Traumatology and Orthopaedics of Kazakhstan
ISSN - e2789-9640

A clinical case

Original Surgical Technique for Treating Nasal Liquorrhea in a Rare Severe Penetrating Head Injury

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Received: 03 August 2025
Revised: 14 September 2025
Accepted: 02 October 2025
Published: 30 October 2025

Citation: Khalit Mustafin, Syuzanna Duisenbay, Daniyar Teltayev, Aidos Doskaliyev, Dmitriy Surdin, Ramil Tankacheyev. Pronation Adaptation During Gait in Adolescents with Thoracic Idiopathic Scoliosis. Trauma & Ortho Kaz, 2025, 76 (5), jto024
https://doi.org/10.52889/1684-9280-2025-76-5-jto024

Abstract

Post-traumatic cerebrospinal fluid leaks are observed in 1–3% of all closed traumatic brain injuries in adults, and 80–90% of all adult cerebrospinal fluid leaks are associated with head trauma. Open penetrating traumatic brain injuries can result in post-traumatic nasal liquorrhea, subarachnoid hemorrhage, parenchymal hemorrhage, neuropathy of the facial and trigeminal nerves, seizure syndrome, and in some cases, death. The diagnosis of nasal liquorrhea is challenging due to the similarity of its clinical presentation to that of diseases of the nasal cavity and paranasal sinuses. One of the most widely used diagnostic methods is computed tomography cisternography, while the current standard of treatment is endoscopic endonasal skull base reconstruction using autologous grafts. In this article, we present a rare and unique clinical case of surgical treatment for nasal liquorrhea following a severe penetrating skull injury sustained by a patient who fell from a haymaking tractor onto a pitchfork. One of the prongs fully penetrated the brain structures, and the only complication resulting from the injury was nasal liquorrhea. computed tomography cisternography was performed to localize the source of the leak. We then carried out minimally invasive surgical treatment using an endoscopic approach to the skull base. During surgery, cerebrospinal fluid was actively drained via a lumbar drain. To close the skull base defect, we used autologous tissue harvested from the patient: a wide fascia lata and adipose tissue obtained from the lateral surface of the left thigh.

Keywords: post-traumatic nasal liquorrhea, nasal liquorrhea, penetrating traumatic brain injury, skull base defect repair, endoscopic skull base defect repair.

1. Introduction

Cerebrospinal fluid (CSF) plays a vital role in protecting the brain and maintaining intracranial pressure (ICP). Produced by the choroid plexuses, CSF circulates continuously with an average daily turnover and a total volume of approximately 140 mL. In the setting of severe cranio-maxillofacial trauma, disruption of the dura mater may lead to CSF leakage from the subarachnoid space. Post-traumatic CSF leaks (PTCL) occur in 1–3% of all closed head injuries in adults, and trauma accounts for 80–90% of CSF leak cases in this population [1]. The risk of meningitis due to traumatic CSF fistula is associated with significant morbidity and potential mortality, depending on the etiology and anatomical site of the leak [2].

Nasal CSF rhinorrhea refers to the outflow of CSF from the cranial subarachnoid space into the nasal cavity or paranasal sinuses as a result of a congenital or acquired defect of the skull base and associated meningeal membranes [3]. According to various authors, post-traumatic CSF rhinorrhea accounts for 80–95% of all CSF leak cases, although only 1–2% of patients with head trauma develop this complication [4–6]. In approximately 85% of cases, early-onset rhinorrhea resolves spontaneously within the first week. The most consistent and characteristic symptom of nasal CSF leakage is the discharge of clear, colorless fluid from the nasal cavity, often accompanied by persistent, compressive headaches.

Depending on the severity and frequency of CSF outflow, rhinorrhea may present as mild “nasal moistening”, “occasional drops” (seen in about half of the cases), “frequent drops,” or as profuse leakage, known as the “teapot sign” [7].

The diagnosis of occult nasal CSF leaks remains a clinical challenge due to symptom overlap with other sinonasal pathologies. The most accessible bedside method in the setting of trauma and bleeding is the “halo sign” or “double-ring sign” [8]. Diagnostic imaging tools include nasal endoscopy, paranasal sinus computed tomography (CT), cranial CT or Magnetic resonance imaging (MRI), CT cisternography, and radionuclide cisternography [9]. Laboratory tests rely on the detection of CSF-specific biomarkers such as β2-transferrin and β-trace protein (β-TP) [10]. Fluorescein-based testing is rarely used due to its potential neurotoxicity [11–12].

Surgical management of CSF rhinorrhea involves various techniques, including intracranial approaches via craniotomy and minimally invasive endoscopic procedures [13]. In line with the advancement of endoscopic technologies and the global trend toward minimally invasive surgery, several transnasal approaches to the frontal sinus have been developed, including Draf types I–III and combined methods [14]. The combined approach entails endoscopic access via the frontal recess in conjunction with external frontal sinusotomy through the anterior sinus wall.

Recent literature reports success rates of 95–97% for combined and endonasal endoscopic skull base repairs, with low complication rates and faster postoperative recovery [7]. However, despite these promising results (based on case series ranging from 5 to 46 patients), clear practical guidelines for management remain limited [15].

Nasal CSF leaks may adversely affect cerebral perfusion and function due to the loss of the CSF cushion and may increase the risk of direct parenchymal trauma. Chronic or untreated CSF leaks can result in low-pressure headaches, neck pain, tinnitus, and in some cases, anosmia or ageusia. Furthermore, an open communication between the subarachnoid space and the nasal cavity provides a direct route for life-threatening infections, including meningitis [16].

Currently, three major challenges persist in neurosurgical practice:

1. Delayed diagnosis of post-traumatic CSF rhinorrhea;
2. Insufficient use of advanced neuroimaging, particularly CT cisternography;
3. Limited application of minimally invasive and effective surgical techniques, which may lead to serious disabling complications following penetrating traumatic brain injury (TBI) and negatively affect patients’ psychosocial rehabilitation and quality of life.

This paper presents a clinical case of severe penetrating TBI, describing the diagnostic algorithm and surgical treatment of nasal CSF leakage. Our aim is to raise awareness among clinicians of the importance of early detection and treatment of CSF rhinorrhea in neurotraumatology. We highlight the safety, simplicity, and high diagnostic value of CT cisternography, and the effectiveness of endoscopic transnasal skull base reconstruction using autologous grafts (fascia and fat). The paper demonstrates a unique case of full neurological recovery following successful surgical management of post-traumatic nasal CSF leak.

https://doi.org/10.52889/1684-9280-2025-76-5-jto024

2. Clinical Case Description

A clinical case of penetrating cranial trauma is presented in patient B., 17 years old, who was admitted with complaints of head heaviness, headache, and clear, colorless nasal discharge from the right side of the nose.

According to relatives and the medical documentation, the patient sustained a severe penetrating injury after falling from a height of 3 meters from a hay tractor, during which one of the pitchfork prongs penetrated its full length through an area 2 cm above the right mandibular angle, passing through the facial bones, skull base structures, basal ganglia, and brain parenchyma, reaching the inner surface of the left parietal bone.

Immediately after the injury, the patient removed the foreign body by himself and was then transported by ambulance to a regional multidisciplinary hospital.

At the hospital, the patient was diagnosed with: Open penetrating traumatic brain injury; grade III cerebral contusion; acute intraparenchymal hemorrhage in the left basal ganglia; diffuse cerebral edema; fracture of the inferior wall of the left maxillary sinus; fracture of the sphenoid wing; bilateral hematosinus; pneumocephalus.

On magnetic resonance imaging of the brain (Figure 1), signs of gliotic changes along the traumatic tract of the foreign body were observed, as well as a focus of hemorrhage in the projection of the basal ganglia of the left cerebral hemisphere.

Ten days after discharge, the patient developed severe headaches and nasal discharge (CSF rhinorrhea), and was re-hospitalized at the regional multidisciplinary hospital.

Upon medical examination in the emergency department, no neurological deficits were detected, but the medical record describes a scar located 2 cm above the right mandibular angle, measuring 1 cm, and clear nasal discharge from the right side was observed when the patient bent his head forward — lasting 4–5 minutes.

The patient was referred for surgical treatment to the National Center for Neurosurgery.

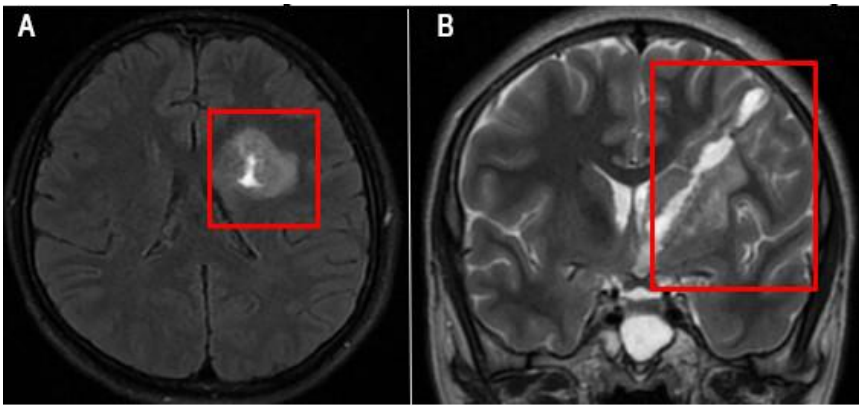

Figure 1 – Preoperative brain MRI scans. A) Axial T1-weighted image: visualizes a post-traumatic hemorrhagic focus in the region of the basal ganglia of the left cerebral hemisphere. B) Coronal T2-weighted image: visualizes the trajectory of the traumatic injury

At the Department of Neurosurgery of the National Center for Neurosurgery, the patient underwent CT cisternography.

Procedure description

Before the procedure, the patient was positioned on his right side. A lumbar puncture was performed at the L3–L4 vertebral level. After obtaining cerebrospinal fluid, 5 mL of iodixanol was injected into the subarachnoid space of the spinal cord. Immediately following contrast administration, the patient was placed in the Trendelenburg position and transported on a stretcher to the Radiology Department for brain scanning.

It is important to note that the CT scan of the brain was initiated 20 minutes after contrast injection, to allow sufficient time for the contrast agent to circulate through the basal cisterns of the skull base and reach the anterior cranial fossa.

https://doi.org/10.52889/1684-9280-2025-76-5-jto024

On the obtained CT images, a bony defect of the skull base was detected in the area of the floor of the sella turcica, along with an accumulation of fluid in the right maxillary sinus and right nasal passage (Figure 2).

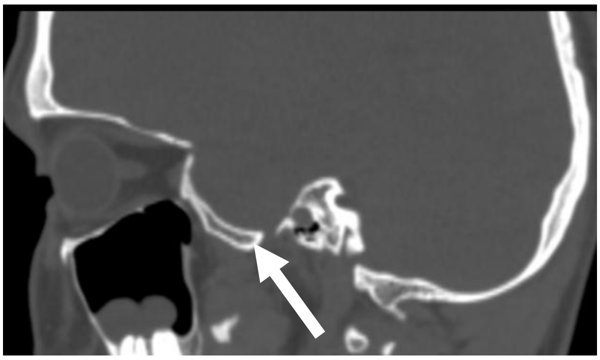

Figure 2 – CT cisternography from 07.10.2024: bone window (sagittal view); the white arrow indicates the bony defect of the skull base

As soon as the source of the CSF leak was identified, the patient was scheduled for surgical intervention.

Surgical Protocol

Under general endotracheal anesthesia, and following standard preparation of the surgical field, autologous grafts were harvested from the left thigh: a fragment of tensor fascia lata measuring 3×4 cm, and a fat graft of the same dimensions (3×4 cm).

Next, a lumbar drain was inserted at the L3–L4 vertebral level. The distal end of the drainage system was connected to a reservoir fixed at the level of the patient's shoulder.

The patient was positioned supine, with the head rotated 15 degrees to the right. A standard endoscopic transnasal approach was performed through the right nasal passage to access the anterior wall of the sphenoid sinus.

Using neuronavigation, the entry point for trepanation of the anterior sphenoid wall was identified. A Kerrison rongeur and a high-speed drill were used to enlarge the bony opening and expose the sphenoid sinus.

Upon inspection with a 30-degree rigid endoscope, a hypertrophic cone-shaped mucosal protrusion was visualized at the floor of the sella turcica, with clear CSF leaking from the apex. The dural defect measured 0.5 × 0.5 cm.

The edges of the defect were skeletonized using micro-forceps. Skull base reconstruction was initiated using 0° and 45° rigid endoscopes:

1) Three layers of tensor fascia lata were placed over the defect,
2) A fourth layer of fat graft was added on top,
3) The graft was secured with fibrillar material (Figure 3 A-E).

Following skull base repair, intracranial pressure was reduced by elevating the head of the bed by 30 degrees and opening the lumbar drainage system.

Upon final inspection with 0° and 45° endoscopes, no visible CSF leakage was observed at the repair site.

In the final step, the autologous graft was secured in the middle nasal meatus using biological glue.

A total of 30 adolescents with thoracic or thoracic-dominant AIS were included in the final analysis. The mean age was 14.90 ± 2.92 years, and the mean Cobb angle of the major spinal curve was 35.27 ± 8.64°. PSI values were calculated separately for the convex and concave feet during five distinct stance phases.

As presented in Table 1, the pronation supination index was significantly higher on the convex side during the foot contact phase compared to the concave side (54.01 ± 3.91 vs. 52.13 ± 4.70; $p = 0.04$), indicating greater pronation at initial contact. No statistically significant differences were observed between sides during early-midsupport, midsupport, late-midsupport, or toe-off phases ($p > 0.05$).

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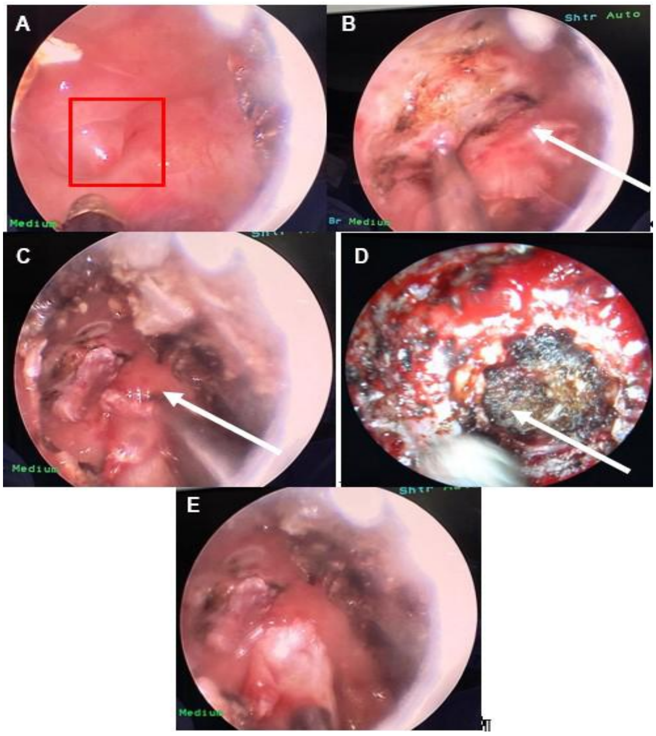

Figure 3 – Intraoperative visualization of the skull base defect: A) The hypertrophic mucosal layer, outlined in red, appears cone-shaped; clear CSF is seen leaking from the apex of the cone; B) Placement of the first layer – a small-sized fragment of autologous fascia lata; C) Placement of the second layer – a medium-sized fragment of autologous fascia lata; D) Placement of the third layer – a large-sized fragment of autologous fascia lata; E) Application of hemostatic material – fibrillar gauze

On follow-up brain MRI (Figure 4): an oblique gliotic tract is visualized within the frontal lobe parenchyma and subcortical structures of the left hemisphere, with peripheral ischemic foci on DWI/ADC, and a hemorrhagic component evident on T2 FLAIR and T1-weighted images, located in the region of the basal ganglia.

At the site of the skull base reconstruction, the dura mater appears thickened.

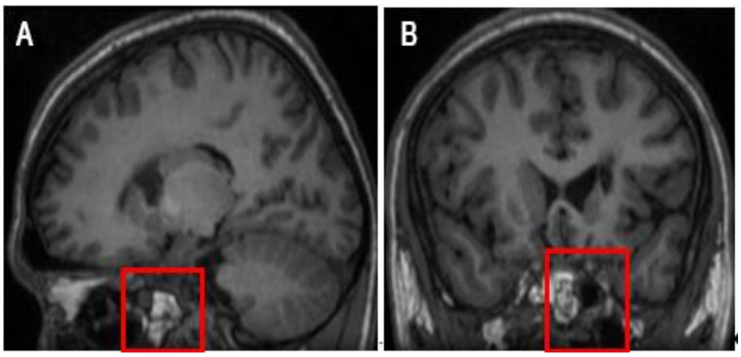

Figure 4 – Postoperative follow-up brain MRI: sagittal T1-weighted images. The autologous graft is marked within the red square

In the chiasmo-sellar region, there are areas of high signal intensity on T2-weighted and T2 FLAIR sequences, attributed to mucosal edema, CSF–hemorrhagic components, and most likely to the presence of hemostatic material (fibrillar).

Following the operation, active daily CSF drainage was performed via the lumbar drain, with 20 mL

https://doi.org/10.52889/1684-9280-2025-76-5-jto024

manually evacuated per day, and an additional ~100 mL of spontaneous CSF outflow per day into the external collection chamber.

The lumbar drain was removed on postoperative day 7, and the patient was discharged 2 days later in satisfactory condition.

3. Discussion

Early diagnosis of nasal CSF leakage is crucial for ensuring favorable outcomes and full recovery without the development of neurological deficits. One of the key diagnostic methods remains CT cisternography, an invasive procedure performed in inpatient settings under strict aseptic conditions to prevent the introduction of infection into the operative field or cerebrospinal fluid.

Despite its high diagnostic accuracy, CT cisternography is still underutilized in neurosurgical practice. For this reason, we aimed to provide a comprehensive description of the technique to raise awareness and improve clinical application among specialists.

In global neurosurgical practice, three main approaches are used for the surgical treatment of CSF rhinorrhea: transcranial, endoscopic endonasal, and combined approaches. Among these, the endoscopic endonasal and combined approaches are considered methods of choice due to their high efficacy and minimal invasiveness, with reported success rates of 86% and 93%, respectively, and complication rates ranging from 4% to 20% [15].

Over the past 17 years, our team has widely and successfully implemented endoscopic transnasal skull base repair in cases of CSF leaks. In the early postoperative period, it is essential to maintain low intracranial pressure, for which we routinely utilize lumbar puncture and cerebrospinal fluid drainage. This strategy plays a key role in preventing recurrence of the leak.

Open TBI can be accompanied by a range of complications, including subarachnoid hemorrhage (SAH), parenchymal hemorrhage, facial and trigeminal neuropathies, post-traumatic CSF rhinorrhea, seizure syndromes, and in some cases, death. The reported frequency of facial nerve neuropathy in TBI cases ranges from 5% to 10%, trigeminal neuropathy occurs in approximately 5–10%, post-traumatic CSF rhinorrhea in 5–15%, SAH in 10–30%, parenchymal hemorrhage in 20–30%, seizure disorders in 5–15%, and post-traumatic meningoencephalitis in 1.3–3.5% of TBI patients [17–18].

In the unique clinical case presented here, involving a severe penetrating cranial injury with damage to multiple critical brain structures, the only postoperative complication was nasal CSF leakage — which, if left untreated, could have led to life-threatening sequelae.

Thanks to the accurate localization of the leak using CT cisternography, and the effective endonasal endoscopic skull base reconstruction using autologous tissue grafts, we achieved complete recovery of the patient without any neurological deficits.

4. Conclusions

CSF rhinorrhea is one of the most serious complications of penetrating TBI and thus, clinicians encountering such cases in practice must employ all available diagnostic tools, including invasive procedures such as CT cisternography.

The use of modern endoscopic skull base reconstruction techniques in CSF rhinorrhea is considered the gold standard in managing this complex pathology. These methods are effective, minimally invasive, and associated with low complication rates and short rehabilitation periods.

The unique clinical case presented here—complete recovery after a severe penetrating cranial injury—demonstrates the high efficacy of timely diagnosis and the therapeutic strategy selected.

By thoroughly describing the key diagnostic and surgical techniques we use in our daily practice, we are confident that this material will be valuable for medical professionals.

Conflicts of Interest. The authors declare no conflicts of interest.

Author Contributions: Conceptualization – Kh.A.M. and A.Zh.D.; methodology – D.K.T.; data analysis – Kh.A.M. and S.N.D.; clinical data collection and case provision – D.A.S.; writing—original draft preparation – S.N.D.; writing—review and editing – R.Sh.T. and Kh.A.M. All authors have read and agreed to the published version of the manuscript.

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Бас сүйегінің сирек кездесетін ауыр ену жарақаты кезіндегі назалдық ликвореяның диагностикасы мен хирургиялық емінің төл әдісі

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Түйіндеме

Жарақаттан кейінгі жұлын сұйықтықтың ағуы ересектердегі барлық жабық бас сүйек-ми жарақаттарының 1-3% жағдайында кездеседі ал ересек пациенттердегі жұлын сұйықтығының ағуының 80–90% себебі бас сүйек-ми жарақатымен байланысты. Ашық еніп кететін бас сүйек-ми жарақаты жарақаттан кейінгі кезеңде мұрыннан ликвореясы, субарахноидальды және паренхиматозды қан құйылуы, бет және үш тармақты жүйкесінің нейропатиясы, құрысу синдромына, ал кейбір жағдайларда өлімге әкелуі мүмкін. Мұрын ликвореясын диагностикалаудың қиындығы оның клиникалық көріністерінің мұрын қуысы мен қойнаулары ауруларына ұқсастығымен байланысты. Диагностиканың кеңінен қолданылатын әдістерінің бірі — КТ-цистернография, ал қазіргі заманғы емдеу тәсілі — эндоскопиялық эндоназальды қол жеткізу және аутотрансплантат көмегімен ақауларды жөндеу болып табылады.

Бұл мақалада біз бас сүйегінің ауыр ену жарақаты нәтижесінде пайда болған мұрын ликвореясын хирургиялық әдіспен емдеудің сирек және ерекше клиникалық жағдайын ұсынамыз. Науқастың шөп шабу кезінде трактордан құлап, тырманың шанышқысы бас миына толық енуі орын алды және алынған жарақаттың жалғыз асқынуы — мұрын ликвореясы болды. Диагностика мақсатында КТ-цистернография жүргізіліп, ликвор ағуының көзі анықталды. Кейін біз науқасқа ми негізіне эндоскопиялық қолжетімділік арқылы жарақаттан кейінгі мұрын ликвореясын аз инвазивті хирургиялық ем жасадық. Операция барысында жұлын сұйықтығын люмбальды дренаж арқылы ағызу әдісі қолданылды. Ал бас сүйегінің негізі ақауын пластикалау үшін пациенттің өз тіндері, сол жақ жамбастың бүйір беткейінен алдын ала алынған, жамбас фасциясы мен аутожир пайдаланылды.

Түйін сөздер: жарақаттан кейінгі мұрын ликворея, мұрын ликвореясы, енген бас-ми жарақаты, бас сүйек ақауын пластикалау, эндоскопиялық бас негізі ақауын пластикалау.

Оригинальная хирургическая методика диагностики и лечения назальной ликвореи при редкой тяжелой проникающей травме черепа

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Резюме

Посттравматическое истечение спинномозговой жидкости наблюдаются в 1–3 % всех закрытых черепно-мозговых травм у взрослых, а 80–90% всех причин утечки спинномозговой жидкости у взрослых пациентов связаны с травмами головы. Открытая проникающая черепно-мозговая травма может стать причиной развития посттравматической назальной ликвореи, субарахноидального кровоизлияния, паренхиматозного

https://doi.org/10.52889/1684-9280-2025-76-5-jto024

кровоизлияния, нейропатии лицевого и тройничного нервов, судорожного синдрома, а в некоторых случаях и летального исхода. Сложность диагностики назальной ликвореи связана со схожестью его клинических проявлений с заболеваниями полости носа и околоносовых пазух. Одним из распространенных методов его диагностики является КТ-цистернография, а современным методом лечения назальной ликвореи является эндоскопический эндоназальный доступ и пластика дефекта аутотрансплантатом.

В данной статье мы представляем вашему вниманию редкий и уникальный клинический случай применения хирургической методики лечения назальной ликвореи после тяжелой проникающей травмы черепа, полученной в результате падения пациента с сенокосного трактора на вилы. Произошло проникновение зубца вил на всю длину в структуры головного мозга, а единственным осложнением полученной травмы была назальная ликворея. Для диагностики назальной ликвореи нами была применена КТ-цистернография, которая помогла нам локализовать источник назальной ликвореи. Затем мы провели пациенту малоинвазивное хирургическое лечение посттравматической назальной ликвореи с применением эндоскопического доступа к основанию черепа. Во время операции мы применили методику дренирования спинномозговой жидкости через люмбальный дренаж, а для пластики дефекта основания черепа аутотрансплантата мы использовали собственные ткани пациента: широкую фасцию бедра и аутожир, взятые предварительно из боковой поверхности левого бедра пациента.

Ключевые слова: посттравматическая назоликворея, назоликворея, проникающая черепно-мозговая травма, пластика дефекта черепа, эндоскопическая пластика дефекта основания черепа.