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Beyond Metastatic Disease: A Pictorial Review of Multinodular Lung Disease With Computed Tomographic Pathologic Correlation

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Multinodular lung disease is routinely encountered on chest computed tomography (CT). Pulmonary nodules may be categorized as perilymphatic, random, or centrilobular, based on their CT distribution. Recognition of the pattern of distribution allows the differential diagnosis to be narrowed to a few common diseases. This review illustrates the CT appearance and provides a practical differential diagnosis of each pattern of nodules.

Secondary Pulmonary Lobule

Patterns of distribution of multinodular lung disease are described with relation to the secondary pulmonary lobule. The secondary pulmonary lobule is the smallest unit of lung function marginated by connective tissue septa (interlobular septa) (Figure 1). Pulmonary veins and lymphatics course within the interlobular septa at the edges of secondary lobules. The artery and bronchus supplying each secondary pulmonary lobule are named the centrilobular artery and centrilobular bronchus. The centrilobular artery and bronchus lie adjacent to one another, and are accompanied by pulmonary lymphatics. Pulmonary lymphatics, in addition to their locations within the interlobular septa and along bronchoarterial bundles, are present within the pleura.

Perilymphatic Nodules

A perilymphatic pattern describes nodules in the expected distribution of pulmonary lymphatics: along pleural surfaces, interlobular septa, and the peribronchovascular interstitium (Figure 2). Keys to the recognition of a perilymphatic nodular pattern are identification of subpleural and peribronchovascular nodules. The ‘‘pipe-cleaner sign’’ describes the beaded appearance of bronchovascular bundles that results from nodules within peribronchovascular lymphatics. The beaded appearance resembles that of a pipe cleaner, a brush originally used to clean smoking pipes (Figure 3). Diseases in which perilymphatic nodules predominate include sarcoidosis, lymphangitic carcinomatosis, silicosis, and coal worker’s pneumoconiosis (CWP).

Sarcoidosis

Sarcoidosis is a multisystem granulomatous disease of unknown etiology characterized by the presence of noncaseating granulomata. The lung is the most commonly affected organ [1]. Although sarcoidosis can have a myriad of appearances on CT imaging of the chest, it is most commonly characterized by paratracheal and symmetric bilateral hilar lymphadenopathy and perilymphatic nodules. Nodules in sarcoidosis predominate along bronchovascular bundles and along pleural surfaces [2]. Pulmonary parenchymal abnormalities in sarcoidosis are almost always bilateral and predominate in the upper lobes. Confluent alveolar opacities, conglomerate masses, traction bronchiectasis, air trapping, and architectural distortion also may be present.

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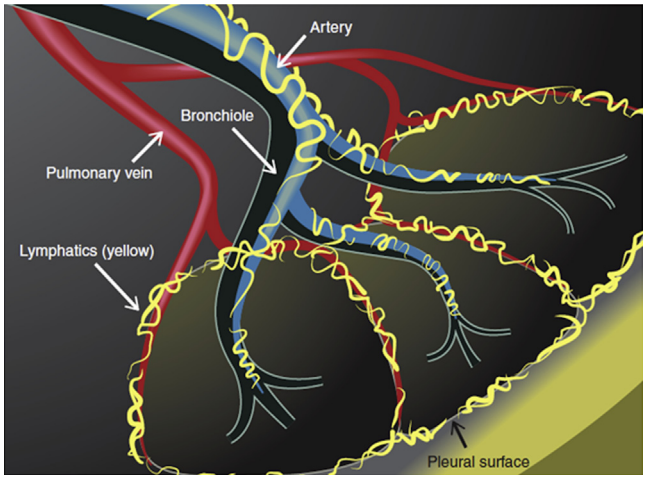

Figure 1. Schematic of 3 normal secondary pulmonary lobules. Secondary pulmonary lobules are marginated by interlobular septa. Pulmonary veins (red) and lymphatics (yellow) are located within the interlobular septa. Lymphatics also are located along bronchovascular bundles and within the pleura. Note that centrilobular bronchioles and arterioles are found in the center of secondary lobules. This figure is available in colour online at http://carjonline.org/.

Pulmonary Lymphangitic Carcinomatosis

Pulmonary lymphangitic carcinomatosis (PLC) is the dissemination of tumour in the lymphatic system of the lungs. The pathologic hallmark of PLC is the presence of malignant cells in the lymphatic vessels of bronchovascular bundles, interlobular septa, and pleura. PLC occurs most commonly with adenocarcinomas of the lung, breast, gastrointestinal system, prostate, and kidney. In most cases, the tumour spreads hematogenously to the lungs and then invades the pulmonary lymphatics and surrounding interstitium [3]. PLC is characterized on CT by smooth and/or nodular thickening of the peribronchovascular interstitium, interlobular septa, and pleura [4,5] (Figures 4 and 5). PLC may be diffuse, unilateral, or focal. The perilymphatic pattern of PLC may occur in conjunction with imaging features of hematogenous spread of tumour, which produces a mixed pattern of both perilymphatic and randomly distributed nodules.

Pneumoconioses

Pneumoconioses are lung diseases caused by the inhalation of dusts. Silicosis, CWP, and asbestosis are the most commonly occurring pneumoconioses. A perilymphatic pattern of nodules may be seen in either silicosis or CWP (Figure 6). Silicosis is caused by the inhalation of fine particles of crystalline silicon dioxide (silica). Occupations such as mining, quarrying, tunneling, stonecutting, and sandblasting are associated with silicosis. CWP is caused by exposure to coal dust, which contains silica. A clinical history of exposure is essential for the diagnosis of silicosis and CWP. The characteristic abnormality in simple silicosis-CWP is small well-circumscribed nodules, centrilobular, and subpleural predominant, and that usually are 2-5 mm in diameter [6]. Nodules predominate in upper and posterior lungs as a result of diminished lymphatic clearance in these regions [6]. The disease is considered ‘‘complicated’’ when nodules coalesce to form larger nodules (at least 1 cm in diameter) and masses.

Random Nodules

Randomly distributed nodules are usually the result of hematogenous dissemination. In distinction to perilymphatic

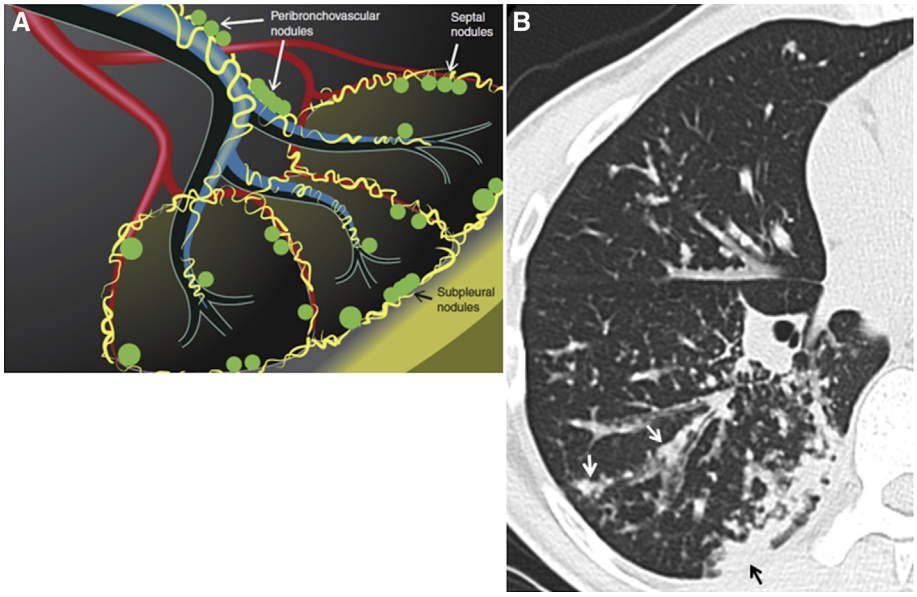

Figure 2. Perilymphatic nodules. (A) A perilymphatic pattern describes nodules in the expected distribution of pulmonary lymphatics: along pleural surfaces, interlobular septa, and the peribronchovascular interstitium. (B) Sarcoidosis. Computed tomography image, showing peribronchovascular (white arrows) and subpleural (black arrow) nodularity. This figure is available in colour online at http://carjonline.org/.