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# Computed tomography of the chest—II: clinical applications

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### Key points

- Computed tomography (CT) scans can detect pathology that may be missed on a conventional chest radiograph and is the initial investigation of choice for major trauma.
- A systematic approach for reviewing a CT scan of the chest minimizes the risk of missing significant pathology.
- Chest CT may be used in the planning of airway management such as in thyroid goitre, tracheo-oesophageal fistulae, or for double-lumen tube placement.
- Lung parenchyma can be more accurately assessed with CT than conventional chest radiographs.
- Significant cardiac pathology may be detected on CT scans.

In the previous article in this edition of the journal, the authors stated a systematic approach to the process of reviewing a computed tomography (CT) scan of the chest is vital not to miss potentially subtle pathology. This article, the second of two concerning CT chest, will examine the clinical applications of chest CT and the various pathologies that may occur in relation to anatomical areas of interest. The clinician reviewing the scans must have an accurate history and pertinent examination findings to focus attention on likely areas of pathology. The lung parenchyma, pleurae, and mediastinum must all be comprehensively examined so as to minimize the risk of missing pathology when reviewing chest CT scans. This article will explore these three specific anatomical areas initially and then focus on the role of CT chest in trauma and in the diagnosis of certain cardiovascular pathologies.

## Lung parenchyma and airways

Inspect the lung parenchyma, bronchi, and distal airways assessing their patency and diameter. Ground glass opacification of the lungs refers to the appearance of a hazy opacity that does not obscure the associated pulmonary vessels (Fig. 1). This appearance from parenchymal abnormalities is seen with either: alveolar wall inflammation or thickening, partial air-space filling, or with some combination of the two (Fig. 2). Common causes include pulmonary oedema; adult respiratory distress syndrome; viral, mycoplasmal, and pneumocystis pneumonias; pulmonary haemorrhage; and other diffuse interstitial lung diseases.

Early interstitial pulmonary oedema is demonstrated by the loss in definition of subsegmental and segmental vessels, the appearance of Kerley lines, and pleural effusions. Further, oedema will migrate centrally with progressive blurring of vessels, first at the lobar level and later at the level of the hilum. At this point, lung radiolucency decreases markedly, giving a ground glass appearance (Fig. 3).

Thereafter, a sudden extension of oedema into the alveolar spaces creates small nodular or acinar areas of increased opacity that coalesce into consolidation. These areas can display a

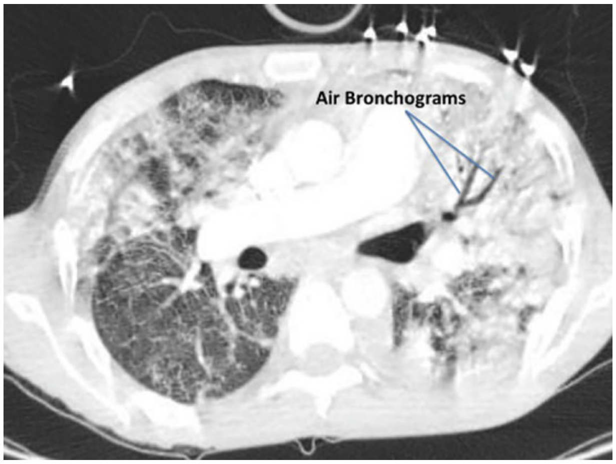


Fig 1 Consolidation of the left lung parenchyma with air bronchograms located within and patchy ground glass changes in the right lung.

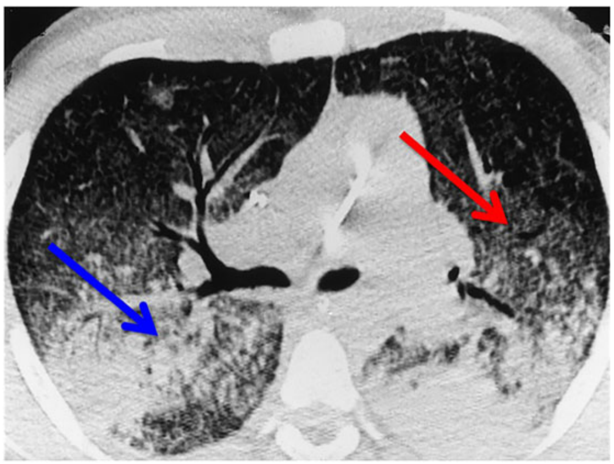

Fig 2 Adult respiratory distress syndrome with areas of parenchymal consolidation (blue arrow) in the dependent areas and ground glass opacification (red arrow) in the non-dependent areas.

Fig 3 Pulmonary oedema.

Fig 4 Left upper lobe cavitating lesion (red arrow)—differentials would include infective causes (mycobacterium or bacterial), septic pulmonary emboli, or malignancy.

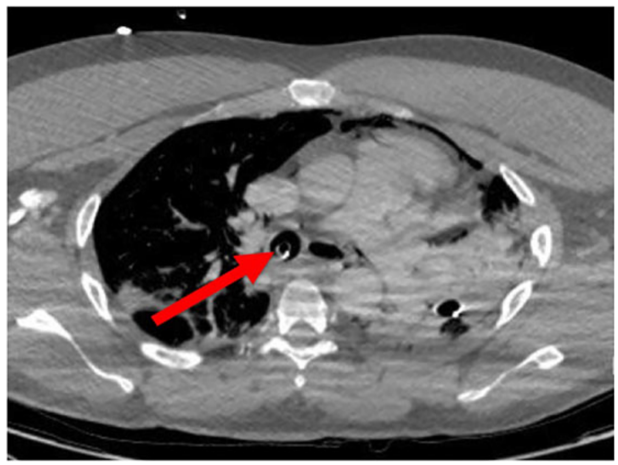

Fig 5 Right endobronchial intubation—the tracheal tube is seen within the right main bronchus (red arrow).

gravitational antero-posterior gradient. With cardiac causes of pulmonary oedema, left atrial or ventricular enlargement, such as in longstanding severe mitral regurgitation, may be seen.[1] Inspection of the parenchyma and airways should be methodical and comprehensive (Fig. 4). The airway can usually be followed from the glottis down to the segmental bronchi which may reveal structural abnormalities, masses, foreign bodies or misplaced endotracheal tubes (Fig. 5).

## Pulmonary pleurae

Pleural disease encompasses pneumothoraces, effusions, infection, and tumours. Normally, the pleural fissures are seen as a distinct line, or their position could be recognized as a relatively avascular zone within the lung. In disease states, one may be able to observe pleural thickening and accumulation of fluid, such as blood or pus, in the dependent portions of the lung. CT scan will detect and may distinguish simple pleural effusion and empyema. Supine chest X-rays have an extremely low sensitivity (<25%) in detecting pneumothoraces—especially in supine patients—but these may be readily identified by CT (Figs 6–9).

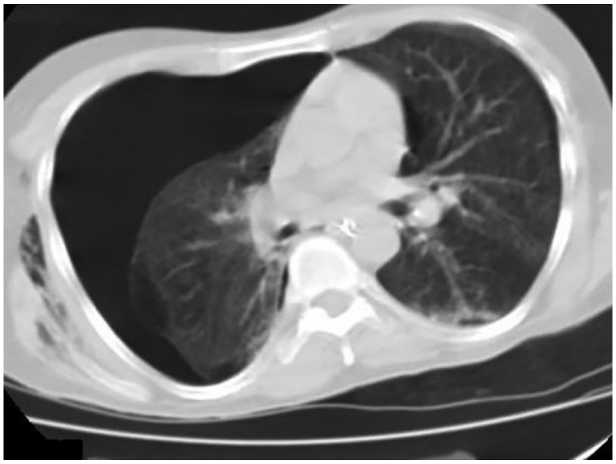

Fig 6 Left pneumothorax with mediastinal shift.

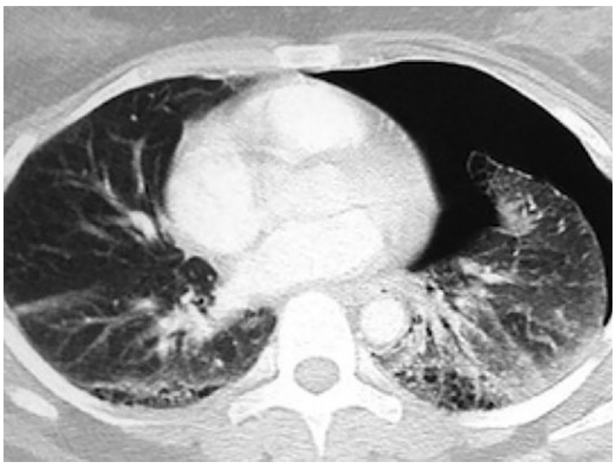

Fig 7 Left anterior pneumothorax.

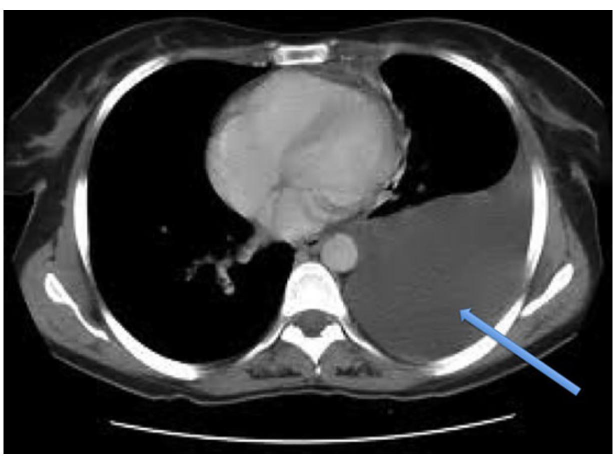

Fig 8 Pleural effusion (blue arrow) noted within the left pleural cavity.

## Mediastinum

Structures contained within the mediastinum include the thymus, oesophagus, tracheo-bronchial tree, and lymph nodes.

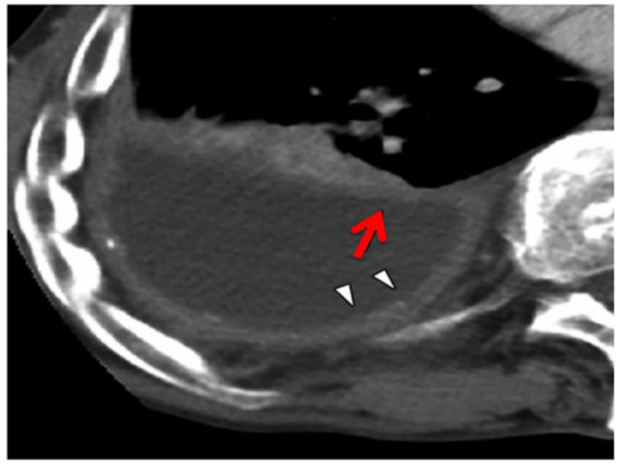

Fig 9 Split pleura sign—contrast-enhanced CT scan demonstrates thickening of the visceral (red arrow) and parietal pleura (white arrow heads) separated by fluid. The split pleura sign is seen mainly in empyema but may also be seen in haemothorax.

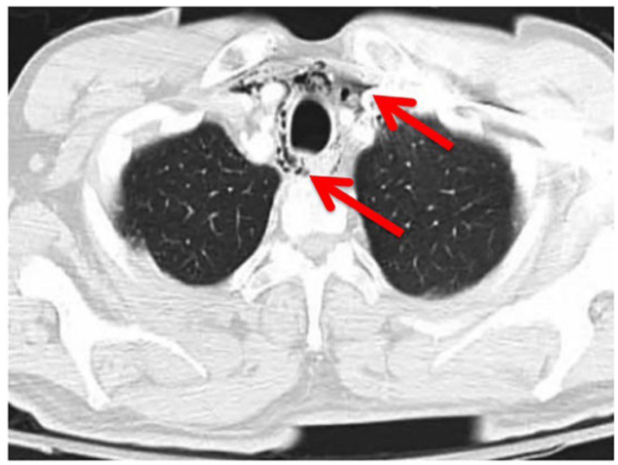

Fig 10 Pneumomediastinum—there is free gas within the mediastinum as highlighted by the arrows. This can be from either intrathoracic air (emanating from the trachea, major bronchi, oesophagus, or pleural space) or extrathoracic air (originating from the head and neck or the abdomen).

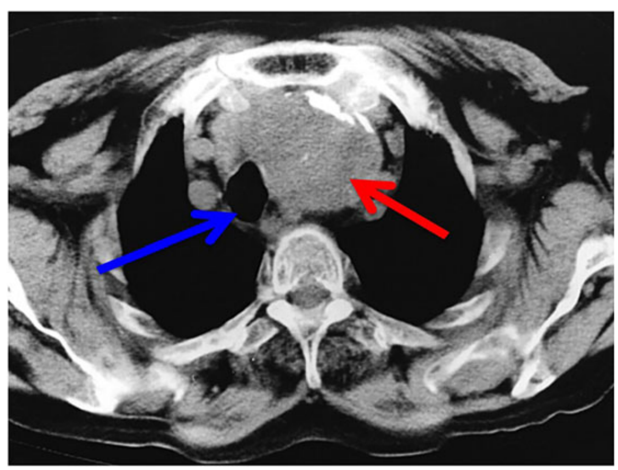

Fig 11 Retrosternal goitre (red arrow) causing significant tracheal deviation (blue arrow).

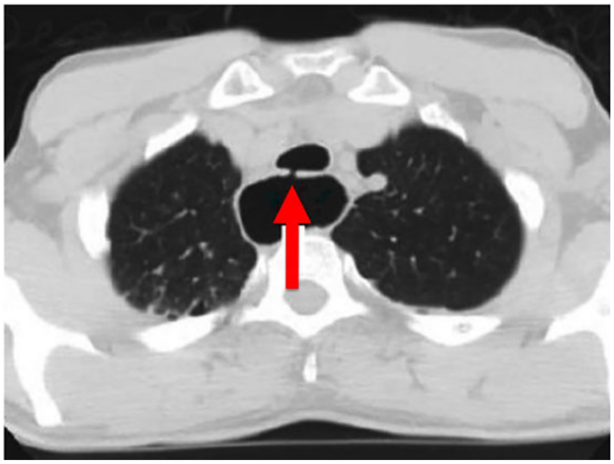

Fig 12 Tracheo-oesophageal fistula evidenced by the defect highlighted (red arrow).

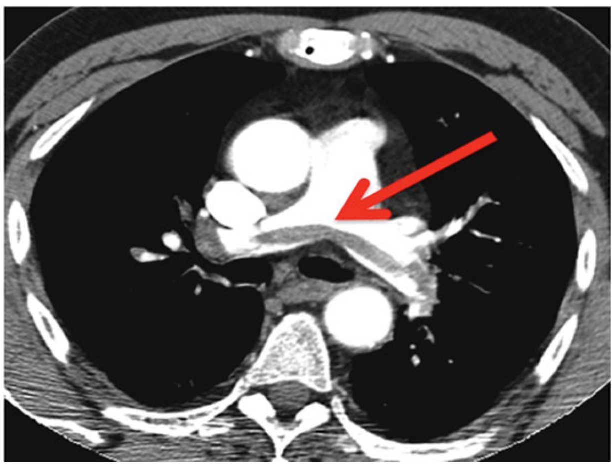

Fig 13 Saddle embolus noted within the pulmonary bifurcation.

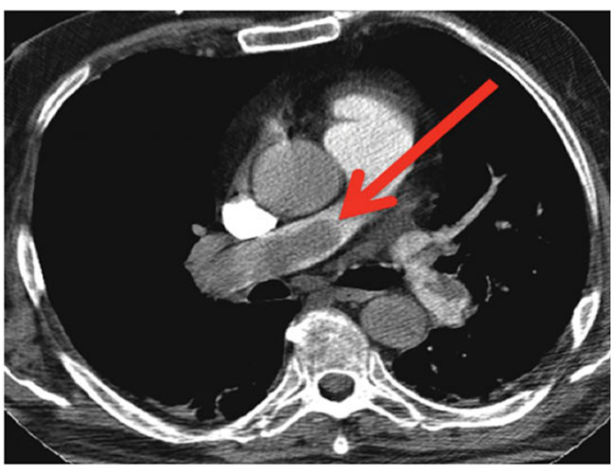

Fig 14 Embolus within the right main pulmonary artery.

Chest CT may therefore be useful in the planning of airway management such as in thyroid goitre, tracheo-oesophageal fistulae, or for double-lumen tube placement (Figs 10–12).

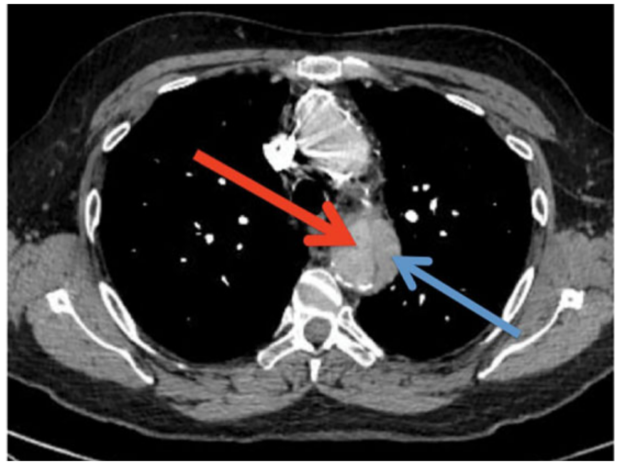

Fig 15 Descending thoracic aortic dissection with the true arterial lumen highlighted by the red arrow and the false lumen by the blue arrow.

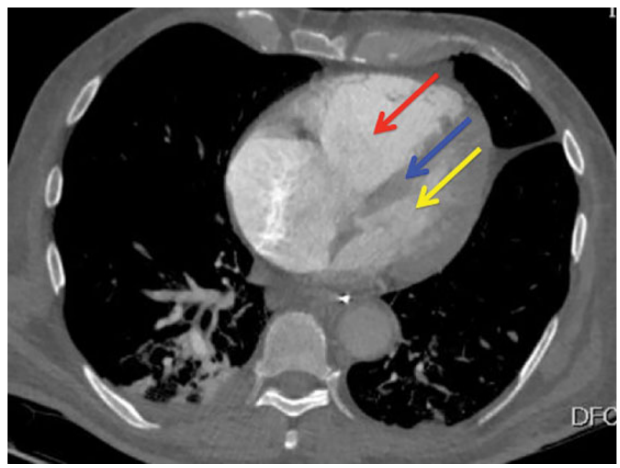

Fig 16 Dilated right ventricle (red arrow) with flattening of the interventricular septum (blue arrow) and compression of the left ventricle (yellow arrow) indicating right-sided volume or pressure overload. This picture may be seen in acute massive pulmonary embolus.

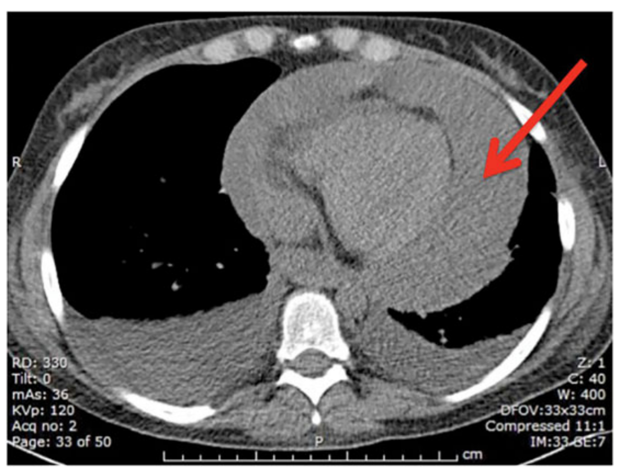


Fig 17 Large pericardial (red arrow) and pleural effusions.

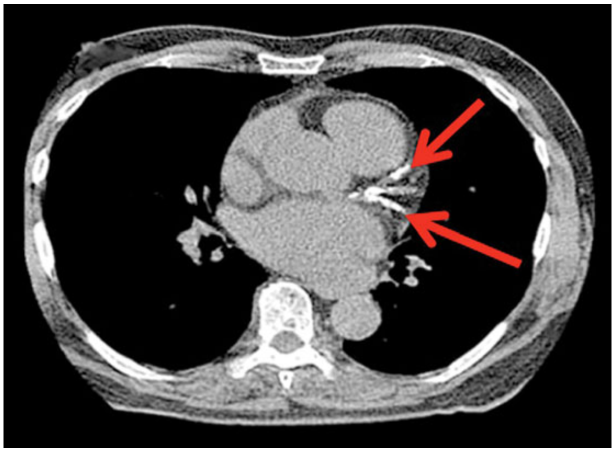

Fig 18 Coronary artery calcification—CT coronary angiogram can be used as an alternative to coronary angiography. It is utilized in those patients with a low risk of coronary artery disease and a low level of coronary artery calcification, measured using the CT calcium score, within the vessels.

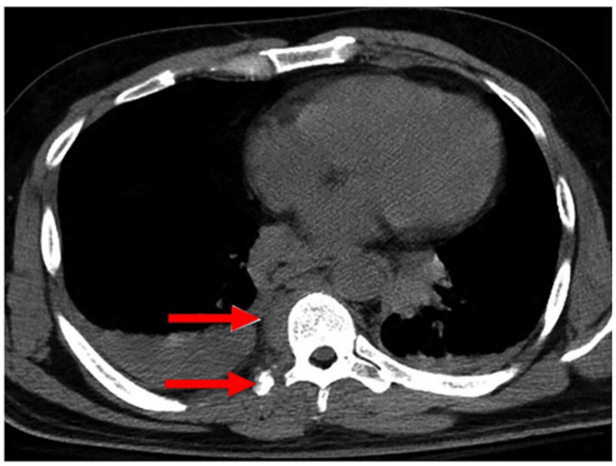

Fig 19 Large mediastinal haematoma (red arrows) from a right-sided transverse process fracture of the thoracic spine and an associated right-sided haemothorax in a trauma patient.

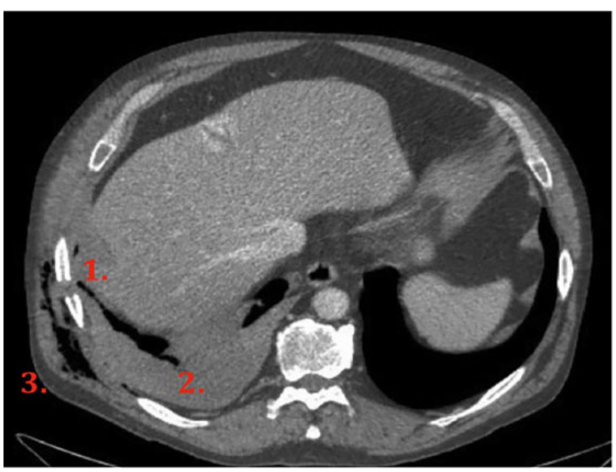


Fig 20 Fractured right 9th rib (1), haemopneumothorax (2), and subcutaneous emphysema (3).

Fig 21 Lung contusions appear dense and are usually peripheral, non-segmental, and non-lobar. The increased lung density seen in the lung periphery is due to haemorrhage and oedema.

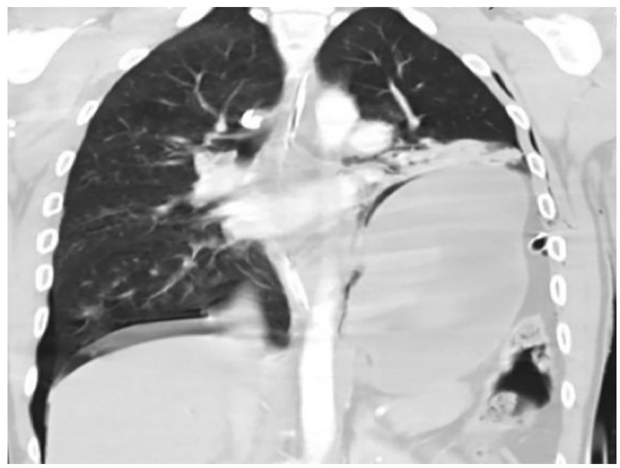

Fig 22 Left-sided traumatic diaphragmatic defect with herniation of the abdominal contents into the thoracic cavity and compression of the left lung parenchyma. There is also a right-sided pneumothorax.

## Cardiovascular pathology

A contrast CT can identify vascular anomalies within the thorax, such as emboli and large vessel intimal disruption. Signs of right ventricular dilatation on CT may be used to grade the severity of pulmonary embolus (Figs 13–15).[2]

The coronary vasculature, cardiac chambers, and pericardial space can also be assessed but beat-to-beat motion leads to limitations in assessment (Figs 16–18).

## Trauma

When assessing the trauma CT of the thorax, it is important to again work systematically through the components of the thoracic cavity to ensure completeness, using all three windows (lung, mediastinal, and bone) (Figs 19–22).

## Summary

This article is an introduction to both clinical applications of chest CT and some of the pathology that it can be used to diagnose. It is important for both intensive care physicians and anaesthetists to have some basic skills in the interpretation of chest CT, but close liaison with experts in the radiology department is essential.

## Acknowledgement

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## Declaration of interest

None declared.

## MCQs

The associated MCQs (to support CME/CPD activity) can be accessed at https://access.oxfordjournals.org by subscribers to *BJA Education*.

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