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Emergency Laparoscopic-assisted versus Open Right Hemicolectomy for Obstructing Right-sided Colonic Carcinoma: A Comparative Study of Short-term Clinical Outcomes

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Abstract
Background The aim of the present study was to compare the clinical outcomes of emergency laparoscopic-assisted versus open right hemicolectomy for obstructing right-sided colonic carcinoma.
Methods Between July 2003 and July 2006, 43 consecutive patients with obstructing right-sided colonic carcinoma underwent emergency right hemicolectomy at our institution, 14 with the laparoscopic-assisted approach and 29 with the open approach. Clinical data were retrospectively recorded and compared between the two groups.
Results There were no significant differences between the two groups with respect to age, gender, co-morbidities, duration of obstructing symptoms, tumor length, and tumor staging. The laparoscopic-assisted group had longer operative time than the open group (187.5 min versus 145 min; $p = 0.034$) but less blood loss (20 ml versus 100 ml; $p = 0.020$). The median time to full ambulation was significantly shorter in the laparoscopic-assisted group (4 days versus 6 days; $p = 0.016$), but the time to return of gastrointestinal function and the duration of hospital stay were similar between the two groups. More patients in the open group developed postoperative complications (55.2% versus 28.6%), but the difference was not statistically significant.
Conclusions Emergency laparoscopic-assisted right hemicolectomy for obstructing right-sided colonic carcinoma is feasible and safe. In comparison with the open approach, the laparoscopic-assisted procedure is associated with less blood loss, earlier ambulation, and possibly lower morbidity rate.

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Laparoscopic-assisted right hemicolectomy is an established minimally invasive procedure in treating patients with uncomplicated right-sided colonic carcinoma. Compared to open right hemicolectomy, it is associated with faster postoperative recovery and lower morbidity [1–3]. Right-sided colonic carcinoma complicated with intestinal obstruction has been considered in many early reports to be a contraindication to laparoscopic-assisted right hemicolectomy because of the lack of intra-abdominal working space and the risk of injuring the distended bowel during manipulation [2]. However, with advancements in skills and technology, the application of the laparoscopic approach in emergency settings has become possible. We have previously reported that emergency laparoscopic-assisted right hemicolectomy for obstructing right-sided colonic carcinoma was feasible and safe in the hands of experienced laparoscopic surgeons [4]. In the present study, we compared the short-term clinical outcomes of emergency laparoscopic-assisted versus open right hemicolectomy for obstructing right-sided colonic carcinoma.

Patients and methods

Between July 2003 and July 2006, 43 consecutive patients with obstructing right-sided colonic carcinoma who

underwent emergency right hemicolectomy at our institution were included in this retrospective study. The *right colon* was defined as the cecum, ascending colon, hepatic flexure, and transverse colon proximal to the splenic flexure. All patients had clinical features of intestinal obstruction (abdominal pain, abdominal distension, and constipation) without peritonitis, and plain abdominal x-ray films showed dilated right-sided colon and moderately dilated small bowel loops with multiple fluid levels. The diagnosis of right-sided colonic obstruction by tumor was confirmed, either by water-soluble contrast enema or computed tomography.

All patients underwent emergency surgery after fluid deficits and electrolyte imbalances had been corrected. The surgical approach (laparoscopic-assisted or open) was left to the discretion of the operating surgeons, depending on their expertise and the condition of each patient. Not all colorectal specialists at our institution were experienced in emergency laparoscopic colorectal resection.

Our techniques for emergency laparoscopic-assisted right hemicolectomy have been reported previously [4]. In principle, we mobilize the right-sided colon from the terminal ileum to the transverse colon. The lymphovascular pedicles are then transected intracorporeally with endoscopic linear staplers. A port wound is extended to deliver the specimen under the protection of a plastic bag. The division of the remaining mesentery, the marginal artery, and the bowel is done extracorporeally. The ileocolic anastomosis is performed extracorporeally and either hand-sewn or completed with two linear staplers (functional end-to-end anastomosis). In the present series, diet was resumed as soon as bowel function returned clinically (as indicated by positive bowel sound and passage of flatus). Patients were discharged when they tolerated diet and were fully ambulatory.

Clinical data including operative details and immediate clinical outcomes were retrospectively collected from medical records and compared between the two groups. Patients were regarded to be suffering from prolonged ileus if they were unable to resume diet after postoperative day 4 and required parenteral nutrition supplementation. Time to full ambulation was defined as the time when the patient could walk independently in the ward without assistance.

Statistical analysis was performed with Statistical Package for Social Science (SPSS) version 14.0 for Windows (SPSS Inc., Chicago, IL, USA). The chi-square test (or Fisher's exact test) was used to compare categorical data, and the Mann-Whitney *U*-test was used to compare nonparametric data. A p value of 0.05 or less was considered statistically significant.

Results

Fourteen patients in this series underwent the laparoscopic-assisted approach, and 29 patients underwent the open approach. The demographic data for the two groups of patients are shown in Table 1. There were no significant differences between the groups in terms of age, gender, body mass index, co-morbidities, or history of previous abdominal operations. Prior operations included hysterectomy, cholecystectomy, and appendectomy in the laparoscopic-assisted group, and partial gastrectomy, cholecystectomy, and appendectomy in the open group. The duration of obstructing symptoms and the tumor length were also similar between the two groups.

The operative results are shown in Table 2. All laparoscopic-assisted procedures were carried out by colorectal specialists experienced in laparoscopic surgery, whereas only 48.3% of open procedures were performed by colorectal surgeons; the rest were performed by general surgeons. More patients in the laparoscopic-assisted group underwent curative resection (85.7% versus 58.6%), but the difference was not statistically significant ($p = 0.095$).

Table 1 Demographic and pathological data

	Laparoscopic-assisted group ($n = 14$)	Open group ($n = 29$)	p Value
Age, years[a]	68.5 (45–80)	71 (44–94)	0.533[c]
Sex ratio (M/F)	6:8	14:15	0.739[b]
Body mass index, kg/m^2[a]	21.1 (18.6–35.5)	20.7 (17.8–26.9)	0.606[c]
ASA grading (I/II/III/IV)	3/9/2/0	3/18/7/1	0.624[b]
Co-morbidities, n (%)	11 (78.6)	24 (82.8)	1.000[b]
Previous abdominal operations, n (%)	3 (21.4)	3 (10.3)	0.373[b]
Duration of symptoms, days[a]	3 (1–6)	3 (1–10)	0.979[c]
TNM staging (I/II/III/IV)	2/6/4/2	0/11/7/11	0.111[b]
Length of tumor (cm)[a]	4 (2–9)	4 (2–14)	0.875[c]
Number of lymph nodes removed[a]	16.5 (9–36)	15 (8–52)	0.452[c]

ASA American Society of Anesthesiologists

[a] Data expressed in median (range)

[b] Chi-square test or Fisher's exact test

[c] Mann-Whitney *U*-test

Table 2 Operative results

	Laparoscopic-assisted group ($n = 14$)	Open group ($n = 29$)	p Value
Surgery by colorectal specialist, n (%)	14 (100)	14 (48.3)	0.001[b]
Curative resection, n (%)	12 (85.7)	17 (58.6)	0.095[b]
Incisional length, cm[a]	6.3 (5–9)	15 (10–30)	<0.001[c]
Extended right hemicolectomy/right hemicolectomy	4/10	9/20	1.000[b]
Anastomosis: hand-sewn/stapled/stoma	4/10/0	22/5/2	0.002[b]
Conversion, n (%)	0 (0)	–	–
Operative time, min[a]	187.5 (106–350)	145 (55–240)	0.034[c]
Blood loss, ml[a]	20 (0–500)	100 (0–700)	0.020[c]

[a] Data expressed in median (range)

[b] Chi-square test or Fisher's exact test

[c] Mann-Whitney U-test

There were no conversions to open operation in the laparoscopic-assisted group. The incisional length was significantly shorter in the laparoscopic-assisted group than the open group (6.3 cm versus 15 cm; $p < 0.001$). Compared to the open group, the laparoscopic-assisted group had significantly longer operative time (187.5 min versus 145 min, $p = 0.034$) but significantly less blood loss (20 ml versus 100 ml; $p = 0.020$).

Table 3 shows the immediate clinical outcomes. The median time to full ambulation was significantly shorter in the laparoscopic-assisted group (4 days versus 6 days; $p = 0.016$), but the time to return of gastrointestinal function and the duration of hospital stay were similar between the two groups.

Table 4 shows the postoperative complications. More patients in the open group developed postoperative complications (55.2% versus 28.6%), but the difference was not statistically significant ($p = 0.119$). Septic complications like wound infection, chest infection, and urinary tract infection were observed only in the open group. One patient in the laparoscopic-assisted group developed acute coronary syndrome (ACS) and died on day 19. In the open group, 3 patients died in the immediate postoperative period: 2 died of ACS and 1 died of pulmonary embolism.

Table 3 Immediate clinical outcomes

	Laparoscopic-assisted group ($n = 14$)	Open group ($n = 29$)	p Value
Duration of parenteral analgesia, days	2 (0–9)	4 (1–7)	0.118[a]
Time to resumption of diet, days	4 (3–10)	3 (2–12)	0.178[a]
Time to first bowel motion, days	5 (3–8)	5 (1–10)	0.645[a]
Time to full ambulation, days	4 (3–9)	6 (4–10)	0.016[a]
Hospital stay, days	7 (6–18)	9 (6–40)	0.251[a]

All data are expressed in median (range)

[a] Mann Whitney U-test

A separate analysis was performed to compare the clinical outcomes of emergency laparoscopic-assisted versus open right hemicolectomy carried out by colorectal surgeons only (Table 5). The advantages of the laparoscopic-assisted group remained largely unchanged, including less blood loss (20 ml versus 100 ml; $p = 0.068$), earlier ambulation (4 days versus 7 days; $p = 0.009$), and lower morbidity rate (28.6% versus 50%; $p = 0.440$).

Discussion

The technical feasibility and clinical safety of the laparoscopic-assisted approach in treating patients with obstructing colorectal carcinoma has recently been confirmed by several series in the literature [4–6]. The present

Table 4 Postoperative complications

	Laparoscopic-assisted group ($n = 14$)	Open group ($n = 29$)	p Value
Acute coronary syndrome	1[a]	2[b]	
Atrial fibrillation	0	2	
Transient ischemic attack	0	1	
Respiratory failure	0	1	
Pulmonary embolism	0	1[b]	
Wound infection	0	5	
Chest infection	0	3	
Urinary tract infection	0	3	
Retention of urine	0	3	
Prolonged ileus	3	1	
Total number of complications	4	22	
Total number of patients with complications, n (%)	4 (28.6)	16 (55.2)	0.119[c]
Postoperative deaths, n (%)	1 (7.1)	3 (10.3)	1.000[c]

[a] Cause of postoperative death in the laparoscopic-assisted group

[b] Cause of postoperative death in the open group

[c] Chi-square test or Fisher's exact test

Table 5 Clinical outcomes of surgery performed by colorectal specialists only

	Laparoscopic-assisted group ($n = 14$)	Open group ($n = 14$)	p Value
Operative time, min[a]	187.5 (106–350)	125 (55–240)	0.008[c]
Blood loss, ml[a]	20 (0–500)	100 (20–700)	0.068[c]
Time to full ambulation, days[a]	4 (3–9)	7 (4–10)	0.009[c]
Number of patients with complications, n (%)	4 (28.6)	7 (50)	0.440[b]

[a] Data are expressed in median (range)

[b] Chi-square test or Fisher's exact test

[c] Mann-Whitney U-test

study has further indicated that emergency laparoscopic-assisted right hemicolectomy for obstructing right-sided colonic carcinoma yields better short-term clinical outcomes when compared to its open counterpart, including less blood loss, earlier ambulation, and possibly lower morbidity. Remarkably, no patient in the laparoscopic-assisted group developed any septic complication.

Laparoscopic surgery has been consistently shown by latest randomized controlled trials to be associated with faster return of gastrointestinal function and shorter hospital stay when compared to open surgery for elective resection of colorectal carcinoma [1, 3, 7, 8]. However, these advantages were not seen in our study of emergency resection. Unexpectedly, more patients in the laparoscopic-assisted group developed prolonged ileus. This may be partially explained by the longer operative time and hence longer duration of bowel manipulation in these patients, or it may be due to the effect of chance alone.

All laparoscopic-assisted procedures in our study were carried out by colorectal specialists who were fully competent in advanced laparoscopic surgery, whereas only 48.3% of the open procedures were performed by colorectal surgeons (who were experienced in emergency open but not laparoscopic colorectal resection). Consequently, one may argue that the advantages observed in the laparoscopic-assisted group were attributable to surgeon factor. In fact, surgical specialization has been shown to have a positive impact on the outcomes of both elective and emergency colorectal surgery [9, 10].

In order to address this issue, a subgroup analysis was performed to compare the clinical outcomes of either approach carried out by colorectal surgeons only. The advantages of the laparoscopic-assisted group remained largely unchanged, and thus we believe that these advantages were genuinely related to the laparoscopic approach itself.

Although emergency laparoscopic-assisted right hemicolectomy has been shown to be feasible in our study, we believe that this approach cannot be practically applied to every patient with obstructing right-sided colonic carcinoma. Patients with a small stenotic tumor, short duration of obstructing symptoms, and mild dilatation of small bowel loops (secondary to competent ileocecal valve) are most suitable for the laparoscopic approach [4]. In contrast, patients with a grossly distended abdomen and dilated bowel loops are generally not good candidates for laparoscopic surgery because of poor visibility and a high risk of bowel injury. Patients with bulky and fixed obstructing tumors should also be excluded from laparoscopic surgery. Careful patient selection with preoperative computed tomography scan is mandatory to avoid futile operations and complications. Finally, as shown in our study, previous history of abdominal operation is not regarded as a contraindication to the laparoscopic approach even in the emergency setting.

Recently, colorectal stents have been used successfully as preoperative "bridges to surgery" for patients with obstructing left-sided colorectal carcinoma. Endoscopic relief of the obstruction allows for optimization of the patient's condition, more accurate preoperative staging, and safer elective laparoscopic surgery after full bowel preparation—the "endolaparoscopic approach" [11]. Published data on the use of colorectal stents in treating obstructing right-sided colonic carcinoma, however, are scarce [12–14]. The long distance and tortuosity of the bowel make it difficult for endoscopists to advance the stent to the point of obstruction in the right-sided colon. Colorectal stenting is not without risks, and bowel perforation can occur [15]. Moreover, we have shown in both our previous report [4] and the present study that emergency laparoscopic-assisted right hemicolectomy for obstructing right-sided colonic carcinoma is technically feasible and safe in the hands of experienced laparoscopic surgeons, and that prior endoscopic decompression with colorectal stents is not necessary. Nevertheless, we do acknowledge that in patients with grossly distended abdomen and dilated bowel loops, the "endolaparoscopic" approach or even the open approach may be a better and safer option than the straight laparoscopic approach [4, 12].

Our study was not a randomized study, and thus bias attributable to case selection was inevitable. Besides, the oncological outcomes in terms of recurrence and survival rates have not been evaluated because the duration of follow-up was still short. A randomized study with larger number of patients and longer duration of follow-up is necessary to prove the true value of emergency laparoscopic-assisted right hemicolectomy for obstructing right-sided colonic carcinoma.

In conclusion, emergency laparoscopic-assisted right hemicolectomy for obstructing right-sided colonic

carcinoma is feasible and safe. Compared with the open approach, the laparoscopic-assisted procedure is associated with less blood loss, earlier ambulation, and possibly lower morbidity rate.

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