

Simplifying Laparoscopic Surgery for Left Side Colon and Rectal Cancer Using Linear Stapler for Vascular Ligation: A Prospective Cohort Study

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Abstract

Introduction: Systematic lymphadenectomy and ligation of the feeding artery is extremely important when performing radical resection in colorectal cancer. However, vascular surgery via laparoscopy requires advanced skills and techniques; thus, this procedure needs to be simplified while maintaining quality of the surgery to make it a preferred technique for the surgeons. **Methods:** There were 49 patients who underwent laparoscopic sigmoidectomy or anterior resection till T2 level for sigmoid colon cancer and recto-sigmoid colon cancer. We analyzed short-term and long-term outcomes between stapling ligation and clipping ligation techniques used in these surgeries. **Results:** The mean volume of blood loss in the stapling ligation group was 12.8 ± 12.3 ml, which was significantly lower than 41.9 ± 71.2 ml of mean volume of blood loss in the clipping ligation group. There was no significant difference in the mean duration of surgery, the mean number of harvested lymph nodes, morbidity, recurrence, and 5-year relapse free survival rates between the 2 groups. **Conclusions:** This study demonstrates a surgical technique using staplers for vascular treatment of tumor-feeding arteries as a new technical improvement in laparoscopic colectomy for the treatment of early-stage colon cancer. We found that the described procedure was technically safe, simple, convenient, and oncologically valid.

Keywords

Laparoscopic Surgery, Colorectal Cancer, Vascular Ligation, Linear Stapler

1. Introduction

Since Jacobs *et al.* reported the first laparoscopic colectomy in 1991 [1], it has become popular as a minimally invasive surgical technique that offers excellent cosmetic results. In recent years, this technique has been used in rectal resection for rectal cancer, and is likely to become even more widely used in the future. The greatest advantage of laparoscopic surgery is that it is minimally invasive. The small size of the surgical incision has led to improvements in the cosmetic aspects of the surgery and reduced wound pain. Furthermore, intestinal peristalsis is maintained during the surgery; thus, the technique also offers great advantages such as early ambulation and a shorter period to initiate oral intake of food and water [2] [3] [4] [5] [6]. Additionally, the added magnification of endoscopes has facilitated better understanding of microscopic blood vessels and nerves. Thus, it has enabled reduction in the amount of blood loss and increase in nerve preservation.

Systematic lymphadenectomy through ligation of the feeding artery is extremely important when performing radical resection in colorectal cancer. However, vascular surgery via laparoscopy requires advanced skills and techniques; thus, this procedure needs to be simplified while maintaining quality of the surgery to make it a preferred technique for the surgeons. In laparoscopic surgery for colorectal cancer, there are no reports of long and short-term outcomes on vascular ligation using linear stapler. To simplify the procedure of laparoscopic surgical treatment of early-stage colorectal cancer, we used surgical staplers to perform vascular reconstruction during lymphadenectomy. We analyzed if this surgical method was technically safe and valid from an oncological viewpoint in this study.

2. Materials and Methods

2.1. Data Source

This study included 49 patients with sigmoid colon and recto-sigmoid colon cancer who had been selected from a list of patients with early-stage colorectal cancer (until T2 level). These patients had undergone laparoscopic radical colectomy with D2 lymphadenectomy in accordance with the Guidelines for the Treatment of Colon Cancer in Japan [7] at Kitasato University (Sagamihara, Japan) between January 2006 and December 2011. According to the vascular reconstruction method performed during lymphadenectomy, they were categorized into 2 groups. In one group, linear stapler was used (stapling ligation), while in the other, clips were used (clipping ligation). The stapling ligation was used in 35 patients (20 underwent sigmoidectomy and 15 underwent anterior resection) and clipping ligation was used in 14 patients (10 underwent sigmoidectomy and 4 underwent anterior resection) (Table 1). Blood loss, duration of surgery, number of harvested lymph nodes, morbidity, recurrence, and five-year relapse-free survival, were obtained from the medical records and analyzed in detail.

2.2. Surgical Technique

In vascular reconstruction using staplers, detachment and mobilization of the mesocolon using the internal approach was performed and was followed by an incision in the avascular area of the mesocolon. Following this, the mesentery was opened, a stapler was inserted, and superior rectal artery, inferior mesenteric vein, and adipose tissue of the mesocolon were ligated and detached (**Figure 1(a)**). The avascular area of the mesocolon was identified as an area between proximal left colic artery and the marginal vessels, lateral to the superior rectal artery (**Figure 1(b)**). Endo GIA™ Tri-Staple™ Technology 45-mm Grey cartridge (Medtronic, Minneapolis, MN) was used as the surgical stapler.

In vascular reconstruction using clips, the same technique was used for the separation and mobilization of the mesocolon. Identification and exposure of the avascular area were followed by double-clipping for vascular reconstruction. Ligation and separation were performed to complete the vascular reconstruction of the procedure.

2.3. Statistical Analysis

Statistical analysis was performed using JMP version 11.0.2 (SAS Institute). Mann–Whitney U test was used to analyze differences between stapling ligation

Table 1. Patient characteristics.

	Stapling n = 35	Clipping n = 14	<i>P</i>
Mean age (years ± SD)	64.4 ± 10.3	65.7 ± 11.2	0.58
Gender Male/Female	16/19	9/5	0.29
Procedure			
Sigmoidectomy/Anterior resection	20/15	10/4	0.41
pT factor <T2/T2	30/5	10/4	0.22
pN factor N0/N1	32/3	14/0	0.20
Median follow-up times (months, range)	73.2 (41.9 - 108.8)	69.5 (32.3 - 108.7)	0.98

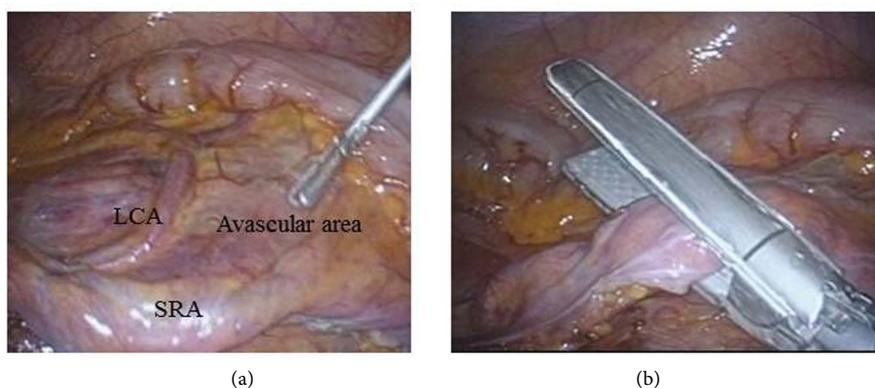


Figure 1. Vascular pedicle ligation technique. After mobilizing from retroperitoneum with medial approach, we opened the avascular area of mesentery (a) and ligated the vascular pedicle with a linear stapler (b). LCA: left colic artery, SRA: superior rectal artery.

and clipping ligation techniques, and a p -value <0.05 was considered to indicate statistical significance.

2.4. Ethical Statements

All patients were given detailed explanation and informed written consents were obtained in accordance with the guidelines of the Declaration of Helsinki.

3. Results

In stapling ligation group, the mean age of patients (males, 16; females, 19) was 64.4 ± 10.3 years, and the median follow-up period was 73.2 (range, 41.9 - 108.8) months (Table 1). The mean age of patients (males, 9; females, 5) in clipping ligation group was 65.7 ± 11.2 years, and the median follow-up period was 69.5 (range, 32.3 - 108.7) months (Table 1).

The mean duration of surgery was 203.6 ± 47.6 min in the stapling ligation group and 220.5 ± 51.5 min in the clipping ligation group. The mean volume of blood loss in the stapling ligation group was 12.8 ± 12.3 ml, which was significantly lower than 41.9 ± 71.2 ml lost in the clipping ligation group (Table 2). There was no significant difference in the mean number of harvested lymph nodes, morbidity, and recurrence between the 2 groups (Table 2). Five-year relapse free survival rate was 95.2% in stapling ligation group and 100% in clipping ligation group (Figure 2, $p = 0.5479$).

4. Discussion

Based on the findings of previous randomized controlled studies, a consensus has been reached regarding the efficacy and safety of laparoscopic colectomy in the treatment of early-stage colon cancer [3] [8] [9] [10] [11]. Additionally, compared with open surgery, laparoscopic surgery has been enormously beneficial to the quality of life of patients because of the reduced postoperative pain, low risk of developing a postoperative ileus, and shorter postoperative hospital stay [2] [3] [4] [5] [6]. In radical treatment of colorectal cancer, the main feeding artery needs to be ligated proximally, along with resection of the lymph nodes thereof [12] [13] [14] [15]. In recent years, lymphadenectomy with preservation

Table 2. Short-term and long-term outcomes.

	Stapling n = 35	Clipping n = 14	<i>P</i>
Operation time (min.)	203.6 ± 47.6	220.5 ± 51.5	0.29
Blood loss (ml)	12.8 ± 12.3	41.9 ± 71.2	0.02
Harvested lymph node (number)	10.9 ± 7.4	10.6 ± 7.0	0.92
Recurrence (rate, %)	1 (2.9%)	0 (0.0%)	0.55
Morbidity (rate, %)	4 (11.4%)	2 (15.4%)	0.72

Morbidity; Clavien-Dindo classification Grade III ≤.

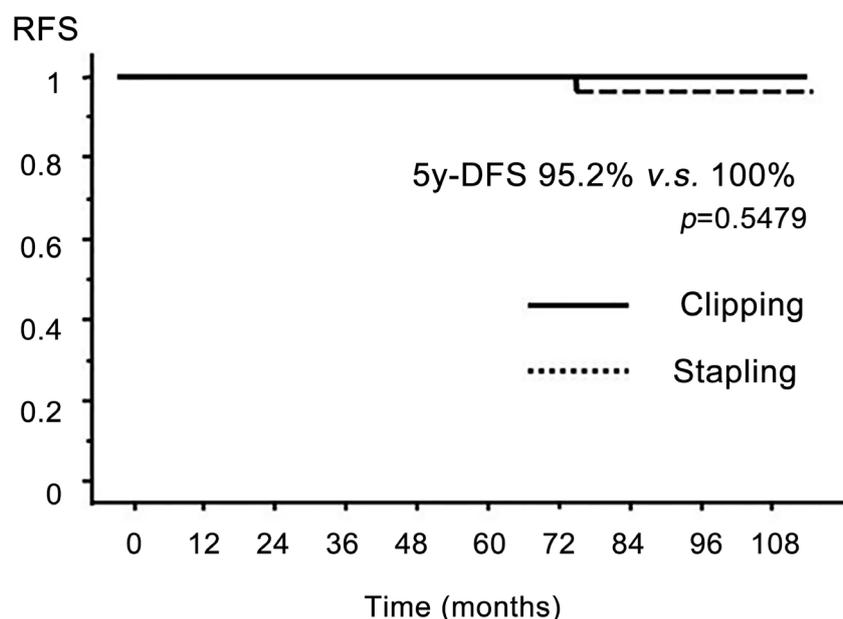


Figure 2. The 5-year relapse-free survival (RFS). There were no significant differences between the clipping ligation and stapling ligation group.

of the colic artery in laparoscopic surgical treatment of sigmoid and rectal cancers has been reported [16]. However, considerable training is required before a surgeon can perform this highly skill-intensive surgery. Thus, to further improve laparoscopic surgery in colorectal cancers, it is important to make devise new surgical techniques that are technically simple and oncologically safe.

Guidelines pertaining to the treatment of colon cancers published by the Japan Society for Cancer of the Colon and Rectum specify the ranges of lymphadenectomy to be performed depending on the depth of tumor infiltration in the intestinal wall and the extent of lymph node metastasis. According to the guidelines, D2 lymphadenectomy, which is indicated for early-stage cancers (up to the stage of cT2N0), should be combined with resection of tumor-specific lymph nodes located around the feeding artery (known as intermediate lymph nodes). In right-side colon cancers such as cecal cancer and ascending colon cancer, this is achieved through ligation and resection of the ileocolic artery and right colic artery. In contrast, in left-side colon cancers and rectal cancers, such as sigmoid cancer and rectosigmoid junction cancer, it is achieved through ligation and resection of the sigmoid artery and rectal artery after bifurcation of the left colic artery [7]. In both cases, each artery needs to be exposed and each branch confirmed, following which they are ligated using clips and resected. Thus, there is a risk of bleeding due to the sheathing of blood vessels and due to damage to the vascular wall. Additionally, strenuous effort is required for this procedure. Kobayashi *et al.* [17] previously reported that the mean time required to perform a D2 lymphadenectomy was 36.2 min and that the procedure took a long time to perform because of its complexity. Therefore, in this study, which was aimed at simplifying the surgical technique used in laparoscopic surgery for early-stage

colon cancers, stapler ligation was used to perform vascular reconstruction during lymphadenectomy, and its adequacy was examined.

The results revealed that there was no significant difference in the duration of the surgery between the stapling ligation group and clipping ligation group. We believe the absence of difference was because tasks, other than vascular reconstruction, are time consuming.

However, blood loss was significantly lesser in the stapling ligation group than in the clipping ligation group, which we believe was because of the complexity of the branching of blood vessels in the left side of colon. In other words, in clipping ligation, considerable blood loss was thought to have resulted from procedures aimed at exposing complex vascular branches and treating the mesenteric adipose tissue whereas in stapling ligation, the mesenteric adipose tissue and blood vessels were ligated and dissected in bulk, which reduced the associated bleeding.

No apparent differences were observed in the number of harvested lymph nodes, morbidity, recurrence, and 5-year relapse free survival rates between the 2 groups. These findings suggest that the procedure described in this study was valid from, both, oncological and technical viewpoints.

Since this study is a retrospective study in a single center and the number of cases is small, there is a limit to describing validity and safety. However, the stapling ligation technique is a simple and useful procedure, it is expected that prospective randomized control trial will be conducted to demonstrate validity and safety.

5. Conclusion

This study demonstrates a surgical technique using staplers for the vascular treatment of tumor-feeding arteries as a technical improvement in laparoscopic colectomy for the treatment of early-stage colon cancer. Additionally, we found that the described procedure was technically safe, simple, convenient, and oncologically valid. In the future, this procedure may potentially contribute to an increase in laparoscopic colectomy for the treatment of colon cancers.

Conflict of Interests

The authors declare that they have no conflict of interests.

Authors' Contributions

Masanori Naito: designed the study, performed the procedures, collected data, and composed the manuscript.

Masahiko Watanabe: reviewed the manuscript.

Hirohisa Miura, Takatoshi Nakamura, Takeo Sato, Takahiro Yamanashi and Atsuko Tsutsui: performed procedures.

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