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Comparison of Three Different Minimally Invasive Procedures of Distal Gastrectomy for Nonoverweight Patients with T1N0-1 Gastric Cancer

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Laparoscopic-assisted distal gastrectomy has recently come to be a standard procedure for the treatment of early gastric cancer[1–5] in select patients. The minimal invasiveness associated with laparoscopic procedures for the resection of gastrointestinal cancer has been repeatedly explained in part by the short incision that is required.[6–11] We used two different approaches to perform distal gastrectomies for the resection of gastric cancer as minimally invasive alternatives to a standard laparoscopic approach prior to our surgical team's complete mastery of the skills required for laparoscopic oncological surgery for gastric cancer.[9,12] If the minimal invasiveness associated with laparoscopic-assisted gastrectomy can be explained by the small incision, a gastrectomy via a small incision without the use of a pneumoperitoneum may provide a similar outcome in patients. However, to our knowledge, such a comparison has not been previously made. We compared the minimal invasiveness of three different approaches (minilaparotomy, minilaparotomy approach with laparoscopic assistance, and standard laparoscopic-assisted approach) to performing a distal gastrectomy for T1N0-1 gastric cancer in nonoverweight patients (body mass index, $\leq$25 kg/m^2) performed within a limited study period.

Key words: Laparoscopy – Minilaparotomy – Gastrectomy – Gastric cancer

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Patients and Methods

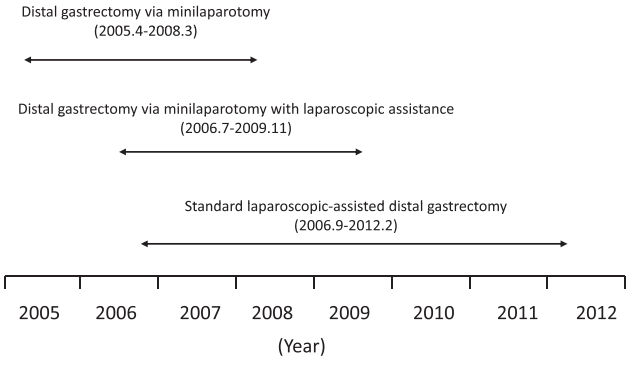
The present study was approved by the ethics committee of Saitama Medical Center, Saitama Medical University.

Patients

The medical records of patients with gastric cancer who underwent a gastrectomy at our institution between April 2005 and February 2012 and who met the following criteria were extracted: clinical diagnosis of T1N0-1 disease according to the Japanese Classification of Gastric Carcinoma,[13] tumor located in the middle or lower third of the stomach, body mass index $\leq$25.0 kg/m^2, and treatment with a standard laparoscopic-assisted distal gastrectomy (LADG), a distal gastrectomy via a minilaparotomy (ML), or a distal gastrectomy via a minilaparotomy with laparoscopic assistance (MLLA). LADG was performed between September 2006 and February 2012, ML was performed between April 2005 and March 2008, and MLLA was performed between July 2006 and November 2009 (Fig. 1). The choice of procedure depended on the policy of our surgical team and/or the surgeons' preferences during the transition from open surgery to laparoscopic-assisted surgery at our institution. Written informed consent was obtained from each patient regarding the choice of the different surgical approaches.

Methods

We retrospectively analyzed data obtained from prospectively recorded medical charts of patients undergoing LADG (n = 24), ML (n = 27), or MLLA (n = 21). We evaluated patient age, sex, body mass index (kg/m^2), American Society of Anesthesiologists (ASA) classification, location of tumor, pathologic stage, length of incision, type of reconstruction, duration of surgery, blood loss, type of lymph node dissection, number of harvested lymph nodes, postoperative complications, postoperative changes in white blood cell (WBC) counts and serum C-reactive protein (CRP) levels, postoperative use of analgesic agents (pentazocine, 15 mg, intramuscular injection), time until flatus, and time until the start of solid foods. Postoperative complications were graded according to the Clavien-Dindo classification.[14]



Fig, 1 Periods during which the three approaches were utilized.

Surgical Procedures

The first author (NH), who has been accredited with an Endoscopic Surgical Skill Qualification from the Japan Society for Endoscopic Surgery (JSES), oversaw the LADG procedures as the operating surgeon or a supervising assistant. Another author (HI), who had performed more than 200 curative colectomies for colon cancer via a minilaparotomy,[8,15,16] supervised the ML and MLLA procedures.

ML: The detailed surgical procedures related to our minilaparotomy approach have been described elsewhere.[9] Briefly, all the surgical procedures for a distal gastrectomy with lymph node dissection were performed using only conventional instruments through an upper median abdominal incision, with a maximum length of 7 cm under direct vision. A wound retractor, Alexis (medium size; Applied Medica, Rancho Santa Margarita, California) was applied to the edge of the wound. When necessary for dissecting lymph nodes around the celiac artery, or dissecting the gastrosplenic ligament, a Kent retractor (Takasago, Tokyo, Japan), the bar of which was placed beside the patient's left axilla, was used to slide the wound toward the head or laterally.

MLLA: This procedure was the same as a distal gastrectomy via a minilaparotomy, in terms of the length of the skin incision and the method used for wound retraction. A laparoscope was introduced into the abdomen through the minilaparotomy wound. In addition, a Harmonic scalpel (Ethicon Endo-Surgery, Cincinnati, Ohio) or Ligasure (Covidien, Mansfield, Massachusetts) was used to perform the dissection around the stomach and lymph nodes for deep surgical fields.

LADG: All the surgical procedures for dissection around the stomach and lymph nodes were performed through 6 ports utilizing a Harmonic scalpel (Ethicon Endo-Surgery) and a 10-mmHg carbon dioxide pneumoperitoneum. The main arteries and

veins were divided after clipping using an Endo Clip (ML size or L size, Covidien). After the dissection around the stomach and lymph nodes, a short incision (4–6 cm) was made in the upper abdomen to extract the specimen. After applying the wound retractor, Alexis (small size; Applied Medica) to the edge of the wound, reconstruction was performed as in the other two procedures.

Reconstruction

Our basic reconstruction method was a Billroth-I reconstruction, which has been reported elsewhere.[9] However, the Roux-en-Y method, as reported by Fujita *et al*[17] was used as an alternative to the Billroth-I method according to the surgeon's preference and judgment in cases with an upper tumor location in the middle third of the stomach. Briefly, the jejunum was divided using a linear stapler, an Endo GIA 60 (Covidien) or Echeron 60 (Ethicon Endo-Surgery) and the jejunal loop ascended through the antecolic route. A side-to-side gastrojejunostomy was created between the end of the jejunal Roux limb and the greater curvature of the remnant stomach using an Endo GIA 60 (Covidien) or Echeron 60 (Ethicon Endo-Surgery). The jejunal anastomosis was placed 30 cm distal to the gastrojejunal anastomosis, and a side-to-side anastomosis was performed using an End GIA 60 (Covidien) or Echeron 60 (Ethicon Endo-Surgery).

Lymph Node Dissection

Lymph node dissection (D1 + α or D1 + β) was performed in accordance with the Guidelines for the Treatment of Gastric Cancer[18] for all three methods. D1 was defined as the dissection of lymph nodes existing along the major vessels feeding the stomach. The α and β dissections were suffixed for the additional node dissection of No. 7, 8a, and 9, which are located along the left gastric artery, common hepatic artery, and celiac trunk, respectively. Alpha stands for node No. 7, and beta stands for nodes No. 7, 8a, and 9. When the tumor location was in the lower third of the stomach, node No.8a was included in alpha.

Statistical Analysis

For the statistical analyses, a statistical software package (StatFlex ver. 6.0, Artec, Inc, Osaka, Japan) running on a Windows personal computer was used. For the comparison of nominal variables, a chi-square test was used. Continuous data were expressed as the median and range, and were compared using a one-way analysis of variance (ANOVA) among the three groups. A P-value <0.05 was considered to denote statistical significance. When the P-values were <0.05 according to the ANOVA, a subsequent post-hoc test (Dunnett's test) was performed using the standard laparoscopic group as the control group.

Results

No significant differences were observed among the three groups in terms of the patient age, male-to-female ratio, body mass index, ASA score, and pathologic stage. In terms of tumor location, the frequency of a location in the middle third of the stomach was highest in the LADG group and lowest in the MLLA group ($P = 0.04$; Table 1). The length of the incision was significantly shorter in the LADG group than in the other two groups ($P < 0.01$, Dunnett's test followed by an ANOVA). Roux-en-Y reconstructions were performed in 6 patients (25%) in the LADG group, while this type of reconstruction was not performed in the other two groups ($P < 0.01$). Significant differences in the duration of the surgery, blood loss, type of lymph node dissection, and number of harvested lymph nodes were observed among the three groups ($P < 0.01$,

Table 1 Background data

	LADG group (n = 24)	ML group (n = 27)	MLLA group (n = 21)	*P*
Age (y)	68.5 (38–88)	66.0 (49–86)	65.0 (46–84)	0.81
Sex (male:female)	15:9	19:8	12: 9	0.63
Body mass index (kg/m^2)	21.1 (17.2–24.4)	21.3 (16.6–25.0)	21.2 (16.5–25.0)	0.65
ASA (I:II:III)	11:13:0	7:14:6	7:12:2	0.16
Tumor location (middle third:lower third)	17:7	16:11	7:14	0.04
		0.38*	0.012*	
pStage (IA/IB/II)	21:1:2	23:2:2	19:2:0	0.70

*P value versus LADG

Table 2 Surgical factors

	LADG group (n =2 4)	ML group (n = 27)	MLLA group (n = 21)	*P*
Length of incision (cm)	5 (4–6)	7 (6–7) <0.01*	7 (6–7) <0.01*	<0.01
Type of reconstruction (Billroth I : Roux-en-Y)	18:6	27:0	21:0	<0.01
Duration of surgery (min)	252.5 (185–315)	145.0 (105–170) <0.01*	140 (115–190) <0.01*	<0.01
Blood loss (ml)	50 (0–240)	160 (25–520) <0.01*	130 (30–320) <0.05*	<0.01
Lymph node dissection (D + α:D1 + β)	11:13	20:7 0.04*	8:13 0.60*	0.04
Number of lymph nodes harvested	26.5 (9–54)	20.0 (8–51) NS*	31 (10–64) NS*	<0.01

**P* value versus LADG, NS: not significant

ANOVA). A Dunnett's test showed that the duration of surgery was significantly longer in the LADG group than in the other two groups ($P < 0.01$), while the blood loss was significantly less in the LGDG group than in the other two groups ($P < 0.01$). The percentage of patients who underwent a D1 + β lymph node dissection was significantly highest in the LADG group and lowest in the ML group ($P = 0.04$). The number of harvested lymph nodes significantly differed among the three groups ($P < 0.01$), but no significant difference was found between the LADG group and the other two groups (Table 2). In terms of postoperative complications, two patients in the LADG group developed urinary complications (Clavien-Dindo classification I and II). In the ML group, one patient each developed wound infection (Clavien-Dindo classification I), enteritis, or an anastomotic ulcer (Clavien-Dindo classification II). In the MLLA group, one patient each developed wound infection (Clavien-Dindo classification I) or an intra-abdominal hematoma. The latter patient underwent a re-operation through the minilaparotomy wound (Clavien-Dindo classification IIIb; Table 3). No significant differences in the frequency of postoperative complications were observed among the three groups. Postoperative changes in the WBC counts and the serum levels of CRP are shown in Table 4. The WBC counts and the serum C-reactive protein level were significantly lower in the LADG group than in the ML group ($P < 0.01$, 0.05, Dunnett's test followed by ANOVA). The WBC and the serum levels of CRP on POD 4 and 7 did not differ significantly among the three groups. No significant differences in the time until flatus, the time until the intake of solid food, and postoperative analgesic use were observed (Table 5).

Discussion

We have clearly shown that the three different procedures were almost similar in terms of clinical outcome and the laboratory data that is usually used as parameters for evaluating the degree of minimal invasiveness, even though the operative time was significantly longer and the blood loss was significantly less following an LADG, compared with the other two approaches. In other words, this study suggests that ML and MLLA seem to have an invasiveness that is identical to that of LADG when

Table 3 Postoperative complications according to the Clavien-Dindo classification

Clavien-Dindo classification	LADG group (n = 24)	ML group (n = 27)	MLLA group (n = 21)	*P*
I				
Wound infection		1	1	
Urinary retention	1			
II				
Urinary infection	1			
Enteritis		1		
Anastomostic ulcer		1		
IIIb				
Intra-abdominal hematoma			1	
Total	2	3	2	0.97

Table 4 Postoperative changes in white blood cell (WBC) counts and serum levels of C-reactive protein (CRP)

	LADG group (n = 24)	ML group (n = 27)	MLLA group (n = 21)	*P*
WBC POD1 (/μL)	9050 (6500–13900)	10700 (5700–20400) <0.01*	9900 (5600–11900) NS*	<0.01
WBC POD4 (/μL)	5850 (4000–17900)	5300 (3300–10400)	6100 (3200–10700)	0.67
WBC POD7 (/μL)	6100 (3800–10900)	6300 (3000–12000)	6100 (2000–11400)	0.59
CRP POD1 (mg/dL)	5.6 (2.4–9.4)	6.8 (2.5–11.4) <0.05*	6.7 (3.2–12.6) NS	0.04
CRP POD4 (mg/dL)	3.2 (1.1–16.0)	6.8 (1.7–18.6)	5.9 (2.6–13.6)	0.1
CRP POD7 (mg/dL)	1.5 (0.3–11.4)	2.4 (0.1–19.9)	2.0 (0.2–6.9)	0.23

**P* value versus LADG, NS: not significant

used for an oncologic distal gastrectomy for early gastric cancer.

A gasless approach (abdominal wall lifting) has been introduced as an alternative approach to a laparoscopic-assisted standard approach in the past. Nowadays, this approach is rarely performed because of the improvement in laparoscopic instrumentation and surgical skills. We have performed curative colectomy for colon cancer using an ML (skin incision, <7 cm) as the surgical approach of first choice since September 2000.[8,15,16] Based on this abundant experience, we have come to think of distal gastrectomy via ML as an original procedure. In addition, as laparoscopy is useful to perform lymph node dissection and exfoliation through a small incision, we have gradually and naturally evolved from a pure ML to MLLA. During the same period, LADG itself began to emerge gradually, and our surgical team trained hard to obtain sufficient skills to perform LADG. As a result, LADG became a standard procedure during the latter half of the study period.

The present study had some limitations. Some variation in background factors, such as surgical procedures, surgical team, tumor location, node dissection, reconstruction method, etc., are obvious, and the patient analysis was limited to a small number of patients from a single institution. However, we believe that the parameters used for this study are relatively common and objective enough to evaluate postoperative surgical stress, and our results are highly suggestive for the determination of surgical stress among different approaches.

We have previously reported that a distal gastrectomy via an ML seems to be a feasible, safe, and favorable procedure.[9] This study setting was based on nonoverweight patients (BMI $\leq$ 25 kg/m^2) with a Japanese Classification of N0 or N1. While this setting is clearly limited, it was selected for two reasons. First, previous papers have concluded that the difficulty in performing LADG depends on the BMI, so we selected a BMI of less than 25 kg/m^2 as a patient selection. Noshiro *et al*[19] and Kim *et al*[20] reported that a laparoscopic-assisted distal gastrectomy for early gastric cancer in patients with an elevated BMI ($\geq$24.2 kg/m^2 or $\geq$23 kg/m^2) required a significantly longer operative time, compared with those with a lower BMI. Second, since our gastrectomy with ML technique was based on our experience performing curative colectomies via ML, it was necessary for us to unify the surgical difficulty of the colectomy and the gastrectomy. The largest difference between these two procedures arises from anatomic differences. A colectomy can be done almost straightforwardly by pulling the organ outside of the incision. However, the stomach does not have the same mobility, and the procedure must often be performed three-dimensionally inside the abdominal space. Thus, patients with early gastric cancers requiring limited node dissection were candidates.

With the advance of laparoscopic devices and development of more sophisticated surgical skills, laparoscopic approaches are now more safe and

Table 5 Postoperative recovery and analgesic use

	LADG group (n = 24)	ML group (n = 27)	MLLA group (n = 21)	*P*
First pass of flatus (days)	1 (0–3)	2 (1–4)	1 (1–7)	0.21
Start of solid foods (days)	5 (5–8)	5 (5–9)	5 (5–7)	0.23
Use of pentazocine (15 mg, i.m.)	1 (0–4)	1 (0–9)	1 (0–6)	0.59

**P* value versus LADG, NS: not significant

easy than ever before, even with patients with a BMI of more than 25 kg/m^2 and those who require a wide regional lymph node dissection.[21–23] Also, the operative time is shortened, and the wound incision is smaller.[24–26] This procedure can be improved even further. On the contrary, ML has some limitations with regard to surgical maneuvers. Even with the use of laparoscopy, surgical maneuvers near the celiac axis remain difficult, as they must be performed deep inside the abdominal cavity and the window size for access is limited in an ML. Therefore, further improvement is unlikely because of the distinctive features of a gastrectomy.

Laparoscopic-assisted surgery requires well-trained surgeons, newly devised instruments, and last, but not least, a number of skilled hands, and not all institutions can satisfactorily meet the needs of laparoscopic-assisted surgery. Moreover, the present health insurance system is unlikely to cover all the expenses associated with laparoscopic surgery. Therefore, in conjunction with the results of our study, ML should be considered as minimally invasive alternative to LADG.

In conclusion, we have demonstrated that the three different surgical approaches seem to be almost identical in terms of surgical stress. The laparoscopic-assisted approach will undoubtedly continue to be the gold standard of minimally invasive surgical procedures for gastric cancer. However, we believe that ML is a valid alternative procedure when LADG is not available.

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