Vacuum-assisted closure dressing in split-thickness skin grafting

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ABSTRACT

Vacuum-assisted closure (VAC) has been applied to a variety of acute and chronic wounds that are difficult to manage, and is associated with improved wound healing outcomes. It involves the application of sub-atmospheric pressure in a controlled way to secure a split-thickness skin graft on the wound that has been sealed with an occlusive dressing. A study was conducted on the patients with a variety of indications for skin grafting, admitted to Azadi Teaching Hospital between March 2010 and August 2017. After the application of split-thickness skin graft, a closed, controlled suction was applied on the wound. The graft was then continuously observed, and the dressing was changed as needed. A total of 39 split-thickness skin grafting procedures were performed on 37 patients (20 male, 17 female), the age of the patients ranging between 7 and 68 years. The average grafted area was 1270 cm², and the percent graft take ranged from 90 - 100%. Vacuum-assisted closure opposes the graft firmly on the wound bed, sucks out the seroma and/or hematoma, prevents shearing of the graft and aids in immobilization of the grafted part; thus improving the quantity and quality of the graft take. This study also established that VAC was particularly useful when the wound site is difficult to access, the wound is highly contoured and the conditions are less-than-ideal for complete graft take.

INTRODUCTION

Vacuum-assisted closure (VAC) is a relatively new technology with applications in a variety of difficult to manage acute and chronic wounds. It is known by many pseudonyms, such as topical negative pressure (TNP), sub-atmospheric pressure dressing (SPD), vacuum sealing technique (VSD), and sealed surface wound suction (SSS) (Banwell and Téot, 2003). Vacuum-assisted closure involves the controlled application of sub-atmospheric pressure/negative pressure to a sealed system comprising of a sponge and suction tubing secured to the wound with adhesive drape (Morykwas et al, 1997). Encouraging results in terms of rates of healing have been reported in the literature.

The use of vacuum-assisted closure was originally reported in 1997 by Morykwas et al. (Morykwas et al., 1997). Their work was inspired by previous studies conducted on negative pressure that had suggested it might improve wound healing. Reportedly, negative pressure increased blood flow to the desired part, as evidenced by hyperaemia.

Split-thickness skin grafting is an uncomplicated, versatile technique used for a variety of indications. It has been used extensively in burn wounds, as well
as during subsequent reconstructive procedures. Other indications include traumatic soft tissue loss, tumor excisions and many congenital and acquired diseases. The vast utility of this technique warrants continuous refinement to ensure best possible results in the unfortunate victims whose problems are often compounded by unfavourable local general conditions (Polfer  et al., 2015). The graft integration to the affected area involves revascularization, lymphatic revascularization, and reinnervation.

Some of the well-known reasons for unsuccessful graft take are improper positioning of the graft due to uneven bed, compromised graft bed preparation, presence of seroma or hematoma under the graft, shearing forces between the graft and the graft bed, and infection. In addition, the extensiveness of the burnt or traumatized area and the difficulty in fixing a bolster on the graft or immobilization of the graft assembly also decreases the rate of graft take. Success in graft take can be realized by avoiding the above-mentioned problems and ensuring a proper nutritional status of the patient (Hazani et al., 2012) (Hsiao et al., 2014). The technique of negative pressure dressing, initially used for better wound healing, has been tried on skin grafts and has shown to increase the graft take rates (Fleischmann et al., 1996).

In this study, we report the use and success rate of using vacuum-assisted closure combined with split-thickness skin grafting on a variety of indications.

MATERIALS AND METHODS

The study, including 37 patients, was conducted at Azadi Teaching Hospital between March 2010 and August 2017. Patients who had skin grafting in a burnt or traumatized area, irrespective of their acute or chronic condition were included. Patients were excluded if the application of VAC in the traumatized area would technically be not possible. Such traumatized areas included oral commissures and eyelids.

The split-thickness skin graft was applied to the wounded region and secured with staples or vicryl sutures as necessary. The graft was then covered with Vaseline gauze, followed by the application of low density polyurethane foam of one and half inch thickness that was cut according to the contour of the graft. A perforated flexible transparent plastic tube (5 mm inner diameter, 1.0 m length) was inserted into the foam by making a shallow slit in the latter. The entire graft assembly, except the lumen of the plastic tube, was covered with a broad sterile transparent adhesive film whose edges were sealed to the normal skin. This ensures the isolation of the dressing from the environment. The patient was then shifted from the operation theater, and the unsealed tube was connected to a VAC machine for continuous vacuum suction of 95-120 mm Hg. Effective creation of negative pressure was confirmed by the collapse of the foam and absence of the gushing sound of air leak from the system. Splinting and/or elevation of the grafted part were done when deemed necessary.

The dressings and the maintenance of suction were continuously monitored by the resident nursing staff. On the fourth postoperative day, the graft was inspected, and the VAC was discontinued. The patients were followed up for a total of 3 weeks.

Percentage of graft take was assessed by gross examination that included consensus of the treating plastic surgery unit on day nine.

RESULTS AND DISCUSSION

Out of the 37 patients, 20 were male, and 17 female and the mean age of the patients was 32 years (range: 7 – 68 years). A total of 39 split-thickness skin grafts were used, where the average grafted area was $12 \pm 70 \text{ cm}^2$. The causes for the skin graft and the site of the graft are mentioned in Table 1.

<table>
<thead>
<tr>
<th>Indications for grafting</th>
<th>No. of cases</th>
</tr>
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<tbody>
<tr>
<td>Post-burn wounds</td>
<td>9</td>
</tr>
<tr>
<td>Contracture release and scar excision</td>
<td>6</td>
</tr>
<tr>
<td>Post-trauma wounds</td>
<td>21</td>
</tr>
<tr>
<td>Tumor excision</td>
<td>1</td>
</tr>
<tr>
<td>Site of wound</td>
<td>No. of cases</td>
</tr>
<tr>
<td>Upper limb</td>
<td>10</td>
</tr>
<tr>
<td>Lower Limb</td>
<td>22</td>
</tr>
<tr>
<td>Trunk</td>
<td>7</td>
</tr>
</tbody>
</table>

All the patients, including children as young as 7 years, were found to be comfortable with the vacuum closure assembly; they were not any more inconvenienced than they were with the routine bed rest and immobilizations. Although leakage of air was noticed in five dressings, they were immediately sealed using additional adhesive film. The principal investigator personally demonstrated turning off the suction to the resident nurse and patients’ contact in each case so that they can handle the situation if the patient is in discomfort or blood is found in the foam/tube.
The mean duration of dressing on the grafted area was 8 days, and at nine postoperative days, the percent graft take ranged from 90-100%. The photos of four such cases have been shown (Figure 1, Figure 2, Figure 3, Figure 4) that depicts the results of the surgeries after a few days, and then a few months.

The use of vacuum-assisted closure dressing for wounds has been described and popularized since the mid-90s (Morykwas et al., 1997) (Fleischmann et al., 1996). It has been shown through several animal experiments that application of controlled sub-atmospheric pressure plays an important role in wound healing. Although this technique is old, it gained immense popularity in the past decade as a method of treatment of acute and chronic wounds of nearly every etiology, and complex reconstructions during plastic surgery where other treatments are impossible (Chiummariello et al., 2013).

The various attributes of the application of sub-atmospheric pressure include, an increased local blood flow, clearance of discharges from the wound surface, reduction in bacterial load, decreased edema, increased rate of granulation tissue formation, production of mechanical stress within the tissue resulting in protein and matrix molecular synthesis, enhanced epithelialization, elimina-
tion of dead space ensuring proper apposition of the graft onto the recipient bed. It also reduces shearing forces, seroma or hematoma formation and promotes rapid graft take (Morykwas et al., 1997) (Fleischmann et al., 1996) (Andrews et al., 2006) (Moisidis et al., 2004) (Schneider et al., 1998). It has been shown that the granulation tissue of high quality profused with capillaries is formed with this technique, which is capable of managing the skin graft (Chiummariello et al., 2013). When negative pressure is used, the application of the graft on the wound becomes easier, compared to the bolster dressing, and the treatment duration is reduced (Kim and Hong, 2007). In this technique, polyurethane foam was used because the application of negative pressure would condense the foam, which in turn would compress the graft and decrease the dead space between the graft and wound bed. Polyurethane foam can be applied on large areas where bolster dressing is not possible (Hoeller et al., 2014).

Table 2: Contraindications for vacuum-assisted closure

<table>
<thead>
<tr>
<th>Relative contraindications</th>
<th>Difficult hemostasis</th>
<th>Anticoagulation</th>
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<tr>
<td>Absolute contraindications</td>
<td>Fistula to organs or body cavity</td>
<td>Osteomyelitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Necrotic tissue</td>
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<tr>
<td></td>
<td></td>
<td>Cancerous tissue</td>
</tr>
</tbody>
</table>

Despite the creation of a suitable environment for wound healing, contraindications to the use of this technique exists. Table 2 mentions the various contraindications for VAC obtained from KCI Medical Ltd, Witney, Oxfordshire, England. Two types of contraindications were present; relative contraindication required vigilance while using two drugs or procedures together, whereas absolute contraindication could result in a life-threatening situation. The most significant limitation is the inability to obtain an air-tight seal at certain anatomical sites. In maxillofacial practice, although this technique has been successfully used on the face and neck, difficulties were faced for the peri-oral region (Avery et al., 2000).

The various attributes of negative pressure work either individually, or in combination to increase the graft take and reduce the duration of wound healing. It has been reported that a skin graft on the trunk enables the patient to change postures, thus preventing pressure sores without disturbing the graft (Sposato et al., 2001). When the mini-VAC machine was used for lower limb skin grafts or even wounds in ischemic patient, the graft perfectly adhered to the recipient area; ambulation and limb movement did not disturb the dressing, confinement of the patient to bed became unnecessary, thus greatly reducing nursing assistance (Sposato et al., 2001). A study by Hynes et al. concluded that split-thickness skin grafts in combination with negative pressure dressings were the most effective and appropriate means of treating axillary defects such as severe hidradenitis suppurativa following their surgical excision (Hynes et al., 2002). The utility of this technique in improving the quantity and quality of the graft has been demonstrated by several studies (Andrews et al., 2006) (Moisidis et al., 2004) (Schneider et al., 1998) (Vidrine et al., 2005) (Llanos et al., 2006). Our study corroborates those findings by demonstrating a better adherence of the graft to the bed leading to an increase in the amount of graft take. In the study carried out by Rozen et al, full take of skin graft without any operative complications was observed in all the 9 cases (Rozen et al., 2008). It has been claimed that VAC combined with skin graft may offer a simplified approach for managing unique and complex defects on the lower limbs, and thus should be included in the reconstructive surgeons’ armamentaria (Pu, 2009).

CONCLUSION

A higher percentage of graft take and reduced duration of graft dressings were noted with the use of VAC on split-thickness skin grafts. The findings from our study suggests that such negative pressure dressing improves graft take and speeds up the process of graft take in burn and traumatized patients, and it is particularly useful when the graft site is anatomically challenging, the graft bed is highly contoured, and the grafting conditions seem less-than-ideal for complete graft take.

Abbreviations: Not Applicable

Declarations

Ethics approval and consent to participate: Ethical consent has been taken from.

Trial registration number: 124

Name of registry: Kirkuk university/research department

URL of registry: http://uokirkuk.edu.iq; Medical@uokirkuk.edu.iq

Date of registration: 3/01/2010

Date of enrolment of the first participant to the trial: 1/02/2010
Consent for publication: Consent has been taken from the institution and the patients.

Availability of data and material: The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare they don’t have any conflict of interest.

Funding: Authors declare that they have not received any funds from any source.

Authors’ contributions: AAA has conceptualized and designed the study and also was involved in the conduction of the study. YN and AB have written and conducted the study.

ACKNOWLEDGEMENT

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