Surgical treatment of spontaneous spinal cerebrospinal fluid leaks

WOUTER I. SCHEIVINK, M.D., VITTORIO M. MORREALE, M.D., JOHN L. D. ATKINSON, M.D., FREDRIC B. MEYER, M.D., DAVID G. PIEPGRAS, M.D., AND MICHAEL J. EBERSOLD, M.D.

Department of Neurologic Surgery, Mayo Clinic, Rochester, Minnesota

Object. Spontaneous spinal cerebrospinal fluid (CSF) leaks are an increasingly recognized cause of intracranial hypotension and may require neurosurgical intervention. In the present report the authors review their experience with the surgical management of spontaneous spinal CSF leaks.

Methods. Between 1992 and 1997, 10 patients with spontaneous spinal CSF leaks and intracranial hypotension were treated surgically. The mean age of the seven women and three men was 42.3 years (range 22–61 years). Preoperative imaging showed a single meningeal diverticulum in two patients, a complex of diverticula in one patient, and a focal CSF leak alone in seven patients. Surgical exploration in these seven patients demonstrated meningeal diverticula in one patient; no clear source of CSF leakage could be identified in the remaining six patients. Treatment consisted of ligation of the diverticula or packing of the epidural space with muscle or Gelfoam. Multiple simultaneous spinal CSF leaks were identified in three patients.

Conclusions. All patients experienced complete relief of their headaches postoperatively. There has been no recurrence of symptoms in any of the patients during a mean follow-up period of 19 months (range 3–58 months; 16 person-years of cumulative follow up). Complications consisted of transient intracranial hypertension in one patient and leg numbness in another patient.

Although the disease is often self-limiting, surgical treatment has an important role in the management of spontaneous spinal CSF leaks. Surgery is effective in eliminating the headaches and the morbidity is generally low. Surgical exploration for a focal CSF leak, as demonstrated on radiographic studies, usually does not reveal a clear source of the leak. Some patients may have multiple simultaneous CSF leaks.

KEY WORDS • cerebrospinal fluid leak • headache • intracranial hypotension • intracranial pressure

S PONTANEOUS intracranial hypotension due to spinal cerebrospinal fluid (CSF) leakage is an uncommon but increasingly recognized cause of postural headaches.1,3,6,12,15,17,20,21 Epidemiological studies have not been reported, but the prevalence of spontaneous intracranial hypotension in Olmsted County, Minnesota, in 1995 was approximately one in 50,000 persons (unpublished data). Similar to the well-recognized syndrome of low CSF pressure headaches that follows diagnostic lumbar puncture, associated symptoms are common in spontaneous intracranial hypotension and include nausea, vomiting, photophobia, cranial nerve palsies, and tinnitus.1,3,4,6,13,15,17,21 In addition, patients with spontaneous spinal CSF leaks may complain of local back pain in the area of the leak.17 Characteristic findings on magnetic resonance (MR) imaging consist of intracranial meningeal enhancement, subdural fluid collection, and “sagging” of the brain, including caudal displacement of the cerebellar tonsils.3,8,9,15,17,20 The diagnosis of intracranial hypotension is confirmed by a low or low-normal opening pressure on lumbar puncture. Examination of the CSF often shows pleocytosis and an increased protein content. Computerized tomography (CT) myelography and radionuclide cisternography are the most useful radiographic studies to diagnose and localize the spinal CSF leak.17 The cause of the spontaneous spinal CSF leakage often remains unknown; however, the combination of a trivial precipitating event2,10,16 and an underlying weakness of the spinal meninges4,7,11,13,19 is generally suspected.

The disease is often self-limiting, and epidural blood patches are commonly used successfully as the initial and only treatment of spontaneous spinal CSF leaks. Surgical treatment of the leak is rarely reported.12,17,18 The purpose of the present report is to review our experience with the surgical management of spontaneous spinal CSF leaks.

Clinical Material and Methods

We identified 24 patients evaluated at the Mayo Clinic between 1986 and early 1997 in whom a spontaneous spinal CSF leakage was radiographically confirmed. Of these, 10 patients underwent surgery to correct the CSF leakage. One patient was treated in 1992, one in 1994, three in 1995, three in 1996, and two in the first month of
1997. The mean age of the seven men and three women was 42.3 years (range 22–61 years). Medical records and all imaging studies were reviewed and follow-up evaluation was completed for all patients through April 1997.

### Results

The clinical and radiographic features of the 10 patients are summarized in Table 1. All patients suffered from postural headaches, although in some cases the postural component decreased over time. Associated symptoms included nausea and vomiting in four patients, bowel and bladder incontinence in one patient, apathy and facial pain in one patient, and blurred vision in one patient. Transient cranial nerve dysfunction was experienced by three patients.

The duration of symptoms ranged from 3 weeks to 9 years. Five patients had undergone numerous attempts at nonsurgical treatment including epidural blood patch application before surgical intervention; five patients underwent surgery as the primary treatment of their CSF leak.

Computerized tomography (CT) myelography was performed in all patients and in cisternography was performed in six of them. Preoperative radiographic studies showed a single discrete meningeal diverticulum in two patients and an extensive complex of diverticula in one patient. In the remaining seven patients no structural abnormalities were found, but focal spinal CSF leakage was clearly demonstrated (Figs. 1 and 2). The locations of the CSF leaks are shown in Table 1. In two patients CT myelography indicated the presence of a cervical as well as a thoracic CSF leak (Fig. 3). Treatment was directed at the cervical CSF leakage in both cases, because it was substantially larger and the thoracic abnormality may have represented a localized CSF collection, but not the site of a leak.

Surgery confirmed the configuration of meningeal diverticula that was demonstrated on the preoperative imaging. Discrete meningeal diverticula were ligated as described previously. The complex of meningeal diverticula was surrounded with blood-soaked Gelfoam.

Among the seven patients who underwent surgical exploration of a focal CSF leak, a clear source of the CSF leakage was detected in only one patient. This patient was found to have two separate actively leaking meningeal diverticula arising from the axilla of the T-10 and T-11 nerve roots, and these diverticula were ligated and buttressed with pieces of muscle. In the remaining six patients, the exact cause of the leakage could not be determined in spite of careful and extensive extradural exploration of the thecal sac and multiple nerve roots in all cases. In addition, intradural exploration was performed in three patients and saline or dye was injected intradurally in two patients. Extradural CSF was found in all patients in the general area of the CSF leakage, which was indicated on preoperative imaging, except for two of the three patients who underwent surgical exploration for cervical CSF leakage while in the sitting position. The dura was found to be extremely lax in these patients, confirming the presence of low intradural pressure and CSF leakage. Areas of attenuated dura of nerve root sleeves were detected in three patients, but were not believed to explain active CSF leakage adequately. Pieces of muscle or Gelfoam were used to pack the epidural space around the nerve roots suspected of harboring the leakage in these six patients with a “negative” exploration. Fibrin glue and intradural packing of the nerve root sleeve were used as adjunct treatment in two patients.
All patients experienced complete relief of their headaches and associated nausea and vomiting within 24 hours of surgery. In addition, a patient with bowel and bladder incontinence and a patient with facial pain and apathy noted relief from or substantial improvement in these symptoms. There has been no recurrence of symptoms in any of the patients during a mean follow-up period of 19 months (range 3–58 months; 16 person-years of cumulative follow-up). Among the six patients in whom both pre- and postoperative MR imaging was performed, meningeal enhancement resolved in all six and the features of brain sagging resolved in four over a period ranging from 5 days to 3 months; in two patients downward displacement of the cerebellar tonsils persisted over a 6- to 9-month period, although the meningeal enhancement and headaches had completely resolved.

Two patients suffered complications. Mild leg numbness was noted on the 2nd postoperative day by a patient who underwent surgical exploration for thoracic CSF leakage, which was treated with packing of the epidural space. Postoperative T₂-weighted MR imaging showed a small focus of increased signal in the thoracic cord and the leg numbness has persisted for 2 years. Blurred vision and papilledema developed several weeks after ligation of a lumbar meningeal diverticulum in a patient who had had symptoms for 9 years. The visual symptoms and papilledema resolved completely over a 1-month period.

**Discussion**

In this study we report our relatively limited, but thus far generally satisfactory, experience with surgical treatment of spontaneous spinal CSF leaks. Among the 10 patients in this study, the CSF leaks were found to be caused by a single meningeal diverticulum in two patients, two meningeal diverticula in one patient, and a complex of meningeal diverticula in one patient. In spite of careful and extensive surgical exploration, the exact source of the leakage could not be identified in the remaining six patients, although attenuated dura was noted in half of these patients. Possibly, a small linear dural tear or “blowout” of a small meningeal diverticulum may have escaped detection or the attenuated dura itself may have allowed CSF to seep intermittently into the extradural space.

Depending on the surgical findings, a variety of techniques were used to treat these spontaneous spinal CSF leaks. Discrete meningeal diverticula without spinal root fibers were treated with suture ligation of the neck of the diverticulum. Likewise, meningeal diverticula that contained spinal nerve root fibers of a nonappendicular nerve root were treated by ligating the nerve root. For discrete meningeal diverticula that contained spinal nerve root fibers of an appendicular root, treatment consisted of circumferentially ligating the diverticulum around the nerve root without compromising the root; alternatively, an attempt at plication and reconstruction of the diverticulum can be made in such cases. An extensive complex of leaking meningeal diverticula that extended over several spinal levels defied direct surgical intervention and an epidural blood patch, consisting of blood-soaked Gelfoam, was placed around the diverticula. Similarly, for those patients who underwent surgical exploration for a CSF leak but in whom no clear structural defect was found, pieces of muscle and Gelfoam were used to pack the epidural space around the nerve root suspected of harboring a leak. Fibrin glue and intradural packing of the nerve root sleeve were also used in selected cases.
Surgical treatment in this group of patients with spontaneous spinal CSF leaks was very effective in eliminating the patients’ headaches, even though we were unable to identify the exact source of the leak in the majority of patients who underwent surgical exploration. Because the entity of spontaneous spinal CSF leaks and intracranial hypotension has become well recognized only fairly recently, our follow-up period has been short (16 patient-years of total follow up). However, no recurrences have been noted. Improvement was shown in the appearance of the brain settling and meningeal enhancement in all patients who underwent pre- and postoperative MR imaging. Clinical improvement preceded radiographic improvement, as has been noted by others, and in some patients meningeal enhancement resolved although some degree of caudal displacement of the cerebellar tonsils persisted.

The morbidity in our series consisted of mild but persistent postoperative leg numbness in a patient with a thoracic CSF leak and transient blurred vision and papilledema in a patient with a lumbar CSF leak. The exact cause of the leg numbness could not be established but may have been related to the extensive nature of the intraoperatively placed epidural blood patch. In the other patient we have postulated that the sudden interruption of the abnormal pathway of CSF resorption, which had been present for many years, resulted in transient intracranial hypertension. In some patients, surgical exploration revealed two separate actively leaking meningeal diverticula at adjacent spinal levels or CT myelography indicated the presence of multiple simultaneous leaks at different spinal levels. For those patients in whom imaging studies demonstrated multiple leaks we directed our treatment at the largest leak with satisfactory results.

Most cases of spontaneous intracranial hypotension caused by spinal CSF leakage probably resolve spontaneously. In those patients with persistent symptoms, placement of an epidural blood patch is often the initial treatment of choice if conservative measures, such as bed rest and oral hydration, fail. Application of a generous lumbar epidural blood patch is often efficacious in providing relief of symptoms, although the benefit may be transient, particularly when the CSF leak is at a substantially higher spinal level. Placement of the epidural blood patch can then be repeated (multiple times if necessary) at the same level or applied directly at the site of the CSF leak. The indications for surgical treatment of spontaneous spinal CSF leakage have not been firmly established. The most straightforward indication may be the presence of persistent symptoms in spite of the placement of multiple epidural blood patches in a patient in whom a discrete leaking meningeal diverticulum has been radiographically demonstrated. In addition, surgery may be considered as the primary treatment in all patients who have such meningeal diverticula, particularly when the patients are young and the diverticula are large. Spinal meningeal diverticula may grow and cause other neurological symptoms. In addition, the long-term efficacy of epidural blood patch application has not been established under these circumstances and may be less than optimal. We have also offered surgical exploration for focal spinal CSF leaks that have been demonstrated on CT myelography, especially in patients in whom multiple attempts at nonsurgical treatment have failed.

References


Manuscript received May 8, 1997. Accepted in final form August 8, 1997.
Address reprint requests to: Wouter I. Schievink, M.D., Barrow Neurosurgical Associates, 2910 North Third Avenue, Phoenix, Arizona 85013.