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Management of Incidental Lung Nodules

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The incidental pulmonary nodule is commonly encountered when interpreting chest CTs. The management of pulmonary nodules requires a multidisciplinary approach entailing integration of nodule size and features, clinical risk factors, and patient preference and comorbidities. Guidelines have been issued for the management of both solid and subsolid nodules, with the Fleischner Society issuing revised guidelines in 2017. This article focuses on the CT imaging characteristics and clinical behavior of pulmonary nodules, with review of the current management guidelines that reflect this knowledge.
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The pulmonary nodule is frequently detected incidentally on chest radiography and CT. Approximately 15%-30% of CT studies identify pulmonary nodules.[1,2] The management of these nodules is challenging given that they may represent malignant, inflammatory, or other benign etiologies that are difficult to discriminate. Nodule management is evolving as knowledge is gained from research investigations. A large amount of this information derives from screening CT studies that include, but are not limited to, the National Lung Screening Trial (NLST), the Dutch-Belgian Lung Screening Trial (NELSON) trial, and the Pan-Canadian Early Detection of Lung Cancer Study (PanCan) and increasing reports of the behavior of incidentally detected pulmonary nodules.[3] This information has contributed to the development of nodule management guidelines for lung cancer screening and for managing the incidentally detected lung nodule on CT.

Nodule management guidelines for the incidentally detected nodule have been issued, such as those by the Fleischner Society recently revised in 2017, and the American College of Chest Physicians (ACCP). Recommendations are based on current knowledge of the clinical and imaging features and their influence on risk for malignancy. More sophisticated methods for evaluating malignancy risk of lung nodules such as prediction models and risk calculators are being developed and validated and will aid in management decisions in both screening[4] and nonscreening scenarios.[5,6]

This review focuses on current key concepts pertaining to managing the incidentally detected pulmonary nodule, with emphasis placed upon CT nodule characteristics and their relationship to clinical behavior. This current knowledge is reflected in the framework of the 2017 revised Fleischner Society recommendations for the incidentally detected lung nodule.

Concept 1. Attention to CT Technique Aids in Nodule Management

Thin-section CT images have been supported for accuracy of attenuation assessment and measurement by the Fleischner Society. Thin sections should be 1.5 mm or less to ensure adequate measurement and minimize volume averaging, particularly when small nodules or solid areas are being evaluated (Fig. 1).[7,8] The use of low-dose CT has been recommended for the follow up of pulmonary nodules to minimize radiation exposure. Also, off axial coronal and sagittal reformats facilitate characterization of lesions (Fig. 2). Overlooked or misdiagnosed nodules have often been shown to be at the lung apices,[9] whose assessment can be aided with multiplanar images. Image data should be reconstructed utilizing a high-frequency reconstruction algorithm to maximize spatial resolution and enhance morphologic evaluation of pulmonary nodules. A soft tissue or low-frequency reconstruction algorithm is better for assessing the presence of calcification, which can be erroneous, particularly for small or suspected fat-attenuation nodules, when performed using images reconstructed with a high-frequency algorithm that results in higher image noise.

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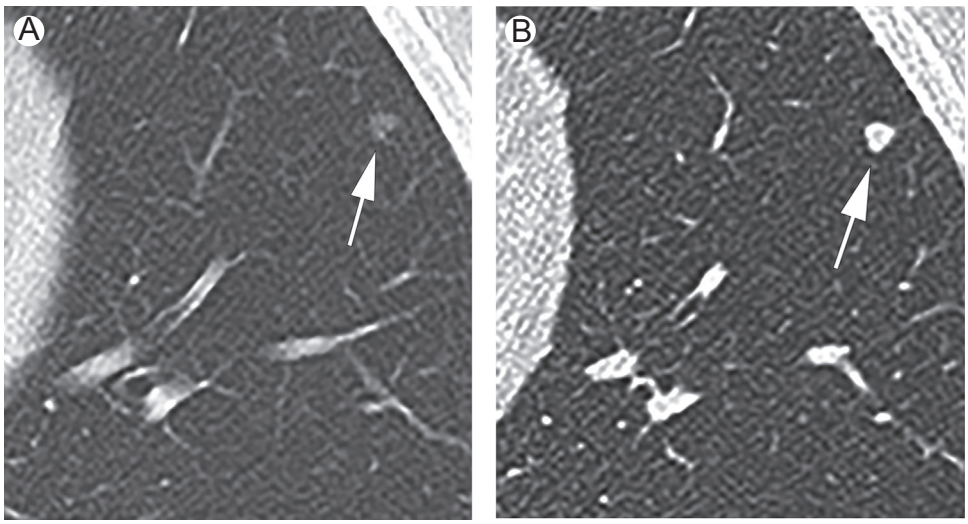

Figure 1 Thin CT sections facilitate accurate evaluation of nodule size and density. Noncontrast 5 mm axial chest CT image reconstructed with a sharp high-frequency algorithm and viewed under lung window settings (A) shows a nodule (arrow) in the left upper lobe that appears ground-glass in attenuation. Thin 1 mm axial image (B) reveals that the nodule (arrow) is actually solid in density. The margins are better seen on thin sections, enabling easier measurement.

Concept 2. Nodule Attenuation Guides Management: Nodule Attenuation and Related Differential Diagnoses

The pulmonary nodule can represent either malignant or benign etiologies. Nodule attenuation is a key factor, as the differential diagnosis for solid lung nodules differs from subsolid lung nodules. Solitary solid nodules derive from a range of entities that encompass lung cancer, mycobacterial and fungal infection, hamartomas, solitary metastases, carcinoid tumors, and vascular malformations and aneurysms. Calcifications in solid nodules have been described in benign lesions. The nodule should be entirely calcified, have a centrally-located calcification (Fig. 3) occupying a majority of the nodule, or have a whorled (lamellated) distribution. "Popcorn" calcifications, which are dense large clustered calcifications, have been associated with hamartomas, although are sometimes difficult to characterize, and nodules with a popcorn calcification pattern can be further

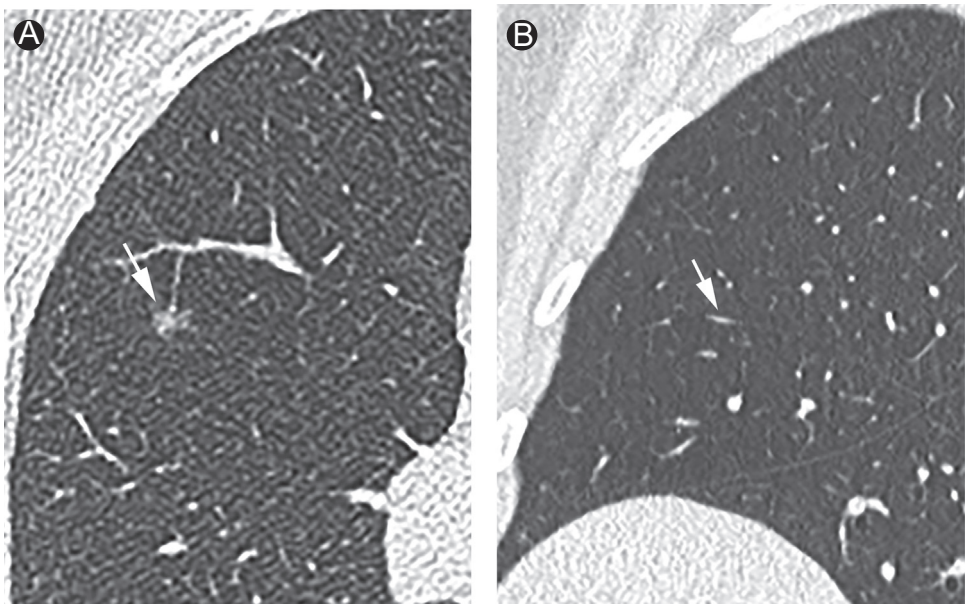

Figure 2 Off axial images facilitate nodule characterization. Noncontrast 1 mm axial chest CT (A) shows an ill-defined soft tissue nodule (arrow) in the anterior right middle lobe. Sagittal reformatted image (B) better localizes the nodule (arrow) to the right middle lobe, shows the nodule as abutting the right minor fissure, and demonstrates its flat shape in another (craniocaudal) dimension, favoring a benign perifissural nodule.