A Woman With Recent Stroke Presenting With Respiratory Failure and Shock

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A woman in her 70s with a medical history of diabetes and hypertension presented to the ED with 1 day of sudden dyspnea and orthopnea. One week earlier, after a plane flight, the patient suffered a left basal ganglia infarct that resolved with t-PA administration. Stroke workup included an echocardiogram that revealed moderate right ventricular dilatation and mild right ventricular hypokinesis with a bubble study consistent with a patent foramen ovale. Lower extremity vascular studies were not obtained. She was discharged 2 days before her current presentation without complaints. CT angiography of the lungs obtained in the ED demonstrated extensive pulmonary emboli within the bilateral main pulmonary arteries extending into numerous segmental branches with evidence of right heart strain.

Critical care medicine was consulted for further management of submassive pulmonary embolism. Vitals were oxygen saturation of 94% on room air, BP 95/66 mm Hg, heart rate 110 beats/min, and respiratory rate 22 beats/min. Her physical examination was notable for accessory muscle use. Laboratory tests were significant for elevations in lactic acid (4.5 mmol/L), troponin (0.19 ng/L), alanine transaminase (405 μ/L), aspartate transaminase (548 μ/L), and potassium (6.1 mEq/L). As part of the evaluation, point-of-care ultrasonography (POCUS) was performed to assess the patient’s shock state (Video 1).

Question 1: In addition to submassive pulmonary embolism, what unexpected diagnosis was made with POCUS?

Question 2: What were the next recommended steps in management?
**Answers:** Cardiac POCUS demonstrated severe right ventricular dilatation resulting in left ventricular compression, right ventricular hypokinesis, and a large biatrial thromboembolism passing through a patent foramen ovale. The impending paradoxical embolism, a clot in transit, was identified as a mobile, serpentine-like, hyperechoic structure straddling the atrial septum. The impending paradoxical embolism was best seen in the subcostal long-axis view. Additionally, a prominent moderator band was visualized toward the right ventricular apex. DVT was not present on a compression study of the bilateral lower extremity vasculature (Video 2).

Cardiothoracic surgery was consulted for further surgical intervention. The patient underwent an emergent thromboembolectomy and patent foramen ovale (PFO) closure (Fig 1). The postoperative course was complicated by hypoxic respiratory failure, right ventricular failure, acute renal failure, and shock requiring mechanical ventilation, venoarterial extracorporeal membrane oxygenation, and renal replacement therapy. Ultimately, the patient was discharged with only dialysis needs.

**Discussion**

Paradoxical embolization arises when a venous thrombus migrates to the arterial circulation in the setting of an abnormal intracardiac or intrapulmonary communication and favorable right-to-left pressure gradient.\(^1\)\(^-\)\(^5\) When a thrombus gets lodged within an atrial communication, the phenomenon is known as an impending paradoxical embolism (IPE).\(^3\)\(^,\)\(^5\)\(^,\)\(^6\) Most frequently, the communication is intracardiac and represents a PFO.\(^4\) Pulmonary embolism, a prevailing cause of acute pulmonary hypertension, has been found to occur in up to 94% of patients with IPE.\(^7\) Arterial embolization is present in approximately one-half of documented IPEs.\(^2\)\(^,\)\(^4\) The sequelae of paradoxical embolism can be disastrous, with clinical manifestations such as peripheral ischemia, cerebral infarction, and MI and mortality rates among those identified and treated are as high as 21%.\(^3\)\(^,\)\(^7\) Early recognition and management are crucial to improved outcomes.

Since first described echocardiographically by Nellessen,\(^6\) IPE has remained a rarely diagnosed clinical entity and the optimal management strategy is ill-defined. Therapeutic options include thromboembolectomy, systemic thrombolysis, and anticoagulation, or a combination of these approaches. Current recommendations for management and outcomes are based on case series and small systematic reviews, with acknowledged methodological limitations from the rarity of presentation.

In a cohort of 88 patients by Fauveau et al.,\(^7\) all IPE diagnoses were made with echocardiography, with 30% of those by transthoracic echocardiography. Transesophageal echocardiography was triggered by the recognition of an intracardiac thrombus on transthoracic echocardiography, most frequently in the right atrium. Sixty-three percent underwent emergent surgical thromboembolectomy. Management with therapeutic anticoagulation alone was used in 24% of their population and was found to have a similar mortality rate to surgery (13% vs 14%). Anticoagulation alone was more frequently used in patients with stroke and significant comorbidities who were deemed unfavorable surgical candidates. Thrombolysis, used in 12.5% of the cohort, was associated with an increased mortality rate (36%), although it was more often used in hemodynamically unstable patients with severe pulmonary embolism and shock. Given the small and heterogeneous population, statistical comparisons between groups were not obtained. The authors stated that “surgical management appears justified for prevention of paradoxical embolism,” although systemic anticoagulation alone may be an “acceptable alternative” in poor surgical candidates.

In similar cohort of 174 patients diagnosed with IPE, Myers et al.\(^2\) demonstrated a 30-day mortality rate of 18%, with two-thirds of the death occurring within 24 h of diagnosis. Age, coma, and systemic embolism at presentation were significantly increased among the deceased. There was a higher prevalence of surgery among survivors vs nonsurvivors (64.5% vs 34.4%). Although the trend toward survival with surgery was not
significant, systemic embolism occurred more frequently in the thrombolysis and anticoagulation groups. The authors suggest that emergent thromboembolectomy may be considered the treatment of choice. Furthermore, they emphasize that surgery should not be excluded as a therapeutic option for patients presenting with hypotension, shock, or cardiac arrest given the availability of cardiopulmonary bypass and ventricular assist devices.

The patient in our study was initially scheduled for catheter-directed thrombolysis as the management of her pulmonary embolism, until POCUS demonstrated IPE. Given her recent stroke, the size of the PFO, and the clot burden, systemic thrombolysis would have increased the risk of clot fragmentation and embolization, additional cerebrovascular accidents, hemorrhagic conversion, and hemodynamic collapse. It is conceivable that the patient’s initial stroke was a result of a paradoxical embolism, and that a pulmonary embolism was not evident because of thrombolytic use. This case highlights the importance of POCUS in the selection of a treatment plan for patients presenting with submassive pulmonary embolism. Although definitive evidence is lacking, emergent thromboembolectomy was the best management option for the patient in our study and should be considered for patients diagnosed with IPE.

Reverberations

1. Consider paradoxical embolism and/or IPE in patients presenting with signs and symptoms of both venous and arterial thrombosis.

2. Point-of-care transthoracic echocardiography is an essential tool in the initial diagnosis and management of submassive pulmonary embolism.

3. Transesophageal echocardiography should be obtained when there is high clinical suspicion for paradoxical embolism or in setting of a visualized atrial thrombus.

4. IPE represents a distinct clinical entity for which early emergent surgery should be considered.

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Additional information: To analyze this case with the videos, see the online version of this article.

References


