Staging lung cancer

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In non-small cell lung cancer (NSCLC), radical surgical resection is considered to represent therapy most likely to offer cure. This is usually only possible if there is no involvement of unresectable structures and no distant metastases. In advanced disease, particularly in the presence of distant metastases, cure is usually not possible and palliative chemotherapy and radiotherapy is considered the most appropriate therapeutic strategy.

In small cell lung cancer (SCLC) treatment consists of chemotherapy with or without additional radiotherapy. In selected cases of disease limited to one hemithorax radical surgery in combination with chemo- and/or radiotherapy may provide curative treatment.

The aim of staging procedures is to determine the extent of the disease and, thus, select the most appropriate treatment. For this purpose it is important to reliably detect local tumor extent (T stage: T1-T4) as well as the presence or absence of lymphatic (N stage: N0-N3) and hematogeneous (M stage: M0, M1) metastases (Table 1).

Staging system

Revisions in stage grouping of the TNM subsets in the international system for staging lung cancer were made 1997, to provide greater specificity for identifying patient groups with similar prognoses and treatment options. Patients who are likely to benefit from surgical resection are those with localized disease. Only stages I, II and IIIA can be considered as technically resectable (Table 2). Patients considered as definitely unresectable are those having distant metastases (M1), controlateral or subclavian lymph node metastases (N3) or tumor classified T4.

The local extent of tumor affects the extent of surgery required for radical resection. Generally, a tumor sur-

Table I. TNM description for staging lung cancer (1)

TX	Primary tumor cannot be assessed or cannot be visualized despite presence of malignant cells in sputum or bronchial washings
T0	No evidence of primary tumor
Tis	Carcinoma in situ
T1	Tumor ≤ 3 cm surrounded by lung or visceral pleura; without bronchoscopic evidence of infiltration of main bronchus
T2	Tumor > 3 cm / infiltration of main bronchus > 2 cm to carina / infiltration of visceral pleura / obstructive pneumonitis or atelectasis extending to the hilum but not involving entire lung
T3	Infiltration of main bronchus < 2 cm to carina / infiltration of parietal or mediastinal pleura, chest wall, pericardium, diaphragm / obstructive pneumonitis or atelectasis of entire lung
T4	Infiltration of heart, great vessels, trachea, esophagus, vertebral body / malignant pleural or pericardial effusion / satellite tumor nodules within the same lobe
NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastases
N1	Metastasis to ipsilateral intrapulmonary, peribronchial or hilar lymph nodes
N2	Metastasis to ipsilateral mediastinal and/or subcarinal lymph nodes
N3	Metastasis to contralateral hilar, contralateral mediastinal, ipsi- or contralateral scalene or supraclavicular lymph node metastases (note: cervical or abdominal lymph node metastases are considered M1)
MX	Presence of distant metastases can not be assessed
M0	No distant metastases
M1	Distant metastases (brain, adrenal, skeleton etc.), lymphatic distant metastases (cervical and abdominal lymph nodes), satellite tumor nodules in other lobes

Table II. Stage grouping - TNM subsets (1)

Stage I A	T1	N0	M0
Stage I B	T2	N0	M0
Stage II A	T1	N1	M0
Stage II B	T2	N1	M0
	T3	N0	M0
Stage III A	T3	N1	M0
	T1-3	N2	M0
Stage III B	T4	N0-2	M0
	T1-4	N3	M0
Stage IV	T1-4	N0-3	M1

Table III. Staging of small cell lung cancer (Veterans Administration Lung Cancer Study Group) (2)

Very limited disease (VLD)
Stage I and II

Limited disease (LD)
Primary tumor limited to one hemithorax
Ipsilateral hilar, mediastinal or supraclavicular lymph node metastases
Contralateral mediastinal lymph node metastases
Atelectasis
Paralysis of recurrent or phrenic nerve
Small pleural effusion with no malignant cells

Extensive disease I (ED I)
Contralateral hilar or supraclavicular lymph node metastases
Infiltration of chest wall
Pleural effusion (except for small effusion with non malignant cells)
Superior vena cava syndrome
Metastases to controlateral lung

Extensive disease II (ED II)
Pleuritic carcinomatosis
Lymphangitic carcinomatosis
Distant metastases

rounded by aerated lung with no invasion of the main bronchus (T1) can be resected by lobectomy, whereas infiltration of the main bronchus, chest wall, diaphragm or mediastinum requires more aggressive surgery (pneumonectomy or sleeve resection, resection of chest wall, diaphragm etc.) which is associated with higher morbidity and mortality. Infiltration of structures that are either unresectable (heart) or in which resection is usually associated with higher morbidity or mortality (esophagus, brachial plexus, spine, aorta, superior vena cava etc.) are usually considered inoperable, particularly in view of the usually poor survival associated with these degrees of tumor extent. Other features do not affect resectability but reflect a more extensive tumor spread such as the presence of satellite tumor nodules in the same lobe.

As treatment options in small cell lung cancer are more limited a simplified staging system is often used in clinical practice (Table 3).

Tumour extent

CT continues to play a major role in preoperative staging of non-small cell lung cancer for selecting those patients with localized disease who are likely to benefit from surgical resection. Certain CT findings have been demonstrated as being diagnostic of unresectable disease. In many of these situations, biopsy proof of diagnosis is necessary but thoracotomy is not indicated. Although gross mediastinal invasion can be confidently diagnosed with CT, the contiguity of tumor with adjacent mediastinal structures is not equivalent to definite invasion.

MR has the same limitations as CT in distinguishing tumor contiguity from tumor extension into mediastinal structures.

Owing to its superior contrast resolution, MR may demonstrate subtle chest wall invasion and be superior to CT in this regard. MR is also thought to be more accurate that CT in depicting chest wall invasion from superior sulcus tumor that commonly involves the vertebra posteriorly, and the subclavian vessels and brachial plexus anteriorly. On the other hand, using helical scanning with thin collimation, bolus injection of contrast medium, and sagittal and coronal reconstructions, the anatomical environment of the plexus may also be accurately assessed with CT. MR remains an alternative only in cases in which the CT findings are inconclusive and in those in which extension into the neural foramina and epidural space is suspected.

Both CT and MRI cannot reliably differentiate between benign and malignant pleural and pericardial effusions. Presence of malignant pleural or pericardial effusion is best diagnosed by demonstration of malignant cells at aspiration.

Nodal extent

CT is very valuable in detecting mediastinal lymph node enlargement. Low sensitivity of CT is due to its inability to detect microscopic metas-

tases within normal-sized lymph nodes. Low specificity arises from the frequent occurrence of enlarged hyperplastic nodes. Consequently, all patients with abnormal mediastinal lymph nodes on CT scans need lymph node resection or biopsy. MR has no superiority over CT and is not indicated in this regard. Positron emission tomography (PET) with F-18 2 fluoro-2-deoxy-D-glucose (FDG) is more sensitive and specific than CT for nodal staging in lung cancer.

Mediastinoscopy has proven to be unnecessary in patients with CT evidence for stage I disease and a negative PET of the regional nodes. Increased FDG uptake in hilar and mediastinal lymph nodes can be used to direct surgical nodal sampling. The combined use of CT and PET to stage intrathoracic nodal metastases is not only clinically useful but also cost-effective. PET reduces the probability that a patient with unresectable mediastinal nodal metastases will undergo an attempt at curative resection.

Distant metastases

In most institutions lung cancer patients undergo routine staging procedures including chest radiographs, CT of the chest, abdomen and brain, bone scintigraphy and ultrasound examination of the abdomen. Because the adrenal glands are the most common site for extrathoracic metastases, CT examination should include the upper abdomen. An adrenal mass however may represent an incidental adenoma. Most incidental non-hyperfunctioning adrenal adenomas are less than 3 cm in diameter and of uniform low attenuation (< 10 HU), because of their fat content. Routine unenhanced CT of the adrenal glands allows accurate prospective characterization of many adrenal masses in patients with lung carcinoma.

In institutions in which PET is readily available, this may be performed as the only additional examination after CT, as it is the most accurate non-invasive imaging technique to confirm or exclude both lymph node and distant metastases (except for brain metastases) in a single examination. Whole-Body FDG-PET improves the detection of extrathoracic disease and alters management in up to 40% of cases.

Conclusion

CT remains the imaging technique of choice in staging lung cancer. Despite its limitation, CT is indicated in order to determine the extent of the primary tumor, to evaluate the mediastinal space for the presence of nodal enlargement, and to screen metastatic disease in the adrenal glands. MR is only indicated as an additional examination in patients with superior sulcus tumor. Whole body PET is the best technique for screening both lymph node and distant metastases.

Suggested reading

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