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A COMPARATIVE STUDY BETWEEN CONTINUOUS VS INTERMITTENT NEGATIVE PRESSURE WOUND THERAPY IN TERMS OF WOUND HEALING IN TERTIARY CARE HOSPITAL

General Surgery

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ABSTRACT

Background: Negative Pressure Wound Therapy (NPWT) has proven to be an effective approach in wound care by applying regulated subatmospheric pressure to the wound site, facilitating granulation tissue development, decreasing edema, enhancing perfusion, and removing exudate and bacterial contaminants. **Aim and objectives:** To compare the effectiveness of continuous vs intermittent negative pressure wound therapy in healing of soft tissue wounds. **Methods:** A total of 50 patients were included with Group A(25 patients) who underwent continuous negative pressure, while Group B (25 patients) treated with intermittent negative pressure. Results: The mean wound volume at presentation was $141.1 \pm 30.4 cm^3$ in the continuous NPWT group and $143.0 \pm 32.4 cm^3$ in the intermittent NPWT group. After the first NPWT cycle, wound volume decreased to 95.2 ± 39.4^3 in the continuous group and $103.0 \pm 33.6 cm^3$ in the intermittent group. By Day 10, mean wound volumes were reduced to $39.5 \pm 22.5 cm^3$ and $58.0 \pm 31.3 cm^3$ respectively. **Conclusion:** Continuous NPWT showed slightly greater early reduction in wound volume after the first treatment cycle.Intermittent NPWT, however, demonstrated a greater overall percentage reduction in wound volume during later treatment cycles.

KEYWORDS

Negative pressure wound therapy(NPWT), continuous pressure, intermittent pressure

INTRODUCTION

Wound care continues to be a significant challenge in modern healthcare because of the considerable strain that acute and chronic wounds place on patients, healthcare systems, and resources. Chronic non-healing wounds greatly diminish quality of life, raise morbidity rates, and result in extended hospitalizations and rising treatment expenses. Progress in wound care technologies has aimed at speeding up healing, minimizing complications, and enhancing patient outcomes. Among these advancements, Negative Pressure Wound Therapy (NPWT) has become a significant method in the treatment of intricate wounds.[1] This treatment aids in wound healing by eliminating surplus exudate, minimizing edema, enhancing local blood flow, lowering bacterial count, and encouraging the formation of granulation tissue.[2] NPWT has proven to be effective for various wound types, such as diabetic ulcers, traumatic injuries, pressure ulcers, vascular wounds, surgical sites, grafts, and flaps. Due to these advantages, NPWT has become a crucial part of contemporary wound care practices.[3]

Although it is commonly utilized, ideal parameters for NPWT utilization continue to be a subject of ongoing study. One parameter is the method of negative pressure delivery—continuous or intermittent. Continuous NPWT maintains a steady negative pressure during treatment, ensuring a stable wound environment with regular exudate removal. This approach is commonly favored during the initial phases of therapy, in wounds with significant drainage, or when it is crucial to preserve graft stability. In contrast, intermittent NPWT switches between phases of negative pressure and periods of diminished or absent pressure.[4] This repetitive application is believed to boost cellular activation, angiogenesis, and granulation tissue development via continual mechanical stress and enhanced microcirculatory dynamics.[5]

The physiological foundation of NPWT includes both macrodeformation and microdeformation. Macrodeformation pertains to the alignment of wound margins, resulting in decreased wound volume, whereas microdeformation on a cellular scale activates mechanotransduction pathways that promote fibroblast growth, collagen production, and new blood vessel formation.[6] The varying pressure cycles in intermittent NPWT could enhance these biological reactions by hindering tissue adaptation to a steady force, which may speed up wound healing in the proliferative phase. Intermittent therapy might also lead to heightened pain or discomfort during pressure changes, potentially impacting patient tolerance and adherence.[7]

Aim : To compare the effectiveness of continuous vs intermittent negative pressure wound therapy in healing of soft tissue wounds.

Objectives:

To observe the following factors regarding continuous and intermittent negative pressure wound therapy:

1. Reduction in wound volume
2. To assess complications related to negative pressure wound therapy

Materials and methods:

This randomized comparative study was conducted at zydus hospital, dahod over a period of one year. The study included patients presenting with acute or chronic soft tissue wounds of varying etiologies, including diabetic ulcers, traumatic wounds, pressure sores, vascular ulcers, and iatrogenic wounds. Written informed consent was obtained from all participants prior to enrollment.

A total of 50 patients were included in the study and randomly allocated into two groups with equal distribution. Group A consisted of 25 patients who underwent continuous negative pressure wound therapy, while Group B included 25 patients treated with intermittent negative pressure wound therapy. The sample size was calculated using a two-sample t-test framework with a significance level of 0.05 and a statistical power of 80%, based on assumptions derived from previously published literature.

All wounds were initially assessed clinically and underwent thorough surgical debridement before therapy initiation. Tissue samples were collected for routine culture and sensitivity testing prior to debridement. The wound bed was then irrigated with normal saline and cleaned with povidone-iodine solution to maintain aseptic conditions. A polyurethane silver granufoam dressing was cut to match the wound dimensions and placed over the wound bed. The foam dressing was then sealed with a transparent adhesive polyurethane sheet to create an airtight environment. A drainage tube connected to a vacuum suction pump was inserted into the foam to apply negative pressure.

In Group A, continuous negative pressure of 125 mmHg was applied throughout the treatment period. In Group B, intermittent negative pressure ranging from 0 to 125 mmHg was applied at intervals every half hour following a two-hour cycle. Dressings were changed every five days depending on wound condition, exudate levels, and clinical judgment.

Outcome measures included changes in wound volume, percentage wound volume reduction, occurrence of VAC leak, peri-wound excoriation, and the final intervention required for wound closure. Statistical analysis was performed using SPSS version 20. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages.

Inclusion criteria:
All patients with acute or chronic wounds of varying aetiologies, including diabetic, traumatic, pressure sore, vascular, and iatrogenic wounds, who were undergoing NPWT.

Exclusion criteria:
The following patients were excluded from the study:
- Patients with wounds having underlying chronic osteomyelitis.
- Patients with abdominal wounds with exposed intra-abdominal organs.
- Wounds with exposed major vessels.
- Wounds caused by an underlying malignant condition.
- Superficial wounds that could heal without any intervention.
- Wounds that could be closed by primary suturing or skin grafting.

RESULTS:
The research involved 50 individuals, consisting of 25 patients in the continuous NPWT category and 25 in the intermittent NPWT category. The average age of the participants was 51.6 ± 11.8 years. In the continuous NPWT group, the average age was 50.8 ± 12.2 years, whereas in the intermittent NPWT group it was 52.4 ± 11.6 years. The predominant age category was 50–59 years (36%), with the next highest being those aged 60 years and older (34%). The study population was predominantly made up of male participants (64%), whereas females represented 36%. The average age of the participants was 51.6 ± 11.8 years. The study population was predominantly male, making up 64%, while females represented 36%.

Table 1: Age distribution of the study participants (N=50)

Age group	Group A – Continuous NPWT (n = 25)	Group B – Intermittent NPWT (n = 25)	Total (N = 50)	p-value
<40	4 (16)	3 (12)	7 (14)	0.82
40-49	3 (12)	5 (20)	8 (16)	
50-59	10 (40)	8 (32)	18 (36)	
60 and above	8 (32)	9 (36)	17 (34)	

Table 2: Sex distribution of the study participants (N=50)

Sex	Group A – Continuous NPWT (n = 25)	Group B – Intermittent NPWT (n = 25)	Total (N = 50)	p-value
Male	15 (60)	17 (68)	32 (64)	0.556
Female	10 (40)	8 (32)	18 (36)	

Diabetes mellitus was the most common comorbidity, found in 60% of individuals in both cohorts. Hypertension was noted in 38% of patients overall, whereas peripheral vascular disease was found in 18%. Diabetic ulcers accounted for the highest percentage of wound etiology (40%), followed by traumatic injuries (22%), pressure ulcers (20%), vascular wounds (12%), and iatrogenic injuries (6%).

Table 3: Comorbidities distribution of the study participants

Comorbidities	Group A (n = 25)	Group B (n = 25)	Total (N = 50)	p-value
Diabetes mellitus	15 (60)	15 (60)	30 (60)	1
Hypertension	9 (36)	11 (44)	19 (38)	0.564
Peripheral vascular disease	4 (16)	5 (20)	9 (18)	0.713

Table 4: Wound etiology distribution of the study participants (N=50)

Wound etiology	Group A (n = 25)	Group B (n = 25)	Total (N = 50)	p-value
Diabetic ulcer	9 (36)	11 (44)	20 (40)	0.906
Iatrogenic	1 (4)	2 (8)	3 (6)	
Pressure sore	6 (24)	4 (16)	10 (20)	
Trauma	5 (20)	6 (24)	11 (22)	
Vascular ulcer	3 (12)	3 (12)	6 (12)	

The initial wound volume was similar in both groups. The average wound volume at presentation was 141.1 ± 30.4 cm³ for the continuous NPWT group and 143.0 ± 32.4cm³ for the intermittent NPWT group. Following the initial NPWT cycle, wound volume reduced to 95.2 ± 39.4cm³ in the continuous group compared to 103.0 ± 33.6 cm³ in the intermittent group. On Day 10, average wound volumes decreased to 39.5 ± 22.5cm³ and 58.0 ± 31.3cm³, respectively.

Table 5: Change in wound volume (cm3) over time (N=50)

Time point	Group A (Continuous NPWT) Mean ± SD	Group B (Intermittent NPWT) Mean ± SD	p-value
Day 0 (before 1st cycle)	141.1 ± 30.4	143.0 ± 32.4	0.913
Day 5 (after 1st cycle)	95.2 ± 39.4	103.0 ± 33.6	0.687
Day 10 (after 2nd cycle)	39.5 ± 22.5	58.0 ± 31.3	0.223

The percentage of wound volume reduction showed statistically significant differences among the groups. Following the initial cycle, the average decrease was 30.1±19.2% for the continuous group and 25.0±15.3% for the intermittent group (p = 0.034). After the second cycle, the decrease was 56.2±21.6% for the continuous group and 62.6±20.5% for the intermittent group (p = 0.029). Following the third cycle, wound reduction achieved 86.2±22% and 91.5±15.0% respectively (p = 0.036).

Table 6: Wound volume reduction (%) over time (N=50)

Time point	Group A (Continuous NPWT) Mean ± SD	Group B (Intermittent NPWT) Mean ± SD	p-value
After 1st cycle	30.1±19.2	25.0±15.3	0.034*
After 2nd cycle	56.2±21.6	62.6±20.5	0.029*
After 3rd cycle	86.2±22	91.5±15.0	0.036*

Complications noted during treatment included VAC leakage and excoriation around the wound. A VAC leak happened in 12% of patients in the continuous NPWT group and 24% in the intermittent NPWT group following the initial cycle. Peri-wound excoriation was somewhat more common in the intermittent group. These complications progressively lessened with following cycles and were not present by Day 15 in both groups.In terms of final wound management, secondary healing was observed in 76% of patients in the continuous group and 64% in the intermittent group, while split-thickness skin grafting was required in 16% and 24% respectively.

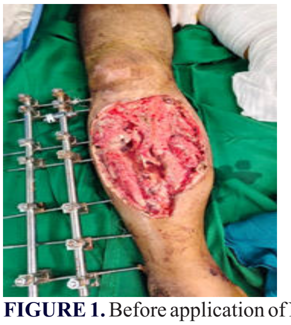

FIGURE 1. Before application of NPWT
FIGURE 2. After application of continuous NPWT

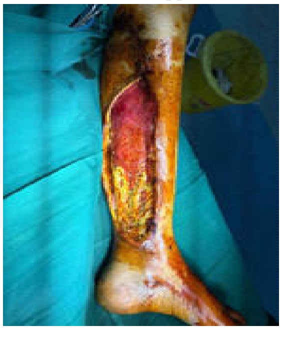

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FIGURE 3: Before NPWT application
FIGURE 4: After application of intermittent NPWT

DISCUSSION:

This randomized comparative study assessed the efficacy of continuous versus intermittent negative pressure wound therapy (NPWT) for healing soft tissue wounds in a group of 50 patients. Outcomes evaluated comprised wound volume decrease, wound score enhancement, wound grade advancement, complications, and final treatment. Results were analyzed in connection with prior research.

The current research involved 50 subjects with an average age of 51.6 ± 11.8 years. The average age in the continuous NPWT group was 50.8 ± 12.2 years, whereas the intermittent NPWT group had an average age of 52.4 ± 11.6years. The majority of participants fell within the 50–59 age range (36%), with the second largest group being individuals aged 60 years and older (34%). This age distribution represents the usual demographic characteristics of patients with chronic or complex wounds. Comparable findings were documented by Langer et al. (2015), who assessed NPWT in 60 patients with chronic wounds and observed that most were middle-aged or older adults with various comorbid conditions.[8]

Regarding sex distribution, the current study had a majority of male participants (64%), while female participants made up 36%. The intermittent NPWT cohort comprised 68% males and 32% females, while the continuous NPWT cohort included 60% males and 40% females. Clinical wound management studies have also reported a similar male predominance. For example, Kirsner et al. (2019) conducted a randomized clinical trial with 164 patients suffering from venous leg ulcers and diabetic foot ulcers treated using NPWT, noting that a larger share of participants were male, indicating the increased occurrence of traumatic and diabetic wounds in men.[9]

The main goal of this study was to assess the efficacy of continuous versus intermittent NPWT in the healing of soft tissue injuries. At baseline, the average wound volume was similar in both groups, with the continuous NPWT group at 141.1 ± 30.4cm³ and the intermittent NPWT group at 143.0 ± 32.4cm³ ($p = 0.913$). After the initial NPWT cycle, wound volumes reduced to 95.2 ± 39.4cm³ and 103.0 ± 33.6 cm³ in the continuous and intermittent groups, respectively. By Day 10, additional decreases were noted, with volumes of 39.5 ± 22.5 cm³ in the continuous group and 58.0 ± 31.3cm³ in the intermittent group. These results show that each treatment method led to significant decreases in wound size over time.

The percentage decrease in wound volume offered additional understanding of the relative effectiveness of continuous versus intermittent NPWT. Following the initial treatment cycle, the average decrease was 30.1±19.2% in the continuous NPWT group and 25.0±15.3% in the intermittent group, indicating a statistically significant variation ($p = 0.034$). After the second cycle, the intermittent group demonstrated a larger decrease 62.6±20.5% than the continuous group 56.2±21.6%, which was statistically significant ($p = 0.029$). At the third cycle, the decrease was 91.5±15.0%in the intermittent group and 86.2±22% in the continuous group ($p = 0.036$). These findings indicate that while continuous NPWT showed a marginally higher initial reduction, intermittent NPWT resulted in a more significant overall reduction during the later phases of treatment.

Complications like VAC leakage were also assessed during treatment. In the current study, VAC leak was observed in 12% of participants in the continuous group and in 24% of the intermittent group following the first cycle. Following the second cycle, leaks occurred in 4% and 12% of participants, and by the third cycle, neither group reported any leaks.

In this study, peri-wound skin excoriation was noted as a minor complication during NPWT therapy, especially during the initial treatment cycles. Following the first cycle, skin excoriation was observed in 8% of patients in the continuous NPWT group, in contrast to 24% in the intermittent NPWT group, and by Day 10 it had disappeared in the continuous group but continued to be present in 16% of patients undergoing intermittent therapy. Nonetheless, there were no instances of excoriation observed in either group by Day 15, indicating that this issue was temporary and resolved with ongoing treatment and suitable wound care. Excoriation around the wound during NPWT is typically due to extended exposure of adjacent skin to moisture, leakage of exudate, or irritation from adhesive dressings and frequent changes in pressure.

In summary, Continuous NPWT achieved marginally quicker initial wound reduction, whereas intermittent NPWT demonstrated a higher percentage reduction in the later treatment phases. Enhancements were noted in wound score, wound grade, and ultimate healing results, with few complications. These findings align with earlier studies showing that NPWT promotes wound healing by increasing blood flow, aiding in exudate removal, and encouraging granulation tissue development.

CONCLUSION:

The results of this randomized comparative study reveal that negative pressure wound therapy is an effective approach for managing soft tissue wounds from various causes. Both continuous and intermittent NPWT notably enhanced wound healing results by decreasing wound volume, enhancing wound scores, and promoting advancement toward wound closure.

Continuous NPWT exhibited a somewhat higher early decrease in wound volume following the initial treatment cycle, indicating that ongoing negative pressure might ensure swift initial wound stabilization by preserving a stable wound environment and facilitating ongoing exudate drainage.

Intermittent NPWT, on the other hand, showed a higher overall percentage decrease in wound volume in the later therapy cycles. The repetitive fluctuation in pressure might improve blood flow to tissues and encourage the development of granulation tissue by repeatedly mechanically stimulating the wound bed, thus facilitating tissue repair during the healing's proliferative phase.

While both modalities proved to be safe and effective, the complication rates in the intermittent NPWT group were slightly elevated. According to percentage distribution, patients undergoing intermittent therapy exhibited a higher occurrence of VAC leak and peri-wound excoriation than those receiving continuous NPWT. These issues were typically trivial and diminished over time with appropriate dressing methods and wound management.

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