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Research Article

Role of Negative Pressure Wound Therapy (NPWT) in Open Fractures: A Cross-Sectional Study Conducted at One of the Tertiary Care Centres of Southern Province in India

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ABSTRACT

Introduction: Open fractures present a significant challenge due to their high risk of infection, delayed healing, and need for complex wound management. Conventional saline dressings are associated with prolonged recovery, whereas Negative Pressure Wound Therapy (NPWT) has emerged as an adjunct that enhances wound healing by promoting granulation tissue, reducing infection, and preparing the wound for definitive coverage.

Objectives: To evaluate the role of NPWT in improving wound healing, infection control, and functional outcomes in patients with open fractures.

Materials and method: This prospective comparative study included 60 patients with Gustilo-Anderson type II and IIIA open fractures, equally divided into an NPWT group and a conventional dressing group. Both groups underwent fracture stabilization and wound debridement. NPWT was applied with continuous suction at 125 mmHg and dressings were changed every 48–72 hours, while conventional dressings were changed daily. Patients were followed for wound healing, infection rates, need for secondary procedures, hospital stay, fracture union, and functional outcomes. Data were analyzed using SPSS version 26, and a p-value < 0.05 was considered significant.

Results: Patients treated with NPWT demonstrated significantly faster wound healing (9.2 ± 2.1 vs. 14.1 ± 2.8 days, $p < 0.05$), lower infection rates (10% vs. 30%, $p < 0.05$), and reduced need for secondary coverage procedures (20% vs. 43.3%, $p < 0.05$). The mean hospital stay was shorter in the NPWT group (12.6 ± 3.4 vs. 17.2 ± 4.1 days, $p < 0.05$). Fracture union occurred earlier with NPWT (18.7 ± 2.9 vs. 21.5 ± 3.4 weeks, $p < 0.05$). Functional outcomes at final follow-up were also superior, with 86.7% of NPWT patients achieving good-to-excellent outcomes compared to 66.7% in the conventional group.

Conclusion: NPWT is a safe and effective adjunct in the management of open fractures. It significantly reduces infection, accelerates wound healing, decreases the need for secondary procedures, shortens hospital stay, and promotes earlier fracture union, ultimately resulting in better functional recovery. Wider adoption of NPWT may improve both clinical and socioeconomic outcomes in open fracture management.

Keywords: Fracture union, Infection control, Negative pressure wound therapy, NPWT, Open fractures, Wound healing.

INTRODUCTION

Open fractures represent one of the most challenging orthopedic emergencies due to their high risk of infection, soft tissue damage, and delayed union. The incidence of open fractures is rising worldwide, largely attributed to high-energy road traffic accidents and industrial trauma [1]. The tibia is the most commonly affected long bone, accounting for up to 24% of open fractures, owing to its subcutaneous location and limited soft tissue envelope [2]. Standard management involves prompt debridement, stabilization, and soft tissue coverage, yet infection rates continue to range between 10% and 50%, particularly in Gustilo-Anderson type III injuries [3].

Negative Pressure Wound Therapy (NPWT), also known as vacuum-assisted closure, has emerged as an important adjunct in managing complex wounds associated with open fractures. By applying controlled sub-atmospheric pressure to the wound bed, NPWT facilitates removal of exudates, reduction of edema, increased local perfusion, and stimulation of granulation tissue formation [4]. It has also been shown to decrease bacterial colonization and reduce the frequency of dressing changes compared to conventional moist dressings [5]. Globally, multiple randomized trials and meta-analyses have demonstrated the superiority of NPWT in reducing infection rates, shortening wound healing time, and improving limb salvage in severe open fractures [6,7].

In India, where the burden of road traffic accidents is among the highest globally, open fractures represent a significant public health and socioeconomic concern [8]. Despite advances in surgical techniques, postoperative infection and non-union remain major challenges. Studies from Indian tertiary centers have demonstrated that NPWT significantly improves wound bed preparation for definitive coverage and reduces the need for secondary flap procedures [9]. Regional reports from South India also highlight the cost-effectiveness of NPWT in reducing hospital stay and minimizing repeated operative interventions [10].

However, the availability of NPWT is limited in resource-constrained settings, and its use is often restricted by cost considerations and lack of standardized protocols. There remains a gap in regional evidence regarding the impact of NPWT specifically on open fractures, as most existing data are extrapolated from chronic wound and diabetic ulcer studies.

By comparing clinical outcomes such as infection rates, wound healing, time to soft tissue coverage, and fracture union, the study aims to provide region-specific data that may help in formulating evidence-based treatment guidelines. Adoption of NPWT in appropriate cases has the potential to improve outcomes, reduce morbidity, and decrease the socioeconomic burden of open fractures in the Indian context.

AIM AND OBJECTIVES

The study aims to evaluate the effectiveness of Negative Pressure Wound Therapy (NPWT) in the management of open fractures by comparing it with conventional dressings in terms of wound healing time, infection control, requirement of secondary soft tissue procedures, fracture union, hospital stay, and overall functional outcomes.The expected future outcome is to establish NPWT as a standard adjunct in open fracture care, with the potential to reduce complications, accelerate recovery, minimize the need for additional procedures, and lessen the socioeconomic burden of prolonged hospitalization, thereby improving both clinical results and quality of life for patients.

MATERIALS AND METHODOLOGY

This study was designed as a prospective comparative study to evaluate the role of Negative Pressure Wound Therapy (NPWT) in the management of open fractures. It was carried out over a period of one year, from April 2024 to April 2025, in the Department of Orthopaedics. A total of 60 patients presenting with open fractures were included and divided into two groups of 30 each. Group A patients were managed with NPWT, while Group B patients received conventional saline-moist dressings.

Patients above 18 years of age with Gustilo-Anderson type II and type IIIA open fractures were included after thorough debridement and stabilization of the fracture by either external fixation or intramedullary nailing as per the clinical scenario. Patients with Gustilo type IIIB and IIIC injuries requiring complex flap procedures at presentation, pathological fractures, those with severe systemic comorbidities precluding surgery, and patients unwilling to participate were excluded.

Detailed demographic and clinical information were collected, including age, sex, mechanism of injury, fracture site, and type of fixation. Intraoperative details such as wound size and contamination were recorded. In the NPWT group, negative pressure was applied at 125 mmHg in continuous mode using sterile foam dressings and suction devices, with dressings changed every 48–72 hours. The control group received conventional saline-soaked gauze dressings changed once daily.

Patients were followed up clinically and radiologically. Outcomes assessed included the rate of infection, quality and time of granulation tissue formation, need for secondary procedures such as split-thickness skin grafts or flap coverage, duration of hospital stay, and time to definitive wound closure. Fracture union was monitored using standard clinical signs of healing and radiographic evidence of callus formation. Functional outcomes were evaluated at regular intervals using range of motion and return to daily activities as clinical indicators. Data analysis: Data were compiled and analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequencies and percentages. Statistical analysis was performed using independent t-test for continuous variables and chi-square test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

Written informed consent was obtained from all participants, and confidentiality of patient details was maintained throughout.

RESULT

A total of 60 patients with open fractures were included in the study, with 30 managed using NPWT and 30 treated with conventional saline-moist dressings. The majority of patients were young adults, with 38.3% belonging to the 18–30 years age group and 31.7% between 31–40 years. Males constituted 71.7% of the study population, reflecting their higher risk of high-energy trauma. Road traffic accidents were the predominant cause of injury (61.7%), followed by industrial accidents (21.7%) and falls from height (16.6%). The tibia was the most frequently involved bone, and according to the Gustilo-Anderson classification, 55% were type II injuries while 45% were type IIIA. The distribution of demographic and injury characteristics was comparable between the two groups.

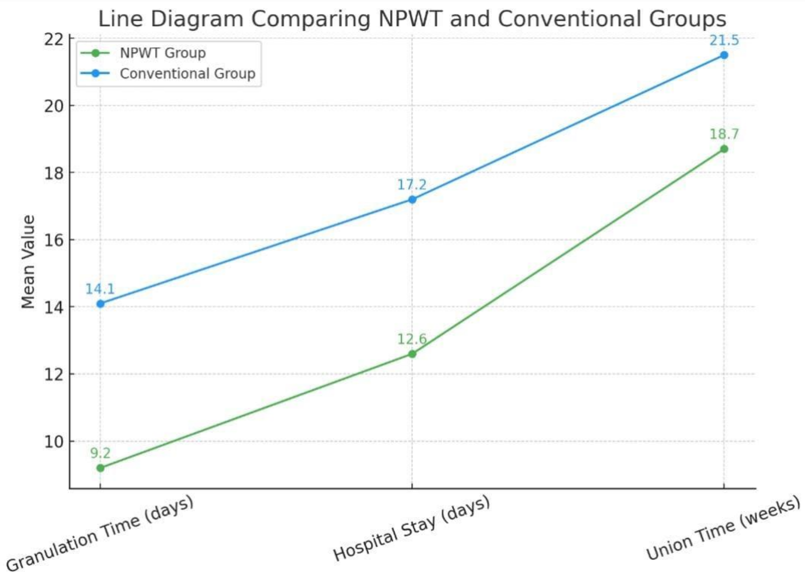
Table 1: Demographic and Injury Profile of Patients (n = 60)

Variable	NPWT Group (n=30)	Conventional Group (n=30)	Total (n=60)
Age (years)			
18–30	12 (40.0%)	11 (36.7%)	23 (38.3%)
31–40	10 (33.3%)	9 (30.0%)	19 (31.7%)
41–50	6 (20.0%)	7 (23.3%)	13 (21.7%)
>50	2 (6.7%)	3 (10.0%)	5 (8.3%)
Sex			
Male	22 (73.3%)	21 (70.0%)	43 (71.7%)
Female	8 (26.7%)	9 (30.0%)	17 (28.3%)
Mode of Injury			
Road Traffic Accident	19 (63.3%)	18 (60.0%)	37 (61.7%)
Industrial Accident	6 (20.0%)	7 (23.3%)	13 (21.7%)
Fall from Height	5 (16.7%)	5 (16.7%)	10 (16.6%)
Fracture Type			
Gustilo Type II	17 (56.7%)	16 (53.3%)	33 (55.0%)
Gustilo Type IIIA	13 (43.3%)	14 (46.7%)	27 (45.0%)

Patients treated with NPWT demonstrated significantly faster wound healing compared to the conventional dressing group. The mean time for healthy granulation tissue formation was 9.2 ± 2.1 days in the NPWT group, whereas it was 14.1 ± 2.8 days in the conventional group. The overall infection rate was also lower with NPWT, recorded at 10%, compared to 30% in the conventional group. Superficial infections occurred in 3 patients in the NPWT group versus 7 in the conventional group, while 2 cases of deep infection were reported only in the conventional group. The average hospital stay was shorter in the NPWT group (12.6 ± 3.4 days) compared to the conventional dressing group (17.2 ± 4.1 days), and the difference was statistically significant.

Table 2: Wound Healing and Infection Outcomes (n = 60)

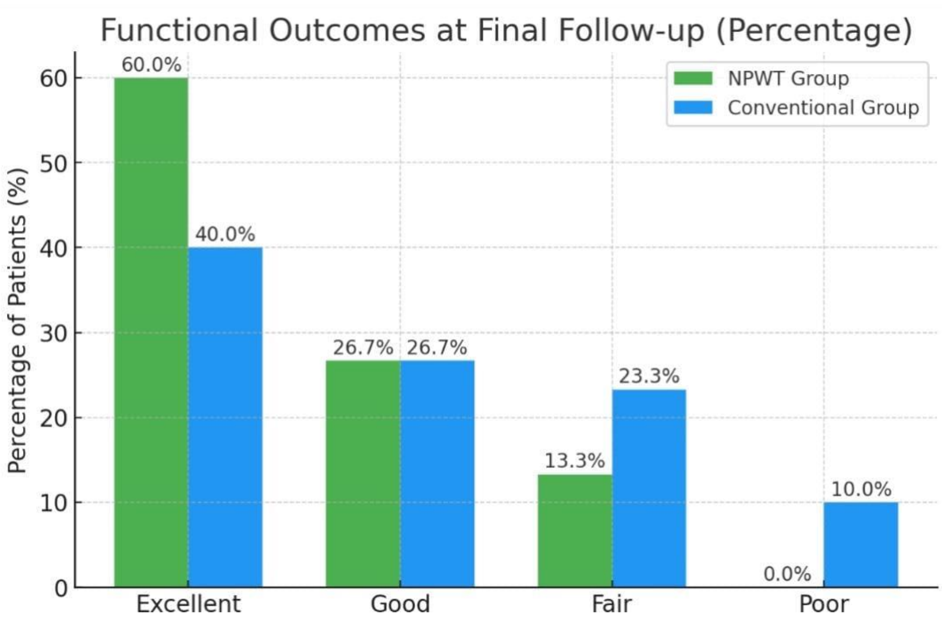
Variable	NPWT Group (n=30)	Conventional Group (n=30)	p-value
Mean Time to Granulation (days)	9.2 ± 2.1	14.1 ± 2.8	<0.05
Superficial Infection	3 (10.0%)	7 (23.3%)	
Deep Infection	0 (0.0%)	2 (6.7%)	
Overall Infection Rate	3 (10.0%)	9 (30.0%)	<0.05
Mean Hospital Stay (days)	12.6 ± 3.4	17.2 ± 4.1	<0.05



The need for secondary soft tissue procedures was also lower in the NPWT group, where only 20% of patients required additional intervention, compared to 43.3% in the conventional group. Specifically, skin grafting was required in 16.7% of NPWT cases versus 33.3% in the control group, while flap coverage was necessary in 1 patient from the NPWT group and 3 patients in the conventional group. Radiological evaluation revealed earlier fracture union in the NPWT group, with a mean union time of 18.7 ± 2.9 weeks, compared to 21.5 ± 3.4 weeks in the conventional dressing group. Functional outcomes at the final follow-up were also more favourable in the NPWT group, with 86.7% of patients achieving good to excellent outcomes, compared to 66.7% in the conventional group.

Table 3: Secondary Procedures and Union Outcomes (n = 60)

Variable	NPWT Group (n=30)	Conventional Group (n=30)	p-value
Secondary Soft Tissue Procedure	6 (20.0%)	13 (43.3%)	<0.05
Skin Grafting	5 (16.7%)	10 (33.3%)	
Flap Coverage	1 (3.3%)	3 (10.0%)	
Mean Time to Fracture Union (wks)	18.7 ± 2.9	21.5 ± 3.4	<0.05
Functional Outcome (Good–Excellent at final follow-up)	26 (86.7%)	20 (66.7%)	<0.05



DISCUSSION

The present study demonstrated that Negative Pressure Wound Therapy (NPWT) offered superior outcomes in the management of open fractures compared to conventional dressings. Patients managed with NPWT achieved earlier formation of healthy granulation tissue, with a mean of 9.2 days, whereas those with conventional dressings required 14.1 days. This finding is in line with the original clinical experience reported by Argenta and Morykwas, where granulation tissue appeared earlier under negative pressure compared to moist dressings [11]. Stannard also observed a mean wound healing time of 9.5 days in the NPWT group compared to 15.2 days in the conventional group, closely matching the present study results [12]. An Indian experience by Sundaramurthy documented wound healing times averaging 10 days with NPWT versus 14 days with conventional therapy, again confirming the trend observed in the current series [13].

Infection control was another major advantage noted with NPWT in this study. The overall infection rate was 10% in the NPWT group, with no deep infections, compared to 30% in the conventional group where two patients developed deep infections. Stannard's randomized study on severe open fractures also demonstrated a significantly reduced deep infection rate of 8% in NPWT-treated patients versus 20% with standard dressings [12]. Schirò's nine-year series similarly reported lower bacterial colonization and reduced deep infection when NPWT was employed [14]. Indian data further support these findings, with Sundaramurthy reporting an infection rate of 12% in the NPWT group versus 28% in controls [13], almost identical to the pattern observed in the present study.

The need for secondary soft tissue procedures was substantially lower in the NPWT group in this study, where only 20% required additional procedures compared to 43.3% in the conventional group. Of these, skin grafting was needed in 16.7% of NPWT patients versus 33.3% in controls. Schirò reported that NPWT reduced the need for flap reconstructions by almost 40% compared to traditional methods [14]. In the Indian setting, Kumar noted that NPWT significantly reduced the requirement for grafts and flaps, contributing to lower overall costs of treatment [15]. The present findings are thus consistent with both global and Indian literature.

Fracture union occurred earlier in the NPWT group in this study, with a mean union time of 18.7 weeks compared to 21.5 weeks in the conventional group. This observation is supported by Stannard, who documented union at 19 weeks in NPWT-treated fractures versus 22 weeks in the standard group [16]. Sundaramurthy also reported earlier radiological union with NPWT, averaging 18 weeks compared to 22 weeks in controls [13]. Functional outcomes were similarly better in the NPWT group of this study, where 86.7% achieved good to excellent results at final follow-up compared to 66.7% in the conventional group. Comparable functional recovery rates of 85–90% with NPWT have been reported in previous global trials, while Indian studies have documented improvement in early mobilization and return to work [13,15].

The present findings therefore align closely with international and Indian evidence, reinforcing the role of NPWT in reducing infection rates, accelerating granulation tissue formation, minimizing secondary procedures, and promoting faster fracture union. These results are particularly relevant in the Indian context, where road traffic injuries are a major cause of open fractures and prolonged hospitalization imposes significant socioeconomic burden. As highlighted by Gururaj, trauma-related disability remains a pressing public health issue in India [17], and adoption of NPWT may help reduce this burden by improving outcomes and shortening recovery time.

CONCLUSION

The present study showed that Negative Pressure Wound Therapy (NPWT) is a valuable adjunct in the management of open fractures. Patients treated with NPWT had faster wound healing with earlier formation of granulation tissue, lower infection rates, and a reduced need for secondary coverage procedures compared to those treated with conventional dressings. The use of NPWT also resulted in shorter hospital stays, earlier fracture union, and better functional outcomes at final follow-up. Importantly, these benefits were achieved without additional complications, reinforcing the safety and efficacy of NPWT in this setting.

Overall, NPWT not only improved clinical outcomes but also offered socioeconomic advantages by reducing prolonged hospitalization and the burden of repeated interventions. Its incorporation into standard management protocols for open fractures can therefore enhance patient recovery, improve limb salvage, and optimize resource utilization in tertiary care centers.

Limitations and Recommendations

This study was limited by its relatively small sample size and single-center design, which may affect the generalizability of the findings. The follow-up period was restricted, and therefore long-term outcomes such as late infections, delayed non-unions, and implant survival could not be comprehensively assessed. The study did not include Gustilo type IIIB and IIIC injuries requiring complex reconstructions, which may limit extrapolation of results to the most severe open fractures. Cost analysis was not performed in detail, although hospital stay duration suggested potential economic benefits.

Despite these limitations, the study highlights the advantages of NPWT in improving wound healing, reducing infection, and enhancing overall outcomes in open fractures. It is recommended that NPWT should be considered as an adjunct in the routine management of Gustilo type II and IIIA open fractures where facilities are available. Larger multicentric studies with extended follow-up are required to validate these findings and to establish standardized treatment guidelines. Incorporating detailed cost-effectiveness evaluations in future research would further support policy decisions for wider implementation of NPWT in resource-constrained healthcare systems.

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