Interpretation of Chest Radiographs

Reynard McDonald, MD
Medical Director
NJMS Global Tuberculosis Institute
When x-rays are produced and directed toward the patient, they may act in three basic ways:

<table>
<thead>
<tr>
<th>They may be…</th>
<th>Which means…</th>
</tr>
</thead>
<tbody>
<tr>
<td>unabsorbed</td>
<td>they pass through the patient unchanged and strike the x-ray film</td>
</tr>
<tr>
<td>completely absorbed</td>
<td>the energy of the x-ray is totally deposited within the patient</td>
</tr>
<tr>
<td>scattered</td>
<td>they are deflected within the patient but may still strike the x-ray film</td>
</tr>
</tbody>
</table>
Factors that contribute to X-ray absorption include:
- The density of the tissue the beam strikes
- The energy of the X-ray beam (the energy of the X-ray beam is usually fairly constant in posterior/anterior and lateral radiography)
**Tissue Density**

**Whitest/Most Dense**
- Metal
- Contrast material (*i.e.*, x-ray dye)
- Bone
- Calcium
- Soft tissue
- Fat
- Air or gas

**Blackest/Least Dense**
The term posterior/anterior (PA) refers to the direction of the X-ray beam which in this case traverses the patient from posterior (back) to anterior (front).

The PA view taken at a distance of 6 feet to reduce magnification and enhance sharpness.
Normal Frontal (PA) Chest Radiograph
Normal Frontal (PA) Chest Radiograph
PA & AP Chest X-rays

PA View

AP View
• The other routine view is the lateral radiograph

• By convention it is taken at a distance of 6 feet and the left side of the chest is held against the X-ray cassette

• Often it is difficult to detect lesions located behind the heart, near the mediastinum, or near the diaphragm on the PA view

• The lateral view generally shows such lesions, so we use it routinely
Basic Patterns of Disease

- **Consolidation** (or airspace filling)
- **Interstitial** (including linear and reticular opacities, small well-defined nodules, miliary patterns, and peribronchovascular thickening)
- **Solitary nodule**
- **Mass**
- **Lymphadenopathy**
- **Cyst/cavity**
- **Pleural abnormalities**
Consolidation

• Also known as air space disease (ASD), alveolar filling disease, or acinar disease

• Appearance and findings
  • Increased opacity
  • Ill defined, hazy, patchy, fluffy, or cloud-like
  • Silhouette sign
  • Air bronchograms
  • Butterfly or bat-wing pattern
  • Lobar or segmental distribution
PA Chest Radiograph
(LLL pneumonia consolidation)
Lateral Chest Radiograph
(LLL pneumonia consolidation)
Self Check
Consolidation (Airspace Opacity) (RUL pneumonia)
Basic Patterns of Disease

• Consolidation (or airspace filling)

• Interstitial (including linear and reticular opacities, small well-defined nodules, miliary patterns, and peribronchovascular thickening)

• Solitary nodule

• Mass

• Lymphadenopathy

• Cyst/cavity

• Pleural abnormalities
Interstitial Lung Disease (ILD)

• Appearance and findings
  • Reticular pattern, increased linear opacities
  • Interlobular septal thickening (Kerley B lines)
  • Peribronchial thickening (cuffing or tram tracking)
  • Honeycombing
  • Discrete miliary nodules
  • Reticulonodular pattern
Normal

Interstitial disease
Linear Opacities
Nodules
Miliary Pattern
Basic Patterns of Disease

- **Consolidation** (or airspace filling)
- **Interstitial** (including linear and reticular opacities, small well-defined nodules, miliary patterns, and peribronchovascular thickening)
- **Solitary nodule**
- **Mass**
- **Lymphadenopathy**
- **Cyst/cavity**
- **Pleural abnormalities**
Masses

• Nodules and masses are discrete areas of increased lung opacity whose borders do not conform to anatomic divisions (such as a fissure)

• Masses are similar to nodules except that they are larger, measuring greater than 30mm in diameter

• Nodules and masses should be described by noting their size, the sharpness of their borders, their number, their location and the presence or absence of calcification
Lung Mass
Basic Patterns of Disease

- **Consolidation** (or airspace filling)
- **Interstitial** (including linear and reticular opacities, small well-defined nodules, miliary patterns, and peribronchovascular thickening)
- **Solitary nodule**
- **Mass**
- **Lymphadenopathy**
- **Cyst/cavity**
- **Pleural abnormalities**
Lymphadenopathy

• Enlarged lymph nodes appear on the chest radiograph as soft tissue densities in characteristic locations, including:
  – Right paratracheal area
  – Hila
  – Aorticopulmonary window
  – Subcarinal mediastinum
  – Superior mediastinum
  – Supraclavicular area
  – Paraspinal region
  – Retrosternal area on the lateral radiograph

• One or more regions may be involved, and in certain conditions, nodes may calcify
Lymphadenopathy

• Hilar enlargement due to adenopathy is frequently lobular

• Thickening of the posterior wall of the bronchus intermedius may be due to lymphadenopathy, tumor or edema

• Lymphadenopathy is often best visualized on the lateral radiograph, when it fills the normally clear infrahilar window with an unexpected contour
Lymphadenopathy
Mediastinal Lymphadenopathy
Basic Patterns of Disease

- **Consolidation** (or airspace filling)

- **Interstitial** (including linear and reticular opacities, small well-defined nodules, miliary patterns, and peribronchovascular thickening)

- **Solitary nodule**

- **Mass**

- **Lymphadenopathy**

- **Cyst/cavity**

- **Pleural abnormalities**
Cysts and Cavities

• Focal lucent areas within the lung may result from cavities, cysts, emphysema, and bronchiectasis

• Pulmonary cysts differ from cavities in that cavities are created by necrosis of lung parenchyma, whereas true cysts are formed by other means

• Pulmonary cavities may result from infection, neoplasm, and infarction

• Pulmonary cysts commonly result from infections, trauma, or toxic ingestion, as well as other rare etiologies
Cysts and Cavities

- Pulmonary cysts and cavities are characterized by noting:
  - Their distribution
  - Their number
  - The character of the inner lining
  - The thickness of the wall (at the thickest portion, not including air-fluid levels) and
  - The nature of the contents of the lesion
Cavity
Basic Patterns of Disease

- Consolidation (or airspace filling)

- Interstitial (including linear and reticular opacities, small well-defined nodules, miliary patterns, and peribronchovascular thickening)

- Solitary nodule

- Mass

- Lymphadenopathy

- Cyst/cavity

- Pleural abnormalities
Pleural Disease

• Because pleural abnormalities are, by definition, outside the lung parenchyma, an air bronchogram cannot be seen

• Pleural abnormalities are usually homogeneous opacities

• In the upright patient, a pleural effusion will form a curvilinear interface with aerated lung that resembles a meniscus. This occurs because the pleural fluid settles dependently within the pleural space

• In the supine patient, a pleural effusion may layer posteriorly in a dependent fashion, creating a hazy opacity over the entire hemithorax
Pleural Effusion
Self Check
Answer
Primary TB in a Child
Primary TB in an adult (RLL consolidation)
Primary TB with Cavitation
Tuberculosis...
TB in a 10 year old
Post-Primary ( Reactivation) TB (PA View)
Post-Primary (Reactivation) TB (Lateral View)
Tuberculoma
Airspace Consolidation with Cavitation
Volume Loss (Atelectasis)
Paratracheal Adenopathy in HIV
Fibrotic Scarring
Self Check
Answer
Summary: Chest Radiographs

- Tuberculosis has a myriad of radiographic appearances
- Chest X-rays are snapshots and cannot determine if the disease is active or infectious
- Tuberculosis may present atypically when patients are immune compromised
- Direct comparison to old films is critically important to follow disease progression