Cerebrospinal Fluid Leaks Following Cervical Spine Surgery

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Background: A cerebrospinal fluid leak during cervical spine surgery is a feared complication. However, little is known about the prevalence, management, and long-term course of these events.

Methods: The medical records of 1994 patients who had elective cervical spine surgery during an eleven-year period (1994 through 2005) were reviewed. Patients with cervical cerebrospinal fluid leaks identified at the time of surgery were followed both clinically and radiographically for an average of 5.4 years postoperatively. The prevalence, etiology, management, and outcome of all of the cervical cerebrospinal fluid leaks were analyzed.

Results: The overall prevalence of cerebrospinal fluid leaks was 1%. The prevalence of cerebrospinal fluid leaks was higher in patients with a diagnosis of ossification of the posterior longitudinal ligament (12.5%), patients having a revision anterior procedure (1.92%), men (1.56%), and patients undergoing an anterior cervical corpectomy and arthrodesis (1.77%).

Conclusions: Many cervical dural tears can be managed by observation alone or by placement of a lumbar cerebrospinal fluid shunt either during the index procedure or in the postoperative period. At an average follow-up of 5.4 years, there were no long-term sequelae of the cervical dural tears in our series.

Level of Evidence: Prognostic Level II. See Instructions to Authors for a complete description of levels of evidence.

Cerebrospinal fluid leaks after lumbar spine surgery are well documented and are among the most commonly reported complications, occurring in approximately 14% of patients who have lumbar spine surgery, according to a review of the cases of 641 patients by Wang et al.1 However, cerebrospinal fluid leaks in the cervical spine, although they are recognized as important complications, have been poorly characterized and seldom reported. Many authors have mentioned the risk of meningitis, spinocutaneous fistula, or pseudomeningocele associated with cerebrospinal fluid leaks in the cervical spine2-4. However, the prevalence, ideal management, and long-term course of such leaks are unknown. Most authors agree that lumbar dural tears should be repaired primarily5-6; however, there are only limited data to guide the management of cerebrospinal fluid leaks in the cervical spine. In a search of the English-language literature, we found the cases of only eleven patients who had incidental cervical dural tears and we were unable to find any data describing the management or long-term course of cervical dural tears5-7.

The purpose of this study was to determine the prevalence and etiology of incidental durotomies during elective surgery of the cervical spine. In addition, we sought to identify risk factors for cervical cerebrospinal fluid leaks, describe their intraoperative and postoperative management, and determine the long-term outcomes.

Materials and Methods

After obtaining approval from our institutional review board, we reviewed the records of all patients who had an elective cervical spine procedure performed by the two senior authors (J.D.K. and W.F.D.) during an eleven-year period (1994 through 2005). The surgeries were performed at a university teaching hospital with the assistance of orthopaedic surgery residents and spine fellows.

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Data were recorded from both the hospital charts and the office charts. The first postoperative evaluation usually took place at two to four weeks, followed by evaluations at three months, six months, one year, and then yearly. The date of the last office note was used as the final follow-up evaluation for each patient.

The information recorded for each patient included the demographic data, preoperative diagnosis, location of the tear, and the intraoperative and postoperative management. Any signs or symptoms that could be attributed to the dural tear were also recorded, and these included tinnitus, blurry vision, positional headaches, delayed wound-healing, excessive clear or serosanguineous drainage, subcutaneous fluid collections, dysphagia, nausea, vomiting, blurred vision, neck stiffness, photophobia, strabismus, new or worsening motor or sensory findings, the development of a pseudomeningocele, a draining sinus, wound infection, or meningitis.

Statistical Analysis
The prevalence of cerebrospinal fluid leaks was calculated as the proportion of dural tears to the total number of individuals undergoing cervical spine surgery. To identify factors associated with the cerebrospinal fluid leaks, we used chi-square tests to determine the relationship between cerebrospinal fluid leaks and the surgical approach (anterior compared with posterior), surgical procedure (anterior cervical discectomy and fusion compared with anterior cervical corpectomy and fusion), primary compared with revision surgery, and ossification of the posterior longitudinal ligament. Because the overall number of cerebrospinal fluid leaks was small, the Yates correction factor was used to calculate the chi-square statistic if the expected frequency in any one cell was less than one or if >20% of the cells were less than five. We also calculated the relative risk and 95% confidence interval for each risk factor for a cerebrospinal fluid leak. The a priori alpha level for all statistical tests was set at 0.05. With the number of patients available for review, our study had a power of >80% to discern differences between various groups in the prevalence of cerebrospinal fluid leaks of as small as 5% at an a priori alpha level of 0.05.

Results
Demographic Data
One thousand nine hundred and ninety-four patients had elective cervical spine surgery. Of the 1994 patients, 222 had combined anterior-posterior procedures so there were a total of 2216 approaches to the cervical spine. Of the 2216 approaches to the spine, 1600 (72%) were anterior and 616 (28%) were posterior.

Prevalence
There were twenty dural tears, which were all diagnosed intraoperatively by visualization of clear fluid extravasating from the wound (see Appendix). Therefore, the overall prevalence of cerebrospinal fluid leaks was 1%. The prevalence for the various subsets of patients listed above is shown in a table in the Appendix. There were no intraoperative neuromonitoring changes (somatosensory evoked potentials) for any patient who had a cerebrospinal fluid leak.

Risk Factors for a Cerebrospinal Fluid Leak
The relative risk for the development of a cerebrospinal fluid leak was calculated for nonoverlapping subsets of patients. The relative risk for the development of a cerebrospinal fluid leak for an anterior compared with a posterior procedure was not significant (p ≥ 0.05). However, among the patients who had an anterior procedure, those undergoing anterior cervical corpectomy and fusion were 3.15 (95% confidence interval, 1.15 to 8.68) times more likely to have a cerebrospinal fluid leak than were patients undergoing anterior cervical discectomy and fusion (1.77% compared with 0.56%; p = 0.05) (see Appendix). Patients undergoing a revision anterior corpectomy and fusion were 2.77 (95% confidence interval, 0.75 to 10.29) times more likely to have a cerebrospinal fluid leak develop than were patients undergoing a primary anterior cervical corpectomy and fusion (4.9% compared with 1.77%; p = 0.05) (see Appendix). Patients with ossification of the posterior longitudinal ligament were 13.74 (95% confidence interval, 4.53 to 41.61) times more likely to have a cerebrospinal fluid leak than were patients without this condition (12.5% compared with 0.91%; p = 0.05). Patients having a revision anterior procedure were 2.75 (95% confidence interval, 0.85 to 8.93) times more likely to have a cerebrospinal fluid leak develop than were patients having a primary anterior procedure (1.91% compared with 0.7%; p = 0.05). Finally, men were 3.9 (95% confidence interval, 1.25 to 8.40) times more likely to have a cerebrospinal fluid leak develop compared with women (1.56% compared with 0.4%; p = 0.05). Age was not a significant risk factor.

The dural tears occurred while an electrocautery device was used during a posterior exposure (two patients), while a pituitary rongeur was used during an anterior discectomy (one patient), while a Kerrison rongeur was used during resection of the posterior longitudinal ligament (fourteen patients) and during a posterior foraminotomy (one patient), and while the lamina was elevated during a laminoplasty (two patients). Sixteen patients, two of whom (Cases 9 and 13) had a cerebrospinal fluid leak develop during resection of the ossified ligament, had a diagnosis of ossification of the posterior longitudinal ligament.

Treatment
The treatment for the tear was based on the algorithm shown in Figure 1. All dural tears that were accessible were repaired primarily (Cases 16 through 20). Dural tears that were not accessible were treated either with observation alone (Cases 1 through 11) or by insertion of a cerebrospinal fluid leak shunt at the time of the index procedure (Cases 12 through 15). In no instance was additional bone resected in order to gain access to repair a dural tear. With the exception of one patient (Case 18), no leak that occurred during an anterior cervical discectomy and fusion had adequate visibility to allow a repair. Only five of the twenty tears were accessible and thus repaired.
The presence of a dural tear did not alter the normal use of wound drains. A subfascial drain was always placed for posterior cervical wounds, and a submuscular drain was placed for anterior cervical wounds. Anterior drains were usually discontinued on postoperative day 1 or 2, and posterior drains were discontinued on postoperative day 2. The drains were kept on gravity suction with use of a Jackson-Pratt bulb (Baxter Healthcare, Deerfield, Illinois) that was fully expanded so that it would not hold suction. All patients with a dural tear were confined to bed rest with the head elevated 30° for at least one night. They were also all given antiemetics in an attempt to avoid the increased intrathecal pressure associated with emesis.

Outcome

Of the twenty patients with a cerebrospinal fluid leak, twelve (60%) had resolution of all signs and symptoms of the leak within three days of the index procedure, seventeen (85%) within one week, nineteen (95%) within four weeks, and all twenty (100%) within four months. No patient had any long-term sequelae that could be attributed to the leak.

Three patients (Cases 6, 9, and 14) had some type of adverse occurrence in the immediate postoperative period. One patient (Case 6) had undergone an anterior cervical corpectomy and fusion with use of a fibular strut graft and was noted to have a small dural tear intraoperatively. He presented to our office on postoperative day 7 with an asymptomatic fluctuant mass on his neck consistent with a pseudomeningocele. He was then taken back to the operating room where the cervical wound was explored and irrigated; however, the fibular graft was left in place and the dural tear was not exposed or repaired. A lumbar cerebrospinal fluid drain was inserted and left in place for five days. When he was seen at his follow-up office visit at three weeks, he had no additional sequelae from the tear. The second patient (Case 9) had a persistently draining wound for three days after a revision anterior cervical corpectomy and fusion in which a small dural tear occurred while an attempt was made to remove an ossified posterior longitudinal ligament. The third patient (Case 14) had development of transient postoperative motor weakness in the intrinsic muscles of the right hand, which had resolved by the time of her four-month follow-up visit.

No patient had spinocutaneous fistula, wound infection, or meningitis. All twenty patients with cerebrospinal fluid leaks returned to the office for follow-up evaluation, and all twenty had healed wounds when they were seen in the office two to four weeks after the last operative procedure. At the final follow-up evaluation, no patient had any evidence of infection, pseudomeningocele, or sinus tract formation. There were no long-term sequelae at the time of the final documented follow-up at an average of 5.4 years (range, sixteen months to eleven years).

Discussion

The prevalence of cervical dural tears has been reported to range from 0.5% to 3%[^4-^7,^10]. However, in none of those reports were cervical dural tears the main focus of the report. The overall prevalence of cerebrospinal fluid leaks during cervical spine surgery in our series was 1% (twenty of 1994 patients). The largest risk factor for the development of a cerebrospinal fluid leak in our series was the presence of an ossified posterior longitudinal ligament. Ossification of the posterior longitudinal ligament is a known risk factor for dural deficiency, resulting in cerebrospinal fluid leaks[^11,^12]. When they had this diagnosis, patients were 13.7 times more likely to have a cerebrospinal fluid leak during cervical spine surgery compared with patients without ossification of the posterior longitudinal ligament (p = 0.05). Of the 1994 patients included in our study, sixteen had a diagnosis of ossification of the posterior longitudinal ligament. Two of them (Cases 9 and 13) had a cerebrospinal fluid leak develop.

Patients having revision anterior cervical spine surgery (an anterior approach through a previous incision) were the second most likely subset to have a cerebrospinal fluid leak develop. Patients undergoing revision anterior cervical procedures were 2.7 times more likely to have a cerebrospinal fluid leak compared with patients having a primary anterior cervical procedure (p = 0.05).

The most common cause of a cerebrospinal fluid leak in our series was injury to the dura when a Kerrison rongeur was used to resect the posterior longitudinal ligament. It has been the practice of both senior authors to resect this ligament during an anterior discectomy and fusion during an anterior corpectomy and fusion when it was believed that there may be disc material posterior to it. The need to routinely resect the posterior longitudinal ligament during anterior cervical surgery has been the subject of debate. Some authors have advocated removing it only if there is preoperative evidence of disc material posterior to it, while others have recommended always removing it[^13-^15]. However, Humphreys et al. showed that preoperative magnetic resonance imaging had a sensitivity of only 46.2% and a specificity of 92.9% for predicting the presence of extruded disc material posterior to the posterior longitudinal ligament[^16]. They routinely resected the ligament during anterior cervical discectomy and found that preoperative magnetic resonance imaging failed to predict disc material posterior to the posterior longitudinal ligament in fourteen of the fifty-four levels studied. While resection of this ligament may help to ensure complete removal of any extruded disc material, it also increases operative time and may increase the risk of development of a cerebrospinal fluid leak.

Two spinal fluid leaks occurred while an electrocautery device was used during posterior approaches to the spine. When operating on the posterior portion of the cervical spine, surgeons should be mindful that the dura is vulnerable to injury, even during the exposure.

If there was adequate exposure, a direct repair of the dural tear was performed. Only five of the twenty tears, however, were amenable to a direct repair. The repair was usually done with a 4-0 silk suture, but other methods that use collagen grafts, fibrin glue, or fat or muscle patches have also been described with good results[^3,^4,^16-^20].
The management of the fifteen dural tears that could not be repaired was governed by the size and degree of the cerebrospinal fluid leak (Fig. 1). Smaller tears that had a low likelihood of leaking were covered with a small piece of Gelfoam (Pfizer, New York, New York), and the surgery was then continued in an otherwise normal fashion. Larger dural tears were left alone, but a lumbar cerebrospinal fluid shunt was placed at the time of the index surgery. The use of a lumbar cerebrospinal fluid shunt has been previously described for the treatment of a lumbar dural tear. The shunt was initially titrated to drain cerebrospinal fluid at a rate of 10 mL/hr. The rate was then further reduced if the patient had a positional headache develop. If there was any uncertainty about the propensity of an inaccessible dural leak to continue to drain, we always leaned toward placing a lumbar cerebrospinal fluid shunt. It should be noted that the insertion of a cerebrospinal fluid shunt at the time of the index procedure was done in only four of the fifteen patients who did not undergo a direct repair.

The one patient (Case 6) in our series who had a pseudomeningocele develop went on to heal without complication, although the insertion of the lumbar cerebrospinal fluid shunt was delayed until postoperative day 7. Our data provide some support for the treatment of small inaccessible cerebrospinal fluid leaks with observation for a few days before a decision is made to place a cerebrospinal fluid shunt since ten of the eleven dural tears that were simply observed healed spontaneously. If a cervical cerebrospinal fluid leak does not heal spontaneously, there does not seem to be any adverse effect of inserting a cerebrospinal fluid shunt even a week after the index procedure.

Appendix

Tables showing clinical details of all study patients are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on “Supplementary Material”) and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM).
References


