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VACUUM-ASSISTED CLOSURE VERSUS CONVENTIONAL DRESSING IN WOUND HEALING: A PROSPECTIVE RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Chronic and complex wounds impose a significant clinical and economic burden. Vacuum-Assisted Closure (VAC) therapy offers a promising alternative to conventional dressings, yet evidence from rural tertiary care centres in central India remains limited. **Materials and Methods:** A prospective, parallel-group, randomized controlled trial was conducted at a tertiary care centre in Gondia, Maharashtra. Sixty patients with acute traumatic, dehisced, or chronic non-healing wounds were randomized to VAC therapy (Group V, n=30) or conventional dressings with daily serial debridement (Group C, n=30). Wound volume, discharge resolution, slough clearance, and granulation tissue formation were assessed on days 3, 6, 9, and 12. **Results:** Both groups were comparable at baseline (mean age 49.6 ± 15.2 vs 53.5 ± 14.8 years; p=0.31). By day 6, all 30 patients in Group V had achieved wound contraction versus 5 in Group C (p<0.001). Total wound volume reduction by day 12 was 55.8 ± 14.6% in Group V versus 15.2 ± 10.8% in Group C (p<0.001). Complete slough clearance and significantly greater discharge resolution were achieved in Group V at each assessment point. Mean time to wound bed preparation was shorter in Group V (5.4 ± 2.1 vs 11.2 ± 2.8 days; p<0.001). Among diabetic patients, 90.9% in Group V achieved granulation by day 6 versus none in Group C. **Conclusion:** VAC therapy is significantly superior to conventional dressings in accelerating wound contraction, granulation tissue formation, slough clearance, and wound bed preparation, including in diabetic patients, making it a valuable adjunct in resource-limited tertiary care settings.

INTRODUCTION

Wounds that fail to progress through an orderly and timely sequence of repair represent a major surgical challenge, particularly in resource-limited settings. Chronic wounds are operationally defined as wounds that fail to achieve a 20–40% reduction in size within two to four weeks of optimal treatment, or which remain unhealed beyond six weeks.[1] In India, the burden of non-healing wounds is amplified by a high prevalence of diabetes mellitus, malnutrition, and delayed presentation, often to rural tertiary care centres where specialist resources are limited.[2,3]

Standard wound care comprises initial surgical debridement, followed by wet-to-moist gauze dressings requiring daily changes. While inexpensive and widely available, these dressings are associated with non-selective debridement, frequent painful changes, wound desiccation, and significant nursing burden.[4] Specialized dressings and hyperbaric oxygen are often unavailable in rural settings.

Vacuum-Assisted Closure (VAC) therapy, pioneered by Argenta and Morykwas in 1993, applies controlled sub-atmospheric pressure to the wound surface via a sealed polyurethane foam interface.[5] The negative pressure environment removes exudate and inflammatory mediators, reduces interstitial oedema, augments local perfusion, decreases bacterial bioburden, and mechanically stimulates granulation tissue formation.[5,6] Randomized trials from India and elsewhere have demonstrated the superiority of

VAC over conventional dressings, particularly for diabetic foot ulcers and necrotizing fasciitis.[7–10] However, data from rural tertiary care centres in central India, where the patient population differs in comorbidity profile and socioeconomic context, remain limited.

This trial was therefore designed to compare VAC therapy with conventional dressing in a heterogeneous population of acute and chronic non-healing wounds at a government medical college in Gondia, Maharashtra.

MATERIALS AND METHODS

Study Design and Setting: A prospective, parallel-group, single-centre randomized controlled trial was conducted in the Department of General Surgery, Government Medical College and Hospital, Gondia, Maharashtra (a 600-bed rural tertiary care referral centre), between 2023 and 2025. The study was approved by the Institutional Ethics Committee.

Participants: Sixty patients were consecutively enrolled and randomly allocated (1:1) to Group V (VAC) or Group C (Conventional). Inclusion criteria encompassed: diabetic foot ulcers, acute traumatic wounds, dehisced surgical wounds, pressure ulcers, venous stasis ulcers, and post-debridement wounds from necrotizing fasciitis. Patients were excluded for: fistulae communicating with body cavities, necrotic eschar, untreated osteomyelitis, malignancy in the wound, active uncontrolled bleeding, histologically confirmed tubercular sinuses, immunocompromised status (HIV, immunosuppressive therapy), and those with uncorrected anaemia, hypoproteinaemia, or BMI extremes that precluded meaningful comparison.

Randomization: Allocation was performed using an online random number generator immediately prior to first dressing application. Sequentially numbered opaque sealed envelopes were opened by a nurse not involved in wound assessment. Due to the nature of the interventions, blinding of patients and treating surgeons was not feasible; however, all wound measurements were performed by a dedicated assessor.

Interventions: Conventional dressing (Group C): Wounds received daily serial debridement of slough and necrotic tissue, wound lavage with dilute povidone-iodine and normal saline, and dressing with paraffin gauze.

VAC therapy (Group V): After wound cleansing, a polyurethane foam was cut to wound dimensions, sealed with a transparent adhesive drape, and connected to a 2-in-1 Pro NPW Therapy System set to continuous negative pressure of 125 mmHg. Dressings and foam were changed every 72 hours. Fresh tubing and canisters were used for each patient.

Outcome Measures

The primary outcome was wound volume reduction (vertical length × transverse length × depth, cm^3) expressed as percentage change from baseline. Secondary outcomes included: wound discharge resolution, slough clearance, granulation tissue formation (each recorded as present/absent), mean time to wound bed preparation, and type of wound reconstruction performed (split-thickness skin grafting, delayed primary closure, or secondary intention healing). All assessments were performed on days 3, 6, 9, and 12.

Statistical Analysis

Data were entered in Microsoft Excel 2019 and analysed using SPSS version 25.0. Continuous variables are presented as mean ± standard deviation; categorical variables as frequencies and percentages. Intergroup comparisons used the independent samples t-test for continuous and the chi-square test for categorical data. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

Sixty patients were enrolled (30 per group). Baseline demographic and comorbidity profiles were comparable between groups. [Table 1] Mean age was 49.6 ± 15.2 years in Group V and 53.5 ± 14.8 years in Group C (p=0.31). Male predominance was noted in both groups (60% vs 63.3%; p=0.79). Type 2 diabetes mellitus was present in 11 (36.7%) and 14 (46.7%) patients respectively (p=0.43).

Table 1: Baseline Demographics and Comorbidities (n=60)

Parameter	Group V (VAC) n=30	Group C (Conventional) n=30	p-Value
Mean Age (years)	49.6 ± 15.2	53.5 ± 14.8	0.31
Male	18 (60%)	19 (63.3%)	0.79
Female	12 (40%)	11 (36.7%)	0.79
No Comorbidities	16 (53.3%)	14 (46.7%)	0.61
Diabetes Mellitus Type 2	11 (36.7%)	14 (46.7%)	0.43
Hypertension	1 (3.3%)	2 (6.7%)	0.55
Anaemia	2 (6.7%)	0 (0%)	0.15

*** Statistically significant (p<0.05). Data presented as mean ± SD or n (%).**

Wound contraction was significantly more frequent in Group V at every assessment point. [Table 2] By day 6, all 30 patients in Group V had achieved contraction versus only 5 in Group C. Overall wound volume reduction by day 12 was 55.8 ± 14.6% in Group V versus 15.2 ± 10.8% in Group C (p<0.001. [Table 3]

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Table 2: Number of Patients Achieving Wound Contraction (n=60)

Time Point	Group V (n=30)	Group C (n=30)	p-Value
Day 0 → Day 3	26 (86.7%)	2 (6.7%)	<0.001*
Day 0 → Day 6	30 (100%)	5 (16.7%)	<0.001*
Day 0 → Day 9	30 (100%)	17 (56.7%)	<0.001*

*** Statistically significant (chi-square test). Values represent number of patients.**

Table 3: Percentage Wound Volume Reduction from Baseline (n=60)

Time Point	Group V	Group C	p-Value
Day 0–Day 3	13.5 ± 10.2%	0.8 ± 2.1%	<0.001*
Day 0–Day 6	28.9 ± 12.8%	2.9 ± 4.7%	<0.001*
Day 0–Day 9	44.1 ± 15.3%	9.4 ± 8.2%	<0.001*
Day 0–Day 12	55.8 ± 14.6%	15.2 ± 10.8%	<0.001*

*** Statistically significant (chi-square test). Values represent mean ± SD.**

Wound Discharge, Slough Clearance, and Granulation Tissue

[Table 4] summarizes the three key wound bed parameters across all time points. By day 12, discharge had resolved in 25/30 (83.3%) patients in Group V versus 5/30 (16.7%) in Group C (p<0.001). Complete slough clearance was achieved in all 30 patients in Group V by day 12 versus 15/30 (50%) in Group C (p<0.001). Granulation tissue was present in all 30 Group V patients by day 9 versus 17/30 (56.7%) in Group C (p<0.001); by day 12, the difference narrowed (30 vs 26; p=0.12).

Table 4: Wound Discharge Resolution, Slough Clearance, and Granulation Tissue (No. of patients) (n=60)

Assessment Day	Discharge V	Discharge C	Slough V	Slough C	Granulation V	Granulation C
Day 3	9	0	15	1	24	1
Day 6	15	0	22	2	28	3
Day 9	20	2	27	8	30	17
Day 12	25	5	30	15	30	26
p-Value	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.12 (Day 12)

*** Statistically significant (chi-square test). V = Group V (VAC); C = Group C (Conventional).**

Secondary Outcomes

Mean time to wound bed preparation was significantly shorter in Group V (5.4 ± 2.1 days) compared with Group C (11.2 ± 2.8 days; p<0.001). Wound reconstruction was performed in 22/30 (73.3%) patients in Group V compared with 6/30 (20%) in Group C (p<0.001). In Group V, 13 patients underwent split-thickness skin grafting (STSG) versus 3 in Group C; 9 underwent delayed primary closure versus 3 in Group C; while 8 healed by secondary intention compared with 24 in Group C (p<0.001).

Diabetic and Non-Diabetic Subgroup Analysis

Among diabetic patients, Group V demonstrated significantly greater wound volume reduction by day 12 (52.1 ± 15.8% vs 8.9 ± 9.1%; p<0.001) and superior granulation tissue formation by day 6 (90.9% vs 0%; p<0.001). Non-diabetic patients in Group V similarly showed superior volume reduction (58.0 ± 13.8% vs 20.5 ± 9.6%; p<0.001) and granulation formation (94.7% vs 18.8%; p<0.001) at day 6. Full subgroup data are presented in [Table 5].

Table 5: Diabetic and Non-Diabetic Subgroup Analysis

Parameter	Group V	Group C	p-Value
Diabetic Subgroup (V: n=11, C: n=14)			
Baseline Wound Volume (cm³)	17.4 ± 11.2	18.2 ± 8.9	0.85
Day 12 Wound Volume (cm³)	7.8 ± 5.4	16.8 ± 8.2	0.005*
% Volume Reduction	52.1 ± 15.8%	8.9 ± 9.1%	<0.001*
Granulation at Day 6	10/11 (90.9%)	0/14 (0%)	<0.001*
Non-Diabetic Subgroup (V: n=19, C: n=16)			
% Volume Reduction	58.0 ± 13.8%	20.5 ± 9.6%	<0.001*
Granulation at Day 6	18/19 (94.7%)	3/16 (18.8%)	<0.001*

*** Statistically significant. Values represent mean ± SD or n/N (%). Baseline wound volumes were comparable in the diabetic subgroup (p=0.85).**

DISCUSSION

This randomized controlled trial demonstrates that VAC therapy is significantly superior to conventional dressings in accelerating wound contraction, reducing wound volume, clearing slough and discharge, and promoting granulation tissue formation in a heterogeneous population of acute and chronic wounds at a rural tertiary care centre. These findings are consistent with, and extend, evidence from published Indian RCTs.[11]

The most striking finding was the speed of response. By day 6, every patient in Group V had achieved measurable wound contraction, whereas only 16.7% of Group C patients had done so. This parallels the mechanistic understanding of VAC: sub-atmospheric pressure applies a radially inward mechanical force across the wound margins, directly compressing the wound volume, while

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simultaneously removing exudate that would otherwise maintain a hostile, pro-inflammatory wound microenvironment.[5,6]

Our results corroborate those of Sangma et al,[7] from JIPMER, Puducherry, who demonstrated significantly faster granulation tissue formation and reduced time to healing in VAC-treated diabetic foot ulcers. Lone et al,[8] in a prospective case-control study from Srinagar, similarly reported 92.85% granulation tissue formation by week 2 in the VAC group versus 53.57% in controls. Singh et al,[9] in a comparable 60-patient RCT from Amritsar, found shorter hospital stays and superior graft uptake in VAC-treated patients. Our observation that 90.9% of diabetic patients in Group V achieved granulation by day 6 versus none in Group C resonates with the broader literature on the particular benefit of VAC in the impaired healing milieu of diabetes, where microvascular insufficiency, impaired phagocytosis, and neuropathy compound wound chronicity.[3,10]

The finding that 73.3% of Group V patients underwent wound reconstruction (STSG or delayed primary closure) versus only 20% in Group C is clinically significant. It reflects VAC's capacity to convert a wound from a state unsuitable for reconstruction to one with a healthy, well-vascularized granulation bed — the so-called "bridge to reconstruction" function well recognized in the plastic surgery literature.[6] Conversely, the high rate of secondary-intention healing in Group C (80%) reflects inadequate wound bed preparation within the study period.[12]

The mean time to wound bed preparation was halved in Group V (5.4 vs 11.2 days), which carries direct implications for healthcare resource utilization in a government hospital setting: shorter inpatient durations, fewer nursing man-hours, and earlier surgical scheduling.[13]

Among published Indian comparisons, our wound volume reduction of 55.8% by day 12 in the VAC group compares favourably with Ravari et al,[10] who noted significant ulcer depth reduction in VAC-treated diabetic foot ulcer patients, and with the meta-analytic findings of Zhang et al,[11] who demonstrated lower mortality in VAC-treated necrotizing fasciitis, though without significant differences in hospital stay or number of debridements in that specific condition.[14,15]

Limitations

This study has several limitations. First, it was conducted at a single centre, limiting generalizability. Second, blinding of clinicians and patients was not possible. Third, follow-up was restricted to 12 days; long-term outcomes including final wound closure rates, recurrence, and patient-reported outcomes were not captured. Fourth, cost-effectiveness was not formally evaluated — a relevant consideration given the higher acquisition cost of VAC equipment relative to gauze dressings in low-resource settings. Future multicentre trials with longer follow-up, formal cost-utility analyses, and patient-reported outcome measures are warranted.

CONCLUSION

VAC therapy is significantly superior to conventional dressings in accelerating wound contraction, slough clearance, discharge resolution, and granulation tissue formation in a heterogeneous wound population at a rural tertiary care centre. The benefit extends to diabetic patients, where the advantage is particularly marked. VAC therapy substantially shortens time to wound bed preparation and enables a larger proportion of patients to undergo definitive wound reconstruction. These results support the wider adoption of VAC as a standard adjunct for complex wound management in Indian government hospital settings.

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