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A COMPARATIVE STUDY OF NEGATIVE PRESSURE DRESSING VERSUS CONVENTIONAL MOIST DRESSING IN THE MANAGEMENT OF ULCERS

General Surgery

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ABSTRACT

Background: Chronic ulcers remain a significant surgical problem because of delayed healing and high morbidity. Conventional moist dressing (CMD) is the long-standing standard of care but offers limited active stimulation of tissue regeneration, whereas negative pressure dressing (NPD) is believed to enhance wound bed preparation. This study compared NPD with CMD in the management of ulcers of varied aetiology. **Methods:** A prospective comparative study was carried out on 64 patients admitted with ulcers at a tertiary care teaching hospital, allocated by simple randomisation (chits method) to CMD (n = 32) or NPD (n = 32). Healing time, rate and time to complete granulation tissue formation, number of dressings, hospital stay and requirement for skin grafting were recorded and analysed. **Results:** Baseline age, gender distribution, ulcer duration, ulcer size, comorbidity status and smoking habit were comparable between groups ($p > 0.05$). Time to complete granulation tissue formation was significantly shorter with NPD (13.38 ± 3.10 days) than CMD (22.94 ± 9.89 days; $p < 0.001$). The number of dressings required was markedly lower with NPD (3.00 ± 1.02) than CMD (15.38 ± 6.19; $p < 0.001$), and hospital stay was shorter with NPD (19.53 ± 3.39 days) than CMD (31.13 ± 10.81 days; $p < 0.001$). Skin grafting was required more often in the NPD group (68.8% vs 28.1%; $p = 0.001$), reflecting earlier readiness of the wound bed. **Conclusion:** Negative pressure dressing significantly accelerates granulation tissue formation, reduces dressing frequency and shortens hospital stay compared with conventional moist dressing, and should be considered a preferred modality in the management of chronic and non-healing ulcers.

KEYWORDS

Negative Pressure Dressing, Conventional Moist Dressing, Chronic Ulcers, Granulation Tissue, Wound Healing, NPWT

1. INTRODUCTION

Chronic ulceration is one of the most demanding problems in surgical practice, marked by considerable patient morbidity, high recurrence and substantial economic burden [1]. Historical descriptions, dating back to Hippocrates, recognised the association between venous disease and ulceration, though early management strategies were often counterproductive. Wound care has since evolved from empirical topical remedies to structured, evidence-based protocols.

Once systemic pathology has been addressed, the central objective in chronic wound management becomes wound bed preparation—the process of removing barriers that keep a wound arrested in the inflammatory phase. The TIME framework (Tissue, Infection, Moisture balance and Edge advancement), introduced in 2002, provides a systematic method of identifying and correcting these barriers before advanced interventions are considered [2]. Effective healing requires a clean, well-granulated wound bed, absence of infection and a balanced moisture environment; conventional dressings frequently fall short of sustaining all three conditions simultaneously.

Negative pressure dressing (also referred to as negative pressure wound therapy(NPWT) or vacuum-assisted closure(VAC)) accelerates healing through a combination of mechanical and physiological effects. At the macroscopic level it generates a centripetal force that draws wound margins together, reducing wound surface area, while at the microscopic level it induces microstrain at the tissue–foam interface [3,4]. These mechanical forces act as a stimulus for mechano-transduction, promoting cellular migration and mitosis that are essential for new tissue formation[5]. NPD also modulates local fluid dynamics: continuous removal of exudate reduces interstitial oedema and decompresses the microvasculature, improving oxygen and nutrient delivery to the wound bed[6]. The closed, occlusive environment further assists microbial clearance, maintains optimal moisture and reduces the need for daily dressing changes, thereby lowering both patient discomfort and nursing workload [7,8].

Randomised and observational studies have reported that NPWT accelerates wound closure even in long-standing wounds that were previously unresponsive to conventional treatment, and pooled analyses of controlled trials have shown faster granulation, reduced healing time and fewer complications with NPWT compared with conventional dressing [9,10]. However, much of this evidence originates from studies focused predominantly on diabetic foot ulcers, and comparative data across a broader case-mix of ulcer aetiologies from Indian tertiary care settings remain limited. This study was therefore undertaken to compare NPD with CMD across a heterogeneous cohort of chronic and traumatic ulcers, with the hypothesis that NPD provides faster healing and better granulation tissue formation over a shorter treatment duration than CMD.

2. Objectives

- To determine the outcome of ulcers following conventional moist dressing (CMD).
- To determine the outcome of ulcers following negative pressure dressing (NPD).
- To assess the healing rate and rate of granulation tissue formation following the two procedures.

3. MATERIALS AND METHODS

3.1 Study Design and Setting

This was a prospective, comparative, non-blinded study conducted in the Department of General Surgery, Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka, a tertiary referral centre with a dedicated wound-care infrastructure for diabetic foot, venous, traumatic and pressure ulcers. Patients admitted with ulcers in the male and female surgical wards were enrolled and followed over a defined period, allowing comparison of healing outcomes between the two dressing modalities. Group allocation was based on simple randomisation using the chits method; blinding was not feasible given the nature of the interventions.

3.2 Study Duration

The study was conducted over a period of 24 months from the time of initial patient recruitment, a duration considered adequate to capture healing outcomes, recurrence and complications across a diverse patient population and to allow reliable comparison of the two treatment arms.

3.3 Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients aged 18 years or older, of either sex, with an ulcer confirmed by clinical examination and, where necessary, radiography or Doppler study.
- Patients willing to provide informed consent and follow the prescribed care regimen.
- Traumatic wounds.
- Full-thickness surgical wounds.
- Chronic wounds.
- Stage 3 and 4 pressure ulcers.
- Diabetic ulcers.
- Arterial and venous ulcers.

Exclusion Criteria

- Immunocompromised patients, including those with HIV/AIDS or on long-term steroid, chemotherapy or radiotherapy.
- Age below 18 years.
- Absence of written informed consent or inability to comply with the study protocol.
- Malignant ulcers.
- Necrotic tissue with eschar.
- Untreated osteomyelitis.
- Fistulas.
- Wounds exposing arteries.
- Freshly anastomosed blood vessels.
- Patients on anticoagulant therapy.
- Open wounds associated with fractures.

3.4 Sampling and Sample Size

A purposive sampling method was used; all patients admitted during the study period who satisfied the inclusion and exclusion criteria were considered, and eligible patients were randomised by the chits method to the CMD or NPD arm. The sample size was derived using the standard formula for comparison of means, $n = 2[Z(1-\alpha/2) + Z(1-\beta)]^2 \cdot \sigma^2/d^2$, with the appearance of granulation tissue (in days) as the primary outcome variable, a 5% level of significance (Z = 1.96), 90% power (Z = 1.24), a pooled standard deviation of 7.855 days and an effect size of 6.1 days. This yielded a sample size of 64 patients (32 per group), providing adequate power to detect a clinically meaningful difference in granulation tissue formation between the two dressing modalities.

3.5 Study Groups and Procedure

Patients were assigned to one of two groups: (i) the CMD group, managed with standard conventional moist dressing changed as required by soakage, and (ii) the NPD group, managed with negative pressure dressing renewed on average every 2–5 days depending on ulcer size and suction patency. Following admission, all patients underwent detailed clinical evaluation, relevant investigations (complete blood count, glycaemic profile, serology, Doppler or radiography where indicated, and pus culture and sensitivity) and debridement where necessary, followed by informed consent and randomisation. Patients were monitored throughout hospitalisation for complications and followed up to assess healing progress, need for definitive surgery, and recurrence.

3.6 Study Parameters

- Number of days required for healing — total duration from initiation of treatment to complete wound healing or readiness for definitive closure.
- Number of dressings performed overall.
- Rate of granulation tissue formation, expressed as percentage of ulcer surface area covered by healthy granulation tissue at predetermined intervals.
- Period of hospital stay, from admission to discharge following adequate wound management.
- Time taken to achieve complete granulation tissue formation over the ulcer bed.

3.7 Data Collection and Ethical Considerations

Data were recorded on a structured case record form covering sociodemographic details, clinical and laboratory parameters and follow-up visits, with all interviews and assessments conducted by the principal investigator. Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was taken from all participants prior to enrolment.

3.8 Statistical Analysis

Data were entered into a spreadsheet for cleaning and preliminary organisation. Descriptive statistics (mean, median, standard deviation and frequency distribution) were used to summarise baseline and outcome variables. Continuous variables such as granulation tissue formation and healing time were compared between groups using the unpaired Student's t-test, while categorical variables were compared using the chi-square test. Healing time and recurrence were additionally analysed using Kaplan–Meier survival analysis. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS software, version 22.

4. RESULTS

A total of 64 patients were enrolled, 32 in each group. Baseline demographic and clinical characteristics were comparable between the CMD and NPD groups, confirming that any differences in outcome could be attributed to the dressing modality rather than confounding factors.

4.1 Demographic and Baseline Characteristics

The mean age was 47.16 ± 12.71 years in the CMD group and 53.19 ± 12.49 years in the NPD group (p = 0.060). Males slightly outnumbered females in both groups (CMD 53.1% vs 46.9%; NPD 56.2% vs 43.8%; $\chi^2 = 0.063$, p = 0.802). Mean ulcer duration before treatment was 25.53 ± 22.10 days in the CMD group and 17.69 ± 18.79 days in the NPD group (p = 0.131), and mean ulcer size was 50.13 ± 70.24 cm² in the CMD group versus 81.31 ± 85.13 cm² in the NPD group (p = 0.115). Comorbidities were present in 56.3% of CMD patients and 68.8% of NPD patients ($\chi^2 = 1.067$, p = 0.302), and smoking status was identical in both groups (34.4% smokers, 65.6% non-smokers; p = 1.000). None of these baseline differences reached statistical significance.

Table 1. Baseline Demographic and Clinical Characteristics of the Two Groups

Parameter	CMD (n = 32)	NPD (n = 32)	Test statistic	p-value
Mean age (years)	47.16 ± 12.71	53.19 ± 12.49	t = −1.914	0.060
Male: Female	17:15 (53.1%:46.9%)	18:14 (56.2%:43.8%)	$\chi^2 = 0.063$	0.802
Ulcer duration (days)	25.53 ± 22.10	17.69 ± 18.79	t = 1.530	0.131
Ulcer size (cm²)	50.13 ± 70.24	81.31 ± 85.13	t = −1.599	0.115
Comorbidities present	18/32 (56.3%)	22/32 (68.8%)	$\chi^2 = 1.067$	0.302
Smokers	11/32 (34.4%)	11/32 (34.4%)	$\chi^2 = 0.000$	1.000

4.2 Primary Healing Outcomes

The mean rate of granulation tissue formation, expressed as a percentage of ulcer surface area, was comparable between groups (CMD 24.53 ± 12.14% vs NPD 26.00 ± 14.28%; t = −0.443, p = 0.659). However, the time taken to achieve complete granulation tissue formation was significantly shorter with NPD (13.38 ± 3.10 days) than with CMD (22.94 ± 9.89 days; t = 5.220, p < 0.001), an approximate 42% reduction in granulation time.

The number of dressing changes required was markedly and significantly lower in the NPD group (3.00 ± 1.02) than the CMD group (15.38 ± 6.19; t = 11.161, p < 0.001), representing an approximate 80% reduction in dressing frequency. Mean hospital stay was significantly shorter with NPD (19.53 ± 3.39 days) than CMD (31.13 ± 10.81 days; t = 5.787, p < 0.001), an approximate 37% reduction. Skin grafting was required significantly more often in the NPD group (68.8%) than the CMD group (28.1%; $\chi^2 = 10.573$, p = 0.001), consistent with earlier attainment of a healthy, graft-ready wound bed rather than greater wound severity.

Table 2. Comparison of Primary Healing Outcomes Between CMD and NPD Groups

Outcome parameter	CMD (n = 32)	NPD (n = 32)	Test statistic	p- value
Rate of granulation tissue formation (%)	24.53 ± 12.14	26.00 ± 14.28	t = −0.443	0.659
Time to complete granulation (days)	22.94 ± 9.89	13.38 ± 3.10	t = 5.220	<0.001*
Number of dressings	15.38 ± 6.19	3.00 ± 1.02	t = 11.161	<0.001*

Hospital stay (days)	31.13 ± 10.81	19.53 ± 3.39	t = 5.787	<0.001*
Skin grafting required, n (%)	9 (28.1%)	22 (68.8%)	χ^2 = 10.573	0.001*

**p < 0.05 was considered statistically significant.*

Overall, across every measured healing parameter — granulation speed, dressing frequency, hospital stay and readiness for grafting — negative pressure dressing consistently outperformed conventional moist dressing, while baseline demographic and clinical characteristics remained closely matched between groups.

Figure 1. Clinical Photographs Demonstrating Negative Pressure Wound Therapy.
(A) Wound After Debridement Before NPWT. (B) NPWT Dressing in Situ. (C) Healthy Granulation Tissue After NPWT Showing a Graft-ready Wound Bed.

5. DISCUSSION

Chronic and non-healing ulcers remain a major surgical challenge because of delayed healing, repeated hospital visits and high treatment costs [11]. Conventional moist dressing has long been the mainstay of wound care, but its limited capacity to actively accelerate healing has driven interest in adjunctive modalities such as negative pressure dressing, which optimises the wound environment and promotes tissue regeneration.

The demographic profile in the present cohort, with a male predominance and comparable mean age between arms, mirrors that reported in earlier comparative studies of NPWT and conventional dressing [12,13,14,15]. The absence of significant baseline differences in age, gender, ulcer duration, ulcer size, comorbidity and smoking status indicates that the two groups were well matched, so that differences in outcome can reasonably be attributed to the dressing modality rather than to confounding patient factors [16,17].

The significantly shorter time to complete granulation tissue formation observed with NPD in this study is consistent with prior reports: Priyatham et al. described granulation times of 14–18 days with VAC compared with 28–30 days with conventional dressing [20]; Dsouza et al. reported 8.5 days versus 15.6 days [19]; and Kajagar and Joshi similarly found faster granulation with VAC [18]. This reproducibility across independent cohorts strengthens confidence in the biological plausibility of sub-atmospheric pressure promoting angiogenesis and fibroblast activity through mechanotransduction and improved microcirculation [3,4,5,6].

A marked reduction in the number of dressing changes with NPD, seen in this study, has similarly been reported by Kajagar et al. and Dsouza et al., who described infrequent NPWT dressing changes compared with daily conventional dressing [18,19]. Fewer dressing changes translate into reduced patient discomfort and nursing workload, an advantage also emphasised by Mouës et al. and Joseph et al. in their evaluation of VAC therapy [7,8].

Hospital stay was significantly shorter with NPD, a finding paralleled by Priyatham et al. (32.4 vs 59.4 days), Shah et al., and the meta-analysis by Wang et al., which similarly reported reduced treatment duration with NPWT compared with conventional moist dressing across multiple randomised trials [10,14,15,20]. Shorter hospitalisation reflects faster wound progression and earlier readiness for definitive closure, with favourable implications for cost-effective resource utilisation [9,10].

The higher rate of skin grafting in the NPD group is best interpreted as a marker of earlier development of a healthy, vascularised wound bed rather than greater wound severity, a pattern also described by Kajagar et al. and Dsouza et al. [18,19]. Early attainment of a graft-ready bed shortens overall treatment duration and improves the likelihood of successful graft uptake [9].

Comorbidities and smoking status did not significantly influence healing outcomes in either group in the present study, consistent with earlier reports that these systemic factors do not independently alter the comparative efficacy of NPWT versus conventional dressing when evenly distributed between groups [15,16,17]. This supports the conclusion that the dressing modality itself, rather than patient-related systemic factors, was the principal determinant of healing efficiency in this cohort.

Taken together, these findings reinforce a substantial and consistent body of literature — including Indian tertiary-centre studies such as those of Reddy et al. and Samaddar et al. — demonstrating the superiority of negative pressure dressing over conventional moist dressing across multiple healing parameters in ulcers of varied aetiology [12,13].

5.1 Strengths

The prospective comparative design permitted direct evaluation of NPD and CMD under similar clinical conditions, with well-matched baseline characteristics and systematic assessment of multiple objective outcome parameters. Standardised protocols for wound assessment and dressing application, along with inclusion of patient-related factors such as comorbidities and smoking, add to the clinical relevance and real-world applicability of the findings.

5.2 Limitations

The study was conducted at a single tertiary centre with a relatively modest sample size, which may limit generalisability. Blinding was not feasible given the nature of the interventions. Long-term outcomes such as ulcer recurrence, late complications and formal cost-effectiveness analysis were not assessed, and microbiological or biochemical markers of healing were not evaluated. Follow-up was limited to the healing phase.

5.3 Recommendations and Future Directions

Based on these findings, negative pressure dressing may be considered a preferred modality for chronic and non-healing ulcers, particularly large, deep or slow-healing wounds, while conventional moist dressing may remain appropriate for smaller or uncomplicated ulcers. Adequate training of surgical staff in the application and monitoring of negative pressure systems, individualised patient selection, and early initiation after debridement are advisable. Larger multicentre trials with longer follow-up, formal cost-effectiveness analysis, and studies focused on specific ulcer aetiologies would help refine and validate treatment protocols further.

6. CONCLUSION

In this prospective comparative study of 64 patients, negative pressure dressing significantly accelerated granulation tissue formation, reduced the number of dressing changes required and shortened hospital stay compared with conventional moist dressing, while enabling earlier readiness for definitive wound closure, including skin grafting. Baseline demographic and clinical factors, including comorbidities and smoking, did not significantly influence outcomes, indicating that the dressing modality itself was the principal determinant of healing efficiency. These findings, consistent with existing literature, support the use of negative pressure dressing as an effective and reliable modality in the management of chronic and non-healing ulcers.

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