Original Article
The effect of vacuum sealing drainage after early wound abrasion on wound healing in diabetic patients with deep second degree burn and its influence on the inflammatory response

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Abstract: Objective: To investigate the effect of vacuum sealing drainage (VSD) after early wound abrasion (WA) in diabetic patients with deep second degree burn (DSDB). Methods: This prospective study selected 89 diabetic patients with DSDB treated in our hospital. Using the random number table method, the patients were divided into the control group (44 cases with conventional treatment after early WA) and observation group (45 cases with VSD treatment after WA). Wound healing, fungal infection rate, serum levels of inflammatory factors and vascular endothelial growth factor (VEGF), and adverse reactions in both groups were compared. Results: After 2 weeks of treatment, the total effective rate of observation group was higher than that of control group, and the incidence of adverse reactions showed an opposite trend (both P<0.05). Compared with the control group, the wound healing time was shortened, the wound healing rate was increased, and the fungal infection rate was decreased in the observation group (all P<0.05). Compared with before treatment, serum TNF-α levels in both groups were decreased, while serum levels of IL-10, IL-4 and VEGF were increased after treatment, and the changes in the observation group were more obvious (all P<0.05). Conclusions: In diabetic patients with DSDB, VSD after early WA can effectively reduce the incidence of fungal infection, reduce inflammation, improve VEGF level, and facilitate wound healing.

Keywords: Diabetes, deep second degree burn, early wound abrasion, vacuum sealing drainage, wound healing, inflammatory response

Introduction

Burns cause damage to the skin and subcutaneous tissues, which destroy normal defense function of the skin, can easily cause infection, redness and swelling. Therefore, timely and effective anti-infection is of great significance to promote the healing of skin lesions after burns [1]. Diabetic patients are always in hyperglycemia state, in which bacterial breeding frequently occurs [2]. Therefore, compared with ordinary burn patients, diabetic patients are prone to infection after burns, adding difficulty to the healing of their skin lesions. Early wound abrasion (WA) is the main means of clinical treatment for burns, but different postoperative treatments have different impact on postoperative wound healing [3].

On the basis of the traditional drainage method, vacuum sealing drainage (VSD) refers to a drainage tube placement on the wound. The drainage tube is not in direct contact with the body wound, but is wrapped with polyvinyl alcohol sponge, so as to form a closed drainage system. It can effectively remove the wound exudation and prevent bacteria invasion, thereby promoting wound healing [4]. However, there are rare studies on fungal infection of wound and vascular endothelial growth factor (VEGF) level in diabetic patients with deep second degree burn (DSDB) who received VSD after early WA. Yuan et al. found that VSD after early WA could promote burn wound healing of DSDB, but they did not investigate the infection status of fungi and VEGF level [5]. This research comprehensively evaluated the therapeutic effect
Effect of VSD after early WA in diabetic patients with DSDB on WH and IS

of VSD after early WA in patients with DSDB from the wound healing time, fungal infection rate, inflammatory response, VEGF level and adverse reactions.

Materials and methods

General information

This prospective study selected 89 diabetic patients with DSDB admitted in our hospital from November 2018 to October 2019. Using the random number table method, the patients were divided into the control group (44 cases, conventional treatment after early WA) and observation group (45 cases, VSD treatment after WA).

Inclusion criteria: patients aged 25-68 years old; patients who met the diagnostic criteria of diabetes in the Definition, Classification, Diagnosis, Screening and Prevention of Diabetes Mellitus (2019 Edition) [6]; patients whose burn area of DSDB was <10% of body surface area; patients whose time from burn to admission was less than 12 hours.

Exclusion criteria: Patients with severe inhalational lung injury; patients with blood system disease or mental abnormality.

All patients and their family members in this study understood the content of this experiment and signed the informed consent. This study was approved by the Ethics Committee of our hospital.

Methods

After admission, patients in both groups were given routine treatment, including active blood glucose control, debridement and anti-infection, etc. Within 24 h after admission, all patients received early WA [7]. After disinfection, the necrotic wound was rubbed off with steel wire ball, covered with vaseline gauze, and then bandaged with iodophor gauze. And the dressing was changed daily.

VSD was performed in the observation group after early WA [8]. The VSD auxiliary material was cut into an appropriate size and placed on the wound surface. The negative pressure was set as -26.0 to -40.0 kP, and continuous negative pressure attraction was maintained. The

color and amount of drainage fluid were observed, and the abnormalities were handled in time. The VSD auxiliary material was removed 5-7 days later, and the necrotic tissue was removed together. The dressing was changed daily until the wound epithelialization.

Outcome measures

Primary outcome measures: (1) Clinical efficacy was evaluated according to wound healing 2 weeks after treatment [9]. Markedly effective: No redness or exudation in the wound; effective: the wound was still slightly red and swollen, accompanied by little secretions; ineffective: not up to the above standards or wound deterioration. Total effective rate: Number of cases (markedly effective + effective)/total number of cases * 100%. (2) Wound healing time was compared between the two groups. (3) The wound secretions were taken with sterile cotton swabs for fungal examination, and the wound fungal infection rates before and after treatment were compared.

Secondary outcome measures: (1) The levels of inflammatory factors such as tumor necrosis factor-α (TNF-α), interleukin-10 (IL-10) and interleukin-4 (IL-4), and VEGF level were detected by ELISA. (2) The adverse reactions of the two groups during treatment were recorded, such as infection, redness and swelling at the wound edge, wound exudate and wound pain.

Statistical analysis

SPSS 20.0 was used for statistical analysis. Count data were represented by number of cases, and tested by χ² test; measurement data were expressed as \( \bar{x} \pm sd \). Pair t test was used for comparison between the same group before and after treatment, and independent t test was used for comparison between two groups. P<0.05 was considered statistically significant.

Results

Comparison of general information

No statistical difference was seen in the general information between the two groups (all P>0.05). The two groups were comparable. See Table 1.
Effect of VSD after early WA in diabetic patients with DSDB on WH and IS

Comparison of clinical efficacy

After 2 weeks of treatment, the total effective rate of observation group was higher than that of control group (P<0.05). See Table 2.

Comparison of wound healing time and wound healing rate

The wound healing time of observation group was (18.9±3.3) d, significantly earlier than that of control group (22.3±4.2) d. And the wound healing rate was significantly increased (observation group vs. control group, P=0.000<0.05).

Comparison of fungal infection rate

There was no significant difference in the wound fungal infection rate between the two groups before and 1 week after treatment (both P>0.05). After 2 weeks of treatment, the wound fungal infection rate of the observation group was lower than that of the control group (P<0.05). See Table 3.

Comparison of inflammatory factor levels

Compared with before treatment, serum TNF-α levels in both groups were decreased after treatment, and lower TNF-α level was seen in the observation group; there were opposite trends in the serum IL-10 and IL-4 levels (all P<0.05). See Table 4.

Comparison of VEGF level

Compared with before treatment, serum VEGF levels in both groups were significantly increased after treatment, and the observation group had higher VEGF level than the control group (all P<0.05). See Figure 1.

Comparison of adverse reactions

During treatment, the incidence of total adverse reactions in the observation group was lower than that in the control group (P<0.05). See Table 5.

Discussion

For diabetic patients with burns, the hyperglycemic environment in the body is more suitable for the growth of pathogenic bacteria, causing more serious inflammatory response of the body; some patients even have systemic invasive infection, leading to the prolonged wound [10, 11]. For DSDB patients, VSD after early WA is used for postoperative drainage, which can remove the wound exudation in time and help

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**Table 1. Comparison of general information (X ± sd)**

<table>
<thead>
<tr>
<th>Index</th>
<th>Observation group (n=45)</th>
<th>Control group (n=44)</th>
<th>x²/t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (n)</td>
<td></td>
<td></td>
<td>1.363</td>
<td>0.243</td>
</tr>
<tr>
<td>Male</td>
<td>25</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>20</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>43.3±6.4</td>
<td>42.8±7.3</td>
<td>0.343</td>
<td>0.732</td>
</tr>
<tr>
<td>Total burn area/total surface area (%)</td>
<td>16.87±3.39</td>
<td>17.22±4.65</td>
<td>0.405</td>
<td>0.686</td>
</tr>
<tr>
<td>DSDB area/body surface area (%)</td>
<td>7.47±1.08</td>
<td>7.78±1.40</td>
<td>1.168</td>
<td>0.246</td>
</tr>
<tr>
<td>Time from burn to admission (h)</td>
<td>3.0±1.1</td>
<td>3.1±1.2</td>
<td>0.410</td>
<td>0.683</td>
</tr>
<tr>
<td>Blood glucose at admission (mmol/L)</td>
<td>10.87±1.94</td>
<td>11.04±2.26</td>
<td>0.380</td>
<td>0.705</td>
</tr>
</tbody>
</table>

Note: DSDB: deep second degree burn.

**Table 2. Comparison of clinical efficacy after treatment (n, %)**

<table>
<thead>
<tr>
<th>Group</th>
<th>Markedly effective</th>
<th>Effective</th>
<th>Ineffective</th>
<th>Total effective rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group (n=45)</td>
<td>19 (42.22)</td>
<td>23 (51.11)</td>
<td>3 (6.67)</td>
<td>42 (93.33)#</td>
</tr>
<tr>
<td>Control group (n=44)</td>
<td>16 (36.36)</td>
<td>18 (40.91)</td>
<td>10 (22.73)</td>
<td>34 (77.27)</td>
</tr>
</tbody>
</table>

Note: Compared with the control group, #P<0.05.

**Table 3. Comparison of fungal infection rate (n, %)**

<table>
<thead>
<tr>
<th>Group</th>
<th>Before treatment</th>
<th>One week after treatment</th>
<th>Two weeks after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation (n=45)</td>
<td>2 (4.44)</td>
<td>3 (6.67)</td>
<td>1 (2.22)#</td>
</tr>
<tr>
<td>Control group (n=44)</td>
<td>2 (4.55)</td>
<td>6 (13.64)</td>
<td>6 (13.64)</td>
</tr>
</tbody>
</table>

Note: Compared with control group, #P<0.05.
Effect of VSD after early WA in diabetic patients with DSDB on WH and IS

Table 4. Comparisons of inflammatory factor levels (X ± sd)

<table>
<thead>
<tr>
<th>Group</th>
<th>TNF-α (ng/mL)</th>
<th>IL-10 (ng/mL)</th>
<th>IL-4 (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observation (n=45)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before treatment</td>
<td>19.94±3.30</td>
<td>18.59±4.40</td>
<td>10.77±3.30</td>
</tr>
<tr>
<td>Two weeks after treatment</td>
<td>12.20±2.50*a</td>
<td>24.58±3.75*a</td>
<td>17.04±3.21*a</td>
</tr>
<tr>
<td><strong>Control group (n=44)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before treatment</td>
<td>20.35±3.84</td>
<td>17.89±5.39</td>
<td>10.59±4.29</td>
</tr>
<tr>
<td>Two weeks after treatment</td>
<td>17.76±2.76 *</td>
<td>21.40±4.33 *</td>
<td>13.33±3.20 *</td>
</tr>
</tbody>
</table>

Note: Compared with before treatment, *P<0.05; compared with control group, #P<0.05.

Figure 1. Comparison of VEGF level. VEGF, vascular endothelial growth factor. Compared with before treatment, *P<0.05, compared with control group, #P<0.05.

This study showed that the wound healing time in the observation group was obviously shortened, and the total clinical effective rate in the observation group was higher than that in the control group. This indicated that VSD after early WA could effectively promote wound healing of DSDB in diabetic patients, and its curative effect is superior to the implementation of early WA alone. Yuan et al. also reported that the wound healing time of patients undergoing VSD after early WA was significantly shortened, and the length of hospital stay was also significantly shorter than that of patients undergoing early WA alone [5]. Postoperative infection is a main and key factor influencing the burn wound healing [14]. Diabetic patients are predisposed to infection after DSDB, causing prolonged wound healing. Therefore, it is extremely important to take appropriate measures to timely and effectively control fungal infections for diabetic patients with DSDB so as to speed up burn wounds healing [15]. In this study, the wound fungal infection rate in the observation group was lower than that in the control group 2 weeks after treatment, suggesting that VSD after early WA can effectively reduce the incidence of wound fungal infection in the diabetic patients with DSDB. VSD after early WA can effectively reduce the local microcirculation of burn wounds, promote the outflow of wound exudate, and greatly reduce local tissue edema of burn wounds, so it is helpful to reduce the occurrence of infection [16].

In the process of occurrence and development of inflammatory response, a variety of inflammatory factors are involved and play an important role. TNF-α, a pro-inflammatory cytokine, is involved in the pathophysiological process of inflammation diseases, multiple organ failure and other diseases [17, 18]. Both IL-10 and IL-4 belong to anti-inflammatory cytokines, which have opposite effects to pro-inflammatory cytokines [19]. In addition, VEGF is a powerful pro-angiogenic factor, which can improve local wound blood perfusion, promote the formation of new blood vessels, and stimulate the generation of granulation tissue from different aspects [20, 21]. In this study, compared with before treatment, the serum levels of TNF-α were reduced, but the serum levels of IL-10, IL-4 and VEGF were increased in both groups after treatment, and more obvious changes were seen in the observation group. The results indicated that VSD after early WA could effectively inhibit the body's inflammatory response in diabetic patients with DSDB, improve VEGF level and promote angiogenesis and growth of granulation tissue, which may be the key mechanism for the better effect of VSD after early WA on diabetic patients with DSDB. Yang et al. also found that VSD was more advantageous in improving VEGF level after early WA, which was consistent with the results of this study [22]. Moreover, during treatment, lower total incidence of adverse reactions was seen in the observation group, indicating that VSD after
Effect of VSD after early WA in diabetic patients with DSDB on WH and IS

Table 5. Comparison of adverse reaction (n, %)

<table>
<thead>
<tr>
<th>Group</th>
<th>Infection</th>
<th>Redness and swelling at the wound edge</th>
<th>Wound exudate</th>
<th>Wound pain</th>
<th>Total incidence of adverse reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation (n=45)</td>
<td>3 (6.67)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (2.22)</td>
<td>4 (8.89)*</td>
</tr>
<tr>
<td>Control group (n=44)</td>
<td>6 (13.64)</td>
<td>2 (4.55)</td>
<td>2 (4.55)</td>
<td>2 (4.55)</td>
<td>12 (27.27)</td>
</tr>
</tbody>
</table>

Note: Compared with control group, *P<0.05.

early WA could obviously reduce postoperative occurrence of adverse reactions in diabetic patients with DSDB.

Some limitations exist in this study. This is a single center clinical study, with limited sample size and shorter follow-up time; therefore, multi-center clinical observation with a large sample size should be conducted to comprehensively evaluate the therapeutic advantage of VSD after early WA in diabetic patients with DSDB.

In conclusion, VSD after early WA can effectively reduce the occurrence of fungal infection in diabetic patients with DSDB, inhibit the body's inflammatory response, improve VEGF level and promote wound healing, and the curative effect is superior to early WA alone.

Disclosure of conflict of interest

None.

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Effect of VSD after early WA in diabetic patients with DSDB on WH and IS


