# Intracranial Transthecal Fat Migration After a Sacral Fracture: 2 Case Reports

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABDEF 1 **Marlena Bereźniak**
ABDEF 1 **Piotr Palczewski** (ID)
B 2 **Jarosław Czerwiński**
B 1 **Małgorzata Deręgowska-Cylke**
A 1 **Marek Gołębiowski**

1 1st Department of Clinical Radiology, Medical University of Warsaw, Warsaw, Poland
2 Department of Emergency Medicine, Medical University of Warsaw, Warsaw, Poland

Corresponding Author: Piotr Palczewski, e-mail: sounded@wp.pl
Financial support: None declared
Conflict of interest: None declared

**Case series**
**Patients:** **Female, 84-year-old • Male, 60-year-old**
**Final Diagnosis:** **Intraventricular fat droplets • sacral fracture extending into a large meningeal cyst**
**Symptoms:** **Back pain • headache**
**Medication:** —
**Clinical Procedure:** —
**Specialty:** **Neurology • Radiology**

**Objective:** **Unusual clinical course**
**Background:** The presence of fat droplets within the subarachnoid space is an uncommon finding, which is almost exclusively associated with a ruptured dermoid cyst. In a trauma setting, transthecal migration of fat droplets is an extremely rare occurrence. We present 2 case reports of intracranial transthecal migration of fatty bone marrow after sacral fractures.
**Case Reports:** Both patients presented to the Emergency Department (ED) after falls from a standing height. The first patient, an 84-year-old woman, suffered a stable sacral fracture extending into a large meningeal cyst within the right S2 foramen. Her initial neurological assessment and computed tomography (CT) of the head were unremarkable. As the fracture did not require surgical treatment, she was discharged home and prescribed bed rest, analgesics, and venous thromboembolism prophylaxis. Three days after the injury, she was readmitted to the ED with a mild headache, dizziness, and an episode of nausea and vomiting. A follow-up head CT revealed fat droplets in the subarachnoid space and lateral ventricles. After successful symptomatic treatment, she was discharged home in good general condition.

The second patient, a 60-year-old man, underwent a head CT for a scalp hematoma, which revealed fat droplets in the 3rd ventricle and right lateral ventricle. The pelvic CT revealed a large sacral meningeal cyst with microfractures in its wall. He was discharged home on the same day and prescribed bed rest and analgesics.
**Conclusions:** The detection of intracranial intrathecal fat droplets in association with a specific trauma mechanism should initiate the search for a sacral fracture.

**Keywords:** **Multidetector Computed Tomography • Spinal Fractures • Tarlov Cysts**

**Full-text PDF:** https://www.amjcaserep.com/abstract/index/idArt/932760

📄 2029    ▦ —    📊 3    📑 23

## Background

The presence of fat droplets in the cerebrospinal fluid (CSF) is an unusual imaging finding, which is almost always associated with spontaneous, postoperative, or post-traumatic rupture of fat-containing tumors (most frequently dermoid cysts) [1,2]. Although dermoid cysts are rare and represent only 0.5% of all primary intracranial tumors, the observation of fat in the subarachnoid space after trauma in the absence of intracranial or intraspinal tumors is exceptional and has been reported only after sacral fractures [1-6]. We found 5 previous reports of these occurrences. Two of these reports described elderly patients who had low-energy trauma and the fatty bone marrow had migrated intracranially from the sacral fracture site through a meningeal breach at a Tarlov cyst [5,6]. We present 2 more cases of sacral fractures that extended into the meningeal cysts, followed by the dissemination of fat droplets into the CSF pathways, causing benign chemical meningitis in 1 patient.

## Case Reports

### Case 1

An 84-year-old woman presented to the Emergency Department (ED) with a sudden parietal headache and lower back pain after falling from a standing height the previous day. She was being treated for hypertension, hypothyroidism, cataract surgery in her right eye, and osteoporosis. Physical examination revealed tenderness to palpation over the lumbosacral spinous processes, which was most prominent over the sacral area. Ecchymoses and swelling were observed over the sacral region extending to the left gluteal region. No signs of pelvic instability or any evidence of blunt trauma were noted in the parietal regions. The neurological assessment was unremarkable. On admission, the Glasgow Coma Scale (GCS) score was 15, the left pupil was round and reactive to light, the right pupil was irregularly shaped and unreactive after ophthalmic surgery, there were no cranial nerve deficits, and no weakness or anesthesia in the lower extremities.

The initial non-contrast head computed tomography (CT) did not show any skull fractures or other clinically significant abnormalities and no intraventricular or subarachnoid fat droplets were present (**Figure 1A**). Based on plain radiography of the sacrum, a fracture at the S3 level was suspected. A CT of the pelvis confirmed a stable horizontal sacral fracture (type A2 according to the Arbeitsgemeinschaft für Osteosynthesefragen Spine Classification) extending into a large meningeal (Tarlov) cyst within the right S2 foramen without significant displacement (**Figure 1B**). After an orthopedic consultation, she was discharged home on the same day, and prescribed bed rest,



**Figure 1.** (**A**) Axial non-contrast computed tomography images in the soft tissue window at the interthalamic adhesion level at presentation (1 day after trauma). (**B**) Sagittal non-contrast computed tomography images in the bone window showed a comminuted sacral fracture (arrowheads) extending into a meningeal cyst (arrow) within the right S2 foramen.

**Figure 2.** Three days after the trauma, fat droplets (arrows) were seen in the most anterior aspect of the frontal horns of the lateral ventricles, left Sylvian fissure, and the cistern of the lamina terminalis.

analgesics, and a 2-week prophylactic treatment for venous thromboembolism (VTE) with low molecular weight heparin to diminish the risk of deep vein thrombosis and pulmonary embolism. No other medical treatment was required.

Two days later (3 days after the injury), she returned to the ED with a mild headache, dizziness, and nausea. She rated the pain intensity as 5/10. A head CT was performed to exclude a delayed-onset hematoma and revealed the presence of small droplets of lipid-dense material (-80 Hounsfield units) in the frontal horns of the lateral ventricles, the left Sylvian fissure, and the cistern of the lamina terminalis (**Figure 2**). She was administered intravenous fluid therapy and antiemetics (5-hydroxytryptamine 3 receptor antagonist), which successfully alleviated her symptoms. The neurological reexamination did not indicate hospital admission and she was discharged home in good general condition to continue the bed rest, analgesic treatment, and VTE prophylaxis. At the orthopedic follow-up visit 2 weeks later, she was asymptomatic, except for mild residual pain (3/10) in the sacral region.

## Case 2

A 60-year-old previously healthy man who worked on a stud farm presented to the ED after he was kicked in the chest by a horse and fell to the ground without loss of consciousness. He had no significant medical or family history. The physical
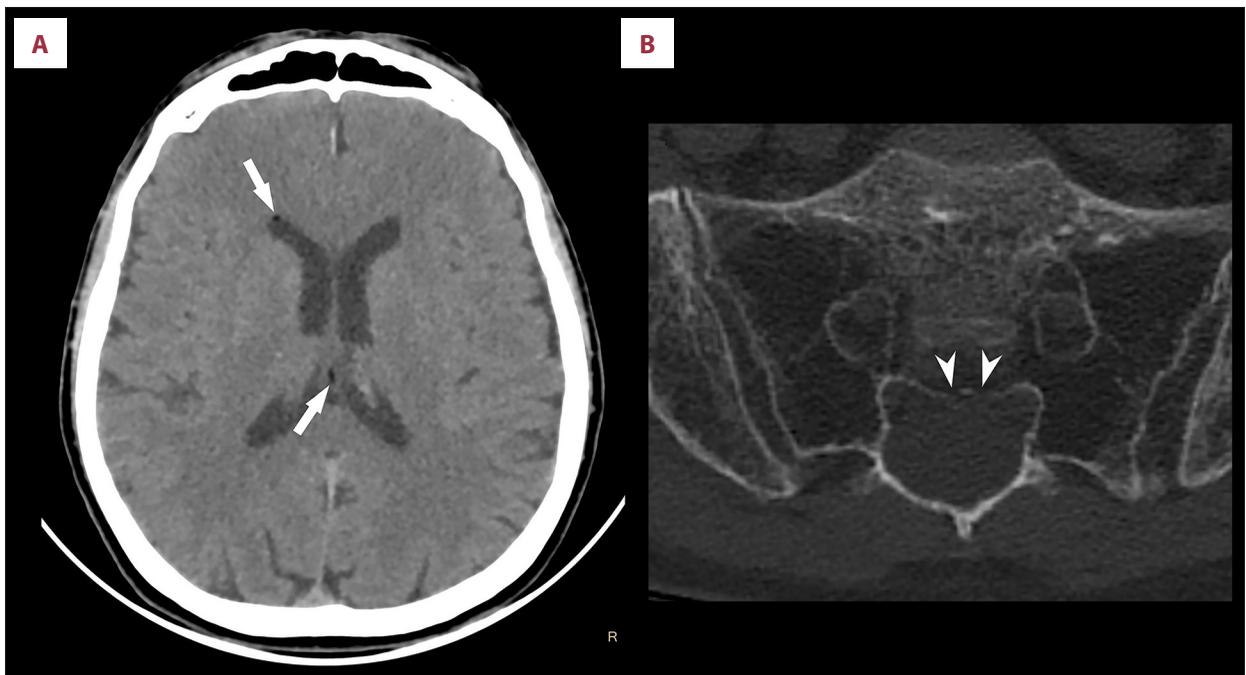


**Figure 3.** (**A**) Axial non-contrast head computed tomography images in the soft tissue window showed fat droplets in the 3rd ventricle and right lateral ventricle (arrows). (**B**) An axial non-contrast computed tomography image showed an expansive cystic lesion within the right S2 foramen that is isodense to cerebrospinal fluid, with several undisplaced microfractures in its wall (arrowheads).

examination revealed an occipital scalp hematoma, chest wall bruising, tenderness to palpitation and crepitus over the left chest wall, mainly in the midaxillary line. No signs of blunt trauma were noted in the sacral region. His neurological assessment was unremarkable. At admission his GCS score was 15; however, he reported mild dizziness.

The posteroanterior and left oblique chest X-rays revealed multiple left-sided rib fractures. A non-contrast head CT revealed fat droplets in the 3rd ventricle and right lateral ventricle (**Figure 3A**). Based on our experience with the previous patient from Case Report 1, a CT of the sacrum was recommended, to detect the potential cause of the transthecal fat migration. A CT of the pelvis confirmed the suspicion of a sacral fracture and demonstrated a large meningeal cyst within the right S2 sacral foramen, with several undisplaced microfractures in its wall (**Figure 3B**). After an orthopedic consultation, the patient was discharged home on the same day and prescribed bed rest and analgesics. Four weeks after the trauma, he did not attend his scheduled follow-up appointment; however, 6 weeks after the trauma, he reported via a phone call that he was symptom free.

Both patients gave verbal consent for the publication of this case report, which was sufficient, as our Institutional Review Board does not require written informed consent for case reports that do not contain any patient identification details.

## Discussion

The presence of fat droplets in the subarachnoid space or intraventricular space is an uncommon imaging finding. The first radiological description of intracranial fat dissemination was reported on a skull radiography in 1977, secondary to the spontaneous rupture of an intracranial dermoid cyst [7]. The spontaneous or iatrogenic rupture of lipid-containing masses (mostly dermoid or epidermoid cysts, and sometimes pineal teratomas) is an established cause of dissemination of fat droplets within the subarachnoid space [1,2,4]. It is rare that the rupture of an intracranial dermoid cyst is caused by trauma [8]. The mechanism of rupture in relation to minor closed-head trauma is unknown. Esquenazi et al presumed that sudden shifts in the cyst sac, which is adherent to some partially mobile intracranial structures, can induce a rupture [8]. In our patients, the initial CT did not show any underlying fat-containing intracranial lesions. The intracranial migration of fat after the rupture of a spinal dermoid cyst is possible and can be related to injury [9,10]. Scearce et al described a unique case of contamination of the CSF pathways due to a dermoid cyst that ruptured into the lumbosacral subarachnoid space following trauma [10]. Spinal dermoid cysts are most often located in the lumbosacral region. On CT, the dermoid cyst usually

presents as a well-circumscribed mass (mostly isodense to CSF) with discrete regions of hypoattenuating fat [11]. However, the sacral cysts in our patients showed a uniform fluid density on CT without any fatty contents. These findings are consistent with Tarlov cysts (or perineural cysts), which are cystic dilatations between the perineurium and endoneurium of spinal nerve roots filled exclusively with CSF. They are mostly located in the sacral spinal canal between the origin of the nerve root and the dorsal-root ganglion, and found in approximately 5% of patients with back pain. Tarlov cysts are more common in women [12-14]. Approximately 1% of perineural cysts are symptomatic due to compression or stretching of the adjacent nerve roots [12,15,16]. However, Tarlov cysts can slowly increase in size over time and cause significant bone scalloping [17]. Their propensity to attenuate the mechanical endurance of the sacrum is seen in cases complicated with insufficiency fractures reported in young patients [16].

The observation of fat in the subarachnoid space after trauma in the absence of an intracranial or intraspinal tumor is exceptional and has been reported exclusively after sacral fractures [2-5]. The abundance of fatty yellow marrow in the sacral bone (especially in older patients) is a well-known phenomenon [18]. Like the brain, the spinal cord is encased within 3 layers of meninges. The outer dura mater is lined with middle arachnoid mater and the inner pia mater covers the spinal cord surface. Caudally, the dura extends to the level of S2/S3, where it blends with the periosteum to envelop the filum terminale, which anchors the dural sac [19]. The filum terminale is continuous with the pia mater. The spinal subarachnoid space, which is continuous with the intracranial subarachnoid space, lies between the arachnoid mater and pia mater. Therefore, a sacral fracture above or at the level of the filum terminale, accompanied by a meningeal tear can result in the retrograde passage of low-density fatty bone marrow along the CSF pathways. Piveteau et al and Woo et al reported subarachnoid hemorrhage and lipid-dense material in the basal cisterns and ventricles after high-energy open-book pelvic fractures with sacral fractures. However, other reports showed that the migration of fatty marrow into the dural sac after minor trauma is also possible [2,3]. Lyo et al described intraventricular and subarachnoid fat dissemination after a patient had a fall. A CT of their patient's lumbosacral junction revealed a dislocated, comminuted sacral fracture [4]. Moser et al and Kain et al reported that in elderly patients with low-energy trauma the fatty bone marrow migrated from the sacral fracture site to the brain through a meningeal breach at the Tarlov cyst [5,6]. To the best of our knowledge, those are the only 2 cases reported in the literature, which are similar to the 2 cases we presented here. However, those patients did not show any neurological symptoms.

Our first patient's symptoms on the 3rd day after the trauma can be explained by mild chemical meningitis or intracranial

hypotension (ICH) syndrome due to a meningeal tear in the sacral area. The features of ICH include thickening of the pachymeninges, subdural collections, engorgement of venous sinuses, enlargement of the pituitary gland, and the descent of the brain [20]. The sagging of the brain is evidenced by the descent of the cerebellar tonsils, reduction/effacement of the subarachnoid cisterns, inferior displacement of the optic chiasm, and the descent of the iter (opening of the Sylvian aqueduct) judged relative to the incisural line [20]. As none of these features were present in our patient, we presumed that chemical meningitis was responsible for her symptoms. Aseptic chemical inflammation of the meninges caused by irritation due to the presence of cholesterol breakdown products is a well-known complication of the rupture of fat-containing tumors [4]. The presentation of chemical meningitis is often similar to that of bacterial meningitis, with headaches, seizures, vomiting, and neck stiffness as the clinical symptoms [1,20]. However, in contrast to bacterial meningitis, aseptic meningitis is usually self-limited. In severe cases, high doses of corticosteroids are the most effective treatment [4].

Finally, the differential diagnosis of hypoattenuating material seen in the subarachnoid space in a brain CT should be addressed. Pneumoencephalus is a common complication of skull fractures involving pneumatized bones, and on a standard brain window it can be visually indiscernible from fat droplets. Gas and fat droplets are located in non-dependent regions of the subarachnoid space [2]. However, fat droplets (-50 Hounsfield units) can be easily distinguished from air (-1000 Hounsfield units) when the density on a CT scan is measured [21]. Pneumoencephalus can also be caused by an unintentional dura puncture during epidural anesthesia or therapeutic spinal injections and very rarely occurs as a result of the injection of air through an intravenous catheter.

Therefore, obtaining the patient's history of previous medical procedures is crucial for an accurate diagnosis [21-23]. Magnetic resonance imaging (MRI) with its excellent contrast resolution allows a straightforward characterization of the CSF pathway contamination. The fat droplets in the subarachnoid and intraventricular space demonstrate high signal intensity on both T1- and T2-weighted images, while gas has very low signal intensity [4,22]. However, MRI is more expensive, takes longer to perform, and is not as readily available as CT in an emergency setting.

## Conclusions

The presence of post-traumatic intracranial intrathecal fat warrant imaging of the neuroaxis for a ruptured fat-containing mass or sacral fracture. In the setting of a specific trauma mechanism, it is reasonable to begin the diagnosis with a pelvic CT to look for a sacral fracture.

### Declaration of Figures Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

## References:

1. Jacków J, Tse G, Martin A, Sąsiadek M, Romanowski C. Ruptured intracranial dermoid cysts: A pictorial review. Pol J Radiol. 2018;83:e465-70
2. Woo JK, Malfair D, Vertinsky T, et al. Intracranial transthecal subarachnoid fat emboli and subarachnoid haemorrhage arising from a sacral fracture and dural tear. Br J Radiol. 2010;83(985):e18-21
3. Piveteau A, Boto J, Vargas MI. Intracranial subarachnoid fat arising from a comminuted sacral fracture. J Neuroradiol. 2016;43(4):305-6
4. Lyo IU, Sim HB, Park JB, Kwon SC. Intraventricular and subarachnoid fat after spinal injury. J Korean Neurosurg Soc. 2008;44(2):95-97
5. Moser T, Szwarc D, Zöllner G, et al. Subarachnoid fat: Unusual migration from pelvis to brain. Neurology. 2008;71(22):1838
6. Kain II K, Jain N, O'Brien K. Findings of subarachnoid fat after trauma to a Tarlov cyst. Radiol Case Rep. 2020;16(2):258-61
7. Maravilla KR. Intraventricular fat-fluid level secondary to rupture of an intracranial dermoid cyst. Am J Roentgenol. 1977;128(3):500-1
8. Esquenazi Y, Kerr K, Bhattacharjee MB, Tandon N. Traumatic rupture of an intracranial dermoid cyst: Case report and literature review. Surg Neurol Int. 2013;4:80
9. Calabrò F, Capellini C, Jinkins JR. Rupture of spinal dermoid tumors with spread of fatty droplets in the cerebrospinal fluid pathways. Neuroradiology. 2000;42(8):572-79
10. Scearce TA, Shaw CM, Bronstein AD, Swanson PD. Intraventricular fat from a ruptured sacral dermoid cyst: Clinical, radiographic, and pathological correlation. Case report. J Neurosurg. 1993;78(4):666-68
11. De Maio PN, Mikulis DJ, et al. AIRP best cases in radiologic-pathologic correlation: Spinal conus dermoid cyst with lipid dissemination. Radiographics. 2012;32(4):1215-21
12. Burdan F, Mocarska A, Janczarek M, et al. Incidence of spinal perineurial (Tarlov) cysts among East-European patients. PLoS One. 2013;8(8):e71514
13. Tarlov IM. Perineural cysts of the spinal nerve roots. Arch Neural Psychiatry. 1938;40:1067-74
14. Paulsen RD, Call GA, Murtagh FR. Prevalence and percutaneous drainage of cysts of the sacral nerve root sheath (Tarlov cysts). Am J Neuroradiol. 1994;15(2):293-97
15. Ibrahim S, Victorio V. Symptomatic Tarlov cyst: A case report and surgical management. Indonesian Journal of Neurosurgery. 2020;3(3):115-18
16. Puffer RC, Gates MJ, Copeland W 3rd, et al. Tarlov cyst causing sacral insufficiency fracture. Oper Neurosurg (Hagerstown). 2017;13(3):E4-7
17. Klepinowski T, Orbik W, Sagan L. Global incidence of spinal perineural Tarlov's cysts and their morphological characteristics: A meta-analysis of 13,266 subjects. Surg Radiol Anat. 2021;43(6):855-63

18. Ricci C, Cova M, Kang YS, et al. Normal age-related patterns of cellular and fatty bone marrow distribution in the axial skeleton: MR imaging study. Radiology. 1990;177(1):83-88

19. Nagel SJ, Reddy CG, Frizon LA, et al. Spinal dura mater: Biophysical characteristics relevant to medical device development. J Med Eng Technol. 2018;42(2):128-39

20. Paldino M, Mogilner AY, Tenner MS. Intracranial hypotension syndrome: A comprehensive review. Neurosurg Focus. 2003;15(6):ECP2

21. Tran P, Reed EJ, Hahn F, et al. Incidence, radiographical features, and proposed mechanism for pneumocephalus from intravenous injection of air. West J Emerg Med. 2010;11(2):180-85

22. Syed SF, Garcon E. A case of diffuse subarachnoid pneumocephalus after epidural injection. OMICS J Radiol. 2013;2(4): p.1000120

23. Sachdeva S, Sanwatsarkar S, Maheshwari M, Singh P. Pneumocephalus after epidural injection: A rare complication of a common procedure. Indian J Pain. 2017;31(3):194-96