Active Paradoxical and Pulmonary Emboli in a First Trimester Pregnancy

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ABSTRACT
Capturing a paradoxical embolism in real-time has been a challenge in recent literature. We present the unique case of a 33-year-old, G3P2 female at 8 weeks gestation presenting with dyspnea. An active thrombus through an undiagnosed patent foramen ovale was found requiring emergent surgical intervention with a positive outcome. The presence of a deep vein thrombosis, inferior vena caval thrombus, patent foramen ovale, and pulmonary artery thrombi was contemporarily documented. To our knowledge, there is minimal literature with this presentation.

Keywords: Bypass, cardiopulmonary, echocardiography, patent foramen ovale, thrombus

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HISTORY
A 33-year-old African-American G3P2 female at 8 weeks gestation with no past medical or gestational history presented with 2 weeks of progressive left calf pain with recent worsening dyspnea on exertion which prompted her to go to the emergency room where venous duplex ultrasound of her lower extremities demonstrated significant thrombotic occlusions through the left distal femoral vein, popliteal vein, with extension into the posterior and peroneal veins. There were notable pulmonary emboli throughout pulmonary vasculature with evidence of right heart strain from Computed tomography of pulmonary arteries. Fractionated heparin (80 mg) was administered and the patient was transferred to our institution for further evaluation and treatment. On arrival, vitals were—blood pressure 94/79, heart rate of 110, respiratory rate of 25 with an oxygen saturation of 99% on 5 L nasal cannula. Physical exam findings included worsening dyspnea at rest with diffuse chest discomfort, left calf distension, benign neurologic exam. Arterial blood gas demonstrated a pH of 7.47, PCO2 29, PO2 192 on 5 L nasal cannula. Transthoracic echocardiography at bedside noted a significant clot burden in the inferior vena cava traveling to the right atrium and what appeared to be thrombus in the left atrium with extension into the mitral valve. The right heart demonstrated free wall akinesis with sparing of the apex suggestive of McConnell’s sign. Preoperative fetal evaluation by obstetrics with pelvic ultrasound revealed faint heart tones. Due to her worsening presentation, obstetrics and cardiothoracic surgery agreed to proceed with surgery for manual extraction of clot burden and closure of the patent foramen ovale. Given the complex nature of her presentation, there were discussions about fetal viability and potential outcomes with the patient. With such an early gestational age, intraoperative fetal monitoring would not be reliable and was not utilized. Goals of care were established with the perfusionists for cardiopulmonary...
bypass to run the bypass pump at higher-than-normal rates around an index of 2.4 L/min/m², maintain pulsatile flow via roller pumps, with conservation of normothermia, and avoidance of sustained hypotension. Maintaining a mean arterial pressure greater than 75 mmHg and avoidance of vasoconstricting agents such as phenylephrine were the hemodynamic goals.

Intraoperative transesophageal echocardiography demonstrated a thrombus in the inferior vena cava, a thrombus in transit through a patent foramen ovale with extension through the mitral valve, thrombus in the right pulmonary artery, severe right ventricular dilation with reduced right ventricular systolic function with decreased left ventricular volume [Figures 1–5 and Videos 1–5]. The patient underwent successful median sternotomy with cardiopulmonary bypass for right atrial exploration and removal of thrombus, pulmonary embolectomy, and patent foramen ovale closure. Intraoperative use of transesophageal echocardiography aided identification and extraction of distal clots in the pulmonary arteries [Figure 6 and Video 6]. In the postoperative period, the patient developed atrial fibrillation that resolved after cardioversion. The remainder of her course was unremarkable. Fetal evaluation by obstetrics demonstrated viable fetus heart tones via pelvic ultrasound postoperative day two.

DISCUSSION

Venous thromboembolism is a significant cause of maternal mortality in the United States, accounting for 15% of maternal deaths. \[1\] The clinical course of Venous thromboembolism can be further complicated in patients
with coexisting patent foramen ovale (PFO), a congenital defect that persists in the intra-atrial septum when there is a failure of the foramen to close in infancy. The risk for paradoxical embolus is increased in patients with pulmonary embolism due to an increase in pulmonary artery pressure which leads to the right to left shunting, allowing a clot to enter the arterial circulation. The consequences of paradoxical emboli can be serious and include stroke, myocardial infarction, and peripheral ischemia.\(^2\) Despite optimal management, a thrombus in transit across a PFO is associated with a mortality of 18%, with two-thirds of the deaths occurring within the first 24 h after the diagnosis.\(^3\) We hypothesize that the increase in pulmonary artery pressure significantly contributed to the right to left shunting with a PFO in our patient.

Screening for a PFO is not currently part of routine pre-partum medical care, and since many patients remain clinically asymptomatic, it is frequently missed until complications occur.\(^2\) Transesophageal echocardiography is a safe and accurate tool for the diagnosis of a PFO. Injection of agitated saline into a vein, while both atria are visualized, is needed to confirm the diagnosis.\(^4\) However, in our patient, the presence of thrombus in the PFO occluded the aperture so that no saline could reach the left atrium.

Other main concerns for this patient were the possible negative effects of cardiopulmonary bypass, and anesthetic agents on the fetus, especially with sparse literature in first-trimester pregnancies. Fetal mortality during maternal cardiac surgery with cardiopulmonary bypass ranges from 16 to 33%.\(^5\) Our goals were to maintain normothermia, pulsatile flow, avoid hypotension, and increase pump flow rates. Pulsatile flow preserves placental perfusion by maintaining endothelial nitric oxide synthesis. This limits the placental vascular resistance that is observed with nonpulsatile flow.\(^6\) Hypothermia alters the acid-base balance, which alters oxygen dissociation from hemoglobin. Transplacental flow and subsequent perfusion and oxygen delivery are impaired in this process. Maintenance of normothermia is necessary to optimize fetal oxygenation. Although no blood transfusions were needed, our threshold for transfusing packed red blood cells was slightly lower to ensure adequate fetal oxygenation. Phenylephrine and ephedrine were the main vasoconstricting agents used for this case, and are considered safe during pregnancy.\(^7\)

In rare cases, transesophageal echocardiography has been used to witness a paradoxical emboli traversing the PFO from the right to the left atrium, although documentation of these images is uncommon.\(^8\) We present a unique case of intra-atrial communication with the right to left shunting, a mobile thrombus in transit, and multiple pulmonary emboli in a first-trimester patient that required the use of cardiopulmonary bypass. The decision to proceed with surgical removal versus thrombolytic therapy was based on the active thrombus in transit that potentially could have embolized or propagated further. The intraoperative use of TEE was a vital tool in the process of thrombus extraction especially with the aid of three-dimensional imaging. Further follow-up is pending.

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Conflicts of interest
There are no conflicts of interest.
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