Fat Embolism in Long Bone Fracture Patients and its Complications: A Prospective Study

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Abstract

Background: Incidence of fat embolism after long bone fracture in Indian scenario is not studied much. In our study we try to analyse data over 2 years to find incidence and its complications.

Materials and Methods: Two hundred FES (fat embolism syndrome) suspected patients secondary to long bone fractures admitted over a 1 year period included. Patients satisfying the clinical criteria proposed by Gurd and Wilson, and Schonfeld were included in the study. Clinical features, risk factors, complications and any sequelae were noted.

Results: Out of 200 patient's majority were male patients. Maximum (85.5%) cases were used immobilizers to stabilize case. Isolated fractures (97%) were more compare to multiple fracture (3%). Associated features included features of altered sensoriam (n = 14, 7%), petechial rash (6%), tachycardia (16.5%) and fever (14.5%). Hypoxemia was demonstrable in 25.5% (51patients) cases. Fat embolism was found in 2% (4 cases) study population. Hypoxia @ 72 hours more in multiple fractures (50%) compare to isolated fractures (4.6%). This association was statistically significant. (P<0.05) No long-term sequelae were observed.

Conclusion: We conclude that in our representative population the incidence of fat embolism is slightly higher compared to other population. This amounts to 2% of people with long bone fractures of lower limb. Fat embolism was more in femur fractures compared to tibia fractures and the chance of fat embolism was more in multiple fractures when compared to isolated fractures. The incidence of fat embolism was more in closed fractures as compared to open fractures. Other salient features of the study were the increased incidence of fat embolism noted in fractures which were not immobilized.

Key Words: Accidents; ARDS; Fat embolism syndrome; Fracture.

Introduction

The term 'fat embolism' indicates the presence of fat globules in the peripheral circulation and lung parenchyma after fracture of long bones, pelvis or other major trauma. It occurs in approximately all patients who sustain a long bone or a pelvic fracture. In 1861,Zenker described fat droplets in the lung capillaries of a railroad worker who sustained a fatal thoracoabdominal crush injury [1].

'Fat embolism syndrome' is a serious manifestation of fat embolism phenomenon (follow an insult associated with the release of fat into the circulation) characterized clinically by triad of dyspnoea, petechiae and mental confusion. Traumatic fat embolism occurs in individuals with severe skeletal injuries, but the clinical presentation is usually mild and goes unrecognized. Approximately 10 percent of these patients develop clinical findings, collectively known as fat embolism syndrome (FES). FES is most commonly associated with orthopedic trauma, with highest incidence in closed, long bone fractures of the lower extremities, particularly the femur [2]. In its most severe form, FES is associated with a 1-2 percent mortality rate [3]. The risk of FES complicating orthopedic trauma is highest in ages 10 to 40 years and occurs in men more frequently than women [4].

In the orthopedic and trauma literature ,the incidence of FES has ranged from <1% to >30% of cases. The wide range of incidence likely reflects the heterogeneity of diagnostic criteria. Recent population level data from the National Hospital Discharge Survey found an FES incidence of 0.17% in patients with isolated or multiple orthopedic fractures [4]. The incidence increased to 0.54% in isolated femoral fractures and 1.29% if multiple fractures including the femur were present [4]. Although FES remains are latively rare entity, subclinical FE in the trauma population is highly prevalent, with an autopsy series finding fat emboli in the pulmonary circulation of 82% of trauma patients and 88% of patients who received cardiopulmonary resuscitation [6].

The importance of fat embolism as a complication of fractures has been recognized for over 100 years. During this time there have been short bursts of rapid progress in knowledge and understanding of the problem separated by periods of confusion and misunderstandings. Presently, as a result of improvements in technology, new information has been derived to reduce significantly the morbidity and mortality of fat embolism.

This study is our attempt to prospectively describe fat embolism and hypoxia in patients attending suspected FES secondary to long bone fractures, and the factors associated with it and its complications.

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Material and methods

The present study was conducted in department of Orthopedics, Sancheti Institute for Orthopedics and Rehabilitation, Pune, India. All the patients with fat embolism secondary to long bone fractures were included in the study using inclusion and exclusion criteria. Protocol was reviewed and approved by institution review board. Informed written consent was obtained from study subjects.

Inclusion criteria

- All patients having fat embolism secondary to long bone fractures
- Patients presenting with long bone fractures – tibial and femoral, shall be included in the study.

Exclusion criteria

- Patients with Concomitant injuries of the skull, chest wall and lungs, abdominal cavity, pelvis or urogenital diaphragm; pregnancy; pathological fractures
- Patients with obvious cause of hypoxemia or mental obtundation like head injury, overt sepsis, rib fractures, spinal cord trauma, abdominal trauma

Study duration: 2016 to 2018

Data Collection Methods

All the patients who were selected were admitted to the hospital in orthopaedic department.

Their age, sex, mechanism of injury were recorded. At time of admission chest x-ray done, average readings of Blood pressure, pulse rate, respiratory rate and GCS in 24 hrs, 48 hrs and 72 hrs were recorded. Ophthalmology reference was done in 24, 48 and 72 hrs for fundoscopic examination to look for retinal emboli. Also recorded were the presence or absence of skin/conjunctiva petichiae in 24, 48 and 72 hrs.

All the patients were examined with ABG within 12 hrs of admission and subsequently every 24 hrs for 3 days. Radial artery was preferred for ABG analysis and ABG readings on room air were recorded. Hypoxemic patients were then placed on oxygen support through mask and were shifted to ICU for observation and management.

Laboratory investigations in the form of urine for fat globules and platelet count at 24, 48 hours performed.

A positive diagnosis requires at least one major and four minor signs.

Patients with hypoxemia alone were categorized as subclinical, those with hypoxemia with clinical symptoms not completely fulfilling Gurds criteria were categorized as clinical and those with hypoxemia, clinical symptoms and thrombocytopenia/positive urine fat globules completely fulfilling Gurds criteria were categorized as overt.

Criteria for diagnosis of fat embolism syndrome was the GURD'S criteria.

Major Criteria	Minor Criteria
Hypoxemia (PaO2 < 60 mm Hg)	Tachycardia >100 bpm
Central nervous system depression	Pyrexia >98.5°F
Petechial rash	Retinal emboli on fundoscopy
Pulmonary edema	Fat in urine
	Fat in sputum
	Thrombocytopenia(<1 lakh)
	Decreased hematocrit

Table 1: study subjects data

	Frequency	Percent
Age Groups (yrs)		
	39	19.5
Nov-20	84	42.2
21-30	9	4.5
31-40	7	3.5
41-50	47	23.6
51-60	12	6
61-70	2	1
71-80		
Male	143	71.5
Female	57	28.5
	Frequency	Percent
Mode of Injury		
RTA	178	89
Fall from Height	13	6.5
Others	9	4.5
Isolated	194	97
Multiple	6	3
Femur	146	75.2
Tibia	48	24.8

Results

In our study of 200 patients with long bone fractures of lower limb, 74.5% (149patients) did not have any signs of hypoxemia; where as 25.5% (51patients) had hypoxemia. Out 51 patients, 14.5% (29 patients) had clinical signs like tachycardia, tachypnoea and cerebral sypmptoms) whereas 9% (18 patients) had no such sypmptoms.2% (4 patients) had hypoxemia with clinical symptoms along with thrombocytopenia and 1% (2 patients) needed ventilatory support.

Table 2: Incidence of Fat Embolism and Clinical Symptoms

	Frequent	%
Fat Embolism	4	2
Tachycardia	33	16.5
Increased Temparature	29	14.5
Altered Sensoriam	14	7
Petichiae (fundus /skin)	12	6

In our study of hypoxemia majority 20% (40 patients) developed hypoxemia at 48 hrs and 10% (20 patients) developed hypoxemia within 24 hrs and 6% (12patients) at 72 hrs.

In present study 33(16.5%) patients were found with tachycardia, 29(14.5%) patients with increased temperature, altered sensoriam in 7% and petechiae in 6%. (Table-2)

Incidence of fat embolism

In present study fat embolism was found in 2% (4 cases) of study subjects. (Table-2)

Association between type of injury and hypoxia status

In present study sub clinical(11.9%) and overt hypoxia (3.4%) was more in closed fractures but clinical hypoxia (16.3%) was more in open fractures. Major proportion of clinical and Overt hypoxia cases were found in mulple fractures compared to isolated fractures. This association was statistically significant. (P<0.05) (Table-3)

In present study sub-clinical hypoxia was found more patients of femur (11%) compare to tibia (6.3%) fractures. Clinical hypoxia was more in multiple fractures (33.3%) followed by femur fracture (14.4%) and tibia fractures (12.5%).This association was statistically significant.(P<0.05). Clinical hypoxia was more in immobalizer not used patient (17.2%) compare to immobilizer used patients (14%).Overt hypoxia was observed in only immobilizer used patients. (Table-3)

Hypoxia @ 24 hours more in multiple fractures compare to isolated fractures. Hypoxia @ 48 hours more in multiple fractures (33.3%) compare to isolated fractures (10.3%).This association was not significant. (P>0.05) Hypoxia @ 72 hours more in multiple fractures (50%) compare to isolated fractures (4.6%).This association was statistically significant. (P<0.05) (Table-4)

Table 3: Association Between Type Of Injury and Hypoxia Status

	No Hypoxia	Sub clinical	Clinical	Overt	Total	P Value
Closed	44(74.6%)	7(11.9%)	6(10.2%)	2(3.4%)	59	-
Open	104(73.8%)	12(8.5%)	23(16.3%)	2(1.4%)	141	
Isolated	146(75.3%)	19 (9.8%)	27(13.9%)	2(1.0%)	194	0.06*
Multiple	2 (33.3%)	0 (0.0%)	2 (33.3%)	2 (33.3%)	6	
Multiple #	2 (33.3%)	0 (0.0%)	2(33.3%)	2(33.3%)	6	0.00*
Tibia #	37 (77.1%)	3 (6.3%)	6 (12.5%)	2(4.2%)	48	
Femur #	109(74.7%)	16(11.0%)	21(14.4%)	0(0.0%)	146	
Immubalizers Used	126 (73.7%)	17(9.9%)	24(14.0%)	4(2.3%)	194	-

Table 4: Association Between Hypoxia @24hrs,48 hrs & 72hrs and Type of Skeletal Injury

Type of Skeletal Injury	Hypoxia at	Hypoxia at	Hypoxia at
	24hrs	48hrs	72hrs
Isolated	19 (9.8%)	20(10.3%)	9(4.6%)
Multiple	1(16.7%)	2(33.3%)	3(50.0%)

Discussion

Although full blown fat embolism syndrome is a rare event, subclinical hypoxemia occurs frequently in patients sustaining long bone fractures. It is found that patients who are hypoxemic are always at risk of developing clinical FES and its sequelae. Keeping these facts in mind we conducted a prospective study in 200 patients with long bone fractures to study the incidence of hypoxia, fat embolism and factors associated with it in long bone diaphyseal fractures of lower limb.

Age distribution

In our study of 200 patients, the average age of patients was 33.6 yrs and the incidence of fat embolism was more in younger age group. Majority of the studies which was done by Stein et al4 showed the mean age of presentation to be 31 yrs. The larger distribution of younger age group of patients show that younger age group of patients are more prone for fractures and hence its complications.

Sex distribution

In our study 71.5 % were men and women were only 28.5 % hence increasing the incidence of fat embolism among the male population. Similar study done by Bulger EM et al 5 showed similar figures with increased incidence among the male population. The higher percentage of males could be due to the social system existing in our country and the larger number of male 2 wheeler riders.

Mode of injury

In our series mainly Road traffic accidents contributed 89 % .Similar studies Bulger EM et al 5 reported that the mechanism of injury leading to long bone fractures were Road Traffic Accidents accounting for 86 %.

Immobilization

In this prospective study 85.5% of patients had some mode of immobilization used at time of presentation to our hospital in the form of slab, Thomas splint etc. we do not have any data to compare with. This shows that the awareness among doctors at periphery and the general public regarding immobilization and its importance is present

Type of skeletal injury

In our study of 200 patients majority 194 (97%) had isolated long bone fracture and 6 (3%) of them had multiple long bone fractures. Among the long bone fractures there were 146 (75.2%) femur fractures and 48 (24.8%) tibia fractures. Among the femur fractures, (23.2%) were closed fractures and 76.8% were open fractures. Among the isolated tibia fracture there was equal incidence of closed and open fractures.

Incidence of hypoxemia

In our study the incidence of hypoxemia was 25.5 % out of which majority (14.5%) were clinical and 9% were subclinical and 2% of patients fulfilled the criteria for FES.

Type of skeletal injury and hypoxemia

In our study hypoxemia was found more number of hypoxemia in multiple long bone fractures (4/6=66.7%) and all of them were clinically symptomatic. Among islolated long bone fractures the incidence of hypoxemia was (48/194=24.7%) and there were subclinical, clinical and overt type in the same group. Among the isolated fracture group the incidence of hypoxemia was more among the fracture femur group(37/146=25.3%) when compared to tibia (11/48=22.9%). Also found in our study was that bilateral femur fractures had very high incidence of fat embolism (5 out of 6) among the multiple fracture group. Studies by Peletier LF et al6 also shows an increase incidence of fat embolism in multiple long bone fractures when compared to islolated long bone fractures and increase incidence among fracture femur group.

Open or closed fractures and fat embolism

Study by Peletier LF et al [6] shows increased incidence of fat embolism among closed fractures .In our study sub clinical(11.9%) and overt hypoxia (3.4%) was more in closed fractures but clinical hypoxia (16.3%) was more in open fractures .

When considering the incidence of hypoxemia in femur fracture compared to tibia fracture, there was a clear edge of femur fracture which is also supported by study done by Stein PD et al4 which showed femur fracture to be more likely to produce fat embolism.

Immobilization and development of hypoxia

In our study, majority of the patients (97%) had immobilization used at time of presentation. Among the patients who did not have any immobilization used the incidence of fat embolism was 24.1%. Study done by Allgower M et al [7] supports the finding of increased incidence among patients without immobilization. Movement at the fracture site will throw more emboli into the circulation thus leading to increase in fat embolism and its severity.

Hypoxemia and timing of development

In our study, majority of patients developed hypoxemia in 48 hrs after injury. In a study done by Beck JP8 shows an incidence of fat embolism of 60 % in 48 hrs and 90% by 72 hrs. There were 5 patients who developed hypoxemia in 24 hrs of injury.

There are reported cases of early development of fat embolism. The physic- chemical theory of fat embolism would explain the delayed development of fat embolism.

Clinical symptoms

In our study, in patients with clinical symptoms of hypoxia, majority had tachycardia (16.5%), followed by increased temperature (14.5%), symptoms of confusion in 7 %, and 6% had petichiae.

Incidence in comparison with other studies

The reported incidences of fat embolism syndrome among patients with single or multiple fractures or various injuries ranges from 0 to 17%.Among the various studies that formed the basis of our study – Bulger EM et al5 and Stein PD et al4 the incidence of fat embolism syndrome was 0.9%.In our study the incidence was 2%.The fact that these studies have taken all fractures including long bone fractures of the upper limb and that the incidence of fat embolism were minimal in those fractures could explain the low incidence in their studies. The incidence of hypoxemia alone would be 25.5 % which could be compared to the figures given by Bulger EM et al5 of 30%. The fact that there are various criteria for diagnosing fat embolism, would explain such wide variety of incidence of fat embolism being reported in literature.

The incidence of fat embolism was found to be high in men, in fractures which were not immobilized, in fractures associated with RTAs. The incidence was also found to be high with femur fractures, in closed fractures and multiple fractures. Among multiple fractures, bilateral femur fractures had higher incidence of fat embolism. Conclusion could not be made regarding the fracture pattern and fat embolism in our study.

Comparison of incidence of fat embolism syndrome in different studies

Laboratory studies and fat embolism

Even though Urine fat globules are given as minor criteria to diagnose fat embolism, none of our patients had urine fat globules positive and very few patients had thrombocytopenia. This is in contrast to the study done by Bulger EM et al5 which showed 54 % patients were positive for urine fat globules and 37% patients had thrombocytopenia. We believe that Fat embolism is primarily a clinical diagnosis and laboratory investigations are contributory.

Mortality and fat embolism

In our study there was one mortality (2%).Mortality from fat embolism syndrome in case series of 7 to 100 patients ranged from 6% to 29%.3,25,89 and a series of 208 patients with fat embolism syndrome collected from 1963 to 1983 showed a mortality of 54%.94

Conclusion

We conclude that in our representative population the incidence of fat embolism is slightly higher compared to other population. This amounts to 2% of people with long bone fractures of lower limb. Fat embolism was more in femur fractures compared to tibia fractures and the chance of fat embolism was more in multiple fractures when compared to isolated fractures. The incidence of fat embolism was more in closed fractures as compared to open fractures. Other salient features of the study were the increased incidence of fat embolism noted in fractures which were not immobilized.

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