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The efficacy of endoscopic endonasal duraplasty compared to transcranial duraplasty for post-traumatic CSF rhinorrhea in terms of CSF rhinorrhea recurrence and other complications. A prospective cohort study from a low-middle-income country

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Keywords
traumatic brain injury, CSF rhinorrhoea, dura mater, endoscopy, craniotomy, developing countries

ABSTRACT

Objectives. To determine the efficacy of endoscopic endonasal dura repair versus transcranial dura repair for post-traumatic CSF rhinorrhoea in terms of CSF rhinorrhea recurrence and other complications.

Materials and methods. A total of 92 patients (age 15-50 years, both genders) with an established diagnosis of CSF rhinorrhea following traumatic brain injury were enrolled in this prospective cohort study. Group A and Group B were formed from the patients. Group A received endoscopic endonasal duraplasty, while Group B received transcranial duraplasty. Recurrence of CSF rhinorrhea, as well as any other complications (meningitis, anosmia, hydrocephalus, and abscess), were noted and compared between the two groups one week, two weeks, and four weeks after the procedure.

Results. In Group A, the mean age was 28.6 ± 9.9 SD years and in Group B it was 29.9 ± 8.6 SD years. In group A, there were 63% (n=29/46) patients who had age between 15-30 years and 37% (n=17/46) had age between 31-50 years. In group B, 52.2% (n=24/46) patients had age between 15-30 years and 47.8% (n=22/46) had age between 31-50 years. In group A, there were 82.6% (n=38/46) males and 17.4% (n=8/46) were females and in group B there were 87% (n=40/46) males and 13% (n=6/46) females. At one month follow-up, overall recurrence of rhinorrhea was observed in 17.4% (n=8/46) patients in Group A, while it was 41.3% (n=19/46) patients in Group B (P=0.012). On the other hand, overall complications were 8.7% (n=21/46) in Group A patients, while they were 45.7% (n=21/46) in Group B patients (P=0.001).

Conclusions. During a one-month follow-up, patients who received endoscopic repair experienced fewer recurrences and other complications overall than patients who underwent transcranial duraplasty, and the difference was statistically significant. We advise conducting studies with a larger sample size and longer follow-up periods.

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Introduction

Cerebrospinal fluid (CSF) rhinorrhea is defined as the leakage of CSF from the nose as a result of communication with the subarachnoid space.[1] It entails removing all of the barriers that separate the subarachnoid space from the upper aerodigestive tract, including the nasal cavity or paranasal sinus mucosa, skull base (i.e., bone), dura mater, and subarachnoid membrane.[2] Accidental trauma is responsible for 70-80% of CSF rhinorrhea.[3] More than half of the leaks are discovered within the first two days, 70% within the first week, and nearly all within the first three months.[4] The most commonly presenting sign is unilateral watery nasal discharge following skull base trauma.[5] Patients may also present with altered mental status, seizures, or meningitis, necessitating a high level of suspicion for an accurate diagnosis.[6]

The treatment can be either conservative or surgical. Early surgical repair is critical to avoid the risk of ascending infection.[7] Early surgical repair (within 7 days) appears to reduce the risk of meningitis.[8] Neurosurgeons have traditionally repaired these lesions via a transcranial approach.[1] According to reports, the endoscopic endonasal approach is much safer than the transcranial approach and is well tolerated.[4] It has gained widespread acceptance as the preferred technique due to its superior visualisation, exact graft placement, minimal harm to the surrounding tissue, preservation of olfactory function in the event of a fistula leak through the cribriform plate, shortened operating time, and quicker recovery time.[1]

According to published data, the endoscopic endonasal approach results in significantly less recurrence of CSF rhinorrhea. Given the high morbidity rate associated with open craniotomy, such as brain retraction, olfactory nerve injury, anosmia, abscess/wound infection, sepsis, and recurrence, an endoscopic endonasal approach is preferable. Furthermore, the shorter hospital stay and return of functional independence associated with endoscopic endonasal surgery have made it the method of choice for CSF rhinorrhea repair. In our study, patients who had endoscopic repair had fewer overall recurrences and other complications than patients who underwent transcranial duraplasty during a one-month follow-up.

Materials and methods

Study design: A prospective cohort study

Setting: Department of Neurosurgery, Pakistan Institute of Medical Sciences, Islamabad, Pakistan.

Study duration: 3 years (30-07-2017 to 29-07-2020)

Sample size: It was calculated by World Health Organization (WHO) sample size calculator while keeping the parameters as: 5% level of significance and 80% power of test. The sample size turned out to be 46 patients in each group and a total of 92 patients were included in the study.

Sampling technique: Non-probability based consecutive sampling technique.

Sample selection

a) Inclusion criteria

- CSF rhinorrhea following traumatic brain injury
- Age: 15-50 years

b) Exclusion criteria

- CSF rhinorrhea with concomitant otorrhea
- Redo surgeries
- Acute infections
- Severe deviated nasal septum (DNS)
- Pregnant woman

Data collection procedure

Following approval from the hospital's ethical committee, the study was launched. The study included patients admitted to the Neurosurgery ward who had CSF rhinorrhea as a result of traumatic brain injury as evidenced by clinical examination, Computed Tomography (CT) scan skull with 3D reconstruction, and Magnetic Resonance Imaging (MRI) brain T2 weighted images with coronal cuts. Each study participant provided written informed consent. On pre-designed performa, initial data such as age, gender, contact number, and date of admission were recorded. Group A and Group B were formed from the patients. Group A received endoscopic endonasal duraplasty, while Group B received transcranial duraplasty. Any complications with any of the procedures were documented.

Surgical technique for endoscopic duraplasty

After baseline investigations, imaging, necessary blood products, and pre-anaesthetic evaluation, the patient was shifted to the operating room with informed written consent. Preoperative nasal

preparation was performed to clean the nasal cavity and prevent perioperative nasal bleeding. Eight hours before surgery, cotton gauze soaked in a 2% adrenaline/lignocaine/antibiotic mixture was placed inside each nostril. The surgical field was cleaned and draped after the patient was put under general anaesthesia. The procedure began with locating the source of the leak. A partial middle turbinectomy was performed to widen the surgical corridor and to use the bone as a graft in multilayer repair. To prepare the area for grafting, the mucoperiosteum around the defect was removed. Depending on the size, location, and aetiology of the defect, a multilayer (sandwich grafting) reconstruction was performed using some or all of the following 5 layers. The first layer is a fat plug harvested from the anterior aspect of the thigh, the second layer is a fascia layer with fascia lata tucked beneath the bony edge, the third layer is bone harvested from the middle turbinate or nasal septum, the fourth layer is fascia lata overlay graft over defect, and the fifth layer is free mucoperiosteal fat or vascularized nasoseptal flap or middle turbinate flap. The nose was then packed with a water-filled catheter and left for 3-4 days after surgery. At one week, two weeks, and four weeks, CSF rhinorrhea was noted if it occurred at all.

Surgical technique for transcranial duraplasty

Bicoronal or unilateral subfrontal approaches were used to accomplish transcranial intradural repairs. All patients underwent preoperative standard investigations to get them ready for surgery, and their general anaesthesia readiness was assessed. The patient was moved to the operating room and placed in the supine position. After making the appropriate hairline incisions, the patients who required a wide exposure underwent a bicoronal approach, while the remaining patients underwent a unilateral approach. Both techniques used the same remaining steps, which included drilling burr holes and elevating the bone flap bilaterally or unilaterally depending on the situation. If necessary, frontal sinuses were cranialized. A linear dural incision was made, the brain was retracted, the CSF was sucked, a cribriform plate defect was found, and a fascia lata graft was applied to cover the defect. Dura was sealed up watertight. The dural hitch stitches were applied, and the bone flap was replaced and secured. Skin was closed in the usual manner and an antiseptic dressing was applied.

Data analysis procedure

Statistical Package for Social Sciences (SPSS) version 23.0 was used to enter and analyse the collected data. For numerical variables such as age, mean and standard deviation were calculated. For categorical variables such as gender and complications, frequency and percentages were presented in both groups. The Chi-square test was used to compare the complication rate between the two groups. P-values of 0.05 were deemed significant.

RESULTS

1. Demography of the selected population

A total of 92 patients (age 15-50 years, both genders) with an established diagnosis of CSF rhinorrhea following traumatic brain injury were enrolled in the study. Group A and Group B were formed from the patients. Group A received endoscopic endonasal duraplasty, while Group B received transcranial duraplasty. Recurrence of CSF rhinorrhea, as well as any other complications, was recorded and compared in both groups one week, two weeks, and four weeks after the procedure. There were 82.6% (n=38/46) males and 14.4% (n=8/46) females in group A, and 87% (n=40/46) males and 13% (n=6/46) females in group B. (Figure. 1 & Table. 1). The mean age in Group A was 28.6 (± 9.9 SD) years, while it was 29.9 (± 8.6 SD) years in Group B (Table. 1). In group A, 63% (n=29/46) of the patients were between the ages of 15 and 30, while 37% (n=17/46) were between the ages of 31 and 50. In group B, 52.2% (n=24/46) of the patients were between the ages of 15 and 30, and 47.8% (n=22/46) were between the ages of 31 and 50 (Figure. 2 & Table. 1).

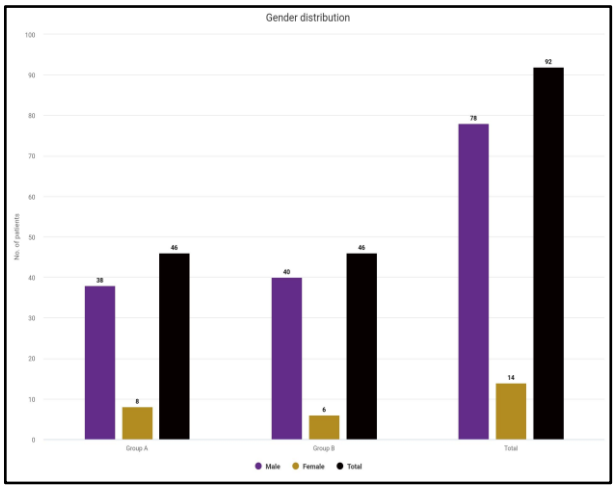

Figure 1. Gender distribution in both the study groups

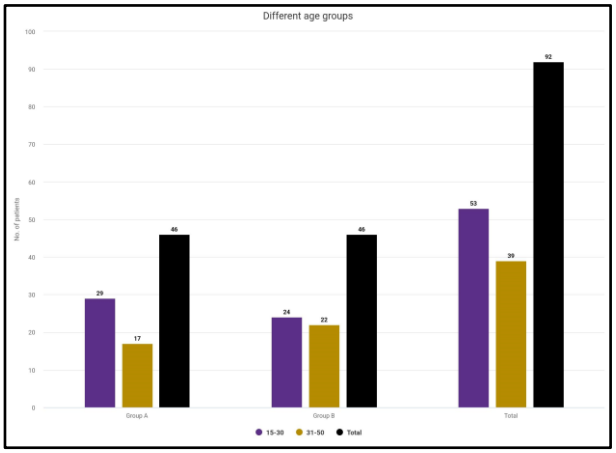

Figure 2. Different age groups in both the study groups

2. Outcomes of therapy:

a. At one week

Recurrence of rhinorrhea was observed in 10.9% (n=5/46) patients in Group A, while it was 19.6% (n=9/46) in Group B patients. Although the recurrence rate was lower in patients who underwent endoscopic repair, yet the difference was not statistically significant (P=0.246) (Table. 2). Overall complications were observed in 6.5% % (n=3/46) patients in Group A, while they were observed in 32.6% (n=15/46) patients in Group B. The complication rate was lower in patients who underwent endoscopic repair and the difference was statistically significant (P=0.006). The most frequent complication was hydrocephalus (4.3%) followed by meningitis (2.2%) in group A, while the most frequent one in group B was anosmia (8.7%) followed by meningitis (6.5%) (Table. 2).

b. At two weeks

Recurrence of rhinorrhea was observed in 13% (n=6/46) patients in Group A, while it was 6.5% (n=3/46) in Group B patients (P=0.292) (Table. 3). Overall complications were observed in 2.2% (n=1/46) patients in Group A, while they were observed in 6.5% (n=3/46) patients in Group B. Although the complication rate was lower in patients who underwent endoscopic repair, yet the difference was not statistically significant (P=0.360). The most frequent complication was meningitis (2.2%) in group A, while in group B it was hydrocephalus (4.3%) and meningitis (2.2%) (Table. 3).

c. At four weeks

Recurrence of rhinorrhea was observed in 0% (n=0/46) patients in Group A, while it was 4.5% (n=4/46) in Group B (P=0.041) (Table. 4). Overall complications were 0% (n=0/46) in Group A, while they were 6.5% (n=3/46) in Group B (P=0.060) (Table. 4). The most frequent complication was abscess (6.5%) in group B at four weeks.

d. Overall recurrence and other complications rate during one-month follow-up

During one month follow-up, recurrence of rhinorrhea was observed in 17.4% (n=8/46) patients in Group A, while it was observed in 41.3% (n=19/46) patients in Group B. The recurrence rate was lower in patients who underwent endoscopic repair and the difference was statistically significant (P=0.012) (Table. 5). During one month of follow-up, complications were observed in 8.7% (n=4/46) patients in Group A, while they were observed in 45.7% (n=21/46) patients in Group B. The complication rate was lower in patients who underwent endoscopic repair and the difference was statistically significant (P=0.001) (Table. 5). Stratification results with reference to gender and age groups for overall recurrence and other complications during one-month follow-up are given in Table. 6 and Table. 7, respectively.

Discussion

CSF leaks can be injurious to brain blood supply and function, as well as increase the risk of direct trauma to the brain parenchyma due to fluid cushion loss. Furthermore, the presence of CSF leak indicates the need for additional evaluation and management to find out the cause. The open communication of the subarachnoid space with CSF leak presents a path for life-threatening central nervous system (CNS) infection, including meningitis. Both intracranial and endoscopic transnasal approaches have been used to treat CSF rhinorrhea with high success rates of 70-100%. When compared to the endoscopic transnasal approach, the morbidity associated with the intracranial approach has been reported to be significantly higher.[8,9,10] We intended to compare the efficacy of endoscopic endonasal dural repair versus transcranial dural repair in this study. A total of 92 adult patients (age 15-50 years, both genders) with a confirmed diagnosis of CSF rhinorrhea after traumatic brain injury were included. The recurrence of CSF rhinorrhea, as well as any other complications, was recorded at one, two, and four weeks after the

procedure and compared between the two groups.

According to published data, the endoscopic endonasal approach results in significantly less recurrence of CSF rhinorrhea. Given the high morbidity rate associated with open craniotomy, such as brain retraction, olfactory nerve injury, anosmia, abscess/wound infection, sepsis, and recurrence, an endonasal endoscopic approach is preferable. Moreover, decreased time of hospital stay, return of functional independence associated with endoscopic endonasal surgery has established itself as the procedure of choice for CSF rhinorrhea repair.[8,9,10] We found similar findings in our study. During one month follow-up, the recurrence (17.4% versus 41.3%, P=0.012) and other complications rate (8.7% versus 45.7%, P=0.001) was significantly lower in patients who underwent endoscopic duraplasty compared to those who underwent transcranial duraplasty. Bhatti SN et al.[9] examined the outcomes of transnasal endoscopic repair for CSF rhinorrhea in a previous study. Twenty-one patients with CSF rhinorrhea who had failed to respond to conservative treatment were included in the study and were operated on transnasally with a rigid endoscope. Over a 9-month follow-up period, the overall success rate was 95% (n=20/21 cases). One patient died as a result of CSF leak and meningitis one month after surgery. The authors concluded that transnasal endoscopic treatment of CSF rhinorrhea was highly effective and safe. Tahir MZ et al.[10] presented 11-year data on the management of CSF rhinorrhea at a tertiary care hospital in Karachi in another study from the local population. The medical records of 43 patients were scrutinised. Eleven of the 43 patients were treated conservatively, 22 had intracranial repairs, and 10 had transnasal endoscopic repairs. They found that the transnasal endoscopic approach has comparable success rates to the intracranial approach while causing significantly less morbidity. Furthermore, a summary of different studies performed in Pakistan regarding the surgical management of CSF rhinorrhea is given in Table. 8. A total of 460 patients including 273 with traumatic cause for CSF rhinorrhoea had been operated on. Endoscopic repair was performed in 223 (49.6%) patients compared to transcranial repair performed in other 232 (50.4%) patients. Recurrence was 7% in the endoscopic cases compared to 7.8% for the transcranial ones. Other complications were 0.44% in the endoscopic cases compared to 20.3% for the transcranial cases.

Christoforidou et al.[11] conducted a prospective study on 18 consecutive patients with CSF leaks who underwent endonasal repair and compared outcomes to a previous cohort of 25 patients who had CSF leaks treated with a craniotomy. The endoscopic group had similar success rates with a significantly lower rate of complications and a shorter length of hospital stay than the craniotomy group. Endoscopic technique was also associated with significantly lower costs and higher patient satisfaction. The authors concluded that an endoscopic approach is the best way to treat CSF leaks in the anterior and middle skull base that are not associated with complex intracranial pathology. However, we did not use cost or patient satisfaction as outcome variables in our study. Komotar RJ et al.[12] assessed the role of endoscopy in the management of CSF rhinorrhea due to traumatic injury in a large systematic review that included 71 studies and 1178 patients. Their combined findings showed that the rate of successful repair was comparable (90%) between the open and endoscopic cohorts. However, when compared to open approaches, the endoscopic group had a significantly lower rate of complications. Meningitis (3.9% versus 1.1%, P=0.034), abscess/wound infection (6.8% versus 0.7%, P=0.001), and sepsis (3.8% versus 0%, P=0.003) were observed as complications.

In summary, the current study's findings and evidence from the literature suggest that an endoscopic endonasal approach is a safe and effective treatment for CSF rhinorrhea caused by traumatic injury. Endoscopic endonasal approach has a success rate comparable to transcranial duraplasty, but with significantly lower recurrence and complication rates. Due to the difficulty of randomization and ethical concerns, there are not many studies comparing the two techniques in the literature. The current study's main strength is its prospective design. There are several limitations to the current study. Firstly, we feel the sample size was relatively smaller yet sufficient to draw the inference. Secondly, the follow-up period (four weeks) was relatively shorter as several studies reported recurrence of CSF rhinorrhea even a year after the surgery. Furthermore, we did not account for other variables such as procedure duration and hospital stay duration in both groups. The other variables that we did not investigate in this study were patient

satisfaction and the overall cost of both procedures. We recommend larger sample size studies with longer follow-up periods. We also propose future studies that take into account other variables such as procedure duration, length of hospital stay, overall cost incurred, and patient satisfaction. Several studies have been conducted using various graft materials for endoscopic repair; we believe this is an area for future research.

Conclusions

During a one-month follow-up, patients who underwent endoscopic repair had a lower recurrence and other complications rate than those who underwent transcranial duraplasty, and the difference was statistically significant. We recommend studies with larger sample sizes and longer follow-up periods. We also propose future studies that take into account other variables such as procedure duration, length of hospital stay, overall cost incurred, and patient satisfaction.

Table. 1. Different parameters in both the study groups

Parameters		Groups		Total
		A	B	
Gender	Male	38 (82.6%)	40 (87%)	78 (84.8%)
	Female	8 (14.4%)	6 (13%)	14 (15.2%)
Total no. of patients		46 (100%)	46 (100%)	92 (100%)
Mean age ± SD (years)		28.6 ± 9.9	29.9 ± 8.6	-
Age groups (years)	15-30	29 (63%)	24 (52.2%)	53 (57.6%)
	31-50	17 (37%)	22 (47.8%)	39 (42.4%)

Table. 2. Recurrence and complications at one week in both the study groups

At one week		Groups		Total	P-value Chi-square
		A	B		
Recurrence	Present	5 (10.9%)	9 (19.6%)	14 (15.2%)	0.246
	Absent	41 (89.1%)	37 (80.4%)	78 (84.8%)	
	Total	46 (100%)	46 (100%)	92 (100%)	
Complications	Meningitis	1 (2.2%)	5 (10.9%)	6 (6.5%)	0.006
	Anosmia	0 (0%)	8 (17.4%)	8 (8.7%)	
	Hydrocephalus	2 (4.3%)	2 (4.3%)	4 (4.4%)	
	None	43 (93.5%)	31 (67.4%)	74 (80.4%)	
	Total	46 (100%)	46 (100%)	92 (100%)	

Table. 3. Recurrence and complications at two weeks in both the study groups

At two weeks		Groups		Total	P-value Chi-square
		A	B		
Recurrence	Present	3 (6.5%)	6 (13%)	9 (9.8%)	0.292
	Absent	43 (93.5)	40 (87%)	83 (90.2%)	
	Total	46 (100%)	46 (100%)	92 (100%)	
Complications	Meningitis	1 (2.2%)	1 (2.2%)	2 (2.2%)	0.360
	Hydrocephalus	0 (0%)	2 (4.3%)	2 (2.2%)	
	None	45 (97.8%)	43 (93.5%)	88 (95.6%)	
	Total	46 (100%)	46 (100%)	92 (100%)	

Table. 4. Recurrence and complications at four weeks in both the study groups

At four weeks		Groups		Total	P-value Chi-square
		A	B		
Recurrence	Present	0 (0%)	4 (8.7%)	4 (4.3%)	0.041
	Absent	46 (100%)	42 (91.3%)	88 (95.7%)	
	Total	46 (100%)	46 (100%)	92 (100%)	
Complications	Abscess	0 (0%)	3 (6.5%)	3 (3.3%)	0.06
	None	46 (100%)	43 (93.5%)	89 (96.7%)	
	Total	46 (100%)	46 (100%)	92 (100%)	

Table. 5. Overall recurrence and complications during one month follow-up

During one month follow-up		Groups		Total	P-value Chi-square
		A	B		
Overall recurrence	Present	8 (17.4%)	19 (41.3%)	27 (29.3%)	0.012
	Absent	38 (82.6%)	27 (58.7%)	65 (70.7%)	
	Total	46 (100%)	46 (100%)	92 (100%)	
Overall complications	Present	4 (8.7%)	21 (45.7%)	25 (27.2%)	0.001
	Absent	42 (91.3%)	25 (54.3%)	67 (72.8%)	
	Total	46 (100%)	46 (100%)	92 (100%)	

Table. 6. Overall recurrence rate during one month follow-up (stratification with reference to gender and age groups)

Variables	Overall recurrence during one month follow-up	Groups		Total	P-value Chi-square
		A	B		
Male	Present	6 (15.8%)	15 (37.5%)	21 (26.9%)	0.031
	Absent	32 (84.2%)	25 (62.5%)	57 (73.1%)	
Female	Present	2 (25%)	4 (66.7%)	6 (42.9%)	0.119
	Absent	6 (75%)	2 (33.3%)	8 (57.1%)	
15-30 years	Present	5 (17.2%)	9 (37.5%)	14 (26.4%)	0.096
	Absent	24 (82.8%)	15 (62.5%)	39 (73.6%)	
31-50 years	Present	3 (17.6%)	10 (45.5%)	13 (33.3%)	0.041
	Absent	14 (82.4%)	12 (54.5%)	26 (66.7%)	

Table. 7. Overall complication rate during one month follow-up (stratification with reference to gender and age groups)

Variables	Overall complications during one month follow-up	Groups		Total	P-value Chi-square
		A	B		
Male	Present	4 (10.5%)	21 (52.5%)	25 (32.1%)	0.001
	Absent	34 (89.5%)	19 (47.5%)	53 (67.9)	
Female	Present	0 (0%)	0 (0%)	0 (0%)	1.0
	Absent	8 (100%)	6 (100%)	14 (100%)	
15-30 years	Present	3 (10.3%)	11 (45.8%)	14 (26.4%)	0.004
	Absent	26 (89.7%)	13 (54.2%)	39 (73.6%)	
31-50 years	Present	1 (5.9%)	10 (45.5%)	11 (28.2%)	0.006
	Absent	16 (94.1%)	12 (54.5%)	28 (71.8%)	

Table. 8. Summary of different studies performed in Pakistan regarding surgical management of CSF rhinorrhea

S. no.	Authors	Year	Total no. of patients	Trauma	Endoscopic duraplasty A	Transcranial duraplasty B	Recurrence		Complications	
							A	B	A	B
1	Amin MU and Ghaffar A[13]	2006	1	1	-	1	-	0	-	0

2	Bhatti SN et al.[9]	2011	21	16	21	-	2	-	0	-
3	Tahir MZ et al.[10]	2011	32	11	10	22	3	3	NA	NA
4	Farooq MU and Ansar MA[14]	2011	23	17	23	-	1	-	0	-
5	Akhter S et al.[15]	2012	5	1	5	-	0	-	0	-
6	Aurangzeb A et al.[16]	2012	27	23	-	27	-	1	-	5
7	Khaleeq S et al.[17]	2015	48	48	-	48	-	5	-	10
8	Sheikh F et al.[18]	2015	20	4	20	-	2	-	0	-
9	Amir S et al.[19]	2017	30	30	-	30	-	3	-	10
10	Rahman ZU and Khan MM[20]	2018	60	60	-	60	-	6	-	20
11	Abbas T et al.[21]	2019	40	27	40	-	4	-	0	-
12	Satti SA et al.[22]	2021	14	14	-	14	NA	NA	NA	NA
13	Saleem S et al.[23]	2021	27	11	27	-	2	-	0	-
14	Mahmood K et al.[24]	2021	62	NA	62	-	NA	-	NA	-
15	Simair IA et al.[25]	2021	40	NA	20	20	2	0	1	1
16	Samija S et al.[26]	2022	10	10	-	10	-	NA	-	1
Total			460	273	228 (49.6%)	232 (50.4%)	16 (7.0%)	18 (7.8%)	1 (0.44%)	47 (20.3%)

*NA: not available

List of Abbreviations
CSF: Cerebrospinal fluid
DNS: Deviated nasal septum
CT: Computed Tomography
MRI: Magnetic Resonance Imaging
WHO: World Health Organization
SPSS: Statistical Package for Social Sciences

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