TB Intensive
San Antonio, Texas
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Diagnosis of TB: Radiology
Michael McCarthy, MD, FACR
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Michael McCarthy, MD, FACR has the following disclosures to make:

• No conflict of interests

• No relevant financial relationships with any commercial companies pertaining to this educational activity
TB Intensive

Diagnosis of TB: Radiology

Michael J. McCarthy, M.D., F.A.C.R.
Professor & Chair Department of Radiology
The University of Texas HSC
at San Antonio
A Note of Thanks and Sincere Appreciation!

• Invitation to address you today
• For a large amount of the material you will view today, I thank

  • Dr. Santiago Restrepo, UTHSCSA
  • Dr. Diane Strollo, U. of Pittsburgh Medical Center

Disclosures

• None
Disclosures

• None
• “I wish I had some”

Objectives

• Objective: Using radiologic-pathologic correlations, the audience will understand the radiographic manifestations of TB in the following states of disease:
• Content:
  • The Initial infection [Most of the U.S. population]
  • Post primary or Reactivation TB and Progressive Primary (Immune Competent) [Foreign born]
  • Primary TB (Immune Deficient) [Children, HIV, IVDA, Alcoholism, Homeless, Medication]
  • Extrapulmonary TB
  • Use of CT and PET/CT as a tools
Mycobacterium TB: Introduction

• Wide spread and deadly
• Infects
  ~ 1/3 world population
  15 million in US
• 21\textsuperscript{st} century: ↓ TB in US
  2010: 11,181 cases reported
  3.6 cases/100,000
  Lowest since 1953
  except CA, TX, FL, NY = ½ all cases in US

MTB: US Epidemiology

• HIV is greatest risk factor
  Men age 22 - 44, US born
  Recent TB infection
• Foreign born, high TB rates
  Reactivation of latent TB
  >50\% cases TB in US
  ~ 90\% of MDR TB
• Homeless, malnourished, overcrowded
• Chronically ill or immune suppressed
• Children ≤ 5 years old
The Initial Infection

- Each droplet: 1-5 µm
- Inhalation of tiny droplets into alveoli
- Organisms divide q 16 - 20 hours
- PMN response is ineffective
- T-cells & macrophages contain infection
The Initial Infection

- Each droplet: 1-5 µm (< 3 AFB)
- Inhalation of tiny droplets into alveoli
- Organisms divide q 16 - 20 hours
- T-cells & macrophages contain infection
- 2-6 week: cell-mediated immunity
  - Necrotizing granulomas

TB Infection: Typical Case

- Exposed to TB
- Converts skin test
- Patient is asymptomatic

Courtesy: Dr. Santiago Restrepo
TB Infection: Typical Case

- Exposed to TB
- Converts skin test
- Patient is asymptomatic and
- Chest radiograph is normal!

Pathology:
Ghon focus & Ghon or Ranke Complex
Tuberculosis: Active Disease

- Postprimary or Reactivation TB
  In 5% endogenous reactivation of latent infection develops many years after the primary infection (Simon focus)
Tree in Bud

Courtesy: Dr. Santiago Restrepo

Tree in Bud

Courtesy: Dr. Santiago Restrepo
Consumption

TB: The Initial Infection

- Inhale tiny droplets into alveoli
- T-cells & macrophages contain infection
  - 2-6 week: cell-mediated immunity
    - Necrotizing granulomas
- If local host response fails:
  - Granulomatous response surrounds infection
  - Tubercle may enlarge, spreads to nodes
    - Lymphatic & hematogenous spread
- Patients at risk: Very young; Elderly; Immune suppressed (HIV; Steroids; Cancer patients; Alcoholics; IVDA)
Tuberculosis: Active Disease

• **Progressive Primary Infection**
  In 5% of infected individuals, immunity is inadequate and clinically active disease develops within 1 year

Primary Tuberculosis

• Typical Patient: children & immune compromised
• Parenchymal opacity / consolidation
  - unilateral, 70%
  - dense and homogeneous
• Lymphadenopathy
  - hilar or paratracheal
  - central low attenuation
• Pleural effusion

Courtesy: Dr. Santiago Restrepo
Courtesy: Dr. Santiago Restrepo

20 year old woman

Courtesy: Dr. Santiago Restrepo
HIV Patient

- CD-4 count dependent
- Primary TB features
  - Consolidation
  - Adenopathy
- Complications
  - Pleural effusion
  - Miliary disease
  - Extrapulmonary disease

TB: Consolidation in AIDS

Findings:
- Segmental
- Lung base

DDx:
- Pneumonia
- Immune impaired

Courtesy of Dr. Sandy Rubin
TB: Consolidation in AIDS

Findings:
- RLL consolidation
- LAN

DDx: Community acquired pna.

Immune impaired

Courtesy: Dr. Santiago Restrepo

Courtesy of Dr. Sandy Rubin
TB: Lymphadenopathy in AIDS

DDx LAN:
Malignant
Granulomatous
TB
Fungal

Courtesy of Dr. Diane Strollo
TB: Lymphadenopathy in AIDS

Central necrosis
Peripheral enhancement

34M IVDA
TB: Immune Compromised Host
Renal Txp. - Miliary

TB: Complications and Sequelae

- Intrapulmonary
  - Large airway disease (tracheobronchial)
  - Bronchiectasis
  - Mycetomas
  - Rasmussen aneurysms
TB Broncholith

Tracheobronchial TB

- TB is the most common cause of inflammatory stricture of a bronchus
- 10% - 20% of TB patients
- Circumferential wall thickening
- Luminal narrowing
- Long segment involvement
- Left > Right

Moon WK, et al. AJR 1997;169:649
TB: LMSB Stenosis

Courtesy: Dr. Santiago Restrepo
21 F RMB Obliteration

Courtesy: Dr. Santiago Restrepo
Bronchiectasis
TB: Hemoptysis

Upper lung fibrosis
Fungus ball LUL

Courtesy of Dr. Diane Strollo

TB: Aspergilloma

Bronchial artery
Source of hemoptysis

Courtesy of Dr. Diane Strollo
TB: Fibrocavitary Hemoptysis
Aspergilloma

Pneumonectomy

Courtesy of Dr. Diane Strollo

TB: Fibrocavitary Hemoptysis
TB: Fibrocavitary Hemoptysis Rasmussen (Pseudo)Aneurysm

TB Consolidation & Hemoptysis:

Dr. Santiago Restrepo
Hemoptysis: Intercostal arteries

TB: Complications and Sequelae

- **Intrapulmonary**
  - Large airway disease (tracheobronchial)
  - Bronchiectasis
  - Mycetomas
  - Rasmussen aneurysms

- **Extrapulmonary**
  - Lymphatic
  - Pleuritis / fibrothorax
  - Miliary
  - Empyema necessitatis
  - CNS Abscess and basal meningitis
  - Osteomyelitis
  - Spondylitis / spondylodiskitis
Extrapulmonary TB

- 85% Pulmonary; 15% Extrapulmonary
  - Lymphatic (27.5%) *
  - Pleural (23.4%)
  - Genitourinary (12.8%)
  - Miliary (9.5%)
  - Bone and joint (9.4%)
  - Other (8.6%)
  - Meningeal (5%)*
  - Peritoneal (3.8%)
- Clinical challenge: less common; less familiar; less accessible sites
- Therefore: greater visceral damage.

CDC: 1984

Extrapulmonary TB

- In HIV patients-rule of thirds:
  - 1/3 only pulmonary
  - 1/3 only extrapulmonary
  - 1/3 both pulmonary and extrapulmonary
  - Therefore: 2/3 have extrapulmonary disease
- Chest film is abnormal in most, though not all cases of disseminated disease.
Lymphadenopathy

Primary TB

Courtesy: Dr. Santiago Restrepo
18 M with HIV

TB: Pleural Effusion

Courtesy: Dr. Santiago Restrepo

Courtesy of Dr. Diane Strollo
TB: Pleural Effusion & Nodule

Courtesy of Dr. Diane Strollo

Courtesy: Dr. Santiago Restrepo
Miliary Tuberculosis

- Systemic hematogenous spread of TB
- 2% - 6% of TB patients
- More frequent with reactivation/pp TB
- Alone or with typical parenchymal changes of post primary TB
- 1 mm – 3 mm nodules, randomly distributed
- Interlobular septal thickening

Millet Seeds

Slender plant, 1-15 feet
Maize like kernels:
~ 2 mm in diameter
1/6 of world grain
1/3 of grain for 3rd world
Africa and India
Producer: India
Miliary TB

Courtesy: Dr. Santiago Restrepo
Multiple Drug Resistance (MDR-TB)

Looks like accelerated active TB
Multi-lobar cavities + consolidation

Immune Reconstitution Syndrome (IRS)

Paradoxical worsening of symptoms & imaging
Reflects recovery of immune surveillance
Reported with initiation of TB therapy
HAART for HIV infection
CXR: adenopathy, consolidation, effusions
Exclude MDR-TB, treatment failure
Supportive measures, corticosteroids

Multi-drug Resistant TB
Multi-drug Resistant TB

Courtesy: Dr. Santiago Restrepo
Role of CT

- Symptoms in face of negative CXR
- Symptoms in face of abnormal CXR (+ stable) e.g. hemoptysis
- Better defining the abnormal radiograph
- Lack of response to standard therapy
- Expensive
Role of PET/CT

- Differential Diagnosis
- Disease activity
- More rapid identification of response to therapy than CXR or CT
- Expensive

TB: Summary

Who develops TB: foreign born, HIV+, immune compromised; young and very old

Most infected individuals have latent TB & normal CXR & never develop active TB

Imaging reflects immune status, not time course

Findings not always conclusive of TB (Atypical mycobacterial disease); Cancer; Granulomatous infections

Pathophysiology of the infection in man
**TB: Summary**

Immune Competent: “Reactive” “Post-primary”
- Upper lungs: Solitary or clustered nodules; consolidation; cavity; TIB;
- + Lymphadenopathy but not dominant, pleural effusion

Immune Deficient (children, elderly and HIV): “Primary”
- Lower lungs: Consolidation with LAN; miliary; pleural effusion

Radiographic patterns:
- Post primary TB and Primary TB;
- Extrapulmonary disease.

Role of CT and PET/CT
TB: Airway Involvement

- Bronchial stricture
- LUL atelectasis
- Tree-in-bud

Courtesy of Dr. Sandy Rubin
TB: Airway Involvement

Pneumonectomy
Bronchopleural fistula
Recurrent TB

Courtesy of Dr. Diane Strollo
TB: Lymphadenopathy in AIDS

Courtesy of Dr. Sandy Rubin

Courtesy: Dr. Santiago Restrepo
TB: Airway Involvement

Tubercle forms in airway submucosa
=> Ulceration, fibrosis, stenosis

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<tr>
<th>Acute</th>
<th>Chronic</th>
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<tbody>
<tr>
<td>• Tracheitis</td>
<td>• Tracheal stenosis</td>
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<td>• Tracheal compression</td>
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<td>• Bronchiolitis</td>
<td>• 2nd amyloid</td>
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Courtesy of Dr. Diane Strollo

Courtesy: Dr. Santiago Restrepo