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The Role of Negative Pressure Wound Therapy in Enhancing Skin Graft Integration and Survival

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Abstract **Background**: Skin grafting remains one of the routinely used surgical procedures in the plastic and reconstructive department of any hospital. Many conventional therapies have been used to provide adequate adherence of skin grafts to their bed. One of the emerging methods that has been used as an alternative method for securing skin grafts is NPWT. **Objective:** To evaluate the effectiveness of NPWT in increasing skin graft survival by increasing its integration to the recipient site. **Method:** A prospective study conducted between 2025 to 2026 that included 20 patients who are present with soft tissue loss of different sites and cause. Those patients were managed using STSG that was secured using NPWT. In all of our patients, the recipient site was clean and free from infection before operation. **Result:** Results: On postoperative day 5, 18/20 patients (90%) had complete graft take. This percentage is not a measure of the percentage of graft area surviving, but rather the percentage of patients with complete graft take. No infections, contact dermatitis was reported and no patients reported pain and discontinued NPWT. **Conclusion:** Patients with STSG secured with NPWT show complete recipient site coverage with no complications. NPWT provides a simple and secure method that increases skin graft take. However, the cost of NPWT should be taken into consideration.

Key Words Negative-Pressure Wound Therapy, Split-Thickness Skin Graft, Skin Graft Take, Graft Integration, Graft Survival, Wound Healing

INTRODUCTION

One of the fundamental techniques that is widely used to reconstruct skin defects is the use of split-thickness skin graft. There are many factors that determine skin graft take, including the status of the recipient site, thickness of the graft and coverage technique [1]. There are many methods that have been implemented in order to increase the take of skin grafts; these methods include the use of mesh skin graft, bolstering, fibrin glue, and platelet-rich plasma [2]. In 1997, Morykwas *et al.* [3] introduced the technique of negative-pressure wound therapy (NPWT) that based on using of close system that placed sub-atmosphere pressure over surface. This negative pressure can enhance blood supply, promote angiogenesis and stimulate for formation of healthy granulation tissue that improved wound healing [4]. Many recent studies had confirmed the effectiveness of NPWT of stabilization and increase intake of skin graft at recipient site as it provides uniform even pressure that aid in fixation of skin graft to the defect [5]. In this study, we evaluate the effectiveness of using NPWT as a dressing over skin graft to enhance its intake and survival rate.

PATIENTS AND METHOD

A prospective study that was conducted between January 2025 to April 2026 at Al-Shaheed Ghazi Al-Hariri Hospital / Department of Plastic and Reconstructive Surgery. In this study, a total of 20 patients who underwent split-thickness grafts for various tissue defects were evaluated at around postoperative day 5 for the effectiveness of using NPWT as a method of stabilising skin grafts.

We excluded those patients who had skin graft in face and neck, patient with active bleeding, defect with exposed neurovascular bundle], and patient who are not compliant with using of NPWT. Data collected from patients included age, sex, site of defect, aetiology of defect and outcome of skin graft. Also, any associated complication that could

occur with the use of NPWT was recorded. All wounds that were subjected to cover by skin graft were covered by healthy granulation tissue and had laboratory evidence of absence of active infection through using wound swab for culture and sensitivity.

Treatment Protocol

The operations are done either under general anaesthesia, regional anaesthesia, or local anaesthesia with sedation. After standard steps of preparation of both donor and recipient sites, the split-thickness skin graft is taken with an electric dermatome (usually from the thigh). The grafts are fenestrated with a No. 11 scalpel and fixed to the recipient site by either a stapler or 3/0 Nylon suture.

Then a soft silicone layer is directly applied to the skin graft, with caution that this silicone sheath does not overlap into the surrounding healthy skin. After that, a foam of polyurethane is applied on top of the silicone. The foam is covered by an adhesive transparent dressing to ensure an airtight seal. Then small cut hole is made in the transparent dressing through which catheter of NPWT is introduced and this catheter is attached to the pump system of NPWT.

The device is then set to produce continuous pressure that varies between 75 and 125 mmHg. The NPWT was kept for 5 days; then the NPWT was removed, and the graft was inspected. The graft intake was determined and present of complications, such as hematoma.

STSG loss was determined on the basis of the area of the recipient site where the graft did not adhere to the bed, which showed as a pale-colored area.

Report individual pressure settings in a table if no consistent selection rule was used. Do not infer device details, operating mode or pressure adjustments from the reported pressure range alone.

Postoperative Follow-up

Seroma or infection is evaluated. The graft, after removal of NPWT, is kept on a simple dressing that consists of antibiotic-impregnated gauze for 2 weeks. All patients are kept on regular follow-up visits that extend up to 6 months after operation.

RESULTS

A total of 20 patients (16 males, 4 female) with ages ranging from 7 to 65 years were included in this study. The cause of the defect was acute traumatic injury (11 cases), diabetic foot ulcer (4 cases), unstable scar (3 cases), and post-malignant resection defect (2 cases). The sites of skin graft were in the lower extremity (12 cases), abdomen (4 cases), chest (1 case), and forearm (3 cases). No donor site complication was noted in any of our patients.

None of our patients included in this study had interruption of their treatment due to severe pain, infection, or device failure. None of our patients had bleeding, local or systemic infection, contact dermatitis or severe pain during treatment.

Table 1: Demographic and Clinical Characteristics of the Study Patients (n = 20)

Variable	Category	Number (%)
Gender	Male	16 (80)
	Female	4 (20)
Age range (years)	7–65	20 (100)
Cause of skin defect	Acute traumatic injury	11 (55)
	Diabetic foot ulcer	4 (20)
	Unstable scar	3 (15)
	Post-malignant resection defect	2 (10)
Skin graft site	Lower extremity	12 (60)
	Abdomen	4 (20)
	Forearm	3 (15)
	Chest	1 (5)

Clinical inspection of the skin graft at day 5 revealed that the skin graft had complete take in 18 cases (90%); only two patients had partial skin graft loss. None of our patients had hematoma or seroma beneath the graft. During the follow-up period, which was extended to 6 months after operation, no complications were recorded. Two patients had hypertrophic scar at the edge of the wound and were subjected to intralesional steroid injection, and they are still on regular follow-up. As shown in Table 1.

DISCUSSION

Success of any skin graft procedure depends on the survival of the skin graft. Appropriate application of pressure on the skin graft is crucial to ensure its intake and survival. One of the most common methods that used to fix skin graft to recipient site is tie-over; however, the tie-over technique required surgical skill and it lack of appropriate tension on the skin graft which may lead to development of hematoma and skin graft dislocation from its bed which reduce its survival rate [5,6].

Fibrin glue has been described as an ideal material because of its human origin and provides firm adhesion in seconds or minutes. However, many problems could be associated with fibrin glue, including its high cost, limited adhesive strength when compared to mechanical fixation, potential for allergic reaction, and risk of transmission of hepatitis C virus and HIV [7].

Negative pressure wound therapy is not just for preparation of the wound bed but can be applied to be used as skin graft fixation. There are many mechanisms through which NPWT acts for fixation of the skin graft in bed and increases its survival rate [8]. These include immobilisation of split-thickness skin graft without a splint, equal pressure application on irregular or highly mobile areas, removal of exudate and bacteria, and improvement in tissue oxygenation. Also, NPWT provides a moist environment which prevents skin graft desiccation and enhances its survival [9].

Rapp *et al.* suggest that even after only 3 hours of application of NPWT on an isolated skin graft, low surface pressure leads to high FGF-2 fibroblast growth factor. FGF-2 is a known growth factor that is involved in cellular proliferation and neovascularisation within the dermis. Also, they noticed that NPWT acts to upregulate endothelin-1, a

gene associated with the release of VEGF and promotes neovascularization [10].

The first description of using NPWT as a bolster for STSG is dated 1998 by *et al.* and since that time it has become a standard method for securing split-thickness skin grafts. Encouraged by a plethora of studies that showed the efficacy and safety of using NPWT as a securement for STSG, we adapted to using it routinely in our department, and our results yielded very promising and satisfactory outcomes in terms of increased survival rate of STSG [11].

Using NPWT as a bolster dressing for STSG offers many advantages, including providing consistent graft fixation regardless of the bed of the graft. The shape of NPWT foam can be changed to match the recipient site of STSG so provide uniform pressure applied on STSG which enhance its intake.

Also, NPWT when used as a bolster for STSG it helps to remove or minimise seroma or hematoma formation. NPWT prevent shear forces that lead to dislodging the STSG from the bed. Also, NPWT is associated with less effort for nursing staff. NPWT, when used in our study it showed a reduction in reoperation and thus reflected in reduced cost and shorter hospital stay

Blume *et al.* [12] conducted a 10-year review of a total of 142 patients who had STSG after surgery. Their results show that patients who had NPWT are less likely to have secondary operations. Scherer *et al.* [13] in their study showed that the NPWT group had a 16% lower reoperation rate compared with the conventional rate. Although NPWT has been criticised due to its high cost, the high cost might be outweighed by benefits of improving skin graft survival and reducing complications. Ho *et al.* [14] reported that the cost of 5-day NPWT treatment was 400 dollars, while the cost of reoperation was 1450 dollars [15].

The most frequently used negative pressure of NPWT for optimising wound healing is 80–125 mmHg, which was adapted in our study. However, optimal negative pressure for skin graft stabilisation is not yet fully established [16]. Evangelista *et al.* [17]. compared different pressure values of 50, 75, 100, and 125 mmHg and showed high graft survival in all groups (more than 95%); however, those with less pressure showed less secondary skin reaction and less pain. Jiang *et al.* [18]. in their meta-analysis, showed improvement of skin graft take in negative pressure of 80 mmHg, and no improvement in skin graft take in negative pressure of 125 mmHg. This was consistent with a study led by Topaz [19].

NPWT, when used to secure STSG, has been shown to reduce operative time, as was seen by Incotomi *et al.* [20], as they were using only NPWT to secure skin graft without using any suture fixation. The mean surgical time for those patients who had NPWT without suturing was 31.5 minutes, while in the control group (graft fixed with tie-over bolster, securing with fibrin glue, or NPWT after sutures) it was 55.7 minutes [21].

In our study, we uncovered the dressing of NPWT and evaluated the skin graft at day 5. Hsiao *et al.* [16]. evaluated the skin also at day 7. In a prospective phase II study conducted by Nakamura *et al.* [22], they showed that when using NPWT as a dressing for STSG, the mean survival rate of the skin graft at day 5 and 10 was 98.7% and 96.5%, respectively [23].

Many studies compare the outcome of skin graft using conventional dressing with that of using NPWT. Nakamura *et al.* in their retrospective study revealed that patient who had fixed their skin graft by NPWT showed significant higher graft survival rate than tie-over method ($p<0.0012$). In addition, the time of operation in the NPWT group was shorter than in the tie-over group [24]. Schneider *et al.* [13] found in their study that patients who had NPWT as a bolster for their STSG necessitate re-grafting in only 1%, while those patients who had tie-over for their STSG required re-grafting in 5%

Yin *et al.* [1] conducted a systematic review and meta-analysis that included 653 patients. Their results showed that patients treated with NPWT had a significantly higher rate of skin graft intake compared to those patients who were treated by conventional methods.

Lilanos *et al.* [2] conducted a randomised, double-masked, controlled trial on 60 patients. They divided their patients into two groups: a group that received NPWT dressing for their skin graft, with a control group that did not receive NPWT. Their results showed that the NPWT group had 0.00 cm^2 median loss of the STSG versus 4.5 cm^2 in the control group. The median hospital stay for the NPWT group was 13.5 days, while in the control group, the median hospital stay was 17 days ($p<0.001$).

Skin graft fixation by NPWT had some limitations in terms of its cost and restriction of patient activity because the patient is connected to a tube. Also, NPWT cannot be used for areas that have inadequate space for placing the dressing.

What is interesting in our results is that they were not influenced by different variables such as the duration of the wound, cause of the wound, age of patients, and total grafted area.

CONCLUSION

The use of negative-pressure wound therapy (NPWT) as a secondary method for securing split-thickness skin grafts (STSGs) showed excellent results in terms of increasing skin-graft survival, reducing complications, and minimising the need for reoperation. The technique is simple and was associated with no complications. When used to secure skin grafts, NPWT reduced hospital stay. Therefore, it is recommended for routine use in patients undergoing STSG coverage.

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