

# The Association of Meningitis with Postoperative Cerebrospinal Fluid Fistula

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J Neurol Surg B 2012;73:401–404.

## Abstract

**Objective** To determine the risk factors for and the clinical course of postoperative meningitis following lateral skull base surgery and to determine its relationship to cerebrospinal fluid (CSF) fistula.

**Patients** Patients undergoing lateral skull base surgery between July 1999 and February 2010 at an academic tertiary referral center. All subjects had culture-proven meningitis or suspected bacterial meningitis in the postoperative period. Medical records were compared with the lateral skull base patients who did not develop meningitis.

**Results** Of 508 procedures, 16 patients developed meningitis (3.1%). The most common diagnosis was acoustic neuroma in 81.3%; 68.8% of patients had a CSF leak prior to onset of meningitis, and 50% received a lumbar drain. The median time from surgery to the onset of meningitis was 12 days with a range of 2 to 880 days. The relative risk of developing meningitis in the setting of postoperative CSF fistula is 10.2 ( $p < 0.0001$ ). No meningitis-associated mortality was observed.

**Conclusions** Postoperative meningitis occurred in a small number of patients undergoing lateral skull base surgery. A postoperative CSF fistula leads to an increased risk of meningitis by a factor of 10.2.

## Keywords

- ▶ meningitis
- ▶ postoperative meningitis
- ▶ acoustic neuroma

## Introduction

Bacterial meningitis is a risk of transdural lateral skull base surgery. Reported rates of meningitis following acoustic neuroma and other posterior cranial fossa surgery range from 0.14 to 9.2%.<sup>1–5</sup> Patients may present with headache, fever, nuchal rigidity, altered mental status, nausea, and vomiting. Bacterial meningitis is confirmed after culture of an organism from a lumbar puncture cerebrospinal fluid (CSF) aspirate. Chemical or aseptic meningitis is diagnosed with symptoms similar to bacterial meningitis but with a negative CSF culture. Unlike community-acquired meningitis, mortality from postoperative meningitis is very unusual. A recent literature review noted only one death related to

meningitis in 4,914 operations of the cerebellopontine angle.<sup>6</sup> The objective of this study is to determine risk factors and to describe the clinical course of postoperative meningitis following lateral skull base surgery, with special emphasis on the role of cerebrospinal fluid fistula in developing meningitis.

## Methods

Patients undergoing transdural lateral skull base surgery at a tertiary referral center from July 1999 to February 2010 were identified after approval by the University of Texas Southwestern Institutional Review Board (IRB Number: STU 062010–043). A retrospective chart review identified

received

November 21, 2011

accepted after revision

August 13, 2012

published online

November 5, 2012

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Verlag KG Stuttgart · New York

DOI <http://dx.doi.org/10.1055/s-0032-1329618>.  
ISSN 2193-6331.

patients who had developed postoperative meningitis. Patients were diagnosed with bacterial meningitis based on lumbar puncture culture results. Patients with presumed bacterial meningitis were identified by characteristics such as fever, nuchal rigidity, photophobia, CSF analysis, altered mental status, peripheral blood leukocytosis, and response to antibiotics. Patient characteristics (including surgical approach, perioperative CSF fistula, use of a lumbar drain, CSF profile, hospitalization length, and morbidity) were recorded.

Fever was defined as temperature greater than 38.5°C. Headache was determined by a new-onset, or progressively worsening, headache. Mental status change was defined as observed confusion, listlessness, lethargy, or somnolence. CSF fistula was defined as clear fluid draining from the operative incision, nose, or ear. Included were CSF fistulas that spontaneously resolved or resolved with pressure dressings or wound overclosure. Total length of hospitalization was determined by number of days in the initial hospital stay plus any hospital days if the patient was readmitted.

Preoperative antibiotics are given prior to incision in the operating room and continued for 24 hours. After this period, antibiotics are discontinued and only resumed if there is concern for meningitis or other bacterial infections. Patients were administered intraoperative and postoperative parenteral and oral steroids for vestibular schwannoma surgery. Patients were transitioned to oral steroids on the second postoperative day that were tapered over 7 to 14 days. Indications for steroid administration include prevention of chemical meningitis, brainstem/cerebellum edema, and delayed or progressive facial nerve dysfunction. Patients who underwent operations for diagnoses such as cerebrospinal fluid (CSF) otorrhea, vascular malformations, or paragangliomas did not follow a specific steroid protocol and were treated according to the operating surgeon's preference.

## Results

Five hundred eight transdural lateral skull base procedures were identified during the study period. Sixteen patients (3.1%) developed bacterial or suspected bacterial meningitis. With respect to surgical approach, meningitis occurred with the translabyrinthine approach in 9 patients (56.3%), the suboccipital approach in 5 patients (31.3%), and the middle cranial fossa approach in 2 patients (12.5%). Of patients who developed postoperative meningitis, the most common diagnosis was acoustic neuroma in 13 patients (81.3%). The remaining two diagnoses were facial nerve schwannoma and arteriovenous malformation. Half of the patients were female, and the average age was 52.1 years.

Signs and symptoms of meningitis at onset of diagnosis are listed in **Table 1**. All patients had an elevated peripheral white blood cell (WBC) count at the time of meningitis diagnosis. WBC counts ranged from 14 to 40.1 K/ $\mu$ L and averaged 20.8 K/ $\mu$ L. Total CSF protein was elevated in all patients (normal range 20 to 60 mg/dL) with a range from 63 to 1434 mg/dL and an average of 540.1 mg/dL. CSF glucose (normal range 40 to 70 mg/dL) was below normal in 14 patients (87.5%) with a range from 0 to 75 mg/dL and an

**Table 1** Signs and symptoms of meningitis at the time of diagnosis

Sign or symptom	Number of patients	Percentage
Headache	14	87.5
Nausea or vomiting	12	75
Fever	10	62.5
Mental status changes	9	56.3
Photophobia	5	31.3
Nuchal rigidity	5	31.3

average value of 25.3 mg/dL. CSF WBC was elevated in all patients with an average value of 11,520 mm<sup>3</sup>. A neutrophilic preponderance was seen on the differential in 15 patients (93.8%). CSF culture was positive in 11 patients (68.8%), negative in 4, and was not performed or not documented in 1. One patient with a negative culture had gram-positive cocci. Cultured organisms are listed in **Table 2**.

The median time to meningitis onset was 12 days (range; 2 to 880 days) postoperatively. The average length of hospitalization was 18.1 days (range; 9 to 37 days). Thirteen patients (81.3%) required readmission as signs and symptoms of meningitis developed after discharge from their initial hospitalization. All patients were treated with broad-spectrum antibiotics until identification of an organism and specific antibiotic sensitivities were obtained. All patients had resolution of meningitis with antibiotic treatment. No meningitis-associated mortality or long-term morbidity was observed.

**Table 3** shows the relative risk of meningitis by surgical approach. The suboccipital approach was the only procedure with a statistically significant increased risk of meningitis.

A CSF fistula was documented in 90 patients. Of these, 11 (12.2%) developed meningitis, a relative risk of 10.2 (95%

**Table 2** Bacteria cultured from cerebrospinal fluid (CSF) of patients with postoperative meningitis

Organism isolated on CSF culture	Number of patients
<i>Enterococcus</i>	2
Alpha-hemolytic streptococcus	1
<i>Viridans streptococcus</i>	1
<i>Acinetobacter</i> species	1
<i>Escherichia coli</i>	1
<i>Staphylococcus epidermidis</i>	1
<i>Propionibacterium acnes</i>	1
<i>Enterobacter aerogenes</i>	1
<i>Haemophilus influenzae</i>	1
<i>Pseudomonas aeruginosa</i>	1

**Table 3** Relative risk of developing postoperative meningitis stratified by type of surgical approach

Surgical approach	Number of patients	Percentage who developed meningitis	Relative risk	95% CI	p Value
Translabyrinthine	242	3.7	1.47	0.55–3.88	0.44
Middle fossa	72	2.8	0.89	0.21–3.85	0.88
Suboccipital	62	5.4	3.35	1.20–9.32	0.02
Transpetrosal	42	0	0.34	0.02–5.58	0.45
Infratemporal/transtemporal	41	0	0.35	0.02–5.72	0.46
Other	49	0	0.29	0.02–4.74	0.38

confidence interval [CI] 3.6 to 28.7,  $p < 0.0001$ ). Of patients who developed meningitis, 11 (68.8%) developed a postoperative CSF fistula, and 8 were treated with a lumbar drain. For patients in which a lumbar drain was utilized, the drain was left in place for a mean of 4.75 days (range 1 to 6) in patients who developed meningitis, which is similar to a mean of 4.6 days (range 1 to 7) in patients who did not develop meningitis. Development of a CSF fistula preceded meningitis in all cases.

Delayed onset of meningitis was noted in one patient after a suboccipital approach for vestibular schwannoma excision. The patient developed CSF rhinorrhea on postoperative day 3 and was treated unsuccessfully with lumbar drainage. The patient underwent operative repair on postoperative day 9 with closure of the external auditory canal and eustachian tube obliteration. Recurrent rhinorrhea was noted 1.5 years later, but she did not seek medical care until she presented to an emergency room with mental status changes, fever, nausea, and vomiting nearly 2.5 years after surgery. She was found to have *Haemophilus influenzae* meningitis and responded to a course of antibiotics. A second operation revealed a CSF leak from peritubal air cells, which were obliterated. No recurrent CSF rhinorrhea or meningitis has been observed at last follow-up.

## Discussion

Postoperative meningitis is a well-described complication of lateral skull base surgery. Although mortality is rare, early diagnosis and treatment is important in the management of these patients.

In this series, 3.1% of 508 patients developed postoperative meningitis, well within the range of 0.14 to 9.2% described in other series.<sup>1–5</sup> Meningitis was diagnosed at a median of 12 days postoperatively and the majority (81.3%) of patients were diagnosed after discharge from their initial hospitalization. This highlights the need to discuss signs of meningitis with patients to hasten care with the onset of meningitis.

The most common presenting signs and symptoms in patients with meningitis were a new or progressive headache, nausea, vomiting, fever, and mental status changes. These signs and symptoms can be easily missed given that headache and nausea are common in the postoperative period of lateral skull base surgery. Fever may be suppressed

by the use of analgesic agents containing antipyretic medication such as acetaminophen. Other features of meningism, such as nuchal rigidity and photophobia, were less common, involving less than a third of patients each. If meningitis is expected, a low threshold to perform a lumbar puncture is suggested.

A greater percentage of patients developed meningitis after the suboccipital approach (5.4%) than the other approaches utilized. This was associated with a relative risk of 3.35, which was statistically significant. Although not examined in this retrospective review, larger tumors at our institution are typically removed via a translabyrinthine approach, so larger tumor size or longer operative procedures are unlikely to be the cause of this increased risk with the suboccipital approach.

The presence of a CSF fistula is an important risk factor for development of meningitis. This series showed that a CSF fistula contributed to a relative risk of 10.2 in developing meningitis, a statistically significant finding. This is in contrast to an analysis of postcraniotomy risk factors in a series reported by Kourbeti et al, in which the presence of CSF leak was not statistically significant in developing meningitis.<sup>7</sup> A CSF fistula communicating between the environment and the intracranial space seems to be an obvious risk for meningitis, but the relative risk of developing meningitis had not been previously elucidated. The patient who developed meningitis more than 2 years postoperatively demonstrates the importance of discussing signs of a CSF fistula with patients and stressing the importance of seeking care if a leak is suspected. This patient had been lost to follow-up and likely would have avoided meningitis had her CSF rhinorrhea been repaired earlier.

## Conclusion

Postoperative meningitis is uncommon following lateral skull base surgery. If a CSF fistula develops postoperatively, the patient is at significantly higher risk of meningitis, by a factor of 10.2.

### Note

Presented at the AAO–HNS 2011 Annual Meeting and OTO EXPO, September 11, 2011.

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