SPANDIDOS PUBLICATIONS

ONCOLOGY LETTERS 14: 4142-4150, 2017

Safety and feasibility of laparoscopic intersphincteric resection for a lower rectal tumor

NOBUHISA MATSUHASHI, TAKAO TAKAHASHI, TOSHIYUKI TANAHASHI, SATOSHI MATSUI, HISASHI IMAI, YOSHIHIRO TANAKA, KAZUYA YAMAGUCHI, SHINJI OSADA and KAZUHIRO YOSHIDA

Department of Surgical Oncology, Gifu University School of Medicine, Gifu 501-1194, Japan

Received April 15, 2016; Accepted May 11, 2017

DOI: 10.3892/ol.2017.6664

Abstract. The aim of the present study was to evaluate the short-term surgical outcomes of laparoscopic intersphincteric resection (ISR) for a lower rectal tumor in comparison with a case-control series of patients undergoing open ISR. Quality of life factors and anal function were also evaluated. Between July 2008 and April 2013, 103 patients with lower rectal cancer underwent laparoscopic surgery at the Surgical Oncology Department of Gifu University School of Medicine. A total of 25 patients with lower rectal cancer underwent ISR, and 19/25 patients who underwent laparoscopic ISR were compared with the control group of 6 patients who underwent open ISR. The technical feasibility and safety of ISR, and the short- and long-term outcomes following laparoscopic ISR were evaluated. Additional data associated with fecal incontinence conditions of the postoperative patients were evaluated using the Modified Fecal Incontinence Quality of Life scale. There was no recorded perioperative mortality, three complications were observed to occur in three patients and the morbidity rate was 15.8%. The postoperative complications detected included bleeding in one patient and ileus in two patients of the laparoscopic ISR group. The rate of severe complications of grade ≥3a was 15.8% and that of grade ≥3b was 5.3%. In the matched case-control study, blood loss was significantly lower in the laparoscopic ISR group. The median postoperative hospital stay was 14.1 days in the laparoscopic ISR group, which was significantly shorter compared with in the open ISR group (18.7 days). Cancer recurrence was detected in one (5%) patient in a single inguinal lymph node. No significant differences between the ISR and ultra-low anterior resection (ULAR) groups were observed in the maximum resting and maximum squeeze pressures; the outcomes for anal function and fecal incontinence were the same for ISR and ULAR. Thus, laparoscopic ISR for lower rectal cancer may provide a benefit in the early postoperative period without increasing morbidity or mortality.

Correspondence to: Professor Kazuhiro Yoshida, Department of Surgical Oncology, Gifu University School of Medicine, 1-1 Yanagido, Gifu 501-1194, Japan
E-mail: kyoshida@gifu-u.ac.jp

Abbreviations: CRT, chemoradiotherapy; ISR, intersphincteric resection; ULAR, ultra-low anterior resection; GMMS, gastrointestinal manometry system; Lap ISR, laparoscopic ISR; mFIQL, modified fecal incontinence quality of life scale; RCT, randomized clinical trial

Key words: rectal tumor, intersphincteric resection, laparoscopic surgery modified fecal incontinence quality of life scale, manometry

Introduction

The use of laparoscopic colectomy was first reported in 1991 (1). Laparoscopic surgery, including colectomy for early-stage cancer, has been developed worldwide over the past several years (2). In addition, the laparoscopic colorectal approach can offer certain potential benefits over open surgery, including an earlier return of bowel function, reduced postoperative pain, shorter hospital stay and improved cosmesis. Therefore, laparoscopic colectomy by pioneering laparoscopic surgeons has been gradually accepted on the basis of its technical advantages, safety and feasibility in numerous studies (3-5). However, laparoscopic surgery for rectal cancer is still more complicated than laparoscopic colectomy, owing to its technical difficulty in the pelvic area (6,7). Certain prior reports of experimental laparoscopic surgery revealed that laparoscopic surgery for rectal cancer is technically feasible (6-9), but, in general, the treatment of very low rectal cancer remains a challenge for colorectal surgeons. In addition, the intersphincteric resection of very low rectal tumors remains controversial (10). The results of laparoscopic ISR (Lap ISR) have been reported following various studies conducted in the 2000s (10-16). There is no associated major wound to the abdominal wall with Lap ISR, with the exception of for a diverting ileostomy as the specimen is removed via the anus. However, to the best of our knowledge, all previous reports were retrospective and single-institutional, or included only a limited number of studies (11-13). The present case study evaluated the short- and long-term surgical outcomes of Lap ISR for lower rectal cancer, and compared them with a case-control series of patients who underwent open ISR.

Recently, 3-dimensional vector manometry (3D manometry) has been used to determine the median of the maximum resting pressure and maximum squeeze pressure in the anal sphincter (14). The current study also examined postoperative

sphincter status using manometry in patients who underwent ISR and ultra-low anterior resection (ULAR) to clarify specific findings associated with these two surgical procedures. This study evaluated fecal incontinence conditions of postoperative patients with the Modified Fecal Incontinence Quality of Life scale (mFIQL). Defecatory function was assessed in terms of the frequency of bowel movements and continence (15-17).

Materials and methods

Patients. Between July 2008 and April 2013, 360 patients with colorectal cancer underwent laparoscopic surgery at the Surgical Oncology Department of Gifu University School of Medicine (Gifu, Japan). The patients ranged in age from 16-90 (mean, 65.4) years; 199 were male and 161 were female. In addition, 103 patients with low rectal cancer who underwent laparoscopic surgery, 25 patients with lower rectal cancer that underwent ISR and 19/25 patients (18.4%; 19/103; low rectal cancer) who underwent Lap ISR were compared with the control group of patients who underwent open ISR at the Department of Surgical Oncology, Gifu University. In all cases, the tumor stage was evaluated prior to surgery by digital examination, colonoscopy and chest, abdominal and pelvic computed tomography. Preoperative criteria for the exclusion of patients from ISR were as follows: Clinical T4 tumors based on the Japanese Classification of Colorectal Carcinoma (18); poorly differentiated adenocarcinoma (revealed by biopsy specimens); infiltrating gross appearance of the tumors; a degree of preoperative incontinence. Preoperative criteria for Lap ISR were the diagnosis of clinical stages T2 and N0-1. None of the patients included in the present study had received preoperative chemoradiotherapy (CRT) or pre/postoperative radiotherapy. All patients with tumor node metastasis (TNM) stage II/III tumors received postoperative adjuvant systemic chemotherapy with UFT or leucovorin or capecitabine. Patient follow-up was comprised of clinical assessment, evaluation of tumor markers (carcinoembryonic antigen and CA 19-9), chest radiography, abdominal ultrasonography, computed tomography and magnetic resonance imaging for the early detection of recurrent tumors. Survival time was calculated from the date of surgery to the date of the last follow-up examination or cancer-associated mortality.

Surgical procedure. ISR was performed according to the methods described by Schiessel *et al* (10). The operation was performed according to the following procedural steps. Firstly, laparoscopic exploration was performed with five ports after pneumoperitoneum was induced. Secondly, mobilization of the jejunum and the ileum was conducted in the right-head-ventral side position. This mobilization was indicated to provide an optimal surgical view of the left side of the colon. Dissection of the left side of the colon was performed using a medial-lateral retroperitoneal approach (Fig. 1). Thirdly, lymphadenectomy around the inferior mesenteric artery and ligation of this artery were performed. The surgeon elected to perform either division at the origin of the inferior mesenteric artery or at the preserved left colic artery. Retroperitoneal dissection was performed from a medial-lateral approach. Fourthly, mobilization of the rectum and excision of the mesorectum were performed. The dissection progressed to the endopelvic fascia and levator ani muscle (Fig. 2). With transanal dissection, as the mucosa and internal anal sphincter were circumferentially incised, the transanal intersphincteric dissection allowed connection with the laparoscopic dissection (Fig. 3). At this stage in the procedure, the proximal rectum (recto-sigmoid section) was cut with an Echelon Flex™ stapling device (ECR60B; Ethicon Endo-Surgery; Ethicon, Inc., Cincinnati, OH, USA). The tissue specimen was then extracted via the anus. The anal canal was exposed with a self-holding retractor (Lone Star Retractor system; Cooper Surgical, Inc., Trumbull, CT, USA). A circular incision of the rectum was performed by closing the anal canal with an interrupted suture. Finally, reconstruction consisted of a hand-sewn colonal straight anastomosis without creating a colonic pouch. A diverting ileostomy was created in all cases (Fig. 4).

Evaluation of postoperative condition. Postoperative patient condition was evaluated using the Clavien-Dindo method (24), in which surgical complications are classified at five levels according to the invasiveness of the treatment to be administered: Grade 1 (requires no treatment); grade 2 (requires medical therapy); grade 3a (requires surgical, endoscopic or radiologic intervention but not general anesthesia); grade 3b (also requires general anesthesia); grade 4 (life-threatening complications that require intensive care); grade 5 (patient mortality). The condition of each patient was retrospectively determined to range from grade 2-5. Grade 1 complications, with the exception of surgical site infection, were not evaluated to exclude the possibility of description bias in patient records. Severe complications were considered as grade ≥3b.

Evaluation of defecatory status with modified fecal incontinence quality of life scale (mFIQL). Hashimoto *et al* (17) reported on the FIQL scale following ISR for very low rectal cancer. This novel scale is practical to administer and is sensitive to a range of functional problems associated with fecal incontinence in patients who have undergone ISR. Postoperative patient fecal incontinence conditions were evaluated using the mFIQL. The following 14 items are included: 1, I am afraid to go out; 2, I avoid visiting friends; 3, I avoid staying overnight away from home; 4, it is difficult for me to get out and do things like going to a movie or theater; 5, I cut down on how much I eat before I go out; 6, whenever I am away from home, I try to stay near a restroom as much as possible; 7, it is important to plan my schedule (daily activities) around my bowel pattern; 8, I cannot do many of things I want to do; 9, I avoid traveling by plane or train; 10, I worry about not being able to get to the toilet in time; 11, I avoid going out to eat; 12, I cannot get to sleep, or wake up during the night; 13, the possibility of bowel accidents is always on my mind; 14, whenever I go someplace new, I specifically locate where the bathrooms are. Response categories are as follows: 1, none of the time; 2, a little of the time; 3, some of the time; 4, all the time. The mFIQL assigns a different score for each item response and recalculates the score as mFIQL = [(total points of 14 items) - 14]/42x100.

Gastrointestinal manometry system. All gastrointestinal manometry system (GMMS) measurements were performed by three independent researchers. The GMMS is an

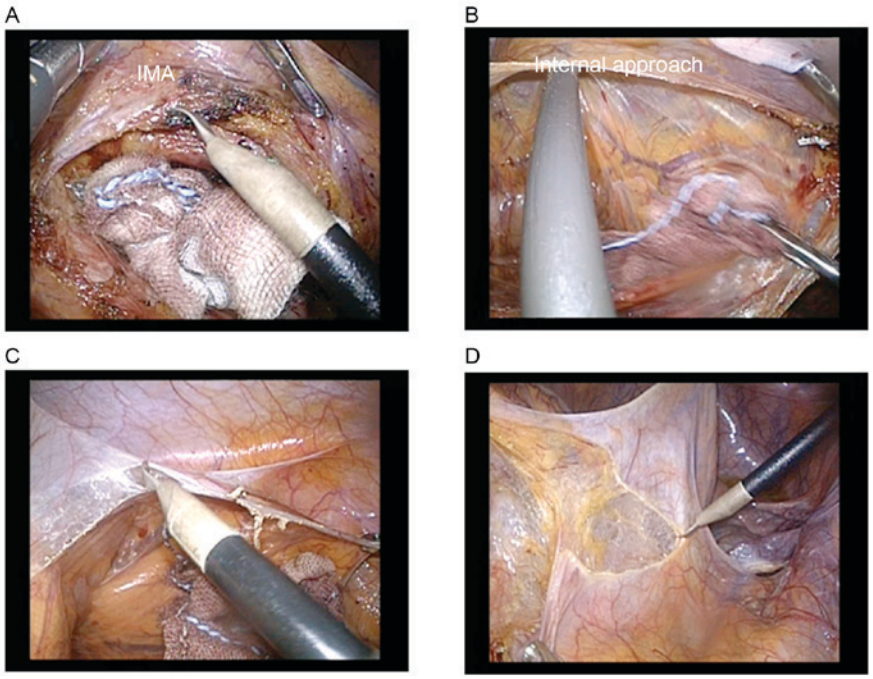

Figure 1. Laparoscopic procedure 1. (A) Mobilization of the left side colon was performed in the internal approach from lateral-to-medial retroperitoneal dissection. Lymphadenectomy around the inferior mesenteric artery and ligation of this artery was performed. The surgeon elected to perform either division at the radix of the inferior mesenteric artery or preservation of the left colonic artery. (B) Internal approach: In the medial-lateral approach, the second and the third procedures were implemented in reverse order. (C) Lateral approach. (D) Mobilization of the rectum and excision of the mesorectum were performed.

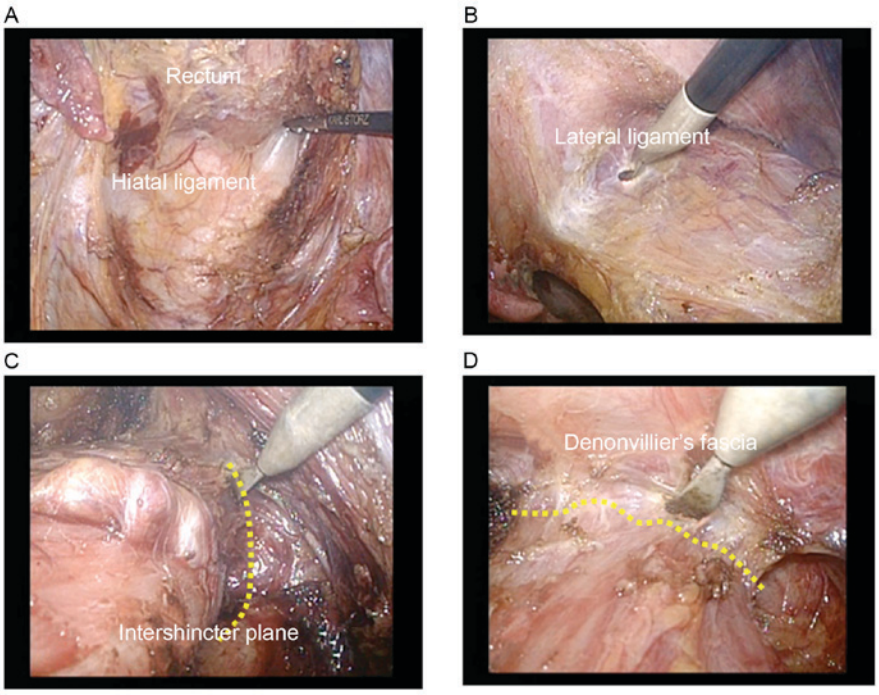

Figure 2. Laparoscopic procedure 2. (A) The posterior side of the rectum. (B and C) The lateral ligaments of the rectum between the visceral and parietal endopelvic fascia through the anus. (D) On the anterior side on the rectum, Denonviller's fascia.

anorectal function testing kit (Star Medical, Inc., Tokyo, Japan). The resting and anal squeeze pressures were each recorded using the pull-through method with the patient in a left-lateral posture. In the rapid pull-through method (step 1), automatic extraction of the pressure transducer catheter enables measurement of internal pressure distribution from the sphincter muscles. This method measures the maximum resting pressure and the high-pressure zone. In the station method (step 2), the sensor is moved in 1-cm increments from the rectum to the distal end of the anal sphincter muscles and measurements are recorded at six points. The measurements are obtained in two states, including when

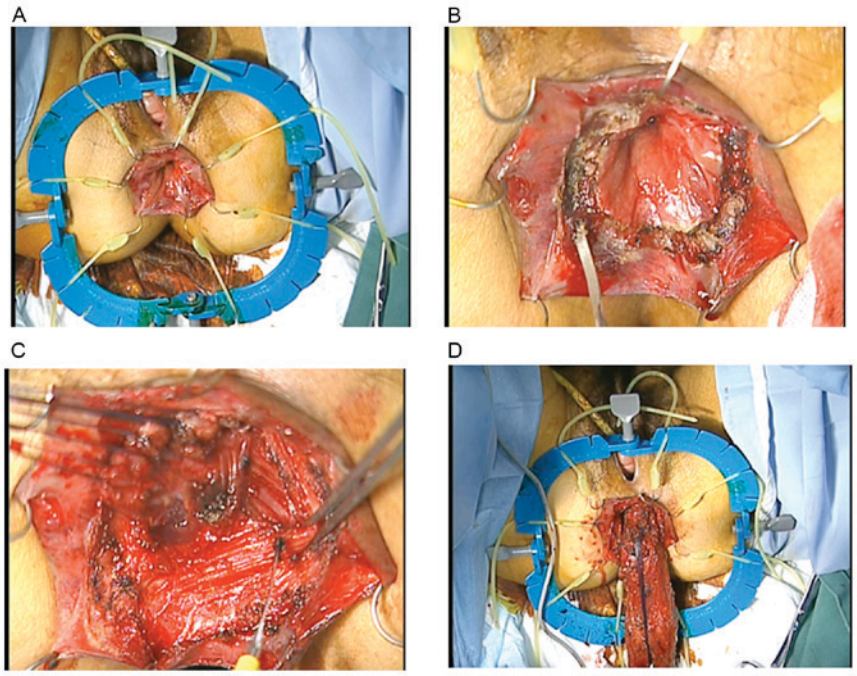

Figure 3. Transanal rectal dissection 1. (A) The anal canal was exposed with a self-holding retracter. (B and C) A circular incision of the rectum was performed by closing the anal canal with an interrupted suture for preventing stool contamination. (D) The rectum, including the tumor, was mobilized proximally by exposing the levator ani.

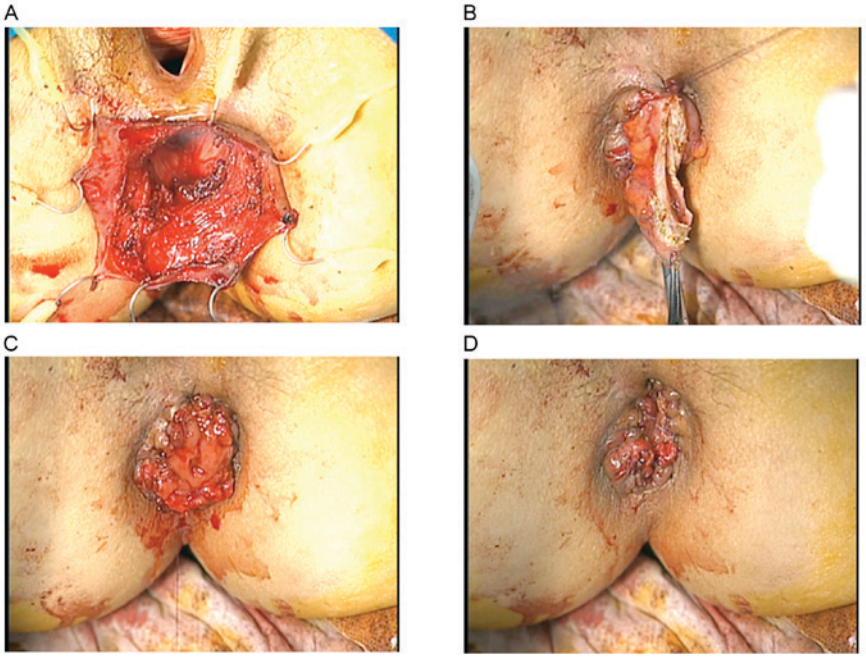

Figure 4. Transanal rectal dissection 2. (A) Mobilization of the rectum and excision of the mesorectum were performed. (B and C) The anastomosis was created by transanal hand suturing. (D) The postoperative view of the anus. Finally, a diverting ileostomy is created. The diverting ileostomy is reversed 3-6 months following surgery.

the patient is relaxed and when the patient is performing maximum sphincter push. The maximum pressure value in each of these states was recorded; this method measures squeeze pressure.

Written informed consent was obtained from all patients prior to the examination. The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki and the guidelines of the Regional Ethical Committees of Zurich, Switzerland and Basel, Switzerland.

Statistical analysis. All data are presented as the mean ± standard deviation. The data were statistically evaluated using the Student's t-test, Wilcoxon signed-rank test, Kaplan-Meier method, log-rank test and Pearson's

product-moment correlation coefficient, in order to determine statistical significances. All statistical analysis was performed using SPSS 11.5J software (SPSS Japan, Inc., Tokyo, Japan). A two-sided p-value of <0.05 was considered to indicate a statistically significant result.

Results

During the study period, 25 patients with very low rectal cancer underwent ISR. The patient profiles and intra-operative factors are listed in Tables I-III. In total, 6/25 patients underwent open ISR, due to patient preference in 2 cases and the necessity for lateral lymphadenectomy due to suspected lateral lymph node metastasis in the other 4 cases. Therefore, the present study included 19 patients who underwent laparoscopic total mesorectal excision with ISR and diverting ileostomy. There were 19 males and 6 females with a median age of 66.1 years (range, 38-86 years; Table I). Mean body mass index (BMI) was 22.2±2.0 kg/m^2 and the median tumor size was 31.3 mm (range, 9-85 mm). Three patients had neuroendocrine tumors (NET) and 22 patients had cancer; 17 patients had clinical T1 tumors, 4 had clinical T2 tumors, 4 had clinical T3 tumors and none had T4 tumors. Preoperative CRT was not performed in ISR (Table II). Three cases of NET were T1 tumors and underwent Lap ISR. Conversion to open surgery was necessary for two (10.5%) patients due to obesity and bleeding, but these two patients were the first and second to undergo Lap ISR. A total of 17 patients completely underwent the laparoscopic approach. In the Lap ISR group, the median surgery time was 399 min (range, 240-565 min) and the median estimated blood loss was 65 ml (range, 10-1,770 ml). There were no occurrences of perioperative mortality, three complications were observed in three patients and the morbidity rate was 15.8% (3/19). Postoperative complications of bleeding were detected in one patient and of ileus in a single patient in the Lap ISR group. The rate of severe complications of grade ≥3a was 15.8% and that of grade ≥3b was 10.5% (Clavien-Dindo classification). In the matched case-control study, the surgical time was significantly longer, but blood loss was significantly lower in the Lap ISR group. The median postoperative hospital stay was 14.1 days for the Lap ISR group, which was significantly shorter than that in the open ISR group (18.7 days). Four cases in the open ISR group underwent lateral lymph node dissection. Tumor recurrence was detected in one (5%) patient in the inguinal lymph node. From 3-12 months after the initial surgery for all patients, routine radiological examination prior to ileostomy closure was performed to identify any signs of minor anastomotic leakage and recurrence. All patients involved were alive at the date of final follow up. The demographical characteristics of the patients in the case-control study are presented in Table I. Cases and controls were well matched; however, the BMI of the open ISR group was slightly higher than that of the Lap ISR group (P=0.51). Surgical and postoperative results are presented in Table III. No significant differences were observed in the complication rates between the two groups.

Evaluation of anal function. Functional outcomes were assessed using the aforementioned questionnaire. Questionnaires regarding anal function were retrospectively collected from the patients following closure of the diverting stoma. Incontinence was assessed using the mFIQL. Anal function was evaluated in 11 patients who underwent stoma closure during the present study in April 2013. At 12 months following stoma closure, the mean mFIQL score for all patients was 26.5 points. Defecatory function was assessed at 12 months and 54 months following ISR. All 11 patients underwent ileostomy closure a median of 5.3 (range 3-8) months following ISR. The average score for each item on the mFIQL from 12-24 months after stoma closure was as follows:

Table I. Characteristics of patients with lower rectal cancer.

Patient characteristics	P-value
Age at surgery, years (mean, range)	66.1 (38-86)
Sex, n	
Male	19
Female	6
BMI, kg/m^2 (mean, range)	22.2 (18.3-27.1)
ASA, n (%)	
I	8 (32.0%)
II	17 (68.0%)
III	0
Preoperative diagnosis, n (%)	
Carcinoid	3 (12.0%)
Cancer	22 (88.0%)

ASA, American Society of Anesthesiologists physical status classification (31).

Table II. Operative outcomes, morbidity and mortality.

Tumor size (mm)	31.3 (9-85)
No. of pT stages (%)	
Tis	3 (12.0%)
T1	14 (56.0%)
T2	2 (8.0%)
T3	6 (24.0%)
No. of pN classifications (%)	
N0	17 (68.0%)
N1	8 (32.0%)
N2	0
Histological differentiation (%)	
Well	9 (36.0%)
Moderate	12 (48.0%)
Poor	0
Other type	4 (16.0%)
Stage (%)	
0	3 (12.0%)
I	12 (48.0%)
II	2 (8.0%)
IIIA	8 (32.0%)

Table III. Pathological findings and oncological clearance.

Characteristic	ISR (n=6)	Lap-ISR (n=19)
Operative time (min)	435.5 (241-637)	399.1 (240-565)
Blood loss (g)	1125.8 (300-1830)	274.2 (10-1770)
Lymph node harvest	28.0 (7-49)	9.2 (3-20)
Postoperative stay (days)	18.7 (14-30)	14.1 (9-32)
Morbidity and mortality		
Intra-operative morbidity	0	2 (10.5%)
Postoperative mortality (%)	0	0
Postoperative morbidity	1 (16.6%)	0
Anastomotic leakage	0	0
Ileus	0	2 (10.5%)
Bleeding	0	1 (5.3%)
Intra-abdominal infection	1 (16.6%)	0
Grade of morbidity		
Clavien-Dindo I-II	0	0
Clavien-Dindo IIIa	1(16.6%)	2 (10.5%)
Clavien-Dindo IIIb	0	1 (5.3%)
Clavien-Dindo IV-V	0	0

ISR, intersphincteric resection; Lap-ISR, laparoscopic intersphincteric resection.

Table IV. Modified fecal incontinence quality of life scale score.

Item	12-24 months (n=6)	24-53 months (n=5)
1	2.5	1.8
2	1.5	1.8
3	1.5	2.3
4	1.6	2.8
5	2	3.5
6	2.6	4.3
7	2.1	4.6
8	1.1	4.6
9	1.5	5.3
10	2.6	6.3
11	1.1	6.1
12	1.5	6.8
13	3.6	8.3
14	3	8.5
Total	34.9	37.9

Item 1, 2.5; item 2, 1.5; item 3, 1.5; item 4, 1.6; item 5, 2.0; item 6, 2.7; item 7, 2.3; item 8, 1.2; item 9, 1.5; item 10, 2.7; item 11, 1.2; item 12, 1.5; item 13, 3.7; item 14, 3.0. There was a total score of 34.9 points from 12-24 months following stoma closure (n=6).

The average score for each item from 24-54 months after stoma closure was as follows: Item 1, 2.2; item 2, 2.0; item 3, 2.2; item 4, 3.0; item 5, 1.4; item 6, 2.6; item 7, 3.0; item 8, 1.4; item 9, 3.0; item 10, 2.0; item 11, 1.4; item 12, 1.4; item 13, 3.2; item 14, 3.0. The total score was 37.6 points (n=5). No significant difference between groups was observed in terms of mFIQL total score (Table IV).

Table V. Manometry comparison between Lap-ISR and Lap-sLAR.

	Maximum pressure, mmHg	
Surgical procedure	Resting	Squeeze
Lap-ISR (n=6)	29.2±18.9	141.7±87.9
Lap-sLAR (n=9)	38.2±21.1	134.1±93.3

Data are the mean ± standard deviation. Lap-ISR, laparoscopic intersphincteric resection; Lap-sLAR, laparoscopic intersphincteric resection.

The results of anal manometry were compared between the ISR and ULAR groups. In the ISR group, the median maximum resting pressure was 29.2±18.9 mmHg and the maximum squeeze pressure was 141.7±87.9 mmHg. In the ULAR group, the median maximum resting pressure was 38.2±21.1 mmHg and the maximum squeeze pressure was 134.1±93.4 mmHg. No significant differences between the groups were observed in terms of these two pressure values (Table V).

Discussion

Abdominoperineal resection (APR) is the standard surgery administered for rectal cancer located 5 cm below the anal verge or 2 cm below the dentate line (7). However, quality of

life following APR is unsatisfactory as a permanent stoma may result in social limitations and a poor quality of life. Therefore, ISR with coloanal anastomosis for low rectal tumors has been adopted as an alternative to APR following the report in 1994 by Schiessel *et al* (10), who succeeded in preserving the sphincter and avoiding the necessity of a permanent stoma. ISR was performed via the abdominal route and through the anus. ISR was divided into three type groups as a formal classification. In total ISR, the distal resection line of the internal anal sphincter is at the intersphincteric groove, between the dentate line and the intersphincteric groove in subtotal ISR and at the dentate line in partial ISR (13). There are three types of ISR (partial, subtotal and total). In addition, coloanal anastomosis is performed using a transanal hand-sewn technique. Ultra low anterior resection of the rectum using a double-stapling technique is not regarded to be an ISR (14). In the early stages, it was unclear whether there was an increased risk of local recurrence with ISR; however, recent studies have revealed that short-term outcomes and oncological results following ISR are satisfactory in patients with low rectal cancer. Lap ISR was first described by Watanabe *et al* (11) in 2000. A number of case series on Lap ISR have subsequently been reported, but the technique requires a higher level of skill than for laparoscopic low anterior resection; therefore, it is yet to be recognized as a common procedure (12,13). At the Surgical Oncology Department of Gifu, Lap ISR was initiated in 2008 following an accumulation of experience using the open approach and with advances in laparoscopic technique from 100 cases of low anterior resection that had been performed at the department. The results of the present study demonstrated that it is a relatively safe procedure and provides benefits in the early postoperative period without an associated increase in morbidity or mortality. The number of surgeons able to perform Lap ISR is currently limited. In a comparison of open and Lap ISR in a relatively small number of cases, Fujimoto *et al* (19) observed that the complication rates of the two methods did not significantly differ. The results of the 'Takano' study conducted by Yamada *et al* (14) are similar to those of Fujimoto *et al* (19).

The majority of retrospective studies have not defined complications. Our previous studies have described the associated complications (20-23). Recently, Dindo proposed a novel system for classifying surgical complications; the Clavien-Dindo classification (24). Although, to the best of our knowledge, retrospective studies have not mentioned the Clavien-Dindo classification, the strength of the present study was that complications were catalogued according to the Clavien-Dindo classification (24). In another prospective study, Jeong *et al* (25) defined complications as the abnormal findings of radiologic tests that had been performed when a complication was clinically suspected, which would include complications of grade ≥2 according to the Clavien-Dindo classification. The rate of severe complications of grade ≥3a was 15.8%, and of grade ≥3b was 5.3%. In addition, the oncological outcomes following Lap ISR were acceptable with a low recurrence rate, in only one (4.0%) patient in a single inguinal lymph node, although it is noted that the majority of patients who underwent Lap ISR had early-stage disease.

These results suggest that the indications for Lap ISR may be expanded, provided that the surgery is conducted by an experienced surgical team. Lap ISR is considered to be safe and technically and oncologically feasible. The complication rates and postoperative hospital stay durations were observed to be similar between both groups, indicating that Lap ISR appears to be a safe alternative to laparotomy with favorable short- and long-term postoperative outcomes. One limitation of the current study was that it was not randomized but performed retrospectively, which may have introduced bias. Therefore, a prospective, multicenter randomized clinical trial (RCT) is required to demonstrate that laparoscopic total mesorectal excision with ISR is a feasible procedure for patients with very low rectal cancer. However, due to an insufficient number of patients on whom to perform an RCT, except for the study by Fujii *et al* (26), the safety of Lap ISR was analyzed in a single-center study.

To address the second limitation, a longer follow-up period will be required to assess the incidences of local recurrence, disease-free survival and the functional outcomes. However, from the numerous prior studies available, there are only a few reports detailing the short-term outcomes, and reports of the median- to long-term outcomes are even scarcer. As for the third limitation, patients who underwent preoperative adjuvant CRT were not included. Overall, ≥66.66% of the patients who underwent Lap ISR were diagnosed as clinical stage I in the present study. Among current surgical concepts, the circumferential resection margin has been demonstrated to be a more important oncologic concept than the distal margin in rectal cancer surgery in the present study. The circumferential resection margin was assessed from January 2008 and was negative in all 25 cases. Pelvic recurrence was not noted during follow-up. Lap ISR for lower rectal cancer confers benefits in the early postoperative period without a corresponding increase in morbidity or mortality, and is associated with long-term benefits that are comparable with those following open ISR in selected patients with lower rectal cancer.

In the absence of a large-scale RCT to compare open and Lap ISR, and due to the small number of institutions capable of conducting high-quality Lap ISR, the safety of this procedure requires confirmation through the prospective accumulation of more cases and data.

Another important problem is that the FIQL is likely to be more sensitive in detecting changes in quality of life following ISR. Evaluation of anal function is often conducted using Wexner's continence grading scale and Kirwan's classification (15,16). However, Hashimoto *et al* (17) reported a novel method for the evaluation of fecal incontinence function, the mFIQL, a method of evaluating function compared with other types of function evaluation, including the Wexner and Kirwan systems (17,27,28). This was our first time performing a functional evaluation using the mFIQL total score. No significant difference was observed between the first time period (from 12-24 months after stoma closure) and the second time period (from 24-54 months after stoma closure) in terms of the mFIQL total score. It was judged that the fecal incontinence function reached a plateau at ~1 year following stoma closure. Furthermore, the quality of life satisfaction rating in patients with closed stoma was 100%.

In addition, evaluation by manometry was compared between patients undergoing ISR and those undergoing ULAR during the present study. There were no significant differences

between the groups in terms of the maximum resting pressure and the maximum squeeze pressure. Therefore, it was determined that ISR was a better option for anal function. The cases included were almost all early-stage cancer at the preoperative stage. Furthermore, none of the cases included CRT performed during the preoperative period. As there are currently few reports of short- and long-term results, the patients were evaluated using mFIQL and manometry. Further prospective studies on the evaluation of anal function, including postoperative short- and long-term results, will be necessary (29,30).

In conclusion, Lap ISR for lower rectal cancer provides certain benefits during the early postoperative period without increasing morbidity or mortality. The present study results highlight the necessity of a having surgical team with a high level of experience with laparoscopic surgery. Demystification of the laparoscopic procedure is indispensable to the future standardization of Lap ISR, as even open ISR is a highly difficult operation, and it will require time to further standardize Lap ISR. Quality of life was not fully evaluated in the present study. Therefore, the patient quality of life must be evaluated in future studies.

Acknowledgements

The authors wish to declare the following potential conflicts of interest: K.Y. has received honoraria for lecturing from Chugai Pharmaceutical. Co., Ltd., Taiho Pharmaceutical Co., Ltd., Takeda Pharmaceutical Co., Ltd., Eli Lilly and Company, Daiichi Sankyo Co., Ltd., Ono Pharmaceutical Co., Ltd., Merck Serono Co., Ltd., Novartis Pharma K.K., Sanofi K.K.; and research funding from Ajinomoto Pharmaceutical Co., Ltd., Takeda Pharmaceutical Co., Ltd., Chugai Pharmaceutical Co., Ltd., Daiichi Sankyo Co., Ltd., Taiho Pharmaceutical Co., Ono Pharmaceutical Co., Yakult Honsha Co., Ltd., outside the submitted work. T.T. has received honoraria for lecturing from Takeda Pharmaceutical Co., Ltd.

References

1. Jacobs M, Verdeja JC and Goldstein HS: Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc 1: 144-150. 1991
2. Lord SA, Larach SW, Ferrara A, Williamson PR, Lago CP and Lube MW: Laparoscopic resections for colorectal carcinoma. A three-year experience. Dis Colon Rectum 39: 148-154, 1996.
3. Lacy AM, García-Valdecasas JC, Delgado S, Castells A, Taurá P, Piqué JM and Visa J: Laparoscopic-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: A randomized trial. Lancet 359: 2224-2229, 2002.
4. Clinical Outcomes of Surgical Therapy Study Group, Nelson H, Sargent DJ, Wieand HS, Fleshman J, Anvari M, Stryker SJ, Beart RW Jr, Hellinger M and Flanagan R Jr: A comparison laparoscopic assisted and open colectomy for colon cancer. N Engl J Med 350: 2050-2059, 2004.
5. Braga M, Vignali A, Gianotti L, Zuliani W, Radaelli G, Gruarin P, Dellabona P and Di Carlo V: Laparoscopic versus open colorectal surgery: A randomized trial on short-term outcome. Ann Surg 236: 759-767, 2002.
6. Yamamoto S, Yoshimura K, Konishi F and Watanabe M: Phase II trial to evaluate laparoscopic surgery for stage 0/I rectal carcinoma. Jpn J Clin Oncol 38: 497-500, 2008.
7. Miyajima N, Fukunaga M, Hasegawa H, Tanaka J, Okuda J and Watanabe M; Japan Society of Laparoscopic Colorectal Surgery: Results of a multicenter study of 1,057 cases of rectal cancer treated by laparoscopic surgery. Surg Endosc 23: 113-118, 2009.
8. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM and Brown JM; MRC CLASICC trial group: Short-term endpoints of conventional versus laparoscopic assisted surgery in patients with colorectal cancer (MRC CLASICC trial): Multicentre, randomised controlled trial. Lancet 365: 1718-1726, 2005.
9. Jayne DG, Thorpe HC, Copeland J, Quirke P, Brown JM and Guillou PJ: Five-year follow-up of the medical research council CLASICC trial of randomized trial of laparoscopically assisted versus open surgery for colorectal cancer. Br J Surg 97: 1638-1645, 2010.
10. Schiessel R, Novi G, Holzer B, Rosen HR, Renner K, Hölbling N, Feil W and Urban M: Technique and long-term results of intersphincteric resection for low rectal cancer. Dis Colon Rectum 48: 1858-1867, 2005.
11. Watanabe M, Teramoto T, Hasegawa H and Kitajima M: Laparoscopic ultralow anterior resection combined with per anus intersphincteric rectal dissection for lower rectal cancer. Dis Colon Rectum 43 (10 Suppl): S94-S97, 2000.
12. Saito N, Sugito M, Ito M, Kobayashi A, Nishizawa Y, Yoneyama Y, Nishizawa Y and Minagawa N: Oncologic outcome of intersphincteric resection for very low rectal cancer. World J Surg 33: 1750-1756, 2009.
13. Yamada K, Ogata S, Saiki Y, Fukunaga M, Tsuji Y and Takano M: Long-term results of intersphincteric resection for low rectal cancer. Dis Colon Rectum 52: 1065-1071, 2009.
14. Yamada K, Ogata S, Saiki Y, Fukunaga M, Tsuji Y and Takano M: Functional results of intersphincteric resection for low rectal cancer. Br J Surg 94: 1272-1277, 2007.
15. Oliveira L, Pfeifer J and Wexner SD: Physiological and clinical outcome of anterior sphincteroplasty. Br J Surg 83: 502-505, 1996.
16. Kienle P, Abend F, Dueck M, Abel U, Treiber M and Riedl S: Influence of intraoperative and postoperative radiotherapy on functional outcome in patients undergoing standard and deep anterior resection for rectal cancer. Dis Colon Rectum 49: 557-567, 2006.
17. Hashimoto H, Shiokawa H, Funahashi K, Saito N, Sawada T, Shirouzu K, Yamada K, Sugihara K, Watanabe T, Sugita A, *et al*: Development and validation of a modified fecal incontinence quality of life scale for Japanese patients after intersphincteric resection for very low rectal cancer. J Gastroenterol 45: 928-935, 2010.
18. Japanese Classification of Colorectal Carcinoma. 2nd English edition, 2009.
19. Fujimoto Y, Akiyoshi T, Kuroyanagi H, Konishi T, Ueno M, Oya M and Yamaguchi T: Safety and feasibility of laparoscopic intersphincteric resection for very low rectal cancer. J Gastrointest Surg 14: 645-650, 2010.
20. Yamamoto S, Fujita S, Akasu T, Inada R, Takawa M and Moriya Y: Short-term outcomes of laparoscopic intersphincteric resection for lower rectal cancer and comparison with open approach. Dig Surg 28: 404-409, 2011.
21. Lim SW, Huh JW, Kim YJ and Kim HR: Laparoscopic intersphincteric resection for low rectal cancer. World J Surg 35: 2811-2817, 2011.
22. Chamlou R, Parc Y, Simon T, Bennis M, Dehni N, Parc R and Tiret E: Long-term results of intersphincteric resection for low rectal cancer. Ann Surg 246: 916-922, 2007.
23. Portier G, Ghouti L, Kirzin S, Guimbaud R, Rives M and Lazorthes F: Oncological outcome of ultra-low coloanal anastomosis with and without intersphincteric resection for low rectal adenocarcinoma. Br J Surg 94: 341-345, 2007.
24. Dindo D, Demartines N and Clavien PA: Classification of surgical complication: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240: 205-213, 2004.
25. Jeong O, Park YK, Ryu SY and Kim YJ: Effect of age on surgical outcomes of extended gastrectomy with D2 lymph node dissection in gastric carcinoma: Prospective cohort study. Ann Surg Oncol 17: 1589-1596, 2010.
26. Fujii S, Yamamoto S, Ito M, Yamaguchi S, Sakamoto K, Kinugasa Y, Kokuba Y, Okuda J, Yoshimura K and Watanabe M: Short-term outcomes of laparoscopic intersphincteric resection from a phase II trial to evaluate laparoscopic surgery for stage 0/I rectal cancer: Japan Society of Laparoscopic Colorectal Surgery Lap RC. Surg Endosc 26: 3067-3076, 2012.
27. Barisic G, Markovic V, Popovic M, Dimitrijevic I, Gavrilovic P and Krivokapic Z: Function after intersphincteric resection for low rectal cancer and its influence on quality of life. Colorectal Dis 13: 638-643, 2011.

28. Rockwood TH: Incontinence severity and QOL scales for fecal incontinence. Gastroenterology 126 (1 Suppl 1): S106-S113, 2004.
29. Hirano A, Koda K, Kosugi C, Yamazaki M and Yasuda H: Damage to anal sphincter/levator ani muscles caused by operative procedure in anal sphincter-preserving operation for rectal cancer. Am J Surg 201: 508-513, 2011.
30. Koda K, Yasuda H, Hirano A, Kosugi C, Suzuki M, Yamazaki M, Tezuka T, Higuchi R, Tsuchiya H and Saito N: Evaluation of postoperative damage to anal sphincter/levator ani muscles with three-dimensional vector manometry after sphincter-preserving operation for rectal cancer. J Am Coll Surg 208: 362-367.2009.
31. Fitz-Henry J: The ASA classification and peri-operative risk. Ann R Coll Surg Engl 93: 185-187, 2011.