Case report

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A Case of late post-traumatic paradoxical nasal cerebrospinal fluid leak: a multidisciplinary approach to diagnosis and treatment

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Nasal cerebrospinal fluid (CSF) leakage occurs in 12–30% of patients with skull base fractures, whereas its late paradoxical form is observed in only 2% of traumatic brain injury (TBI) cases and represents an extremely rare and insufficiently studied phenomenon.

A retrospective analysis of this clinical case was performed, illustrating the complexity of differential diagnosis and emphasizing the priority of clinical reasoning in the management of complex patients with TBI.

Ten years after sustaining severe TBI with a fracture of the petrous part of the right temporal bone, the patient developed paradoxical nasal CSF leakage that had not been verified at the outpatient stage. Following comprehensive evaluation at the Romodanov Neurosurgery Institute of the National Academy of Medical Sciences of Ukraine, the patient underwent surgical treatment, which resulted in complete resolution of the CSF leak. The patient was discharged in satisfactory condition without signs of recurrence.

The presented case demonstrates an exceptionally rare combination in adults (0.05–1.0%) of meningoencephalocele and a porencephalic cyst associated with a growing skull base fracture, which led to the development of late post-traumatic paradoxical nasal CSF leakage. In the absence of access to β2-transferrin testing, the key diagnostic marker was identified as the combination of nasal CSF leakage with a specific audiometric pattern (mixed hearing loss with an intact tympanic membrane), which required mandatory verification using combined neuroimaging modalities (computed tomography and magnetic resonance imaging). A surgical strategy focused on watertight duraplasty proved effective, ensuring cessation of CSF leakage and partial regression of the conductive component of hearing loss despite the high recurrence risk reported in the literature.

Conclusions: Timely diagnosis of late post-traumatic paradoxical nasal CSF leakage is critically important for preventing intracranial complications; however, it remains a challenging task in patients with a history of TBI. The presented clinical case highlights the necessity of a multidisciplinary approach for accurate verification of the pathology and selection of effective treatment strategies in the remote post-traumatic period.

Keywords: *paradoxical rhinorrhea; post-traumatic nasal cerebrospinal fluid leak; multidisciplinary approach; CSF fistula; pure-tone audiometry; hearing loss; diagnostic markers*

Introduction

Nasal cerebrospinal fluid (CSF) leakage is a rare but clinically significant complication of traumatic brain injury (TBI). In cases of basilar skull fractures, the incidence of post-traumatic CSF leakage increases to 12–30%. Several reviews have reported that nasal CSF leakage develops in approximately 2% of patients with TBI. These data underscore the need for careful assessment and monitoring of patients with suspected skull base fractures [1].

Late post-traumatic CSF leakage, manifesting months or years after injury, is considered a rare complication. In most cases, post-traumatic CSF leakage occurs within the first 48 h or during the first 3 months after trauma. Clinical reports describing the development of CSF leakage later than 3 months after injury have been presented only in isolated publications [1].

Late paradoxical nasal CSF leakage is an uncommon phenomenon described predominantly in the form of isolated case reports and small case series. No large systematic studies providing data on its incidence have been conducted. General epidemiological data on cranial CSF leaks indicate considerable variability depending on etiology and the type of skull fracture [2].

Paradoxical nasal CSF leakage represents a clinical condition in which a defect in the middle ear or mastoid process results in communication between the CSF spaces and the nasal cavity through the Eustachian

tube or pathological fistulas, clinically manifesting as unilateral clear nasal discharge [3].

The presented clinical observation of late post-traumatic paradoxical nasal CSF leakage is of methodological interest, illustrating the complexity of differential diagnosis and emphasizing the priority of clinical reasoning. A detailed retroprospective analysis of the patient's medical records was performed with comparison of clinical and instrumental findings.

Clinical Case

Patient R., born in 1984.

Medical history. Ten years earlier (26 May 2015), the patient sustained severe TBI as a result of a road traffic accident. Multislice computed tomography (MSCT) of the brain performed in Bila Tserkva on 26 May 2015 revealed cerebral contusions with lesions in both frontal lobes and the right temporal lobe, as well as traumatic subarachnoid hemorrhage. A longitudinal fracture of the petrous part of the right temporal bone and linear fractures of the temporal and occipital squamae were identified. No surgical intervention was performed. There were no documented signs of CSF leakage during the acute period.

History of present illness. Approximately 2 months before admission, the patient noticed discharge of clear fluid from the right nasal cavity. Otolaryngologists at the local healthcare facility did not confirm the diagnosis of nasal CSF leakage. The patient was referred by a neurologist to the Romodanov Neurosurgery Institute of the National Academy of Medical Sciences of Ukraine (Kyiv).

Complaints at admission. Periodic headache and leakage of clear fluid from the right nasal passage.

Otolaryngological consultation. Objective findings (preoperative examination dated 25 November 2025): anterior rhinoscopy demonstrated deviation of the nasal septum to the left, causing obstruction of the left common nasal meatus and relative widening of the right nasal cavity. The mucosa of the inferior and middle nasal turbinates was hypertrophic, pale pink with areas of cyanotic discoloration. Nasal breathing was moderately impaired. Transparent watery rhinorrhea from the right nasal cavity was observed, with increased intensity during forward bending (positional test) and coughing. The unilateral nature of the discharge raised suspicion of CSF leakage and warranted further diagnostic evaluation. Assessment of olfactory function revealed right-sided hyposmia of mixed origin, whereas olfaction on the left side remained intact.

Given the lack of routine availability of β2-transferrin testing in Ukraine, verification of cerebrospinal fluid in the nasal secretion was performed using a qualitative glucose test. The study was conducted with strict adherence to the biomaterial collection protocol. Measures were taken to prevent contamination with blood or purulent content. A positive glucose test result from the right nasal secretion supported the diagnosis of right-sided late post-traumatic paradoxical nasal CSF leakage.

Otoscopy: on the left side, the tympanic membrane was intact and transparent, without signs of inflammation; anatomical landmarks were clearly visualized, and mobility was preserved. On the right side, the tympanic membrane was thickened and opaque, with reduced excursion (mobility) during pneumatic testing. Signs of serous effusion behind the membrane were visualized. The clinical findings were verified as Eustachian tube dysfunction with impaired ventilatory function. The results of pure-tone threshold audiometry are presented in ***Fig. 2*.**

Oropharyngoscopy: the palatine tonsils were hypertrophic, exhibiting pronounced cryptic architecture and isolated fibrinopurulent deposits; palpation revealed moderate tissue density. The mucosa of the posterior pharyngeal wall and soft palate showed no signs of active inflammation. Regional cervical lymph nodes were not enlarged. The clinical picture was verified as chronic tonsillitis in remission.

No signs of involvement of the caudal group of cranial nerves (dysarthria, dysphagia, or dysphonia) were detected. The functions of the oculomotor group, trigeminal nerve, and facial nerve were preserved, without pathological changes. Gustatory sensitivity was intact. No spontaneous nystagmus was observed. Mild static ataxia (slight unsteadiness) was noted in the Romberg position.

Conclusion. Suspected right-sided late post-traumatic paradoxical nasal CSF rhinorrhea; right-sided chronic mixed hearing loss; right-sided hyposmia of mixed etiology**.**

Ophthalmological examination (25 Nov 2025). Visual acuity: OD = 1.0, OS = 1.0. Visual fields were unchanged. The optic discs were pale pink with well-defined margins; the retinal arteries were narrowed and tortuous. Hypertensive retinal angiopathy was diagnosed.

Internal medicine examination (25 Nov 2025). Grade II, stage III arterial hypertension with a risk of developing heart failure grade 0–I. Grade II obesity.

MSCT of the brain (07 Nov 2025). A non-united fracture of the calvarial bones and skull base on the right was identified, with fragment diastasis of up to 9 mm, extending to the petrous part of the right temporal bone with fragment diastasis of up to 4 mm and communication between the middle ear structures (canals) and an intracranial focus of encephalomalacia in the right temporal lobe, which communicated with the posterior horn of the right lateral ventricle. The right middle ear cavity and mastoid air cells were filled with fluid-colloid content. Foci of encephalomalacia measuring 52 × 34 mm were detected in both frontal lobes and the right temporal lobe. Periventricularly and diffusely within the cerebral white matter, foci of leukoaraiosis and enlarged perivascular spaces of the basal ganglia were observed bilaterally. The cortical sulci of the cerebral hemispheres and cerebellum were clearly visualized. The ventricular system was asymmetric and dilated. The convexital cerebrospinal fluid spaces, insular and basal cisterns were irregularly enlarged, and the sulci were deepened. Midline structures were not displaced (***Fig. 1***).

An elective surgical procedure was performed on 26 November, 2025.

The patient was positioned in the left lateral decubitus position. A lumbar drain was inserted. Following skin preparation with antiseptic solutions, a horseshoe-shaped incision of the soft tissues was made in the right temporo-occipital region. A free bone flap was created from a single burr hole using an electric trephine.

The dura mater was tense, and cerebral pulsation was absent. The dura mater was opened in an arcuate fashion. Access to the posterior surface of the petrous part of the temporal bone was achieved. During the approach, a porencephalic cyst communicating with the temporal horn of the right lateral ventricle was opened. Revision of the temporal bone revealed an old fracture line extending into the petrous part of the temporal bone, with formation of CSF fistula in the region of the posterior surface of the petrous temporal bone. Diastasis of the bony edges extending into the petrous temporal bone was identified. The porencephalic CSF cyst was adjacent to the bony defect of the petrous temporal bone wall, with formation of a meningoencephalocele measuring 0.5 × 2.0 cm extending into the petrous cavity. The bony defect was reconstructed using a temporalis muscle graft, Surgispon® sponge, and TachoComb® collagen sponge fixed with butyl cyanoacrylate glue. Satisfactory cerebral pulsation was noted. Interrupted sutures were placed on the dura mater. The dural defect was repaired using a TachoComb® sponge. The bone flap was repositioned and secured with bone sutures. Layered closure of the soft tissues was performed. An aseptic dressing was applied.

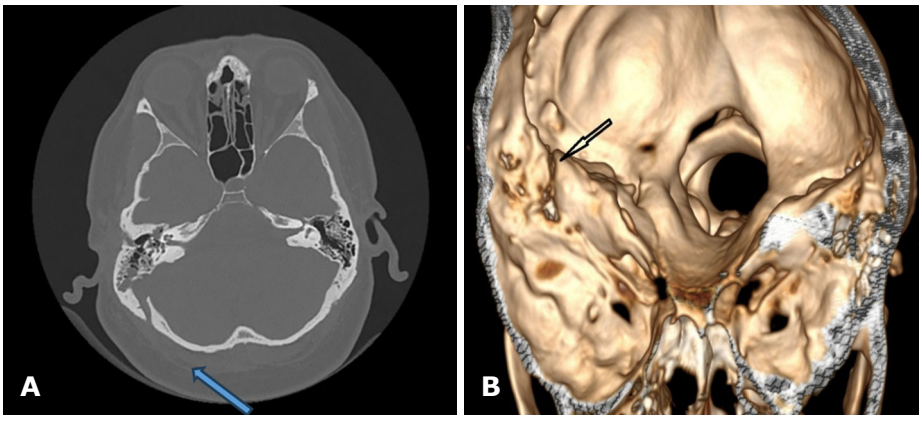

Fig. 1. MSCT of the patient's temporal bones: A — axial projection in the bone window; B — 3D reconstruction. Arrows indicate the fracture line of the petrous part of the right temporal bone with marked fragment diastasis

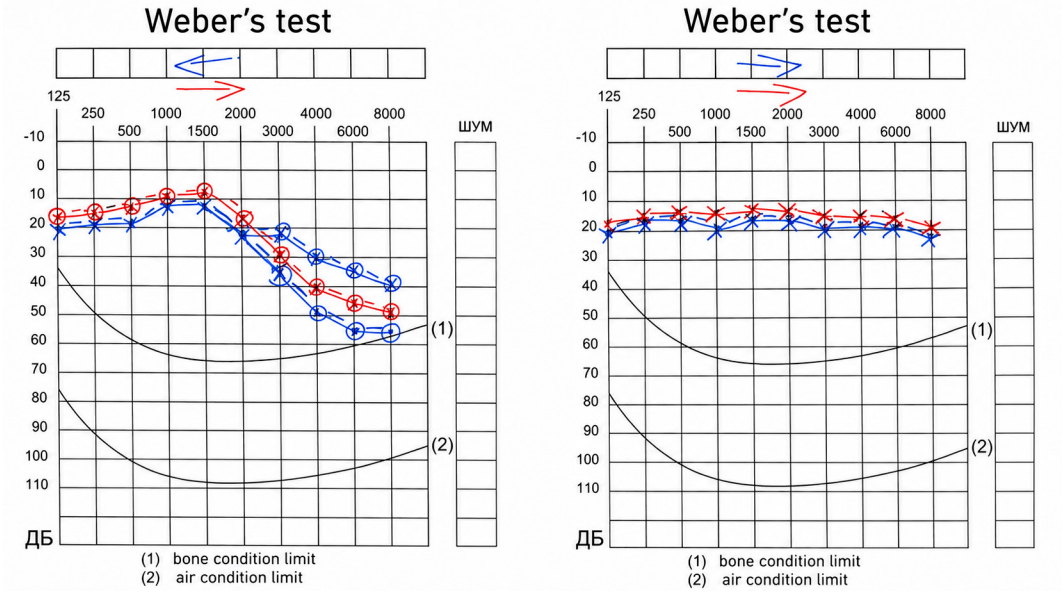

Fig. 2. Dynamics of pure-tone threshold audiometry for air and bone conduction (0.25–8.0 kHz): blue line — preoperative assessment (25 Nov 2025); red line — postoperative follow-up (09 Dec 2025). Left ear: preservation of hearing thresholds within 0–20 dB for both air and bone conduction at frequencies of 250–8000 Hz before and after surgery. Right ear: preoperatively, mixed hearing loss with predominance of conductive and high-frequency sensorineural components was observed. Air conduction thresholds remained within normal limits (≤20 dB) at frequencies up to 2000 Hz, with gradual elevation of thresholds to 60 dB at frequencies up to 8000 Hz. The air–bone gap within the 3000–8000 Hz range was 15–25 dB (mean 16–20 dB). Postoperatively, positive dynamics were observed due to a reduction in the conductive component (decrease in the air–bone gap) while the sensorineural deficit persisted

Given the presence of a porencephalic cyst and associated meningoencephalocele, the risk of recurrent CSF leakage was considered moderately high. To prevent CSF hypertension and ensure watertight closure of the defect, an external lumbar drain was maintained postoperatively for 7 days. Concurrent dehydration therapy was administered. Following drain removal, no clinical signs of nasal CSF leakage were observed. No CSF leakage was detected.

Otolaryngology consultation (09 Dec 2025): positive clinical dynamics were noted. Audiometric findings demonstrated improvement in hearing function of the conductive type (***Fig. 2***). The glucose provocation test using the Valsalva maneuver was negative, indicating the absence of CSF leakage after surgical intervention.

The patient was discharged in satisfactory condition with marked positive clinical dynamics, including the absence of nasal CSF leakage, regression of the cephalgic syndrome, and objective restoration of auditory function. A course of acetazolamide was recommended for correction of CSF dynamics, along with adherence to a protective regimen avoiding physical exertion and continued follow-up by specialists.

Discussion

The presented clinical case demonstrates a complex pathogenetic relationship between traumatic injury to the skull base structures and the development of delayed post-traumatic paradoxical CSF leakage. Analysis of this case revealed insufficient diagnostic vigilance regarding nasal CSF leakage at the outpatient stage of otorhinolaryngological care. Despite pronounced rhinorrhea, specific diagnostic evaluation and differential diagnosis aimed at excluding a CSF fistula were not performed in a timely manner. This highlights the need to improve awareness among primary- and secondary-care physicians regarding the management algorithms for patients with suspected CSF leakage, particularly in cases of atypical rhinosinusitis.

A key diagnostic indicator in this case was the combination of characteristic rhinorrhea with a specific audiometric pattern, namely mixed hearing loss on the affected side. This finding suggested the presence of cerebrospinal fluid within the middle ear cavity despite an intact tympanic membrane. The conductive defect caused by impaired sound transmission in the middle ear was combined with a sensorineural component. Such an audiometric configuration is typical of chronic otitis media, otosclerosis, or post-traumatic changes involving both peripheral and conductive structures of the auditory analyzer. The air conduction curve demonstrated a descending configuration. The audiogram pattern served as an indirect sign of the presence of CSF within the tympanic cavity. The observed postoperative dynamics corresponded to partial restoration of middle ear functional status following surgical intervention while preserving the sensorineural deficit. Postoperative monitoring confirmed the effectiveness of the selected surgical strategy, which resulted in cessation of CSF leakage and partial regression of the conductive component of hearing loss.

A limitation of this clinical observation is the absence of laboratory verification using β2-transferrin testing, which is considered the reference standard for confirming the presence of cerebrospinal fluid in nasal secretions. In Ukraine, this test has not been implemented in the routine practice of specialized neurosurgical centers, possibly because of the requirement for expensive equipment, the need for methodological validation, and logistical and organizational challenges. Consequently, alternative diagnostic approaches were employed. It should be noted that qualitative glucose testing is characterized by low specificity and a risk of false-positive results in cases of contamination of the sample with blood or purulent discharge. Therefore, the diagnostic concept was based on a systematic approach involving comprehensive analysis of clinical and instrumental otoneurological examination findings, neuroimaging data, and dynamic patient monitoring.

The pathogenesis of CSF leakage in this case was associated with the combination of several critical factors. First, the patient had a growing skull fracture, a rare pathology in the adult population. According to the literature, the incidence of this condition ranges from 0.05 to 1.0% among skull fracture cases, with the majority of observations (approximately 90%) occurring in children younger than 3 years of age. Detection of this pathology in an adult patient is considered exceptional and requires heightened clinical vigilance [4]. The second critical factor was the presence of a porencephalic cyst communicating with the inferior horn of the right lateral ventricle. This resulted in herniation of brain tissue and formation of a meningoencephalocele through the fracture diastasis of the petrous temporal bone (***Fig. 3***).

In the available scientific literature, the combination of a growing skull fracture with concurrent formation of a meningocele or meningoencephalocele has been described only in isolated clinical case reports, confirming the rarity of this pathology. In particular, G.W. Britz *et al*. (1998) reported a rare case of CSF leakage in an adult patient in whom a parietal bone defect was associated with the formation of a meningocele, thereby confirming the possibility of development of this pathology in adulthood [5, 6]. This substantially limits the possibility of extrapolating the available data to formulate universal conclusions regarding pathogenetic mechanisms and optimal treatment strategies in adult patients.

From a clinical perspective, such a combination of pathological changes is fundamentally important because the presence of a meningo(encephalo)cele modifies the surgical strategy. In particular, there is a need not only for reconstruction of the bony defect but also for reliable watertight repair of the dura mater, which is critical for the prevention of recurrent CSF leakage and ascending intracranial infectious complications [7].

For diagnostic verification, combined neuroimaging is recommended: computed tomography for precise assessment of bony destruction and magnetic resonance imaging for verification of dural defects, objective evaluation of the extent of prolapse, and assessment of parenchymal status. According to the literature, magnetic resonance imaging enables differentiation between prolapse patterns (isolated herniation of brain tissue, leptomeningeal cyst, or combined variants), which is critically important for preoperative planning.

When a meningo(encephalo)cele is confirmed, the primary surgical objective is watertight duraplasty. In adult patients, the choice of material for cranioplasty

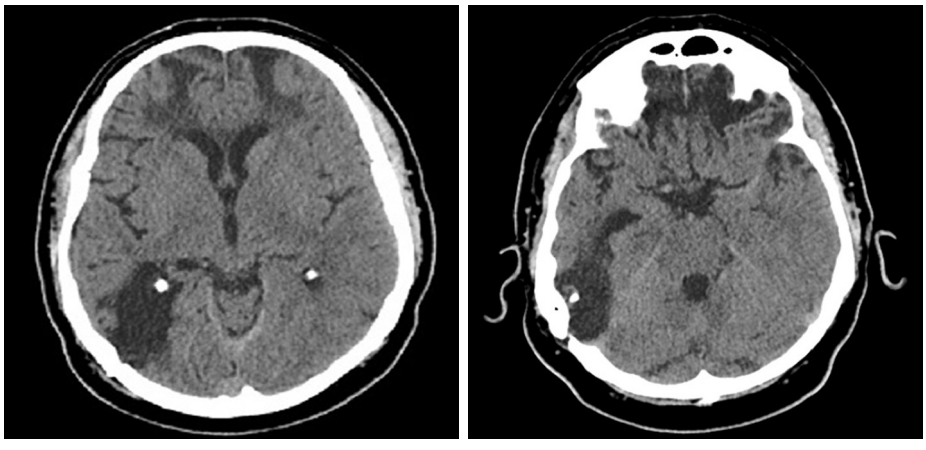

Fig. 3. MSCT of the brain. Porencephalic cyst of the temporal region

should be based on assessment of the risk of resorption, cosmetic requirements, and the presence of associated factors (history of infection, need for revision surgery).

Analysis of the literature data indicates a high incidence of postoperative infectious complications and recurrent CSF leakage.

Conclusions

The diagnosis of delayed post-traumatic paradoxical nasal CSF leakage remains a challenging issue in clinical practice. Delayed verification of this pathology may lead to severe intracranial complications, including fatal outcomes.

The presented clinical case highlights the necessity of considering paradoxical nasal CSF leakage in the differential diagnosis of rhinorrhea of unclear etiology in patients with a history of traumatic brain injury, even many years after the trauma. Confirmation of the diagnosis and selection of the optimal treatment strategy require coordinated collaboration among the otolaryngologist, radiologist, and neurosurgeon. Treatment efficacy directly depends on a multidisciplinary approach and timely diagnosis.

Disclosure

Conflict of interest

The authors declare no conflict of interest.

Informed consent

Written informed consent was obtained from the patient.

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