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Original Paper

Surgical Outcomes of Laparoscopic *vs.* Open Surgery for Rectal Carcinoma - A Matched Case-control Study

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ABSTRACT

Background/Aims: The present study evaluated the short- and middle-term surgical outcomes of laparoscopic surgery (LS) for rectal carcinoma in comparison with a case-control series of open surgery (OS).

Methodology: Between February 1998 and December 2004, 47 patients with rectal carcinoma underwent LS. These patients were compared with a conventional OS group matched for age, gender, location of tumor, surgical procedure, extent of resection and pathological stage.

Results: The median follow-up period for the LS group and the OS group was 25 and 49 months, respectively. In the LS group, median operative time was significantly longer but median blood loss was lower than those in the OS group. There was one requiring conversion to OS. Postoperative intervals until liquid and solid intakes, and hospital stay were significantly shorter in the LS group. Postoperative complications rates are similar and anastomotic leakage occurred in one patient in each group. In the LS group, the levels of white blood cell count on postoperative day 1 and C-reactive protein on postoperative days 1 and 2 were significantly lower than those in the OS group.

Conclusions: LS for rectal carcinoma provides benefits during the early postoperative period without increase in morbidity or mortality.

KEY WORDS: Laparoscopic surgery; Laparoscopic anterior resection; Rectal carcinoma; Case-control study; Surgical outcome

ABBREVIATIONS: Laparoscopic Surgery (LS); Open Surgery (OS); Intersphinctic Rectal Resection and Handsewn Coloanal Anastomosis (ISR-CAA); Abdominoperineal Resection (APR); Randomized Clinical Trial (RCT); White Blood Cell (WBC); C-Reactive Protein (CRP)

INTRODUCTION

Since the first report of laparoscopic colectomy in 1991 by Jacobs *et al.* (1), laparoscopic surgery has been tried and applied to a wide range of colorectal disease, including colorectal carcinoma. Recently many studies have demonstrated several advantages of laparoscopic surgery (LS) over conventional open surgery (OS), including reduced surgical blood loss, decreased postoperative pain and ileus, shorter hospital stay and favorable effects on immunologic status (2-5). With regard to long-term oncological safety, which is the most important concern for LS for malignancies, there have been no reports indicating that LS is inferior to conventional OS by randomized clinical trial (RCT) (6-8).

However, laparoscopic approach to rectal carcinoma is very difficult from a technical standpoint compared for that of colon carcinoma. Following laparoscopic anterior resection for rectal carcinoma, anastomotic leakage has been reported to occur in 7.2-20% (9-15), and as a result, some reports recommended routine covering ileostomy with this procedure even for patients who would not require ileostomy if they selected open anterior resection (9). In fact, many RCTs regarding laparoscopic resection for colorectal carcinoma have excluded patients with middle and lower rectal carcinoma (6-8). Due to the lack of comparative studies, it remains controversial as to whether LS for rectal carcinoma can be regarded minimally invasive surgery.

Since our first laparoscopic surgery for colonic carcinoma in 1993, about 400 patients have undergone laparoscopic resection for colorectal disease at our institution. Because the safety of LS in cancer patients remains to be established, candidates for radical surgery were patients preoperatively diagnosed with T1 or T2 disease. Additionally, LS cases also included patients who were preoperatively diagnosed with T3 but who preferred to undergo LS, as well as those with colon or upper rectal carcinoma for which palliative resection was considered necessary. In June 2001, we unified our surgical and postoperative management procedures, as a consequence, the complication rate and mean length of hospitalization have been reduced at our institution (16,17).

The aim of this study was to analyze the short-term and the middle-term surgical outcomes of LS for patients with rectal carcinoma and compare them with a matched group of patients who underwent similar conventional OS.

METHODOLOGY

Patients

Between February 1998 and December 2004, we

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TABLE 1 Patient Characteristics

		LS group	OS group	*P* value
No. of patients		47	47	
Sex ratio (male: female)		28: 19	28: 19	>0.999
Age (yr; mean and range)		60 (35-76)	60 (39-84)	0.551
Body mass index (kg/m^2, mean and range)		23.0 (17.3-32.4)	23.2 (18.1-33.8)	0.934
Prior abdominal surgery (%)		13 (27.7)	15 (31.9)	0.823
Location	Upper rectum	25	25	
	Middle rectum	10	10	
	Lower rectum	12	12	
Surgical procedure	Anterior resection	43	43	
	Abdominoperineal resection	1	1	
	Anterior resection with ISR-CAA	3	3	
	Covering ileostomy	11	9	
	Transverse-coloplasty pouch	4	4	
Year of surgery	1997-1999	1	16	
	2000-2002	20	21	
	2003-	26	10	
Pathological stage	UICC Stage 0	2	2	
	UICC Stage I	34	34	
	UICC Stage II	1	1	
	UICC Stage III	10	10	
Follow-up period (month)		24.6 (3.0-65.8)	49.2 (3.7-99.3)	<0.001

ISR-CAA: intersphincteric rectal resection and handsewn coloanal anastomosis.

TABLE 2 Intraoperative and Postoperative Results

	LS group	OS group	*P* valve
Operative time (min.)	255 (117-472)	150 (94-475)	<0.001
Blood loss (mL)	60 (5-477)	72 (10-945)	0.021
Conversion	1	-	-
Liquid intake (days)	1 (1-4)	4 (1-7)	<0.001
Solid intake (days)	3 (2-8)	5 (3-80)	<0.001
Hospital stay (days)	8 (7-23)	15 (10-101)	<0.001

Values are medians (range).

TABLE 3 Morbidities and Mortality

		LS group	OS group	*P* valve
Mortality		0	0	>0.999
Morbidity	Wound sepsis	3	3	>0.999
	Bowel obstruction	1	7	0.059
	Anastomotic leakage	1	1	>0.999
	Anastomotic bleeding	1	0	0.500
	Neurogenic bladder	0	1	0.500
	Pneumonia	1	0	0.500
	Pulmonary embolism	0	1	0.500
Total (No. of patients)		7 (14.9%)	12 (25.5%)	0.304

performed 47 curative laparoscopic resections for patients with rectal carcinoma. All patients were evaluated before surgery by clinical investigation including total colonoscopy, barium enema and computed tomography. To evaluate co-morbid conditions, cardiopulmonary function and renal function test were performed. We excluded the following groups of patients from LS: patients with tumors larger than 7cm, patients with a history of extensive adhesions, patients with intestinal obstruction, and patients with severe obesity (body mass index $>32kg/m^2$) and patients who did not consent to LS.

The analyzed parameters included age, gender, body mass index, prior abdominal surgery, operative time, blood loss, days until resumption of diet and length of postoperative hospital stay. Pathological staging was performed according to TNM classification. White blood cell (WBC) count and C-reactive protein (CRP) in serum were measured preoperatively and on postoperative day 1 routinely, and on postoperative day 2, if necessary.

Each laparoscopic case was compared with the control OS group of patients matched for age, gender, location of tumor, surgical procedure, extent of resection and pathological stage.

Laparoscopic Technique

Techniques for laparoscopic resection have previously been described (16,17). Initial port placement was performed using the open technique and pneumoperitoneum was induced using carbon dioxide. Two 5-mm ports were then inserted into the left lower mid-abdominal and the left lower quadrant regions, and two other 12-mm ports were inserted into the mid-lower and right mid-abdominal regions under laparoscopic guidance.

The left colon was initially mobilized laterally to medially until the left ureter and superior hypogastric nerve plexus were identified. The mobilization of splenic flexure was performed if necessary. Then, a window was made between the mesocolon containing the arch of the inferior mesenteric vessels and the superior hypogastric nerve plexus, starting at the bifurcation, with support from an assistant holding the sigmoid mesocolon ventrally under traction and to the left using a 5-mm bowel grasper through the left lower quadrant port. After the dissection proceeding to the origin of the inferior mesenteric artery, taking care not to injure the superior hypogastric nerve plexus and the roots of the sympathetic nerves, intracorporeal high ligation of the inferior mesenteric artery was performed. After cutting the inferior mesenteric vein and left colic artery, mobilization of the rectum and mesorectum was performed. The avascular plane between the intact mesorectum anteriorly, and the superior hypogastric nerve plexus, right and left hypogastric nerves, and Waldeyer's fascia posteriorly was entered by sharp dissection, and extended down to the level of the levator muscle for middle and lower rectal carcinomas, taking care to protect the pelvic nerves. For upper rectal lesions, mesorectal tissue extending down to 5cm below the tumor was excised routinely using ultrasonic shears (Laparoscopic Coagulating Shears, Ethicon Endo-Surgery Inc, Cincinnati, OH). Middle and lower rectal tumors were treated by total mesorectal excision. Immediately before rectal transection, laparoscopic rectal clamping was performed just above the anticipated point of rectal transection, using a bowel clamping device intro-

duced through the 12-mm mid-lower port. Rectal washout was performed routinely using 1,000mL of a 5 percent povidone-iodine solution. Rectal transection was then performed by multiple firing technique, using Endo GIA Universal staples, introduced through the 12-mm right mid-abdominal port. A 4- to 5-cm incision was then made over the mid-lower 12-mm port site, and the bowel was exteriorized under wound protection and divided with appropriate proximal clearance. After inserting the anvil head of the circular stapler into the end of the proximal colon, the proximal colon was internalized and the incision was closed. Intracorporeal anastomosis under laparoscopic view was performed by the double-stapling technique (DST) using a circular stapler (ECS 29mm or 33mm, Ethicon Endo-Surgery Inc, Cincinnati, OH). Patients with low anastomosis within 1cm from the dentate line and incomplete "doughnuts" underwent covering ileostomy.

For patients with lesions located within 5cm of the dentate line with more than 2cm of the distal free margin to the dentate line (with no evidence of carcinoma invasion into the sphincters or pelvic floor), laparoscopic intersphincteric rectal resection and handsewn coloanal anastomosis (ISR-CAA) was performed. This surgical technique was described previously (18). For patients undergoing abdominoperineal resection (APR), laparoscopic procedures were followed by perineal dissection in the standard fashion, and end colostomy creation using the left lower abdominal port site.

Statistical Analysis

Statistical analysis was performed using Student's *t* test, the Mann-Whitney *U* test, and the Fisher's exact test as appropriate. A *P* valve of less than 0.05 was considered significant.

RESULTS

Patient demographic characteristics are summarized in **Table 1**. Cases and controls were well matched for gender, age, tumor site, surgical procedure, extent of resection and TNM stage; however, the follow-up period in the OS group was significantly longer than that in the LS group. There were no significant differences in the patient's characteristics, including BMI and rate of prior abdominal surgery, between the two groups. In both groups, three patients underwent ISR-CAA and a transverse-coloplasty pouch was created in 4 patients. Overall, covering ileostomy was required for 11 patients in the LS group, and 9 patients in the OS group. All the patients with covering ileostomy underwent subsequent ileostomy closure.

Surgical and postoperative results are demonstrated in **Table 2**. In the LS group, operative time was significantly longer but blood loss was significantly lower. There was one case requiring conversion to OS because of severe adhesion after repeated cesarean section. Liquid and solid intakes were started on median postoperative days 1 and 3 in the LS group, which

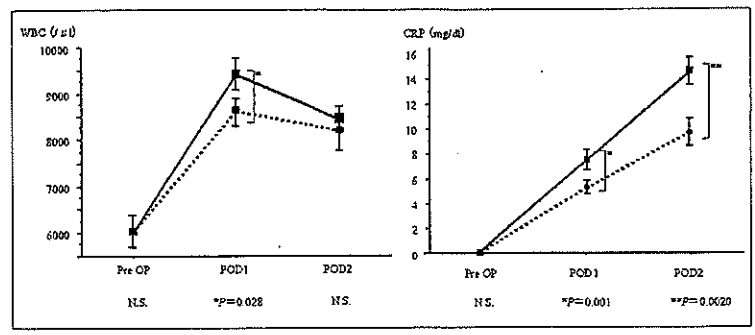

FIGURE 1 The level of white blood cell (WBC) count (**a**) on postoperative day (POD) 1 and the level of serum C-reactive protein (CRP) (**b**) on POD 1and 2 were significantly lower in LS group (●) than OS group (■). Each bar represents the mean standard error.

was significantly shorter than that in the OS group. Similarly, the median postoperative hospital stay was 8 days in the LS group, which was significantly shorter than 15 days in the OS group. All patients were discharged to home.

The postoperative complications are listed in **Table 3**. There were no perioperative mortalities in either group. The rate of postoperative bowel obstruction was 2.1% (1/47) in the LS group and 14.9 % (7/47) in the OS group (P=0.059). An anastomotic leakage occurred in one patient in each group. In the LS group, one patient, who had covering ileostomy during the initial operation, experienced anastomotic leakage that was conservatively managed. In the OS group, a patient with an anastomotic leakage required emergency operation for abdominal drainage and diverting ileostomy. Another patient in the LS group experienced anastomotic bleeding, that was conservatively managed. There was no significant difference in total complication rates between the two groups.

Preoperative and postoperative levels of WBC and CRP in serum are presented in **Figure 1**. In the LS group, the level of WBC on postoperative day 1 and the level of CRP on postoperative day 1 and 2 were significantly lower than those in the OS group.

At the end of the study period, there were no patients who had developed a recurrence or died in this series.

DISCUSSION

To date, there are few studies comparing surgical outcomes between LS *versus* OS for rectal carcinoma (11,19). In this study, we were able to demonstrate that the minimal invasiveness of LS, which has been demonstrated for colon carcinoma, can be preserved in LS for rectal carcinoma as well. Needless to say, the quality of surgery during LS for rectal carcinoma is important. If the rate of conversion to OS increases, outcomes of LS will be shifted to outcomes of OS, thus making it difficult to detect differences between the two groups. In addition, if the complication rate increases, hospitalization after surgery can be prolonged, resulting in a loss of the advantages of LS. In this study, there was only one case requiring conversion to OS, and the anastomotic leakage rate was

lower (2.1%, 1/47) than the rates previously reported. We consider that these facts contributed greatly to demonstrating the minimal invasiveness of LS for rectal carcinoma. And the fact that WBC on postoperative day 1 and CRP values on postoperative day 1 and 2 were significantly lower in the LS group can be regarded as objective data suggesting the minimal invasiveness of LS.

At our institution, there has been much consideration given to the technical safety of LS, and surgeons with a thorough expertise in OS had accumulated enough experience in LS for colon carcinoma, which is technically relatively easy to perform. Thereafter, the indications were expanded to include rectal carcinoma. As a result, LS for rectal carcinoma has been successfully performed with significantly reduced blood loss, earlier start of oral intake and shortened postoperative hospital stay, as compared to OS. At present, the long-term oncological outcome of LS for rectal carcinoma remains unclear and hence the indications for LS for rectal carcinoma remain limited, but it may be technically possible to gradually reduce those limits and expand our indications.

One of the advantages of LS for rectal carcinoma is that by inserting a flexible scope into the narrow pelvis to magnify the operative field, the surgeon can safely mobilize the rectum because of easy identification of the loose connective tissue between the mesorectum and the surrounding tissues such as the hypogastric nerves and the pelvic nerve plexuses, which is not always easy to recognize under direct vision during OS. Another advantage of LS is that everyone participating in the operation can have the same field of view. However, there are several technical limitations in LS. It is often very difficult to occlude and transect the bowel in LS, especially when the tumor is located in the lower rectum. Furthermore, lateral lymph node dissection combined with total mesorectal excision remains the standard surgical procedure for patients with T3 and T4 lower rectal carcinoma in Japan, and lateral lymph node dissection by laparoscopy remain an unexplored frontier (16,20). In particular, previous studies have reported an anastomotic leakage rate of 7.2 to 20% in patients who underwent laparoscopic low anterior resection (9-15), and some authors have recommended covering ileostomy as a routine in this procedure (9). However, this can deteriorate the short-term quality of life of the patient and can also promote local recurrence in the long term (21). Therefore, the utmost effort should be made to avoid this complication.

At our institution, patients with low anastomosis within 1cm from the dentate line, incomplete doughnuts with DST, and laparoscopic intersphincteric rectal resection and handsewn coloanal anastomosis underwent covering ileostomy. However, the decision to perform protective ileostomy in this series was based on much looser criteria than those used in OS in order to avoid major anastomosis complications that could lead to permanent stoma or fatal outcome, especially in the early LS cases involving lower rectal carcinoma. In the future, it may be appropriate to set the same indications for ileostomy as in OS.

In sphincter-preserving surgery for rectal carcinoma, whether performed by LS or by OS, the procedure for dissection and anastomosis is the phase with the highest technical difficulty. For patients with lesions located more than 2cm of the distal free margin to the dentate line with no evidence of carcinoma invasion into the sphincters or pelvic floor, we usually perform laparoscopic DST anastomosis. However, as we previously indicated, during LS for lower rectal carcinoma, the closer the site of dissection of the rectum is to the anus, the more difficult the rectal dissection technique is, thus increasing the use of endolinear staplers needed to perform the dissection. In such cases, it is important to securely penetrate the first and second crossing points using a circular stapler to prevent anastomotic leakage (17).

One of the distinctive points of the present study is that only one patient underwent laparoscopic APR. Recently, laparoscopic ISR-CAA has been reported for patients with lesions located in the lower rectum with greater than 2cm of distal free margin to the dentate line (18). This technique allows a sufficient distal margin to be obtained under direct vision in order to preserve the sphincter and avoid APR. As a consequence, only one patient underwent laparoscopic APR. Although we considered that laparoscopic ISR-CAA was possible in that case, the patient's choice was laparoscopic APR.

With regard to the oncological outcome which is the most important factor in terms of a carcinoma surgery, recently reported results of three RCTs in patients with colon carcinoma or upper rectal carcinoma indicating that the treatment outcome of LS is equal to or better than that of OS (6-8). However, many RCTs have excluded patients with middle and lower rectal carcinoma because of great technical difficulties, and there has been only case series reporting experiences of a single or multiple institutions (2,9-14). Further investigations based on multicenter RCT are necessary for middle and lower rectal carcinoma cases as well.

In conclusion, the findings of the present study demonstrated that LS for rectal carcinoma could be performed safely compared to OS without increased morbidity or mortality. The radical resection of middle and lower rectal carcinoma is a procedure that requires advanced technical skills in OS, to say nothing of LS. With improvements in technology and surgical experience, the indications for this procedure are expected to expand. However, at present, as the oncological outcome remains unclear, expansion of the indications to include advanced lower rectal carcinoma should proceed cautiously.

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REVIEW ARTICLE

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Function-preserving surgery for rectal cancer

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Abstract When total mesorectal excision (TME) is accurately performed, dysfunction, theoretically, does not occur. However, there are differences among individuals in the running patterns and the volumes of nerve fibers, and if obesity or a narrow pelvis is present, nerve identification is difficult. Currently, the rate of urinary dysfunction after rectal surgery ranges from 33% to 70%. Many factors other than nerve preservation play a role in minor incontinence. Male sexual function shows impotence rates ranging from 20% to 46%, while 20%–60% of potent patients are unable to ejaculate. In women, information on sexual function is not easily obtained, and there are more unknown aspects than in men. As urinary, sexual, and defecation dysfunction due to adjuvant radiotherapy have been reported to occur at a high frequency, the creation of a protocol that enables analysis of long-term functional outcome will be essential for future clinical trials. In the treatment of rectal cancer, surgeon-related factors are extremely important, not only in achieving local control but also in preserving function. This article reviews findings from recent studies investigating urinary, sexual, and defecation dysfunction after rectal cancer surgery and discusses questions to be studied in the future.

Key words rectal cancer · urinary, sexual, defecation dysfunction · adjuvant radiotherapy · quality of life in rectal cancer patients

Introduction

The goals of surgical treatment of rectal cancer are: firstly, to achieve local control by complete removal of the lesion; secondly, to preserve urinary and sexual functions; and thirdly, to preserve anal sphincteric function if possible; while the ultimate goal is, of course, to cure the rectal cancer. This article reviews findings from recent studies investigating urinary, sexual, and defecation dysfunction after rectal cancer surgery, and discusses questions to be studied in the future.

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Differences in treatment strategies:

In Western countries, nonanatomical dissections represented by blind hand dissection were the standard operative procedures for rectal cancer. In consequence of this technique, rates of local recurrence as high as 30% were reported.[1,2] In the latter half of the 1980s, total mesorectal excision (TME), proposed by Heald et al.,[3] began to be employed. This procedure, which involves dissecting the rectum with TME under direct vision based on anatomical indexes, came into widespread use in Western countries during the 1990s. The first reason for the spread of its use was the oncological superiority, as indicated by reports of local recurrence rates as low as 4%.[4] The second reason was the benefit from preserving urinary and sexual functions. During the same period, clinical trials examining the use of adjuvant chemoradiation were conducted, with the aim of overcoming the high local recurrence rate.[5] A notable product that resulted from these studies is the Dutch CKVO 95-04 TME Trial.[6]

In Japan, on the other hand, having been influenced by the extended surgery for gastric cancer, leading hospitals began to employ extended surgery for rectal cancer around the beginning of the 1970s, thereby producing good results: firstly, 5-year survival rates were favorable compared with historical controls,[7] and secondly, the topography of lymph node metastases of rectal cancer was elucidated in terms of the frequency of lateral lymph node metastases.[8,9] In Japanese patients, body mass indexes and the rates of atherosclerosis are generally lower than in Western patients; for such physical reasons, there was no increase in morbidity and mortality due to extended surgery. However, extended surgery was associated with severe urinary and sexual dysfunction, as it involved the resection of auto-

nomic nerves in the pelvis.[10] At the beginning of the 1980s, having reflected upon the previous results, researchers began to vigorously conduct basic and clinical studies to investigate the running patterns and functions of the intrapelvic autonomic nerves; and, consequently, autonomic nerve-preserving surgery with lateral node dissection came into existence.[11-13] The combination of TME with autonomic nerve identification, which was subsequently proposed by Heald and Enker, reflects the findings of research on the pelvic autonomic nerves conducted in Japan.[14]

The gross anatomy of the autonomic nerves in the pelvis has been almost totally elucidated. When TME is accurately performed, urinary and sexual dysfunctions, theoretically, do not occur. However, even with accurate anatomical knowledge, there are differences among individuals in the running patterns of the nerves and the volumes of nerve fibers in each region of the pelvis; and if a factor such as obesity or narrow pelvis is added, intraoperative nerve identification will be difficult, possibly causing nerve injury. If the cancer directly invades the autonomic nerves, combined resection of these nerves must be performed.

Urinary function (UF)

The sympathetic nerves inhibit contraction of the detrusor muscle and promote constriction of the bladder neck, ensuring urinary continence. But there are still many questions concerning UF; for example, to what extent the sympathetic nerves such as the superior hypogastric nerve plexus (SHNP) and hypogastric nerves (HN) are actually responsible for normal urination is still unknown. On the other hand, the parasympathetic nerves innervate the detrusor muscle and are therefore necessary for urinary voiding. Currently, the rate of urinary dysfunction after surgery for rectal cancer ranges from 30% to 70%. Many factors other than nerve preservation play a role in minor incontinence of bladder function.[15,16] Loss of sympathetic innervation, which may be the result of damage to the hypogastric nerves, may result in urgency and stress incontinence in females. The fact that major incontinence as a result of precise autonomic nerve-preserving techniques was not reported indicates that substantial urinary morbidity was avoided.[17,18] Posterior tilting of the bladder after an abdominoperineal resection (APR) or inflammatory change in the paravesical tissues may also cause difficulty in bladder empting.[19] However, urinary dysfunction after bilateral resection of the inferior hypogastric nerve plexus (IHNP) is devastating. A surprisingly large proportion of patients suffer various urinary tract problems due to extended lymphadenectomy. The extent of resection should be decided by the extent of the cancer, and routine excision of the IHNP should not be performed.[10]

Sexual function (SF)

Results of studies of male SF after conventional rectal cancer surgery show impotence rates ranging from 20% to 46%, while 20%–60% of potent patients are unable to ejaculate.[17,20] These sexual dysfunctions are, of course, due to intraoperative nerve injury. Therefore, preservation of the pelvic autonomic nerves such as the HP and IHNP seems to adequately lower the incidence of sexual morbidity. Havenga,[18] and Enker[21] reported that the use of autonomic nerve-preserving pelvic sidewall dissections enabled preservation of potency and ejaculation in 86.7% and 87.9%, respectively, of male rectal cancer patients. The reports by Maas et al.[17,22] and others[11] about Dutch patients with rectal cancer, although the number of patients was small, are also worth paying attention to. In a pilot study, several types of autonomic nerve-preserving techniques were performed according to the extent of rectal cancer. Of 17 patients in whom the bilateral IHNPs were preserved, 16 (94%) maintained erectile ability. With preservation of the SHNP, ejaculation was maintained in 90% of the patients. These two results practically proved that when precise autonomic nerve preservation is done, nearly 90% of male sexual function can be preserved. This means that in the treatment of rectal cancer, surgeon-related factors are extremely important, not only in achieving local control but also in preserving function.[23]

In all rectal cancer patients whose SHNP was sacrified for an oncological reason, the operation was associated with ejaculation dysfunction. But when the IHNPs are preserved, impotence does not occur. In other words, ejaculation dysfunction results from the sacrifice of the SHNP, and impotence results from the sacrifice of the IHNP. Another important finding is that a 2-year follow-up with questionnaires showed that both urinary and sexual functions were preserved unchanged compared with findings in the first postoperative questionnaire.

In Western countries, clinical trials investigating the role of preoperative radiotherapy (PRT) for stage T3 or more rectal cancer were conducted and a significant effect of PRT in preventing local recurrence was reported.[5,6] Consequently, PRT became a standard treatment for rectal cancer in Western countries. However, is this treatment strategy correct, as expected? The advantages and disadvantages of radiotherapy should be discussed not only in terms of local control but also in terms of dysfunction. The nature of radiation damage to tissues and organs is the manifestation of damage to lymphatic and blood vessels: tissues within the radiation field become fibrotic, blood flow becomes impaired, and the functions of organs exposed to radiotherapy deteriorate over time. These are all well-known basic facts about radiation biology. There were reports that erectile deficiency occurred in as many as 62% of patients undergoing radiotherapy for prostate cancer.[24,25] Thus far, there have been only a small number of reports regarding its negative effects; however, the number of such reports has recently begun to increase. Heriot et al.[26] reported that radiotherapy had an adverse effect on the ability to have and mantain an erection, to attain orgasm, and to be sexually active in comparison with patients undergoing surgery alone (7.4%, 12.6%, 16.2%, and 13.7% reductions, respectively, 8 months after surgery; $P < 0.05$). In addition, in a report by Marijnen et al.,[27] the realities of sexual dysfunc-

tion due to preoperative short-term high-dose radiotherapy in the Dutch trial are described as follows. At 24 months, 76% of male patients without PRT and 67% of patients with PRT who were previously active were still sexually active. For female patients, these figures were 90% and 72%, respectively. A negative influence of PRT was observed in males for ejaculation disorders, with a further deterioration over time, which can be explained by the fact that the seminal vesicles have been irradiated and may stop function. Irradiated men show a decrease in erectile function for up to 2 years, suggesting late radiation damage to the small vessels. As noted above, urinary and sexual dysfunctions due to PRT were reported to occur at a high frequency, but the realities of dysfunctions, that last for 2 years or longer remain unclear. Furthermore, no clinical trial has yet been conducted to investigate differences in the dysfunctions between short-term high-dose (25 Gy in five fractions over 5–7 days) and conventional (50.4 Gy) radiation therapy protocols. Therefore, the creation of a protocol that enables analysis of long-term functional outcome will be essential for future clinical trials.

Laparoscopic rectal surgery (LRS) is applied in the treatment of rectal cancer, but there have been only a few reports on functional outcomes due to LRS. The report from the conventional versus daparoscopic-Assisted Surgery In Calorectal Cancer (CLASICC) trial shows that LRS did not adversely affect bladder function, but there was a trend towards worse male sexual function. This may be explained by the higher rate of TME in the LRS group.[28] LRS, in which the running patterns of nerves in each region can easily be identified compared with open surgery, needs to be further investigated in terms of functional outcomes in the treatment of rectal cancer.

The physiologic function of autonomic nerves in females is considered as follows: the sympathetic nerves are responsible for emissions and the rhythmic contraction of the genital ducts and organs during orgasm. The parasympathetic nerves are responsible for increased blood flow to the vagina and vulva, causing vaginal lubrication and swelling of the labia and clitoris. Hendren et al.[29] observed that specific sexual problems in women were loss of libido (41%), loss of arousal (29%), loss of lubrication (56%), lack of orgasm (35%), and dyspareunia (46%), and they speculated that deterioration of SF after an APR in women were due to colostomy and radiation-induced scarring. However, in women, information on SF before and after surgery is not easily obtained, and there are more unknown aspects than in men.

Defecation function (DF)

Transanal hand-sewn anastomosis and intersphincteric resection (ISR) have also begun to be employed for rectal cancer within 5 cm of the anal verge, which was conventionally considered as an indication for APR, thereby expanding the indications for sphincter-preserving surgery (SPS).[30,31] Ueno et al.[32] investigated intramural distal spread using pathologic specimens obtained during APR, and reported that three factors: tumor budding in the invasive front, involvement of three-quarters or more of the circumference, and type 3 gross appearance were correlated with the frequency of intramural distal spread; hence, if none of these factors was present, the 1-cm rule of distal clearance can be applied. This finding provided a pathologic basis for expanding the indications for ISR.[32]

A study has investigated the use of magnetic resonance imaging (MRI) to visualize the presence or absence of tumor invasion of the internal and external anal sphincters and the levator ani muscle, for the purpose of obtaining a basis for confirming the indications for ISR.[33] ISR involves contradictory factors including: (1) compromising the radicality of cancer surgery; (2) deteriorating DF after operation; and (3) intraoperative implantation. At the same time, it is necessary to know that the degree of technical difficulty of ISR depends on the patient's body shape. Large males with well-developed muscles and obese patients with a narrow pelvis require a deep transanal approach, which involves a high degree of technical difficulty.

Normal DF is achieved by the neurological coordination between reservoir and sphincteric functions (defecation reflex). SPS, particularly transanal anastomosis and ISR, inevitably involves the deterioration of reservoir function and loss of defecation reflex. Bittorf et al.[34] reported that J-pouch reconstruction enabled the improvement of DF. However, in order to determine whether the creation of a colonic pouch or straight coloanal anastomosis is an effective reconstruction technique for improving DF in Japanese patients, it is necessary to conduct an investigation specifically designed for Japanese patients, because the properties of the stool differ according to eating habits.

In two randomized studies, postoperative DF was investigated in groups who had received preoperative short-term high-dose radiotherapy. Dahlberg et al.[35] reported that the number of defecation was significantly increased in the irradiated group. Incontinence for loose stools, urgency, and emptying difficulties were also more frequent in that group, compared with the surgery-alone group. On the other hand, Marijnen et al.[36] reported that there was no significant difference in DF between their two groups (PRT- arm and PRT + arm) at 24 months after surgery.

Gervaz et al.[37] investigated the impact of adjuvant chemoradiotherapy on DF in patients undergoing J-pouch reconstruction. In their study, incontinence to gas, liquid stool, and solid stool were significantly more frequent in the irradiated group. Moreover, irradiated patients reported more frequent pouch-related problems, such as clustering and sensations of incomplete evacuation. Regression analysis demonstrated that radiation-induced sphincter-dysfunction was progressive over time.

After a comprehensive evaluation of DF using a validated instrument, Temple et al.[38] concluded that patients treated with adjuvant radiotherapy, coloanal anastomoses, or handsewn anastomoses had significantly worse function.

As we have seen, DF in irradiated patients is significantly impaired, similarly to SF. The probable reasons for the

impairment include fibrosis of the anal sphincteric muscles or anal canal epithelium and lowered compliance of the intrapelvic organs. Therefore, long-term observations are required to investigate to what extent irradiation has a negative impact on DF.

There are differences in radiation sensitivity among organs, but radiation damage extends widely over the intrapelvic organs; hence, one should understand, from a comprehensive viewpoint, that urinary, sexual, and defecation dysfunctions reflect neurogenic, vasculogenic, and musculogenic damage. It can possibly be said that now is the time to strictly limit the indications for preoperative radiotherapy for rectal cancer to patients at high risk of local recurrence.

Is sentinel lymph node (SLNS) navigation surgery (SLNNS) effective for rectal cancer?

SLNs are the lymph nodes most likely to harbor metastasis from a primary lesion, and SLNNS is a concept based on the assumption that such lymph nodes exist. During this procedure, SLNs are marked, using a dye and/or radioactive material for identification, and are subsequently excised to examine for the presence or absence of metastasis. If the SLNs identified are found without metastasis, then the lymph node dissection is not performed; if the SLNs contain metastasis, the lymph node dissection is performed. In other words, the sentinel node examination is an intraoperative test to confirm that limited surgery or function-preserving surgery is beneficial. For breast cancer and malignant melanoma, this test is effective, because SLNs are located at sites far from the primary lesion. Conversely, the colon and the rectum, particularly the rectum, are organs rich in lymphatics, and their lymphatic pathways start just below the tumor. For this reason, the marker is injected near the tumor site, which then overlaps with the injected site, thus making it difficult to differentiate SLNs from the background, and reducing the effectiveness of the procedure. There have been attempts to investigate SLN biopsy for digestive tract cancer, but with sensitivity ranging from 70% to 100% and false-negative rates of 0 to 40%, SLN biopsy loses importance as a method for selecting patients for lymph node dissection. It can be said that the significance of SLNs rather relies on the efficient retrieval of lymph nodes. In Western countries, SLNNS has been applied to colorectal cancer, with the view that the expansion of patient selection for adjuvant therapy by upgrading stage I/II to stage III can benefit patients.[39,40]

Are there true scales for quality of life (QOL) evaluation?

It is difficult to evaluate QOL after rectal cancer surgery. In many articles, analyses show that if there is no tumor invasion into the anal sphincter muscles, SPS should be selected.[41] But in the Dutch trial, an analysis using health-related QOL showed no difference in QOL between APR and SPS.[36] To decide whether or not to perform SPS, discussion with the patient and consideration of the patient's personal situation are required. A report from Norway shows that, with a better body image and fewer male sexual problems, patients had a more favorable QOL after SPS compared with that after APR; however, there was no difference in overall QOL.[42] Even after total pelvic exenteration, even the patients with double stomas reported having a good QOL. This may be attributable to the adaptation or response shift seen particularly in individuals who have overcome cancer, a disease that threatens the patient's life.[43,44] Thus, the question arises as to whether there really are evaluation methods that can objectively produce an overall QOL score. Even with the use of the randomized controlled clinical trial, a methodology with a high level of evidence, it is difficult to evaluate QOL studies. Is there a difference in the basic evaluation scale between the logic of the medical professional and the logic of patients? If there is, medical professionals may be still at a stage where information about QOL should be humbly learned from patients.

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Diseases of the Colon & Rectum

Intersphincteric Resection in Patients with Very Low Rectal Cancer: A Review of the Japanese Experience

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PURPOSE: This study was designed to evaluate the feasibility and oncologic and functional outcomes of intersphincteric resection for very low rectal cancer. METHODS: A feasibility study was performed using 213 specimens from abdominoperineal resections of rectal cancer. Oncologic and functional outcomes were investigated in 228 patients with rectal cancer located <5 cm from the anal verge who underwent intersphincteric resection at seven institutions in Japan between 1995 and 2004. RESULTS: Curative operations were accomplished by intersphincteric resection in 86 percent of patients who underwent abdominoperineal resection. Complete microscopic curative surgery was achieved by intersphincteric resection in 225 of 228 patients. Morbidity was 24 percent, and mortality was 0.4 percent. During the median observation time of 41 months, rate of local recurrence was 5.8 percent at three years, and five-year overall and disease-free survival rates were 91.9 percent and 83.2 percent, respectively. In 181 patients who received stoma closure, 68 percent displayed good continence, and only 7 percent showed worsened continence at 24 months after stoma closure. Patients with total intersphincteric resection displayed significantly worse continence than patients with partial or subtotal resection. CONCLUSIONS: Curability with intersphincteric resection was verified histologically, and acceptable oncologic and functional outcomes were obtained by using these procedures in patients with very low rectal cancer. However, information on potential functional adverse effects after intersphincteric resection should be provided to patients preoperatively. [Key words: Very low rectal cancer; Intersphincteric resection; Abdominoperineal resection; Coloanal anastomosis; Anal function]

Local control and survival for patients with rectal cancer have been improving with the development of surgical techniques and combined adjuvant therapies.[1,2] The advent of mechanical low-stapling and double-stapling techniques and sutured coloanal anastomosis has facilitated easier anastomosis at the distal rectum. These methods have increased the frequency of sphincter salvage. Nevertheless, permanent colostomy is still performed in approximately 20 percent of patients with low rectal cancer. Abdomi-

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noperineal resection (APR) is a standard surgery for low rectal cancers located <5 cm from the anal verge or <2 cm from the dentate line (DL). These cancers may be associated with lymph node metastasis along the levator ani muscle or in the fatty tissue of the ischiorectal fossa,[3] and also may have the potential for microscopic involvement of the rectal wall below the tumor.[4] APR has been established as a standard procedure in patients with lower rectal cancer. Patients undergoing APR can experience some problems with quality of life, because permanent colostomy results in psychologic and social limitations.[5,6]

In recent years, intersphincteric resection (ISR) with coloanal anastomosis has been proposed to avoid permanent colostomy for rectal cancers located <5 cm from the anal verge, although these tumors are not generally considered for sphincter-saving procedures.[7–13] Several studies have reported that local control and functional results after ISR are satisfactory.[7,10–14] Experiences with ISR, including partial external sphincteric resection (PESR), also have been reported in recent studies[12,15]; however, data remain scarce. The rationale for ISR in patients with very low rectal cancer is described in this review article by using data from Japanese experiences and Western reports, and our theoretic background is provided based on the histologic evidence.

PATIENTS AND METHODS

Pathologic and Theoretic Background

The pathologic study was performed by a surgical pathologist (KS) at Kurume University. In this pathologic study of 213 surgical specimens from APR for lower rectal cancer or anal canal cancer excluding anal cancer, the external sphincter muscle, puborectalis muscle, and fatty tissue of ischiorectal fossa were investigated for direct invasion and skip metastasis. The entire tumor mass was sectioned at 5-mm intervals, including oral and anal parts up to 5 cm from the tumor. The same surgical pathologist (KS) made all final pathologic diagnoses.[15,16]

Patient Population

A total of 228 consecutive patients (168 males) who underwent ISR between 1995 and 2004 were identified from the hospital databases, and medical charts were retrospectively reviewed. These 228 patients received ISR at seven institutions in Japan that participated in the "Studies on preservation of anal function for very low rectal cancer patients," sponsored by Grant-in-Aid 14-10 for Cancer Research from the Ministry of Health, Welfare and Labor of Japan. Median age was 58 (range, 27–77) years. All 228 patients displayed adenocarcinoma located <5 cm from the anal verge.

The anal verge was defined as the terminal part of the surgical and anatomic anal canal. The intersphincteric groove (ISG) exists between the terminal part of the internal sphincter (IS) and the subcutaneous part of the external sphincter (ES). Exact level of the lower edge of the tumor from the anal verge was assessed and measured by digital examination and endoscopy. All tumors found infiltrating the rectal wall on digital examination, computed tomography (CT), magnetic resonance imaging (MRI), or endorectal ultrasonography (US) were eliminated from consideration for local excision. Patients were classified according to International Union Against Cancer (UICC) standards[17] after preoperative diagnosis using CT, MRI, US, colonoscopy, chest radiography, and biopsy.

An exception to selection of ISR was made if malignant infiltration of other organs or of the striated muscles of the pelvic floor (such as levator ani muscle or external sphincter) was suspected, if tumors displayed low differentiation on histopathology, or if preoperative anal function demonstrated marked insufficiency. Patients with synchronous metastases also were excluded from ISR. These patients were treated by using conventional APR. In the present study, ISR was performed mainly in very low rectal cancer patients with T3, T2, or T1 (massive invasion of the submucosa) disease lying <5 cm from the anal verge. All resected specimens were examined to determine macroscopic and microscopic surgical margins (distal and radial). Postoperative mortality and morbidity, local control, and survival also were investigated.

Surgical Technique and Classification

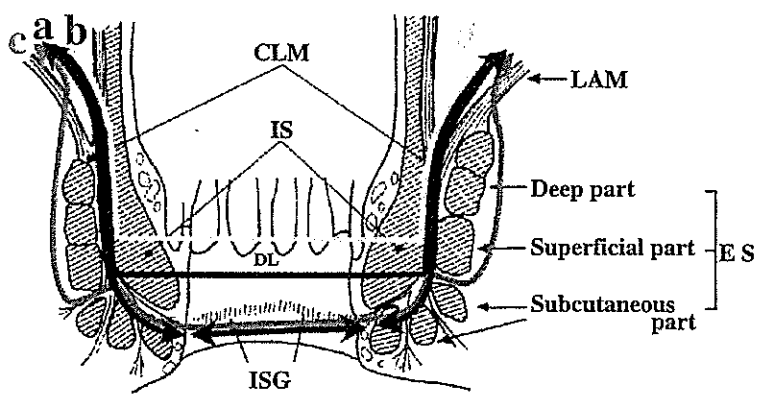
ISR was performed according to the methods previously reported by Schiessel *et al.*[7] and others.[10,12,15] The surgical technique included both abdominal and perianal approaches. Abdominal dissection was performed first. Total mesorectal excision (TME) with lateral node dissection was undertaken. During the abdominal approach, the autonomic nerve system was preserved to the fullest

extent possible, using Japanese methods previously described.[18–22] The rectum was mobilized carefully as low as possible to the pelvic floor to facilitate the perianal approach. The IS was then exposed and circumferentially divided from the puborectalis muscle and ES. During these procedures, the tumor was evaluated through gentle palpation by the surgeon. If tumor had invaded beyond the rectum into the puborectalis muscle or ES at the anorectal junction or anal canal, the puborectalis muscle was resected and fatty tissue of the ischiorectal fossa was visualized. ISR plus PESR was performed in those patients.

After the abdominal approach, perianal resection was performed. Circumferential incision of the mucosa and IS was initiated 1 to 2 cm distal to the tumor. The anal orifice was closed by pursestring suture to avoid spread of tumor cells during perianal operation.[12] Once the intersphincteric space was entered, careful dissection continued upward between the smooth and striated sphincters under constant guidance by the abdominal surgeon.

Total ISR involved complete excision of the IS for tumors spreading to or beyond the DL. The distal cut-end line was at the ISG. Total ISR was unnecessary in patients with tumor located ≥2 cm from the DL. Those patients underwent subtotal ISR. The distal cut-end line was between the DL and ISG, and the DL was included in the resected specimen. In patients with tumor located from >2 to 3 cm from the DL, the distal cut-end line was just on or above the DL. This procedure, partial ISR, sometimes includes conventional coloanal anastomosis procedures. When patients displayed tumor invading the ES, ISR plus PESR was performed. At least the subcutaneous part of the ES was preserved in these patients. ISR was classified into four types: total ISR; subtotal ISR; partial ISR; and ISR + PESR (Fig. 1).

After specimen removal and generous irrigation of the pelvic cavity, the sigmoid colon was pulled down and coloanal anastomosis with or without colonic pouch was made according to the method described by Parks.[23] Anastomoses were performed by using perianal manual suturing in all patients.



Type of ISR	Anastomotic line	Sacrificed sphincter
Partial	Just on DL or within 1cm oral side from DL	Partial IS
Subtotal	Between DL and ISG	Almost all of IS
Total	Just on ISG	Total IS without or with partial ES

Figure 1. Resecting lines in intersphincteric resection (ISR) are illustrated. PESR=partial external sphincteric resection.

Finally, a diverting stoma using terminal ileum or transverse colon was established. This stoma was closed at three to six months postoperatively.

Adjuvant Therapy

Preoperative radiochemotherapy was performed in 57 patients with T3 tumors who agreed to preoperative adjuvant therapy at the National Cancer Center Hospital East (NCCHE), National Defense Medical College, or Chiba University. Other patients underwent surgery alone, because preoperative radiochemotherapy for resectable rectal cancer is not standard in Japan. The 44 patients from the NCCHE received 45 Gy during a five-week period, followed by operation two weeks later. In addition, continuous infusion of 5-flurouracil (250 mg/m^2/day) was administered to these patients during radiotherapy to increase radiotherapeutic efficacy. Although revaluation using CT, MRI, US, and colonoscopy was performed in these patients after completion of preoperative radiochemotherapy, all patients underwent ISR. Most patients with Stage III tumor (pTNM pathologic classification) received postoperative chemotherapy with 5-fluorouracil and folinic acid, or tegaful uracil, or others for six months or more.

Follow-Up and Functional Assessment

Follow-up examinations were performed every three months for two years postoperatively, and subsequently every six months. Examinations included clinical, laboratory (including tumor markers, such as carcinoembryonic antigen and carbohydrate antigen 19-9), and radiologic (abdominal and pelvic CT and chest radiography) investigations.

Functional outcomes also were assessed at the same time by using our functional questionnaire. This functional questionnaire asked about stool frequency (number of bowel movements per 24 hours), feces and flatus discrimination, urgency (ability to defer stool evacuation for >15 minutes), fragmentation (≥2 evacuations in 1 hour), soiling during the day and night, use of pads, use of medications, and alimentary restriction. Incontinence was assessed by using the continence scores of both the Jorge and Wexner,[24] and classification by Kirwan *et al.*[25]

Median follow-up was 41 (range, 10–84) months. No patients were lost to follow-up, and 57 percent of patients were observed for ≥36 months.

Statistical Analysis

Overall survival (OS) and disease-free survival (DFS) were calculated by using Kaplan-Meier methods. Duration to final follow-up evaluation, treatment failure, or death was measured from the date of rectal resection. Assessment of local recurrence was evaluated by using a cumulative local disease-free survival curve. Assessment of recurrence and survival was performed in patients with microscopically curative surgery.

RESULTS

Pathologic Validity

Pathologic study of the 213 surgical specimens from APR for lower rectal cancer or anal canal cancer (excluding anal cancer) revealed neither direct invasion nor skip metastasis in subcutaneous external sphincter muscle or fatty tissue of the ischiorecal fossa; however, spread of cancer to the deep and superficial ES muscles or puborectalis muscle was observed in 14 percent. Curative operation was thus accomplished by using ISR in 86 percent of patients undergoing APR. When tumor invasion exceeds the IS at the surgical anal canal, safe surgical margins can be obtained using ISR with combined resection of the deep and superficial ESs. Complete radical surgery can theoretically be accomplished even if subcutaneous ES muscle is not resected.

Population

The study was comprised of 228 patients with very low rectal cancer (including surgical anal canal cancer) who underwent ISR between 1995 to October 2004. Tumor characteristics and surgical procedures are shown in Table 1. Median lower edge of the tumor was 3.4 (range, 2–5) cm from the anal verge. Tumor staging was T3 tumor (n = 103), T2 tumor (n = 78), or T1 (n = 46). Surgical procedure was subtotal ISR in 124 patients, total ISR with or without PESR in 69 patients with tumor located ≤ 2 cm from the anal verge, and partial ISR in 35 patients. These procedures were decided according to tumor localization. All patients underwent coloanal anastomosis by manual suturing. Anastomosis involved a colonic J-pouch (n = 51), coloplasty (n = 25), side-to-end anastomosis (n = 5), or straight anastomosis (n = 147).

Table 1.
Patients Undergoing ISR

	(n = 228)
Age (yr)	58 (27–77)
Male/female ratio	168/60
Tumor	
Distance from anal verge (cm)	3.4 (2–5)
Clinical stage	
T1	46
T2	78
T3	103
T4	1
Procedure	
Partial ISR	35
Subtotal ISR	124
Total ISR (with or without PESR)	69
Morbidity rate	24 percent (55/228)
Mortality rate	0.4 percent (1/228)

ISR = intersphincteric resection; PESR = partial external sphincteric resection.

Data are medians with ranges in parentheses or numbers of patients.

Fifty-seven patients received preoperative radiochemotherapy.

Morbidity and Mortality

Postoperative complications occurred in 55 patients (24 percent), including anastomotic leakage (n = 23), pelvic infection and abscess (n = 10), anastomotic stenosis (n = 7), colonic ischemia and necrosis (n = 4), anovaginal fistula (n = 3), postoperative bleeding (n = 3), mucosal prolapse (n = 3), and postoperative ileus (n = 2). In 9 of these 55 patients (4 percent), additional surgery, such as APR or Hartmann's operation, was required because of postoperative massive hemorrhage, colon necrosis, or anastomotic insufficiency. Surgery-related death occurred in one patient (0.4 percent) who experienced a breakdown of colonic J-pouch and died of sepsis. No differences in morbidity were identified between the radiochemotherapy and surgery-alone groups.

Pathologic Findings

Radical resection of the tumor was achieved in all 228 patients. Surgery was judged as microscopically curative in 225 patients (98.7 percent) who displayed adequate cancer-free margins (distal and radial). Unclear surgical margins were noted in three patients with Type 3 tumor, because microscopic vessel involvements were observed very near to the surgical margins. These three patients were excluded from assessments for recurrence and survival, although none of these patients received additional surgery, such as APR, because obvious positive margins were not identified. Follow-up was performed as usual.

Recurrences

During the median observation time of 41 months, 30 of 225 patients developed recurrence. These recurrences comprised lung metastasis (n = 11), liver metastasis (n = 11), local recurrence including regional lymph node metastasis (n = 8), inguinal lymph node metastasis (n = 4), bone metastasis

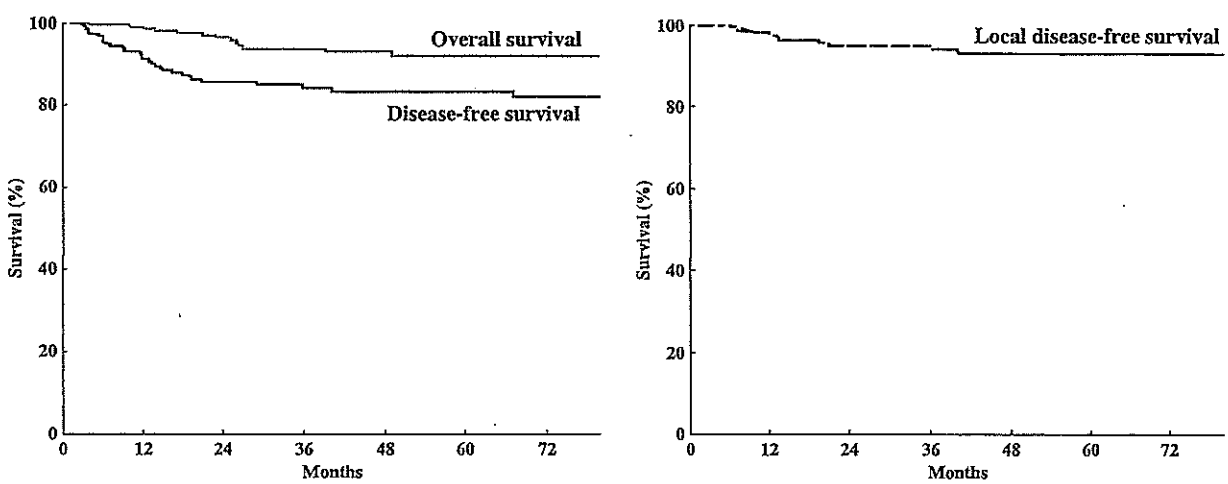


Figure 2. Overall survival was 91.9 percent and disease-free survival was 83.2 percent at five years. Acceptable local control also was obtained.

Table 2.
Functional Results After Stoma Closure

	(n = 181)			
	3 Months	6 Months	12 Months	24 Months
Continence				
Wexner score (n = 110)	17 ± 1.7	11.2 ± 4	8.4 ± 4.5	7.8 ± 4.2[a]
Kirwan classification				
I Perfect	17	19	36	36
II Incontinence of flatus	11	12	16	32
III Occasional minor soiling	45	51	36	25
IV Frequent major soiling	19	16	12	7
V Incontinent (required colostomy)	8	2	0	0

ISR = intersphincteric resection.
Data are means ± standard deviations or percentages.
[a] Partial ISR (mean, 6); subtotal ISR (mean, 7.8); total ISR with or without partial external sphincteric resection (mean, 11.1).

(n = 1), and abdominal wall metastasis (n = 1). In seven of eight patients with local recurrence, recurrence occurred in lateral nodes[18–22] located between the pelvic plexus and lateral pelvic wall, or in the tissue surrounding the external iliac artery. Local recurrence in one patient occurred in the prostate with multiple lung metastases. Patients with liver or lung metastasis alone received curative partial hepatic or lung resection (n = 9). Patients with regional or inguinal lymph node metastasis also received lymphadenectomy (n = 4). Cumulative local recurrence rate was 5.8 percent at three years and 6.7 percent at five years (Fig. 2). No patients displayed anastomotic recurrence. No differences in recurrence rate or site were noted between preoperative radiochemotherapy and surgery-alone groups, although median observation time was shorter in the preoperative radiochemotherapy group (26 months) compared with the surgery-alone group.

Survival

A total of 18 patients died, with 16 deaths from distant metastasis. OS was 91.9 percent at five years, and DFS was 83.2 percent at five years (Fig. 2). No significant differences in OS or DFS were identified between preoperative radiochemotherapy and surgery-alone groups at three years (DFS: 75.1 *vs.* 85.8 percent).

Functional Outcome

Of 219 patients excluding patients with additional surgery, such as APR or Hartmann's operation, 181 received diverting stoma closure at a median of five (range, 3–24) months postoperatively. Stoma closure is planned for 30 patients. Conversely, no plan for stoma closure was made in eight patients because of anal dysfunction (n = 3), early-phase recurrence (n = 3), or anovaginal fistula (n = 2). Continence status is shown in Table 2. Although only 30 percent of patients displayed good continence (Kirwan's Grade 1–11) at six months after stoma closure, 68 percent of patients showed good continence at 24 months after stoma closure. Worsened continence was observed in only 7 percent of patients.

Wexner score was investigated sufficiently in 110 patients, with scores of 11.2 ± 4 at six months after stoma closure, 8.4 ± 4.5 at 12 months, and 7.8 ± 4.2 at 24 months. Anal function improved monthly until 24 months after stoma closure. However, day or night soilings were sometimes observed at 24 months after stoma closure in patients with total ISR. Mean Wexner score at 24 months after stoma closure was 6 in the partial ISR group, 7.8 in the subtotal ISR group, and 11.1 in the group that underwent total ISR with or without PESR. Although no significant differences in Wexner score were apparent between partial and subtotal ISR groups, patients who underwent total ISR with or without PESR exhibited significantly worse continence than those with partial or subtotal ISR (Wexner score, 11.1 *vs.* 6 and 7.8, respectively; $P < 0.05$).

DISCUSSION

The general consensus is that most rectal cancers <5 cm from the anal verge or <2 cm from the dentate line are treated by using APR. In recent years,

however, the need for a margin of ≥2 cm margin has been challenged, and a distal margin of 1 to 2 cm is now considered sufficient in most instances. Sphincter-saving operations, such as ultralow and conventional coloanal anastomosis for cancer of the lower third of the rectum, have been reported by specialized teams, with local recurrence rates of 4 to 13 percent.[26–31] Although ultralow and coloanal anastomosis have been associated with some controversial functional results, patients without permanent stoma have been widely accepted as displaying better quality of life. However, most tumors in these studies have been located ≥5 cm from the anal verge. In more recent years, ISR with coloanal anastomosis has been reported for rectal cancer located <5 cm from the anal verge by a few specialized teams.[7–13] However, some fears of oncologic results and poor anal functions have been noted, as patients display reduced surgical margins compared with APR and the internal sphincter is removed.

This study was designed to investigate the pathologic evidence and oncologic and functional results of ISR. In the present series, tumors were located ≤5 cm from the anal verge. All these patients would have required APR if treated using standard procedures. According to pathologic examination using resected specimens from APR in this study, curative operation can be accomplished by ISR in almost all patients undergoing APR. In fact, 225 of 228 patients (98 percent) who underwent ISR were considered to display histologically curative results. These results demonstrate the pathologic appropriateness of ISR and the possibility of preserving anal function during the surgical treatment of very low rectal cancers.

Rullier *et al.*[13] reported 92 rectal carcinomas at 3 cm from the anal verge, finding that the distal resection margin was 2 cm and negative in 98 percent of cases. They also reported that median circumferential margin was 5 (range, 0–15) mm and positive (≤1 mm) in ten cases (11 percent). These results show that radical tumor resection can be achieved by ISR procedures in almost all patients with very low rectal cancer.

Morbidity in our study was relatively high, with 55 of 228 patients (24 percent) experiencing complications, although the rate of serious complications was low. Our findings do not differ from those of other reports. Rullier *et al.*[13] reported similar results, with a morbidity rate of 27 percent, whereas Schiessel *et al.*[7] described a rate of 18.4 percent (7/38 patients). Unfortunately, one procedure-related death occurred in the present study. Morbidity rate was particularly high in the first half of our study, although no changes in surgical technique were enacted during this period. Careful treatment and skillfulness in this procedure are needed for these patients if surgery-related complications are to be kept at a minimum.

Although an increase in local recurrence was feared in ISR because of reduced surgical margins compared with APR, cumulative five-year local recurrence rate was 6.7 percent in this series. All local recurrences in this study were outside the normal TME planes. These recurrences would not have been prevented using standard APR and seemed to result from inadequate lateral node dissection. Rullier *et al.*[13] reported that 1 of 58 patients (2 percent) developed local recurrence during a median observation of 40 months. Schiessel *et al.*[7] reported that 4 of 38 patients (10.5 percent) exhibited local recurrence during a median follow-up of three years. Local control in this study does not differ substantially from rates in these other reports. These results demonstrate that acceptable local control can be obtained by using ISR procedures. However, two of three patients with unclear surgical margins in this study developed local recurrence with distant metastases during a median observation of 28 months. Achievement of complete microscopic resection seems important for local control. The five-year overall survival rate in our series was 91.9 percent, whereas the five-year disease-free survival rate was 83.2 percent. Rullier *et al.*[13] reported similar results, with an 81 percent five-year survival rate. Conversely, data for APR patients who underwent surgery in our seven institutions during the same time period showed that APR patients displayed tumors with the same background compared with patients who received ISR, with a median five-year DFS of 65.1 (range, 63.6–70) percent, and median five-year local recurrence rate was 10 (range, 3–19) percent. These data led us to consider the oncologic results of ISR obtained in this study as acceptable. The limit for ISR procedures seems to be circumferential clearance, rather than distal.

Some fears were held for functional outcomes after ISR procedures, because loss of the rectum and IS may induce anal dysfunctions, such as stool frequency, urgency, fragmentation, soiling, and fecal incontinence.[14,32] Approximately 30 to 60 percent of low colorectal or coloanal anastomoses induce functional disturbances collectively termed anterior resection

syndrome.[33–37] Most authors believe preservation of the whole anal sphincter and mucosa is crucial for maintenance of good continence. APR thus represents a standard surgery when distance between the lower edge of the tumor and the anal ring is <2 cm.[38] However, in this study, 93 percent of patients showed good or relatively good continence (Kirwan's Grade 1–111) at 24 months after stoma closure. Mean Wexner score was 7.8 at 24 months after stoma closure. Bretagnol *et al.*[14] and others have reported similar results.[7,10–12] However, seven patients displayed worsened continence. In addition, three patients could not undergo closure of the diverting stoma because of anal dysfunction. Furthermore, patients who underwent total ISR with or without PESR displayed significantly worsened continence compared with partial and subtotal ISR groups in our experience. Information on the potential functional adverse effects after total ISR should be provided to patients preoperatively.

Fecal incontinence after ISR is primarily caused by anal-sphincter insufficiency. Physiologic studies have shown that removal of the internal anal sphincter is associated with a significant decrease in resting pressure.[7,10,12] Anal sphincter insufficiency also may be caused by injury of the external anal sphincter during ISR. Furthermore, neorectal insufficiency may facilitate fecal incontinence, as demonstrated by randomized studies comparing straight and J-pouch coloanal anastomoses.[14,39,40] Anal functions in ISR procedures need to be investigated to compare straight, J-pouch, and transverse coloplasty coloanal anastomoses. More careful intraoperative management, additional surgery, such as colonic pouch, biofeedback treatment, and careful patient selection may facilitate improved outcomes in terms of anal function.

CONCLUSIONS

Curability with ISR procedures was verified histologically in patients with very low rectal cancer. Acceptable oncologic and functional results were obtained by using ISR procedures in patients with very low rectal cancer <5 cm from the anal verge. These procedures can be recommended for APR candidate patients; however, information on potential functional adverse effects after ISR should be provided to patients preoperatively.

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