Accuracy of CT Cisternography in the Diagnosis of Cerebrospinal Fluid (CSF) Rhinorrhea

S AHSAN[a], Y RAHMAN[b], A JOARDER[c], MA MOONMOON[d]

Abstract

Background: *Cerebrospinal fluid (CSF) Rhinorrhea refers to the leakage of CSF into the nasal cavity. Accurate detection and precise localization of the leak are essential for effective management and prevention of serious complications such as meningitis and brain abscess. Small or pinhole defects pose a particular diagnostic challenge.*

Methods: *This retrospective cross-sectional study was conducted from February 2016 to January 2024 and included 80 patients with clinical suspicion of CSF Rhinorrhea who underwent CT cisternography at a tertiary care hospital. High-resolution paranasal sinus CT scans were performed following intrathecal administration of iodinated contrast material. Demographic characteristics, CSF leak type, and anatomical location were analyzed using descriptive statistics. A CSF leak was considered present when direct contrast extravasation or opacification of nasal packs was demonstrated on imaging.*

Results: *Of the 80 patients evaluated, CT cisternography demonstrated active CSF leakage in 53 patients. A marked female predominance was observed (75.5%), with most patients belonging to the 41–60-year age group. Spontaneous CSF leaks were more common than traumatic leaks (81.1%), and the cribriform plate was the most frequently involved site (67.9%). Surgical confirmation was available for all CT-positive cases, supporting the accuracy of CT cisternography in localizing active CSF leaks in this subgroup.*

Conclusion: *CT cisternography is a valuable imaging modality for detecting and localizing CSF rhinorrhea in patients with active leaks and plays a vital role in guiding surgical management. Although high diagnostic performance was observed in surgically confirmed cases, cautious interpretation is warranted due to methodological limitations. The observed demographic patterns and leak characteristics provide clinically relevant insights that may assist in targeted diagnostic evaluation and management.*

Keywords: CSF rhinorrhea, CT Cisternography, CSF leaks, meningitis, diagnostic imaging.

(J Bangladesh Coll Phys Surg 2026; 44: 3-10)
DOI: https://doi.org/10.3329/jbcps.v44i1.87214

Introduction

Cerebrospinal fluid (CSF) rhinorrhea is defined as the leakage of CSF into the paranasal sinuses and nasal cavity, typically presenting as clear, watery nasal discharge[1]. CSF rhinorrhea may be classified as acquired or spontaneous[2]. Acquired CSF leaks are most commonly post-traumatic or iatrogenic and may occur following severe head injury or surgical procedures, resulting in dural disruption [3–5]. Spontaneous CSF rhinorrhea may be associated with congenital anomalies such as cephaloceles, persistent craniopharyngeal canal, or defects of the cribriform plate.

Patients with CSF rhinorrhea may present with a spectrum of clinical manifestations ranging from intermittent or continuous clear nasal discharge and headache to potentially life-threatening complications, including meningitis, pneumocephalus, and brain abscess. Therefore, timely identification and closure of the defect, either by endoscopic or surgical approaches, is essential to prevent morbidity and recurrence. Accurate localization of the leak site and precise assessment of the defect size are crucial for optimal surgical planning and successful repair. Additionally, it

a. Dr. Sania Ahsan, Senior Consultant, Department of Radiology and Imaging, Evercare Hospital, Dhaka, Bangladesh.
b. Dr. Aliuzzaman Joarder, Senior Consultant, Department of Neurosurgery, Evercare Hospital, Dhaka, Bangladesh.
c. Dr. Yeasmina Rahman, Associate Consultant, Radiology and Imaging Department, Evercare Hospital, Dhaka, Bangladesh.
d. Dr. Mahbuba Azim Moonmoon, Senior Specialist, Department of Radiology and Imaging, Evercare Hospital, Dhaka, Bangladesh.
Address of Correspondence: Dr. Sania Ahsan, Department of Radiology and Imaging, Evercare Hospital, Dhaka, Bangladesh. Mobile: 01711563687, E-mail: sania.ahsan@yahoo.ca, sania.ahsan@evercarebd.com

Received: 19 March, 2025 **Accept:** 25 November, 2025

is essential to exclude alternative sources of nasal discharge that may mimic CSF rhinorrhea [6].

Imaging plays a central role in the detection and characterization of CSF leaks. Advances in imaging techniques have significantly improved neuroradiologists' ability to identify even small skull-base defects responsible for CSF leakage. High-resolution, isotropic thin-section computed tomography (CT) is particularly effective in delineating bony anatomy and localizing skull base defects [7].

Computed tomography (CT) cisternography is a minimally invasive imaging technique that involves intrathecal administration of iodinated contrast material to visualize CSF pathways and directly demonstrate active leakage[8]. This technique allows precise anatomical localization of osseous defects and visualization of contrast extravasation, which is particularly valuable for surgical planning[7,8]. Although adverse effects such as headache, meningeal irritation, allergic reactions, and seizures have been reported, these complications are uncommon when low-osmolar non-ionic contrast agents are used[7–9]. CT cisternography is widely regarded as a highly sensitive diagnostic modality, especially when conventional imaging is inconclusive10.

Despite its diagnostic utility, CT cisternography has limitations. The technique may fail to demonstrate intermittent or inactive leaks and is contraindicated in patients with raised intracranial pressure or certain spinal disorders. Magnetic resonance imaging (MRI) cisternography, particularly with heavily T2-weighted sequences and fat suppression, offers a non-invasive alternative for depicting CSF as a high-signal-intensity structure without the need for intrathecal contrast administration. However, MRI has limited spatial resolution and provides less detailed visualization of bony anatomy compared with CT. Although gradient-echo sequences improve osseous delineation, CT remains superior for precise evaluation of skull base defects.

Given the ongoing need for accurate localization of CSF leaks and appropriate selection of imaging modalities, this study aimed to evaluate the diagnostic accuracy and clinical utility of CT cisternography in patients with suspected cerebrospinal fluid (CSF) rhinorrhea.

Methods

Study design and population

A retrospective cross-sectional study was conducted in the Department of Radiology and Imaging at Evercare Hospital, Dhaka, from February 2016 to January 2024 to evaluate the diagnostic performance of CT cisternography in patients with suspected cerebrospinal fluid (CSF) rhinorrhea. During the study period, 80 consecutive patients (N = 80) with clinical suspicion of CSF rhinorrhea underwent CT cisternography. Clinical suspicion was based on the presence of persistent clear, watery nasal or aural discharge, post-traumatic watery nasal discharge, or other clinical features suggestive of CSF leakage.

Among the 80 patients examined, 53 demonstrated active contrast extravasation on CT cisternography and were categorized as CT-positive. The remaining 27 patients showed no demonstrable contrast leakage and were classified as CT-negative. CT-negative patients were managed conservatively and followed clinically. Surgical correlation was available for all CT-positive cases, whereas CT-negative cases did not undergo surgical exploration due to the absence of imaging-confirmed active leakage. Consequently, these CT-negative cases were excluded from the sensitivity and specificity calculations because a uniform reference standard was unavailable for this subgroup.

CT cisternography was considered positive when direct visualization of contrast leakage into the nasal cavity or paranasal sinuses, or opacification of nasal packs following intrathecal contrast administration, was observed. Diagnostic performance parameters were calculated based on imaging findings with operative confirmation, acknowledging the inherent limitations related to retrospective design and selective surgical verification.

Inclusion and exclusion criteria

Patients were included if they had persistent or intermittent crystal-clear nasal or aural discharge with clinical suspicion of CSF rhinorrhea. Exclusion criteria included absence of active, clear nasal discharge at presentation, known hypersensitivity to iodinated contrast media, chronic kidney disease, malignant disease, organ failure, severe coagulopathy or thrombocytopenia, localized infection at the lumbar puncture site, and pregnancy.

Data collection and ethical considerations

Data were collected using a pre-designed semi-structured questionnaire, and all clinical and imaging findings were recorded in a standardized clinical datasheet. Written informed consent was obtained from all participants before the procedure. Ethical approval was obtained from the hospital's institutional ethics committee, and the confidentiality of patient information was maintained throughout the study.

Pre-procedural evaluation included a detailed assessment of medical history, current medications, contrast allergies, seizure history, and bleeding tendencies. Anticoagulant and antiplatelet medications were discontinued as per institutional protocol. Patients were counseled regarding the risks, benefits, and alternative imaging options before undergoing CT cisternography.

CT cisternography technique

High-resolution non-contrast CT scans of the skull base and paranasal sinuses were initially performed using a Siemens Somatom Definition Edge 128-slice CT scanner. Imaging was acquired with a 0.75-mm slice thickness using a bone window algorithm, with multiplanar reformations at 1-mm thickness in axial, coronal, and sagittal planes to identify suspected defects of the cribriform plate, ethmoidal roof, and skull base.

Lumbar puncture was subsequently performed under strict aseptic conditions, followed by intrathecal administration of 8–10 ml of non-ionic, low-osmolar iodinated contrast material. Patients were positioned prone in the Trendelenburg position for approximately 10–15 minutes to facilitate contrast migration to the basal cisterns, after which prone CT imaging was performed. Adequate opacification of the basal cisterns and frontal sulci was confirmed. If necessary, patients were maintained in a head-down position for an additional 15–20 minutes before repeat imaging to ensure optimal visualization of contrast distribution[11].

Data analysis

Descriptive statistics were used to summarize demographic and clinical variables. Continuous variables were reported as mean ± standard deviation, and categorical variables were presented as frequencies and percentages. Associations between categorical variables were assessed using the chi-square test where appropriate. A p-value of <0.05 was considered statistically significant. Results were presented in tabular form. Random verification checks were performed to ensure data accuracy. Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 26.0.

Results

Among the 80 patients evaluated, CT cisternography demonstrated active cerebrospinal fluid (CSF) leakage in 53 patients (66.3%). All CT-positive cases subsequently underwent surgical repair, and intraoperative findings confirmed the presence and anatomical location of the CSF leak in all cases. Twenty-seven patients did not demonstrate contrast leakage on CT cisternography and were managed conservatively without surgical exploration. As a uniform reference standard was not available for these CT-negative cases, formal calculations of sensitivity and specificity were limited to surgically confirmed cases.

Within these methodological constraints, CT cisternography demonstrated high accuracy in detecting and localizing CSF leaks in patients with active rhinorrhea.

Of the total 80 patients who underwent CT cisternography, detailed demographic and clinical analyses were performed on the 53 CT-positive patients with surgically confirmed CSF leaks. The study population showed a marked female predominance, with females comprising 75.5% (n = 40) of cases and males 24.5% (n = 13).

The age distribution showed that the majority of patients were middle-aged, with 56.6% (n = 30) in the 41–60-year age group. Patients aged 21–40 years accounted for 33.9% (n = 18), while those aged over 60 years and 10–20 years represented smaller proportions at 3.77% (n = 2) and 1.8% (n = 3), respectively.

Table-I

Distribution of the study population based on baseline characteristics (n = 53)

Baseline Characteristics	(N, %)
Gender	
Male	13,24.5%
Female	40,75.5%
Age	
10-20	3,1.8%
21-40	18,33.9%
41-60	30,56.6%
>60	2,3.77.0%

Among the 53 CT-positive patients, spontaneous CSF leaks were more common, occurring in 81.1% (n = 43), whereas traumatic CSF leaks accounted for 18.9% (n = 10).

Table-II

Distribution of study population based on type of CSF leak (n = 53)

CSF leak	(N, %)
Spontaneous	43,81.1%
Traumatic	10,18.9%

Analysis of leak location revealed that the cribriform plate was the most frequently involved site, accounting for 67.9% (n = 36) of cases. This was followed by the frontal sinus in 13.2% (n = 7) and the sphenoid sinus in 11.3% (n = 6). Leaks involving the ethmoid air cells and middle ear were relatively uncommon, observed in 5.7% (n = 3) and 1.9% (n = 1) of cases, respectively.

Table-III

Distribution of study population based on location of CSF leak (n = 53)

Location of defect	(N, %)
Cribriform plate	36,67.9%
Frontal sinus	7,13.2%
Sphenoid sinus	6,11.3%
Ethmoid air cells	3,5.7%
Middle ear	1,1.9%

Among male patients (n = 13), spontaneous CSF leaks were observed in 61.5% (n = 8), while traumatic leaks were identified in 38.5% (n = 5). This distribution did not reach statistical significance (p = 0.11; ns).

In contrast, female patients (n = 40) demonstrated a significantly higher proportion of spontaneous CSF leaks (87.5%; n = 35) compared to traumatic leaks (12.5%; n = 5), and this association was statistically significant (p = 0.03; s).

The cribriform plate was the most common site of leakage across all age groups. The highest frequency was observed in the 41–60-year age group, where 53.8% (n = 21) of patients demonstrated cribriform plate defects; this association was statistically significant (p = 0.004; s).

In younger age groups, cribriform plate involvement was less frequent and did not reach statistical significance, occurring in 28.5% (n = 2) of patients aged 10–20 years and 37.9% (n = 11) of patients aged 21–40 years. Frontal and sphenoid sinus leaks were observed exclusively in the 21–40 and 41–60-year age groups, but there was no statistically significant association with age. Involvement of the ethmoid air cells and middle ear was rare and did not demonstrate statistical significance across age groups.

Table-IV

Association of gender with type of CSF leak (n = 53)

Gender	Spontaneous CSF leak	Traumatic CSF leak	df, p-value
Male (n=13)	8, 61.5%	5, 38.55	2, 0.11^{ns}
Female (n=40)	35,87.55	5,12.5%	1, 0.03^{s}

*s=statistically significant *ns= statistically not significant

Table-V

Association of age with location of CSF leak (n = 53)

Age	Cribriform plate	Frontal sinus	Sphenoid sinus	Ethmoid air cells	Middle ear	df, p-value
10-20 (n=7)	2,28.5%	0,0.0%	0,0.0%	0.0.0%	1,14.2%	3,0.06^{ns}
21-40 (n=29)	11,37.9%	2,6.7%	3,10.3%	2,6.7%	0,0.0%	4,0.71^{ns}
41-60 (n=39)	21,53.8%	4,10.2%	3,7.7%	2,5.1%	0,0.0%	3,0.004^{s}
>60 (n=5)	2,40.0%	0,0.0%	0,0.0%	0,0.0%	0,0.0%	6,0.83^{ns}

*s=statistically significant *ns= statistically not significant

Cases

Case 1

A 28-year-old male patient presented with left-sided clear, watery nasal discharge following a road traffic accident. CT cisternography demonstrated active contrast extravasation through a bony defect measuring approximately 3 mm at the roof of the left cribriform plate (Fig. 1).

Case 2

A 33-year-old female patient presented with right-sided clear, watery nasal discharge with a prior history of head injury. CT cisternography revealed contrast leakage through a bony defect measuring approximately 5.3 mm at the lateral wall of the right sphenoid sinus (Fig. 2).

Right sphenoid sinus measuring 5.3 mm (Fig. 2).

Case 3

A 56-year-old male patient presented with spontaneous right-sided clear, watery nasal discharge without any history of trauma. CT cisternography demonstrated active contrast leakage through a bony defect measuring approximately 3.3 mm at the roof of the right cribriform plate (Fig. 3).

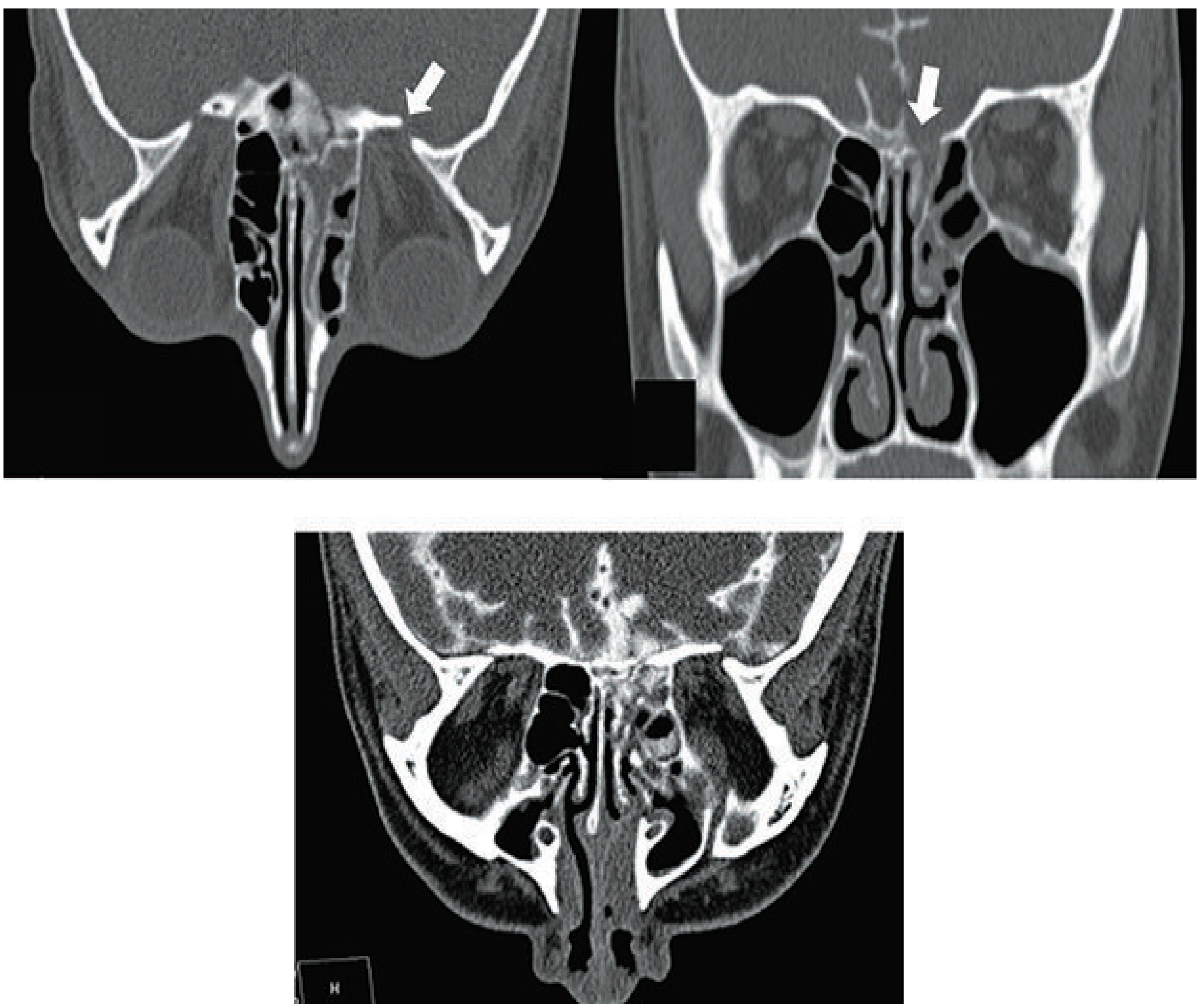

Figure 1: *Non-contrast CT images with bone window in axial and coronal planes (A, B) demonstrate a bony defect at the roof of the left cribriform plate (white arrow). CT cisternography in the axial plane (C) shows contrast leakage into the left ethmoidal sinus.*

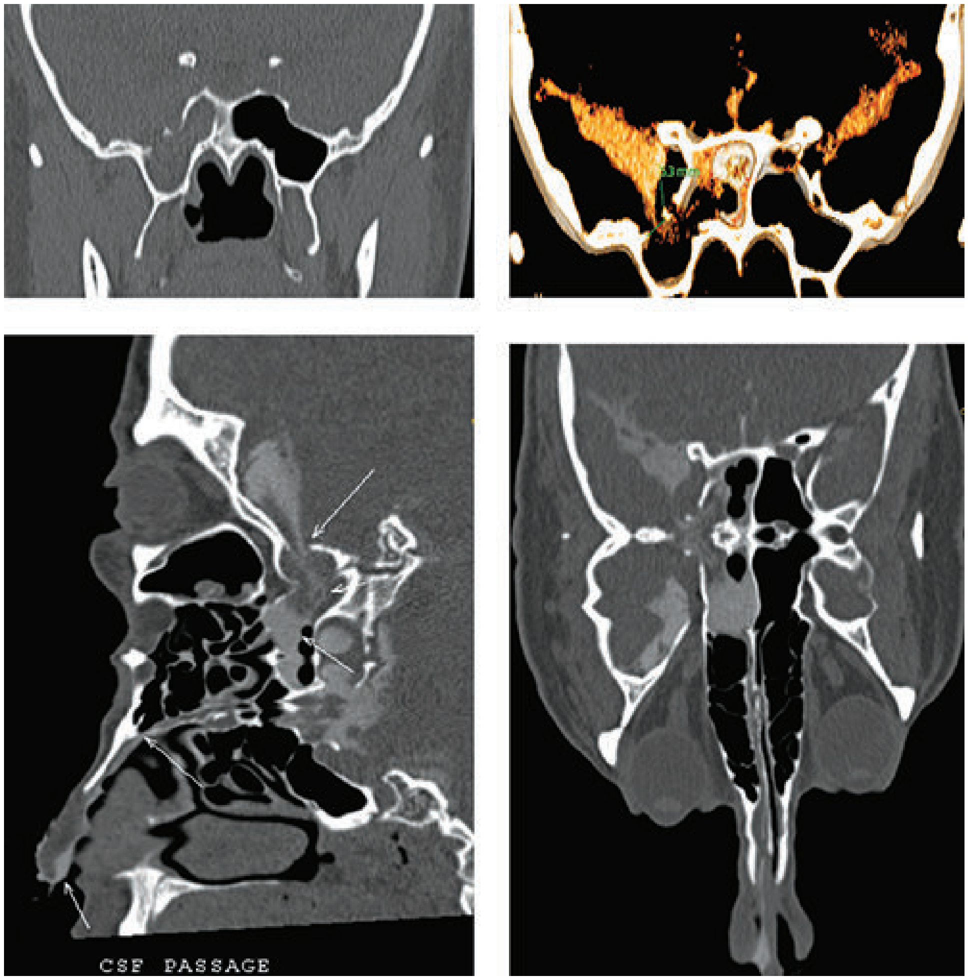

Figure 2: *Non-contrast CT with bone window in the coronal plane (A) shows a defect in the lateral wall of the right sphenoid sinus. CT cisternography volume-rendered image (B), sagittal (C), and coronal (D) reformatted images demonstrate contrast leakage into the right sphenoid and adjacent ethmoidal sinuses.*

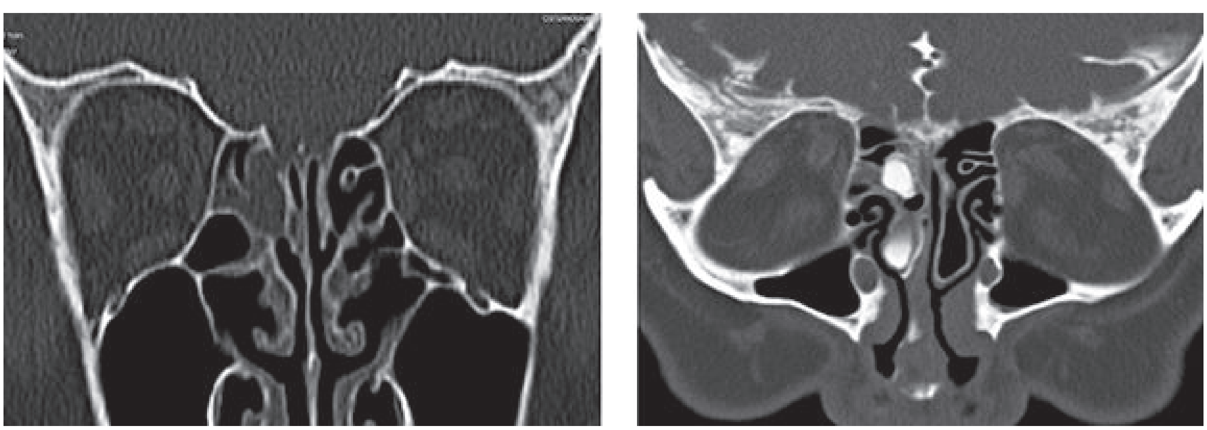

Figure 3: *Non-contrast CT with bone window in the coronal plane (A) demonstrates a bony defect at the roof of the right cribriform plate. CT cisternography in the coronal plane (B) shows contrast leakage into the adjacent ethmoidal sinus.*

Discussion

In the present study, CT cisternography demonstrated high reliability in detecting and localizing cerebrospinal fluid (CSF) leaks in patients with clinically suspected active CSF rhinorrhea. All CT-positive cases were confirmed intraoperatively, supporting the value of CT cisternography in precise anatomical localization and surgical planning. These findings underscore the role of CT cisternography as a robust imaging modality in patients with continuous CSF leakage requiring definitive intervention.

However, the diagnostic performance of CT cisternography in this study must be interpreted with caution. CT-negative patients did not undergo surgical exploration, limiting the availability of a uniform reference standard and introducing the possibility of verification bias. As a result, formal estimates of sensitivity and specificity may be inflated, a limitation acknowledged in prior studies evaluating imaging techniques for CSF leak detection. Despite this constraint, the consistent intraoperative confirmation of CT-positive cases supports the clinical utility of CT cisternography in appropriately selected patients.

Among the 80 patients evaluated, active contrast leakage was demonstrated in 53, while 27 did not show imaging evidence of contrast extravasation. Although these CT-negative patients continued to exhibit clear nasal discharge in the prone position, no significant change in Hounsfield unit (HU) values was observed in nasal packs between pre- and post-contrast scans. Many of these patients also had associated sinusitis, suggesting alternative explanations for their symptoms. These findings highlight the known limitation of CT cisternography in detecting intermittent or inactive leaks, reinforcing the importance of correlating imaging findings with clinical presentation[3].

The demographic analysis revealed a marked female predominance, with females constituting 75.5% of the study population and demonstrating a significantly higher proportion of spontaneous CSF leaks. This observation is consistent with previously published studies by Wang et al. and Schievink, which suggest an increased susceptibility among females, potentially related to conditions such as idiopathic intracranial hypertension [12,13]. Age distribution analysis showed that middle-aged patients (41–60 years) were most frequently affected, particularly with cribriform plate defects. This finding aligns with the observations of Hong et al., who reported a similar age-related pattern and proposed that cumulative anatomical or physiological changes contribute [14].

Anatomical localization analysis identified the cribriform plate as the most common site of CSF leakage, accounting for more than two-thirds of cases. This predilection reflects the inherent structural vulnerability of the cribriform plate and is well documented in the literature [15,16]. The predominance of spontaneous over traumatic CSF leaks observed in this study further supports emerging evidence that spontaneous CSF rhinorrhea represents a distinct clinical entity with unique pathophysiological mechanisms and demographic associations.

From a clinical perspective, these findings emphasize the importance of precise preoperative localization of CSF leaks to facilitate targeted surgical repair and reduce recurrence rates. CT cisternography, by providing high-resolution visualization of skull base defects and active contrast extravasation, remains a valuable diagnostic tool in this context. Nevertheless, its use should be guided by careful patient selection, particularly in cases of suspected intermittent leakage or elevated intracranial pressure.

Conclusion

CT cisternography is an effective imaging modality for detecting and localizing cerebrospinal fluid rhinorrhea in patients with active CSF leaks. It provides detailed anatomical information that is crucial for surgical planning and management. Although excellent diagnostic performance was observed in surgically confirmed cases, caution is warranted when interpreting diagnostic accuracy due to methodological limitations. When used in appropriate clinical settings, CT cisternography continues to play an important role in the diagnostic evaluation of CSF rhinorrhea.

Limitations

This study has several limitations. First, its retrospective single-center design may limit the generalizability of the findings. Second, CT-negative patients were managed conservatively without surgical confirmation, limiting comprehensive assessment of diagnostic accuracy and introducing potential verification bias. Third, CT cisternography may be less sensitive in cases of intermittent or inactive CSF leakage, potentially contributing to false-negative results. Future prospective studies with uniform reference standards and direct comparison with MRI cisternography are recommended further to define the optimal diagnostic approach for CSF rhinorrhea.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

References:

1. UVA Health. CSF rhinorrhea treatment from skull specialists [Internet]. Charlottesville (VA): UVA Health; c2022 [cited 2022 Oct 30]. Available from: https://uvahealth.com/services/benign-brain-tumor/csf-rhinorrhea
2. Lobo BC, Baumanis MM, Nelson RF. Surgical repair of spontaneous cerebrospinal fluid leaks: a systematic review. Laryngoscope Investig Otolaryngol. 2017 Oct;2(5):215–24.
3. Xie M, Zhou K, Kachra S, McHugh T, Sommer DD. Diagnosis and localization of cerebrospinal fluid rhinorrhea: a systematic review. Am J Rhinol Allergy. 2022 May;36(3):397–406.
4. Lloyd KM, DelGaudio JM, Hudgins PA. Imaging of skull base cerebrospinal fluid leaks in adults. Radiology. 2008 Sep;248(3):725–36.
5. Bullock R, Soares D. Current imaging of cerebrospinal fluid leaks. West Indian Med J. 2009;58(4):362–8.
6. Atta H, Seifeldein GS, AlMamoun M, Imam H. Reliability of multidetector CT in the diagnosis of cerebrospinal fluid rhinorrhea with operative correlation. Egypt J Radiol Nucl Med. 2017;48(1):107–13.
7. Dogan SN, Salt V, Korkmazer B, Arslan S, Islak C, Kocer N, et al. Intrathecal use of gadobutrol for gadolinium-enhanced MR cisternography in the evaluation of patients with otorhinorrhea. Neuroradiology. 2020 Nov;62(11):1381–7.
8. Aydin K, Guven K, Sencer S, Jinkins JR, Minareci O. MRI cisternography with gadolinium-containing contrast medium: its role, advantages and limitations in the investigation of rhinorrhoea. Neuroradiology. 2004 Jan;46(1):75–80.
9. Vemuri NV, Karanam LS, Manchikanti V, Dandamudi S, Puvvada SK, Vemuri VK. Imaging review of cerebrospinal fluid leaks. Indian J Radiol Imaging. 2017 Oct;27(4):441–6.
10. Algin O, Hakyemez B, Gokalp G, Ozcan T, Korfali E, Parlak MU. The contribution of 3D-CISS and contrast-enhanced MR cisternography in detecting cerebrospinal fluid leak in patients with rhinorrhoea. Br J Radiol. 2010 Mar;83(987):225–32.
11. Radiopaedia. CT cisternography [Internet]. Melbourne: Radiopaedia.org; c2022 [cited 2022 Oct 31]. Available from: https://radiopaedia.org/articles/ct-cisternography-1
12. Wang EW, Vandergrift WA 3rd, Schlosser RJ. Spontaneous cerebrospinal fluid leaks: a variant of benign intracranial hypertension. Ann Otol Rhinol Laryngol. 2011 Jul;120(7):448–54.
13. Schievink WI. Spontaneous spinal cerebrospinal fluid leaks and intracranial hypotension. JAMA. 2006 May 17;295(19):2286–96.
14. Hong CS, Kundishora AJ, Elsamadicy AA, Vining E, Manes RP, Omay SB. A unique subset: idiopathic intracranial hypertension presenting as spontaneous CSF leak of the anterior skull base. J Neurol Surg B Skull Base. 2021 Apr;82(2):230–7.
15. Clark D, Bullock P, Hui T, Firth J. Benign intracranial hypertension: a cause of CSF rhinorrhoea. J Neurol Neurosurg Psychiatry. 1994 Jul;57(7):847–9.
16. Sasindran V, Mathew N, Shabna A, Harikrishan B. Spontaneous medial cribriform CSF leak: endoscopic surgical repair with free mucosal graft—our experience. Indian J Otolaryngol Head Neck Surg. 2018 Dec;70(4):387–91.