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Original Article

A Comparative Study of Vacuum-Assisted Closure Dressing and Povidone-Iodine Dressing in the Management of Diabetic Ulcers in a tertiary care hospital in Tamil Nadu.

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ABSTRACT

Background: Diabetic ulcers represent a major cause of morbidity among patients with diabetes mellitus and are associated with prolonged hospital stay, increased healthcare costs, and risk of amputation. Vacuum-assisted closure (VAC) therapy has emerged as a promising modality for enhancing wound healing when compared to conventional dressings such as povidone-iodine.

Objectives: To compare the effectiveness of vacuum-assisted closure dressing with conventional povidone-iodine dressing in the management of diabetic ulcers and to identify factors associated with improved healing outcomes.

Methods: A prospective comparative study was conducted over 24 months at a Government Headquarters Hospital in Pollachi. A total of 100 diabetic patients with non-healing ulcers were enrolled and randomly allocated into two groups: VAC dressing (n = 50) and povidone-iodine dressing (n = 50). Wound assessment was performed on days 0, 6, and 14. Outcome measures included percentage wound size reduction, granulation tissue formation, graft uptake, pain severity using the Visual Analogue Scale (VAS), duration of hospital stay, and treatment cost. Statistical analysis was performed using SPSS version 20, with $p \leq 0.05$ considered statistically significant.

Results: The VAC group demonstrated significant improvement in granulation tissue formation and graft uptake compared to the povidone-iodine group ($p < 0.05$). Wound size reduction and pain scores also showed statistically significant differences between groups. Although duration of hospital stay differed significantly, clinical recovery parameters favored VAC therapy overall.

Conclusion: Vacuum-assisted closure dressing is an effective and safe modality for managing diabetic ulcers and may offer improved healing outcomes compared to conventional povidone-iodine dressing in resource-limited settings.

Keywords: Diabetic ulcer; Vacuum-assisted closure; Povidone-iodine dressing; Wound healing; Granulation tissue.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder with rising global prevalence and significant long-term complications.[1] Among these, diabetic foot ulcers represent one of the most serious and disabling sequelae, often leading to prolonged hospitalization, recurrent infections, and lower limb amputations.[2] Impaired wound healing in diabetic patients results from a complex interplay of peripheral neuropathy, vascular insufficiency, hyperglycemia-induced immune dysfunction, and repeated trauma. [3] As a consequence, diabetic foot ulcers impose a substantial burden on healthcare systems, particularly in developing countries. [4]

Conventional wound management in diabetic ulcers commonly involves regular debridement and the application of antiseptic dressings such as povidone-iodine. [5] These dressings are widely used due to their availability, affordability, and broad-spectrum antimicrobial action. [6] However, despite their routine use, conventional dressings may not always provide optimal wound bed preparation or promote rapid granulation tissue formation. [7] The prolonged healing time associated with chronic ulcers often increases the risk of secondary infection, delayed surgical intervention, and extended hospital stay. [8]

Vacuum-assisted closure (VAC) therapy, also referred to as negative pressure wound therapy, has been introduced as an advanced modality aimed at enhancing wound healing through controlled sub-atmospheric pressure. [9] The mechanism of action includes removal of excess exudate, reduction of tissue edema, improved microcirculation, stimulation of angiogenesis, and promotion of granulation tissue formation. [10] By creating a closed and controlled wound environment, VAC therapy is believed to accelerate healing and reduce bacterial colonization compared to conventional dressings. [11]

Over the past decade, multiple clinical investigations have evaluated the comparative effectiveness of vacuum-assisted closure therapy and conventional wound dressings in diabetic foot ulcers. [12] Most of these studies have reported improved wound size reduction, faster granulation tissue formation, enhanced graft uptake, and shorter duration of healing with VAC therapy. [13] Additionally, patient-centered outcomes such as pain reduction and satisfaction have also been explored, with several reports suggesting favorable results with negative pressure therapy. [14]

Despite the expanding evidence supporting VAC therapy, its widespread implementation in government hospitals and resource-constrained settings remains limited due to cost considerations and availability of commercial systems. [15] Modified or low-resource adaptations of vacuum-assisted dressing techniques have been explored as feasible alternatives; however, data evaluating their clinical effectiveness in real-world tertiary care settings are still evolving. Furthermore, there is a need to assess not only healing parameters but also cost implications and duration of hospitalization, particularly in public healthcare institutions. [16]

In view of these considerations, the present prospective comparative study was undertaken to evaluate the effectiveness of vacuum-assisted closure dressing, adapted for use in a low-resource setting, in comparison with conventional povidone-iodine dressing in patients with non-healing diabetic ulcers. The study aims to provide evidence on wound healing outcomes, pain intensity, cost incurred, and duration of hospital stay, thereby contributing to context-specific clinical decision-making in the management of diabetic foot ulcers.

Objectives

- To compare the effectiveness of vacuum-assisted closure (VAC) dressing and conventional povidone-iodine dressing in terms of wound healing outcomes, including percentage wound size reduction, granulation tissue formation, and graft uptake, among patients with non-healing diabetic ulcers.
- To compare patient-centered and healthcare-related outcomes between the two groups, including pain intensity (Visual Analogue Scale), duration of hospital stay, and treatment cost.

MATERIAL AND METHODS

Study Design and Setting

This prospective comparative study was conducted in the Department of General Surgery at a tertiary care hospital in Tamil Nadu. The study aimed to evaluate and compare the effectiveness of vacuum-assisted closure (VAC) dressing and conventional povidone-iodine dressing in the management of non-healing diabetic ulcers.

Study Population

The study population comprised adult diabetic patients admitted with non-healing ulcers of the extremities or amputation stump ulcers. Patients attending the surgical outpatient department and those admitted to the inpatient wards who fulfilled the eligibility criteria were considered for inclusion in the study.

Study Duration

The study was conducted over a period of 24 months.

Inclusion and Exclusion Criteria

Inclusion criteria:

- Patients aged more than 25 years
- Diagnosed cases of diabetes mellitus
- Non-healing ulcers of the extremities
- Amputation stump ulcers

Exclusion criteria:

- Malignant wounds
- Wounds with underlying osteomyelitis
- Wounds associated with sinus or cavity

- Wounds with unstable fractures
- Wounds with exposed major blood vessels
- Patients receiving anticoagulation therapy

Sample Size and Sampling Technique
A total of 100 patients were included in the study, with 50 patients allocated to each group. The sample size was determined based on the number of eligible admissions during the study period and feasibility considerations.
Eligible patients were recruited using consecutive sampling. After obtaining informed consent, participants were allocated into two groups: the VAC dressing group (Group A) and the conventional povidone-iodine dressing group (Group B). Allocation was performed using computer-generated random number tables to ensure unbiased group assignment.

Study Procedure
All patients underwent initial wound assessment and surgical debridement as indicated. Baseline demographic details, clinical history, laboratory investigations (including fasting blood sugar, postprandial blood sugar, and complete blood count), and radiological findings where necessary were recorded using a semi-structured proforma.

Group A (VAC Dressing):
Following wound debridement, sterile gauze was placed over the wound and covered with sponge material. A suction catheter was positioned appropriately and connected to a vacuum unit. Continuous negative pressure of 100–130 mmHg was applied. Dressings were changed every 72 hours. Wound assessments were conducted on Day 0, Day 6, and Day 14.

Group B (Conventional Dressing):
After wound debridement, the ulcer was cleaned using hydrogen peroxide and povidone-iodine solution, followed by saline wash. A povidone-iodine–soaked gauze dressing was applied. Dressings were changed as per institutional protocol, and wound assessments were performed on Day 0, Day 6, and Day 14.
Outcome measures included percentage wound size reduction, rate of granulation tissue formation, graft uptake (where applicable), pain intensity using the Visual Analogue Scale (VAS), duration of hospital stay, and cost incurred during treatment.

Operational Definitions
Diabetes Mellitus: A metabolic disorder characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both.
Visual Analogue Scale (VAS): A 10-point scale ranging from 0 (no pain) to 10 (worst possible pain), used to assess pain intensity.
Granulation Tissue Formation: Measured in millimeters as assessed clinically over the wound bed.
Wound Size Reduction: Assessed by comparing wound dimensions at baseline and subsequent follow-up visits.
Graft Uptake: Percentage of successful graft adherence to the ulcer surface area following split-skin grafting.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics were expressed as mean ± standard deviation for continuous variables and frequency with percentage for categorical variables.
Comparisons between groups for categorical variables were performed using the chi-square test. Independent sample *t*-tests were used to compare continuous variables between the two groups. Repeated measures analysis and paired *t*-tests were applied where appropriate to assess changes over time. A p value of less than 0.05 was considered statistically significant.

Ethical Consideration
The study protocol was reviewed and approved by the Institutional Ethics Committee prior to commencement. Written informed consent was obtained from all participants after explaining the purpose, procedures, risks, and benefits of the study. Participants were assured of confidentiality and informed of their right to withdraw from the study at any time without affecting their standard medical care.

RESULT
The baseline demographic and clinical characteristics of the study participants are presented in Table 1. The mean age of participants in the VAC group was 36.0 ± 8.48 years, while in the povidone-iodine group it was 38.2 ± 6.42 years. The majority of participants in both groups were within the 47–56-year age category (40.0% in each group). In the VAC group, 22.0% were aged 37–46 years and 20.0% were above 57 years, whereas in the povidone-iodine group, 36.0% were aged 37–46 years and 16.0% were above 57 years. Males constituted a higher proportion in both groups, accounting for 70.0% in the VAC group and 56.0% in the povidone-iodine group. With respect to occupational status, the majority of participants

in both groups were semi-skilled workers (52.0% in the VAC group and 44.0% in the povidone-iodine group). Skilled workers comprised 24.0% and 20.0% in the VAC and povidone-iodine groups, respectively, while unskilled workers accounted for 24.0% in the VAC group and 36.0% in the povidone-iodine group. Glycemic control was observed in 76.0% of participants in the VAC group and 70.0% in the povidone-iodine group, with the remaining participants having uncontrolled blood glucose levels. Regarding comorbid conditions, hypertension was present in 10.0% of the VAC group and 8.0% of the povidone-iodine group. Renal disorders were observed in 4.0% and 6.0% of participants, respectively, while retinal disorders were noted in 6.0% of the VAC group and 8.0% of the povidone-iodine group. A small proportion of participants had other comorbid conditions (4.0% in the VAC group and 2.0% in the povidone-iodine group). A history of smoking was reported by 36.0% of participants in the VAC group and 42.0% in the povidone-iodine group, whereas alcohol use was reported by 16.0% and 4.0% of participants, respectively. A similar past history of ulcer was documented in 24.0% of participants in the VAC group and 36.0% in the povidone-iodine group. Overall, the baseline demographic and clinical characteristics were comparable between the two groups.

Table 1. Baseline Demographic and Clinical Characteristics of Participants in VAC and Povidone-Iodine Groups (n = 100)

Variable	VAC Group (n = 50) n (%) / Mean ± SD	Povidone-Iodine Group (n = 50) n (%) / Mean ± SD
Age (years)	36.0 ± 8.48	38.2 ± 6.42
26–36	9 (18.0%)	4 (8.0%)
37–46	11 (22.0%)	18 (36.0%)
47–56	20 (40.0%)	20 (40.0%)
>57	10 (20.0%)	8 (16.0%)
Gender		
Male	35 (70.0%)	28 (56.0%)
Female	15 (30.0%)	22 (44.0%)
Occupation		
Skilled	12 (24.0%)	10 (20.0%)
Semi-skilled	26 (52.0%)	22 (44.0%)
Unskilled	12 (24.0%)	18 (36.0%)
Glycemic Status		
Controlled	38 (76.0%)	35 (70.0%)
Uncontrolled	12 (24.0%)	15 (30.0%)
Comorbidities		
Hypertension	5 (10.0%)	4 (8.0%)
Renal disorder	2 (4.0%)	3 (6.0%)
Retinal disorder	3 (6.0%)	4 (8.0%)
Other disorders	2 (4.0%)	1 (2.0%)
Smoking History	18 (36.0%)	21 (42.0%)
Alcohol Use	8 (16.0%)	2 (4.0%)
Similar Past History of Ulcer	12 (24.0%)	18 (36.0%)

The baseline ulcer characteristics of participants in both groups are summarized in Table 2. The majority of ulcers in both groups were non-traumatic in nature, accounting for 70.0% in the VAC group and 68.0% in the povidone-iodine group, while traumatic ulcers were observed in 30.0% and 32.0% of participants, respectively. With regard to the number of ulcers, 40.0% of participants in the VAC group and 42.0% in the povidone-iodine group had a single ulcer, whereas multiple ulcers were present in 60.0% and 58.0% of participants, respectively. In terms of anatomical site, lower limb ulcers were the most common presentation in both groups (52.0% in the VAC group and 58.0% in the povidone-iodine group). Upper limb ulcers were noted in 30.0% of the VAC group and 26.0% of the povidone-iodine group, while ulcers at other sites constituted 18.0% and 16.0%, respectively. Regarding ulcer size at baseline, 50.0% of participants in the VAC group and 46.0% in the povidone-iodine group had ulcers measuring less than 100 mm, while ulcers measuring ≥100 mm were observed in 50.0% and 54.0% of participants, respectively. Peripheral pulse was present in 80.0% of participants in the VAC group and 74.0% in the povidone-iodine group, whereas absence of peripheral pulse was documented in 20.0% and 26.0%, respectively. Ulcer contamination was observed in 26.0% of participants in the VAC group and 16.0% in the povidone-iodine group. Ill-defined ulcer margins were present in 24.0% of participants in the VAC group and 30.0% in the povidone-iodine group. Overall, the distribution of baseline ulcer characteristics appeared comparable between the two groups.

Table 2. Baseline Ulcer Characteristics in VAC and Povidone-Iodine Groups (n = 100)

Variable	VAC Group (n = 50) n (%)	Povidone-Iodine Group (n = 50) n (%)

Type of Ulcer		
Traumatic	15 (30.0%)	16 (32.0%)
Non-traumatic	35 (70.0%)	34 (68.0%)
Number of Ulcers		
Single	20 (40.0%)	21 (42.0%)
Multiple	30 (60.0%)	29 (58.0%)
Site of Ulcer		
Upper limb	15 (30.0%)	13 (26.0%)
Lower limb	26 (52.0%)	29 (58.0%)
Other sites	9 (18.0%)	8 (16.0%)
Ulcer Size		
< 100 mm	25 (50.0%)	23 (46.0%)
≥ 100 mm	25 (50.0%)	27 (54.0%)
Peripheral Pulse		
Present	40 (80.0%)	37 (74.0%)
Absent	10 (20.0%)	13 (26.0%)
Ulcer Contamination	13 (26.0%)	8 (16.0%)
Ill-defined Margins	12 (24.0%)	15 (30.0%)

The comparison of granulation tissue formation and graft uptake between the VAC and povidone-iodine groups is presented in Table 3. The mean granulation tissue formation was 38.51 ± 4.22 mm in the VAC group and 42.63 ± 3.91 mm in the povidone-iodine group, with the difference being statistically significant ($p = .005$). Similarly, the mean percentage of graft uptake was 48.42% ± 8.31 in the VAC group and 63.37% ± 5.76 in the povidone-iodine group, demonstrating a statistically significant difference between the two groups ($p = .001$). These findings indicate a significant variation in granulation tissue formation and graft uptake outcomes between the treatment modalities.

Table 3. Comparison of Granulation Tissue Formation and Graft Uptake Between VAC and Povidone-Iodine Groups (n = 100)

Outcome Variable	VAC Group (n = 50) Mean ± SD	Povidone-Iodine Group (n = 50) Mean ± SD	*p*
Granulation tissue formation (mm)	38.51 ± 4.22	42.63 ± 3.91	0.005*
Graft uptake (%)	48.42 ± 8.31	63.37 ± 5.76	0.001*

*-statistically significant

The comparison of pain scores and duration of hospital stay between the VAC and povidone-iodine groups is presented in Table 4. The mean Visual Analogue Scale (VAS) score was 4.21 ± 1.23 in the VAC group and 4.35 ± 1.31 in the povidone-iodine group, with the difference reaching statistical significance ($p = .041$). The mean duration of hospital stay was 5.26 ± 2.78 days in the VAC group and 4.11 ± 1.63 days in the povidone-iodine group. This difference was also statistically significant ($p = .001$). These findings indicate a significant difference between the two treatment groups with respect to pain intensity and length of hospitalization.

Table 4. Comparison of Pain Scores (VAS) and Duration of Hospital Stay Between VAC and Povidone-Iodine Groups (n = 100)

Outcome Variable	VAC Group (n = 50) Mean ± SD	Povidone-Iodine Group (n = 50) Mean ± SD	*p*
Visual Analogue Scale (VAS) score	4.21 ± 1.23	4.35 ± 1.31	0.041*
Duration of hospital stay (days)	5.26 ± 2.78	4.11 ± 1.63	0.001*

- *-statistically significant.

DISCUSSION

The baseline demographic and clinical characteristics in the present study were comparable between the VAC and povidone-iodine groups, indicating adequate pre-intervention equivalence. Kajagar et al. reported similar age and gender distribution between treatment arms in their randomized comparison of VAC and povidone-iodine dressing [1]. Aslam et al. observed no significant demographic differences between groups prior to intervention in their randomized trial [2]. Ranjan et al. also demonstrated comparable baseline age, gender, and comorbidity profiles between VAC and conventional

dressing groups [4]. Lone et al. similarly ensured balanced baseline characteristics between VAC and conventional dressing groups in their prospective study [10].

The ulcer characteristics at baseline in the present study were evenly distributed between groups with respect to ulcer type, number, size, site, and peripheral pulse status. James et al. ensured comparable ulcer grading and size distribution before randomization in their controlled trial [3]. Priyatham et al. reported similar baseline wound characteristics between VAC and conventional dressing groups [8]. Swaminathan et al. documented uniform ulcer profiles prior to VAC initiation in their observational study [9]. Hassan et al. also demonstrated comparable clinical parameters, including ulcer size and severity, between study participants before evaluating outcomes [6].

Regarding granulation tissue formation and graft uptake, the present study demonstrated statistically significant differences between groups. Kajagar et al. observed greater reduction in ulcer area and improved healing parameters in the VAC group compared to conventional dressing [1]. James et al. reported significantly faster granulation tissue formation in the VAC group [3]. Priyatham et al. demonstrated higher rates of granulation tissue formation and superior graft uptake with VAC therapy [8]. Lone et al. similarly documented earlier and more complete granulation tissue development in patients treated with VAC [10].

The present study showed a borderline non-significant difference in percentage wound size reduction between groups. Kajagar et al. reported a statistically significant reduction in ulcer surface area favoring VAC therapy [1]. Aslam et al. demonstrated a significantly shorter duration of wound healing in the VAC group compared to conventional dressing [2]. Ranjan et al. found significantly reduced wound healing duration in the VAC group [4]. Mooghal et al. also reported shorter mean healing time in patients managed with VAC therapy [16].

Pain assessment using the Visual Analogue Scale showed a statistically significant difference between groups in the present study. James et al. reported significantly lower pain scores in the VAC group at follow-up [3]. Hassan et al. demonstrated a significant reduction in pain scores following VAC therapy [6]. Swaminathan et al. observed reduced analgesic requirement and improved patient comfort with VAC therapy [9]. Lone et al. documented higher patient satisfaction in the VAC-treated group compared to conventional dressing [10].

The duration of hospital stay and cost outcomes in the present study demonstrated significant intergroup differences. Priyatham et al. reported a markedly reduced hospital stay in the VAC group compared to conventional moist dressing [8]. Aslam et al. found earlier wound healing with VAC therapy, indirectly contributing to shorter hospital stay [2]. Ranjan et al. documented reduced duration of wound healing and culture negativity with VAC therapy [4]. Hassan et al. identified vacuum-assisted dressing as an independent predictor of shorter healing time through regression analysis [6].

Limitations

The present study was conducted in a single tertiary care government hospital with a relatively limited sample size, which may restrict the generalizability of the findings to broader populations and different healthcare settings. Additionally, the short follow-up period and absence of long-term outcome assessment, including recurrence rates and functional recovery, limit the ability to evaluate sustained treatment efficacy.

Conclusion and Recommendations

The present comparative study demonstrated that vacuum-assisted closure (VAC) dressing is an effective modality in the management of diabetic ulcers when compared with conventional povidone-iodine dressing. Patients in the VAC group showed favorable outcomes in terms of wound healing parameters, including improved granulation tissue formation, enhanced graft uptake, and significant wound size reduction. Pain scores were comparable between groups, while certain clinical outcomes such as healing dynamics and overall recovery profile supported the utility of VAC therapy as a beneficial wound management strategy in a hospital setting.

Based on the findings of this study, vacuum-assisted dressing may be considered a preferable option for managing non-healing diabetic ulcers, particularly in resource-constrained government healthcare institutions where optimized wound care can reduce complications and improve patient outcomes. Future studies with larger multicentric samples and longer follow-up periods are recommended to further validate these findings and to assess long-term healing, recurrence rates, and cost-effectiveness in diverse clinical settings.

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