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SURGICAL ENDOSCOPY
and Other Interventional Techniques

New technique of laparoscopic colectomy with the LAP DISC and a 5-mm flexible scope

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Abstract
Purpose: We devised a new method for the safe introduction of the first trocar and induction of pneumoperitoneum for laparoscopic excision of the large intestine.
Methods: With this method, a small laparotomy is first conducted according to the size of the exposed affected intestinal tract or tumor size, prior to the application of a LAP DISC (LD) to the wound and introduction of a 12-mm trocar for the establishment of pneumoperitoneum. The method is advantageous in that organ injury and vessel injury are avoided when the small laparotomy is conducted first, and prompt transition to a conventional laparotomy is possible. The diaphragm of the iris bulb can be controlled in a non-stepwise manner. In addition, trocars, the stapler, and other instruments, can be inserted under the pneumoperitoneum. Furthermore, the use of a 5-mm flexible scope allows surgical maneuvers, except for application of LD, to be conducted via 5-mm trocars. In addition, the 5-mm scope can be inserted through any trocar, allowing multidirectional avoidance of dead space and intraperitoneal observation. When only 5-mm trocars are used, it is not necessary for the sites of trocar puncture to be closed by sutures, and this minimizes the risk of adhesions and port-site herniation. The method is also considered to be excellent from the point of view of esthetics.
Results: We employed this surgical approach in 50 patients with colorectal cancer at our hospital. None of the patients developed any traumatic complications associated with the insertion of trocars, and none of the patients, even those with a past history of abdominal operation, required conversion to conventional laparotomy.
Conclusions: Based on these results, this method involving a small laparotomy prior to the application of an LD and introduction of a 12-mm trocar for establishing pneumoperitoneum, with the efficient use of a 5-mm flexible camera, is considered to be safe and useful for laparoscopic excision of the large intestine.

Key words: Laparoscopic colectomy — LAP DISC — 5-mm flexible scope

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Laparoscopic excision of the large intestine allows reduction of postoperative wound pain, shortening of the duration of hospitalization, and early return to daily routine for patients, as compared to conventional laparotomy. Therefore, because of the less invasive nature of this approach, it has come to be widely adopted in recent years. Nevertheless, complications specific to laparoscopic surgeries have also been reported [5].

Great vessel injury and visceral injury as traumatic complications associated with trocar insertion have been reported in 0.09% of patients undergoing laparoscopic surgery [1, 3]; the incidence of such injury was reported to be 37.9% on insertion of the first trocar, and 22% on insertion of the second trocar [12]. According to some reports, organs outside the visual field were injured during the operation because of the narrowness of the field, and there are even reports of death associated with severe complications such as massive postoperative hemorrhage [7, 9–11]. Hemorrhage related to removal of a trocar, postoperative port-site herniation, and adhesive intestinal obstruction occur most frequently around 1 week after the operation, at incidences ranging from 0.01% to 0.02% [6, 8].

We used a new method in which the first trocar is inserted after the application of a LAP DISC (LD), and a 5-mm flexible scope is used efficiently, for laparoscopic excision of the large intestine. The safety and usefulness of the method are discussed.

Patients and methods

The subjects were 50 patients in whom laparoscopic excision of the large intestine was conducted via an LD at our hospital during the

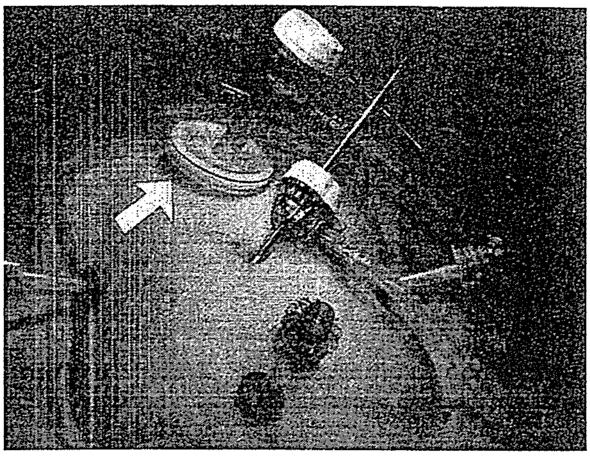

Fig. 1. A LAP DISC was applied at the site of the small incision, and a 12-mm trocar was inserted for the induction of pneumoperitoneum.

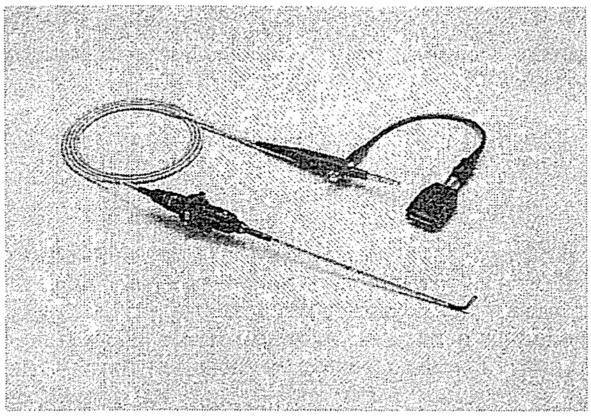

Fig. 2. The 5-mm flexible scope (LTF type VP).

period from December 2003 to December 2004. There were 32 men and 18 women, ranging in age from 38 to 90 years (mean, 67 ± 1.8 years). In terms of the site of the malignancy, there were 6 cases of cecal cancer, 12 of ascending colon cancer, 2 of transverse colon cancer, 14 of sigmoid colon cancer, and 16 of rectal cancer. There were 13 patients with a previous history of abdominal surgery, including 7 with a history of appendectomy, 3 with a history of gynecological surgery, and 3 with a history of gastrectomy.

Technique

For insertion of the first trocar, a skin incision of approximately 3–5 cm was made 2 fingerbreadths below the xiphoid process for lesions located in the right colon, and 2 fingerbreadths above the pubis for lesions located in the left colon or rectum. In cases requiring abdomino-perineal resection of the rectum, however, a round skin incision 2.5 cm in diameter was made immediately beneath the planned site of construction of the artificial anus. An LD (Johnson and Johnson) was applied at the site of the small incision, and a 12-mm trocar was inserted for induction of pneumoperitoneum (Fig. 1). Additional trocars, including one for introduction of the camera, were inserted into the infraumbilical region under direct observation with a 5-mm flexible scope (OLYMPUS) (Fig. 2).

After completion of the intraperitoneal maneuvers, the intestinal tract was exposed extracorporeally via the LD and excised. This method facilitates the repeat establishment of a pneumoperitoneum and allows prompt anastomosis with the double-stapling technique (DST), drain insertion, and confirmation of hemostasis. A transition to laparotomy is also facilitated, because a small incision is already made. The intestinal tract is repositioned before repeat establishment of pneumoperitoneum by insertion of a trocar via the LD. After confirming the absence of hemorrhage following removal of the trocar, the wound at the site of the LD was closed.

Results

The surgical procedure conducted was excision of the colon in 34 patients 68%), anterior excision in 10 patients (20%), and abdominoperineal resection of the rectum in 6 patients (12%). The median intraoperative blood loss was 20 ml (10–440 ml), and the median operative time was 210 minutes (range, 130–360 minutes). None of the patients required transition from laparoscopic surgery to laparotomy. Histopathologically, the tumor was classified into stage 0 in 4 patients, stage I in 21 patients, stage II in 13 patients, and stage III in 12 patients. The median number of lymph nodes screened was 16 (range: 6–26). There was no case of surgical death and none of the patients required reoperation. Postoperative complications were recognized in 4 patients (8%), and wound infection was seen in 4 patients. There were no cases of ileus, rupture of sutures, postoperative hemorrhage, or port-site recurrence. Severe adhesions from previous abdominal operation were recognized in 13 patients (26%), and a trocar could be inserted safely under direct visualization at various angles with the 5-mm flexible scope. The median duration of postoperative hospitalization was 8 days (range: 4–21 days).

Discussion

In recent years, laparoscopic surgeries have come to be widely performed. Unlike conventional laparotomy, laparoscopic operations are conducted after the induction of pneumoperitoneum, and they involve the use of specific surgical devices and manipulations within narrow spaces. Therefore, complications are bound to occur. It is particularly important for the safe performance of laparoscopic operations to avoid traumatic complications associated with the insertion of a trocar.

We sought to avoid such traumatic complications by safely inserting trocars through an LD, and by efficiently using a 5-mm flexible scope. The LD adheres to the abdominal wall, preventing the leakage of pneumoperitoneum gas. It protects the wound, preventing infection and port-site recurrence. It is easily applied, and the size of the iris bulb can be freely controlled. Accordingly, it is easy to establish pneumoperitoneum, repeatedly if required, under which condition various devices, including trocars are inserted. It is also possible to make a prompt transition to laparotomy, in the event of traumatic complications, such as intraoperative hemorrhage. The skin incision is closed after hemostasis as been confirmed at all sites of trocar insertion. Thus secondary hemorrhage from the sites of trocar insertion is avoided. Furthermore, a 5-mm flexible scope can be inserted through all trocars, leading to the avoidance of dead space, and the scope allows free visualization of the optimum visual field. Herniation and adhesive intestinal obstruction at the sites of trocar insertion have been reported to occur at incidences of 86.3%, 10.9%, and 2.7% for ≥ 10 mm, < 10 mm and ≥ 8 mm, and < 8 mm trocars, respectively [11]. Based on these data, it can be surmised that the risk of herniation at sites of trocar insertion can be minimized by the use of 5-mm trocars. However, caution must also be exercised during the application of an LD, because tension is applied on the iris bulb, with ensuing risk of rupture, when the abdominal wall is thick as in very obese patients and muscularly well-developed patients.

The reported incidence of wound infection is 2.8% at the port site and 11% at the site of the wound from which the excised intestinal tract is extracted [2]. In our hospital, wound infection has occurred only at the wound created for removal of the excised intestinal tract, at an incidence of 8%. Although the incidence of infection in our patients tended to be low, we emphasize that every effort should be made to prevent this complication by timely and appropriate antibiotic administration and lavage of the wound site.

From the above-described results and observations, our method of laparoscopic colectomy using safe insertion of the first trocar via an LD and efficient use of a 5-mm flexible scope is considered to be less invasive than other procedures, highly safe, and efficient.

Conclusions

We used a new method in which the first trocar is inserted after the application of a LAP DISC (LD), and a 5-mm flexible scope is used efficiently for laparoscopic excision of the large intestine. The safety and usefulness of the method are discussed.

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Short Time to Recurrence After Hepatic Resection Correlates with Poor Prognosis in Colorectal Hepatic Metastasis

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Background: Early recurrence is a major problem after hepatic resection of colorectal hepatic metastasis (CHM). Our aim was to investigate the relationship between time to recurrence after CHM resection and overall survival.
Methods: A retrospective analysis was performed for 101 consecutive patients who underwent hepatic resection for CHM and have been followed more than 5 years.
Results: Among 101 patients, 82 (81%) had a recurrence. Overall survival of patients with recurrence within 6 months after CHM resection was significantly worse than that of patients with recurrence after more than 6 months ($P < 0.01$). Overall survival was poorer when time to recurrence was shorter. One of the reasons for poor prognosis of patients with recurrence within 6 months was that only a few patients could undergo a second resection for recurrence after CHM resection. Histological type, including poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor, bilobar metastases, microscopic positive surgical margin and carcinoembryonic antigen (CEA) above 15 ng/ml had predictive value for decreased recurrence-free survival after CHM resection.
Conclusion: Short time to recurrence after CHM resection correlates with a poor prognosis. Histological type of poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor might be a predictor for early recurrence after CHM resection.

Key words: colorectal cancer – hepatic metastasis – resection – recurrence

INTRODUCTION

Hepatic resection is currently the only potentially curative treatment for colorectal hepatic metastasis (CHM) (1–6). However, frequent recurrence is a major problem after surgery, with 80–85% of patients experiencing a recurrence (2,3,6). Thus, reduction of recurrence is necessary to improve prognosis after CHM resection.

A correlation between a short time to recurrence after resection of the primary tumor and poor prognosis after resection of recurrence has been demonstrated in colorectal cancer (2,5), breast cancer (7), hepatocellular carcinoma (8) and renal cell carcinoma (9). In CHM, however, the correlation between time to recurrence after resection for CHM and prognosis is still obscure. The relation between time to recurrence after resection and prognosis is complicated in CHM because many recurrences after CHM resection can be resected, and resection sometimes contributes to long-term survival (10–12).

This study was conducted to determine the correlation between time to recurrence after CHM resection and prognosis by scrutinizing recurrence after CHM resection, which may suggest the best timing for adjuvant chemotherapy and elucidate whether time to recurrence can be a surrogate endpoint for adjuvant study in resectable CHM. We also compared clinicopathological factors and time to recurrence to find out preoperative predictive factors for early recurrence.

PATIENTS AND METHODS

Patient Population

A total of 101 patients who had undergone hepatic resection for CHM at the National Cancer Center Hospital East between September 1992 and January 2000 and have been followed precisely for more than 5 years were examined retrospectively. The patients consisted of 56 (55%) men and 45 (45%) women, ranging in age from 23 to 78 years (mean, 60 years). None of the patients had received adjuvant chemotherapy after primary colorectal resection.

The criteria for hepatectomy were as follows: metastatic lesions were confined to the liver and all lesions could be

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resected using oncologic principles while preserving liver function. Extended lobectomy plus partial resections were considered as the upper limit of hepatectomy that could be performed safely, and trisegmentectomy was applied only when the volume of the residual liver was deemed to be abundant. Neither the number of metastatic tumors nor tumor size, in themselves, excluded patients from hepatectomy.

No patient received adjuvant therapy after CHM resection.

SURGICAL PROCEDURE

After laparotomy, a careful search was performed for local recurrences, extrahepatic metastases and peritoneal dissemination in the abdominal cavity. Any suspicious lesions were examined by biopsy. If the regional lymph nodes (hepatoduodenal or peripancreatic lymph nodes) were positive, dissection of the regional lymph nodes was performed. Intraoperative bimanual liver palpation and ultrasonography were performed to confirm tumor location and size of the lesions in all patients; all resections were ultrasound-guided procedures. Hepatic resection was performed with tumor-free resection margins using the forceps fracture method under inflow occlusion (Pringle's maneuver).

CLINICAL FOLLOW-UP

After hepatic resection, patients were closely followed up with diagnostic imaging (chest X-ray and abdominal CT every 3 months, measurement of serum carcinoembryonic antigen (CEA) levels every month and annual colonoscopy to detect tumor recurrence) up to 5years. After 5 years patients were followed up every 6 months or annually.

MORPHOLOGIC INVESTIGATIONS

The resected colorectal specimens and hepatic specimens were fixed in 10% phosphate-buffered formalin and cut at intervals of 5 mm and 10 mm, respectively, and then embedded in paraffin. Serial sections of 3 μm thickness were stained with hematoxylin and eosin for morphologic examination. Histological diagnosis was performed according to the World Health Organization intestinal tumor classification (13).

STATISTICAL ANALYSIS

The chi-square test and student *t*-test were used to compare data (Dukes' stage, primary location, positive regional lymph node, size of tumor, number of tumors, synchronous/metachronous, tumor distribution and ratio of recurrence) between subgroups based on time to recurrence. Mann–Whitney's *U*-test was used to compare preoperative serum CEA level between subgroups. Analyses of survival were performed using the Kaplan–Meier method (14), and differences between the curves were tested using the log-rank test. The log-rank test was also used to examine the significance of associations between survival curves and CEA cutoff values of 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 and 200 ng/ml.

Factors related to survival were analyzed with the Cox proportional hazards regression model (15). A *P*-value of <0.05 was considered statistically significant.

RESULTS

SURGICAL RESECTIONS

Partial resection was performed on 47 patients, subsegmentectomy on 9, segmentectomy on 25, lobectomy on 11, extended lobectomy on 6 and trisegmentectomy on 3 according to Couinaud's anatomical classification (16). A microscopic positive surgical margin was observed in 14 patients. There was no perioperative mortality. Twenty-one complications were observed: 7 cases of biliary leak; 6 cases of intra-abdominal abscess; 4 cases of wound infection; and 1 case each of liver failure, ileus, lung abscess and urinary tract infection.

SURVIVAL AFTER CHM RESECTION

The overall 5-year Kaplan–Meier survival rate after hepatic resection for CHM was 42%, with a median survival of

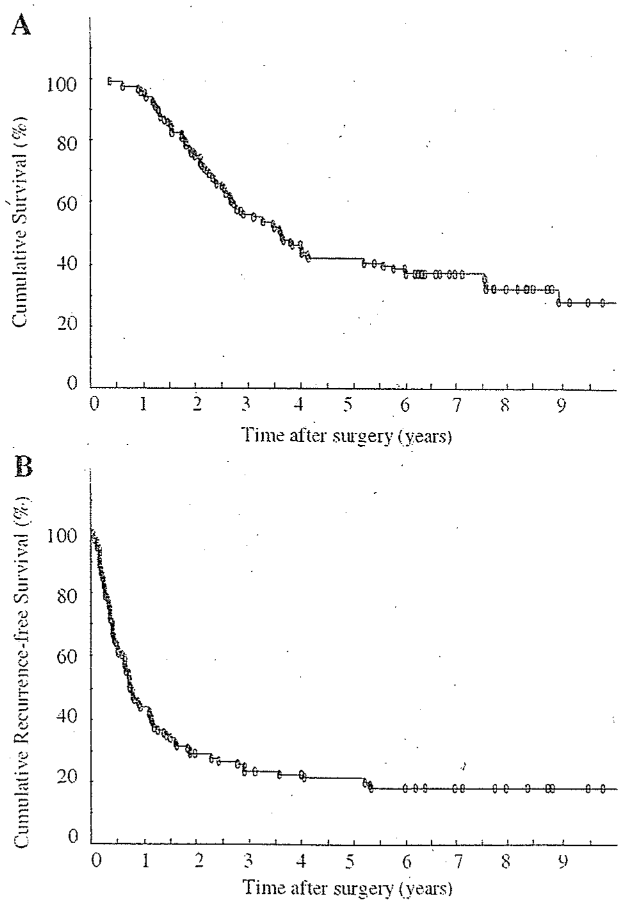

Figure 1. Cumulative survival (A) and recurrence-free survival curves (B) for 101 patients with resected colorectal hepatic metastasis.

34 months (Fig. 1A). Recurrence-free 1-, 3- and 5-year survival rates were 43, 23 and 21%, with a median recurrence-free survival of 9 months (Fig. 1B). The median follow-up duration of survivors was 87 months.

Recurrences After CHM Resection (Fig.2)

Among the 101 patients who underwent CHM resection, 82 (81%) developed recurrences. Locations of recurrences were as follows: liver in 36 patients, lung in 17, both liver and lung in 9, lymph node in 6, peritoneum and local recurrence in 4 each, brain and adrenal gland in 2 each, and ovary and bone in 1 each. Thirty-seven recurrences (45%) occurred within 6 months after hepatic resection and 72 recurrences (88%) occurred within 2 years. The ratio of hepatic recurrences to total recurrences was significantly higher in 1st–12th month than that after 12th month from CHM resection ($P = 0.01$). The ratio of pulmonary recurrence and that of recurrence in organs other than the liver and lung were significantly higher after 24th month ($P < 0.05$) and in 13th–24th month ($P < 0.05$) from CHM resection, respectively, than those in the other period. Of the 82 patients with recurrence after hepatic resection 36 received re-resection. Re-resection could be performed in only 10 of 24 patients (42%) whose recurrence occurred in the liver or lung within 6 months after hepatic resection, whereas re-resection could be performed in 22 of 29 patients (76%) whose recurrence occurred in the liver or lung more than 6 months later ($P = 0.01$). Of the remaining 46 patients, 33 received systemic chemotherapy, 7 received hepatic arterial infusion, 2 received radiation therapy and 4 received best supportive care.

Clinicopathological Features According to Time to Recurrence

Table 1 summarizes the primary and metastatic tumor characteristics. Patients were classified into three subgroups according to time to recurrence after hepatic resection as follows: no recurrence, recurrence within 6 months and recurrence after more than 6 months. There were no significant differences in primary tumor characteristics between the three subgroups. All patients in the no recurrence group had a primary tumor that was classified as a well- or moderately differentiated carcinoma.

In terms of characteristics of the metastatic tumor, the number of tumors was significantly less ($P < 0.01$) and unilobar distribution was seen significantly more frequently ($P < 0.01$) in the no recurrence group compared with the other subgroups.

Survival According to Time to Recurrence

Kaplan–Meier curves for overall survival after CHM resection according to time to recurrence in patients who developed recurrences are shown in Fig. 3A. Patients were divided into four subgroups according to time to recurrence after hepatic resection as follows: within 6 months, 7th–12th month, 13th–24th month and after 24th month. Overall survival of

Resection n=101

↓

Recurrence n=82

Time to recurrence	n	%	Location: Liver (resected case)	Lung	Liver + Lung	Others
–6 months	37	45.1	19 (8)	5 (2)	6 (0)	7 (1)
7–12 months	20	24.4	11 (7)	3 (2)	2 (1)	4 (1)
13–24 months	15	18.3	3 (3)	3 (2)	1 (0)	8 (1)
25– months	10	12.2	3 (3)	6 (5)		1 (0)

Figure 2. Locations of recurrence according to time to recurrence after resection of colorectal hepatic metastasis. The number of resected cases for the recurrence is shown in parentheses.

Table 1. Clinicopathological findings of 101 patients with colorectal hepatic metastases according to time to recurrence

Variable	No recurrence (19)	Recurrence within 6 months (37)	Recurrence after more than 6 months (45)	*P*-value*
Primary colorectal tumor				
TNM Classification				0.63
I	1	1	2	
II	4	11	6	
III	10	12	21	
IV	4	13	16	
Location				0.85
Rectum	4	7	17	
Colon	15	30	28	
Number of positive lymph nodes (mean ± SD)	1.3 ± 2.1	2.3 ± 3.8	1.4 ± 1.7	0.29
Histological type of adenocarcinoma				
Well- or moderately differentiated	19	33	42	
Poorly differentiated signet ring cell or mucinous	0	4	3	
Hepatic metastases				
Maximum size of tumor (mean ± SD, cm)	4.5 ± 3.1	3.6 ± 2.1	4.3 ± 3.3	0.26
Number of tumors (mean ± SD)	1.3 ± 0.6	2.5 ± 1.6	1.9 ± 1.4	<0.01
Preoperative CEA level (mean ± SD, ng/ml)	264.0 ± 818.0	41.3 ± 53.8	220.7 ± 879.7	0.25
Synchronous/metachronous				0.94
Synchronous	7	14	18	
Metachronous	12	23	27	
Distribution of metastases				<0.01
Unilobar	18	20	29	
Bilobar	1	17	16	

SD, standard deviation; CEA, carcinoembryonic antigen.
*Difference between patients with no recurrence and those with recurrence within 6 months.

patients with recurrence within 6 months after resection was significantly worse than that of patients with recurrence in 7th–12th month ($P = 0.04$), that of patients with recurrence in 13th–24th month ($P < 0.01$) and that of patients with recurrence after 24th month ($P < 0.01$). Overall 5-year survival rate in patients who developed recurrence within 6 months after hepatic resection was only 10% with a median survival of 26 months. Overall survival was poorer when time to recurrence was shorter.

Figure 3B shows overall survival after recurrence according to time to recurrence. Overall survival after recurrence of patients with recurrence within 6 months after resection was still worse than that of patients with recurrence in 13th–24th month ($P < 0.04$) and that of patients with recurrence after 24th month ($P < 0.03$). Overall survival after recurrence of patients with recurrence in 7th–12th month after resection seemed to be better than that of patients with recurrence within 6 months, but the difference was not significant ($P = 0.14$). Survival after recurrence tended to be poorer when time to recurrence was shorter. Overall survival after recurrence of patients with recurrence within 6 months after resection was significantly worse than that of patients with recurrence in more than 6 months ($P < 0.01$).

Correlation Between Clinicopathological Factors and Recurrence-Free Survival

To find prognostic factors for recurrence-free survival after CHM resection, correlations between clinicopathological factors and recurrence-free survival were analyzed (Table 2). Histological type of tumor, including poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor ($P < 0.01$) (Fig. 4), two or more hepatic tumors ($P < 0.01$), bilobar distribution ($P < 0.01$), microscopic positive surgical margin ($P = 0.03$) and CEA level before hepatic resection above 15 ng/ml ($P = 0.04$) were significantly associated with poor recurrence-free survival.

We examined the independent predictive value of the aforementioned factors in recurrence-free survival. Data were analyzed using a Cox regression model (Table 3). Histological type of poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor [$P < 0.01$;

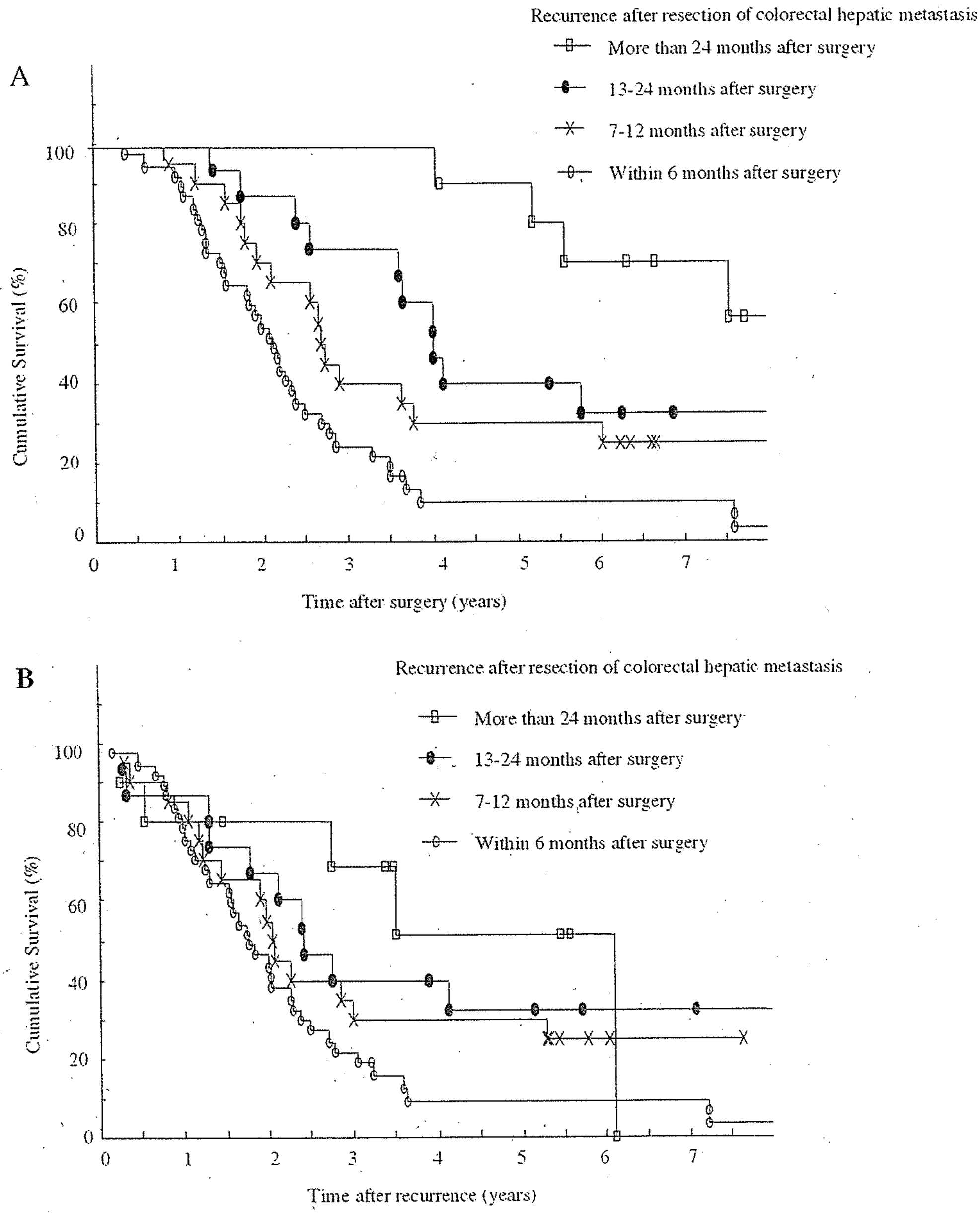

Figure 3. (A) Cumulative survival curves after resection of colorectal hepatic metastasis according to the time to recurrence. (B) Cumulative survival curves after recurrence after resection of colorectal hepatic metastasis according to the time to recurrence.

relative risk (RR) = 5.16; 95% confidence interval (CI), 2.10–12.69], bilobar metastases (P = 0.04; RR = 2.73; 95% CI, 1.03–7.27), microscopic positive surgical margin (P = 0.03; RR = 2.25; 95% CI, 1.11–4.59) and CEA level above 15 ng/ml (P = 0.02; RR = 1.96; 95% CI, 1.09–3.55) had a predictive value for decreased recurrence-free survival after CHM resection. Median disease-free survivals and 1-year recurrence rates of patients with the aforementioned factors were 4.6, 5.6, 5.0 and 8.4 months and 100, 70, 79 and 65%, respectively.

Histological type of poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor and CEA level above 15 ng/ml were also the poor prognostic factors for overall survival (data not shown).

DISCUSSION

The goal of this study was to assess the correlation between time to recurrence after CHM resection and prognosis. Results showed that prognosis of patients with recurrence within 6 months after resection was significantly worse than that of patients with recurrence after more than 6 months. Our findings indicate that short time to recurrence after CHM resection correlates with a poor prognosis.

The main reason for poor prognosis of patients with recurrence within 6 months was that only a few patients could undergo a second resection for recurrence after CHM resection. Most patients who could not undergo a second resection

Table 2. Correlation between clinicopathological factors and disease-free survival after hepatectomy for colorectal hepatic metastases

Variable	No. of patients	Median disease-free survival (months)	*P*-value
Primary colorectal lesion			
Location			
Colon	73	9.0	0.67
Rectum	28	9.5	
TNM Classification			
I, II	25	6.2	0.87
III, IV	76	9.6	
Lymph node metastasis			
Absent	35	9.0	0.79
Present	66	9.5	
Histological type of adenocarcinoma			
Well- or moderately differentiated	94	11.3	<0.01
Poorly differentiated signet ring cell or mucinous	7	5.1	
Hepatic metastases			
Number of tumors			
Solitary	58	13.6	<0.01
⩾2	43	5.9	
Maximum size of the tumor (cm)			
<5	77	9.0	0.58
⩾5	24	13.4	
Distribution of metastases			
Unilobar	67	13.5	<0.01
Bilobar	34	5.7	
Microscopic surgical margin			
Negative	87	10.3	0.03
Positive	14	6.4	
CEA level before treatment (ng/ml)			
<15	47	15.4	0.04
⩾15	54	8.4	
Synchronous/metachronous			
Synchronous	39	9.1	0.84
Metachronous	62	9.3	
Interval between colorectal resection and hepatectomy			
<1 year	65	7.8	0.11
⩾1 year	36	13.5	

CEA, carcinoembryonic antigen.

had extensive disease such as hepatic or pulmonary recurrence with much tumor burden, recurrence involving multiple organs, or distant metastases outside liver and lung that were not suitable for resection. In this series, re-resection rates of recurrence in the remnant liver and lung were relatively low (42 and 40%, respectively) when recurrences were observed within 6 months after CHM resection, whereas they were high (76 and 75%, respectively) when recurrences were observed more than 6 months after resection.

Tumor doubling time is correlated with prognosis in various cancers (17–20). In CHM, it has been reported that short tumor doubling time is a poor prognostic factor for both overall and disease-free survival (21). Short time to recurrence represents short tumor doubling time. Those results are in accord with those of the present study.

Our results suggest that recurrence-free survival can be a surrogate endpoint for adjuvant trial in resectable CHM. Moreover, recurrence within 6 months should be a major target for additional chemotherapy because of a great number and the poor prognosis of these patients. Theoretically, if we can determine which patients will have a recurrence with short recurrence-free survival, we could identify which ones would possibly benefit from neoadjuvant chemotherapy. Adam *et al.* (22) showed efficacy of neoadjuvant chemotherapy for CHM patients with four or more tumors regardless of initially resectable or not, as long as objective tumor response or stabilization was achieved by chemotherapy, and demonstrated the possibility of neoadjuvant chemotherapy for resectable CHM. However, neoadjuvant chemotherapy sometimes causes chemotherapy-associated steatohepatitis which may increase operative morbidity (23,24); then, neoadjuvant chemotherapy should be recommended for high-risk patients for recurrence.

In the present study, histological type of poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor, bilobar metastases, microscopic positive surgical margin and CEA above 15 ng/ml were the independent prognostic factors for poor recurrence-free survival. Especially, histological type of poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor exhibited the strongest power for predicting early recurrence because all patients with the factor had recurred within 10 months. Then, histological type of poorly differentiated signet ring cell or mucinous adenocarcinoma in the primary tumor, which was not considered in other large studies (2,5), should be considered as one of the preoperative predictors of early recurrence after CHM resection. Patients with the factor are recommended to receive neoadjuvant chemotherapy. Bilobar metastases and CEA above 15 ng/ml were also prognostic factors for recurrence; however, long-term recurrence-free survival was achieved in some patients with the factors. Neoadjuvant chemotherapy for patients with either of the factors is controversial. In addition, considering the correlation between positive surgical margin and early recurrence, hepatic surgeons should pay much attention to keep negative surgical margin during hepatic dissection in order to prevent early recurrence.

In a retrospective analysis of consecutive 1001 CHM patients by Fong *et al.* (5), poor prognostic factors for recurrence after CHM resection were positive surgical margin, extrahepatic disease, node-positive primary, less than

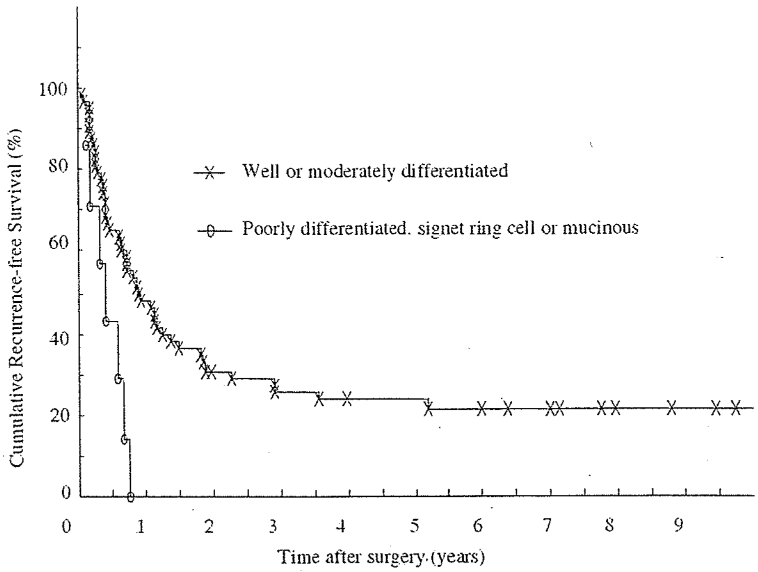

Figure 4. Recurrence-free survival curves after resection of colorectal hepatic metastasis according to the histological type of primary tumor.

Table 3. Multivariate analyses of factors affecting disease-free survival after hepatectomy for colorectal hepatic metastases

Variable	Relative risk (95% CI)	*P*-value
Primary colorectal lesion		
Histological type of adenocarcinoma		
Well- or moderately differentiated	–	<0.01
Poorly differentiated signet ring cell or mucinous	5.16 (2.10–12.69)	
Hepatic metastases		
Number of tumors		
Solitary	–	0.60
⩾2	1.29 (0.50–3.38)	
Distribution of metastases		
Unilobar	–	0.04
Bilobar	2.73 (1.03–7.27)	
Microscopic surgical margin		
Negative	–	0.03
Positive	2.25 (1.11–4.59)	
CEA level before treatment (ng/ml)		
<15	–	0.02
⩾15	1.96 (1.09–3.55)	

CI, confidence interval; –, reference.

12 months of disease-free interval from the primary resection, 2 or more tumors, tumor size >5 cm and CEA >200 ng/ml. The aforementioned prognostic factors for recurrence were also predictors of poor overall survival, and the fact was consistent with the concept of our results that short time to recurrence correlated with poor survival. Fong *et al.* proposed a scoring system using five poor prognostic factors and insisted that the scoring system was useful in choosing adjuvant therapy.

The difference between our results and those of Fong's might be partly due to patients' background and the number of patients examined. In the present study, patients with extrahepatic disease were excluded because CHM with extrahepatic disease was totally different from pure CHM considering pathways of metastases. Moreover, none of the patients had received adjuvant chemotherapy after primary colorectal resection or CHM resection. However, the possibility that not all of Fong's predictors could be validated well because of relatively small population of our study cannot be ruled out.

In the present study, patients were followed and examined precisely at least for 5 years in order to elucidate complete profile of recurrence, and then median follow-up of survivors was 87 months. This study has clarified frequencies of the recurrences after CHM resection in liver, lung and other organs respectively according to time to recurrence and also clarified the resection-rates for those recurrences. On the result of the present study, the organ where recurrence had occurred most frequently and the resection-rate for the recurrences differed according to time to recurrence after CHM resection. Frequency of hepatic recurrence decreased rapidly after 2 years of CHM resection; however, that of pulmonary recurrence was not low even more than 2 years after CHM resection. A periodical checkup by chest XP or chest CT adding to abdominal examination is recommended for 5 years at least.

In conclusion, short time to recurrence after CHM resection correlates with a poor prognosis. This result provides grounds for proposal that an effective neoadjuvant chemotherapy and a system using the clinicopathological factors and pharmacogenetics which identify best candidates for the neoadjuvant chemotherapy are needed in order to reduce early recurrence. Histological type of primary tumor might be a strong predictor for early recurrence after CHM resection.

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Operation

腹腔鏡下手術における吻合のポイント
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腹腔鏡下手術における吻合のポイント ―胃・大腸手術の吻合法―

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はじめに

腹腔鏡下手術（LAP）は胃癌や大腸癌の外科において不可欠な手術法となってきた。郭清手技の難度が高く，吻合法では簡略で，安全，確実な方法が望まれ，器械吻合が積極的に導入されている。吻合の基本は開腹手術とまったく同様であるが，二次元画像や狭視野という制約を伴う操作である。本稿ではLAPでの器械吻合を安全で合理的に行うための手技とポイントを中心に解説する。

I. 腹腔鏡下胃切除における吻合

体内吻合は手技的に煩雑であり，高度な手技が要求されるため簡略な小切開からの体外吻合が普及している。我々が行っている器械を利用した体外吻合の手技とポイントを概説する。

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key words：腹腔鏡下手術，吻合法，hemi-double stapling technique

1. hemi-double stapling techniqueを利用した残胃十二指腸吻合

a）吻合前の準備

通常は十二指腸の授動は行わない。郭清後に小切開を介して体外で十二指腸を切離する方法と，郭清前に体内でEndo GIAで切離する方法があるが，後者のほうが郭清操作の視野確保が容易である[1]。

ポイント：大彎側口側の大網と血管処理を腹腔鏡下に十分口側まで行うと，血管や脾を損傷することなく胃を体外へ引き出すことができ，体外操作がしやすい。

b）小切開

剣状突起の1～2横指尾側に約4～5 cmの縦または横切開を加える。

ポイント：小切開を適正な部位におくことは，あとの吻合を容易に行うためにきわめて重要である。腹壁の厚み，肥満度により長さを調整し，視野不良の場合は無理せず切開創を延長する。

c）十二指腸切離

巾着縫合用の波状鉗子で十二指腸切離部を把持し，3-0ナイロン直針を利用し巾着縫合を行い，その口側で切離する。

d）アンビルヘッド挿入

十二指腸の断端を開放し，サーキュラーステイプラー（CS）のアンビルヘッドを挿入する（図1a）。PC-EEAでは28または31，CDHでは29を使用する。巾着縫合糸をアンビルヘッ

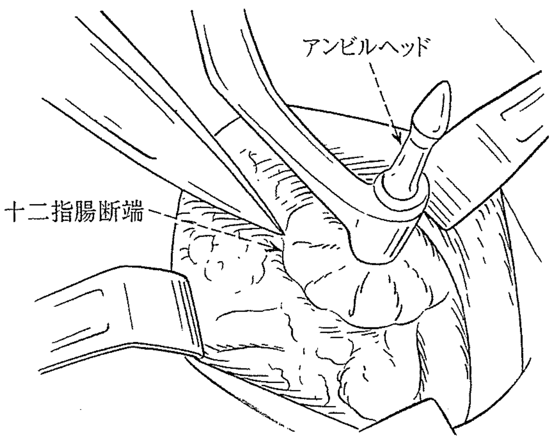


図 1a アンビルヘッドの挿入・固定
巾着縫合糸をアンビルヘッド近傍で結紮し，シャフトを固定する。糸の固定が緩むとステイプル形成不全，縫合不全の原因となる。

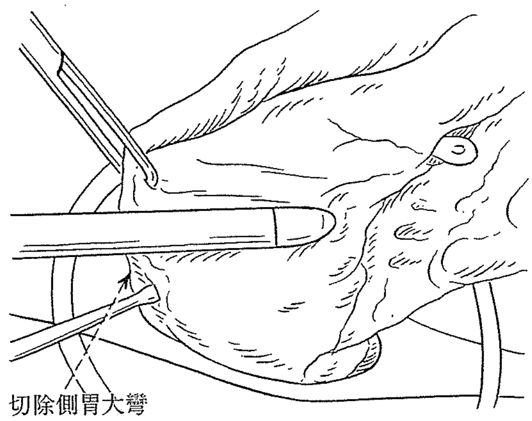


図 1b LS での大彎切離
LS のはじめの切離長を長く取りすぎると，吻合部の止血操作が困難となるため，約5 cm にとどめる。

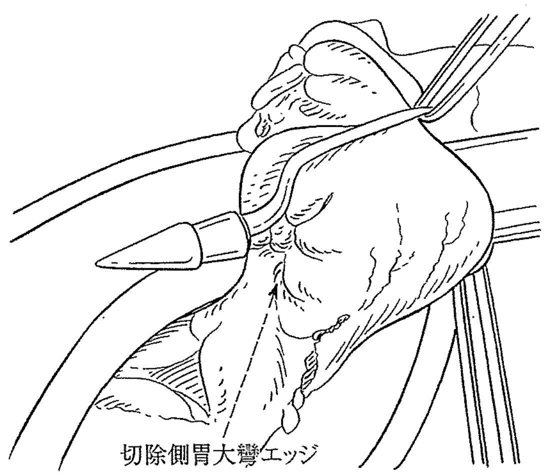


図 1c CS 本体の挿入
小切開から CS 本体を挿入し，切離断端の大彎側のエッジ近傍からセンターロッドを貫通する。

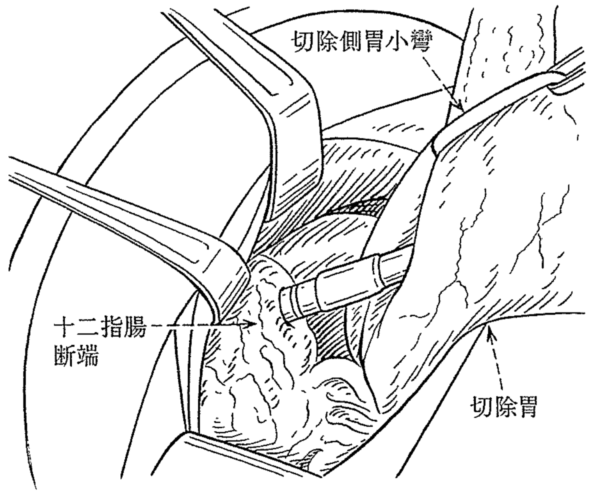


図 1d CS 合体操作
十二指腸側，残胃壁とも牽引しすぎた状態で合体すると，術後吻合部狭窄の原因となる。

ドの直近（タイングゾーン）で結紮してシャフトを固定する。

ポイント：結紮糸が緩むとステイプル形成不全や縫合不全の原因となる。不十分な場合はやり直すか，絹糸で追加の結紮を加える。

e) 小彎の作製と吻合

病変を確認したのち，切離ラインを決定し，大彎にほぼ直角にリニアーステイプラー（LS）ブルーで約 5 cm 切離する（**図 1b**）。次にこの近傍に小切開を加え，ここから CS 本体を挿入し，切離断端の大彎のエッジよりセンターロッドを貫通する（**図 1c**）（CDH では槍の装着は不要である）。次に十二指腸側にあるアンビルと本体を合体する（**図 1d**）。

ポイント：はじめの切離長を長く取りすぎると吻合部が視認不良となり，止血操作が困難となるため，約 5 cm にとどめるのがコツである。病変が切離線に近い場合は，小切開から病変部位を直接視認して切離線を決定する。合体時は

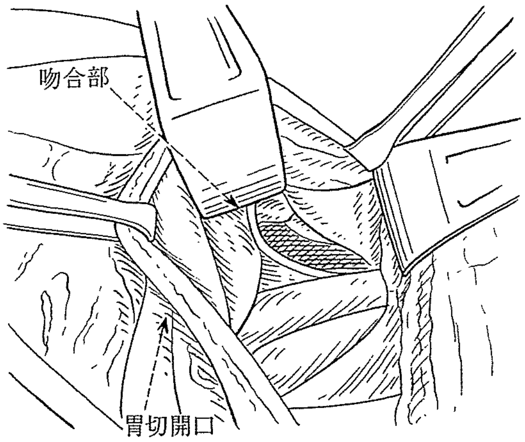


図 1e　吻合部の確認
内腔から直視下に吻合部の止血状態を確認し，止血不良な部位を確実にZ縫合で止血する。

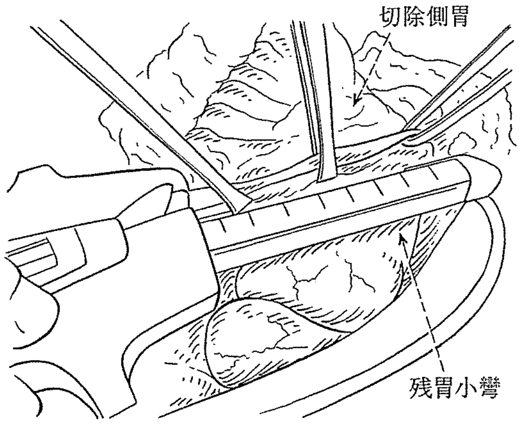


図 1f　小彎の閉鎖・作製
切離ラインを口側に斜めに設定しすぎると，小彎切離部位が口側にずれてLS 1回で切離できない。

切離ラインを小彎にするためやや背側へ残胃を捻転し，さらに夾雑物が入り込まないようにする。PC-EEAは表示窓のグリーンマークが進まないところまでハンドルをしっかり絞める。CDHはギャップセッティング機構があり，組織の厚さ，ハンドルの抵抗を参考にレッドマークを微調整する。絞めすぎると粘膜が離開し，出血しやすい。吻合部の視野が不良な場合は腹腔鏡下に吻合状況を確認する。十二指腸，残胃壁とも牽引しすぎた状態で合体すると，術後吻合部狭窄の原因となる。打ち抜きは吻合器がブレないようにしっかりと固定し，ゆっくりと1回で確実に行い，10秒ほど絞めたままの状態を保ち，ステイプル形成が安定化するのを待つ。

CSを抜去後，小切開を介して内腔から直視下に吻合部の止血状態を十分に確認する。止血不良な部位は4-0バイオシンのZ縫合で確実に止血する（図1e）。次に，始めの切離ラインに合わせ，切開部位を含めLSで閉鎖・切離することで小彎を作製し，これと同時に胃切除と吻合を終了する（図1f）。

ポイント：切離ラインを口側に斜めに設定しすぎると小彎切離部位が口側にずれてしまうため，LS1回で切離しきれない。ステイプルライン（SL）は重なる部位のみ4-0バイオシンで補強縫合する。吻合状態はSLの連続性と，ステイプル形成状態を確認する。

2．他の吻合法

a）残胃後壁十二指腸器械吻合

胃をLSで切離したのちに前壁を切開し，ここからCSを挿入し胃の後壁で吻合し，その後前壁の切開部位をLSで閉鎖する方法である。血行障害を回避するために，小彎の切離ラインより必ず2 cm以上離して吻合する。体内で機能的端端吻合（FA）を応用したβ吻合は手技的にやや煩雑でEndo GIAの使用回数が多い。

b）残胃空腸Roux-Y吻合

残胃が小さい場合，吻合に緊張がかかる場合に選択するが，基本術式に本法を採用している施設もある。十二指腸はEndo GIAで切離し，体外で器械または手縫いで残胃空腸吻合を結腸前または結腸後ルートで行う。空腸の処理などBillroth I法に比べやや手間がかかるが，吻合は体外で直視下にゆとりを持って行える。Billroth I法とRoux-Y吻合の優劣に関しては，今後さらなる検討課題である。

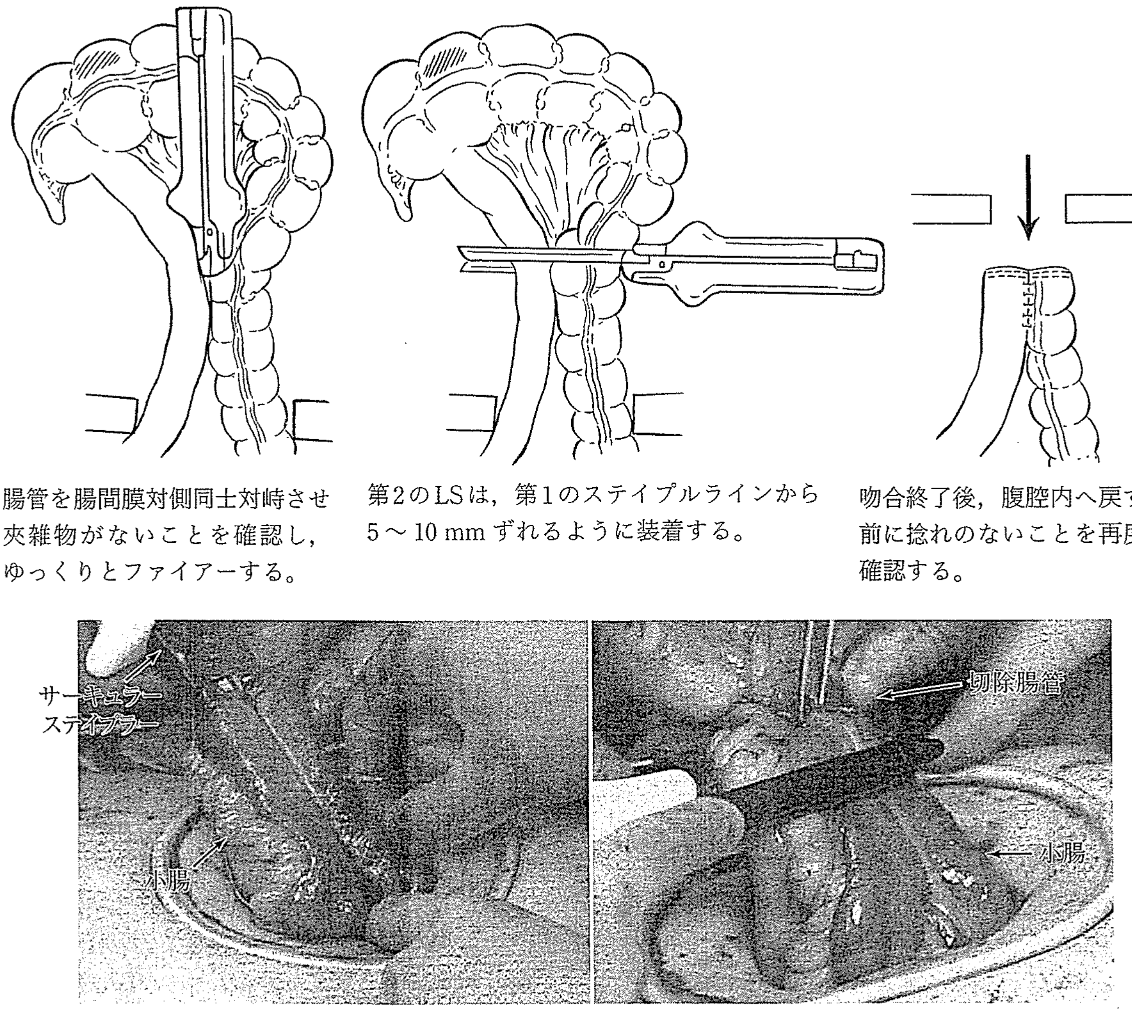


図 2　機能的端端吻合

II. 腹腔鏡下胃全摘術における食道空腸吻合

小切開から直視下に行う方法は容易に思えるが，良視野で無理なく安全に吻合するには症例により切開をかなり長くする必要がある。むしろ体内吻合のほうが小切開ですみ，しかも良視野で操作できる。我々は経口アンビル挿入法，これを改良した方法として double stapling 変法を主に選択しているが，ほかに FA を応用した体内吻合などがある[2]。

III. 結腸の吻合

盲腸からS状結腸の口側の吻合では，おもに小切開を利用した体外吻合が行われる。吻合法は手縫いか器械吻合であるが，簡略，確実性により次第に器械による FA が広く普及している[3]。

a）機能的端端吻合（図 2）

腸管が小切開から十分に体外へ引き出せるように切除腸管の剝離，授動を十分に行う。血管処理，間膜処理を終了後，捻れがないように切離側腸管には Lister 鉗子で，温存側には腸鉗子

を掛け遮断する。吻合予定部近傍にステイ縫合を行い，この近傍の小腸と大腸の間膜対側にLS挿入用の小孔を開ける。ここから綿球を挿入し，吻合部腸管内を清拭する。その後，LS 75 mmを愛護的に挿入し，腸管を腸間膜対側同士対峙させ腸間膜など夾雑物がないことを確認し，ゆっくりとファイアーする。

ファイアー後，20秒間待つとSLがより安定し，止血効果がある。次に第2のLSを第1のLSと直交するように装着し，挿入口の閉鎖と腸管切離を同時に行う。

ポイント：SLを直視下に内腔から4-0バイオシンによるZ縫合で止血し，さらに股の部位はAllis鉗子で把持し同様に補強する。第2のLSは第1のSLから5〜10 mmずれるように，しかも2横指程度の吻合径が確保できるように装着する。SLの補強はステイプルが重なる部位のみをZ縫合で補強する。

通常間膜の閉鎖は行っていない。不完全な閉鎖は逆に腸閉塞の原因になる可能性がある。吻合終了後，捻れのないことを再度確認する。ほかにコロンキットによるLSを4回使用する吻合法もある。

IV. 直腸の吻合

S状結腸の肛側から上部直腸では通常のdouble stapling technique（DST），下部直腸では通常のDSTかIO-DST，これが困難な場合には反転DSTを選択する。ここではもっとも使用頻度の高いDSTについて述べる[4)5)]。

1. DST手技の実際

斜視鏡を使用する場合にはスコープの位置を右上腹部のポートとすると，吻合操作全般の視野が良好に確保できる。

a) 直腸間膜処置

直腸間膜はまず右側から直腸固有筋膜を切離し，そののち上直腸動脈をUSADで止血切離する。

ポイント：直腸周囲ではUSADによる直腸壁損傷に注意する。LigaSureがあると，収束して間膜処理ができるため簡略である。できるだけ右側より左側へ間膜処理を進めたのち，残りを左側より処置する。

b) 直腸切離

遠位側直腸切離予定部位，血管処理部位を慎重に決定後，LSで直腸を切離する。長軸に直角に切離するには直腸を左頭側に牽引し，右下ポート（できるだけ尾側，外側に設置する）よりLSを挿入する（図3a）。

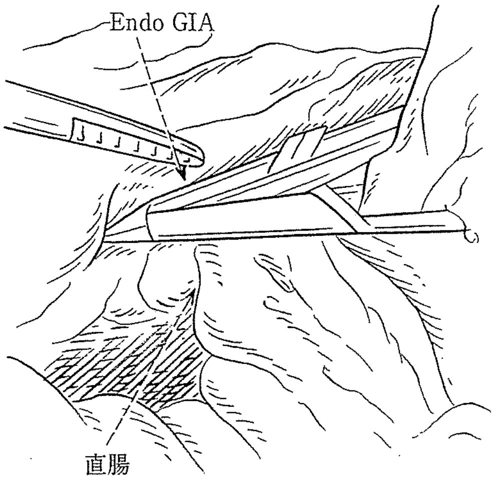
ポイント：低位の直腸切離では恥骨上にポートを設置し，これからEndo GIAを挿入するIO-DSTはアプローチが容易で切離もしやすい。

直腸壁が厚い場合はステイプル高2 mm（グリーン），薄い場合は1.5 mm（ブルー）のEndo GIAを選択する。LAPでは直腸を斜めに切離しやすくLSで1回で切離が完了できず，ステイプル形成が不完全になりやすい欠点がある。左側奥に存在する尿管など夾雑物がないことを確認する。

ポイント：直腸切離を長軸に直角に行うには直腸，とくに後壁を肛門側へ十分剝離する。直腸低位で縫合長60 mmのLSで適正な方向に切離できない場合は，はじめから計画的に45 mm長を使用し2〜3回に分割切離し，吻合時に重複部を残さずに打ち抜く[3)]。切離を容易にする工夫として，肛門操作の助手が会陰部をこぶしで頭側に圧迫する方法，指を肛門から切離されていない直腸に愛護的に挿入し，腹側に吊り上げる方法が有用である。ただしLSを3回以上要した場合は縫合不全の発生頻度が高まる。

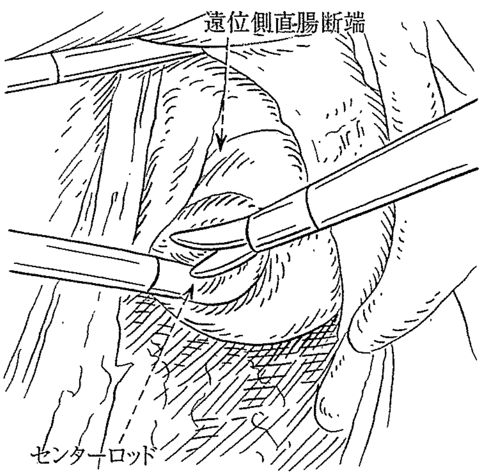
c) 近位側腸管処理

臍部または下腹部に小切開をおき，ポート部再発と感染を予防のため創縁にラッププロテクターを装着する。近位側腸管は巾着縫合を行い，アンビルヘッドを装着する。CSのサイズはあらかじめ肛門径を確認し，無理なく入る最大径で通常PC-EEA 31 mm，CDH 33 mmを選択する。無理に太いCSを使用すると，吻合部狭窄を招くことがある。

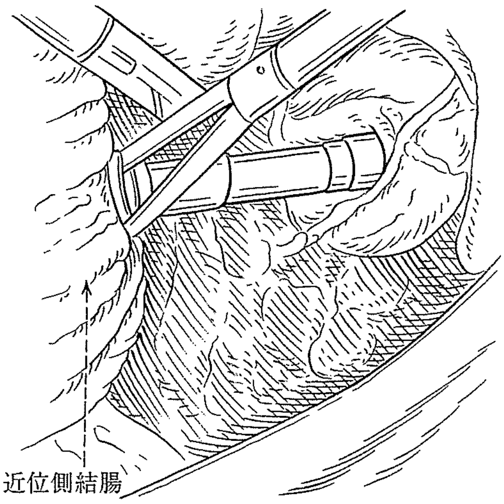


a）LS で直腸を長軸に直角に切離するが，1回で切離できない場合は，無理せず2回に分けて切離する。

b）トロカール穿刺はステイプルライン中央，直近で，しかもステイプル接合部を打ち抜ける部位で行う。



c）術者が鉗子で穿刺部位近傍の組織を押さえながら穿刺する。



d）口側のアンビルを把持し，CS 本体の方向を指示し，助手と連動し結合操作を行う。

図 3　DST 吻合

d）　吻合操作

再気腹し，LAP 操作に戻る。吻合操作は術者と肛門操作の助手が協調して行う。頭低位とし，肛門操作の助手はモニターを見ながら術者の鉗子の誘導に連動して，CS 本体をゆっくりと進める。

ポイント：CS 本体の位置がわかりにくい場合は，鉗子で軽く触れて CS 本体の辺縁を確認し誘導する。

トロカールは SL 中央，直近で穿刺する（図3b）。

ポイント：穿刺時トロカールにより直腸壁が押し上げられ，引き延ばされることを防ぐために，術者が鉗子で穿刺部位近傍の組織を押さえ

て穿刺する（図3c）。

術者は口側のアンビルを把持し，CS本体の方向を指示しながら合体操作を行う（図3d）。CS合体操作の注意点は胃の吻合の項で前述した。とくにファイアー時に合体部がふれないように注意する。

e）　吻合状態，吻合部出血の確認

吻合終了後，ステイプルの形成状態，吻合部の緊張の具合，捻れを確認し，さらにリークテストを行う。我々は直腸鏡を愛護的に挿入し，挿気することでリークの確認と吻合部出血の確認を行っている。通常に吻合が終了した場合はdog earに対しても補強縫合は必要なく，SLの形成が不安定な部位のみ補強縫合する。前方切除術では原則的にドレーンを挿入している。

2.　反転DST

LAPの低位直腸吻合におけるDSTは，技術的に難度が高いうえに現状のLAP用の器械吻合では確実なSLの形成，直腸洗浄，肛門側切離ラインの決定，安定した切離面の確保など困難な問題がある。これらの解決策として反転DSTがある[6]。肛門縁より3〜4 cm以内で，より低位で切離する場合は反転が不完全となる可能性があり，経肛門吻合を選択する。

おわりに

腹腔鏡下手術の吻合法とポイントを解説した。器械吻合のトラブルの原因は器械に対する知識不足と手技に起因するものが多い。縫合不全の合併はLAPの利点である低侵襲性をいちじるしく損ねる。器械に対する正しい知識，吻合に対する基本を遵守した手技に加え二次元画面，狭視野のなかで適正に使いこなし，合併症のない吻合をめざさなければならない。

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