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Original article

Survival benefit of high ligation of the inferior mesenteric artery in sigmoid colon or rectal cancer surgery

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Background: The aim of this study was to assess the impact of inferior mesenteric artery (IMA) root nodal dissection before high ligation of the artery on survival in patients with sigmoid colon or rectal cancer.

Methods: Data on 1188 consecutive patients who underwent resection for sigmoid colon or rectal cancer, with high ligation of the IMA, were identified from a prospective database (April 1965 to December 1999). Survival of patients with involvement of nodes along the IMA proximal to the origin of the left colic artery (root nodes, station 253) through the bifurcation of the superior rectal artery (trunk nodes, station 252) was determined.

Results: Twenty patients (1·7 per cent) had metastatic involvement of station 253 lymph nodes and 99 (8·3 per cent) had metastases to station 252. The 5- and 10-year survival rates of patients with metastases to station 253 were 40 and 21 per cent, and those for patients with metastases to station 252 were 50 and 35 per cent, respectively.

Conclusion: High ligation of the IMA allows curative resection and long-term survival in patients with cancer of the sigmoid colon or rectum and nodal metastases at the origin of the IMA.

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Introduction

During surgery for sigmoid colon or rectal cancer, the inferior mesenteric artery (IMA) may be ligated at a point just below the origin of the left colic artery (low ligation) or at the origin of the IMA directly from the aorta (high ligation). The high-ligation technique enables *en bloc* removal of additional lymphatic drainage from cancers at and around the origin of the IMA, but it is unclear whether this confers a survival advantage.

There have been no prospective controlled or randomized studies of high *versus* low ligation. Guidelines published by Nelson *et al.*[1] recommend low ligation for rectal cancer surgery, except when metastases to lymph nodes beyond the origin of the left colic artery are suspected. However, this recommendation is based on the data from one French randomized trial in patients with left colonic cancer[2].

No study has investigated the detailed anatomical distribution of lymph node metastases along the IMA in a large series in which high ligation was performed routinely. The few studies on this issue included limited numbers of patients with colorectal cancer, ranging from 129 to 198[3–5]. Other studies have reported details of such lymph node distributions, but only in patients who underwent colorectal cancer resection and whose operative findings indicated the need for high ligation of the IMA[4,6,7]. This type of intraoperative determination is known to be unreliable[8]. At present, the true distribution of lymph node metastasis along the IMA in patients with sigmoid colon or rectal cancer who undergo potentially curative resection is unknown.

Some favourable outcomes after high ligation may be attributable to the stage migration phenomenon, which may arise as a result of more accurate staging owing to more extensive lymphadenectomy[6,9,10]. A proportion of patients will therefore be assigned to a more advanced stage than would otherwise be the case, although their prognosis is the same. If this occurs, the overall results in

each stage improve and the proportion of patients in more advanced stages increases[11].

The present study was a prospective analysis of the largest known series of curative resections for sigmoid colon or rectal cancer in which high ligation was performed routinely. The study was designed to circumvent the stage migration effect in order to provide direct information on the significance of lymph node metastases along the IMA. The aim was to evaluate whether patients with sigmoid colon or rectal cancer and metastasis in certain nodes that are left behind after low ligation would benefit from high ligation in terms of curability of resection and survival.

Patients and methods

Since the foundation of the Aichi Cancer Centre Hospital, high ligation of the IMA for proximally extended lymph node dissection in patients with sigmoid colon or rectal cancer has been adopted as a standard procedure, except when adequate exposure to allow ligation of the IMA on the aorta is considered too hazardous. Data on 1361 consecutive patients who had histologically proven adenocarcinoma of the sigmoid colon or rectum and who underwent high ligation of the IMA between April 1965 and December 1999 were documented prospectively. Dissection of all lymph nodes surrounding the root of the IMA was performed before IMA ligation and excision flush with the aorta, irrespective of the operative findings with regard to the presence or absence of lymph node metastasis (*Fig. 1*).

Eighteen patients with cancers confined to the mucosa were excluded. To examine the curative value of apparently complete resection of lymph nodes along the IMA, 155 patients in whom there was clear evidence of surgical incurability were also excluded. These patients had either macroscopic or microscopic residual tumour tissue left at operation, or underwent macroscopically complete resection of hepatic or peritoneal metastases. A total of 1188 patients remained eligible, and these formed the study population.

Rectal tumours were sited as follows: lower rectum (below the peritoneal reflection), upper rectum (above the peritoneal reflection) and rectosigmoid. Lateral pelvic lymphadenectomy was used for lower rectal cancer with T2 or deeper invasion. Twenty-nine of the patients with Dukes' C lower rectal cancer received adjuvant radiotherapy. Adjuvant chemotherapy, mainly using oral 5-fluorouracil prodrugs (uracil and tegafur, UFT), was administered to patients with Dukes' A (15 sigmoid colon, 56 rectal), Dukes' B (57 sigmoid colon, 88 rectal) or Dukes' C (57 sigmoid colon, 179 rectal) tumours deemed to be at high risk for metastasis.

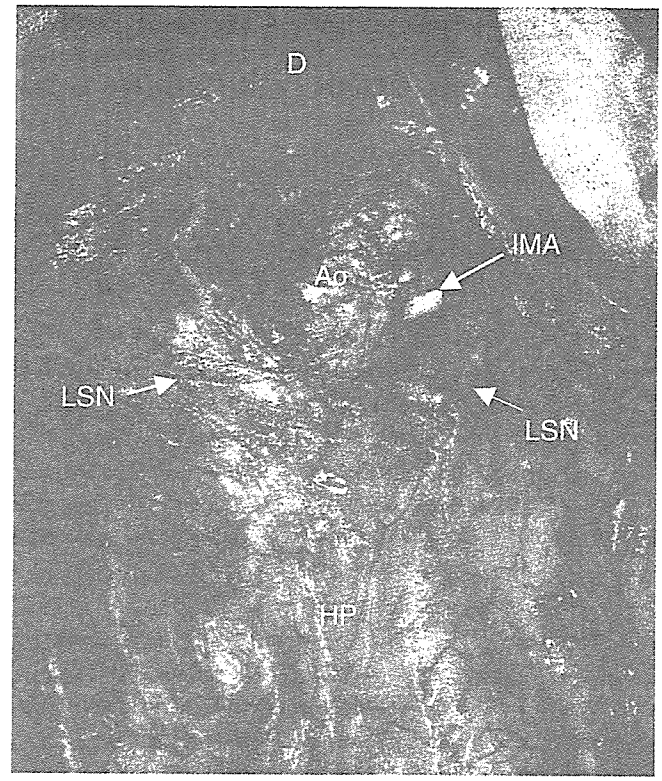


Fig. 1 High ligation of the inferior mesenteric artery at its origin from the aorta. Ao, aorta; D, duodenum, HP, hypogastric plexus; IMA, inferior mesenteric artery; LSN, lumbar splanchnic nerve

Level of ligation of inferior mesenteric artery and pathological examination of lymph nodes

The inferior mesenteric lymph nodes conglomerate around the origin of the IMA, and their location has been defined ambiguously as both the root and the periphery[12]. The Japanese criteria (Japanese Society for Cancer of the Colon and Rectum, JSCCR)[13] define the nodes at the origin of the IMA (station 253) as those nodes that lie along the IMA proximal to the origin of the left colic artery (*Fig. 2*). They define the inferior mesenteric trunk nodes (station 252) as those nodes that lie along the IMA from distal to the origin of the left colic artery to the bifurcation of the superior rectal artery. A high ligation was defined as ligation of the IMA at its root and including dissection of station 253 nodes. A low ligation was defined as ligation of the IMA at or below the level of the origin of the left colic artery and removal of the pericolic and intermediate groups of lymph nodes only, including station 252 nodes, with the primary cancer.

All regional lymph nodes were dissected individually from the adipose connective tissue of the specimen immediately after resection by the surgeons who performed the operation. Node numbers and locations were recorded on

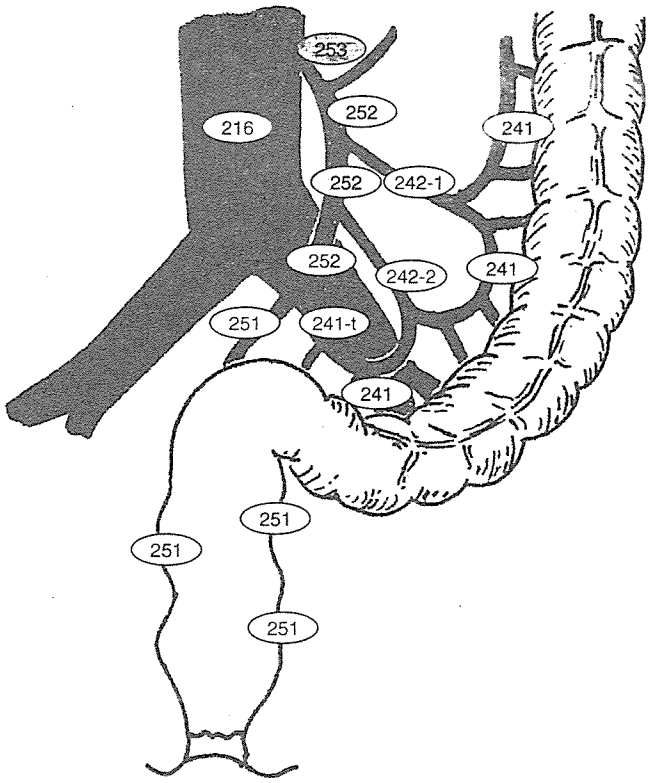


Fig. 2 Japanese Society for Cancer of the Colon and Rectum classification of lymph nodes[13] (shaded ovals denote inferior mesenteric lymph nodes)

a lymph node map (*Fig. 2*). Nodes were assigned to the appropriate station according to the classification of the JSCCR. Nodes found at each station were labelled and sent for pathological assessment. This system, which is standard practice in Japan, yields an exact topographical representation of the nodes combined with their number. Fat clearing methods were not used to collect lymph nodes from the specimen. All specimens were formalin fixed and paraffin embedded. A single section for each lymph node was routinely examined. Sections of 4 μm were cut and stained with haematoxylin and eosin for histological analysis. Special attention was paid to evaluation of the incidence of metastasis to lymph node stations 252 to 253 in relation to the tumour site, depth of invasion and survival data.

Statistical analysis

Overall and cancer-specific survival of patients with lymph node metastases along the IMA was calculated for each nodal station by the Kaplan–Meier method, irrespective of metastasis to other lymph node stations. Operative deaths were not excluded from the survival analysis. Follow-up data were documented prospectively.

Results

The characteristics of the 1188 patients who underwent potentially curative resection with high ligation are shown in *Table 1*. The overall hospital mortality rate was 0·2 per cent (three of 1188). The overall morbidity rate was 31·5 per cent (374 of 1188). Three hundred and forty-seven patients (29·2 per cent) had one or more surgical complications.

The mean number of nodes examined per patient was 28·6. A total of 107 patients had nodal involvement at stations 252 and/or 253. The incidence of metastasis to station 252 nodes was 8·3 per cent (99 of 1188). Station 252 nodal metastases occurred more frequently in patients with pT3 and pT4 lower rectal cancer (*Table 2*). The incidence of metastasis to station 253 nodes was 1·7 per cent (20 of 1188); this represented the frequency of residual metastatic nodes that would normally have been left behind in a low ligation. Of the 20 patients with station 253 nodal metastases, eight did not have cancer deposits in the station 252 nodes studied, that is they demonstrated skip metastases. There was a steady increase in the rate of

Table 1 Characteristic of 1188 patients who underwent a high ligation with curative intent

	No. of patients
Age (years)*	58·6 (59) (23–86)
Sex ratio (F : M)	482 : 706
Site of primary tumour	
Sigmoid colon	421 (35·4)
Rectosigmoid	202 (17·0)
Upper rectum	216 (18·2)
Lower rectum	349 (29·4)
Type of resection	
Sigmoidectomy	393 (33·1)
High anterior resection	141 (11·9)
Low anterior resection	329 (27·7)
Abdominoperineal resection	286 (24·1)
Hartmann's operation	15 (1·3)
Total pelvic exenteration	10 (0·8)
Other	14 (1·2)
Other surgery	
Lateral pelvic node dissection	301 (25·3)
Postoperative death	3 (0·2)
Postoperative morbidity	374 (31·5)
Urinary or sexual dysfunction	103 (8·7)
Ileus	77 (6·5)
Urinary tract infection	47 (3·9)
Wound infection	42 (3·5)
Anastomotic leakage	39 (3·3)
Intraabdominal or pelvic infection	39 (3·3)
Non-surgical (cardiac, respiratory, renal, cerebral)	27 (2·3)
No. of lymph nodes examined per patient*	28·6 (22·6) (7–115)

Values in parentheses are percentages unless otherwise indicated; *values are mean (median) (range).

Table 2 Nodal metastases to station 252

	Incidence of metastasis				
	pT1	pT2	pT3	pT4	Total
Sigmoid colon	2 of 100 (2)	0 of 67 (0)	7 of 169 (4·1)	5 of 85 (6)	14 of 421 (3·3)
Rectosigmoid	0 of 21 (0)	4 of 37 (11)	12 of 110 (10·9)	5 of 34 (15)	21 of 202 (10·4)
Upper rectum	1 of 30 (3)	0 of 51 (0)	13 of 105 (12·4)	3 of 30 (10)	17 of 216 (7·9)
Lower rectum	1 of 42 (2)	6 of 119 (5)	36 of 164 (22·0)	4 of 24 (17)	47 of 349 (13·5)
Total	4 of 193 (2·1)	10 of 274 (3·6)	68 of 548 (12·4)	17 of 173 (9·8)	99 of 1188 (8·3)

Values in parentheses are percentages. pT, pathological tumour stage.

positivity in station 253 nodes with increasing depth of invasion, irrespective of the tumour location; however, no station 253 nodal metastases occurred in patients with pT1 cancer (*Table 3*). Mean positive node yields of 2·0 from station 252 and 1·9 from station 253 were obtained from patients with nodal involvement along the IMA (*Table 4*).

Follow-up continued until January 2005 for all eligible patients. The median follow-up period for survivors was 79·3 months. Follow-up was completed in all patients with nodal metastases along the IMA. Actuarial overall survival rates were 50 (95 per cent confidence interval (c.i.) 41 to 60) per cent at 5 years and 35 (95 per cent c.i. 24 to 46) per cent at 10 years in patients with metastases to station 252, and 40 (95 per cent c.i. 19 to 62) per cent at 5 years and 21 (95 per cent c.i. 2 to 41) per cent at 10 years in patients with metastases to station 253 (*Fig. 3*). The cancer-specific survival rates were 53 (95 per cent c.i. 43 to 64) per cent at 5 years and 41 (95 per cent c.i. 30 to 53) per cent at 10 years in patients with metastases to station 252, and 42 (95 per cent c.i. 20 to 64) per cent at 5 years and 23 (95 per cent c.i. 2 to 43) per cent at 10 years in patients with metastases to station 253 (*Fig. 4*).

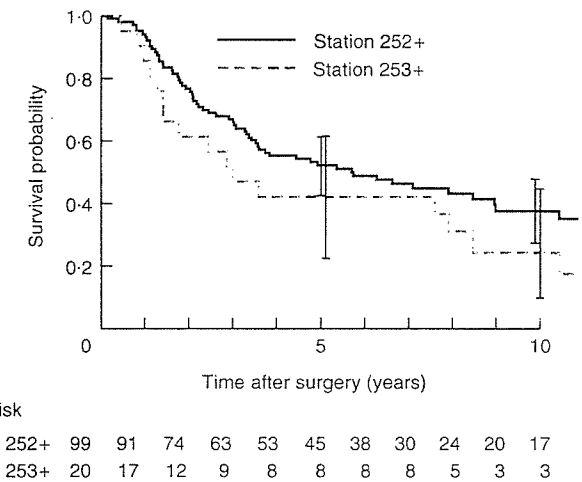


Fig. 3 Overall survival curves for patients with sigmoid colon or rectal cancer who underwent high ligation, according to inferior mesenteric lymph node status. +, Metastatic nodal disease present. Vertical bars represent 95 per cent confidence intervals

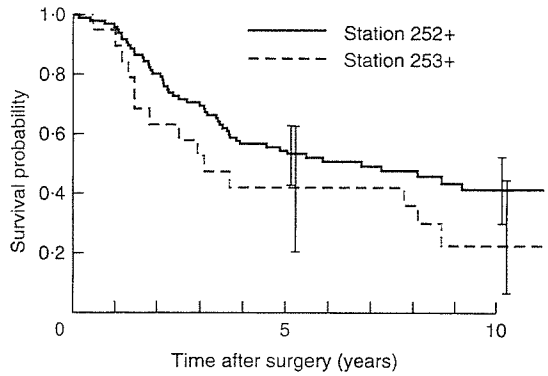
Discussion

In 1908, Moynihan[14] advised high ligation of the IMA in resections for cancer of the sigmoid colon or upper rectum. However, because the oncological effectiveness of high ligation of the IMA is not generally accepted, the level at which the IMA is ligated in operations for sigmoid colon or rectal cancer has varied greatly[3,4,7,15–20], depending largely on the surgeon[6,20]. Recent reports have shown a stage-specific survival benefit of high ligation[6,9,10]. However, these studies did not eliminate the stage migration phenomenon and failed to show a survival

Table 3 Nodal metastases to station 253

	Incidence of metastasis					
	pT1	pT2	pT3	pT4	Total	Skip Metastasis*
Sigmoid colon	0 of 100 (0)	1 of 67 (1)	2 of 169 (1·2)	3 of 85 (4)	6 of 421 (1·4)	4 of 421 (1·0)
Rectosigmoid	0 of 21 (0)	0 of 37 (0)	3 of 110 (2·7)	1 of 34 (3)	4 of 202 (2·0)	2 of 202 (1·0)
Upper rectum	0 of 30 (0)	0 of 51 (0)	2 of 105 (1·9)	0 of 30 (0)	2 of 216 (0·9)	0 of 216 (0)
Lower rectum	0 of 42 (0)	0 of 119 (0)	7 of 164 (4·3)	1 of 24 (4)	8 of 349 (2·3)	2 of 349 (0·6)
Total	0 of 193 (0)	1 of 274 (0·4)	14 of 548 (2·6)	5 of 173 (2·9)	20 of 1188 (1·7)	8 of 1188 (0·7)

Values in parentheses are percentages. *Node positive at station 253 without nodal involvement at station 252. pT, pathological tumour stage.



No. at risk

Station 252+	99	91	74	63	53	45	38	30	24	20	17
Station 253+	20	17	12	9	8	8	8	8	5	3	3

Fig. 4 Cancer-specific survival curves for patients with sigmoid colon or rectal cancer who underwent high ligation, according to inferior mesenteric lymph node status. +, Metastatic nodal disease present. Vertical bars represent 95 per cent confidence intervals

Table 4 Frequency of positive nodes in patients with nodal involvement along the inferior mesenteric artery

	Frequency of positive nodes	
	No. of positive nodes	No. of nodes harvested*
Station 252	2·0 (1·0) (1–16)	5·8 (5·0) (1–23)
Station 253	1·9 (1·0) (1–6)	3·2 (3·0) (1–10)

*Values are mean (median) (range).

advantage for patients with advanced node metastases. Furthermore, other recent series did not find any survival benefit after high ligation[4,7,19,20]. There has been no randomized or prospective study of high *versus* low ligation in patients with sigmoid colon or rectal cancer.

This prospective (but uncontrolled) study introduced a novel concept[21] for evaluation of the effectiveness of high ligation in sigmoid colon or rectal cancer surgery. The methodological approach was based on the assumption that patients who survived in the long term after resection of lymph node metastases would not have done so if the involved lymph nodes had been left *in situ*. The frequency of metastasis in nodal stations that would be left behind after low ligation of the IMA was evaluated, and the therapeutic effect of node dissection was determined by examining the incidence of metastases and the survival rates of patients with nodal deposits in those particular stations, irrespective of nodal metastases to any other lymph node station.

Potentially curative resection was achieved in 20 patients with involvement of nodal station 253, and 5-year overall and cancer-specific survival rates were 40 and 42 per cent respectively. These results demonstrate the therapeutic benefit of high ligation, because there would probably have been no long-term survivors if low ligation had been performed. However, the benefit of routine use of high ligation in patients undergoing curative resection was low (1·7 per cent, 20 of 1188) and only 0·7 per cent of patients with sigmoid colon or rectal cancer are likely be cured by high ligation of the IMA (incidence rate of metastasis 1·7 per cent, times survival rate 42 per cent). This low incidence of metastasis in the lymph nodes at the base of the IMA does not undermine the rationale behind high ligation of this artery. Surgery must always be performed for the greater good of the patient, especially if it can be carried out without adding appreciably to the risk. The negligible operative mortality and morbidity rates in this study confirm that high ligation of the IMA can be performed safely. Urinary or sexual dysfunction was the most frequent postoperative complication. Three hundred and one of the patients with lower rectal cancer also underwent lateral pelvic lymph node dissection. The autonomic nerves are intentionally sacrificed or preserved depending on whether the cancer has spread to them. This additional step is considered to be the major cause of such complications.

Five-year survival rates after low ligation in patients with involvement of middle-level lymph nodes (station 252) along the IMA of 20·5 per cent[6] and 32 per cent[22] have been reported. In the present study, patients with involvement of nodal station 252 had appreciably higher survival rates (more than 50 per cent) after high ligation, suggesting a positive effect of high ligation of the IMA on survival. Resection with curative intent could be achieved by high ligation in 107 patients with nodal involvement at stations 252 and/or 253. Because some of these nodes are left behind in a low ligation, high ligation increased the curative resection rate by 9·0 per cent (107 of 1188) at worst (assuming that low ligation would have involved ligation of the superior rectal artery at a low level). The proportion of patients with node-positive disease (Dukes' C) was 40·3 per cent (479 of 1188) in this study, which suggests that low ligation would have led to residual metastases being left in the nodes of a maximum of one-quarter of these patients. Thus, high ligation might save the occasional patient and prove helpful in those who have nodal metastases limited to below the level of the left colic artery by providing a greater margin of safety when the artery, including all the surrounding glands and lymphatics, is excised by a single block dissection; however, these data are inconclusive. The survival benefit of high ligation still remains to be investigated. Likewise, to say that high ligation of the IMA is essential to remove nodes at

station 253 is premature at the present time. Dunphy and Pikula[23] suggested a modified procedure instead of high ligation, in which fatty tissues and nodes were dissected free and excised in the angle between the IMA and aorta, and the artery was ligated below the left colic branch. Comparison of this procedure with high ligation is beyond the scope of this paper.

The results of this study suggest that high ligation of the IMA is beneficial in patients with node-positive disease. An optimal lymphadenectomy, therefore, should include the dissection of tumour-containing nodes. When the operative findings have indicated that high ligation of the IMA should be performed in patients undergoing colorectal cancer resection, several authors have reported the anatomical distribution of nodal metastases along the IMA[4,6,7]. However, intraoperative assessment for the presence of lymph node metastases is not reliable[12]. This uncertainty was demonstrated in the present study as nearly half of the patients with positive station 253 nodal metastases had no metastases in station 252 nodes. Upper lymphatic spread along the IMA was strongly related to the depth of tumour invasion. Both station 252 and 253 nodal metastases occurred more frequently in patients with pT3 and pT4 tumours. In contrast, no station 253 nodal metastases occurred in those with pT1 cancers. Therefore, low ligation may be sufficient for pT1 sigmoid colon or rectal cancers. However, there is no method of accurately assessing the depth of tumour invasion before or during operation. Indeed, by using information on the extent of lymph node involvement and the depth of tumour invasion, it is impossible to decide whether high ligation should be performed for sigmoid colon or rectal cancer. An ill chosen or poorly executed operation may increase the risk of local recurrence and adversely affect survival.

The present results show that high ligation of the IMA can be performed safely and is of therapeutic value in patients with sigmoid colon or rectal cancer who have IMA root node metastases. They also provide indirect evidence that high ligation has a possible beneficial effect on patients with middle-level node metastases along the IMA. These findings indicate that wide resection of the regional mesenteric lymphatics with high ligation of the IMA should usually be performed when operating with curative intent for sigmoid colon or rectal cancer.

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Operation

低位前方切除（開腹法）

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加藤　知行*　平井　孝*2　金光　幸秀*2　小森　康司*2

はじめに

直腸癌に対する手術は大きく，直腸・肛門管を摘除して人工肛門を造設する直腸切断術と，直腸を腹腔側から操作して切除し腸管を吻合する前方切除術とに分けられ，肛門側の切離線が腹膜翻転部よりも肛門側で切離して吻合するものを直腸低位前方切除術という。いずれの術式を選択するにしても，直腸間膜内リンパ節と側方リンパ節郭清は同じように行え，直腸切断術と直腸低位前方切除術との郭清範囲の違いは，肛門管よりも下方向の郭清，すなわち坐骨直腸窩の下直腸リンパ節の郭清ができるかどうかの違いである。

しかし，最近は坐骨直腸窩にはリンパ節が存在しないのではないかと考えられており，直腸切断術と低位前方切除術の違いは，肛門側への癌の壁内進展に対する腸管切除量の違いといってよい。近年は肛門管へ癌が進展する症例に対しても，内肛門括約筋切除や外肛門括約筋切除を行って吻合しようとする術式が試みられているが，これはいまだ臨床試験段階の術式である。直腸癌の手術では解剖学的剝離層を視認して操作を進めることが肝要であり，本稿では腫瘍が肛門管よりも口側にある症例に対する低位前方切除術について，剝離操作を中心にその要点を解説する。

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key words：直腸癌，低位前方切除

I. 適　応

低位前方切除術の適応は，腹膜翻転部に近い上部直腸（Ra）および下部直腸（Rb）の癌で，直腸を切除しても吻合ができる症例となる。我々は直腸の肛門側の腸管切除量は3 cmを原則としている[1]が，直腸癌における肛門側への癌壁内進展は2 cmまでがほとんどであり，肛門管に近い癌では肛門機能を温存するために分化型腺癌であれば2 cmでもよく，mp癌やsm癌では1 cmでもよしとしている。一方，低分化腺癌の場合には4 cm以上切除することが必要である。

II. 手術手技

1. 体　位

下肢は術中に肢位の変換が容易なレピテーター®（瑞穂医科工業社）で把持し，股関節を軽く屈曲した載石位とする（図1）。開腹後に骨盤高位にする。執刀者は患者の左側に立つ。

2. 開　腹

恥骨結合上縁より臍の右側を通って臍より約8 cm頭側までの腹部正中切開する。開創器をかけて小腸をintestinal bagに納めて腹腔外へ出す。

コメント：① 横行結腸が腹腔外へ垂直に持ち上げられ，下腸間膜動脈根部の処理が無理なく行えるように，十分に大きく開腹して術野を得ることが肝要である。② 皮膚切開が臍の右

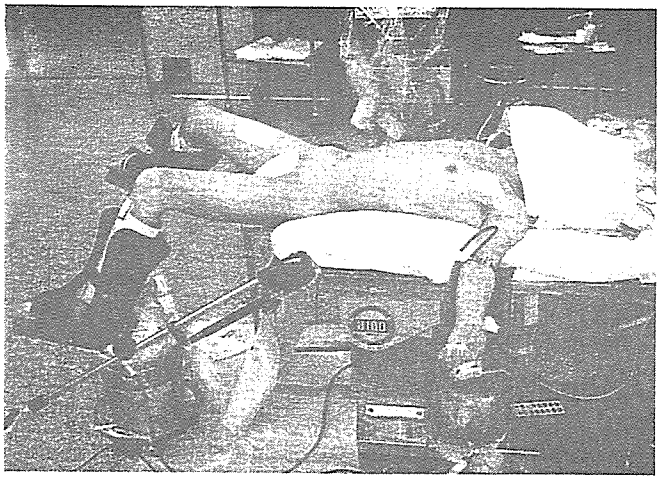


図 1　体　位

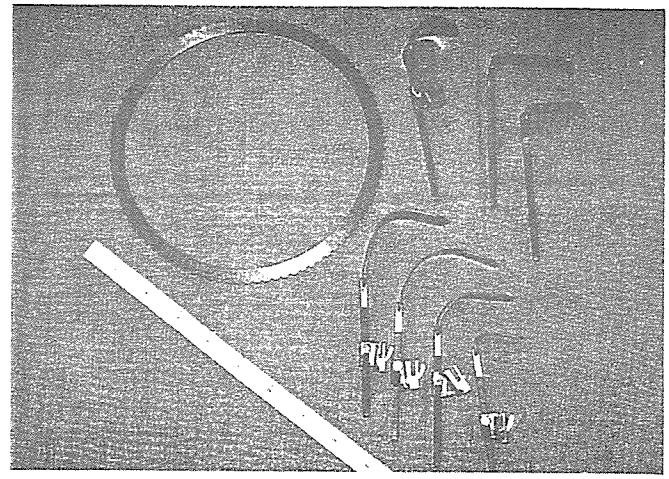


図 2　我々の用いている開創器

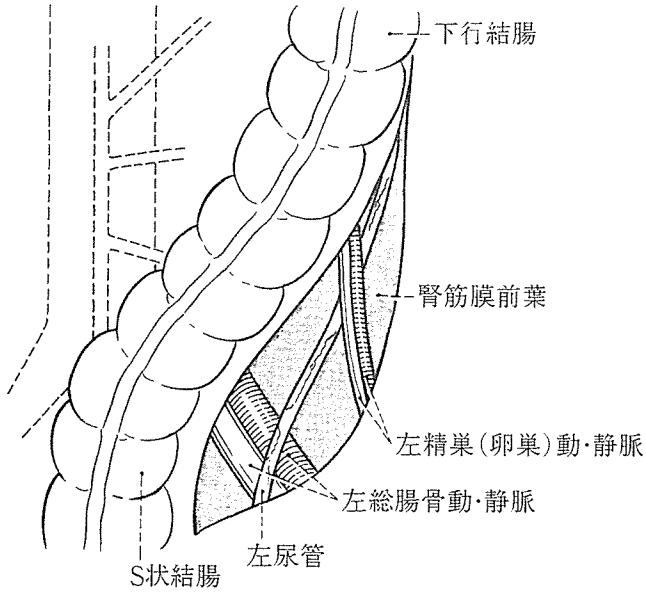


図 3　S 状結腸と下行結腸の授動

S 状結腸と壁側腹膜との癒着を剝離したのちに，電気メスで S 状結腸間膜および下行結腸間膜の後葉と腎筋膜前葉との fusion を両者の間で剝離・授動する。

側を通るのは，万一人工肛門を作製するときに左側腹部に造設するからである。③ 開創器は，鉤が 2 葉のものだと開腹創が紡錘状になり，頭側（下腸間膜根部）と尾側（骨盤内）の視野が十分に得られない。鉤が多葉のものを使い，頭側から尾側まで十分に開創するようにし，必要に応じて開創器を動かして操作する術野を展開できるものがよい。我々は任意の位置にいくつも鉤が掛けられるブックウオルターレトラクターセット®（コッドマン社）を使用している（図 2）。

3.　S 状結腸の授動と下腸間膜動脈根部の切離

S 状結腸と左壁側腹膜の癒着を剝離し，ついで S 状結腸間膜を腎筋膜前葉を背側へ落として剝離・授動する。頭側は下腸間膜動脈根部の高さまで，尾側は左総腸骨動脈あたりまで，内側は大動脈の右側まで露出しておく（図 3）。

コメント：腎筋膜前葉を確認して腸間膜から剝離することが重要で，この層で剝離を進めれば尿管や精巣（卵巣）動・静脈は腎筋膜の背側にあるので損傷することはなく，上下神経叢は自然に温存される（図 4a，b）。

S 状結腸を左側へ牽引し，右総腸骨動脈上縁から十二指腸水平部に向かって小腸と S 状結腸間膜の移行部で後腹膜を切開，大動脈の右側で血管鞘を切開して下腸間膜動脈根部を確認する。根部周囲の血管鞘の結合織を 1 cm ほど根部に付けて大動脈の外膜を露出し，下腸管膜動脈を根部で二重結紮・切離する（図 5，6）。

コメント：① 大動脈右側からアプローチする理由は，右側の腰部交感神経は右外側へ離れているので損傷する危険がないためである。後腹膜下筋膜の厚い症例では大動脈と大静脈の位

図 4　S 状結腸間膜後葉と腎筋膜前葉の fusion の剝離
a）左側に S 状結腸，右側に腎筋膜前葉（ピンセットで把持している）を見る。第 1 助手に剝離する部分を広く確認できるように S 状結腸を把持させ，fusion を剝離する。適格な部位で行えば両者の間に血管はなく，出血しない。
b）右側に S 状結腸，左側に腎筋膜前葉を見る。腎筋膜を透かして左尿管を視認することができる。

置の識別がむずかしいことがあり，注意して操作する。左側の腰部交換神経は下腸間膜動脈に密接していることも多く，注意する（図 7）。② 脂肪織が乏しい患者では，左腰部交感神経を下腸間膜動脈から遊離しようとすると下腸間膜動脈が露出することがある。このような症例では，腰部交感神経を切離して郭清側に付けるようにし，下腸間膜動脈を被っている間膜を破らないようにする。リンパ節転移がある場合に同間膜を破れば，癌を散布することになる。③ 動脈硬化が強い症例では，下腸間膜動脈根部の結紮に際して動脈が破綻することがある。破綻しても再度鉗子を掛けて結紮できるだけの余裕がある部位で結紮する。

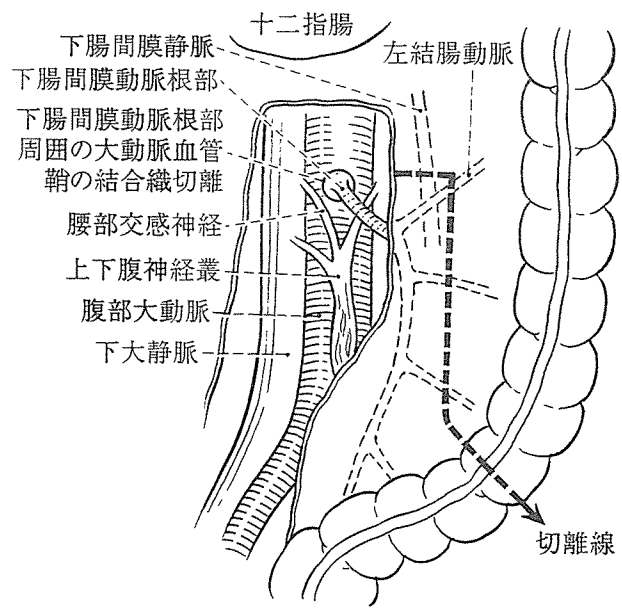


図 5　下腸間膜動脈の根部切断と S 状結腸切離
下腸間膜動脈周囲の大動脈の結合織を切離して，動脈根部を露出する。左腰部交感神経が，下腸間膜動脈に近接しているので注意する。

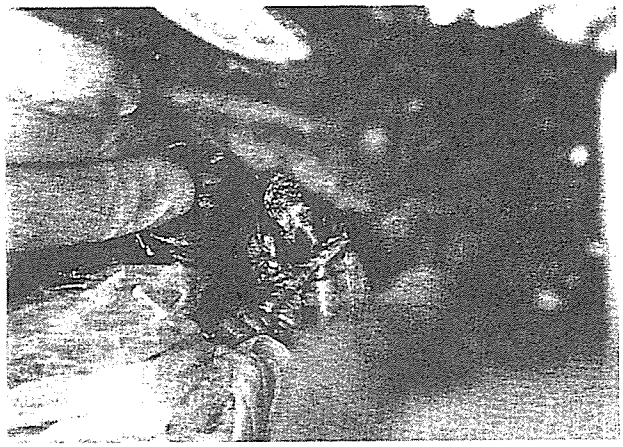
4.　S 状結腸間膜および S 状結腸の切離

下腸間膜動脈の切離部位と同じ高さで下腸間膜静脈および左結腸動・静脈を切離する。S 状結腸動脈の 1 枝以上を摘徐直腸側へ付けるようにして S 状結腸を切離する。

コメント：① 下腸間膜静脈の切離に先立ち，それより内側の後腹膜は結紮・切離する。この部分はリンパ管網が発達しているので，切離後のリンパ漏を防ぐためである。② 最下 S 状結腸動脈より口側で切離しても，ときに marginal artery が欠損していて温存側腸管の血流不全をみることがあるので注意する。

5.　直腸の遊離

直腸を固有筋膜に沿って後方を肛門挙筋まで遊離する。ときに下腹神経が直腸固有筋膜に癒



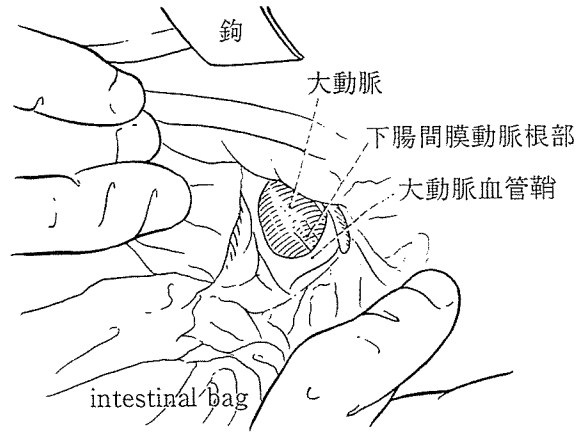
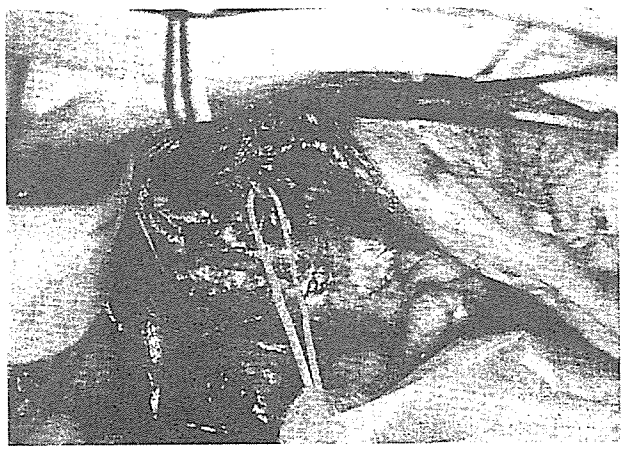


図 6　下腸間膜動脈根部の露出



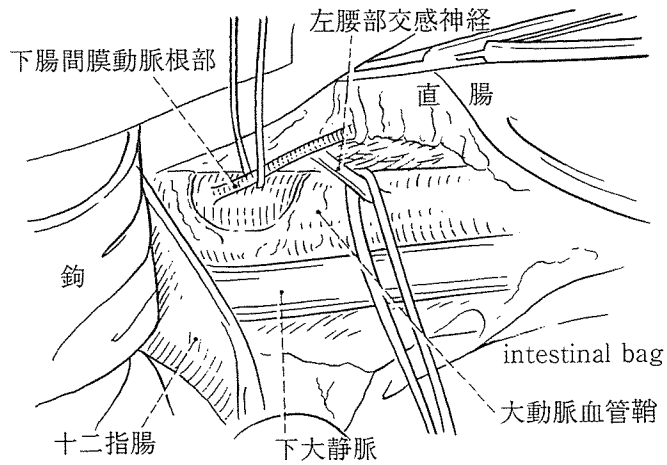


図 7　下腸間膜動脈と左腰部交感神経

着しているので，固有筋膜を破らないように注意して神経を剝離する（図 8）。

コメント：S 状結腸を切離するまでは腎筋膜前葉を露出・視認して剝離するが，岬角よりも尾側の剝離に移ったら，それより腹側の直腸固有筋膜を視認して剝離操作を進めるように意識する。

肛門挙筋まで到達したら左右背側に剝離操作を進め，膀胱下腹筋膜の尾側の肛門挙筋を露出する。これは，のちに前方から直腸を剝離して肛門挙筋と側方靱帯の間の間隙（挙筋前腔）を開放するのに必要な操作である（図 9）。

鉤を精嚢腺（腟）の膨らみを一部確認できる位置に置いて膀胱を上方へ引き，直腸を手前背側に向かって牽引し，膀胱（子宮）直腸窩を進展させて腹膜翻転部で U 字型に切開する。さらに進展を加えて精嚢を露出させ，Denonvilliers 筋膜を直腸側に付けて前立腺の後床（腟後壁 1/2）に剝離を進める。

前立腺後床（腟後壁 1/2）に到達したら，同レベルで直腸前壁から外側・肛門挙筋側に Metzenbaum を操作し，肛門挙筋と膀胱下腹筋膜の尾側との間の疎な結合織を剝離して挙筋前腔を開放する（図 10）。この際，骨盤神経叢から泌尿・生殖器への自律神経の臓側枝が精嚢・前立腺（腟・子宮）の外側を接するように走行するので，損傷しないように注意する。

挙筋前腔に鉤を挿入して側方靱帯の尾側縁を

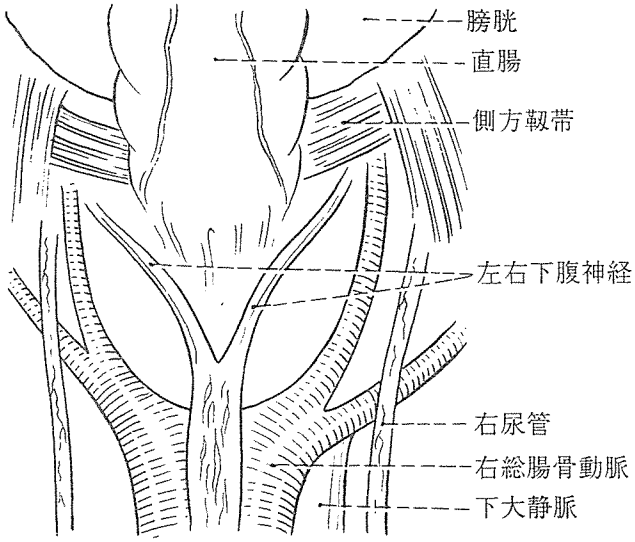


図 8　直腸後壁の剝離
直腸固有筋膜に沿って後壁を肛門挙筋まで剝離する。下腹神経が，固有筋膜に癒着していることがあるので損傷しないように注意する。同時に，側方靱帯の頭側と背側を露出しておく。

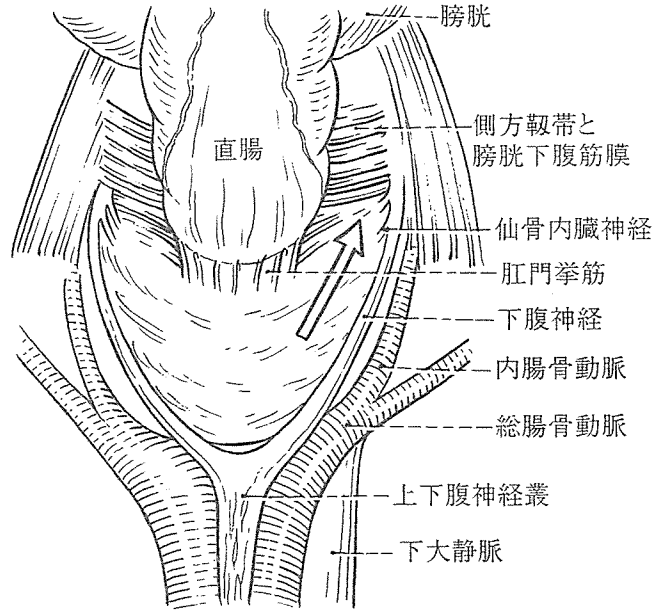


図 9　直腸後壁での肛門挙筋の露出
肛門挙筋に到達したら，肛門挙筋に沿って外側に矢印の方向へ剝離を進め，膀胱下腹筋膜の尾側との間を剝離する。

露出する。下腹神経に続く骨盤神経叢の位置を想定して，骨盤神経叢を温存しながら直腸固有筋膜に沿って側方靱帯を切離する（図11）。反対側も同様に側方靱帯を切離する。側方靱帯の切離は，電気メスで行えば中直腸動脈からの出血をみることは少ない。直腸周囲が完全に剝離され，後方，両側方で肛門挙筋が露出していることを確認する。前方はできるかぎり肛門側へ向かって前立腺の下床（腟後壁）を剝離する。

コメント：骨盤内直腸の剝離には，各種の幅および長さの鉤を使い分けて術野を展開し，操作する部位を直接視認することが肝要で，第2助手が能力を一番発揮するところである（図12）。

6.　直腸の切離

腫瘍下縁より約5 cm肛門側の直腸間膜を切離する。直腸前壁で直腸Denonvilliers筋膜を切開して直腸外膜を露出し，周囲脂肪織を直腸壁からMetzenbaumで剝離し，Kelly鉗子で肛門側脂肪をはさんでから電気メスで脂肪織を切離し，脂肪織切離端は結紮する。ときに切離した脂肪織から出血があるので，この操作は必要である。同様の操作を繰り返して直腸壁全周を露出する。

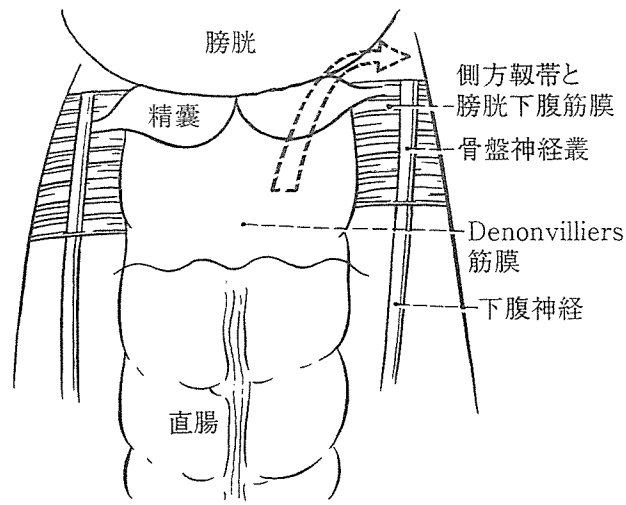


図 10　直腸前壁の剝離と側方靱帯切離
Denonvilliers筋膜を直腸側に付けて前壁を剝離する。前立腺（腟後壁）に到達したら骨盤神経叢からの臓側枝を損傷しないように，直腸壁に沿ってMetzenbaumで剝離して挙筋前腔を開放する（白点線矢印）。挙筋前腔へ細長い鉤を入れ側方靱帯を遊離し，骨盤神経叢を温存して直腸固有筋膜の延長線上で側方靱帯を切離する。

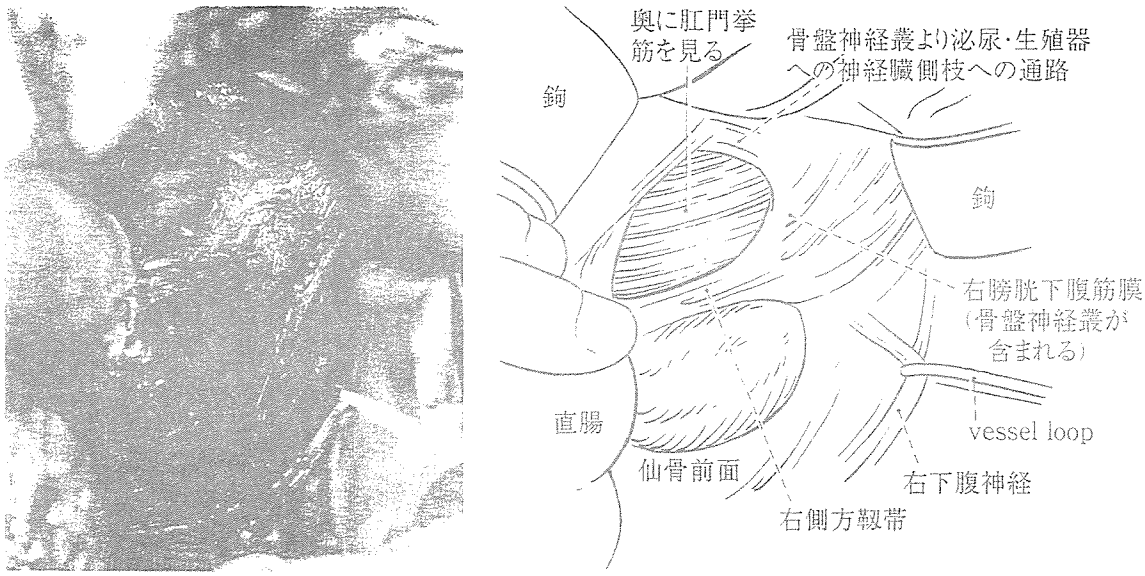


図 11　右側方靱帯

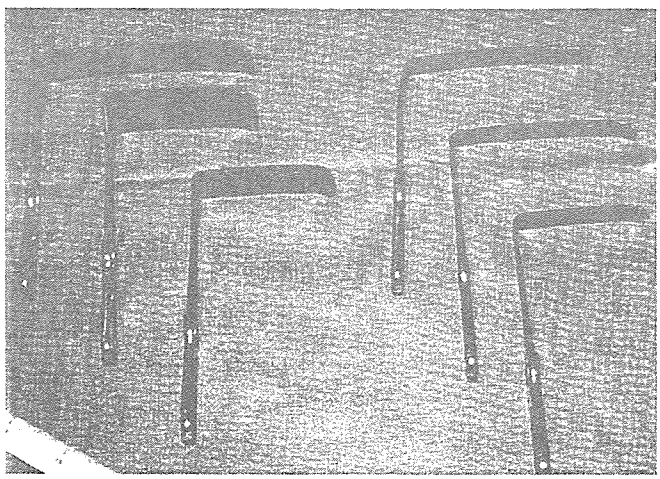


図 12　我々の用いている鉤
各種の長さと幅の鉤を作製して使用している。このほかに肝臓鉤，血管鉤，尿管鉤なども利用する。

コメント：① 直腸周囲の脂肪織は前壁でもっとも薄いので，前壁で直腸壁を露出するのがよい。② Kelly 鉗子で脂肪織をはさむ際に，前もって直腸固有筋膜を電気メスで全周に切離しておくと Kelly 鉗子を通すのに容易である。

③ 肛門挙筋直上を切離腺とする場合は，直腸間膜は挙筋前面から剝離すればよく，この場合，肛門挙筋近傍の直腸間膜脂肪は薄くて，直腸間膜を途中で切離するよりもその剝離は容易である。

直腸壁を全周に露出したら，脂肪織を口側へ郭清して約 2 cm 壁を露出する。腫瘍の肛門側へ直腸前方切除鉗子を掛けて，2,000 m*l* の生理食塩液で肛門側直腸を洗浄する。肛門側直腸へ直腸前方切除鉗子を掛けて，腫瘍より 3 cm 肛門側で直腸を電気メスで切離する。

肛門挙筋直上で切離する場合は，リニアステイプラー；TL30®を切離線に掛け，ステイプラーに沿って直腸をメスで切離する。

コメント：TL30 を掛けた場合に，電気メスで直腸を切離すると器械に通電してステイプルが外れることがある。

7.　S 状結腸・直腸端端吻合

S 状結腸断端および直腸断端に 2-0 プロリンで purse string suture を掛けて，end to end に器械吻合を行う。吻合器は腸管径に合わせて 29～33 を使用している。

コメント：① 器械吻合については，double stapling はできるだけ行わないようにしている。これはサーキュラーステイプラーのカッターがリニアステイプルに重なったときにステイプルを切離できず，リニアステイプルを引き抜いて吻合部の欠損を作ることがあるためであ

る。また，肛門管直上で直腸壁を切離して断端が肛門管内へ潜ってしまったように見えても，助手に肛門側から握り拳で肛門管を腹腔側へ突き出すようにしてもらうと断端を確認でき，Allis 鉗子で断端を把持して引き上げて purse string suture を掛けることができる。骨盤腔が狭くてこの操作ができないと思われるときには double stapling を行っている。② 器械吻合では手縫い吻合よりも吻合部狭窄を起こしやすい。筆者の器械吻合選択の目安は，吻合部が肛門から指を挿入して狭窄を用指拡張できる距離としている。そうすると低位前方切除例のみとなり，高位で吻合するときは Gambee 法による手縫い吻合を行っている。

8. 閉　腹

骨盤腔内を生理食塩液で満たし，肛門から直腸内へネラトンカテーテルを挿入して空気を注入し，air leak test を行う。腹腔内を 2,000～3,000 m*l* の生理食塩液で洗浄する。腹膜外ルートから骨盤腔内へ 8 mm ドレーンを 1 本（側方郭清を行った場合には左右から 2 本）挿入する。

後腹膜を閉鎖する。この場合，十二指腸水平脚および Treitz 靱帯が腹膜で締め付けられないように注意する。腹壁は吸収糸で 3 層に閉鎖する。腹膜は 2-0 連続，筋膜は 1-0 連続，皮膚は 3-0 連続で埋没縫合している。

ドレーナージは closed system で行い，自然落下あるいは −50 mmHg の低圧持続吸引ポータブルバッグで行う。

コメント：直腸癌では局所再発や肝転移再発などで再び開腹することがあり，再開腹することを念頭において手術を行うことが必要である。術後の癒着を防止するためには，術中の出血を少なくし，また確実に止血すること，挫滅組織を残さないこと，閉腹時の腹膜断端を腹腔側へ出さないことが肝要である。癒着防止フィルム（セプラフィルム[5]）は使用していない。

おわりに

下部直腸（Rb）進行癌では側方リンパ節郭清を行うことを基本としている。側方郭清の適応は Rb で壁深達度が mp 以上の症例とし，術中に摘出した直腸の腫瘍直下リンパ節の迅速標本を作製して鏡検し，リンパ節転移がなければ神経完全温存を，リンパ節転移があれば第 4 仙骨神経（S4）のみを温存することにしている。したがって，側方リンパ節郭清は直腸を摘出したあとに，吻合する前に行っている。

本稿は頁数の関係で側方リンパ節郭清まで詳述することはできなかった。拙著[2)3)] を参考にしていただきたい。

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特集：大腸疾患の外科―最新の諸問題

11. 大腸癌肝転移・肺転移に対する治療方針

―― 最近の諸問題 ――

加藤知行　平井　孝　金光幸秀　小森康司

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南　江　堂

11. 大腸癌肝転移・肺転移に対する治療方針――最近の諸問題*

加藤知行　平井　孝　金光幸秀　小森康司**

〔要旨〕大腸癌肝転移および肺転移に対する標準治療は完全切除である．肝転移切除に関する現在の討議点は①肝切除術式は部分切除か，系統切除か，②同時性肝転移に対する切除時期，③転移個数・大きさからみた切除適応，④他臓器転移例の対応，⑤肝門部リンパ節郭清，⑥切除断端距離，⑦補助療法，などである．切除不能例に対してはneoadjuvant chemotherapy，門脈塞栓，凝固療法などを取り入れて切除可能状態とする工夫がされている．肺転移切除に関する問題も肝転移と同様であるが，切除術式については，胸腔鏡手術や凝固療法などの低侵襲手術が取り入れられている．

はじめに

大腸癌の転移に対する治療は，原発巣と同様に，外科的完全切除以外に根治的な治療法はない．転移・再発に対する治療については古くから多くの報告があるが，診断法が進歩して転移巣が早期に的確に発見され，手術法や周術期の患者管理が進歩してより安全に手術ができるようになれば，以前には適応とされなかった転移巣が根治手術の対象とみなされるようになる．

本稿では，外科的切除が現在の標準治療とされる大腸癌肝転移と肺転移に対する外科治療上の最近の問題点を中心に解説する．

キーワード：大腸癌，肝転移，肺転移，外科治療

* Recent problems in the treatment of liver and lung metastases from colon and rectum

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I. 肝転移

1. 外科治療の現状

大腸癌肝転移は全症例の約20%を占めて[1]もっとも多い転移・再発であり，転移・再発大腸癌治療の最大の対象である．

転移巣非切除例の5年生存率が5%以下であるのに対し，肝切除後の5年生存率は20～50%である．症例を前期と後期で分けて分析した報告では近年の予後は向上している[2]．

肝切除後の再発は残肝再発が40%，次いで肺転移が20%にみられて[3]，肝切除後はこの二つの再発の予防法が現在の課題である．

肝切除後の予後に関係すると思われる因子を表1に示す．切除後の予後不良因子として異論がないのは，剥離面に癌が露出しているような不完全

表1．肝転移切除後の予後不良因子

1）原発巣因子 根治度　C リンパ節転移陽性(転移個数多) 組織型：低分化／粘液 ly　2～3 budding あり 2）肝転移巣因子 肝転移組織型：低分化／粘液 肝転移個数(多発) 局在(両葉) 肝転移程度(H_3)* 腫瘍最大径 衛星病変あり 肝転移進展因子 門脈腫瘍塞栓，肝静脈腫瘍塞栓 胆管内腫瘍進展，門脈浸潤 神経周囲浸潤 腫瘍周囲偽皮膜形成 liver cell entrapment 肉眼型 肝所属リンパ節転移陽性	3）肝転移切除後の予後因子：手術因子 断端陽性 tw＜10 mm 肝転移巣の遺残 4）肝転移切除後の予後因子：背景因子 術前遠隔転移 肝転移時の他臓器転移 同時性 無病期間＜1年 肝切除前 CEA 高値 肝切除後 CEA 高値 肝切除後 CA19-9 高値

*：大腸癌取扱い規約(第6版)による　　(文献3より引用)

切除，肝所属リンパ節転移陽性，衛星病変など肝転移進展因子陽性例，肝外転移巣を有することである．予後に大きく影響を与える因子は，肝転移個数，肝切除断端距離(tw)，肝転移切除後のCEA値とCA19-9値などである．『大腸癌取扱い規約(第7版)』[4]で新たに採用された肝転移の進行度分類における予後規定因子は，肝転移巣の転移個数と最大径および原発巣のリンパ節転移度である．

肝転移巣切除後の残肝再発についても根治の可能性があれば，初回手術と同じ基準で切除の対象となる[5,6]．再肝切除の成績は，5年生存率は30～50%[7,8]と良好であり再肝切除は肝転移の治療成績を向上させる重要な因子である．

2．肝切除の適応と術式

肝切除の適応基準として①外科切除のリスクがよいこと，②原発巣がコントロールされていること，③適度な残肝量を残して肝転移巣が完全に切除できること，④肝転移以外の遠隔転移がないこと，⑤肝所属リンパ節転移がないことが一般にあげられ，さらに肝転移巣の条件として⑥肝転移個数4個以下，⑦twを10 mm以上切除できることが手術のstandard criteriaとされてきた．肝転移症例のうち，切除可能なものは25～50%とされる[9]．

肝切除術式は局所切除，区域切除，葉切除，拡大葉切除(3区域切除)などが行われ，大きく分けて，解剖学的肝系統切除と非解剖学的肝局所切除とに分類される．手術に関係するいくつかの問題点について考察する．

3．切除時期

同時性肝転移に対しては，原発巣と同時に切除する意見と，まず原発巣を切除して，その後3ヵ月ほど待って肝転移巣を切除する意見とがある．

同時切除を行う理由は①経過観察をしても予後にかわりはなく，②術中超音波検査で小病巣も把握できるから遅らせる必要はない，③3ヵ月遅らせることで肝転移巣からの2次転移の危険性