図10　結腸肛門吻合終了時

表3　根治的肛門括約筋部分温存術の症例

Nov. 1999～Dec. 2006　NCCHE			
no. of patients	: 132		
gender	: male 97, female 35		
age, median (range ; yr)	: 57 (27～80)		
distance to AV, median (range ; cm)	: 3.7 (1.5～5.0)		
surgical procedure	: total ISR	: 23	38 → APR : 1, Hartmann : 2
	total ISR with PESR	: 15	
	subtotal ISR	: 59	
	partial ISR	: 35	
neoadjuvant therapy (45Gy, 5-Fu)	: 48		

follow-up period : 36 months, median (range : 3～74months)

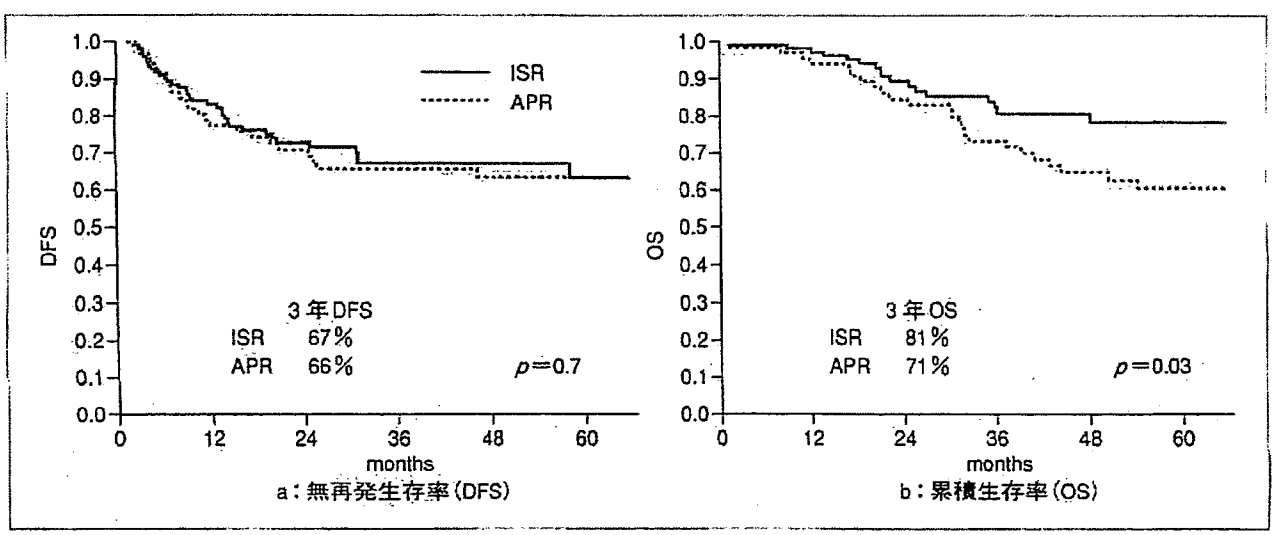

図11　予後 (ISR vs APR)
median follow-up：ISR 1082日, APR1450日

4. diverting stoma造設，ドレーンの留置

肛門側操作の終了後，diverting stoma（回腸または横行結腸）の造設を行う。骨盤腔内に2本のドレーンを後腹膜経路で留置し，後腹膜を修復した後に閉腹して手術を終了する。diverting stomaの閉鎖は，3カ月以後に行っている。

おわりに

本稿で述べた肛門括約筋部分温存手術により，大半の下部直腸癌症例で直腸切断術は回避可能である。当施設では2006年12月までに，根治的な本手術法を132例に施行した（表3）。手術関連合併症はやや多く，20～30％に認められた。その中間成績において，腫瘍学的予後はAPRに劣らないこと（図11），多くは許容範囲内であるが種々の程度の排便機能障害が確かに存在すること，などが判明している。また再発は肺転移再発がもっとも多く，surgical marginsからの再発は少ないことも判明している。しかし，長期の腫瘍学的および排便機能の予後，その他についてはまだ十分な結果が得られていないのが実情である。このため本法は，まだ標準術式にはなっていない。現在，本法の多施設共同臨床試験（厚生労働省がん研究助成金研究，および大腸癌研究会プロジェクト研究）が進行中であり，その結果が待たれるところである。以上のことより，手術手技の複雑さ，合併症や排便機能障害も考慮し，本法の実施には十分な慎重さが要求される。

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Clinicopathological Features of Skip Metastasis in Colorectal Cancer

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ABSTRACT

Background/Aims: Japanese general rules for the staging of colorectal cancer conventionally classify lymph node metastasis into three groups according to location with respect to the primary tumor. Skip metastasis, in which distant nodes are positive but regional nodes are negative, is often encountered but poorly understood. We studied the clinicopathological features of skip metastasis in colorectal cancer.

Methodology: The location of positive nodes was classified in 323 patients with Dukes' stage C colorectal cancer. Skip n2 lymph node metastasis was defined as positive N2 metastasis without negative N1 or N3 metastasis. Clinicopathological findings and survival were compared between the patients with skip n2 metastasis (skip n2 group) and those with n1 (n1 group) or n2 metastasis (n2 group).

Results: There were 211 patients in the n1 group, 91 in the n2 group, and 21 in the skip n2 group. Pathological examination showed that the skip n2 group had fewer positive nodes than the n1 and n2 groups, but was positioned between these groups with respect to the degree of lymphatic invasion. Cumulative survival was significantly poorer in the n2 group than in the skip n2 group ($p=0.039$ by log-rank test). Survival was similar in the skip n2 group and n1 group. There was also no difference in survival between patients in the skip n2 group and patients with one, two, or three N1 metastases.

Conclusions: Lymph nodes with skip n2 metastasis are most likely sentinel nodes of the primary tumor in patients with colorectal cancer. The prognosis of patients with skip n2 metastasis is therefore better than that of patients with n2 metastasis and similar to that of patients with n1 metastasis.

KEY WORDS: Skip metastasis; Colorectal cancer; Lymph node metastasis

ABBREVIATIONS: Hematoxylin and Eosin (HE)

INTRODUCTION

Although various prognostic factors have been proposed in colorectal cancer, lymph node metastasis and the depth of tumor invasion remain the most reliable predictors of outcome. The presence of lymph node metastasis has been used in many staging systems since the establishment of Dukes' classification (1). The numbers or locations of lymph node metastases are included as staging factors for lymph node metastasis in Dukes' stage C disease (2-5).

In Japan, lymph node metastasis is classified according to the General Rules for Clinical and Pathological Studies on Cancer of the Colon, Rectum and Anus (6). Information on the number of positive nodes and the location of lymph node metastasis is thereby provided. Skip metastasis, in which distant nodes are positive but regional nodes are negative, is often encountered but poorly understood. The presence of skip metastasis can increase the risks associated with laparoscopic surgery or other minimally invasive procedures. Failure to diagnosis skip metastasis can also lead to selection of ineffective regimens for chemotherapy. To gain a better understanding of the status and implications of skip metastasis, we studied the clinicopathological features of skip metastasis in patients with Dukes' stage C colorectal cancer.

METHODOLOGY

Patients and Methods

From February 1990 through August 2002, we studied 323 patients with Dukes' stage C colorectal cancer who underwent curative resection at Kanagawa Cancer Center. Patients with multiple advanced cancers or mucinous or signet-ring-cell carcinomas were excluded.

During operation, the distance from the tumor margin was measured and marked on the mesentery at 5-cm intervals to determine lymph-node location. The mesentery was separated from the resected specimen and fixed in 10% formalin solution. All removed lymph nodes were embedded in paraffin, stained with hematoxylin and eosin (HE), and examined histopathologically to determine metastatic status. The resected nodes were histologically examined by two pathologists. We evaluated the numbers of positive nodes and the locations of lymph node metastases and classified

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TABLE 1 The Number of Cases with Skipping Nodal Metastasis of n2 according to the Location of the Tumor

	Location	n1	Skip n2	n2	Total cases	Skip %
Colon	Cecum	7	1	4	12	8.3%
	Ascending	24	1	9	34	2.9%
	Transverse	14	1	3	18	5.6%
	Descending	10	2	4	16	12.5%
	Sigmoid	63	5	26	94	5.3%
Rectum	Rectosigmoid	35	1	10	46	2.2%
	Rectum above peritoneal reflection	17	5	7	29	17.2%
	Rectum below peritoneal reflection	39	5	27	71	7.0%

TABLE 2 Number of the Cases in Three Directions of the Skip n2 Metastasis according to the Location of the Tumor

	Location	Main nodes	Paracolorectal nodes	Lateral nodes	Total cases
Colon	Cecum	1			1
	Ascending	1			1
	Transverse		1		1
	Descending	1	1		2
	Sigmoid	5			5
Rectum	Rectosigmoid	1			1
	Rectum above peritoneal reflection	5			5
	Rectum below peritoneal reflection	3		2	5
		17	2	2	21

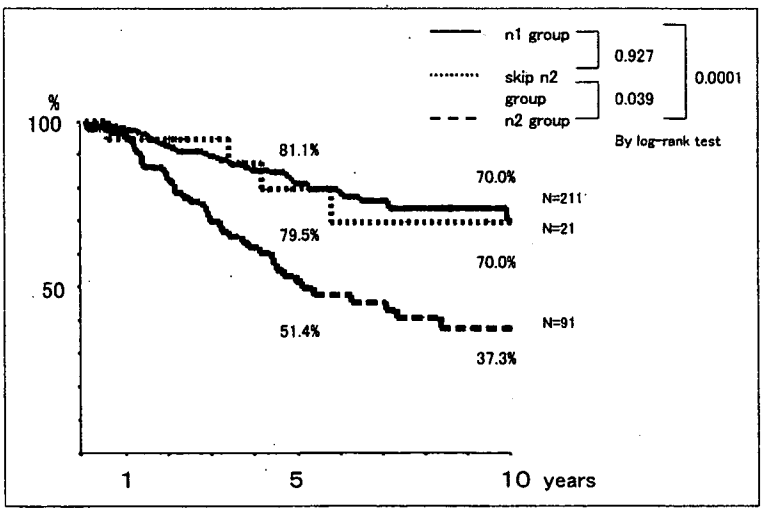

FIGURE 1 Overall survival rates of patients with n1, skip n2, and n2 lymph nodes metastasis.

positive nodes as n1, n2, and n3 according to the Japanese General Rules for Clinical and Pathological Studies on Cancer of the Colon, Rectum and Anus (6).

The Japanese rules propose that colon cancer has two directions of lymph nodes metastasis: along the axis of the bowel (paracolic nodes) and along the origin of the main vessel supplying the primary tumor site (main nodes). Rectal cancer has three types of lymph node metastasis: paracolic nodes, main nodes, and lateral pelvic nodes along the internal and external iliac arteries. The paracolorectal nodes located within 5cm from the tumor margin are classified as N1 nodes, and those between 5 and 10cm from the tumor margin are classified as N2 nodes. The N2 nodes also include the main nodes, with the exception of the N3 nodes, around the origin of the main vessel. The patients were classified as having n1, n2, or n3 lymph node metastasis according to the level of the most distant, microscopically positive nodes. These categories are defined as follows: n1 metastasis means positive nodes only in the N1 region; n2 metastasis indicates positive nodes in the N1 and N2 regions and negative nodes in the N3 region; and skip n2 metastasis means positive nodes in the N2 region, but negative nodes in the N1 and N3 regions. In addition, cases with positive lateral pelvic nodes, but negative paracolorectal nodes and main nodes were also considered positive for skip n2 metastasis.

Clinicopathological findings and survival were compared between the skip n2 group and the n1 or n2 group. The chi-square test and unpaired t-test were used for statistical analysis of two unpaired samples. Cumulative 5-year survival rates were calculated by the Kaplan-Meier method. The log-rank test was used to compare survival curves. All tests were two-tailed, and $p<0.05$ was considered to indicate statistical significance.

RESULTS

The 323 patients with Dukes' stage C disease were classified according to the location of positive nodes. There were 211 patients in the n1 group and 91 in the n2 group, as compared with only 21 in the skip n2 group.

Skip n2 metastasis was most commonly associated with primary tumors arising in the descending colon and upper rectum as compared with other portions of the colorectum (**Table 1**). The direction of skip n2 metastasis with respect to the location of the primary tumor was mainly along the main nodes (**Table 2**). Two of five cases (40%) of lower rectal cancer had skip metastasis to the lateral pelvic nodes.

Clinicopathological examination (**Table 3**) showed that the frequency of well-differentiated adenocarcinoma was higher in the skip n2 group than in the n1 or n2 groups. The degree of lymphatic invasion in the skip n2 group was intermediate between those in the n1 and n2 groups. Other clinicopathological findings did not differ significantly among the three groups.

The mean number of positive nodes in the skip n2 group was significantly lower than those in the n1 and n2 group (**Table 4**).

Cumulative survival was significantly poorer in the n2 group than in the skip n2 group ($p=0.039$ by log-rank test). Survival was similar in the skip n2 group and n1 group (**Figure 1**). There was also no difference in survival between the skip n2 group and patients with one, two, or three N1 metastases (**Figure 2**).

TABLE 3 Clinicopathological Features of the Three Groups

		n1 group	skip n2 group	n2 group	*P* value
Gender	male	118	12	58	0.448
	female	93	9	33	
Age		62.0 0.8	66.6±1.8	62.7±1.2	ns***
Diameter	(mm)	47.1±1.3	49.0±2.7	51.3±1.9	ns***
Histological type[a]	wel	65	10	14	
	mod	129	11	69	0.010
	por	17	0	8	
Macroscopic type	1	31	4	9	
	2	146	12	60	
	3	26	5	17	0.414
	4	8	0	5	
Depth of invasion	11	9	1	0	
	12	19	2	5	
	13	108	10	42	0.003
	14	75	8	44	
Iy[b]	0	49	5	14	
	1	129	12	45	
	2	27	3	24	0.011
	3	6	0	8	
V[c]	0	87	9	27	
	1	65	5	32	
	2	49	7	27	0.435
	3	9	0	5	

ns*** ; there were no significance between n1, skip n2 and n2 groups.
[a] Histological type-wel: well differentiated adenocarcinoma; mod: moderately differentiated adenocarcinoma; por: poorly differentiated adenocarcinoma.
[b]ly: lymphatic invasion were classified with degree of amounts of tumor invasion.
[c]v: venous invasion were classified with degree of amounts of tumor invasion.

DISCUSSION

Our study showed that skip n2 metastasis was less common than n1 and n2 metastases. The degree of lymphatic invasion associated with skip n2 metastasis was intermediate between that of n1 and n2 metastases, suggesting that implantation of tumor cells in distant lymph nodes requires a high degree of lymphatic invasion.

Recently, many investigators have reported that sentinel node mapping is useful for staging colorectal cancer (7-9). Marrie *et al.* (10) found that direct lymphatic drainage to apical anatomic skip lesions occurred in 15% of 26 colon cancers evaluated by keratin 20 reverse transcription polymerase chain reaction. Saha *et al.* (11) reported skip metastasis in 3.9% of colorectal cancers on hematoxylin and eosin staining. The incidence of skip metastasis in colorectal cancer as assessed by molecular techniques is estimated to be higher than previously estimated (8).

Our study also demonstrated that the survival of patients with skip n2 metastasis was similar to that of patients with one, two, or three N1 metastases. Moreover, the mean number of positive nodes in the skip n2 group was significantly lower than that in the n1 and n2 groups. This finding suggests that most lymph nodes with skip metastasis are sentinel nodes. Lymph node mapping is therefore useful for detecting lymph nodes with skip metastasis and can help to ensure that metastatic lymph nodes are completely resected along with the primary tumor.

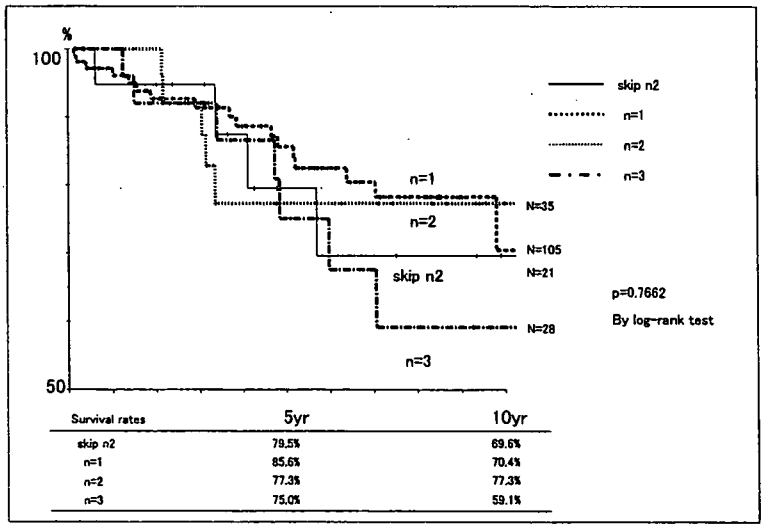

FIGURE 2 Overall survival rates of patients with one, two, three lymph node metastasis in N1 area and skip n2 lymph node metastasis.

Yamamoto *et al.* (12) found that the presence of skip metastasis is associated with better outcomes than the absence of skip metastasis in patients with colorectal cancer. Shida *et al.* (13) reported that 31.6% of patients with n2 colon cancer have skip metastasis, but

TABLE 4 Comparison of the Number of Lymph Nodes with Metastasis

	Total number of dissected lymph		Number of n1 lymph		Number of n2 lymph nodes with metastasis		Total number of lymph nodes with metastasis	
n1 group	29.7±1.2		2.5±0.2		0		2.5±0.2	
		P=0.489						P=0.036
skip n2 group	26.9±3.2	P=0.628	0	P<0.001	1.2±0.1		1.3±0.1	P<0.001
		P=0.596				P=0.010		P<0.001
n2 group	28.7±1.4		4.2±0.4		2.5±0.2		6.8±0.5	

(Mean±SE)

found no significant difference between patients with skip metastasis and those without skip metastasis. We found that the outcome of patients with skip n2 metastasis was similar to that of patients with n1 metastasis, but better than that of patients with n2 metastasis. This finding justifies the staging of colorectal cancer according to the number of lymph node metastases, as done in the TNM classification (14). However, an anatomical assessment of lymph node metastasis is useful for deciding the required extent of mesenteric lymph node resection. Moreover, the possibility of skip metastasis should be considered in patients undergoing curative resection for colorectal cancer.

Our results suggest that both the locations and the numbers of lymph node metastases should be incorporated into classification systems for the evaluation of patient prognosis.

In summary, our clinicopathological study showed that n2 skip metastasis was less common than n1 or n2 metastasis. The degree of lymphatic invasion associated with n2 skip metastasis was intermediate between that associated with n1 metastasis and that associated with n2 metastasis. Lymph nodes with skip metastasis were apparently sentinel nodes of the primary tumor. Therefore, the outcome of patients with skip n2 metastasis was similar to that of patients with n1 metastasis, but better than that of patients with n2 metastasis.

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Original Paper

Lateral Lymph Node Dissection for Lower Rectal Cancer

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KEY WORDS: Lateral lymph node dissection; Lower rectal cancer

ABBREVIATIONS: Lymph Node Dissection (LLD)

ABSTRACT

Background/Aims: This study was conducted to evaluate the effects of lateral lymph node dissection (LLD) on overall survival, disease-free survival, and local recurrence for the patients with lower rectal cancer.

Methodology: From 1990 through 2000, 169 consecutive patients with T2 (TNM classification) or more advanced, extended lower rectal cancer (located below the peritoneal reflection) underwent curative resection at Kanagawa Cancer Center were reviewed.

One hundred and forty-three patients who underwent LLD and the 26 patients who did not were entered in this study.

Results: Cox's multivariate regression analysis showed T stage (TMN classification), N stage (TNM classification), and LLD were found to be significantly related to the rates of both cumulative survival and disease-free survival. That mean LLD was identified as a significant prognostic factor. But disease-free survival did not differ significantly between the patients who underwent LLD and those who did not undergo LLD in stage I, II, or III disease ($p=0.3681$, $p=0.1815$, and $p=0.0896$, respectively).

The local recurrence rate was similar in patients who received LLD (17.5 percent) and in those who did not receive LLD (23.1 percent; $p=0.498$). But 7 patients with lateral lymph node metastasis (33.3 percent) remained disease free. And these patients had local lateral lymph node metastasis and benefited from LLD.

Conclusions: LLD can substantially improve outcomes in selected patients at high risk for lateral lymph node metastasis. A randomized controlled clinical study is necessary to clarify the role of LLD in the treatment of rectal cancer.

INTRODUCTION

In lower rectal cancer, lymphatic drainage is mainly to the superior rectal artery and inferior mesenteric artery or to the lateral lymph nodes beyond the pelvic nerve plexus (1-3). Lymph node metastasis most frequently occurs along the inferior mesenteric artery, and patients with lateral node metastasis have a poor prognosis (4-6). Lateral lymph node dissection (LLD) has therefore received considerable attention.

In Japan, extended lymphadenectomy has been done to improve outcome in rectal cancer (7-9), but complications associated with auto-nerve resection, such as urinary dysfunction and sexual disturbance, became evident with improved survival (7,10). Subsequently, surgeons in Japan developed a procedure for LLD with auto-nerve preservation (4,11-15). This procedure has improved urinary function, but sexual function remains unsatisfactory (4,11). Lateral lymph node metastasis has been considered systemic disease in patients with rectal cancer (16). However, some patients have only lateral lymph node metastasis, and the lateral lymph nodes have been designated regional lymph nodes (6,17,18). Such patients have had good outcomes after LLD. Available evidence thus suggests that LLD should be avoided in patients with a low risk of lateral lymph node metastasis or those unlikely to benefit from the procedure, thereby enhancing their postoperative quality of life. On the other hand, LLD should be done patients likely to benefit from the procedure in terms of a lower risk of local recurrence and an improved outcome. In this retrospective study, we evaluated the effects of LLD on overall survival, disease-free survival, and local recurrence.

METHODOLOGY

From 1990 through 2000, 169 consecutive patients with T2 (TNM classification) or more advanced, extended lower rectal cancer (located below the peritoneal reflection) underwent curative resection at Kanagawa Cancer Center. The diagnosis of depth of tumor invasion was due to barium enema, computed tomography, and colonoscopy. Because liver metastasis, peritoneal dissemination, and distant metastasis were considered to have a far stronger impact on outcome than LLD, patients with these conditions were excluded from analysis. Histopathologically, well, moderately, and poorly differentiated adenocarcinomas and mucinous adenocarcinomas were studied.

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Clinicopathological data was obtained from clinical chart, retrospectively.

The indication for LLD was originally T2 or more advanced, extended lower rectal cancer. We performed LLD with auto-nerve preservation. This procedure was contained total mesorectal resection. LLD was not done in patients who had cardiovascular complications or respiratory dysfunction, elderly patients, and those not consenting to the procedure. Patients were followed up by computed tomography and measurement of serum tumor makers (CEA and CA19-9) at intervals of 2 to 4 months for the first 2 years and 4 to 6 months thereafter. Median follow-up was 5.6 months. Adjuvant chemotherapy was recommended in all patients, and received by only patients hoped. Radiotherapy was not given.

The statistical significance of differences between groups was evaluated with the chi-square test and *t*-test. Cumulative survival rate and disease-free survival rate were calculated by the Kaplan-Meier method, and survival curves were compared by the log-rank test. Cox's regression analysis was used for univariate and multivariate analyses. A p value of <0.05 was considered to indicate statistical significance.

RESULTS

Clinicopathological Features of the Patients and Related Factors

The clinicopathological features of the 143 patients who underwent LLD and the 26 patients who did not are shown in **Table 1**. Mean age ($p=0.008$) and preoperative complications ($p=0.008$) differed significantly between these groups.

The overall rates of cumulative survival and disease-free survival at 5 years were 73.3 percent and 61.5 percent, respectively **(Figure 1)**. Cox's univariate regression analysis showed that the cumulative survival rate was significantly related to macroscopic type, T stage (TMN classification), N stage (TNM classification), preoperative levels of CEA and CA19-9 in serum, and LLD **(Table 2)**. In addition to these factors, disease-free survival rate was significantly related to histological type and intraoperative lymph node metastasis **(Table 3)**. T stage (TMN classification), N stage (TNM classification), and LLD were found to be significantly related to the rates of both cumulative survival and disease-free survival **(Tables 4, 5)**. LLD was thus an important prognostic factor for both cumulative and disease-free survival.

Survival Rate of Patients Undergoing LLD and Those Not Undergoing LLD

The disease-free survival rate at 5 years was significantly higher in patients who underwent LLD (65.4 percent) than in those who did not undergo LLD (39.0 percent; $p=0.0182$) **(Figure 2)**. Disease-free survival did not differ significantly between the patients who underwent LLD and those who did not undergo LLD in stage I, II, or III disease ($p=0.3681$, $p=0.1815$, and $p=0.0896$, respectively) **(Figure 3)**.

TABLE 1 Clinicopathological Features of Patients

		LLD (N=143)	No LLD (N=26)	*P* value
Sex	male	102	17	
	female	41	9	0.541
Age (Mean±SE)		60.2±0.9	66.4±1.9	0.008
Macroscopic type	elevated	120	17	
	depressed	23	9	0.088
Tumor diameter (Mean±SE)		53.2±1.7	52.6±5.9	0.902
Pathological type	well	49	10	
	mod	81	14	0.909
	others	13	2	
Depth of invasion	pT2	37	9	
	pT3	91	14	0.613
	pT4	15	3	
Lymph node status	pN0	67	10	
	pN1	35	7	0.72
	pN2	41	9	
Pathological stage (TNM)	I	28	5	
	II	39	5	0.66
	III	76	16	
Adjuvant chemotherapy	(-)	61	16	0.075
	(+)	82	10	
Preoperative serum CEA	normal	115	21	
	high	28	5	0.967
Preoperative serum CA19-9	normal	115	19	
	high	28	7	0.395
Preoperative complications	(-)		112	14
	(+)	31	12	0.008

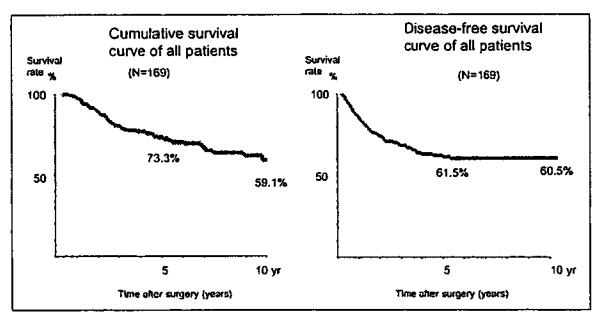

FIGURE 1 Mean observation period was 3390±146 (S.E.) days (95%CI: 3104-3675) after surgery for cumulative survival and 3098±157 (S.E.) days (95%CI:2790-3405) after surgery for disease-free survival.

Lateral Lymph Node Metastasis and Effect of LLD in Stage III Disease

The rate of disease-free survival 5 years after LLD did not differ significantly between patients with stage III disease who had lateral lymph node metastasis (33.3 percent) and those without lateral lymph node metastasis (47.4 percent). The rate of disease-free survival at 5 years was significantly higher in patients with stage III disease without lateral lymph node metastasis who underwent LLD (47.4 percent) than in patients with stage III disease who did not undergo LLD (25.0 percent; $p=0.0449$) **(Figure 4)**. Disease-free survival at 5 years was also analyzed after dividing the patients who underwent LLD into three groups: those without lateral lymph node metastasis, those with only one lateral lymph node metastasis, and those with two or more lateral lymph node metastases. There was no significant difference in disease-

free survival among these three groups. However, patients with one or more lateral lymph node metastases tended to have a poorer outcome than those without lateral lymph node metastasis (**Figure 5**).

Pattern of Recurrence With or Without LLD

The overall rate of recurrence was 34.3 percent in the patients who underwent LLD. Among these patients, the recurrence rate was 66.7 percent in patients with lateral lymph node metastasis and 28.7 percent in those without metastasis ($p=0.001$). The recurrence rate differed significantly between patients who underwent LLD (34.3 percent) and those who did not undergo LLD (57.7 percent) ($p=0.023$). The local recurrence was defined as intrapelvic recurrence except anastomotic one. The local recurrence rate was similar in patients who received LLD (17.5 percent) and in those who did not receive LLD (23.1 percent; $p=0.498$) (**Table 6**). The local recurrence rate in patients with lateral lymph node metastasis was 38.1 percent, as compared with 13.9 percent in patients without lateral lymph node metastasis ($p=0.007$).

Seven patients with lateral lymph node metastasis (33.3 percent) remained disease free. These patients had local lateral lymph node metastasis and benefited from LLD.

TABLE 2 Univariate Analysis of Prognostic Factors for Cumulative Survival

			Exp	C.I. 95%	*P* value
Sex	male	119	1.358	0.713-2.585	0.352
	female	50	1		
Macroscopic type	elevated	137	1		
	depressed	32	1.865	1.024-3.394	**0.041**
Pathological type	well	59	0.565	0.223-1.436	0.23
	mod	95	0.658	0.274-1.580	0.349
	others	15	1		
Depth of invasion	pT2	46	1		
	pT3	105	3.621	1.423-9.215	**0.007**
	pT4	18	10.065	3.460-29.277	**0.000**
Lymph node status	pN0	77	1		
	pN1	42	2.842	1.261-6.404	**0.012**
	pN2	50	7.079	3.436-14.588	**0.000**
Macroscopic lymph node metastasis	(-)	65	1		
	(+)	104	1.727	0.947-3.148	0.074
Adjuvant chemotherapy	(-)	77	1.065	0.619-1.833	0.821
	(+)	92	1		
Preoperative serum CEA	normal	136	1		
	high	33	1.946	1.054-3.592	**0.033**
Preoperative serum CA19-9	normal	134	1		
	high	35	2.18	1.211-3.925	**0.009**
Lateral lymph node dissection	(-)	26	2.342	1.271-4.317	**0.006**

TABLE 3 Univariate Analysis of Disease-free Survival

			Exp	C.I. 95%	*P* value
Sex	male	119	1.264	0.718-2.225	0.418
	female	50	1		
Macroscopic type	elevated	137	1		
	depressed	32	1.849	1.061-3.222	0.030
Pathological type	well	59	0.400	0.181-0.885	0.024
	mod	95	0.518	0.249-1.076	0.078
	others	15	1		
Depth of invasion	pT2	46	1		
	pT3	105	2.437	1.188-5.000	0.015
	pT4	18	5.334	2.241-12.696	0.000
Lymph node status	pN0	77	1		
	pN1	42	4.751	2.301-9.810	0.000
	pN2	50	7.015	3.514-14.008	0.000
Macroscopic lymph node metastasis	(-)	65	1		
	(+)	104	1.976	1.134-3.443	0.016
Adjuvant chemotherapy	(-)	77	1		
	(+)	92	1.123	0.686-1.841	0.644
Preoperative serum CEA	normal	136	1		
	high	33	2.281	1.330-3.911	0.003
Preoperative serum CA19-9	normal	134	1		
	high	35	2.068	1.207-3.542	0.008
Lateral lymph node dissection	(-)	26	1.983	1.111-3.539	0.021
	(+)	143	1		

TABLE 4 Multivariate Analysis of Prognostic Factors for Cumulative Survival

		Exp	C.I. 95%	*P* value
pT2		1		
pT3		2.386	0.884-6.439	0.086
pT4		6.547	2.080-20.607	0.001
pN0		1		
pN1		2.873	1.262-6.542	0.012
pN2		5.232	2.476-11.055	0.000
Lateral lymph node dissection	(+)	1		
	(-)	2.490	1.339-4.631	0.004

TABLE 5 Multivariate Analysis of Prognostic Factors or Disease-free Survival

		Exp	C.I. 95%	*P* value
pT2		1		
pT3		1.515	0.701-3.275	0.291
pT4		3.733	1.462-9.530	0.006
pN0		1		
pN1		4.877	2.343-10.150	0.000
pN2		5.852	2.834-12.083	0.000
Lateral lymph node dissection	(+)	1		
	(-)	2.074	1.154-3.726	0.015

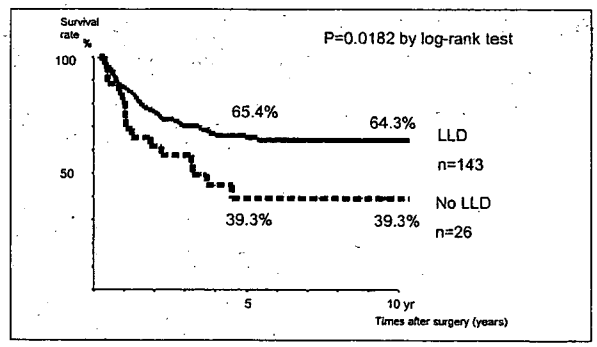

FIGURE 2 Disease-free survival curves of patients with and those without lateral lymph node dissection. LLD: lateral lymph node dissection. There were significant differences between the LLD group and No LLD group ($p=0.0182$ by log-rank test).

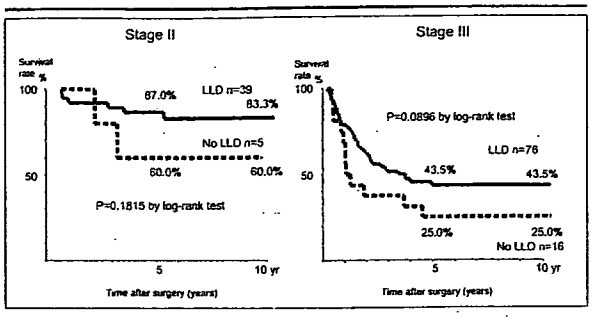

FIGURE 3 Disease-free survival curves of patients with and those without lateral lymph node dissection in stage II and stage III disease.
LLD: lateral lymph node dissection. There was no significant difference between the two groups for stage II (p=0.1815) or stage III (p=0.0896) by the log-rank test.

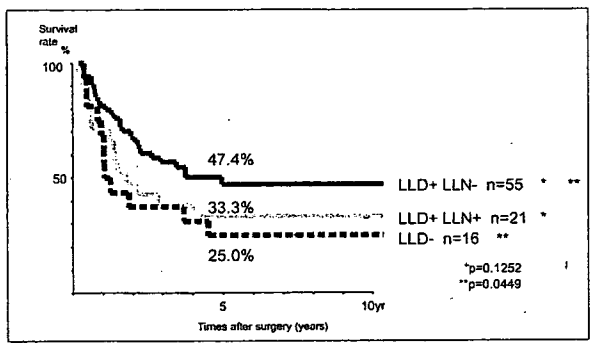

FIGURE 4 Disease-free survival curves of three groups with stage III disease: lateral lymph node metastasis group, without lateral lymph node metastasis group, and without lateral lymph node dissection group.
LLD: lateral lymph node dissection. LLN: lateral lymph node. There was a significant difference between the LLD+LLN- and LLD- groups (p=0.0449) and no significant difference between the LLD+LLN- and LLD+LLN+ groups (p=0.1252) by the log-rank test.

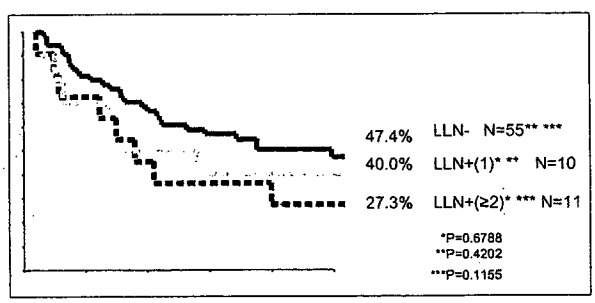

FIGURE 5 Disease-free survival curves of three groups with stage III disease: only one lateral lymph node metastasis group, two or more lateral lymph node metastases group and no lateral lymph node metastasis group.
LLN: lateral lymph node. There was no significant difference among the three groups. The survival of patients with even one lateral lymph node metastasis tended to be poorer than that of patients without lateral lymph node metastasis.

DISCUSSION

In Japan, extended operation with *en bloc* excision of both the primary tumor and superior regional lymph nodes, including the lateral nodes, was previously recommended to prevent local recurrence and improve survival in patients with advanced rectal cancer (7-9). However, this procedure disturbed urinary and sexual functions (7,10). Techniques for LLD with auto-nerve preservation were thus developed to prevent such complications (4,11-15). Surgeons at leading hospitals have introduced these techniques to Japan. We have performed LLD with auto-nerve preservation since 1990.

Many patients with advanced lower rectal cancer prophylactically undergo LLD, but the contribution of LLD to the prevention of local recurrence and improvement of survival remains unclear. The rate of lateral lymph node metastasis in advanced lower rectal cancer ranges from 13 percent to 24 percent (2,3,5,14,18). The internal iliac nodes and obturator nodes are most likely to have metastasis (6). Lateral lymph node metastasis is most often associated with 1) cancer below the peritoneal reflection, 2) mesorectal node metastasis, 3) deeply penetrating tumors, and 4) poorly differentiated adenocarcinoma (2). Patients with one or more of these conditions are thus most likely to benefit from LLD.

We studied patients who had T2 or more advanced disease because T1 tumors are usually free of lateral lymph node metastasis (18). Our analyses showed that T stage (TNM classification), N stage (TNM classification), and LLD were independently related to disease-free survival. Because LLD was one of the factors identified, we compared disease-free survival rates between patients who underwent LLD and those who did not undergo LLD. We found that LLD was associated with a better outcome than no LLD. However, this finding might have been biased by the fact that LLD was not done in patients who were elderly or had severe cardiovascular or respiratory disease. As for disease stage, there was no significant difference in the prevalence of stage II or stage III disease between patients who underwent LLD and those who did not. When we compared outcomes in stage III disease among patients without lateral lymph node metastasis, those with only one lateral lymph node metastasis, and those with two or more lateral lymph node metastases, we found that outcome was negatively affected by the presence of even one positive lateral node. Fujita *et al.* (17) reported that LLD did not improve survival in patients with stage II or III disease. However, among patients with pathological N1 (TNM classification) lymph node metastasis, those who underwent LLD had a better outcome than those who did not undergo LLD.

What is the value of LLD? The rate of local recurrence after LLD ranges from 4.8 percent to 12.5 percent (5,14,15,18,19). The difference in the rate of local recurrence rate between LLD and total mesorectal excision (TME) is minimal (16,20), and LLD has not

TABLE 6 Local recurrence Rate

	All patients	Patients with local recurrence	
LLD-	26	6 (23.1%)	P=0.498
LLD+	143	25 (17.5%)	

been shown to be superior to TME. Enker *et al.* (16) reported that the local recurrence rate after TME was only 7.3 percent.

The outcomes of patients with lateral lymph node metastasis are poor owing to a high rate of relapse caused by remote metastasis. This factor may be responsible for an unbridgeable gap between potential benefits of LLD and an improvement in survival. In our study, the rate of local recurrence did not differ significantly between patients who underwent LLD (17.5 percent) and those who did not (23.1 percent). However, the rate of local recurrence among patients with lateral lymph node metastasis was 38.1 percent, implying that local recurrence was controlled in the remaining 61.9 percent. Moreover, 33.3 percent of the patients with lateral lymph node metastasis remained disease free. These patients most likely had local rather than systemic disease. Our results suggest that LLD positively contributed to outcome in 20.6 percent of the patients with lateral lymph node metastasis.

Firm conclusions have yet to be made concerning the contribution of LLD to outcome. In Japan, randomized controlled clinical studies have been begun by the Japanese Clinical Oncology Group to clarify the role of LLD in the treatment of rectal cancer. Preoperative radiotherapy has been used to maintain sexual and urinary functions and reduce local recurrence after standard TME in patients with rectal cancer (21,22) and thereby improve their quality of life after operation. We believe that LLD and radiation therapy can substantially improve outcomes in selected patients at high risk for lateral lymph node metastasis.

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直腸癌手術に対する神経温存D3郭清手術 手技—開腹アプローチ—

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はじめに

直腸癌における神経温存手術は，内腸骨動脈領域の側方リンパ節，下腸間膜動脈領域や大動脈周囲のリンパ節の郭清により，自律神経が損傷されたために生じた機能障害の反省から，1980年代より提唱されるようになった術式である。直腸癌手術と関連する自律神経系は，下腸間膜動脈起始部で大動脈左右から出る腰内臓神経，それらが大動脈前面で交差合流して形成する下腹神経叢，これがさらに岬角近くで左右に分岐し，仙骨より前方に向かう骨盤内臓神経と合流する骨盤神経叢である。詳細は前稿で述べてあるので，本稿では腫瘍が腹膜反転部付近に存在する進行直腸癌を想定して，上記のすべての神経を温存し，主リンパ節および側方リンパ節郭清を伴う手術手技について述べる。

I. 手術手技

手術の操作は，S状結腸と下行結腸の一部を後腹膜からの授動，下腸間膜動脈根部，同静脈の処理，間膜および口側結腸の切離，直腸間膜の剝離授動，直腸切離，側方郭清，吻合という手順で行っている。

1. 上部自律神経温存（腰内臓神経～下腹神経叢～左右下腹神経）

結腸間膜の剝離は尿管と総腸骨動脈が交差する部位の内側（大動脈分岐部より外側の高さ）から行う。これはS状結腸を牽引することで，仙骨前面の剝離層である結合織と下腹神経が比較的容易に確認できるからである。この層を頭側に向かってホワイトラインまで切開を延ばし，腎筋膜前葉と後腹膜下筋膜を大動脈前面まで進める。この剝離面には血管はないので，ほぼ無血状態で剝離可能である。この場合，助手が十分にカウンタートラクションをかけることが肝要である。また，肥満で脂肪の多い人や剝離層がよくわからない場合は，至摘剝離層よりも背側に入ってしまうことがあるので，下行結腸側のホワイトラインから先に切開剝離を始めると，剝離層を間違わずに進めることができ，余計な出血を来すことは少ない。

大動脈近傍まで達すると，上下腹神経が白色調の索状物として確認できることが多い。確認できればこの時点で間膜より十分に鋭的に剝離しておく（慣れないうちはテーピングしておくとわかりやすい）。この神経叢がわからないと，剝離が大動脈前面へ向かってしまい，神経を間膜側に残したまま授動することになる。次にS状結腸を左側に牽引し，下大静脈右側で後腹膜

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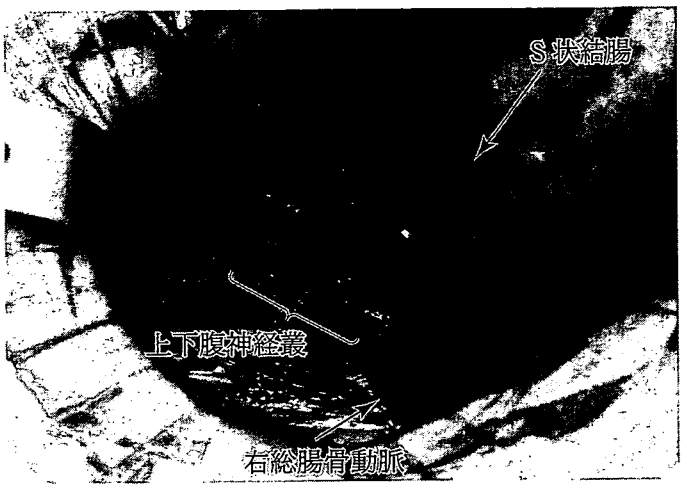

図 1
S状結腸を左側に牽引し，上下腹神経の走行を確認しながら切離できる。(左が頭側)

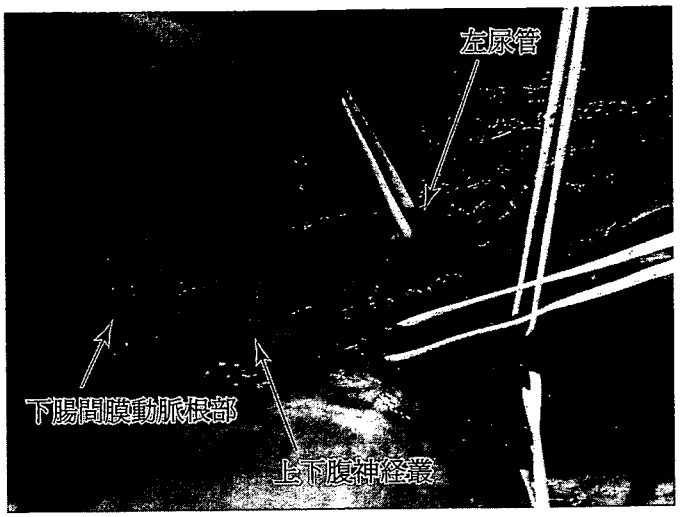

図 2
下腸間膜動脈の根部を結紮・切離した上下腹神経叢が大動脈前面に温存されている。(左が頭側)

を切開する。左側の剝離が十分にできていると，後腹膜を切開，牽引するのみで結腸が授動され，上下腹神経の走行を確認しながら切離できる(**図 1**)。切開は十二指腸水平脚まで，さらに同部位の大動脈前面で逆U字に行い，下腸間膜動脈根部を明らかにする。

大動脈前面には左右の頭背側から走行する数本の腰内臓神経が合流交錯してネットワークを形成している。この確認は肉眼的にはなかなかむずかしいと思われ，メチレンブルーを希釈した液体で染色すると比較的明瞭となり，神経温存には効果的と考えられる[1]。したがって，大動脈外膜がむき出しになるような剝離は神経を損傷していると考えられ，脂肪織を残すような剝離が妥当と思われる。下腸間膜動脈の根部を結紮・切離したあとは，すでに剝離した結腸間膜とともに腹側に牽引することで，上下腹神経の走行が確認でき，それを大動脈に残すように剝離すれば損傷なく行える(**図 2**)。

これらの操作で，上下腹神経叢が大動脈前面に温存され，同定ができればこの後の操作が容易となる。

2. 下部自律神経温存(左右下腹神経～骨盤内臓神経～骨盤神経叢)

S状結腸を離断し，直腸側断端を腹腔外尾側へ挙上すると上方側から温存してきた下腹神経の走行がよりはっきりする(**図 3**)。その下腹神経が骨盤側に残るように直腸固有筋膜を尾側に向かって剝離を進める。この直腸間膜背側(直腸後腔)は血管のない白い膜状の結合織であり，この層を Waldeyer 筋膜まで剝離を進める(**図 4**)。次に，左右の骨盤腹膜切開線を腹膜反転部まで延長し，直腸と骨盤腹膜にカウンタートラクションをかけると良好な視野が展開する。直腸後壁側から側方に左右に回り込むように下腹神経の内側を剝離していくと，骨盤神経叢の内側に至る。

再度，後壁に戻って Waldeyer 筋膜を鋭的に穿破すると肛門挙筋が現れる。さらに索状物として触知される尾骨直腸靱帯を切離すると直腸後壁の固定が解除され，直腸は十分に腹側に挙上され，神経の走行がよりはっきりとする(**図 5**)。この部位における操作のコツは術者，あるいは助手が切離した直腸を牽引しつつ，さらに剝離操作部位を腸ベラなどで先を利かせるように腹側に圧迫し，良好な視野を保持することである。視野が良くなると同時に切離する結合

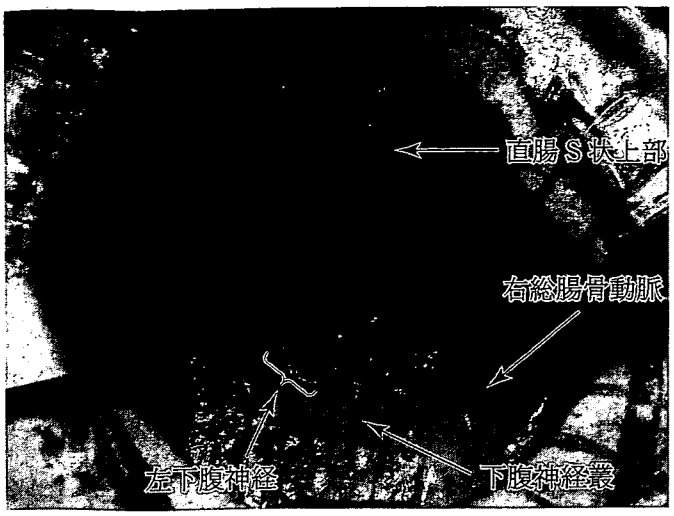

図 3
直腸側断端を腹腔外尾側へ挙上すると下腹神経の走行がよりはっきりする。(手前が頭側)

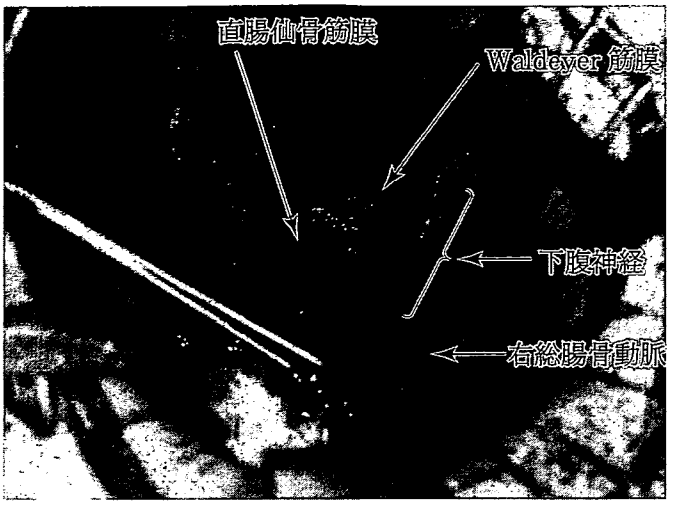

図 4
直腸後腔を剝離すると直腸仙骨筋膜に達し，それを切開するとWaldeyer筋膜に達する。(手前が頭側)

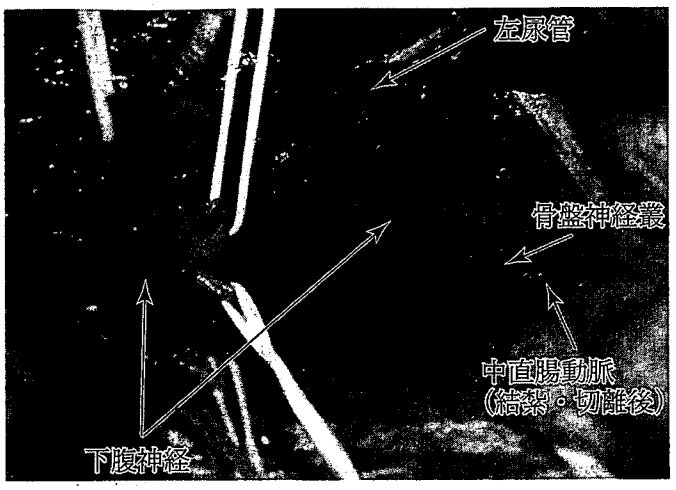

図 5
直腸後壁を十分に腹側に挙上すると，神経の走行がよりはっきりとする。(左が頭側)

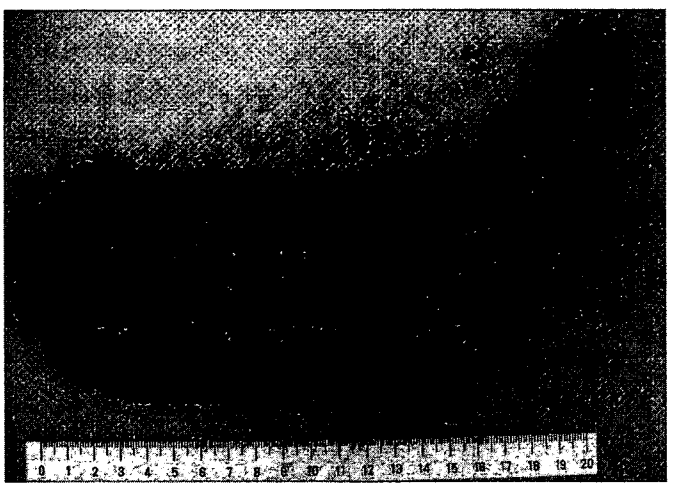

図 6
TMEを施行された摘出標本の直腸間膜剝離面。平滑で光沢をもって見える。

織の層がはっきりするので，圧排を少しずつ奥に進めながら行うと剝離層を誤らない。また，ここの操作においては電気メスやCooperなどで鋭的，鈍的に剝離しても出血はほとんどみないが，とくに下部直腸になると正中部で強い線維組織がみられ，これを背側に入ってしまうと仙骨前の静脈叢から出血を来すので，直腸側に沿って切離するのが肝要である。またここでは，骨盤内臓神経の損傷に注意が必要である。

第2〜4仙骨神経は仙骨外側から立ち上がる索状物として認識される。したがって，前述の正中の線維組織を切離して対側に牽引すると，損傷の可能性を減らすことができる。このように直腸固有筋膜が破れないように肛門挙筋が露出するところまで剝離を進めることが重要である〔摘出標本をみると直腸間膜の剝離面が薄い膜に覆われて光沢をもって見え（**図6**），いわゆるtotal mesorectal excision：TME[2]がなさ

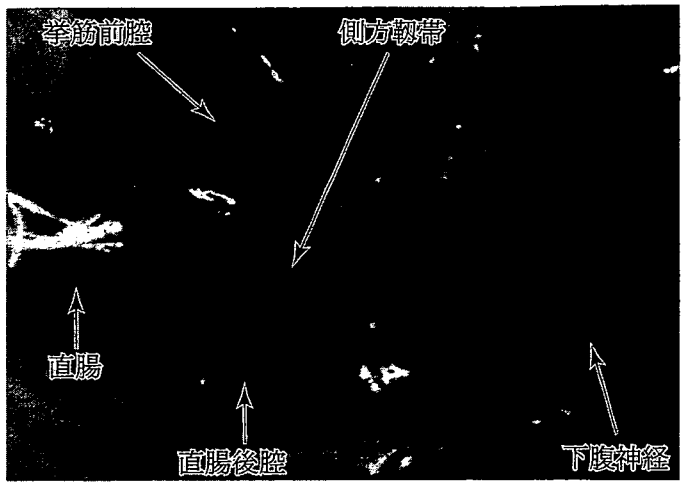

図 7
直腸側腔は直腸後腔，挙筋前腔につながる。直腸を対側に牽引しながら開窓すると直腸と骨盤をつなげている側方靱帯が同定できる。

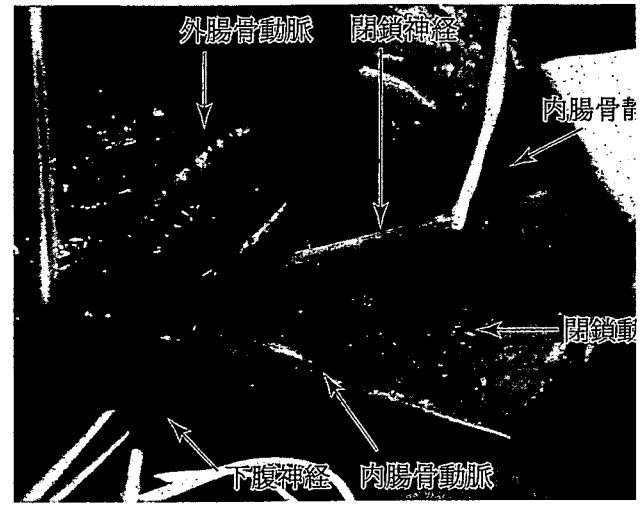

図 8　左側方郭清
内腸骨動脈外側の閉鎖腔を神経，血管だけにする。（左側頭側）

れてなければならない〕。

次に直腸前方の剝離を行う。腹膜翻転部腹膜を切開し，脂肪織を切離すると直腸の筋線維が確認される。これに沿い Denonvilliers 筋膜を精嚢（子宮・膣）から剝離する。癌の浸潤がないかぎり，前立腺（膣）の後壁は容易に剝離可能である。男性の場合，精嚢外側の脂肪織を鈍的に剝離し安易に切離していくと，しばしば neurovascular band（神経血管束）を損傷し，出血をみることがあるので注意が必要である。

腹膜翻転部より尾側の直腸外側と内腸骨血管の間には脂肪織が存在するので，鈍的に剝離すると直腸側腔に至る。これは先に剝離した直腸後腔，挙筋前腔につながるので，直腸を対側に牽引しながら開窓すると，直腸と骨盤をつなぎ神経血管束を形成している側方靱帯が同定できる（**図 7**）。ここでは下腹神経や骨盤神経叢を確認しつつ，直腸に向かう血管や神経は切離するが，腹側にある精嚢や膀胱に向かう神経の損傷を回避しなければならない。両側の側方靱帯が切離されると，直腸はほぼ遊離されたことになる。

直腸側壁における側方靱帯の切離の際に，骨盤神経叢から膀胱枝などの臓側枝が走行していることを留意しながら，ここの操作を確実に行うことも自律神経温存術のポイントの一つとなる。

3. 側方リンパ節郭清

側方郭清は腹腔内や腹膜外からのアプローチがあり，内・外腸骨動脈間の閉鎖腔（No.283）や内腸骨動脈周囲（No.263）の直腸側腔，膀胱側腔の脂肪織を摘出することである。我々は同意位が直視下に見え，視野が良好な外側アプローチで行っている[3]。この際，内腸骨動脈，上膀胱動脈，下腹神経などにテーピングしておくと郭清が安全で系統的に十分に行える。中直腸動脈根部（内腸骨末梢）リンパ節郭清の際には骨盤内臓神経が近接しているためその損傷に留意が必要である。

腹膜の剝離は内・外腸骨動脈部位を想定しそこに向かって正中切開部腹膜の剝離から始める。血管が同定できたらそれを露出するように外側から内側に向かって閉鎖神経，動・静脈を明らかにしつつ骨盤側壁，後方の坐骨神経が露出するまで行い，閉鎖リンパ節郭清を終了する（**図 8**）。ついで，内腸骨動脈に沿ってその周囲を剝離・露出し，上膀胱動脈を確認する。この内側下方には骨盤神経叢が存在するので，血管にテーピングし外側に牽引すると，神経叢と血

管の間にスペースを作ることができ，神経損傷をより回避できる。さらに末梢では内腸骨動・静脈から分岐する閉鎖動・静脈，下膀胱動・静脈，その内背側の梨状筋から骨盤神経叢に向かう骨盤神経（S3，S4）があることを考慮し，その温存に努めながら周囲脂肪織を摘出（閉鎖動・静脈は合併切除することもあるが，とくに問題ないと思われる）して側方郭清を終了する（図9）。

森ら[4]は自律神経温存をする側方郭清術における要点を次のように挙げている。

①閉鎖リンパ節郭清では腹膜外経路で行うのが確実だが，腹膜内経路と併用することで内腸骨動脈末梢部が直視下に操作可能となり，その内側に存在する骨盤神経叢の温存が容易である。

②上膀胱動脈の露出とテーピングによる牽引で，内腸骨動脈末梢部との間が開大する。内腸骨動脈の末梢に梨状筋を確認でき，その内側のS3起始部の温存が容易になる。

③下膀胱動・静脈を確認し，これらを膀胱流入部まで，周囲脂肪織を含めて切除すると，下膀胱動・静脈の裏に存在するS4起始部の確認温存が容易になる。

また，森ら[4]は本術式の手技において，鋏による鋭的操作は神経叢をできるかぎり薄く剝離可能で，神経周囲のリンパ節転移，脂肪浸潤組織の摘出が可能であるが，神経損傷を多くしているという問題点も挙げている。

図9　左側方郭清
内腸骨動脈に沿って剝離を進め，神経叢と血管の間にスペースを作る。上膀胱動脈が分岐したあとの内腸骨動脈の末梢では閉鎖動脈，下膀胱動脈がみられる。
骨盤神経叢に向かう骨盤神経（S3，S4）はこの内背側に存在する。（左が頭側）

おわりに

直腸癌に対する自律神経温存術の手技について述べた。本術式の手技は標準的な直腸癌の手術手技に加え，解剖学的知識とリンパ節郭清の基本的手技が身についていれば可能なものと思われる。

ポイントは3つ。下腸間膜動脈起始部の処理を行う際の腰内臓神経の温存の場合と，仙骨前面における直腸剝離と下腹神経の温存，側方靱帯切離の際の骨盤神経叢の温存に尽きる。

そして何よりも，本術式が患者の術後のQOLに関わるものであり，術者である以上看過できない手技であるということを念頭において励行することである。

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Functional Outcome After Sphincter Excision for Ultralow Rectal Cancer

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This article shows a prospective study investigating bowel function after transanal rectal resection with internal and external sphincterectomy for low rectal cancer. Eight patients underwent standard low anterior resection with colonic J-pouch anal anastomosis (LARJ), and eight patients underwent transanal rectal resection with internal and external sphincter resection (IESR). Manometry, manovolumetry, transit time study, and a questionnaire were performed before and after the operation. Six and 12 months after the operation, maximum resting pressure and squeezing pressure were significantly lower in IESR group than in LARJ group, whereas there was no significant difference between the two groups in terms of constant sensation, maximum tolerable volume, or neorectal compliance. Although the functional score of the IESR group remained low at 6 months after the operation in comparison with the LARJ group, it improved at 12 months after the operation. Transanal rectal resection with internal and external sphincterectomy showed usefulness in preserving bowel function and avoiding permanent colostomy.

Key words: Rectal cancer – Anus-preserving operation – Anorectal function – Intersphincteric resection – External sphincter muscle resection

Since Parks[1] described sphincter-saving operation for rectal cancer, low anterior resection has gained safety with improved circular staplers and has consequently decreased the number of patients with permanent colostomy. The sphincter-saving operation using a colonic J-pouch to preserve bowel function improves postoperative quality of life and has become a widespread treatment for rectal cancer.[2–4]

In 1994, Schissel *et al*[5] reported intersphincteric resection (ISR) for a rectal cancer located in the vicinity of the anal canal. Although anal sphincteric resection preserving the anus has been applied even to those with low rectal cancer or anal canal cancer to avoid permanent colostomy, those studies on postoperative anal and bowel functions are still unknown.

Curative treatment of rectal cancer requires not

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only resection of the internal anal sphincter muscle for carcinoma invading the internal anal sphincter muscle but also partial resection of the deep-superficial external anal sphincter muscles for carcinoma invading their muscles. This is the first prospective study comparing early postoperative bowel function between standard low anterior resection with colonic J-pouch anal anastomosis (LARJ) and transanal rectal resection with internal and external sphincter resection (IESR) in patients with low rectal cancer or anal canal cancer.

Patients and Methods

From January 2001 to December 2001, LARJ and IESR were performed in 16 patients with low rectal cancer or anal canal cancer. We assessed the patients by verbal and written information about the objective, importance, and procedure of the study, and we obtained their consent to examination and operations. Before surgery, the distance from the dentate line to the lower edge of tumor was measured with a rigid rectoscope. Diagnosis for whether the tumor infiltrated the internal-external anal sphincter muscles or not was made from computed tomography (CT) and ultrasonography.

Rectal cancer with its lower edge locating at 2 cm or more from the dentate line was indicated for LARJ, whereas ISR was applied if the lower edge was within 2 cm from the dentate line and the tumor invasion was limited to the internal sphincter muscle. IESR was applied if the tumor invasion was suspected beyond the internal sphincter muscle.

Operative procedure

According to the transabdominal approach, the inferior mesenteric artery was severed, and the rectum was resected including total mesorectum. Splenic flexure was completely mobilized. The anal canal was resected including the dentate line at the intramuscular groove by transanal approach. The IESR group consisted of eight patients.

Figure 1A shows the schema of ISR. The indication is applied for T1 or T2 cancer invading within the muscle layer. The dentate line is also excised, and the anal canal is removed at the intermuscular groove. The puborectal muscle and external sphincter muscles are all preserved. Figure 1B shows the schema of ESR. The indication is applied for T3 cancer invading beyond the muscle layer. The puborectal muscle is cut off. The dentate line is also excised, and the anal canal is removed at the intermuscular groove. The subcutaneous external sphincter muscle is preserved.

Five patients underwent ISR, and three patients underwent transanal rectal resection with IESR; however, only the subcutaneous external sphincter muscle was preserved (Fig. 1). The colonic J-pouch anoderm anastomosis including subcutaneous external sphincter muscle was performed. Temporary ileostomy was also performed in all patients. The stoma was closed 3–10 months after operation.

Physiological examination

Anorectal function test and transit time study were conducted before operation and 6 and 12 months after operation. The manometric study was performed by the pull-through procedure with an 8-Fr water-filled open-tip catheter,[4,6] which measured the maximum resting pressure (MRP), high-pressure zone (HPZ), and maximum squeezing pressure (MSP). The manovolumetric study was performed by an 8-Fr catheter attached a latex dilatation balloon to be inserted into the rectum, which measured the constant sensation (CS), the maximum tolerable volume (MTV), and compliance.[7] Biofeedback with anal manometry, digital examination, and exercises by instrumentation were performed when the patients visited.

The time transit study was performed by the Sitzmarks (ring type, double D type and Tri-chamber type; Konsyl Co.). They were orally administered after breakfast for 3 days, and abdominal radiography was taken on the fourth day. During this period, any medications or treatments that affected bowel movements were withheld. We measured the whole transit time and segmental transit time study. The whole transit time and the segmental transit time in two areas of the large bowel, *i.e.*, transit time in the right colon (cecum, ascending colon, and transverse colon) and transit time in the left colon (descending colon, sigmoid colon, and neorectum), were calculated by the method of Arhan *et al* and Metcalf *et al*[8,9] Ten patients with colon cancer without obstruction served as preoperative controls, Their preoperative transit times were compared with the transit times of the two groups.

Questionnaire

Patients were asked to fill out a questionnaire on defecation frequency, stool consistency, dietary restriction, nocturnal defecation, distinction between stool and gas, soiling, fecal incontinence, sense of residual stool, fecal urgency, difficulty of defecation,

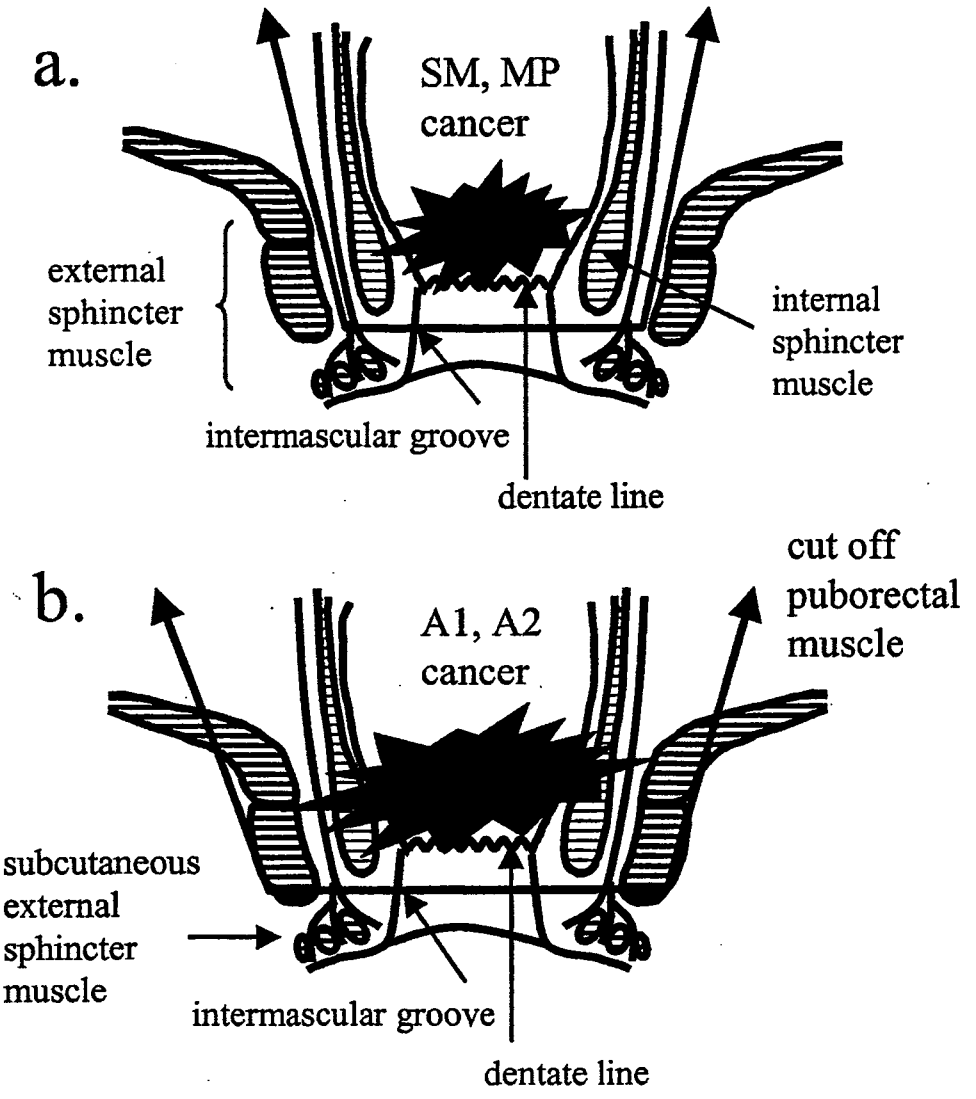

Fig. 1 (a) Schema of the internal sphincter resection line. (b) Schema of the external-internal sphincter resection line. SM, tumor invasion of submucosa; MP, tumor invasion of muscularis propria.

sense of controlling the anus, curtailment of daily activities, and limitation on outing and traveling. Bowel functional score were assessed by Komatsu's score. Three parameters (bowel frequency, soiling, and urgency) were evaluated and scored 0 (poor), 1 (fair), or 2 (good) to obtain the functional score ranging from a total of 0 to 6.[10] Continence grading was assessed by five parameters of Wexner's Continence Grading Score.[11]

Statistical analysis

The statistical analysis of quantitative variables was performed using the Mann-Whitney *U* test and Wilcoxon signed ranks test for comparison between groups and evaluation of time-related changes. $P < 0.05$ was considered statistically significant.

Results

As Table 1 shows, there was no significant difference in male/female ratio or age between the LARJ ($n = 8$) and IESR groups ($n = 8$). The lower edge of tumor was located at 4.1 cm on average from the dentate line in the LARJ group and at 1.3 cm in the IESR group. The length of internal anal sphincter muscle removed in the IESR group measured an average of

Table 1 Patient characteristics

	LARJ group (n = 8)	IESR group (n = 8)
Sex (male/female)	6/2	5/3
Age	62 (48–84)	61 (45–74)
Dukes stage (A, B, C)	2,3,3	4,2,2
Anastomotic length from the anal verge (cm)	4.1 (3.5–5)	1.3 (0.5–2.0)
Operative time (min)	377	361
Morbidity	1 (12.5%)	2 (25%)
Postoperative ileus	0 (0%)	2 (25%)
Pouchitis	1 (12.5%)	0 (0%)
Leakage	0 (0%)	0 (0%)

14.7 ± 5.9 mm in diameter. However, the internal anal sphincter muscle in the LARJ group was not removed. Postoperative leakage was not found in the two groups. Pouchitis was found in one patient in the LARJ group. Postoperative ileus was found in two patients in the IESR group.

IESR required an average of 361 minutes in operating time. On the other hand, LARJ required an average of 377 minutes. Figure 2 summarizes the data on functional tests (manometry). MRP values in the IESR group were significantly decreased 1 month after surgery and were not significantly improved 12 months after surgery. On the other hand, MRP values in the LARJ group were improved 12 months after surgery. (Strong contraction waves in the pouch were not found in both groups.) The HPZ values were significantly decreased after IESR because the value was 1.5 ± 0.4 cm and that showed no significant improvement at 12 months after surgery. Postoperative MSP values showed a significant decrease in the IESR group compared with the value of the LARJ group. Both groups significantly decreased the MTV values at 1 month after surgery. Figure 3 shows the data on the manovolumetric study (manovolumetry). MTV in the LARJ group showed improvement at 12 months after surgery compared with the preoperative values, but in the IESR group, there was no improvement. In IESR patients, CS values were 1.5 ± 1.3 ml/cm H_2O at 6 months after surgery, indicating a significantly lower compliance; this was maintained at 12 months after surgery, with a CS value of 2.3 ± 0.8 ml/cm H_2O.

Figure 4 shows results of the transit time study. The difference in transit time through the whole colon between the two groups was not statistically significant at 6 months after surgery. The transit time in the left colon was 14.6 ± 9.2 hours in the LARJ group and 11.6 ± 5.5 hours in the IESR group at 12

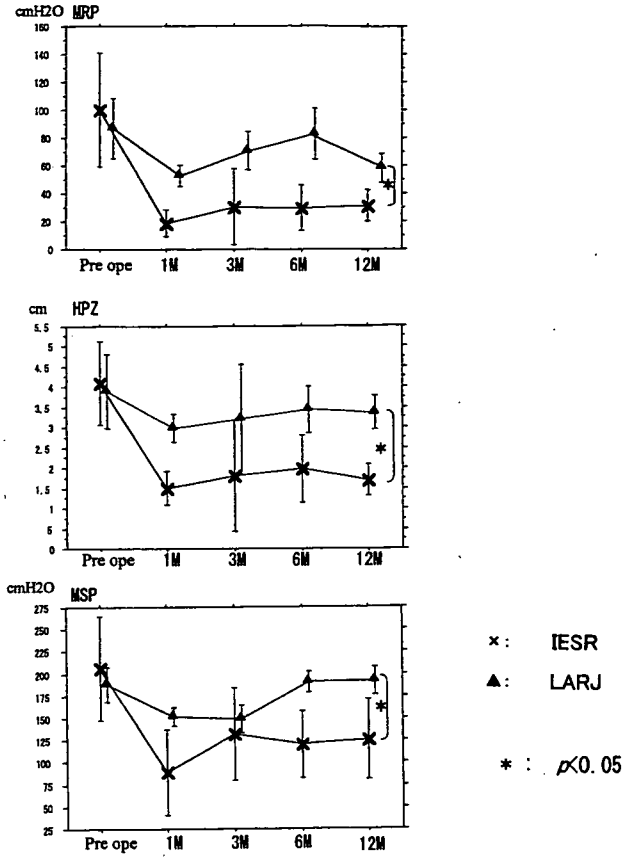

Fig. 2 Manometric examination in comparison of the IESR group with the LARJ group. M, months after surgery.

months after surgery, and this showed a trend toward delayed transit in the left colon compared with that of preoperative control patients.

As for the functional score (Table 2), it was 3.0 ± 1.3 in the IESR group at 6 months after surgery, which was significantly lower than 5.2 ± 1.0 in the LARJ group. However, the IESR group showed a trend toward improvement, with a score of 3.8 ± 1.8 at 12 months after surgery (Fig. 5). Analysis of each parameter revealed frequent defecation in the IESR group at 6 months after surgery. The number of defecations was 6.0 ± 2.8 in the IESR group compared with 4.4 ± 2.2 in the LARJ group; however, this decreased with time to 2.7 ± 1.2 in the IESR group and 3.2 ± 1.4 in the LARJ group at 12 months. Night soiling was observed in six IESR patients (three ISR patients and all three ESR patients) at 6 months after surgery, but was limited to one LARJ and two IESR patients (two ESR patients) at 12 months after surgery. Postoperative urgency was not significantly different between the two groups. According to the questionnaire, all patients felt more