Interpretation of Chest Radiographs
Reynard McDonald, MD
Medical Director
NJMS Global Tuberculosis Institute

X-Rays

When x-rays are produced and directed toward the patient, they may act in three basic ways:

They may be… Which means…

unabsorbed they pass through the patient unchanged and strike the x-ray film
completely absorbed the energy of the x-ray is totally deposited within the patient
scattered they are deflected within the patient but may still strike the x-ray film

X-ray Absorption

Factors that contribute to X-ray absorption include:
– Density of the tissue the beam strikes
– 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
Posterior/Anterior (PA) Radiograph

- 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)
- PA view is taken at a distance of 6 feet to reduce magnification and enhance sharpness
Lateral Radiograph

- Lateral radiograph is the other routine view
- 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
- Lateral view generally shows lesions located behind the heart, near the mediastinum, or near the diaphragm on the PA view
  - These lesions are otherwise difficult to detect

Assessing Technical Quality of Radiographic Studies

- Before interpreting, the reader should always assess the quality of the study
- These technical parameters should be assessed:
  - Exposure
  - Proper positioning
  - Inspiratory effort
Exposure

• Properly exposed:
  – Thoracic intervertebral disc space just visible
  – Branching vessels through heart clearly visible

• Underexposed:
  – Difficult to “see through” mediastinal contours & heart
  – Lung parenchyma not clearly visible

• Overexposed:
  – Film appears “too black”
  – Small lung nodules or other faint pulmonary parenchymal opacities difficult to see
  – May be compensated by use of bright or “hot” light

Overexposure

Proper Exposure

Proper Positioning

• No patient rotation

• Medial clavicle heads equidistant from spinous processes

• Medial clavicle ends overlie the junction of 1st anterior ribs or manubrium

• Lordotic projection: clavicles projected cranial to 1st ribs
  – Useful for viewing pulmonary apices
  – Undesirable for routine frontal radiographs
Inspiratory Effort

- Full inspiration results in diaphragm projected to 9-10th posterior ribs in normal patients
  - Below 11th ribs, lung volumes are abnormally large
    - Air trapping or obstructive pulmonary disease
  - Above 8th ribs, lung volumes are abnormally low
    - Poor inspiratory effort or restrictive lung disease
- Low lung volumes can:
  - Result in basilar vascular crowding and atelectasis
  - Create appearance of interstitial lung disease or pneumonia in lung bases, or cardiac enlargement

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
Silhouette Sign: RLL Pneumonia

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
Nodules

• 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

Miliary Pattern

• Nodules and masses: discrete areas of increased lung opacity whose borders do not conform to anatomic divisions (such as a fissure)
• Masses: similar to nodules but larger, >30mm in diameter
• Nodules and masses are described by:
  – Size
  – Number, single or multiple
  – Sharpness of their borders
  – Location
  – Presence or absence of calcification
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 as soft tissue densities in characteristic locations, including:
  - Right paratracheal area
  - Hila
  - Aorticopulmonary window
  - Subcarinal mediastinum
  - Superior mediastinum
  - Supraclavicular area
  - Paraspinous 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 best visualized on the lateral radiograph
  - It fills the normally clear infrachilar window with an unexpected contour
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:**
  - Commonly result from infections, trauma, or toxic ingestion, as well as other rare etiologies

- **Pulmonary cavities:**
  - Created by necrosis of lung parenchyma
  - May result from infection, neoplasm, and infarction

Cysts and Cavities

- Pulmonary cysts and cavities are characterized by:
  - Number and location
  - Character of the inner lining
  - Thickness of the wall (at the thickest portion, not including air-fluid levels)
  - Nature of the contents of the lesion

**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

- Since pleural abnormalities are 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.
  - 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.

Self Check

Answer
Post-Primary (Reactivation) TB (Lateral View)

Tuberculoma

Airspace Consolidation with Cavitation

Volume Loss (Atelectasis)
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 immunocompromised
- Direct comparison to old films is critically important to follow disease progression