Surg Endosc (2011) 25:861–866
DOI 10.1007/s00464-010-1284-7

Laparoscopic lymph node dissection around the inferior mesenteric artery with preservation of the left colic artery

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Received: 20 December 2009 / Accepted: 26 July 2010 / Published online: 20 August 2010

Abstract
Aim Curative resection of sigmoid and rectal cancer includes "high tie" of the inferior mesenteric artery (IMA). However, IMA ligation compromises blood flow to the anastomosis, which may increase the leakage rate. Accordingly, some surgeons employ a technique of lymph node (LN) dissection around the IMA, preserving the IMA and left colic artery (LCA). The same technique was reported to need longer time in laparoscopic surgery due to technical difficulties. We present herein a simple and secure method of laparoscopic LN dissection around the IMA that allows preservation of the IMA and LCA, and report the operative results.
Methods Our method involves peeling off the vascular sheath from the IMA and dissection of the LN around the IMA together with the sheath. The feasibility of the technique was evaluated in 72 consecutive cases of laparoscopic resection of sigmoid and rectal cancer.
Results The IMA was ligated at its root in 27 cases (high tie, group A). Lymph nodes around the IMA were dissected with preservation of the IMA and LCA in 21 cases (group B). The root of the superior rectal artery was ligated in 24 cases of Tis and T1N0 ("low tie," group C). Mean operative time was 207.6, 221.2, and 198.5 min for group A, B, and C, respectively. Respective blood loss was 47.8, 44.0, and 58.5 g, and mean numbers of harvested LN were 17.3, 16.3, and 10.7. None of the operative results of groups A and B were different statistically. LN dissection was not associated with any morbidity.
Conclusion Our method allows equivalent laparoscopic lymph node dissection to the high tie technique without excessive operative time or bleeding.

Keywords Laparoscopic · Colorectal surgery · High tie · Leakage · Blood flow

In curatively intended resection of sigmoid and rectal cancer, ligation of the root of the inferior mesenteric artery (IMA), high tie, is considered necessary for wide lymph node dissection [1]. Several studies have shown the importance of lymph node dissection up to the root of the IMA in terms of better survival and precise staging [2, 3]. However, ligation of the IMA has been known to decrease blood flow to the anastomosis [4, 5]. Whether impaired blood flow could increase the leakage rate is uncertain, so several surgeons prefer a technique of lymph node dissection up to the root of the IMA, with preservation of the IMA and left colic artery (LCA) [6, 7]. Laparoscopic surgery has been employed recently for resection of colorectal cancer. The issue of high tie in this technique is similar to that for open surgery. In laparoscopic surgery, some surgeons also employ the technique of lymph node dissection around the IMA with preservation of the IMA and LCA [8]. However, this approach is technically demanding and requires a long time. We present herein an easy and secure method to dissect the lymph nodes around the IMA with preservation of the IMA and LCA in laparoscopic surgery.

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Methods

Surgical technique (Figs. 1, 2, 3)

Patients were laid in head-down position during the laparoscopic procedure. The lymph nodes were dissected after mobilizing the sigmoid colon with medial to lateral approach. In patients of group A (see below), the root of the IMA was exposed and ligated, then the inferior mesenteric vein (IMV) was ligated at the same level. In patients of group B (see below), the root of the IMA was exposed first, and the vascular sheath of the IMA was dissected to expose the tunica adventitia of the IMA. There is a loose layer between the vascular sheath and the tunica adventitia, so once the surgeon accesses this layer, it is easy to peel off the vascular sheath, and the lymph nodes are then detached from the IMA together with the vascular sheath. The vascular sheath is peeled off down to the bifurcation of the LCA and superior rectal artery (SRA), and continuously the dissection is extended towards the LCA. From where the LCA crosses the IMV, the dissection is advanced along the IMV up to the level of the root of the IMA. Finally, the sigmoid mesentery is transected from the root of the IMA to the IMV, and en bloc dissection of the lymph nodes around the IMA is completed. After dissection of the lymph node, the root of the SRA is ligated. Then the IMV is ligated just distal to the LCA. In group C (see below), the vascular sheath was dissected from the IMA, and the root of the SRA was located and ligated. During these procedures, care should be taken to preserve the left hypogastric nerve. The other procedures of the operation were similar in the three groups.

Evaluation of the technique

From January 2007 to June 2009, we prospectively collected the results of 72 consecutive, curatively operated cases of sigmoid colon and upper rectal cancer. All cases were staged preoperatively by colonoscopy and enhanced computed tomography. The method of lymph node dissection was decided preoperatively according to the stage of the individual case. The IMA was ligated at its root when lymph node metastasis was suspected along the IMA and/or SRA (group A). In cases of Tis and T1, the root of the SRA was ligated, and dissection of lymph nodes around the IMA was not attempted (group C). Otherwise, lymph nodes around the IMA were dissected but the IMA and LCA was preserved (group B). The operative time, estimated blood loss, intra- and postoperative morbidity, and number of dissected lymph nodes in these three groups were compared.

Statistical analysis

Differences between two groups were analyzed using the Student *t*-test. *p*-Value less than 0.05 was considered statistically significant.

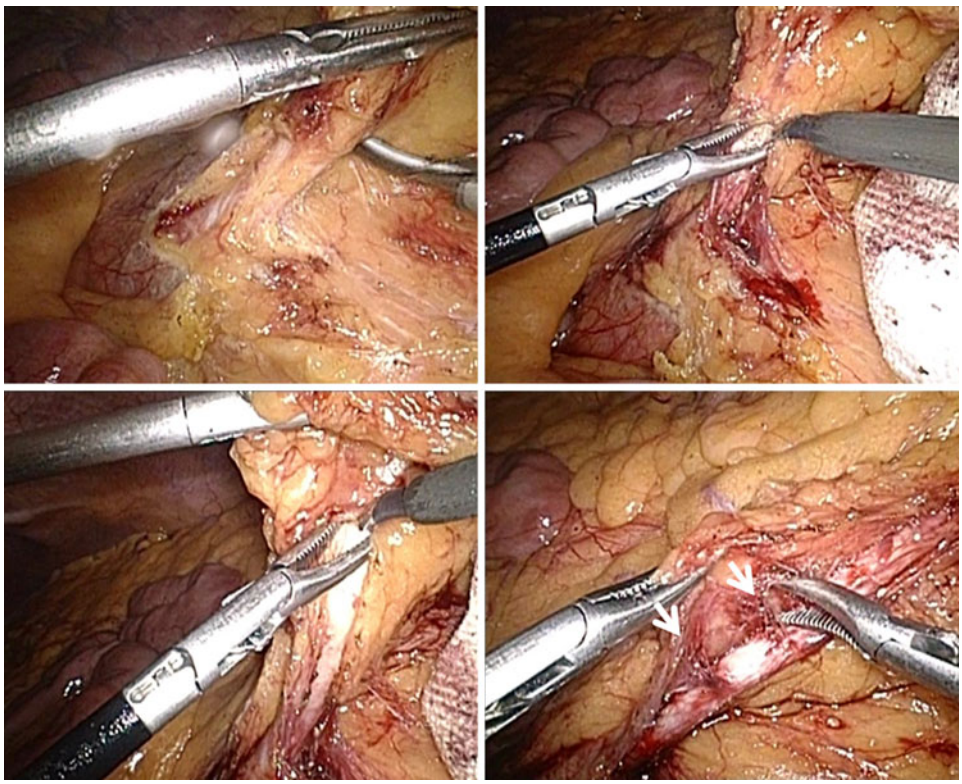

Fig. 1 Operative technique (part 1). *Top left:* The root of the IMA is exposed. *Top right:* Dissection of the vascular sheath commences from the root of the IMA. *Bottom left:* Dissection is advanced distally. *Bottom right:* Several small vessels (*arrow*) encountered between the vascular sheath and the tunica adventitia of the IMA, which are coagulated and cut using electrocautery

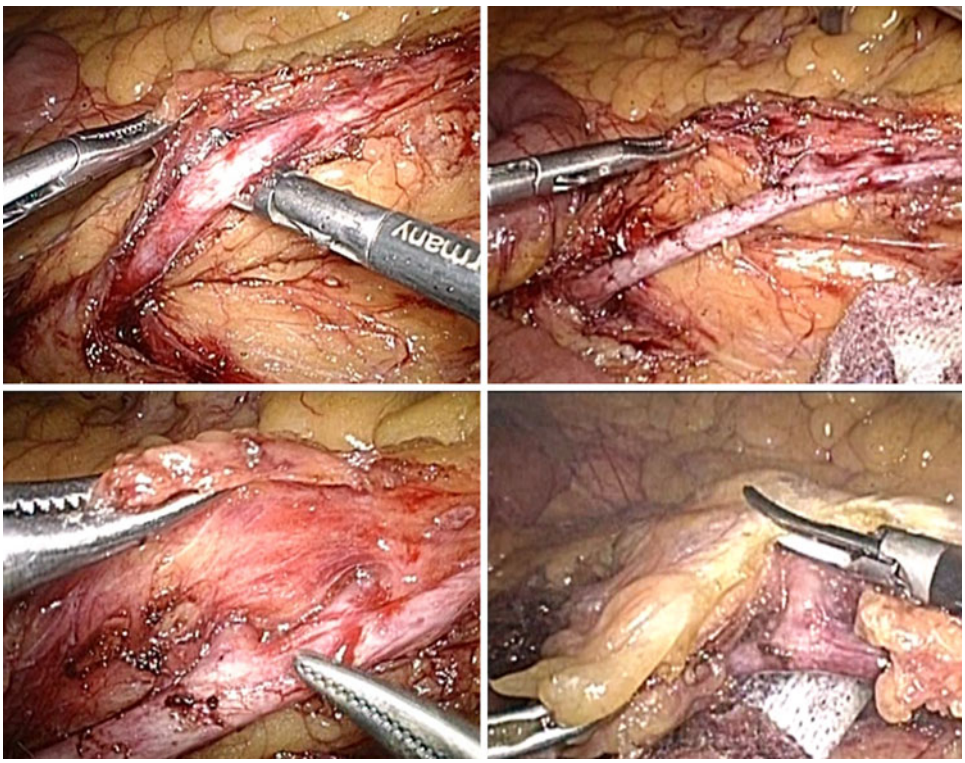

Fig. 2 Operative technique (part 2). *Top left:* During lymph node dissection, the surgeon grasps the vascular sheath instead of the lymph nodes. *Top right:* From the root of the IMA to the bifurcation of the LCA and SRA, the entire vascular sheath is peeled off. *Bottom left:* The bifurcation of the LCA and SRA, and the branch to the sigmoid colon; as shown here, the vascular sheath is made of fine fibrous tissues and is a firm membranous structure. *Bottom right:* The mesentery was transected along the LCA. From the cross point of the IMV and LCA, the dissection is advanced along the IMV up to the level of the root of the IMA

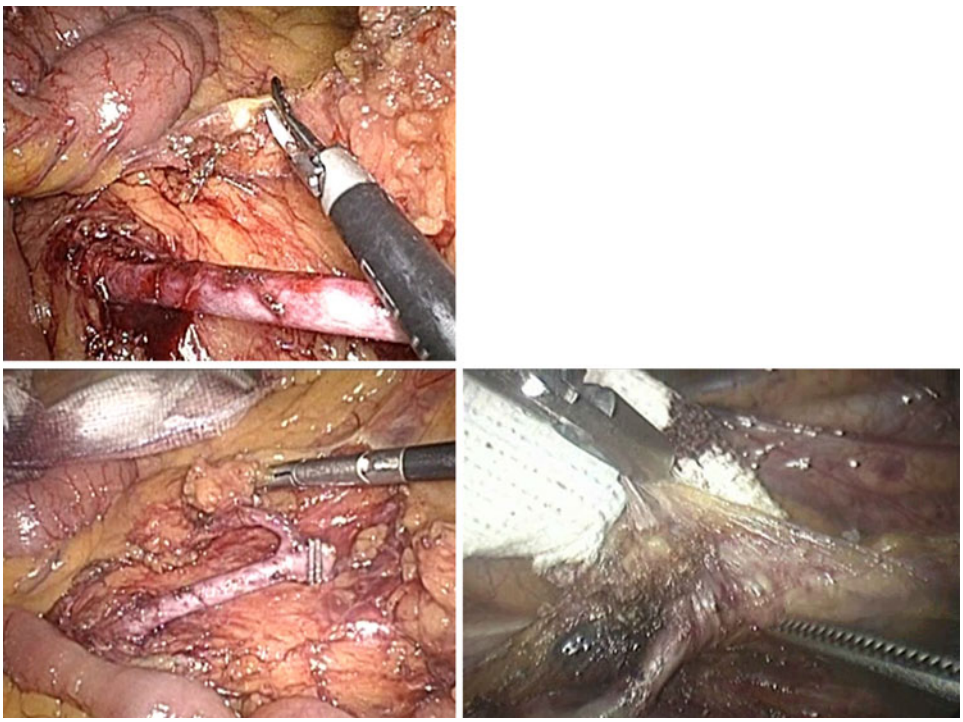

Fig. 3 Operative technique (part 3). *Top:* The mesentery is transected transversely from the root of the IMA to the IMV, to complete the lymph node dissection. *Bottom left:* Following lymph node dissection, the root of the SRA is ligated and cut; the skeletonized IMA and LCA are shown. *Bottom right* (a different case): Note the presence of dense fibrous tissues around the vascular sheath, which interferes with the lymph node dissection by conventional technique

Results (Tables 1, 2)

Among 72 cases, 27 were categorized as group A, 21 cases as group B, and 24 cases as group C. All cases underwent lymph node dissection as scheduled. The male-to-female ratio, age, body mass index, and American Society of Anesthesiologists (ASA) score of the three groups were not different. The operative time of group A, B, and C was 207.6, 221.2, and 198.5 min, respectively. The blood loss was 47.8, 44.0, and 58.5 g, respectively. None required

Table 1 Clinical background of participating patients

	Group A	Group B	Group C
n	27	21	24
Male/female	11/16	12/9	13/11
Age (years)	62.1	64.9	62.9
ASA score 1/2/3[a]	13/13/1	11/10/0	16/7/1
BMI	22.0	22.4	21.9
Previous Abdominal Surgery	6	6	9

BMI body mass index

[a] American Society of Anesthesiologists (ASA) physical status classification system: (1) a normal healthy patient, (2) a patient with mild systemic disease, (3) a patient with severe systemic disease, (4) a patient with severe systemic disease posing a constant threat to life, (5) a moribund patient who was not expected to survive without the operation, (6) a declared brain-dead patient whose organs were dissected out for donation. The proportions of the three groups were not different

blood transfusion. The mean number of harvested lymph nodes was 17.3, 16.3, and 10.7 for groups A, B and C, respectively. None of the operative results of group A and B were statistically different. One case in each group required conversion to open surgery. The reasons for conversion were intra-abdominal adhesion due to previous surgery in two cases, and elevated central venous pressure due to pneumoperitoneum in one case. In group C, bowel injury occurred during adhesiolysis, but was repaired laparoscopically. No intra- or postoperative morbidities associated with lymph node dissection were encountered in the entire cohort. Reoperation was required in one case of group C for anastomotic leakage. Postoperative recovery of bowel movements and hospital stays of group A, B, and C were not different.

Discussion

Several groups have discussed the significance of thorough lymph node dissection up to the root of the IMA [9]. Kanemitsu et al. [2] indicated that the high tie contributed to survival prolongation. They reported that the 5-year survival rate of patients who had lymph node metastasis around the IMA but underwent lymph node dissection up to the root of the IMA was as good as 40%. Chin and colleagues presented similar result [3]. Titu et al. [1] stressed that the high tie was important for precise staging of the cancer. In contrast, the drawbacks of the high tie have been discussed by other groups. For example, Dworkin and Allen Mersh [4] assessed the influence of clamping of the IMA, using Doppler flowmetry. They showed that the blood flow to the sigmoid colon fell by 50% during at least 5 days postoperatively. Similar results were reported by Seike et al. [5]. Furthermore, other reports discussed the influence of IMA ligation on anastomotic leakage. Tocchi et al. [10] assessed the influence of IMA preservation on the leakage rate in 163 cases with diverticular disease in the left colon in a randomized controlled study, and indicated that radiologically and clinically detected leakages were significantly higher with ligation of the IMA. With regard to cancer surgery, Corder et al. [11] reported that the leak rate was not different between high tie and low tie; however, their study was retrospective in

Table 2 Operative results

	Group A	Group B	Group B	
n	27	21	24	
Operative time (min)	207.6	221.2	198.5	Group A versus group B; $p = 0.173$
Blood loss (g)	47.8	44.0	58.5	
Conversion to open surgery	1	1	1	
Intraoperative morbidity	0	0	1 bowel injury	
Diverting stoma	0	0	0	
Harvested lymph nodes	17.3	16.3	10.7	Group A versus group B; $p = 0.333$
Postoperative morbidity	Ileus, gastric ulcer, delirium, herpes zoster	Subcutaneous emphysema, anastomotic bleeding	Ileus, anastomotic bleeding, anastomotic leakage, portal thrombosis	
Reoperation	0	0	1	
POS (days)	14.7	11.1	14.3	Group A versus group B; $p = 0.093$

All postoperative morbidities, excluding one case of group C with anastomotic leakage, improved conservatively. There was no mortality

POS postoperative hospital stay

nature, conducted in only 30 cases. Based on the above background, some surgeons prefer lymph node dissection up to the root of the IMA with preservation of the IMA and LCA [6, 7] Recently, laparoscopic surgery has been indicated for curative resection of rectal cancer [12–17]. With regard to the method of lymph node dissection around the IMA, Hino et al. [8] analyzed the data of laparoscopic resection of rectal cancer conducted in major hospitals in Japan. Laparoscopic resection of rectal cancer with lymph node dissection up to the root of the IMA was performed in 411 cases. Among them, 155 cases included preservation of the IMA and LCA.

Laparoscopic dissection of lymph nodes with preservation of the IMA and LCA is technically demanding and requires a long time [18]. The reason for the difficulty is the dense fibrous tissue around the IMA (Fig. 3, lower right). This fibrous tissue is dense outside the vascular sheath and thus interferes with the dissection of lymph node from the vascular sheath. The method presented in this report describes accessing the layer between the vascular sheath and the tunica adventitia as the first step of lymph node dissection. Previous reports on lymph node dissection around the IMA did not refer specifically to the layer of dissection; however, we emphasize here the importance of the dissection of this layer. Between the vascular sheath and the artery, there are only several small vessels. They are easily managed using electrocautery. The fibrous tissue outside the vascular sheath does not exist inside the vascular sheath, so the vascular sheath is easily and promptly peeled off from the artery. Lymph nodes around the IMA were dissected together with the peeled vascular sheath. The other merit of our method is that the surgeon can grasp the vascular sheath instead of the lymph nodes themselves during dissection of the lymph nodes. The vascular sheath is a firm fibrous tissue and thus can be grasped easily. This allows the surgeon to dissect the lymph nodes promptly and prevents injury to the lymph nodes during dissection.

In our technique, we set the lateral border of the lymph node dissection at the medial sides of the IMV and LCA. The IMV was ligated just distal to the LCA. Compared with the high tie, lymph nodes outside the IMV were not dissected. However, there were few lymph nodes in this area. In fact, there was no difference in the number of harvested lymph nodes between groups A and B. Thus, we do not think that our method compromises the radicality of the operation.

Thus, laparoscopic lymph node dissection around the IMA including IMA and LCA preservation did not require longer operative time than the high tie, and the number of harvested lymph nodes and the associated morbidity were the same in the two techniques. In conclusion, laparoscopic lymph node dissection around the IMA preserving the root of the IMA and LCA was feasible by our method, without compromising operation time, blood loss, operative safety or the number of harvested lymph nodes. However, how preservation of blood flow could contribute to improvement of the leakage rate without compromising oncological results remains unclear. Further studies are required to confirm that this technique contributes to better clinical outcome in laparoscopic colorectal surgery.

Disclosures Authors Mitsugu Sekimoto, Ichiro Takemasa, Tsunekazu Mizushima, Masataka Ikeda, Hirofumi Yamamoto, Yuichiro Doki, and Masaki Mori have no conflicts of interest or financial ties to disclose.

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