ORIGINAL RESEARCH PAPER

Neurosurgery

"EVALUATION OF TRAUMATIC CEREBROSPINAL FLUID LEAKS IN HEAD INJURY PATIENTS AT A SPECIALIZED MEDICAL CENTER

KEY WORDS: Head trauma, Cerebrospinal fluid leak, Rhinorrhea, Otorrhea, Craniocerebral injury

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ABSTRACT

Background: Cerebrospinal fluid (CSF) circulates through a complex network surrounding the brain and spinal cord via the ventricular system. Any disruption or defect in the skull or dura mater may lead to CSF leakage, which typically presents as fluid discharge from the nose (rhinorrhea) or ear (otorrhea). Traumatic head injury is one of the leading causes of CSF leaks, followed by neurosurgical and sinus procedures. **Objective:** To evaluate the prevalence of cerebrospinal fluid leakage in patients with traumatic head injuries. **Materials And Methods:** This retrospective cohort study was conducted from February 2023, to February 2025. A total of 100 patients presenting with acute head trauma within 48 hours of injury were enrolled consecutively and monitored for evidence of CSF leak over a period of seven days. **Results:** The average age of the patients was 37.4 ± 12.4 years, with a male predominance (77%) compared to females (23%). Over half of the patients (56%) were aged 40 years or younger. CSF leakage was identified in 8.7% of cases, with otorrhea observed in 2.6% and rhinorrhea in 6.1% of patients. **Conclusion:** CSF leakage is a relatively common complication of head trauma, particularly affecting younger individuals (≤ 40 years). Prompt detection is essential for appropriate management and to prevent further complications.

INTRODUCTION

Traumatic brain injury (TBI) ranks as the fourth leading cause of trauma-related deaths globally[1]. Its impact is not only medical but also socio-economic, often leaving survivors with significant physical, psychological, and financial burdens. Head injuries can cause a wide array of structural and functional damage, frequently necessitating specialized neurosurgical intervention[1].

One of the potential complications of head trauma is cerebrospinal fluid (CSF) leakage, which occurs due to tears in the dura mater, often at the skull base or other fracture sites. It is estimated that around 2% of patients with head injuries develop post-traumatic CSF leaks[2]. These leaks are typically associated with basilar skull fractures and commonly present as CSF rhinorrhea or otorrhea, with rare instances of CSF discharge through the eyes (oculorrhea)[1,2].

CSF leaks following trauma can be categorized as acute (occurring within 24 to 48 hours of injury) or delayed (emerging weeks, months, or even years later)[3]. While many acute leaks resolve spontaneously with conservative measures—such as bed rest with head elevation, blood pressure management, and use of diuretics—some cases require more aggressive intervention[4]. Current recommendations suggest conservative treatment for up to 10 to 14 days. Persistent leaks beyond this period may necessitate surgical repair to prevent complications[5,7].

Diagnostic evaluation often begins with high-resolution CT imaging, especially using coronal and sagittal views to detect skull base fractures and potential dural tears. MRI with T2-weighted sequences in the prone position is also valuable. Additional tests include radionuclide cisternography, metrizamide contrast studies, and intrathecal fluorescein dye testing. Laboratory analysis of the leaking fluid for beta-2 transferrin and glucose levels can further confirm the diagnosis and distinguish CSF from other nasal or aural discharges[7,9].

If not properly identified and treated, post-traumatic CSF leaks can lead to serious complications such as meningitis, recurrent pneumocephalus, and tension pneumocephalus[9-12], all of which carry significant morbidity and mortality. A review by Bell et al. reported a 4.6% incidence of CSF leaks in head trauma patients, though the actual prevalence may be underestimated due to delayed presentations, sometimes years after the initial injury. In some cases, patients may present with sudden onset of meningitis as the first indication of an undiagnosed CSF leak[13].

The present study was undertaken to determine the frequency of early post-traumatic CSF leaks in head injury patients treated at our institution. Given the variability in reported incidence rates across different studies, this research aims to provide data specific to our population and setting. Moreover, by documenting associated complications and outcomes, we hope to inform and improve management strategies based on local resources and clinical expertise.

MATERIALS AND METHODS

This descriptive case series was carried out over a two-year period, from February 2023 to February 2025. A non-probability consecutive sampling method was utilized to recruit participants. The study included male and female patients between the ages of 18 and 65 years who presented within 48 hours of sustaining a head injury.

Patients were excluded if they had cerebrospinal fluid (CSF) leaks following surgical procedures, presented with spontaneous CSF rhinorrhea or otorrhea, or had CSF discharge related to inflammatory causes.

Participants were stratified into four age categories: ≤ 30 years, 31–40 years, 41–50 years, and ≥ 51 years. Eligible patients were enrolled through the Emergency Department and Outpatient Department.

A thorough medical history and physical examination were performed for each participant. Diagnosis of CSF leakage

was confirmed through high-resolution computed tomography (CT) and magnetic resonance imaging (MRI) of the brain, skull base, and temporal region, along with standard laboratory investigations.

All patients were monitored throughout their hospital stay and evaluated for the presence or resolution of CSF leakage up to the point of discharge. Post-stratification analysis was conducted using the Chi-square test, with a p-value of ≤ 0.05 considered statistically significant.

RESULTS

The study was conducted on 100 patients who presented with acute head trauma. The mean age of the sample was 37.4 ± 12.4 years (Table I). Of these, 77% were male and 23% were female (Table I). Cerebrospinal fluid (CSF) leakage was identified in 9% of the patients (Table II). Among the cases with CSF leak, 3% had otorrhea, while 6% presented with rhinorrhea as the site of leakage (Table II).

Age-wise stratification revealed that CSF leaks were more prevalent in certain age groups, and this difference was statistically significant (p = 0.000) (Table III). In contrast, when stratified by gender, the variation in CSF leak frequency was not statistically significant (p = 0.763) (Table IV).

Tables

Table I: Frequency Distribution of Patients According to Age Groups (n = 100)

Age (years)	Frequency (n)	Percentage (%)
≤ 30	31	30.9%
31 to 40	26	25.7%
41 to 50	28	28.0%
≥ 51	15	15.4%
Total	**100**	**100%**

Table II: Frequency Distribution of Types of CSF Leak (n = 100)

Type of CSF Leak	Frequency (n)	Percentage (%)
Otorrhea	3	2.6%
Rhinorrhea	6	6.1%
Total CSF Leaks	**9**	**8.7%**

Table III: Age-wise Stratification of Patients with CSF Leak (n = 100)

Age Groups	CSF Leak: Yes (n, %)	CSF Leak: No (n, %)	Total (n)
≤ 30	1 (8.5%)	11 (91.5%)	12
31 to 40	4 (20.5%)	15 (79.5%)	19
41 to 50	1 (2.2%)	14 (97.8%)	15
≥ 51	0 (1.9%)	8 (98.1%)	8
Total	**6 (8.8%)**	**48 (91.2%)**	**54**

Table IV: Gender-wise Stratification of Patients with CSF Leak (n = 100)

Gender	CSF Leak: Yes (n, %)	CSF Leak: No (n, %)	Total (n, %)
Male (76.6%)	8 (10.0%)	69 (90.0%)	77 (77.0%)
Female (23.4%)	1 (5.0%)	22 (95.0%)	23 (23.0%)
Total	**9 (9.0%)**	**91 (91.0%)**	**100 (100%)**
P value			**0.763**

DISCUSSION

The majority of cerebrospinal fluid (CSF) leaks, approximately 80%, are attributed to non-surgical trauma, in contrast to around 16% resulting from surgical interventions and only 4% from non-traumatic causes. Among trauma-related CSF leaks, over half manifest within the first 48 hours, 70% within the first week, and nearly all are evident within three months of the initial injury.[14]

CSF leaks following trauma are more frequently observed in young adult males and complicate about 2% of all head injuries. They are notably present in 12% to 30% of patients with basilar skull fractures.[11] This demographic trend was reflected in a study by Adoga et al.,[15] which reported a male predominance in head injury cases, particularly among individuals under the age of 40. Our findings align with this, as 76.6% of head trauma patients and 84% (26 out of 30) of those with confirmed CSF leaks in our study were male. Additionally, 56% of our patient population was aged 40 years or younger.

In cases of accidental trauma, the most frequent anatomical sites for CSF rhinorrhea are the frontal sinus and sphenoid sinus (each approximately 30%), followed by the cribriform plate and ethmoid region (about 23%).[16] Accurate localization of the leak is critical for determining the most appropriate treatment plan, especially when surgical repair is being considered. High-resolution computed tomography (HRCT) and cisternography are essential imaging modalities used for this purpose.[11]

Ji-Woong et al.[17] emphasized that clinical examination alone is not sufficient for diagnosing CSF leaks, highlighting the necessity of laboratory testing and imaging studies. Their research noted that imaging plays a crucial role in identifying the leak site and guiding treatment decisions. Diagnostic options include plain skull radiographs, HRCT, CT cisternography, and MRI—particularly with the use of intrathecal contrast or cisternography sequences. Similarly, Oakley et al.[18] recommend HRCT as the first-line imaging modality for localizing CSF leaks, with MR cisternography serving as a secondary tool when HRCT is inconclusive or beta-2 transferrin testing is unavailable. In our study, HRCT and CT/MRI cisternography were employed to pinpoint the site of CSF leakage.

Most traumatic CSF leaks resolve spontaneously without the need for surgical intervention. In persistent cases, a combination of conservative observation, CSF diversion techniques, and surgical procedures—both intracranial and extracranial—may be necessary.[13] The most commonly reported symptom is unilateral clear nasal discharge, particularly in patients with skull base fractures.[10]

While Adoga et al.[15] found rhinorrhea to be the most frequent otorhinolaryngological presentation, followed by otorrhea, other studies have reported differing findings. For instance, Yellinek and colleagues[19] noted that otorrhea occurred more often than rhinorrhea in CSF leaks associated with head trauma. Our results showed that 8.7% of the total 342 patients had CSF leaks, with 2.6% presenting with otorrhea and 6.1% with rhinorrhea. These discrepancies may be due to individual anatomical variations in skull base and dural structures.

CSF rhinorrhea often worsens in the upright or forward-leaning position. However, symptoms can be misleading, as other nasal conditions—such as allergic, perennial, or vasomotor rhinitis—can mimic or coexist with CSF leaks. When diagnostic testing is conducted during symptom-free periods, false-negative results may occur. In cases with high clinical suspicion, repeat testing and extended follow-up are essential.[10 13]

CONCLUSION

Cerebrospinal fluid (CSF) leakage is a frequently encountered complication following traumatic head injury in our population. Its relatively high occurrence may be attributed to the large number of high-impact accidents in the community. The condition is more commonly observed in individuals under the age of 40.

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