

Fig. 2 Histological examination of fixed cadavers: haematoxylin and eosin-stained horizontal sections of fascial structures. **a** Posterior to the rectum at the level of the first to second sacral vertebrae, **b** posterior to the rectum at the level of the third to fourth sacral vertebrae and **c** posterolateral to the rectum at the level of the fourth sacral vertebrae. The middle rectal veins (MRV) run through the pelvic plexus, which was considered to represent the lateral ligament (white star). Black arrows, fascia propria of the rectum; black arrowheads, prehypogastric nerve fascia; white arrows, parietal presacral fascia; asterisks, levator ani muscles. HGN, hypogastric nerve; IGA, inferior gluteal artery; IPV, internal pudendal vein; MR, mesorectum; PM, piriformis muscle; PN, pudendal nerve; PSN, pelvic splanchnic nerves; PX, pelvic plexus; R, rectum, S1–4, first to fourth sacral vertebrae; SRA, superior rectal artery; SRV, superior rectal vein

This work was undertaken within the provisions of the Declaration of Helsinki, 1995 (revised in Edinburgh, 2000), although the present research project did not include any specific protocols that required examination and approval by an ethics committee.

Results

Histological observations

Between the levels of the first and second sacral vertebrae, two fasciae were identified within the multilaminar structure between the FPR and the sacral periosteum (Fig. 2a). One was located adjacent to the FPR and immediately ventral to the HGN (temporarily termed

the pre-HGN fascia), whereas the other fascia was located dorsal to the HGN and immediately ventral to the sacral veins. The latter continued to a fascia covering the ventral surface of the levator ani muscle (see below), and was thus called the parietal presacral fascia. The FPR, pre-HGN fascia and parietal presacral fascia were not artifacts caused by histological preparation, as these structures were all identified as woven fibrous tissues at higher magnifications. In contrast, the mesorectum comprised many lobules, but no specific fascial structure separating the lobules was identified.

At the levels of the third and fourth sacral vertebrae, the HGN was not located near the sacrum, and the retrorectal multilaminar structure between the FPR and sacral periosteum was thin (Fig. 2b). The FPR was also

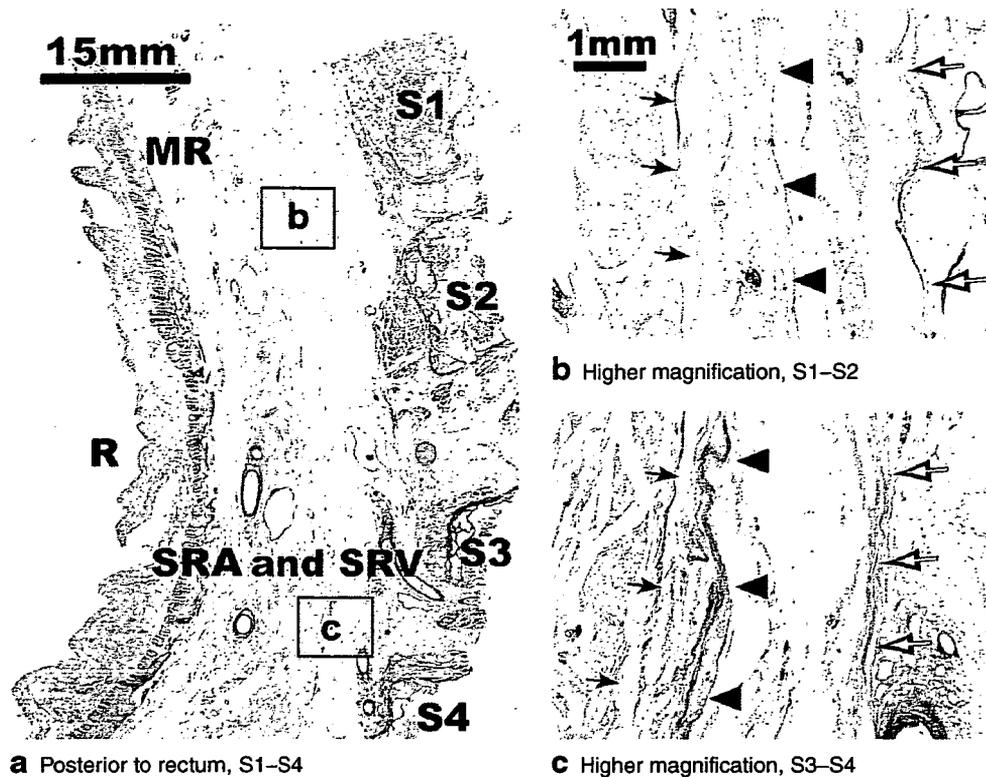


Fig. 3 Histological examination of fixed cadavers: haematoxylin and eosin-stained sagittal sections of fascial structures posterior to the rectum. **b** and **c** show boxes marked in **a** at higher magnification. Black arrows, fascia propria of the rectum; black arrowheads, prehypogastric nerve fascia; white arrows, parietal presacral fascia. MR, mesorectum; R, rectum, S1–4, first to fourth sacral vertebrae; SRA, superior rectal artery; SRV, superior rectal vein

thin and attached to the pre-HGN fascia. The FPR was difficult to discriminate from the pre-HGN fascia. At this level, the pre-HGN fascia and parietal presacral fascia also comprised thick woven fibrous tissues.

Pelvic splanchnic nerves were identified arising from the third and fourth sacral foramina and running toward the pelvic plexus (*Fig. 2c*). Slices included the levator ani muscle. Parietal presacral fascia was divided into several laminae extending ventrolaterally: fasciae lining or enclosing the pelvic plexus; fasciae providing a posterior attachment for levator ani muscle and lining the medial or superior surface of the muscle sheet; and fasciae enclosing the pudendal nerve and associated inferior gluteal and internal pudendal vessels.

Immediately medial to the pelvic plexus, the FPR and pre-HGN fascia appeared to fuse with one of the ventrolateral continuations or divisions of the parietal presacral fascia, resulting in very thick and multilayered fasciae medial to the pelvic plexus (*Fig. 2c*). The pelvic plexus in this area was packed within a thickness of 3–7 mm and attached tightly to the lateral side of the mesorectum.

In sagittal sections, the basic four fasciae (FPR, pre-HGN fascia, parietal presacral fascia and sacral periosteum) were evident as multilaminar structures posterior to the rectum. The first three were closely located within a width of 3–4 mm (*Fig. 3*). There was no fascial structure connecting directly between the FPR and parietal presacral fascia (that is, the rectosacral fascia), whereas multilaminar structures were arrayed parallel to the concave ventral surface of the sacrum. The pre-HGN fascia was thick at the level of the third and fourth sacral vertebrae (*Fig. 3a,c*).

Fresh cadaver dissection and histological assessment

With sharp dissection in the avascular plane of areolar tissue under direct vision, the FPR was clearly seen and the HGN was identified behind the pre-HGN fascia (*Fig. 4a,b*). After posterior mobilization of the rectum up to the level of the third or fourth sacral vertebrae, the so-called rectosacral fascia was clearly observed connecting between the FPR and a parietal structure (*Fig. 4b*). A strip of dura was successfully attached to the rectosacral fascia and the

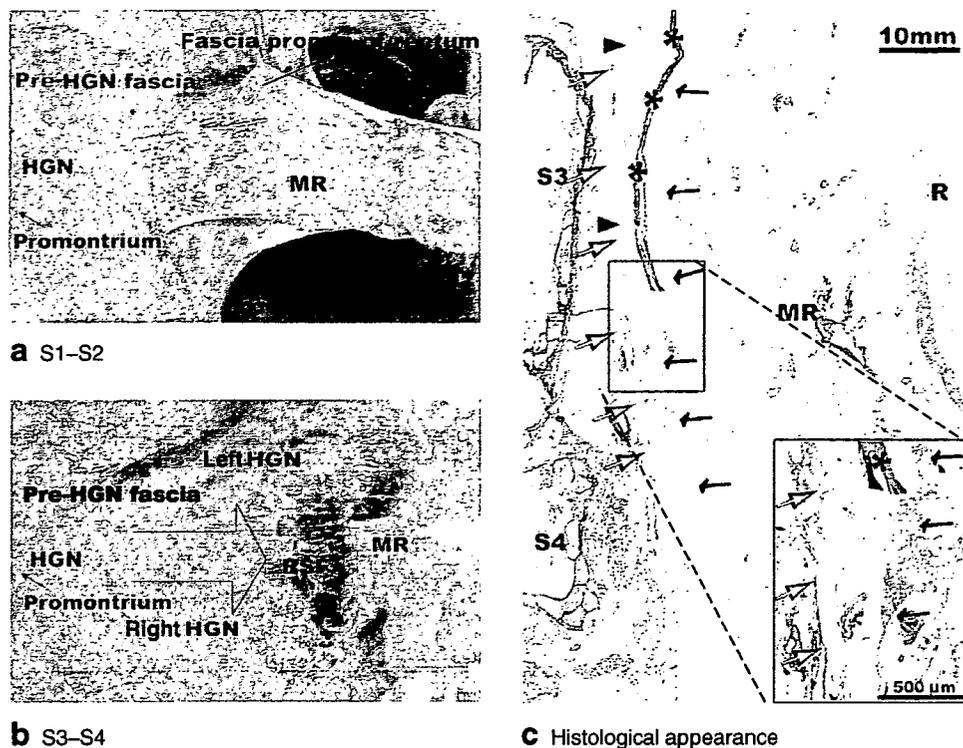


Fig. 4 Fresh cadaver dissections showing **a** posterior mobilization of the rectum at the level of the first to second sacral vertebrae and **b** retrosacral fascia (RSF) at the level of the third to fourth sacral vertebrae. **c** Histological evaluation of a fresh cadaver dissection, with higher-magnification view shown in inset. Dotted line in **a** shows surgical plane. Large arrow in **b** shows position of inserted dura mater. Black arrows (in **c**), fascia propria of the rectum; arrowheads, prehypogastric nerve fascia; white arrows, parietal presacral fascia; asterisks, dura mater. HGN, hypogastric nerve; MR, mesorectum; R, rectum; S1–4, first to fourth sacral vertebrae

plane closed by ligation. Histologically, dura mater was clearly identified between the FPR and pre-HGN fascia, but no fascia connecting the FPR to the parietal presacral fascia was found (*Fig. 4c*).

Discussion

The present study has demonstrated that, rather than the FPR, a multilaminar posterior envelope of the mesorectum contains another two histologically clear and/or thick fasciae: the parietal presacral fascia^{7,21–23} (synonymous with Waldéyer's fascia¹²) covering the presacral venous plexus and the pre-HGN fascia immediately ventral to the course of the HGN. The term 'hypogastric nerve sheath'^{24,25} rather than pre-HGN fascia seems appropriate, as the HGN is enclosed with connective tissues when subjected to sharp dissection during surgery^{10,11,26}. Sharp dissection in front of the pre-HGN fascia seems to lead the plane precisely between the pelvic plexus and FPR. In contrast, a surgical plane along the parietal presacral fascia is likely to mislead the surgeon and result in injury to the

pelvic splanchnic nerves and/or pelvic plexus, because the parietal presacral fascia divides into several laminae lining or enclosing these nerves (*Fig. 5*).

The FPR seems to attach to or join this multilaminar structure. Notably, it was demonstrated previously that one lateral continuation of Denonvilliers' fascia separates the pelvic plexus from the mesorectum²⁰. Moreover, histologically the FPR seems to attach to Denonvilliers' fascia and its lateral continuation. As a result of this morphology, lateral continuation of Denonvilliers' fascia²⁰ was most likely to be consistent with the most medial division of the parietal presacral fascia and pre-HGN fascia in the present study. The outer fascial tube, including the parietal presacral fascia, Denonvilliers' fascia and a communicating portion between them, seems to surround the mesorectum immediately outside the FPR.

Given the very close topographic relation between the outer fascial tube and the FPR, anatomists have rarely identified the FPR²⁷. The pre-HGN fascia, or HGN sheath, seem to join this outer tube from the medial side. Moreover, in combination with another parietal

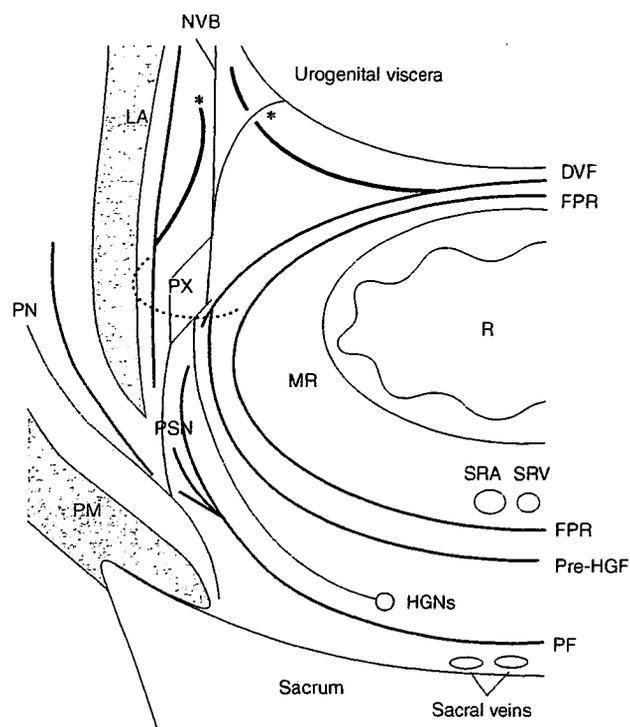


Fig. 5 Schematic representation of fascial structures posterolateral to the rectum. One division of the parietal presacral fascia (PF) continues to the endopelvic fascia lining the levator ani (LA) and another continues ventrolaterally to connect with Denonvilliers' fascia (DVF). A mesentery-like structure (circled by dotted line) extends to the viscera from parietal structures. The urological neurovascular bundle (NVB) may be enclosed by secondary divisions (asterisks) of the aforementioned fasciae²⁸. FPR, fascia propria of the rectum; HGN, hypogastric nerve; MR, mesorectum; PM, piriformis muscle; PN, pudendal nerve; pre-HGF, pre-HGN fascia; PSN, pelvic splanchnic nerve; PX, pelvic plexus; R, rectum; SRA, superior rectal artery; SRV, superior rectal vein

fascial division, the outer fascial tube seems to provide a mesentery-like structure for the urogenital viscera (Fig. 5), in which pelvic splanchnic nerves continue to the cavernous nerve²⁹. Enclosing the mesentery-like structure for the urogenital viscera, the communicating portion between the parietal presacral fascia and Denonvilliers' fascia cannot simply be regarded as a 'parietal' fascia.

The dorsoventral fascial communication between the parietal presacral fascia and Denonvilliers' fascia was thick and adhered to the FPR near the pelvic plexus. The authors speculated that, when the middle rectal artery is absent, the so-called lateral ligament of the rectum is likely to correspond to a surgical artifact when the FPR is separated at the adhesion and the divisions of the parietal presacral fascia are fasciculated by traction^{30,31}.

A direct fascial connection was not likely between the FPR and sacral periosteum at the level of the third and fourth sacral vertebrae. The present fresh cadaver dissection in combination with histological examination demonstrated that the so-called rectosacral fascia was likely to correspond to a surgical artifact that arose when the tightly packed posterior multilaminar structure was separated. In the multilaminar structure, the pre-HGN fascia was particularly thick at this level. However, incidentally, the present histological findings did not include a vein of the mesorectum draining into the sacral vein behind the parietal presacral fascia. Dorsal venous drainage might occur via a vascular sheath that resembles the rectosacral fascia.

This study has shown that the pre-HGN fascia is evident between the FPR and parietal presacral fascia in the retrorectal multilaminar structure. Sharp dissection in front of the pre-HGN fascia seems reliable according to the histological configuration of the posterolateral fasciae.

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Comparison Between the Oncologic Outcome of Laparoscopic Surgery and Open Surgery for T1 and T2 Rectosigmoidal and Rectal Carcinoma: Matched Case-control Study

Takatoshi Nakamura¹, Yukihiro Kokuba¹, Hiroyuki Mitomi², Wataru Onozato¹
Kazuhiko Hatate¹, Takerou Satoh¹, Heita Ozawa¹, Atusi Ihara¹, Masahiko Watanabe¹

¹Department of Surgery Kitasato University Hospital, ²Department of Pathology
National Sagamihara Hospital, Kanagawa, Japan

Corresponding Author: Masahiko Watanabe, Department of Surgery, Kitasato University Hospital
1-15-1 Kitasato, Sagamihara, Kanagawa 228-8520, Japan

Tel: +81 42 748 9111, Fax: +81 42 748 5120, E-mail: n-toshi@Kitasato-u.ac.jp

KEY WORDS:

Laparoscopic surgery; Rectal cancer; Matched case-control study

ABBREVIATIONS:

Laparoscopic Resection (Lap-R); Open Surgery (O-R); Randomized Controlled Trials (RCT)

ABSTRACT

Background/Aims: The long-term outcome of laparoscopic resection (Lap-R) of rectal cancer is still unclear. The purpose of this study was to elucidate the validity of Lap-R by comparing the short-term and mid-term outcome of Lap-R performed in our hospital to treat T1 and T2 rectal cancer patients with that of patients with the same clinicopathological background treated for rectal cancer by open surgery (O-R).

Methodology: We conducted a matched case-control study of the oncologic outcome of T1 and T2 rectal cancer patients who had undergone Lap-R between 1996 and 2002 by matching them for sex, age, location, and TNM classification with patients who underwent O-R during the same period, and the total number of subjects in both groups combined was 76.

Results: The median follow-up period in the Lap-R group was 36 months, as opposed to 58 months in the O-R group. There were no operative deaths in either group. Comparison of the postoperative complications showed that intraoperative blood loss was significantly less in the Lap-R group than in the O-R group ($P < 0.0001$), and there were fewer cases of intestinal obstruction ($p = 0.0312$). The number of postoperative hospital days was also significantly

shorter ($p = 0.00046$).

The overall survival rate was 91.6% in the Lap-R group and 92.7% in the O-R groups, and the difference was not significant ($p = 0.5306$). The recurrence-free survival rate was 96.7% in the Lap-R group and 82.4% in the O-R group, and the difference was not significant ($p = 0.4587$). The difference in recurrence rate between the groups was not significant ($p = 0.446$), and there were no differences in modes of recurrence, but local recurrence was the most common mode in both groups. No recurrences were observed at the site of the port in the Lap-R group.

Conclusions: When we performed our matched case-control study of Lap-R and O-R as surgical procedures for T1 and T2 rectal cancer, Lap-R was less invasive based on the short-term outcome. Moreover, there were no significant differences in mode of recurrence or recurrence rate, and no significant difference between the two groups was observed in oncologic outcome. It will be necessary to await the results of both Japanese and international randomized controlled trials (RCT). However, short- and mid-term follow-up of identical patients at a single institution as in the present study also appeared to have sufficient significance.

INTRODUCTION

It has been more than 10 years since laparoscopic surgery (Lap-R) became a choice of treatment for colorectal cancer. The advantages of Lap-R for colon cancer have been reported to be that it enables less postoperative pain, decreased postoperative intestinal obstruction, a shorter postoperative hospital stay, an earlier return to a normal life, and even better postoperative quality of life (1-4). RCT in regard to long-term outcome have been performed in various countries, and the long-term outcome of Lap-R has been reported

to be equivalent to that of open surgery (O-R) (5,6). However, Lap-R for rectal cancer is definitely a difficult operation from a technical standpoint, and in many clinical studies it has been described as not being indicated for rectal cancer (5,6). As a result, the safety and low invasiveness of Lap-R are unclear. Furthermore, there have been no large-scale RCT on the short-term outcome or long-term outcome, and they are also still unclear.

The present study was a matched case-control study in which we compared the safety, low invasive-

ness, and short-term outcome of Lap-R with O-R in T1 and T2 rectal cancer patients, excluding T3 and T4 rectal cancers, which require neoadjuvant chemotherapy, and assessed the validity of Lap-R as a procedure for T1 and T2 rectal cancer.

METHODOLOGY

Lap-R was performed on 71 rectal cancer patients during the period from April 1996 to December 2003, and we adopted the patients with depth of invasion T1 and T2 who did not have any obvious preoperative lymph node metastases or distant metastases as potential subjects of the study. Patients with intestinal obstruction or who did not consent to Lap-R were excluded. Before surgery all patients underwent contrast enema fluoroscopy, colorectal endoscopy, abdominal ultrasonography, and abdominal and pelvic CT examinations. The location of the rectal cancers was determined by colorectal endoscopy. The cancers were classified according to their distance from the anal verge as under rectum (0cm to 7cm), upper rectum (7.1cm to 12cm), and rectosigmoid (12.1cm to 17cm). We matched 38 patients each who underwent Lap-R and O-R for pathologic TNM category, sex, age (± 5 y), location, and day of surgery (between 1990 and 2003) and adopted them as the subject group (Table 1).

The surgical technique of Lap-R consisted of inserting the initial port in the upper portion of the umbilicus and insufflating the abdomen with CO₂ at a mean pressure of 8 mmHg/hr. There were no conversions from Lap-R to O-R. In addition to outpatient clinic visits, postoperative follow-up consisted of CEA measurements (every 3 to 12 months), contrast enema examinations, abdominal ultrasound examinations, and thoracic and abdominal CT examination (6 months), and recurrence was judged on the basis of the imaging findings and the histopathological findings considered as a whole. Postoperative adjuvant chemotherapy, principally with fluorouracil (5-FU), was performed in a total of 8 patients, 4 stage III patients each in the Lap-R group and the O-R group, and the significant difference in number of patients to whom it was administered was the same in both groups.

The Mann-Whitney U test was used to statistically analyze the non-parametric data. Overall survival rates were calculated by the Kaplan-Meier method, and group comparisons were made by the log-rank test.

RESULTS

Comparison between the Lap-R group and O-R group showed an intraoperative blood loss of 50mL in the Lap-R group and 205mL in the O-R group, and there was significantly less bleeding in the Lap-R group ($P < 0.0001$). The length of the postoperative hospital stay was 12 days in the Lap-R group and 16.5 days in the O-R group, and significantly shorter in the Lap-R group ($p = 0.00096$, Table 2). On the other hand, there were no significant differences between the groups in operation time, time until resumption of

TABLE 1 Demographic characteristics of the Patients

| | Laparoscopic surgery group | Open surgery group |
|----------------------------|----------------------------|--------------------|
| Number of patients | 38 | 38 |
| Sex ratio (Male:Female) | 27:11 | 27:11 |
| Age (yr; Mean [range]) | 61 (30-77) | 62.5 (49-85) |
| Location | | |
| Rectosigmoid | 10 | 10 |
| Upper Rectum | 12 | 12 |
| Under Rectum | 16 | 16 |
| TNM stage | | |
| pT1N0 | 25 | 25 |
| pT2N0 | 9 | 9 |
| pT2N1 | 3 | 3 |
| pT2N2 | 1 | 1 |
| Period [mo; median/range/] | 36 (8-90) | 58 (15-120) |

pTNM stage: pathological TNM stage.

TABLE 2 Operative and Postoperative Results

| | Laparoscopic surgery Group | Open surgery Group | p-value |
|--|----------------------------|--------------------|---------------|
| Mean Operation Time (min) | 240 (145-560) | 225 (115-415) | NS |
| Bleeding (mL) | 50 (10-460) | 205 (60-1580) | $p < 0.0001$ |
| Mean time to oral intake (days) | 3 (2-8) | 4 (2-14) | NS |
| Mean number days of parenteral opiates | 1 (0-5) | 1 (0-5) | NS |
| Mean length of stay (days) | 14 (7-64) | 19.5 (9-66) | $p = 0.00046$ |

TABLE 3 Number of Patients with Postoperative Complications

| Complication | Laparoscopic surgery Group (n=38) | Open surgery Group (n=38) | p-value |
|----------------------|-----------------------------------|---------------------------|--------------|
| Anastomotic leak | 1 | 2 | NS |
| Anastomotic stenosis | 0 | 1 | NS |
| Bleeding | 2 | 1 | NS |
| Wound infection | 2 | 4 | NS |
| Prolonged ileus | 2 | 10 | $p = 0.0312$ |

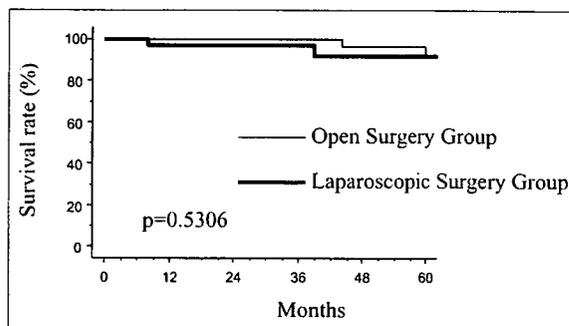


FIGURE 1 Comparison between the overall curves of the laparoscopic surgery group and the open surgery group.

meals, or number of times analgesics were used (Table 2). Comparison of the postoperative complications showed significantly fewer cases of intestinal obstruction in the Lap-R group ($p = 0.0312$). There were no significant differences between the groups in suture failure, anastomotic stenosis, postoperative bleeding, or wound infection (Table 3). The cumulative 5-year survival rate was 91.6% in the Lap-R group and 92.7% in the O-R group, and the difference was not significant ($p = 0.5306$, Figure 1). The recurrence-

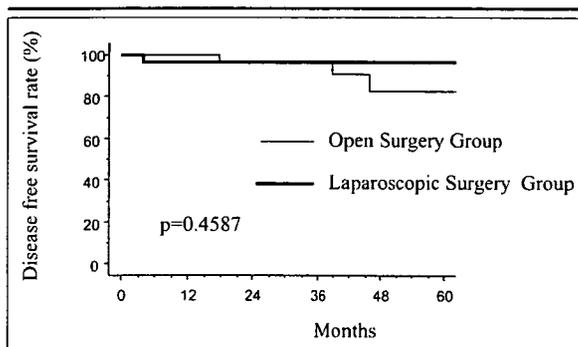


FIGURE 2 Comparison between the disease-free survival curve of the laparoscopic surgery group and the open surgery group.

TABLE 4 Cases of Tumor Recurrence after Laparoscopic Colectomy and Open Colectomy

| Location | Method | pTNM | Time of recurrence (mo) | Site of recurrence* | Outcome (mo) |
|------------|--------------|-------|-------------------------|---------------------|--------------|
| 1 Under R | laparoscopic | pT1N0 | 31 | Lung | 39, dead |
| 2 Upper R | laparoscopic | pT2N0 | 6 | local | 8, dead |
| 3 Under R | open | pT1N0 | 46 | local | 60, dead |
| 4 Rectosig | open | pT1N0 | 39 | local | 44, dead |
| 5 Under R | open | pT2N1 | 68 | Liver | 79, dead |

*Site where recurrence was first noticed.

free survival rate was 96.7% in the Lap-R group and 82.4% in the O-R group, and the difference was not significant ($p=0.458$, Figure 2).

There were 2 cases (5%) of postoperative recurrence in the Lap-R group. In 1 case it consisted of pulmonary metastasis, and in the other case there was local recurrence. In the O-R group, on the other hand, there were 3 cases (7%) of recurrence. In 2 cases it was local recurrence, and in the other case it was liver metastasis. As a result, there was no significant difference in recurrence rate between the groups. No port-site recurrence was observed in the Lap-R group.

DISCUSSION

The results of the matched case-control study of Lap-R and O-R for T1 and T2 rectal cancer revealed a more favorable short-term outcome after Lap-R than after O-R and no difference between the groups in long-term outcome. In terms of the short-term outcome, there was significantly less blood loss and intestinal obstruction with Lap-R, and the postoperative length of stay was also significantly shorter than after O-R. Among the postoperative complications there was only 1 case of suture failure in the Lap-R group. It has been reported in 5.7% to 21% of patients in whom Lap-R was performed, and some institutions routinely recommend a colostomy for low rectal cancer (7-11). When the intestine is sectioned on the distal side of the rectum, it appears to become a cause of suture failure due to the choice of device, difficulty of the maneuvers, etc. Presumably that is why there are differences among institutions in the safety of the

anastomoses.

In regard to short-term outcome, there is less postoperative pain with Lap-R, early ambulation is possible, and peristalsis resumes sooner. As a result, oral intake starts earlier after Lap-R than after O-R, and the hospital stay is shorter, and earlier return to the patient's normal life has also been demonstrated. Thus, there have been many reports that Lap-R is less invasive and that postoperative QOL is better (10-15). However, Yamamoto *et al.* compared the invasiveness markers CRP and WBC count, as well as IL-6 and NK activity and found no significant differences between the two groups in any of the markers (16). In the future we should also probably monitor invasion markers in relation to the short-term outcome and assess the low invasiveness of Lap-R more objectively.

In regard to the long-term outcome, Anthuber *et al.* assessed 101 rectal cancer patients in a report from a single institution, and the results showed that significantly fewer postoperative complications occurred after Lap-R than after O-R. They also reported that the long-term outcome was almost the same in both groups (17). However, patients with T3 and T4 rectal cancer that had been treated by neoadjuvant chemotherapy were included among the subjects, and it cannot be said to have been adequate as evidence for Lap-R. In our own study we found no significant differences between the two groups in regard to the long-term outcome of T1 and T2 rectal cancer in terms of mode of recurrence, recurrence rate, overall survival rate, or recurrence-free survival rate. However, no large-scale RCT in regard to Lap-R have been conducted in Japan or abroad, and the present study was a retrospective comparison between Lap-R and O-R. The results showed 1 case of local recurrence after Lap-R and 2 cases of recurrence after O-R. The difference was not statistically significant, but because maneuvers within the narrow pelvis are considered necessary for rectal cancer, maneuvers that might cause damage at the tumor site increase the risk of tumor cell dissemination in the peritoneal cavity during surgery (18). Thus, it appears particularly necessary to perform maneuvers with forceps cautiously during Lap-R. However, the magnifying visual effect of the endoscope is exploited in the narrow pelvis, and by maintaining a good field of vision, it may also be able to increase the safety of the intraoperative maneuvers (19). First, it seems necessary to conduct an RCT in which T1 and T2 rectal cancer patients are the subjects and confirm the long-term outcome of Lap-R. The next step would be to add various preoperative chemotherapy methods and radiotherapy methods to surgical treatment, which is currently the method of treatment for T3 and T4 rectal cancer patients. As a result, there is a strong possibility that differences in the short-term and long-term outcome of rectal cancer will occur as a result of preoperative therapy. Thus, it will be necessary to conduct the assessments by standardizing treatment methods prospectively without creating any preoperative or postoperative bias. As a result of advances in laparo-

scopic surgery technology and accumulation of experience, in the future Lap-R will probably become one of the choices for the treatment of rectal cancer. The

validity of Lap-R should be demonstrated based on the results of many multi-center RCT.

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低位前方切除時の安全な消化管器械吻合

前田耕太郎 花井 恒一 佐藤 美信
升森 宏次 小出 欽和 船橋 益夫

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低位前方切除時の安全な消化管器械吻合

前田耕太郎* 花井 恒一*² 佐藤 美信*²
 升森 宏次*² 小出 欽和*² 船橋 益夫*²

はじめに

進行下部直腸癌に対する低位前方切除時の吻合は、器械吻合法の開発により安定した手技となった。さらに double stapling technique (DST) の登場により¹⁾、直腸を牽引しながら切離と縫合を同時に行い、経肛門的な吻合を行うために、より低位での吻合が、より確実で容易となってきた。

しかしながら、従来のリニアステイプラーを用いた吻合法では、男性の狭骨盤例ではリニアステイプラーの挿入が困難な症例があったり、リニアステイプラーのヘッドがある程度のボリュームを占めるため、切除肛門側の臓器の噛みこみや縫合部の確認ができないなどの問題があった。これらの問題を解決するために、我々はリニアステイプラーの代わりにエンドステイプラーを使用し、直腸を水平方向に切離する代わりに垂直方向に切離し、サーキュラーステイプラーで吻合する方法を IO-DST²⁾³⁾と称して行っているため、その手技と成績について述べる。

* Kotaro MAEDA 藤田保健衛生大学消化器外科教授

*² Tsunekazu HANAI et al. 同外科

key words : 直腸癌, 低位前方切除術, 器械吻合

I. IO-DST の手術

吻合の手技をより安全に確実にを行う場合には、定型的な手技が必須である (表 1)。

1. 剝離と直腸内洗浄

腹側より直腸を total mesenteric excision (TME) の層で肛門挙筋まで十分剝離したのち、腫瘍肛門側の直腸に直角鉗子を掛ける (図 1)。

次に、残存直腸内の遊離癌細胞を除去し吻合部局所再発を防止するために、I 式直腸内洗浄用肛門鏡 (ユフ精器社) を用いて経肛門的な洗浄を蒸留水で行う。洗浄量は、腹膜靱帯部以上の腫瘍では 2,000 ml、以下の癌では 1,500 ml とする⁴⁾。

2. 直腸の切離

直腸の切離には、エンドステイプラーを使用する。切離の際には、左手で直角鉗子ごと直腸を口側に牽引しつつ、AW の距離を勘案して

表 1 IO 吻合の手順

- 1 TME による直腸剝離
- 2 腫瘍肛門側への直角鉗子装着
- 3 I 式洗浄器による直腸洗浄
- 4 エンドステイプラーによる直腸切離
- 5 サーキュラーステイプラーによる吻合
- 6 肛門鏡による出血の確認
- 7 リークテスト

肛門側切離線の直腸に垂直方向にエンドステイプラーを挿入する(図1)。直腸の牽引の方向は、骨盤内で単に頭側に牽引すると図2のように直腸が斜めに切離されてしまうため、頭側背側に牽引しつつ切離を行う(図3)。このように牽引することにより、エンドステイプラーが体に対して垂直方向に設置されなくても、切離の方向は直腸と直角になる。これは、肛門が体幹の背側よりやや腹側に位置しているために、考慮しなければならない手技の注意点である。

直腸切離の際の体位は、従来の碎石位を用いると下部直腸がより肛門側に位置するようになるため、大腿開脚水平位を用いる⁵⁾。この体位が困難な場合には、碎石位の脚の角度をより水平にすると、下部直腸がより口側に位置して吻合が行いやすい。

3. 吻合

エンドステイプラーによる切離で、直腸の縫合線はI字になっている。吻合には、サーキュラスステイプラーを用いて行うが、サーキュラスステイプラーの挿入にはK式開肛器(ユフ精器社)を使用する⁶⁾。K式開肛器を使用することにより、肛門の損傷も少なく、どの吻合

器も容易に挿入が可能である。ただし、K式開肛器挿入の際には、術者が直腸切離断端をガーゼで押さえておくほうが、余計な直腸の損傷もなく、より安全である。

サーキュラスステイプラーで打ち抜く部位は(表2)、エンドステイプラーで切離した切離線の側方で後壁側を原則としている。エンドステ

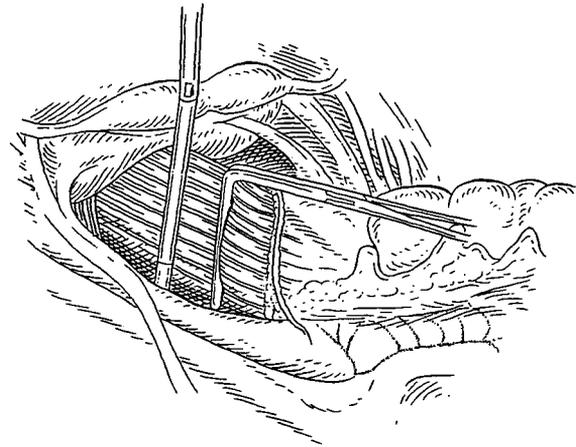


図1 IO-DSTの直腸切離

直角鉗子を掛け、直腸を洗浄後エンドステイプラーによる直腸の切離を行う。

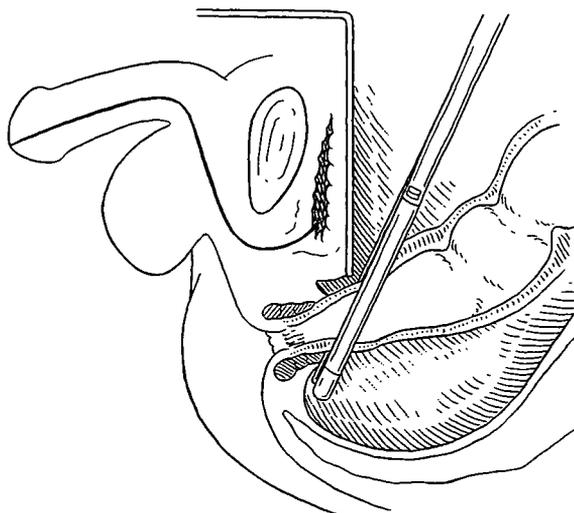


図2 エンドステイプラーの不適切な装着法

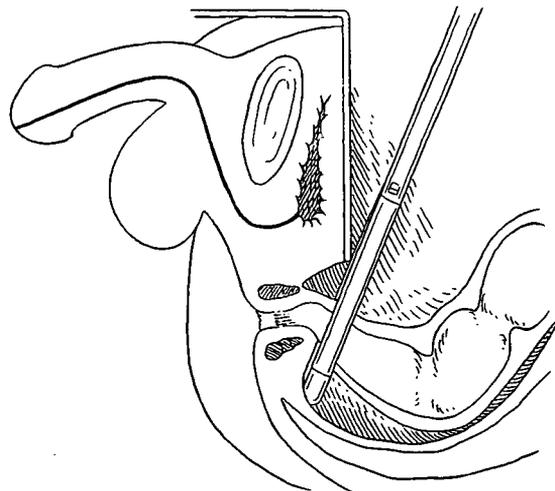


図3 エンドステイプラーの適切な装着法

表 2 IO 吻合の原則

- ・ Staple on staple 部を打ち抜く
- ・ できれば直腸切離部の背側を打ち抜く
- ・ 腔壁などの巻き込みがないことを確認
- ・ サークュラーステイプラーはエンドステイプラーによる切離部の側方に打ち出す

イプラーを 2 回使用して直腸を切離した場合には, staple on staple の部位はサーキュラーステイプラーで打ち抜くようにする。

4. 吻合後のチェック

吻合後のチェックは, とくに重要である。器械は常に万能であると考えるのでなく, そのでき具合を確認する操作を怠らない注意が必要である。

吻合後には, 肛門鏡を用いて吻合部に出血のないことを確認する。その後, 腹側から骨盤内に生理食塩液を満たし, ネラトンを経肛門より挿入し, ネラトンに接続した注射器より空気を注入しリークテストを行う。エアーリークがみられた場合には, 腹側より追加縫合を行い, 再度リークテストでエアーリークのないことを確認して, 手術を終了する。

II. single stapling と double stapling, 経肛門吻合法の比較

低位直腸癌に対する低位前方切除術を施行した際に, single stapling technique (SST) による吻合を行った 47 例と IO-DST により吻合を行った 34 例, 経肛門吻合 (PAA) を施行した 9 例を retrospective に比較検討した⁷⁾。

肛門縁から腫瘍下縁までの距離と吻合後の肛門縁からの距離は, SST に比し IO-DST を行った症例で有意に短く (7.0, 5.0 対 5.8, 4.0 cm), 低位での吻合がなされていた。経肛門吻合 (5.0, 4.0 cm) と IO-DST 間では差がなかった。

出血量は, SST (578 ml) および PAA (950 ml) に比べて IO-DST (400 ml) で有意に少なく,

手術時間は PAA (327 分) に比し IO-DST (281 分) で有意に短かった。

肛門側の腫瘍より切離断端までの距離は, 3 術式で差はなかった。

術後 1 カ月目の排便回数は, IO-DST (1 日 2.5 回) では SST (1 日 4.0 回) に比べて有意に少なく, 術後 1 年以上経過後は IO-DST (1 日 2.0 回) は PAA (1 日 3.5 回) に比べて有意に少なかった。

術後合併症や局所再発の頻度には, これらの 3 吻合術式間で差はなかった。

III. IO-DST の成績

1. 対象症例

IO-DST を施行した 105 例 (男性 76, 女性 29 例) の成績を示す。年齢の中央値は 59 歳 (range 36~86) で, 77 例には covering loop stoma を作製した。68 例には, 側方のリンパ節郭清を施行した。Dukes A が 30 例, B が 29 例, C が 36 例, D が 10 例であった。

肛門縁より腫瘍までの距離は, T1 腫瘍では 5 cm (range 4.0~10.0) で, T2-4 腫瘍では 6.5 cm (range 3.0~15.0) であった。

腫瘍より肛門側切離線までの距離は, T1 腫瘍では 2 cm (range 1.0~4.0) で, T2-4 腫瘍では 2.5 cm (range 1.0~6.0) であった。

術後の肛門縁より吻合部までの距離は, T1 腫瘍では 4.2 cm (range 3.0~6.0) で, T2-4 腫瘍では 4.0 cm (range 2.5~7.0) であった。

2. 術後の合併症

術後の合併症は, ストーマを作製した症例で合計 12 例 (15.6%), 作製しなかった症例で 4 例 (14.3%) とほぼ同等であった (表 3)。

ストーマを作製した症例での縫合不全は 3 例 (3.9%) で, 作製しなかった症例では 2 例 (7.1%) であった (表 3)。ストーマを作製した症例では, 狭窄, 直腸腔瘻, 術後イレウス, 術後腸炎がおのおの 1 例 (各 1.3%) みられ, 創感染も 5 例 (6.5%) みられた。ストーマを作製しなかった

表3 IO-DST 術後の合併症

| | ストーマあり (n = 77) | ストーマなし (n = 28) |
|------|--------------------|--------------------|
| 縫合不全 | 3 (3.9%) | 2 (7.1%) |
| 狭窄 | 1 (1.3%) | 0 (0%) |
| 直腸腔瘻 | 1 (1.3%) | 0 (0%) |
| イレウス | 1 (1.3%) | 0 (0%) |
| 腸炎 | 1 (1.3%) | 1 (3.6%) |
| 創感染 | 5 (6.5%) | 1 (3.6%) |
| 計 | 12 (15.6%) | 4 (14.3%) |

表4 IO-DST 術後の再発

| | |
|------|------------|
| 治癒切除 | 92 (100%) |
| 計 | 12 (13.0%) |
| 肝臓 | 7 (7.6%) |
| 肺 | 6 (6.5%) |
| 骨盤内 | 4 (4.3%) |
| リンパ節 | 1 (1.1%) |
| 脳 | 1 (1.1%) |
| 骨 | 1 (1.1%) |

*吻合部再発はなし

症例では、術後腸炎が1例(3.6%)、創感染が1例みられている。

3. 術後再発

治癒切除例92例では、再発は合計12例(13.0%)みられた(表4)。遠隔転移が主にみられ、骨盤内の局所再発は4例(4.3%)にみられたが、吻合部再発はみられなかった。

4. 術後排便機能

IO-DST 術後の術後1カ月目の排便機能は、ストーマのなかった症例で1日3.5回(range 1~10)、ストーマ造設例では閉鎖術後1カ月目で4.0回(range 1~10)と早期より良好であった(表5)。

術後1年目には、ストーマのなかった症例で1日2.0回(range 1~4)、ストーマ造設例では3.0回(range 0.5~5)であった。

表5 IO-DST 術後の排便機能

| | ストーマあり (n = 77) | ストーマなし (n = 28) |
|--------------------|--------------------|--------------------|
| n | 69 | 27 |
| 排便回数(日) (術後1カ月) | 4.0 (1~10) | 3.5 (1~10) |
| n | 67 | 21 |
| 排便回数(日) (術後1年) | 3.0 (0.5~5) | 2.0 (1~4) |

n: 症例数 () 内は range

よって形成された吻合口が肛門管と同様の垂直方向に長い楕円形の形状をしているためと考えている。

より安全な吻合を行う際にもっとも重要であるのは、安定した手技を確実にを行い、その結果を逐次確認する操作を行うことであることを最後に申し述べたい。

おわりに

エンドステイプラーを使用して直腸を垂直方向に切離(I字形)したのち、サーキュラーステイプラーを使用して吻合(O字形)するIO-DSTの手術手技と成績について概説した。本吻合法では、最終的に垂直方向に長い楕円形の吻合口が形成されることになる。術後早期より良好な排便機能が得られるのは、本吻合法に

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Morphological characteristics of lateral pelvic lymph nodes in rectal carcinoma

Hiroyoshi Matsuoka · Tadahiko Masaki ·
Masanori Sugiyama · Yutaka Atomi ·
Yasuo Ohkura · Atsuhiko Sakamoto

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Abstract

Aim Macroscopic and imaging indicators for lymph node metastasis have been documented not in lateral pelvic lymph nodes but in mesorectal lymph nodes in patients with rectal carcinoma. We conducted this study to uncover morphological characteristics of lateral pelvic lymph nodes in patients with rectal carcinoma.

Materials and methods Fifty-eight patients with locally advanced rectal carcinoma who had total mesorectal excision and lateral pelvic lymph node dissection were studied. Total number of lateral pelvic lymph nodes evaluated was 462, with 538 mesorectal lymph nodes being used for comparison. Factors of lymph nodes evaluated were size (long- and short-axes diameters), shape (ovoid and irregular), and heterogeneity of internal structure. Receiver operating characteristic (ROC) curve analysis was used to compare the diagnostic accuracy of each factor.

Results Lateral pelvic lymph node at non-metastatic status appeared to be longer (4.5 vs 3.5 mm) and thinner (2.2 vs 2.6 mm) than mesorectal lymph nodes. ROC curve analysis, for discriminating non-metastatic and metastatic lateral pelvic lymph nodes, revealed that a short-axis diameter appeared to be the most prominent factor with highest area under curve (0.907) and was more reliable than either long-axis diameter (0.811) or shape (0.527) other than internal structure (1.00). A short-axis diameter was an

independent risk factor for metastasis by multivariate analysis with an odds ratio of 1.29 ($p < 0.0001$, 95% confident interval, 1.22–1.36). The most reliable cut-off value was 4 mm with 96% of sensitivity, 68% of specificity, and 82% of overall accuracy.

Conclusion Lateral pelvic lymph nodes tended to be longer and thinner than mesorectal lymph nodes at non-metastatic status. A short-axis diameter of 4 mm or larger was the prominent indicator of metastasis in lateral pelvic lymph nodes.

Keywords Lateral pelvic lymph node · Lateral pelvic lymph node dissection · Rectal cancer · Mesorectal excision

Introduction

As the characteristics of mesorectal lymph nodes have been closed up following the introduction of total mesorectal excision [1], pathological characteristics of these lymph nodes were already clarified [2–6]. Furthermore, optimal criteria for preoperative imaging diagnosis of mesorectal lymph nodes have already been demonstrated [7–9]. In terms of lateral pelvic lymph nodes metastasis, it is an important factor for local recurrence and survival, and dissection is needed, if metastasis is detected [10–12].

Although it has recently been reported that accuracy of preoperative diagnosis of lateral pelvic lymph nodes was higher than that of mesorectal lymph nodes, the optimal diagnostic criteria are still controversial [13].

When clarifying optimal preoperative diagnostic criteria, pathologic exploration would be needed beforehand. However, there has been no paper describing the pathological characteristics of lateral pelvic lymph nodes. Therefore, we conducted this study to clarify morphological character-

H. Matsuoka (✉) · T. Masaki · M. Sugiyama · Y. Atomi
Department of Surgery, Kyorin University, School of Medicine,
Tokyo, Japan
e-mail: hiroelvis@aol.com

Y. Ohkura · A. Sakamoto
Department of Pathology, Kyorin University, School of Medicine,
Tokyo, Japan

Table 1 Comparison between non-metastatic mesorectal and lateral pelvic lymph nodes

| | | Non-metastatic LPLNs (440) | Non-metastatic MRLNs (420) | <i>p</i> |
|-------------------------------|-----------|----------------------------|----------------------------|-------------------|
| Long-axis diameter (mm) | Mean | 4.5 | 3.5 | <i>p</i> <0.01 |
| | Range | 0.3–22.0 | 0.1–12.0 | |
| Short-axis diameter (mm) | Mean | 2.2 | 2.6 | <i>p</i> <0.0001 |
| | Range | 0.3–10.0 | 0.1–8.0 | |
| Shape (number of lymph nodes) | Ovoid | 257 (59%) | 374 (89%) | <i>p</i> <0.00001 |
| | Irregular | 183 (41%) | 46 (11%) | |

MRLN Mesorectal lymph nodes, *LPLN* lateral pelvic lymph nodes

istics of lateral pelvic lymph nodes by comparing them with those of mesorectal lymph nodes as counterpart.

Materials and methods

Fifty-eight patients with locally advanced rectal carcinoma (tumor, node and distant metastasis, T3 or T4 stage) who had total mesorectal excision and lateral pelvic lymph node dissection between July 1997 and June 2006 were studied. We performed lateral pelvic lymph node dissection similarly as reported in the previous literatures [10–12]. Unilateral dissection was performed when the tumor was located in the right or left side. Bilateral dissection was performed when the tumor occupied more than half of the rectal circumference or was situated at the anterior or posterior parts of the rectum. All visible and palpable lateral

pelvic lymph nodes were harvested, fixed in 10% formalin, embedded in paraffin blocks, and sectioned along the greatest dimension.

Hematoxylin and eosin staining was performed, and histological findings were recorded in the computer database. Total number of lateral pelvic lymph nodes evaluated was 462 (positive for metastasis, 22; negative for metastasis, 440), with 420 non-metastatic mesorectal lymph nodes being used for comparison. Factors of lymph nodes evaluated were size, shape, and internal structure. Long- and short-axes diameters were measured on the pathologic slides. Shape was categorized into ovoid (round or ellipse) and irregular (other than round and ellipse). Heterogeneity of internal structure was categorized into negative or positive. Heterogeneity was defined as positive if the tumor deposit destroyed lymph follicle. Therefore, this was the gold standard of metastasis.

Statistical analysis was performed using SPSS version 6.1 for Windows (SPSS Japan, Tokyo, Japan). Univariate analysis was obtained with Mann–Whitney *U* test for numeric data and Fisher's exact test for categorized data. Difference was considered significant when a *p* value was less than 0.05. Multivariate analysis was performed by logistic regression analysis.

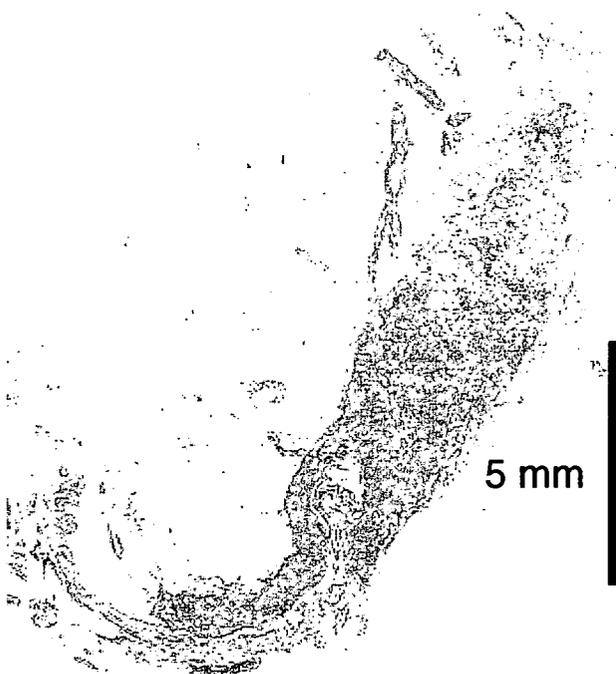


Fig. 1 A non-metastatic lateral pelvic lymph node, 14 mm in a long axis diameter with irregular shape and no tumor involvement. A black line indicates 5 mm (hematoxylin and eosin stain)

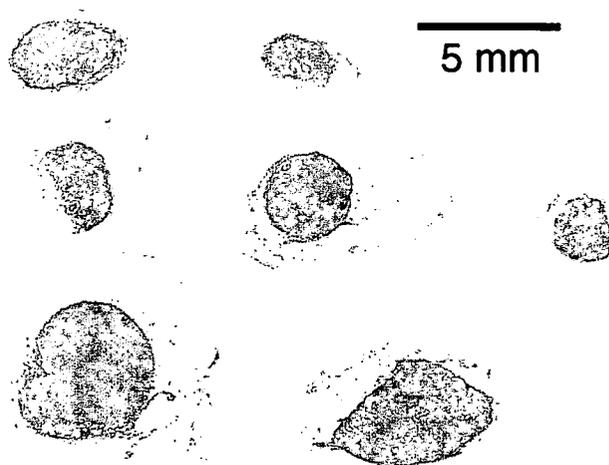


Fig. 2 Non-metastatic mesorectal lymph nodes. Long-axis diameter, 5 mm or less, with ovoid shape and homogenous internal structure. A black line indicates 5 mm (hematoxylin and eosin stain)

Table 2 Comparison between non-metastatic and metastatic lateral pelvic lymph nodes

| | | Non-metastatic LPLNs (440) | Metastatic LPLNs (22) | <i>p</i> |
|-------------------------------|-----------|----------------------------|-----------------------|--------------------|
| Long-axis diameter (mm) | Mean | 4.5 | 10.0 | <i>p</i> < 0.00001 |
| | Range | 0.3–22.0 | 3.0–25.0 | |
| Short-axis diameter (mm) | Mean | 2.2 | 6.9 | <i>p</i> < 0.00001 |
| | Range | 0.3–10.0 | 2.0–16.0 | |
| Shape (number of lymph nodes) | Ovoid | 257 (59%) | 14 (64%) | ns |
| | Irregular | 183 (41%) | 8 (36%) | |

LPLN Lateral pelvic lymph nodes, *ns* not significant

Receiver operating characteristic (ROC) curve analysis was used to compare the diagnostic accuracy of each factor. It represents that, when a ROC curve approaches nearest to the point (0,1), both sensitivity and specificity are highest. Area under ROC curve was used for the evaluation of an optimal criterion. When both sensitivity and specificity are



Fig. 3 A metastatic lateral pelvic lymph node, 15 mm in a long axis diameter with irregular shape and half heterogenous change in internal structure by tumor involvement (hematoxylin and eosin stain)

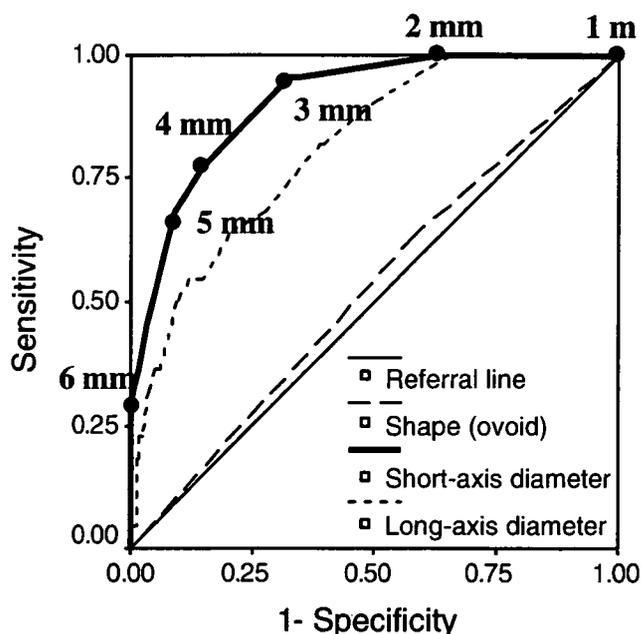


Fig. 4 ROC curves in terms of lateral pelvic lymph nodes metastasis

100%, area under ROC curve indicates value 1, whereas when both sensitivity and specificity are 0%, area under ROC curve indicates value 0 [14–16]. In the ROC curve analysis, areas under curves were represented to clarify diagnostic accuracy of each factor. Long- and short-axes diameters were analyzed as numeric data. Ovoid shape was chosen as metastatic criteria because the majority of metastatic nodes were ovoid (64% in metastatic lateral pelvic lymph nodes). Presence of heterogeneity in internal structure was used as a gold standard as metastasis because all of metastatic nodes were heterogeneous due to tumor involvement.

Results

Mean number of lateral pelvic lymph nodes harvested in each case was 12 (range 1–38). Of these, mean number of metastatic lateral pelvic lymph nodes was 1 (range 0–8) per case. The number of mesorectal lymph nodes harvested in each case ranged from 4 to 22, with a mean of 14. Of these,

Table 3 Logistic regression analysis for risk factor of metastasis

| | Odds ratio | 95% Confidence interval | <i>p</i> |
|---------------------|------------|-------------------------|----------|
| Long-axis diameter | x | x | ns |
| Short-axis diameter | 1.29 | 1.22–1.36 | <0.0001 |
| Shape (ovoid) | x | x | ns |

ns Not significant

mean number of metastatic mesorectal lymph nodes was 1 (range 0–9) per case.

As shown in Table 1, in the non-metastatic lymph node groups, lateral pelvic lymph nodes appeared to be longer than mesorectal lymph nodes in a long-axis diameter (mean 4.5 vs 3.5 mm, $p < 0.01$), and shorter in a short-axis diameter (mean 2.2 vs 2.6 mm, $p < 0.0001$). Non-metastatic lateral pelvic lymph nodes appeared to be long and irregular in shape, whereas mesorectal lymph nodes were likely to be ovoid (Figs. 1 and 2).

As shown in Table 2, although there was no significant difference in terms of shape between metastatic and non-metastatic lateral pelvic lymph nodes, long (mean 10.0 vs 4.5 mm, $p < 0.00001$) and short-axis diameter (mean 6.9 vs 2.2 mm, $p < 0.00001$) were significantly increased (Fig. 3). As shown in Fig. 4, a short-axis diameter showed the highest area under curve and was more reliable than either a long-axis diameter or shape other than internal structure in the evaluation of lymph node metastasis. By multivariate analysis, a short-axis diameter was the independent risk factor for metastasis with an odds ratio of 1.29 ($p < 0.0001$, 95% confident interval, 1.22–1.36; Table 3). A cut-off value of lymph node metastasis was 4 mm in a short-axis diameter (Fig. 4). Sensitivity was 96%, specificity was 68%, and overall accuracy was 82%, respectively.

Discussion

The characteristics of lymph nodes are different by the location of nodes [17, 18]. It has already been reported in the mediastinal lymph nodes in lung carcinoma [19, 20]. These reports suggested that distinguished cut-off value is needed in each location of lymph nodes. However, in the pelvic lymph nodes, such observation has not yet been reported.

Although mesorectal lymph nodes have been well discussed in terms of their characteristics [2–6], lateral pelvic lymph nodes have seldom been discussed so far. There was only one report from Canessa et al. [21] describing size of lateral pelvic lymph nodes in disease-free cadavers. However, they did not evaluate tumor-bearing lateral pelvic lymph nodes. In the present study, we found that the significant morphologic indicator of metastasis was a short-axis diameter. There have been some reports showing that a short-axis diameter was a more reliable indicator of a metastatic lymph node than a long-axis diameter due to its less oriented bias [22, 23]. A similar finding was noted also in the present study. Clinical utility of a short-axis diameter should be examined in the preoperative imaging diagnosis of lymph node metastasis.

There are a lot of imaging tools to date such as ultrasonography, magnetic resonance imaging (MRI), multi-

detector or multislice computed tomography, sentinel lymph node mapping, and positron emission tomography (PET). However, preoperative diagnosis of lymph node metastasis is still a challenge because of fatal drawbacks such as micrometastasis or existence of slice intervals. Some authors stated that sentinel lymph node biopsy for lymph node metastasis was a useless procedure [24, 25]. Although PET scan is helpful to detect distant metastasis, diagnostic ability in lymph node staging is still unsatisfactory with approximately 50% of accuracy [26, 27]. In terms of detection of lateral pelvic lymph node metastasis, Arii et al. [13] has recently described that MRI is superior to CT scan due to its high resolution. Hopefully, we would like to address on this issue by using MRI in the next step.

Conclusions

Lateral pelvic lymph nodes tended to be longer and thinner than mesorectal lymph nodes. A short-axis diameter was a significant indicator for metastasis. A cut-off value of metastatic lateral pelvic lymph node was 4 mm in a short-axis diameter.

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