*Int Surg* 2018;**103:**435–442
DOI: 10.9738/INTSURG-D-15-00155.1

# The Feasibility of Laparoscopic Gastrectomy for Remnant Gastric Cancer

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**We compared laparoscopic gastrectomy for remnant gastric cancer (LRG) with open gastrectomy for remnant gastric cancer (ORG) to assess the safety and invasive nature of LRG. This study was a retrospective study. The study population consisted of 27 consecutive patients who underwent gastrectomy for remnant gastric cancer. Of these, 15 underwent ORG between January 2003 and April 2007, and 12 underwent LRG between May 2007 and January 2013. The operation time was not significantly different between the 2 groups. However, blood loss was significantly less in the LRG group than in the ORG group. No intraoperative blood transfusion was required. There was no significant difference in morbidity rate between the LRG (1/12, 8.3%) and ORG (4/15, 26.7%) groups, and no patients died in either group. Body temperature on postoperative day (POD) 7 ($P = 0.034$); systolic blood pressure on PODs 6 ($P = 0.042$) and 7 ($P = 0.035$); and heart rate on POD 7 ($P = 0.049$) were significantly lower in the LRG group than in the ORG group. No significant differences were observed in white blood cell count, or C-reactive protein and serum albumin levels between the groups. Serum total protein levels were significantly higher on POD 1 ($P = 0.020$), and the number of lymphocytes was significantly higher on POD 7 in the LRG group than in the ORG group ($P = 0.036$). Pain scores on POD 7 were significantly lower in the LRG group than in the ORG group ($P = 0.033$). LRG is a technically feasible and safe procedure.**

*Key words:* Gastrectomy – Remnant stomach – Laparoscopic gastrectomy – Gastric cancer

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Since the introduction of laparoscopic gastrectomy (LG) in 1990, the use of this procedure has rapidly spread. LG is currently recognized as a common treatment for early gastric cancer, particularly among Asian countries.[1] However, this procedure is not widely used for gastric cancer patients who previously underwent upper abdominal surgery or advanced gastric cancer patients with D2 lymph node dissection. Of these technically challenging LG procedures, laparoscopic gastrectomy for remnant gastric cancer (LRG) for patients with previous distal gastrectomy (DG) is the most difficult to perform because of extensive adhesion around the remnant stomach and abdominal wound. Consequently, there are relatively few reports on LRG and the merits of this procedure remain unknown.[2–8]

We began using LRG for gastric cancer of the remnant stomach in May 2007 after performing LG over 150 times and have performed LRG in 12 patients to date. In this study, to determine whether LRG is a safe, we compared LRG with open gastrectomy for remnant gastric cancer (ORG), which had been used before introduction of LRG. Moreover, we describe technical advice for LRG.

## Patients and Methods

This study was a retrospective study. The study population consisted of 27 consecutive patients who underwent gastrectomy for remnant gastric cancer between January 2003 and December 2013. Of these, 15 underwent ORG between January 2003 and April 2007, and 12 underwent LRG between May 2007 and January 2013. A total of 1236 gastrectomy procedures for gastric cancer were performed during the same period. All of the LRGs were performed by an experienced laparoscopic surgeon and the same surgeon participated in all ORGs as an operator or assistant. Informed consent was obtained from all of the patients prior to surgery. The ORG and LRG procedures for gastric cancer were performed as follows:

1. Total remnant gastrectomy with D1 lymph node dissection (left paracardial lymph nodes and those along the short gastric vessels, the proximal splenic artery, and the distal splenic artery) was performed for most cases of early gastric cancer, excluding those indicated for endoscopic tumor dissection.
2. Total remnant gastrectomy with D2 lymph node dissection (D1 + splenic hilar lymph nodes) was performed for advanced gastric cancer cases, for which curative resection was expected. We added distal pancreatectomy with splenectomy for patients with suspicion of tumor invasion to the splenic hilum or pancreatic tail.
3. Noncurative total remnant gastrectomy without systematic lymph node dissection was performed for stage IV patients who could not consume food because of stenosis or bleeding of tumors.

Gastric cancer was described in accordance with the Japanese Classification of Gastric Carcinoma: 3rd English edition and the Japanese Gastric Cancer Treatment Guidelines 2010 of the Japanese Gastric Cancer Association.[9,10]

## Surgical Procedures

### *ORG*

ORG was performed through a midline laparotomy incision approximately 20 cm in length. An esophagojejunostomy was performed using a 25-mm diameter circular stapler and a Y-limb anastomosis was hand sewn. An electrocautery device was used for dissection in all of the patients.

### *LRG*

LRG was performed using 5 ports (two 5-mm bilateral costal arch ports, two 12-mm bilateral flank ports, and one 12-mm camera port) in the umbilical region. Laparoscopic coagulating shears (LCSs) and a vessel sealing device (LigaSure, Covidien Ltd, Hamilton, Bermuda) were used for dissection. Roux-en-Y reconstruction was performed in all of the patients. An esophagojejunostomy was achieved laparoscopically using a linear stapler (side-to-side anastomosis) in 9 patients or a circular stapler (DST Series EEA OrVil, Covidien Ltd) in 3 patients. A linear stapler was used for Y-limb anastomosis (side-to-side anastomosis). The camera port (esophagojejunostomy performed using a linear stapler) or left flank port (esophagojejunostomy performed using the OrVil system) wound was extended to 4 cm for stomach extraction and to perform Y-limb anastomosis.

The major technical difference between LRG and standard LG is the requirement for widespread adhesiolysis around the stomach remnant and wound. However, LRG requires dissection of fewer vessels than LG. Therefore, LRG is essentially dependent on safe adhesiolysis.

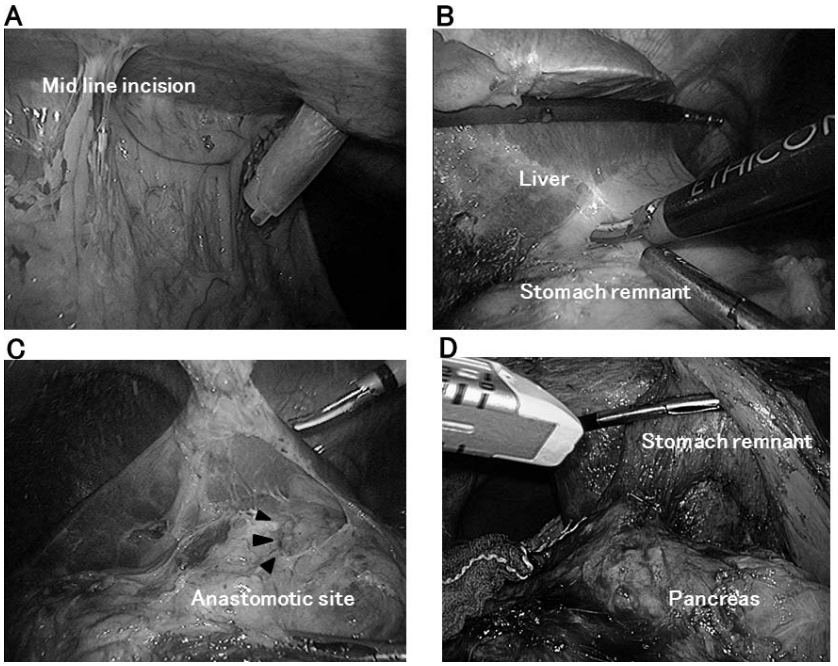


**Fig. 1** Adhesion and adhesiolysis of laparoscopic gastrectomy for remnant stomach. (A) Adhesion around the midline incision. (B) Adhesion between the stomach remnant and liver. (C) Adhesion around the anastomotic site (Billroth I reconstruction). (D) Completion of adhesiolysis around the anastomotic site.

The order of port insertion is important in gastrectomy, which is usually performed by initially making a midline incision. Therefore, port insertion should be carefully considered to avoid adhesion under the wound. In patients with median incisions, we inserted the first port in the left flank region as a temporary camera port, after which a 5-mm port (to perform abdominal wall adhesiolysis around the median incision wound) was inserted into the left hypochondriac region (Fig. 1A). To ease approaching adhesion under the midline wound, the left side ports were set more laterally than in standard LG. As adhesiolysis of the abdominal wall progressed, the remaining ports were sequentially inserted (one 12-mm camera port near the umbilicus, one 5-mm right hypochondriac port, and one 12-mm right flank port).

The next step is to perform adhesiolysis around the stomach remnant. The perimeter of the remnant stomach is adhered to the transverse colon or its mesentery at the caudal side, with the lateral segment of the liver at the cranial side, and with the pancreas at the dorsal side. Adhesions between the stomach and transverse colon/mesocolon were not rigid in our patients. Therefore, we recommend that this part should be dissected first. Severe adhesion was always observed around the anastomotic site (pancreas, liver, and hepatoduodenal ligament in Billroth I reconstruction cases) and around the lesser curvature of the stomach remnant (to the lateral segment of the liver and upper pancreas; Fig. 1B and 1C). Among these adhesions, adhesiolysis around anastomotic sites should be completed prior to advancing adhesiolysis of the lesser curvature. The approach to adhesion around the lesser curvature is remarkably easier by dissection of the duodenum, resulting in good mobility of the stomach remnant (Fig. 1D). Adhesion between the liver and lesser curvature of the stomach remnant is widespread and bleeding occurs easily. However, after dissection of the duodenum, adhesiolysis using LCSs was not difficult. The stump of the left gastric artery is an additional rigid adhesion point that should be considered to avoid injury. Adhesion around the stump of the left gastric artery always presents difficulty. Therefore, adhesiolysis near the stump of the left gastric artery should be performed along with that of the gastric wall. Overall, however, laparoscopic adhesiolysis using LCSs resulted in an evident decrease in blood loss compared with open surgery, which presents a major benefit of the LRG procedure.

*Analysis of safety and feasibility*

Surgical duration, amount of blood loss, blood transfusion rate, intraoperative complication rate, postoperative morbidity rate, and mortality rate were compared between the LRG and ORG groups.

*Assessment of invasive nature and postoperative pain*

The day of first defecation, postoperative vital signs, hematological parameters, and a pain scale were compared to identify the least invasive procedure. Postoperative vital signs (body temperature, systolic blood pressure, and heart rate) were recorded 3 times a day and analyzed on postoperative days (PODs) 1 through 7 using daily maximum values. White blood cell (WBC) and lymphocyte counts and serum total protein (TP) and albumin (ALB) levels were measured on the day before surgery and on PODs 1, 4, and 7. C-reactive protein (CRP) levels were measured on PODs 1, 4, and 7. We used the Wong–Baker FACES pain rating scale to evaluate differences in pain experienced by patients after LRG and ORG. Each patient was evaluated from PODs 1 through 7 and temporal changes in pain were compared between the LRG and ORG groups. The FACES pain rating scale scores were recorded 3 times a day, and the highest daily score was used for analysis. Continuous epidural anesthesia was administered for 2 days immediately after surgery.

*Statistical analysis*

The *t*-test, Pearson's $\chi^2$ test, and the log-rank test were used for statistical analysis. Statistical software (SPSS for Windows, 16.0 SPSS Inc, Chicago, Illinois) was used for statistical analyses. Differences with a *P* value of $<0.05$ were considered statistically significant.

## Results

*Patient background characteristics*

Patient characteristics are shown in Table 1. The mean age of patients in the LRG group was significantly lower than that of patients in the ORG group (64.8 ± 6.4 versus 76.3 ± 5.7 years). However, there were no significant differences in sex, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, duration after distal gastrectomy, reconstruction method of distal gastrectomy, simultaneous distal pancreatectomy and splenectomy, and pStage between the groups (Table 1).

*Safety and feasibility*

None of the LRG patients required conversion to open surgery. The mean surgical duration for the LRG group (284.9 ± 46.2 minutes) was 63.9 minutes longer than that for the ORG group (221.0 ± 121.0 minutes), although this difference was not significant ($P = 0.096$). Blood loss in the LRG group was significantly less than that in the ORG group (57.6 ± 46.2 versus 278.8 ± 215.8 mL, $P = 0.002$). No intraoperative blood transfusion was required and no complications occurred in either of the groups. The first defecation of the LRG group was significantly earlier than that of the ORG group (3.2 ± 0.6 versus 4.0 ± 0.8 days, $P = 0.006$). There was no significant difference in morbidity rate between the LRG (1/12, 8.3%) and ORG groups (4/15, 26.7%), and no deaths occurred in either of the groups. The length of postoperative hospital stay in the LDG group (13.8 ± 2.7 days) was shorter than that in the ODG group (21.7 ± 8.8 days; Table 2).

*Table 1 Patient background characteristics*

| | LRG (n = 12) | ORG (n = 15) | *P* |
|---|---|---|---|
| Age | 64.8 ± 6.4 | 76.3 ± 5.7 | <0.000 |
| Sex | | | |
| Male, n (%) | 10 (69.6) | 13 (86.7) | 1.000 |
| Female, n (%) | 2 (30.4) | 2 (13.3) | |
| BMI (kg/m$^2$) | 21.6 ± 2.7 | 20.9 ± 2.8 | 0.507 |
| ASA | | | |
| 1, n (%) | 3 (25.0) | 1 (6.7) | 0.251 |
| 2, n (%) | 7 (58.3) | 8 (53.3) | |
| 3, n (%) | 2 (16.7) | 6 (40.0) | |
| Duration after DG | 9.1 ± 8.9 | 12.2 ± 11.0 | 0.434 |
| Reconstruction of DG | | | |
| Billroth I, n (%) | 11 (91.7) | 14 (93.3) | 1.000 |
| Billroth II, n (%) | 1 (8.3) | 1 (6.7) | |
| PS | | | |
| +, n (%) | 1 (8.3) | 2 (13.3) | 1.000 |
| −, n (%) | 11 (91.7) | 13 (86.7) | |
| pStage | | | |
| IA, n (%) | 8 (66.7) | 8 (53.3) | 0.369 |
| IB, n (%) | 1 (8.3) | 5 (33.3) | |
| IIA, n (%) | 0 (0) | 1 (6.7) | |
| IIIA, n (%) | 1 (8.3) | 0 (0) | |
| IIIB, n (%) | 1 (8.3) | 0 (0) | |
| IV, n (%) | 1 (8.3) | 1 (6.7) | |

PS, gastrectomy with distal pancreatectomy + splenectomy.

*Nature of invasiveness*

**Vital signs**

The first defecation of the LRG group was significantly earlier than that of the ORG group (3.2 ± 0.6 versus 4.0 ± 0.8 days; Table 1). There was no significant difference in body temperature immediately after surgery between the 2 groups. However, a significantly lower mean body temperature was observed in the LRG group on POD 7 compared with the ORG group ($P = 0.034$, Fig. 2A). Significantly lower values were observed for

*Table 2 Operative results*

| | LRG (n = 12) | ORG (n = 15) | *P* |
|---|---|---|---|
| Operation time, min | 284.9 ± 46.2 | 221.0 ± 121.0 | 0.096 |
| Blood loss, mL | 57.6 ± 46.2 | 278.8 ± 215.8 | 0.002 |
| Intraoperative blood transfusion | | | |
| –, n (%) | 12 (100) | 15 (100) | |
| +, n (%) | 0 (0) | 0 (0) | |
| Intraoperative complication | | | |
| –, n (%) | 12 (100) | 15 (100) | |
| +, n (%) | 0 (0) | 0 (0) | |
| The day of first defecation | 3.2 ± 0.6 | 4.0 ± 0.8 | 0.006 |
| Morbidity | | | |
| –, n (%) | 11 (91.7) | 11 (73.3) | 0.342 |
| +, n (%) | 1 (8.3)* | 4 (26.7)** | |
| Mortality | | | |
| –, n (%) | 12 (100) | 15 (100) | |
| +, n (%) | 0 (0) | 0 (0) | |

*Pneumonia (1 case).

**Intra-abdominal abscess (2 cases), ileus (1 case), pancreatic juice leakage (1 case).

systolic blood pressure in the LRG group on PODs 6 ($P = 0.042$) and 7 ($P = 0.035$), and a significantly lower heart rate was observed in the LRG group on POD 7 compared with the ORG group ($P = 0.049$, Fig. 2B and 2C).

**Hematological parameters**

The WBC count appeared to be lower in the LRG group on PODs 4 and 7 compared with the ORG group, but this was not significant (Fig. 3A). No significant difference was observed in serum CRP levels between the 2 groups (Fig. 3B).

TP levels were generally higher in the LRG group after surgery compared with the ORG group, with a significant difference observed on POD 1 ($P = 0.020$, Fig. 4A). There was no significant difference in serum ALB levels between the groups (Fig. 4B). However, the number of lymphocytes was significantly higher in the LRG group on POD 7 compared with the ORG group ($P = 0.036$, Fig. 4C).

**Pain score**

There was no significant difference in Wong–Baker FACES scores between the LRG and ORG groups immediately after surgery, but the scores were significantly lower in the LRG group on POD 7 ($P = 0.033$, Fig. 5).

**Prognosis after gastrectomy for remnant gastric cancer**

To date, all patients who underwent LRG are alive. No patients, except those with stage IV disease, have shown signs of recurrence. The median observational period of LRG patients was 18 months (range: 1–60 months). In ORG patients, 1 stage IV patient died of gastric cancer and 2 patients died of other diseases. The median observational period of ORG patients was 28 months (range: 6–65 months). There was no significant difference in cumulative overall survival between the LRG and ORG groups ($P = 0.276$, Fig. 6).

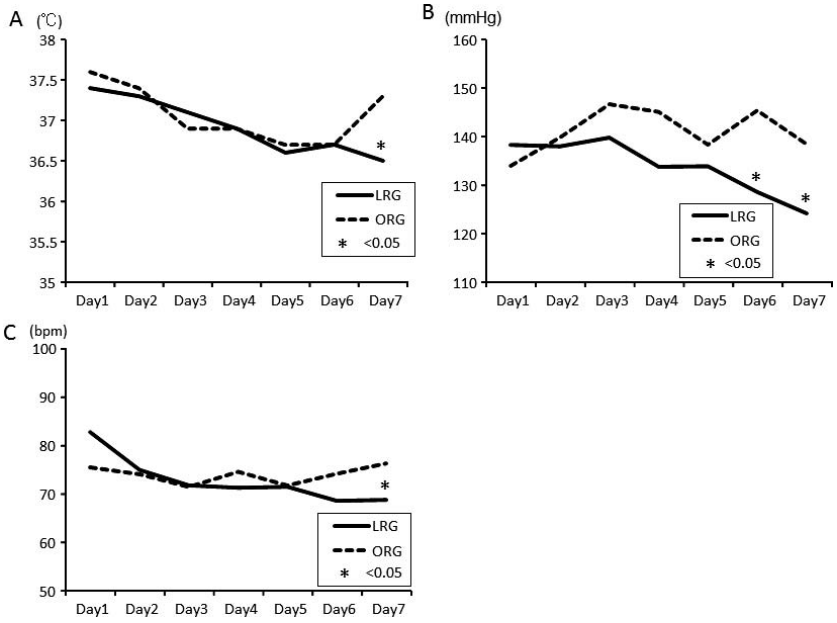


**Fig. 2** Changes in vital signs. (A) Change in body temperature. (B) Change in systolic blood pressure. (C) Change in heart rate.

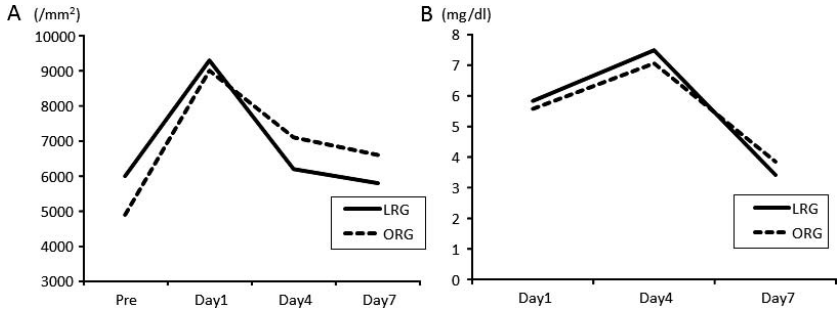


**Fig. 3** Change in WBC counts and CRP levels. (A) Change in WBC count. (B) Change in CRP levels.

## Discussion

Gastrectomy for remnant gastric cancer is required when a new lesion develops in the gastric remnant or for a pathological oral margin-positive case by distal gastrectomy. However, almost all gastrectomies for remnant gastric cancer are performed to treat new lesions. The rate of occurrence of gastric cancer of the stomach remnant is reportedly 2% to 3% after distal gastrectomy. Therefore, gastrectomy for gastric cancer of the remnant stomach is relatively rare.[11–13] The rate of gastrectomy for remnant gastric cancer in all gastric cancer surgeries performed in our institute between 2003 and 2013 was 2.2% (27/1236), in accordance with previous reports. LG that is performed with an upper middle incision is not considered a laparoscopic procedure in many hospitals. Therefore, there are only a few reports on LRG, and the feasibility and physiological/hematological responses of this procedure remain unclear. Consequently, the importance of a study of such a minor portion of surgeries performed worldwide may be questioned. However, we believe that demonstration of the feasibility and less physiologic stress of LRG will have future applications in laparoscopic surgery.

In this study, we assessed the feasibility of LRG. Gastrectomy for remnant gastric cancer may be associated with some risks, such as increased blood loss and potential injury to adjacent organs by adhesiolysis of massive adhesions. If LRG increases the incidence of these risks compared with OGR, then LRG is not acceptable as a feasible procedure, in spite of less physiologic stress. There are relatively few reports regarding LRG and even fewer case reports. A study by Nagai *et al*[8] described 12 cases. However, all of the patients in this series underwent LRG without conversion to open surgery and none experienced intraoperative complications.[2–8] In the present study, the mean duration of LRG was approximately 1 hour longer than that of

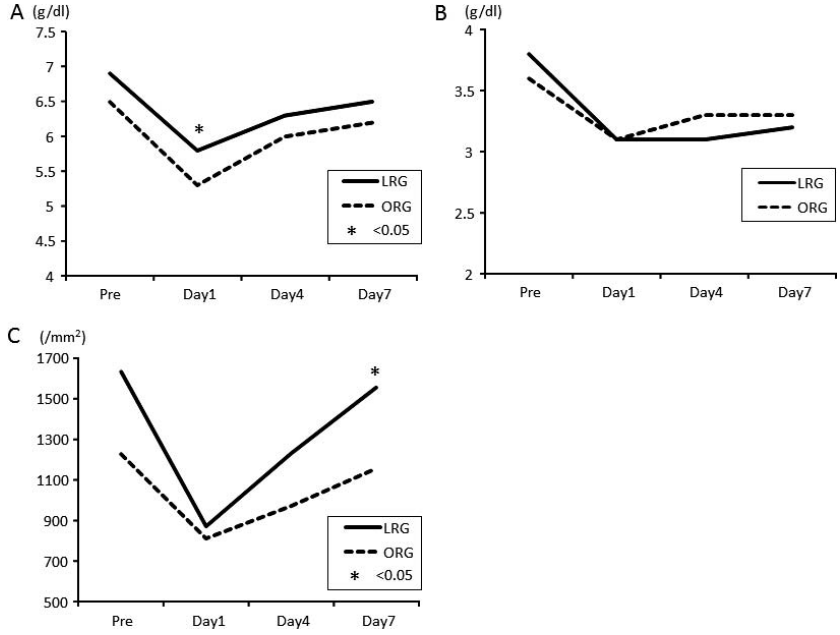


**Fig. 4** Changes in serum total protein and albumin levels and lymphocyte count. (A) Change in serum TP levels. (B) Change in serum albumin levels. (C) Change in lymphocyte count.

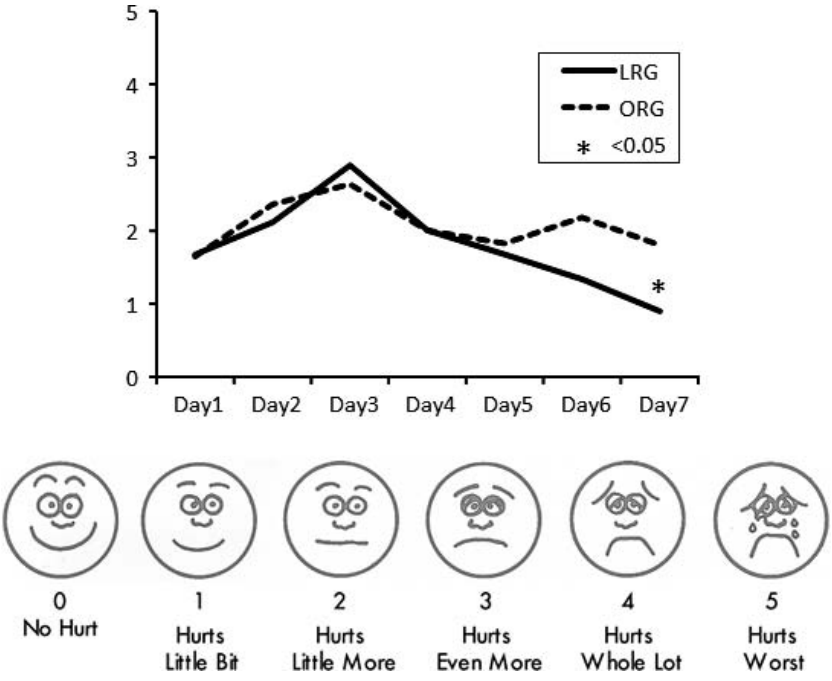


**Fig. 5** Changes in pain FACES scale scores. Wong–Baker FACES pain rating scale scores are explained to each patient. In brief, pain level is reflected by a caricature resembling a smiling face due to the absence of pain or a frowning face because of excessive pain. Face 0 indicates no pain, face 1 indicates some pain, faces 2 through 4 indicate slightly more pain, and face 5 indicates the most pain. The patient is asked to choose the face that best describes the level of pain. Hockenberry MJ, Wilson D, Winkelstein ML: Wong's Essentials of Pediatric Nursing, ed. 7, St. Louis, 2005, p. 1259. Used with permission. Copyright, Mosby.

ORG. However, the mean blood loss with LRG was significantly less than that with ORG, and no LRG patients required conversion or experienced intraoperative complications. Furthermore, the postoperative complication rate was lower (but not significant) in the LRG group compared with that in the ORG group. Therefore, we consider that LRG is a technically feasible procedure as long as surgeons with laparoscopic experience perform the procedures.

There are only a small number of reports on the invasiveness of LRG. Nagai *et al*[8] reported a less invasive nature in their feasibility study of LRG. They noted less blood loss and a shorter term of resumption of water and food intake with this method. In the present study, we assessed the less invasive nature of LRG in more detail by comparing daily changes in vital signs, hematological parameters, and pain scores between LRG and ORG. Body temperature, systolic blood pressure, and heart rate were examined as indicators of postoperative vital signs, and earlier normalization of all of these variables was observed in the LRG group compared with the ORG group. Hematologic examinations showed that WBC count and CRP levels were indicative of inflammation, TP and ALB levels, and lymphocyte count were selected as nutritional indices in this study. No significant differences in WBC count and CRP levels were observed during the postoperative period. Analysis of the inflammatory indices in this study failed to determine whether LRG was less invasive than ORG. Nutritional assessment showed that TP levels were significantly higher in the LRG group than in the ORG group on POD 1 and the number of lymphocytes was significantly higher in the LRG than in the ORG group on POD 7. However, there was no significant difference in serum ALB levels throughout the study period. Generally, there were no clear differences in hematological parameters in contrast to vital signs. However, all of our data indicated that LRG was significantly advantageous.

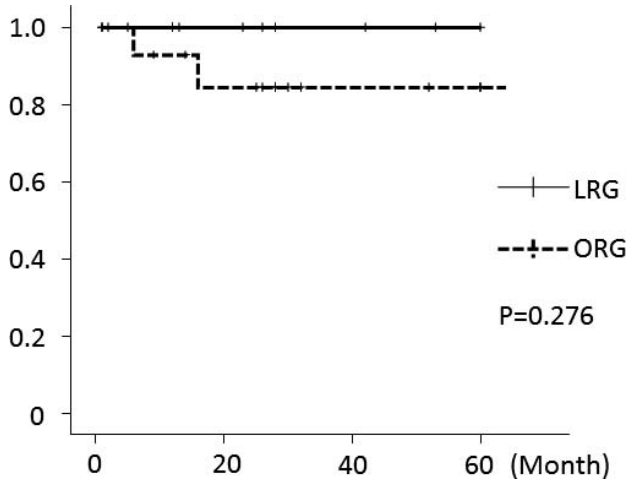


**Fig. 6** Cumulative overall survival of LRG and ORG.

We found that hematological parameters in LRG were equal to or greater than those in ORG. In future studies, a larger number of patients are required to determine whether homological parameters are appropriate to determine the invasiveness of LRG.

The Wong–Baker FACES pain rating scale was designed to evaluate pain. The present study showed that pain subsided earlier with LRG than with ORG. These characteristics of LRG are similar to results of our previous report of comparing laparoscopic gastrectomy and open gastrectomy.[14,15] In the current study, we assessed a small number of patients and the mean age of the ORG group was higher than that of the LRG group. In future studies, a larger number of patients are required, including feasibility, surgical stress and long-term prognosis of LRG.

In conclusion, LRG is a technically feasible and safe procedure during the intraoperative and postoperative courses. Furthermore, LRG may be less invasive compared with ORG, and this may contribute to the future development of laparoscopic surgery.

## Acknowledgments

Hideki Kawamura, Susumu Shibasaki, Tadashi Yoshida, Shigenori Homma, Masahiro Takahashi, and Akinobu Taketomi report no conflicts of interest or financial ties to disclose.

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