in vivo *29*: 295-300 (2015)

Outcomes of Laparoscopic and Open Surgery for Colorectal Cancer in the Emergency Setting

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Abstract. *Aim: To evaluate the short-term and oncological outcomes of laparoscopy compared to open procedures for colorectal cancer in the emergency setting. Patients and Methods: Forty-nine consecutive patients undergoing emergency open (n=38) or laparoscopic (n=11) major resection were analyzed. Results: There were no significant differences in age, gender, American Society of Anesthesiologists (ASA) score, body mass index (BMI), history of previous abdominal surgery and tumor location between the open and laparoscopy groups. Pathological T4 tumors were more commonly observed in the open-surgery group than the laparoscopy group (47% vs. 9%; p=0.022). Obstruction (45% vs. 27%) and perforation (42% vs. 27%) were also more common in the open-surgery group. Bleeding or anemia was more common in the laparoscopy group (8% vs. 45%; p=0.028). There were no open conversions in the laparoscopy group. Regarding the type of surgery, Hartmann's operation was more common in the open-surgery group (32%) and right hemicolectomy was more common in the laparoscopy group (36%; p=0.058). There was no difference in the 30-day complication rate of open surgery (34%) and laparoscopy (36%) (p=0.895). Mean time to tolerable diet (8 days vs. 6 days, p=0.035) and mean length of hospital stay (17 days vs. 13 days, p=0.041) were shorter in the laparoscopy group. Overall recurrence and cancer-specific death did not differ between the two groups. Conclusion: In selected colorectal cancer patients, emergency laparoscopy confers benefits in terms of short-term and oncological outcomes. Therefore, experienced laparoscopic surgeons may more actively consider the use of laparoscopy in the emergency setting.*

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Key Words: Colorectal cancer, laparoscopy, emergency.

Laparoscopy for colorectal cancer has favorable short-term outcomes, including less analgesic use, earlier resumption of diet and shorter hospital stay (1-3). Moreover, the oncological safety of laparoscopy has been confirmed in several randomized trials (4-6). However, because laparoscopy performed in the emergency setting is frequently excluded from clinical trials, little information is available on outcomes of emergency laparoscopy for colorectal cancer.

Emergency surgery is a well-known risk factor for postoperative morbidity and mortality after colorectal resection (7, 8). Laparoscopic colorectal surgery is technically demanding with a steep learning curve and requires a well-organized operating staff and appropriate surgical instruments (9, 10). Thus, in clinical practice, laparoscopy for colorectal cancer is most often considered in the elective setting and is not widely adopted in the emergency setting (11). Between 1996 and 2006, only 543 out of 102,236 (0.6%) emergency major colorectal surgeries performed in the English National Health Service hospitals were carried-out by laparoscopy (12). Current guidelines support the use of emergency laparoscopy in several benign abdominal diseases, including cholecystitis, appendicitis, diverticulitis or gynecologic disorders. However, the benefit of emergency laparoscopy in patients with colorectal cancer is unclear because of the paucity of data (13, 14).

Previous studies have investigated the role of laparoscopy in patients with benign colorectal diseases, such as diverticulitis (15) or inflammatory bowel disease (16). Some authors reported single-arm studies investigating the outcomes of laparoscopy for benign and malignant colorectal diseases (17, 18). To date, four comparative studies on emergency colorectal cancer resection by laparoscopy or open surgery have indicated that laparoscopy in the emergency setting is safe and feasible with respect to short-term outcomes (19-22); however, oncologic outcomes were not reported.

Emergent conditions, including obstructing and perforated colorectal cancers, result in a difficult surgical environment, such as distended, fragile or edematous bowel or easy touch

bleeding. If technical difficulties are anticipated, surgeons are unwilling to consider a laparoscopic approach. However, we postulated that, for selected patients, the reduction in surgical stress after laparoscopy enables for faster short-term recovery compared to open surgery, even in the emergency setting. In addition, oncological outcomes of laparoscopy may be comparable. This study aimed to evaluate the short-term and oncologic outcomes of laparoscopy compared to open procedures for resection of colorectal cancer in the emergency setting.

Patients and Methods

Patients. This is a retrospective cohort study performed at a tertiary referral center. This study followed the STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) guidelines (23) and was approved by the Institutional Review Board of Wonju Severance Christian Hospital. All participants signed an informed consent agreement. Forty-nine consecutive patients undergoing emergency surgery for colorectal cancer between January 1, 2008 and December 31, 2013 were enrolled. Eligibility criteria included patients with histologically confirmed colorectal cancer who underwent major colorectal resection with curative intent. Patients undergoing R2 resection (macroscopic residual disease), multivisceral resection or non-resectional or bypass procedures for colorectal cancer were excluded from this study.

Study end-points. The primary endpoint was to compare short-term outcomes of laparoscopy and open surgery for colorectal cancer in the emergency setting. Secondary end-points evaluated the oncologic outcomes of patients receiving emergency laparoscopy and open surgery for colorectal cancer.

Surgery, adjuvant therapy and follow-up. Surgeries were performed by two colorectal surgeons. The need for an emergency operation was determined after a multidisciplinary team meeting and the type of surgical procedure, either laparoscopic or open, was decided at the surgeon's discretion. Detailed laparoscopic and open procedures were explained to the patients and their families and informed consent was obtained from all patients. Because of the emergency setting, standardized bowel preparation was not performed and the duration of antibiotic treatment was decided by the operating surgeon based on postoperative clinical course. Complete mesocolic excision for colon cancer and total mesorectal excision for rectal cancer were performed using standard surgical procedures. Detailed operative procedures are described elsewhere (24).

After recovery from surgery, all patients with stage II, III or IV disease were recommended to receive chemotherapy according to the National Comprehensive Cancer Network (NCCN) guidelines (25). Chemotherapy regimens included fluorouracil with folinic acid, capecitabine or oxaliplatin/irrinotecan, or in combination with targeted agents. Adjuvant radiation was used in patients with stage II and III rectal cancer. All surgical patients were registered in a dedicated colorectal database and followed at a 3- or 6-month interval for the first 5 years and then yearly thereafter.

Outcome measures. Postoperative complications were defined as events that required additional treatment within 30 days of surgery, based on the Clavien–Dindo classification (26). Laparoscopy data were analyzed according to the intention-to-treat principle. Conversion to open surgery was defined as completion of planned surgical procedures using a conventional laparotomy incision. Treatments, such as intensive care unit (ICU) care or blood transfusions, were included in the analysis if they were required within 48 hours after primary surgery.

Statistical analysis. All statistical analyses were performed using the IBM SPSS Statistics for Windows, version 20.0 (IBM, Armonk, NY, USA). Categorical variables were described by frequencies and percentages and compared by the Chi-square test or Fisher's exact test as appropriate. Continuous variables were described as mean and standard deviation and analyzed by the Mann–Whitney *U*-test. Survival analysis was performed by the Kaplan–Meier method with log-rank tests. A p-value <0.05 was considered statistically significant.

Results

Patients' characteristics. Forty-nine consecutive colorectal cancer patients who underwent emergency surgery were analyzed according to a primary surgical approach of open (n=38) or laparoscopic (n=11) procedure. There were no significant differences regarding age, gender, American Society of Anesthesiologists (ASA) score, body mass index (BMI), history of previous abdominal surgery and tumor location between the open and laparoscopy groups. Pathological T4 tumors were more commonly observed in the open-surgery group than the laparoscopy group (47% *vs*. 9%; p=0.022). Detailed patients' characteristics are summarized in Table I.

Reasons for emergency surgery. Obstruction (45% *vs*. 27%) and perforation (42% *vs*. 27%) were more common in the open surgery group than the laparoscopy group. Bleeding or anemia was more common in the laparoscopy group (8% *vs*. 45%; p=0.028) (Table II).

Surgery and histopathology results. There were no open conversions in the laparoscopy group. Regarding the type of surgery, Hartmann's operation was more common in the open surgery group (32%) and right hemicolectomy was more common in the laparoscopy group (36%; p=0.058). Mean operative time and mean blood loss did not differ between the two groups.

Stage IV tumors were more common in the open group (34%) and stage 0/I tumors were more common in the laparoscopy group (36%) (p=0.002). Positive circumferential margin, histologic grade and number of lymph nodes harvested did not differ between the two groups. Tumor diameter was larger in the open-surgery group (6 cm *vs*. 4 cm; p=0.019) (Table III).

Short-term outcomes. There was no difference in the 30-day complication rate of open surgery (34%) and laparoscopy (36%) groups (p=0.895). There was no mortality in either group. Intensive care unit (ICU) admission was more common in the

Table I. *Patients' characteristics.*

	Open (n=38) N (%)	Laparoscopy (n=11) N (%)	*p-Value*
Age (years), mean (SD)	68 (12)	67 (13)	0.884
Gender			
Male	27 (71)	5 (45)	0.116
Female	11 (29)	6 (55)	
ASA score			
1	2 (5)	3 (27)	0.177
2	23 (61)	6 (55)	
3	12 (32)	2 (18)	
4	1 (3)	0 (0)	
BMI (kg/m^2), mean (SD)	23 (4)	23 (5)	0.607
T4 tumor			
(+)	18 (47)	1 (9)	0.022
Previous laparotomy			
(+)	3 (8)	0 (0)	0.336
Preoperative chemoradiation			
(+)	1 (3)	0 (0)	0.587
Tumor location			
Right colon	9 (24)	5 (45)	0.262
Left colon	6 (16)	0 (0)	
Sigmoid colon	16 (42)	3 (27)	
Rectum	5 (13)	3 (27)	
Multiple	2 (5)	0 (0)	

SD, Standard deviation; ASA, American Society of Anesthesiologists; BMI, body mass index.

Table II. *Reason for emergency surgery.*

	Open N (%)	Laparoscopy N (%)	*p-Value*
Obstruction	17 (45)	3 (27)	
Perforation	16 (42)	3 (27)	
Bleeding, anemia	3 (8)	5 (45)	*p*=0.028
Prolapse, bowel ischemia	2 (5)	0 (0)	

Table III. *Surgical factors and histopathology results.*

	Open N (%)	Laparoscopy N (%)	*p-Value*
Type of operation			
Hartmann	12 (32)	1 (9)	0.058
LAR	2 (5)	3 (27)	
Proctocolectomy	2 (5)	0 (0)	
AR, Left colectomy	5 (13)	2 (18)	
Total, subtotal colectomy	7 (18)	0 (0)	
Right colectomy	10 (26)	4 (36)	
Transverse colectomy	0 (0)	1 (9)	
Operative time (min), mean (SD)	180 (62)	190 (107)	0.702
Estimated blood loss (ml), mean (SD)	93 (122)	164 (216)	0.319
TNM classification			
0	0 (0)	1 (9)	0.002
1	0 (0)	3 (27)	
2	13 (34)	2 (18)	
3	12 (32)	4 (36)	
4	13 (34)	1 (9)	
Histologic grade			
G1, G2	35 (92)	10 (91)	0.898
G3, other	3 (8)	1 (9)	
Circumferential margin			
≤1 mm	5 (63)	0 (0)	0.064
Lymph node yield (no.), mean (SD)	24 (13)	17 (8)	0.117
Distal margin (cm), mean (SD)	16 (13)	12 (11)	0.357
Tumor diameter (cm), mean (SD)	6 (3)	4 (2)	0.019

LAR, Low anterior resection; AR, anterior resection; SD, standard deviation.

open-surgery group (76% *vs*. 9%; $p<0.001$). The proportion of patients receiving chemotherapy was 74% in the open-surgery group and 45% in the laparoscopy group ($p=0.079$). Although not significant, the mean time from surgery to chemotherapy commencement was shorter with laparoscopy (37 days) than with open surgery (41 days, $p=0.427$).

Mean time to tolerable diet (8 days *vs*. 6 days, $p=0.035$) and mean length of hospital stay (17 days *vs*. 13 days, $p=0.041$) were shorter in the laparoscopy group (Table IV).

Oncological outcomes. Overall recurrence and cancer-specific death did not differ between the two groups (Table V). Sites of recurrence (n=13) were liver only (n=4), carcinomatosis (n=3) and multiple sites (n=6).

The 5-year cancer-specific survival rates using Kaplan-Meier curves were 57.5% and 87.5% for open and laparoscopic approaches, respectively ($p=0.212$) (Figure 1A). The corresponding 5-year recurrence-free survival rates were 63.9% and 87.5%, respectively ($p=0.122$) (Figure 1B).

Discussion

The major finding of this study is that patients who underwent emergency laparoscopy had better short-term outcomes in terms of shorter time to tolerable diet and shorter hospital stay. Emergency laparoscopy showed comparable oncological outcomes to open surgery in terms of cancer-specific and recurrence-free survival.

Although emergency laparoscopy for colorectal cancer showed favorable outcomes in the present series, laparoscopy may not be suitable for all patients. We observed that T4 tumor (47% *vs*. 9%), stage IV disease (34% *vs*. 9%), larger tumor (6 cm *vs*. 4 cm), perforated tumor (42% *vs*. 27%) and obstructing tumor (45% *vs*. 27%) were more common in the open surgery group. Tumor fixation to an adjacent organ and difficult tumor dissection of a locally advanced tumor are major reasons for open conversion during elective laparoscopic surgery (1, 2). Additionally, distended small

Table IV. *Short-term outcomes*.

	Open N (%)	Laparoscopy N (%)	*p*
30-day complication			
(+)	13 (34)	4 (36)	0.895
Clavien-Dindo score			
1,2	10 (77)	2 (50)	0.301
3,4,5	3 (23)	2 (50)	
Type of complication			
Pulmonary	3	1	
Wound	3	1	
Leakage	0	1	
Obstruction	3	1	
Urinary	1	0	
Other	4	1	
ICU admission			
(+)	29 (76)	1 (9)	<0.001
Blood transfusion			
(+)	17 (45)	5 (45)	0.966
Adjuvant chemotherapy			
(+)	28 (74)	5 (45)	0.079
Time to chemotherapy initiation (days), mean (SD)	41 (10)	37 (10)	0.427
Time to toleration of diet (days), mean (SD)	8 (2)	6 (3)	0.035
Hospital stay (days), mean (SD)	17 (10)	13 (4)	0.041

SD, Standard deviation; ICU, intensive care unit. *Two of 17 patients (12%) had more than one type of complication.

Table V. *Oncological outcomes*.

	Open N (%)	Laparoscopy N (%)	*p*
Recurrence			
0	0 (0)	0 (0)	0.137
1	0 (0)	0 (0)	
2	1 (8)	0 (0)	
3	1 (8)	1 (100)	
4	10 (83)	0 (0)	
Cancer-specific death			
0	0 (0)	0 (0)	0.290
1	0 (0)	0 (0)	
2	1 (11)	0 (0)	
3	1 (11)	1 (100)	
4	7 (78)	0 (0)	

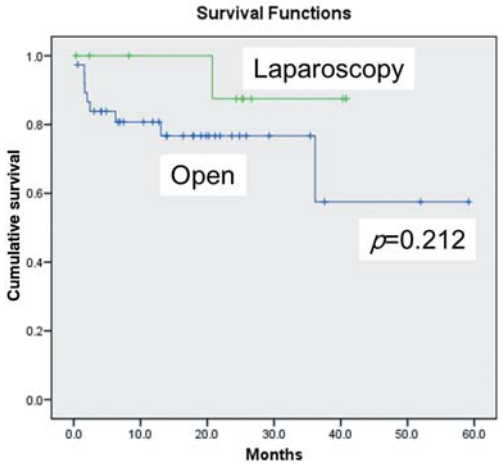

Figure 1. *Kaplan-Meier analysis of 5-year cancer-specific survival. There was no significant difference in cancer-specific survival rate between open (57.5%) and laparoscopic (87.5%) approaches (p=0.212).*

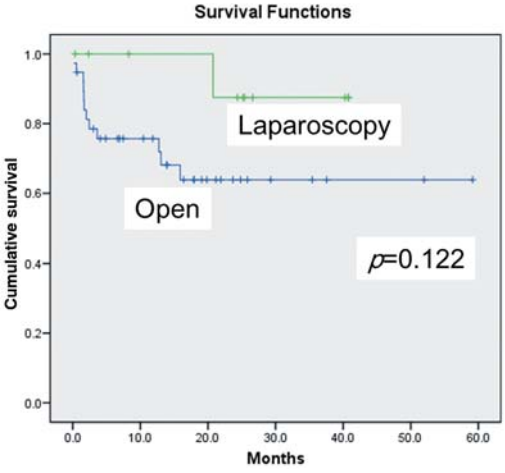

Figure 2. *Kaplan-Meier analysis of 5-year recurrence-free survival. There was no significant difference in recurrence-free survival rates between open (63.9%) and laparoscopic (87.5%) approaches (p=0.122).*

bowel due to tumor obstruction may prevent appropriate surgical exposure and in patients with a perforated tumor with severe fecal contamination it is difficult to clean-up the contamination with a laparoscopic approach (21). Thus, proper patient selection is mandatory when deciding whether to perform laparoscopy. Whenever possible, we obtained a preoperative computed tomography scan before the surgical decision. Patients with a small tumor and short duration of obstruction with mild dilatation of small bowel have been suggested as good candidates for laparoscopy (22).

Surgeons tend to perceive increased technical difficulties for emergency situations, such as anticipated longer operative time, a less-organized operative team or fatigue of night work. All surgeries in the present study were performed by two colorectal surgeons with experience of over 600 and 200 cases of laparoscopic surgeries, respectively. In general, 30-70 cases are required to overcome the learning period for laparoscopic colorectal surgery.(9) Thus, we believe that emergency laparoscopy may not be recommended for all colorectal surgeons. However, with sufficient surgical

training and experience, surgeons may become comfortable with emergency laparoscopic surgery.

The role of emergency laparoscopy for colorectal cancer, compared to open surgery, has not been extensively evaluated. Catani *et al*. (20) demonstrated lower postoperative morbidity (0% *vs*. 15%) and shorter median hospital stay (6 days *vs*. 8 days) in 34 patients, including 12 with colorectal cancer who underwent emergency laparoscopy, compared to open surgery. There were two conversions in patients with Hinchey III and IV grade diverticular perforation. Ballian *et al*. (19) compared 341 laparoscopic (26.6% colorectal cancer) and 3,211 open (14.4% colorectal cancer) colon resections using the American College of Surgeons National Surgical Quality Improvement Program database. They observed that laparoscopy is associated with a longer operative time, shorter hospital stay and similar postoperative morbidity and mortality. Nash *et al*. (21) evaluated a total of 68 patients who underwent emergency minimally-invasive (n=36, 5 with colorectal cancer) and open colectomy (n=32, 6 with colorectal cancer). Colonic perforation or obstruction was more common in the open-surgery group. There was no difference in postoperative morbidity and the minimally-invasive approach was associated with a longer operative time and fewer cases of prolonged hospitalization (>7 days). Ng *et al*. (22) evaluated outcomes of laparoscopic (n=14) emergency and open right hemicolectomy (n=29) for colon cancer. Laparoscopy was associated with longer operative time but less blood loss and a shorter time to full ambulation. Our findings are in line with these studies. The 30-day complication rate and oncological parameters, such as lymph node harvest and resection margin length, did not differ between the laparoscopy and open groups. Moreover, we demonstrated that the oncological outcomes of laparoscopy were comparable between the groups.

Most studies of emergency colectomy have reported longer operative times with laparoscopy (19, 21, 22). In the present study, the mean operative time did not differ between the surgical approaches. This might be due to more complicated cases, such as obstruction and perforation, included in the open surgery group. Prolonged operative time may discourage a surgeon from selecting laparoscopy; however, operative time is not always a good surrogate marker for surgical outcome (27).

Although there was no conversion in this study, previous studies have reported converted cases (20, 21). Open conversion itself is not a risk factor for adverse outcomes (28). When contemplating surgical approaches in questionable cases, diagnostic laparoscopy or early conversion may be one strategy to identify a potential good candidate for laparoscopy.

A major limitation of the present study is the relatively small number of patients. However, as far as we are aware of, this is the first study to evaluate the oncologic outcomes of emergency laparoscopy compared to open surgery.

In summary, in selected colorectal cancer patients, laparoscopy in the emergency setting provides short-term benefits, such as shorter time to tolerable diet and decreased length of hospital stay compared to open surgery. As expected, the oncological outcomes of laparoscopy were comparable to those of open surgery. Based on these results, it appears that emergency laparoscopy confers benefits in terms of short-term and oncologic outcomes, as shown for elective laparoscopy for colorectal cancer. Hence, the use of laparoscopy in the emergency setting may be more actively considered by experienced laparoscopic surgeons. Future larger studies will be valuable to further evaluate the role of laparoscopy for colorectal cancer in the emergency setting and criteria for proper selection of patients who would benefit from a laparoscopic approach.

Acknowledgements

The Authors would like to thank Hyun Jun Kwon for helping us maintain a colorectal database and for performing statistical analyses.

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Received January 12, 2015
Revised January 23, 2015
Accepted January 26, 2015