

## **Clinical Indication of Laparoscopic Surgery for Colorectal Cancer: The Optimal Extent of Lymph Node Dissection based on Depth of Colorectal Cancer and Technical Feasibility of Laparoscopic Colorectal Surgery.**

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### ABSTRACT

Recently, laparoscopic colorectal surgery has been considered to be appropriate for colorectal cancer, and the feasibility of many laparoscopic techniques has been established; however, the indication for curative colorectal cancers is controversial. In this study, before laparoscopic procedure was performed on patients with colorectal cancers, 641 patients who had undergone open laparotomy for colorectal cancer during the past 16 years were evaluated for the distribution of metastatic lymph nodes classified by depth of invasion. The results obtained were as follows: The rate of all lymph node metastasis of patients with pTis was 0%. The rate of intermediate lymph node (n2) metastasis of patients with pT1 and pT2 tumor was low (3.4% and 4.1% respectively), however, in patients with pT3 and pT4 tumors, this rate was much higher (15.9% and 15.8% respectively). Therefore, with regard to lymph nodes dissection for colorectal cancer it might be concluded that the intermediate lymph nodes metastases in patients with pT1 and pT2 tumors (less than 5%) were negligible. However, in patients with pT3 and pT4 tumors, for the purpose of performing a complete harvest of intermediate lymph nodes, D3-dissection (including principal lymph node dissection) is required. it is questionable whether or not performance of the laparoscopic procedure for cancer achieves the same extent of lymph node dissection as compared with open laparotomy. Dissection was restricted to intermediate grade lymph node including the paracolic lymph nodes (D2). Accordingly, patients with pT3 and pT4 tumor should be excluded from indication for laparoscopic procedure.

Between October 1997 and November 1998, laparoscopic colorectal resec-

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tions were performed on a limited number of the above mentioned patients with Tis, T1 and T2 tumor. The grade of lymph node dissection was determined by the results of a preoperative assessment of the depth of cancer invasion. With the exception of one patient, whose preoperative assessment for depth of cancer invasion was a limitation at the muscularis propria, but whose histological outcome had been pT3 tumor, all the other patients were able to undergo laparoscopic colorectal resection. The final histological results were as follows: 3 patients with pTis tumor, 6 pT1 tumor, and 3 pT2 tumor. One of the pT3 patients alone was converted from a laparoscopic procedure to open laparotomy because of the intraoperative proof of intermediate lymph node metastases, and subsequently this patient underwent principal lymph node dissection (D3-dissection). With regard to the histological metastasis of harvested lymph nodes, no patients was found to have regional lymph node metastasis except for one patient only who had a pT3 tumor. Thus the histological findings were similar to those for conventional open laparotomy.

In this study, it was concluded that by laparoscopic procedure a safe and complete dissection of intermediate lymph nodes including the paracolic lymph nodes (n1 and n2) could be achieved. On the other hand, the true incidence of port site recurrence, and also its mechanism remain unknown to date. However, it is considered that the incidence of port site recurrence in patients with serosal invasion (T4 tumor) is higher than in those without (i.e., patients with pTis, pT1, pT2 and pT3 tumor). We are also convinced that a number of patients with pTis, pT1 and pT2 undergoing laparoscopic procedure were able to gain curative colorectal resection in terms of port site non-recurrence, and strongly believe that the application of laparoscopic colorectal surgery for cancer might be acceptable.

**Key words :** Laparoscopic Surgery, Colorectal Cancer,  
Lymph Node Dissection

## INTRODUCTION

Minimally invasive surgery has been expanding in all fields of surgery, especially since 1987 when Phillip Mouret described laparoscopic cholecystectomy (1). During recent years this technique has developed tremendously for the surgical treatment of cholecystectomy. Moreover, there have been many reports on the use of laparoscopic techniques for various abdominal operations including colorectal ones. Laparoscopic colorectal surgery is significantly more

challenging than laparoscopic cholecystectomy and is presently considered to be suitable for either benign diseases (2, 3), or early cancers. However, the application of this procedure for colorectal cancers invading the muscularis propria or deeper layers is controversial. In addition to the technical difficulties involved in carrying out lymph node dissection, which is a routine procedure for invasive cancers in open laparotomy, there are concerns regarding the proper role of laparoscopic colorectal surgery in the treatment of cancer which are of paramount importance to the surgeon. Although the feasibility of many laparoscopic colorectal procedures have been established, there are serious concerns about the application of these techniques for patients with colorectal cancer (4, 5).

Basic oncologic principles must be observed when performing the laparoscopic technique for cancer. It is possible that laparoscopic colorectal resection results in less extensive lymph node dissection, but if this result in a reduction in the rate of cancer curability its application for cancer is questionable. In regard to the application of the laparoscopic technique for cancer, the surgeon is not able to palpate the mesocolon for lymph node metastasis or to estimate the extent of regional lymph node metastasis during operation. Therefore, the extent of lymph node dissection should be determined before laparoscopic colorectal resection. In addition, doubts about this procedure for colorectal cancer have been raised regarding the adequacy of cancer clearance and the incidence of local recurrence. Furthermore, an increasing number of reports of port site recurrence has added to these concerns (6, 7, 8, 9, 10).

The primary purposes of this study was to evaluate the distribution of metastatic lymph nodes histologically classified by depth of invasion of cancer into submucosa, muscularis propria and deeper layer in patients who had undergone open laparotomy for colorectal cancer. The results obtained might indicate the optimal extent of lymph node dissection when performing the laparoscopic technique for cancer, in which it seems that the distribution of metastatic lymph nodes depends on depth of cancer invasion. In this study, the indications, extent of lymph node dissection, and technical feasibility of laparoscopic colorectal surgery for cancer were investigated.

#### Materials and Methods

Histological data regarding depth of cancer invasion and distribution of metastatic lymph nodes for 641 patients who had undergone colorectal cancer by open laparotomy between October 1980 and September 1996 were analysed retrospectively. The lower rectal cancer located at Rb according to the classification proposed by the Japanese Society for Cancer of the Colon and

Rectum (J. S. C. C. R) (11), was excluded in this study because presently there are technical difficulties with the operation, for example, a laparoscopic linear stapler can not be placed on the rectum at the level of the plane of the levator ani muscles to perform transection of the rectum in distal margin. Sites of the primary tumor in the 641 patients are shown in Table 1. The number of patients in each pT category, i.e., the histologic depth of primary tumor invasion by the TNM classification (12) is shown in Table 2.

**Table 1** Sites of primary tumor in the 641 patients who had undergone colorectal resection by open lapalotomy

Primary tumor site	Number of patients
Cecum (C)	46
Ascending colon (A)	80
Transverse colon (T)	52
Descending colon (D)	27
Sigmoid colon (S)	218
Rectum (Rs)	74
Rectum (Ra)	144
<b>Total</b>	<b>641</b>

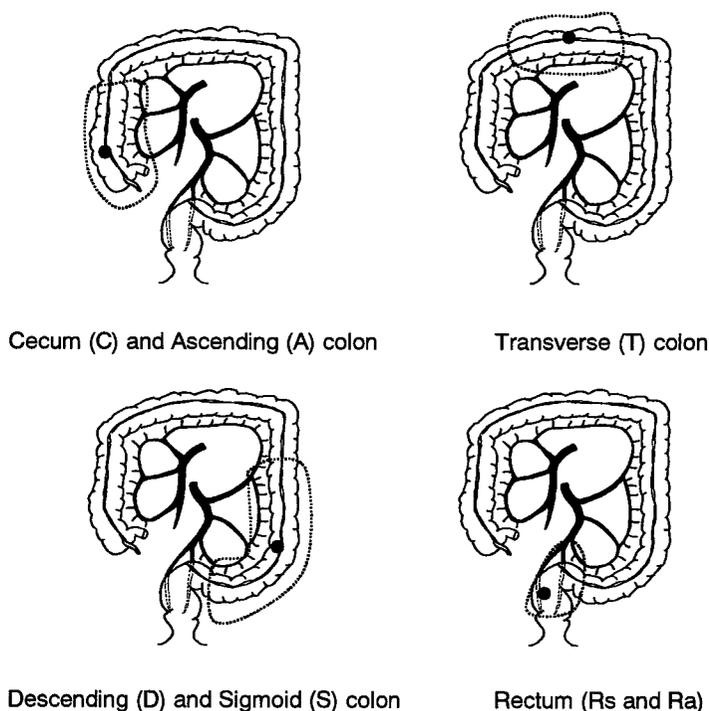
Parentheses are defined according to the classification proposed by the Japanese Society for Cancer of the Colon and Rectum (J. S. C. C. R).

**Table 2** Histological depth of primary tumor invasion in the 641 patients

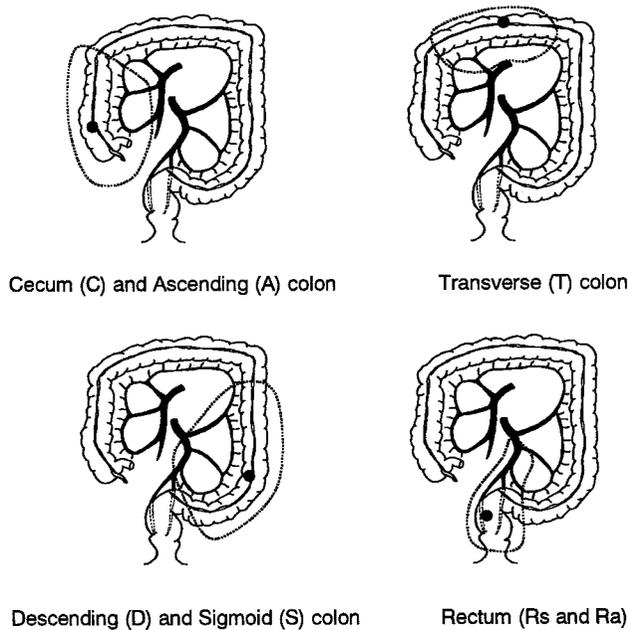
Depth of tumor*	Number of patients
pTis	28
pT1	29
pT2	74
pT3	377
pT4	133
<b>Total</b>	<b>641</b>

\*pTis, tumor invades mucosa; pT1, tumor invades submucosa; pT2, tumor invades muscularis propria; pT3, tumor penetrates muscularis propria into subserosa or into nonperitonealized paracolic tissues; pT4, tumor directly invades other organs and/or penetrates visceral peritoneum.

According to the distribution of metastatic lymph nodes based on each respective case's depth of cancer invasion, the optimal extent of lymph node dissection was determined, and subsequently laparoscopic colorectal resection with lymph nodes dissection was performed. The grade of lymph node dissection (D1, D1+ a , D2 and D3) and the regional lymph nodes including the grade of dissection (paracolic lymph nodes, n1; intermediate lymph nodes, n2; principal lymph node, n3) were classified according to the criteria of the J. S. C. C. R, and D1+ a was defined as a grade of dissection between D1 and D2. However, because it is questionable whether or not this procedure achieves the same extent of lymph node dissection as is feasible with open laparotomy (see Discussion), in this study, the grade of lymph nodes dissection was restricted to the intermediate level including the paracolic lymph nodes (D2). Using the J. S. C. C. R criteria, the extents of D1 and D2 lymph node dissection and colectomy concerning each site of the primary lesion respectively are schematically shown in Figures 1 and 2.



**Fig. 1** The extent of D1 or D1+ a dissection with colorectal resection  
The extent of colectomy is defined as proximal and distal 5 cm margins of resection.

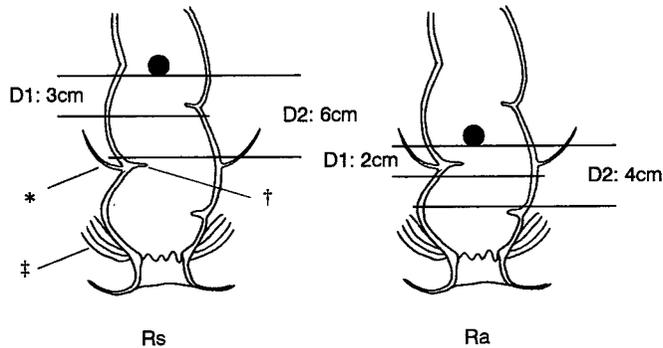


**Fig. 2** The extent of D2 dissection with colorectal resection

The extent of colectomy is defined as proximal and distal 10 cm margins of resection.

However in regard to the rectum, because the distal margin distances of resected rectum from the anal edge of the tumor location were different from those distances of the resected colon the distal margin distances of resection for the rectum were classified into Ra and Rs, as shown in Figure 3.

The subjects of this study were 16 patients with colorectal cancer who underwent laparoscopic colorectal resection between October 1997 to November 1998. Their ages ranged from 23 to 75 years (62 years on average), and there were 9 men and 7 women. The sites of the lesions are shown in Table 3. The preoperative assessment of the depth of cancer invasion was based on the findings of barium enema, colonoscopy, and endoscopic ultrasonography (EUS) (13,14). The extent of lymph node dissection in each patient was determined according to a preoperative assessment of the depth of cancer invasion, i.e., Tis (preoperative or clinical diagnosis) corresponds to pTis (histological diagnosis), T1 and T2 correspond to pT1 and pT2. In all patients, the site of the tumor or the site of the preceding colonoscopic polypectomy was marked preoperatively by tattooing with China ink to show distal and proximal margins near the tumor, and the laparoscopic surgery was performed under pneumoperitoneum.



**Fig. 3** The distal margin distances of resection for rectum

\* , Peritoneum; †, Houston valve; ‡, Levator ani musculus.

D1 dissection: The same lymph node dissection of colon was performed with colectomy using proximal 5 cm margins of resection, however distal margin distances from resected tumor were different from the colon, as follows: Tumor located at Rs (according to J. S. C. C. R), Distal 3 cm margin of resection; Tumor located at Ra (according to J. S. C. C. R), Distal 2 cm margin of resection.

D2 dissection: The same lymph node dissection of colon was performed with colectomy using proximal 10 cm margin of resection, however distal margin distances from resected tumor were different from the colon, as follows: Tumor located at Rs, Distal 6 cm margin of resection; Tumor located at Ra, Distal 4 cm margin of resection.

**Table 3** Sites of primary tumor in the 16 patients who underwent laparoscopic colorectal resection, including one who required conversion to open laparotomy

Primary tumor site	Number of patients
Cecum (C)	3
Ascending colon (A)	2
Transverse colon (T)	2
Descending colon (D)	1
Sigmoid colon (S)	3
Rectum (Rs)	2
Rectum (Ra)	3
<b>Total</b>	<b>16</b>

## Results

The correlation between the depth of cancer invasion and the histological distribution of metastatic lymph nodes is shown in Table 4. Patients with pTis tumor were found to have no lymph node metastasis. Whereas only one

**Table 4** Incidence (%) of regional lymph node metastases, the counterpart of histological depth of cancer invasion in the 641 patients

Depth of tumor	n1: paracolic lymph node	n2: intermediate lymph node	n3: principal lymph node
pTis (28)	0 (0)	0 (0)	0 (0)
pT1 (29)	6.9 (2)	3.4 (1)	0 (0)
pT2 (74)	12.3 (9)	4.1 (3)	0 (0)
pT3 (377)	25.8 (97)	15.9 (60)	5.0 (19)
pT4 (133)	25.6 (34)	15.8 (21)	7.5 (10)
<b>Total (641)</b>			

Parentheses are number of patients.

of the patients with pT1 tumor was found to have intermediate lymph node metastasis (the rate of metastasis was 3.4%, 1/29), three of the patients with pT2 tumor were found to have it (the rate of metastasis was 4.1%, 3/74). However, in principal lymph nodes, both groups of patients were found to have no metastasis. In this study, it was concluded that with regard to lymph nodes dissection for colorectal cancer the metastasis of the patients with pT1 and pT2 tumor was negligible. Patients with pT3 and pT4 tumors were sometimes found to have intermediate lymph node metastasis (the rate was 15.9 and 15.8%, respectively). In addition, there were those who were found to have principal lymph node metastasis (the rate was more than 5.0%). We were convinced that the local depth of invasion of colorectal cancer was correlated with the extent of regional lymph node metastasis.

According to the foregoing results, the grade of lymph node dissection in laparoscopic procedure should be restricted to D2 dissection (see Materials and Methods) and therefore, laparoscopic colorectal resections were only performed on a limited number of patients with Tis, T1 and T2 tumors. The results of a preoperative assessment of the depth of cancer invasion, and the grade of lymph node dissection carried out on the 16 patients are shown in Table 5. In 3 patients with Tis tumors, which were not suitable for colonoscopic removal, i.e., polypectomy or endoscopic mucosal resection (EMR), because no metastatic lymph nodes existed, lymph node dissection was not required, but to ensure that proximal and distal margins of resection were free of cancer invasion, partial resection or so-called D0 was performed. In 4 of 8 patients with T1 tumors, colonoscopic polypectomy or EMR had already been performed prior to the laparoscopic surgery, and the histology of the specimens removed from these patients showed massive invasion in the submucosa. In 2 of 8 patients with T1 tumors, paracolic lymph node and partial in-

**Table 5** Preoperative assessment on the depth of cancer invasion and the grade of lymph node dissection (D-number) in the 16 patients who underwent laparoscopic colorectal resection

Depth of tumor	D0	D1 or D1+ $\alpha$	D2	D3	Total number of patients
Tis	1	2	0	0	3
T1 (after EMR or PP) <sup>1)</sup>	0	1	3	0	4
T1	0	1	3	0	4
T2	0	0	4	1 <sup>2)</sup>	5

1) EMR, endoscopic mucosal resection; PP, polypectomy.

2) One of the five preoperative cases assessed as T2 tumors and scheduled for laparoscopic procedure was converted to an open laparotomy following histological discovery of penetration of the muscularis propria during operation. Subsequently this patient underwent principal lymph nodes dissection (D3).

intermediate lymph node dissection were performed (so-called D1+ $\alpha$ ), and subsequently the other 6 patients underwent intermediate lymph node dissection including the paracolic lymph nodes (D2). In all 5 patients with T2 tumors, D2 dissection was tried, however in one of these patients, the laparoscopic procedure was converted to an open laparotomy because of the existence of intermediate lymph node metastases by intraoperative histological diagnosis, and subsequently this patient underwent principal lymph nodes dissection (D3-dissection).

The final histological results in relation to the grade of lymph node dissection are shown in Table 6. There were 3 patients with pTis tumor, 6

**Table 6** The grade of lymph node dissection (D-number) and histological depth of invasion in the 16 patients who underwent laparoscopic colorectal resection

Depth of tumor	D0	D1 or D1+ $\alpha$	D2	D3	Total number of patients
Tis	1	2	0	0	3
pT1	0	2	4	0	6
pT2	0	0	3	0	3
pT3	0	0	0	1 <sup>1)</sup>	1
No residual tumor <sup>2)</sup>	0	0	3	0	3

1) One of the five preoperative assessments as T2 tumors is described in Table 5.

2) In three of four patients with cancer invasion of the submucosa, colonoscopic polypectomy or EMR had been performed before laparoscopic surgery, whereas, because colonoscopically removed specimens showed massive invasion in the submucosa, subsequently, these patients underwent laparoscopic colorectal resection. However, residual cancer cells in resected specimens were not found.

with pT1 tumor, and 3 with pT2 tumor. From among the patients with pT3 tumor, only the above mentioned case converted from laparoscopic procedure to open laparotomy. 3 of 4 patients with T1 tumors had undergone colonoscopic polypectomy or EMR prior to the laparoscopic surgery, however, residual cancer cells in the resected specimens by laparoscopic procedure were not found there after. Accordingly "no residual tumor" is used in Table 6., as the basis of the histological findings therein. Lymph nodes harvested by laparoscopic procedure were carefully examined histologically for any metastasis and subsequently no other patient was found to have regional lymph node metastasis except for one with pT3 tumor whose histological findings for harvested lymph nodes were similar to those of conventional open laparotomy.

#### Discussion

Following the widespread introduction of laparoscopic procedure, the number of such resections has been increasing in the literature (15, 16, 17, 18), and we consider that it is now a well established procedure for such benign disease as diverticulitis, Crohn's disease, adenoma and submucosal lipoma. This study attempted to elucidate the technical feasibility of performing laparoscopic resection in patients with colorectal cancer while observing oncologic principles. The most important intent of cancer surgery is considered to be appropriate lymph node dissection according to the progression of the individual cancer, a high ligation of vessels and adequate resection margins proximal and distal to the pathology. Some reports in the relevant literature confirmed no difference between the extent of lymph node dissection obtained laparoscopically and that resulting from standard open laparotomy for colorectal cancer (19, 20). However, we concluded that the extent of lymph node dissection achieved by laparoscopic procedure was not the same as that by the current surgical standard open laparotomy. This is the case because when the laparoscopic technique is used for large scale colorectal lymph node dissection (e.g. D3), the grade of technical feasibility is largely dependent upon the anatomic location of the primary tumor. Particularly in regard to the right colon (A and C, tumors from the cecum to the hepatic flexure), laparoscopic mobilization from the iliac fossa to the mid-transverse colon is easily performed as the ureter and duodenum are visualized. At this point in the operation, the right colon can be easily withdrawn from an incision of about 5cm. After extracorporeal delivery, the mesentery can be transected at any level desired, after which bowel resection and anastomosis are performed. Likewise, the ileocolic vessels can be easily ligated at the level of the superior mesenteric vessels (D3-dissection). But in regard to the primary

tumor located at the transverse colon (T), performing D3-dissection appears technically difficult without hemorrhage because principal lymph nodes are located at the site where the root of the middle colic vessels issue from the superior mesenteric vessels. In addition, the surrounding tissues are located adjacent to the pancreas and cannot be extracorporeally delivered. Thus when performing these procedures, with safety in mind, a D2-dissection is appropriate for tumors located at transverse colon. Furthermore in regard to the left colon (D, S, Rs and Ra, tumors from the splenic flexure to distal rectum), the same technique cannot be performed because the aorta cannot be brought to the skin level. Accordingly intracorporeal division of the inferior mesenteric vessels must be undertaken and these procedures are relatively difficult. But when the inferior mesenteric vessels are ligated at the level of the inferior mesenteric artery from which the left colic artery issues (D2-dissection), both extracorporeal and intracorporeal methods respectively can be easily performed. Accordingly, in this study, the grade of lymph node dissection was restricted to D2 and performance of this dissection was possible for tumors located at any site except for rectal tumor at Rb. In addition, from our estimations of the harvested lymph nodes from the 641 patients who had undergone open laparotomy, the depth of cancer invasion showed a histological correlation with the distribution of metastatic lymph nodes. In patients with pT3 and pT4 tumors, intermediate lymph node metastasis was sometimes found, and for the purpose of performing a complete harvest of intermediate lymph nodes, D3-dissection is required; thus patients with pT3 and pT4 tumors were excluded from indication for laparoscopic procedure. Moreover in regard to lymph node dissection, there are several reports in the literature stating that the number of harvested lymph nodes are useful for an evaluation of lymph node dissection (21, 22). However, merely counting the number of lymph nodes in the resected specimen does not guarantee that an oncologic resection has been successfully achieved. In addition, the simple removal of a long colon segment with paracolic lymph nodes (n1) without performing a dissection of intermediate lymph nodes (n2) or principal lymph nodes (n3) can theoretically show the same number of nodes as in the removal of a smaller colon segment where intermediate lymph nodes or principal lymph nodes are also harvested. Thus an evaluation of lymph node dissection should be made dependent on the level of ligation for the mesenteric vessels. Accordingly, this study did not take into account the number of harvested lymph nodes.

In the context of the treatment of malignant disease, the criticism of visceral laparoscopic cancer surgery which has received most attention has

been the issue of abdominal wall or port site recurrence, and there have been several reports of such recurrences, reinforcing the concern about using laparoscopic techniques in patients with cancer (6,7,8,9,10). Surprisingly, in 1994, Lauroy *et al.* (23) reported patients with Dukes A tumor (T2 tumor) undergoing laparoscopic resection and experiencing port site recurrence nine month later. Contrary to this report, in 1996, Cook and Dehn (24) reported a 25% port site recurrence rate of serosal invasion versus a 0% port site recurrence rate of serosa not penetrated by the tumor in patients with gastrointestinal malignancies who had undergone laparoscopic resection. At the present time, the true incidence of port site recurrence and its mechanism remain unknown. However, it is considered that the incidence of port site recurrence in patients with serosal invasion (T4 tumor) is higher than in those where it is absent (*i.e.*, patients with pTis, pT1, pT2 and pT3 tumor). In preoperative assessment, it seems that identification of the depth of cancer invasion between T3 and T4 is questionable regardless of the modality employed (25), *i.e.*, air contrast barium enema, colonoscopy, or EUS (13,14). In order to prevent port site recurrence, the pT3 and pT4 tumors have to date been excluded from indications for laparoscopic colorectal resection for cancer as the indications for this procedure include consideration the extent of lymph node dissection.

In this study, it was concluded that dissection of intermediate lymph nodes including the paracolic lymph nodes by laparoscopic procedure could be achieved safely and completely. We are also convinced that a number of patients with pTis, pT1 and pT2 undergoing laparoscopic procedure were able to gain curative colorectal resection in terms of port site non-recurrence, and strongly believe that the application of laparoscopic colorectal surgery for cancer might be acceptable. Although it is one of the important factors, lymph node dissection may not be the overriding concern with regard to laparoscopic colorectal cancer surgery. The overriding deterrent might be the risk of port site recurrence of the cancer. Until the results of the ongoing prospective randomized trials are available, the true incidence and risk of port site recurrence for patients with colorectal cancer following laparoscopic resection will not be known and therefore, before employing laparoscopic procedure for colorectal cancer serious and cautious consideration should be made.

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