CASE REPORT

Intracranial transthecal subarachnoid fat emboli and subarachnoid haemorrhage arising from a sacral fracture and dural tear

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ABSTRACT. We present the case of a 28-year-old man with an unusual aetiology of lipid-dense material in the subarachnoid space. CT of the head at presentation was normal. MRI of the spine revealed a defect in the dura at L5/S1, with avulsed left L5 and S1 nerve roots. Haematoma and marrow fat were observed in close relation to the dural tear adjacent to the sacral fracture. Head CT and MRI subsequently demonstrated new lipid-dense material and haemorrhage in the subarachnoid space after sacral instrumentation, presumably owing to transthecal displacement of fatty marrow.

Received 6 December 2008
Revised 7 January 2009
Accepted 19 January 2009

DOI: 10.1259/bjr/66268641

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The presence of fat droplets within the subarachnoid space is an unusual finding and is most commonly the sequelae of a ruptured dermoid. We present a unique case with CT and MRI that demonstrates the development of subarachnoid fat emboli and subarachnoid haemorrhage secondary to pelvic trauma. A sacral fracture with an adjacent dural tear and nerve root avulsion is the putative source of the subarachnoid fat and blood.

Case report

A 28-year-old man presented to the emergency room after being struck by a high-speed vehicle as a pedestrian. He suffered multiple orthopaedic injuries, including an open-book pelvic fracture as well as upper and lower extremity fractures. Pertinent physical examination findings included the absence of left ankle dorsiflexion, plantar flexion, inversion and eversion. An absence of light touch and pinprick sensation in the left L5 and S1 dermatomes was also noted.

At presentation, CT of the head did not demonstrate any calvarial or skull base fracture or other intracranial abnormalities (Figure 1a). Specifically, neither subarachnoid haemorrhage nor subarachnoid fat droplets were present. CT of the pelvis demonstrated a transforaminal left sacral fracture and superior and inferior left pubic rami fractures. A mixed fat and blood attenuation collection was also seen within the left aspect of the thecal sac at the L5/S1 level. Fixation of the sacral fracture, with the placement of an iliosacral screw, was performed shortly after initial imaging.

Three days post-trauma, repeat CT of the head was performed because of a decreased level of consciousness.

Small supernatant globules of fat (–124 Hounsfield units (HU)) were identified in the subarachnoid space in the prepontine cistern (Figure 1b), frontal horns of the lateral ventricles and foramen magnum. Intraventricular blood and subarachnoid haemorrhage in the interpeduncular fossa were also seen. A CT angiogram from the aortic arch to the vertex revealed no evidence of traumatic dissection, aneurysm or vascular malformation that would explain the presence of the new subarachnoid haemorrhage. MRI of the brain performed the same day confirmed the presence of subarachnoid and intraventricular fat and haemorrhage (Figure 2a,b). The MR study also showed several T_2 /FLAIR (fluid-attenuated inversion-recovery) hyperintensities in the cerebral white matter, as well as in the splenium of the corpus callosum, in keeping with diffuse axonal injury.

MRI of the post-operative lumbosacral spine revealed a defect in the dura at L5/S1 (Figure 3a), with avulsed left L5 and S1 nerve roots (Figure 3b). Blood and marrow fat was observed to enter the thecal sac through the dural tear (Figure 3c). Approximately three weeks post-trauma, nerve conduction studies showed absent motor unit recruitment in the tibialis anterior and medial gastrocnemius muscles, consistent with avulsion of the L5 and S1 nerve roots. Otherwise, the patient made an uneventful neurological recovery.

Discussion

Fat emboli to the brain are usually seen in the context of cerebral fat embolism syndrome following displaced long bone fractures of the lower extremities [1]. Fat emboli to the middle cerebral artery have also been reported during mitral valve replacement [2].

Observation of fat-attenuation droplets in the subarachnoid space is an unusual finding that has rarely been reported in the literature. Rupture of intracranial dermoid cysts is a known cause for lipid in the subarachnoid space. They are associated with intraventricular fat/

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Figure 1. Axial non-contrast CT images with wide windows at the level of the prepontine cistern at (a) presentation and at (b) 3 days post-trauma. (a) Normal cerebrospinal fluid is seen in the prepontine cistern (arrow). (b) Globules and linear strands of fat (–124 HU) are seen in the prepontine cistern (arrowheads).

cerebrospinal fluid levels, with generalised and localised subarachnoid spread of the contents of the dermoid cyst [3]. Ruptures of teratomas [4, 5] and intraspinal dermoids [6] have also been implicated as a source of subarachnoid fat-attenuation droplets. One case report described the dissemination of fat particles in the basal cisterns and frontal horns of the lateral ventricles following removal of a foramen magnum meningioma [7]. The patient was

asymptomatic and follow-up MRI showed resolution of the subarachnoid fat at seven months.

Traumatic transthecal fat emboli have rarely been described in the literature. One case report described retrograde intraventricular haemorrhage and fat after trauma to a sacral pseudomeningocele in the presence of spina bifida occulta [8]. No imaging of the brain before the traumatic event was presented.

Figure 2. Axial non-contrast T_1 weighted MR images of the brain three days post-trauma. (a) Hyperintense non-dependent fat globules are seen in the prepontine cistern (arrow). (b) Tiny hyperintense fat globules are present in the anterior aspect of the frontal horns (arrows) with haemorrhage in the trigones (arrowheads) bilaterally.

Figure 3. Axial non-contrast T_2 weighted MR images of the spine three days post-trauma. (a) A focal defect is shown in the left anterolateral aspect of the thecal sac at the level of the L5 superior endplate (arrow). (b) An avulsed left L5 nerve root (arrow), absence of the left S1 nerve root and epidural hematoma (squiggly arrow) at the level of the L5/S1 disc are also indicated, as are the right L5 and S1 nerve roots (arrowheads). (c) A dural tear with blood and fat extending into thecal sac (arrow) is seen at the level of the L5/S1 disc. The image also shows a small pseudomeningocele (squiggly arrow) and an iliosacral screw (arrowheads).

The mean density of retroperitoneal fat in a healthy subject has been shown to be -118 HU [9], which corresponds to the density of the fat globules in our patient. Fat in the subarachnoid space will generally be situated in non-dependent sites, as fat is less dense than cerebrospinal fluid.

Traumatic avulsion of the lumbosacral nerve roots is a rare occurrence following high-velocity trauma. It is usually associated with pelvic fractures, lumbosacral

vertebral body fractures and delayed development of pseudomeningoceles [10–12]. A review of the literature did not reveal any report of lumbosacral nerve root avulsion associated with transthecal subarachnoid fat emboli.

In our patient, imaging demonstrated the development of subarachnoid fat emboli and subarachnoid haemorrhage, which probably originated from a comminuted left sacral fracture complicated by nerve root avulsion.

The presence of the dural tear adjacent to the sacral fracture probably allowed sacral bone marrow, including blood and fat, to enter the thecal sac. Interestingly, this may have occurred during internal fixation of the pelvic fracture, which was performed in the interval between the two CT studies. This is the only putative source of the fat and blood, as the initial CT was unremarkable and the following work-up, including a CT angiogram and MRI of the brain and spine, was otherwise negative. Presumably, our patient's transient decreased level of consciousness was caused by diffuse axonal injury. No neurological sequelae attributable to the presence of subarachnoid fat emboli were identified. The detection of subarachnoid fat within the head of a trauma patient should initiate a search for significant injury in the spine.

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