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Case report

Cerebral and pulmonary fat embolism after unilateral total knee arthroplasty

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ABSTRACT

Fat embolism syndrome is the presence of a fatty embolus in the circulatory system that can manifest itself in multiple ways, ranging from asymptomatic presentation to respiratory failure, neurocognitive deficits, and death. It is a relatively common complication after procedures or conditions such as orthopaedic surgery, severe burns, liver injury, closed-chest cardiac massage, and liposuction. This pathology is relatively common in the field of orthopaedics, especially in long bone fractures and procedures such as total hip replacements. It is typically an exclusion diagnosis, and the management is supportive care. In this report, we present a case of a 63-year-old patient who, during a cemented total knee replacement, presented with fat embolism syndrome with neurological and pulmonary manifestations, and subsequently made a complete recovery at discharge.

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Introduction

Fat embolism syndrome (FES) is the presence of a fatty embolus in the circulatory system. It can manifest itself in multiple ways, ranging from asymptomatic to severe cases of respiratory dysfunction, coma, and even death [1]. The classic triad of presentation for FES consists of hypoxemia, neurological alterations, and cutaneous petechial rash. It is most commonly observed in cases of long bone fractures and during or following orthopaedic procedures such as total hip replacement (0.6%-10%) and total knee arthroplasty (TKA) (0.1%-12%) [2-4]. Risk factors include male sex, young adults, obesity, multiple fractures, and long bone fractures [5,6]. It is usually a diagnosis of exclusion and primarily based on clinical features using the Gurd and Wilson [7] criteria (Table 1). Laboratory tests and imaging studies are of complementary use.

The usual treatment for FES is one of supportive care with close monitoring. General management such as ventilator support and non-specific hemodynamic support may be essential to maintain adequate arterial oxygenation [8,9].

The literature shows that 1%-5% of patients suffering from pelvic trauma, long bone fractures, and some orthopaedic procedures can present with FES [1]. In this group of patients, 75% will have respiratory symptoms as the initial presenting sign, 86% will present neurological alterations, and only 20%-50% will present with a cutaneous petechial rash [10]. The symptoms may take up to 24-72 hours to develop following the injury or intervention [2,10].

In the last 20 years, at least 4 clinical cases have described the association between FES and unilateral TKA [11-14]. Two of the cases developed symptoms intraoperatively and the other 2 within 6-36 hours postoperatively, respectively. Two of the patients suffered cardiac arrest and 1 of them passed away. The rest of the patients made a complete recovery.

In this report, we present a case of a 63-year-old patient who, during a left TKA, presented with symptoms of FES intraoperatively including hypoxemia and decreased PO2 saturation level. Clinically, she developed aphasia, dyspnea, and facial paralysis as the condition evolved. Following supportive care, she eventually made a complete recovery at discharge.

Case history

The case report is about a 63-year-old female patient with a body mass index of 26.4 and past medical history of depression, systemic lupus erythematosus, arterial hypertension, and hypothyroidism.

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Table 1
Gurd and Wilson criteria for diagnosis of FES.

Major criteria	Minor criteria
Respiratory distress	Tachycardia (>110 bpm)
Cerebral symptoms in non-head injury patients	Fever (>38.5°C)
Petechial rash	Jaundice
	Renal changes
	Retinal changes
	Drop in hemoglobin
	New onset thrombocytopenia
	Elevated erythrocyte sedimentation rate
	Fat macroglobulinemia

Two major criteria or 1 major criterion and 4 minor criteria suggest a diagnosis of FES.

Her usual medications included bupropion, venlafaxine, prednisone, hormone replacement therapy, valsartan, calcium plus vitamin D, and levothyroxine. She had no known drug allergies.

The patient visited our orthopaedic clinic with a history of long-standing left knee pain, and a prior open surgery for fixation of a femoral condyle fracture 20 years ago.

Her physical examination revealed a valgus alignment of approximately 20°, with medial-lateral instability, moderate joint effusion, tricompartmental pain, and preserved range of motion from full extension to 130° of flexion.

Her left knee radiographs showed tricompartmental osteoarthritis more severe in the lateral compartment, with valgus alignment (Fig. 1a). The long leg alignment films showed a mechanical valgus misalignment of 15°.

Therefore, we recommended proceeding with a cemented left TKA with a semi-constrained implant and revision stems for both the tibia and femur (Fig. 1b).

The surgery started with a standard longitudinal anterior approach. The capsule was entered through a medial parapatellar incision. The tibial preparation was done using sequential intramedullary reaming until cortical chatter was achieved (17 mm). A clean-up cut to produce a resected surface with a neutral slope was performed with the oscillating saw. No offset and augments were used. The femoral preparation was done using an intramedullary guide with sequential reaming until cortical chatter was achieved (18 mm). The femoral cuts were performed according to the femoral resection guides. No femoral offset or augmentations were used. After stability, alignment and trial implants were checked; cemented definitive implants were impacted into the prepared surfaces. The tourniquet was deflated after a total ischemia time of 120 minutes, with minimal bleeding.

After cementation, and at the moment that the tourniquet was deflated, the patient had an episode of oxygen desaturation down to 80% and EtCO2 decrease, which promptly and spontaneously recovered, but alerted the anesthesia staff.

During the immediate post-operative recovery phase, right facial paralysis, dysarthria, and vision loss were present. The patient was evaluated immediately by a neurologist, who specifically noted aphasia, right hemianopsia, complete right hemiplegia, right hemiparesis of brachial predominance, without facial paralysis or meningeal signs. Deep tendon reflexes were present, and National Institutes of Health stroke score was 11 (moderate).

Complete imaging studies were performed with a head computed tomography (CT), brain magnetic resonance imaging (MRI) with diffusion, and a CT chest angiogram. The head CT did not show any lesions; however, an MRI with diffusion showed hyperintense images in T2 (starry sky pattern), suggestive of hyperacute ischemia (Fig. 2). The CT chest angiogram showed embolic defects in multiple branches at the segmental and subsegmental bilateral pulmonary arteries, with characteristics suggesting a fat embolism (FE) (Fig. 3).

The patient was transferred to the intensive care unit (ICU) for close monitoring and support. Given the contraindication of performing therapeutic anticoagulant treatment due to recent surgery and the risk of hemorrhagic transformation of brain lesions, an inferior vena cava filter was placed without incidents in an

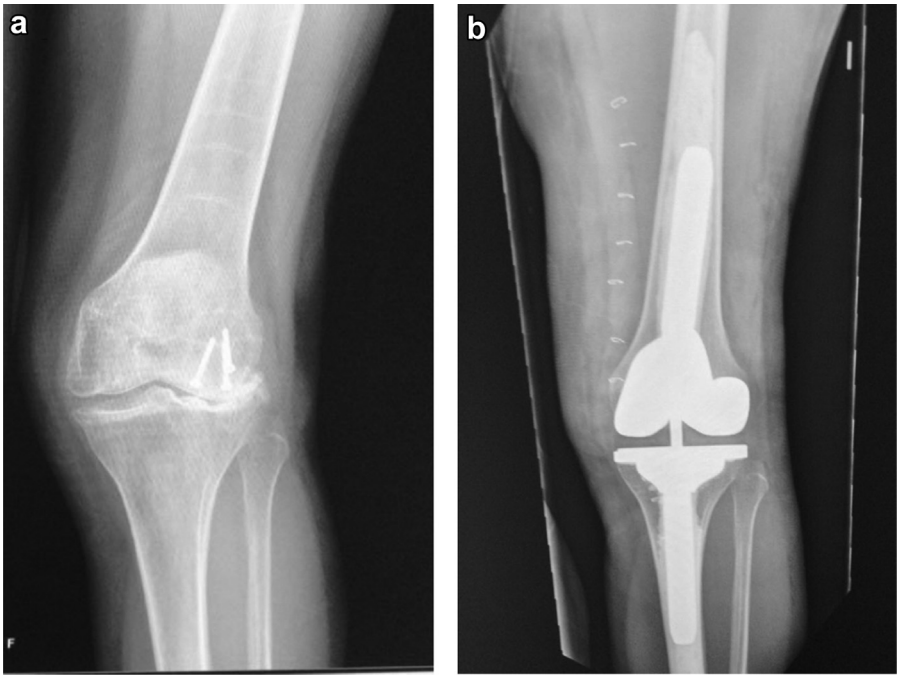

Figure 1. (a) Preoperative left knee radiograph showing tricompartmental osteoarthritis most severe in the lateral compartment, with valgus alignment and screws in the lateral femoral condyle from a previous fracture. (b) Postoperative left knee radiograph following total knee arthroplasty with a semi-constrained implant.

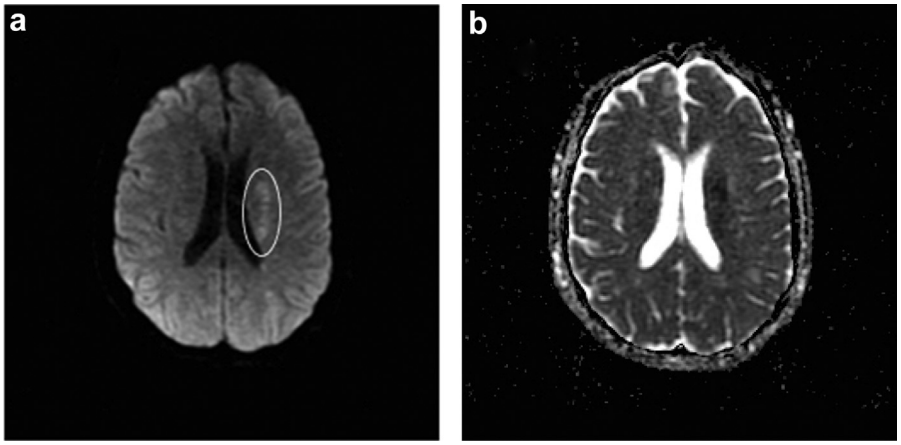

Figure 2. Brain magnetic resonance image: (a) sequence of diffusion where a hyperintensity focus (starry sky pattern) of the left periventricular white matter is observed (inside the white circle). (b) Apparent diffusion coefficient map with presence of negative values, consistent with a focus of restriction, which can be observed in the context of a hyperacute stroke.

infrarenal position. In addition, a nasogastric tube was placed to manage any possible swallowing disorder. Empiric treatment with intravenous (IV) corticosteroids was initiated, using methylprednisolone 6 mg/kg divided into 6 doses to be administered in 48 hours (40 mg every 8 hours IV for 2 days).

On her second post-operative day, she presented a clear regression of the neurological symptoms, accomplished activation, and movement of all her limbs against gravity without problems. Her O_2 requirements decreased drastically. She recovered language almost completely with some minor difficulties with tone, and responded satisfactorily to motor, neurological, and respiratory physical therapy. The patient was maintained with general hemodynamic support in the ICU for 3 days and then transferred to intermediate care. She was discharged 10 days after surgery, without any ongoing sequelae.

At the time of the current report, the patient has been followed for more than 2 years, without any additional complication secondary to her knee replacement, and an overall excellent functional and clinical outcome.

Discussion

FE is the presence of fat droplets in the circulatory system, which may or may not present symptoms. Between 3%-5% of cases develop FES, which consists of damage and dysfunction of certain organs due to FE, usually occurring within 12-72 hours after the intervention or injury [10].

FES is usually observed in cases of long bone fractures (0.9%-2.2%) [15], but it has also been described in certain orthopaedic procedures, with simultaneous bilateral knee arthroplasty being one of the most frequent (0.17%) [16]. The presence of confusion in post-operative patients following unilateral knee arthroplasty is 4 times lower than in those treated simultaneously [17]; however, the index of suspicion in these patients must be high.

It is a diagnosis of exclusion based on a myriad of clinical symptoms. Several organs may be affected; however, the 3 major clinical findings include respiratory dysfunction, neurological alterations, and skin rash of variable extension. Diagnosis is made by clinical criteria proposed by Gurd and Wilson [7], requiring 2 major criteria or 1 major criterion plus 4 minor criteria to make the diagnosis (Table 1).

The use of advanced imaging and laboratory tests is complementary since they can help guide our differential diagnosis and rule out other entities. In addition, they may aid in patient prognosis, but they are not specific for this FES pathology [1,3,18].

Brain MRI is very useful when faced with diagnostic uncertainty due to its greater sensitivity, especially after a negative head CT, as we observed in our case [8,19].

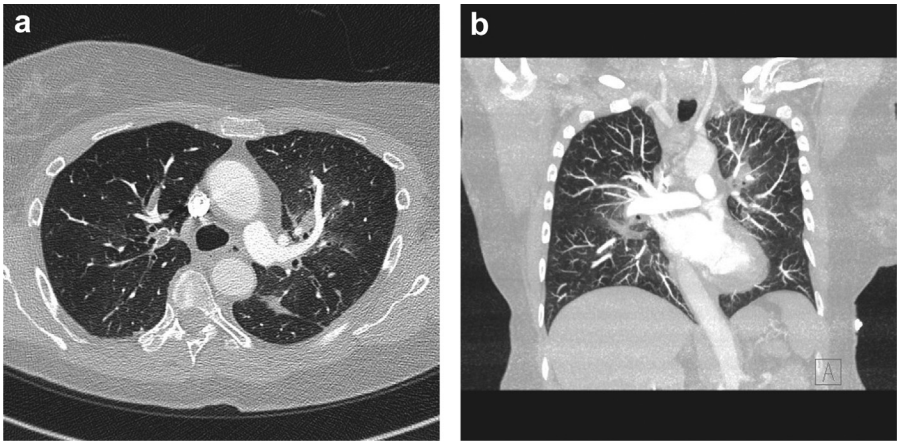

Figure 3. CT chest angiogram with pulmonary protocol, where adequate opacification of the pulmonary arteries and its branches is observed. Central filling defects are visualized in bilateral segmental and subsegmental branches consistent with acute pulmonary thromboembolism: (a) axial cut and (b) coronal cut.

When FES is encountered, prevention, early detection, and appropriate management are crucial. The risk is greater in adults, obese or polytraumatized patients [5,6]. Adili et al [20], in a comparative cohort study, observed a higher incidence of FES in patients with risk factors undergoing simultaneous bilateral knee arthroplasty vs unilateral arthroplasty, especially when a tourniquet was utilized.

Modifications of surgical techniques such as cementless arthroplasties or the use of computerized assisted navigation have not shown to have a lower incidence of FES [21]. However, irrigation of the femoral canal and aspiration of the bone marrow contents have shown satisfactory results, decreasing the incidence of FES [22].

We did not find any studies that address the relevance of the femoral canal reaming on the incidence of FES for total knee replacement procedures, which could be a factor to consider in our specific case report.

The probability of facing FES after a revision arthroplasty is actually lower because the fatty tissue of the medullary canal was removed in the first surgery. It is believed that the multiple impacts and attempts to remove the prosthesis may be the cause of this complication in revision scenarios [23].

Regarding the treatment, mainly supportive measures are required. Maintenance of arterial oxygenation within normal ranges and the adequate control of fluid resuscitation and avoiding fluid overload are fundamental for the prevention of shock, which can exacerbate lung and brain damage caused by FES [8,9].

There are no comparative studies supporting the use of corticosteroids, while some studies note its ineffectiveness [13]. In our case, IV methylprednisolone was implemented empirically for 2 days upon admission to the ICU, which may or may not have been beneficial.

Finally, the use of heparin is not only considered ineffective, but it can worsen the clinical picture in the setting of FES by increasing the risk of hemorrhages and fatty acids in the circulatory system [24,25]. In our case, given the relative contraindication of anticoagulant use because of the previous surgery, an inferior vena cava filter was implanted.

Summary

Despite the low incidence of FES in unilateral knee arthroplasty, one must always consider it and have a high index of suspicion in the presence of neurological and/or respiratory alterations following surgery. Early diagnosis along with supportive measures including close monitoring, hemodynamic control, and adequate rehabilitation is essential. It is crucial to avoid the use of anticoagulant therapy as it can worsen the clinical scenario in a case of FES.

References

[1] Al-Shaer DS, Ayoub O, Ahamed NA, et al. Cerebral fat embolism syndrome following total knee replacement causing a devastating neurocognitive sequelae. Neurosciences (Riyadh) 2016;21(3):271.
[2] Yeo SH, Chang HW, Sohn SI, Cho CH, Baec KC. Pulmonary and cerebral fat embolism syndrome after total knee replacement. J Clin Med Res 2013;5(3):239.
[3] Filomeno LTB, Carelli CR, Silva NC, Barros Filho TE, Amatuzzi MM. Fat embolism: a review for current orthopaedics practice. Acta Ortop Bras 2005;13(4):196.
[4] Kim YH. Incidence of fat embolism syndrome after cemented or cementless bilateral simultaneous and unilateral total knee arthroplasty. J Arthroplasty 2001;16(6):730.
[5] Lu K, Xu M, Li W, Wang K, Wang D. A study on dynamic monitoring, components, and risk factors of embolism during total knee arthroplasty. Medicine (Baltimore) 2017;96(51):e9303.
[6] Stein PD, Yaekoub AY, Matta F, Kleerekoper M. Fat embolism syndrome. Am J Med Sci 2008;336(6):472.
[7] Gurd AR, Wilson RI. The fat embolism syndrome. J Bone Joint Surg Br 1974;56B(3):408.
[8] Murray DG, Racz GB. Fat-embolism syndrome (respiratory insufficiency syndrome). J Bone Joint Surg Am 1974;56:1338.
[9] Shaikh N. Emergency management of fat embolism syndrome. J Emerg Trauma Shock 2009;2(1):29.
[10] Chang RN, Kim JH, Lee H, et al. Cerebral fat embolism after bilateral total knee replacement arthroplasty—a case report-. Korean J Anesthesiol 2010;50:207.
[11] Jenkins K, Chung F, Wennberg R, Etchells E, Davey R. Fat embolism syndrome and elective knee arthroplasty. Can J Anaesth 2002;49(1):19.
[12] Hall T, Callaghan JJ. Fat embolism precipitated by reaming of the femoral canal during revision of a total knee replacement. A case report. J Bone Joint Surg Am 1994;76(6):899.
[13] Enneking FK. Cardiac arrest during total knee replacement using a long-stem prosthesis. J Clin Anesth 1995;7(3):253.
[14] Saad RA, Fahmy AA, Ahmed MH. Fatal fat embolism complicating total knee replacement: another manifestation of the metabolic syndrome? Arch Orthop Trauma Surg 2007;127(5):387.
[15] Deo H, West G, Butcher C, Lewis P. The prevalence of cognitive dysfunction after conventional and computer-assisted total knee replacement. Knee 2011;18:117.
[16] Lee SC, Yoon JY, Nam CH, Kim TK, Jung KA, Lee DW. Cerebral fat embolism syndrome after simultaneous bilateral total knee arthroplasty: a case series. J Arthroplasty 2012;27:409.
[17] Lane GJ, Hozack WJ, Shah S, et al. Simultaneous bilateral versus unilateral total knee arthroplasty. Outcomes analysis. Clin Orthop Relat Res 1997;(345):106.
[18] Parisi DM, Koval K, Egol K. Fat embolism syndrome. Am J Orthop (Belle Mead NJ) 2002;31(9):507.
[19] Metting Z, Rodiger LA, Regtien JG, van der Naalt J. Delayed come in head injury: consider fat embolism. Clin Neurol Neurosurg 2009;111:597.
[20] Adili A, Bhandari M, Petruccelli D, De Beer J. Sequential bilateral total knee arthroplasty under 1 anesthetic in patients > or = 75 years old: complications and functional outcomes. J Arthroplasty 2001;16(3):271.
[21] O'Connor MI, Brodersen MP, Feinglass NG, Leone BJ, Crook JE, Switzer BE. Fat emboli in total knee arthroplasty: a prospective randomized study of computer-assisted navigation vs standard surgical technique. J Arthroplasty 2010;25(7):1034.
[22] Ries MD, Rauscher LA. Intramedullary pressure and pulmonary function during total knee arthroplasty. Clin Orthop 1998;356:154.
[23] Ritter MA, Harty LD. Fat embolism in revision total hip arthroplasty. J Arthroplasty 2002;17(8):1063.
[24] Freeman JI, Enneking FK. Orthopedic complications. In: Civetta JM, Taylor RW, Kirby RR, editors. Critical care. 3rd ed. Philadelphia (PA): Lippincot-Raven; 1996. p. 1231.
[25] Peltier LF. Fat embolism: the toxic properties of neutral fat and free fatty acids. Surgery 1956;40:665.