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ORIGINAL ARTICLE

Incidence of and risk factors for incisional hernia after closure of temporary ileostomy for colorectal malignancy

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Abstract

Purpose Incisional hernia is a major complication after stoma closure and can cause uncomfortable symptoms. In this study, we evaluated the risk factors for hernia formation with the aim of reducing the incidence of incisional hernia.

Methods A total of 134 oncology patients underwent closure of a temporary loop ileostomy between May 2004 and December 2013. The incidence of incisional hernia was determined by routine follow-up computed tomography scanning every 6 months. The relationships between patients' characteristics, including age, sex, obesity, diabetes mellitus, surgical site infection, chronic obstructive pulmonary disease, hypertension, hypoalbuminemia, smoking, and presence of a midline hernia and the occurrence of incisional hernia were retrospectively evaluated.

Results The median follow-up time was 47 months (range 8–130). Hernias occurred in 23.9% of patients (32/134). The median time to detection of hernias was 8 months (range 2–39). The Chi-squared test revealed significant differences in obesity ($P=0.0003$), hypertension ($P=0.0057$), and incisional hernia history ($P=0.0000$) between patients with and without incisional hernia. Multivariable analysis and univariate analysis revealed that hypertension and the presence of midline incisional hernia were risk factors for incisional hernia.

Conclusions Hypertension and the presence of a midline incisional hernia were the major risk factors for incisional hernia after loop ileostomy closure. These risk factors can be addressed before planning surgery.

Keywords Incisional hernia · Stoma closure · Loop ileostomy · Stoma site hernia · Hernia

Introduction

The reported rate of incisional hernia complicating closure of a temporary ileostomy ranges from 11.1 to 13.5% [1, 2].

Patients with incisional hernia can present with discomfort and pain [3], and may develop cosmetic problems [4]. The reoperation rate for repair of incisional hernia at a stoma closure site has been reported to range from 4 to 20% [5, 6].

Prophylactic mesh placement can prevent abdominal incisional hernia formation after stoma closure [7–9], but it is associated with complications such as surgical site infection (SSI) and adhesions [7, 8].

Some have reported that careful positioning of mesh made of the appropriate materials [7–9] has resulted in a decreased incidence of incisional hernia without the usual complications associated with mesh use. These results have been controversial, because of the small number of reported cases. Better understanding of the risk factors for incisional hernia in patients undergoing closure of a temporary ileostomy will help to determine which patients may benefit from the use of mesh.

Most reports of hernia formation after stoma closure included a mixture of ileostomy and colostomy closure cases in their analyses [5, 10, 11]. There are few reports with large numbers of subjects on incisional hernia formation solely after ileostomy closure [1, 2].

We considered that the risk factors for incisional hernia after ileostomy closure can be more accurately examined by evaluating only patients who have undergone closure of temporary loop ileostomy.

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Methods

Patients

A total of 138 patients underwent closure of a temporary loop ileostomy from May 2004 to December 2013 at TOHO University Omori Hospital.

In our study, most stomal hernias were detected at 8 months or later. There is a substantial probability a hernia may occur between the end of follow-up and 8 months after stoma closure. These patients were potential false-negatives and a cause of bias in this study. Thus, we excluded 4 patients that were followed up for < 8 months and evaluated the remaining 134 patients.

Because patients whose primary indication for an operation with stoma construction was a benign condition did not routinely undergo follow-up computed tomography (CT) scans, we evaluated the postoperative incidence of incisional hernia on CT scans routinely performed in oncology patients.

Surgical procedure

The abdominal wall was separated into three layers: the peritoneum and posterior sheath of the rectus abdominis muscle, the anterior sheath of the rectus abdominis muscle, and the skin. The three layers were then closed upon one another. The skin closures were triangular type in 78% of patients (105/134), conventional linear type in 17% (23/134), purse-string type in 3% (4/134), and unknown in 2 patients. We did not use mesh for any patients.

Hernia diagnosis

The incidence of incisional hernia was determined by two independent observers (a surgeon and a radiologist) using follow-up CT scans every 6 months postoperatively. We defined incisional hernia according to the European Hernia Society: "An abdominal wall hernia is an abnormal protrusion of the contents of the abdominal cavity or of pre-peritoneal fat through a defect or weakness in the abdominal wall [12]". Two specific cases are shown in Fig. 1.

When laparotomy was performed for recurrence, ileus, or repair of incisional hernia, the observation for hernia occurrence was stopped.

Risk factors

The relationships between the patients' characteristics and the occurrence of incisional hernia were retrospectively evaluated. The possible risk factors in this study were age ≥ 65 years, sex, obesity (body mass index [BMI] of ≥ 25 kg/m^2). The mean BMI in Japan is 22.5 kg/m^2 [13], and obesity is defined as a BMI of ≥ 25 kg/m^2 by the Japan Society for the Study of Obesity [14], poorly controlled diabetes mellitus (HbA1c of > 6.5%), SSI (diagnosed according to the Centers for Disease Control guidelines), chronic obstructive pulmonary disease (COPD), hypoalbuminemia, (albumin < 3.0 g/dL), smoking, chemotherapy (patients underwent oral or intravenous chemotherapy during the period between stoma construction and stoma closure), hypertension (patients treated with antihypertensives), and the presence of a midline incisional hernia [the diagnosis of a midline incisional hernia being made according to the definition of the European Hernia Society (EHS)].

We attempted to evaluate the relationship of loop ileostomy-site incisional hernia with steroid use and deep SSI.

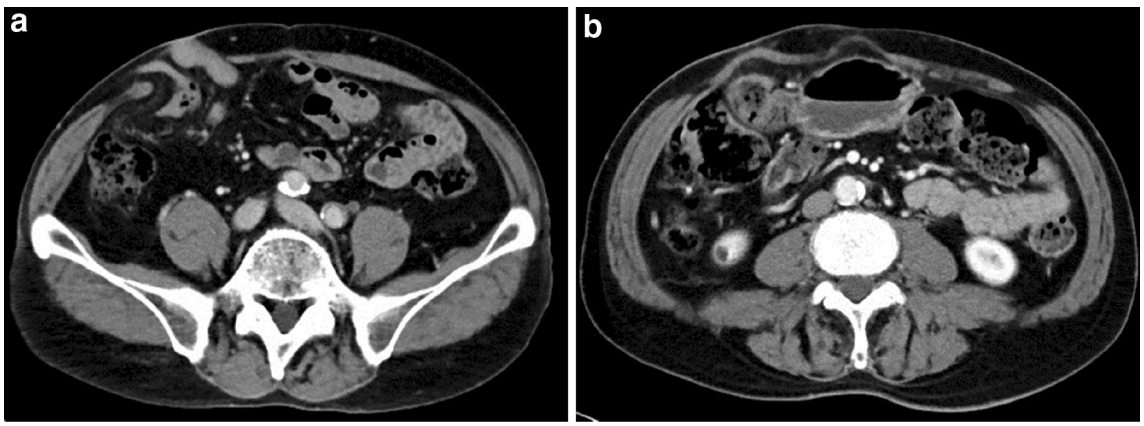

Fig. 1 Computed tomography images. **a** Case (1) The abdominal rectus muscles are dehisced, with small intestine was herniating through the defect. **b** Case (2) Intraperitoneal fat herniating through the stoma closure site and the midline incision site

However, this evaluation was not possible because the number of patients was too small (steroid use, $n=1$; deep SSI, $n=3$).

Statistical analysis

Characteristics of patients without SSI, COPD, or hypoalbuminemia were first subjected to univariate analysis using the Chi-squared test. Then data on patients with SSI, COPD, hypoalbuminemia were subjected to univariate analysis using Fisher's exact test. Factors with $P<0.2$ were then entered into a multivariable logistic regression model. Incisional hernia-free time interval curves were estimated according to the Kaplan–Meier method. Statistical analyses were performed using commercial software (SPSS for Windows, v13.0J®, SPSS Japan Inc., Tokyo, Japan). $P<0.05$ was considered statistically significant.

Table 1 Clinical characteristics of patients

Characteristics	Value ($N=134$)
Follow-up, median, month	47 (8–130)
Sex, *n* (%)	
Male	84 (62.7)
Female	50 (37.3)
Age, median	65 (27–85)
Age (≥ 65), *n* (%)	68 (50.7)
BMI, median, kg/m^2	22.1 (16.1–36.7)
Obesity (BMI ≥ 25), *n* (%)	31 (23.1)
COPD, *n* (%)	5 (3.7)
Hyper tension, *n* (%)	48 (35.8)
Diabetes, *n* (%)	21 (15.7)
Midline incisional hernia, *n* (%)	44 (32.8)
Surgical site infection, *n* (%)	14 (10.4)
Smoking, *n* (%) (unknown 1)	23 (17.2)
Hypoalbuminemia, *n* (%)	7 (5.2)
Postoperative chemotherapy	67 (50.0)

BMI body mass index, *COPD* chronic obstructive pulmonary disease

Results

The median follow-up time was 47 months (range 8–130). The primary surgical indications were rectal cancer ($n=118$), colon cancer ($n=15$), and a gastrointestinal tumor ($n=1$). The patients' features are shown in Table 1.

Postoperative incisional hernia occurred in 23.9% (32/134) of patients. Among these patients, 9.4% (3/32) required surgery for incisional hernia repair. The estimated freedom from incisional hernia at the stoma site according to the Kaplan–Meier method is shown in Fig. 2. The median time to incisional hernia detection was 8 months (range 2–39); 78% (25/32) of hernias occurred within 1 year after stoma closure.

There were significant differences in obesity and hypertension and midline incisional hernia between patients with loop ileostomy-site incisional hernia and no incisional hernia (obesity, $P=0.0003$; hypertension, $P=0.0057$; midline incisional hernia, $P=0.0000$) (Table 2). The multivariable analysis and univariate analysis revealed that hypertension and midline incisional hernia were risk factors for incisional hernia (Table 3).

Discussion

In studies that targeted only ileostomy-site hernias as defined by the EHS and that used CT for hernia detection, as in our study, the occurrence rate of ileostomy-site hernias ranged from 11.0% (median follow-up time, 30.7 months) [1] to 13.5% (median follow-up time, 20.5 months) [2].

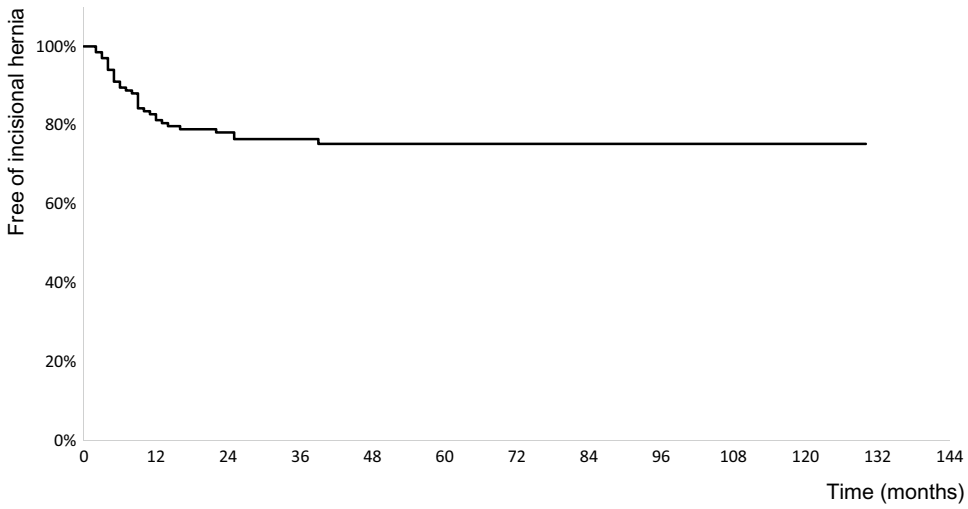

Fig. 2 Kaplan–Meier curves of estimated freedom from incisional hernia at the stoma site among 134 patients after closure of temporary diverting loop ileostomy

Table 2 Hernia vs. no hernia group: patient demographics and characteristics

Variables	Hernia ($N=32$)	No hernia ($N=102$)	P
Follow-up, median, month	46.5 (9–130)	48 (8–130)	0.49
Sex, *n* (%)			0.38
Male	18 (56.3)	66 (64.7)	
Female	14 (43.7)	36 (35.3)	
Age, median	65 (27–82)	65 (34–85)	0.80
Age (≥ 65), *n* (%)	16 (50.0)	52 (50.9)	0.92
Obesity (BMI ≥ 25), *n* (%)	**15 (46.9)**	**16 (15.7)**	**0.0003***
COPD, *n* (%)	1 (3.1)	4 (3.9)	1
Hyper tension, *n* (%)	**18 (56.3)**	**30 (28.6)**	**0.0057**
Diabetes, *n* (%)	5 (15.6)	16 (15.7)	0.99
Midline incisional hernia, *n* (%)	**21 (65.6)**	**23 (22.5)**	**0.0000***
Surgical site infection, *n* (%)	5 (15.6)	9 (8.8)	0.32
Smoking, *n* (%) (unknown 1)	5 (15.6)	18 (17.6)	0.77
Hypoalbuminemia, *n* (%)	3 (9.4)	4 (3.9)	0.36
Postoperative chemotherapy	18 (56.3)	49 (48.0)	0.41

Items with significant differences are in bold

BMI body mass index, *COPD* chronic obstructive pulmonary disease

*Statistically significant ($P<0.05$)

Table 3 Multivariable analysis of factors associated with incisional hernia after ileostomy closure

	Coefficient	Odds ratio	95% CI	P value
Obesity	0.83			0.10
MIH	**1.73**	**5.63**	**2.23–14.19**	**0.0003**
Hypertension	**0.96**	**2.60**	**1.01–6.69**	**0.046**

Items with significant differences are in bold

CI confidence interval, *MIH* midline incisional hernia

In the present study, the hernia incidence rate was 23.9% (median follow-up period, 47 months), which is higher than the rate in previous reports. Because we diagnosed hernia using CT with the definition of the European Hernia Society (EHS), small hernias that may have not been identified in previous reports were included, which may be the reason for the higher incidence rate.

Differences in surgical technique may have also contributed, but we were unable to evaluate this in the present study because of the insufficiency of surgical information.

CT is more sensitive than physical examination for hernia detection. Baucom et al. [15] reported that the detection rate of incisional hernia by physical examination was 23% lower than detection by CT and that 31% of incisional hernias were missed by physical examination in obese patients. Many other reports have also described the usefulness of radiological examination for hernia detection. Bhangu et al. [5] reported that the detection rate of incisional hernia was 14% by clinical findings alone, 31% by radiological findings, and 34% by combined clinical and radiological findings. Cingi et al. [10] reported that the hernia detection rate was 26% by clinical findings and 48% by CT findings.

The median time to incisional hernia detection was 8 months after stoma closure. Burger et al. [16] evaluated the relationship of the distance between the rectus abdominis muscles and the incidence of incisional hernia by CT scans within 1 month after stoma closure. They found that the mean and maximum distances between the muscles were significantly larger in patients with than without an incisional hernia, with > 90% of patients with an incisional hernia having a maximum distance of > 25 mm compared with < 20% of patients without an incisional hernia. The authors concluded that the occurrence of incisional hernia could be predicted by measuring the distance between the rectus abdominis muscles on postoperative CT and that incisional hernia developed within several weeks of surgery. Additional studies using CT showed that the time to detection of incisional hernia was 8.0 months [2] and 8.9 months [7]. These results suggest that incisional hernia occurs several months after stoma closure. Moreover, Claes et al. [17] reported that CT scans could identify incisional hernia 5 months earlier than physical examination. This study suggests that clinical findings reveal incisional hernia later than do CT findings.

A BMI ≥ 30 kg/m^2 [2, 11, 18], hypertension [2, 18], diabetes mellitus [11], older age [11], stoma prolapse [18], parastomal hernia [18], and reversal of colostomy in patients with an underlying malignancy [18] have been reported in previous studies as risk factors for post-reduction incisional hernia. Reported risk factors for midline incisional hernia include a BMI ≥ 25 kg/m^2 [19], SSI [20], hypoalbuminemia [19], female sex [19], male sex [20], chronic obstructive pulmonary disease [21], smoking [20], and inguinal hernia [22].

Although it did not eventually become a risk factor in our study, there are many reports that obesity is a risk factor for hernia. The obesity-induced direct force that increases abdominal wall tension secondary to high intra-abdominal pressure may explain why obesity is a risk factor for incisional hernia [23, 24]. The inherent anatomic features of adipose tissue, vascular insufficiency, cellular and composition modifications, oxidative stress, alterations in immune mediators, and nutritional deficiencies may also negatively affect wound healing [25]. Our results point to hypertension and midline incisional hernia as risk factors for incisional hernia following loop ileostomy reversal.

Hypertension has been shown to promote abnormal wound healing by inducing endothelial dysfunction and inflammation-induced hypoxia in previous studies [26]. Hypertension was identified as a risk factor for hernia in our investigation. There were two studies that reported

hypertension as risk factor of stoma site hernia. But different definitions for hypertension were used in these studies. Brook et al. [2] defined hypertension ≥ 140/90 and evaluated the risk using Spearman's rho, while Amelung et al. [18] defined hypertension as a systolic BP > 140 mmHg on more than three consecutive occasions. Our definition was patients treated with antihypertensives. It will be necessary to evaluate hypertension as risk factor for stoma site hernia using a unified definition in the future.

Only one report has suggested that midline incisional hernia is a risk factor for incisional hernia at the stoma closure site. It has been suggested [6] that the occurrence of hernia in patients with midline incisional hernia was fourfold higher than that in patients without midline incisional hernia [6, 10]. Bhangu et al. and DuBay et al. [6, 27] explained that incisional hernia reduced abdominal wall compliance via fibrotic atrophy of the internal oblique muscles and that this degeneration increased the risk of additional abdominal incisional hernia.

Furthermore, collagen disorders may be a contributory factor to incisional hernia at the stoma closure site. The type I/III collagen ratio in the fascia of patients with inguinal and abdominal incisional hernia is reportedly decreased, and this alteration of collagen types causes the collagen fibers to become thin and exhibit weaker biomechanical strength [28, 29]. This mechanism might be a cause of weakness of the abdominal wall, predisposing to abdominal incisional hernia formation at the stoma site.

Some recent studies have shown that prophylactic mesh placement effectively prevented stoma site hernia formation [7–9].

Liu et al. [7] reported on the use of permanent synthetic mesh reinforcement in 47 of 83 patients undergoing ileostomy closure. Polypropylene mesh was reinforced with an onlay placement. The rates of stoma site wound infection were similar between groups (4.3% vs. 2.8%; $P = 0$ 0.99). The incidence of hernia development was significantly less in the mesh reinforcement group compared with controls (6.4% vs 36.1%; $P = 0.001$). Warren et al. [8] reported on retromuscular large-pore polypropylene mesh reinforcements in ostomy reversal in 91 of 359 patients (colostomy 56.5%, ileostomy 43.5%). The incidence of stomal hernias was decreased significantly in the mesh group compared with the no mesh group (1% vs. 17.2%; $P < 0.001$), as was the occurrence of a midline hernia (6% vs. 19%; $P = 0.004$). The SSI rates were identical (20% vs. 19.8%; $P = 1.000$) Superficial SSI was lower with mesh (8% vs. 16.4%; $P = 0.039$).

Maggiori et al. [9] reported a matched case–control study involving 30 patients that received retromuscular prophylactic biological mesh, compared with 64 matched patients with suture closure of the stoma wound. At 1-year follow-up with CT scan, the hernia rate in the mesh group was significantly lower than the rate in the control group, (3% vs. 19%; $P = 0.043$). The wound infection rate was not significantly different between the two groups.

Although infection, erosion, adhesion, and fistula formation as complications were feared in mesh placement for stoma closure, mesh reinforcement decreased hernia occurrence without increasing complication in these studies [7–9].

As these reports dealt with small numbers of patients, prophylactic mesh placement for stoma closure remains controversial. Currently, randomized controlled trials of closure of a stoma site with vs. without biological mesh reinforcement are ongoing [30]. Depending on the results of randomized study, mesh reinforcement may become a more important option for prevention of stoma site hernia.

According to our results, patients with hypertension and midline incisional hernia may be the best candidates for the use of mesh.

Although hypertension can be improved by lifestyle habits, patients with midline incisional hernia have no recourse to reduce their risk, making them obvious candidates for the use of mesh.

Limitations

This study has a limitation. More than 10 operators performed stoma closure in this study. Although the surgical procedure of stoma closure has been established in our hospital, there may still be slight differences in the operation method and suture material depending on the time period during which the surgery was performed and the operator performing the procedure. We could not evaluate these differences because a detailed description was absent from some operation notes.

Conclusion

We found that the risk factors for incisional hernia formation at the loop ileostomy stoma closure site were hypertension and midline incisional hernia.

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Author contributions TK: Drafting and critical revision of the article; KF: Conception or design of the work, final approval of the version to be published; MG: Document collection; MU: Data analysis and interpretation; SK: Data collection, analysis, and interpretation; TK: Data collection; YN: Data collection; HS: Documents collection; JK: Conception or design of the work, data analysis and interpretation.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest to declare.

Ethical approval This study was approved by the ethical committee of our institution (no. M17242).

Human and animal rights This article does not contain any studies directly involving human participants, as it is a review of data already collected in a database.

Informed consent For this type of study, formal consent was not necessary.

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