Clinical Neurology and Neurosurgery 170 (2018) 61–66

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Management of iatrogenic spinal cerebrospinal fluid leaks: A cohort of 124 patients

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ARTICLE INFO

Keywords:
Cerebrospinal fluid leak
Durotomy
Meningitis
Meningocele
Spinal drain

ABSTRACT

Objectives: Cerebrospinal fluid leaks are a frequent complication of spinal surgery, with reported rates between 2 and 20%. Management is highly variable and dependent on comorbidities, complexity of the index procedure, and surgeons' experience. Treatment options include primary or delayed repair, with or without spinal drainage. Using a retrospective cohort, the authors aim to identify the appropriate management of iatrogenic spinal cerebrospinal fluid (CSF) leaks.

Patients and Methods: We queried our institutional database for postoperative spinal CSF leaks between 1/1/2007 and 3/14/2017 using Current Procedural Terminology (CPT) and International Classification of Disease (ICD) codes. Excluded were patients who had primarily intradural procedures such as tethered cord release, tumor resection, and posterior fossa decompression. Information regarding patient demographics, surgical characteristics, and postoperative course was gathered, including whether primary closure (with nonabsorbable suture) was achieved, lumbar drain placement at initial surgery, use of fibrin sealant, number of subsequent explorations, rate of infection, length of stay, and number of hospital admissions.

Results: Our cohort consisted of 124 patients who suffered intraoperative iatrogenic CSF leak out of 3965 procedures, for a rate of 3.1%. Primary dural closure (± lumbar drain) was attempted in 64 patients, with successful repair in 47 (73.4%). Lumbar drain placement (± primary closure) was performed in 49, with success in 43 (87.8%). Delayed exploration of the surgical wound was required in 34 patients. Patients in whom primary closure could not be achieved and did not have a lumbar drain placed had a 39.5% reexploration rate. Patients who were treated with delayed exploration had statistically significant increase in length of stay (19.6 vs. 7.8 days), hospital admissions (2.1 vs. 1.0), and infections (15 vs. 0).

Conclusion: CSF leaks are fraught with complications requiring reexploration for repair in 27.4% of cases. Primary repair of the leak and use of fibrin sealant upon discovery, with consideration of lumbar drain, should be performed whenever possible, as they are associated with shorter hospital stays, fewer hospital admissions, and lower rates of reoperation and infection.

1. Introduction

Incidental durotomy and subsequent cerebrospinal fluid (CSF) leak is a well-known complication following spinal surgery, with reported incidence ranging between 2 and 20% [1–15]. This variability is likely attributable to the diversity of populations analyzed, as the vast majority of studies are derived from single-center cohorts that focus on select procedures. The largest study to date examined over 6000 cases with documented CSF leak repair using the National Surgical Quality Improvement Program [16]. The authors identified increasing age, number of operative levels, diagnosis of ankylosing spondylitis, combined or posterior approach, as well as obesity (Body Mass Index [BMI] ≥ 30) and corticosteroid use to be independent risk factors for a dural tear [16].

Cerebrospinal fluid leak may have a significant impact on patients' postoperative recovery secondary to the development of mild to severe short-term and perioperative complications, including headache, neurologic deficit, meningocele or fistula formation, wound dehiscence, meningitis, arachnoiditis, or even spinal abscess [1,14,17,18]. Furthermore, according to a recently published study examining 239 patients over a 13-month period, incidental durotomy or postoperative CSF leak is associated with an increase in hospital costs as high as 50%

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https://doi.org/10.1016/j.clineuro.2018.04.017
Received 27 December 2017; Received in revised form 10 April 2018; Accepted 21 April 2018
Available online 22 April 2018
0303-8467/

Table 1
Case numbers.

	Cervical	Thoracic	Lumbar	Total
Total Number of Cases	1684	115	2166	3965
Number of Patients with CSF leaks	25 (1.5%)	5 (4.3%)	94 (4.3%)	124 (3.1%)

[19]. Therefore, minimizing complications during spinal surgery with prompt repair of dural tears when they arise is paramount for an expeditious recovery and the avoidance of further complications. Treating such leaks can span the gamut, from a few sutures and tissue adhesives at the time of the index procedure to lumbar drain placement and multiple surgical explorations. In an attempt to further elucidate the best approach for the management of these leaks, we reviewed our experience over the past 10 years.

2. Materials and methods

2.1. Data source and patient cohort

Following Institutional Review Board approval (IRB No. 201,705,759), we queried our administrative database for patients who received treatment for spinal CSF leak in our institution since January 2007, with the last occurrence in March 2017. The cohort consisted of patients undergoing spinal surgery for degenerative spine disease and deformity who had confirmed iatrogenic CSF leak intraoperatively. They were identified using Current Procedural Terminology (CPT) and International Classification of Disease (ICD) codes. Exclusion criteria included patients who had intentional opening of the dura during surgery, such as for tethered cord release, tumor resection, and posterior fossa decompression. Cases where the dura was violated without CSF leaking through the intact arachnoid were also excluded.

The leak was recognized either at the time of the index surgery or postoperatively as CSF drainage from the incision or from the development of a secondary meningocele. Postoperative MRI studies were obtained when the patient continued to be symptomatic or a meningocele was suspected on clinical examination. The leak was considered to be successfully repaired when the patient no longer had symptoms of intracranial hypotension, no evidence of CSF leakage from the incision, or resolution of a symptomatic secondary meningocele on postoperative MRI.

In cases where the dural defect was sutured, it was closed with 5-0 or 6-0 polypropylene suture (Ethicon, Somerville, NJ) and in some cases covered with fibrin sealant (Tisseel, Baxter Healthcare Corporation), or more recently polyethylene glycol hydrogel (DuraSeal, Integra LifeSciences Corporation, NJ). These sealants were used sparingly to cover the suture line or defect with a thin, 1-mm layer. Because of high water absorption capacity, excessive amounts of sealant were avoided to avert unwanted mass effect [20]. Spinal drains, when used, were routinely left in for at least 5 days. Henceforth, patients undergoing treatment by either primary repair or spinal drainage at the time of discovery of the leak are considered to have received initial treatment. Those who did not undergo primary repair or drainage believing the leak was inconsequential or impossible to repair, belong to the delayed repair group.

2.2. Statistical analysis

Descriptive statistics were used to present the available demographic information, operative characteristics, and surgical outcomes. Continuous variables were summarized with means and standard deviations. Categorical variables were summarized with frequencies and proportions and were compared using Pearson's Chi-square test. Statistical analysis was performed using open-source software R version 3.1.2. (R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/). Level of statistical significance was established at 0.05.

3. Results

Our cohort consisted of 124 patients (59 females) who suffered iatrogenic spinal CSF leak out of 3965 spinal procedures at our institution over approximately a 10-year period, for an incidence of 3.1% (Table 1). Mean age ± SD and BMI were 55.1 ± 15.6 years and 32.4 ± 8.1 respectively (Table 2). Forty-seven (37.9%) had prior spinal surgery. Sixty-nine patients (55.6%) had undergone spinal instrumentation, 24 cervical and 45 lumbar (Table 2). Of the 94 lumbar patients, most (93) had undergone decompression, with the remaining patient undergoing only posterior fusion for instability.

Lumbar spine was the most common location of CSF leak (94 patients), followed by the cervical (25 patients) and thoracic spine (5 patients) (Table 2). Infection complicating the dural tear occurred in 15 patients, all of whom required delayed exploration (Table 3). Primary closure was not attempted in all cases. When the dural tear was located in the far lateral or ventral aspect of the canal, primary repair with suture was not always feasible, especially during anterior cervical or thoracic procedures. The use of fibrin sealant was documented in 23 patients, most of which were in the lumbar spine (16). The mean duration of follow-up for all patients was 17 months.

Of the 25 patients who underwent a cervical procedure with iatrogenic CSF leak, only 3 were able to be closed primarily due to the ventral location of the dural tear. One patient who suffered a leak after corpectomy for OPLL failed two spinal drainage attempts and ventriculostomy, but was successfully treated with a ventriculoperitoneal shunt (Fig. 1). One patient developed a leak after a two-level anterior cervical fusion with prevertebral CSF accumulation. This leak was

Table 2
Patient demographics and surgical characteristics.

	Cervical	Thoracic	Lumbar	All
Age (Avg ± STD)	52.9 ± 13.8	67.0 ± 6.2	55.1 ± 16.2	55.1 ± 15.6
Sex				
Male	16	5	45	65
Female	9	1	49	59
BMI (Avg ± STD)	30.1 ± 7.4	32.8 ± 3.7	33.0 ± 8.3	32.4 ± 8.1
Previous Surgery	5	0	42	47
Laminectomy	6	1	93	100
Discectomy	21	5	77	103
Instrumented Fusion	24	0	45	69
Primary Closure	3	0	61	64
Lumbar Drain Placement	14	3	32	49
Fibrin Sealant Used	5	2	16	23
Follow-up, months (Avg ± STD)	18 ± 32	5 ± 6	18 ± 25	17 ± 26