CT and x-ray signs point to pulmonary pathologies

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Patterns in radiological images can help with the identification and differential diagnosis of selected processes.1,2 Such signs should be recognizable, having a characteristic appearance that can be identified.

Several radiological signs can be of use when diagnosing pulmonary pathology: the crazy-paving sign, the golden "S," the gloved finger, the halo sign, the deep sulcus sign, the incomplete border, the luftsichel and scimitar signs, and the leafless tree.

Crazy-paving sign. This pattern, seen on thin-section CT images of the lungs, is characterized by a reticular pattern superimposed on ground-glass, resembling a path that has been made with broken pieces of paving (Figure 1). The reticular pattern is believed to result from a thickening of the interlobular septa, while the areas of ground-glass opacity result from partial alveolar filling processes.3 The crazy-paving sign was initially recognized in patients with pulmonary alveolar proteinosis, though it may be seen in patients with other diseases. The differential diagnosis includes Pneumocystis jiroveci pneumonia, mucinous bronchioloalveolar carcinoma, sarcoidosis, lipoid pneumonia, adult respiratory distress syndrome, and pulmonary hemorrhage.

Golden "S." This finding is seen on posteroanterior chest radiographs when a large central mass produces partial collapse of the right upper lobe. As the lobe collapses, the minor fissure moves superiorly and medially toward the mediastinum. The collapsed lobe is visible as a concave triangular opacity, while the central mass forms a convex bulge at the origin of the lobe. The combination resembles a reverse "S" shape (Figure 2). The golden "S" sign should always raise suspicion of a central neoplasm, such as primary bronchial carcinoma. Other central masses to consider include metastasis, primary mediastinal tumor, and enlarged lymph nodes. Although initially used to describe right upper lobe collapse, the golden "S" sign can be applicable to atelectasis involving any lobe.4

Gloved finger. Visible on conventional chest radiographs and CT images, this sign is characterized by branching fingerlike opacities that originate from the hila and are directed peripherally (Figure 3). These opacities represent dilated bronchi filled with mucus (mucoid impaction). The lung distal to the mucoid impaction remains aerated by collateral air drift through the interalveolar pores and the canals of Lambert, allowing the dilated bronchi to be seen.5 Bronchial impaction may be secondary to obstructive and nonobstructive processes. Any obstructing lesion can lead to distal bronchiectasis and mucoid impaction.

The most common benign lesions that cause bronchial obstruction are hamartoma and lipoma. Malignant neoplasms most likely to lead to obstruction are bronchogenic carcinoma and carcinoid tumors.

Some other, less common, causes of obstruction are congenital bronchial atresia, broncholithiasis, and aspirated foreign bodies. Non-obstructive causes of bronchial impaction include allergic bronchopulmonary aspergillosis; asthma; and cystic fibrosis, with or without associated allergic bronchopulmonary aspergillosis.

Halo sign. Visible on CT studies, this refers to a zone of ground-glass attenuation surrounding a pulmonary nodule or mass (Figure 4). The presence of such a halo is usually associated with hemorrhagic nodules.

The halo sign was initially described in patients with invasive aspergillosis.6 It may also occur with other infections, such as viral pneumonia, and in other conditions associated with pulmonary hemorrhagic nodules, such as lung metastases from hypervascular tumors (angiosarcoma, choriocarcinoma, and osteosarcoma), pulmonary Kaposi sarcoma, or Wegener's granulomatosis. The halo sign may be seen in cases of lepidic tumoral growth, where tumor cells spread along the
alveolar walls, preserving the underlying architecture of the lung. This feature is usually associated with bronchioloalveolar carcinoma.

Observation of the halo sign in patients with neutropenia and fever is regarded as early evidence of pulmonary aspergillosis, even before serologic tests become positive. It warrants the administration of systemic antifungal therapy.

Deep sulcus sign. This sign is visible on chest radiographs obtained with the patient in a supine position. It is seen as a lucency of the lateral costophrenic angle that is more profound than usual. It is caused by pneumothorax, with the air collecting in the costophrenic angle (Figure 5).

The deep sulcus sign is a useful clue in the diagnosis of pneumothorax in neonates or in critically ill patients. Approximately 30% of pneumothoraces go undetected on supine radio-graphs. Failure to diagnose this condition may be life-threatening.

Practitioners should ensure that the lateral costophrenic angles of patients who have suffered severe chest injury are included on the radiograph. This is also important in the intensive care setting for procedures such as insertion of a subclavian central venous catheter and for the use of positive pressure ventilation.²

Incomplete border sign. Visualized on conventional chest radio-graphs, this sign is suggestive of a lesion external to the lung. Extra-pulmonary masses will have a sharp, well-defined edge on the pulmonary side and an ill-defined edge on the other side (incomplete border) along at least one portion of the mass contour. The mass will appear to merge with the adjacent soft-tissue opacity of the chest wall (Figure 6).

The apparent incompleteness of the mass border is due to the absence of radiographic contrast between the soft-tissue opacity of the chest wall and the mass itself. The well-defined edge is seen where the mass meets air in the lung.² The three most common extra-pulmonary lesions are extrapleural fat, fibrous tumors of pleura, and rib lesions with accompanying soft- tissue masses. Observation of the incomplete border sign should be followed by a CT study to determine the radiological density of the mass. Lufthsichel sign. The word "luftsichel" is German for "air crescent." This finding is seen on PA chest radiographs and is taken to be a sign of left upper lobe collapse.

Most cases of left upper lobe collapse in adults are secondary to endobronchial neoplasm. Collapse of the lobe causes a major fissure to assume a vertical position, roughly parallel to the anterior chest wall. The lobe migrates anteriorly and medially, being contiguous with the left heart border and obliterating its contour on the PA chest radiograph as it collapses.⁸ As the left upper lobe moves anteromedially, the superior segment of the left lower lobe hyperinflates to fill the vacated apical space. This segment will insinuate itself between the aortic arch and the collapsed left upper lobe, creating a sharp outline, or periaortic lucency, hence the luftsichel (Figure 7).

Scimitar sign. This is a broad, curved shadow seen on PA chest radiographs that extends inferiorly toward the diaphragm along the right side of the heart, resembling a Turkish sword. It is indicative of a partial, anomalous pulmonary venous return, most commonly to the infra-diaphragmatic inferior vena cava. This vein is part of the congenital hypogenetic lung (scimitar) syndrome, which comprises right lung hypoplasia, anomalous venous return, and a small right pulmonary artery.⁷ It occurs almost exclusively on the right side (Figure 8).

The anomalous pulmonary vein is seen on only a third of PA radiographs, though it is always seen on CT studies, together with other components of the triad. It is occasionally accompanied by other abnormalities, such as horseshoe lung and duplication of the diaphragm.

Leafless tree sign. This describes the appearance of air-filled bronchi within a pulmonary infiltrate on high-resolution CT. The bronchi are stretched and squeezed, and the branching is sparse, simulating a leafless tree (Figure 9).

This appearance is due to cellular infiltration of the alveolar space. It is distinct from inflammation, in which bronchi within the infiltrate are dilated.⁵ The leafless tree sign is usually seen in cases of peripheral tumoral infiltration of the lung. This will generally be due to alveolar cell carcinoma. Other causes include lymphomatous disorders and amyloidosis of the lung.

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