Massive Left Ventricular Thrombus After ST-Segment Elevation Myocardial Infarction in a Young Man With Factor V Leiden

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INTRODUCTION

An increasing number of patients with acute coronary syndromes (ACSs) are young adults. A common complication following ACS is the development of left ventricular (LV) thrombus in the setting of Virchow's triad. In this report, we present the case of a young patient with multiple risk factors for thrombosis found to have a massive LV thrombus following an acute anterior ST-segment elevation myocardial infarction (STEMI). We discuss the risk factors of ACS in young adults, diagnosis of LV thrombus through multimodality imaging, and management of LV thrombus.

CASE PRESENTATION

A 36-year-old man presented to the hospital after cardiac arrest in the community. Their medical history was significant for schizophrenia on olanzapine, tobacco use, heterozygous factor V Leiden (FVL), and recent unprovoked saddle pulmonary embolism. The patient had not been taking their prescribed apixaban for months. When the paramedics arrived, the patient was in cardiac arrest with ventricular fibrillation. The patient underwent defibrillation twice and three rounds of chest compressions before return of spontaneous circulation. On arrival to the hospital, vital signs showed a heart rate of 101 beats/min, blood pressure of 83/64 mm Hg, and oxygen saturation of 100% while on mechanical ventilation. Physical examination was unremarkable, with the exception of faint heart sounds on auscultation. Electrocardiography was notable for ST-segment elevations in the precordial leads (Figure 1). Troponin on arrival was 0.10 ng/mL and peaked 5 hours after presentation at 1.42 ng/mL. The results of serum electrolyte assessment, coagulation panel, glycated hemoglobin measurement, and urine drug screening were unremarkable. The lipid panel revealed total cholesterol of 128 mg/dL, triglyceride of 82 mg/dL, low-density lipoprotein of 84 mg/dL, and high-density lipoprotein of 28 mg/dL. The patient was started on targeted temperature management for post–cardiac arrest care and admitted to the cardiac care unit.

The patient was quickly taken for coronary angiography on the day of presentation, which revealed single-vessel coronary artery disease (CAD) with 99% subacute thrombotic occlusion of the mid left anterior descending coronary artery (Figure 2A, Video 1). A drug-eluting stent was deployed in the mid left anterior descending coronary artery (Figure 2B, Video 2), and dual-antiplatelet therapy (DAPT) with aspirin 81 mg/d and ticagrelor 90 mg twice per day was initiated along with heparin.

Transthoracic echocardiograph (TTE) with the administration of an ultrasound enhancing agent was completed on hospital day 2 as part of routine post-STEMI care. This revealed a severely dilated left ventricle with severe global hypokinesis and an estimated ejection fraction of 24%. There was dyskinesis of the apical segments and mid anteroseptum, akinesis of the mid anterior and inferoseptal walls, and hypokinesis of the mid inferior and inferolateral walls, with relatively preserved motion of the basal segments. A large apical LV thrombus measuring 2.8 × 4.2 cm was discovered (Figure 3, Videos 3 and 4).

The patient's hospital course was further complicated by shock and continued dependence on vasopressors. Given the patient's poor hemodynamics and a tender abdomen, computed tomography (CT) of the chest and abdomen was performed on hospital day 5 to evaluate for pulmonary embolism and abdominal pathology. The imaging was significant for a 2-cm-thick mural thrombus along the contour of the cardiac apex (Figure 4A), consistent with the previous echocardiogram. In addition, there was a small thrombus adjacent to the inferior vena cava catheter (Figure 4B) and a small pulmonary embolism in the right middle lobe subsegmental artery (Figure 4C).

The patient was continued on heparin infusion for the LV thrombus, subsegmental pulmonary embolism, and inferior vena cava thrombus. In addition, the patient was found to have *Escherichia coli* bacteremia and completed a 2-week course of ceftriaxone.

After discharge from the hospital, this patient was subsequently continued on a lifelong course of rivaroxaban for their history of mixed arterial and venous thrombi and FVL. DAPT was continued for 1 month, and only ticagrelor was continued for antiplatelet therapy thereafter. At 3-month follow-up, repeat TTE showed a reduction in size of the LV thrombus to 2.9 × 0.7 cm (Figure 5A, Video 5). At 8-month follow-up, repeat TTE demonstrated complete resolution of the LV thrombus (Figure 5B, Video 6).

DISCUSSION

An increasing proportion of ACSs occur among young adults (<55 years of age).[1] These patients have similar risk factors as older adults, including male sex, high risk ethnicities, family history, cigarette use, obesity, hypercoagulable states, dyslipidemia, hypertension, and

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VIDEO HIGHLIGHTS

Video 1: Coronary angiography, left anterior oblique cranial view, demonstrates single-vessel CAD with 99% subacute thrombotic occlusion of the mid left anterior descending coronary artery.

Video 2: Coronary angiography, left anterior oblique cranial view, demonstrates revascularization of the mid left anterior descending coronary artery after deployment of a drug-eluting stent.

Video 3: Two-dimensional TTE after the administration of an ultrasound enhancing agent demonstrates the large apical LV thrombus in the following views: parasternal long axis, apical four chamber, apical three chamber, and apical two chamber.

Video 4: Two-dimensional TTE without ultrasound enhancing agent demonstrates the large apical LV thrombus and severely reduced LV ejection fraction of 24% in the following views: apical four chamber, apical three chamber, and apical two chamber.

Video 5: Two-dimensional TTE, apical four-chamber view without ultrasound enhancing agent at 3-month follow up. The LV thrombus is reduced in size to 2.9 × 0.7 cm.

Video 6: Two-dimensional TTE, apical four-chamber and two-chamber views after the administration of an ultrasound enhancing agent at 8-month follow-up. The LV thrombus is no longer present.

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diabetes. It is often a combination of many risk factors that contribute to the development of premature CAD.[2] Male sex, active cigarette use, FVL, and olanzapine use were identified as potential risk factors for ACS in this patient. FVL, the most commonly inherited thrombophilia characterized by less efficient inactivation of factor V by protein C, is a known risk factor for venous thrombosis. Although the association of FVL with arterial thrombosis is controversial, a large meta-analysis revealed a moderate association of FVL with CAD.[3] Olanzapine and other antipsychotics have been shown to be dose-dependent risk factors for myocardial infarction in patients with schizophrenia.[4] The underlying mechanism of the increased risk may be related to dopamine D_3 receptor blockade by antipsychotics. A randomized control trial identified olanzapine to have the highest increased CAD risk among the studied antipsychotics.[5]

LV thrombus most often occurs after large, anteroseptal myocardial infarction and arises adjacent to an akinetic or hypokinetic LV segment, commonly at the LV apex.[6] In this report, an occlusion of the mid left anterior descending coronary artery resulted in diffuse LV hypokinesis and the formation of a large apical LV thrombus. The patient's unusually massive LV thrombus is an excellent example of the underlying Virchow's triad of blood stasis, endothelial injury, and hypercoagulability that precedes thrombus formation. The patient had developed endothelial injury and decreased LV function following a STEMI, and he had a hypercoagulable state from heterozygous FVL. Notably, there are few studies examining the association between LV thrombus formation and inherited hypercoagulable states such as FVL. A small, prospective study of 183 patients showed that FVL did not confer a greater risk for LV thrombus.[7]

The incidence of LV thrombus has decreased over the past several decades with the advancement of early reperfusion therapy.[8] Despite the decreasing incidence, diagnosis of LV thrombus remains imperative because of the devastating complications of embolization. Cardiovascular magnetic resonance (CMR) is the optimum imaging study for the diagnosis of LV thrombus.[9] However, this imaging modality is limited by cost and widespread availability.

In contrast to CMR, TTE is the most common imaging modality used in diagnosing LV thrombus because of its low cost, widespread availability, and capacity to assess ventricular structure and function. TTE has high specificity for detecting LV thrombus (96%), but this modality has a significantly lower sensitivity (23%) in comparison with CMR (88%).[9] Although the massive LV thrombus was readily apparent on TTE in our patient, smaller LV thrombi could have

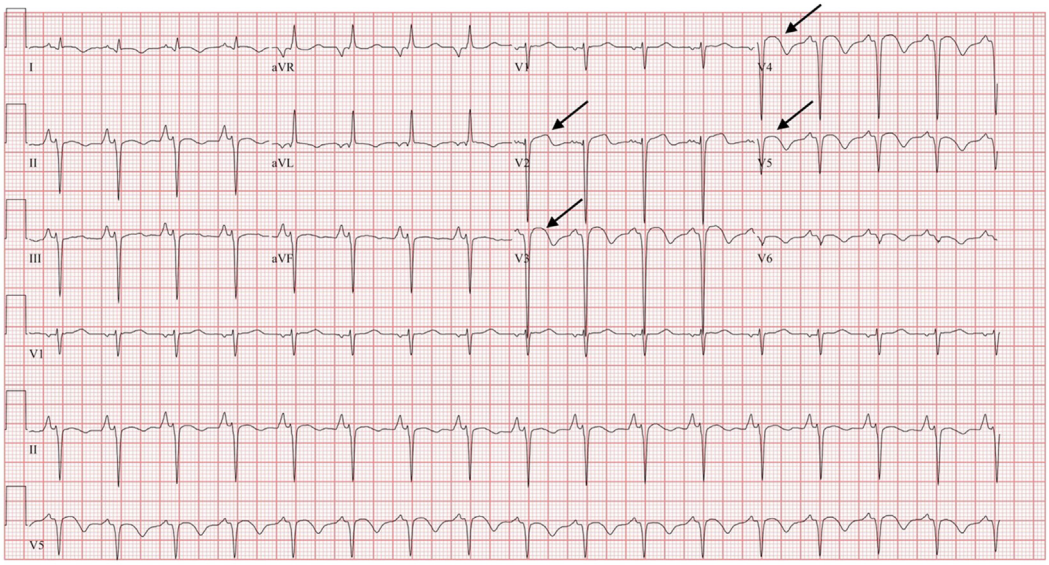

Figure 1 Electrocardiogram on admission showing ST-segment elevations in the precordial leads (*arrows*).

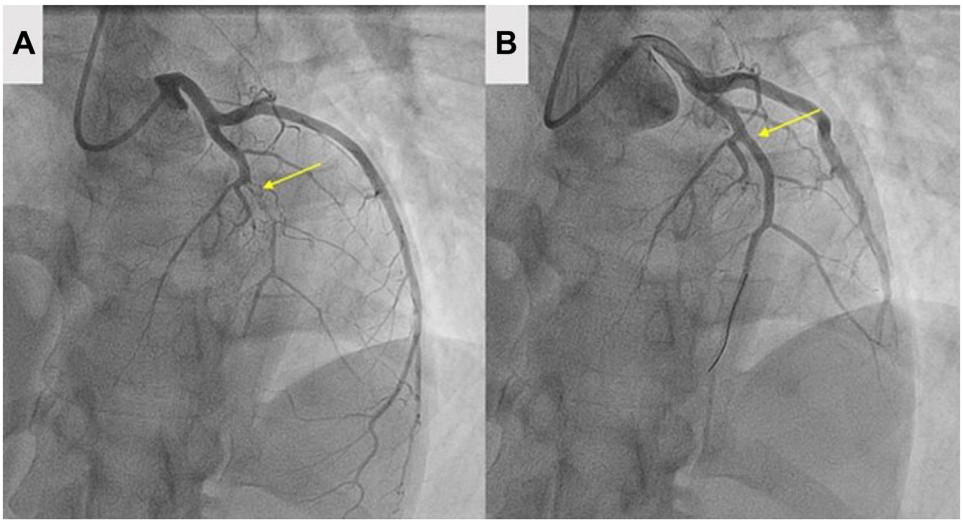

Figure 2 Coronary angiography, left anterior oblique cranial view. **(A)** Single-vessel CAD with 99% subacute thrombotic occlusion of the mid left anterior descending coronary artery (*arrow*). **(B)** Revascularization of the mid left anterior descending coronary artery after the deployment of a drug-eluting stent (*arrow*).

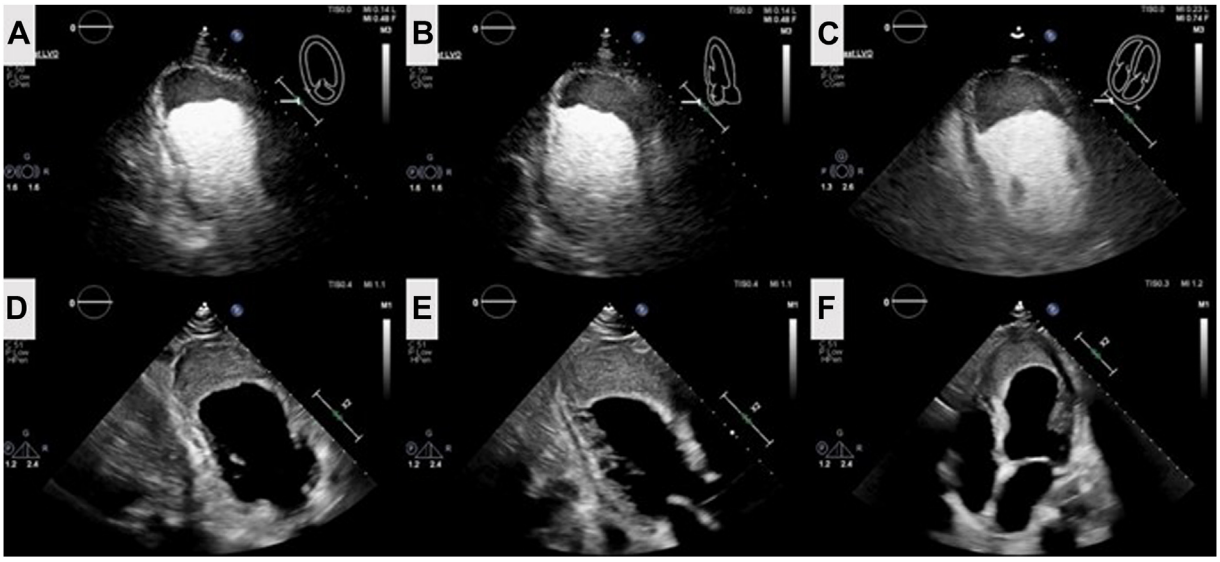

Figure 3 Two-dimensional TTE demonstrating a large apical LV thrombus. **(A)** Apical two-chamber view with ultrasound enhancing agent (UEA). **(B)** Apical three-chamber view with UEA. **(C)** Apical four-chamber view with UEA. **(D)** Apical two-chamber view without UEA. **(E)** Apical three-chamber view without UEA. **(F)** Apical four-chamber view without UEA.

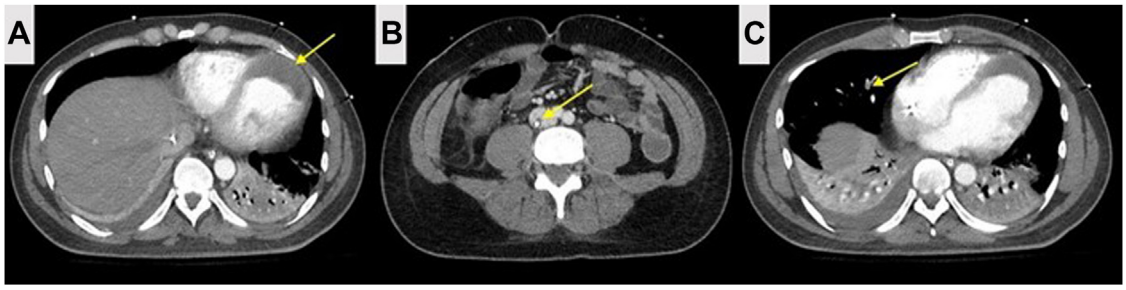

Figure 4 Computed tomographic angiography of the chest and abdomen. **(A)** A 2-cm-thick hypodense lesion along the contour of the cardiac apex. **(B)** Small thrombus seen adjacent to the inferior vena cava catheter. **(C)** Small pulmonary embolism seen in the right middle lobe subsegmental artery.

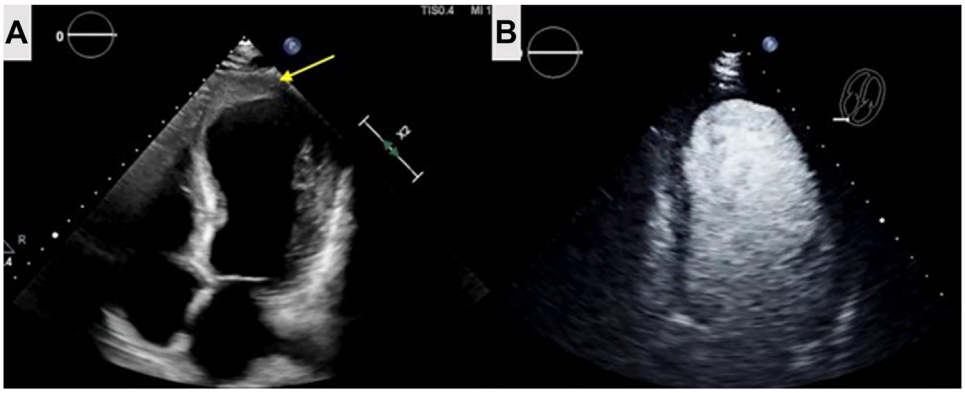

Figure 5 TTE. **(A)** Apical four-chamber view without ultrasound enhancing agent at 3-month follow-up. The LV thrombus is reduced in size to 2.9 × 0.7 cm (*arrow*). **(B)** Apical four-chamber view with ultrasound-enhancing agent at 8-month follow-up. The LV thrombus is no longer present.

been missed. The addition of an ultrasound enhancing agent to TTE improves the sensitivity for thrombus detection from 35% to 64%. An apical wall abnormality can be used to stratify which patients would benefit most from CMR.[6]

CT has also been shown to provide similar specificity and sensitivity as TTE in the identification of LV thrombus, which has a threshold value of 65 Hounsfield units.[10,11] In this report, the indication for our patient's CT was to assess for a pulmonary embolism but offers a correlation of the large LV thrombus (attenuation value of 40 Hounsfield units).

The treatment of LV thrombus after acute myocardial infarction remains challenging because of a lack of randomized clinical trials to guide anticoagulation therapy. While vitamin K antagonists (VKA) are presently the preferred anticoagulant for LV thrombus, observational studies comparing the efficacy of direct oral anticoagulants versus VKA have produced varying results.[12] A large, multicenter retrospective study found an increased association of stroke and systemic embolism with off-label direct oral anticoagulant use compared with VKAs.[13] On the other hand, the only randomized controlled trial comparing the use of rivaroxaban versus warfarin in the treatment of LV thrombus demonstrated the noninferiority of rivaroxaban and faster thrombus resolution in comparison with warfarin.[14]

Current guidelines report various recommendations for anticoagulation in the treatment of LV thrombus after recent myocardial infarction. The 2013 American College of Cardiology Foundation/American Heart Association STEMI guidelines recommend a duration of VKA therapy limited to 3 months when combined with DAPT with a target international normalized ratio of 2.0 to 2.5. The 2017 European Society of Cardiology STEMI guidelines recommend oral anticoagulation for up to 6 months, guided by repeated imaging. The American College of Chest Physicians guidelines recommend a VKA combined with DAPT for 3 to 6 months for patients with anterior myocardial infarctions and definite LV thrombus. On a case-by-case basis, direct oral anticoagulants can be considered if the patient cannot tolerate VKAs or for ease of use.[12]

CONCLUSION

ACS can occur in young patients with multiple risk factors, including hypercoagulable states such as FVL and the use of medications that interfere with the clotting cascade. A life-threatening complication of myocardial infarction is the formation of LV thrombus because of Virchow's triad, which can be diagnosed using several imaging modalities, including echocardiography and cardiac CT. Treatment of LV thrombus involves the use of anticoagulation, although a consensus regarding which anticoagulant to use has not yet been reached.

ETHICS STATEMENT

The authors declare that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

CONSENT STATEMENT

The authors declare that since this was a non-interventional, retrospective, observational study utilizing de-identified data, informed consent was not required from the patient under an IRB exemption status.

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DISCLOSURE STATEMENT

The authors report no conflict of interest.

SUPPLEMENTARY DATA

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