Postoperative Cerebrospinal Fluid Leak Rates with Subfascial Epidural Drain Placement after Intentional Durotomy in Spine Surgery

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Abstract

Study Design Retrospective chart review.

Objective Postoperative cerebrospinal fluid (CSF) leak is a known complication of intraoperative durotomy. Intraoperative placement of subfascial epidural drains following primary dural repair has been proposed as a potential management strategy to prevent formation of CSF cutaneous fistula and symptomatic pseudomeningocele. Here we describe our experience with subfascial drain after intentional durotomy.

Methods Medical records of patients who underwent placement of subfascial epidural drains during spinal procedures with intentional intraoperative durotomies over a 4-year period at two institutions were retrospectively reviewed. Primary outcomes of interest were postoperative CSF cutaneous fistula or symptomatic pseudomeningocele formation.

Results Twenty-five patients were included. Mean length of follow-up was 9.5 months. Twelve patients (48%) underwent simultaneous arthrodesis. The average duration of the drain was 5.3 days with average daily output of 126.5 mL. Subgroup analyses revealed that average drain duration for the arthrodesis group was 6.33 days, which is significantly greater than that of the nonfused group, which was 3.7 days ($p = 0.016$). Similarly, the average daily drain output for the arthrodesis subgroup at 153.1 mL was significantly higher than that of the nonfused subgroup (86.8 mL, $p = 0.04$). No patient developed postoperative CSF cutaneous fistula or symptomatic pseudomeningocele or had negative sequelae associated with overdrainage of CSF. One patient had a delayed wound infection.

Conclusions The intraoperative placement of subfascial epidural drains was not associated with postoperative development of CSF cutaneous fistula, symptomatic pseudomeningocele, overdrainage, or subdural hematoma in the cases reviewed. Subfascial closed wound drain placement is a safe and efficacious management method after intentional spinal durotomies. It is particularly helpful in those who undergo simultaneous arthrodesis, as those patients have statistically higher daily drain output and longer drain durations.

Keywords
- subfascial epidural drain
- intentional durotomy
- CSF leak
- arthrodesis

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Introduction

Cerebrospinal fluid (CSF) leak is a recognized complication of spinal surgeries. The incidence of CSF leak during spine surgery is 2 to 5%.[1] In cases of intradural tumor removal or nerve root sacrifice, the dura is opened intentionally, thus exposing patients to the risk of CSF leak. Although most durotomies are repaired and most patients do not experience symptomatic CSF leak, it could nevertheless potentially lead to spinal headache, formation of a pseudomeningocele, wound breakdown, and subsequent leakage of CSF through the skin. Furthermore, reports exist of intracranial hemorrhage associated with CSF leak after spinal surgeries.[2] CSF leak can occur anywhere from the cervical to lumbar spine. In addition to primary closure of dura, numerous other options have been developed and are used intraoperatively in the management of a CSF leak. These include the use of fibrin glue and surgical clips in minimally invasive surgeries.[3–8] Postoperatively, supine bed rest has been instituted to decrease the rate of CSF leak. Refractory CSF leaks have been treated with lumbar drain placement, oversewing the incision and repeat surgery.[9,10]

Here we review our experience at two institutions with utilizing epidural subfascial drains after intentional intraoperative durotomies to prevent CSF leak. We take particular interest in cases of concurrent durotomy and arthrodesis, the latter of which is now commonly performed to enhance spinal column stability in patients with iatrogenic or pathologic spinal instability. Arthrodesis and instrumentation are associated with a relatively high rate of bleeding, often necessitating drain placement to avoid postoperative hematoma or seroma, the pressure of which could cause neurologic symptoms that may require reoperation.[11,12] In patients who undergo durotomies and arthrodesis, the dilemma is whether an epidural subfascial suction drain should be placed, given the potential of exacerbating the CSF leak. Here we present our experience at two institutions with utilization of epidural subfascial drain placement after intentional intraoperative durotomies.

Methods

Chart Review

A retrospective review was performed to identify patients undergoing spinal surgery over a 4-year period at University of California, Los Angeles and University of California, San Francisco medical centers. The inclusion criteria include (1) known intentional durotomy with egress of CSF, (2) intraoperative placement of subfascial epidural drains, (3) complete documentation of daily drain output available via electronic medical record, and (4) at least one postoperative follow-up visit. Medical records were surveyed for patient age and sex, medical comorbidities, duration of drain placement, daily drain output, perioperative laboratory data, and postoperative complications. The primary outcomes of interest were the development of postoperative CSF cutaneous fistula or symptomatic pseudomeningocele formation.

Surgical Technique

Following the intradural component of the case, the durotomy was closed with running 4–0 Nurolon or 5–0 Prolene (Ethicon, Somerville, New Jersey, United States) to achieve primary watertight closure. One layer of either Tissel fibrin glue (Baxter, Deerfield, Illinois, United States) or Duraseal (Covidien, Minneapolis, Minnesota, United States) was applied to the primary closed durotomy site. Valsava maneuvers up to 40 mm H_2O were performed at the surgeon's discretion but were not always performed. A medium or 19-French channel Davol drain (Bard Davol Inc., Covington, Georgia, United States) was placed in the epidural space at the site of durotomy and tunneled out through a separate incision distal to the closed wound. The fascia was then closed with either interrupted 0 Vicryl or no. 1 polydioxanone sutures (Ethicon). The subcutaneous tissue and skin were then reapproximated in standard fashion utilizing interrupted 2–0 Vicryl sutures (Ethicon) and surgical skin staples (Covidien) or 4–0 subcuticular sutures, respectively. The Davol drain was set to half-bulb suction. Both the quality and quantity of the daily drain output were recorded. The patients were placed in bed rest with the head of bed flat for 48 hours. They were mobilized after that. The patients who underwent simultaneous arthrodesis were placed in external rigid orthotics for a total of 6 weeks. If there was evidence of leakage from the wound, suction was then adjusted to full-bulb suction. The drains were discontinued after daily output became negligible (<30 mL/24 h) or 3 to 5 days following surgery when the incision appeared well healed (even if output was still high, >100 mL/24 h), prior to discharge. If output remained high prior to drain discontinuation, the drain was clamped first and the wound site evaluated for CSF leak. If there was no evidence of CSF leak, then the drains were removed. Of note, no patients required reopening of the drains after clamping. A figure-of-eight stitch was placed at the drain exit site after drain removal if CSF leaked out of the drain site. Patients were clinically evaluated and the wound sites were examined at follow-up visits.

Results

Twenty-five spinal surgery cases with known intentional intraoperative durotomies were identified from the review of the authors' surgical logs (►**Table 1**). Thirteen men (age 52.4 ± 15.7 years) and 12 women (age 63.3 ± 12.7 years) were included in the study. The length of follow-up ranged from 0.5 to 28 months (9.5 ± 7.4 months). The surgeries range from 1 to 11 levels with an average of 3.3 ± 2.8 levels. Of the 25 patients, 13 (52%) were not fused and the remaining (48%) had arthrodesis. The mean duration of the drain was 5.3 ± 3.4 days with a range from 2 to 18 days. The average daily drain output was 126.5 ± 103.2 mL. No patient developed symptomatic CSF leak.

We observed a direct correlative trend between the number of spinal surgery levels and the duration of the drain placement. However, this difference was not statistically significant ($r^2 = 0.57$, ►**Fig. 1**). The average drain duration

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Table 1 Detailed description of all 25 subjects who underwent surgeries involving intentional durotomies in the two institutions from the surgeons' case log

Patient no.	Age (y) and sex	Operations	Indication	Fusion	Levels	LOD (d)	F/U (mo)	Preoperative radiation
1	42 M	L1–3 laminectomy T9–L3 pedicle screw placements T9–L3 posterolateral fusion T11 kyphoplasty	Prostate cancer metastatic to T11 vertebral body	Y	7	9	5	N
2	18 M	C1–C7 laminectomy Occipital plate, C3–C6 lateral mass screws T1–T3 pedicle screws T1–T3 bilateral laminotomy O–T3 posterior fusion	C1–C4 neurofibromas	Y	11	8	28	N
3	77 F	T11–T12 laminectomy T11–T12 posterolateral fusion	T12 intradural extramedullary nerve sheath tumor	Y	2	4	21	N
4	65 F	T5–T7 laminectomy T6 left radical foraminotomy T5–T7 posterolateral fusion	T6 intradural extramedullary tumor and extradural foraminal tumor	Y	3	4	4	N
5	41 F	C4–T2 laminectomy C4–C6 lateral mass screws T1–T2 pedicle screws C4–T2 posterolateral fusion	Left C4–T2 intradural extramedullary neurofibroma	Y	6	4	14	N
6	64 M	T5–T7 laminectomy T5–T7 posterolateral fusion	T6 intradural intramedullary hemangioblastoma	Y	3	6	4	N
7	64 M	T2–T5 laminectomy T3–T4 lateral extracavitary corpectomy C4–C6 lateral mass screws T1 bilateral, T2 right, T5–7 bilateral pedicle screws C4–T7 posterolateral fusion	Epidural renal cell carcinoma metastatic to T2–T3 and T4–T5	Y	11	18	0.5	Y
8	66 M	T2–T4 laminectomy T3 transpedicular partial corpectomy T2 bilateral, T3 right, T4 bilateral pedicle screws T2–T4 posterolateral fusion	T3 ventral epidural metastatic prostate cancer	Y	3	9	3	N
9	74 F	T7–10 laminectomy T7, 8, 10, 11 pedicle screws T7–T11 posterolateral fusion	Metastatic T7–T10 intradural/extradural breast cancer	Y	5	9	1	N
10	25 M	C3–C6 diskectomy C4–C5 corpectomy, cage placement L vertebral artery ligation C3–C6 anterior fusion with plate	Left C4–C6 nerve sheath tumor	Y	4	3	9	N

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Table 1 (*Continued*)

Patient no.	Age (y) and sex	Operations	Indication	Fusion	Levels	LOD (d)	F/U (mo)	Preoperative radiation
11	75 F	T6–T7 laminectomy T6–T7 posterolateral fusion	T6–T7 intradural arachnoid cyst	Y	2	4	1	N
12	50 M	L5 laminectomy	Capillary hemangioblastoma (WHO grade I)	N	1	3	12	N
13	65 F	T12–L1 laminectomy, T11–L1 total left facetectomy	Cellular schwannoma (WHO grade I)	Y	3	8	12	N
14	66 M	L2–L3 laminectomy (MIS)	Schwannoma	N	2	3	12	N
15	49 F	L4 laminectomy	Schwannoma	N	1	3	14	N
16	65 F	L1–L2 laminectomy	Myxopapillary ependymoma (WHO grade I)	N	2	3	12	N
17	64 F	T7–T9 laminectomy	Meningioma (WHO grade I)	N	3	3	20	N
18	67 F	C1 laminectomy	Meningioma (WHO grade I)	N	1	3	21	N
19	51 M	L3 laminectomy	Schwannoma	N	1	4	15	N
20	42 F	T7–T9 laminectomy	Anaplastic ependymoma (WHO grade III)	N	3	6	8	N
21	59 M	L1–L2 laminectomy	Metastatic melanoma	N	1	2	4	N
22	63 M	T1–T5 laminectomy	Lipoma	N	4	4	5	N
23	51 M	T1–T2 laminectomy	Schwannoma	N	1	4	6	N
24	76 F	T8–T9 laminectomy	Meningioma	N	1	4	5	N
25	6 2M	T9–10 laminectomy	Meningioma	N	1	4	1	N

Abbreviations: FU, follow-up; LOD, length of drain; MIS, minimal invasive surgery; N, no; WHO, World Health Organization; Y, yes.
Note: All cases experienced primary closure of dura.

for fused patients was 6.33 ± 4.0 days, which was significantly longer than that of patients who did not undergo arthrodesis (3.7 ± 1.1 days, $p = 0.016$). Similarly, the average daily drain output for patients who underwent arthrodesis (153.1 ± 117.4 mL) was significantly higher than that of patients who did not undergo arthrodesis (86.8 ± 63.5 mL, $p = 0.04$). Overall, the daily drain output showed a downward trend over time (►**Fig. 2**).

One patient (4%; patient no. 1) experienced a delayed postoperative wound infection requiring reoperation for exploration and wound washout ~2 weeks after the surgery. This patient had a complicated history of multiple spinal surgeries at or near the operating site. Furthermore, his postoperative care was complicated by his immobility, chemotherapy, radiation, and existing deep venous thrombosis. No seroma or pseudomeningocele were identified on his postoperative magnetic resonance imaging or during the

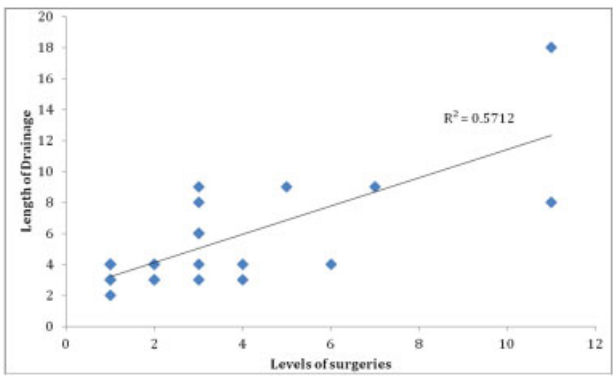

Fig. 1 The relationship between the number of spinal levels involved in surgery and duration of the drain.

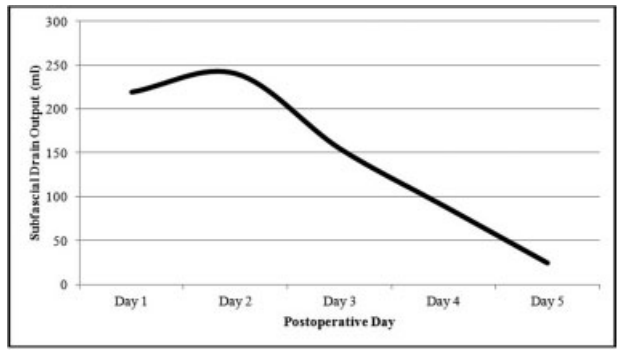

Fig. 2 Daily drain output with time for patient no. 6.

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reoperation. The infection appeared to be limited to the epifascial plane.

Discussion

CSF leak is a known and frustrating complication associated with all spinal surgeries and can cause headache, pseudomeningocele, and wound breakdown.[13,14] Although primary watertight closure remains the gold standard, numerous other strategies have been developed. However, no consensus has been reached regarding the best management modality. Dilemmas commonly encountered include whether to leave a closed suction wound drain and whether to encourage early mobilization.[15–17] Many surgeons avoid leaving a closed suction wound drain in patients with known durotomy for fear of worsening the CSF leak, which is especially problematic when the surgery involves multilevel instrumentation and a surgical drain is usually required to prevent postoperative hematoma.

Our mean drain duration was 5.3 $\pm$ 3.4 days and mean daily drain output was 126.5 $\pm$ 103.2 mL. Subgroup analyses revealed that the drain duration was significantly longer in patients who underwent arthrodesis compared with those who did not (6.33 $\pm$ 4.0 days versus 3.7 $\pm$ 1.1 days, $p = 0.016$). The average daily drain output was also significantly higher in the arthrodesis group (153.1 $\pm$ 117.4 mL versus 86.8 $\pm$ 63.5 mL, $p = 0.04$). Furthermore, we noticed a linear trend in the relationship between drain duration and the number of spinal levels of operation, although the difference was not statistically significant. To our knowledge, this study is the first to report such a relationship. Surgeries involving arthrodesis tend to have more extensive dissection, and the decortication processes tend to induce more seroma or hematoma formation. The seroma or hematoma could be symptomatic because of its compression on the neural structures.[11,12]

Complications associated with closed suction wound drains have been previously described.[18,19] These complications include infection, hematoma formation, and additional neurologic deficit. In addition, in cases with known durotomies, there is a concern for worsening of CSF leak, possible formation of CSF cutaneous fistula, pseudomeningocele, and the potential for intracranial subdural hematoma with excessive drainage of CSF. Of note, none of the patients in our study suffered any of the aforementioned consequences. Although one patient did have a superficial wound infection that required a washout, he had multiple comorbidities and highly complicated preoperative and postoperative courses, which was an anomaly in our study.

Our findings expand upon the initial findings of Hughes et al for the management of CSF leak after lumbar spinal surgery.[20] Although analogous in principle, our treatment strategy is different in that our intraoperative subfascial epidural drains were placed on an inpatient basis, and patients had their drains removed prior to discharge. Despite these differences, we observed similar results in terms of our primary outcomes of interest, namely the formation of postoperative CSF fistula and symptomatic pseudomeningocele. Of the 25 patients in the present study, none displayed evidence of persistent CSF leak due to durotomy at the most recent follow-up. And more importantly, none of the 25 patients suffered negative consequences associated with the drain. Specifically, none of the patients had a postoperative CSF leak or postoperative symptomatic pseudomeningocele requiring intervention. Therefore, our results suggest that the techniques described herein may be employed safely and efficaciously in patients with intentional durotomies.

The subfascial epidural closed suction drain likely prevents the formation of the CSF fistula/leak in a similar manner to the traditional lumbar drain. The closed suction drain provides a lower resistance pathway for the CSF to flow if there is a small leak from the durotomy after the primary watertight closure, which allows time for the dura, soft tissue, and fascia to scar and seal the durotomy, thereby closing the dead space. It also allows the surgical wound to epithelialize. The small drain tubing tract could eventually be closed with a figure-of-eight stitch if CSF continues to leak. The advantage of intraoperative placement of the epidural closed suction drain over a lumbar drain is that the epidural drain is placed under direct visualization at the same time of surgery. Therefore, it avoids the potential pain and complications associated with lumbar drain placement.

However, our study is limited by the nature of a retrospective chart review. In addition, the small sample size limits our ability to reach certain conclusions. Furthermore, intentional durotomies are usually associated with a lower rate of CSF leak because they usually involve much better-quality dura and the primary closures are of significantly higher quality. Therefore, future randomized prospective studies with larger sample sizes are needed to draw further conclusions.

Conclusions

We present a review of 25 cases in which epidural subfascial drains were placed intraoperatively in patients undergoing spine surgeries with intentional durotomies. No patients developed a postoperative CSF cutaneous leak, symptomatic pseudomeningocele, or complications associated closed suction drains at latest follow-up. We conclude that the placement of an epidural surgical drain after durotomy to divert CSF away from the wound prevented postoperative CSF leak and pseudomeningocele. However, larger studies would be useful to further evaluate the durability of such a treatment modality after durotomy.

Disclosures
Tianyi Niu: none
Derek S. Lu: none
Andrew Yew: none
Darryl Lau: none
Haydn Hoffman: none
David McArthur: none
Dean Chou: Consultant (Medtronic, Orthofix, Globus)
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