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Multislice CT and CT angiography for non-invasive evaluation of bronchopulmonary sequestration

Bronchopulmonary sequestration

Bronchopulmonary sequestration (BPS) is a rare congenital anomaly due to disturbed embryogenesis with a surplus budding of the lungs. BPS has no communication with the bronchial system. In most cases the blood supply of the sequestration is systemic via the aorta.

There are two types of BPS: intralobar sequestration without its own pleural covering and extralobar sequestration with a separate pleura. They are clinically manifested in different ways. Sequestration normally occurs in the left lower lobe. The venous drainage often occurs via the pulmonary veins, producing a large shunt volume. The clinical symptoms are caused by recurrence of infection because of extensive therapy resistance, and rarely by haemoptysis.

Intralobar sequestration

Intralobar sequestration (ILS) is a non-functioning lung tissue that does not communicate with the normal bronchial tree. Communication, however, may develop as a result of chronic chest infection. ILS occurs on the left side (60%), most commonly in the posterior basal segment. However, it can also occur in the upper lobe and is covered by the pleura of the pulmonary lobe. The incidence in males and females is equal. ILS receives its blood supply from thoracic or abdominal aorta or one of its branches, and the anomalous artery is often very large compared to the volume of the tissue it supplied. The venous drainage invariably occurs via the pulmonary veins, producing a left-to-left shunt. On rough examination it may be a solid or cystic mass, depending on the inflammatory changes and infection. ILS is very rarely associated with other anomalies. Cardiac anomalies are most common when ILS occurs in the upper lobes.

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Extralobar sequestration (EPS)

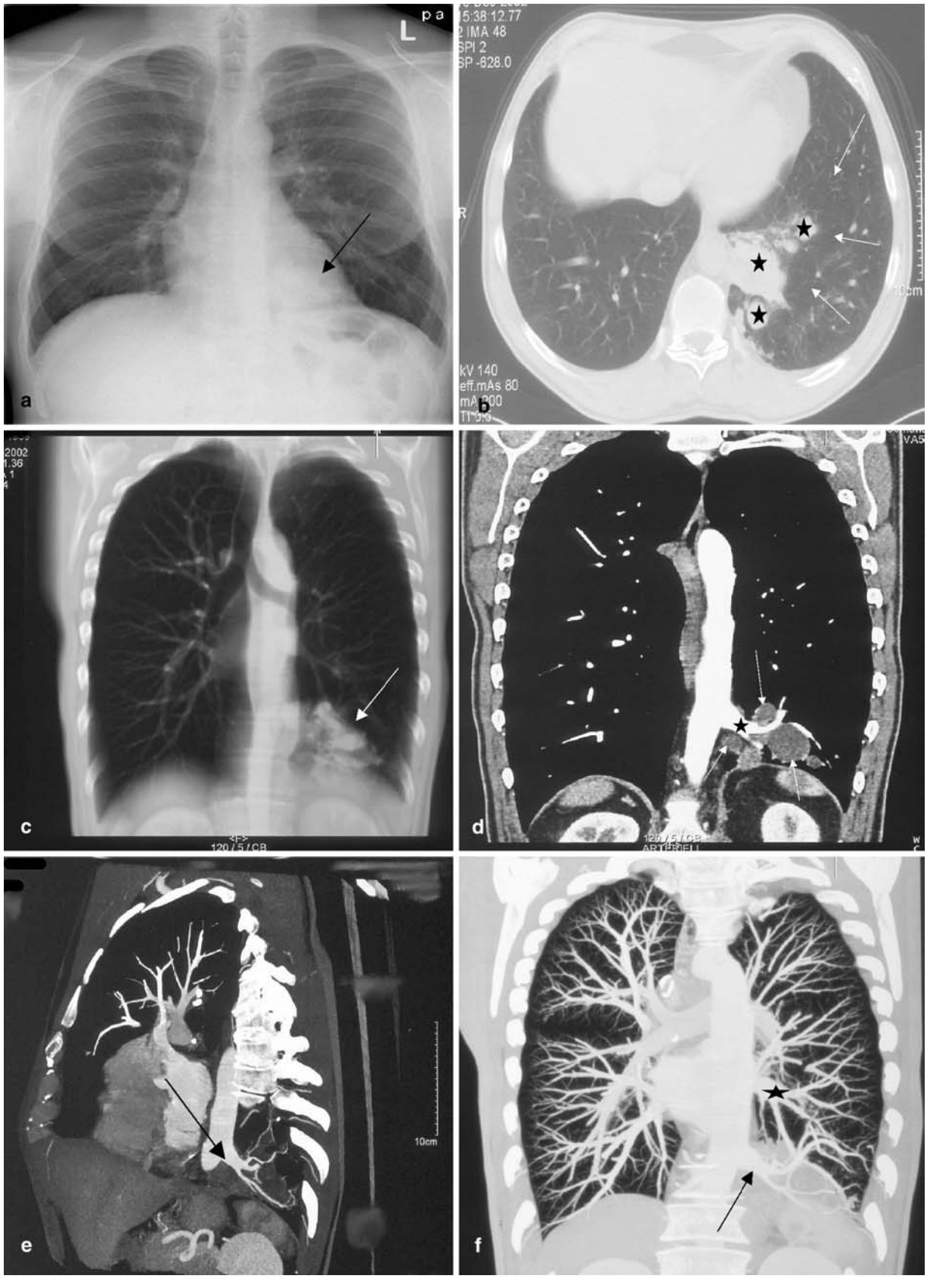
EPS accounts for 25% of all pulmonary sequestrations and is covered by its own pleura. ELS appears on the left side (90%), above or below the diaphragm or within the mediastinum, and receives its blood supply, like ILS, from a systemic artery. Multiple arteries of supply may be present. The venous drainage usually runs via the systemic venous system (inferior vena cava, azygos, hemiazygos or portal vein), creating a left-to-right shunt. ELS is often associated with other congenital anomalies.

Clinical features

IPS presents in early adulthood, but 50% of the patients reach the age of 20 years before the diagnosis is made as an accidental finding on radiograph. EPS is mainly found in neonates, and less frequently in late infancy or early childhood. Most of the patients are asymptomatic and become symptomatic as a result of respiratory infection, displacement of the organs or when a complication occurs. The clinical picture is usually of lower lobe pneumonia.

Imaging studies

The radiographic appearance of sequestration depends on: presence or absence of an associated infection, de-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gree of aeration and associated anomalies. When it communicates with the lung, mostly after being infected, it appears as an air-containing cystic mass, often multiple. It may also contain an air-fluid level simulating an abscess, a bronchiectatic cavity or an infected cyst with emphysematous lung. And when it does not communicate, it appears as a homogeneous mass of water density at the affected side and may be mistaken for pneumonia, neoplasm or atelectas. ILS may appear as a paravertebral well-defined nodular mass behind the heart surrounded by ill-defined opacities. Bronchography shows draping of normal bronchi about the sequestration, and the filling of sequestration can be seen when communication occurs between BPS and contiguous tissue or airways as a result of infection. CT scan is useful in non-invasive evaluation of BPS and more clearly reveals the characteristic features of the lesion. BPS appears in the lower lobe as homogeneous or heterogeneous consolidation, cavitation or cystic mass with fluid or air alone or air-fluid levels. It is surrounded by emphysematous changes (air-trapping). After the bolus injection of contrast material is applied, dynamic CT scan demonstrates the anomalous vessel in up to 80% of cases. The vessel can be traced to the BPS. Multislice CT has not only improved visualisation of the lesion, but also delineation of the origin and course of the anomalous artery. However, the failure to visualise the artery does not exclude the diagnosis of BPS. Junpei Ikezoe classified in his study the parenchymal abnormalities of the intralobar sequestration shown at CT scan into three types: single or multiple cysts containing air or mucus, emphysema surrounding the lesion and hypervascularity of the lesion. (Two sequestrations out of 24 showed hypervascularity of the lesion.) The imaging features in our patient are: inhomogeneous mass in the left lower lung, bronchiectatic lesions filled with impacted mucus (bronchiectatic mucoceale), air-trapping at the border of the lesion and normal lung, aberrant artery originating from the thoracic aorta, venous drainage via pulmonary veins and hypervascularisation of the lesion. Unlike conventional angiography, CT angiography is minimally invasive and can demonstrate not only the arterial supply, venous drainage and hypervascularisation of the sequestration, but also sequestration.

◀ **Fig. 1 a** Bronchopulmonary sequestration (BPS). Chest radiograph (PA view) of a 43-year-old patient (male) with repeated chest infection shows a homogeneous mass behind the heart in the left lower lobe (*arrow*). **b** CT scan (lung window) shows a hypervascular mass (*stars*) surrounded by air-trapping (*arrows*) at the border of the mass and normal lung tissue. **c** Thick-slice MIP of the CT scan shows a mass in the left lower lobe. **d** Contrast-enhanced CT scan. Cystic fluid-filled bronchiectasis (*arrows*) is visualised surrounding the aberrant artery (*star*). **e** CT angiographic evaluation demonstrating the posterior course of the aberrant vessel (*arrow*). **f** MPR showing arterial supply from the thoracic aorta (*arrow*) and venous drainage through the pulmonary vein (*star*)

Benefits of multislice computed tomography

The development of multislice CT (16 slices, 0.5–1 mm collimation) has further improved and increased the use of computed tomography. Multislice computed tomography (MSCT) in thoracic imaging allows scanning of the entire chest within a single breath-hold and provides better spatial resolution in less time with minimal radiation exposure. Besides, it helps in eliminating respiratory artefacts, minimising motion artefacts and producing overlapping slices. MSCT not only reveals the radiographic features of the sequestration, but also the complex character of the sequestration. In addition, it helps to identify the aberrant arterial supply and venous drainage of the sequestration. Multiplanar reconstruction (MPR) provides visualisation of spatial correlation and differentiation between pathology and normal findings. Maximum intensity projection (MIP) gives a better overview and better correlation and differentiation between arteries and veins. Multislice CT provides unequivocal diagnosis of the sequestration with better surgical planning. Chest X-ray, bronchogram, CT, MRI and ultrasonography are helpful in identifying various aspects of the BPS. Some authors are stating that angiography is the gold standard for identifying BPS, systemic artery and venous drainage.

In our case age, localisation, arterial supply, venous drainage via pulmonary veins, hypervascularisation of the lesion and air-trapping around the consolidation (bronchiectatic mucoceale) favour the diagnosis of intralobar BPS (Fig. 1a–f). The diagnosis was confirmed intraoperatively.

Differential diagnosis

The differential diagnosis includes cystic adenomatoid malformation, bronchial atresia, bronchogenic cyst, bronchiectasis, pneumonia, lung abscess and systemic arterial supply to non-sequestered lung.

Treatment options

(1) Conventional surgery: lobectomy, segmental resection, simple excision
(2) Embolisation or ligation of the aberrant systemic artery

Conclusion

BPS can be determined by chest X-ray and the diagnosis of pulmonary sequestration should be considered if the CT scan shows a hypervascular basal lung lesion associated with air-trapping sometimes accompanied by an anomalous systemic artery.