Echocardiographic detection of free-floating thrombus in left ventricle during coronary artery bypass grafting

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ABSTRACT

We report an incident of detection of a free-floating thrombus in the left ventricle (LV) using intraoperative two-dimensional (2D) and three-dimensional (3D) transesophageal echocardiography (TEE) during proximal coronary artery bypass graft anastomosis. A 58-year-old man presented to us with a 6-month history of chest pain without any history suggestive of myocardial infarction or transient ischemic attacks. His preoperative echocardiography revealed the systolic dysfunction of LV, mild hypokinesia of basal and mid-anterior wall, and the absence of an aneurysm. He was scheduled for on-pump coronary artery bypass surgery. On intraoperative TEE before establishing cardiopulmonary bypass (CPB), a small immobile mass was found attached to LV apical area. After completion of distal coronary artery grafting, when the aortic cross-clamp was removed, the heart was filled partially and beating spontaneously. TEE examination using 2D mode revealed a free-floating mass in the LV, which was suspected to be a thrombus. Additional navigation using biplane and 3D modes confirmed the presence of the thrombus and distinguished it from papillary muscles and artifact. The surgeon opened the left atrium after re-establishing electromechanical quiescence and removed a thrombus measuring 1.5 cm × 1 cm from the LV. The LV mass in the apical region was no longer seen after discontinuation of CPB. Accurate TEE-detection and timely removal of the thrombus averted disastrous embolic complications. Intraoperative 2D and recent biplane and 3D echocardiography modes are useful monitoring tools during the conduct of CPB.

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INTRODUCTION

Left ventricular thrombus (LVT) is a well-recognized complication of acute myocardial infarction (AMI) and congestive heart failure (CHF) due to severely impaired LV systolic function. The utility of intraoperative transesophageal echocardiography (TEE) and real-time three-dimensional TEE (RT-3D TEE) is well established in patients operated for coronary artery bypass grafting (CABG). [1,2] We report an incident of TEE-detection of a free-floating thrombus in the left ventricle (LV) during proximal coronary artery graft anastomosis. Timely removal of the thrombus averted disastrous embolic complications.

CLINICAL PRESENTATION

A 58-year-old man presented with a history of

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chest pain 6 months ago, which was treated with primary balloon angioplasty of circumflex artery. There was no history suggestive of myocardial infarction (MI) and transient ischemic attacks. Preoperative examination revealed a normal sinus rhythm with a heart rate of 70/min and blood pressure of 124/86 mmHg. The features of transthoracic echocardiography (TTE) were LV ejection fraction of 38%, hypokinesia of basal and mid-anterior wall, and mild mitral regurgitation. No thrombus was visualized on preoperative TTE. After withholding clopidogrel a week before surgery and omission of aspirin 5 days before the surgery, medication consisted of a daily oral dose of metoprolol 50 mg. The patient was scheduled to undergo elective CABG for the triple-vessel disease. On the day of surgery, after standard anesthetic induction a 3D TEE probe was inserted for cardiac examination (I/E 33, Philips Medical Systems, Bothell, WA, USA), which confirmed the findings on preoperative TTE. The LV apex was mildly hypokinetic, and there was no evidence of any LV an aneurysm. A small mass was seen attached to the apical region in 4-chamber view, which had echogenicity similar to the myocardium [Figure 1a and Video 1]. However, as it was not freely mobile, we decided not to remove it through left ventriculotomy. After the injection of intravenous heparin 300 units/kg and achieving activated clotting time of 564 s, cardiopulmonary bypass (CPB) was established. The aorta was cross-clamped, and antegrade cold blood cardioplegia was delivered into the aortic root. The first diagonal artery, the first obtuse marginal artery and the posterior descending artery received reversed saphenous venous grafts while the left anterior descending artery was anastomosed with the left internal mammary artery. Proximal venous anastomosis was commenced after applying side biting clamp on ascending aorta. At that time, TEE examination in a partially-filled and beating heart revealed a free-floating mass in the LV. When inspected in biplane mode with 4-chamber as the reference image and 2-chamber as the orthogonal image, it was seen simultaneously and continuously changing its location within the LV cavity in both views [Figure 2 and Video 2]. The mass was observed on RT-3D TEE imaging through virtually left ventriculotomy in the frontal plane and short-axis plane. It could be easily distinguished from both papillary muscles by making fine adjustments in gain and compression [Figure 3 and Video 3]. Considering that the LV mass was a free-floating thrombus, surgeon re-applied the aortic cross-clamp immediately and administered cardioplegia. After opening the left atrium, a long forceps was introduced across the mitral valve, and an LV thrombus measuring 1.5 cm × 1 cm was removed [Figure 4]. Saline lavage was given to the LV cavity, and aorta was de-clamped after adequate de-airing. After completion of proximal graft anastomoses, the patient was weaned from CPB with an inotropic infusion of epinephrine 0.05 mcg × μg* kg^{-1}* min^{-1}. The LV mass in the apical region was no longer

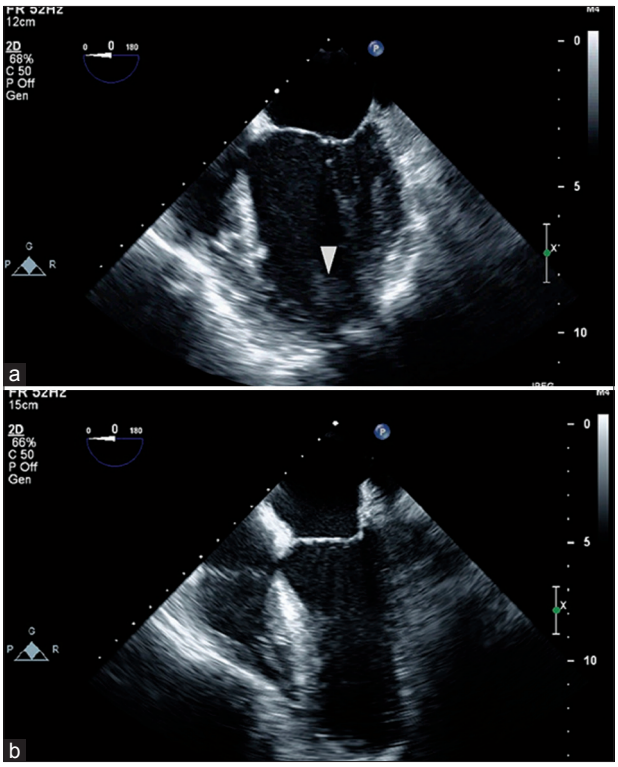

Figure 1: (a) A small mass (white arrow head) is seen attached to an apical region of the left ventricle in 4-chamber view, which has echogenicity similar to the myocardium. (b) The left ventricle mass in the apical region is not seen after weaning the patient from cardiopulmonary bypass

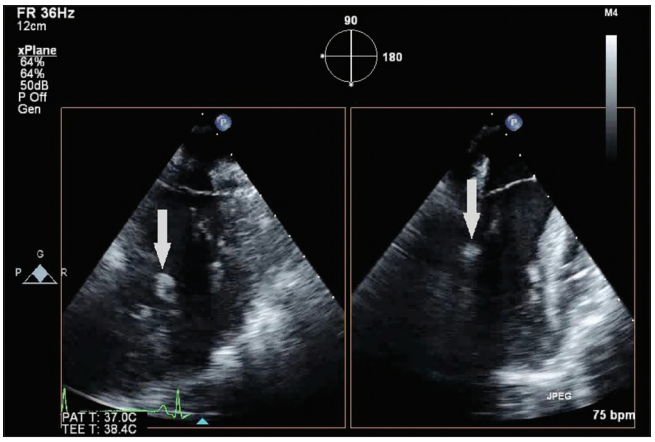

Figure 2: The left ventricle mass (white arrow) when inspected in biplane mode with 4-chamber as the reference image and 2-chamber as the orthogonal image, is seen simultaneously and continuously changing its location within the left ventricle cavity in both views

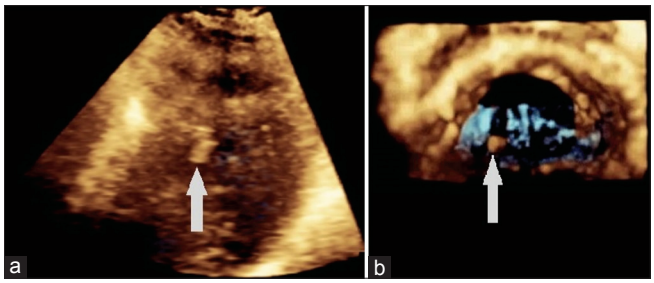

Figure 3: The left ventricle mass (white arrow) is observed on real-time three-dimensional transesophageal echocardiography imaging through virtual left ventriculotomy in frontal plane with high gain (a) and in virtual short-axis plane with low gain (b). It can be easily distinguished from both papillary muscles by making fine adjustments in gain and compression

seen [Figure 1b and Video 1]. The trachea was extubated after 15 h of elective ventilation. The postoperative recovery was uneventful without any neurological deficit.

DISCUSSION

A free-floating thrombus in a beating left-heart during the CPB is a potential source of systemic embolization[3] that warrants surgical extraction. However, reopening the heart for the surgical retrieval of a thrombus increases the morbidity by prolonging CPB and adding the risk of cardiotomy. The distal coronary anastomosis may get disrupted during cardiac handling for de-airing. Hence, correct identification of the thrombus was mandatory for further decision making in our patient. A suspected free-floating LV thrombus during partial CPB must be distinguished from other LV masses like prominent or ruptured papillary muscles, pedunculated tumors such as papillary fibroelastoma and myxoma, tumor fragments, artifacts due to CPB cannulation and foreign bodies like surgical gauze pieces. The free-floating thrombus in our patient was seen in different locations and at different phases of the cardiac cycle. The papillary muscles have echogenicity similar to that of the myocardium. Anatomically present in the middle and upper third of the LV cavity, the prominent papillary muscles do not be change their location during the different phases of the cardiac cycle and increase in thickness along with myocardium during systole. A ruptured papillary muscle may appear as a free-floating mass on echocardiography. However, symptomatology and catastrophic presentation due to acute mitral regurgitation and LV failure will not remain unnoticed in the preoperative period. Isolated pedunculated LV tumors such as papillary fibroblastoma and myxomas are rare. Those which are prone for dislodgment will be associated with embolic

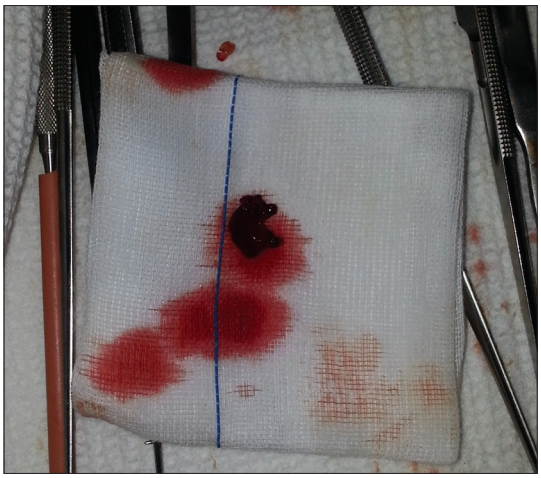

Figure 4: A left ventricle thrombus measuring 1.5 cm × 1 cm is seen after removal from left ventricle

episodes and will be seen as highly mobile masses in the preoperative period. Surgical materials such as gauze pieces, pledgets, and suture pieces may be retained in the ventricle during surgery and seen on echocardiography. However, since the cardiac chambers were not opened before detection of LV mass in our patient that possibility was ruled out. An echodense object within left atrium may generate mirror-image artifacts in the LV.[4] A left atrial vent inserted during CPB could have been seen as an artifact in the LV, especially when the heart was filled partially. However, it was evident on biplane examination that the LV mass was not a falsely perceived object as it could be seen moving simultaneously in the orthogonal images.

The identification of LV thrombi in the pre-CPB period may alter the management. A free-floating LV thrombus usually is associated with the presence of thrombi in the LV cavity. After anterior wall MI, thrombi are often formed in the poorly functioning LV within akinetic or aneurysmal ventricular segments of the apex and anterior wall.[5] They are variable in shape, size, adherence, mobility, and echogenicity. For echocardiographic identification of a thrombus, a clear thrombus-blood interface, and a distinct border from endocardium should be visualized in at least 2 planes adjacent to the akinetic or dyskinetic myocardium.[3,6,7] If the echogenicity of a thrombus is different from that of the underlying myocardium, it can be detected easily by echocardiography. However, many thrombi have the echogenicity similar to that of the myocardium and are difficult to visualize. Higher gain settings are necessary for better delineation of hypoechogenic thrombi. The LV false tendons, especially in the apical region, may appear like thrombi. Loukas *et al*.[8] classified the LV

false tendons into five types depending upon their location as follows: Type I between the posteromedial papillary muscle and the ventricular septum; Type II between the papillary muscles; Type III between the anterolateral papillary muscle and the ventricular septum; Type IV between the ventricular septum and the free wall; and Type V as web-like structures with three or more points of insertion. The LV false tendons have the same echocardiographic appearance as that of the myocardium to which they were attached and typically shorten during the LV contraction.[9] They traverse within the LV cavity which surrounds them as an echolucent space. Unlike the papillary muscles, they are free from any attachment of the chordae tendinae extending to the mitral valve leaflets. Trabeculi is endocardial projections beneath the papillary muscles extending toward the apex, which are more than 1.5 mm in size and have sinusoidal spaces within. They are associated with LV noncompaction. LV tumor like papillary fibroelastoma is characterized as a pedunculated mass with surface hair-like figures and internally as a low echo density lesion, attached to the endocardial surface by a small stalk.[10] However, it is not possible to diagnose papillary fibroelastoma prior to surgery by echocardiogram alone in all cases.

Echocardiography has the potential to miss the ventricular thrombi due to incomplete endocardial resolution. Srichai *et al*.,[11] found that TTE and TEE could identify only 27% and 39% of confirmed LV thrombi, respectively. Although, we noticed a small LV mass near the apex before establishing CPB, we were not certain whether it was a thrombus or not, as it could be seen only in one view and had echogenicity similar to the myocardium. There was no preceding history of MI or embolic events. Surgical thrombectomy involves LV incision, which may result in LV dysfunction, propensity for arrhythmias, and delayed aneurysm formation.[6] The surgical extraction is reserved for patients at high risk for embolization due to prior embolic events, mobile, and protrusive thrombi or failed anticoagulation therapy. Hence, we decided not to remove it through ventriculotomy. The American Society of Echocardiography Guidelines for performing a comprehensive TEE examination recommends the use of biplane mode for simultaneously visualizing the heart in 2 orthogonal planes in the same cardiac cycle.[12] We could confirm the presence of the free-floating thrombus in 4-chamber view and 2-chamber view simultaneously and ruled out the possibility of any artifact. 3D echocardiography has been shown to be potentially superior to two-dimensional techniques for assessing intracardiac masses as it acquires a pyramidal volume of information that can be visualized from different angles. The LV could be cropped in different planes including frontal and short axis planes so that thrombus could be easily identified and distinguished from papillary muscles. Another advantage of RT-3D TEE is that postprocessing gain and compression can be adjusted to optimally visualize the thrombus.

CONCLUSION

In summary, LV thrombi may get dislodged due to cardiac manipulations during CABG, which needs urgent retrieval because of the impending risk of systemic embolization. Intraoperative TEE is valuable in detecting a free-floating LV thrombus and in distinguishing it from other similar-appearing lesions such as ruptured papillary muscles and surgical material. Biplane mode and RT-3D TEE are useful additional modalities to enhance the diagnostic accuracy of an intracardiac mass.

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Conflicts of interest
There are no conflicts of interest.

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