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Original Research Article

Comparative Evaluation of Negative Pressure Wound Therapy versus Conventional Dressing in the Management of Grade II and Grade III Ulcers: A Prospective Comparative Study

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Abstract

Background: Chronic ulcers are associated with delayed wound healing, prolonged hospitalization, repeated dressing procedures and frequent requirement for surgical debridement. Negative pressure wound therapy (NPWT) has emerged as an important adjunct in the management of complex wounds by promoting granulation tissue formation, controlling exudate and reducing tissue oedema. This study compared NPWT with conventional dressing in the management of Grade II and Grade III ulcers.

Aim: To compare the effectiveness of NPWT and conventional dressing with respect to time to complete granulation, number of dressing applications, duration of hospital stay and requirement for repeat debridement.

Materials and Methods: This prospective, non-randomized comparative study included 100 patients with Grade II and Grade III ulcers. Fifty patients received NPWT (Group A) and 50 received conventional wound dressing (Group B). Baseline demographic characteristics and ulcer grade were compared between groups. The primary outcome was achievement of 100% granulation within 15 days. Secondary outcomes included mean time to complete granulation, number of dressing applications, duration of hospital stay and requirement for re-debridement. Categorical variables were analysed using the chi-square test, with $p<0.05$ considered statistically significant.

Results: Baseline demographic characteristics and ulcer severity were comparable between the two groups. Complete granulation within 15 days was achieved in 34 (68%) patients in the NPWT group compared with 21 (42%) in the conventional dressing group ($\chi^2=6.828$, $p=0.008$). Mean time to complete granulation was significantly lower with NPWT (13.98±5.155 days) than with conventional dressing (20.58±6.85 days). The mean number of dressing applications was 11.42±4.45 in Group A versus 17.56±6.459 in Group B ($\chi^2=16.327$, $p=0.0000533$). Mean hospital stay was significantly shorter with NPWT (22.72±9.075 days) compared with conventional treatment (39.92±12.47 days). Re-debridement was required in 6 (12%) patients in Group A compared with 22 (44%) patients in Group B ($\chi^2=12.69$, $p=0.000366$).

Conclusion: NPWT was associated with faster granulation, fewer dressing requirements, shorter hospital stay and reduced need for repeat debridement compared with conventional dressing. It appears to be an effective adjunct for appropriately selected Grade II and Grade III ulcers.

Keywords: Negative Pressure Wound Therapy; Vacuum-Assisted Closure; Chronic Ulcers; Wound Healing; Granulation Tissue; Conventional Dressing; Re-Debridement; Hospital Stay.

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Introduction

Chronic wounds and ulcers continue to represent a substantial clinical challenge because of their prolonged healing time, recurrent infection, repeated need for wound care and considerable healthcare-resource utilization. The problem is particularly important in patients with diabetes mellitus, peripheral vascular disease, neuropathy, immobility, malnutrition and other systemic conditions that interfere with normal tissue repair. Chronic ulcers may progress to deep tissue

infection, osteomyelitis, sepsis and, in severe cases, limb loss. Effective wound management therefore requires not only control of infection and removal of devitalized tissue but also optimization of the local wound environment to promote granulation, epithelialization and eventual wound closure. [1-6] Normal wound healing is a highly coordinated process consisting of overlapping phases of haemostasis, inflammation, proliferation and remodelling. Fibroblast proliferation, angiogenesis, extracellular-matrix deposition and epithelial migration are particularly important during the proliferative phase. Chronic wounds frequently fail to progress normally through these stages and remain in a state of persistent inflammation characterized by excessive protease activity, impaired angiogenesis, altered extracellular-matrix turnover and defective cellular proliferation. [7-10] Systemic factors such as diabetes, malnutrition, anaemia and vascular insufficiency further impair oxygen delivery and collagen synthesis, while local factors such as infection, excessive exudate, oedema, necrotic tissue and repeated mechanical trauma perpetuate delayed healing. [2,7,8]

Traditional wound management has historically relied on gauze, saline-moistened dressings, alginates, hydrocolloids and other conventional wound products. These dressings can maintain an adequately moist environment, absorb exudate and protect the wound from external contamination. They remain attractive because they are inexpensive, widely available and relatively simple to use. However, deeper and highly exudative ulcers may require frequent dressing changes, and conventional gauze may adhere to the wound bed, causing pain and mechanical disruption of newly formed granulation tissue during dressing changes. [11-13]

The concept of moist wound healing established that maintaining an appropriate degree of moisture can accelerate epithelialization compared with exposure to a dry wound environment. [14] Nevertheless, maintenance of optimal moisture alone may be insufficient for large, deep or highly exudative wounds. Effective wound-bed preparation requires control of necrotic tissue, infection, exudate, oedema and local mechanical stress. [11-13]

Negative pressure wound therapy (NPWT), commonly referred to as vacuum-assisted closure (VAC), introduced an important development in the management of complex wounds.

NPWT uses a sealed wound dressing connected to a suction source to apply controlled subatmospheric pressure to the wound bed. The technique produces both mechanical and biological effects. Macro deformation draws wound edges towards one another and reduces wound dimensions, while microdeformation at the wound interface stimulates cellular activity. These effects are associated with enhanced fibroblast activity, angiogenesis, extracellular-matrix formation and granulation tissue development. [15-18] NPWT also provides continuous removal of wound exudate and interstitial fluid, thereby reducing tissue oedema and local fluid accumulation. Improved control of exudate may help maintain a favourable moist wound environment and reduce periwound maceration. Experimental studies have additionally demonstrated changes in local microvascular blood flow with negative pressure, supporting the concept that NPWT can improve the physiological environment required for tissue repair. [17,19]

The clinical application of NPWT has expanded to diabetic foot ulcers, pressure ulcers, traumatic wounds, postoperative wounds, open fractures and other complex soft-tissue defects. Several randomized and prospective studies have reported more rapid granulation, reduced dressing requirements and improved wound outcomes compared with conventional wound treatment. [15-20] Armstrong and Lavery demonstrated beneficial effects of NPWT following partial diabetic foot amputation, while Vuerstaek et al. reported improved outcomes with VAC compared with modern wound dressings in chronic leg ulcers. [20,21]

Despite these advantages, NPWT has limitations. It requires specialized equipment, trained personnel and appropriate patient selection. Cost and equipment availability can be significant barriers, particularly in resource-limited healthcare systems. NPWT should not substitute for adequate debridement, vascular assessment, infection control, pressure off-loading or treatment of the underlying aetiology. Furthermore, bleeding, pain, periwound skin problems and device-related complications may occur. [15,22-25] The present study was undertaken to compare NPWT with conventional dressing treatment in patients with Grade II and Grade III ulcers. The principal outcomes assessed were the time required to achieve complete granulation, number of dressing applications, duration of hospital stay and requirement for re-debridement. The study is particularly relevant because these parameters reflect not only biological wound healing but also the practical burden of wound care on patients, nursing personnel and hospital resources.

Aim: The primary aim of this study was to compare the clinical effectiveness of negative pressure wound therapy with conventional dressing treatment in patients with Grade II and Grade III ulcers.

Objectives

1. To compare the proportion of patients achieving 100% granulation within 15 days between NPWT and conventional dressing groups.
2. To compare the mean duration required to achieve complete granulation tissue formation.
3. To compare the number of dressing applications required during treatment.
4. To compare the duration of hospital stay between the two treatment groups.
5. To compare the requirement for repeat surgical debridement.
6. To assess whether NPWT provides a clinically meaningful reduction in the overall burden of wound management.

Materials and Methods

Study Design and Population: The available study record describes a prospective, non-randomized comparative clinical study involving 100 patients with Grade II and Grade III ulcers. Patients were divided equally into two treatment groups of 50 patients each. Group A received negative pressure wound therapy, whereas Group B received conventional wound dressing treatment. The study documentation describes the comparison as controlled but specifically acknowledges the non-randomized nature of the study.

The study population consisted predominantly of patients with Grade III ulcers. In Group A, 31 patients had Grade III ulcers and 19 had Grade II ulcers, while Group B contained 33 patients with Grade III ulcers and 17 with Grade II ulcers. The difference in baseline ulcer grade was not statistically significant (χ^2=0.174, p=0.676), indicating comparable ulcer severity between the groups.

Because the source document does not provide the original recruitment dates, study centre, formal sample-size calculation or detailed eligibility criteria, these methodological details should be inserted from the original study protocol and institutional records before submission.

Group Allocation and Intervention: Fifty patients were treated with NPWT and constituted Group A, while 50 patients received conventional wound dressings and constituted Group B. There was no cross-over between the documented treatment groups.

For NPWT, the wound was managed using a sealed dressing connected to a negative-pressure suction system. The therapeutic principle involves continuous evacuation of wound exudate and interstitial fluid while maintaining controlled subatmospheric pressure over the wound surface. The source document describes the principal mechanisms as macrodeformation, microdeformation, enhanced granulation, oedema and exudate control, improved local perfusion and reduction of wound contamination.

Conventional wound management consisted of standard wound dressing procedures. Traditional dressing systems are designed to protect the wound, maintain moisture balance, absorb exudate and facilitate wound-bed preparation. However, frequent replacement may be necessary, particularly in wounds with substantial exudate.

All patients were managed according to the principles of appropriate wound care, including wound assessment, debridement where indicated and management of infection and underlying wound-related factors. The precise dressing products, NPWT pressure settings, dressing-change interval and antibiotic protocols were not specified in the source document and should be added from the original case records.

Outcome Measures: The primary wound-healing outcome was the time required to achieve 100% granulation tissue. Patients were categorized according to whether complete granulation occurred within 15 days or after 15 days.

Secondary outcomes included:

- Number of dressing applications required during treatment.
- Duration of hospital stay, categorized as ≤30 days or >30 days.
- Mean duration of hospitalization.
- Requirement for repeat wound debridement.

Statistical Analysis: Categorical variables were compared using the chi-square test. Continuous variables were summarized using means and standard deviations, with 95% confidence intervals reported in the original dataset. A p value <0.05 was considered statistically significant. The source document reports chi-square statistics and corresponding p values for the major categorical outcomes.

The original document does not identify the statistical software used. This should be added before submission.

Results

Baseline Demographic Characteristics: A total of 100 patients were included, with 50 patients in each treatment group. Group A comprised 32 males and 18 females, whereas Group B comprised 30 males and 20 females. Overall, the cohort consisted of 62 males and 38 females. The difference in sex distribution was not statistically significant (χ^2=0.17, p=0.68), demonstrating satisfactory demographic comparability between the treatment groups.

The age distribution was also similar between groups. In Group A, 2 patients were aged <30

years, 5 were aged 31–40 years, 18 were aged 41–50 years, 17 were aged 51–60 years and 8 were aged >60 years. Corresponding numbers in Group B were 1, 6, 19, 17 and 7 patients, respectively. The difference was not statistically significant (χ^2=0.04, p=0.84). The majority of patients in both groups were between 41 and 60 years of age (Table 1).

Table 1: Demographic Characteristics

Dressing	VAC	Conventional	Male	Female	< 60 Years	>60 Years
Group A	50	0	32	18	92	8
Group B	0	50	30	20	93	7
Total	50	50	62	38	185	15

Ulcer grade: Grade III ulcers constituted the majority of the study population. Group A included 31 Grade III and 19 Grade II ulcers, whereas Group B included 33 Grade III and 17 Grade II ulcers. The difference was statistically nonsignificant (χ^2=0.174, p=0.676). Thus, the two groups were reasonably balanced with respect to ulcer severity at baseline (TABLE 2)

Table 2: Ulcer Grade and Complete Granulation

	Grade 2 Ulcer	Grade 3 Ulcer
Group A	19	31
Group B	17	33
Total	36	64

Time to Complete Granulation: A major difference was observed in the time required to achieve 100% granulation tissue.

In the NPWT group, 34 of 50 patients (68%) achieved complete granulation within 15 days, compared with 21 of 50 patients (42%) in the conventional dressing group. Conversely, 16 patients (32%) in Group A and 29 patients (58%) in Group B required more than 15 days to achieve complete granulation.

This difference was statistically significant (χ^2=6.828, p=0.008). The mean time to complete granulation was 13.98±5.155 days in the NPWT group compared with 20.58±6.85 days in the conventional group. The mean difference was approximately 6.60 days in favour of NPWT. The 95% confidence interval reported in the source was ±1.429 days for Group A and ±1.90 days for Group B.

Thus, patients receiving NPWT achieved complete granulation approximately one week earlier than those receiving conventional dressings. The proportion achieving granulation within 15 days was approximately 1.62 times higher with NPWT (TABLE 3).

Table 3: Appearance of Complete Granulation

	Granulation <15 Days	Granulation > 15 Days	Mean (Days)	Sd
Group A	34	16	13.98	5.155
Group B	21	29	20.58	6.85
Total	55	45		

Number of dressing applications: A substantial reduction in dressing requirements was observed in the NPWT group. Twenty-six patients (52%) in Group A required fewer than 10 dressing applications, whereas only 7 patients (14%) in Group B required fewer than 10 applications. Conversely, 24 patients (48%) in Group A required more than 10 dressings compared with 43 patients (86%) in Group B. The difference was highly statistically significant (χ^2=16.327, p=0.0000533). The mean number of dressing applications was 11.42±4.45 in the NPWT group and 17.56±6.459 in the conventional group.

Therefore, NPWT was associated with an average reduction of approximately 6.14 dressing applications per patient, representing a reduction of approximately 35% compared with conventional treatment (TABLE 4).

Table 4: Number Of Dressing Required:

	<10 Dressing	>10 Dressing	Mean	Sd
Group A	26	24	11.42	4.45
Group B	7	43	17.56	6.459
Total	33	67		

Duration of hospital stay

Hospitalization was substantially shorter among patients treated with NPWT. Thirty-one of 50 patients (62%) in Group A were discharged within 30 days compared with only 14 of 50 patients (28%) in Group B. Nineteen patients (38%) in Group A remained hospitalized for more than 30 days compared with 36 patients (72%) in Group B. The difference was statistically significant (χ^2=11.677, p=0.000063). The mean hospital stay was 22.72±9.075 days in the NPWT group compared with 39.92±12.47 days in the conventional group.

The mean reduction was approximately 17.2 hospital days per patient. Thus, the probability of discharge within 30 days was more than twice as high in the NPWT group compared with the conventional dressing group (TABLE 5).

Table 5: Duration of Hospital Stay:

	<30 Days	>30 Days	Mean	Sd
Group A	31	19	22.72	9.075
Group B	14	36	39.92	12.47
Total	45	55		

Requirement for re-debridement: Repeat debridement was required in only 6 patients (12%) in Group A compared with 22 patients (44%) in Group B. Forty-four patients (88%) receiving NPWT did not require re-debridement, compared with 28 patients (56%) treated conventionally.

The difference was statistically significant (χ^2=12.69, p=0.000366).

The absolute reduction in the requirement for re-debridement was 32 percentage points. In practical terms, approximately three additional patients would avoid re-debridement for every 10 patients treated with NPWT rather than conventional dressing, based on the observed study data.

Discussion

The present study demonstrates clinically and statistically significant advantages of NPWT over conventional dressing treatment in Grade II and Grade III ulcers. The most important findings were earlier complete granulation, fewer dressing applications, shorter hospitalization and substantially lower requirement for repeat debridement.

The baseline comparability of the two groups strengthens interpretation of these findings. There were no statistically significant differences in sex, age or ulcer grade between treatment groups. Both groups contained a similar proportion of Grade III ulcers, suggesting that the observed differences in wound outcomes were unlikely to be explained simply by an imbalance in initial ulcer severity.

Effect on granulation: The most direct biological benefit observed was acceleration of granulation. Sixty-eight percent of patients treated with NPWT achieved complete granulation within 15 days compared with 42% receiving conventional treatment. The mean time to complete granulation was also reduced by approximately 6.6 days. This finding is biologically plausible because NPWT acts through several complementary mechanisms. Negative pressure causes macrodeformation of the wound, reducing wound dimensions and approximating the wound edges. At the cellular level, microdeformation stimulates fibroblast proliferation, endothelial activity and extracellular-matrix formation. These processes promote the development of healthy granulation tissue and establish a vascularized wound bed suitable for subsequent epithelialization, secondary closure or grafting. [15-18]

Morykwas and Argenta originally demonstrated the physiological basis for VAC therapy, while subsequent experimental work has demonstrated effects on wound perfusion and cellular responses. [15,16,19] The current study's finding of a mean granulation time of 13.98 days with NPWT is therefore consistent with the proposed biological mechanism.

The findings are also consistent with previous comparative studies. Joseph et al. reported favourable outcomes with VAC compared with standard therapy in chronic non-healing wounds. Mouës et al. demonstrated advantages of VAC compared with conventional gauze therapy, while Vuerstaek et al. reported improved wound management using VAC compared with modern wound dressings. [17,20,21]

However, faster granulation should not automatically be equated with definitive wound closure. Granulation is one stage of the healing process, and final healing depends on epithelialization, wound size, underlying perfusion, infection control and management of the underlying cause. Therefore, the present finding should be interpreted as accelerated wound-bed preparation rather than proof of universal superiority for complete wound closure.

Reduction in dressing requirements: The NPWT group required significantly fewer dressing applications. The mean number of dressing applications was 11.42 compared with 17.56 with conventional care. This represents an approximately 35% reduction.

The clinical importance of this reduction extends beyond convenience. Every dressing change may expose the wound to mechanical trauma, contamination and pain. Conventional gauze may adhere to newly formed granulation tissue and disrupt the wound surface during removal. [11,12] Frequent dressing changes also consume nursing time, dressing materials and procedural resources.

NPWT maintains a sealed environment and allows the wound to remain undisturbed for longer periods while exudate is continuously removed. This may explain the lower dressing burden observed in the present study. The reduction in dressing frequency is particularly relevant in high-volume hospitals and resource-constrained settings where nursing manpower and dressing materials represent substantial healthcare costs.

The economic implications are also supported by previous randomized studies. Apelqvist et al. demonstrated important differences in resource utilization and economic costs associated with VAC therapy in diabetic foot wounds. [22] Thus, although the initial acquisition and application costs of NPWT may be greater than those of conventional dressings, the total cost of care may be influenced by reduced dressing frequency, shorter hospitalization and fewer repeat procedures.

Reduction in hospital stay: One of the most clinically significant findings was the reduction in hospital stay. The mean hospitalization was 22.72 days with NPWT compared with 39.92 days with conventional treatment, representing an average reduction of 17.2 days.

Hospital length of stay is a composite outcome influenced by wound healing, infection, need for debridement, readiness for definitive closure and general medical condition. The magnitude of reduction observed in this study is therefore clinically important. Faster granulation and fewer repeat debridements may have contributed to earlier readiness for discharge.

Previous studies have similarly reported reductions in hospitalization or treatment duration with NPWT in selected wound populations. Armstrong and Lavery demonstrated benefits of NPWT in diabetic foot wounds, while Vuerstaek et al. reported improved healing-related outcomes in chronic leg ulcers. [20,21] The present study extends these observations to a mixed Grade II and Grade III ulcer population.

Nevertheless, hospitalization should be interpreted cautiously because discharge decisions may depend on institutional practice, availability of outpatient wound-care facilities and social factors. The source study does not provide detailed information regarding these variables.

Reduction in repeat debridement: The requirement for re-debridement was 12% in the NPWT group compared with 44% in the conventional group. This represents an absolute reduction of 32 percentage points and a relative reduction of approximately 73%.

Repeat debridement is clinically important because it exposes patients to additional procedures, anaesthesia where required, postoperative pain and additional healthcare expenditure. Repeated mechanical disruption may also delay healing by removing newly formed tissue.

The lower requirement for re-debridement in the NPWT group may reflect improved exudate evacuation, more rapid development of healthy granulation tissue and better stabilization of the wound environment. However, NPWT cannot substitute for adequate initial surgical debridement. Necrotic tissue, abscesses, osteomyelitis and uncontrolled infection require appropriate surgical management. The source document itself emphasizes that NPWT should complement rather than replace debridement and infection control.

Clinical implications: The combined effect of faster granulation, fewer dressing changes, shorter hospital stay and fewer re-debridements suggests that NPWT may reduce both the biological and logistical burden of managing complex ulcers.

The greatest potential benefit may occur in wounds that are deep, moderately or heavily exudative, difficult to dress repeatedly or require preparation for subsequent grafting or secondary closure. NPWT can continuously remove exudate while providing mechanical stabilization and a controlled wound environment. [15,18,23]

However, appropriate patient selection remains essential. NPWT should be used cautiously in wounds with exposed major vessels, uncontrolled bleeding, untreated necrosis or inadequately controlled infection. Bleeding and periwound skin complications are recognized potential adverse effects. The uploaded document specifically discusses the risks of bleeding, maceration, contact dermatitis and pain associated with wound treatment.

Similarly, advanced wound technology should not distract from correction of the underlying cause. Peripheral arterial disease requires vascular assessment and, when indicated, revascularization. Pressure ulcers require pressure redistribution and off-loading. Diabetic ulcers require glycaemic optimization, neuropathy management and appropriate footwear or off-loading. Malnutrition requires nutritional assessment and correction. Without addressing these factors, even an advanced dressing may fail to achieve durable healing.

Strengths and limitations: The principal strength of this study is the prospective comparison of two treatment approaches with equal group sizes and standardized reporting of clinically meaningful wound-care outcomes. The groups were statistically comparable in sex, age and ulcer grade, reducing concerns about major baseline imbalance. The study evaluated outcomes that are directly relevant to clinical practice and resource utilization.

The limitations must nevertheless be acknowledged. First, the study was non-randomized, creating the possibility of selection bias. Although baseline variables were comparable, unmeasured confounding factors could have influenced treatment allocation and outcomes.

Second, the sample size of 100 patients is relatively small compared with large multicentre randomized trials. Third, the study did not report long-term wound recurrence, definitive wound closure, quality of life, pain scores or detailed cost-effectiveness outcomes.

In addition, the available study document does not specify the exact NPWT pressure used, detailed dressing protocols, wound aetiology distribution, antibiotic strategy, vascular status or precise inclusion and exclusion criteria. These details are important because the effectiveness of NPWT can vary according to wound type, perfusion, infection status and depth. These methodological details should therefore be incorporated from the original study records before journal submission.

Finally, the present results demonstrate superiority of NPWT for the measured outcomes but should not be generalized to every chronic wound. The evidence base indicates that NPWT is most useful when integrated into comprehensive wound-bed preparation rather than used as an isolated intervention. [23-25]

Conclusion

In this prospective comparative study of 100 patients with Grade II and Grade III ulcers, negative pressure wound therapy was associated with significantly faster granulation, fewer dressing applications, shorter hospitalization and a lower requirement for repeat debridement compared with conventional dressing treatment. Complete granulation within 15 days occurred in 68% of patients receiving NPWT compared with 42% receiving conventional treatment. The mean time to complete granulation was 13.98 days versus 20.58 days. NPWT reduced the mean number of dressing applications from 17.56 to 11.42 and reduced mean hospital stay from 39.92 to 22.72 days. Repeat debridement was required in only 12% of NPWT-treated patients compared with 44% of patients treated conventionally.

These findings suggest that NPWT can provide an efficient method of wound-bed preparation and may reduce the overall burden of care in appropriately selected Grade II and Grade III ulcers. Its advantages appear to extend beyond faster granulation to include fewer dressing procedures, reduced hospitalization and fewer repeat surgical interventions.

Nevertheless, NPWT should be regarded as an adjunct to comprehensive wound management rather than a substitute for adequate debridement, infection control, vascular optimization, pressure off-loading and correction of systemic factors. Larger, multicentre randomized controlled trials with standardized NPWT protocols, long-term healing outcomes, quality-of-life assessment and formal cost-effectiveness analysis are required to establish the broader applicability and economic value of NPWT.

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