CLINICAL VIGNETTE

Diagnostic Considerations in the Evaluation of Cavitary Lung Lesions

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Introduction

Cavitary lung lesions are a nonspecific finding in many disease processes including acute and chronic infections, malignancy, and autoimmune diseases. Location and morphology of a cavitary lesion in addition to history-taking remains crucial in elucidating etiology and guiding evaluation. Our patient presented with acute decompensated heart failure. His clinical picture was complicated by the discovery of cavitary lung lesions with risk factors for both malignant and infectious etiologies.

Case Report

A 54-year-old unhoused male with substance use disorder, and intermittent incarceration presented with one week of chest pain and dyspnea on exertion prior to admission. He was recently admitted to an outside hospital for a similar presentation and was diagnosed with pulmonary embolism and heart failure. He had moderate clot burden and ejection fraction of 20-25%. Imaging noted cavitary pulmonary lesions and mediastinal lymphadenopathy. Endobronchial ultrasound (EBUS) and biopsy raised concern for lymphoproliferative neoplasm of B-cell origin; lymphoplasmacytic lymphoma versus marginal zone lymphoma.

The patient was unaware of these findings and presented to our facility with paroxysmal nocturnal dyspnea, three-pillow orthopnea, dry cough, and worsening bilateral lower extremity swelling. He denied fever, chills, night sweats or unintentional weight loss. He also reported that he had not been taking his furosemide or apixaban since discharge after his medications were stolen. Social history includes 20-pack year of cigarette use, and occasional smoking methamphetamine. He denied intravenous drug use or alcohol use disorder. There was no known tuberculosis exposures, however, he was incarcerated intermittently with and unstable housing. He denied recent travel or sick contacts.

Upon presentation to the emergency room, he was afebrile with blood pressure 125/88, heart rate 120/min, and respiratory rate of 24, he required two liters of oxygen supplementation to maintain oxygen saturation of 99%. Physical exam was notable for diffuse fine rhonchi in bilateral lung fields with diminished breath sounds on the left, and lower extremity +1 pitting edema bilaterally. Bedside point of care ultrasound (POCUS) demonstrated an IVC of 2.4cm. Labs included elevated BNP of 3023 and an anion gap of 5.8. EKG demonstrated a left anterior

fascicular block. CT angiography showed pulmonary embolism. There was a loculated left pleural effusion with patchy foci of ground-glass attenuation within the right lower lobe consolidation and numerous cavitary nodules with air-fluid levels, peribronchial thickening, and mediastinal lymphadenopathy (Figure 1). Further focused imaging with CT chest showed a 2.6-cm cavitary lesion in the right lower lobe, tree-in-bud nodularity of the bilateral lower lobe opacities, and a hydropneumothorax with possible empyema in the loculated left pleural effusion (Figure 2).

The patient was admitted for acute decompensated heart failure and evaluation of pulmonary cavitary nodules. Transthoracic echocardiogram showed ejection fraction of 25-30% with grade III diastolic dysfunction and he was restarted on diuretics. He underwent extensive infectious testing for pulmonary nodules including coccidioides, cryptococcus, aspergillus, histoplasma and pulmonary tuberculosis which all resulted negative. Thoracentesis and thoracotomy showed exudative pleural fluid. However, the pleural fluid was negative for bacterial, aerobic, anaerobic, fungal cultures, MTB and ADA, and BioFire testing. Cytology did not reveal any malignancy. He underwent a mediastinoscopy with excision of two right paratracheal lymph node. Pathology from both lymph nodes was negative for malignancy with sinus histiocytosis and no immunophenotypically abnormal populations on flow cytometry. The patient was discharged on guideline-directed medical therapy for heart failure. He is also followed closely with oncology and pulmonology. A future repeat EBUS is planned with additional biopsies.

Discussion

A cavity is defined as a "gas-filled space, seen as a lucency or low-attenuation area, within pulmonary consolidation, mass, or nodule"[1]. This differentiates it from other radiographic findings such as pneumatoceles, cysts, bronchiectasis, or bullae. The differential diagnoses of cavitary lung lesions includes three main etiologies: infectious, malignant, and rheumatologic. Clinical and epidemiological cues help differentiate between the three categories.

The pathophysiology of cavitary formation in the lungs includes necrosis and subsequent expulsion via the bronchial tree[2]. Necrosis can be suppurative or caseous from infection, ischemic from emboli, or from dilatation and subsequent dis-

placement of lung structures. Some pathogenic processes have a higher tendency to cavitate, such as Mycobacterium tuberculosis due to its propensity to cause caseous necrosis, or Klebsiella pneumoniae with extensive pyogenic lung necrosis associated with toxin release[3]. The pathophysiology of malignant cavitary formation includes internal tumor cyst formation or internal desquamation of tumor cells with subsequent liquefaction due to treatment-related necrosis[4].

Primary malignancies causing cavitary lesions are usually of lung parenchymal origin but also be seen in lymphoma and Kaposi's sarcoma in HIV patients. Metastatic cavitary lesions are also possible with squamous cell origin tumor more likely to cavitate. This has been proposed to be related to the pathogenesis of internal desquamation[3]. If presenting in isolation, wall thickness can be useful for differentiating between benign and malignant processes: a thickness less than 7mm is highly specific for benign disease, and greater than 24mm is highly specific for malignant disease[5]. However, there are some reports of thin-walled carcinomas.

Infectious causes are another broad etiologic category of cavitary lung lesions. Most notable is Mycobacterium tuberculosis, well-known for causing cavitary lesions in up to 87% of patients with pulmonary TB. This is likely due to a complex interplay of host matrix metalloproteases, vascular permeability based on proximity to an airway, and the expression of a necrotizing toxin which induces host-cell necrosis[6]. MTB can also mimic malignancy with peritoneal implants and diffuse lymphadenopathy. Other bacterial causes of nodules and cavities include Nocardia and Klebsiella. Septic emboli can result from hematogenous dissemination of extrapulmonary infections such as endocarditis. These emboli are usually peripherally located in the lung parenchyma[2].

Although the rheumatologic etiologies for cavitary lesions are not as broad, they are important to rule out. These include lymphocytic interstitial pneumonia, which can be associated with various autoimmune disorders such as rheumatoid arthritis, myasthenia gravis, and Sjogren's syndrome in additional to viral causes such as HIV, Epstein-Barr, and human T-cell leukemia virus[7]. Granulomatosis with polyangiitis, a systemic vasculitis, frequently has pulmonary manifestations with nodules and infiltrates with up to 50% prevalence. These tend to present with upper respiratory tract symptoms[3]. Notably, the lung nodules of sarcoidosis can also occasionally cavitate, reported in up to 6.8% of patients in one study. They tend to be accompanied by other CT findings including fibrosis, pleural thickening, and ground-glass opacities[3].

Conclusion

Cavitary pulmonary lesions are nonspecific findings and can represent sequelae of infection, malignancy, autoimmune processes, or a combination. A broad infectious evaluation should include comprehensive history and evaluation for both fungal and bacterial etiologies. In order to rule out malignancy, the type and location of biopsy is important, for adequate tissue

sampling and to minimize the number of invasive procedures needed. Treatment is primarily medical with therapy targeted at the underlying pathologic process. Some cases require surgical resection.
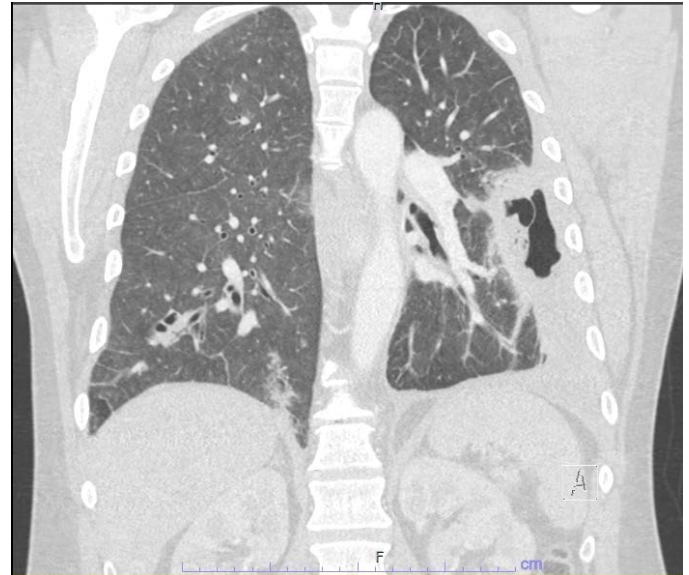
Figures

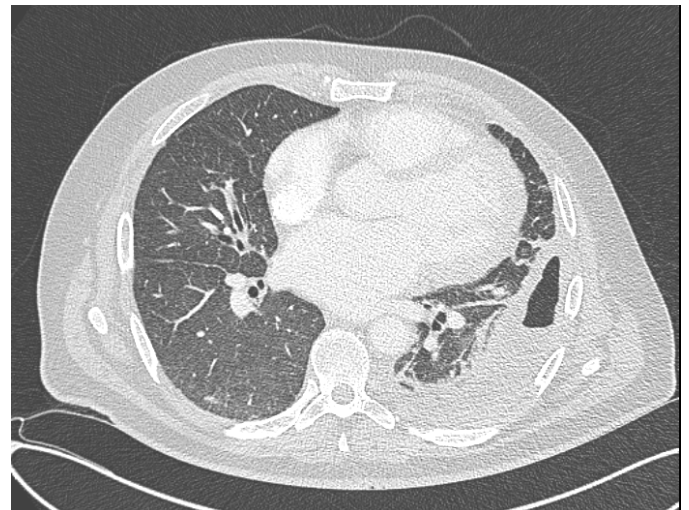Figure 1. CTPA with right lower lobe consolidation with loculated left pleural effusion.

Figure 2. CT chest demonstrating tree-in-bud nodularity of the bilateral lower lobe opacities, and a hydropneumothorax with possible empyema in the loculated left pleural effusion.

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