

## Case Report

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# Extensive Pulmonary Embolism with Patent Foramen Ovale: Unique Presentation Highlights Importance of Multidisciplinary Management Strategies

Ryan Richard<sup>1</sup>, Ashley Desmett<sup>1</sup>, Alexandra Kadl<sup>1,2\*</sup>

<sup>1</sup>Department of Medicine, University of Virginia, USA

<sup>2</sup>Department of Pharmacology, University of Virginia, USA

**\*Corresponding author:** Alexandra Kadl, Department of Pharmacology, University of Virginia, USA. Tel: + +1 434-243-6352; E-Mail: AK5SC@hscmail.mcc.virginia.edu

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## Introduction

Paradoxical embolism occurs when a venous clot enters the arterial circulation through a right to left shunt, most commonly through a Patent Foramen Ovale (PFO). Paradoxical embolism can also be seen with atrial septal defects, ventricular septal defects, and, rarely, with extra cardiac vascular shunts [1]. These events can occasionally be detected as clots in transit on imaging, when clot is visualized in the systemic circulation prior to and during embolization. We have found multiple case reports in which a large clot has been detected traversing the PFO [2-4]. Paradoxical emboli can create dangerous clinical scenarios and surgical intervention is often recommended. We report a case of a 65-year-old female who was admitted to our hospital with a large pulmonary embolism and was found to have a clot in transit through a PFO.

## Presentation

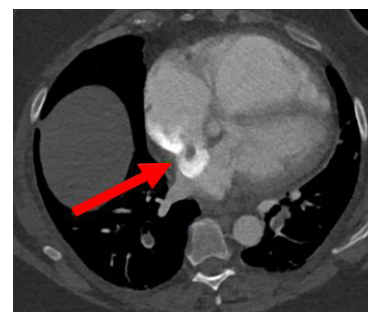
The patient is a 65-year-old female with a history of morbid obesity (BMI of 52), moderate obstructive sleep apnea (non-compliant with prescribed CPAP), and a single episode of provoked deep vein thrombosis 5 years prior to presentation. She was no longer on anticoagulation at the time of presentation. Three months prior to presentation, she underwent transthoracic echocardiogram due to bilateral, symmetric lower extremity edema. This study showed moderate left ventricular hypertrophy and normal right ventricular size; however, the study was limited due to her body habitus.

She had been on multiple cross-country trips, including lengthy flights, in the weeks leading to presentation. In July 2016, she presented to the pulmonary clinic for a one week history of progressive, acute dyspnea. On a six-minute walk test, she was only able to walk 50 meters due to severe hip pain and dyspnea.

At rest, pulse oximetry was 87-90%, and on exam she was tachycardic with heart rates between 100 and 110, her blood pressure was 138/78. She was transferred to the Emergency room due to concern for acute pulmonary embolism. Lower extremity ultrasounds showed bilateral deep vein thrombosis. A CT-Pulmonary Angiogram (CTPA) revealed extensive bilateral pulmonary emboli, and an atrial septal defect with the concern for thrombus extending from the right atrium into the left atrium (see Figure 1 and Figure 2).



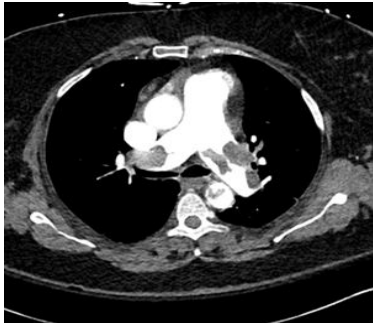
**Figure 1:** Axial View of CTPA Showing Clot Burden in the Both Main Pulmonary Arteries.



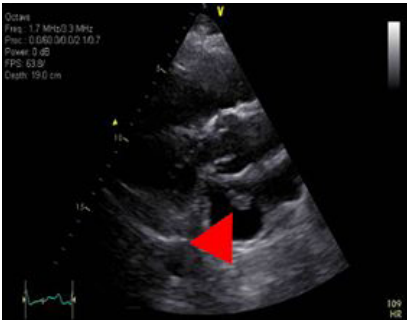
**Figure 2:** Axial View Showing Clot in the PFO.

Hospital Course

She was admitted to the Medical Intensive Care Unit and started on anticoagulation with heparin. Subsequent aortic angiogram further demonstrated thrombus extending through the PFO into the descending aorta and continuing into the bilateral internal iliac arteries and a branch of the right profunda femoral artery (Figure 3). An emergent transthoracic echocardiogram confirmed a clot extending through a PFO and traversing her mitral valve into her Left Ventricular Outflow Tract (LVOT) (Figure 4). Her right ventricle was severely dilated with a severely reduced ejection fraction. Her hypoxia worsened, and she developed hemodynamic instability, necessitating the initiation of a norepinephrine infusion (see Table 1). Throughout her admission, there was ongoing collaboration between critical care, vascular medicine, cardiothoracic surgery, and interventional radiology. Given her clinical deterioration and the concern for further systemic embolism and/or stroke with thrombolysis (systemic or catheter-directed), the decision was made to proceed to surgery. Intra-operative transesophageal echocardiography confirmed the clot in transit. She was placed on cardiopulmonary bypass, her atrial septal defect was closed, large amounts of thrombi were removed from both main pulmonary arteries, and a large thrombus was removed from her left atrium. After surgery, the patient was on norepinephrine and milrinone infusions, as well as inhaled nitric oxide. She was alert and responding to commands with no focal neurologic deficits, making paradoxical emboli into the cerebral circulation unlikely. The patient was weaned off vasoactive drugs and inhaled nitric oxide within 48h after surgery. She was successfully extubated on Post-Operative Day (POD) 8, and discharged home on POD 11. She was discharged on 4L supplemental oxygen.



**Figure 3:** Axial View of CTA Showing Clot Burden in the both Main Pulmonary Arteries (red arrows). There is also Evidence of Clot in the Descending Aorta (Blue Arrow).



**Figure 4:** TTE. Parasternal Long Axis View Showing a Mobile Mass Red Arrow) in the Left Atrium.

Parameter	Result
Blood Pressure	102/60
Heart Rate	123
SpO <sub>2</sub>	89% on 4L oxygen
Troponin	<0.02
BNP	1096
PESI Score	85 (Class II): Low Risk 1.7-3.5% predicted 30-day mortality
sPESI Score	1: High Risk 8.9% predicted 30-day mortality

**Table 1 :** Clinical Parameters at Transfer to the Medical ICU-Highlighting Pitfalls Of Clinical Scoring Systems in Certain Patient Populations.

Outpatient Follow-Up

At her 6-month follow-up visit, she was no longer requiring supplemental oxygen, and showed significant improvement in her 6-minute walk distance to 270 meters. Despite clinical improvement, her echocardiogram continued to show a severely dilated right ventricle with severely reduced right ventricular function. A repeat CTPA at that time showed a decrease in the overall clot burden, but with persistent wedge-shaped infarcts and segmental clots. A subsequent ventilation-perfusion scan and right heart catheterization supported a diagnosis of mild Chronic Thromboembolic Pulmonary Hypertension (CTEPH). The patient will be continued on life-long anticoagulation with Apixiban for CTEPH. Her age-appropriate cancer screening has been negative thus far. She was referred to Hematology, but no further investigation into clotting disorders has been necessary, given her indication for life-long anticoagulation. She has also been initiated on nightly CPAP for her OSA and is now compliant with therapy.

## Discussion

This case highlights the complex clinical decision-making process involved in the treatment of clots in transit. Studies have shown the incidence of PFOs in the population is around 25-30% on autopsy [5]. These PFOs are most often asymptomatic; however, they can cause a significant right to left shunt when right-sided cardiac pressures exceed left-sided pressures, as seen in a large acute PE. The treatment of a thrombus extending through a PFO remains controversial [6]. Our current treatment options for clinically significant pulmonary embolism now include: anticoagulation, systemic thrombolysis, catheter directed thrombolysis, and mechanical extraction (intravascular vs surgical) [7-9]. Studies have shown the major bleeding risk with thrombolytic therapy to be increased when compared to anticoagulation with heparin alone (9.2 vs 3.4 percent), including an increased risk of intracranial hemorrhage (1.5 vs 0.2 percent) [10]. In patients with a thrombus lodged in the PFO, consensus opinion in the literature states that emergency surgery is indicated [6,11]. This is due in large part to the concern that thrombolytic therapy may cause pieces of clot to dislodge and lead to further systemic embolization and stroke [12]; however, there is a lack of clinical trial data to show whether any other treatment modality would have less risk of embolization. Decisions are based on expert opinion and on the individual patient risk and presentation. This case also highlights the importance of collaboration between specialists to determine the best individualized treatment approach in this complex clinical scenario. In our institution, we have established a PE-alert team that evaluates every patient admitted with sub-massive or massive pulmonary embolism. In our case, there were extensive discussions between multiple specialists regarding the best treatment choice. As shown in (Table 1), her PE-severity index was rather low at 85, putting her into a low risk group; while her simplified PE-severity index was 1, putting her into a high-risk group. These severity scores do not consider complications such as a PFO or a thrombus extending into the arterial circulation. In this case, the patient showed worsening right heart failure and respiratory failure requiring vasoactive drugs, as well as an increase in supplemental oxygen. We also discussed the treatment options with the patient and her family. Together, we decided that she was at high risk for stroke with any therapy, but we thought that by placing her on cardiopulmonary bypass, removing the left atrial clot, and closing the PFO would be

the most beneficial and safest approach. Her excellent neurologic outcome supported our decision. We feel this multi-disciplinary collaborative approach was vital to her positive outcome, and supports the development of PE response teams in academic centers throughout the country.

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