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Case Report

Metabolic Steal of the Myocardium by Primary Cardiac Lymphoma

Osamu Imataki Hiroyuki Kubo Haruyuki Fujita Makiko Uemura

Division of Hematology, Department of Internal Medicine, Faculty of Medicine, Kagawa University, Takamatsu, Japan

Keywords

Primary cardiac lymphoma · Metabolic steal phenomenon · Positron emission tomography · ^{18}F-fluorodeoxyglucose

Abstract

Less than 1.0% of malignant lymphomas are primary cardiac lymphoma (PCL), a rare malignant lymphoma. Due to its infrequency, the metabolic dynamics of the treatment have not been completely analyzed. A 62-year-old man who had been complaining of exertional dyspnea for a month arrived at our emergency room. He developed right cardiac failure as a result of a mass in the right atrium, according to a computed tomography (CT) scan. According to an echocardiogram, the mass was obstructing his blood flow and affecting how his heart worked. The lump was pathologically determined to be diffuse large B-cell lymphoma after he underwent urgent heart surgery. The lesion was only localized in the heart, according to a postoperative ^{18}F-fluorodeoxyglucose positron emission tomography (^{18}F-FDG-PET)/CT scan, indicating that the disease was in clinical stage IE. An ^{18}F-FDG-PET/CT scan showed a thickness of the right atrial wall as residual disease despite the majority of the cardiac lymphomatous mass being removed during surgery; it also showed that the usual uptake of ^{18}F-FDG in healthy myocardium had diminished. Following chemotherapy, ^{18}F-FDG uptake recovered in the patient's normal myocardium of the heart in remission. In conclusion, a sort of "metabolic steal phenomenon" that may be connected to PCL is the difference in uptake between tumor-involved and healthy myocardium.

Correspondence to:
Osamu Imataki, imataki.osamu@kagawa-u.ac.jp

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Introduction

With an autopsy incidence of 0.001–0.030%, primary heart malignancies are extremely uncommon [1]. Primary cardiac lymphoma (PCL) is challenging to identify due to its location. Consequently, diagnostic procedures like computed tomography (CT) and magnetic resonance imaging are frequently performed, with a biopsy serving as the final, conclusive confirmation. PCL accounts for approximately 30% of all primary cardiac tumors [2, 3]. According to the most recent case report, PCL could be discovered at random during a skin biopsy, much like intravascular lymphoma [4]. Such information could assist in the early discovery of PCL and enhance the prognosis for patients with this uncommon, incurable condition. PCL is still challenging to diagnose, though, because it is challenging to find a cardiac mass and decide how to perform a cardiac biopsy. Using ^{18}F-fluorodeoxyglucose positron emission tomography (^{18}F-FDG-PET), a patient's metabolic condition can be verified, and some pathological abnormalities can be found [5]. PCL may be challenging to diagnose even using ^{18}F-FDG-PET [6]. Although lymphoma cells have high glucose metabolic activity, which is seen in the images as areas of enhanced absorption, they may be challenging to identify from intact myocardium [5, 7]. This case report was followed by the CARE guideline (see www.karger.com/doi/10.1159/000527638).

Case Report

A 62-year-old man with PCL presented to our emergency department with a 1-month history of dyspnea on exertion. He developed right cardiac failure as a result of a mass in the right atrium, according to a CT scan. According to an echocardiogram, the mass was obstructing his blood flow and affecting how his heart worked. The lump was removed during emergency heart surgery, and pathology revealed that it was a malignant lymphoma of the diffuse large B cell (DLBCL) type. At the onset, ultrasound echocardiography was performed and revealed a preserved ejection fraction (74%), as well as an intra-atrial mass of 83 × 46 mm, which disturbed right atrial blood flow. Because of the atrial fibrillation rhythm, regurgitation was difficult to detect. There was no evidence of pulmonary hypertension. It is conceived that the right atrial mass causes right heart failure and reduces venous return. Because of heart failure, the patient's general condition was too poor to perform ^{18}F-FDG-PET/CT scanning prior to treatment. He underwent emergency cardiac surgery for tumor excision. A postoperative ^{18}F-FDG-PET/CT scan was performed to localize the lymphoma and determine the clinical stage. The lesion was localized in the heart, indicating that the disease was in stage IE (Ann Arbor classification). Despite the excision of the majority of the cardiac lymphomatous mass during surgery, ^{18}F-FDG-PET/CT revealed a thickness of the right atrial wall (shown in Fig. 1a) indicating residual lymphoma tissue (shown in Fig. 1b). As shown in the ^{18}F-FDG-PET image, the normal myocardium had little ^{18}F-FDG uptake (shown in Fig. 1c). Our patient had neither glucose intolerance nor myocardial ischemic disease, and we could not identify any other explanation for his normal myocardium's low isotope uptake. However, after chemotherapy with cyclophosphamide, THP-doxorubicin (pirarubicin), vincristine, and prednisolone, the patient was in remission, and normal ^{18}F-FDG uptake in the patient's myocardium was restored.

Conclusion

According to an autopsy case series, PCL is a rare disease that accounts for less than 1.2% of all cardiac tumors [8]. Furthermore, PCL accounts for less than 1.0% of extranodal

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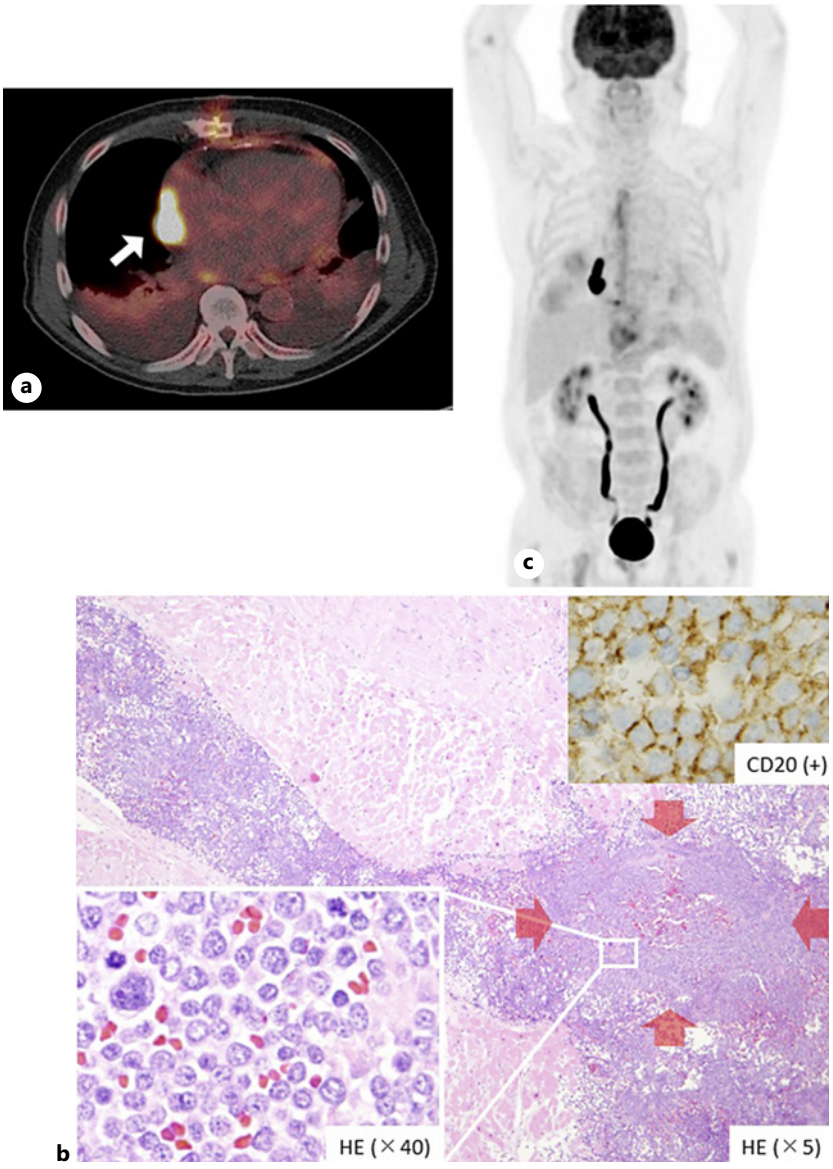

Fig. 1. ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography (^{18}F-FDG-PET/CT) study. **a** After resecting the cardiac mass, which was diagnosed as a cardiac lymphoma, ^{18}F-FDG-PET/CT detected residual disease on the right atrial wall (arrow). **b** Pathological features. The patient's cardiac tumor was diagnosed pathologically as DLBCL. The tumor has a typical phenotypic marker of mature B cells, CD20+, and CD10+. Arrows indicate the area of infiltration in the pericardial lymphoma tissue. **c** ^{18}F-FDG uptake is suppressed in normal myocardial tissue.

lymphomas [9]. DLBCL is the most common histopathology, but there have also been reports of Burkitt lymphoma, T-cell lymphoma [10], and plasmablastic lymphoma [4]. The most common symptoms and clinical findings of PCL are dyspnea, arrhythmia, pericardial effusion, fever, chills, night sweating, and weight loss [4]. PCL is more common in older men, with a median age of 63 years and men:women ratio 1:1.94 [4]. PCL affects both immunocompromised and immunocompetent subjects, but the incidence and outcome are worse in immunocompromised subjects [4]. The reasons for the better outcome in immunocompetent patients are unknown. A case series of PCL developing from cardiac myxoma in patients with

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normal immunity has been reported [11]. The 4 cases were all Epstein-Barr virus-encoded small RNA-positive with DLBCL histology and stage IE. All patients were in remission after only surgical resection, with no chemotherapy or radiotherapy, and had an indolent clinical course. Therefore, it is likely that biological differences in lymphoma oncogenesis exist between immunocompetent and immunocompromised individuals. In our case, the pathological origin of the lymphoma was endocardium, and no myxoma was found. PCL is more common in the right heart system (92%), with the highest frequency in the right atrium, followed by the right ventricle, left atrium, and finally the left ventricle [4]. This location preference suggests that systemic (nodular) lymphoma is streaming into the right atrium via the flow of venous return [4, 12]. Surgical interventions should be considered in patients with unstable hemodynamics [13, 14]. According to a previous report, the Fontan operation can be performed as a tentative revascularization to stabilize hemodynamics and enable chemotherapy. Although surgery for PCL does not improve prognosis, it does allow for more time to administer chemotherapy, especially in patients with hemodynamic instability [14]. CHOP therapy is frequently used as a form of chemotherapy. The objective response rate was 79% when treated with either surgery or chemotherapy [4]. In this case, the patient underwent a conservative surgical resection followed by a CHOP-like chemotherapy regimen that was modified due to the patient's cardiac function.

The difference in uptake between tumor-involved and healthy myocardium is a type of "metabolic steal phenomenon," which was also observed in a recent PCL case report [15], where pre- and post-chemotherapy ^{18}F-FDG-PET imaging was presented. After overnight fasting, the physiological uptake of FDG in the myocardium remains constant [16]. Even under normal physiological conditions, ^{18}F-FDG uptake in the myocardium can vary in heterogeneous patterns [17], depending on a patient's fasting state and the rate of glucose metabolism in each individual myocardium [17]. However, because no left ventricular asynergy was observed, we concluded that the detection of ^{18}F-FDG accumulation as myocardiopathy was not hindered by congestive heart failure. Actually, the SUVmax of the myocardium ranges between 1.5 and 3.5 [18]. Furthermore, we can discriminate the relative uptake as the standard reference in each mediastinal SUVmax. In addition, the ^{18}F-FDG uptake value in partial or regional normal myocardium is as low as 2.3±0.9 [17]. This value has a minor impact due to the increased uptake of the myocardium with lymphoma. Then, by sight, we can easily recognize the difference between normal and sick myocardium. This uptake difference was clearly observed before and after chemotherapy. Furthermore, in the patient's evaluation for detecting primary myocardial tumors, such as cardiac myxoma or cardiac sarcoma, myocardial glucose metabolism could not be avoided. Indeed, other benign pericardial tumors [5] did not inhibit myocardial uptake of FDG. Moreover, we believe that the metabolic steal phenomenon is significant in cardiac lymphoma tissue because, we hypothesize, the physiological metabolism of the myocardium is relatively low due to fatty acid metabolism or because lymphoma myocardium is metabolically more active. In contrast to the increased uptake of FDG in cardiac tissue with lymphoma, we believe that the metabolic steal of FDG in intact myocardium is a sign of PCL. Alternatively, SUVmaxes of the mediastinum and myocardium were measured to rule out the possibility of artificial activity contribution from the spillover of myocardial or blood ^{18}F-FDG uptake into the tumor region [17, 19]. In conclusion, as our case suggests, the metabolic steal phenomenon may be associated with PCLs.

Statement of Ethics

The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The subject has given their written informed consent to publish their

case (including publication of images). This study has been granted an exemption from requiring ethics approval by the institute's committee on human research, Kagawa University Internal Review Board.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Osamu Imataki and Haruyuki Fujita managed the patient's case, contributed to the literature search, and wrote the manuscript. Hiroyuki Kubo managed the patient's case, qualified the patient's data, and suggested important intellectual content. Makiko Uemura made substantial contributions to the concept and design of this report. Makiko Uemura was involved in supervision of the manuscript and managed the research. All authors approved the final version of the manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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