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Original Article

Correlation of clinical parameters with imaging findings to confirm the diagnosis of fat embolism syndrome

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Abstract: Background: Fat embolism syndrome (FES) is a multi-organ dysfunction caused by the fat emboli. The diagnostic of FES remains a challenge for clinicians. The clinical criteria including those of Gurd's and Wilson's although universally used for its diagnosis are not specific. Different methods of imaging are increasingly performed in the patients with presumed FES. The objective of this study is to determine whether there is a correlation between the clinical parameters and the imaging findings in confirming the FES diagnosis. Methods: Patients admitted with FES were identified from the surgical intensive unit registry and enrolled in this study. Patient's demographic data, admission diagnosis, associated injuries, comorbid conditions, time to deteriorate, surgical duration, clinical manifestations, imaging findings and outcome were recorded. Data was entered into the SPSS program and required tests were applied for comparisons with a p value <0.05 considered as significant. Results: A total of 81 patients were enrolled in this study. Majority of patients (51/63%) were young male and without comorbidity (58/71.6%). About a half of the patients (49.4%) underwent intramedullary nailing for long bone fracture. Respiratory insufficiencies occurred in 98% patients and of them 11.1% had diffuse alveolar hemorrhage. Neurological deterioration was seen in 70% of the patients while the petechial skin rash was rare (2.5%). All patients had an abnormal chest x-ray but chest computerized tomography scan (CT) showed patchy alveolar opacities in 49 (60.5%) of them. Cerebral edema was a common finding in the CT brain while the brain magnetic resonance imaging (MRI) revealed a typical star field appearance in 28.4% of the patients. There was a significant correlation (P<0.05) between the major and minor clinical criteria components and abnormal imaging findings. Conclusions: The FES is common in young males with long bone fractures. Respiratory distress and neurological deterioration were common presentations. We suggest that the all patients with suspected FES by clinical criteria should have imaging studies to confirm the diagnosis.

Keywords: Intramedullary nailing, hypoxia, neurological deterioration, petechial skin rash, imaging studies, fat embolism syndrome

Introduction

Fat embolism syndrome (FES) is defined as a multi-organ dysfunction mainly involving the brain, lungs and skin due to fat emboli. Fat embolism syndrome (FES) can occur due to traumatic or non-traumatic etiologies. FES frequently occurs after the long bone fractures. In up to 5% of patients it is non-traumatic in origin seen in a number of scenarios including severe acute pancreatitis, sickle cell crisis, following liposuction, total parental nutrition and steroids therapy [1]. The reported incidence of FES varies from 1 to 29% depending on type of the studies because no definitive diagnostic tests have been developed for FES. The incidence has been reported as low as only 0.9% when clinical criteria were used alone for diagnosis. However it has been shown to increase up to 20% in the postmortem studies [2]. This demonstrates that clinical criteria are not specific and may underdiagnose the FES. Therefore, various imaging modalities are increasingly used.

It is not yet clear when to request imaging tests to help in the diagnosis of FES. The available literature of FES is mainly from case reports

Table 1. Clinical and imaging parameters

Variable		Number (n)	Percentage (%)
Gender	Male	51	63
	Female	30	37
Comorbidities	Diabetes Mellitus (DM)	8	9.9
	Hypertension (HTN)	8	9.9
	Coronary Artery Disease (CAD)	4	4.9
	DM and HTN	3	3.7
	None	58	71.6
Petechial Rashes		2	2.5
Oxygen Desaturation		80	98.8
Intubation		41	51.4
Vasopressors		18	22.2
Pinkish ETT secretions		30	37
Alveolar Hemorrhages		9	11.1
Oliguria		30	37
Raised INR		7	8.5
Raised Liver Function Test		10	12.3
Raised C-Reactive protein		52	64.2
Retinal changes		5	6.2
Raised D-Dimer		50	61.6
Neurological Impairment	Drowsy	41	50.6
	Unconscious	16	19.8
Radiological Findings			
Chest X-Ray	Bilateral infiltrates	81	100
Computerized Tomography Chest	Bilateral Alveolar opacities	49	60.5
Computerized Tomography Brain	Brain Edema	17	21
	Normal	14	17.3
	Basal ganglia Hypo density	2	2.5
	Cerebellar hypo densities	1	1.2
	Multiple small infarctions	1	1.2
Magnetic Resonance Imaging Brain	Star field Appearance	23	28.4
	Normal	1	1.2
Outcome	Survived	75	92.6
	Died	6	7.4

and its diagnosis is made by exclusion of other clinical conditions and based on clinical criteria's. Imaging studies have been rarely used. The specific findings in the CT chest and the brain MRI can help in diagnosis of FES [3, 4]. The objective of this study was to find out a correlation between the clinical criteria and imaging findings in the diagnosis of the FES.

Patients and methods

This is a retrospective study conducted in a tertiary hospital after approval from the Medical Research Committee (MRC) (approval number: 12257/12). All patients admitted to the surgical intensive care unit (SICU) with presumed FES diagnosis based on the Gurd's and Wilson's clinical criteria were identified from the SICU registry over a period of 10 years from January 2005 to December 2015. All patients had at least 1 major and 4 minor criteria for FES. Clinical conditions like aspiration pneumonia, lobar pneumonia and cardiogenic pulmonary edema were excluded. Patients demographic data, primary diagnosis, comorbidities, injuries, surgical intervention, duration of surgery, time of deterioration, clinical and hemodynamic parameters, laboratory data on

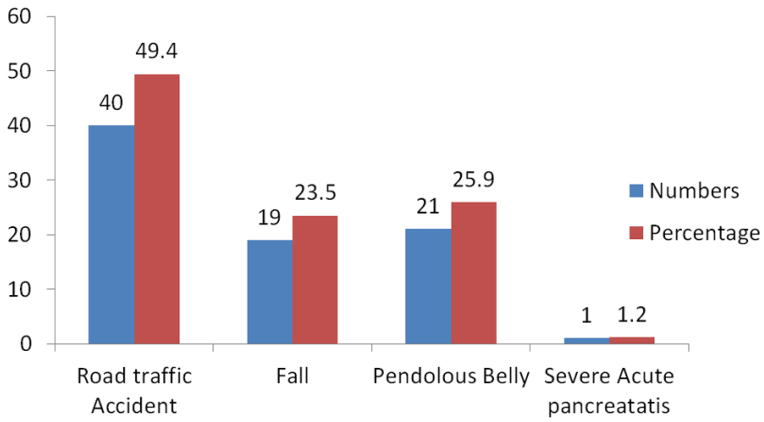

Figure 1. Etiology of Fat embolism syndrome. Description of primary etiology for fat embolism syndrome in number and the percentage.

deterioration, imaging studies chest x-ray, CT and MRI findings, Sequential organ failure assessment score (SOFA score), type of assisted ventilation (invasive or noninvasive) and patients' outcome were recorded.

In this study tachycardia, tachypnea and fever were defined when patients heart rate more than 100/minute, respiratory rate more than 30/minutes and core body temperature more than 38°C respectively. Hypoxia and desaturation was defined as PaO_2 of less than 90 mmHg and oxygen saturation (SPO_2) of less than 90% on O_2 of 6 liters/minutes. Thrombocytopenia and leukocytosis were defined when platelet count was less than 150 × 10^3/ul and leucocytes more than 11 × 10^3/ul. Patients were considered unconscious when Glasgow coma scale (GCS) less than 8 and confused when GCS 9 to 14.

Data was entered into the SPSS program 19th version (Chicago, Illinois), and data is presented as mean, percentage, standard deviation as appropriate and statistical analysis were conducted using T-square test for continuous variables and Pearson chi-square or Fisher exact test for categorical variables. A *p*-value less than 0.05 was considered as statistically significant.

Results

A total of 81 patients were included in this study. Majority of (51/63%) patients were male (**Table 1**). Fat embolism syndrome occurred in 72.9% patients who sustained trauma including 49.4% of them involved in road traffic collision and 23.5% had skeletal injuries due to unintentional fall from a height. A near quarter (23.5%) of patients developed FES after abdominoplasty with liposuction or multiple sites dermolipectomy. One patient had FES as a complication of severe acute pancreatitis (**Figure 1**).

The details of patient's skeletal injuries leading to the FES are shown in the **Figure 2**. Right femur fracture was the most common long bone fracture (24.7%) associated with FES, 14.8% patients had bilateral fracture femur, and 12.3% patients had pelvic hemiarthroplasty (**Figure 2**). In 67.9% of the patients there were no other associated injuries. The common associated injury (12.3%) was fracture humerus and pelvic fractures in another 7.4% patients and 12.3% patients had other associated injuries like hepatic, splenic and fibular injuries (**Figure 2**). Majority of patients (58/71.66%) were without any comorbidities, 8 (9.9%) had diabetes mellitus (DM) 8 (9.9%) hypertension (HTN) 4 (4.9%) had coronary artery disease and in 3 (3.7%) both DM and HTN (**Table 1**).

Figure 3 shows the types of surgical interventions in this cohort of patients. The patients developed FES following intra-medullary nailing of long bone (49.4%) and hemiarthroplasty (11.1%). Another 12.3% of them had FES without any intervention while waiting for surgery. About a quarter of patients (23.5%) patients had FES post abdominoplasty and dermolipectomy (**Figure 3**).

Hypoxia and oxygen desaturation occurred in 98.8% of patients, and of them 41 (50.61%) required tracheal intubation and invasive mechanical ventilation whereas 40 patients (49.39%) improved with non-invasive ventilation. Thirty seven percent of patients had pinkish endotracheal secretions and 11.1% (9 patients) had diffuse alveolar hemorrhage visualized on bronchoscopic examination (**Table 1**). Petechial skin rash, a pathognomonic sign of FES, was detected only in 2 patients (2.5%). Fifty seven (69.7%) had neurological impairment. Eighteen patients (22.2%) requir-

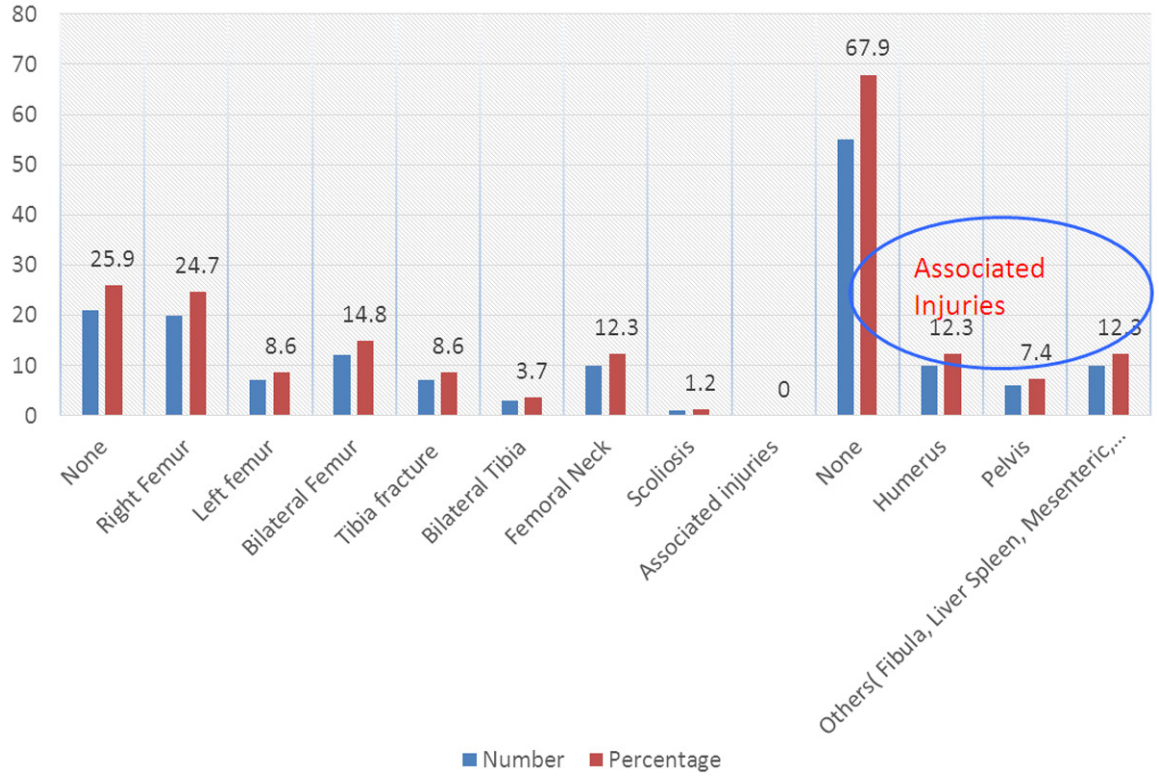

Figure 2. Skeletal fractures and associated injuries. Description of long bone skeletal fracture resulting from the primary etiology. It also describes the associated injuries and fractures.

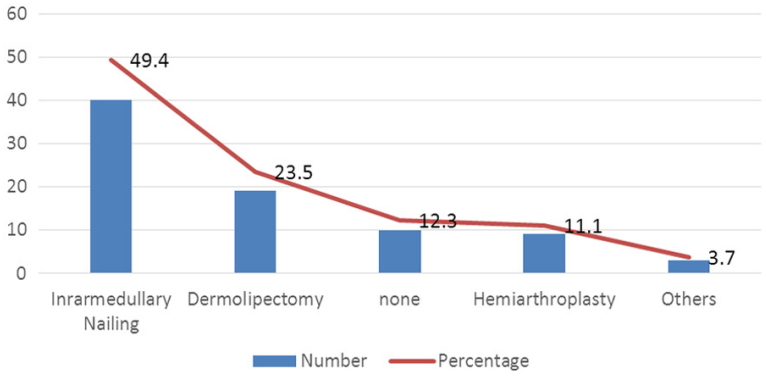

Figure 3. Surgical intervention. In this figure description of the surgical interventions in the patient group resulting in fat embolism syndrome. It also describes the patient developing fat embolism syndrome without any interventions, while waiting for surgery.

ed hemodynamic support with vasopressors and had fulminant FES. Retinopathy was seen in 6.2% of patients. Oliguria and lipiduria were found in 37% of patients. Liver dysfunction and coagulopathy occurred in 12.3% and 8.5% patients respectively (**Table 1**).

Imaging findings are shown in **Table 1**. Chest x-ray done in all patients showed diffuse bilateral infiltrate. The CT chest performed in 49 (60.5%) patients showed typical diffuse alveolar opacities. The CT brain performed in 35 (43.20%) patients, it show diffuse cerebral edema in 17 (21%) patients but it was found normal in 14 (17.3%) and 2 (2.5%) patients it showed basal ganglia region hypo densities where as in 1 (1.2%) each patient it showed multiple cerebellar hypodensities. The MRI brain was performed in 24 patients (29.6%) and in 23 (28.39%) it showed a typical star field appearance and 1 (1.2%) patient showed normal MRI brain (**Table 1**).

The patients mean age was 36.79 (±17.63) years. The patients with neurological deterioration had a mean Glasgow coma score (GCS) was 12.11 (±3.017). The time to deterioration from admission was 18.39 (±34.31) hours. Mean duration of intramedullary nailing sur-

Table 2. Age, clinical and monitoring parameter

Variable	Number	Mean	SD
Age (Years)	81	36.79	17.632
GCS (Glasgow coma score)	81	12.11	3.017
Time to deterioration (Hours.)	81	18.39	34.319
Duration Surgery (Minute)	70	173.63	94.533
D-Dimer (μg/mL)	81	1.709	0.717
ESR (Erythrocyte sedimentation rate)	81	75.23	42.527
Heart Rate/minute	81	126.84	14.462
Respiratory Rate/minute	81	35	5.716
Temperature (°C)	81	38.641	0.6984
PaO_2 (mmHg)	81	76.35	10.4
SPO_2 (%)	81	73.95	10.366
PCO_2 (mmHg)	81	36.15	4.117
Lactic acid (mmol/L)	73	3.693	2.0438
Procalcitonin (ng/mL)	9	5.889	9.1165
Hemoglobin (gm/dL)	81	7.184	0.9486
Serum Creatinine (μmol/L)	81	129.77	85.033
WBC (White blood count) × 10^3/μL	81	13.623	3.7224
Platelet Count (× 10^3/μL)	81	103.1	51.106
Serum Calcium (mmol/L)	77	1.932	0.2599
SOFA (Sequential Organ failure assessment) Score	81	6.84	5.2
Duration of intubation (days)	28	15.75	27.321

gery was 173.63 (±94.53) minutes. All patients were febrile with tachycardia and tachypnea. Mean arterial partial pressure of oxygen (PaO_2) and oxygen saturation (SpO_2) were 76.35 (±10.40) mmHg and 73.95% (±10.36) respectively (**Table 2**). Mean haemoglobin and platelet count were 7.18 (±0.94) gram/dL and 103 × 10^3 (±51.10) respectively. There was no severe thrombocytopenia. All patients had leukocytosis. Seventy-three patients had lactic acidosis with a mean blood lactate of 3.69 (±2.04) mmol/L. Procalcitonin measured in 9 patients was elevated with a mean 5.88 (±9.11) ng/ml. Mean serum creatinine level was 129.77 (±85.03) umol/L and mean SOFA score was 6.84 (±5.2) (**Table 2**).

Table 3 provides a detail comparison of clinical parameters with imaging findings. Chest X ray was found to be significantly abnormal in male compared to the female patients (P<0.05). Abnormal chest x-ray finding was significantly higher (P<0.001) in patients with oxygen desaturation, alveolar hemorrhage and in unconscious patients. Oliguria had no impact on chest x-ray finding in patients (**Table 3**). CT chest abnormalities were significantly associated (P<0.05) with deterioration of level of consciousness and oliguria but not associated with skin petechial rash, retinopathy and oxygen desaturation (P<0.66/0.44 and 0.11 respectively). Most common finding on CT head was cerebral edema which was found to be the cause of deteriorating consciousness level in the majority of our patients. We also found a significant (P<0.05) correlation between cerebral edema and oliguria. The MRI brain performed in 24 patients, showed a star field abnormal appearance 23 and 1 patient had normal MRI study. These abnormal MRI findings were significantly associated (P<0.05) with deterioration of level of consciousness and oliguria (**Table 3**).

Abnormal imaging findings were significantly (P<0.05) higher in FES with hypoxia, tachycardia, tachypnea, fever, deterioration in conscious level, renal impairment, elevated D-dimer, raised ESR, abnormal cardiac function and high extravascular lung water index (**Table 4**). There was no significant difference in age, duration of surgeries, procalcitonin, bilirubin, hemoglobin or platelet count and abnormal imaging studies (**Table 4**).

Table 3. Correlation between Clinical findings and Imaging studies

Chest X Ray								
Variables		Abnormal		Normal				*p* Value
Gender	Male	17 (85%)		34 (55.7%)				0.019
	Female	3 (15%)		27 (44.3%)				
Oxygen Desaturation	Yes	59 (100%)		21 (98.4%)				0.001
Pinkish ETT secretions	Yes	18 (90%)		12 (19.7%)				0.001
Oliguria	Yes	24 (40.7%)		6 (27.3%)				0.266
Alveolar Hemorrhage	Yes	8 (40%)		1 (1.6%)				0.001
Unconscious	Yes	12 (20.3%)		4 (18.2%)				0.001
Computerized Tomography Chest								
Variables		Bilateral Alveolar opacities	Not done	Bilateral basal infiltrates				*p* Value
Conscious level	Drowsy	28 (62.2%)	13 (40.6%)	0 (0%)				0.001
	Unconscious	13 (28.9%)	3 (9.4%)	0 (0%)				
Oxygen Desaturation	Yes	44 (97.8%)	32 (100%)	4 (100%)				0.667
Petechial rash	Yes	2 (4.4%)	0 (0%)	0 (0%)				0.44
Retinal changes	Yes	5 (11.1%)	0 (0%)	0 (0%)				0.119
Oliguria	Yes	24 (53.3%)	5 (15.6%)	1 (25%)				0.003
Magnetic resonance imaging Brain								
Variables		Abnormal (star field appearance)	Not done	Normal				*p* Value
Oxygen Desaturation	Yes	23 (100%)	57 (98.2%)	1 (100%)				0.808
Conscious level	Drowsy	10 (43.5%)	30 (52.6%)	1 (100%)				0.001
	Unconscious	13 (56.5%)	3 (5.3%)	0 (0%)				
Petechial rash	Yes	2 (8.7%)	0 (0%)	0 (0%)				0.075
Retinal Changes	Yes	5 (21.7%)	0 (0%)	0 (0%)				0.001
Oliguria	Yes	16 (69.6%)	14 (24.6%)	0 (0%)				0.001
Computerized Tomography Brain								
Variables		Brain edema	CT Not done	Normal	Cerebellar Hypo density	Basal Ganglia Hypo density	Multiple small Infarcts	*p* Value
Oxygen Desaturation	Yes	17 (100%)	46 (97.8%)	14 (100%)	1 (100%)	2 (100%)	10 (100%)	0.979
Conscious level	Drowsy	7 (41.2%)	22 (47.8%)	12 (85.7%)	0 (0%)	0 (0%)	0 (0%)	0.001
	Unconscious	10 (58%)	2 (4.3%)	0 (0%)	1 (100%)	2 (100%)	1 (100%)	
Petechial rash	Yes	0 (0%)	0 (0%)	1 (7.1%)	0 (0%)	0 (0%)	1 (100%)	0.001
Retinal Changes	Yes	3 (17.6%)	0 (0%)	2 (14.3%)	0 (0%)	0 (0%)	0 (0%)	0.12
Oliguria	Yes	12 (70.6%)	10 (21.7%)	5 (35.7%)	1 (100%)	2 (100%)	1 (100%)	0.004

Table 4. Clinical parameters versus radiological findings

Variable	Abnormal	Normal	*p* value
Age (Year)	33.7±16.8	37.8±17.9	0.37
Surgery duration (minutes)	145.5±72.643	181.9±99.1	0.177
D-dimer (µg/mL)	2.09±1.06	1.58±0.511	0.005
SpO_2 (%)	64.90±5.92	76.92±9.79	0.001
PaO_2 (mmHg)	69.16±8.76	78.70±9.84	0.001
PCO_2 (mmHg)	37.10±4.36	35.84±4.02	0.236
Heart rate (minute)	138.35±7.05	123.07±14.2	0.001
Respiratory rate(minute)	38.35±5.01	33.90±5.53	0.002
Temperature (°C)	39.26±0.85	38.43±0.49	0.001
Erythrocyte Sedimentation Rate (ESR)	97.15±23.4	68.05±44.9	0.001
Lactic acid (mmol/L)	3.32± 0.59	3.83±2.36	0.148
Procalcitonin (ng/mL)	9.7±13.2	2.8±3.017	0.379
Serum creatinine (µmol/L)	183.95±104	112± 69.76	0.001
Platelet Count (× 10^3/µL)	89.6±36.11	107.52±54.7	0.175
Hemoglobin (gm/dl)	6.9±0.90	7.29±0.95	0.196
International normalizing Ratio	1.10±0.24	1.05±0.17	0.404
Bilirubin (µmol/L)	1.15±0.36	1.11±0.32	0.682
Right ventricular Systolic pressure (mmHg)	29.4±22.4	12.21±18.6	0.001
Ejection Fraction %	31.23±25.59	15.34±22.8	0.011
Extravascular Lung water index (mL/kg)	9.92±7.86	2.76±2.69	0.002
Cardiac Index (L/min/m^2)	3.45±1.03	2.89±0.74	0.284
Serum Calcium (mmol/L)	2.02±0.175	1.90±0.27	0.075
Albumin (gm/L)	26.45±3.53	26.74±3.50	0.751

All these symptomatic patients who were diagnosed on the basis of Gurd's and Wilson's criteria have found to have abnormal imaging results. The overall mortality in this cohort of patients was 7.4% (**Table 1**).

Discussion

Fat embolism syndrome (FES) is a rare complication of skeletal long bone fractures and very rarely it can occur due to medical and non-traumatic conditions [1]. FES is defined as multi-organ dysfunction or failure due to circulating fat emboli in the microcirculation [1, 5]. Occasionally these FES patients present with profound cardiovascular collapse and shock secondary to massive mechanical blockage of pulmonary vessels by the fat emboli. It is called fulminant FES [5]. Twenty two percent of our patients had fulminant FES requiring vasopressor support and ventilatory support.

Ninety five percent of FES has been reported to occur after long bone skeletal trauma and only 5% as non-traumatic FES [1, 5]. In this study non-traumatic FES was found in 27.1% of patients including 23.5% post dermolipectomy and 3.7% severe acute pancreatitis, percutaneous screw fixation femur and scoliosis correction. FES incidence has been reported to vary according to the number of long bones fractured, single or multiple either unilateral or/and bilateral. The incidence of FES has been variably reported being higher in the prospective studies and lower in the retrospective studies. In one case series a single long bone fracture has been associated with FES in less than 3% of patients whereas bilateral long bone fractures tend to increase its incidence up to 33% [6]. Another case series recently reported much lower incidence 0.54% with isolated femur fracture increasing up to 1.29% with multiple long bone fracture [7].

In this study majority of FES occurred in young patients (mean age 36.79 years) who were otherwise healthy with no comorbidities (58/71.6%). The older age group who developed FES following hemiarthroplasty was mostly affected by DM and HTN. Fracture femur was most common injury in our patients followed by fracture pelvis. The most common surgical intervention in this study was intramedullary nailing of fracture shaft of the femur although 12.3% of our patients developed FES without any intervention while waiting for surgery. The early intramedullary nailing of fracture has become the standard of care for long bone shaft fractures due to obvious reasons [9]. During reaming and nailing of the intramedullary cavity, the intramedullary pressure can increase up to the 300 mmHg and such an increase in pressure facilitates the migration of fat particles and globules through

venous openings into systemic circulation [1, 5]. The literature from early eighties even suggests that the intramedullary nailing increases the incidence of pulmonary complications [10]. This could be possibly explained due to subclinical undiagnosed FES.

In this study about a quarter (23.5%) of the patients developed FES after abdominoplasty and liposuction. This incidence is much higher compared to other studies. FES after plastic surgical procedure has been reported earlier as a number of case reports. According to an American Society for Aesthetic Plastic Surgery survey, the complication rate per 100,000 liposuctions has been reported as low as 0.25% [11]. In this tertiary health center a large number of patients undergo abdominoplasty in combination with liposuction or liposuction alone in multiple sites. This independent risk factor may be the reason for the high incidence of FES in our study [12].

The diagnosis of FES is basically a diagnosis of exclusion because the described clinical diagnostic criteria are nonspecific. When these criteria's were used alone for the diagnosis of FES, the incidence has been found to be quite low (0.9%) compared to that in post-mortem studies as high as 20% [2]. Therefore the reliability of these clinical criteria has been questioned leading to more imaging studies being performed for FES diagnosis.

A classic presenting triad of FES includes respiratory distress, neurological deterioration and petechial skin rashes. In this study 98% patients had initial hypoxemia and respiratory distress. The respiratory distress has been variably described to occur in 75 to 95% of FES patients in a number of case series [1, 3, 13]. In this study one half (50.61%) of the patients with respiratory insufficiency required tracheal intubation and invasive mechanical ventilation whereas the other half (49.39%) did improve with the use of non-invasive ventilation. It appears that the use of non-invasive ventilation in mild to moderate pulmonary FES cases has increased due to its inherent advantages of less trauma and infection [14].

In this study a total of 9 (11.1%) patients had diffuse alveolar hemorrhage which led to acute respiratory distress syndrome (ARDS). As far as we are aware there is not much literature available about alveolar hemorrhage in FES except isolated case reports [15]. The inflammatory response sets in due to the presence of lipoprotein in alveoli. In addition, the catecholamine surges activates lipase which acts on fat deposits in pulmonary system liberating high concentration of free fatty acid locally, leading to disruption of pulmonary capillaries and diffuse alveolar hemorrhage [15].

The skin manifestation of FES is petechial rash in upper part of the body mainly in the chest, axilla, oral mucosa and conjunctiva. This has been variably described to occur in 33-60% patients [1, 2, 15]. Only 2.5% of our FES patients had petechial rash. Petechial rash appearance varies widely and depends on the skin color. This low incidence may be attributed to darker skin color in our population, hence skin rashes might have been difficult to observe and notice.

Acute kidney injury was seen in 37% of our patients with oliguria, lipiduria and raised serum creatinine. None of these patients required renal replacement therapy. Acute kidney injury has been described to occur in 30-60% of the FES patients usually on 3rd day after the trauma or surgery as a result of an inflammatory reaction in the renal system [1, 16].

Neurological deterioration is one of the important manifestations of FES. It has been reported to develop in up to 86% of patients [1, 5]. In this study it was seen in 70% of our patients. Mean time of patients' deterioration was 18.39 (±34.31) hours following surgery and duration of surgery was around three hours. The frequently reported time for deterioration is after 36 hours of trauma or surgery [15, 17]. As we initially used Gurd's criteria for the diagnosis of FES, our patients also had significant tachycardia, tachypnea, fever and raised ESR apart from typical triad of FES [18].

Most challenging aspect of the management is diagnosis of FES. Imaging studies in combination with clinical picture in the presence of risk factors would be the recommended approach in the diagnosis of FES [3]. Among the Imaging studies, chest x-ray will show snow storm appearance or bilateral infiltrates. Although the chest x-ray was abnormal in all of our patients but the CT chest did show bilateral

typical patchy alveolar opacities in only 60.5% [19]. Majorities of our patients had brain edema (78%) on CT head, and in 22% patients it was normal. It is reported in the literature that most of the FES patients will have a normal CT brain, but many have brain edema due to the toxic effect of fatty acids on brain [1, 3, 20]. MRI is most sensitive imaging study and T2 weighted images will show the small, scattered, non-confluent, hyper intense lesions mainly in white matters, because of typicality it is called star field appearance [1, 3, 21]. In our study 23 patient's MRI brain showed typical star field appearance to a varying degree and in 1 patient it was normal it may due to delay in imaging study.

We compared the association of major and minor component of Gurd's and Wilson clinical criteria: hypoxia, oxygen desaturation, pinkish endotracheal secretions, deteriorating level of consciousness, petechial skin rash, fever, retinopathy, oliguria, increased ESR and renal impairment with the abnormal imaging findings in chest x-ray, CT chest, CT and MRI brain. We found a significant correlation ($P<0.05$) between the component of clinical criteria and abnormal imaging studies. We also found an association between abnormal imaging findings and higher extra-vascular lung water index, raised right ventricular pressure and cardiac chamber dilatation. A drop in hemoglobin and platelet count was not significantly associated with imaging abnormality.

Conclusion

The findings in this study suggest that FES is common in younger male patients following intramedullary nailing of long bone fracture. Hypoxia, respiratory insufficiencies and neurological deterioration were the common presentations. We found a significant correlation between clinical parameters and the imaging abnormalities. We therefore recommend early imaging studies to establish FES diagnosis and further management when FES is suspected based on clinical criteria alone.

Disclosure of conflict of interest

None.

Abbreviations

FES, fat Embolism syndrome; CT, computerized tomography; MRI, Magnetic resonance imaging; SOFA, sequential organ failure assessment score; GCS, Glasgow coma score; DM, Diabetes mellitus; HTN, hypertension; CAD, coronary artery disease; ARDS: acute respiratory distress syndrome; ETT, Endotracheal tube; NIV, None invasive ventilation; ESR, Erythrocyte sedimentation rate; EVLWI, Extra vascular lung water index; RTA, Road traffic accident.

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