Thoracic surgical radiographic and CT pathology: radiology in the radical treatment of lung cancer

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Abstract

Radiology has an important role in the diagnosis, staging and treatment of lung cancer and can offer minimally invasive therapies for poor surgical candidates. Radiology is also important in the follow up of patients after treatment, the assessment of treatment complications and detection of recurrent disease. Understanding the normal post-operative and post-radiation appearances, and recognizing early and late complications is useful for all clinicians involved in the care of patients with cancer.

Keywords Lobectomy; non-small cell lung cancer (NSCLC); pneumonectomy; radiofrequency ablation (RFA); stereotactic ablative radiotherapy (SABR); surgery

Royal College of Anaesthetists CPD Matrix: 2A03; 2A12; 3G00

Learning objectives

After reading this article, you should be able to:

- highlight the imaging modalities used to diagnose and stage lung cancer
- discuss the different modalities for radical treatment including surgery and radical radiotherapy
- discuss the radiological appearances post thoracic surgery and potential complications
- discuss the types of radiation therapy and post-radiation changes and complications
- introduce radiofrequency ablation of lung tumours and the follow-up imaging features
- understand the early and late complications that can occur following radical treatment and what key imaging findings to look for

Introduction

Lung cancer is the most frequent cause of cancer-related deaths worldwide, with 1.6 million people dying as a result of the disease every year. The 5-year survival rates remain low at 4–17% depending on stage at diagnosis and regional differences despite progress in diagnosis and treatment.[1]

The management of non-small cell lung cancer (NSCLC) has improved over the last decade with further advances in radiological staging, surgery, combined modality therapies and radiation technology. An important role of imaging is in the selection of which patients are suitable for radical treatment with curative intent.[2,3] This article will review the role of radiology in the assessment of the suitability of patients for radical treatment and the role of radiology in post treatment follow up and detection of complications.

The role of imaging in patient selection for radical treatment

Imaging is central in establishing accurate diagnosis and staging of lung cancer.

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Plain chest x-ray (CXR) remains an integral tool for initial assessment of patients. All patients will go on to have a multidetector computed tomography (CT) scan with intravenous contrast, in the absence of contraindications, to accurately stage the suspected lung cancer. This is to triage patients' further management and decide the most appropriate way to obtain tissue for a histological diagnosis.[2,3] A tissue diagnosis can be obtained by bronchoscopy, CT-guided biopsy, endobronchial ultrasound or mediastinoscopy, or biopsy of a distant metastasis.[4,5] CT allows for accurate delineation of the tumour anatomy, location and volume for staging and usually gives an accurate measurement of the tumour stage.

Patients thought to be suitable for radical treatment after initial CT will be further imaged with positron emission tomography CT (PET-CT). PET-CT is useful in the evaluation of mediastinal lymph nodes. If the nodes demonstrate increased uptake on PET, this is suspicious of mediastinal nodal metastatic disease. PET-CT can direct biopsy of abnormal mediastinal nodes by endobronchial ultrasound, endo-oesophageal ultrasound or mediastinoscopy which can both stage the patient and give a histological diagnosis if positive.[3]

PET-CT is also useful in differentiating the extent of a proximal tumour from distal lobar collapse, which can be difficult on CT[2] (Figure 1).

PET-CT is particularly sensitive in the assessment of metastases not visible on the initial staging CT, with the exception of brain metastases.[2] Adrenal glands, liver and bones are common sites of metastatic disease. Most adrenal lesions found on CT are benign. PET-CT is useful to distinguish between benign and malignant adrenal lesions with sensitivity of 94–100% and specificity of 80–100%.[2] For bone metastases, PET-CT is more sensitive than conventional bone scintigraphy and bone lesions seen on PET-CT will exclude patients from radical treatment.[2]

If PET-CT suggests that the patient has no mediastinal nodal disease and no distant metastases and if the primary tumour appears to be resectable, then the patient may be suitable for radical treatment.

Limitations of PET-CT include false negative results from disease with low metabolic activity resulting in low tracer uptake

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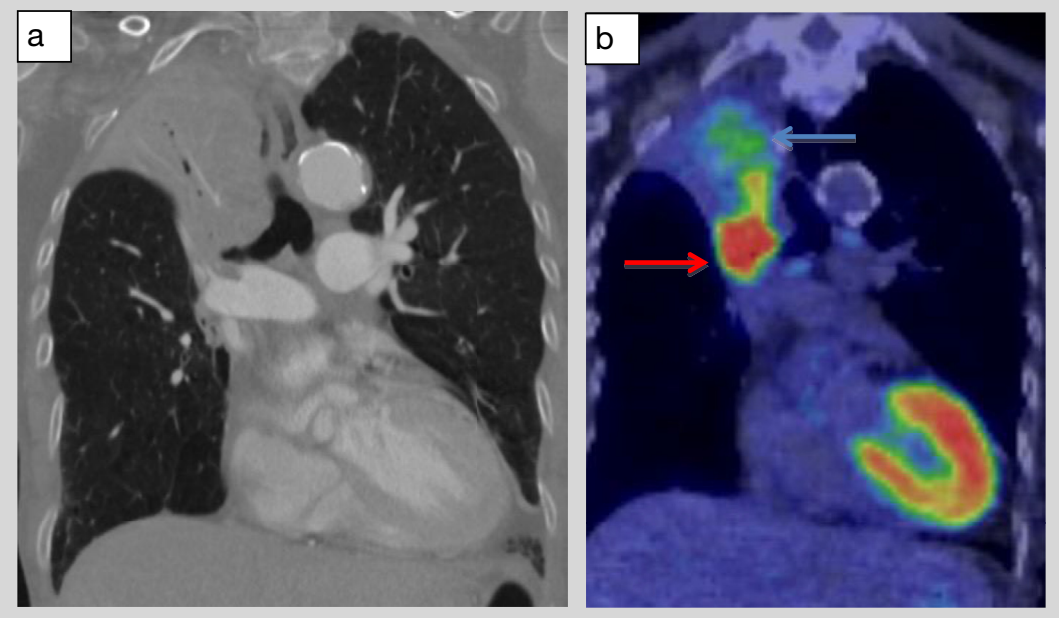

Figure 1 Patient presenting with cough and haemoptysis. Right upper lobe collapse confirmed on CT (**a**) with a suspected hilar mass, merging with the collapsed lung and not clearly seen separately. Central hilar obstructing mass only confidently identified on PET-CT (**b**) clearly showing a markedly avid right upper lobe obstructing tumour (red arrow). Mild heterogeneous tracer uptake in collapsed lung was secondary to post-obstructive infective atelectasis (blue arrow).

such as in carcinoid and bronchioalveolar cell carcinoma. Other limitations include misregistration secondary to breathing artefact, uncontrolled diabetes and lesions smaller than 8 mm. False positive uptake can also be seen in inflammatory conditions.[2] Brain metastases are often not visible on PET-CT due to the normal high uptake of the brain but are easily visible on contrast enhanced CT or MRI.

Radical treatment options

Surgery

Surgery with radical resection gives the patient the highest chance of cure and of long-term survival. Accurate staging is important to ensure a patient is not overstaged and as a result miss out on potentially curative treatment. Discussion of patients at the lung cancer multidisciplinary team (MDT) meeting is a vital part of this process. Surgery in operable patients is recommended treatment for patients with early stage disease, stage I–II NSCLC.[6]

Lobectomy is considered the standard surgical treatment for tumours if technically possible (Figure 2). There is a higher mortality risk if a pneumonectomy is required for complete resection[2,7] as such, it is reserved for more central tumours, where there may be no other technical way to completely excise the tumour, e.g. if a main bronchus is involved (Figure 3). Following pneumonectomy, the post-pneumonectomy space accumulates fluid in the first few weeks and over several months there will be mediastinal shift and contralateral lung herniation across the midline towards the post-pneumonectomy space as the fluid is reabsorbed (Figure 4). Chest wall reconstruction may be required and polytetrafluoroethylene prosthesis meshes can be used to cover the surgical defect, which are at risk of infection (Figure 5). Lung-preserving surgical options include segmentectomy, wedge resection and sleeve resection.

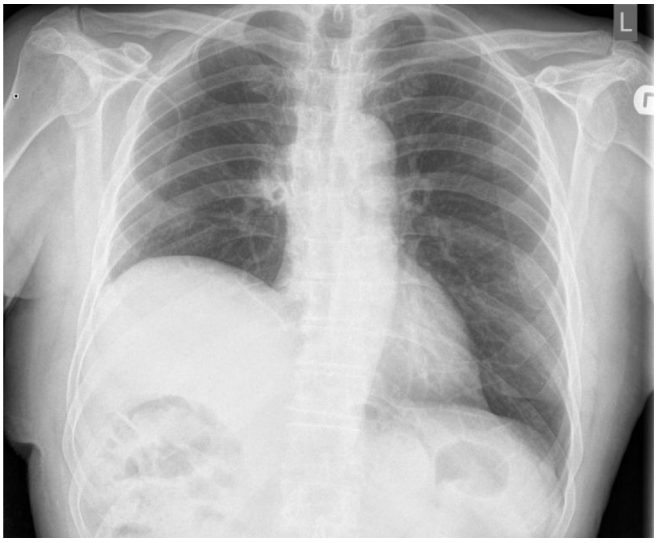

Figure 2 Right upper lobectomy. Normal postoperative appearances showing volume loss on the right and a raised right hemidiaphragm.

The incidence of complications following pneumonectomy is 20–60%. Early postoperative complications include haemothorax, infection, cardiac arrhythmia, pulmonary oedema, pulmonary embolism, cardiac herniation and acute respiratory distress syndrome.[8]

Bronchopleural fistula is a major postoperative complication that occurs when there is a connection between the airway and the pleural space most often post pneumonectomy (Figure 6). This is a serious, potentially fatal complication, often resulting in infection with a significant mortality rate.[3,8] In the early postoperative period, this is usually secondary to infection or

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