

Intraoperative and Delayed Cerebrospinal Fluid Leak Occurrence and Commonalities in a Single-Surgeon Cohort

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INTRODUCTION: Cerebrospinal fluid leaks are an infrequent complication of spine surgery occurring intraoperatively and as delayed leaks occurring weeks or months postoperatively. Reported rates vary, with estimates from 2.6-8% intraoperatively in a primary surgery and 0.83%-14.3% for delayed leaks.¹ We reviewed a single neurosurgeon's spine surgery cases to examine CSF leak occurrence, appropriate treatment for those cases, and determine characteristics of patients with either intraoperative or delayed CSF leaks.

METHODS: Institutional Review Board oversight was obtained. 39,085 surgery records by CPT code were reviewed for procedures performed by a single neurosurgeon (JRE) from 4/21-12/24, brain and neuromodulation procedures were removed, and codes were then consolidated to 2,889 spine surgeries performed. Patients were 53% male, 47% female with overall average patient age of 54.2 (15.4) years. Cervical, thoracic, and lumbar procedures were included and consisted predominantly of discectomy, laminectomy, fusion, and/or arthroplasty. Operative and visit notes were reviewed for dural tear or CSF leak to identify all leaks, both intraoperative and delayed, as well as for patient demographics (age and sex) and engagement with preoperative conservative treatment. Patient histories were examined to determine if there were relationships between conservative care and leak occurrence. Statistical analysis using Excel and Python followed complete data review and included descriptive statistics, ANOVA, and chi square.

RESULTS SECTION: Intraoperative leaks were identified in 56 of the 2,889 cases (1.94%, 50% male; details in table 1) with an average age of 61.3 (15.2) years. These individuals were significantly older than patients not experiencing a leak ($p < 0.0001$). Lumbar procedures leak rates were not significantly different from cervical (1.91% lumbar, 1.39% cervical, $p = 0.348$). Delayed leaks were found in 0.28% of the patients (eight cases), all of which were in males having lumbar discectomies (5 L4-5, 3 L5-S1). Those experiencing delayed leaks were significantly younger at 40 (11.4, $p = 0.01$) years with spinal headaches developing 2-7 weeks following surgery. (Figure 1) The percentage of patients engaging in preoperative conservative care (not including pharmacotherapy) was 85% with 67% participating in physical therapy, 69% in injection therapy, and 23% in chiropractic care. There were no significant differences between conservative care type(s) and leak status ($p = 0.205$). (Figure 2)

DISCUSSION: In this patient group there is a lower than previously reported rate of both intraoperative and delayed CSF leaks. This low rate is anticipated to be attributable to a combination of utilizing minimally invasive surgical techniques and surgeon skill and experience. Leaks have been typically considered to be lower in cervical than lumbar procedures; however, the difference was nonsignificant in this group. Rates of intraoperative leaks were likewise similar in lumbar discectomy and fusions; however, all of the delayed leaks were in a lumbar discectomy. This is anticipated to be due to the challenge of removing calcified disc in a smaller surgical space and as segment motion is maintained, allowing bone to impinge the dura and tear causing delayed leaks. Techniques utilized to reduce leak risk include removing bone first, removing the ligament (if needed) medially to laterally, and performing all decompressions under the microscope. Successful intraoperative treatment utilizes stitches when needed, Duragen patches, and Surgacell to provide a lattice for platelet adherence. Most intraoperative leaks repair well, and patients have no postoperative headaches. Delayed leaks are often successfully treated with blood patches; however, a myelogram should be performed with a delayed leak not responding to a blood patch. Limitations of this study are the small patient numbers, which reduced effective evaluation of patient characteristics associated with CSF leaks. This is also a single surgeon cohort and may not be representative of other practices and surgical techniques which could impact the rates and impact of patient characteristics. It is notable that the cases of delayed leaks were in younger male patients undergoing discectomy, and further evaluation of patient characteristics in a larger sample would be beneficial in determining if this pattern is noted in other clinics and if a reminder of mindful movement is beneficial in preventing those delayed leaks.

SIGNIFICANCE/CLINICAL RELEVANCE: Despite the low rates of CSF leaks, this potential complication in spine surgery requires surgical care and patient awareness. In particular, this study demonstrated that younger males having a lumbar discectomy are the most likely to have a delayed CSF leak and that risk should be discussed preoperatively.

REFERENCES: 1. Epstein NE, Agulnick MA. Perspective: Timely diagnosis and repair of intraoperative thoracic/lumbar cerebrospinal fluid (CSF) leaks. Surg Neurol Int. 2024 Jul 26;15:255. doi: 10.25259/SNI_509_2024. PMID: 39108388; PMCID: PMC11302591.

IMAGES AND TABLES:

Surgery type	Total cases	Intraoperative leaks (% of surgery type)	Sex distribution for intraoperative leaks	Delayed leaks - all Male (% of surgery type)
Lumbar fusion	941	23 (2.44%)	14F/9M	--
Lumbar arthroplasty	80	0	--	--
Lumbar discectomy	648	14 (2.16%)	5F/9M	8 (1.23%)
Lumbar laminectomy	272	8 (2.94%)	4F/4M	--
Thoracic fusion	28	0	--	--
Thoracic laminectomy	8	0	--	--
Cervical fusion	300	8 (2.67%)	3F/5M	--
Cervical arthroplasty	473	3 (0.63%)	2F/1M	--
Cervical laminectomy	13	0	--	--
Cervical discectomy	7	0	--	--
Removal of hardware	28	0	--	--
Sacroiliac	18	0	--	--
Other	73	0	--	--

Table 1. Leak rates did not differ significantly between cervical and lumbar procedures (1.91% lumbar, 1.39% cervical, $p = 0.348$). There were eight cases of delayed leaks (0.28% of the patients), all of which affected males having lumbar discectomies (5 L4-5, 3 L5-S1).

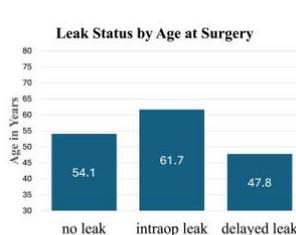


Figure 1. Individuals with an intraoperative leak were significantly older ($p < 0.0001$) as anticipated, while individuals with a delayed leak were significantly younger ($p < 0.01$) than individuals not experiencing a CSF leak.

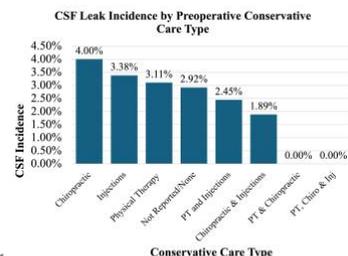


Figure 2. Conservative care type did not significantly impact CSF leak incidence, although there were no leaks for those with all three modalities or both PT and chiropractic care.