

## Role of Vacuum-Assisted Closure Dressing in the Management of Diabetic Foot Ulcers: A Prospective Comparative Study from a Tertiary Care Centre in Patna, Bihar

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### Abstract

**Background:** Diabetic foot ulcer (DFU) is a major complication of diabetes mellitus and is associated with prolonged hospitalization, recurrent infection, and increased risk of lower limb amputation. Vacuum-Assisted Closure (VAC) therapy has emerged as an effective adjunct in diabetic wound management.

**Objective:** To compare the effectiveness of VAC therapy with conventional saline dressing in the treatment of diabetic foot ulcers.

**Methods:** This prospective comparative study included 80 patients with Wagner grade II–IV diabetic foot ulcers. Following surgical debridement, 40 patients received VAC therapy and 40 patients underwent conventional saline dressing. Outcomes assessed included wound area reduction, granulation tissue formation, hospital stay, and limb salvage rate.

**Results:** The VAC group demonstrated significantly greater wound area reduction (66.4% vs. 41.2%,  $p < 0.001$ ), earlier granulation tissue formation (11.6 ± 3.4 vs. 18.9 ± 4.8 days,  $p < 0.001$ ), and shorter hospital stay (12.4 ± 3.7 vs. 19.6 ± 5.2 days,  $p < 0.001$ ) compared with the conventional dressing group. Limb salvage was achieved in 95.0% of patients in the VAC group compared with 80.0% in the conventional group ( $p = 0.04$ ).

**Conclusion:** VAC therapy significantly improves wound healing, accelerates granulation tissue formation, reduces hospital stay, and enhances limb salvage in patients with diabetic foot ulcers.

**Keywords:** Diabetic Foot Ulcer, Vacuum-Assisted Closure, Negative Pressure Wound Therapy, Wound Healing, Limb Salvage.

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### Introduction

Diabetes mellitus is a rapidly growing global health concern and is associated with numerous microvascular and macrovascular complications. Among these complications, diabetic foot ulcer (DFU) remains one of the most serious and disabling conditions, contributing significantly to morbidity, mortality, healthcare expenditure, and reduced quality of life [1,2]. India has one of the largest populations of individuals living with diabetes, and the burden of diabetic foot disease continues to increase due to the rising prevalence of diabetes, increasing life expectancy, and delayed healthcare-seeking [1,3].

A diabetic foot ulcer is defined as a full-thickness wound occurring below the ankle in a patient with diabetes. The pathogenesis of diabetic foot ulceration is multifactorial and involves peripheral neuropathy, peripheral arterial disease, impaired

immunity, foot deformities, repetitive trauma, and poor glycemic control [1,14,15]. Peripheral neuropathy results in loss of protective sensation and abnormal pressure distribution over the foot, making patients vulnerable to unnoticed injuries. Simultaneously, vascular insufficiency compromises tissue perfusion and oxygen delivery, leading to delayed wound healing and increased susceptibility to infection [14,15].

It has been estimated that approximately 15–25% of patients with diabetes will develop a foot ulcer during their lifetime, and diabetic foot ulcers account for a substantial proportion of diabetes-related hospital admissions [1,3]. Chronic wounds frequently become infected and may progress to cellulitis, deep tissue infection, osteomyelitis, gangrene, and ultimately limb amputation if not managed appropriately [16,17]. The management

of diabetic foot ulcers requires a multidisciplinary approach involving strict glycemic control, infection management, surgical debridement, pressure off-loading, vascular assessment, and wound care [16–18]. Conventional moist saline dressing remains one of the most widely used methods of wound management. However, conventional dressings often require frequent changes, prolonged treatment duration, and extended hospitalization, particularly in patients with large or infected ulcers [12].

Negative Pressure Wound Therapy (NPWT), commonly referred to as Vacuum-Assisted Closure (VAC) therapy, has emerged as an important advancement in wound management. VAC therapy involves the application of controlled sub-atmospheric pressure to a wound through a foam dressing connected to a vacuum device [12,20]. The technique promotes wound healing through several mechanisms, including removal of excess exudate, reduction of tissue edema, enhancement of local blood circulation, stimulation of angiogenesis, reduction in bacterial burden, and promotion of granulation tissue formation [4–8,20].

Several studies have demonstrated favorable outcomes with VAC therapy in the management of diabetic foot ulcers. Previous investigators have reported significantly greater wound area reduction, earlier development of healthy granulation tissue, shorter hospital stay, and improved rates of limb salvage among patients treated with NPWT compared with conventional wound care [4–11,20–22].

In view of the growing burden of diabetic foot ulcers and the need for effective wound management strategies, the present study was undertaken to evaluate the role of Vacuum-Assisted Closure dressing in the management of diabetic foot ulcers and to compare its clinical outcomes with those achieved using conventional saline dressing in patients treated at a tertiary care centre in Patna, Bihar.

## Materials and Methods

**Study Design and Setting:** A prospective comparative study was conducted in the Department of Plastic and Reconstructive Surgery at Patna Medical College and Hospital (PMCH), Patna, Bihar, over a period of 18 months from January 2024 to June 2025. The study aimed to evaluate the effectiveness of Vacuum-Assisted Closure (VAC) therapy compared with conventional saline dressing in the management of diabetic foot ulcers.

**Ethical Considerations:** The study protocol was reviewed and approved by the Institutional Ethics Committee before initiation of the study. Written informed consent was obtained from all

participants prior to enrolment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

**Study Population:** Patients presenting to the Plastic Surgery Department with diabetic foot ulcers and requiring inpatient management were screened for eligibility. A total of 80 patients fulfilling the selection criteria were included in the study.

## Inclusion Criteria

- Patients aged 18 years and above.
- Patients diagnosed with Type 1 or Type 2 diabetes mellitus.
- Wagner Grade II, III, or IV diabetic foot ulcers.
- Patients willing to provide written informed consent.

## Exclusion Criteria

- Wagner Grade I ulcers managed on an outpatient basis.
- Wagner Grade V ulcers requiring immediate major amputation.
- Critical limb ischemia unsuitable for revascularization.
- Malignant ulcers.
- Patients with severe systemic illness precluding surgery.
- Patients unwilling to participate in the study.

**Study Groups:** After initial evaluation and adequate surgical debridement, patients were allocated into two treatment groups comprising 40 patients each.

**Group A (VAC Group):** Patients received Negative Pressure Wound Therapy (Vacuum-Assisted Closure dressing).

**Group B (Conventional Dressing Group):** Patients received standard moist saline dressing according to institutional protocol.

**Clinical Assessment:** A detailed history was obtained from each patient, including age, sex, and duration of diabetes, smoking status, associated comorbidities, previous ulcer history, and duration of the current ulcer. A thorough local examination of the ulcer was performed, and ulcer severity was classified according to Wagner's grading system.

## Laboratory Investigations

All patients underwent routine laboratory investigations including:

- Complete blood count
- Fasting blood sugar
- Postprandial blood sugar
- Glycated hemoglobin (HbA1c)
- Renal function tests
- Serum electrolytes

- Pus culture and sensitivity

Radiological investigations, including plain radiographs of the affected foot, were performed whenever osteomyelitis was suspected.

**Initial Wound Preparation:** All patients underwent meticulous surgical debridement under appropriate anaesthesia. Necrotic tissue, slough, infected tissue, and nonviable structures were excised until a healthy bleeding wound bed was obtained. Broad-spectrum antibiotics were initiated empirically and subsequently modified according to culture sensitivity reports.

**VAC Dressing Technique:** Following debridement, a sterile polyurethane foam sponge was trimmed according to wound dimensions and placed within the wound cavity. A suction tube was incorporated into the foam dressing and the wound was sealed using an adhesive transparent film to create an airtight environment.

Continuous negative pressure of 125 mmHg was applied using a VAC device. Dressings were changed every 72 hours or earlier when clinically indicated. VAC therapy was continued until adequate granulation tissue formation was achieved or definitive wound coverage was performed.

**Conventional Dressing Technique:** Patients in the conventional dressing group underwent daily moist saline dressings following debridement. Additional debridement procedures were performed whenever required.

Wound assessment was carried out regularly until satisfactory healing or wound coverage was achieved.

**Measurement of Wound Area:** Wound dimensions were measured using a sterile measuring scale. Maximum length and width were recorded in centimeters, and wound area was calculated using the following formula:

$$\text{Wound Area (cm}^2\text{)} = \text{Length} \times \text{Width}$$

Percentage reduction in wound area was calculated as:

$$\text{Percentage Reduction} = \left[ \frac{\text{Initial Wound Area} - \text{Final Wound Area}}{\text{Initial Wound Area}} \right] \times 100$$

**Follow-up:** Patients were assessed weekly during hospitalization and subsequently during outpatient follow-up visits. Wound healing progress, granulation tissue formation, graft uptake, complications, and limb salvage outcomes were recorded systematically.

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using Jamovi version 2.4. Continuous variables were expressed as mean  $\pm$  standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using Student's t-test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

**Results:** A total of 80 patients with diabetic foot ulcers were included in the study. Forty patients received Vacuum-Assisted Closure (VAC) therapy (Group A), while forty patients underwent conventional saline dressing (Group B). All enrolled patients completed the study and were included in the final analysis.

**Baseline Characteristics:** The mean age of patients in the VAC group was 57.4  $\pm$  8.6 years, while that in the conventional dressing group was 56.8  $\pm$  9.1 years. Males predominated in both groups, accounting for 72.5% and 70.0% of patients, respectively. There was no statistically significant difference between the two groups with regard to age, sex distribution, duration of diabetes, smoking status, or glycemic control ( $p > 0.05$ ) (Table 1).

**Table 1: Baseline Characteristics of Study Participants**

Variable	VAC Group (n=40)	Conventional Group (n=40)	p-value
Age (years)	57.4 $\pm$ 8.6	56.8 $\pm$ 9.1	0.76
Male sex, n (%)	29 (72.5)	28 (70.0)	0.81
Duration of diabetes (years)	9.4 $\pm$ 4.2	8.9 $\pm$ 4.7	0.62
HbA1c (%)	8.8 $\pm$ 1.2	8.6 $\pm$ 1.4	0.48
Smokers, n (%)	14 (35.0)	16 (40.0)	0.64

**Wagner Grade Distribution:** Most patients presented with Wagner Grade III diabetic foot ulcers. The distribution of ulcer severity was comparable between the two study groups (Table 2).

**Table 2: Distribution According to Wagner Grade**

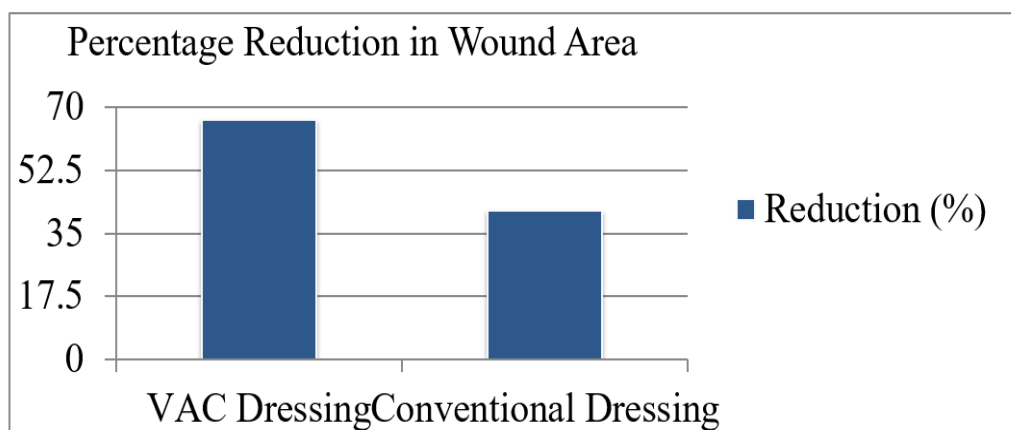
Wagner Grade	VAC Group n (%)	Conventional Group n (%)
Grade II	12 (30.0)	13 (32.5)
Grade III	20 (50.0)	18 (45.0)
Grade IV	8 (20.0)	9 (22.5)

**Reduction in Wound Area:** The mean baseline wound area was comparable between the two groups. At four weeks of treatment, wounds managed with VAC therapy demonstrated significantly greater reduction in wound area

compared with conventional dressing. The mean percentage reduction in wound area was  $66.4 \pm 15.2\%$  in the VAC group compared with  $41.2 \pm 13.7\%$  in the conventional dressing group ( $p < 0.001$ ) (Table 3) (Figure 1).

**Table 3: Comparison of Wound Area Reduction**

Variable	VAC Group	Conventional Group	p-value
Initial wound area (cm <sup>2</sup> )	$34.8 \pm 11.7$	$35.6 \pm 12.3$	0.78
Final wound area (cm <sup>2</sup> )	$11.7 \pm 6.3$	$20.9 \pm 8.5$	<0.001
Percentage reduction (%)	$66.4 \pm 15.2$	$41.2 \pm 13.7$	<0.001



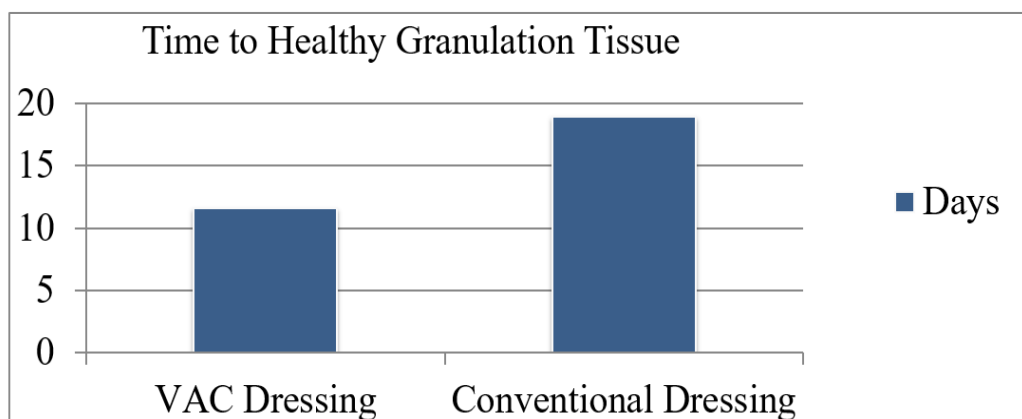
**Figure 1: Comparison of Percentage Reduction in Wound Area between VAC Therapy and Conventional Saline Dressing**

**Granulation Tissue Formation:** Healthy granulation tissue developed significantly earlier in the VAC group than in the conventional dressing group. The mean duration required for adequate

granulation tissue formation was  $11.6 \pm 3.4$  days in the VAC group compared with  $18.9 \pm 4.8$  days in the conventional group ( $p < 0.001$ ) (Table 4; Figure 2).

**Table 4: Time Required for Healthy Granulation Tissue Formation**

Variable	VAC Group	Conventional Group	p-value
Time to healthy granulation tissue (days)	$11.6 \pm 3.4$	$18.9 \pm 4.8$	<0.001



**Figure 2: Comparison of Time Required for Healthy Granulation Tissue Formation**

**Requirement of Definitive Wound Coverage:** A significantly higher proportion of patients in the VAC group became suitable for split-thickness skin grafting following wound bed preparation (Table 5).

**Table 5: Definitive Wound Coverage Procedures**

Procedure	VAC Group n (%)	Conventional Group n (%)	p-value
Skin grafting	31 (77.5)	22 (55.0)	0.03
Flap coverage	5 (12.5)	7 (17.5)	0.53
Secondary healing	4 (10.0)	11 (27.5)	0.04

**Duration of Hospital Stay:** The duration of hospitalization was significantly lower among patients treated with VAC therapy. The mean

hospital stay was 12.4 ±3.7 days in the VAC group compared with 19.6 ±5.2 days in the conventional dressing group (p < 0.001) (Table 6).

**Table 6: Comparison of Hospital Stay**

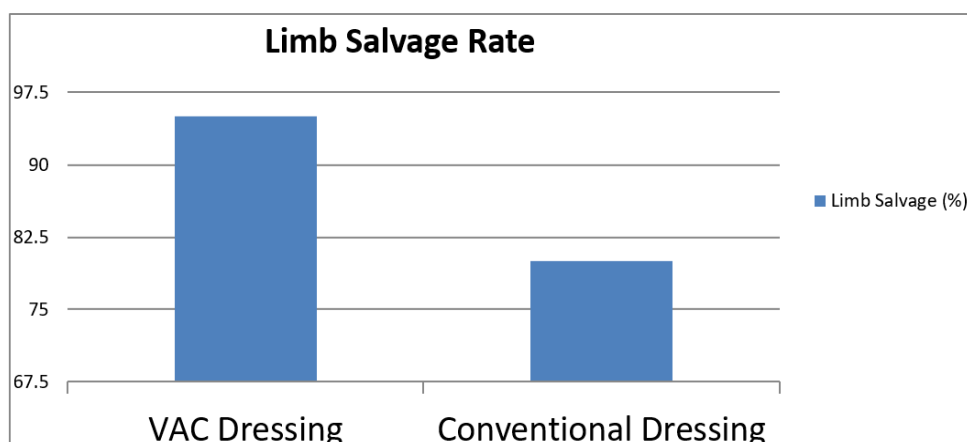
Variable	VAC Group	Conventional Group	p-value
Hospital stay (days)	12.4 ± 3.7	19.6 ± 5.2	<0.001

**Limb Salvage and Amputation Outcomes:** Limb salvage was achieved in 38 patients (95.0%) in the VAC group compared with 32 patients (80.0%) in the conventional dressing group. Major amputation

was required in only two patients receiving VAC therapy compared with eight patients managed with conventional dressings (Table 7; Figure 3).

**Table 7: Limb Salvage Outcomes**

Outcome	VAC Group n (%)	Conventional Group n (%)	p-value
Limb salvage	38 (95.0)	32 (80.0)	0.04
Major amputation	2 (5.0)	8 (20.0)	0.04



**Figure 3: Comparison of Limb Salvage Rates between VAC Therapy and Conventional Dressing**

**Complications**

Minor peri-wound skin maceration was observed in three patients (7.5%) in the VAC group and resolved with appropriate local wound care. Persistent wound infection requiring repeat debridement occurred in four patients (10.0%) in the VAC group compared with nine patients (22.5%) in the conventional dressing group.

Overall, patients treated with Vacuum-Assisted Closure therapy demonstrated significantly superior outcomes with respect to wound area reduction, granulation tissue formation, duration of hospital stay, and limb salvage compared with patients managed using conventional saline dressings.

**Discussion**

Diabetic foot ulcer (DFU) remains a major cause of morbidity, prolonged hospitalization, and lower limb amputation among patients with diabetes mellitus. Effective wound management is essential for limb preservation and improved quality of life. In the present study, Vacuum-Assisted Closure (VAC) therapy demonstrated superior outcomes compared with conventional saline dressing in

terms of wound area reduction, granulation tissue formation, duration of hospitalization, and limb salvage.

The majority of patients in our study were males in the fifth and sixth decades of life, which is consistent with previous reports on diabetic foot disease [1,3,15]. This may be attributed to the higher prevalence of diabetes, occupational exposure to trauma, and delayed healthcare-seeking behavior among middle-aged men.

A key finding of the present study was the significantly greater reduction in wound area among patients treated with VAC therapy. The mean wound area reduction at four weeks was 66.4% in the VAC group compared with 41.2% in the conventional dressing group.

Similar findings have been reported by Maranna et al. [4], Campitiello et al. [5], and Zhang et al. [6], who observed faster wound contraction and improved healing rates with negative pressure wound therapy. The enhanced wound contraction associated with VAC therapy may be due to mechanical microdeformation, stimulation of

fibroblast proliferation, angiogenesis, and collagen synthesis [12,20].

Another important observation was the significantly earlier development of healthy granulation tissue in the VAC group. Patients receiving VAC therapy achieved adequate granulation tissue formation in 11.6 days compared with 18.9 days in the conventional dressing group. Previous studies have similarly demonstrated accelerated granulation tissue formation with NPWT due to improved local blood flow, reduced edema, and enhanced oxygen delivery to the wound bed [5,6,20,21].

In the present study, a greater proportion of patients in the VAC group underwent successful split-thickness skin grafting. VAC therapy effectively prepared the wound bed by promoting healthy granulation tissue and reducing bacterial contamination, thereby facilitating definitive wound coverage. Comparable findings have been reported by Singh et al. [10] and Preetha et al. [11].

Hospital stay was significantly shorter among patients treated with VAC therapy. The mean duration of hospitalization was 12.4 days in the VAC group compared with 19.6 days in the conventional dressing group.

Reduced hospital stay has also been reported by Driver et al. [20] and Dumville et al. [21], highlighting the potential economic benefits of VAC therapy, particularly in resource-constrained healthcare settings.

Limb salvage remains the ultimate goal in diabetic foot management. In our study, limb salvage was achieved in 95% of patients receiving VAC therapy compared with 80% of those managed with conventional dressings. The lower rate of major amputation in the VAC group may be attributed to enhanced wound healing, improved infection control, and better preservation of viable tissue. Similar improvements in limb salvage have been documented in previous studies evaluating NPWT in diabetic foot ulcers [6–10].

The incidence of wound-related complications was also lower among patients treated with VAC therapy. Continuous removal of wound exudate and reduction of bacterial burden likely contributed to improved infection control and reduced need for repeat debridement. Although VAC therapy cannot replace adequate surgical debridement and antibiotic therapy, it serves as an effective adjunct in the comprehensive management of diabetic foot ulcers.

### Conclusion

Overall, the findings of the present study support the use of Vacuum-Assisted Closure therapy as an effective adjunctive treatment for diabetic foot

ulcers. Compared with conventional dressing, VAC therapy resulted in faster wound healing, earlier granulation tissue formation, shorter hospital stay, and improved limb salvage, making it a valuable tool in contemporary plastic and reconstructive surgery practice. The present study has certain limitations. It was conducted at a single tertiary care centre with a relatively small sample size, and long-term follow-up data were not available for all patients. Larger multicentric studies with extended follow-up are needed to further validate these findings.

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