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Conventional Bolster Dressing Versus Vacuum-Assisted Closure Device for Securing Split-Thickness Skin Graft in Contoured Wide Raw Area Reconstruction: A Randomized Clinical Trial

OLA SEIF, M.D.*; EMAD M. ABDELRAHMAN, M.D.**; SHERIF M. ELKAFFAS, M.D.**; AHMED A. SHOULAH, M.D.*; NASHWA MOHAMED EMARA, M.D.***; EMAN IBRAHIM ELGENDY, M.D.*** and MOHAMED H. ABDELHALIM, M.D.*

The Departments of Plastic Surgery, General Surgery** and Pathology***, Faculty of Medicine, Benha University*

Abstract

Background: Contour wounds that require skin graft closure are frequently situated in unique or complicated anatomical areas, making it difficult and inefficient to stabilize them using traditional bolsters.

Objective: The aim of this work is to compare vacuum-assisted closure (VAC) with Conventional bolster dressing in terms of graft take, histology of wound healing, hospitalization duration, and expenses.

Patients and Methods: In the current study 62 patients were reconstructed using a split thickness skin graft and supported by a VAC (Group A n=31) or a traditional bolster dressing (Group B n=31). The following characteristics were assessed in both groups; operative time, hospital stay. Complications, graft take as well as histological assessment of the skin.

Results: The mean age of the included patients in the current study was 42.3±9.34 and 41.1±8.92 in group A and B respectively. Post-operative complications showed statistically significant seroma and hematoma in patients who received conventional bolsters. The histopathological assessment showed that the Hyperkeratosis, pigmentation, neovascularization, collagen deposition and fibroblastic activity were more evident in patients who used VAC ($p<0.001$*).

Conclusion: VAC device is an effective methos for securing split-thickness skin grafts in contoured wide raw area reconstruction with minimal postoperative complications, better healing and favorable aesthetic outcome.

Key Words: *VAC – Traditional Bolster – Contour wounds – STSG.*

Ethical Committee: Approval was obtained Ethical and Research Committee of Faculty of Medicine, Benha University. An informed written consent was obtained from all patients regarding surgical procedures and publication of their photos.

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Correspondence to: Dr. Emad M. Abdelrahman,
E-Mail: emadsahan301@gmail.com

Introduction

Split-thickness skin grafts (STSG) are regarded as an important technique for wide raw area repair [1]. The recipient bed, compliance with the bed's contour, the existence of hematoma or seroma, and the patient's nutritional state all have a direct impact on the outcome of an STSG take [2].

As first dressings, bolsters are frequently utilized to keep STSG adherent to the wound bed. A bolster dressing's primary objective is to apply uniform pressure over the graft's surface in order to reduce shear stresses between the graft and the wound bed and to stop hematoma and seroma from forming [3,4].

Contour wounds that require skin graft closure are frequently situated in unique or complicated anatomical areas, making it difficult and inefficient to stabilize them using traditional bolsters [5].

The vacuum-assisted closure (VAC) device applies –ve pressure to a cell polyurethane foam dressing sealed over a wound using a computerized suction pump, is the current standard for negative pressure wound therapy (NPWT). Furthermore, the VAC device easily adapts to wounds with unusual shapes, which is why it is frequently utilized to fix STSG instead of traditional bolster dressings [5,6].

In order to secure split thickness skin graft in contoured large raw area reconstruction, the purpose of this work is to compare vacuum-assisted closure with standard bolster dressing in terms of graft take, histology of wound healing, hospitalization duration, and expenses.

Patients and Methods

The current study was carried out from June 2021 to June 2023 at the Plastic and Reconstructive Surgery Unit of the General Surgery Department, Faculty of Medicine, Benha University Hospital. Before the first case was enrolled, permission to conduct the research was acquired by the Benha University Faculty of Medicine's Institute of Ethical and Research Committee.

The 62 patients in the study had large contoured raw areas that were repaired using a split thickness skin graft and supported by a vacuum-assisted closure (Group A n=31) using (Suprasorb CNP P3, LR international UK, 2018) or a traditional bolster dressing (Group B n=31).

Randomization: It was done by specific software (Random Allocation Software 1.0, 2011).

Raw areas with necrotic tissue that needed to be cleaned up, as well as any exposed bone, tendon, cartilage, or neurovascular structures, were excluded. Also, Patients who refused to participate in the research were also excluded.

After being properly informed about the procedure and its circumstances, the subjects who consented to participate in this clinical investigation completed an informed consent form. After complete history taking, comprehensive local and general assessment, and tissue Assessment, the procedure was done under general or regional anesthesia.

Procedure:

Using a conventional approach, all wounds were debrided down to a viable and healthy wound bed (Fig. 1-A,B). In short, following the removal of the damaged tissue, a donor site is used to harvest split thickness skin graft (STSG) using a dermatome that is programmed to create STSGs that are 0.03cm thick. Grafts can have a 1:1 or 1.5:1 mesh. The STSG is then circumferentially fastened to the wound bed using staples or sutures (Fig. 2). The graft in Group A is then dressed with a nonadherent material (Vaseline gauze) (Fig. 3). The VAC sponge is then fixed in place with adhesive lamination. Continuous negative 125mmHg suction is maintained on the VAC setting with additional cost of about 3000 pound per week. Group B was given Graft covering with the conventional bolsters. Operative time was recorded for all patients.

Prophylactic antibacterial therapy was given to the patient started with the induction of anesthesia for 5 days including cefotaxime 1gm every 12 hours. Analgesics, anti-edematous medications were all part of the immediate postoperative care for 5 days.

Following the removal of the vacuum-assisted closure device or bolster dressing after 5 days, the following characteristics were examined in both groups:

- The surface area where the graft was taken compared to the untaken area (Fig. 4-A,B). The skin graft "take" rate was evaluated by the surgeon as ((total graft area) – (graft loss area)) / ((total graft area) × 100) two weeks after dressing removal. The graft loss area was determined by inspecting the areas where the graft had failed to adhere to the wound bed or where graft tissue necrosis had occurred.
- The histology of a bunch biopsy of about 3x5mm was obtained from a transplant 3 weeks after the procedure. Histology samples were examined using hematoxylin and eosin (H & E) staining to look for hyperkeratosis, melanin deposition (Fig. 5-A,B), neovascularization collagen deposition, granulation tissue, inflammatory cell (Figs. 6,7).
- Length of hospitalization.
- Aesthetic outcome: The results of these procedures were assessed at the 30-day mark using the patient and observer scar assessment scale (POSAS) [7,8] (many patients began anti-scar measures, such as pressure garments and anti-scar creams, after the 30-day mark in order to improve the outcomes).

Outcomes:

The primary outcome was successful closure of contoured wide raw area with minimal postoperative complications and good graft take. The secondary outcome was the improvement of the healing process and aesthetic outcome.

Statistical analysis:

To determine the sample size, the G*power 3.1 program (Universities, Dusseldorf, Germany) was used. The sample size was determined using postoperative complications, the main endpoint of the current investigation. 31 patients from each group of 62 patients were included, with 95% power, 0.05 type one error (2 tailed), and an effect size of 0.9.

Through data distribution analysis, the normality of the measured results was investigated. Chi-square test was used to the gender nominal data. The assessed factors were subjected to a two-way mixed ANOVA. The ANOVA test was used to the participant demographic data. Whereas nominal data were shown as number and %. Numerical data were presented as mean and SD. A significant threshold of $p<0.05$ was established. The statistical analysis was conducted using SPSS Statistics version 20.

Fig. (1-A): Debridement of the wound in Group A.

Fig. (1-B): Debridement of the wound in Group B.

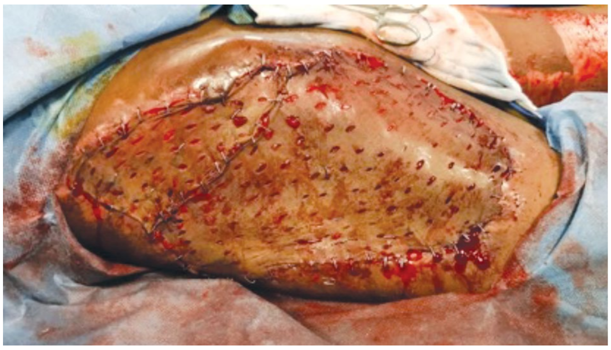

Fig. (2): Fixation of STSG.

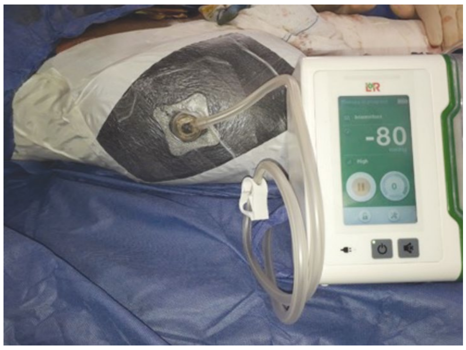

Fig. (3): Vac application.

Fig. (4-A): Graft Take in Group A.

Fig. (4-B): Graft Take in Group B.

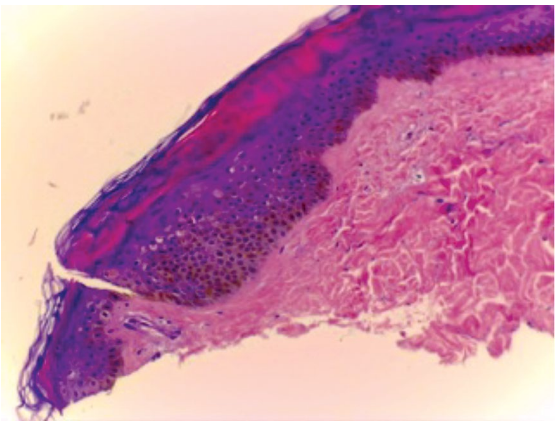

Fig. (5-A): Melanin deposition and Hyperkeratosis in VAC Group A.

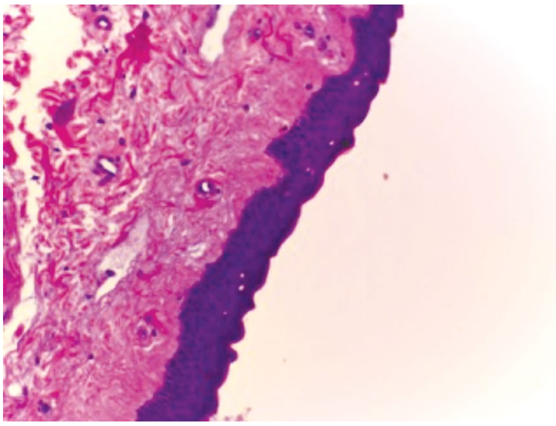

Fig. (5-B): Melanin deposition and Hyperkeratosis in Group B.

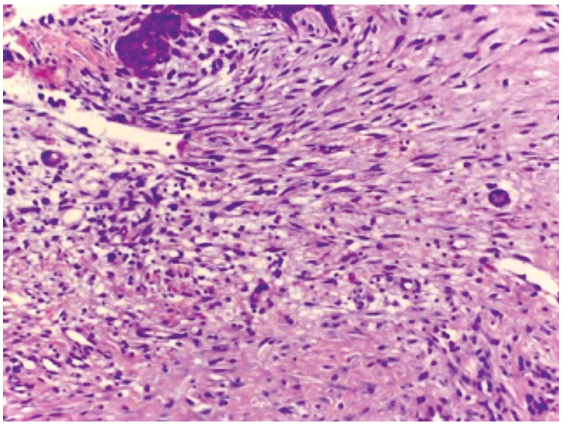

Fig. (6): Neovascularization and Fibroblastic activity in Group A.

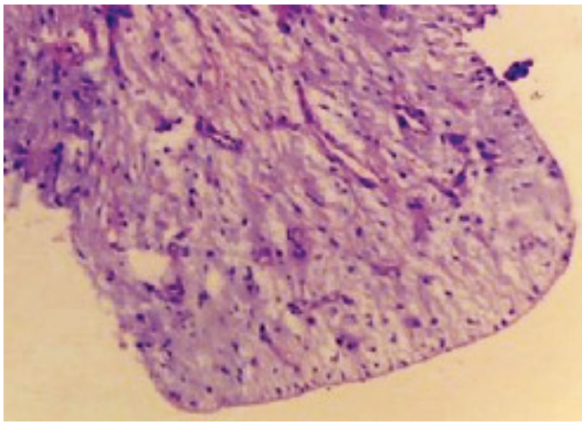

Fig. (7): Neovascularization and Fibroblastic activity in Group B.

Results

The mean age of the patients included in the current study was 41.1±8.92 for group B and 42.3±9.34 for group A. There was no statistically significant difference in comorbidities, etiological variables, or sociodemographic data between the two groups. Tables (1,2) revealed that while there was no statistically significant difference in the mean operative duration between the two groups (p=0.086), group B's hospital stay was noticeably longer than Group A's (p=0.012). Comparing patients who had traditional bolsters (Group B) with those who employed VAC (Group A), the reported post-operative sequelae of group B patients demonstrated statistically significant higher seroma and hematoma accumulation (p<0.001*). Group A had a significantly higher graft take group B patients (p<0.001*).

Histopathological evaluation in the current study revealed that patients who received VAC had more pronounced and statistically significant hyperkeratosis, pigmentation, neovascularization, collagen deposition, and fibroblastic activity (p<0.001*) (Table 3).

Table (1): Sociodemographic characteristics, comorbidities, and wound characteristics.

Variables	Group A VAC N=31	Group B Conventional Bolster N=31	p-value
Age:			
Mean ± SD	42.3±9.34	41.1±8.92	0.08
Sex: N (%)			
Males	19 (61.3%)	17 (54.8%)	0.072
Females	12 (38.7%)	14 (45.2%)	
Co morbidities: N (%)			
DM	3 (9.7%)	2 (6.5%)	0.07
Hypertension	2 (6.5%)	2 (6.5%)	1.00
Ischemic Heart Disease	1 (3.2%)	1 (3.2%)	1.00
Cause of the Raw area: N (%)			
Trauma	27 (87%)	25 (80.7%)	0.068
Burn	4 (13%)	6 (19.3%)	0.0.71
Site: N (%)			
Lower Limb	12 (38.7%)	14 (45.2%)	0.12
Abdomen and trunk	9 (29 %)	7 (22.6%)	0.09
Upper Limb	10 (32%)	10 (32%)	1.00

DM: Diabetes mellitus.

Regarding the visual result, Table (4) demonstrated a statistically significant difference between the two groups in the Patient and Observer Assessment scale. In the patient scar assessment scale, the VAC group had less discomfort, stiffness, itching, and abnormalities than Group B. Additionally, the observer assessment scale revealed improved pliability, thickness, vascularity, pigmentation, and relief in group A than in group B patients.

Table (2): Operative data and postoperative complications.

Variables	Group A VAC N=31	Group B Conventional Bolster N=31	*p*-value
Graft fixation on the wound bed:			
Sutures	12 (38.7%)	9 (29%)	0.081
Stables	19 (61.3%)	22 (71%)	0.067
Operative time	45.4±9.5	41.3±8.4	0.13
Hospital stay (in days)	1.9±95	2.7±1.6	0.012*
Graft size	16.2±4.6 X 14.6±5.9	17.8±5.8 X 12.8±4.2	0.89
Post operative complications:			
Pain (VAS)	3.6±1.2	4.8±1.6	0.041*
Infection	2 (6.5%)	5 (16.2)	<0.001*
Seroma	1 (3.2%)	6 (19.3%)	<0.001*
Graft take	92.6±6.4	83.2±4.8	<0.001*

VAS: Visual Analogue Scale.

Table (3): Histological Assessment of skin Biopsy in both Groups.

Variables	Group A VAC N=31	Group B Conventional Bolster N=31	*p*-value
Hyperkeratosis: N (%) of cases			
Mild	5 (16.2)	9 (29%)	<0.001*
Moderate	9 (29%)	13 (41.9)	
Marked	17 (54.8%)	9 (29%)	
Pigmentation: N (%) of cases			
Mild	8 (25.8)	14 (45.2%)	<0.001*
Moderate	6 (19.3%)	9 (29%)	
Marked	17 (54.8%)	8 (25.8)	
Neovascularization: N (%) of cases			
Mild	4 (13%)	9 (29%)	<0.001*
Moderate	7 (22.6%)	14 (45.2%)	
Marked	20 (64%)	8 (25.8)	
Collagen fibers deposition: N (%) of cases			
Mild	5 (16.2)	11 (35.5%)	<0.001*
Moderate	4 (13%)	3 (9.7%)	
Marked	22 (71%)	17 (54.8%)	
Fibroblastic activities: N (%) of cases			
Mild	7 (22.6%)	9 (29%)	<0.001*
Moderate	6 (19.3%)	12 (38.7%)	
Marked	18 (58%)	10 (32%)	

Table (4): Aesthetic Outcome Assessment by POSAS.

Patient Scar Assessment Scale (OSAS)				Observer Scar Assessment Scale (PSAS)			
Variable	Group A N=31	Group B N=31	*p*-value	Variable	Group A N=31	Group B N=31	*p*-value
Painful	1.8±1.3	3.1±1.1	<0.001*	Vascularity	2.1±1.1	4.1±1.2	<0.001*
Itching	2.1±0.9	2.9±1.3	<0.001*	Pigmentation	2.3±0.7	3.5±1	<0.001*
Color	2.1±1.1	2.9±1	<0.001*	Thickness	1.8±0.9	3.1±1.2	<0.001*
Stiffness	2.3±1.4	4.1±1.3	<0.001*	Relief	1.9±1	3.1±0.8	<0.001*
Scar thickness	2.1±0.6	3.1±0.8	<0.001*	Pliability	2.2±1.2	3.2±1.1	<0.001*
Scar irregularities	2.2±0.7	3.2±1.1	<0.001*	Surface area	2.3±1.1	3.7±1.2	<0.001*
Total patient	13.2±4.3	22.1±6.8	<0.001*	Total observer	14.1±3.8	24.6±5.7	<0.001*
Overall opinion	2.1±0.8	3.3±0.9	<0.001*	Overall opinion	2.2±0.78	3.9±1.2	<0.001*

Discussion

It has been reported that a variety of bolsters can hold STSGs to promote wound healing. Covering of STSG with A bolster with or without tie-over usually aims to improve graft adhesion and lower the risk of hemorrhage and hematoma in the surgical site **[9]**. The anatomic position and the surgeon's desire are determinant for choosing this technique according to a recent study by Kromka et al., **[10]**.

A large sample study by Waltzman et al., demonstrated that SFSGs can be securely fastened with VAC. Furthermore, they showed that VAC could be applied to places like the thighs, trunk, and other curved areas that were physically difficult to apply traditional bolster dressings **[11]**.

In numerous recent research, VAC has been mentioned as a potential substitute technique for these kinds of procedures. Korber et al., reported that the healing rate when using VAC was much higher than in the group receiving traditional dressings [12], which agrees with our results. In our study, the histopathological assessment showed that the elements indicating wound healing like Hyperkeratosis, pigmentation, neovascularization, collagen deposition and fibroblastic activity were more evident and statistically significant in patients who used VAC and this was reflected on the Graft take where it was significantly better in patients received Graft securing with VAC as a bolster.

Scherer et al., [13] and Nakamura et al., [14] revealed that the graft take rates of VAC and traditional bolster dressings were 96% and 89%, respectively and this was in line with our results. Our results showed the graft take was 94% and 83% in Group A and B respectively and this may be due to the evidence that VAC increases the graft take rate of SFSG by promoting revascularization and minimizing the buildup of seroma or exudate beneath the graft, [15]. As a result, using a VAC can improve PTSG outcomes [16].

Time and cost are crucial in surgical decisions [14]. There is higher short-term medical expenses during dressing are more in VAC's Patients When compared to standard bolster dressing, the overall long-term expenses may be lower due to the large reduction in postoperative treatment length, which could offset the rise in short-term costs [12].

A recent study [14] showed that VAC is superior to the conventional bolster approach in terms of skin graft survival and take. Similar results were seen in the current investigation, where the VAC system's simple application process resulted in evident more wound healing and graft take.

White et al., reported in their study minimal postoperative complications in VAC group when compared to the conventional dressing and this come in accordance with our study which shows that the VAC-based dressing strategy resulted in considerably lower levels of postoperative discomfort than the traditional bolster technique also during dressing changes, the wound bed may be physically disturbed by conventional wound dressings [17,18].

Gonzalez et al., [19] described evident lymphocytes and fibroblasts in the proliferative phase of wound healing. These findings are consistent with the current study's findings, which showed that fibroblasts were present in both groups but were more prevalent in Group A.

The current study's findings on collagen production and its conversion from fibrils into bundles in VAC patients were noteworthy, suggesting a better healing process and corroborated by the findings of Sabry et al., [8], who identified collagen synthesis as a key marker for wound healing.

The purpose of the (POSAS) is to assess different kinds of scars in a subjective manner. It is easier to use and offers insights from both the patient and the observers, making it a more beneficial tool than others. It produced valid and dependable results for scar evaluation [7,20]. In the current study, group A achieved an improvement in all items of POSAS and OSAS score when compared with the Group B and this is assumed to be due to the better healing process documented in patients received VAC as a bolster when compared with those received the conventional bolster.

Conclusion: VAC device is an effective method for securing split-thickness skin grafts in contoured wide raw area reconstruction with minimal postoperative complications, better healing and favorable aesthetic outcome.

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