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Original Article

Impact of the Lumbar Catheter on the Incidence of Postsurgical Meningitis in the Endoscopic Endonasal Approach

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Abstract

Objectives Endoscopic endonasal approach (EEA) procedures are inherently contaminated due to direct access through the nasopharyngeal mucosa. The reported rate of postoperative meningitis in EEA procedures is between 0.7 and 10%. Lumbar catheters are used in EEA surgeries to prevent cerebrospinal fluid (CSF) fistulae, but their use is associated with increased infection rates. This study investigated whether there is a difference in rates of postoperative meningitis based on lumbar catheter (LC) utilization.
Methods We performed a retrospective review of consecutive patients who underwent EEA surgeries between January 2016 and March 2023 at a single institution (Fundación para la Lucha contra las Enfermedades Neurológicas de la Infancia).
Main Outcome Incidence of meningitis following EEA surgery with lumbar catheter.
Results Seventy-two patients were enrolled, median age was 44 years, and 53% were female. The most frequent surgery performed was craniopharyngioma 46% (26 patients). A LC was used in 28 patients. Meningitis was diagnosed in 11 of 72 patients (15.2%), being higher in the LC group (10 patients). The odds ratio for the development of meningitis in the presence of an LC was 23.38 (95% confidence interval, 2.77–123.78; $p < 0.004$). There was no statistical difference in the reported incidence of meningitis when CSF leak was present.
Conclusions This study demonstrates an extremely high incidence of meningitis (36%) following EEA procedures when an LC is used. The incidence of meningitis was not significantly associated with CSF leak in our cohort.

Keywords
- CSF leak
- expanded EEA
- lumbar catheter
- meningitis

Introduction

The applications of endoscopic endonasal approaches (EEAs) to skull base surgery have expanded the scope to include pathologies that a few years ago would have not even been contemplated.[1] Early results confirm the safety and efficacy of this technique, and the incidence of complications associated with EEAs compares favorably with external or microscopic approaches. The most common complication in EEA is the postoperative cerebrospinal fluid (CSF) leak. Other complications include transient neurologic deficits, permanent neurologic deficits, and intracranial infection. The potential risk of postoperative CSF leaks associated with the larger defects

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created through expanded EEA can be minimized significantly (<5%) by multilayered closure with a vascularized pedicled nasoseptal flap,[2] a meticulous surgical technique, and postoperative lumbar drainage (LD) through a catheter.[3,4]

Although a lumbar catheter (LC) is an effective and safe treatment modality which has been successfully utilized in a variety of neurosurgical procedures, it is not risk free.[5] Complications are frequently reported, and meningitis is a common complication of LD. The incidence varies among different reports between 5 and 30% but could be higher than 40%.[6] These large variations in infection rates are due to a myriad of reasons, such as primary diseases, drain indwelling procedures, patient population, and use of prophylactic antibiotics. Furthermore, most parts of the studies are a mixture of lumbar and external ventricular drainages, preventing knowing the real number of infections by LCs. The literature on the incidence and risk factors of LC-related meningitis is scarce, and it is primary focus when an LC is used for control of intracranial hypertension, drainage of bloody or infectious CSF, or prevention of complications secondary to aneurysmal subarachnoid hemorrhage.

The purpose of this study was to describe the association between an LC and postsurgical meningitis in patients with an endoscopic endonasal approach in skull base surgery.

Methods

The records of all neurosurgical patients with an EEA operated at Fundación para la Lucha contra las Enfermedades Neurológicas de la Infancia between January 2016 and March 2023 were retrospectively reviewed. EEA surgeries included tuberculum sellae meningiomas, craniopharyngioma, chordomas, chondrosarcomas of the skull base, esthesioneuroblastoma, oncocytoma, and trigeminal neurinoma. Pituitary adenomas were excluded due to the local policy of absence of routine LD.

Method of Lumbar Drainage

EEA surgeries were considered for LD if the patient presented a risk for postoperative CSF leak development, such as an anticipated large sellar opening, high body mass index, or radiological signs of high intracranial pressure. All catheters were placed under sterile conditions in the operating room before the surgery. To place LCs, a vertebral interspace between L3–L4 and L5–S1 was targeted, and a spinal needle was placed in the subarachnoid space. After the catheter was inserted into the subarachnoid space, the spinal needle was removed, and the drain was attached to a drainage bag. The external part of the intraspinal catheter was positioned transversely across the back, secured to the patient's flank, and covered with a clear adhesive dressing. There was a routine drainage of 200–250 mL CSF per day, to a closed system. The LD was removed at the patient's bedside between days 3 and 5, according to the attending neurosurgeon. The catheters were removed early because of clinical signs of central nervous system infection, accidental dislodgment, or absence of drainage.

Data Collection

Patient records were examined for patient characteristics, clinical data (fever, signs of meningitis, headache, and neurological status), drain characteristics (blockage, site leakage, and involuntary disconnection), diagnostic tests, and treatment information. The following data was extracted: age, sex, type of surgery, duration of LC prior to CSF sampling, concomitant antibiotic treatment prior to CSF collection, causative organisms, and Gram stains of CSF samples, as the CSF characteristics (cellularity, protein, glucose, and lactate), glycemia measurement simultaneous to CSF extraction, immunosuppression, and underlying diabetes.

Definition of Infection

Meningitis was clinically suspected in surgical patients presenting fever (temperature > 38.3 °C), unexplained neurological deterioration, and/or clinical signs typical of central nervous system infection with no other recognized cause (e.g., headache, stiff neck, and/or altered mental status). CSF tests were performed, and the patient was categorized following institutional guidelines.

1. Proven postsurgical meningitis: positive bacterial CSF culture or Gram stain, plus worsening of CSF parameters (increased white cell count (≥100 /mL), decreased glucose level (<40 mg/dL in CSF or CSF/plasma glucose ratio <0.4), and/or elevated CSF lactate >4 mmol/L).
2. Presumed postsurgical meningitis: Patients who received antibiotics 24 hours before CSF sample, plus worsening of CSF parameters (increased white cell count (≥250 /mL), decreased glucose level (<40 mg/dL in CSF or CSF/plasma glucose ratio <0.4), and/or elevated CSF lactate > 4 mmol/L).
3. No postsurgical meningitis: neither proven nor presumed criteria.

The CSF result would be considered to be a contamination when a patient had CSF culture positive for a common skin pathogen, and CSF analysis was normal.

Statistical Analysis

Frequency tests were used in the descriptive analyses, as appropriate. Data are expressed as median (range), or absolute number (percentage). Cases of proven and probable postneurosurgical bacterial meningitis will be combined into a single group (postneurosurgical bacterial meningitis group) for statistical analysis. Univariate logistic analysis will be performed to assess the association between the primary outcome and the following covariates: age, sex, type of surgery, catheter duration, fistulae, involuntary drain disconnection, diabetes, and immunosuppression. Parameters significant in univariate analyses ($p < 0.05$) will be included in a multivariate regression model. The association between the use of a LC and postneurosurgical meningitis will be evaluated using a logistic regression model adjusted for covariates (odds ratios and their respective 95% confidence intervals: odds ratio [OR] 95% confidence interval [CI]). All analyses were performed in IBM SPSS (version 23.0.0.0, Chicago, United States).

Institutional review board approvals were obtained for the study, and inform consent was waived. All procedures were conducted in accordance with IRB ethical standards as per the Declaration of Helsinki (1975).

Results

During the study period, 72 patients satisfying the inclusion criteria were enrolled. The median age was 44 years (interquartile range [IQR]: 24–64) and 53% were female (38 patients). Types of surgery were craniopharyngioma 36.1% (26 patients), chordoma 20.9% (15), chondrosarcoma 11.1% (8), tuberculum sellae meningiomas 23.6% (17), trigeminal neurinoma 4.2% (3), esthesioneuroblastoma 2.8% (2), and oncocytoma 1.4% (1). Demographic data are shown in ►**Table 1**, stratified by the presence of LC. No statistical difference was seen in comorbidities.

Meningitis was diagnosed in 11 of 72 patients (15.3%), being higher in the LC group (►**Table 1**). The median time to infection was 3 days in both groups, and fistulae presence was higher with LD. Gram-negative and Gram-positive microorganisms were equally cultured in the CSF (5 of 11 bacteria for each group, 45.5%), and one negative culture with pathological CSF was seen. Most frequent positive microbiological cultures were *Staphylococcus aureus* (31%) and *Klebsiella pneumoniae* (15.4%).

The presence of LC or fistulae was a factor related to postoperative meningitis. However, in a multivariate regression model, only the presence of LC was associated with infection (►**Table 2**).

Table 2 Independent Factors for postoperative meningitis in EEA surgery

	Adjusted OR (95% CI)	*p*-Value
Lumbar catheter	23.38 (2.77–123.78)	0.004
Fistulae	5.47 (0.93–36.02)	0.071

Abbreviations: CI, confidence interval; EEA, endoscopic endonasal approaches; OR, odd ratio.
Note: Generalized linear model (binary logistic).

Discussion

EEA has become an efficient surgical technique for the treatment of skull base tumors. However, postoperative meningitis remains one of the most concerning complications, with a reported rate between 0 and 15%. Consistent with this observation, our study found meningitis in 15.3% of our patients. However, when only cases with postoperative LC are account, the meningitis rate increased to 36%.

Our rate of meningitis fell over the higher range, probably due to a more inclusive definition of meningitis compared with other studies, as well as the inclusion of cases with larger defects of the arachnoid, and the exclusion of pituitary adenomas, thus increasing the surgical complexity. Most parts of the studies accepted the definition of CSF infections by Mayhall et al[7] which requires a positive CSF culture. This definition excludes patients with meningitis to negative cultures and has low sensitivity in cases with the administration of previous antibiotics, such as in the days close to

Table 1 Baseline characteristics

	Lumbar catheter (*n*: 28)	No Lumbar catheter (*n*: 44)	*p*-Value
Gender (female)	18 (64%)	20 (45%)	0.12
Age, median (IQR)	46 (28–62)	43 (21–64)	0.65
Diabetes mellitus	1	2	0.84
Immunosuppression	0	2	0.26
Type surgery			0.13
Craniopharyngioma	15	11	
Chordoma	5	10	
Chondrosarcoma	1	7	
Tuberculum sellae meningiomas	7	10	
Esthesioneuroblastoma	0	2	
Oncocytoma	0	1	
Trigeminal neurinoma	0	3	
Meningitis	10 (36%)	1 (2.3%)	**0.001**
Time to meningitis (days) Median (IQR)	3 (2–8)	5 (5–5)	0.18
Fistulae	5	2	**0.02**
Drain opening	1	0	0.42

Abbreviation: IQR, interquartile range.
Bold values indicate *p*-Value of significance level: < 0.05.

surgery, underestimating the real number of infections. Therefore, other authors used the Infectious Diseases Society of America /US Centers for Disease Control and Prevention (CDC) definition,[8] which incorporates the presence of CSF abnormalities (pleocytosis, low glucose level, and/or high protein level) and clinically relevant factors such as fever and change in mental status. However, our study includes a broader definition of infection (proven and presumed postsurgical meningitis),[9] with consequently a higher rate of infections.

The most important factor for developing meningitis in our cohort was the presence of a postoperative LC. Although one potential downside of LD is that it may prove to be an additional source for meningitis, no previous report in the literature has addressed this issue in skull base surgery. Risk factors for infection have been described as associated with complex tumors, presence of an external ventricular drain or shunt, and postoperative CSF leak, but not to the presence of lumbar drains.[10]

CSF leak remains one of the major challenges of skull base surgery. Thus, to lower intracranial pressure and thus potentially prevent postoperative CSF leaks, LD is often used in the perioperative and postoperative periods. However, its use to prevent CSF leaks after EEA surgery remains controversial. Clinical practice varies widely, and some studies suggest that LD does not need to be routinely used since the advent of the nasoseptal flap.[2] An important confounder is identifying CSF leaks as high flow or low flow. A practical definition of "high-flow CSF leak" is one that violates a ventricle or cistern (requires a more robust reconstruction), a dural defect larger than 1 cm^2, or a significant arachnoid dissection. A randomized controlled trial from Pittsburgh evaluated the use of perioperative LD in high-risk EEA surgeries and found that they were associated with a significant reduction in postoperative CSF leak rates (21.2 vs. 8.2%).[3] Nevertheless, several studies noted that perioperative LD did not affect the postoperative CSF leak rate.[11–13]

We did not observe an increased rate of meningitis when LD was associated with a CSF leak. This record is different from what is usually reported in the literature. Kono et al described a series of 1,000 endoscopic surgeries in which CSF leak, which occurred in 14% of cases, was the strongest risk factor for developing subsequent meningitis with an OR of 12.99.[14] Lai et al reported that the presence of postoperative CSF leak was associated with subsequent meningitis (OR: 91.99).[15] Similar results were shown by Lee et al,[16] where the risk of developing meningitis in patients with a CSF leak was significantly higher than those without a leak (OR: 11.48). The discrepancy with our study probably lies in the scarce number of fistulae in the cohort, leading to an almost significant result in the multivariate analysis ($p = 0.071$, ►**Table 2**). We hypothesize that probably with a greater number of patients; this risk factor would be significant, in agreement with the literature.

The duration of catheterization is a major risk factor for the development of drain-related meningitis. Several studies confirmed that the length of time of the lumbar drain was usually associated with postoperatively infection.[17–19] Our experience was no different, confirming the relationship between lumbar catheterization time and the probability of postsurgical meningitis associated with drainage. Therefore, timely removal of LC remains a recommended approach to prevent infection.

We observed a greater rate of meningitis in EEA surgeries than after a standard craniotomy, independently of the utilization of lumbar drains. We found a meningitis rate of 1.21% in a previous study, with the same meningitis definition,[9] compared with the 15.3% in the actual series. This finding was also seen by other authors, which found a raise in 3 to 10% in meningitis in EEA for skull base surgeries.[14,20] The increase in the number of infections could be probable due to the fact of operating through the "clean-contaminated" field of the sinonasal cavities, where many instruments and graft materials pass through this potentially contaminated field during the procedure.

Considering the high risk of meningeal infection associated with the use of an LD, and with other available options for fistula prevention, the LC should only be used in high-flow CFS leak in patients with other risk factors (such as high body mass index), technical difficulties to perform a multilayered closure, preoperative hydrocephalus, and/or extension to retroclival region.

Several limitations of this study are worth citing. First, the retrospective nature of the study has the inherent bias of this kind of design. Second, the definition of meningitis utilized differed from the CDC definition, but it was based on well-defined alterations of CSF and clinical signs and was used in previously published research.[9] Last, the small number of patients was probably due to the exclusion of pituitary adenomas in this cohort, and hence keeping out the main indication for the endonasal approach. Nevertheless, these fact leads to a selection of more serious pathologies,[14] and therefore a greater probability of using an LC, supporting the conclusion of the study.

Conclusion

Our findings suggest that the utilization of LC increases the incidence of postoperative meningitis in endoscopic endonasal surgery. This information adds to the controversial fact about the use of LC to prevent CSF leaks, advocating its use only in high-risk, high-flow cases.

Conflict of Interest
None declared.

References

1 Paluzzi A, Gardner P, Fernandez-Miranda JC, Snyderman C. The expanding role of endoscopic skull base surgery. Br J Neurosurg 2012;26(05):649–661
2 Hadad G, Bassagasteguy L, Carrau RL, et al. A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap. Laryngoscope 2006;116(10):1882–1886
3 Zwagerman NT, Wang EW, Shin SS, et al. Does lumbar drainage reduce postoperative cerebrospinal fluid leak after endoscopic endonasal skull base surgery? A prospective, randomized controlled trial. J Neurosurg 2018;131(04):1–7

4 Ackerman PD, Spencer DA, Prabhu VC. The efficacy and safety of preoperative lumbar drain placement in anterior skull base surgery. J Neurol Surg Rep 2013;74(01):1–9

5 Açikbaş SC, Akyüz M, Kazan S, Tuncer R. Complications of closed continuous lumbar drainage of cerebrospinal fluid. Acta Neurochir (Wien) 2002;144(05):475–480

6 Li G, Zhang Y, Zhao J, Han Z, Zhu X, Hou K. Some cool considerations of external lumbar drainage during its widespread application in neurosurgical practice: a long way to go. Chin Neurosurg J 2016;2(1)

7 Mayhall CG, Archer NH, Lamb VA, et al. Ventriculostomy-related infections. A prospective epidemiologic study. N Engl J Med 1984; 310(09):553–559

8 Tunkel AR, Hasbun R, Bhimraj A, et al. 2017 Infectious Diseases Society of America's Clinical Practice Guidelines for Healthcare-Associated Ventriculitis and Meningitis. Clin Infect Dis 2017;64 (06):e34–e65

9 Maskin LP, Capparelli F, Mora A, et al. Cerebrospinal fluid lactate in post-neurosurgical bacterial meningitis diagnosis. Clin Neurol Neurosurg 2013;115(09):1820–1825

10 Ivan ME, Iorgulescu JB, El-Sayed I, et al. Risk factors for postoperative cerebrospinal fluid leak and meningitis after expanded endoscopic endonasal surgery. J Clin Neurosci 2015;22(01): 48–54

11 Caggiano C, Penn DL, Laws ER Jr. The role of the lumbar drain in endoscopic endonasal skull base surgery: a retrospective analysis of 811 cases. World Neurosurg 2018;117:e575–e579

12 Guo X, Zhu Y, Hong Y. Efficacy and safety of intraoperative lumbar drain in endoscopic skull base tumor resection: a meta-analysis. Front Oncol 2020;10:606

13 Qiao N, Li C, Liu F, et al. Risk factors for cerebrospinal fluid leak after extended endoscopic endonasal surgery for adult patients with craniopharyngiomas: a multivariate analysis of 364 cases. J Neurosurg 2023;140(01):47–58

14 Kono Y, Prevedello DM, Snyderman CH, et al. One thousand endoscopic skull base surgical procedures demystifying the infection potential: incidence and description of postoperative meningitis and brain abscesses. Infect Control Hosp Epidemiol 2011;32(01):77–83

15 Lai LT, Trooboff S, Morgan MK, Harvey RJ. The risk of meningitis following expanded endoscopic endonasal skull base surgery: a systematic review. J Neurol Surg B Skull Base 2014;75(01):18–26

16 Lee SJ, Cohen J, Chan J, Walgama E, Wu A, Mamelak AN. Infectious complications of expanded endoscopic transsphenoidal surgery: a retrospective cohort analysis of 100 cases. J Neurol Surg B Skull Base 2020;81(05):497–504

17 Liang H, Zhang L, Gao A, et al. Risk factors for infections related to lumbar drainage in spontaneous subarachnoid hemorrhage. Neurocrit Care 2016;25(02):243–249

18 Scheithauer S, Bürgel U, Bickenbach J, et al. External ventricular and lumbar drainage-associated meningoventriculitis: prospective analysis of time-dependent infection rates and risk factor analysis. Infection 2010;38(03):205–209

19 Schade RP, Schinkel J, Visser LG, Van Dijk JM, Voormolen JH, Kuijper EJ. Bacterial meningitis caused by the use of ventricular or lumbar cerebrospinal fluid catheters. J Neurosurg 2005;102 (02):229–234

20 Kryzanski JT, Annino DJ, Gopal H, Heilman CB. Low complication rates of cranial and craniofacial approaches to midline anterior skull base lesions. Skull Base 2008;18(04):229–241

