Staging of Lung Cancer

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KEYWORDS

• NSCLC • Lung cancer • TNM staging

KEY POINTS

- Staging of lung cancer determines management and therapeutic options; therefore, accuracy of staging is essential.
- Clinical staging in patients presenting with lung cancer generally underestimates the extent of disease when compared with the pathologic stage.
- Radiologic imaging, including computed tomography (CT), MRI, and ^{18}F-fluoro-2-deoxy-D-glucose PET/CT, is an essential component of clinical staging and allows assessment of disease manifestations that are important for surgical, oncologic, and radiation therapy planning.
- The 7th edition of TNM Staging from the International Association for the Study of Lung Cancer/American Thoracic Society has been used since 2010 and the 8th edition is expected in 2015.
- Future staging classifications for lung cancer may include information about histology, biomarkers, and biochemical and demographic prognostic factors.

INTRODUCTION

Primary lung cancer is the leading cause of cancer mortality in the world, largely prefaced by the fact that patients with lung cancer often present with locally advanced or metastatic disease.[1] Imaging is important in the clinical staging and management of these patients because therapeutic options and mortality are to a considerable degree dependent on stage at presentation.

This article discusses the use of chest radiography, computed tomography (CT), MRI, and PET in the current TNM staging of non-small cell lung cancer (NSCLC). In addition, limitations, current controversies, and future directions in staging are briefly reviewed.

IMAGING TECHNIQUES

Clinical evaluation in patients presenting with lung cancer is required to provide an initial assessment of stage, although, in general, the clinical stage underestimates the extent of disease when compared with the pathologic stage. Radiologic imaging is an essential component of this clinical staging and allows assessment of disease manifestations that are important for surgical, oncologic, and radiation therapy planning, including size of the primary tumor, location and relationship to normal anatomic structures in the thorax, and existence of nodal and/or metastatic disease.

Numerous clinical guidelines have been promulgated by different organizations to aid in the evaluation of patients with lung cancer and assist in therapeutic decision-making. Silvestri and colleagues[2] have recently reviewed clinical lung cancer staging based on the American College of Chest Physicians (ACCP) 3rd edition of Evidence-Based Clinical Practice Guidelines for Diagnosis and Management of Lung Cancer, referenced in this article.

Chest Radiography

Chest radiography is commonly a first assessment modality for patients who present with

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cardiopulmonary symptoms, including chest pain, cough, and dyspnea. However, although useful in ascertaining advanced disease, the limitations of chest radiography in accurately determining TNM descriptors in patients with potentially resectable disease typically mandate imaging with CT and/or PET/CT and/or MRI. In assessing the value of multimodality staging for lung cancer, Farjah and colleagues[3] found that patients who underwent bimodality evaluation (CT plus PET or CT plus invasive staging), or trimodality staging (CT, PET, and invasive staging) had a significantly lower risk of death compared with single-modality assessment. Bimodality staging compared with single modality had a hazard ratio of 0.58 (99% confidence interval [CI], 0.56–0.60) and trimodality evaluation compared with single-modality had a hazard ratio of 0.49 (99% CI, 0.45–0.54).

Computed Tomography

A CT of the chest with administration of intravenous contrast material is recommended for evaluation of all patients with known or suspected primary lung cancer.[2] CT is used to assess most characteristics of the primary tumor (T descriptor), including size and location, but locoregional invasion can be difficult to determine. CT can demonstrate frank mediastinal or chest wall invasion, but it is not optimal in distinguishing the presence or extent of subtle involvement of the pleura, mediastinal structures, or chest wall.

Detection of nodal metastases is also performed with CT, using greater than 1 cm short-axis diameter as a threshold for suspected metastatic disease. CT is useful in determining the absence or presence of intrathoracic and extrathoracic metastatic disease, including contralateral lung nodules, pleural and pericardial nodules and effusions, bone metastases, or adrenal nodules/masses.

CT of the chest alone is sufficient for staging of patients with pure ground glass opacities and an otherwise normal study, and for patients with peripheral stage IA disease.[2] Otherwise, further imaging with ^{18}F-fluoro-2-deoxy-D-glucose (FDG) PET is recommended for NSCLC patients potentially eligible for curative treatment. When PET is unavailable or cannot be performed, a contrast-enhanced CT of the abdomen is recommended.[2]

MRI

MRI has superior soft tissue contrast compared with CT and is the optimal modality for evaluating subtle mediastinal or chest wall involvement by tumor. For paramediastinal tumors, MRI is useful in assessing tumor involvement of the heart, great vessels, and pericardium and is better than CT at identifying myocardial or cardiac chamber invasion.[4] MRI is also effective in the evaluation of superior sulcus tumors. MRI is the first-line imaging modality in the investigation of brain metastases.[2,5] In addition, small lesions in the liver can be more frequently detected on contrast-enhanced MRI than CT,[6] and chemical shift MRI can be used to characterize adrenal nodules.

PET

FDG PET has poor intrinsic resolution and generally is not useful in evaluating the primary tumor, but the detection of nodal and distant metastases is improved compared with CT.[7,8] Furthermore, integrated FDG PET/CT is more accurate for nodal and metastatic disease staging than separately interpreted FDG PET and CT.[9] Accordingly, FDG PET and FDG PET/CT are now commonly used for staging in patients with NSCLC.[2,8] In most patients with NSCLC, whole-body FDG PET is recommended when no metastatic disease is detected on CT, as unexpected detection of nodal and/or distant metastases can affect management in up to 14% of patients.[10] In fact, it has been reported that unnecessary thoracotomy can be avoided in 1 of 5 patients through the use of FDG PET imaging.[7]

TNM STAGING: 7TH EDITION

The current 7th edition of the TNM staging system classification for NSCLC is founded entirely on anatomic information (**Table 1**).[11] Stage evaluation of patients with small cell lung cancer (SCLC) is similar but is not addressed here.[12] For the interested reader, the review by Jett and colleagues[13] on staging and management of SCLC provides an excellent resource.

Primary Tumor

The T descriptor is determined by the size, location, and extent of the primary tumor and is usually assessed by CT (**Box 1**). Descriptors T1 through T4 reflect prognosis and determine treatment options in patients with limited nodal metastasis and absence of distant metastasis.[14]

T Descriptor	5-year Survival (%)
pT1a N0M0	77
pT1b N0M0	71
pT2a N0M0	58
pT2b N0M0	49
pT2c N0M0	35
pT3 N0M0	38
pT4 (any N)	22