Letter

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Atrial invasion from primary lung adenocarcinoma extension *via* the pulmonary vein

Akshay Machanahalli Balakrishna[1,*], Bryton Perman[1], Mahmoud Ismayl[1], Dua Noor Butt[1], Dixitha Anugula[2], Ahmed Aboeata[3]

[1] Division of Internal Medicine, Creighton University School of Medicine, Omaha, NE, USA;
[2] Department of Cardiology, Houston Methodist DeBakey Heart & Vascular Center, Houston, Texas, USA;
[3] Division of Cardiovascular Diseases, Creighton University School of Medicine, Omaha, NE, USA.

SUMMARY Intravascular extension of lung adenocarcinoma is one of the four defined routes of metastasis to the heart but is rarely described in the literature. This is a rare case of primary lung adenocarcinoma with intravenous extension to the left atrium via the pulmonary vein. A 56-year-old female presented to the hospital with chest tightness and dyspnea. Chest computed tomography revealed a right hilar mass extending through the right superior pulmonary vein into the left atrium. Transthoracic echocardiography revealed a large, partially mobile left atrial mass occupying the entire atrial cavity and affecting mitral valve closure. Endobronchial ultrasound with transbronchial biopsy of the right middle lobe of the lung histologically showed a poorly differentiated adenocarcinoma compatible with the primary lung cancer. The patient was deemed a poor surgical candidate by cardiothoracic surgery due to the extent of metastasis and was started on chemoradiation. The patient's left atrial tumor mass started shrinking in size after starting the treatment. This unique case displaying intravascular extension of lung cancer to the left atrium has rarely been described in the literature.

Keywords lung adenocarcinoma, pulmonary vein, left atrium, invasion

The literature has rarely reported direct intravenous extension of non-small cell lung cancer to the heart (*1*). Involvement of the mediastinum in lung cancer is associated with an extremely poor prognosis, and many surgeons consider such tumors inoperable. Choosing the management between surgical resection, radiation, and conservative management continues to be challenging. We discuss the case of a patient presenting with the left atrial invasion of primary lung adenocarcinoma *via* the pulmonary vein, along with a brief review of the literature. Informed consent was obtained from the patient, and this study was approved by the institutional review board.

A 56-year-old female with a past medical history of resected right upper lobe lung granuloma and hypertension was admitted to our hospital with complaints of chest tightness and dyspnea that started 1 month before hospital admission. She reported progressive dyspnea over the month with an associated dry cough. Dyspnea was notably worse with exertion and in the supine position. Night sweats, fatigue, and recent weight loss were also reported. She had no fevers, chills, sputum production, or hemoptysis. A 60 pack-year smoking history was noted but quit 11 years prior. Upon admission, the patient was afebrile and hemodynamically stable. Oxygen saturation was 96% on room air. The electrocardiogram showed normal sinus rhythm with no ST or T wave changes. Chest X-ray (Figure 1A) was concerning for a right hilar mass. Follow-up chest computed tomography (Figure 1B and 1C) revealed a large left atrial mass extending into the right lung hilum through the right superior pulmonary vein with mild to moderate narrowing of the superior vena cava. Subsequent transthoracic echocardiography (Figure 1D) showed a large, partially mobile left atrial mass measuring 6.42 cm by 4.85 cm, occupying the entire atrial cavity and affecting mitral valve closure. The right ventricular systolic pressure was also noted to be 76.3 mmHg. The ensuing endobronchial ultrasound with transbronchial biopsy of the right middle lobe of the lung was completed. Histopathology showed poorly-differentiated adenocarcinoma compatible with primary lung cancer. Fluorodeoxyglucose-positron emission tomography scan showed large left atrial mass extension to the right hilum within the right superior pulmonary vein, with increased contrast uptake values in the left atrial and hilar component, suggesting malignancy. Cardiothoracic surgery was consulted. A nonsurgical

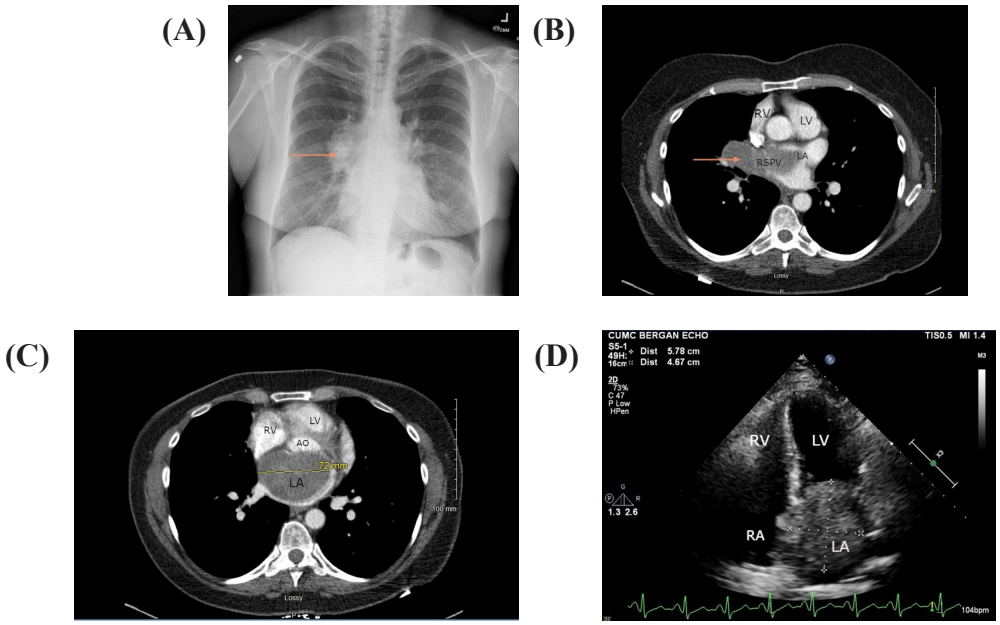

Figure 1. (A) Chest X-ray posteroanterior view showing a right hilar mass/adenopathy; **(B)** CT chest showing right hilar mass (arrow) extending through the right superior pulmonary vein into the left atrium; **(C)** CT chest showing large left atrial mass (dotted line); **(D)** Transthoracic Echocardiogram apical 4 chamber view, the dotted line showing the size of large mass noted in the left atrium. LA: left atrium; RA: right atrium; LV: left ventricle; RV: right ventricle; RSPV: right superior pulmonary vein.

management approach was opted due to the extent and degree of tumor spread. The patient was started on chemotherapy with carboplatin and paclitaxel, along with radiation therapy. After reviewing the PACIFIC trial (*2*), which showed improved survival in stage III lung cancer patients treated with chemoradiation followed by durvalumab, the patient was started on durvalumab. Repeat echocardiograms at 2 months and 3 months after discharge showed improvement in the size of the atrial mass. The patient tolerated the treatment very well and is back to working full time. She denied any cardiac or respiratory symptoms during the most recent follow-up at the cardio-oncology clinic 3 months after discharge.

Secondary cardiac tumors are the most common form of malignancy involving the heart. The incidence was previously thought to be very low, but with advancements in diagnostic modalities have risen significantly (*3*). Lung cancer has been described as the highest incident cause of secondary cardiac malignancy followed by breast cancer, malignant melanoma, and leukemia (*3*). Cardiac metastasis has been described to have three main routes of spread to the heart: distant (lymphatic/hematogenous spread), direct invasion, and intravenous extension; with the major metastatic pathway from the lungs described as a direct invasion (*3*). Atrial invasion of lung cancer through intravascular penetration, as described above, is extremely rare.

In a majority of cases such as the one described here, symptoms of lung cancer or heart failure are the presenting complaints (*4*). Obstruction of the pulmonary veins or mitral valve orifice may also lead to pulmonary edema (*5*). Like atrial myxoma, tumors invading the left atrium may occupy a majority of the atrial cavity and can lead to mitral valve stenosis by prolapsing into the valve orifice, as seen in the described case. Thromboembolic events have also rarely been reported (*1,5*).

Initial imaging with chest computed tomography (CT) is often ordered for symptom evaluation. Transthoracic Echocardiography can provide essential information about mass size, location, mobility, and hemodynamic effects (*6*). However, it has several limitations including the restricted field of view, limited imaging of the extracardiac, and mediastinal structures. Transesophageal echocardiography offers additional imaging planes but is more invasive (*7*). Cardiac CT is a commonly used second-line diagnostic method that offers high-quality images with a greater spatial resolution (*8*). Positron emission tomography can also be used to identify cardiac masses; however, its availability remains limited. CMR imaging is often used for its strong tissue characterization with high-contrast resolution (*9*). Limitations of CMR include their contraindication in patients with intracardiac defibrillators and pacemakers.

Lung cancer involving the intrapericardial pulmonary veins or left atrium is classified as T4 (according to American Joint Committee on Cancer 8th edition) irrespective of the magnitude of tumor infiltration, and T4N2 in the setting of mediastinal lymph node metastasis as in the present case. Initial management should include a surgical evaluation. When appropriate, the preference is complete tumor resection in combination with chemotherapy and/or radiotherapy (*4*). Literature review showed reports mostly describing partial left atrium resection without cardiopulmonary bypass; however, this is only possible if the wall of the left atrium is infiltrated locally without atrial cavity involvement (*10*).

Perioperative mortality for this procedure is reported at 5 to 18% (*7*). The 5-year survival rate in cases of non-small cell lung carcinoma penetrating the left atrium ranges from 0% to 22%. Factors associated with unfavorable effects on survival include mediastinal lymph node involvement (stage N2), location of the primary tumor in the lower lung lobes, and incomplete surgical resection (*10*). In our case, surgical resection was deferred due to extent of cancer involving the mediastinum and major blood vessels. The patient significantly benefited from the chemoradiation after discharge.

In conclusion, if the tumor is in an intra-atrial position or extensively infiltrates the left atrial wall, radical resection under cardiopulmonary bypass is recommended, however, if mediastinal lymph nodes are involved, patients have a poor prognosis and should be treated conservatively.

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**Address correspondence to:*
Akshay Machanahalli Balakrishna, Division of Internal Medicine, Creighton University School of Medicine, 7500 Mercy Rd Suite 302, Omaha, NE 68124, USA.
E-mail: dr.akshaymb@gmail.com

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