Surgical Margins and Short-Term Results of Laparoscopic Total Mesorectal Excision for Low Rectal Cancer

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ABSTRACT

Background and Objectives: The confines of the narrow bony pelvis make laparoscopic surgery more challenging in the treatment of low rectal cancer. Macroscopic evaluation of the completeness of the mesorectum provides detailed information about the quality of surgery. This study was performed to observe the short-term outcomes and evaluate the macroscopic quality of specimens acquired from laparoscopic total mesorectal excision versus open total mesorectal excision in patients with low rectal cancer.

Methods: A total of 177 patients with low rectal cancer underwent total mesorectal excision by either a laparoscopic (n = 87) or open (n = 90) approach. In all cases the surgical time, blood loss, intraoperative and postoperative complications, postoperative bowel opening, and hospital stay were assessed. Special attention was given to the macroscopic judgment concerning the cut edge of peritoneal reflection, Denonvilliers fascia, completeness of the mesorectum, and bowel wall below the mesorectum.

Results: The surgical time was 160 ± 40 minutes in the laparoscopic group. It was not significantly different from that in the open group ($P = .782$). The operative blood loss was 28 ± 5 mL in the group undergoing laparoscopic surgery and 80 ± 20 mL in the group undergoing open surgery ($P < .01$). Intraoperative injuries to the pelvic autonomic nervous system were recorded in 4 cases in the laparoscopic group compared with 12 cases in the open group ($P < .05$). The incidences of chest infection and anastomotic leakage were similar between the 2 approaches. The postoperative bowel opening time was 2.1 ± 1.5 days in the laparoscopic group and 3.5 ± 1.6 days in the open group ($P < .01$), whereas the hospital stay was 5.2 ± 1.8 days and 7.0 ± 2.1 days, respectively ($P < .01$). Intact Denonvilliers fascia and complete total mesorectal excision were more likely to be achieved by the laparoscopic approach than the open approach ($P < .01$). Colorectal anastomoses were located significantly lower in the laparoscopic group than in the open group ($P < .01$).

Conclusion: Laparoscopic total mesorectal excision has consistent advantages over open total mesorectal excision, including similar surgical time, less blood loss, reduced hospital stay, and shorter disability period. A complete macroscopic specimen is more likely to be acquired by laparoscopy because of the better pelvic view offered by the approach.

Key Words: Laparoscopy, Rectal carcinoma, Macroscopic evaluation.

INTRODUCTION

Rectal cancer is a common malignancy leading to high morbidity and mortality rates. Surgery is the main choice of treatment for patients with rectal cancer.[1,2] The concept of total mesorectal excision (TME), which was introduced by Heald and Ryall[3] during the 1980s, has significantly improved the outcome for patients with rectal cancer, particularly with regard to local recurrence. The results of some studies showed that TME was a superior surgical modality for the treatment of rectal cancer because the local recurrence rates were reduced from between 30% and 40% to 5% after TME.[4] Therefore TME has been generally accepted as the gold standard for rectal cancer surgery.

In the early days of minimally invasive surgery, there was concern about the oncologic safety of the laparoscopic approach for the treatment of colorectal cancer. However, recent reports derived from randomized comparative studies, most of them multicentric, have shown that laparoscopy for the surgical treatment of colon cancer is associated with morbidity, mortality, and long-term cancer-related survival rates similar to those seen with the open approach. The advantages of laparoscopic surgery

have translated into smaller incisions and shorter recovery. However, the confines of the narrow bony pelvis and angling limits in current stapling technology, along with the standard practice of autonomic nerve–sparing TME, have made laparoscopic surgery more challenging in the treatment of low rectal cancer. Because of the absence of long-term (5-year) data on survival and recurrence, the role of laparoscopy in rectal cancer resection has been debated.

Macroscopic evaluation of the completeness of the mesorectum provides significant information about the quality of surgery for low rectal cancer. Few studies have offered data on macroscopic evaluation of resected specimens after laparoscopic TME.[5] The aims of this study were to observe the short-term outcomes and to evaluate the macroscopic quality of specimens acquired after laparoscopic versus open TME in patients with low rectal cancer.

METHODS

Patients

From May 2010 to May 2012, a series of 88 patients with biopsy-proved rectal cancer received laparoscopic radical resection at the department of general surgery of our university hospital. Conversion was defined as a laparoscopic procedure that had to be abandoned and replaced with median laparotomy. The reason for conversion was dense adhesions (n = 1). The pathologic specimens were prospectively examined and matched with the resection specimens from 90 patients who had undergone open TME. All the patients in both groups underwent surgery according to the principle of TME.[3] The resections were performed by 2 experienced laparoscopic colorectal surgeons trained in TME surgery. Patients with rectal tumors located within the distal 10 cm of the anal verge were included in the study. The 2 groups were matched for sex and type of resection, which included low anterior resection (LAR) and abdominoperineal resection (APR). The decision to perform either LAR with stapled colorectal anastomosis or APR was made according to tumor localization above the anal verge, size, and histologic type. Digital examination and fiberoptic colonoscopy were performed to assess the extent of tumor at the periphery of the rectum, the distance from the anal verge, and the degree of fixation. Computed tomography was performed to evaluate the extent of tumor infiltration to the other organs. Patients with tumors extending to the pelvic walls or organs were excluded from the study. The mean age of the patients was 62 years (range, 39–82 years) in the

laparoscopic group and 64 years (range, 41–83 years) in the open group (**Table 1**). The results of intraoperative and postoperative follow-up were compared between the 2 groups, including operative time, intraoperative and postoperative complications, time of bowel function rehabilitation, and postoperative hospital stay.

Macroscopic Evaluation of Specimens

Special care was taken regarding the macroscopic judgment concerning the completeness of the mesorectum. Pathologic examination of each specimen was performed in a standardized fashion by the technique based on the procedure originally described by Parfitt and Driman.[6] After the mesorectal surface had been inked, the specimen was sliced at approximately 3- to 5-mm intervals. The depth of tumor spread in relation to the circumferential

Table 1.
Patients and Tumor Characteristics: Laparoscopic Versus Open Total Mesorectal Excision

Characteristic	Laparoscopic (n = 87)	Open (n = 90)	P Value
Age, yr	62 (39–82)	64 (41–83)	.392
Sex (male:female)	49:38	52:38	.845
Tumor size, mm	51 ± 8	52 ± 7	.377
Type of carcinoma			.945
Ulcer	60	64	
Lump	15	14	
Infiltrate	12	12	
Histologic type			.702
Well differentiated	18	19	
Moderately differentiated	52	49	
Poorly differentiated	17	22	
Tumor status			.762
T1	2	3	
T2	20	24	
T3	65	63	
T4	0	0	
N status			.799
N0	44	48	
N1	33	30	
N2	10	12	
No. of lymph nodes	8 ± 3	7 ± 3	.128
Tumor localization above anal verge (range), cm	6 (1–10)	8 (1–10)	< .05

margin, as well as the presence of discontinuous tumor deposits and lymph nodes involved by tumor, was evaluated. The largest tumor diameter and the location of the tumor were recorded. All lymph nodes were submitted for microscopic examination. Macroscopic quality assessment of the resected specimen was performed in all patients by a single colorectal surgeon trained in TME and included evaluation of the following:

1. The quality of the mesorectum was graded as described by Quirke et al.[7,8] Both the specimen as a whole (fresh) and cross-sectional slices (fixed) were examined to make an adequate interpretation (**Table 2**).

2. If there was at least 1 cm of peritoneal edge at the cul-de-sac, the cut edge of the peritoneal reflection anterior to the rectum was considered adequate.[9]

3. The Denonvilliers fascia was intact at the level of the middle rectum, especially for anterior cancers.[10]

4. In the case of APR of the rectum, the resected bowel wall below the mesorectum was graded as 1 of the 4 following groups as described by Quirke et al.[7]: substandard, a defect of the muscularis propria or perforation of the tumor; standard, intact muscularis propria of the specimen; enhanced, circumferentially covered by a slice of levator ani musculature; or radical, circumferentially covered by a levator ani muscular cuff ≥1 cm thick.

Statistical Analysis

Values are expressed as median and range. Statistical analysis was performed with SPSS software for Windows (version 13; IBM, Armonk, NY, USA). Comparisons between the 2 groups were made by applying either the Student t or Mann-Whitney U test for unpaired values as appropriate. The χ^2 test with Yates correction for small samples was applied to compare differences in variables expressed as proportions. Differences were considered significant at $P < .05$.

RESULTS

Patient and tumor characteristics of the 2 groups are shown in **Table 1**. The 177 patients were divided into 2 groups: 87 patients (49 men [56%] and 38 women [44%]) underwent TME by the laparoscopic approach, whereas 90 patients (52 men [57%] and 38 women [43%]) underwent TME by the open approach. There was no difference between the 2 groups with regard to age, sex, tumor size, type of carcinoma, histologic type, or postoperative clinical staging. Rectal tumors were located at a significantly lower level from the anal verge in the laparoscopic group than in the open group (6 cm for laparoscopy vs 8 cm for open, $P < .05$).

Short-term outcomes of the 2 groups are shown in **Table 3**. Conversion to open surgery was documented in 1 case because of dense adhesions. The surgical time for the laparoscopic approach was 160 ± 40 minutes with no significant difference compared with that for open resection ($P = .782$). The operative blood loss was 28 ± 5 mL (range, 5–40 mL) for the laparoscopic approach and 80 ± 20 mL (range, 50–120 mL) for the open approach ($P < .01$). Intraoperative injuries to the pelvic autonomic nervous system were record in 4 cases in the laparoscopic group compared with 12 cases in the open group ($P < .05$). No damage to the ureter, bowel, and vascular system occurred in either group. The incidence of chest infection was 1.1% for the laparoscopic approach and 4.4% for the open approach ($P = .186$). The rate of anastomotic leakage in both the open and laparoscopic groups was 1.1% ($P = .981$). The postoperative bowel opening time was 2.1 ± 1.5 days (range, 1–4 days) in the laparoscopic group and 3.5 ± 1.6 days (range, 3–7 days) in the open group ($P < .01$), whereas the hospital stay was 5.2 ± 1.8 days and 7.0 ± 2.1 days, respectively ($P < .01$).

The results of macroscopic evaluation of the specimens are shown in **Table 4**. Laparoscopic and conventional resections showed comparable node clearance between

Table 2.
Grading of Quality and Completeness of Mesorectum in Total Mesorectal Excision Specimen

	Mesorectum	Defects	Coning	Circumferential Resection Margin
Grade I (complete)	Intact, smooth	Not deeper than 5 mm	None	Smooth, regular
Grade II (nearly complete)	Moderate bulk, irregular	No visible muscularis propria	Moderate	Irregular
Grade III (incomplete)	Little bulk	Down to muscularis propria	Moderate-marked	Irregular

Table 3. Short-Term Outcomes			
	Laparoscopic (n = 87)	Open (n = 90)	*P* Value
Type of surgery (%)			.271
LAR	75 (86)	72 (80)	
APR	12 (14)	18 (20)	
Surgical time, min	160 ± 40	150 ± 35	.782
Blood loss, mL	28 ± 5	80 ± 20	< .01
Intraoperative complications (%)			
Injuries to pelvic autonomic nervous system	4 (5.7)	12 (13.3)	< .05
Other iatrogenic injuries (ureter, bowel, vascular system)	0	0	
Postoperative complications			
Chest infection	1 (1.1)	4 (4.4)	.186
Anastomotic leakage	1 (1.1)	1 (1.1)	.981
Postoperative bowel opening, d	2.1 ± 1.5	3.5 ± 1.6	< .01
Hospital stay, d	5.2 ± 1.8	7.0 ± 2.1	< .01

Table 4. Macroscopic Evaluation of Specimen			
Characteristic	Laparoscopic (n = 87)	Open (n = 90)	*P* Value
No. of lymph nodes harvested	14 ± 5	13 ± 6	.231
Cut edge of peritoneal reflection (%)			.499
Adequate	84 (96.5)	85 (94.4)	
Inadequate	3 (3.5)	5 (5.6)	
Denonvilliers fascia (%)			< .01
Intact	85 (97.7)	74 (82.2)	
Violated	2 (2.3)	16 (17.8)	
TME (%)			< .01
Grade I (complete)	83 (95.4)	72 (80)	
Grade II (nearly complete)	3 (3.4)	15 (16.7)	
Grade III (incomplete)	1 (1.2)	3 (3.3)	
Bowel wall below mesorectum (%)	n = 12	n = 18	.842
Substandard	0	0	
Standard	2 (16.7)	2 (11.1)	
Enhanced	3 (25)	6 (33.3)	
Radical	7 (58.3)	10 (55.6)	
Distance of anastomosis from anal verge (range), cm	3 ± 1.2	5 ± 1.1	< .01
Distal margin of clearance (range), mm	23 ± 8	21 ± 9	.120

the 2 approaches. An adequate cut edge of peritoneal reflection was accounted for in most cases after either approach (84 of 87 [96.5%] for laparoscopy vs 85 of 90 [94.4%] for open, *P* = .499). A more intact Denonvilliers fascia was achieved by the laparoscopic approach than by the open approach (85 of 87 [97.7%] for laparoscopy vs 74 of 90 [82.2%] for open, *P* < .01). An oncologically more complete surgery was achieved by the laparoscopic approach than by the open approach. Complete TME was achieved at a significantly greater rate after laparoscopy than after the open approach (83 of 87 [95.4%] for laparoscopy vs 72 of 90 [80%]) for open, *P* < .01) (**Figure 1**). Enhanced or radical APR of the rectum was achieved in all cases after either approach. Colorectal or coloanal anastomoses were located significantly lower in the laparoscopic group than in the open group (3 ± 1.2 cm for laparoscopy vs 5 ± 1.1 cm for open, *P* < .01). This was attributed to the lower location of rectal tumors in the former group. In practical terms, distal transaction of the rectum and anastomosis were at or below the pelvic aspect of the levator ani muscles. The distal margin of clearance for the laparoscopic approach was 23 ± 8 mm, with no significant difference compared with open resection (*P* = .120).

DISCUSSION

Following the practice of Heald and coworkers in the late 20th century, it is generally recognized that the principles of TME should be applied in rectal tumors located at the middle and lower levels. In the past decade, a laparoscopic approach for this surgical procedure was attempted and encouraging results were reported in terms of recovery and effect.[11]

Our study was not randomized and therefore would be subject to bias. To minimize the impact of the learning curve, the general surgeons, who have experience in performing >90 laparoscopic surgeries as the attending physicians, should have acquired the skills needed to perform laparoscopic resection for rectal cancer. The surgical time for rectal cancer is closely associated with the surgeon's experience and the pathology. The mean surgical times for laparoscopic resection for rectal cancer, including LAR and APR, commonly were reported to be

Figure 1. Examples of complete mesorectum. The external surface appears smooth, without defects. There is adequate bulk, without coning.

between 180 and 260 minutes.[12,13] In this study the mean surgical time of 160 minutes for laparoscopic APR was not significantly different from that for open resection. The similar surgical time was attributed to the fact that the laparoscopic group always underwent surgery by the same surgeons, who have performed 90 laparoscopic surgeries before this study. Few comparative studies and randomized controlled trials have been conducted to show that laparoscopic techniques may be associated with less surgical blood loss and reduced perioperative transfusions. Blood loss has ranged between 90 and 320 mL for laparoscopic resection in these studies.[14,15] With regard to our study, the mean operative blood loss was only 28 mL in the laparoscopic group, which was closely associated with factors of the surgeons' skill.

Among other iatrogenic injuries (ureter, bowel, vascular system), injuries to the pelvic autonomic nervous system have been much more debated. Injuries to the pelvic

autonomic nervous system were recorded in only 4 cases in the laparoscopic group compared with 12 cases in the open group. This finding shows a significant difference between the 2 techniques. Laparoscopy, provided with the characteristics of amplifying the local view, may help in eliminating the blind zone of naked eyes in an open procedure. Thus the identification of the operating plane and the protection of the autonomic nerves could also be beneficial. Anastomotic leakage is one of the worst postoperative complications. In contrast to Breukink et al.,[16] who reported an anastomotic leakage rate of 9% in the laparoscopic group versus 14% in the open group, the rate of anastomotic leakage for either approach ranged from 1% to 2% in our study. Similar to findings reported by Memon et al.,[17] laparoscopy for TME in this study has shown consistent advantages over open TME, including a reduced hospital stay, a shorter disability period, less postoperative pain, and a lower rate of chest infection.

However, the aforementioned advantages of laparoscopic TME are beneficial to patients only when the oncologic cure rate for this technique is at least similar to that for open TME. The adequacy of oncologic resection in laparoscopic TME has been shown in various studies. In most of these studies, only surgical margins, lymph node yield, and the length of bowel resected were evaluated.[18] Most laparoscopic TME series report lower median numbers of harvested nodes.[13] However, our study comparing laparoscopic and conventional resections showed comparable node clearance between the 2 approaches. In this study a high tie of the inferior mesenteric vessels, which is the preferred technique during laparoscopic TME, has led to improved lymph node harvest, thus facilitating accurate tumor staging. It has been shown that a technically poor TME in patients with negative Circumferential Resection Margin (CRM) is associated with increased recurrence and worse survival compared with patients having negative margins in whom complete TME has been achieved. Therefore the quality of the excised mesorectum is of additional prognostic value in patients who do not have CRM involvement.[8]

In general, the laparoscopic approach was associated with more complete TME and more intact Denonvilliers fascia in all aspects compared with the open approach. Furthermore, moderate or incomplete TME at the lateral and posterior aspects was significantly more common after open surgery than after laparoscopic surgery. We conducted a study of 177 patients (87 laparoscopic procedures and 90 open procedures). In all specimens the cut edge of the peritoneal reflection at the anterior mid rectum, the Denonvilliers fascia, the visceral fascia covering
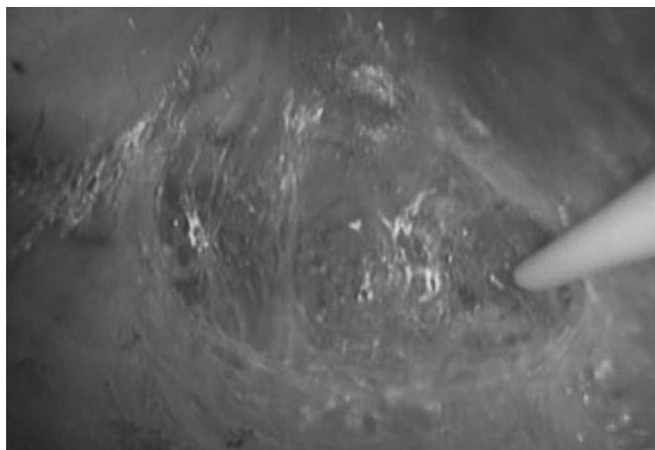
Figure 2. Dissection occurred within a fascial plane.

the posterior and lateral mesorectum, and the bowel wall below the mesorectum were assessed macroscopically. Colorectal anastomoses were located significantly lower in the laparoscopic group. The Denonvilliers fascia was violated in 16 patients after open surgery, and a more complete TME with intact visceral pelvic fascia was performed with laparoscopic versus open surgery.

However, it is known that the outcome for rectal cancer treatment is improved with both specialized surgical training and a higher volume of rectal cancer procedures.[19] In our study the operations for all the patients were performed by 2 experienced, specialized laparoscopic colorectal surgeons. Furthermore, more complete TME after laparoscopy is attributed to the perfect deep pelvic view offered by the approach: dissection of the rectum and the mesorectum at all aspects down to the pelvic floor can be carried out under direct vision, thus preventing inadvertent entering of incorrect planes (**Figure 2**). The better view and the ease with which LAR of the rectum can be achieved may also explain the increased percentage of patients with lower colorectal anastomoses in the laparoscopic group compared with the open group. The advantage of a better view and more complete TME by use of the laparoscopic approach has also been emphasized by other authors.[20–22]

CONCLUSION

A macroscopically complete specimen after TME for rectal cancer is more likely to be acquired by laparoscopy because of the better pelvic view offered by the approach. Nevertheless, a randomized controlled trial comparing laparoscopic TME with open TME is required to verify any possible additional benefits of laparoscopy.

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