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ORIGINAL ARTICLE

Evaluating the efficacy of negative pressure wound therapy (NPWT) in optimizing chronic lower limb wounds.

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ABSTRACT… Objective: To evaluate the efficacy of Negative Pressure Wound Therapy in optimizing chronic lower limb wounds of various etiologies. **Study Design:** Descriptive, Prospective. **Setting:** Department of Burns and Plastic Surgery, Lady Reading Hospital Peshawar. **Period:** December 2024 to November 2025. **Methods:** A total of 100 patients meeting the inclusion criteria were enrolled through non-probability consecutive sampling. NPWT was applied after proper debridement, using intermittent negative pressure ranging from -90 to -120 mmHg. Wounds were assessed for granulation tissue, infection status, and size reduction. Data were analyzed using SPSS version 29, with a significance level of 0.05. **Results:** The mean age of patients was 50.27 years, with a male-to-female ratio of 2:1. Trauma (42%) was the most common etiology. NPWT resulted in a significant wound size reduction from 18.2 cm^2 to 12.0 cm^2 ($p = 0.002$), with 100% of patients developing granulation tissue. Healing occurred by secondary intention in 38% and primary closure in 27% of cases. Overall efficacy of negative pressure wound therapy was 81%. The therapy was well-tolerated with minimal complications. **Conclusion:** negative pressure wound therapy proved effective in promoting granulation tissue formation, reducing wound size, and preparing chronic lower limb wounds for closure, supporting its role as a valuable tool in managing chronic wounds.

Key words: Chronic Leg Wounds, Negative Pressure Wound Therapy (NPWT), Optimized Wound Bed, Vacuum Assisted Closure (VAC).

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INTRODUCTION

Chronic wounds are defined as wounds that do not heal within 4 to 6 weeks or exhibit less than a 20–40% reduction in size despite appropriate treatment.[1] Although most wounds undergo the standard healing stages of hemostasis, inflammation, proliferation, and maturation, a significant number fail to progress through these phases. This failure results in chronic wounds, contributing to increased morbidity and financial burden on patients and healthcare systems.[2]

Chronic wounds frequently lead to the accumulation of necrotic tissue, infections, edema, and impaired blood flow. These issues necessitate treatment focused on preparing the wound bed to promote healing or facilitate alternative ways of healing such as primary closure, grafts, or flaps.[2] While immediate reconstruction of wounds should be considered, particularly in the lower limbs, several factors can cause delays between the initial injury and debridement and the definitive management through reconstruction.[3] Negative pressure wound therapy (NPWT) remains an important adjunct in managing these chronic wounds, aiding in the preparation of wound for optimal healing or definitive reconstruction.[4]

Negative pressure wound therapy (NPWT) is a non-invasive dressing technique that employs a device to generate sub-atmospheric pressure ranging from 50 to 150 mm Hg. This pressure can be applied continuously or intermittently, facilitating the drainage of wound exudates and enhancing tissue perfusion and promote healing through wound contraction and granulation tissue formation.[5] The primary mechanism of Negative pressure therapy involves mechanotransduction and micro-deformation, which induces cellular proliferation under hypoxic conditions, creating an environment conducive to angiogenesis.[6]

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Negative pressure therapy has the potential to promote wound contraction and granulation formation, accelerating tissue repair while typically reducing dressing change frequency and hospital stays.[7] Various studies have reported positive outcomes, including one conducted in India, which found that Negative pressure wound therapy was 79% effective in promoting granulation tissue and reducing wound size in chronic lower limb wounds.[8]

Chronic lower limb wounds present a significant clinical challenge. Due to the lack of local data on this topic, the aim of this study is to assess the efficacy of negative pressure wound therapy in optimizing chronic wounds of various etiologies in the lower limb, specifically in terms of promoting a healthy wound bed. While several studies have reported varying success rates for negative pressure wound therapy, this research seeks to provide local evidence and support the use of this non-invasive therapy in managing chronic wounds until they heal or undergo definitive reconstruction.

METHODS

This descriptive study was conducted in the Burns and Plastic Surgery Unit at Lady Reading Hospital, Peshawar, from March 2025 to September 2025. A sample size of 100 patients was determined using the WHO sample size calculator, based on an expected efficacy of 79%.[8] A non-probability consecutive sampling technique was used for patient selection.

Inclusion criteria consisted of patients aged 18 years and above, of both genders, presenting with chronic non-healing wounds on the lower limbs. These wounds were secondary to causes such as trauma, infection, diabetes, pressure ulcers, or post-amputation stumps. Patients were excluded if they were non-compliant or unwilling to participate, had wounds due to excision of malignant lesions or post-radiotherapy, or presented with comorbidities including chronic kidney disease, cardiovascular or lung disease, and peripheral vascular disease. Additional exclusion criteria included patients with sepsis, malnutrition, bone involvement (such as osteomyelitis or gangrene), or those receiving immunosuppressant, steroids, or anticoagulants.

Data Collection and Analysis

Following ethical approval from the hospital's ethical committee (590/LRH/MTI-31-12-24) and research department, 100 patients who met the inclusion criteria were enrolled in the study. Informed consent was obtained from each participant. Demographic and clinical data were collected using a structured proforma, including details such as name, age, gender, address, occupation, wound characteristics (site, size, etiology, previous treatments), and post-therapy wound status (presence of granulation tissue, signs of infection, reduction in wound size in centimeters), along with any complications observed. Data were analyzed using SPSS version 29. Quantitative variables such as age, wound duration, and wound size were expressed as mean ± standard deviation, while categorical variables such as gender, wound etiology, and treatment history were presented as frequencies and percentages. Post-stratification Student's t-tests were applied to compare numerical data, particularly wound status before and after therapy, using a significance level of 0.05. All results were illustrated using appropriate tables and graphs.

Procedure Details

All procedures were performed under spinal anesthesia after obtaining informed written consent from each patient. Preoperative and postoperative photographs were taken for documentation purposes. Patients were positioned supine on the operating table, and following standard aseptic measures including cleaning and draping, thorough debridement of the wound was carried out. The wounds were first irrigated with hydrogen peroxide followed by 0.9% normal saline to ensure thorough cleansing. Once the wound bed was adequately prepared, Negative Pressure Wound Therapy (NPWT) was initiated. A sterilized foam dressing was cut to match the shape and size of the wound, and small perforations were made in the suction tube, which was then embedded within the foam. The surrounding skin was treated with tincture of benzoin to enhance the adhesion of the opsite dressing and to ensure a proper seal. The opsite was applied over the foam, carefully molded around the suction tubing to create a mesentery. A suction machine was then connected, and the area was secured with a crepe bandage to protect the opsite

and maintain the seal.

Intermittent vacuum-assisted closure (VAC) was employed, with negative pressure levels ranging from -90 mmHg to -120 mmHg, adjusted according to the anatomical site and patient tolerance. Dressing changes were scheduled at intervals of 3 to 5 days. In cases where clinical signs of infection were observed, wound cultures were obtained during debridement, and targeted antibiotic therapy was initiated based on culture sensitivity results. The progression of wound healing, including changes in wound size and appearance, was documented at each dressing change through direct measurements and serial photographs. The end point of therapy was a wound exhibiting healthy granulation tissue, with no clinical signs of infection, necrotic tissue, or slough, or a wound that had sufficiently reduced in size (10-15% decrease in surface area per week or a 20-40% overall reduction), making it suitable for primary closure or soft tissue coverage via graft or flap.

RESULTS

The mean age recorded was 50.27 years (SD: 19.18, Range: 19-79 years). 66% were male and 34% were female (ratio 2:1).

The most common cause of wounds was trauma (42%), followed by infections (20%) and diabetic ulcers (10%). Table-I Diabetic ulcers primarily affected the foot and ankle (35%), while trauma-related wounds were predominantly located in the lower leg and thigh (50%). Frequencies of wound sites are shown in bar graph. Figure-1

FIGURE-1

Showing most common wound sites and their frequencies

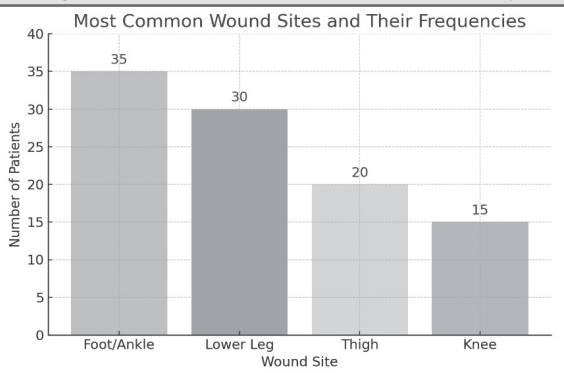
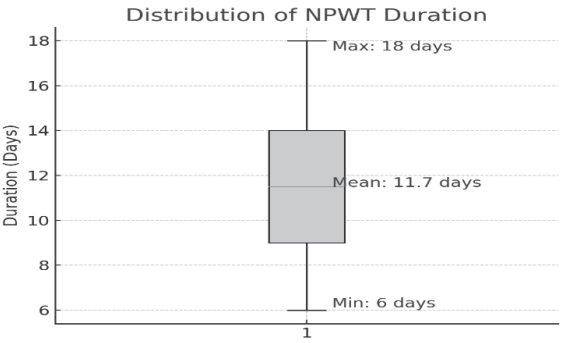


FIGURE-2

BOX-Plot showing duration of dressing (s):



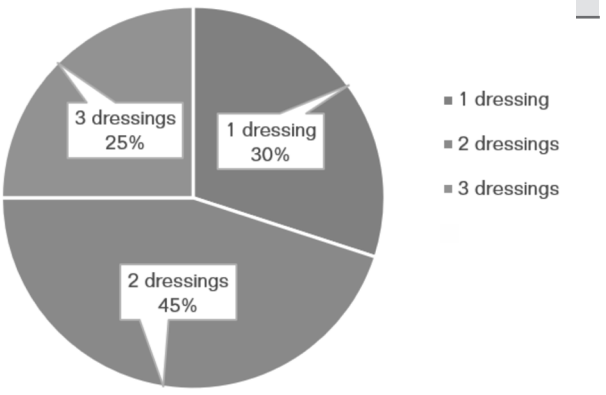
Negative Pressure Wound Therapy (NPWT) demonstrated an overall efficacy of 81%. The mean wound size before NPWT was 18.2 cm^2 (SD: 5.7 cm^2), which significantly decreased to 12.0 cm^2 (SD: 4.5 cm^2) after treatment, with an average reduction of 6.2 cm^2, representing a 34.1% decrease (p value = 0.002).

The mean duration of NPWT was 11.2 days (SD: 3.4), with a range from 6 to 18 days. Figure-2

Most of the patients (45%) required 2 dressings. Figure-3

FIGURE-3

P



Granulation tissue developed in 100% of patients, and 79% showed improved vascularity. Among the treated wounds, 38% healed by secondary intention, while 27% achieved primary closure, although this difference was not statistically significant (χ^2 = 11.45, p = 0.491). Table-I

TABLE-I

Cross tabulation of wound etiology with wound closure

Wound Etiology	Primarily Closed (%age)	Healed by Secondary Intention (%age)	Graft (%age)	Flap (%age)	Total (%age)	
Trauma	12	18	8	4	42	Chi square $\chi^{(2)}$ = 11.45
Infection	6	8	4	2	20	
Pressure Ulcers	3	5	2	0	10	
Diabetic Ulcers	4	4	2	0	10	p = 0.491
Others	2	3	4	9	18	
Total	27	38	20	15	100	

NPWT was well-tolerated, with 85% of patients reporting no significant discomfort, although pain was reported as the most common complication, affecting 6% of the patients.

DISCUSSION

Chronic lower limb wounds represent a global clinical challenge, with global incidence steadily increasing each year.

These wounds, whether resulting from trauma, diabetes, infection, or pressure ulcers, often evolve into complex cases that are difficult to manage and require a multidisciplinary approach for effective management.[9] Despite the introduction of new wound care techniques, Negative Pressure Wound Therapy (NPWT) remains a key treatment option. It helps converting chronic wounds into more manageable acute ones, making them amenable to definitive closure methods like grafts or flaps. KCI™, the pioneers of NPWT technology, recommend its use for various open wounds, except in cases of untreated infection or malignancy.[10]

Negative Pressure Wound Therapy has become widely adopted over the past two decades in the USA and many other countries[11], likely due to a deeper understanding of its mechanism of action and the growing body of larger studies that highlight its crucial role in wound management, especially when compared to conventional dressings.[12]

In our study, the majority of chronic wounds were trauma-related (42%), followed by infections (20%) and ulcers (20%). These findings are consistent with those reported in a Romanian study by Fotea et al., where trauma accounted for 67% of acute wounds, while among chronic wounds, ulcers made up 42% and infections 8%. [13] The high prevalence of trauma-related chronic wounds in our study highlights that lower limbs are particularly susceptible to complex wounds, often due to delayed healing, inadequate care, or underlying conditions such as diabetes and vascular diseases.[14]

we observed the overall efficacy of negative pressure wound therapy in 81%. And significant 34.1% reduction Which is similar to a study done in India that reported overall efficacy of 80.6% in chronic lower limb wounds whereas, a study by Fotea et al. reported a 42% reduction 13 where as khursheed et al reported 29.92% reduction[15] in wound size with negative pressure dressing. NPWT's is particularly beneficial in optimizing wound bed i-e it promotes wound healing by stimulating granulation tissue formation, improving tissue perfusion, and accelerating wound contraction.[16]

The observed mean therapy duration of 11.2 days and the need for decreased dressing changes further highlights the efficiency of NPWT in promoting wound healing while minimizing intervention frequency and financial burden on both patients and healthcare systems. A study by Siedal et al.[17] on diabetic foot ulcers demonstrated that NPWT reduced the treatment duration by 16 days compared to standard moist wound care. Additionally, a systematic review and meta-analysis by Burhan et al. concluded that NPWT significantly enhances chronic wound healing, with treatment durations ranging from 7 days to 25 weeks.[18] Rashid et al reported that <90% of patients were ready for wound coverage.

Once the wound bed is optimized and the wound has significantly contracted, achieving wound coverage becomes more feasible. Usually after 1st or 2nd dressing wound coverage is possible whether through secondary intention, direct primary closure, or skin coverage via graft or flap.[18,19] We observed an average of two dressing changes, which is consistent with the findings reported by Rashid et al[20] who noted that over 90% of their patients were ready for wound coverage after similar treatment. In our study, 38% of patients healed by secondary intention, 27% underwent direct primary closure, and the remaining 35% received flap or graft coverage (20% and 15%, respectively). Similarly, Fotea et al.[13] observed comparable trends in wound management, where 41.24% cases were covered with split-thickness skin grafts (STSG), 27.84% cases underwent flap procedures, and the remaining cases followed secondary healing.

One limitation of this study is the absence of a control group treated with conventional dressing methods, which would have allowed for a direct comparative analysis. Additionally, the study was conducted at a single center, which may limit the generalizability of the findings. Further multicenter, randomized controlled trials are recommended to validate these outcomes and assess long-term benefits.

CONCLUSION

This study shows that Negative Pressure Wound Therapy (NPWT) is an effective and well-tolerated treatment for chronic lower limb wounds, promoting healing by enhancing granulation tissue, reducing wound size, and improving vascularity. With an 81% efficacy rate and strong patient compliance, NPWT proves to be a valuable tool in managing complex wounds. These findings support its use, especially in resource-limited settings, and suggest the need for further research with larger sample sizes to confirm long-term outcomes.

LIMITATIONS

Since this study is conducted solely in single surgical unit, multiple center studies with greater sample size are needed to further evaluate the effectiveness of the negative pressure wound therapy in chronic lower limb wounds.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Ihtesham Ali Khan:** Data collection.
2	**Zahra Tauqeer:** Data analysis.
3	**Riaz Ahmed Khan Afridi:** Conception.