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Signs in chest imaging

Oktay Algın, Gökhan Gökalp, Uğur Topal

ABSTRACT
A radiological sign can sometimes resemble a particular object or pattern and is often highly suggestive of a group of similar pathologies. Awareness of such similarities can shorten the differential diagnosis list. Many such signs have been described for X-ray and computed tomography (CT) images. In this article, we present the most frequently encountered plain film and CT signs in chest imaging. These signs include for plain films the air bronchogram sign, silhouette sign, deep sulcus sign, Continuous diaphragm sign, air crescent ("meniscus") sign, Golden S sign, cervicothoracic sign, Luftsichel sign, scimitar sign, doughnut sign, Hampton hump sign, Westermark sign, and juxtaphrenic peak sign, and for CT the gloved finger sign, CT halo sign, signet ring sign, comet tail sign, CT angiogram sign, crazy paving pattern, tree-in-bud sign, feeding vessel sign, split pleura sign, and reversed halo sign.

Key words: • *X-ray* • *computed tomography, X-ray* • *thorax*

Radiological practice includes classification of illnesses with similar characteristics through recognizable signs. Knowledge of and ability to recognize these signs can aid the physician in shortening the differential diagnosis list and deciding on the ultimate diagnosis for a patient. In this report, 23 important and frequently seen radiological signs are presented and described using chest X-rays, computed tomography (CT) images, illustrations and photographs.

Plain films

Air bronchogram sign

Bronchi, which are not normally seen, become visible as a result of opacification of the lung parenchyma. Branching, tubular lucencies of bronchi are seen in an opacified lung (Fig. 1a). This sign shows that the pathology is in the lung parenchyma itself (1). This sign is most frequently encountered in pneumonia and pulmonary edema. Its generalized form can be seen in respiratory distress syndrome (2). The air bronchogram sign shows that the central bronchi are not obstructed; however, it can also be seen when a mass causes half-obstruction. Bronchioalveolar carcinoma, lymphoma, interstitial fibrosis, alveolar hemorrhage, fibrosis due to radiation and sarcoidosis can also present with this sign (1–3). This sign can also be seen on CT images (Fig. 1b).

Silhouette sign

In a chest x-ray, non-visualization of the border of an anatomical structure that is normally visualized shows that the area neighboring this margin is filled with tissue or material of the same density (Fig. 2). The silhouette sign is an important sign indicating the localization of a lesion (4). A well-known example is obliteration of the right heart border due to middle lobe atelectasis. This rule can also be applied to the arch of the aorta, the hemidiaphragms and the left border of the heart.

A silhouette sign of the hila is called the "hilum overlay sign". It is used to determine the localization of a lesion in the hilar region in chest X-rays. If hilar vessels can clearly be seen inside the lesion, the lesion is either anterior or posterior to the hilus. If the hilar vessels cannot be discriminated from the lesion, the lesion is at the hilus (Fig. 3) (5–7).

Deep sulcus sign

The deep sulcus sign describes the radiolucency extending from the lateral costophrenic angle to the hypochondrium (Fig. 4). It is an important clue indicating possible pneumothorax in chest x-rays obtained in the supine position. When plain films are taken with the subject in an upright position, the free air in the pleural space gathers at the apicolateral space. In the supine position, the air accumulating at the anterior space forms a triangular radiolucency that makes the infe-

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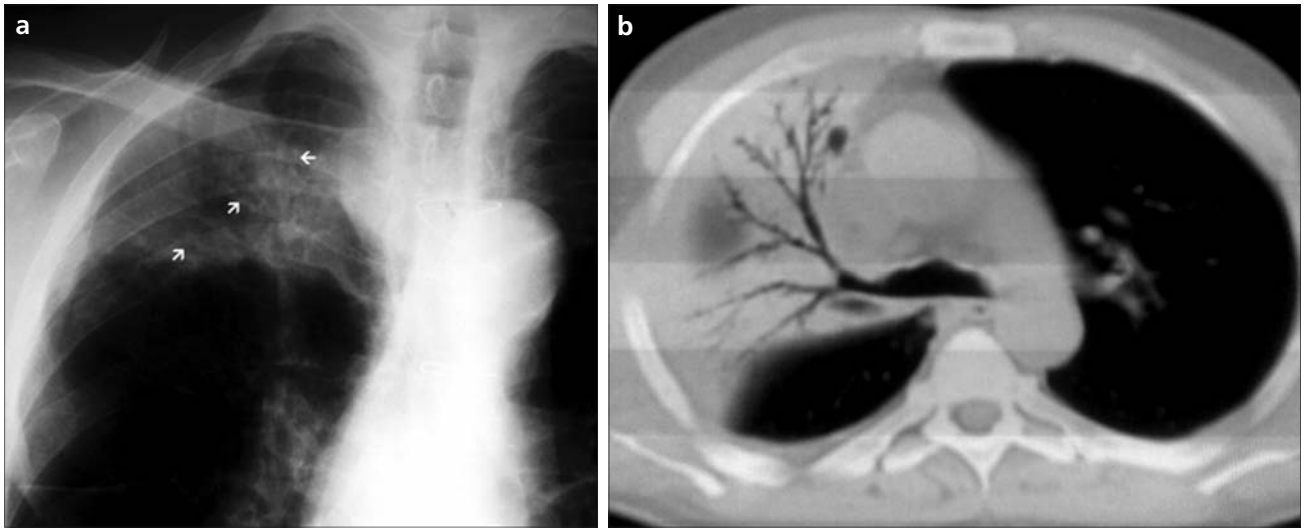

Figure 1. a–c. Air bronchogram sign. **a.** Chest X-ray of a patient who had radiotherapy for breast cancer. Consolidation with air bronchograms *(arrows)* due to radiation pneumonitis at the upper lobe of the right lung. **b.** Air bronchogram sign on CT. **c.** Illustration of air bronchogram sign.

rior borders of the lateral costophrenic angle conspicuous (8).

Continuous diaphragm sign

The continuous diaphragm sign occurs as a result of continuation of mediastinal air accumulated at the lower border of the heart with both hemidiaphragms (Fig. 4). It is useful in differentiating pneumothorax from pneumomediastinum (7).

Air crescent ("meniscus") sign

The air crescent ("meniscus") sign is the result of air accumulation between a mass or nodule and normal lung parenchyma (Fig. 5). It is most frequently encountered in neutropenic patients with aspergillosis. In invasive aspergillosis, nearly two weeks after the onset of the infection, neutrophils increase in number and separate necrotic tissue from the normal lung parenchyma. The separated area then fills with air, resulting in the air crescent sign. In

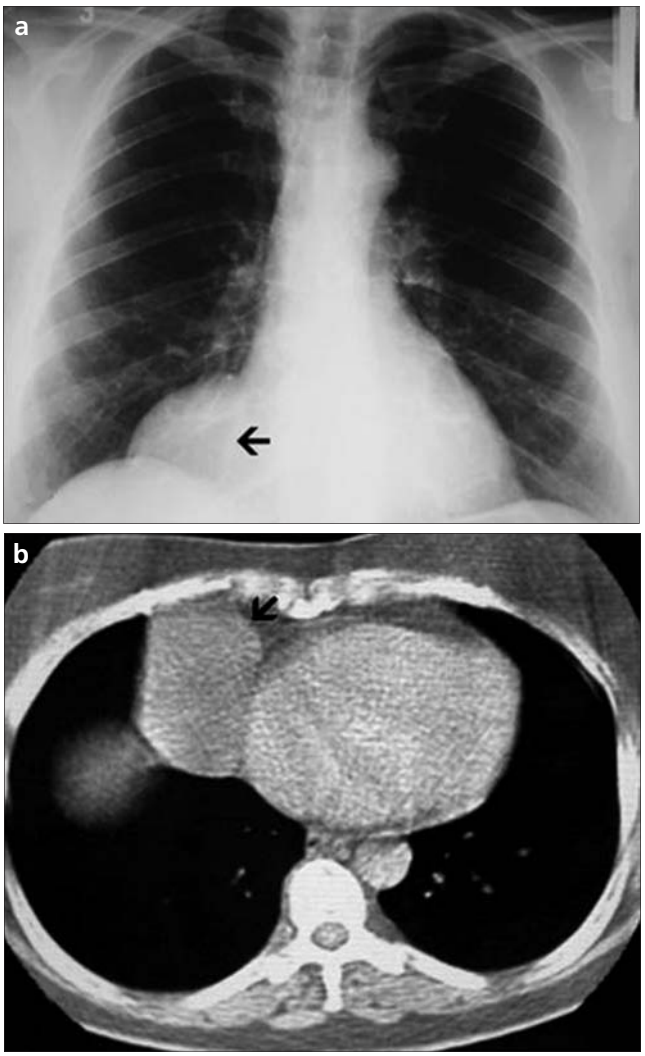

Figure 2. a, b. Silhouette sign. **a.** Chest X-ray of a patient without any complaints; the lesion obscures the right border of the heart *(arrow).* **b.** CT image demonstrates a cystic lesion (pericardial cyst) *(arrow).*

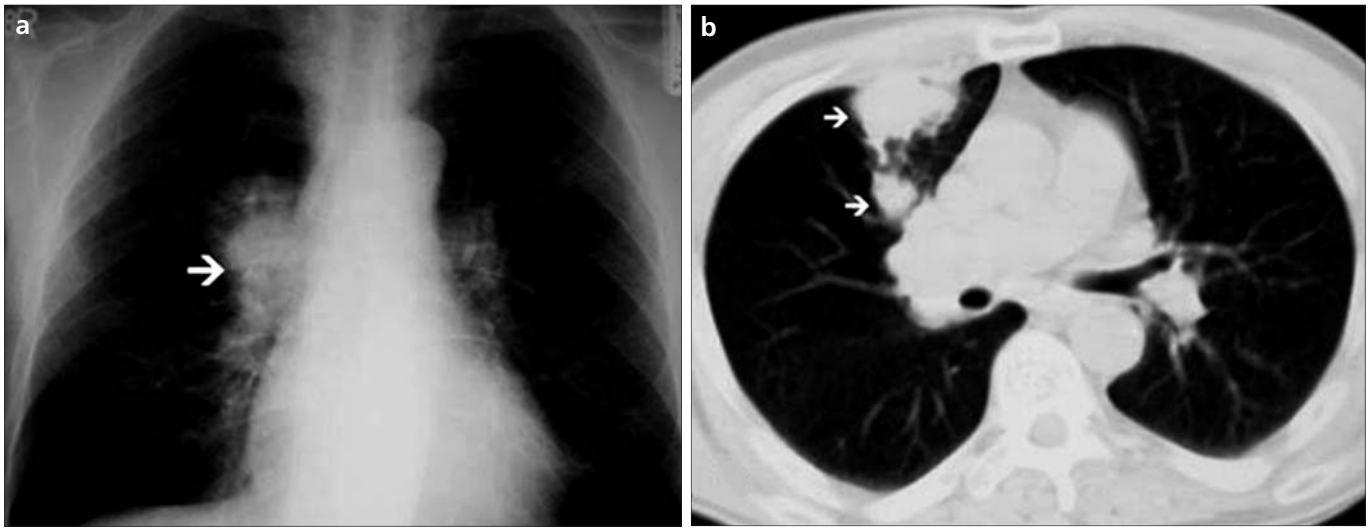

Figure 3. a, b. Hilum overlay sign. **a.** Chest X-ray of a patient with hemoptysis demonstrating enlarged right hilus. Hilar vessels can be seen inside the lesion, which shows that the lesion is not at the hilus *(arrow).* **b.** Lung CT, mass at the right upper lobe *(arrows)* and lymph nodes at the right hilus.

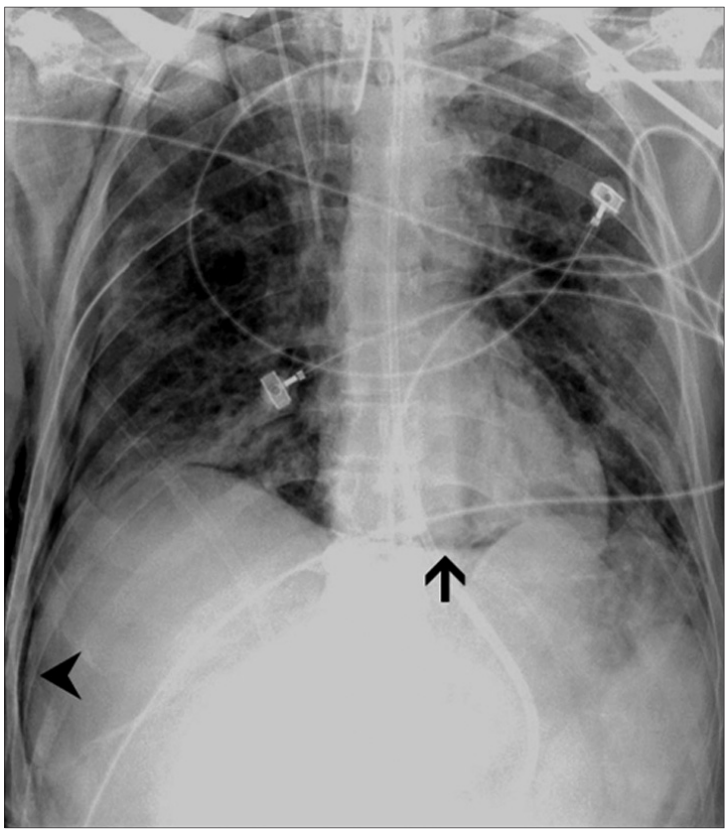

Figure 4. Deep sulcus sign and continuous diaphragm sign. Chest X-ray obtained in the supine position from a patient with trauma history. Pleural free air accumulating at the right costodiaphragmatic sinus and extending to the hypochondrium is depicted *(arrowhead).* Mediastinal air neighboring the lower border of the heart causes the continuous diaphragm sign by combining the hemidiaphragms *(arrow).*

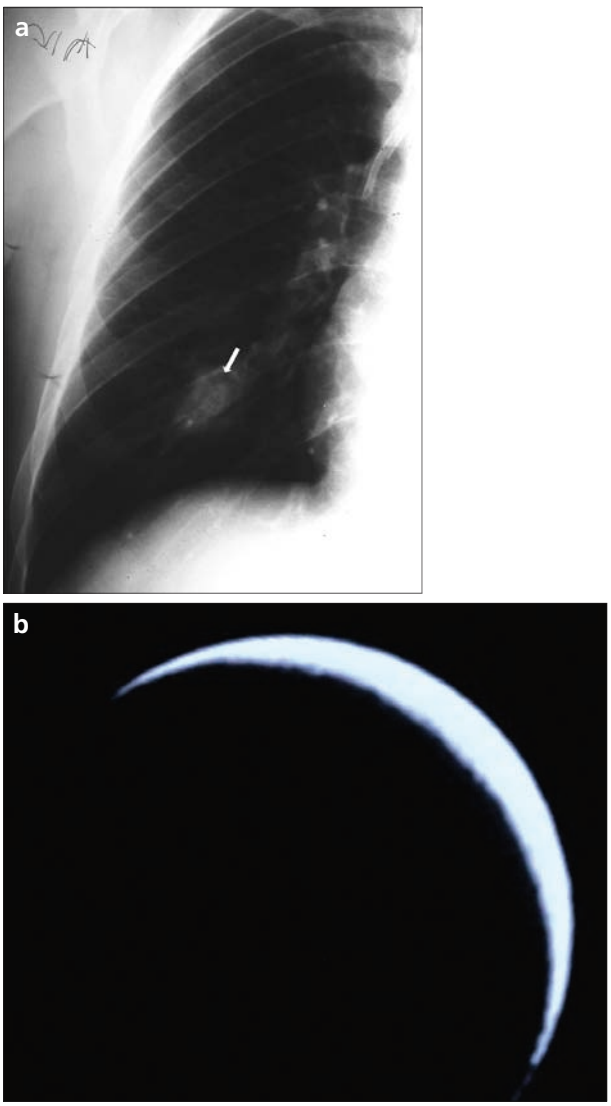

Figure 5. a, b. Air-crescent sign. **a.** Chest X-ray of a patient with invasive aspergillosis; crescent-shaped air density around the consolidation area is seen *(arrow).* **b.** Crescent.

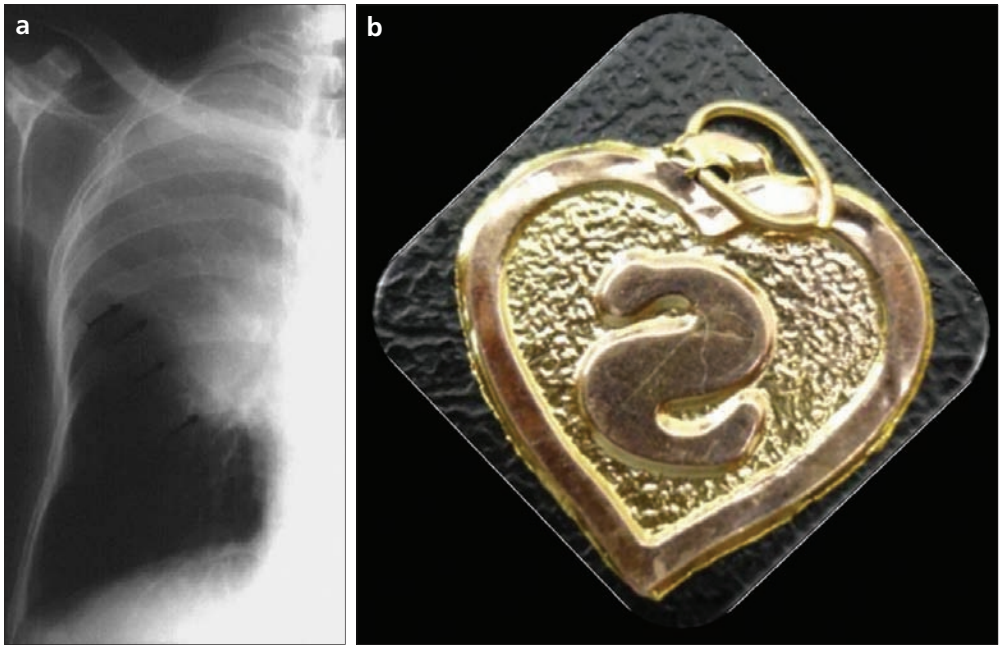

Figure 6. a, b. Golden's (reverse S) sign. **a.** Chest X-ray of a patient with a centrally located mass. The reverse S sign due to right upper lobe atelectasis is clearly depicted. The lateral portion of the 'S' is formed by the superiorly displaced minor fissure and the medial portion by the mass *(arrows)*. **b.** Golden S.

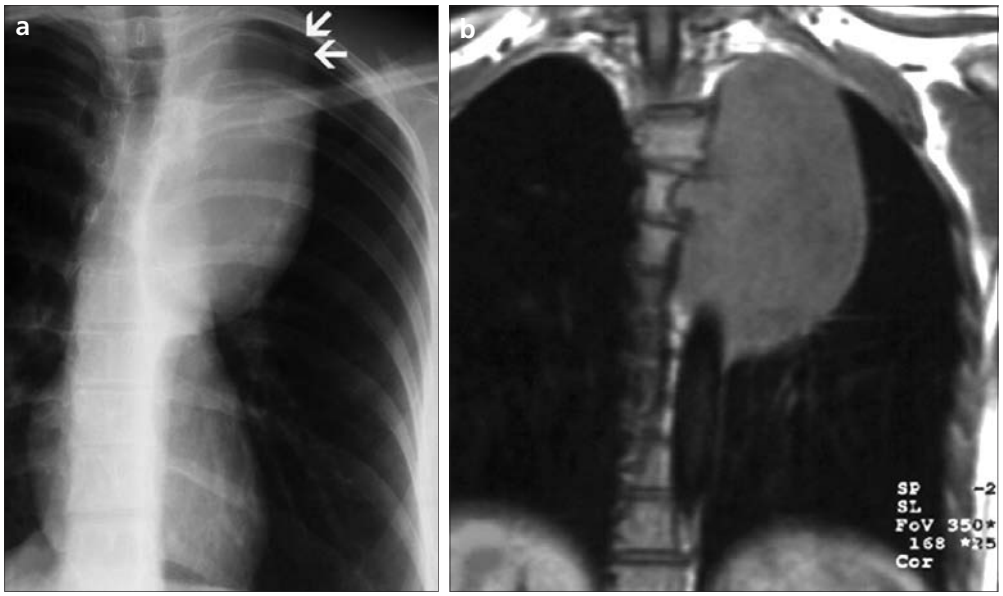

Figure 7. a, b. Cervicothoracic sign. **a.** Frontal radiograph of the chest demonstrating a mass with a distinct cranial border projecting above the level of the clavicles, supporting a posterior mediastinal location *(arrows)*. **b.** T1-weighted coronal magnetic resonance image of the same patient. The left posterior mediastinal mass is a biopsy-proven ganglioneuroma.

an immunocompromised patient, this sign is highly suggestive of invasive aspergillosis. Other causes of the air crescent sign are intracavitary fungus ball (mycetoma), hydatid cyst with bronchial involvement, hematoma, abscess, necrotizing pneumonia, cystic bronchiectasis filled with mucus plugs and papillomatosis (2, 9). Saprophytic colonization of aspergillus species within the cavities previously formed due to sarcoidosis and tuberculosis causes intracavitary fungus ball formation. Air between the cavity wall and the fungus ball can also cause the air crescent sign. Normal host immunity and the long period, often years, required for the formation of the ball can aid in distinguishing this condition from invasive aspergillosis. The ball's movement with the movements of the patient helps in differentiating it from a malignant mass attached to the wall (2).

Golden's sign

The golden's sign is encountered when there is right upper lobe atelectasis due to a centrally located mass. The minor fissure migrates superiorly, and a "reversed S" shape containing the mass forms (Fig. 6). The superiorly displaced, lateral and concave portion of the "S" is formed by the minor fissure, while the inferiorly and medially located convex part is formed by the margin of the mass. This sign is an important clue indicating a central mass obstructing the bronchus. It can be seen in every lobe, though it has been described for the right upper lobe (10).

Cervicothoracic sign

The cervicothoracic sign is used to describe the location of a lesion at the inlet of the thoracic cavity. In this anatomical space, the posterior portions of the lung apices are located more supe-

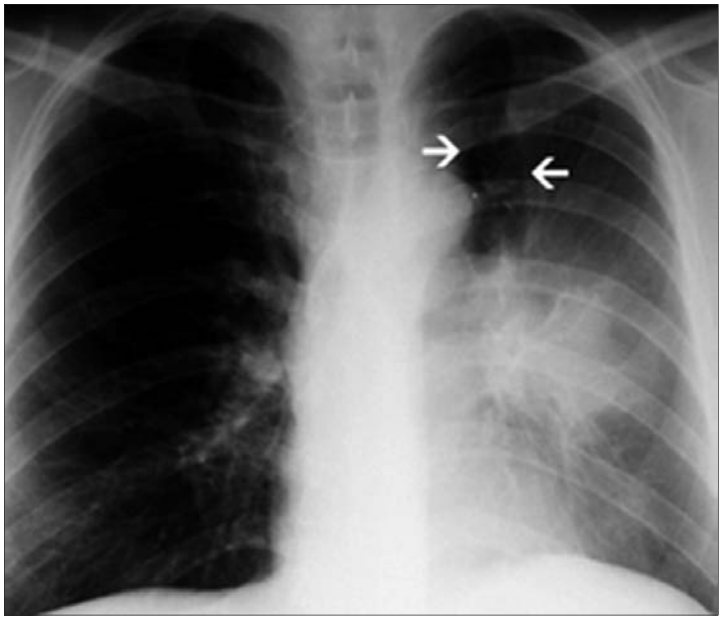

Figure 8. Luftsichel sign. A patient with a centrally located mass at the left lung. Frontal chest radiograph demonstrates volume loss due to left upper lobe atelectasis and crescent-shaped radiolucency around the aortic arch, formed by the upper segment of the left lower lobe *(arrows).*

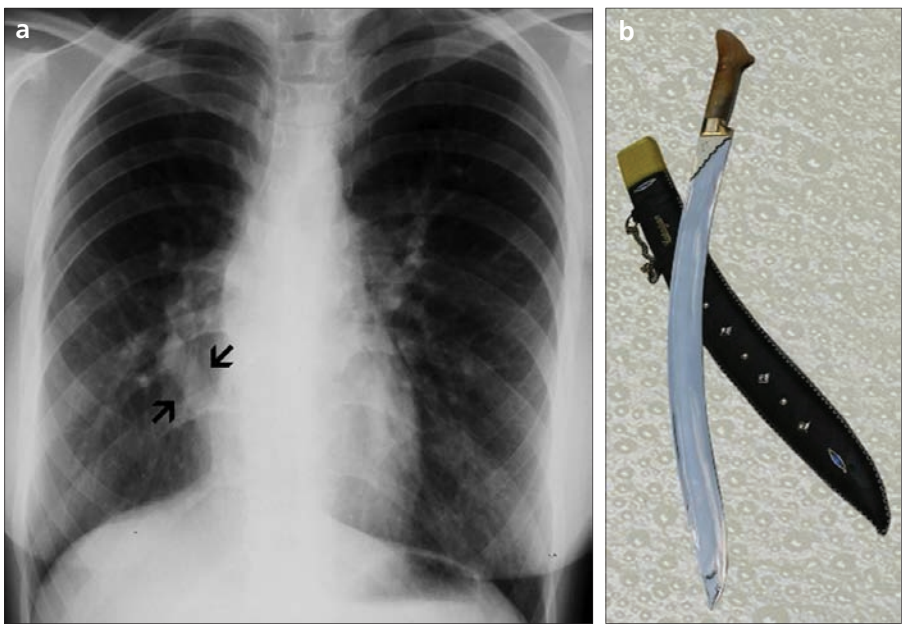

Figure 9. a, b. Scimitar sign. **a.** Frontal radiograph of a patient with hypogenetic lung syndrome. The abnormal inferior pulmonary vein is seen as a tubular opacity paralleling the right border of the heart *(arrows).* **b.** Scimitar.

riorly than the anterior portions (Fig. 7). For this reason, a lesion clearly visible above the clavicles on the frontal view must lie posteriorly and be entirely within the thorax. If the cranial border of the lesion is obscured at or below the level of the clavicles, it is located at the anterior mediastinum (7). The borders are not clearly delineated because the lesion is far from the air-filled lung and there are cervical soft tissues at this level (7).

Luftsichel sign

The word "Luftsichel" in German means "air crescent". This sign is seen in severe left upper lobe collapse. Due to the lack of a minor fissure on the left side, upper lobe collapse causes vertical positioning and anterior and medial displacement of the major fissure. The superior segment of the left lower lobe migrates superior and anteriorly between the arch of the aorta and the atelectatic lobe. The crescent-shaped radiolucency around the aortic arch is called the Luftsichel sign (Fig. 8) (7, 11).

Scimitar sign

The scimitar sign indicates anomalous venous return of the right inferior pulmonary vein (total or segmental) directly to the hepatic vein, portal vein or inferior vena cava. A tubular-shaped opacity extending towards the diaphragm along the right side of the heart is seen (Fig. 9). The abnormal pulmonary vein resembles a Turkish sword called a *"pala"*. The scimitar sign is associated with congenital hypogenetic lung syndrome (scimitar syndrome) (12).

Doughnut sign

The doughnut sign occurs when mediastinal lymphadenomegaly occurs behind the bronchus intermedius in the subcarinal region (7, 12, 13). Lymphadenopathy is seen as lobulated densities on lateral radiographs (Fig. 10) (12, 14).

Hampton hump sign

The Hampton hump sign occurs within two days as a result of alveolar wall necrosis accompanying alveolar hemorrhage due to pulmonary infarct (7). It is a wedge-shaped, pleura-based consolidation with a rounded convex apex directed towards the hilus (Fig. 11). This sign was first described by Aubrey Otis Hampton (7). It is usually encountered at the lower lobes and heals with scar formation.

Westermark sign

The Westermark sign describes a decrease of vascularization at the periphery of the lungs due to mechanical obstruction or reflex vasoconstriction in pulmonary embolism (oligemia). It was first described by Neil Westermark (7). An increase in translucency on frontal radiographs is depicted (Fig. 12) (7).

Juxtaphrenic peak sign

The juxtaphrenic peak sign, which occurs in upper lobe atelectasis, describes the triangular opacity projecting superiorly at the medial half of the diaphragm (Fig. 13). It is most commonly related to the presence of an inferior accessory fissure (7). The

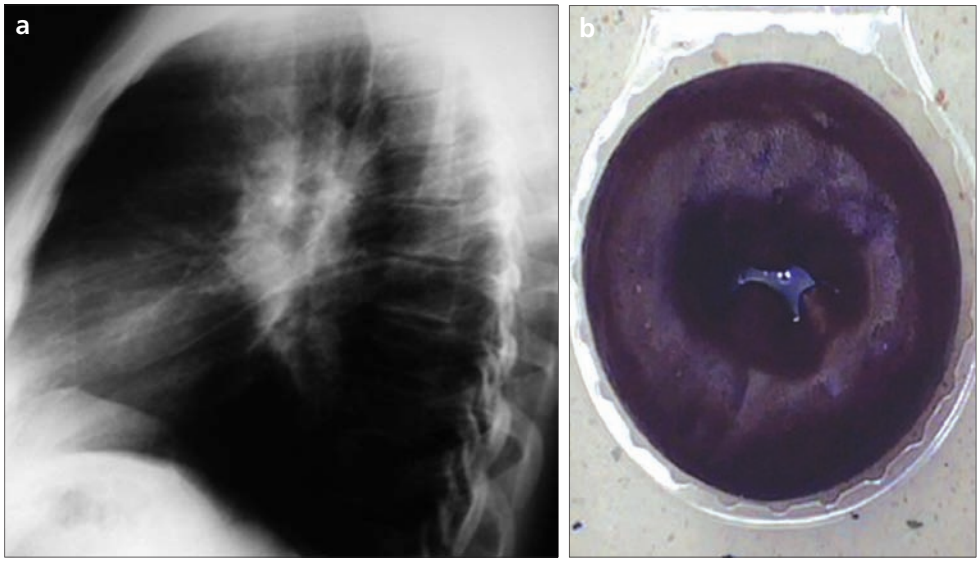

Figure 10. a, b. Doughnut sign. **a.** Lateral radiograph of the chest demonstrates enlarged lymph nodes at both hila and the subcarinal region. The described pattern is formed by the radiolucent area at the central portion and by the surrounding opacities due to the lymph nodes. **b.** Doughnut.

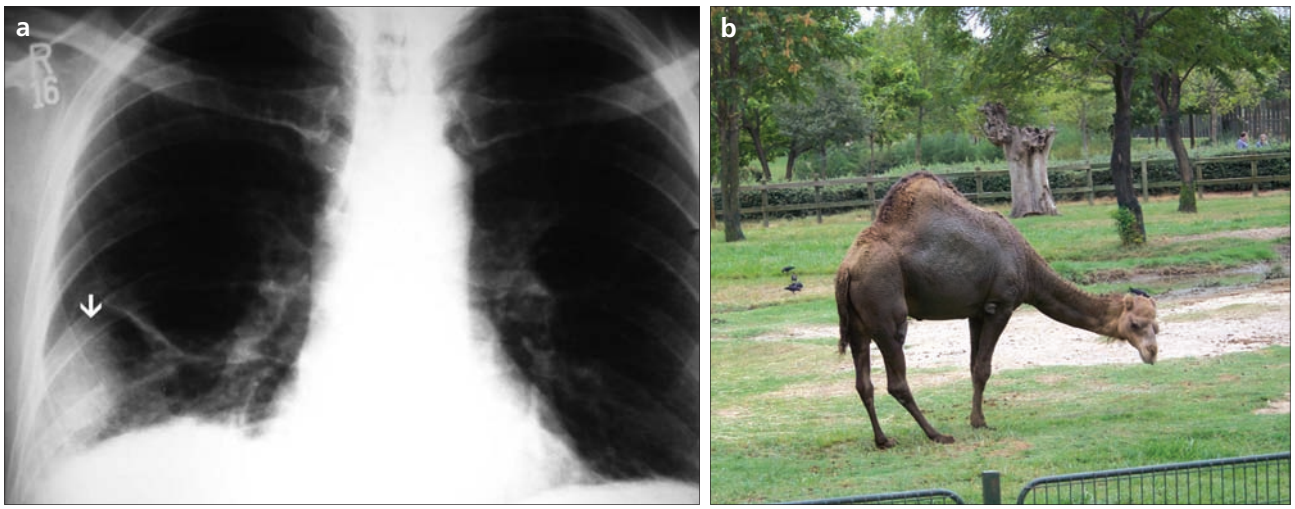

Figure 11. a, b. Hampton hump sign. **a.** Chest X-ray of a patient with pulmonary embolism showing a peripherally located, wedge-shaped homogenous opacity consistent with the infarct area *(arrow).* **b.** Hump of a camel.

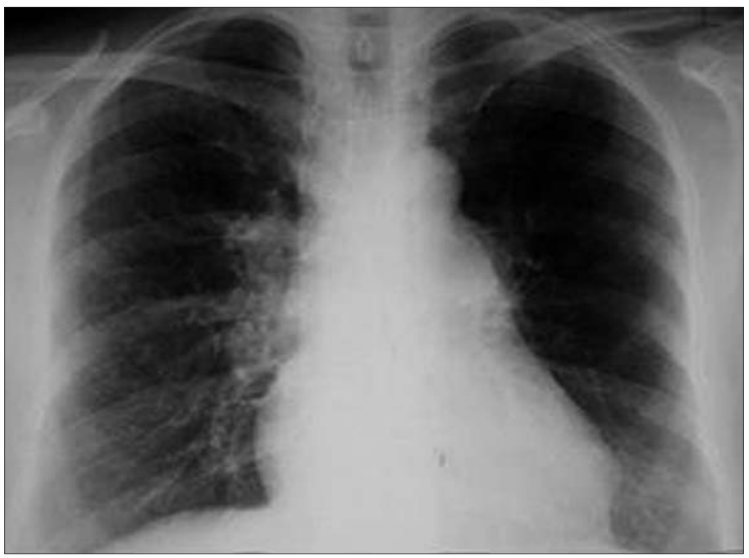

Figure 12. Westermark sign. Frontal radiograph of a patient with pulmonary embolism, showing increased radiolucency in the upper and middle zones of the left lung due to decreased vascularization.

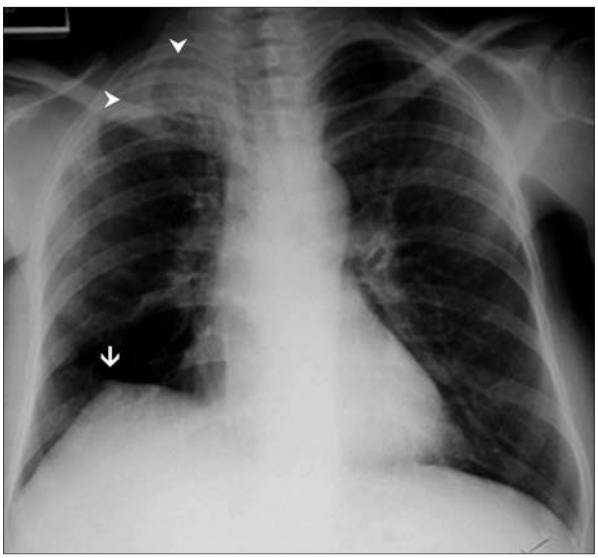

Figure 13. Juxtaphrenic peak sign. Frontal radiograph of a patient with right upper lobe atelectasis *(arrowheads),* superior displacement of the right diaphragm and a 'peak' at the middle *(arrow).*

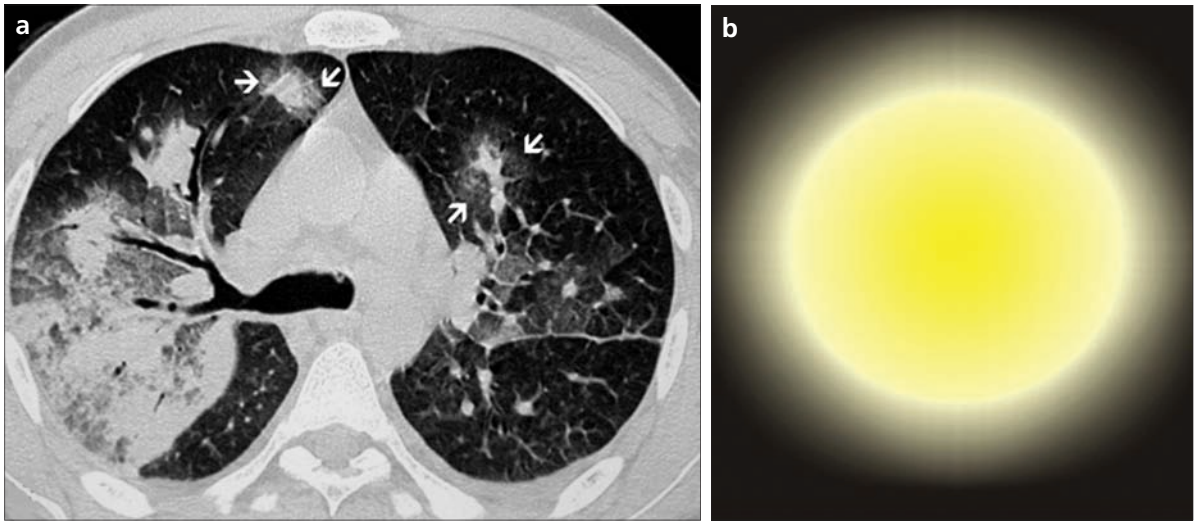

Figure 14. a, b. CT halo sign. **a.** Invasive aspergillosis in a patient with acute leukemia: CT image shows halo sign *(arrows).* **b.** Sunshine.

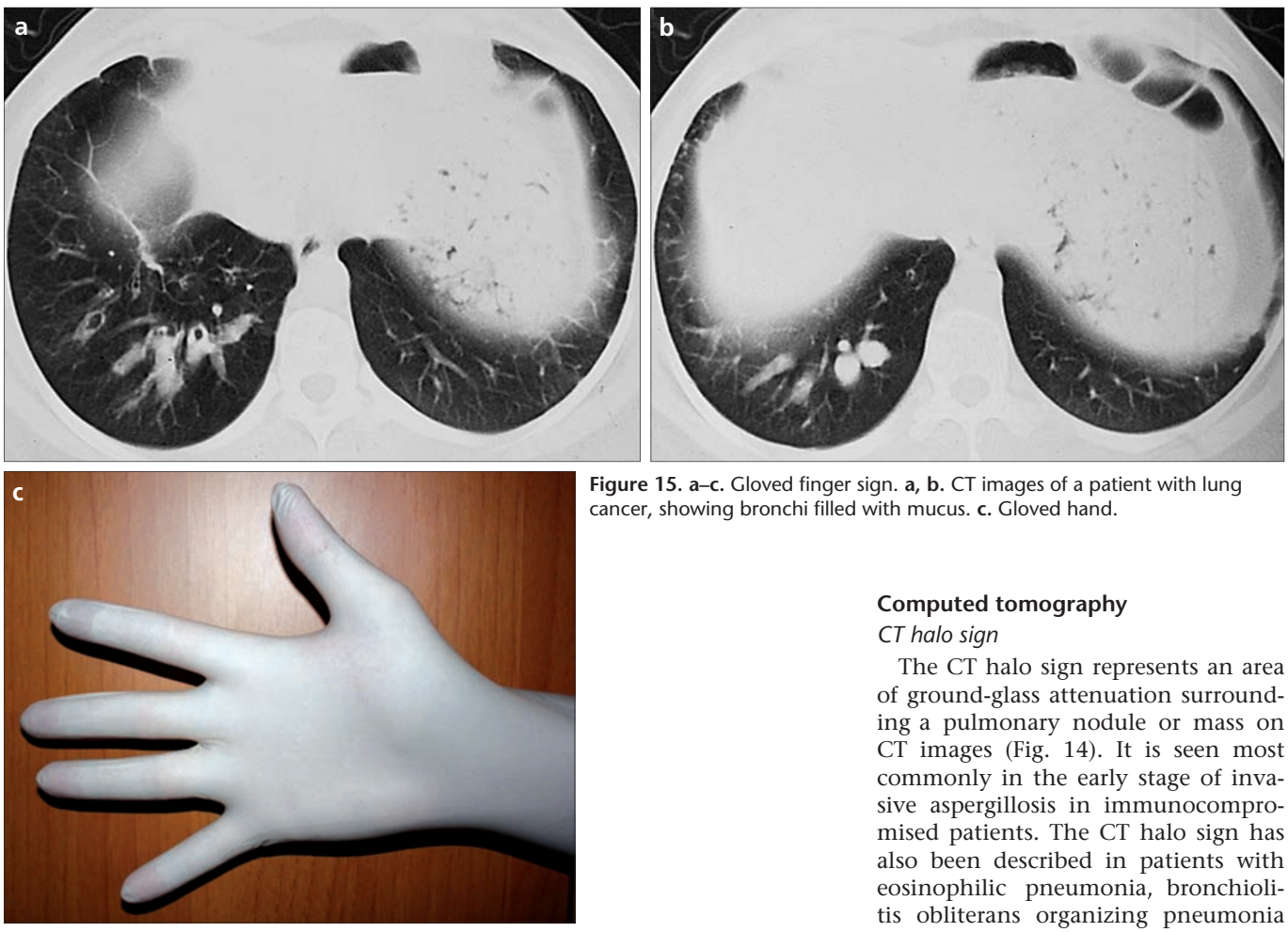

Figure 15. a–c. Gloved finger sign. **a, b.** CT images of a patient with lung cancer, showing bronchi filled with mucus. **c.** Gloved hand.

mechanism is not known with certainty; according to one theory, the negative pressure of upper lobe atelectasis causes upward retraction of the visceral pleura, and protrusion of extrapleural fat into the recess of the fissure is responsible (15). The juxtaphrenic sign can also be seen in combined right upper and middle lobe volume loss or even with middle lobe collapse only.

Computed tomography

CT halo sign

The CT halo sign represents an area of ground-glass attenuation surrounding a pulmonary nodule or mass on CT images (Fig. 14). It is seen most commonly in the early stage of invasive aspergillosis in immunocompromised patients. The CT halo sign has also been described in patients with eosinophilic pneumonia, bronchiolitis obliterans organizing pneumonia (BOOP), candidiasis, Wegener granulomatosis, bronchoalveolar carcinoma, and lymphoma (16–19). Formation of the halo sign varies according to the disease. Alveolar hemorrhage in aspergillosis and/or tumor infiltration on the bronchial walls in bronchoalveolar carcinoma are considered the causes of this sign (16–19).

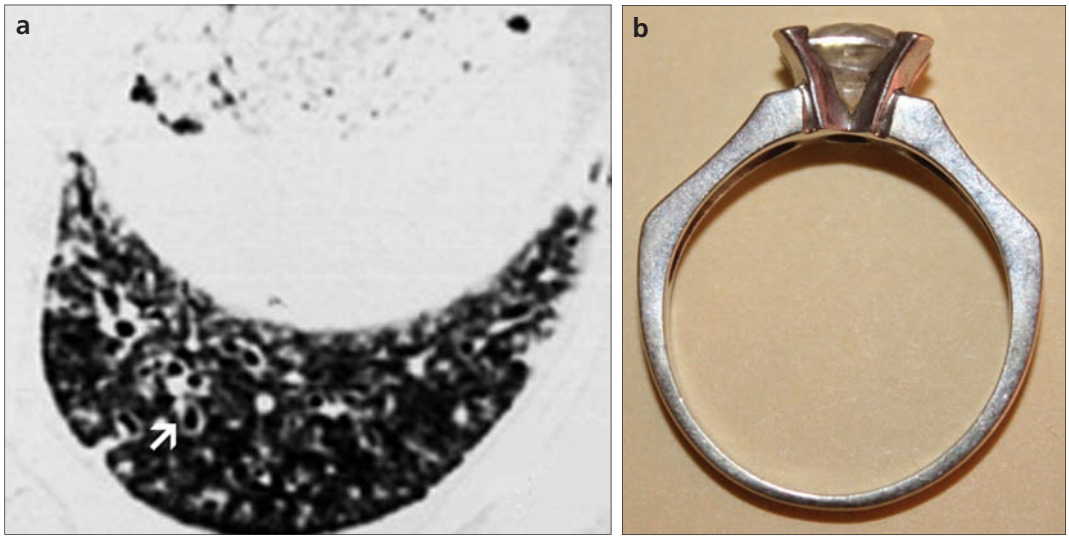

Figure 16. a, b. Signet ring sign. **a.** A patient with bronchiectasis. Dilated bronchus and the adjacent pulmonary artery are seen in the left lower lobe *(arrow).* **b.** Signet ring.

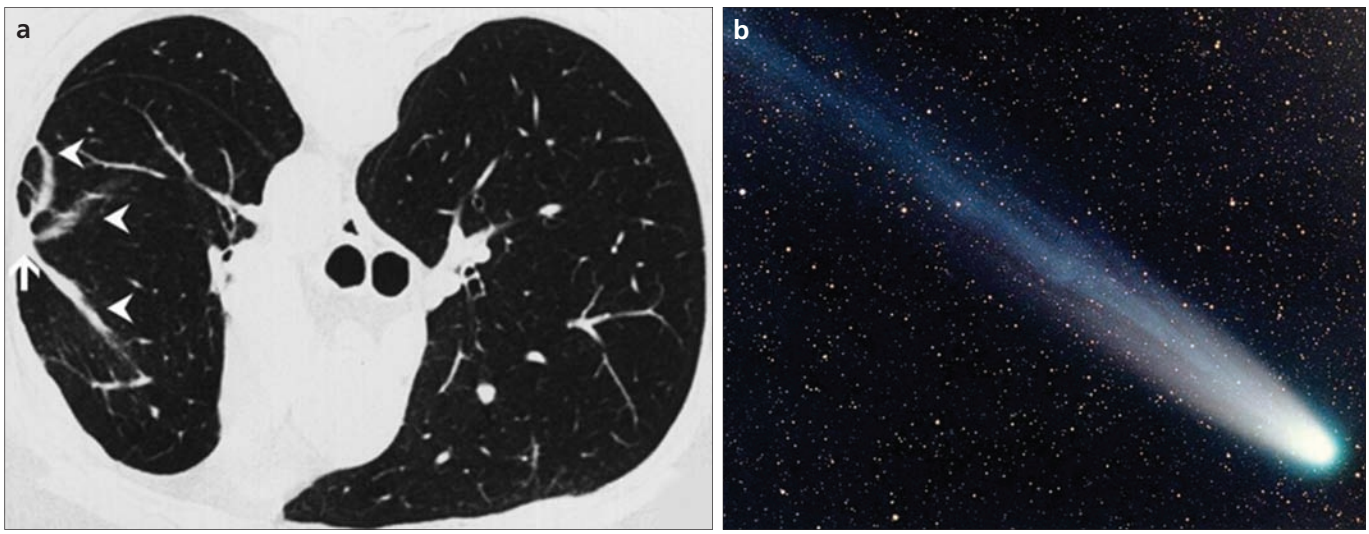

Figure 17. a, b. Comet tail sign. **a.** Prone CT image of a patient with tuberculosis pleuritis history. Subpleural atelectasis *(arrow)* and bronchovascular structures extending toward the hilum *(arrowheads)* are seen. **b.** Comet.

Gloved finger sign

This sign is characterized by branching tubular or finger-like soft tissue densities (Fig. 15). This appearance is formed by dilated bronchi filled with mucus (mucoid impaction). On CT images, mucus-filled bronchi are seen as Y- or V-shaped densities (20, 21). Any obstructing lesion can lead to distal bronchiectasis and mucoid impaction. Benign and malignant neoplasms, congenital bronchial atresia, broncholithiasis, tuberculous stricture, intralobar sequestration, intrapulmonary bronchogenic cyst, and foreign body aspiration can cause mucoid impaction of a bronchus. Allergic bronchopulmonary aspergillosis (ABPA), asthma, and cystic fibrosis can cause this sign without obstruction. In asthma and asthma with ABPA, there is increased airway hypersensitivity and mucus production. Also, in APBA, the cause of bronchial impaction is saprophytic proliferation of aspergillus organisms within the dilated bronchi. In cystic fibrosis, the cause of mucoid impaction is impaired ciliary action and abnormally thick secretions (20, 21).

Signet ring sign

Normally, the diameter of a bronchus is equal to the diameter of the adjacent pulmonary artery (bronchoarterial ratio = 1). The signet ring sign occurs when the bronchoarterial ratio is increased (7) (Fig. 16). This sign is usually seen in patients with bronchiectasis or irreversible abnormal bronchial dilatation (7). The signet ring sign can be seen anywhere in the lung. It is an adjunct finding that can help in differentiating bronchiectasis from other cystic lung lesions (22). Accompanying findings such as peribronchial thickening, lack of bronchial tapering, and visualization of bronchi within 1 cm of the pleura are all contributing findings confirming the diagnosis (7).

Comet tail sign

The comet tail sign refers to curvilinear opacities that extend from a subpleural "mass" toward the hilum. It consists of distortion of vessels and bronchi that lead to an adjacent area of rounded atelectasis. This sign is a characteristic feature of round atelectasis (Fig. 17).

Adjacent pleural thickening is an essential finding. There is volume loss in the affected lobe. However, there are two hypotheses regarding the formation of the rounded atelectasis: an underlying pleural effusion that causes local atelectasis in the adjacent lung and a local pleuritis caused by irritants such as asbestos, tuberculosis, nonspecific pleuritis or Dressler syndrome (23). As in the other atelectasis types, the homogeneous enhancement occurs after the intravenous administration of contrast material. The rounded atelectasis is sometimes impossible to differentiate from peripheral lung cancer. Biopsy is indicated in cases that are equivocal (23).

CT angiogram sign

The CT angiogram sign consists of enhancing pulmonary vessels in a homogeneous low-attenuating consolidation of lung parenchyma relative to the chest wall musculature at the mediastinal window (Fig. 18). This sign has been described in the lobar form of bronchoalveolar cell carcinoma (17, 24). Another important cause of the CT angiogram sign is pneumonia. The low-attenuating area has been considered to be the result of mucus production by tumor cells. The CT angiogram sign has also been reported in pulmonary edema, obstructive pneumonitis due to central lung tumors, lymphoma, and metastasis from gastrointestinal carcinomas (25, 26).

Crazy paving pattern

The crazy paving pattern consists of scattered or diffuse ground-glass attenuation with superimposed interlobular septal thickening and intralobular lines (Fig. 19) (27–29). It was initially described in cases of alveolar proteinosis (30). In alveolar proteinosis, the ground-glass attenuation reflects the low-density intraalveolar material (glycoprotein), whereas the superimposed reticular attenuation is due to infiltration of the interstitium by inflammatory cells (29). This finding can be caused by *Pneumocystis carinii* pneumonia, mucinous bronchoalveolar carcinoma, pulmonary alveolar proteinosis, sarcoidosis, nonspecific interstitial pneumonia, organizing pneumonia, exogenous lipoid pneumonia, adult respiratory distress syndrome, and pulmonary hemorrhage syndromes (27, 28).

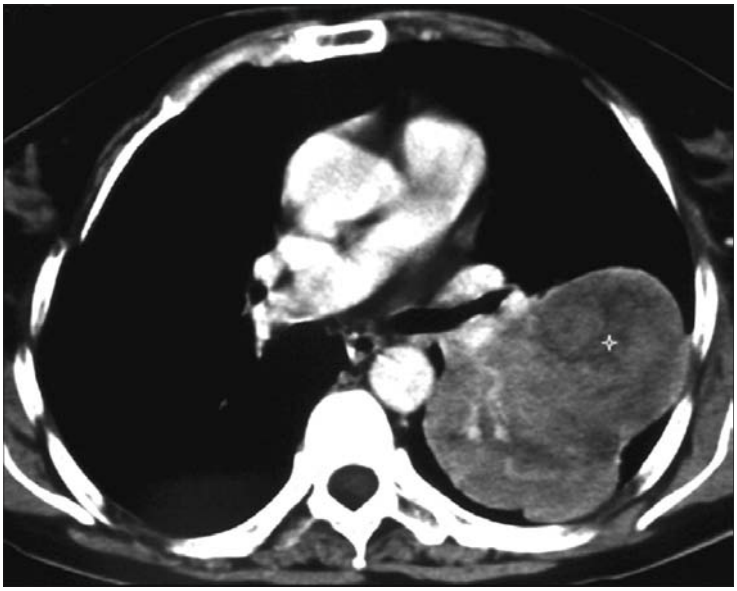

Figure 18. CT angiogram sign. A patient with bronchoalveolar carcinoma. Enhancing pulmonary vessels in a low-attenuating mass are seen.

Figure 19. a, b. Crazy paving pattern. **a.** Patient with situs inversus and Kartagener syndrome showing diffuse ground-glass attenuation with superimposed interlobular septal thickening and intralobular lines in both lungs. The cause of diffuse parenchymal disease in this patient was alveolar proteinosis. **b.** Paving stones.

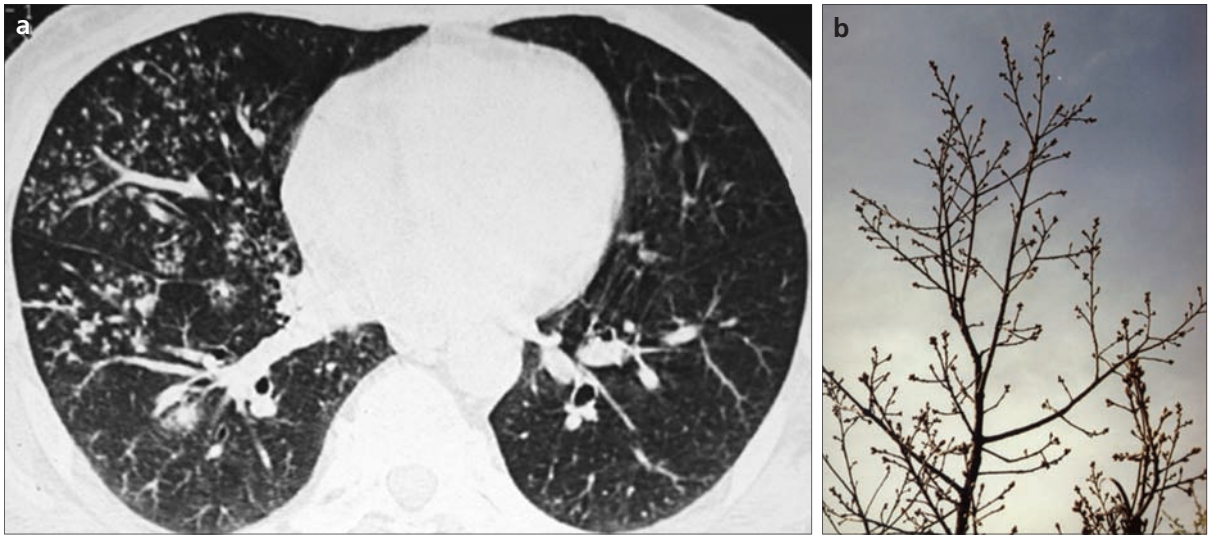

Figure 20. a, b. Tree-in-bud pattern. **a.** Patient with tuberculosis: small centrilobular nodules connected to multiple branching linear structures are seen. **b.** Tree-in-bud.

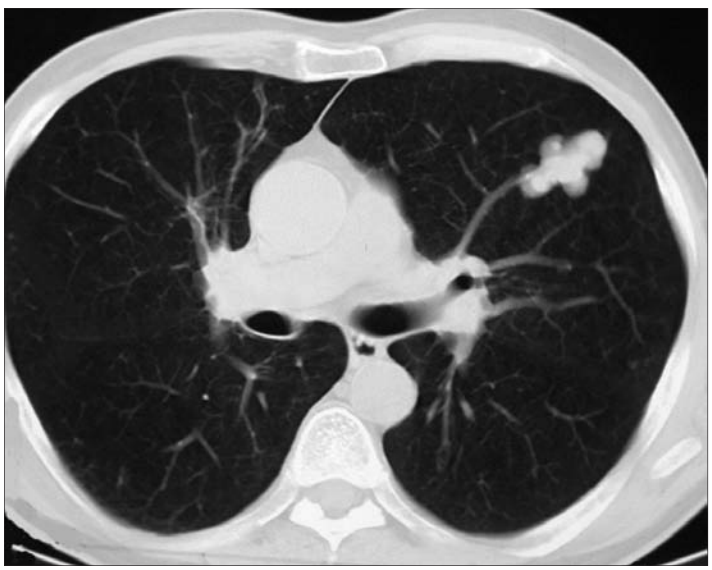

Figure 21. Feeding vessel sign. A patient with bronchial carcinoma. Pulmonary artery leading directly to the mass is seen.

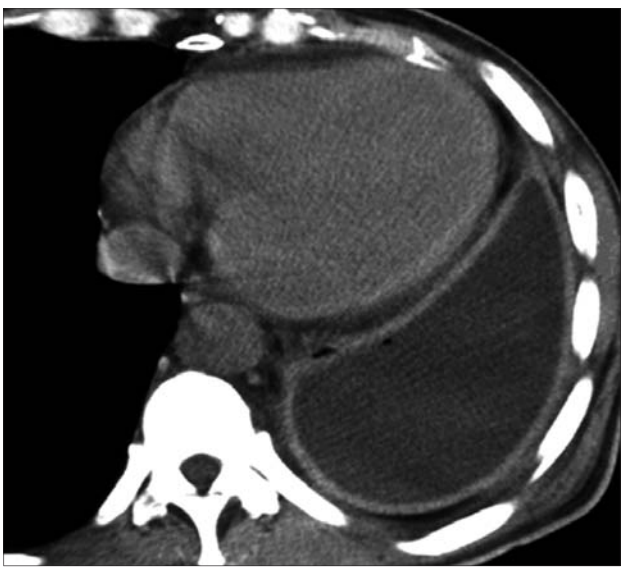

Figure 22. Split pleura sign. A patient with empyema. Visceral and parietal pleura are thickened and separated because of fluid.

Tree-in-bud sign

The tree-in-bud pattern is characterized by small centrilobular nodules connected to multiple branching linear structures of similar caliber originating from a single stalk (Fig. 20). This pattern is a finding of small airways disease. Initially, this sign was described in cases with transbronchial spread of *Mycobacterium tuberculosis* (31). It has subsequently been reported as a manifestation of a variety of entities. These entities include peripheral airway diseases such as infection (bacterial, fungal, viral, or parasitic), congenital disorders, idiopathic disorders (obliterative bronchiolitis, panbronchiolitis), aspiration or inhalation of foreign substances, immunological disorders, connective tissue disorders and vascular diseases (particularly tumor microembolisms) (7, 32–34).

Feeding vessel sign

The feeding vessel sign consists of a distinct vessel leading directly to a nodule or a mass (Fig. 21). This sign has been considered highly suggestive of septic embolism and also frequently occurs in pulmonary metastasis and arteriovenous fistula. It is rarely seen in lung cancer and granuloma (16, 35).

Split pleura sign

The split pleura sign is characterized by thickened pleural layers separated by fluid (Fig. 22). This sign is found primarily in empyema, and it helps to differentiate from abscess. It is also frequently seen in hemothorax and talc pleurodesis (20, 36).

Reversed halo sign

The reversed halo sign (atoll sign) is defined as a focal round area of ground-glass attenuation and surrounding air-space consolidation of crescent or ring shapes (37). Kim et al. were the first to describe this particular CT feature as the "reversed halo sign".

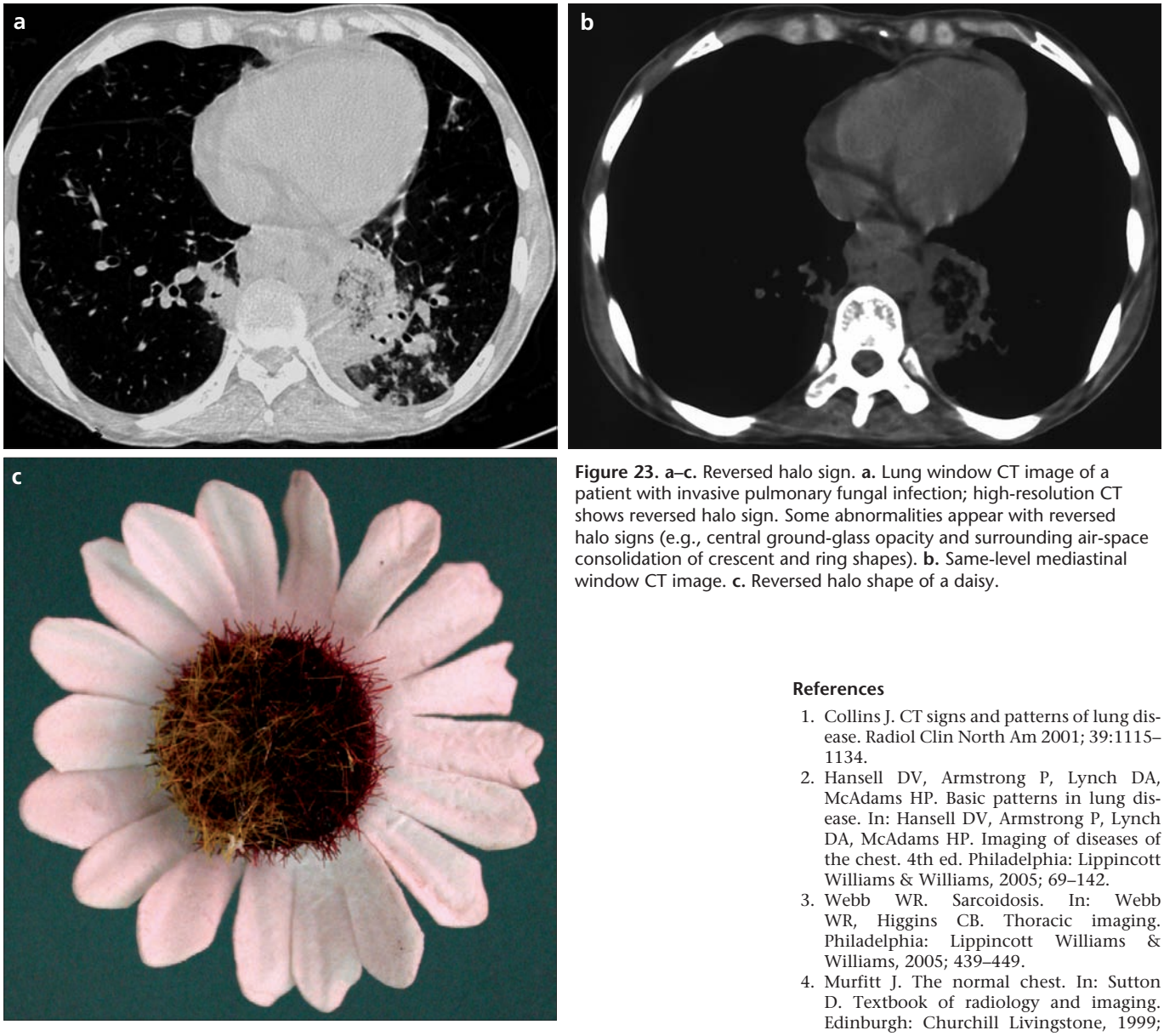

Figure 23. a–c. Reversed halo sign. **a.** Lung window CT image of a patient with invasive pulmonary fungal infection; high-resolution CT shows reversed halo sign. Some abnormalities appear with reversed halo signs (e.g., central ground-glass opacity and surrounding air-space consolidation of crescent and ring shapes). **b.** Same-level mediastinal window CT image. **c.** Reversed halo shape of a daisy.

It is defined as a central ground glass opacity surrounded by denser consolidation shaped like a crescent (forming more than three quarters of a circle) or ring (forming a complete circle) that is at least 2 mm in thickness (38, 39) (Fig. 23). The reversed halo sign seen on CT appears to be relatively specific to a diagnosis of cryptogenic organizing pneumonia (38). It is also reported in lymphomatoid granulomatosis, sarcoidosis, pulmonary paracoccidioidomycosis and other pulmonary fungal infections (38–42). Voloudaki et al. reported that the central ground glass opacity corresponds histopathologically to the area of alveolar septal inflammation (inflammatory infiltrates in the alveolar septum with macrophages, lymphocytes, plasmatic cells and some giant cells, with a relative preservation of alveolar spaces) and cellular debris and that the ring-shaped or crescentic peripheral air-space consolidation corresponds to the area of organizing pneumonia within the alveolar ducts (37, 41).

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