12.1 Introduction

Accurate intraoperative assessment of disease extension is an essential component of surgery for non-small-cell lung cancer (NSCLC). Although the size of the primary tumor and invasion of adjacent structures (T descriptor) may be readily determined by the surgeon and pathologist, the presence or absence of tumor within the intrathoracic lymph nodes (N descriptor) can be ascertained only by microscopic examination. Histologic staging relies on the quality of the specimens that are submitted to the pathologist. Thus, care must be taken to ensure that the appropriate specimens are obtained and properly handled. In order to appreciate the technical aspects of the staging procedures, an understanding of pulmonary lymphatic drainage and intrathoracic metastatic patterns is necessary. The information that is derived from the surgical/pathologic staging process is important for three reasons. First, it allows optimal decisions regarding the need for additional therapy. Second, it provides prognostic information. Third, it provides a reproducible method for comparison of different treatment strategies.

12.2 Patterns of Lymphatic Drainage and Metastases

The classic description of the mediastinal lymph nodes in the human adult is found in Anatomie des Lymphatiques de l’Homme, in which meticulous postmortem dissection was combined with dye injection of the lymphatics to identify common drainage pathways. An in vivo radionuclide investigation of pulmonary drainage patterns was performed in 179 patients who had no evidence of lymph node metastases [1]. 99mTc-labeled antimony sulfide or rhenium colloid was injected submucosally under bronchoscopic guidance into each segmental bronchus. A total of 192 lymphoscintigraphies were performed. The results are summarized in Fig. 12.1. The apical and posterior segments of the right upper lobe drained to the ipsilateral scalene nodes via the hilum, tracheobronchial angle, and upper paratracheal nodes. The anterior segment of the right upper lobe drained via three dominant pathways. Approximately half of the patients drained via the same pathway as the other right upper lobe segments. The remainder drained via the subcarinal nodes, continuing to the pretracheal, right paratracheal (left paratracheal rarely), and right scalene nodes, or alternatively to the left scalene nodes by way of the innominate vein and left anterior mediastinal nodes. The middle lobe and superior segment of the lower lobe exhibited similar drainage patterns. In both cases, the preferential pathway was to the right scalene nodes through the pathways described above. However, a minority drained to the left scalene nodes via the subcarinal and left paratracheal nodes. The basal segments of the right lung ultimately drained to the right scalene nodes via the subcarinal and right paratracheal nodes.

Drainage patterns observed in the left lung were more variable. The dominant pathway of the apical-posterior segment of the left upper lobe was to the subcarinal nodes, continuing along either the vagus nerve to the scalene nodes or along the recurrent laryngeal nerve to the mediastinal nodes. The lingula and anterior segments of the left upper lobe shared a similar
pattern, draining along the phrenic nerve to the para-aortic and left scalene nodes. The basal segments of the lower lobe drained primarily through the subcarinal, pretracheal, and right (occasionally left) paratracheal nodes to the right scalene nodes. The superior segment of the lower lobe exhibited the most variability, draining by all of the above pathways.

Whereas Hata et al. [1] outlined the lymphatic drainage patterns of patients without lymph node metastases, several investigators have studied the metastatic patterns in patients with biopsy-proven nodal involvement. Borrie [2] documented the patterns of dissemination within the intrapulmonary lymphatics of resected specimens from 92 patients. He found that tumors in all lobes of the right lung metastasized to the lymph nodes situated between the upper lobe and the middle lobe bronchi. Similarly, tumors of both lobes of the left lung commonly metastasized to the lymph nodes between the lobar bronchi (sumps of Borrie). The mediastinal lymph nodes were not studied.

Nohl-Oser [3, 4] confirmed these findings and supplemented them with his own results regarding metastasis to the mediastinal nodes. Lymph nodes harvested by mediastinoscopy, scalene node biopsy, or mediastinal lymph node dissection from 749 patients with stage I–IV NSCLC were analyzed. Right upper lobe tumors frequently spread to the ipsilateral mediastinum, but rarely to the subcarinal nodes or the contralateral mediastinum. Right lower lobe tumors commonly metastasized to the subcarinal nodes and ipsilateral mediastinum, but were unlikely to spread to the contralateral mediastinum. He could not draw conclusions regarding tumors originating in the right middle lobe, due to an insufficient number of cases. Tumors of the left upper and lower lobe seemed to metastasize to the subcarinal and contralateral mediastinal nodes.

In a study of 166 patients with biopsy-proven N2 NSCLC, Asamura et al. [5] described metastatic patterns with some similarities to those described above. Tumors in all lobes appeared to metastasize to the mediastinum by way of the interlobar and hilar nodes. Right upper lobe tumors most commonly spread to the lower pretracheal nodes (74%). Metastases to the subcarinal nodes were much less frequent (13%). Right middle lobe tumors involved the subcarinal nodes most frequently (88%), followed by the lower pretracheal nodes (75%). Right lower lobe tumors involved the ipsilateral paratracheal nodes as well as the upper and lower pretracheal nodes (76%), and the subcarinal nodes less often (58%). Left upper lobe tumors, collectively, spread most commonly to the aortopulmonary window (59%) and para-aortic nodes (32%). Subcarinal nodes were less frequently involved (21%), but were the most common site for tumors of the lingula. Left lower lobe tumors...