ISSN 1948-9366 (online)

World Journal of *Gastrointestinal Surgery*

World J Gastrointest Surg 2020 December 27; 12(12): 468-563

Published by Baishideng Publishing Group Inc

World Journal of Gastrointestinal Surgery

Contents

Monthly Volume 12 Number 12 December 27, 2020

World Journal of Gastrointestinal Surgery

Monthly Volume 12 Number 12 December 27, 2020

Contents

ABOUT COVER

Associate editor of *World Journal of Gastrointestinal Surgery*, Dr. Vishal G Shelat is a Senior Consultant Surgeon at Tan Tock Seng Hospital, Singapore. Having received his Bachelor's degree from Gujarat University (Ahmedabad, India) in 2000, Dr. Shelat undertook his postgraduate training first at B.J. Medical College and Civil Hospital (Ahmedabad, India), receiving his Master's degree in 2003, and then at the National University of Singapore, receiving his MD (General Surgery) in 2008. He became Consultant Surgeon in the Department of Surgery at Tan Tock Seng Hospital in 2014. His research interests include the application of evidence-based medicine in digestive diseases, particularly to study the effects of such integrative medicine methods on and management of disease-syndrome pattern establishment. Currently, he serves as member of the Chapter of General Surgery, College of Surgeons of Singapore and Treasurer for the Singapore Hepatopancreaticobiliary Association. (L-Editor: Filipodia)

AIMS AND SCOPE

The primary aim of *World Journal of Gastrointestinal Surgery* (*WJGS*, *World J Gastrointest Surg*) is to provide scholars and readers from various fields of gastrointestinal surgery with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, *etc*.

INDEXING/ABSTRACTING

The *WJGS* is now abstracted and indexed in Science Citation Index Expanded (SCIE, also known as SciSearch®), Current Contents/Clinical Medicine, Journal Citation Reports/Science Edition, PubMed, and PubMed Central. The 2020 edition of Journal Citation Reports® cites the 2019 impact factor (IF) for *WJGS* as 1.863; IF without journal self cites: 1.824; Ranking: 109 among 210 journals in surgery; Quartile category: Q3; Ranking: 77 among 88 journals in gastroenterology and hepatology; and Quartile category: Q4.

RESPONSIBLE EDITORS FOR THIS ISSUE

NAME OF JOURNAL
World Journal of Gastrointestinal Surgery

ISSN
ISSN 1948-9366 (online)

LAUNCH DATE
November 30, 2009

FREQUENCY
Monthly

EDITORS-IN-CHIEF
Shu-You Peng, Varut Lohsiriwat, Jin Gu

EDITORIAL BOARD MEMBERS
https://www.wjgnet.com/1948-9366/editorialboard.htm

PUBLICATION DATE
December 27, 2020

INSTRUCTIONS TO AUTHORS
https://www.wjgnet.com/bpg/gerinfo/204

GUIDELINES FOR ETHICS DOCUMENTS
https://www.wjgnet.com/bpg/GerInfo/287

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH
https://www.wjgnet.com/bpg/gerinfo/240

PUBLICATION ETHICS
https://www.wjgnet.com/bpg/GerInfo/288

PUBLICATION MISCONDUCT
https://www.wjgnet.com/bpg/gerinfo/208

ARTICLE PROCESSING CHARGE
https://www.wjgnet.com/bpg/gerinfo/242

STEPS FOR SUBMITTING MANUSCRIPTS
https://www.wjgnet.com/bpg/GerInfo/239

ONLINE SUBMISSION
https://www.f6publishing.com

E-mail: bpgoffice@wjgnet.com https://www.wjgnet.com

World Journal of Gastrointestinal Surgery

Submit a Manuscript: https://www.f6publishing.com

World J Gastrointest Surg 2020 December 27; 12(12): 507-519

DOI: 10.4240/wjgs.v12.i12.507

ISSN 1948-9366 (online)

ORIGINAL ARTICLE

Retrospective Study

Risk factors for postoperative stoma outlet obstruction in ulcerative colitis

Tomoaki Kitahara, Yu Sato, Takashi Oshiro, Rie Matsunaga, Makoto Nagashima, Shinichi Okazumi

ORCID number: Tomoaki Kitahara 0000-0002-8838-7355; Yu Sato 0000-0003-4939-5704; Takashi Oshiro 0000-0002-1421-3125; Rie Matsunaga 0000-0001-5692-0621; Makoto Nagashima 0000-0001-7369-2173; Shinichi Okazumi 0000-0003-1494-4611.

Author contributions: Kitahara T designed and performed the research and wrote the paper; Sato Y and Matsunaga R designed the research and contributed to the analysis; Oshiro T, Nagashima M, and Okazumi S provided clinical advice and supervised the report; and all authors have approved the final version of the article to be published.

Institutional review board statement: This study was reviewed and approved by the Ethics Committee of the Toho University Sakura Medical Center (IRB approval code: S19026, Toho University Sakura Medical Center).

Informed consent statement: Patients were not required to give informed consent in order to be included in the study because the analysis used anonymous clinical data that were obtained after each patient had agreed to treatment by written consent. The details of the study were published on the home page of Toho University Sakura

Tomoaki Kitahara, Yu Sato, Takashi Oshiro, Rie Matsunaga, Makoto Nagashima, Shinichi Okazumi, Department of Surgery, Toho University Sakura Medical Center, Sakura 285-8741, Chiba, Japan

Corresponding author: Yu Sato, MD, Lecturer, Department of Surgery, Toho University Sakura Medical Center, 564-1, Shimoshizu, Sakura 285-8741, Chiba, Japan. yu.sato@med.toho-u.ac.jp

Abstract

BACKGROUND

Current medical treatments can achieve remission of ulcerative colitis (UC). Surgery is required when potent drug treatment is ineffective or when colon cancer or high-grade dysplasia develops. The standard procedure is restorative proctocolectomy (RPC) with ileal pouch-anal anastomosis, commonly performed as two- or three-stage RPC with diverting ileostomy. Postoperative stoma outlet obstruction (SOO) is frequent, but the causes are not well known.

AIM

To identify the risk factors for SOO after stoma surgery in patients with UC.

METHODS

We retrospectively reviewed the files of 148 consecutive UC patients who underwent surgery with stoma construction. SOO was defined as small bowel obstruction symptoms and intestinal dilatation just below the penetrating part of the stoma on computed tomography. Patients were divided into two groups: Those who developed SOO within 30 d after surgery and those who did not. Patient characteristics, intraoperative parameters, the stoma site, and rectus abdominis muscle thickness were collected. Moreover, we identified the patients who repeatedly developed SOO. Univariate and multivariate analyses were performed to identify risk factors for SOO and recurring SOO.

RESULTS

Eighty-nine patients who underwent two-stage RPC were included between January 2008 and March 2020. Postoperatively, SOO occurred in 25 (16.9%) patients after a median time of 9 d (range 2-26). Compared to patients without SOO, patients with SOO had a significantly higher rate of malignant tumors or dysplasia (36.0% *vs* 17.1%, $P = 0.032$), lower total glucocorticoid dose one month before surgery (0 mg *vs* 0 mg, $P = 0.026$), higher preoperative total protein level (6.8 g/dL *vs* 6.3 g/dL, $P = 0.048$), higher rate of loop ileostomy (88.0% *vs* 55.3%, P

Medical Center.

Conflict-of-interest statement: The authors have no conflicts of interest to declare.

Data sharing statement: No additional data are available.

Manuscript source: Unsolicited manuscript

Specialty type: Gastroenterology and hepatology

Country/Territory of origin: Japan

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): 0
Grade C (Good): C
Grade D (Fair): D
Grade E (Poor): 0

Received: August 3, 2020
Peer-review started: August 3, 2020
First decision: September 17, 2020
Revised: September 28, 2020
Accepted: November 13, 2020
Article in press: November 13, 2020
Published online: December 27, 2020

P-Reviewer: Giudici F, Madnani M
S-Editor: Huang P
L-Editor: Webster JR
P-Editor: Li JH

= 0.002), and higher maximum stoma drainage volume (2300 mL *vs* 1690 mL, *P* = 0.004). Loop ileostomy (OR = 6.361; 95%CI 1.322–30.611; *P* = 0.021) and maximum stoma drainage volume (OR = 1.000; 95%CI 1.000–1.001; *P* = 0.015) were confirmed as independent risk factors for SOO. Eighteen patients with SOO were treated conservatively without recurrence (sSOO group). Seven (28.0%) patients repeatedly developed SOO (rSOO group) during the observation period. A significant difference was observed in the rectus abdominis muscle thickness between the two groups (sSOO 9.3 mm, rSOO 12.7 mm, *P* = 0.006). Muscle thickness was confirmed as an independent risk factor for recurring SOO (OR = 2.676; 95%CI 1.176-4.300; *P* = 0.008).

CONCLUSION

In this study, high maximum stoma drainage volume and loop ileostomy are independent risk factors for SOO. Additionally, among patients with a thick rectus abdominis muscle, the risk of SOO recurrence is high.

Key Words: Ileal pouch anal anastomosis; Ileostomy; Loop ileostomy; Proctocolectomy and restorative; Surgical stomas; Total proctocolectomy; Ulcerative colitis

Core Tip: This was a retrospective study to identify risk factors for stoma outlet obstruction (SOO) that develops after stoma surgery in patients with ulcerative colitis. High maximum stoma drainage volume and loop ileostomy were independent risk factors for the development of SOO. In patients with thick rectus abdominis muscles, SOO may recur.

Citation: Kitahara T, Sato Y, Oshiro T, Matsunaga R, Nagashima M, Okazumi S. Risk factors for postoperative stoma outlet obstruction in ulcerative colitis. *World J Gastrointest Surg* 2020; 12(12): 507-519
URL: https://www.wjgnet.com/1948-9366/full/v12/i12/507.htm
DOI: https://dx.doi.org/10.4240/wjgs.v12.i12.507

INTRODUCTION

Ulcerative colitis (UC) is a chronic inflammatory bowel disease of unknown cause. The number of patients with UC is increasing in Japan, similar to other countries globally[1,2]. Recent advancements in medical treatments have allowed UC patients to enter remission. However, surgery is required when potent drug treatment is ineffective, or when colon cancer or high-grade dysplasia occurs after long-term disease. Previous reports have indicated that 25%-30% of patients with UC require surgery[3-5]. The standard procedure for UC is restorative proctocolectomy (RPC) with ileal pouch-anal anastomosis (IPAA)[6]. One-stage RPC without an ileostomy may be performed in some cases[7,8], but pouch complications, especially anastomotic leakage, can be life-threatening for UC patients whose immune system is weakened by poor nutrition or the use of glucocorticoids and immunosuppressants. Weston-Petrides *et al*[9] established that diverting ileostomy reduces the frequency of pouch-related leaks. Therefore, it is common to perform two- or three-stage RPC with diverting ileostomy. Depending on the individual patient's characteristics, such as age and preoperative activities of daily living, they may be fitted with a permanent stoma without anastomosis[10].

The construction of a stoma may cause various complications. Among them, stoma outlet obstruction (SOO) is often seen after surgery for UC. SOO does not only decrease a patient's quality of life, but also, if it cannot be treated conservatively, the stoma has to be reversed. However, if there are pouch-related complications, stoma reversal cannot be performed. Therefore, it is clinically important to prevent SOO. However, the causes of SOO are not well understood. The aim of this study was to identify the risk factors for the development of SOO after stoma surgery in patients with UC.

MATERIALS AND METHODS

Patients

We retrospectively reviewed the medical files of 148 consecutive UC patients who underwent surgery with stoma construction at Toho University Sakura Medical Center, Chiba, Japan, between January 2008 and March 2020.

Definition of SOO

SOO was identified based on the following criteria: Small bowel obstruction (SBO) symptoms such as abdominal distension, abdominal pain, or vomiting, and computed tomography (CT) showing intestinal dilatation just below the penetrating part of the stoma site.

In the non-SOO group, 17 cases presented with SBO symptoms. CT was not performed, and it was not possible to distinguish between SBO, ileus, and SOO in nine of these patients. Therefore, these cases were included in the non-SOO group based on the definition of SOO in this study.

Based on this definition, the patients were divided into two groups as follows: Those who developed SOO within 30 d after surgery, and those who did not.

Stoma construction methods

First, a stoma site was marked preoperatively based on the Cleveland Clinic standards[11] by the responsible wound ostomy care nurse of the Department of Surgery. An end ileostomy was created at the marked site of the lower-right quadrant from 2008 to September 2012. From October 2012 through to March 2020, a loop ileostomy was created at the marked site of the lower-left quadrant to reduce mesenteric torsion. For loop ileostomy, the part of the ileum to be lifted was selected 30-50 cm orally from the anastomosis.

The marked skin was cut circularly, and the subcutaneous fat around the stoma was removed. Thereafter, the anterior and posterior sheath of the rectus abdominis were incised longitudinally over a length of approximately 3 cm, and the rectus abdominis was split. Finally, the two sheaths of the rectus abdominis and the peritoneum were sutured to reduce the thickness of the muscle layer. The sheath and the peritoneum margins were then fixed to the serosa and muscle layer of the intestine using four stitches.

Variables

Patients' age, sex, body mass index (BMI), the indication for surgery, Mayo endoscopic score, the extent of disease, disease duration, disease severity, total glucocorticoid dose from onset of UC to surgery, and total glucocorticoid dose one month before surgery were recorded. We also noted the preoperative total protein, albumin, and C-reactive protein levels, white blood cell count, and Onodera-Prognostic Nutritional Index. With regard to the intervention, we recorded the surgical approach, site and type of the stoma, operative time, amount of intraoperative bleeding, and maximum stoma drainage volume per day reported in the inpatient chart.

In this study, the stoma position was changed from right to left during the observation period. Therefore, we examined whether stoma sidedness contributed to the development of SOO.

Furthermore, we retrospectively calculated the thickness of the rectus abdominis muscle and the subcutaneous fat from the skin to the rectus abdominis muscle surface at the umbilical level using the axial view of the preoperative CT scan.

Moreover, we identified the patients who repeatedly developed SOO within the SOO group to identify the risk factors for repeated SOO.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 24 (IBM Corp., Armonk, NY, United States). Chi-square or Fisher's exact tests were used to compare categorical variables, while the Mann-Whitney *U* test was used to compare continuous variables. ORs and 95%CIs were calculated in a multivariate logistic regression analysis. Variables with a P value < 0.05 in the univariate analysis were included in the multivariate analysis. P values < 0.05 in the multivariate analysis were considered statistically significant.

RESULTS

Eighty-nine patients who underwent RPC with IPAA (*i.e.*, two-stage RPC) were included; one patient underwent colectomy with ileorectal anastomosis, 10 patients underwent colectomy with end ileostomy (*i.e.*, the first stage of three-stage RPC), 46 patients underwent proctocolectomy with permanent end ileostomy, and two patients underwent proctectomy with end ileostomy (*i.e.*, patients in whom the anus could not be preserved in the second stage of two-stage surgery). The patient characteristics, operative details and outcomes, and CT measurements are shown in Tables 1 and 2.

SOO occurred in 25 (16.9%) patients. The median time to primary SOO was 9 d (range: 2-26) after surgery. In the non-SOO group, 17 cases presented with SBO symptoms. Of these, two were diagnosed with SBO, and six were diagnosed with ileus by CT only. CT was not performed, and it was not possible to distinguish between SBO, ileus, and SOO in nine of these patients. Therefore, these nine cases were included in the non-SOO group based on the definition of SOO in this study.

In 92 of the 148 cases, we were able to inspect the intraperitoneal cavity (such as during second-stage surgery, including stoma reversal) during the follow-up period. In the SOO group, adhesions below the ileostomy were observed in seven cases, but no significant difference was observed compared with the non-SOO group. In addition, there were no cases of ileum torsion around the ileostomy in either group.

Compared to patients without SOO, patients with SOO had a significantly higher rate of malignant tumors or dysplasia (36.0% *vs* 17.1%, $P = 0.032$), a lower total glucocorticoid dose one month before surgery [0 mg (range 0-765 mg) *vs* 0 mg (range 0-1720 mg), $P = 0.026$], a higher preoperative total protein level (6.8 g/dL *vs* 6.3 g/dL, $P = 0.048$), a higher rate of loop ileostomy (88.0% *vs* 55.3%, $P = 0.002$), and a higher maximum stoma drainage volume (2300 mL *vs* 1690 mL, $P = 0.004$) in the univariate analysis (Tables 1 and 2). In the multivariate analysis, loop ileostomy (OR = 6.361; 95%CI 1.322-30.611; $P = 0.021$) and maximum stoma drainage volume (OR = 1.000; 95%CI 1.000-1.001; $P = 0.015$) were detected as independent risk factors for SOO (Table 3).

Patient characteristics are compared between the two stoma sides with IPAA in Tables 4 and 5. There were significant differences in the BMI, disease duration, preoperative white blood cell counts, and distance from the pouch to the stoma, but no significant differences in SOO development and other complications.

Two different patterns in the clinical course were observed in the 25 patients in the SOO group. Among them, 18 did not suffer a recurrence after their obstructive symptoms had been relieved by either insertion of a decompression tube through the stoma or nasogastric tubing and intravenous fluid resuscitation (sSOO group). However, seven (28.0%) had recurring SOO during the observation period (rSOO group). In the univariate analysis, a significant difference in the rectus abdominis muscle thickness was observed between the two groups (sSOO 9.3 mm, rSOO 12.7 mm, $P = 0.006$) (Tables 6 and 7). Rectus abdominis muscle thickness was an independent factor for recurring SOO in the multivariate analysis (OR = 2.676; 95%CI 1.176-4.300; $P = 0.008$) (Table 8).

DISCUSSION

In this retrospective study, we investigated the risk factors for SOO after stoma surgery in patients with UC. High maximum stoma drainage volume and loop ileostomy were independent risk factors for the development of SOO. Moreover, we found that SOO may recur in patients with thick rectus abdominis muscles.

Stoma-related complications include parastomal dermatitis, SBO, stoma prolapse, parastomal hernia, and stoma retraction[12]. The incidence of stoma-related complications varies from 39% to 76% in studies[13-15]. It has further been reported that inflammatory bowel disease has many stoma-related complications[16].

The procedure for creating a stoma in our study is not a globally standardized method. We found five cases (0.03%) of ileostomy prolapse and five cases (0.03%) of an incisional peristomal hernia during the observation period. There was no impression that there were more stoma-related complications compared to the standardized procedure. In addition, no particular complications were observed during stoma reversal in these patients.

With regard to stoma-related complications, SBO requires special attention as it makes it impossible for the patient to eat, and it sometimes requires re-operation if relief is not obtained with conservative treatment. In SBO, SOO with stenosis just

Table 1 Patient characteristics in the compared groups

	Overall (*n* = 148)	SOO (+) (*n* = 25)	SOO (-) (*n* = 123)	*P* value
Age[1] (yr), (range)	48 (13-84)	50 (13-77)	48 (14-84)	0.614
Gender				
Male	95 (64.2%)	18 (72.0%)	77 (62.6%)	0.372
Female	53 (35.8%)	7 (28.0%)	46 (37.4%)	
Indication for surgery				
Medical intractability	118 (79.7%)	16 (64.0%)	102 (82.9%)	0.032
Malignancy or dysplasia	30 (20.3%)	9 (36.0%)	21 (17.1%)	
BMI[1] (kg/m^2), (range)	20.1 (11.7-36.1)	19.8 (14.8-25.5)	20.3 (11.7-36.1)	0.634
Mayo endoscopic score[1] (range)	3 (0-3)	2 (0-3)	3 (0-3)	0.186
Extent of disease				
Pancolitis	137 (92.6%)	24 (96.0%)	113 (91.9%)	0.691
Left-sided colitis	11 (7.4%)	1 (4.0%)	10 (8.1%)	
Proctitis	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Disease duration[1], (mo), (range)	33 (0-413)	40.5 (3-336)	33 (0-413)	0.535
Disease severity				
Mild	25 (16.9%)	6 (24.0%)	19 (15.4%)	0.341
Moderate	71 (48.0%)	14 (56.0%)	57 (46.3%)	
Severe	38 (25.7%)	4 (16.0%)	34 (27.6%)	
Fulminant	14 (9.5%)	1 (4.0%)	13 (10.6%)	
Total glucocorticoid dose from onset of UC to surgery[2]				
10000 mg or more	9 (7.3%)	2 (10.0%)	7 (6.7%)	0.637
Less than 10000 mg	115 (92.7%)	18 (90.0%)	97 (93.3%)	
Total glucocorticoid dose 1 mo before surgery[1] (mg), (range)	0 (0-1720)	0 (0-765)	0 (0-1720)	0.026
Preoperative total protein level[1] (g/dL), (range)	6.4 (2.5-9.3)	6.8 (4.5-9.3)	6.3 (2.5-8.6)	0.048
Preoperative albumin level[1] (g/dL), (range)	3.2 (1.4-4.9)	3.6 (2.0-4.6)	3.1 (1.4-4.9)	0.203
Preoperative white blood cell count[1] (cells/μL), (range)	7455 (1850-20080)	7500 (2660-16670)	7450 (1850-20080)	0.543
Preoperative C-reactive protein level[1] (mg/dL), (range)	1.4 (0.0-32.4)	1.1 (0.0-8.8)	1.57 (0.0-32.4)	0.335
Onodera Prognostic Nutritional index[1] (range)	37.8 (15.9-57.5)	39.3 (29.2-56.9)	37.6 (15.9-57.5)	0.274

[1]Variables are indicated by median.
[2]Variable is unknown in 24 patients. BMI: Body mass index; UC: Ulcerative colitis.

below the stoma site can occur. Although this has previously been reported as SBO caused by an ileal fistula after total colectomy for UC[17], the number of non-UC patients with SOO is increasing due to the higher frequency of performing diverting ileostomy in surgery for rectal cancer[18,19]. However, there are still no clear diagnostic criteria for SOO, and it is difficult to distinguish SOO from SBO based on the clinical evaluation and symptoms alone. Therefore, CT imaging is required for diagnosis to confirm SBO with stenosis just below the stoma. In this study, we used these signs on CT images as diagnostic criteria.

A few studies have implied that a diverting stoma reduced the leakage risk in surgery for rectal cancer[20,21]. Although a similar report has been published in UC[9], other studies found that the leakage risk is not influenced by a stoma in surgery for UC[22,23]. Moreover, it has been shown that one-stage RPC is possible in selected patients[7] and that a diverting ileostomy may not be necessary in UC. However, many patients who need surgery for UC receive high-dose glucocorticoids and immunosuppressants and are undernourished. Therefore, they have a high risk of

Table 2 Operative details and outcomes and computed tomography measurements in the compared groups

	Overall (*n* = 148)	SOO (+) (*n* = 25)	SOO (-) (*n* = 123)	*P* value
Surgical approach				
Laparoscopy	146 (98.6%)	25 (100.0%)	121 (98.4%)	1.000
Open	2 (1.4%)	0 (0.0%)	2 (1.6%)	
Site of stoma				
Right	85 (57.4%)	10 (40.0%)	75 (61.0%)	0.053
Left	63 (42.6%)	15 (60.0%)	48 (39.0%)	
Type of stoma				
End	58 (39.2%)	3 (12.0%)	55 (44.7%)	0.002
Loop	90 (60.8%)	22 (88.0%)	68 (55.3%)	
Operative time[1] (min), (range)	346 (208-631)	339 (234-595)	347 (208-631)	0.890
Intraoperative bleeding[1] (mL), (range)	73.5 (4-1316)	51 (5-811)	80 (4-1316)	0.310
Maximum stoma drainage volume[1] (mL), (range)	1800 (150-7800)	2300 (450-5230)	1690 (150-7800)	0.004
Days from surgery to maximum stoma drainage volume[1] (d), (range)	6 (1-22)	8 (2-21)	4 (1-22)	0.326
Adhesions below the ileostomy[2]				
Yes	21 (22.8%)	7 (35.0%)	14 (19.4%)	0.123
None	71 (77.2%)	13 (65.0%)	58 (80.6%)	
Rectus abdominal muscle thickness at umbilical level[1] (mm), (range)	9.6 (3.6-15.7)	10.4 (6.1-14.2)	9.6 (3.6-15.7)	0.189
Subcutaneous fat thickness at umbilical level[1] (mm), (range)	15.5 (2.4-52.3)	11.6 (6.6-36.0)	16.3 (2.4-52.3)	0.051

[1]Variables are indicated by median.
[2]Variable is unknown in 56 patients.

Table 3 Multivariate analysis of risk factors associated with stoma outlet obstruction

Factor	Odds ratio	95%CI		*P* value
		Lower	Upper	
Malignancy or dysplasia	0.558	0.156	1.991	0.369
Total glucocorticoid dose 1 mo before surgery	0.998	0.995	1.001	0.244
Preoperative total protein level	1.220	0.686	2.168	0.499
Loop ileostomy	7.315	1.514	35.332	0.013
Maximum stoma drainage volume	1.000	1.000	1.001	0.035

leakage. Anastomotic leakage may cause a pelvic abscess and pouch failure and can be fatal. For these reasons, we consider a diverting ileostomy necessary in surgery for UC and, thus, perform it routinely at our institution.

The causes of SOO have been reported to include torsion, adhesions around the abdominal wall, or stenosis of the ileum where it penetrates the abdominal wall[18,24]. In this study, it was difficult to assess these aspects because CT imaging was not performed for patients who did not have SBO, and we could not compare between the two groups. However, there was no significant difference in the occurrence of adhesions or torsion between the two groups in the cases in which intraperitoneal inspection or CT could be performed. It is unlikely that SOO developed due to stenosis since all our patients had an approximately 3 cm incision at the initiation of stoma surgery. However, if an ileostomy is constructed under the condition of a pneumoperitoneum, it may actually be installed obliquely even if the surgeon intends to create it perpendicular to the abdominal wall due to the bowel loop[25,26]. As a result, the gap between the skin and the abdominal wall may cause a shutter mechanism, resulting in stenosis of the ileum within the abdominal wall. Therefore, it has been

Table 4 Patients characteristics in relation to stoma sidedness with ileal pouch-anal anastomosis

	Overall (*n* = 90)	Right side (*n* = 31)	Left side (*n* = 59)	*P* value
Age[1] (yr), (range)	41 (13-71)	41 (14-71)	41 (13-67)	0.690
Gender				
Male	54 (60.0%)	17 (54.8%)	37 (62.7%)	0.469
Female	36 (40.0%)	14 (45.2%)	22 (37.3%)	
Indication for surgery				
Medical intractability	72 (80.0%)	26 (83.9%)	46 (78.0%)	0.506
Malignancy or dysplasia	18 (20.0%)	5 (16.1%)	13 (22.0%)	
BMI[1] (kg/m^2), (range)	19.8 (13.9-36.1)	21.8 (16.0-27.8)	19.3 (13.9-36.1)	0.023
Mayo endoscopic score[1] (range)	3 (0-3)	3 (0-3)	3 (0-3)	0.878
Extent of disease				
Pancolitis	84 (93.3%)	29 (93.5%)	55 (93.2%)	0.662
Left-sided colitis	6 (6.7%)	2 (6.5%)	4 (6.8%)	
Proctitis	0	0	0	
Disease duration[1] (mo), (range)	38 (1-336)	21 (1-252)	56 (1-336)	0.016
Disease severity				
Mild	17 (18.9%)	6 (19.4%)	11 (18.6%)	0.471
Moderate	44 (48.9%)	12 (38.7%)	32 (54.2%)	
Severe	21 (23.3%)	9 (29.0%)	12 (20.3%)	
Fulminant	8 (8.9%)	4 (12.9%)	4 (6.8%)	
Total glucocorticoid dose from onset of UC to surgery[2]				
10000 mg or more	7 (9.3%)	2 (8.7%)	5 (9.4%)	0.644
Less than 10000 mg	69 (90.7%)	21 (91.3%)	48 (90.6%)	
Total glucocorticoid dose 1 mo before surgery[1] (mg), (range)	0 (0-1000)	0 (0-595)	0 (0-1000)	0.955
Preoperative total protein level[1] (g/dL), (range)	6.45 (4.2-9.3)	6.4 (4.2-8.5)	6.45 (4.2-9.3)	0.919
Preoperative albumin level[1] (g/dL), (range)	3.45 (1.8-4.9)	3.6 (2.1-4.8)	3.4 (1.8-4.9)	0.586
Preoperative white blood cell count[1] (cells/μL), (range)	7315 (2660-20080)	6120 (2660-10630)	8770 (2850-20080)	< 0.001
Preoperative C-reactive protein level[1] (mg/dL), (range)	0.78 (0.01-17.41)	0.48 (0.01-8.78)	1.06 (0.02-17.41)	0.155
Onodera Prognostic Nutritional index[1] (range)	41.4 (22.2-57.5)	39.6 (24.7-57.5)	42.0 (22.2-57.5)	0.977

[1]Variables are indicated by median.
[2]Variable is unknown in 14 patients. BMI: Body mass index; UC: Ulcerative colitis.

recommended that the pneumoperitoneum should be deflated before constructing the ileostomy[27]. Laparoscopic surgery has been reported to be a risk factor for SOO[28], and it is hypothesized that this results from the described technical difficulties during the ileostomy.

Previous studies have also found that subcutaneous fat and thickness of the rectus abdominis muscle are risk factors for SOO[19,29]. In this study, there was no significant difference in these factors at the umbilicus level between patients with and without SOO. We assume this is because the ileostomy construction technique at our institution entails removing as much subcutaneous fat as possible, and the fascia to the peritoneum is ligated and then sutured to the ileum. Our procedure reduces both the subcutaneous fat and muscle thickness, thus preventing SOO.

Some authors described a cruciate incision of the rectus fascia and a distance from the anastomosis to the stoma of 30 cm or less as risk factors for SOO[28,30]. In the patients included in this study, the fascia was incised longitudinally, and the distance from the anastomosis to the stoma was at least 30 cm. Thus, we could not determine the

Table 5 Operative details and outcomes and computed tomography measurements in relation to stoma sidedness with ileal pouch-anal anastomosis

	Overall (*n* = 90)	Right side (*n* = 31)	Left side (*n* = 59)	*P* value
Surgical approach				
Laparoscopy	89 (98.9%)	30 (96.8%)	59 (100%)	0.344
Open	1 (1.1%)	1 (3.2%)	0	
Operative time[1] (min), (range)	346 (222-631)	347 (227-487)	339 (222-631)	0.393
Intraoperative bleeding[1] (mL), (range)	61.5 (5-741)	52 (5-337)	63 (5-741)	0.959
Maximum stoma drainage volume[1] (mL), (range)	2000 (150-5230)	1900 (150-4600)	2000 (400-5230)	0.577
Days from surgery to maximum stoma drainage volume[1] (d), (range)	6 (1-21)	6 (1-21)	6 (1-14)	0.051
Rectus abdominal muscle thickness at umbilical level[1] (mm), (range)	9.8 (5.7-15.7)	10.65 (6.3-13.6)	9.5 (5.7-15.7)	0.228
Subcutaneous fat thickness at umbilical level[1] (mm), (range)	15.7 (2.9-52.3)	16.9 (7.2-42.5)	13.8 (2.9-52.3)	0.058
Stoma outlet obstruction				
Yes	22 (24.4%)	8 (25.8%)	14 (23.7%)	0.827
None	68 (75.6%)	23 (74.2%)	45 (76.3%)	
Distance from pouch to stoma (cm), (range)	30 (30-50)	30 (30-50)	40 (30-50)	< 0.001
IPAA dehiscence				
Yes	6 (6.7%)	0	6 (10.2%)	0.072
None	84 (93.3%)	31 (100%)	53 (89.8%)	
Postoperative complications (Clavien-Dindo classification)				
Grade 1 or less	47 (52.2%)	15 (48.4%)	32 (54.2%)	0.598
Grade 2 or higher	43 (47.8%)	16 (51.6%)	27 (45.8%)	

[1]Variables are indicated by median.

influence of these factors. Hisamitsu *et al*[31] reported that a high-output stoma is a risk factor for SOO and distinguished two types of SOOs: Those with large and those with small stoma drainage volumes. The author describes that high output causes relative stenosis at the stoma site. The large intestine is responsible for 5%-10% of water reabsorption within the intestinal tract. In an ileostomy, the stoma drainage volume increases because this reabsorption from the large intestine is eliminated. Depending on the individual, electrolyte abnormalities or dehydration may occur due to the loss of water. Additionally, the small intestine has an estimated internal pressure of approximately 9-10 cmH_2O, which is lower than that of the large intestine[32]. Therefore, it is expected that external pressure may easily affect the internal pressure in the ileum, particularly where it enters the abdominal wall. In this situation, because of the large drainage volume, high-output stoma cause passage obstructions in the abdominal wall, and this can result in SOO, even without apparent stenosis. This is believed to be one of the reasons why ileostomy results more frequently in SOOs than colostomy[33].

A high-output stoma was also an independent risk factor for SOO in our study. Since there was no significant difference in the surgical procedures and rectus abdominis muscle/subcutaneous fat thickness, we consider a relative obstruction of the stoma caused by the high output as one of the causes of SOO. Thus, determining how to control a high-output stoma is important in preventing SOO. Many patients with UC have a history of malnutrition, and their body fluid tends to shift extracellularly and extravascularly after surgical interventions. This results in edema of the mucosa of the small intestine, and further suppression of water reabsorption is thought to cause high-output stoma more easily. To prevent this, it is important to limit postoperative fluid and to administer albumin and diuretics. In some cases, temporary glucocorticoid administration may be used to reduce edema of the intestinal mucosa.

Table 6 Patient characteristics in the stoma outlet obstruction group

	sSOO (*n* = 18)	rSOO (*n* = 7)	*P* value
Age[1] (yr), (range)	50.5 (13-77)	50 (16-71)	0.745
Gender			
Male	6 (33.3%)	6 (85.7%)	0.337
Female	12 (66.7%)	1 (14.3%)	
Indication for surgery			
Medical intractability	12 (66.7%)	4 (57.1%)	0.499
Malignancy or dysplasia	6 (33.3%)	3 (42.9%)	
BMI[1] (kg/m^2), (range)	18.9 (14.8-25.5)	21.8 (19.0-24.2)	0.158
Mayo endoscopic score[1] (range)	2 (0-3)	2 (0-3)	0.657
Extent of disease			
Pancolitis	17 (94.4%)	7 (100.0%)	0.720
Left-sided colitis	1 (5.6%)	0 (0.0%)	
Proctitis	0 (0.0%)	0 (0.0%)	
Disease duration[1] (mo), (range)	40.5 (3-336)	49 (15-108)	0.923
Disease severity			
Mild	5 (27.8%)	1 (14.3%)	0.141
Moderate	11 (61.1%)	3 (42.9%)	
Severe	1 (5.6%)	3 (42.9%)	
Fulminant	1 (5.6%)	0 (0.0%)	
Total glucocorticoid dose from onset of UC to surgery[2]			
10000 mg or more	1	1	0.521
Less than 10000 mg	13	5	
Total glucocorticoid dose 1 mo before surgery[1] (mg), (range)	0 (0-765)	0 (0-280)	0.745
Preoperative total protein level[1] (g/dL), (range)	6.8 (4.8-9.3)	6.8 (4.5-8.1)	0.745
Preoperative albumin level[1] (g/dL), (range)	3.5 (2.0-4.6)	4.2 (2.3-4.6)	0.657

[1]Variables are indicated by median.
[2]Variable is unknown in 5 patients.

There were two types of SOO in this study: One in which SOO improved under conservative treatment without subsequent problems, and the other in which SOO recurred. The rectus abdominis was significantly thicker in the rSOO group than in the sSOO group, and this was an independent risk factor for SOO recurrence. In both types, a high-output stoma was a risk factor for SOO, and fluid management was important. However, in patients with a thick rectus abdominis, SOO recurred, even if the high output of the stoma had been controlled. As a result, re-operation was required in six patients at our institution because the patients' quality of life was markedly reduced by frequent SOO recurrence. Based on the findings from a report, the rectus abdominis thickness is a risk factor for SOO. Constructing the stoma at the lateral edge of the rectus abdominis muscle when the muscle was more than 10 mm thick led to an improved condition and was thus recognized as a preventative method[27]. In patients with a rectus abdominis thickness of more than 1 cm, the stoma construction method should be adopted accordingly.

A loop ileostomy was also an independent risk factor for SOO in our patients, similar to the findings from a previous study. Although we could not confirm this, a previous study[30] found that the twisting of the mesentery in a loop ileostomy is greater than in an end ileostomy. Therefore, ensuring correct positioning of the ileum when elevating it is important. An alternative option may be to avoid loop ileostomies altogether.

Table 7 Operative details and outcomes and computed tomography measurements in the stoma outlet obstruction group

	sSOO (*n* = 18)	rSOO (*n* = 7)	*P* value
Surgical approach			
Laparoscopy	18 (100.0%)	7 (100.0%)	
Open	0 (0.0%)	0 (0.0%)	
Site of stoma			
Right	6 (33.3%)	4 (57.1%)	0.261
Left	12 (66.7%)	3 (42.9%)	
Type of stoma			
End	3 (16.7%)	0 (0.0%)	0.355
Loop	15 (83.3%)	7 (100.0%)	
Operative time[1] (min), (range)	333 (234-595)	345 (258-441)	0.929
Intraoperative bleeding[1] (mL), (range)	56.5 (5-811)	51 (20-78)	0.495
Maximum stoma drainage volume[1] (mL), (range)	2250 (450-5230)	2660 (800-4600)	0.492
Rectus abdominal muscle thickness at umbilical level[1] (mm), (range)	9.3 (6.1-13.3)	12.7 (8.9-14.2)	0.006
Subcutaneous fat thickness at umbilical level[1] (mm), (range)	11.5 (6.6-36.0)	11.6 (7.3-20.4)	0.836

[1]Variables are indicated by median.

Table 8 Multivariate analysis of the risk factors for repeated stoma outlet obstruction

Factor	Odds ratio	95%CI		*P* value
		Lower	Upper	
Rectus abdominal muscle thickness at umbilical level	2.249	1.176	4.300	0.014

Recently, an increasing number of studies compared modified two-stage RPC with traditional two-stage RPC[34,35]. One of these studies concluded that modified RPC did not influence the risk of an anastomotic leak, which was associated with more severe UC[34]. Modified two-stage RPC is a surgical procedure in which subtotal colectomy and end ileostomy are performed in the first stage, and IPAA and stoma reversal are performed in the second stage after a patient's general condition has improved. With this method, a loop ileostomy, which is a risk factor for SOO, can be avoided.

Our results should be interpreted within the limitations of this study. This was a retrospective study in a small number of patients at a single institution. Eighty-nine patients were included, which may not be sufficient to generalize our findings. Therefore, other risk factors for SOO may exist. The diagnosis of SOO required CT imaging. Thus, clinically suspicious patients who did not undergo CT may have been included in the non-SOO group. Finally, the standard stoma site changed during the study period, which may have affected SOO occurrence due to different twisting of the mesentery. Future prospective studies with a larger sample size are required to clarify the risk factors for SOO.

CONCLUSION

In conclusion, high stoma drainage volume and loop ileostomy were independent risk factors for SOO in our UC patients. In patients with thick rectus abdominis muscles, SOO may recur regardless of initial improvement. Surgeons should be aware of the importance of fluid management and carefully choose the stoma position in patients with thick rectus abdominis muscles to prevent SOO recurrence. Finally, there is a need to develop alternative surgical procedures to avoid loop ileostomy.

ARTICLE HIGHLIGHTS

Research background

The standard procedure for ulcerative colitis (UC) is restorative proctocolectomy with ileal pouch-anal anastomosis, and it is common to perform two- or three-stage restorative proctocolectomy with diverting ileostomy.

Research motivation

Stoma outlet obstruction (SOO) often occurs after surgery for UC but its causes are not well known.

Research objectives

To identify the risk factors for SOO after stoma surgery in patients with UC.

Research methods

A retrospective study of 148 UC patients. Univariate and multivariate analyses were performed to identify risk factors for SOO and recurring SOO.

Research results

SOO occurred in 25 (16.9%) patients. In the multivariate analysis, loop ileostomy (OR = 6.361; 95%CI 1.322-30.611; P = 0.021) and maximum stoma drainage volume (OR = 1.000; 95%CI 1.000-1.001; P = 0.015) were found to be independent risk factors for SOO. Among the 25 patients with SOO, seven (28.0%) patients repeatedly developed SOO during the period of observation. Rectus abdominis muscle thickness was an independent risk factor for recurring SOO (OR = 2.676; 95%CI 1.176-4.300; P = 0.008).

Research conclusions

High maximum stoma drainage volume and loop ileostomy were independent risk factors for SOO in this study. In patients with a thick rectus abdominis muscle, the risk of SOO recurrence is high.

Research perspectives

Surgeons should be aware of the importance of fluid management and careful selection of the stoma position in patients with thick rectus abdominis muscles to prevent SOO recurrence. Alternative surgical procedures that can avoid loop ileostomy are required.

REFERENCES

1 **Japan Intractable Diseases Information Center**. Annual report 2012-2016. Available from: http://www.nanbyou.or.jp/entry/62

2 **Ng SC**, Shi HY, Hamidi N, Underwood FE, Tang W, Benchimol EI, Panaccione R, Ghosh S, Wu JCY, Chan FKL, Sung JJY, Kaplan GG. Worldwide incidence and prevalence of inflammatory bowel disease in the 21st century: a systematic review of population-based studies. *Lancet* 2018; **390**: 2769-2778 [PMID: 29050646 DOI: 10.1016/S0140-6736(17)32448-0]

3 **Neumann PA**, Mennigen RB, Senninger N, Bruewer M, Rijcken E. Timing of restorative proctocolectomy in patients with medically refractory ulcerative colitis: the patient's point of view. *Dis Colon Rectum* 2012; **55**: 756-761 [PMID: 22706127 DOI: 10.1097/DCR.0b013e318251e004]

4 **Windsor A**, Michetti P, Bemelman W, Ghosh S. The positioning of colectomy in the treatment of ulcerative colitis in the era of biologic therapy. *Inflamm Bowel Dis* 2013; **19**: 2695-2703 [PMID: 23846487 DOI: 10.1097/MIB.0b013e318292fae6]

5 **Xu W**, Ye H, Zhu Y, Ding W, Fu J, Cui L, Du P. Long-term quality of life associated with early surgical complications in patients with ulcerative colitis after ileal pouch-anal anastomosis: A single-center retrospective study. *Int J Surg* 2017; **48**: 174-179 [PMID: 29104126 DOI: 10.1016/j.ijsu.2017.10.070]

6 **Parks AG**, Nicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. *Br Med J* 1978; **2**: 85-88 [PMID: 667572 DOI: 10.1136/bmj.2.6130.85]

7 **Ikeuchi H**, Nakano H, Uchino M, Nakamura M, Noda M, Yanagi H, Yamamura T. Safety of one-stage restorative proctocolectomy for ulcerative colitis. *Dis Colon Rectum* 2005; **48**: 1550-1555 [PMID: 15937613 DOI: 10.1007/s10350-005-0083-z]

8 **Heuschen UA**, Hinz U, Allemeyer EH, Lucas M, Heuschen G, Herfarth C. One- or two-stage procedure for restorative proctocolectomy: rationale for a surgical strategy in ulcerative colitis. *Ann Surg* 2001; **234**: 788-794 [PMID: 11729385 DOI: 10.1097/00000658-200112000-00010]

9 **Weston-Petrides GK**, Lovegrove RE, Tilney HS, Heriot AG, Nicholls RJ, Mortensen NJ, Fazio VW, Tekkis PP. Comparison of outcomes after restorative proctocolectomy with or without defunctioning ileostomy. *Arch Surg* 2008; **143**: 406-412 [PMID: 18427030 DOI: 10.1001/archsurg.143.4.406]

10 **da Luz Moreira A**, Kiran RP, Lavery I. Clinical outcomes of ileorectal anastomosis for ulcerative colitis. *Br J Surg* 2010; **97**: 65-69 [PMID: 20013930 DOI: 10.1002/bjs.6809]

11 **Erwin-Toth P**, Barrett P. Stoma site marking: a primer. *Ostomy Wound Manage* 1997; **43**: 18-22, 24 [PMID: 9205395]

12 **Shabbir J**, Britton DC. Stoma complications: a literature overview. *Colorectal Dis* 2010; **12**: 958-964 [PMID: 19604288 DOI: 10.1111/j.1463-1318.2009.02006.x]

13 **Mäkelä JT**, Turku PH, Laitinen ST. Analysis of late stomal complications following ostomy surgery. *Ann Chir Gynaecol* 1997; **86**: 305-310 [PMID: 9474424]

14 **Leong AP**, Londono-Schimmer EE, Phillips RK. Life-table analysis of stomal complications following ileostomy. *Br J Surg* 1994; **81**: 727-729 [PMID: 8044564 DOI: 10.1002/bjs.1800810536]

15 **Arumugam PJ**, Bevan L, Macdonald L, Watkins AJ, Morgan AR, Beynon J, Carr ND. A prospective audit of stomas--analysis of risk factors and complications and their management. *Colorectal Dis* 2003; **5**: 49-52 [PMID: 12780927 DOI: 10.1046/j.1463-1318.2003.00403.x]

16 **Duchesne JC**, Wang YZ, Weintraub SL, Boyle M, Hunt JP. Stoma complications: a multivariate analysis. *Am Surg* 2002; **68**: 961-966; discussion 966 [PMID: 12455788]

17 **Francois Y**, Dozois RR, Kelly KA, Beart RW Jr, Wolff BG, Pemberton JH, Ilstrup DM. Small intestinal obstruction complicating ileal pouch-anal anastomosis. *Ann Surg* 1989; **209**: 46-50 [PMID: 2535923 DOI: 10.1097/00000658-198901000-00007]

18 **Fujii T**, Morita H, Sutoh T, Yajima R, Tsutsumi S, Asao T, Kuwano H. Outlet Obstruction of Temporary Loop Diverting Ileostomy. *Hepatogastroenterology* 2015; **62**: 602-605 [PMID: 26897937]

19 **Fujii T**, Tsutsumi S, Matsumoto A, Fukasawa T, Tabe Y, Yajima R, Asao T, Kuwano H. Thickness of subcutaneous fat as a strong risk factor for wound infections in elective colorectal surgery: impact of prediction using preoperative CT. *Dig Surg* 2010; **27**: 331-335 [PMID: 20689296 DOI: 10.1159/000297521]

20 **Kang CY**, Halabi WJ, Chaudhry OO, Nguyen V, Pigazzi A, Carmichael JC, Mills S, Stamos MJ. Risk factors for anastomotic leakage after anterior resection for rectal cancer. *JAMA Surg* 2013; **148**: 65-71 [PMID: 22986932 DOI: 10.1001/2013.jamasurg.2]

21 **Ulrich AB**, Seiler C, Rahbari N, Weitz J, Büchler MW. Diverting stoma after low anterior resection: more arguments in favor. *Dis Colon Rectum* 2009; **52**: 412-418 [PMID: 19333040 DOI: 10.1007/DCR.0b013e318197e1b1]

22 **Beyer-Berjot L**, Baumstarck K, Loubière S, Vicaut E, Berdah SV, Benoist S, Lefèvre JH; GETAID Chirurgie group. Is diverting loop ileostomy necessary for completion proctectomy with ileal pouch-anal anastomosis? *BMC Surg* 2019; **19**: 192 [PMID: 31830976 DOI: 10.1186/s12893-019-0657-7]

23 **Sahami S**, Buskens CJ, Fadok TY, Tanis PJ, de Buck van Overstraeten A, Wolthuis AM, Bemelman WA, D'Hoore A. Defunctioning Ileostomy is not Associated with Reduced Leakage in Proctocolectomy and Ileal Pouch Anastomosis Surgeries for IBD. *J Crohns Colitis* 2016; **10**: 779-785 [PMID: 26512136 DOI: 10.1093/ecco-jcc/jjv201]

24 **Ng KH**, Ng DC, Cheung HY, Wong JC, Yau KK, Chung CC, Li MK. Obstructive complications of laparoscopically created defunctioning ileostomy. *Dis Colon Rectum* 2008; **51**: 1664-1668 [PMID: 18536966 DOI: 10.1007/s10350-008-9351-z]

25 **Oliveira L**, Reissman P, Nogueras J, Wexner SD. Laparoscopic creation of stomas. *Surg Endosc* 1997; **11**: 19-23 [PMID: 8994982 DOI: 10.1007/s004649900287]

26 **Liu J**, Bruch HP, Farke S, Nolde J, Schwandner O. Stoma formation for fecal diversion: a plea for the laparoscopic approach. *Tech Coloproctol* 2005; **9**: 9-14 [PMID: 15868492 DOI: 10.1007/s10151-005-0185-6]

27 **Yoshida Y**, Morikawa M, Kurebayashi H, Yokoi S, Koneri K, Murakami M, Hirono Y, Katatama K, Goi T. Risk Factors and Preventive Measures for Outlet Obstruction after Temporary Ileostomy Construction during Rectal Resection. *Nihon Rinsho Geka Gakkai Zasshi* 2018; **79**: 2389-2396

28 **Mizushima T**, Kameyama H, Watanabe K, Kurachi K, Fukushima K, Nezu R, Uchino M, Sugita A, Futami K. Risk factors of small bowel obstruction following total proctocolectomy and ileal pouch anal anastomosis with diverting loop-ileostomy for ulcerative colitis. *Ann Gastroenterol Surg* 2017; **1**: 122-128 [PMID: 29863130 DOI: 10.1002/ags3.12017]

29 **Kanazawa A**, Shiozawa M, Inagaki D, Sugano N, Akaike M, Imada T. A study on postoperative ileus in patients with ileostomy as a diverting stoma after low anterior resection. *Nippon Daicho Komonbyo Gakkai Zasshi* 2009; **62**: 497-501

30 **Uchino M**, Ikeuchi H, Bando T, Matsuoka H, Matsumoto T, Takesue Y, Tomita N. Efficacy of a cross incision at the rectal muscle fascia and ileostomy rotation for prevention of outlet obstruction at the ostomy site in restorative proctocolectomy for ulcerative colitis. *Nippon Daicho Komonbyo Gakkai Zasshi* 2011; **64**: 73-77

31 Hisamitsu K. Postoperative outlet obstruction in patients with ileostomy. *Nippon Daicho Komonbyo Gakkai Zasshi* 2018; **71**: 152-156

32 **FINK S**. The intraluminal pressures in the intact human intestine. *Gastroenterology* 1959; **36**: 661-671 [PMID: 13653288]

33 **Eto K**, Kosuge M, Ohkuma M, Noaki R, Neki K, Ito D, Sugano H, Takeda Y, Yanaga K. Defunctioning Ileostomy Is a Key Risk Factor for Small Bowel Obstruction After Colorectal Cancer Resection. *Anticancer Res* 2018; **38**: 1789-1795 [PMID: 29491118 DOI: 10.21873/anticanres.12417]

34 **Zittan E**, Wong-Chong N, Ma GW, McLeod RS, Silverberg MS, Cohen Z. Modified Two-stage Ileal Pouch-Anal Anastomosis Results in Lower Rate of Anastomotic Leak Compared with Traditional Two-stage Surgery for Ulcerative Colitis. *J Crohns Colitis* 2016; **10**: 766-772 [PMID: 26951468 DOI: 10.1093/ecco-jcc/jjw069]

35 **Samples J**, Evans K, Chaumont N, Strassle P, Sadiq T, Koruda M. Variant Two-Stage Ileal Pouch-Anal Anastomosis: An Innovative and Effective Alternative to Standard Resection in Ulcerative Colitis. *J Am Coll Surg* 2017; **224**: 557-563 [PMID: 28315811 DOI: 10.1016/j.jamcollsurg.2016.12.049]

Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-3991568
E-mail: bpgoffice@wjgnet.com
Help Desk: https://www.f6publishing.com/helpdesk
https://www.wjgnet.com