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Drainage after posterior single-level instrumented lumbar fusion

Natural pressure vs negative pressure

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Abstract

Recent findings have shown a trend toward recommending against the routine use of drains in spinal surgery because it carries the risk for potential complications. However, most surgeons still use closed suction drainage to prevent hematoma formation. This study is to compare the clinical outcomes between natural pressure drainage and negative pressure drainage after posterior lumbar interbody fusion.

Consecutive 132 patients who underwent spinal fusion in the Third Hospital of Hebei Medical University and met the inclusion criteria were reviewed from January 2018 to January 2019 and divided into negative pressure drainage group and natural pressure drainage group according to different pressure drainage. There were 64 patients who had a negative pressure drainage placed and 68 patients who had a natural pressure drainage placed. Demographics, intraoperative blood loss, operative room time, drainage volume at the 1st postoperative day, total volume of postoperative drainage, the total drainage days, postoperative temperature, and postoperative complications (wound infection, symptomatic hematoma) were compared between the 2 groups.

The median drainage volume at the 1st postoperative day in negative pressure group was 204.89 ± 95.19 mL, while in natural pressure group, it was 141.00 ± 52.19 mL (P = .000). The median total volume of postoperative drainage in negative pressure group was 378.06 ± 117.98 mL, while in natural pressure group, it was 249.32 ± 70.74 mL (P = .000). The median total drainage days between natural pressure group and negative pressure group were obviously different (2.93 ± 0.55 vs 3.51 ± 0.71 days, P = .000). There was no difference in patient characteristics, operative data, postoperative temperature, and complications.

Natural pressure drainage significantly reduced postoperative drainage volume and indwelling time, but did not increase postoperative complications. Therefore, it may offer an alternative to negative pressure drainage and is as safe and effective as negative pressure drainage.

Abbreviations: PLIF = posterior lumbar interbody fusion, SHE = spinal epidural hematoma, SEH = spinal epidural hematoma, SSI = surgical-site infection.

Keywords: posterior lumbar interbody fusion, natural pressure drainage, negative pressure drainage, epidural hematoma, surgical-site infection, clinical outcome

1. Introduction

It is reported that the incidence of symptomatic spinal epidural hematoma (SEH) which is a severe complication of spinal surgery was 0.1% to 3%.[1] Most hematomas require no treatment and are symptomless. Though the occurrence of SEH is rare, if not treated properly and timely, the neurologic sequella may be devastating because the hematoma could cause compression of the spinal cord or nerve roots leading to neurologic consequences such as urinary and fecal incontinence, motor, and sensory loss. One of preventive measures is the utilization of drains. In theory, negative pressure drainage is more powerful to prevent the formation of hematomas in the operative field, which could decrease the tension of incisions and contribute to wound

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TC and HC contributed equally to the work.

The Ethical Board Review of the Third Hospital of Hebei Medical University (Shijiazhuang, China) has approved the conduction of the study after a thorough examination and verification. The study has been performed in accordance with the ethical standards of Declaration of Helsinki in the 1964.

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healing. However, which drainage method, natural pressure drainage or negative pressure drainage is better is ambiguous. This retrospective clinical study was designed to compare the clinical outcomes between both groups in patients underwent posterior instrumented spinal fusion.

2. Patients and methods

2.1. Patient population

A retrospective review of consecutive posterior lumbar interbody fusion (PLIF) at a single level for lumbar disease was performed between January 2018 and January 2019. All patients performed the same midline lumbar incision and underwent autogeous bone graft. Exclusions criteria were as follows: patients who underwent mutisegmental lumbar surgery or with infectious lumbar diseases, abnormal coagulation function, intraoperative, and postoperative cerebrospinal fluid leakage. Finally, 132 patients met the inclusion criteria. There were 79 males and 53 females. The age ranged from 24 to 70 with a mean age of 50.61 years. We identified 64 patients who had a negative pressure drainage placed and 68 patients who had a natural pressure drainage placed. Every patient was conducted by the same senior surgeon.

2.2. Surgical procedures

Every patient was placed in the prone position after general anesthesia. Medial skin incision was used to expose the posterior elements. Bilateral laminotomies and medial facetecomies were performed by an rongeur or osteotome. The nucleus pulposus clamp was used to remove the nucleus pulposus after the thecal sac and nerve roots were exposed. A complete discectomy down to the exposed endplate was performed using a series of shavers and curettes. Harvested local bones and a proper sized cage with bone autograft were inserted. Pedicle screws were applied to the surgical segment. A closed drainage (Fig. 1A) was placed below the deep fascia, over the exposed dura before wound closure. The difference of 2 groups is that negative pressure group always used negative pressure absorbing ball to keep negative pressure (Fig. 1B, C). All patients were given a dose of 1 g of 1st-generation cephalosporin when surgery started and 4 additional doses on the 1st day after surgery. The drain was removed when volume of drain did not exceed 50 mL/d.

2.3. Statistical analysis

The following data were recorded: age, gender, weight, diagnosis, operating time, intraoperative blood loss, the drainage volume, postoperative temperature, total drainage days, and postoperative complications. Continuous data are presented as mean ± standard deviation. The Chi-squared test or the Fisher exact test was used to compare categorical variables. Shapiro–Wilk test was used to check the normality of continuous variables and the Student t test or the Mann–Whitney U test was performed to compare continuous data with normal or skewed distribution. All statistical analysis was performed using SPSS version 24.0 (SPSS Inc, Chicago, IL) and a P-value <.05 was considered statistically significant.

3. Result

No significant difference was found in weight, age, types of diagnosis, gender, operating time, and intraoperative blood loss for both groups (Table 1).

Drainage volume on the 1st day after surgery and total drainage volume were found to be higher in patients with negative pressure drainage placed compared with natural pressure drainage placed (141.00 ± 52.19 vs 204.89 ± 95.19 mL, P = .000; 249.32 ± 70.74 vs 378.06 ± 117.98 mL, P = .000). However, there was no difference in body temperature on 1st and 2nd day after surgery for both groups (37.18 ± 0.54°C vs 37.21 ± 0.60°C, P = .927; 37.22 ± 0.55°C vs 37.15 ± 0.53°C, P = .536). Duration of drainage was also significantly different (2.93 ± 0.55 days vs 3.51 ± 0.71 days, P = .000). No deep infection was found in both groups. The postoperative complication profile was similar between 2 groups in superficial wound infection (negative group: 3.1% vs natural group: 1.5%, P = .958). There was 1 case of hematoma in natural pressure drainage group (1.5%) and no hematoma was found in negative pressure drainage group (0%). All of these postoperative parameters are shown in Table 2.

4. Discussion

There is little evidence on practice patterns of drain use in spine surgery, including drain types, indication for placement, depth of drain placement, duration, and removal based on a fixed interval or drain output. Drain use seems to be a matter of practice without clear guidelines. The present study is an investigation about different methods of drainage after single-level PLIF. In comparison with negative drainage, natural pressure drainage can decrease the drain output, duration, and blood loss but does not increase complications such as infection and hematoma. These results suggest natural drainage is a safe and effective drainage strategy.

The SEH after spinal surgery is a complication and has been defined as symptomatic and asymptomatic. The incidence of asymptomatic hematomas has been reported at high rates (33–100%).[2] A different degree of SEH on magnetic resonance imaging can be found in patients after spinal surgery. Sokolowski et al found the incidence of postoperative SHE compressing the dural sac was 58%.[3] Another study of 184 patients with microendoscopic decompressive laminotomy for single-level lumbar spinal stenosis suggested the SHE incidence was 100%.[4] Previous studies have focused on risk factors for epidural hematoma and showed that using a drain was not a significant risk factor.[5–8] Intraoperative adequate hemostasis plays a very important role for prevention of SEH. It may be difficult to obtain adequate hemostasis in many cases because the epidural deep venous plexus, near to the nerve roots are the major sources of bleeding. Furthermore, hypertension may occur when waking and could result in bleeding again.[9,10] This further reveals the necessity of natural or negative pressure drainage, which both could evacuate watery state fluid and minute necrotic tissues such as fat. In terms of symptomatic hematoma, our results showed no statistically significant difference between the 2 groups. In theory, negative pressure drainage can produce more force, which could reduce the size of the hematoma more powerfully. However, we must realize that natural pressure drainage can make a certain amount of blood remain in the wound, maintaining with a certain tension. These blood and other fluid can accelerate coagulation to decrease bleeding and achieve better hemostatic effect. Therefore, natural drainage may be able to effectively reduce the formation of hematoma as well as negative pressure drainage.

Which drainage method is better is uncertain. In terms of postoperative wound complications, there was no significant difference between the 2 drainage methods, and both of them

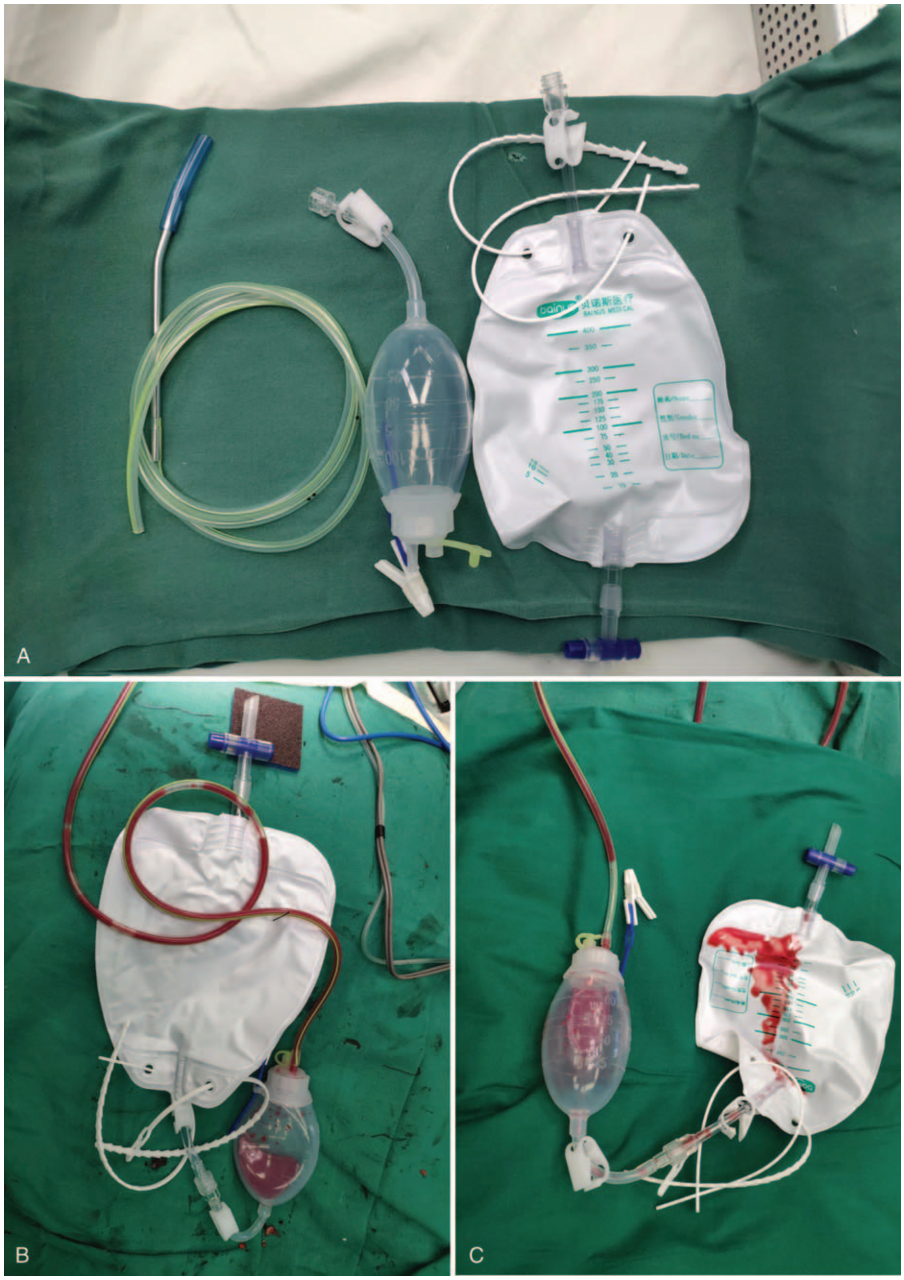

Figure 1. (A) Drainage constitution: drainage tube, bag body, platoon fluid switch, negative pressure absorbing ball. (B) Negative pressure group used negative pressure absorbing ball to keep negative pressure. (C) Natural pressure group do not squeeze negative pressure absorbing ball to keep natural pressure.

could achieve good clinical results. Our results reveal that natural pressure drainage not only do not increase infection but also decrease drainage volume and blood loss. The suction force of natural pressure drainage generated by siphonic effect is about 1/3 to 1/2 the suction force that reported to be generated by a Jackson–Pratt 100 mL bulb at full suction.[11] Negative pressure drainage may result in excessive external drainage and blood loss. While natural pressure drainage can make some blood and fluid collections in the wound so as to maintain a certain tension, achieve a better hemostatic effect, decrease the drainage volume, and drain indwelling time. The drainage volume is a very important factor that determines inpatient duration. Therefore, shortening the hospital stay by reducing drain indwelling time both decreases the medical cost, blood loss, and the discomfort of patients.

There were several studies on the relationship between duration of drainage and the occurrence of postoperative surgical-site infection (SSI). A case–control study of risk factors for SSI showed that prolonged drain indwelling time was a strong risk factor for SSI following instrumented spinal fusion procedures.[12] Felippe et al[13] found that bacterial colonization rates of surgical drains increased 3-fold from postoperative day 7 to day 14. Pennington et al[14] found that infected patients had longer drain retention time than controls and came to a conclusion that prolonged duration of drainage correlates with deep SSI after spine surgery. Therefore, discontinuing the drain as

Table 1

Demographic results and intraoperative parameters of 2 groups.

	Natural pressure group	Negative pressure group	*P*-value
Age, yr	50.21 ± 12.82	51.05 ± 11.39	.692*
Height, cm	167.85 ± 8.00	165.39 ± 7.60	.073*
Weight, kg	72.39 ± 10.77	69.03 ± 9.31	.058*
Gender			.241†
Male	44	35	
Female	24	29	
Diagnosis			.307†
Spinal stenosis	49	51	
Spondylolisthesis	19	13	
Operating time, min	139.59 ± 30.10	130.48 ± 29.55	.082*
intraoperative blood loss, mL	372.06 ± 130.55	346.88 ± 105.36	.390‡

* Student *t* test.
† Chi-squared test.
‡ Mann–Whitney *U* test.

early as possible may reduce infection rates. But our study showed no significant difference in infection rates between the 2 groups. There may be several reasons. First, all patients use broad-spectrum antibiotics during and on the 1st day after operation, which can effectively prevent wound infection. Second, the drainage in both groups did not last long, which may have prevented the bacteria from growing to the point of causing infection. Finally, the relatively small sample size in this study may make it difficult to accurately reflect the incidence of postoperative wound infection in the 2 groups of patients. An interest in failure to use drainage in lumbar surgery has been increasing. Recent studies indicated that postoperative complications such as wound infection and hematoma formation were identical for both the drain and no-drain groups.[15–19] However, the high risk of symptomatic hematoma should not be ignored. Therefore, if a strategy that failure to use a drain does guarantee the safety of patients, the results cannot be advantageous.

The inflammatory stimulus of surgery and resolves inside could lead to operative fever[20] and severe complications (SSI, deep vein thrombosis, or drug fever) which can also be characterized by fever. In addition, most reasons of the fever in the first 48 hours after surgery were noninfectious.[21] Surgeons must consider possible causes and do not jump to the conclusion that postoperative fever was caused by infection. Ovadia et al[15] found that the postoperative fever value was equal during postoperative days 1 to 3. However, there was a obvious difference in fever values on day 6, with higher mean values in the no-drain group. Similarly, another study of 139 spinal deformity patients underwent elective spinal decompression and fusion suggested that the prevalence of postoperative fever was similar between drain group and nondrainage group.[16] In the present study, our results revealed that the core body temperature was similar between 2 groups. A possible reason may be inflammatory stimulus was absorbed similarly in patients.

Table 2

Comparison of postoperative parameters between 2 groups.

	Natural pressure group	Negative pressure group	*P*-value
Drainage volume (day 1), mL	141.00 ± 52.19	204.89 ± 95.19	.000*
Total drainage volume, mL	249.32 ± 70.74	378.06 ± 117.98	.000†
Drain days	2.93 ± 0.55	3.52 ± 0.71	.000*
Temperature, °C			
Day 1	37.18 ± 0.54	37.21 ± 0.60	.927*
Day 2	37.22 ± 0.55	37.15 ± 0.53	.536*
Complications			
Superficial wound infection	1	2	.958‡
Deep wound infection	0	0	NA
Symptomatic hematoma	1	0	1.000§

NA = no available.
* Mann–Whitney *U* test.
† Student *t* test.
‡ Chi-squared test.
§ Fisher exact test.

This study has some of the following limitations. The sample size is small, which may not have the strong evidence to make firm conclusions. Furthermore, a group without closed suction drainage was not included. We cannot draw a conclusion whether natural or negative pressure drainage offers benefits or disadvantages compared with a system that did not apply a drainage system.

Our data showed that natural pressure drainage can reduce the total volume of drain and the length of drainage day, without increasing the postoperative complications. As we know, early removal of drainage makes patients feel more comfortable and makes the patient initiate mobilization and ambulation earlier. Based on this research, we demonstrate that natural pressure drainage is as safe and effective as negative pressure drainage and may offer a reasonable alternative to patients underwent posterior single-level instrumented lumbar fusion.

Author contributions

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References

[1] Zeng X, Wang W, Zhao Z, et al. Causes and preventive measures of symptomatic spinal epidural haematoma after spinal surgery. Int Orthop 2017;41:1395–403.
[2] Ahn DK, Kim JH, Chang BK, et al. Can we prevent a postoperative spinal epidural hematoma by using larger diameter suction drains? Clin Orthop Surg 2016;8:78–83.
[3] Sokolowski MJ, Garvey TA, Perl JN, et al. Prospective study of postoperative lumbar epidural hematoma: incidence and risk factors. Spine (Phila Pa 1976) 2008;33:108–13.
[4] Merter A, Shibayama M. Does the drain placement technique affect the amount of postoperative spinal epidural hematoma after microendoscopic decompressive laminotomy for lumbar spinal stenosis? J Orthop Surg (Hong Kong) 2019;27:2309499019869023.
[5] Awad JN, Kebaish KM, Donigan J, et al. Analysis of the risk factors for the development of post-operative spinal epidural haematoma. J Bone Joint Surg Br 2005;87:1248–52.
[6] Kou J, Fischgrund J, Biddinger A, et al. Risk factors for spinal epidural hematoma after spinal surgery. Spine (Phila Pa 1976) 2002;27:1670–3.
[7] Kebaish KM, Awad JN. Spinal epidural hematoma causing acute cauda equina syndrome. Neurosurg Focus 2004;16:e1.
[8] Amiri AR, Fouyas IP, Cro S, et al. Postoperative spinal epidural hematoma (SEH): incidence, risk factors, onset, and management. Spine J 2013;13:134–40.
[9] Nakamura S, Ikeda S, Taguchi M. Urokinase-treated antithrombogenic drains and optimized drain placement in endoscopic lumbar decompressive surgery. J Neurol Surg A Cent Eur Neurosurg 2016;77:354–60.
[10] Yamada K, Abe Y, Satoh S, et al. Large increase in blood pressure after extubation and high body mass index elevate the risk of spinal epidural hematoma after spinal surgery. Spine (Phila Pa 1976) 2015;40:1046–52.
[11] Tenny SO, Thorell WE. Suction forces generated by passive bile bag drainage on a model of post-subdural hematoma evacuation. Acta Neurochir (Wien) 2018;160:1305–9.

[12] Rao SB, Vasquez G, Harrop J, et al. Risk factors for surgical site infections following spinal fusion procedures: a case-control study. Clin Infect Dis 2011;53:686–92.
[13] Felippe WA, Werneck GL, Santoro-Lopes G. Surgical site infection among women discharged with a drain in situ after breast cancer surgery. World J Surg 2007;31:2293–9.
[14] Pennington Z, Lubelski D, Molina C, et al. Prolonged post-surgical drain retention increases risk for deep wound infection after spine surgery. World Neurosurg 2019;130:e846–53.
[15] Ovadia D, Drexler M, Kramer M, et al. Closed wound subfascial suction drainage in posterior fusion surgery for adolescent idiopathic scoliosis. Spine 2019;44:377–83.
[16] Adogwa O, Elsamadicy AA, Sergesketter AR, et al. Post-operative drain use in patients undergoing decompression and fusion: incidence of complications and symptomatic hematoma. J Spine Surg 2018;4:220–6.
[17] Gubin AV, Prudnikova OG, Subramanyam KN, et al. Role of closed drain after multi-level posterior spinal surgery in adults: a randomised open-label superiority trial. Eur Spine J 2019;28:146–54.
[18] Kanayama M, Oha F, Togawa D, et al. Is closed-suction drainage necessary for single-level lumbar decompression?: review of 560 cases. Clin Orthop Relat Res 2010;468:2690–4.
[19] Liu J, Chen W, Fu B, et al. The use of closed suction drainage in lumbar spinal surgery: is it really necessary? World Neurosurg 2016;90:109–15.
[20] Pile JC. Evaluating postoperative fever: a focused approach. Cleve Clin J Med 2006;73(Suppl 1):S62–6.
[21] Liang J, Qiu G, Chua S, et al. Comparison between subcutaneous closed-suction drainage and conventional closed-suction drainage in adolescent idiopathic scoliosis patients undergoing posterior instrumented spinal fusion: a randomized control trial. J Spinal Disord Tech 2013;26:256–9.