Laparoscopic-Assisted Colectomy with Lymph Node Dissection for Invasive Carcinoma of the Colon

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Abstract: The results of performing laparoscopic-assisted colectomy in 20 patients with invasive carcinoma of the colon were analyzed in this study. The site of the lesion was the right colon in 5 patients, the transverse colon in 1, the left colon in 13, and the rectosigmoid in 1. In 2 patients, the laparoscopic procedure needed to be converted to an open laparotomy. Limited lymph node dissection (R1+, R2) was carried out in 10 patients and extensive node dissection (R3) was carried out in 9 patients. The histological depth of invasion in the 18 patients who underwent laparoscopic-assisted colectomy was the submucosa in 9, the muscularis propria in 2, and the extramuscular layer in 7. There were 3 patients who developed postoperative complications, 1 of whom underwent reoperation due to perforation of the colon. The postoperative course of the patients who underwent laparoscopic surgery was compared with that of a retrospectively selected control group of patients who had undergone open laparotomy. The postoperative recovery of the patients who underwent laparoscopic surgery was significantly faster than that of those who had undergone open laparotomy. Thus, we consider that laparoscopic-assisted colectomy with lymph node dissection is technically feasible provided that patients are properly selected. This procedure may be indicated not only for colonic carcinoma in the early stage, but also for that with invasion of the muscularis propria or the extramuscular layer.

Key Words: laparoscopic-assisted colectomy, colon cancer, lymph node dissection, postoperative course

Introduction

Laparoscopic-assisted colectomy has been practiced for the past 4 years in Western countries,[1-3] and was introduced in Japan in 1993. In general, the indications for

laparoscopic-assisted colectomy are considered to be either benign diseases,[4,5] or carcinomas in the early stage which are not suitable for colonoscopic removal.[6,7] However, the application of this procedure to resect carcinomas with invasion of the muscularis propria or invasion penetrating the muscularis propria is controversial, mainly because of the technical difficulties involved in carrying out lymph node dissection which is a routine procedure for invasive carcinomas in open laparotomy. We performed laparoscopic-assisted colectomy with lymph node dissection in 20 patients who had colorectal carcinomas with invasion of the submucosa or deeper layers of the bowel wall. In this study, the indications, extent of lymph node dissection, technical feasibility of the procedure, and postoperative course of the patients were analyzed.

Patients and Methods

During the period from January 1993 to December 1994, laparoscopic-assisted colectomy was performed in 20 patients who had colonic carcinoma with invasion of the submucosa or deeper layers. Their ages ranged from 46 to 71 years with a mean age of 60.8 years, and there were 12 men and 8 women. The sites of the lesions are shown in Table 1.

Colonoscopic polypectomy had already been performed prior to the laparoscopic surgery in 6 patients, and the histology of the polypectomy specimens in these patients showed either moderate to massive invasion in the submucosa with or without lymphatic channel invasion, which was the reason for the subsequent colectomy. In the remaining 14 patients, the preoperative assessment of cancer invasion was made based on the findings of barium enema, colonoscopy, and in some cases, endoscopic ultrasonography.

The grade of lymph node dissection in each patient was basically determined according to a preoperative

Table 1. Sites of the lesions in the 20 patients undergoing laparoscopic-assisted colectomy, including two who required conversion to open laparotomy

Cecum	3
Ascending colon	2
Transverse colon	1
Descending colon	1
Sigmoid colon	12
Rectosigmoid colon	1
Total	20

Table 2. Preoperative assessment of invasion and the extent of lymph node dissection in the 18 patients who underwent laparoscopic-assisted colectomy

	R1+	R2	R3
Submucosa (after polypectomy)	6	0	0
Submucosa	1	1	0
Muscularis propria	0	1	3
Extramuscular	0	0	6

assessment of the depth of cancer invasion. In this study, the grade of lymph node dissection was classified according to the classification proposed by the Japanese Research Society for Carcinoma of the Colon, Rectum, and Anus.[8] The grades of lymph node dissection of the representative cases, according to this classification, are schematically shown in Fig. 1., where R1+ dissection indicates a grade of dissection between R1 and R2. In 13 patients, the site of the tumor or the site of the preceding colonoscopic polypectomy was marked preoperatively by a colonoscopic injection of sterilized China ink into the submucosa near the tumor. In the other 7 patients, preoperative tumor site marking was not carried out because it was considered that the tumor was large enough to be identified during the laparoscopic procedure. In all the patients, the laparoscopic surgery was performed under pneumoperitoneum.

The technical aspects fo the laparoscopic surgery were analyzed, with particular emphasis on the methods of lymph node dissection. The operating time and post-operative course of the 18 patients in whom the laparoscopic procedure was completed was compared with that of 47 patients with colon carcinoma who had undergone curative operation by the standard open laparotomy method. Among these 47 patients, 16 with limited node dissection of R1 or R2 were operated on between 1985 and 1993, and 31 with extensive dissection of R3 were operated on between 1992 and 1993. There were 26 males and 21 females, ranging in age from 42 to 79 years with a mean age of 63.1 years. The sites of the lesions were the right colon in 13 patients, the transverse colon in 5, the descending colon in 5, and the

sigmoid colon in 24. The histological depth of invasion in these 47 patients was the submucosa in 18 patients, the muscularis propria in 3, and the extramuscular layer in 26.

Statistical analysis was carried out by Student's t-test and chi-squared analysis. A P value of less than 0.05 was considered to be significant.

Results

The trocar sites in the patients with left-sided or right-sided lesions are shown in Fig. 2. In patients with lesions in the right colon, a subumbilical 10–12-mm trocar was placed for the scope, 10–12-mm trocars were placed in the lower and upper midline, and a 5-mm or a 10–12-mm trocar was placed in the right side of the abdomen. In patients with lesions in the sigmoid colon, a sub-umbilical 10–12-mm trocar was placed for the scope, 10–12-mm trocars were placed in the upper midline and in the right lower abdomen, and one 5-mm or 10–12-mm trocar was placed in the left lower abdomen. A small incision to bring out the mobilized colon was also made as indicated in Fig. 2.

In 2 patients with sigmoid colon carcinoma, the laparoscopic procedure needed to be converted to an open laparotomy, due to extensive adhesions between the long sigmoid colon and the descending colon, which were located in parallel with each other, in 1 patient; and due to carcinomatous invasion into the urinary bladder in the other. The results of a preoperative assessment on the depth of cancer invasion and the extent of lymph node dissection carried out in the 18 patients are shown in Table 2. In 6 of 9 patients with cancer invasion of the submucosa, colonoscopic polypectomy had been carried out prior to the laparoscopic surgery. The preoperative assessment revealed that the depth of cancer invasion in the other 14 patients was the sub-mucosa in 3, the muscularis propria in 4, and the extramuscular layer in 7 patients. The grade of lymph node dissection and the preoperative assessment of invasion are also shown in Table 2. The pericolic nodes and part of the intermediate nodes were dissected as R1+ in 6 patients in whom the histology of the polypoid lesions removed at the preceding colonoscopic polypectomy showed invasion of the submucosa and in 1 in whom the preoperative assessment of depth of invasion was the submucosa. Dissection up to the intermediate nodes as R2 was performed in 2 patients in whom the preoperative assessment of invasion was the submucosa, and in 1 in whom the preoperative assessment of invasion was the muscularis propria. Lymph node dissection up to the main nodes as R3 was performed in 2 patients in whom the assessment of the depth of invasion was muscularis propria and in 6 pa-
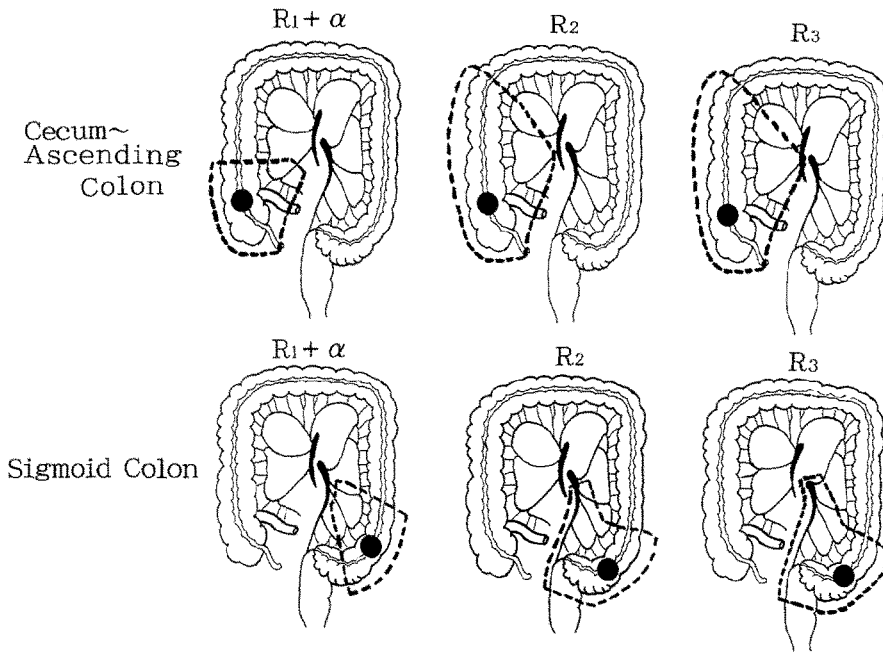
Fig. 1. Grades of lymph node dissection for right-sided and left-sided lesions
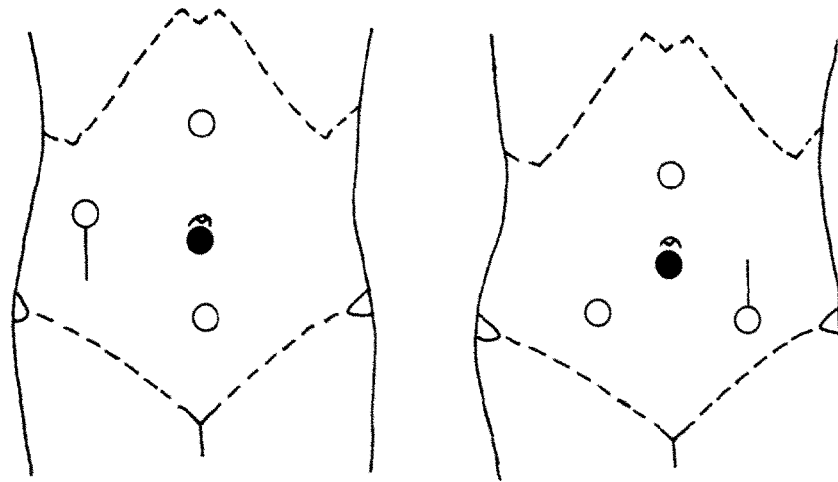

Fig. 2. Sites of the ports and the small incision

tients in whom the invasion was assessed as penetrating the muscularis propria.

In 2 patients with cecal carcinoma in whom R3 dissection was carried out, the origins of the ileocolic vein and artery were exposed and divided after being clipped (Fig. 3). In 1 of these patients, division of the origin of both the ileocolic and the right colic artery and vein were carried out. In 6 patients with sigmoid colon carcinoma in whom R3 dissection was carried out, the origin of the inferior mesenteric artery was exposed and divided (Fig. 4). In these 6 patients, the base of the sigmoid mesocolon was dissected at the ventral side of

the aorta using an ultrasonic dissector (Sumisonic, Sumitomo Bakelite, Tokyo, Japan) and scissors for laparoscopic use. During this procedure, the preaortic autonomic nerve plexus was preserved. Dissection at the base of the sigmoid mesentery was directed cranially towards the site of origin of the inferior mesenteric artery with the aid of the ultrasonic dissector. After the origin of the inferior mesenteric artery had been reached, the artery was clipped and divided.

The mesenteric vessels were divided intracorporeally in 13 of the 18 patients. During exposure of the mesenteric vessels for division, the ultrasonic dissector was
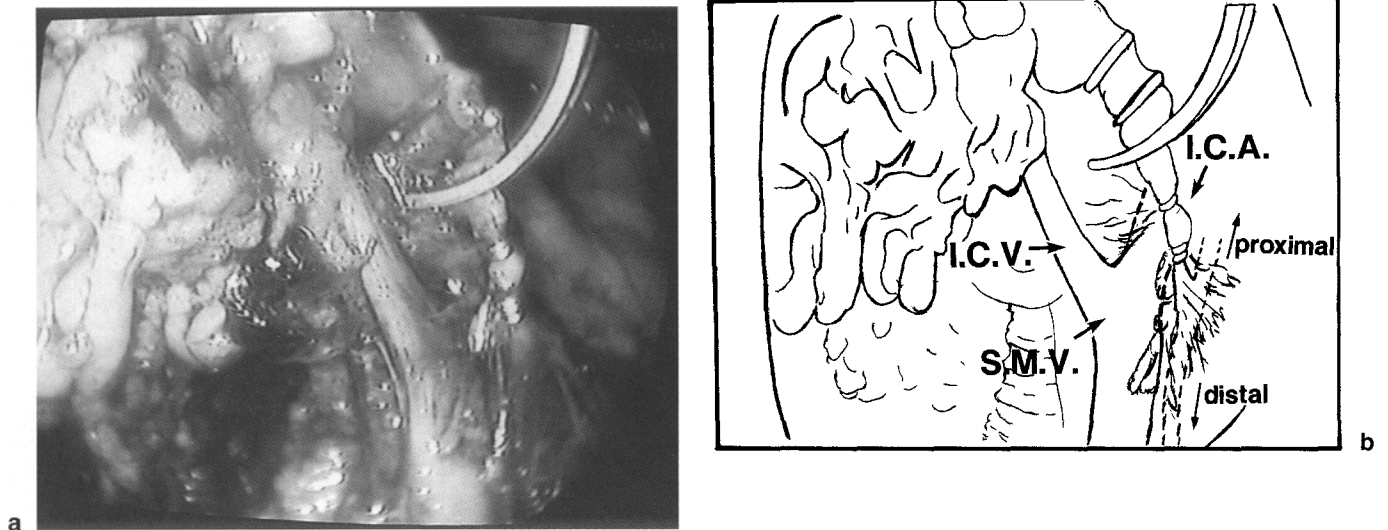
Fig. 3. a Dissection at the origin of the ileocolic vessels in a patient with cecal carcinoma. **b** Schema of **a**. *I.C.V.*, ileocolic vein; *I.C.A.*, ileocolic artery; *S.M.V.*, superior mesenteric vein
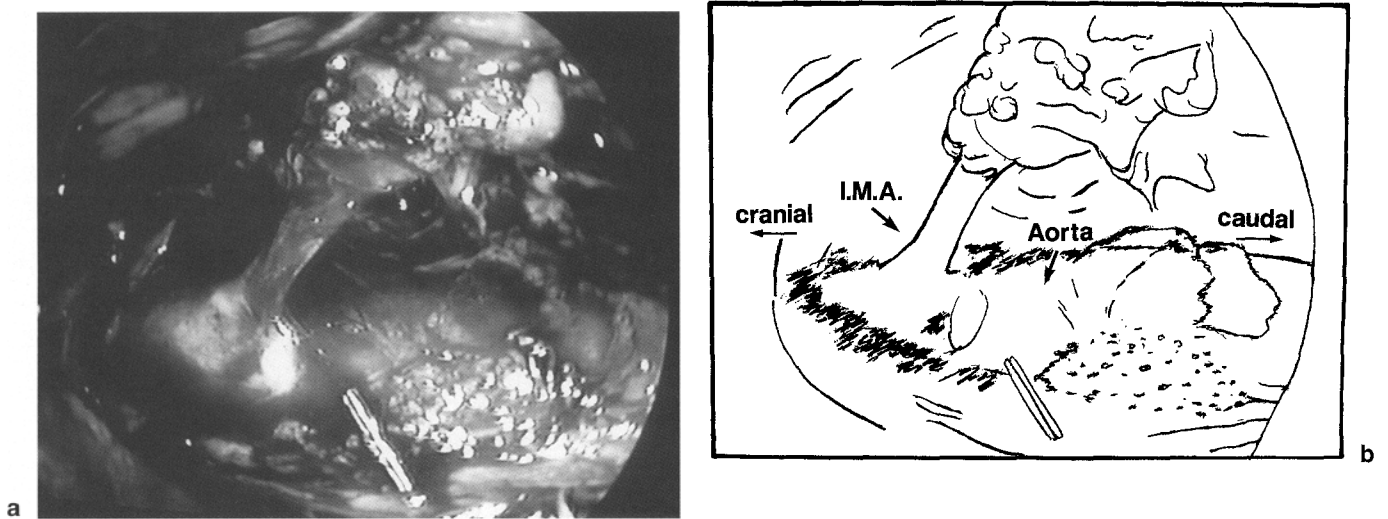
Fig. 4. a Dissection at the origin of the inferior mesenteric artery in a patient with sigmoid colon carcinoma. **b.** Scheme of **a**. *I.M.A*, inferior mesenteric artery

used to expose the fatty tissue surrounding the vessels to be divided. After exposure of these vessels, the mesenteric vessels were clipped three times at the proximal side and twice at the distal side before being divided. In the other 5 patients, the mesenteric vessels were divided during the extracorporeal procedure. In all the patients, a small abdominal incision was made to bring out and remove the mobilized bowel with the lesion. The small incision was protected by a plastic sheet when the bowel containing the tumor was brought out.

In 8 patients with lesions in the sigmoid colon in whom R2 or R3 dissection was carried out, extracorporeal resection of the bowel, and intracorporeal anastomosis by the double stapling method,[9] were performed.

In these patients, the bowel distal to the tumor was transected with a linear stapler for laparoscopic use, being either an EndoGIA 60 (US Surgical, Norwalk, CT, USA) or an Endocutter 60 (Ethicon Endo-Surgery, Cincinnati, OH, USA). In the other 10 patients — 5 with a right-sided lesion, 1 with a transverse lesion, and 4 with left-sided lesions — extracorporeal resection and anastomosis were carried out after the mobilized bowel was brought out through the small abdominal incision.

The final histological results in relation to the degree of lymph node dissection are shown in Table 3. There were 9 patients with invasion of the submucosa, 2 with invasion of the muscularis propria, and 7 with extra-

muscular invasion. Histological depth of invasion and the sites of the lesions are shown in Table 4. In most of the patients with invasion of the muscularis propria or deeper, the lesions were located in the cecum, proximal ascending colon, or in the middle part of the sigmoid colon. Lymph node metastasis was present in the 2 patients with sigmoid colon cancer in whom R3 lymph node dissection was carried out. Only one pericolic lymph node was involved in these two patients.

All but 3 patients had an uneventful postoperative course. In 1 patient a colonic perforation occurred as a result of injury to the colonic wall by the diathermy used during the operation. This patient underwent reoperation in two stages followed by an uneventful recovery. In another patient, a Penrose drain was dislodged into the peritoneal cavity on the 3rd postoperative day. The drain was retrieved under spinal anesthesia by reopening the small abdominal incision. In the 3rd patient, there was a minor degree of postoperative ileus which resolved spontaneously.

The operating time and the results of the postoperative course of the 18 patients who underwent laparoscopic-assisted colectomy were analyzed in comparison with a retrospective control group of 47 patients who had undergone open laparotomy. A small number of patients who experienced postoperative complications and those without accurate records of the specific data were excluded from the analysis. There were no significant differences in the age and sex distributions between the two groups (Table 5). In this comparative analysis, the patients in both groups were classified into two subgroups according to the extent of the lymph node dissection (Table 6). One group consisted of 16 patients who had undergone R1+ and R2 dissection, and the other group consisted of 31 patients who had undergone R3 dissection.

In both the R1+ plus R2, and R3 subgroups, the operating time was significantly longer in the laparoscopy patients than in the open laparotomy patients; however, postoperative bowel sounds, flatus, and ambulation occurred significantly earlier in the patients with laparoscopic colectomy than in those who had undergone open laparotomy. Only in the R1+ plus R2 subgroup was the hospital stay significantly shorter in the laparoscopy patients than in the open laparotomy patients (Table 6).

Discussion

The indication for laparoscopic-assisted colectomy has been considered as patients with adenomas or carcinomas in the early stage or those with benign conditions such as diverticular disease or inflammatory bowel disease. However, in the present series, laparoscopic-assisted colectomy was completed in 18 of 20 patients in whom cancer invasion had reached the submucosa or deeper.

The major controversy lies in whether or not it was feasible to perform a sufficient extent of lymph node dissection laparoscopically, particularly in patients with cancer invasion of the muscularis propria or of the extramuscular layer. We consider that the extent of lymph node dissection performed laparoscopically should be no less than the extent of dissection which is routinely carried out in standard laparotomy for colonic carcinoma, in accordance with the opinion of Placencia et al.[9] In previous reports, lymph node dissection was evaluated by the number of lymph nodes harvested;[10,11] however, we consider that lymph node dissection should be evaluated primarily by the level of ligation of the mesenteric vessels, which is why we classified the

Table 3. Extent of lymph node dissection and histological depth of invasion in the 18 patients who underwent laparoscopic-assisted colectomy

	R1+	R2	R3
Submucosa	7	1	1
Muscularis propria	0	1	1
Subserosa	0	0	5
Serosa	0	0	2

Table 5. Age and sex distributions of the two groups of patients

	Age (years)	Sex
Laparoscopic-assisted colectomy	46–71, mean 60.8	male 12, Female 6
Open laparotomy	42–79, mean 64.5	male 26, Female 21

There were no significant differences in the age and sex distributions between the two groups

Table 4. Sites of the lesions and histological depth of invasion in the 18 patients who underwent laparoscopic-assisted colectomy

	Cecum	Ascending	Transverse	Descending	Sigmoid
Submucosa	1	1	1	1	5
Muscularis propria	1	1			2
Subserosa					3
Serosa	1				1

Table 6. Comparison of laparoscopic-assisted colectomy and open laparotomy

Parameter	R1+, R2 or R3	Laparo or open	n	mean ± SD	P
Operation time	R1+, R2	Laparo	9	248 ± 45 min	<0.05
		Open	16	205 ± 46 min	
	R3	Laparo	9	262 ± 27 min	<0.0001
		Open	31	205 ± 54 min	
Bowel sound	R1+, R2	Laparo	7	1.14 ± 0.38 p.o.d.	<0.05
		Open	16	1.75 ± 0.68 p.o.d.	
	R3	Laparo	9	1.44 ± 0.53 p.o.d.	<0.05
		Open	31	2.03 ± 1.11 p.o.d.	
Flatus	R1+, R2	Laparo	8	2.88 ± 0.83 p.o.d.	<0.05
		Open	16	3.69 ± 0.87 p.o.d.	
	R3	Laparo	9	2.56 ± 0.73 p.o.d.	<0.001
		Open	31	4.19 ± 1.22 p.o.d.	
Ambulation	R1 +, R2	Laparo	8	1.50 ± 1.07 p.o.d.	<0.01
		Open	16	2.94 ± 1.06 p.o.d.	
	R3	Laparo	9	1.67 ± 0.50 p.o.d.	<0.0000001
		Open	31	3.48 ± 1.15 p.o.d.	
Discharge	R1+, R2	Laparo	8	14.13 ± 3.00 p.o.d.	<0.05
		Open	14	17.71 ± 2.87 p.o.d.	
	R3	Laparo	7	18.14 ± 2.85 p.o.d.	N.S.
		Open	29	18.70 ± 4.18 p.o.d.	

Laparo, laparoscopic-assisted colectomy; open, open laparotomy; p.o.d., postoperative day; N.S., not significant

grades of lymph node dissection according to the classification proposed by the Japanese Research Society for Cancer of the Colon, Rectum and Anus.[8]

In five of our patients with carcinoma of the left colon, the cancer invasion was histologically limited to the submucosa of the polypectomy specimens, and subsequently colectomy was carried out. The percentage of lymph node metastasis in the colectomy specimens from such patients had been reported as 0%–9%,[12–15] and most of the involved lymph nodes, if any, are limited to the pericolic area.[16] Based on these facts, a lymph node dissection of R1+ was considered to be sufficient for the 6 patients in whom histology of the polypectomy specimens showed invasion of the submucosa.

In the present series, patients were selected for laparoscopic-assisted colectomy based upon the following three criteria when R2 or R3 lymphnode dissection was indicated. Firstly, the tumor should be situated in the proximal ascending colon or the cecum, or in the middle part of the sigmoid colon. In patients with right-sided lesions located as mentioned above, R2 or R3 dissection extended to the origin of the ileocolic vessels, which was not considered a difficult procedure. To perform R2 or R3 dissection for lesions located in the sigmoid colon, the origin of the inferior mesenteric artery must be exposed (Fig. 4), which is not considered a difficult procedure under laparoscopy, provided that patients are properly selected. In addition to this, when the tumor is located in the middle part of the sigmoid colon, sufficient length of the bowel can be removed without causing tension at the anastomotic site; however, obese patients are not suitable candidates for this procedure as dissection is too difficult when the mesen-

tery is thick with fatty tissue. Thirdly, although this is a criterion for laparoscopic-assisted colectomy in general, only patients without a history of a major abdominal surgery should be selected for this procedure.

R2 or R3 lymph node dissection was made possible by the meticulous usage of scissors for laparoscopic use and also of an ultrasonic dissector, which was particularly effective for removing the fatty tissue surrounding the vessels to be divided such as the inferior mesenteric artery, and the superior rectal artery in patients with sigmoid colon carcinoma. By using this device, there was less injury to the small blood vessels in the fatty tissue and less risk of inadvertent injury to the mesenteric vessels. The feasibility of proximal vascular ligation was demonstrated by Decanini who performed abdominoperineal resection on cadavers.[17]

According to previous reports on laparoscopic-assisted colectomy, the percentage of cases requiring conversion to open laparotomy ranged from 8% to 40%.[3,5,17] In our series, there were 2 patients with sigmoid colon carcinoma in whom the laparoscopic procedure needed to be converted to open laparotomy, due to adhesion between adjacent segments of the colon in 1 patient, and due to cancer invasion of the urinary bladder in the other patient. Difficulty in lymph node dissection was not the reason for the conversion in either of these patients.

Reports have been published on port-site recurrence after laparoscopic-assisted colectomy for cancer;[18–22] however, the number of well-documented cases of port-site recurrence is insufficient for proper analysis. According to these reports the port-site recurrence occurred within 1 year after the operation. Although it

is possible that only patients with serosal invasion are at risk of developing port-site recurrence, it is still unknown whether there is a higher incidence of seeding of cancer cells in the wound of the abdominal wall in those who have undergone a laparoscopic procedure than in those who have undergone open laparotomy. This problem remains to be solved by further studies and the analysis of meticulous follow-up of patients undergoing this procedure.

The time taken to perform laparoscopic colectomy was significantly longer than laparotomy; however, the postoperative recovery was faster. Although this comparison was not made in a randomized fashion, We consider that postoperative recovery after the laparoscopic procedure may be faster than that of the open laparotomy. Similar results based on uncontrolled studies were reported by Peters et al.[23] and Ramos et al.,[24] while Harmon et al. reported that the stress response of patients resulting from the operative intervention as assessed by interleukin-6 was less intense following laparoscopic-assisted colectomy than following colectomy performed through an open laparotomy.[25] Furthermore, the early resumption of enteral nutrition with positive nitrogen balance following laparoscopic-assisted colectomy was reported by Senagore et al.[26] The results of these reports support the belief that laparoscopic colectomy is advantageous due to fast postoperative recovery.

Another advantage of this procedure is the small operation scar. Wexner et al.[27] reported that laparoscopic-assisted total abdominal colectomy and ileoanal anastomosis for ulcerative colitis could be performed with a small Pfannenstiel's incision in the lower abdomen which would obviously be beneficial cosmetically, particularly for young patients.

In conclusion, our results showed that the laparoscopic-assisted colectomy with lymph node dissection is technically feasible provided that patients are properly selected. This procedure can be done without encountering any significant difficulties when the tumor is situated in the cecum, proximal ascending colon, or in the middle part of the sigmoid colon. However, obese patients and those who have undergone a previous major abdominal operation should not be selected for this procedure. Taking these prerequisites into consideration, this procedure may be indicated not only for colonic carcinomas in the early stage, but also for carcinomas invading the muscularis propria or the deeper layers.

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