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Case Report

Indeterminate pulmonary nodule in lung allograft characterized using dual-energy computed tomography ☆

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ABSTRACT

Pulmonary nodules (PNs) arising in the lung transplant recipient pose a diagnostic challenge for providers. Conventional computed tomography (CT) has improved our ability to detect PNs in this population, but establishing a confident diagnosis with imaging alone remains difficult. Dual-energy spectral detector CT is a novel, emerging technology that provides insight into the radiographic behavior of PNs, and has potential in differentiating benign from malignant morphologies. Herein, we report a case of a PN in a lung transplant recipient whose initial diagnostic work-up was inconclusive, but then had the diagnosis rendered using a spectral detector CT.

Introduction

Pulmonary nodules (PNs) in the lung transplant (LTx) population are frequently encountered, and often are attributed to infectious and noninfectious causes [1]. Most PNs are detected using conventional computed tomographic (CT) imaging, but considerable overlap exists between the varying etiologies of PNs in lung transplant recipients (LTR), making accurate diagnosis difficult. As such, these patients are often referred for invasive tissue sampling for final diagnosis. We report a case of a suspicious PN in a LTR whose initial imaging and biopsy results were nondiagnostic, but then underwent repeat imaging using a dual-energy spectral detector CT (SDCT), which confirmed the diagnosis.

☆ Competing Interests: BY is a consultant for Pinnacle Biologics, Auris Surgical Robotics and ProVation. All remaining authors have no conflicts of interest to disclose.

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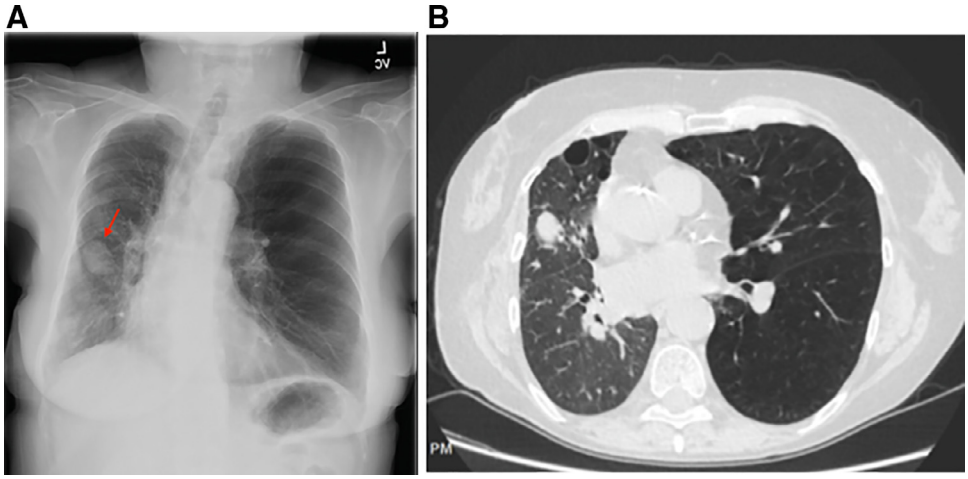

Fig. 1 – (A) PA view chest radiograph demonstrates a well-defined nodular density in the right middle lung zone (arrow), new compared to examination from 1-month prior. Axial (B) lung window CT image without contrast shows a homogeneously attenuating RML nodule.

Case report

A 65-year-old woman with very severe chronic obstructive pulmonary disease who underwent a single right LTx 6 months earlier presented to the outpatient clinic for routine follow-up. The patient felt well with no acute respiratory complaints. Her vitals were stable and the physical examination was unremarkable. Spirometry showed no significant change from prior testing. Surveillance lung transplant biopsy and bronchoalveolar lavage were performed 3 weeks prior, and had no signs of rejection or infection.

A surveillance chest radiograph was obtained and showed a new, nodular opacity within the right middle lung zone. Subsequent noncontrast CT imaging was remarkable for a homogenously attenuating right middle lobe (RML) nodule (Fig. 1). Since a benign or malignant process could not be differentiated from imaging alone, the patient was referred for bronchoscopic tissue sampling. Histopathology specimens were retrieved and showed type II pneumocyte hyperplasia and chronic inflammation. No malignant cells were identified and a thorough infectious work-up was negative. Given the nondiagnostic biopsy result, and inability to definitively exclude malignancy, a repeat contrast-enhanced CT scan of the chest was obtained. Because the study was performed using a SDCT, additional reconstructions were available, including iodine density maps (IDMs) and virtual noncontrast (VNC) images (Fig. 2).

With conventional imaging, no definite comment could be made regarding the behavior of the nodule. However, using SDCT, we identified hyperattenuation on VNC images and an absence of contrast enhancement on IDMs. This in combination with the clinical history of recent surveillance lung transplant biopsy led to the presumptive diagnosis of biopsy associated pulmonary hematoma (PH). Based on these findings, additional diagnostic studies including positron emission tomography (PET) and repeat biopsy were avoided, and follow-up CT imaging showed a decrease in nodule size, confirming the diagnosis (Fig. 3).

Comment

In the era of chest CT imaging, an estimated 1.57 million incidental PNs are detected annually in the United States (US) [2]. PN development in LTR is particularly worrisome as these patients are at high risk for opportunistic infections and malignancy. In 2018, a total of 2562 lung transplants were performed in the US, the largest number to date. With more candidates being listed for transplant each year, along with an increasing donor pool, the number of transplants performed and consequently PNs detected in this population is expected to rise [3].

PH as a cause of PN formation in LTR has previously been described up to 47 days after transbronchial biopsy [4]. Mehta et al reported that thirteen percent of transbronchial biopsy procedures performed in LTR result in the transient development of PHs, a finding that was not observed in a control group of non-LTx patients who had no new nodules identified. On imaging, PHs were reported as round or oval shaped, ranging from 0.4 to 3 cm in size, and typically solid in nature. Interestingly, the authors postulate that LTR are susceptible to PH formation because of disruptions in lymphatic drainage in the lung allograft [4].

Most incidentally detected PNs should be managed according to the Fleischner Society Guidelines. LTR, however, because of their immunocompromised status represent a high-risk group that are excluded from these recommendations. Therefore, the diagnostic approach in this population should be individualized, considering the clinical history in conjunction with the radiographic findings [5]. Unfortunately, conventional CT imaging is relatively limited in its ability to distinguish between the varying etiologies of PNs in LTR.

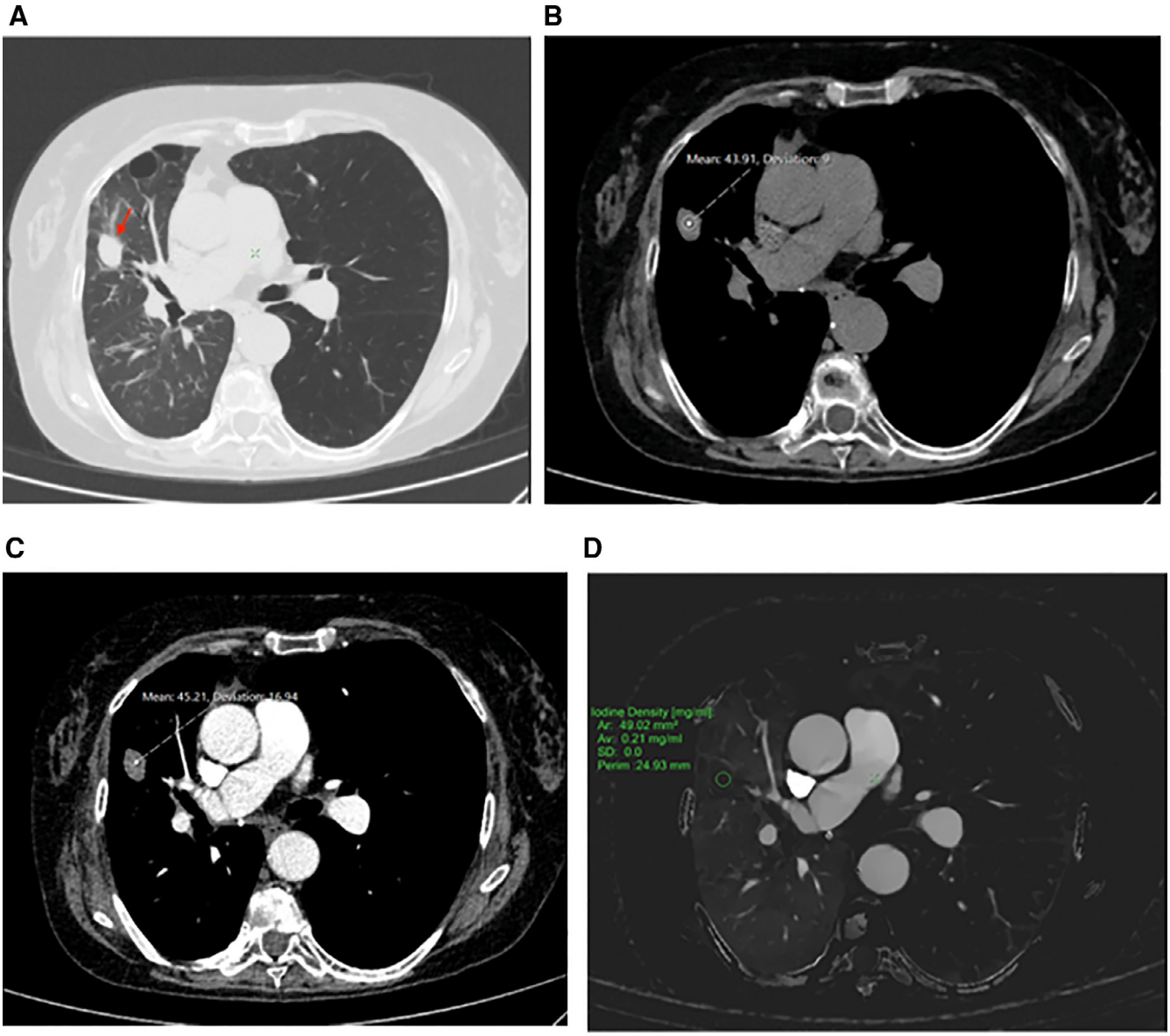

Fig. 2 – Axial lung window (A) and soft tissue (B) conventional CT images demonstrate the same RML nodule with hyperattenuation (arrow, Hounsfield units 45), which may represent hemorrhage or post contrast enhancement. Axial VNC image (C) shows persistent hyperattenuation of the nodule (Hounsfield units 43), suggesting absence of discernible postcontrast enhancement associated with the nodule. Axial IDM image (D) further confirms lack of iodine and therefore enhancement in the RML nodule (average iodine density of nearly zero) favors a benign etiology.

SDCT is a novel imaging modality outfitted with a dual-layer detector that processes high and low energy photons separately. Unlike conventional CT imaging, SDCT can extrapolate information from both detector layers facilitating the reformatting of different spectral images, including IDMs and VNC images. Iodine mapping can be used to quantify the distribution of contrasted media, which provides a surrogate marker for organ perfusion. VNC images are a substitute for true noncontrast images that aid in differentiating hyperattenuation associated with calcification or hemorrhage from postcontrast enhancement.

In our patient, hyperattenuation in the nodule confirmed on VNC images coupled with absence of contrast enhancement on IDMs, pointed toward the benign activity of the nodule, and more specifically a PH. Absent the findings on VNC images, other imaging parameters from IDMs can be helpful in assessing the behavior of PNs. There are multiple studies showing a comparable role of dual-energy CT, not only for differentiating benignity from malignancy, but for assessment of lung cancer invasiveness and response to chemoradiotherapy in comparison to PET/CT [6–8].

This case highlights a novel approach to diagnosing PNs in LTR using SDCT. Because of the uncertainty surrounding diagnosis of PNs in this high-risk population, many will undergo additional testing including invasive sampling. SDCT provides an alternative approach to characterizing and addressing the

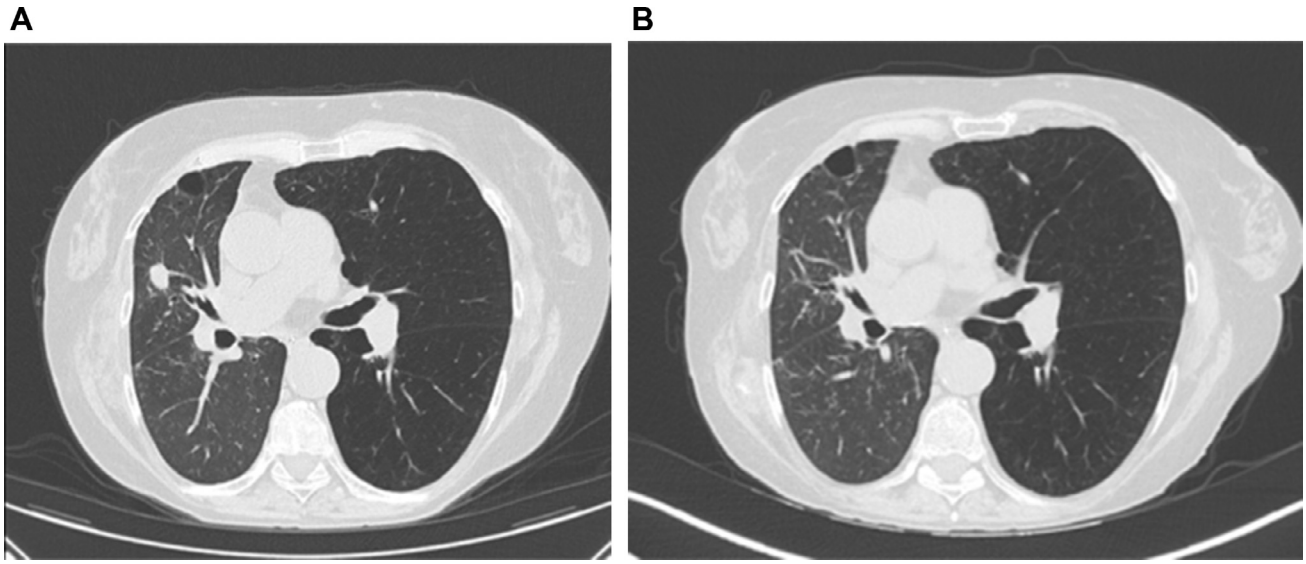

Fig. 3 – Serial follow-up axial lung windowed CT image at 1 month after biopsy (A) showed significant decrease in size of the RML nodule without new suspicious characteristics. Axial lung windowed CT image at 4 months after biopsy (B) demonstrates complete resolution of the RML nodule, confirming the benign diagnosis suggested by SDCT.

activity of these nodules without additional radiation dosing compared to conventional CT, which in some cases may obviate the need for a more extensive and costlier workup.

Consent Statement

Written informed consent for publication of this case was obtained from the patient.

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