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Original Research

Factors Affecting Success Rates in Endoscopic Repair of CSF Rhinorrhea

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Abstract

Objectives: Our aim in this study is to assess the effect of factors such as age, etiology, defect size, application of lumbar drainage and surgical technique on Cerebrospinal Fluid (CSF) fistula repair success rates.

Methods: The Electronic Medical Records (EMR) system of our clinic was retrospectively reviewed for cases that were operated between 2006 and 2020 for CSF fistula originating from anterior skull base with endoscopic transnasal technique. A total of 35 patients were included in the study. Patients were grouped according to the number of layers used in repair (two, three or four-layered reconstruction) and defect size (smaller than 5 mm, 5 to 10 mm and larger than 10mm), etiology, location of the defect and application of lumbar drainage as LD (+) and LD (-). Complications and CSF leak recurrence were compared between groups.

Results: Recurrence rates in patients who had 2 layered reconstructions were significantly higher compared to patients who had 3 or 4 layered reconstructions (p=0.049). The recurrence rate in LD (+) group (41.7%) was significantly lower compared to LD (-) group (4.3%) (p=0.012). There were no significant difference in recurrence rates between groups in terms of age, defect size, defect location and etiology.

Conclusion: In endoscopic transnasal repair of anterior skull base-derived bos fistulas, planning the reconstruction at least 3 times and applying lumbar CSF drainage increases the success rates.

Keywords: Cerebrospinal fluid fistula, cerebrospinal fluid leak, endoscopic surgery, rhinorrhea

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Cerebrospinal Fluid (CSF) fistula originating from anterior skull base can present with rhinorrhea or recurrent meningitis. Although previously external approaches were preferred for fistula repair, within the last 10 years, endoscopic transnasal route increased in popularity. Endoscopic repair approach has several advantages such as a better view of the surgical field, less trauma to neighboring tissues, preservation of smell, shorter operation time and faster recovery.[1] Success rates of CSF fistula repair with endoscopic approach are high. However, there are studies with variable findings about the effects of factors such as surgical technique, the size of the defect, etiology, and CSF pressure control after the surgery on success rate.[2]

Techniques used to reduce CSF pressure after surgery include head elevation, cough prevention, medications to suppress sneeze reflex, stool softeners and lumbar drainage.[2,3] There are conflicting reports in the literature about the efficacy of lumbar drainage application on surgical

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success.[2-6] The surgical repair techniques include the usage of grafts such as fat, fascia or cartilage and local flaps. Although the common view is that a multilayered repair is crucial, there isn't a consensus about the ideal number of layers needed.[3,6] Our aim in this study is to assess the effect of factors such as age, etiology, defect size, application of lumbar drainage and surgical technique on CSF fistula repair success rates in our clinic.

Methods

The Electronic Medical Records (EMR) system of Sisli Hamidiye Etfal Training and Research Hospital Hospital Otolaryngology Clinic was retrospectively reviewed for cases that were operated between 2006 and 2020 for CSF fistula originating from anterior skull base with endoscopic transnasal technique. Before starting the study, the study was approved by the institutional ethical committee (number: 1840 date: 30.03.2021). Exclusion criteria included missing patient information, patients lost to follow-up, and patients who were previously operated elsewhere. A total of 35 patients were included in the study.

All the included patients had Paranasal Sinus Computerized Tomography (CT) scans with a 1 mm slice thickness uploaded in the system. CT scans were used to establish defect location and measure defect size (Fig. 1). Cisternography with Magnetic Resonance Imaging (MRI) technique was additionally used for patients whose CT scans did not show the defect clearly. All patients with rhinorrhea were diagnosed with CSF leak by measuring beta-2 transferrin levels in rhinorrhea fluid. Patients who did not have rhinorrhea but had a history of recurrent meningitis were diagnosed with showing a skull base defect in CT scans.

All repairs were done by the same senior surgeon. To find the skull base defect during surgery, 1 milliliter of 1 to 10 diluted fluorescein was administered through the drain for patients with lumbar drainage (Fig. 2). Different combinations of fascia lata, fat or septal cartilage grafts and septal mucosal or middle turbinate flaps were used for fistula repair. For that reason, patients were grouped according to the number of layers used in repair rather than the type of reconstruction material used (Fig. 3). For surgical technique, patients were grouped according to the number of layers (two, three or four-layered reconstructions) and defect size (smaller than 5 mm, 5 to 10 mm and larger than 10 mm). Defect size was measured on CT scans as the largest diameter of defect in the skull base. For etiology patients were divided into four groups according to the etiology as iatrogenic, traumatic, idiopathic, or congenital. For the location of the defect, they were grouped as originating from sphenoid sinus, ethmoid roof, or frontal sinus. Finally, patients who had preoperative lumbar drainage applied were grouped as LD (+) and those without lumbar drainage as LD (-). Lumbar drains were removed on the 5th day after surgery for all patients. Complications, rhinorrhea and CSF leak recurrence were also noted.

Patients with a history of head trauma were assumed to be traumatic regardless of the time that symptoms started. Similarly, those with a history of nasal surgery were assumed to be iatrogenic.

Statistical Analysis

SPSS 15.0 for Windows software (SPSS Inc., Chicago, Il, USA) was used for the statistical analysis. Descriptive statistics included numbers and percentages for categorical variables and median and interquartile range for numeric variables. Groups were compared for numerical variables with Student's T test when normality assumptions were met and with Mann-Whitney U test otherwise. For categorical variables, Chi-Squared and Fisher's Exact tests were used. Statistical significance level was determined as $p<0.05$.

Results

A total of 35 patients were included in the study. The youngest patient included in the study was 5 years old, while the oldest was 77. Mean age was 44.26±17.25. Sixteen (45.7%) were male and 19 (54.3%) were female. Etiology was iatrogenic in 10 (28.6%) patients, congenital in one (2.9%) patient, traumatic in 12 (34.3%) patients and idiopathic in 12 (34.3%) patients. Defect location was on ethmoid roof in 28 (80%) patients, on sfenoid roof in 5 (14.3%) patients and in frontal sinus in 2 (5.7%) patients. The size of the defect was less than 5 mm in 15 (42.9%) patients, 5-10 mm in 11 (31.4%) patients and larger than 10 mm in 9 (25.7%) patients. Six (17.1%) patients had 2 layered, 25 (71.4%) patients had 3 layered and 4 (11.4%) patients had four layered repairs. While 23 (65.7%) patients had lumbar drainage during the surgery, 12 (34.3%) did not. After the surgery, 6 (17.1%) patients had rhinorrhea recurrence and 29 (82.9%) did not have a recurrence (Table 1).

The mean age of patients with rhinorrhea recurrence was 32.33±14.26 and of those without recurrence 46.72±16.98. In terms of age, no statistically significant difference was found between groups ($p=0.062$). Two patients with recurrence were female and 4 males. No statistically significant difference was found in terms of gender between groups ($p=0.248$). No recurrence was found in patients with iatrogenic and congenital etiologies but 4 (50%) patients with traumatic and 2 (16.6%) with idiopathic etiologies had recurrence (Table 2). When Fisher's Exact test was conducted, no statistically significant difference was found between

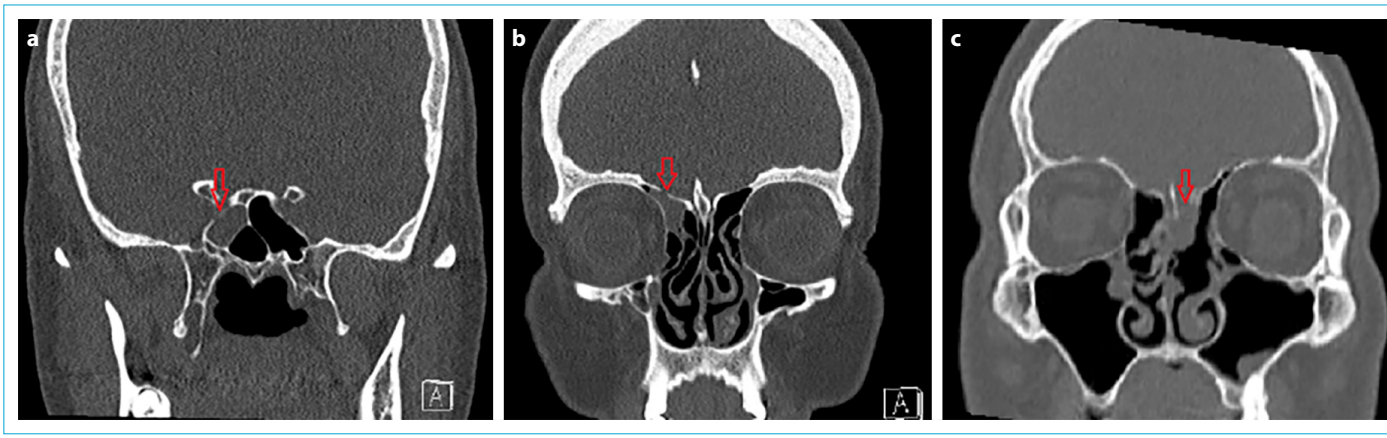

Figure 1. CT scan images of patients had CSF leak. Skull base defects were showed by red arrow. **(a)** Anterior skull base defect placed in sfenoid sinus roof. **(b)** Anterior skull base defect placed in entrance of frontal sinus. **(c)** Anterior skull base defect placed in ethmoid roof.

CT: Computerized tomography, CSF: Cerebrospinal fluid.

groups for recurrence in terms of etiology (p=0.089). Four patients with a defect on ethmoid roof, 1 patient with sphenoid roof defect and 1 patient with a defect in the frontal sinus had recurrence (Table 3). In terms of defect location, no statistically significant difference between groups was found for recurrence rates (p=0.425). Four patients with defect size less than 5mm, 1 patient with defect size between 5 and 10 mm and 1 patient with defect size larger than 10 mm had recurrence (Table 4). No statistically significant difference was found between groups for recurrence in terms of defect size (p=0.429). Three out of 6 patients who had 2 layered reconstructions, 2 out of 25 patients who had 3 layered reconstructions and 1 patient who had 4 layered reconstructions had recurrence (Table 5). Recurrence rates in patients who had 2 layered reconstructions were significantly higher compared to other groups in Fisher's Exact test (p=0.049). While only 1 out of 23 patients with lumbar drainage introduced during surgery had recurrence, 5 out of 12 patients without drainage had recurrence (Table 6). The recurrence rate in LD (+) group was significantly lower compared to LD (-) group (p=0.012). Of note, all the pa-

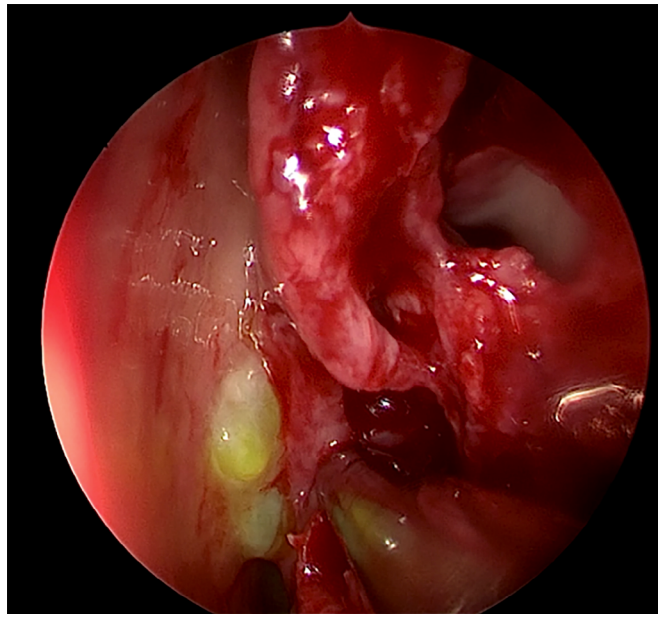

Figure 2. Image of cerebrospinal fluid leak from the ethmoid roof of a patient who was administered fluorescein.

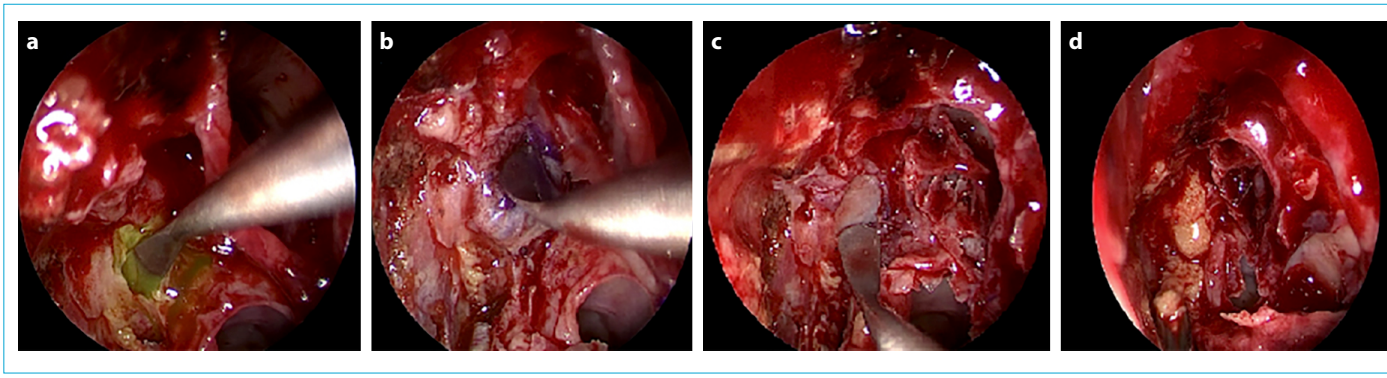

Figure 3. Surgical steps of a patient with three layered repair of anterior skull base defect placed in ethmoid roof. **(a)** Elevation of dura mater and exposure of defect. **(b)** First layer, repair with fascia lata. **(c)** Second layer, repair with cartilage. **(d)** Third layer repair with fat tissue.

Table 1. Demographic data of the patients, etiologic factors, defect size and locations, lumbar drainage status, reconstruction techniques and recurrence rates

	n	%
Age, (mean), (min-max)	44.26±17.25 5-77	
Gender		
Male	16	45.7
Female	19	54.3
Etiology		
Iatrogenic	10	28.6
Congenital	1	2.9
Post-traumatic	12	34.3
Idiopathic	12	34.3
Defect location		
Ethmoid roof	28	80
Sphenoid roof	5	14.3
Frontal sinus	2	5.7
Defect size		
<5mm	15	42.9
5–10 mm	11	31.4
>10mm	9	25.7
Lumbar drainage status		
Positive	23	65.7
Negative	12	34.3
Reconstruction technique		
2-layered	6	17.1
3-layered	25	71.4
4-layered	4	11.4
Recurrence		
Present	6	17.1
Absent	29	82.9

tients who had 2 layered reconstructions without drainage had recurrence. Only 22.2% of patients who had 3 layered reconstructions with drainage had recurrence (Table 7).

Discussion

Endoscopic repair of CSF fistula is an established surgical technique with high success rates.[3,5] Success rates depend on multiple factors. Due to the relatively low incidence of CSF rhinorrhea, standardizing the technique and assessing factors affecting success rates is challenging. In our study, the surgical technique was standardized since all the patients were operated by the same surgeon. On the other hand, factors such as defect size and repair technique were not standardized. Success rates were assessed in terms of defect size, defect location, reconstruction technique, etiology, and presence of CSF drainage. Our success rate for CSF fistula repair of 85.3% is relevant to the current literature. Hegazy et al.[6] reported a 90% success rate of CSF fistula repair in a recent meta-analysis of 14 studies.

Table 2. Recurrence rates according to etiology

Etiology	n	Recurrence		No recurrence	
		n	%	n	%
Iatrogenic	10	0	0	10	100
Idiopathic	12	2	16.7	10	83.3
Congenital	1	0	0	1	100
Post-traumatic	12	4	33.3	8	66.7

Fisher's Exact test p=0.089.

Table 3. Recurrence rates according to the location of the defect

Location	n	Recurrence		No Recurrence	
		n	%	n	%
Ethmoid Roof	28	4	14.3	24	85.7
Sphenoid Roof	5	1	20	4	80
Frontal Sinus	2	1	50	1	50

Chi-Squared test p=0.425.

Table 4. Recurrence rates according to the size of the defect

Defect Size	n	Recurrence		No Recurrence	
		n	%	n	%
<5 mm	15	4	26.7	11	73.3
5 to 10 mm	11	1	9.1	10	90.9
>10 mm	9	1	11.1	8	88.9

Chi-Squared test p=0.429.

Table 5. Recurrence rates according to the number of layers used for reconstruction

Number of layers	n	Recurrence		No Recurrence	
		n	%	n	%
2-layered	6	3	50	3	88.9
3-layered	25	2	8	23	92
4-layered	4	1	25	3	75

Fisher's Exact Test p=0.049.

Table 6. Recurrence rates according to lumbar drainage status

Lumbar drainage	n	Recurrence		No Recurrence	
		n	%	n	%
Used	23	1	4.3	22	95.7
Not Used	12	5	41.7	7	58.3

Fisher's Exact Test p=0.012.

Literature suggests that surgical success rates are lower with spontaneous rhinorrhea and reconstruction without multiple layers. The number of layers preferred for recon-

Table 7. Recurrence rates compared by surgical technique and lumbar drainage status

	Lumbar drainage (+) n=23				Lumbar drainage (-) n=12			
	Recurrence		No Recurrence		Recurrence		No Recurrence	
	n	%	n	%	n	%	n	%
2-layered reconstruction n=6	0	0	3	100	3	100	0	0
3 or more layered reconstruction n=29	1	5	19	95	2	22.2	7	77.7

struction varies between one and 5. Rates of surgery failure according to layers varies in literature. Failure rates vary between 0-20% when only 2-layered reconstruction was preferred and between 0-14% when only 3-layered reconstruction was used.[7-11] Similarly, recurrence rates with 3 or 4-layered reconstructions were significantly lower compared to 2-layered reconstruction in our study as well.

There are conflicting reports about the efficacy of the application of lumbar drainage during CSF fistula surgery – a procedure with inherent risks.[6,7,12-15] There are reports of CSF rhinorrhea control by only using CSF drainage without surgery, especially in traumatic cases.[16,17] In a randomized controlled prospective trial, Zwagerman et al.[14] found that recurrence rates were significantly lower in patients with lumbar drainage (8.2%) compared to those without drainage (2.2%). Similarly, Bien et al.[18] reported that for patients undergoing skull base surgery, postoperative CSF leak rates were significantly lower in patients with lumbar drainage (12%) compared to patients without drainage (35%). On the other hand, in another study Ransom et al.[13] found that recurrence rates did not change with the application of lumbar drainage controlled for defect size. Also, the same study reported hospital stay was longer when lumbar drainage was applied. In their meta-analysis with 12 studies and 508 cases, Ahmed et al.[2] suggested that there was insufficient evidence for the efficacy of lumbar drainage in reducing recurrence rates.

In our study, recurrence rates were significantly higher in patients without lumbar drainage. However, this difference can also be explained by the fact that the same group had higher rates of 2-layered reconstruction which would increase recurrence rates. For the 2-layered reconstruction group, recurrence was 100% in patients without lumbar drainage and 0% in patients with lumbar drainage. For the 3-layered reconstruction group, recurrence rates were 22% for patients without lumbar drainage. Therefore, it can be argued that application of lumbar drainage can increase success rates in patients who are undergoing 2-layered reconstructions.

Another advantage of lumbar drainage application is that it allows administration of fluorescein which allows easy detection of defect location. Complication rates of lumbar drainage vary between 3-12% in the literature.[19] In our study, one patient had meningitis symptoms on the 2nd day after surgery. It is difficult to ascertain that meningitis was caused by the lumbar drainage. Apart from this isolated case, no complications were encountered related to the use of lumbar drainage. The main limitations of our study are the relatively few number of patients, inability to classify graft types and heterogeneity of defect characteristics.

Conclusion

Endoscopic transnasal CSF fistula repair is a surgical procedure with high success rates. Planning the reconstruction with at least 3-layers and application of lumbar CSF drainage increase success rates. For more accurate results, there is a need for studies with higher numbers of patients with similar features in terms of etiological factors, features of anterior skull base defect, and reconstruction techniques.

Disclosures

Ethics Committee Approval: The study was approved by the Sisli Hamidiye Etfal Training and Research Hospital Ethics Committee (no: 1840, date: 30.03.2021).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – S.K.D.; Design – E.S., S.K.D.; Supervision – S.K.D., A.C.; Materials – A.C., N.S.; Data collection &/or processing – E.S., S.K.D.; Analysis and/or interpretation – S.K.D., B.T.; Literature search – S.T., S.K.D.; Writing – S.T., S.K.D.; Critical review – E.S.

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