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Risk Factors for Early Postoperative Small Bowel Obstruction After Colectomy for Colorectal Cancer

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Abstract
Background Small bowel obstruction (SBO) after colectomy leads to markedly lower patient quality of life, longer hospital stays, and increased hospitalization costs. From a systemic treatment point of view, early postoperative SBO is one of the major concerns of the surgery because it often delays chemotherapy in advanced cases. The goal of this single-center study was to evaluate the risk factors for early postoperative SBO.
Methods Univariate and multivariate analyses were performed for 1,004 patients who underwent open colectomy (OC, 421 patients) or laparoscopic-assisted colectomy (LAC, 583 patients) for colorectal cancer between January 1997 and December 2008.
Results The overall early postoperative SBO were 45 cases (4.5%). Univariate analysis of the risk factors for early postoperative SBO showed no statistical significance between respective risk factors and occurrence of SBO for age >70 years, body mass index >25 kg/m^2, ASA score ≥3, pT stage T4, pN stage ≥N1, pM stage M1, or increased blood loss. Multivariate analysis demonstrated that OC (odds ratio (OR), 2.62; 95% confidence interval (CI), 1.34–5.13; $P = 0.005$), and rectal cancer (OR, 2.12; 95% CI, 1.1–4.1; $P = 0.025$) were independent risk factors for postoperative SBO after colectomy for colorectal cancer. Regarding the causes of SBO, paralytic obstruction was more frequent in the LAC group, and adhesive obstruction was more frequent in the OC group.
Conclusions Early postoperative SBO cases are more likely to occur with OC and rectal cancer. LAC is an effective surgical procedure from the perspective of reducing the incidence of early postoperative SBO after colectomy for colorectal cancer.

Introduction

Small bowel obstruction (SBO)—a common postoperative morbidity of colectomy for colorectal cancer [1]—leads to markedly lower patient quality of life, longer hospital stays, and increased hospitalization costs [2]. From a systemic treatment point of view, early postoperative SBO is one of the major concerns of the surgery because it often delays chemotherapy in advanced cases. Therefore, the appearance of early postoperative SBO symptoms is a serious issue because it affects the long-term prognosis of patients with colorectal cancer.

The indications for laparoscopy-assisted colectomy (LAC) have recently expanded because of the benefits of reduced postoperative wound pain, more rapid dietary intake, and shorter hospital stays compared with open colectomy (OC) [3–5]. Some reports indicate that postoperative SBO after LAC is less frequent than after OC [5, 6]. However, most of these studies have involved only a small series of patients with gynecological problems, particularly infertility [7, 8], or were performed with animal models [9, 10].

This study was designed to evaluate the risk factors for early postoperative SBO after colectomy for colorectal cancer from our database, which contains >1,000 colectomy cases over 11 years.

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Patients and methods

Subjects were selected from 1,210 patients with colorectal cancer who underwent colectomy at Iwate Medical University Hospital between January 1997 and December 2008. A total of 206 patients were excluded from present study. Of 206 patients excluded, 64 patients underwent resection of other organs for metastatic or other lesions (e.g., gastric or genitourinary cancers) simultaneously with colectomy. The remaining 142 patients could not undergo curative resection of colorectal cancer due to marked other organs invasion: these risks result in greater blood loss, longer operating time, and higher rates of complications. Overall, we analyzed data from 1,004 patients. Early postoperative SBO that may occur within 30 days after surgery and is defined as a condition requiring following three treatments: fasting, insertion a ileus tube or surgery for ileus symptoms, such as abdominal fullness, nausea, and vomiting. Early postoperative SBO is classified as adhesive, strangulated, or paralytic. In the present study, we defined those take more than 7 days to resume diet after colectomy as paralytic SBO. The time was set at 7 days because the average time for diet resumption after LAC or OC in patients with colorectal cancer at our institution is 4 days. The treatment for patients kept ileus symptoms after fasting was to insert an ileus tube to decompress of the obstructed intestine. Adhesiolysis was performed in patients who showed no improvement 1 week after tube insertion. Emergency resection of the small intestine was performed in one patient diagnosed with strangulated intestinal obstruction. The cause of early postoperative SBO for each patient was determined by physical examination, radiographic image findings from the ileus tube, intraoperative findings, and other means.

One experienced colorectal surgeon performed or assisted all colectomies by both OC and LAC. Laparoscopy-assisted colectomy was performed with carbon dioxide pneumoperitoneum using a five-trocar technique. At the time of tumor resection, the trocar wound at one location was extended to 3–4 cm, and intestinal resection and anastomosis were performed outside the body. Double-stapling technique was used for rectal anastomosis in both LAC and OC. A covering stoma was created and a drain was inserted in case of postoperative anastomotic leak was considered for those with cancer at very low level of the rectum, malnutrition, diabetes mellitus, and immunosuppressant drugs. If the postoperative anastomotic leak was not evident, the drain was removed within 4 days after surgery.

Data were analyzed by using StatView version 5.0 (SAS Institute, Cary, NC, USA). Pearson's chi-square test was used to compare frequencies between groups. Univariate logistic regression was performed to identify factors that were significantly associated with occurrence of SBO. Potential risk factors with $P < 0.05$ on univariate analysis were entered into a multivariate logistic model to establish independent predictors of occurrence of SBO. Final statistical results were considered significant at $P < 0.05$.

Results

We analyzed the information of 1,004 patients who underwent colectomy from our database. Of these patients, 421 (41.9%) and 583 (58.1%) underwent OC and LAC, respectively. Median patient age was 69 (range, 22–94) years; and 56.4% were men. More than half of patients were TNM stage II and III: 28.6 and 28.5%, respectively (Table 1).

The overall early postoperative SBO were 45 cases (4.5%). Table 2 shows the incidence of SBO by risk factors. Ileocecal resection, right hemicolectomy, transverse colectomy, left hemicolectomy, and sigmoid colectomy

Table 1 Characteristics of patients with colectomy for colorectal cancer

Characteristics	No. of patients (%)
Age (years)[a]	69 (22–94)
Sex	
Male	566 (56.4)
Female	438 (43.6)
Tumor location	
Colon	618 (61.6)
Rectum	386 (38.4)
TNM stage	
0	64 (6.4)
I	191 (19)
II	287 (28.6)
III	286 (28.5)
IV	176 (17.5)
Operative procedure	
Open	421 (41.9)
Laparoscopic	583 (58.1)
Operative type	
Ileocecal resection	90 (9)
Right hemicolectomy	176 (17.5)
Transverse colectomy	69 (6.9)
Left hemicolectomy	58 (5.8)
Sigmoid colectomy	208 (20.7)
Anterior rectal resection	301 (30)
Hartmann's procedure	51 (5.1)
Miles' operation	51 (5.1)

TNM tumor node metastasis

[a] Values are median (range)

Table 2 Risk factors of early postoperative SBO after colectomy for colorectal cancer

Variable	No. of patients (%)
Age (years)	
>70	23 (5.1)
≤70	22 (4)
Sex	
Male	32 (6)
Female	13 (2.7)
Body mass index (kg/m^2)	
>25	10 (4.1)
≤25	35 (4.6)
ASA	
1, 2	44 (4.5)
≥3	1 (6.3)
Operative procedure	
Open	31 (8.8)
Laparoscopic	14 (2.4)
Operative type	
Colonic	17 (2.8)
Rectal	28 (7.3)
Tumor size (cm)	
>5	19 (7.1)
≤5	26 (3.5)
pT stage	
≤T3	41 (4.3)
T4	4 (7.4)
pN stage	
N0	23 (3.7)
≥N1	22 (5.8)
pM stage	
M0	38 (4.6)
M1	7 (4.0)
Operating time (min)	
>180	29 (6.1)
≤180	16 (3)
Blood loss (ml)	
>100	20 (6.3)
≤100	25 (3.6)

SBO small-bowel obstruction, *ASA* American Society of Anesthesiologists, *pTNM* pathological tumor node metastasis

were classified as colonic surgery, whereas anterior rectal resection, Hartmann's procedure, and Miles' operation were classified as rectal surgery. The risk factors associated with a high incidence of postoperative SBO were OC (8.8%), pT4 stage (7.4%), rectal surgery (7.3%), tumor size >5 cm, ASA score ≥3 (6.3%), blood loss >100 ml (6.3%), and operating time >180 min (6.1%).

Variables that were potentially associated with postoperative SBO and analyzed in the univariate model are presented in Table 3. Some of the factors that did not reach statistical significance in the univariate analysis were age >70 years, body mass index >25 kg/m^2, ASA score ≥3, pT stage T4, pN stage ≥N1, and pM stage M1.

Table 3 Univariate analysis for risk factors of early postoperative SBO after colectomy for colorectal cancer

Variable	Univariate analysis	
	OR (95% CI)	*P* value
Age > 70 years	1.29 (0.71–2.35)	0.4
Male sex	1.96 (1.02–3.78)	0.04
Body mass index > 25 kg/m^2	1.11 (0.44–1.85)	0.77
ASA score ≥ 3	1.43 (0.19–11.1)	0.73
Open colectomy	3.23 (1.7–6.15)	0.004
Rectal surgery	2.75 (1.49–5.1)	0.001
Tumor size > 5 cm	2.07 (1.13–3.81)	0.02
pT stage T4	1.77 (0.61–5.15)	0.29
pN stage ≥ N1	1.61 (0.89–2.94)	0.12
pM stage M1	1.16 (0.38–1.96)	0.72
Increased operating time	2.07 (1.11–3.86)	0.02
Increased blood loss	1.79 (0.98–3.28)	0.058

SBO small-bowel obstruction, *OR* odds ratio, *CI* confidence interval, *ASA* American Society of Anesthesiologists, *pTNM* pathological tumor node metastasis

Multivariate analysis revealed that OC (odds ratio (OR), 2.62; 95% confidence interval (CI), 1.34–5.13; $P = 0.005$) and rectal cancer (OR, 2.12; 95% CI, 1.1–4.1; $P = 0.025$) were independent risk factors for postoperative SBO (Table 4).

Early postoperative SBO rate was a higher incidence in the OC group (7.4 vs. 2.4%; $P < 0.001$). Regarding the causes of SBO, paralytic obstruction was more frequent in the LAC group, and adhesive obstruction was more frequent in the OC group. No differences were observed between the OC and LAC groups with respect to the treatment method for early postoperative SBO (Table 5).

Discussion

This study is a retrospective investigation into the risk factors for early postoperative SBO after colectomy for colorectal cancer. A randomized, controlled trial (RCT) will be required to draw more accurate conclusions, but it should be noted that the reported incidence of postcolectomy SBO is 5–10.3% [11–13], and even in the present study, it was as low as 4.5%. Therefore, a very large number of patients will be needed to yield satisfactory results in an RCT [14], implying that an RCT at a single institution may be unrealistic. Many surgeons have most noticed in daily clinical practice in which SBO occurs less

Table 4 Multivariate analysis for risk factors of early postoperative SBO after colectomy for colorectal cancer

Variable	Multivariate analysis	
	Adjusted OR (95% CI)	*P* value
Male sex	1.59 (0.81–3.12)	0.18
Rectal cancer	2.12 (1.1–4.1)	0.025
Open colectomy	2.62 (1.34–5.13)	0.005
Tumor size > 5 cm	1.43 (0.75–2.71)	0.28
Increased operating time	1.44 (0.74–2.82)	0.29

SBO small-bowel obstruction, *OR* odds ratio, *CI* confidence interval

Table 5 Causes and treatments of early postoperative SBO after OC and LAC group

	OC group ($n = 31$)	LAC group ($n = 14$)
Cause		
Adhesion	8 (25.8)	1 (7.1)
Strangulation	1 (3.2)	0 (0)
Paralysis	20 (64.5)	12 (85.7)
Unknown	2 (6.5)	1 (7.1)
Treatment		
Fast cure only	18 (58)	8 (57.1)
Placement of long intestinal tube	10 (32.3)	5 (35.7)
Adhesiotomy	2 (6.5)	1 (7.1)
Small intestinal resection	1 (3.2)	0 (0)

SBO small-bowel obstruction, *OC* open colectomy, *LAC* laparoscopy-assisted colectomy

Data are numbers with percentages in *parentheses*

often with LAC than with OC [5, 6]. In this regard, several animal experiment studies have been performed [9, 10]. However, there have been a few reports of studies of SBO after OC and LAC in patients with colorectal cancer [15, 16]. Although our present study is retrospective, we think that it is precious data because we were able to present objective results in regard to the risk factors of postoperative SBO in more than 1,000 patients with colorectal cancer.

One of the unique features of the present study is a multivariate analysis for early postoperative SBO independent risk factors of OC. Interestingly, this analysis showed that OC and rectal cancer had greater associations with postcolectomy SBO than did other patient-, tumor-, or surgery-related factors. In the present study, the tumor-related factors pT, pN, and pM showed no association with the incidence of early postoperative SBO in univariate analysis. In cases of advanced cancer, the extent of resection must be increased according to the depth of cancer invasion or lymph node metastasis. However, the degree of surgical invasiveness resulting from the expanding of resection is lower than from OC or rectal surgery and, therefore, is not considered to be the direct cause of early postoperative SBO. Large tumor size and increased operating time showed positive correlations with early postoperative SBO in univariate analysis, but in multivariate analysis, there was no association with early postoperative SBO compared with those for OC and rectal cancer.

As reported in several animal studies [17–19], postoperative SBO is associated with the local inflammatory reaction induced by surgical manipulation. According to an earlier study [20], it has been reported that local to systemic inflammatory responses are elicited by excessive injury to the body wall and peritoneum by open surgery or manual handling of the intestines, resulting in systemic immune response. On the other hand, the reduction in abdominal wall injury and delicate handling of intestines using laparoscopic devices in LAC seems to reduce the postoperative inflammatory response and to decrease incidence of SBO [15]. In an experiment using pigs, Hiki et al. [21] reported no difference in inflammatory cytokines expression under pneumoperitoneum versus open abdominal manipulations using the same laparoscopic equipment.

Recent long-term investigations into the rates of recurrence and survival after LAC have shown no differences compared with OC [22–24]. The curative rate of LAC has been equal to that of OC, whereas the low invasiveness of LAC does not contribute to long-term patient prognosis. However, with respect to short-term outcomes, such as postoperative morbidities and length of hospital stay, there has been number of reports attesting to the usefulness of LAC [3–5, 25, 26]. In the present study, OC was a major risk factor for early postoperative SBO, which is thought to affect the long-term prognosis of patients with colorectal cancer.

Various factors other than inflammatory responses may play a role in early postoperative SBO, such as postoperative wound pain, walking, intestinal peristalsis, and diet resumption. These factors are thought to contribute to the decreased incidence of SBO. Early postoperative SBO reduces patient quality of life as well as alters consecutive therapies. For instance, SBO leads to delay in introduction of chemotherapy in patients with advanced colorectal cancer. For patients with rectal cancer, which is considered to be a risk factor for postoperative SBO, attention must be paid to the selection of the surgical procedure, taking operating time into account.

In conclusion, early postoperative SBO cases are more likely with OC and rectal cancer. Laparoscopy-assisted colectomy is an effective surgical procedure from the perspective of reducing incidence of early postoperative SBO after colectomy for colorectal cancer.

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