Is closed-suction drainage necessary after intradural primary spinal cord tumor surgery?

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Abstract

Purpose The efficacy of closed-suction drainage in primary intradural spinal cord tumor surgery has not been addressed. We investigated whether closed-suction drainage is essential after primary intradural spinal cord tumor surgery.

Methods From January 2003 to October 2011, 169 consecutive patients with primary intradural spinal cord tumors operated by a single surgeon were selected. Closed-suction drainage was inserted in patients before August 2007, but was not used after August 2007. After removal of tumor and meticulous hemostasis, the opened dura was closed and made watertight using 4-0 silk with interrupt suture and 1.0 cm³ of surgical glue was applied in common. Closed-suction drainage was inserted below the muscular fascia in 75 patients (group I, M:F = 39:36; 46.20 ± 15.63 years) and was not inserted in 94 patients (group II, M:F = 46:48; 51.05 ± 14.89 years).

Results Neurological deficit precluding ambulation did not occur in all patients. Between group I and II, there were no significant differences in body mass index (22.75 ± 3.16 vs. 23.51 ± 3.22 kg/m²; $p = 0.13$), laminectomy level (2.45 ± 1.46 vs. 2.33 ± 1.91; $p = 0.65$), operation

time (260.65 ± 109.08 vs. 231.52 ± 90.08 min; $p = 0.06$), estimated intraoperative blood loss (456.93 ± 406.62 vs. 383.94 ± 257.25 cm³; $p = 0.18$), and hospital stay period (9.25 ± 5.01 vs. 9.35 ± 5.75 days; $p = 0.91$). Two patients in group I underwent revision surgery due to wound problems, while revision surgery was not performed in group II ($p = 0.20$).

Conclusion Closed-suction drainage may not be essential after primary intradural spinal cord tumor surgery.

Keywords Drainage · Spinal cord neoplasms · Complications · Hematoma · Wound infection · Spine

Introduction

Closed-suction drainage has been commonly used postoperatively to prevent postoperative hematoma or other fluid collection and to reduce dead space. Following spine surgery, it is also commonly applied, because postoperative hematoma and fluid collection may be associated with neurological injury and infection [1–3]. Although the presence of a drain theoretically reduces these problems, the use of prophylactic drains in spine surgery for degenerative spine disease is controversial [4–7]. A randomized study [6] and several retrospective comparative studies [4, 8, 9] have reported that closed-suction drainage was not beneficial for reducing hematoma/fluid collection or infection, after degenerative spine disease surgery. Most degenerative spine diseases comprise extradural lesions and, in such cases, hematoma/fluid collection or infection are the main points of interest with regard to wound drainage. For intradural spine disease, leakage or collection of cerebrospinal fluid (CSF) through closed dura or the surgical wound is an additional point of interest. However,

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there are no reports that have determined the necessity of using closed-suction drainage after intradural spine surgery. Closed-suction drainage may be beneficial in reducing CSF collection, but such drainage may promote continuous leakage of CSF through closed dura or the surgical wound. In this regard, we have investigated whether closed-suction drainage confers benefit after primary intradural spinal cord tumor surgery.

Materials and methods

From January 2003 to October 2011, 441 primary intradural spinal cord tumors were operated in our institute. We reviewed images and medical records of these patients retrospectively. The study was approved by the institutional review board of our hospital (H-1111-019-384). Of the 441 operations, only those patients operated by a single surgeon ($n = 182$) were selected. Of those 182 patients, we excluded non-ambulatory patients ($n = 4$), patients with a bleeding tendency ($n = 1$), and those undergoing a revision operation due to recurrent or residual tumor ($n = 8$). Consequently, 169 patients were included in the present study.

At our institute, closed-suction drainage was inserted routinely before August 2007; however, after August 2007, it was no longer used after intradural spine surgery. Seventy-five patients (group I, male (M):female (F) = 39:36; average age 46.20 ± 15.63 years) had closed-suction drainage inserted below the deep fascia for 1–3 days, postoperatively, and 94 patients (group II, M:F = 46:48; 51.05 ± 14.89 years) did not.

The pathologic diagnosis of the patients in the two groups varied. The number of patients with meningioma was 10 versus 17, schwannoma was 36 versus 52, neurofibroma was 3 versus 0, ependymoma was 12 versus 8, hemangioblastoma was 1 versus 2, glioneuronal tumor was 5 versus 7, and with other pathologies was 8 versus 8 in groups I versus II, respectively. The average number of laminectomy level was 2.45 ± 1.46 in group I and 2.33 ± 1.91 in group II. Detailed surgery level is presented in Fig. 1.

Surgical procedures were similar in both the groups, except for the use of closed-suction drainage. Conventional midline approaches with laminectomy and durotomy were performed on patients in a prone position and under general anesthesia. After tumor removal and meticulous hemostasis, the arachnoid membrane was closed by 8-0 nylon, a watertight dural closure was made using 4-0 silk with interrupt suture and 1.0 cm^3 of fibrin bio glue (green plast; Green Cross, Seoul, Korea) was applied in common. The lamina was replaced with a mini-plate or a translaminar screw, if possible [10]. Muscle, fascia, and skin were closed in a layer-by-layer fashion in common. In meningioma cases, we coagulated the tumor origin and did not resect the dura [11].

If a watertight primary dural closure was not possible, supplementary muscle patch or artificial dura were used for closure. In group I, before closing the muscle layer, a silicone drain (Barovacdrain; Sewoon Medical, Seoul, Korea) was inserted below the fascia and the skin. Insertion was approximately 2–3 cm below the surgical skin incision in group I. The drain was connected to a 400 cm^3 bag equipped with a spring to generate negative pressure.

The principles used to care for patients postoperatively were similar in both the groups. Prophylactic antibiotics with first generation cephalosporin were given to each patient once, beginning 1 h before incision and was continued for 24 h postoperatively. All patients in both the groups were encouraged to ambulate from the day of the operation. The closed-suction drainage bag was emptied when it was full. The bag and drain were removed if the daily amount drained was less than 50 cm^3 . If CSF appeared in the drain tube or bag, the tube was clamped and removed. The surgical wound was closely observed in both the groups every day, beginning on the second postoperative day, and if CSF leakage through the skin wound was suspected, the leakage point was sutured with nylon or staples. Typically, the drain was applied for 1–3 days postoperatively. Even if CSF collection under the surgical wound was suspected, wound aspiration was never attempted. Although postoperative magnetic resonance (MR) imaging was not routinely used, images were obtained from 134 patients (60 patients in group I and 74 patients in group II) during the period between day 1 and month 4, postoperatively.

Statistical analysis

Age, height, weight, body mass index (BMI), number of laminectomy levels, operation time, estimated intraoperative blood loss, hospital stay period, and postoperative day 1 and day 2 body temperatures were compared between groups using Student's *t* tests. Sex ratio, number of patients provided with muscle patch or artificial dura, number of laminectomy levels, pre- and postoperative Frankel grade, and pathology were compared using χ^2 tests. Two-tailed probability (*p*) values less than 0.05 were considered indicative of a significant difference. SPSS for Windows (version 19.0; SPSS, Chicago, IL, USA) was used for statistical analysis.

Results

Demographics

Test results for demographic data are presented in Table 1. Distribution of sex was not different between the groups

Fig. 1 Number of patients at each spinal surgery level

($p = 0.69$), while mean age in group II was older than that in group I ($p = 0.04$). Height, weight and BMI were not different between the groups (163.89 ± 9.88 vs. 162.47 ± 9.29 cm, $p = 0.34$; 61.33 ± 11.78 vs. 62.13 ± 10.48 kg, $p = 0.64$; 22.75 ± 3.16 vs. 23.51 ± 3.22 kg/m², $p = 0.13$, respectively), and the number of laminectomy levels and the amount of operation time were not different between the groups (2.45 ± 1.46 vs. 2.33 ± 1.91 , $p = 0.65$; 260.65 ± 109.08 vs. 231.52 ± 90.08 min, $p = 0.06$). Mean estimated intraoperative blood loss was also not different (456.93 ± 406.62 vs. 383.94 ± 257.25 cm³, $p = 0.18$). Primary dural closure was possible in 72 (94.7 %) group I patients and 92 (97.9 %) group II patients; the difference was not significant ($p = 0.66$). The proportion of patients undergoing laminoplasty was not different between the groups (57/75 vs. 82/94, $p = 0.06$). Postoperatively, all patients could ambulate from the day of operation. The number of Frankel grade D was 41, grade E was 34 in group I and the number of Frankel grade D was 43, grade E was 51 in group II [12]. These postoperative neurological outcomes were not statistically different between the two groups ($p = 0.28$, Table 1).

Postoperative hospital course

Postoperatively, neurological deficits precluding patients from walking did not occur. All patients were able to walk from the operation day onward. The duration of closed-suction drainage was 1.31 ± 0.58 days (range 1–3) in

group I. The hospital stay period, and postoperative day 1 and day 2 body temperatures were not different between the groups (Table 2). Mean hospital stay period was 9.25 ± 5.01 days in group I and 9.35 ± 5.75 days in group II ($p = 0.91$). Body temperature was 36.76 ± 4.40 versus 36.21 ± 6.64 °C on day 1 ($p = 0.54$) and 37.13 ± 0.63 versus 37.19 ± 0.55 °C on day 2 ($p = 0.51$), postoperatively.

Among the 134 patients with postoperative MR images (60 patients in group I and 74 in group II), fluid collection, which seemed to be CSF, at the surgical wound site was observed in 13 patients (9.7 %) (5 patients in group I, 8.3 % and 8 patients in group II, 10.8 %, $p = 0.87$). Study of MR images showed fluid with signals that are characteristics of CSF at the surgical site (Fig. 2a, b). No patient showed neurological symptoms associated with CSF collection at the surgical wound and cessation of CSF collection was confirmed in 11 patients without resulting in further problems (Fig. 2c, d).

Revision operations were performed in 16 patients, of which 14 were for removal of a residual or recurrent mass, but 2 patients in group I underwent revision surgeries due to surgical wound infection (Tables 2, 3). Postoperative wound infection was suspected based on clinical symptoms and laboratory findings. One patient (case I, Table 3) exhibited wound swelling, wound dehiscence, and redness at postoperative day 21, while the other patient (case II, Table 3) had wound dehiscence and wound discharge at postoperative day 5. Culture study revealed *Streptococcus*

Table 1 Baseline characteristics of patients

Group (<i>n</i> = 169)	Group I (<i>n</i> = 75)	Group II (<i>n</i> = 94)	<i>p</i> value
Sex (male:female)	39:36	46:48	0.69
Mean age	46.0 ± 15.63	51.05 ± 14.89	0.04*
Mean height (cm)	163.89 ± 9.88	162.47 ± 9.29	0.34
Mean weight (kg)	61.33 ± 11.78	62.13 ± 10.48	0.64
Mean BMI (kg/m ²)	22.75 ± 3.16	23.51 ± 3.22	0.13
Mean number of laminectomy levels	2.45 ± 1.46	2.33 ± 1.91	0.65
Mean operation time (min)	260.65 ± 109.08	231.52 ± 90.08	0.06
Mean estimated intraoperative blood loss (cm ³)	456.93 ± 406.62	383.94 ± 257.25	0.18
Use of muscle patch or artificial dura	3 (4 %)	2 (2.1 %)	0.66
Laminoplasty: laminectomy ratio	57:18	82:12	0.06
Preoperative Frankel grade			
D	50	53	0.21
E	25	41	
Postoperative Frankel grade			
D	41	43	0.28
E	34	51	
Pathology			
Meningioma	10	17	0.31
Schwannoma	36	52	
Neurofibroma	3	0	
Ependymoma	12	8	
Hemangioblastoma	1	2	
Glioneuronal tumor	5	7	
Others	8	8	

BMI body mass index, CSF cerebrospinal fluid, Group I group with drain, Group II group without drain

* Statistical significance

Table 2 Comparison of groups with and without postsurgical closed-suction drain insertion

Group (<i>n</i> = 169)	Group I (<i>n</i> = 75)	Group II (<i>n</i> = 94)	<i>p</i> value
Mean hospital stay period (days)	9.25 ± 5.01	9.35 ± 5.75	0.91
Mean body temperature (°C)			
POD 1	36.76 ± 4.40	36.21 ± 6.64	0.54
POD 2	37.13 ± 0.63	37.19 ± 0.55	0.51
Revision operations for wound problems	2	0	0.20

CSF cerebrospinal fluid, POD postoperative day, Group I group with drain, Group II group without drain

viridans in case II and third generation cephalosporin was used for 10 days. Neither patient had recurrence of their wound problem. In group II, no patient required a revision

operation for a wound-related problem ($p = 0.20$; Table 2).

Discussion

There have been several studies attempting to verify the efficacy of using closed-suction drainage after surgery for degenerative spine disease. A prospective randomized study ($n = 83$) by Brown and Brookfield [6] provided an analysis of the possible benefits or increased complications in extensive lumbar spine surgery. Their findings revealed no difference between the groups in terms of infection or hematoma collection. A similar study, but with a retrospective design, of patients undergoing single-level fusion procedures ($n = 85$) showed no benefit of perioperative wound drains [9]. A larger retrospective study ($n = 560$) showed that the risk of postoperative complications in single-level lumbar decompression patients did not increase when the surgical wound was closed without the placement of a closed-suction drainage [8]. Based on those combined results, it seems that placement of a closed-suction drainage has little benefit with respect to the rates of infection or hematoma collection for surgeries related to degenerative spine disease.

However, such results may not be applicable for intradural surgery, because intradural surgery has an additional problem related to other degenerative spine disease surgeries, i.e., CSF leakage. After intradural spine surgery, CSF leakage and collection may happen even after the provision of a watertight dural closure. A closed-suction drainage theoretically reduces postoperative hematoma and fluid collection; however, a closed-suction drainage may promote CSF leakage after intradural spine surgery. In such a conflicting CSF situation, it is difficult to decide whether to insert closed-suction drainage after intradural spine surgery. However, this issue has not yet been addressed in other studies.

In the present study, a retrospective, comparative study was undertaken to determine the necessity of using closed-suction drainage after surgery for a primary intradural spinal cord tumor. Although there was period difference (drains were used from January 2003 to August 2007; no drains were used from August 2007 to October 2011), the closure procedures were similar between the two groups. To reduce a possible surgeon-volume effect, all selected surgeries were performed by a single surgeon (C.K.C.). Among the potential confounding factors, none were significantly different between the groups except for the patients age (Tables 1, 2). It has been reported that age, in patients older than 60 years, is correlated with increased postoperative infection [13]; here, however, the mean age of both groups was less than 60 years and only two patients

Fig. 2 Illustrative case showing spontaneous resolution of CSF collection at wound site. Immediate postoperative T2-weighted axial (a) and sagittal (b) MR image showing CSF collection. A closed-

suction drain was not inserted in this patient. *Multiple small arrows* indicate the CSF collection boundary. MR images taken 5 months later shows spontaneous disappearance of CSF collection (c, d)

had postoperative infections. Therefore, it seemed that the age difference between our groups did not contribute to postoperative surgical site infection. On that basis, the baseline characteristics are similar in both the groups.

Although transient CSF collection was detected in the MR images of 13 patients, cessation of CSF collection without further problem was confirmed in 11 patients. No problem associated with surgical wounds occurred in the group II patients, but problems occurred in two of the group I patients (39- and 45-years old female patients). The baseline characteristics of those two patients were similar to those of the other patients (compare Tables 1 and 3).

Based on the combined results, it seems that closed-suction drainage may not be essential in reducing CSF collection or in reducing surgical wound problems after

intradural spine surgery. Moreover, in comparison to the usual surgical wound infection rate of 4.4 % [13], the rate of infection in group I (2.1 %) should not be directly attributed to the use of the closed-suction drainage.

Limitations of this study

Several limitations of this study should be noted. First, this is a retrospective study with historical control. Although baseline characteristics in the study groups were similar, and all operations were performed by a single surgeon, such a study may include inevitable selection bias. Second, surgical procedure, suturing material, and bio glue may be different from surgeon to surgeon; thus, the present results cannot be generalized. In addition, minimally invasive

Table 3 Summary of patients undergoing revision operation for wound problems

	Sex	Age	Pathology	Surgery level	Number of laminectomy levels	Height (cm)	Weight (kg)	BMI (kg/m ³)	Operation time (min)	EBL (cm ³)	Primary dural closure	Laminoplasty or laminectomy	Drain inserted
Case I	F	39	Schwannoma	T12-L1	2	154	56.6	23.87	230	200	Y	Laminoplasty	Y
Case II	F	45	Schwannoma	T12-L1	2	160	53.6	20.94	240	400	Y	Laminoplasty	Y

BMI body mass index, EBL estimated blood loss, CSF cerebrospinal fluid, Y yes

spine surgery is a recent application in cases of primary spinal cord tumor surgery and closure procedures may differ. Third, because of limited surgical exposure, the present study's results should not be applied for cases of extensive spine surgery. In this study, lateral muscular dissection was usually limited at lamina. Therefore, post-operative dead space for collection of fluid such as blood, CSF, and interstitial fluid would be smaller than those in more extensive surgeries. Finally, the addition of items replacing lamina also may contribute in reducing dead space. Thus, the present results cannot be generalized to other surgeries.

Nonetheless, the present study does address the efficacy of using prophylactic closed-suction drainage in a subset of patients who have undergone intradural spinal cord tumor surgery. In the course of clinical practice, surgeons may insert closed-suction drainage prophylactically during wound closure without solid evidence supporting its efficacy. Our results show that meticulous bleeding control, watertight dural closure, and tight layer-by-layer wound closure without closed-suction drainage are sufficient after intradural spinal cord tumor surgery. A large, prospective, randomized control study would help surgeons decide on whether closed-suction drainage should be used in primary intradural spinal cord tumor surgery.

Conclusions

Prophylactic use of closed-suction drainage for reducing hematoma collection, CSF leakage, or infection may not be essential after primary intradural spinal cord tumor surgery. A large, prospective, randomized control study may provide additional supporting evidence.

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Conflict of interest The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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