

## REVIEW

# Lung metastases

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### Abstract

Because the lungs are the most frequently affected target organs for metastatic disease, their assessment is of paramount importance in the management of oncologic patients. While plain chest radiography is still the standard modality for detection and monitoring, the increasing use of helical CT, and particularly multi-detector row CT, as the most sensitive imaging technique in the identification of metastases has already made its impact on innovative patient care. Furthermore, pulmonary imaging may be enriched by novel tools, such as molecular imaging, in the near future.

**Keywords:** Pulmonary neoplasm; pleural neoplasm; (multi-detector row) computed tomography; molecular imaging.

### Introduction

With regard to pulmonary metastases, the staging and follow-up of patients with known malignant disorders are often a part of daily radiological practice. Therefore, extensive knowledge about the pathophysiology and imaging features of metastatic disease, differential diagnosis and the impact of the diagnosis on patients' management are major concerns for the radiologist. Here, after a rapid overview of the radiological appearance of metastatic pulmonary disease, we will discuss major differential diagnoses and finally note novel imaging approaches.

### Imaging patterns of metastatic spread

Hematogenous spread is most frequently seen in tumors with a venous drainage directly into the lung, including malignancies of the head and neck, thyroid, adrenals, kidneys, testes, melanoma, and osteosarcoma<sup>[1]</sup>. CT is particularly superior to plain chest radiography in detecting small peripheral or subpleural metastases, as well as the size and predominant distribution of pulmonary nodules. Diffuse miliary seeding (medullary carcinoma of

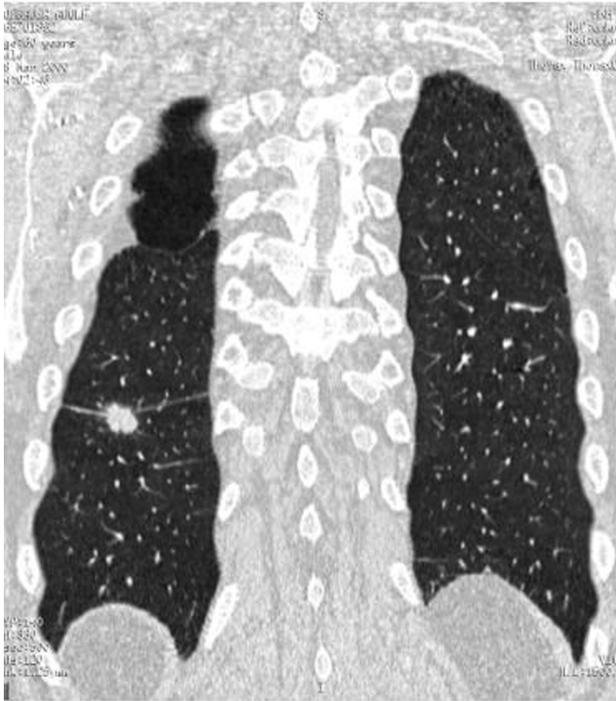
the thyroid), large singular metastases (choriocarcinoma, melanoma, and hypernephroma), calcification of metastases (osteosarcoma, adenocarcinoma, and secondary to chemo- and radiation therapy), and cavitation of pulmonary metastases (squamous cell carcinoma of the head and neck and from the genitourinary tract in women) are typical features.

Pulmonary metastatic disease may also appear as lymphangitic carcinomatosis (most commonly tumors of the lung, stomach, breast, pancreas, uterus, rectum and prostate). The mechanisms of metastatic involvement of the lymphatics include antegrade lymphatic invasion through the diaphragm and/or pleural surfaces, and retrograde lymphatic spread from hilar nodal metastases. Plain film findings of lymphangitic carcinomatosis include reticular or reticulo-nodular interstitial markings, usually with irregular contours, and thickening of the interlobular septa (Kerley B lines), and may be associated with hilar adenopathy and pleural disease. High-resolution CT is sensitive in the detection of patterns such as thickened core structures in the central portions of the secondary pulmonary lobules<sup>[2]</sup>.

Macroscopically evident endobronchial metastases (advanced malignant breast, kidney, colon, rectum, or

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pancreatic disease) have a low incidence and are radiographically identified in the major airways in 2–5% of patients who are dying from solid tumors (see Fig. 1)<sup>[3]</sup>. On plain radiographs, endobronchial metastases are visible only when they attain a certain size but have not yet caused post-obstructive atelectasis.



**Figure 1** A 65-year-old male patient with a history of colon cancer and a solitary lung metastasis, suggesting endobronchial origin.

Metastatic seeding to the pleura (cancers of the lung, breast, pancreas, and stomach)<sup>[4]</sup> frequently occurs, due to hematogenous dissemination with extension to the pleura, with lymphangitic spread, or originating from established hepatic metastases. Radiologically, pleural metastases may appear as nodules or plaque-like formations on plain films and CT scans. Malignant pleural effusions, observed in up to 42% of cases, most commonly arise from primary tumors of the lungs, the breast and the ovaries, and from lymphoma.

### Differential diagnosis of pulmonary metastases

In patients with known primary malignancies, the appearance of multiple bilateral pulmonary nodules is highly indicative of metastatic disease and obviates the need for further diagnostic procedures. However, the development of a single pulmonary nodule in a patient with known malignant disease is a special case, because the overall incidence of an additional primary lung

carcinoma is greater than that for a solitary metastasis. In particular, the development of the solitary pulmonary nodule in patients with head and neck cancers should immediately raise suspicion of a primary neoplasm of the lung. Conversely, patients with known sarcoma or melanoma more frequently develop solitary lung metastases than primary bronchogenic carcinoma (see Fig. 2)<sup>[5]</sup>.

Apart from malignant disease, the differential diagnosis of single or multiple pulmonary nodules in patients with known malignancies should include pulmonary nodules of benign origin. The list of differential diagnosis for benign nodules is long and includes granuloma, sterilised metastases, infection (such as invasive aspergillus and candidiasis), and the proliferation of intrapulmonary lymph nodes. If a reasonable possibility exists that a new nodule may represent benign disease, histopathological proof can definitely influence patient management. Here, interventional percutaneous localisation techniques may be helpful in the preoperative marking of a lesion.



**Figure 2** A 58-year-old male patient, 5 years of disease-free survival after melanoma of the left limb, now presenting with a solitary lesion of the right lower lobe. Multi-detector row CT, coronal reformation.

## The role of imaging at present and in the future

The role of lung imaging in the management of cancer patients is to detect or exclude metastases to the lungs during every phase of disease. The chest radiograph is still the initial test for the identification of pulmonary metastases. Helical CT, and particularly multi-detector row CT with maximum intensity projection (MIP) and multi-planar reconstructions (MPR)<sup>[6,7]</sup>, is used due to its increased sensitivity, especially when imaging of pulmonary nodules may have a profound impact on patient management. Within the last few years, molecular research and drug discovery have led to dramatic advances in understanding of the molecular pathways of disease. In the future, we might be able to use results of molecular imaging research in routine clinical practice. Some examples of future possibilities are exemplified by techniques now in use, such as the combination of spiral CT with nuclear imaging approaches. For example fluoro-2-deoxy-D-glucose (FDG) PET imaging for the detection of pulmonary metastases<sup>[8,9]</sup>, and the image-guided delivery of an adenoviral vector, encoding for the tumor suppressor gene p53, into lung lesions (for a review, see<sup>[10]</sup>).

## Conclusion

In oncologic patients, the increased use of highly sensitive imaging techniques will lead to ongoing improvement in the detection of metastatic pulmonary disease. Nevertheless, a fundamental understanding of the epidemiology, pathogenesis, and morphologic patterns of disease is necessary to adequately and effectively

aid in the management of oncologic patients. In the future, specific imaging of molecular targets may allow earlier visualisation and characterisation of malignant disease.

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