

## Elusive left ventricular thrombus: Diagnostic role of cardiac magnetic resonance imaging-A case report and review of the literature

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### Abstract

Identification of left ventricular mural thrombus (LVT) may be challenging depending on the imaging modality used. We present a case of LVT which was incidentally identified on cine cardiac magnetic resonance imaging (CMR). A sixty-four years old female presented with worsening dyspnea on exertion with troponin elevation. Transthoracic echocardiography (TTE) revealed a dilated left ventricle (LV) and ejection fraction (EF 30%) with thinning and akinesis of inferior/inferolateral wall was noted with basal and mid inferior wall aneurysm, and thrombus was not identified. CMR done to ascertain viability of myocardium revealed a mural thrombus within basal inferior aneurysm. This was not visualized on transthoracic echocardiography with and without use of contrast. She underwent coronary artery bypass grafting, bioprosthetic mitral valve replacement, resection and plication of posterior left ventricular aneurysm with removal of mural thrombus, and was started on anticoagulation with warfarin post-operatively for the apical thrombi. Cardiac magnetic resonance is a well suited imaging modality in detecting LVT due to its high resolution images and is more reproducible than TTE. In our patient, conventional TTE despite administration of echo-contrast agents failed to diagnose the presence of LVT in the basal inferior aneurysm as well as the apical thrombi. Delayed-enhancement CMR provides the greatest sensitivity for detection of left ventricular thrombus, superior

to standard transthoracic and contrast-enhanced transthoracic echocardiography.

**Key words:** Left ventricular thrombus; Cardiovascular magnetic resonance; Transthoracic echocardiogram

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**Core tip:** Delayed-enhancement cardiac magnetic resonance imaging provides the greatest sensitivity for detection of left ventricular thrombus, superior to standard transthoracic and contrast-enhanced transthoracic echocardiography.

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## INTRODUCTION

Left ventricular mural thrombus (LVT) complicating myocardial infarction has significant morbidity and potential mortality. Studies have demonstrated high incidence of LVT following anterior myocardial infarction<sup>[1]</sup>. LVT carries both short term and long term risk of embolic events which may result in stroke and systemic complications<sup>[2,3]</sup>. Early identification and prompt treatment is crucial in management of these patients. Multiple imaging modalities may be used to diagnose LVT including transthoracic echocardiography (TTE), transesophageal echocardiography (TEE), and cardiac magnetic resonance imaging (CMR)<sup>[4]</sup>. We present a patient with worsening dyspnea on exertion and heart failure with reduced ejection fraction (HFrEF) who was later found to have a laminated LV mural thrombus which was not identified on TTE despite ultrasound contrast agent administration for LV opacification.

## CASE REPORT

A sixty-four years old female with a past medical as well as family history of type II diabetes and hypertension presented to an outside facility with worsening dyspnea on exertion that had rapidly progressed from her baseline along with troponin elevation. Her electrocardiogram (EKG) did not show evidence for ST elevation. A transthoracic echocardiogram (TTE) was performed which revealed EF 20%-25%, severe inferior hypokinesis, mild apical hypokinesis. She underwent cardiac catheterization for presumed ischemic cardiomyopathy due to reduced EF and troponin elevation, which revealed chronic occlusion of the right coronary artery, subtotal occlusion of the proximal LAD, a severe

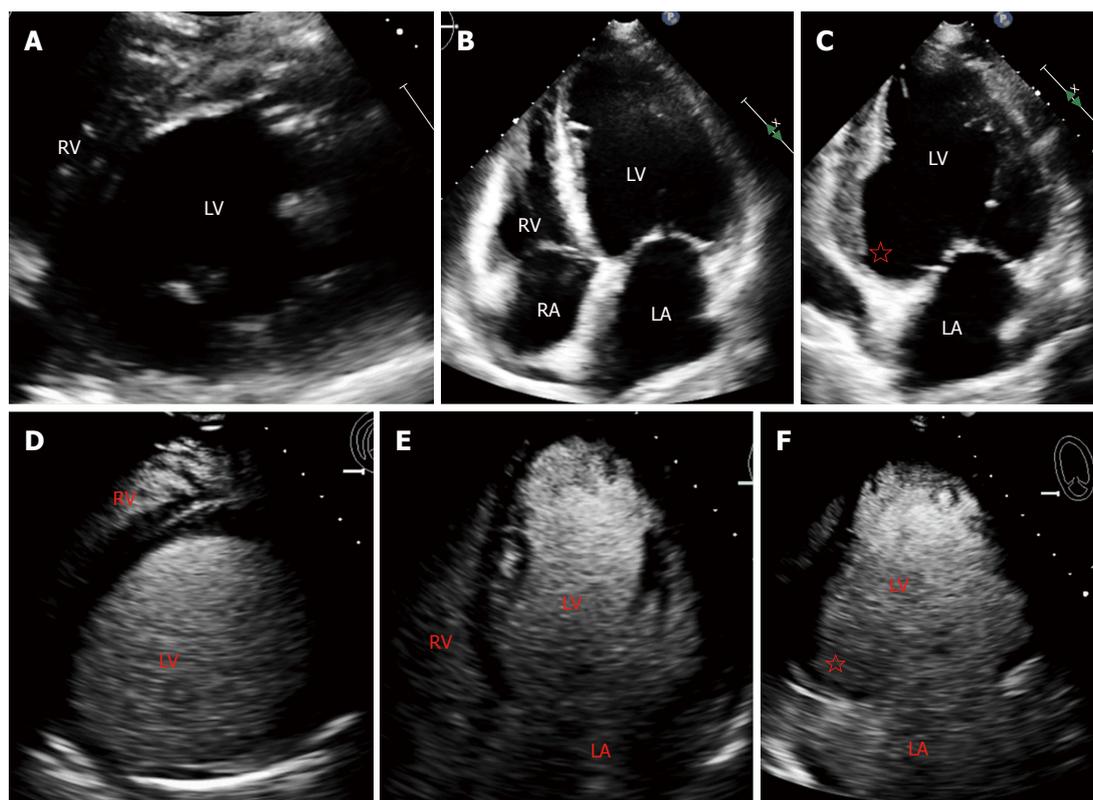
stenosis in the first circumflex marginal and an occluded second marginal. She was transferred to our facility for coronary artery bypass grafting. TTE on presentation to our facility revealed a severely dilated left ventricle (LV) with eccentric hypertrophy and reduced ejection fraction (EF) of 30%. Thinning and akinesis of the inferior/inferolateral wall was noted with basal and mid inferior wall aneurysm which was likely supplied by an occluded right coronary artery. There was severe functional secondary mitral regurgitation arising from annular dilatation. No thrombus was identified despite administration of ultrasound contrast agent (Figure 1).

CMR was also done within 24 h of the TTE to ascertain viability of myocardium to determine candidacy for surgical revascularization. CMR revealed a severely dilated LV chamber size with large basal inferior wall aneurysm. Post Gadolinium Inversion recovery sequences with high inversion time of 600 ms revealed 3 cm x 1.3 cm mass within basal inferior aneurysm with homogenous black appearance confirming presence of mural thrombus. There were also 2 apical thrombi visualized with largest measuring 1 cm x 1 cm (Figure 2). Aneurysmal basal inferior wall was non-viable however myocardium supplied by left anterior descending (LAD) and left circumflex territory (LCX) was noted to be viable. She underwent coronary artery bypass grafting with a saphenous vein graft (SVG) to LAD and a SVG to the first obtuse marginal branch of LCX as well as bioprosthetic mitral valve replacement (MVR). She also underwent resection and plication of posterior left ventricular aneurysm with removal of mural thrombus. She was started on anticoagulation with warfarin post-operatively for the apical thrombi.

## DISCUSSION

While transthoracic echocardiography is a valuable diagnostic test in assessing cardiac structure and function and remains a mainstay as initial diagnostic imaging for potential cardiac source of embolism<sup>[5]</sup>, its utility in the detection and diagnosis of LVT is variable. Previous consensus documents have recommended TTE as an initial screening tool for LVT<sup>[6,7]</sup> and early studies have evaluated its sensitivity and specificity in detection of LVT<sup>[8-10]</sup>. Factors such as indication for TTE and use of echo contrast influence its sensitivity for detection of LVT as reported by Weinsaft *et al.*<sup>[11]</sup> If the clinical indication was specifically to evaluate for LVT, the sensitivity increased from 26% to 60%, with an overall sensitivity and specificity of 33% and 91%, respectively. CMR is currently a widely available imaging modality gaining popularity for detection of cardiac thrombus. Investigators have found CMR to have a higher sensitivity and specificity of 58% and 99%, respectively for detection of LV thrombus in comparison with TTE. Additionally, they found that both cine-CMR and TTE were less likely to detect small protuberant thrombus as well as mural thrombus.

Cardiac magnetic resonance is a well suited imaging



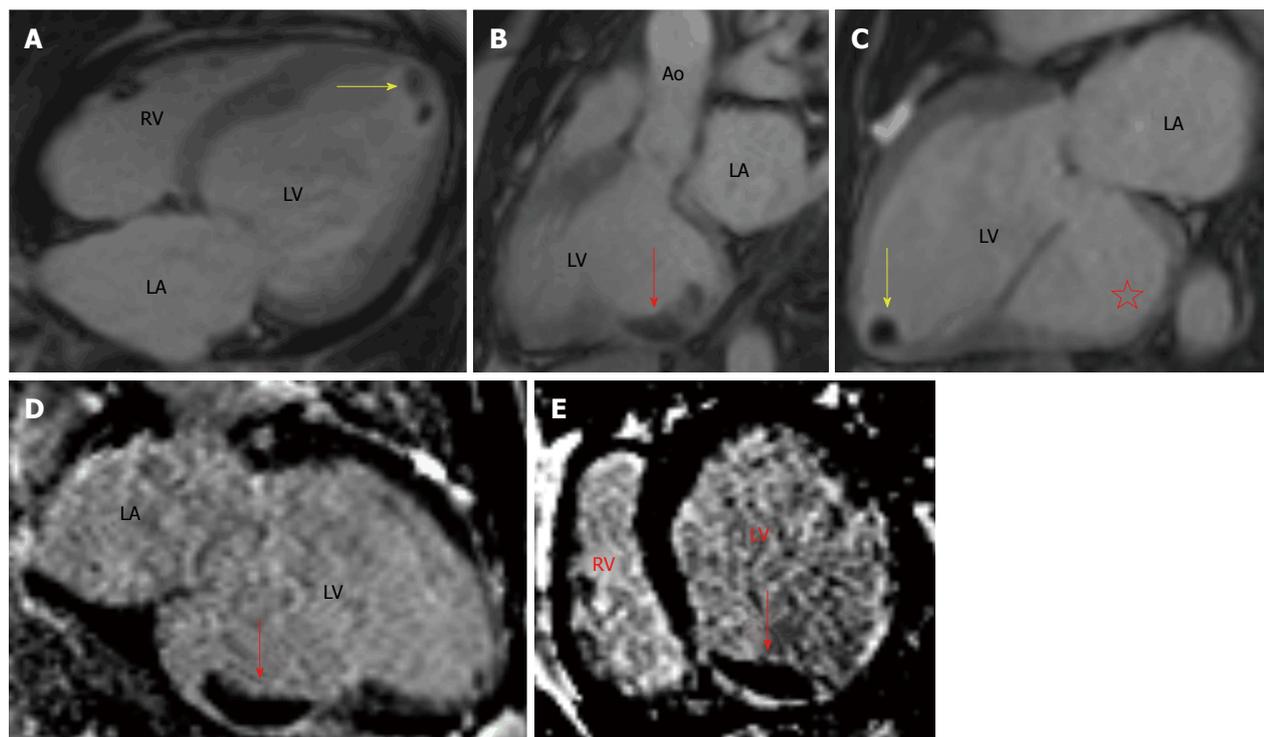
**Figure 1** Transthoracic echocardiogram without and with definity contrast demonstrated absence of thrombus. A: Parasternal short axis of transthoracic echocardiogram; B: Apical 4-chamber of transthoracic echocardiogram; C: Apical 2-chamber of transthoracic echocardiogram; D: Parasternal short axis transthoracic echocardiogram with definity contrast; E: Apical 4-chamber transthoracic echocardiogram with definity contrast; F: Apical 2-chamber transthoracic echocardiogram with definity contrast. There is an inferior wall aneurysm (red star). LA: Left atrium; LV: Left ventricle; RV: Right ventricle; RA: Right atrium.

modality in detecting LVT due to its high resolution images and is more reproducible than TTE<sup>[12]</sup>. While it is the preferred method for definitive detection of LVT, differences in sensitivity exist between cine and delayed enhancement CMR (DE-CMR). DE-CMR is a technique which utilizes Inversion Recovery (IR) sequences which is typically used to identify infarcted myocardium from viable myocardium to aid in determination of candidacy for surgical revascularization in patients with severely reduced left ventricular function. Conventional DE-CMR utilizes an inversion time (also known as TI) of about 200-300 ms which makes viable myocardium appear black (null) while infarcted myocardium appears bright whereas mural thrombus appears variable, gray with an “etched” appearance. DE-CMR can be tailored to detect thrombus by adjusting the inversion time to longer intervals, *i.e.*, long TI fixed at about 600 ms aids in nulling avascular tissue such as mural thrombus and renders a homogeneously black appearance which is characteristic and diagnostic of thrombus. Weinsaft and colleagues compared sensitivities of cine-CMR vs DE-CMR amongst a sample and found that DE-CMR identified LVT in a higher number of patients compared to cine-CMR (7% vs 4.7%) which was confirmed by pathology<sup>[13]</sup>. The limitation of cine-CMR was especially evident with mural thrombi and it was concluded by the authors that DE-CMR is a more clinically useful tool for detection of LVT. Additionally, DE-CMR with long TI has

also been demonstrated to be effective in differentiating thrombus from neoplasm<sup>[14]</sup>.

Our case highlights the limitations of transthoracic echocardiography in detecting laminated mural thrombi. In these instances, DE-CMR is invaluable in establishing a diagnosis. The indication for TTE in this case was not detection of LVT, and hence the literature would suggest that the sensitivity for detection in this case would be low (26%). Additional groups such as Srichai *et al*<sup>[4]</sup> demonstrated a 100% sensitivity of DE-CMR in detecting LV thrombi in patients with recent systemic embolism whereas TTE detected 33% and TEE detected 50% of confirmed thrombus. Diagnosis requires a high index of suspicion with careful attention to patient risk factors and predisposing anatomy on echocardiography.

In our patient, conventional TTE despite administration of echo-contrast agents failed to diagnose the presence of LVT in the basal inferior aneurysm as well as the apical thrombi. Lack of echo-contrast uptake by a laminated thrombus in an aneurysmal basal inferior wall camouflaged as the myocardium itself and hence likely concealed the thrombus. Two small apical thrombi which were well visualized in DE-CMR were also not detected in contrast-enhanced TTE which points to the decreased sensitivity of the modality to exclude LVT. Cine-CMR in our patient revealed thinned, dyskinetic basal inferior wall aneurysm and DE-CMR confirmed the presence of thrombi. CMR proved to be a comprehensive diagnostic



**Figure 2** Delayed enhancement cardiac magnetic resonance imaging illustrates a large mural thrombus measuring 3.0 cm x 1.3 cm (red arrow) adherence to the basal inferior wall aneurysm (red star) as well as two apical thrombi (yellow arrow). A: 4-chamber of delayed enhancement cardiac magnetic resonance imaging (CMR) with long TI; B and C: 3-chamber of delayed enhancement CMR with long TI; D: 2-chamber of delayed enhancement CMR with standard TI; E: Short axis of delayed enhancement CMR with standard TI. LA: Left atrium; LV: Left ventricle; RV: Right ventricle; CMR: Cardiac magnetic resonance imaging.

tool in identifying myocardial viability/candidacy for surgical revascularization, confirming severity of mitral regurgitation, and detecting ventricular aneurysm and mural thrombi. Preoperative diagnosis of LVT and aneurysm was vital in the management of our patient not only to initiate anticoagulation therapy but also aided in surgical planning. Our patient successfully underwent CABG, MVR, removal of mural thrombus, and resection and plication of ventricular aneurysm.

In conclusion, Delayed-enhancement CMR provides the greatest sensitivity for detection of left ventricular thrombus, superior to standard transthoracic and contrast-enhanced transthoracic echocardiography.

## ARTICLE HIGHLIGHTS

### Case characteristics

A 64-year-old female with type II diabetes and hypertension presented with worsening dyspnea on exertion that had rapidly progressed from her baseline with orthopnea and paroxysmal nocturnal dyspnea.

### Clinical diagnosis

Pulmonary rales, jugular venous distension, and a loud holosystolic murmur radiating to axilla.

### Differential diagnosis

New-onset heart failure due to mitral regurgitation vs cardiomyopathy.

### Laboratory diagnosis

Elevated troponin and brain natriuretic peptide.

### Imaging diagnosis

Transthoracic echocardiogram with ultrasound enhancing agent showed severe functional secondary mitral regurgitation and reduced left ventricle ejection fraction of 30% with inferior wall aneurysm, while delayed enhancement cardiac magnetic resonance imaging (CMR) illustrated a large mural thrombus measuring 3.0 cm x 1.3 cm adherence to the basal inferior wall aneurysm as well as two apical thrombi.

### Treatment

Coronary artery bypass grafting, mitral valve replacement, removal of mural thrombus, and resection and plication of ventricular aneurysm.

### Related reports

Cardiac magnetic resonance is a well suited imaging modality in detecting left ventricular thrombus due to its high resolution images and is more reproducible than transthoracic echocardiogram.

### Experiences and lessons

Delayed-enhancement CMR provides the greatest sensitivity for detection of left ventricular thrombus, superior to standard transthoracic and contrast-enhanced transthoracic echocardiography.

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