**Name of Journal:** *World Journal of Clinical Cases*

**Manuscript NO:** 59152

**Manuscript Type:** CASE REPORT

**Postoperative complications of concomitant fat embolism syndrome, pulmonary embolism and tympanic membrane perforation after tibiofibular fracture: A case report**

Shao J *et al*. Postoperative complications after tibiofibular fracture

Jin Shao, De-Ce Kong, Xin-Hui Zheng, Tian-Ning Chen, Tie-Yi Yang

**Jin Shao, De-Ce Kong, Tie-Yi Yang,** Department of Orthopedics, Pudong New Area Gongli Hospital, School of Clinical Medicine, Shanghai University, Shanghai 200135, China

**Xin-Hui Zheng, Tian-Ning Chen,** Graduate School, Ningxia Medical University, Yinchuan 750004, Ningxia Hui Autonomous Region, China

**Author contributions:** Shao J, Kong DC, and Yang TY participated in the diagnosis and treatment of the patient, provided follow-up, drafted and reviewed the manuscript; Kong DC, Zheng XH, and Chen TN acquired clinical data; Shao J, Kong DC, and Yang TY conducted investigations, reviewed literature, and assisted in polishing the manuscript for final publication; and all of the authors read and approved the final manuscript.

**Supported by** the Subject Leadership Project of Shanghai Pudong New Area, No. PWRd2016-06; and the Featured Clinical Discipline Project of Shanghai Pudong, No. PWYts2018-03.

**Corresponding author: Tie-Yi Yang, MD, Chief Doctor, Director, Professor,** Department of Orthopedics, Pudong New Area Gongli Hospital, School of Clinical Medicine, Shanghai University, No. 219 Miaopu Road, Pudong New Area, Shanghai 200135, China. yangtieyi@163.com

**Received:** August 27, 2020

**Revised:** November 9, 2020

**Accepted:** November 21, 2020

**Published online:**

**Abstract**

BACKGROUND

Fat embolism syndrome (FES) is a rare disease characterized by pulmonary distress, neurologic symptoms, and petechial rash and seriously threatens human life and health. It is still neglected clinically because of the lack of verifiable diagnostic criteria and atypical clinical symptoms. No studies on FES with pulmonary embolism (PE) and tympanic membrane perforation have been reported to date. Here, we report a rare case of concomitant FES, PE and tympanic membrane perforation after surgery in a patient with a tibiofibular fracture.

CASE SUMMARY

A 39-year-old man presented with right lower extremity pain due to a car accident while driving a motorbike on the road. X-ray and computed tomography scans revealed a fracture of the right mid-shaft tibia and proximal fibula categorized as a type A2 fracture according to the AO classification. A successful minimally invasive operation was performed 3 d after the injury. Postoperatively, the patient developed sudden symptoms of respiratory distress and hearing loss. Early diagnosis was made, and supportive treatments were used at the early stage of FES. Seven days after surgery, he presented a clear recovery from respiratory symptoms. The outcome of fracture healing was excellent, and his hearing of the left ear was mildly impaired at the last follow-up of 4 mo.

CONCLUSION

Concomitant FES, PE and tympanic membrane perforation are very rare but represent potentially fatal complications of trauma or orthopaedic surgery and present with predominantly pulmonary symptoms. Early diagnosis and treatment can reduce the mortality of FES, and prevention is better than a cure.

**Key Words:** Fat embolism syndrome; Tibiofibular fracture; Pulmonary embolism; Tympanic membrane perforation; Postoperative complication; Case report

Shao J, Kong DC, Zheng XH, Chen TN, Yang TY. Postoperative complications of concomitant fat embolism syndrome, pulmonary embolism and tympanic membrane perforation after tibiofibular fracture: A case report. *World J Clin Cases* 2020; In press

**Core Tip:** Fat embolism syndrome (FES) is a rare complication after internal fixation. This case suggests that any clinical manifestations of patients should be identified after internal fixation to avoid delays in treatment. Even with a lack of verifiable diagnostic criteria for FES, FES should be highly suspected for patients with sudden hypoxemia and atypical neurological symptoms. Early diagnosis and supportive treatment are still recommended.

**INTRODUCTION**

The precise causes of patient death remain unknown clinically. Fat embolism syndrome (FES) is one of the most common causes of death. In fact, in 1873, it was reported that the first patient with FES who fell from a roof and sustained a comminuted distal femur fracture[1]. Due to the lack of verifiable diagnostic criteria, the actual incidence of FES varies in different reports[2-4]. Despite extensive reports of the morbidity and mortality of FES[5-7], this condition may still be neglected clinically as of now. FES refers to the clinical symptoms that follow a clear history of trauma, particularly long bone fractures (*e.g.*, femur, tibia). Although the exact mechanisms that result in FES are still unknown, it is likely that both mechanical and biochemical components contribute to the pathologic and physical manifestations of FES. Here, we report a rare case of concomitant FES, pulmonary embolism (PE) and tympanic membrane perforation after surgery in a patient with a tibiofibular fracture.

**CASE PRESENTATION**

***Chief complaints***

Severe pain and swelling on his right calf.

***History of present illness***

A 39-year-old man was admitted to the department of emergency orthopaedics in our hospital due to right lower extremity trauma in a car accident 2 h prior.

***History of past illness***

The patient had a free previous medical history.

***Personal and family history***

The patient had no prior surgeries and did not smoke tobacco or drink alcohol. Family history was negative.

***Physical examination***

After admission, the patient’s temperature was 36.8 °C, heart rate was 89 bpm, respiratory rate was 19 breaths per minute, and blood pressure was 112/89 mmHg. Severe pain and swelling were found on the patient’s right calf, while no numbness was found. Peripheral circulation was in good condition, with the dorsalis pedis artery pulse detected. The limitation of the right ankle joint during flexion and extension. Calcaneal traction was used to relieve pain and reduce swelling after admission.

***Laboratory examinations***

There are no specific laboratory tests for FES; however, anaemia, hypoxia, decreases in RBC count and haematocrit, and fluctuations in the inflammatory indices [*e.g.*, white blood cell (WBC), C-reactive protein (CRP)] are found at the early stage of FES (Table 1).

***Imaging examinations***

After X-ray and computed tomography (CT) examinations, he was diagnosed with fractures of the right mid-shaft tibia and proximal fibula (type A2 according to the AO classification) (Figure 1A). Preoperative routine examinations, including chest radiography (Figure 1B) and colour Doppler ultrasound of the lower extremity blood vessels, were performed, and the results showed no significant abnormalities.

**FINAL DIAGNOSIS**

The patient was diagnosed with fracture of the right mid-shaft tibia and proximal fibula.

**TREATMENT**

The patient was scheduled to undergo internal fixation of the tibia 3 d after the injury. A successful operation (Figure 1C) was performed via a minimally invasive anteromedial approach, with an operation time of 90 min and intraoperative bleeding volume of 100 mL.

Unfortunately, approximately 30 h after surgery, the patient developed sudden symptoms of respiratory distress. He became confused and developed tachypnoea (respiratory rate of 36 breaths/min) and tachycardia (heart rate: 120 bpm), and his oxygen saturation dropped below 90% on 4 L/min of oxygen *via* nasal cannula. No obvious petechial rash was present. A medical consultation was requested immediately for persistent respiratory distress symptoms, and the patient became weaker and more unresponsive. Decreased breath sounds and a small amount of scattered moist rales could be heard. However, his pupils were equal and round, and his reaction to light was normal. Computed tomography angiography (CTA) of the chest and CT of the head were performed. Moreover, the patient was transferred to the intensive care unit for close monitoring and supportive care. Then, he developed a fever of 38.4 °C 4 h later and required 50 L/min of oxygen to maintain a saturation > 95%. The CT scan of the head did not show any lesions (Figure 1D); however, the chest radiograph (Figure 1E) and CTA image (Figure 1F) demonstrated diffuse ground-glass opacities in both lungs, and a limited mural thrombus was found in one distal pulmonary artery (Figure 1G, the red arrow). There are no specific laboratory tests for FES; however, anaemia, hypoxia, decreases in RBC count and haematocrit, and fluctuations in the inflammatory indices (*e.g.*, WBC, CRP) are found at the early stage of FES (Table 1). Given that the patient’s dyspnoea was caused by a fat embolism (FE) and PE, high-flow oxygen inhalation (50 L/min), corticosteroids, anticoagulants and other supportive treatments were used. He experienced hearing loss in his left ear 4 d after surgery, and an otoscopic examination demonstrated that the left tympanic membrane had a small circular perforation (Figure 1H). He was treated conservatively with analgesia and empiric antibiotics.

**OUTCOME AND FOLLOW-UP**

Fortunately, the patient gradually became more alert, his breathing became smooth, and his hearing in the left ear improved. Seven days after surgery, he presented a clear recovery from respiratory symptoms, showed improvements, and moved all his limbs against gravity without problems. His oxygen requirements decreased from 50 L/min to 4 L/min to maintain a saturation of > 95%. On the 10th day after the operation, the repeat chest CT demonstrated remarkable absorption of the diffuse ground-glass opacities and mural thrombus (Figure 1I and J), and the patient returned to the orthopaedic ward and was discharged on the 18th day after the operation. The outcome of fracture healing was excellent, and his hearing of the left ear was mildly impaired at the last follow-up of 4 mo. He was satisfied with the treatments he received.

**DISCUSSION**

FE is defined as the presence of fat droplets in the systemic circulation after trauma, especially after long bone fracture fixation[8]. FE is not similar to FES; only a minority of patients develop FES clinically, and most patients present as asymptomatic. Numerous studies have found that early surgical stabilization of the fracture (external or internal fixation) before 24 h dramatically reduces the incidence of FES and pulmonary complications[1,9,10]. However, the timing of fracture fixation remains controversial, especially in patients with polytraumatic injuries, in terms of the advantages of early fixation and the risk of serious complications of early definitive fixation (a potential second source of trauma)[11].

Both mechanical and biochemical components contribute to the physical manifestations and pathology of FES. Mechanically, fat droplets as emboli are forced into the circulation during orthopaedic procedures, especially intramedullary fixation. The emboli can affect different organs and cause symptoms, especially the lungs and brain.

Biochemically, free fatty acids are released when lipase produced by the lungs acts on embolic fat. Pulmonary endothelial cells and pneumocytes are damaged, leading to arterial hypoxemia[12].

FES is a potentially devastating cause of morbidity and mortality in polytrauma patients. The clinical features of FES vary. FES usually has an asymptomatic interval for approximately 12 to 72 h after the initial injury, followed by a classical triad of findings: Pulmonary distress, neurologic symptoms, and petechial rash[10]. This condition is often asymptomatic until pulmonary manifestations occur, which is when we first considered FES. A massive pulmonary FE is often found at autopsy. Pulmonary manifestations, including dyspnoea, tachypnoea, and hypoxemia to acute respiratory distress syndrome (ARDS), are the earliest symptoms and can be seen in 75% of patients[13]. Hypoxia is the most common finding and is present in 95% of patients[8]. Neurologic manifestations may include ischaemic/haemorrhagic strokes, retinal ischaemia, seizures, autonomic dysfunction, and diffuse brain injury[14], which are present in 80% of patients[10]. FES is not necessarily accompanied by organic changes in brain tissue; CT scans of the brain may be normal, but brain magnetic resonance imaging is more sensitive in detecting FES[10,15]. However, isolated cerebral FES without any pulmonary symptoms was reported in a patient with multiple injuries[16]. This patient initially presented with hypoxia and atypical neurological symptoms 30 h after surgery. The delay in presentation is consistent with biochemical theory.

A number of respiratory parameters, vital signs, and laboratory results can provide additional information according to Gurd, Schonfeld, and Lindeque’s criteria[10].

Overall, in this patient, we diagnosed FES with PE and conductive deafness based on typical hypoxia (PaO2: 58 mmHg in the arterial blood), mild neurological symptoms, fever (temperature: 38.4 °C > 38 °C), changes in vital signs (respiratory rate: 36/min > 30/min; heart rate: 120 bpm), and some laboratory tests combined with pulmonary CT findings. Nonetheless, there is no benchmark diagnostic test for FES. Many imaging modalities can facilitate the diagnosis of FES, but none of the findings are specific. Chest radiographic findings may show diffuse bilateral patchy infiltrates, consistent with ARDS, although this must be differentiated from pulmonary haemorrhage or pulmonary oedema. CTA of the chest can demonstrate diffuse interlobular septal thickening with a superimposed ground-glass abnormality, as well as numerous discrete small nodules, which are consistent with FES.

The most important treatment for FES is supportive care for the lung and cardiovascular system to correct hypoxia and maintain haemodynamic stability. Unnecessary transfers between wards and movement should be avoided to reduce the risk of the embolus breaking off and cardiopulmonary collapse. If patients exhibit neurologic involvement, frequent neurological examinations and intracranial pressure monitoring should be considered. The use of corticosteroids and heparin has been suggested as a possible treatment but remains controversial and has not been shown to reduce morbidity or mortality[17].

**CONCLUSION**

Concomitant FES, PE and tympanic membrane perforation are very rare but represent potentially fatal complications of trauma or orthopaedic surgery and present with predominantly pulmonary symptoms. This case reminds us to more carefully consider and examine similar patients who are encountered in clinical practice. Early diagnosis and treatment can reduce the mortality of FES, and prevention is better than a cure.

**REFERENCES**

1 **Dunn RH**, Jackson T, Burlew CC, Pieracci FM, Fox C, Cohen M, Campion EM, Lawless R, Mauffrey C. Fat emboli syndrome and the orthopaedic trauma surgeon: lessons learned and clinical recommendations. *Int Orthop* 2017; **41**: 1729-1734 [PMID: 28555248 DOI: 10.1007/s00264-017-3507-1]

2 **Mellor A**, Soni N. Fat embolism. *Anaesthesia* 2001; **56**: 145-154 [PMID: 11167474 DOI: 10.1046/j.1365-2044.2001.01724.x]

3 **Stein PD**, Yaekoub AY, Matta F, Kleerekoper M. Fat embolism syndrome. *Am J Med Sci* 2008; **336**: 472-477 [PMID: 19092320 DOI: 10.1097/MAJ.0b013e318172f5d2]

4 **Milroy CM**, Parai JL. Fat Embolism, Fat Embolism Syndrome and the Autopsy. *Acad Forensic Pathol* 2019; **9**: 136-154 [PMID: 32110249 DOI: 10.1177/1925362119896351]

5 **Cvetković D**, Živković V, Nikolić S. An unusual case of pulmonary fat embolism following blunt trauma. *Forensic Sci Med Pathol* 2019; **15**: 292-295 [PMID: 30535906 DOI: 10.1007/s12024-018-0053-0]

6 **Li S**, Zou D, Qin Z, Liu N, Zhang J, Li Z, Shao Y, Deng K, Chen Y, Huang P. Nonfracture-associated pulmonary fat embolism after blunt force fatality: case report and review of the literature. *Am J Forensic Med Pathol* 2015; **36**: 61-65 [PMID: 25651164 DOI: 10.1097/PAF.0000000000000142]

7 **Takada M**, Chiba S, Nagai T, Takeshita H, Kanno S, Ikawa T, Sakamoto K, Sagi M, Ichiba K, Mukai T. Inflammatory responses to neutral fat and fatty acids in multiple organs in a rat model of fat embolism syndrome. *Forensic Sci Int* 2015; **254**: 126-132 [PMID: 26218407 DOI: 10.1016/j.forsciint.2015.07.011]

8 **Newbigin K**, Souza CA, Torres C, Marchiori E, Gupta A, Inacio J, Armstrong M, Peña E. Fat embolism syndrome: State-of-the-art review focused on pulmonary imaging findings. *Respir Med* 2016; **113**: 93-100 [PMID: 26895808 DOI: 10.1016/j.rmed.2016.01.018]

9 **Porpodis K**, Karanikas M, Zarogoulidis P, Konoglou M, Domvri K, Mitrakas A, Boglou P, Bakali S, Iordanidis A, Zervas V, Courcoutsakis N, Katsikogiannis N, Zarogoulidis K. Fat embolism due to bilateral femoral fracture: a case report. *Int J Gen Med* 2012; **5**: 59-63 [PMID: 22287848 DOI: 10.2147/IJGM.S28455]

10 **Rothberg DL**, Makarewich CA. Fat Embolism and Fat Embolism Syndrome. *J Am Acad Orthop Surg* 2019; **27**: e346-e355 [PMID: 30958807 DOI: 10.5435/JAAOS-D-17-00571]

11 **Blokhuis TJ**, Pape HC, Frölke JP. Timing of definitive fixation of major long bone fractures: Can fat embolism syndrome be prevented? *Injury* 2017; **48** Suppl 1: S3-S6 [PMID: 28449860 DOI: 10.1016/j.injury.2017.04.015]

12 **Paredes JC**, Syquia JF, Chang AM, Zamuco JT. Fat embolism syndrome after shoulder hemiarthroplasty. *J Shoulder Elbow Surg* 2011; **20**: e1-e5 [PMID: 21393020 DOI: 10.1016/j.jse.2010.11.027]

13 **Powers KA**, Talbot LA. Fat embolism syndrome after femur fracture with intramedullary nailing: case report. *Am J Crit Care* 2011; **20**: 267, 264-266 [PMID: 21532048 DOI: 10.4037/ajcc2011694]

14 **Morales-Vidal SG**. Neurologic Complications of Fat Embolism Syndrome. *Curr Neurol Neurosci Rep* 2019; **19**: 14 [PMID: 30788612 DOI: 10.1007/s11910-019-0928-9]

15 **Citerio G**, Bianchini E, Beretta L. Magnetic resonance imaging of cerebral fat embolism: a case report. *Intensive Care Med* 1995; **21**: 679-681 [PMID: 8522674 DOI: 10.1007/BF01711549]

16 **Huang CK**, Huang CY, Li CL, Yang JM, Wu CH, Chen CH, Wu PT. Isolated and early-onset cerebral fat embolism syndrome in a multiply injured patient: a rare case. *BMC Musculoskelet Disord* 2019; **20**: 377 [PMID: 31421672 DOI: 10.1186/s12891-019-2736-4]

17 **Habashi NM**, Andrews PL, Scalea TM. Therapeutic aspects of fat embolism syndrome. *Injury* 2006; **37** Suppl 4: S68-S73 [PMID: 16990063 DOI: 10.1016/j.injury.2006.08.042]

**Footnotes**

**Informed consent statement:** Consent was obtained from patients for publication of this report and any accompanying images.

**Conflict-of-interest statement:** All the authors declare that they have no conflict of interest.

**CARE Checklist (2016) statement:** The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/Licenses/by-nc/4.0/

**Manuscript source:** Unsolicited manuscript

**Peer-review started:** August 27, 2020

**First decision:** November 3, 2020

**Article in press:**

**Specialty type:** Medicine, research and experimental

**Country/Territory of origin:** China

**Peer-review report’s scientific quality classification**

Grade A (Excellent): 0

Grade B (Very good): B, B

Grade C (Good): 0

Grade D (Fair): 0

Grade E (Poor): 0

**P-Reviewer:** Ampollini L **S-Editor:** Huang P **L-Editor: P-Editor:**

**Figure Legends**



**Figure 1 Patient’s imaging data.** A: Anteroposterior radiograph of the fracture of the right tibia and fibula; B: Anteroposterior radiograph of the chest after admission; C: Anteroposterior radiograph of the right tibia and fibula 3 mo after surgery; D: Computed tomography (CT) scan of the brain demonstrating no pathological changes; E: Bedside chest radiography with diffuse interstitial opacities 30 h after surgery; F: Computed tomography angiography (CTA) of the chest demonstrating diffuse superimposed ground-glass abnormalities in both lungs, as well as numerous discrete small nodules, which are consistent with fat embolism syndrome; G: CTA of the chest demonstrating a limited mural thrombus at the right distal pulmonary artery (red arrow); H: Otoscopic examination demonstrating that the left tympanic membrane had a small circular perforation; I and J: Repeat chest CT demonstrating remarkable absorption of the diffuse ground-glass opacities and mural thrombus 10 d after the operation.

**Table 1 Laboratory tests**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Reference range** | **Pre-operation** | **30 h after surgery** | **48 h after surgery** | **72 h after surgery** |
| WBC (109/L) | 3.5-9.5 | 13.63 | 11.25 | 8.73 | 14.8 |
| HG (g/L) | 130-175 | 146 | 104 | 91 | 93 |
| RBC (1012/L) | 4.3-5.8 | 4.85 | 3.27 | 2.98 | 2.97 |
| Haematocrit (%) | 40-50 | 44.8 | 30.5 | 28 | 28.1 |
| Platelet count (PLT) (109/L) | 125-350 | 245 | 198 | 207 | 233 |
| CRP (mg/L) | 0-10 | 8.6 | 85.4 | 116 | 44.7 |
| Prothrombin time (s) | 11-15 | 14 | 14.9 | 14.5 | 14.5 |
| Prothrombin time/international normalized ratio | 0.85-1.50 | 1.1 | 1.19 | 1.15 | 1.15 |
| Activated partial-thromboplastin time (s) | 25.00-45.00 | 37.1 | 38.1 | 52.9 | 39.2 |
| Potassium (mmol/L) | 3.5-5.1 | 4.5 | 3.65 | 3.76 | 3.5 |
| Sodium (mmol/L) | 137-147 | 141 | 140 | 143 | 141 |
| Chloride (mmol/L) | 99-110 | 104 | 108.6 | 109.3 | 108.9 |
| Calcium (mmol/L) | 2.11-2.52 | 2.19 | 1.89 | 1.95 | 1.85 |
| Carbon dioxide (mmol/L) | 22-29 | 30 | 27.9 | 28.9 | 27.4 |
| Alanine aminotransferase (U/L) | 9.0-60.0 | 24.3 | 70 | 64 | 47.8 |
| Aspartate aminotransferase (U/L) | 15.0-45.0 | 21 | 48 | 28 | 29.9 |
| Alkaline phosphatase (U/L) | 45.0-125.0 | 49.1 | 104 | 91 | 58.3 |
| Albumin (g/L) | 40.0-55.0 | 42.4 | 27.8 | 29.6 | 31.1 |
| Total protein (g/L) | 65.0-85.0 | 68.8 | 54.5 | 56.4 | 51.4 |
| Urea (mmol/L) | 3.1-8.0 | 6.19 | 3.25 | 5.64 | 7.63 |
| Creatinine (μmol/L) | 57-97 | 62 | 44 | 49 | 60 |
| Uric acid (μmol/L) | 238-416 | 311 | 183 | 178 | 163 |
| Arterial blood gas (fraction of inspired oxygen) |  |  |  |  |  |
| Partial pressure of CO2 (mmHg) | 35.00-48.00 |  | 43 | 38 | 37 |
| Partial pressure of O2 (mmHg) | 83.00-108.00 |  | 58 | 135 | 130 |
| Base excess (%) | -2.00-3.00 |  | 1.3 | 3.9 | 2.6 |

WBC: White blood cell count; HG: Haemoglobin; RBC: Red blood cell count; CRP: C-reactive protein.