CASE SERIES

Endonasal endoscopic repair of cerebrospinal fluid leaks versus craniotomy: comparison of the outcomes

Christoforidou A[1], Tsitsopoulos PP[2], Selviaridis P[3], Vital V[1], Constantinidis J[1]

[1]1st Department of Otorhinolaryngology Head and Neck Surgery, AHEPA Hospital
[2]2nd Department of Neurosurgery, Ippokratio General Hospital
[3]1st Department of Neurosurgery, AHEPA Hospital
Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract

Background: Cerebrospinal fluid (CSF) leaks have been traditionally managed via craniotomy with an intradural repair. The endonasal endoscopic approach represents a minimally invasive alternative. This study aimed to compare the outcomes of the two methods.

Case Series: This is a prospective case series of 18 consecutive patients who underwent endonasal repair of a CSF leak. Thirteen variables were evaluated during the study, including age, gender, body mass index, site of the defect, CSF leak etiology, days of hospitalization, use of lumbar drainage, the success of repair, complications, recurrence, duration, and cost of surgery as well as patient satisfaction. The outcomes were compared with a historical cohort of 25 patients treated for CSF leaks with a craniotomy.

Though we found no significant difference in the success of the repair, the endoscopic group had a significantly shorter duration of the procedure and hospitalization, a lower rate of complications, lower cost, and higher patient satisfaction.

Conclusion: The presented data further solidify the endoscopic approach as the preferred method to address CSF leaks located in the anterior and middle skull base in cases not associated with complex intracranial pathology. Hippokratia 2016, 20(4): 299-302

Keywords: Cerebrospinal fluid leak, fistula, rhinorrhea, endoscopic repair, craniotomy, complication, recurrence, cost, patient satisfaction

Corresponding Author: Artemis Christoforidou, 23 G.Gennimata str, 55132, Kalamaria, Thessaloniki, Greece, tel: +306937546922, e-mail: achristoforidou@gmail.com

Introduction

A cerebrospinal fistula is the flow of cerebrospinal fluid (CSF) out of the subarachnoid space as a consequence of a rupture of the epithelium, bone, dura, and arachnoid mater[1]. The risk of developing meningitis in patients with CSF fistulas is 10 % per annum and 40 % in total[2], due to the entrance of microbial flora from the nose and sinuses directly to the brain[3].

In the past, both the diagnosis and mainly the repair of skull base fistulas was a task of the neurosurgeon in the process of craniotomy[4]. In the last twenty years, the progress of endonasal endoscopic surgery enhanced the role of Otolaryngologists, promoting the minimally invasive reconstruction of the CSF fistulas. However, in many cases, there is still no agreement on the method that will provide the best results for the patients[5]. Optimal treatment remains unclear for oversized defects, fistulas located in the frontal and sphenoid sinus, leaks accompanied by increased intracranial pressure, or recurrent cases.

Though there are multiple case series presenting the results of endonasal endoscopic repair of CSF leaks[2,6-8], to our knowledge there are very few actually comparing it with the traditional transcranial approach. The aim of this study was to evaluate the results of a series of patients treated endoscopically and compare the outcomes with a historical cohort of patients treated with a craniotomy.

Case Series

This combined prospective-retrospective multicenter study involved two University Otorhinolaryngology departments and two University Neurosurgical departments in tertiary hospitals from 1999 to 2015. The prospective part of the study was conducted since 2010 on 18 consecutive patients suffering from CSF leaks, who underwent endonasal endoscopic repair. For each patient the following 13 variables were evaluated: age, gender, body mass index (BMI), site of the defect, CSF leak etiology, days of hospitalization, use of lumbar drainage, the success of repair, complications, recurrence, duration, and cost of surgery as well as patient satisfaction.

For the retrospective part of the study, the historical data of 40 patients who had CSF leak and underwent craniotomy were retrieved. Patients who suffered from severe concomitant brain damage or extensive skull fractures that

required a craniotomy (13 patients), as well as patients with CSF rhinorrhea of temporal bone origin (2 patients), were excluded from the analysis. For the remaining 25 patients, the same variables were evaluated, and the outcomes were compared with those of the endonasal group.

To assess patient satisfaction, we used the Glasgow benefit inventory (GBI), which is a subjective patient orientated post-interventional questionnaire developed to provide a standard metric to compare benefit across different interventions[9]. All patients were contacted by telephone or letter, and the GBI questionnaire was completed after a mini interview. Six patients of the retrospective group were lost to follow-up, so for them, only data from their clinical records were included. The study was approved by the ethical committee of the Medical School of Aristotle University of Thessaloniki (No 4/11-6-2010).

Statistical analysis

Results are expressed as mean values and standard deviations (SD) for continuous variables. Findings for the categorical variables-nominal type of data are presented as frequencies (number of responses) and percentage distribution. Student t-test and non-parametric Mann-Whitney tests were utilized when appropriate. Chi-square test of independence (χ^2-test) and Fisher exact test have been employed to compare the statistically significant association between two categorical variables. All tests were two-sided and statistical calculations were performed using the Statistical Package for Social Sciences (SPSS) statistical software, version 17 (SPSS Inc., Chicago, IL, USA). A 5 % statistical significance level was considered for all statistical tests.

Management

For patients who underwent endoscopic procedures the surgical techniques varied according to the size and location of the defect (Table 1). The recipient bed was prepared by removing several mm of mucosa surrounding the bony defect to decrease the risk of mucous lifting the graft. Stripping of the mucosa also leads to osteogenesis around the defect which strengthens the repair. When a meningoencephalocele was present, it was cauterized and resected. Meticulous hemostasis was done while ablating the encephalocele, to avoid retraction of the sac and feeding vessels into the cranial cavity with subsequent intracranial bleeding. The three-layer plug was stabilized with fibrin-glue (Tisseel, Baxter, Westlake Village, CA, USA) and gelfoam (Pfizer, New York City, USA). This protected the duraplasty during the removal of the expandable gauze packing (Merocel pack, Medtronic Inc., Minneapolis, USA) that was intraoperatively placed in the nasal cavity and left in place for 1-3 days. If access to the lateral recess of the sphenoid sinus precluded direct closure, the sinus was obliterated with abdominal fat. In one patient who suffered from a fistula in the frontal recess, the endonasal approach was combined with a frontal mini-trephination.

For patients who underwent craniotomy, the patient had the head fixed in a Mayfield holder or a horseshoe and a bifrontal, unilateral or pterional craniotomy was performed. After mobilization of the brain and identification of the defect, this was repaired. Direct suturing, a graft of synthetic or autologous dura, muscle, fat or fascia was used, and fibrin-glue was placed on top to secure the seal. The bone was placed back, and the wound was closed in layers.

All patients were administered perioperative intravenous, blood-brain/blood-CSF barrier-penetrating, broad-spectrum antibiotics until discharge from the hospital.

Results

Table 2 shows the patients' characteristics and the cause of rhinorrhea. In the two subgroups of our study taken together (n =43), trauma accounted for only 31 % of CSF leaks, partly because many patients with traumatic leaks had severe concomitant pathology that required craniotomy and were, therefore, excluded from the analysis. Women suffered more often from idiopathic rhinorrhea, while men had more frequently post-traumatic fistulas (p =0.017). In addition, patients with idiopathic fistulas had significantly higher BMI compared to those with post-traumatic ones (p =0.037). The most common location of the defect was the cribriform plate of the ethmoid bone (16 patients, 38.1 %), followed by the sphenoid sinus (15, 35.7 %), the anterior ethmoid (5, 11.9 %), the frontal sinus (3, 7.1 %), and the posterior ethmoid (1 patient, 2.4 %). In two patients (4.8 %) we found more than one defect in the skull base. We were not able to retrieve data for the location of the leak for one patient.

The duration of hospitalization ranged from 3 to 41

Table 1: The endoscopic endonasal repair technique performed in this case series of patients with cerebrospinal fluid leaks varied according to the size and location of the defect.

Location of the fistula	**Defect size**		
	<5 mm	>5 mm	>2 cm (large defects)
Ethmoid roof	Overlay with mucoperiosteal free graft (from the turbinates)	Underlay + overlay	Underlay (temporalis fascia or fascia lata or fat) + bone or cartilage fitted to the defect + mucoperiostial or mucoperichondrial graft or local flaps + /- lumbar drainage
Cribriform plate	Middle turbinate resection + overlay with mucoperiosteal free graft	Middle turbinate resection + underlay +overlay	
Sphenoid sinus	Overlay with mucoperiosteal free graft	Underlay + overlay + fat	

Table 2: Patients' characteristics and cause of rhinorrhea for the 18 consecutive patients who underwent endoscopic endonasal repair (endoscopic group) and the historical cohort of 25 patients treated with a craniotomy (craniotomy group).

	Mean Age (range)	Gender		Body Mass Index *			Aetiology **		
		F (n, %)	M (n, %)	Normal (n, %)	Overweight (n, %)	Obese (n, %)	Spontaneous (n, %)	Post-traumatic (n, %)	Iatrogenic (n, %)
Endoscopic Group	48.1 (24-67)	16 (88.9)	2 (11.1)	2 (11.1)	6 (33.3)	10 (55.6)	15 (83.3)	2 (11.1)	1 (5.6)
Craniotomy Group	43.9 (16-75)	11 (44.0)	14 (56.0)	9 (40.9)	9 (40.9)	4 (18.2)	11 (45.8)	11 (45.8)	2 (8.3)
Total	45.6 (16-75)	27 (62.8)	16 (37.2)	11 (27.5)	15 (37.5)	14 (35.0)	26 (61.9)	13 (31.0)	3 (7.1)

*: No data were available for the body mass index of three patients from the craniotomy group, **: No data were available for the etiology of the fistula of one patient from the craniotomy group.

(median: 10) days for the endonasal group and from 8 to 62 (median: 24) days for the craniotomy group ($p < 0.001$). The duration of the procedure ranged from 2 to 4 (median: 2.75) hours for the endonasal group and from 2.5 to 10 (median: 4.5) hours for the craniotomy group ($p < 0.001$).

A lumbar drainage was used in two patients of the endonasal group (11.1 %) and in eight patients of the craniotomy group (32 %). A ventriculoperitoneal (VP) shunt was applied in two patients who underwent craniotomy (8 %).

Closure of the CSF leak was achieved in 17 (94.4 %) patients of the endonasal group and 17 (89.5 %) patients of the neurosurgical group ($p = 0.99$). Patients who were lost to follow-up were not included in this analysis as we did not have data for the success of their repair.

Recurrence occurred in two (11.8 %) of the patients of the endonasal group after six to twelve months and in three (17.6 %) of the patients of the craniotomy group after six months to ten years and ($p = 0.99$). Patients in whom the initial repair was unsuccessful, were excluded from the calculation of recurrence.

Patients from the endonasal group reported no complications. In total, 11 patients of the craniotomy group (57.9 %) suffered from at least one complication ($p = 0.000$). These were: a loss of smell (five patients), epilepsy (four patients), disfiguring scar (three patients), and post-operative intracranial bleeding (one patient). Two patients reported both loss of smell and epilepsy. For two of the patients who reported seizures, it was unclear if these were caused by the surgical intervention or by the trauma that led to it. We were unable to gather any data regarding complications for the six patients who were lost to follow-up.

Patient satisfaction according to the GBI questionnaire was significantly higher in the endonasal group. The mean general GBI score was 27.2 (SD: 19.3) for the endonasal group and 10.3 (SD: 19.4) for the craniotomy group ($p = 0.029$).

Regarding the cost of the procedures, we used the costing of the Greek national health system (NHS) to conclude that the transcranial procedures were much more expensive than the endonasal ones since the first ones are reimbursed for 3,400 Euros and the latter for 800 Euros.

Follow-up ranged from 0 to 5 (mean: 3.4) years for the endonasal group and from 2 to 16 (mean: 11.2) years for the craniotomy group.

Discussion

Numerous sources have reported that there is an association between obese females and spontaneous CSF leaks[10]. Our data support this as well, as we concluded that women were more prone to idiopathic CSF leaks and that patients with spontaneous leaks had significantly higher BMI.

According to the literature, the most frequent fistula location is the cribriform plate of the ethmoid bone (35 %), followed by the sphenoid sinus (26 %), the anterior ethmoid (18 %), the frontal sinus (10 %), the posterior ethmoid (9 %) and the lower clivus (2 %)[11]. Our results were similar.

Surgical treatment of a CSF fistula was first described by Dandy in 1926[11]. Since then, transcranial approaches have been utilized routinely for the repair of osteodural defects. The first report of an extracranial repair of a CSF fistula was published by Dohlman in 1948[12]. The first endonasal approach was performed by Hirsch in 1952, while the first endoscopic approach was reported by Wigand in 1981[13].

Intracranial access (craniotomy) applies where there are skull fractures requiring reconstruction, extensive skull base fractures, intracranial hemorrhages and contusions requiring treatment or sizeable deficits of the dura, where the probability of relapse is high[14]. The reported success rate is 70-80 %[2]. The advantages of this method are that it provides a direct visualization of the deficit, it gives the opportunity to inspect the cerebral cortex for damage and enables the use of large vascularized pericranial grafts[7,15]. On the other hand, the disadvantages are the increased mortality and morbidity, risk of brain damage and the difficult access to the sphenoid sinus[16]. The most common reported complication is the permanent anosmia due to mobilization or damage to the olfactory bulbs. Other complications include intracranial hemorrhage, memory deficits, seizures, osteomyelitis, and recurrence[2,6,7]. In our series, the number of complications was significantly higher in the neurosurgical group.

The extracranial access includes open and endoscopic techniques. The clear anatomical exposure of the roof of the nasal and paranasal sinuses with the endoscope ena-

bles better lighting and magnification and offers the surgeon the ability to accurately determine the area of the CSF leak[17]. Endoscopic methods do not require external incisions, therefore do not create scars, significantly reduce morbidity, minimize intranasal mucosal damage and consequently late complications (e.g., mucoceles) and, overall, allow better access. Especially for the sphenoid sinus and the upper clivus, the surgical approach is much easier using the endoscopic endonasal techniques[16]. It has also been found to avoid stigmatization resulting from shaving of patient's hair and to significantly reduce the duration of hospitalization[18]. In our study, the duration of hospitalization, as well as the duration of the surgical procedure were significantly lower in the endonasal group. Studies have demonstrated a 76-97 % success rate for this method[11], while are increased to 86-100 % after reoperation[6,10]. Our endoscopic repair rate of 94.4 % compares well with the standards in the literature. Moreover, this access allows the close postoperative monitoring and early recognition of recurrence[7]. The rate of complications namely meningitis, pneumocephalus, intracranial bleeding or hematoma, cerebral abscess, and anosmia is less than 1 %[11,19]. Our patients who were treated with endonasal approach reported no complications.

As far as patient satisfaction is concerned, we did not find any studies addressing this issue. We estimated it to be significantly higher in the endonasal group. This can be easily explained by the fact that this method is characterized by lower morbidity and faster rehabilitation.

Regarding the cost of the performed procedures, we relied solely upon the Greek NHS costing system, as it was impossible to find the actual cost for each individual procedure. Moreover, patients can return to work sooner, thus reducing the indirect costs.

The rarity and complexity of this clinical entity make the design and realization of a randomized control study very difficult. We present a series of patients with CSF leaks who were treated with endonasal approach and compare them with a historic cohort of patients who were treated with a craniotomy. Inevitably, the follow-up period was much longer for the craniotomy group, adding some bias in the comparison of recurrence and complications. Though we acknowledge the weaknesses of our study regarding lack of randomization and stratification, we believe it offers valuable information comparing these two methods.

Conclusion

Endoscopic techniques are gaining widespread acceptance as effective methods for closure of anterior skull base CSF leaks of any etiology, carrying a high overall success rate, and minimal morbidity. We were able to compare the costs, the duration of the procedure and hospitalization, the rates of success and recurrence, the complications, and patient satisfaction using a validated questionnaire. Though we found no significant difference in the success of the repair, the rest of our results were in favor of the endonasal approach.

The presented data further solidify the endoscopic approach as the preferred method to address CSF leaks located in the skull base that are not associated with additional intracranial pathology.

Conflict of interest

None of the authors has any conflict of interest.

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