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Comparative Study of Negative Pressure Wound Therapy and Silver-releasing Foam Dressings in the Management of Diabetic Foot Ulcers

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ABSTRACT

Introduction: Diabetic foot ulcers (DFUs) can be defined as a major complication of Diabetes Mellitus that often results in infections and amputations. Wound care is of outmost importance, for with appropriate management, further problems do not occur and the wound heals. Negative Pressure Wound Therapy (NPWT) and silver-releasing foam dressings are two of the modalities of management of DFUs. **Objectives:** This proposal sought to determine the effectiveness of NPWT and silver-releasing foam dressings in the healing of diabetic foot ulcers and in the reduction of ulcer size over a six-week period. **Materials and Methods:** This study was quasi-experimental, and 120 patients across the PNS Hafeez Hospital in Islamabad were selected. Patients were randomly allocated to either the NPWT group or the silver-releasing foam dressing group. They include the time taken for the wounds to heal and the reduction of the size of the ulcer over a period of six weeks. **Results:** NPWT achieved a faster healing time in the study period of 19.7 days and had a greater percentage of mean ulcer area reduction, 38.7%, than the silver-releasing foam dressing of 24.9 days and 26.5%, respectively. **Conclusion:** This study confirms that Negative Pressure Wound Therapy (NPWT) is more effective than silver-releasing foam dressings in reducing DFU size and accelerating healing. NPWT promotes faster re-epithelialization due to its vacuum effect. However, drug-releasing foam dressings remain beneficial, especially when NPWT is unavailable. Treatment choice should consider patient needs and resources. Further research with larger samples and longer observation is needed to validate these findings and assess long-term impacts.

INTRODUCTION

Diabetic foot ulcers (DFUs) are one of the major and serious diabetic microvascular complications that affect the patient's health and his/her quality of life. Diabetes mellitus, a chronic metabolic disease resulting from the aforementioned decreased ability of insulin to open the cell's doors to glucose or reduced glucose uptake by body tissues, is prevalent in millions of people. According to the sources from the International Diabetes Federation, currently, more than 425 million people are affected by diabetes, and it is estimated that this number will go up to 642 million in the year 2040. Diabetes is now more frequently diagnosed in LMICs, and Pakistan has the highest burden of such an ailment in the third position globally. Diabetic patient with long-term hyperglycemia has various complications, such as peripheral neuropathy, impaired wound healing, and peripheral vascular disease, making it difficult to treat foot ulcers and increasing infection rates (1).

DFUs are considered dangerous as it is challenging to treat, which may result in high death rates and limb amputations. Moreover, it can be postulated that 15-20% of diabetic patients develops foot ulcers at some time in their lives, and 50% of these ulcers become infected, resulting in a high incidence of amputation in the diabetic population. There are few treatment options for individuals with DFUs other than managing their glucose levels, effectively caring for the ulcer, and, at times, surgery. The use of specialized wound dressings is essential in the management of these ulcers, where dressings like Negative Pressure Wound Therapy (NPWT) and silver-releasing foam dressings (Ag dressings) have been proven to enhance the process of wound healing and reduce the development of infections (2, 3).

Negative Pressure Wound Therapy (NPWT) is the process that utilizes negative pressure to treat the wound through the use of a vacuum-assisted device. This kind

of therapy aids in cleaning the wound, preventing swelling, and promoting an increase in blood flow to the area that has been affected and healing. NPWT has also been established as effective in the management of DFUs as it promotes granulation tissue formation by providing the appropriate conditions for tissue regeneration (4). However, as discussed earlier, NPWT is quite effective, though its use is restricted to healthcare facilities because it involves the use of specific medical equipment that needs to be constantly calibrated.

Otherwise, there is silver-releasing foam dressings and the efficiency of this type of dressings is caused because it is an antimicrobial one and it is effective when treating chronic wounds. Silver ions, when they are released from these dressings, have a bacteriostatic effect and they also reduce the inflammation process of the wounded site and hence promote healing (5, 6). Silver-containing antiseptic dressings, including Ag foam, have been employed for many years in wound care, especially for the management of diabetic foot ulcers. The dressings, apart from helping maintain a moist healing environment, also help decrease the density of bacteria in the wound, which is a key factor in minimizing infection and enhancing the healing process (7).

The purpose of the present trial is to compare the outcomes of NPWT and silver-releasing foam dressings in patients with DFUs regarding time to healing. This comparison is significant since it alerts the reader to the fact that while each treatment comes with certain advantages, one also has potential problems equalling the other. Even though NPWT is proven to be effective in wound reduction and the establishment of new granulation tissue, it is time-consuming and involves expensive equipment, which hinders the general application of the therapy. On the other hand, silver-releasing foam dressings are more affordable and easier to use, but comparative and superior healing outcomes compared to NPWT remain an area of research interest (8, 9). Therefore, this research play a role in identifying proven information to help clinicians in the management of choice of wound care modality for diabetic patients with the view of minimizing complications such as amputations and enhancing the healing of DFU patients.

Through assessments of the healing time and the size of the ulcers treated, this paper is helpful in providing comparative results on the efficacy of NPWT and Ag dressings in treating DFUs. This research may also contribute to wound healing optimization, using the various approaches if they have to be used in the future depending on the situational analysis of the patient and the available resources in various settings (10, 11). In view of the increasing global burden of diabetes, especially in countries like Pakistan, the results of this study may go a long way in containing the cost of healthcare and enhancing the quality of life of diabetic patients with foot ulcers (12, 13). Further, as earlier noted, one of the major challenges that accompany the ever-increasing incidence of diabetes is its complications, specifically diabetic foot ulcers. New technologies like NPWT and silver-releasing foam dressings seem to provide new options, but further study is justified to define the optimal treatment method. This study sought to achieve this objective by comparing the two common modalities used in the management of DFUs to come up with the best practices that helps to enhance patient outcomes.

Objective

The purpose of present study is to assess comparative effectiveness of the Negative Pressure Wound Therapy (NPWT) and silver-releasing foam dressings for diabetic foot ulcers over six weeks healing period.

MATERIALS AND METHODS

Study Design

This research is proposed to be a Randomised Controlled Trial (RCT) with objectives set for the purpose of determining the efficacy of Negative Pressure Wound Therapy (NPWT) and Silver-releasing foam dressings to treat diabetic foot ulcers (DFUs).

Study Setting

This research was done at the Department of Surgery at Hafeez Hospital in Islamabad, which is associated with the College of Physicians-Surgeons Pakistan.

Duration of the Study

The study was conducted over a period of one year, starting from August 2023 to August 2024.

Inclusion Criteria

Subjects who was included are patients between the ages of 20 and 70 years diagnosed with diabetes mellitus, which presented a Grade 1 or 2 diabetic foot ulcer based on Wagner's classification. These inclusion criteria shall include a patient's HbA1c being equal to or higher than 6.5 and ulcers being in the moderate size range of 1x1 cm^2 to 3x3 cm^2. For this reason, only those respondents who consent to participate in the study was included.

Exclusion Criteria

Specifically, those patients whose HbA1c <6.5%, BMI >30, or with any of the following comorbidity, malignancy, tuberculosis, rheumatoid arthritis, or osteomyelitis was excluded. Moreover, patients with venous ulcers or any non-diabetic foot ulcer was considered for the study, as agreed upon by the steering committee.

METHODS

Recruitment of subjects into the study involved convenience sampling of patients who shall fulfill the inclusion criteria after providing informed consent. These participants was randomly divided into two

groups, with one assigned to use the negative pressure wound therapy (NPWT). At the same time, the other was the silver-releasing foam dressing. The surgical interventions performed included wound debridement and cleaning with sterile water in both groups. For Group A, NPWT was applied with a VAC system whereby the wound was cleared periodically by applying a suction pressure of between -50 and - 125 mbar during the healing process. Silver-releasing foam dressings in group B shall be applied on the wound bed to exhibit microbial suppression and promote wound healing through a moist environment. Surgical dressings was changed after three days depending on the amount of exudate present on the dressing. The first objective was measured by healing time, days to heal after contracting the wound, the extent of healing, and the size of the ulcer. One of the requirements is to have both groups to be monitored for six weeks to compare their healing process.

RESULTS

The results obtained in the present study were compared to determine the effectiveness of negative pressure wound therapy (NPWT) and the efficacy of silver-releasing foam dressings (Ag dressings) in the wound healing of individuals. Some of the following are commonly used as assessment tools to evaluate the merits of treatment: the number of days taken to heal the wound and the size of the ulcer recovered within the six-week timetable.

Table 1

Baseline Characteristics of Study Participants

Parameter	Group A (NPWT)	Group B (Ag Dressings)	Total
Number of Patients	60	60	120
Age (mean ± SD)	55.4 ± 8.6	56.1 ± 7.9	55.8 ± 8.2
Gender (Male/Female)	35/25	37/23	72/48
HbA1c (%) (mean ± SD)	8.2 ± 1.3	8.0 ± 1.2	8.1 ± 1.25
Ulcer Size (cm^2) (mean ± SD)	2.3 ± 0.7	2.4 ± 0.8	2.35 ± 0.75

Table 2

Wound Healing Time (Days)

Group	Mean Healing Time (Days)	Standard Deviation	Range
Group A (NPWT)	19.7	7.5	14-28
Group B (Ag Dressings)	24.9	9.4	18-35

The healing of the wound was most effective in Group A (NPWT), where the mean healing days were 19.7 with a standard deviation of 7.5 days. In this regard, wound healing outcomes were group B (Ag dressings) with an observation of 24.9 days of mean and SD 9.4 days. The Dow Company conducted comparative research between NPWT and the control group to evaluate the healing time, which gave considerable outcomes that suggested that NPWT healed faster.

Table 3

Reduction in Ulcer Size (% Change)

Group	Mean Reduction in Ulcer Size (%)	Standard Deviation	Range
Group A (NPWT)	38.7%	12.6	25-52%
Group B (Ag Dressings)	26.5%	10.9	15-40%

Moreover, on average, in the NPWT group, the size of the ulcers was reduced as compared to the group using Ag dressing, up to a percentage of 38.7%, as compared to 26.5%. The implication of the above findings is that NPWT not only hastened the rate of healing but also the size of the ulcers. The data collected were then analyzed using social package statistics and sciences code. The analysis of variance test was done using the healing time, size of the ulcer, and the group to determine if there was a significant difference. The analysis also revealed that there was a highly significant difference in the healing periods ($p < 0.05$), and NPWT recorded the best results in the healing rates. The size of the ulcer was also reduced more in the NPWT group as compared with the Ag dressing group ($p < 0.05$).

DISCUSSION

Diabetic foot ulcer (DFU) is a challenging situation in clinical practice because wound healing is particularly demanding in diabetic patients. NPWT has been used commonly as an off-loading modality, and Ag dressings include silver alginate dressings. This has led to this study in order to compare and establish the efficiency of these two treatments of duration taken for the ulcer to headlands and the size of the ulcer after a particular period of treatment. The outcomes also supported that NPWT had resulted in a better enhancement of wound healing rate and ulcer surface area reduction when compared with silver-releasing foam dressing, as found out in other studies. The result of this study indicates that NPWT, the mean healing time, was lower compared with that of Ag dressings, taking 19.7 days on average compared to the 24.9 days taken on average by Ag dressing. This is in concurrence with past studies that have shown that NPWT facilitates wound healing through the stimulation of blood circulation, reduction in swelling, and the development of granulation tissue. By doing this, negative pressure promotes tissue regeneration by promoting a conducive healing environment by removing exudate and improving tissue oxygenation, which are essential markers of healing (1). Similarly, the suction ability of the NPWT also contributes toward minimizing bacterial colonization and enhances the rate of wound healing (2).

However, as mentioned earlier, the process of action of silver–releasing foam dressings is quite different as it

involves the release of silver ions with antimicrobial properties. Silver ions have been shown to have bacteriostatic properties, thus decreasing the bacterial presence in wounds to avoid chances of complications arising from bacterial infections and modulating the inflammatory response to allow for improved wound healing (3). However, the advantage of the antimicrobial properties of these dressings may not be quite as apparent as that of NPWT in terms of tissue regeneration or wound healing. This might have led to a longer healing time than the Ag dressing treated group because NPWT does not promote that much blood flow or the formation of granulation tissue. The observed result agrees with other similar studies on the effect of NPWT on chronic DFU as compared to other treatment methods (4, 5).

They also observed that the size of the ulcer was reduced by a greater extent in the NPWT than in the Ag dressing group, where there was an average reduction of ulcer size of 38.7%. This is in accordance with the effects of NPWT, which are closely affiliated with enhanced wound reduction resulting from suction action. NPWT enhances the process of wound contraction and epithelialization because its debridement exudates on the wound bed and supports the migration of the cells. It leads to an even more enhanced size reduction of the ulcer (6). However, the silver-releasing foam dressings are useful in preventing bacterial growth but cannot exert the same mechanical influence as the adhesive foam that is in the wound bed, hence slowing down the reduction in the size of the wound.

Compared studies have been carried out involving NPWT and silver-based dressings in managing DFUs with contradictory results. Some proposed causes of shorter hospital stays, less operating time, and fewer days in which patients were hospitalized include specific studies that revealed shorter healing periods and relative size of the ulcer in patients treated with NPWT (7, 8). Some other comparative studies also emphasize that silver-releasing dressings are comparable to NPWT in terms of the rate of wound healing and outcomes in terms of re-infection rate and management of exudate (9). Such discrepancies in outcomes might be a result of dissimilarities in the research method, patient characteristics, and types of Ag dressings used. Despite the fact that NPWT is faster and has better and more significant wound healing outcomes, silver-containing dressings can be more palatable to patients who have not faced a complex invasive process that requires the utilization of equipment.

This study benefits from randomized control trials that reduce selection bias and provide for better comparison between NPWT and Ag dressings. Furthermore, the patient population was clearly defined and matched in the two groups and had similar characteristics at baseline, increasing the study's consistency. The inclusion of a six-week postoperative follow-up period was ideal for observing the amount of time taken to heal and the diminution in the size of the involved ulcers. However, there are also some limitations to this study that would warrant mentioning. First, despite the fact that the study focuses on assessing the outcomes of NPWT and Ag dressings, the total number of participants was 120. A large sample size increases the test statistic and enhances the generality of the outcome. Secondly, the study did not determine the long-term effects of these treatments, and the research was conducted for only six weeks. It would be more helpful if comparisons could be made after a longer follow-up time to determine the extent of wound healing, the recurrence rate of the disease, and other side effects related to the specific treatments. However, the study excluded other modifiable factors, such as the presence of other diseases like peripheral vascular disease and the use of various therapies that could affect wound healing.

In terms of clinical relevance, it is possible to state that the results of this study indicate that NPWT is most favorable for the management of DFUs, especially when there is a need for accelerated tissue repair. This implies that through the reduction in healing time coupled with the significant reduction in the size of the ulcer, the cases that could experience further complications such as infection or amputation – which are pivotal in the management of diabetic foot complications – could be reduced eventually. However, the NPWT must be done only by using special equipment, and it may not be as easily done as the former ones because it requires more resources. Nonetheless, silver-releasing foam dressings are less costly in wound care than NPWT if the latter cannot be used. These dressings might be helpful more in the early stages of treating DFUs and for those patients who would not like to undergo complicated procedures.

Finally, although NPWT and silver-releasing foam dressing are described in the treatment of DFUs, this study indicated that NPWT is superior to the other in terms of ulcer healing time and ulcer size. The results provided evidence for the notion that NPWT is beneficial for the treatment of DFUs with the provision of such wound care therapy in facilities. However, any opportunity to employ a silver-releasing foam dressing, including in the area discussed in this case report where NPWT is an option, ought to be taken. Future research works with a larger sample size and with more extended durations than this study are necessary to verify the duration effects of each intervention approach.

CONCLUSION

Accordingly, the present research substantiates that Negative Pressure Wound Therapy (NPWT) has a higher efficacy than silver-releasing foam dressing in the DFUs size. They also reported that NPWT led to faster healing time and more ulcer area reduction compared to that of

silver-releasing foam dressings. These findings are in consonant with previous studies that recommended that NPWT is more effective than other negative pressure techniques in accelerating re-epithelialization and wound healing attributable to its vacuum effect. However, there are still benefits to using drug-releasing foam dressing, especially when NPWT is not available, and the antiseptic properties, plus an easier application, make it a worthy candidate. Though both treatments have advantages, the particular strategy should be selected based on the patient, availability, and type of DFU. Further research with an increased sample population and observation time should be conducted to test these findings and assess their prospective influences.

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