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Original Article

Comparison of laparoscopic versus open surgery in a three-stage operation for obstructive left-sided colorectal cancer

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Abstract

Background: Treatment for obstructive left-sided colorectal cancer (OLCC) typically consists of a three-staged procedure. During the first stage, the obstruction is managed with diversion colostomy. Traditionally in the second stage, we perform open resection for the primary tumor. In this study, we evaluated the feasibility of laparoscopic resection of OLCC with diversion colostomy in terms of operative results and short-term outcomes.

Methods: A total of 20 patients underwent laparoscopic resection for OLCC (study group), 48 patients underwent open resection for OLCC (control group 1), and 53 patients underwent laparoscopic resection for non-OLCC (control group 2). Afterwards, results from the procedures were obtained and clinical data were analyzed.

Results: The operative time was significantly longer in the study group than in the control group 1 (153 minutes vs. 126 minutes, $p = 0.041$), and the length of hospitalization was shorter in the study group than in the control group 1 (5.3 days vs. 7.6 days, $p = 0.032$). Regarding the operative results and short-term outcomes, there were no significant differences between the study group and control group 2. Colostomy retraction was a specific morbidity which occurred in two patients of the study group.

Conclusion: Laparoscopic resection of OLCC with diversion colostomy is feasible. Abdominal cavity adhesion is only limited. We strongly recommend that laparoscopic resection should be performed at least 2 weeks after diversion colostomy, and the plastic rod should be left in place during the pneumoperitoneum to reduce the risk of colostomy retraction.

Keywords: colorectal cancer; laparoscopic; left-sided; obstructive

1. Introduction

Up to 20% of patients with colorectal cancer (CRC) present with symptoms of acute, complete, or partial obstruction.[1–4] It is generally accepted that obstructive right-sided CRC can be treated with right hemicolectomy and ileocolic anastomosis, resolving the obstruction and cancer at the same time.[2] Meanwhile, the optimal treatment for obstructive left-sided colorectal cancer (OLCC) remains controversial.[5–7] However, several options for OLCC are available[8]: (1) diversion colostomy and subsequent resection (two or three-staged procedure); (2) primary resection with anastomosis or without anastomosis (Hartmann's procedure); and (3) colonoscopic stenting by self-expanding metallic stents for palliation or bridge to resection.

In our hospital, the first choice for OLCC is the conventional three-staged procedure. During the first stage, the

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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obstruction is managed with the diversion colostomy. The second stage takes place a few weeks later when the tumor is resected and the colostomy is closed (2-stage procedure) or, alternatively, the colostomy can be closed at a third stage. Traditionally in the second stage, we perform open resection for OLCC. Recently, laparoscopic resection has become an accepted therapeutic option for treating patients with CRC after the publication of large randomized trials that confirmed the safety and oncologic equivalency of this procedure with open resection.[9,10] In patients with diversion colostomy, the concern for laparoscopic surgery is the possibility of abdominal cavity adhesion and bowel distention, which may preclude laparoscopic resection.[11] However, some studies have mentioned that previous abdominal surgery is not a contraindication for laparoscopic CRC surgery.[12–14]

In a review of literature, we found few reports regarding the laparoscopic resection of OLCC with diversion colostomy. Therefore, in this retrospective study, we evaluated the feasibility of laparoscopic resection in this group of patients in terms of operative results and short-term outcomes.

2. Methods

We conducted a retrospective case-control study by reviewing the charts of patients with OLCC between January 2005 and December 2013 at Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan consecutively. Ultimately, a total of 109 patients were enrolled. Patients receiving only diversion colostomy ($n = 11$), one-staged resection of tumor without diversion colostomy ($n = 9$), neoadjuvant concurrent chemoradiation therapy for middle to lower rectal cancer ($n = 8$), stage IV with unresectable metastasis ($n = 7$), or poor performance status with an Eastern Cooperative Oncology Group score > 3 ($n = 6$) were excluded from this study. All the patients included in this study first received diversion colostomy followed by resection of the obstructive tumor.

We performed traditional open resection and a total of 48 patients were initially enrolled (control group 1). After January 2010, we began performing the laparoscopic resections and a total of 20 patients were enrolled (study group 1). During the same period (from January 2010 to December 2013), those patients with nonobstructive left-sided CRC receiving laparoscopic resection were also included and a total of 53 patients were enrolled (control group 2).

2.1. Surgical technique

We performed diversion colostomy over the proximal transverse colon in most of the cases (Figs. 1A and 1B). In some cases with obstructive tumor over the splenic flexure or descending colon, we performed diversion colostomy over distal transverse colon due to the possibility of simultaneous resection of primary tumor and colostomy. After the colostomy was exteriorized, we routinely inserted a plastic rod through the mesentery to ensure a complete diversion of stool and to avoid colostomy retraction (Fig. 1C). Resection of the OLCC was performed 10–20 days after diversion colostomy.[15]

Whether the procedure involved open or laparoscopic resection, the same no-touch isolation technique and the so-called ''medial-to-lateral'' approach was performed. The dissection begins with high ligation of the inferior mesenteric artery at its origin from the aorta. The sigmoid colon and rectum is then mobilized as far down as possible on its posterior and right lateral surfaces before opening the anterior rectal space from the right to the left, extending from the Pouch of Douglas. Anastomosis is then performed by using

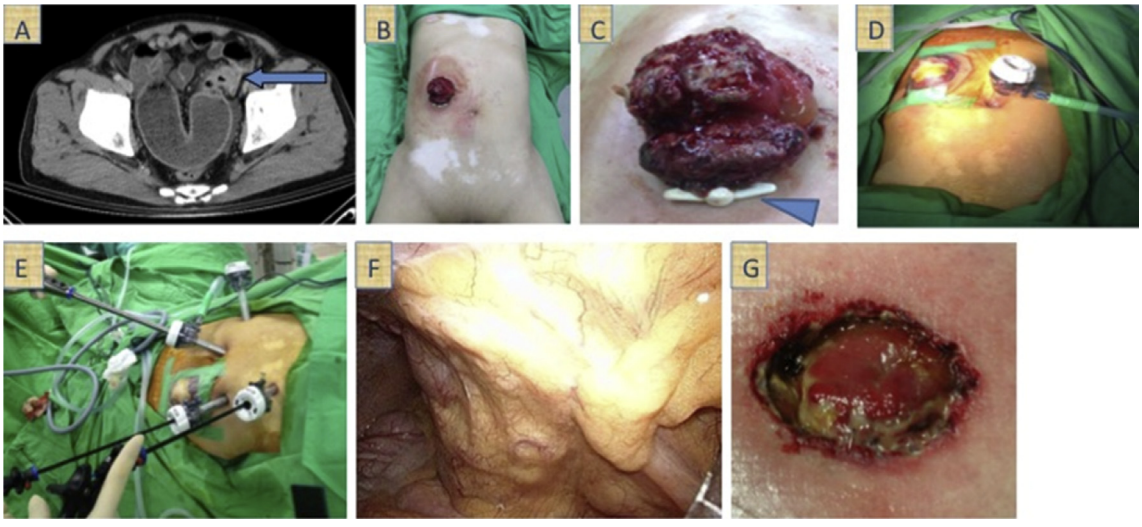

Fig. 1. (A) A 60-year-old man presented with obstructive sigmoid colon on a computed tomography scan (arrow); (B) loop colostomy was created over the proximal transverse colon at the right upper quadrant of abdomen; (C,D) laparoscopic resection was performed 2 weeks later after loop colostomy. The plastic rod (arrowhead) should be left in place to avoid colostomy retraction during pneumoperitoneum; (E) after well-draping of the colostomy, pneumoperitoneum and trocar insertion could be created safely during the laparoscopic surgery; (F) only limited adhesions around the colostomy; and (G) colostomy retraction during the laparoscopic resection.

either the hand-sewn method in the left hemicolectomy and subtotal colectomy, or the standard double-stapling method in the anterior resection or the low anterior resection.

Patients undergoing laparoscopic left-sided colorectal surgery were placed in the Trendelenburg position (30°). The surgeon stood to the patient's right side, the first assistant stood to the surgeon's left side, and the second assistant stood to the patient's left side. Our laparoscopic approach for OLCC has been standardized as follows: after the colostomy is well-draped (Fig. 1D), a pneumoperitoneum (around 12–14 mmHg) was created using a conventional open method[16] over the umbilical incision (12 mm) and the following ports were inserted: one in the right abdomen (12 mm), one in the right iliac fossa (12 mm), and one in the left abdomen (12 mm) (Fig. 1E). When necessary, a fifth (12 mm) port was inserted into the left iliac fossa. Splenic flexure take-down was routinely performed. In cases involving low anterior resection, the anastomosis is performed using standard double-stapling techniques. Patients undergoing anterior resection, left hemicolectomy, or subtotal colectomy, received a small mini-incision over the umbilicus for removal of the specimen and extracorporeal anastomosis. In this study, all the laparoscopic surgery was performed by the same surgeon.

The patients' clinical characteristics, including age, sex, tumor location, site of diversion colostomy creation, previous abdominal operation, preoperative carcinoembryonic antigen (CEA) level (ng/mL), perioperative albumin level (ng/dL), and clinical TNM stage were collected. The parameters for operative results and short-term outcomes included procedure name, body mass index (BMI), number of lymph nodes retrieved, operative time, blood loss, blood transfusion required, conversion to open surgery, postoperative mortality, operative morbidity, time to flatus, diet, and length of hospitalization. Operative time was defined as the time between the first skin incision and completion of wound closure. Conversion to open surgery was defined as an incision > 10 cm. We believe that extending the length of an incision to > 10 cm should be considered conversion. In our experience, most laparoscopic patients require incisions measuring ~ 5 cm and almost never > 10 cm in order to retrieve the specimen.[17] In our hospital, oral intake of water was started when flatus onset was noted in the ostomy bag and if there was no abdominal discomfort. The oral intake of a normal diet was started when the patient reported no discomfort after oral intake of water for at least 1 day. The length of hospitalization was defined as the interval from the date of resection until discharge.

We compared the study group with control group 1 and control group 2, respectively, to reflect the feasibility of laparoscopic resection. All quantitative data are expressed as means ± standard deviation. Two independent sample t tests were used for group comparisons of quantitative data. All qualitative data are expressed as n (%). Qualitative data were compared between the groups using the Fisher's exact probability test. Statistical analysis was performed using SPSS version 12.0 for Windows (SPSS Inc., Chicago, IL, USA). Significance was defined as a $p < 0.05$.

3. Results

There were 20 patients in the study group (laparoscopic resection in OLCC), 48 patients in control group 1 (open resection in OLCC), and 53 patients in control group 2 (laparoscopic resection in nonobstructive left-sided CRC). Table 1 shows the patients' clinical characteristics between the study group and control group 1. No significant differences were noted in age, sex, site of diversion colostomy creation, previous abdominal operation, BMI, preoperative CEA level, perioperative albumin level, and clinical TNM stage. However, there was a significant difference in the location of tumor obstruction. Sigmoid colon cancer was more commonly found in the study group than in control group 1 ($p < 0.001$).

Regarding the operative results and short-term outcomes, there were no significant differences in the procedure, number of lymph node retrieved (13.6 vs. 14.2), blood loss (68.7 mL vs. 80.9 mL), transfusion required (0 vs. 2), postoperative mortality (no mortality in both groups), and operative morbidity (25% vs. 19%). The most common causes of morbidity included anastomosis leakage, wound infection, prolonged postop ileus (> 7 days), and colostomy retraction. There were two patients in the study group and four patients in control group 1 who underwent subtotal colectomy with synchronous resection of colostomy. The operative time was significantly longer in the study group than in control group 1 (153 minutes vs. 126 minutes, $p = 0.041$). Regarding the postoperative recovery, the length of hospitalization was shorter in the study group than in control group 1 (5.3 days vs. 7.6 days, $p = 0.032$). However, there was no difference in time to flatus and time to diet.

Table 2 shows the patients' clinical characteristics between the study group and control group 2. No significant differences were also noted in age, sex, site of diversion colostomy creation, previous abdominal operation, BMI, preoperative CEA level, perioperative albumin level, and clinical TNM stage. Sigmoid colon cancer was also more commonly found in the study group than in control group 2 ($p < 0.001$).

Regarding the operative results and short-term outcomes, there were no significant differences in the procedure, number of lymph node retrieved (13.6 vs. 12.8), blood loss (68.7 mL vs. 71.5 mL), transfusion required (0 vs. 1), pneumoperitoneum pressure (12–14 mmHg), operative time (153 minutes vs. 143 minutes), postoperative mortality (no mortality in both groups), and operative morbidity (25% vs. 9.4%). Four patients (20%) in the study group required conversion to open resection (2 for bulky mesosigmoid or tumor, and 2 for colostomy retraction). In control group 2, four patients (7.5%) required conversion to open resection (3 for bulky mesosigmoid or tumor, and 1 for spleen laceration). Postoperative recovery showed no difference in time to flatus, time to diet, and length of hospitalization.

4. Discussion

The role of laparoscopic surgery in the management of patients with a history of previous abdominal operation has not

Table 1
Clinical characteristics, operative results, and short-term outcomes of the study group (laparoscopic resection in obstructive left-sided colorectal cancer) and control group 1 (open resection in obstructive left-sided colorectal cancer).

Clinical characteristics	Study group (n = 20)	Control group 1 (n = 48)	p
Age (y)	63.8 ± 15.7 (38–80)	60.8 ± 17.4 (41–79)	0.685
Female/male	5/15	17/28	0.294
Location of tumor obstruction			<0.001
Upper rectum	2	8	
Sigmoid colon	14	23	
Descending colon (including splenic flexure)	4	17	
Site of loop colostomy creation			0.665
Proximal transverse colon	18	43	
Distal transverse colon	2	5	
Previous abdominal operation	3 (10)	10 (20.8)	0.425
Preoperative CEA (ng/mL)	1.8–650	1.0–1205	0.839
Perioperative albumin (ng/dL)	2.9 ± 0.9 (1.9–5.2)	3.1 ± 1.5 (2.2–4.8)	0.068
Clinical TNM stage			0.873
I	2	5	
II	8	20	
III	7	17	
IV	3	6	
Procedure			0.987
Low anterior resection	3	8	
Anterior resection	9	23	
Left hemicolectomy	6	13	
Subtotal colectomy with resection of colostomy	2	4	
Body mass index (kg/m^2)			0.781
<18.5	3	8	
18.5–24	15	35	
>24	2	5	
Number of lymph nodes retrieved	13.6 ± 9.1 (8–25)	14.2 ± 8.7 (10–31)	0.633
Blood loss (mL)	68.7 ± 53 (15–250)	80.9 ± 66 (20–550)	0.742
Transfusions required	0	2	0.495
Operative time (min)	153 ± 65 (96–242)	126 ± 76 (85–290)	0.041
Postoperative mortality	0	0	—
Operative morbidity	5 (25)	9 (19)	0.467
Anastomotic leakage	3	4	
Wound infection	3	3	
Prolonged postoperative ileus (>7 d)	2	4	
Colostomy retraction	2	0	
Time to flatus (d)	2.1 ± 2.3 (1.6–3.7)	2.5 ± 2.4 (2.0–5.8)	0.209
Time to diet (d)	3.6 ± 3.7 (3–11)	4.1 ± 4.6 (3.1–13)	0.158
Length of hospitalization (d)	5.3 ± 6.8 (4–17)	7.6 ± 8.2 (5–30)	0.032

Data are presented as n, n (%), or mean ± SD (range).

yet been determined. Adhesion formation following abdominal surgery results from peritoneal inflammation, rapid peritoneal mesothelialization, postoperative macrophage inflow, and reorganization of the fibrin gel matrix.[18] Previous abdominal operation leads to the formation of adhesions in 51%, 72%, and 93% of patients with a history of minor, major, or multiple operations, respectively.[19]

Menzies and Ellis[20] reported that, of patients who had previously undergone one or more abdominal procedures, 93% had intra-abdominal adhesions at relaparotomy. Adhesions are associated with an increased risk of intestinal obstruction and prolonged operative times. Therefore, inadvertent intestinal injury during laparotomy and postoperative morbidity is more common in patients with multiple abdominal operations.[21] These observations have led to the notion that previous abdominal operation represents a relative contraindication to laparoscopic surgery. In 2012, Bonjer et al[16] reported a high conversion rate (38.4%) in patients with obstructive rectal cancer and diversion colostomy due to adhesions, poor visualization, and/or bulky tumors. The authors concluded that diversion colostomy may preclude laparoscopic resection.

However, in our study, we clearly demonstrated that laparoscopic resection of OLCC with diversion colostomy is feasible, involving a shorter length of hospitalization but a longer operative time. The concern of adhesion is not a major problem. In our experience, diversion colostomy is a minor surgery with only limited adhesion formation around the colostomy site (Fig. 1F), and does not preclude the pneumoperitoneum setup (Fig. 1D) and laparoscopic surgery (Fig. 1E). The peritoneal cavity is inflated similar to conventional laparoscopic surgery with comparable intra-abdominal pressure (12–14 mmHg). Although there is only limited adhesion around the colostomy site, we still set up

Table 2
Clinical characteristics, operative results, and short-term outcomes of the study group (laparoscopic resection in obstructive left-sided colorectal cancer) and control group 2 (laparoscopic resection in nonobstructive left-sided colorectal cancer).

Clinical characteristics	Study group (n = 20)	Control group 2 (n = 53)	p
Age (y)	63.8 ± 15.7 (38–80)	57.4 ± 13.4 (31–78)	0.123
Female/male	5/15	20/33	0.188
Location of tumor			<0.001
Upper rectum	2	13	
Sigmoid colon	14	30	
Descending colon (including splenic flexure)	4	10	
Previous abdominal operation	3 (10)	7 (13.2)	0.555
Preoperative CEA (ng/mL)	1.8–650	2.1–68	0.653
Perioperative albumin (ng/dL)	2.9 ± 0.9 (1.9–5.2)	3.6 ± 1.2 (2.4–4.9)	0.854
Clinical TNM stage			0.944
I	2	8	
II	8	19	
III	7	19	
IV	3	7	
Procedure			0.053
Low anterior resection	3	14	
Anterior resection	9	30	
Left hemicolectomy	6	9	
Subtotal colectomy with resection of colostomy	2	0	
Body mass index (kg/m^2)			0.871
<18.5	3	8	
18.5–24	15	35	
>24	2	5	
No. of lymph nodes retrieved	13.6 ± 9.1 (8–25)	12.8 ± 4.3 (9–21)	0.589
Blood loss (mL)	68.7 ± 53 (15–250)	71.5 ± 66 (10–150)	0.387
Transfusions required	0	1	0.726
Pneumoperitoneum pressure (mmHg)	12–14	12–14	—
Operative time (min)	153 ± 65 (96–242)	143 ± 38 (96–210)	0.059
Postoperative mortality	0	0	—
Operative morbidity	5 (25)	5 (9.4)	0.093
Anastomotic leakage	3	2	
Wound infection	3	2	
Prolonged postoperative ileus (>7 d)	2	2	
Colostomy retraction	2	—	
Conversion to open surgery	4 (20)	4 (7.5)	0.137
Bulky mesosigmoid or tumor	2	3	
Bleeding due to spleen laceration	0	1	
Colostomy retraction	2	0	
Time to flatus (d)	2.1 ± 2.3 (1.6–3.7)	2.8 ± 1.4 (2.0–3.7)	0.386
Time to diet (d)	3.6 ± 3.7 (3–11)	3.8 ± 2.6 (2–8)	0.866
Length of hospitalization (d)	5.3 ± 6.8 (4–17)	4.9 ± 4.8 (3–10)	0.145

Data are presented as n, n (%), or mean ± SD (range).

the pneumoperitoneum by way of the conventional open method to reduce the risk of bowel injury.[22]

Colostomy retraction was a specific morbidity, and occurred perioperatively in two of the study group patients (Fig. 1G). In these two patients, we found that the plastic rod had been removed only 10 days after diversion colostomy creation. For a loop colostomy, a supporting rod or bridge can be removed 3–5 days later.[15] However, in this case we thought the colostomy mucosa might not be fully matured and secured it to the periostomy skin in these two patients. So when the abdominal cavity was inflated during pneumoperitoneum, the colostomy mucosa was separated from the periostomy skin resulting in colostomy retraction. The surgery was converted to open resection in both of the patients due to incomplete pneumoperitoneum. Based on this finding, we left the plastic rod in place and performed the laparoscopic surgery at least 14 days (from 14 days to 20 days) after diversion colostomy creation in the those patients. No colostomy retraction occurred afterward.

Diversion colostomy is a historical component of the staged therapeutic schema for OLCC.[8] We do not choose diversion ileostomy for temporary diversion because a competent ileocecal valve precludes an ileostomy from decompressing a colonic obstruction.[23] If the obstructive site is around the descending colon or splenic flexure and the distal transverse colon is redundant, sometimes we will choose distal transverse colon for diversion. This is because we can simultaneously perform resection of the tumor and colostomy, thereby avoiding the third stage operation (closure of colostomy).[24] In our investigation, there were two patients in the study group and four patients in control group 1 who received subtotal colectomy with resection of colostomy.

In OLCC, the distended bowel may compromise the blood supply in the mesentery; therefore, the leakage rate of primary anastomosis can be up to 18%.[2] Additionally, the operative mortality is 12% and a wound infection rate is 40%.[25] In our study, the anastomosis leakage rate was higher in the study group (15%, 3 in 20 patients) than in the control group 1 (8.3%, 4 in 48 patients). All of the patients with leakage did not receive reoperation and all recovered after conservative treatment. Proximal diversion colostomy significantly reduces the risk of a reoperation following an anastomotic leak.[26]

Four patients in the study group (20%) required conversion to open resection (2 for bulky mesosigmoid or tumor, and 2 for colostomy retraction). In control group 2, four patients (7.5%) required conversion to open resection (3 for bulky mesosigmoid or tumor, 1 for spleen laceration). The conversion rate was 20% in the study group, which is higher than control group 2 but similar to previous studies.[27,28]

In our study, there were three, six, and seven patients with distant metastasis in the study group, control group 1, and control group 2, respectively. Laparoscopic resection of the primary tumor in patients with stage IV CRC still showed benefits in our previous study.[17] Therefore, even in patients with OLCC with synchronous distant metastasis, we still performed diversion colostomy first and resected the primary tumor in the second stage if the distant metastasis was resectable.

In conclusion, laparoscopic resection of OLCC with diversion colostomy is feasible as reflected by a shorter length of hospitalization than open resection. Abdominal cavity adhesion is limited to that area around the colostomy site and does not preclude laparoscopic surgery. We strongly recommend that the laparoscopic resection should be performed at least 2 weeks after diversion colostomy, with the plastic rod left in place during the pneumoperitoneum to reduce the risk of colostomy retraction. The major limitation of our result is the retrospective nature of the case−control study. Furthermore, this study is also a single surgeon experience with limited case numbers and therefore may involve some selection bias. Consequently, further prospective studies are needed to confirm its efficacy and safety.

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