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Review article

State-of-the-art: Radiological investigation of pleural disease

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ABSTRACT

Pleural disease is common. Radiological investigation of pleural effusion, thickening, masses, and pneumothorax is key in diagnosing and determining management. Conventional chest radiograph (CXR) remains as the initial investigation of choice for patients with suspected pleural disease. When abnormalities are detected, thoracic ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET) can each play important roles in further investigation, but appropriate modality selection is critical.

US adds significant value in the identification of pleural fluid and pleural nodularity, guiding pleural procedures and, increasingly, as "point of care" assessment for pneumothorax, but is highly operator dependent. CT scan is the modality of choice for further assessment of pleural disease: Characterising pleural thickening, some pleural effusions and demonstration of homogeneity of pleural masses and areas of fatty attenuation or calcification. MRI has specific utility for soft tissue abnormalities and may have a role for younger patients requiring follow-up serial imaging. MRI and PET/CT may provide additional information in malignant pleural disease regarding prognosis and response to therapy.

This article summarises existing techniques, highlighting the benefits and applications of these different imaging modalities and provides an up to date review of the evidence.

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Abbreviations

CT	Computed Tomography
CXR	Chest radiography
DCEMRI	Dynamic contrast-enhanced MRI
DWI	Diffusion-Weighted Imaging (MRI sequence)
MRI	Magnetic Resonance Imaging
PE	Pulmonary Embolism
PET	Positron Emission Tomography
STIR	Short Tau Inversion Recovery (MRI sequence)
US	Ultrasound

1. Introduction/background

Pleural disease is common, affecting over 300 people per 100,000 population each year [1]. Radiological investigation of pleural effusion, thickening, masses, and pneumothorax is key in establishing a diagnosis, as well as initial and ongoing management.

Chest radiography (CXR) is still the accepted initial modality for the investigation of pleural disease. When abnormalities are detected, thoracic ultrasound, computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET) can each play important roles in further investigation, but appropriate modality selection is critical.

This article summarises existing techniques, highlighting the benefits and applications of these different imaging modalities and provides an up to date review of the evidence.

2. Technique

2.1. Chest radiography

An erect posterior-anterior CXR should be performed wherever possible. Previously, lateral CXR were used to demonstrate small effusions, but in many countries by this has been superseded the widespread use of US and CT imaging. Supine CXR are less useful than erect CXR in the detection of air or fluid, as air will be dispersed anteriorly and fluid posteriorly.

2.2. Ultrasound

Ultrasound (US) is frequently used to assess pleural disease detected on CXR. Its portability and ease of use allows US to be performed on patients as outpatients or inpatients (including critically unwell patients in intensive care who may not be suitable for an erect CXR). Use of US is now mandated in pleural procedures investigating pleural fluid: pleural aspiration or chest drain insertion [2,3]. 3.5–5.0 MHz sector transducer probes are the most commonly used as they provide good depth penetration to fully visual effusions in larger patients, whilst still allowing good spatial resolution at low depth to aid interventional procedures. The use of US requires training to effectively record quality images and correctly identify pleural disease. Therefore, US can be highly operator dependent with some features, such as diffuse pleural thickening and pneumothorax, requiring experience to interpret.

2.3. Computed tomography (CT)

CT investigation of pleural disease should involve multi-slice thin sections (0.5–2.0 mm) to enable multi-planar reconstruction. Volumetric data acquisition with multi-slice CT allows easy access to isotropic 3-D reformatting. Images should be reviewed using mediastinal window setting (40/400) on a soft-tissue algorithm but supplemented by review of the fissures using lung windows (−500/1500). Ideally, intravenous contrast should be administered, with a delay of 60–90 s ("pleural phase") to allow maximum pleural soft tissue enhancement [4] A significant proportion patients presenting with unilateral effusion may incidentally have a pulmonary embolism (PE), particularly those subsequently diagnosed with pleural malignancy [5]. A single scan with delayed acquisition could

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