INTRODUCTION
Primary cardiac lymphoma is rare. Depending on the site of involvement, the clinical symptoms are variable including heart failure, arrhythmias, atrioventricular disturbances, pericardial effusion, superior vena cava syndrome, and stroke. Here, we report the successful treatment of sick sinus syndrome in an 84-year-old man with cardiac lymphoma via chemotherapy without pacemaker implantation.

CASE HISTORY
An 84-year-old man with a history of hypertension and dyslipidemia visited another hospital for abdominal pain. Computed tomography (CT) showed intra-abdominal lymphadenopathy. Histopathologic examination of a biopsy specimen was consistent with a diagnosis of follicular lymphoma (grade 1). Two days later, he was admitted to another hospital for syncope. His blood pressure was stable, but electrocardiography revealed marked bradycardia (30 bpm) with sinus arrest up to 5.4 s (Figure 1A). There was no ST-segment change suggestive of acute coronary syndrome. He had no previous history of syncope and did not take any medication that could cause bradycardia. In accordance with the Advanced Cardiac Life Support (ACLS) protocol, atropine was administered as symptomatic bradycardia. The pulse rate promptly improved, and his consciousness had stabilized. Therefore, transcutaneous temporary pacing was not performed, and isoprenaline was started to maintain the pulse rate.

EXAMINATION, DIFFERENTIAL DIAGNOSIS, AND TREATMENT
He was transferred to our hospital for further evaluation. His vital signs were stable after starting continuous

Abstract
Successful treatment of the acute phase of bradycardia in patients with cardiac lymphoma via medical therapy alone has not been reported. This case report describes the successful treatment of sick sinus syndrome in an 84-year-old man with cardiac lymphoma via chemotherapy without pacemaker implantation.

KEYWORDS
chemotherapy, follicular lymphoma, pacemaker implantation, primary cardiac lymphoma, sick sinus syndrome
intravenous infusion (CIV) of isoprenaline. The electrocardiography showed findings of left atrial load, but the pulse rate was stable at about 70 bpm (Figure 1B). Laboratory tests showed no electrolyte abnormalities, but the levels of soluble interleukin-2 receptor (5188 U/ml) and brain natriuretic peptide (140 pg/ml) were elevated. Transthoracic echocardiography revealed a 34-x50-mm mass in the posterior wall of the left atrium with an intact left ventricular wall motion (Figure 2A). Contrast-enhanced cardiac CT showed a mass surrounding the right atrium, left atrium, and left ventricle with marked luminal narrowing (Figure 3). The coronary artery was running inside the mass. Hence, it was considered to have a low propensity for invasion. Based on these results, we considered the cardiac mass to be the cause of sick sinus syndrome. Positron emission tomography-CT (PET-CT) showed mild accumulation in the mesenteric lymph node where the initial biopsy was performed and high accumulation in the heart, mainly in the atrial wall (Figure 4). Bone marrow examination did not show any infiltration of lymphoma. These findings were consistent with primary cardiac follicular lymphoma (Ann Arbor Classification Stage IV).

**FIGURE 1** Electrocardiogram monitoring at the previous doctor (A). It shows sinus arrest up to 5.4 s and following escape rhythm. After atropine injection and starting continuous intravenous infusion of isoprenaline, the pulse rate was stable at about 70 bpm (B)
Due to concerns of anthracycline-related cardiotoxicity, bendamustine and rituximab (BR therapy) were initiated. After 3 days of chemotherapy, echocardiography showed cardiac mass reduction (Figure 2B). After 17 days, contrast-enhanced cardiac CT revealed marked mass reduction with only a small residual tumor in the right atrium. The CIV rate of isoprenaline was tapered.

Treatment with oral theophylline (400 mg/day) resolved his sinus arrest and stabilized his pulse rate at 60–80 bpm. After two cycles of BR therapy, the patient was discharged. He then completed six cycles of BR therapy with repeated short hospitalizations. However, 3 weeks later, he was admitted to our hospital for high fever. CT revealed no lymphadenopathy, cardiac tumor recurrence, or any other potential etiology of fever. However, as pancytopenia progressed, we suspected haemophagocytic syndrome or bone marrow infiltration of lymphoma. Bone marrow examination revealed infiltration of high-grade B-cell lymphoma. Immunostaining showed that the tumor cells were positive for CD79a and PAX5, and negative for CD3 and CD20. Nine days later, the patient died.

With the consent of the patient’s family, we performed a pathologic autopsy. Histopathologic examination revealed diffuse large B-cell lymphoma (DLBCL) in the spleen, liver, bone marrow, adrenal glands, para-aortic lymph nodes, and mesenteric lymph nodes (Figure 5A–C). The tumor cells were positive for CD79a, Bcl-2, and Bcl-6 and negative for CD3 and CD20. Moreover, the Ki-67 index was found to be 70%. These findings were consistent with the transformation of follicular lymphoma to DLBCL. Interestingly, there was no sinus node scarring or residual cardiac lesions, which was the primary site of follicular lymphoma (Figure 5D).
FIGURE 4  PET-CT before chemotherapy, showing high accumulation in the heart and mild accumulation in the mesenteric lymph node.

FIGURE 5  Histopathological images obtained at autopsy. Infiltration of DLBCL was observed in bone marrow (A), liver (B), and adrenal glands (C). In the sinus node, there was no residual lymphoma and no obvious scarring or fibrosis (D).
Primary cardiac lymphoma (PCL) is an extranodal lymphoma characterized by cardiac or pericardiac involvement. It is a rare disease, accounting for 1.3% of primary cardiac tumors. Although mesenteric lymph node involvement was observed in our patient, PET-CT confirmed that the cardiac mass was the main lesion, suggesting a diagnosis of PCL.

The most common histologic type of PCL is DLBCL, followed by follicular B-cell lymphoma, Burkitt lymphoma, and others. In our case, the patient was diagnosed with follicular lymphoma based on the mesenteric lymph node biopsy. However, the autopsy showed DLBCL infiltration in the bone marrow, liver, and adrenal glands, suggesting the potential transformation of follicular lymphoma into DLBCL. Due to concerns of anthracycline-related cardiotoxicity, BR therapy was chosen. However, BR therapy led to early relapse.

The clinical presentation of cardiac lymphoma is variable and dependent on various factors (i.e., tumor location, size, growth rate, degree of invasion, and friability). Common symptoms include heart failure, pericardial effusion, arrhythmias, superior vena cava syndrome, and stroke. Arrhythmias caused by cardiac lymphoma include atrial flutter, atrial fibrillation, atrioventricular conduction disturbances, and sick sinus syndrome. However, to the best of our knowledge, cases of sick sinus syndrome associated with cardiac lymphoma are rarely reported.

In cases of bradycardia and syncope, pacemaker implantation is recommended (Class I). However, in cases wherein the tumor is located in the right aspect of the heart or superior vena cava, pulmonary embolism may occur due to pacemaker lead-induced tumor injury. In such cases, a leadless or epicardial pacemaker may be considered. Nevertheless, it is important to note that pacemaker implantation is an invasive procedure with a potential risk of device infection in the long term. To the best of our knowledge, successful treatment of the acute phase of bradycardia in patients with cardiac lymphoma via medical therapy alone has not been reported. In our case, pathologic autopsy revealed complete resolution of the cardiac mass. This suggests that arrhythmias associated with infiltration of lymphoma in the cardiac conduction system are reversible with prompt chemotherapy. Depending on the general condition of the patient, degree of arrhythmia, and location of the tumor, it may be reasonable to defer pacemaker implantation and initiate medical therapy (e.g., beta-agonists) to treat transient arrhythmias.

In conclusion, we have described the successful treatment of sick sinus syndrome in a patient with cardiac lymphoma via chemotherapy alone.

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CONFLICTS OF INTEREST
The authors declare no conflict of interest.

AUTHOR CONTRIBUTION
YH was involved in the clinical management, literature review, and wrote the manuscript. ST was involved in the revision of the manuscript and supervised all the aspects. TS was involved in the clinical management and the revision of the manuscript.

ETHICAL APPROVAL
No ethical approval is required.

CONSENT
Written informed consent was obtained from the patient’s family to publish this report in accordance with the journal’s patient consent policy.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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