Back to Basics - ‘Must Know’ Classical Signs in Thoracic Radiology

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ABSTRACT

There are a few signs in radiology which are based on many common objects or patterns that we come across in our routine lives. The objective behind the association between such common objects and the corresponding pathologies is to make the reader understand and remember the disease process. These signs do not necessarily indicate a particular disease, but are usually suggestive of a group of similar pathologies which will facilitate in the narrowing down of the differential diagnosis. These signs can be seen in different imaging modalities like plain radiograph and computed tomography. In this essay, we describe 24 classical radiological signs used in chest imaging, which would be extremely helpful in routine clinical practice not only for radiologists but also for chest physicians and cardiothoracic surgeons.

Key words: Chest, computed tomography, signs, thoracic radiography, X-ray

INTRODUCTION

Radiological signs are classical and distinctive abnormalities, characteristic of a disease or a group of similar pathologies which can be seen either on a plain radiograph or on a computed tomography (CT) scan. These signs are generally based upon and associated with common objects and patterns that we come across in our routine lives. The objective behind establishing such an association is to help the reader understand and memorize their appearance and characteristics. The familiarity and application of these signs can facilitate in narrowing down the differential diagnosis and timely management of the disease. The knowledge of these signs is helpful to residents and practitioners across various streams like radiology, internal medicine, chest medicine, and cardiothoracic surgery. The aim of this essay is to serve as a ready reference guide in the field of chest imaging.

Air crescent sign

Air crescent sign appears as a crescent of air surrounding a soft-tissue mass in a pulmonary cavity and can be seen in both plain X-ray and CT scan [Figure 1]. Though it is characteristic of invasive pulmonary aspergillosis, it can also be seen in cavitating neoplasms, lung abscesses, and infections. This sign is considered a good marker of immune activity as it is seen when the necrotic tissue gets invaded by leukocytes and replaced by air in invasive pulmonary...
aspergillosis.\(^1\) The other conditions in which air crescent sign can be seen are pulmonary gangrene,\(^2\) pulmonary hematoma,\(^2\) Rasmussen aneurysm in a tuberculous cavity,\(^2\) and lung hydatid.\(^2,3\) It mimics Monad sign which is seen in patients with aspergilloma in a pulmonary cavity.

**Bulging fissure sign**

Bulging fissure sign is seen classically in consolidation caused by *Klebsiella pneumoniae* infection in the right upper lobe. It occurs due to large exudates produced by the *Klebsiella* organism which expands the lobe and causes a bulge in the fissure, and can be seen in plain X-ray and CT scan [Figure 2]. Although the main causative organism responsible for this sign is *K. pneumoniae*, other causes are tuberculosis, pneumococcal pneumonia, *Hemophilus influenzae*, lung abscesses, and tumors like bronchoalveolar carcinoma.\(^4,5\)

**Cervicothoracic sign**

This sign was described by Benjamin Felson and based on the Silhouette sign.\(^6\) This sign is seen on plain X-ray and is used to differentiate between an anterior and posterior mass in the superior mediastinum. At the level of the thoracic inlet, the posterior part of the lung extends superiorly to the clavicle compared to the anterior part; hence, any mass when situated in the posterior mediastinum, is completely surrounded by the lung tissue from all sides. This leads to a well-defined cephalic border seen well above the clavicle.\(^7\) In contrast to this, anterior mediastinal masses have ill-defined cephalic margins due to their anatomical contact with the soft tissues of the neck, either at or below the clavicle\(^8\) [Figure 3a-d], indicating a cervicothoracic lesion.

**Comet tail sign**

In comet tail sign, a subpleural mass produces distortion of the adjacent bronchovascular bundles and appears as a curvilinear opacity extending from the subpleural mass toward the ipsilateral hilum as seen on CT scan, thus resembling a comet tail [Figure 4]. This round atelectasis is associated with pleural effusion or pleural thickening and is seen in approximately 70% of asbestos-related pleural disease.\(^9\) The other uncommon causes are chronic pleural infections like tuberculosis, congestive heart failure, or pulmonary infarct.\(^10\) Round atelectasis is mostly seen in lower lobes, but can rarely involve other lobes as well. Fine needle aspiration biopsy and/or excision biopsy may be required in equivocal cases to exclude the possibility of neoplasm.\(^11\)

**Continuous diaphragm sign**

This sign is seen in pneumomediastinum in which air accumulates between the lower border of the heart and the superior part of the diaphragm, which results in complete visualization of the diaphragm in chest X-ray [Figure 5a and b], hence named continuous diaphragm sign.\(^12\) Normally, the central part of the diaphragm is obscured by the heart, and hence is not seen on chest radiographs. Though this sign is commonly seen in pneumomediastinum, it can occasionally be also seen in pneumopericardium.\(^13\) This sign when seen, is a differential tool between pneumomediastinum and pneumothorax.\(^12,14\)

**Crazy paving sign**

Crazy paving sign is seen with a combination of thickened interlobular septa and areas of ground glass opacities (GGO) on high-resolution computed tomography (HRCT) lung...
resembling irregular paving stones. Originally noted in pulmonary alveolar proteinosis, the common causes are adult respiratory distress syndrome, infectious causes like Pneumocystis carinii pneumonia, bacterial pneumonia, etc. The rare causes include nonspecific interstitial pneumonia, sarcoidosis, and respiratory bronchiolitis superimposed on interstitial lung disease. Histologically, the thick interlobular septa represent inflammation, while the ground glass opacities are due to intra-alveolar protein-rich fluid in pulmonary alveolar proteinosis.

**CT halo sign**

Halo sign is a circular mass or a consolidation surrounded by ground glass opacities [Figure 7]. It was first reported by Kuhlman et al., in 1985 in a case of pulmonary aspergillosis indicating hemorrhagic nodules. Various diseases produce different histological features leading to the formation of a halo. For example, in cases of invasive aspergillosis, halo represents hemorrhage, whereas in cases of carcinoma, the same represents lepidic spread of tumor. The appearance of halo sign on CT has been mostly assessed to be an indication of pulmonary hemorrhage, but it is also seen in various infections and inflammatory and neoplastic conditions. It is associated with fungal infections like invasive aspergillosis, Pneumocystis jiroveci pneumonia, and candidiasis, bacterial infections like TB, Nocardia, and Legionella, viral infections like cytomegalovirus and herpes, inflammatory conditions like Wegener’s granulomatosis, vascular causes like infarct, and neoplastic conditions like metastatic tumor, Kaposi sarcoma, bronchioalveolar carcinoma, and
adenocarcinoma. Although nonspecific, the presence of the halo requires detailed history, thorough clinical evaluation, and correlation with laboratory and radiological investigations to narrow down the differential diagnosis.

**Deep sulcus sign**
This sign is seen in supine chest radiographs of pneumothorax in which air accumulates in the lateral costophrenic angle, which appears lucent and deep when compared to the other costophrenic angle [Figure 8]. This sign is visualized in supine position when air accumulates in the nondependent parts of the pleura, i.e. anterior and basal parts, in contrast to the upright position in which air accumulates in the apex of the pleura. Once visualized, one should always look for other signs of pneumothorax in cases of major trauma, neonates, and ICU patients to avoid errors.\[16\] False deep sulcus sign can be seen in chronic obstructive pulmonary disease.\[17\]

**Double density sign**
Left atrial enlargement appears as a curvilinear soft-tissue density in the right retrocardiac region in chest radiographs. This curvilinear density along with the right atrium opacity represents the double density sign [Figure 9]. In severe cases, this curvilinear density of the left atrium may even project beyond the right atrium border which is called the atrial escape.\[18,19\] Once visualized, one should also look for other signs of left atrial enlargement like carinal widening, elevation of the left main bronchus, and enlargement of the left atrial appendage.

**Feeding vessel sign**
This sign consists of a pulmonary artery leading to the center of the nodule signifying the hematogenous origin of the nodule [Figure 10]. It is seen in CT scan of the chest, and is a strong indication of septic embolism and is seen in approximately 67–100% of septic embolus cases.\[20\] This can also be seen in secondaries to the lung, hemorrhagic nodules, pulmonary vasculitis, pulmonary infarct, and pulmonary arteriovenous malformation.\[21,22\] The feeding vessel may even rotate around the nodule instead of entering the center of the nodule, which is seen clearly on multiplanar images or may even represent a pulmonary vein.\[23\]

**Finger-in-glove sign**
This sign which can be seen in plain X-ray and CT scans of the chest appears as a tubular soft-tissue density opacity radiating from the hilum to the lung periphery and, thus, mimicking fingers-in-a-glove [Figure 11]. It occurs due to impaction of mucus in the bronchi, which results in bronchiectasis surrounded by aerated lung. This sign was first described in 1978 by Mintzer et al., in a case of allergic bronchopulmonary aspergillosis (ABPA).\[24\] It occurs due to two main pathologies – obstructive and non-obstructive. Obstructive pathologies comprise benign tumors like hamartoma, lipoma, etc., and malignant neoplasms like bronchogenic carcinoma or metastases, while congenital causes include bronchial atresia, etc. The non-obstructive pathologies are ABPA and cystic fibrosis. ABPA is more common in asthmatic patients with Aspergillus infection. Mucoid impaction in cystic fibrosis occurs due to thick mucus secretions and mucociliary dysfunction.

**Fleishner sign**
This sign was first described by Felix Fleishner and it represents dilatation of the proximal pulmonary arteries...
due to pulmonary embolism [Figure 12]. It is seen on both plain X-ray and CT scan of chest. This could be either due to large embolus enlarging the pulmonary artery or increased pressure in pulmonary arterial circulation.

Hampton’s hump
It was first described by Aubrey Otis Hampton in 1940 and was even named after him. It is also known as the melting sign owing to its resolution resembling a melting ice cube. This sign is a classical radiographic feature of pulmonary embolism, which represents wedge-shaped area of pulmonary infarction secondary to embolus as seen on plain X-ray or CT scan [Figure 13]. The accurate and timely diagnosis of this disease, which carries a mortality rate of 26–30% in untreated patients and a rate of 2–8% even in treated patients, is extremely important.

Hilum overlay sign
This sign was also described by Benjamin Felson and it helps to determine whether an opacity seen on chest X-ray is within the hilum or anterior or posterior to it. It is based on the Silhouette sign. If opacity is situated within the hilum, there will not be any air between the margins of the hilar structures, which will in turn lead to obscuration of the opacities from the proximal pulmonary artery. This will appear as opacity inseparable from hilar structures, confirming its location to be within the hilum [Figure 14a–c]. On the other hand, if a mass produces opacity through which hilar vessels are clearly seen, then the mass can be said to be located anterior or posterior to the hilum [Figure 15a and b].

Juxtaphrenic sign
This sign was first described by Katten et al., in 1980, and
hence, it is also known as the Katten’s sign.\textsuperscript{[32]} It is seen on chest radiograph and appears as a peak arising from the medial part of the diaphragm [Figure 16]. This peak is caused most commonly by traction from the inferior accessory fissure,\textsuperscript{[33]} but can also be caused by major fissure or inferior pulmonary ligament. It is seen in upper lobe collapse, middle lobe collapse, and in cases of post upper lobectomy.\textsuperscript{[34]}

Knuckle sign
It appears as abrupt tapering of a pulmonary artery (white arrow) secondary to embolus [Figure 17]. It is seen on a CT scan. Once detected, one should look for other signs of pulmonary thromboembolism like Fleishner sign, Westermark sign, etc., and determine the extent and severity of pulmonary thromboembolism.

Naclerio’s v sign
This sign is a common presentation in pneumomediastinum in which there occurs a lucency in the shape of “V” which is caused by air outlining the medial part of the left hemidiaphragm and lower mediastinal border [Figure 18a and b], and can be seen both on X-ray and CT scan. Although this sign was first described by Naclerio in cases of spontaneous esophageal rupture,\textsuperscript{[35]} this sign is not specific for esophageal rupture.\textsuperscript{[36]}

Polo mint sign
This sign is seen in a blood vessel in a contrast-enhanced CT scan in which the central filling defects represent the thrombus while the peripheral rim appears as a hyperattenuating area due to contrast which mimics the polo mint [Figure 19a]. This could be seen in any vessel with thrombus, such as pulmonary artery, superior vena cava [Figure 19b], or portal vein.\textsuperscript{[37]}

Signet ring sign
This sign appears as a round area of soft-tissue attenuation...
abutting a circle of lucent air in HRCT of lungs [Figure 20] and, thus, mimicking a ring. This soft-tissue attenuation represents a pulmonary artery lying adjacent to the dilated bronchi and is seen in cases of bronchiectasis.\[^{38}\] Bronchiectasis is defined as an irreversible and abnormal dilatation of the bronchus\[^{38}\] and can be classified as cylindrical, varicose, and cystic types on the basis of morphology. Bronchiectasis is diagnosed when the dilated bronchus measures more than 50% of the associated pulmonary artery, along with other findings like bronchial wall thickening, visualization of bronchi within 1 cm of the pleura, and non-tapering bronchi.\[^{38}\] False-positive increase in the bronchoarterial ratio can be seen with increased altitude on HRCT.\[^{39}\]

**Silhouette sign**

This sign is present when an intra-thoracic lesion touches the border of the heart, aorta, or diaphragm and that border is obliterated on the X-ray [Figure 21a–c].\[^{31}\] Conversely, an object which is not neighboring these structures will not obliterate their border [Figure 22a–c].\[^{31,31}\] This absence or presence of silhouette helps in localizing the lesion anatomically. This is based on the fact that variation in the densities between nearby structures results in different radiological shadows.\[^{8}\]

The lesions in the right middle lobe and lingula usually obliterates the right and left borders of the heart, respectively. Similarly, the lower lobe lesion obliterates the diaphragm and descending aorta. Lesions in the anterior segment of the right upper lobe obliterates the right paratracheal stripe, whereas lesions in the apicoposterior segment of the left upper lobe obliterates the aortic knuckle.

This term was first described by Dr. Benjamin Felson in 1950.\[^{31}\] It is also known as the loss of outline sign or loss of silhouette sign.\[^{40}\]

**Split pleura sign**

Split pleura sign is seen in CT scan in cases of empyema which most commonly occurs due to bacterial pneumonia.

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**Figure 17:** 67-year-old female presented with chest pain and was diagnosed with pulmonary thromboembolism. Contrast-enhanced CT scan of chest shows abrupt tapering of a pulmonary artery (white arrow) secondary to embolus and thus producing the radiologic sign, knuckle sign.

**Figure 18:** 66-year-old male presented with severe chest pain after an episode of vomiting and was diagnosed with esophageal tear resulting in pneumomediastinum. (a) Coronal image of CT chest shows air outlining the left hemidiaphragm (white arrowhead) and left lateral wall of aorta (white arrow) appearing as “V” and thus producing the radiologic sign, Naclerio’s V sign. (b) Scanogram shows air outlining the left lateral wall of the aorta (white arrow).

**Figure 19:** (a) 62-year-old male presented with chest pain and was diagnosed with pulmonary thromboembolism. Contrast-enhanced axial image of CT chest shows central embolus with peripheral contrast in a right pulmonary artery branch (white arrow) producing the radiologic sign, polo mint sign. (b) 38-year-old female with chronic renal failure presented with swelling of whole body and was diagnosed with superior vena cava obstruction due to thrombus. Contrast-enhanced CT scan of chest shows central embolus with peripheral contrast in the superior vena cava (white arrow) producing the radiologic sign, polo mint sign.

**Figure 20:** 54-year-old male presented with difficulty in breathing and was diagnosed with asthma. HRCT of lung shows dilated bronchi (white arrows) lying adjacent to the pulmonary artery (white arrowhead) producing the radiologic sign, signet ring sign.
There occurs fluid accumulation in the pleural space, which causes fibrin coating of the inner visceral and outer parietal layers of pleura. This results in separation, thickening, and increased enhancement of pleural layers, producing split pleura sign [Figure 23]. Empyema causes extrapleural fat stranding and thickening of extrapleural soft tissues. 

Even though these pleural changes are commonly seen in empyema, similar changes can also be visualized in conditions like mesothelioma, hemothorax, and post lobectomy.

**Thymic notch sign**

This sign is seen in newborn chest radiographs in which the inferior border of the thymus forms a notch with the heart border [Figure 24a and b]. Other signs seen in the thymus are the wave sign, which is the gentle undulations seen on the right border of thymus due to costochondral junction impressions, and the sail sign, which is a triangular-shaped inferior margin of the thymus mostly seen on the right side.

**Visceral pleural white line**

This is seen in pneumothorax in which there occurs separation of the visceral and parietal layers of the pleura by air, leading to visualization of a white line of visceral pleura in a plain X-ray [Figure 25]. Hence, it is called the visceral pleural white line. A skin fold might mimic visceral pleural white line; however, when traced, it tracks outside the lung field.

**Westermark sign**

Westermark sign is defined as a focal area of oligemia distal to an occluded pulmonary artery [Figure 26]. This
area appears hypoattenuated compared to the normal lung and can be seen on both X-ray and CT scan. This sign was first described by Neil Westermark in the year 1938.\textsuperscript{[44]} This sign is quite rare and seen in 2% of patients with pulmonary thromboembolism.\textsuperscript{[45]} It occurs due to a combination of obstruction of pulmonary artery by embolus and vasoconstriction occurring in the hypoxic lung.\textsuperscript{[28]}

**CONCLUSION**

These signs are compiled with an intention to provide a comprehensive review of the scientific basis behind these signs and their importance in thoracic imaging. With a thorough understanding of these signs in conjunction with the relevant medical history, we can have a systematic approach to the problems in thoracic imaging, which can assist in a proper patient management.

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