https://doi.org/10.3329/cbmj.v14i2.83263

Outcome of Transnasal Endoscopic Repair in Cerebrospinal Fluid Rhinorrhea: A Multicentre Experience from Bangladesh

*Zoheb SJM[1], Samad MS[2]

Abstract

Cerebrospinal fluid (CSF) rhinorrhea occurs due to abnormal leakage of CSF through the nasal cavity, often resulting from trauma, surgery, or spontaneous causes. Transnasal endoscopic repair has emerged as the preferred surgical approach due to its minimally invasive nature and high success rates. This prospective, observational study was conducted in four tertiary level specialized institutions in Dhaka, Bangladesh, between April 2023 and September 2024, to evaluate the outcomes of transnasal endoscopic repair of cerebrospinal fluid rhinorrhea. A total of 37 patients diagnosed with CSF rhinorrhea who underwent transnasal endoscopic repair were enrolled in this study through purposive sampling. Data was collected on patient clinical characteristics, site and size of the CSF leaks, surgical techniques, graft materials, and postoperative outcomes. Follow-up was conducted at regular intervals (2 weeks, 1, 3, 4 and 6 months) to assess the success or failure and monitor complications, if any. Trauma (45.90%), iatrogenic (10.80%), and spontaneous rhinorrhea (43.20%) were the main causes, with 49% of participants having chronic conditions. History of preoperative meningitis was present in 8.1% cases. Pre-operative anosmia was present in 27.03% cases. The cribriform plate was the most common leak site (43.2%), and smaller leaks (<1 cm²) were prevalent (67.6%). Encephalocele is present in 16.2% cases. Surgically, a combination of fascia lava, fat, and septal cartilage was most commonly used (56.8%), with the combined technique being the preferred approach (59.5%). Tissue glue was used in 54.1% cases. Merocel pack was used in 62.2% cases with a mean duration of pack was 5.59 days. Postoperatively, 45.9% received lumbar drains with an average duration of 5.47 days. A lumber drain was given to all the patients with spontaneous CSF rhinorrhoea and hypertensive patients. The average duration of hospital stay was 7.38 days. Post-operative complications like anosmia was present in 43.2% cases after 2 weeks, 24.3% cases after one month and was absent after 3 months, 4 months and 6 months. Complications like nasal oedema was present in 27.03% cases after 2 weeks, 16.23% cases after 1 month, 5.4% cases after 3 months and was absent after 4 months and 6 months. Synechia was present in 5.4% cases after 2 weeks, 2.7 % cases after 1 month and was absent after 3 months, 4 months and 6 months. Crusting was present in 89.19% cases after 2 weeks, 54.05% cases after one month, 2.7% cases after 3 months, 2.7% cases after 4 months and was absent after 6 months. The success rate for endoscopic repair was 89.2% after 6 months of follow-up. The combined surgical approach showed the best outcomes. Overall, while initial success rates were promising, the long-term outcomes highlighted areas for further investigation to reduce the risk of failures over time.

CBMJ 2025 July: vol. 14 no. 02 P:57-65

Keywords: Cerebrosinal fuid (CSF) rhinorrhea, transnasal endoscopic repair, surgical outcome, postoperative complications

Introduction

CSF leaks can be considered as congenital, spontaneous or post-traumatic. Post- traumatic leaks can be further divided into those associated with head trauma, those seen as a complication of sinus surgery and those seen as a part of skull base surgery.[1] A more recent study suggested that the incidence of meningitis may be as low as 0.3% per year per active leak person.[2] CSF leaks are quoted as occurring in perhaps 2% of head injuries and 12% to 30% of skull base fractures.[3] Most CSF leaks occur as a result of blunt trauma. They may present as CSF otorrhea, CSF oto-rhinorrhea or CSF rhinorrhea. Congenital CSF leaks in association with encephalocele or meningoencephaloceles are uncommon.[1,4]

1. *Dr. Sarwar Jahan Md. Zoheb, Registrar, Department of Otolaryngology (ENT) & Head and Neck Surgery (HNS), Dhaka Medical Collage, Dhaka.
2. Dr. Md. Sazzad Samad, Assistant Professor, Department of Otolaryngology (ENT), Dhaka Medical Collage, Dhaka.

Address of Correspondence:
Email: sazzadsagore@gmail.com

The history of surgical repair of CSF rhinorrhoea began in 1926 when, Walter Dandy, an American surgeon reported the first successful intracranial repair using a bifrontal craniotomy.[4] In 1948, Dohlman introduced the first extracranial approach using a naso-orbital incision, and then subsequently, others developed a variety of endonasal approaches.[6] Wigand, in 1981, performed the first successful transnasal endoscopic approach to repair anterior cranial base CSF rhinorrhea.[6] Endoscopic endonasal technique being widely adopted in neurosurgical practice, as CSF rhinorrhoea is a common complication after anterior skull base fracture following head injury and is a rare entity.[7] In the last four decades, with the advent of the rod lens rigid endoscope and the development of instruments tailored to transnasal endoscopic technique, endoscopic closure has revolutionized the management of CSF rhinorrhoea due its less morbidity and better closure rate.[5] This approach has been documented to significantly reduce postoperative morbidity while effectively addressing CSF leaks originating from various anatomical locations, particularly the ethmoid and sphenoid sinuses.[8,9] The overall success rate of repair was high at 90% for primary and 97% for secondary repairs. A low complication rate of less than 0.03% was reported.[10] Some literature analysis suggests that the grafting material used to repair the leaks is variable and depends wholly on the authors experience. It appears that free grafts are preferred to pedunculated ones.[11] Surgeons have described single or multilayer grafts accordingly to their preference and experience. The techniques of placement of the graft may be underlay, overlay or partial underlay.[12] Endoscopic transnasal repair has proven to be highly successful and should now be considered as the standard of care in spontaneous CSF rhinorrhoea for cases not responding to conservative methods.[13] Endoscopic repair has numerous advantages, such as precise identification and access to the defect site and error free placement of the graft. Trans-nasal endoscopic repair minimizes the risk of permanent anosmia.[14.15] This is particularly beneficial for patients, as it reduces the overall burden of treatment and enhances the quality of care. The defects are successfully repaired by transnasal endoscopic surgery, with the assistance of virtual endoscopic images, which were created by the surgical planning and navigation system from thin-slice CT images. This incremental improvement in the imaging technique helped with the diagnosis and surgical treatment of CSF rhinorrhea.[16]

The diagnosis of CSF rhinorrhoea is both clinical and radiological. Currently, CT scan with intrathecal contrast is the gold standard for diagnosis. Beta-2 transferrin levels are estimated whenever there is doubt about the nature of the nasal fluid.[17] Fluorescein injected intrathecally is a valuable test for determining the site of the leak and also to confirm the absence of a leak when the beta-2 transferrin is negative.[18] Moreover, potentially serious sequelae of these leaks, including meningitis, neurologic deficits, pneumonia, pneumocephalus, or even death, can lead to increase in hospital cost and potential malpractice litigation. Delay in diagnosis and management are associated with increased neurologic sequelae and postoperative meningitis in these patients.[19]

The present study was designed to evaluate the outcomes of transnasal endoscopic repair in cerebrospinal fluid (CSF) rhinorrhea involving four tertiary level specialized hospitals in Dhaka city, Bangladesh.

Methods

This prospective, observational study was carried out in four tertiary level specialized institutions of Dhaka city, Bangladesh, between April 2023 and September 2024. Departments of ENT & Head-Neck Surgery of Dhaka Medical College Hospital, Bangabandhu Sheikh Mujib Medical University (BSMMU), National Institute of Ear, Nose and Throat (NIENT) and National Institute of Neurosciences (NINS) were involved in this study. All cases of CSF rhinorrhea admitted into the above mentioned hospitals were our study population. Patients were selected based on our inclusion and exclusion criteria. A purposive sampling technique was used.

Inclusion criteria:

i) Patients of all ages and genders with CSF rhinorrhea who did not respond to sufficient conservative treatment; and

ii) Patients willingly wanted to participate in the study.

Exclusion criteria:

i) Patients who had neoplasms or space occupying lesions in the nose, sinus, skull base, or brain;

ii) Patients with a recent history of meningitis within the past eight weeks;

iii) Patients suffering from allergic rhinitis or other forms of rhinosinusitis; and

iv) Patients who are unwilling to comply with the study protocol.

Upon admission, a detailed history was taken, followed by thorough general, ENT, systemic examinations, and relevant investigations. The diagnosis and identification of the leakage site were prioritized, starting with nasoendoscopy. Preoperative HRCT scans with bony windows were performed for all cases, and T2W MRI was used for selected cases. Cisternography was reserved for cases where CT, MRI, and nasoendoscopy failed to locate the leak. Surgery was done by surgeons who had minimum experience of 5 years to do transnasal endoscopic repair of CSF rhinorrhoea and who were designated as associate professor and professor. Various repair techniques, including underlay, overlay, combined, or bath plug techniques, were considered for treatment. Tissue glue was used for some patients. Merocel and BIPP pack was used as packing material. Lumber drain was given to all the patients of spontaneous leaks and patients with hypertension. Postoperative follow-up occurred at 2 weeks, 1 month, 3 months, 4 months and 6 months with special instructions given to patients. Confounding and outcome variables were documented. Written informed consent was obtained from parents or legal guardians using a prescribed form, and all data were recorded in a pre- structured, pre-tested questionnaire. Operative and follow-up procedures were similarly documented in a structured format.

Following data collection, data input was done. The collected data was assessed for completeness, accuracy, and consistency before analysis. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 26.0 for windows. The normality of the data was checked by the Shapiro-Wilk test. Continuous variables were expressed as mean and standard deviation (SD), while categorical variables were summarized using frequency and percentage. The data were presented in simple ways in tables, graphs and figures.

The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh.

Results

Our study involved 37 participants. Trauma occurred in 45.95% of participants, while 10.81% had iatrogenic causes. Spontaneous rhinorrhea affected 43.24%, and 8.1% had a history of meningitis. Additionally, 48.64% had a chronic condition (Table-I).

Table-I: Clinical characteristics of participants (n=37)

Etiology	Frequency	Percentage
Traumatic	17	45.95
Spontaneous/ idiopathic	16	43.24
Iatrogenic	4	10.81
History of meningitis		
Yes	3	8.10
No	34	91.90
Any chronic condition		
Yes	18	48.64
No	19	51.35

4 patients presented with iatrogenic causes. Among them, 25% were from FESS surgery, 25% were from surgery during juvenile nasopharyngeal angiofibroma, 25% from septoplasty surgery and 25% from surgery on advanced sinonasal malignancy (Table-II). The most common site of leakage, as identified through CT scans, was the cribriform plate, which accounted for 43.2% of cases, followed by the sphenoid sinus (27.0%). Smaller leaks (<1 cm²) were observed in 67.6% of cases, and encephaloceles were present in 16.2% of subjects (Table-III). Most of the patients (56.8%) received fascia lata with fat and septal cartilage as graft material and 2.7% using only fat. The combined surgical method was most common (59.5%), followed by underlay (24.3%), overlay (13.5%), and bath plug (2.7%). Tissue glue was used in 54.1% of surgeries. Merocel packing was used in 62.2% of cases, BIPP in 37.8% and the mean duration of pack was 5.49 days (Table-IV).

Table-II: Distribution of participants according to iatrogenic causes (n=37)

Iatrogenic causes	Frequency	Percentage
Due to FESS	1	25
Due to surgery on juvenile nasopharyngeal angiofibroma	1	25
Due to septoplasty	1	25
Due to surgery on advanced sinonasal malignancy	1	25

Table-III: CSF leak characteristics of the patients (n=37)

Variables	Frequency	Percentage
Site of leak (CT scan)		
Cribriform plate	16	43.2
Fovea ethmoidalis	8	21.6
Lateral lamella	2	5.4
Sphenoid sinus	10	27.0
Frontal sinus	1	2.7
Leakage size		
<1 cm square	25	67.6
>1 cm square	12	32.4
Encephalocele		
Present	6	16.2
Absent	31	83.8

Table-IV: Surgical technique, graft materials, tissue glue, and nasal pack related information (n=37)

Variables	Frequency	Percentage
Graft material used		
Fascia lata + fat	15	40.54
Fascia lata +fat+ septal Cartilage	21	56.80
Fat	1	2.70
Surgical technique		
Underlay	9	24.3
Overlay	5	13.5
Combined	22	59.5
Bath plug	1	2.7
Use of tissue glue		
Yes	20	54.1
No	17	45.9
Pack use		
Merocel pack	23	62.2
BIPP pack	14	37.8
Duration of the pack		
Mean±SD	5.59±1.04 days	
Median (min-max)	5 (3-7) days	

45.9% patients received lumbar drains. The mean duration of using drain was 5.47 days, with a median of 5 days (range 5-7). The overall mean post-hospital stay was 7.38 days, with a median of 7 days (range 5–9) (Table-V). Postoperative outcomes were evaluated over six months. By the end of three, four, and six months, 89.2% of the patients experienced successful repair, indicating a high success rate for the procedure. Conversely, 10.8% of the patients faced failure in the repair process (Table-VI).

Table-V: Use of lumber drain and hospital stay (n=37)

Variables	Frequency	Percentage
Lumbar drain		
Given	17	45.90
Not given	20	54.10
Duration of lumber drain		
Mean±SD	5.47±0.874 days	
Median (min-max)	5 (5-7) days	
Hospital stay		
Mean ±SD	7.38±1.32 days	
Median (min-max)	7 (5-9) days	

Table-VI: Postoperative outcomes of endoscopic repair of CSF rhinorrhoea (n=37)

Outcomes	After 2 weeks Frequency (Percentage)	After 1 month Frequency (Percentage)	After 3 months Frequency (Percentage)	After 4 months Frequency (Percentage)	After 6 months Frequency (Percentage)
Anosmia	16 (43.2)	9 (24.3)	-	-	-
Nasal oedema	10 (27.03)	6 (16.23)	2 (5.4)	-	-
Synechia	2 (5.4)	1 (2.7)	-	-	-
Crusting	33 (89.19)	20 (54.05)	1 (2.7)	1 (2.7)	-
Successful repair	37 (100)	37 (100)	33 (89.2)	33 (89.2)	33 (89.2)
Failure	-	-	4 (10.8)	-	-

Discussion

In the present study, 4 patients (89.2%) showed recurrence of CSF leakage at 6 months follow-up. A study done by Virk *et al.* showed similar success rate[20], while several studies showed a higher success rate.[8,21-27] However, Schoentgen *et al.*[28] reported a lower success rate.

In another study conducted by Ghosh *et al.*[14] revealed that patients were monitored postoperatively at one month and six months. At the one-month mark, a recurrence of cerebrospinal fluid (CSF) leakage was observed in 4.76% of patients. By the six-month follow-up, the recurrence rate had increased to 14.28%. Consequently, 85.72% of the patients in this series were considered free from recurrence at the six-month evaluation. In this study, CT scans revealed that the cribriform plate (43.2%) and sphenoid sinus (29.7%) were the most frequent leak sites. The majority of leaks was smaller than 1 cm² (67.6%). Preoperative radiological methods adopted by Patel, Gugliani & Vishwakarma[29] stated that the defect sizes as follows: less than 0.5 cm in 8 cases (6.7%), between 0.6 and 1.0 cm in 19 cases (16.2%), between 1.1 and 1.5 cm in 33 cases (28%), between 1.6 and 2.0 cm in 37 cases (31.3%), and between 2.1 and 2.5 cm in 21 cases (17.7%). The sites of the CSF leaks were primarily from the cribriform plate in 48 cases (41%), followed by the sphenoid sinus in 37 cases (31%), the frontal sinus in 23 cases (19%), and the ethmoid sinus in 10 cases (9%). Baban *et al*.[5] showed that out of 21 patients, 16 patients had leak size (<1 cm^2), while 5 patients had leak size (>1 cm^2). The majority of site of leakage was in sphenoid sinus 11 (52.4%), followed by cribriform plate 6 (28.6%), fovea ethmoidalis 2 (9.5%) and lateral lamella 2 (9.5%). Dissanayake & Dayasena[21] revealed that cribiform plate and sphenoid were the most common sites of leaks, representing 37.9% each, while Bubshait & Almomen[22] revealed that the sites of CSF leak were vary with eight cases (14%) involving frontal bone, roof of ethmoid 14(25%), cribriform plate 22(39%) and sphenoid sinus walls 12(21%).

In this study the most common graft materials were fascia lata and fat (56.8%), followed by fascia lata and fat (40.54%). The combined surgical technique was used in 59.5% of cases, followed by the underlay technique (24.3%). Singh, Kumar & Grewal[30] used a common combination being fat, middle turbinate (MT) mucosa, and septal bone, which was used in 50% of the cases. Other combinations included fat, MT mucosa with inferior turbinate mucosa (13%), fat, MT mucosa with septal cartilage (13%), and fat with septal mucosa and fibrin glue (25%). while Bubshait & Almomen[22] used underlay/inlay grafts in 16 patients, overlay/onlay grafts in 14 patients, and multilayered grafts and flaps in 31 patients. Baban *et al.*[5] used combined fascia lata graft and nasoseptal flap in 57.1% patients, in 23.8% patients by mucoperiosteal flap of the middle turbinate, 9.5% by only fascia lata and in 9.5% a pedicled septal flap was utilized.

In this study, the postoperative follow-up was given at 2 weeks, 1 month, 3 months, 4 months and 6 months. Anosmia, nasal edema, synechia and crusting were the most common complications, which decreased over time. The overall mean post-hospital stay was 7.38 days. According to Singh, Kumar & Grewal,[30] the mean follow-up period was 12 months. Hospital stay in most cases (75%) was less than 2 weeks and in 25% of patients it was up to 4 weeks. Bubshait & Almomen[22] reported their postoperative follow-up period ranged from one to ten years, averaging three years. The average hospitalization duration was 6.5

days, with a median stay of four days. However, in our country limited resources may hamper longer follow-up and observation.

Tissue glue was used in 54.1% of surgeries, and Merocel nasal packing was the most common choice (62.2%). Mean duration of the pack was 5.59 days. Keshri *et al.*[31] used tissue glue in all of their 43 cases (satisfactory outcome was 95.3%). Ishfaq *et al*.[8] employed tissue glue in their 40 patients followed by nasal packing which showed 90% successful outcome. Patel, Gugliani & Vishwakarma[29] used fibrin glue or tissue glue in 118 patients, which was further supported by nasal packing. The average duration for nasal pack was 4 days. Similar to our study, Grover *et al*.[6] kept nasal pack up to 5-7 days at postoperative unit. In this study, most of the cases were traumatic (45.90%) and idiopathic (43.24%), followed by surgical trauma (10.80%). Dissanayake & Dayasena[21] revealed that 31% patients reported history of trauma, whereas the remaining 69% experienced spontaneous CSF rhinorrhoea. Bubshait & Almomen, 2021) reported the CSF leaks were caused by trauma in 30 cases and occurred spontaneously in 26 cases. Among the female patients, 21 (70%) experienced spontaneous CSF leaks. Patel, Gugliani & Vishwakarma[29] identified the causes of cerebrospinal fluid (CSF) leaks as traumatic in 52% cases, iatrogenic following endoscopic nasal surgery in 23%, idiopathic in 19%, and due to an intracranial tumor in 6%. In this study, lumber drain was given to 17 patients (45.9%). The mean duration of lumber drain was 5.47±0.874 days. Similar report was found in the study done by Wahiduzzaman *et al.*[32] in one of the institutions we explored. Keshri *et al.*[31] used lumber drain in 23 patients out of 43 patients, while Singh, Kumar & Grewal[30] used lumber drain in 3 patients out of 8.

Conclusion

The study on cerebrospinal fluid rhinorrhea repair through endoscopic surgery revealed several significant findings at two weeks, one month, three months, four months, and six months. Clinical characteristics such as a history of the presence of meningitis and chronic conditions like constipation were strongly associated with failures, while smaller CSF leaks (<1cm²), Cribriform plate leaks and the absence of encephalocele contributed to successful outcomes. Surgically, the combined technique was most effective, yielding a 66.7% success rate without failures, whereas the overlay technique exhibited a 75% failure rate. The use of fascia lata with fat and cartilage, the most common graft material, did not significantly impact success or failure rates, though the use of perioperative tissue glue and longer packing durations were linked to better outcomes. Post-operatively, the use of lumbar drains and the duration of hospital stay did not significantly affect healing rates. Overall, while the majority of patients had successful repairs, failure rates increased slightly over time, particularly in cases with a history of preoperative meningitis, chronic conditions, sphenoid sinus leaks, larger leaks, the presence of encephalocele, overlay surgical technique, not using tissue glue and in those with shorter duration of pack. To better capture long-term outcomes and potential complications, future studies should consider extending the follow-up period beyond six months, allowing for a more thorough assessment of surgical success and failure over time.

References

1. *Watkinson JC, Clarke RW. Scott-Brown's Otorhinolaryngology and Head and Neck Surgery. 8th ed. Boca Raton: Taylor & Francis. 2008.*
2. *Daudia A, Biswas D, Jones NS. Risk of meningitis with cerebrospinal fluid rhinorrhea. Ann Otol Rhinol Laryngol. 2007;116(12):902-5.*
3. *Dalgic A, Okay HO, Gezici AR, Daglioglu E, Akdag R, Ergungor MF. An effective and less invasive treatment of post-traumatic cerebrospinal fluid fistula: closed lumbar drainage system. Minim Invasive Neurosurg. 2008;51(3):154-7.*
4. *Dandy WE. Pneumocephalus (intracranial pneumatocele or aerocele). Arch Surg. 1926;12(5):949-82.*
5. *Baban MI, Shareef DJ, Hadi SJ, Shawkat A, Castelnuovo P. Outcomes of transnasal endoscopic repair of cerebrospinal fluid leaks: a prospective cohort study. Egypt J Otolaryngol. 2022;38:61.*
6. *Grover M, Singhal P, Singh SN, Sharma MP, Jain A. Transnasal endoscopic cerebrospinal fluid rhinorrhea repair: our experience of 35 cases. Int J Clin Rhinol. 2014;7(2):47-51.*
7. *Oles K, Skladzien J, Leszczynska J. Transnasal endoscopic treatment of cerebrospinal fluid leaks: 10 years' experience. B-ENT. 2013;9(3):201-6.*
8. *Ishfaq M, Abbas T, Akmal M, Choudhry N, Hassan AU, Afzal O, et al. Outcome of endoscopic repair of CSF rhinorrhea with endonasal endoscopic approach in terms of success of repair. Pak J Neurol Surg. 2019;23(4):257-63.*
9. *Hayashi Y, Iwato M, Kita D, Fukui I. Spontaneous cerebrospinal fluid leakage through fistulas at the clivus repaired with endoscopic endonasal approach. Surg Neurol Int. 2015;6:106.*
10. *Majhi S, Sharma A. Outcome of endoscopic cerebrospinal fluid rhinorrhoea repair: an institutional study. Indian J Otolaryngol Head Neck Surg. 2019;71(1):76-80.*
11. *Psaltis AJ, Schlosser RJ, Banks CA, Yawn J, Soler ZM. A systematic review of the endoscopic repair of cerebrospinal fluid leaks. Otolaryngol Head Neck Surg. 2012;147(2):196-203.*
12. *Castelnuovo P, Mauri S, Locatelli D, Emanuelli E, Delù G, Giulio GD. Endoscopic repair of cerebrospinal fluid rhinorrhea: learning from our failures. Am J Rhinol. 2001;15(5):333-42.*
13. *Manandhar S, Meghanadh KR, Reddy NVR. Endoscopic repair of cerebrospinal fluid (CSF) rhinorrhea with multilayer grafts. Birat J Health Sci. 2021;6(1):1291-7.*
14. *Ghosh SK, Kundu I, Singh MK, Chakraborty R, Banerjee S. Endoscopic repair of spontaneous CSF rhinorrhoea: results from 21 cases. Bengal J Otolaryngol Head Neck Surg. 2020;28(1):71-5.*
15. *Sarkar A, Sharma N. Spontaneous CSF rhinorrhea: our experience. Indian J Otolaryngol Head Neck Surg. 2016;68(1):126-9.*
16. *Saleem M, Ur Rehman N, Khan R, Alamgir A, Bibi S, Ahmad H. Transnasal endoscopic surgical repair of cerebrospinal fluid (CSF) rhinorrhea by inferior turbinate grafts. J Rawalpindi Med Coll. 2021;25(3):409-13.*
17. *Yamaguchi T, Sakamoto T, Miwa T, Tabu H, Kanemaru SI. Diagnosis of spontaneous cerebrospinal fluid rhinorrhea using thin-slice computed tomographic images with multiplanar reconstruction and three-dimensional virtual view endoscopy. Cureus. 2022;14(7):e26868.*
18. *Kirtane MV, Gautham, K, Upadhyaya SR. Endoscopic CSF rhinorrhea closure: our experience in 267 cases. Otolaryngol Head Neck Surg. 2005;132(2):208-12.*
19. *Bateman N, Jones NS. Rhinorrhoea feigning cerebrospinal fluid leak: nine illustrative cases. J Laryngol Otol. 2000;114(6):462-4.*
20. *Virk JS, Elmiyeh B, Stamatoglou C, Saleh HA. Optimising outcomes in the management of spontaneous cerebrospinal fluid rhinorrhoea. Rhinology. 2013;51(3):268-74.*
21. *Dissanayake S, Dayasena RP. Is endoscopic repair a successful method in the treatment of CSF rhinorrhoea? a retrospective study. Ceylon J Otolaryngol. 2017;6(1):5-11.*

22. *Bubshait RF, Almomen AA. The endonasal endoscopic management of cerebrospinal fluid rhinorrhea. Cureus. 2021;13(2):e13457.*

23. *Sharma D, Singh D, Sinha S, Srivastva A, Singh H, Jagetia A, et al. CSF rhinorrhea: an overview of endoscopic repair. Indian J Neurotrauma. 2010;7(2):157-62.*

24. *Lindstrom DR, Toohill RJ, Loehrl TA, Smith TL. Management of cerebrospinal fluid rhinorrhea: the Medical College of Wisconsin experience. The Laryngoscope. 2004;114(6):969-74.*

25. *Singh R, Hazarika P, Nayak DR, Balakrishnan R, Hazarika M, Singh A. Endoscopic repair of cerebrospinal fluid rhinorrhea – Manipal experience. Indian J Otolaryngol Head Neck Surg. 2009;61(1):14-8.*

26. *Banks CA, Palmer JN, Chiu AG, O'Malley BW, Woodworth BA, Kennedy DW. Endoscopic closure of CSF rhinorrhea: 193 cases over 21 years. Otolaryngol Head Neck Surg. 2009;140(6):826-33.*

27. *Lee T, Huang C, Chuang C, Huang S. Transnasal endoscopic repair of cerebrospinal fluid rhinorrhea and skull base defect: ten year experience. Laryngoscope, 2004;114(8):1475-81.*

28. *Schoentgen C, Henio PL, Godey B, Jegoux F. Management of post- traumatic cerebrospinal fluid (CSF) leak of anterior skull base: 10 years' experience. Acta Oto-Laryngologica. 2013;133(9):944-50.*

29. *Patel K, Gugliani A, Vishwakarma R. Endoscopic cerebrospinal fluid leak repair: how we do it. Int J Otorhinolaryngol Head Neck Surg. 2019;5(4):965.*

30. *Singh A, Kumar N, Grewal SS. Trans-nasal endoscopic repair of cerebrospinal fluid rhinorrhoea: a retrospective analysis. Int J Otorhinolaryngol Head Neck Surg. 2018;4(6):1372.*

31. *Keshri A, Jain R, Manogaran RS, Behari S, Khatri D, Mathialagan A. Management of spontaneous CSF rhinorrhea: an institutional experience. J Neurol Surg B Skull Base. 2019;80(5):493-9.*

32. *Wahiduzzaman M, Hossain A, Talukder MHR, Ali MI, Tarafder F, Tarafder KH, et al. Endoscopic Transnasal repair of cerebrospinal fluid leakage: experience in BSMMU. Mymensingh Med J. 2024;33(1):192-7.*