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Effects of Negative Pressure Wound Therapy on Wound Dehiscence and Surgical Site Infection Following Instrumented Spinal Fusion Surgery–A Single Surgeon's Experience

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Abstract

BACKGROUND: Incisional negative pressure wound therapy (NPWT) is used in many surgical specialties to prevent postoperative dehiscence and surgical site infections (SSIs). However, little is known about the role of incisional NPWT in spine fusion surgery. Therefore, we sought to report a single surgeon's experience using incisional NPWT and describe its effects on dehiscence and SSIs after instrumented spine surgery.

METHODS: We compared rates of hospital readmission and return to the operating room for dehiscence and SSIs in a consecutive series of patients who underwent spinal fusion surgery with or without NPWT from 2015 to 2018.

RESULTS: A total of 393 patients without and 76 patients with NPWT were included for analysis. Half way through the data collection period, all patients who underwent anterior lumbar fusion received NPWT. Three of 15 (20.0%) of non-NPWT patients who underwent anterior lumbar fusion had dehiscence or SSI compared with zero of 23 (0.0%) of NPWT patients ($P = 0.01$). NPWT for posterior surgeries was used on a case-by-case basis using risk factors that contribute to SSIs and dehiscence. NPWT patients had higher rates of spinal neoplasia (0.5% vs. 11.3%, $P < 0.0001$), osteomyelitis/diskitis (1.3% vs. 7.5%, $P = 0.02$), durotomy (14.9% vs. 28.6%,

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Ryan M. Naylor: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Hannah E. Gilder:** Writing - original draft, Project administration. **Nikita Gupta:** Investigation. **Thomas C. Hydrick:** Investigation. **Joshua R. Labott:** Investigation. **David J. Mauler:** Investigation. **Taylor P. Trentadue:** Investigation. **Brandon Ghislain:** Investigation. **Benjamin D. Elder:** Conceptualization, Methodology, Writing - review & editing, Supervision. **Jeremy L. Fogelson:** Conceptualization, Methodology, Writing - review & editing, Supervision.

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$P = 0.007$), revision surgery (32.2% vs. 59.6%, $P = 0.0001$), and longer fusion constructs (7 vs. 11 levels, $P < 0.0001$) but had similar rates of dehiscence and SSIs as non-NPWT patients (5.6% vs. 5.7%, $P = 0.98$).

CONCLUSIONS: NPWT decreases dehiscence and SSIs in patients undergoing lumbar fusion through an anterior approach. When preferentially used in patients at high risk for postoperative wound complications, NPWT prevents increased rates of dehiscence and SSI.

Keywords

NPWT; Prevention; Spine fusion; Surgical wound complications

INTRODUCTION

Wound dehiscence and surgical site infections (SSIs) are a significant source of morbidity,[1] reoperation,[2] hospital readmission,[3] and increased costs[4] after instrumented spine surgery. Negative pressure wound therapy (NPWT) has been found to be an effective tool to treat dehiscence and SSIs in complex deep spinal wounds with exposed hardware,[5-10] but its role in preventing dehiscence and SSIs of closed incisions is an area of active investigation.[11] Indeed, only 1 paper to date has investigated the role of NPWT in preventing dehiscence and SSIs in spinal fusion surgery[12] with 2 ongoing clinical trials (NCT03820219 and NCT03632005). Incisional NPWT is achieved by overlying the wound with moist sterile gauze and foam, sealing it with adhesive tape, and connecting it to a vacuum pump using a drainage hose. Incisional NPWT is thought to facilitate wound healing by maintaining the sterile field, decreasing tension across the incision, drawing fluid out of the wound edges, reducing pathogen burden, and promoting formation of granulation tissue via angiogenesis.[10,11,13]

Although NPWT is an established treatment modality for the management of complex open wounds, its role in preventing dehiscence and SSIs after spine surgery is less well established. Nonetheless, wound complications after spine fusion surgery continue to be a significant problem, with nearly 40% of postspine surgery hospital readmissions being for wound complications and with SSI and dehiscence rates as high as 20% in some series.[1-4,10,12] Therefore, we sought to report our experience using NPWT as a means of preventing wound complications after instrumented spine fusion surgery.

MATERIALS AND METHODS

Patient Selection and Clinical Parameters

This retrospective cohort study was approved by the institutional review board (IRB 18-008561), which also issued a consent waiver for this minimal risk study. All procedures performed by the senior author from 2015 to 2018 at a single institution were reviewed. Inclusion criteria were spine operations in which hardware was implanted. Exclusion criteria included anterior cervical fusions, cases in which the patient was younger than 18 years old, and cases in which the senior author was not the primary surgeon.

A total of 469 cases were identified, and a retrospective review of the electronic medical record was performed. Basic demographic parameters, including age and sex, and variables thought to inhibit wound healing, including body mass index (BMI), presence of diabetes mellitus type 2 (D2M), whether the patient was an active smoker, and whether the patient was undergoing a revision surgery were recorded. In addition, the surgical indication for each case was classified as degenerative/deformity, traumatic, neoplastic, or infectious. Infectious etiologies included osteomyelitis and/or diskitis. Relevant operative details were recorded including anterior or posterior approach, spine segment(s) involved, number of levels fused (i.e., fusion length), incidence of an intraoperative durotomy (accidental or purposeful), and whether incisional NPWT was used at the time of closure. Roughly half way through the data collection period of this study the senior author started using incisional NPWT for all anterior lumbar fusions, whereas before this, no patients received incisional NPWT. Patients who underwent posterior spine fusion surgery were selected for NPWT on a case-by-case basis based on the surgeon's subjective risk assessment for postoperative wound complications based on their medical comorbidities, surgical indication, length of fusion, presence of cerebrospinal fluid (CSF) leak at the time of surgery, and whether it was a revision surgery. For patients who underwent staged anterior and posterior fusions, each incision was recorded separately. The primary endpoint was hospital readmission or return to the operating room for dehiscence, which included persistent CSF leak, or SSI within 90 days of the fusion procedure. No data were collected for patients who may have been treated non-surgically for postoperative wound complications. Data for patients in the non-NPWT and NPWT groups were collected simultaneously and verified by at least 1 independent reviewer to limit bias.

Perioperative Management

All patients who underwent posterior fusions received weight-based intravenous antibiotics at the time of surgical incision. If there were no antibiotic allergies, intravenous cefazolin and vancomycin were given. Patients with a documented penicillin allergy received intravenous vancomycin alone. Alternatively, patients with both penicillin and vancomycin allergies received intravenous clindamycin. Intravenous antibiotics were redosed every 8 hours for cefazolin and clindamycin or every 12 hours for vancomycin for 24 hours postoperatively or until all subfascial drains were removed, whichever was longer. Patients who underwent anterior fusions were treated with intravenous clindamycin at the time of surgical incision and postoperative cefazolin as described above. The surgical site was sterilized with either ChloraPrep (BD, Franklin Lakes, New Jersey, USA) or DuraPrep (3M, Minneapolis, Minnesota, USA) and covered with Ioban (3M) before incision. All wounds were irrigated copiously with normal saline before closure. Before closing the posterior spine incisions, 1–2 g of vancomycin powder was liberally applied directly to the subfascial as well as suprafascial space unless the patient had a documented allergy to vancomycin. Before suprafascial vancomycin powder application, the wound was irrigated with normal saline. No antibiotic powder was used in the anterior incisions. All wounds were closed in anatomical layers and the skin was closed using a subcutaneous 2-0 Quill suture (Surgical Specialties, Wyomissing, Pennsylvania, USA), subcutaneous 4-0 Monocryl (Ethicon, Bridgewater, New Jersey, USA), or a nylon vertical mattress suture. Incisions not

undergoing NPWT were then covered with Steri-Strips (3M) and Primapore dressing (Smith & Nephew, Watford, United Kingdom).

Application and Maintenance of NPWT

NPWT was achieved using a Vacuum Assisted Closure (V.A.C.) device (KCI, Singapore). After skin closure with the sterile field still intact, a single layer of Xeroform (Cardinal Health, Dublin, Ohio, USA) was placed over the entire incision. V.A.C. GranuFoam was then placed over the Xeroform and sealed to the skin using Tegaderm dressing (3M). A small cut was made through the Tegaderm directly overlaying the V.A.C. GranuFoam to which the SensaT.R.A.C. Pad (KCI) was affixed. Alternatively, a Xeroform-V.A.C. GranuFoam bridge was created perpendicular to the incision such that the V.A.C. GranuFoam overlaid the cut through the Tegaderm and the SensaT.R.A.C. Pad attached to the distal end of the bridge to facilitate patient comfort. The SensaT.R.A.C. Pad was then connected to a 500 mL InfoV.A.C. canister (KCI), which was subsequently connected to the V.A.C.Ulta Negative Pressure Wound Therapy System (KCI), and the pump was set to 75 mm Hg low-intensity continuous negative pressure. NPWT was employed for a median of 5 days with an average of 1 sterile bedside dressing change. NPWT was generally used until within 24 hours of patient discharge.

Statistical Analysis

Age and BMI were expressed as mean values and compared using 2-tailed Student's *t*-tests. Fusion length was expressed as a median value and also compared using a 2-tailed Student's *t*-test. All other variables, including incidence of D2M, active smoking status, surgical indication, and combined rates of returning to the operating room and hospital readmission, were compared using χ^2 tests. Statistical significance was defined as $P < 0.05$.

RESULTS

A total of 469 cases of patients who underwent instrumented spine fusion surgery between 2015 and 2018 were included for analysis. All of the patients were at least 18 years old, and the senior author was the primary surgeon listed on each case. Patients who underwent anterior cervical fusions were excluded from analysis because those patients were not eligible for NPWT. Three hundred and ninety-three patients (84%) were not treated with NPWT, whereas 76 patients (16%) were treated with incisional NPWT.

The effects of NPWT on wound dehiscence and SSI in patients who underwent anterior lumbar fusions are demonstrated in Table 1. Thirty-eight patients underwent anterior lumbar fusion surgery. Fifteen patients were not treated with NPWT, whereas 23 received NPWT. Patients were selected for NPWT based on the date of their operation: about half way through the data collection period of this study the senior author began using incisional NPWT for all anterior lumbar fusions, whereas before this, no patients received incisional NPWT. This practice change was made in an attempt to decrease postoperative wound complications after anterior lumbar fusion surgery. There were no statistically significant differences in the average age, BMI, incidence of D2M, or active smoking status between non-NPWT and NPWT patients who underwent anterior lumbar fusions. Approximately

87% of patients in both cohorts underwent surgery for a degenerative process or deformity correction. Notably, 3 of 15 (20.0%) non-NPWT patients who underwent anterior lumbar fusion surgery had dehiscence or SSI requiring a return to the operating room, readmission to the hospital, or both. By contrast, 0 of 23 (0.0%) NPWT patients had dehiscence or SSI ($P = 0.01$).

The effects of incisional NPWT on dehiscence and SSI in posterior spine fusion surgery are reported in Table 2. The majority of patients (92%) in the overall cohort underwent posterior spine fusion surgeries. Three hundred and seventy-eight patients were not treated with NPWT, whereas 53 patients underwent NPWT. Patients who underwent posterior spine fusion surgery were selected for NPWT on a case-by-case basis based on the surgeon's subjective risk assessment for postoperative wound complications based on their medical comorbidities, surgical indication, length of fusion, presence of CSF leak at the time of surgery, and whether it was a revision surgery. Accordingly, patients in the NPWT cohort had longer fusion constructs compared with non-NPWT patients, with those in the non-NPWT group having an average fusion construct length of 7 compared with 11 in the NPWT cohort ($P < 0.0001$). Moreover, 6 of 53 (11.3%) patients in the NPWT group underwent surgery for a neoplastic indication compared with just 2 of 378 (0.5%) in the non-NPWT group ($P < 0.0001$). Furthermore, 4 of 53 (7.5%) NPWT patients underwent surgical intervention with fusion for an infectious indication (e.g., osteomyelitis and/or diskitis) compared with 5 of 378 (1.3%) non-NPWT patients ($P = 0.02$). In addition, 31 of 53 (58.5%) patients in the NPWT group were undergoing a revision operation compared with 121 of 378 (32.0%) patients in the non-NPWT cohort ($P = 0.0001$). Finally, 15 (28.3%) patients in the NPWT cohort had a durotomy, whereas 56 (14.8%) patients in the control group had a CSF leak at the time of surgery ($P = 0.007$). Two patients in the non-NPWT groups who sustained an intraoperative durotomy returned to the operating room for postoperative wound complications, one for superficial wound necrosis and the other for a deep spinal wound infection. Zero patients in the NPWT groups with a spinal fluid leak returned to the operating room. There were no statistically significant differences in age, BMI, prevalence of D2M, or active smoking status between the non-NPWT and NPWT groups among patients who underwent posterior spine fusions. Despite NPWT being used selectively in patients felt to be at especially high risk of postoperative wound complications, the incidence of wound dehiscence and SSI was 5.6% in the non-NPWT group and 5.7% in the NPWT group ($P = 0.98$).

A subgroup analysis of patients who underwent posterior spine fusion surgery to determine whether NPWT decreased post-operative wound complications based on which anatomical region(s) of the spine were fused is presented in Table 3. Fusions involving a single anatomical segment—cervical, thoracic, or lumbar—had a low overall rate of dehiscence and SSI regardless of whether or not NPWT was used (3.2% non-NPWT vs. 0.0% NPWT). In contrast, 6.7% in the control and 7.1% of patients in the NPWT cohorts had a postoperative wound complication when the fusion construct spanned multiple segments of the spine ($P = 0.92$). Interestingly, however, there was a numerical reduction in postoperative wound complications for fusion constructs that started in the thoracic spine and that received NPWT regardless of how many anatomical segments were instrumented, but this was not statistically significant (5.6% non-NPWT vs. 0.0% NPWT, $P = 0.11$).

DISCUSSION

SSI and wound dehiscence are known postoperative complications associated with significant morbidity in patients undergoing instrumented spine surgery.[1-4,12] In this retrospective cohort study based on a single surgeon's experience, we found that NPWT applied over a closed surgical incision reduced postoperative wound complications after anterior lumbar fusions. In addition, when preferentially used in patients undergoing posterior spine fusion surgery for a neoplastic or infectious etiology, those with especially long incisions and fusion constructs, those who experience an intraoperative durotomy, and those undergoing a revision surgery, NPWT prevents increased rates of dehiscence and SSI.

Recent publications from the general surgery literature clearly demonstrate the superiority of incisional NPWT versus non-NPWT in decreasing SSIs and wound dehiscence when performing transabdominal surgical procedures.[14,15] Thus, the data presented here add to this body of evidence and demonstrate that incisional NPWT also decreases SSIs and wound dehiscence for transabdominal approaches with instrumentation placement in the lumbar spine. The rate of SSI and dehiscence after anterior lumbar fusion in this series is higher than what has previously been reported in the literature.[16,17] Reasons for this discrepancy may be secondary to how postoperative wound complications are defined and/or differences in postsurgical practices between groups, including the use of NPWT, as well as sampling bias in the current study as only 15 patients who underwent anterior spinal fusion surgery without NPWT were analyzed. Importantly, universal implementation of NPWT for all patients undergoing transabdominal spinal fusion has decreased postoperative dehiscence in our practice to rates comparable with or below what has been reported in the literature. Thus, the data from the current study suggest that using incisional NPWT might help ameliorate high readmission rates and/or decrease the frequency of postoperative complications secondary to the wound healing abnormalities that can confound anterior lumbar fusions.

For patients who underwent posterior spinal fusion surgery, the overall rate of SSI and wound dehiscence was similar between the non-NPWT and NPWT groups. However, patients in the NPWT cohort were selected for NPWT because they were felt to be at higher risk of postoperative wound complications.[2,18-21] As such, these patients were undergoing surgery for a neoplastic or infectious process at significantly higher rates than those patients not receiving NPWT and they had longer fusion constructs, incidental durotomy, and were undergoing revision surgeries about twice as frequently as those in the non-NPWT group. This strongly suggests that NPWT prevents SSI and dehiscence in patients for whom spinal fusion surgery is high risk. For patients with an underlying malignancy, infectious process, or who were undergoing revision surgeries, the local wound microenvironment is profoundly altered compared with patients without these risk factors.[13] Although the full mechanism of action of NPWT remains enigmatic, it is likely that NPWT is able to overcome the altered microenvironment through increasing tissue perfusion,[22] suppressing inflammation through cellular signaling,[23] and promoting lymphatic drainage[24] to provide an overall comparable rate of postoperative wound complications in these 2 heterogeneous patient populations.

Patients who underwent posterior spinal fusion in the NPWT group also had significantly longer fusion constructs compared with patients in the non-NPWT group. Fusion length in this context is likely a surrogate marker for surgical complexity as well as operative time and blood loss, which have been shown to increase rates of postoperative wound complications.[25] Moreover, longer fusion constructs require longer incisions and longer incisions are more likely to have complications compared with shorter incisions. However, the data from the current study demonstrate that incisional NPWT overcame these risk factors and prevented the expected increase in postoperative wound complications in this patient population.

The use of NPWT after an intraoperative durotomy remains controversial yet our data suggest that incisional NPWT after primary repair of a spinal fluid leak is safe and may ameliorate the associated risk of postoperative wound complications. Jones et al[26] were the first to suggest that NPWT should not be used in the presence of an active CSF leak, which subsequently led to the recommendation that NPWT be avoided in all cases with a spinal fluid leak.[10] However, it is important to note that Jones et al. used NPWT to treat established subfascial spinal wound infections by placing the V.A.C. sponge deep within the wound directly over bone and hardware, whereas we used NPWT to prevent dehiscence and/or SSI by placing the V.A.C. sponge on the surface of the skin of the closed wound. Thus, negative pressure was transmitted directly to the dural tube in the former scenario, whereas several surgically repaired layers, including the water-tight fascia, separated the dural tube and vacuum suction device in the latter scenario. Moreover, 2 groups have recently published their experience using NPWT in treating deep spinal wound infections after an intraoperative durotomy, and both groups reported this practice to be safe with regard to CSF leak–related complications.[27,28] Thus, the use of incisional NPWT in patients with a primarily repaired water-tight dural closure after intraoperative CSF leak appears to be safe.

It is interesting to note that posterior spinal fusions beginning in the thoracic spine (i.e., thoracic-only fusions, thoracolumbar fusions, and thoracic to sacral fusions) demonstrated a trend toward fewer instances of SSI and wound dehiscence in patients receiving incisional NPWT (5.6% vs. 0.0%, $P = 0.11$). Although not statistically significant, this is an interesting and clinically relevant finding because postoperative patients generally spend many hours supine in bed, thus placing considerable mechanical stress and pressure on the thoracic spine. Therefore, the biomechanics of thoracic spine fusion surgery may make these wounds particularly susceptible to dehiscence. Thus, the advantage of NPWT in this particular subgroup is by providing an additional physical barrier between the surgical wound and hospital bed as well as decreasing tension across the incision, likely preventing SSI and dehiscence. This is an area that deserves further study.

Only 1 prior study examined the effects of NPWT on postoperative incisional complications after posterior spinal fusion.[12] That study reported a 50% reduction in the incidence of wound complications with the use of NPWT in a homogeneous cohort of 160 patients consisting exclusively of long-segment posterior spinal fusion patients. The current study adds to this previous study by analyzing the effects of incisional NPWT on anterior lumbar fusion surgeries and by analyzing the effects of NPWT in an additional 431 patients undergoing long-segment posterior spinal fusion surgery. There are several limitations of the current study. The major limitation of the current series is the selection bias by which

patients who underwent posterior spine fusion surgery either received or did not receive NPWT. Determination as to whether or not NPWT was used for a given patient who underwent posterior fusion was made on a subjective rather than objective basis based on the patient's medical comorbidities, surgical indication (e.g., infection, neoplasm, etc.), length of fusion, intraoperative CSF leak, and revision surgery status. This inherently introduced a degree of bias that is virtually impossible to mitigate through advanced statistical analyses and further highlights the importance of including the dehiscence and SSI rates for patients undergoing anterior spinal fusion surgery as that population of patients was much more homogeneous than those undergoing posterior fusions. Therefore, we sought to quantify the selection bias to demonstrate how heterogeneous the posterior fusion non-NPWT and NPWT groups were in terms of various risk factors that have been linked to dehiscence and/or SSI. Despite the propensity of patients in the NPWT cohort to experience postoperative wound complications, there was no difference in rates of dehiscence or SSI between the 2 groups, leading us to conclude that use of NPWT prevented increased rates of wound dehiscence and SSI in patients at high risk for postoperative wound complications. Despite this key limitation, this study is intended to provide an early assessment of the utility of NPWT in spinal surgery. A randomized prospective study would be required to optimally evaluate this question. Despite its limitations as a prospective study protocol, this retrospective study accurately reflects how individual clinical decisions were made, and therefore the results of the current study demonstrate what can be expected in terms of using NPWT in a select group of patients who are thought to be at elevated risk of postoperative wound complications. Prospective studies able to control for bias and confounders will be important to determine the extent to which NPWT prevents dehiscence and SSI after spinal fusion surgery. Additional limitations include this being a single surgeon series, a high baseline rate of postoperative wound complications for patients undergoing anterior lumbar fusion surgery, the use of a single brand of NPWT, and a limited sample size of patients who actually received NPWT.

On the basis of the results presented here, spine surgeons should consider incisional NPWT in all patients undergoing anterior lumbar fusion and in patients undergoing posterior spine fusion surgery for a neoplastic or infectious etiology, those with especially long incisions and fusion constructs, those who experience a planned or incidental intraoperative durotomy, and those undergoing revision surgeries with the goal of preventing increased SSI and dehiscence rates in this patient population. Although NPWT used in the management of open spine wounds with a repaired durotomy is contraindicated,[10] we are the first to report that applying incisional NPWT over a repaired durotomy is safe and effective in preventing SSI and/or dehiscence. The results of 2 ongoing clinical trials (NCT03820219 and NCT03632005) will help better determine the overall utility of incisional NPWT in patients undergoing posterior spine fusion surgery in terms of decreasing overall postoperative wound complications.

CONCLUSIONS

NPWT decreased dehiscence and SSI rates in patients undergoing lumbar fusion through an anterior approach. Moreover, when preferentially used in patients undergoing posterior spine fusion surgery for a neoplastic or infectious etiology, those with especially long incisions

and fusion constructs, those who experience an intraoperative durotomy, and those undergoing a revision surgery, NPWT prevents increased rates of dehiscence and SSI.

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Abbreviations and Acronyms

BMI	Body mass index
CSF	Cerebrospinal fluid
D2M	Diabetes mellitus type 2
NPWT	Negative pressure wound therapy
SSI	Surgical site infection
V.A.C.	Vacuum Assisted Closure

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Table 1.

Characteristics and Outcomes for Patients Undergoing Anterior Lumbar Fusion Surgery

Variable	Non-NPWT (n = 15)	NPWT (n = 23)	*P* Value
Demographics			
Age * (years)	60.5 (10.8)	59.2 (12.3)	0.75
BMI * (kg/m^2)	29.6 (7.0)	29.3 (5.4)	0.89
D2M prevalence	3 (20.0)	4 (17.4)	0.84
Active smoker	1 (6.7)	1 (4.3)	0.76
Indication			
Degenerative/deformity	13 (86.7)	20 (87.0)	0.98
Trauma	1 (6.7)	1 (4.3)	0.76
Cancer	1 (6.7)	2 (8.7)	0.82
Surgical parameters			
Fusion length †	3 (1.0)	3 (1.6)	0.22
Results			
Infection/dehiscence	3 (20.0)	0 (0.0)	0.01

Data are presented as average (standard deviation) or n (%).

NPWT, negative pressure wound therapy; BMI, body mass index; D2M, diabetes mellitus type 2.

* Mean.

† Median.

Table 2.

Characteristics and Outcomes for Patients Undergoing Posterior Lumbar Fusion Surgery

Variable	Non-NPWT (n = 378)	NPWT (n = 53)	*P* Value
Demographics			
Age * (years)	61.1 (14.4)	57.1 (15.2)	0.06
BMI * (kg/m^2)	29.2 (6.0)	28.7 (6.8)	0.61
D2M prevalence	66 (17.5)	13 (24.5)	0.23
Active smoker	33 (8.7)	5 (9.4)	0.87
Indication			
Degenerative/deformity	334 (88.4)	37 (69.8)	**0.001** *
Trauma	37 (9.8)	6 (11.3)	0.73
Cancer	2 (0.5)	6 (11.3)	**<0.0001** *
Infectious	5(1.3)	4 (7.5)	**0.02** *
Surgical parameters			
Fusion length †	7 (4.8)	11 (6.0)	**<0.0001** *
Revision	121 (32.0)	31 (58.5)	**0.0001** *
Durotomy	56 (14.8)	15 (28.3)	**0.007** *
Results			
Infection/dehiscence	21 (5.6)	3 (5.7)	0.98

Data are presented as average (standard deviation) or n (%).

NPWT, negative pressure wound therapy; BMI, body mass index; D2M, diabetes mellitus type 2.

* Mean.

† Median.

Table 3.

Subgroup Analysis for Patients Undergoing Posterior Lumbar Fusion Surgery

Segment(s)	Non-NPWT (%)	NPWT (%)	*P* Value
Cervical	0/44 (0.0)	0/1 (0.0)	
Thoracic	0/16 (0.0)	0/7 (0.0)	
Lumbar	4/64 (6.3)	0/3 (0.0)	0.54
Multilevel	17/254 (6.7)	3/42 (7.1)	0.92
C-T	5/42 (11.9)	1/12 (8.3)	0.72
T-L	2/25 (8.0)	0/4 (0.0)	0.31
L-S	4/100 (4.0)	1/9 (11.1)	0.40
C-T-L	0/3 (0.0)	–	
T-L-S	5/83 (6.0)	0/13 (0.0)	0.22
C-T-L-S	0/3 (0.0)	1/4 (25.0)	0.26

Numerator represents number of patients in each category with wound dehiscence/SSI and the denominator represents total number of patients in each category.

NPWT, negative pressure wound therapy; C, cervical; T, thoracic; L, lumbar; S, sacral; SSI, surgical site infection.