Clinical Application of the Chest Radiograph
Chapter 9
(Procedures in Radiology)
X-Rays

• Electromagnetic rays that penetrate matter
• Radiographic studies provide a valuable picture of body structures. These studies can be as simple as routine chest radiography or as complex as dye-enhanced cardiac catheterization.
Indications

- To evaluate dye excretion in the urinary system (e.g., intravenous pyelography [IVP], antegrade pyelography, retrograde pyelography).
- To evaluate arterial occlusive disease (e.g., arteriography of the kidney, adrenal glands, or cerebrum).
- To evaluate a joint after injection of a radiopaque substance (arthrography).
- To evaluate the gastrointestinal (GI) tract with barium contrast medium (e.g., barium enema, upper gastrointestinal series).
- To evaluate bone disorders such as fractures, infections, and arthritis (long bone x-ray films).
- To evaluate the tracheobronchial tree (bronchography).
- To visualize the heart chambers, arteries, and great vessels (cardiac catheterization).
- To evaluate the pulmonary and cardiac systems (chest radiography).
- To guide needles for biopsy of tumors and aspiration of fluid.
- To evaluate abdominal organs (computed tomography [CT] of the abdomen).
- To provide an accurate clinical picture of the liver (CT portogram).
- To determine patency of the fallopian tubes (hysterosalpingography).
- To evaluate abdominal pain or trauma (kidneys, ureter, and bladder [KUB] or obstruction series).
- To detect breast cancer (mammography).
- To diagnose a pulmonary embolus (pulmonary angiography).
Radiological Studies

- Plain Radiography
- Fluoroscopy
- Tomography
- Angiography
- Ultrasound
- MR
Positioning for Chest Radiography

• The basic views:
  – Anteroposterior (AP)
  – Posteroanterior (PA)
  – Lateral
  – Lateral decubitus
  – Oblique
  – Apical lordotic

• Patient and film about 6 feet from the x-ray

• Ideally performed at full inspiration
Techniques for Examining the Chest X-Ray

Systematic Progression
  Is the whole chest visible on the film?
  Is the patient well positioned?

1. Bony Structures
   – Spine
   – Clavicles

2. Diaphragms

3. Vascular Structures

4. Cardiac shadow

5. Lungs
Normal frontal chest film. Note the medial ends of the clavicles (*arrows*) with the spinous process (*arrowhead*) framed between them.
Normal lateral chest film
What are some reasons to obtain a chest x-ray?
Line Placement

Portable chest film showing good position of the pulmonary artery catheter as it passes through the right side of the heart and into the right pulmonary artery (*long white arrow*). Note the position of the right and left chest tubes (*large black arrows*), endotracheal tube (*black arrow with asterisk*), and nasogastric tube (*small black arrow*). A short white arrow points to the left subclavian central venous pressure line in good position.
Endotracheal Tube

Portable supine chest film demonstrates malposition of an endotracheal tube in the right mainstem bronchus (arrow).
Chest Tube

Close-up view of a chest film showing a left chest tube in good position. Note that three distinct lines are seen along the tube. The thicker line in the middle is a radiopaque stripe that allows visualization of the entire length of the tube. The other two lines are the edges of the tube itself; they would not be visible if the tube was accidentally placed in the soft tissues of the chest wall.
Poor Line Placement

Anteroposterior chest film demonstrating a total parenteral nutrition line in the right jugular vein (*large arrow*). The line has punctured the vein and entered the right lung. Nutritional substances have been infused into the right pleural space. Note that a left subclavian central venous pressure line is in good position (*small arrow*).
Poor Line Placement

Two portable supine chest films obtained 30 hours apart. A, A wedged Swan-Ganz (pulmonary artery) catheter in the right lower lobe (arrow). B, Film obtained after retraction of the catheter shows increased density at the site, reflecting an area of infarction caused by prolonged inadvertent wedging of the catheter (arrows).
Pleural Effusion
Hydropneumothorax

A single posteroanterior view of the chest in a patient with a hydropneumothorax. Note the air-fluid level in the pleural space. The visceral pleura is slightly thickened (arrow) from prior surgery on the right.
Pneumothorax

Complete atelectasis of the left lung (curved arrows) resulting from a large left pneumothorax.
Tension pneumothorax

Portable chest radiograph in a patient status-post median sternotomy and coronary artery bypass grafting. Note the large right pneumothorax displacing the mediastinum to the left and the right hemidiaphragm inferiorly. These findings indicate the presence of a tension pneumothorax on the right requiring immediate chest tube placement.
Hyperinflation

Posteroanterior chest film. Note marked hyperinflation with large lung volumes, low-set diaphragm, small, narrow heart, and enlarged intercostal spaces.
Air Bronchograms

This portable radiograph shows diffuse increased density throughout both lungs highlighted by tubular lucencies. These are air bronchograms. They are visualized because of the alveolar filling that surrounds them. This typical alveolar-filling pattern (air space disease) suggests acute pneumonia, pulmonary hemorrhage, or pulmonary edema.
Pulmonary Edema

Moderate pulmonary edema. Cephalization of the blood flow is visible *(white arrows)*. The blood vessels to the apex of the lung are enlarged and similar in size to the blood vessels to the base of the lungs. The inset displays peribronchial cuffing *(black arrows)*; the inset is from the right hilum of the same film but enhanced to make the peribronchial cuffing easier to see.
Severe Pulmonary Edema

Severe pulmonary edema. Both lungs are opacified in a bat’s wing distribution. The hilar vessels are not visible due to the edema in the lung tissue surrounding these vessels. Peribronchial cuffing can be seen at the *black arrows*.
Scleroderma

Posteroanterior view of the chest in a patient complaining of shortness of breath. The film demonstrates interstitial lung disease. The lung volumes are diminished. Several small cystic lucencies are visualized between the increased basilar interstitial markings representing honeycombing. The diagnosis is scleroderma lung. No esophageal abnormalities are evident on this film.
Cardiac Silhouette

Posteroanterior chest film shows an enlarged cardiac silhouette. The lateral lung margins are slightly displaced away from the inner chest wall in both costophrenic angles, which is consistent with bilateral effusions.
Silhouette Sign

Seen when the border of the heart, aorta, or diaphragm is obliterated

Note the consolidation in the patient’s right lung. The infiltrate must be in the right middle lobe because the right heart border is blurred.
Plate Atelectasis

Posteroanterior chest film shows linear areas of plate atelectasis in both lower lobes.
Three portable chest films obtained within a 20-hour time span. **A**, Good aeration of both lungs. **B**, Film obtained 17 hours later shows complete opacification of the left hemithorax. Bronchoscopy performed after this film revealed a mucus plug in the left main bronchus. It was removed at bronchoscopy. **C**, Partial reexpansion.
Posteroanterior (PA) (A) and lateral (B) views of the chest in a patient with right upper lobe collapse. A, Note the wedge opacity of the right upper lobe. Note the inferior bulge (arrows) of the minor fissure on the PA film. This indicates the presence of a central mass. B, The wedge shape of right upper lobe atelectasis (arrows) is well seen on the lateral film.
Posteroanterior and lateral views of the chest of a patient with bullous emphysema. Marked pulmonary hyperinflation is worse on the right. The asymmetrical hyperinflation is producing mediastinal shift to the left. There is flattening of the diaphragm, prominence of the clear spaces, and large areas in the upper lung zones that are devoid of any vascular markings. The walls of these bullous air spaces are well visualized.
**Pneumomediastinum**

Posteroanterior view of the chest of an 11-year-old asthmatic shows linear lucencies (free air) in the mediastinum and extending into the soft tissues of the neck bilaterally. Note the free air around the lateral aspect of the right clavicle (*arrow*).
Ultrasound

- More sensitive for conventional x-rays for pleural effusions
- Differentiates between solid pleural lesions and pleural fluid
- Guides pleural drainage procedures
Computed Tomography

• Sequence of x-ray films
• 3-D cross-sectional view
• “Slices” 0.5 to 1 cm apart of the entire circumference of the body
• May enhance the image with radiopaque contrast
  – In addition to radiation, risk of iodine allergies, nephrotoxicity
CT Scans
Posteroanterior chest film indicating the four levels at which computed tomographic scan slices B, C, D, and E were obtained.
Cardiac Catheterization

- Used to visualize heart chambers, arteries, and great vessels
- Evaluates chest pain, locates the region of coronary occlusion
- Right Heart (subclavian, brachial, or femoral vein); Left Heart (femoral, brachial, radial artery)
- Sterile procedure
- Angiogram versus Angioplasty
Cardiac Catheterization
Cardiac Catheterization Results

Clinical Significance

- Coronary artery occlusive disease
- Anatomic variation of the cardiac chambers and great.
- Ventricular aneurysm
- Ventricular mural thrombi
- Intracardiac tumor
- Altered blood flow dynamics
- Ventricular wall motion deficits
- Acquired or congenital septal defects and valvular abnormalities
- Aortic root arteriosclerotic or aneurysmal disease
- Anomalies in pulmonary venous return
- Pulmonary emboli
- Pulmonary hypertension
- Reduced cardiac output
- Arterial oxygen desaturation
Magnetic Resonance Imaging

- Limited usage in lung disease
- Precise position of tumors and the involvement of the surrounding structures
Lung Scanning

**Ventilation**
- Breathe radioactive gas or nebulized aerosol
- Does not enter lung region with poor ventilation

**Perfusion**
- Injection of radionuclides into a peripheral vein
- Lodge in the pulmonary capillaries
- Radioactivity is decreased over areas of poor perfusion
V/Q Scan Interpretation

- Pulmonary Embolism
- Pneumonia, atelectasis
- Report as “high probability” or “indeterminate”
Lung scan

A, Perfusion. B, Ventilation. There are multiple perfusion defects noted on the perfusion lung scan. However, the uptake of radionuclide on the ventilation scan is normal. The combination of findings is because of pulmonary emboli.
Abnormal ventilation-perfusion scan
The ventilation study (A) demonstrates bilateral lung filling without gross defects; however, the perfusion scan (B) shows multiple subsegmental perfusion defects of both lungs. These findings are highly suggestive of pulmonary emboli.
Pulmonary Angiography

- Evaluates thromboembolic disease of the lungs
- Used when the V/Q scan is inconclusive
- Inject a contrast medium into the pulmonary artery
CT angiogram

A patient with an acute pulmonary thromboembolism. The embolism is seen as the dark area within the white contrast-enhanced blood vessels (arrow). (Courtesy G. Foster.)
PET Scan
Considerations

• With the increasing concern about radiation exposure, the patient may want to know if the proposed benefit outweighs the risk involved
• Cost of exams
• Significant contribution to medicine