * #6 = >1 cm (1.7 cm) and SUVmax 5.4 * Cervical mediastinoscopy pathology report: #2R, #2L, #4R, #4L, and #7 — no metastasis detected</p>	<ul style="list-style-type: none"> I would perform invasive sampling of the aortopulmonary (APP) lymph nodes, and if N2 is detected, I would refer the patient for neoadjuvant therapy. I would rely on PET-CT findings and consider the patient to have N2 disease (#6), referring them for neoadjuvant therapy. In my routine practice, I do not sample suspicious isolated APP lymph nodes in left upper lobe tumors. I do not believe that possible N2 disease in this region would change my treatment strategy. I would proceed directly to surgery and refer the patient for adjuvant therapy based on the postoperative pathology results.
<p>9. On PET-CT examination: * Left upper lobe NSCLC, T1c (2–3 cm) * #6 = >1 cm (1.6 cm) and SUVmax 4.8 * #4L = >1 cm (1.6 cm) and SUVmax 4.3 * Endobronchial ultrasound (EBUS) pathology report: metastasis present in #4L Which of the following would you recommend?</p>	<ul style="list-style-type: none"> I would perform invasive sampling of the aortopulmonary window. If N2 is detected, I would consider the patient to have multiple N2 disease and refer for definitive treatment. I would not perform pathological sampling of the aortopulmonary window. I do not consider possible metastasis in station #6 to have the same poor survival prognosis as other multiple N2 cases. I would refer the patient for neoadjuvant therapy. I would not perform pathological sampling of the aortopulmonary window. Based on PET-CT findings, I would consider the patient to have multiple N2 disease and refer for definitive treatment.

worked in centers with more than 5 thoracic surgeons (Fig. 1). In terms of multidisciplinary tumor boards, 70.4% (n=86) stated that regular tumor board meetings were held

at their hospitals, 23% (n=28) reported that such meetings were not conducted, and 6.6% (n=8) indicated that they were held occasionally (Fig. 2).

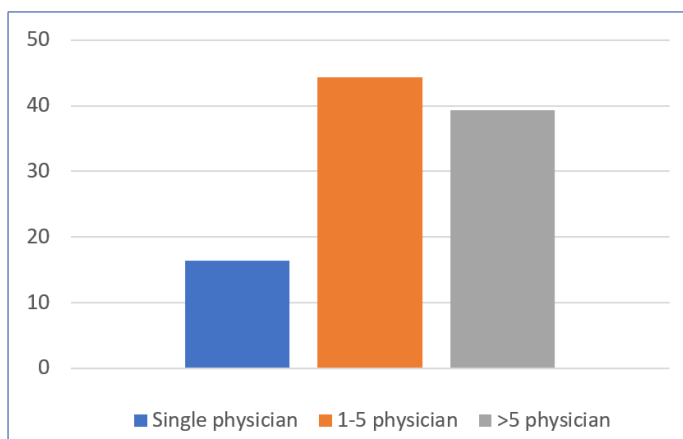


Figure 1. Percentage distribution of participants according to the number of thoracic surgeons in their center.

Participants were asked about their approach to mediastinal staging in the presence of a radiologically positive, single, non-bulky MLN. Participants were also asked about their approach to mediastinal staging in cases with PET-CT–negative findings but with an MLN>1 cm detected on CT imaging (Table 2).

In NSCLC cases without radiological suspicion of N2 disease, participants were asked about their approach to mediastinal staging in the following scenarios: T1 tumors with radiologically suspicious N1 metastasis, centrally located tumors <3 cm, adenocarcinomas >3 cm, and squamous cell carcinomas >3 cm (Table 3).

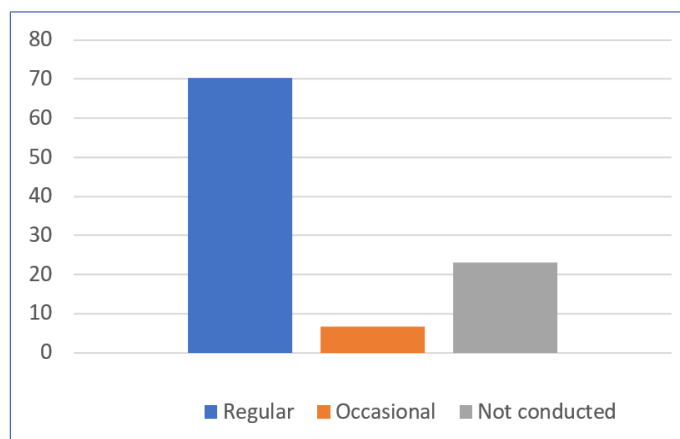


Figure 2. Rates of multidisciplinary tumor board meetings at participants' institutions.

In Question 7, participants were asked whether they would consider a tumor located in the paravertebral region (more than 2 cm from the hilum, in the medial one-third on CT sections) to be a central tumor. A total of 95.1% (n=116) of participants stated that they did not consider tumors in this location to be central.

In the final two questions, participants were asked about their approach to sampling the aortopulmonary window (APP) region for staging purposes in the presence of radiologically suspicious lymph node invasion in this area (Table 4).

Table 2. Participant responses and guideline concordance for scenario-based questions involving radiologically suspicious single-station N2 disease (Questions 1 and 2)

Question 1: On PET-CT examination:
 * Right upper lobe adenocarcinoma case
 * #4R > 1 cm (1.4 cm) and SUVmax 4.8
 * No pathological involvement of other mediastinal lymph nodes

Options	n (%)	Guideline concordance
I would perform pathological sampling of the mediastinal lymph nodes using invasive or minimally invasive methods. If a single N2 is detected in the 4R station, I would recommend neoadjuvant therapy.	104 (85.2)	85.2
I would rely on PET-CT findings. I would consider the patient as having single N2 disease and recommend neoadjuvant therapy.	5 (4.1)	
I would recommend direct surgery. If N2 is detected in the postoperative pathology report, I would refer the patient for adjuvant therapy.	13 (10.7)	
Question 2: On PET-CT examination: * Right upper lobe NSCLC, T2a (3–4 cm) * No pathological involvement of mediastinal lymph nodes * #4R > 1 cm (1.34 cm)		61.5
I would perform pathological sampling of the mediastinal lymph nodes using invasive or minimally invasive methods. If a single N2 is detected in the 4R station, I would recommend neoadjuvant therapy.	75 (61.5)	
I would rely on PET-CT findings. I have no suspicion of N2 disease. I would not recommend pathological sampling of the mediastinal lymph nodes. I would proceed directly to surgery.	47 (38.5)	

Table 3. Approaches to mediastinal staging in NSCLC cases without radiological suspicion of N2 disease (Questions 3–6)

Questions 3-6: Approach in tumors without radiological suspicion of N2 disease:	I would perform pathological sampling of mediastinal lymph nodes (MLND) for staging purposes. I would rule out the possibility of N2 disease.	Based on PET-CT findings, the patient does not have N2 disease. I would proceed directly to surgery.	Guideline concordance
	n (%)	n (%)	
* Right upper lobe adenocarcinoma, T1 (0–3 cm) * Hilar lymph node with SUVmax = 5.2 (suspicious for N1)	54 (44.3)	68 (55.7)	44.3
* Right upper lobe adenocarcinoma, T1c (2–3 cm) * Centrally located tumor	72 (59)	50 (41)	59
* Right lower lobe adenocarcinoma, T2b (>3 cm, 4–5 cm)	45 (36.9)	77 (63.1)	36.9
* Right lower lobe squamous cell carcinoma, T2a (>3 cm, 3–4 cm)	27 (19.7)	98 (80.3)	19.7

Table 4. Participant preferences regarding aortopulmonary window (Stations 5–6) sampling in radiologically suspicious left upper lobe NSCLC scenarios (Questions 8 and 9)

Options	n (%)	Guideline concordance
I would perform invasive sampling of the aortopulmonary (APP) lymph nodes, and if N2 is detected, I would refer the patient for neoadjuvant therapy.	23 (18.9)	
I would rely on PET-CT findings and consider the patient to have N2 disease (#6), referring them for neoadjuvant therapy.	25 (20.5)	18.9
In my routine practice, I do not sample suspicious isolated APP lymph nodes in left upper lobe tumors. I do not believe that possible N2 disease in this region would change my treatment strategy. I would proceed directly to surgery and refer the patient for adjuvant therapy based on the postoperative pathology results.	74 (60.7)	
Question 8: On PET-CT examination: * Left upper lobe NSCLC, T2a (3–4 cm) * #6 > 1 cm (1.7 cm) and SUVmax 5.4 * Cervical mediastinoscopy pathology report: #2R, #2L, #4R, #4L, and #7 — no metastasis detected		
Question 9: On PET-CT examination: * Left upper lobe NSCLC, T1c (2–3 cm) * #6 > 1 cm (1.6 cm) and SUVmax 4.8 * #4L > 1 cm (1.6 cm) and SUVmax 4.3 * Endobronchial ultrasound (EBUS) pathology report: metastasis present in #4L		
I would perform invasive sampling of the aortopulmonary window. If N2 is detected, I would consider the patient to have multiple N2 disease and refer for definitive treatment.	21 (17.2)	
I would not perform pathological sampling of the aortopulmonary window. I do not believe that possible metastasis in station #6 carries the same poor survival prognosis as other multiple N2 cases. I would refer the patient for neoadjuvant therapy.	55 (45.1)	17.2
I would not perform pathological sampling of the aortopulmonary window. Based on PET-CT findings, I would consider the patient to have multiple N2 disease and refer for definitive treatment.	46 (37.7)	

Discussion

Mediastinal staging of non-small cell lung cancer is of paramount importance. In NSCLC cases, detection of nodal involvement during preoperative staging alters the treat-

ment protocol. It differentiates surgically resectable from unresectable disease, informs prognostic assessment, and enables precise comparison of outcomes across clinical trials.^[1,7]

Despite minor variations, current guidelines converge on common principles regarding mediastinal lymph node staging. Accordingly, invasive mediastinal staging is not required in cases with normal-sized mediastinal lymph nodes (<1 cm) on CT, a negative PET-CT scan (with some studies using a cutoff $SUV_{max} \leq 2.5$ for 18F-fluorodeoxyglucose uptake as the threshold for normalcy), a peripheral clinical stage IA (T1N0M0) tumor, and a negative clinical evaluation.^[2] The American Association of Chest Physicians (ACCP) guidelines define a T1 tumor as a primary tumor with a diameter of 3 cm or smaller, surrounded by lung or visceral pleura, or an endobronchial tumor located distal to the lobar bronchus. In contrast, the European Society of Thoracic Surgeons (ESTS) guidelines apply this definition exclusively to squamous cell carcinomas; consequently, for adenocarcinomas, they recommend mediastinal lymph node staging even in the absence of radiologically detected N2 disease.^[2,3,8]

All guidelines recommend mediastinal lymph node staging in the presence of radiological suspicion of N2 disease. In patients without N2 suspicion, mediastinal lymph node staging is recommended for centrally located tumors, in cases of suspected N1 disease (enlarged N1 nodes and/or PET-CT-positive N1 nodes), and for tumors >3 cm. (Level IIB; B: strong or moderate evidence for efficacy but with limited clinical benefit; generally recommended).^[2,3,8] The European Society for Medical Oncology (ESMO) and the ESTS define the indication for mediastinal lymph node staging in tumors >3 cm mainly as adenocarcinomas with high FDG uptake, without providing a clear recommendation for squamous cell carcinoma cases.^[9,10] According to the literature, the likelihood of unsuspected N2 disease in >3 cm cN0 cases ranges from 6% to 14.8%.^[11,12] In our study, the proportion of physicians who believed that invasive mediastinal lymph node staging should be performed in squamous cell carcinoma cases without radiological suspicion of N2 disease was 19.7%, whereas this proportion increased to 36.9% when the same case was presented as adenocarcinoma. Although mediastinal lymph node staging is recommended by guidelines for tumors >3 cm, Buero et al.^[6] reported that in IB–IIA NSCLC cases without radiological suspicion of N2 disease, no pN2 was detected in any patient, and the negative predictive value of PET-CT was 100%.

One of the most significant differences among guidelines lies in the definition of a central tumor. In fact, there is no consensus on the definition of a central tumor. The recommendation to perform mediastinal lymph node staging in <3 cm centrally located tumors underscores the importance of how a central tumor is defined. The ESTS and the Nation-

al Comprehensive Cancer Network (NCCN) define “central” as within the inner two-thirds of the lung,^[3,13] whereas the ACCP defines it as within the inner one-third.^[2]

In our study, 95.1% of participating physicians defined a central tumor on computed tomography as one located within the inner one-third on longitudinal sections. Similar survey studies have shown considerable variation among physicians in how a central tumor is defined. In a survey involving 218 pulmonologists and thoracic surgeons, participants were asked how they determine the thirds of a hemithorax; 182 (84%) selected a system of concentric lines originating from the hilum.^[14] This radiologic definition has been associated with a higher rate of occult N2 disease.^[15] At the time the guidelines were developed, the incidence of occult N2 disease in central tumors was approximately 20%. However, more recent studies have shown that this rate has decreased substantially. Although guidelines recommend mediastinal lymph node sampling in central tumors, Decaluwé et al.^[16] did not show a significant association between central location and pN2 in T1 central tumors. Similarly, regardless of the definition of central tumor, the rate of pN2 in T1 tumors has been reported to range between 0% and 4.8%.^[17] Casal et al.^[18] compared two different definitions — concentric lines with the inner one-third and concentric lines with the inner two-thirds based on the center of the tumor — and found no increase in pN2 rates compared with non-central tumors for either definition. These findings indicate that the rates cited in earlier guideline references are not consistent with those reported in more recent studies. However, three recent studies comparing several definitions of centrality found that none of those proposed by the guidelines predicted N2 disease in contemporary series.^[19] In our study, 59% of physicians believed that mediastinal lymph node staging should be performed in central tumors. We believe that the recommendation for mediastinal lymph node sampling in T1 central tumors, as well as the definition of a central tumor itself, should be re-evaluated through large-scale studies.

The ACCP and ESTS recommend sampling of aortopulmonary window lymph nodes (stations 5 and 6) in left upper lobe tumors if involvement changes the treatment strategy, albeit with a low level of recommendation.^[2,3,8] No randomized trials evaluating whether staging of lymph nodes in stations 5–6 before resection is preferable. The consensus is that the role of neoadjuvant therapy in these patients remains controversial, and further research is warranted in this area. In a survey conducted in Canada, 52.2% of thoracic surgeons reported that they do not sample aortopulmonary window lymph nodes. Participants noted that left upper lobe tumors with single-station involvement of me-

diastinal nodes have survival outcomes similar to those of patients with only N1 disease.[20] In our study, only 18.9% of physicians believed that sampling should be performed in the aortopulmonary lymph nodes when there was suspicion of single-station N2 disease in this region. In the case of possible multiple N2 disease, 17.2% of respondents supported sampling to rule out multiple N2 involvement in this region, whereas 45.1% favored a neoadjuvant treatment approach for multiple N2 disease in this location.

Limitation

Bulky N2 disease lacks a universally accepted definition; however, it is generally correlated with radiographic group A, as outlined in the American College of Chest Physicians Evidence-based Clinical Practice Guidelines. This group is characterized by mediastinal infiltration in which discrete lymph nodes cannot be clearly distinguished or measured. The term “bulky” is not determined solely by lymph node size; nevertheless, the committee considers lymph nodes with a short-axis diameter >25 mm to also represent bulky disease (Level V). While bulky disease may be limited to a single station, it more commonly reflects multistation or multi-zonal involvement. As the present study focuses on preoperative lymph node staging, the technical considerations and procedural details for obtaining histological confirmation in bulky mediastinal nodal disease lie beyond the scope of this article.

Conclusion

This nationwide survey demonstrates that thoracic surgeons in Türkiye generally adhere to guideline-based indications for mediastinal staging in NSCLC, though notable variability persists in selected clinical scenarios. Differences were most evident in the management of centrally located tumors, tumors >3 cm without radiological N2 suspicion, and aortopulmonary window lymph node involvement, reflecting ongoing areas of controversy in contemporary guidelines. These findings underscore the need for clearer definitions — particularly regarding tumor centrality — and further evidence to guide the role of aortopulmonary sampling. Strengthening educational initiatives and harmonizing institutional practices may enhance the consistency of staging strategies and support more standardized decision-making in NSCLC care.

Disclosures

Ethics Committee Approval: The study was approved by Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital Ethics Committee (No: 329-6, Date: 24.08.2022).

Informed Consent: Written and verbal informed consent was obtained from all participants prior to data collection.

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