Prolonged Use of Subfascial Epidural Drain and Antibiotics for Management of Thoracic Cerebrospinal Fluid Leakage

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Research Article

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Abstract

Background: Cerebrospinal fluid (CSF) leakage is a common and frustrating complication surrounding spine surgery. However, the incidence and treatment of CSF leakage after thoracic spinal surgery has seldom been reported. The aim of this study was to evaluate the efficacy of prolonged subfascial epidural drain and antibiotics to treat CSF leakage after posterior thoracic decompression surgery.

Methods: A total of 121 patients, who underwent thoracic decompression between September 2012 to September 2021, were retrospectively reviewed, consisting of 56 patients with CSF leakage (Group A) and 65 without CSF leakage (Group B). Demographic data, surgical procedures, perioperative management of CSF leakage, and complications were identified from patients' medical records.

Results: In Group A, the average patient age at surgery was 52.3±11.2 years (24 to 76 years) and the average subfascial drainage time was 7.6±2.7 days (2 to 16 days). Two patients from group A underwent direct dura repair, with one of which still presenting with CSF leakage postoperatively. Four patients (7.1%) presented with deep wound infection and were successfully managed with wound debridement or intravenous antibiotics. In group B, the average patient age was 54.9±11.9 years (25 to 80 years) and the average subfascial drainage time was 3.8±1.4 days (2 to 7 days). One patient (1.5%) had a superficial wound infection and was treated with antibiotics. No patients presented with wound dehiscence, wound exudation or CSF fistulation. No significant difference in infection rate was observed between the two groups.

Conclusion: No significant difference in infection rates was observed between the patients with and without thoracic CSF leakage, who were treated with different protocol. Prolonged use of subfascial epidural drain and antibiotics can effectively manage thoracic CSF leakage due to dural tear in patients after thoracic decompression surgery.

Introduction

Cerebrospinal fluid (CSF) leakage is a common and frustrating complication surrounding spine surgery, identified by recognition of dura tear intraoperatively or outflow of clear drainage fluid postoperatively[1]. Reported rates of CSF leakage range from < 1–17%%[2–6] and the rate of persistent leakage post lumbar discectomy or laminectomy was estimated to be 0.07–2%[7]. Surprisingly, the incidence and treatment of CSF leakage after thoracic spinal surgery has seldom been reported.

Persistent CSF leakage leads to detrimental complications, such as headache, pseudo-meningocele, wound infection, meningitis and even death [8–13]. However, to the best of our knowledge, no standard protocol is available guiding CSF leakage management, especially for thoracic CSF leakage[11], and treatment of thoracic CSF leak with prolonged use of subfascial epidural drain and antibiotics has not been reported before. The purpose of this study was to retrospectively review the efficacy of prolonged use of subfascial epidural drain and antibiotics in treatment with thoracic CSF leakage and compare the results with the patients without CSF leakage with regular treatment.

Methods

Patients

From September 2012 to September 2021, 121 patients who underwent thoracic decompression surgery due to thoracic spinal stenosis were enrolled in this study, which was approved by the institutional review board of Peking Union Medical College Hospital. Patients with infection, tumor, fracture, and spinal deformity were excluded from this study. 56 patients with CSF leakage were classified into group A, and 65 patients without CSF leakage were classified into group B. Five patients in group A and four patients in group B underwent revision surgery while other patients only had primary surgery. Age, sex, surgical procedures, perioperative CSF leakage management, and complications were retrieved from the patients' medical records. Patients were followed up regularly in the outpatient clinic.

Surgical Procedure

All surgical procedures were the same between group A and B, and were performed by a single senior spine surgeon. Thoracic laminectomy and ligamentum flavum resection were performed in all cases. For patients with ossification of the posterior longitudinal ligament (OPLL) as the main pathogenic factor, circular decompression was performed. The ossified dura mater was also resected if presented. Two patients in group A underwent direct repair of the dura, with one of the two still presenting with CSF leakage postoperatively. Other patients underwent indirect repair because the dural defect was too big or located too far out to adopt direct repair. A piece of hemostatic sponge or gelatin sponge was layered over the durotomy site, followed by layered wound closure in indirect repair. A drainage tube was placed under the muscular layer, connected to a 1000 mL bag without suction to establish a closed drainage system. The crucial deep fascial layer was closed through a single continuous suture, with intermittent reinforcement sutures to strengthen the closure.

Postoperative Treatment

Postoperative management was different between group A and B. In group A, the patients laid supine in the Trendelenberg position postoperatively with the head down to 15°. The drainage collection bag was kept below the patient's bed to avoid over-drainage of CSF. CSF flow was monitored to ensure the drainage was around 300 mL every 24 hours and to detect early signs of infection. If increased drainage was observed, the drainage bag height level was raised to reduce drainage volume. However, the height of the bag should always be positioned below the patient to prevent reverse flow. The drainage tube was removed 7 to 10 days after operation. The drain tube tract was closed with a figure-of-eight suture to prevent CSF fistulation. Patients could get up and walk after removal of the drainage tube. Prophylactic intravenous vancomycin and third-generation cephalosporin or meropenem antibiotics were prescribed postoperatively until drainage tube was removed and body temperature was normal. In group B, patients used the same drainage system with group A and were bedridden in supine for 2 to 3 days due to pain or

other discomfort. Drainage tube was removed when the amount of drainage was less than 50mL. Second-generation intravenous cephalosporin was administered for less than 24 hours postoperatively.

Statistical analysis

The Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) software was used for data analysis. The enumeration data and measurement data were analyzed by χ^2 and t-test, respectively. Logistic regression analysis was used to determine the risk factors of infection rate. P value < 0.05 indicates statistical significance.

Results

Demographics

Demographic data are shown in Table 1. No significant difference was observed regarding age, blood loss and body mass index (BMI) between patients in groups A and B. The average subfascial drainage time was 7.6 ± 2.7 days (2 to 16 days) and 3.8 ± 1.4 days (2 to 7 days) in groups A and B, respectively. The time of drainage in group A was significantly longer than that in group B (P = 0.003).

Table 1
Demographic data of the patients with or without CSF leakage.

	Gender (M/F)	Age(years)	OPLL	OLF	DO	Blood Loss (mL)	BMI(Kg/m^2)
Group A	21/35	52.3 ± 11.2	21	55	50	1053.6 ± 700.1	28.0 ± 4.1
Group B	36/29	54.9 ± 11.9	12	56	10	890.8 ± 745.3	27.5 ± 5.7
CSF: cerebrospinal fluid							

Complications

One patient experienced hemorrhagic shock and complete paralysis of lower limbs due to spinal cord ischemia in group A. Partial recovery was achieved through rehabilitation and physical therapy exercises. Another two patients had spinal cord injury and weakness of the lower limbs with partial recovery after rehabilitation and two patients were found to have malposition of the screw and underwent revision surgery. In group B, two patients had temporary weakness of the lower limbs and one patient underwent revision surgery due to implant failure.

In group A, one patient underwent debridement due to delayed wound healing. Four patients (7.1%) suffered from deep wound infection, one of which underwent debridement while the remaining three cases were treated with antibiotics. All four patients recovered smoothly. In group B, one patient suffered

from superficial wound infection (1.5%) and was treated with antibiotics. No patients from either group presented with wound breakdown, wound exudation or CSF fistulation, and there was no significant difference in infection rates between the two groups ($P = 0.122$). Logistic regression analysis showed that infection was not related to age, blood loss, BMI and drainage time.

Discussion

The rate of cerebrospinal fluid leakage after spine surgery

Durotomy-induced CSF leakage is undesirable but relatively common in spine surgery, especially in cases with dural adhesion and dural ossification. The incidence varied with different procedures and different series of patients[14]. Woff et al.[11] observed that 1.7% of 1359 lumbar patients had CSF leakage. However, Khan et al.[15] reported an overall CSF leakage incidence as high as 10.6% in 3183 lumbar patients, which consisted of the largest number of cases. Hannallah et al.[16] noted that 1% of 2216 cervical spine procedures had CSF leakage. Cammisa et al.[5] retrospectively reviewed 2144 patients, including 422 cervical surgery (338 anterior and 84 posterior), 7 posterior thoracic surgery, and 1715 lumbosacral surgery (1646 posterior and 69 anterior), and the overall incidence of CSF leakage was 3.5%. There were few reports about CSF leakage after thoracic decompression, and the incidence varied from 10–22.2%[17–19]. In this study, the incidence of CSF leak was 46.3%, which was higher than that in previous studies, and could be due to the higher rate of dural ossification (DO) (49.6%).

Repair Strategy For Dural Tear

CSF leakage induces adverse sequelae if handled improperly, such as wound non-healing, infection, CSF fistulas and meningitis [1, 14]. The treatment of CSF leakage can be classified into two treatment regimens: 1) directly close with sutures or indirectly close the dura tear with the onlay technique using dural substitute material to stop CSF leakage; 2) reduce the subarachnoid fluid and/or increase the epidural space pressure to decelerate CSF leakage[14].

Generally, direct repair is the best way to treat dural tear[20]. However, it still has a failure rate of 5–9% in previous studies[14]. In our study, one of two patients in group A had a failed direct repair of dura. Indirect closure with the onlay technique will be indicated when it is impossible to suture directly onto the edge of the dura mater or dura tear that involves the nerve root sleeve or axilla, or if dural tear lies anteriorly[2, 14]. Fat/fascia/muscle grafting, synthetic grafts, and collagen matrix/gelatin sponge can be used for this technique[21]. Some surgeons choose not suturing if there is no breach in the arachnoid[11, 21, 22]. The rationale for this approach was that the risk of arachnoid herniation is balanced by the risk of CSF leakage through the needle holes during suturing. In addition, direct suture repair may prolong the operative time and increase surgical risk[1]. Conservative measures in the management of dura tears included drain placement, adjustment of patient position, fluid restriction and acetazolamide to decrease CSF production[4, 23]. Although many methods for managing CSF leakage have been proposed, the

optimal one remains controversial[1]. In our study, all except two patients underwent indirect repair and subfascial wound drainage in group A due to difficulty for direct repair.

The Role Of Prolonged Wound Drain

The use of wound drains is also controversial. Some surgeons defend controlled continuous drainage to prevent meningoceles and extradural hematomas[9, 11]. For patients with CSF leakage, continuously evacuating CSF out of the wound, has been shown to facilitate sufficient healing and sealing time for the dura, soft tissue, and fascia, thereby preventing dead space[24] and also allows the surgical wound to epithelialize and prevent the formation of CSF fistula[3, 10]. In the meantime, a tight fascial closure can increase the epidural fluid pressure, restrict CSF flow, and facilitate the dura flaps to adhere[1, 14]. Some authors counter the placement of drainage due to concern of CSF hypovolemia due to overdrainage[9, 25], which will induce headache, nausea, and vomiting[22]. There was also a concern of complications associated with closed suction wound drains, including infection, hematoma formation, and additional neurological deficit[26, 27]. However, in the study by Niu et al.[10], none of the 25 patients suffered from complications associated with subfascial drain after intentional durotomy. In our study, subfascial drainage was placed for all the patients to prevent extradural hematomas and evacuate the CSF to facilitate the wound to heal.

When CSF leakage occurred, the drains were left in place for a longer time than usual. The drain tubes were only pulled out when the surgeon assessed the fascia and wound closures to be well healed. However, there is no consensus about the duration of subfascial drainage. Hughes et al.[24] proposed this time to be about 10 to 17 days postoperatively for patients without suture of durotomy[28]. Fang et al.[14] recommended drain tube duration of more than 7 days. Others support postoperative drainage for an average of 3 days[1]. In the process of soft tissue repair, the inflammatory response starts in two days. Primary fibroblastic bridging occurs until postoperative day 6, and the surface is coated with inflammatory cells until postoperative day 10[27, 29]. Considering the above results, we left the wound drain in-situ for an average of 7.6 days in group A in our study. The positive results showed that none of the patients suffered from wound breakdown or fistula.

The Role Of Preventive Use Of Antibiotics For Cerebrospinal Fluid Leakage After Spine Surgery

Another risk of wound drains is ascending infection or meningitis from a tube left in place for a long time. The rate of deep wound infection could be as high as 8.1% in patients with durotomies[5]. Although there is a consensus on the pertinence of prophylactic antibiotic therapy at induction[30, 31], the indication for prolonged antibiotic therapy, when a tear occurs, is subject to debate[11]. Considering the risk of infection and secondary serious consequences, such as meningitis, we prolonged the time for prophylactic use of

antibiotics to be 7 to 10 days, and the results showed that the rate of infection had no significant difference between the patients in group A and B.

Limitations

Several limitations of this study should be noted. This was a retrospective study and had all the limitations of retrospective studies. There was no control group that had a longer duration of drainage tube without prolonged use of antibiotics. However, it is clinically not suitable to set up this control group due to the high risk of infection, and serious adverse consequences.

Conclusions

In comparison, there was no significant difference of infection rate between group A and B. Besides, it is noteworthy that there were no wound breakdown or CSF fistulation. Based on this preliminary study, we can conclude that when faced with thoracic dura tear, prolonged subfascial epidural drainage and antibiotics can effectively manage CSF leakage.

Abbreviations

CSF: Cerebrospinal fluid; OPLL: ossification of the posterior longitudinal ligament; DO: dural ossification; BMI: body mass index

Declarations

Ethics approval and consent to participate

The usage of samples was approved by the Ethics Committee of Peking Union Medical College Hospital and none of the patients participated in this study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Prof. Yu Zhao and Jiliang Zhai conceived, designed and supervised the study; Medical records were reviewed by Jiliang Zhai; The first draft of the manuscript was written by Jiliang Zhai and edited by Shigong Guo and Da He. All authors read and approved the final manuscript before submission.

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