

Original Research Article

A comparative study between subcutaneous negative pressure and simple skin closure in a midline skin incision following an emergency exploratory laparotomy

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Abstract

Introduction: Surgical site infection (SSI) is a common complication following emergency laparotomy, particularly in cases with higher contamination levels. These patients are at an increased risk of surgical site infection and delayed wound healing. To reduce the incidence of infection, negative suction drains are often used in the subcutaneous space to evacuate infected content and collect seroma, thereby improving wound healing. This study aims to observe the role of subcutaneous drains in reducing SSI in emergency laparotomies and compare the outcomes of subcutaneous negative pressure closure (using Romo-vac Drain) versus simple skin closure for midline skin incisions. The objective is to identify the optimal method for managing laparotomy wounds between subcutaneous negative pressure closure and simple skin closure. By comparing SSI rates and duration of hospital stay, we aim to determine the most effective approach for these patients.

Methods: A longitudinal study was conducted involving 50 patients who met the inclusion and exclusion criteria. Twenty-five patients had a subcutaneous negative pressure drain placed, while the remaining 25 patients underwent simple skin closure without drain placement. SSI infections were graded using the Southampton wound grading system during the post-operative period.

Results: The incidence of SSI and the mean duration of hospital stay were found to be significantly lower in patients with subcutaneous negative pressure drain (12% and 7 days, respectively) compared to those without drain (88% and 10.76 days). All measured parameters showed statistically significant differences.

Conclusions: The placement of subcutaneous negative pressure drain significantly reduces the occurrence of post-operative surgical site infections and duration of hospital stay following emergency exploratory laparotomy for acute abdomen cases. This approach promotes improved wound healing, faster recovery, and decreased patient morbidity. Furthermore, it helps alleviate the financial burden by reducing hospital stay duration and facilitating early discharge.

Key words: Surgical Site Infections (SSI), subcutaneous negative pressure drain, emergency laparotomy.

1. INTRODUCTION:-

Infections which occur in the wound created by an invasive surgical procedure are generally known as surgical site infections (SSI).¹ SSI previously termed as postoperative wound infection is defined as that infection presenting up to 30 days after a surgical procedure if no prosthetic is implanted and up to 1 year if a prosthetic is implanted in the patient's body.¹ SSI is one of the most common post-operative complications, occurring in at least 5% of all patients undergoing surgery and 30-40% of patients undergoing abdominal surgery, depending on the level of contamination². Patients requiring emergency laparotomy procedure has increased risk of SSI and delayed wound healing. The incidence of SSI increases with the degree of contamination. Infection occurs at much higher rates after operations like perforative peritonitis with an incidence of 5-15%, compared to less than 5% for elective abdominal surgeries². Numerous risk factors have been identified as causing SSI. Body Mass Index and obesity have been linked to increased risk of SSI, and wound complication rates increases from 7% to 23% due to obesity³. Many other factors as Diabetes mellitus, malnutrition, smoking, ASA class, operative time, contaminated surgeries, and the emergence of antimicrobial-resistant pathogens have been identified as important factors affecting SSI⁴. Various measures have been proposed for reducing SSIs. Some of them are used in routine practice. Hand washing, minimizing shaving, skin preparation, and preoperative antibiotics have been shown to decrease postoperative wound complications.

It has been demonstrated that negative vacuum discharge in the subcutaneous space reduces the number of cases of infection by removing infected seroma from the subcutaneous space. Negative suction enhances the wound's capacity to heal by decreasing its bacterial burden. Negative pressure providing a moist and protected environment, reducing peripheral edema around the wound, stimulating circulation to the wound bed, decreasing bacterial colonization, increasing the rate of granulation tissue formation and epithelisation.⁵

The most common type is superficial wound infection occurring within the first week of surgery.⁶ The presence of hematoma, serous fluid, and dead space in surgical wounds act as a culture medium and increases the risk of surgical site infection. In the early post-operative period, implantation of a subcutaneous drain removes fluids along with detritus from the subcutaneous layer and eliminates dead space, thus minimizing incisional SSIs. SSI leads to increased duration of hospital stay and increased morbidity⁷ alongside increasing unnecessary patient suffering. The research presented here contrasts the subcutaneous sole closed suction drain and straightforward customary closure of centerline incisions in the skin in emergency exploratory laparotomies conducted over acute abdominal conditions. A drain works on the principle of eliminating "dead space" in a wound. It helps to overcome various barriers to wound healing as listed below.

BARRIERS TO WOUND HEALING	ROLE OF A DRAIN
EXCESS INTERSTITIAL FLUID	EVACUATES FLUID
EXCESS EXUDATES	REMOVE EXUDATES
INADEQUATE PERFUSION	IMPROVES PERFUSION BY RELIEVING EDEMA
LACK OF GRANULATION TISSUE	PROMOTES GRANULATION TISSUE FORMATION BY REDUCING THE DEAD SPACE
EXCESS BACTERIAL BURDEN	REDUCES THE INFECTION LOAD

2. MATERIALS AND METHODS

This interventional and longitudinal study aimed to investigate the effectiveness of a subcutaneous negative pressure drain in reducing SSI in patients who underwent emergency exploratory laparotomy. The study population included all patients who had undergone this procedure at the Department of General Surgery in COMJNMH, Kalyani, Nadia. The target population consisted of patients who had attended the Surgery department through the Emergency Department or Outpatient department at COMJNMH, Kalyani, Nadia. The inclusion criteria included patients of both sexes, aged 12 years and above, with indications for laparotomy. Patients below 12 years of age were excluded from the study. The study was conducted in the indoor patient setting at the College of Medicine and JNM Hospital, Kalyani, Nadia, West Bengal. The study period was one year from the approval of the Institutional Ethical Committee. The sample size was 50 patients, considering a prevalence of 2.8%, an estimated error of 5%, and a confidence interval (Z) of 1.96. With a 10% allowance for non-response, the final sample size was 50 to ensure adequate data collection.

Study Method:

Patients will then be divided into two groups by simple randomisation, Group A in whom the negative pressure suction drain (romovac drain 16Fr) will be placed in subcutaneous plane and fixed at the time of closure of abdomen and Group B in whom no negative suction drain is placed in subcutaneous space at the time of closure of abdomen. Both groups will be matched according to age, sex, BMI and surgeons with comparable experience.

Patients were followed daily to check for wound examination, quantity of drainage and for dressing. Drain was removed when the output is less than 5ml in 24 hours. The wounds were assessed and graded using the Southampton wound grading system throughout the post-operative follow-up period, which lasted until day 30. Data was compiled, analysed and inference to be made on the basis of calculations.

Plan of data analysis and statistics:

The data collected will be entered in MS excel. The data will be analysed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism version 5. Data will be summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Results will be presented in Tables, charts and texts wherever appropriate. Proportion will be calculated and appropriate statistical tests will be done. Two – tailed significance test with p value of 0.05 or less will be considered statistically significant.

SOUTHAMPTON WOUND – GRADING SYSTEM

GRADE	APPEARANCE	
0	Normal Healing	
I	Normal Healing with mild bruising or erythema	
	Ia	Some Bruising
	Ib	Considerable Bruising
	Ic	Mild Erythma
II	Erythma plus other signs of inflammation	
	IIa	At one point
	IIb	Around sutures
	IIc	Along Wound
	IIc	Around Wound
III	Clear or hemoserous discharge	
	IIIa	At one point only(≤ 2 cm)
	IIIb	Along Wound (>2 cm)
	IIIc	Large volume
	IIIc	Prolonged (>3 days)
IV	Pus	
	Iva	At one point only (≤ 2 cm)
	IVb	Along wound (>2 cm)
V	Deep or severe wound infection with or without tissue breakdown; hematoma requiring aspiration)	

3. RESULTS**Table 1: Distribution of study group according to age**

Age in group	Frequency	Percent
<20	4	8.0%
21-30	9	18.0%
31-40	18	36.0%
41-50	9	18.0%
51-60	7	14.0%
>60	3	6.0%
Total	50	100.0%

8.0% of participants were under 20 years old, 18.0% were aged 21-30, 36.0% were aged 31-40, 18.0% were aged 41-50, 14.0% were aged 51-60, and 6.0% were over 60. Th Participants were 50.

Table 2: Distribution of study population according to Group

Group	Frequency	Percent
With drain	25	50.0%
Without drain	25	50.0%
Total	50	100.0%

The study population was evenly distributed between two groups: 25 participants (50.0%) with a drain and 25 participants (50.0%) without a drain.

Table 3: Distribution of the Study population in two groups according to gender

GROUP			
Sex	With Drain	Without Drain	TOTAL
Female	6	7	13
Male	19	18	37
TOTAL	25	25	50

Chi-square value: 0.1040; **p-value:** 0.7471

Odds ratio: 0.8120 (0.2288, 2.8822)

Study population was in 2 groups according to gender was as follows: 13 females (6 with drain, 7 without drain) and 37 males (19 with drain, 18 without drain). The chi-square value was 0.1040 with a p-value of 0.7471, indicating no significant association between gender and the use of a drain. The odds ratio was 0.8120 (95% confidence interval: 0.2288, 2.8822), suggesting no substantial difference in the odds of having a drain between males and females.

Table 4: Distribution of the Study population in two groups according to operative findings

GROUP			
Operative Findings	With Drain	Without Drain	TOTAL
Appendicular Perforation	6	5	11
Band Adhesion	1	4	5
Blunt Trauma To Abdomen With Hollow Viscus Perforation	1	2	3
Gut Obstruction With Gangrene	4	7	11
Peptic Perforation	8	5	13
Ruptured Liver Abscess	3	1	4
Tubercular Peritonitis	2	1	3
TOTAL	25	25	50

Chi-square value: 5.0681; **p-value:** 0.5351

Study population was made in 2 groups, based on operative findings, is presented in Table 4. The "With drain" group had various operative findings, including 6 cases of appendicular perforation, 1 of band adhesion, 1 of blunt trauma to the abdomen with hollow viscus perforation, 4 of gut obstruction with gangrene, 8 of peptic perforation, 3 of ruptured liver abscess, and 2 of tubercular peritonitis. Similarly, the "Without drain" group had different operative findings, including 5 cases of appendicular perforation, 4 of band adhesion (4), 2 of blunt trauma to the abdomen with hollow viscus perforation, 7 of gut obstruction with gangrene, 5 of peptic perforation, 1 of ruptured liver abscess, and 1 of tubercular peritonitis (1).

The chi-square value was 5.0681, indicating no significant association between drain usage and operative findings (p=0.5351). Therefore, there is no evidence to suggest a difference in operative findings between the two groups based on the presence or absence of a drain.

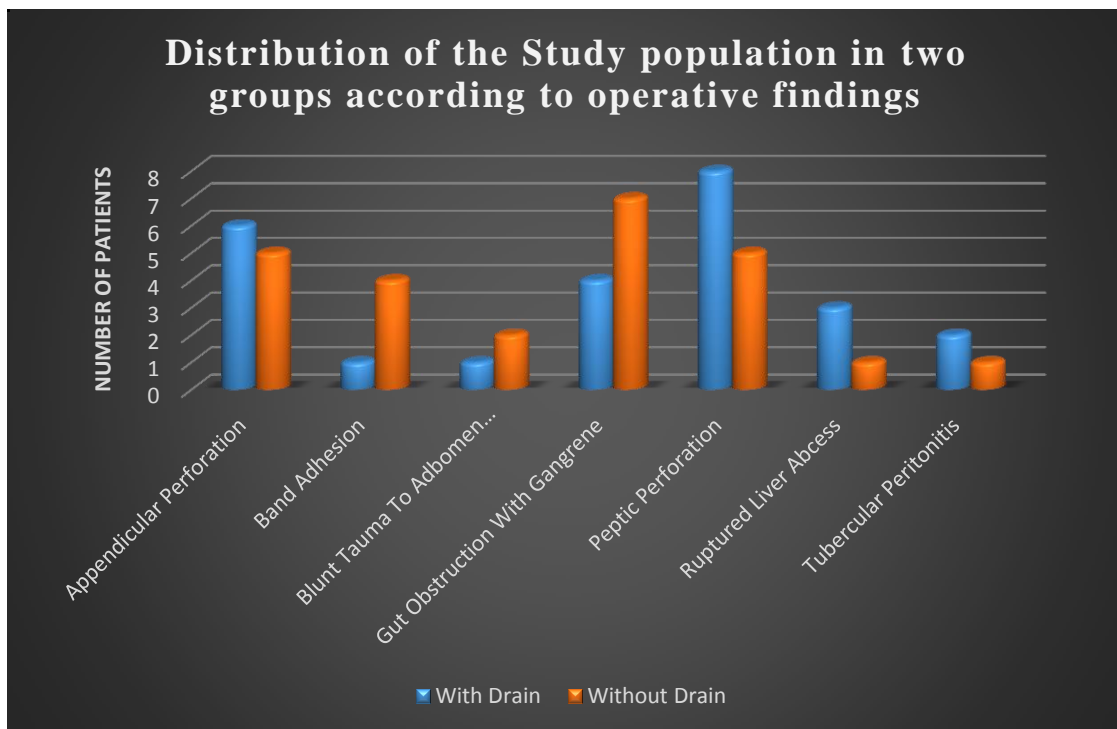
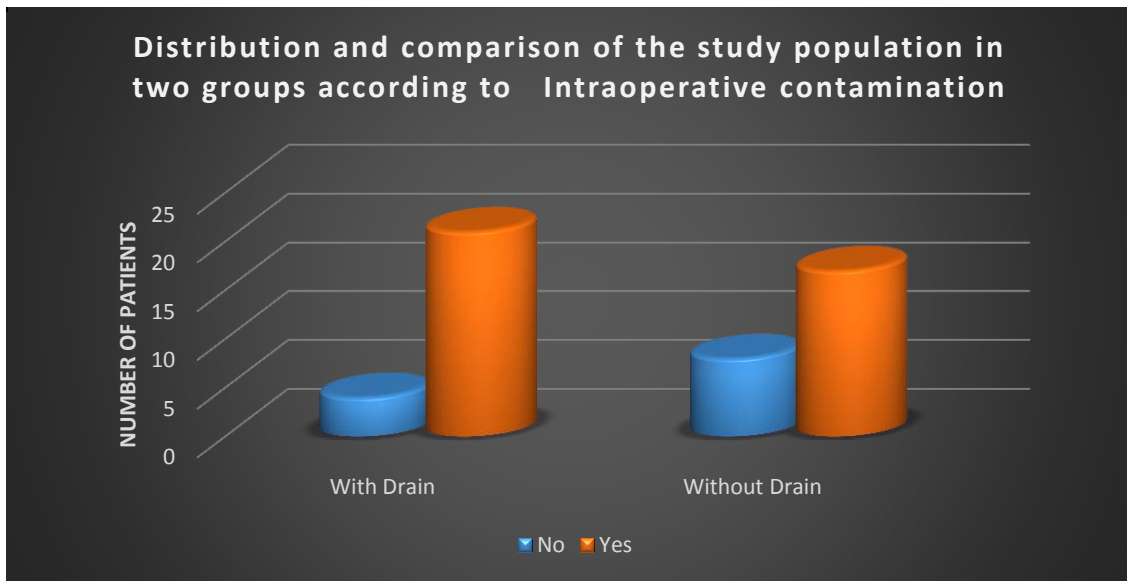


Table 5: Distribution and comparison of the study population in two groups according to Intraoperative contamination

GROUP			
Intraoperative contamination	With drain	Without drain	TOTAL
No	4	8	12
Yes	21	17	38
TOTAL	25	25	50

Chi-square value: 1.7544; **p-value:** 0.1853

Odds ratio: 0.4048 (0.1039, 1.5770)



The distribution and comparison of the study population in two groups, based on intraoperative contamination, are presented in Table 5. In the "With drain" group, 4 patients had no intraoperative contamination, while 21 patients did. In the "Without drain" group, 8 patients had no intraoperative contamination, while 17 patients did. The chi-square value was 1.7544, indicating no significant association between drain usage and intraoperative contamination ($p=0.1853$). The odds ratio was 0.4048 (95% CI: 0.1039, 1.5770), suggesting no significant difference in the odds of intraoperative contamination between the two groups.

Table 6: Distribution and comparison of the study population in two groups according to Surgical site infections

GROUP			
Surgical site infections	With drain	Without drain	TOTAL
No	22	3	25
Yes	3	22	25
TOTAL	25	25	50

Chi-square value: 28.8800; **p-value:** <0.0001

Odds ratio: 53.7778 (9.7659, 296.1368)

The distribution and comparison of the study population in two groups, categorized by surgical site infections, are presented in Table 6. In the "With drain" group, 22 patients did not have surgical site infections, while 3 patients did. In the "Without drain" group, 3 patients did not have surgical site infections, while 22 patients did. The chi-square value was 28.8800, indicating a highly significant association between drain usage and surgical site infections ($p<0.0001$). The odds ratio was 53.7778 (95% CI: 9.7659, 296.1368), suggesting a significantly higher odds of developing surgical site infections in the absence of a drain.

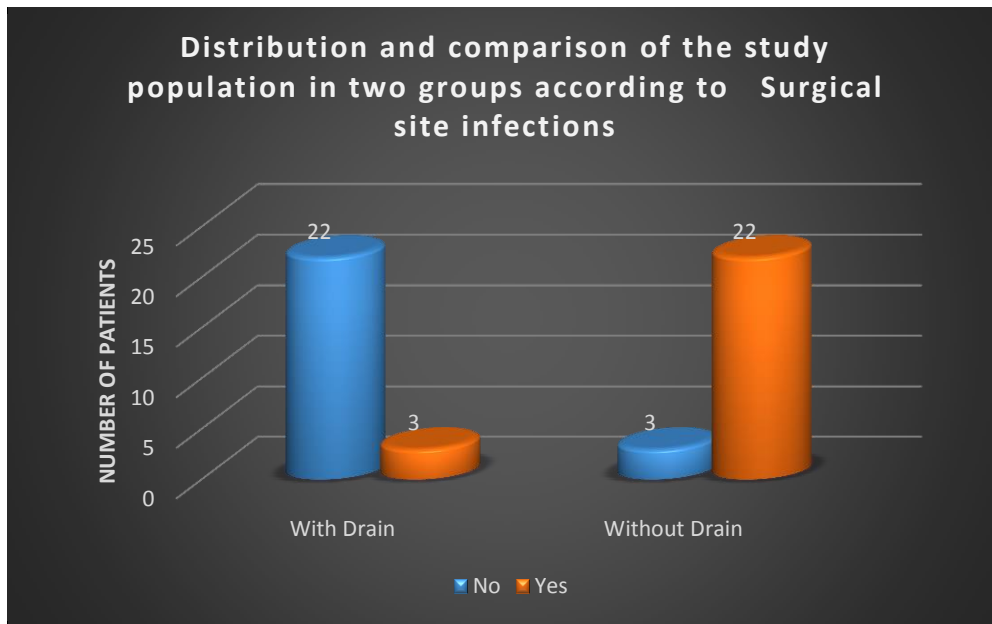


Table 7: Comparison and Distribution of study population in two groups according to Mean Duration of hospital stay in Days

		Number	Mean	SD	Minimum	Maximum	Median	p-value
Duration of hospital stay in Days	with drain	25	7.00	1.73	4.00	11.00	7.00	0.0003
	without drain	25	10.76	4.53	4.00	21.00	10.00	

The study compared the duration of hospital stay in two groups: one with a drain and one without a drain. The group with a drain (n=25) had a significantly shorter mean hospital stay of 7.0 days (SD=1.7321), ranging from 4.0 to 11.0 days. The median duration in this group was 7.0 days, and the p-value was 0.0003, indicating a statistically significant difference.

In contrast, the group without a drain (n=25) had a longer mean hospital stay of 10.7 days (SD=4.5303), ranging from 4.0 to 21.0 days. The median duration in this group was 10 days. Overall, these findings suggest that the presence of a drain during hospitalization is associated with a significantly shorter duration of stay compared to patients without a drain. The statistically significant p-value further supports this conclusion.

4. DISCUSSION

SSI presented a formidable obstacle in the context of major surgical procedures. Formerly known as postoperative wound infection, SSI used to be characterized as a medical condition that manifested within a month after the event of a procedure, with the exception of cases involving prosthetic implants, for which the timeframe was up to one year.¹ The incidence of SSI had significant effects on mortality, morbidity, healthcare expenditures, patient inconvenience, and discontentment. Particularly, open abdominal surgery was associated with

an increased risk of SSI, resulting in increased morbidity, mortality, and treatment costs. This issue demanded attention due to its far-reaching implications in the field of healthcare.

This study has been done on 50 patients at Department of General Surgery, College of Medicine and JNM Hospital, Kalyani. In our study it has been found that majority of the patients were in 31-40yrs age group. In our study it has been seen that majority of the patients (37 patients, 74%) were male, whereas 26% (13 patients) were female which was similar to study done by Dugad D et al on 50 patients in which they found that 72% patients (36 patients) were male and 28% (14 patients) were female.⁸

In our study the common operative finding was peptic perforation seen in 13 patients (26%) followed by appendicular perforations and Gut obstruction with gangrene seen in 11 patients (22%). In a study done by El-Badry AM et al their most common operative finding was gut obstruction (16/54 patients) followed by appendicular pathology (15/54 patients) followed by peptic ulcer disease (11/54 patients).⁹

In our study 25 patients each were in drain group and without drain group. In our study it has been seen that overall SSI was seen in 25 patients (50%) among which incidence of SSI in drain group was 12% (3 patients) compared to without drain group which was 88% (22 patients) which was similar to a study done by Kagita R et al on 76 patients and their findings were that SSI in patients with drain group was 12.5% (5/40 patients) whereas in without drain group was 69.94% (25/36 patients). In our study association of surgical site infections with group was statistically significant ($p < 0.0001$).¹⁰

In our study intraoperative contamination was seen in 76% patients (38 patients) among which intraoperative contamination was 55.3% and 44.7% in with drain group and without drain group respectively. Association of Intraoperative Contamination with Group in our study was not statistically significant ($p = 0.1853$).

Wound grading according to SOUTHAMPTON wound grading system in our study was as follows, in drain group 22 patients had grade 0, 2 patients had grade I, 1 patient had grade II wound, whereas in without drain group 3 patients had grade 0, 5 patients each had grade II, III, V and 7 patients had grade IV wound. The association of surgical wound classification with group was statistically significant ($p < 0.0001$).

In our study mean duration of subcutaneous suction drain was 4.76 days.

In our study in drain group duration of hospital stay was from 4-11 days with mean duration of 7 days with SD of 1.7321 whereas in without drain group duration of hospital stay was from 4-21 days with mean duration of 10.76 with SD of 4.5303. The distribution of mean duration of hospital stay with group was statistically significant ($p = 0.0003$) in our study.

Relevant studies

Several studies have been conducted in this regard worldwide, some of which have been highlighted here as follows:-

El-Badry AM et al¹¹(2022) conducted a prospective study on 54 patients from June 2017 to January 2021 at Sohag University Hospital to investigate whether subcutaneous closed suction drain (SCSD) could minimize SSI in setting of emergency abdominal surgery. According to incision sealing technique, patients were allocated to group A with no SCSD as well as group B with incision closure over SCSD. Incisional surgical site infection (ISSI), incision dehiscence, and hernia from the incision were compared between the two groups. In their study median age was 62 years. In their study Group B exhibited significantly lower rates of ISSI (3 patients, 11%) and wound dehiscence (zero) compared with group A, (12 patients, 44%) and (5 patients, 15%), respectively. Likewise, the duration of hospital stay was

significantly shorter among patients in group B versus those in group A. The reduction of ISSI, wounds dehiscence, and hernia from the incision with subcutaneous closed aspiration drain favors its routine use over closing of non-traumatic emergency midline laparotomy incisions.

Dugad D et al ¹² (2021) conducted a prospective investigation on 50 participants to compare the subcutaneous solitary closed suction drain and straightforward typical closure of the incision in the skin in emergency laparotomy over perforation of the hollow viscus. The objective of the current research was to determine if the placement of a subcutaneous closed vacuum catheter at the site of the incision reduces the probability of post-operative SSI in emergency laparotomies for perforation of the hollow viscus. The patients were then arbitrarily assigned to Group I in subcutaneous closed suction drain or Group II, which was the group without drain. Post procedure for perforation of the hollow viscus, their study reveals that subcutaneous negative pressure outflow substantially reduces the number of instances of postoperative SSI and the length of hospitalization. This aids in early recovery, improves wound healing, and reduces the financial burden on patients by shortening their hospital stays and preventing infections.

Karthick R et al ¹³ (2020) conducted a prospective study done on 100 patients undergoing emergency midline laparotomy surgery in the department of general surgery after, Government vellore medical college to determine (1) whether the insertion of a subcutaneous closed suction drain at incisional site reduces the incidence of postoperative SSI in emergency laparotomy cases, (2) to find the effect of closed suction drain in reducing the duration of hospital stay when compared to simple closure. Patients were divided in two groups, Group A included 50 patients who had subcutaneous closed suction drain before skin closure & Group B included 50 patients who had no subcutaneous drain. In their study they observed that in Group A wound complications, seroma, hematoma, length of hospital stay was 42%, 18%, 6%, 9.12 +/- 2.51 days respectively. In Group B wound complications, seroma, hematoma, length of hospital stay was 14%, 0%, 0%, 7.70 +/- 1.44 days. They concluded that subcutaneous single closed suction drain reduces postoperative surgical site infection, seroma, postoperative pain and the duration of hospital stay significantly compared to patients in whom negative suction drain was not placed.

Kagita R et al ¹⁴ (2019) conducted a prospective study on 76 patients between October 2016 to March 2018 to establish the efficacy of a subcutaneous negative pressure for preventing SSI following exploratory laparotomy and were randomized into subcutaneous drainage (DG) and no drainage group (NDG). The diagnosis of superficial SSI was made and was graded according to Southampton Grading System. 5 patients in drain group (40) and 25 patients in no drain group (36) had incisional SSI with statistical difference ($p < 0.05$). They concluded that subcutaneous negative pressure prevents post-operative SSI significantly and reduces hospital stay in a patient undergone emergency laparotomy, compared to patients in whom negative pressure drain was not placed.

Gupta P et al ¹⁵ (2017) conducted a on 100 patients in department of surgery at rural tertiary centre to compare the incidence of SSI in post emergency abdominal surgical wounds with subcutaneous suction drains versus those in whom drain was not placed. They observed that 24% of patients in drain group develop surgical site infections whereas 50% of patients in non-drain group develop infection. Incidence of infection in drain group was lower than the no drain group (p value 0.05) and was statistically significant. They concluded that subcutaneous drain in emergency setting play significant role in reducing the incidence of SSI which is significant statistically.

Ashok Kumar M et al ¹⁶ (2017) conducted a prospective study on 60 patients to compare the effectiveness of sub-cutaneous negative suction drainage tube and conventional abdominal

wall closure in cases of peritonitis with regard to SSI, wound dehiscence, wound secondary suturing and duration of hospital stay. They were divided into 2 Group, in Group A 30 patients were managed with subcutaneous negative suction drainage tube during abdominal wall closure and Group B 30 other patients underwent conventional method of abdominal wall closure. The incidence of SSI and wound dehiscence in group A was 23% and 43% respectively, and in group B was 60% and 89. The mean duration of hospital stay was significantly less when subcutaneous suction drain was placed (9 days). They concluded that Subcutaneous suction drainage tube is an effective method of abdominal wall closure in cases of peritonitis when compared to conventional primary skin closure as it significantly reduces the incidence of SSI, wound dehiscence, wound secondary suturing and duration of hospital stay.

Vaghani Y et al¹⁷ (2014) conducted a prospective study on 60 patients from November 2012 to June 2013 at SMIMER hospital, Surat to compare a role of negative pressure closure versus simple closure of laparotomy wound of ileal perforation. They were divided in two groups, group A closed with Negative pressure closure (By putting subcutaneous Negative Suction Drain) at the time of laparotomy wound closure and other group B with simple closure. They reported that SSI was 25% in group A and 57.7% in group B, average hospital stay for group A was 12 day and 18 day for group B. They concluded that Overall morbidity was less with Negative pressure closure in compare to simple closure and it highly affects the morbidity and somehow mortality also.

5. CONCLUSION

Our study concludes that the implantation of a subcutaneous negative pressure drain following an emergency exploratory laparotomy for an acute abdomen greatly decreases the possibility of recuperating SSI and length of stay in the hospital. This promotes faster wound healing and recovery, which reduces the patient's morbidity. It also reduces the strain on finances by reducing hospital stays and promoting early discharge.

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