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Original article

Subfascial drainage for management of cerebrospinal fluid leakage after posterior spine surgery—A prospective study based on Poiseuille's law

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ABSTRACT

Purpose: Up to date, some approaches retarding the flow of cerebrospinal fluid (CSF) could be regarded as direct applications of the fluid mechanics (Poiseuille's law). However, there is a lack of the research on the efficacy of subfascial drainage for management of CSF leak after spine surgery based on the law. This is a prospective and comparative study on subfascial drainage for CSF.

Methods: Every four months in the three years from January 2010 to December 2012, the patients were enrolled respectively in Group A, Group B and Group C, in which, the drainage tube was discontinued within postoperative 3–4 days, 5–6 days, 7–10 days. Results and complications of postoperative CSF leak were investigated, and mean wound healing time (MWHT) of the three groups was compared.

Results: A total of 108 cases (Group A/B/C:35/32/41) of CSF leak following posterior spine surgery were admitted to Tianjin Union Medicine Center, and 92 cases have been followed up for more than 1 year (follow-up rate of 85.2%). Preoperative demographics were similar among the 3 groups. In Group A, 7 patients developed CSF leak through the wound (CSFLW), of which 5 cases had to undergo reoperation. One case in Group A was confirmed to have pseudomeningocele at the 1st month after surgery. The MWHT was (16.6 ± 3.6) days. In Group B, 3 patients developed CSFLW and cured by reoperation, in which 1 case of superficial infection recovered well after reoperation. MWHT was (11.4 ± 2.2) days. In Group C, CSFLW was not found and MWHT was (10.1 ± 2.9) days. The differences of MWHT among Groups A, B and C were statistically significant.

Conclusion: Postoperative subfascial drainage, which is used to decrease the subfascial space pressure (P_2), would help wound healing. When it is placed for more than 7 days, the wound resistance (R_w) would be strong enough to withstand the subarachnoid pressure (P_1). Meanwhile, the power transduction in a sequence of $R_w > P_2 > P_1$ will indirectly retard CSF leak at the durotomy site and accordingly facilitate the healing of damaged spinal dura mater.

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Introduction

Durotomy-induced cerebrospinal fluid (CSF) leak is a common complication during spine surgery with a reported incidence of 3%–16%.¹ CSF leak can be identified by direct intraoperative recognition or by postoperative elicitation of characteristic symptomatology. If handled improperly, it may pose risks with persistent leak through the wound, nerve root entrapment, meningitis, brain abscess, or even intracranial hemorrhage.² The optimal method for

managing CSF leak remains controversial. The current treatment principle has been focused on direct suture of durotomy site. However, in some cases, the torn/defected dura can not be repaired adequately during operation. And direct suture repair may prolong operative time and increase surgical risk.

CSF follows Poiseuille's law during its flow in the subarachnoid space, and approaches to retarding CSF leak is regarded as direct applications of the law.^{3,4} The flow results from the difference of fluid pressures at 2 communicating points and the resistance between the two points ($F = P_1 - P_2 / R$)⁵ (Figs. 1 and 2). So the following treatment methods could be summarized to decrease P_1 , increase P_2 , and increase R: adjusting patient's position,⁶ CSF shunting by subarachnoid catheter,^{7,8} inhibiting the formation of CSF with drugs such as acetazolamide,⁹ applying repair materials such as collagen

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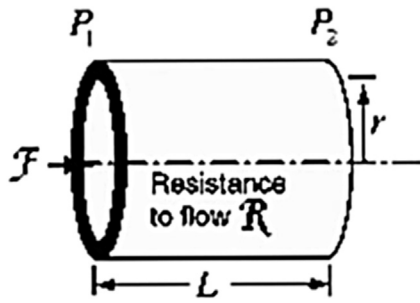


Fig. 1. The formula of Poiseuille's law.

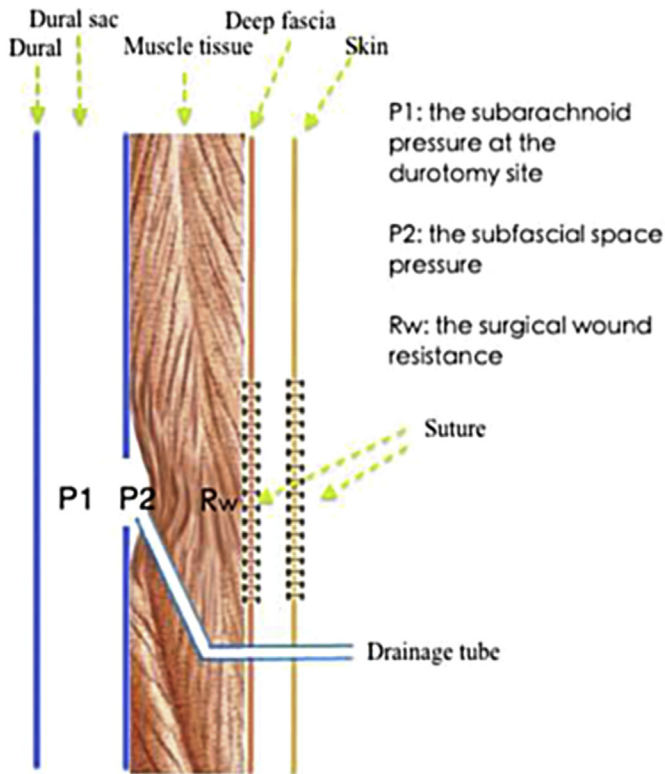


Fig. 2. Physical concepts in CSF flow.

matrix,¹⁰ patch,¹¹ hydrogel,¹² fibrin glue,¹³ epidural blood patch¹⁴ or suture techniques including posterior lumbar disk scope¹⁵ or the U clip,¹⁶ and applying external pressure on the wound or partial pressure suture.¹⁷

In this prospective study, we made a further elucidation on the duration of postoperative drain placement and Poiseuille's law.

Materials and methods

Patient selection

We examined the detailed data from a cohort of patients undergoing posterior spine surgery during January 2010 to December 2012 at Tianjin Union Medicine Center. The Institutional Review Committee of the centre approved this research. All patients were well explained about the study and an informed consent was obtained from them.

Inclusion criteria: 1) cases undergoing posterior spine surgery; 2) the torn/defected dura beyond repaired one during operation

and left unrepaired; 3) postoperative CSF leak >100 mL/day; 4) sufficient and necessary information in the operative report and medical record; 5) more than 1 year follow-up.

Exclusion criteria: 1) cases combined with morbidities of diabetes, obesity, malnutrition, cancer, or spinal infection; 2) cases with incomplete information mentioned above.

Every four months in the three years, the patients were enrolled respectively in Group A, Group B and Group C, in which, the drainage tube was discontinued within postoperative 3–4 days, 5–6 days, 7–10 days respectively. A total of 108 cases (Group A/B/C:35/32/41) were enrolled and followed up at postoperative 1 month, 3 month, and 1 year.

Medical record review

The medical and operative records were reviewed and information regarding sex, age, surgical procedures, surgical site, methods and materials for repair, and the data about location and size of the durotomy were also extracted for analysis. Medical records were used to gather information regarding postoperative treatment such as the duration of drainage tube placement, complications and wound healing time.

Surgical procedure

All procedures throughout this study were performed by a senior spinal surgeon and his team. A piece of gelatin sponge was layered over the durotomy site. The surgical incision was sutured layer by layer and it is imperative that the wound closure is so watertight that it could withstand the strength of the Valsalva maneuver at the conclusion of the suture repair. The most important deep fascial layer of wound closure was accomplished in an interrupted fashion. The drainage tube (8 mm × 400 mm) was placed in the subfascial space close to the durotomy site, connected to a 1000 mL bag without suction to establish a closed drainage system. The skin entry site of drainage tube was covered with a transparent waterproof dressing in order to ensure sterility. The collection bag was kept on the patient's bed to avoid gravity drainage of CSF and patient was requested to rest on bed during the postoperative wound drain period. Additionally, the drainage bag was changed every 24 h with strict aseptic measures and wound dressing was done every 24–72 h. Postoperatively patients were given third generation cephalosporin (2 g/day, tid) for 7 days.

Treatment of postoperative CSF leak

Conservative treatment methods included increasing the local incision pressure and keeping patients with a special position. Reoperation intervention was indicated after a failure of conservative treatment, which included exposure of incision, placement of drainage tube in the subfascial space and suture of the deep fascia under local anesthesia.

Statistical analysis

Preoperative and postoperative *t*-value was calculated by SPSS 19.0 statistical software. A *p* value <0.05 is considered to be statistically significant.

Results

Patient characteristics

92 cases (M/F: 47/45, Group A/B/C: 31/25/36) have been followed up (follow-up rate of 85.2%), with the mean age of 53.7

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