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Case Series

Fat embolism syndrome: a case series and review of literature

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ABSTRACT

Fat embolism and fat embolism syndrome (FES) is a clinical spectrum characterized by dissemination of fat emboli into the systematic circulation usually as a result of orthopedic trauma and related surgical procedures. we present a case series of three patients who had FES of variable presentation and severity. In our first case patient initially developed FES pre operatively which was complicated by acute pulmonary thromboembolism in the post operative period. In our third case patient developed FES after intra medullary nail fixation of femoral shaft fracture. Fat embolism is relatively rare but fatal complication in orthopedic trauma and during long bone fracture manipulations. In addition, fat embolism is a risk factor for pulmonary thromboembolism as was evident in our first case. So, patients of fat embolism should be closely monitored for the later. Gurd and Wilson are the most commonly used criteria for the diagnosis of FES. Treatment is largely supportive and some preventive measures include early fixation of long bone fractures. Prophylactic use of steroids in a meta-analysis has been found to prevent occurrence of FES in nearly two third of patients. There is no proven role of hypertonic dextrose infusion, heparin or corticosteroids in the treatment of FES and therefore are not routinely recommended. In case of fulminant FES steroids should be considered.

Keywords: Fat embolism syndrome, Long bone fracture, Gurd and Wilson criteria

INTRODUCTION

Fat embolism syndrome (FES) occurs in 0.5-11% of the patients with a mortality of 7-10%. There is increased incidence of pulmonary thromboembolism in these patents. The first clinical presentation of FES was described by Zenker after a patient suffered a crush injury. The clinical diagnosis of this condition was given by Von Bergman.[1,2] Finally in early 70's the clinical criterion for the diagnosis of fat embolism was proposed by Gurd and final modification was done by Wilson in 1974 and established a combined Gurd and Wilson criteria which is most commonly used in clinical practice.[3-5] Although this criterion helps in the diagnosis of FES it still remains a diagnostic challenge for majority of the clinicians.

The most commonly used clinical trial of FES includes central nervous system (CNS) manifestations, respiratory failure and skin rash.[4,5] Petechial rash occurs in 50-60% of the patients, lasting transiently for 4-6 hours usually seen on anterior thorax and axillae.[6,7] Retinal lesions occurs in 50% of the patients, are self-limiting and usually disappear within weeks. There occurs an asymptomatic interval of 12-72 hours after initial injury. The highest incidence is seen in 10-40-years age group with slightly higher incidence in males.[8,9]

CASE SERIES

Case 1

A 23-year-old young healthy female was brought to orthopedic emergency department with history of road traffic accident. On assessment she had closed bilateral femoral shaft fractures (Figure 1). The fractures were immediately splinted and she was admitted for definitive

fixation. 48 hours after admission she developed sudden and progressive shortness of breath and hypoxia with an oximetric saturation of 75% on ambient air, requiring fraction of inspired oxygen (FiO_2) of 60% to maintain saturation of >94%. There was no altered sensorium, truncal rash, vision abnormality but she was febrile, restless, tachycardic and in respiratory distress. Cheat X-ray was grossly normal.

Having suffered bilateral femoral shaft fracture and subsequent immobilization a possibility of fat embolism vs pulmonary embolism was made. Computed tomography pulmonary angiogram (CTPA) was done which showed ground glass opacities in bilateral lung fields more in the lower zones consistent with interstitial hemorrhage associated with fat embolism (Figure 1). Hemogram revealed drop of hemoglobin from 13 mg/dl to 11 mg/dl and thrombocytopenia. Erythrocyte sedimentation rate (ESR) was raised and serum fat macro globules were present fulfilling the Gurd and Wilson criteria for FES. She was managed in intensive care unit (ICU) with oxygen support, aggressive vital monitoring, deep vein thrombosis (DVT) prophylaxis and intravenous methylprednisolone.

She showed progressive improvement in her oxygen saturation over a period of five days and after achieving hemodynamic stability she was subjected to fixation of fractures under spinal anesthesia and immediate post-operative course remained uneventful.

Three days after internal fixation of fracture she again developed hypoxia and was tachycardic and tachypnoeic on clinical examination. There was no fever or any new infiltrates on chest X-ray. Qualifying as high risk on Well's PTE score CTPA was done which showed thrombi in left interlobar artery and right lower lobe segmental branches (Figure 2). There was no hypotension or right ventricular strain on echocardiography and cardiac biomarkers were negative. She was started on rivaroxaban 15 mg BD. She showed improvement in oxygenation and was discharged after 15 days of complicated hospital course in hemodynamically stable condition on oral anticoagulation.

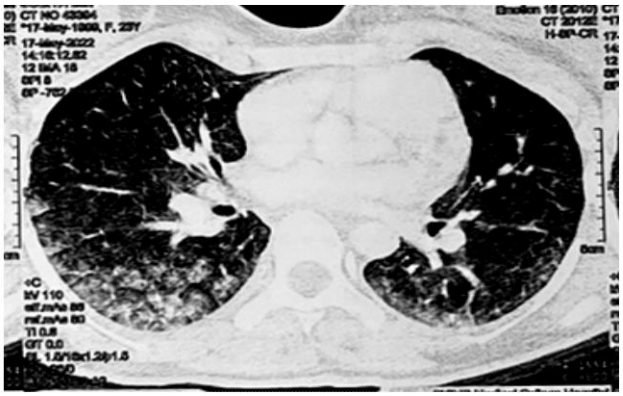

Figure 1: Shows ground glass opacities in bilateral lung fields (R>L).

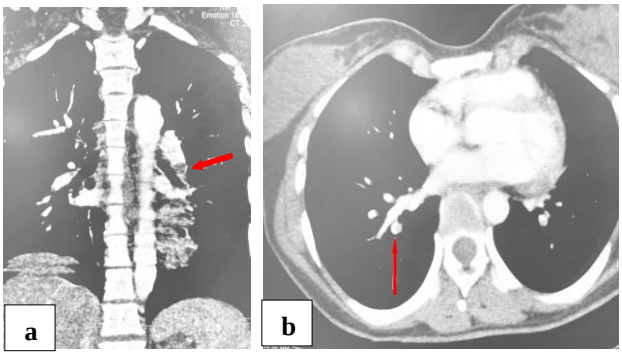

Figure 2: Depicting thrombus in (a) left interlobar artery, and (b) right lower lobe segmental artery.

Case 2

A 45-year male was referred from a secondary care hospital with sudden onset breathlessness and altered mental status two days after suffering road traffic accident in which he fractured his left tibia. On examination he was agitated, pale and tachypnoeic. X-ray chest revealed no gross infilterates. CT scan of chest revealed bilateral ground glass opacities more in the lower lobes (Figure 3). Hemogram revealed anemia and thrombocytopenia with high ESR. He was managed as fat embolism syndrome (Gurd and Wilson criteria) by immediate fixation of tibial fracture along with oxygen support and other symptomatic treatment. The patient showed signs of recovery and was discharged home after one week in a hemodynamically stable condition.

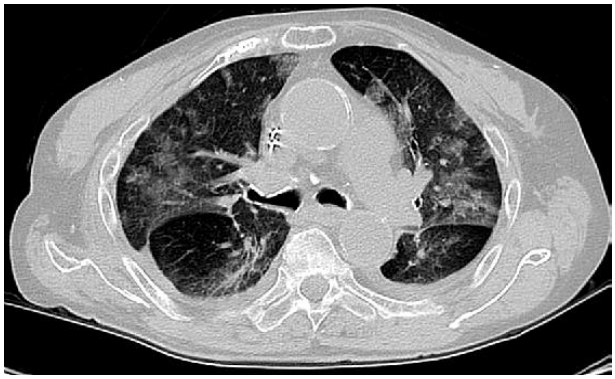

Figure 3: Depicting groundglass opacities in bilateral lung fields.

Case 3

A 25-year-old male was admitted to our hospital after suffering a road traffic accident resulting in fracture shaft of femur. After stabilization fixation of the fracture was done by intramedullary nail (Figure 4). 12 hours after the procedure patient developed hypoxia and blood gas revealed type-I respiratory failure. Having normal chest X-ray and moderate probability for PTE as per Wells criteria CTPA was done which did not reveal any thrombus but showed bilateral interstitial infiltrates with areas of ground glassing. Although the patient did not fulfil diagnostic

criteria for fess, he was managed on same lines in view of long bone fracture and intramedullary nailing. The patient showed full recovery over a period of one week.

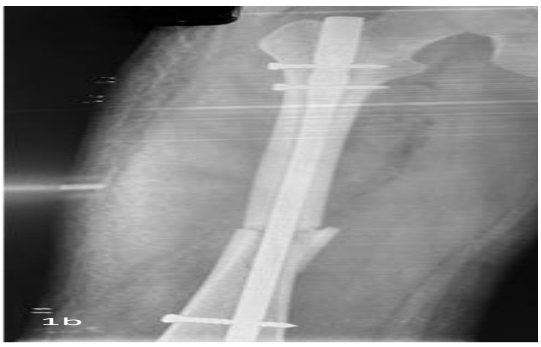

Figure 4: Shows femoral shaft fracture fixated by intramedullary nail.

DISCUSSION

FES is mostly commonly seen after orthopaedic trauma especially in a background of long bone closed fractures (case 1 and 2). It can also occur as a complication during orthopaedic surgery like after intramedullary nail fixation or manipulation of fracture sites (case 3). The incidence is 0.17% in isolated/multiple orthopaedic fractures, 0.54% in isolated femoral fractures and 1.29% in multiple fractures including femoral fractures.[10] Asymptomatic fat embolism is seen in 82% of autopsy specimens. In patients who have received CPR asymptomatic fat embolism has been found in 88 of autopsy specimens.[7] However, there are non-traumatic causes of FES which are rare but otherwise well established. These include acute or chronic pancreatitis, sickle cell crises, alcoholic liver diseases, bone marrow harvest/transplantation, liposuction, infusion of fat emulsion, steroids and lymphography.[11]

Pathophysiology

Two theories have been proposed to explain the pathophysiology of FES.

Mechanical theory

It was proposed by Gasling who suggested that fat cells after getting released from bone marrow mount a pro inflammatory cascade in addition to having a prothrombotic potential. After lodging in pulmonary circulation there occurs interstitial hemorrhage, edema, alveolar collapse resulting in reactive hypoxemic vasoconstriction. Massive fat embolism can lead to obstructive shock and even death mimicking a massive pulmonary thromboembolism.[12-14]

Biochemical theory

It was proposed by Baker et al it suggested that the fat released from the bone marrow into systemic circulation is lysed by serum lipases into glycerol and toxic free fatty acids which damage pneumocytes and endothelial cells with release of phospholipase A2, TNF alpha, interleukin 6 and CRP leading to ARDS.[12-14]

Clinical spectrum

The cardinal manifestations of FES include CNS, pulmonary and skin/integumentary disturbances. The CNS manifestations include agitation, anxiousness, restlessness and severe manifestations can be in the form of seizures and coma. Petechial rash is caused by post obstructive haemorrhage at capillary level. It is located in non-dependent regions like conjunctiva, head and neck, anterior thorax or axillae (Figure 5).[15] Ocular manifestations include cotton wool spots, exudates, retinal haemorrhage and macular edema (Figure 6).[16]

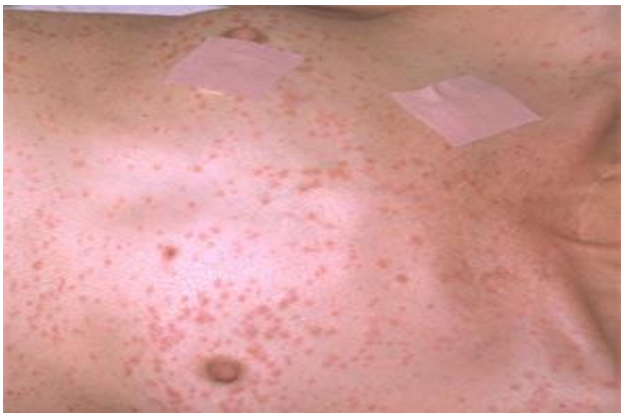

Figure 5: Classical petechial rash on thorax and axilla in a patient with fat embolism syndrome.[15]

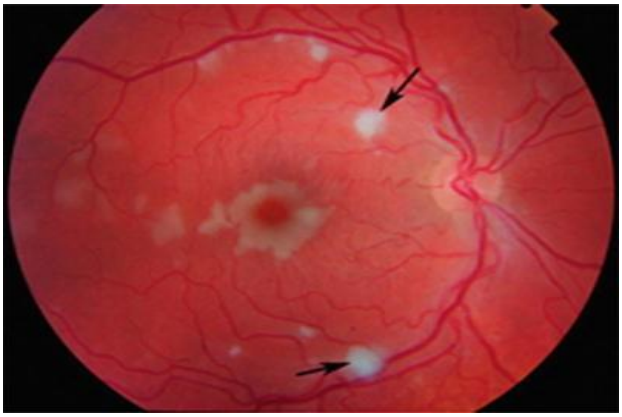

Figure 6: Image of fundus showing cotton wool spots, macular edema and few superficial hemorrhages suggestive of ocular fat embolism syndrome.[16]

Diagnosis

Following three set of criteria have been proposed for the diagnosis of FES of which Gurd and Wilson stands the most reliable and commonly used criteria (Table 1).[17]

Table 1: Diagnostic criteria for FES.

Gurd and Wilson criteria (2 major or 1 major and 4 minor criteria should be present)	Schoenfeld criteria (score of >5 is required)	Lindeque criteria (not used nowadays)
Major criteria	Petechial rash (5 points)	Sustained PO_2 <8 kp
Altered mental status in non-head injury patient	Diffuse infiltrates on chest X-ray (4 points)	PCO_2 >7.3
Petechial rash	Hypoxemia (3 points)	Respiratory rate >35 breaths per minute
Respiratory failure	Fever (1 point)	Shortness of breath, restlessness, tachycardia
Minor criteria	Tachycardia (1 point)	
Fever >38.5°C	Confusion (1 point)	
Retinal involvement		
Heart rate >110 bpm		
Renal signs		
Jaundice		
Fat macro globulinemia		
Anemia		
High ESR		
Thrombocytopenia		

ESR=Erythrocyte sedimentation rate, bpm= beats per minute, FES=fat embolism syndrome

Ancillary investigations

In addition to the above-mentioned criteria some ancillary investigations are recommended as a part of diagnostic workup of FES.

Haemogram reveals anemia and thrombocytopenia in two third of the patients. Biochemical parameters may reveal azotemia and metabolic acidosis. Arterial blood gas analysis reveals ventilation perfusion mismatch which is hallmark of FES. It also reveals low partial pressure of oxygen with increased A-a gradient.[18]

Imaging

Chest X-ray is grossly normal but can have florid presentation varying from bilateral lung infiltrates to a full-fledged pulmonary edema, diffused interstitial infiltrates and snow storm appearance (Figure 7).[18,19]

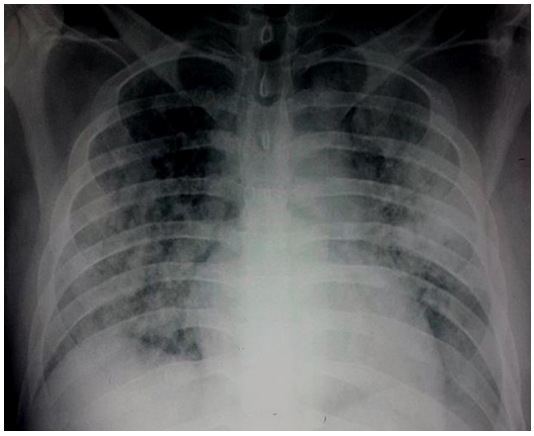

Figure 7: Chest X-ray showing bilateral diffuse infiltrates snow storm appearance.[18]

CT scan of chest

CT scan of the chest reveals areas of vascular congestion, crazy paving, ground glass opacities in geographic distribution with interlobular septal thickening, areas of consolidation and inflamed pulmonary lymph nodes or hemorrhage (Figure 8).[20-23] CT imaging of brain has low sensitivity for fat embolism but is done to rule out alternative causes for altered mental status.

MRI of brain

MRI of the brain is most sensitive to reveal fat embolism related changes. The chief areas of brain which are involved are centrum semi ovale, sub cortical white matter, ganglionic regions and thalamus (Figure 9).[24,31,32]

Management

No definitive management till date has proven to decrease the mortality in FES. The treatment lies strictly on symptomatic care and intensive ventilatory support.[28-30] Early fixation of fractures (<24 hours) has been found to prevent the occurrence of FES.[28,29] External fixation should be attempted in high-risk patients.[29] Hypertonic Dextrose infusion has been found to decrease free fatty acid mobilization. Ethanol has been tried due to its inhibitory effect on lypolysis but none of the above therapies has proved beneficial.[30] Heparin is not recommended in view of bleeding risk.

Steroids

Steroids should be considered in case of fulminant FES. These work by inhibiting compliment activated leucocyte aggregation, limiting free fatty acids levels and membrane stabilization. Meta-analysis from seven randomized

controlled trials have revealed that the use of prophylactic steroids with long bone fractures reduces the incidences of FES by 78%.[27,28] The number needed to prevent one episode of FES was eight but large trials are needed to confirm the above findings. Some techniques which have been advocated to decrease the leakage of fat cells into systemic circulation but have not found beneficial in reducing the occurrence of FES are: bone marrow lavage prior to fixation, femoral bone venting, and creation of small holes by drilling the cortex of long bone to reduce intra medullary pressure.[29]

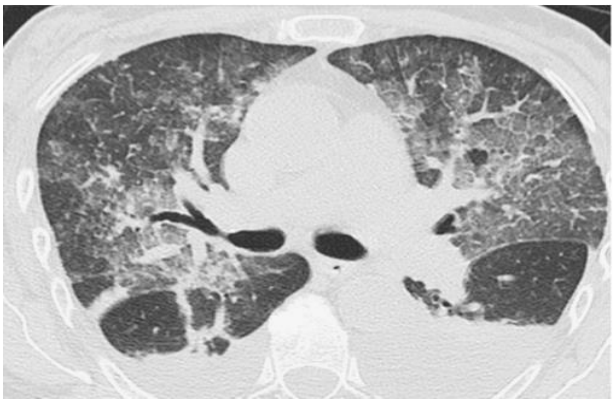

Figure 8: CT image of chest showing extensive bilateral crazy paving pattern more in perihilar regions.[20]

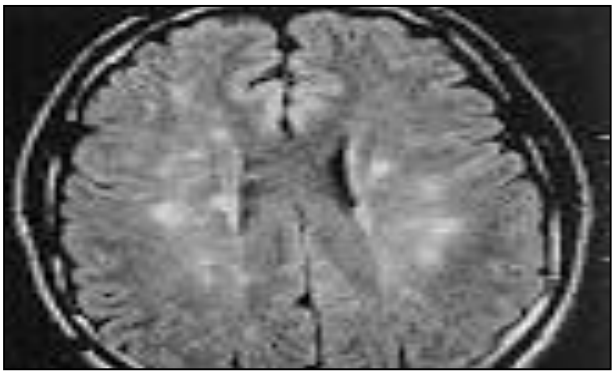

Figure 9: Fluid attenuated inversion recovery MR image of brain showing multiple focal lesions in periventricular and deep white matter characteristic of cerebral FES.[24]

CONCLUSION

The mortality in FES ranges from 7-10% with some studies quoting up to 20%. The cause of mortality is usually ARDS followed by cerebral edema. Prognosis depends on early fixation of long bone fracture. Most of the patients who receive adequate supportive therapy show full recovery from respiratory, neurological and retinal complications. Our case series highlights the rare presentation of FES in which one patient (case 1) developed concomitant FES and acute PTE. Another patient (case 3) developed FES after fixation of fracture with intramedullary nail. Finally, these patients are at increased risk of pulmonary thromboembolism (case 1) and therefore close monitoring of hemodynamics and DVT prophylaxix should be strongly considered.

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