A Rare Case of Primary Intracardiac Diffuse Large B-Cell Lymphoma: Multimodality Imaging to the Rescue

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INTRODUCTION

Cardiac tumors may be primary (benign or malignant) or metastatic. Symptoms tend to be nonspecific and develop according to the location and nature of the tumor. Primary cardiac lymphoma is extremely rare and most often occurs in immunocompromised patients. It may present in any of the four cardiac chambers but has a predilection for the right atrium (RA) and the right ventricle (RV). It can grow rapidly, resulting in heart failure, myocardial ischemia, and fatal arrhythmias. Multimodality cardiac imaging is necessary and effective in the diagnostic evaluation of patients with suspected cardiac malignancy.[1] Once the diagnosis is established, treatment for primary lymphoma should begin as soon as possible.[2]

CASE PRESENTATION

A 71-year-old man with a history of deep vein thrombosis 30 years ago that was treated with warfarin presented to the emergency department with dyspnea on exertion and lethargy. A recent outpatient stress test was negative for myocardial ischemia. Given his progressive limiting symptoms, he presented to the hospital for further evaluation.

On presentation, he was dyspneic, hemodynamically stable, and not hypoxic. He denied any chest pain, palpitations, syncope, leg swelling, nausea, vomiting, fevers, chills, or weight loss. The physical exam, electrocardiogram, chest x-ray, and cardiac markers, including troponins and B-type natriuretic peptide, were unremarkable. He had a mildly elevated d-dimer.

Given his previous history of deep vein thrombosis, a computed tomography angiography (CTA) of the chest was performed in the emergency department as there was concern for a pulmonary embolism. It revealed mass-like thickening in the atrioventricular (AV) groove between the RA and RV surrounding the right coronary artery measuring 4.3 × 4.2 cm and a separate round mass at the junction of the inferior vena cava (IVC) and RA measuring 5.8 × 4.8 cm (Figure 1). No pulmonary embolism was seen.

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A transthoracic echocardiogram (TTE) was subsequently performed to further evaluate the abnormalities identified on CTA (Figure 2, Videos 1 and 2). The lesions were clearly visualized and appeared hypoechoic. TTE also revealed a normal ejection fraction and elevated right atrial pressures with a dilated IVC.

Cardiac magnetic resonance imaging (MRI) was performed revealing several cardiac masses (Figure 3): a 4.6 × 3.8 cm mass in the posterior wall of the RA extending into the IVC; a second 4.5 × 3.4 cm mass located along the AV groove between the RA and the RV surrounding the right coronary artery; a third 3.1 × 2.0 cm mass located in the interatrial septum. The masses were isointense on T1-weighted imaging, hyperintense on T2-weighted imaging, and partially enhancing on late gadolinium enhancement sequences (Video 3). These findings were consistent with a malignant process, including lymphoma or angiosarcoma.

Using simultaneous fluoroscopic and two-dimensional TTE guidance, a 6-Fr Bioptome forceps was used to biopsy the IVC and RA mass. Six samples were taken for surgical pathology evaluation. Subsequent pathological and histological analysis identified the mass as diffuse large B-cell lymphoma (Figure 4).

Prechemotherapy positron emission tomography/CT (PET/CT) revealed a hypermetabolic mass along the posterior wall of the RA extending into the IVC, appearing contiguous with the previously described mass in the interatrial septum; the standardized uptake value of this mass was 19.8, measuring 6.0 × 5.5 cm. A second hypermetabolic mass of 25 standardized uptake value measuring 4.5 × 3.3 cm was noted along the lateral wall of the RA. These masses were compatible with malignancy. The patient completed six rounds of chemotherapy with close oncological follow-up. At 10-week follow up, a postchemotherapy PET/CT revealed complete resolution of tumor burden (Figure 5). Postchemotherapy TTE images were also obtained revealing total resolution of the previous hypoechoic masses (Video 4, Video 5).

DISCUSSION

Primary cardiac tumors are rare and comprise about 0.3%-0.7% of all cardiac tumors. About 25% of primary cardiac tumors are malignant and have a very poor prognosis. The survival rate without treatment or resection is 10% after 9-12 months.[3]

Of all cardiac tumors, metastatic tumors are the most common. Primary cardiac lymphoma is an extremely rare malignancy, usually occurring in patients with immunocompromised states.[1] They comprise about 1% of primary cardiac tumors and are usually of non-Hodgkin type.[3] The RA and RV are the two most frequently involved sites for primary cardiac lymphoma, and, in general, right-sided cardiac tumors are more malignant and grow more quickly.[4,5] Secondary cardiac lymphoma is much more common. Its incidence at autopsy ranges from 8.7% to 20%.[6] Secondary lymphoma tends to spread via the blood, lymphatics, or directly from a mediastinal

VIDEO HIGHLIGHTS

Video 1: TTE apical four-chamber view. The hypoechoic mass is located at the AV groove between the RA and the RV.
Video 2: TTE right ventricular inflow view. An anterior hypoechoic mass is identified.
Video 3: *Top panel*: Steady state free precession (SSFP) images in four-chamber orientation. The masses are seen at the AV groove between the RA and RV, at the junction of the RA and IVC, and at the interatrial septum. *Middle panel*: Fast gradient echo perfusion images. The mass takes up gadolinium on first-pass perfusion. *Bottom panel (still image)*: Delayed enhancement images. There is partial late gadolinium enhancement of the masses. A small pericardial effusion is seen as well.
Video 4: TTE apical four-chamber view postchemotherapy. Complete resolution of the mass is noted compared with Video 1.
Video 5: TTE right ventricular inflow view postchemotherapy. Complete resolution of the mass compared with Video 2.

View the video content online at www.cvcasejournal.com.

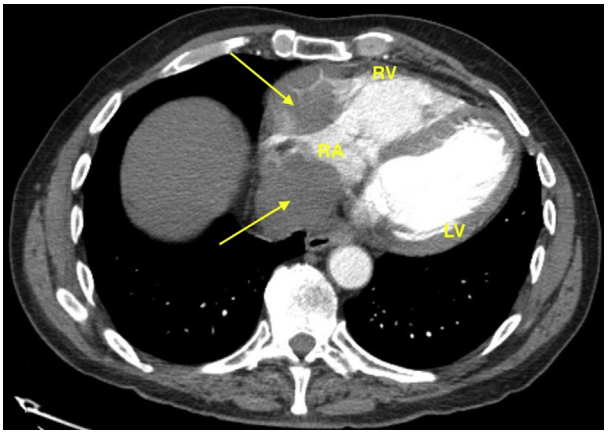

Figure 1 CTA of the chest. *Arrows* denote large mass-like density at the inferior cavoatrial junction extending into the RA as well as focal mass-like thickening within the AV groove between the RA and the RV, surrounding the right coronary artery. *LV*, Left ventricle.

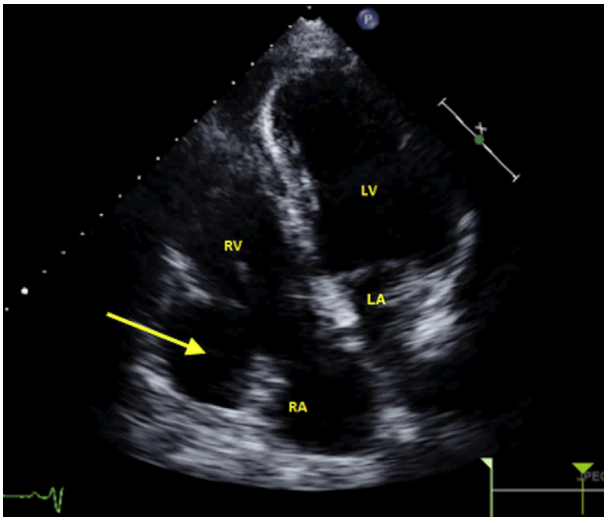

Figure 2 TTE apical four-chamber view. The hypoechoic intracardiac mass is located at the AV groove between the RA and the RV (*marked by arrow*). *LA*, Left atrium; *LV*, left ventricle.

lymphoma and can affect both the right and left side of the heart. Symptoms develop based on the area of cardiac involvement. The usual presentation of secondary cardiac lymphoma includes the finding of a pericardial effusion with or without tamponade, although pericardial or myocardial nodular masses may be found on echocardiogram. This is also usually in the context of widespread disease.[7]

Primary cardiac lymphoma can present with many nonspecific symptoms, including arrhythmias, syncope, shortness of breath, chest pain, fevers, night sweats, and weight loss.[8] The patient's dyspnea described in the case may have been related to one of the masses surrounding the right coronary artery, which may have resulted in compression of the right coronary artery, leading to myocardial ischemia with exertion. Similar to superior vena cava syndrome, one of the other likely causes of his dyspnea relates to obstruction of venous return by the mass at the RA/IVC junction. Recognition of his own symptoms is what allowed for proper diagnosis and initiation of appropriate treatment.

In the past, primary cardiac tumors were frequently diagnosed at autopsy, but modern technology allows for early diagnosis and treatment, ultimately improving prognosis.[3]

Multimodality imaging with echocardiography, CT, and cardiac MRI is paramount to early diagnosis and management. Crucial information including tumor size, location, mobility, mechanism of tumor implantation, relationship with adjacent structures, and myocardial invasion can be obtained to strategize best treatment options. Echocardiography, including TTE and transesophageal echocardiography, is the most commonly used imaging modality and is excellent at delineating multiple cardiac structures and characteristics of a mass, such as its mobility, attachment, and potential for hemodynamic consequences.[9] Some limitations when evaluating for cardiac tumors include limited spatial resolution with a narrow field of view and poor characterization of tissue. Additional imaging modalities should be used to acquire more information.[10] In the case presented, the borders of the hypoechoic mass seen on TTE (Figure 2, Video 1) are not well delineated but are nicely visualized on cardiac MRI.

CTA can be used to assess anatomy, infiltration, and vascularity of the mass as well as for evidence of extracardiac metastasis. Cardiac MRI offers superior contrast resolution along with the ability to obtain wide field of view and multiplanar imaging. It is excellent for the assessment of size, shape, tissue characterization, and relationships to other cardiac structures.[11] Cardiac MRI is particularly useful in distinguishing tumor from thrombus.[12] The best possible imaging technique is a combination of these methods, as each provides different information for diagnosis and treatment planning.

Tissue biopsy is essential to definitively diagnose cardiac tumors. Endomyocardial biopsy is an effective way to diagnose select cardiac tumors but should not be performed on tumors with features sugges-

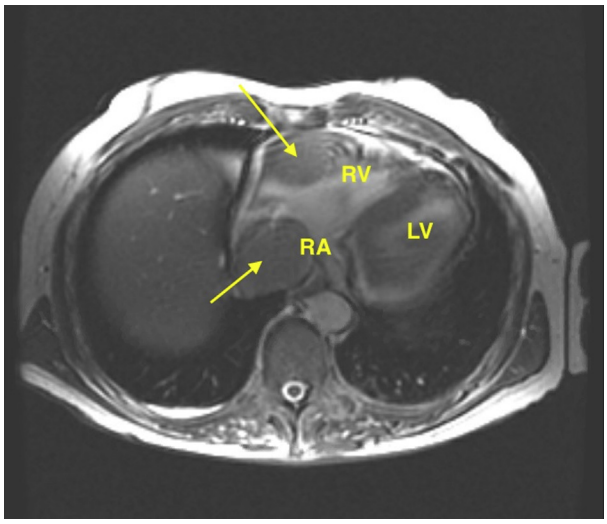

Figure 3 Cardiac MRI three-chamber view. The *arrows* denote the intracardiac masses; the first mass is located in the posterior wall of the RA; the second mass is located along the AV groove between the RA and the RV; the third mass located in the interatrial septum is not well visualized in this figure. *LV*, Left ventricle.

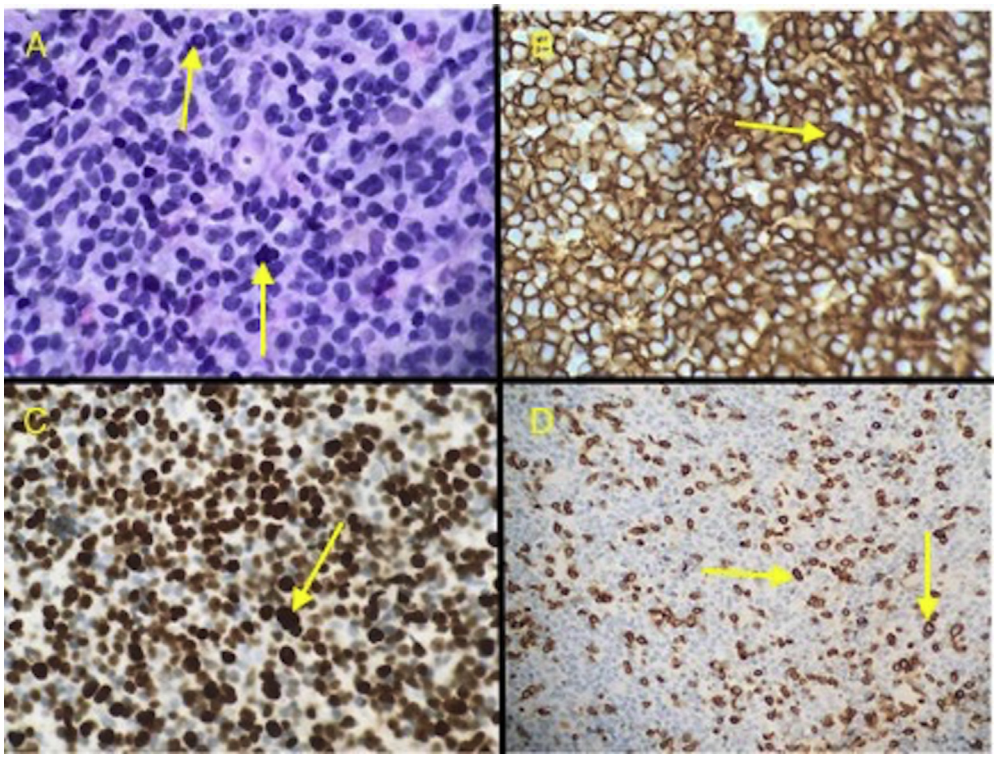

Figure 4 Histopathological stains of IVC/RA mass. **(A)** Hematoxylin and Eosin stain revealing diffuse proliferation of large atypical lymphoid cells (*marked by arrows*). **(B)** Lymphoma cells showing distinct membrane staining for CD20 (pan B-cell marker, *marked by arrow*). **(C)** High Ki67 proliferative index (nuclear marker, *marked by arrow*). **(D)** Scattered reactive T-cells are positive for CD3 (pan T-cell marker, *marked by arrows*).

tive of myxoma as there is a high risk of embolization with manipulation.[13] Surgical resection allows for definitive diagnosis with tumors that tend to be mobile because of cardiac contraction, respiratory motion, and dynamic blood flow. Location should also be taken into account; tumors located at the junction of the IVC and RA are in a prime location to obtain a catheter-guided biopsy. With cardiac lymphoma, endomyocardial biopsy is optimal.[14]

Diffuse large B-cell lymphoma is a fatal malignancy, with patients typically dying within a few months of diagnosis if untreated.[8] It is absolutely essential to diagnose primary cardiac lymphoma as early

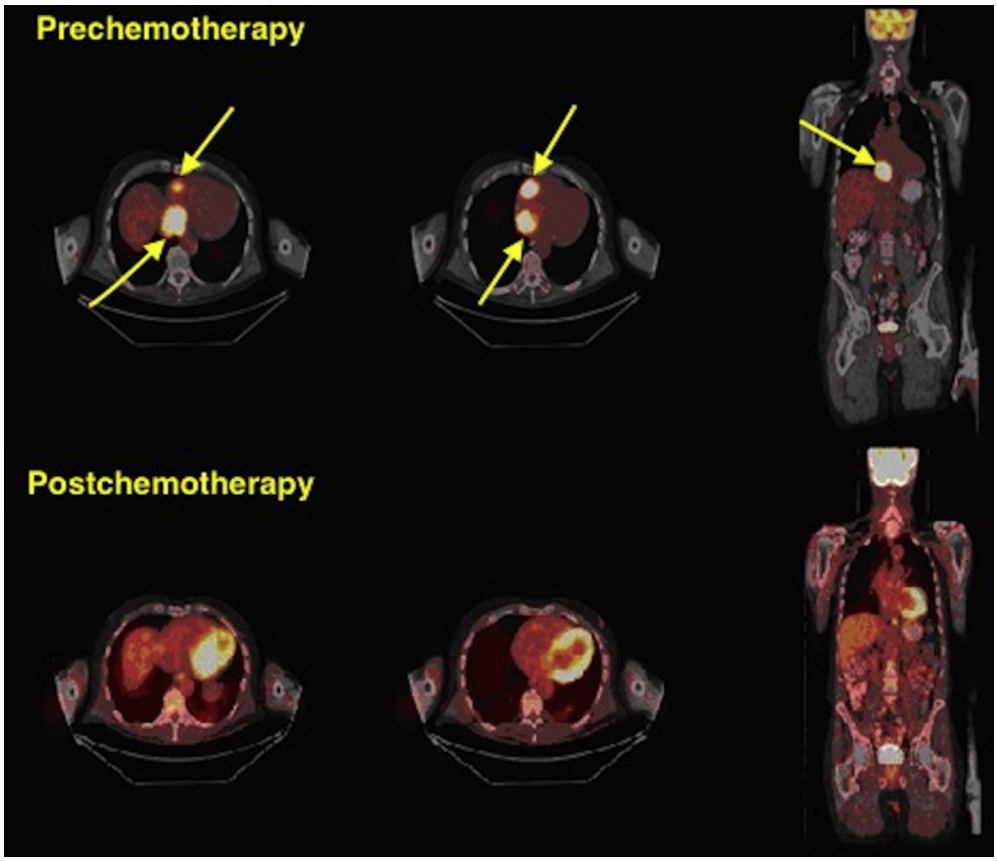

Figure 5 PET/CT scan before and after 10 weeks of RCHOP (rituxan, cyclophosphamide, doxorubicin, vincristine, prednisone). Interval resolution of the hypermetabolic activity associated with the masses reported previously anterior to the right heart and posterior to the RA (masses *marked by arrows*). New patchy hypermetabolic activity at the posterior inferior left lung base is associated with a patchy infiltrate, which may be due to an infectious or inflammatory etiology. As the patient did not follow the correct diet prior to the postchemotherapy scan, there was increased physiological uptake of the myocardium noted.

as possible to achieve optimal outcomes for patients, as chemotherapy initiated early can improve prognosis and can potentially be curative.

CONCLUSION

Primary malignant cardiac tumors are extremely rare and lethal. Multimodality imaging including echocardiography, cardiac CT, and cardiac MRI are key for establishing an early diagnosis and for the determination of treatment strategies including chemotherapy and surgery.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2019.02.002.

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