

THROMBOSIS

CASE REPORT: CLINICAL CASE

Quadri-Chamber Thrombi and Impending Paradoxical Embolism

Thrombus in Transit Through Patent Foramen Ovale

Samier Deen, DO, Paul Gilbert, MD, Kush Agrawal, MD, Abby Borhan, MD



ABSTRACT

Thrombus-in-transit through patent foramen ovale (PFO) is an extremely rare diagnosis that can often be associated with pulmonary embolism. Currently, data exists to guide management options; however, there is no medical consensus with regard to the optimal treatment strategy for thrombus-in-transit through PFO. (J Am Coll Cardiol Case Rep 2024;29:102226) © 2024 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

HISTORY OF PRESENTATION

The 36-year-old female presented with 4 to 5 days of progressively worsening shortness of breath. She reported dyspnea on exertion while climbing stairs but denied shortness of breath at rest. The patient denies any history of cardiac or pulmonary problems. She denied any chest pain or any other symptom complaints. History was primarily acquired from previous records given the brevity of the encounter.

Vital signs noted tachycardia at 107 beats/min, blood pressure of 134/90 mm Hg, respiratory rate of 16 breaths/min, and oxygen saturation of 98% on room air. On physical examination, the patient was

uncomfortable appearing. Cardiopulmonary examination revealed tachycardia and increased work of breathing but was otherwise unremarkable.

MEDICAL HISTORY

Her past medical history includes morbid obesity (body mass index 41 kg/m²), tobacco abuse (10 pack-year history), polysubstance abuse including active heroin use and history of methamphetamine use, attention deficit hyperactivity disorder, depression, and chronic low back pain. Family history was significant for multiple cancers including her mother with uterine cancer, maternal grandfather with gastric cancer, maternal grandmother with lung cancer, and paternal grandfather with thyroid cancer.

LEARNING OBJECTIVES

- To differentiate management options for thrombus-in-transit through PFO based on hemodynamic assessment.
- To recognize the role of early surgical referral for stroke prevention.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis is broad and includes but is not limited to acute pulmonary causes such as pulmonary embolism (PE), pneumonia, pneumothorax, or asthma exacerbation. Cardiac causes may include coronary artery vasospasm (given age and history of

From the HonorHealth/Thompson Peak Medical Center, Scottsdale, Arizona, USA.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the [Author Center](#).

Manuscript received December 22, 2023; accepted January 3, 2024.

**ABBREVIATIONS
AND ACRONYMS**

IVC = inferior vena cava

PE = pulmonary embolism

PFO = patent foramen ovale

RV = right ventricle

polysubstance abuse), pericarditis, and pericardial effusion.

INVESTIGATIONS

Laboratory evaluation revealed D-dimer of 6.29 $\mu\text{g/mL}$ (0.00-0.50 $\mu\text{g/mL}$), B-type natriuretic peptide of 512 pg/mL (0-100 pg/mL), and troponin I of 0.04 ng/mL (0.00-0.03 ng/mL). Electrocardiogram revealed sinus tachycardia with incomplete right bundle branch block and T-wave inversions in leads V₁ to V₅. Computed tomography angiography of the chest showed significant bilateral diffuse clot burden within the pulmonary arteries with right ventricular strain (**Figure 1**), mild peripheral patchy interstitial infiltrates primarily in the left lower lobe, and a wedge-shaped low-density area in the spleen that may represent infarct (**Figure 2**). Transthoracic echocardiographic findings demonstrated a large amount of organized thrombus traversing the tricuspid valve, attached to the interatrial septum as well as thrombus in the left atrium involving the mitral valve consistent with thrombus in transit through patent foramen ovale (PFO) (**Figure 3, Videos 1 to 3**). Additional findings included normal left ventricle size and function with an ejection fraction of 55%. Right ventricle (RV) pressure and volume overload were noted with RV enlargement, moderate reduction in RV systolic function, and elevated right ventricular systolic pressure at 81 mm Hg with a maximum tricuspid regurgitation velocity of 4.27 m/s. Inferior vena cava (IVC) demonstrates a diameter ≤ 21 mm with $< 50\%$ collapsibility.

Intraoperative transesophageal echocardiographic findings redemonstrated a large mobile thrombus in the right atrium traversing the PFO with thrombus present in the left atrium (**Video 4**).

MANAGEMENT

This patient was admitted to the inpatient service for bilateral submassive pulmonary emboli and was initiated on an intravenous heparin drip accordingly with plan for thrombectomy. Given the significant clot burden and concern for impending paradoxical embolization, the patient was referred for emergent cardiac surgery where she ultimately underwent surgical pulmonary thromboendarterectomy and right and left ventricular surgical thromboembolectomy with subsequent PFO closure thereafter.

Her postoperative course was complicated by significant RV dysfunction; she remained on venoarterial extracorporeal membrane oxygenation for approximately 2 weeks before being successfully weaned off. An IVC filter was placed to protect from additional and/or subsequent venous thromboembolism. She was eventually discharged home on apixaban 10 mg twice daily to complete a 1-week loading dose duration, followed by 5 mg twice daily.

DISCUSSION

Thrombus-in-transit through PFO is an extremely rare event; a total of 194 patients (185 articles) were found to have trapped thrombus in a PFO according

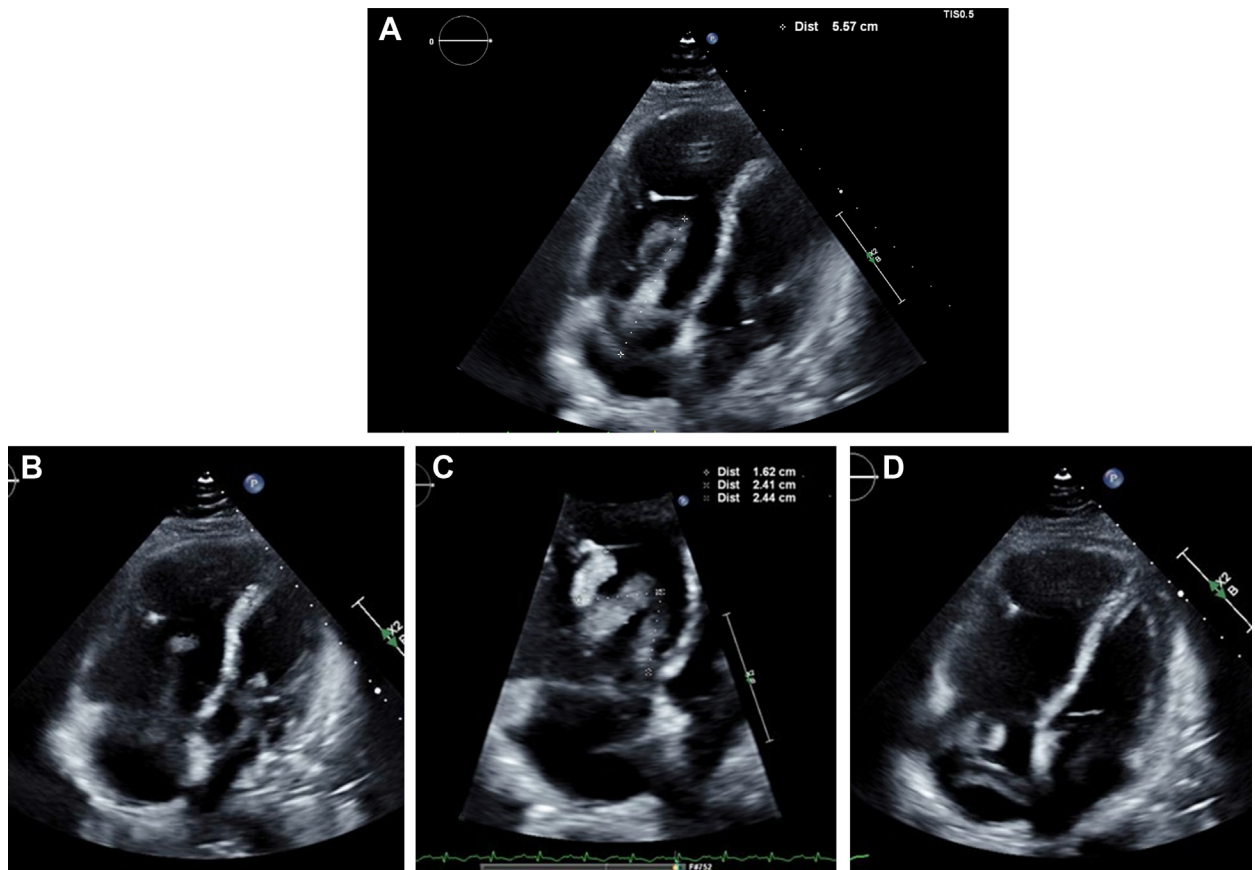
FIGURE 1 Computed Tomography Angiography

Axial computed tomography angiography of the chest demonstrating significant bilateral diffuse clot burden within the pulmonary arteries (arrows).

FIGURE 2 Computed Tomography

Wedge-shaped hypodensity in the spleen, which may represent infarct (arrow).

FIGURE 3 Transthoracic Echocardiogram of Thrombus-in-Transit



(A) Large amount of organized thrombus noted in the right atrium, traversing the tricuspid valve on A4C view. (B) Thrombi traversing the mitral valve and tricuspid valve into both ventricles in a simultaneous fashion on A4C view. (C) Visualization of serpiginous morphology of thrombus organized in RV on traversing the tricuspid valve on modified RV A4C view. (D) Thrombus in right atrium adhered to interatrial septum with demonstration of PFO on A4C view. A4C = apical 4-chamber; PFO = patent foramen ovale; RV = right ventricle.

to a PubMed database search conducted from 1991-2015.¹ The advancement of available diagnostic imaging modalities, including transthoracic and/or transesophageal echocardiography, has led to an increased incidence of this condition since the first reported case confirmed using echocardiography in 1985.²⁻⁴ Due to the rarity of thrombus-in-transit through PFO events, there is a paucity of data and thus optimal management remains controversial. Given the very high mortality associated with this condition and the risk for paradoxical embolism, thrombus-in-transit through PFO also represents both a timely and therapeutic challenge.^{1-3,5,6}

This case represents an unusual presentation of thrombus-in-transit through PFO given the presence of 4-chamber involvement; the exact incidence of which is unknown. As for this patient, she was also

noted to have severe PE-induced pulmonary hypertension, conferring a greater mortality risk via pressure gradients facilitating the passage of thrombus-in-transit through PFO and thus increasing the likelihood of paradoxical embolization and sudden death.⁶ Of note, no systematic investigation was performed during the creation of this case report, and thus ethical/institutional review board approval was not obtained.

Potential therapeutic interventions include anticoagulation, thrombolysis, percutaneous/endovascular mechanical or aspiration thrombectomy, and cardiac surgery such as thrombectomy and PFO closure.^{5,2} Thrombolysis should be reserved for cases of hemodynamic instability given the increased risk for thrombus fragmentation, embolization, and higher associated mortality.^{1-3,5,6}

After an extensive review of available published cases till 2013, Baydoun et al² created a treatment algorithm with regard to optimizing treatment strategy. Recommendations for hemodynamically stable patients include emergent surgery (cardiac thrombectomy and PFO closure) for patients who are low-to-moderate surgical risk and anticoagulation for patients who are high surgical risk, whereas thrombolysis or anticoagulation (if not a candidate for thrombolysis) is recommended for patients that are hemodynamically unstable or with associated comorbidities.² Although surgical repair has been associated with a reduction in subsequent embolic events and improved survival as compared with thrombolysis or anticoagulation, one systematic review found that heterogeneity between treatment groups limited the generalizability of the findings.¹ Thus, further research is warranted to identify optimal treatment strategies.

FOLLOW-UP

After 10 months, the patient is currently asymptomatic without any exercise intolerance and her IVC filter has been removed. She underwent a thrombophilia work-up that was unremarkable. Her most current transthoracic echocardiogram revealed a

normal right ventricular systolic pressure of 26 mm Hg, mildly enlarged RV, and mildly reduced RV systolic function, all of which improved from prior results.

CONCLUSIONS

Thrombus-in-transit through PFO is an extremely rare diagnosis that carries a high acute mortality risk and is often associated with PE.^{1-3,5,6} Early surgical referral is critical given the devastating consequences of paradoxical embolism and stroke, whereas thrombolysis should be reserved for cases of hemodynamic instability due to increased associated mortality.^{1-3,5,6} Although data exist to guide management options, there is currently no medical consensus with regard to the optimal treatment strategy for thrombus-in-transit through PFO.^{1-3,5,6}

FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr Samier Deen, HonorHealth/Thompson Peak Medical Center, 7400 E Thompson Peak Pkwy, Scottsdale, Arizona 85255, USA. E-mail: sdeen@honorhealth.com.

REFERENCES

- Seo WW, Kim SE, Park MS, et al. Systematic review of treatment for trapped thrombus in patent foramen ovale. *Korean Circ J*. 2017;47:776-785. <https://doi.org/10.4070/kcj.2016.0295>
- Baydoun H, Barakat I, Hatem E, Chalhoub M, Mroueh A. Thrombus in transit through patent foramen ovale. *Case Rep Cardiol*. 2013;2013:395879. <https://doi.org/10.1155/2013/395879>
- Fauveau E, Cohen A, Bonnet N, Gacem K, Lardoux H. Surgical or medical treatment for thrombus straddling the patent foramen ovale: impending paradoxical embolism? Report of four clinical cases and literature review. *Arch Car-diovasc Dis*. 2008;101:637-644. <https://doi.org/10.1016/j.acvd.2008.08.011>
- Nellessen U, Daniel WG, Matheis G, Oelert H, Depping K, Lichtlen PR. Impending paradoxical embolism from atrial thrombus: correct diagnosis by transesophageal echocardiography and prevention by surgery. *J Am Coll Cardiol*. 1985;5:1002-1004. [https://doi.org/10.1016/s0735-1097\(85\)80449-6](https://doi.org/10.1016/s0735-1097(85)80449-6)
- Pires MIFB, Almeida I, Santos JM, Correia M. Thrombus in transit through a patent foramen ovale: catch it if you can—a case report. *Eur Heart J Case Rep*. 2021;5:ytab382. <https://doi.org/10.1093/ehjcr/ytab382>
- Lu C, Li J, Wang W, Gong K, Zhao L, Fu X. Large thrombus-in-transit within a patent foramen ovale in a patient with pulmonary embolism: a case report. *J Int Med Res*. 2018;46:4332-4337. <https://doi.org/10.1177/0300060518789820>

KEY WORDS inferior vena cava, patent foramen ovale, pulmonary embolism, thrombus-in-transit

APPENDIX For supplemental videos, please see the online version of this paper.