Research Square

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Endoscopic Endonasal Surgery for Cholesteatomas of the Posterior Cranial Fossa and Parasellar Region

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Abstract

Background: Endoscopic endonasal surgery (EES) offers a direct ventral corridor to the skull base, potentially enabling maximal resection of extensive cholesteatomas (epidermoid cysts) in the posterior cranial fossa and parasellar region. However, outcomes and complications specific to this approach require detailed analysis.

Methods: A retrospective review was conducted on 34 patients who underwent EES for cholesteatomas of the posterior fossa and parasellar region at a single high-volume center (2011-2025). Surgical approaches were tailored to the lesion's extent. Extent of resection (near-total >95%, subtotal 90-95%), complications, and neurological outcomes were analyzed.

Results: Near-total resection was achieved in 65% of cases and subtotal in 35%. The most frequent complications were postoperative cerebrospinal fluid (CSF) leakage (23.5%) and meningitis (23.5%; 33.3% in patients with intradural extension). Rates were significantly higher than for other skull base tumors. Only visual symptoms showed consistent postoperative improvement. New or worsened cranial nerve deficits occurred in 12% of cases. The rates of CSF leakage and meningitis were 25% and 33%, respectively. Arrested hydrocephalus requiring shunting developed in 14.7% of patients.

Conclusion: EES provides a valid alternative for the surgical management of posterior fossa and parasellar cholesteatomas, allowing for a high degree of resection. However, it is associated with a notably higher risk of CSF leakage and meningitis compared to EES for other pathologies, attributable to the lesion's adhesive and inflammatory characteristics. Furthermore, significant recovery of preoperative neurological deficits (except visual) is uncommon. These findings underscore that such complex procedures should be performed in specialized centers with extensive expertise in endoscopic skull base surgery and multidisciplinary perioperative care.

Introduction

Cholesteatomas (epidermoid cysts) are benign, non-neoplastic lesions, predominantly of congenital origin. They arise from displaced ectodermal epithelial cells during neural tube closure in the embryological stage of neurulation. An acquired form is possible due to iatrogenic implantation of epidermal cells into the subarachnoid space during invasive procedures or as a result of trauma. The content of epidermoid cysts consists of keratinous debris and cholesterol crystals, which give the lesion its characteristic density and pearly-white appearance, in contrast to dermoid cysts that also contain skin appendages (hair, fat, teeth, nail tissue).

Epidermoid cysts account for approximately 0.2–1.8% of all intracranial space-occupying lesions [1]. These lesions are typically located in the middle ear, behind the tympanic membrane, or within the petrous part of the temporal bone. Less commonly, cholesteatomas are found in the chiasm-sellar region and cerebellopontine angle (CPA), as well as in the prepontine cistern [2,3].

Epidermoid cysts exhibit slow, expansive growth, often enveloping nerves and blood vessels. They may remain clinically silent for a long time until they reach a significant size, causing compression of adjacent neurovascular structures. Due to the potential for local aseptic inflammation, these cysts often develop dense adhesions to the surrounding arachnoid membrane and brain structures without true parenchymal invasion. Large cholesteatomas occupying several anatomical regions (including the CPA, chiasm-sellar region, clivus, and ventral parts of the posterior cranial fossa) can cause facial nerve palsy, oculomotor disturbances, vertigo, tinnitus, visual impairment, and headache.

The only treatment for cholesteatomas is surgical resection. However, radical removal of lesions located among major vessels and cranial nerves of the posterior fossa is either nearly impossible or associated with unacceptably high risks of complications [4–8]. Depending on the location and extent of the lesion, various transcranial approaches to its supra- and infratentorial parts have been used (e.g., subfrontal, pterional, retrosigmoid, midline suboccipital, etc.). Currently, the endoscopic endonasal approach has been introduced into practice alongside these for lesions located in the clivus, medial parts of the petrous temporal bones, chiasm-sellar region, and ventral/ventrolateral peribrainstem areas (prepontine cistern, CPA, interpeduncular cistern).

At the Burdenko Neurosurgery Center the endoscopic endonasal approach for the removal of various skull base tumors has been routinely used since 2005. To date, we have accumulated experience in treating 34 patients with cholesteatomas of the posterior cranial fossa and parasellar region operated on using the endoscopic endonasal approach. During treatment, we observed a relatively higher frequency of complications, necessitating a thorough analysis of the outcomes.

Methods

Between 2011 and 2025, 34 patients (23 women, 11 men) with cholesteatomas of the posterior cranial fossa and parasellar region were operated on using the endoscopic endonasal approach At the Burdenko Neurosurgery Center. The median age was 41 years (interquartile range 32-51).

The involvement of anatomical regions by the lesions is presented in Figure 1. Most frequently, the cholesteatomas extended into the **endosuprasellar region**, **CPA**, and **clivus**.

Due to their expansive growth, cholesteatomas often occupy several anatomical regions (as shown in Figure 1), which is illustrated in Figure 2.

Owing to their expansive growth pattern, cholesteatomas frequently occupied multiple anatomical regions (as per Figure 1), a distribution detailed in Figure 2.

In 24 patients (70.6%), the cholesteatomas had an intradural component (involving the chiasmal-sellar region, peribrainstem area, and/or CPA). In 10 patients (29.4%), the lesions were located purely extradurally, predominantly in the clivus or the petrous portion of the temporal bone; in 2 of these cases, the lesion was confined to the chiasmal-sellar region.

Clinical symptoms were present in 29 patients (85.3%). Visual disturbances consistent with chiasmal syndrome were observed in 7 patients (20.6%). Impairment of oculomotor nerve function was noted in 3 patients (8.8%), abducens nerve dysfunction in 7 (20.6%), trigeminal nerve involvement in 10 (29.4%), facial nerve palsy in 5 (14.7%), and bulbar cranial nerve deficits in 2 (5.8%) patients. Motor deficits in the form of hemiparesis were recorded in 1 patient (2.9%).

All patients underwent endoscopic endonasal transsphenoidal resection of the lesion. Depending on the tumor's location and extent, a standard transsellar approach (35.3% of cases), as well as anterior (23.5%) or posterior (41.2%) expanded endoscopic endonasal approaches were employed. The surgical techniques for these approaches are well-documented in the literature [9–13].

Statistical analysis was performed using Statistica 10.0 software (StatSoft Inc., USA). Categorical variables were analyzed using Fisher's exact test, and continuous variables using the Mann-Whitney U test. Results of statistical hypothesis testing were considered significant at $p < 0.05$. Mean values are presented with standard deviation.

Results

Achieving complete resection of a cholesteatoma located in the skull base structures, especially when it is intradural and adherent to the arachnoid membrane, is, in our experience and consistent with the literature, nearly impossible due to the lesion's extremely dense adhesions to surrounding structures and the arachnoid. Therefore, the most appropriate assessment for a visually complete resection with minor residual fragments left on vessels, cranial nerves, brain tissue, or membranes is **near-total removal** (95-99% of the lesion), while resection of 90-95% is considered **subtotal** [4,14]. Near-total removal was achieved in 22 patients (64.7%). In the remaining cases (n=12, 35.3%), the resection was subtotal (examples shown in Fig. 3,4).

Analysis of the extent of resection relative to the predominant cholesteatoma location revealed that lesions situated in the clivus and the medial/paramedian portions of the petrous temporal bone were most successfully removed. In contrast, lesions with a peribrainstem location were, predictably, the least completely resected (Figure 5).

During surgery, the specific approach was selected based on the lesion's location: a standard approach to the sphenoid sinus and clivus (for lesions confined solely to the clivus and petrous temporal bone), supplemented by a transsellar approach when the lesion extended into the chiasmal-sellar region (n=12), or anterior (n=8) and posterior (n=14) expanded approaches.

An intraoperative CSF leak occurred in 19 of the 24 patients with intradural extension of the lesion. Notably, in 5 patients with endo-suprasellar cholesteatomas, no CSF leak was observed during surgery despite intradural growth, a finding attributed to the presence of a dense arachnoid membrane. Among patients with purely extradural lesions (n=10), an intraoperative CSF leak was noted in one case due to

dense adhesion of the cholesteatoma capsule to the thinned dura mater in the region of the posterior petrous temporal bone wall.

In all cases with an intraoperative CSF leak, multilayer skull base reconstruction was performed using autologous fat and autologous fascia. This reconstruction was supplemented with a nasoseptal mucoperiosteal flap in 6 patients (17.6%), and in 2 cases, microsutures were placed to approximate the autologous fascia to the dura mater at the skull base defect. In the absence of an intraoperative CSF leak, the defect was repaired using autologous bone and hemostatic foam.

The mean operative time was 184.2 ± 96.6 minutes (range 75–510 minutes), and the mean blood loss was 101.0 ± 37.7 ml (range 75–510 ml).

The dynamics of the clinical picture, assessed at the time of discharge, are presented in Figure 6. Improvement was noted only in visual function, manifesting as increased acuity and expanded visual fields in patients with pre-existing dysfunction. Regarding other neurological symptoms, no significant postoperative improvement was observed. There was an increase in the incidence of facial nerve deficits by 5.9% (in both cases, the lesion extended into the cerebellopontine angle), abducens nerve deficits by 11.8%, and bulbar cranial nerve deficits by 2.9%. New motor deficits developed in 3 cases (8.8%), presenting as lower paraparesis (2 cases) and tetraparesis (1 case). In all cases where motor deficits developed, the neoplasms were compressing the ventral surface of the brainstem ($p < 0.05$, Fisher's exact test compared to the subgroup without brainstem involvement), and the patients had also suffered from postoperative meningitis ($p < 0.05$, Fisher's exact test compared to the subgroup without meningitis).

Postoperative CSF leakage developed in 8 (23.5%) patients. Among these, 7 had experienced an intraoperative CSF leak (in 3 of them, reconstruction utilized fat, fascia, and a nasoseptal flap; in 4, a flap was not used), while 1 patient did not have an intraoperative leak.

Among patients with intradural extension of the lesion (n=24), the rate of postoperative CSF leak was 25% (6/24). In patients without intradural growth (n=10), the rate was 20% (2/10); this difference was not statistically significant ($p > 0.05$, Fisher's exact test). In the latter group, one patient had an intraoperative CSF leak (the lesion was densely adherent to the dura mater, resulting in a pinpoint defect during capsule dissection), while the other, undergoing removal of an endo-suprasellar cholesteatoma, had no intraoperative leak, and skull base reconstruction was performed using hemostatic foam and fibrin glue.

The frequency of CSF leakage in patients with intradural extension of cholesteatomas, stratified by the surgical approach used, is presented in Figure 7. Postoperative CSF leakage most frequently occurred after the posterior expanded approach; however, no statistically significant difference was found between the patient subgroups based on the surgical approach ($p > 0.05$, Fisher's exact test).

In all cases of postoperative rhinorrhea, an external lumbar drain was placed. Revision surgery was performed in 5 cases (in 3 of them, revision for repair of the CSF fistula was required five times), while in

the remaining cases the leakage resolved with lumbar drainage alone.

Meningitis developed in 8 patients (23.5% of all patients and 33.3% of patients with intradural lesion extension). All of these patients had experienced an intraoperative CSF leak and had lesions with intradural growth.

In 6 patients, meningitis developed on postoperative days 1-2. In 2 patients, it occurred secondary to postoperative CSF leakage, on days 10 and 11 after the initial surgery. The identified pathogens are presented in Table 1.

Table 1. Characteristics of meningitis cases.

№	Pathogen	Time to meningitis onset (postoperative days)	Total duration of meningitis (days)	Postoperative CSF leakage	Peak CSF cell count
1	Staphylococcus aureus, Staphylococcus epidermidis	1	68	-	17405
2	Staphylococcus epidermidis, Candida parapsilosis, Candida dibliniensis	11 (in the context of CSF leakage)	90	+	19740
3	no	10 (in the context of CSF leakage)	30	+	4655
4	Klebsiella sp. (Pantoea sp)	2	22	-	10300
5	Staphylococcus epidermidis, Raoultella ornithinolytica, Candida albicans, Klebsiella pneumoniae	2	18	+	16640
6	no	2	26	+	6100
7	Klebsiella pneumoniae, Serratia marcescens	1	59	+	35472
8	Escherichia coli	2	9	-	42479

The median total duration of meningitis was 28 ± 28.6 days [IQR 20;63.5]. All patients except one (the last case in Table 1) experienced a fluctuating clinical course with periods of normalized CSF cell count but persistently low glucose levels and elevated lactate in the CSF.

A CSF shunting procedure was required in 5 (14.7%) cases (4 of these patients had postoperative meningitis).

The median length of hospital stay was 13.5 days [6;32]. Four patients were hospitalized for more than 80 days (range 85-152 days). All of them had meningitis lasting between 18 and 90 days. Three of these patients underwent 5 revision surgeries each due to persistent CSF rhinorrhea. There were no fatal outcomes.

Discussion

The rationale for employing the endoscopic endonasal approach in the surgery of ventral posterior fossa and skull base cholesteatomas was its anatomical validity as an anterior corridor to this region. This approach enables the creation of a wide working space between major vessels and cranial nerves, sufficient for confident and safe bimanual instrumentation under endoscopic visualization. Additional advantages include excellent illumination and visualization in a deep, narrow surgical field, the ability to remove lesions outside the direct line of sight using angled optics and instruments, and the absence of brain retraction.

The expected outcome of using this approach was maximal safe resection with a complication rate not exceeding that of traditional transcranial routes. The extent of resection was indeed achieved at a satisfactorily high level, attributable to the aforementioned advantages of endoscopic technique. Specifically, near-total removal was accomplished in 65% of cases, while in 35% of cases, no more than 10% of the original tumor volume remained, which was classified as subtotal resection. Our results proved comparable to literature data on transcranial surgery for these lesions, where gross-total or near-total removal is achieved in no more than 70% of cases [15,16], and even less frequently for lesions involving the brainstem (where the rate of radical resection does not exceed 37% [1]). Authors of other endonasal series similarly report rates of total and near-total removal in the range of 60-80% [4,17].

Opinions on disease progression following total versus non-total removal vary, given the similar reported rates of recurrence/progression [6,7]. Consequently, in our view, it is prudent to avoid attempts at dissecting capsule fragments that are densely adherent to vessels and nerves. The likelihood of recurrence should thus be considered as virtually inevitable, with the extent of resection primarily determining the interval before a subsequent, often more challenging, operation becomes necessary.

However, when analyzing our other outcomes, we noted a higher frequency of complications such as CSF leakage and meningitis, prolonged hospital stays, and infrequent regression of preoperative symptoms compared to our extensive experience (over 10,000 procedures) with endoscopic endonasal surgery for other skull base neoplasms. Specifically, in the present cohort with intradurally extending cholesteatomas, the rates of postoperative rhinorrhea and meningitis were 25% and 33.3%, respectively. According to our data, these rates are significantly higher than for other tumor types in similar locations (where postoperative CSF leakage occurs in no more than 5% of cases with an intraoperative leak, and meningitis develops in up to 20% of cases) [4,5]. Analyzing the reconstruction techniques in patients with

intradural extension, we did not identify any particular methods as clearly superior or inferior, as CSF leakage occurred with various combinations of sealing and fixation materials and different layering sequences.

According to the literature, these complications are quite frequent. In endonasal surgery for intradural cholesteatomas, the rates of postoperative CSF leakage and meningitis (both bacterial and aseptic) can reach 30% [4,17–19]. In transcranial surgery, the rate of meningitis is also notably high—up to 40% for aseptic inflammation despite perioperative glucocorticoid therapy, and up to 7% for bacterial meningitis. The rate of CSF leakage is understandably lower in transcranial approaches (approximately 5%) due to the ability to achieve a more watertight closure of superficial tissues compared to reconstruction within the narrow, deep surgical field of endoscopic endonasal surgery [1,4,5,8,15,16,20].

These high rates of both CSF leakage and meningitis can be explained by the presence of a chronic inflammatory process caused by the effect of desquamated epithelial cell products on surrounding structures. This process also leads to the formation of dense adhesions to critically important neurovascular structures, which hinders radical resection and, consequently, perpetuates the inflammatory response [21]. A high frequency of impaired CSF resorption (arrested hydrocephalus) is also noted (14.7% in our series; up to 30% according to literature [16]), necessitating CSF shunting procedures, which is likewise attributed to chronic inflammation and meningitis [4].

Given the prolonged, chronic nature of the disease, the absence of significant regression in clinical symptoms following tumor removal was an expected outcome. Furthermore, the development of new neurological deficits makes surgery for cholesteatomas potentially more morbid compared to other neoplasms in this region (in our data, the rate of cranial nerve function worsening reached 12%). However, a review of the literature indicates that the frequency of similar complications in surgery for other posterior fossa tumors, via various approaches, can also reach 30-40% [22,23,32–36,24–31].

Conclusion

Endoscopic endonasal surgery constitutes a viable alternative to transcranial approaches for cholesteatomas of the posterior cranial fossa and parasellar region. However, compared to outcomes for other skull base neoplasms, cholesteatoma surgery is associated with a higher incidence of complications and limited efficacy in improving preoperative neurological deficits. This is likely attributable to the intrinsic nature of the disease, characterized by a slow-burning chronic inflammatory process and the propensity of these lesions to disseminate within the subarachnoid space. While the physical properties of cholesteatomas can make their dissection mechanically less challenging than other tumors in similar locations, there is a clear need for further optimization of surgical approaches, skull base reconstruction techniques, and perioperative anti-inflammatory and antimicrobial therapy to reduce the rates of postoperative meningitis and CSF leakage. Such procedures should be performed in large, high-volume neurosurgical centers by surgeons with specific expertise in this area.

Abbreviations

Endoscopic endonasal surgery
EES
cerebrospinal fluid
CSF
cerebellopontine angle
CPA

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Declarations of interest: none

Author Contributions

Shkarubo Alexey, Kalinin Pavel, Chenov Ilia and Sharipov Oleg contributed to the study conception and design. Material preparation and data collection were permored by Maksyutova Gulnara, Konyashin Daniil, Donskoy Artem, Andreev Dmitry. Analysis was performed by Kutin Maxim, Fomicherv Dmitry. The first draft of the manuscript was written by Chernov Ilia.

All authors read and approved the final manuscript.

Ethics approval

Name of the Approval Committee: *local ethics committee of the The Burdenko neurosurgical center*

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Local Ethics Committee of the The Burdenko neurosurgical center

Consent to participate

Informed consent was obtained from all individual participants included in the study.

The authors affirm that human research participants provided informed consent for publication of the images in Figures 3 and 4.

Clinical trial number: not applicable

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Figures

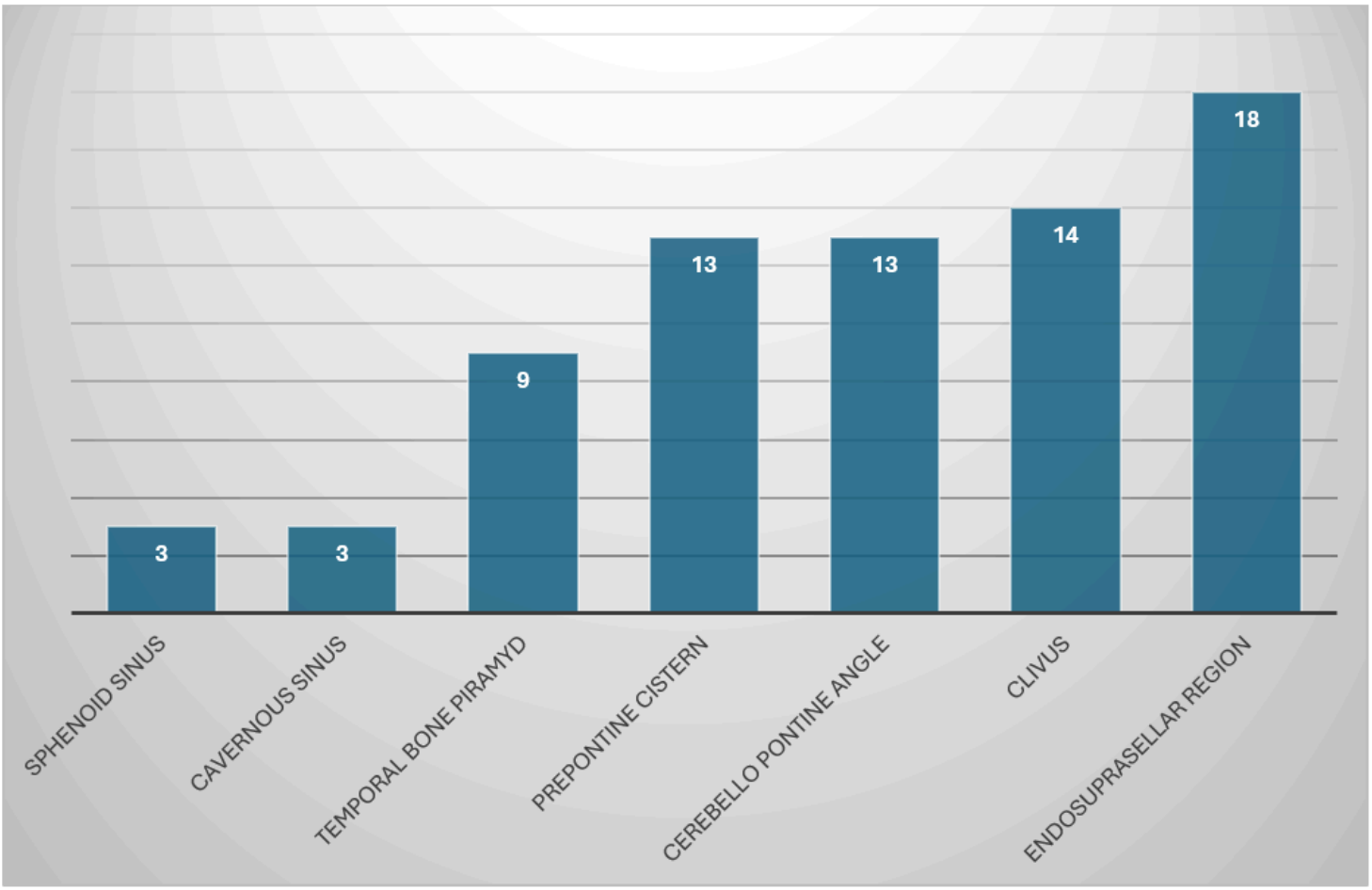


Figure 1

Localization of cholesteatomas.

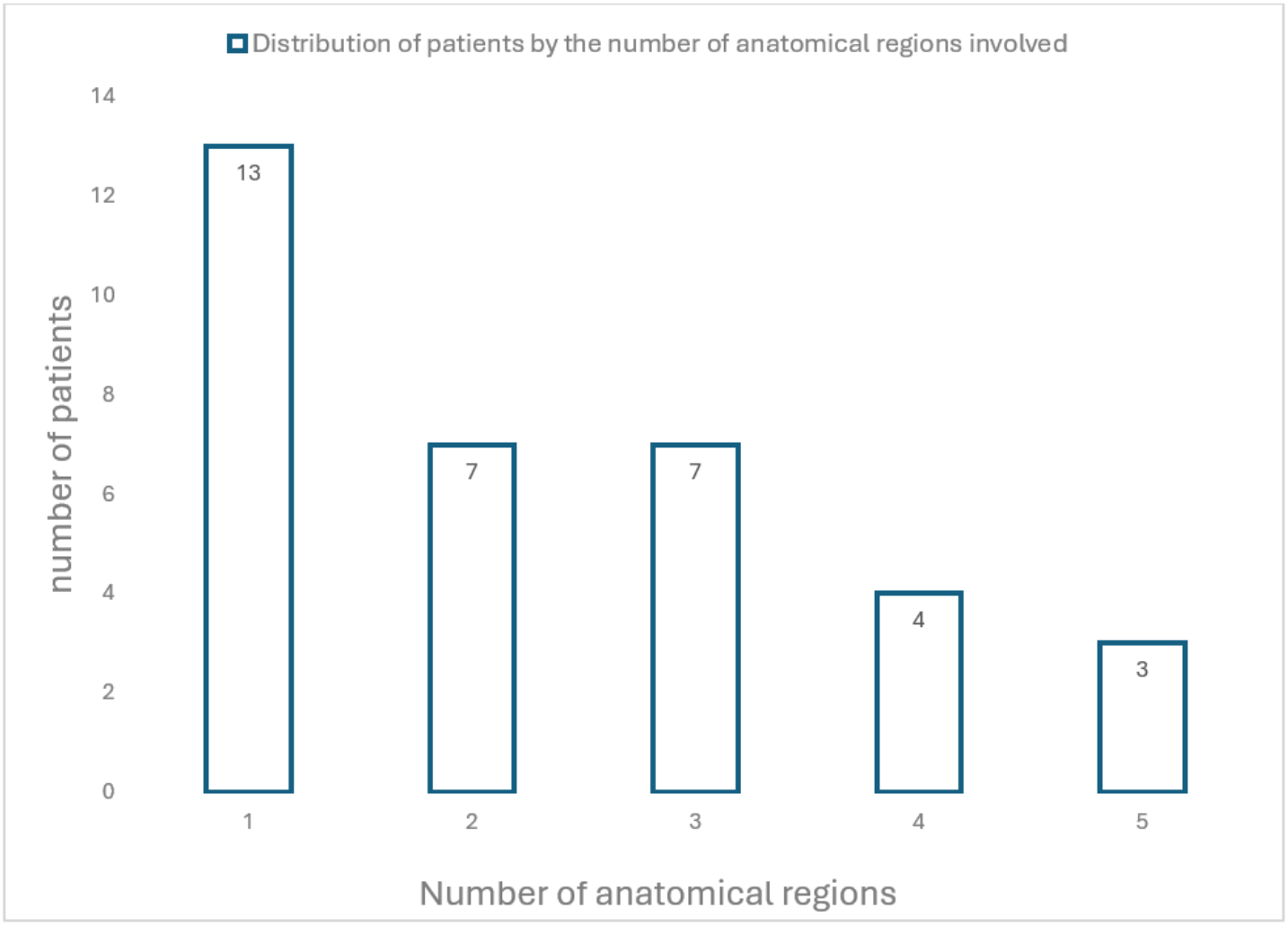


Figure 2

Distribution of cholesteatomas.

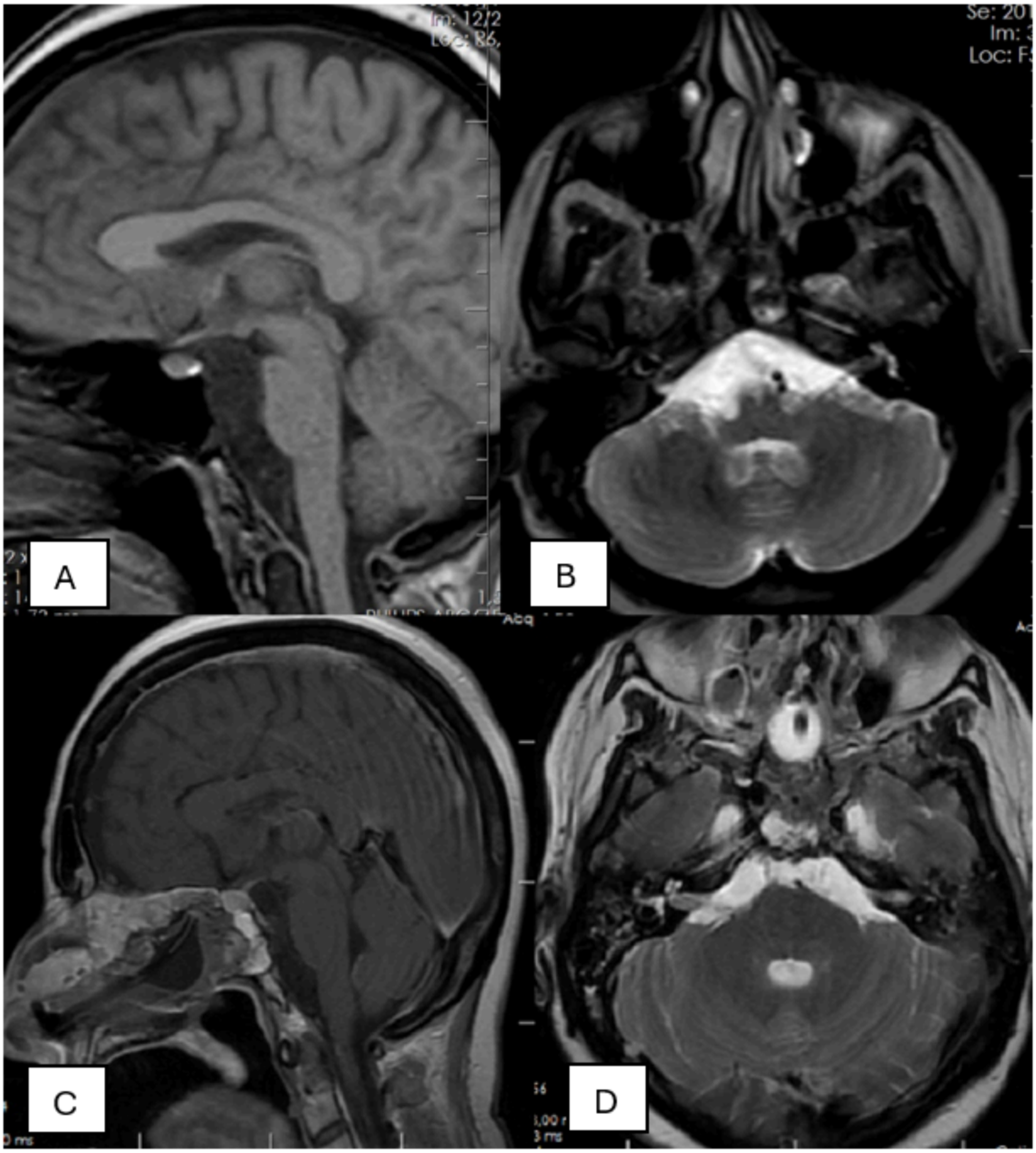


Figure 3

A *– Sagittal T1-weighted MRI;* ***B*** *– Axial T2-weighted MRI: a cholesteatoma in the ventral posterior cranial fossa and the interpeduncular cistern.* ***C*** *– Sagittal T1-weighted MRI;* ***D*** *– Axial T2-weighted MRI: the result after near-total endoscopic endonasal removal of the lesion using a posterior expanded approach, without intraoperative complications. The postoperative course was complicated by meningitis.*

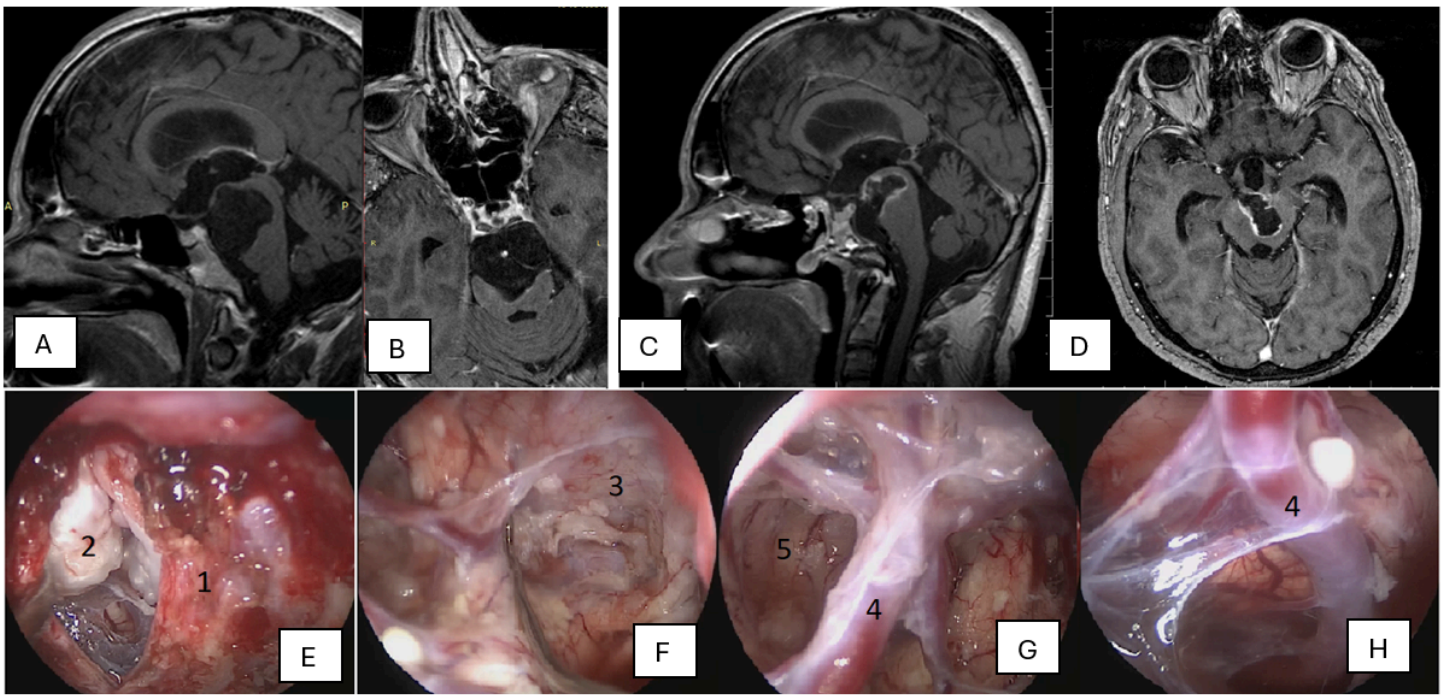


Figure 4

A *– Sagittal contrast-enhanced T1-weighted MRI;* ***B*** *– Axial contrast-enhanced T1-weighted MRI: a cholesteatoma in the ventral parts of the posterior cranial fossa and the interpeduncular cistern, causing brainstem compression.* ***C*** *– Sagittal contrast-enhanced T1-weighted MRI;* ***D*** *– Axial contrast-enhanced T1-weighted MRI: status after near-total endoscopic endonasal resection of the lesion using a posterior expanded approach, without intraoperative complications. The postoperative course was complicated by meningitis and cerebrospinal fluid leakage, which required 5 revision surgeries.* ***1*** *– clival dura mater,* ***2*** *– cholesteatoma in the prepontine cistern,* ***3*** *– tentorium cerebelli,* ***4*** *– basilar artery,* ***5*** *– brainstem.*

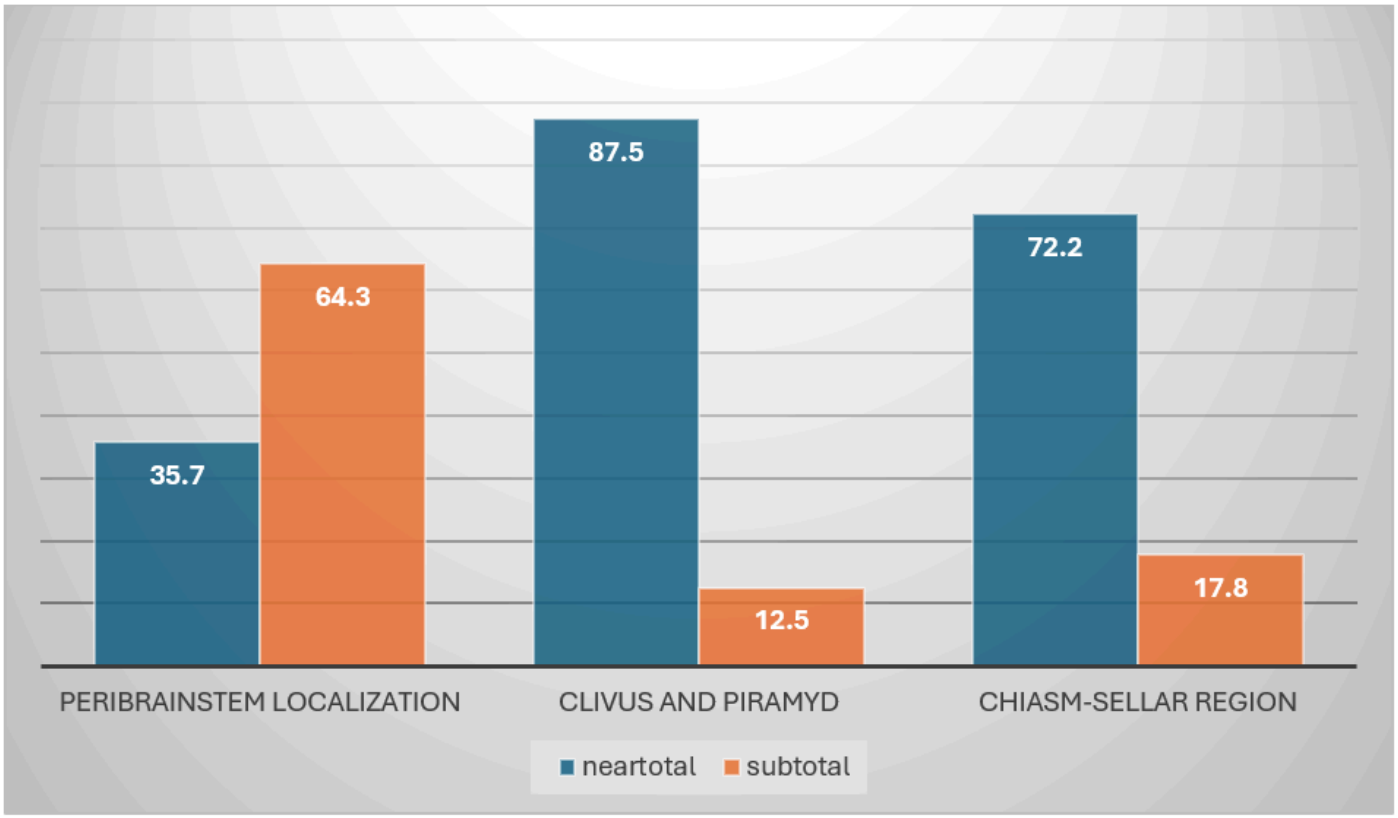


Figure 5

Extent of resection depending on the lesion's location (% of patients in location-based subgroups).

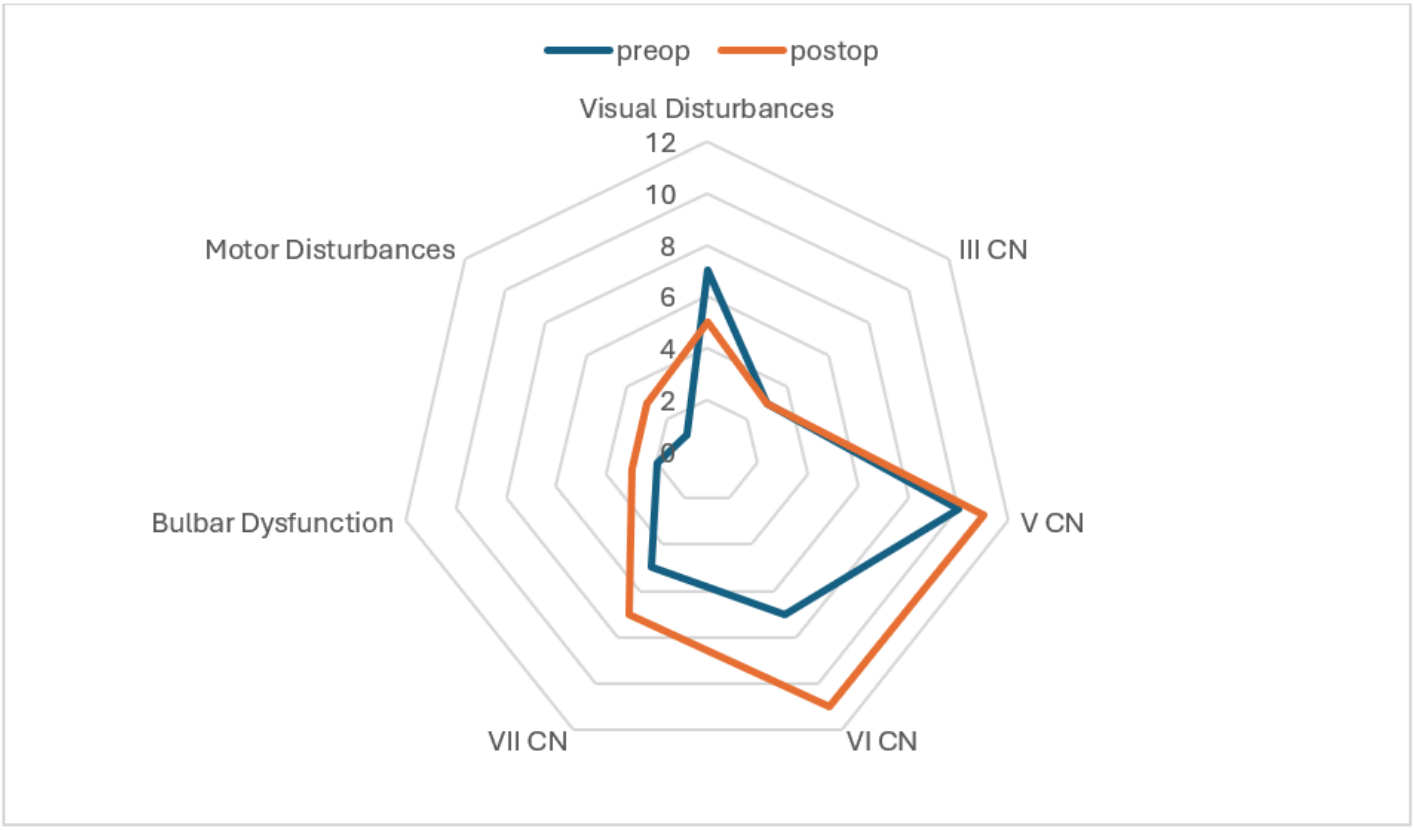


Figure 6

Clinical course in the study patient cohort.

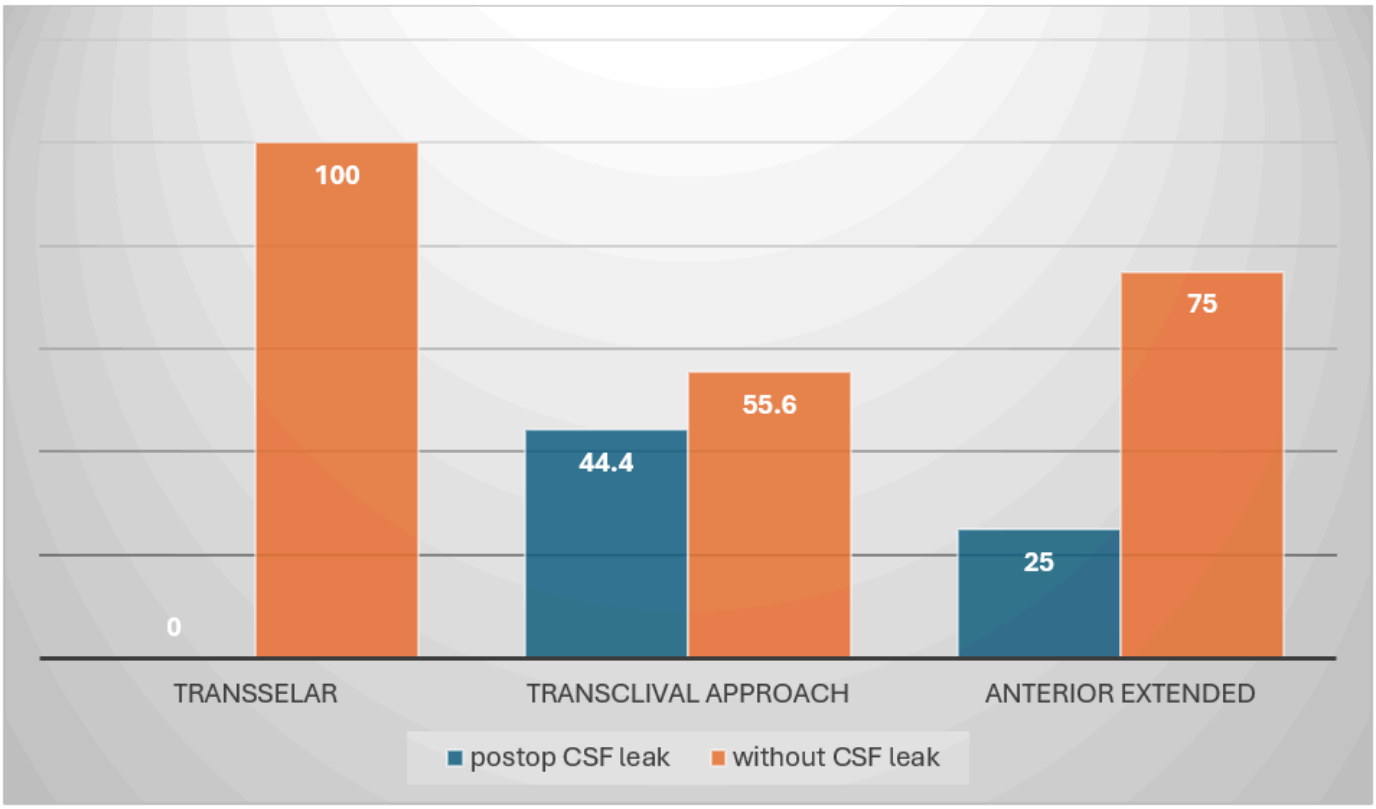


Figure 7

Frequency of CSF leakage according to the surgical approach.