Original Article

Laparoscopic-assisted Versus Open Surgery for Rectal Cancer

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Key Words
Laparoscopic surgery
Short-term outcome
Rectal cancer

Purpose. The aim of this study was to compare the short-term outcome for consecutive patients undergoing either laparoscopic or open rectal resection for cancer in a single specialized institution.
Methods. All patients with rectal cancer admitted to our institution from September 2006 to August 2008 were included in the study. Patients who underwent emergency operation were excluded. Patients were given the option of laparoscopic or open colectomy and asked to choose after thorough explanation of the pros and cons of each procedure. Patients who had clinical T3 stage cancer or positive lymph nodes were treated with preoperative chemoradiotherapy. The same surgical team was used for all surgical procedures and all patients were prospectively followed for a minimum period of 6 months, in accordance with NCCN Clinical Guidelines in Oncology.
Results. Of the 151 consecutive patients in the study, 76 chose to undergo laparoscopic colectomies while 75 decided on open surgery. The procedures included low anterior resection with staple anastomosis for 99 patients (laparoscopy/convention: 45/54), abdominoperineal resection for 13 patients (laparoscopy/convention: 9/4), Hartmann's procedure for 12 patients (laparoscopy/convention: 4/8), and low anterior resection with hand-sewn transanal coloanal anastomosis for 27 patients (laparoscopy/convention: 18/9). Conversion to an open procedure occurred for 7 patients (9.2%). Postoperative complications developed in 18 patients in laproscopy group and 14 patients in the conventional group. The length of hospital stay for the conventional group was significantly longer than that of laparoscopic group (12 vs 10 days; $p < 0.001$). Furthermore, laparoscopic surgery offers decreased rate of blood loss (145 vs 218 cc; $p < 0.001$), but higher operative time compared to open surgery (234 vs 181 minutes; $p < 0.001$).
Conclusion. Laparoscopic resection is a safe and feasible method of operation for rectal cancer. It does not affect the early surgical oncological outcome, such as length of specimen removed, distal margin, and number of lymph node identified. It also offers decreased rate of blood loss and shorter lengths of hospital stay. However, longer follow-up duration and larger sample sizes will be needed to reveal definitive long-term results of laparoscopic-assisted surgery.
[*J Soc Colon Rectal Surgeon* (*Taiwan*) *2010;21:79-86*]

Received: Auguest 25, 2009. Accepted: January 23, 2010.
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During the past two decades, remarkable progress has been made in the treatment of rectal cancer. Total mesorectal excision is an effective method for preventing local recurrence.[1] Laparoscopic colectomy for colon cancer has gained much acceptance since the COST trial,[2] and offers comparable cancer-related survival rates to open colectomy when performed by an experienced surgeon.[3] In addition, the oncologic results of the laparoscopic approach for Stage II or III left-sided colon cancers are similar to those of traditional open surgery.[4]

The minimally invasive procedure is argued to be more favorable than conventional techniques in colorectal surgery, thereby encouraging a growing number of studies that have provided more specific details on laparoscopic excision of rectal cancer.[5-8] Despite the acclaim earned from its users, the laparoscopic approach for rectal cancer remains controversial. This study aims to compare the feasibility, safety, and short-term surgical outcomes of the laparoscopic approach with those of conventional open surgery in patients with rectal cancer in a single specialized institution.

Materials and Methods

All patients with rectal cancer admitted to our institution from September 2006 to August 2008 were included in the study. Patients who underwent emergency operation were excluded. Patients were given the option of laparoscopic or open colectomy and asked to choose after having received a thorough explanation of the pros and cons of each procedure. All patients underwent preoperative tumor staging, which included evaluation of colonoscopic biopsy specimens, endorectal ultrasound, computed tomography of the abdomen and pelvis, and chest radiography. Patients who had clinical T3 stage cancer or positive lymph nodes were treated with preoperative chemoradiotherapy.

To maintain consistency of clinical practice, the same surgical team performed all surgical procedures. Patients in both groups underwent total mesorectal excision, which included high ligation of the inferior mesenteric vessels, en bloc excision of the rectum under meticulous sharp dissection, and proper clearance of resection margins. A wound protector sleeve was used to prevent possible implantation of cancer cells. Specimens were removed through a 4-6 cm minilaparotomy unless abdominoperineal resection was necessary, in which case specimens were removed through perineal access.

During low anterior resection, the splenic flexure was taken down in order to achieve maximal colonic mobilization and allow for tension-free anastomosis. Double-stapling anastomosis with a circular stapler was performed, provided that the patient had an adequate healthy rectal stump and that an adequate margin could be obtained via transection with the transverse stapler. Otherwise, a hand-sewn transanal coloanal anastomosis was performed. In this study, diverting ileostomies were not routinely performed; the choice to create a protective ileostomy was strictly an intraoperative decision in patients with gas leakage diagnosed by hydropneumatic testing, an incomplete doughnut after stapling, or in patients who required hand-sewn coloanal anastomosis. A perianastomotic extraperitoneal drain was left in place after surgery in all patients.

Patients were prospectively followed for a minimum period of 6 months, in accordance with NCCN Clinical Guidelines in Oncology. Parameters assessed included length of surgical specimen, clearance of margins of the specimen, and the number of lymph nodes identified. Three pathologists performed detailed examinations of the resected specimens using standardized techniques. The pathologists were not informed about the surgical technique used (laparoscopic or open).

Data were analyzed using the chi-square test for categorical variables. Independent risk factors were assessed using SPSS software. A p value < 0.05 was considered statistically significant.

Results

Of the 151 consecutive patients enrolled in the study, 76 chose to undergo laparoscopic colectomy and 75 decided to undergo open surgery. Patient characteristics and distribution among ASA classes of risk

were similar in both groups (Table 1). Short-term surgical results were shown in Table 2. Among the patients who underwent laparoscopic surgery, 72 were treated with curative intent and 4 (5.3%) underwent laparoscopic resection as palliative care because of synchronous liver metastases. Among the patients that underwent open surgery, 63 were treated with curative intent and 12 (16%) received palliative treatment. Neoadjuvant chemoradiotherapy was administered to 20 patients in the laparoscopy group and to 15 patients in the open surgery group. Patients with synchronous metastases did not receive neoadjuvant treatment.

Table 1. Patient demographics

Patient Characteristic	Laparoscopy (n = 76)	Open (n = 75)	*p* value
Age mean (years)	62	64.6	0.318
Gender			0.795
Male (%)	43 (56.6)	44 (58.7)	
Female (%)	33 (43.4)	31 (41.3)	
ASA* class			0.643
< 3 (%)	64 (84.2)	62 (82.7)	
≥ 3 (%)	12 (15.8)	13 (17.3)	
Previous malignancy	3	5	NS
Metastasis			NS
Liver	4	11	
Lung	0	1	
Tumor location			
Upper rectum	25	31	
Middle rectum	24	31	
Lower rectum	27	13	
Pre-OP CCRT	20 (26.3)	15 (20)	NS

* American Society of Anesthesiologists

Various surgeries were performed in the two groups of patients and a thorough breakdown of surgical complications is included in Table 3. Of the 45 patients who underwent low anterior laparoscopic resection, 13 required a protective ileostomy. Anastomotic leaks requiring laparoscopic re-operation with protective ileostomy occurred in three patients. Small bowel perforation occurred after the laparoscopic procedure in one patient. The perforation was repaired and the resection was performed via re-laparotomy. Postoperative bleeding requiring emergency operation occurred in one patient. Finally, one patient died due to acute myocardial infarction during surgery. Other notable complications occurred during laparoscopic Hartmann procedures and abdominoperineal resec-

Table 2. Surgical results

Surgical Parameter	Laparoscopy	Open	*p* value
Operative Method			0.07
WME*	45	54	
TME + CAA**	18	9	
APR***	9	4	
Hartmann	4	8	
Diverting	26	23	0.642
Operative Time (min)	234.0	180.7	< 0.001
Blood loss (mL)	145.0	218	< 0.001
Conversion	7	-	
Length of Hospital Stay (days)	10	12	< 0.001
Operative Complication	18	14	NS
Operative Mortality	1	0	NS

* Wide mesorectal excision
** Total mesorectal excision+ coloanal anastomosis
*** Abdominoperineal resection

Table 3. Surgical complications

	Laparoscopic (n = 76)					Open (n = 75)					*p*
	WME (n = 45)		TME + CAA (n = 18)		Others (n = 13)	WME (n = 54)		TME + CAA (n = 9)		Others (n = 12)	
Protective ileostomy	Yes (n = 13)	No (n = 32)	Yes (n = 13)	No (n = 5)		Yes (n = 19)	No (n = 35)	Yes (n = 4)	No (n = 5)		
Anastomotic leakage	1	3	3	2		1	1	0	1		$p < 0.05$
Anastomosis stricture							1				
Fistula formation			1								
Postoperative ileus	2						1				
Small bowel perforation		1									
Postoperative bleeding		1					1				
Intraoperative complications					1	0					
Wound Infection	3					3	3			2	
Total	18 (23.7%)					14 (18.7%)					NS

tions. Intraoperative troche-induced aortic injury occurred in one patient and others had an uneventful postoperative course. The overall complication rate in the laparoscopic group was 23.7%.

The conversion rate from laparoscopic to open surgery was 9.2% (n = 7). The conversions occurred during low anterior resections with staple anastomosis in 3 patients; during low anterior resection with hand-sewn transanal coloanal anastomosis in 1 patient; during abdominoperineal resection in 1 patient; and during Hartmann procedures in 2 patients. These conversions were performed for various reasons such as difficulty in isolating the rectum (n = 2), marginal arterial injury (n = 1), colon injury (n = 1), spleen injury (n = 1), acute myocardiac infarction during operation (n = 1), and aorta injury (n = 1). Among these patients, 5 had T3 stage cancer, 1 had Tx stage cancer, and 1 had T1 stage cancer.

In the open colectomy group, 19 patients received protective ileostomies. Anastomotic leakage occurred in three patients and wound infection requiring debridement occurred in 8 patients. One patient experienced postoperative bleeding and underwent re-operation and one patient had an anastomosis stricture which resulted in a Hartmann operation 3 months later. The overall complication rate in the open colectomy group was 18.7%.

TNM staging after laparoscopic or open resection was similar between both groups of patients (Table 4). There were also a significant number of cases in which the tumor was in complete remission as a result of preoperative chemoradiotherapy. The remission rate was also similar between patients who underwent laparoscopic surgery (n = 8; 10.5%) and those who underwent open surgery (n = 7; 9.3%).

Table 4. Tumor information

Tumor Characteristics	Laparoscopy	Open	*p* value
Tumor size, mean (cm)	3.82	4.13	NS
TNM stage			0.137
cis-I	14 (18.4%)	10 (13.3%)	
II	18 (23.7%)	16 (21.3%)	
III	32 (42.1%)	30 (40.0%)	
IV	4 (5.3%)	12 (16%)	
s/p CCRT with CR	8 (10.5%)	7 (9.3%)	
Tumor invasion to other organ	3 (3.9%)	5 (6.7%)	
Length of specimens removal (cm)	18.1	18.2	NS
Lymph node harvest, mean	15.5	17.9	0.085
Distal margin	3.1	2.8	0.05
Lymphovascular invasion	19 (25%)	28 (37.3%)	0.102
Perineural invasion	24 (31.6%)	32 (42.7%)	0.140

Discussion

The aim of this study was to compare the feasibility, safety, and short-term surgical outcomes of the laparoscopic approach with those of conventional open surgery. This study was not a randomized investigation and was based on consecutive rectal cancer patients that underwent laparoscopic surgery or open surgery in a single specialized institution. The rate of palliative resections was higher in the open surgery group than in the laparoscopic surgery group. This may have simply been because laparoscopic surgery for palliative resection is not covered by the National Health Insurance system in Taiwan, and, therefore, requires the patient to pay out-of-pocket, thereby possibly influencing the patient's choice of operative method.

There were no significant differences in operative mortality or morbidity between the two surgical procedures. In addition, preoperative chemoradiotherapy did not cause any specific difficulties in open or laparoscopic surgical dissection. Operative time was significantly higher in the laparoscopic group, possibly due to the time needed for setting up laparoscopic equipment. Despite the increased duration, blood loss was significantly lower for this group. This may have been the result of meticulous dissection during laparoscopic surgery. Furthermore, the length of hospital stay was also significantly shorter.

No statistically significant differences were found in the length of the specimen removed, length of distal margins, or the number of lymph nodes identified between the two groups. Scott and Grace recommended that at least 13 lymph nodes be histologically examined for reliable assessment of the nodal stage in colorectal cancer.[9] Other studies maintain that 14 or 15 nodes (range 12-17) should be examined to provide reliable nodal staging in rectal cancer.[10,11] In our study, the mean number of lymph nodes harvested

was 15.5 in the laparoscopic group and 17.9 in the open group. These numbers comply with the number of nodes required by the UICC. The number of nodes, however, is not always an indicator of oncologic adequacy because nodal staging is dependent on the skill of the pathologist.[12]

In this study, the intraoperative conversion rate from laparoscopic to open surgery was 9.2%. It mainly resulted from difficulty in identifying anatomic landmarks and was not related to tumor stage and size. The rate of conversion to open procedures has been reported to vary from as low as 3% to as high as 29%.[5,12-16] This discrepancy may be related to the surgeon's threshold or expertise. In addition, a well-trained team may be another important factor in reducing the conversion rate. In our study, most conversions occurred during the first year of the study, which we believe was due to the factors discussed above.

Although there was no significant difference in the overall complication rate between the two groups, the rate of anastomotic leakage was significantly higher (11.8%) in the laparoscopic group. Although few authors have reported leak rates lower than 5% after total mesorectal excision,[17] others have reported leak rates as high as 10% to 20%.[18,19] Our rate was consistent with published reports describing a range of 7-17%.[12,14,20,21] Several risk factors, such as gender, obesity, and the level of anastomosis, are reported to be associated with postoperative complications, especially anastomotic leakage.[22,23] The incidence of anastomotic leakage in laparoscopic rectal surgery seems to be higher than in open surgery.[18,24] Double-stapling may be one of the reasons for the higher rate of leakage in laparoscopic rectal surgery. Laparoscopic linear stapling through a port to transect the rectum is usually needed more than once. This results in an unduly long staple line and consequently, a higher leakage rate.[25] Another explanation for the higher leakage rate associated with laparoscopic surgery is the limitation of the degree of laparoscopic linear staple rotation. Ideally, the stapler should rotate 90 degrees to allow a perpendicular transection of the rectum; however, the current commercially available stapler can only rotate 42 degrees at most, resulting in an ischemic sharp angle on the rectal stump, thereby increasing the chance of anastomotic leakage. In addition to multiple stapling, the degree of teamwork may be another factor affecting morbidity and the rate of anastomotic leakage. Table 5, which illustrates the division our study into four equal time periods, reveals that the complication rate is notably higher in the first two periods. The morbidity rate during the first and second period was high, while the complication rate dropped after the third period. While not statistically significant, the anastomotic leakage rate decreased after the third period. In conclusion, maturation of teamwork may explain why the complication rate decreased as the periods increased.

Some authors maintain that the risk of positive resection margins is higher with laparoscopy, resulting in higher local recurrence rates.[15] Yet, our study showed no positive margins and no local recurrence in the short-term follow-up. Liang et al. reported that there was no difference in the estimated cumulative recurrence rate for Stage II or III left-sided colon cancer between laparoscopic and open methods.[4] In our study, despite the favorable postoperative data, evaluation of oncological adequacy should only be based on distal margin clearance or on the number of lymph nodes removed. Long-term outcomes in terms of local recur-

Table 5. Distribution based on period

Complication	Period I (n = 19)	Period II (n = 20)	Period III (n = 16)	Period IV (n = 21)	*p* value
Post-op Morbidity	8 (42.1%)	5 (25%)	2 (12.5%)	3 (14.3%)	< 0.05
Anastomotic leakage	4	2	1	2	0.387
Fistula formation	1	0	0	0	-
Postoperative ileus	1	0	0	1	-
Small bowel perforation	0	1	0	0	-
Postoperative bleeding	0	1	0	0	-
Intraoperative complications	0	1	0	0	
Wound infection	2	0	1	0	-

• The interval of each period is six months.

rence and 5-year survival rates should also be considered.

Conclusion

Laparoscopic resection is a safe and effective treatment for rectal cancer. The length of specimens removed, the length of distal margins, and the number of lymph nodes identified are similar between laparoscopic and open surgical methods. Furthermore, laparoscopic surgery is associated with a decreased rate of blood loss and shorter lengths of hospital stay. Despite these benefits, the rate of anastomotic leakage was higher among patients who underwent laparoscopic resection than among those who underwent open surgery. Thus, there is still room for improvement in the technical aspects of this procedure. Prospective studies with longer follow-up duration and larger sample sizes are needed to reveal definitive long-term results of laparoscopic-assisted surgery.

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原　著

直腸癌在腹腔鏡手術和傳統剖腹手術的比較

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目的　這篇文章的目的在於比較單一機構的直腸癌病人，接受腹腔鏡手術或傳統開腹手術短期預後的不同。

方法　從 2006 年九月到 2008 年八月，在中國醫藥大學附設醫院接受直腸癌手術的病人的所有病人。施行緊急手術的病人排除在外。病人在經過醫師的詳盡解釋後，選擇腹腔鏡手術或者傳統剖腹手術。臨床上腫瘤侵犯深度超過漿膜層的病人或者淋巴結侵犯呈陽性者，則施與手術前的合併的放射及化學治療，兩個手術方式的團隊是相同的，所有的病人都根據 NCCN 腫瘤臨床指南追蹤，追蹤的時間爲半年。

結果　總共有 151 位病人包含在這個研究，76 個病人選擇腹腔鏡手術而 75 個病人選擇剖腹手術。包含了 99 位病人接受低位直腸切除 (腹腔鏡手術/剖腹手術：45/54)，13 位病人接受腹部會陰部聯合切除 (腹腔鏡手術/剖腹手術：9/4)，12 位病人接受 Hartmann 術式 (腹腔鏡手術/剖腹手術：4/8)，而 27 位病人接受低位直腸切除合併手縫式經肛門之肛門大腸吻合 (腹腔鏡手術/剖腹手術：18/9)。由腹腔鏡手術轉爲開腹手術的病人有 7 位 (9.2%)。手術後的併發症在腹腔鏡手術有 18 位，而在剖腹手術有 14 位。住院時間而言剖腹手術有較長的住院天數 (12 與 10 天；$p < 0.001$)。腹腔鏡手術相對於剖腹手術來說，有較少的失血量 (145 與 218 cc；$p < 0.001$)，但是卻有較長的手術時間 (234 與 181 分鐘；$p < 0.001$)。

結論　腹腔鏡直腸手術在直腸癌是一種安全且可行的方式，這種方式並不影響短期的腫瘤及手術預後，如標本移除的長度、遠端的安全範圍、以及淋巴結取得的數目。它也可以減少病人的住院天數以及手術的失血量。然而，這仍需要長期的追蹤以及更多的病人數印證他的可行性以及長期的預後。

關鍵詞　腹腔鏡手術、短期預後、直腸癌。