**Pulmonary TB: HRCT findings**

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- **Tuberculosis: History**
  - BC 5000: Evidence of TB in neolithic man
  - BC 2900: Pyramid builders
  - BC 1000: Pott’s dis. in mummies

- **Victims of tuberculosis**
  - Writer: Goethe, Schiller, Dostoevsky, Chekhov, Laurence, Poe, Kafka, Rousseau
  - Philosopher: Spinoza, S. Johnson
  - Artist: Modigliani, Gauguin
  - Musician: Chopin, Paganini
  - Physician: Laennec

- **M. tuberculosis: Genome Sequence**
  - Determination of genome sequence: help new prophylactic & therapeutic intervention
  - M. tuberculosis, H37RV
  - 4,411,529 base pairs: 4,000 genes

- **Estimates of the global burden caused by TB in 2010**
  - 12 million prevalent cases
  - 8.8 million new TB cases (128 cases/100,000 population)
  - 1.7 million death from TB (4700 deaths/day)
  - Most cases were in the Asia (59%), African (26%) and smaller cases were in Europe (5%).

*Towards universal access to diagnosis and treatment of multidrug-resistant and extensively drug-resistant tuberculosis by 2015. WHO PROGRESS REPORT 2011*
**Diagnosis of tuberculosis**

- Prompt Dx of TB
  - Public health infection control
  - Ensure appropriate Tx of TB patient
    - Conversion to noninfectious condition
    - Cure
  - Limited sensitivity of culture test

*Imaging Dx would provide opportunity of prompt Dx. & appropriate Tx.*

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**Tuberculosis**

*Primary vs Reactivation*

- **Primary TB**
  Disease developing after initial exposure
  - atypical radiologic presentation

- **Reactivation TB**
  Disease developing as a result of reactivation of a previous focus
  - typical radiologic presentation

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**Molecular epidemiology concept**

- Based on DNA fingerprinting
  - Restriction fragment length polymorphism (RFLP) analysis of M. TB isolates

- TB isolates in terms of space & time
- Identification of primary & reactivation TB
  - Clustered isolates (primary)
  - Unique isolates (reactivation)


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**Radiographic manifestation of TB**

*New concept*

- No difference in radiographic features bet. primary & reactivation TB
- Significant predictors of radiographic appearance of TB
  - Patients’ immune status
  - Immunocompromised patients: tendency toward primary TB form
  - Immunocompetent patients tend to have the reactivation TB form

*Geng E, et al. JAMA 2005*

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*Clinical and Radiographic Correlates of Primary and Reactivation Tuberculosis*

A Molecular Epidemiology Study

- Elton Geng, MD, MPH
- Bruce Kareshewski, PhD
- Joe Rautzib, MD, MPH
- Neil W. Solingen, MD

Context: The traditional teaching that pulmonary tuberculosis characterized by lymphadenopathy, effusion, and fever or miliary or miliary-like are usual radiography represent “primary” disease from newly acquired infection, whereas upper lobe in addition, and diffuse were represented as reactivation disease acquired in the more distant past, is not based on well-established clinical evidence. Furthermore, it is not supported by the current literature. The current literature supports the idea that primary disease is a distinct entity. Its duration is shorter and mortality is lower than that of reactivation disease. The duration of primary disease is also shorter and mortality is lower than that of reactivation disease.
Radiologic features of Tuberculosis:  
Atypical vs Typical

Atypical radiologic features:  
**Primary pattern**
- Lymphadenopathy
- Pleural effusion
- Miliary nodules
- Lower lobe disease

Primary Tuberculosis in Children
- Unsensitized host
- Airborne droplets (2 - 10μ)
- Necrotizing pneumonitis
- Spread by lymphatics
- Spontaneous resolution: over 90%

Pulmonary TB in Children:  
**CT**
- 41 patients (mean age, 6 yrs)
- CT findings:
  - Mediast. & hilar lymphad. : 83%
  - Seg. or lobar consolidation : 49%
  - Bronchogenic spread : 29%
  - Miliary nodule : 17%
- CT is useful in Dx. and detection of Cx.

Kim WS et al. AJR 1997;168:1005

13 m/o m. Prim. TB: consolidation & LN

24/F  
Fever, weakness
Miliary Tuberculosis: HRCT

- 25 patients
- Millary nodules: 88%
- Ground-glass opacity: 92%
  - large GGO: dyspnea, impending ARDS
- Intralob. reticulation, septal line: 40%

Hong SW et al JCAT 1998;22:220

Typical radiologic features: Reactivation pattern

- Caseating granuloma
- Bronchogenic spread
- Cavitation
- Upper lobe disease
**Postprimary or Reactivation Tuberculosis**

- Sensitized host
- Tendency to be localized
- Rare lymphatic spread: mainly bronchogenic
- Apex, Sup. segment of lower lobe

**Typical radiologic features**

- Caseating granuloma
- Bronchogenic spread
- Cavitation
- Upper lobe disease

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**Tuberculosis**

Chronic debilitating granulomatous disease

**Early lesions?**

**Advanced lesions?**

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**Typical radiologic features**

- Caseating granuloma
- Bronchogenic spread
- Cavitation
- Upper lobe disease

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**Pulmonary TB**

*Courtesy of Dr. Itoh*
Tuberculosis

Highly contrasted lesions

Tuberculosis

Highly contrasted centrilobular lesions

TB: Highly contrasted lesions

Why?

Pulmonary TB

Caseous materials

Fill the bronchiole and alveolar ducts

Bronchogenic Spread:

“Tree-in-bud”
Bronchogenic spread TB

Centrilobular: tree-in-bud

Bronchopneumonia

Multiple nodules

Centrilobular inflammatory nodules

Centrilobular inflammatory nodule

Bronchiole

Paraseptal parenchyma

Pulmonary vein

Hypersensitivity pneumonitis
Productive cough

Diffuse Panbronchiolitis

TB

Sarcoid

Bronchogenic spread TB

DPB

Tuberculosis: HRCT of Early Bronchogenic Spread Lesions

Tree-in-bud appearance

High contrasted lesions

Caseation Necrosis: Good & Bad

* Homo sapiens
  * Tissue damage
  * Delayed type hypersensitivity
  * Activated mono/macroph, cytokines, chemotactic factor

* M. TB
  * Unable to multiply within solid caseum

Tsuyuguchi I. Dialogue between M tb & H sapiens. Tuberculosis 2001

Recent Bronchogenic Tuberculosis

- Centrilobular lesion (97%)
- Tree-in-bud appearance
- Bronchial wall thickening (79%)
- Poorly-defined nodule (5-8mm) (76%)
- Cavitary nodules (66%)
- Lobular consolidation (52%)

Miliary Tuberculosis: HRCT

- 25 patients
- Miliary nodules: 88%
- Ground-glass opacity: 92%
  - Large GGO: dyspnea, impending ARDS
- Intralobular reticulation, septal line: 40%

Hong SW et al. JCAT 1998;22:220

Coal worker's pneumoconiosis with PMF

Random Uniform Abut pleura

Miliary TB with DIC & ARDS

Immunologic Balance btw H. sapiens & M. TB

**Homo sapiens**

- Cell mediated immunity
- Delayed type hypersensitivity
- Anti-TB drug

**M. TB**

- Armour-plated with lipid cover
- Genetic mutation

Tsuyuguchi I. Tuberculosis 2001

39/M. Multi-Drug Resistant TB
Typical radiologic features

- Caseating granuloma
- Bronchogenic spread
- Cavitation
- Upper lobe disease

Cavities in MDR-TB

Centrilobular cavity evolution

5 mo Anti-TB Rx

9 mo Anti-TB Rx

Pneumonectomy, meningitis

TB cavity

Courtesy of Dr. Itoh
Healing process of tuberculosis

- Resolution
- Fibrosis
- Calcification

Healing of tuberculous lesion

Tuberculosis in subsets of patients

- Acquired Immune Deficiency Syndrome
- Diabetes Mellitus
- SLE
- Myelodysplastic synrome
- Alcoholics
**Pulmonary tuberculosis**

**AIDS**

- **Risk**: 50 - 200 times
- **Radiology**: depends on CD4 count
  - 200 ↑: post-primary
  - 200 ↓: primary
- **Pathology**: Extensive necrosis but few cavity
  - Poorly organized or no granuloma
  - Numerous bacilli

**Diabetes Mellitus**

- **Pathophysiology**:
  - Phagocytosis & intracellular killing ↓
  - Suppress granuloma formation
- **Radiology**:
  - Large airspace consolidation
  - Multiple small cavities
  - Extensive local & bronchog. spread

**SLE**

- **22 pt. with active TB (8.8%) /256 consecutive SLE pts., all on steroid**
- **HRCT findings**:
  - Miliary TB: 54%
  - CLN in upper lobe: 36%
  - Consolidation in LL: 18%
  - Lymphadenitis: 18%
  - Cavity: 0%

- **Immunity**: Steroid (lymphokine, chemotaxis ↓)
  - Inherent cell-mediated immunity ↓

*Kim HY, et al. AJR 1999*
Pulmonary tuberculosis
Myelodysplastic Syndrome

- Acquired blood disorders
  - May progress to acute leukemia
  - Pancytopenia in spite of having a cellular marrow
- 12 TB/195 MDS
- Common extrapulmonary involvement
  - 50%
- Primary pattern (50%)
24/F previous healthy. AFB(+)
Dyspnea, fever

TB Pleural Effusion:
Paradoxical Response

- 16 patients with TB pleurisy
  14 men, mean 27 yrs
- New pulmonary nodule(s) during anti-TB Tx.
- All ipsilateral peripheral nodules
- Transient worsening but ultimately improve with treatment

TB in Patients with IPF

- 143 patients with IPF (mean age: 58.4 yr)
- 9/143 (6.3%) had active TB
  - 5.4 x of age adjusted AFB (+) prevalence
- CT: Mimic Cancer or Pneumonia
  - Subpleural nodule (6)
  - Lobar or lobular consolidation (3)
  - Location: RLL (4), LLL (3), UL (2)

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