Duplex ultrasound evidence of fat embolism syndrome

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Fat embolism syndrome (FES) is a potentially fatal disease associated with long-bone and pelvic fractures. First described in 1862, its triad of symptoms are petechial rash, respiratory distress, and altered mental status.1,3-5 Historically, patients with a long-bone fracture have a 4% chance of developing FES; however, the true incidence may range as high as 29%.1,3-5

This discrepancy in incidence is largely a result of the variable diagnostic criteria. In 1970, Gurd6 developed a list of criteria to aid in the diagnosis of FES. There are three major criteria: petechial rash, respiratory symptoms plus bilateral signs with positive radiographic changes, and cerebral signs unrelated to a head injury. One major criteria can be added to any four of the following minor criteria to attain a diagnosis: tachycardia, pyrexia, retinal fat or petechiae, urinary fat globules or oliguria, sudden hemoglobin drop, sudden thrombocytopenia, high erythrocyte sedimentation rate, and sputum fat globules.6

Pell et al7 reported ultrasound evidence of echogenic emboli on transesophageal echocardiograms in patients undergoing intramedullary nailing, but its invasive nature does not make it an ideal screening tool. Transcranial Doppler has also been used for the diagnosis cerebral emboli, although these insults may occur without the development of FES.8,9 Continuous pulse oximetry post-operatively has been proposed as the best screening method because respiratory symptoms will develop in ≥75% of patients, but this is hardly a specific test for FES.5 We propose a new objective finding on a noninvasive vascular examination—specifically, venous duplex ultrasound imaging—as a useful diagnostic criterion.

We present two patients who received venous duplex studies after long-bone fractures. A Phillips CXSO ultrasound machine (Phillips Medical Systems, Bothell, Wash) was used with a 12-MHz transducer. The Southern Illinois University Institutional Review Board approved the study, and the patients provided informed consent.

CASE REPORTS

Patient 1. A 19-year-old man presented after a motor vehicle accident that caused significant head trauma, bilateral femur fractures, spinal fractures, spleen lacerations, and pulmonary contusions. He was intubated, sedated, and taken for immediate external fixation and washout of his bilateral femur fractures. Given his intracranial hemorrhage, prophylactic anticoagulation was contraindicated. The patient was deemed at high risk for developing venous thromboembolic disease given his immobility. A lower extremity venous study 2 days after the injury did not reveal any lower extremity deep venous thrombosis (DVT). However, several discrete hyperechoic emboli were noted in the femoral veins bilaterally. These emboli did not appear to be flow limiting. The sonographer was able to reproduce all the necessary criteria to rule out a DVT, including assessment of compressibility, spontaneity, phasicity, augmentation, and pulsatility of flow, but the emboli were consistent with the FES that the patient developed (Fig 1). The patient was eventually extubated and discharged to a rehabilitation facility.

Patient 2. An 83-year-old woman presented to the emergency department after a fall causing a nondisplaced spiral fracture of the distal left femur extending into the left femoral condyle. On day 3 of her admission, she reported chest pain and anxiety. An electrocardiogram and cardiac enzymes analysis revealed a non-ST segment elevation myocardial infarction, which was treated conservatively. Given the acuity of her symptoms and her relative immobility, a venous duplex study was ordered to evaluate for a possible lower extremity DVT as an etiology for a pulmonary embolus. The study was negative for DVT; however, a focal hyperechoic mass within the lumen of her left femoral vein was identified. This mass was visualized in contact with the anterior and posterior walls of the vein but was not found to obstruct blood flow. The vein met all the standard necessary criteria to rule out a DVT, as described in the first patient (Fig 2). Downstream from this mass were smaller hyperechoic masses visualized to be travelling proximally. The result of a computed tomography angiography of the chest to

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evaluate for a possible pulmonary embolus was negative. It was hence determined that the structures seen on duplex were fat emboli.

The patient received supportive medical therapy, including bed rest, to avoid further release of fat emboli. She was eventually transferred to an extended care facility.

DISCUSSION

FES is a potentially fatal constellation of insults to several vascular beds, particularly the brain, lungs, and skin. Two major theories have been offered to explain the pathophysiology of FES. The first is a mechanical theory, where obstructive fat microemboli travel through disrupted venules and embolize to the affected end organs. Systemic emboli passing through pulmonary capillaries have also been described. The biochemical theory suggests that a proinflammatory state occurs from the release of glycerol and toxic free fatty acids by tissue lipases, leading to end-organ injury and causing acute respiratory distress syndrome, encephalopathy, petechiae, and a consumptive coagulopathy.

Although fat embolism occurs in many patients with long-bone fractures, the clinical signs of FES will develop in only a small percentage of these patients. Our first patient experienced fever, a nonspecific sign, a sudden drop in hemoglobin, and sudden thrombocytopenia that were disproportionate to the surgical blood loss, both respectively seen in 37% and 67% of FES patients. He had a prolonged intubation time relative to his injuries (14 days) and had acute respiratory distress syndrome about 1 week after injury. In retrospect and according to Gurd’s criteria the patient did have FES. Patient 2 did not display any signs or symptoms of FES. These patients show the potential usefulness of visualizing fat emboli in the setting of traumatic orthopedic injuries, which may allow for earlier diagnosis and treatment of FES. They also highlight the important notion that fat emboli may exist without the development of FES.

The fat emboli visualized in our duplex ultrasound images of the lower extremity veins were discrete hyperchoic masses, spherical in shape, nonobstructive, and most were seen circulating with the blood flow, with the veins remaining compressible, and showing phasic flow with breathing. This contrasts with a thrombus, which is usually adherent to the vein wall, hypochoic when acute, leading to a noncompressible vein, and showing nonphasic flow with breathing.

Our description is similar to several in the literature, notably a recent report by Summerfield et al, who viewed fat emboli using bedside echocardiography, and to a report by Harris et al describing similar sonographic findings of traumatic fat embolus in the common femoral vein. Almost all of the available literature examining fat embolism and ultrasound detection comes from monitoring studies after orthopedic procedures. An older but more trauma-related report by Pell et al examined 24 patients undergoing intramedullary nailing of 17 tibial and seven femoral fractures by intraoperative transesophageal echocardiography. All patients had evidence of circulating fat emboli, but FES occurred in only four patients that had evidence of >10 mm emboli, and one of them died. Hence, detection of fat emboli, and possibly risk-stratifying trauma patients according to the physical characteristics of those emboli, may be valuable in directing more resources and attention to those patients at risk for FES.

To date, treatment for FES remains supportive and prevention is key. Detecting these emboli may push for earlier orthopedic fixation, proven to decrease the incidence of fat embolism, and possibly the administration of corticosteroids, a practice that has shown some benefit in these patients. Finally, one may wonder why such reports have not been more frequent. The most important reason may be the fleeting nature of fat emboli when released from the injured tissues into the circulation according to either of the proposed models in this report. Unless they are visualized at the

Fig 1. Grayscale ultrasound image shows several fat emboli (arrowheads) in the common femoral vein.

Fig 2. Grayscale ultrasound image shows a sizeable fat embolus in the left common femoral vein.
time they are circulating in the lower extremities or are big enough to lodge in a vessel, they will not be visualized.

CONCLUSIONS

Venous duplex ultrasound imaging allows visualization of fat globule embolization in patients with long-bone fractures and may be a useful adjunctive criterion in the diagnosis of FES, possibly leading to earlier orthopedic fixation and allocation of resources.

REFERENCES
