Table 4. TR and curative resection rate

Recurrence site	TR	Patients with curative resection for relapse	Patients without resection for relapse	Total number of relapses %	Resection rate, %	p value
Liver		172	201	373 (7.1)	46.1	
	A	71	117	188	37.8	0.0023
	B	80	60	140	57.1	
	C	21	24	45	46.7	
Lung		95	155	250 (4.8)	38.0	
	A	24	58	82	29.3	0.038
	B	43	70	113	38.1	
	C	28	27	55	50.9	
Local		78	131	209 (4.0)	37.3	
	A	21	53	74	28.4	NS (0.14)
	B	40	55	95	42.1	
	C	17	23	40	42.5	
Anastomosis		15	7	22 (0.4)	68.2	
	A	4	3	7	57.1	NS (0.63)
	B	10	4	14	71.4	
	C	1	0	1	100.0	

The total number of patients in this study was 5,230. A = TR ≤ 1 year; B = 1 year < TR ≤ 3 years; C = 3 years < TR.

resection rates for hepatic relapse were 37.8% in group A and 54.6% in the combined group that included groups B and C. In a French population-based study, the curative surgery rate was 7.2% in synchronous liver metastases and 19.8% in metachronous ones [22]. The authors of this previous study indicated that the synchronous presence of liver metastasis with primary colorectal cancer was associated with a lower curative resection rate than metachronous liver metastasis. On the other hand, we could not find any previous study on the association between timing of relapse and the resection rates of lung metastasis from colorectal cancer. As for local relapse, several studies reported that there were no significant associations between timing of relapse and curative resection rate, which are consistent with the findings of the present study [17, 23, 24].

This study also demonstrated that the overall survival after relapse differed according to the timing of relapse in patients with hepatic and local relapse after curative resection for colorectal cancer. One of the reasons for this phenomenon may have been the differences in the resection rate according to the timing of relapse, because the prognoses after the resection with curative intent for relapse did not differ according to the timing of relapse.

At the present time, surgery with curative intent seems to be the only way to achieve the long-term survival of patients with colorectal cancer relapse. During the period of the present study, chemotherapies such as FOLFOX or FOLFIRI were not available in Japan. Chemotherapy for colorectal cancer has improved remarkably in recent years. To cure patients with relapse of colorectal cancer, it is necessary to increase the rate of curative resection for recurrent tumors. Recent studies have demonstrated that neoadjuvant chemotherapy can render nonresectable liver metastases resectable [25, 26]. Therefore, advances in chemotherapy may contribute to the improvement of surgical resection for metastases from colorectal cancer.

In conclusion, the timing of relapse after curative resection for colorectal cancer may affect the rate of curative resection for recurrent tumors. However, if patients can undergo curative resection for recurrent tumors, they may receive a survival benefit regardless of the timing of relapse. Further studies will be needed to validate our results in the era of multiagent chemotherapy.

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SURGERY TODAY

Retrospective, Matched Case–Control Study Comparing the Oncologic Outcomes Between Laparoscopic Surgery and Open Surgery in Patients with Right-Sided Colon Cancer

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Abstract
Purpose. The short- and long-term outcomes of laparoscopic surgery for right-sided colon cancer remain largely uninvestigated. This study was undertaken to compare the morbidity and mortality after either a laparoscopic right hemicolectomy (LRHC) or an open right hemicolectomy (ORHC) for this type of tumor.
Methods. The study group included 100 patients who underwent an LRHC and 100 patients who underwent an ORHC for right-sided colon cancer from 1990 through 2004. The two groups were retrospectively well matched with respect to sex, age (±5 years), and pathological tumor-node-metastasis (TNM) stage.
Results. The median follow-up period was 83 months in the LRHC group and 105 months in the ORHC group. The LRHC group had a lower volume of intraoperative bleeding ($P < 0.001$), a lower rate of wound infection ($P = 0.019$) or postoperative intestinal obstruction ($P = 0.013$), and a shorter hospital stay ($P < 0.001$) than the ORHC group. The rate of recurrence did not differ significantly between the LRHC group (19%) and the ORHC group (22%). In patients with TNM stage I or II, the disease-free survival (DFS) rate (94.9% vs 95.1%) and overall survival (OS) rate (95.8% vs 95.0%) did not differ significantly between the two groups. A similar tendency was observed in patients with stage III with the rates for DFS (71.3% vs 60.4%) and OS (73.6% vs 64.1%), respectively.
Conclusions. An LRHC for right-sided colon cancer has the advantage over an ORHC of better short-term outcomes, and both groups have similar long-term oncologic outcomes. An LRHC is thus an acceptable alternative to an ORHC for the treatment of this type cancer.

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Key words Right-sided colon cancer · Laparoscopic surgery · Hemicolectomy

Introduction

The indications for laparoscopic surgery have been extended from early colon cancer to advanced cancer.[1,2] This procedure has several distinct advantages in comparison to open surgery, including briefer use of analgesics, earlier return of bowel motility, a shorter hospital stay, and faster perioperative recovery.[2,3] The meta-analysis of the results of 2512 procedures from 12 randomized clinical trials reported improved short-term outcomes for laparoscopic surgery in comparison to conventional open surgery for colorectal cancer.[4] Laparoscopic surgery has also been performed in our hospital on more than 600 patients with colon cancer. Recently, the medium-term outcome of laparoscopic surgery and open surgery for advanced colorectal cancer were assessed in a matched group of patients, revealing that no significant difference was found in the survival or recurrence rate.[5] In addition, our study demonstrated the incidence of wound infections to be significantly lower after a laparoscopic colectomy than after an open procedure.[6] Laparoscopic surgery to a right-sided tumor is technically different from that of a rectosigmoid tumor.[8,9] The previous study, however, did not separate right-sided from left-sided tumors. Few retrospective studies have focused on the safety and efficacy of laparoscopic surgery for right-sided colon cancer.[10–13] The present matched case–control study was thus designed to compare the short- and long-term outcomes between laparoscopic and open surgeries in patients with right-sided colon cancer. Its ultimate goal was to determine whether a laparoscopic resection of this type of tumor is warranted.

Subjects and Methods

A laparoscopic colectomy was first performed in our hospital in 1996. From 1996 through 1999, laparoscopic surgery was basically indicated for early colon cancer. From 2000, the indication of this procedure was extended to advanced cancer confirmed to have no direct invasion to other organs on preoperative diagnostic imaging studies. All patients underwent a barium enema examination, colonoscopy, abdominal ultrasonography, and computed tomography (CT) of the chest and abdomen before surgery. The procedure for a lymph node dissection was determined based on the depth of tumor invasion on preoperative diagnosis in patients with right-sided colon cancer, who underwent a laparoscopic right hemicolectomy (LRHC) and those that underwent an open right hemicolectomy (ORHC); D2 and D3 lymphadenectomies according to the Japanese Classification of Colorectal Carcinoma[14] were applied for T1 and T2 or deeper tumors, respectively.

From April 1990 through December 2004, a total of 1895 patients underwent surgery for colorectal cancer. During the study period, there were 333 patients with right-sided colon cancers (109 patients for LRHC; 224 for ORHC) of the 1895. A retrospective, matched case–control study of the patients treated with an LRHC and ORHC was carried out; the groups were matched for sex, age (±5 years), and pathological tumor-node-metastasis (TNM) stage. The patients with an intractable intestinal obstruction and patients in whom the LRHC was switched to an ORHC were excluded from the present study.

Finally, 100 patients who underwent an LRHC and 100 who underwent an ORHC were compared (Table 1). The median (range) follow-up period was 83 (36–156) months in the LRHC group (number of

Table 1. Demographic characteristics of the patients

	LRHC (n = 100)	ORHC (n = 100)	P value
Male:female	65:35	65:35	NS
Age (years)[a]	64 (39–89)	65 (39–88)	NS
Location			NS
Cecum	14	21	
Ascending colon	72	62	
Transverse colon	14	17	
BMI (kg/m^2)[a]	22 (15–33)	22 (15–34)	NS
ASA status			NS
I	36	31	
II	55	51	
III	9	18	
Tumor size (cm)[a]	3.5 (0.7–9.4)	4.7 (0.8–14)	NS
No. of lymph nodes removed[a]	14 (10–58)	20 (12–92)	NS
pT category			NS
pT1	19	19	
pT2	11	11	
pT3	70	70	
pN category			NS
pN0	61	61	
pN1	27	27	
pN2	12	12	
Tumor differentiation			NS
Well	51	56	
Moderate	43	38	
Poor	4	3	
Mucinous	2	3	
pTNM			NS
I	29	29	
II	32	32	
III	39	39	
Follow-up period (months)[a]	83 (36–156)[b]	105 (48–216)[c]	NS

LRHC, laparoscopic right hemicolectomy; ORHC, open right hemicolectomy; BMI, body mass index; ASA status, physical status according to the American Society of Anesthesiologists classification; NS, not significant

[a]Values are expressed as median (range)

[b]n (alive at last visit) = 87

[c]n (alive at last visit) = 82

Table 2. Demographic characteristics of the patients in former and latter terms

	Former term (1990–2000)			Latter term (2001–2004)		
	LRHC (n = 45)	ORHC (n = 67)	P value	LRHC (n = 55)	ORHC (n = 33)	P value
Male:female	29:16	48:19	NS	36:19	17:16	NS
Age (years)[a]	62 (39–86)	63 (39–88)	NS	68 (50–89)	66 (53–86)	NS
Location			NS			NS
Cecum	5	12		9	9	
Ascending colon	33	42		39	20	
Transverse colon	7	13		7	4	
BMI (kg/m^2)[a]	22 (15–27)	21 (15–28)	NS	22 (16–33)	23 (18–34)	NS
ASA status			NS			NS
I	22	22		14	9	
II	21	31		34	20	
III	2	14		7	4	
Tumor size (cm)[a]	3.1 (0.7–9.4)	4.5 (0.8–12)	NS	3.5 (1.3–7.5)	5.5 (1–14)	NS
No. of lymph nodes removed[a]	24 (10–58)	29 (5–92)	NS	18 (10–38)	22 (2–42)	NS
pT category			NS			NS
pT1	12	14		7	5	
pT2	9	7		3	4	
pT3	24	46		45	24	
pN category			NS			NS
pN0	33	49		29	15	
pN1	7	15		21	16	
pN2	5	3		5	2	
Tumor differentiation			NS			NS
Well	32	40		19	16	
Moderate	10	22		33	16	
Poor	2	3		2	0	
Mucinous	1	2		1	1	
pTNM			NS			NS
I	21	21		8	7	
II	11	27		21	8	
III	13	19		26	18	
Follow-up period (months)[a]	101 (24–156)	105 (48–216)	NS	63 (12–92)	68 (14–100)	NS

LRHC, laparoscopic right hemicolectomy; ORHC, open right hemicolectomy; BMI, body mass index; ASA status, physical status according to the American Society of Anesthesiologists classification; NS, not significant
[a]Values are expressed as median (range)

patients alive at last visit [n] = 87) and 105 (48–216) months in the ORHC group (n = 82). The demographic characteristics such as age, body mass index, physical status according to the American Society of Anesthesiology (ASA) status, tumor size, the number of dissected lymph nodes, and pathological TNM stage did not differ significantly between the LRHC group and the ORHC group (Table 1). The numbers of subjects who underwent surgery during the following periods were: 1990 through 2000 (former term), 45 patients underwent an LRHC and 67 patients underwent an ORHC; and 2001 through 2004 (latter term), 55 LRHCs and 33 ORHCs. In the former and latter terms, the clinical and pathological data including the number of dissecting lymph nodes did not significantly differ between LRHC and ORHC (Table 2).

The technique for laparoscopic surgery has been described previously;[15] a new method was employed in which the first trocar was inserted after the application of a LAP DISC placed on the upper abdomen. After pneumoperitoneum, an additional four trocars were inserted into abdominal cavity under observation with a 5-mm flexible scope.

The postoperative follow-up examinations included the measurement of serum carcinoembryonic antigen levels (every 3 months to 1 year), CT scans of the chest and abdomen (at 6-month intervals), and colonoscopy, in addition to routine outpatient visits. Recurrent disease was assessed based on the clinical, laboratory, diagnostic imaging, and pathological findings.

A statistical analysis was performed with the Chi-square and Mann–Whitney U-tests. Disease-free survival (DFS) and overall survival (OS) rates were estimated according to the Kaplan–Meier method. The log-rank test was used to compare these survival rates between the groups. P values of less than 0.05 were considered to indicate statistical significance.

Table 3. Operative time, blood loss during operation, hospital stay, and postoperative complications

	LRHC	ORHC	*P* value
Operation time (min)[a]	215 (85–355)	195 (100–332)	NS
Blood loss during operation (ml)[a]	50 (0–400)	120 (0–900)	<0.001
Hospital stay (days)[a]	9 (5–50)	17 (8–57)	<0.001
Wound infection[b]	3	13	0.019
Ileus[b]	7	20	0.013
Postoperative bleeding[b]	1	1	NS

NS, not significant
[a]Values are expressed as median (range)
[b]Values represent number of events

Results

Table 3 shows the short-term outcomes of right-sided colon cancer patients with LRHC and ORHC. The median bleeding volume was significantly lower in the LRHC group (50 ml) than in the ORHC group (120 ml; $P < 0.001$). The median hospital stay after surgery was significantly shorter in the LRHC (9 days) than in the ORHC (17 days; $P < 0.001$). Postoperative complications were significantly less frequent in the LRHC (11%) than in the ORHC (34%; $P = 0.001$); wound infections ($P = 0.019$) and postoperative intestinal obstruction ($P = 0.013$) were significantly less frequent in the former than in the latter. No significant difference was found in the operation time and postoperative bleeding rate. The recurrence rate did not differ significantly between the LRHC (19%) and the ORHC (22%). Liver metastasis was the most common form of recurrence in both groups. No port-site recurrence occurred in the LRHC group. As for the long-term outcomes of patients with TNM stage I or II colon cancer, the DFS rate (94.9% vs 95.1%) and OS rate (95.8% vs 95.0%) did not differ significantly between the LRHC and ORHC groups (Fig. 1a,b). A similar tendency was observed in patients with stage III colon cancer with the rates for DFS (71.3% vs 60.4%) and OS (73.6% vs 64.1%), respectively (Fig. 2a,b).

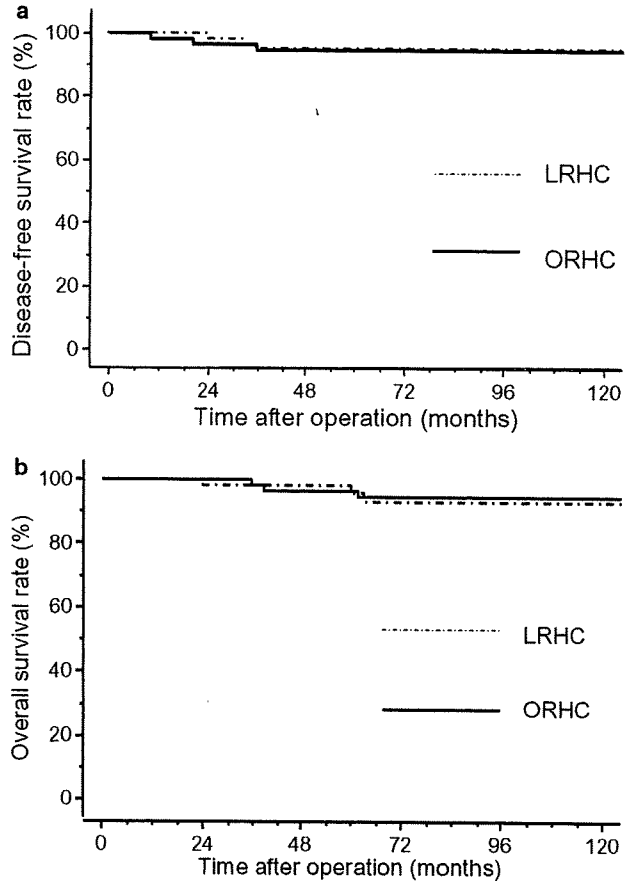

Fig. 1. a Comparison of the disease-free survival rates in patients with stage I or II colon cancer between the laparoscopic right hemicolectomy (*LRHC*) group and the open right hemicolectomy (*ORHC*) group. **b** Comparison of the overall survival rates in patients with stage I or II colon cancer between the LRHC group and the ORHC group

Discussion

An LRHC was associated with a significantly smaller intraoperative bleeding volume, significantly lower rates of wound infection and intestinal obstruction, and a significantly shorter hospital stay than was ORHC in this retrospective, matched case–control study of patients with right-sided colon cancer. There was no significant difference in the recurrence rate, the form of recurrence, or long-term outcomes between the groups. Sex, age, body-mass index, ASA status, tumor size, pathological TNM stage, and the number of dissected lymph nodes were similar in the LRHC group and the ORHC group. The comparison of oncologic outcomes in both groups is therefore considered valid.

A radical lymphadenectomy along the feeding arteries of the tumor is the standard procedure for advanced colorectal cancer. Laparoscopy provides a better, magnified view for surgery,[1,2] but it is not easy to identify

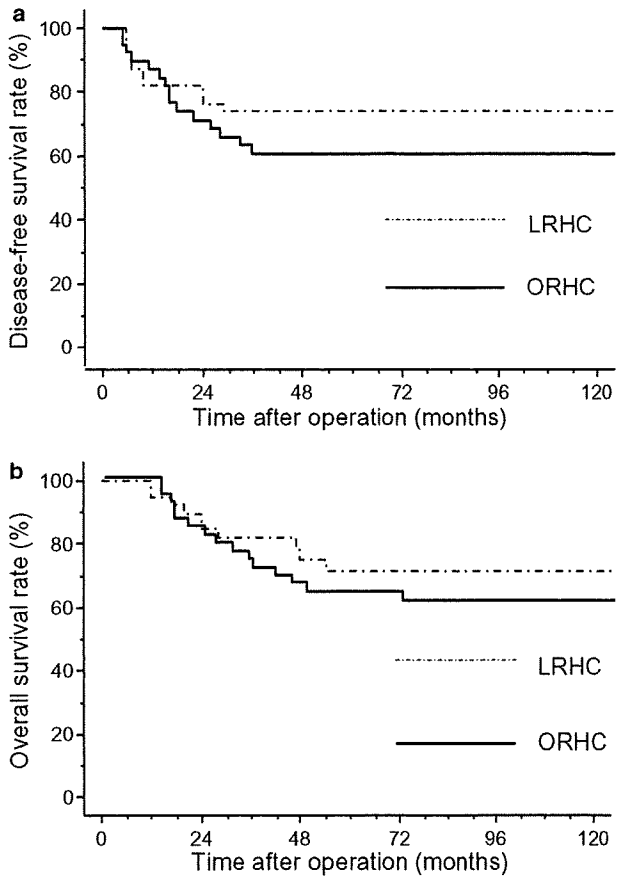

Fig. 2. **a** Comparison of the disease-free survival rates in patients with stage III colon cancer between the laparoscopic right hemicolectomy (*LRHC*) group and the open right hemicolectomy (*ORHC*) group. **b** Comparison of the overall survival rates in patients with stage III colon cancer between the LRHC group and the ORHC group

the origin of the vascular supply of an intent tumor with this procedure. Left-sided colon cancer can be easily treated by a laparoscopic high ligation of the inferior mesenteric artery with an extended lymphadenectomy. In right-sided colon cancer there are two feeders, i.e., the ileocolic and the right colic arteries, with wide-range variations of vascular architecture. A laparoscopic lymphadenectomy intracorporeally performed is therefore more difficult for right-sided colon cancer than for a left-sided tumor. The same degree of a lymphadenectomy as achieved by an ORHC was reported to be feasible in an LRHC.[8,11] In the present study, the number of lymph nodes removed was not significantly different in the LRHC group and the ORHC group. Three-dimensional CT may allow for the identification of the vascular supply, thereby simplifying the procedure for a complete lymphadenectomy along the feeding arteries in an LRHC.

Some reports have now suggested that laparoscopic surgery for colon cancer is generally an acceptable procedure with less invasiveness in comparison to open surgery,[1–4] although these studies have been conducted for heterogeneous group of patients in terms of tumor location. From the limited information of right-sided colon cancer carried out in a single center, the currently available data suggest that LRHCs have the same morbidity[10,13] and oncologic clearance,[11,13] faster postoperative recovery,[13] and similar survival rate[12] as in ORHCs. These results are consistent with the present study. The operation time was significantly longer for an LRHC.[10,12,13] In contrast, the current study found no significant differences in the operation time between the two groups. One study showed that LRHC was significantly more expensive than ORHC.[10,12]

In the current limited retrospective study, LRHC was confirmed to be a useful procedure for the treatment of right-sided colon cancer. Further prospective studies in multiple institutions are needed to establish LRHC as a standard procedure.

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Original Paper

Analysis of the Risk Factors for Wound Infection after Surgical Treatment of Colorectal Cancer: A Matched Case Control Study

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KEY WORDS:
Colorectal cancer; Wound infection; High–pressure cleansing

ABBREVIATIONS:
Laparoscopic Colectomy (LAC);
Open Colectomy (OC);
High–Pressure (HP);
Non–High Pressure (NP)

ABSTRACT

Background/Aims: The present study, with a matched case-control study design, was undertaken to evaluate the usefulness of high-pressure washing for preventing postoperative wound infection by comparing the outcomes in cases in which the high-pressure washing was performed with those in which the procedure was not adopted.

Methodology: A total of 100 of the above-mentioned 264 patients were selected for this study and divided into two groups (the high- pressure washing group (n=50) and the non-high pressure washing group (n=50)) in such as manner as to obtain good matching of the following 6 parameters between the two groups.

Results: Postoperative wound infection was noted in 11% of all cases (11/100). Univariate analysis revealed that postoperative wound infection was significantly more frequent in cases where the tumor site was the rectum (p=0.011), the surgical approach was open abdominal surgery (p=0.032) and high- pressure washing of the wound was not adopted (p=0.021).

Conclusion: The results of this study suggest that in order to prevent wound infection after surgery for colorectal cancer, it is advisable to select, as far as possible, the laparoscopic surgical approach and to undertake high- pressure washing of the wound immediately before closure of the abdomen.

INTRODUCTION

Palliative surgery for colorectal cancer is conducted under semi-contaminated settings. Wound infection has been reported to occur in 3-30% of all patients after surgery for colorectal cancer or lower gastrointestinal surgery (1). The reported patient-related risk factors for postoperative wound infection include the body mass index (BMI) (2), malnutrition (3), diabetes mellitus (4), advanced age (5) and smoking (6). The surgery-related risk factors include a long operation time (7), massive blood loss (8) and intraoperative blood transfusion (9). Attempts have been made to prevent wound infection by optimizing or improving the antibiotic dosing period, and undertaking appropriate preoperative intestinal treatment, drains management and management of the operative wound. Wound infection can not only cause pain, but also prolong the hospital stay and have a negative impact on the medical expenditure of the patient. The present study was undertaken to analyze the incidence of wound infections in patients who underwent surgical treatment for colorectal cancer at the same facility and by the same surgeon using standard operative procedures and perioperative management methods, with the goal to identifying the risk factors for wound infection after such surgery.

METHODOLOGY

Between January 2004 and December 2006, 264 patients underwent surgical treatment for colorectal cancer at Kitasato University hospital. All of these patients received mechanical intestinal treatment prior to the operation. Before closure of the abdomen during surgery, high- pressure washing of the subcutaneous tissue after muscle layer suturing (HP group) (**Figure 1**) or non-high pressure washing of the wound (NP group) was performed to prevent postoperative wound infection. For the high-pressure washing, warmed physiological saline (500 ml) was applied to the wound using a 20ml syringe fitted with a 23- gauge ophthalmic lavage needle. For the NP group, physiological saline was applied to the wound without high pressure. The 145 patients undergoing the surgery during the 19-month period from January 1 to July 2005 were allocated to the NP group. The 119 patients undergoing the surgery during the 16-month period from August 2005 to December 2006 were allocated to the HP group. From these 264 patients, 100 patients were

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selected for this study and divided into two groups (high- pressure washing group (n=50) and non-high pressure washing group(n=50)) in such as manner as to obtain good matching of the following 6 parameters between the two groups: male-to-female ratio, age (± 5 years), site of the tumor (right colon, transverse colon, left colon, rectum), operative procedure (laparoscopic surgery, open surgery), TNM stage and BMI (± 1) (**Table 1**).

According to the classification of the American Society of Anesthesiologists (ASA), the general condition of the patients was scored as follows. In the HP group, 37 cases (74%) were rated as Class I, 10 cases (20%) as Class II and 3 cases (6%) as Class III. In the NP group, 37 cases (74%) were rated as Class I, 11 cases (22%) as Class II and 2 cases (8%) as Class III; there was no significant difference in terms of the class distribution between the two groups ($p = 0.884$). There was no case with a preoperative hemoglobin level of below 8.0 g/dl. Intraoperative blood transfusion was required in 4 cases.

In accordance with the standards of our hospital, patients with a tumor depth of Tis, T1 or T2 are judged as suitable candidates for laparoscopic surgery, and those with a tumor depth of T4 or A1 are considered as candidates for open abdominal surgery. For patients with a tumor depth of T3 or A, the operative procedure is selected using the method of a randomized controlled trial after obtaining informed consent from the patient. None of the study subjects required switching from laparoscopic surgery to open surgery during the surgery. The same suture was employed to close the abdomen in both the laparoscopic surgery group and the open surgery group.

The closed operative wound was covered with a polyurethane film dressing for 48 hours. The cover was then removed without further disinfection. To prevent postoperative wound infection, either cefmetazole sodium (CMZ, 1 g/dose) or flomoxef sodium (FMOX, 1 g/dose) was administered by intravenous infusion after the surgery. During the surgery, the same antibiotic was administered once at the dose of 1g. After the surgery, an additional 1 g dose of the same antibiotic was administered after an interval of 3 hours; on the day after the surgery, the antibiotic was administered only once (1g).

In accordance with the Guidelines on Prevention of Surgical Site Infection (SSI) (1999) (10), cases showing discharge of pus were judged as having wound infection, and cases showing redness alone were rated as not having wound infection.

The postoperative follow-up period was 7-30 months (median, 15 months) in the HP group and 21-39 months (median, 30 months) in the NP group. During the follow-up period, each patient was instructed to visit the hospital at intervals of 2-4 weeks for checking of the operative wound as well for adjuvant chemotherapy, and relevant investigative procedures such as postoperative thoracic and abdominal computed tomography, etc.

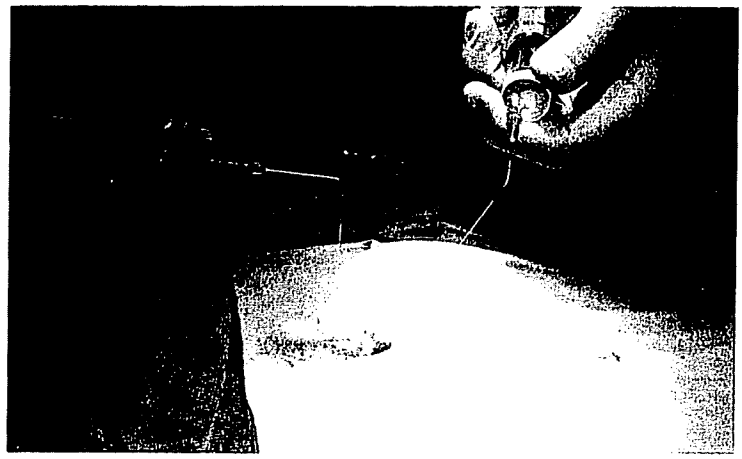

FIGURE 1 Before closure of the abdomen during surgery, high– pressure washing of the subcutaneous tissue after muscle layer suturing (HP group)

Ten possible risk factors for wound infection were compared between the two groups: adoption/non-adoption of high-pressure washing (high- pressure washing vs non-high pressure washing), sex (male vs female), age (>65 years vs. ≤65 years), body mass index (BMI; >25% vs. ≤25%), tumor site (colon vs. rectum), surgical approach (laparoscopic surgery vs. open surgery), operation time (>180 minutes vs ≤180 minutes), blood loss (>100ml vs. ≤100ml), disease stage (0, I or II vs. III or IV) and antibiotic used (CMZ vs. FMOX).

The data were analyzed statistically using the chi-square test and Mann-Whitney *U*-test. $p<0.05$ was regarded as denoting statistical significance. Multivariate analysis was carried out using logistic regression analysis, focusing on parameters with a P value of less than 0.25. These analyses were carried out using SPSS, ver. 8.0J (SPSS, Inc., Chicago, USA).

RESULTS

The incidence of wound infection after surgery for colorectal cancer was 11% (11/100). Univariate analysis revealed that the incidence of wound infection was significantly higher in cases where the tumor site was the rectum ($p=0.011$), the operative approach was open abdominal surgery ($p=0.032$) and the high- pressure washing method of the wound was not adopted ($p=0.021$) (**Table 2**).

Multivariate analysis revealed two independent predictors of wound infection, i.e., the operative approach (open abdominal surgery, $p = 0.039$, odds ratio: 4.266) and the wound washing method (NP group, $p = 0.034$, odds ratio: 5.968) (**Table 3**).

The incidence of wound infection was 7% (5/74) after laparoscopic surgery and 23% (6/26) after open abdominal surgery. The corresponding incidences were 4% (2/50) in the HP group and 18% (9/50) in the NP group.

The mean duration of hospital stay was 8 days (5-31 days) in patients without wound infection and 15 days (7-40 days) in patients diagnosed to have

TABLE 1. Demographic Characteristics of the Patients

	HP group	NP group
Number of patients	50	50
Male : Female	36 : 14	36 : 14
Age(yr: Mean[range])	66(42-87)	67(40-90)
Location		
Cecum-ascending colon	13	13
Transverse	6	6
Descending-sigmoid	15	15
Rectum	16	16
Tumor size (cm) [median (range)]	4.1(0.8-8.0)	3.5(1.0-7.5)
Ope method(LAC : OC)	37 : 13	37 : 13
pTNM stage 0	3	3
I (pT1N0)	6	6
I (pT2N0)	4	4
II (pT3N0)	20	20
III (pT3N1)	13	13
IV	4	4
Wound infection (present : absent)	2 : 48	9 : 31
BMI(%) [median (range)]	21.9 (17.6-28.3)	22.8 (16.6-26.8)
Period [mo; median(range)]	15 (7-30)	30 (21-39)

LAC: laparoscopic colectomy; OC: Open colectomy; HP: high-pressure; NP: non-high pressure

wound infection. The difference between the two groups with and without wound infection was significant ($p < 0.041$). During the follow-up period after discharge from the hospital, none of the patients developed relapse of the wound infection, anastomotic leaks or ileal adhesions.

When the ASA class was compared between the patients undergoing laparoscopic surgery and those undergoing open abdominal surgery, no significant difference in the ASA class distribution was noted between the group undergoing laparoscopic surgery and that undergoing open abdominal surgery ($p = 0.884$). Among the patients undergoing laparoscopic surgery, 56 cases (76%) were rated as Class I, 15 cases (20%) as Class II and 3 cases (4%) as Class III. Among the patients undergoing open surgery, 16 cases (67%) were rated as Class I, 6 cases (23%) as Class II and 2 cases (7%) as Class III.

Culture of the pus from the infected wound was carried out for 9 of the 11 cases (2 cases from the HP group and 7 cases from the NP group). All of these cases showed positive culture. The most frequently isolated pathogen was bacteria of the genus *Bacteroides* (6 cases), followed by *Staphylococcus aureus* (2 cases) and *Pseudomonas aeruginosa* (1 case). No significant difference in the distribution of the isolated pathogens was noted between the HP group and the NP group. All of the *Bacteroides* strains isolated from 6 cases and *Staphylococcus aureus strains isolated* from 2 cases were susceptible to the prophylactic antibiotic used.

DISCUSSION

In the present study, the non-adoption of high-pressure washing (NP) and open abdominal surgery were identified as independent risk factors for wound infection after surgical treatment for colorectal cancer. The present study was designed so as to allow analysis under constant conditions (i.e., surgery at the same facility, by the same surgeon, and under standardized preoperative, intraoperative and postoperative management conditions).

Carlos *et al.* carried out high- pressure washing of closed operative wounds in 283 patients after appendectomy. The method of high- pressure washing adopted by them involved application of physiological saline (300ml) to the wound under high pressure from a distance of 2cm, using a 20 ml syringe fitted with an 18- gauge needle. They analyzed the incidence of wound infection among these patients, and reported that wound infection occurred in 9 (16.3%) of the 55 patients and 29 (72.5%) of the 40 patients in whom high -pressure washing had or had not been adopted ($p = 0.0006$) (12).

No study has reported the effects of high- pressure washing of the operative wound after muscle layer suturing but before closure of the abdomen in patients undergoing surgery for colorectal cancer. This technique is unique to our hospital. It has been reported that a bacterial count of at least 105 per g tissue is needed for wound infection to develop (11). From this point of view, the technique of high- pressure washing of the operative wound after muscle layer suturing developed at our facility may reduce the subcutaneous bacterial count in the operative wound.

In the present study, the incidence of wound infection was significantly lower after laparoscopic surgery than after open abdominal surgery. Of the reports published to date concerning the incidence of wound infection after laparoscopic and open abdominal surgery, some studies have reported a similar incidence between the two operative approaches (13), while others have shown a significantly lower incidence after laparoscopic surgery (14). According to a meta-analysis of studies on postoperative wound infection reported by Abraham, the incidence of wound infection after laparoscopic surgery (3.9%) differs significantly from that after open surgery (8.9%) ($p< 0.005$) (15). The results of the present study are consistent with the results of the meta-analysis reported by Abraham.

According to one report, the presence of sutures

in a closed operative wound can elevate the bacterial count to 104 in the wound (16). Open abdominal surgery requires a larger skin incision than laparoscopic surgery. As a result, the number of sutures needed is greater in open abdominal surgery, which might possibly lead to a higher bacterial count and a higher incidence of wound infection. The incidence of wound infection after laparoscopic surgery has been reported to be 2.7% at the port for trocar insertion area and 10.8% for the wound through which the intestine is pulled out (17). At our facility, infection at the port for trocar insertion did not occur in any of the cases, and the incidence of infection of the wound through which the intestine is pulled out was lower (4%) than the reported incidence. The incidence of wound infection after open abdominal surgery, on the other hand, has been reported to be about 20% (18), and the incidence at our facility (23%) was close to the reported incidence.

The relationship between underlying diabetes mellitus and wound infection after surgery for colorectal cancer remains un-clarified. In the present study, diabetes mellitus was not identified as a risk factor for wound infection in our patients in whom strict blood glucose control was ensured both before and after the surgery, in accordance with the standard practice at our hospital. Regarding the relationship between BMI and wound infection, Smith *et al.* reported that the incidence of wound infection increased as the BMI became higher (2). The BMI was over 25% in 53% of the patients studied by Smith *et al.* At our hospital, the percentage of patients with a BMI of over 25% was lower (20%), which probably explains why BMI was not identified as a risk factor in the present study.

The bacteria most commonly responsible for postoperative wound infection are Bacteroides and Staphylococcus aureus. In the present study, some patients developed wound infection despite prophylactic treatment with antibiotics to which the pathogens were found to be susceptible. This result suggests the necessity of considering the use of these antibiotics at higher dose levels and/or for longer periods of time.

Expectations are high for the further exploration of the risk factors for wound infection after this kind of surgery are further explored at many facilities, towards the goal of establishing a valid means for preventing postoperative wound infection.

TABLE 2 Wound Infection Detected Free of Wound Infection

	wound infection (n=11)	not wound infection (n=89)	*p*-value
Sex			0.189
Male : Female	6 : 5	66 : 23	
Age (yr)			0.710
≤65 : >65	6 : 5	39 : 50	
Tumor site			0.011
Colon : Rectum	3 : 8	60 : 29	
Ope Method			0.032
laparoscopic : Open	5 : 6	69 : 20	
Cleansing of wound			0.021
Present : Absent	2 : 9	48 : 41	
BMI (kg/m2)			0.837
≤25 : >25	3 : 8	60 : 29	
Operative time (min)			0.404
≤180 : >180	5 : 6	29 : 60	
Blood loss volume (ml)			0.983
≤100 : >100	8 : 3	65 : 24	
TNM Stage			0.861
0, I, II : III, IV	7 : 4	59 : 30	
Antibiot ics			0.739
CMZ : FMOX	4 : 7	37 : 52	

CMZ: cefmetazole sodium; FMOX: flomoxef sodium

TABLE 3 Multivariate Analysis

	S.E.	Odds ratio	95%CI	*p*-value
Ope method				
Open	1	1		
laparoscopic	0.701	4.266	1.079-16.866	0.039
High-pressure wound cleansing				
absent	1	1		
present	0.840	5.968	1.150-30.963	0.034

S.E.: standard error; 95%CI: confidence interval

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Influence of learning curve on short-term results after laparoscopic resection for rectal cancer

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Abstract
Background Technical difficulties have been encountered in laparoscopic surgery for the treatment of rectal cancer. There are fewer studies about the learning curve for laparoscopic rectal resection.
Methods Between June 1995 and August 2007, 200 patients who were scheduled to undergo laparoscopic rectal resection for rectal cancer were enrolled in the study. Each surgeon's operative experience was divided into three groups: 1–20 cases, 21–40 cases, and 41 or more cases. Furthermore, patients were divided chronologically into four groups of 50 patients each. This report describes the association between the learning curves (surgeon's experience and team's experience) and short-term outcomes such as operating time, complication rate, and hospital stay in the case of laparoscopic resection for rectal cancer. We also analyzed how the learning curve influences several postoperative outcomes compared with other clinical factors.
Results The team's experience was not associated with short-term results except for surgical site infection (SSI). On the other hand, surgeon's experience was associated with mean operating time and SSI rate. The endpoints of the learning curve for reducing mean operating time and SSI rate were defined as 40 and 20 cases of laparoscopic rectal resection. In contrast, anastomotic leakage was not associated with surgeon's experience and showed the greatest correlation with total mesorectal excision (TME).
Conclusion Surgeon's learning improved operating time and SSI. On the other hand, low level of anastomosis accompanied with TME was strongly related with leakage, and the association between leakage and surgeon's learning was not clearly demonstrated.

Keywords Learning curve · Laparoscopic surgery · Rectal cancer · TME · Operating time · Leakage

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Indications of laparoscopic rectal resection are continually increasing worldwide. Several large-scale randomized trials conducted in various countries have proven that laparoscopic resections for colon cancers are comparable to conventional operations with regard to oncological outcome [1–5]. However, whether or not laparoscopic resection for rectal cancer is comparable to open surgery with respect to this point remains unclear.

Technical difficulties have been encountered in laparoscopic surgery for the treatment of rectal cancer. Some studies have reported positive circumferential margins [3] and increase in anastomotic leakage [6] in laparoscopic rectal surgery. These results suggest that inadequate procedures in laparoscopic rectal surgery could lead to an increase in the complication rate and poor survival.

Some studies regarding the learning curve in laparoscopic colectomy have been reported. Most of these studies showed trends toward declining rates of short-term complications with experience [7–10]. Laparoscopic colectomy showed a learning curve, which stabilized at 35–50 cases [7]. However, there have been fewer reports concerning this point in laparoscopic rectal resection, although this surgery is expected to have higher complication rates than laparoscopic colectomy. Although a greater number of general surgeons have now acquired the skills to perform laparoscopic colectomy, experience with more advanced procedures is required for learning laparoscopic rectal resection.

This report describes the association between the learning curve and short-term outcomes such as operating time, complication rate, and hospital stay in the case of laparoscopic resection for rectal cancer. We also analyzed how the learning curve influences several postoperative outcomes compared with other clinical factors.

Patients and methods

Between June 1995 and August 2007, 200 patients who were scheduled to undergo laparoscopic rectal resection for rectal cancer at the National Cancer Center Hospital East were enrolled in the present study. Of these, 93 patients had tumors in the upper rectum, and 107 patients had tumors in the middle or lower rectum. Our criteria for laparoscopic surgery candidates were tumor stage less than T3 for upper rectal cancers and less than T2 for middle and lower rectal cancers. Laparoscopic anterior resection, intersphincteric resection (ISR), and abdominoperineal resection were performed in 185, 13, and 2 patients, respectively. None of the patients underwent lateral lymphadenectomy. All anastomoses were performed using the double stapling technique (DST) or hand-sewn technique. Laparoscopic ISR followed by hand-sewn anastomoses [11] were performed in 13 patients whose tumors were located within 5 cm from the anal verge. All the procedures were undertaken with curative intent (i.e., R0 or R1 classifications).

Surgical procedures

Each patient was placed in the modified lithotomy position and was administered general anesthesia. The surgeon and the camera operator stood on the right side of the patient, and the first assistant stood on the left side. In most cases, CO_2 pneumoperitoneum was created by performing an initial open incision. For laparoscopic anterior resection, four or five trocar ports between 5 and 12 mm in diameter were positioned.

Using 5-mm graspers through the left port, the assistant held the sigmoid colon under traction ventrally and to the left. The retroperitoneum was then incised at the sacral promontory, while preserving the bilateral hypogastric nerves, and the inferior mesenteric vessels were identified and divided. Mesorectal excision was performed to complete the excision of the visceral rectal mesentery or the mesorectum. The rectum, which was completely enveloped within the visceral pelvic fascia, was then excised using sharp dissection techniques. Anterior dissection was performed between the rectum and Denonvilliers' fascia in men and between the rectum and the posterior vaginal wall in women. In the total mesorectal excision (TME) procedure, dissection was extended posteriorly and laterally until circumferential mobilization of the bowel was accomplished at the level of the puborectal muscle. For upper or middle rectal cancers in which a distal surgical margin could be obtained without TME, the mesorectal fat was divided to expose the rectal wall; this procedure was defined as tumor-specific mesorectal excision (TSME) [12]. Prior to rectal division, rectal irrigation was routinely performed using 2 l normal saline containing 5% povidone iodine. The levels at which the rectum was divided were determined according to the tumor site and stage in order to ensure an adequate distal margin.

To avoid contamination and wound recurrence, a wound protector was used in all patients. One of two procedures was selected for the transection of the rectal wall. The first procedure involved oblique transection from the right lower port, and the other involved vertical transection from the suprapubic port. The excised specimens were removed through the small incision at the right lower or suprapubic port site. Next, the anvil of the circular stapler was positioned in the oral colon. The circular stapler was then inserted through the rectum, and an end-to-end DST anastomosis was completed. When ISR was used [13], the specimens were excised by perianal resection via the abdominal approach. In these cases, anastomoses were made by using the hand-sewn technique. A drain was placed in the pelvis at the end of the operation. Protective ileostomy was performed in 15 patients: 11 with laparoscopic ISR and 4 with low anterior resection.

Definition of operative experience

Operative experience was represented by each surgeon's case sequence number. Each surgeon's operative experience was divided into three groups: 1–20 cases, 21–40 cases, and 41 or more cases. These criteria were used to evaluate the learning curve of individual surgeons. Further, patients were divided chronologically into four groups of 50 patients each. These groups were used to evaluate the learning curve based on the team experience.

Statistical analysis

The statistical analysis was performed using the STATISTICA data analysis software system, version 6 (StatSoft, Inc., 2003; www.statsoft.com). Descriptive statistics methods were used to manage patient data and to perform statistical calculations. Comparisons of categorical or ordinal variables were performed using the Pearson χ^2 test. The Mann–Whitney U test was used to compare nonparametric data. A p value of 0.05 was considered significant.

According to the World Health Organization classification, individuals with body mass index (BMI) ≥ 25 kg/m^2 were considered overweight and those with BMI < 25 kg/m^2, as non-overweight [14]. Factors that might affect the risk

of major surgical complications, such as the BMI, sex, age, tumor location, pathological stage (1, 2, 3, and 4) were evaluated as potential confounding factors. The difference in the distribution of these factors between surgeons with experiences of <21 and ≥21 cases was examined by the χ^2 test. We used the operating time, conversion rate, total rate of postoperative complication, rate of anastomotic leakage, rate of surgical site infection (SSI), reoperation rate, and hospital stay as the endpoints that might be affected by experience in laparoscopic rectal resection. In addition, the effect of experience on these endpoints was also evaluated by the odds ratio. The association of these endpoints with the experience was evaluated not only for the individual surgeons but also for the team.

A logistic regression model was applied to analyze the impact of clinical variables (BMI, TME, and surgeon's experience) on long operating time, occurrence of SSI, and occurrence of anastomotic leakage. In the analysis, long operating time was defined as operation time over 4 h. The following variables were examined as possible risk factors of poor short-term outcome: BMI, TME, and experience. In this analysis, the 95% confidence intervals (CI) were calculated.

Results

Laparoscopic rectal resection was performed in 115 patients by surgeons with experience of <21 operations; in 45 patients, by surgeons with experience of 21–40 operations; and in 39 patients, by surgeons with experience of >40 operations. Table 1 shows the background data regarding the team's and the surgeons' experiences. In the first of the four chronologically divided groups comprising 50 patients each, only two patients underwent TME; in the second group, the number of patients who underwent TME increased to 23. Among the three groups based on the surgeons' experience, the surgeons' backgrounds varied with both the site of rectal cancer and whether or not TME was performed. Surgery in patients with middle or lower rectal cancers and TME tended to be performed by surgeons with experience of >20 laparoscopic rectal resections. Significant differences in the backgrounds were not seen with regard to other clinical factors.

On comparing the data of all 50 patients in each of the four groups based on the team's experience, no difference was observed among the groups with respect to the following parameters. In the first, second, third, and fourth groups, respectively, the mean operating times were 235, 241, 212, and 213 min; conversion rates were 6, 6, 10, and 4%; total rates of postoperative complication were 16, 36, 24, and 30%; anastomotic leakage rates were 0, 12, 2, and 12%; reoperation rates were 0, 8, 2, and 4%; and lengths of hospital stay were 11, 13, 10, and 11 days. The SSI rate in the fourth group was significantly lower than that in the third group (0% vs. 8%, $p = 0.04$) (Table 2).

The association between the surgeons' experience and short-term results is also shown in Table 2. No difference

Table 1 Backgrounds by team's or surgeon's experience

Backgrounds	Experience of team				Experience of operator		
	0–50	51–100	101–150	151–200	0–20	21–40	≥41
Sex							
Male	35	28	32	29	75	26	24
Female	15	22	18	21	40	19	16
BMI (kg/m^2)							
<25	36	45	42	40	89	40	34
≥25	14	5	8	10	26	5	6
Site of the rectum							
Upper	39	16	25	15	70	14	9
Middle or lower	11	34	25	35	45	31	31
TME							
−	48	27	35	25	94	24	17
+	2	23	15	25	21	21	23
Tumor diameter							
<5 cm	45	40	37	41	91	38	34
≥5 cm	5	10	13	9	24	7	6
Stage							
1 or 2	35	34	30	30	77	25	27
3 or 4	15	16	20	20	38	20	13

Table 2 Association between team's or surgeon's experience and short-term outcomes

Short-term results	Team's experience				Surgeon's experience		
	0–50	51–100	101–150	151–200	0–20	21–40	≥41
Mean operating time (min)	235	241	212	213	238	228	179*
Conversion rate	6% (3/50)	6% (3/50)	10% (5/50)	4% (2/50)	10% (11/115)	2% (1/45)	3% (1/40)
Postoperative complication rate	16% (8/50)	36% (18/50)	24% (12/50)	30% (15/50)	23% (26/115)	29% (13/45)	35% (14/40)
Anastomotic leakage rate	0% (0/50)	12% (6/50)	2% (1/50)	12% (6/50)	3% (4/115)	9% (4/45)	13% (5/40)
SSI rate	12% (6/50)	12% (6/50)	8% (4/50)	0% (0/50)	12% (14/115)	4%** (2/45)	0% (0/40)
Reoperation rate	0% (0/50)	8% (4/50)	2% (1/50)	4% (2/50)	2% (2/115)	4% (2/45)	8% (3/40)
Length of hospital stay (day)	11	13	10	11	11	12	12

* $p < 0.01$ (≥41 versus 21–40, in surgeon's experience)

** $p < 0.01$ (21–40 versus 0–20, in surgeon's experience)

Table 3 Multifactorial analysis of clinical factors which influence operating time, SSI, and leakage rate

Variable	Cases	Operating time			SSI			Anastomotic leakage		
		Odds ratio	(95% CI)	p value	Odds ratio	(95% CI)	p value	Odds ratio	(95% CI)	p value
BMI (kg/m^2)										
<25	165									
≥25	35	2.3	(1.1–5.1)	0.04	3.0	(1.2–10.9)	0.02			NS
TME										
–	135									
+	65	3.3	(1.5–6.9)	<0.01			NS	4.5	(1.2–16.8)	0.02
Surgeon's experience										
≥21	85									
<21	115	3	(1.4–6.4)	<0.01	5.0	(1.1–23.2)	0.04			NS

SSI, surgical site infection; BMI, body mass index; TME, total mesorectal excision; 95%CI, 95% confidence interval; NS, not significant

in the total rate of postoperative complication (23%, 29%, and 35% in the first, second, and third groups, respectively) and median hospital stay (11, 12, and 12 days in the first, second, and third groups, respectively) was observed among the three groups based on the surgeons' experience. The rates of anastomotic leakage (3, 9, and 13% in the first, second, and third groups, respectively) and reoperation (2, 4, and 8% in the first, second, and third groups, respectively) increased with increase in the surgeons' experience, but these increases were not statistically significant. On the other hand, the mean operating time and SSI rate were significantly associated with the surgeons' experience. The endpoints of the learning curve for reducing the mean operating time and SSI rate were defined as 40 cases (228 min in the second group versus 179 min in the third group based on the surgeons' experience, $p < 0.01$) and 20 cases (12% in the first group versus 4% in the second group, $p < 0.01$) of laparoscopic rectal resection.

Next, multifactorial analysis was performed to determine the factors responsible for long operation time, SSI, and anastomotic leakage. Long operation time, i.e., >4 h, was associated with surgeons' experience < 21 cases (odds ratio = 3.0, 95% CI 1.4–6.4), performance of TME (odds ratio = 3.3, 95% CI 1.5–6.9), and BMI > 25 (odds ratio = 2.3, 95% CI 1.1–5.1). SSI rate was also associated with surgeon's experience < 21 cases (odds ratio = 5.0, 95% CI 1.1–23.2) and BMI > 25 (odds ratio = 3.0, 95% CI 1.2–10.9). In contrast, anastomotic leakage was not associated with the BMI and surgeon's experience and showed the greatest correlation with TME (odds ratio = 4.5, 95% CI 1.2–16.8).

Discussion

We clearly described that surgeons' experience was essential in the learning process for reducing the operating time and the occurrence of SSI in laparoscopic rectal resection. In contrast, anastomotic leakage—one of the most important complications—is not associated with the surgeon's experience and was instead influenced by low levels of anastomosis after TME. Additionally, it is

suggested that individual surgeon's experience was more important than the team's experience for reducing the operating time and preventing the occurrence of SSI in laparoscopic rectal resection.

Postoperative complications were not related to the learning curve in this study. Surprisingly, higher anastomotic leakage and reoperation rates were found in the late phase of the surgeons' experience than in the early phase. More patients with middle or lower rectal cancer were present in the late group than in the early group; this might be the cause of the adverse results in our study. Whether greater experience in laparoscopic rectal resection can prevent anastomotic leakage, and if so, the exact level of surgeons' experience required, remains unclear.

Some authors reported that TME was the most frequently related with anastomotic leakage in conventional rectal resection [15–17], which is consistent with our results for laparoscopic rectal resection. Recently, there have been reports of laparoscopic rectal resection with leakage rates of 6–18% [6, 18–21], and this value appears to be comparable with results of conventional surgery for rectal cancer. These laparoscopic studies with high quality of operation included more than 100 patients and had a <2% mortality rate and 3–12% conversion rate. This suggested that laparoscopic rectal surgery could be performed with the same quality as conventional surgery; however, procedural and oncological safety in laparoscopic TME for lower rectal cancer remains unclear.

A defined learning curve was reported to be 35–70 cases in laparoscopic colectomy [7–10]. These reports described that the operating time decreased as the learning curve improved, but whether or not the complication rate decreased with the learning curve was controversial. The present study also demonstrated that operating time was associated with the learning curve of 40 surgeon's experiences in laparoscopic surgery for rectal cancer. Our study did not show any association between the complication rate and the surgeon's experience. With more advanced procedures and devices in laparoscopic rectal resection, more postoperative complications will become preventable.

The surgical team's experience in the four chronologically divided groups comprising 50 patients each was not related to the operating time, conversion rate, and rate of complications, including leakage, except for SSI, and the results were in contrast to former reports concerning the learning curve of laparoscopic colectomy. Agachan's and Reissman's studies [8, 10] showed that the complication rates improved with the team's experience. This study included 15 operators who were in training and had experienced no fewer than 20 laparoscopic rectal resections, and each chronological group included trained surgeons. Therefore, by adjusting the members in a laparoscopic team, the learning curve of the team experience might be associated with improved complication rates.

In conclusion, the surgeon's learning improved the operating time and SSI, and the endpoints of learning curves for these parameters were 40 and 20 cases of laparoscopic rectal resection, respectively. On the other hand, low level of anastomosis accompanied with TME was strongly related with leakage, and the association between leakage and surgeon's learning was not clearly demonstrated.

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Oncologic Outcome of Intersphincteric Resection for Very Low Rectal Cancer

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Abstract
Background In 2000 we launched a prospective program of intersphincteric resection (ISR) for very low rectal cancer. In this study we compared the oncologic outcome of patients who underwent ISR with the outcome of patients who underwent abdominoperineal resection (APR).
Methods The data of 202 patients with very low rectal cancer who underwent curative ISR ($n = 132$) or curative APR ($n = 70$) between 1995 and 2006 were analyzed. Patients were divided into ISR and APR groups. Survival and local recurrence were investigated in both groups.
Results The median follow-up was 40 months in the ISR group and 57 months in the APR group. The 5-year local relapse-free survival rate was 83% in the ISR group and 80% in the APR group ($p = 0.364$), and the 5-year disease-free survival rate was 69% in the ISR group and 63% in the APR group ($p = 0.714$).
Conclusions For very low rectal cancers, ISR appears to be oncologically acceptable and can reduce the number of APRs.

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Introduction

The main goal of rectal cancer surgery is to cure the carcinoma and achieve local control. An additional goal is to preserve anal sphincter function for a better quality of life. The development of surgical techniques and combined adjuvant therapy has led to improved local control and patient survival [1]. The technique of total mesorectal excision, developed by Heald et al. [2], is now the gold standard in the operative management of rectal cancer in the middle and lower thirds. The advent of mechanical low-stapling and double-stapling techniques, as well as sutured coloanal anastomosis, has facilitated anastomosis at the distal rectum. These methods have increased the incidence of sphincter salvage. Further understanding of the safe distal resection margin has increased the incidence of successful sphincter-saving surgery. Distal intramural spread rarely extends more than 1 cm beyond the edge of the tumor [3, 4]. Nevertheless, lower rectal cancers located less than 5 cm from the anal verge or less than 2 cm from the dentate line are traditionally treated by abdominoperineal resection (APR) [5–7].

In recent years additional efforts have been made to increase the rate of sphincter preservation. The most extreme form of rectal resection is abdominoperineal intersphincteric resection with coloanal anastomosis (ISR) [7–21]. It is an alternative to APR for tumors in the suprasphincteric part of the rectum and tumors extending into the anal canal. Since 2000 this procedure has often been performed at our institute as an alternative to APR for consenting patients, although APR is still the standard surgical procedure for patients with very low rectal cancer in Japan.

The aims of this study were to determine the oncologic outcome following ISR of very low rectal cancer and to