Diagnostic significance of fat globules in blood in fulminant-type fat embolism syndrome

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Abstract

Detecting fat globules in blood in diagnosing fat embolism syndrome (FES) remains controversial. This case illustrated two life threatening episodes possibly due to FES, with a dramatic increases of fat globules in blood. Significance of quantitative change of fat in blood in diagnosing FES should be evaluated in the future.

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INTRODUCTION

Fat embolism syndrome (FES) typically occurs after major trauma generally involving fractures of the pelvis and/or the femur and manifests clinical symptoms 12–72 h after the insult[1]. It is a clinical diagnosis made based on the symptoms of cerebral symptoms, respiratory distress, petechial rash with or without acute circulatory failure, kidney injury, thrombocytopenia, anaemia and so on[2]. It is also known that FES develops after bone fixation surgery[3]. Although fat entering from the fractured bone marrow into the systemic circulation plays a vital role, detection of fat in blood has not been widely performed for diagnosing FES, and the significance of fat globules in blood remains unknown.

In this report, we describe a case of a trauma patient who developed two episodes of severe circulatory and respiratory compromise that finally resulted in cardiac arrest presumably due to FES. In particular, we retrospectively investigated the serial changes in fat globules in the blood smear samples of this patient in association with clinical deterioration.

CASE PRESENTATION

A 63-year-old man was injured by hitting a truck while driving a car. He was hospitalised with a left pelvic fracture, multiple vertebral fractures and multiple rib fractures. The pelvic fractures were complicated fractures which reached pubic, ischium, ilium and the sacroiliac joint. On admission, haemoglobin, haematocrit,

and platelets were 16.8 g/dl, 50.1%, and 217×10^3 /μl, respectively. His general status was stable, except severe delirium that developed on the 2nd to 4th day after admission.

On the 6th admission day, he underwent a vertebroplasty of the 12th thoracic vertebra and a posterior fixation surgery at the level between the 3rd thoracic vertebra and the 3rdlumbar vertebra. Immediately after the 6-h operation, when his body position was changed from prone to supine in the operating room, his blood pressure declined to 48/25 mmHg and oxygen saturation decreased from 99% to 90% with inspiring 40% fraction of oxygen. Although these symptoms soon improved, severe delirium relapsed when he was brought to the general ward. The blood test performed immediately after the operation revealed an increased serum creatinine from a baseline level of 0.54 mg/dl to a postoperative level of 1.82 mg/dl.

On the 8th day, immediately after the postural change in the general ward, he again suddenly lost consciousness, with the blood pressure and heart rate being 68/26 mmHg and of 116 beats per min, respectively. The medical emergency team was called, and he was intubated promptly. Transthoracic echocardiography showed marked enlargement of the right-sided heart accompanied by McConnell's sign, namely, akinesis of the mid free wall with apical hyperkinesis of the right ventricle. Then, ventricular fibrillation occurred, and cardiopulmonary resuscitation was initiated. We suspected that the patient could have massive pulmonary thromboembolism and then initiated venoarterial extracorporeal life support using a heart–lung machine. Spontaneous circulation was returned 30 min after the cardiac arrest. Life-supporting treatment, including extracorporeal membrane oxygenation and mechanical ventilation, along with medical treatment was continued.

Despite our best efforts, he died of severe brain oedema due to ischaemic encephalopathy on the 9th admission day.

INVESTIGATIONS

A brain computed tomography (CT) revealed diffuse swelling. A contrast-enhanced CT scan of the chest showed marked enlargement of the right-sided heart, patchy ground-glass appearance in the bilateral lung field, and consolidation in the S6 region of the right lung. However, there was no thrombus in the pulmonary artery. Petechiae were prominent on his skin of the anterior thorax, and his blood test disclosed thrombocytopenia with a platelet count of 75×10^3/μl, anaemia with a haemoglobin level of 7.5 g/dl and coagulopathy with an activated partial thromboplastin time of 79.6 (reference range: 25-35) s, prothrombin time-international normalized ratio of 2.31 and d-dimer level of 73.7 μg/ml.

Based on all these findings, we made a diagnosis of FES according to Gurd and Wilson criteria[2]. Retrospectively, we examined fat globules in peripheral blood by Giemsa staining using his whole blood samples preserved in our laboratory. Our findings showed a few white round bodies representing fat globules in blood in the sample collected on the 4th day (Figure 1a.). However, the number of fat globules with various sizes increased dramatically after the first collapse on the 6th day (Figure 1b.). Thereafter, they almost disappeared from the sample collected on the 7th day (Figure 1c.) but again increased in the sample collected 1 h before the cardiac arrest on the 8th day (Figure 1d.); all these findings corresponded to his clinical deterioration. Using fat-specific Sudan Black staining, we further confirmed that the white round bodies were definitely fat globules (Figure 1e.). Figure 2 shows serial changes of fraction of the area occupied by fat globules in microscopic fields shown as Figure 1a-d.

DISCUSSION

The clinical course of this patient with major trauma was characterised by two episodes of dramatic circulatory compromise that occurred after changing his body position. Although our snap diagnosis was pulmonary thromboembolism, the contrast-enhanced CT scan showed no signs of thrombus in the pulmonary artery. The patient developed delirium, acute kidney injury, skin petechiae, thrombocytopenia, anaemia and coagulopathy, all of which were supportive of the final diagnosis of FES[2].

Bajuri et al. [4] proposed two variants of FES; an acute fulminant type and a classic type. The former type of FES develops in a short period through an obstructive mechanism often accompanied by severe

hypotension and hypoxemia, whereas the latter typically has a latency period of 24–36 h through subsequent biochemical reactions presenting with various organ symptoms, including the brain, skin, kidney, blood cell and coagulation. In our patient, both variants were therefore overlapped during the 9-day hospital course.

Importantly, according to our investigation, massive fat globules appeared in the blood samples collected immediately after the two episodes of circulatory collapse.

Significance of detecting fat globules in blood remains controversial; in fact, some diagnostic criteria includes it[2], while others not[5]. One possible explanation is the lack of specificity. Fat globules in blood could be observed in trauma patients without the development of FES and even in non-trauma patients[6]. In patients with traumatic long bone fractures, fat embolism itself in the pathology was observed in >90% of cases, whereas the incidence of FES, which was diagnosed based on Gurd's criteria, was 0.9%[5].

However, in acute fulminant FES occurring through the mechanism of massive embolism of pulmonary microcirculation[7], the amount of fat globules in blood may correspond to the clinical symptoms, which was observed in our case. A previous report indicated that fat globules can pass through pulmonary microcirculation because of their deformability and enter systemic circulation within 3 h after bone surgery[8]. Moreover, fat globules can pass through patent foramen ovale and other arteriovenous shunts in the subpleural parts of the lungs or anastomoses between bronchial or pulmonary arteries and capillary net in the peribronchial tissues[9]. Our case indicates that serial changes in a quantity of fat globules may have great significance in some cases of FES, and should be evaluated in the future.

Our patient developed FES almost a week after the trauma. It is possible that fat globules could have entered into systemic circulation intermittently from unstable fractured bones that had not been surgically fixed. A previous study reported that the period of fat globulemia was longer in patients with long bone fractures treated conservatively than in patients with fractures surgically fixed early[10]. If this were the case, stabilising the fractured bones as early as possible may prevent the risk of FES[11].

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Author1; Ayu Asakage: The author contributed to the conception to the work, obtaining patient's consent to request confidential data, analysing and interpreting data and submitting the final version of the report for publication.

Author2; Michiko Fujisawa: The author contributed to critical revision of the report and general advice.

Author3; Tetsuhiro Takei: The author contributed to critical revision of the report and general advice.

Author4; Jiro Kumagai: The author contributedto pathological supervision for figure creation.

ETHICAL APPROVAL

The patient has given his written informed consent to publish his case including publication of images.

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