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Intraoperative pulmonary embolism during general anesthesia diagnosed with transesophageal echocardiography: A case report

Matthew Abikenari, Sassan Rafizadeh, Clinton Kakazu

ABSTRACT

Introduction: Acute pulmonary embolism (APE) is a potentially life-threatening condition with significant morbidity and mortality, particularly in the perioperative period. Early detection and intervention are crucial, but common signs and symptoms may not be easily identifiable under general anesthesia. This report presents a case of intraoperative APE in a 43-year-old female undergoing general anesthesia for left patella tendon repair following a ground-level fall.

Case Report: During the procedure, the patient experienced an acute pulmonary embolism. Rescue transesophageal echocardiography (TEE) revealed a thrombus in the right main pulmonary artery and signs of right heart strain, including tricuspid regurgitation and right ventricular dilation. The patient was immediately taken to the interventional radiology suite for catheter thrombectomy. Following the procedure, her condition stabilized, and she was discharged with anticoagulation therapy.

Conclusion: This case highlights the clinical challenges of diagnosing intraoperative APE in anesthetized patients, where typical symptoms may be obscured. Intraoperative TEE proved crucial in the timely detection of the embolism and enabled life-saving intervention. The importance of utilizing advanced diagnostic tools in managing intraoperative emergencies is underscored. Future research aimed at developing pathophysiologic models and diagnostic flowcharts for intraoperative APE may help improve outcomes in similarly challenging cases.

Keywords: Acute pulmonary embolism (APE), Catheter thrombectomy, Interventional radiology (IR), Intraoperative diagnosis, Transesophageal echocardiography (TEE), Venous thromboembolism

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INTRODUCTION

Despite contemporary advances in diagnostic tools and treatment strategies, pulmonary embolism (PE) persists as a clinical entity with substantial life-threatening outcomes. Perioperative acute pulmonary embolism (APE), in particular, is associated with a high level of morbidity and mortality [1, 2]. The common signs and symptoms include chest pain, dyspnea, anxiety, and tachypnea, which are not present in the anesthetized patient [1]. Vigilance is required to recognize the intraoperative signs of pulmonary embolism, which may include a sudden drop in end-tidal carbon dioxide ($EtCO_2$), hypoxia, hypotension, shock, or cardiac arrest [3, 4]. Here, we present a young, healthy patient who

experienced an intraoperative pulmonary embolism during general anesthesia. Furthermore, we discuss the immediate echocardiographic findings, subsequent management, and broader implications [5].

CASE REPORT

A 75-kg 43-year-old female patient with a previous medical history of obesity was scheduled for left patella tendon repair after a ground-level fall. She was physically active, had a body mass index (BMI) of 32 kg/m², and did not smoke or consume recreational drugs or alcohol.

Preoperatively, the patient was notably anxious and given 2 mg of midazolam intravenously, and an ultrasound-guided left femoral nerve block was performed for postoperative pain control. The patient was induced with 200 mg of propofol intravenously, and a laryngeal mask airway (LMA) was placed, with the patient breathing spontaneously. Prior to the incision, a tourniquet was inflated to 300 mmHg over the thigh of the operative side with a total tourniquet time of 60 minutes. Upon deflation of the tourniquet, the patient had a sudden onset of hypoxia from 100% to 85%, $EtCO_2$ dropped precipitously from 42 to 6 mmHg, and heart rate increased from 73 to 120 beats per minute. The patient was intubated and placed on a 100% fraction of inspired oxygen (FiO_2), with an improvement in hypoxia of 97% and an improvement in $EtCO_2$ of 25. Intraoperative arterial blood gas (ABG) showed an arterial pH of 7.33, O_2 partial pressure of 141 mmHg, carbon dioxide (CO_2) partial pressure of 44.1 mmHg, and hemoglobin concentration of 12.2 g/dL.

Transesophageal echocardiography revealed venous thromboembolism in the right main pulmonary artery (PA) and a normal left PA (Figure 1A). Furthermore, a modified bicaval view showed tricuspid regurgitation (TR) with a peak velocity of 294 cm/s and a gradient of 35 mmHg (Figure 1B). Due to the patient's unstable condition, the interventional radiology (IR) team was immediately consulted, and it was decided to proceed with thrombectomy. After the left patellar tendon repair was completed, the patient was promptly transported to the IR suite for the procedure. A pulmonary angiogram was performed, showing a filling defect in the right main pulmonary artery extending into the right upper, middle, and lower PA segments (Figure 2A), consistent with intraoperative TEE findings. Pre-thrombectomy ABG showed a pH of 7.16, O_2 partial pressure of 129 mmHg on 95% oxygen, carbon dioxide (CO_2) partial pressure of 70.4 mmHg, and hemoglobin concentration of 11.9 g/dL. Aspiration thrombectomy was performed using a Cat Penumbra thrombectomy device. Thrombi were removed from the right main, right upper, right middle, and right lower PA segments (Figure 2C). A repeat angiogram showed markedly improved perfusion to the right lung (Figure 2B), accompanied by improvement in vital signs. Post-thrombectomy ABG showed an arterial pH of 7.37, O_2 partial pressure of 278 mmHg on 40% oxygen, carbon dioxide (CO_2) partial pressure of 44 mmHg, and hemoglobin concentration of 11.2 g/dL. The patient remained intubated and was transferred to the surgical intensive care unit, where she received a heparin bolus and started on a heparin infusion.

Bilateral lower extremity Doppler ultrasound on postoperative day (POD) 1 demonstrated a clot in the left common femoral, left femoral, and left popliteal veins consistent with acute deep venous thrombosis (DVT). The patient remained intubated until the first day after surgery, when she was extubated and transitioned to breathing room air.

Transthoracic echocardiography prior to discharge revealed improvement in right ventricular function and only a trace tricuspid regurgitant jet. The patient was discharged on POD5 with Rivaroxaban for anticoagulation.

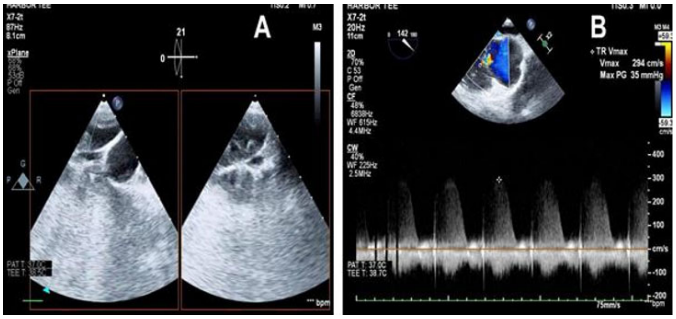

Figure 1: (A) A transesophageal echocardiogram (TEE) shows venous thromboembolism in the right main pulmonary artery (PA), along with a normal left PA. (B) A modified bicaval view shows tricuspid regurgitation (TR) with a maximum velocity of 294 cm/s and a gradient of 35 mmHg.

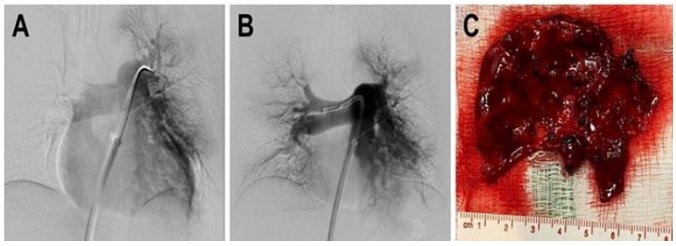

Figure 2: (A) A pulmonary angiogram shows a filling deficit in the right main pulmonary artery, with extension into the right upper, middle, and lower PA segments, consistent with the intraoperative TEE findings. (B) A repeat angiogram shows markedly improved perfusion to the right lung, accompanied by improvement in vital signs. (C) Image of the thrombi removed from the right upper, middle, and lower PA segments.

DISCUSSION

The incidence of acute pulmonary embolism has been reported to be as high as 30% after orthopedic surgeries [1, 6]. Risk factors can be hereditary traits (protein C deficiency, etc.), acquired (malignancy,

trauma, etc.), medications, such as oral contraceptives, or surgical factors (e.g., hip or knee replacement) [7, 8]. Intraoperative PE can be especially difficult to diagnose as the common signs and symptoms, such as chest pain, dyspnea, anxiety, and tachypnea, are not available while the patient is under general anesthesia [9, 10]. Hence, early diagnosis and treatment are of critical importance and can significantly aid in reducing morbidity and mortality [11, 12].

Intraoperative diagnosis of PE is a diagnosis of exclusion. Other pathologies that might present similarly include malposition or dislodgement of the endotracheal tube, pneumothorax, myocardial ischemia, and bronchospasm. Changes seen on standard intraoperative monitors can help raise suspicion and warrant further diagnostic testing. In addition, the pathophysiologic development and timing of intraoperative APE are influenced by the surgical procedures and general anesthesia, which follow distinct pathways compared to the patients' natural breathing patterns before and after surgery [13].

In addition, the incidence of deep vein thrombosis (DVT) and pulmonary embolism (PE) is notably higher in patients who experience trauma followed by prolonged immobilization, such as those recovering from ground-level falls or undergoing orthopedic surgeries. Immobilization leads to venous stasis, a primary component of Virchow's triad, which contributes to developing venous thromboembolism (VTE) [1, 7]. Studies have demonstrated that patients undergoing orthopedic procedures like knee or hip surgeries are particularly at risk, with reported incidences of PE ranging from 2–10%, depending on factors such as the length of immobilization, the use of tourniquets, and individual risk factors like obesity [6, 8]. In the case presented, the patient's prolonged immobilization after the fall and the use of a tourniquet during surgery likely exacerbated her risk for developing PE. The sudden intraoperative changes in oxygenation and $EtCO_2$ underscored the importance of early diagnosis using tools like transesophageal echocardiography (TEE), which facilitated prompt intervention via catheter-directed thrombectomy, significantly improving the patient's outcome [8].

Electrocardiography (EKG) changes in APE frequently point to signs of right heart strain. The most common EKG findings reported include sinus tachycardia, T-wave inversion in lead V1–V4, III and aVF, S-wave in lead I, Q-wave in lead III, right bundle branch block, P pulmonale, and ST-segment elevation in leads V1–V2 [1, 2]. While these signs may be seen with cases of APE, they may be difficult to appreciate intraoperatively, as intraoperative tachycardia may be due to the light plane of anesthesia, pain, or hypovolemia. Furthermore, echocardiography may provide direct visualization of the thrombus and or the right heart strain sequelae of APE. Modified bicaval views showing TR greater than 270 cm/s are associated with PE. Midesophageal 4-chamber views may demonstrate right ventricular (RV) dilation, increase in RV to left ventricle (LV) dimension ratio, septal shift into the LV, RV free wall hypokinesis, akinesis, or McConnell's sign [1]. Our patient had a peak TR jet velocity of 294 cm/s, RV dilation, and a large thrombus visualized in the right main pulmonary artery.

An elevated $PaCO_2$ accompanied our patient's precipitous drop in $EtCO_2$ sometimes referred to as a "separation phenomenon" [14]. This is unlike a spontaneously breathing patient whose blood gas changes would commonly show respiratory alkalosis due to tachypnea [1, 14]. Pneumothorax was considered as a possible diagnosis. However, the likelihood was reduced because peak airway pressures were normal, and auscultation confirmed equal and clear breath sounds on both sides of the chest.

Our presentation is similar to a previous case report of a 28-year-old female undergone open reduction internal fixation of her left clavicle and left ankle after a motor vehicle collision. However, our patient did not share some of the comorbidities of the former patient, such as BMI in the morbid obesity range, multiple orthopedic traumas, or a history of smoking.

CONCLUSION

We have reported a case of intraoperative APE in a patient undergoing orthopedic surgery following a ground-level fall that was diagnosed by emergent intraoperative TEE. The patient developed hypoxia and a steep drop in $EtCO_2$, prompting the provider to utilize emergent intraoperative TEE to confirm a diagnosis of APE. This led to immediate treatment via aspiration thrombectomy with improvement in vital signs. Transesophageal echocardiography or transthoracic ultrasounds are becoming more readily available and can be implemented intraoperatively while performing other tests to narrow a diagnosis.

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Author Contributions

Matthew Abikenari – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Sassan Rafizadeh – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.