TB as Seen on a Chest X-ray

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Disclosures

• None relevant
Objectives

• You will
  • Be able to identify **major structures** on a normal chest x-ray
  • Identify and correctly name **major chest x-ray abnormalities** seen commonly in TB
  • **Recognize chest x-ray patterns** that suggest TB & when you find them
Basics of Diagnostic X-ray Physics

- X-rays are directed at the patient and variably absorbed
  - When not absorbed
    - Pass through patient & strike the x-ray film or
  - When completely absorbed
    - Don’t strike x-ray film or
  - When scattered
    - Some strike the x-ray film
Absorption

- Absorption depends on the
  - Energy of the x-ray beam
  - Density of the tissue

Shade / Density

- Whitest = Most Dense
  - Metal
  - Contrast material (dye)
  - Calcium
  - Bone
  - Water
  - Soft Tissue
  - Fat
  - Air / Gas

- Blackest = Least Dense
Normal Frontal Chest X-ray: Posterior Anterior

Note silhouette formed by
- lung adjacent to heart
- lung adjacent to diaphragm

Silhouette Sign

Lifeinthefastlane.com
Normal Lateral Chest X-ray
Normal PA & Lateral X-ray: Hilum

Hilum – Major bronchi, Pulmonary veins & arteries, Lymph nodes at the root of the lung)
Normal PA & Lateral X-ray: Mediastinum

Mediastinum – Central chest organs (not lungs) – Heart, Aorta, Trachea, Thymus, Esophagus, Lymph nodes, Nerves (between 2 pleuras)
Normal PA & Lateral X-ray: Apex, Right Paratracheal Stripe

- **Apex of lung**
  - Area of lung above the level of the anterior end of the 1\textsuperscript{st} rib

- **Paratracheal stripe**
  - Seen between the air in the trachea & air in the lung
Wink Sign: Apex
Normal PA & Lateral X-ray: Apex, Right Paratracheal Stripe

- Apex of lung
  - Area of lung above the level of the anterior end of the 1st rib
- Paratracheal stripe
  - Seen between the air in the trachea & air in the lung
Special Methods of Detection for Apical Lesions

- AP Lordotic (AKA “Apical Lordotic”)
  - Lift ribs & clavicle off lung lesions
AP Lordotic for Clarifying Apical Lesions

- Standard PA Chest X-ray
- AP Lordotic Chest X-ray
Dual Energy Digital Subtraction Techniques: Useful for nodules

- Takes advantage of the effect of energy of x-ray beam on absorption.
- Dual Energy Technique can make bones fade or be seen more distinctly
The TB Image Library is a joint project of the Curry International TB Center and Firland Northwest TB Center as an educational resource to share radiographic images related to tuberculosis.

- Individuals may use this site to gain an appreciation for the broad spectrum of presentation TB may have using various imaging modalities.
- The library images are free to download for non-commercial educational purposes only. All images should be credited in the format: CITC/Firland TB Image Library; contributor.
- To contribute images or offer comments/feedback/questions, please email: CurryTBcenter@ucsf.edu

Basic TB Chest abnormalities and patterns of disease

- Consolidation/Opacities
- Cavitations/cysts
- Linear opacities/fibrosis
- Nodules/Masses
- Miliary pattern
- Lymphadenopathy
- Pleural abnormalities
- Tracheobronchial abnormalities
Consolidation

- Appears as a relatively homogeneous white area on chest x-ray
- Although the terms opacity and density are sometimes used, areas of consolidation are usually translucent; structures such as ribs are visible through the consolidation
- Is caused by filling of airspace with fluid, cells, pus, blood
- Without significant volume loss
Consolidation

- **Air bronchogram** may be visible because air in the bronchus forms a silhouette with fluid in airspace (characteristic of consolidation; not always present).

- **Silhouette sign** occurs when opacity is contiguous with heart or diaphragm, causing loss of normal silhouette
Consolidation / Opacity / Density

• The initial lesion in primary TB can be in any location in the lung

• In later ("reactivation") TB, location is most frequently in the upper and posterior portions of the lung
  • Apical and posterior segments of the right upper lobe
  • Apical-posterior segment of the left upper lobe
  • Superior segments of the lower lobes
Consolidation, Air Bronchogram
Left upper lobe apical-posterior segment
Nodules / Masses

• Nodule - discrete opacity or density that is 2-30 mm in diameter

• TB nodules can be
  • Solitary
  • Multiple
  • Associated with other chest x-ray abnormalities due to TB

• A common pattern for primary TB is a nodule (the primary focus of infection) plus ipsilateral enlarged mediastinal or hilar lymph node(s)
Nodules / Masses

• TB nodules
  • Can cavitate (form cavities)
  • Calcify when they heal

• A mass is larger than a nodule and is not typical of TB
Screening for TB in High Risk Individuals

- 22 year old, cough for 4 days, contact of case
- OT Student from Taiwan, TB skin test + 3 years ago; no symptoms, no Rx
TB Screening: Indicated for high risk individuals. So is treatment for + test.

- Health Care Worker with + TB skin test 1 year earlier
- Patient with metastatic colon cancer. Wife treated for TB. Patient had + TST; never treated
46 Year Old Bangladeshi Woman with: Poorly Controlled Diabetes – “Tuberculoma”

- **1st CT Scan** – note rim enhancement, central low attenuation
- **6 Weeks Later**
PET Scans do NOT Differentiate TB from Cancer: This Patient had TB

“FDG avid pulmonary nodule in the right middle lobe, along with two FDG avid lymph nodes involving the right hilum and subcarinal region. Findings suspicious for malignancy.”
Cavities

• Most common in advanced disease (reactivation TB)
• Highly contagious, contain many actively multiplying organisms
• Endobronchial spread to other areas of lung
• Higher risk of developing drug resistance
• May take longer to treat
• Wall thickness thin to medium
• Significant air / fluid levels are rare
Cavities: Think Swiss Cheese
Young Man from Vietnam: Negative TB skin test, T-Spot, and QFT
Young Man from Vietnam: Negative TB skin test, T-Spot, and QFT
Multiple Findings on CT Scan

- Cavities, consolidation with air bronchograms, nodules, “tree-in-bud” densities
Tree-in-Bud
Young Woman Treated for Pneumonia And 6 Months Later
26 Year Old Woman from Yemen
Hemoptysis, Fever, Weight Loss
26 Year Old Woman from Yemen
Hemoptysis, Fever, Weight Loss
Miliary TB

- Disseminated disease
- *Usually* occurs during initial (primary) infection with hematogenous spread of MTB
- Uniformly distributed nodules ~ 2 mm. in size
- May progress to septic shock and acute respiratory failure
- After infection, miliary TB &/or meningitis occur in ~ 10-20% of babies < 1 year old
NEJM – New@NEJM.org Oct, 2013
Miliary Pattern

• 15 year old with disseminated MDR TB

• Substance abuser, treated with prednisone for misdiagnosis of sarcoidosis
Miliary TB

- Courtesy of George D. McSherry, MD
- Courtesy of Ted Standiford, MD
TB Pleural Effusions and Other Abnormalities

- Small to very large, can loculate
- Usually unilateral
- Primary (or post primary disease)
- Fluid can be serous, thick & congealing, or bloody – not frank pus unless complicated
- Exudate – high protein and LDH, white cells predominantly lymphocytes
- ↑ Adenosine deaminase and IFN-γ levels
- Bronchopleural fistulas can occur
44 Year Old Man: Homeless Shelter Outbreak

• Note meniscus sign, silhouette sign, less translucency than consolidation
40 Year Old with Known Exposure to Contagious Case 1-2 Months Ago

• IV dye helps distinguish lung from pleural fluid
Lymphadenopathy

• Frequent in primary disease
• In children can be massive and compress airways
• Rim enhancement with dye and low attenuation centrally suggests TB
Recent Contact with TB Case: PET Scan Shown Before

Ghon Complex

Frank Netter
15 Year Old Boy with Cough Contact to Aunt with MDR TB

- Sputum culture + for MDR TB
Recent Contact to Active Case: Large Day Care Center Outbreak

- Sputum culture + for MTB
- Note right hilum compared to left
Linear Shadows / Fibrosis

- Can be old healed TB or active chronic TB
- Often seen with immigrants labeled B1
- Can be associated with volume loss
Treated TB: Note Volume Loss
Tracheobronchial TB

• Airways can be compressed by large lymph nodes
• TB can be endobronchial
• Bronchiectasis and bronchostenosis are common sequelae
• Atelectasis or collapse of the lung beyond an obstructing lesion can occur (similar to lung cancer)
10 Month Old from Ghana with Fever: Baseline & 1 month into treatment

• Courtesy of Pamela Hackert, MD
• After 2 weeks of treatment • Source Case
Homeless Man
Who can name the 2 surgical procedures performed on this patient?

Alice Neel (1900-1984) TB Harlem
And The Names Are:

- Right plombage
- Left thoracoplasty
Conclusion: You can Learn to Recognize TB When You See It!