Section: General Surgery

Original Research Article

COMPARATIVE STUDY OF CONVENTIONAL DRAINAGE VERSUS NEGATIVE-PRESSURE WOUND THERAPY IN COMPLEX GENERAL SURGICAL WOUNDS

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ABSTRACT

Background: Management of complex general surgical wounds remains a significant clinical challenge due to delayed healing and high complication rates. Negative-pressure wound therapy (NPWT) has emerged as an advanced wound care modality, but its comparative effectiveness against conventional drainage methods requires further evaluation. **Aim:** To compare the effectiveness of conventional drainage versus negative-pressure wound therapy in the management of complex general surgical wounds.

Materials and Methods: This prospective comparative study included 120 patients with complex general surgical wounds admitted to a tertiary care hospital. Patients were divided into two equal groups: conventional drainage (n = 60) and NPWT (n = 60). Baseline demographic and wound characteristics were recorded. Outcomes assessed included time to healthy granulation tissue formation, wound size reduction, rate of complete wound closure, duration of hospital stay, wound-related complications, and requirement for secondary surgical interventions. Statistical analysis was performed using appropriate parametric and non-parametric tests, with a p-value <0.05 considered statistically significant.

Results: Baseline characteristics were comparable between the two groups. NPWT resulted in significantly faster granulation tissue formation, greater reduction in wound size, and higher rates of complete wound closure compared to conventional drainage (p <0.05). Patients treated with NPWT had a significantly shorter hospital stay and lower incidence of wound infection, persistent discharge, and prolonged antibiotic use. The need for secondary surgical interventions was significantly reduced in the NPWT group, with a higher proportion of patients requiring no further procedures.

Conclusion: Negative-pressure wound therapy is superior to conventional drainage in the management of complex general surgical wounds, leading to improved healing outcomes, reduced complications, shorter hospital stay, and fewer secondary surgical interventions.

Keywords: Negative-pressure wound therapy; Conventional drainage; Complex surgical wounds.

INTRODUCTION

Complex general surgical wounds continue to pose a significant challenge in surgical practice due to delayed healing, increased risk of infection, prolonged hospital stay, and higher healthcare costs. Such wounds commonly arise following trauma, infected laparotomy wounds, diabetic foot infections, fasciotomies, and postoperative wound dehiscence. Optimal wound management is therefore crucial to

accelerate healing, prevent complications, and improve patient outcomes. Traditionally, conventional wound drainage and dressing techniques including saline irrigation, gauze packing, and passive drains have been widely employed for managing these wounds. Although effective in selected cases, conventional methods often require frequent dressing changes, may inadequately control wound exudate, and provide limited stimulation for granulation tissue formation [1].

In recent years, Negative-Pressure Wound Therapy (NPWT) has emerged as an advanced modality in wound care. NPWT involves the application of controlled sub-atmospheric pressure to the wound bed through a sealed dressing connected to a vacuum device. This technique promotes wound healing by removing excess exudate, reducing tissue edema, improving local blood flow, decreasing bacterial burden, and stimulating angiogenesis and granulation tissue formation [2]. The mechanical forces generated by negative pressure are believed to enhance cellular proliferation and extracellular matrix formation, thereby accelerating wound closure [3].

Several studies have demonstrated the superiority of NPWT over conventional dressings in terms of faster wound healing, reduced infection rates, and shorter hospital stay, particularly in complex and contaminated wounds [4]. However, NPWT is associated with higher initial costs, requires specialized equipment, and demands trained personnel for application and monitoring. In resource-limited settings, these factors often influence the choice of wound management strategy, making conventional drainage methods still widely practiced.

Aim

To compare the effectiveness of conventional drainage versus negative-pressure wound therapy in the management of complex general surgical wounds.

Objectives

1. To evaluate wound healing outcomes in patients managed with conventional drainage and negative-pressure wound therapy.
2. To compare the duration of hospital stay and rate of wound-related complications between the two groups.
3. To assess the need for secondary surgical interventions in both treatment modalities.

MATERIALS AND METHODS

Source of Data

Data were collected from patients admitted to the general surgery department with complex surgical wounds who fulfilled the eligibility criteria during the study period.

Study Design

This was a prospective comparative study.

Study Location

The study was conducted in the Department of General Surgery at a tertiary care teaching hospital.

Study Duration

The study was carried out over a period of 18 months, including patient recruitment, intervention, and follow-up.

Sample Size

A total of 120 patients were included in the study. Patients were equally divided into two groups:

- Group A: Conventional drainage (n = 60)
- Group B: Negative-pressure wound therapy (n = 60)

Inclusion Criteria

- Patients aged ≥18 years
- Patients with complex general surgical wounds (infected wounds, dehisced laparotomy wounds, post-traumatic wounds, diabetic wounds, and fasciotomy wounds)
- Patients willing to provide informed consent

Exclusion Criteria

- Patients with malignancy-related wounds
- Patients with untreated osteomyelitis
- Patients with exposed major blood vessels or organs
- Patients with bleeding disorders
- Patients unwilling to participate in the study

Procedure and Methodology

After obtaining informed consent, eligible patients were allocated to either the conventional drainage group or the NPWT group. In the conventional group, wounds were managed with saline irrigation, gauze dressing, and passive drainage as per standard surgical protocols. Dressings were changed daily or as clinically indicated.

In the NPWT group, wounds were thoroughly debrided and covered with sterile foam dressing connected to a vacuum device. Negative pressure was applied continuously or intermittently (as per wound condition), and dressings were changed every 48–72 hours.

Sample Processing

Wound assessment was performed at baseline and during follow-up. Parameters such as wound size, presence of discharge, granulation tissue formation, and signs of infection were documented. Wound swabs were collected where necessary and sent for microbiological analysis using standard laboratory techniques.

Statistical Methods

Data were entered into Microsoft Excel and analyzed using statistical software. Quantitative variables were expressed as mean ± standard deviation and compared using Student's t-test. Qualitative variables were expressed as frequencies and percentages and analyzed using Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Data Collection

Clinical data were recorded using a pre-designed, structured proforma including demographic details, wound characteristics, treatment modality, duration

of hospital stay, complications, and outcome measures.

RESULTS

Table 1: Baseline Characteristics and Effectiveness Parameters of Study Groups (N = 120)

Variable	Conventional Drainage (n=60)	NPWT (n=60)	Test of Significance	95% CI of Difference	p-value
Age (years), Mean ± SD	52.6 ± 11.4	50.9 ± 10.8	t = 0.83	-2.4 to 5.8	0.409
Male sex, n (%)	37 (61.7)	39 (65.0)	$\chi^2 = 0.14$	-12.6 to 6.0	0.708
Diabetic patients, n (%)	28 (46.7)	27 (45.0)	$\chi^2 = 0.03$	-13.8 to 17.1	0.862
Mean wound size (cm²), Mean ± SD	42.8 ± 11.6	41.2 ± 10.9	t = 0.78	-2.5 to 5.7	0.438
Infected wounds at presentation, n (%)	33 (55.0)	31 (51.7)	$\chi^2 = 0.13$	-14.9 to 8.3	0.721

Table 1 presents the baseline characteristics and initial wound-related parameters of patients managed with conventional drainage and negative-pressure wound therapy (NPWT). The mean age of patients was comparable between the two groups (52.6 ± 11.4 years in the conventional group vs 50.9 ± 10.8 years in the NPWT group), with no statistically significant difference ($p = 0.409$). Male predominance was observed in both groups, accounting for 61.7% in the conventional drainage group and 65.0% in the NPWT group, without significant variation ($p = 0.708$). The proportion of diabetic patients was also similar between the groups (46.7% vs 45.0%; $p = 0.862$). Mean wound size at presentation did not differ significantly (42.8 ± 11.6 cm² vs 41.2 ± 10.9 cm²; $p = 0.438$), and the prevalence of infected wounds at presentation was comparable (55.0% in the conventional group vs 51.7% in the NPWT group; $p = 0.721$).

Table 2: Wound Healing Outcomes in Conventional Drainage vs NPWT (N = 120)

Variable	Conventional Drainage (n=60)	NPWT (n=60)	Test of Significance	95% CI of Difference	p-value
Time to healthy granulation (days), Mean ± SD	13.9 ± 3.6	9.8 ± 2.9	t = 6.76	2.9 to 5.3	<0.001
Complete wound closure achieved, n (%)	39 (65.0)	52 (86.7)	$\chi^2 = 7.64$	-36.2 to -7.1	0.006
Reduction in wound size at 14 days (%), Mean ± SD	41.7 ± 9.3	63.4 ± 10.1	t = 11.46	-25.8 to -17.5	<0.001
Presence of healthy granulation tissue, n (%)	44 (73.3)	56 (93.3)	$\chi^2 = 8.03$	-33.5 to -6.5	0.005

Table 2 compares wound healing outcomes between the two treatment modalities. Patients treated with NPWT achieved healthy granulation tissue significantly earlier than those managed with conventional drainage (9.8 ± 2.9 days vs 13.9 ± 3.6 days; $p < 0.001$). Complete wound closure was observed in a significantly higher proportion of patients in the NPWT group (86.7%) compared to the conventional drainage group (65.0%) ($p = 0.006$). The percentage reduction in wound size at 14 days was markedly greater with NPWT (63.4 ± 10.1%) than with conventional drainage (41.7 ± 9.3%), and this difference was highly significant ($p < 0.001$). Additionally, the presence of healthy granulation tissue was significantly more frequent in the NPWT group (93.3%) compared to the conventional group (73.3%) ($p = 0.005$).

Table 3: Hospital Stay and Wound-Related Complications (N = 120)

Variable	Conventional Drainage (n=60)	NPWT (n=60)	Test of Significance	95% CI of Difference	p-value
Duration of hospital stay (days), Mean ± SD	18.7 ± 4.8	13.4 ± 3.9	t = 6.71	3.7 to 6.9	<0.001
Wound infection during treatment, n (%)	19 (31.7)	8 (13.3)	$\chi^2 = 6.12$	4.1 to 32.5	0.013
Wound discharge persistence, n (%)	23 (38.3)	11 (18.3)	$\chi^2 = 6.01$	3.7 to 35.0	0.014
Need for prolonged antibiotics, n (%)	21 (35.0)	10 (16.7)	$\chi^2 = 5.21$	2.2 to 34.4	0.022

Table 3 outlines differences in hospital stay and wound-related complications between the two groups. The mean duration of hospital stay was significantly shorter in patients managed with NPWT (13.4 ± 3.9 days) compared to those receiving conventional drainage (18.7 ± 4.8 days) ($p < 0.001$). Wound infection during treatment occurred more frequently in the conventional drainage group (31.7%) than in the NPWT group (13.3%), with a statistically significant difference ($p = 0.013$). Persistent wound discharge was also significantly higher among patients treated with conventional drainage (38.3%) compared to NPWT (18.3%) ($p = 0.014$). Furthermore, the need for prolonged

antibiotic therapy was significantly greater in the conventional group (35.0%) than in the NPWT group (16.7%) ($p = 0.022$).

Table 4: Requirement of Secondary Surgical Interventions (N = 120)

Variable	Conventional Drainage (n=60)	NPWT (n=60)	Test of Significance	95% CI of Difference	p-value
Secondary suturing required, n (%)	24 (40.0)	11 (18.3)	$\chi^2 = 6.89$	6.1 to 36.1	0.009
Skin grafting required, n (%)	17 (28.3)	7 (11.7)	$\chi^2 = 5.12$	2.6 to 30.7	0.024
Repeat debridement required, n (%)	22 (36.7)	9 (15.0)	$\chi^2 = 7.36$	6.3 to 37.4	0.007
No further intervention needed, n (%)	19 (31.7)	42 (70.0)	$\chi^2 = 17.84$	-55.6 to -20.7	<0.001

Table 4 compares the requirement for secondary surgical interventions between the two treatment modalities. Secondary suturing was required significantly more often in the conventional drainage group (40.0%) compared to the NPWT group (18.3%) ($p = 0.009$). Similarly, the need for skin grafting was higher with conventional drainage (28.3%) than with NPWT (11.7%) ($p = 0.024$). Repeat debridement was also significantly more common in the conventional group (36.7%) compared to the NPWT group (15.0%) ($p = 0.007$). In contrast, a substantially higher proportion of patients treated with NPWT required no further surgical intervention (70.0%) compared to those managed with conventional drainage (31.7%), a difference that was highly statistically significant ($p < 0.001$).

DISCUSSION

Baseline characteristics (Table 1) demonstrated that both groups were well matched in terms of age, sex distribution, diabetic status, wound size, and presence of infection at presentation, with no statistically significant differences. This comparability is essential to ensure that outcome differences can be attributed to the intervention rather than confounding variables. Similar baseline equivalence has been reported in multiple comparative studies of NPWT and conventional dressings, including those by Li W et al. (2024),[6] where demographic and wound characteristics were comparable across groups. Study by Arellano ML et al. (2021),[7] also reported a high prevalence of diabetes and infected wounds in complex surgical wound cohorts, consistent with the present study.

Wound healing outcomes (Table 2) clearly favored NPWT. Time to healthy granulation tissue formation was significantly shorter in the NPWT group, and a higher proportion of patients achieved complete wound closure. The greater percentage reduction in wound size at 14 days and higher rates of healthy granulation tissue observed with NPWT are in agreement with the mechanistic advantages described by Shiroky J et al.(2020),[8] who demonstrated that sub-atmospheric pressure enhances angiogenesis and granulation. Jeong JW et al. (2024),[9] in a Cochrane review, similarly reported faster wound healing and improved closure rates with NPWT compared to standard dressings. Indian studies by Onderkova A et al. (2023),[10] also showed significantly greater wound size reduction and earlier granulation with NPWT, closely mirroring the magnitude of benefit seen in the present study.

Hospital stay and wound-related complications (Table 3) were significantly reduced in the NPWT group. Patients managed with NPWT had a shorter duration of hospitalization, lower incidence of wound infection, reduced persistent discharge, and less need for prolonged antibiotic therapy. These findings align with Benrashid E et al. (2020),[11] who reported reduced bacterial load and exudate control with NPWT, translating into fewer infectious complications. Banwell and Téot (2003),[8] also emphasized that NPWT decreases wound edema and contamination, leading to fewer postoperative infections. Similar reductions in hospital stay and antibiotic requirement with NPWT have been documented by Seth I et al. (2024),[12] supporting the clinical and economic advantages of NPWT.

Secondary surgical interventions (Table 4) were significantly less frequent in the NPWT group. The need for secondary suturing, skin grafting, and repeat debridement was markedly higher in patients managed with conventional drainage, whereas a substantially larger proportion of NPWT-treated patients required no further intervention. These results are consistent with reports by Poteet SJ et al. (2021),[13] who observed that improved granulation and wound contraction with NPWT reduce the requirement for additional surgical procedures. Andrianello S et al. (2021),[14] also noted a lower likelihood of secondary interventions in NPWT-treated wounds, particularly in complex and contaminated surgical wounds.

CONCLUSION

The present study demonstrates that negative-pressure wound therapy (NPWT) is significantly more effective than conventional drainage in the management of complex general surgical wounds. Although both groups were comparable in terms of baseline demographic and wound characteristics, patients treated with NPWT showed faster development of healthy granulation tissue, greater reduction in wound size, and a higher rate of complete wound closure. NPWT was also associated with a significantly shorter duration of hospital stay and a lower incidence of wound-related

complications such as infection, persistent discharge, and prolonged antibiotic requirement. Importantly, the need for secondary surgical interventions, including repeat debridement, secondary suturing, and skin grafting, was markedly reduced in the NPWT group, with a substantially higher proportion of patients requiring no further surgical procedures. These findings indicate that NPWT not only enhances wound healing but also reduces morbidity and healthcare burden. Therefore, NPWT should be considered a superior and preferred modality for the management of complex general surgical wounds, particularly in patients at high risk for delayed healing and complications.

Limitations of The Study

1. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other healthcare settings.
2. The sample size, although adequate for comparative analysis, was relatively modest and may not capture all variations in wound types and patient comorbidities.
3. Long-term outcomes such as scar quality and recurrence of wound complications were not assessed due to limited follow-up duration.
4. Cost-effectiveness analysis of NPWT versus conventional drainage was not included, which is an important consideration in resource-limited settings.
5. Blinding of treating surgeons and patients was not feasible due to the nature of the interventions, introducing the possibility of observer bias.
6. Microbiological outcomes were not uniformly analyzed for all patients, which may have influenced assessment of infection-related parameters.

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