An approach to assessing the chest radiograph

Introduction

The chest X-ray is the most commonly requested radiological investigation but remains one of the most difficult to interpret. The spectrum of disease encountered within the thorax is vast and too extensive for this review. However, with a systematic approach, most of the crucial abnormalities on a chest film can be assessed. This article gives a basic approach to evaluating the chest radiograph and illustrates common and important conditions that are encountered in everyday practice.

Approach to evaluating chest films

The chest radiograph is usually taken as an erect, postero-anterior film in full inspiration (*Figure 1*). An antero-posterior semi-erect or supine film may be necessary in acutely unwell patients. A lateral projection may be of benefit in certain patients if an abnormality is present on the frontal projection. Knowledge of normal mediastinal and lobar anatomy is important when interpreting the chest X-ray (*Figures 1* and *2*).

1. Check the patient details and date of image
2. Technique. The image should be assessed for:
   a. Adequacy (no missing parts of the chest)
   b. Penetration (thoracic vertebral bodies should be just visible)
   c. Rotation (medial ends of clavicles equidistant from the midline).
3. Check the soft tissues for abnormalities, e.g. surgical emphysema, symmetry of breast shadows, axillary clips, previous sternotomy
4. Check the mediastinum and heart shape and size. The heart size should be <50% of the thoracic diameter (cardiothoracic ratio)
5. Check the diaphragms – both domes of the diaphragm should be clearly seen extending almost to the midline except where the heart is in contact with the diaphragm. The right is usually higher than the left because of the position of the liver. Assess for free gas under the diaphragm
6. Check the hilae for symmetry in size and density. The left is virtually always higher than the right in normal patients
7. Check the lungs:
   a. Compare one side with the other checking for symmetry in volume and density
   b. Assess any shadowing to determine if it is air space, reticular, nodular or a mix of these
   c. Look for nodules or masses.
8. Check the pleura – assessing for pneumothoraces and effusions
9. Check the bones – ribs and shoulders.

This approach takes time initially but is systematic and comprehensive. Over time and with practise the interpreter will grad-

Dr R Sethi *is Specialist Registrar in Radiology and* **Dr SHM Khan** *is Consultant Radiologist and Honorary Senior Lecturer, East Lancashire Hospitals NHS Trust, Royal Blackburn Hospital, Lancashire BB2 3HH*

Correspondence to: Dr SHM Khan

Figure 1. Normal chest radiograph outlining normal silhouettes and structures.

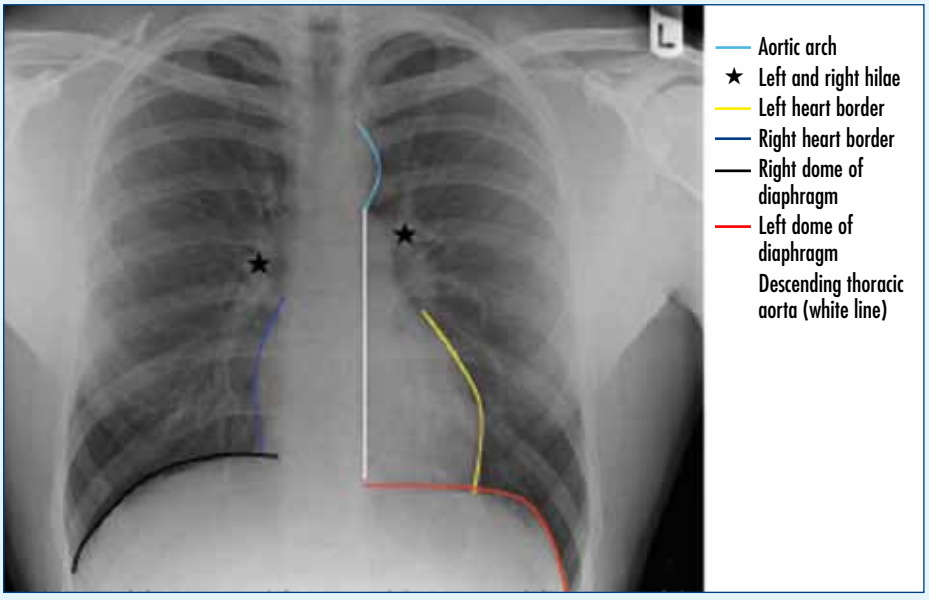
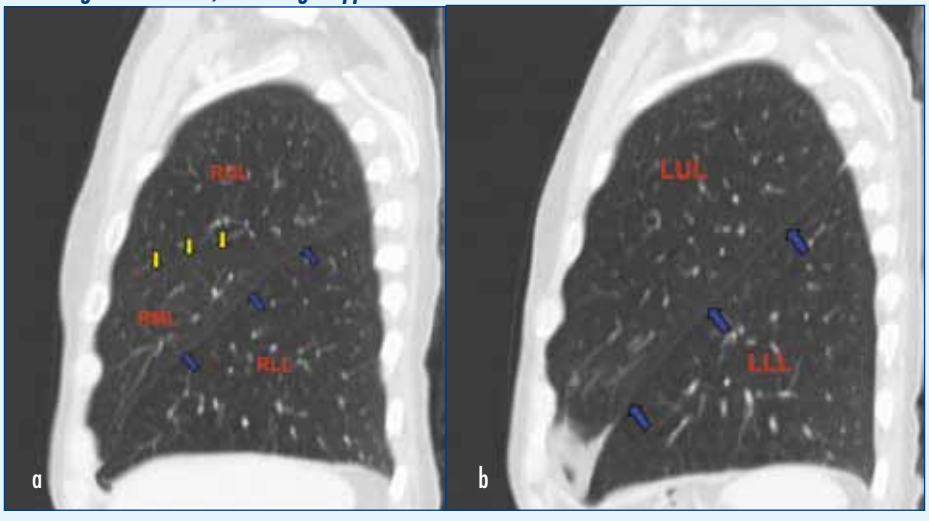


Figure 2. Sagittal computed tomography slice demonstrating normal lobar anatomy (a) in the right lung and (b) in the left lung. The blue arrows indicate the site of the oblique fissure and the yellow arrows indicate the horizontal fissure. LLL = left lower lobe; LUL = left upper lobe; RLL = right lower lobe; RML = right middle lobe; RUL = right upper lobe.



ually become quicker and more adept at detecting abnormalities.

Lobar collapse

The diagnosis of lobar collapse is important as frequently in adults it is secondary to an obstructing bronchial carcinoma. Other causes include mucus plugging, especially in children and asthmatics. The presentation may be acute with dyspnoea and respiratory failure but in cancer patients is often more insidious. The diagnosis of lobar collapse is dependent on:

1. Detection of loss of lung volume
2. Mediastinal shift towards the side of collapse
3. Loss of normal silhouettes on the chest radiograph.

Left lower lobe collapse

There is volume loss in the left lung (*Figure 3*). The left dome of the diaphragm and descending thoracic aorta silhouettes, which lie adjacent to the left lower lobe, are not visualized. There is also a retrocardiac, triangular-shaped area of increased density, the so-called 'sail sign' (blue arrows).

Figure 3. Chest radiograph showing left lower lobe collapse. There is a triangular-shaped area seen in the retrocardiac area (blue arrows) which is the collapsed left lower lobe.

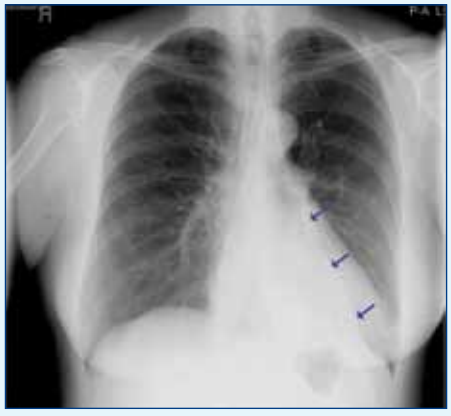
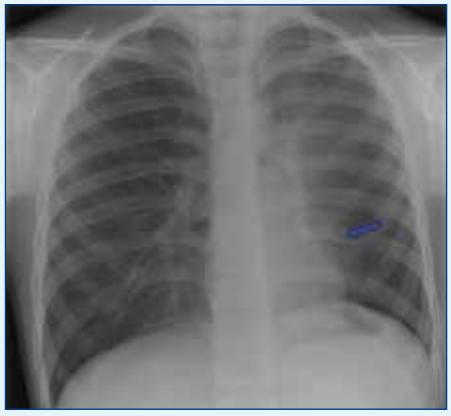


Figure 4. Chest radiograph showing left upper lobe collapse. There is loss of left lung volume with a veil-like opacity of the left hemithorax. The left heart border is obscured (blue arrow).



Left upper lobe collapse

There is loss of volume in the left lung with a veil-like opacity of the left hemithorax (*Figure 4*), as a result of compensatory hyperexpansion of the left lower lobe overlying the collapsed left upper lobe. The left heart border, which lies adjacent to the lingular segment of the left upper lobe, is obscured.

Right upper lobe collapse

There is loss of volume in the right lung (*Figure 5*) with a right upper zone opacity and elevation of the horizontal fissure (blue line).

Figure 5. Chest radiograph demonstrating right upper lobe collapse. There is loss of right lung volume with right upper zone opacity and associated elevation of horizontal fissure (blue arrow).

Right lower lobe collapse

This is similar to a left lower lobe collapse. A triangular-shaped opacity in the right lower zone (*Figure 6*) (blue arrows). Note the right heart border silhouette is preserved (yellow arrow) as this lies adjacent to the right middle lobe. The contour of the right dome of the diaphragm, which lies adjacent to the right lower lobe, is lost.

Right middle lobe collapse

This is the hardest of the collapses to detect and can be very subtle on the frontal projection, being more obvious on the lateral view. On the frontal projection the right heart border loses its sharp border with an opacity, the collapsed right middle lobe, adjacent to it (*Figure 7a* – blue arrow). The lateral projection demonstrates the collapsed lobe (*Figure 7b* – blue arrows) more clearly.

Figure 6. Chest radiograph demonstrating right lower lobe collapse. A triangular-shaped opacity is seen in the right lower zone (blue arrows) and represents the collapsed right lower lobe. Note that the right heart border silhouette is preserved (yellow arrow).

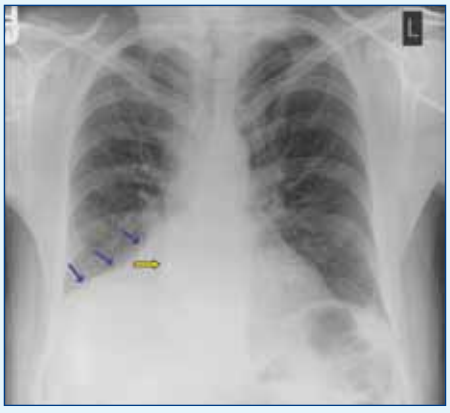
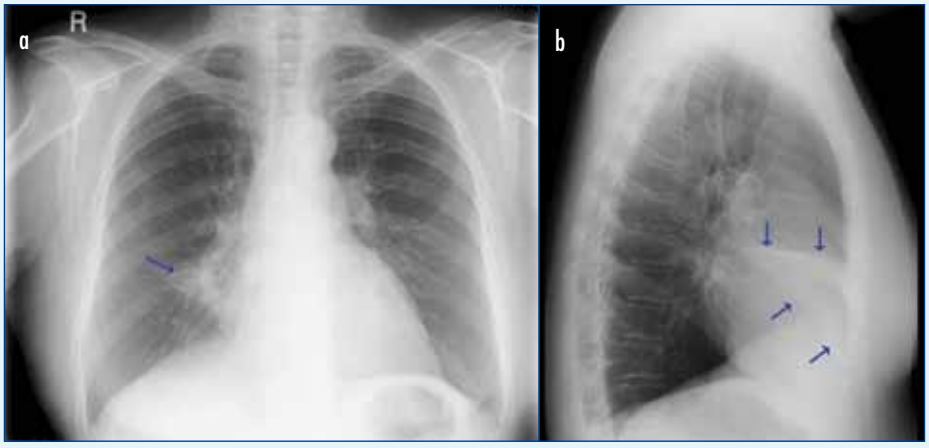


Figure 7. a. Postero-anterior chest radiograph demonstrates right middle lobe collapse (blue arrow) which is seen as an opacity adjacent to the right heart border with loss of right heart border outline. b. Lateral chest radiograph clearly demonstrates the collapsed right middle lobe (blue arrows).



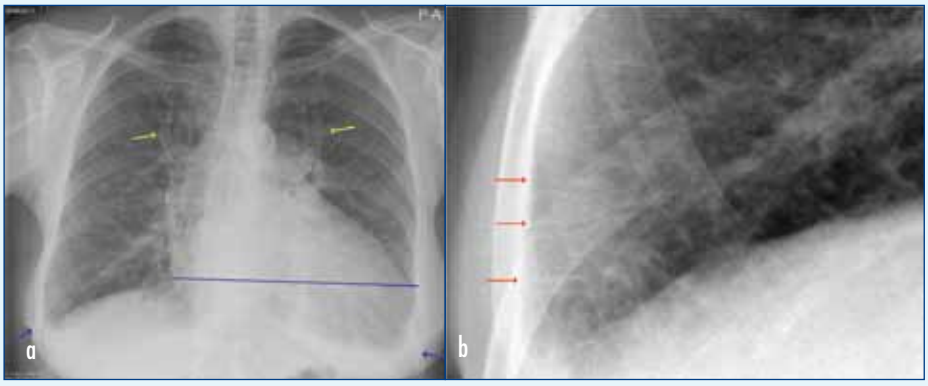


Figure 8. a. Postero-anterior chest radiograph demonstrating features of heart failure. Cardiomegaly (blue line), pleural effusions (blue arrows) and upper lobe diversion (yellow arrow) are seen. b. Close up the right lower lobe also demonstrates Kerley B lines (red arrows) which indicate pulmonary oedema.

Heart failure

Heart failure is common and there are often several signs on the chest film (*Figure 8*). These include:

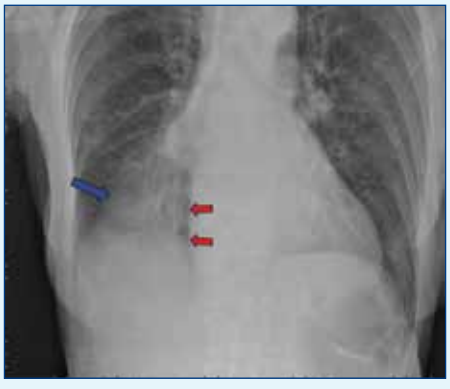
1. Cardiomegaly (cardiothoracic ratio >50%) (blue line)
2. Pleural effusions (blue arrows)
3. Upper lobe diversion (note this is only abnormal in an erect patient) (yellow arrows)
4. Pulmonary oedema which may be interstitial, i.e. septal or 'Kerley B' lines (*Figure 8b* – red arrows) or air space.

Infection

Chest infections commonly manifest as areas of consolidation on a chest radiograph. Frequently this is lobar in distribution. Consolidation differs from collapse in that the lung volume is preserved and air bronchograms can be seen.

Multifocal areas of consolidation raise the possibility of aspiration, especially if this is in the dependent parts of the lung (right middle lobe and right lower lobe). Atypical infections (e.g. mycoplasma, viral pneumonias) may manifest as interstitial (reticular shadowing) patterns of pneumonias (*Figure 9*). Unusual or persistent patterns of consolidation should always raise the possibility of immunosuppression (e.g. *Pneumocystis jirovecii* pneumonia in a patient with acquired immunodeficiency syndrome) or underlying malignancy (bronchoalveolar cell carcinoma).

Figure 9. Right lower lobe consolidation (blue arrow). Note the right dome of the diaphragm is obscured but the right heart border silhouette (red arrows) is maintained, indicating this is right lower lobe rather than middle lobe pathology.



Pneumothorax or pneumomediastinum

Risk factors for a pneumothorax include emphysema (ruptured bulla) and asthma, or they may be spontaneous especially young patients with a tall thin stature (ruptured blebs). Pneumothoraces may be subtle and the apices on a chest radiograph should be carefully scrutinized if the diagnosis is suspected (*Figure 10*).

Figure 10. Left apical pneumothorax. Lung edge can be seen (yellow arrows) with no markings visible peripheral to this.

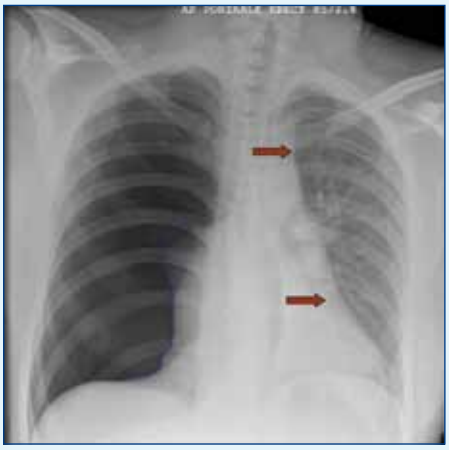


Figure 11. Right tension pneumothorax. There is a large right pneumothorax with complete collapse of the right lung (blue line) and shift of the mediastinum to the left (red arrows). The left lung appears congested.

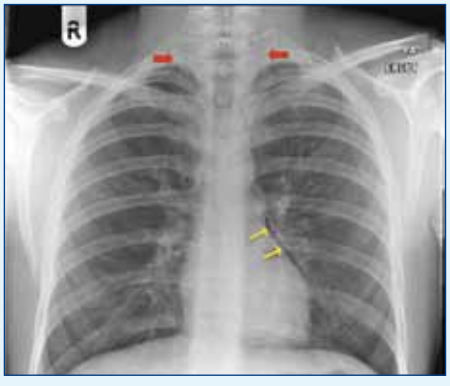
Diagnosis of a pneumothorax is dependent on the following:

1. Detection of a line paralleling the chest wall, i.e. the lung edge
2. Absence of lung markings between the lung edge and the chest wall. If either of these criteria is not met then the diagnosis of a pneumothorax should be in doubt.

A tension pneumothorax is usually obvious clinically and should be treated promptly before any imaging (*Figure 11*).

Pneumomediastinum is a rarer entity and also a more subtle finding on chest X-ray. Causes include spontaneous (in asthmatics), trauma, ruptured oesophagus or secondary to a pneumothorax. Radiolucent streaks of gas can often be seen outlining mediastinal structures and tracking up to the neck (*Figure 12*). There may be co-existing pneumothorax, sub-

Figure 12. Pneumomediastinum in an asthmatic. Streaks of gas are seen tracking into the neck (red arrows). The cardiac shadow is sharply outlined by gas (yellow arrow).



cutaneous emphysema, pneumoperitoneum or pneumoretroperitoneum.

Others

The spectrum of abnormalities on a chest X-ray are vast and a systematic approach is required to ensure other findings are not missed. *Figure 13* demonstrates free gas under the diaphragm and *Figure 14* a fractured clavicle in a trauma patient. BJHM

Figure 13. Free gas under the diaphragm in a patient with a perforated duodenal ulcer.

Figure 14. Fractured right clavicle in a patient following a road traffic accident.

Conflict of interest: none.

Further reading

Goodman LR (1999) *Felson's Principles of Chest Roentgenology.* 2nd edn. Saunders, Philadelphia

Raby N, Berman L, Lacey G (2005) *Accident & Emergency Radiology. The survival Guide.* 2nd edn. Elsevier Saunders, Philadelphia

Squire LF, Novelline RA (1988) *Fundamentals of Radiology.* 4th edn. Harvard University Press, Massachusetts

KEY POINTS

- Interpretation of the chest radiograph is challenging and demands a systematic approach.
- Lobar collapse can be detected by observing loss of lung volume, mediastinal shift towards the side of the collapse and characteristic loss of a normal silhouette.
- Infection usually presents as consolidation, normally in a lobar distribution. Atypical infections may present as interstitial pattern pneumonias.
- Cardiomegaly, pleural effusions, upper lobe diversion and interstitial or alveolar oedema are the classical signs of heart failure on the chest X-ray.
- The diagnosis of pneumothorax is dependent on detecting a lung edge with loss of lung marking between the lung edge and chest wall.