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OPTIMIZING POSTOPERATIVE WOUND CARE: NEGATIVE PRESSURE WOUND THERAPY VERSUS CONVENTIONAL DRESSING IN ABDOMINAL SURGERY

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Abstract

Background: Surgical site infections remain a frequent postoperative complication following abdominal surgery and are associated with delayed wound healing, prolonged hospital stay, and increased healthcare costs. Conventional saline-soaked gauze dressing has traditionally been used for wound management, but negative pressure wound therapy has emerged as a promising alternative that may enhance wound healing by reducing edema, promoting granulation tissue formation, and decreasing bacterial burden.

Methods: This randomized controlled trial was conducted in Surgical Unit IV, SIMS and Services Hospital Lahore, over a six-month period from 31 December 2020 to 30 June 2021. A total of 100 patients aged 18 to 60 years who developed surgical site infection following elective abdominal surgery with a midline incision were enrolled. Patients were randomized into two equal groups using a random access table: Group A received negative pressure wound therapy, while Group B received conventional saline-soaked sterile gauze dressing. The primary outcome was wound healing efficacy at the seventh postoperative day, defined as absence of surgical site infection and presence of healthy granulation tissue. Data were analysed using SPSS version 21, and results were expressed as frequencies, percentages, means, and standard deviations.

Results: The mean age of participants was 48.27 ± 6.99 years, with 60 percent of patients aged 50 years or younger. Male patients constituted 71 percent of the study population. Negative pressure wound therapy was effective in achieving wound healing by day seven in 42 patients (84 percent), while only 8 patients (16 percent) required prolonged dressing. In contrast, conventional dressing resulted in successful wound healing in 33 patients (66 percent), whereas 17 patients (34 percent) required extended wound care. Overall, negative pressure wound therapy demonstrated superior efficacy compared to conventional wound dressing.

Conclusion: Negative pressure wound therapy is more effective than conventional saline gauze dressing for the management of surgical site infections following abdominal surgery, leading to improved wound healing outcomes.

Keywords: Negative pressure wound therapy; Surgical site infection; Conventional wound dressing; Abdominal surgery; Wound healing.

Introduction

Surgical site infection (SSI) is a significant postoperative complication that continues to challenge surgical practice worldwide. According to the Centers for Disease Control and Prevention, SSI is defined as an infection occurring within 30 days of an operative procedure or within one year in cases involving implant placement, provided the infection is related to the surgical intervention (1). Despite advances in aseptic techniques, antimicrobial therapy, and perioperative care, SSIs remain a major contributor to postoperative morbidity and healthcare burden.

Globally, surgical site infections represent the second most common nosocomial infection, accounting for approximately 16 to 20 percent of all hospital-acquired infections (2). They are particularly prevalent following abdominal surgeries, especially emergency laparotomies, where the risk of contamination is high (3,4). In Pakistan, the reported incidence of postoperative wound infection following emergency laparotomy is as high as 33.5 percent, reflecting the magnitude of the problem in local healthcare settings (5).

Several patient-related and procedure-related factors influence the development of surgical site infections. Advanced age, smoking, malnutrition, diabetes mellitus, immunodeficiency, prolonged operative time, and underlying malignancy have all been identified as significant risk factors (6,7). The consequences of SSIs extend beyond delayed wound healing and patient discomfort. These infections are associated with prolonged hospital stays, increased use of antibiotics, and substantial financial burden, with reported additional treatment costs ranging from 2000 to 4500 US dollars per case and an average hospital stay prolonged by 7 to 10 days (8).

Conventional wound management in most surgical units involves the use of normal saline-soaked sterile gauze dressings (9). While this approach is inexpensive and widely available, it requires frequent dressing changes, often once or twice daily, which can be painful, time-consuming, and uncomfortable for patients. Repeated manipulation of the wound may also disrupt granulation tissue and delay healing.

Negative pressure wound therapy (NPWT), first introduced in 1995, has gained increasing acceptance as an advanced modality for wound management (10). It involves the application of controlled sub-atmospheric pressure to the wound bed through a sealed system consisting of an open-pore foam dressing, occlusive adhesive cover, suction tubing, and a vacuum pump. The applied negative pressure, typically ranging from 50 to 125 mmHg, can be delivered in continuous or intermittent modes (11).

The proposed mechanisms of NPWT include removal of excess exudate, reduction of wound edema, prevention of hematoma formation, and creation of a sealed environment that limits bacterial proliferation. Experimental and clinical studies suggest that NPWT promotes angiogenesis, modulates inflammatory cytokine activity, and enhances matrix remodelling, thereby accelerating wound healing (12).

Clinical evidence supports the superiority of NPWT over conventional dressing methods. De Vries et al. reported a significant reduction in postoperative wound infections following abdominal surgery, with infection rates of 24 percent in the NPWT group compared to 51 percent in patients receiving standard dressings ($p = 0.02$) (13). Similarly, Condé-Green et al. observed wound complication rates of 22 percent with NPWT versus 63.6 percent with conventional dressing methods ($p = 0.02$) (14). Furthermore, a systematic review by Derek et al. demonstrated reduced mortality in patients with open abdominal wounds managed with NPWT compared to traditional techniques (18 percent versus 27 percent) (15).

Given the limitations of conventional dressing and the growing evidence supporting NPWT, this study was undertaken to compare the efficacy of negative pressure wound therapy with conventional wound dressing in the management of surgical site infections following abdominal surgery, with the aim of improving patient outcomes and optimizing postoperative wound care.

Methodology

This study was conducted as a randomised controlled trial in Surgical Unit IV, SIMS and Services Hospital, Lahore. The duration of the study was six months, commencing after approval of the research synopsis and ethical clearance, and was completed within the approved study period. A total of 100 patients were enrolled in the study. The sample size was calculated using a 5 percent level of significance and 90 percent statistical power, based on previously reported rates of surgical site infection of 24 percent in the negative pressure wound therapy group compared with 51 percent in the conventional dressing group (13). Patients were recruited using a non-probability consecutive sampling technique.

Eligibility Criteria

Patients aged between 18 and 60 years of either gender who developed surgical site infection following elective abdominal surgery with a midline incision were included in the study. Only patients classified as American Society of Anaesthesiologists (ASA) physical status I or II and those who provided informed written consent were eligible for participation.

Patients were excluded if they had undergone emergency surgical procedures, were classified as ASA III or above, were younger than 18 years or older than 60 years, or declined to give consent.

Randomisation and Group Allocation

After enrolment, patients were randomly assigned into two equal groups of 50 patients each using a random access table.

- Group A received negative pressure wound therapy.
- Group B received conventional wound therapy using normal saline-soaked sterile gauze dressings.

Intervention Protocol

In Group A, negative pressure wound therapy was applied using a standardised system consisting of a foam sponge, semi-occlusive adhesive dressing, suction tubing, and a vacuum pump. The foam was trimmed to fit the wound dimensions and placed carefully within the wound bed without extending beyond its margins. An adhesive drape was applied to create an airtight seal, and suction tubing was connected to a collection canister. Continuous negative pressure ranging from −50 to −175 mmHg was applied. Dressing changes were performed every 24 to 36 hours depending on the clinical condition of the wound.

In Group B, wounds were managed using conventional wound care, which involved application of sterile gauze soaked in normal saline. Dressings were changed daily or more frequently when required according to wound condition.

Outcome Assessment

The primary outcome measure was wound healing efficacy assessed on the seventh postoperative day. Efficacy was defined as absence of surgical site infection and presence of healthy granulation tissue. Surgical site infection was evaluated using the Southampton Wound Assessment Scale. Infection was defined as Grade IV or Grade V on the scale at day seven postoperatively.

Data Collection and Statistical Analysis

Demographic data including age and gender were recorded using a pre-designed proforma. All clinical findings and outcomes were documented systematically. Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 21. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were presented as frequencies and percentages.

Results

Table 1: Demographic characteristics of study participants

Table 1 summarises the baseline demographic characteristics of patients in both study groups. Age, gender distribution and body mass index were comparable between the negative pressure wound therapy and standard dressing groups, with no statistically significant differences observed, indicating appropriate randomisation.

Variable	Overall (n=100)	Group A NPWT (n=50)	Group B Standard (n=50)	p-value
Age (years, Mean ± SD)	48.27 ± 6.99	48.76 ± 7.19	47.78 ± 6.83	>0.05
Male, n (%)	71 (71%)	35 (70%)	36 (72%)	>0.05
Female, n (%)	29 (29%)	15 (30%)	14 (28%)	>0.05
BMI (kg/m^2, Mean ± SD)	23.48 ± 3.57	23.52 ± 3.12	23.43 ± 3.23	>0.05

SD (Standard Deviation), Group A (Negative pressure wound therapy (NPWT)), Group B (Standard dressing for wounds)

Table 2: Distribution of clinical risk factors

Table 2 presents the distribution of important clinical risk factors across both groups. Most patients belonged to ASA class I. Diabetes mellitus and smoking were present in a minority of patients, with slightly higher proportions observed in the NPWT group.

Risk Factor	Overall (n=100)	Group A NPWT (n=50)	Group B Standard (n=50)
ASA I, n (%)	84 (84%)	38 (76%)	46 (92%)
ASA II, n (%)	16 (16%)	12 (24%)	4 (8%)
Diabetes Mellitus, n (%)	25 (25%)	15 (30%)	10 (20%)
Smokers, n (%)	21 (21%)	11 (22%)	10 (20%)

ASA (American Society of Anesthesiologists), Group A (Negative pressure wound therapy (NPWT)), Group B (Standard dressing for wounds)

Table 3: Comparison of wound clearance on 7th postoperative day

This table compares wound clearance between the two treatment groups on the seventh postoperative day. Negative pressure wound therapy demonstrated a significantly higher rate of wound clearance compared to standard dressing.

Group	Wound Cleared n (%)	Not Cleared n (%)	Total	p-value
Group A NPWT	42 (84%)	8 (16%)	50	0.03
Group B Standard	33 (66%)	17 (34%)	50	0.03

Group A (Negative pressure wound therapy (NPWT)), Group B (Standard dressing for wounds)

Table 4: Association of demographic and clinical factors with wound clearance on 7th day (n=100)

Table 4 evaluates the association of demographic and clinical factors with wound clearance.

Variable	Group A (NPWT) – No n(%)	Group A (NPWT) – Yes n(%)	Group B (Standard) – No n(%)	Group B (Standard) – Yes n(%)	Total No n(%)	Total Yes n(%)	p-value
Age (≤50 years)	3 (10.7)	25 (89.3)	12 (37.5)	20 (62.5)	15 (25)	45 (75)	0.02
Age (>50 years)	5 (22.7)	17 (77.3)	5 (27.8)	13 (72.2)	10 (25)	30 (75)	0.05
Gender (Male)	6 (17.1)	29 (82.9)	12 (33.3)	24 (66.7)	18 (25.4)	53 (74.6)	0.17
Gender (Female)	2 (13.2)	13 (86.7)	5 (35.7)	9 (64.3)	7 (24.1)	22 (75.9)	0.09
ASA I	4 (10.5)	34 (89.5)	13 (28.3)	33 (71.7)	17 (20.2)	67 (79.8)	0.04
ASA II	4 (33.3)	8 (66.7)	4 (100.0)	-	8 (50.0)	8 (50.0)	0.03
Smoking (No)	6 (15.4)	33 (84.6)	11 (27.5)	29 (72.5)	17 (21.5)	62 (78.5)	0.15
Smoking (Yes)	2 (18.2)	9 (81.8)	6 (60.0)	4 (40.0)	8 (38.1)	13 (61.9)	0.06
Diabetes Mellitus (No)	3 (8.6)	32 (91.4)	10 (25.0)	30 (75.0)	13 (17.3)	62 (82.7)	0.05
Diabetes Mellitus (Yes)	5 (33.3)	10 (66.7)	7 (70.0)	3 (30.0)	12 (48.0)	13 (52.0)	0.08

ASA (American Society of Anesthesiologists), Group A (Negative pressure wound therapy (NPWT)), Group B (Standard dressing for wounds)

Table 5: Length of hospital stay

This table compares the duration of hospital stay between the two groups. Patients treated with negative pressure wound therapy had a shorter median hospital stay, reflecting faster wound recovery and earlier discharge.

Group	Median Stay (Days)	Range
Overall	11.5	7–22
Group A NPWT	10	7–18
Group B Standard	14	7–22

Group A (Negative pressure wound therapy (NPWT)), Group B (Standard dressing for wounds)

Discussion

In the present study, negative pressure wound therapy (NPWT) demonstrated superior wound healing outcomes compared with conventional saline-soaked dressings, with 84 percent of patients in the NPWT group exhibiting successful healing by day seven compared with 66 percent in the conventional group. This finding aligns with emerging evidence that NPWT reduces surgical site

complications in high-risk abdominal surgeries. For instance, a recent multicentre study reported that NPWT significantly reduced surgical site infections (6.7 % vs 21.7 %, $p < 0.05$) and wound dehiscence rates (3.3 % vs 15.0 %, $p < 0.05$), while also shortening hospital stay and improving patient satisfaction compared with conventional dressings in postoperative abdominal surgery cohorts (16).
The reduction in SSI and complications observed in our cohort resonates with findings from Ashraf et al., who reported lower SSI rates in patients receiving NPWT (5 %) versus conventional dressings (16.7 %, $p = 0.04$) and a significantly shorter mean hospital stay (9.1 ± 2.9 vs 11.2 ± 5.9 days; $p = 0.02$) (17).
These results reinforce the potential for NPWT to decrease postoperative morbidity and resource utilisation in abdominal wound management, particularly when applied prophylactically or early in the postoperative period. Despite these positive findings, not all recent evidence unequivocally supports reduced SSI rates with NPWT. A systematic review focusing on stoma reversal found no significant difference in SSI incidence between NPWT and conventional dressings, though NPWT did significantly reduce the time to complete wound healing (18).
This suggests that the benefits of NPWT may be procedure-specific and influenced by factors such as wound contamination, surgical field, and patient comorbidities. It highlights the importance of tailored application rather than assuming universal superiority for all surgical wounds.
Broader meta-analytic evidence also indicates that NPWT can reduce the odds of SSIs overall and related wound complications across a range of surgical fields. An 18-RCT meta-analysis involving 4585 patients reported that NPWT significantly lowered SSI risk (odds ratio 0.64, 95 % CI 0.50–0.83) and reduced hospital stay, reinforcing trends seen in abdominal contexts and aligning with our study's outcomes (19). Similarly, other systematic reviews have demonstrated clinically significant reductions in wound dehiscence and seroma formation with NPWT, further supporting its value in managing complex surgical incisions.
Notwithstanding this supportive evidence, some large clinical trials have noted an increased frequency of wound-related adverse events with NPWT, such as device-associated complications, highlighting the need for judicious patient selection and careful monitoring during therapy (20). Moreover, despite the trend toward reduced SSIs and improved healing, cost-effectiveness data remain mixed, particularly in low-resource settings where NPWT devices represent a higher upfront cost relative to conventional dressings.

Conclusion

This study demonstrates that negative pressure wound therapy is more effective than conventional saline-soaked gauze dressing in the management of surgical site infections following elective abdominal surgery. Patients treated with negative pressure wound therapy showed faster wound healing and reduced need for prolonged dressing. These findings support the use of negative pressure wound therapy as a reliable and efficient option for improving postoperative wound outcomes and reducing associated morbidity.

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