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Negative Pressure Wound Treatment Causes Faster Epithelialisation Compared to Tulle in the Treatment of Diabetic Foot Ulcers at Prof. Dr. I.G.N.G. Ngoerah Denpasar Hospital

Ida Bagus Wisnu Parbawa Kusuma[1*], Ida Bagus Budiarta[2], Made Agus Dwianthara Sueta[3], IGAB Krisna Wibawa[2], I Wayan Niryana[4], I Gede Suwedagatha[5]

[1]Department of General Surgery, Faculty of Medicine, Udayana University Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Indonesia

[2]Division of Vascular and Endovascular Surgery, Department of Surgery, Faculty of Medicine, Udayana University, Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Indonesia

[3]Division of Digestive Surgery, Department of Surgery, Faculty of Medicine, Udayana University, Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Indonesia

[4]Department of Neurosurgery, Faculty of Medicine, Udayana University Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Indonesia

[5]Division of Traumatology and Acute Care Surgery, Department of Surgery, Faculty of Medicine, Udayana University, Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Indonesia

E-mail: wisnuparbawa@gmail.com; budiartaidabagus@gmail.com; agus_sueta@yahoo.com; krisnawibawa64@gmail.com; niryanawayan@yahoo.com; suwedagatha@yahoo.com

*Corresponding author details: Ida Bagus Wisnu Parbawa Kusuma; wisnuparbawa@gmail.com

ABSTRACT

Background: Diabetic foot ulcer is one of the most serious complications of diabetes mellitus and is associated with prolonged wound healing, infection, gangrene, amputation, and increased healthcare burden. Conventional wound care, such as tulle dressing, is still commonly used; however, its effectiveness may be limited in chronic wounds. Negative Pressure Wound Therapy (NPWT) has been proposed as an alternative modality that may accelerate wound healing by removing excess exudate, reducing oedema, improving local perfusion, and promoting granulation tissue formation. ***Objective:*** To compare epithelialisation in diabetic foot ulcers treated with NPWT versus tulle dressing. ***Methods:*** This was an observational analytic study with a prospective comparative design. A total of 24 patients with diabetic foot ulcers were enrolled and divided into two groups: NPWT (n=12) and tulle dressing (n=12). Wound dimensions were measured before treatment and on day 14. Data were analysed using SPSS version 26. The statistical tests included Chi-square, independent t-test, paired t-test, Shapiro–Wilk test, Levene's test, and Mann–Whitney test where appropriate. ***Results:*** Baseline wound dimensions were not significantly different between the two groups ($p>0.05$). In the NPWT group, the mean wound area decreased from 55.67 ± 17.17 cm^2 to 21.75 ± 7.08 cm^2, whereas in the tulle group it decreased from 48.67 ± 8.99 cm^2 to 36.58 ± 9.21 cm^2. The mean reduction in wound area was significantly greater in the NPWT group, with a mean difference of 21.83 cm^2 (95% CI 10.50–33.62; $p=0.001$). ***Conclusion:*** NPWT resulted in significantly faster epithelialisation than tulle dressing in the treatment of diabetic foot ulcers.

Keywords: diabetic foot; negative pressure wound therapy; tulle; ulcer epithelialization; wound healing

INTRODUCTION

Diabetes mellitus (DM) remains a major global health problem that requires continuous and comprehensive management. The burden of diabetes has increased steadily worldwide, with current estimates showing that hundreds of millions of adults are living with the disease and that the number will continue to rise over the coming decades, particularly in low- and middle-income countries.

In addition to metabolic disturbances, uncontrolled DM leads to long-term vascular complications, including microangiopathy and macroangiopathy, which contribute substantially to tissue ischemia, impaired immunity, and delayed wound healing. In this context, diabetic foot ulcer (DFU) represents one of the most severe and costly complications of diabetes because it often progresses to infection, gangrene, hospitalisation, and amputation. Consistent with the original background text, DM-related lower-extremity wounds remain a critical clinical problem that must be managed carefully [1–3].

DFU is commonly defined as a full-thickness wound below the ankle in a person with diabetes, usually associated with neuropathy, peripheral arterial disease, or both. The condition is clinically important because it is linked to substantial morbidity, mortality, recurrent ulceration, reduced quality of life, and major financial burden. Armstrong, Boulton, and Bus reported that the lifetime risk of developing a diabetic foot ulcer ranges from 19% to 34%, while recurrence remains common even after successful healing, with approximately 40% recurring within one year and 65% within three years. These figures support the urgency stated in the original text and emphasise that DFU is not only an acute wound problem but also a chronic, relapsing disease requiring effective wound-healing strategies [4–6].

The global impact of DFU is substantial. Contemporary reviews estimate that diabetic foot ulcers affect millions of people worldwide each year and remain one of the main precursors of diabetes-related lower-extremity amputation. Standard management includes metabolic control, infection control, debridement, off-loading, vascular assessment, and moisture-balanced wound care. However, despite advances in multidisciplinary care, healing remains prolonged in many patients, and conventional dressings often yield suboptimal results in complex or heavily exudative wounds. This supports the original statement that DFU management remains challenging and that more effective therapeutic strategies are required to reduce prolonged healing, treatment failure, sepsis, amputation, and death [7–9].

Negative Pressure Wound Therapy (NPWT) has emerged as an adjunctive wound-healing modality for chronic and complex wounds, including DFU. By applying controlled subatmospheric pressure to a sealed wound bed, NPWT helps remove excess exudate, reduce interstitial oedema, improve local perfusion, stimulate granulation tissue formation, and facilitate wound contraction. These mechanisms are biologically relevant in diabetic wounds, where chronic inflammation, impaired perfusion, and excess wound fluid often delay epithelialisation. Recent systematic reviews and meta-analyses have shown that NPWT can improve wound healing outcomes and reduce wound area more effectively than conventional dressings, while maintaining an acceptable safety profile. This evidence strengthens the rationale already described in the original thesis text regarding the potential benefit of NPWT over paraffin- or gauze-based dressings [10–13].

Nevertheless, an important evidence gap remains. Although previous studies and guidelines support NPWT as a promising adjunctive therapy, many reports compare NPWT with advanced moist wound therapy or broader categories of standard wound care rather than directly with tulle dressing, which is still commonly used in routine clinical practice in many centres. In addition, outcomes across studies have varied in terms of wound closure, granulation, healing time, and amputation-related endpoints, and local prospective comparative data from Indonesian tertiary-care settings remain limited. Therefore, the present study does not merely repeat prior work; rather, it supports the existing evidence base while addressing a practical local gap by directly comparing NPWT with tulle dressing in a real-world vascular surgery setting. This constitutes the research status and novelty of the study [14,15].

At Prof. Dr. I.G.N.G. Ngoerah Denpasar Hospital, NPWT has not yet routinely become the standard option for diabetic foot ulcer care. Accordingly, this study was conducted to evaluate whether NPWT results in faster epithelialisation than tulle dressing in patients with diabetic foot ulcers treated at this centre. The objective of this study was to compare the epithelialisation of diabetic foot ulcers treated with NPWT and those treated with tulle dressing during a 14-day follow-up period.

METHOD

Study design and setting

A prospective comparative observational study was conducted at the Division of Vascular and Endovascular Surgery, Prof. Dr. I.G.N.G. Ngoerah Denpasar Hospital, Denpasar, Indonesia, from March to April 2024. The study compared wound epithelialisation in patients with diabetic foot ulcers treated with negative pressure wound therapy (NPWT) or tulle dressing during a 14-day follow-up period.

Participants

Patients diagnosed with diabetic foot ulcers who attended the Division of Vascular and Endovascular Surgery during the study period were screened for eligibility. Subjects were enrolled consecutively until the minimum sample size was achieved. A total of 24 patients were included, comprising 12 patients in the NPWT group and 12 patients in the tulle group.

Patients were eligible if they had diabetic foot ulcers and agreed to participate by providing written informed consent. Exclusion criteria were malignancy at the wound base or margin, previously confirmed but untreated osteomyelitis, unexplored non-enteric fistula, necrotic tissue with eschar, and exposed arteries or veins. Patients with significant peripheral arterial insufficiency, defined as an ankle-brachial index (ABI) <0.9 with biphasic or monophasic pedal pulse waveform on Doppler ultrasonography, were also excluded. Patients who

died during follow-up were considered dropouts.

Treatment procedures

All wounds underwent sharp debridement before dressing application. In the NPWT group, polyurethane foam was trimmed according to wound size and placed into the wound bed, then sealed with a transparent adhesive drape. A suction port was applied over the foam and connected to the NPWT device and canister. Negative pressure was initiated at −125 mmHg and reduced to −75 mmHg if pain occurred. Continuous mode was used during the first 24 hours, followed by intermittent mode thereafter with 5 minutes of suction and 2 minutes of rest. Foam dressings were changed every 3 days.

In the tulle group, paraffin tulle dressing was applied directly to the wound bed after debridement and covered with sterile gauze. Dressings were changed every 3 days or earlier if saturated.

The independent variable was wound treatment modality, either NPWT or tulle dressing. The dependent variable was epithelialisation, assessed by reduction in wound dimensions and clinical wound appearance. Baseline characteristics recorded included age, sex, body weight, height, and body mass index (BMI).

Outcome measurement

The primary outcome was wound epithelialisation after 14 days of treatment. Clinically, epithelialisation was defined as the appearance of new epithelial tissue characterized by a pink, dry, and slightly shiny wound surface. Quantitatively, wound size was assessed using wound area measurements at baseline and on day 14. Wound area was calculated using the elliptical formula: length × width × 0.785, expressed in cm^2. Length was measured from the 12 o'clock to the 6 o'clock axis and width from the 3 o'clock to the 9 o'clock axis using the clock method. Measurements were obtained using a caliper. The degree of epithelialisation was expressed as the reduction in wound dimensions between baseline and day 14.

Statistical analysis

Data were analysed using SPSS version 26. Continuous variables were presented as mean ± standard deviation, while categorical variables were presented as frequency and percentage. Normality of distribution was assessed using the Shapiro-Wilk test, and homogeneity of variance was assessed using Levene's test. Between-group comparisons were performed using the independent t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Within-group comparisons before and after treatment were analysed using the paired t-test. Categorical variables were compared using the Chi-square test. A p-value <0.05 was considered statistically significant.

Ethical approval

The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Udayana University / Prof. Dr. I.G.N.G. Ngoerah Denpasar Hospital. Written informed consent was obtained from all participants before enrolment.

RESULT

A total of 24 patients were included in this study, with 12 patients in the NPWT group and 12 patients in the tulle group. Baseline characteristics are presented in Table 1.

TABLE 1: Baseline characteristics of study participants.

Variable	NPWT (n=12)	Tulle (n=12)	p-value
Age, years	55.41 ± 9.47	60.08 ± 9.44	0.240a
Sex			0.673b
Male	8 (66.7%)	7 (58.3%)	
Female	4 (33.3%)	5 (41.7%)	
Wagner grade			0.075c
Grade III	12 (100%)	10 (83.3%)	
Grade II	0	2 (16.7%)	
Body weight, kg	65.50 ± 13.04	61.83 ± 10.65	0.459a
Height, m	1.64 ± 0.81	1.62 ± 0.07	0.659a
Body mass index, kg/m^2	24.18 ± 3.94	23.36 ± 3.84	0.609a
ABI >0.9	12 (100%)	12 (100%)	1.000
Triphasic Doppler waveform	12 (100%)	12 (100%)	1.000
Negative osteomyelitis	12 (100%)	12 (100%)	1.000
Negative nodules	12 (100%)	12 (100%)	1.000
Negative fistula	12 (100%)	12 (100%)	1.000
Negative necrotic tissue with eschar	12 (100%)	12 (100%)	1.000

Values are presented as mean ± standard deviation or n (%). [a]Independent t-test; [b]Chi-square test; [c]Mann-Whitney test.

The mean age was 55.41 ± 9.47 years in the NPWT group and 60.08 ± 9.44 years in the tulle group, with no significant difference between groups (p=0.240). Male patients were more frequent in both groups, accounting for 66.7% in the NPWT group and 58.3% in the tulle group (p=0.673). Most ulcers were classified as Wagner grade III. In the NPWT group, all cases were Wagner grade III, whereas in the tulle group, most cases were Wagner grade III, and two cases were Wagner grade II; this difference was not statistically significant (p=0.075).

There were no significant between-group differences in body weight, height, or body mass index (BMI). Mean body weight was 65.50 ± 13.04 kg in the NPWT group and 61.83 ± 10.65 kg in the tulle group (p=0.459), while mean BMI was 24.18 ± 3.94 kg/m^2 and 23.36 ± 3.84 kg/m^2, respectively (p=0.609). All subjects in both groups had ABI >0.9, triphasic Doppler waveforms, and no evidence of osteomyelitis, nodules, fistula, or necrotic tissue with eschar. Overall, baseline characteristics were comparable between the two groups.

Comparisons of wound dimensions before and after treatment are shown in Table 2. At baseline, wound length, width, and area did not differ significantly between groups. After 14 days of treatment, wound length, width, and area were all significantly lower in the NPWT group than in the tulle group. Within-group analysis also showed significant reductions in wound dimensions from baseline in both groups. However, the magnitude of reduction was greater in the NPWT group, indicating faster epithelialisation.

TABLE 2: Comparison of wound epithelialisation between the NPWT and tulle groups.

Variable	NPWT	Tulle	Mean difference	95% CI	p-value[a]
Wound length, cm					
Baseline	9.17 ± 1.33	8.83 ± 1.33	0.33	-0.79 to 1.46	0.548
Day 14	5.67 ± 1.23	7.41 ± 1.16	1.75	-2.76 to -0.73	0.002
Within-group p-value[b]	<0.001	<0.001			
Δ length	3.50 ± 1.44	1.41 ± 0.99	2.08	1.03 to 3.13	<0.001
Wound width, cm					
Baseline	6.00 ± 1.12	5.50 ± 0.52	0.50	-0.24 to 1.26	0.177
Day 14	3.83 ± 0.83	4.87 ± 0.60	1.04	-1.65 to -0.42	0.002
Within-group p-value[b]	<0.001	0.001			
Δ width	2.17 ± 1.47	0.62 ± 0.48	1.54	0.58 to 2.50	0.002
Wound area, cm^2					
Baseline	55.67 ± 17.17	48.67 ± 8.99	7.00	-4.61 to 18.61	0.224
Day 14	21.75 ± 7.08	36.58 ± 9.21	14.83	-21.79 to -7.87	<0.001
Within-group p-value[b]	<0.001	<0.001			
Δ area	33.91 ± 18.05	12.08 ± 5.68	21.83	10.50 to 33.62	0.001

Values are presented as mean ± standard deviation.
Δ indicates change from baseline to day 14.
[a]Independent t-test.
[b]Paired t-test.

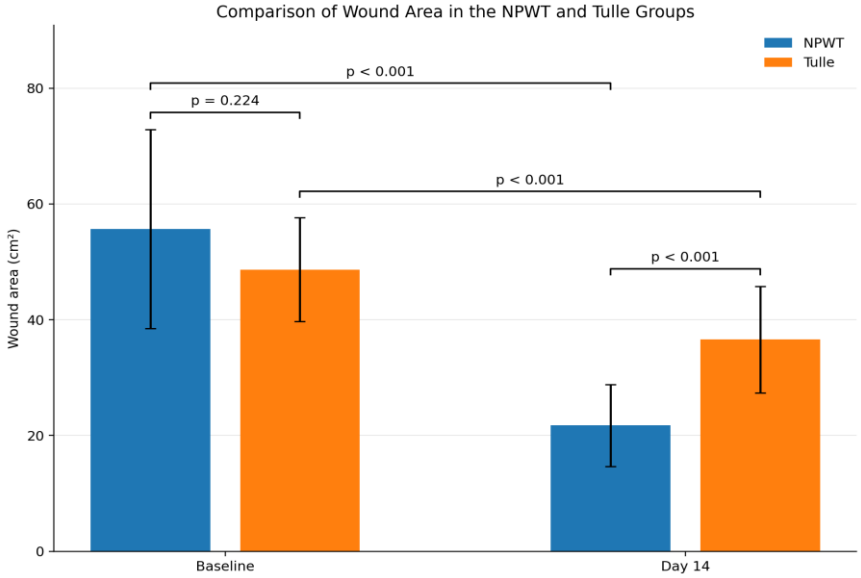

FIGURE 1: Change in wound area from baseline to day 14 in the NPWT and tulle groups. The NPWT group showed a greater reduction in mean wound area compared with the tulle group after 14 days of treatment.

DISCUSSION

In the present study, no statistically significant differences were found between the NPWT and tulle groups in terms of age, sex, ulcer diagnosis, or body mass index. This indicates that the baseline distribution of subjects in the two groups was comparable and that these characteristics were unlikely to have substantially influenced the observed difference in wound epithelialisation. The mean age in the NPWT group was 55.41 years, while that in the tulle group was 60.08 years, indicating that most patients with diabetic foot ulcers in this study were older adults. This finding is in line with the known epidemiology of diabetic foot ulcer, which is more commonly observed in patients with long-standing diabetes and accumulated microvascular and macrovascular complications. Previous reports have likewise shown that diabetic foot ulcer is more frequent in middle-aged and older adults, supporting the age pattern seen in the present cohort [4,8,16,17].

Older age is a well-recognised non-modifiable risk factor for diabetic foot ulcer. In the present study, the mean age of patients in the NPWT and tulle groups was 55.41 and 60.08 years, respectively, indicating that most subjects were in the older adult age group. This finding is consistent with the report by Fitria et al., in which diabetic ulcers were most frequently found in patients aged 55–60 years. Previous reports have also shown that diabetic foot complications are more commonly encountered in the fourth and fifth decades of life and thereafter, reflecting the cumulative effects of longstanding diabetes, microvascular and macrovascular complications, neuropathy, and impaired wound healing. In women, increasing age is also associated with menopause-related hormonal and metabolic changes, including reduced oestrogen levels, increased insulin resistance, obesity, and metabolic syndrome, all of which may further contribute to the risk of type 2 diabetes and its complications [18].

Male patients were more common than female patients in both treatment groups, although the difference between groups was not statistically significant. This pattern is in line with previous studies reporting a predominance of diabetic foot ulcer among men, including reports from Asian populations [19]. Several factors may contribute to this distribution, such as occupational exposure, footwear habits, delayed health-seeking behaviour, and the tendency for men to present with more severe lesions. However, because the sex distribution was comparable between the NPWT and tulle groups in the present study, sex is unlikely to have influenced the difference in epithelialisation outcomes observed between the two treatment modalities [4,17].

Most wounds in this study were classified as Wagner grade III. This is clinically important because Wagner classification remains one of the most widely used tools to assess diabetic foot ulcer severity, and more advanced Wagner grades are generally associated with deeper tissue involvement, higher infection risk, and more complex management. The predominance of Wagner grade III ulcers in the present study is consistent with the type of patients commonly treated in tertiary vascular surgical settings. Since grade III ulcers often require surgical debridement as part of standard care, the findings of the present study should be interpreted in the context of post-debridement wound management. This aligns with the current understanding that debridement is a fundamental component of diabetic foot ulcer treatment because it removes necrotic tissue, reduces local bioburden, and optimises the wound bed for healing [20,21].

Body mass index also did not differ significantly between groups, and the mean BMI in both groups was within the normal range. This finding is relevant because overweight and obesity have been associated with a substantially increased risk of diabetic foot ulcer development and recurrence. Rossboth et al. reported that excess body mass index increased the risk of diabetic foot ulcer occurrence by approximately fourfold (OR 4.05; 95% CI 2.50–6.58; $p<0.00001$), while the risk of ulcer recurrence was nearly four times higher (OR 3.94; 95% CI 2.65–5.84; $p<0.00001$). In the present study, the relatively similar and predominantly normal BMI profile in both groups suggests that anthropometric differences were unlikely to account for the greater wound reduction observed in the NPWT group. A more favourable BMI profile may also have contributed to a better healing environment overall. Nevertheless, recurrence remains a major clinical concern in diabetic foot ulcer care [22]. Guo et al. reported that recurrence rates remain high even after successful healing, reaching 40% within 1 year, 60% within 3 years, and 65% within 5 years. Therefore, although BMI did not differ significantly between groups in this study, long-term ulcer prevention and recurrence control remain essential components of diabetic foot management [23].

The main finding of this study was that both NPWT and tulle dressing reduced wound length, width, and area significantly after treatment, but the reduction was significantly greater in the NPWT group. The mean wound area in the NPWT group decreased from 55.67 ± 17.17 cm^2 before treatment to 21.75 ± 7.08 cm^2 after treatment, whereas in the tulle group it decreased from 48.67 ± 8.99 cm^2 to 36.58 ± 9.21 cm^2. The mean difference in wound area reduction between groups was 21.83 cm^2 (95% CI 10.50–33.62; $p=0.001$). These results indicate that epithelialisation progressed more rapidly in wounds treated with NPWT than in those treated with tulle. Because baseline wound dimensions were not significantly different between groups, the greater wound reduction in the NPWT group is likely to reflect a true treatment-related effect rather than baseline imbalance.

This finding is in accordance with previous reports comparing NPWT with conventional or moist wound therapy. Earlier studies cited in the original thesis, such as Walczak et al., Sifi et al., and Borys et al., also found superior wound reduction or healing

performance with NPWT [24–26]. More recent systematic studies have strengthened this conclusion by showing that NPWT improves wound healing outcomes in diabetic foot ulcers and may also reduce the risk of amputation when used in appropriately selected patients. The current IWGDF guideline on interventions to enhance healing of diabetic foot ulcers also supports considering NPWT in post-surgical diabetic foot wounds within comprehensive multidisciplinary care. Therefore, the results of the present study are not only consistent with the original references but are also reinforced by more recent evidence [10,12,15].

The more favourable effect of NPWT observed in this study is biologically plausible. NPWT applies controlled subatmospheric pressure to the wound surface and thereby removes excess exudate, reduces interstitial oedema, improves local perfusion, promotes granulation tissue formation, and supports wound contraction. These effects are particularly relevant in diabetic foot ulcers, in which chronic inflammation, tissue oedema, bacterial colonisation, and impaired angiogenesis commonly delay wound closure. Contemporary reviews of diabetic foot ulcer management likewise describe exudate control, wound bed preparation, and stimulation of granulation as key components of successful healing, all of which may be enhanced by NPWT [8,15,21].

Another important point is that wound area reduction over a defined follow-up period is a meaningful indicator of healing trajectory, even when complete closure has not yet been achieved. In this study, the significantly smaller wound area in the NPWT group after 14 days suggests that NPWT accelerated early healing. This is clinically relevant because an earlier reduction in wound size is associated with a more favourable overall wound course and may decrease the duration of treatment, the burden of infection, and the need for more extensive procedures. In practical terms, faster epithelialisation can translate into shorter wound care duration and possibly lower morbidity, especially in hospital-based patients with advanced ulcers [4,14].

The findings of the present study also support the use of NPWT as one component of comprehensive diabetic foot ulcer management rather than as an isolated treatment. As reflected both in the original thesis and in current guidelines, optimal diabetic foot ulcer care should include sharp debridement, infection control, offloading, vascular assessment, metabolic optimisation, and appropriate wound dressing selection [10,21]. In this context, NPWT may be particularly beneficial after debridement in wounds that are deep, exudative, or slow to progress with conventional dressings. Thus, the present study provides locally relevant evidence supporting broader use of NPWT at Prof. Dr. I.G.N.G. Ngoerah Denpasar Hospital, where it has not yet routinely become the standard option for diabetic foot ulcer care.

This study has several limitations, including a small sample size (24 subjects), a short follow-up period (14 days) that only assessed early epithelialisation, and an observational design that may introduce residual confounding; however, its strengths include prospective follow-up, direct head-to-head comparison between NPWT and tulle dressing, objective wound dimension measurements, and implementation in a real-world tertiary surgical setting. Overall, the study demonstrates that NPWT provides superior short-term epithelialisation outcomes compared to tulle dressing in diabetic foot ulcers, consistent with existing references and supported by recent systematic reviews and guidelines, thereby supporting the integration of NPWT into multidisciplinary diabetic foot ulcer management, particularly following adequate debridement and in wounds requiring more intensive exudate control and granulation support.

CONCLUSIONS

Negative pressure wound therapy resulted in significantly faster epithelialisation than tulle dressing in patients with diabetic foot ulcers, as demonstrated by greater reductions in wound length, width, and area after 14 days of treatment. These findings indicate that NPWT may provide a more effective wound-healing environment than conventional tulle dressing and support its use as part of comprehensive diabetic foot ulcer management, particularly after adequate debridement.

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REFERENCES

[1] Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract 2019;157:107843. https://doi.org/10.1016/j.diabres.2019.107843.

[2] Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract 2022;183:109119. https://doi.org/10.1016/j.diabres.2021.109119.

[3] Ong KL, Stafford LK, McLaughlin SA, Boyko EJ, Vollset SE, Smith AE, et al. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. The Lancet 2023;402:203–34. https://doi.org/10.1016/S0140-6736(23)01301-6.

[4] Armstrong DG, Tan T-W, Boulton AJM, Bus SA. Diabetic Foot Ulcers. JAMA 2023;330:62. https://doi.org/10.1001/jama.2023.10578.

[5] van Netten JJ, Bus SA, Apelqvist J, Lipsky BA, Hinchliffe RJ, Game F, et al. Definitions and criteria for diabetic foot disease. Diabetes Metab Res Rev 2020;36. https://doi.org/10.1002/dmrr.3268.

[6] Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and Their Recurrence. New England Journal of Medicine 2017;376:2367–75. https://doi.org/10.1056/NEJMra1615439.

[7] Rayman G, Vas P, Dhatariya K, Driver V, Hartemann A, Londahl M, et al. Guidelines on use of interventions to enhance healing of chronic foot ulcers in diabetes (IWGDF 2019 update). Diabetes Metab Res Rev 2020;36. https://doi.org/10.1002/dmrr.3283.

[8] Everett E, Mathioudakis N. Update on management of diabetic foot ulcers. Ann N Y Acad Sci 2018;1411:153–65. https://doi.org/10.1111/nyas.13569.

[9] Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, et al. Practical guidelines on the prevention and management of diabetes-related foot disease (IWGDF 2023 update). Diabetes Metab Res Rev 2024;40. https://doi.org/10.1002/dmrr.3657.

[10] Chen L, Zhang S, Da J, Wu W, Ma F, Tang C, et al. A systematic review and meta-analysis of efficacy and safety of negative pressure wound therapy in the treatment of diabetic foot ulcer. Ann Palliat Med 2021;10:10830–9. https://doi.org/10.21037/apm-21-2476.

[11] Dalmedico M, do Rocio Fedalto A, Martins W, de Carvalho C, Fernandes B, Ioshii S. Effectiveness of Negative Pressure Wound Therapy in Treating Diabetic Foot Ulcers: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Wounds 2024;36:281–9. https://doi.org/10.25270/wnds/23140.

[12] Zhang N, Liu Y, Yan W, Liu F. The effect of negative pressure wound therapy on the outcome of diabetic foot ulcers: A meta-analysis. Int Wound J 2024;21. https://doi.org/10.1111/iwj.14886.

[13] James SD, Sureshkumar S, Elamurugan T, Debasis N, Vijayakumar C, Palanivel C. Comparison of vacuum-assisted closure therapy and conventional dressing on wound healing in patients with diabetic foot ulcer: A randomized controlled trial. Nigerian Journal of Surgery 2019;25:14. https://doi.org/10.4103/njs.NJS_14_18.

[14] Vas P, Rayman G, Dhatariya K, Driver V, Hartemann A, Londahl M, et al. Effectiveness of interventions to enhance healing of chronic foot ulcers in diabetes: a systematic review. Diabetes Metab Res Rev 2020;36. https://doi.org/10.1002/dmrr.3284.

[15] Chen P, Vilorio NC, Dhatariya K, Jeffcoate W, Lobmann R, McIntosh C, et al. Guidelines on interventions to enhance healing of foot ulcers in people with diabetes (IWGDF 2023 update). Diabetes Metab Res Rev 2024;40. https://doi.org/10.1002/dmrr.3644.

[16] Everett E, Mathioudakis N. Update on management of diabetic foot ulcers. Ann N Y Acad Sci 2018;1411:153–65. https://doi.org/10.1111/nyas.13569.

[17] Boulton A, Armstrong D, Krisner R, Attinger C, Lavery L, Lipsky B, et al. Diagnosis and Management of Diabetic Foot Complications. ADA Clinical Compendia 2018;2018:1–20. https://doi.org/10.2337/db20182-1.

[18] Fitria E, Nur A, Marissa N, Ramadhan N. Characteristics of Diabetic Ulcers in Diabetes Mellitus Patients at Dr. Zainal Abidin Regional Hospital and Meuraxa Regional Hospital, Banda Aceh. Buletin Penelitian Kesehatan 2017;45. https://doi.org/10.22435/bpk.v45i3.6818.153-160.

[19] Mehraj DrM. A review of Wagner classification and current concepts in management of diabetic foot. International Journal of Orthopaedics Sciences 2018;4:933–5. https://doi.org/10.22271/ortho.2018.v4.i1n.133.

[20] Shah P, Inturi R, Anne D, Jadhav D, Viswambharan V, Khadilkar R, et al. Wagner's Classification as a Tool for Treating Diabetic Foot Ulcers: Our Observations at a Suburban Teaching Hospital. Cureus 2022. https://doi.org/10.7759/cureus.21501.

[21] Lavery LA, Suludere MA, Attinger CE, Malone M, Kang GE, Crisologo PA, et al. Wound Healing Society guidelines update: Diabetic foot ulcer treatment guidelines. Wound Repair and Regeneration 2024;32:34–46. https://doi.org/10.1111/wrr.13133.

[22] Rossboth S, Lechleitner M, Oberaigner W. Risk factors for diabetic foot complications in type 2 diabetes—A systematic review. Endocrinol Diabetes Metab 2021;4. https://doi.org/10.1002/edm2.175.

[23] Guo Q, Ying G, Jing O, Zhang Y, Liu Y, Deng M, et al. Influencing factors for the recurrence of diabetic foot ulcers: A meta-analysis. Int Wound J 2023;20:1762–75. https://doi.org/10.1111/iwj.14017.

[24] Borys S, Hohendorff J, Frankfurter C, Kiec-Wilk B, Malecki MT. Negative pressure wound therapy use in diabetic foot syndrome—from mechanisms of action to clinical practice. Eur J Clin Invest 2019;49. https://doi.org/10.1111/eci.13067.

[25] Sifi N, Bougenna R, Kaci L. “Low Cost" Negative Pressure Wound Therapy for Acute and Chronic Wounds Healing - About 3 Cases. Res Sq 2021. https://doi.org/10.21203/rs.3.rs-586783/v1.

[26] Walczak DA, Wojtyniak M, Jaguścik R, Porzeżyńska JJ, Fałek W, Czerwińska M, et al. Management of large chronic venous leg ulcers with negative pressure wound therapy. Negative Pressure Wound Therapy Journal 2017;4:17. https://doi.org/10.18487/npwtj.v4i2.26.