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Body Mass Index as a Predictor of Postoperative Complications in Loop Ileostomy Closure after Rectal Resection in Japanese Patients

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ABSTRACT

Loop ileostomy is widely employed after low rectal anastomosis to prevent pelvic sepsis from anastomotic leakage. However, stoma closure carries a risk of morbidity and even mortality in some cases. It is important to assess complications after stoma closure for maximizing the benefit of making loop ileostomy. The aim of this study was to review and examine the possible risk factors associated with complications after closure of loop ileostomies. A retrospective analysis, which focused on risk factors for complications after surgery, was performed for 82 consecutive patients who underwent elective closure of loop ileostomy from 2005-2012 at Hiroshima University Hospital. Postoperative complications developed in 22 patients (26.8%): 12 (14.6%) had an ileus, 8 (9.8%) had a wound infection, 2 (2.4%) had an intraperitoneal abscess and 1 had pseudomembranous enterocolitis. There was no postoperative mortality. In univariate analysis, gender and higher body mass index (BMI) were identified as significant risk factors for postoperative complications. After multivariate analysis, a BMI of 24 kg/m^2 was identified as the cut-off value, above which significantly higher incidences of postoperative complications were observed. Furthermore, patients who succeeded in reducing their weight (BMI <24 kg/m^2) between the first and second surgeries had less morbidity than patients who remained obese (BMI >24 kg/m^2). Our study showed that the majority of complications associated with ileostomy closure are ileus. A BMI >24 kg/m^2 is an independent risk factor for postoperative complications. Weight loss programs before stoma closure might reduce postoperative complications.

Key words: *Loop ileostomy, Ileostomy closure, Complication, BMI*

The creation of a temporary loop ileostomy is a common surgical tool after very low rectal anastomosis to reduce the rate of pelvic sepsis that can result from anastomotic leakage.

Although a temporaly stoma has a clear advantage in some cases, the majority of prophylactic ileostomies are not needed in the end, owing to a reported 5-15% leak rate for low rectal anastomosis[5,6,8,11)]. Therefore, ileostomy only provides a true benefit if the morbidity and mortality from the stoma closure itself remains minimal and is accounted for in the overall risk/benefit calculation.

Common complications of stoma reversal range from wound infection, ileus, incisional hernia, and anastomotic leakage. This procedure has a small but real risk of mortality ranging from 0-4%[1,7,9,10,13,14,20)]. Stoma creation should be balanced against the complication rates of stoma closure. Therefore, it is important to achieve the lowest possible rate of complications after stoma closure.

The aim of this study was to examine the outcomes and morbidity and to identify the possible risk factors associated with complications after the closure of a loop ileostomy in patients with low rectal anastomosis.

MATERIAL AND METHODS

Between April 2005 and April 2012, 82 consecutive patients with rectal tumor underwent

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elective loop ileostomy closure at our institution and were included in this study.

Data were prospectively collected for age, gender, body mass index (BMI), smoking habits, history of diabetes, administration of chemotherapy during primary surgery and stoma closure, primary surgical procedure, approach of primary surgery (i.e., open or laparoscopic), interval between primary surgery and ileostomy closure, complications after primary surgery, creation of ileostomy (i.e., planned or emergent), operation duration, intraoperative blood loss, type of anastomosis (i.e., hand-sewn or stapled), length of hospital stay, and 30-day morbidity and mortality.

Over the study period, in cases of low anterior resection, the decision to construct a loop ileostomy was at the discretion of the operating surgeon who performed the primary surgery.

Prior to closure, all patients underwent a flexible endoscopy to assess the primary anastomosis, and that there was no evidence of leakage.

Closure of the ileostomy was performed via a circumstomal incision with full mobilization of the stoma, followed by partial small bowel resection and anastomosis. In all cases, the method of anastomosis was hand-sewn suture. A hand-sewn end-to-end anastomosis was created using two-layered continuous and interrupted sutures of 3-0 Vicryl (Ethicon, Int.). The ileostomy-bearing segment was excised in all cases. The method of incision closure was entirely at the surgeon's discretion. Systemic prophylactic antibiotics with cefmetazole were administered just before the surgery and continued for up to 2 days after surgery in all cases.

Post-closure ileus was defined as radiologic evidence of dilated small bowel associated with vomiting, abdominal distention, abdominal pain, or absolute constipation, resulting in a need for fasting. Wound infection was defined as discharge of pus from the wound. All complications diagnosed within the first 30 days after ileostomy closure were considered postoperative, including those related to the operative procedure and general complications.

Statistical analysis

Statistical analysis was performed using the chi-squared test and Fisher's exact test for categorical variables and the Mann-Whitney *U* test for continuous variables. The receiver operating characteristic (ROC) curve was used to determine the cut-off BMI. Significance was set at $p<0.05$. After univariate analysis, a multivariate logistic regression analysis was performed. All statistical analyses were performed using JMP 10.0.0 software (SAS Institute, Cary, NC, USA).

RESULTS

Patient characteristics

Patient demographics are summarized in Table 1. In total, 82 loop ileostomies were closed during the study. The subjects consisted of 56 men and 26 women (age range, 32-87 years; median age, 64 years). Median BMI at primary surgery was 23.5 kg/m^2 (range, 16.5-37.6 kg/m^2); median BMI decreased to 22.1 kg/m^2 (range, 16.3-36.2 kg/m^2) at ileostomy closure.

Prior to closure, 20 (24.4%) patients had received adjuvant chemotherapy after primary surgery.

The type of primary anastomosis requiring protective loop ileostomy was low rectal anastomosis in 82 patients (77 for rectal cancer and 5 for rectal carcinoid). Primary surgery was conducted via a laparoscopic approach in 45 patients (54.9%) and via an open approach in 37 (45.1%).

The median interval between primary surgery and ileostomy closure was 106 days (range, 40-293 days).

The median operating time was 103 min (range, 55-475 min). Ileostomy closure was performed by hand-sewn anastomosis in all 82 patients.

Operative morbidity

Overall, postoperative complications were observed in 22 of the total 82 patients who underwent ileostomy closure, resulting in an overall morbidity rate of 26.8%. There was no postoperative mortality. Among the 22 patients, postoperative ileus was the most common complication (12; 14.6%). All patients were successfully managed by gastric decompression, bowel rest, and intravenous hydration, without requiring surgery. Wound infection occurred in 8 (9.8%) patients. Two patients (2.4%) developed an intraperitoneal abscess that was resolved with conservative management. One patient had pseudomembranous enterocolitis.

The median length of the postoperative hospital stay was significantly longer in patients with postoperative complications than in patients without complications (18.5 vs. 9.4 days; $p<0.01$).

Factors associated with morbidity

The correlations between patient characteristics and surgery related complications are summarized in Table 2.

The univariate analysis showed that men had a significantly greater tendency for developing postoperative complications ($p = 0.04$). BMI before stoma closure was 23.3 and 21.6 kg/m^2 for patients with and without postoperative complications, respectively; this difference was statistically significant ($p = 0.02$).

In smokers (ex-smokers included) and diabetic patients, planned stoma creation tended to be

Table 1. Patient Characteristics (n=82)

	N	%
Patient variables		
Age (years: median, range)	64 (32-86)	
Gender		
Male	56	68.3
Female	26	31.7
Body mass index (kg/m^2) (median, range) at ileostomy closure	22.1 (16.3-36.2)	
Body mass index (kg/m^2) (median, range) at primary surgery	23.4 (16.5-37.6)	
Smoking habits		
Non-smoker	44	53.7
Smoker	38	46.3
Diabetes		
Yes	19	23.2
No	63	76.8
Administration of chemotherapy before ileostomy closure		
Yes	20	24.4
No	62	75.6
Surgical variables		
Procedures of primary surgery		
Rectal resection	82	100
Approach of primary surgery		
Open surgery	37	45.1
Laparoscopic surgery	45	54.9
Interval between primary surgery and ileostomy closure (days)	106(40-293)	
Complication after primary surgery		
No	46	56.1
Yes	36	43.9
Creation of ileostomy		
Planned	71	86.6
Emergent	11	13.4
Operative time (min.)	103(55-475)	
Blood loss (gr.)	40 (0-260)	

Table 2. Correlation between postoperative complications and patients' characteristics in ileostomy closure

	Without Complications (n=60)	Complications (n=22)	p value
Patient variables			
Age (years: median, range)	63.0 + 10.9	66.5 + 11.8	0.33
Gender			0.04
Male	37 (66.1%)	19 (33.9%)	
Female	23 (88.5%)	3 (11.5%)	
Body mass index (kg/m2) (median) at ileostomy closure	21.6 + 3.3	23.3 + 3.2	0.02
Body mass index (kg/m2) (median) at primary surgery	22.9 + 3.4	24.7 + 3.2	0.01
Smoking habits			0.62
Non-smoker	31 (70.4%)	13 (29.6%)	
Smoker (including ex-smoker)	29 (76.3%)	9 (23.7%)	
Diabetes			0.38
Yes	12 (63.2%)	7 (23.8%)	
No	48 (76.2%)	15 (23.8%)	
Administration of chemotherapy before ileostomy closure			0.57
Yes	16 (80.0%)	4 (20.0%)	
No	44 (71.0%)	18 (29.0%)	
Surgical variables			
Approach of primary surgery			0.80
Open surgery	28 (75.7%)	9 (24.3%)	
Laparoscopic surgery	32 (71.1%)	13 (28.9%)	
Interval between primary surgery and ileostomy closure (days)	113.5 + 48.1	121.0 + 46.6	0.28
Complication after primary surgery			1.00
No	34 (73.9%)	12 (26.1%)	
Yes	26 (72.2%)	10 (27.8%)	
Creation of ileostomy			0.27
Planned	50 (70.4%)	21 (29.6%)	
Emergent	10 (90.9%)	1 (9.1%)	
Operative time (min.)	113.8 + 59.4	102.9 + 27.0	0.70
Blood loss (gr.)	49.7 + 44.3	41.5 + 41.5	0.55
Length of postoperative hospital stay (days)	9.4 + 2.4	18.5 + 10.1	< 0.01

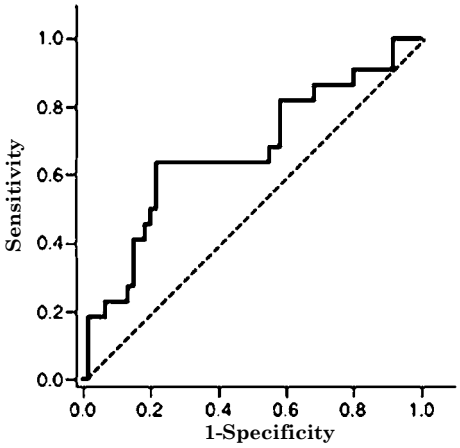

Fig. 1. Receiver operating characteristic (ROC) curve obtained using body mass index (BMI) and the occurrence of operative complications as test variables. A BMI >24 kg/m^2 before stoma closure was associated with an increased risk of postoperative complications, with a sensitivity of 63.6% and 1-specificity of 21.7% (ROC curve, 0.67; p = 0.04)

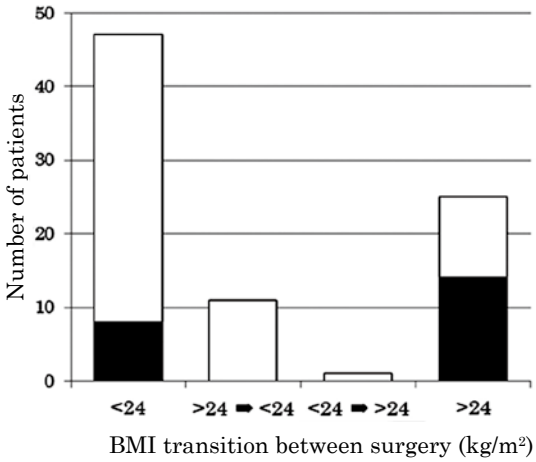

Fig. 2. The incidence of complications by body mass index (BMI) transition category. Patients who lost weight to a BMI <24 kg/m^2 had fewer complications than patients who had or increased their BMI to >24 kg/m^2.

Table 3. Multivariate logistic analysis for risk factor of development of postoperative complications

Variables	Odds ratio	95% confidence interval	p value
Male gender	2.8	0.7- 13.4	0.13
BMI higher than 24.0	6.0	2.0- 18.6	< 0.01

associated with the development of postoperative complications, although this was not statistically significant.

Because there was a significant correlation between BMI and the occurrence of postoperative complications, we determined if there was a cut-off or critical BMI in this series at which the risk of complications was significantly increased. We performed a ROC curve analysis using BMI and the occurrence of complications as the test variables. The curve resulted in an area of 0.67, indicating that a BMI <24 kg/m^2 before stoma closure may result in the occurrence of post-operative complications, with a sensitivity of 63.6% and specificity of 78.3% (Fig. 1). We then divided the patients into 2 groups according to the BMI cut off (24 kg/m^2) and found a significant difference in the postoperative complication rates between these 2 groups (53.9% vs. 14.3%; p<0.01)

The following covariates were entered in the multivariate logistic model: sex (male or female) and BMI (>24 or ≤24 kg/m^2). A BMI >24 kg/m^2 was the only significant predictor of postoperative complications in the multivariate analysis (p<0.01; odds ratio [OR]: 5.96, 95% CI: 2.04-18.6) (Table 3).

To confirm the correlation between BMI and the development of postoperative complications, we investigated the changes in BMI between the primary surgery and stoma closure. Of the total 82 patients, 47 (57.3%) had a BMI ≤24 kg/m^2 through the first and second surgeries, whereas 25 (30.5%) had a BMI >24 kg/m^2 during the same period; BMI decreased from >24 kg/m^2 to ≤24 kg/m^2 in 11 patients (13.4%) through the first and second surgeries, and BMI increased from ≤24 kg/m^2 to >24 kg/m^2 in the remaining 1 patient (1.2%).

There were no postoperative complications in the patients who succeeded in losing weight (BMI ≤24 kg/m^2); meanwhile, patients who maintained a higher BMI or gained weight (BMI >24 kg/m^2) experienced more postoperative complications (Fig. 2).

DISCUSSION

Loop ileostomies are frequently used in colorectal surgery after ileoanal or colorectal anastomosis to prevent complications associated with the anastomosis.

Advances in surgical techniques and mechanical anastomotic devices have increased the rates of low colorectal anastomosis and even coloanal anastomosis. This increase in the rate of sphincter-saving surgery may have led to an increased frequency of loop ileostomy construction.

Although temporary diversion for low colorectal anastomosis is obviously important to reduce the risk of pelvic sepsis and rate of urgent re-ope-

rations[16,17], ileostomy closure is by no means a morbidity-free procedure–its morbidity is sometimes underestimated.

Thus, we aimed to determine the risk factors for complications after ileostomy closure in an effort to recognize modifications in management that might prove beneficial.

The overall morbidity rate of 21% reported here is similar to those of other series, in which the rates ranged from 11-33%[10,14,17,18,20]. The majority of the postoperative complications in our series were minor, and re-operation was not required. More importantly, there was no mortality.

Several factors such as primary disease (i.e., inflammatory bowel disease or diverticular disease), the interval between primary surgery and ileostomy closure, the method of closure (i.e., stapled or hand-sewn anastomosis), gender, complications after primary surgery, and the type of skin closure (i.e., purse string or conventional closure), have been associated with an increased risk of developing postoperative complications after ileostomy closure[1,4,7,9,12,14,15].

In our series, patients who developed postoperative complications after ileostomy closure had significantly higher BMIs.

Although there are several reports examining the possible risk factors associated with complications after stoma closure, few studies describe the correlation between BMI and postoperative complications. Akiyoshi et al reported that BMI and weight loss during their study period were not associated with postoperative complications[1]. Furthermore, since other studies do not describe include patients' BMI, it is unclear whether BMI is actually associated with the development of postoperative complications after ileostomy closure.

On the other hand, gender may have an influence on the development of complications. This study shows that male gender, indicated as a risk factor by a previous study[1], has more complications in univariate analysis. However, male gender is not significantly a risk factor in multivariate analysis.

The most common complication after ileostomy closure in this series was ileus. This finding is similar to other reports[3,18]. The narrow edematous lumen of hand-sewn end-to-end anastomoses might be one of the leading causes of intestinal obstruction. Therefore, a stapled closure is considered to be associated with a lower incidence of intestinal obstruction than a hand-sewn closure because a larger bowel lumen is created, although this was not reported by other comparative studies[2,4,15]. In this series, none of the patients underwent stapled closure; therefore, we did not investigate whether a stapled closure might reduce ileus. We aim to examine the efficacy of stapled closure in reducing ileus in the future.

It might be assumed that a high incidence of postoperative complications –especially ileus– after ileostomy closure in patients with higher BMIs could be a result of the relatively large amount of visceral fat, which encourages tissue edema and results in a narrow lumen of the anastomosis.

The significant adverse impact of higher BMIs on the development of postoperative complications is supported by the change in weight between the primary surgery and stoma closure. Patients who lost weight during the waiting period for stoma closure had fewer postoperative complications than patients who gained or maintained their weight during this time. Furthermore, this result suggests that weight loss in obese patients before stoma closure may reduce the development of postoperative complications.

Our study has a limitation: the BMI cut-off of 24 kg/m^2 seems to be too low for Western people, although this value is categorized as within the "normal range" according to the World Health Organization (WHO) criteria.

However, the WHO notes that there are obvious differences in the relationship between BMI, the percentage of body fat, and body fat distribution across ethnic groups[19]. This study included was confined to Japanese patients. It has been reported that Japanese people have lower BMIs for a given amount of fat than Western people. Therefore, although it is difficult to extrapolate our BMI cut-off level to Western people, it may provide strong evidence that the risk of developing complications after stoma closure increases with increasing BMI.

CONCLUSION

In summary, the present study shows that most complications associated with loop ileostomy closure are ileus. Obese patients have a significantly increased risk of developing surgery-related complications. Dieting to lose weight during primary surgery through stoma closure should be considered to lower the risk of postoperative complications.

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Authors' contributions

YS and YT conceived the study, participated in its design, and participated in the drafting of the manuscript. HE, TH and HT participated in the patients' treatment. HO helped to draft the manuscript and revised it critically. All authors

have read and approved the final manuscript.

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