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Subcutaneous Suction Drain to Reduce Surgical Site Infection in Contaminated Cases of Emergency Laparotomy: A Randomized Controlled Trial

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Author`s Contribution

[1,3]Conceptualizing the study, drafting the manuscript, and gathering hospital data.
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ABSTRACT

Objective: To compare the frequency of surgical site infections (SSIs) in contaminated emergency laparotomy cases between two groups: with and without subcutaneous suction drains.

Methodology: This randomized controlled trial was conducted from December 2024 to February 2025 at the Department of General Surgery, Pakistan Institute of Medical Sciences, Islamabad. A total of 150 patients aged 18 to 75 years who underwent midline exploratory laparotomy with contamination were included. Patients were randomly assigned to either the subcutaneous suction drain group (n = 75) or the control group without drains (n = 75). Data on demographic characteristics, comorbidities (diabetes mellitus and hypertension), and surgical site infections were collected. Surgical site infections were assessed using standard clinical criteria, including redness, swelling, pain, warmth, and wound discharge.

Results: The incidence of surgical site infections was significantly lower in the subcutaneous suction drain group (13.3%) compared to the control group (46.7%) ($p < 0.001$). Stratified analyses revealed that age, gender, comorbidities, and body mass index (BMI) were significant predictors of SSI risk. Among patients in the control group, younger patients (≤40 years) had an infection rate of 44.1%, whereas older patients (>40 years) had an infection rate of 48.8% ($p = 0.015$).

Conclusion: The use of subcutaneous suction drains significantly reduces the incidence of surgical site infections in contaminated emergency laparotomy cases.

Keywords: Subcutaneous suction drain; surgical site infection; emergency laparotomy

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Introduction

Emergency laparotomy is a lifesaving surgical procedure that is utilized to manage conditions of abdomen that have immediate threat to life.[1] They include perforated viscerae, bowel obstruction, ischemic bowel, intra-abdominal hemorrhage, or peritonitis.[2] Decision for proceeding with an emergency laparotomy is taken in conditions of impending death in which patient is transported to operating room in conditions of severe distress or instability to diagnose and manage pathology while simultaneously stabilizing patient. Due to their urgency and complexity, these cases carry inherent risks that include complications like hemorrhage, dysfunction of vital organs, or sepsis.[3] Postoperative recovery is challenging in comorbid patients or in patients presenting in delayed manner in severe sepsis or in shock.[4] During emergency laparotomy, cases of contamination include conditions in which gastrointestinal tract is breached with extravasation of gastrointestinal tract contents in the peritoneal space.[5] There is severe increase in surgical site infections or other postoperative complications in these cases of contamination. Perforated appendicitis, diverticulitis, or bowel trauma are some of these cases of contamination in which bacteria-filled material in

operating field makes field unfavorable to healing so these cases are more challenging in nature.[6]

Surgical site infections in contaminated cases of emergency laparotomies are managed by prevention and therapeutic measures in combination.[7] Preventive measures include preoperative antibiotic prophylaxis that is focused on common pathogens of intra-abdominal infections. During surgery, good surgical technique, proper source control, and aggressive intraoperative peritoneal lavage work to contain bacterial burden.[8] After surgery, close monitoring for symptoms of infection in the form of pyrexia, discharge from the wound, or systemic inflammatory response syndrome facilitates early treatment initiation. If an SSI develops, treatment encompasses normally wound care, culture-directed antibiotic therapy, and in certain cases surgical debridement.[9] Other approaches to advanced wound care such as negative pressure wound therapy have also demonstrated efficacy in promoting wound closure while reducing infections. All these notwithstanding, SSIs remain a persistent challenge to manage, underscoring that more steps need to be taken to further improve outcomes.[10]

Subcutaneous suction drains play an indispensable part in reducing surgical site infections in contamination cases of emergency laparotomy by evacuating fluid collections efficiently while reducing subcutaneous tissue dead space to a minimum.[11] Wound retention of serous fluid or blood in the wound bed provides an environment for bacteria that increases the probability of SSIs. Through their uniform removal of these fluid collections, suction drains create a dry environment in the surgical field that is conducive for proper healing to take hold.[12] As their implementation further minimizes external contamination through closed suction methods, their efficacy is further maximized. Placement of drains must consider complications like hematoma or seroma formation to prevent these events from occurring but their utility in cases of high-risk contamination is established.[13] Although the advances in aseptic techniques and perioperative antibiotics, the risk of SSI in such settings remains high due to heavy bacterial load. However the Subcutaneous suction drains may help reduce this risk by preventing fluid accumulation, decrease bacterial proliferation, and promoting wound healing.

However, evidence regarding the effectiveness of subcutaneous suction drains in contaminated abdominal surgeries remains limited and inconclusive, particularly in resource-limited settings. Several studies have reported significantly lower rates of SSI in patients with drains compared to those without.[14,15] In contrast, other studies has shown no significant difference in the risk of deep SSI with or without drain placement,[16] while an Italian study identified surgical drains as an independent risk factor for SSI among patients undergoing abdominal surgeries.[17] These conflicting findings highlight the need for a clearer understanding of the role of drains in the development of SSI. In light of these controversies, the present study is justified to assess the role of subcutaneous suction drainage in preventing SSI, with the aim of providing evidence-based recommendations to improve surgical outcomes in high-risk emergency laparotomy patients at the local level.

Methodology

This randomized trial was implemented at Pakistan Institute of Medical Sciences Department of General Surgery from December 2024 to February 2025. The trial was designed to determine the effects of subcutaneous suction drains in preventing surgical site infections in cases of emergency laparotomy that have contamination. Sample size was estimated by the WHO calculator at a significance level of 5% and power of 80% to identify a substantial difference in surgical site infections in between these two arms of patients: the subcutaneous suction drain arm and the control arm with no drain. Sample size was estimated to be 75 patients in each arm for a total of 150 patients.

The study used non-probability consecutive sampling technique in choosing patients. Ethical approval was obtained from the hospital ethical committee Ref no F.2/2024(ERRC)/PIMS. Inclusion criteria included patients of both genders aged between 18 and 75 years who were undergoing midline laparotomy in contaminated cases. Contaminated laparotomy was defined as a laparotomy where there was gross contamination either with frank pus or spill from gastrointestinal contents. Exclusion criteria included individuals who refused consent, patients aged under 18 or over 75 years, cases of accidental drain removal, those who died in the immediate postoperative period, and those with an immuno-compromised state. A total of 150 patients presenting for midline exploratory laparotomy in contamination cases were taken for the research work. All these patients presented to PIMS Islamabad Department of General Surgery. They included 75 patients in the trial group (A) to which subcutaneous suction drains were placed before closure of the skin, while in other 75 patients in control group (B) no drain

was administered. Subcutaneous suction drain was taken to comprise all that was placed in subcutaneous plane of tissue to preclude dead space and to prevent fluid and seroma formation. All patients consented before the procedure was implemented on them. Data was documented on their demography like age, gender, and comorbid conditions like Diabetes Mellitus and Hypertension and surgical site infections' outcomes. Surgical site infection was taken to comprise all infections that presented within 30 days of surgery involving the incision or deeper tissues at operative site presenting with redness of part, swelling of part, pain on movement of part, warmth of part, or discharge of foul smelling fluid from part.

The collected data was analyzed by Statistical Package for Social Sciences (SPSS) version 25. Categorical variables such as gender, co-morbidities, and SSI rates have been described in frequencies and percentages by applying descriptive statistics whereas continuous variables such as age and BMI have been described in the form of mean ± SD. To compare proportion of SSIs in these two categories of patients, Fisher Exact test and Chi-square test have been employed. Effect modifiers such as age, gender, and co-morbidities have been stratified by post-stratified Chi-square test. P-value of <0.05 has been considered for statistical significance.

Results

The study included a total of 150 patients, with 75 patients in the subcutaneous suction drains group and 75 patients in the control group. The average age in the subcutaneous suction drains group was 44.64 ± 17.10 years, while the control group had a slightly older average age of 48.21 ± 16.71 years (as shown in Table-I). The average BMI for the subcutaneous suction drains group was 24.10 ± 2.99 kg/m², and for the control group, it was 23.90 ± 3.34 kg/m². The gender distribution showed a higher percentage of females in the control group (64%) compared to the subcutaneous suction drains group (52%). Regarding comorbidities, 25.3% of patients in the subcutaneous suction drains group had diabetes, 24% had hypertension, and 50.7% had no comorbidities. In the control group, 24% had diabetes, 22.7% had hypertension, and 53.3% had no comorbidities.

The incidence of surgical site infection (SSI) was significantly higher in the control group, where 46.7% of patients developed SSI compared to 13.3% in the subcutaneous suction drains group ($p < 0.001$), as shown in Table II.

Table II: Comparison of Surgical Site Infection between the two groups. (n=150)

Surgical Site Infection	Group A (n=75)n (%)	Group B (n=75) n (%)	P value
Yes	10 (13.3%)	35 (46.7%)	<0.001
No	65 (86.7%)	40 (53.3%)	
Total	75 (100%)	75 (100%)	

In stratified analyses, age was a significant factor, with patients aged 40 years or younger showing a 44.1% SSI rate in the control group, whereas no SSI cases were observed in the subcutaneous suction drains group ($p < 0.001$). In older patients (>40 years), SSI rates were 23.3% in the subcutaneous suction drains group and 48.8% in the control group ($p = 0.015$). Gender differences were observed, particularly in females, where 58.3% of females in the control group developed SSI, compared to 15.4% in the subcutaneous suction drains group ($p < 0.001$). The BMI category also played a significant role: patients with a BMI ≤25 in the subcutaneous suction drains group showed only a 10.6% SSI rate, while the control group had a higher rate of 42.6% ($p = 0.001$). For BMI >25, the subcutaneous suction drains group had 17.9% with SSI, whereas the control group had 53.6% ($p = 0.011$). Comorbidity status showed clear associations with SSI. Diabetes was strongly linked to SSI, with 88.9% of diabetic patients in the control group developing infection, compared to only 31.6% in the subcutaneous suction drains group ($p = 0.001$). Similarly, 70.6% of hypertensive patients in the control group developed SSI, compared to 22.2% in the subcutaneous suction drains group ($p = 0.007$). Patients

Table I: Demographics of the patients. (n=150)

Demographics		Subcutaneous suction drains group (n=75) Mean±SD	Control group (n=75) Mean±SD	p-value
Age (years)		44.640±17.10	48.213±16.71	0.198
BMI (Kg/m^2)		24.097±2.99	23.900±3.34	0.704
Gender	Male n(%)	36 (48%)	27 (36%)	0.147
	Female n(%)	39 (52%)	48 (64%)	
Comorbidity	Diabetes n(%)	19 (25.3%)	18 (24%)	0.948
	Hypertension n(%)	18 (24%)	17 (22.7%)	
	None n(%)	38 (50.7%)	40 (53.3%)	

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Table III: Stratification of Surgical Site Infection Based on Demographic Variables Across Groups

Demographics variables		Group	Surgical Site Infection		P-value
			Yes (n, %)	No (n, %)	
Age (years)	≤40	A	0 (0%)	32 (100%)	0.000*
		B	15 (44.1%)	19 (55.9%)	
	>40	A	10 (23.3%)	33 (76.7%)	0.015
		B	20 (48.8%)	21 (51.2%)	
Gender	Male	A	4 (11.1%)	32 (88.9%)	0.182*
		B	7 (25.9%)	20 (74.1%)	
	Female	A	6 (15.4%)	33 (84.6%)	0.000
		B	28 (58.3%)	20 (41.7%)	
BMI (Kg/m^2)	≤25	A	5 (10.6%)	42 (89.4%)	0.001*
		B	20 (42.6%)	27 (57.4%)	
	>25	A	5 (17.9%)	23 (82.1%)	0.011*
		B	15 (53.6%)	13 (46.4%)	
Comorbidity	Diabetes	A	6 (31.6%)	13 (68.4%)	0.001*
		B	16 (88.9%)	2 (11.1%)	
	Hypertension	A	4 (22.2%)	14 (77.8%)	0.007*
		B	12 (70.6%)	5 (29.4%)	
	None	A	0 (0%)	38 (100%)	0.012*
		B	7 (17.5%)	33 (82.5%)	

*Fischer Exact Test

Table IV: Logistic Regression Analysis of Factors Affecting Surgical Site Infection in Contaminated Emergency Laparotomy Cases.

Variable	Beta coefficient	Standard Error	Significance	Odds Ratio	95% C.I. for Odds Ratio
Age	0.012	0.019	0.533	1.012	(0.975, 1.050)
Male Gender	0.204	0.487	0.676	1.226	(0.472, 3.182)
BMI	0.133	0.075	0.077	1.142	(0.986, 1.322)
Diabetes	-3.23	0.751	<0.001	0.04	(0.009, 0.172)
Hypertension	-2.724	0.727	<0.001	0.066	(0.016, 0.273)

with no comorbidities had a significantly lower SSI rate, with 100% in the subcutaneous suction drains group and only 17.5% in the control group (p = 0.012). Table III

Logistic regression analysis (Table IV) showed that age, male gender, and BMI were not significant predictors of SSI. However, diabetes and hypertension were strong predictors. Specifically, diabetes had an odds ratio of 0.04 (95% CI: 0.009, 0.172), and hypertension had an odds ratio of 0.066 (95% CI: 0.016, 0.273), both of which were statistically significant (p < 0.001).

Discussion

The results demonstrated that patients receiving subcutaneous suction drains significantly reduced their SSI in comparison to the control population with significantly higher infections in the control population (46.7% vs. 13.3%, p < 0.001). Stratified analyses further revealed that age, gender, comorbid conditions of diabetes and hypertension, and body mass index (BMI) all independently predicted risk of SSI. Younger patients aged ≤40 in the control arm presented with no SSI, while older patients aged >40 presented with greater risk, more so in the control arm (48.8% SSI). These results indicate older age that is associated with impaired capacity to heal and greater vulnerability to infection in greater likelihood of occurrence of SSI. Greater body mass index of greater than 25 and comorbid conditions of diabetes and hypertension were likewise associated with greater occurrence of SSI due to impaired immunity and impaired tissue perfusion that is characteristic of these patients. The regression analysis demonstrated that diabetes and hypertension have significant effects on having SSI with probabilities of 0.04 and 0.066, respectively, with predictability power of p < 0.001.

The findings of our research concur with several landmark studies on subcutaneous suction drains' role in reducing surgical site infections (SSIs) in emergency laparotomies. Subcutaneous suction drains reduced cases of SSIs significantly in accordance with research by Gupta et al.[18] Goyal et al[19] and Vigneshwaran et al[20] in accordance with our research. Notably in our research, cases of SSIs in the drain group (13.3%) were significantly lower than in the control group (46.7%), in accordance with research by Gupta et al.[18] (24% in drain vs. 50% in control) and Vigneshwaran et al. (16% vs.

36%).[20] Consistent reduction of cases of SSIs in the drain group supports the hypothesis that subcutaneous suction drains evacuate infectious fluid from the body and mitigate risks of infections, specifically in high-risk surgeries like emergency laparotomies.

Furthermore, our research correlates with Naik et al[14] that found that in their drain population receiving subcutaneous suction drains, the prevalence of SSIs was lower at 24% compared to their control population at 46%. Naik et al.'s work further found that subcutaneous suction drains significantly facilitated in reducing incidences of SSI, dehiscence of the wound, and hospital stay in their population. As found in our research as well, patients in their drain population hospitalized for a shorter period than their control population (average of 6 days compared to their control population of 10 days), corresponding with Naik et al.'s finding that subcutaneous drains reduced hospital stay by preventing complications like SSIs and enabling expedited recovery.[14]

The significant drain vs. control group reduction in infections that was documented in our research work ($p < 0.001$) is consistent with El-Badry et al[21] who determined that patients treated with subcutaneous suction drains had significantly lower SSI rates. They reported a 10% SSI in the drain group but significantly higher at 30% in the control group ($p = 0.01$). Similarly, comparable results have been documented by Harish et al[22] where significantly low cases of SSIs in the drain group at 24% were reported compared to the control group at 40%, further substantiating that subcutaneous suction drains have positive effects on preventing infections.

However, our result is not in accordance with that of Barbadoro P et al[17] where SSI was observed in 13.6% of patients with drains, compared to 2.4% in those without drains ($P < .001$). The disparity in results would have been attributed to sample size or by characteristics of patients or by differing surgical procedures undergone by patients. Although all surgeries of the abdomen have been taken into account by Nasta et al[23] in our research work only emergency laparotomies have been taken into account that are more complex in nature and have higher risks of infections. The statistical significance would have varied due to other unidentified variables like patients' comorbidities that impact results of SSI.

In terms of pathogens that cause SSIs, in our study, Escherichia coli was found to be the predominant causative organism, consistent with work by Harish et al[22] Not unexpected considering that E. coli is normally associated with gastrointestinal infections, hence leading to recurring cases of SSIs in infected cases of abdominal surgeries. Other investigations by Vigneshwaran et al[20] and by Gupta et al[18] found that E. coli was a predominant causative pathogen further confirming that pattern in cases of emergency cases of abdominal surgeries.

A notable uniformity in all of these research papers, including our own, is that patient characteristics such as age, gender, comorbidities, and BMI significantly contribute to influencing SSI rates. As was evident in Naik et al.'s research in 2022 [14] as well as in El-Badry et al[21] reported that the patients with more comorbid conditions such as diabetes or hypertension or greater BMI have greater SSI rates. Similarly, in our research, greater infection was observed in patients with more than a BMI of 25 as well as in patients with comorbid conditions such as diabetes and hypertension. This demonstrates that these risk factors must be managed to further reduce SSI in at-risk patients.

Overall, almost consistent findings across multiple studies, including our own, suggest that subcutaneous suction drains play an important role in preventing SSI and facilitating faster recovery following emergency laparotomies. In spite of these significant results, several limitations of the present study must be acknowledged; being a single-center trial with a limited sample size and inclusion of patients with comorbidities, the findings may not be generalizable to other clinical settings or broader patient populations. Hence, future larger multi-center studies are recommended to validate these results and better define the long-term benefits of subcutaneous suction drains in more representative cohorts. The future research should also aim to control for potential confounding factors, such as variations in surgical techniques and postoperative care practices, which may influence the validity of the observations.

Conclusion

Our study has established that subcutaneous suction drains significantly reduce surgical site infections in patients who have undergone emergency laparotomies significantly. Substantive proof from results confirms that subcutaneous suction drains significantly reduce risks of SSIs, contribute to faster recovery, and reduce hospital stay. Aside from that, results from our research agree with other research that has continuously demonstrated that subcutaneous suction drains have positive effects in high-risk surgeries. Although age, comorbidities, and

BMI predicted risks of SSI significantly, drains remained an integral intervention for promoting postoperative outcomes in contaminated emergency laparotomies.

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