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Novel Method of Surgical Incision Management in Patients Undergoing Colorectal Surgery

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We previously demonstrated that subcutaneous drain is effective for preventing incisional surgical site infection (SSI) in patients with thick subcutaneous fat in colorectal surgery. We have recently attempted a novel closure technique in colorectal surgery for the prevention of incisional SSI. In the current study, we described this novel method for prevention of incisional SSI and share our assessment of efficiency of this incision management in patients undergoing colorectal surgery. The procedure "wound dressing with temporary negative pressure" using Opsite Post-Op Visible and an Atom Multipurpose Tube, is a simple and easy method. Immediately after incisions were closed, Opsite Post-Op Visible dressing was applied over the incision site with an Atom Multipurpose catheter, and negative pressure was applied through the catheter. We analyzed the cases of 203 patients who underwent colorectal resection. In 60 cases, we performed this negative pressure system for prevention of SSI. We reviewed the clinical features of these cases treated by this novel method and found that the incisional SSI rate in patients who underwent colorectal resection was significantly reduced following the use of the new method. There were no complications in any of the cases due to DNP. This dressing with negative pressure (DNP) may lead to wound drainage and a reduction of dead space in a subcutaneous wound area. These findings indicate that the use of DNP is safe, easy, and effective for preventing incisional SSI in patients undergoing colorectal surgery.

Key words: Wound dressing – Incisional SSI – Colorectal surgery – Negative pressure – Subcutaneous fat

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Surgical site infection (SSI), including wound infection (incisional SSI), is a frequent cause of complications, with an incidence of up to 30% in colorectal surgery.[1–6] Various risk factors for incisional SSI have been reported, including obesity, emergency operations, and poor glucose control.[7–11] Obesity has been identified as a risk factor for infections and wound complications after a wide variety of surgical procedures.[7,8] We previously demonstrated that the risk of incisional SSI increases with obesity, and that the most useful predictor of incisional SSI is the thickness of subcutaneous fat (TSF), as evaluated by preoperative computed tomography (CT).[12] We also demonstrated that subcutaneous drain is effective for preventing incisional SSI in patients with thick subcutaneous fat in colorectal surgery.[13] Subcutaneous drains are effective for wound drainage and reduce dead space in a subcutaneous wound area, which is considered to lead to a reduced risk of incisional SSI.[13] However, findings regarding the utility of subcutaneous drains in the prevention of incisional SSI remain controversial, and some studies have found that subcutaneous drains do not reduce the incidence of SSI.[14–17] Our previous study also showed the possibility that subcutaneous drains would be useful only for patients with a high risk for incisional SSI and those with thick subcutaneous fat tissue, but not for all patients undergoing colorectal surgery.[13] A possible reason is that subcutaneous drain appears to be unnecessary or rather harmful in patients without thick subcutaneous fat tissue, since the drain is a foreign substance for the human body. Thus, we have recently attempted a novel closure technique in surgery for colorectal surgery for the prevention of incisional SSI. The procedure, which uses Opsite Post-Op Visible film (Opsite is a trademark of Smith & Nephew, London, UK) and an Atom Multipurpose Tube (Atom Medical, Tokyo, Japan), is a very simple and easy method. In the current study, we described the use of this novel method of "wound dressing with temporary negative pressure" for the prevention incisional SSI, and we present our assessment of the efficiency of this incision management in patients undergoing colorectal surgery.

Material and Methods

Treatment regimen and dressing with negative pressure (DNP)

Opsite Post-Op Visible is a waterproof, bacteria-proof dressing with a see-through absorbent pad that was developed to allow clinicians to inspect the incision site without having to remove the dressing.[18] The dressing is made up of a see-through lattice of highly absorbent Allevyn foam (Smith & Nephew), which provides good exudate handling properties.[18] In our patients, immediately after incisions were closed, an Atom Multipurpose catheter (5Fr) was placed on the incision site (not into the subcutaneous tissue) and the Opsite Post-Op Visible dressing was applied over the incision site with the catheter (Fig. 1). Negative pressure was applied through the Atom Multipurpose catheter, which crushed the absorbent foam. Then, the Atom Multipurpose catheter was clamped. While the absorbent foam returned to its original shape, negative pressure was continued in the incision, which was designed to lead to temporary wound drainage and reduction of the dead space in a subcutaneous wound area. The dressing systems were removed 3 to 5 days after surgery.

In cases with elective colorectal surgery, with the exception of those cases with intestinal stenosis, all patients underwent preoperative bowel preparation via an oral laxative. A regimen of systemic prophylactic antibiotics was strictly ensured for all cases, with administration started 30 minutes before incision, repeated every 3 hours during surgery, and then continued in all cases and stopped within 72 hours after the operation, with the exception of patients with severe inflammation. Routine oral antibiotic administration was not performed. Wound irrigation and wound protector were used in all patients who underwent surgery. Contraction of dead space by a subcutaneous suture using polyfilament absorption string was roughly performed.

Patients and Methods

Four hundred and sixty-seven patients who underwent colorectal resection in the Department of General Surgical Science, Graduate School of Medicine, Gunma University, from January 2007 to December 2011 were identified for inclusion in this study. Patients undergoing elective operations were enrolled in this study. Patients who underwent laparoscopic surgery, emergency operations, subcutaneous drain, or surgery with stoma were not included. The resulting sample size was 203 cases. The clinical features of these cases with or without application of the current method were reviewed, and statistical analysis was performed.

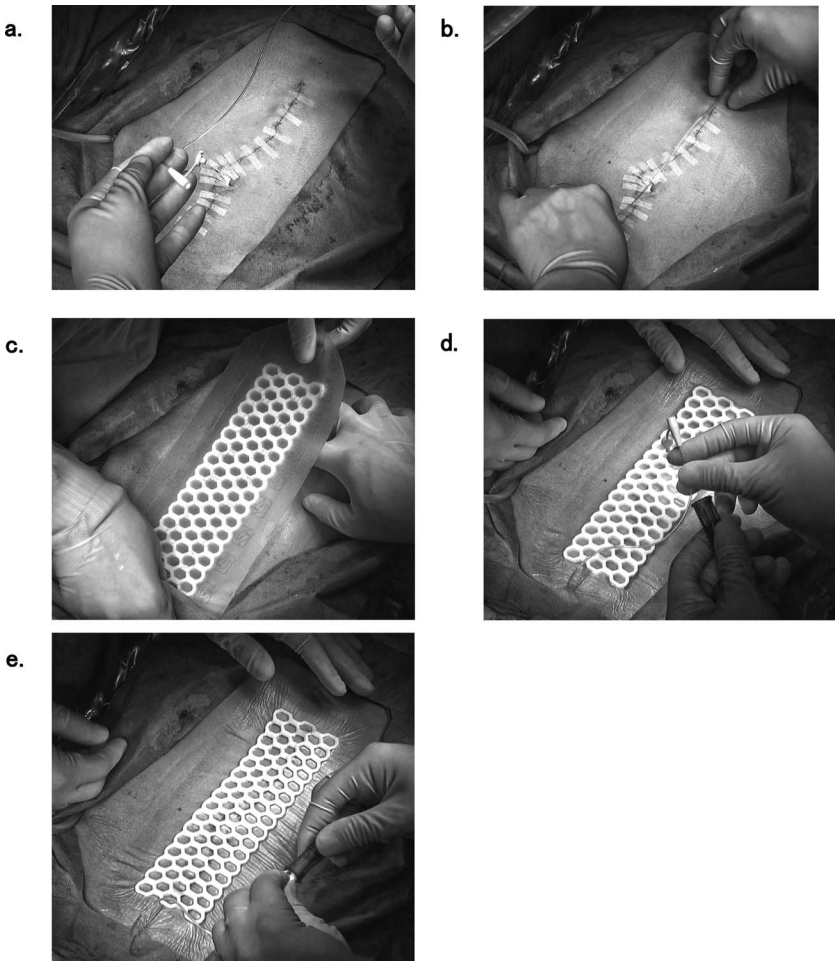

Fig. 1 The novel method of "wound dressing with temporary negative pressure" for the prevention incisional SSI using Opsite Post-Op Visible (Opsite is a trademark of Smith & Nephew) and an Atom Multipurpose Tube (Atom Medical, Japan). In our patients, immediately after incisions were closed, an Atom Multipurpose catheter (5Fr) was placed on the incision site (not into the subcutaneous tissue) and the Opsite Post-Op Visible dressing was applied over the incision site with the catheter (a–c). Negative pressure was applied through the Atom Multipurpose catheter, which crushed the absorbent foam. Then, the Atom Multipurpose catheter was clamped (d, e). While the absorbent foam returned to its original shape, negative pressure was continued in the incision, which was designed to lead to temporary wound drainage and reduction of the dead space in a subcutaneous wound area.

The specific variables recorded for each patient included: age, gender, preoperative body weight, height, history of diabetes, preoperative serum albumin levels, thickness of subcutaneous fat (TSF), location of operation, length of operation, history of laparotomy, and intraoperative blood loss (Table 1). The blood samples were used to measure serum albumin, which was measured using an automatic analyzer. TSF was preoperatively evaluated by CT at a location just below and to the side of the umbilicus.[12,13]

Definitions of incisional SSI

The outcome of interest was the development of an incisional SSI, as defined by the Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), as previously described.[6,12,13,19] Briefly, a superficial incisional SSI occurs within 30 days of surgery and only involves the skin and subcutaneous tissue. By definition, at least one of the following will be present: (1) purulent drainage; (2) organisms isolated from an aseptically obtained culture of incisional fluid or tissue; (3) signs or symptoms of infection that include: pain or tenderness, localized swelling, erythema, heat, and the opening of the wound to some degree; or (4) diagnosis of superficial incisional SSI by a surgeon or attending physician. Deep incisional SSIs occur when the incisional wound involves the muscle and fascial layers, but not the organ space. Additionally, by definition at least one of the following must accompany deep soft tissue involvement: (1) purulent drainage from the deep incision; (2) the incision dehisces spontaneously or deliberately opened by a surgeon in the presence of signs or symptoms of infection; or (3) diagnosis of a deep incisional SSI by a surgeon. Superficial and deep incisional SSIs were combined into the same diagnosis of incisional SSI in this study because in some cases it was difficult to determine whether

Table 1 Patient characteristics with or without DNP

DNP	+	−	*P* value
Patients (n)	60	143	
Age (y)	69.2 ± 11.6	68.3 ± 11.8	0.321
Gender (male/ female, n)	37/23	84/59	0.817
Location (colon/ rectum, n)	48/12	107/36	0.541
Operation time (min)	148.8 ± 53.0	167.7 ± 98.5	0.923
Blood loss (mL)	167.7 ± 208.3	184.1 ± 269.5	0.660
History of laparotomy (n)	17 (28.3%)	29 (20.3%)	0.286
Diabetes (n)	18 (30.0%)	21 (14.7%)	0.020
BMI (kg/m^2)	22.8 ± 3.2	21.9 ± 2.8	0.259
TSF (mm)	17.4 ± 6.4	16.2 ± 5.2	0.078
Albumin (g/dL)	3.71 ± 0.49	3.97 ± 0.42	0.999
Incisional SSI (n)	4 (6.7%)	31 (21.7%)	0.017

Values are expressed as mean ± SD.

BMI, body mass index; DNP, dressing with negative pressure; SSI, surgical site infection; TSF, thickness of subcutaneous fat.

Table 2 Effect of DNP for the prevention of incisional SSI

Incisional SSI	+	−	*P* value
Patients (n)	35	168	
Age (y)	67.4 ± 12.0	68.8 ± 11.7	0.738
Gender (male/ female, n)	19/16	102/66	0.606
Location (colon/ rectum, n)	27/8	128/40	0.922
Operation time (min)	173.6 ± 95.3	159.7 ± 83.4	0.193
Blood loss (mL)	233.7 ± 359.6	167.7 ± 222.4	0.082
History of laparotomy (n)	10 (28.6%)	36 (21.4%)	0.486
Diabetes (n)	6 (17.1%)	33 (19.6%)	0.916
BMI (kg/m^2)	22.8 ± 2.6	22.0 ± 3.0	0.066
TSF (mm)	19.8 ± 5.2	15.9 ± 5.5	<0.001
Albumin (g/dL)	3.97 ± 0.39	3.88 ± 0.42	0.156
DNP (n)	4 (11.4%)	56 (33.3%)	0.017

Values are expressed as mean ± SD.

BMI, body mass index; DNP, dressing with negative pressure; SSI, surgical site infection; TSF, thickness of subcutaneous fat.

a diagnosis of deep or superficial SSIs was appropriate, which might have led to misclassification.[1]

Statistics

Univariate statistical analyses were conducted using the chi-square tests for qualitative variables, as well as unpaired, one-tailed *t* tests. $P < 0.05$ was considered to be statistically significant. The multivariate analysis was conducted using a regression model. To test the independence of the risk factors, the significant variables ($P < 0.05$) in the univariate analyses were entered into a multiple regression analysis with a likelihood of $P < 0.05$.

Results

We analyzed the cases of 203 patients who, during the 5-year period under review, underwent colorectal resection. In 60 cases, we performed dressing with temporary negative pressure (DNP) for the prevention of SSI. There were no complications, such as skin breaks or blistering, in any of the cases due to DNP. The mean age of all the patients was 68.6 ± 11.7, with an age distribution from 21 to 90 years, and 59.6% of the patients were male. Of the patients having the procedure performed, 194 (95.6%) had cancer and others had another diagnosis necessitating resection, including inflammatory bowel disease, carcinoid tumor, ileus, and so on. In these cases, the overall incidence of incisional SSI was 17.2%.

Table 1 summarizes the patient characteristics and the use of the current method. The incidences of incisional SSI in these cases with or without DNP were 6.7% and 21.7%, respectively. The incisional SSI rate in patients who underwent colorectal resection was thus significantly reduced in patients who received the current method. There was no significant difference in the factors such as age, gender, history of laparotomy, or serum albumin level. Furthermore, more cases with DNP had a history of diabetes, which is thought to be a risk factor for incisional SSI, than did those without DNP.

Table 2 summarizes the results of the univariate analysis conducted to determine the relationship between the clinical variables and the presence of incisional SSI. As can be seen, factors such as age, gender, surgical blood loss, history of diabetes, history of laparotomy, preoperative albumin level, and BMI were not predictors of incisional SSI. In short, the analysis of factors with seeming potential to be associated with incisional SSI in this study disclosed that only the presence of DNP and an accumulation of TSF were of statistical significance (Table 2). Multivariate subgroup analysis of the association between these factors and incisional SSI showed that the presence of DNP was independently associated with incisional SSI ($P = 0.003$) and TSF ($P < 0.001$) on multivariate analysis.

Discussion

Incisional SSI occurs at a relatively high rate in colorectal surgery. The risk of developing incisional SSI is largely determined by the amount and type of microbial contamination of the wound and the condition of the wound. Thus, it is important to prevent contamination of the wound, and in case with contamination, drainage is thought to be quite important for prevention of SSI. We have previously demonstrated that subcutaneous drain is effective for preventing incisional SSI in patients with thick subcutaneous fat in colorectal surgery.[13] Suggested mechanisms of preventive action of subcutaneous drains are removing fluids and components in these fluids, reducing dead space of a subcutaneous wound area and helping keep the incision edges together. However, some studies have found that subcutaneous drains do not reduce the incidence of SSI,[16,17] and we also showed that the incisional SSI rate in patients with thick subcutaneous fat tissue was significantly reduced only in high-risk cases. These findings imply the possibility that subcutaneous drains would be useful for high-risk patients, but not for all patients undergoing colorectal surgery. Subcutaneous drain appears to be unnecessary or potentially harmful in patients without thick subcutaneous fat tissue, since the drain is a foreign substance for the human body. Thus, we have performed a new closure technique in surgery for colorectal resection, dressing with temporary negative pressure (DNP), in which an Atom Multipurpose catheter is placed on the incision and Opsite Post-Op Visible dressing is applied over the incision with the catheter for the prevention of incisional SSI. Using this system, it is unnecessary for a foreign body to be inserted into subcutaneous tissue. This drainage system appears also to reduce the dead space and lead to wound adaptation due to temporary negative pressure, which is thought to lead to a reduced risk of incisional SSI. The key observations made in this study can be summarized as follows: (1) the incisional SSI rate in patients with colorectal resection has been significantly reduced using DNP; and (2) DNP appears to be safe and easy to use and may promote uncomplicated wound healing in patients with colorectal surgery. These findings provide clear evidence that the use of DNP is effective for preventing incisional SSI in patients undergoing colorectal surgery.

Obesity is a significant risk factor for wound infection after surgery.[7,8] In obese patients, the increased risk has been variously attributed to decreased oxygen tension in relatively avascular adipose tissue, ischemia along suture lines, and greater wound area and postoperative exudate, with the ensuing difficulties resulting in contamination.[8,20–22] Thus, to prevent incisional SSI, sufficient drainage, and reduced dead space are thought to be important. In the present study, the incisional SSI rate was significantly reduced by DNP. However, the effectiveness of this drainage system is not clear in cases with thick subcutaneous fat tissue and the cases with incisional SSI with DNP had relatively thick subcutaneous fat tissue in our study. Therefore, in cases of obesity with thick subcutaneous fat, a subcutaneous drain should be inserted. Incisional SSI surveillance for obese patients should be performed separately, which should lead to a further reduction in the incidence of incisional SSIs.

In addition, DNP may be useful for preventing postoperative wound contamination. Opsite Post-Op Visible is a waterproof, bacteria-proof dressing with a see-through absorbent pad that was developed to allow clinicians to inspect the incision site and periwound area without having to remove the dressing.[18] Opsite Post-Op Visible has advantages over traditional dressings as the film has been shown to provide a bacterial barrier to most common pathogens as well as methicillin-resistant staphylococcus aureus, and to provide good exudate handling properties through highly absorbent foam.[18]

This study has potential limitations. First, the number of cases in our study was relatively small. Second, there are other known predictors or plausible factors associated with SSI that were not evaluated in this study, including cardiac disease and anemia.[9,10] Additional research is needed to evaluate the clinical outcome of this new wound management, DNP.

In conclusion, we have described a novel method for preventing incisional SSI and demonstrated that wound dressing with temporary negative pressure is effective for preventing incisional SSI in patients with colorectal surgery.

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