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2

Pulmonary Tuberculosis

Introduction

Chapter 1 presented the basic principles of chest radiography, how to distinguish the images of the normal thoracic anatomy from abnormal findings, the common radiographic patterns of thoracic disease, and standard terminology used to describe abnormal findings.

Chapter 2 reviews the radiographic manifestations of pulmonary tuberculosis (TB) and how to apply the terminology covered in Chapter 1 to describe the radiographic findings. By the end of this chapter, readers will be familiar with the various radiographic manifestations of TB.

Because TB has a two-phase pathogenetic sequence by which the disease develops, and because each phase in the sequence is associated with different radiographic features, this chapter begins with an overview of the pathogenesis of TB.

Overview of the pathogenesis of TB

When tubercle bacilli (*Mycobacterium tuberculosis*) are inhaled into the lungs they are deposited in the airways and alveoli in more ventilated areas of the lung – typically in the middle- to lower-lung zones. In previously uninfected persons the bacilli cause an inflammatory reaction which may or may not be seen radiographically. If there is a radiographically visible abnormality, it is referred to as a primary or Ghon focus. This initial infection generally does not produce symptoms.

During this early stage of infection, organisms can spread via lymphatics to the draining lymph nodes in the chest and result in enlargement of hilar and mediastinal lymph nodes. Bacilli can also enter the bloodstream where they spread hematogenously throughout the body. Disease presenting at this stage is referred to as primary TB and is associated with particular radiographic findings.

After several weeks, the host develops a cell-mediated immune response as indicated by a positive tuberculin skin test or interferon gamma release assay. It is estimated that approximately 4.0% of people infected with TB will develop TB disease by the end of 1 year following infection. A cumulative total of approximately 8.0% will have developed TB by the end of the 25th year after infection. Healed lesions may contain viable bacilli that can progress to active TB, although the risk decreases as time after infection increases. Such progression is termed reactivation or post-primary TB. Reactivation disease is also associated with characteristic radiographic findings with typical abnormalities occurring in the upper lobes. This entire pathogenetic sequence is a continuum and many of the radiographic manifestations of primary and reactivation TB overlap. Moreover, in immunodeficiency states such as HIV/AIDS, or treatment with immunosuppressing drugs, atypical radiographic abnormalities are common.

This chapter reviews the radiographic manifestations of TB in line with this pathogenetic sequence. It is important to note that the distinction between primary and reactivation TB has little clinical relevance. Active TB should be treated regardless of whether it is thought to be primary or reactivation. As this chapter will describe, abnormalities thought to be “characteristic” are not specific for TB disease. However, such findings should initiate a clinical and microbiological evaluation that includes tests for TB.

Primary TB

After inhalation of the tubercle bacillus, an early inflammatory response develops at the site of infection that is referred to as the primary focus or Ghon focus. The Ghon focus may be visualized on the chest radiograph as an airspace opacity and is commonly associated with a radiographically evident enlargement of the ipsilateral hilar or paratracheal lymph nodes. The combination of the Ghon focus and ipsilateral lymphadenopathy is called the primary complex or Ranke complex.

In order to review the radiographic manifestations of primary TB, the findings are divided into the following categories:

- Distribution of parenchymal disease
- Patterns of disease
- Tracheobronchial disease
- Hilar and mediastinal lymphadenopathy
- Pleural disease

Distribution of parenchymal disease

Although primary TB can affect any segment of the lung parenchyma, the lower lobes are characteristically involved more often in primary TB than in reactivation disease. However, this predilection varies with age. In children, the upper and lower lobes are involved with equal frequency, whereas in adults, lower-lobe involvement is slightly more common.

Figures 2.1, 2.2, and 2.3 show examples of the parenchymal distribution of primary TB in children and adults.

Primary TB in children and adults

FIGURE 2.1. **Primary TB in a child: Example 1**

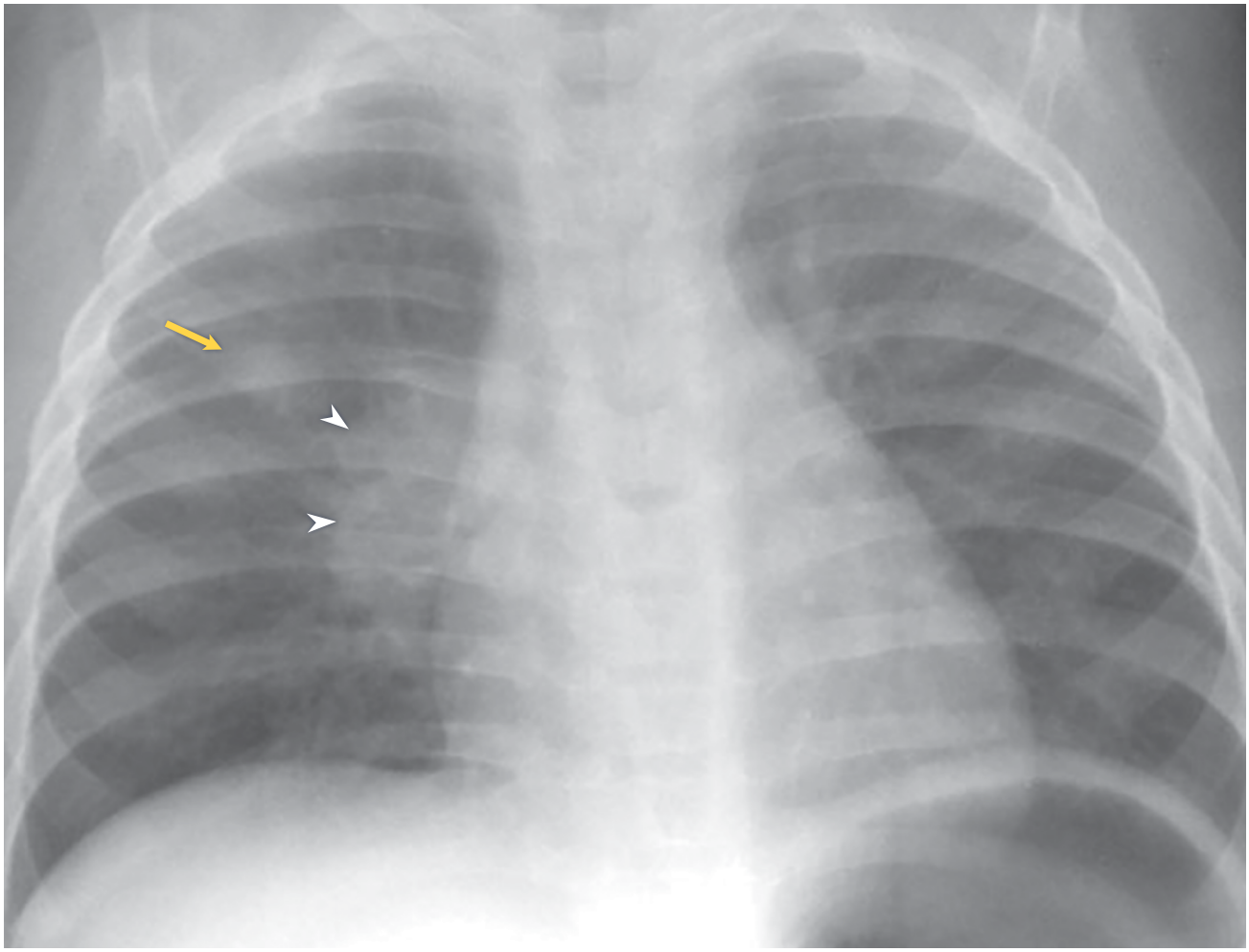


Figure 2.1 demonstrates a right upper-lobe nodule (arrow) and right hilar lymphadenopathy (arrowheads). This is an example of the primary complex (Ghon focus and ipsilateral hilar lymphadenopathy constituting a Ranke complex) that is typical of primary TB in a child.

FIGURE 2.2. **Primary TB in a child: Example 2**

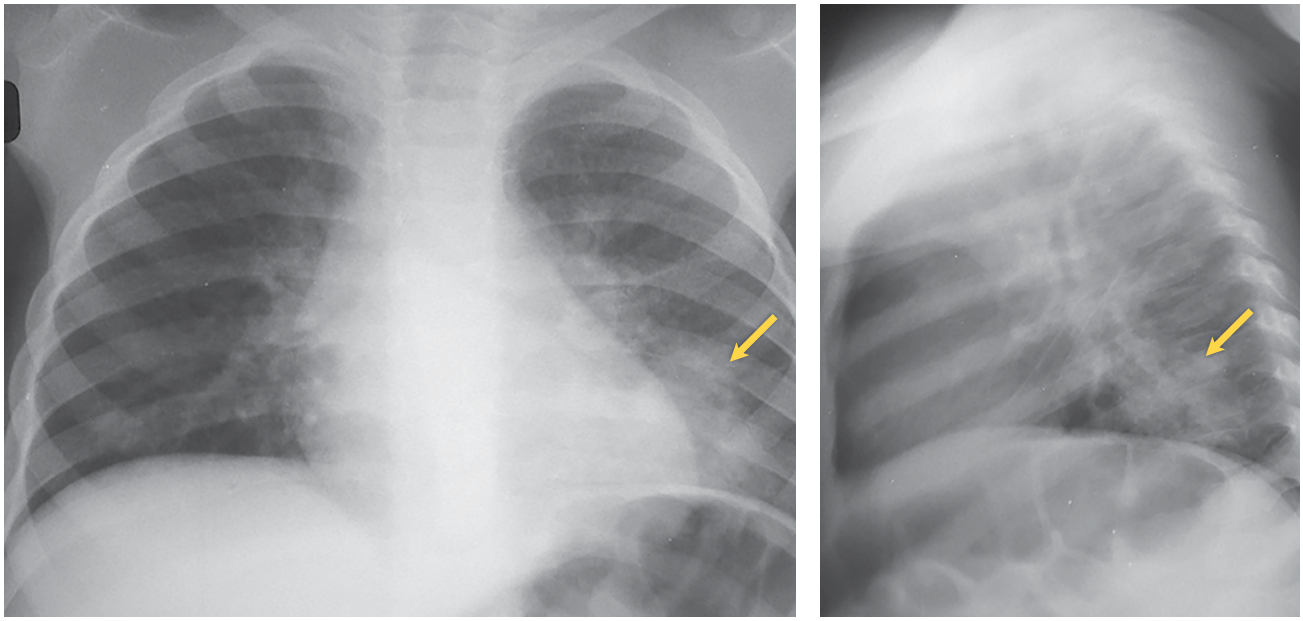


Figure 2.2 demonstrates left lower consolidation (arrow) in a 4-year-old child with TB.

- The upper and lower lobes are affected equally in children.
- Radiographically, the primary complex consists of a parenchymal opacity and enlargement of ipsilateral thoracic lymph nodes.
- Involvement of the anterior segment of the upper lobes can occur in primary disease but is uncommon in reactivation disease in adults.

FIGURE 2.3. **Primary TB in an adult**

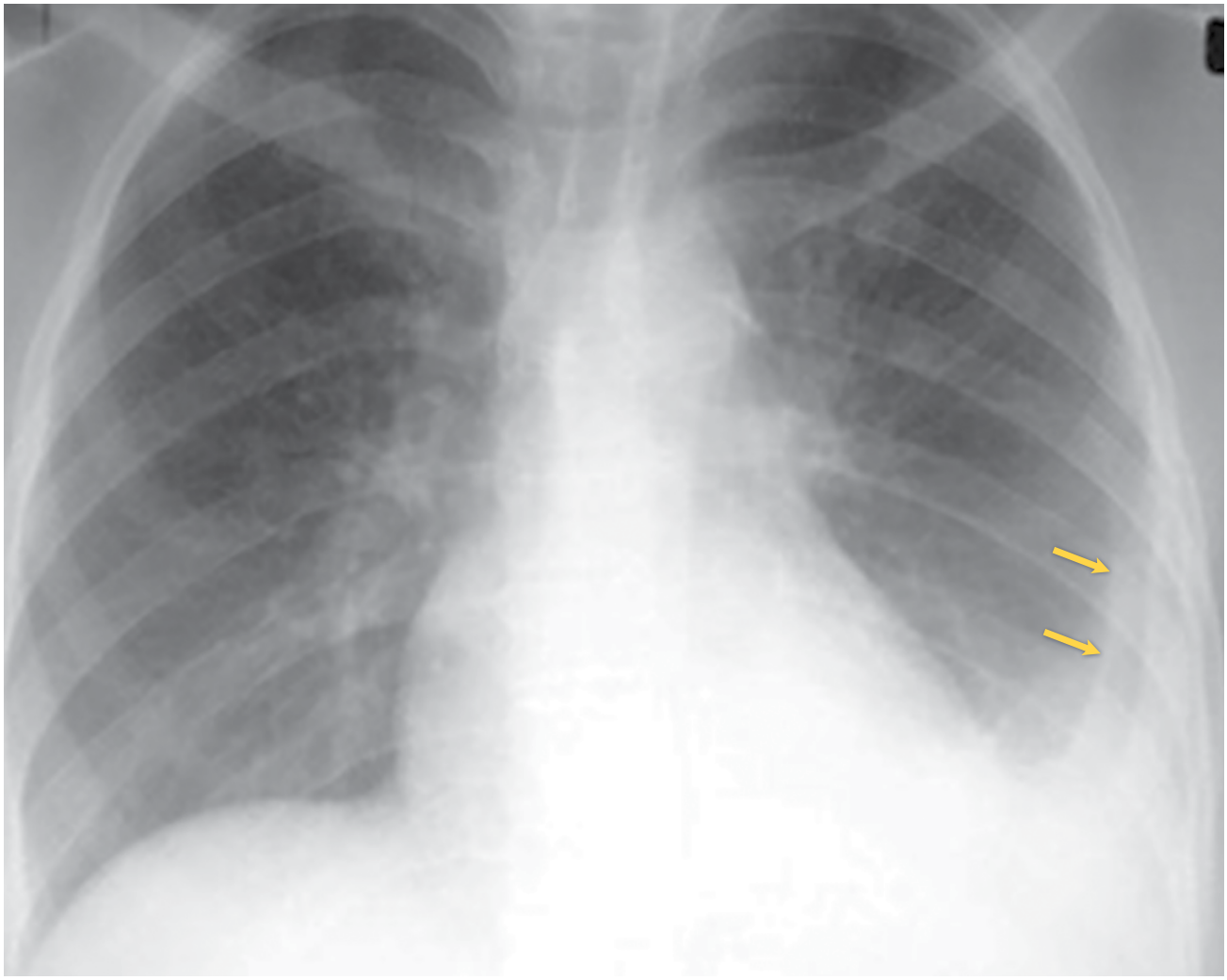


Figure 2.3 demonstrates left lower-lobe airspace opacity and a homogeneous opacity extending along the left lateral chest wall (arrows). These findings are consistent with consolidation and a pleural effusion, which are characteristic of primary TB in an adult. Note that the left hemidiaphragm is not visible (silhouette sign).

- The lower lobes are affected more often than the upper lobes in adults with primary disease.
- Anterior segment involvement can occur, which is unusual in reactivation disease.
- Cavitation, though unusual, can occur in adults with progressive primary TB.

Patterns of disease

In primary TB, parenchymal opacities may be airspace or interstitial in nature. Airspace consolidation is the most common radiographic pattern in primary disease. The most common interstitial pattern of primary disease is that of miliary (or disseminated) TB. Other primary manifestations of TB include tracheobronchial disease, hilar and mediastinal lymphadenopathy, and pleural disease.

Airspace consolidation

FIGURE 2.4. **Primary TB in a child with airspace consolidation**

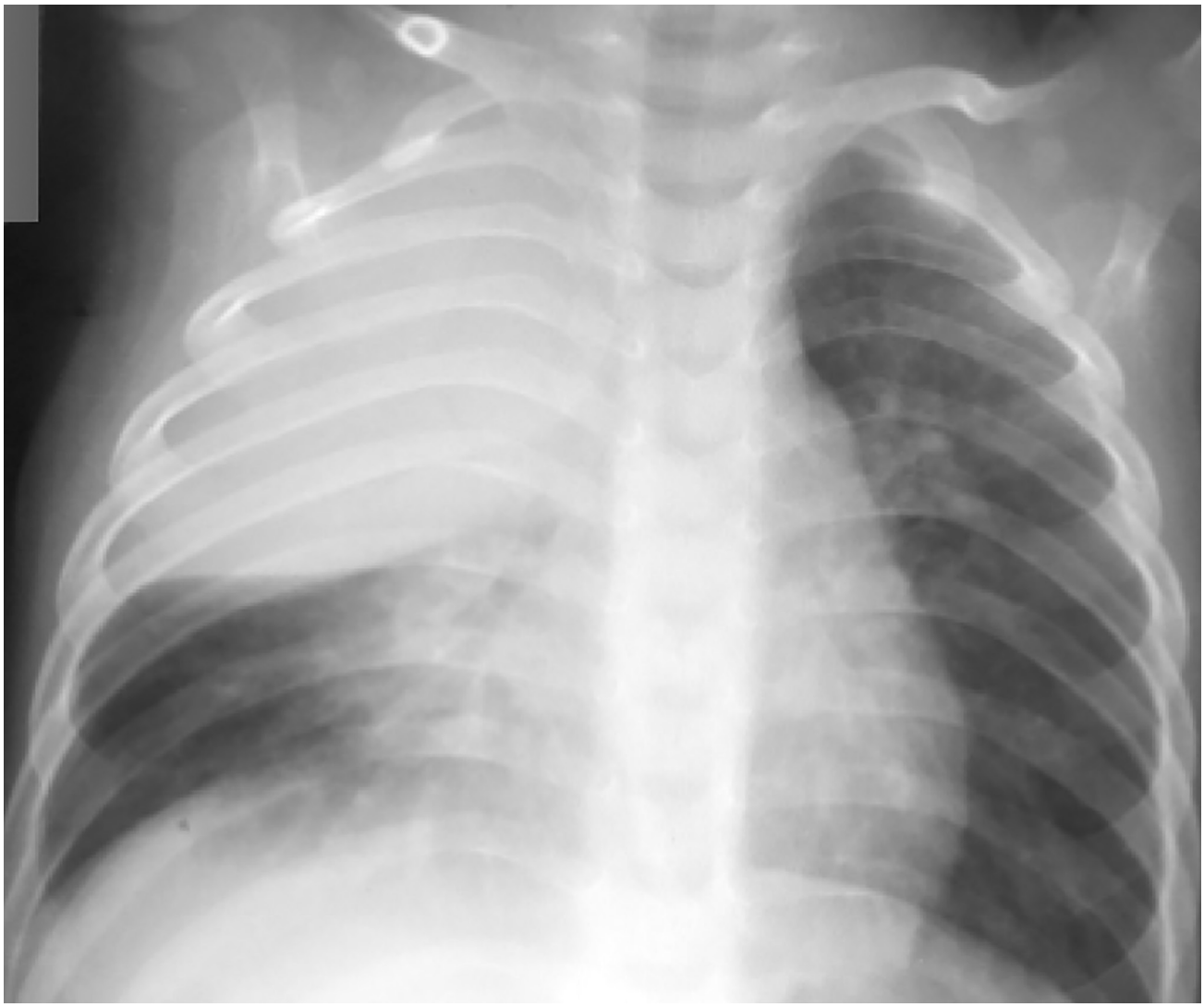


Figure 2.4 demonstrates a right upper-lobe consolidation in a young child. Note the absence of aerated lung in the right upper lobe.

FIGURE 2.5. **TB in a young adult with airspace consolidation**

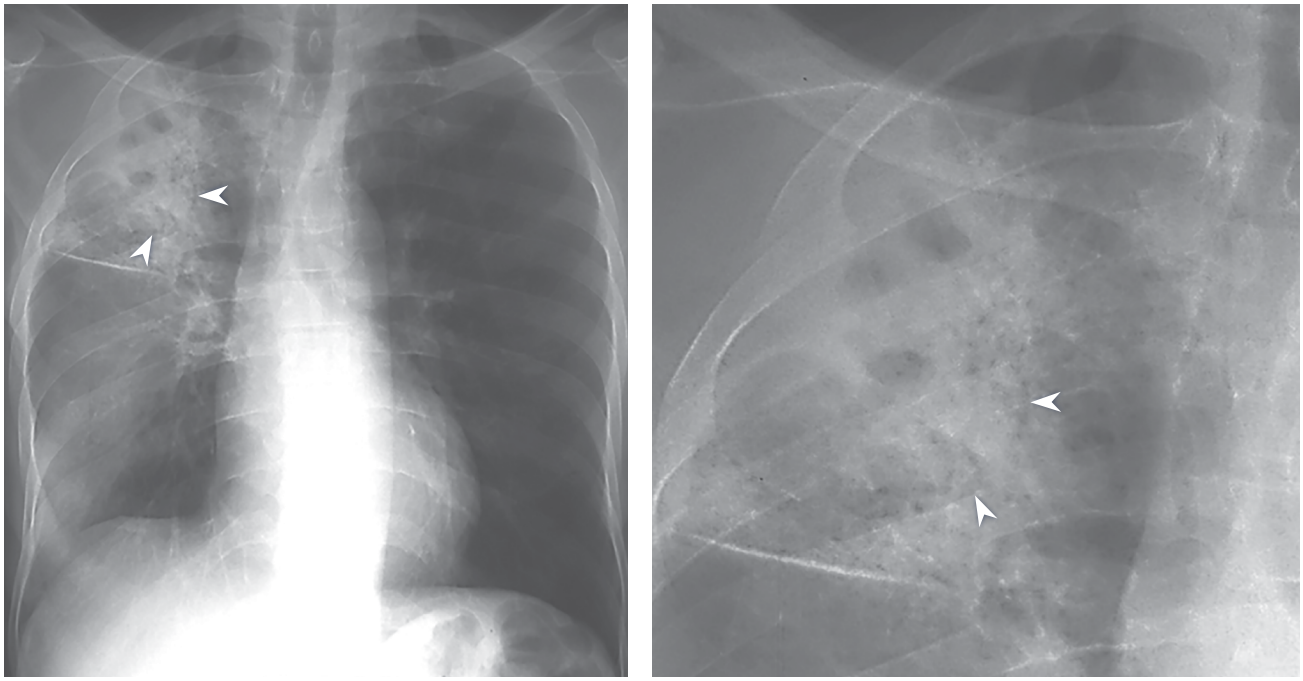


Figure 2.5 demonstrates right upper-lobe airspace consolidation with cavitation and air bronchograms (arrowheads), seen more clearly on the detail image of the right upper lobe. The patient was a college student with TB.

- Airspace consolidation is the typical appearance of primary disease in an adult.
- The consolidation is usually homogeneous in density.
- Air bronchograms may be visualized in the area of consolidation.
- Cavitation is unusual.

Airspace consolidation with cavitation

FIGURE 2.6. **Primary TB with cavitation**

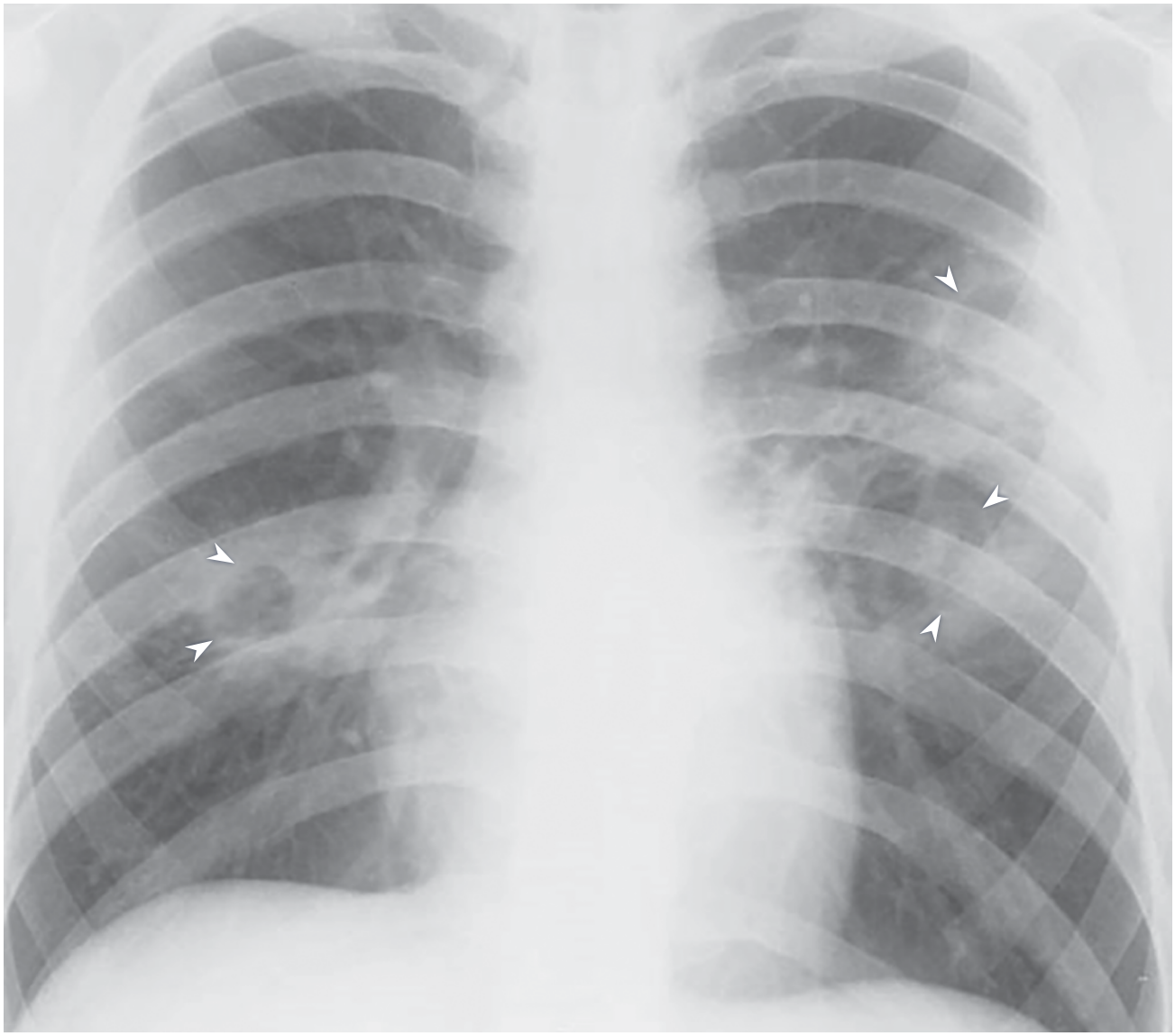


Figure 2.6 demonstrates bilateral opacities with foci of cavitation (arrowheads). The patient was a 35-year-old man who developed TB soon after exposure to another infected individual.

- Cavitation is relatively uncommon in primary disease, particularly in young children.
- Cavitation can occur with progressive primary disease.

Interstitial pattern (miliary)

FIGURE 2.7. **Miliary pattern**

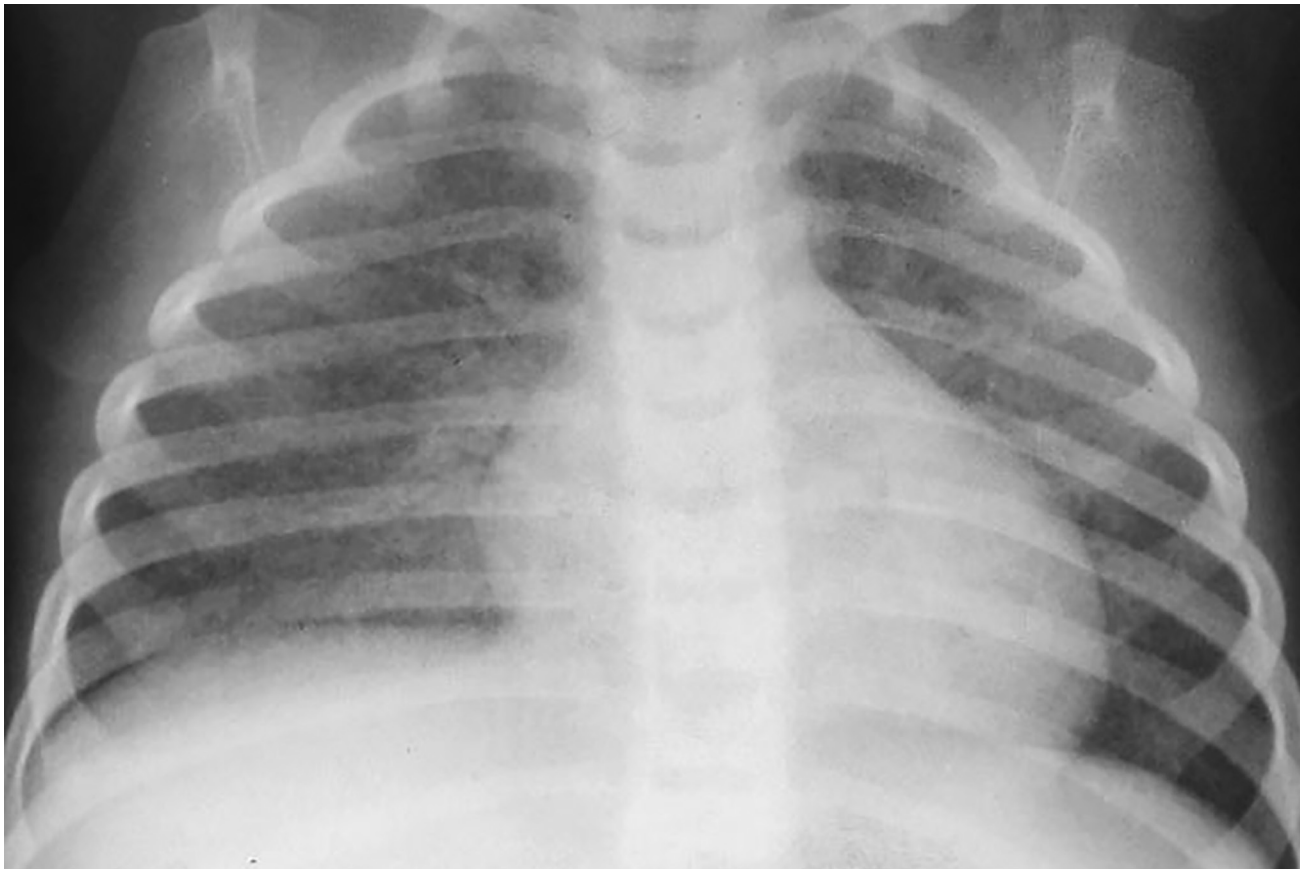


Figure 2.7 demonstrates bilateral diffuse small nodules (2-3 mm in diameter) consistent with a miliary pattern. The patient was a 5-year-old girl with disseminated TB.

- Miliary disease can occur as a consequence of primary or reactivation disease.
- A miliary pattern results from hematogenous dissemination of tubercle bacilli that leads to many nodules of similar size, initially present in the interstitium and ultimately involving the air spaces.
- Most of the nodules in miliary TB are 2 mm in diameter (the size of a millet seed).
- Because miliary nodules result from hematogenous dissemination, more nodules are usually present in the lower-lung zones because of greater blood flow to the bases compared with the apices of the lungs.

Tracheobronchial disease

Lung volume loss (atelectasis) can be caused by fibrotic scarring, endobronchial obstruction, or extrinsic compression of airways by enlarged lymph nodes. Extrinsic compression of airways is particularly common in children because they have compressible airways. In primary TB, endobronchial lesions and extrinsic compression by enlarged lymph nodes are the most common reasons for volume loss.

FIGURE 2.8. **Airspace consolidation with atelectasis**

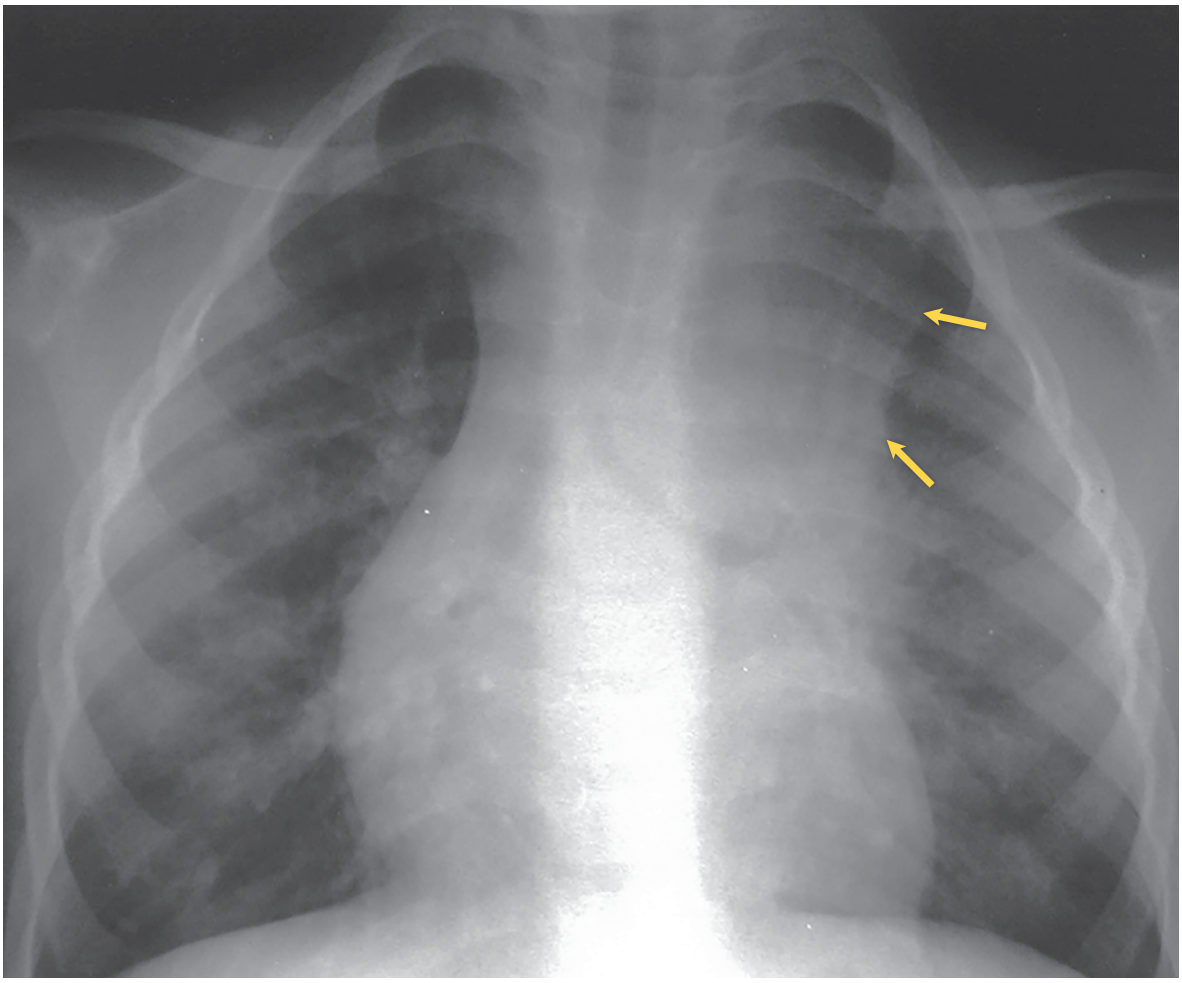


Figure 2.8 demonstrates left upper-lobe airspace opacification with atelectasis. The inferior margin of the airspace consolidation is straight and well visualized (arrows) against the air-containing lower lobe. This represents the major fissure separating the upper and lower lobes.

- Atelectasis caused by TB may result from obstruction of an airway from endobronchial disease or from extrinsic compression due to enlarged lymph nodes.
- The anterior segment of the upper lobe or the medial segment of the middle lobe is most often involved.
- Although less common in adults, segmental collapse is most likely to affect the anterior segment of the upper lobes.

Hilar and mediastinal lymphadenopathy

Early in the pathogenesis of TB, tubercle bacilli spread via lymphatics to draining lymph nodes in the hilar areas and mediastinum. Enlargement of these lymph nodes can sometimes be visualized on the chest radiograph. Lymphadenopathy is particularly common in children with primary TB and adults who are HIV positive.

FIGURE 2.9. **Lymphadenopathy: Example 1**

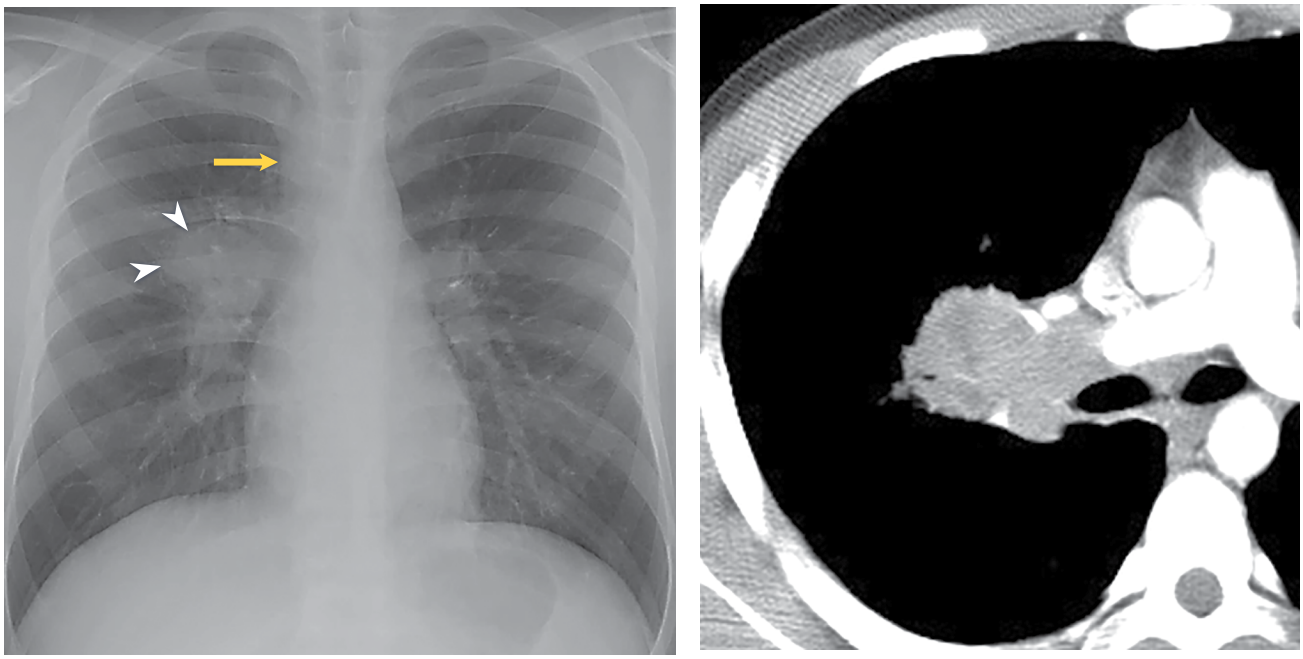


Figure 2.9. Radiograph of a 13-year-old boy (left) demonstrates right hilar (arrowheads) and paratracheal (arrow) lymphadenopathy. The bulky right hilar lymph node enlargement is well seen on CT (right).

- Lymphadenopathy is common among children and persons who are HIV positive.
- There is a predilection for the right side, especially in the paratracheal and hilar areas.
- The younger the child, the more often lymphadenopathy without associated parenchymal disease is seen.
- Enlarged lymph nodes may cause compression of airways leading to atelectasis.
- A lateral chest radiograph is often necessary to confirm the presence of hilar lymphadenopathy in young children. For this reason, two-view chest radiographs are recommended in the pediatric population.

FIGURE 2.10. **Lymphadenopathy: Example 2**

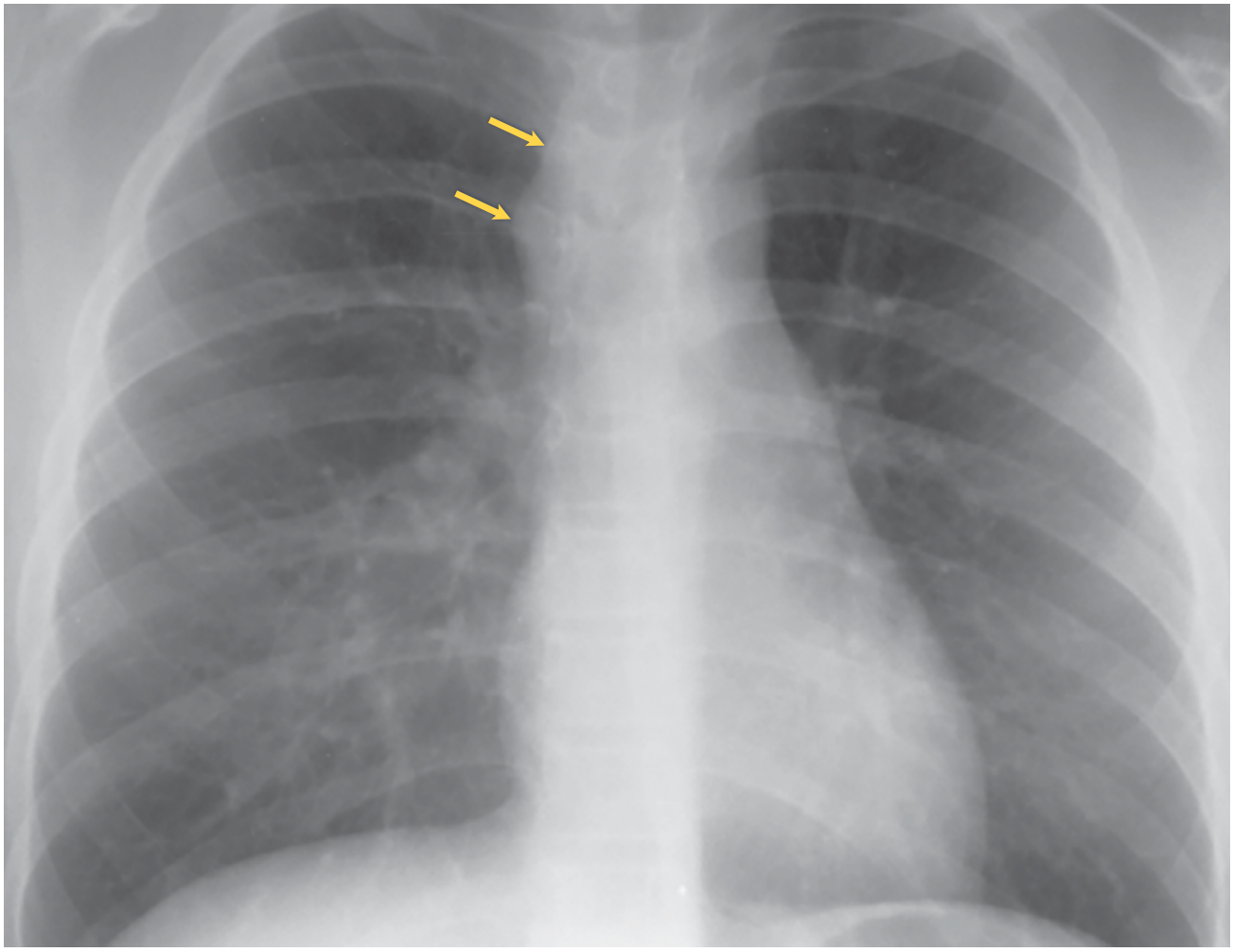


Figure 2.10. Chest radiograph of a 10-year-old child with TB shows thickening of the right paratracheal stripe (arrows) due to lymphadenopathy.

FIGURE 2.11. **Lymphadenopathy: Example 3**

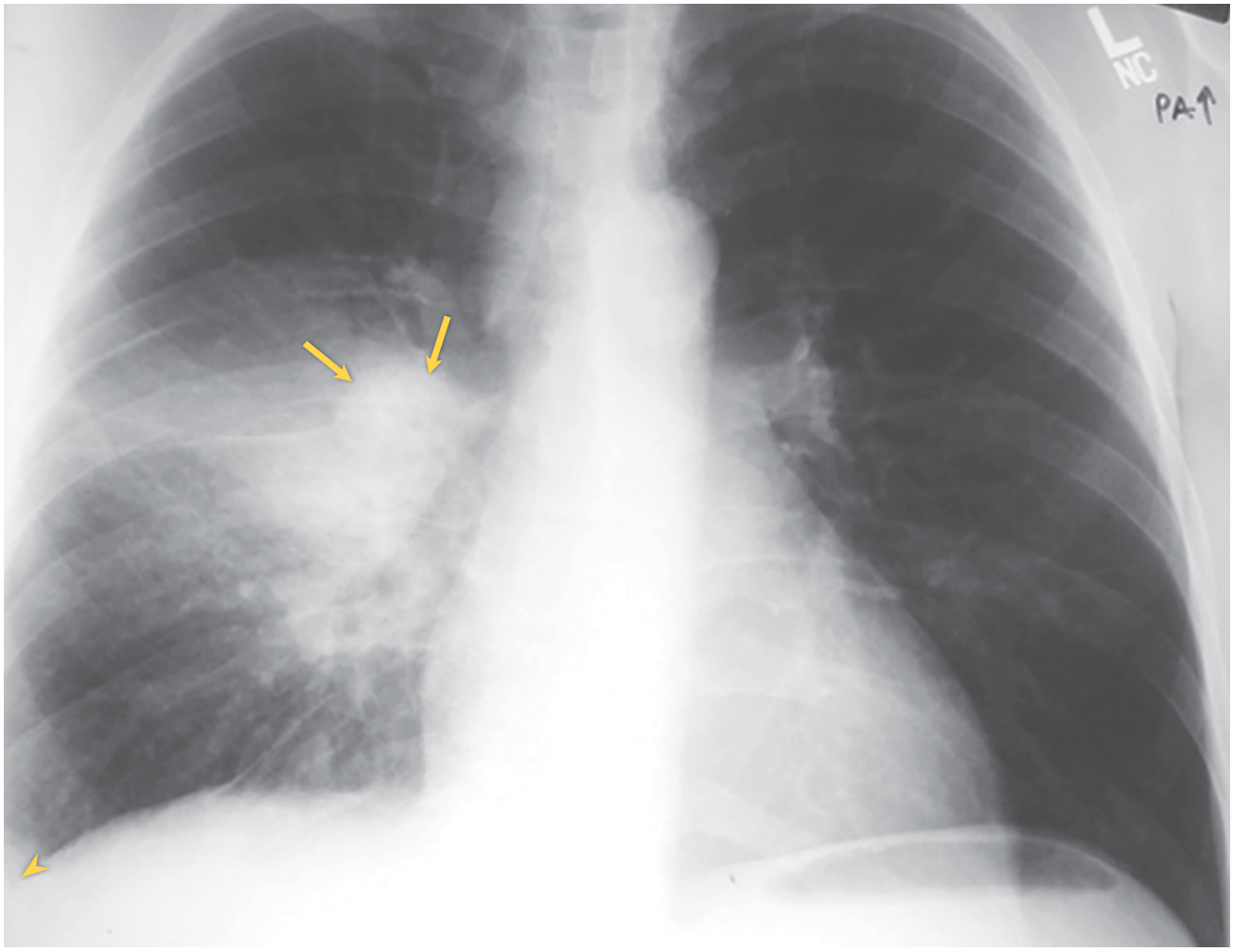


Figure 2.11. Frontal chest radiograph shows right hilar lymphadenopathy (arrows), right mid-lung airspace opacity, and blunting of the right costophrenic angle (arrowhead) consistent with a small pleural effusion. This HIV-negative patient had culture-confirmed primary TB.

Pleural disease

Pleural effusions that develop in the setting of primary disease are usually due to a delayed-type hypersensitivity reaction. These effusions can vary in size from small to large, sometimes occupying an entire hemithorax. In many cases, no parenchymal abnormality can be visualized on plain radiographs, although CT scans and autopsy studies have documented underlying parenchymal disease in most cases. Recognizing a pleural effusion is important so that pleural fluid can be aspirated for diagnostic studies.

FIGURE 2.12. **Pleural effusion**

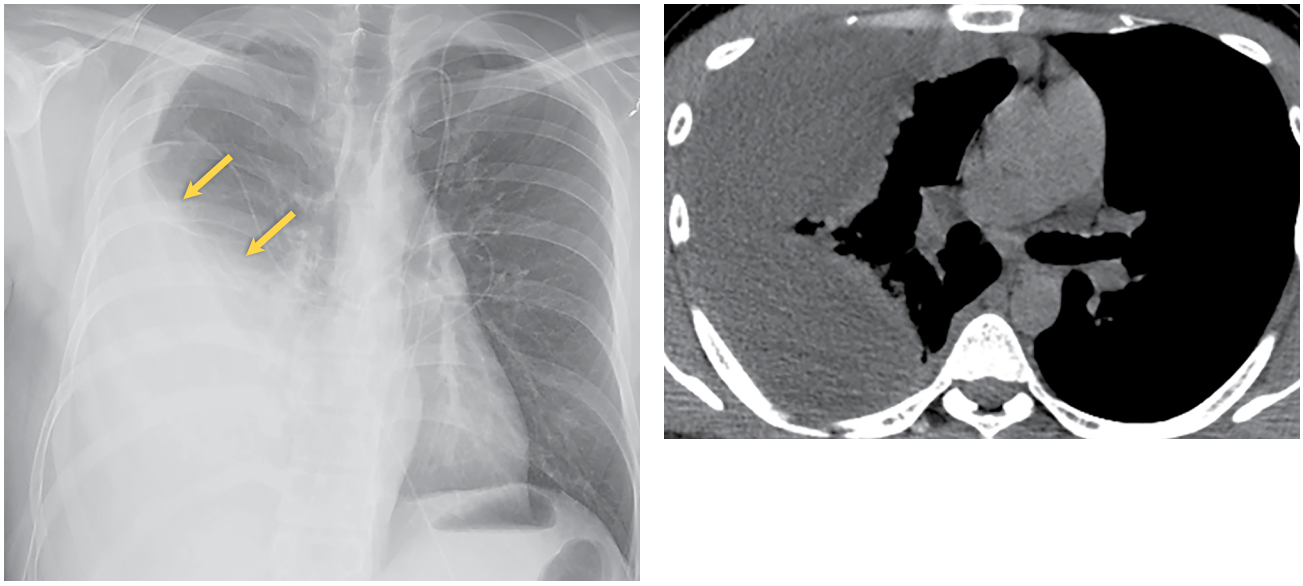


Figure 2.12 demonstrates a large right-sided pleural effusion (arrows), confirmed on CT. Note that the diaphragmatic border cannot be seen because the pleural liquid induces atelectasis in the right middle and right lower lobes, obscuring the right hemidiaphragm and right heart border (silhouette sign).

- Pleural effusions are uncommon in children (10%).
- Pleural effusions are very common in adults with primary TB (40%).
- Pleural effusions may represent the only manifestation of primary TB, particularly in adolescents and young adults.
- Pleural effusions are usually unilateral and may vary in size.

Reactivation (post-primary) TB

Reactivation* TB (also referred to as post-primary TB) is the most common form of disease in adults and occurs in individuals who have developed cell-mediated immunity to *M. tuberculosis*. In most individuals with latent TB infection, the immune system is able to control the infection. In some individuals, however, the organism can reactivate and proliferate, leading to reactivation TB.

Although the radiographic manifestations of reactivation TB overlap those of primary disease, there are several distinguishing features:

- Predilection for upper lobes
- Lack of lymphadenopathy
- Propensity for cavitation

Cavitation is an important characteristic of reactivation TB. In TB, cavities occur as the result of necrosis of lung tissue (caseous necrosis) and contain large numbers of mycobacteria. Hilar and mediastinal lymphadenopathy will not be discussed here because they are unusual in the setting of reactivation TB. As with the previous discussion of primary disease, this section will examine the radiographic manifestations of reactivation TB using the following categories:

- Distribution of parenchymal disease
- Patterns of disease

* The term “reactivated” is considered by some a misnomer as it implies prior “activity” but in most circumstances represents a progression from latent infection onward to active TB disease.

Distribution of parenchymal disease

As with primary TB, any lung segment can be involved with reactivation TB. However, reactivation TB typically involves apical and posterior segments of the upper lobes. If the lower lobe is involved, the superior segment is the most common site of disease. Isolated anterior segment involvement, without other segmental disease, is very unusual in reactivation TB. The predilection for the upper lobes is thought to be due to decreased lymph flow in the upper regions of the lung. An alternative explanation is the presence of higher oxygen tension in that region.

FIGURE 2.13A. **Reactivation (post-primary) TB**

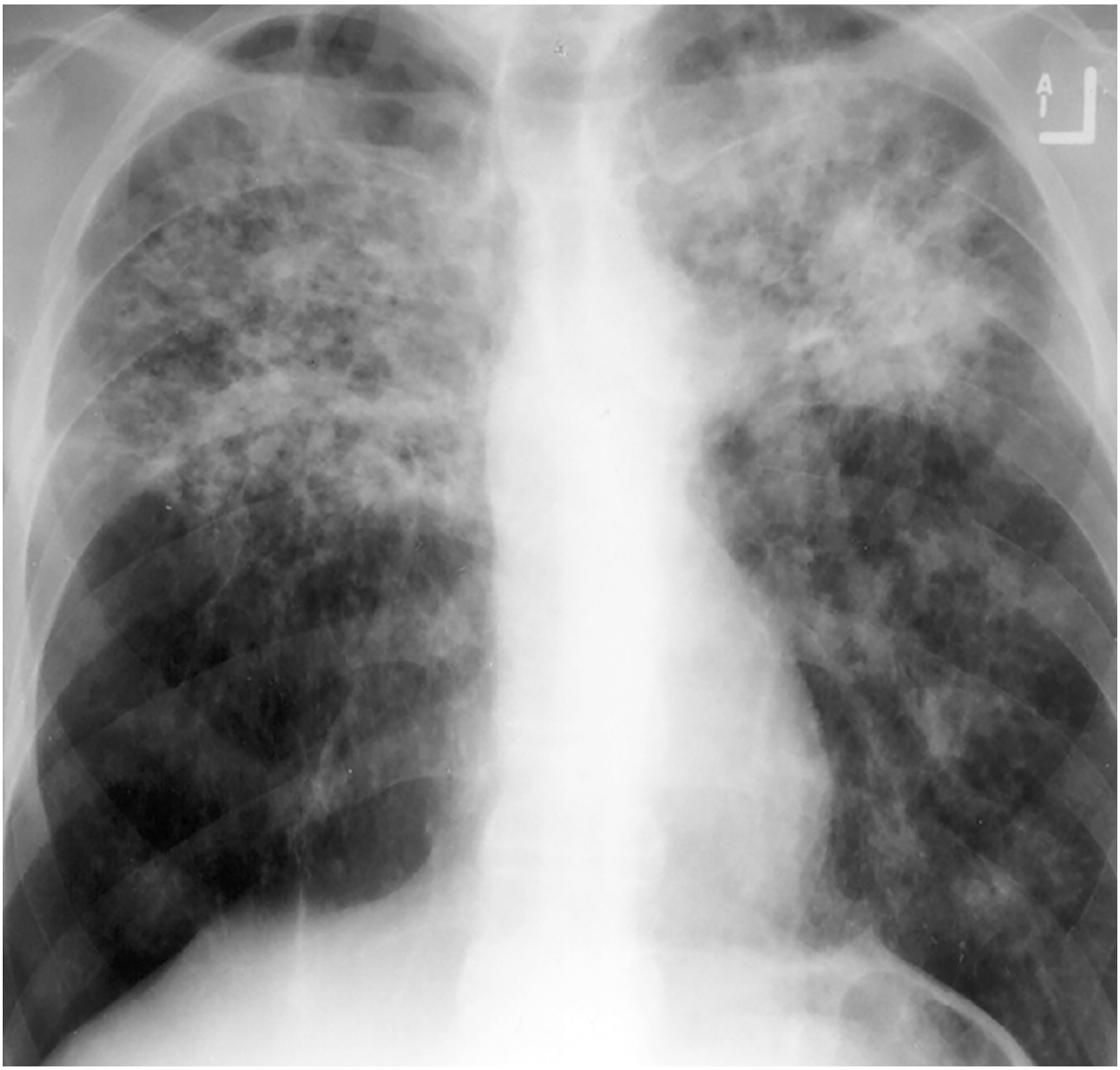


Figure 2.13A demonstrates consolidation in the apical and posterior segments of the right upper lobe and the apicoposterior segment of the left upper lobe, abnormalities characteristic of reactivation TB. Note the upward retraction of the hilar structures, an indication of volume loss.

FIGURE 2.13B. **Reactivation (post-primary) TB, lateral view**

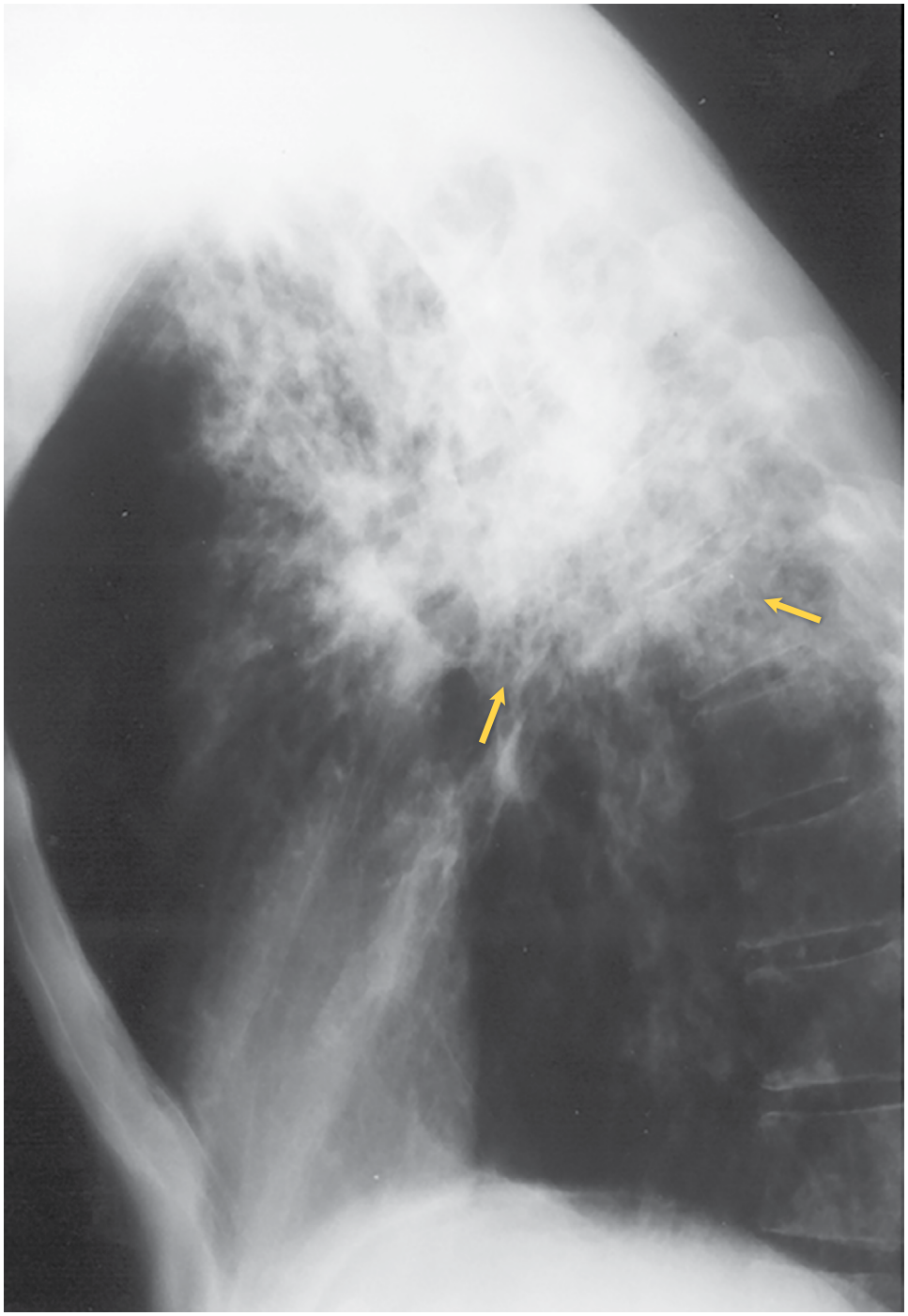


Figure 2.13B, a lateral view of the same patient in Figure 2.13A, shows the typical location of the apicoposterior segment of the left upper lobe, outlined by arrows.

- Reactivation TB characteristically involves the apical and posterior segments of the upper lobes or the superior segment of the lower lobes.
- This upper-lobe apical and posterior distribution is so typical that involvement of the anterior segment of the upper lobe without apical or posterior opacities makes the diagnosis of reactivation TB unlikely.
- In most cases, more than one pulmonary segment is involved.

Patterns of disease

Airspace consolidation is the most common pattern of reactivation disease, as in primary TB. In most cases, however, there is a mixture of radiographic patterns. Note: Disease activity cannot be determined based on the pattern of parenchymal involvement.

Airspace consolidation

FIGURE 2.14. **Airspace consolidation with cavitation: Example 1**

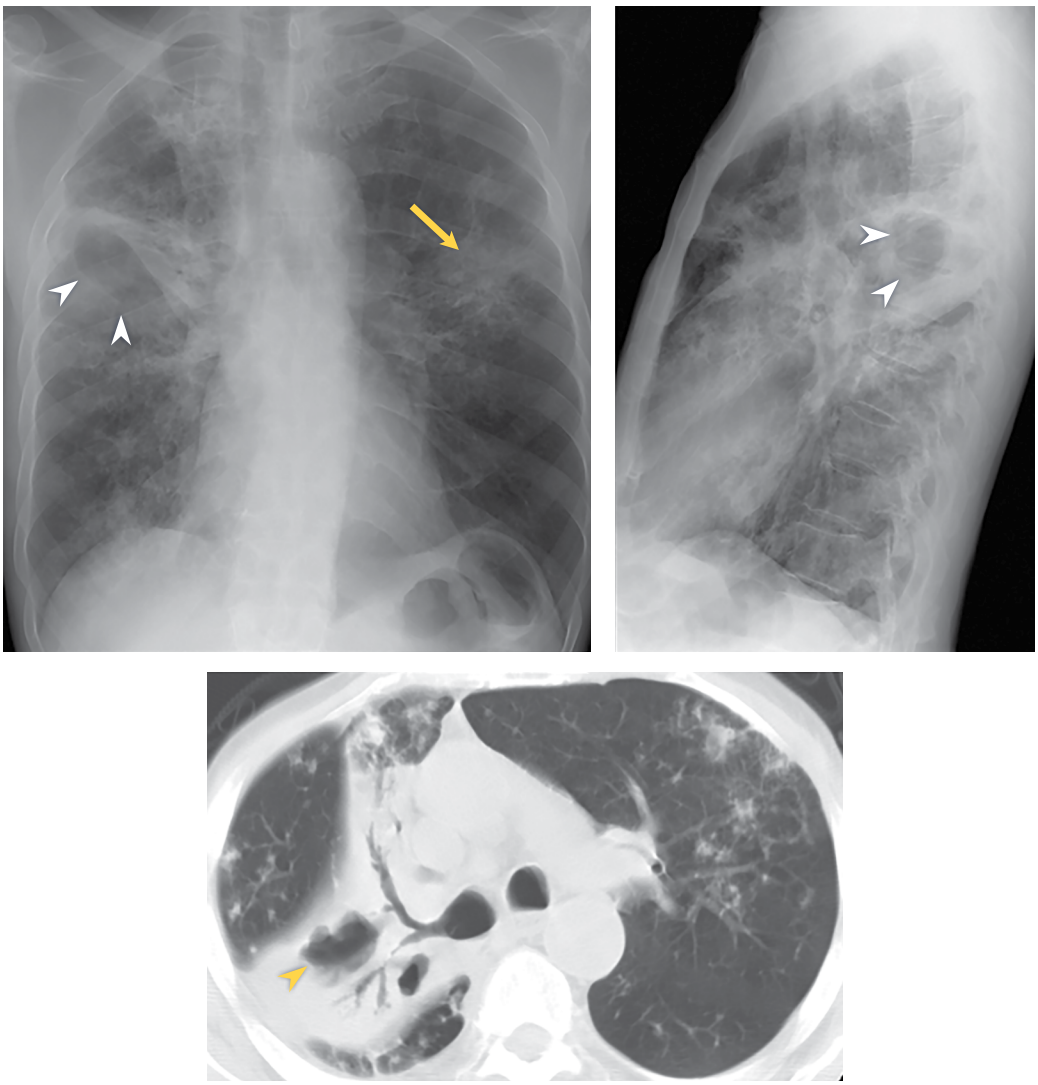


Figure 2.14 demonstrates airspace consolidation (arrow) in the bilateral upper lobes with areas of cavitary consolidation (arrowheads), particularly well seen on CT. Left upper-lobe nodules are also evident on CT.

- Airspace consolidation is the most common parenchymal pattern in reactivation disease.
- Consolidation may be patchy or confluent.
- Air bronchograms may be present within the area of consolidation.
- Cavitation is commonly seen within the consolidated lung.

FIGURE 2.15. **Airspace consolidation with cavitation: Example 2**

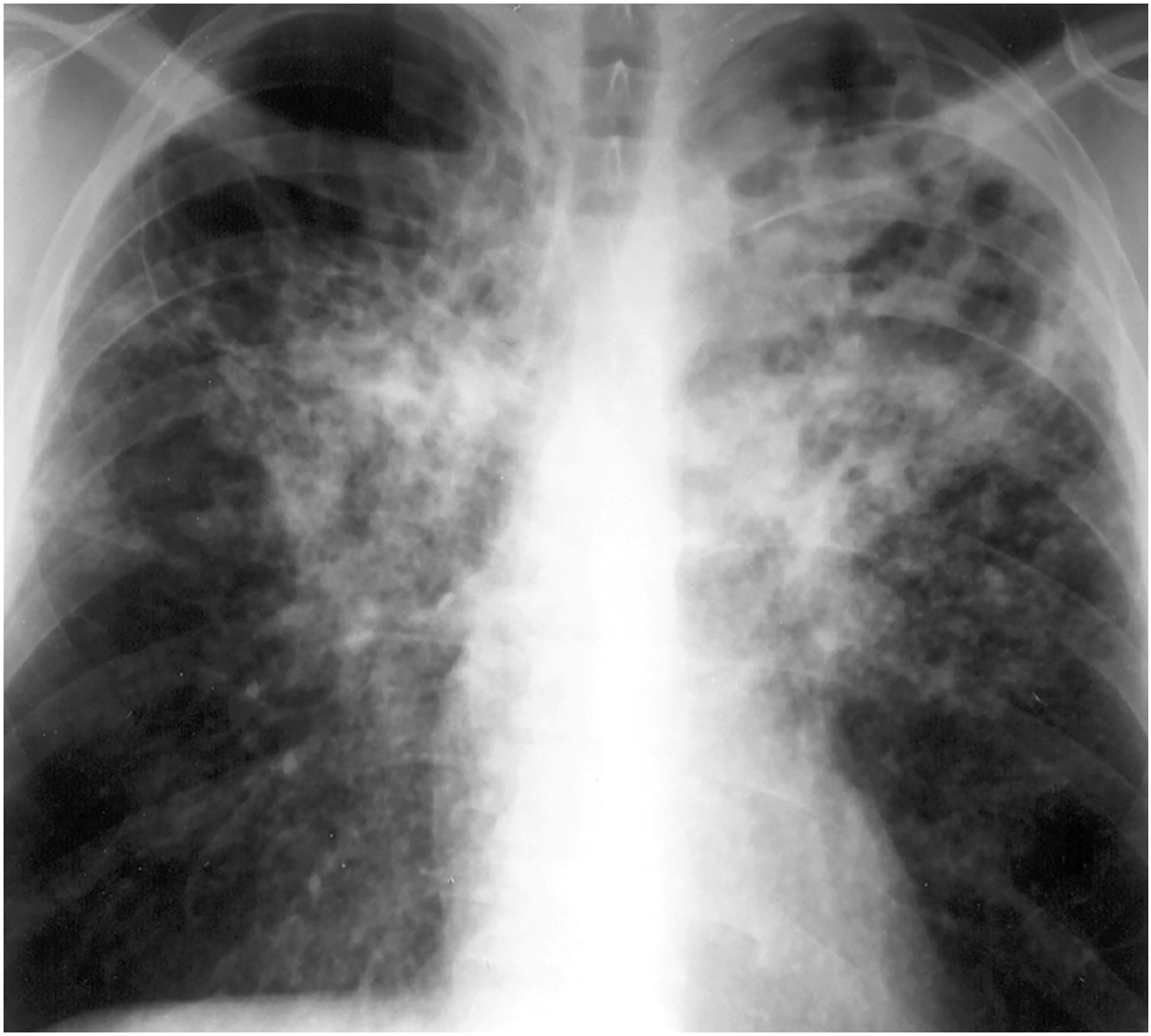


Figure 2.15 demonstrates bilateral airspace consolidation with multiple areas of lucency indicating cavitation.

- Important radiographic features of cavities include the thickness of the cavity wall (walls of cavities are thicker than those of cysts), the presence of fluid, and whether lesions are solitary or multiple.
- Cavitation on chest radiographs is present in more than half of reactivation cases, although it is uncommon in persons with immunosuppressive conditions such as HIV/AIDS.
- Air-fluid levels within cavities caused by TB are uncommon but may occasionally be seen.

FIGURE 2.16. **Airspace consolidation with bronchogenic spread: Example 3**

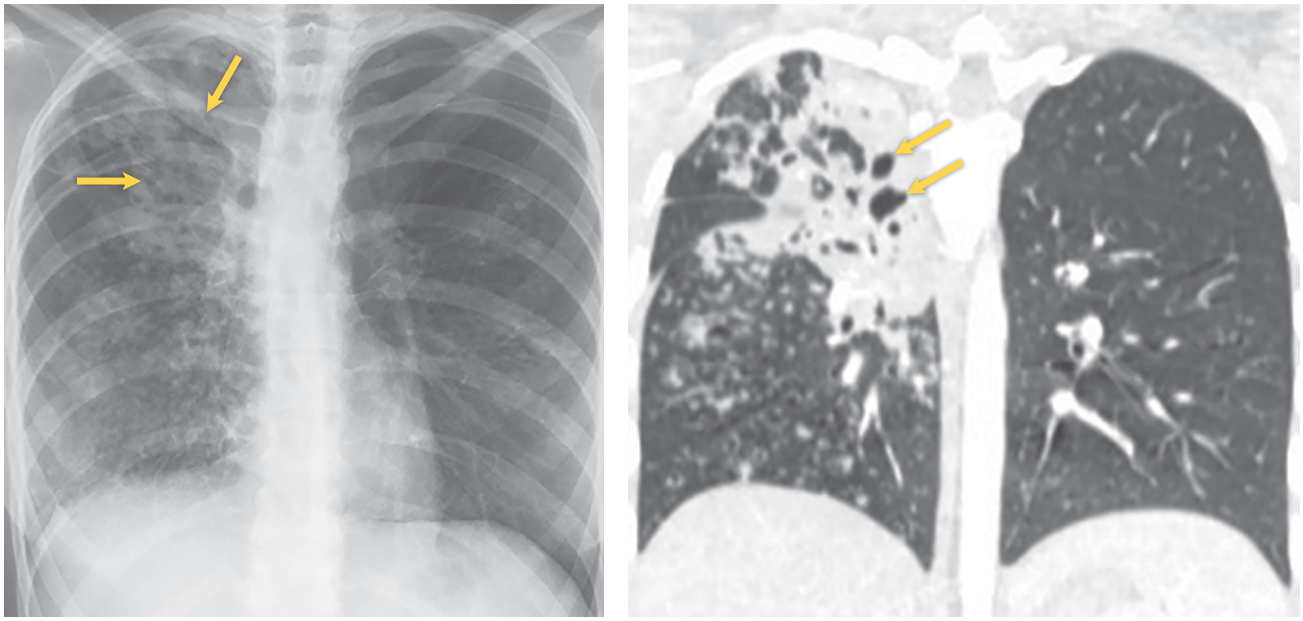


Figure 2.16 demonstrates bilateral (right greater than left) upper-lobe airspace consolidation. There is a large cavity in the right upper lobe (arrows). Note the nodular airspace opacities in the left upper lobe and throughout the right lung that represent bronchogenic spread of TB from the right upper lobe.

- In TB, a bronchogenic pattern results from the spread of infectious material within the bronchial tree, leading to new foci of infection in other bronchopulmonary segments, manifested as airspace nodules.
- Airspace nodules are 4-10 mm in diameter. They have poorly defined borders and multiple small lucent foci within their confines caused by air within bronchioles and alveoli.
- These nodules are best seen with high-resolution CT.

Lung volume loss

Volume loss (atelectasis) can be caused by fibrosis, endobronchial obstruction, or extrinsic compression of airways by enlarged lymph nodes. In the setting of reactivation TB, volume loss is usually due to fibrosis. In some cases, fibrosis leads to narrowing of an airway (bronchostenosis), which can result in segmental or lobar collapse.

FIGURE 2.17. **Volume loss due to fibrosis**

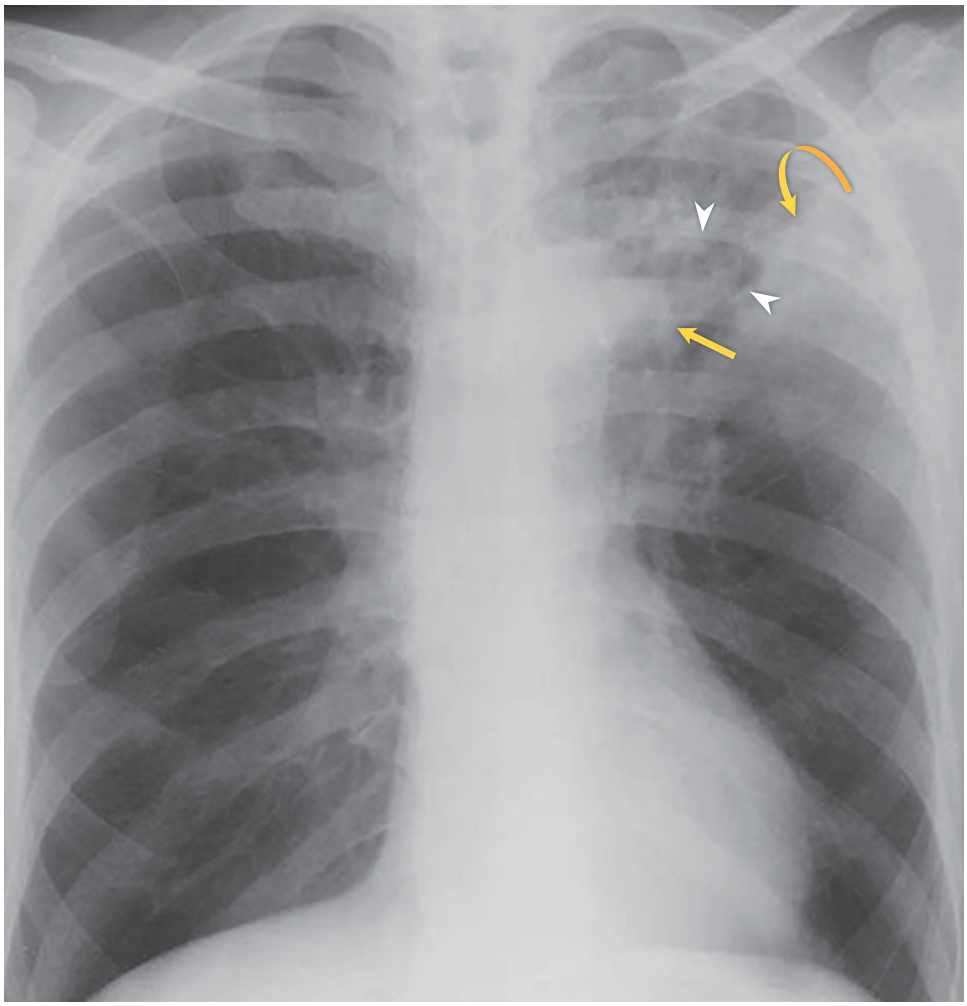


Figure 2.17 demonstrates airspace consolidation (curved arrow) and volume loss in the left upper lobe. The shift of the mediastinum and the left hilar elevation (arrow) are signs of volume loss or atelectasis. Note the area of cavitation (arrowheads).

- Post-primary TB is often associated with significant fibrosis. The resultant scarring can cause volume loss of the involved lung or lobe.
- Fibrotic lesions are often sharply defined and irregular in contour.
- These lesions are much more common in the upper lobes.
- Fibrotic lesions may be indicative of either active or prior TB, a distinction that can only be made by clinical and bacteriological evaluation.

FIGURE 2.18. **Left lower-lobe atelectasis due to bronchostenosis**

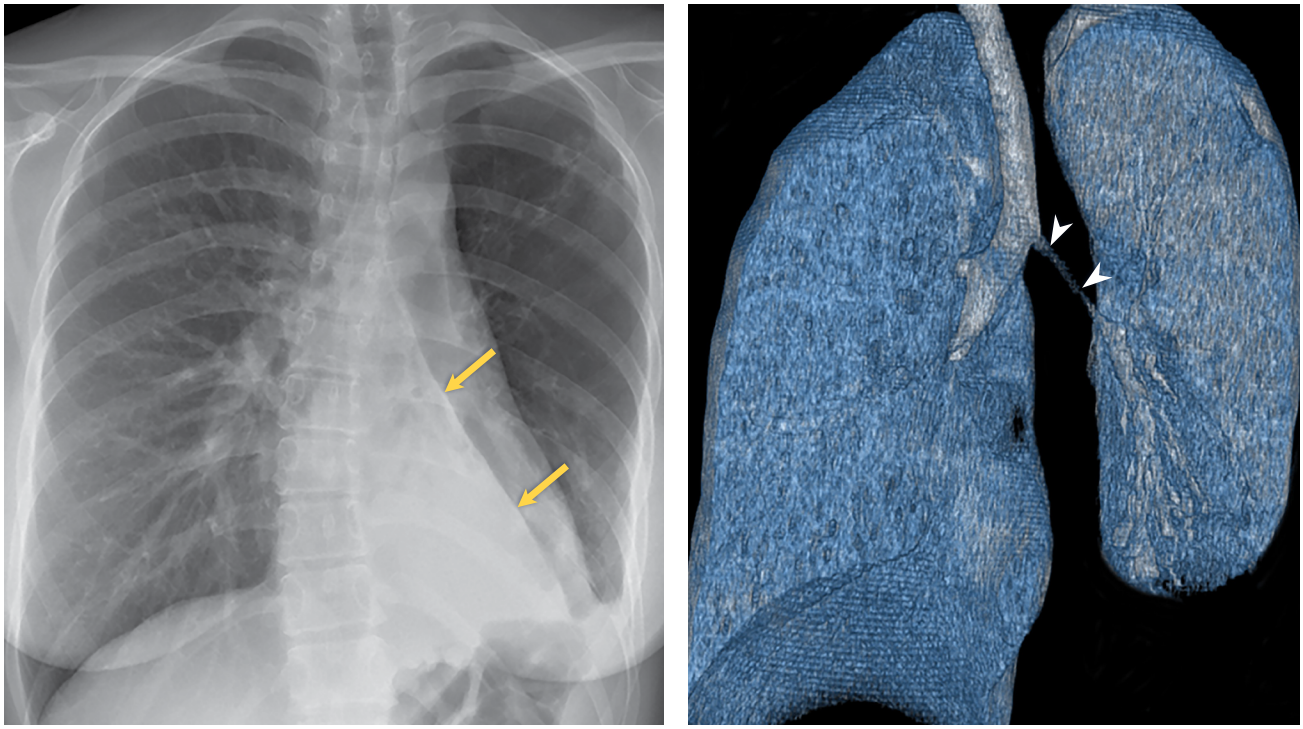


Figure 2.18. Frontal chest radiography (left) shows a left lower-lobe airspace opacity (arrows) obscuring the medial left hemidiaphragm and descending aorta. In addition, the left lung volume appears decreased, with relative hyperlucency of the left upper lobe and leftward shift of the trachea, due to left lower-lobe collapse and volume loss. Volume-rendered coronal CT (right) confirms left mainstem bronchostenosis (arrowheads). Bronchoscopy was performed to rule out a coexisting endobronchial tumor. This person with culture-confirmed TB was determined by bronchoscopy to have bronchostenosis.

FIGURE 2.19. **Right upper-lobe atelectasis due to bronchostenosis**

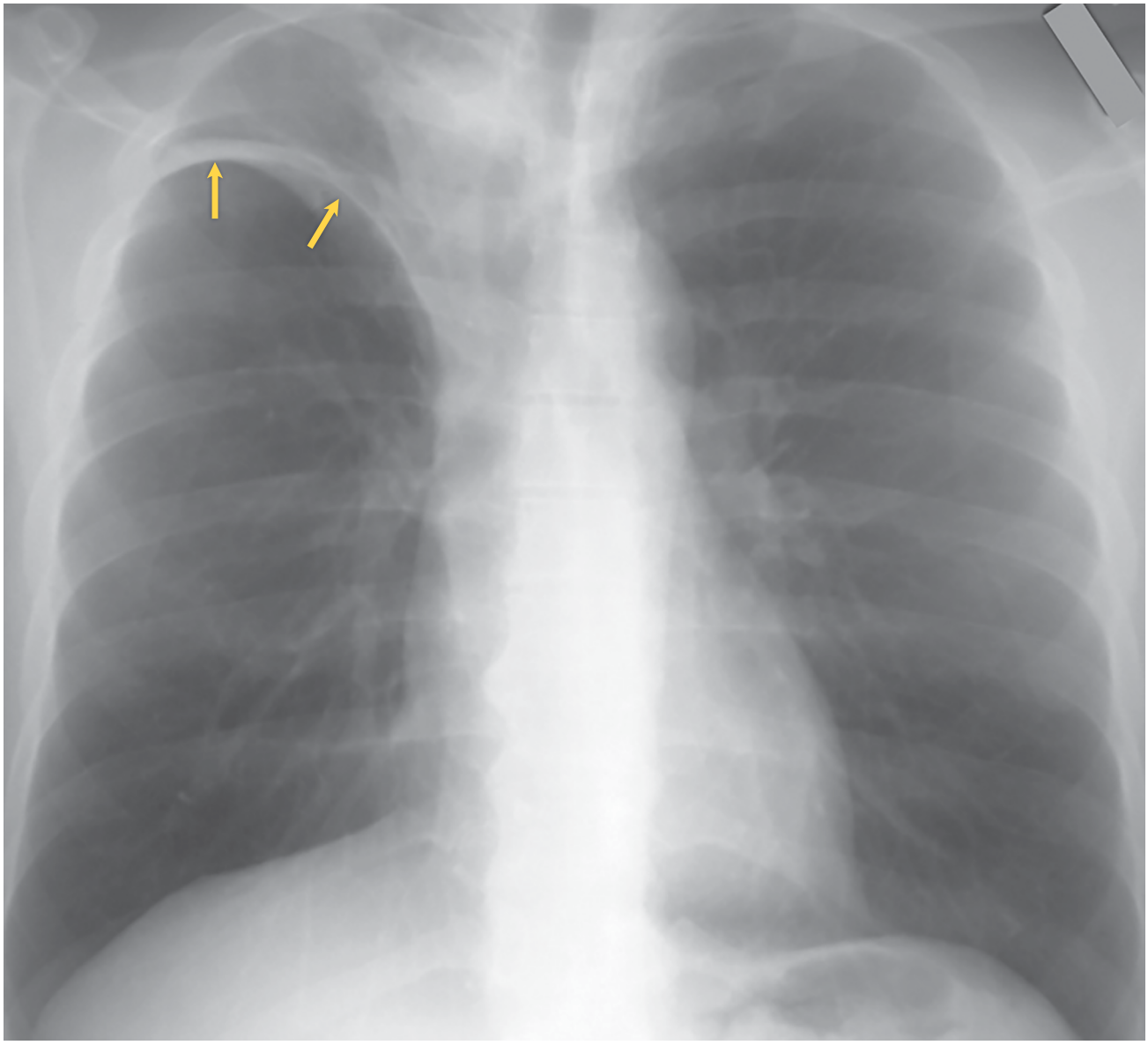


Figure 2.19. Frontal chest radiography shows right upper-lobe airspace opacity adjacent to the trachea with elevation of the minor fissure (arrows), indicating right upper-lobe collapse. This person with culture-confirmed TB was determined by bronchoscopy to have bronchostenosis.

Interstitial opacities (miliary)

FIGURE 2.20. **Miliary pattern**

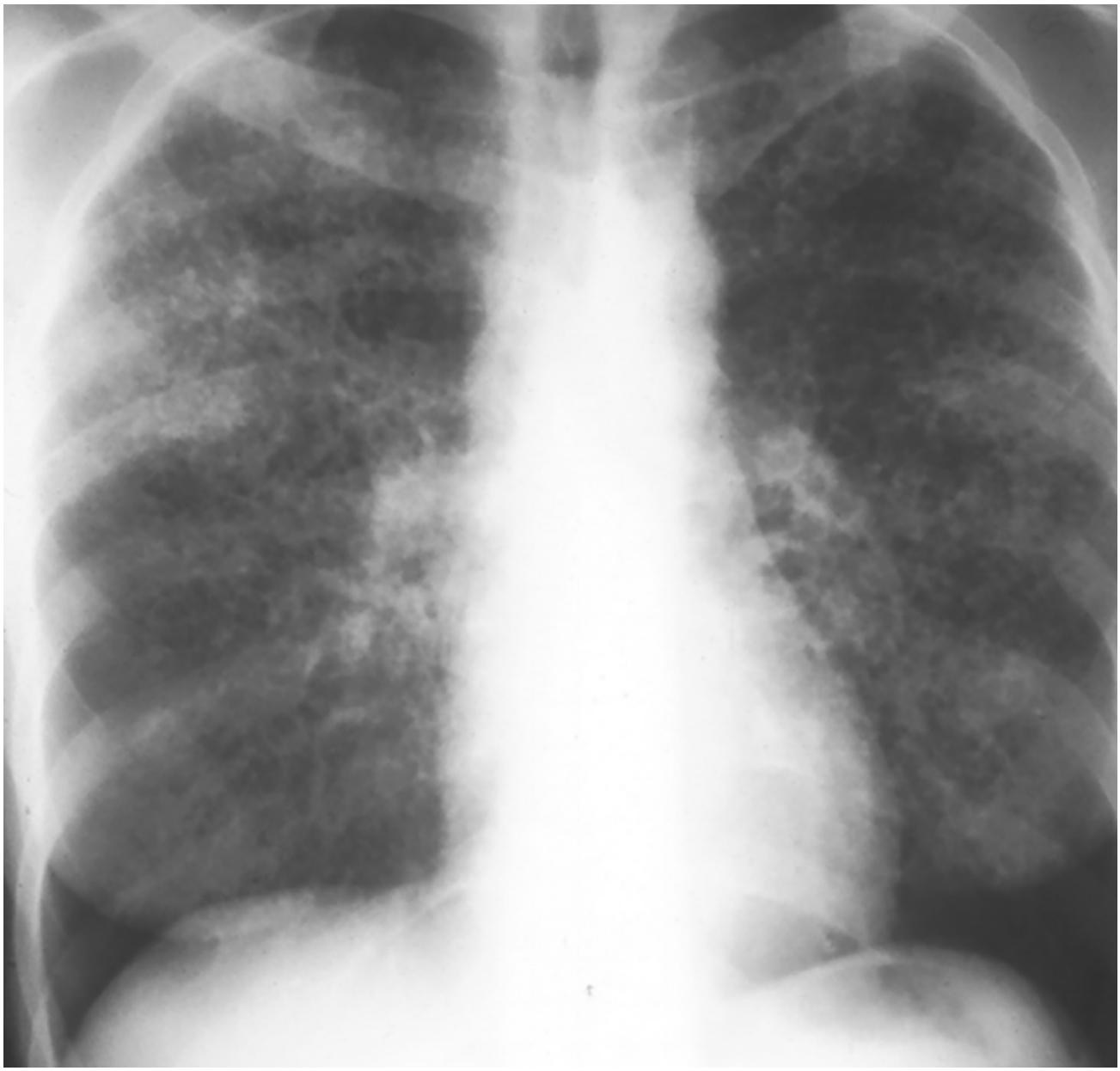


Figure 2.20 demonstrates bilateral diffuse small nodules characteristic of a miliary pattern.

- A miliary pattern results from hematogenous dissemination of tubercle bacilli.
- This dissemination leads to many nodules, initially present in the interstitium and ultimately involving the air spaces.
- Most of the nodules in miliary TB are 2-3 mm in diameter.
- Because miliary nodules result from hematogenous dissemination, more are present in the lower-lung zones due to greater blood flow to the bases compared with the apices of the lungs.

Tuberculoma

Tuberculomas are round or oval opacities, 1-5 cm in diameter, and usually found in the upper lobes. A tuberculoma is thought to be the residual of a healed primary infection. Although they may remain stable for many years, tuberculomas can be sites of disease reactivation, enlarging very slowly with the potential for cavitation.

FIGURE 2.21. **Tuberculoma**

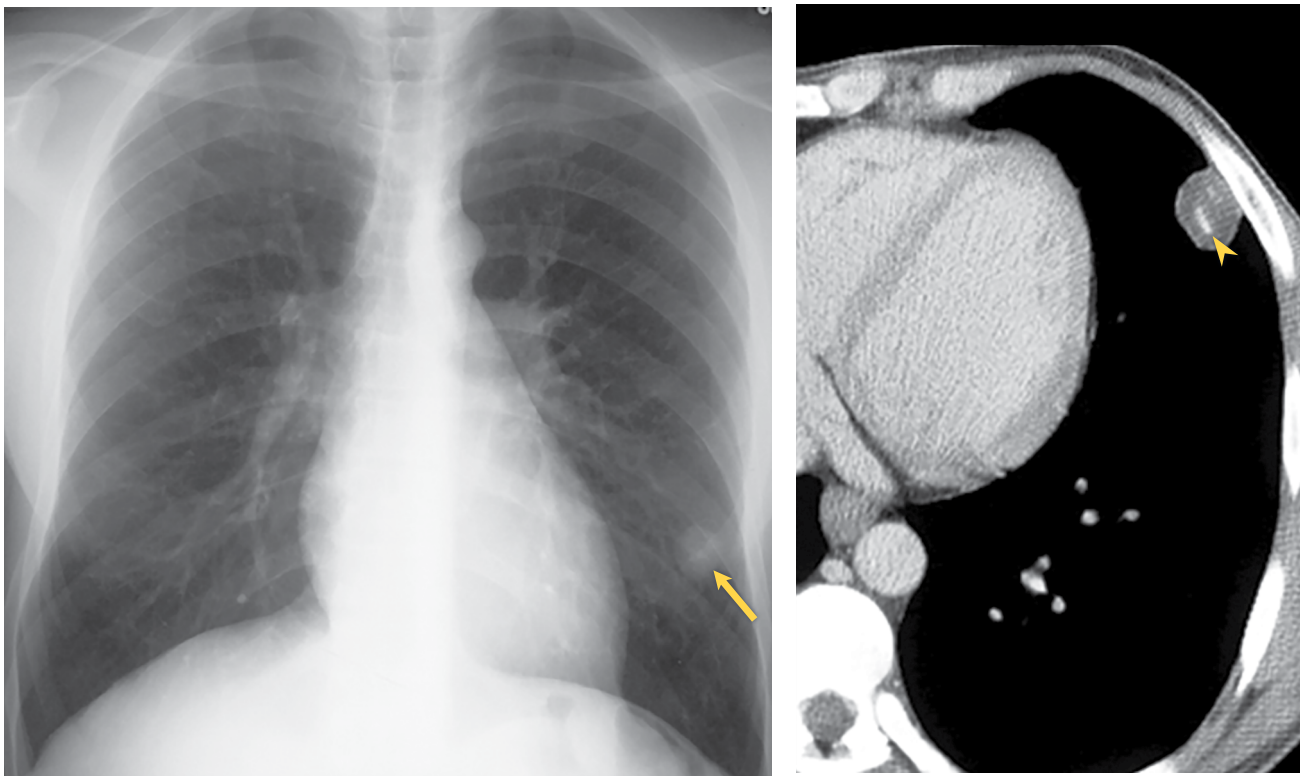


Figure 2.21 demonstrates a circumscribed nodule in the left lower lobe (arrow). Note the dense calcification (arrowhead) in the center of the nodule readily visualized on CT. Radiographically, tuberculomas can simulate a bronchogenic carcinoma.

- Tuberculomas are round or oval opacities, usually 1-5 cm in diameter, and usually found in the upper lobe.
- Tuberculomas are normally smooth and sharply defined.
- Satellite lesions, which are small, discrete nodules surrounding the tuberculoma, occur in 80% of cases and are clues to the diagnosis. However, they may only be visible on high-resolution CT.

Pleural disease

Pleural effusions can be a manifestation of primary or reactivation TB. However, in postprimary disease, the effusion is more likely to be associated with radiographically visible parenchymal abnormalities. Rarely, the effusion is a frank tuberculous empyema. See Figures 2.3 and 2.12 for previous examples of simple tuberculous pleural effusions.

FIGURE 2.22. **Tuberculous empyema**

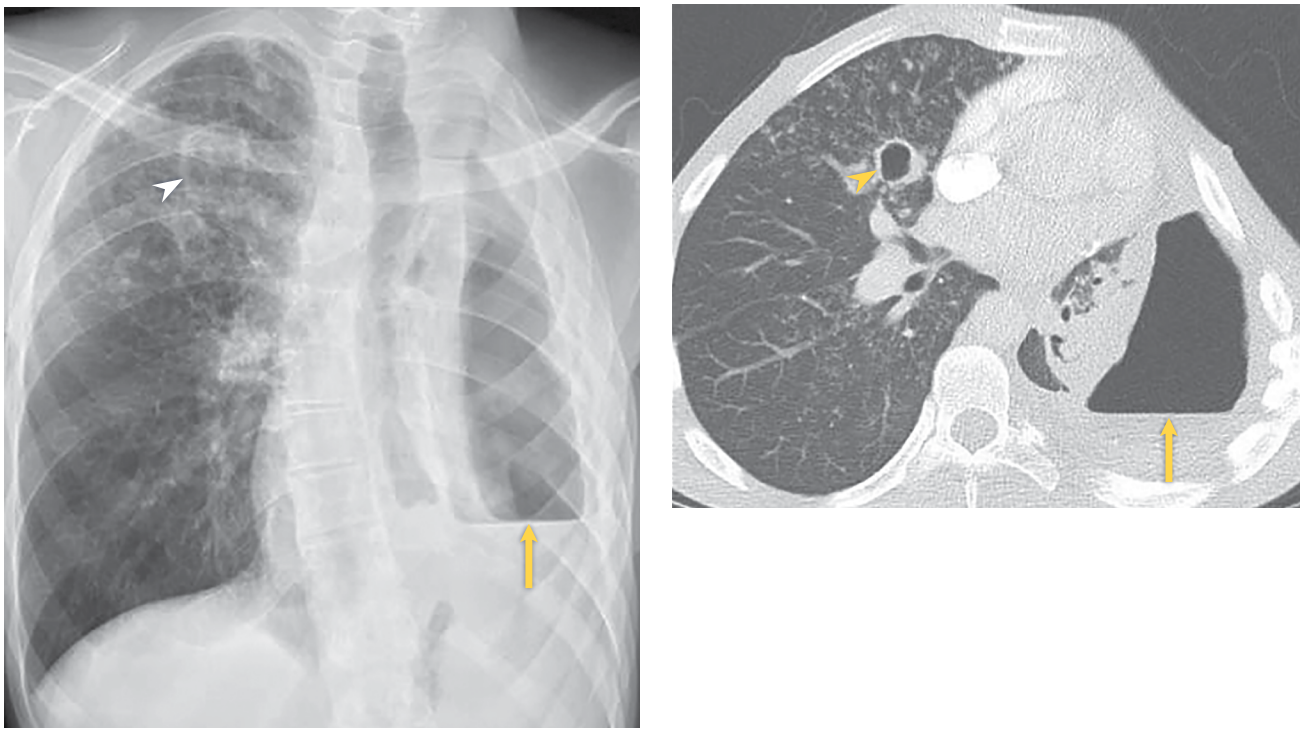


Figure 2.22 shows an example of a tuberculous empyema that developed when a cavitary tuberculous pneumonia ruptured into the left pleural space, creating a bronchopleural fistula. This case demonstrates a left pleural effusion with air-fluid levels (arrows) consistent with a hydropneumothorax. Right upper-lobe cavities (arrowheads) and nodules are present.

- Diagnosis of hydropneumothorax is based on the presence of a pleural effusion accompanied by an air-fluid level within the pleural space.
- The term hydropneumothorax signifies communication of the pleural space with the bronchial tree. Hydropneumothorax is often due to a necrotizing pneumonia such as TB.

TB and immunosuppression

The radiographic manifestations of TB in persons with immunosuppression vary depending on the degree of immunosuppression. In an HIV-positive person whose immune system is relatively intact (i.e., >200 CD4 cells/μL), the radiographic manifestations of TB are similar to those of reactivation disease in persons with intact immune systems.

As the CD4 lymphocyte count declines, the radiographic findings are more like those seen in primary disease.

- The radiographic opacities may be in the lower-lung zones or multilobar in nature.
- Thoracic lymphadenopathy is more common.

Diabetes mellitis is widely recognized as a risk factor for TB although the immunopathogenesis is not fully understood. In some case series of TB in patients with diabetes, an increased frequency of cavitation and lower-lobe involvement has been noted. However, in a large systematic review there was no difference in the radiographic distribution of abnormalities between persons with and without diabetes. There was, however, an increased frequency of cavitation.

Figures 2.23, 2.24, and 2.25 are three examples of unusual (atypical) radiographic manifestations of HIV-related TB.

FIGURE 2.23. **Bilateral diffuse opacities**

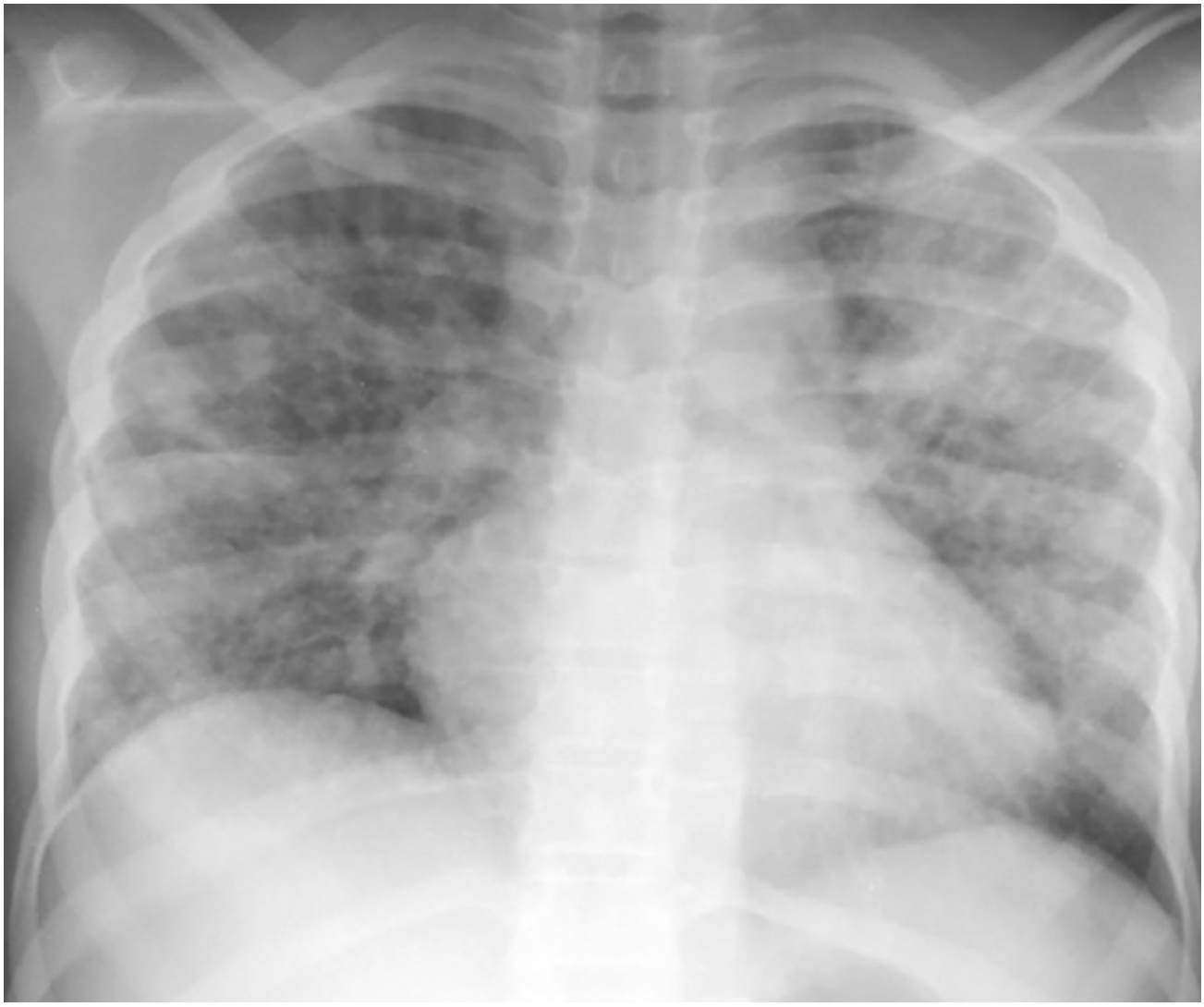


Figure 2.23. Frontal chest radiography shows bilateral diffuse airspace opacities with bilateral hilar enlargement. The patient had AFB smear-positive TB.

FIGURE 2.24. **Large paratracheal lymphadenopathy**

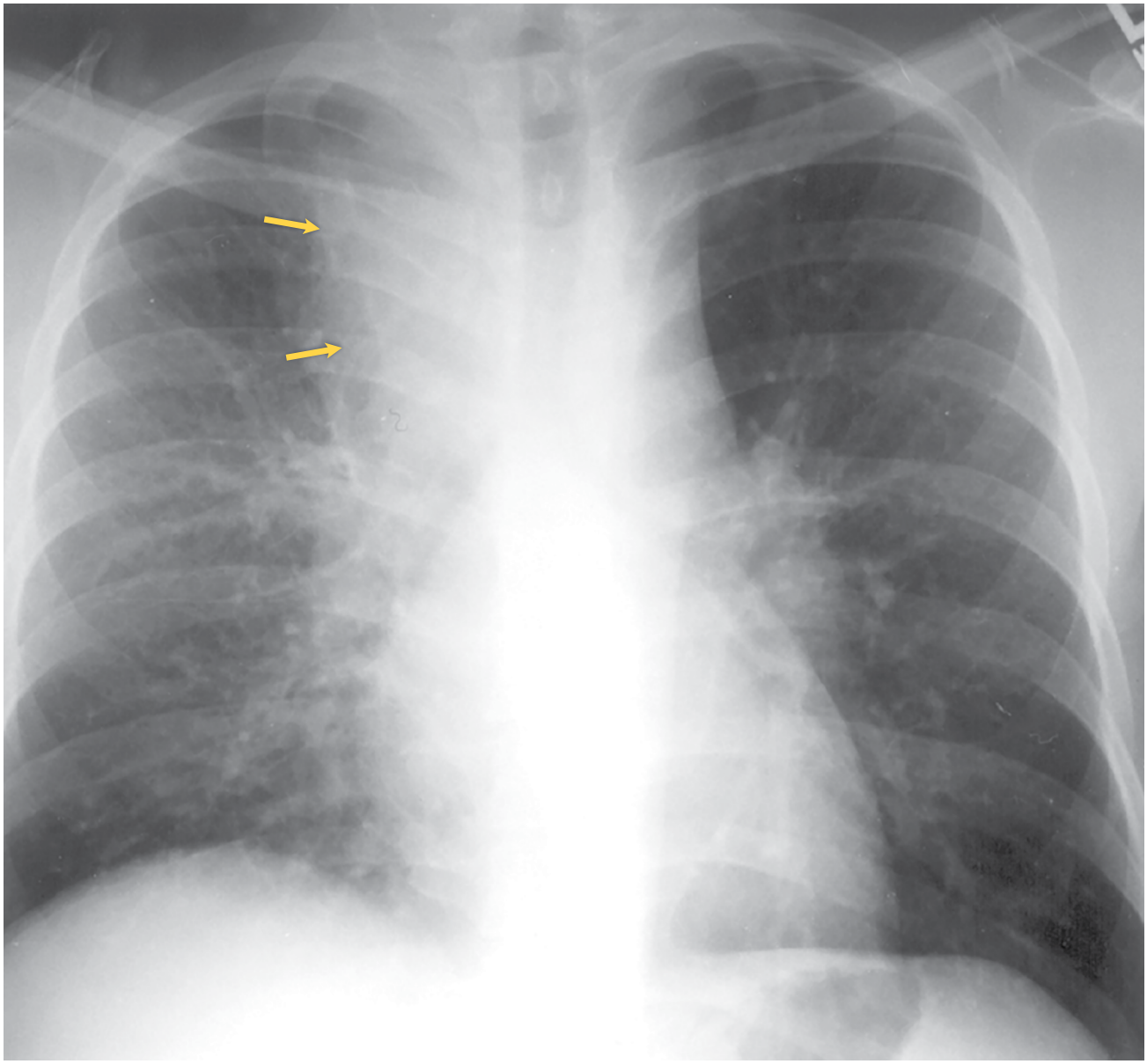


Figure 2.24 demonstrates large bilateral paratracheal lymphadenopathy, causing widening of the right superior mediastinum (arrows) with right middle- and lower-lung zone airspace and linear opacities. Note loss of the normal aortopulmonary window contour. Despite radiographically limited parenchymal disease, the patient was AFB smear-positive.

FIGURE 2.25. **Mediastinal lymphadenopathy**

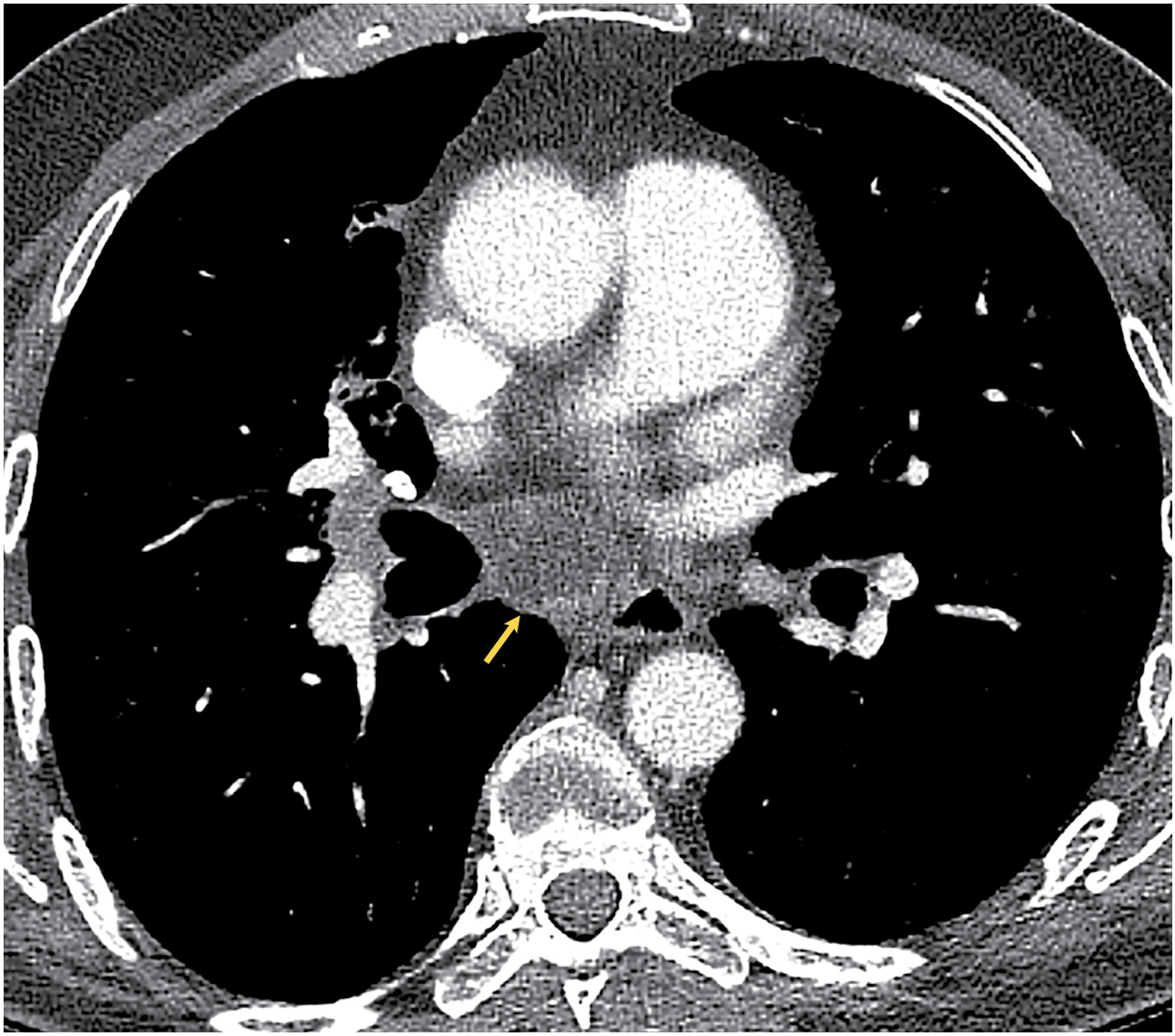


Figure 2.25. Contrast enhanced CT demonstrates subcarinal mediastinal lymphadenopathy (arrow) with central low attenuation ("darkening") due to necrosis. This finding is highly predictive of an infectious process, commonly TB.

Resolution of radiographic abnormalities and healed TB

The radiographic abnormalities in TB are slow to resolve. In some cases, parenchymal opacities and thoracic lymphadenopathy may actually worsen before improving. For this reason, the chest radiograph should be monitored together with the clinical assessment and bacteriological response in order to determine whether there is an appropriate response to treatment.

Primary TB

Healing of the primary complex, with or without therapy, can result in fibrosis and calcification of the Ghon focus. The Ghon focus is represented radiographically as a calcified nodular opacity (i.e., calcified granuloma). Calcified ipsilateral hilar or mediastinal lymph node calcifications (Ranke complex) may also be seen.

Primary TB typically resolves with minimal fibrosis and volume loss. However, patients who develop progressive primary disease with cavitation may have significant fibrosis and may develop bronchiectasis, similar to what may be seen in reactivation disease. Lymphadenopathy may take months to resolve and, in some cases, there may be prolonged enlargement of lymph nodes, particularly in children.

Reactivation TB

The degree of fibrosis and scarring varies considerably with reactivation TB. In general, the more extensive the disease and the worse the cavitation, the more likely it is that there will be fibrosis with associated volume loss. It is important to note that fibrosis and volume loss can occur in the presence of active TB, so these findings should not be used to dismiss a diagnosis of active disease. These residual radiographic abnormalities may be associated with ongoing respiratory symptoms and disability.

The following four figures are examples of healed primary and reactivation TB.

FIGURE 2.26. **Ranke complex**

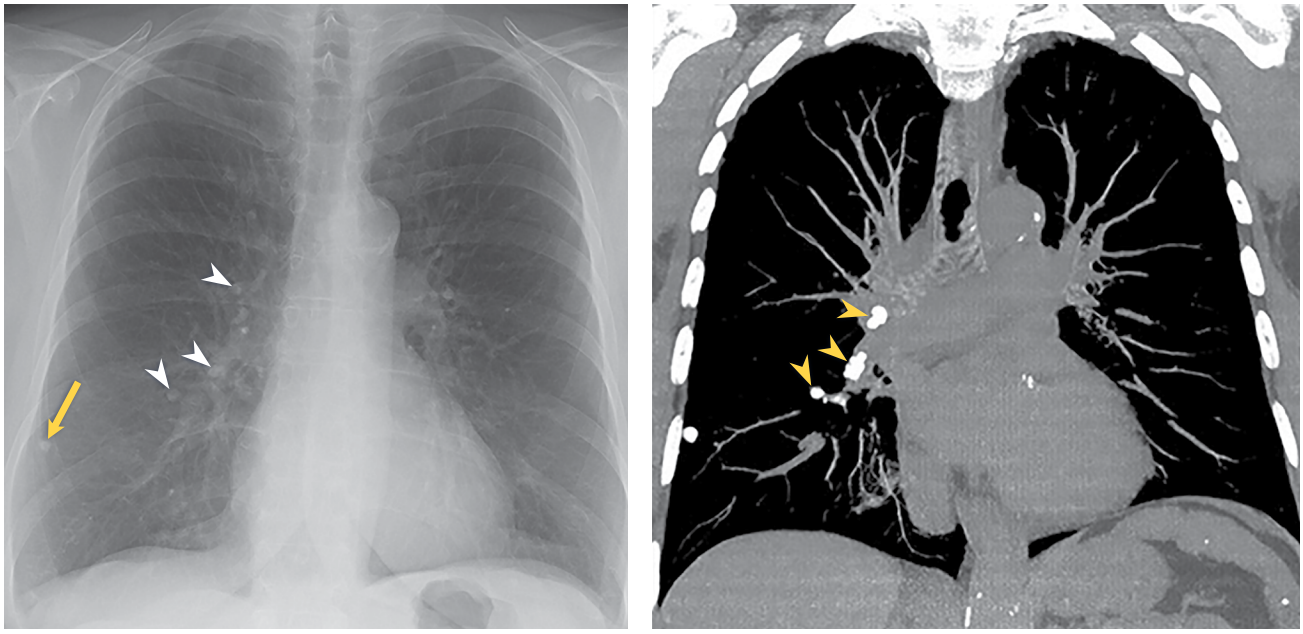


Figure 2.26. Frontal chest radiograph (left) demonstrates a calcified peripheral nodular opacity (arrow) consistent with a Ghon lesion. Calcified right hilar nodes (arrowheads) are also present, both confirmed on coronal CT (right). Together, these lesions are referred to as a Ranke complex.

- A Ghon lesion represents a calcified granuloma in the lung parenchyma.
- A Ranke complex is the combination of a Ghon lesion and an ipsilateral calcified hilar lymph node.
- Neither a Ghon lesion nor a Ranke complex represents active TB.
- Isolated calcified granulomas are not associated with an increased risk of progression to active disease in people with latent TB infection.

FIGURE 2.27. **Previously treated pulmonary TB**

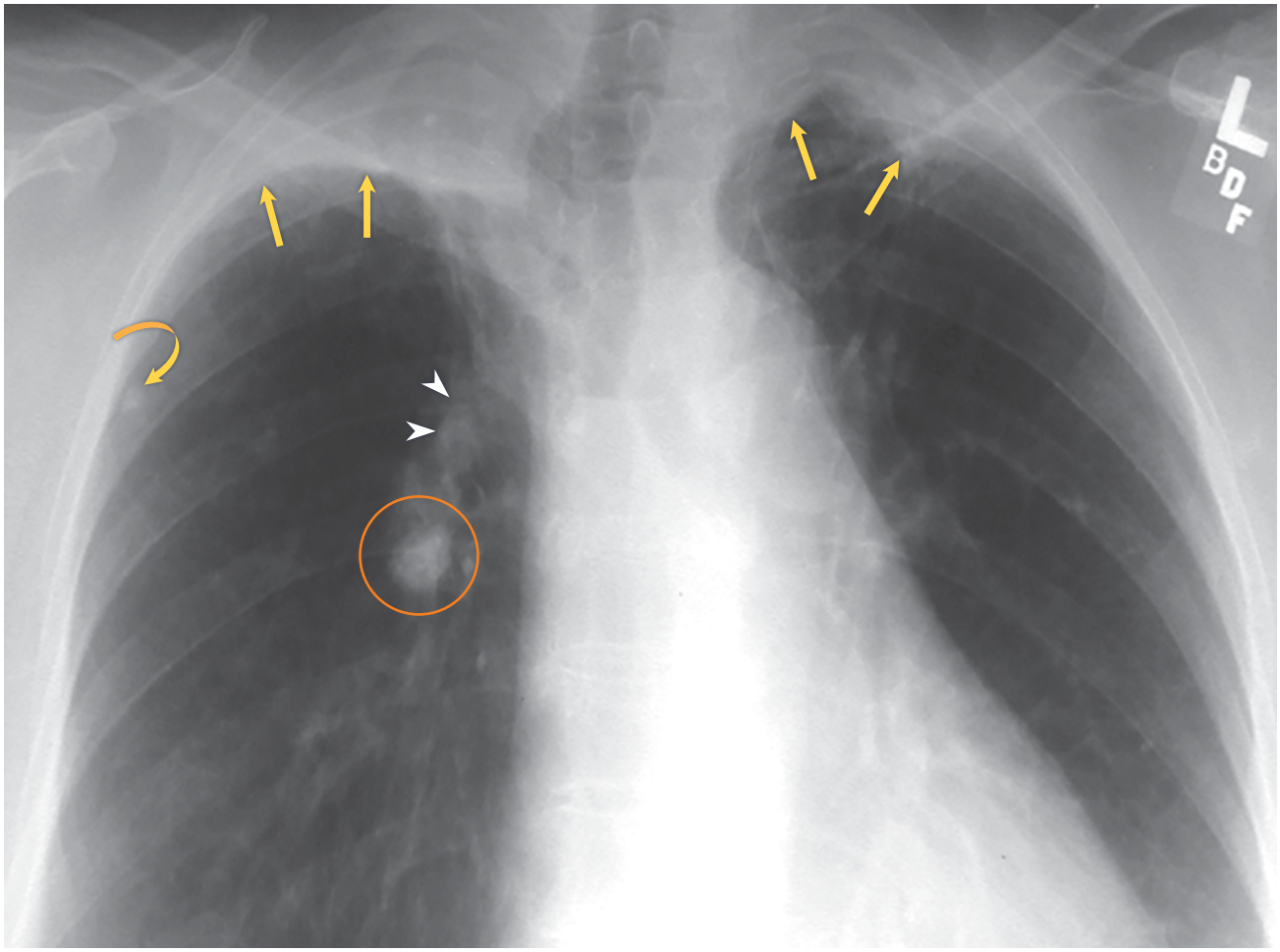


Figure 2.27. Frontal chest radiograph shows a person who had been treated previously for pulmonary TB. The patient has a right upper-lobe calcified granuloma (curved arrow) and calcified right peribronchial lymph nodes (circle). In addition, there is bilateral apical pleural thickening (arrows). Note upper-lobe volume loss evidenced by hilar retraction (arrowheads).

- Apical pleural thickening may be seen with or without surrounding apical parenchymal opacities.
- Apical pleural thickening is not associated with active TB unless there are accompanying parenchymal opacities such as airspace consolidation, nodules, or fibrosis.
- Isolated pleural thickening is not associated with an increased risk of progression to active disease in people with latent TB infection.

FIGURE 2.28. **Fibrotic scarring**

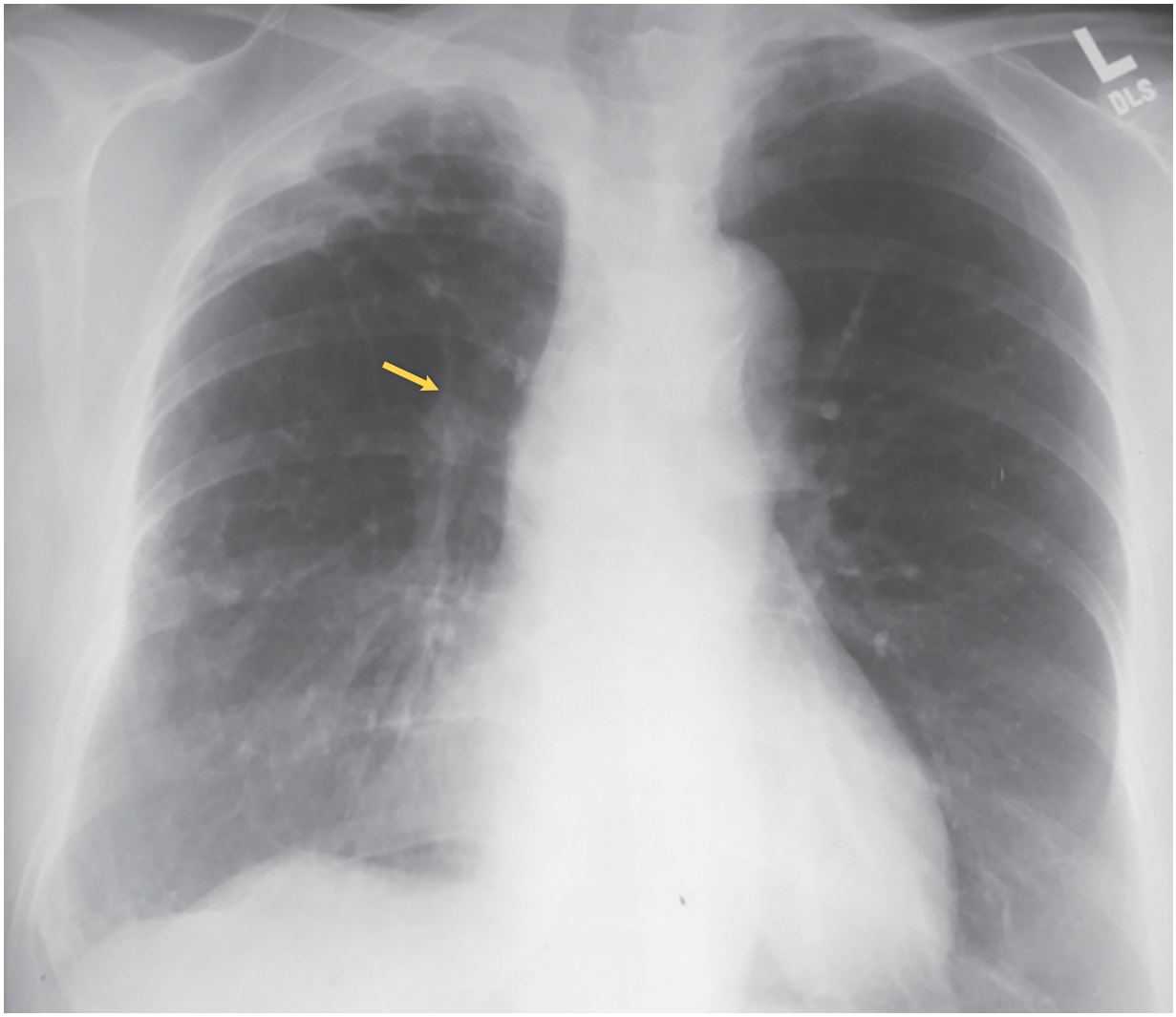


Figure 2.28 demonstrates right upper-lobe linear opacities, apical pleural thickening, and volume loss. Note the elevation of the right hilum (arrow) and hemidiaphragm. This person was asymptomatic and had negative AFB smears and cultures. However, the presence or absence of active infection cannot be determined on a single image. Patients with radiographic findings such as those shown in this example should be evaluated with sputum smear and culture unless there are earlier images showing stability of the abnormalities.

- Reactivation TB is often associated with significant fibrosis. The resultant scarring can cause volume loss of the involved lung or lobe.
- Fibrotic lesions may indicate either active or prior TB. This distinction can only be made by clinical and microbiological evaluation.
- Individuals who have parenchymal opacities suggesting “old TB” but who have not been treated for TB or who have had inadequate treatment are at increased risk of developing active TB. The presence of parenchymal opacities (representing old, healed TB) increases the risk of progression to TB in individuals who have received inadequate prior treatment for TB or latent TB infection.

Practice chest radiographs

Use the following three chest radiographs (Figures 2.29 – 2.31) to practice describing the findings. Check descriptions on pages 2.40 – 2.41.

Using a systematic approach, practice the following steps:

- Describe the abnormalities seen (location, size) using the descriptive terms from Chapter 1.
- Use lessons from Chapter 2 to propose what type of TB presentation may be included in the differential diagnosis of the radiographic abnormalities described.

Figure 2.29

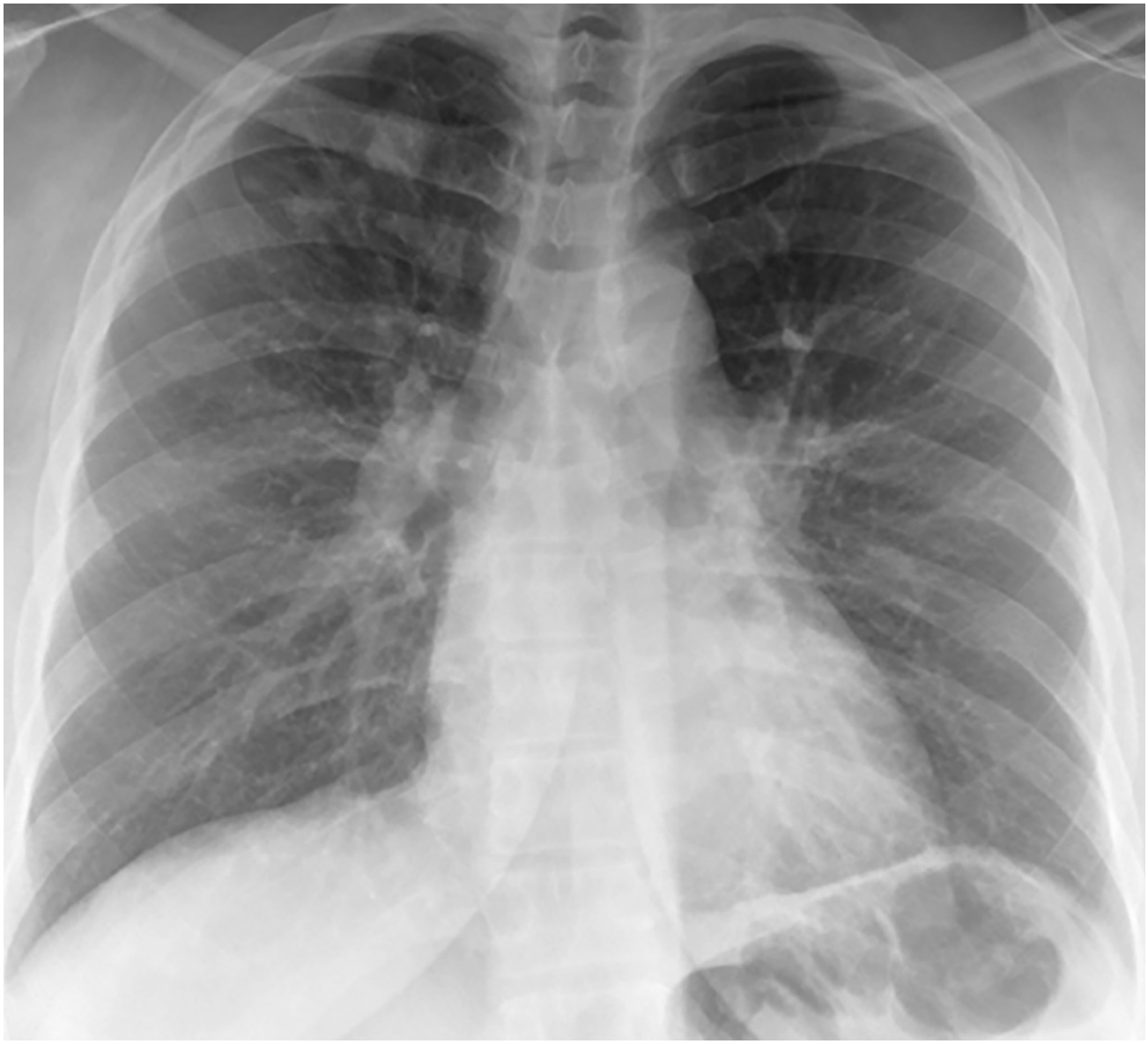


Figure 2.30

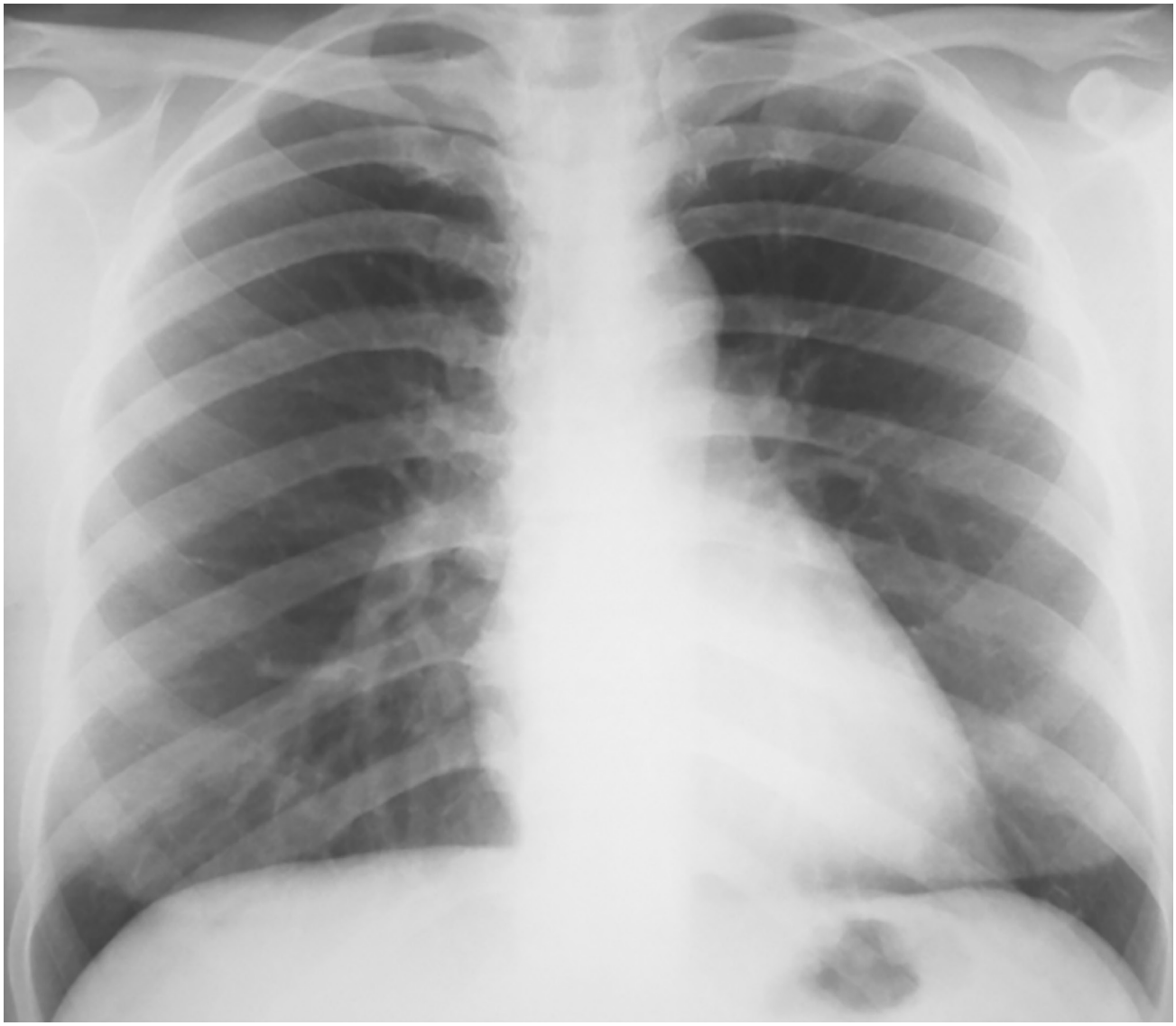
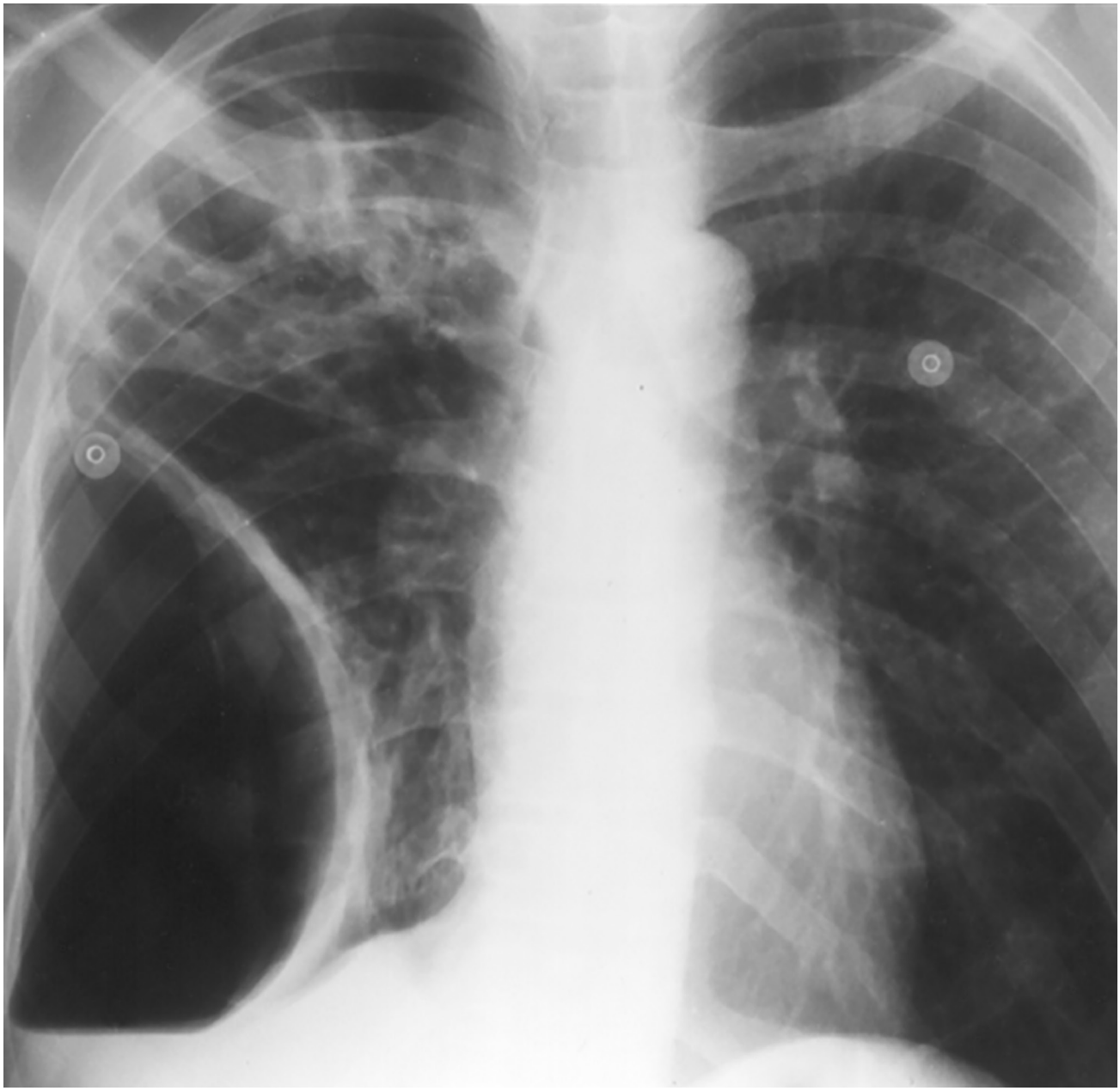


Figure 2.31



Descriptions: Practice chest radiographs

Figure 2.29 description

Imaging findings: There is a 14 mm right apical opacity posterior to the right clavicle in Figure 2.32 (see arrow), confirmed on CT.

Final clinical diagnosis: Culture-confirmed TB

FIGURE 2.32.

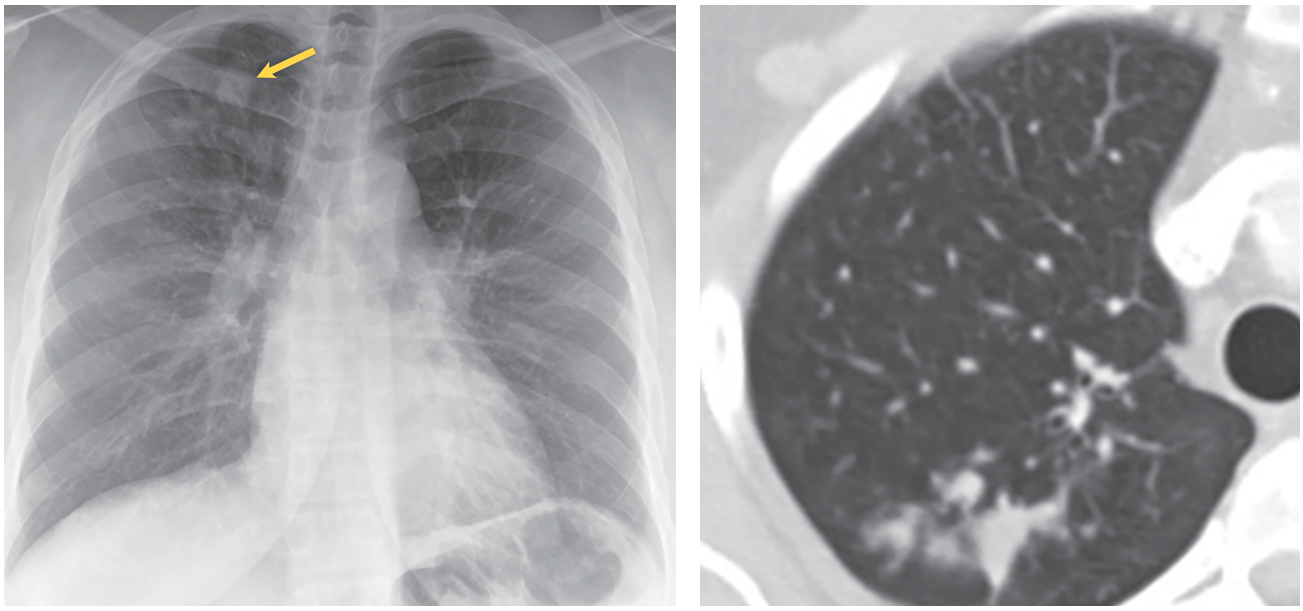


Figure 2.30 description

Imaging findings: Frontal chest radiograph shows a faint 15 mm left apical nodule (arrow, Figure 2.33A), obscured by overlap with the left first rib, confirmed with a lordotic projection (arrow, Figure 2.33B).

Final clinical diagnosis: Culture-confirmed TB following percutaneous biopsy

FIGURE 2.33A.

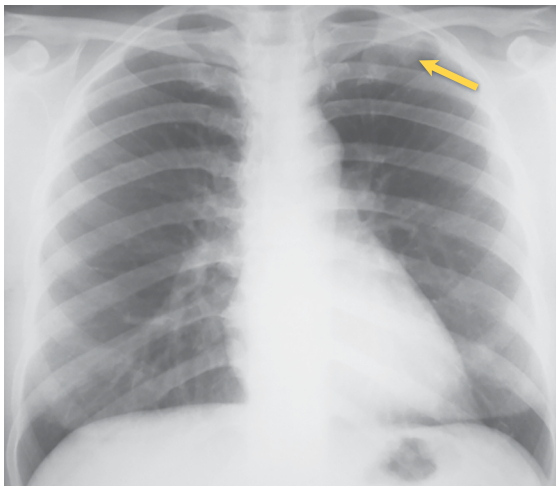


FIGURE 2.33B.

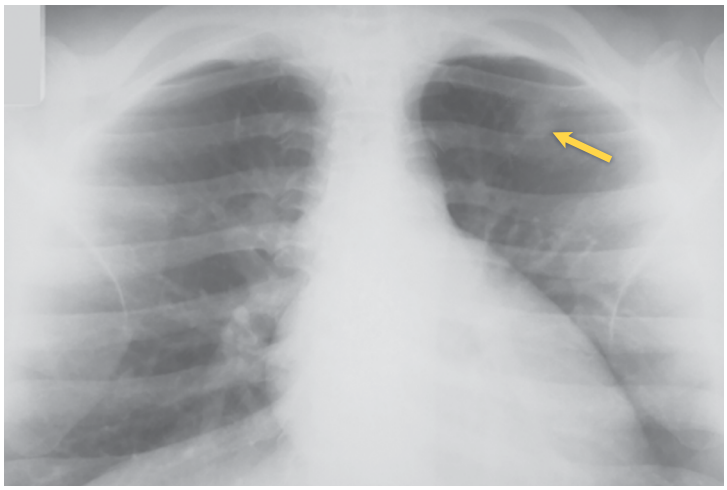
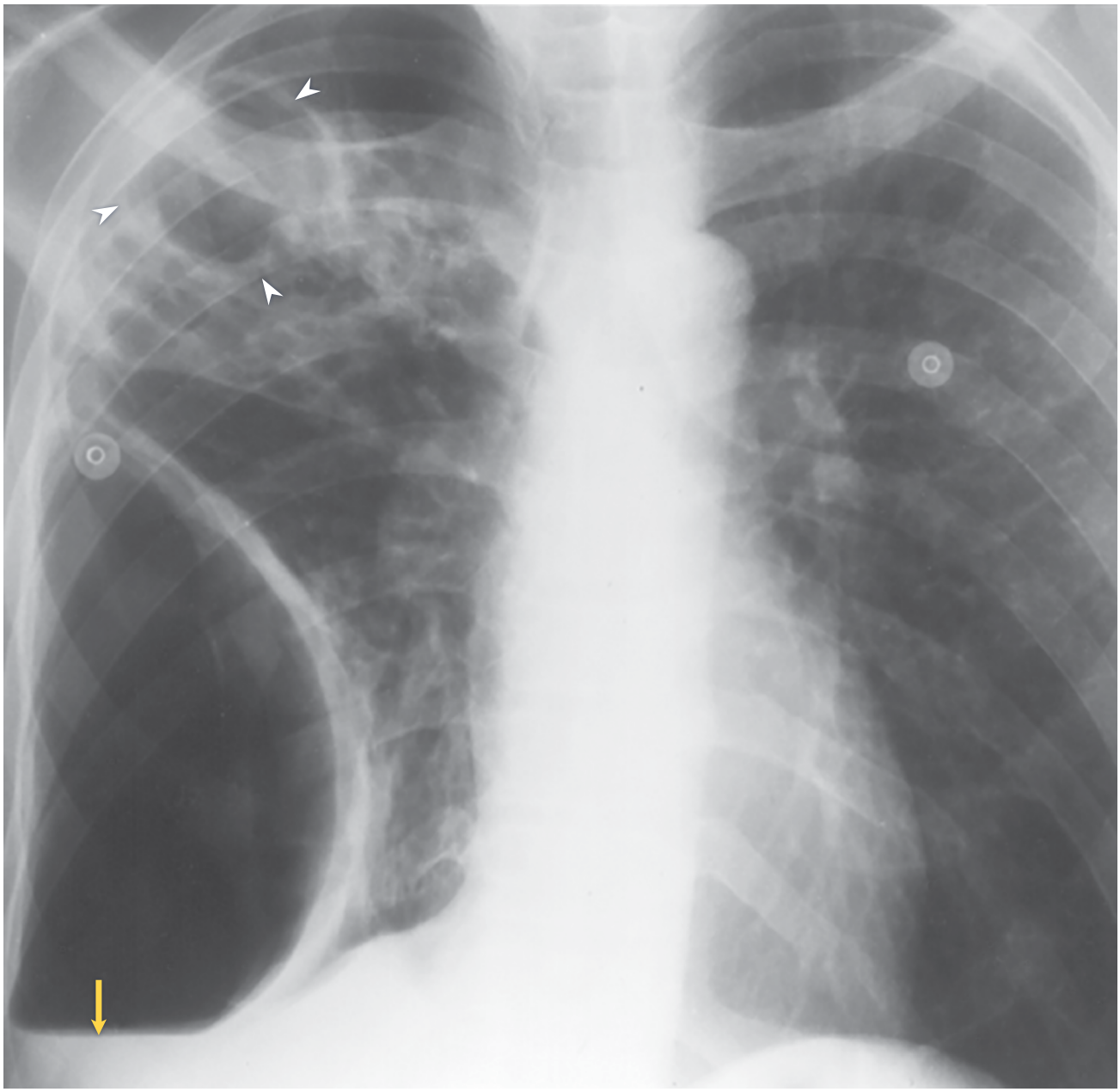


Figure 2.31 description

Imaging findings: Right upper-lobe airspace opacity with cavitation. Note the large cavity (32 mm, arrowheads, Figure 2.34). There is also a large right hydropneumothorax with an air-fluid level (arrow).

Final clinical diagnosis: Smear-positive pulmonary TB with tuberculous empyema

FIGURE 2.34.



Take-home points

- Clinical (or "active") TB commonly develops in a two-stage process. "Primary" TB occurs soon after infection with *M. tuberculosis*. "Post-primary" or "reactivation" TB occurs after cell-mediated immunity develops, often many years after infection.
- The radiographic features of these two stages tend to differ. Primary TB is more common in the lower-lung zones with associated intrathoracic lymphadenopathy and no cavitation. Reactivation TB tends to occur in the apical and posterior upper-lung zones and is associated with cavitation and no lymphadenopathy.
- Radiographic abnormalities cannot be used to make a diagnosis of either active or inactive ("healed" or "old") TB. However, the pattern of radiographic abnormalities can move the diagnosis either up or down in the list of possible diagnoses under consideration and can guide the choices of diagnostic tests.
- Almost any pattern of radiographic abnormalities may occur with TB. Three clues that an abnormality may be caused by TB are:
  1. The presence of intrathoracic (mediastinal and/or hilar) lymphadenopathy
  2. Parenchymal cavitation
  3. Predominant upper-lobe involvement, especially in the apical and posterior segments
- TB may cause lung volume loss due to lymphadenopathy causing airway compression and fibrosis causing lung retraction.
- TB occurring in the presence of immunosuppression is associated with "atypical" radiographic features.

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