CASE REPORT

An improved alternative to vacuum-assisted closure (VAC) as a negative pressure dressing in lower limb split skin grafting: A clinical trial

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Summary

Background: The use of negative pressure in the dressing of split skin grafts has been shown to promote healing by a variety of mechanisms, including a decrease in interstitial oedema, an increase in perfusion and a decrease in bacterial colonisation. Vacuum-assisted closure (VAC) dressings have, until now, been used as the archetype for negative pressure dressings and have been reflected as such in the literature. However, patient mobility and cost are still an issue with these dressings, and alternatives have been keenly sought. We describe an alternative method of negative pressure dressing, which we have found to be a safe and successful alternative in the setting of lower limb split skin grafts.

Materials and methods: A prospective cohort investigation was performed on nine consecutive patients at Monash Medical Centre undergoing split-skin grafting for a lower limb soft tissue defect. The dressing comprised a single cut foam sheet, a conventional disposable closed-system suction drain and an adhesive dressing.

Results: In all nine patients, there was a 100% take of the graft, with no partial or complete loss. There were no complications encountered. Cost analysis demonstrated a minimum treatment cost of $577 over 5 days compared to $3180 for commercial VAC dressed wounds: a net saving of $2603 per patient.

Conclusions: The use of a simple suction drain is a cheap and safe alternative to commercial VAC dressings for the treatment of lower limb split skin grafts. Length of hospital stay and cost are superior to VAC, with no diminished clinical outcome.

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The potential for graft failure in split skin grafting has been the basis for extensive investigation into optimal wound therapy after grafting. The tie-over bolster dressing has been implemented widely, incorporating a bolster dressing made of foam and/or cotton applied over the graft, and fixed in place either by sutures or an elastic bandage (or both). This tie-over bolster dressing immobilises the graft, preventing shearing in the plane between the graft and wound, which is critical for graft survival. This had been a mainstay of graft dressing, until the recent incorporation of negative pressure into graft dressings.

The use of negative pressure in the dressing of split skin grafts has been shown to promote healing beyond that of immobilisation dressings, by a variety of mechanisms. These include increased dermal perfusion, decreased interstitial oedema, decreased bacterial colonisation and stabilisation of the graft, all of which decrease the incidence of seroma and infection. Negative pressure, as used to promote wound healing, was first described by Fleischmann et al. in 1993, with subsequent widespread investigation and usage. In 1995, negative pressure systems known as vacuum-assisted closure (VAC) dressings became commercially available. These have, until now, been used as the archetype for negative pressure dressings and have been reflected as such in the literature. These systems use a foam dressing with an attached perforated drain, which connects to a vacuum unit used to apply the appropriate negative pressure. Commercial VAC dressings successfully achieve the performance outcomes sought after for negative pressure dressings.

There are, however, limitations of VAC which preclude its universal adoption in the appropriate clinical settings. The most significant include prolonged hospital admission during application of the dressing, decreased patient mobility during treatment and the cost of the treatment, comprising the cost of both the dressing itself and costs relating to a prolonged hospital admission. An improvement on the heavy machinery associated with VAC dressings has been the portable VAC, but it is still associated with high costs and complexity requiring home nursing. There are alternative methods for the adoption of negative pressure dressings which are not in widespread use. Simple suction devices have been variably used, without formal review of their role. We discuss the implementation of a simple suction device applied to foam bolster and drain, in the setting of lower limb split skin grafting, used to achieve adequate negative pressure.

Materials and methods

Nine consecutive patients undergoing split skin grafting to the lower limb were recruited at a major tertiary referral hospital. The patients were all coincidentally female, with a mean age of 69 years (range 32 to 99), participation was voluntary, without compensation for participation. There was a 100% response rate from the participants approached.

Skin grafts were harvested with an electric dermatome, set at 0.010 inches, and meshed at a ratio of 1.5: 1 to minimise the potential for fluid accumulation. Grafts were then secured to the recipient site either with staples, used earlier in the study, or absorbable suturing, which avoided painful removal of dressings from stapled skin grafts. In each case, a wound template was created using white foam and stapled or secured to the wound edge. A Jelonet dressing was applied over the meshed graft.

The dressings used in each case comprised a disposable foam base, of similar type used in VAC dressings, and a conventional disposable closed-system suction drain with the associated tubing. Over each graft, a layer of foam was applied to the graft, with the closed-suction drain fixed to the foam by an adhesive dressing (Fig. 1). The graft dressings and drain were subsequently wrapped to the lower limb in a crepe bandage.

Negative pressure was applied to the graft for five to seven days, with patients able to ambulate immediately after.
### Table 1  Demographics and outcomes of split skin graft procedure for all patients

<table>
<thead>
<tr>
<th>Patient Number</th>
<th>Age</th>
<th>Sex</th>
<th>Comorbidities</th>
<th>Relevant Medications</th>
<th>Smoking History</th>
<th>Donor Site</th>
<th>Graft Site</th>
<th>Graft Outcome</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>79</td>
<td>Female</td>
<td>Asthma, Hypertension, Atrial Fibrillation, Stroke</td>
<td>Aspirin</td>
<td>Yes</td>
<td>Right Thigh</td>
<td>Right Leg</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>2</td>
<td>62</td>
<td>Female</td>
<td>Ischaemic Heart Disease</td>
<td>Aspirin</td>
<td>No</td>
<td>Right Thigh</td>
<td>Left Leg</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>3</td>
<td>85</td>
<td>Female</td>
<td>Hypertension, Hypercholesterolaemia</td>
<td>Aspirin</td>
<td>No</td>
<td>Left Thigh</td>
<td>Left Leg</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
<td>Female</td>
<td>Nil</td>
<td>Nil</td>
<td>Yes</td>
<td>Right Thigh</td>
<td>Dorsum</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>5</td>
<td>65</td>
<td>Female</td>
<td>Nil</td>
<td>Diclofenac, Dipyridamole, Aspirin</td>
<td>No</td>
<td>Left Thigh</td>
<td>Right Leg</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>6</td>
<td>99</td>
<td>Female</td>
<td>Ischaemic Heart Disease, Stroke, Chronic Obstructive Pulmonary Disease, Hypertension, Hypercholesterolaemia</td>
<td>Dipyridamole, Aspirin</td>
<td>Yes</td>
<td>Right Thigh</td>
<td>Right Leg</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>7</td>
<td>65</td>
<td>Female</td>
<td>Aortic Stenosis, Type-2 Diabetes, End Stage Renal Failure on Dialysis, Hyperparathyroidism, Congestive Cardiac Failure, Granulomatous Hepatitis, Anemia</td>
<td>Warfarin</td>
<td>No</td>
<td>Left Thigh</td>
<td>Dorsum</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>8</td>
<td>92</td>
<td>Female</td>
<td>Stroke, Aortic Stenosis, Chronic Obstructive Pulmonary Disease, Hypertension</td>
<td>Aspirin, Dipyridamole</td>
<td>Yes</td>
<td>Right Thigh</td>
<td>Right Leg</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
<tr>
<td>9</td>
<td>63</td>
<td>Female</td>
<td>Hypertension, Hypercholesterolaemia</td>
<td>Nil</td>
<td>Yes</td>
<td>Right Thigh</td>
<td>Right Leg</td>
<td>Full Take</td>
<td>Nil</td>
</tr>
</tbody>
</table>

### Table 2  Cost analysis per dressing type, based on a five day treatment period

<table>
<thead>
<tr>
<th>Dressing</th>
<th>Minimum Number of InPatient Hospital Days Required</th>
<th>Inpatient Hospital Costs During Minimum Treatment Period ($)</th>
<th>Hospital-In-The-Home Costs During Minimum Treatment Period ($)</th>
<th>Cost per Dressing Device During Minimum Treatment Period ($)</th>
<th>Total Cost Per Five Day Treatment ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAC</td>
<td>5</td>
<td>2855</td>
<td>0</td>
<td>325</td>
<td>3180</td>
</tr>
<tr>
<td>Portable VAC</td>
<td>1</td>
<td>571</td>
<td>744</td>
<td>375</td>
<td>1690</td>
</tr>
<tr>
<td>Disposable</td>
<td>1</td>
<td>571</td>
<td>0</td>
<td>6</td>
<td>577</td>
</tr>
<tr>
<td>Suction Drain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
postoperatively (Fig. 2). Precluding other medical issues, patients were able to be discharged from hospital on the day of operation, with routine prescription of oral antibiotics for 7 days and no routine prophylactic anticoagulation.

The primary outcomes for the study were graft take and complication rate. A cost analysis was performed using data from the Department of Medical Records. Data were collated and analysed descriptively, precluding the use of comparative statistics.

Results

The demographics of each participant are recorded in Table 1, including co-morbidities, medications and smoking history. In all nine patients there was full take of the skin graft, with no partial or complete graft loss. There were no operative complications, and the dressings were universally well tolerated.

A cost analysis at our institution was performed. VAC dressings, both permanent and portable, were priced according to the manufacturer, KCI Medical Australia, and standard disposable suction drains were priced by our institutional supplier. The analysis was done using the minimal inpatient stay per dressing type, with the requirement for a portable dressing being only one night as an inpatient, and the requirement for a non-portable VAC dressing being 5 days. The cost associated with each dressing was calculated over a treatment period of 5 days (Table 2). The portable VAC dressing required four subsequent treatment days under the 'hospital-in-the-home' unit, for assistance with electronic settings and the emptying of drainage volumes.

Discussion

The benefits of negative pressure dressings over tie-over bolster dressings include an improved graft take due to the removal of fluid beneath the graft and the presence of shear forces. VAC dressings have become popular, but are associated with high costs, patient immobility and prolonged hospital stays. Our study aimed to implement a cheaper and safe alternative. The participants demonstrated a wide variation in co-morbidities and medications (see Table 1), yet there was full take of the skin grafts in all nine patients, with no operative complications. A simple suction drain was thus shown to be both safe and effective for use as a negative pressure dressing in the setting of lower limb skin defects.

The cost analysis, shown in Table 2, demonstrated a significant cost benefit to the use of simple suction drains over VAC and portable VAC dressings. Total cost, length of stay and time to ambulation were all low and shown to be lower than other forms of negative pressure dressings. Furthermore, the analysis does not take into account the further need for rehabilitation often required after prolonged immobilisation with VAC dressings.

The simple suction system described is a cheap and easily available method, with its components of suction device, foam and drain readily available to all surgeons.

The use of a simple suction drain is a cheaper and safe alternative to VAC dressings for the dressing of lower limb split skin grafts. Length of hospital stay and cost were all superior to VAC, and there was no negative effect on clinical outcome.

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References

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