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Original Article

Nursing countermeasures for VSD treatment of orthopedic trauma and infected wounds

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Abstract: Objective: This study intended to investigate the effect of vacuum sealing drainage (VSD) in the treatment of orthopedic trauma and its role in the clinical care. Methods: A total of 104 patients with orthopedic trauma infection admitted to our hospital from January 2019 to January 2020 were divided into control group (n=53, receiving VSD) and study group (n=51, receiving VSD and nursing interventions) by random number table. Surgical outcomes, satisfaction, size of trauma and visual analogue scoring scale (VAS) scores were compared between the two groups. Results: The study group had shorter time to achieve granulation tissue coverage of wound base, trauma recovery and hospital stay than the control group (P<0.05). The satisfaction rate in the study group was higher compared with that in the control group (P<0.05). Before intervention, the VAS scores of the two groups and size of trauma were not significantly different (P>0.05). After intervention, VAS scores were significantly lower and trauma area was significantly smaller in both groups, and the difference was more pronounced in the study group compared with that in the control group (P<0.05). Quality of life scores were higher in the study group compared with the control group (P<0.05). Tumor necrosis factor-α (TNF-α) and interleukin-6 (IL-6) levels were lower in the study group compared with those in the control group (P<0.05). Packed cell volume (PCV), plasma viscosity, and low-cut versus high-cut whole blood viscosity were lower in the study group compared with those in the control group (P<0.05). Conclusion: VSD treatment combined with clinical nursing interventions in patients with orthopedic trauma infection could shorten the time to granulation coverage, wound healing and hospitalization time, and improve indicators of blood rheology. It could also shrink the size of trauma, decrease the level of pain and inflammatory factors, and improve the quality of life, resulting in high satisfaction.

Keywords: Vacuum sealing drainage, trauma infection, pain level, satisfaction, size of trauma, quality of life

Introduction

The increasing incidence of orthopedic trauma is witnessed due to economic development and convenient transportation. Patients with orthopedic trauma often develop soft tissue defects, which prolong the trauma healing and increase the risk of infection [1]. Post-traumatic infection is a common complication after internal fixation of fractures, which complicates the clinical course of patients and leads to prolonged critical care and hospital stay. The rate of infection after fractures is increasing with the widespread use of internal fixation devices [2]. Therefore, treatment options should be explored to prevent and treat orthopedic trauma infections [3].

Open drainage is often used to treat infections in orthopedic trauma, during which pus, necrotic tissue and exudate can be drained to improve the clinical symptoms. However, the treatment course is usually long and the results are often poor [4]. Therefore, the vacuum sealing drainage (VSD) was chosen in this study. This technique is widely used in the treatment of acute and chronic injuries and traumatic wounds. A biological semi-permeable membrane is used to transform open wounds into closed wounds, connecting the drainage tube to a negative pressure device for continuous suction, which can drain decomposition products and necrotic tissue and improve local blood circulation [5, 6]. Since some patients do not understand the purpose and principles of disease treatment,

and thus develop adverse emotions. Evidence has confirmed that nursing interventions combined with VSD treatment exhibit more desirable effects [7]. By providing health education to patients with a series of preoperative, intraoperative and postoperative nursing interventions, nursing staffs can reduce the incidence of adverse events during drainage and promote wound healing [8]. However, there are few clinical studies that investigate the role of VSD treatment combined with nursing interventions in orthopedic trauma infections. In this study, 104 patients with orthopedic trauma infections were enrolled to evaluate the effect of clinical nursing interventions.

Materials and methods

Baseline data

A total of 104 patients with orthopedic trauma infections in our hospital from January 2019 to January 2020 were divided into control group (n=53) and study group (n=51) by random number table. Inclusion criteria: (1) Patients with complete clinical information and signed informed consent; (2) Patients with symptoms of redness, heat, swelling and pain at the site of infection, meeting the diagnostic criteria for infections in orthopedic trauma; (3) Patients with clear history of fracture disease; (4) Patients did not participate in other clinical studies during this study and were available for post-treatment follow-up; (5) Patients had normal cognitive function. Exclusion criteria: (1) Patients with non-infectious trauma; (2) Patients aged <18 years; (3) Patients with secondary severe infection; (4) Patients with immune system or hematopoietic disorders; (5) Patients with malnutrition or malignant disease; (6) Women during pregnancy or lactation. The study subjects agreed to participate, the data were comparable between the two groups (P>0.05), and the Huzhou Cent Hosp, Affiliated Cent Hosp Huzhou University Ethics Committee has approved the study.

Methods

The control group was treated with VSD. (1) Appropriate antibiotics were selected based on the results of the drug sensitivity test, and necrotic tissue and wound exudate were removed by aseptic operation. (2) After completing debridement, negative pressure dressings were selected according to the size of the trauma. The trauma was fully covered with sutures which should be 2 cm greater than the trauma margin. Next, the drainage tube was led out from the trauma surface, fixed, to ensure drainage patency. The negative pressure value was adjusted, accompanied by continuous flushing and intermittent fast flushing, with each flushing performed for 5 to 10 min and done every 4 h. (3) After 7 days of drainage, the drainage device was removed. The trauma condition was accurately assessed to determine whether second-stage surgery was needed. The appropriate trauma repair method was chosen according to the postoperative condition and trauma site.

In the study group, clinical nursing interventions were given combined with VSD treatment. The nursing methods are as follows: (1) Preoperative intervention: personalized health education programs were formulated according to the patient's condition, and the purpose, methods, principles and importance of nursing were explained through lectures or one-on-one approaches. For patients with combined diabetes or malnutrition, nutritional intervention should be carried out timely to improve the nutritional status. (2) Postoperative intervention: the drainage fluid, traumatic skin conditions, blood pressure and heart rate, *etc*., were observed. With flat position, the affected limb was elevated 20-30 cm and the duration, location, nature and severity of pain was assessed. The patient's attention was distracted by playing soothing music, reading newspapers, *etc*. If the pain level was high, painkillers were administrated or the negative pressure was lowered. When the patient gradually adapted, the negative pressure was adjusted. (3) Drainage tube intervention: 48 h postoperatively, the drainage tube was flushed at a rate of 50-60 drops per minute, followed by continuous flushing at a rate of 20-30 drops per minute until extubation while 0.02-0.08 MPa of negative pressure was maintained. If the dressing bulges, it means that the negative pressure drainage system is not appropriately set, and the drainage tube should be checked for air leakage and folding. The leakage location should be re-covered with a semi-permeable membrane. If the drainage device is faulty, it should be renewed immediately. If the blockage is caused by necrotic tissue, the negative pressure source should be

turned off, saline should be injected slowly, the blockage should be flushed and soaked, and when the blockage becomes soft, the negative pressure source should be connected again. (4) Observation of the nature of the drainage fluid. If there was fresh blood, the flushing fluid and negative pressure should be shut down. The drainage tube should be clamped shut, the remaining air should be expelled, the drainage bottle should be replaced, and the negative pressure and flushing fluid should be turned on to ensure that the negative pressure system is effective. (5) Observation of trauma healing: The change in body temperature and trauma of the patients after the completion of surgery was determined to ensure that no air leakage occurred and that the semi-permeable membrane was intact. Based on the results of drug sensitivity test, antibacterial drugs were chosen.

Outcome measurement

Surgical results: time to granulation coverage, healing, and hospitalization time were recorded. The shorter time represented the better treatment effect.

Satisfaction [9]: Patient satisfaction was assessed by self-made satisfaction questionnaire. <60 points: unsatisfied; 60-80 points: satisfied; >80 points: very satisfied. Satisfaction = number of (very satisfied + satisfied) cases/ total number of cases ×100%. The higher satisfaction level represented the better treatment effect.

Visual analogue scoring scale (VAS) scores [10]: The VAS was used to evaluate the pain level using a 10 cm vernier scale with 10 scales marked with "10" and "0" at each end, with 10 indicating severe pain and 0 indicating no pain. Patients marked the scale according to their pain level, with the lower score indicating the less pain.

Quality of life scores [11]: The SF-36 scale was applied to evaluate patients' emotional, social, role, and cognitive functions, with a total score of 100. The higher score represented the better quality of life.

Tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6) levels [12]: 3 mL of fasting venous blood was drawn, followed by centrifugation (3500 rpm, 10 min). The supernatant was separated and serum was obtained. Enzyme-linked immunoassay was used to detect TNF-α and IL-6 levels. The kit was provided by Shanghai Bangjing Industrial Co., Ltd. (Item No. 48T/96T), and related operations were performed according to kit instructions. The more the value tends to the normal value, the more ideal the intervention effect is.

Statistical methods

SPSS19.0 statistical software was applied for data analysis. Data were analyzed by two-sided test. $P<0.05$ was considered statistically significant difference. Quantitative data were expressed by (mean ± SD) and were compared using t-test. ANOVA with post hoc LSD was performed for comparison between the groups. Qualitative data were tested by χ^2 and graphs were plotted using Graphpad Prism 8. $P<0.05$ indicated significant difference.

Results

Comparison of general clinical data between the two groups

The general clinical data of patients in the two groups, such as gender, average age and infection sites, were compared between the two groups, and the results showed that there was little difference between the two groups in the above data ($P>0.05$), suggesting comparability (**Table 1**).

Comparison of surgical outcomes and patient satisfaction

Compared with the control group, the study group had shorter time to granulation coverage, wound healing, and shorter hospital stay ($P<0.05$) (**Table 2**). The satisfaction rate was 83.0% in the control group and 96.1% in the study group, exhibiting significant difference ($P<0.05$) (**Table 3**).

Comparison of VAS scores and size of trauma

Before intervention, there was no significant difference in VAS scores and size of trauma between the two groups ($P>0.05$). After intervention, VAS scores were significantly lower and size of trauma was significantly smaller in both groups, and the improvement was more

Table 1. Comparison of general clinical data between the two groups (χ±s)/[n (%)]

General clinical data		Study group (n=51)	Control group (n=53)	t/χ^2	*P*
Gender	Male	30	32	0.016	0.901
	Female	21	21		
Average age (year)		46.4±1.1	46.2±1.2	0.071	0.944
Average weight (kg)		70.11±2.21	69.98±2.32	0.311	0.756
Infection sites	Foot and ankle	5	4	0.334	0.545
	Calf	18	17		
	Thoracic lumbar sacral portion	9	8		
	Upper forearm	21	22		

Table 2. Comparison of surgical outcomes (χ±s)

Group	Number of cases	Granulation coverage	Healing time	Length of stay
Control group	53	24.2±4.7	24.5±5.2	29.3±7.4
Study group	51	14.3±3.2	17.1±4.3	22.6±5.8
t	/	18.672	16.251	19.354
P	/	0.042	0.046	0.047

Table 3. Comparison of patient satisfaction (cases, %)

Group	Number of cases	Dissatisfied	Satisfied	Very satisfied	Satisfaction rate
Control group	53	9 (17.0)	15 (28.3)	29 (54.7)	83.0%
Study group	51	2 (3.9)	14 (27.5)	35 (68.6)	96.1%
χ^2	/	/	/	/	5.724
P	/	/	/	/	0.039

pronounced in the study group compared with that in the control group (*P*<0.05) (**Table 4**).

Comparison of quality of life

Before intervention, there was no significant difference in cognitive, emotional, role and social function scores between the two groups (*P*>0.05). After intervention, quality of life scores were significantly increased in both groups, and were significantly higher in the study group compared with those in the control group (*P*<0.05) (**Figure 1**).

Comparison of blood rheological indices

Before intervention, there was no significant difference in packed cell volume (PCV), viscosity and low-cut and high-cut whole blood viscosity levels between the two groups (*P*>0.05). After intervention, PCV, viscosity, and low-cut and high-cut whole blood viscosity levels were significantly reduced in both groups, and the improvement was more pronounced in the study group compared with that in the control group (*P*<0.05) (**Figure 2**).

Comparison of TNF-α and IL-6 levels

Before intervention, TNF-α and IL-6 levels were not significantly different in both groups (*P*>0.05). After 7, 14 and 30 days of intervention, TNF-α and IL-6 levels were significantly reduced in both groups, and the reductions in TNF-α and IL-6 levels were more pronounced in the study group than in the control group (*P*<0.05) (**Figure 3**).

Discussion

With the increasing number of patients with orthopedic trauma, the rate of trauma infection is increasing [13]. Negative pressure drainage technique is usually used. The foam dressings will provide a moist environment and thermal insulation, which can be absorbed under appropriate negative pressure [14, 15]. The dressing can absorb exudate and tiny particles of necrotic tissue through its own pores and transfer them into the suction vessel [16-18]. Although necrotic tissue particles are large, they can be adsorbed on the surface of the foam. When the negative pressure is removed, it can be separated from the wound surface together with the foam to maintain the cleanliness of the wound surface [19]. By effectively controlling negative pressure, blood microcirculation can be im-

Table 4. Comparison of VAS scores and size of trauma (cases, %)

Group	Number of cases	VAS score		Size of trauma (cm^2)	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control group	53	8.3±0.7	6.7±0.6	117.6±3.3	112.4±2.8
Study group	51	8.2±0.8	5.4±0.3	117.8±3.5	104.8±2.4
t	/	0.854	14.325	1.754	16.325
P	/	0.054	0.043	0.055	0.042

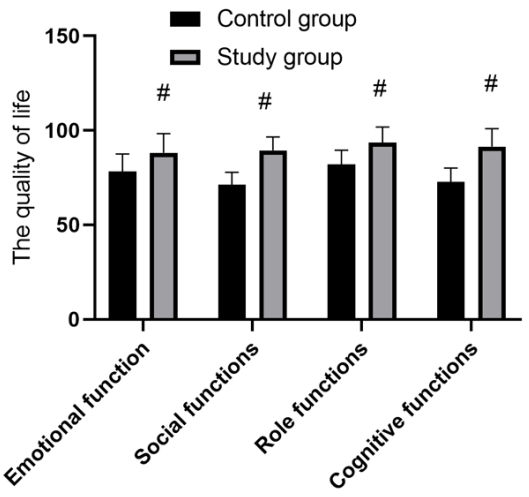

Figure 1. Comparison of quality of life. #Compared with the control group, *P*<0.05.

proved, which facilitates protein synthesis and can provide the required environment for granulation tissue growth [20]. In the treatment of orthopedic trauma infections, VSD plays an important role with following advantages [21]: (1) It can reduce work intensity, which can prevent cross-infection; (2) Under negative pressure, it can suck out bacteria, accumulate blood and necrotic tissue to avoid wound infection; (3) It favors the growth of healthy granulation; (4) The negative pressure state is not conducive to bacterial viability.

The nursing interventions on the basis of VSD treatment showed better treatment effects [22]. The nursing staffs regularly checked the air leakage and folding of the drainage tube, and if there was a malfunction, they could solve it as soon as possible to avoid the air leakage, which improved the safety of care [23, 24]. Nursing staffs closely observed the fluid properties of the drainage bottle as well as bleeding status of the patient's trauma, which could maintain the patency of the drainage tube and could reduce the incidence of infection and facilitate the selection of targeted therapeutic measures [25]. Patients' vital signs, such as blood pressure and heart rate, were monitored to evaluate pain level [26]. This study showed that before intervention, there was no significant difference between the two groups in terms of VAS score and size of trauma (*P*> 0.05). After intervention, the VAS score was significantly decreased and the size of trauma was significantly reduced in both groups, and the change was more significant in the study group (*P*<0.05). The combined clinical intervention was more effective in reducing the size of trauma and decreasing the pain level, which was conducive to the improvement of treatment compliance of patients. The results of the present study showed that compared with the control group, the study group had shorter time to granulation coverage, wound healing, and hospital stay (*P*<0.05); the satisfaction rate of the control group was 83.0%, lower than 96.1% of the study group (*P*<0.05). A study showed that the satisfaction of patients treated with VSD alone was 83.5%, and the satisfaction of patients treated with clinical interventions combined with VSD treatment was 95.7% [27], which was consistent with the results of this study. The reasons may be attributed to that through effective control of negative pressure, blood microcirculation can be improved, which is conducive to protein synthesis, and can provide the necessary environment for the growth of granulation tissue. The results also indicate that VSD treatment can be beneficial to the removal of toxins, bacteria, and exudate, and can facilitate the growth of fresh granulation, and promote the recovery. Elevation of the affected limb by nursing staff, administration of pain medication, or reducing the negative pressure may improve patient comfort and patient satisfaction.

Some scholars explored the effect of VSD treatment on the quality of life of patients, and the results showed that the clinical symptoms of

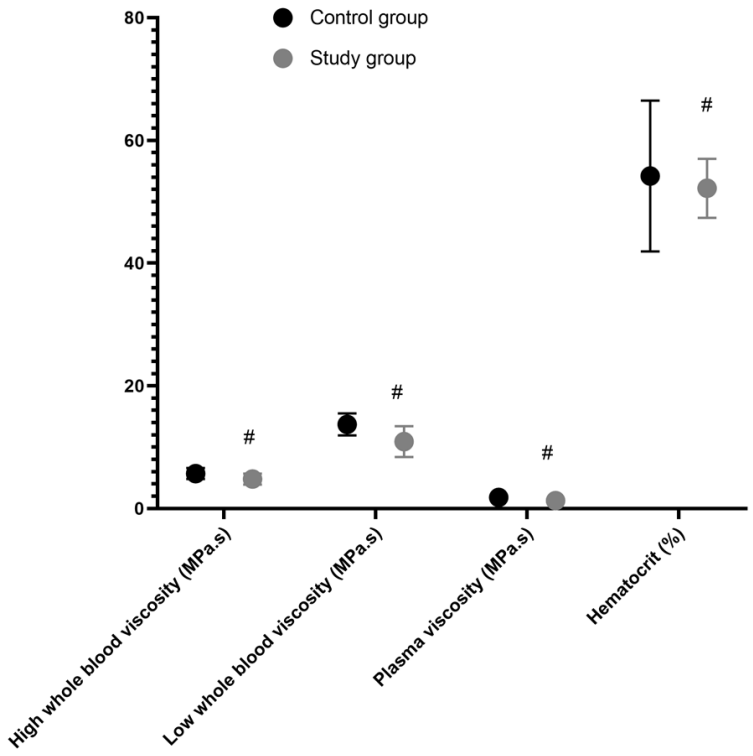

Figure 2. Comparison of blood indicators. #Compared with the control group, $P<0.05$.

patients were significantly improved, but the improvement of some life functions was not remarkable [28]. The possible reason is that clinical medical staffs pay more attention to the treatment of disease regardless of the prognosis. Therefore, combined nursing intervention on the basis of VSD treatment is very critical. This study explored the effect of VSD combined with clinical nursing intervention on the quality of life of patients with orthopedic trauma infection, and the results showed that before intervention, there was no significant difference in cognitive, emotional, role and social function scores between the two groups ($P>0.05$); after treatment, the quality of life scores of the two groups were significantly increased, and were significantly higher in the study group than the control group ($P<0.05$), indicating that combined with clinical nursing intervention on the basis of VSD treatment was beneficial to improving patients' cognition, emotion, role and social function.

Innovation of the study: In this study, combined with clinical nursing intervention on the basis of VSD treatment, the surgical results, satisfaction, size of trauma and VAS scores of patients in the two groups before and after intervention were explored, which could provide a theoretical basis for the development of clinical treatment measures for patients, and all the subjects met the inclusion criteria, which has a high feasibility. Limitation of the study: nevertheless, small sample size and the short duration of the study have an impact on the accuracy of the study. Therefore, the next study should include more samples and extended the study period. The following aspects should be noted in clinical care [29] to avoid hardening and drying of the dressing. After the wound is cleaned and sutured, it is also necessary to ensure adhesive bonding. Proper position should be ensured for drainage patency. When changing the drainage bottle, the drainage tube is first clamped off to avoid reflux of drainage fluid and reinfection. The drainage bottle and the presence of fresh blood in the drainage bottle should be observed. Targeted interventions should be made according to the condition of the patient.

In conclusion, VSD treatment combined with clinical interventions in patients with orthopedic trauma infections are ideal for reducing time to granulation coverage, wound healing and hospitalization time, and improving indicators of blood rheology. It also reduces the size of trauma, the level of pain and inflammatory factors and improves the quality of life and satisfaction.

Disclosure of conflict of interest

None.

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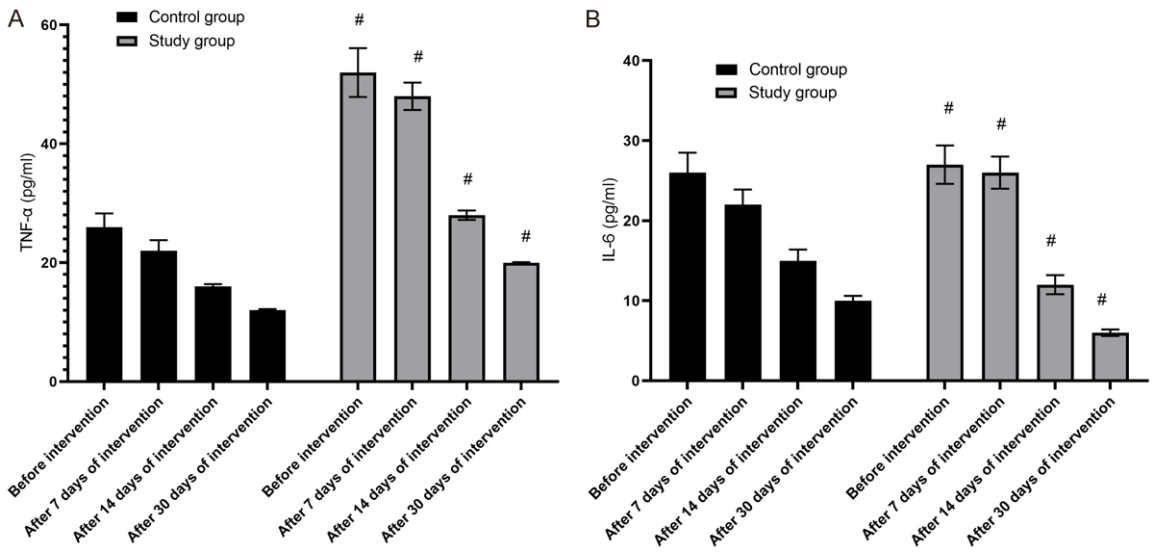

Figure 3. Comparison of TNF-α and IL-6 levels. A: TNF-α; B: IL-6. #Compared with control group, $P<0.05$.

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