Chest Radiology in Pulmonary TB: Classic Findings to Subtle Nuances

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Pathogenesis of Tuberculosis

• Droplet nuclei (1 to 5 μm) containing 2 or 3 organisms reach the alveoli
• Alveolar macrophages ingest M. tuberculosis organisms
• If the organism survives the initial defenses, it multiplies intracellularly
• After 2 - 12 weeks organisms grow to $10^3$ to $10^4$ in number, sufficient to elicit a cellular immune response

Pathogenesis of Tuberculosis

• Before cellular immunity develops, organisms spread via lymphatics to hilar, mediastinal nodes and the blood stream
• Organisms deposited in the upper lung zones, kidneys, bones, and brain find environments that favor growth
• Activated T cells and macrophages from immune individuals form granulomas that limit spread
A CXR is a critical part of evaluating someone with suspected TB

Do they have active TB?
Are they infectious?

Tissue Density

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

Air or gas

Blackest/Least Dense
Intrathoracic Structures

Outline of heart in PA and lateral views. Ao = aorta; LAA = left atrial appendage; LA = left atrium; LV = left ventricle; PA = pulmonary artery; RH = right hilum; RPA = right pulmonary artery; RV = right ventricle.

Lobes of the Right Lung

Lobes of the Left Lung

Normal Frontal (PA) and Lateral Chest Radiograph
Consolidation (Airspace Disease)

Primary vs Post-primary ( Reactivation) TB

- Primary TB
  - Consolidation/infiltrates (middle, lower lobes)
  - Adenopathy (hilar, mediastinal)
  - Milary
  - Tuberculous pleural effusions
- Post-primary TB
  - Infiltrates/consolidation, cavities (apical and post segments upper lobe, superior segment)
  - tree-in-bed opacities
  - Tuberculous pleural effusions

Sensitivity of Chest Radiographs in TB

- CXR normal in 15% of patients
  - More effective screening, earlier detection
  - Changing demographics of at risk population
  - Reduced exposure to TB in childhood
- Maintain high index of suspicion
  - Cough ≥3-4 weeks; fevers ≥1 weeks
  - Recent skin-test conversion

Chest 1999; 115:445
Enhanced Imaging Techniques

Apical Lordotic

Subtraction Imaging

Advantages of Chest CT

- Enhanced detection of TB disease
  - Cavities
  - Centrilobular branching opacities (tree-in-bud)
  - Complications of TB (e.g., aspergilloma, bronchiectasis or endobronchial stenosis, mediastinal fibrosis)
- Distinction between active and inactive disease.
  - Infiltrates/consolidation, cavities, tree-in-bed, adenopathy indicate active disease
  - Fibronodular opacities, calcification suggest inactive disease

Primary TB in Adult
Primary TB

Cavities in Pulmonary TB

- Common finding (40%)
  - Thin or thick walled
  - Apical, post segments UL, superior segment LL
  - Usually not fluid filled
  - Can develop within 6 mos of primary infection
  - Endobronchial spread to other segments

Cavitary Disease with Endobronchial Spread
Post-primary (Reactivation) TB

Atypical Presentation in HIV+ Patient

- TB-HIV co-infection common but decreasing
- Infiltrates, adenopathy, miliary pattern more common

Immune Reconstitution Syndrome
Miliary TB

- Discrete 3-4 mm nodules; interstitial distribution
- Hematogenous spread
- Primary (usually) or post-primary disease

47 yo M on Anti-TNF Therapy

Miliary TB progressing to ARDS

Tuberculous Pleural Effusion

- Small to moderate sized
- Usually unilateral
- Primary or post primary disease; infiltrate in 50%
- Lymphocyte predominant, ↑ adenosine deaminase, IFN-γ levels in fluid
Pleural Complications of TB

Fibrous pleural peel

Bronchopleural fistula

Endobronchial TB

Radiographic Sequelae of TB Infection

Ghon complex
Complications of “Old” TB

Pulmonary MAC disease
- Tree-in-bed, bronchiectasis common
- RML, lingular involvement common
- Prolonged therapy, macrolide susceptibility predictive

TB Mimics

TB
MAC

31 yo pediatrician from Taiwan s/p Rx for LTBI

BAL → \textit{M. kansasii}

Can mimic pulm TB
Rx 12-18 mos rifampin suscep key
**Summary: TB radiographs**

- Tuberculosis has a myriad of radiographic appearances.
- Chest x-rays are snapshots and can’t determine if the disease is active or infectious.
- Tuberculosis may present atypically when patients are immune compromised.
- Direct comparison to old images is critically important to follow disease progression.
- Chest CT has enhanced sensitivity of radiographic detection.