

Original Article

Clinical characteristics and management of patients with fat embolism syndrome in level I Apex Trauma Centre

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ABSTRACT

Purpose: Fat embolism syndrome (FES) is systemic manifestation of fat emboli in the circulation seen mostly after long bone fractures. FES is considered a lethal complication of trauma. There are various case reports and series describing FES. Here we describe the clinical characteristics, management in ICU and outcome of these patients in level I trauma center in a span of 6 months.

Methods: In this prospective study, analysis of all the patients with FES admitted in our polytrauma intensive care unit (ICU) of level I trauma center over a period of 6 months (from August 2017 to January 2018) was done. Demographic data, clinical features, management in ICU and outcome were analyzed.

Results: We admitted 10 cases of FES. The mean age of patients was 31.2 years. The mean duration from time of injury to onset of symptoms was 56 h. All patients presented with hypoxemia and petechiae but central nervous system symptoms were present in 70% of patients. The mean duration of mechanical ventilation was 11.7 days and the mean length of ICU stay was 14.7 days. There was excellent recovery among patients with no neurological deficit.

Conclusion: FES is considered a lethal complication of trauma but timely management can result in favorable outcome. FES can occur even after fixation of the fracture. Hypoxia is the most common and earliest feature of FES followed by CNS manifestations. Any patient presenting with such symptoms should raise the suspicion of FES and mandate early ICU referral.

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Introduction

Fat embolism is the presence of fat globules in the circulation and fat embolism syndrome (FES) is the clinical manifestation of fat emboli in the circulation characterized by specific signs and symptoms. It is important to distinguish between fat embolism and FES. Fat embolism is quite common occurring in more than 90% of patients with long bone fractures¹ but not all the cases of fat embolism progress to fat embolism syndrome. The incidence of FES is variable ranging from <1% in retrospective studies¹ and 11%–29% in prospective studies^{2,3} and typically consists of a triad of neurological, pulmonary and cutaneous symptoms.

FES is commonly seen after orthopaedic trauma i.e. fracture of long bones, pelvis or multiple fractures but can be seen in non-trauma conditions also like after hip or knee arthroplasty, burns, pancreatitis, liposuction and bone marrow transplant procedure.⁴ All the patients who develop FES require intensive care unit admission and critical management.

There are various case reports of FES published in the literature but limited prospective case series. We report 10 cases of fat embolism syndrome (FES) who were admitted in our polytrauma intensive care unit (ICU) of level I trauma center in India over a period of 6 months (from August 2017 to January 2018). Here we described the clinical characteristics, course in ICU and outcome of these patients.

Methods

The study was carried out in surgical ICU of level I trauma centre of All India Institute of Medical Sciences (AIIMS) in India.

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Prospective study and analysis of all the ten patients with fat embolism was done. Demographic data, clinical features, course in ICU and outcome were analyzed. We used Gurd's criteria for diagnosis of FES. It consists of major and minor criteria.

Major criteria

- Respiratory insufficiency
- Cerebral involvement
- Petechial rash.

Minor criteria

- Tachycardia
- Fever
- Jaundice
- Retinal changes
- Renal changes
- Microglobulinemia
- Thrombocytopenia
- Elevated erythrocyte sedimentation rate
- Anemia

One major and four minor criteria must be present to formally make the diagnosis of FES.

Results

We admitted 10 cases of fat embolism in 6 months (August 2017 to January 2018) in our ICU.

Demographic features

All patients were young males between 18 and 42 years (mean age 31.2 years, standard deviation (SD) 12.38 yrs) except one female who was 55 years old. The demographic profile of each patient is given in Table 1. All the cases had fracture femur with or without pelvis fracture except one who had tibial fracture. Most of them were initially admitted and managed in the orthopaedic ward and shifted to ICU once symptomatic. The time duration between the

time of injury and onset of symptoms varied among patients ranging from 16 h to 7 days post injury (mean 56 h, SD 38.2 h).

Out of 10 patients, 4 patients presented with symptoms prior to surgical fixation and 6 patients presented after the surgical procedure. Open reduction and internal fixation was done in 5 patients and 1 patient underwent closed reduction. The time interval between the surgery and admission to ICU varied between 6 and 48 h.

Clinical features

The clinical features of the patients are presented in Table 2. All the patients (100%) presented with hypoxemia and petechiae. The petechiae were present in conjunctiva and upper chest (Figs. 1 and 2]. Central nervous system symptoms were present in 7 out of 10 i.e. 70% of patients. Other features like tachycardia, thrombocytopenia, and fever were present in varying degrees. Six patients developed bilateral infiltrates mimicking acute respiratory distress syndrome (ARDS) on chest X-ray (Fig. 3). Urine for fat globules was positive in all patients.

ICU management and outcome

The management of these patients was primarily supportive. ICU management and outcome are illustrated in Table 3. Out of 10 patients, 6 patients required intubation and mechanical ventilation, 2 patients were managed on non invasive ventilation and 2 patients were managed with oxygen face mask. Duration of mechanical ventilation ranged from 5 to 30 days (mean of 11.7 days, SD 11.45 days) and 5 patients required tracheostomy. Four patients with prolonged ventilation developed ventilator associated pneumonia (VAP), acinetobacter baumannii being the most common isolated organism.

The mean length of ICU stay was 14.7 days ranging from 2 to 34 days (SD 12.1 days). There was no mortality and all the patients survived. The neurological recovery was excellent and all patients who had neurological symptoms recovered fully.

Discussion

FES is regarded as post traumatic complication associated with long bone or pelvic fractures. Fat embolism was first described by Zenker in 1861.⁵ Even after 150 years of first definition, there is no

Table 1
Demographic profile of the patients.

Patient No.	Age (year)	Gender	Mode of injury	Diagnosis	Time of presentation of the symptoms after trauma	Operative procedure	Time of presentation of the symptoms after the operative procedure (h)
1	22	M	RTA	Left femoral shaft fracture	60 h	CREF	24
2	41	M	Fall from height	Open Grade 1 tibia fracture	7 d	ORIF	48
3	32	M	RTA	Bilateral femoral shaft fracture; left olecranon fracture	42 h	ORIF	Before procedure
4	20	M	RTA	Left femoral shaft fracture	4 d	ORIF	6
5	23	M	RTA	Grade 3 open distal end femoral fracture	16 h	ORIF	Before procedure
6	38	M	RTA	Left femoral shaft fracture	72 h	ORIF	48
7	55	F	RTA	Superior and inferior pubic rami fracture; acetabulum fracture; rib fracture	36 h	ORIF	Before procedure
8	18	M	RTA	Superior and inferior pubic rami fracture; femoral neck fracture	24 h	ORIF	Before procedure
9	21	M	RTA	Closed right femoral fracture; right distal femoral fracture; Both bone right leg fracture	5 d	ORIF	36
10	42	M	RTA	Bilateral femoral shaft fracture	4 d	ORIF	24

RTA: road traffic accident, CREF: closed reduction and external fixation; ORIF: open reduction and internal fixation.

Table 2
Clinical features of the patients.

Patient No.	Petechiae	Hypoxaemia	CNS depression	Fever	Urine fat	Retinal fat	Thrombocytopenia	Bilateral infiltrates in chest X ray
1	+	+	+	+	+	–	–	+
2	+	+	+	+	+	–	+	+
3	+	+	+	+	+	–	+	–
4	+	+	–	–	+	–	+	+
5	+	+	+	+	+	–	–	+
6	+	+	+	+	+	–	–	+
7	+	+	+	+	+	–	–	+
8	+	+	+	+	+	–	+	–
9	+	+	–	–	+	–	+	–
10	+	+	–	–	+	–	–	–

+: present; -: absent



Fig. 1. Multiple petechiae in the conjunctiva.



Fig. 2. Petechial rash on the anterior surface of the chest.

definitive diagnostic test available. It is a diagnosis of exclusion based on characteristic sign and symptoms with an underlying cause. Fat embolism syndrome is common in trauma patients and our being Apex Trauma Centre, we admitted 10 cases of fat embolism in our ICU in 6 months period. Our center is a high volume and tertiary referral center for trauma patients. This high occurrence of fat embolism has not been reported in previous reports.

As already established in the literature,⁶ all our patients except one were young patients. Fat embolism is most commonly associated with long bone fractures.^{6,7} In our series, all patients had femur fracture with or without pelvis fracture except one who had tibia bone fracture.

Fat embolism typically manifests 24–72 h after trauma but may occur as early as 12 h and can be delayed up to 2 weeks of insult.⁸ In our study population, the time period varied from as early as 16 h to 7 days post injury. Six patients out of 10 presented after the fixation of the fracture and 4 patients presented before operation. The time gap between the injury and the surgery was between 24 and 96 h. That is the time the patients are most prone to this complication and should be kept under close observation. The timing of presentation after fixation varied from 6 h to 48 h.

According to the literature, pulmonary involvement is the most common feature of FES and may be present in up to 92%–95% of cases.^{1,9} Similarly, in our study, hypoxemia was present in 100% cases. Other causes of hypoxemia like pneumonia, pneumonitis, transfusion related lung injury, effusion, basal atelectasis were



Fig. 3. Chest X-ray of the No. 6 patient shows bilateral infiltrates in upper and lower lobes.

Table 3
ICU course and outcome of the patients.

Patient No.	Oxygen therapy	Time on ventilator (d)	Tracheostomy done	Ventilator Associated Pneumonia	Bacteria isolated In BAL	Total ICU stay (d)	Total hospital stay (d)
1	Venturi mask	Nil	–	–	Nil	2	8
2	Intubated	30	+	+	Acinetobacter + Klebsiella	34	36
3	Intubated	26	+	+	Acinetobacter	27	29
4	Intubated	16	+	+	Staph. aureus	19	22
5	Intubated	7	–	–	Nil	14	21
6	NIV mask	6	–	–	Nil	8	14
7	Intubated	5	+	–	Nil	7	9
8	Intubated	25	+	+	Acinetobacter	30	37
9	NIV mask	2	–	–	Nil	4	10
10	Venturi mask	Nil	–	–	Nil	2	5

BAL: bronchoalveolar lavage; Nil: zero; +: yes; –: no.

ruled out. Approximately 44%–50% cases of FES with long bone fracture require mechanical ventilation.¹⁰ In our study 60% of patients required mechanical ventilation. The characteristic finding of bilateral infiltrates in chest X-ray were present in 6 patients, rest had no specific finding. Thorax computed tomography (CT) was done in one case which revealed features suggestive of FES (Fig. 4). CT scan chest of our patient depicted bilateral micronodular and reticular opacities with areas of ground glass in a random distribution. Though different studies report different times of improvement of pulmonary symptoms ranging from 3rd day to days of ventilation.¹¹ Many of our cases required prolonged ventilation.

Petechial rash which is considered pathognomonic of FES usually develops in 20%–50% of cases.^{1,10,12} In one study, the incidence was as low as 8.3% and the authors⁹ attributed this to retrospective

nature and delay in identification of rash in Asian population. Various studies had reported less recognition in dark skinned patients. However in our series, all the patients i.e. 100% patients developed petechial rash. The reason could be that we prospectively looked for petechiae in all patients who had suspicion of fat embolism. Other studies because of their retrospective nature may have missed this finding. The petechiae were found mainly in the conjunctiva, axilla and upper chest of the patients.

Neurological manifestations vary in cases of FES and may occur in up to 86% of cases.¹³ The symptoms may appear within 10 h or may be delayed up to 5 days and range from acute confusion¹⁴ to altered level of consciousness and seizures.^{1,14} In our series, 70% had neurological involvement. The most common presentation was altered sensorium. Four patients had drop in the neurological status as documented by Glasgow Coma Score (GCS) but none had

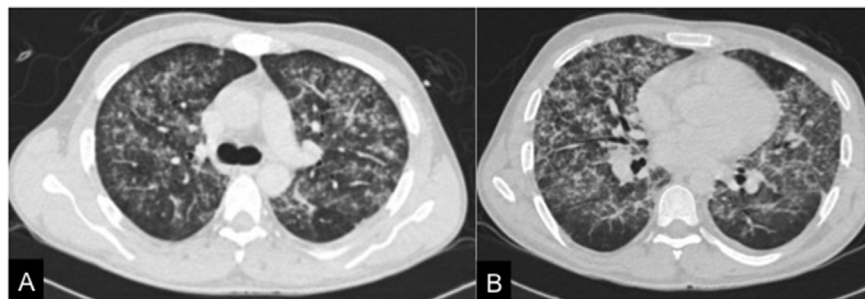


Fig. 4. Axial CT scan images of the chest in lung window of the patient no. 6 shows extensive bilateral micronodular and reticular opacities with areas of ground glass in a random distribution involving both the upper and lower lobes of the lung parenchyma. (A) Upper thoracic section at the level of carina; (B) Middle thoracic section at the level of heart.

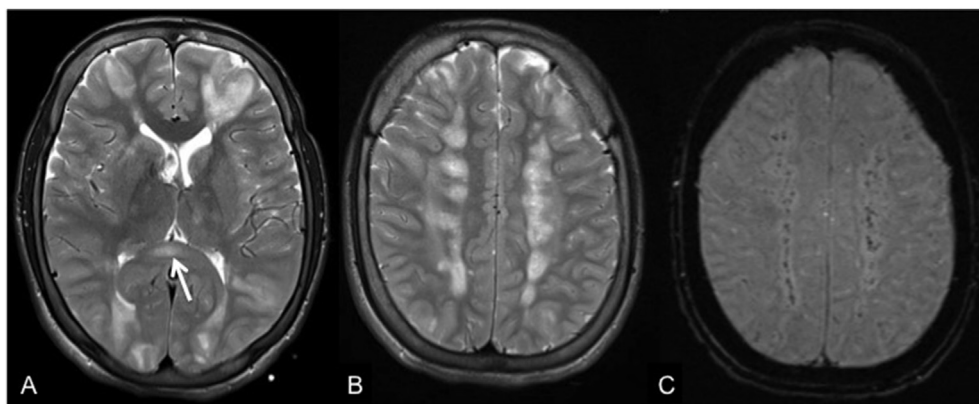


Fig. 5. The T₂ weighted axial MR images of the brain (A, B) of the patient no. 8 shows bilateral asymmetrical patchy hyperintense lesions involving the subcortical and deep white matter including the centrum semiovale. Note the involvement of splenium of corpus callosum (arrow in A). The presence of petechial microhemorrhages within most of these lesions was seen on susceptibility weighted image (C).

lateralizing signs. CT head was done in all patients with no specific finding. As most of the patients were operated and had implants in situ, magnetic resonance imaging (MRI) brain could be done in one patient (Fig. 5). MRI revealed bilateral asymmetrical patchy hyperintense lesions involving the subcortical and deep white matter and the presence of petechial microhemorrhages. All patients with neurological involvement recovered completely without any deficit.

The diagnosis of FES is mainly clinical. There is no standardized validated diagnostic test for FES. Various authors have tried to define diagnostic criteria like Gurd's criteria, Schonfeld and Lindeque^{3,15,16} but none is validated. We used Gurd's criteria for diagnosis of FES as mentioned in methodology section.

Chest radiography is normal in majority of patients. CT thorax may show bilateral ground glass opacities which are well demarcated.^{11,17} CT scan chest of our patient has already been described above. Treatment is mainly supportive. Many strategies including corticosteroids, albumin, heparin have been studied but none is conclusive. Mortality in other studies varies from 5% to 15%¹⁸ and has been mainly attributed to progressive hypoxemia and ARDS. Though many of our patients required prolonged ventilation but all recovered. There was no mortality in our series.

FES is considered a lethal complication of trauma. However, early diagnosis and timely management can result in favorable outcome. Immobilization of the fracture segment and early fixation of the fracture are assumed to be the best strategies to prevent FES but FES can occur even after the fixation. In our study, most of the patients presented after fixation of the fracture. All the patients were immediately shifted and managed in ICU and all recovered fully. Therefore, patients with long bone fractures should be kept under strict vigilance even in the postoperative period and signs like hypoxia or altered sensorium should raise the suspicion of FES mandating early ICU referral.

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None at present.

Ethical statement

The study was performed in accordance with the ethical guidelines of the Institute.

Conflicts of interest

All the authors declare no conflicts of interest.

References

- Bulger EM, Smith DG, Maier RV, et al. Fat embolism syndrome. A 10-year review. *Arch Surg*. 1997;132:435–439.
- Fabian TC, Hoots AV, Stanford DS, et al. Fat embolism syndrome, prospective evaluation of 92 fracture patients. *Crit Care Med*. 1990;18:42–46.
- Lindeque BG, Schoeman HS, Dommissie GF, et al. Fat embolism and the fat embolism syndrome. A double-blind therapeutic study. *J Bone Joint Surg Br*. 1987;69:128–131.
- George J, George R, Dixit R, et al. Fat embolism syndrome. *Lung India*. 2013;30:47–53. <https://doi.org/10.4103/0970-2113.106133>.
- Zenker FA. *Beitrag zur Anatomie und Physiologie de lung*. Dresden, Germany: J Braunsdorf; 1861.
- Stein PD, Yaekoub AY, Matta F, et al. Fat embolism syndrome. *Am J Med Sci*. 2008;336:472–477. <https://doi.org/10.1097/MAJ.0b013e318172f5d2>.
- Akhtar S. Fat embolism. *Anesthesiol Clin*. 2009;27:533–550. <https://doi.org/10.1016/j.anclin.2009.07.018>.
- Carr JB, Hansen ST. Fulminant fat embolism. *Orthopedics*. 1990;13:258–261.
- Gupta B, D'Souza N, Sawhney C, et al. Analyzing fat embolism syndrome in trauma patients at AIIMS apex trauma center, New Delhi, India. *J Emergencies, Trauma, Shock*. 2011;4:337–341. <https://doi.org/10.4103/0974-2700.83859>.
- King MB, Harmon KR. Unusual forms of pulmonary embolism. *Clin Chest Med*. 1994;15:561–580.
- Newbiggin K, Souza CA, Torres C, et al. Fat embolism syndrome: state-of-the-art review focused on pulmonary imaging findings. *Respir Med*. 2016;113:93–100. <https://doi.org/10.1016/j.rmed.2016.01.018>.
- Georgopoulos D, Bouros D. Fat embolism syndrome: clinical examination is still the preferable diagnostic method. *Chest*. 2003;123:982–983.
- Gupta A, Reilly CS. Fat embolism syndrome. *Cont Educ Anaesth Crit Care Pain*. 2007;7:148–151.
- Filomeno LT, Carelli CR, Silva NC, et al. Emboliagordurosa: Uma revisão para a prática ortopédica atual. *Acta Ortopédica Bras*. 2005;13:196–208.
- Gurd AR. Fat embolism: an aid to diagnosis. *J Bone Jt. Surg*. 1970;52:732.
- Schonfeld SA, Ploysongsang Y, DiLisio R, et al. Fat embolism prophylaxis with corticosteroids. A prospective study in high-risk patients. *Ann Intern Med*. 1983;99:438.
- Piolanti M, Dalpiaz G, Scaglione M, et al. Fat embolism syndrome: lung computed tomography findings in 18 patients. *J Comput Assist Tomogr*. 2016;40:335–342. <https://doi.org/10.1097/RCT.0000000000000376>.
- Fulde GW, Harrison P. Fat embolism—a review. *Arch Emerg Med*. 1991;8:233–239.