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ORIGINAL ARTICLE

Impact of prior abdominal surgery on postoperative prolonged ileus after ileostomy repair

Im-kyung Kim, Jeonghyun Kang*, Seung Hyuk Baik, Kang Young Lee, Nam Kyu Kim, Seung-Kook Sohn

Department of Surgery, Yonsei University of College of Medicine, Seoul, South Korea

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Summary *Background and aims:* Postoperative ileus (POI) is one of the most common reasons for sustained hospital stays after ileostomy repair. Although many factors have been investigated as POI risk factors, the investigation of the impact of prior abdominal surgery (PAS) before rectal cancer surgery has been limited. This study aimed to identify the impact of PAS as a risk factor for POI after ileostomy repair.
Material and methods: A total of 220 consecutive patients with rectal cancer who underwent ileostomy repair were enrolled. The patients were divided into PAS-positive and PAS-negative groups according to the history of PAS before rectal cancer surgery. Univariate and multivariate analyses were performed to identify the clinicopathological factors associated with POI.
Results: The PAS-positive group had a longer operation time (111 min vs. 93.4 min, $p = 0.029$) and a greater length of hospital stay (10 days vs. 7.8 days, $p = 0.003$) compared with the PAS-negative group. POI was more frequent in the PAS-positive group (23.1% vs. 6.2%, $p = 0.011$). The POI rate in the entire cohort was 8.1%. The repair method (stapled side-to-side vs. hand-sewn end-to-end, odds ratio OR = 3.6, 95% confidence interval CI = 1.2–11.1, $p = 0.022$) and PAS (odds ratio = 4.0, 95% confidence interval = 1.2–12.8, $p = 0.017$) were significant predictors of POI in the multivariate analysis.
Conclusions: This study suggests that PAS before rectal cancer surgery is associated with POI after ileostomy repair.

Conflict of interest: All authors declare no conflicts of interest.

* Corresponding author. Department of Surgery, Gangnam Severance Hospital, Yonsei University College of Medicine, 211 Eonju-ro, Gangnam-gu, Seoul, 06273, South Korea.
E-mail address: ravic@naver.com (J. Kang).

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1. Introduction

Ileostomy repair after rectal cancer surgery is a relatively simple technique in daily practice. A recent systematic review reported morbidity rates of 17.3—33.0% following ileostomy repair,[1,2] and postoperative ileus (POI) is one of the most common reasons for sustained hospital stays with increased healthcare costs.

POI is defined as either the absence of bowel function for five or more days or the need for reinsertion of a nasogastric (NG) tube after the start of oral diet in the absence of mechanical obstruction.[3] Although several studies have investigated clinical risk factors for POI,[4—7] the pathophysiology of POI is not yet clear. One possible explanation is the finding that prior abdominal surgery (PAS) results in the formation of adhesions in 51—93% of patients,[8] prolonging operative time and raising the possibility of unintentional bowel injury, leading to increased risk of POI or obstruction.[9—11]

Prior research has focused on POI following major bowel resection in open or laparoscopic colorectal surgeries.[4,6,12] As far as we know, the risk factors for POI after ileostomy repair have received little attention. The aim of this study was to identify the impact of PAS as a risk factor for POI after ileostomy repair.

2. Materials and methods

This retrospective study was granted exempt of approval by the Institutional Ethics Review Board at the Gangnam Severance Hospital. Written informed consent was obtained from all patients. Patient records or any other information were anonymized and de-identified prior to analysis.

2.1. Study population

A total of 220 consecutive patients who underwent ileostomy repair after rectal cancer surgery from September 2008 to July 2012 were enrolled. Patient data were collected from the electronic medical records system. Among the 220 patients that were enrolled in the study, 26 had a history of PAS before rectal cancer surgery (PAS-positive group) and 194 had no history of PAS before rectal cancer surgery (PAS-negative group; Figure 1).

2.2. Operative technique and postoperative outcome evaluation

Diversion was performed either during or after rectal cancer surgery. For some patients, a protective ileostomy was made during the initial rectal cancer surgery based on the operating surgeon's individual judgment rather than on a routine protocol. For other patients, postoperative leakage was diagnosed on the basis of clinical signs of pain or fever, the spillage of bowel contents through the indwelled drain, and localized or generalized peritonitis which was confirmed by contrast radiography. In these cases, ileostomy was performed to rescue the patients from pelvic sepsis.

In our center, the ileostomy repair technique for each patient was selected according to the surgeon's preference. Side-to-side anastomosis using a linear stapler was defined as "stapled side-to-side anastomosis". Hand-sewn end-to-end anastomosis was performed either with bowel resection or without bowel resection (the so-called fold-over technique).[13]

Fast-track approach was not used for postoperative management. Postoperative outcomes were evaluated including the time interval between ileostomy formation and reversal, the operative time, postoperative complications, and the length of hospital stay. Postoperative morbidity was defined as adverse events within 30 days of the operation. Along with the patients' symptoms, laboratory and radiologic evaluations were performed to confirm and to categorize the postoperative complications. POI was defined as the absence of bowel function for 5 or more days or the need for insertion of an NG tube after the start of oral diet in the absence of mechanical obstruction.[3] After the diagnosis of POI, the patients were regularly monitored for return of bowel function, as well as clinical symptoms such as nausea, vomiting, and abdominal distension. The NG tube was removed after passage of flatus.

2.3. Statistical analysis

All statistical analyses were performed using SPSS software, version 20.0 (SPSS, Chicago, IL, USA). Categorical variables were analyzed either by a Chi-square test or by Fisher's exact test. Continuous variables were analyzed using the Student *t* test. Univariate and multivariate analyses were performed using logistic regression analysis. A p value < 0.05 was considered statistically significant.

3. Results

The characteristics of each patient group are shown in Table 1. There were no statistically significant differences between the two groups, except that minimally invasive techniques for the initial rectal cancer surgery were more often used in the PAS-negative group (PAS-positive vs. PAS-negative = 61.5% vs. 84%, $p = 0.013$). The duration of ileostomy maintenance did not differ between the two groups.

Among 26 patients in the PAS-positive group, there were 28 events of prior abdominal surgeries. The most common operation performed previously was appendectomy by open

PAS-positive group	PAS	→	Rectal cancer surgery ileostomy formation	→	Ileostomy repair
PAS-negative group	No history of abdominal surgery	→	Rectal cancer surgery ileostomy formation	→	Ileostomy repair

Figure 1 Definition of the PAS-positive group and the PAS-negative group. PAS = prior abdominal surgery.

Table 1 Patient demographics

		PAS-positive group (n = 26, %)	PAS-negative group (n = 194, %)	*P*
Gender	Male	15 (57.7)	146 (75.3)	0.064
	Female	11(42.3)	48 (24.7)	
Age (year)	Mean ± SD	62.5 ± 11.9	59.9 ± 11.2	0.181
BMI (kg/m^2)	Mean ± SD	24.3 ± 3.5	23.3 ± 2.7	0.268
ASA grade	1	16 (61.5)	109 (56.2)	0.297*
	2	6 (23.1)	69 (35.6)	
	3	4 (15.4)	16 (8.2)	
Reason for ileostomy formation	Protective aim	19 (73.1)	167 (86.1)	0.143*
	Leakage management	7 (26.9)	27 (13.9)	
Preoperative chemoradiotherapy	No	19 (73.1)	100 (51.5)	0.058
	Yes	7 (26.9)	94 (48.5)	
Type of initial rectal cancer surgery	Open	10 (38.5)	31 (16.0)	0.013*
	MIS	16 (61.5)	163 (84.0)	
Ileostomy duration (days)	Mean ± SD	200.7 ± 98.8	178.9 ± 87.3	0.241

*Fisher's exact test.
Abbreviations: SD: Standard Deviation; BMI: Body Mass Index; ASA: American Society of Anesthesiology; MIS: Minimally invasive surgery.

method. Others, including gastrectomy, hysterectomy, and exploratory laparotomy were also performed before rectal cancer surgery (Figure 2).

3.1. Perioperative outcomes

The overall usage of different techniques for ileostomy repair did not differ between the two groups. The operation time was significantly longer in PAS-positive group compared with that in the PAS-negative group. In the PAS-positive group, 23.1% of the patients developed POI after ileostomy repair, whereas in the PAS-negative group, only 6.2% of the patients developed POI after ileostomy repair ($p = 0.011$). The length of hospital stay was significantly longer in the PAS-positive group compared with that in the PAS-negative group (Table 2).

3.2. Risk-factor analysis for the prediction of POI after ileostomy repair

Of the 220 patients included in the study, 18 (8.1%) developed POI. In the univariate analysis, the operation time and PAS were significantly associated with the development of POI. The multivariate analysis including the statistically significant or marginally significant ($p < 0.1$) variables from the univariate analysis showed that the repair method (stapled side-to-side vs. hand-sewn end-to-end, odds ratio = 3.6, 95% confidence interval = 1.2−11.1, $p = 0.022$) and PAS (PAS-

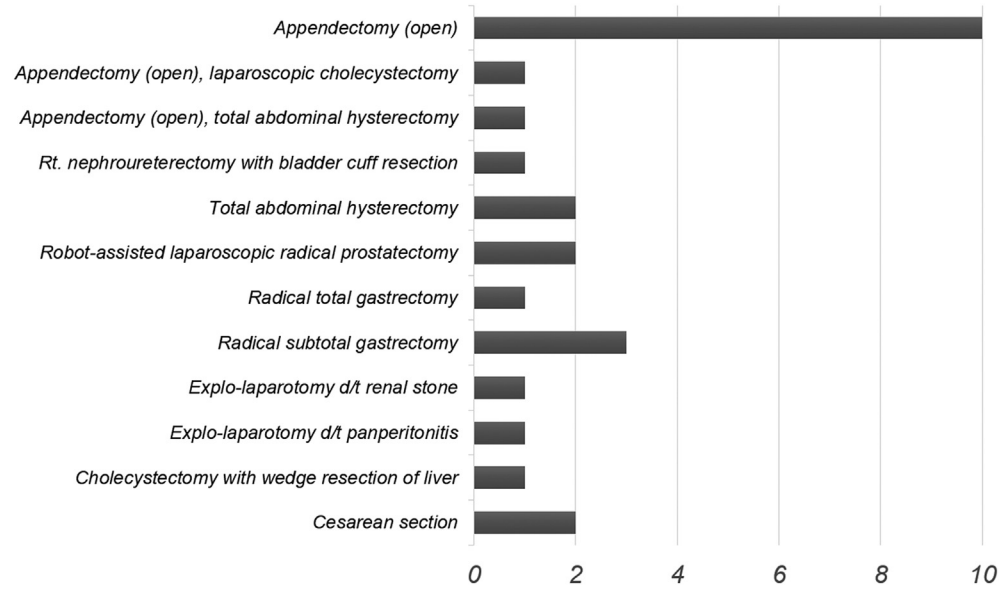

Figure 2 Types of PASs performed in the PAS-positive group. Among 26 patients, 28 surgeries were performed before rectal cancer surgery (allowing overlapped cases). d/t = due to; PAS = prior abdominal surgery; Rt = right.

Table 2 Perioperative outcomes

		PAS-positive group (n = 26, %)	PAS-negative group (n = 194, %)	*P*
Repair methods	Stapled (side-to-side)	15 (57.7)	125 (64.4)	0.454*
	Hand-sewn (end-to-end)	6 (23.1)	44 (22.7)	
	Fold-over technique	3 (11.5)	20 (10.3)	
	Etc.	2 (7.7)	5 (2.6)	
Operation time (min)	Mean ± SD	111.6 ± 46.0	93.4 ± 38.7	0.029
Early complications	Overall	7 (26.9)	22 (11.3)	0.056*
	POI	6 (23.1)	12 (6.2)	0.011*
Length of hospital stay (days)	Mean ± SD	10.0 ± 4.2	7.8 ± 3.4	0.003

*Fisher's exact test.
Abbreviations: SD: Standard Deviation.

negative vs. PAS-positive, odds ratio = 4.0, 95% confidence interval = 1.2–12.8, $p = 0.017$) were independent risk factors for POI (Table 3).

4. Discussion

Our results suggest that hand-sewn end-to-end anastomosis and PAS are associated with a higher risk of POI development after ileostomy repair. The rate of POI in this study was 8.1%, which is on par with those of previous studies.[2,14–16] There have been several efforts to establish risk factors to predict POI. PAS is one of the clinical factors typically analyzed to understand the development of POI. Although the pathogenesis of POI is not clearly established, it is regarded as a multifactorial event involving stress responses to surgical insult.[4,17] The surgical insult may be provoked by multiple laparotomies.

Adhesion after laparotomy develops from peritoneal inflammation, rapid peritoneal mesothelization, postoperative macrophage inflow, and the reorganization of the

Table 3 Univariate and multivariate analysis prediction POI after ileostomy repair

		Univariate analysis		Multivariate analysis	
		N (%)	*P*	Odds Ratio (CI)	*P*
Gender	Male	12/161 (7.5)	0.580*		
	Female	6/59 (10.2)			
Age (year)	< 65	11/139 (7.9)	1.0*		
	≥ 65	7/81 (8.6)			
BMI (kg/m^2)	< 25	13/158 (8.2)	1.0		
	≥ 25	5/62 (8.1)			
ASA	1	10/125 (8)	0.870*		
	2	6/75 (8)			
	3	2/20 (10)			
Preoperative chemoradiotherapy	Yes	9/101 (8.9)	0.807		
	No	9/119 (7.6)			
Repair methods	Stapled (side-to-side)	7/140 (5)	0.066*	1	
	Hand-sewn (end-to-end)	8/50 (16)		3.6 (1.2 − 11.1)	0.022
	Fold-over technique	2/23 (10.4)		1.9 (0.3 − 10.5)	0.425
	Etc.	1/7 (14.3)		1.6 (0.1 − 19.4)	0.687
Ileostomy duration (days)	< 240	14/172 (8.1)	1.0*		
	≥ 240	4/48 (8.3)			
Type of initial rectal cancer surgery	Open	5/41 (12.2)	0.341*		
	MIS	13/179 (7.3)			
Operation time (min)	< 120	10/172 (5.8)	0.031*	1	0.065
	≥ 120	8/48 (16.7)		2.6 (0.9 − 7.7)	
Reason for ileostomy formation	Protective aim	17/186 (9.1)	0.320*		
	Leakage management	1/34 (2.9)			
PAS before rectal cancer operation	PAS-negative	12/194 (6.2)	0.011*	1	0.017
	PAS-positive	6/26 (23.1)		4.0 (1.2 − 12.8)	

*Fisher's exact test.
Abbreviations: SD: Standard Deviation; BMI: Body Mass Index; ASA: American Society of Anesthesiology; MIS: Minimally invasive surgery; PAS: Prior Abdominal Surgery; CI: Confidence Interval.

fibrin gel matrix.[18] PAS causes adhesions to form, making subsequent abdominal surgery difficult. Previous studies revealed that patients with multiple PASs had higher rates of inadvertent enterotomies and delayed recovery of bowel functions.[19–21]

Nevertheless, the impact of PAS on POI after abdominal surgery remains controversial. From many reports, diverse factors have been introduced as predictors of POI after colectomy, such as the clinicopathologic features of the patients, comorbidities, intraoperative events (e.g., operation time, estimated blood loss, and extent of bowel manipulation), and the amounts of postoperative opiates used.[4,22,23] None of those factors showed continuity across entire studies as risk factors for POI. Some researchers have reported that PAS was not associated with POI, even in a univariate analysis.[4,5,7] In contrast, Kronberg et al[6] suggested a predictive score for POI after laparoscopic colectomy, and one of the items composing the predictive score was PAS. Also, in a Japanese series, POI was significantly more frequent among patients with PAS than among those without PAS.[21] In our study, PAS was shown to be a strong predictor of POI after ileostomy repair.

The impact of the technique used for ileostomy closure on postoperative morbidity is controversial. The complication rates between hand-sewn and stapled closure techniques have been reported to be the same.[2,16,24] In contrast, Hasegawa et al[15] reported a higher postoperative obstruction rate for sutured anastomosis than for stapled closure (14% vs. 3%). Gustavsson et al[25] also reported that stapled anastomosis was associated with a lower rate of postoperative small bowel obstruction than hand-sewn anastomosis with or without small bowel resection. In our study, stapled side-to-side anastomosis had a lower rate of POI than hand-sewn anastomosis with small bowel resection. However, there was no difference in the rate of POI between stapled side-to-side anastomosis and the fold-over technique (hand-sewn anastomosis without resection of the small bowel). A possible explanation for that result is that in our study period, the fold-over technique was performed exclusively by a single surgeon who had abundant experience with the technique. In addition, for some patients, although we initially planned to perform a stapled side-to-side anastomosis, it was impossible to perform due to either severe adhesions between the abdomen and the small bowel or too short a remnant of small bowel length from the ileostomy site to the ileocecal valve. In such cases, we inevitably performed hand-sewn end-to-end anastomosis with bowel resection. Therefore, hand-sewn anastomosis with small bowel resection could be not only an influencing factor in POIs but also a reflection of the formation of severe adhesion, which leads to POIs.

Hiranyakas et al[26] reported that compared with open surgery, loop ileostomy closure after initial laparoscopic surgery is associated with improved clinical outcomes in terms of shorter operation time, shorter hospital stay, and lower morbidity. However, their study involved patients with both benign and malignant diagnoses and the ranges of the abdominal inflammatory status and surgical boundary could vary with the diagnosis. In our analysis, which included only patients with rectal cancer, the rate of postoperative ileus did not differ between patients who received initial open surgery and those who received minimally invasive surgery. The impact of laparoscopic versus open surgery on the development of complications after ileostomy repair should be investigated further in homogeneous groups.

This study is limited by its retrospective design. In our analysis, additional operational procedures such as midline incision or stoma-site extension were not available. In addition, the decision about which anastomosis technique to use was left to the surgeon. There was no objective assessment of intraoperative adhesion; therefore it was not possible to know the reasoning behind each selection of anastomosis technique. Most importantly, the degree of surgical expertise could impact the surgical outcomes. Owing to the nature of a training hospital, many trainees in their fellowship on colorectal surgery participated in the operations as an assistant or an operator. Although the exact level of contribution from trainees could not be measured in this retrospective study, the cases performed by trainees were completely under supervision by colorectal staff. As it has been reported that trainees in colorectal surgery could obtain a similar quality of results as consultants if they were supervised,[27] the supervision by colorectal staff might minimize the issue of surgical quality during their early learning periods. However, it would be necessary to adjust the experiences of surgeons with further prospectively designed studies.

In conclusion, this study suggests that PAS prior to initial rectal cancer surgery and the repair technique used following ileostomy are associated with POI after ileostomy repair. Surgeons should be aware of those factors during surgery to reduce the incidence of POI.

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