

Comparative Analysis of Negative Pressure Subcutaneous Drain Versus Conventional Wound Management in Laparotomy Wound Healing: A Prospective Cohort Study

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Abstract: ***Introduction:** Laparotomy wounds are prone to postoperative complications such as surgical site infection, seroma, hematoma, delayed wound healing and wound dehiscence. Negative pressure subcutaneous drainage may improve wound healing by reducing dead space, removing wound collections and improving tissue apposition. **Objectives:** To evaluate the effectiveness of negative pressure subcutaneous drains in enhancing laparotomy wound healing compared with conventional wound management, with specific assessment of wound healing time, infection rate, seroma, hematoma, wound dehiscence, secondary intervention, hospital stay and overall clinical outcome. **Methods:** This prospective cohort study included 97 patients aged 18-70 years undergoing laparotomy at the Department of General Surgery, B.R.D. Medical College, Gorakhpur, during 2024-2025. Forty-nine patients were managed with negative pressure subcutaneous drainage and 48 patients received conventional wound management. Postoperative outcomes were assessed over one month. Continuous variables were expressed as mean $\pm$ SD and categorical variables as frequency and percentage. **Results:** Most patients belonged to the 41-50 years age group (22.68%) and males predominated (69.07%). Emergency laparotomy was performed in 68.04% of patients. Baseline group characteristics were comparable. The Drain Group had shorter wound healing time and hospital stay than the Control Group. Postoperative complications were also significantly lower in the Drain Group, including SSI, seroma, hematoma, wound dehiscence and secondary intervention. **Conclusion:** Negative pressure subcutaneous drainage following laparotomy was associated with faster wound healing, shorter hospitalization and lower postoperative wound complications compared with conventional wound management. It appears to be a useful adjunct for improving laparotomy wound outcomes, particularly in high-risk surgical patients.*

Keywords: Negative pressure subcutaneous drain, laparotomy, surgical site infection, wound healing, seroma, hematoma, wound dehiscence, prospective cohort study

1. Introduction

Emergency laparotomy remains an important life-saving operation in general surgery and is frequently performed for acute abdominal conditions such as hollow viscus perforation, intestinal obstruction, abdominal trauma and peritonitis. Despite improvements in operative technique, anesthesia, antibiotic coverage and perioperative care, postoperative wound morbidity remains a common clinical problem, particularly in emergency and contaminated abdominal procedures.^[1,2]

Surgical site infection is one of the most frequent complications after abdominal surgery and is associated with prolonged hospital stay, increased cost, additional wound procedures and patient discomfort. The risk is especially high in emergency laparotomy because of delayed presentation, peritoneal contamination, bowel edema, systemic sepsis and reduced physiological reserve.^[3,4]

Local wound factors such as dead space, hematoma and serous fluid collection are important contributors to infection and delayed healing. Fluid accumulation within the subcutaneous plane may provide a suitable medium for bacterial proliferation, increase wound tension, impair tissue perfusion and predispose to seroma, hematoma, wound dehiscence and secondary intervention.

Negative pressure subcutaneous drainage aims to overcome these mechanisms by continuously evacuating wound exudate, reducing dead space, improving approximation of tissue planes and decreasing edema. This method may offer a

simpler and more resource-appropriate alternative to advanced closed-incision negative pressure devices, especially in Indian tertiary-care settings where emergency laparotomy workload is high.^[5-7]

Although several studies have evaluated subcutaneous drains and negative pressure wound therapy, prospective comparative evidence in laparotomy wounds remains limited. Therefore, the present study was conducted to compare negative pressure subcutaneous drainage with conventional wound management in patients undergoing laparotomy, focusing on wound healing time, infection rate, seroma, hematoma, wound dehiscence, secondary intervention, hospital stay and overall clinical outcome.

2. Materials & Methods

Study design: Prospective cohort study.

Place of study: Department of General Surgery, B.R.D. Medical College, Gorakhpur.

Study duration: 2024-2025; total 18 months, including 12 months of patient enrolment and one month of follow-up for each patient.

Study population: Patients undergoing elective or emergency laparotomy and fulfilling eligibility criteria.

Sample size: The calculated sample size was 97 patients, based on comparison of two proportions using wound

infection rate as the primary outcome, with 95% confidence level and 80% power.

Inclusion criteria: Patients aged 18-70 years undergoing laparotomy; patients with clean or clean-contaminated surgical wounds; and patients providing written informed consent.

Exclusion criteria: Patients with pre-existing wound infection, immunocompromised status including chemotherapy, HIV/AIDS or uncontrolled diabetes, coagulopathy or bleeding disorder, and patients lost to follow-up.

Study groups: The Drain Group included patients receiving negative pressure subcutaneous drains. The Control Group included patients managed with standard wound closure without negative pressure drainage.

Data collection procedure: Detailed history, clinical examination, relevant investigations and operative details were recorded. Baseline variables included age, sex, BMI, comorbidities, risk factors, type of surgery and wound classification. Operative and postoperative variables included duration of surgery, wound healing time, SSI, seroma, hematoma, wound dehiscence, secondary intervention, pus culture findings and hospital stay.

Outcome measures: Primary outcomes were wound healing time and surgical site infection. Secondary outcomes included seroma, hematoma, wound dehiscence, secondary intervention, hospital stay and overall clinical outcome.

Statistical analysis: Continuous variables were summarized as mean $\pm$ SD and compared using independent t-test. Categorical variables were summarized as frequency and percentage and compared using Chi-square test or Fisher exact test as appropriate. A p-value <0.05 was considered statistically significant.

Ethical considerations: Ethical approval was obtained and written informed consent was secured from all study participants.

3. Results

The study included 97 patients undergoing laparotomy. Most patients belonged to the 41-50 years age group (22.68%) and males constituted the majority of the study population (69.07%). Normal BMI was the most frequent BMI category (51.55%). Most patients had no documented comorbidity (61.86%), while hypertension (17.53%) and diabetes mellitus (16.49%) were the commonest comorbid conditions. Smoking was the most frequent recorded risk factor (24.74%). Emergency laparotomy was performed in 68.04% of patients. Among the 97 patients, 49 patients (50.52%) were managed with negative pressure subcutaneous drainage, while 48 patients (49.48%) received conventional wound management. The two groups were comparable with respect to mean age, gender distribution, BMI, comorbidities and mean duration of surgery, with no statistically significant baseline difference before postoperative outcome assessment.

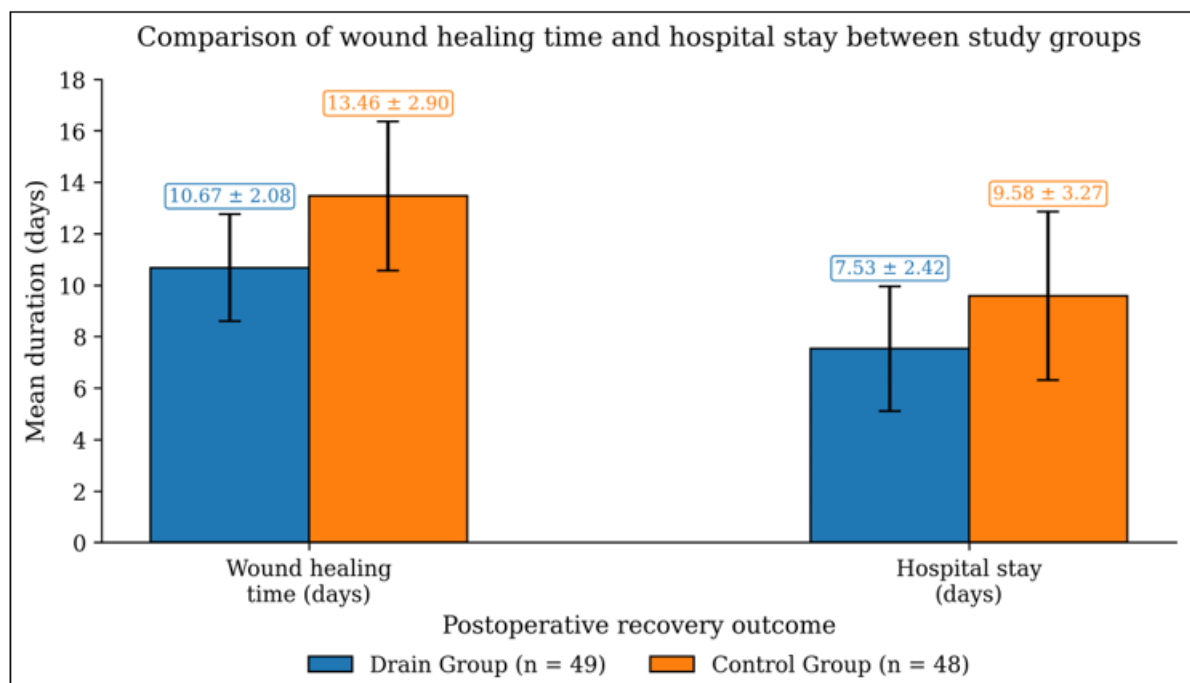


Figure 1: Comparison of wound healing time and hospital stay between Drain Group and Control Group

Figure 1 demonstrates better recovery outcomes in the Drain Group, with shorter wound healing time and shorter hospital stay compared with conventional wound management.

Table 1: Comparison of postoperative wound complications between Drain Group and Control Group, n = 97

Postoperative complication	Drain Group (n=49)	Control Group (n=48)	Chi-square	p-value
Surgical site infection	6 (12.24%)	14 (29.17%)	4.23	0.040
Seroma	5 (10.20%)	13 (27.08%)	4.57	0.033
Hematoma	3 (6.12%)	13 (27.08%)	7.72	0.005
Wound dehiscence	1 (2.04%)	8 (16.67%)	6.17	0.013
Secondary intervention	6 (12.24%)	18 (37.50%)	8.30	0.004

Statistical test used: Chi-square test.

Postoperative wound complications were consistently lower in the Drain Group, with statistically significant reductions in

surgical site infection, seroma, hematoma, wound dehiscence and need for secondary intervention.

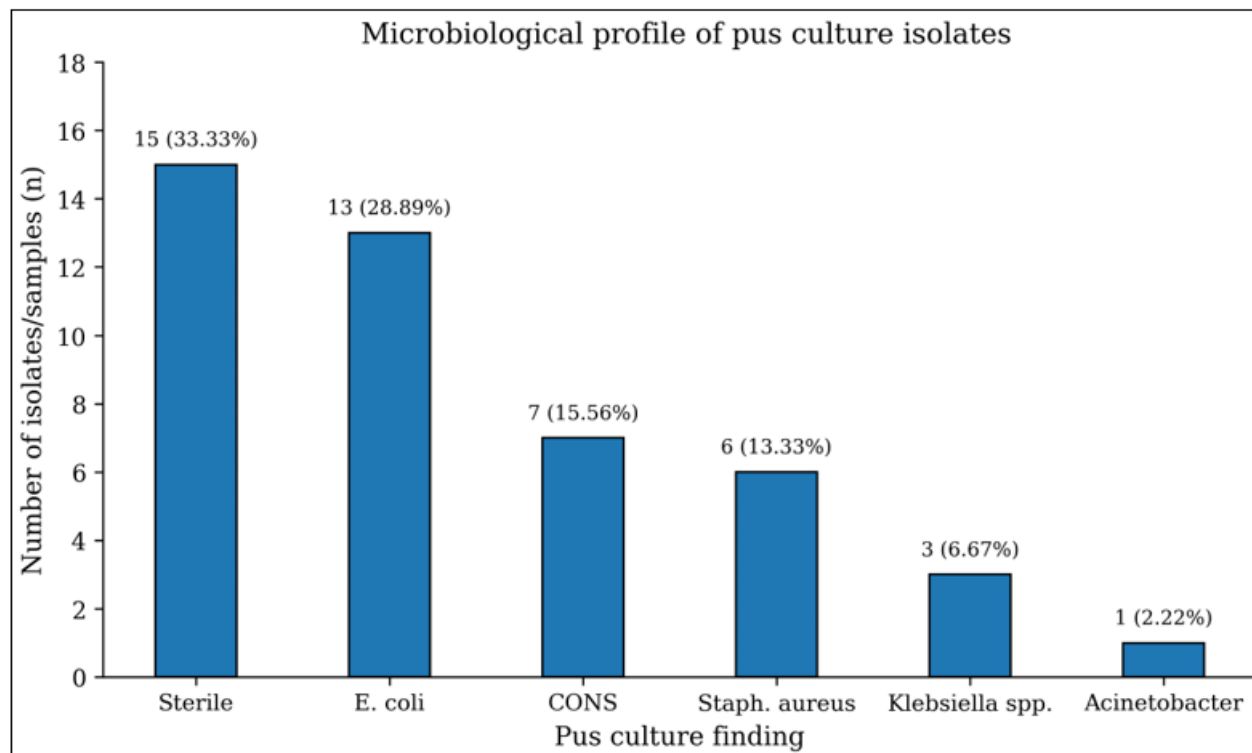
**Figure 2:** Microbiological profile of pus culture isolates among patients with wound infection/discharge, n = 45

Figure 2 shows that sterile culture was the most frequent pus culture finding, followed by E. coli, CONS and Staph. aureus. This microbiological pattern supports the infection-related analysis but remains a secondary supportive finding in relation to the primary wound-healing outcomes.

4. Discussion

The present study evaluated the effect of negative pressure subcutaneous drainage on laparotomy wound healing in a prospective cohort of 97 patients. The principal finding was that patients managed with negative pressure subcutaneous drainage had faster wound healing, shorter hospitalization and significantly lower postoperative wound complications compared with patients managed by conventional wound closure. These findings directly support the study aim of evaluating the effectiveness of negative pressure subcutaneous drains in enhancing laparotomy wound healing.

Baseline findings were kept concise in the result section because they mainly describe the study population. The important point was that the Drain Group and Control Group were comparable with respect to age, gender distribution, BMI, comorbidities and operative duration. This supports fair

interpretation of postoperative outcome differences despite the cohort design.

Mean wound healing time and hospital stay were selected for graphical representation because they are clinically direct recovery outcomes. The shorter healing time in the Drain Group is biologically plausible because negative pressure drainage continuously removes serous fluid and blood, reduces dead space, improves approximation of subcutaneous planes and decreases wound tension. Similar improvement in wound healing has been reported by Gilkar et al., Goyal and Kanojiya, Chung et al., Rajakumari et al. and Hasan et al., who observed better wound outcomes in patients receiving subcutaneous suction or negative pressure drainage. [8,10,12,13,18]

The reduced hospital stay in the Drain Group is clinically meaningful because it reflects earlier wound stability, fewer wound-related complications, less need for additional procedures and reduced healthcare burden. Earlier studies by Goyal and Kanojiya, Gilkar et al., Hasan et al. and Harish et al. also reported reduced hospitalization among patients managed with subcutaneous negative pressure or suction drains. [8,10,18,20]

The complication table was retained as the central analytical table because it directly fulfils the study objectives. Surgical site infection was significantly lower in the Drain Group. This supports the concept that subcutaneous fluid collections act as a bacterial growth medium and increase local tissue tension. Negative pressure drainage may reduce infection by removing exudate, reducing dead space and improving local tissue perfusion. These findings are consistent with systematic evidence on closed-incision negative pressure therapy and with Indian studies evaluating subcutaneous negative pressure drainage after emergency laparotomy.^[5,7-11,13]

Seroma and hematoma were also significantly reduced in the Drain Group. This is expected because the primary mechanical function of a subcutaneous drain is to remove serous and bloody collections from the wound plane. Reduction of these collections decreases bacterial substrate, improves wound-edge approximation and may indirectly reduce SSI and dehiscence. Similar observations have been made in studies evaluating subcutaneous drains in abdominal surgery and high-risk laparotomy wounds.^[13,16-18]

Wound dehiscence and secondary intervention were significantly lower in the Drain Group. These outcomes are clinically important because wound dehiscence is associated with delayed recovery, repeated dressings, re-suturing, prolonged hospitalization and increased treatment cost. Reduction in dehiscence may be attributed to lower infection, lower seroma and hematoma formation, and improved tissue apposition produced by negative pressure drainage.

The pus culture graph was included as a supportive clinical-laboratory figure because it helps explain the infection profile among patients with wound infection or discharge. Sterile culture and *E. coli* were the most common findings, followed by CONS and *Staph. aureus*. This finding supports the microbiological context of postoperative wound infection without overloading the result section with additional demographic tables.

The findings are especially relevant to Indian tertiary-care general surgery practice, where emergency laparotomy is common and patients may present with contamination, sepsis, delayed treatment and poor nutritional or metabolic reserves. A relatively simple negative pressure subcutaneous drain may therefore provide a practical and cost-conscious adjunct to reduce wound morbidity in selected laparotomy patients.

This study has limitations. It was conducted at a single centre with a modest sample size, and the prospective cohort design may still allow selection bias. Follow-up was limited to one month, so long-term outcomes such as scar quality, incisional hernia and cost-effectiveness could not be assessed. Patient satisfaction was part of the intended clinical assessment, but no separate numerical satisfaction result was available for independent manuscript tabulation; therefore, the manuscript does not overstate this outcome.

5. Conclusion

Negative pressure subcutaneous drainage following laparotomy was associated with significantly faster wound

healing, shorter hospital stay and lower postoperative wound complications compared with conventional wound management. The Drain Group showed lower rates of SSI, seroma, hematoma, wound dehiscence and secondary intervention, while baseline characteristics and operative duration were comparable between groups. These findings support the use of negative pressure subcutaneous drains as a useful adjunct for improving laparotomy wound outcomes, particularly in high-risk surgical patients. Larger multicentric randomized studies with longer follow-up are recommended to confirm these findings and evaluate long-term wound, scar and cost outcomes.

Conflict of Interest: None.

Funding: None.

Ethical Approval: Obtained.

Consent: Written informed consent obtained.

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