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THE OUTCOMES OF LOWER EXTREMITY WOUNDS USING SKIN GRAFT COMBINED WITH NEGATIVE PRESSURE WOUND THERAPY ON THE SKIN GRAFTS

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ABSTRACT

Background: *Skin graft fixation is crucial for the success of skin grafting procedures. Negative pressure wound therapy can be employed to secure the skin graft, ensuring graft adherence and preventing fluid accumulation beneath the graft bed with continuous and uniform pressure. Additionally, negative pressure wound therapy eliminates the need for immobilizing splints, reducing patient discomfort associated with splint immobilization.* ***Objectives:*** *To assess the outcomes of lower extremity wounds using skin graft combined negative pressure wound therapy on the skin grafts.* ***Materials and methods:*** *A descriptive cross-sectional study was conducted on 32 patients with lower extremity soft tissue defects treated with skin graft combined negative pressure wound therapy on the skin grafts.* ***Results:*** *The ratio of male and female patients was 68.8% and 31.2%, respectively. For ages, the average age was 50.00 ± 15.37, the highest was 77 and the smallest was 18. About the underlying diseases, we recorded that diabetes was accounted for 34.4%, 12.5% of patients had gout and 6.3% had lower limb vascular disease. Using negative pressure wound therapy applied to mesh skin graft after five days of dressing change: good adherence is 81.3 %, moderate adherence is 15.6%. After 1 month, 93.7% skin grafts resulted in good wound coverage, 6.3% skin grafts resulted in moderate wound coverage.* ***Conclusions:*** *Skin grafts combined with negative pressure vacuums have given good results and effective treatments.*

Keywords: *Skin graft, negative pressure wound therapy, lower extremity wounds.*

I. INTRODUCTION

Skin grafts are a mainstay for reconstructing soft tissue defects following burns, trauma, or surgical intervention. A critical determinant of graft success hinges on achieving secure fixation to the underlying wound bed. Traditionally, elastic dressings or bolster applications with tension sutures are employed to create intimate graft-to-bed contact. Inadequate fixation predisposes the graft to complications such as hematoma formation, infectious compromise, graft movement, and even complete graft rejection, all significantly compromising graft take [1]. The current standard of care utilizes bolster dressings in conjunction with external splints to restrict mobility and achieve effective graft fixation [2]. However, these splints can be a source of significant discomfort and pain for the patient. Negative pressure wound therapy (NPWT), also known as vacuum-assisted closure (VAC), was initially introduced for managing various wounds through the application of controlled suction. NPWT can be employed to secure the skin graft, ensuring graft adherence and

preventing fluid accumulation beneath the graft bed with continuous and uniform pressure [3], [4]. Additionally, NPWT eliminates the need for immobilizing splints, reducing patient discomfort associated with splint immobilization [5].

NPWT has been implemented in Vietnam for wound treatment, and some centers have also applied it to skin graft sites. However, there is a lack of research and reports in the Mekong Delta region in general and Can Tho in particular. Therefore, the purpose of this study was to assess outcomes of lower extremity wounds using skin grafts combined with negative pressure wound therapy on the skin grafts.

II. MATERIALS AND METHODS

2.1. Materials

All patients who underwent skin grafting, treatment, and follow-up at Can Tho Central General Hospital from June 2022 to January 2024.

- **Inclusion criteria:** List of patients indicated for skin graft surgery at Can Tho Central General Hospital.

- **Exclusion criteria:**

+ Patients contraindicated for surgery

+ Patient with coagulopathy

+ Patients who declined to participate in the study.

2.2. Methods

- **Study design:** Descriptive cross-sectional study.

- **Sample size:** 32 patients.

- **Sampling method:** Convenience random sampling.

- **Research content:**

+ Patients were followed from hospital admission to discharge and at 1 month postoperatively.

+ Patient characteristics included age, gender, comorbidities, cause of skin loss, wound size.

+ Bacterial cultures: a sterile cotton-tipped applicator was applied deep into the wounds and was rotated over 1 cm2 area in the deep tissue of wound and then it was kept in the culture tube. The culture and sensitivity reports were collected usually three days afterward. The qualitative method of antibiotic disc diffusion in agar (Kirby Bauer) is often applied to determine the susceptibility of bacteria to different antibiotics.

+ Evaluation of skin graft results:

Evaluation of skin graft results five days after the first dressing change: Good: The skin graft is well-adherent, pink, and covers over 90% of the skin graft surface area. No additional skin grafting is required. Moderate: The skin graft is well-adherent, pink, and covers 50-70% of the skin graft surface area. However, there is patchy necrosis of the skin graft that can self-epithelialize and does not require additional skin grafting. Poor: The skin graft has poor adherence, and more than 30% of the skin graft surface area is necrotic. Additional skin grafting is required.

Evaluation of skin graft results one month after surgery: Good wound healing coverage: The grafted skin has successfully healed the wound over 100% of the covered surface area, with normal scar healing at the graft margins. Moderate wound healing coverage: The grafted skin has healed 70-90% of the covered surface area, with abnormal

scar healing in the skin graft area. Poor wound healing coverage: More than 30% of the covered surface area of the grafted skin has necrotized, requiring additional skin grafting.

- **Data analysis:** Data was evaluated based on the descriptive statistics. Data was then put to statistical analysis using SPSS 25.0. The frequency and percentage of qualitative variables were used to describe them. If the variable had a normal distribution, the means and standard deviation were used to describe it; otherwise, the medians, maximum value, and minimum value were used to describe it. For categorical variables, the chi-square test with Fisher's exact test as a correction will be used, and for continuous variables, the t-test will be used. Variables that are significantly related to treatment outcomes ($p < 0.05$ through univariate analysis).

III. RESULTS

3.1. Patient characteristics

Table 1. A number of comorbidities in the study subjects

Comorbidities	No. of patient	Percentage (%)
Lower extremity vascular disease	2	6.3
Gout	4	12.5
Diabetes	11	34.4
None	15	46.8
Total	32	100

The study recorded a mean patient age of 50.00 ± 15.37 years, with the oldest patient being 77 years old and the youngest 18 years old. In terms of gender, the male to female ratio was 2:1, with 22 male patients (68.8%) and 10 female patients (31.2%). Table 1 presented the patient comorbidities, with the highest proportion (46.8%) having no accompanying medical conditions, and the lowest proportion (6.3%) having lower extremity vascular disease.

Table 2. Causes of skin loss and wound size

Causes of skin loss and wound size		No. of patient	Percentage (%)
Causes of skin loss	Due to old wound	14	43.8
	Post-operative	17	53.1
	Due to new wound	1	3.1
Wound size (cm^2)	<200 cm^2	16	50
	200-500 cm^2	13	40.6
	>500 cm^2	3	9.4

Table 2 shows the causes of skin loss and wound size. Skin loss due to post-operative accounted for the highest proportion (53.1%), while new wound had the lowest incidence (3.1%). Regarding wound size, the majority were in the <200 cm^2 and 200-500 cm^2 categories, at 50% and 40.6% respectively. The smallest wound area is 50.7 cm^2 and the largest wound area is 523.6 cm^2.

3.2. Frequency distribution of pathogenic bacteria

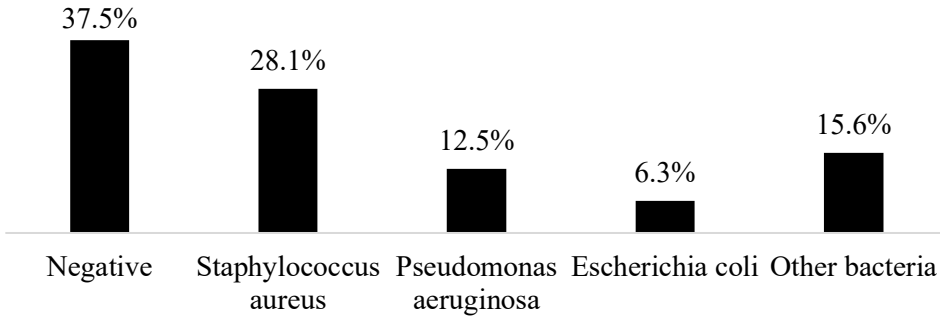

Figure 1. Frequency distribution of patients according to type of pathogenic bacteria.

The bacterial culture results were predominantly positive at 62.5%, while negative cultures accounted for 37.5%. Of the positive cultures, the study found that *Staphylococcus* was the most commonly isolated pathogen, comprising 28.1% of the samples (Fig. 1).

3.3. Skin graft results

Table 3. Graft adherence results after 5 days (first dressing change)

Graft adherence results after 5 days	No. of patient	Percentage (%)
Good	26	81.3
Moderate	5	15.6
Poor	1	3.1
Total	32	100

After 5 days (at the first dressing change), 26 out of 32 skin grafts (81.3%) showed good adherence, 5 out of 32 skin grafts (15.6%) showed moderate adherence and 1 out of 32 skin grafts (3.1%) showed poor adherence.

Table 4. Wound coverage results 1 month after skin grafting surgery

Wound coverage results 1 month		Good		Moderate		Poor	
		n	%	n	%	n	%
Comorbidities	Lower extremity vascular disease	-	-	2	6.3	-	-
	Gout	4	12.5	-	-	-	-
	Diabetes	11	34.4	-	-	-	-
	None	15	46.8	-	-	-	-
Causes of skin loss	Due to old wound	12	37.5	2	6.3	-	-
	Post-operative	17	53.1	-	-	-	-
	Due to new wound	1	3.1	-	-	-	-

After 1 month, 30 out of 32 skin grafts (93.7%) resulted in good wound coverage, 2 out of 32 skin grafts (6.3%) resulted in moderate wound coverage and no skin grafts resulted in poor wound coverage. There were 2 cases with moderate wound coverage results due to concomitant lower extremity vascular disease. Patients with diabetes mellitus and gout had complete wound healing coverage, this difference was significant compared to the group with concomitant lower extremity vascular disease ($p<0.05$). Good wound coverage was highest in the post-operative and due to new wound group, accounting for 100%, with no difference between the 3 groups ($p>0.05$).

IV. DISCUSSION

4.1. Patient characteristics

Gender and age

The observed gender distribution in our study revealed a significant predominance of males, consistent with existing research. A study by Pyo SB *et al.* [5] found a similar trend, with males being affected at a rate 1.5 times higher than females. This suggests a potential underlying biological or environmental factor contributing to this gender disparity.

The average age of participants in our study was 50.00 ± 15.37 years, comparable to the 48.15 ± 25.49 years reported by Dong-Hun Lee *et al.* [6]. This indicates that the condition may manifest across a wide range of ages.

The consistency of our findings with previous research in both gender distribution and age demographics strengthens the generalizability of our results. Further investigation into the mechanisms behind gender-specific susceptibility and age of onset is warranted to develop targeted interventions and improve outcomes for both male and female patients.

Comorbidities

The prevalence of diabetes mellitus among patients in our study was 34.4%, notably higher than that observed in previous research. Specifically, Dong-Hun Lee *et al.* [6] reported a prevalence of 28%, while Pyo SB *et al.* [5] reported 19.8%.

This discrepancy in diabetes prevalence rates may be attributed to several factors, including differences in study populations, diagnostic criteria, or other underlying health conditions. For example, the study by Dong-Hun Lee *et al.* [6] also reported a prevalence of 4% for peripheral vascular disease, a condition known to be associated with diabetes.

Causes of skin loss

The study results indicate that 43.8% of skin loss is due to old wounds and 53.1% to post-operative complications. This aligns with Sarovath's [7] findings of 42.85% and 35.71% for old wounds and post-operative causes respectively.

While both studies highlight the significant role of post-operative factors in skin loss, the study results suggest a slightly higher percentage compared to Sarovath's research. This minor difference may be due to variations in sample size, methodology, or patient characteristics.

Overall, both studies emphasize the importance of addressing both old wounds and post-operative care to prevent and manage skin loss effectively.

4.2. Frequency distribution of pathogenic bacteria

In our study, which focused on the bacterial distribution of the wound before skin grafting, we found a higher rate of positive bacterial cultures (62.5%) compared to negative cultures (37.5%). This indicates a significant presence of bacterial contamination in wounds prior to grafting. Among the isolated bacteria, *Staphylococcus aureus* and *Pseudomonas aeruginosa* were the most prevalent, highlighting their potential role in wound infections after skin grafting procedures. Interestingly, our findings differ slightly from those of Vinodkumar C.S [8], who reported a higher prevalence of *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* in addition to *Staphylococcus aureus*. This variation could be attributed to differences in study populations, geographical locations, or specific healthcare settings. It emphasizes the importance of understanding the local microbial landscape to tailor infection control and treatment strategies effectively. Furthermore, our study sheds light on the distribution of other bacterial species in pre-grafting wound infections. While

Staphylococcus aureus and *Pseudomonas aeruginosa* were the most common, a variety of other bacteria were also isolated, albeit at lower frequencies. This highlights the complexity of wound microbiomes and the need for comprehensive microbial assessments to guide appropriate antibiotic therapy and infection prevention measures.

4.3. Skin graft results

Graft adherence results after 5 days (first dressing change)

Our study demonstrated positive outcomes with skin grafting and negative pressure wound therapy (NPWT), with 81.3% showing good adhesion after 5 days. While slightly lower than the 90-100% good adhesion reported by Soravath [7], our results still indicate a high success rate. Notably, when combining good and moderate adhesion, we found a 96.9% success rate.

These findings align with Dong-Hun Lee's [6] report, highlighting the benefits of NPWT for skin grafts, including good adhesion, faster healing, and reduced complications like hematoma, seroma, or necrosis.

Overall, our research, along with previous studies, supports the efficacy of NPWT in improving skin graft outcomes, showcasing its potential as a valuable tool in wound care.

Wound coverage results 1 month after skin grafting surgery

93.7% of patients had good wound coverage outcomes after 1 month of skin grafting, while 2 patients had moderate wound coverage and underwent spontaneous epithelialization of the wound after one month due to concomitant lower extremity vascular disease. According to Soravath [7] and Chiummariello S [9], 100% had good results and complete wound coverage.

Wound coverage outcomes and comorbidities after 1 month of skin grafting

After 1 month, patients with diabetes mellitus and gout had good wound coverage outcomes, accounting for 46.9%. There was a 6.3% rate of moderate outcomes in patients with lower extremity vascular disease, while the remaining 46.8% of patients without comorbidities also had good outcomes. These results suggest that the combination of negative pressure wound therapy (NPWT) on skin grafts is effective for patients with comorbidities that typically impede wound healing with skin loss (e.g., diabetes mellitus, lower extremity vascular disease).

According to Prashant Moon [10], patients with comorbidities (diabetes mellitus, lower extremity vascular disease, etc.) will have difficulty achieving wound healing. For this group of patients, skin grafting combined with negative pressure wound therapy (NPWT) can increase graft adherence and reduce hospital stay.

Wound coverage outcomes and skin loss after 1 month of skin grafting

Through the research results, we recorded a high proportion of good outcomes in the group with skin loss after surgery, which had undergone negative pressure wound therapy (NPWT) to prepare the graft bed, contributing to facilitating the subsequent skin grafting process. All cases in the study showed good results with a high proportion, which is consistent with the reports of other authors.

V. CONCLUSION

The study recorded positive outcomes of NPWT when monitored at 5 days and 1-month post-treatment. The use of negative pressure wound therapy on skin grafts ensured good graft take without impeding limb mobility, prevented fluid accumulation under the

graft, and reduced the time spent caring for the grafted area and shortening the healing time of the wound.

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