

## Original Article

# The effects of vacuum sealing drainage on improving the efficacy of reducing wound infection and lower extremity deep venous thrombosis in patients with orthopedic trauma

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**Abstract:** Objective: This study aimed to explore the effects of vacuum sealing drainage (VSD) on improving the efficacy of reducing wound infection and lower extremity deep venous thrombosis (LEDVT) in patients with orthopedic trauma. Methods: Altogether 78 patients with orthopedic trauma admitted to our hospital were enrolled and randomized into an experimental group and a control group, with 39 patients each. The patients in the control group were conventionally treated with debridement, dressing change, and anti-infection, while those in the experimental group were treated with VSD based on the control group. Their efficacy, wound healing, wound infection, hospitalization time, anti-infection expenses, and incidence of LEDVT were compared. Results: Compared with those in the control group, the patients in the experimental group had a significantly higher effective rate of treatment ( $P<0.05$ ), a significantly shorter wound healing time ( $P<0.05$ ), significantly fewer wound infections ( $P<0.05$ ), significantly shorter healing times of wound infections ( $P<0.05$ ), significantly less hospitalization time, dressing change frequency, and anti-infection expenses ( $P<0.05$ ), and a significantly lower incidence of LEDVT ( $P<0.05$ ). Conclusion: For patients with orthopedic trauma, VSD is conducive to improving their wound healing rate, and reducing the incidences of wound infection and LEDVT, reducing anti-infection expenses and the economic burden, so it is worthy of clinical promotion.

**Keywords:** Vacuum sealing drainage, orthopedic trauma, wound infection, lower extremity deep venous thrombosis

## Introduction

Orthopedic trauma is a clinically common disease that is occasionally accompanied by serious infections and usually causes soft tissue damage to a patient's muscles, nerves, blood vessels, and tendons [1]. Its incidence has been increasing in recent years. The disease is conventionally treated with a dressing change in the clinic. If the wound area is large, the dressing change takes a long time, and patients with the disease suffer from greater pain. Moreover, the patients have increased blood viscosity and stagnated blood after surgery, which seriously affects the reflux of their lower limb veins and usually causes lower extremity deep venous thrombosis (LEDVT) [2]. Therefore, a new therapeutic method is necessary.

Vacuum sealing drainage (VSD) is mostly used to promote the healing of various wounds [3], such as open abdominal wounds, burns, closed or open wounds, and clean or infected wounds [4-6]. It uses subatmospheric pressure to significantly accelerate the separation of the necrotic tissue, prevent inflammation, and promote granulation growth [5, 7]. According to studies, in addition to promoting continuous wound drainage and wound debridement [8, 9], it also promotes the early growth of the granulation tissue, initiates some beneficial cytological effects, and shortens the healing time of complex wounds, without the recurrence of infections [10, 11]. Conventional dressing change takes longer and involves more frequent dressing changes after debridement, followed by suturing, skin grafting, or flap surgery to close

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the wounds. This method usually leads to pain during dressing change, slow granulation growth, and infections, as well as many wound exudates [12, 13].

VSD in the treatment of patients with orthopedic trauma have been widely studied, but its effects on the incidences of wound infection and LEDVT after treatment have been rarely studied. Therefore, in this study, patients with orthopedic trauma were treated with VSD and a conventional dressing change, respectively, to explore their efficacy and their effects on reducing the incidences of wound infection and LEDVT.

### Materials and methods

#### *General information*

A total of 78 patients with orthopedic trauma admitted to our hospital from August 2016 to February 2017 were enrolled and randomized into the experimental and control groups, with 39 patients each.

#### *Inclusion and exclusion criteria*

The inclusion criteria were as follows: patients who met the diagnostic criteria for orthopedic trauma infection [14] after examination; patients aged 23-75 years old; patients with complete general information; patients without a contraindication to treatment; patients without dysfunction of the major organs. This study was approved by the Ethics Committee of the Shangrao People's Hospital. The research subjects and their families signed an informed consent form. The exclusion criteria were as follows: patients who could not take any preventive measures due to their contraindications at the time of admission; patients with other diseases and who were taking anticoagulants such as heparin, low molecular heparin, and warfarin; patients with LEDVT that was confirmed before surgery; patients with a sensory disturbance, dyskinesia, cognitive impairment, laloplegia, or mental retardation; patients with a mental illness, hepatic or renal dysfunction, or an abnormal immune system.

#### *Therapeutic methods*

The patients in the control group were treated with a conventional dressing change, and the dressing work was conducted after the patients' wounds were cleaned. According to the condi-

tions of the individual wounds and infections, the dressings were changed at intervals of 1-2 days, so that the wounds could be kept clean and dry. Anti-infective drugs could be used. For example, penicillin sodium for injection (Harbin Pharmaceutical Group Co., Ltd., Item No.: H23021439, China) was intravenously dripped 2-4 times daily, 2-20 million units (2.5-25 branches) in total. Two or more debridements were carried out for patients with severe infection. The patients in this group were continuously observed, and their wounds were sutured when their granulation grew well and plump.

The patients in the experimental group were treated with VSD based on conventional debridement. VSD dressings were trimmed according to the size and shape of the wound surface, which was sutured using semitransparent films to form a closed condition. Continuous negative pressure suction was carried out for 7 days, during which air leakage was avoided. After that, if the surface was sunken, VSD was effective. Five days later, the peritoneum was taken out and an etiological examination was conducted on the wounds. Mature granulation was sutured. Patients with large wound surfaces were treated with VSD dressings again, and an etiological examination and a drug sensitivity test were conducted on their wound surface every 8 days. According to the results, continuous negative pressure suction and anti-inflammation were conducted at the same time, until the wound surface was healed.

#### *Outcome measures*

(1) The wound healing and wound infection healing of the patients in the two groups were recorded. The patients' healing rate was recorded (1-7 d, 8-14 d, 15-21 d, and >21 d), and 7 days were one healing cycle. The healing of the wound and the infected wound meant that the epidermis was covered intact and no dressing was required after treatment. The wound infection (with infection or without infection) of the patients was also recorded.

(2) The venous thrombosis of the lower extremities in the two groups was recorded. The evaluation criteria were that the patient felt deep pain in the lower leg, had limb swelling after surgery, and the situation was aggravated. The color ultrasound examination (Jiangsu Jiahua Electronic Equipment Co., Ltd., China) was dire-

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ctly used to observe intravenous and intracavitary conditions, in order to determine where the embolization was located.

(3) Clinical efficacy is divided into cured, markedly effective, effective, and invalid. Cured indicated that a patient's wound healed, no dressing was required, the epidermis was covered intact, and the clinical symptoms disappeared such that they could walk normally. Markedly effective indicated that most of a patient's skin survived, the dressing needed to be replaced, the wound secretion was significantly reduced, and the patient had unapparent lower limb swelling, a normal body temperature, and slight pain. Effective indicated that the patient needed to change the dressing regularly, the secretion on the wound surface was reduced, and the patient had subsiding lower limb swelling, a dropping body temperature, and relieved pain. Invalid indicated that the replanted skin of the patient had necrosis, the secretion and the wound area was increased, and the patient had significant lower limb swelling, a rising body temperature, and severe pain. Total effective rate = [(total number of cases-invalid cases)/total number of cases] × 100%.

### Statistical methods

SPSS 21.0 (EASYBIO, China) was used for the data analysis. Count data within groups were expressed by the number of cases/percentage [n (%)], and their comparison between groups was analyzed using a chi-squared test, but the comparison was analyzed using a chi-squared test with a correction of continuity when the theoretical frequency was less than 5. The measurement data were expressed as the mean ± standard deviation ( $\bar{x} \pm s$ ), and their comparison between groups was analyzed using an independent samples *t* test, and their comparison within groups before and after treatment was analyzed using a paired *t* test. When  $P < 0.05$ , the difference is statistically significant.

## Results

### Comparison of general information

There were no statistically significant differences between the experimental and control groups in terms of gender, age, body weight, place of residence, nationality, educational his-

tory, history of smoking, history of drinking, sports history, injury causes, or classification of fracture and wound types ( $P > 0.05$ ) (**Table 1**).

### Comparison of hospitalization time, dressing change frequency and anti-infection expenses

After treatment, the hospitalization time, dressing change frequency and anti-infection expenses in the experimental group were significantly less than those in the control group ( $P < 0.05$ ) (**Table 2** and **Figure 1**).

### Comparison of wound infection

Compared with those in the control group, the patients in the experimental group had a significantly lower wound infection rate ( $P < 0.05$ ), but a significantly higher non-wound infection rate ( $P < 0.05$ ) (**Table 3**).

### Comparison of wound infection healing

After treatment, the wound infection healing in the experimental group was significantly better than it was in the control group ( $P < 0.05$ ). The 1-7 d and 8-14 d healing rates in the experimental group were significantly higher than they were in the control group ( $P < 0.05$ ), but the 15-21 d and >21 d healing rates were significantly lower than those in the control group ( $P < 0.05$ ) (**Table 4**).

### Comparison of wound healing time

After treatment, the wound healing rate in the experimental group was significantly better than it was in the control group ( $P < 0.05$ ). The 1-7 d and 8-14 d healing rates in the experimental group were significantly higher than they were in the control group ( $P < 0.05$ ), but the 15-21 d and >21 d healing rates were significantly lower than those in the control group ( $P < 0.05$ ) (**Table 5**).

### Comparison of the incidence of LEDVT

After treatment, the incidence of LEDVT in the experimental group (10.26%) was significantly lower than the incidence in the control group (53.85%) ( $P < 0.05$ ), and the incidences of iliac-femoral venous thrombosis, venous thrombosis of the calf, and mixed thrombus were significantly lower than they were in the control group ( $P < 0.05$ ) (**Table 6**).

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**Table 1.** Comparison of the clinical baseline data [n (%)]/( $\bar{x} \pm sd$ )

Categories	Experimental group (n=39)	Control group (n=39)	t/ $\chi^2$	P
Gender			0.466	0.495
Male	23 (58.97)	20 (51.28)		
Female	16 (41.03)	19 (48.72)		
Age (Years)	50.34 $\pm$ 4.51	51.21 $\pm$ 4.52	0.851	0.398
Body mass index (kg/m <sup>2</sup> )	22.84 $\pm$ 2.15	22.42 $\pm$ 1.71	1.043	0.299
Place of residence			1.950	0.163
City	21 (53.85)	27 (69.23)		
Countryside	18 (46.15)	12 (30.77)		
Nationality			0.055	0.815
Han	25 (64.10)	24 (61.54)		
National minorities	14 (35.90)	15 (38.46)		
Educational history			0.821	0.365
$\geq$ Senior high school	22 (56.41)	18 (46.15)		
< Senior high school	17 (43.59)	21 (53.85)		
History of smoking			0.587	0.444
Yes	27 (69.23)	30 (76.92)		
No	12 (30.77)	9 (23.08)		
History of drinking			1.285	0.257
Yes	16 (41.03)	21 (53.85)		
No	23 (58.97)	18 (46.15)		
Sports history			1.847	0.174
Yes	17 (43.59)	23 (58.97)		
No	22 (56.41)	16 (41.03)		
Injury causes			1.019	0.797
Traffic accidents	9 (23.08)	12 (30.77)		
Machines	11 (28.21)	8 (20.51)		
Heavy objects	7 (17.95)	6 (15.38)		
Sports	12 (30.77)	13 (33.33)		
Classification of fracture			0.543	0.762
Cartilage tissue injury	14 (35.90)	11 (28.21)		
Open fractures of extremities	12 (30.77)	13 (33.33)		
Osteofascial injury	13 (33.33)	15 (38.46)		
Wound types			0.209	0.648
New wounds	16 (41.03)	18 (46.15)		
Infected wounds	23 (58.97)	21 (53.85)		

**Table 2.** Comparison of the related indices ( $\bar{x} \pm sd$ )

Categories	Experimental group (n=39)	Control group (n=39)	t	P
Hospitalization time (d)	10.09 $\pm$ 1.88*	18.21 $\pm$ 3.20	13.660	<0.001
Dressing change frequency (Times)	5.45 $\pm$ 0.38*	9.07 $\pm$ 0.96	21.900	<0.001
Anti-infection expenses (RMB)	1542.15 $\pm$ 37.29*	2192.02 $\pm$ 55.96	60.350	<0.001

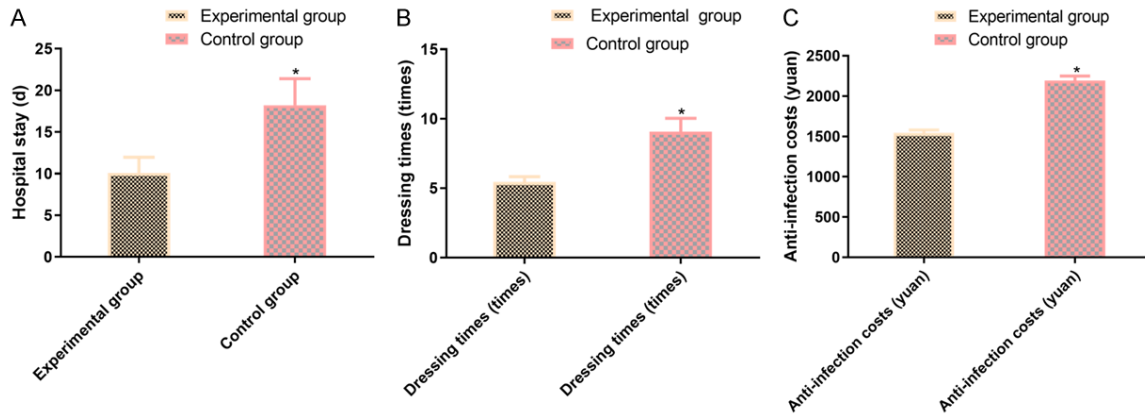
Note: \*indicates P<0.05 compared with the control group after treatment.

### Comparison of the clinical efficacy after treatment

After treatment, the experimental group had 18 cured patients (46.15%), 12 markedly effective

patients (30.77%), 7 effective patients (17.95%), and 2 invalid patients (5.13%), for a total effective rate of 94.87%. The control group had 12 cured patients (30.77%), 10 markedly effective patients (25.64%), 9 effective patients

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**Figure 1.** Comparison of hospitalization time, dressing change frequency, and anti-infection expenses. After treatment, the related indices in the experimental group were better than those in the control group ( $P < 0.05$ ). Compared with those in the control group, patients in the experimental group had significantly shorter hospitalization time ( $P < 0.05$ ) (A), significantly less dressing change frequency ( $P < 0.05$ ) (B), and significantly lower anti-infection expenses ( $P < 0.05$ ) (C). Note: \*indicates  $P < 0.05$  compared with the control group after treatment.

**Table 3.** Comparison of wound infection [n (%)]

Groups	n	Infection	No infection
Experimental group	39	7 (17.95)	32 (82.05)
Control group	39	20 (51.28)	19 (48.72)
$\chi^2$		9.573	9.537
P		0.002	0.002

**Table 4.** Comparison of wound infection healing [n (%)]

Groups	n	1-7 d	8-7 d	15-7 d	>21 d
Experimental group	39	24 (61.54)	13 (33.33)	2 (5.13)	0 (0.00)
Control group	39	12 (30.77)	5 (12.82)	18 (46.15)	4 (10.26)
$\chi^2$		7.429	4.622	17.211	4.216
P		0.006	0.032	<0.001	0.040

**Table 5.** Comparison of wound healing time [n (%)]

Groups	n	1-7 d	8-7 d	15-7 d	>21 d
Experimental group	39	21 (53.85)	15 (38.46)	3 (7.69)	0 (0.00)
Control group	39	7 (17.95)	7 (17.95)	19 (48.72)	6 (15.38)
$\chi^2$		10.921	4.052	16.211	6.500
P		0.001	0.044	<0.001	0.011

(23.08%), and 8 invalid patients (20.51%), for a total effective rate of 79.49%. After treatment, the total effective rate in the experimental group was significantly higher than it was in the control group ( $P < 0.05$ ) (Table 7).

### Discussion

Orthopedic trauma has a high incidence and high mortality around the world. Current non-

surgical or surgical treatment heals wounds, but delayed and failed healing and infections result in serious complications [15]. These complications make patients suffer great pain, increase treatment costs, and aggravate their economic burdens. Therefore, safer, simpler, and more effective treatments for orthopedic trauma infection are of great significance in the clinic.

Previously, conventional dressing change was mainly used to treat the wounds of patients with orthopedic trauma, but a good treatment mode could not be formed and the wound healing took a long time [16]. After the emergence of VSD, its therapeutic effect on the patients has been greatly valued. As a new method for cleaning and closing

wounds suitable for high-risk patients, VSD has been applied to close and clean operative incisions [17]. It can reduce postoperative wound complications [18-20], such as infections, hematoma, and wound dehiscence or delayed healing [21-23]. In a study by Arti et al., VSD compared with conventional dressing change has a faster wound healing rate, a simpler operation, and lower costs. Additionally, it shortens hospitalization time, reduces the infection risk,



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**Table 6.** Comparison of LEDVT [n (%)]

Groups	LEDVT	Thrombosis types		
		Iliac-femoral venous thrombosis	Venous thrombosis of the calf	Mixed thrombus
Experimental group (n=39)	4 (10.26)	1 (2.56)	2 (5.13)	1 (2.56)
Control group (n=39)	21 (53.85)	6 (15.38)	8 (20.51)	7 (17.95)
$\chi^2$	17.011	3.924	4.129	5.014
P	<0.001	0.048	0.042	0.025

**Table 7.** Comparison of the clinical efficacy after treatment

Efficacy	Experimental group (n=39)	Control group (n=39)	$\chi^2$ value	P value
Cured	18 (46.15)	12 (30.77)	-	-
Markedly effective	12 (30.77)	10 (25.64)	-	-
Effective	7 (17.95)	9 (23.08)	-	-
Invalid	2 (5.13)	8 (20.51)	-	-
Total effective rate	37 (94.87)	31 (79.49)	4.129	0.042

and promotes recovery, as well as reduces complications caused by dressings in open fracture wounds [24]. The results of this study showed that after treatment, the hospitalization time, dressing change frequency, and anti-infection expenses in the experimental group were significantly less than those in the control group, which indicates that VSD relieves the patients' pain and reduces the expenses required for the treatment and hospitalization, while reducing dressing change frequency. After treatment, wound infection, wound healing time, and wound infection healing in the experimental group were better than those in the control group, suggesting that VSD can avoid the cross infection of wounds during the treatment, accelerate infected wound healing, and shorten wound healing time. The total effective rate in the experimental group was significantly higher than it was in the control group, which demonstrates that VSD exhibits a better efficacy for patients with orthopedic trauma. These findings are similar to those of Arti. In this study, color Doppler ultrasound was also used to examine the incidence of LEDVT in the two groups after treatment. The results showed that after treatment, the incidence of LEDVT in the experimental group (10.26%) was significantly lower than it was in the control group (53.85%), and the incidences of iliac-femoral venous thrombosis, venous thrombosis of the calf, and mixed thrombus were significantly lower than they were in the control group.

This shows that VSD can prevent LEDVT that may occur in patients with orthopedic trauma after treatment, significantly reducing its incidence.

In this study, the research objects were strictly screened according to the inclusion and exclusion criteria. There was no significant difference between

the experimental and control groups in gender, age, or other general baseline data, which ensured the preciseness and reliability of the study. This study confirmed that VSD can better treat patients with orthopedic trauma, but after treatment, the patients were not followed up for a long time, so there were limitations. These limitations should be addressed in later research to further support the results of this study.

In summary, for patients with orthopedic trauma, VSD can shorten their hospitalization time, reduce their dressing change frequency and treatment costs, and relieve their pain. It can also reduce wound infection, significantly shorten wound healing time and the healing time of wound infection, and reduce the incidence of LEDVT. Therefore, it is worthy of clinical promotion.

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### Disclosure of conflict of interest

None.

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### References

- [1] Ilfeld BM, Ball ST, Cohen SP, Hanling SR, Fowler IM, Wongsarnpigoon A and Boggs JW. Percutaneous peripheral nerve stimulation to control postoperative pain, decrease opioid use, and accelerate functional recovery following orthopedic trauma. *Mil Med* 2019; 184 Suppl 1: 557-564.
- [2] Guzman D, Sabharwal S, Zhao C and Sabharwal S. Venous thromboembolism among pediatric orthopedic trauma patients: a database analysis. *J Pediatr Orthop B* 2018; 27: 93-98.
- [3] Siqueira MB, Ramanathan D, Klika AK, Higuera CA and Barsoum WK. Role of negative pressure wound therapy in total hip and knee arthroplasty. *World J Orthop* 2016; 7: 30-37.
- [4] Schlosser KA, Otero J, Lincourt A and Augenstein VA. Management of surgical incisions using incisional negative-pressure therapy. *Plast Reconstr Surg* 2019; 143: 15S-20S.
- [5] Apelqvist J, Willy C, Fagerdahl AM, Fraccalvieri M, Malmsjo M, Piaggese A, Probst A and Vowden P. EWMA document: negative pressure wound therapy. *J Wound Care* 2017; 26: S1-S154.
- [6] Robert N. Negative pressure wound therapy in orthopaedic surgery. *Orthop Traumatol Surg Res* 2017; 103: S99-S103.
- [7] Iwashita Y, Negi S, Iwashita Y, Higashiura M, Shigi Y, Yamanaka S, Ohya M, Mima T and Shigematsu T. Severe refractory infection due to renocolic fistula in a patient with a giant kidney and ADPKD undergoing long-term hemodialysis. *CEN Case Rep* 2018; 7: 174-177.
- [8] Rupert P, Ochoa RA, Punch L, Van Epps J, Gordon-Burroughs S and Martinez S. The use of NPWT-i technology in complex surgical wounds. *Cureus* 2016; 8: e920.
- [9] Gupta S, Gabriel A, Lantis J and Téot L. Clinical recommendations and practical guide for negative pressure wound therapy with instillation. *Int Wound J* 2016; 13: 159-174.
- [10] Strugala V and Martin R. Meta-analysis of comparative trials evaluating a prophylactic single-use negative pressure wound therapy system for the prevention of surgical site complications. *Surg Infect (Larchmt)* 2017; 18: 810-819.
- [11] Acosta S, Björck M and Wanhainen A. Negative-pressure wound therapy for prevention and treatment of surgical-site infections after vascular surgery. *Br J Surg* 2017; 104: e75-e84.
- [12] Bredow J, Hoffmann K, Oppermann J, Hellmich M, Eysel P and Zarghooni K. Evaluation of absorbent versus conventional wound dressing. *Dtsch Arztebl Int* 2018; 115: 213-219.
- [13] Mendame Ehya RE, Zhao Y, Zheng X, Yi W, Bounda GA, Li Z, Xiao W and Yu A. Comparative effectiveness study between negative pressure wound therapy and conventional wound dressing on perforator flap at the Chinese tertiary referral teaching hospital. *J Tissue Viability* 2017; 26: 282-288.
- [14] Fischer C, Preuss EM, Tanner M, Bruckner T, Krix M, Amarteifio E, Miska M, Moghaddam-Alvandi A, Schmidmaier G and Weber MA. Dynamic contrast-enhanced sonography and dynamic contrast-enhanced magnetic resonance imaging for preoperative diagnosis of infected nonunions. *J Ultrasound Med* 2016; 35: 933-942.
- [15] Mittwede PN, Gottardi R, Alexander PG, Tarkin IS and Tuan RS. Clinical applications of bone tissue engineering in orthopedic trauma. *Curr Pathobiol Rep* 2018; 6: 1-10.
- [16] Willy C, Agarwal A, Andersen CA, Santis G, Gabriel A, Grauhan O, Guerra OM, Lipsky BA, Malas MB, Mathiesen LL, Singh DP and Reddy VS. Closed incision negative pressure therapy: international multidisciplinary consensus recommendations. *Int Wound J* 2017; 14: 385-398.
- [17] Galiano RD, Hudson D, Shin J, van der Hulst R, Tanaydin V, Djohan R, Duteille F, Cockwill J, Megginson S and Huddleston E. Incisional negative pressure wound therapy for prevention of wound healing complications following reduction mammoplasty. *Plast Reconstr Surg Glob Open* 2018; 6: e1560.
- [18] Yu L, Kronen RJ, Simon LE, Stoll CRT, Colditz GA and Tuuli MG. Prophylactic negative-pressure wound therapy after cesarean is associated with reduced risk of surgical site infection: a systematic review and meta-analysis. *Am J Obstet Gynecol* 2018; 218: 200-210, e1.
- [19] Loveluck J, Copeland T, Hill J, Hunt A and Martin R. Biomechanical modeling of the forces applied to closed incisions during single-use negative pressure wound therapy. *Eplasty* 2016; 16: e20.
- [20] Gage MJ, Yoon RS, Egol KA and Liporace FA. Uses of negative pressure wound therapy in orthopedic trauma. *Orthop Clin North Am* 2015; 46: 227-234.
- [21] Stannard JP, Volgas DA, McGwin G 3rd, Stewart RL, Obremskey W, Moore T and Anglen JO. Incisional negative pressure wound therapy after high-risk lower extremity fractures. *J Orthop Trauma* 2012; 26: 37-42.
- [22] Suh H, Lee AY, Park EJ and Hong JP. Negative pressure wound therapy on closed surgical wounds with dead space: animal study using a

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- swine model. *Ann Plast Surg* 2016; 76: 717-722.
- [23] Ma Z, Shou K, Li Z, Jian C, Qi B and Yu A. Negative pressure wound therapy promotes vessel destabilization and maturation at various stages of wound healing and thus influences wound prognosis. *Exp Ther Med* 2016; 11: 1307-1317.
- [24] Arti H, Khorami M and Ebrahimi-Nejad V. Comparison of negative pressure wound therapy (NPWT) & conventional wound dressings in the open fracture wounds. *Pak J Med Sci* 2016; 32: 65-69.