Radiologic Manifestations of Pediatric TB

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Disclosures

No financial disclosures.

Objectives

At the end of this presentation the attendee will be able to:

- Recognize the characteristic imaging findings of tuberculosis in infants and children.
- Differentiate TB from other conditions with similar imaging findings.
- Use advanced imaging to solve special diagnostic challenges.

Primary Tuberculosis

- Any system can be involved
  - Thoracic
  - Central nervous system
  - Abdominal
  - Musculoskeletal
- Multimodality imaging

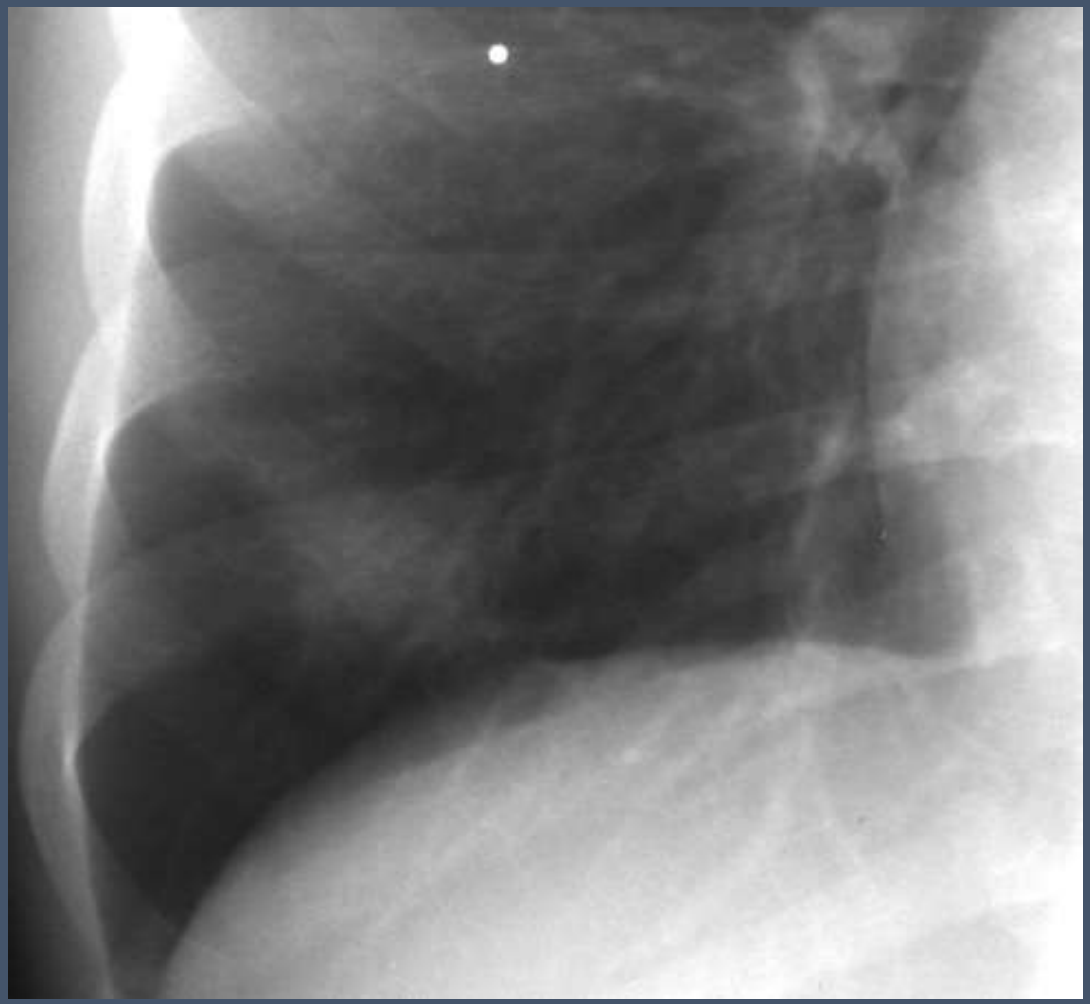
Thoracic Primary Tuberculosis

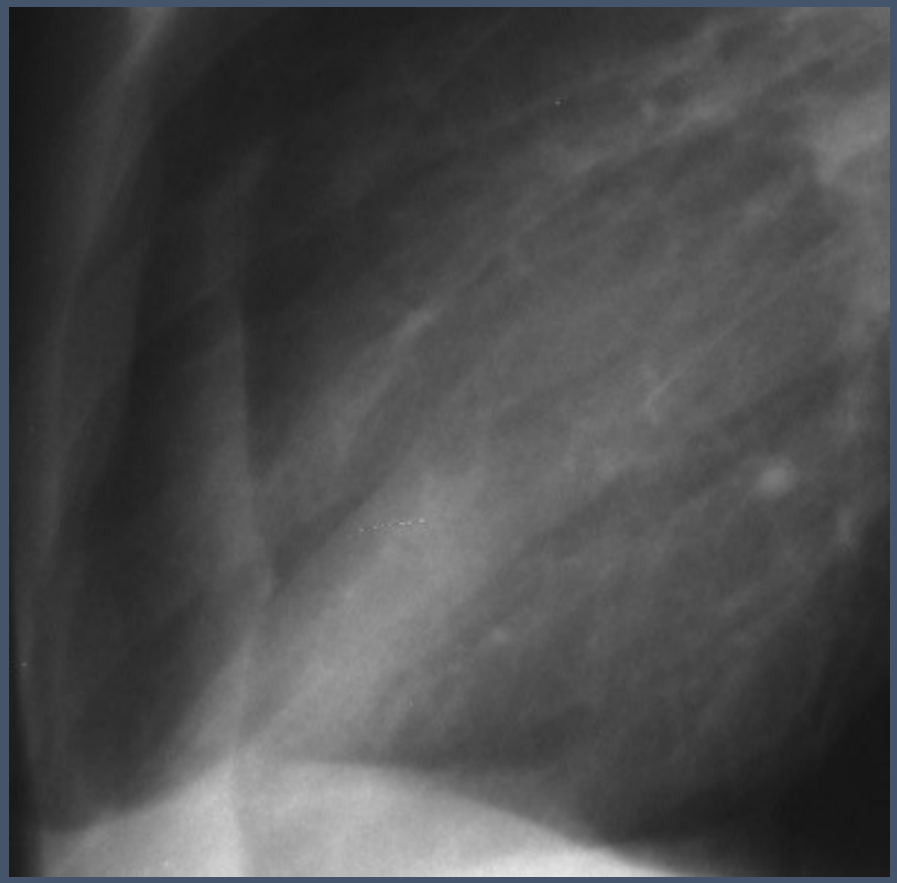
- Imaging findings reflect progression of infection
  - Ghon focus
  - Drainage to regional lymph nodes
  - Intrabronchial spread
  - Penetration of adjacent spaces
  - Hematogenous dissemination

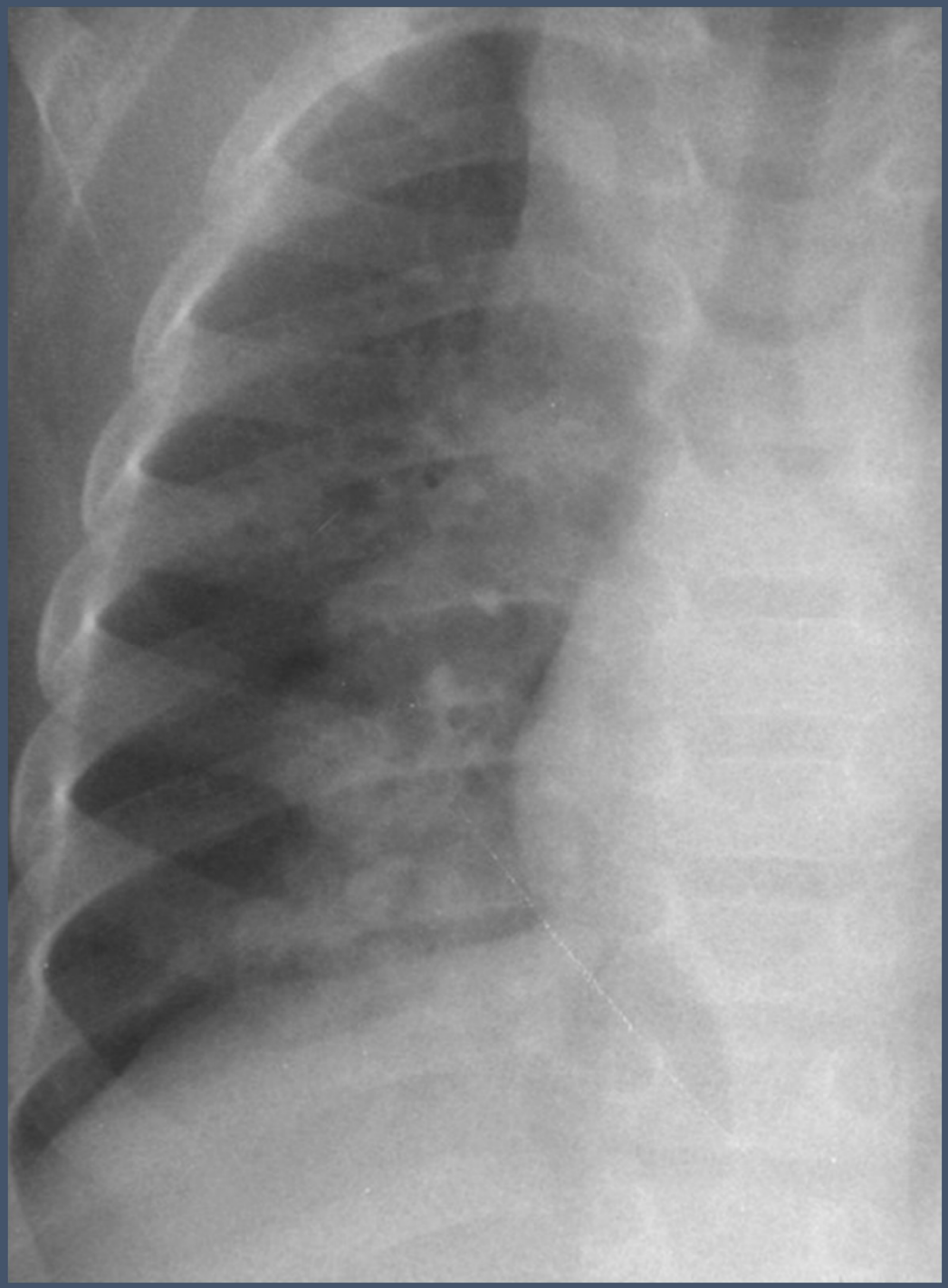
Primary Pulmonary TB

- Radiographs
  - Pulmonary (Ghon) focus
    - Focal airspace opacity
    - Variable in size
    - Often transient, hidden
    - Mild pleural reaction

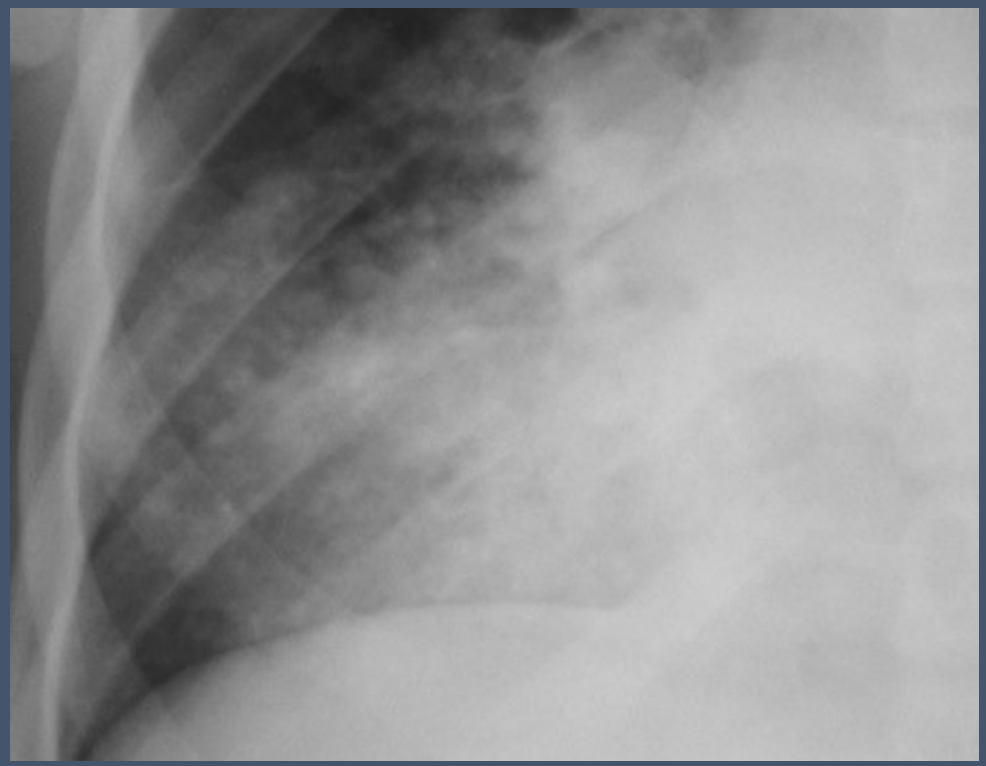
Ghon Focus







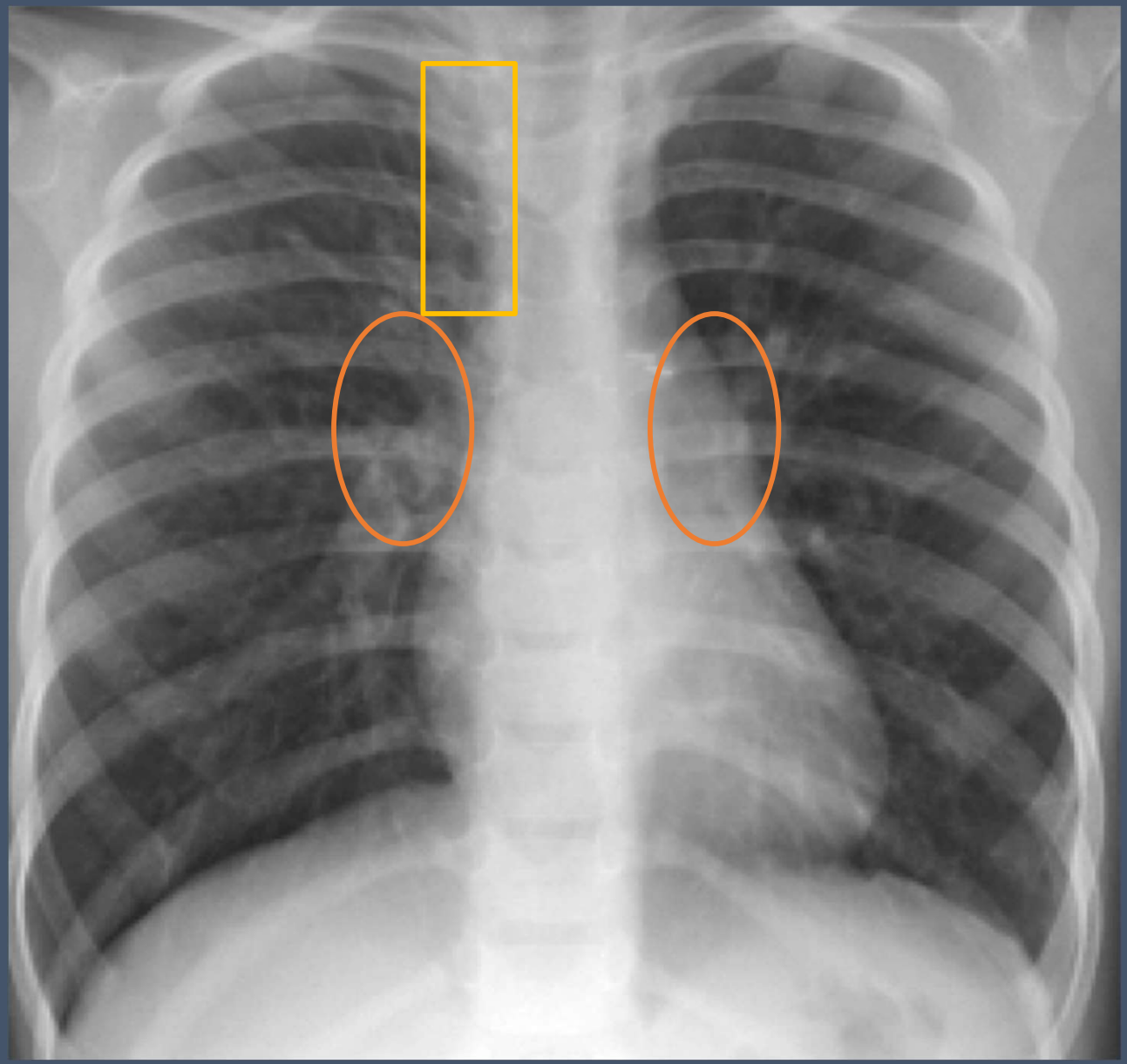
Air space disease with primary TB



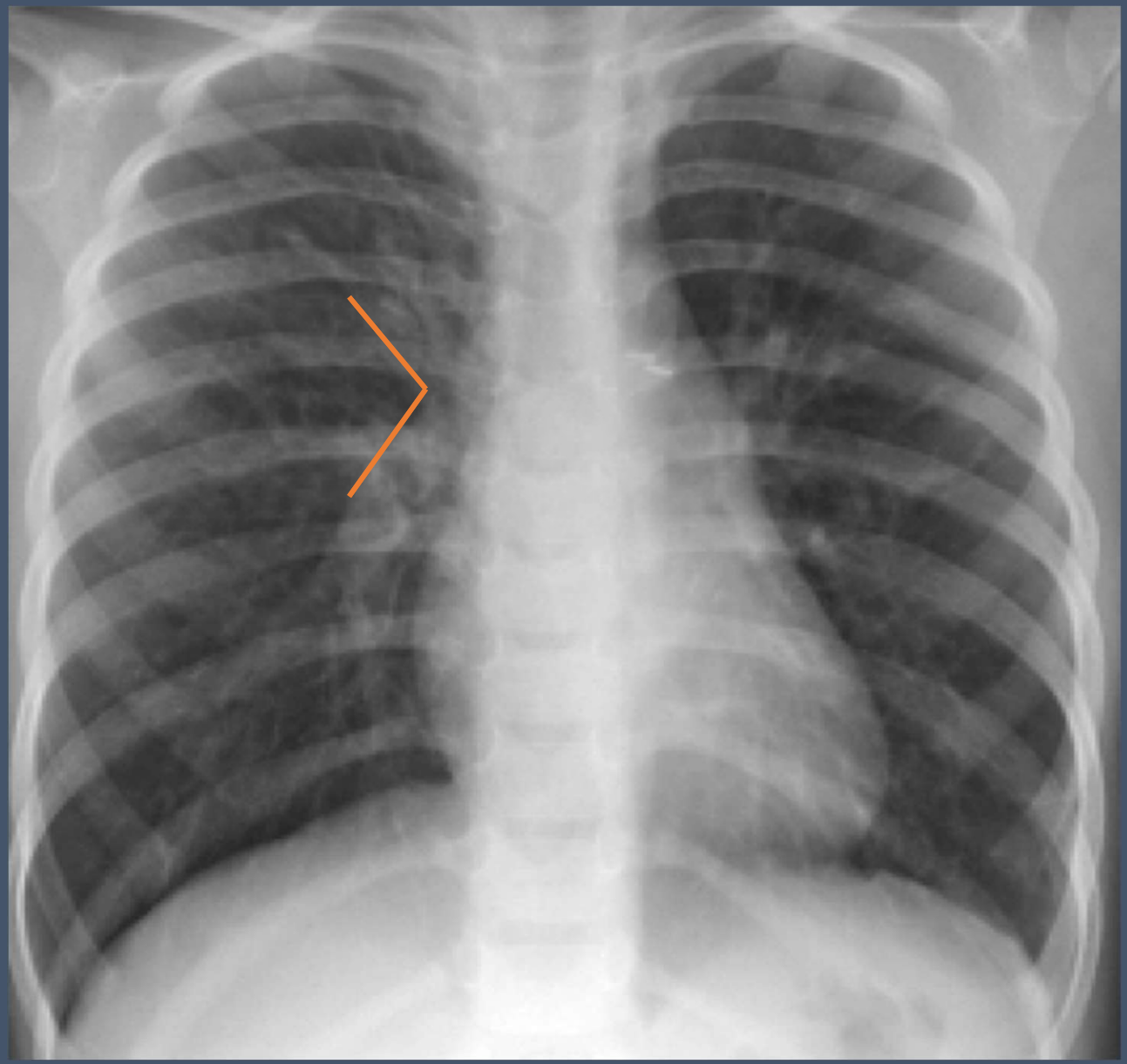
Lymphadenopathy

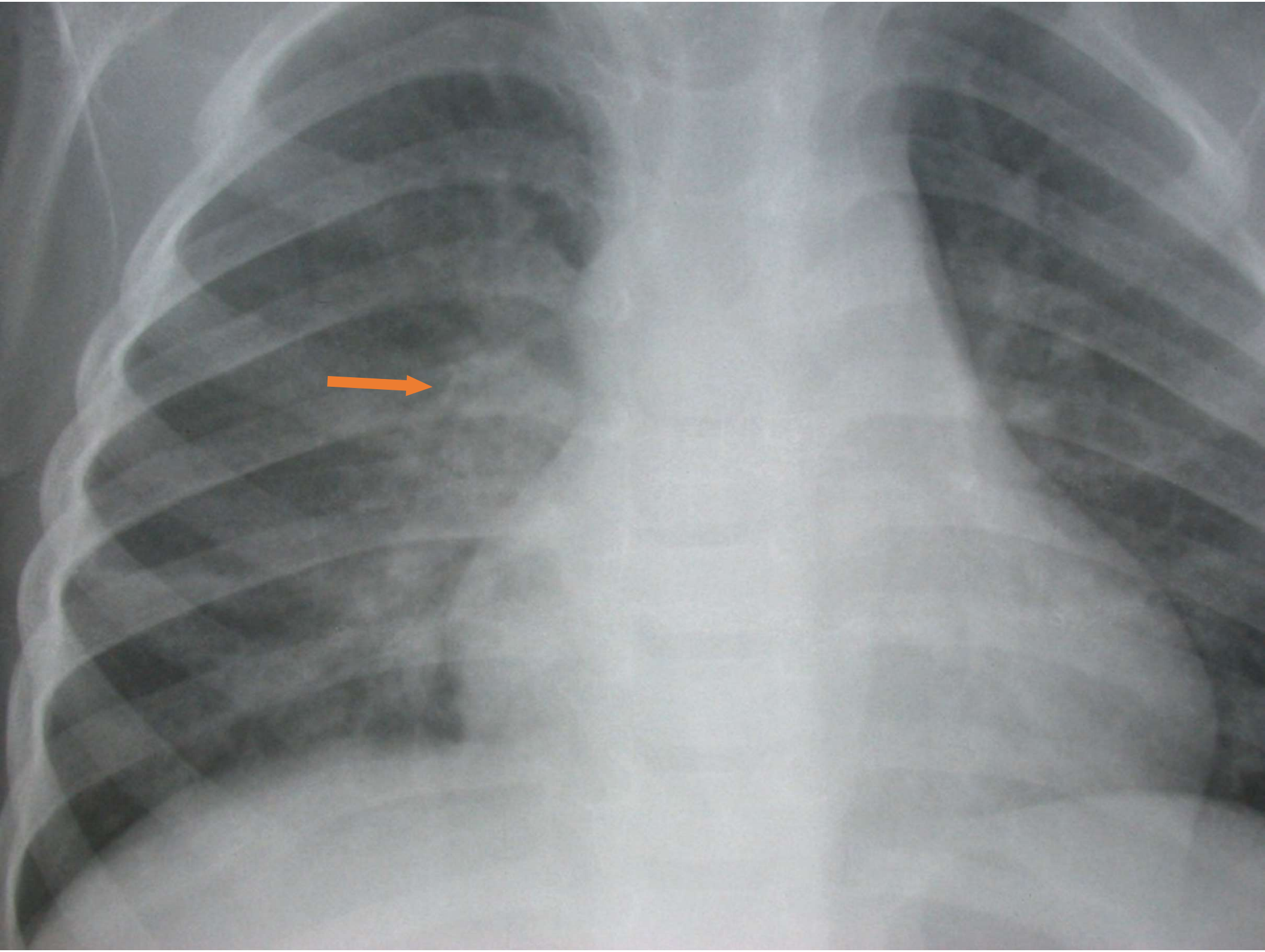
- Hallmark of primary TB on CXR
  - Visible in 50-70% of cases after 1-3 months
  - More common in children <3 yrs of age (50%)
    - 5-14 years of age (9%)
  - Poor interobserver agreement
- Radiographs
  - Difficult to see with confidence
  - PA and lateral views valuable
  - Right hilar, paratracheal most commonly visible

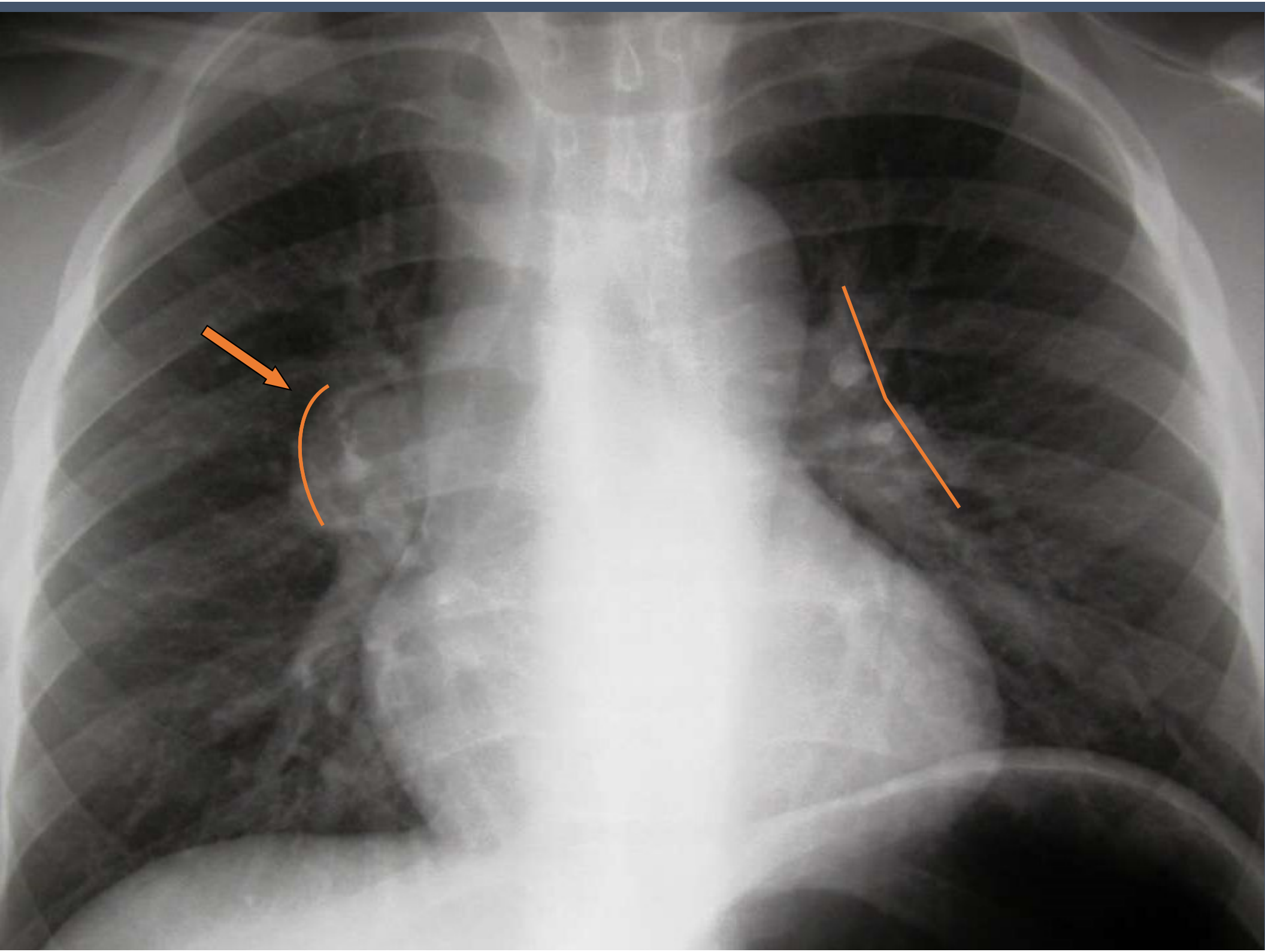
LN Locations on Radiographs

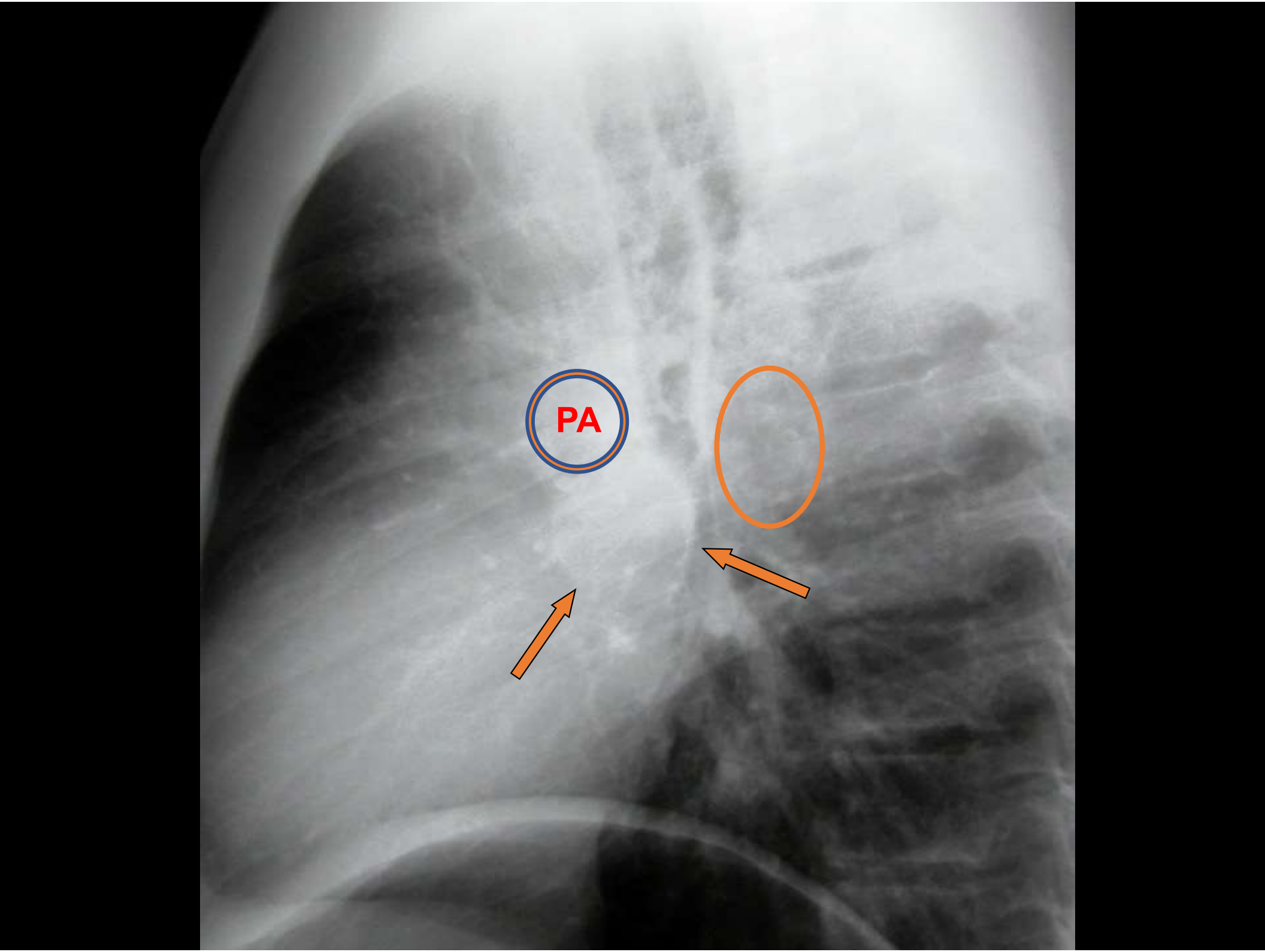


LN Locations on Radiographs

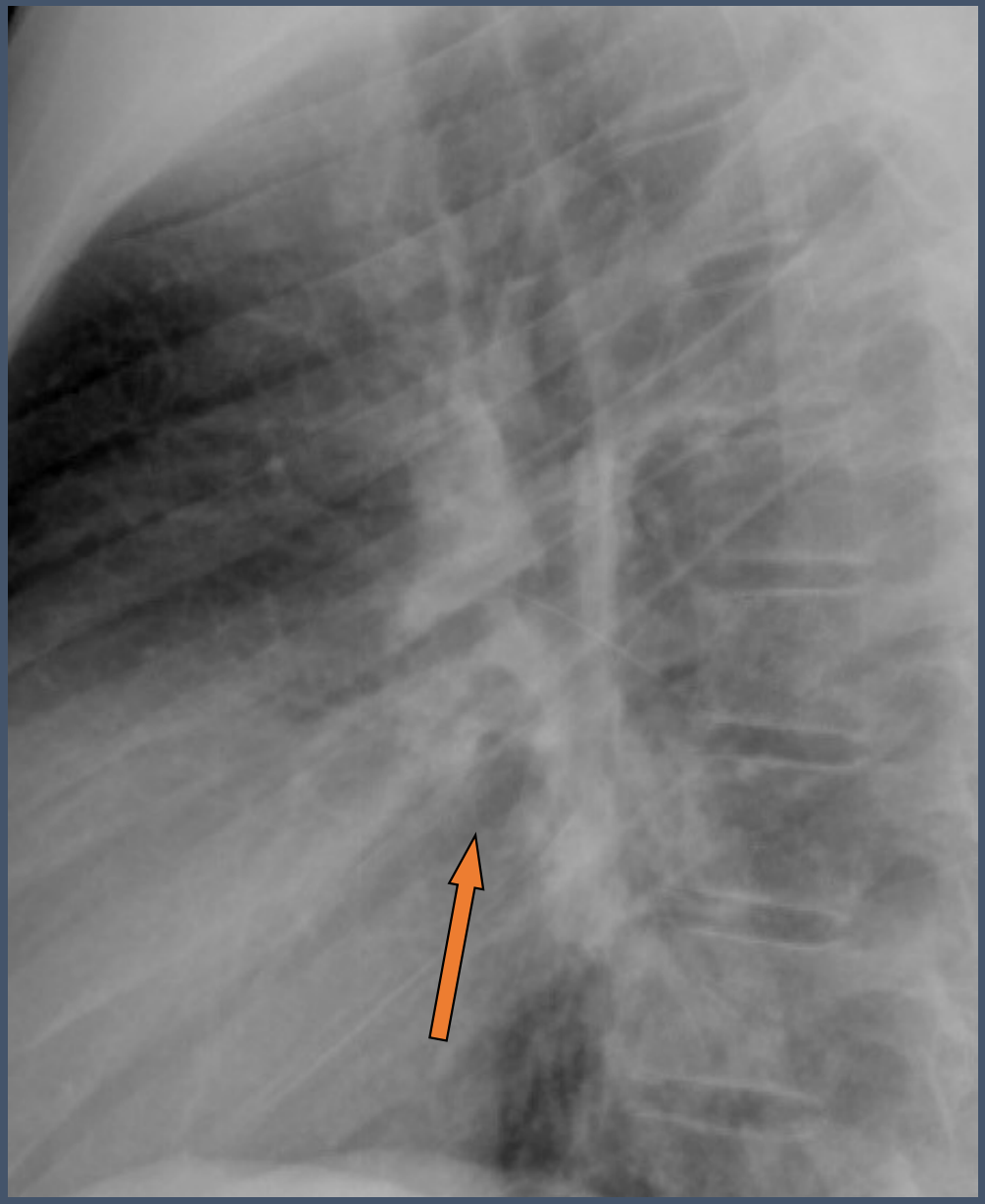




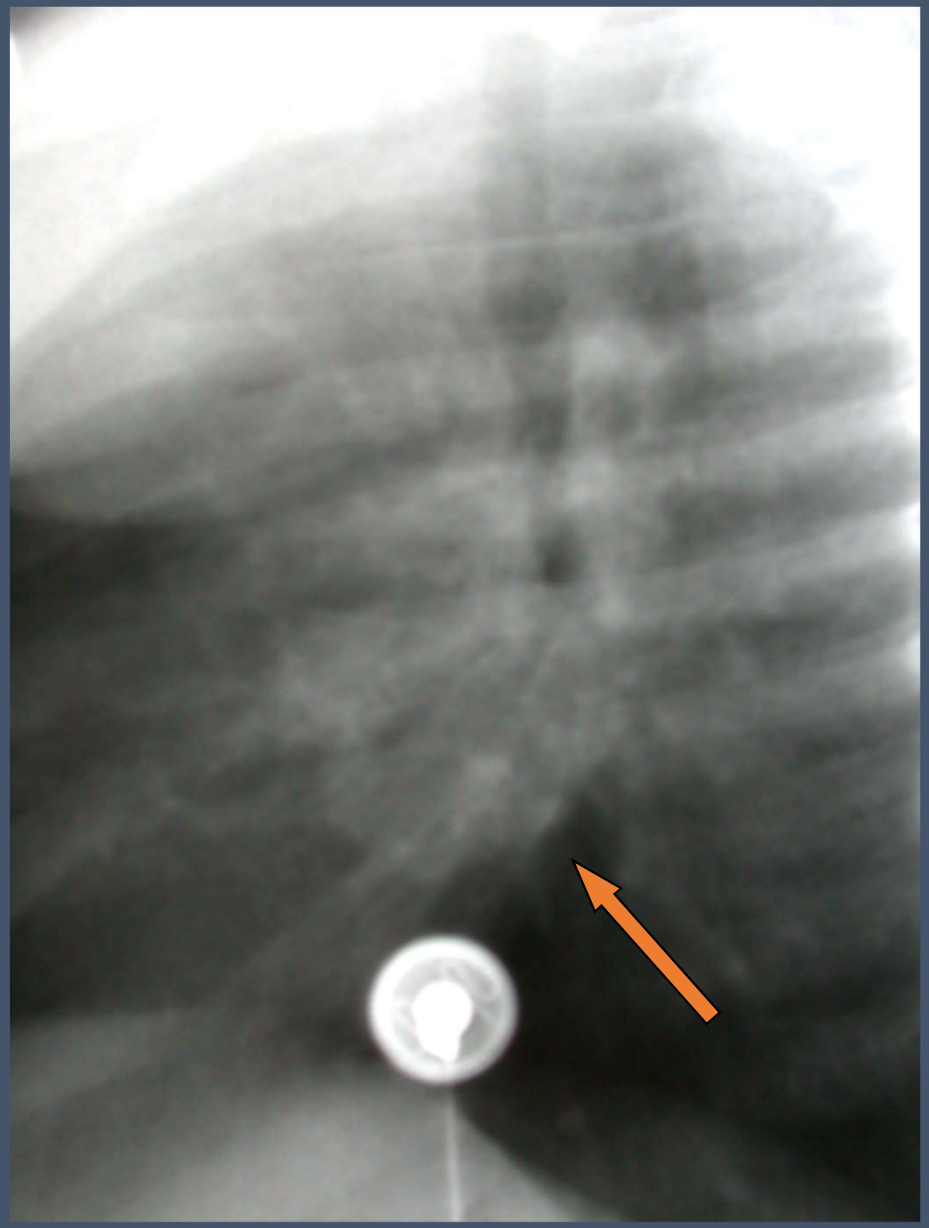



PA

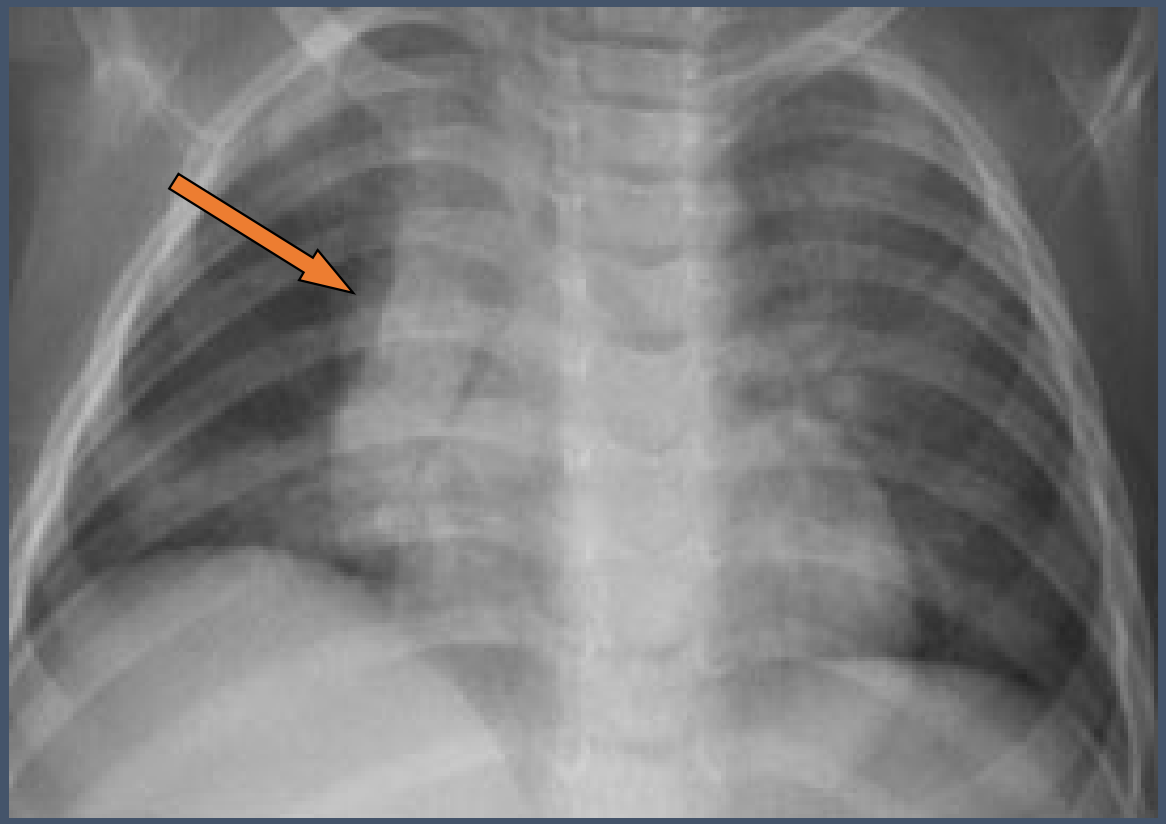
Normal

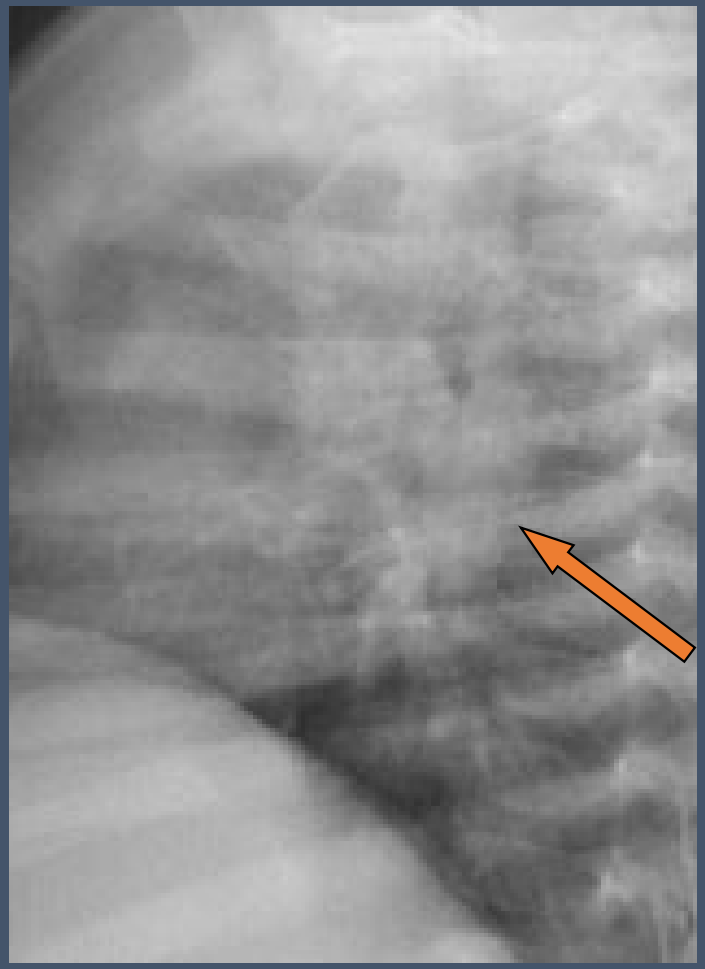


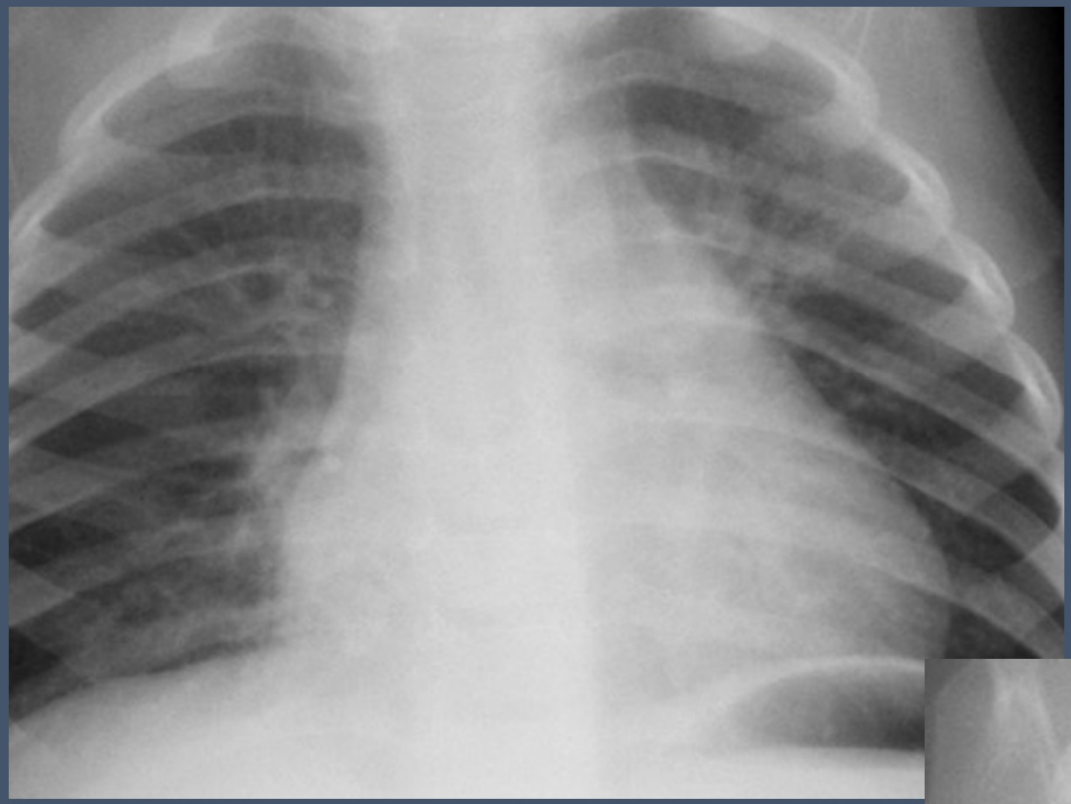
Lymphadenopathy

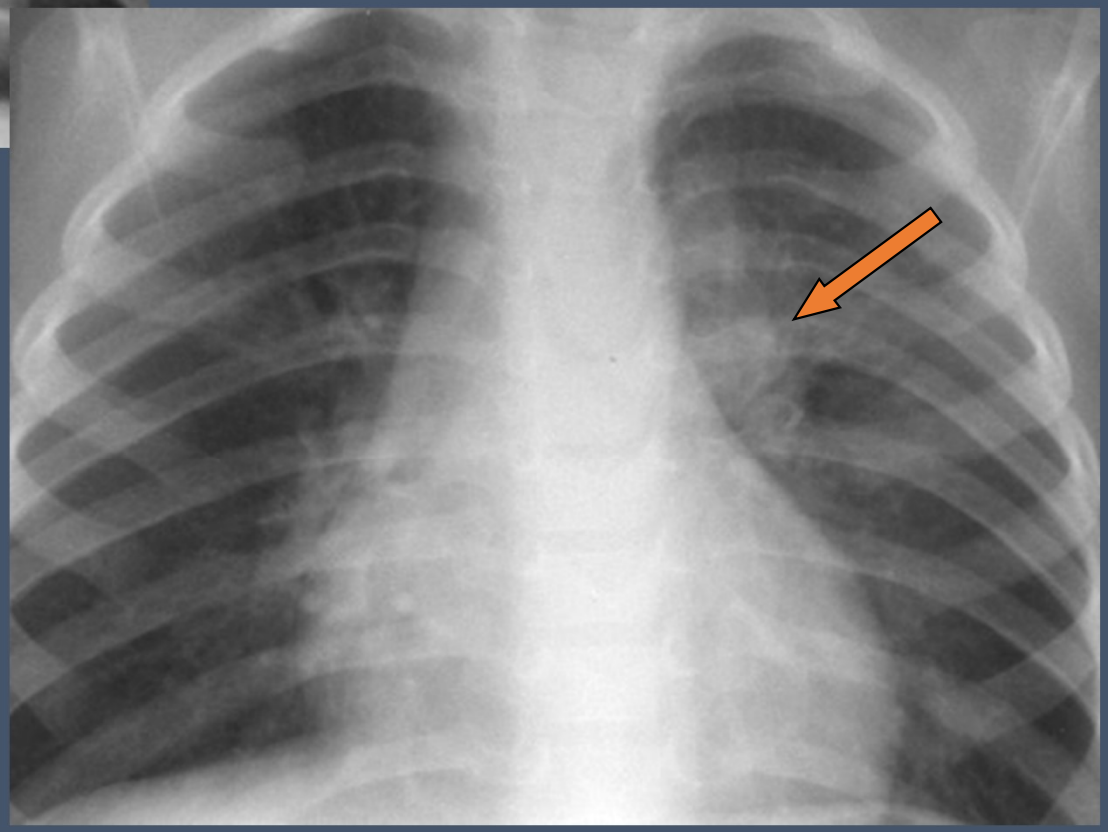


Right Hilar Lymphadenopathy



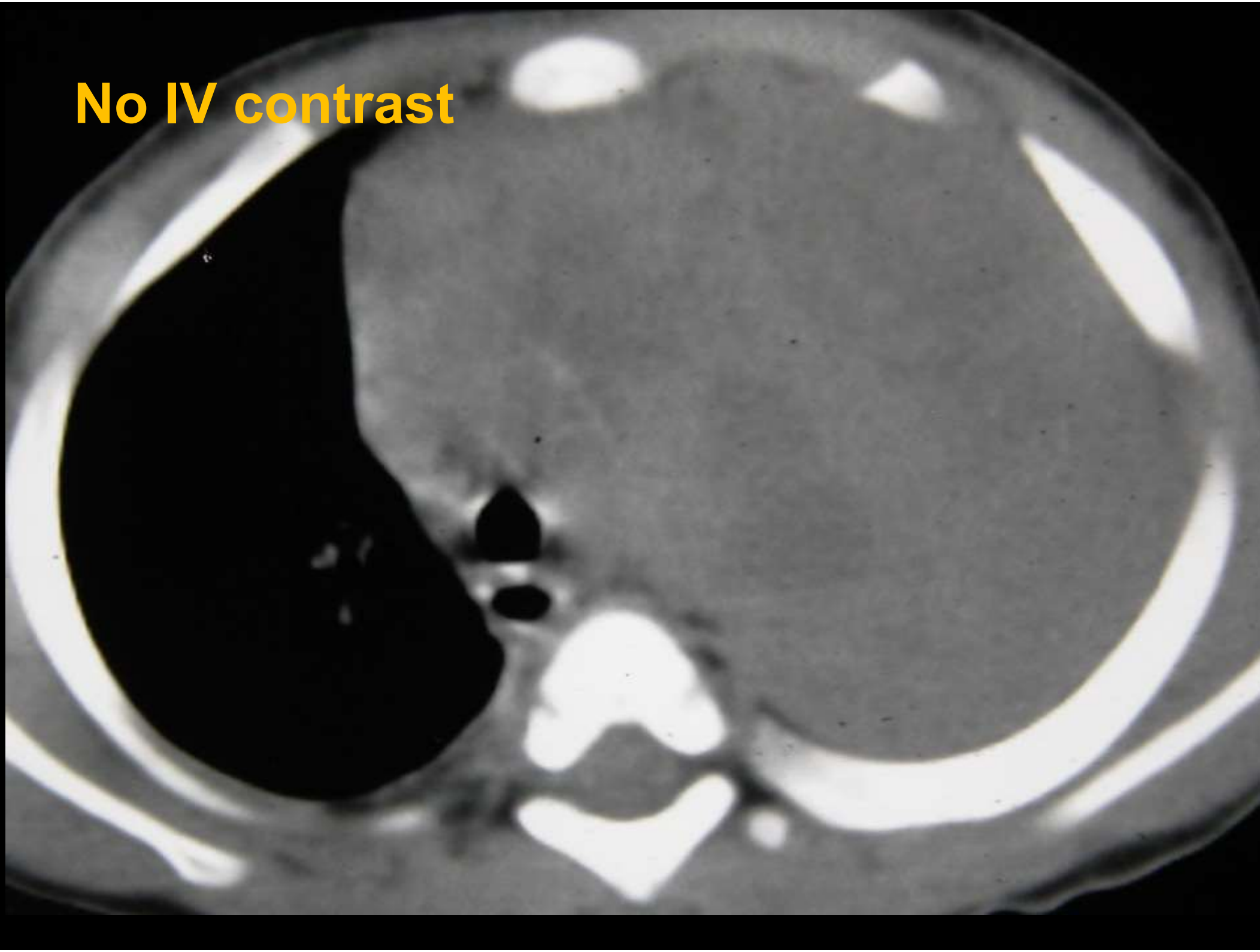






Lymphadenopathy

- CT improves detection
  - Up to 60% with normal CXR have LNs on CT
    - (Delacourt, 1993, Arch Dis Child 69:430.)
- Indicated for:
    - Equivocal or occult disease on XR
    - High risk groups
- CT technique
  - Use IV contrast
  - High resolution protocols for lung disease
    - Not suitable for young children


No IV contrast

MRI for Lymphadenopathy

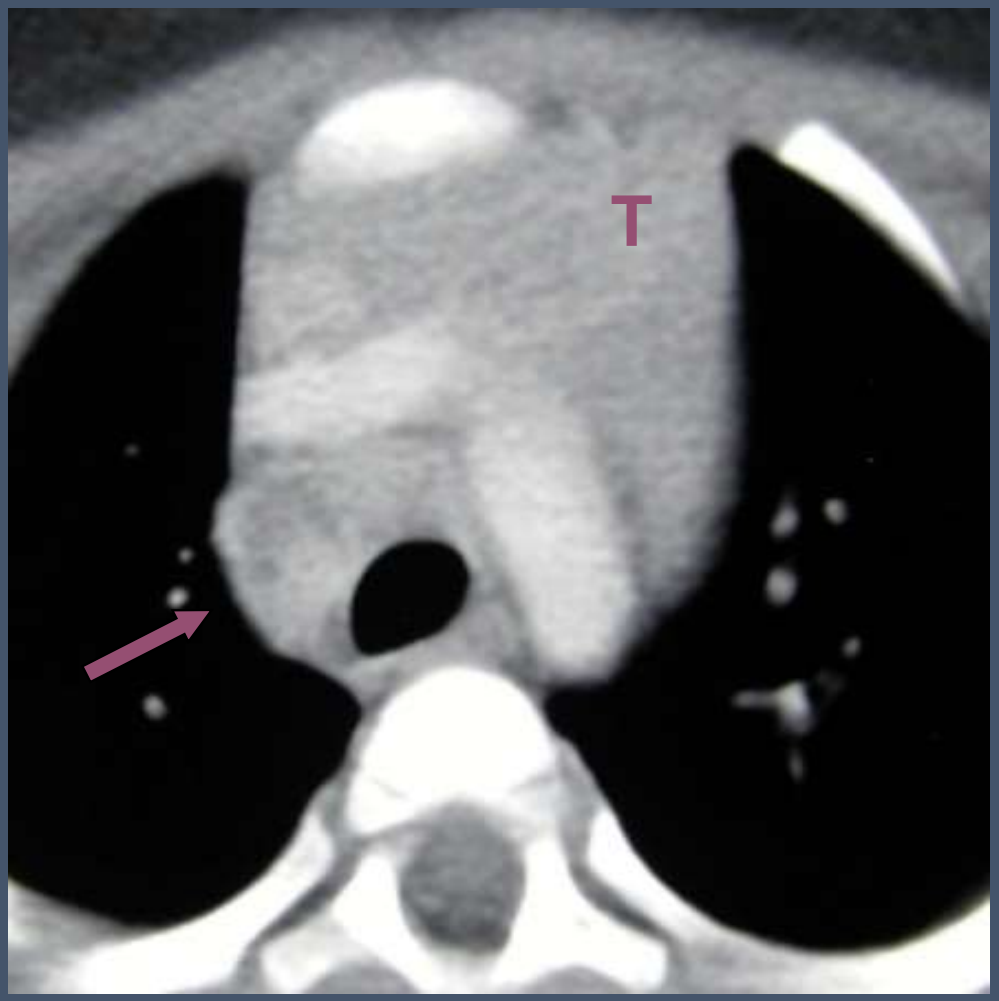
- Benefits
  - Highly effective for:
    - Mediastinal lymph nodes > 7 mm
    - Consolidation
    - Pulmonary nodules > 3 mm
    - Pleural effusions
- Detractors
  - Expensive
  - Need for sedation/anesthesia
  - Poor visibility of lung disease

Lymphadenopathy

- **Sites on CT**
  - **Subcarinal (90%)**
  - **Hilar (Bilateral 72%)**
  - **Anterior mediastinum**
  - **Precarinal**
  - **Right paratracheal**
  - **Multiple sites (96%)**

(Andronikou, Pediatr Radiol (2004) 34:232)

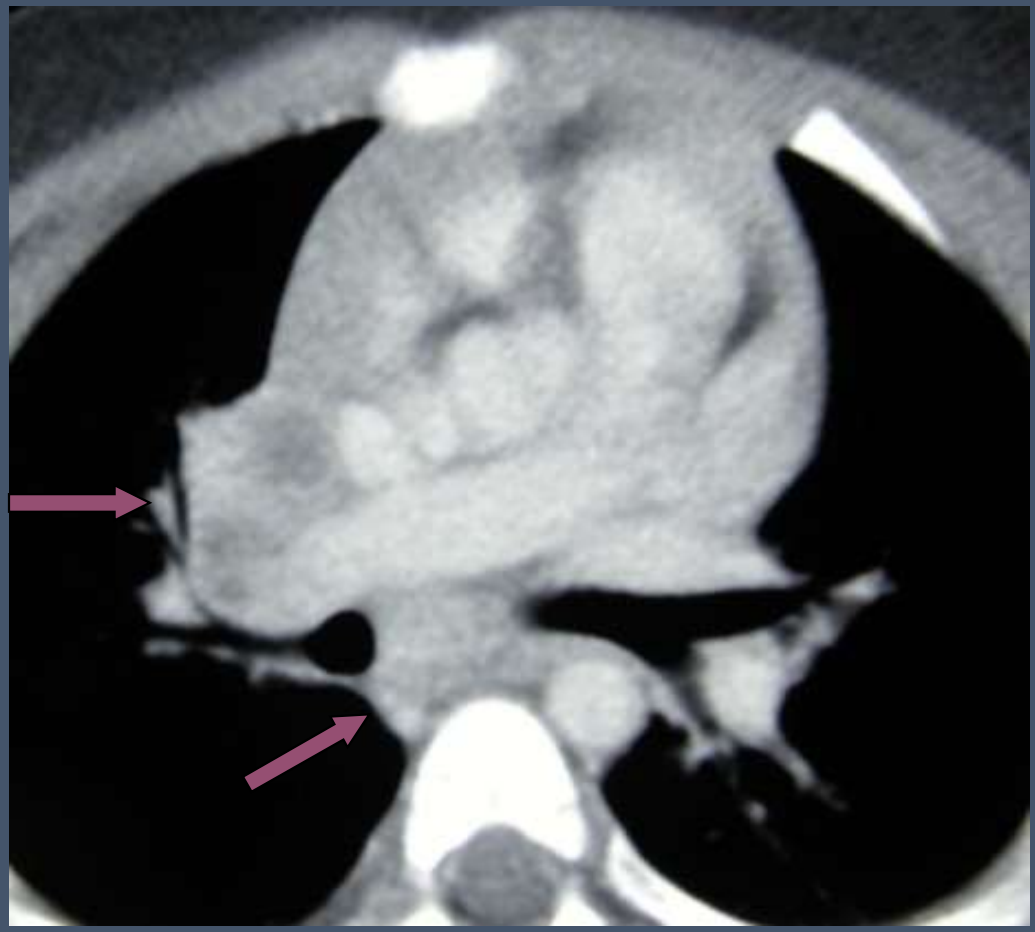
Lymphadenopathy on CT



Paratracheal

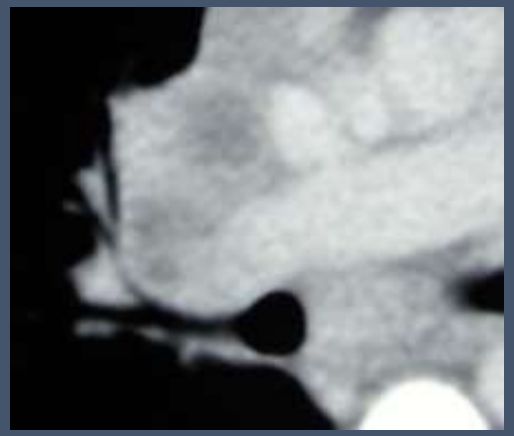
Hilar

Subcarinal



Lymphadenopathy in PTB

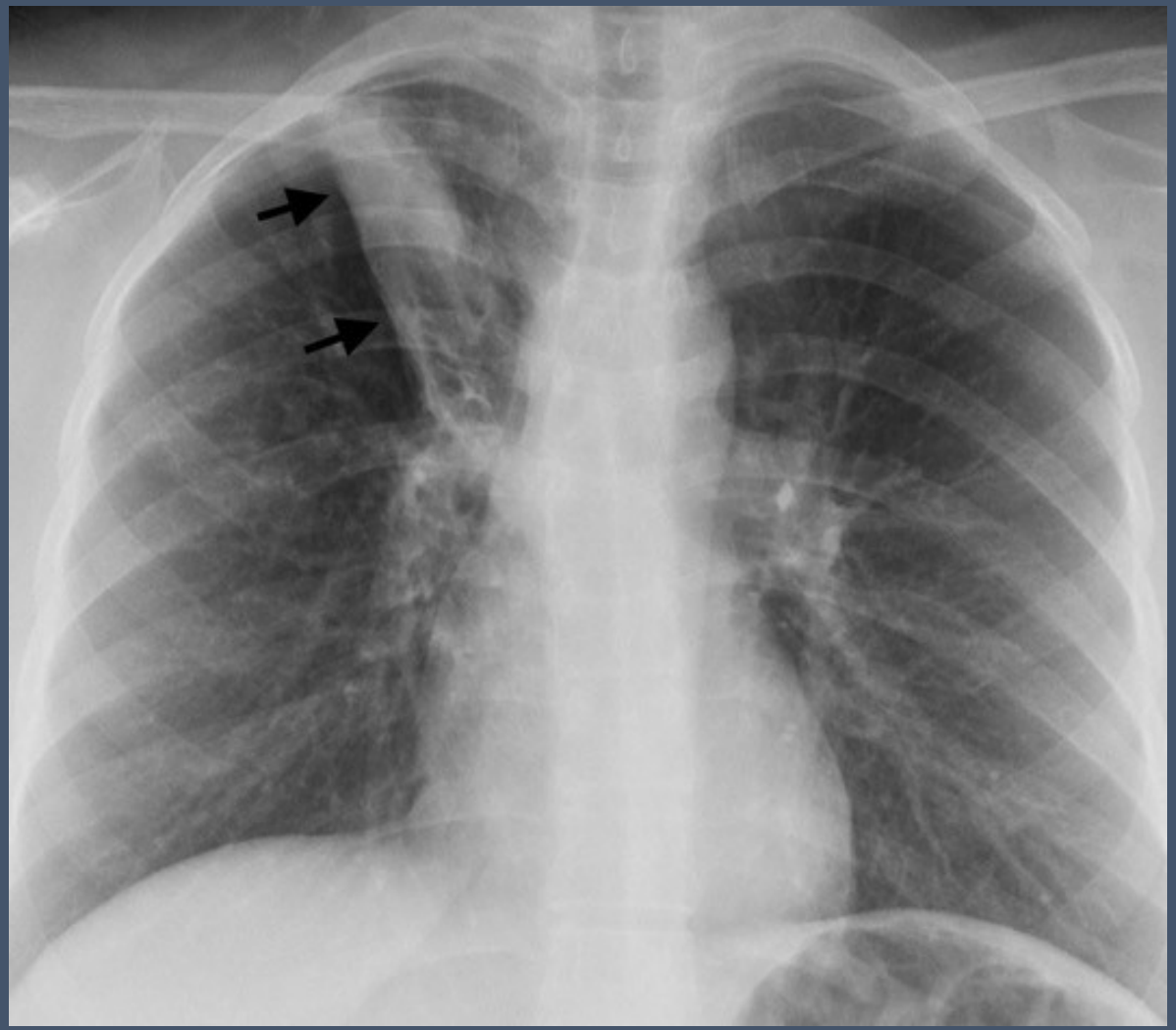
- Size criteria
  - Generally use 1 cm or greater
    - Not well-established
  - May continue to enlarge for 4-12 months after exposure
- Appearance
  - Low-density center with enhancing rim
    - Characteristic, not pathognomonic
  - Calcifications

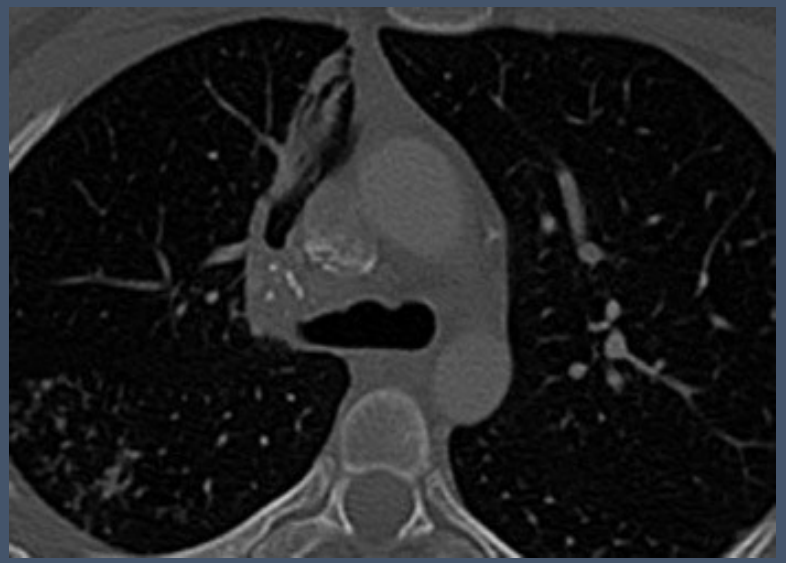


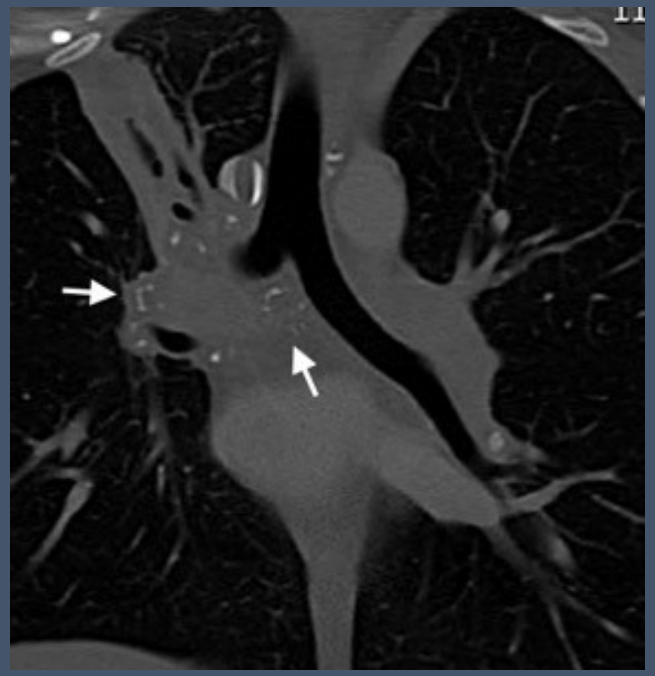
Lymph Node Calcifications

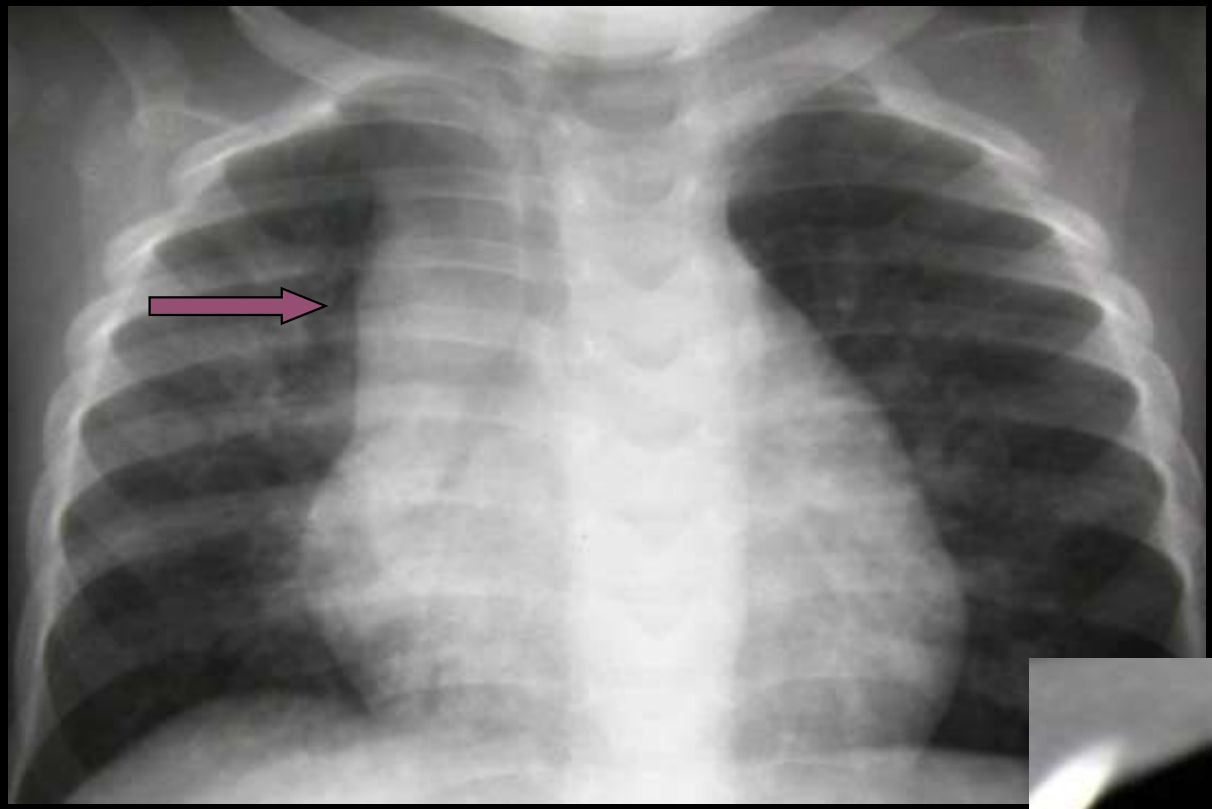
- Calcifications (15-20% on CT)
  - Occurs in areas of caseation
  - 6 mons – 4 yrs after infection
    - Not seen in young infants
  - Occurs earlier in young children

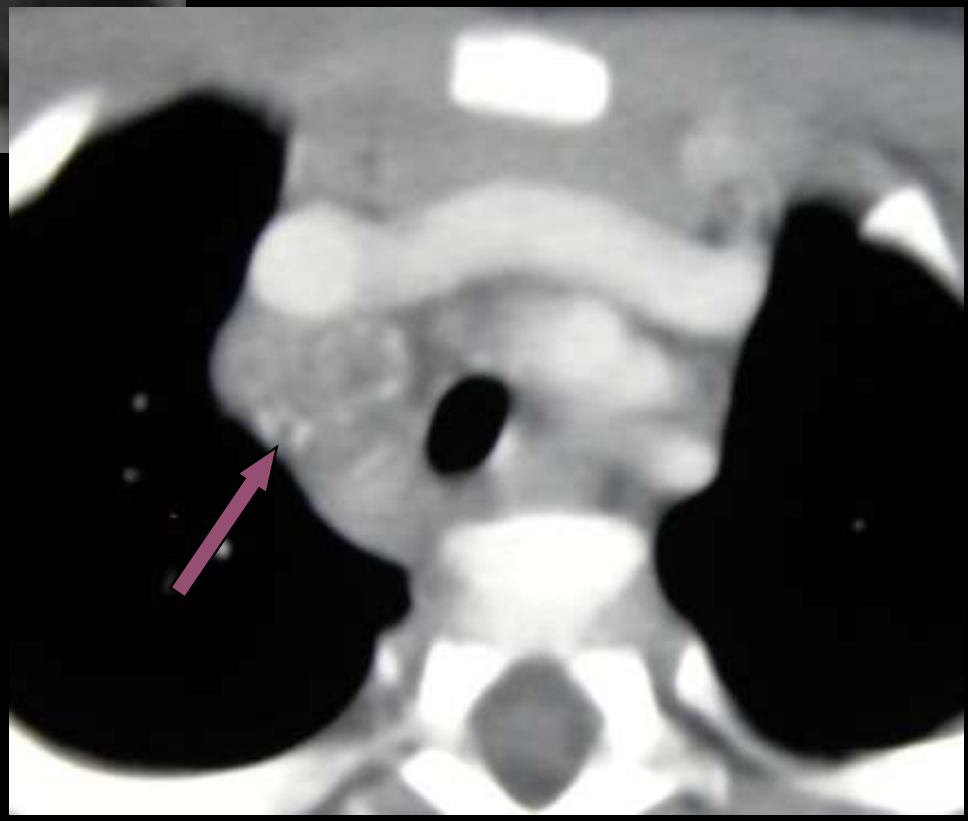
TB with calcified lymph nodes





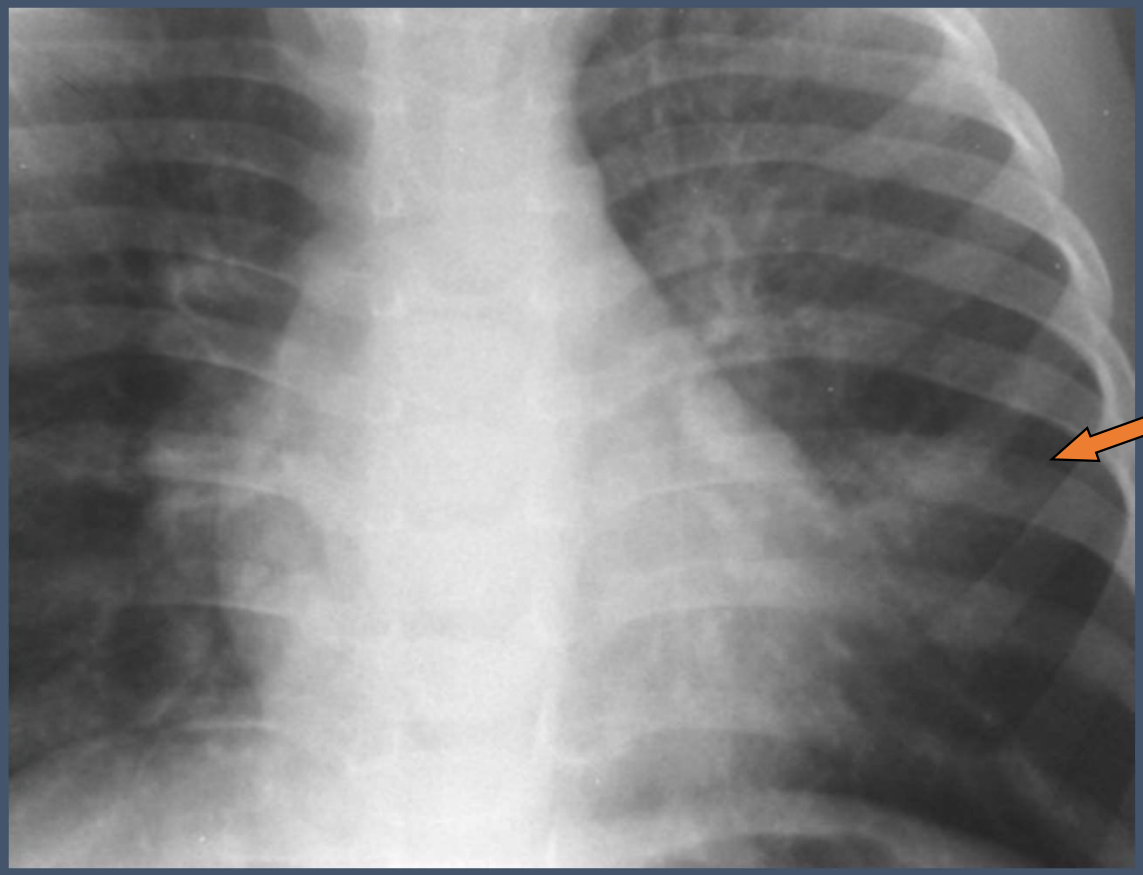


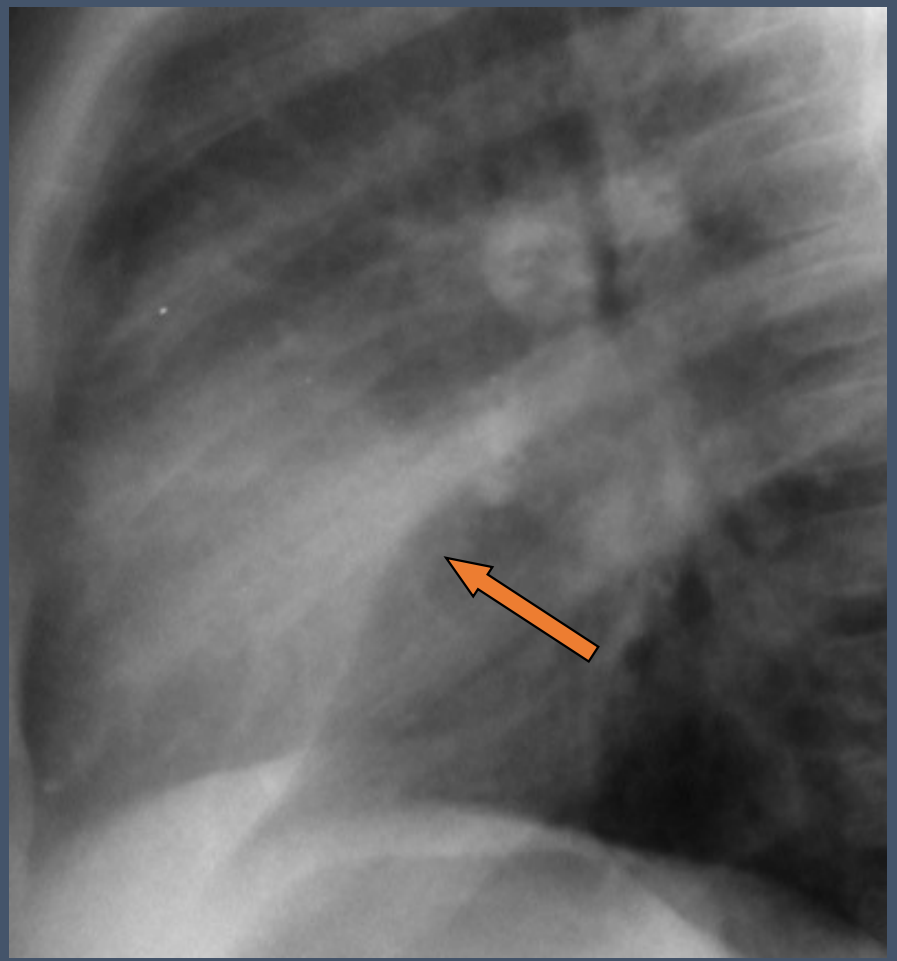




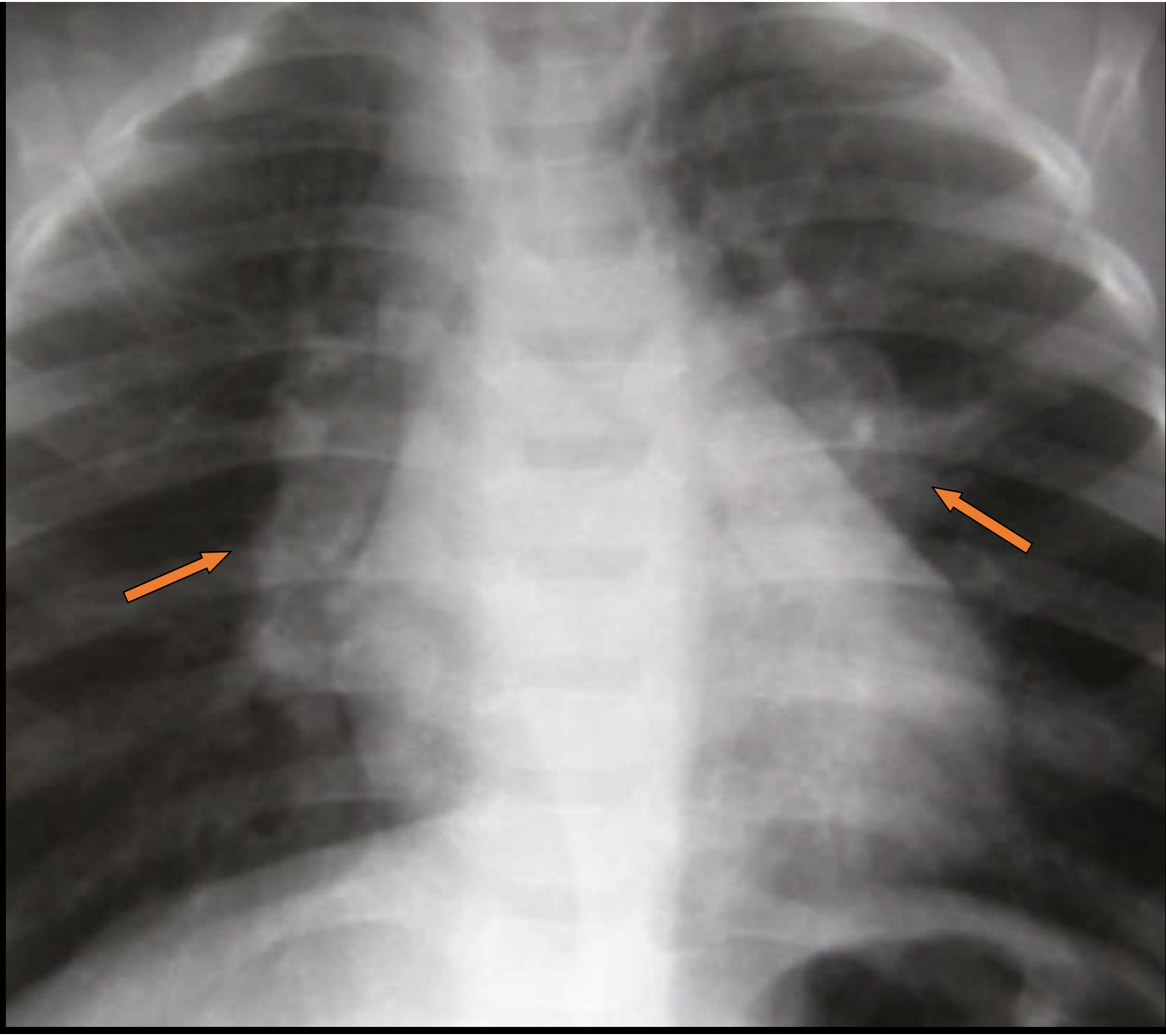
Lymphadenopathy in PTB-Complications

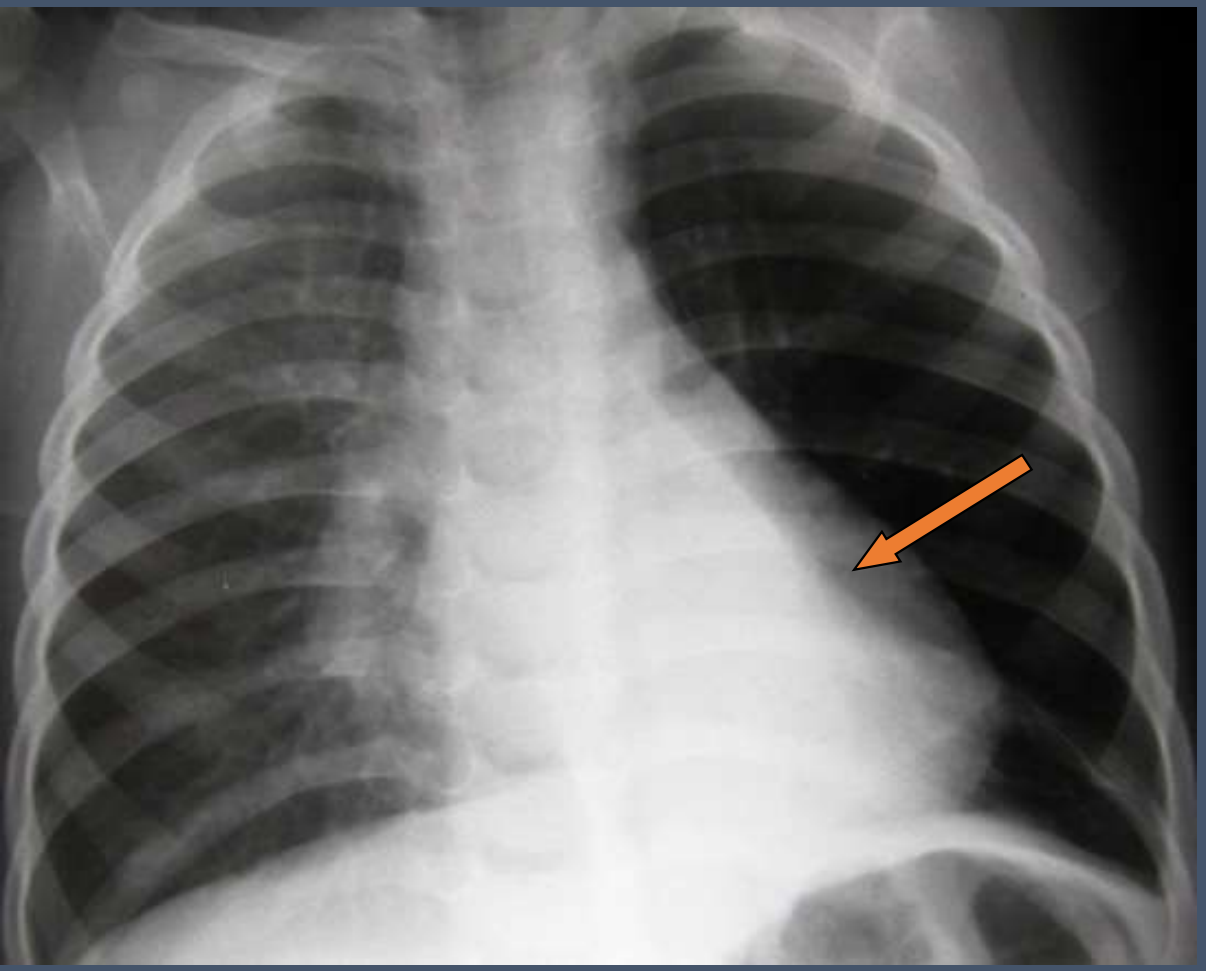
- Airway compromise
  - Extrinsic compression
    - Obstructive emphysema
    - Atelectasis
    - Left > Right
  - Bronchial wall granulomas
  - Intrabronchial caseous material



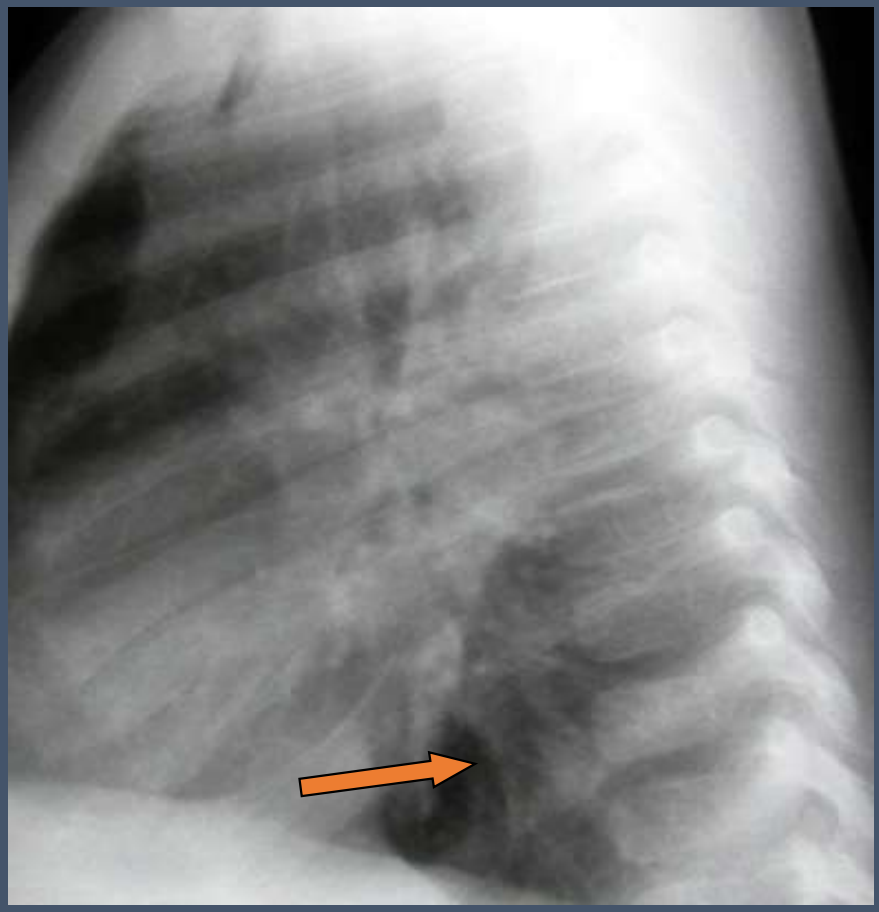


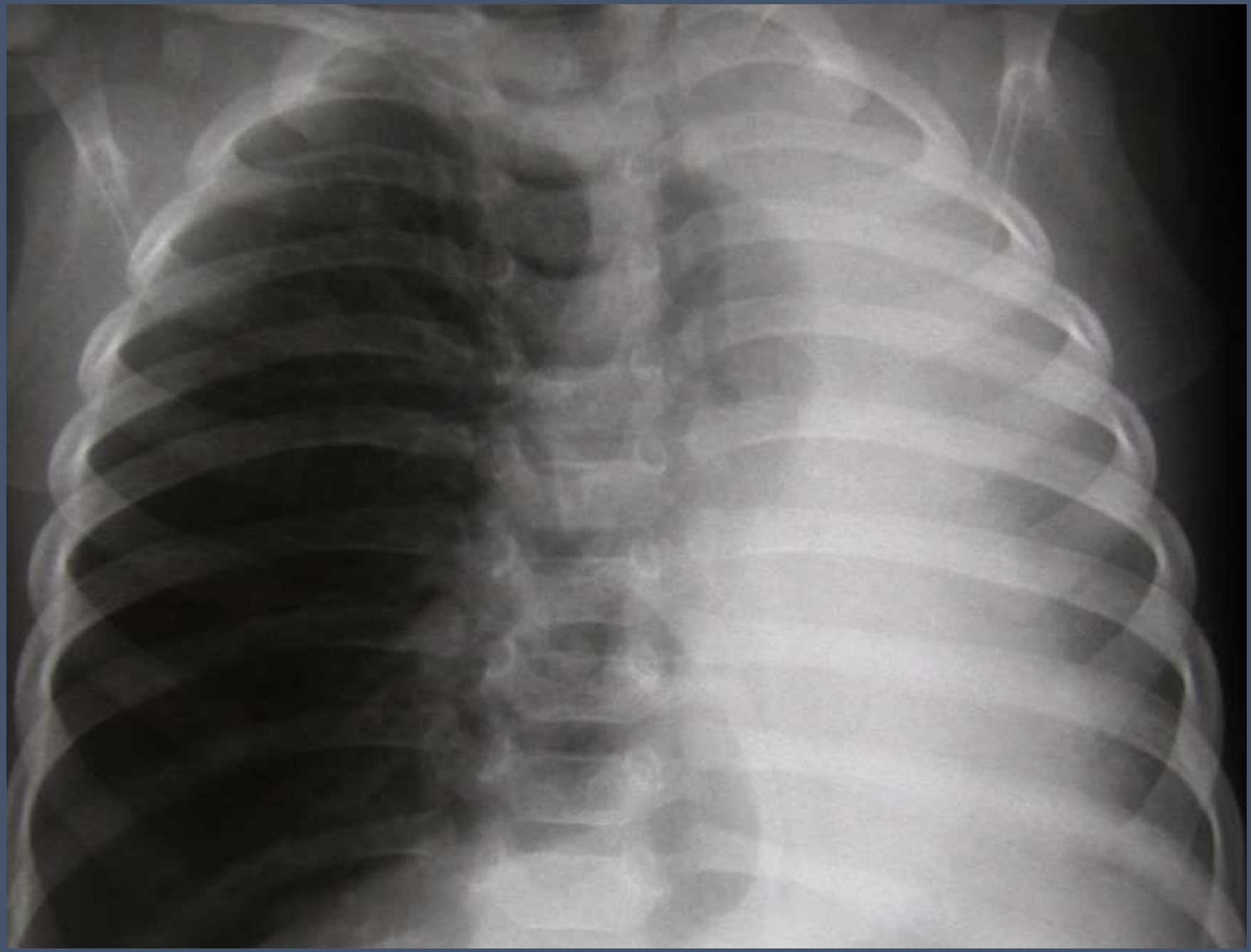
Atelectasis



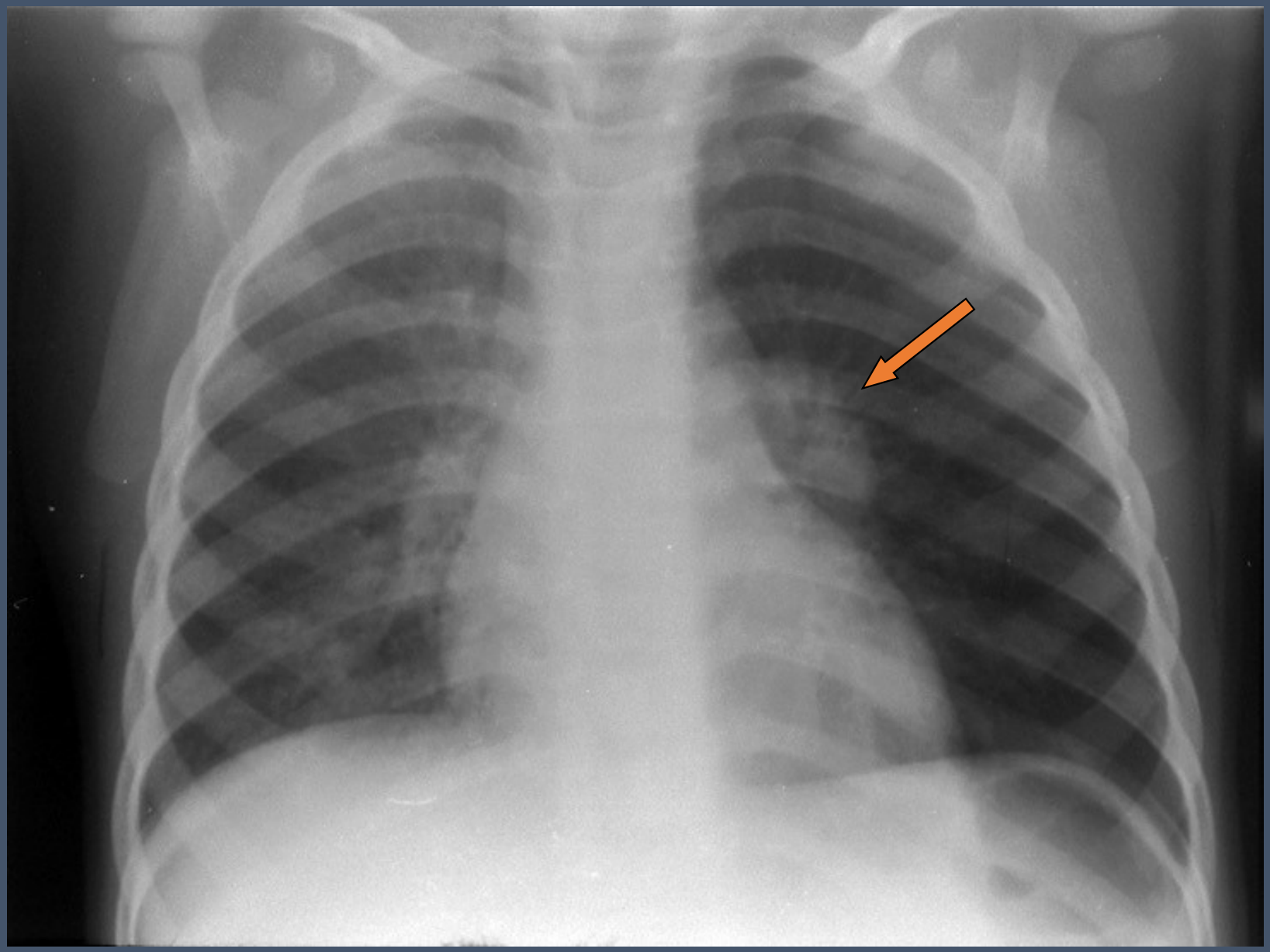


1 month later



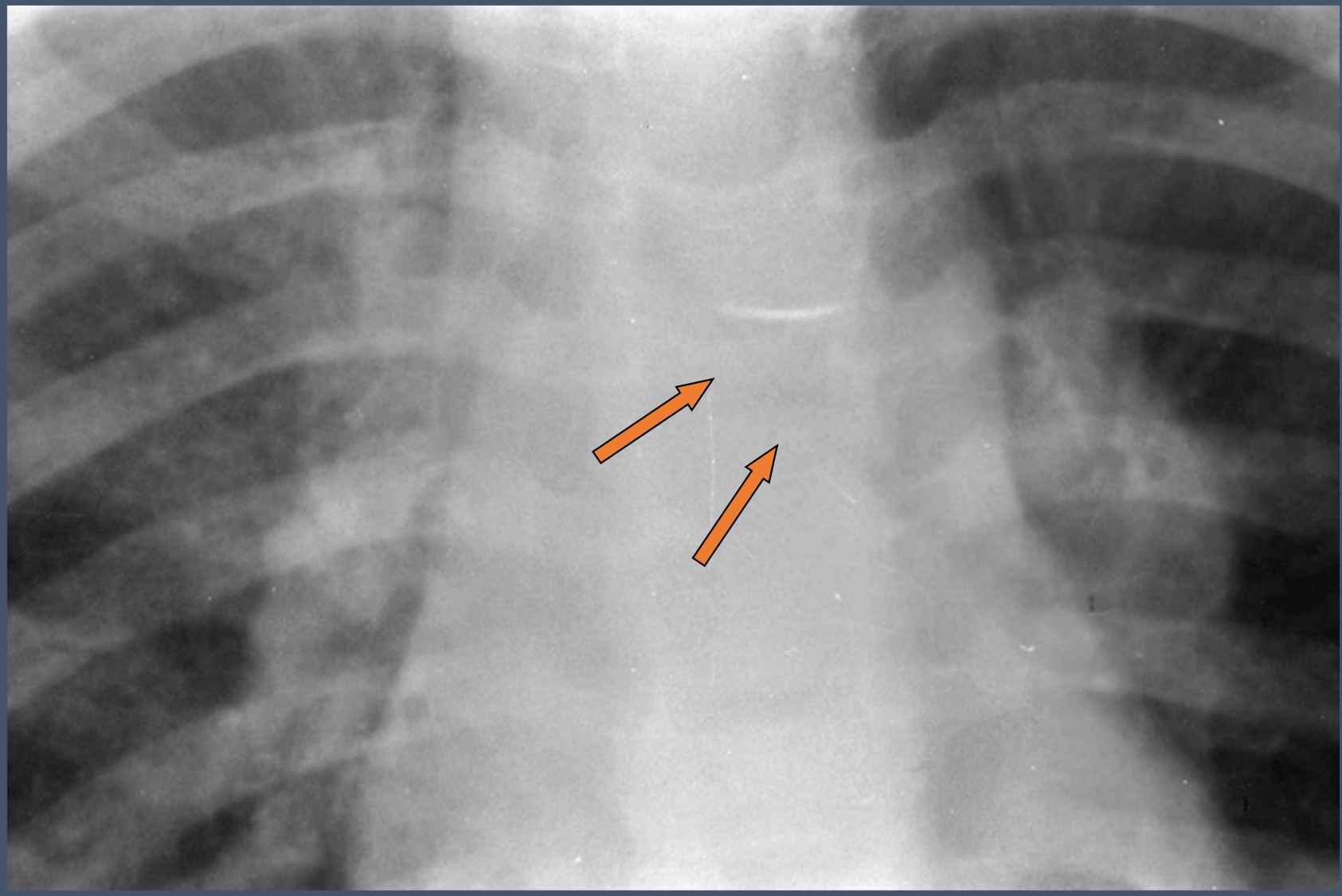


7 days later



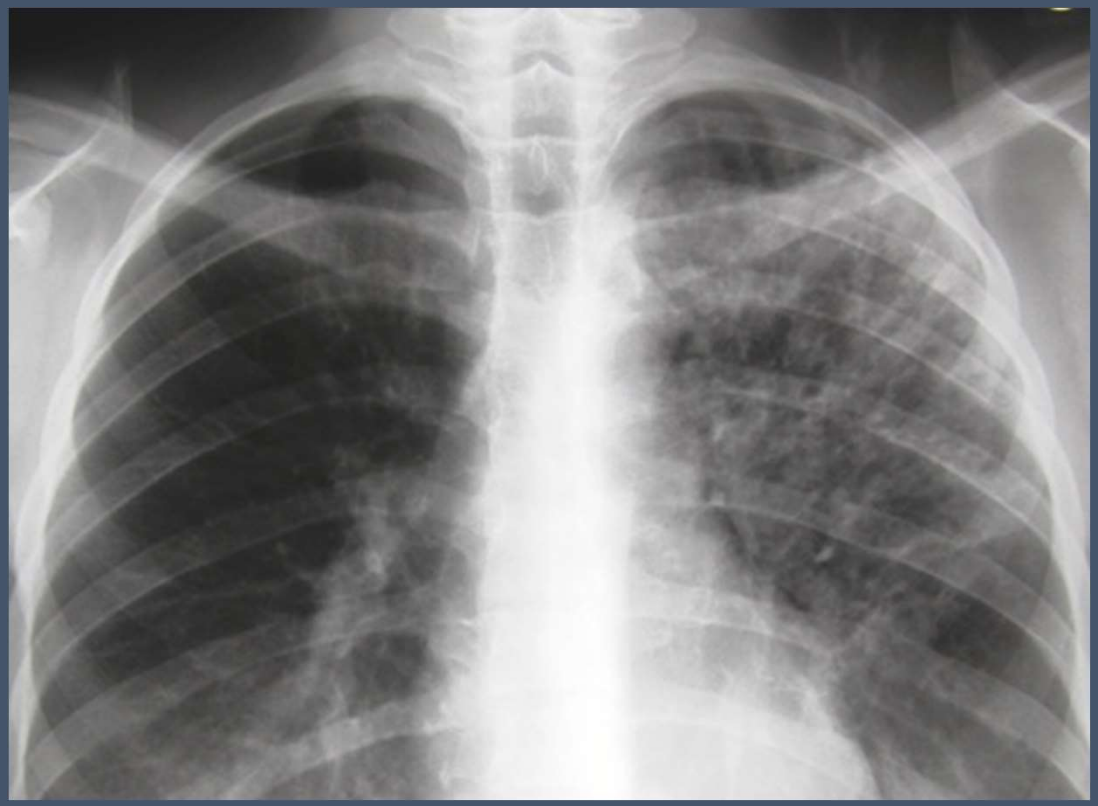
Obstructive Emphysema in TB

- Airway compression more common in young children
- Strong association with TB
  - Poor interobserver agreement on XR



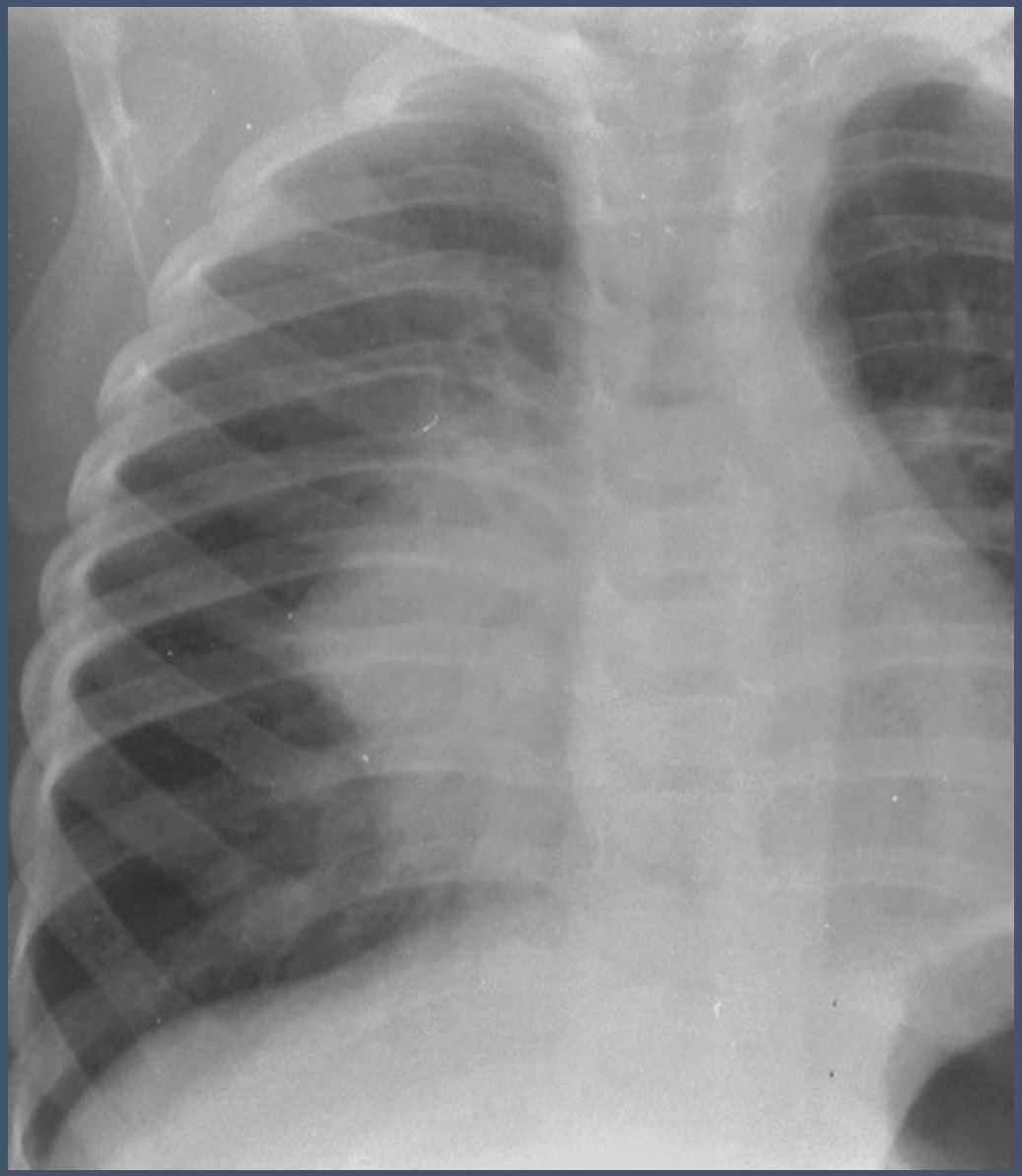
Richter-Joubert et.al, Pediatr Radiol (2017) 47:1283-1291.

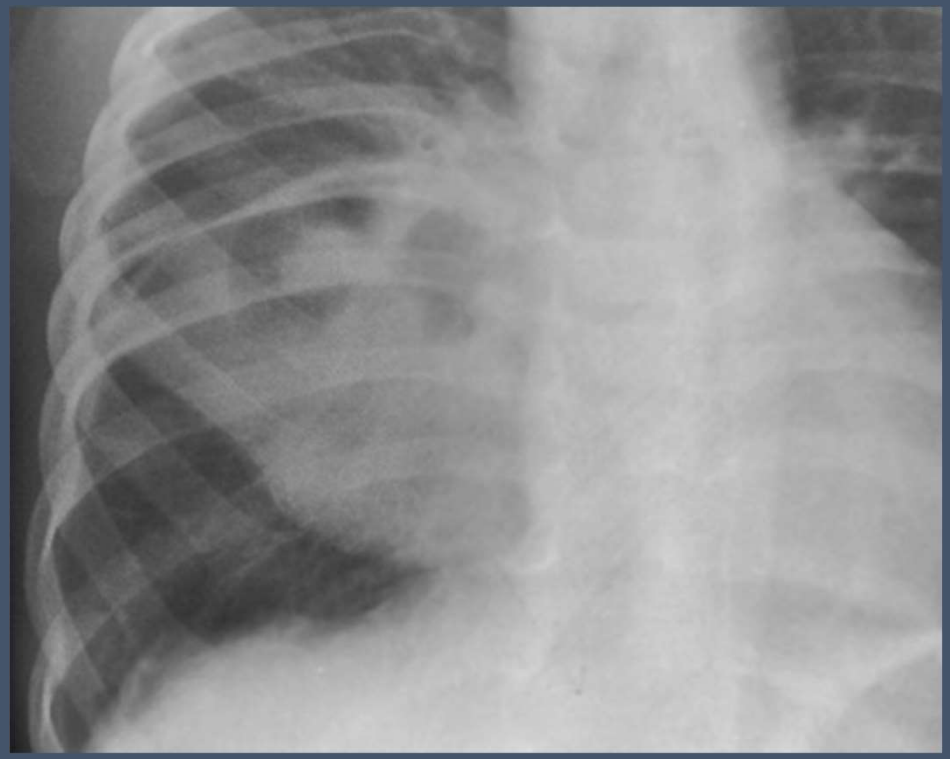
Post-primary TB

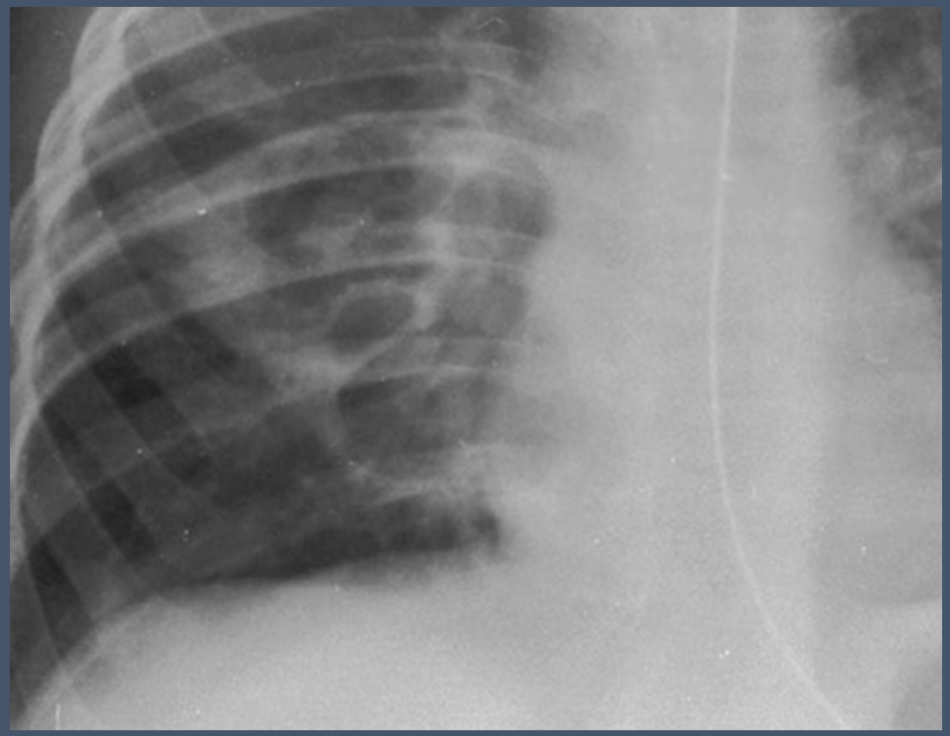


- Mainly in adolescents
- Opacity in apical lung segments
  - Apical and posterior – Upper
  - Apical – Lower
- May lead to cavities and fibrosis

Post primary TB – 13 year old

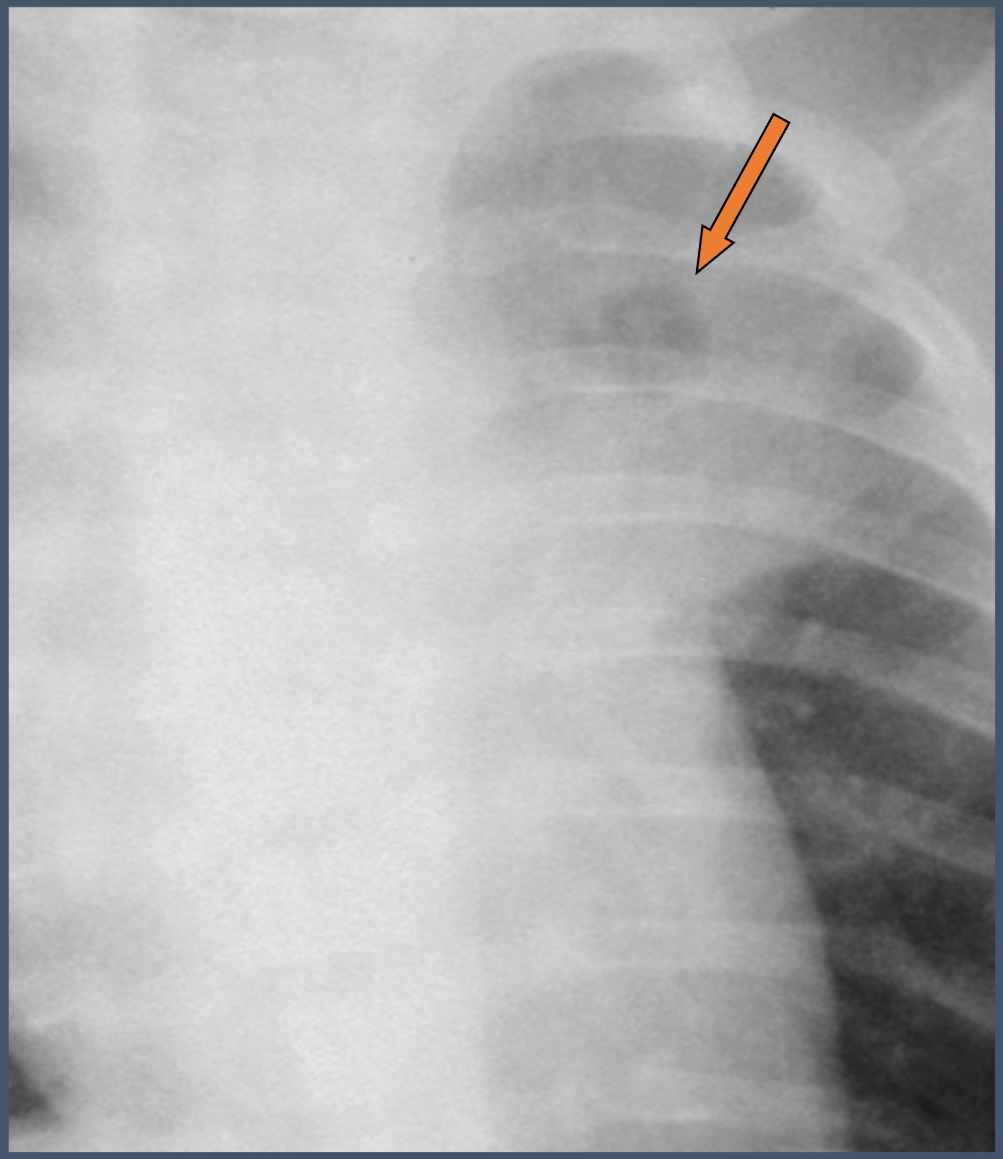


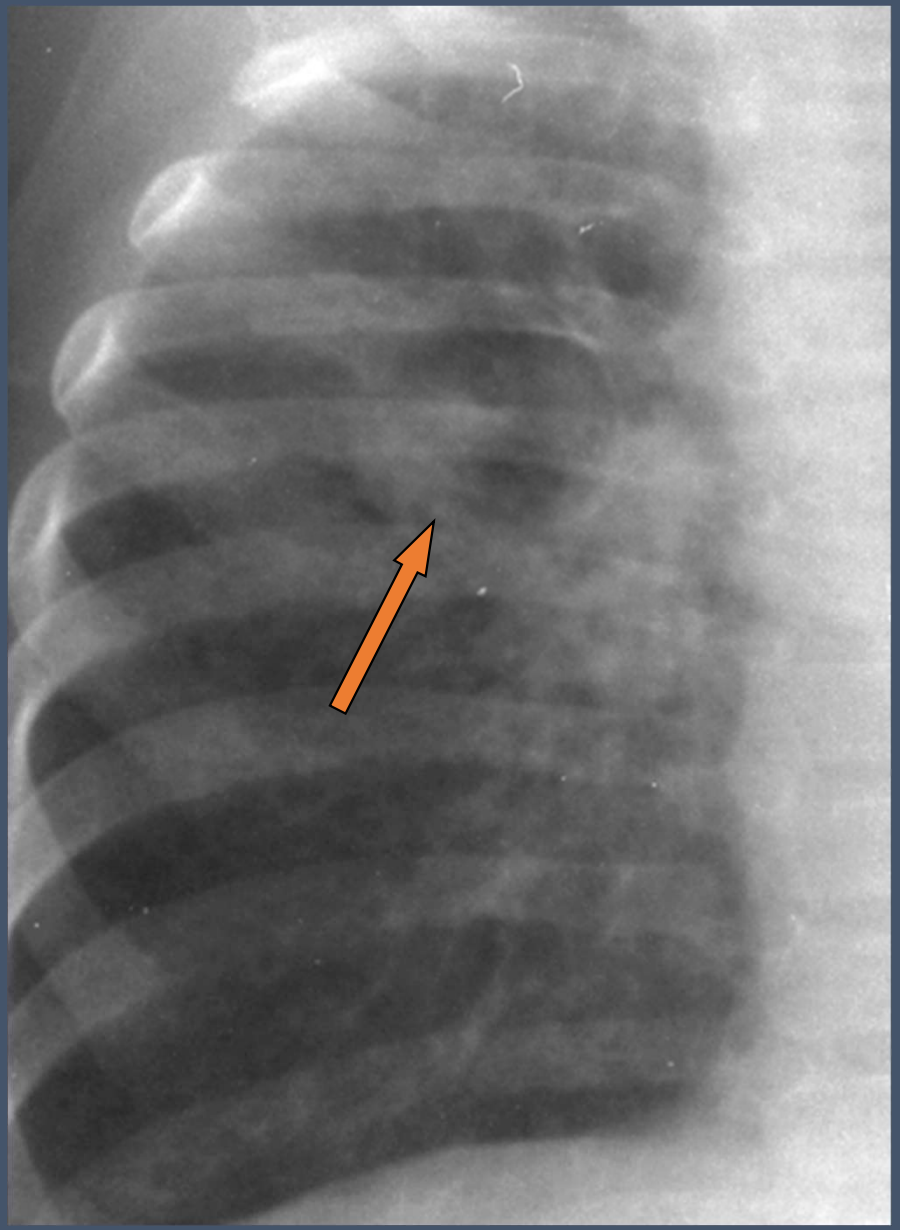


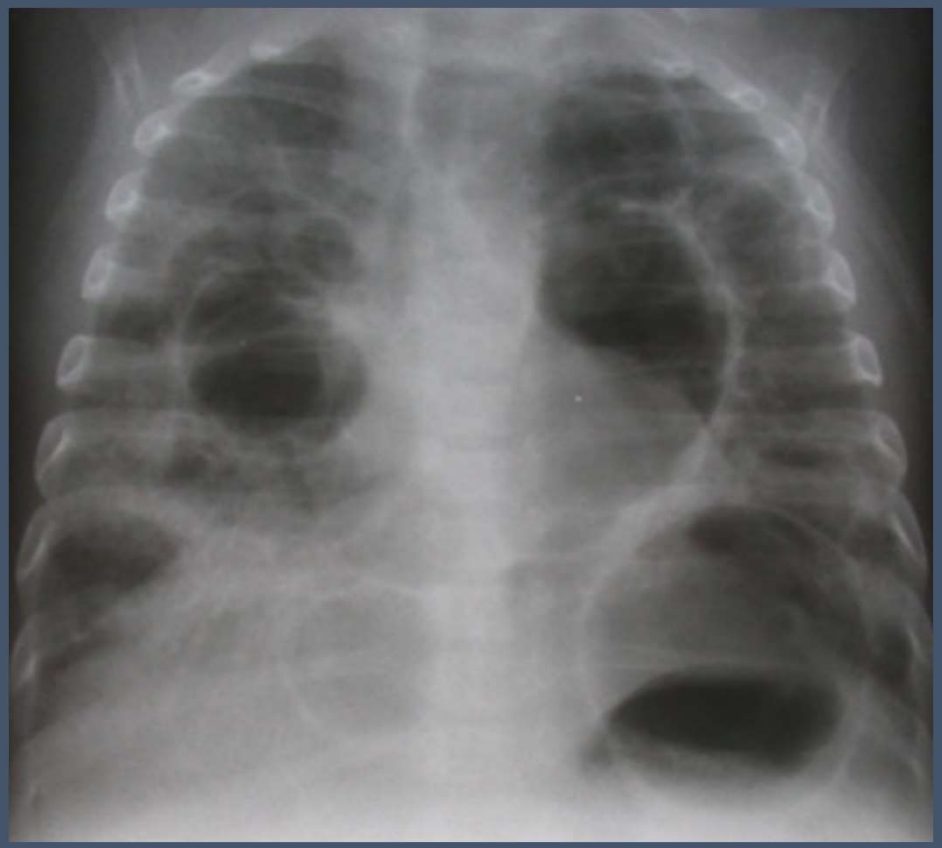


Cavities can occur in cases of progressive primary disease

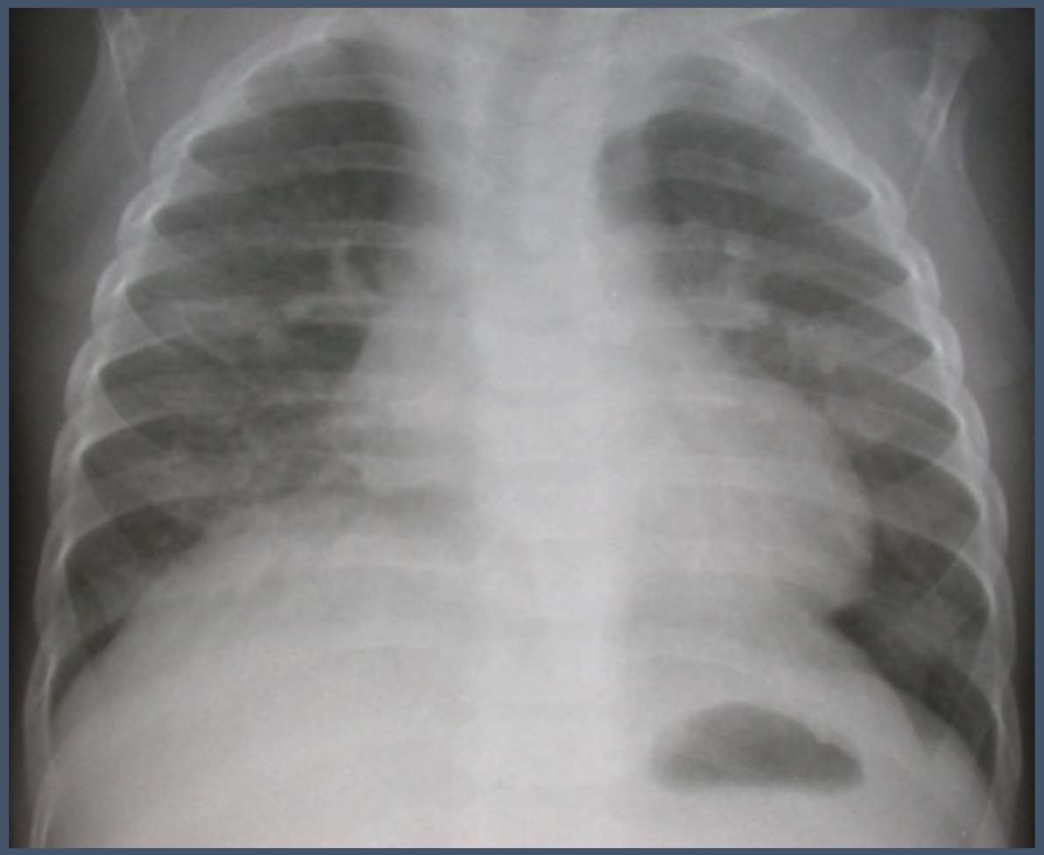
Pneumatoceles also common







At discharge

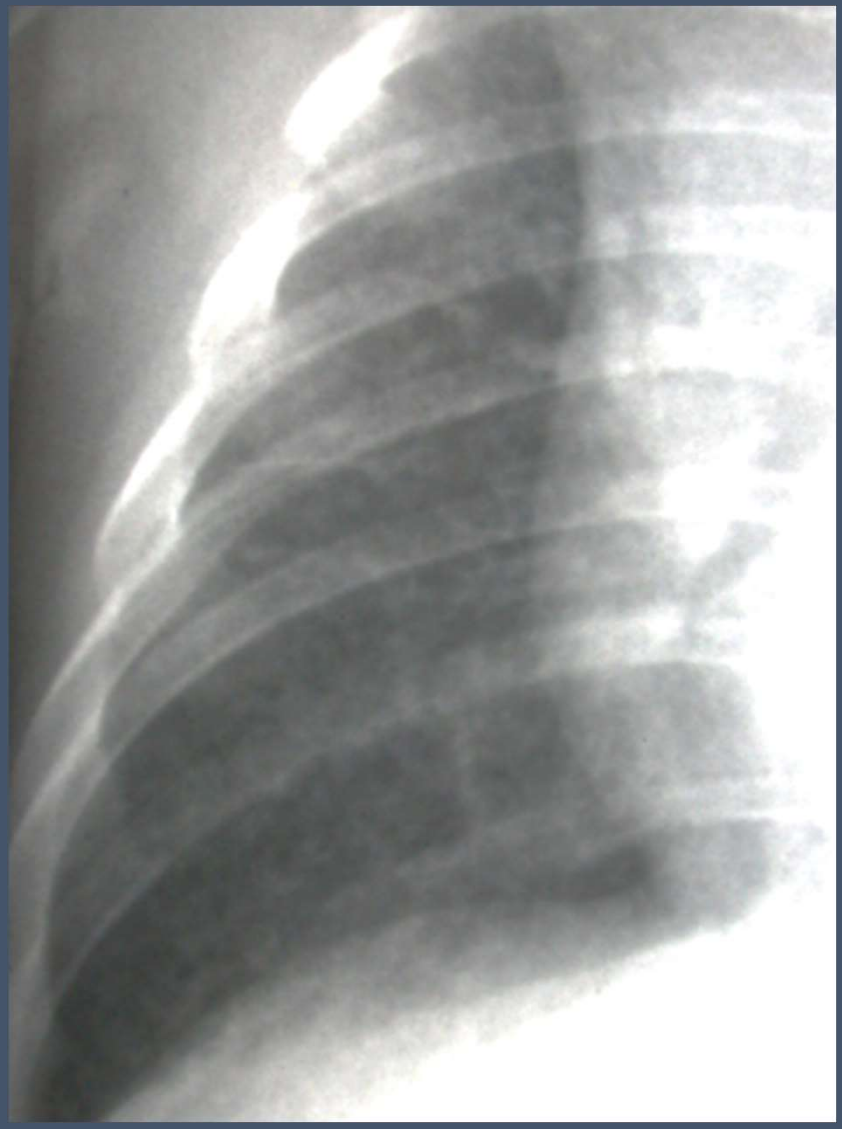


6 months later

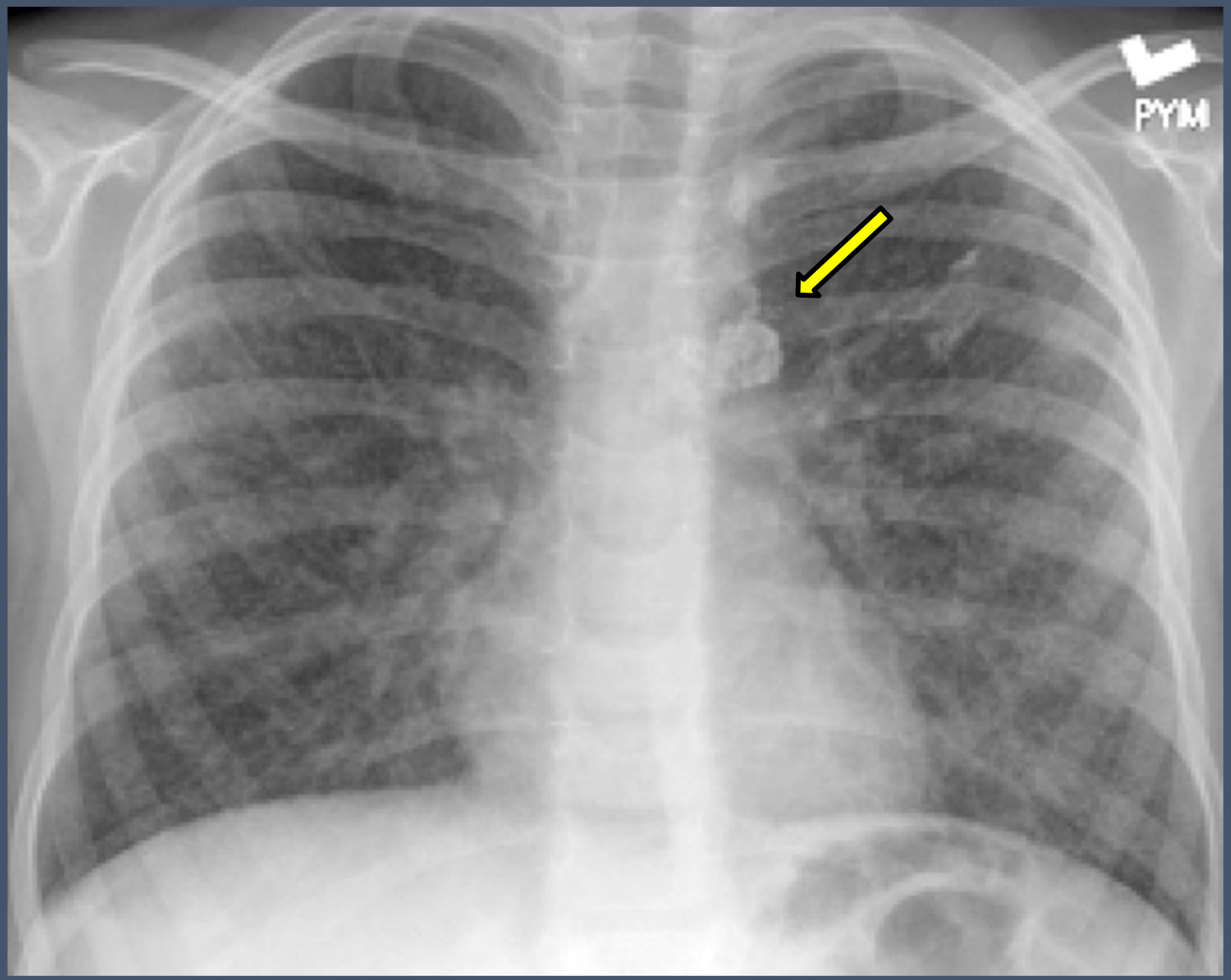
Congenital TB - Pneumatoceles

Disseminated Pulmonary TB

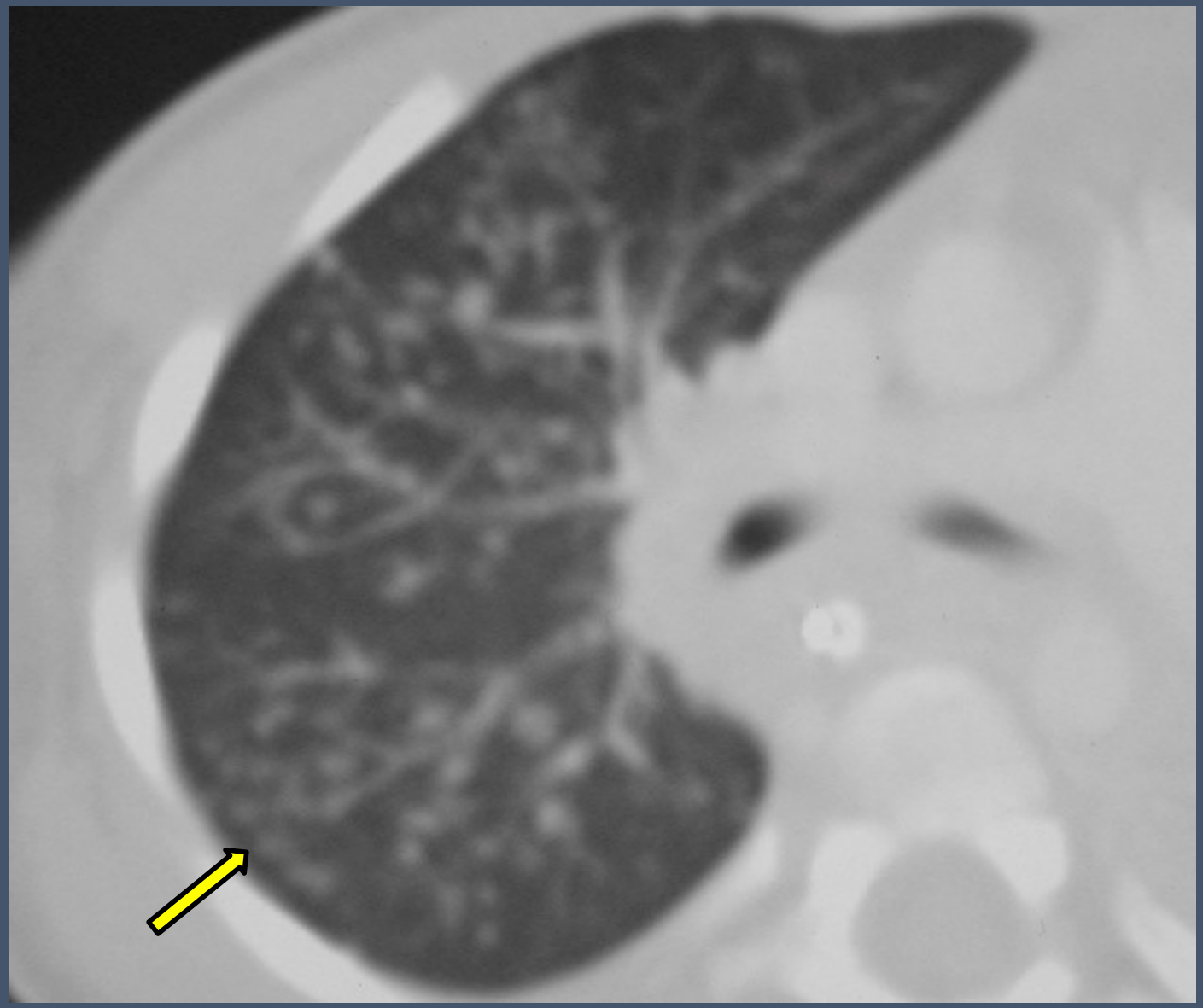
- "Miliary"
  - Hard to see in early stage
  - Typical - <2mm size
  - Larger nodules or ill-defined patches can occur in children
  - Bilateral
  - Evenly distributed

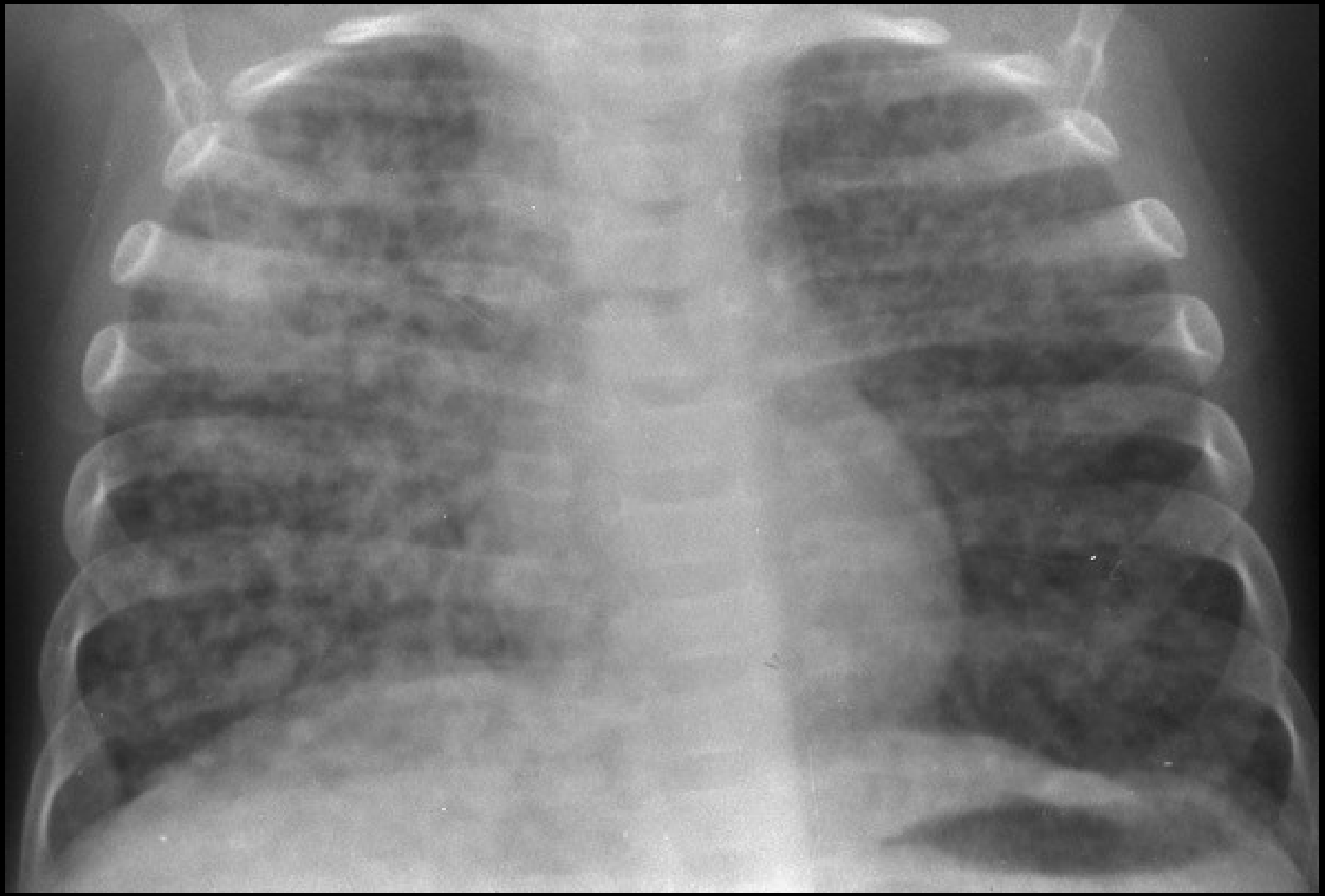


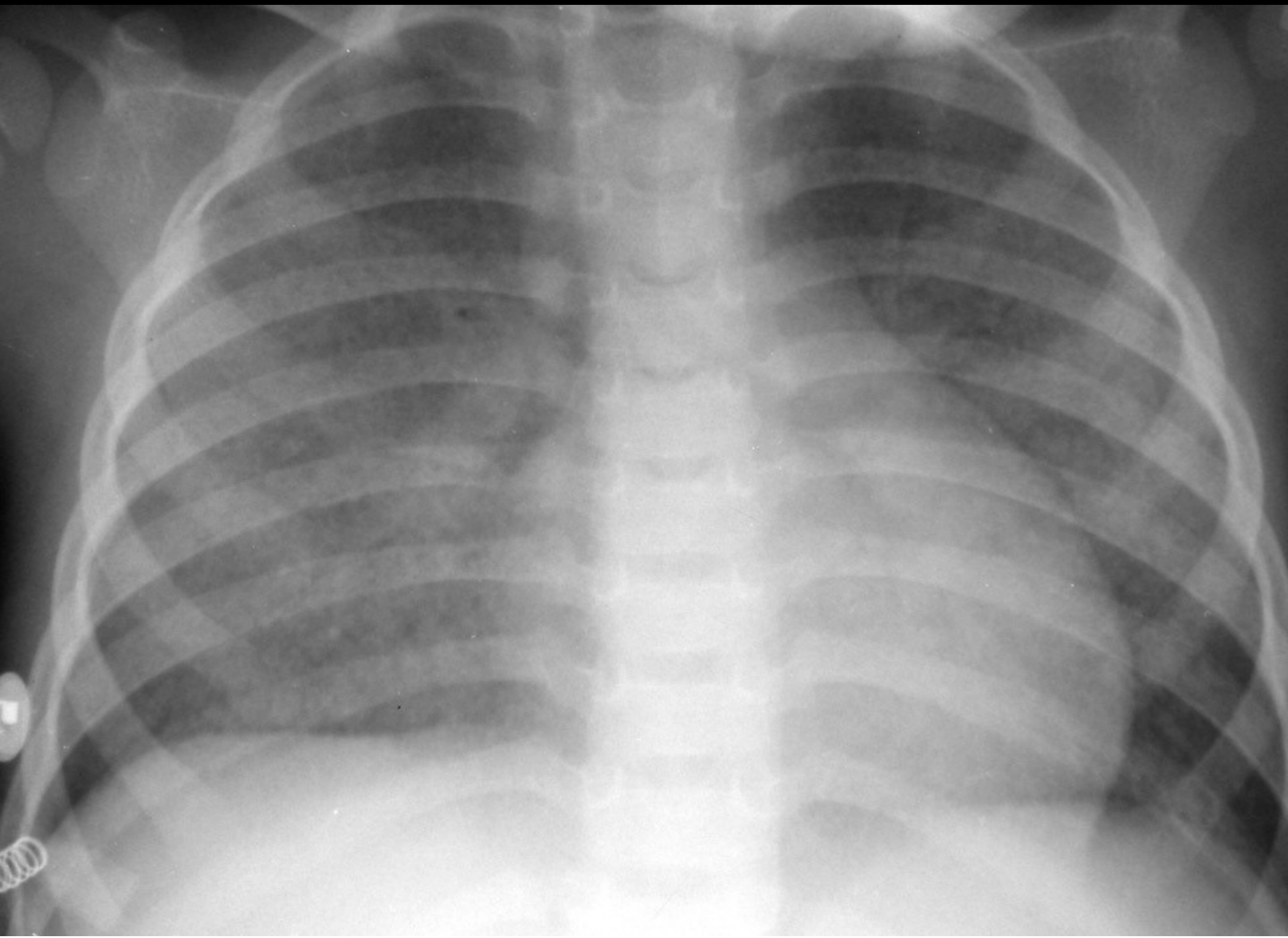
Miliary TB with Calcified Lymphadenopathy and Granulomas

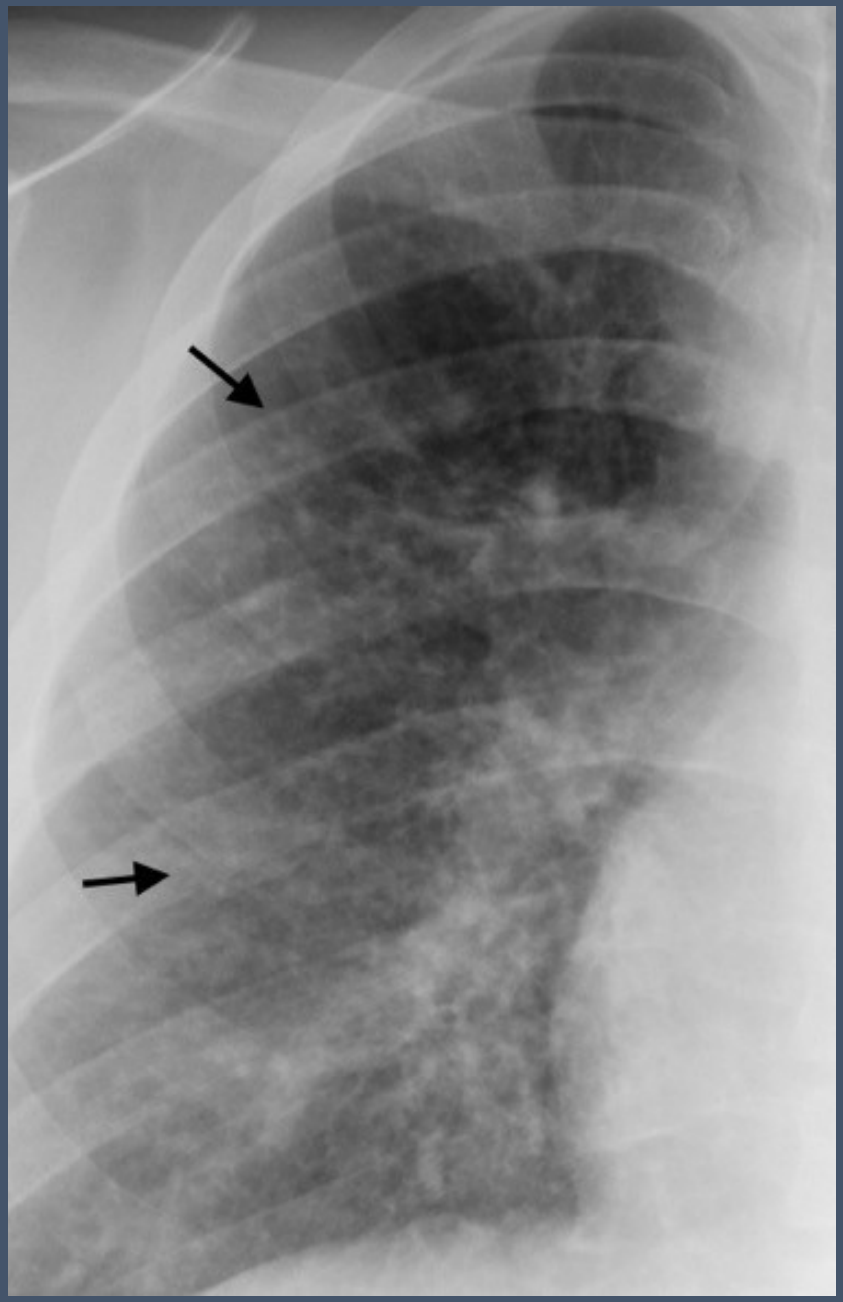


Miliary Nodules - CT

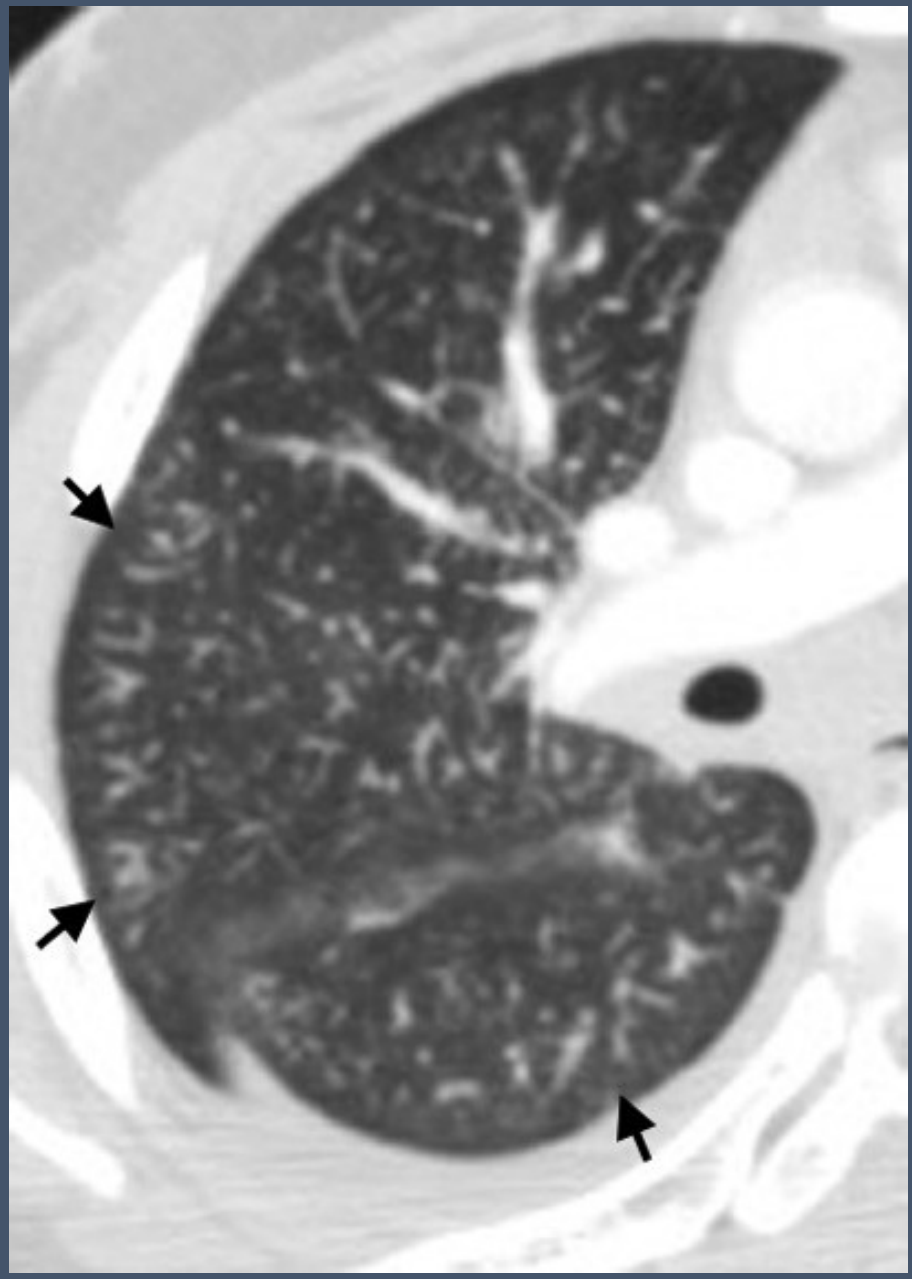






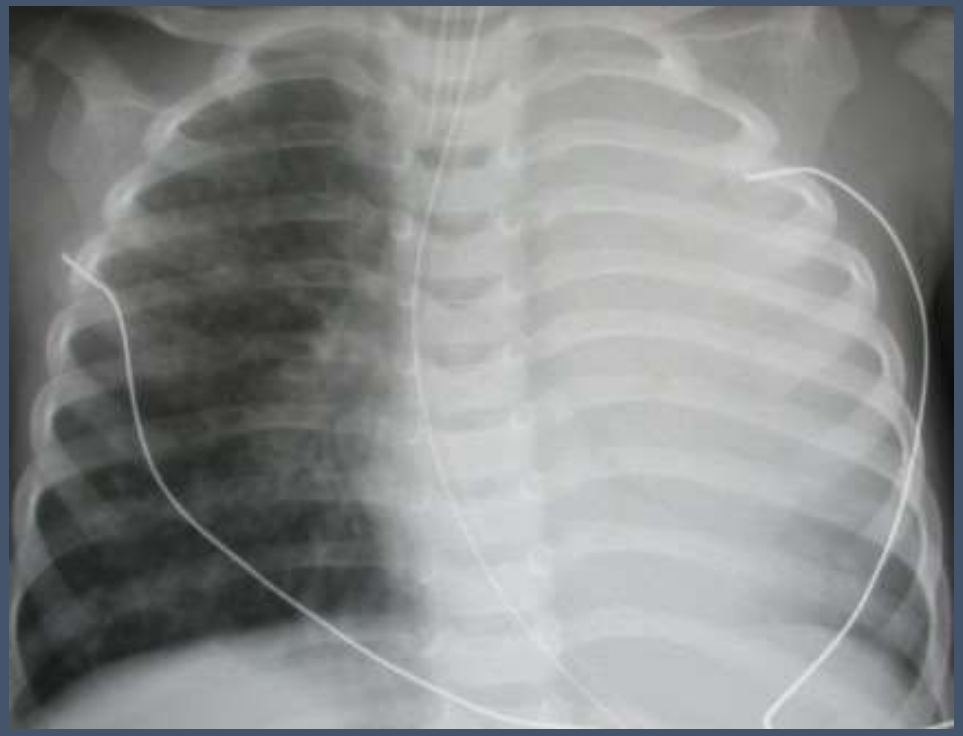


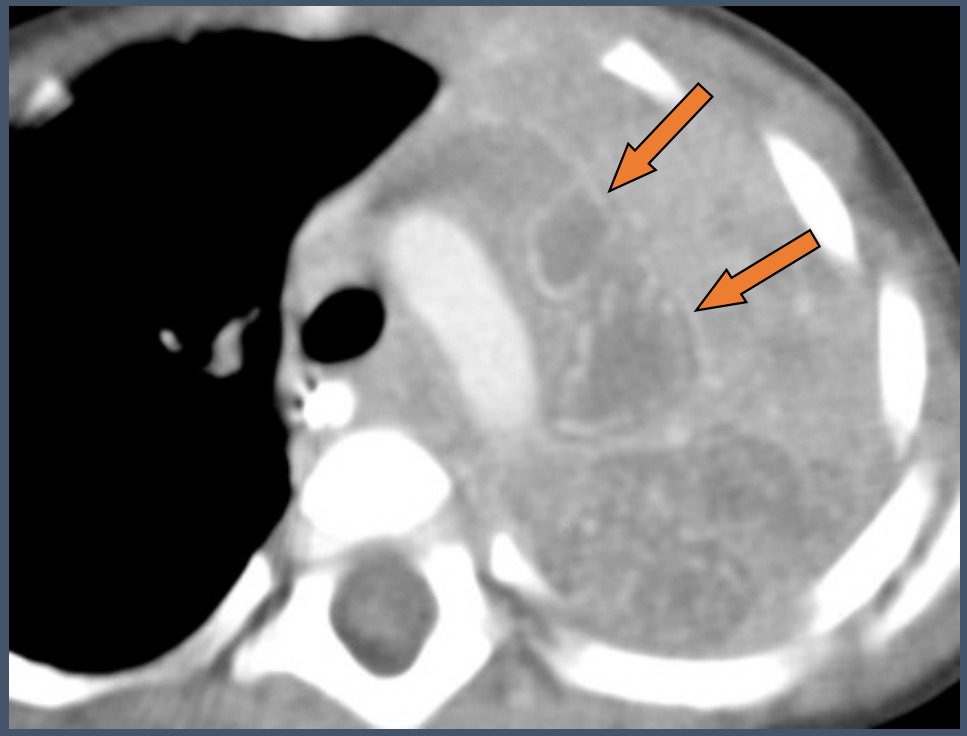
Teen with GI malignancy, TB



Tree-in-bud pattern

Caused by endobronchial spread



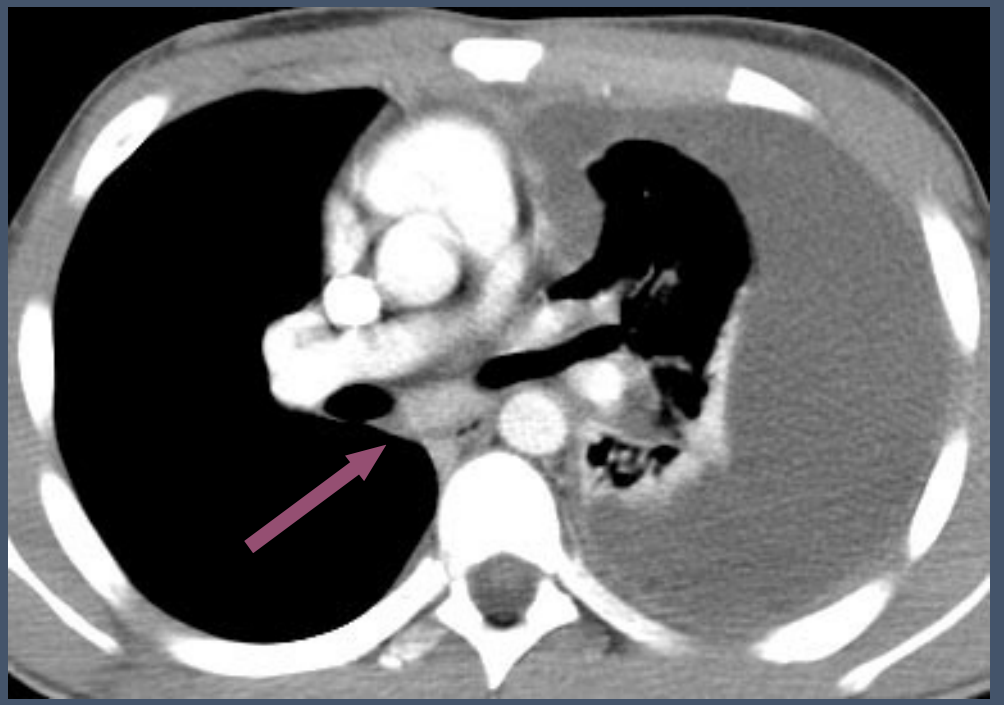


Progressive Primary TB

- Atelectasis
- Fibrosis
- Persistent lymphadenopathy
- Cavitation, bronchiectasis

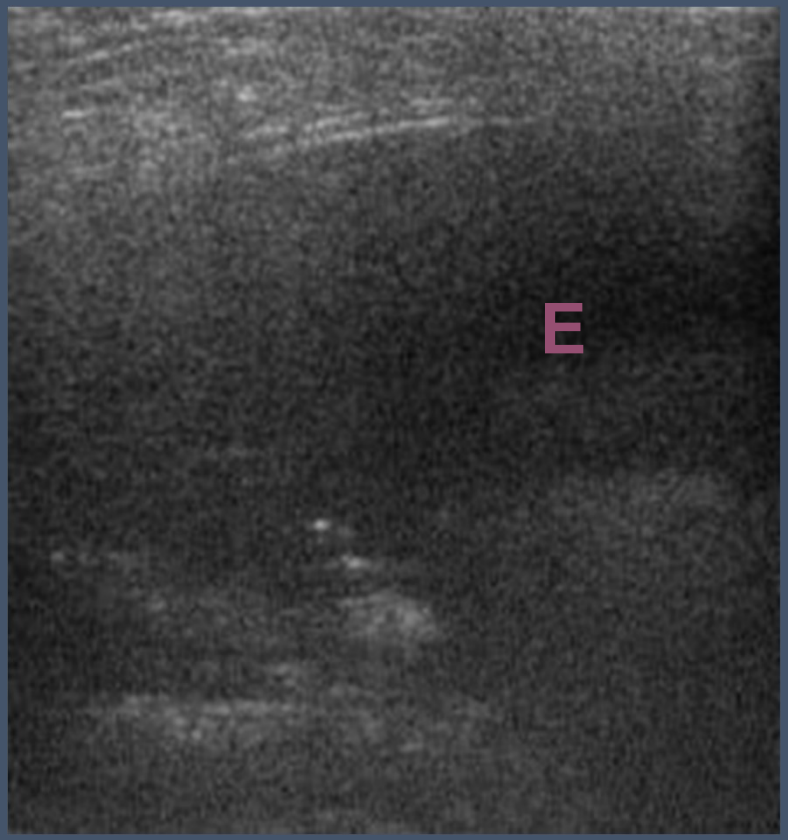
Pleural/Pericardial Disease

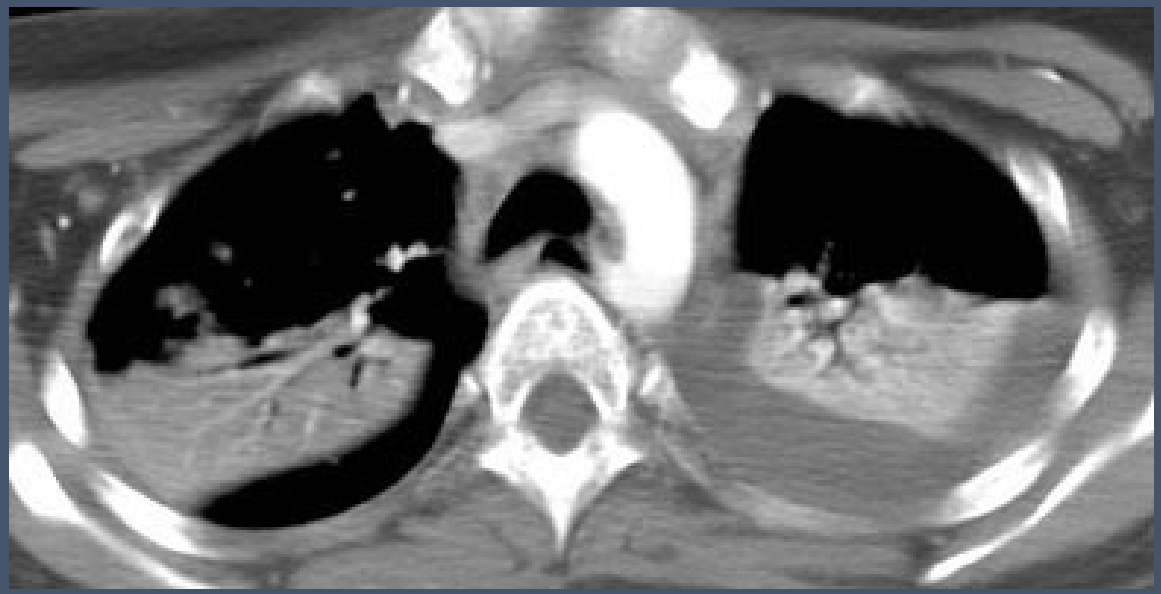
- Pleural effusion
  - Obstruction of lymphatics vs. hypersensitivity reaction
  - Cultures generally negative
- Pericardial effusion
  - Uncommon – 1% of cases
  - Direct extension from mediastinal lymph nodes
  - Hematogenous spread less common



- Can occur 3-6 months after infection.
- Sometimes asymptomatic.
- Usually self-limiting.

Pleural Effusion





Associated with airspace consolidation in 29%

Kim WS, et.al. AJR (2006) 187: 1024-1033.

CNS TB in Children

- 50% <2 years of age
  - Near 90% have abnormal CXR
- Hematogenous spread most common
  - Spread from calvarium, middle ear
- Manifestations
  - Focal disease
  - Meningitis
  - Infarction
  - Hydrocephalus – may occur as early as 1 week after onset in children

TB Localized CNS Disease

- Tuberculoma most common
- CT or MRI (use IV contrast)
  - Ring-enhancing
  - Solid
- Usually < 2 cm diameter
- Rarely calcify

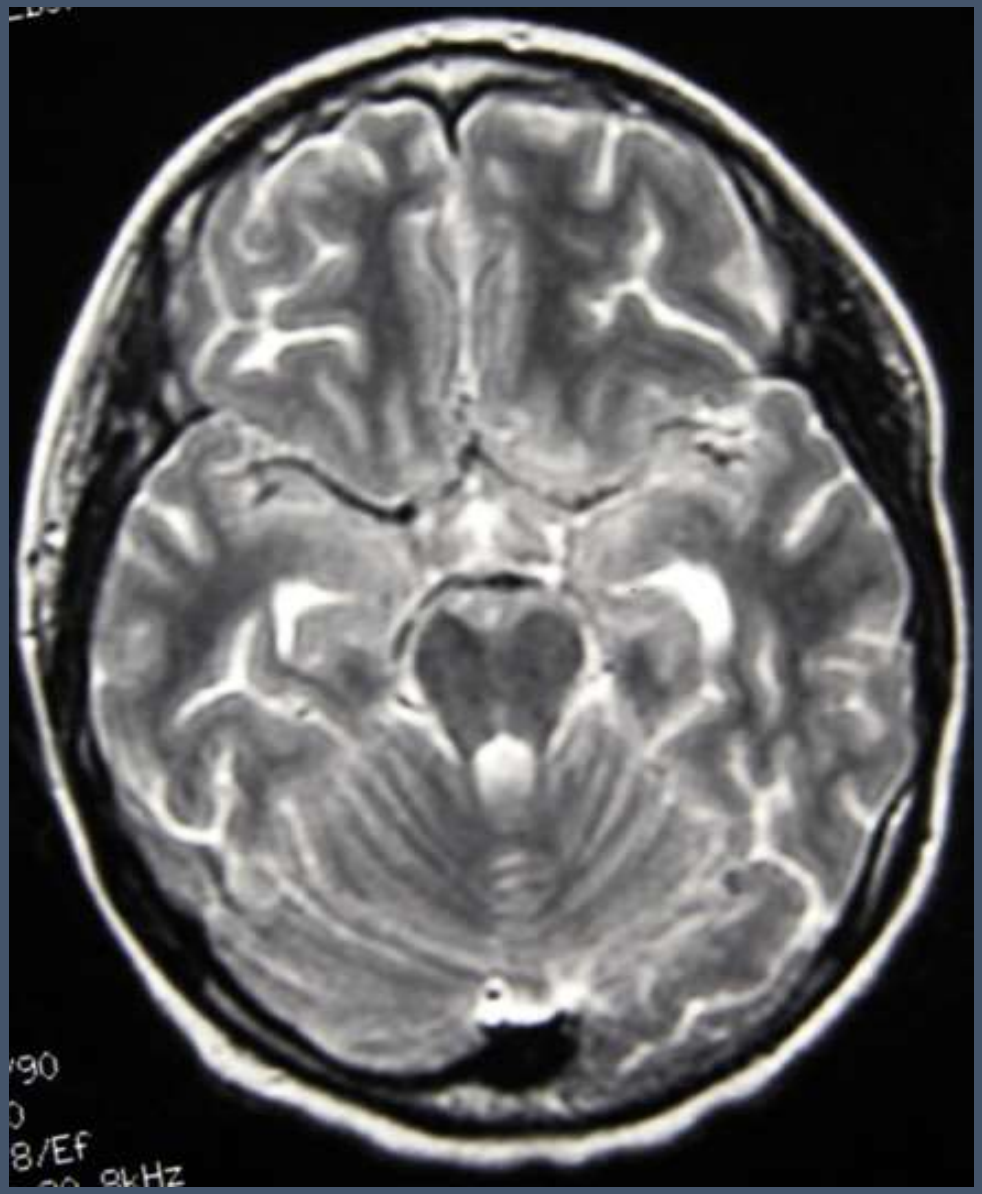
TB Meningitis

- Diffuse most common
- CT
  - Non-contrast – 50% show increased density in basal cisterns
  - Contrast – prominent basal enhancement (double line sign)
- MRI – similar findings

No IV contrast

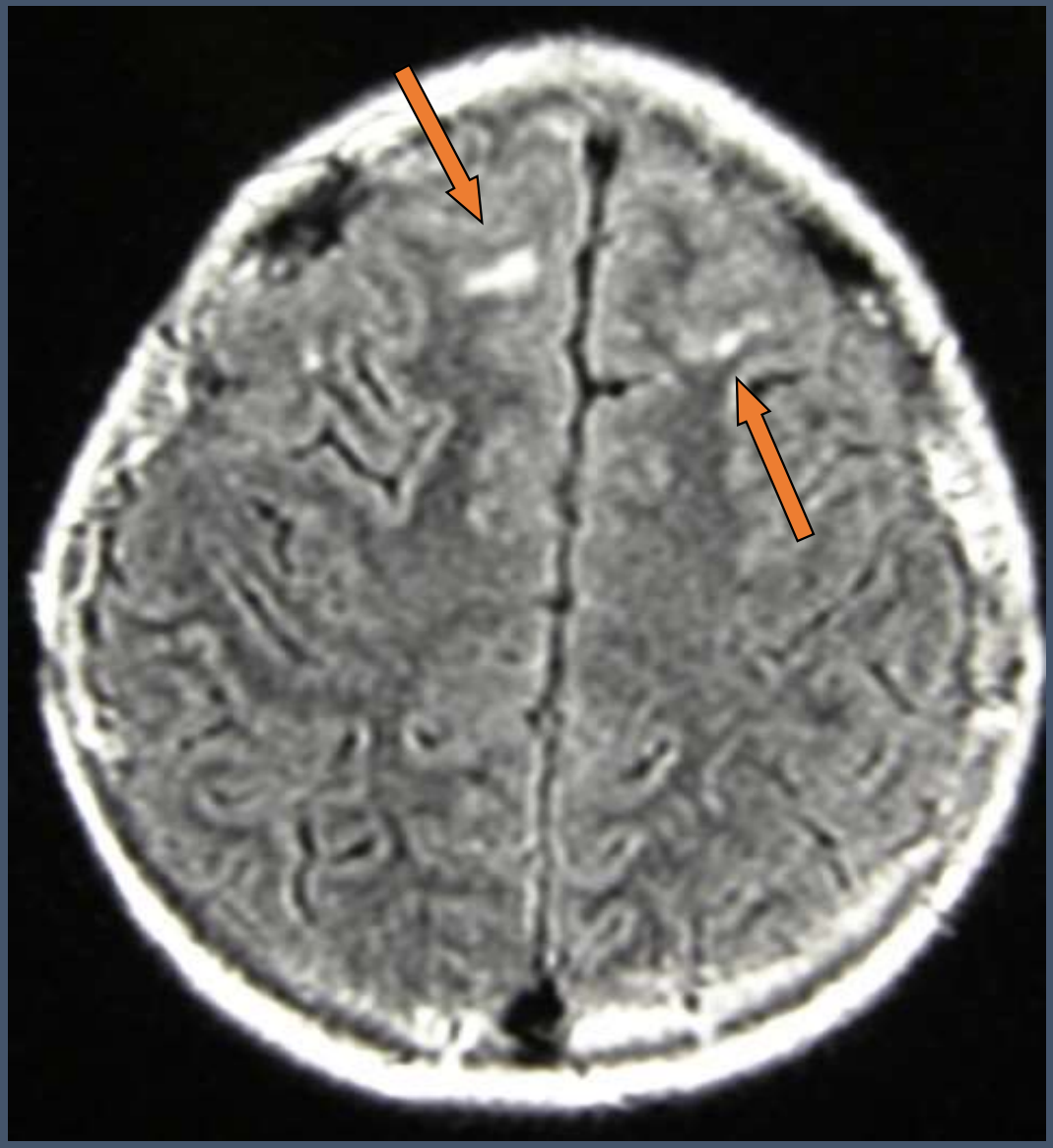
IV contrast

MRI – TB Meningitis



Nodular Meningeal Enhancement – TB Meningitis

Post-meningitis Infarcts



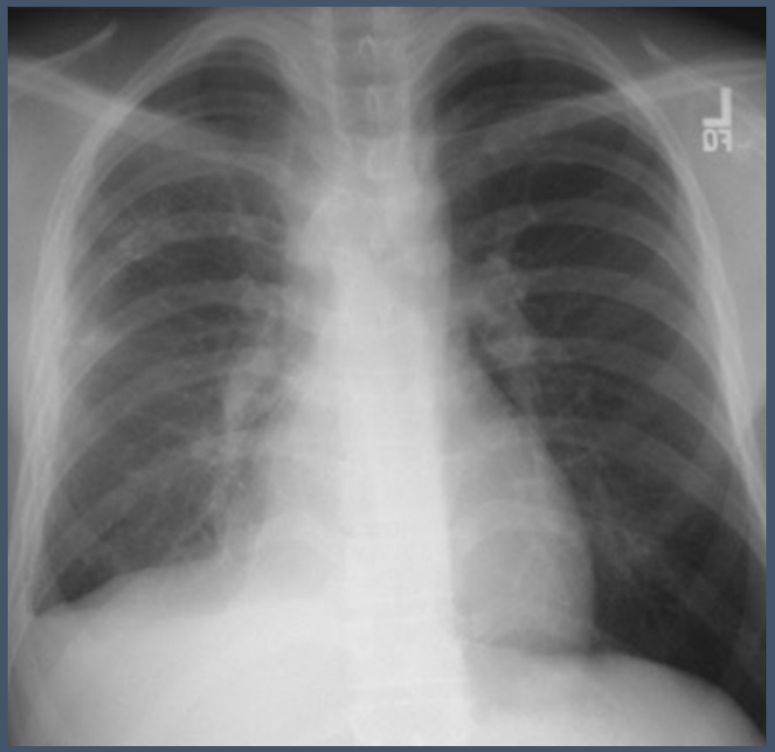
Abdominal TB in Children

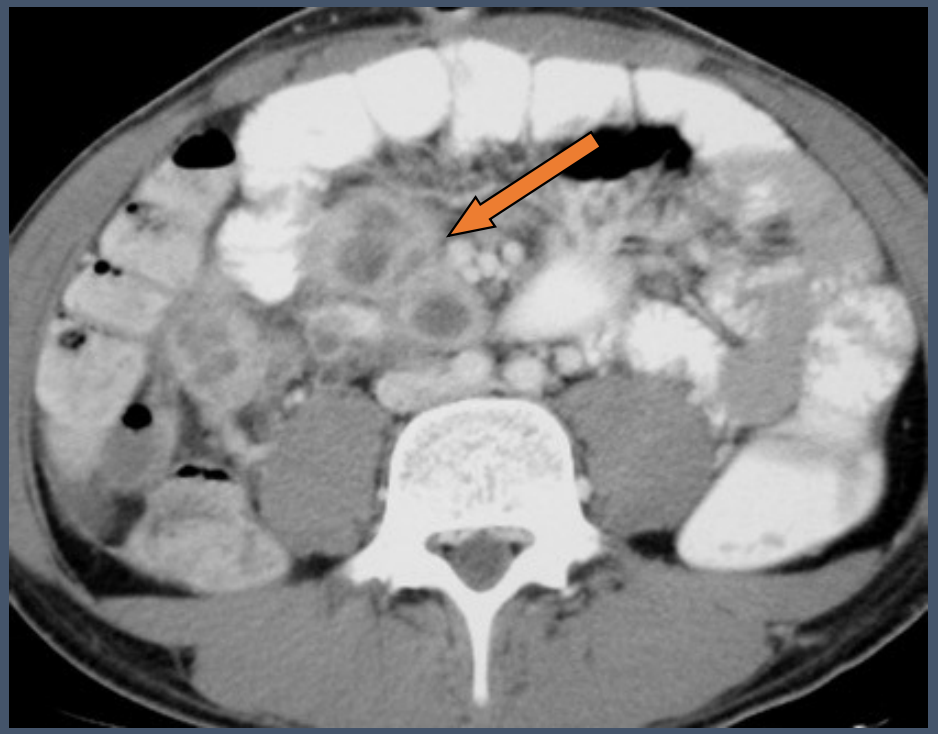
- Less common than in adults
- Findings
  - Lymphadenopathy
  - Solid organ lesions
  - Ascites
  - Bowel wall involvement
  - Inflammatory mass
  - Omental thickening

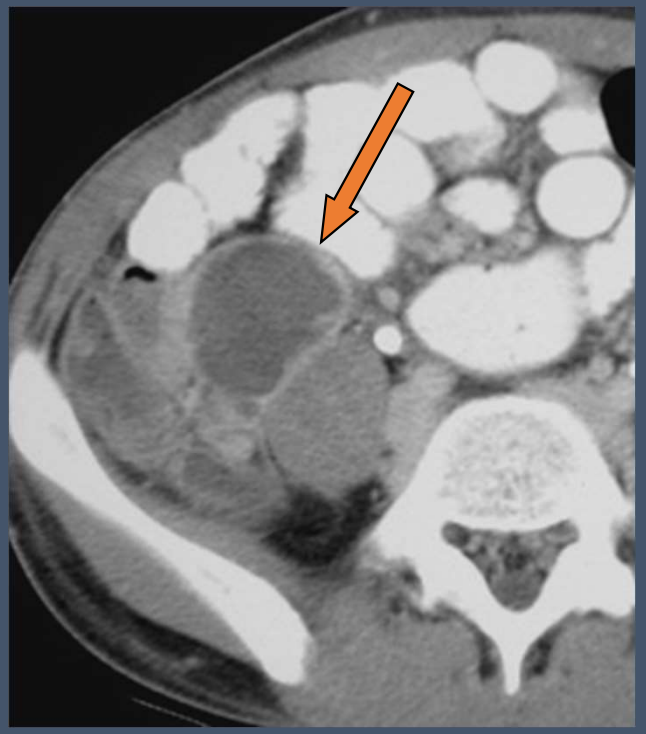
Abdominal TB

- Lymphadenopathy
  - Para-aortic, mesenteric, periportal most common
  - Commonly calcifies

12 year old with night sweats, 20 lb wt. loss, back pain

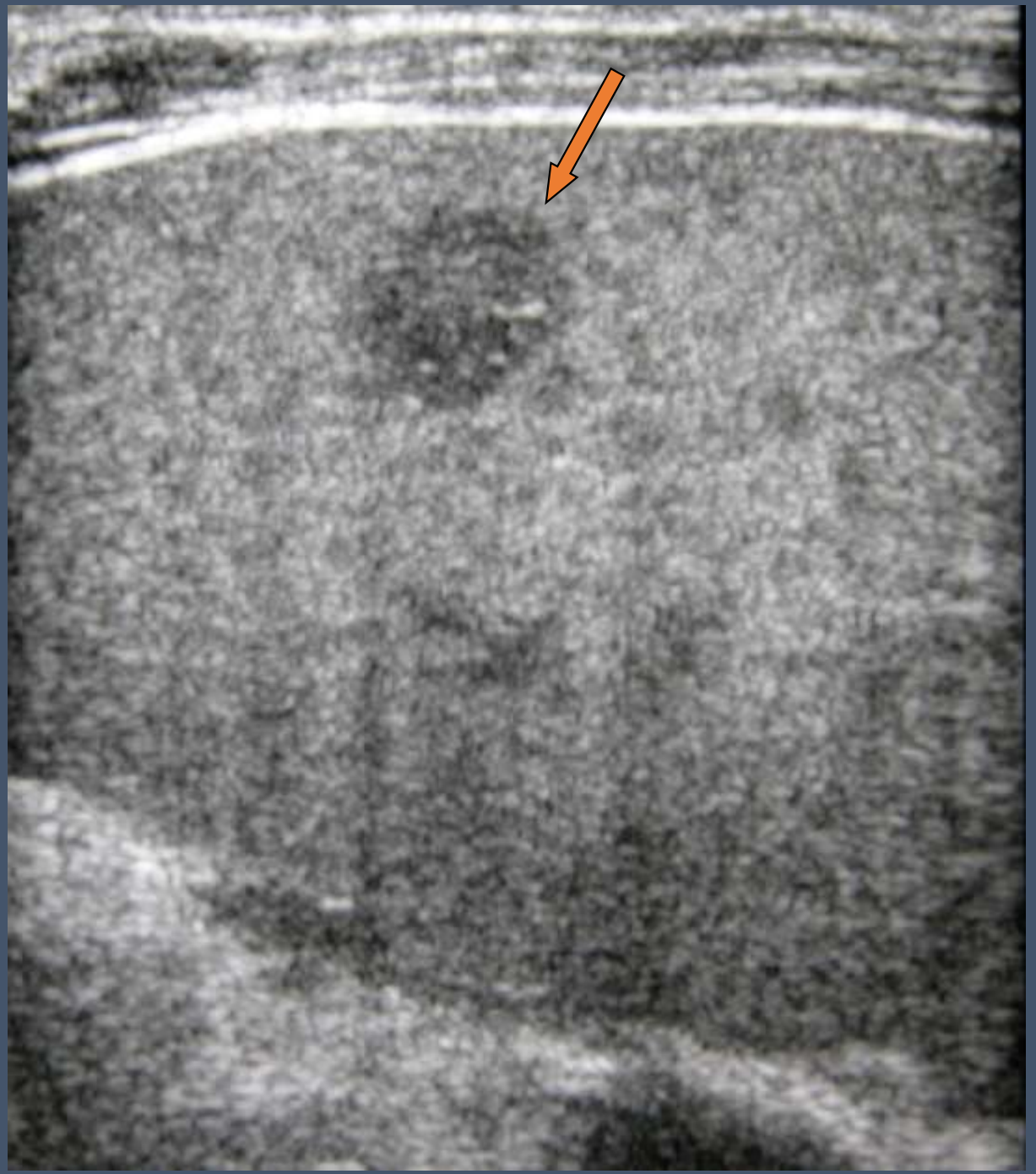


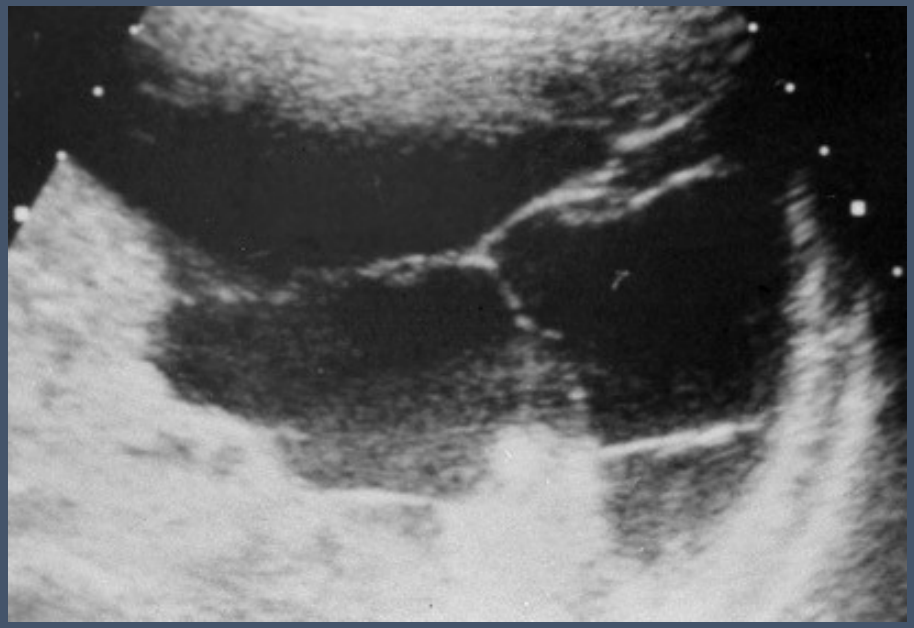




Solid Organ Disease

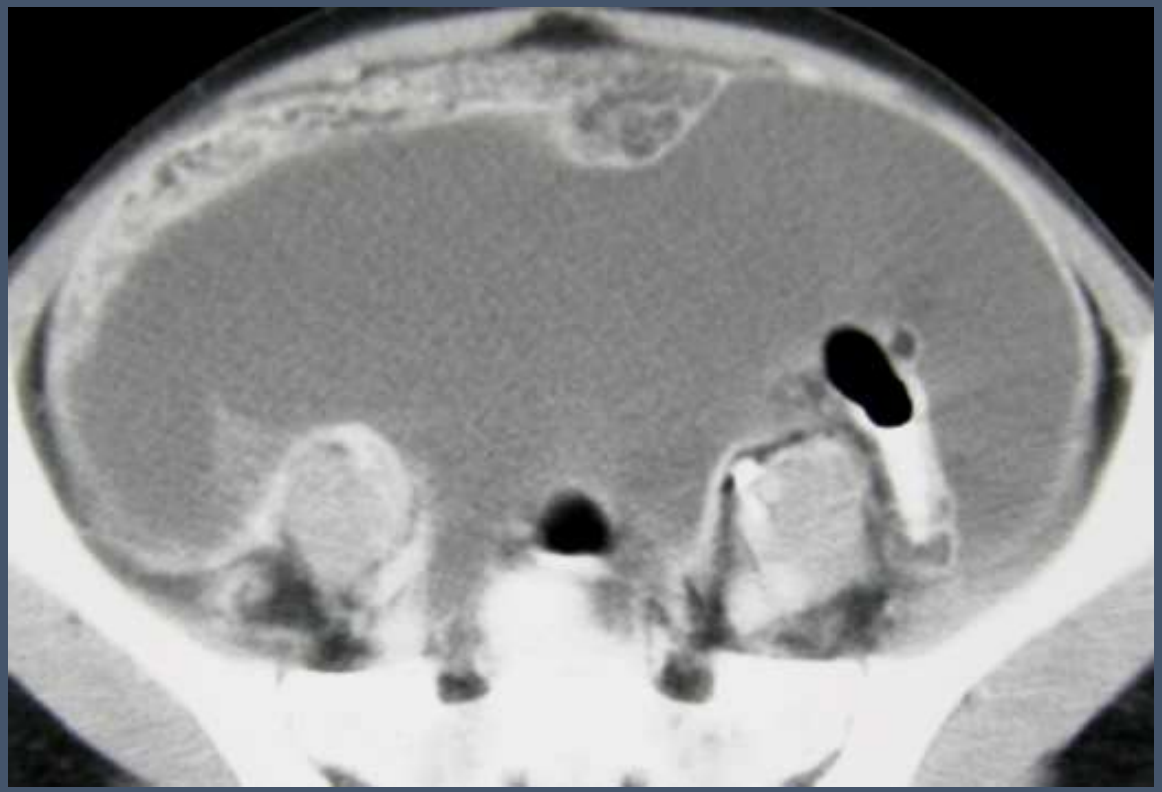
- Microabscess or granuloma
- Liver, spleen
- High frequency ultrasound most sensitive

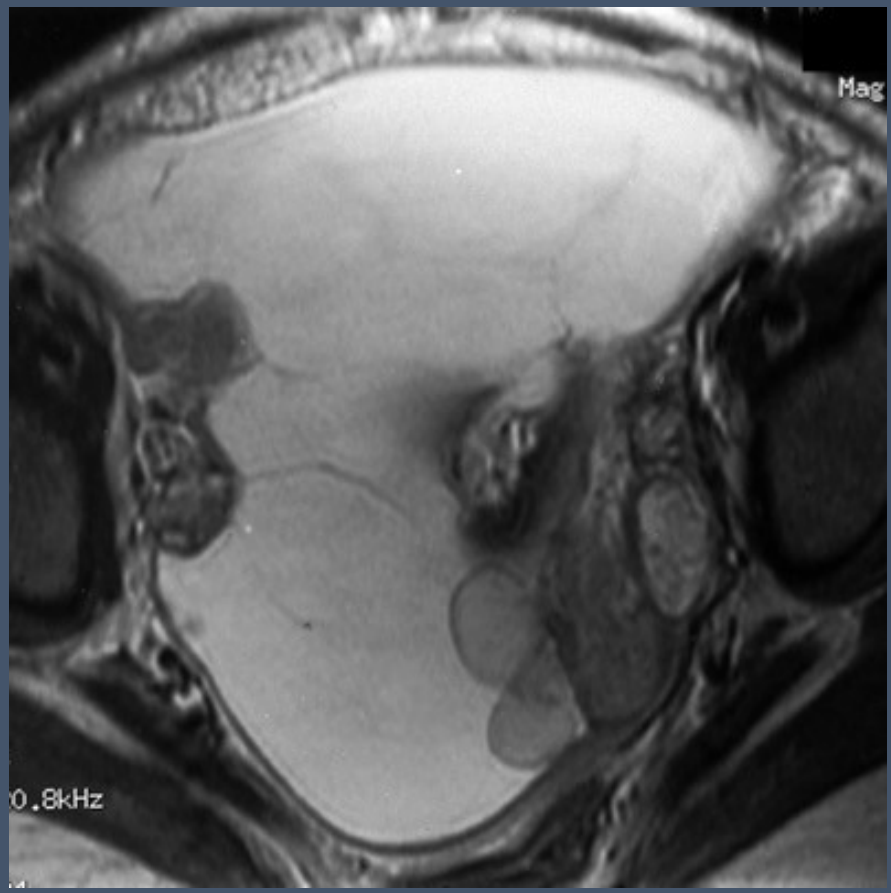




TB Peritonitis

- Rare
- Adhesive peritonitis most common in children





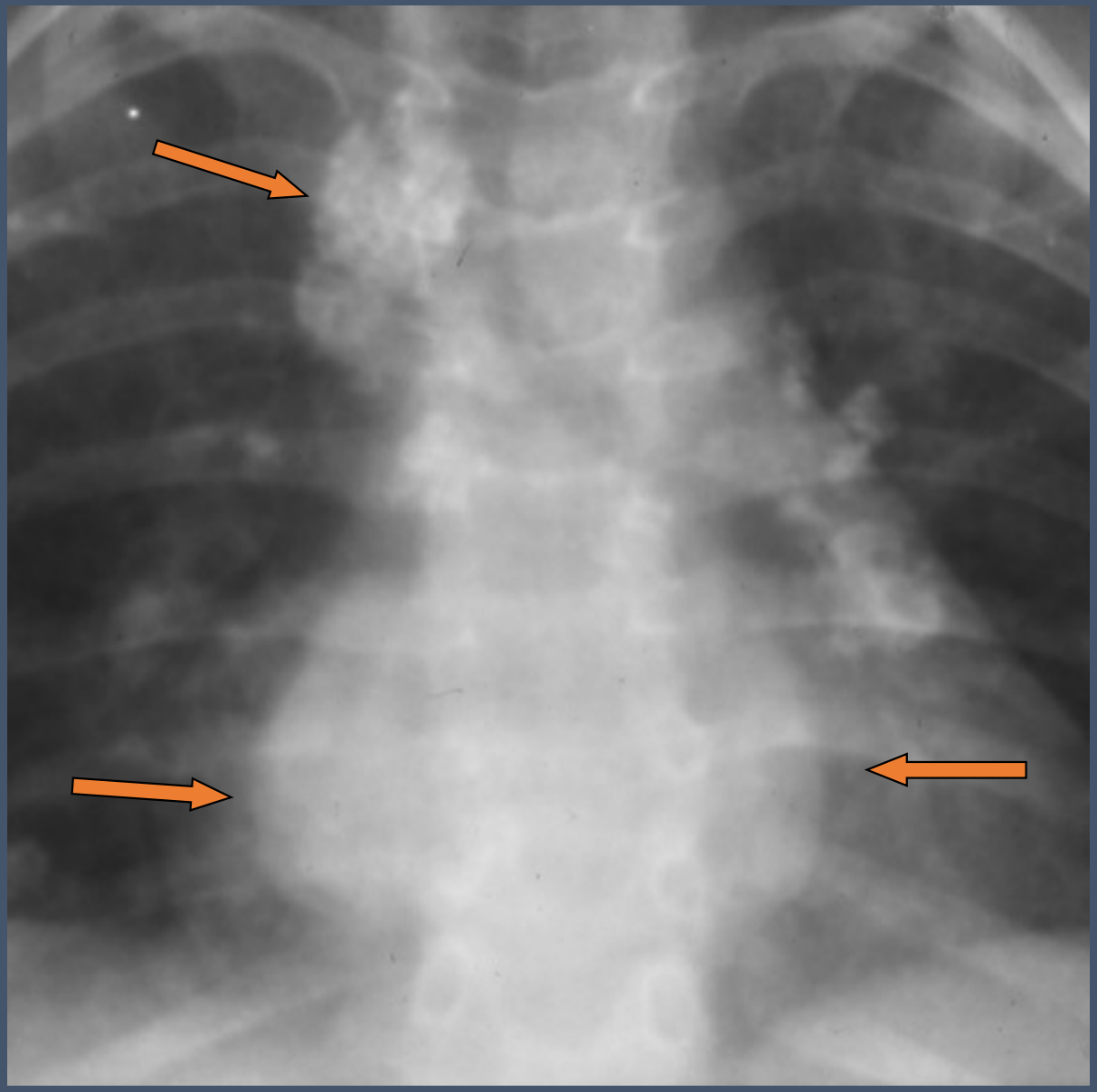
Skeletal TB in Children

- Uncommon
  - 20% of extrapulmonary TB
- Hematogenous origin
  - Primary site often unknown
- Granuloma >> caseating focus >> trabecular destruction >> cortical destruction >> periosteal, soft tissue involvement

TB of Spine

- Common site
  - Vertebral intraosseous abscess
  - Multiple contiguous vertebrae (85%)
  - Spread to disc, subligamentous, soft tissues
  - Posterior elements seldom involved

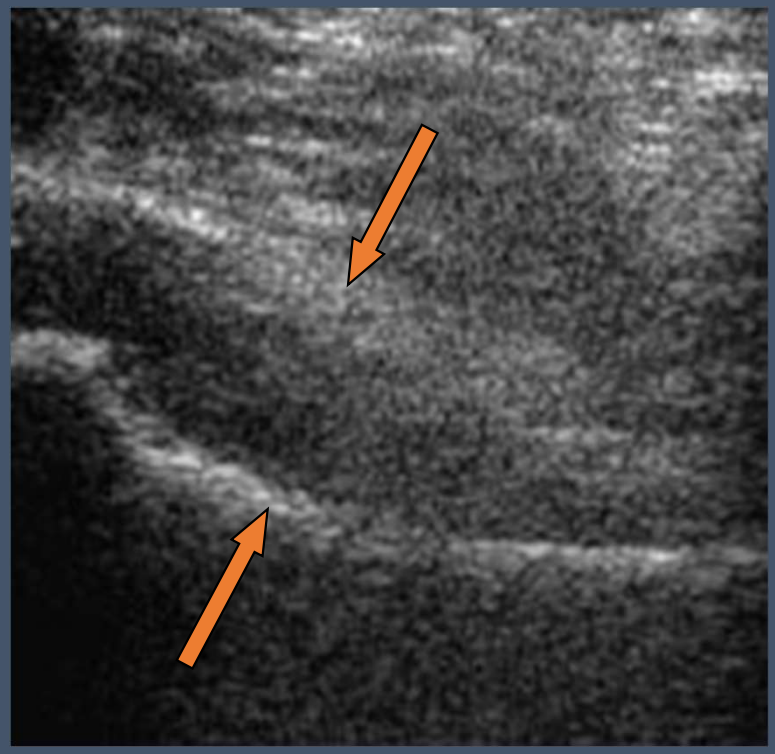
TB Spondylitis



TB Arthritis

- 2nd most common MSK site in children
- Monoarticular
  - Hips, knees most common

US good for screening

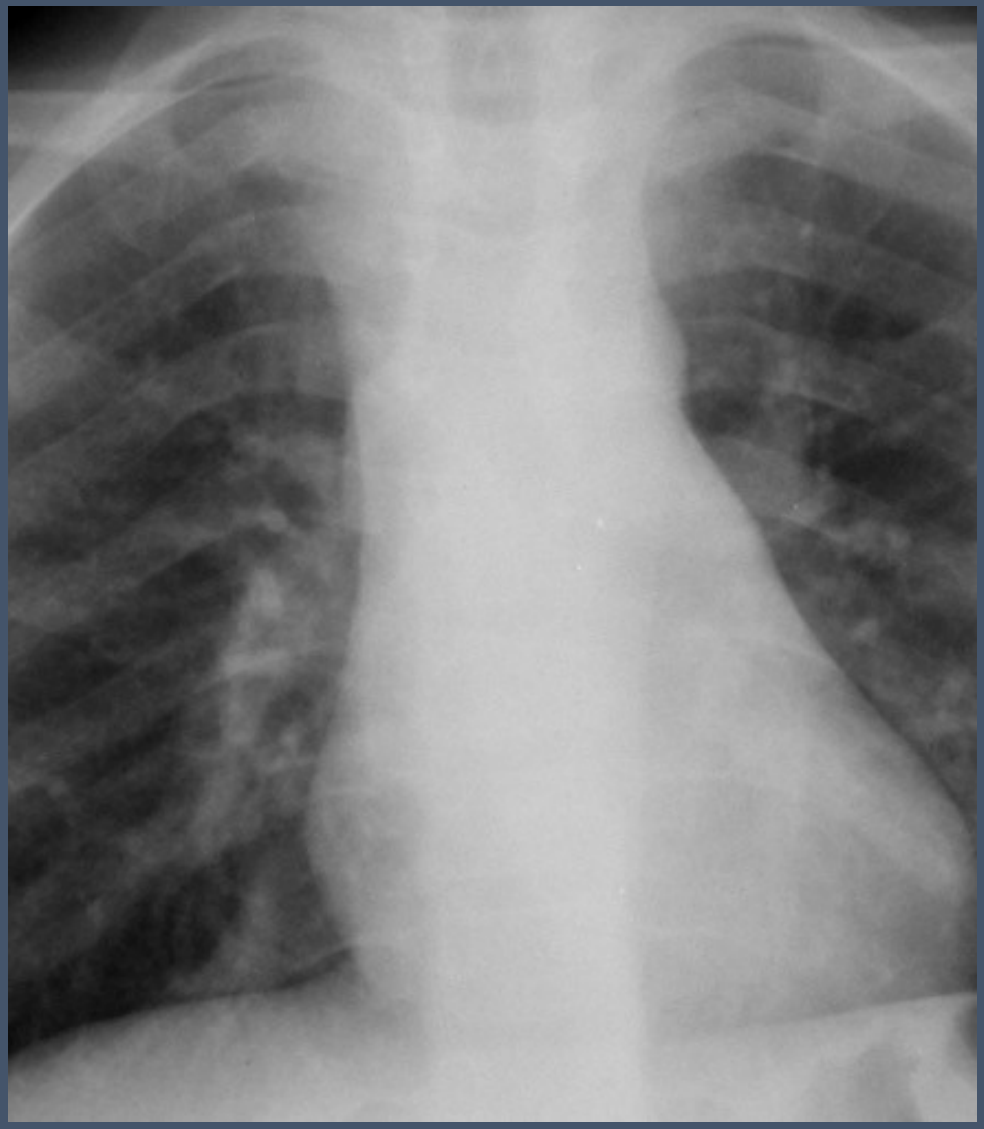


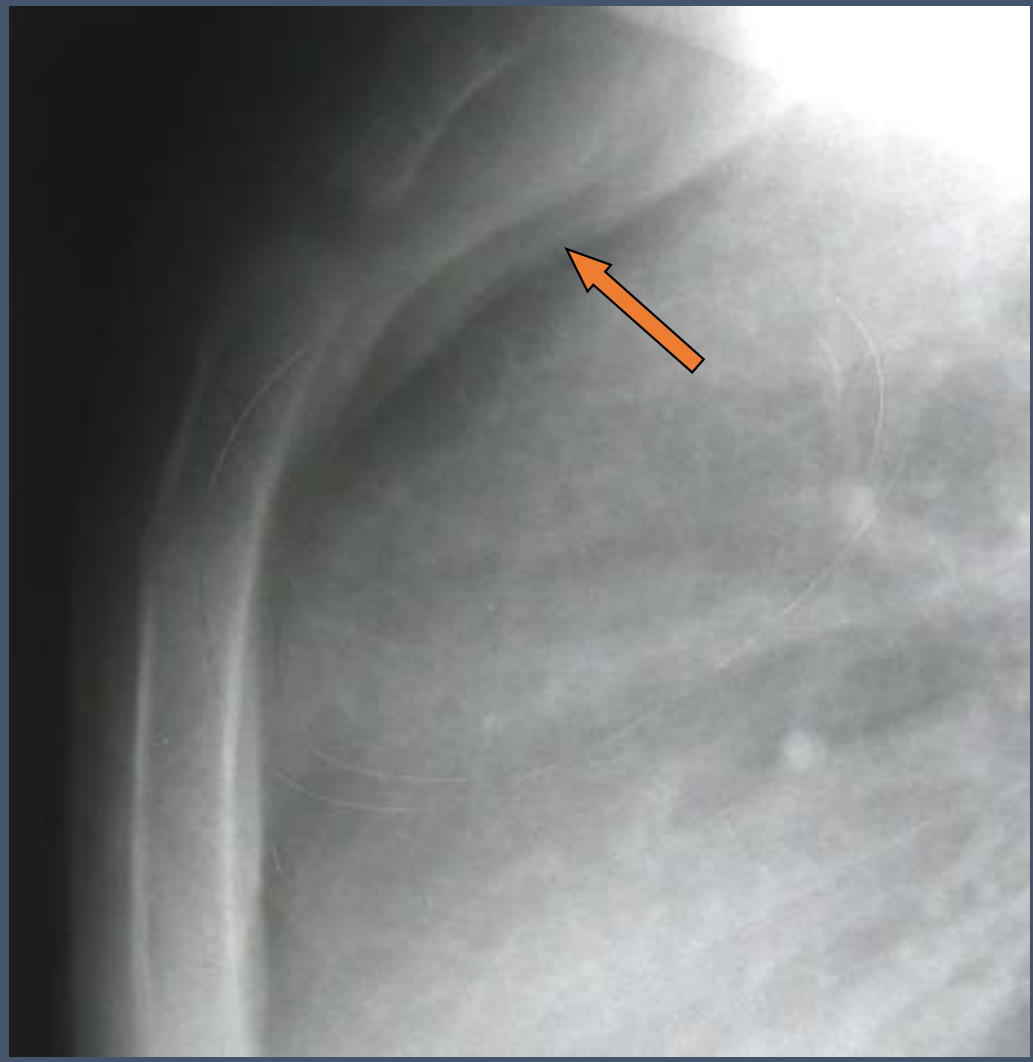
TB Osteomyelitis in Children

- Uncommon – only 11% of skeletal cases
- Solitary lesions most common
- Chest radiograph often normal
- Common sites
  - Skull
  - Hands, feet
  - Long bone metaphyses
  - Ribs

TB Osteomyelitis - Patterns

- Cystic
  - Most common
  - Well-defined lytic lesion
  - Mild sclerosis, expansion
- Infiltrative
  - “Moth-eaten”, ill-defined
  - Nonspecific (Ewings, fungal, chronic pyogenic osteomyelits)
- Spina ventosa (dactylitis)

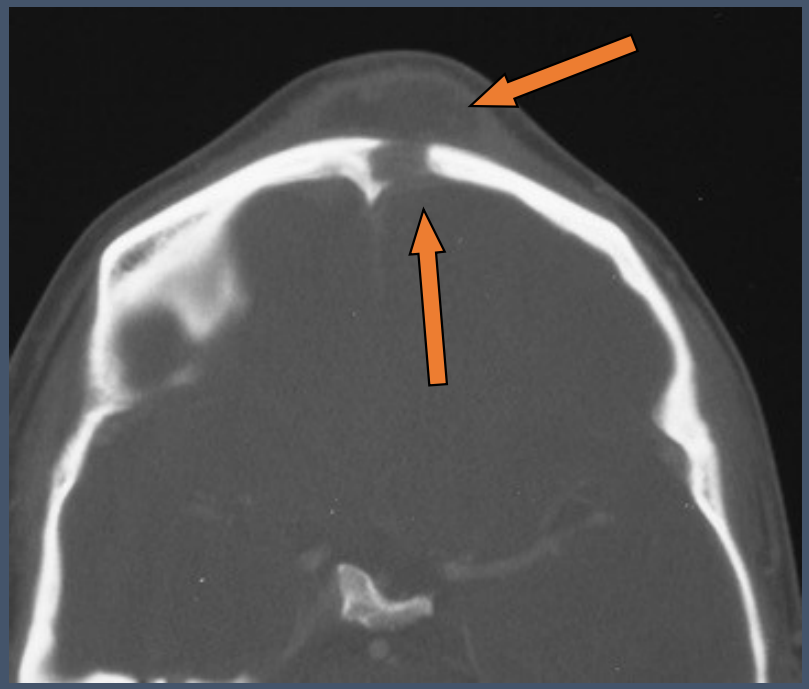


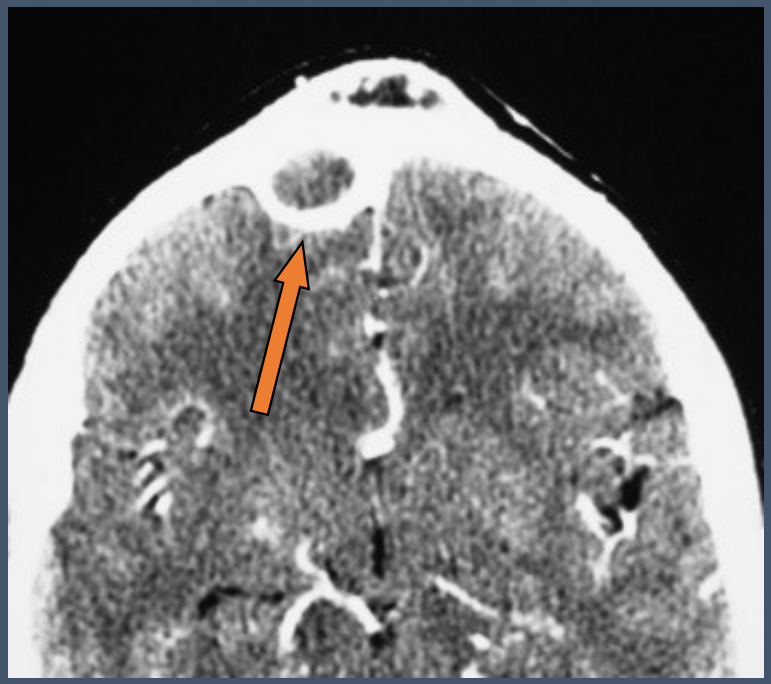


TB of the Sternum

Calvarial TB

- 1% of all skeletal tuberculosis
- 75% of patients are <20 yrs age
- > 80% have bone destruction
  - Frequently visible on radiographs
- 92% have subgaleal swelling





Conclusion

- Primary TB in children has variable and often non-specific appearances on imaging
- Lymphadenopathy remains a key finding
- Use advanced imaging when radiographs are suggestive or confusing