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Graft take rates in low-risk and high-risk patients with negative pressure wound therapy vs tie-over dressings

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Establishing a reliable method of securing skin grafts over wounds of the lower extremities remains a challenge, particularly in high-risk patients. Studies have reported on the use of negative pressure wound therapy using reticulated open-cell foam (NPWT/ROCF) as delivered by V.A.C.® Therapy (KCI Licensing, Inc., San Antonio, TX) as a bolster dressing over split- thickness skin grafts in various populations. The aim of this study was to compare take rates of lower extremity grafts in high-risk patients who received NPWT/ROCF versus tie-over dressings. We also retrospectively evaluated graft take rates in low-risk (no comorbidities) versus high-risk (≥1 comorbidity) graft patients who received post-graft NPWT/ROCF versus tie-over dressings. Forty-seven STSG patient records were analyzed. In the high-risk patient group, a significantly higher number of patients obtained ≥80% graft take rate in the NPWT/ROCF versus tie-over group (p=0.008). Graft take rates were similar between the two dressings in low-risk patients. In this study, NPWT/ROCF appears to improve STSG take compared to tie-over dressings in high-risk patients, which may be related to an improved contact zone between the graft and wound site.

Key words: negative pressure wound therapy, V.A.C. therapy, split-thickness skin graft

Closure of lower extremity wounds remains a challenge in patients with considerable comorbidities. An ever-increasing number of closure options have prompted us to adopt a "reconstructive elevator" approach to our modern lower extremity practice (Figure 1). Typically in our practice, anatomic location, biomechanics and bony pressure points dictate plastic closure selection. Wounds with bone, joint, or tendon exposure without periosteum or paratenon larger than 0.5 cm in diameter are treated with flaps. Wounds located on the weight-bearing areas of the foot are typically treated with secondary intention or preferably cultured cellular grafts. In the literature, a split-thickness skin graft (STSG) is considered by some surgeons to be the preferred method of repair for moderate to large soft tissue defects on non-weight-bearing areas of the extremities [1-5].

Split-thickness skin grafting is a method of transposition of human skin (epidermal and a portion of the dermal layers) from a harvest to recipient site. The stages of STSG healing are: plasmatic imbibition, inosculation, and capillary ingrowth. A skin graft survives the first 48 hours through imbibition, or diffusion, of exudate through the host bed that supplies nutrients and removes waste products. The next step is inosculation, in which the graft develops connections with the recipient blood vessels.

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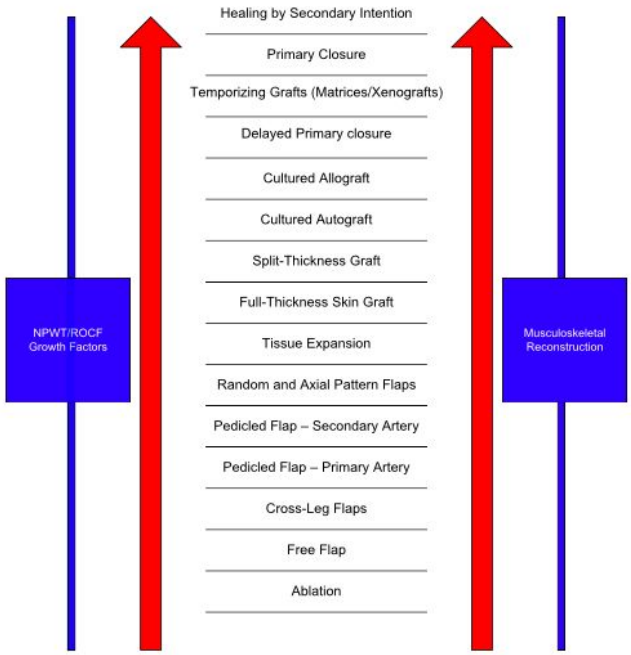

Figure 1 The "reconstructive elevator" approach to modern lower extremity practice.

Finally, capillary in-growth occurs when new vessels grow into the graft from the host bed and actively innervate the graft to establish blood supply [6, 7].

Patient comorbidities, such as diabetes mellitus (DM), lymphedema, and peripheral vascular disease (PVD) are known to impede wound healing [8], and can lead to graft failure. Other reasons for graft failure include ischemia, seroma/hematoma formation, fluid collection, shearing forces, infection, desiccation, and rejection. Reported skin graft failure rates vary dramatically, depending on wound etiology and a host of other factors. The method used to secure the graft can be a critical element in reducing opportunities for failure. Goals of a bolster dressing are to provide even pressure, immobilization and restriction of shearing to the graft, as well as prevent seroma or hematoma formation while providing a moist wound bed beneath the STSG [7].

During the past several years, adjunctive use of negative pressure wound therapy using reticulated open-cell foam (NPWT/ROCF) as delivered by V.A.C.® Therapy (KCI Licensing, Inc., San Antonio, TX) has become a well-established method of securing the graft to the recipient bed. NPWT/ROCF can act as both a temporizing bridge to STSG closure as well as the dressing over the STSG [4, 5, 8-12]. Obtaining successful graft take requires that the skin graft remain immobilized for 2-5 days or until revascularization occurs [13]. The compressed NPWT/ROCF foam maintains continuous, firm contact between the graft and wound bed while the negative pressure actively removes exudates and infectious material from the wound bed. Foam pliability allows relative movement of the wound surface without compromising pressure [4].

While many studies have reported on the use of NPWT/ROCF over STSGs, its relative efficacy versus traditional tie-over bolster dressings has been debated in the literature. We hypothesized that the use of NPWT/ROCF creates an improved contact zone between the graft and wound site as compared to tie-over dressings, which may result in higher graft take rates. We further hypothesized that among high-risk patients with known comorbidities, application of NPWT/ROCF over STSGs on lower extremity wounds leads to higher graft take rates compared to tie-over dressings. To test these hypotheses, we performed a retrospective cohort analysis examining skin graft take rates of high-risk patients treated with NPWT/ROCF versus tie-over cotton bolster dressings.

Patients and Methods

We retrospectively reviewed the charts of consecutive patients who received an STSG procedure performed by the leading author as primary surgeon between March 1994 and May 2007. Records were divided into four groups: 1) High-risk NPWT/ROCF, 2) High-risk tie-over bolster, 3) Low-risk NPWT/ROCF and 4) Low-risk tie-over bolster. Patients were considered high-risk if they had any of the following comorbidities: DM, end-stage renal disease (ESRD), contralateral lower-extremity amputation, lymphedema, smoking, peripheral nerve disorders, spinal cord injuries (SCI) or disorders, PVD, venous insufficiency, immunocompromised, or connective tissue disorders. A hospital IRB Waiver of Authorization was obtained to perform this retrospective data analysis, based on its minimal risk level to patients. All tie-over bolster and NPWT/ROCF dressings were similarly fashioned and placed by the same surgeon. Tie-over patients were treated with a post-graft bolster dressing consisting of normal saline soaked absorbent cotton balls and tied over the graft using 3-0 monofilament nylon sutures.

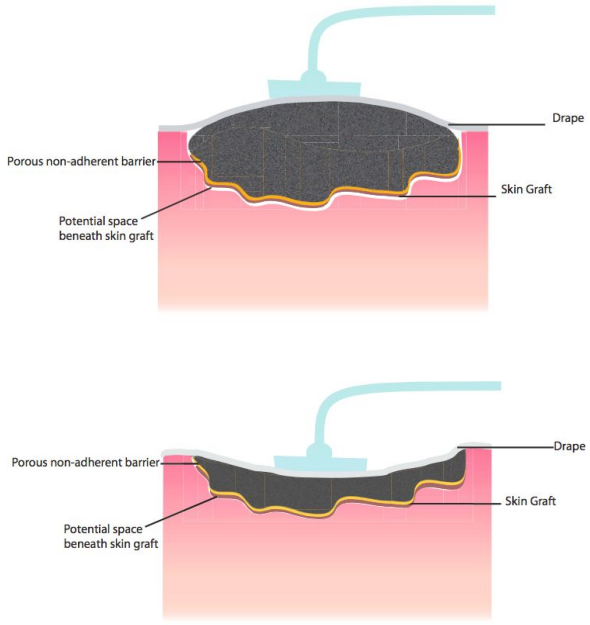

Figure 2 NPWT application diagram.

STSGs in the NPWT/ROCF-treated groups were covered with an available (eg, ADAPTIC®) porous non-adherent layer, an NPWT/ROCF dressing and semi-permeable drape with tubing. The tubing was connected to the subatmospheric pressure unit with -125mmHg applied for 3-5 days (Figure 2). The authors' medical records, digital photograph archives, and surgical logs were reviewed, and percentage of graft take at 14 days post-operative was recorded for each patient. Total number patients with ≥80% and ≥50% graft take were compared between both treatment arms for both high- and low-risk groups. Fisher's exact two-tailed test was utilized to compare the groups by percentage of graft take.

Results

Forty-seven patients met the study inclusion criteria. 15 patients in the NPWT/ROCF group and 21 in the tie-over group were classified as high-risk. There were 5 patients in the NPWT/ROCF group and 6 patients in the tie-over group that were classified as low-risk.

Frequencies of patient comorbidities are listed in Table 1. Wound etiologies in the low-risk patient group included traumatic wounds, post-debridement wounds from necrotizing fasciitis or bites, post-lesion excision sites, and decubitus ulcers.

Wound Subgroup	Low-Risk Tie-Over Group (n=6)		Low-Risk NPWT/ROCF Group (n=5)	
	n	Average % Take	n	Average % Take
Post-infection debridement site	2	90	1	100
Post-trauma	1	100	4	100
Post-excision site	1	90	0	n.a.
Decubitus ulcer	2	90	0	n.a.
Total	6	92.5	5	100

Table 1 Graft rate take rate.

There was a significant difference between the two treatment arms of high-risk patients that achieved a graft take rate ≥80%: 13 of 15 for the NPWT/ROCF group versus 9 of 21 for the tie-over group (p=0.008) (Table 1). The number of patients in the high-risk cohort that achieved ≥50% graft take was also significantly lower in the tie over patient group (14/21) versus the NPWT/ROCF group (15/15; p=0.027). Complete graft failure (0% graft take) was reported in the remaining 7 tie-over and 1 NPWT/ROCF high-risk patients. The average percent graft take rates for high-risk patients in the NPWT/ROCF versus tie-over groups were 90.3% vs. 55.2%, respectively. When subgrouped by comorbidities, the average graft take rate in the NPWT/ROCF-treated patients was higher than the tie-over patients in each of the subgroups, but the difference was not significant, owing to low populations in all subcategories (Table 1). All low-risk NPWT/ROCF and tie-over patients achieved a graft take rate of 80% or greater (Table 2).

Discussion

The retrospective analysis demonstrated significantly improved STSG take rates and survival in high-risk patients who received NPWT/ROCF, compared to traditional tie-over dressings. Our graft take rates in both the high- and low-risk NPWT/ROCF groups—90.3% and 100%, respectively—mirror that which is reported in the literature [14-16]. In 1997, Argenta and Morykwas first demonstrated effective use of NPWT/ROCF as a bolster for STSGs on a variety of acute and chronic wounds [14]. Blackburn et al [15] showed a ≥95% STSG take rate with the use of NPWT/ROCF on contoured wounds in complex anatomic regions.

	High risk tie-over group				High risk NPWT/ROCF Group			
Comorbidity	n	Average % take	≥80% graft take (n)	≥50% graft take (n)	n	Average % take	≥80% graft take (n)	≥50% graft take (n)
DM, ESRD, contralateral lower extremity amputation, PVD	14	57.9	6	4	13	93.1	12	1
SCI/peripheral neuropathy/congenital spinal cord lesion	0	n/a	n/a	n/a	0	n/a	n/a	n/a
Venous insufficiency	6	58.3	3	2	1	95	1	0
Connective tissue disorder/immunocompromised	0	n/a	n/a	n/a	1	50	0	0
smoker	1	0	0	1	0	n/a	n/a	n/a
total	21	55.2	9	7	15	90.3	13	1

Table 2 Comorbidity and graft rate take rate.

A consecutive case series of 61 STSG patients revealed a significant decrease in repeated STSGs for the NPWT/ROCF group as compared to the bolster dressing group, suggesting improved graft survival with adjunctive use of NPWT/ROCF [19]. Our patients have experienced other advantages of NPWT/ROCF reported in the literature, such as enhanced patient mobility, shorter hospital stay, and an earlier return to daily activities while the dressing is in place [2, 15, 17].

Our study's similar graft take rates between the two treatment arms of the low-risk population somewhat support outcomes of other clinical studies that have reported no significant difference in STSG take rates between NPWT/ROCF and tie-over dressing groups [3, 18-19]. Moisidis et al [18] performed a prospective, blinded, randomized controlled trial comparing NPWT/ROCF to standard bolster dressings on 22 adult inpatients with wounds requiring skin grafting. There were no differences in quantitative graft take between the two groups, but NPWT/ROCF had a significantly better qualitative graft take as compared to the standard bolster dressing [18]. In a retrospective chart review, Stone et al also found similar graft take rates between NPWT/ROCF and bolster dressings in 40 trauma patients who underwent soft tissue loss and fasciotomies [3]. Our study results appear to suggest prudent use of NPWT/ROCF in low-risk patients, although the small sample sizes clearly warrant further study.

This study has several limitations including its small size, retrospective nature, and lack of randomization and blinding. Unobserved covariates which could also account for differences in graft take, such as wound size, duration, or type of wound treatment prior to grafting, may also distort the conclusions of the study. Also, the author believes that as his practice changed from utilizing the tie-over dressing to the use of NPWT/ROCF over time, perhaps an improvement in surgical technique could have occurred as well over this period of time. This improvement in technique could have allowed an improved success in the latter portion of the cohort when NPWT/ROCF was utilized more often.

To the authors' knowledge, this study is the first to delineate between high- and low-risk patient populations in comparing NPWT/ROCF versus

tie-over bolster treatment over STSGs. Our results suggest that the presence of patient comorbidities may be an important consideration when choosing a bolster dressing. Combining high and low-risk populations within cohorts may underestimate the utility of NPWT/ROCF in high-risk populations. Our preliminary results are promising and suggest that NPWT/ROCF may be a more efficacious dressing versus traditional tie-over dressings in high-risk patients whereby reliably uniform contact between the graft and dressing is critical to successful graft take.

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