

Surgical outcome of endoscopic endonasal repair of anterior skull base cerebrospinal fluid leaks in a tertiary center

Original Article

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Abstract

Introduction: Cerebrospinal fluid (CSF) leaks are abnormal communications between the subarachnoid space and the nasal cavity and can be classified as spontaneous or traumatic (including iatrogenic fistulas). Various procedures and materials have been described for endoscopic repair. However, the endoscopic technique for repairing CSF leaks is broadly debated.

Objective: To present the experience of a tertiary center in repairing CSF leaks of anterior skull base.

Methods: A retrospective study was conducted in a tertiary hospital between January 2012 and December 2023. All patients who underwent endoscopic repair of anterior skull base CSF leaks were included. Demographic data, symptoms, diagnostic tests, and intraoperative factors were collected. Descriptive and analytical statistical analysis was performed.

Results: Twenty-nine patients (19 women, mean age 59.6 years) with 30 CSF fistulas were included. The most common etiology was spontaneous, accounting for 59% of all cases, followed by iatrogenic (31%) and traumatic (10%). Seven patients with spontaneous CSF fistulas were obese, with one presenting signs of idiopathic intracranial hypertension. Spontaneous fistulas were most frequently located in the cribriform plate and lateral lamella. The lateral lamella was the most common site for iatrogenic CSF fistulas. The mean defect size was 5,8±7,4mm. Lumbar drainage was placed in 12 patients preoperatively. The underlay-overlay technique was used in 63% of cases, the overlay technique in 33%, and a combined (intracranial and endonasal) approach in 3% (one case). Technique selection was based on etiology, defect size, and surgeon preference. In the underlay-overlay technique, Duragen® underlay and free mucosal grafts overlay sealed with fibrin glue were most used. For the overlay technique, free mucosal grafts, Surgicel®, and fibrin glue were typically used. The average number of layers per patient was 3,9±1,2. CSF leaks in the cribriform plate were often repaired exclusively with the overlay technique due to the inability to dissect the dura without significantly enlarging the bony defect. No post-

operative complications occurred. The surgery was successful in all cases except one case in which reintervention was necessary in the first week after surgery.

Conclusion: A high success rate in correcting CSF leaks of anterior skull base was achieved through an endoscopic approach in our series, which compares to literature in general. Surgical technique must be decided according to etiology, size and location of the defect, with no technique proving to be significantly superior.

Keywords: CSF leak, underlay, overlay, nasosseptal flap, free mucosal flaps

Introduction

Cerebrospinal fluid (CSF) fistulas are abnormal communications between the subarachnoid space and nasal cavity and can be classified as non-traumatic or traumatic.¹

The non-traumatic type includes idiopathic spontaneous CSF fistulas, congenital fistulas, and secondary fistulas associated with skull base tumors and subsequent bone erosion.²

Idiopathic spontaneous fistulas most frequently occur in the ethmoid fovea and cribriform plate. Although their etiology remains unclear, they are commonly associated with chronically increased intracranial pressure due to benign intracranial hypertension or obesity, in conjunction with anatomical predisposition.² These cases are particularly challenging to operate due to high recurrence rates, which may be attributed to persistent intracranial hypertension, presence of multiple skull base defects, and herniation of intracranial contents into the nasal cavity.²

Traumatic CSF fistulas include iatrogenic defects, most commonly located in the cribriform plate or sphenoid sinus.³

Surgical repair of skull base defects is crucial to prevent complications related to the communication between the nasal and cranial cavities, such as bacterial meningitis, which can lead to significant morbidity.²

Endoscopic techniques have become the standard in anterior skull base surgery, with high success rates and low morbidity compared to craniotomy. Various techniques and materials have been described for endoscopic repair, including local (septal cartilage, middle

turbinate bone, free septal mucosal graft, and nasoseptal flap), autologous (abdominal fat and fascia lata), and synthetic materials (DuraGen® and fibrin glue).

Despite significant advancements, the optimal endoscopic technique remains a matter of debate.⁴

This study aimed to address the gaps in the literature by providing a critical and selective analysis of the endoscopic techniques for repair of skull base defects, which may contribute to improved otorhinolaryngology practice in Portugal.

Objective

To present the experience of a tertiary referral center in the endoscopic repair of anterior skull base CSF fistulas, evaluate success rates, and identify the most appropriate surgical technique and materials to optimize outcomes.

Materials and methods

This retrospective, cross-sectional study included all patients over the age of 18 years who underwent endoscopic repair of anterior skull base CSF fistulas at the Otorhinolaryngology Department of the Unidade Local de Saúde de Lisboa Ocidental between January 2012 and December 2023.

Patients were selected from electronic surgical records. Only one patient was excluded due to incomplete clinical data. The principal investigator collected data on demographics, comorbidities (obesity, obstructive sleep apnea [OSA], and idiopathic intracranial hypertension), and characteristics of the CSF fistula (etiology, location, defect size, presence of rhinorrhea, and symptom duration). Complementary diagnostic evaluations included computed tomography, magnetic resonance imaging, glucose testing, and β 2-transferrin assays. Intraoperative data included the surgical technique and materials used, number of closure layers, use of intrathecal fluorescein, lumbar drainage, and nasal packing type and duration. Postoperative data comprised length of hospital stay, complications, and recurrence. Patients with

incomplete records (n = 2) were excluded. All patients underwent postoperative follow-up with weekly outpatient visits and nasal endoscopy for 6–8 weeks.

Surgical success was defined as the absence of postoperative rhinorrhea.

The data were compiled in a Microsoft Excel® spreadsheet and analyzed using SPSS® software version 29.0 for MacOS . Qualitative variables were assessed using the Chi-square test, while recurrence-related quantitative variables were analyzed using the Mann-Whitney U or Student’s t-test.

Results

The final sample comprised 29 patients (19 women and 10 men), with a mean age of 60 years (32–84). Regarding comorbidities, seven patients had a body mass index >30 kg/m², two had OSA, and one had signs of idiopathic intracranial hypertension. Rhinorrhea was present at diagnosis in 27 patients. Seven patients had a meningoencephalocele and four had a meningocele. The most frequent fistula locations were the cribriform plate (n = 16) and ethmoid fovea (n = 5), predominantly on the right side (63.3%). Imaging tests showed a mean defect size of 5.8 ± 7.4 mm.

The most common etiology was idiopathic spontaneous (60%), followed by iatrogenic (30%) and non-iatrogenic traumatic causes (10%).

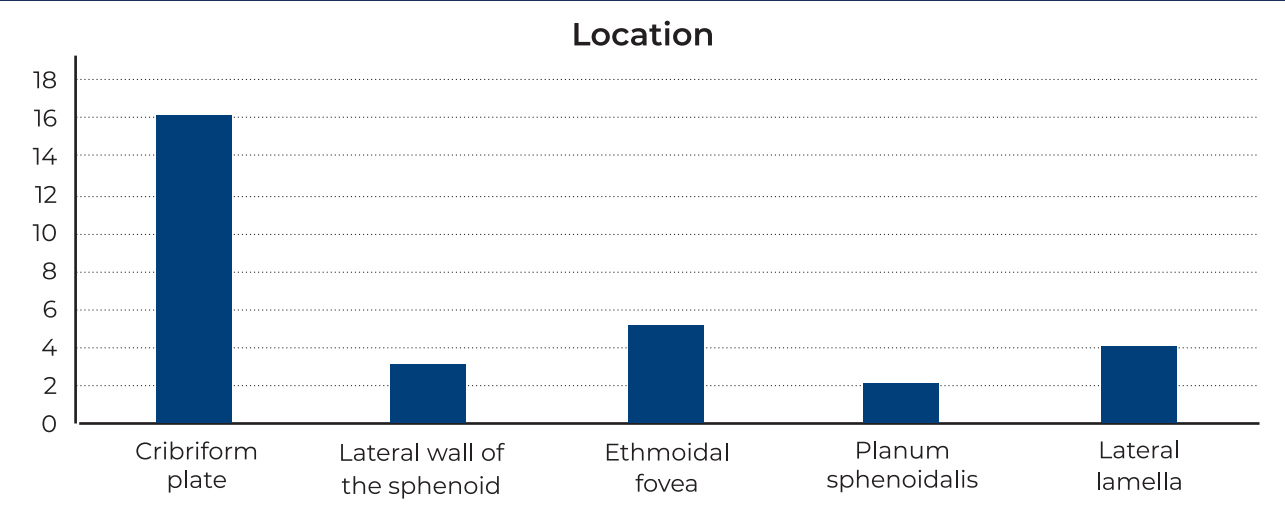
Lumbar drainage was required in 48.3% of cases. Intrathecal fluorescein was administered perioperatively in 13 patients, particularly those with cribriform plate defects, as lumbar drainage is performed in almost all such cases. A total of 30 CSF fistulas in the anterior skull base were repaired endoscopically.

The most common surgical technique was the underlay-overlay (n = 19), followed by overlay alone (n = 10). A combined endonasal and transcranial approach was used in one iatrogenic case. For the underlay layer, the most frequently used material was synthetic dura mater (n = 13), followed by free fascia grafts and pedicled fascia flaps.

For the overlay layer, free nasal mucosa grafts were most commonly used (n = 21), followed by vascularized flaps, including nasoseptal flaps (n = 7). An average of 3.9 ± 1.2 closure layers was used per patient (1–6 layers), including the fibrin glue and Surgicel® layers.

Lumbar drainage was placed in 48.3% of cases. Intrathecal fluorescein was used in 43.3% of cases, primarily when the defect was in the cribriform plate of the ethmoid bone. Lumbar drainage was placed in 92.3% cases requiring intrathecal fluorescein. Merocel® was the most frequently used nasal packing material (63.3%). Recurrence occurred in two cases. One was resolved without surgical revision by using additional lumbar drainage and Surgicel®. The other case was a 69-year-

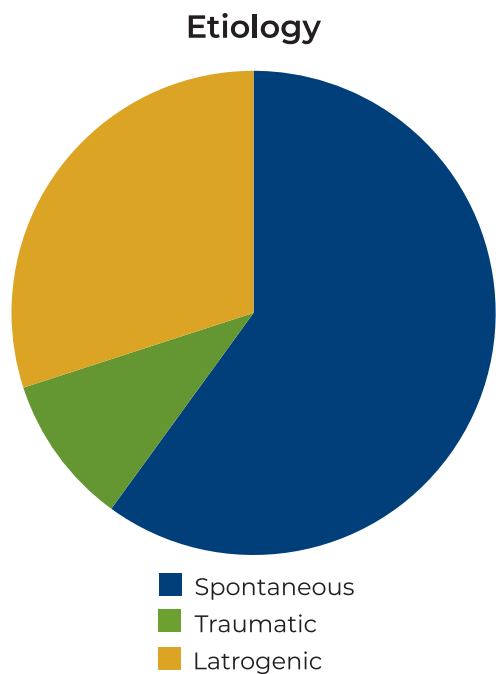
Figure 1
Distribution of cerebrospinal fluid fistulas by the defect location at the skull base (n = 30).



old woman with spontaneous CSF fistula and bacterial meningitis. A CT scan of the paranasal sinuses revealed a 1-cm defect in the cribriform plate of the ethmoid bone. The defect was initially repaired using a six-layer overlay technique with fibrin glue, a free mucosal graft harvested from the middle turbinate, fibrin glue, MeroGel®, fibrin glue, and another layer of MeroGel®. The procedure was completed without complications, and the nasal cavities were bilaterally packed with MeroGel®, which was removed on the second postoperative day. However, one week after the surgery, the patient developed persistent

rhinorrhea that did not resolve with nasal packing, requiring revision surgery. During the revision procedure, the initial materials were removed and a new reconstruction was performed using a three-layer overlay technique: nasoseptal flap, Surgicel®, and Spongostan®. The patient was discharged on postoperative day 10 and has remained free of recurrence for nine years. No significant associations were found between recurrence and sex, body mass index, OSA, etiology, defect location or size, surgical technique or materials, use of lumbar drainage, nasal packing duration, or year of surgery.

Figure 2
Distribution of cerebrospinal fluid fistulas by etiology (n = 30).



Discussion

The gold standard for repairing anterior skull base CSF fistulas remains a topic of debate in the otolaryngology community. Both overlay and underlay approaches are valid and demonstrate comparable outcomes when appropriately selected.¹ In this study, the underlay technique was preferred, while isolated overlay was typically reserved for cribriform plate defects where dural dissection would enlarge the bone defect. A variety of materials, including fat, muscle, fascia, bone, cartilage, vascularized and free grafts, and synthetic alternatives, can be used. The nasoseptal flap has demonstrated superior effectiveness in repairing large defects, providing greater length, width, and rotational range compared to avascular flaps.^{6,8} Sigler et al. reported a 94% success

Figure 3
Materials most commonly used in (A) underlay and (B) overlay techniques

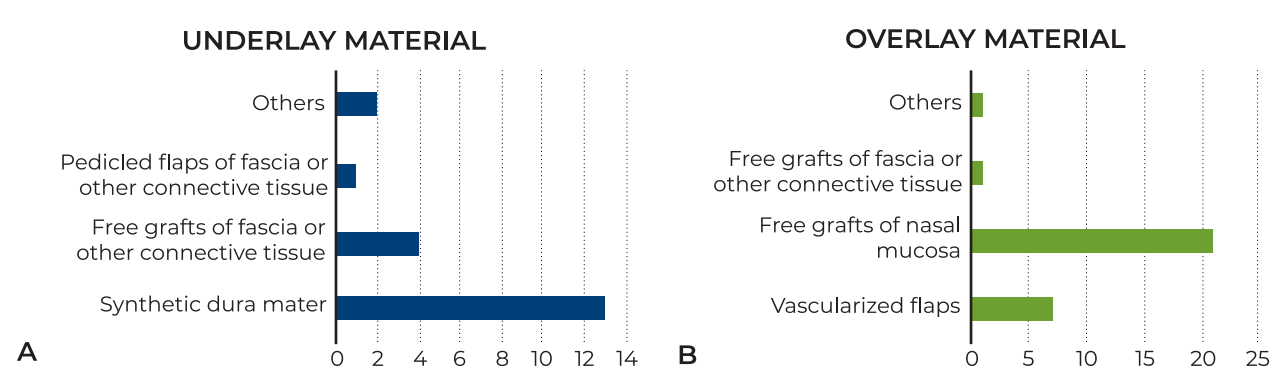
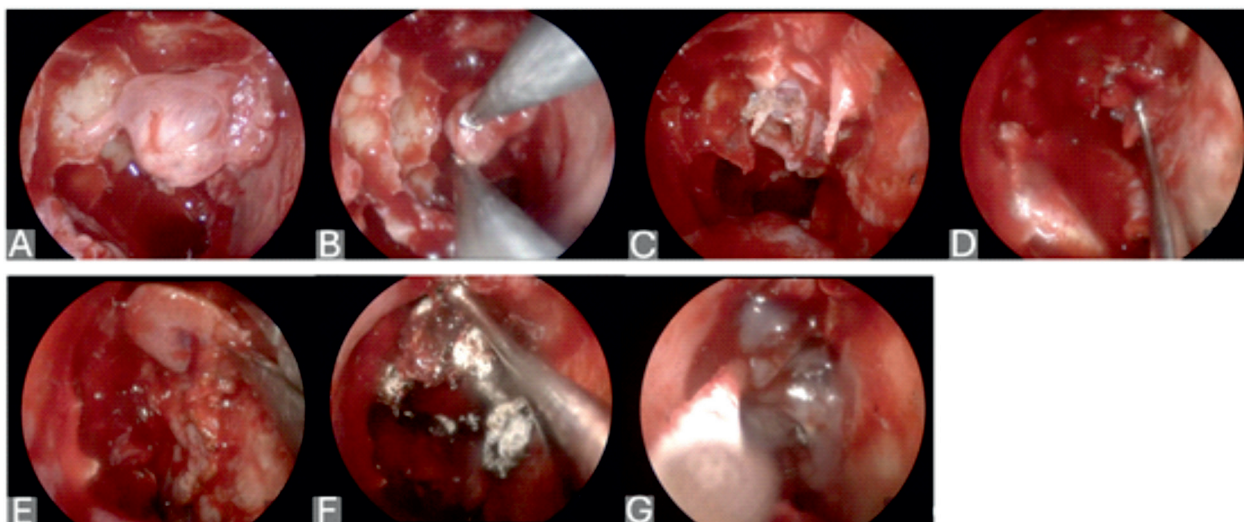
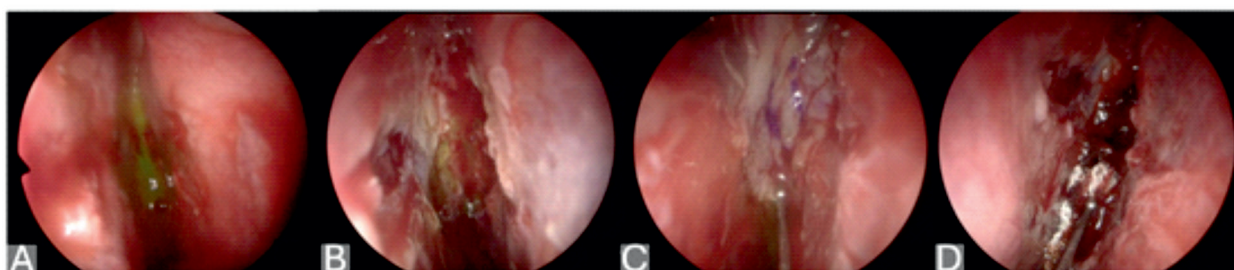


Figure 4
Underlay-overlay repair of a lateral lamella defect



(A) Meningoencephalocele. (B) reduction with bipolar forceps. (C) Exposed skull base defect. (D) Underlay with synthetic dura. (E) Overlay using nasoseptal flap, (F) Surgicel®, and (G) fibrin glue

Figure 5
Overlay repair of an ethmoid cribriform plate defect



(A) Defect identification using intrathecal fluorescein. (B) Exposure with cold instruments. (C) Closure with free nasal mucosa graft and (D) Surgicel® overlay

rate with nasoseptal flaps versus 82% with free mucosal grafts.⁴ Additionally, free mucosal grafts require longer healing times due to their avascularity.⁷ Autologous fascia lata is a common option for large defects, as it creates an effective barrier, especially in combination with nasoseptal flaps, although its harvesting increases the surgical time and surgical wound complications. Synthetic dura may offer a viable alternative.⁶

Lumbar drainage aims to reduce CSF pressure at the repair site, thus promoting healing.⁷ However, its role remains controversial, with several studies reporting no significant

difference in outcomes with or without drainage. Nonetheless, it is recommended for patients with idiopathic intracranial hypertension or those undergoing revision surgery.^{1,5}

In a study involving 193 patients, the success rate of primary closure of anterior skull base CSF fistulas ranged from 85% to 90% with the use of intrathecal fluorescein.¹ In the present case series, intrathecal fluorescein was primarily used in the repair of defects involving the cribriform plate of the ethmoid bone.

Study limitations

This study has some limitations, including its retrospective design and small sample size. Additionally, the use of heterogeneous closure techniques, varied materials, and different numbers of layers for anterior cranial base reconstruction represent further limiting factors.

Conclusion

Endoscopic repair of CSF fistulas has been proven to be a safe and effective technique, offering excellent visualization and access to skull base defects. The high success rate observed in our cohort suggests that the choice of surgical technique should be based on the etiology, size, and anatomical location of the defect, as no single approach demonstrated statistically significant superiority.

In this study, free nasal mucosa grafts were the most frequently used material, particularly for defects in the cribriform plate of the ethmoid. In such cases, the exclusive overlay technique was preferred, as dural dissection at this location is not feasible without significantly enlarging the defect. Conversely, larger anterior cranial base defects were often managed using a nasoseptal flap associated with a combined underlay-overlay technique. Nevertheless, further studies with larger samples are necessary to ascertain whether specific techniques are associated with superior outcomes.

Ethical considerations and conflicts of interest

The authors declare no conflicts of interest.

The study did not receive financial support from any public, commercial, or non-profit funding agency. All data were collected via the SClinico platform, ensuring the anonymity of all participants. No personal or identifiable information was disclosed or used beyond what was strictly necessary for the study's objectives.

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols used at their working center regarding patient data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and the 2013 Helsinki Declaration of The World Medical Association.

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Availability of scientific data

There are no datasets available, or publicity related to this work.

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