Cardiovascular Ultrasound

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Diagnostic characteristics of multimodality imaging for left ventricular lipoma: new insights on surgical intervention

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Abstract

Background The echocardiography is the first-line imaging modality in detecting the cardiac lipoma. Contrast-enhanced echocardiography improves its structural definition and characteristics of blood supply to exclude thrombus and malignant tumors.

Case presentation We introduced a case that large cardiac mass involving nearly the whole left ventricular cavity and papillary muscles without any complications. Multimodal imaging has confirmed lipoma before surgery. However, rather than recommending conservative treatment in accordance with guidelines, surgical intervention was performed to prevent future hemodynamic abnormalities.

Conclusion Combined with multimodal imaging, we showed a rare case on comprehensive evaluation of left ventricular silent lipoma and provided new clues for surgical strategy, which were different from guideline recommendations.

Keywords Cardiac lipoma, Multimodal imaging, Contrast echocardiography

Introduction

Lipoma is the second most common primary benign cardiac neoplasm (8% to 12%) and has been mostly discovered incidentally because it is often asymptomatic [1]. Current guidelines recommend conservative treatment. However, this case still underwent surgical resection, which gives some new enlightenment for its future treatment strategies.

Case report

A 32-year-old man was found incidentally to have left ventricular (LV) occupancy during preoperative examination for kidney stones in local hospital. His medical history and physical examination were unremarkable. Twelve-lead surface ECG revealed no abnormal findings. Transthoracic echocardiography (TTE) on admission revealed two irregular hyperechoic masses at different locations of LV. The one (M1: Fig. 1A1 red arrow, Movie

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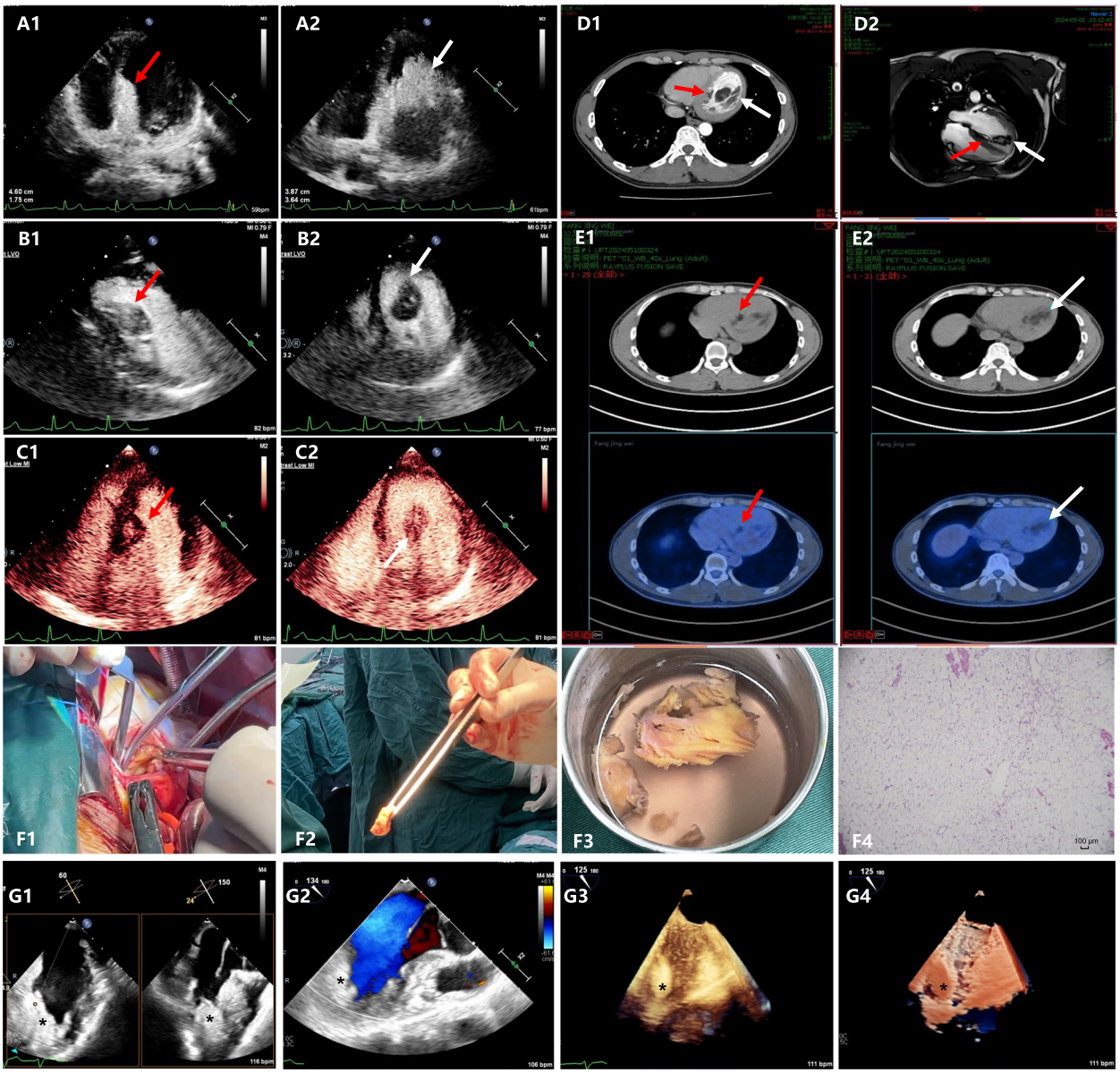

Fig. 1 Multimodal imaging and pathological finding. Non-standard view in transthoracic echocardiography showing multiple homogeneous, abroad-base, immobile masses (M1: red arrow and M2: white arrow) in left ventricular (**A**). Contrast echocardiography displaying no contrast agent filling in above mass and slight enhancement of the contrast agent at the base of masses, indicating an unclear boundary with the myocardium (**B** and **C**). Cardiac MRI and 18F-FDG PET/CT performing the presence of mass in left ventricular (**D** and **E**). Surgical and pathology findings demonstrating the accuracy of imaging diagnosis and the necessity of prophylactic resection (**F** and **G**)

I in the Data Supplement) was attached to basal segment of the LV inferoseptal walls, 4.6×1.8 cm in size and 3.9 cm in base. The superior margin of the attachment was approximately 0.3 cm from the annulus of the anterior mitral leaflet. The other one (M2: Fig. 1A2 white arrow, Movie II in the Data Supplement), appeared to have punctate hyperechoic microcalcifications, was attached to middle and apical segments of the LV inferolateral and inferior walls, 3.9×3.6 cm in size and 3.5 cm in base. Color Doppler imaging revealed no obstruction in left ventricular inflow tract, outflow tract and lumen. To further clarify the nature of the mass, LV contrast echocardiography was performed. Left ventricular opacification (LVO) showed no contrast agent filling in above mass (Fig. 1B1-2, Movie III in the Data Supplement). Myocardial contrast echocardiography (MCE) was performed. A total of 2.5 ml of Sono Vue contrast agent was injected through the left cubital vein at a constant rate for 2 min,

and the tube was flushed with 3 ml normal saline. The right and left heart were developed in turn. It displayed that there was slight enhancement of the contrast agent at the base of masses, indicating an unclear boundary with the myocardium (Fig. 1C1-2, Movie IV in the Data Supplement). These findings taken together led us to making a diagnosis of lipoma of LV. MRI exhibited homogeneous signals similar to fat in all pulse sequences (Fig. 1D1-2). ^{18}F-FDG Positron emission tomography demonstrated no obvious metabolic uptake (Fig. 1E1-2). All imaging findings confirmed the presence of the mass, corresponding with the results of echocardiography.

Considering the large-diameter mass in LV invaded important anatomical structures, the patient underwent surgery to prevent potentially life-threatening complications. To avoid intraoperative heart injury, a small incision in the aortic (Fig. 1F1) was taken to resect most of soft tissue adherent to the interventricular septum (Fig. 1F2-3) and papillary muscles, so as to reduce the possibility of hemodynamic abnormalities in mitral valve orifice, left ventricular outflow and inflow tract. However, it was impossible to remove the entire tumor, because it was integrated with and partly immersed in the interventricular septum by MCE. Intraoperative transesophageal echocardiography showed a residual slightly hyperechoic mass near apical segment of LV inferolateral walls, which real-time 3-dimensional transesophageal echocardiography offered complementary vivid data (Fig. 1G1-4, Movie V in the Data Supplement). The post-operative pathology also ratified all the previous examination findings, characterized by mature adipose tissue with no evidence of malignancy or infiltration (Fig. 1F4).

Discussion

Such large cardiac lipomas involving nearly the whole left ventricular cavity and papillary muscles without any complications are rare. It may grow and cause symptoms or complications such as malignant arrhythmia, outflow tract obstruction, or left ventricular aneurysm, and surgical resection was necessary to prevent its adverse prognosis and even sudden death. Especially for ventricular lipoma, failure of complete resection and post-operative ventricular arrhythmia are correlated with post-operative mortality [2, 3]. We provide new clues for surgical strategies, which were different from the guideline-recommended conservative management for silent lipoma given their benign nature.However, these lipomas may grow over time and lead to complications. Our case highlight the potential risks of leaving such lipomas untreated, especially when they involve critical cardiac structures such as the LV cavity and papillary muscles. Due to malignant arrhythmias caused by the mass's proximity to electric conduction pathways. The mass impinging on ventricular outflow areas will result outflow tract obstruction. Progressive mechanical or compressive effects on the myocardium and surrounding structures will induce left ventricular aneurysm or structural compromise. The patient in our case presented with a large lipoma involving the majority of the LV cavity and papillary muscles, which has rarely been reported without complications. Given the tumor's potential to grow and lead to malignant arrhythmias or outflow obstruction, surgical resection was deemed necessary to prevent adverse outcomes or sudden cardiac death. Hence we provided proactive intervention to prevent late complications and reduce long-term mortality.

TTE is the first-line imaging modality in detecting the cardiac mass [4]. The contrast echocardiography provides real-time assessment of vascularity and perfusion patterns within cardiac masses, which is critical for differentiating benign from malignant lesions [5]. Malignant tumors often exhibit higher vascularity and irregular perfusion, while benign masses, such as myxomas or thrombi, typically display lower or absent perfusion. The ability of it to characterize blood flow in real-time provides unique insights that MRI and PET may not capture, especially in situations requiring immediate intraoperative or bedside evaluation. Furthermore, contrast echocardiography offers the advantage of being a low-cost, non-invasive method that avoids ionizing radiation, making it suitable for patients with contraindications to other imaging modalities, such as impaired renal function (a contraindication for contrast-enhanced MRI) [6, 7]. In our case, slight enhancement of the contrast agent at the base of masses was clearly seen, consistent with the histological characteristics of lipoma with unclear demarcation between the mass and myocardium. In addition, three-dimensional echocardiography (3DE) has an emerging role in the evaluation of cardiac masses. It provides volumetric datasets of cardiac structures, allowing more precise localization, measurement, and spatial characterization of mass morphology compared to two-dimensional echocardiography (2DE). The incremental value of 3DE lies in its ability to generate detailed 3D surface maps of masses, which may assist in determining the relationship of the mass to surrounding structures, guide surgical planning, and facilitate intraoperative imaging [8]. Therefore, we initially eliminate the possible diagnosis of other types of cardiac benign tumors. In addition, this was the classical and comprehensive evaluation by multimodal imaging such as cardiac MRI and 18F-FDG PET/CT, especially providing further details of the soft tissue features, which improved the diagnostic confidence by contrast echocardiography [9]. Furthermore, the contrast echocardiography helps differentiate residual tumor from postoperative thrombus

or scars. Residual tumor tissue typically shows contrast enhancement due to its vascularity, whereas thrombotic or avascular tissue does not uptake contrast. It is particularly valuable in detecting early tumor recurrence during follow-up, since neovasculature within recurrent tumors leads to contrast enhancement [6, 10, 11].

This case highlights that multimodal imaging plays a key role in accurate characterization of LV silent lipoma and displays indispensable value for surgical perioperative strategies, dynamic monitoring and postoperative follow-up.

Abbreviations

LV	Left ventricular
TTE	Transthoracic echocardiography
LVO	Left ventricular opacification
MCE	Myocardial contrast echocardiography

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12947-025-00346-2.

Supplementary Material 1. Movie I-V. Supplementary echocardiographic video.

Acknowledgements
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Authors' contributions
Tianshu Liu and Lingyun Fang made contributions to the data analysis and manuscript preparation. Jiawei Shi, Lin He and Jing Zhang contributed to the conceptualization and experimental design.Yuman Li, Mingxing Xie and Jing Wang participated in the revision.

Funding
This study was supported by National Natural Science Foundation of China (Grant No. 82302227 and 82171961).

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

Declarations

Ethics approval and consent to participate
Consent for retrospective analyses of records and imaging data was waived. This work adheres to the World Medical Association Declaration of Helsinki. The need for signed patient consent was waived.

Competing interests
The authors declare no competing interests.

Received: 14 January 2025 Accepted: 18 March 2025
Published online: 28 March 2025

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