

Cerebral Fat Embolism in the Absence of Systemic Manifestations of Fat Embolism Syndrome

Sistemik Yağ Embolizmi Belirtileri Göstermeyen Bir Serebral Yağ Embolizmi Olgusu

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ABSTRACT Fat embolism syndrome is an uncommon complication of skeletal trauma. The syndrome is characterized by petechial rash, pulmonary insufficiency and neurological symptoms. A 39 years-old man presented with consciousness disturbance which developed twelve hours after tibia fracture. Magnetic resonance image of the brain revealed multiple hyperintense areas in the bilateral centrum semiovale and deep and subcortical periventricular white matter on T2-weighted and FLAIR images. He had no other symptoms or signs of fat embolism syndrome. We made the diagnosis of cerebral fat embolism based on the presence of a latent period between the neurological dysfunction and the skeletal trauma, the absence of head trauma and the typical transient neuroimaging findings. Although respiratory compromise and skin rashes usually accompany neurological symptoms, cases of isolated cerebral fat embolism have been rarely reported. Isolated cerebral fat embolism may pose a diagnostic challenge and brain magnetic resonance imaging findings may contribute to the diagnosis.

Key Words: Embolism, fat; tibial fractures; foramen ovale, patent; stroke

ÖZET Yağ embolizmi sendromu iskelet travmalarının seyrek bir komplikasyonudur. Sendrom, peteşiyal döküntü, pulmoner yetmezlik ve nörolojik semptomlarla karakterizedir. 39 yaşında erkek olgu, tibia kırığı oluşumundan 12 saat sonra gelişen bilinç bozukluğu ile başvurdu. Beyin manyetik rezonans görüntüleme tetkikinde bilateral sentrum semiovale, derin ve subkortikal beyaz cevherde T2 ağırlıklı ve FLAIR imajlarda multipl hiperintens alanlar saptandı. Olgunun yağ embolizmi sendromu ile ilişkili başka belirti veya bulgusu yoktu. Olguya, nörolojik disfonksiyon ile iskelet travması gelişimi arasında latent bir periyod olması, kafa travmasının olmaması ve tipik geçici nörogörüntüleme bulgularına dayanılarak serebral yağ embolizmi tanısı kondu. Respiratuar yetmezlik ve deri döküntülerinin nörolojik semptomlara genellikle eşlik etmesine karşın, nadir olarak izole serebral yağ embolizmi olguları bildirilmiştir. İzole serebral yağ embolizmi tanısız güçlük oluşturabilir ve beyin manyetik rezonans görüntüleme bulguları tanıya katkıda bulunabilir.

Anahtar Kelimeler: Emboli,yağ; tibia kırıkları; oval foramen, kalıcı; inme, felç

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Fat embolism syndrome (FES) is an uncommon but serious complication of skeletal trauma, in particular long bone fractures and orthopedic procedures.¹⁻³ Rarely, FES occurs after non-traumatic conditions.² The syndrome develops after a time interval, ranging from 12 hours to 72 hours after trauma and is characterized by a classic triad of petechial skin rash, respiratory distress and neurological dysfunction.¹⁻⁴ Neurological involvement usually coexists with pulmonary involvement, nevertheless, although rare, cases without pulmonary compromise have been reported previously.⁵⁻¹³ Ho-

wever, there have been few case reports dealing with isolated cerebral fat embolism to date.¹³ We present a case with neurological complications in the absence of other manifestations of FES.

CASE REPORT

A previously healthy 39-year-old man sustained a closed, non-displaced fracture of the middle third of the left tibial shaft in a bicycle accident. He had no head injury and he had not lost consciousness. Upon admission to the emergency room, his score on Glasgow coma scale was 15, physical examination was normal except for the left tibia fracture. Because the fracture was closed and non-displaced, and the bone was in its proper position and alignment on X-ray, a surgical procedure was not considered and immobilization with a above-the knee cast was performed.

Twelve hours after admission, he developed left arm weakness and impairment of consciousness. He had no fever; his pulse was 72 beats per minute and regular, blood pressure was 120/80 mm Hg, and respiratory rate was 16 breaths per minute. Neurological examination revealed a Glasgow coma scale score of 6 (E2 M2 V2), normal pupillary light reflexes, decerebrate posture and incontinence of bowel and bladder. Deep tendon reflexes were brisk on both sides with extensor plantar responses. The patient had no skin or conjunctival petechiae. Retinal examination demonstrated normal findings, no evidence of fat embolism such as edema, cotton wool spots or hemorrhage was observed. The patient maintained his respiration without requiring ventilator support. The arterial blood gas analysis demonstrated that pH was 7.44, partial pressure of carbon dioxide was 32.6, and partial pressure of oxygen was 95.6.

The peripheral white blood cell count was 11.200/mm³, the platelet count 240.000/mm³ and hemoglobin concentration was 14.4 mg/dl. There were no abnormal findings in other laboratory data, including erythrocyte sedimentation rate, C-reactive protein, urine analysis, coagulation tests, and serum levels of glucose, electrolytes, liver enzymes, urea, creatinine, protein, calcium and magnesium. Radiograph of chest, electrocardiogram and caro-

tis and vertebral Doppler ultrasonography were normal. An electroencephalogram showed diffuse slowing of background activity. Fat globules were not seen in either the urine or the sputum. Computerized tomography of the brain was also normal. A cardiac echocardiogram demonstrated a patent foramen ovale. However, transesophageal echocardiogram showed no evidence of right-to-left shunting.

Brain magnetic resonance images (MRI) obtained on admission revealed extensive punctuate and confluent areas of increased signals on conventional T2-weighted (T2W) and fluid attenuation inversion recovery (FLAIR) images in the subcortical, deep and periventricular white matter, centrum semiovale and the left occipital cortex (Figure 1, 2). A repeated MRI scan obtained four weeks after symptom onset demonstrated almost complete resolution of the diffuse white matter signal intensity changes (Figure 3).

We diagnosed cerebral fat embolism despite the absence of pulmonary compromise, skin rashes and accompanying symptoms and the patient was treated with oral prednisolone in addition to gene-

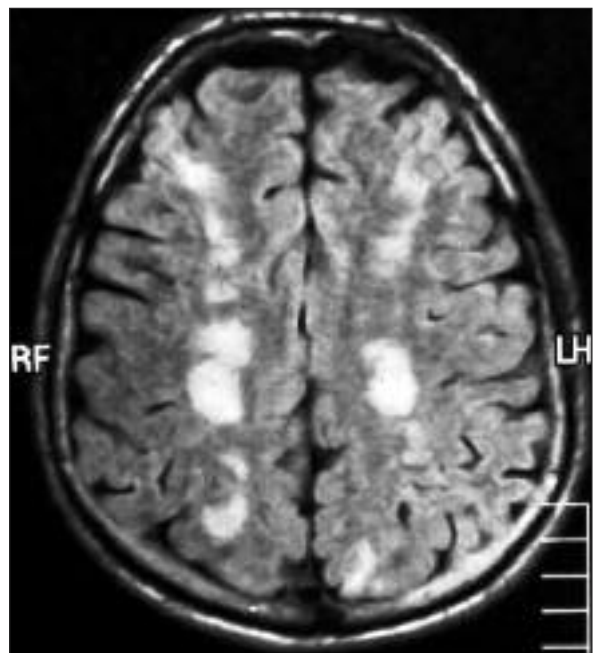


FIGURE 1: Axial fluid-attenuated inversion recovery magnetic resonance image of brain shows punctuate and confluent areas of hyperintensity on the subcortical white matter of bilateral hemispheres and the left occipital cortex.

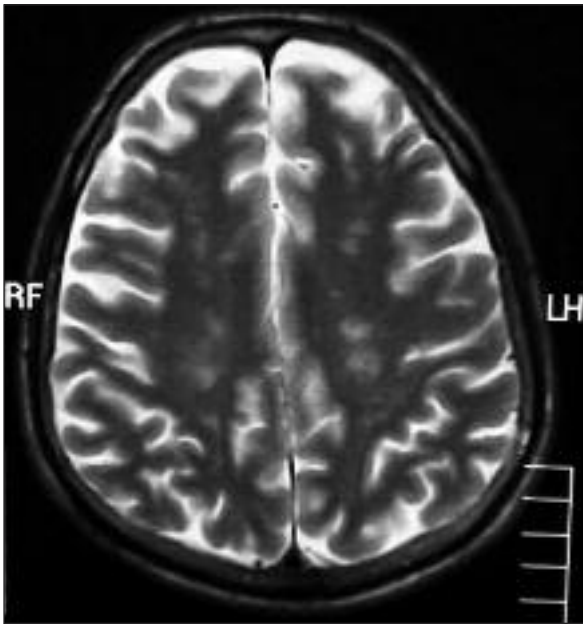


FIGURE 2: Axial T2*-weighted magnetic resonance image of brain shows punctuate areas of hyperintensity on the subcortical white matter of bilateral hemispheres.

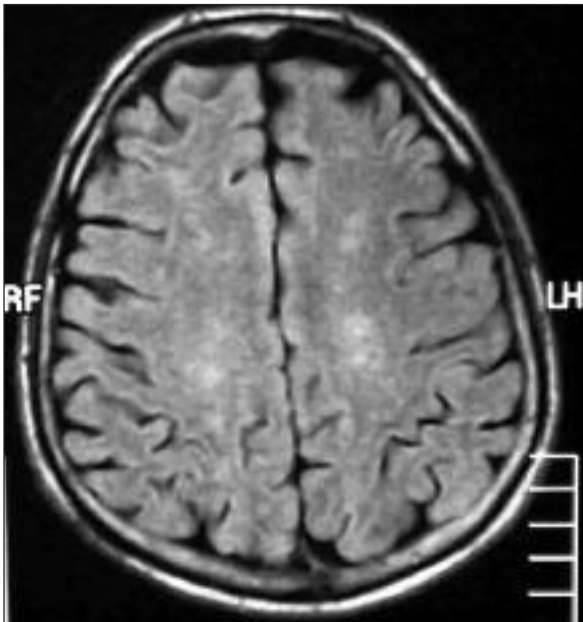


FIGURE 3: Axial fluid-attenuated inversion recovery magnetic resonance image of brain obtained four weeks after symptom onset shows almost complete resolution of the hyperintense signal changes on the subcortical white matter of bilateral hemispheres.

ral supportive care. The patient's mental status improved gradually. The patient was discharged with full of consciousness and recovering paresis of the left upper extremity.

DISCUSSION

Subclinical fat embolism develops in almost all of the patients with pelvic or long-bone fractures.³ However, only 0.26% to 35% of patients with trauma develop classic FES after a symptom-free interval of 12 to 72 hours.¹⁻³ FES is characterized by skin petechias, pulmonary insufficiency and neurological dysfunction.¹⁻⁴ Accompanying symptoms and signs including tachycardia, fever, anemia, thrombocytopenia, hypocalcaemia, hypoalbuminemia, elevated serum lipase and free fatty acids levels and coagulation abnormalities may also be found.^{1,2,4,5}

Pulmonary involvement occurs in up to 75% of patients with FES and presents with tachypnea, dyspnea, hypoxia and cyanosis and its severity ranges from mild dyspnea to acute respiratory distress syndrome.¹⁻³ Cerebral involvement usually accompanies and manifests in a wide range of presentations including headache, altered levels of consciousness, irritability, delirium, focal and generalized seizures, focal neurologic deficits such as aphasia, paresis and pupillary abnormalities, decorticate or decerebrate posturing and coma.^{1,3,6,8-14} Our patient presented with neurological dysfunction compatible with cerebral fat embolism without accompanying symptoms or signs of pulmonary involvement. Although neurological involvement usually coexists with pulmonary involvement, rarely, cases without respiratory insufficiency have been reported.⁵⁻¹³ In majority of these cases, there were other manifestations of FES such as skin rashes, hypoalbuminemia or coagulation abnormality, indeed, isolated cerebral fat embolism is an extremely rare entity.⁵⁻¹³ The diagnosis of isolated cerebral fat embolism is mainly based on the findings of neurological examination and neuroimaging methods.

In cases of suspected cerebral fat embolism, brain MRI is the imaging modality of choice.^{4,5,7-12,15-24} Multiple small, patchy lesions which are hyperintense on FLAIR and conventional T2-weighted images, usually located in the subcortical and periventricular white matter and deep gray matter, characterize cerebral fat embolism.^{4,5,7-12,15-25} The lesions are hypointense or isointense on T1-weighted images.^{7,13,15,17} The lesions are usually distributed in the bilateral border-zone areas.²⁶ Brain MRI of our pati-

ent showed multiple areas of increased signal on T2-weighted and FLAIR images throughout bilateral hemispheres, mostly located at centrum semiovale and border-zone areas, as previously reported. The lesions of cerebral fat embolism gradually resolve within a few weeks to a few months and the disappearance of lesions corresponds to the neurological recovery.^{4,8} Similarly, our patient made a gradual but satisfactory recovery during hospitalization and almost complete resolution of brain MRI findings was noted. This transient nature of the lesions further supported the diagnosis of cerebral fat embolism in our patient.

Cerebral fat embolism must be distinguished from the effects of head trauma such as extra- and intra-cerebral hemorrhage, cerebral contusion and diffuse axonal injury (DAI). DAI manifests with neurological dysfunction immediately after trauma in contrast to cerebral fat embolism which occurs after a time interval following trauma. In addition, although both may manifest with disseminated hyperintense lesions on T2 weighted and FLAIR images of brain, DAI typically occurs in the corpus callosum, internal capsules, basal ganglia, brainstem, and subcortical white matter in contrast to cerebral fat embolism, which predominantly involves centrum semiovale.¹⁸ The delayed onset of neurological dysfunction after skeletal trauma and sparing of the corpus callosum, brainstem and internal capsule and the absence of hemorrhagic lesions on MRI supported the diagnosis of cerebral fat embolism rather than DAI in our patient.

Transcranial Doppler ultrasonographic detection of fat embolism is another tool for establishing the diagnosis in cases of suspected cerebral fat embolism, findings of microembolism may be detected up to 96 hours after injury.²⁷ However, this method is neither specific nor obligatory for the diagnosis, because microembolism may be detected in patients with traumatic long bone fractures despite the absence of fat embolism syndrome and several other patients with cerebral fat embolism without documented embolization by transcranial Doppler ultrasonography have been reported so far.^{5-12,16-22,24,27}

Neurological manifestations of FES have been proposed to occur by occlusion of cerebral blood

vessels by fat emboli and disruption of the blood-brain barrier by toxic free fatty acids. The disruption of blood-brain barrier has been documented by gadolinium enhancement of the lesions in the acute stage.^{7,12} In addition, diffusion weighted images (DWI) may reveal diffuse hyperintense areas with concomitant decrease in apparent diffusion coefficient mapping indicating cytotoxic edema associated with ischemia.^{7,9,17,18,21,22} Furthermore, the lesions disappear without evidence of gliosis.¹⁷ These findings suggest that neurological dysfunction resulting from cerebral fat embolism occurs due to blood-brain barrier breakthrough and cytotoxic edema induced by free fatty acids rather than a simple occlusion of cerebral vessels by fat emboli.

Embolic material may pass into the systemic circulation and may reach the brain through a right-to-left cardiac shunt such as a patent foramen ovale.^{2,11,14} The pressure of the right atrium must be higher than of the left atrium to allow right to left shunting in the case of patent foramen ovale.²⁸ Fat embolization of the pulmonary arterial system may increase the pressure of the pulmonary arteries and the right atrium resulting in right to left shunting. However, our patient had no sign of pulmonary compromise; therefore, paradoxical embolism through the patent foramen ovale would not be expected to cause paradoxical embolism in our patient. In several patients with FES, no evidence of intracardiac shunting has been detected.^{7,9,10,12,17-19} The proposed mechanism of systemic embolization in these patients and we suggest that in our patient, is trans-pulmonary passage of small fat droplets through pulmonary capillaries.^{3,12}

FES treatment consists of optimal fracture management by early stabilization, pulmonary support and shock treatment.^{1-3,25,29,30} Early stabilization of fractures has been shown to reduce the incidence of FES by preventing from liberation of fat particles into the systemic circulation due to fracture movement. The method of fixation is controversial. Increased intramedullary pressure has been associated with development of fat embolization, therefore, external fixation or intramedullary nailing accompanied by surgical

methods to reduce intramedullary pressure is recommended.²⁵ A number of pharmacologic agents including dextran-40, heparin and steroids have been used for the treatment of fat embolism.^{1,25} Among them, only steroids have been proved effective both in the prophylaxis and in the treatment of FES.^{1,25,30} The prognosis of fat embolism syndrome is variable depending on the severity of pulmonary and neurological involvement as well as to associated injuries. The outcome is generally favorable with mortality rates between 1% and 20%.^{1,2}

Despite the marked neurological dysfunction, there were no additional symptoms or signs of FES in our patient. The history of traumatic tibia fracture, absence of cerebral trauma, delayed onset of neurological dysfunction after the trauma and the transient abnormal signals typical for cerebral fat embolism on MRI allowed us to make the diagnosis of cerebral fat embolism in our patient. Because the neurological manifestations are protean and nonspecific, cases with isolated cerebral fat embolism may pose a diagnostic challenge and brain MRI may be a useful diagnostic tool in these circumstances.

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