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Effectiveness of negative pressure wound therapy as a fixator in split thickness skin graft applied diabetic patients: evaluation of 25 cases

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Abstract

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Objective: Microangiopathies expose diabetic patients to lower extremity wounds at certain stages of their lives. Split-thickness skin grafting (STSG) has an important place in the surgical treatment of such wounds. The aim of the present study is to evaluate the effects of negative pressure wound therapy (NPWT) on STSG survival.
Methods: A total of 25 diabetic patients (M = 20, F = 5) with acute or chronic lower extremity open wounds were included in the study. All patients underwent wound debridement under regional anesthesia. STSG was applied after wound debridement. NPWT was applied to STSG to increase graft survival.
Results: The hospitalization times of the patients ranged from 1 to 2 weeks. The mean follow-up period of the patients was 6 months. All wounds healed on the 14th postoperative day. There was no recurrence in the 6-month follow-up period.
Conclusion: We objectively demonstrated the positive effects of NPWT application on STSG and graft survival.
Keywords: Negative pressure wound therapy, Skin grafts, Diabetic patients

INTRODUCTION

Diabetic patients may encounter lower extremity wounds throughout their lives, which often become intractable and complicated for both the patient and the physician (Figure 1). Researchers have described various dressing treatments for treating lower extremity wounds in this patient group (1,2). Researchers have also proven the effectiveness of hyperbaric oxygen therapy (3). However, in most cases, surgical procedures are eventually required. Surgical methods frequently used include split-thickness skin grafts (STSG) and various local and distant flap applications following wound debridement (4).

A common technique for wound care is negative pressure wound therapy (NPWT). This approach involves applying NPWT sponges to the clean wound bed and connecting them to a device that provides continuous or intermittent negative pressure (5,6). NPWT keeps the wound bed clean and accelerates granulation and revascularization. Recent studies have investigated the protective use of NPWT in STSG-applied areas. Applying the sponge to the STSG area wraps the graft and secures it to the wound bed, thereby preventing graft shearing. In addition, it reduces the rates of seroma, hematoma, and infection, which are the biggest obstacles to STSG adaptation (7-9).

This study aimed to evaluate the efficacy of NPWT in patients with diabetic lower extremity wounds who underwent STSG retrospectively.

METHOD

The study included a total of 25 diabetic patients (20 males and five females) with acute or chronic open lower extremity wounds admitted to the Department of Plastic and Reconstructive Surgery of Batman State Hospital between November 2017 and August 2020. All informed consents

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were obtained. The study received approval from the Adana City Hospital Clinical Research Ethics Committee, bearing the date and decision number 2022/2321. We conducted this study adhering to the ethical standards outlined in the 1964 Declaration of Helsinki and its subsequent amendments. The study included patients with open lower extremity wounds and adequate blood supply to their lower extremities. We excluded patients with amputation indications and those who had undergone flap application. We collected samples for culture from all patients admitted to the clinic and arranged their treatment. All patients underwent wound debridement with regional anesthesia. Following wound debridement, we attached the removed STSG from the thigh to the defect using a stapler. We applied Chlorhexidine acetate-impregnated tulle grass (Bactigras®, Smith & Nephew Medical Ltd., Hull, England, UK) and NPWT (Renasys®, Smith & Nephew Medical Ltd., Hull, England, UK) to the STSG. We operated the NPWT at constant pressure and in continuous mode. We closed the graft donor site with chlorhexidine acetate-impregnated tulle grass. We opened and checked the wound site on the 3rd postoperative day, followed by a repeat application of NPWT. The postoperative 6th day saw the termination of NPWT and the continuation of the tulle grass dressing. The postoperative 14th day saw the opening of all areas.

Statistical Analysis

The research data was analyzed using the SPSS (Statistical Package for Social Sciences) for Windows 22.0 program (IBM Corp., Armonk, NY, USA). We evaluated the data using descriptive statistical methods such as number, percentage, mean, and standard deviation. We examined the kurtosis and skewness values to determine whether the research variables showed a normal distribution. The variables' kurtosis and skewness values are considered to have a normal distribution if they are between +1.5 and -1.5 (Tabachnick and Fidell) and +2.0 and -2.0 (George and Mallery). We determined that the variables displayed a normal distribution. We analyzed the data using parametric methods. The Chi-Square test analyzed differences between the proportions of categorical variables in independent groups. We used the t-test to compare quantitative, continuous data between two independent groups.

RESULTS

The mean age of the patients included in the study was 48.2 years (range: 41–58). There were 20 males and five females. The average hospitalization duration of the patients was 8.960±2.441 days (range: 7–14), and the mean follow-up period was six months. On the 3rd postoperative day, when we opened the NPWT, we observed minimal seroma formation at the border of the graft in 8 patients (32.0%). We applied NPWT after the drainage procedure. In those seroma formations, four patients (16.0%) experienced partial graft failure at the wound edges. The 6th postoperative day revealed that all grafts had adapted. We discontinued the NPWT therapy at this point. We continued the tulle grass dressing in the following days to protect the grafts. The average healing period of the patients is 9.920±2.139 days (range: 7–14) (Table 1). The 6-month follow-up period revealed no recurrent wound formation (Figure 2).

Table 1. Characteristics of patients with diabetic foot wounds

Parameter	(n)	(%)
Gender		
Male	20	80.0
Female	5	20.0
Seroma formation	8	32.0
Partial graft failure	4	16.0
Total graft failure	0	100
Long term reccurence	0	100
Durations (Mean±SD)		
Healing period (day)	9.92±2.13	
Hospitalization duration (day)	8.96±2.44	

Figure 1. Patient's preoperative view

Figure 2. Patient's postoperative view. The graft fully conforms to the wound bed

There is a significant difference in patients with seroma formation depending on the occurrence of partial graft failure ($\chi 2 = 10.19$; $p = 0.006$) (Table 2).The healing period varies significantly depending on the seroma formation status of the patients ($t(23) = 6.472$; $p = 0.000$).

The healing period of seroma formation positive patients (X=12.380) was found to be higher than that of seroma formation negative patients (X=8.760). Hospitalization duration varies significantly depending on the seroma

formation status of the patients (t(23) = 5.688; p = 0.003). Hospitalization duration of seroma formation positive patients ($\bar{x}$=11.620) and seroma formation negative patients' hospitalization duration ($\bar{x}$=7.710) were found to be high (Table 3).

Table 2. In those seroma formations, four patients experienced partial graft failure at the wound edges

Parameter n		Positive		Negative		Total		p value
		%	n	%	n	%		
Partial Graft Failure	Positive	4	%50.0	0	%0.0	4	%16.0	χ^2=10.119 p=0.006
	Negative	4	%50.0	17	%100.0	21	%84.0	

Table 3. Hospitalization duration and healing period of patients with diabetic foot wounds who developed seroma formation

Parameter	Positive (n=8)		Negative (n=17)		t	p value
	Mean	SD	Mean	SD		
Healing Period	12.380	1.506	8.760	1.200	6.472	<0.001
Hospitalization Duration	11.620	2.560	7.710	0.920	5.688	0.003

DISCUSSION

The concept of angiogenesis and healing with mechanical forces dates back to 1911 (10). After World War II, the 'envelope technique' was used (11). The NPWT technique, on the other hand, gained popularity in 1997 after Argenta and Morykwas' study of a new method for wound control and treatment (5). Recent years have seen a comparative investigation into the effectiveness of wound healing interventions for chronic foot ulcers in diabetes (6).

A sponge, a connection apparatus, and a device that produces negative pressure make up NPWT. For the last two decades, its use in managing open wounds has been widespread. Primarily, it speeds up the granulation and revascularization of open wounds, while also reducing the risk of infection development. Subsequent studies have suggested that NPWT application on the graft may be beneficial after STSG, yielding successful results (7, 12). More research supported these findings and found that NPWT treatment on STSG stopped graft mobilization and the formation of seroma and/or hematoma, which increased graft survival (13–15). The present study evaluated this basic principle. We applied NPWT to the graft as a bolster dressing after debridement and STSG application in 25 patients with open lower extremity wounds that did not require flap application.

Seroma and hematoma formation can be considered the leading causes of graft loss. Similarly, previous practices of applying dressings after graft adaptation could lead to the mobilization and shifting of the graft. Moreover, the mobilization of the patients may also trigger the mobilization of the grafts. Therefore, immobilization is required, especially after STSG applications to the extremities (7, 12). In this study, the application of NPWT on STSG eliminated the need for immobilization, so we did not use splints after the treatment. We opened the NPWTs on the 3rd postoperative day and evaluated the graft survival. In diabetic patients, total or near-total graft loss can often occur due to impaired wound healing. In 8 patients, we observed graft-wound border-located minimal seroma formation, which regressed following drainage and re-application of NPWT, yielding satisfactory results in all patients. It is very possible for partial graft loss to occur at the wound margins. Often, this area serves as the junction point between the graft and the wound lips, where disruption of wound-graft contact can occasionally occur. However, only 4 of in this patients experienced partial graft loss at the wound border line, and these areas became epithelialized in a short time.

As a result of microcirculation defects in diabetic patients, acute or chronic wounds occur in the lower extremities. These wounds cause serious labor and economic losses. Previous wound care practices for such patients involved frequent dressings with various materials over an extended period (12). Today, almost all wound care clinics use the NPWT application, which has become widespread (16). In fact, home health agencies in developed countries have introduced disposable negative-pressure wound therapy devices in recent years (17). In a 41-patient cohort study, Sun et al. demonstrated the effectiveness of a new and low-cost negative pressure wound therapy (LC-NPWT) in the treatment of diabetic foot ulcers (DFUs) with Wagner grade 3 DFUs (18) as an alternative to this. Negative pressure wound therapy, with novel techniques, has brought new perspectives to the treatment of not only diabetic foot wounds but also almost all surgical wound infections (19). Besides, Driver et al. reported that the NPWT application is cost-effective for these patients who require long-term treatment (1). Of course, it would be incomplete to evaluate this approach only in terms of cost-effectiveness, since frequent dressing for these patients requires serious healthcare worker effort. Changing the dressing every three days after NPWT application suffices, thereby reducing the effort required for wound care. Diabetes is a disease with multiple systemic components. Hospitalization often focuses solely on wound management for these patients, but other systemic conditions may also surface during this period. During hospital care for such patients, it is necessary to collaborate with other disciplines, such as infectious diseases and microbiology specialists, to plan appropriate antibiotic treatments according to the culture results taken before treatment interventions. Similarly, it is essential to cooperate with the endocrinology department for blood sugar regulation. In short, multidisciplinary work is required to manage wounds in diabetic patients.

Limitations of the study

A relative limitation of this clinical study is the use of a medium-sized patient series.

CONCLUSION

After applying STSG, NPWT significantly increases graft survival. NPWT implementation is cost-effective. A multidisciplinary approach is essential for diabetic lower extremity wounds.

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Peer-Review

Both externally and internally peer reviewed.

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

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Ethical Declaration

Ethical permission was obtained from the University of Health Sciences, Adana City Hospital Clinical / Human Research Ethics Committee for this study with date 2022 and number 2321, and Helsinki Declaration rules were followed to conduct this study.

Authorship Contributions

Concept: FC, EK, Design: FC, EK, Supervising: FC, EK and MD, Financing and equipment: FC, EK, Data collection and entry: FC, EK, Analysis and interpretation: FC, EK and MD, Literature search: FC, EK and MD, Writing: FC, EK and MD, Critical review: FC, EK and MD.

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