The Chest Radiograph

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Radiographic Primer of Tuberculosis
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Disclosure

• None
Objectives

• Describe the basic principles of chest radiography as used in the diagnosis and management of Tuberculosis

• Recognize patterns of disease typically seen in patients with Tuberculosis
A ‘conquered’ disease returns
Dreaded in the 19th century, TB plagues new victims today

Massachusetts Public Health
Chest X-ray Service
You have purchased this coupon with Christmas seals through your Tuberculosis Association.
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.

So - where they hit the film, the film, when developed, turns black; where they are blocked, the film is white
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: *The Standard*

- 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)

- A PA view is taken at a distance of 6 feet to reduce magnification and enhance sharpness
X-Ray Room, Pine Street Inn
Normal Frontal (PA) Chest Radiograph
Normal Frontal (PA) Chest Radiograph
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
Normal Lateral Chest Radiograph
Chest Radiograph
A Systematic Approach

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

• Examine surrounding structures
  • Bones, diaphragms, the neck

• Identify *patterns of disease*
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
Exposure

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
Chest Radiograph: Apical Lordotic View
Inspiratory Effort

• Full inspiration results in diaphragm projected to 9-10\textsuperscript{th} posterior ribs in normal patients
  – Below 11\textsuperscript{th} ribs, lung volumes are \textit{abnormally large}
    • Air trapping or obstructive pulmonary disease
  – Above 8\textsuperscript{th} ribs, lung volumes are \textit{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
The Silhouette Sign
The Spine Sign

The Diaphragm silhouettes
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**
Normal Consolidation

Courtesy Reynard McDonald, Rutgers-RTMCC
Consolidation

Air bronchograms
Normal Interstitial disease

Courtesy Reynard McDonald, Rutgers-RTMCC
Linear Opacities
Miliary Pattern
Nodules and Masses

- 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
Nodules
Lung Mass
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
  – Paraspinal region
  – Retrosternal area on the lateral radiograph

• One or more regions may be involved, and in certain conditions, nodes may calcify
Lymphadenopathy
Lymphadenopathy
Mediastinal Lymphadenopathy
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
Cavity
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
Pleural Effusion
Pleural Effusion?

Lateral decubitus view
Test
Primary TB in a Child
Primary TB in a Child
Primary TB in an Adult
Primary TB with Cavitation
Tuberculosis ...
TB in a 10 year old
Post-Primary ("Classic" Reactivation) Tuberculosis
Post-Primary (Reactivation) Tuberculosis
TB: Airspace Consolidation with Cavitation
TB: Volume Loss (Atelectasis)
Tuberculoma
Test
HOW OFTEN SHOULD I CHANGE MY OIL?

• (A) EVERY 3,000 MILES
• (B) EVERY 5,000 MILES
• (C) EVERY 7,500 MILES
• (D) ALL OF THE ABOVE
TB: Paratracheal Adenopathy in HIV
Fibrotic Scarring
Answer
References


Summary: Chest Radiographs

- Tuberculosis has a myriad of radiographic appearances
  - Classically apical-Post segments of Upper Lobes or Superior Segments of Lower Lobes
  - Up to 1/3 of Pulmonary TB will have non-"Classic" CXR
- 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
7 y/o boy w cough, chest pain
Infant’s CXR