The Role of the Laparoscopy on Circumferential Resection Margin Positivity in Patients With Rectal Cancer: Long-term Outcomes at a Single High-volume Institution

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Background: The aim of this study was to evaluate the influence of laparoscopic rectal cancer surgery on circumferential resection margin (CRM) involvement.

Materials and Methods: The data from 579 consecutive patients who underwent laparoscopic or open resection of rectal cancer from October 2002 to August 2008 were analyzed retrospectively. The primary endpoint was CRM status. The secondary endpoints were morbidity, local recurrence rate, overall survival, and disease-free survival.

Results: Laparoscopic resections were performed in 266 patients (46%), and the remainder of the patients underwent open resection. The rates of CRM involvement were similar between the laparoscopic and open groups (5.6% vs. 5.4%). The perioperative morbidity rates between the 2 groups were not significantly different ($P = 0.2$). The incidence of local recurrence for the CRM-negative group was 8.4% (8.3% laparoscopic vs. 8.45% open; $P = 0.99$), whereas the local recurrence rate was 34.3% for the CRM-positive group. The local recurrence rate was 20% for the CRM-positive patients in the laparoscopic group and 47% for the CRM-positive patients in the open group ($P < 0.001$). We did not observe any significant differences in local recurrence rates between the Lap R and Open R groups after omitting CRM status. CRM positivity was correlated with both 5-year survival and the 5-year disease-free survival rate ($P = 0.009$ and $P = 0.001$, respectively). We did not observe any significant differences in morbidity, local recurrence, or overall or disease-free survival rates between the overall laparoscopic and open resection groups.

Conclusions: Laparoscopic surgery for rectal cancer is associated with similar complication rates, CRM involvement status, and long-term outcomes as those associated with open surgery but with the advantages of minimally invasive surgery. Although laparoscopic surgery might necessitate more advanced technical skills, similar long-term oncological results can be obtained with this technique.

Key Words: rectal cancer, laparoscopic surgery, open surgery, long-term outcome, circumferential resection margin

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Colorectal cancer is the third most commonly diagnosed cancer worldwide.[1] Approximately 608,000 deaths from colorectal cancer are estimated to occur annually worldwide, accounting for 8% of all cancer deaths.[1] Surgical resection remains the first-choice method, and it remains an integral part of neoadjuvant therapy for treating colorectal cancer. The laparoscopic treatment modality has many advantages over open techniques in terms of early mobilization, earlier bowel movement, less pain, fewer wound complications, shorter lengths of hospital stay, and an earlier beginning of adjuvant chemotherapy and radiotherapy.[2–8]

The safety and oncological efficacy of laparoscopic surgery for treating colon cancer have been established.[9–14] In the COST study, the local recurrence rate at 5 years (open, 21.8%; laparoscopic, 19.4%; $P = 0.25$), overall 5-year survival (open, 74.6%; laparoscopic, 76.4%; $P = 0.93$), and disease-free 5-year survival (open, 68.4%; laparoscopic, 69.2%; $P = 0.94$) were similar for the 2 groups.[15] A number of single-center and single-surgeon studies have also reported the oncological efficiency of laparoscopic surgery for treating rectal cancer, and multicenter clinical studies are ongoing in the United States and Japan (ACOSOG Z6051 and JCOG 0404, respectively).[16,17]

Recent meta-analyses have indicated that laparoscopic resection (Lap R) of rectal cancer is associated with less postoperative morbidity, earlier postoperative recovery, and similar oncological results compared with conventional open resection (Open R). However, the results of these meta-analyses are mostly based on single-center or single-surgeon studies.[2–5] More favorable long-term results after laparoscopic surgery for rectal cancer have also been reported.[6,18,19] Laparoscopic rectal cancer surgery, although technically challenging, provides a better, more magnified view of the narrow and deep pelvic cavity than open surgery, thus facilitating more accurate and easier resection of the mesorectum, therefore lead offering oncological outcomes.[6] Nevertheless, the use of Lap R in rectal cancer remains controversial because of the limited available long-term (5 year) data on survival and recurrence. Furthermore, this approach is considered technically challenging because it requires accurate pelvic dissection with partial mesorectal excision for proximal cancer and total mesorectal excision (TME) for mid and distal cancers, as these techniques result in the lowest incidence of local recurrence rates.[20–22]

Circumferential resection margin (CRM) involvement is a good indicator of the quality of a TME procedure,[23] and it plays an important role in predicting local recurrence and distant metastasis, as well as survival.[24–28] CRM positivity is defined as a margin of 1 or 2 mm between the

tumor tissue and the radial resection margin.[29,30] CRM positivity is related primarily to tumor characteristics (T and N status), the surgeon's experience with rectal surgery, and the abilities and the efforts of pathologists specializing in gastrointestinal system pathology. CRM positivity predicts local recurrence more accurately for patients who have received neoadjuvant therapy than for patients who have not received neoadjuvant therapy.[25]

In this retrospective, single-center study, we primarily aimed to evaluate CRM involvement in patients with rectal adenocarcinoma after Lap R and Open R. Although there have been many studies that have compared the outcomes of Lap R to those of Open R in patients with rectal adenocarcinoma, there have been few studies that have simultaneously assessed CRM status and long-term oncological results.[7,19,31] Our secondary endpoints were the rates of morbidity, local recurrence, overall survival, and disease-free survival.

MATERIALS AND METHODS

Patients

From October 2002 to August 2008, data from 679 patients with primary adenocarcinoma of the rectum were analyzed retrospectively in the Division of Digestive and Colorectal Surgery, Department of General Surgery, Istanbul University Faculty of Medicine, Istanbul, Turkey. Of these patients, 83 were excluded from the study and 17 withdrew or were lost to follow-up. Thus, a total of 579 patients, who were between the ages of 18 to 80 years and who were treated by open or laparoscopic resection, were included in this study (Fig. 1). A joint decision about the surgical approach was made by the patients and surgeons. Exclusion criteria included a previous history of colorectal surgery, emergent (eg, acute obstruction, hemorrhage, or perforation), rectal cancers due to polyposis syndromes or inflammatory bowel diseases, incurable metastatic rectal cancer, and transanal tumor resection. Patients with metastatic disease were included in this study when curative resection of their metastatic masses was performed. All of the operations were performed by the same surgical team, who had experience in open and advanced laparoscopic colorectal surgery. The patients who required conversion to an open procedure were also evaluated in the Lap R group, as in many previous studies.[7,18,19] All patients provided written informed consent.

Preoperative Evaluation

Chest x-ray, total colonoscopy and biopsy, contrast-enhanced abdominopelvic computed tomography, endorectal ultrasound and/or pelvic phased-array magnetic resonance imaging, routine preoperative blood tests, and determination of serum carcinoembryonic antigen levels were performed for all patients. Preoperative short-course radiotherapy or long-course concurrent chemoradiotherapy

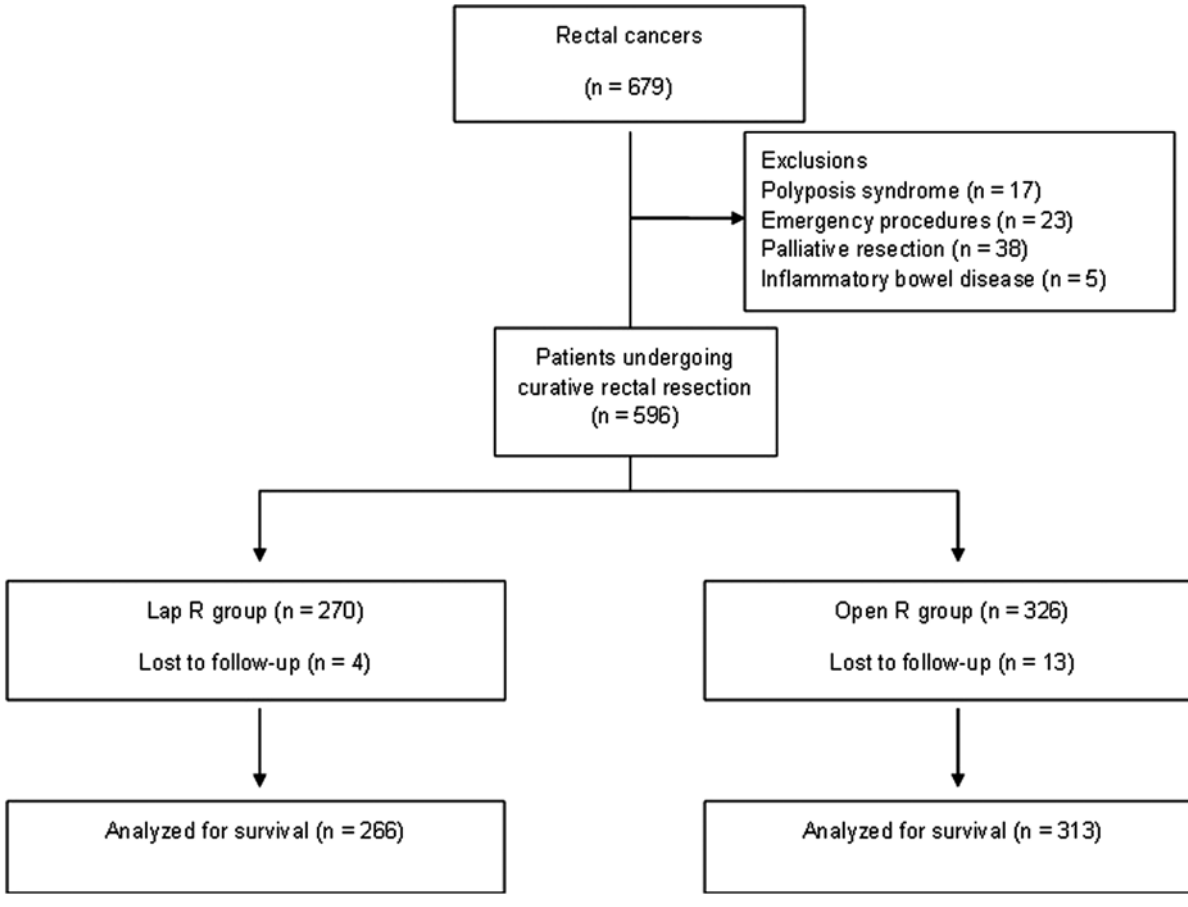

FIGURE 1. Study inclusion flow chart.

was provided for patients with T_3, T_4, or node-positive middle and distal rectal cancers. Surgery was planned within 10 days after short-course radiotherapy and within 6 to 8 weeks after long-course chemoradiotherapy.

Surgical Technique

All patients underwent bowel preparation the day before the operation, and intravenous prophylactic antibiotics were administered during the induction of anesthesia. Deep venous thrombosis prophylaxis with low-molecular weight heparin was provided to each patient individually. Intermittent pneumatic compression devices were used in the perioperative period after 2005.

All patients with middle and distal rectal cancers underwent TME by either Lap R or Open R. For patients with upper rectal cancers, partial mesorectal excision with end-to-end colorectal anastomosis was performed to achieve a distal resection margin of >5 cm. A classical Miles' abdominoperineal resection was performed when there was direct sphincter infiltration.

In the laparoscopic group, a straight approach was employed using 4 or 5 trocars. The inferior mesenteric artery was ligated at its origin, and the mesenteric vein was ligated close to the fourth part of the duodenum at the level of the inferior border of the pancreas. The next step was mobilization of the rectum according to the rules of TME, which were originally described by Heald and Ryall in 1986.[20] In T_4 tumors with anterior organ involvement, en bloc resection was performed (involving the urinary bladder, vagina or seminal vesicles, and the posterior aspect of the prostate). If sphincter-preserving surgery was conducted, anastomosis was performed using standard double-stapling techniques or by coloanal hand-sewn anastomosis.[32,33] In the laparoscopic group, specimens were extracted through a small suprapubic incision after the placement of a wound protector. A protective loop ileostomy was routinely performed in patients who received neoadjuvant therapy and underwent low anterior resection. Conversion to open surgery was required if the surgeon was unable to complete the operation laparoscopically. The details of the surgical techniques have been described in our previous papers.[31,34]

The pathologic specimens were evaluated by experienced pathologists using the technique described by Quirke et al.[35] In the present study, the CRM was considered positive when the distance between the tumor and the surgical border was ≤ 2 mm. The classification of tumors into stages was conducted according to the seventh edition of the American Joint Committee on Cancer manual.[36]

Postoperative Follow-up

Postoperative adjuvant chemotherapy (using fluorouracil and either levamisole or calcium folinate) was routinely administered to patients who received neoadjuvant therapy. Patients who were not treated preoperatively and were classified as pathologic stage II or III received adjuvant chemoradiotherapy.

During the postoperative period, the patients were followed up through clinical examinations and serum carcinoembryonic antigen measurements conducted every 3 months during the first 2 years and then annually. Chest x-rays and abdominopelvic CT scans were performed annually. Control colonoscopies were carried out periodically according to the characteristics of the patients (tailored approach).

Statistical Methods

The patients' characteristics were analyzed by descriptive statistics. For continuous variables, the means ± SDs were calculated. For categorical variables, numbers and percentages in each category were recorded. The characteristics of the Lap R and Open R groups were compared using the Student t test for normally distributed data, the Mann-Whitney test for non-normally distributed data and continuous variables, and the Fisher exact test for categorical variables. Survival time was calculated from surgery to death or to the date of the last follow-up evaluation. The Kaplan-Meier method was applied to estimate the overall survival curves and the median survival times of the Lap R and Open R groups and the CRM-positive and CRM-negative subgroups. The nonparametric log-rank test was used to compare Lap R and Open R survival curves. All P values <0.05 were considered statistically significant, and all of the performed tests were 2-sided. All of the statistical analyses were performed with SPSS, version 12, for Windows (SPSS, Chicago, IL).

RESULTS

The Open R and Lap R groups were comparable in terms of age, sex, tumor location, clinical stage, and the mean follow-up time (Table 1).

In total, 45.9% (n = 266) of the patients received neoadjuvant therapy (50% in the Lap R group vs. 42.5% in the Open R group, $P = 0.07$). Abdominoperineal resection was performed in 35.4% (n = 205) of the patients (22.5% in the Lap R group vs. 46.3% in the Open R group). The overall sphincter preservation rate was 65% (n = 374). Among these patients, a protective loop ileostomy was performed in 223 patients (60%).

Twenty-one patients were converted to open surgery (8%) because of difficulties in pelvic exposure (n = 8), severe adhesion (n = 4), doubt about the status of the margin (n = 4), massive bleeding (n = 3), colonic ischemia due to a failure of the marginal artery circulation (n = 1), or significant hypercapnia due to pneumoperitoneum (n = 1). However, in the later part of the study period, a decrease in conversion rates was observed, from 12.04% in 2005 to 5.26% in 2008 ($P < 0.05$), as we reported in a previous study.[30] The intraoperative, early postoperative, and late morbidity rates between the overall Lap R and

TABLE 1. Demographics of Patients

Variables	Lap R n = 266	Open R n = 313	*P*
Age (y)	58.9 ± 14.1	58.3 ± 13.7	0.6
Sex (male/female)	149/117	180/133	0.4
Tumor location (cm)			
Distal (0-5)	100	130	0.06
Middle (6-10)	89	119	
Proximal (11-15)	77	64	
Preoperative clinical staging			
0-1	62	67	0.3
2	88	101	
3	103	137	
4	13	8	
Neoadjuvant therapy	133	133	0.07
Follow-up period (mo)	56.6 ± 19.1	60.9 ± 28	0.33

Data are means ± SDs or numbers of patients.

TABLE 2. Incidence of Perioperative Complications

	Lap R	Open R	*P*
Complications			0.2
Intraoperative complications			0.32
Bleeding	3	4	
Colonic ischemia	1	—	
Hypercapnia	1	—	
Ureteral injury	—	5	
Bowel injury	—	1	
Early postoperative complications*			0.37
Wound infection	20	19	
Adhesive obstruction	5	3	
Urinary retention	6	5	
Anastomotic leakage	10	15	
Pelvic abscess	2	2	
Atelectasia	5	3	
Urinary infection	3	4	
Late complications†			0.9
Stoma-related	1	2	
Intestinal obstruction	2	2	
Incisional hernia	2	6	
Anastomotic stricture	2	2	
Parastomal hernia	1	2	
Colovaginal fistula	—	1	
Vesicovaginal fistula	1	—	
Enterocutaneous fistula	1	—	
Urinary retention	1	1	
Heart attack	1	—	
Fournier's gangrene	1	—	

Data are means ± SDs or numbers of patients.
*Early postoperative complications were defined as complications occurring within 30 days after surgery.
†Late complications occurred more than 30 days after surgery.

Open R groups were not significantly different ($P = 0.32$, 0.37, and 0.9, respectively) (Table 2). There was only one postoperative death in the Lap R group (0.38%), which was caused by myocardial infarction within 30 days of surgery.

The distal resection margins were tumor-free in all patients. The overall rate of CRM involvement was observed to be 5.5% (n = 32) [5.6% (n = 15) in the Lap R group vs. 5.4% (n = 17) in the Open R group]. The rate of positive circumferential margins did not differ between the 2 groups ($P = 0.91$). However, the mean number of harvested lymph nodes was significantly higher in the overall Lap R group ($P = 0.03$), and there was a significant difference in the mean tumor size between groups (34.4 mm in the overall Lap R group vs. 40.6 mm in the overall Open R group; $P = 0.02$) (Table 3). There was also a significant difference in mean tumor size, mean number of harvested lymph nodes, and pT and pN status between the CRM-positive and CRM-negative groups (Table 4).

TABLE 3. Histopathologic Outcomes

Variables	Lap R	Open R	*P*
Tumor size (mm)	34.4 ± 18.6	40.65 ± 25.3	0.02
No. harvested lymph nodes (total)	21.3 ± 11.7	18.9 ± 11.1	0.03
No. metastatic lymph nodes	5.28 ± 5.4	6.39 ± 7.5	0.37
Resection margins			
Positive			
Distal	—	—	
Circumferential	15	17	0.91

Data are means ± SDs or numbers of patients.

TABLE 4. Histopathologic Outcomes and CRM Status

Variables	Overall CRM (–) Group	Overall CRM (+) Group	*P*
Tumor size (mm)	37.5 ± 22.9	42.2 ± 16.4	0.03
No. positive lymph nodes	2.1 ± 4.9	4.3 ± 5.9	0.001
pT status			0.003
pT_0	18	—	
pT_1	35	—	
pT_2	114	2	
pT_3	353	24	
pT_4	27	6	
pN status			0.025
pN_0	350	13	
pN_1	94	8	
pN_2	103	11	

Data are means ± SDs or numbers of patients.

The mean follow-up period was 58.9 months (range, 48 to 127 mo). CRM involvement was significantly correlated with local recurrence in both groups ($P < 0.001$) (Fig. 2). The incidence of local recurrence for the CRM-negative group was 8.4% (8.3% laparoscopic vs. 8.45% open, $P = 0.99$), whereas the local recurrence rate was 34.3% for the CRM-positive group. The local recurrence rate was 20% for the CRM-positive patients in the laparoscopic group and 47% for the CRM-positive patients in the open group ($P < 0.001$). The survival rate for CRM-negative patients was 71.7% (74.9% Lap R vs. 68.9% Open R), whereas that for CRM-positive patients was 53.1% (66.7% Lap R vs. 41.2% Open R). The disease-free survival rate for CRM-negative patients was 63.6% (67.3% Lap R vs. 60.4% Open R), whereas that for CRM-positive patients was 21.8% (33.3% Lap R vs. 11.8% Open R). CRM positivity was significantly correlated with both the overall and the disease-free survival rates ($P = 0.009$ and $P = 0.001$, respectively) (Figs. 3, 4).

We did not observe any significant difference in local recurrence or in the overall and the disease-free survival rates between the overall Lap R and Open R groups after omitting CRM status (Table 5), and no wound or port-site recurrence was detected in either group. Evaluation of the overall survival rates according to tumor stage in the overall Lap R and Open R groups indicated no difference in the stage I, II, and IV subgroups, whereas the survival rate in stage III patients was higher in the overall Lap R group compared with the overall Open R group ($P = 0.02$)

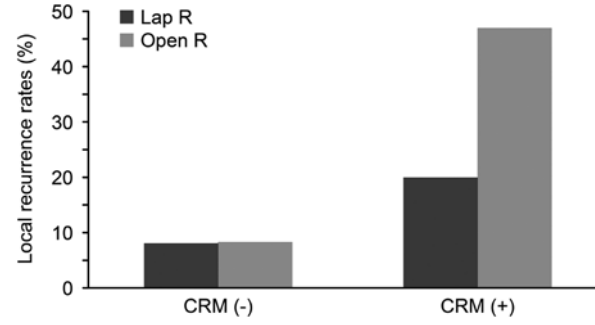

FIGURE 2. Relationship of local recurrence with circumferential resection margin (CRM) status.

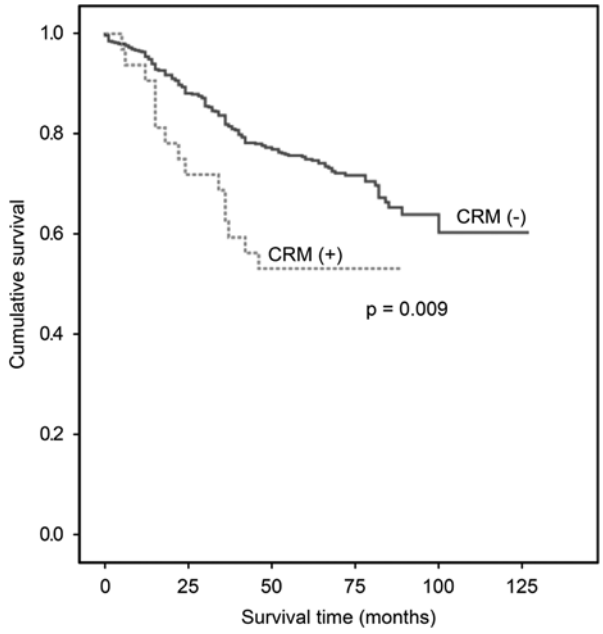

FIGURE 3. The Kaplan-Meier curve for overall survival according to the circumferential resection margin (CRM) status by log-rank test ($P = 0.009$).

(Fig. 5). The overall and disease-free survival curves are shown in Figures 6 and 7.

DISCUSSION

It is now well established that laparoscopic surgery for rectal cancer has greater short-term benefits[2–8] than open surgery, without compromising oncological results.[3,5] However, this approach is not yet widely accepted because of the technical difficulties involved, and some doubts remain regarding long-term oncological outcomes. In addition, there is a lack of multicenter clinical studies comparing the long-term outcomes between laparoscopic and open surgery. However, there are 2 ongoing multicenter studies addressing this topic (ACOSOG Z6051 and JCOG 0404) that are now recruiting patients in the United States and Japan, respectively.[16,17]

In previous studies, we demonstrated the short-term benefits of laparoscopic surgery in terms of a shorter hospital stay and time to oral intake.[31,34] The 2 techniques were found to display similar intraoperative, early postoperative, and late morbidity rates. Our findings are in agreement with the results of previous studies[3,5,14,18,37–40] and confirm the safety of laparoscopic surgery for treating rectal cancer.

The pathologic evaluation of resected rectal carcinoma specimens must include a routine histologic assessment of the CRM, which was the primary endpoint in our study.[41–44] The CRM is considered one of the strongest predictors of surgical quality for rectal cancer.[24,45] Optimized TME procedures performed by experienced surgeons reduce

TABLE 5. Oncologic Outcomes*

	n (%)		
	Overall Lap R Group	Overall Open R Group	*P*
Local recurrence	24 (9)	33 (10.5)	0.15
Overall survival	198 (74.4)	211 (67.4)	0.2
Disease-free survival	175 (65.8)	182 (58.1)	0.1

*Mean follow-up period of 58.9 months (range, 48 to 127 mo).

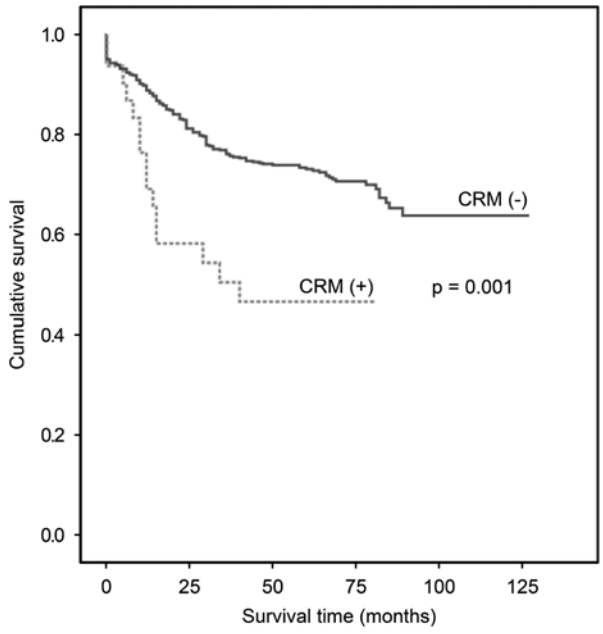

FIGURE 4. The Kaplan-Meier curve for disease-free survival according to circumferential resection margin (CRM) status by log-rank test ($P = 0.001$).

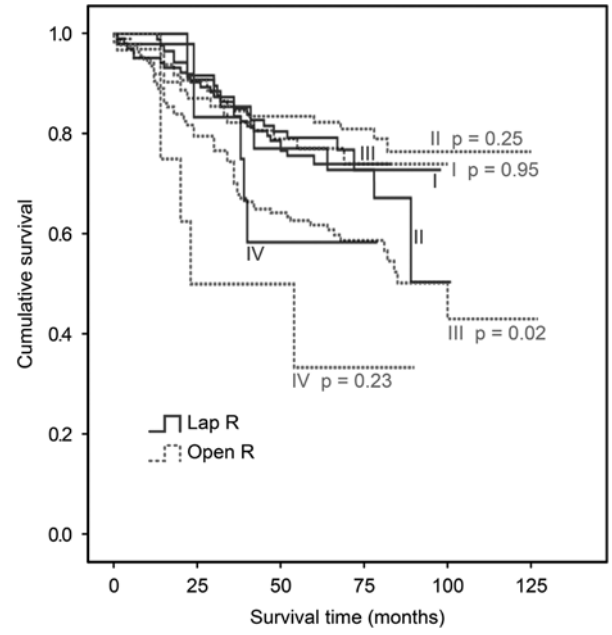

FIGURE 5. The Kaplan-Meier curve for overall survival according to TNM tumor stages of the overall Lap R group versus the Open R group by log-rank test.

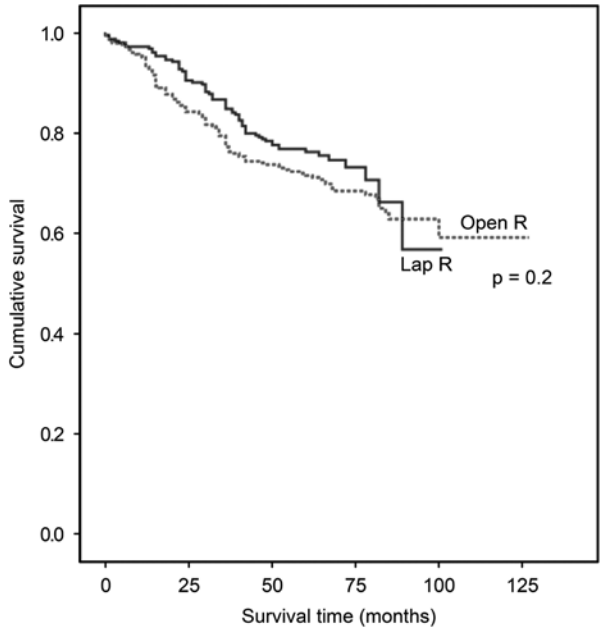

FIGURE 6. The Kaplan-Meier curve for the overall survival of the overall Lap R group versus the Open R group by log-rank test ($P = 0.2$).

the possibility of obtaining CRM-positive specimens.[46] A positive CRM is defined as a direct tumor extension within 1 or 2 mm of the radial, nonperitonealized surface of the resection specimen.[29,30] Previous studies have generally used a threshold of ≤ 1 mm to define CRM involvement. However, a margin of > 2 mm between the tumor tissue and the radial resection margin has been reported to be associated with decreased local recurrence and decreased rates of distant metastases.[5,30] Thus, in the present study, the CRM was considered positive when the distance between the tumor tissue and radial resection margin was ≤ 2 mm. The overall rate of CRM involvement was observed to be 5.6% in the Lap R group and 5.4% in the Open R group. There was no significant difference between the 2 groups with regard to CRM involvement. We also observed no significant difference in the distal resection margin.

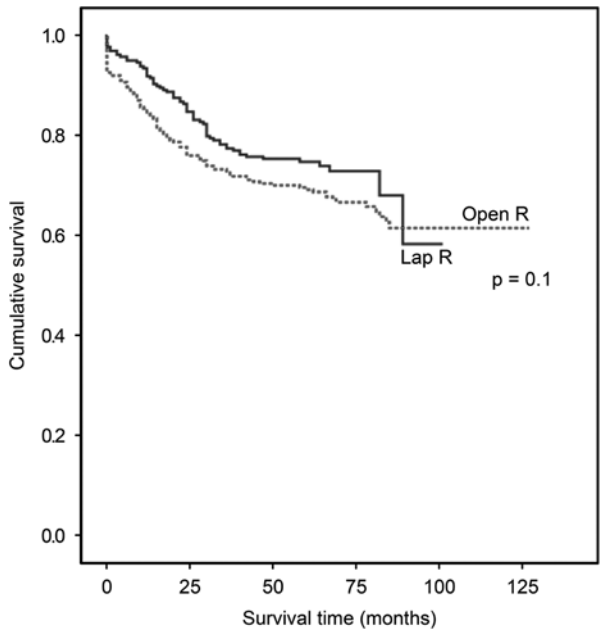

FIGURE 7. The Kaplan-Meier curve for the disease-free survival of the overall Lap R group versus the Open R group by log-rank test ($P = 0.1$).

TABLE 6. Comparative Studies

Author	Patients (n)	CRM Positivity (%)	*P*
Breukink et al[50]*	Lap: 41	7.3	NS
	Open: 41	12.1	
Braga et al[39]†	Lap: 83	1.2	NS
	Open: 85	2.3	
Ng et al[7]‡	Lap: 51	5.8	NS
	Open: 48	4.1	
Ng et al[48]‡	Lap: 76	2.6	0.62
	Open: 77	1.3	
Laurent et al[19]‡	Lap: 238	7	0.68
	Open: 233	6	
Kang et al[49]‡	Lap: 170	2.9	0.77
	Open: 170	4.1	
This study*	Lap: 266	5.6	0.91
	Open: 313	5.4	

*CRM was considered as positive if ≤ 2 mm.
†The limit of CRM positivity was not stated in the study.
‡CRM was considered as positive if ≤ 1 mm.
CRM indicates circumferential resection margin; NS, not significant.

Although the early reported outcomes from a multicenter randomized controlled trial of patients indicate higher rates of positive surgical margins associated with laparoscopic rectal cancer surgery,[47] recent single-center studies have observed positive CRM rates of 1% to 7% and have indicated that there is no difference in CRM involvement rates between patients receiving open and laparoscopic surgery.[7,19,39,48] Higher, but nonsignificant, rates of CRM involvement following open surgery have also been reported[5,49,50] (Table 6).

Our results are in accordance with the outcomes of previous studies and confirm that CRM involvement is significantly correlated with local recurrence and both disease-free and overall survival rates. When the local recurrence rates were compared in the patients with CRM involvement, we observed a higher local recurrence rate in the patients who underwent Open R (20% Lap R vs. 47% Open R). Moreover, the mean number of harvested lymph nodes was significantly greater in the Lap R group in our study. We believe that this might be associated with selecting suitable patients with smaller-sized tumors for laparoscopic surgery during the learning curve period. Indeed, there was a significant difference in tumor size between the 2 groups, but they were comparable in terms of clinical stage and the application of neoadjuvant therapy. Furthermore, significantly lower local recurrence rates after laparoscopic resection were also demonstrated by Morino et al.[18] They observed local recurrence rates of 3.2% in their Lap R group and 12.6% in their Open R group. As in the present study, the 2 groups were homogenous in terms of the distribution of clinical stages.

The results of the present study suggested that there were no differences between the overall Lap R and Open R groups concerning local recurrence rates, overall survival,

TABLE 7. Survival Rates of the Studies Providing Long-term Outcomes

References	Follow-up Period	Stage	Overall Survival (%)		*P*
			Lap	Open	
Morino et al[18]	5 y	I	94.1	94.4	NS
		II	95.0	96.4	NS
		III	82.5	40.5	0.006
		IV	15.8	0	0.013
Braga et al[39]	5 y	I	85	83	0.93
		II	91	72	0.37
		III	65	66	0.98
		IV	10	21	0.95
Lezoche et al[53]	5 y	I	88.8	86.6	0.62
		II	70	58.3	0.91
		III	58.8	46.1	0.93
Kim et al[51]	5 y	I	85.2	81.8	NS
		II	78.5	75.5	NS
		III	50.0	31.9	< 0.05
		IV	10.0	13.9	NS
Laurent et al[19]	5 y	I	—	—	0.97
		II	—	—	0.08
		III	—	—	0.02
		Total	83	72	0.003
This study	5 y	I	75	75.8	0.95
		II	74.7	79.4	0.25
		III	74.8	56.2	0.02
		IV	61.5	37.5	0.23

NS indicates not significant.

and disease-free survival at 5 years. Therefore, our findings confirm the results of recent reports.[19,39,51] In addition, some studies have shown that laparoscopic-assisted surgery is associated with more favorable overall survival, especially in patients with stage III tumors[18,19,52] (Table 7). Our results also indicated that the patients with stage III rectal cancer who underwent Lap R displayed a better overall survival rate than the patients who underwent Open R.

Some limitations of the present study were its nonrandomized treatment arms and retrospective design. However, the Lap R and the Open R groups were balanced in terms of their baseline characteristics, tumor locations, clinical staging, and the administration of neoadjuvant therapy. All of the results of this study were obtained by the same surgical team, who had experience in both open TME and advanced laparoscopic colorectal surgery. We believe that laparoscopic surgery for rectal cancer should become a standard approach in the future, in association with increased surgical experience.

In conclusion, the present study confirms that laparoscopic surgery is safe and results in similar complication rates, CRM involvement status, and long-term outcomes as traditional surgery, thus representing a feasible alternative to the traditional approach, with the advantages that come with a minimally invasive approach. Moreover, we suggest that laparoscopic surgery for rectal cancer may decrease local recurrence rates and can be associated with more favorable overall survival, especially in patients with stage III tumors. Despite the retrospective nature of our trial, the study population presented homogenous characteristics and was sufficiently large to allow us to draw a conclusion. The results of multicenter trials that are ongoing in the United States and Japan are needed to confirm the oncological efficacy and more successful outcomes of laparoscopy for treating rectal cancer.

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