Clinical Radiology

The Royal College of Radiologists

Recommendations for cross-sectional imaging in cancer management, Second edition

Lung cancer

Faculty of Clinical Radiology

Contents

Clinical background

Lung cancer is the third most common cancer in the UK, accounting for around 13% of all new cancer diagnoses.[1] It is a leading cause of death with a well-known and potentially avoidable carcinogen (tobacco).[2] Lung cancer is strongly related to age, with more than 75% of cases diagnosed in persons aged 65 years and over.[3] The majority of individuals with lung cancer are male reflecting the proportion of smokers that are male. However, incidence rates have fallen in men for the last 30 years, and although incidence rates have been growing in women, the rate of increase has been steadily falling, again reflecting the decrease in smoking.[4] About 80–90% of lung cancer is of non-small-cell histology with the rest being of small-cell type.[5] The ratio of cell types appears to have changed over recent years, with an increasing incidence of adenocarcinoma, reflecting changes in smoking prevalence and the use of filters and low tar cigarettes. The stage of lung cancer at diagnosis is critical in determining which patients have potentially curable disease, and which do not. The prognosis from lung cancer is poor. The median survival is 203 days. The disease is often diagnosed late with a five-year survival of 10%, with approximately 70% of patients presenting with stage IIIB or IV disease.[4] However, there has been a significant improvement in one-year survival over the last ten years, with approximately one-third of patients surviving to one year.[4]

Treatment depends on the extent of disease, the location of the primary tumour and the presence or absence of co-morbid conditions. The main purpose of staging is to define which patients are suitable for curative treatment by defining the intrathoracic disease, and identifying extrathoracic disease. It is important to define the extent of the primary tumour and also the extent (volume and location) of nodal involvement, as small volume ipsilateral mediastinal nodes may not preclude surgery, particularly in the context of neoadjuvant chemotherapy.

Surgery remains the mainstay of potentially curative treatment for non-small-cell lung cancer (NSCLC), although recent advances in radiotherapy and percutaneous ablation may enable more patients to undergo attempted curative treatment if they are unsuitable for surgery. Suitability for surgery is dependent upon lung function and performance status. After assessing lung function and performance status, approximately 10–15% of patients are suitable for attempted curative surgery.[6] More recently, trials are being conducted using neoadjuvant chemotherapy to try to increase those suitable for surgery. Additionally, there is a trend for more aggressive potentially curative treatment in patients with solitary metastases, such as solitary brain or adrenal metastases, if the local intrathoracic disease is suitable for resection.

Recently, the International Association for the Study of Lung Cancer group (IASLC) has produced a revised TNM staging system (7th edition) that has been adopted by the Union Internationale Contre le Cancer (UICC).[7] The TNM staging system is used for NSCLC and is now recommended for use in small-cell lung cancer, alongside the use of the more conventional 'limited' (limited to one hemithorax) or 'extensive' (extends outside the hemithorax) disease classification.

Who should be imaged?

All patients with a diagnosis of lung cancer should be staged, unless their co-morbid conditions and performance status make this inappropriate, and even this group of patients, may require CT imaging to guide palliative radiotherapy.

Staging objectives

- To assess resectability.
- To identify the size and extent of the local tumour.
- To assess mediastinal invasion and relationship of the tumour to the carina.
- To assess hilar and mediastinal adenopathy.
- To identify chest wall or vertebral body invasion.

- To identify distant metastases in the liver, adrenal glands and upper abdominal lymph nodes.
- To identify supraclavicular fossa nodes.

Staging

CT of the neck, chest and abdomen is the investigation of choice to stage the primary tumour and to detect metastatic disease. Recent guidelines from the National Institute for Health and Social Care Excellence (NICE, 2011) recommend CT or MRI of the brain should be considered in patients being treated with curative intent, as 2–3% of these patients will have occult cerebral metastases.[6]

CT

- Post-contrast scans through the neck (to include supraclavicular fossa), chest and upper abdomen (to include the liver and adrenal glands).
- 100–150 ml of intravenous iodinated contrast medium. This may be injected via a pump or by hand.
- A scan delay of 20 seconds for optimal visualisation of the pulmonary artery and great vessels or 60 seconds may be used.
- Scan delay of 60–70 seconds for optimal visualisation of the liver in the portal venous phase is recommended.
- Using MDCT slice thickness will depend on scanner capability. In general, sections are acquired at less than 1 mm, dependent upon scanner type and reformatted at 2.5 mm for viewing on a picture archiving and communication systems (PACS) workstations.
- All scans should be reconstructed axially, coronally and sagittally. It is also helpful to routinely reconstruct maximum intensity projection (MIP) to help detect metastatic pulmonary nodules.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and Radiation protection for the patient in CT in Section 2).

MRI

There is now little need for MRI in staging patients with lung cancer. Involvement of the brachial plexus remains better assessed by MRI than MDCT, but the reconstructed sagittal and coronal images from MDCT are usually sufficient to assess invasion of the apical pleura and adjacent structures. T1W and T2W coronal and sagittal images with section thickness of 3 to 4 mm with an appropriate field of view are recommended.

PET-CT

[18]FDG PET-CT should be used in all patients deemed suitable for curative treatment; surgery, radiotherapy and percutaneous ablative therapy. Approximately 15% of patients will have extrathoracic metastatic disease identified by PET-CT not previously identified on MDCT.[7] Recent NICE guidelines suggest that it is possible to triage patients for mediastinal staging to PET-CT or interventions such as endoscopic bronchoscopic ultrasound (EBUS) or mediastinoscopy.[6] Peripheral small tumours without enlarged nodes on MDCT should proceed to PET-CT as the next investigation of choice. Patients with central or large lesions, or MDCT-enlarged lymph nodes should proceed to a sampling technique.

A positive mediastinal PET-CT should be confirmed by biopsy as false-positive uptake can occur with granulomatous disease and in the presence of pneumonic infection or co-morbid disease such as usual interstitial pneumonia (UIP). MDCT-enlarged FDG-negative lymph nodes also require tissue confirmation of disease absence, as 2–5% may be false-negative. If the PET-CT is negative and there are no enlarged mediastinal lymph nodes on MDCT, the patient may proceed to curative treatment without mediastinal nodal sampling.

There is some evidence suggesting that the metabolic activity of the primary tumour, measured by the standardised uptake value (SUV) may be of prognostic significance, although the data is insufficient to guide therapy at present. Additionally, the metabolic activity of the bone marrow has been reported to also be of prognostic significance.

Follow-up

At present, the evidence supporting follow-up imaging is poor after curative therapy, surgery or radiotherapy, and local practice may be followed. Either MDCT or PET-CT should be performed after neoadjuvant therapy before resection. MDCT is routinely performed after chemotherapy to assess disease response.

Tips

- If a solitary possible metastasis is identified on PET-CT that would preclude curative therapy, and the PET-CT is inconclusive, this should be confirmed either by a tissue diagnosis or by a second imaging technique.
- Small ipsi and contralateral pulmonary nodules may not be metastatic and may potentially be subpleural lymph nodes.

Lung metastases

Screening for pulmonary metastases is undertaken when detection will have a major impact on treatment; for example, testicular tumours, soft tissue sarcomas or bone tumours. Routine inclusion of the chest in staging head and neck tumours is more controversial and should be performed on a patient-by-patient basis.

CT

CT is the investigation of choice.

Using MDCT slice thickness will depend on scanner capability. In general, sections are acquired at <1 mm and reformatted in three planes at 2.5 mm for viewing. MIPs should be available for review, as it is proven to improve nodule detection.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and Radiation protection for the patient in CT in Section 2).

Malignant mesothelioma

Clinical background

Malignant mesotheliomas are relatively rare and represent about 1% of all malignant tumours.[8] The risk factor is exposure to asbestos, and the incidence of malignant mesothelioma is expected to continue to increase in the UK over the next five years.[9] Most tumours are diagnosed at an advanced stage with a consequent poor prognosis. Histological cell type effects prognosis but not treatment, and may be divided into sarcomatoid, epithelioid and mixed cell type, with sarcomatoid having the worst prognosis and epithelioid the best. A tissue diagnosis should be obtained in most patients, either by percutaneous biopsy or at thoracoscopy. Biopsy of the pleural tumour and radiotherapy to the portal site should be given to prevent seeding down the track.

These tumours are staged using the TNM classification. T1 to T3 tumours are potentially resectable, although it is recognised that identification of T3 disease is extremely difficult and unreliable on MDCT. Regional nodes include internal mammary, intrathoracic, scalene and supraclavicular nodes.

Who should be imaged?

Many patients are imaged before diagnosis as part of the investigation of recurrent pleural effusions. All patients whose performance status is suitable should be staged.

Staging objectives

- To assess the T stage.
- To assess the N-stage.
- To identify metastatic disease.

Staging

MDCT of the abdomen and chest is the investigation of choice to stage the primary tumour and to detect metastatic disease.

CT

- Post-contrast scans through the chest (to include supraclavicular fossa) and upper abdomen (to include the liver and adrenal glands).
- 100–150 ml of intravenous iodinated contrast medium injected at 3–4 ml/sec.
- Scan delay of 50 seconds for optimal visualisation of the pleural tumour and also allowing assessment of the mediastinal nodes.
- Using MDCT slice thickness will depend on scanner capability. In general, sections are acquired at sub 1 mm and reformatted at 2.5 mm for viewing using three planes.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and Radiation protection for the patient in CT in Section 2).

PET-CT
[18]FDG PET-CT is not proven to be of value in malignant mesothelioma, but in small published series has been shown to detect metastatic disease and provide prognostic information. It is of less value after talc pleurodesis as this causes increased pleural uptake.

Follow-up

Repeat MDCT staging to assess response to chemotherapy.

References

1. www.cancerresearchuk.org/health-professional/cancer-statistics/incidence/common-cancers-compared#heading-Zero (last accessed 05/01/2017)

2. Hecht SS. Tobacco smoke carcinogens and lung cancer. *JNCI: Journal of the National Cancer Institute* 1999; **91**(14): 1,194–1,210.

3. www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer/incidence#heading-One (last accessed 05/01/2017)

4. http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer/incidence#heading-Two (last accessed 05/01/2017)

5. www.cancerresearchuk.org/about-cancer/lung-cancer/stages-types-grades/types (last accessed 05/01/2017)

6. National Institute for Health and Social Care Excellence. *The diagnosis and treatment of lung cancer (update).* London: National Institute of Health and Social Care Excellence, 2011.

7. Goldstraw P, Crowley J, Chansky K *et al*. The IASLC Lung Cancer Staging Project: proposals for the revision of the TNM stage groupings in the forthcoming (seventh) edition of the TNM Classification of malignant tumours. *J Thorac Oncol* 2007; **2:** 706–714.

8. www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/mesothelioma/incidence (last accessed 05/01/2018)

9. Health and Safety Executive. Mesothelioma in Great Britain. *Mesothelioma mortality in Great Britain 1968–2015.* London: Health and Safety Executive 2017.

Authors:

Dr Fergus Gleeson, Department of Clinical Radiology, Churchill Hospital, Oxford

Dr Sujal Desai, Department of Clinical Radiology, Kings College Hospital, London

Citation details

Gleeson F, Desai S. Lung cancer. In: Nicholson T (ed). *Recommendations for cross-sectional imaging in cancer management*, Second edition. London: The Royal College of Radiologists, 2014.

Ref No. BFCR(14)2
© The Royal College of Radiologists, April 2014.

The Royal College of Radiologists
63 Lincoln's Inn Fields, London WC2A 3JW
Tel: +44 (0)20 7405 1282
Email: enquiries@rcr.ac.uk **www.rcr.ac.uk**

A Charity registered with the Charity Commission No. 211540

Clinical Radiology
The Royal College of Radiologists

Faculty of Clinical Radiology