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Laparoscopic Low Anterior Resection with Two Planned Stapler Fires

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ABSTRACT

Background: Anastomotic leakage during laparoscopic low anterior resection (Lap-LAR) for rectal cancer remains challenging for colorectal surgeons. Firing linear staplers multiple times has been reported as a risk factor for iatrogenic anastomotic leakage. Our institute usually performs rectal transection using 2 planned stapler fires followed by anastomosis with the double-stapling technique.

Methods: Between November 2009 and September 2016, a total of 272 consecutive patients underwent Lap-LAR with double-stapling anastomosis for rectal cancer. We inserted a linear 45-mm stapler cartridge from a port in the lower right quadrant of the abdomen. The first transection was made up to three-quarters of the rectal wall, and the remaining rectum was completely resected using a second stapler. During this procedure, the intersection of the 2 staple lines, which might otherwise cause anastomotic leakage, was located in the center of the stump of the distal rectum, so the intersection at the rectal stump was able to be easily removed using a circular stapler.

Results: None of our patients were converted to open surgery. Among the 272 Lap-LAR procedures for which use of 2 stapler fires was planned, 3 fires occurred in error only once (0.4%). Rectovaginal fistula and anastomotic leakage occurred in 1 patient (0.4%) and 9 patients (3.3%), respectively, and 49 (18.0%) patients required protective diverting stoma.

Conclusion: Rectal transection with 2 planned stapler fires appears safe, practical, and straightforward to standardize, and reduces the need for multiple linear fires and the incidence of anastomotic leakage.

Key Words: Rectal cancer; Low anterior resection; Double stapling technique; Rectal transection.

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INTRODUCTION

Anastomotic leakage is a major problem among patients who undergo laparoscopic low anterior resection (Lap-LAR) for rectal cancers. This complication is associated with not only short-term results, but also long-term results such as local recurrence and patient survival.[1–7] Reducing anastomotic leakage has been recognized as a constant task for colorectal surgeons. In 1980, Knight et al[8] reported using a circular stapler to transect a linear staple line for LARs of the rectum, and Cohen et al[9] named this anastomosis method the "double staple technique" (DST). Since then, the DST has been accepted by many surgeons for use in LARs to treat rectal cancer. However, despite such technical improvements and advances in equipment, recent studies have reported that the rate of anastomotic leakage after DST has remained at around 6% to 18%.[4,10–14] In particular, causes of anastomotic leakage after Lap-LAR may differ from those after open surgery, due to the difficulty of the pelvic approach, the lack of tactile sense, and the inadequacy of cutting angles after transection. Several studies have reported that use of more than 3 cartridges for rectal transection represents a risk factor for anastomotic leakage after Lap-LAR.[15–17] In our institute, we have performed Lap-LARs using the DST method. As a feature of our DST anastomoses, 2 planned stapler fires were adopted to avoid needing 3 or more rectal transections, which require multiple stapler firings. This report describes a DST procedure using 2 planned stapler fires in 272 patients with rectal cancer requiring Lap-LARs. In addition, we describe the methods for our standardized technical procedure.

MATERIALS AND METHODS

Patients and Methods

The database at our institution for procedures performed between November 2009 and September 2016 showed

that 272 consecutive patients underwent Lap-LAR with the DST method for rectal cancer. Among these 272 patients, 163 (59.9%) were male and 109 (40.1%) were female. Median age was 63 years (range, 29–89 years). Mean body mass index (BMI) was 23.6 kg/m^2 (range, 17.4–40.3 kg/m^2) (**Table 1**). The lower edges of the tumor were within 10 cm from the anal verge in all cases. Either tumor-specific mesorectal excision (TSME) or total mesorectal excision (TME) was adopted as the standard surgical technique according to the location of the tumor. Tumors located between the inferior margin of the second sacral vertebra and the peritoneal reflection were recorded as being in the upper rectum, while those located below the peritoneal reflection were recorded as in the lower rectum.[18] A total of 136 patients (50.0%) had upper rectal cancer, and the remaining 136 patients (50.0%) had lower rectal cancer. Preoperative chemotherapy was performed in 17 patients (6.3%), and chemoradiotherapy was performed in 3 patients (1.1%) (**Table 1**). Neoadjuvant therapy was indicated in cases receiving chemotherapy with FOLFOX or XELOX among patients with clinical T4 or with a lateral lymph node showing a short-axis diameter of 5 mm or more, and neoadjuvant chemoradiotherapy was also performed for cases of progressive disease on neoadjuvant chemotherapy. The indications for protective diverting ileostomy or colostomy were neoadjuvant therapy and obstruction by a bulky tumor. Clinical anastomotic leakage was investigated in the event of clinical symptoms of sepsis, including abdominal pain, tenderness, and fever with shivering. Clinical anastomotic leakage was diagnosed by the presence of any of the following: fecal discharge from the pelvic drain; abscess at the level of the anastomosis; and fluid or air surrounding the anastomotic site on computed tomography. All curative operations were performed by 3 qualified surgeons (through the Endoscopic Surgical Skill Qualification System in Japan) at our institution.

Table 1.
Characteristics of the Study Population

Variables	Population (n = 272)
Age (years)*	63 (29–89)
Sex (male/female)	163/109
BMI (kg/m^2)*	23.6 (17.4–40.3)
Site of rectal cancer, *n* (%)	
Upper	136 (50)
Lower	136 (50)
Neoadjuvant chemotherapy, *n* (%)	17 (6.3)
Neoadjuvant chemoradiotherapy, *n* (%)	3 (1.1)

BMI, body mass index.
*, Median (range).

Surgical Techniques

Port Placement and TME

The operation was performed under pneumoperitoneum with the patient placed in a modified lithotomy, Trendelenburg position with the right side facing down. Port placements for Lap-LARs are shown in **Figure 1**. The 12-mm port in the lower right quadrant was inserted as caudally and medially as possible, paying attention to avoid damage to the inferior epigastric vessels under laparoscopic guidance. This facilitated adjustment of a linear stapler to be perpendicular to the rectum. For all patients, we adopted a medial-to-lateral approach, and low ligation of the inferior mesenteric artery was routinely performed to preserve the left colic artery. The splenic flexure was not mobilized in most cases. For upper rectal cancer, TSME or TME was performed. For all lower rectal cancers, TME was performed. These procedures were performed to identify and preserve the hypogastric nerves and pelvic plexus, without cancer invasion. The rectococcygeal liga-

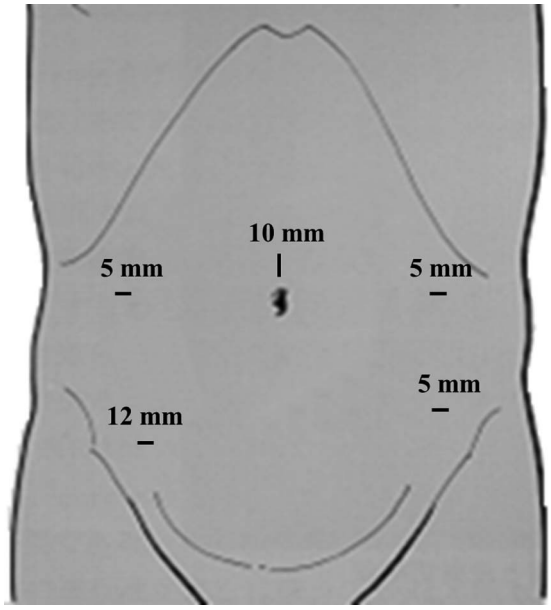

Figure 1. Port placement for Lap-LAR. A 5-port technique is employed in Lap-LAR, with a 10-mm port at the navel, a 12-mm port in the lower right quadrant, and a 5-mm port in each of the other 3 quadrants. The 12-mm port in the lower right quadrant should be inserted in a position as caudally and medially as possible.

ment was severed intra-abdominally in the cases with TMEs, but was preserved in TSMEs. In both cases, rectal mobilization was made sufficiently distal from the expected transection line, as the most important target of a Lap-LAR with 2 planned stapler fires. Before transection, the rectum below the tumor lesion was closed with a temporary intestinal clip using a clip applicator inserted from the right lower quadrant port, then the distal rectum was washed with saline.

DST Using 2 Planned Linear Stapler Fires

The rectal transections were performed intracorporeally with linear staplers through the 12-mm port in the right lower quadrant. We usually used an ECHELON Flex 45-mm gold cartridge (Johnson & Johnson K.K., Ethicon Endo-Surgery Inc., Tokyo, Japan), which is a linear stapler with an articulation function. For patients who had received preoperative chemoradiotherapy or neoadjuvant chemotherapy, a green cartridge was used because of intestinal edema. To definitively complete the transections with the 2 linear staplers and to involve the intersection of the 2 linear staple lines with the circular stapler, the first stapler needed to be inserted up to three-quarters of the rectal wall, just below the intestinal clip. When the ports were placed caudally and medially in the lower right quadrant, the first linear stapler could approach the rectum at right angles to the long axis of the rectum. At that time, the linear stapler was kept straight without flexing and was fired in that state (**Figure 2**). While firing the first linear stapler, an assistant held the mesocolon on the proximal side of the tumor with the right grasper and pulled the rectum in the left cephalad direction and then lifted the seminal vesicle or vaginal wall with the left grasper to avoid involving these organs. The left grasper of the operator made fine adjustments to the rectum angle so as to avoid damaging the rectum with the linear stapler.

For the second linear stapler fire, we approached the remaining rectum with the linear stapler and then articulated the linear stapler with the rectum pulled in the right cephalad direction (**Figure 3**). By articulating, the remaining rectum could be covered by the stapler's cartridge without the tip of the linear stapler hitting the pelvic floor. While firing the second linear stapler, the operator's left grasper pulled the rectum up toward the right cephalad direction, and the assistant's left grasper was applied to support the portion of rectum distal to the linear stapler (**Figure 3**). The assistant pulled up the seminal vesicle and vaginal wall using the right grasper, so that the anterior aspect of the rectum was more visible. Firing was then performed after confirming that the rectum was included in the line displayed on the tip of the stapler. As a result of these procedures, the intersection of the first and second linear staple lines was located approximately at the center of the stump of the distal rectum (**Figure 4A**) and was therefore easily involved in the circular stapler (**Figure 4B**).

The specimen was extracted through a small incision in the umbilical port. The anvil of the circular stapler was secured in place and the colon was returned intra-abdominally. The incision site was then temporarily closed. End-to-end anastomosis was performed intracorporeally using a DST with a circular stapler. We usually used a 25 CDH (Johnson & Johnson K.K., Ethicon Endo-Surgery Inc., Tokyo, Japan) circular stapler. The rod of the circular stapler was inserted transanally, piercing the rectal stump near the intersection of the 2 linear staple lines. With the DST using 2 planned linear stapler fires, since the intersection

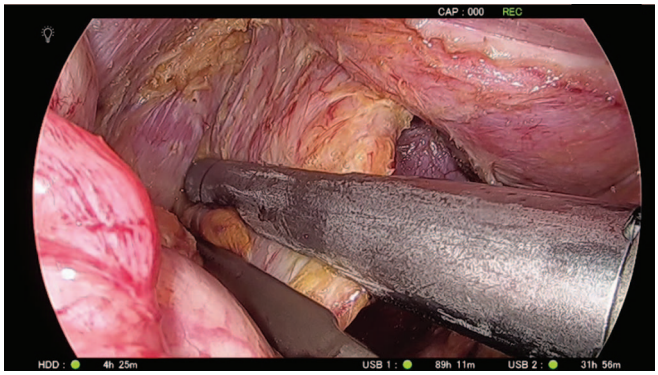

Figure 2. Rectal transection by first stapler fire. The first stapler reaches the upper quarter of the rectum along its long axis and is kept straight without articulating, then is fired in that state. At this time, the rectum is pulled in a left cephalad direction.

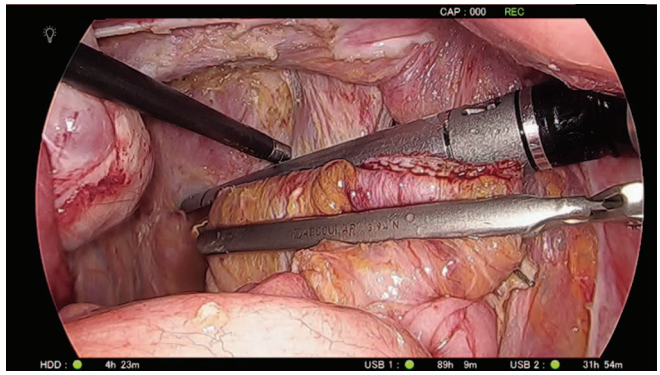

Figure 3. Rectal transection by second stapler fire. For the second linear stapler fire, the remaining rectum is included in the cartridge and the stapler is then articulated. At this time, the rectum is pulled in a right cephalad direction.

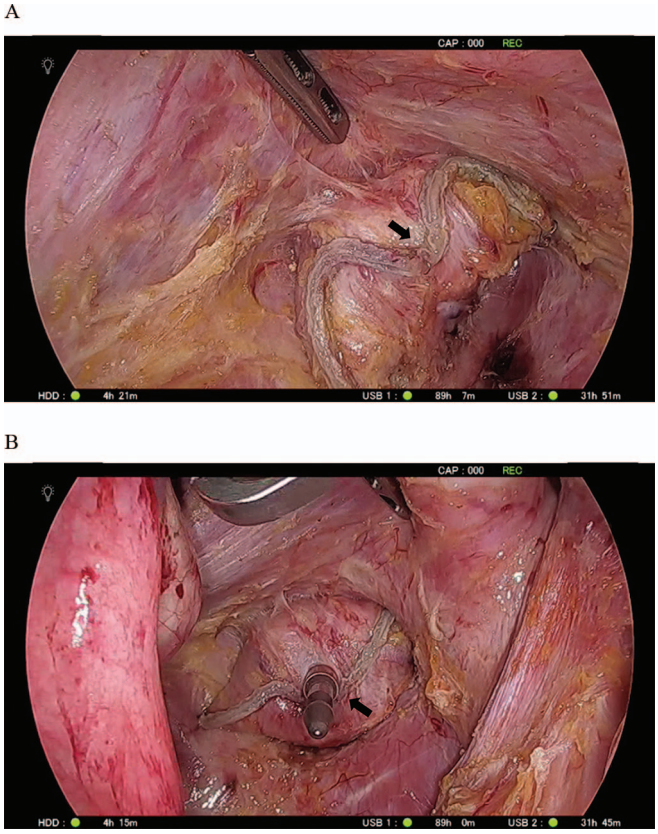

Figure 4. End-to-end anastomosis by DST. (**A**) Rectal stump from transection with 2 planned linear stapler fires. The intersection of the 2 linear staple lines is located approximately at the center of the stump of the distal rectum ➟: Intersection. (**B**) End-to-end anastomosis is performed using DST with a circular stapler. The rod of a circular stapler inserted transanally pierces the rectal stump near the intersection of the 2 linear staple lines. The intersection is easily included in the circular stapler. ➟: Intersection.

was located at the center of the rectal stump, the intersection at risk of anastomotic leakage was easily included. The circular stapler was closed, paying attention to avoid including any adjacent tissue (particularly the vaginal wall), then fired. After completion of this procedure, the anastomosis was confirmed using an air-leak test. If an air leakage was found, we checked and repaired the leak point and then performed diverting ileostomy. Indications that a covering ileostomy was needed were tumor with a diameter ≥6 cm, chemoradiotherapy or neoadjuvant chemotherapy patients, Intersphincteric resection (ISR) cases, and air leak-positive cases. A surgical drain was placed in the pelvis from the left lower quadrant, and a transanal drainage tube was inserted for 4 to 5 postoperative days in all cases.

RESULTS

The surgical outcomes are shown in **Table 2**. We performed laparoscopic TSMEs for rectal cancer in 50 cases and TMEs in 222 cases. Lateral lymph node dissections were performed in 9 patients (3.3%). Splenic flexure mobilization and high ligation of the inferior mesenteric artery were performed in 1 patient (0.4%) with sigmoid colon cancer, but no complications were encountered. No cases required blood transfusions and no hospital deaths were encountered. Among the 272 Lap-LARs for which only 2 stapler fires had been planned, 3 fires occurred in error only once (0.4%), when an intestinal clip applicator was mistakenly held by the first cartridge. Fortunately, no anastomotic leakage occurred. In addition, for the 271 cases in which the transection was completed in 2 fires, the intersection could be included within the circular staple. Anastomotic leakage occurred in 9 cases (3.3%; 9/272 cases): 7 were male (4.2%; 7/163 cases), and 2 were female (1.8%; 2/109 cases); 7 involved TMEs (3.2%; 7/222 cases), and 2 involved TSMEs (4.0%; 2/50 cases). Anastomotic leakages that required reoperation with a diverting stoma occurred in 5 cases (1.8%; 5/272), whereas leakages that required drainage only with no reoperation were seen in 4 cases. For the case with vaginal fistula, we created a diverting stoma the day after the event and closed the stoma after 8 months. A protective diverting ileostomy or colostomy was created in 49 cases (18.0%; 49/272), 3 of

Table 2.
Surgical Outcomes

Variables	Population (n = 272)
Conversions (%), *n* (%)	0 (0)
Operative time (minutes)*	210 (128–447)
Blood loss (mL)*	10.5 (1–446)
Surgical procedures, *n* (%)	
TME	222 (81.6)
TSME	50 (18.4)
Lateral lymph node dissection, *n* (%)	9 (3.3)
Number of staplers for rectal transection, *n* (%)	
2	271 (99.6)
3	1 (0.4)
Protective diverting ileostomy or colostomy, *n* (%)	49 (18.0)
Anastomotic leakage, *n* (%)	9 (3.3)

*, Median (range).

which showed anastomotic leakage. In the 49 cases of protective diverting stoma, contrast enema was routinely performed before stoma closure, and no leakage or stenosis of the anastomosis was encountered. No bleeding that required hemostatic treatment was seen in the anastomotic region.

DISCUSSION

Anastomotic leakage after rectal cancer surgery has an enormous influence not only on short-term results, such as extending the hospitalization period, increasing the treatment cost, and delaying administration of adjuvant chemotherapy, but also on local recurrence rate and long-term prognosis.[1–7] Various risk factors, including sex, age, preoperative therapy, tumor location and size, pelvis size, BMI, intra-operative bleeding, and the diameter of the circular stapler,[15–17,19–21] have been reported to contribute to the occurrence of anastomotic leakage after rectal cancer surgery. Surgical technique, which must be performed within the narrow pelvic region and among complex anatomical structures, is also related to anastomotic leakage. Making rectal transections using a linear stapler in laparoscopic surgery is relatively difficult compared with open surgery. Several studies have reported that use of more than 3 cartridges for rectal transection was a risk factor for anastomotic leakage after Lap-LAR.[15–17] These findings appear attributable to an unduly long stapling line at an oblique angle in the lower position. Another reason may be that the intersection of linear staples, which is considered a risk factor for anastomotic leakage, will likely remain on the rectal stump. In contrast, a report by Kuroyanagi et al[22] showed that when the port in the lower right quadrant of the abdomen was placed more caudally and medially, a laparoscopic stapler could be inserted perpendicular to the long axis of the rectum through cooperation between the surgeon and assistant. Furthermore, when the techniques of the operator and assistant were well choreographed, transection was able to be completed with 2 cartridges in 84.6% of cases (66/78 cases), while 3 firings were required in 15.4% (12/78 cases). As a result, the rate of anastomotic leakage was a phenomenal 2.6% (2/78 cases). Another cause of anastomotic leakage is the existence of an intersection caused by multiple firings. Conversely, Kawada et al[17] reported that the existence of an intersection of linear staples did not significantly affect the risk for anastomotic leakage. However, although no significant difference was seen, the risk was 10.4% when the intersection did not remain, which was lower than the 17.4% rate when the intersection remained. In addition, they reported that the intersection was placed near the edge of the lower rectal stump, so removal of the intersection was technically difficult. Using our procedure, the transection was completed with 2 linear stapler firings in 99.6% of cases (271/272 cases), and 3 linear staple lines was required in only one case. For all 271 cases completed with 2 linear stapler firings, the intersection of the linear staple lines could be included within the circular staple. This fact was confirmed by checking that the intersection was present in the donut-shaped structure within the circular stapler after the DST.

The rate of anastomotic leakage in this study was 3.3%, representing a good result, but the major limitation of this study was the difference in BMI between Japanese and Western populations. The surgical techniques that must be performed within the narrow pelvis and in cases of higher BMI are reportedly related to anastomotic leakage.[20,23–25] Mean BMI for our patients was 23.6 kg/m^2, much lower than generally seen in Western populations, but we did in fact have 5 patients with BMI $\geq$ 30 kg/m^2 in this study. We still performed the 2 planned stapler fires with slight modifications for patients with BMI $\geq$ 30 kg/m^2. These technical modifications were to wrap gauze around the thick rectum of obese patients and apply cephalad traction, and to always use a green stapler cartridge for rectal resection. With these technical modifications, we believe that this procedure, which involves 2 planned stapler fires with a linear 45-mm stapler cartridge, is very effective for cases with a narrow pelvis and higher BMI.

CONCLUSION

We demonstrated that rectal transection with 2 planned stapler fires to prevent excessive linear stapler fires appears to be safe and feasible. We believe this procedure offers a useful standard in Lap-LAR for lower rectal cancer, which is considered a technically difficult cancer to treat surgically, resulting in further reductions to the risk of anastomotic leakage.

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