

Thrombus in Transit Entrapped Within a Patent Foramen Ovale: Role of Multimodality Imaging



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INTRODUCTION

Thrombus in transit (TIT) is defined as a thrombus attached to any structure within the right heart chambers. Thrombus in transit is an extremely rare finding during echocardiography and is considered a life-threatening condition. Thrombus in transit may embolize to the pulmonary arteries causing pulmonary embolism (PE), or, rarely, it may cross the right heart to the left side through intracardiac shunts, commonly the patent foramen ovale (PFO), resulting in systemic embolization.^{1,2} We present a case of bilateral PE and a large TIT entrapped in the PFO and treated with thrombolytic therapy without major consequences.

CASE PRESENTATION

A 38-year-old male patient was admitted with a 5-day history of chest pain, progressive dyspnea, and nonproductive cough. The patient denied any history of fever, lower limb swelling, night sweats, weight loss, or recent immobilization.

Physical examination revealed a temperature of 36.6 °C, heart rate of 122 beats/minute, blood pressure of 130/98 mm Hg, respiratory rate of 22 breaths/minute, and oxygen saturation of 96% (on 6 L of oxygen). Cardiovascular examination was remarkable for loud second heart sound with no murmurs or peripheral edema.

The patient was not on any regular medications, and there was no history of recent travel, surgeries, or family history of clotting disorders. The initial laboratory results showed a hemoglobin of 149 g/L (reference range, 135-170 g/L), white blood cell count of $10.3 \times 10^9/L$ (reference range, $3.50-10.0 \times 10^9/L$), platelet count of $518 \times 10^9/L$ (reference range, $150-400 \times 10^9/L$), fibrinogen of 3.4 g/L (reference range, 1.7-4.2 g/L), and troponin I of 54 ng/L (normal, <14 ng/L). Other laboratory results were within normal limits. Polymerase chain reaction for COVID-19 was negative.

Electrocardiogram showed sinus tachycardia (heart rate of 115 beats/minute) with right-axis deviation. The initial chest x-ray revealed mildly enlarged cardiac silhouette with elevation of the cardiac apex, suggesting right ventricular (RV) enlargement (Figure 1).

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Keywords: Transesophageal echocardiography, Thrombus in transit, PFO

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2468-6441

<https://doi.org/10.1016/j.case.2022.12.007>

VIDEO HIGHLIGHTS

Video 1: Two-dimensional TTE. The apical 4-chamber view demonstrates a mobile thrombus in the right atrium and attached to the atrial septum.

Video 2: Two-dimensional TTE. The parasternal long-axis view demonstrates dilated right ventricle and trivial pericardial effusion with a D-shape LV.

Video 3: Two-dimensional TTE. The apical 4-chamber view after agitated saline injection shows a dilated right heart with abnormal atrial and ventricular septal motion and a few bubbles in the left heart chambers, suggesting the presence of right-to-left shunt.

Video 4: Two-dimensional TEE. Zoomed bicaval (84°) view shows TIT entrapped within the PFO and protruding into the left atrium.

Video 5: Two-dimensional TEE. Zoomed bicaval (131°) view with color flow Doppler reveals flow within the PFO.

Video 6: Two-dimensional TEE. Upper esophageal window, rightward rotated, 28° view focused on the pulmonary artery demonstrates a large, mobile thrombus at the bifurcation into the right and left main branches.

Video 7: Echocardiography. Follow-up post-thrombolytic therapy. Zoomed two-dimensional TEE bicaval (92°) view confirms a complete thrombus resolution.

View the video content online at www.cvcasejournal.com.

Computed tomography angiography (CTA) of the thorax showed bilateral PE, dilated RV, and TIT in the right atrium attached to the atrial septum (Figure 2).

The transthoracic echocardiography (TTE) confirmed the CTA findings of TIT (Figure 3, Video 1) and demonstrated normal left ventricle (LV) size, mildly reduced LV systolic function (LV ejection fraction of 45%-50%), severely dilated RV (RV end-diastolic diameter of 6.4 cm), severely reduced RV systolic function (tricuspid annular plane systolic excursion of 1.3 cm), RV systolic pressure of 45-50 mm Hg, and severely dilated right atrium (right atrial volume index of 64.3 mL/m²; Videos 2 and 3). After injection of agitated saline, a few bubbles were noted in the left side after the first heartbeat, suggesting the presence of right-left shunt. Transesophageal echocardiography (TEE; Figure 4) illustrated the TIT (Video 4) attached to the fossa ovalis, the right-to-left shunt through the PFO (Video 5), and thrombus in the right pulmonary artery (Video 6). Bilateral lower limb ultrasound was remarkable for bilateral partially occlusive deep venous thrombosis at the level of deep and superficial femoral veins bifurcations and partially occlusive superficial thrombophlebitis of the left greater saphenous vein. A CTA of the abdomen and pelvis

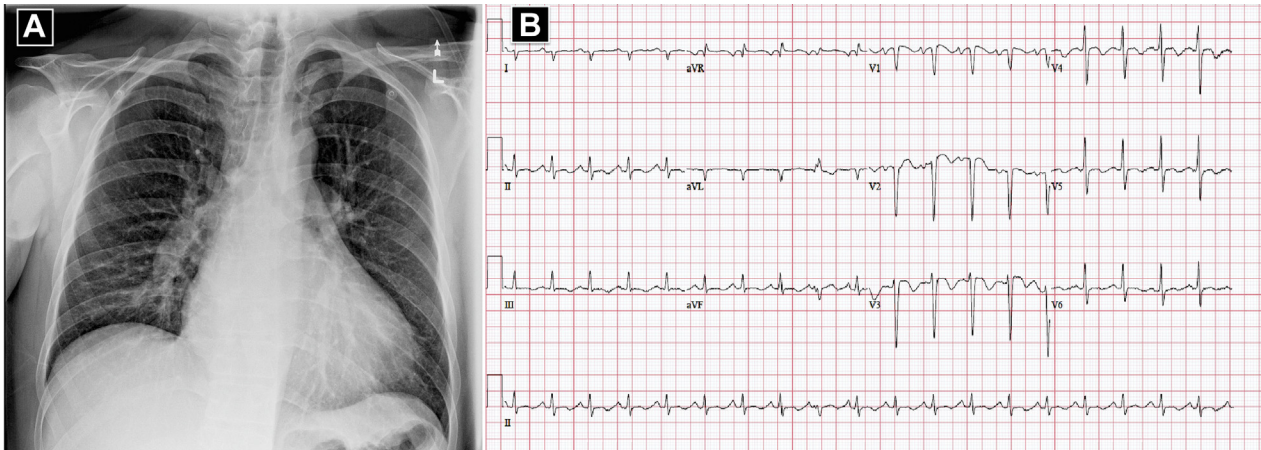


Figure 1 (A) Chest x-ray, posterior-anterior projection, demonstrates RV enlargement. (B) Twelve-lead electrocardiogram demonstrates sinus tachycardia, right-axis deviation, and diffuse nonspecific T-wave abnormalities.

was performed to rule out malignancy and was normal. Pulmonary embolism with TIT was on the differential diagnosis, supported by echocardiographic findings of PFO shunt and TIT entrapped within

PFO. Given the CTA findings, the patient was commenced on subcutaneous low molecular weight heparin (dalteparin) 20,000 units daily. The patient declined catheter-based removal of the thrombus; thus

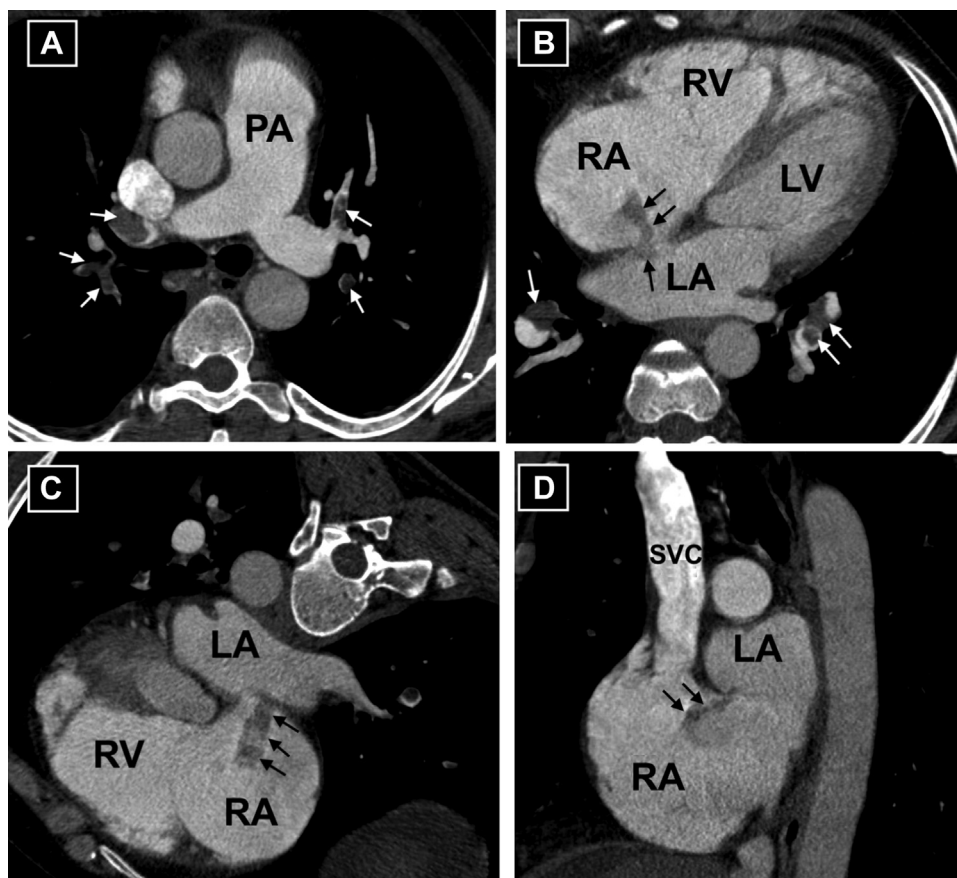


Figure 2 Computed tomography angiography of the chest, PE protocol. (A) Axial image at the level of main pulmonary artery shows multiple filling defects in the pulmonary artery (PA) branches (*white arrows*). (B) Axial image at the level of the RV demonstrates bilateral filling defects in the pulmonary artery branches (*white arrows*), TIT attached to the atrial septum (*black arrows*), and dilated right heart chambers. (C) Axial oblique and (D) sagittal oblique views reveal the TIT (*black arrows*). LA, Left atrium; RA, right atrium; SVC, superior vena cava.

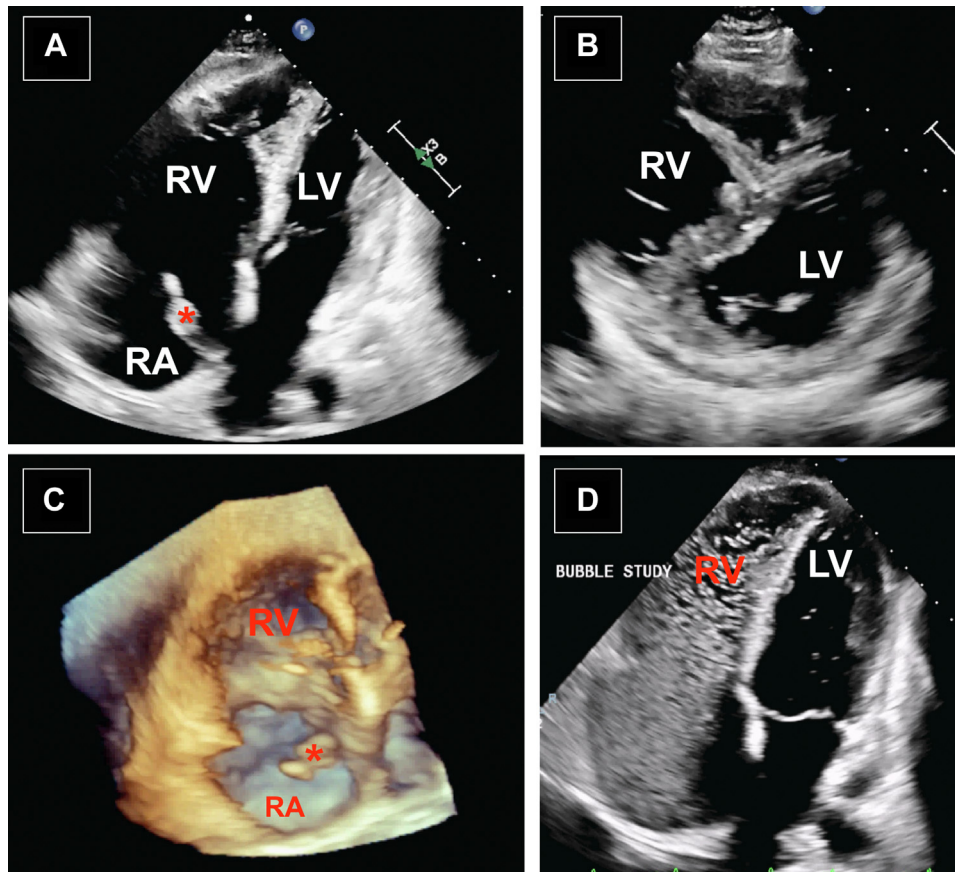


Figure 3 Transthoracic echocardiography. **(A)** Two-dimensional apical 4-chamber view, diastolic phase, demonstrates a dilated right heart with TIT (*) best seen in the right atrium (RA) attached to atrial septum. **(B)** Two-dimensional parasternal long-axis view, systolic phase, demonstrates ventricular septal flattening as a sign of increased RV pressure. **(C)** Three-dimensional apical 4-chamber view, diastolic phase, demonstrates a dilated right heart with TIT (*) best seen in the RA attached to the atrial septum. **(D)** Two-dimensional apical 4-chamber view, systolic phase after agitated saline bubble injection, demonstrates a few bubbles in the left heart side confirming a right-to-left shunt.

thrombolytic therapy with 50 mg of intravenous alteplase was administered. A follow-up TEE showed resolution of the TIT (Video 7), so the patient was discharged on apixaban 5 mg twice per day.

DISCUSSION

Although TIT is a rare incidental finding in patients with PE, paradoxical embolization of TIT is a life-threatening condition and can result in devastating consequences like massive cerebrovascular events. To cross the right-heart side into the left side, TIT uses intracardiac shunts like PFO and can be occasionally entrapped in the atrial septum within the PFO tunnel, causing thrombus protrusion to both atrial sides.²

Transthoracic echocardiography and TEE have a valuable role in imaging TIT through determining the size and extension of the thrombus into the left-heart chambers and subsequently guiding the management plan. In contrast to CTA, echocardiography can provide both functional and structural information such as ventricular systolic function, RV systolic pressure, and the degree of mobility of the TIT. Subcostal views are particularly important to diagnose the presence of intracardiac shunt and to illustrate the protrusion of the thrombus through the PFO. Importantly, echocardiography with agitated saline

injection during Valsalva maneuver can improve the sensitivity of PFO and intracardiac shunt detection.³

The prevalence of PFO ranges between 10% and 27% within the normal population,⁴ and it is the most common intracardiac shunt contributing to paradoxical embolization. Pulmonary embolism increases pulmonary and right-heart pressures, and these hemodynamic changes augment the separation between the fossa ovalis flaps and increase right-to-left shunt size, thus facilitating the transmission of TIT to the left side.⁵

Kasper *et al.*⁶ conducted a review analysis of 85 patients diagnosed with hemodynamically significant PE and found that 39% had PFO on echocardiographic evaluation. The association between PFO and large PE increases the risk of paradoxical embolism, mechanical ventilation, and use of vasopressor agents.

In this case report, the underlying origin of the thrombus was deep vein thrombosis. Venous thromboembolism (VTE) accounts for 44% of all diagnosed PEs.⁷ Due to the absence of VTE risk factors, deep vein thrombosis in this patient was defined unprovoked, which has a reported prevalence between 25% and 50% of VTEs.⁸

There are multiple therapeutic options for TIT, which include surgical thrombectomy, percutaneous retrieval technique, and medical treatment with thrombolysis and/or anticoagulation, with surgical intervention indicated in hemodynamically unstable patients.^{1,9}

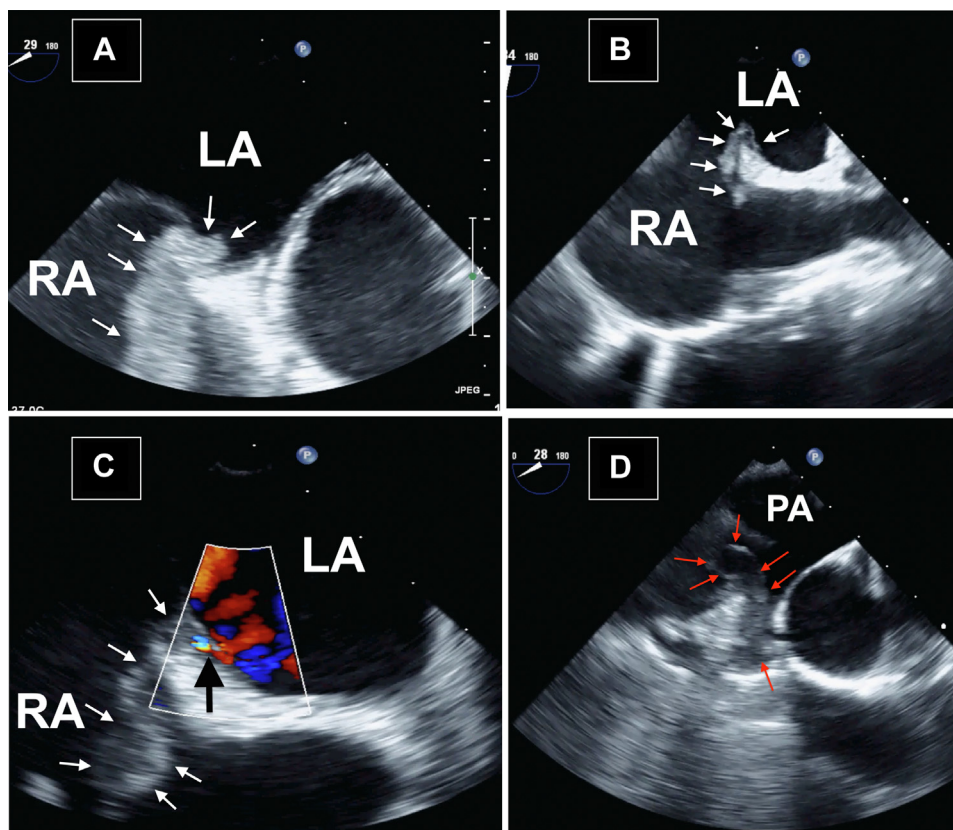


Figure 4 Two-dimensional TEE, mid and upper esophageal windows. **(A)** 29° zoomed view demonstrates the TIT (*arrows*). **(B)** Bicaval view focused on the PFO demonstrates the TIT (*arrows*) in both the right and left atrium (RA and LA). **(C)** Zoomed short-axis display with color flow Doppler demonstrates the TIT (*white arrows*) and the PFO (*black arrow*). **(D)** Upper esophageal window, rightward rotated, 28° view focused on the pulmonary artery (PA), demonstrates a thrombus (*red arrows*).

CONCLUSION

In this report we presented a patient with submassive PE and TIT straddling in the PFO that was resolved completely with thrombolytic therapy and anticoagulation.

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

Complete written informed consent was obtained from the patient (or appropriate parent, guardian, or power of attorney) for the publication of this study and accompanying images.

FUNDING STATEMENT

The authors declare that this report did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

DISCLOSURE STATEMENT

The authors report no conflict of interest.

ACKNOWLEDGMENTS

We thank Ms. Jordan Manlongat for her contribution in echocardiography images acquisition.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.case.2022.12.007>.

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