CASE REPORT

Two variants of fat embolism syndrome evolving in a young patient with multiple fractures

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SUMMARY

Fat embolism syndrome (FES) is a continuum of fat emboli. Variants of FES: acute fulminant form and classic FES are postulated to represent two different pathomechanisms. Acute fulminant FES occurs during the first 24 h. It is attributed to massive mechanical blockage pulmonary vasculature by the fat emboli. The classic FES typically has a latency period of 24–36 h manifestation of respiratory failure and other signs of fat embolism. Progression of asymptomatic fat embolism with FES frequently represents inadequate treatment of hypovolaemic shock. We present a rare case of two variants of FES evolving in a patient with multiple fractures to emphasis the importance of adequate and appropriate treatment of shock in preventing the development of FES. Since supportive therapy which is a ventilatory support remains as the treatment of FES, it is appropriate to treat FES in the intensive care unit setting.

Malaysia Medical Centre (A&E UKMMC), following a motor bike accident which occurred at 10:20 h on 2 February. His motorcycle rammed into a stationary car.

He arrived with a severe pain over the right thigh, right forearm and hand. He had a brief loss of consciousness and transient amnesia as he could not recall the exact mechanism of injury. His Glasgow Coma Scale (GCS) was 15/15, pulse rate 92 bpm, blood pressure 165/93 mm Hg and a baseline haemoglobin of 15.4 g/dl (haematocrit 46.2%) and platelet count 264. Neurocirculatory status was intact for the injured tender, deformed and swollen limbs. There was an open wound of 2×1 cm at zone 6 extensor aspect of the right hand fourth web space. Significant life-threatening thoracic and intra-abdominal injury was ruled out. CT scan of the brain performed at 13:00 h was reported as normal. The appropriate radiographic imaging revealed multiple fractures of the upper and lower extremity (figure 1).

INTRODUCTION

Fat embolism syndrome (FES) is a clinical syndrome characterised by the presence of fat emboli in the circulation with the additional manifestations of an identifiable clinical pattern of signs and symptoms.

Depending on the time of stabilisation, type of fracture treatment and location of the fracture, the incidence of FES associated with femoral shaft fractures is 0.9–13.2%.^{1–2} The death rate of FES is 5–10%.^{3–5} In polytrauma patients, it can be difficult to attribute pulmonary or brain dysfunction to fat emboli.

We report a unique case of evolving FES representing both early-onset and late-onset variants with sufficient supportive treatment and prompt fixation.

This case also dispels myth that FES is a contraindication for interlocking of long bone fixation. The issue of immediate or early stabilisation is no longer controversial. With current techniques; intramedullary nailing (IMN) has become a possible consideration if a new device RIA (reaming, insertion and aspiration) is used.

A written informed consent was obtained from the patient for publication of this case report and accompanying images.

CASE PRESENTATION

A 25-year-old man presented to the Accident & Emergency Trauma Zone of Universiti Kebangsaan

Figure 1 (A) Fracture of the right mid-shaft femur Winquist I; (B and C) Galeazzi fracture of the distal third right radius; (D and E) open fracture of the right midshaft fourth metacarpal; and (F) no evidence of any rib fracture or haemopneumothorax.

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The orthopaedic and traumatology unit was contacted by 14:00 h. The patient was transferred to the trauma ward for fluid replacement therapy with 8 pints of intravenous normal saline 0.9% with strict input and output charting. Skin traction was applied for the right lower limb as he has an interlocking nail in the ipsilateral tibia owing to a previous trauma about 3 years ago. The wound was irrigated with normal saline 0.9% and plaster backslab applied to the right forearm and hand. Intravenous cefuroxime and appropriate analgesics were prescribed. He was scheduled for fixation next morning, as the emergency operating theatre was hectic with other urgent cases.

Approximately at around 13 h after the accident, the patient had developed tachycardia and fever 37.8°C without sign of shortness of breath. The pulse oximetry revealed an oxygen saturation of 92–94% under room air. He was supported with 3 litre nasal prong oxygen after which the saturation became 99%. Arterial blood gas (ABG) showed no respiratory acidosis. ECG did not reveal any right heart strain.

After 7 h, he showed poor respiratory effort. However, air entry was equal and there was no crepitations and rhonchi. Pulse oximetry showed that the oxygen saturation dropped to 94% despite 3 litre nasal prong. Face mask of 5 litre was substituted. He was still tachycardic with haemoglobin 12.5 g/dl (haematocrit 37.4%) and platelet count 235.

Examination at this stage revealed a depressed level of consciousness. His clinical cognitive capability, level of attention and working memory were grossly impaired. His response time was slow and he seemed depressed. His GCS score was 14/15 and a referral to the neurosurgical team was immediately made. An urgent CT of the brain was repeated at 15:00 h and there was no findings of any abnormal pathological lesion. D-dimer test was performed, however positive at 2.58. Interestingly the ABG showed a compensated respiratory alkalotic picture.

An urgent spiral CT pulmonary angiogram (CTPA) depicted minimal contusions of the posterobasal segment of both the lower lobes. It did not require any surgical intervention and was not an absolute contraindication for the operation planned (figure 2).

Forty-eight hours after the initial trauma, the patient developed more classic signs of FES, namely scarce petechiae over both conjunctivas in the morning of 4 February. He was still tachycardic and had fever. We proceeded with the operation with all the fractures reduced and stabilised with extramedullary fixation device using a dynamic compression plate (figure 3).

On the next day postoperation, the patient was pale with haemoglobin 9.3 g/dl (haematocrit 27.3%) and platelet 161. He was still tachycardic and the temperature was spiking at 38.5°C. The pulse oximetry dropped despite of nasal prong oxygenation. He was supported with high flow mask 100%. A repeat full

blood count showed haemoglobin 8.7 g/dl (haematocrit 25.8%) and platelet 122. The petechiae had extended to the anterior chest wall and both the axilla. A total of 3 pints of packed cell was transfused. Haemoglobin was optimised to 10 g/dl. His GCS was full but he seemed depressed and he was slightly slow to respond to the regular morning assessment.

Chest radiograph showed patchy haziness at the lower zones bilaterally (figures 4 and 5). Blood and sputum sent to exclude nosocomial pneumonia with sepsis did not grow any organisms. A repeat CTPA was performed at 17:00 h to exclude any worsening contusion or pulmonary embolism (PE). There were diffuse ground glass opacities seen in both the lungs, predominantly over the lower lobes. Some areas of ground glass opacities have coalesced to form consolidation. There were multiple small lung nodules seen bilaterally and mild interlobular septa thickening seen in the lower lobes. These changes were not seen in the previous study. Minimal pleural effusion was also present bilaterally. Features are highly suspicious of fat embolism (FE). Oxygen support was given accordingly and deep breathing exercise plus chest and limb physiotherapy was instituted.

On 6 February, at about 12:00 h patient had one episode of epistaxis. The otorhinolaryngology team performed a fiberoptic laryngoscopic evaluation and excluded local pathology. On day 7 post-trauma the distribution of petechiae extended to the whole abdomen (figure 6). He was orientated to person and place but had a slow reaction time with a seemingly blunt affect. With the aid of physiotherapy, he began mobilising on wheel chair.

After gradual tapering of the Venturi mask oxygen support, he was put back on the 3-litre nasal prong oxygen on day 8 post-trauma. He had a drastic positive change in his behaviour and personality. He was more attentive, talkative and cheerful. Oxygen therapy was finally stopped and he was eventually discharged on 12 February, with outpatient rehabilitation in the physiotherapy unit and subsequent follow-up in the orthopaedic clinic.

DIFFERENTIAL DIAGNOSIS

Pulmonary embolism.

OUTCOME AND FOLLOW-UP

Upon follow-up he remains well and had achieved full union after 3-month postoperative.

Progression was good with no complications.

DISCUSSION

FE occurs readily in humans, mainly after trauma and is most often asymptomatic, while the FES has an incidence between 1% and 29% in various series.⁶ The syndrome may present across a spectrum from subclinical features to a fulminant course including a cerebral form, which carries higher mortality.⁷ The incidence was reported to be higher in closed fractures in comparison to open fractures.⁸ In patients more than 72 h postinjury, or postoperative one must exclude possible pulmonary thromboembolism from the differential diagnosis.

The typical clinical picture is that of acute lung injury, that may even progress to acute cor pulmonale in the fulminant type;⁸ however, only a minority requires ventilation. The lung is usually the first organ to be involved; and manifest symptoms between 24 and 72 h leading to respiratory acidosis. Our patient's ABG did not elicit a respiratory or metabolic acidosis picture maybe because of the early and adequate supportive treatment. Lung contusion has been demonstrated to cause a leak of blood and plasma that fills the alveoli, which reduces

Figure 2 CT pulmonary angiogram with (A) and without (B) contrast showing petechial lesions at the posterobasal segments of both the lobes suggestive of contusion.

Figure 3 (A and B) The x-rays of the anteroposterior and lateral view of the right femur. A broad dynamic compression plate was used to stabilise the fracture. (C and D) Anteroposterior and lateral views of the right upper extremities. A miniplate was used to stabilise the right fourth metacarpal. A small dynamic compression plate and a Kirschner wire (k-wire) were used to stabilise the right radius and distal radioulnar joint.

ventilation and decreases the regional ventilation-to-perfusion ratio, and produces hypoxaemia.⁹ The vascular response to alveolar hypoxia is vasoconstriction. The regional vasoconstriction leads to a physiological redistribution of blood from the contused to the non-contused lung; Elmaraghy *et al*¹⁰ reported a larger proportion of fat deposition in the non-contused lung areas than contused ones. This finding could indicate a redistribution of the pulmonary circulation because of the injury. The combination of pulmonary FE and lung contusion leads to substantially more pulmonary dysfunction than either form of injury alone.

The effect of fat on the lungs seems to appear in two phases: first, the immediate effect of the mechanical obstruction of pulmonary capillaries and second, the toxic and biochemical effects

associated with vasculitis, pneumonitis and a local inflammatory reaction.¹¹ A hypothesis has been formulated that fat emboli through free fatty acids (FFAs) is implicated as a causative factor in the pathogenesis of acute inflammatory reaction in pulmonary parenchyma, resulting in a pulmonary dysfunction equal to that seen in acute respiratory distress syndrome (ARDS).¹²

In the study of Bosse *et al*,² no evidence of increased incidence of ARDS, PE, or multiorgan failure were demonstrated in multiinjured patients with chest trauma and femoral shaft fracture stabilised with reamed IMN compared to the patients with plate fracture stabilisation. Several studies^{13–15} have demonstrated that delayed stabilisation of femoral shaft fractures in patients with multiple injuries increases the incidence of pulmonary complications (ARDS, FES and pneumonia), duration of hospital stay, intensive care unit time and costs. The reduction of FES after internal fixation of long-bone fractures might be a result of a reduced marrow fat release from the fracture region following its surgical stabilisation. How the body is triggered and how it changes its pattern of reaction to the second surgical trauma is unknown.

In the studies of Wolinsky *et al*¹⁶ and Kutscha-Lissberg *et al*¹⁷ reported that the fat embolisation that occurred during reamed IMN did not significantly affect pulmonary function. The authors thus concluded that pulmonary complications were related to the severity of injury rather than the type of surgical treatment performed.¹⁷ Handolin *et al*¹⁸ compared the occurrence of PE, FES, ARDS, pneumonia and alveoloarterial oxygen tension difference in patients with pulmonary contusion only and in patients with pulmonary contusion and further immediate IMN of long-bone fractures. There was no significant difference between the groups indicating no negative impact owing to the reaming procedure.

Figure 4 Chest radiograph on post-trauma day 3.

Figure 5 (A) with contrast and (B) without contrast showing features suggestive of fat embolism syndrome.

In contrast to these studies, Pape *et al*¹⁹ found that early IMN of the femur may cause additional damage to the lungs and may trigger ARDS in multitraumatised patients with severe chest injuries. These conflicting data from clinical studies neither deny nor disprove the existence of FE or FES; rather they question the harmful effects of fat in the circulatory system. FE is experimentally proven by histological investigations and sonographic visualisation of embolic echoes after manipulation of bone marrow and an increase in intramedullary pressure.²⁰

Reaming of the intramedullary canal was associated with an increased liberation of growth factors and that the osteogenic effect of reaming could be secondary not only to the graft

debris, but also to the increased liberation of these molecules.^{21 22}

Neurological manifestations are the second most common symptoms seen and may vary from altered sensorium such as confusion, restlessness, drowsiness, to focal or generalised encephalopathy with motor-sensory deficits and sometimes coma. Our patient did exhibit altered conscious level which prompted an urgent CT scan of the brain but findings were negative. Early neurological changes may be detected on a diffusion-weighted MRI (DWMRI) in patients who do not present with the other typical manifestations.²³ This may have been useful in our patient if performed in the early phase.

The cutaneous manifestations typically present with petechiae are commonly seen in about 50% of patients. It normally appears on the conjunctivae on day 2 and may involve the chest and axilla. It generally disappears by day 7.²⁴ However in our case the petechiae extended till the abdomen and was still present till the day of discharge, that is on day 10. This is postulated to be owing to the fat droplets embolising via the sub-clavian and carotid arteries. Factors contributing to the petechial rash may include stasis, consumption of coagulation factors and platelets, and endothelial damage from FFAs leading to rupture of thin-walled capillaries.²⁵ These typically appear after the other clinical manifestations.

Numerous clinical diagnostic guideline systems exist, such as those described by Gurd,²⁶ Lindeque *et al*²⁷ and Schonfeld *et al*.²⁸ In our patient three major criteria were positive and the following minor criteria were present according to the Gurd system: tachycardia, fever and decrease in haemoglobin.²⁶

We did not test for fat globules in the sputum or urine and an erythrocyte sedimentation rate was also not performed. Retinoscopy was not performed at the early stage.

Haematological tests may reveal a decrease in haematocrit and thrombocytopenia, as occurred in our case. Fat globules may be present in the urine. Bronchoalveolar lavage may show Sudan or oil-red positive macrophages.²⁹ This was not performed in our patient.

Chest radiograph did reveal a 'snow storm' appearance owing to diffuse bilateral alveolar infiltrates, which was confirmed by a CT pulmonary scan in our patient. ECG may be non-specific or may show myocardial involvement.²³ A late laboratory marker is the serum lipase that elevates after day 3 and peaks between days 5 and 8.²³

DWMRI scan has been considered as a useful investigation in excluding cerebral FES in patients who present with acute neurological deterioration where FES is suspected.²⁵ Previous reports have indicated that FES is usually associated with

Figure 6 Petechiae with haemorrhagic spot on the conjunctiva and abdomen.

hyperintense imaging on DWMRI scans because of ischaemia.³⁰ However, hypointense imaging in a FES patient has been documented in one case report that was attributed to minute haemorrhages in the brain.²⁵

Management of FES is generally supportive including ventilatory assistance, inotropic support when indicated, adequate fluid therapy and early orthopaedic fracture stabilisation.²³ The role of steroids is controversial and may have a role in preventing or minimising the late phase, but has only been shown to be of benefit if given prior to the event,²⁹ which is impractical in cases of trauma.

Learning point

This patient presented with a case of very early onset FES, in itself a rare occurrence,³¹ with an atypical presentation and progression of disease, whose prolonged recovery period can be attributed to the neurological sequelae of bradykinetic mutism characterised by a lack of spontaneous body movement, speech and slow thought process despite intact neural pathways.³² The diffusion-weighted MRI will be useful in confirming the diagnosis in this case. Interlocking of the right femur for better rotational stability should have been the choice of implant.

Competing interests None.

Patient consent Obtained.

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REFERENCES

- Allardice DB, Meek RN, Woodruff B. Increasing our knowledge of the pathogenesis of fat embolism: a prospective study of 43 patients with fractured femoral shafts. *J Trauma* 1974;14:955–62.
- Bosse MJ, MacKenzie EJ, Riemer BL. Adult respiratory distress syndrome, pneumonia, and mortality following thoracic injury and a femoral fracture treated either with intramedullary nailing with reaming or with a plate. A comparative study. *J Bone Joint Surg* 1997;79-A:799–809.
- Gurd AR, Wilson RI. The fat embolism syndrome. *J Bone Joint Surg* 1974;56-B:408–16.
- Bulger EM, Smith DG, Maier RV. Fat embolism syndrome. A 10-year review. *Arch Surg* 1997;132:435–9.
- Fabian TC, Hoots AV, Stanford DS. Fat embolism syndrome: prospective evaluation in 92 fractures patients. *Crit Care Med* 1990;18:42–6.
- Djelouah I, Lefevre G, Ozier Y. Fat embolism in orthopaedic surgery: role of bone marrow fatty acid. *Anaesth Analg* 1997;85:441–3.
- Habashi NM, Andrews PL, Scalea TM. Therapeutic aspects of fat embolism syndrome. *Injury* 2006;37S:568–73.
- Georgopoulos D, Bouros D. Fat embolism syndrome: clinical examination is still the preferable diagnostic method. *Chest* 2003;123:982–3.
- Oppenheimer L, Craven KD, Forkert L. Pathophysiology of pulmonary contusion in dogs. *J Appl Physiol* 1979;47:718–28.
- Elmaraghy AW, Aksenov S, Byrick RJ. Pathophysiological effect of fat embolism in a canine model of pulmonary contusion. *J Bone Joint Surg* 1999;81-A:1155–64.
- Sevitt S. The significance and pathology of fat embolism. *Ann Clin Res* 1977;9:173–80.
- Curtis AM, Knowles GD, Putman CE. The three syndromes of fat embolism: pulmonary manifestations. *Yale J Biol Med* 1979;52:149–57.
- Bone LB, Johnson KD, Weigelt J. Early versus delayed stabilization of femoral fractures. A prospective randomized study. *J Bone Joint Surg* 1989;71-A:336–40.
- Charash WE, Fabian TC, Croce MA. Delayed surgical fixation of femur fractures is a risk factor for pulmonary failure independent of thoracic trauma. *J Trauma* 1994;37:667–72.
- Johnson KD, Cadambi A, Seibert GB. Incidence of adult respiratory distress syndrome in patients with multiple musculoskeletal injuries: effect of early operative stabilization of fractures. *J Trauma* 1985;25:375–84.
- Wolinsky PR, Banit D, Parker RE. Reamed intramedullary femoral nailing after induction of an “ARDSlike” state in sheep: effect on clinically applicable markers of pulmonary function. *J Orthop Trauma* 1998;12:169–76.
- Kutscha-Lissberg F, Hopf FK, Kollig E. How risky is early intramedullary nailing of femoral fractures in polytraumatized patients? *Injury* 2001;32:289–93.
- Handolin L, Pajarinen J, Lassus J. Early intramedullary nailing of lower extremity fracture and respiratory function in polytraumatized patients with a chest injury: a retrospective study of 61 patients. *Acta Orthop Scand* 2004;75:477–80.
- Pape HC, Auf'm Kolk M, Paffrath T. Primary intramedullary femur fixation in multiple trauma patients with associated lung contusion—a cause of posttraumatic ARDS? *J Trauma* 1993;34:540–8.
- Wenda K, Ritter G, Ahlers J. Detection and effects of bone marrow intravasations in operations in the area of the femoral marrow cavity. *Unfallchirurg* 1990;93:56–61.
- Jaffe FA. Petechial hemorrhages. A review of pathogenesis. *Am J Forensic Med Pathol* 1994;15:203–7.
- Wenisch S, Trinkaus K, Hild A. Human reaming debris: a source of multipotent stem cells. *Bone* 2005;36:74–83.
- Glazer JL, Onion DK. Fat embolism in a surgical patient. *J Am Board Fam Pract* 2001;14:310–13.
- Husebye EE, Lyberg T, Roise O. Bone marrow fat in the circulation: clinical entities and pathophysiological mechanisms. *Injury* 2006;37S:58–18.
- Yanagawa Y, Kaneko N, Sakamoto T, et al. Fat embolism syndrome with multiple hypo-intensity signals by head magnetic resonance imaging demonstrating a favorable outcome: a case report. *Am J Emerg Med* 2007;25:217–18.
- Gurd A. Fat embolism: an aid to diagnosis. *J Bone Joint Surg* 1970;52-B:732–7.
- Lindeque B, Schoeman H, Dommissie G, et al. Fat embolism and the fat embolism syndrome. *J Bone Joint Surg* 1987;69-B:128–31.
- Schonfeld SA, Ploysongsang Y, DiLisio R. Fat embolism prophylaxis with corticosteroids. *Ann Intern Med* 1983;99:438–43.
- Gupta A, Reilly CS. Fat embolism syndrome. *Cont Educ Anaesth Crit Care Pain* 2007;7:148–51.
- Soeger A, Daniaux M, Felber S, et al. MRI findings in cerebral fat embolism. *Eur Radiol* 1998;8:1590–3.
- Huber-Lang M, Brinkman A, Straeter J. An unusual case of early fulminant post traumatic fat embolism syndrome. *Anaesthesia* 2005;60:1141–3.
- Choudhari KA. Subarachnoid haemorrhage and akinetic mutism. *Br J Neurosurg* 2004;18:253–8.

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