

HRCT Patterns of Diffuse Lung Disease: A Pictorial Essay

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Abstract

Review Article

This article describes the HRCT patterns and imaging protocol and findings in diffuse parenchymal lung disease and provides detailed visualization of the lung parenchyma and illustrates the pattern and distribution of the disease which can help in formulating a differential diagnosis when these patterns are encountered on imaging.

Keywords: HRCT patterns; high-resolution computed tomography; HRCT protocols; lung parenchyma; diffuse parenchymal lung disease.

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INTRODUCTION

The lungs are the organs of respiration, where gaseous exchange occurs between the respiratory air and blood [6]. The lungs are situated so that one lies on each side of the mediastinum. They are therefore separated from each other by the heart and great vessels and other structures in the mediastinum [7]. Each lung contains a branching system of air tubes called the bronchial tree, extending from the main bronchus to the terminal bronchioles [10]. Each lung has a pulmonary artery supplying blood to it and two pulmonary veins draining blood from it [8].

Diffuse parenchymal lung disease (DPLD) describes a heterogeneous group of disorders of the lower respiratory tract characterized by inflammation and derangement of the interstitium and loss of functional alveolar units [2]. Diffuse pulmonary diseases can be classified in two categories: (1) Obstructive disease (airway disease), characterized by limitation of airflow usually resulting from an increase in resistance caused by partial or complete obstruction at any level, and (2) Restrictive disease, characterized by reduced expansion of lung parenchyma accompanied by decreased total lung capacity [16]. Interstitial lung diseases encompass a diverse group of more than 200 separate entities affecting the lung parenchyma. Because these conditions are multilobar and frequently bilateral in distribution on imaging, the term 'diffuse

parenchymal lung disease' (DPLD) has been suggested as both more appropriate and less restrictive at the microscopic pathology level [11].

Computed tomography of the chest can be extremely useful when chest radiographs provide insufficient information to answer important clinical questions about diagnosis, extent of disease, and prognosis [1]. HRCT can depict the normal and abnormal interstitium with anatomic detail similar to that of gross pathologic specimens and has become the imaging modality of choice in the evaluation of patients with suspected IID [17]. Current indications for HRCT include the evaluation of suspected diffuse infiltrative lung disease in patients who have normal, nonspecific, or inconsistent radiographic findings [4]. Recognition of the appearance pattern often allows developing an appropriate differential diagnosis list including all the major categories of disease that might lead to the identified pattern [12].

Since HRCT is the radiological imaging technique that most closely reflects changes in lung structure, it is the method of choice for the diagnostic work-up of patients with known or suspected DILD [19].

HRCT Techniques

Basic HRCT technique uses thin slices, scanning at full inspiration, and reconstruction with a

sharp algorithm. To provide an accurate assessment of lung abnormalities, thin slices (0.625 to 1.25 mm) are required. These are reconstructed using a sharp or edge enhancing algorithm to improve characterization of abnormal findings [13]. There are multiple protocols in current use for obtaining HRCT scans. Examples of two such protocols—spaced axial images and multidetector volumetric HRCT [19]. In nearly all patients, images are routinely obtained in the supine position, at full inspiration [13]. HRCT images with the patient in the prone position can be acquired to differentiate the dependent edematous changes often seen in the lung bases [15].

HRCT Patterns of Diffuse Lung Disease

Diffuse abnormalities of the lung parenchyma on HRCT can be broadly categorized into one of the following four patterns: reticular and short linear opacities; nodular opacities; increased lung opacity

(ground-glass opacity or consolidation); and cystic airspaces and areas of decreased lung density [14].

Reticular Pattern

A reticular opacities represent linear opacities that intersect one another at various angles, producing a netlike pattern [3]. The term is purely descriptive (reticulum = network) and there are several morphologic variations to this basic pattern, ranging from generalized thickening of the interlobular septa to honeycomb lung destruction [14]. The most important form of reticular opacity encountered on HRCT imaging is intralobular interstitial thickening [3].

Honeycombing is defined as clustered, air-filled cysts that are often of similar diameters on the order of 3-10 mm or occasionally larger [9]. Honeycombing indicates the presence of end stage lung and seen in almost any process leading to end-stage pulmonary fibrosis [5].

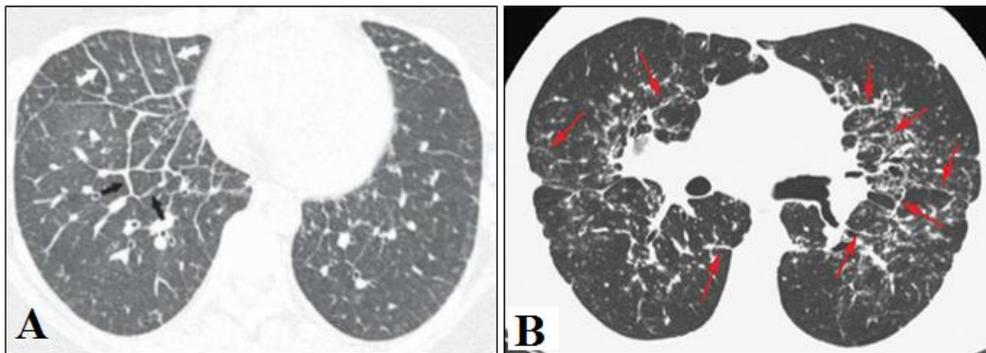


Fig-1: Interlobular Septal thickening: A) Axial HRCT chest image shows thickened interlobular septa as lines 1 to 2 cm in length, separated by 1 to 2 cm, extending to the pleura (white arrows) and as polygonal arcades (black arrows) outlining secondary pulmonary lobules. B) Axial HRCT chest image show numerous irregularly thickened interlobular septa (arrows) are associated with lung fibrosis and distortion of lung architecture

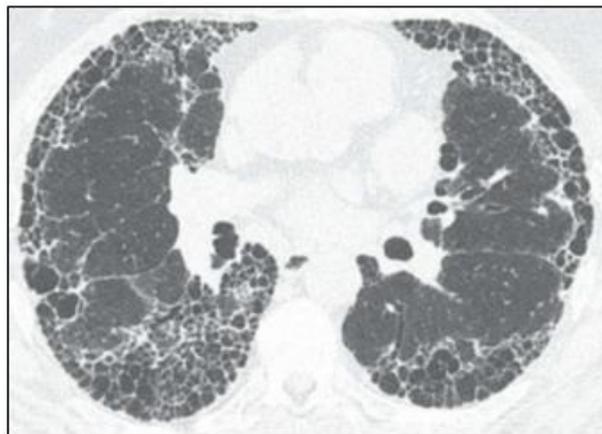


Fig-2: Honeycombing: Axial HRCT chest image demonstrates multiple clustered cystic air spaces with well-defined walls in the subpleural regions of both lungs

Nodular Pattern

Nodular pattern is defined by the presence of multiple roundish pulmonary opacities ranging in diameter from 2 to 10 mm [18]. A nodular pattern is a feature of both interstitial and airspace diseases. The localization of nodules as well as other characteristics

such as their density, clarity of outline, and range or uniformity of size may indicate whether the nodules are lying predominantly within the interstitium or air spaces [14]. Morphology, density, and distribution of the nodules depend on the route of arrival and the modality of spread [18].

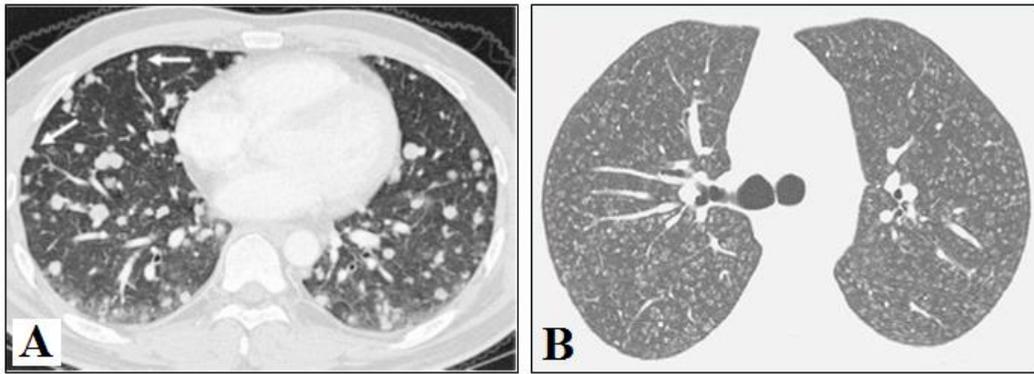


Fig-3: Nodules: A) Axial HRCT chest image through the lower lobes shows innumerable sharply defined nodules throughout both lungs. B) Axial HRCT chest image show ill-defined centrilobular nodules in a patient with hypersensitivity pneumonitis

Ground-Glass Opacity

A hazy increase in the density of the lung parenchyma on HRCT is described as a ‘ground-glass’ opacification. Unlike the analogous abnormality on chest radiography, in which the pulmonary vessels are

often indistinct, ground-glass opacity on HRCT does not obscure the pulmonary vasculature [14]. If the vessels are obscured, the term consolidation is used [21].

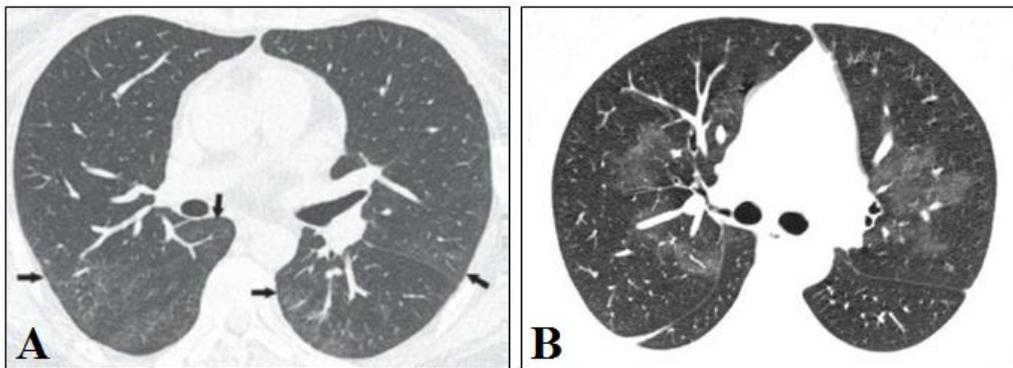


Fig-4: Ground-glass pattern: A) Axial HRCT chest image shows bilateral areas of hazy increase in opacity without obscuration of the underlying vascular margins involving the posterior lung regions (arrows). B) Axial HRCT chest image shows Symmetric perihilar ground-glass opacity, representing pulmonary hemorrhage in a patient with Wegener’s granulomatosis

Mosaic Attenuation Pattern

The correct interpretation of an HRCT of the lungs showing ‘a patchwork of regions of differing attenuation can be a considerable challenge. The pattern was originally termed mosaic oligemia but, less mechanistically and more descriptively, mosaic attenuation pattern (or simply mosaic pattern) is now

the preferred term [14]. Mosaic perfusion is most frequent in patients with airways diseases that result in focal air trapping or poor ventilation of lung parenchyma; in these patients, areas of poorly ventilated lung are poorly perfused because of reflex vasoconstriction or because of a permanent reduction in the pulmonary capillary bed [20].

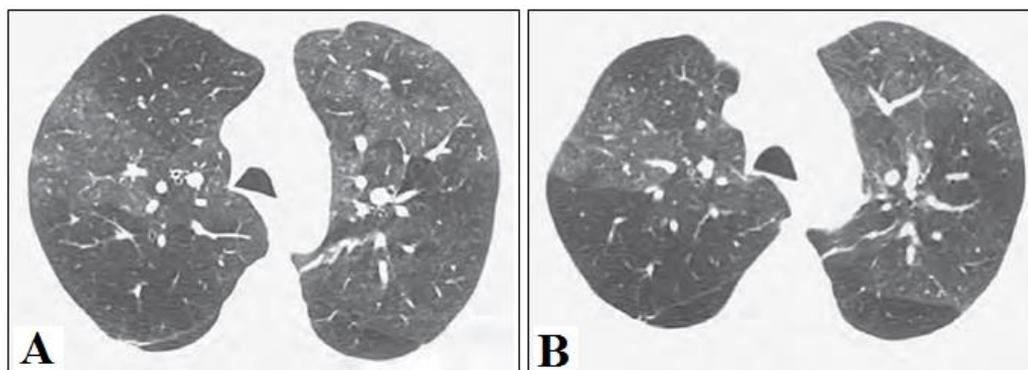


Fig-5: Mosaic perfusion pattern: A) Axial HRCT chest image performed at end-inspiration shows extensive bilateral areas of decreased attenuation and vascularity, with redistribution of blood flow to normal lung resulting in a mosaic perfusion pattern. B) Axial HRCT chest image performed after maximal expiration demonstrates extensive air trapping (severe chronic asthma)

Consolidation

By definition, vessels are obscured by consolidated (white) lung and an air bronchogram may, or may not, be present. The distribution characteristics

of consolidated lung are clearly depicted on HRCT, but important information about the rate of change of this nonspecific pattern should always be sought from serial chest radiographs [14].

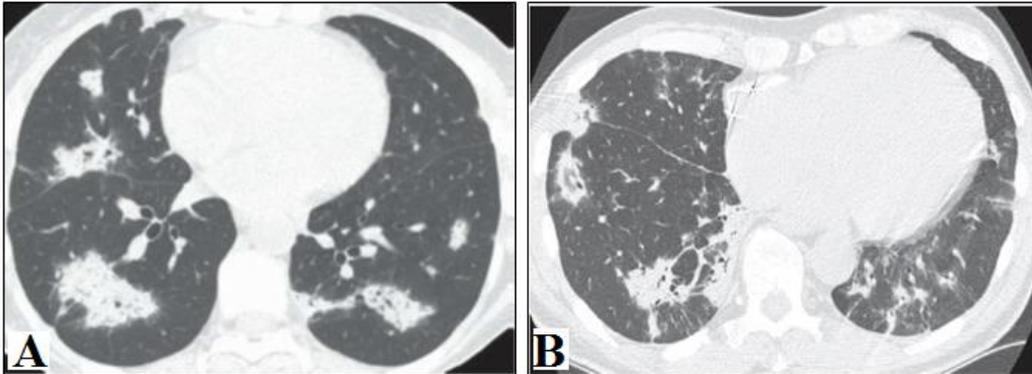


Fig-6: Consolidation: A) Axial HRCT chest image demonstrates bilateral patchy areas of homogeneous increase in attenuation with obscuration of the underlying vessels. B) Axial HRCT chest image show Patchy regions of peribronchovascular and subpleural consolidation are seen in this patient with chronic symptoms.

Cystic Airspaces

The terms 'cystic airspace' or 'lung cyst' are used to describe a clearly defined air-containing space with a definable wall [14]. The term is used to describe enlarged airspaces seen in Langerhans cell histiocytosis, lymphangioleiomyomatosis, and lymphoid interstitial

pneumonia; in end-stage fibrosis (honeycombing) as may be seen in idiopathic pulmonary fibrosis; and, less commonly, in chronic hypersensitivity pneumonitis, nonspecific interstitial pneumonia, asbestosis, and sarcoidosis [21].

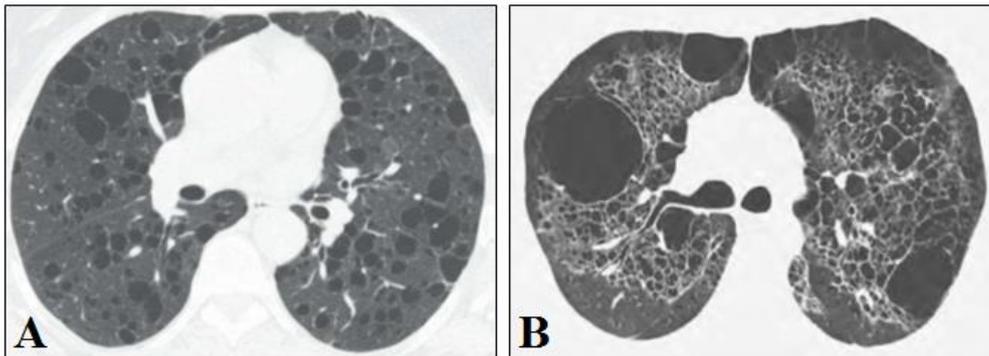


Fig-7: Cystic pattern: A) Axial HRCT chest image shows multiple bilateral circumscribed air-containing spaces ranging from a few millimeters to approximately 2 cm in diameter with fine smooth walls. B) Axial HRCT chest image shows numerous bilateral cysts of various sizes and evidence of emphysema. Ground-glass opacities adjacent to the cystic spaces also are noted

Decreased Attenuation Lung

There are fewer differential diagnoses of areas of lung with less than normal attenuation (darker than expected) than of groundglass opacification. Although there are several pathophysiologic causes for decreased attenuation, in practice the two commonest are emphysema and air-trapping due to small airways disease [14].

the same time. In addition, they allow post-processing techniques such as maximum (MIP) and minimum (MinIP) intensity projection reformation. So that, High-resolution CT (HRCT) has become a valuable tool for the evaluation of patients with diffuse pulmonary diseases because it provides detailed visualization of the lung parenchyma and identifying the pattern and distribution of disease helps in formulating a differential diagnosis, and detecting the Diffuse Parenchymal Lung Diseases in the early course of disease.

CONCLUSION

High Resolution Computed Tomography (HRCT) protocols use thin sections, a fast acquisition to reduce motion artifact, and optimal spatial resolution to acquire images of the entire lung, they result in a more complete assessment of the lung and Lung nodules are not missed and the central airways can be evaluated at

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