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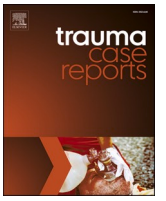

A case of fatal fulminant fat embolism syndrome saved by VA-ECMO in the acute phase of multiple trauma

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ABSTRACT

Fat embolism syndrome (FES) is a rare complication of long bone fractures, with fulminant FES developing within 12 h of injury and often proving fatal (Shaikh, 2009 [1]). Here, we present a case of fulminant FES in a patient who developed sudden right heart failure after undergoing external fixation of a lower leg fracture and required veno-arterial extracorporeal membrane oxygenation (VA-ECMO). A 79-year-old woman injured in a traffic accident was transferred to our emergency department. Upon arrival, her level of consciousness deteriorated, and she developed circulatory failure. We promptly performed transcatheter arterial embolization for the pelvic fracture and external fixation of the tibiofibular fracture. Within four hours of the injury, she was admitted to our intensive care unit (ICU). Two hours after ICU admission, her hemodynamic status worsened, necessitating the administration of maximum catecholamine dose. Echocardiography revealed petechial hemorrhage of the palpebral conjunctiva and enlargement of the right ventricle. Despite maximal supportive care, the patient remained cardiovascularly unstable. Therefore, VA-ECMO was initiated to stabilize her hemodynamic status. Thereafter, her hemodynamics stabilized, and ECMO support was weaned off and removed on day 3. Subsequent magnetic resonance imaging revealed evidence of cerebral fat embolism. On day 9, she underwent open reduction of the left lower leg with internal fixation and was transferred to another hospital on day 29. This report documents the successful management of fulminant FES during the acute phase of multiple traumas. Clinicians should consider VA-ECMO when suspecting uncontrolled circulatory failure due to fulminant FES, even in the acute phase of multiple trauma.

Introduction

Fat embolism syndrome (FES) is a rare complication of long bone fractures, with fulminant FES being the most fatal form, typically occurring within 12 h of injury. It has a very high mortality rate due to acute right-sided heart failure [1]. Supportive care remains the mainstay of therapy. Here, we report a case of fulminant FES in a patient who developed acute right heart failure and was rescued by venoarterial extracorporeal membrane oxygenation (VA-ECMO) in the early phase after trauma.

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Case presentation

A 79-year-old woman injured in a traffic accident was admitted to our emergency department (ED). Despite hypoxemia (oxygen saturation of 90 % with a 10 L mask), she was alert (Glasgow coma scale [GCS] score of 15 [E4V5M6]), and other vital signs were normal. However, during examination in the ED, her level of consciousness suddenly deteriorated (GCS score of 4 [E2V1M1]), and she developed circulatory failure (blood pressure of 67/46 mmHg). Computed tomography (CT) revealed an open fracture of the tibiofibular diaphysis and pelvic fracture with contrast extravasation. Immediate transcatheter arterial embolization of the pelvic fracture was performed. After stabilizing her blood pressure, external fixation of the tibiofibular fracture was performed in the operating room two hours after the injury, and the patient was transferred to our intensive care unit (ICU).

After admission to the ICU, her levels of consciousness and oxygenation did not improve. Two hours after ICU admission, she developed cardiovascular instability and required an intravenous infusion of norepinephrine and dobutamine. Despite administering catecholamine and increasing the dosage of norepinephrine and dobutamine to 0.32 γ and 3.85 γ, respectively, her vital signs remained unstable, and moderate hypoxemia persisted (PaO_2/FiO_2 [P/F] ratio 111). Echocardiography revealed marked right ventricular enlargement and left ventricular pressure drainage with severe tricuspid regurgitation. No other findings suggestive of blunt cardiac injury were observed (Fig. 1A). Additionally, the patient exhibited petechial hemorrhage of the palpebral conjunctiva (Fig. 2). Contrast-enhanced CT was repeated to rule out pulmonary embolism, and no massive thrombus was found in the pulmonary artery. However, a slight increase in hematoma was observed around the pelvic fracture site. Thus, we suspected that she had developed fulminant FES and decided to initiate VA-ECMO. While initiating the VA-ECMO procedure, the patient experienced a cardiac arrest for a brief period. After implementing VA-ECMO, her oxygenation level and hemodynamics improved, and ECMO support was weaned off and removed on day 3.

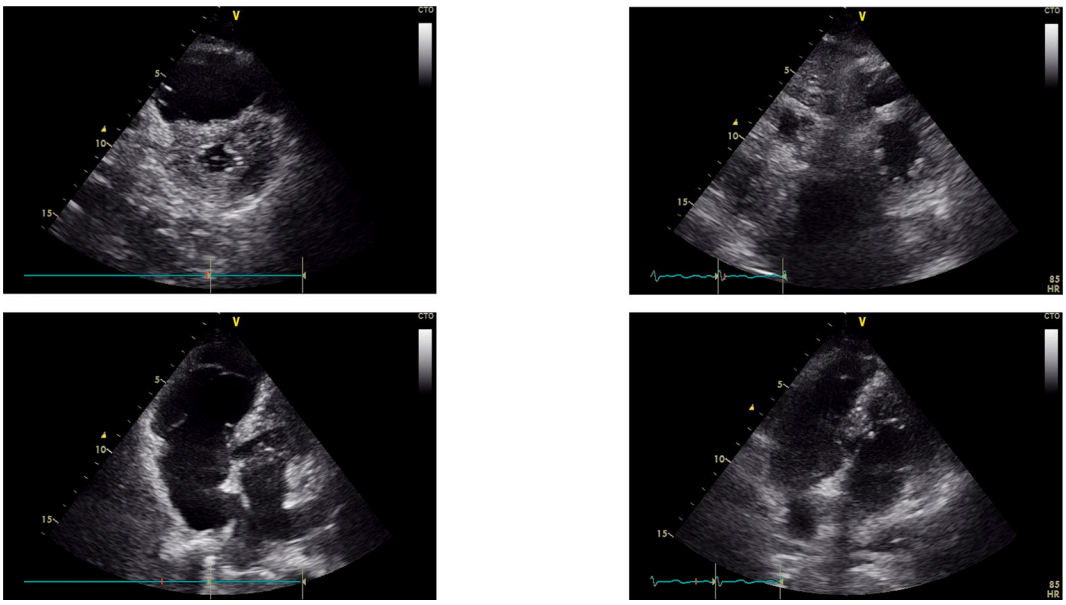
On day 6, brain magnetic resonance imaging revealed several monotonous punctuate microbleeds in the subcortical white matter characteristic of the “walnut kernel microbleed pattern”, and is indicative of cerebral fat embolism [2] (Fig. 3). Thus, we confirmed the diagnosis of FES. On day 8, echocardiography showed improvement in the enlargement of the right ventricle and atrium (Fig. 1B). On day 9, the patient underwent open reduction of the left lower leg with internal fixation. She was then transferred to another hospital on day 29.

The patient provided written informed consent for the publication of this case report.

Discussion

We encountered a case of fulminant FES that occurred within 12 h after injury and was rescued by VA-ECMO. This case underscores the clinical implications for managing fulminant FES.

In this case, VA-ECMO proved invaluable for rescuing a patient with fulminant FES and drastic circulatory failure. Despite



(a) day2
short axis and four chamber view

(b) day8
short axis and four chamber view

Fig. 1. (1A performed on day 2, 1B performed on day 8)
Echocardiography revealed enlargement of the right ventricle and atrium (short-axis and four-chamber view). After the patient did not require ECMO support.

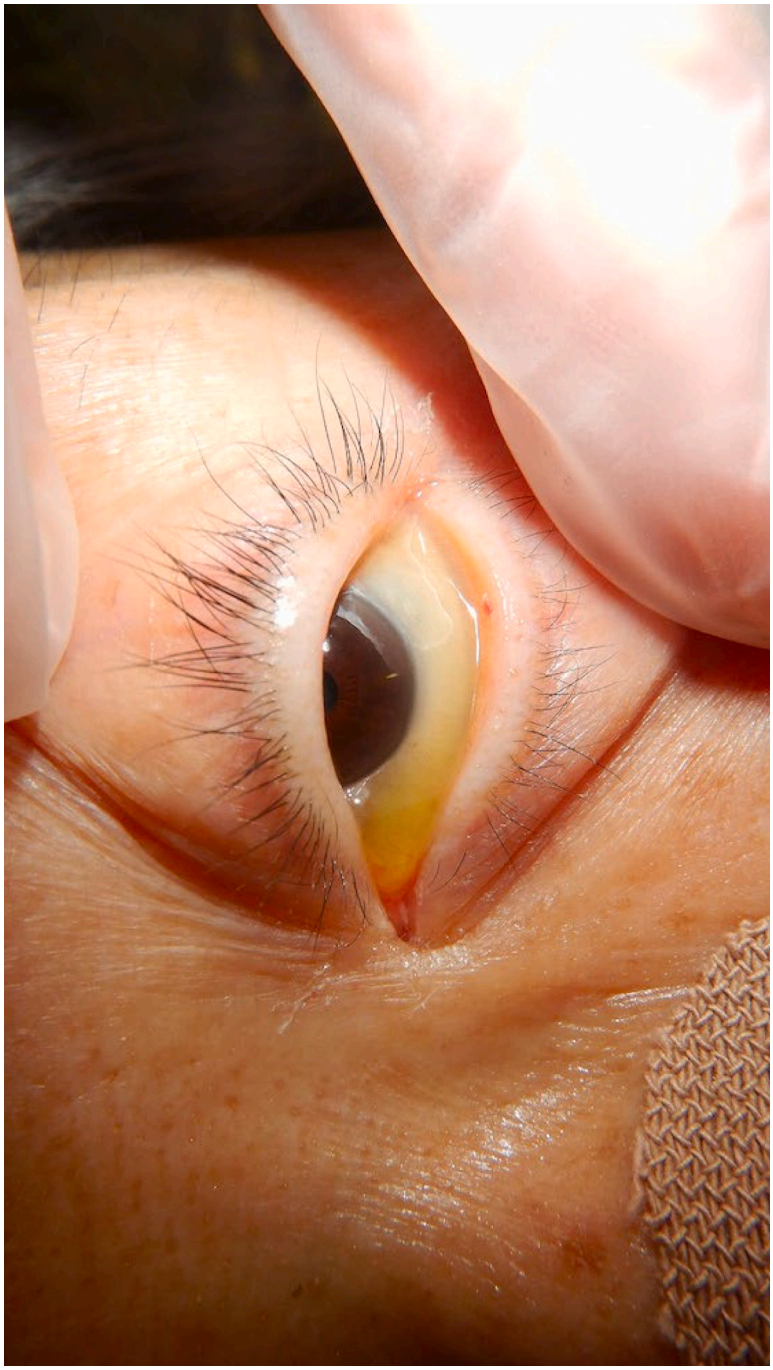
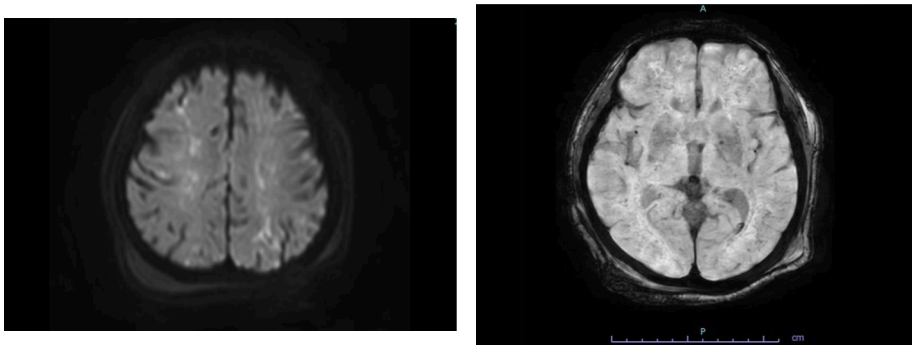


Fig. 2. Petechial hemorrhage of the patient's palpebral conjunctiva.



diffusion-weighted imaging susceptibility-weighted imaging

Fig. 3. MRI on day 6 revealed diffuse high-intensity areas on diffusion-weighted imaging and several microbleeds consistent with the "walnut kernel" pattern on susceptibility-weighted imaging.

administering the maximum dose of catecholamine, mechanical ventilation support, and appropriate transfusion after admission to the ICU, her hemodynamic status continued to deteriorate. All supportive care procedures except VA-ECMO were performed at that time. FES was suspected based on the physical and ultrasonography findings; however, we were unable to confirm the diagnosis. Nevertheless, given the high likelihood of circulatory failure due to FES, we decided to implement VA-ECMO. Fortunately, the patient had no head trauma, and a preliminary CT showed no hemorrhagic lesions, allowing for the administration of VA-ECMO without complications. Considering the severity of the circulatory failure, we believe that the patient could not have been saved without implementing VA-ECMO.

Despite its high mortality rate, fulminant FES currently lacks a fundamental treatment [1]. The utility of VA-ECMO in FES remains uncertain. Several case reports describe the implementation of VA-ECMO for managing FES during elective surgery [3,4]. A case report details a patient with posttraumatic FES who was rescued by VA-ECMO 48 h after injury [5]. However, as in our case, it is very rare to rescue patients with fulminant FES, which occurs immediately after injury in such a rapid course, using VA-ECMO.

In terms of the etiology of FES, it is reasonable for clinicians to consider introducing VA-ECMO for life-threatening fulminant FES. Insufficient circulation in FES is reportedly triggered by occlusion of pulmonary vessels with fat droplets from bone marrow or fatty tissues [6]. Occlusion of the pulmonary vessels is thought to increase the afterload on the right heart system and decrease the output of the left ventricle. Considering the effect of VA-ECMO on circulation, which significantly decreases the preload of the right heart system, we suggest that it significantly affects the insufficient circulation observed in FES.

In clinical settings, confirming the diagnosis of FES is challenging due to its rapid time course. Moreover, it is not common practice to introduce VA-ECMO in patients with acute trauma and potential hemorrhagic circulatory failure. Given these clinical complexities, determining whether to introduce VA-ECMO in patients with trauma is challenging. For early detection and treatment, clinicians should consider fulminant FES as a differential diagnosis when a patient with trauma develops rapid circulatory failure. Additionally, VA-ECMO should be considered when supportive care is ineffective and there is a very low possibility of hemorrhagic shock.

Conclusions

This report documents the successful treatment of an acute trauma patient with fulminant FES using VA-ECMO. In patients with fulminant FES wherein supportive care is ineffective, VA-ECMO can be a life-saving treatment.

CRediT authorship contribution statement

Yuki Yamafuji: Writing – original draft, Writing – review & editing. **Masafumi Suga:** Writing – review & editing. **Seiya Fujisawa:** Writing – review & editing. **Gentoku Oosuki:** Writing – review & editing. **Takuya Taira:** Writing – review & editing. **Ryo Takahashi:** Writing – review & editing. **Shigenari Matsuyama:** Writing – review & editing. **Satoshi Ishihara:** Writing – review & editing.

Declaration of competing interest

The authors declare no conflict of interest.

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Ethics statement

The patient provided written informed consent.

Consent statement

The patient provided written informed consent for publication of this case report.

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