Basic Chest X-ray Interpretation Programme 2

In this second chest x-ray tutorial I will now start to look at some of the more commonly encountered pathologies. I have split this up into abnormalities involving the lungs and pleural spaces, heart, hila, hidden areas and finally commonly encountered disease processes involving multiple areas. In this tutorial we will concentrate on abnormalities involving the lungs and pleural spaces.

When looking at the lungs the first step is to decide whether any areas look more white or black than they should do. We will initially concentrate on areas of increased shadowing. Having decided that there is an abnormality, it is important to try to decide what pattern or patterns of shadowing are present as there are a limited number and each different pattern has a list of differential diagnoses associated with it. In essence opacities can be air space, interstitial, due to collapsed lung, a focal mass/nodule or multiple nodules or relate to the pleura and pleural spaces. I will now go through each of these in turn.

Lungs and pleura: too white
Air space
Interstitial
Collapse
Mass / nodule / cavity
Pleural

Air space shadowing and consolidation
These are equivalent terms and is caused by fluid filling the smaller bronchi, bronchioles and alveoli. The nature of this fluid cannot be determined on the radiograph but could be pus in infection, water as in pulmonary oedema, haemorrhage for example in some of the vasculitides, malignant cells in alveolar carcinoma or proteinaceous fluid. Correlation with the clinical setting is required to narrow the differential down further. Depending on the degree and extent of consolidation the shadowing can range from focal subtle patchy areas to widespread dense confluent shadows.

The hallmark of consolidation are air bronchograms. Usually the smaller bronchi, bronchioles and alveoli are not seen as they are filled with air and their walls are too thin to be detected on the plain radiograph. When the air spaces fill up, the alveoli fill first, with the bronchi being relatively spared. Therefore the bronchi, which are still air filled, stand out against the alveoli, which are filled with pus, fluid, haemorrhage, etc. This is called an air bronchogram.

A good example of air bronchograms is seen in this x-ray. Due to the diffuse dense consolidation within the left lung it is possible to see the main left bronchus dividing into smaller more peripheral bronchi.
The next example shows increased air space shadowing in the right upper zone with the dark tubular air bronchograms once again clearly visible. In this case it is possible to say that the consolidation is in the upper lobe as the consolidation is clearly limited by the horizontal fissure which you will remember separates the upper lobe from the middle lobe.

The final example shows patchy opacification in the left mid and lower zones with a few air bronchograms visible. The left heart border is no longer seen and so using our knowledge of the silhouette sign which was discussed in tutorial one, we can be quite confident that this consolidation is affecting the lingula lobe as it is this lobe that abuts the left heart border.

**Interstitial Shadowing**
Now we will look at interstitial shadowing. The interstitial space is a potential space that surrounds the bronchi, alveoli and vessels. When there is disease in the interstitium it manifests itself by reticulonodular shadowing - that is criss crossing lines or tiny nodules or both. There are two two processes affecting the interstitium. First, accumulation of fluid which occurs in pulmonary oedema or in lymphangitis carcinomatosa, which is invasion of the pulmonary lymphatics by malignant cells. And secondly, inflammation leading to fibrosis which has many causes including idiopathic fibrosing alveolitis, sarcoidosis, asbestosis, radiotherapy, drugs to name a few. Fibrosis is usually associated with a loss of lung volume in the affected areas.

The following two x-rays are examples of diffuse bilateral interstitial shadowing. Note the difference between this pattern which is essentially a meshwork of lines and the more confluent patchy air space shadowing discussed earlier.
Collapse
Collapse of a lobe is caused by proximal obstruction - for example, by a neoplasm, mucus plug such as in a postoperative patient, or foreign body such as in a child or a malpositioned endotracheal tube. When the lobe is not aerated it will lose much of its volume and collapse to a predictable location depending on whether it is an upper, middle, or lower lobe. The non-aerated collapsed lung produces the increased shadowing but there are also other signs that should alert you to a lobar collapse. These are due to the loss of lung volume and include mediastinal and tracheal shift towards the side of collapse and movement of the hilum up or down from where it normally lies. In addition, the horizontal fissure will be pulled up in a right upper lobe collapse and down in a right lower lobe collapse. If a collapsed lobe is seen, it is important to try and look for the cause for example, a large carcinoma or ET tube.

This is an example of right upper lobe collapse. Note the triangular opacification in the right upper zone.
The lower border of the shadowing is limited by the horizontal fissure that has been pulled up. The right hilum is difficult to see but has probably also been pulled up. The cause for this collapse is not obvious but note the patient is intubated* and therefore may well be on intensive care or post-op and so mucus plugging is a common cause in this scenario.

The diagram highlights the direction in which the lobe collapses and explains the appearances of the radiograph.

The next example shows a dense sail shaped opacity projected behind the left heart caused by a collapsed left lower lobe.

In this case the associated signs of volume loss are not however obvious. In addition, there is some loss of clarity of the right heart border in keeping with right middle lobe consolidation or collapse. Due to the small size of the right middle lobe and lingula lobe, the secondary signs of lung volume loss are sometimes not seen and often the only sign of their collapse is loss of clarity of the heart border. As a result it is difficult to differentiate collapse from consolidation in these lobes on a frontal radiograph alone. In these cases a lateral x-ray becomes helpful.

The diagrams shows the position of the collapsed lung in left lower and right middle lobe collapse.
Focal lung lesions
A coin lesion is a term used to describe a focal discrete opacity within a lung. The main concern is that it may represent a carcinoma, There are however differential diagnoses including a solitary metastasis (or the only one of multiple metastases to be large enough to be visualised on a plain radiograph), a focal area of consolidation, an abscess, an area of infarction or a benign tumour.

It is often difficult to tell on a plain x-ray alone which of these it represents and for this reason we often proceed to CT scanning. An example of a suspicious looking coin lesion is seen in the right upper zone of this x-ray. Note the irregular spiculated edge to the lesion which is commonly seen in carcinoma which this turned out to be.

Some coin lesions may cavitate: that is to say develop an area of necrosis within them. This appears as an area of darkness within the lesion. There may also be an air fluid level. The fluid will be white and have a horizontal upper border with black air above.
The causes of a cavitating lung lesion include infection such as TB or staphylococcus which can sometimes but not always form a focal abscess, a carcinoma typically squamous cell type, an infarct or rarely in some collagen-vascular disorders such as rheumatoid arthritis.

The first radiograph shows a focal thick walled cavitating lesion within the left lung with an air fluid level clearly seen.

The next example shows multiple thin walled cavities, once again with obvious air fluid levels.

If there are multiple focal lesions, a different list of diagnoses should be considered. The differential diagnoses can be further subdivided depending on the size of the lesions.

Greater than 5mm, the most common cause is metastases typically from breast, testis, GI tract, kidney and thyroid. More rarely inflammatory nodules for example in rheumatoid arthritis or Wegener’s granulomatosis may cause multiple large nodules.
The differential for small nodules include metastases although they are usually bigger, Sarcoid which can also cause reticular shadowing, Miliary tuberculosis so called because they look like tiny seeds "milia" due to haematogenous spread, Pneumoconiosis - for example due to inhaling coal dust which is rare nowadays and Chickenpox pneumonia.

This x-ray shows multiple large nodules greater than 5mm in diameter caused by metastases from testicular malignancy.

If you look carefully at the next x-ray you will see innumerable tiny sub 5mm nodules throughout both lungs in a patient with sarcoidosis.
Finally in this tutorial we will look at opacification caused by pleural based abnormalities. Most commonly seen is pleural effusions but one can also see areas of pleural thickening or calcified pleural plaques, typically in asbestos exposure or previous TB. Pleural masses are rarely encountered but can be due to benign fibromas, malignant tumours such as mesothelioma or metastases to the pleura.

**Pleural Effusions**

Pleural effusions can be either transudates or exudates depending on the protein content. Transudates are commonly caused by heart failure, liver failure, and low body protein as seen in for example nephrotic syndrome or malnutrition. Exudates are usually due to malignancy, infection or infarction. Pleural effusions appear as confluent shadows that start in the lung bases and rise as the effusion gets bigger. As pleural effusions are fluid, the upper border of the shadowing will have a meniscus and so be concave. Small pleural effusions manifest as blunting of the costophrenic angles which should normally form sharp acute angles.

In this x-ray a confluent dense shadow is seen in the right mid and lower zone with a concave upper border, a meniscus. This is a large right pleural effusion.

This next x-ray shows blunting of both costophrenic angles both with a meniscus consistent with small bilateral pleural effusions.

So in summary, in this tutorial you should hopefully have become more familiar with the main patterns of increased shadowing one encounters and the differential diagnoses associated with these different patterns.