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Case Report

Overcoming challenges in the treatment of massive pulmonary embolism in the elderly: Role of extracorporeal membrane oxygenation

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ABSTRACT

Population aging represents a paramount medical and socio-demographic challenge globally. As living standards improve and medical technology advances, the elderly population experiences an increasing number of detected and treated pulmonary embolisms (PE). However, rescuing massive pulmonary embolism (MPE) in the elderly remains a difficult task. Conventional thrombolysis or surgical thrombolysis might be contraindicated, leading extracorporeal membrane oxygenation (ECMO) to emerge as a treatment modality for MPE in the elderly. Nevertheless, data are scarce regarding the use of ECMO as a standalone treatment for MPE. In this paper, we present the case of an 85-year-old patient with a prior cerebral infarction, who received a diagnosis of MPE in the main trunks of bilateral pulmonary arteries. Considering the patient's systemic condition, the Pulmonary Embolism Response Team (PERT) opted to administer VA-ECMO as the sole treatment approach. Remarkably, the patient achieved a favorable recovery outcome. Our case report contributes new evidence to the treatment of elderly individuals with MPE and highlights the potential of ECMO-only regimens for addressing such cases.

1. Introduction

Pulmonary embolism (PE) is a leading cause of cardiovascular death globally, and properly managing high-risk cases remains a significant challenge for medical professionals [1,2]. Advanced age, being a risk factor for PE, further complicates treatment decisions, making individualized care plans crucial for patient outcomes [3]. In situations where conventional treatment options prove inadequate for MPE, ECMO offers a broader time window for therapeutic decisions. Venous-arterial ECMO (VA-ECMO) stabilizes both respiration and circulation, and its systemic heparin anticoagulation aligns with the salvage strategy for PE [4]. Nevertheless, the management of ECMO and the treatment of MPE present challenges due to the absence of established evidence-based treatment protocols [5].

2. Case presentation

An 85-year-old male presented with unexplained asthma for more than 6 months, and sought medical attention at the Emergency Department of the Army Specialty Medical Center. Considering his habit of sitting for long periods (> 4h) every day playing Chinese chess, and the patient had a history of cerebral infarction for 3 years and had been regularly taking enteric-coated aspirin tablets.

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However, during the period of taking oral Chinese herbal medicine due to asthma fatigue, he stopped taking them 1.5 months before admission. He did not have a history of smoking or alcohol consumption. Chest computed tomography (CT) revealed multiple filling defects in both the main and branch pulmonary arteries (Fig. 1). Upon examination in the emergency department, the patient's Glasgow Coma Scale was 15, and no fever. The patient had a heart rate of 118 beats per minute, blood pressure of 80/62 mmHg, and respiratory rate of 38 breaths per minute. Blood gas analysis revealed a pH of 7.42, PCO_2 of 32 mmHg, PO_2 of 62 mmHg, and lactate level of 1.9mmol/L (FiO_2 :21 %). The severity of pulmonary embolism was graded as 5 according to the pulmonary embolism severity index (PESI) [6]. Ultrasound measurement showed severe regurgitation of the tricuspid valve, reduced left ventricular diastolic function, a pulmonary artery pressure of 58 mmHg. Furthermore, bilateral lower limb arteriovenous ultrasound indicated left lower limb intermuscular vein thrombosis. Therefore, the patient was admitted to the intensive care unit (ICU) for treatment. The primary diagnosis upon admission was an MPE. Upon admission to the ICU, the patient was found to be lethargic with a body temperature of 36.2 °C, a heart rate of 118 beats per minute, and a respiratory rate of 22 breaths per minute (FiO_2 : 41 %). The blood pressure was measured at 165/85 mmHg. Laboratory findings revealed a white blood cell count of $9.72 \times 10^9/L$, hemoglobin level of $109 \times 10^9/L$, platelet count of $106 \times 10^9/L$, elevated neutrophil ratio of 86.7 %, activated partial thromboplastin time of 29.6s, fibrinogen concentration of 1.86g/L, D-dimer level of 10609 μ g/L, total calcium level of 2.18mmol/L, BNP level of 179pg/mL, and normal liver and kidney function. After obtaining consent and signature from the family, the patient was given electroencephalogram bifrequency index (Bis) monitoring, analgesia and sedation (target value 45–65), end-expiratory carbon dioxide monitoring with the assistance of an endotracheal intubation ventilator, VA-ECMO circulatory support, and infection prevention measures, etc. During the first 3 days of VA-ECMO support, his end-tidal carbon dioxide gradually increased to normal levels, heart ultrasound showed a significant increase in LVEF, and markers including troponin, myoglobin, creatine kinase isoenzymes, and D-dimer showed a decreasing trend. With the same ventilator settings, the patient's arterial oxygen partial pressure showed no significant fluctuations despite reducing the VA-ECMO parameters. Systemic heparinization anticoagulation was performed for a sustained period during the hospitalization, and pulmonary arteriography on the 4th day confirmed the right ventricular pressure is 26/-5 mmHg, and the pulmonary arterial pressure is 22/-1 mmHg, clear pulmonary arteries bilaterally without any filling defects (Fig. 2). The VA-ECMO was successfully removed after angiography. The patient's transoral intubation was removed on the 5th day, transferred out of the ICU on the 8th day, and discharged on the 13th day. There were no neurological or limb function complications observed during the 90-day follow-up.

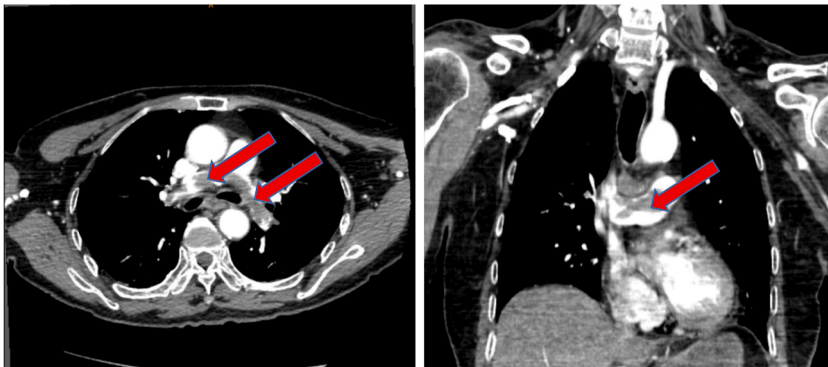


Fig. 1. On the day of admission, enhanced CT showed bilateral pulmonary artery trunk embolization.



Fig. 2. On the 4th day of hospitalization, bilateral pulmonary angiography showed good vascular filling.

3. Discussion

The initial clinical manifestations of pulmonary embolism (PE) are varied, many patients experience asymptomatic or mild symptoms, making prompt identification and diagnosis challenging. As a result, most patients require imaging and other ancillary tests to confirm the diagnosis [7–9]. Despite increasing rates of PE diagnosis, a concerning 59 % of high-risk patients remain undiagnosed until death [10]. Once the PE diagnosis is confirmed, an immediate assessment of the risk level is necessary to develop an appropriate treatment plan. However, the classification process should not solely rely on the size of the thrombus [11].

In this case, the source of the embolus in the pulmonary embolism cannot be determined, and the event's timing remains uncertain. Specific indicators are lacking to distinguish whether the pulmonary embolism is primary or originated from other venous systems. Instead, one can only be hypothesized on the basis the patient's clinical presentation and relevant tests and examinations. This hypothesis is supported by the patient's advanced age, the poor quality of systemic blood vessels, prior history of cerebral infarction, long-term use of oral antiplatelet drugs, and sedentary lifestyle. In secondary deep vein thrombosis of the lower extremities, the thrombus dislodged into the pulmonary artery trunk, leading to minor respiratory symptoms. Subsequently, the patient ceased using aspirin antiplatelet drugs, which resulted in rapid thrombus expansion, leading to the emergence of more severe respiratory distress. At this point, the size of the embolism in the pulmonary arteries is significant. In terms of treatment, we promptly initiated the Pulmonary Embolism Response Team (PERT) with the ICU as its core. And within 10 minutes, an ECMO pipeline and circulatory support were established. Considering the patient's advanced age and the risk of thrombolytic or thrombolysis, systemic heparinization was implemented to rely on the body's fibrinolytic system for thrombolysis. This approach ensured that the embolism could be effectively eliminated while being supported by extracorporeal circulation, thus mitigating the risk of life-threatening cardiovascular events [12].

In the treatment of MPE, there are many doubts surrounding the use of ECMO, with some studies excluding patients over 80 years old [13]. ECMO, as an advanced life support measure, has a role in MPE treatment mainly by achieving systemic anticoagulation effects with heparinization. However, in elderly patients with comorbidities such as cerebral hemorrhage or stroke, this additional therapeutic effect becomes a relative contraindication. For such patients, mechanical thrombectomy is one of the preferred approaches. While emergency mechanical thrombectomy might be a viable option for this patient, the advanced age and a history of cerebrovascular disease, extensive thrombus burden, and uncertain time of thrombus formation can potentially lead to catastrophic consequences such as thrombus dislodgement and rapid circulatory deterioration.

For elderly patients, the primary concern lies in their compromised vascular health, diminished cardiac and pulmonary reserve, decreased tolerance to hypoxia, and the urgent need for a reliable program to deliver oxygen support. In cases where high-risk pulmonary embolism accompanies obstructive shock, ECMO proves to be the optimal choice for stable circulatory support. Therefore, we chose to perform a thrombectomy on the 4th day under the protection of VA-ECMO circulatory support, following a comprehensive assessment of the patient's overall condition. During the procedure, it was observed that the thrombus in the patient had completely dissolved. This indirectly confirms that the patient's extensive pulmonary embolism was a recent development. Performing thrombectomy intervention earlier without extracorporeal circulatory support could have posed higher risks. Our treatment plan was the most suitable for this patient. Additionally, once a stable systemic blood and oxygen supply is established to maintain the proper function of oxygen-consuming organs, a prompt evaluation of thrombolysis protocols becomes crucial. It is important to note that elderly patients face a higher risk of complications with thrombolysis, particularly the grave consequence of cerebral hemorrhage, outweighing the potential benefits of rapidly addressing pulmonary embolism emboli. Consequently, routine thrombolysis is not recommended [14–16]. It is worth emphasizing that ECMO is increasingly being used in conditions that were previously considered relatively contraindicated. With the arrival of global aging, when a large number of elderly patients with concomitant cerebral infarction experience MPE, our team, based on existing literature and guidelines, chooses a more conservative approach of prioritizing life-saving treatment, which is the optimal choice for this patient [17]. The patient's coagulation balance during ECMO treatment is undoubtedly a significant challenge, while another challenge is to prevent new-onset neurological complications and avoid exacerbation of pre-existing ischemic strokes [18].

This case report observed that older patients often experience less severe bodily reactions and mild vascular reactivity. The patient under study displayed a small pulse pressure difference during the onset of obstructive shock, with only a simple decrease in systolic blood pressure. It is important to note that in elderly patients, normal diastolic blood pressure may be adequate to meet their metabolic needs, thus not manifesting various symptoms of shock. Nevertheless, during the consultation, the experienced doctor opted for an enhanced chest CT scan with the informed consent of the patient and his family. This scan revealed the presence of embolism in the bilateral aortic trunks of the lungs. Consequently, the patient was promptly admitted to the ICU for monitoring and treatment with pulmonary embolism response teams (PERT) [19]. This decision proved crucial for the survival of the patient and led to a more favorable prognosis.

As a relatively young discipline in China, critical care medicine is rapidly advancing. In the new medical landscape of the current era, critical care physicians are progressively shifting their focus from the diagnosis or treatment of specific diseases towards obtaining a comprehensive understanding of severe illnesses. Our objective is to rectify the body's dysregulated response by addressing the underlying causes of reversible diseases. However, it is important to recognize that this is not a short-term process. While the disease itself may be reversible, the body's dysregulated response may not necessarily be reversible. Therefore, under this treatment premise, formulating a personalized treatment plan based on the individual situation is necessary, and ECMO is gradually being proficiently mastered and successfully applied in relatively contraindicated cases.

4. Conclusions

We reported a case of an advanced age patient with a history of previous cerebral infarction, who had an extensive pulmonary embolism. After receiving preventive VA-ECMO treatment, bilateral pulmonary artery thrombi disappeared. We believe that VA-ECMO can be used as an emergency treatment strategy for extensive pulmonary embolism.

Ethics approval statement and patient consent statement

Medical research review by the Ethics Committee of the Army Medical Center of PLA (NO.100).

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CRedit authorship contribution statement

Shasha Wu: Writing – original draft. **Jun Liu:** Writing – review & editing. **Shifeng Shao:** Writing – review & editing, Supervision.

Declaration of competing interest

None.

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