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CASE REPORT

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A massive cardiac lipoma in the right atrium with multimodality imaging

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Abstract

We report the noninvasive imaging diagnosis of a massive right atrial lipoma in a young male patient. Echocardiography and myocardial contrast echocardiography were used to assess echo intensity, tumor size, anatomic boundary, hemodynamics, and contrast agent perfusion. Dual-source CT revealed that the CT value of the tumor was fat density. Cardiac MRI showed high signals of T1 and T2 weighted images, while the low signals of fat saturation sequences. Finally, the tumor was surgically resected and the diagnosis of right atrial lipoma was confirmed by pathological section. Our study indicates that multimodal imaging may facilitate a potential pathological diagnosis before biopsy and can help plan further treatment.

Keywords Cardiac lipoma, Multimodal imaging

Background

Primary cardiac tumors are rare, occurring approximately 0.001–0.28% of autopsies. Cardiac lipomas (CL) are a benign tumor with a slightly lower incidence than myxomas. CL represent approximately 4% of all benign tumors and are most frequently observed in middle-aged and older individuals [1]. The detection rate of these tumors has increased in recent years, likely attributable to advancements in and accessibility of multimodal imaging technology [2]. They are usually asymptomatic and found accidentally during non-cardiac surgery or autopsy. Imaging can provide for tumors' adjacent relationships, predicted tumor character, and guide clinical diagnosis and treatment. This case demonstrates that a massive CL may be diagnosed noninvasively through specific multimodality imaging characteristics.

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Case presentation

During a pre-employment physical examination outside the hospital, a 25-year-old man was incidentally found to have a mass in the right atrium on echocardiogram. However, his electrocardiogram revealed normal sinus rhythm, and a chest X-ray showed no significant heart enlargement. The patient reported no noticeable discomfort at rest but experienced mild chest tightness and shortness of breath after physical exertion. His physical examination and laboratory tests were unremarkable, and he had no additional cardiovascular risk factors.

Transthoracic echocardiography found a high echogenic massive tumor (70×52 mm) in the right atrium, slight compression of the right ventricle base and tricuspid valve, and normal biventricular function (Fig. 1A-B). Myocardial contrast echocardiography revealed higher contrast agent perfusion in the tumor (Fig. 1C-D). A dual-source CT scan showed a 57×56 mm block mass in the right atrium, with fat density (mean CT value of -66HU) and scattered soft tissue density shadows (Fig. 2A-B). The superior vena cava is somewhat displaced by the mass. Cardiac magnetic resonance imaging (MRI) revealed a massive tumor (83×49×64 mm) in the right atrium, with

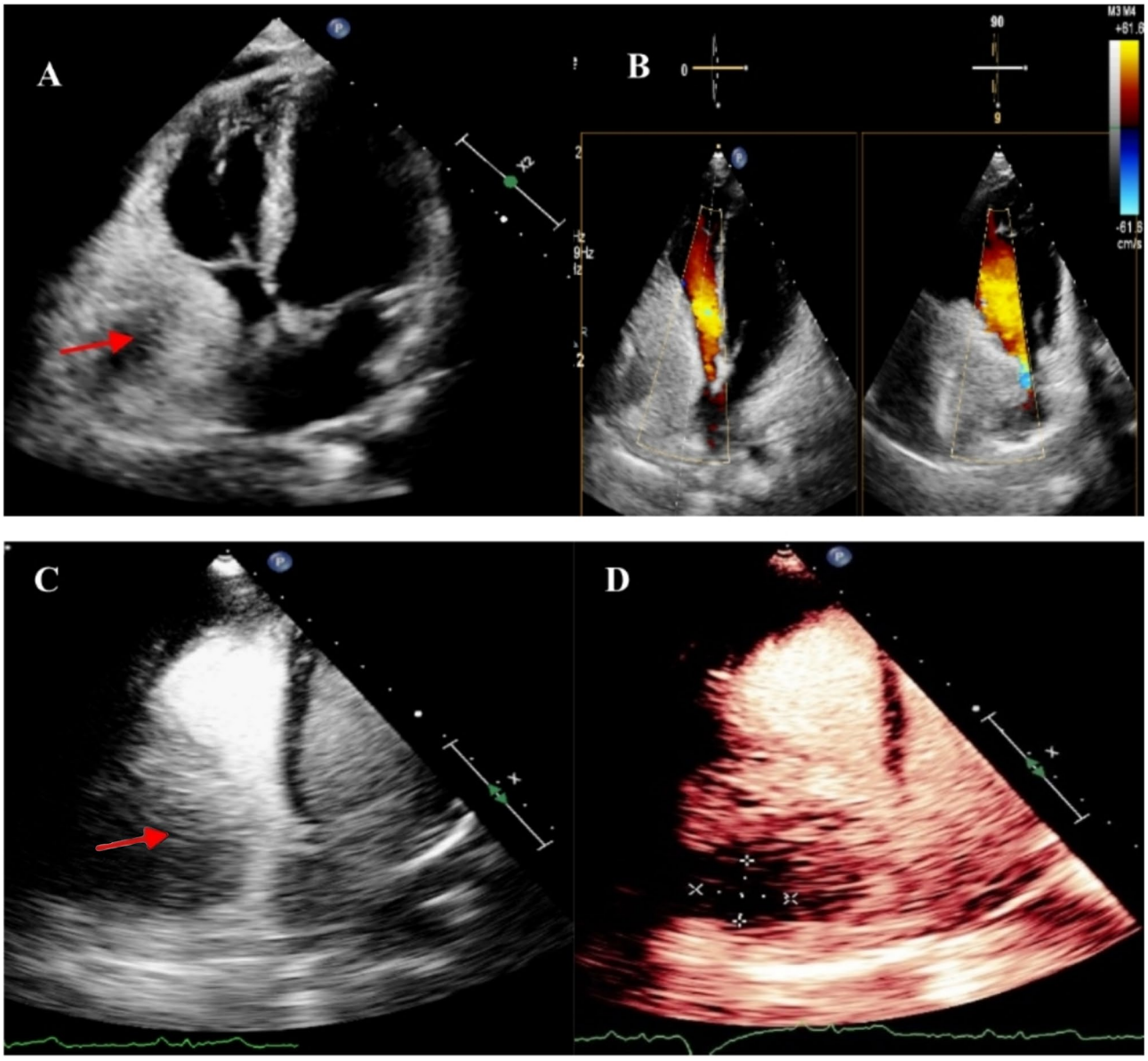

Fig. 1 **A**-**D** (**A**) Transthoracic echocardiography: Apical four-chamber view showed a high echogenic and homogeneous massive mass (arrow) in the right atrium. (**B**) Color doppler flow imaging with X-plane: The right ventricle base and tricuspid valve was light compressed of by mass. (**C**) Left ventricular opacification: The boundary between the mass (arrow) and the anterior lateral wall of the base of the right ventricle was not clearness. (**D**) Myocardial contrast echocardiography: The tumor displayed heterogeneous enhancement with the majority of the tumor showing increased contrast uptake, while specific regions measuring approximately 1.9×2.5 cm demonstrated reduced contrast uptake

high signal intensity on T1- and T2- weighted image, and low signal intensity with fat sequence, without obvious enhancement (Fig. 3A-C).

Based on imaging findings, surgical intervention was initiated after obtaining the patient's informed consent. A median sternotomy was performed, and cardiopulmonary bypass (CPB) was established routinely, with intubation of the right atrium at a right-angle. A huge yellow fatty mass, approximately 120×60×60 mm in size, was identified in the right atrium, margins clear, soft outside, slightly hard inside, with no visible envelope (Fig. 4A). Most of the right atrial parietal tissue, an upper portion of the superior vena cava and atrial septum were extensively fused with the tumor. The lower edge of the tumor was approximately 2 cm from the opening of the inferior vena cava and about 0.5 cm from the right atrioventricular groove. Importantly, the tumor did not invade the right pulmonary artery, left atrial roof, or aortic root, nor did it involve the tricuspid valve, right ventricle, and right coronary artery. The right atrial wall and tumor were completely excised with a margin of more than 0.5 cm from the tumor edge, including total resection of the

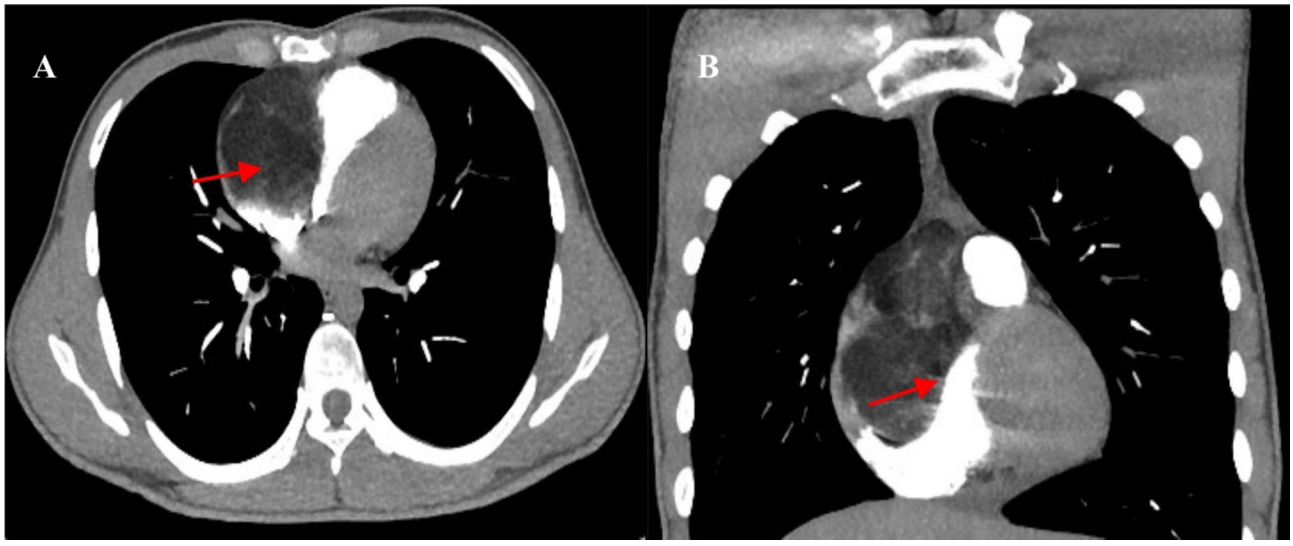

Fig. 2 **A**-**B** (**A**-**B**) dual-source CT scan showed a 57 × 56 mm block mass (arrow) in the right atrium, with fat density (mean CT value of -66HU) and scattered soft tissue density shadows

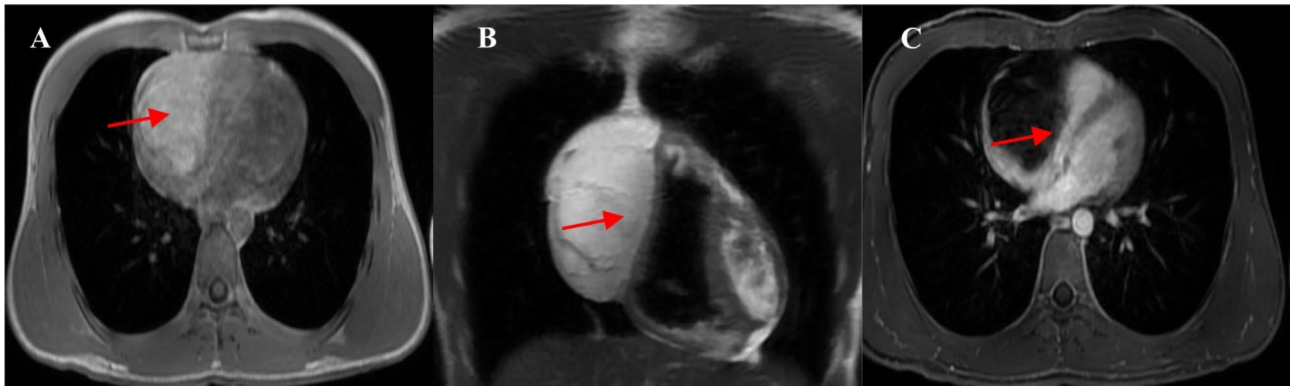

Fig. 3 **A**-**C** Cardiac magnetic resonance imaging revealed a massive tumor (arrow) in the right atrium, with high signal intensity on T1-(**A**) and T2-weighted image (**B**), and low signal intensity with fat sequence, without obvious enhancement (**C**)

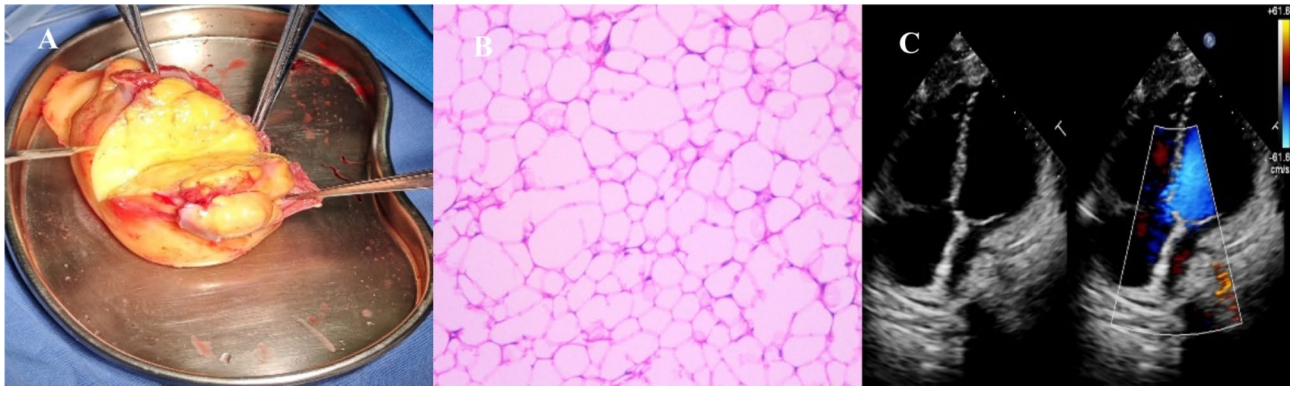

Fig. 4 **A**-**C** (**A**)The pathological gross specimen showed a huge yellow fatty mass. (**B**)The microscope (HE 1 × 100) revealed a large number of mature fat cells. (**C**) There was no obvious abnormal echo in the right atrium three months after surgery

sinus node and the upper atrial septum. After trimming the bovine pericardial patch, a 5−0 Prolene suture was used to repair the atrial septum. Additionally, the bovine pericardial patch was utilized alongside a 4−0 suture for the repair and reconstruction of the superior vena cava and right atrium, with anastomosis of the superior vena cava performed using a 2.0 cm probe. The duration of CPB was 165 min, with an aortic cross-clamp time of 127 min. No P wave was observed following cardiac reanimation postoperatively, necessitating the implantation of a temporary pacemaker to maintain overall cardiac rhythm. Sinus rhythm resumed one week after surgery. Finally, the patient's pathology report revealed a CL in the right atrium. The fibrous septum contained a considerable number of fat cells, and the cytoplasm was vacuolated without atypia (Fig. 4B). Following an echocardiogram immediately and three months after surgery, the patient's right atrial mass gone (Fig. 4C) and biventricular function satisfactory. No other complications were reported.

Discussion and conclusions

CL is primarily composed of mature adipose cells in the interatrial groove or adjacent to the epicardium, and it can be classified as subendocardial lipomas, intramyocardial, and subepicardial according to the location of occurrence. The right atrium, left ventricle, and pericardium are the most commonly described sites in the literature [3]. Based on the microscopic manifestations, CL can be divided into isolated, intramuscular, and special forms, such as atrioventricular valve lipomatous hamartoma and lipomatous hypertrophy of the interatrial septum [4].

The clinical manifestations of CL are determined by the tumor's texture, size, location and obstruction status. The most common consequences are dyspnea and arrhythmia. Angina pectoris can be caused by a compression of the coronary artery. If the left ventricle is compressed, the left heart's systolic function is impaired. Arrhythmia can occur when there is damage to the conduction system. Because lipomas usually have a relatively complete envelope, embolism symptoms are uncommon.

CL should be distinguished from lipomatous hypertrophy of the interatrial septum, myxoma, thrombus, and malignant tumors based on locations, imaging characteristics, mobility, clinical presentation, and age of presentation [5] (Table 1). A probable etiology can be determined by integrating multimodal imaging features with clinical expertise, thereby facilitating further diagnostic investigations and guiding management strategies.

In this case, although the tumor was large, there were no obvious symptoms, which could be attributed to the fact that the tumor did not block the tricuspid valve opening and the patient was young and well tolerated. Due to the large size and mild compression of the right atrium, surgical resection was performed, followed up for three months, and the recovery was satisfactory. This study also has some limitations, such as the lack of genetic testing [6] and the short postoperative follow-up period. The diagnosis of CL often relies on multimodality imaging. Echocardiography can be used as the primary screening and follow-up method and can provide information on echo intensity, homogeneity, and hemodynamic abnormality related to the tumor. The blood supply of tumors provided by contrast-enhanced ultrasound has suggestive significance for benign and malignant. CT can further

Table 1 Differential diagnosis of Cardiac Lipoma

	Lipoma	Lipomatous hypertrophy of the interatrial septum	Myxomas	Thrombus		Malignant tumors
				left heart	right heart	
Age	middle-elderly	elderly	middle-younger	middle-elderly	middle-younger	middle-younger
Location	subendocardial, intramyocardial and subepicardial	the proximal and distal portions of the atrial septum except for the fossa ovalis	left atrium (75–80%), right atrium (15–20%)	left ventricular apex	right ventricular, right atrium	right heart, pericardium
Appearance on imaging	hyperechoic in the cavity, hypoechoic in the pericardium	hyperechoic	lobulated and stretched appearance	fresh-hypoechoic, organize-hyperechoic	hypoechoic, irregular in shape	lobulated and invasive masses, ambiguous boundaries
Signal characteristics	homogenous	homogenous	heterogeneous	homogenous	homogenous	heterogeneous
Echo contrast agents	non-perfusion or partially enhanced	non-perfusion	partially enhanced	perfusion defect	perfusion defect	hyper-enhancement
Mobility	immobile	immobile	mobile	immobile	mobile	immobile
Clinical presentation	dyspnea, arrhythmia	asymptomatic	embolization, obstruct atrioventricular valve	myocardial infarction	deep vein thrombosis, pulmonary embolism	hemorrhagic pericardial effusions, arrhythmias, heart failure

clarify the neighborly relationship of the tumors and make up for the lack of ultrasound image quality, and the lipoma presents a low-density change, with a specific CT value range of -10~-100. The appearance of CL in MRI has differential significance for the pathological diagnosis of tumor. T1- and T2-weighted image have a high signal, while the fat saturation sequence has a low signal.

The clinical detection rate of CL has increased over the years, and multimodal imaging information was valuable for selecting the intubation method for CPB, determining the location and size of the right atrial approach incision, and assessing the need for valve repair or replacement.

Author contributions
The authors declare no relationships that could be construed as a conflict of interest, and manuscript is approved by all authors for publication. LZ analyzed the data and wrote the paper. QW performed an echocardiography examination for the patient. XS and LXS collected the other image data. YD collected the clinical data.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The patient provided written informed permission, and ethical approval was waived. All methods were performed in accordance with the Declaration of Helsinki.

Consent for publication
Written informed consent was obtained from the patient for the publication of this case report and any accompanying images.

Competing interests
The authors declare no competing interests.

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