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Role of subcutaneous closed suction drain in the prevention of incisional surgical site infection after loop ileostomy reversal with purse-string skin closure: a retrospective observational study

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Abstract

Background Surgical site infection (SSI) is not rare after loop ileostomy reversal. This study assessed the effects of a subcutaneous closed suction drain on reducing SSIs after loop ileostomy reversal with purse-string skin closure.

Methods This retrospective study included 229 patients who underwent loop ileostomy reversal with purse-string closure at the Pusan National University Yangsan Hospital between January 2017 and December 2021. We divided the patients into those with a subcutaneous drain (SD group) and those without it (ND group). We analyzed variables that affected SSI occurrence in both groups.

Results The SD and ND groups included 109 and 120 patients, respectively. The number of incisional SSIs was significantly lower in the SD than in the ND group (0 vs. 7 events). An average of 35.7 mL of fluid was collected in the drainage bulb during hospitalization. The C-reactive protein level on postoperative day 4 was significantly lower in the SD group than in the ND group. The insertion of a subcutaneous drain was the only factor associated with a reduced incidence of SSIs ($p = 0.015$).

Conclusions Subcutaneous closed suction drain with purse-string skin closure in loop ileostomy reversal can reduce incisional SSI occurrence.

Keywords Ileostomy reversal, Subcutaneous closed suction drain, Purse-string skin closure, Surgical site infection

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Introduction

In loop ileostomy reversal, the two main skin closure techniques are linear skin closure (LSC) and purse-string skin closure (PSC). Several systematic reviews have demonstrated that the PSC technique is associated with a lower incidence of surgical site infections (SSIs) than the LSC technique (5% vs. 24%) [1–4]. Therefore, recent guidelines recommended PSC in stoma reversal [5]. Although PSC reduces their incidence, SSIs still occur, and patients may experience discomfort due to discharge from the incision site until the wound heals completely.

Several strategies have been implemented to reduce the incidence of SSIs and patient discomfort. Antibiotics can be administered intravenously during the perioperative period; however, many studies have indicated that prolonged antibiotic use has no effect on the incidence of SSIs after elective bowel surgeries. Therefore, current guidelines do not recommend the use of antibiotics postoperatively [6]. Negative pressure wound therapy (NPWT) reportedly reduces the incidence of SSIs [7–9]. However, NPWT incurs additional costs for patients and requires the transport of equipment; thus, patients may experience discomfort when moving.

In this study, we used a subcutaneous closed suction drain to reduce the incidence of SSIs in patients undergoing ileostomy reversal using the PSC technique. A subcutaneous drain can be an alternative method for preventing SSI by eliminating exudates or hematomas from the ileostomy repair wound. In addition, it is less expensive and more convenient for patients and surgeons than NPWT. Subcutaneous drain placement has been shown to be beneficial in reducing SSI events in loop ileostomy reversal with the LSC technique [10]; however, there have been no reports regarding the role of subcutaneous closed suction drain insertion with the PSC technique in loop ileostomy reversal.

Therefore, in this study, we aimed to determine the efficacy of subcutaneous drainage in preventing SSI events.

Methods

Patient population

This retrospective study included patients who underwent loop ileostomy reversal with purse-string closure at the Pusan National University Yangsan Hospital between January 2017 and December 2021. All data were obtained from a prospectively maintained database. Patients were followed up for at least one month after surgery. Stoma reversal surgery for infection or inflammation was excluded because it could affect the occurrence of SSIs. The study was approved by the Institutional Review Board of the Pusan National University Yangsan Hospital (No. 05-2022-249) and was conducted in accordance with the Declaration of Helsinki. In this study, patients with subcutaneous closed suction drainage during ileostomy reversal were designated as the subcutaneous drain (SD) group, whereas those without subcutaneous drainage were designated as the no drain (ND) group. Placement of a subcutaneous closed suction drain was selected by the surgeons' discretion. Surgeon A and B utilized the drain, and surgeon C did not. All surgeons were experienced colorectal surgeons. The drain placement was not selected by patient's issues.

Clinical data selection

Clinical variables, including age, sex, body mass index (BMI), past medical history (diabetes mellitus (DM), alcohol or tobacco use, concomitant chemoradiation therapy (CCRT), or chemotherapy), preoperative albumin, prognostic nutritional index (PNI) and duration of surgery were collected. During admission, the amount of subcutaneous drainage and postoperative laboratory findings were recorded. PNI was calculated by serum albumin and lymphocyte counts of peripheral blood; PNI = 10×albumin (g/dL) + 0.005×lymphocyte count (per mm3) [11]. SSI was defined as an infection occurring within 30 d after the surgical procedure using the criteria provided by the Centers for Disease Control and Prevention and the National Healthcare Safety Network [12].

Surgical techniques

All patients were placed in the supine position. After sterilization, the small intestine forming the ileostomy was resected. The remaining part of the small intestine was connected with a linear stapler using a side-to-side anastomosis technique. The abdominal fascia was closed with interrupted 1−0 Vicryl sutures. The subcutaneous space was cleaned by irrigation with normal sterile saline. In the SD group, a 3.2 mm diameter drain tube (EZ-VAC 100; GEMSKOREA, Seoul, Korea) was inserted into the subcutaneous space over the fascia for drainage and connected to a 100-mL silicon bulb (Fig. 1). The skin was closed with polydioxanone (PDS) 2−0 using the purse-string technique. A silicone foam dressing was used to sustain closed status for effective drainage. In the ND group, the same procedures were performed except placement of the subcutaneous drain tube.

Perioperative management

All patients were admitted 1 d prior to ileostomy reversal. Patients consumed a low-residue diet until midnight on the day of admission. A prophylactic antibiotic (cefotetan, 2nd generation cephalosporin) was administered 10–15 min prior to the incision, but no antibiotics were administered after the surgery. Administration of water began 6 h after the patient returned to the ward. Water was given until postoperative day (POD) 2. On PODs 2 and 4, laboratory tests and abdominal radiography were performed to evaluate the possibility of advancing the

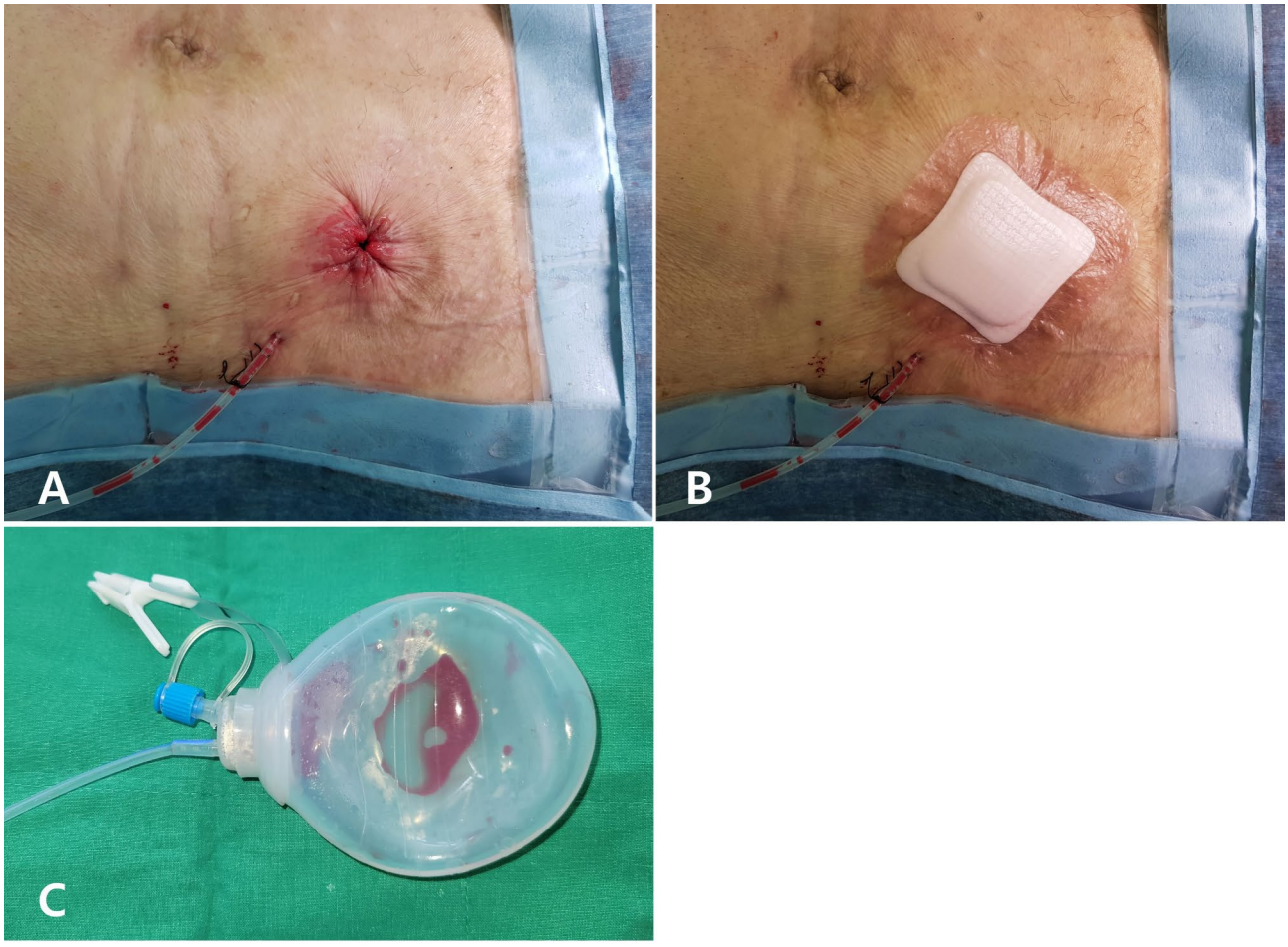

Fig. 1 Placement of a 3.2 mm diameter drain tube in the subcutaneous space over the abdominal fascia during loop ileostomy reversal. (**A**) Purse-string skin closure after insertion of the drain tube. (**B**) Dressing complete with a silicone foam dressing. (**C**) A drainage bulb to be attached to the drain tube and to maintain well in the negative pressure on postoperative day 3

diet. In the SD group, the drainage volume was monitored daily, with the drain being removed 1 d prior to discharge (POD 4). On PODs 2 and 4, disinfection was performed using a povidone-iodine solution in both groups. Upon confirming the lack of any SSIs or other postoperative complications, the patient was discharged on POD 5.

Statistical analysis

Statistical analyses were performed using the IBM SPSS Statistics for Windows (version 26.0; IBM Corp., Armonk, NY, USA). Continuous variables were compared using independent *t*-tests, whereas non-normally distributed data were analyzed using the Mann–Whitney U test. Associations between categorical variables were analyzed using the chi-square and Fisher's exact tests. A p value <0.05 was deemed statistically significant.

Results

Characteristics of patients

A total of 229 patients were included in this study (109 in the SD group and 120 in the ND group). Table 1 presents the characteristics of each group. Statistically significant differences were detected between the two groups in terms of age and sex. The number of patients who received chemotherapy and radiotherapy was higher in the ND group. Preoperative serum albumin was significantly higher in the ND group (SD, 4.2 g/dL vs. ND, 4.4 g/dL, $p<0.001$). PNI tended to be higher in the ND group. BMI, diabetes, alcohol intake, smoking, steroid usage, and operative time were not significantly different between groups.

Postoperative results

The number of incisional SSI events was significantly lower in the SD group than in the ND group (0 events (0%) vs. 7 events (5.8%), $p=0.015$) (Table 2). No organ or space SSIs occurred in either group. Approximately 13

Table 1 Clinical characteristics of all patients

Variables	SD group (*n* = 109)	ND group (*n* = 120)	*p*-value
Age (years)	60.8 ± 15.6	64.4 ± 10.8	0.043
Sex (male/female)	74/35 (67.9/32.1)	96/24 (80/20)	0.036
BMI (kg/m^2)	22.9 ± 3.8	23.0 ± 3.0	0.723
Diabetes	22 (20.2)	20 (16.7)	0.492
Alcohol intake	6 (5.5)	5 (4.2)	0.636
Smoking	7 (6.4)	9 (7.5)	0.749
Steroid usage	1 (0.9)	0 (0)	0.476
Previous chemoradiation therapy (+)	15 (13.9)	41 (34.2)	< 0.001
Previous chemotherapy (+)	41 (37.6)	68 (56.7)	0.004
Preoperative albumin (g/dL)	4.2 ± 0.4	4.4 ± 0.3	< 0.001
PNI	50.6 ± 6.1	51.9 ± 5.1	0.064
Operative time (minutes)	54.4 ± 15.6	56.5 ± 17.5	0.344

Data are presented as mean ± standard deviation or numbers with percentages in parentheses, unless otherwise indicated. SD, subcutaneous drainage; ND, no drainage; BMI, body mass index; PNI, prognostic nutritional index.

Table 2 Postoperative results

Variables	SD group (*n* = 109)	ND group (*n* = 120)	*p*-value
Incisional SSI	0 (0)	7 (5.8)	0.015
Organ/space SSI	0 (0)	0 (0)	> 0.999
Amount of subcutaneous drainage (mL)			
POD 0	7.1 ± 6.8		
POD 1	13.1 ± 10.7		
POD 2	7.6 ± 7.2		
POD 3	5.0 ± 4.7		
POD 4	2.9 ± 3.1		
Total (average)	35.7		
Postoperative laboratory findings			
WBC (cells/mm^3) on POD 2	6684 ± 2379	6715 ± 1982	0.915
CRP (mg/L) on POD 2	74.7 ± 53.2	77.2 ± 43.9	0.699
WBC (cells/mm^3) on POD 4	5559 ± 1885	5573 ± 2002	0.962
CRP (mg/L) on POD 4	53.1 ± 48.2	73.8 ± 60.7	0.008

Data are presented as mean ± standard deviation or numbers with percentages in parentheses, unless otherwise indicated. SD, subcutaneous drainage; ND, no drainage; SSI, surgical site infection; ER, emergency room; OPD, outpatient department; POD, postoperative day; WBC, white blood cell; CRP, C-reactive protein.

mL of subcutaneous drainage was collected on POD 1 and 7.6 mL on POD 2. An average of 35.7 mL of drainage was collected throughout the admission. Additionally, CRP levels were lower in the SD group than in the ND group 1 d before discharge (53.1 mg/L vs. 73.8 mg/L, $p = 0.008$).

Analysis of risk factors for SSI

The placement of a subcutaneous closed suction drain was the only factor associated with a reduced incidence of SSI after loop ileostomy reversal (0% vs. 49.1%, $p = 0.015$) (Table 3). Age, sex, previous chemoradiation therapy, previous chemotherapy, preoperative albumin, PNI, and operative time were not associated with SSI events.

Table 3 Risk factors for surgical site infection after purse-string skin closure at loop ileostomy reversal

Factors	SSI (+) (*n* = 7)	SSI (-) (*n* = 222)	*p*-value
Age (years)	64.1 ± 12.9	62.7 ± 13.4	0.772
Sex (male/female)	5/2 (71.4/28.6)	165/57 (74.3/25.7)	> 0.999
BMI (kg/m^2)	23.8 ± 2.5	22.9 ± 3.4	0.532
Diabetes	1 (14.3)	41 (18.5)	> 0.999
Alcohol intake	0 (0)	11 (5.0)	> 0.999
Smoking	1 (14.3)	15 (6.8)	0.402
Steroid usage	0 (0)	1 (0.5)	> 0.999
Previous chemoradiation therapy (+)	2 (28.6)	54 (24.4)	0.682
Previous chemotherapy (+)	3 (42.9)	106 (47.7)	> 0.999
Preoperative albumin (g/dL)	4.5 ± 0.2	4.3 ± 0.4	0.076
PNI	54.3 ± 6.2	51.2 ± 5.6	0.155
Operative time (minutes)	63.6 ± 16.5	55.2 ± 16.6	0.190
Placement of subcutaneous drain			
Yes	0 (0)	109 (49.1)	0.015
No	7 (100)	113 (50.9)	

Data are presented as mean ± standard deviation or numbers with percentages in parentheses, unless otherwise indicated. SSI, surgical site infection; BMI, body mass index; PNI, prognostic nutritional index.

Discussion

This study aimed to evaluate the efficacy and benefits of subcutaneous closed suction drain during ileostomy reversal using the PSC technique. Our results revealed that the insertion of a subcutaneous drain was the only factor associated with a reduced incidence of incisional SSIs after ileostomy reversal. In addition, approximately 36 mL of effluent was collected for 5 d after the surgery. Because these quantities are not negligible, this suggested that subcutaneous drainage can alleviate patient discomfort associated with incision site discharge and promote wound healing by removing exudates or hematomas.

Numerous techniques have been used to reduce the occurrence of SSIs after various surgeries, including after loop ileostomy reversal. Antibiotics can be used to prevent infections, with preoperative prophylactic antibiotics being particularly helpful in preventing SSIs. However, postoperative antibiotic use has been reported to have no additional benefit for SSI prevention [13]. In addition, the use of povidone-iodine irrigation during surgery has been explored for preventing SSIs. Povidone-iodine irrigation is more effective than saline irrigation in reducing SSIs [14]. However, this solution should be used cautiously in patients with iodine sensitivity, thyroid disease, renal disease, or burns [15].

NPWT is another method used to reduce the incidence of SSIs after ileostomy reversal. A prospective randomized controlled trial found that NPWT after ileostomy reversal reduced the incidence of SSIs and wound healing complications [7]. In addition, two meta-analyses indicated that NPWT significantly reduced the incidence of SSIs compared with conventional wound dressings [9, 16]. NPWT is an extensively researched method for preventing SSIs following surgery, such as ileostomy reversal [8]. However, additional medical costs and techniques are required for performing NPWT [8].

A subcutaneous closed suction drain may be more effective than NPWT in reducing the incidence of SSIs after loop ileostomy reversal because it is simple and cost effective. Fukuoka et al. [10] showed that subcutaneous administration of a combination of closed suction drainage and subcuticular sutures reduced the rate of SSIs in loop ileostomy reversal. These studies used conventional LSC techniques. We hypothesized that incorporating subcutaneous drainage into loop ileostomy reversal with the PSC technique would also effectively reduce the incidence of SSIs. Moreover, it may be more cost effective than NPWT. The technique requires a simple drainage tube and a 100-mL light silicone bulb, which are more convenient than NPWT equipment. Furthermore, subcutaneous drain insertion is a simpler technique than NPWT during surgery. Additionally, we did not experience any complications regarding drain insertion. Therefore, we concluded that the subcutaneous drainage technique is more practical than NPWT. Finally, in the present study, the incidence of SSIs was significantly lower in the SD group than in the ND group.

Studies of the combination of subcutaneous closed suction drain and PSC techniques after ileostomy reversal are rare, although SSI still occurs after ileostomy reversal, and there have been several studies on subcutaneous drainage with other surgical techniques. One of the reasons may be how the closed suction is sustained after the PSC technique because of the inevitable hole in the wound after the PSC technique. We used a silicone foam dressing product on the wound to maintain an appropriate closed status for effective drainage. We experienced no difficulties in sustaining the closed suction during the study period.

The combination of subcutaneous drainage and PSC techniques may also be more beneficial than conventional PSC techniques. Conventional PSC techniques do not include subcutaneous closed suction drainage; therefore, wound healing problems can result from direct contact with subcutaneous discharge. In the present study, approximately 36 mL of exudation was recorded for a total of 5 d. If the fluid drained though the inevitable opening of the purse-string suture, the discharge can cause patient discomfort and require continuous care of the wound and discharge removal. Therefore, patient discomfort and additional wound care could be avoided by placing a subcutaneous drain, which would result in minimal exudation leakage through the opening. Additionally, the wound healing period can take longer up, to 30 d, using conventional PSC techniques [17]. The subcutaneous drainage technique did not require any additional wound care after hospital discharge, and in most cases, the wound closed within two weeks after surgery.

This study had several limitations. The primary limitation of this study was its single-center, retrospective design. The SD and ND groups differed statistically in terms of age, sex, and number of patients undergoing chemotherapy or combined chemotherapy and radiation therapy. However, these variables were not significantly associated with the incidence of SSIs. In addition, PNI, which reflects patients' nutritional and inflammatory status, tended to be higher in the ND group, suggesting that there were some advantages in the ND group [18]. Therefore, we viewed these differences as coincidental outcomes of a retrospective analysis, and they did not significantly affect our conclusion. Second, we did not investigate the direct effects of discharge on patient pain and wound healing. Therefore, we could not conclude directly if patient discomfort was reduced. Third, because no SSI events occurred in the SD group, additional statistical evaluations, such as logistic regression, were not possible. Further research should be conducted in a randomized controlled design to decrease forms of bias.

In conclusion, a subcutaneous closed suction drain could reduce the incidence of incisional SSIs after loop-ileostomy reversal with purse-string skin closure. The risk of infection might be reduced by removing exudate or hematoma from the wound site.

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Author contributions
YSJ and BSP designed the research.; YSJ, SHC, BSP, GMS, and HSK collected the patients' clinical data, and analyzed the data.; YSJ and BSP wrote the main manuscript text.; SHC, GMS, and HSK provided critical revision.All authors reviewed the manuscript.

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None.

Data availability
The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Institutional Review Board of the Pusan National University Yangsan Hospital (No. 05-2022-249) and was conducted in

accordance with the Declaration of Helsinki. The need for informed consent was waived because of the retrospective nature of the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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